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***We can only see a short distance ahead,  
but we can see plenty  
there that needs to be done.***

Alan Turing

**Special Issue on Business Intelligence and Semantic Web**

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## Challenges In Cloud Computing

### Automation

- How long to deploy an application?
- What version do I use?
- How do I upgrade applications?

### Portability

- How do I change providers?
- What is being used?
- How much does it cost?

### Auto-Scaling

- Can my application auto-scale?
- How do I configure auto-scaling?

### Disaster Recovery Planning

- Can my application tolerate faults?
- How do I recover my system?

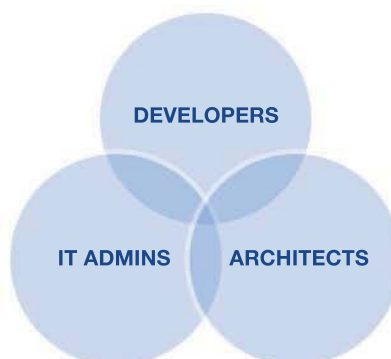
## ElasticBox Solution

### Automation

- ✓ Automatic Deployments
- ✓ Automatic Configuration
- ✓ Disaster Recovery

### Runtime Environment

- ✓ Application Scaling
- ✓ Fault Tolerance
- ✓ Resource Clean-up
- ✓ Replication



### Framework Design

- ✓ Architecture Policies
- ✓ Versioning
- ✓ Platform Management

### Infrastructure Control

- ✓ Cost Analysis
- ✓ Policy Management
- ✓ Traceability



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SPECIAL ISSUE ON BUSINESS INTELLIGENCE AND SEMANTIC WEB

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# Editor's Note

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## THE IMPACT OF BUSINESS INTELLIGENCE TECHNOLOGIES

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The key concept of "business intelligence" surround a set of techniques, procedures and tools focused to achieve competitive advantages in enterprises. Latest business intelligence technologies put forward new theories that prove the use of BI on core value-adding processes can directly improve business performance and value creation. These theories cover the design and implementation of infrastructure, processes, and best practices for warehousing, integrating, reporting, and analyzing business information. Following these theories, the leading research companies in business intelligence offers a broad portfolio of tools and applications designed to help companies to optimize business performance by connecting people, information, and businesses across complex business networks.

Currently research studies discover new scenarios of successful BI integrations using semantic web technologies in order to help to deploy business intelligence applications that allowed companies to manage revenue delivery and reduce costs. With the advance of the Semantic Web and its related technologies, many novel solutions are proposed to turn raw data into usable knowledge and allow the information to be shared and reused across application, enterprise, and community boundaries. This trend make traditional information systems facing new challenges to be intelligent by building and consuming the explicit semantics of the heterogeneous source data. The underpinning standards and programming environments are already in place to be used by scientists and engineers in constructing the next generation intelligent systems. Research and development, ranging from strategies, technologies, frameworks to tools, are required to make the behaviour of information discovery, classification, and interpretation with semantic intelligence.

Following the new wave of these theories, we have decided create this special issue that is focused mainly in three areas: business intelligence, semantic web mining and BI interactive interfaces. Most relevant research studies and IT business cases received has been selected and published.

We hope receive more contributions from IA and multimedia researchers, in order to open and extend future next issues of the journal.

Finally, we would like to thank all unselfish contributions made by the members of editor's council.

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## WELCOME TO NEW MEMBERS

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We are pleased to welcome two new members to our Editorial Board:



**Dr. Lei Shu** is a currently Specially Assigned Research Fellow in Department of Multimedia Engineering, Graduate School of Information Science and Technology, Osaka University, Japan, with Prof. Shojiro Nishio and Prof. Takahiro Hara, and was a Research Scientist in the Digital Enterprise Research Institute (DERI), at the National University of Ireland, Galway (NUIG), with Prof.

Manfred Hauswirth. He received the B.Sc. degree in Computer Science from South Central University for Nationalities, China, 2002, and the M.Sc. degree in Computer Engineering from Kyung Hee University, Korea, 2005, and the PhD degree in Digital Enterprise Research Institute, NUIG, in 2010. He has published over 70 papers in related conferences, journals, and books, including around 40 papers during the PhD course, 3 of his published papers are further published as breaking news, and 1 of his papers is further published by ZDNet.com and silicon.com as white paper. He has already built up various collaborations with more than 300 researchers, including more than 90 co-authors. He has been awarded the MASS 2009 IEEE TCs Travel Grant and the Outstanding Leadership Award of EUC 2009 as Publicity Chair. He has taken part in a number of projects: Integrating Heterogeneous Sensor Networks into One, CAMUS: Context-Aware Middleware for Ubiquitous Computing Systems, Sensor OS, GSN: Global Sensor Network Middleware for Interconnecting Heterogeneous Sensing Systems, and Semantic Reality. He has implemented a new open source wireless sensor networks simulator & visualizer: NetTopo, which has more than 60 international users. His research interests include semantic sensor networks, wireless sensor network, context aware and sensor network middleware.



**Dr. Ke Ning** is a Research Manager at DERI/CIMRU, National University of Ireland, Galway. His research interests include Computer Integrated Manufacturing System, Business Process Modelling, Semantic Web Technologies, collaborative Working Environment (CWE), Context-aware computing. He has published about 30 papers on these areas. He joined DERI as a post-doc researcher in

February 2006. Before that he was an IT-Specialist at IBM china. He received his Ph.D on Enterprise Informatics from Tsinghua University, Beijing, China in 2004.



**Dr. JianQiang Li** received the B.S. degree in mechatronics from Beijing Institute of Technology, Beijing, China, in 1996, the MS and PhD degree in control science and engineering from Tsinghua University, China in 2003. He joined NEC Labs China in 2005 as a research staff. Before that, he worked as a Senior Researcher for one year at the Digital Enterprise Research Institute in Galway,

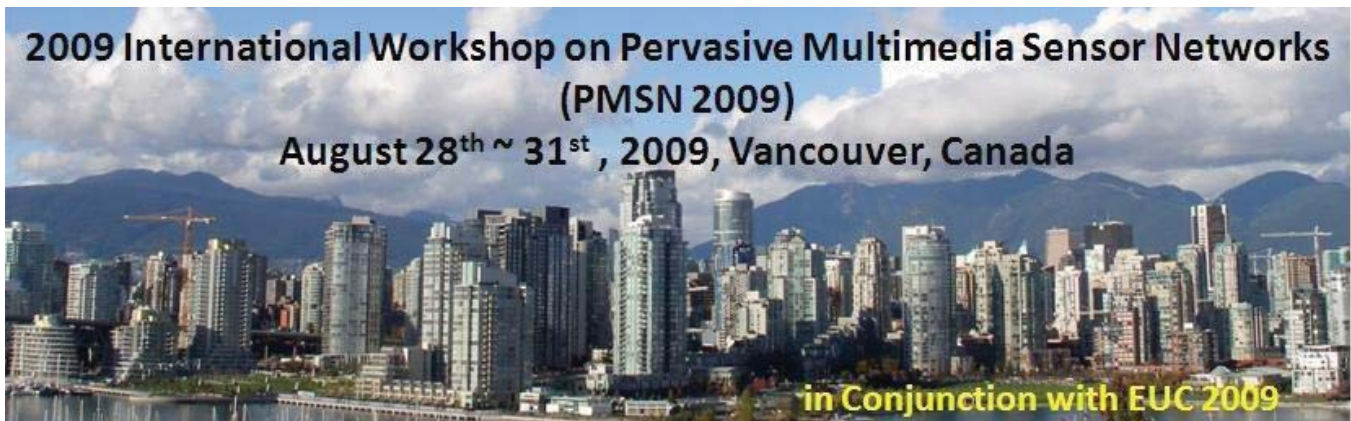
Ireland. His research interests included Web mining, Semantic Web, ubiquitous computing, and business intelligence. He published more than 20 research papers in journals and conferences, issued 10 patents and patents pending, and co-authored a book entitled *Enterprise Integration and Enterprise Integration Platform*. He has been acting as a reviewer for IEEE Transaction on SMC A/B/C and IEEE Transaction on Automatic Control.

## Relevant conferences and workshops – Year 2009



The first workshop on “Real-Time Business Intelligence” (RTBI’09), co-located with APWEB/WAIM 2009 conference, focuses on the challenges associated with the modeling, architectural designs, technologies, and applications for real-time BI. As one of the most critical tools in obtaining competitive advantage (and thus surviving) in the business world, real-time business intelligence is one of the key driving forces in IT investments.

Reliable and real-time collection of business intelligence requires co-operation of the many loosely-coupled components of the IT infrastructure of an enterprise. Consequently, as these infrastructures become more complex and as the data sizes get closer to the petabyte levels, designing and deploying real-time business intelligence solutions is becoming a real challenge. In this workshop, we would like to explore alternative solutions to the imminent "scalability" problem in real-time business intelligence.



The 2009 International Workshop on Pervasive Multimedia Sensor Networks (PMSN’09) will be held in conjunction with the 7th IEEE/IFIP International Conference on Embedded and Ubiquitous Computing (EUC-09), August 29th-31st, 2009, Vancouver, Canada.

Having the development of low-cost imaging sensors, CMOS cameras, sensitive microphones, PMSN have been proposed and drawn lots of attention from the research community. PMSN are a new and emerging type of sensor network that contains sensor nodes equipped with cameras, microphones, and other sensors producing multimedia content. These networks have the potential to enable a large class of applications ranging from assisting elderly in public spaces to border protection that benefit from the use of numerous sensor nodes that deliver multimedia content, e.g., multimedia surveillance networks, target tracking, environmental monitoring, and traffic management systems. PMSNs require effective harvesting and communication of event features in the form of multimedia such as audio, image, and video. Comparing with traditional wireless sensor networks, a lot of new challenges are faced by PMSNs, e.g., energy efficient multimedia processing and communication, heterogeneous multimedia reliability definitions, tight QoS expectations, and high bandwidth demands. This workshop is intended to provide a forum for presenting, exchanging and discussing the most recent advances in different aspects of pervasive multimedia sensor networks and applications. In particular, this workshop will bring together leading researchers, industry professionals, and research students to study the special problems and challenges of multimedia mobile and wireless environments.

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# Prospecting the future with AI

Dr. Jose Miguel Castillo, Conchi Cortes, Julian Gonzalez and Armando Benito.

Information Systems Division. EUVE Tech. Center

**Abstract** — If we were able to foresee the future, we could be prepared to reduce the impact of bad situations as well as getting the most of profiting periods. Our world is a dynamic system that evolves as time goes by. The number of variables that can influence in future situations outnumbers our capacity of prediction at a first glance. This article will show an alternative way to foresee potential future scenarios based on human experts' opinion, what can be considered as a knowledge modeling tool.

**Keywords** — MAS, Prevention, Prospective, Scenarios.

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## I. INTRODUCTION

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THIS article presents a solution to model human expert's opinion with the aim of generating future and possible scenarios. Although the problem of foreseeing the future is common to any area, an urgent solution is required to those with have critical social repercussions. Fields like national security, demography or economy are examples of areas in which Prospective techniques are applicable.

The goal of our current research is to obtain an applicable technology which enables us to be aware of possible critical scenarios before they actually materialize, allowing us to analyse them and come up with appropriate risk mitigation strategies. The project includes the application of a specific methodology [5] to foresee possible future scenarios of crisis based on the opinion of human experts and the development of multi-agent systems (MAS) [13] to automate the creation of such scenarios. Getting results in this field will enable the achievement of a new technology, and also a suitable methodology for the development of automated environments for the prevention of scenarios of crisis.

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## II. FORESEEING THE FUTURE

---

Before facing a future scenario, the first and fundamental phase is to foresee it. It is better to be prepared for future scenarios rather than suffer their consequences. After figuring out the possible future scenario of crisis, the second phase consists of analyzing all elements or factors which should be modified in order to avoid the scenario to materialize.

The scenarios of crisis are mainly created inside a social environment. A social environment evolves as a dynamic system, with phases of stability, instability, or even worse, of a chaotic nature. The creation of future scenarios based on stable dynamic systems uses classical techniques like Prediction or Projection in which tendencies of historical data are applied. However, inside the field of security it is hard to meet a stable dynamic system which generates

scenarios based on predictable guidelines. The collapse of transports, the economic crisis, natural disasters and terrorist attacks are just a few of many examples of scenarios of crisis which are difficult to estimate with techniques based upon Prediction and Projection. Normally, the scenarios of crisis are born due to an accumulation of events that would otherwise be ineffective in isolation; however when occurring together they create an unsustainable and critical scenario.

From a conceptual point of view, our research is going to be developed under Prospective proceedings (instead of Prediction and Projection). The final aim is to develop a technology which is able to identify and alert on the generation of possible social scenarios of risk or crisis.

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## III. PROSPECTIVE TECHNIQUES

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Nowadays, the current use of Prospective is more related to the field of social sciences. Prospective tries to create an image of the future, reducing the consideration of the past, but never actually forgetting it. The prospective methods which correspond to an imaginative and intuitive exploration of the future, lie on structural premises based on the past but open constantly to changes [8]. Consequently, the opinion of groups of experts is used for the creation of future scenarios.

The classical prospective method would consist of [3]:

- Submission of a questionnaire to the expert group to grade the probability of each event.
- Achievement of the common criterion of the group by using the Delphi method.
- Use of the cross impact technique to modify the conditional probability of each event.
- Elaboration of the cross impact technique to obtain the most probable scenarios
- Strategic interpretation of the most probable scenarios.

Initially, a group of analysts select the area of study and identify a list of possible events related to a future scenario.

After listing the events linked to a scenario, a human expert group has to research the influence that each event has on the others. This enables a more thorough study in terms of probabilities. The Delphi method [6] is used to bring the group to a common conclusion. Since the events probabilities are not isolated, the Bayes theorem has to be applied to obtain conditional probabilities. After that, the analysts group has to produce a set of scenarios with their consequent probabilities. Of course, it is assumed that the probability of all possible scenarios is equal to 100%. Those scenarios with higher probability will be chosen for a detailed sensitive analysis. We can follow a similar process



in analysing different contexts, like those related to banking, commerce, military operations, industry, disruptive technologies, etc.

After the application of the method we obtain a matrix with future scenarios graded by their probabilities.

The following figure shows an example of a matrix with ten possible scenarios. In the first column the events that can be involved in the scenario are listed. In the bottom line the probability for such scenarios to happen is given.

Ev	Sc1	Sc2	Sc3	Sc4	Sc5	Sc6	Sc7	Sc8	Sc9	Sc10
1										
2										
3										
4										
5										
6										
7										
8										
Prob	6.77	3.22	2.87	2.79	2.78	2.55	2.21	2.20	2.13	1.44

Cells in grey: the event doesn't exit

Figure 1. Example of a matrix with probable scenarios

IV. A MAS-ORIENTED ARCHITECTURE APPROACH

In this section, we illustrate our Multi-Agent System approach within this class of domains. The objective consists of the construction of a model that faces the problem from a different perspective from the classical statistical prospective methods exposed in the previous section. We use possibilities graded by linguistic tags instead of probabilities, we take a different track towards the problem compared to classical methods.

Each agent of the MAS has been developed to carry out a specific function; all of them are based on Artificial Intelligence procedures [12] [14]. Taking into account the final objectives of the prospective technique (envisioning future scenarios and possibility of modification of those that can be critical); and on the other hand, the technological advantages of using a MAS-oriented architecture, we can summarise the knowledge extraction and knowledge exploitation as follows:

-Submission of a questionnaire to the expert group to grade the possibility of each event expressed with linguistic tags.

-Achievement of the common criterion of the group by using fuzzy logic procedures and generation of the set of most possible scenarios.

-Submission of a questionnaire to the expert group to grade the possible results of the most possible scenarios.

-Introduction of a real scenario and declaration of the general variables: intensity of migrations and level of social stability.

-In case of an undesired result, introduction of the desired variables and activation of the analyser Agent to look for the events that have to be influenced or modified.

From a methodological point of view to get to a solution with MAS, we have implemented a number of phases, as follows [5]:

A. Statement of the Problem

Our purpose is to construct a planning system based on MAS, with capacity to generate future scenarios by using prospective methods. Thus, this new approach helps us overcome the limitations and criticism pertinent to the classical Prospective technique [10].

B. Establishing the System Limits

An expert group will be in charge of defining the events that belong to a specific scenario. By applying fuzzy logic procedures, linguistic tags can be defined in order to identify each event's intensity. The system will yield a scenario as a result of such events.

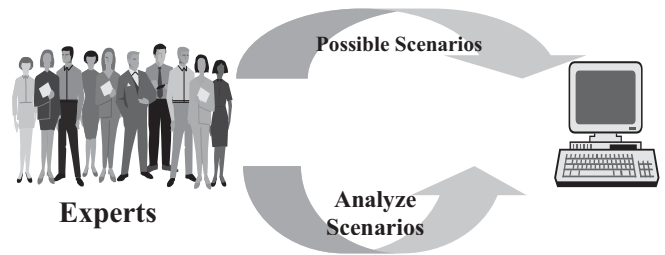


Figure 2. Knowledge extraction

C. Objectives Identification

The objectives that we are pursuing are summarised as follows:

-To provide a scenario as a result of the set of events and their intensities as given by the expert group.

-To perform a sensitive analysis in order to determine which events can have a major influence on the scenario and how to obtain an ideal scenario by changing as few events as possible.

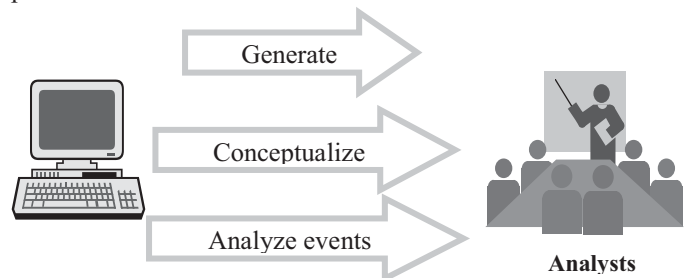


Figure 3. Knowledge exploitation

D. Data identification

The input of our planning system will be the set of events for a specific situation. These events will be graded for their relevance. The input will be provided by a group of strategic analysts.

The output of our planning system will be the global description of a scenario composed by several items and their corresponding relevancies. They will be defined by using linguistic tag variables [17].

Initially the output that matches a specific set of events will also be defined by the group of analysts.

The user could define an ideal scenario by modifying the relevance of the scenario items. The planning system will

respond with a list of possible solutions by describing the events to be modified.

E. Rules Identification

We can identify two main processes in this MAS model:

- Matching events and their relevancies to scenarios defined by items and their intensities.
- Prospecting the range of possible events we can modify in order to obtain the ideal scenario.

F. Selection of Agents

We have used a neuro-fuzzy network [9] [17] aimed at reproducing human knowledge and experience in order to create a scenario by studying the influence among events. Thus, we talk about possibilities instead of probabilities and avoid using complex probabilistic techniques which are in most cases unclear for the human expert group.

We have implemented an intelligent search to make the sensitive analysis of variables (events) that can help us to arrive at an ideal scenario.

G. Model Building

We have built two agents in the MAS-oriented model: the Classifier agent and the Analyser agent. *The first one* will obtain the scenario after analysing the proposed events.

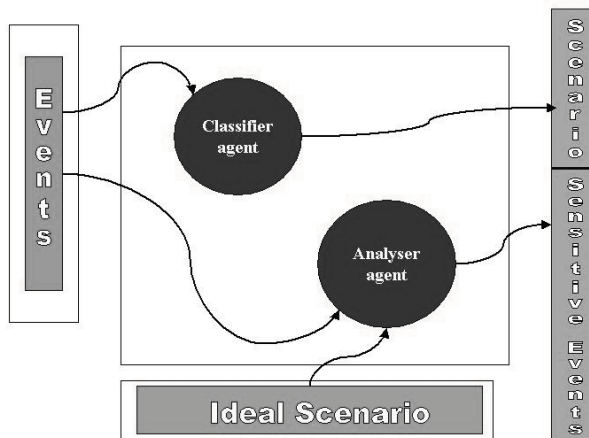


Figure 4. Strategic Planning Model

The process would be as follows:

The group of strategic analysts proposes different sets of events to the expert group. Each produced scenario will represent a global state as a result of the influence of the events. This state will be defined by the expert group.

The knowledge extracted from the expert group will be used to train the Classifier Agent. Once the Classifier Agent has been trained, it can be used to generate new scenarios by presenting it with a set of events never used in the training phase. Thus, the knowledge of the expert group has been transferred to the Classifier Agent.

It has been necessary to develop the classifier agent by means of fuzzy logic, since most of the times we express data in terms of adjectives. It is very common to define the relevance of the events or objectives in terms of linguistic

tags. In this environment, Fuzzy Logic [15] provides a set of powerful tools.

The *second agent* is useful in determining which events can be influenced by us in order to arrive to the desired scenario.

It is possible that the scenario doesn't match our expectations. In this case, the Analyser Agent is responsible for looking for the events which are to be influenced in order to get closer to an ideal scenario.

We have used intelligent search as an Artificial Intelligence procedure to construct the Analyser Agent.

In Figure 4, we can observe the inputs to the model, the Agents we have designed to build the model, and the results we can obtain after its use. The model can be used for two purposes: to obtain a scenario as a result of the events, or to present an ideal scenario and look for the events that we have to influence in order to obtain such scenario.

In summary, the Classifier Agent receives the events and yields a scenario, while the Analyser Agent receives an ideal scenario and the original set of events and provides the list of events to be modified in order to obtain the ideal scenario.

V. A CASE STUDY FOR SOCIAL STABILITY

As a result of the application of the MAS-oriented model, we have developed a software prototype to validate the model in a real prospective problem. The prototype can be used to accomplish three different objectives: to produce the most possible scenarios, to foresee the result of a specific scenario, and finally to analyse which events should be modified to get an ideal scenario.

As an example, we are going to solve a strategic planning problem that deals with the future migratory movement in central Europe. The events and scenarios are fictitious. We want to know the possible influence of a set of events to create a political and social scenario.

The events are:

- 1-Higher restriction to obtain the nationality in the EC
- 2-Eastern Europe countries are accepted in the EC
- 3-Racial riots happen in European Cities
- 4-Worldwide financial crisis
- 5-Negative birth rate in Europe
- 6-Strong epidemic in Africa
- 7-European measures to support African economies
- 8-Economic instability in Russia

With the use of the software prototype we can get the following:

- Set of the most possible scenarios.
- Consequences of the most possible scenarios regarding two general variables: intensity of migrations and level of social stability.
- Introduction of an ideal scenario.
- Events that should be influenced or modified to obtain the ideal scenario.

A group of strategic analysts have created a set of ten questionnaires to be studied by the expert group, who have to qualify them with adjectives like 'Very possible, Possible, Not possible'.

Ev	Sc1	Sc2	Sc3	Sc4	Sc5	Sc6	Sc7	Sc8	Sc9	Sc10
1										
2										
3										
4										
5										
6										
7										
8										
VP,P,NP										

Cells in grey: the event doesn't exit

Figure 5. Possible events questionnaire

The answers from the expert group are treated with fuzzy logic procedures. The extracted knowledge is fed into the Classifier Agents. The software prototype is ready to be used. It yields the list of the most possible scenarios. The prototype found a total of 49 highly possible scenarios that can be displayed or printed. The group of strategic analysts has to decide whether to choose all of them or whether to choose only the most relevant. The group decides that the scenario in which all events are present has to be analysed in depth (Sc1). The analysts submit a new questionnaire to the expert group with ten possible scenarios. They will grade the possible results in terms of intensity of migrations and level of social stability.

Ev	Sc1	Sc2	Sc3	Sc4	Sc5	Sc6	Sc7	Sc8	Sc9	Sc10
1	H	M	L	H	H	H	M	M	L	L
2	H	H	H	L	M	M	H	M	H	H
3	H	H	M	H	M	M	M	H	L	H
4	H	H	H	H	M	M	L	H	L	H
5	H	B	H	L	H	M	M	M	H	L
6	H	H	L	H	M	L	M	H	M	L
7	H	H	H	H	H	M	H	M	M	H
8	H	H	H	H	M	L	L	H	L	H
Migration										
S. Stabili										

H=High; M=Medium; L=Low

Figure 6. Possible scenario questionnaire

The answer of the expert group is treated with fuzzy logic procedures, and again the extracted knowledge is forwarded to the Classifier Agents. Once the events that belong to the scenario are defined, the group of strategic analysts presents one situation which is the most possible or perhaps the one which will result in the worst case scenario. Inputs are introduced in the prototype.

Eventos	Influencia
Higher restriction to obtain the nationality in the EC	Medium
Eastern Europe countries are accepted in EC	High
Racial riots happen in European Cities	High
Worldwide financial crisis	High
Negative birth rate in Europe	Low
Strong epidemic in Africa	High
European measures to support African economies	High
Economic instability in Russia	High

Figure 7. Possible events

The classifier agent will produce a global scenario definition in terms of intensity of migrations and level of social stability.

Escenas	Intensidad
INTENSITY OF MIGRATIONS	Medium
LEVEL OF SOCIAL STABILITY	Low

Figure 8. Expected scenario

The group of strategic analysts decides that it is dangerous to permit the creation of a social environment with a low level of social stability, so they introduce an ideal scenario with the intention of knowing the events that should be modified.

Escenas	Intensidad
INTENSITY OF MIGRATIONS	Medium
LEVEL OF SOCIAL STABILITY	Medium

Figure 9. Ideal scenario

The prototype has generated a great number of solutions in a short period of time. The solutions are sorted and listed according to the number of events to be modified.

	Descripción del evento a modificar.	Grado de Influencia.
Solución. 1...		
	Strong epidemic in Africa	Low
Solución. 2...		
	Higher restriction to obtain the nationality in the EC	Low
	Negative birth rate in Europe	High
Solución. 3...		
	Higher restriction to obtain the nationality in the EC	Low
	Negative birth rate in Europe	Medium
Solución. 4...		
	Higher restriction to obtain the nationality in the EC	High
	Strong epidemic in Africa	Low

Figure 10. Events to modify

In summary, given a specific set of events that are considered as most possible, we have obtained a scenario in which social stability is low. To get a medium level of social stability we should act according to one of the solutions generated by the prototype (e.g. to reduce the possibility of 'a strong epidemic in Africa').

## VI. RELATED WORKS

The problem that we address consists of the construction of agent-based models to solve a specific operational problem such as foreseeing future undesired social scenarios. We tackle this problem with a methodological approach, with the aim of preventing undesired future scenarios from happening. Consequently, the two main fields that are related to this paper are: MAS-oriented architectures and Prospective planning methods

The concept of agent generation is not new and has been addressed in many publications such as in [11], [16] and [7]. Agents have to be constructed under a specific objective. There are many papers related to methodologies in this field; however, most of them are targeted at obtaining efficient communication among agents as in [1], [2] and [4]. This

paper tackles the specific construction of MAS-oriented models to solve strategic planning problems in the field of security. Prospective is a well-known technique based on statistical methods, as described in [8] and [3]. In this work a new solution is given on the basis of a MAS-oriented architecture. The model is built by using a methodological approach [5].

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## VII. FUTURE WORKS

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In order to validate the architecture and new approach showed in this article, in 2010 we are going to develop some prospective studies together with the Spanish Institute of Strategic Studies. The initial scenarios on which we are going to work are:

- The strategic and political future of Afghanistan
- The future of the North Atlantic Treaty Organization
- Policy and Security in the European Union

The results in these areas will be published at the end of 2010. We are also planning to present a large scale European Project under the FP7 to validate the concept of MAS-oriented architectures for prospecting in field of security.

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## VIII. CONCLUSION

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In this article we have presented the idea of Prospective as a useful tool to envisage future and possible scenarios of crisis or risk. We have illustrated the use of Prospective in domains where decisions with long-term impacts need to be taken. One of the most important advantages that this work can offer is the possibility of foreseeing future scenarios with computer aided control. This characteristic implies the automatic reorganization in real time if the scenario changes or new biased events show up unexpectedly as time goes by. Furthermore, by comparing our work with classical methods, we found the following advantages:

- A natural use of linguistic tags instead of probability to define the possibility or intensity of events.
- The achievement of a common criterion of the expert group without using the Delphi method.
- The use of the concept of scenario implications expressed with global variables.
- A Sensitivity analysis of the events that should be modified in order to obtain an ideal scenario.

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## REFERENCES

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- [1] Aarsten, A., Brugali, D. y Vlad, C. (1996). Cooperating Among Autonomous Agents, Proceedings of the 4th International Conference on Control, Automation, Robotics, and Vision. Singapore
- [2] Agre y Rosenschein (1996). Computational Theories of Interaction and Agency, MIT Press,
- [3] Bas, E. (1999). Prospectiva. Cómo usar el pensamiento sobre el futuro. Ariel

- [4] Bradshaw, J. M., (1996). KAoS: An Open Agent Architecture Supporting Reuse, Interoperability, and Extensibility. Knowledge Acquisition Workshop (KAW)
- [5] Castillo, J.M., Ossowski, S., Pastor, L., (2006); Planning Projects: A new approach through MECIMPLAN. Proc. of the IADIS Int. Conf. on e-Society. Dublin (Ireland).
- [6] Dalkey, N.C. (1975). Méthode Delphi. Dunod.
- [7] Durfee, E. ; Cox, J. et ali. (2001). Integrating Multiagent Coordination with Reactive Plan Execution. Proceedings of the ACM Conference on Autonomous Agents (Agents-01), pages 149-150, June.
- [8] Godet, M. (1993). De l'anticipation à l'action. Manuel de prospective et de stratégie. Dunod.
- [9] Haykin, Simon, (1999). Neural networks. A comprehensive foundation. Prentice Hall.
- [10] Meadows, D. (1982); Groping in the dark; the first decade of Global Modelling. Bristol, John & Sons.
- [11] Much, Richard et ali (1999). Intelligent Software Agents. Prentice Hall
- [12] Nilsson, Nils J., (1998). Artificial Intelligence: A new synthesis. McGraw Hill.
- [13] Riecken, D., (1994). An architecture of integrated agents. Communications of the ACM, 37(7):107-116
- [14] Russell N., (2003). Artificial Intelligence: A modern approach. Prentice- Hall.
- [15] Sugeno, M., (1985). Industrial applications of fuzzy control. Elsevier Science Pub. Co.
- [16] Wezel, W., (2006). Planning in Intelligent Systems. Wiley
- [17] Zadeh, L.A., (1975). The concept of a linguistic variable and its application to approximate reasoning, Parts 1-3. Information Sciences.

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# Mapping Persian Words to WordNet Synsets

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**Abstract**—Lexical ontologies are one of the main resources for developing natural language processing and semantic web applications. Mapping lexical ontologies of different languages is very important for inter-lingual tasks. On the other hand mapping approaches can be implied to build lexical ontologies for a new language based on pre-existing resources of other languages. In this paper we propose a semantic approach for mapping Persian words to Princeton WordNet Synsets. As there is no lexical ontology for Persian, our approach helps not only in building one for this language but also enables semantic web applications on Persian documents. To do the mapping, we calculate the similarity of Persian words and English synsets using their features such as super-classes and subclasses, domain and related words. Our approach is an improvement of an existing one applying in a new domain, which increases the recall noticeably.

**Keywords**— *Lexical Ontology, Semantic Lexicon, Princeton WordNet, Automatic Mapping.*

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## I. INTRODUCTION

ONTOLOGY is defined as a formal, explicit specifications of a shared conceptualization [1]. In fact, an ontology assembles a shared lexicon for researchers of a specific domain indicating the concepts, relations and rules of domain. Lexical ontologies are ontologies whose concepts are lexicalized in a specific language and has special linguistic relations. Lexical ontologies sometimes called as semantic lexicons are among major conceptual-linguistic resources which are needed in many natural language processing applications especially where semantic processing is focused. Having such resources enables many semantic web and Natural Language Processing (NLP) applications.

One of the most famous semantic lexicons which has been the base for many others is WordNet. WordNet is a lexical ontology based on theories of psycho-linguistics about mental lexicon. WordNet designing was started under supervision of Professor G. A. Miller in the cognitive science laboratory of Princeton University in 1986 and its first version was presented in 1991.

WordNet is a rich computational linguistic resource for Natural Language Processing (NLP) used in Machine Translation, Internet Searches, Document Classification,

Information Retrieval, and many web applications. After presenting English WordNet (Princeton), similar resources have been developed for more than 40 live languages all around the world. One of the main approaches to build a wordnet for a new language is using pre-existing lexical resources of other languages. English WordNet (Princeton WordNet) can help this process as an important lexical resource.

Persian language is the official language of Iran, Tajikistan and Afghanistan. This language with the Indo-Aryan languages constitutes the Indo-Iranian group within the Satem branch of the Indo-European family. The lack of linguistic resources such as lexical ontologies, semantic lexicons, electronic complete Persian thesauri, parallel corpora and even complete computational bilingual dictionaries have been some of the problems encountered in developing Persian NLP systems and spreading semantic web applications.

In this paper we offer an improved methodology for mapping Persian words to English WordNet synsets. To do the mapping, we calculate the similarity of Persian words and English synsets using their features such as super-classes and subclasses, domain and related words. Our approach is an improvement of an existing one [2] applying in a new domain, which increases the recall noticeably. The main resources we exploit for the mapping are an English-Persian dictionary [3] (including 252864 entries), a Persian-Persian dictionary [4] (incl. about 116 thousand entries) and a Persian thesaurus [5] (incl. about 10 thousand entries).

This paper is organized as follows: In Section 2, previous related works are described. Section 3 introduces our suggested approach and Section 4 presents some experimental results. Finally in Section 5 some conclusions and future works are discussed.

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## II. RELATED WORK

A Spanish research group [6] presented a new and robust approach for linking already existing lexical/semantic hierarchies. They applied a constraint satisfaction algorithm (relaxation labeling) to select the best match for a node of hierarchy among all the candidate nodes in the other side. They took advantage of hyperonymy and hyponymy relations in hierarchies. The following year, the same group [7] applied their work on mapping of nominal part of WordNet 1.5 to WordNet 1.6 with a high precision.

A Korean group [8] presented automatic construction of

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Korean WordNet from pre-existing lexical resources in 2000. Six automatic WSD (Word Sense Disambiguation) techniques were used for linking Korean words collected from bilingual MRD (Machine Readable Dictionary) to English WordNet synsets. They used Machine Learning methods to combine these six techniques.

Another group [9] presented observations on structural properties of WordNets of three languages: English, Hindi, and Marathi. They reported their work on linking English, Hindi and Marathi synsets. They proposed a formula for computing the similarities of nodes in two hierarchies.

Farreres [2] proposed a two-phase methodology for mapping Spanish thesaurus to English WordNet. His methodology is structured as a sequence of two processes. The aim of the first process that is based on a work in 1997 [10], is mapping of Spanish words to WordNet synsets. The second process takes advantage of hierarchies to accept or reject associations produced in the first phase.

One of the ways of constructing a WordNet for a certain language (source language) starts by mapping a thesaurus of source language to English (destination language) WordNet. This approach includes two processes. In the first process, words of source language are mapped to WordNet synsets. In the second process, these mappings are accepted or rejected according to the hierarchy of English WordNet and source language thesaurus

In Our work we have improved the first phase of Farreres' work-the most complete work due to 2007- and applied it on Persian language. We will show that our improvements will increment the recall noticeably while saves or also makes the precision a little bit better.

### III. SUGGESTED APPROACH

In the previous section a brief history of related works was presented. Since our approach is an improvement to Farreres' methodology, in this section we explain the first process of his work in parallel with our approach (called SBU methodology) and show the similarities and differences. Our goal is finding the most appropriate synset(s) for mapping Persian words to them. The suggested approach is language independent. It can be applied to any language and we used Persian language as a case study.

This approach takes advantage of some preexisting resources in the source language (Persian) and target language (English). Essential resources are bilingual Persian-English and English-Persian dictionaries, monolingual Persian-Persian dictionary, and English WordNet. We used Aryanpour dictionary as Persian-English and English-Persian dictionary, the Sokhan dictionary as Persian-Persian dictionary and WordNet 2.1.

At the start, for a Persian word PW, we should find its translations in a bilingual dictionary. For English translations (EW) of PW, we find its synsets in WordNet (WNS). As is shown in the Fig. 1, for each PW there are many candidate synsets in WordNet (WNS), the majority of which is not appropriate for PW. So we should specify truth probability of associations between PW and WNSs.

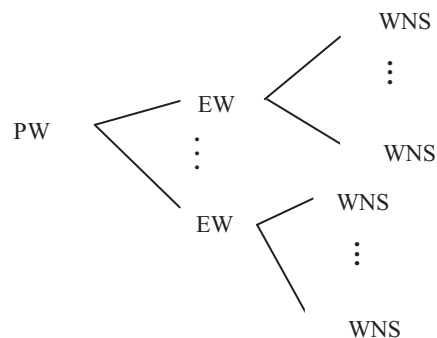


Fig. 1. Candidate WordNet synsets for a Persian word

#### A. Similarity Methods

According to Farreres' classification, similarity factors between PW and WNS are divided into four main groups regarding the kind of knowledge sources involved in the process: Class methods, Structural methods, Conceptual Distance methods and Hybrid methods.

#### Classification Methods

These methods classified Persian words in eight categories depending on its English translations (EWs) and their WordNet synsets (WNSs) for each EW. These methods are divided into two main groups, namely, Monosemous and Polysemous. Our approach is the same as Farreres' methodology in Classification methods.

##### a- Monosemous Group.

English words in this group have only one synset in WordNet. Four Monosemous methods are described below:

Mono1 (1:1): A Persian word has only one English translation. Also the English word has Persian word as its unique translation (Fig. 2).



Fig. 2. Mono1 method

Mono2 (1:N, N>1): A Persian word has more than one English translation. Also each English word has the Persian word as its unique translation (Fig. 3).

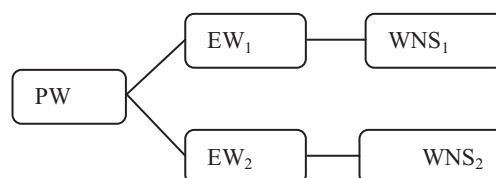


Fig. 3. Mono2 method

Mono3 (N:1, N>1): Several Persian words have the same translation EW. The English word EW has several translations to Persian. (Fig. 4).

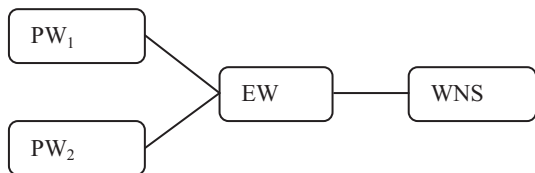


Fig. 4. Mono3 method

Mono4 (M:N, M,N>1): Several Persian words have different translations. English words also have several translations to Persian (Fig. 5). Note that there is at least two Persian words having several common English words.

b- Polysemous Group

English words in this group have several synsets in WordNet. Polysemous methods are like the Monosemous ones. We do not expand them for avoiding repetition.

Structural Methods

These methods are based on the comparison of the taxonomic relations between WordNet synsets. Four methods constituting structural methods are as follows:

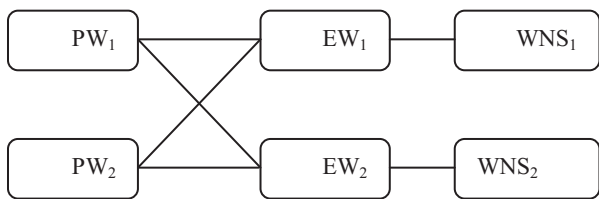


Fig. 5. Mono4 method

a- Intersection Method:

If English words share at least one common synset in WordNet, the probability of associating Persian word to common synsets increases (Fig. 6).

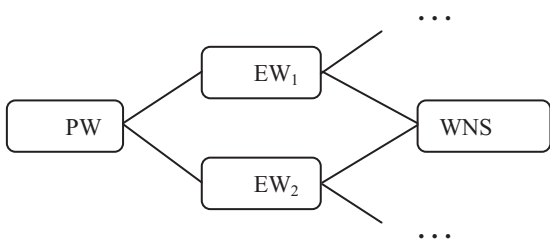


Fig. 6. Intersection method

b- Brother Method:

If some synsets of English words are brothers (they have common father), the probability of associating Persian word to brother synsets increases (Fig. 7).

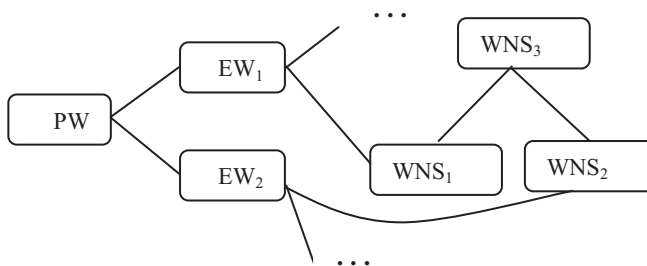


Fig. 7. Brother method

c- Ancestor Method:

If some synsets are ancestors of another synset, the probability of associating the Persian word to hyponym synset increases (Fig. 8).

d- Child Method:

If some synsets are descendants of another synset, the probability of associating Persian word to hyperonym synset increases (Fig. 8).

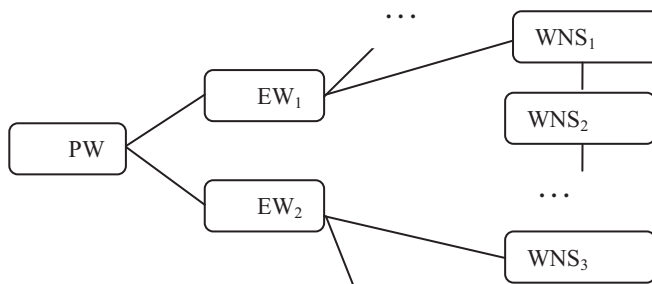


Fig. 8. Ancestor and Children method

Some differences of our approach (SBU) and Farreres' methodology lie in the structural methods. Farreres divided structural methods into Intersection, Brother, Father and Distant Methods. Intersection and Brother are the same as above. Father method is based on immediate hyperonym and Distant method is based on non-immediate hyperonyms. We merged two methods Father and Distant as Ancestor method. We applied Child method in a different way from Father and Distant methods, while in the Farreres' methodology they are not detached. Severance of Ancestor and Child methods causes to lead associations into hyperonym synsets with general meanings or hyponym synsets with specific meanings. This leading is done by means of training phase in machine learning techniques (explained below in Composition of Methods subsection). The mapping system learns which hyperonym or hyponym associations are more important than others in training phase. Then it applies this collected information to automatic computing of correctness probability of each association.

Conceptual Distance Methods

These methods are based on semantic closeness of synsets

in WordNet. There are many formulas computing conceptual distance between two concepts (word or synset). For example, it is defined in [12] as the length of the shortest path between two concepts in a hierarchy [2]. We used the equation 1 [11] for computing semantic similarity.

$$(1) \quad sim(s, t) = \frac{2 * depth(LCA(s, t))}{depth h(s) + depth h(t)}$$

in which  $s$  and  $t$  are the synsets;  $sim(s, t)$  is semantic similarity of  $s$  and  $t$ ;  $depth(x)$  is depth of synset  $x$  regarding the root of WordNet hierarchy (the node "entity" for nouns); and finally  $LCA(s, t)$  is the Least Common Ancestor of synsets  $s$  and  $t$ .  $LCA(s, t)$  is an ancestor of  $s$  and  $t$  which is the deepest one in the WordNet hierarchy.

Two implications of equation 1 are (a) deeper synsets have higher semantic similarity together than the shallow ones and (b) shorter path between  $s$  and  $t$  causes higher semantic similarity. Farreres divided this group into three methods:

#### 1) CD1 Method

This method uses co-occurrent words of Persian word. Following [13] two words are co-occurring in a dictionary if they appear in the same definition [2]. If some synsets of PW are semantically closer to some synsets of co-occurring words, probability of associating Persian word to its closer synsets increases.

#### 2) CD2 Method

This method uses genus word(s) of Persian word. In fact, genus is one of hypernyms of PW. PW is a kind of genus word. If some synsets of PW are semantically closer to some synsets of genus words, probability of associating Persian word to its closer synsets increases. For example, Sokhan dictionary defines the Persian word آواز - avaz (song) as: صدایی که ... - sedayi ke ... (the sound that ...). So the term صدا - seda (sound) is genus of آواز - avaz (song) and آواز - avaz (song) is a kind of صدا - seda (sound).

#### 3) CD3 Method

This method is based on the semantic similarity of candidate synsets of Persian word. If some synsets of PW are semantically closer to all other candidate synsets, probability of associating Persian word to its closer synsets increases.

We considered these three methods in our approach but with two minor modifications. As the first difference, we utilized the words having "related-to" relation with PW instead of co-occurrence relation. We used Fararooy Thesaurus [5] for extracting "related-to" words of PW. Because co-occurrent words could not help us so much disambiguate the PW to find the best association. For example, as for the Persian word استاد - ostad (master), one of co-occurring words is محترم - mohtaram (respectable) because the term استاد محترم - ostade mohtaram (respectable master) is repeated many times in documents and dictionaries. But semantic similarity of these two words is very low. We used the words ماهر - maher (skillful) and آموزگار - amoozgar (instructor) extracted from Fararooy

thesaurus which have "related-to" relation with the Persian word استاد - ostad (master). They have remarkable similarity with the main Persian word and could help disambiguate the meaning of استاد - ostad (master) more precisely.

The second modification is about CD3. We will exemplify to explain the modification. In the Farreres' methodology if two synsets have a brother relation together, value of both brother and CD3 methods becomes 1 for these two synsets, indicating that these synsets are brother and have high semantic similarity (low conceptual distance) since brother relation cause high semantic similarity.

This assignment makes create dependency between methods, while the methods must be independent from each other. According to statistical method Logistic Regression for estimating coefficients (importance) of each method (explained in subsection 3.3), this dependency prevents exact estimation of coefficients.

For this reason we got advantage of CD3 method only for synsets that do not have Brother, Ancestor and Child relations with other synsets. The last improvement of CD methods is using gloss and examples of synsets to achieve more similarities. If English translations of genus word(s) and "related-to" words (and semantic label explained in hybrid methods) occur in glosses or examples of some synsets of PW, the probability of associating Persian word to those synsets increases.

#### Hybrid Methods

In this group, two methods, namely, Variant and Field are presented without relation to other methods.

#### 1) Variant Method

This method seeks WordNet synsets whose words share the same translations in English-Persian dictionary. In the other words, if two or more words of a synset have only one translation for the same Persian word, probability of associating Persian word with that synset increases.

#### 2) Field Method

It uses semantic label(s) of Persian word. This label indicates the domain of Persian word PW and PW is a member of that domain. If some synsets of PW are semantically closer to some synsets of semantic label(s), the probability of associating Persian word with its closer synsets increases.

For example, Sokhan dictionary defines the Persian word اردک - ordak (duck) as: (جانوری پرنده ای که) ... - (janevari) parandeyi ke ... ((animal) a bird that ...), then the term جانوری - janevari (animal) is the semantic label of اردک - ordak (duck).

Now, let us analyze hybrid methods. Variant method is the inverse case of Intersection method in Structural group but Intersection starts from the Persian word to arrive at WordNet synset, while Variant starts from WordNet synset to arrive at Persian word. Here the dependency problem appeared in CD3 method is the same but more obvious than previous case. In the other word, if PW shares its translations in one synset, value of Intersection and Variant methods will be 1. Actually the Intersection and Variant methods are the



same and dependency of these two methods is another drawback of Farreres' methodology. Therefore, we eliminated the Variant method in our approach.

As for Field method, we applied it as a member of conceptual distance methods. Then the name of hybrid methods is deleted in our approach. We mention again that genus and semantic label of a Persian word is extracted from Sokhan dictionary and the "related-to" words are extracted from Fararoy thesaurus.

*B. Presentation of Similarities*

Farreres used the vector (SW-synID,  $m_1, m_2, \dots, m_{17}$ , Accept or Reject) to present associations between Spanish words and WordNet synsets. For example, the vector (SW<sub>1</sub>- 8054099 , 000000101000110 , Reject) indicates, an association between SW<sub>1</sub> and synset with ID 8054099 is rejected.

$m_i$  specifies whether the  $i^{th}$  method can be applied to this association or not. The value 1 indicates that the method is applicable and 0 indicates that it is not applicable to the association. In this example only  $m_7, m_9, m_{13}$  and  $m_{14}$  methods could be applied to this association. The value of  $m_9$  in this example means that at least two English translations of SW<sub>1</sub> are located in the synset with ID 8054099. But there is no difference as to how many translations of Spanish word share the synset. This is another drawback of Farreres' methodology. It means that under the same condition, probability of associating SW with a synset that shares two translations of SW are the same as other synset that shares, say, four translations. This problem recurs in other methods except for classification methods. We solved this problem by using the values 0 to 5 instead of 0 and 1. In other words, two values of 0 to 1 were replaced by six values of 0 to 5. For example, in the Intersection method, depending on the number of English translations of Persian word that share a synset, the values 1, 2 and 3 are assigned to  $m_9$  respectively.

Table 1 compares SBU and Farreres' methodologies regarding the methods used.

As an example to compare two methodologies suppose that PW is included in poly3 method by one of its translations in Classification methods. Consequently  $m_7$  is 1. Four words of its translations share the synset WNS<sub>1</sub>, then the value 1 is assigned to  $m_9$  and  $m_{17}$  in Farreres. But in the SBU, only  $m_9$  is assigned by value 3. This synset does not have brother relation with other candidate synsets, then value of  $m_{10}$  in Farreres and SBU is 0. WNS<sub>1</sub> does not have an immediate hypernym among candidate synsets but two synsets of translations of PW are the second and third level hypernyms of WNS<sub>1</sub>. As a result in Farreres,  $m_{11}$  and  $m_{12}$  get values 0 and 1 respectively and in SBU, only  $m_{11}$  gets the value 2. We considered only five levels of ancestors (and also five levels of children) for a synset. So in this case, value 2 is suitable for  $m_{11}$ .

TABLE 1. COMPARISON OF SBU AND FARRERES' METHODOLOGIES

Method groups		SBU	Farreres
Classification	$m_1$	Mono1	Mono1
	$m_2$	Mono2	Mono2
	$m_3$	Mono3	Mono3
	$m_4$	Mono4	Mono4
	$m_5$	Poly1	Poly1
	$m_6$	Poly2	Poly2
	$m_7$	Poly3	Poly3
	$m_8$	Poly4	Poly4
Structural	$m_9$	Intersection	Intersection
	$m_{10}$	Brother	Brother
	$m_{11}$	Ancestor	Father
	$m_{12}$	Children	Distant
Conceptual Distance	$m_{13}$	Related-to	CD1
	$m_{14}$	Genus (CD2)	CD2
	$m_{15}$	CD3	CD3 ( $m_{15}$ )
	$m_{16}$	Field ( $m_{16}$ )	
Hybrid			Variant( $m_{16}$ )
			Field( $m_{17}$ )

Two other candidate synsets of PW are immediate children of WNS<sub>1</sub>. This relation does not change values of methods of Farreres but the value 1 is assigned to  $m_{12}$  in SBU. WNS<sub>1</sub> does not have any close semantic similarity with candidate synsets of co-occurrent words and those words that have "related-to" relation with PW, then  $m_{13}$  is 0 in both methodologies. The sum of semantic similarities of candidate synsets of PW with candidate synsets of genus word of PW is 3.83. It causes to assign the values 1 and 4 to  $m_{14}$  in Farreres and SBU methodologies respectively. There is no semantic similarity between candidate synsets of PW and its semantic label, thus the value 0 is assigned to  $m_{16}$  and  $m_{17}$  in SBU and Farreres respectively.

Finally the values 0 and 1 are assigned to  $m_{15}$  in SBU and Farreres respectively. Despite the fact that WNS<sub>1</sub> has some semantic relations like hyperonymy and hyponymy with other candidate synsets, we consider the CD3 method just for synsets that have no close relations like Intersection, Brother, Ancestor and Child with other candidate synsets. Note that eliminating this condition causes a dependency between each structural method with CD3 method. For example, if a synset has a brother among candidate synsets, the value 1 is assigned to the Brother method, and also the value of CD3 becomes 1. Note that brother relation is a kind of close semantic similarity. This dependency is explained above in Variant method and is a drawback of Farreres' methodology. Table 2 shows comparison of vectors of the example explained.

TABLE 2. VECTORS OF EXPLAINED EXAMPLE FOR EACH METHOD

Farreres	00000010100101001
SBU	0000001030230201

C. Composition of Methods

Now some questions come into mind: Are all of methods useful? Should they be independent? How important is each of them? How can we specify their coefficients for computing final similarity?

We should specify coefficients of each method in final equation of probability computation. Then the input of our methodology is an association between PW and a synset having vector of 16 values and the output is the correctness probability of that association.

To achieve this goal, we took advantage of Logistic Regression model [14] like Farreres' methodology. Logistic Regression is a statistical method for calculating the importance coefficients of each method in the composition. A positive regression coefficient means that that method increases the probability of the outcome (association correctness), while a negative regression coefficient means that method decreases the probability of that outcome. Actually this model is used as a Machine Learning method whose training phase includes analyzing input data (the associations, their vectors and their human evaluation) and the test phase computes P(ok) that is correctness probability of an association according to its vector of methods. Equation 2 is the formula computing P(ok) using Logistic Regression.

$$(2)p(ok) = \frac{e^{\beta_0 + \sum \beta_i m_i}}{1 + e^{\beta_0 + \sum \beta_i m_i}}$$

$\beta_i$  is coefficient of  $i^{th}$  method but  $\beta_0$  is a constant. The higher value of  $\beta_i$  means the higher impact of  $m_i$  on probability computation.  $m_i$  is value of  $i^{th}$  method in the association. We used SPSS as a statistical tool for Logistic Regression.

D. Training Phase

At first, we applied our methodology on 150 Persian words. Having computed vectors of each association, about 2500 associations between Persian words and WordNet synsets were created. For regressing these associations, it was necessary to enter only some of them and their correctness probability achieved by human evaluation to SPSS. Of course the more associations given to SPSS leads to more accuracy in computation of coefficients. SPSS estimates coefficients according to correctness probabilities of given associations. For this reason we classified associations in groups having the same vector. Then about 120 groups were achieved. Groups having less than 5 vectors were eliminated because their effects in this regression were very low. For each association of each group, we accepted or rejected it. For example, the vector 0000000104400111 was accepted in 40 cases and was rejected in 10 cases, then its correctness probability by human evaluation is  $40 / 50 = \%80$ .

After computing of this probability for each vector, we entered them into SPSS. Then coefficients of each method

were achieved. We repeated this regression for Farreres' methodology. Results are presented in Table 3.

TABLE 3  
COEFFICIENTS OF METHODS IN EACH METHODOLOGY

$\beta_i$	SBU	Farreres
$\beta_0$	-3.505	-2.291
$\beta_1$	0	0
$\beta_2$	0	0
$\beta_3$	1.515	0.3
$\beta_4$	0	-0.301
$\beta_5$	0	22.037
$\beta_6$	0	0
$\beta_7$	0.510	-0.683
$\beta_8$	0	-0.86
$\beta_9$	1.643	1.628
$\beta_{10}$	0.639	0.503
$\beta_{11}$	0.311	0.973
$\beta_{12}$	0.974	0.302
$\beta_{13}$	0.673	0.137
$\beta_{14}$	0.408	1.054
$\beta_{15}$	-2.140	0.403
$\beta_{16}$	0.177	0
$\beta_{17}$	-	-0.315

Now we justify coefficients of our methodology. As can be seen, some methods have coefficients zero. This might have two reasons: (1) these methods occur rarely in practice, and (2) their influence on final probability is very low. Since the methods mono1, mono2, mono4, poly1 and poly2 occur rarely in practice (and also in test data), their coefficients are zero. But as for poly4, although this method is repeated a lot, it does not change final probability noticeably. Therefore its coefficient is zero as well. Values of other methods are justifiable according to their effect and importance in computing probability. For example, intersection of two words in a synset has more effect than brother relationship of synsets. Negative coefficient of  $m_{15}$  (CD3) is due to the fact that it is applied only to associations whose values of their structural methods are zero. It means that in these associations, there is no close semantic similarity with other candidate synsets; then in these cases, negative coefficient reduces correctness probability of association.

IV. EVALUATION

To evaluate our work, we compared its results with Farreres'. For this comparison we set the acceptance threshold to different values and calculated the precision and recall for each threshold. Before describing the comparison results lets clear the issue by an example.

Consider the Persian word بغض – boghz (spite, hatred). The words دشمنی – doshmani (enmity) and کینه – kineh (rancor) have "related-to" relation with this Persian word obtained from Fararoyy thesaurus and its genus and semantic label are احساس – ehsas(sensation) and روانشناسی –

ravanshenasi (psychology) respectively obtained from Sokhan dictionary. Results of our methodology for the word بغض – boghz (spite, hatred) are presented in Table 4.

In this table in the forth column A stands for Accept and R for reject and shows the human evaluation of this association. If we select a threshold between 0.30 and 0.40, then associations 1, 2, 4 and 7 are correctly and only association 6 is incorrectly accepted.

TABLE 4. CANDIDATE ASSOCIATIONS FOR PERSIAN WORD *بغض* – *BOGHZ* (SPITE, HATRED)

EW	Synset ID	Vector	Human Eval.	Esti- mation
grudge	7446948	0001000000200310	A	0.39
spite	7448078	0000000100200310	A	0.39
spite	4787145	0000000100000210	R	0.15
hatred	7443888	0001000000030320	A	0.9
dislike	6119053	0000001000000123	R	0.27
dislike	7399432	0000001000000320	R	0.46
animus	7445512	0010000000200310	A	0.74

We employed precision and recall measures for evaluating and comparing our methodology (SBU) with Farreres' methodology. Results of applying two methodologies to Persian language are presented in Table 5 and their comparisons are presented in Fig. 9 and Fig. 10.

TABLE 5. COMPARISON OF PRECISIONS AND RECALLS OF SBU AND FARRERES' METHODOLOGIES

Threshold	Precisions		Recalls	
	SBU	Farreres	SBU	Farreres
0.25	0.53	0.53	0.91	0.67
0.30	0.58	0.58	0.77	0.62
0.35	0.60	0.60	0.72	0.60
0.36	0.61	0.61	0.71	0.60
0.37	0.61	0.61	0.71	0.57
0.38	0.62	0.61	0.70	0.57
0.39	0.62	0.62	0.68	0.57
0.40	0.63	0.62	0.67	0.56
0.45	0.64	0.66	0.62	0.47
0.50	0.66	0.68	0.58	0.42
0.60	0.69	0.72	0.53	0.29
0.70	0.72	0.76	0.51	0.27

As can be seen, for each threshold of accepting or rejecting associations, we obtained various precision and recall values. Since in the second phase of this work, the pre-produced associations will be accepted or rejected

ultimately, production of associations is more important than their correctness in the first phase. In other words, high value of recall is more important than high value of precision because most of incorrect associations will be rejected further in the second phase using hierarchical structures of Persian thesaurus and WordNet. This final acceptance or

rejection will take advantage of hyperonymy and hyponymy relations in the hierarchies. Then we do not have to select a decisive threshold value in this phase. Also note that the structural similarity between Persian thesaurus and English WordNet was not used in the first phase.

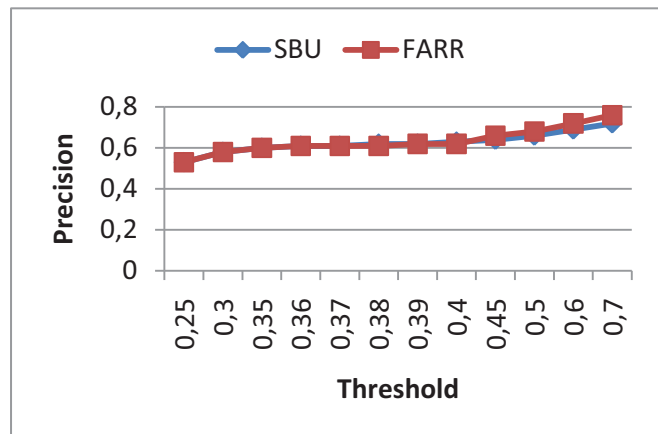


Fig. 9. Comparison of precision of two methodologies

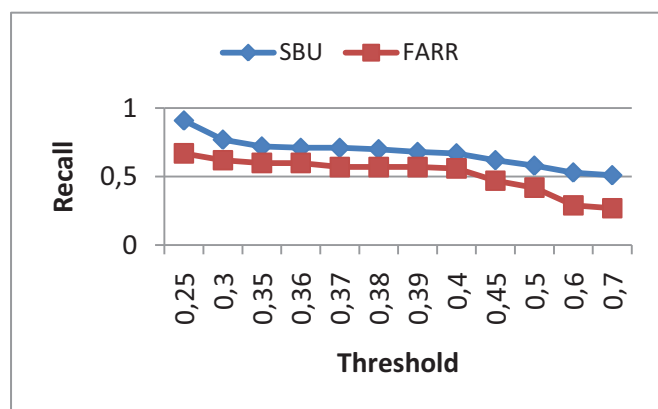


Fig. 10. Comparison of recalls of two methodologies

## V. CONCLUSION AND FUTURE WORKS

In this paper we proposed an improved methodology based on Farreres' methodology for mapping Persian words to WordNet synsets. The methodology is language independent and we used Persian language as a case study. The recall values we achieved in our methodology were higher than those achieved in Farreres' methodology. An association between Persian word and every candidate synset for it was constructed. This work took advantage of 16 similarity methods indicating how similar a Persian word is to each of its candidate synset.

We obtained coefficients (importance) of each method used in computing correctness probability of each

association by Logistic Regression model. This model uses evaluated associations by human for estimating coefficient of each method. Finally we obtained a formula whose input is an association and whose output is correctness probability of this association.

After evaluating our methodology, different Precisions and recalls were obtained based on threshold values. In the future works, we will do second phase of this methodology. In the second phase, pre-produced associations will be accepted or rejected ultimately using the structural properties of synsets in two languages. In the first phase, high value of recall is more important than high value of Precision because most of incorrect associations will be rejected in the second phase using hierarchical structures of Persian thesaurus and WordNet. This ultimate acceptance or rejection, will take advantage of hypernymy and hyponymy relations in the hierarchies.

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#### ACKNOWLEDGMENT

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#### REFERENCES

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- [1] T. R. Gruber, A Translation Approach to Portable Ontologies, *knowledge Acquisition*, 5(2), pp. 199-220, 1993.
- [2] J. Farreres, Automatic Construction of Wide-Coverage Domain-Independent Lexico-Conceptual Ontologies. PhD Thesis, Polytechnic University of Catalonia, Barcelona, 2005.
- [3] M. Assi, M. Aryanpour, Aryanpour English-Persian and Persian-English dictionary. <http://www.aryanpour.com>.
- [4] H. Anvari, Persian-Persian Sokhan dictionary. Tehran: Sokhan Pub., 2002.
- [5] J. Fararooy, Fararooy Persian Thesaurus. Available at <http://www.persianthesaurus.com>
- [6] J. Daudé, L. Padró, G. Rigau, Mapping multilingual hierarchies using relaxation labeling. In *Proceedings of the Joint SIGDAT Conference on Empirical Methods in Natural Language Processing and Very Large Corpora (EMNLP/VLC'99)*, Maryland, 1999.
- [7] J. Daudé, L. Padró, G. Rigau, Mapping Wordnets using structural information. In *Proceedings of the 38th Annual Meeting of the Association for Computational Linguistics*, Hong Kong, China (2000)
- [8] C. Lee, G. Lee, S. Jung Yun, Automatic Wordnet mapping using word sense disambiguation. In *Proceedings of the Joint SIGDAT Conference on Empirical Methods in Natural Language Processing and Very Large Corpora (EMNLP/VLC 2000)*, Hong Kong (2000)
- [9] J. Ramanand, A. Ukey, B. Kiran Singh, P. Bhattacharyya, Mapping and Structural Analysis of Multi-lingual Wordnets. *IEEE Data Eng. Bull.* 30(1): 30-43 (2007)
- [10] J. Atserias, S. Climent, X. Farreres, G. Rigau, H. Rodriguez, Combining multiple methods for the automatic construction of multilingual Wordnets. In *Proceedings of the International Conference on Recent Advances in Natural Language Processing (RANLP)*, Tzigov Chark, Bulgaria (1997)
- [11] T. Simpson, T. Dao, WordNet-based semantic similarity measurement. <http://www.codeproject.com/KB/string/semanticsimilaritywordnet.aspx>
- [12] R. Rada, H. Mili, E. Bicknell, M. Blettner, Development and application of a metric on semantic nets. *IEEE Transactions on Systems, Man and Cybernetics*, 19(1):17-30, (1989)
- [13] Y. Wilks, D. Fass, C. Guo, J. McDonal, T. Plate, B. Slator, *Semantics and the Lexicon*. chapter Providing Machine Tractable Dictionary Tools, pages 341-401. Kluwer Academic Publishers, Dordrecht (1993)
- [14] L. Lebart, *Traitement Statistique des Données*. DUNOD, Paris (1990)

# Ontology of a scene based on Java 3D architecture.

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**Abstract** – The present article seeks to make an approach to the class hierarchy of a scene built with the architecture Java 3D, to develop an ontology of a scene as from the semantic essential components for the semantic structuring of the Web3D

Java was selected because the language recommended by the W3C Consortium for the Development of the Web3D oriented applications as from X3D standard is Xj3D which composition of their Schemas is based the architecture of Java3D

In first instance identifies the domain and scope of the ontology, defining classes and subclasses that comprise from Java3D architecture and the essential elements of a scene, as its point of origin, the field of rotation, translation The limitation of the scene and the definition of shaders, then define the slots that are declared in RDF as a framework for describing the properties of the classes established from identifying the domain and range of each class, then develops composition of the OWL ontology on SWOOP

Finally, be perform instantiations of the ontology building for a Iconosphere object as from class expressions defined.

**Keywords:** *Ontology, Java3D, Web3D, X3D.*

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## I. INTRODUCTION

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THE term web 3D makes reference to the programming language, standards, files formats and any kind of technology that can be used to the construction of virtual environments of immersion in the web [1]. The construction of those environments is not easy and requires an artist team, illustrators, designers and programmers for its construction, turning this process into an independent labor of the required technology to make it real [3]. To turn this artisanal labor into an industrial one, it is necessary, first of all, to identify the semantic structure of the 3D objects that constitute the immersion environments, to make the searching, recycling, development and the assemble of new environments, easier, faster and richer.

Taking in account that the majority of 3D environments is characterized for its objects, which are built for geometrical low level elements, such as polygonal net or NURBS surfaces [6]; the authors make the semantic association, sharing the perception of the visitors toward the objects

which compound the environment, unfortunately even when the users Identify the relationships and the semantic associations of the 3D objects, they cannot infer high level information descriptions, stored in the 3D, and they cannot make the manufacture process of new environments. Besides nowadays the molding practices do not stimulate the semantic connotation of the 3D objects, some of them specify limited opportunities, such as the manager of layers or the tagging of objects; which is not constantly used for the standard storage of the high level structures and it is presented to other people as an additional working molding result [15]. The lack of a high level standard for the environment elements description is an inconvenient for the advanced usage of 3D world description, which require the semantic knowledge of those elements. The knowledge usage possibilities, are first of all the searching engines, which process formulated requests in a natural language making reference to the high level characteristics (for instance, finding buildings that have inside of them, patios surrounded by columns) in second place the extraction of semantic objects from big files to facilitate the exam and the automatic creation of high level libraries which can be used to create different 3d environments, knowing that the usage of high level description is not only useful in the 3d virtual environments but includes everything which is related with the mixed reality. (For example the high level description of a virtual model in a real map environment, can help to the navigation in a real or mixed scene when summarizing the virtual and real elements of it) [15].

The current research proposes to develop the semantic composition, starting in the hierarchy of the tridimensional visualization based on Java 3D architecture, used in the construction of 3D objects, having in account the architecture of the geometrical composition that is proposed in the X3D standard, for this reason a revision of the syntactic point of view is made, also a semantic one based on the principal programming languages for virtual immersion environments in the web, such as VRML and O3D, to unify a hierarchy of the 3D objects construction. For the development of the semantic composition, we apply the methodology competency questions; this one allows the

construction of ontologies about specific domains, putting limits to the domain, defining the classes and sub classes, the relationships between them and the production parting from the SWOOP tools, generating RDF and OWL files [13].

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## II. 3D E INTERNET

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There are a variety of 3D applications development oriented internet especially in the entertainment, which require many developers and special processing specifications that are not common to most people, these many people can be made by communities interested in create 3D environments for use either as a business, an educational or entertainment [1], as with SecondLife, developed for the Linden Lab laboratory [17], that provides the infrastructure for processing and storage that this community needs. Development in Second Life begins with structures pre-established because the interactivity and usability are subject to the proposed platform by Linden Lab, with low-level geometric structures without any semantic description [15], impossible to identify the properties of the virtual environment and the possibility of building manufacturing agents for distributed development [7]. The construction of an ontology of a scene is needed as a starting point for developing integrated services Web3D distributed manufacturing agents for complex and rich virtual worlds [18].

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## III. WEB 3D STANDARS

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There are several standards used in the Web 3D, the main ones: VRML (Virtual Reality Modelling Language) and X3D (Extensible 3D) [6]. VRML is a file format that allows the creation of interactive objects and worlds in three-dimensional [20]. X3D is an open standard XML, a 3D file format that allows the creation and transmission of 3D data between different applications, especially in network [22]. The ISO 19775 Extensible 3D specification provides a application programming language independent interface (API), allowing access to a range of services and functions, For integration with a programming language. X3D provides abstract interfaces that depending on the syntax are inserted into an established language. One of the languages that allow for such insertion is Java, which generates the specification Xj3D. ISO / IEC 19777 specifies a layer for the Java programming language [23]. One of the main differences between VRML/X3D and Xj3D, conceptually, is that the latter is defined as a script programming language of low level 3D scenes [10]. The creation of three dimensional objects and Java elements requires not only the formation of 3D elements, but also the definition of all aspects of display and control capabilities [16]. To create the simplest scenario, the Java code is well above that required in VRML/X3D, but on the other hand the control of different elements in the system is superior and more natural in Java [9]. You can also use Java as file viewer VRML/X3D, using one of the loaders of VRML/X3D developed for Java. The main advantages are the ability to execute on different platforms and avoid the need to install a specific plugin for each browser [11].

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## IV. EXTENSIBLE 3D LANGUAGE BINDINGS JAVA

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This specification provides a set of independent implementations of the classes and interfaces that represent the possible interactions with the X3D scene through UPS. The file shows the specifications of the application must remain hidden to the user. If classes are declared abstract, it is expected that the classes that inherit from the browser they use according to the needs [23]. A communications session based on Java depends on the type of driver set: applet or component. The difference is given by the way it obtains relating to browser, once obtained may not differ from services using a request time in which it generates the Java code you want to access the X3D browser [16]. An X3D browser is set by creating a new instance of the component class X3D CreateBrowser that can be used to control the properties of the browser. For example, a property can be used to request a Swing based component instead of AWT, or a software off-screen rendering by establishing and running the browser is also able to add additional properties. [23]. Xj3D uses Java3D framework and adapts according to the specification of developing an X3D XML Schema [21], that can create your own data types and namespaces, Because X3D Shaders specifies an architecture without to point in the operation and integration of these. Because framework Xj3D be used java3D architecture, this is selected for the specification of the scene [10].

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## V. ARCHITECTURE OF A JAVA3D SCENE

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Every Java3D scenario begins with a virtual universe that will be the container for all the graphics on the scene; this consists of locating objects that establish the relevant positions on the scene. Each universe will be a totally independent entity; therefore an object won't be able to exist in two virtual universes [16]. The locating objects are instances of the class Locale and are the node of the graphic branches in which the scene will be divided into. They consist of BranchGroup and are in charge of defining the origin point in the Cartesian space from double precision coordinates. There will be one for each universe. From the locating object which is the trunk of a tree there are groups of branches, transformations and visualization spreading out.

The compiler at the time of making a render follows the classes' hierarchy, which, if not respected, will generate class recognition errors. The class Locale has a subclass called Node and most of the objects appearing on the scene are at the same time Node subclasses; therefore it is established that Node puts together the branches, the transformations and the visualization. From these groups we get graphic objects that will allow us to define the shape of the objects, its colour and texture composition and the lighting needed to be visualized; these objects will be established as Shape. [5]. Figure 1 presents the diagram of the hierarchy of the classes of a scene made with Java3D. In the Java3D programs you have to program in stages each piece of the scene's diagram and then connect each stage with each other to make the final program. The virtual universe is the universo that hides behind the screen. When

programming in three dimensions what we have to achieve is to project a shaft from the object behind the screen to the observer's eye. [8].

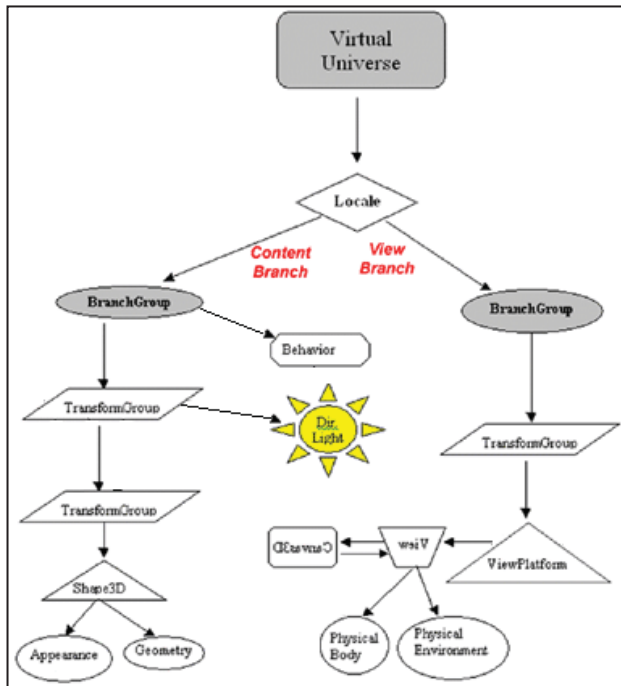


Figure 1. Diagram of a Graphic Scene

VI. DOMAIN AND REACH

With the development of this ontology is to make a first approach to the conceptualization of a 3D scene from Java3D architecture, identifying the resources essential to the definition of the scene and the properties or slots of these resources [14]. With the semantic conceptualization of a scene is looking to establish class structures of the objects composing the scene, to facilitate assembly and reuse of these objects in the construction of more complex scenes with the help of agents manufacturing [18]. The ontology should answer questions such as:

- What is a scene?
- What are the essential components of a scene?
- What are the relationships between these components?
- What is the limiting factor in the scene?
- Where is the origin of the scene?
- How it is given the shifting of the elements in the scene?
- How it is given the rotation of the elements in the scene?
- How the scene is displayed?
- What is the range of illumination of the scene?

VII. CLASSES AND SUBCLASSES

Bearing in mind the construction of a simple scenario in Java3D, nine classes have been identified that allow us to create a virtual universe, locate the origin, put together transformations, branches and object visualization components that will be made from meshes of triangles with

shadows and lighting properties.

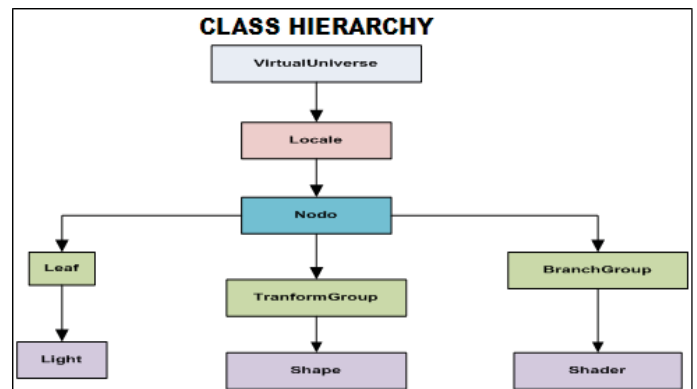


Figure 2. Diagram of a Graphic Scene

Figure 2 shows the hierarchy of classes used and the directions of the arrows allow us to infer the inheritance relations between them; the necessary classes to build a simple scene in Java3D are:

- a. VirtualUniverse: It is all the other ones' superclass as it is the container of all the graphics in the scene.
- b. Locale: It defines the Cartesian origin of the Euclidian space.
- c. Node: It allows the definition of the representations of the scene
- d. Leaf: It allows the specification of shapes, lighting and behavior.
- e. TransformGroup: It places the objects in space and allows its rotation and scalability.
- f. BranchGroup: It is in charge of the visualization of the scene..
- g. Light: It identifies a specific type of lighting.
- h. Shape: Construye formas 3D.
- i. Shape: It builds 3D shapes.
- j. Shader: It defines color and shadows of the objects created with Shape

For the edition of the ontology in OWL language (Ontology Web Language), which was selected because it was W3C's recommendation and the fact it allows several functionalities such as DAME and OIL, as it is and RDFS model's extension, they allow the redefinition of properties and the definition of classes through Boolean restrictions and operations, so the editor SWOOP beta 2.3 edition was used [2].

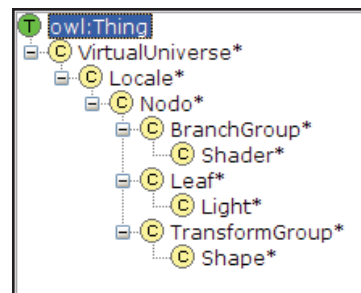


Figure 3. Classes and Subclasses

Figure 3 shows classes and subclasses of tree in SWOOP

editor. The description languages' function is to represent data and there is a frame for the description of RDF resources (Resource Description Framework) which is one of the XML vocabularies and it is made up based on the following rules [12]:

- A resource is any thing that may have an URI, this includes all the web sites, all the individual elements of each XML document y many more.
- A property is a resource that has a name and that can be used to identify responsibilities or other resources' actions.
- A sentence consists of a combination of a resource, a property and a value. These parts are known as subject, predicate and object of the sentence. The use of RDF allows the independence between resources, the exchange of information, and the scalability due to its simplicity. [4].

Figure 4 shows the RDF description of the Class VirtualUniverse:

```
<rdf:RDF xml:base="&EGJ3D;#"
  xmlns:owl="&owl;"
  xmlns:rdf="&rdf;"
  xmlns:rdfs="&rdfs;">
  <owl:Class rdf:about="#VirtualUniverse">
    <owl:intersectionOf rdf:parseType="Collection">
      <owl:Class rdf:about="#Locale"/>
      <owl:Restriction>
        <owl:onProperty>
          <owl:ObjectProperty rdf:about="#defineUniverso"/>
        </owl:onProperty>
        <owl:someValuesFrom rdf:resource="#Locale"/>
      </owl:Restriction>
    </owl:intersectionOf>
  </owl:Class>

  <owl:AnnotationProperty rdf:about="&rdfs;comment"/>
</rdf:RDF>
```

Figure 4. RDF of the Class VirtualUniverse

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### VIII.PROPERTIES DEFINITION

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Properties allow the establishment of the classes' responsibilities and the relations between them, which have a range and an application domain [11]. The ontology properties were identified from the classes responsibilities and then it was establish their range and domain so the relation between the different classes could be identified. The properties established where:

- defineUniverse:** Property responsible for the class VirtualUniverse and corresponds to the graphic scenario's creation, but this needs other elements such as nodes, the Locale, objects' geometry, the light and the visual appearance. The domain and range of this property is the class VirtualUniverse.
- especificCartesianOrigin:** Property responsible for the class and consists of the identification of the origin of the similar universe. The domain and range of this property is the class Locale
- defineUtilityScene:** An object in a scene needs light to

be visualized, a shape and geometric composition, an appearance, and certain rotation around an axis possibilities or movement from one point to another. There are several classes in charge of these actions, like the class Shape, which defines the geometric shape or the class Shader in charge of the appearance, but all of these belong to the class Node which is the domain and range of this property

- DefineLightingRange:** In order to visualize an object in a scene first you have to establish the light from the scene that is getting to each of the points of the projection plane. The best way to answer this question is to follow a straight line from this point in the projection plane and the focal point until it impacts a representable surface in the scene; at this point the light that should impact this point is established. The properties of the surface and the light's incidence angle establish what amount of light should be reflected by the incident vision angle; this is the reason why it is necessary to define the range of lighting with the class Light. The domain and range of this property is the class Leaf.
- visualize:** The light's impact over a surface and the subsequent re-radiation by diffusion phenomenon can be very fuzzy , for example, the re-radiation in every direction in an isotropic way. This means the camera will see the same amount of light from that surface point regardless the incident vision angle [8]. Given that the amount of light that impacts a surface depends on the angle of incidence of the light. If most of the light hitting a surface is reflected in a fuzzy way, the surface will have a matt appearance. This is why during the visualization process it is necessary to establish the way in which the object will radiate its environment affecting the rest of the objects in the scene. The domain and range of this property is the class BranchGroup.
- moves:** This property allows the recalculation of all the positions of all the vertexes of a geometric object from a relocation of the centroid in the Euclidean space. The domain and range of this property is the class TransformGroup.
- rotates:** This property performs turns of the object around the axis of the centroid specifying an axis in a single direction, x, y or z, or a diagonal established. The domain and range of this property is the class TranformGroup.

```
<rdf:RDF xml:base="&EGJ3D;#"
  xmlns:owl="&owl;"
  xmlns:rdf="&rdf;"
  xmlns:rdfs="&rdfs;">
  <owl:ObjectProperty rdf:about="#defineRangoIluminación">
    <rdfs:domain>
      <owl:Class rdf:about="#Leaf"/>
    </rdfs:domain>
    <rdfs:range rdf:resource="#Leaf"/>
  </owl:ObjectProperty>
</rdf:RDF>
```

Figure 5. RDF of the Propertie defineLightingRange



Figure 5 shows the RDF description of the property `defineLightingRange`.

IX. INSTANCES CREATION

The instantiation is the creation of individuals from the assignment of values to the attributes of a class therefore each individual will have certain particular properties defined in the class where he belongs. For each class an individual was defined which has certain particular characteristics opposite to the domain range of the properties responsible for the classes:

- **Screens:** Instance of the class `VirtualUniverse` that is a simple graphic container.
- **Axis:** Instance of the class `Locale`. Screen locator placing the Y plane horizontal, the X plane perpendicular to the screen and the Z plane vertical.
- **Layers:** Instance of the class `Node`. Allows the visualization of the scene in perspective.
- **Leaf:** Instance of the class `Lamp`, which allows the establishment of the focal axis of the light.
- **Pipeline:** Instance of the class `BranchGroup`, assigns a determined color to the faces of the geometric object.
- **Scale:** Instance of the class `TransformGroup` that modifies the size of the geometric figure.
- **Icosphere:** Instancia de la clase `Shape` y crea un Icosaedro que tiene 20 caras todas formadas por triángulos equiláteros.
- **Fresnel:** Instance of the class `Shader`; defines how reflective the material is depending on the angle between the normal surface and the observation direction.
- **Hemi:** Instance of the class `Light`; projects light evenly through a hemisphere that surrounds the scene.

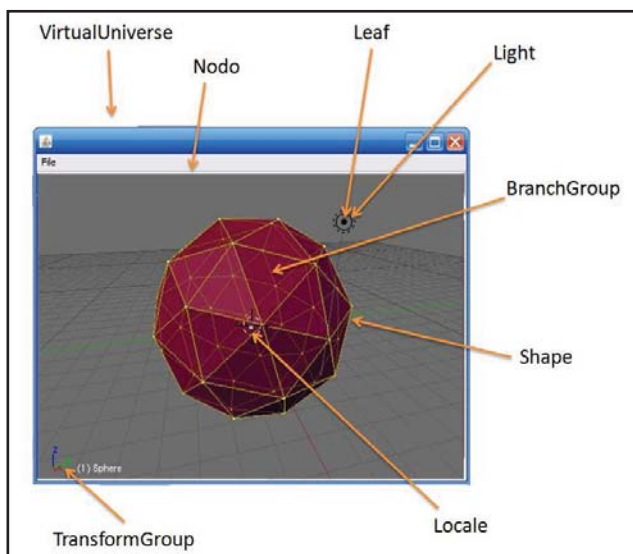


Figure 6. Instantiation Example

X. CLASS EXPRESSIONS

The class expressions allow us to establish the relations between the classes and the properties so by means of inference the relations between individuals can be established, the following class expressions were created:

$VirtualUniverse \equiv (\exists Locale.defineUniverso) \cap Locale$

$Locale \equiv (\exists Nodo.especificaOrigenCartesiano) \cap Nodo$

$\equiv (\exists BranchGroup.defineUtilidadEscena) \cap BranchGroup \cap TransformGroup \cap Leaf$

$Leaf \equiv (\exists Light.ilumina) \cap Light$

$BranchGroup \equiv (\exists Shaders.visualiza) \cap Shaders$

$TransformGroup \equiv (\exists Shape.trasladar) \cap Shape$

```
<rdf:RDF xml:base="&EGJ3D;"
  xmlns:EGJ3D="&EGJ3D;"
  xmlns:owl="&owl;"
  xmlns:rdf="&rdf;"
  xmlns:rdfs="&rdfs;">
  <EGJ3D:Shape rdf:about="#Icosphere">
    <rdfs:comment xml:lang="en"></rdfs:comment>
  </EGJ3D:Shape>
  <owl:Class rdf:about="#Shape"/>
  <owl:AnnotationProperty rdf:about="&rdfs;comment"/>
</rdf:RDF>
```

Figure 7. Instantiation Example

XI. CONCLUSION

The construction of an ontology for the definition of tridimensional spaces will allow the Web3d to standardize the development of scenarios and the creation of manufacture agents that will make easier the modeling and texturing processes. The biggest difficulty in the ontology's development lies on the definition of abstract classes which allow the instantiation of non visual individuals, which determine graphic behaviors. The identification of the properties from the responsibilities of the classes generates different fields of similar domains bringing all the classes closer to a general equivalence state. All classes are equivalent with each other, for example, the class `Light` is equivalent to the class `VirtualUniverse`.

REFERENCES

- [1] ALPCAN. Tansu, BAUCKHAGE. Christian, KOTSOVINOS. Evangelos (2007). Towards 3D Internet: Why, What, and How?. Deutsche Telekom Laboratories Ernst-Reuter-Platz 7, 10587 Berlin, Germany. [http://www.tansu.alpcan.org/papers/Alpcan-3D\\_Internet.pdf](http://www.tansu.alpcan.org/papers/Alpcan-3D_Internet.pdf)
- [2] ANTONIOU. Grigoris, HARMELEN. Frank Van. (2004). Web Ontology Language: OWL. Department of Computer Science, University of Crete and Department of AI, Vrije Universiteit Amsterdam.
- [3] BERTINI, Marco. Del BIMBO, Alberto. (2005). Automatic video annotation using ontologies extended with visual information. Proceedings of the 13th annual ACM international conference on Multimedia. (pp. 395 - 398). <http://portal.acm.org/citation.cfm?id=1101149.1101235&coll=ACM&dl=ACM&CFID=40134319&CFTOKEN=68049444>
- [4] DOAN, Anhui. MADHAVAN, Jayant. (2002). Learning to map between ontologies on the semantic web. Proceedings of the 11th international conference on World Wide Web. ACM. (pp. 662 - 673). <http://portal.acm.org/citation.cfm?id=511446.511532&coll=ACM&dl=ACM&CFID=40138157&CFTOKEN=10917136>
- [6] ESCRIBANO. Manuel. (1995). Programación de Gráficos 3D. Addison Wesley, Delaware, 228p.
- [7] GEER, David.(2005).Making 3D Technology Universal Phed by the IEEE Computer Society, 38, 08, (pp. 23-25). <http://ieeexplore.ieee.org/iel5/2/32069/01492260.pdf>
- [9] GIBBINS, Nicholas. HARRIS, Stephen. (2003). Agent-based semantic web services. Proceedings of the 12th international conference on World Wide Web. ACM. (pp. 710 - 717). <http://portal.acm.org/citation.cfm?id=775152.775251&coll=ACM&dl=ACM&CFID=41273239&CFTOKEN=77032621>
- [11] [8]HEAM, Donald. BAKER, Pauline. (2004). Computer Graphics with OpenGL. Published by Pearson Education. Indiana University. 895 p. [http://dlist.sir.arizona.edu/1897/01/12\\_Zhang.pdf](http://dlist.sir.arizona.edu/1897/01/12_Zhang.pdf)
- [12] HUDSON. Alan, BAUCH. (2003). An introduction to the Xj3D toolkit. Proceedings of the eighth international conference on 3D Web technology. ACM. (pp. 190). <http://portal.acm.org/citation.cfm?id=636593.636627&coll=ACM&dl=ACM&CFID=40134319&CFTOKEN=68049444>
- [14] KRAUSE. Dirk, (2008). Serious Games – The State of the Game, The relationship between virtual worlds and Web 3D. Proceedings Pixelpark white paper. (pp. 18). [http://www.pixelpark.de/de/pixelpark/\\_ressourcen/attachments/publikationen/080529\\_White\\_Paper\\_Serious\\_Games\\_English\\_final.pdf](http://www.pixelpark.de/de/pixelpark/_ressourcen/attachments/publikationen/080529_White_Paper_Serious_Games_English_final.pdf)
- [16] MOUNTINHO, Gonzalo. PARISI, Tony. (2004). X3D programmable shaders. Proceedings of the ninth international conference on 3D Web technology. ACM. (pp. 99 - 108). <http://portal.acm.org/citation.cfm?id=985040.985055&coll=ACM&dl=ACM&CFID=40134319&CFTOKEN=68049444>
- [18] NOY. Natalya, MCGUINNESS. Deborah. (2004). Ontology Development 101: A Guide to Creating Your First Ontology. Stanford University.
- [19] OMG. (2005). Ontology Definition Metamodel. Third Revised Submission to OMG/RFP. <http://www.omg.org/docs/ad/05-08-01.pdf>
- [20] PARISI. Salvatore, BAUCH. Jochen, BERSSENBRÜGGE Jan. (2007). Using Ontology to create 3D Aniations for Training Purposes. Department of Computer Integrated Manufacturing, Heinz Nixdorf Institute – University of Paderborn [http://www.sersc.org/journals/IJSEIA/vol1\\_no1\\_2007/IJSEIA-2007-01-01-05.pdf](http://www.sersc.org/journals/IJSEIA/vol1_no1_2007/IJSEIA-2007-01-01-05.pdf)
- [21] PITTARELLO, Fabio. De FAVERI, Alessandro. (2006). Semantic description of 3D environments: a proposal based on web standards. Proceedings of the eleventh international conference on 3D web technology. ACM. (pp. 85-95). <http://portal.acm.org/citation.cfm?id=1122591.1122603&coll=ACM&dl=ACM&CFID=41266025&CFTOKEN=53829823>
- [23] PLATDEPADUA. Joan. (2003). Programación en 3D con Java 3D. Alfaomega. México 303 p.
- [24] PURBRICK, Jim. LENTCZNER, Mark. (2007). Second life: the world's biggest programming environment. Conference on Object Oriented Programming Systems Languages and Applications. ACM. (pp. 720). <http://portal.acm.org/citation.cfm?id=1297846.1297849&jmp=abstract&coll=ACM&dl=ACM&CFID=40134319&CFTOKEN=68049444#abstract>
- [26] TRAUM, David. RICKEL, Jeff. (2002). Embodied Agents for Multi-party Dialogue in Immersive Virtual Worlds. Proceedings of the first international joint conference on Autonomous agents and multiagent systems: part 2. ACM. (pp. 766-773).
- [27] <http://portal.acm.org/citation.cfm?id=544862.544922&coll=ACM&dl=ACM&CFID=41266025&CFTOKEN=53829823>
- [28] ZHANG. Jane. (2007). Ontology and the Semantic Web. Proceedings of the North American Symposium on Knowledge Organization. Harvard University.
- [29] ISO/IEC 14772-1:1997. (1997). The Virtual Reality Modeling Language (VRML) Functional specification and UTF-8 encoding. Web3D Consortium International Electrotechnical Commission. Cambridge, Massachusetts.
- [30] <http://www.web3d.org/x3d/specifications/vrml/ISO-IEC-14772-VRML97/>
- [31] ISO/IEC FCD 19776-1 Ed. 2. (2001). XML Schema. Web3D Consortium International Electrotechnical Commission. Cambridge, Massachusetts.
- [32] <http://www.web3d.org/x3d/specifications/ISO-IEC-FCD-19776-1.2-X3DEncodings-XML/index.html>
- [33] ISO/IEC 14772-2:2004. (2004). The Virtual Reality Modeling Language (VRML) External authoring interface (EAI). International Web3D Consortium Electrotechnical Commission. Cambridge, Massachusetts. [http://www.web3d.org/x3d/specifications/vrml/ISO-IEC-14772-VRML97/#ISO\\_IEC\\_14772Part2](http://www.web3d.org/x3d/specifications/vrml/ISO-IEC-14772-VRML97/#ISO_IEC_14772Part2)
- [34] ISO/IEC 19775-1:2008. (2008). Extensible 3D (X3D) — Part 2: Scene access interface (SAI). International Web3D Consortium Electrotechnical Commission. Cambridge, Massachusetts.
- [35] <http://www.web3d.org/x3d/specifications/ISO-IEC-19775-1.2-X3D-AbstractSpecification/index.html>
- [36] Xj3D as a Java3D Loader. (2006). International Web3D Consortium. [http://www.xj3d.org/tutorials/j3d\\_loader.html](http://www.xj3d.org/tutorials/j3d_loader.html)

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# A Mix Model of Discounted Cash-Flow and OWA Operators for Strategic Valuation

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**Abstract** — The stock market volatility and the actual stock Exchange activity have increased the need of counting with effective methods on the part of financial analysts to achieve a division in relation to the investment actions, being also growing the demand of methodological instruments that reduce and minimize the risks and uncertainty when valuating financial actives and companies. These systems not only must use quantitative information but the inclusion of qualitative information must also bear heavily on them, as an improvement element in the adjustment of these valuating methods, with the aim of throwing a more well-conceived or less mistaken decision.

In this work, the use of Discounted Cash-Flow model is proposed, with quantitative information together with the OWA operators as an inclusion method of qualitative information in the traditional valuating models, with the aim of generating an strategic valuating system which allows to develop more agreed and less mistaken valuations.

**Keywords** — Discounted Cash-Flow, OWA operators, Linguistic Information, Strategic Valuation.

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## XII. INTRODUCTION

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Nowadays, the success of the stock exchange activity as well as actives valuations into the business market mostly depend on the capacity of anticipating to the stock market trends and the achievement of a quick reply. Managers must assimilate the information and adopt the decisions in a chaotic environment, provided with risk and uncertainty, most of times without counting with experience and an adequate planning, and even without having enough time to carry out an strict

and systematic analysis (Besoun, 2004; Cross & Brodt,

2006). All these circumstances lay the reasons why the knowledge of the recent decision techniques have a special

outstanding into the business and stock market environment. Generally it is not feasible to establish in all these processes and standard criterion of decision which could be useful in any case, given that every operation is 'different in itself' from the rest, motivated by the several circumstances and risk elements. That's the reason why the end in a decision system, within this field, is banded to a negotiation process or consensus between both interested parts with its aim.

In many cases, such mechanisms have being established by the different opinions applied to the experts, who facilitate a series of valuations which allow the obtaining of a final value of satisfactory decision. In these conditions, it is necessary to enable different mechanisms which allow to generate representative results of the group and operate with the risk produced, related to the uncertainty of the opinions expressed by the decision-makers, that most of the time, will be defined in a qualitative ways (Kaufmann & Gil, 1986).

In the strategic valuation it is pretended to determine an interval of reasonable values in which the definitive value of the considered element will be included. For instance, when valuating a company the aim is to obtain an estimation which may never be a unique or exact number due to the difficulties belongings to the decision process. However this will depend on the company situation, the transaction moment and the method we use. To determine the right valuation it is necessary to establish hypothesis and future uncertainty scenes due to the possibility of event in relation to the risk elements inherent to the event scene. These hypotheses are involved in a risk and uncertainty universe, so that the final result will be an interval or series of values, and not only one of them. Finally, the information derived from the valuation report developed by the experts will mean the base in the parties' negotiation, from which the definitive transaction price will arise.

The valuation methods use future estimations which, in many cases, are being giving out by experts according to their experience or reality perception, what means an added risk. In these conditions, it is necessary the disposition of several instruments which allow to operate with the

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uncertainty or risk of the expressed opinions, which normally will be defined in linguistic values in different ways of expression. It is also necessary that these instruments should be able to add the opinions in a representative value of them.

A new strategic valuation model is represented in this work, not only to a business manager level but also to the agents and stock market investors, offering to the eloquent a new instrument based on operators of aggregate OWA, with the aim to provide a better quality decision in a context with lack of information and with the need of taking it with celerity, permitting our decision be as correct as possible.

The article structure is the following: In the next section the valuating model 'Discounted Cash-Flow' will be introduced; in the third section it is shown the information using linguistic labels with the two tuplas model and the proposed aggregate operator OWA; in the fourth section the new model of strategic valuation will be presented, developing a detailed example of application, and finally, conclusions will be shown.

---

### XIII. STRATEGIC VALUATION. DISCOUNTED CASH-FLOW

---

One of the most important sides of the modern financial theory is the one referred to the strategic valuation of enterprises. The demand for adequate methods when valuating acts and enterprises is increasing. The role which has been played by the fusion processes and the acquisition in the actual strategy of business is requiring adequate financial models which allow inferring the potential synergies of all kinds of operations of combinations and/or societies restoration (Ruiz & Gil, 2004).

The value is searching its support in a logical or mathematical basis being as rigorous as possible. It looks for the objectivity, neutrality and independence opposite to the parts, strong relations in the stock market and even the market situation itself. However the need of predicting future scenes in which the own activity is developing, could create the impossibility to determine a specific and certain value, this may origin an interval of possible values within which the most certain and possible value of the enterprise will be found. The definitive value will come by consent and negotiation between the interested parts. As a result, the extent of possible values interval will distinguish the valuation report before the decision.

It is precisely in this point where we want to improve the quality of the available information to the investor, if it is possible to decrease interval extent of the possible values with the methodology proposed, the position of the interested parts will be closer to each other. Being like this, the possibility of agreement to finalize the operation will have increased in a well-balanced consensual price and even minimally negotiated. In this way, a rise in the stock market efficiency and fluidity is produced.

Within the last few years, with the stock markets worldwide extension, the technological development of these ones and the appearance of new financial instruments,

have promoted new valuation techniques improving the ones already existing.

This fact has meant a growth not only in the valuating methods and its possible action setting but also in the need to discriminate against which methods are applicable in certain circumstances and the veracity or credibility of the results.

In this report it is used one of the methods which is actually the most accepted in the professional and scientific community, the 'Discounted Cash-Flow' model. The following expression distinguishes it.

$$V_E = \sum_{t=1}^n \frac{CFL_t}{\prod_{j=1}^t (1 + K_j)}$$

Where  $V_E$  represents the enterprise actual value;  $CFL$  is the 'Cash Flow' free from the enterprise for the period  $-t$  (including the residual value);  $K_j$  is the adequate updating valuation and agreed for risk (WACC) to the period  $-j$  and  $n$  is the valuation horizon.

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### XIV. LINGUISTIC MODEL AND OWA OPERATOR

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Actually the concept of linguistic variable is widely used in those decision making problems with imprecise assessments given in a linguistic way for some of its elements. Usually, many aspects of different activities cannot be assessed in a quantitative form, but rather in a qualitative one, i.e., with vague or imprecise knowledge. In that case a better approach may be to use linguistic assessments instead of numerical values. The fuzzy linguistic approach represents qualitative aspects as linguistic values by means of linguistic variables.

This approach is adequate in some situations, for example, when attempting to qualify phenomena related to human perception, we are often led to use words in natural language. This may arise for different reasons. There are some situations where the information may not be quantified due to its nature, and thus, it may be stated only in linguistic terms (e.g., when evaluating financial situations terms like "bad", "poor", "tolerable", "average", "good" can be used). In other cases, precise quantitative information may not be stated because either it is not available or the cost of its computation is too high, then an "approximate value" may be tolerated (e.g., when evaluating the cost of a infrastructure, terms like "expensive", "very expensive", "cheap" are used instead of numerical values). The fuzzy linguistic approach has been applied with very good results in different problems, such as, information retrieval, decision-making, etc.

This linguistic information model used to define the proposed valuation system is designated 2 - tuple fuzzy linguistic defined in 'Herrera & Martinez', 2000. This model presents the advantage of permitting to equalize the information expressed by the experts in different properties without lost of information.

From this concept, in “Herrera & Martinez” (2000) is developed a linguistic representation model which represents the linguistic information by means of 2-tuples  $(r_i, \alpha_i)$ ,  $r_i \in S$  and  $\alpha_i \in [-0.5, 0.5)$ .  $r_i$  represents the linguistics label center of the information and  $\alpha_i$  is a numerical value that represents the translation from the original result  $\beta$  to the closest index label in the linguistic term set  $(r_i)$ , i.e., the Symbolic Translation.

This linguistic representation model defines a set of functions to make transformations among linguistic terms, 2-tuples and numerical values.

*Definition.* Let  $s_i \in S$  be a linguistic term, then its equivalent 2-tuple representation is obtained by means of the function  $\theta$  as:

$$\theta : S \rightarrow (S \times [-0.5, 0.5)), \quad \theta(s_i) = (s_i, 0) / s_i \in S$$

*Definition.* Let  $S = \{s_0, s_1, \dots, s_g\}$  be a linguistic term set and  $\beta \in [0, g]$  a value supporting the result of a symbolic aggregation operation, then the 2-tuple that expresses the equivalent information to  $\beta$  is obtained with the following function:

$$\Delta : [0, g] \rightarrow S \times [-0.5, 0.5),$$

$$\Delta(\beta) = \begin{cases} s_i & i = \text{round}(\beta) \\ \alpha = \beta - i & \alpha \in [-0.5, 0.5) \end{cases}$$

where round is the usual operation,  $s_i$  has the closest index label to  $\beta$  and  $\alpha$  is the value of the symbolic translation.

*Definition.* Let  $S = \{s_0, s_1, \dots, s_g\}$  be a linguistic term set and  $(s_i, \alpha)$  be a linguistic 2-tuple. There is always a  $\Delta^{-1}$  function, such that, from a 2-tuple it returns its equivalent numerical value  $\beta \in [0, g]$ .

$$\Delta^{-1} : S \times [-0.5, 0.5) \rightarrow [0, g], \quad \Delta^{-1}(s_i, \alpha) = i + \alpha = \beta$$

To carry out the aggregate stage of the linguistic information produced in the valuation process, the use of operators OWA is proposed, mainly because since its definitions they have been shown as one of the most effective option to choose when taking a decision in group (Herrera et al. ,1996; Pasi & Yager, 2006; Peláez & Doña, 2006; Llamazares, 2007), not only for the satisfied specific properties (Yager, 1988; Liu, 2006; Amin 2007) but also for the possibility of representing blurred concepts as the majority through the aggregate semantic of operators and its combination with linguistic quantifiers (Pasi & Yager 2006; Peláez & Doña 2006).

The OWA operator used in this work is the LAMA (Peláez & Doña, 2003b), due to this operator is adequate to synthesize linguistic information in decision making environments producing aggregated results with a majority semantic (Peláez et al., 2007).

The LAMA operator is based in most of the process

(Peláez & Doña 2003a) and is a mapping function  $F: R^n \rightarrow R$  that has associated a weighting vector  $W = [w_1, w_2, \dots, w_n]^T$  where  $w_i \in [0, 1]$  y  $\sum_{i=1}^n w_i = 1$ .

$$LAMA(a_1, a_2, \dots, a_n) = b_1 \otimes w_1 \oplus b_2 \otimes w_2 \oplus \dots \oplus b_n \otimes w_n$$

with  $b_j$  being the  $j^{\text{th}}$  largest element of the  $a_i$ , and  $\oplus$  is the sum of labels and  $\otimes$  is the product of a label by a positive real defined in (Herrera & Martinez, 2000).

The weights used in the LAMA operator are usually calculated from majority process (Peláez & Doña 2003a) as follow:

Let  $\delta_i$  the cardinality for the element  $i$  with  $\delta_i > 0$ , then.

$$w_i = f_i(b_1, \dots, b_n) = \frac{\gamma_i^{\delta_{\min}}}{\theta_{\delta_{\max}} \cdot \theta_{\delta_{\max}-1} \cdot \dots \cdot \theta_{\delta_{\min}+1} \cdot \theta_{\delta_{\min}}} + \frac{\gamma_i^{\delta_{\min}+1}}{\theta_{\delta_{\max}} \cdot \theta_{\delta_{\max}-1} \cdot \dots \cdot \theta_{\delta_{\min}+1}} + \dots + \frac{\gamma_i^{\delta_{\max}}}{\theta_{\delta_{\max}}}$$

where

$$\gamma_i^k = \begin{cases} 1 & \text{if } \delta_i \geq k \\ 0 & \text{otherwise} \end{cases}$$

and

$$\theta_i = \begin{cases} (\text{number of item with cardinality} \geq i) + 1 & \text{if } i \neq \delta_{\min} \\ \text{number of item with cardinality} \geq i & \text{otherwise} \end{cases}$$

The majority operators aggregate in function of  $\delta_i$  that generally represents the importance of the element  $i$  using its cardinality. Most of the processes are considered the formation of discussion of majority groups depending on similarities or distances among the experts' opinions. All values with a minimum of separation are considered inside the same group. The calculation method for the value  $\delta_i$  is independent from the definition of most of the operators.

---

## XV. STRATEGIC VALUATION. PROPOSED MODEL

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Firstly, we take the estimation of the updating valuation appropriate and agreed to the risk, which is usually the balance of average cost of capital (WACC). We should start with an analysis which considers every possible section among those we expected a valued fluctuation to the periods which are considered in the research, in order to be a start point in the decision process between the parts which are taking over such process. In the following example, it has been established an analysis period of three years, and it has been considered the following intervals for the interest rate:

Table IV.1. Intervals for the Updating valuations

Updating valuations
---------------------

Year 1	Year 2	Year 3
[0,04; 0,05]	[0,045; 0,06]	[0,05; 0,06]

Next we ask, for instance, ten experts who express their valuations about the intervals, making use of the following linguistic group:  $S = \{S_8$  (practically sure),  $S_7$  (very high),  $S_6$  (high),  $S_5$  (little high),  $S_4$  (medium),  $S_3$  (little low),  $S_2$  (low),  $S_1$  (very low),  $S_0$  (practically low)).

Table IV.2. Linguistic values. Valuate fluctuation. Expressed values by the experts

	[0,04 ; 0,05]	[0,045 ; 0,06]	[0,05 ; 0,06]
e <sub>1</sub>	(S <sub>6,0</sub> ) - (S <sub>8,0</sub> )	(S <sub>8,0</sub> )	(S <sub>2,0</sub> ) - (S <sub>4,0</sub> )
e <sub>2</sub>	(S <sub>5,0.33</sub> ) - (S <sub>7,-0.37</sub> )	(S <sub>5,0.33</sub> ) - (S <sub>8,0</sub> )	(S <sub>0,0</sub> ) - (S <sub>4,0</sub> )
e <sub>3</sub>	(S <sub>6,0</sub> )	(S <sub>8,0</sub> )	(S <sub>0,0</sub> ) - (S <sub>3,0</sub> )
e <sub>4</sub>	(S <sub>5,0</sub> )	(S <sub>7,0</sub> ) - (S <sub>8,0</sub> )	(S <sub>2,0</sub> ) - (S <sub>4,0</sub> )
e <sub>5</sub>	(S <sub>6,0</sub> ) - (S <sub>8,0</sub> )	(S <sub>6,0</sub> ) - (S <sub>8,0</sub> )	(S <sub>2,0</sub> )
e <sub>6</sub>	(S <sub>8,0</sub> )	(S <sub>8,0</sub> )	(S <sub>0,0</sub> ) - (S <sub>2,0</sub> )
e <sub>7</sub>	(S <sub>8,0</sub> )	(S <sub>5,0</sub> ) - (S <sub>7,0</sub> )	(S <sub>2,0</sub> ) - (S <sub>4,0</sub> )
e <sub>8</sub>	(S <sub>5,0</sub> ) - (S <sub>7,0</sub> )	(S <sub>5,0</sub> ) - (S <sub>6,0</sub> )	(S <sub>5,0</sub> ) - (S <sub>7,0</sub> )
e <sub>9</sub>	(S <sub>8,0</sub> )	(S <sub>1,0.33</sub> ) - (S <sub>3,-0.33</sub> )	(S <sub>7,-0.37</sub> ) - (S <sub>8,0</sub> )
e <sub>10</sub>	(S <sub>0,0</sub> ) - (S <sub>1,0</sub> )	(S <sub>5,0</sub> ) - (S <sub>6,0</sub> )	(S <sub>6,0</sub> ) - (S <sub>8,0</sub> )

Immediately after, we proceed to obtain an agent for each interval. In this way it is applied most of the linguistic operator afore defined, with the aim of obtaining a value which represents the whole collection of opinions made by the different experts in a majority way.

Extreme [0,04]

$$\phi = (S_{8,0}) \otimes 0.433 \oplus (S_{6,0}) \otimes 0.433 \oplus (S_{5,0}) \otimes 0.1 \oplus (S_{5,0.33}) \otimes 0.017 \oplus$$

$$\oplus (S_{0,0}) \otimes 0.017 = (S_{7,-0.35})$$

Extreme [0,05]

$$\phi = (S_{8,0}) \otimes 0.947 \oplus (S_{7,-0.33}) \otimes 0.0106 \oplus (S_{7,0}) \otimes 0.0106 \oplus$$

$$\oplus (S_{6,0}) \otimes 0.0106 \oplus$$

$$\oplus (S_{5,0}) \otimes 0.0106 \oplus (S_{1,0}) \otimes 0.0106 = (S_{8,-0.15})$$

Future valuation for year 1:

$$i_1 = [0,04] + (0,01)(\cdot)[0,738; 0,872] = [0,04738; 0,04872]$$

Future valuation for year 2:

$$i_2 = [0,045] + (0,015)(\cdot)[0,6172; 0,8577] = [0,05426; 0,05787]$$

Future valuation for year 3:

$$i_3 = [0,05] + (0,01)(\cdot)[0,1831; 0,4362] = [0,05183; 0,05436]$$

The following step needs to establish some values which customers and sellers are agree with according to the possible Cash Flows free to obtain in the considered periods. In order to get it, firstly we start with intervals to qualify the CFL which will be useful as a reference to apply for the opinion of the experts at such content. These must be established not only for the customers' part, but also for the seller's one. To operative effects of the practical decision it has been established the following intervals indicating the possible CFL in financial units for the three analysis periods: year 1 [4.000; 6.000]; year 2 [3.000; 6.000]; year 3 [2.000; 5.000].

From the previous valuations, it is possible to apply for the cooperation of experts when expressing their opinions through linguistic valuations taking customers and seller positions.

Table IV.3. Linguistic Valuations; Cash Flow Free

	[4.000 ; 6000]	[3.000 ; 6000]	[2.000 ; 5.000]
Customer			
e <sub>1</sub>	(S <sub>4,0</sub> ) - (S <sub>6,0</sub> )	(S <sub>2,0</sub> ) - (S <sub>4,0</sub> )	(S <sub>2,0</sub> ) - (S <sub>4,0</sub> )
e <sub>2</sub>	(S <sub>3,-0.33</sub> ) - (S <sub>4,0</sub> )	(S <sub>4,0</sub> ) - (S <sub>7,-0.33</sub> )	(S <sub>0,0</sub> ) - (S <sub>4,0</sub> )
e <sub>3</sub>	(S <sub>5,0</sub> )	(S <sub>1,0</sub> ) - (S <sub>2,0</sub> )	(S <sub>0,0</sub> ) - (S <sub>3,0</sub> )
e <sub>4</sub>	(S <sub>5,0</sub> )	(S <sub>5,0</sub> ) - (S <sub>6,0</sub> )	(S <sub>2,0</sub> ) - (S <sub>4,0</sub> )
e <sub>5</sub>	(S <sub>2,0</sub> ) - (S <sub>4,0</sub> )	(S <sub>4,0</sub> ) - (S <sub>6,0</sub> )	(S <sub>2,0</sub> )
Seller			
e <sub>1</sub>	(S <sub>7,-0.33</sub> ) - (S <sub>8,0</sub> )	(S <sub>4,0</sub> ) - (S <sub>5,0.33</sub> )	(S <sub>5,0.33</sub> ) - (S <sub>7,-0.33</sub> )
e <sub>2</sub>	(S <sub>5,0</sub> ) - (S <sub>6,0</sub> )	(S <sub>7,0</sub> ) - (S <sub>8,0</sub> )	(S <sub>3,0</sub> ) - (S <sub>4,0</sub> )
e <sub>3</sub>	(S <sub>4,0</sub> ) - (S <sub>6,0</sub> )	(S <sub>6,0</sub> )	(S <sub>2,0</sub> ) - (S <sub>4,0</sub> )
e <sub>4</sub>	(S <sub>2,0</sub> ) - (S <sub>6,0</sub> )	(S <sub>2,0</sub> ) - (S <sub>4,0</sub> )	(S <sub>2,0</sub> ) - (S <sub>6,0</sub> )
e <sub>5</sub>	(S <sub>5,0</sub> ) - (S <sub>6,0</sub> )	(S <sub>7,0</sub> ) - (S <sub>8,0</sub> )	(S <sub>6,0</sub> ) - (S <sub>7,0</sub> )

Then, the unified information will be aggregated being used again the last operator OWA. In order not to reaffirming the calculus, we only develop the operations belonging to the first period for the customers.

Extreme [4.000]

$$\phi = (S_{5,0}) \otimes 0.625 \oplus (S_{4,0}) \otimes 0.125 \oplus (S_{2,0}) \otimes 0.125 \oplus$$

$$\oplus (S_1, 0.33) \otimes 0.125 = (S_4, 0.04)$$

Extreme [6.000]

$$\phi = (S_5, 0) \otimes 0.625 \oplus (S_4, 0) \otimes 0.125 \oplus (S_2, 0) \otimes 0.125 \oplus$$

$$\oplus (S_1, 0.33) \otimes 0.125 = (S_4, 0.04)$$

CFL Seller

$$CFL_1^C = [4.000] + (2.000)(\cdot)[0,4490;0,5185] = [4.898;5.037]$$

To the customers we obtain:

CFL Seller

$$CFL_1^V = [4.000] + (2.000)(\cdot)[0,4768;0,6805] = [4.953;5.361]$$

And for the remaining intervals:

Interval CFL Customer - Seller [3000, 6000]

$$CFL_2^C = [3.000] + (3.000)(\cdot)[0,388;0,6018] = [4.164;4.805]$$

$$CFL_2^V = [3.000] + (3.000)(\cdot)[0,6527;0,7688] = [4.958;5.306]$$

Interval CFL Customer - Seller [2000, 5000]

$$CFL_3^C = [2.000] + (3.000)(\cdot)[0,1666;0,4166] = [2.500;3.249]$$

$$CFL_3^V = [2.000] + (3.000)(\cdot)[0,3379;0,5601] = [3.013;3.680]$$

In the table IV is presented a calculus summary.

Table IV. 4. Calculus Summary

Updating valuations	Year-1	
Interval-K	0,040	0,050
Interval- $\phi$	0,738	0,872
Interval-K <sub>adjusted</sub>	0,04738	0,04872
Cash-Flow Free	Year-1	
Interval-CFL	4.000	6.000
Interval- $\phi$	0,4490	0,6805
Interval-CFL <sub>adjusted</sub>	4.898,00	5.361,00
Updating valuations	Year-2	
Interval-K	0,045	0,060
Interval- $\phi$	0,617	0,858
Interval-K <sub>adjusted</sub>	0,05426	0,05787
Cash-Flow Free	Year-2	
Interval-CFL	3.000	6.000
Interval- $\phi$	0,3880	0,7688
Interval-CFL <sub>adjusted</sub>	4.164,00	5.306,40
Updating valuations	Year-3	
Interval-K	0,050	0,060

Interval- $\phi$	0,183	0,436
Interval-K <sub>adjusted</sub>	0,05183	0,05436
Cash-Flow Free	Year-3	
Interval-CFL	2.000	5.000
Interval- $\phi$	0,1666	0,5601
Interval-CFL <sub>adjusted</sub>	2.499,80	3.680,30

We notice how using the majority operator we get to reduce the interval of variable values considered in the valuation (table 5), which leads us to consider that the enterprise value derived from them will equally present a more reduced interval than if we do not use such operators.

Table IV.5. Range of the interval

Updating valuation	Year-1	Year-2	Year-3
Range of Interval-K	0,010	0,015	0,010
Range of Interval -K <sub>adjusted</sub>	0,00134	0,00361	0,00253
Cash-Flow Free	Year-1	Year-2	Year-3
Interval-CFL	2.000,0	3.000,0	3.000,0
Range of Interval -CFL <sub>adjusted</sub>	463,00	1.142,4	1.180,5

In fact, it is shown in the table 6 the comparative calculus of the two related versions, proving that the use of the majority operators OWA reduces the interval of the positive estimated values in a considerable form, reaching like this our targets. In our example, if we apply directly to the first information the classic expression of 'Discounted Cash-Flow' we will obtain the following interval [8.971; 17.122] with a breadth of 8.151, whereas if we consider the information in the form proposed by the majority operators OWA we will thus obtain a more appreciably narrow interval, that is [11.514; 14.379] of breadth 2.864. The reduction of the range interval is due to the increase of the inferior extreme and the decrease of the higher one.

Table IV.6. Comparative results

Valuation	Interval of Values		Range
V <sub>E(CFL)</sub>	8.971	17.122	8.151
V <sub>E(adjusted)</sub>	11.514	14.379	2.864

XVI. CONCLUSIONS

In this report it has been presented a new strategic valuation system based on the 'Discounted Cash-Flow' model, aggregate operators OWA and linguistic information. Due to the importance that valuation process is representative of the main part of the estimation done by the

experts, it has been used the majority operator LAMA extended to the linguistic representation of 2-tuple, which allows to work with a manifold information in the attaching process.

The use of majority operators OWA in uncertainty contexts, risk and where consent estimations are based on subjective opinions (training and experience) of the stock market agents may produce a greatest ease to come to a value of consent or balance in a quick and objective way. These linguistic operators summarize the first information, allowing an attitude approach which provides the achievement of a consent value or the fast attainment of a balance price in the stock market.

Furthermore, at the same time they generate possibilities of arbitrage and a volatility reduction. In other words, they generate quality information providing efficient decisions, which produces a greatest market efficiency and fluidity.

Finally, we would like to indicate that the proposed methodology is absolutely flexible and adaptable to whichever decision stage both on business and stock market, then allowing having the valuation weights by means of a previous calculus, being used again in other valuation processes, making the method application almost immediate. This is not possible with the traditional methods.

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#### REFERENCES

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- [1] G. R. Amin. Notes on properties of the OWA weights determination mode. *Computers & Industrial Engineering* 52. 533–538. 2007.
- [2] J.-J. Besoun. El nuevo reto del director financiero: riesgo y beneficio. *Revista Estrategia Financiera*. Anuario 2004. 2004.
- [3] R. L. Cross, S. E. Brodt. El valor del juicio intuitivo en la toma de decisiones. *Expansión/Harvard Deusto. Dirigir en la Incertidumbre*, pp. 153-176. 2006.
- [4] F. Herrera, E. Herrera-Viedma, J. I. Verdegay. Direct approach processes in group decision making using linguistic OWA operators. *Fuzzy Set and Systems* 79, 175-190. 1996.
- [5] F. Herrera, L. Martínez. A 2-tuple fuzzy linguistic representation on model for computing with words. *IEEE Transactions on Fuzzy Systems* 8:6, 746-752. 2000.
- [6] A. Kaufmann, J. Gil Aluja. *Introducción de la teoría de los subconjuntos borrosos en la gestión de empresas*. Ed. Milladoiro, Santiago de Compostela. 1986.
- [7] B. Llamazares. Choosing OWA operator weights in the field of Social Choice. *Information Sciences: an International Journal*. 177, 21, 4745-4756. 2007.
- [8] X. W. Liu. Some properties of the weighted OWA operator. *IEEE Transactions on Systems, Man and Cybernetics*, 36, 1, 118-127. 2006.
- [9] G. Pasi & R. Yager. Modeling the Concept of Majority Opinion in Group Decision Making. *Recent Advancements of Fuzzy Sets: Theory and Practice. Information Sciences*, 176, 4, 390-414. 2006.
- [10] J. I. Peláez, J. M. Doña. LAMA: A Linguistic Aggregation of Majority Additive Operator. *International Journal of Intelligent Systems*. 2003.
- [11] J. I. Peláez, J. M. Doña. Majority Additive-Ordered Weighting Averaging: A New Neat Ordered Weighting Averaging Operators Based on the Majority Process. *International Journal of Intelligent Systems*, 18, 4, 469-481. 2003.
- [12] J. I. Peláez, J. M. Doña. A Majority Model in Group Decision Making Using QMA-OWA Operators. *International Journal of Intelligent Systems*, 193-208, 2006.
- [13] J. I. Peláez, J. M. Doña, J. A. Gómez-Ruiz. Analysis of OWA Operators in Decision Making for Modelling the Majority Concept. *Applied Mathematics and Computation*. 2007.
- [14] R. J. Ruiz, A. M. Gil. *El valor de la empresa*. Instituto superior de técnicas y prácticas bancarias. Madrid. 2004.
- [15] R. Yager. On ordered weighted averaging aggregation operators in multi-criteria decision making. *IEEE Trans. On Systems, Man and Cybernetics* 18. 183-190. 1988.



# Developing a Business Application with BPM and MDE

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**Abstract** – In this paper we have designed an architecture for the generation of a business application, that allows to business users to adapt their processes to the constant change. At the moment all the architectures based to a great extent on SOA allow to modify the processes in a short period of time, but we go beyond and give the possibility to the business user of modifying their processes. To design this architecture, we rely on the fundamental use of two technologies: BPM (Business Process Modeling) and MDE (Model Driven Engineering). Inside these technologies we focus on the creation of a business process notation extended from BPMN that is agile, easy to learn and design, and capable to provide semantic information about the process. Therefore this notation allows business process to modify their processes to achieve the proposed goal.

**Keywords:** *Business Process Modeling Notation (BPMN), XML Process Definition Language (XPDL), Atlas Transformation Language (ATL), Model Driven Engineering (MDE).*

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## I. INTRODUCTION

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**N**OWADAYS the increasing tendency to the development of applications based in business processes have triggered a new need due to the constants changes well for restructuring of the organization or for the improvement of their processes that the applications may suffer. For this motive one of the most increasing requirements on the part of the users of business is the possibility of adjustment to the changes, through applications that allow them to manage their own business processes.

The goal of this paper is to present an architecture to offer this functionality which is required by the users. In the practice we have applied this architecture to an application about the food traceability of “*Cabrales Cheese*” [1], but we would apply it to any other application. Initially we begin from the development of a MDE [2], actually a MDA (Model Driven Architecture) [2], which generate an Web Application in ASP.NET. This paper is structured as follows: Section 2 similar architectures at the moment. Section 3 designed architecture for business application. Section 4 generation of the application. Section 5 conclusion. Section 6 future work.

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## II. SIMILAR ARCHITECTURES AT THE MOMENT

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At the moment we have not found architectures for the design of applications that allows the business user to modify or to add new processes. Therefore we will present those architectures that, being based on BPM and MDA, they try to orientate the user towards the development of applications that satisfy their goals. Previously we need to define what we understand for BPM and MDA.

For BPM we understand those graphical notations that allow us to represent the business processes of a certain organization or company.

For MDA [1,3,4] we understand those architectures that driven by models try to separate the functional specification of the system to the specification of the implementation of this functionality in a specific platform.

Once clarified the area of the technologies that allow us to filter the existing architectures, we will continue to see them in detail.

### *A. BPM with Activity Diagrams UML 2.0 and MDA*

This architecture is characterized for being easy and simple of integrating due to the great relation that exists between the activity diagrams and the class diagrams. The class diagrams will allow to MDA to generate the final application.

#### *1) Stage of description*

This architecture focuses on the use of activity diagrams for the representation of the business processes. In the work [5] the activity diagrams are obtained and through of transformations based on code the class diagrams are achieved. Each activity of the activity diagram is mapped to one class in the class diagram. Once obtained the class diagrams they are moved to a MDA tool that will generate the specified application from the class diagrams.

In the work [6] we pretend to generate Web services from the activity diagram. Thank to an UML profile these diagrams provide enough information to be transformed to class diagrams and finally, through the class diagrams, MDA will generate the Web services.

## 2) *Stage of review*

These architectures provide various easy and simple transformations of the activity diagrams to the class diagrams, but they were rejected as a point of departure for our architecture due to the lack of expressiveness that has the activity diagrams UML 2.0 with regard to another notation for the modelled of business process as BPMN (Business Process Modeling Notation) [7]. This lack of expressiveness it is commented in detail in [8,9].

### *B. BPM with BPMN and MDA*

This architecture is characterized for being one of most used and complex, moreover in the most of cases it is completely orientated to services.

#### 1) *Stage of description*

This architecture focuses on BPMN use on the level CIM of the MDA. BPMN is a standard developed and promoted by BPMI (Business Process Management Initiative), whose principal goal is to provide an understandable notation for anyone, from analysts to business users as well as to assure that the languages for the business process execution could be visualized by a common notation.

In the works [10,11], applications orientated to SOA are generated. Therefore BPMN diagrams are transformed to a process model executable language, which in this case is WS-BPEL (Web Service Business Process Execution Language) [12, 13, 14]. WS-BPEL is a standard defined by OASIS (Organization for the Advancement of Structured Information Standards), capable of specify, to achieve the automation of the business processes, to orchestrate the multiple activities of the Web services, to interpret and to execute the processes following a certain architecture. Once obtained the model WS-BPEL it will be generated the whole application with MDA help.

In the works [15, 16] is proposed to pass from BPMN to UML 2.0 activity diagrams and later, from these, pass to class diagrams or to class diagrams directly as it happens in [15], where transformations are made through QVT (Query/View/Transformation)[17]. In the work [16] is considered to pass from BPMN to class diagrams with the addition of an ontological search of terms belonging to the domain of the application, which provides help to identify classes of the domain, to be able to come to a class diagrams checked enough. Once obtained the class diagrams, MDA will generate the application.

#### 2) *Stage of review*

In the works [15, 16] even using BPMN as notation for the business process modelled, an information loss is produced during the pass from BPMN to class diagrams, because they are not capable of express clearly error notations and exceptions and some others aspects.

On the other hand, the works [10,11] this information loss is not produced in the transformation from BPMN to WS-

BPEL. Moreover the transformation from BPMN to WS-BPEL is the most supported by all the both commercial and free tools existing nowadays (Intalio, Oracle BPEL Process Manager, WebMethods) so this transformation is practically direct. The proposed architectures in the works [10,11] were considered as a point of departure for ours.

### *C. BPM with Owner Business Process Modeling Notations and MDA*

This architecture is characterized for being most complex and less used at the moment.

#### 1) *Stage of description*

This architecture in the work [18] presents the integration between two commercial tools: Bizzdesigner and OptimalJ. This integration tries to combine the design and analysis of business process in enterprises application development based in MDA. Bizzdesigner [19] is used for the design, analysis, documentation and information related with business processes. Bizzdesigner uses one owner notations for BPM.

OptimalJ [20] is a MDA implementation based in Eclipse [21]. OptimalJ allows a quick design, development and deployment of J2EE applications. This architecture uses Bizzdesigner to design and model the business process on the level CIM, whereas for the level PIM and PSM use OptimalJ.

#### 2) *Stage of review*

This architecture quickly is discarded because use one owner notation for the Business Process Modeling. This is a problem which involves explaining to business users this notation moreover tool dependence on Bizzdesigner. Therefore this does not allow using another tool or notation for the Business Process Modeling to business users.

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## III. DESIGNED ARCHITECTURE FOR BUSINESS APPLICATION

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The designed architecture has as goal to allow to business users adjustment to the constant changes that suffer their processes. For this reason it allows to any user himself to modify the business processes, in order to adapt them to the new needs that are produced constantly. These modifications will produce changes in the behavior of the application through the architecture proposed by OMG for MDA.

We applied this architecture to our application of food traceability of "Cabrales Cheese", beginning from an application based on MDA, already implemented and into operation with its CIM, PIM and specified PSM. Below we show the business process model for the application "Cabrales Cheese".

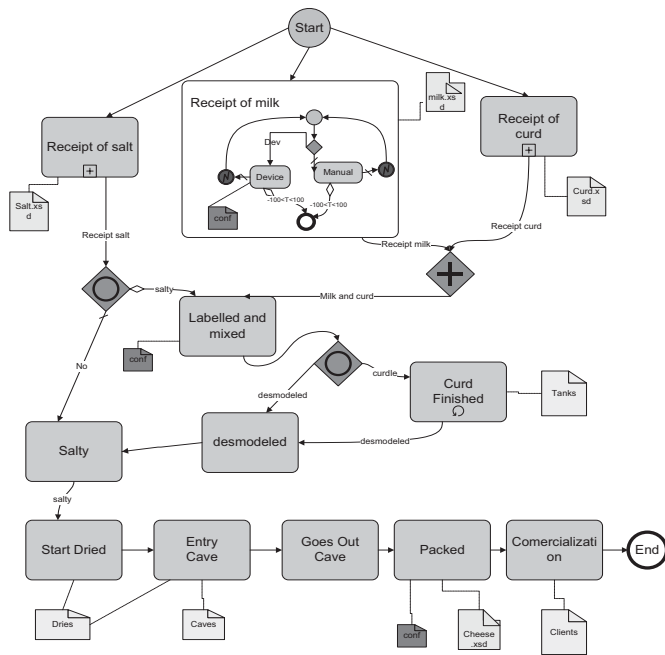


Fig. 2 BPMN – Application Cabrales Cheese

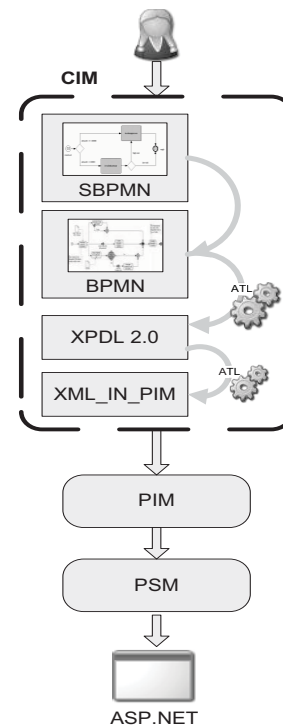


Fig. 3 Designed Architecture

The principal difference of this architecture is going to have one more layer of abstraction belonging to the level CIM. This layer will include the graphical notation that allows representing the business processes of the application.

This graphical notation is BPMN which is the one more extended nowadays for business processes. BPMN is a notation understood by analysts, developers and business users but the last group of users are not capable of using such notation to modify its business processes without need any technical knowledge [22]. To solve this problem we propose an extended notation of the own BPMN but easier, agiler and simpler for the business users, so that it allows them to modify the business processes without any need of technical knowledge. We show below the designed architecture with the levels proposed by MDA. In this figure we focused more the level CIM which is most important.

Inside of the level CIM one important layer is the referred to the transformations between the business process diagrams and the model PIM of our MDA, in which we make two transformations with ATL [23]. One of them model – model of BPMN to XPDL [24] and the other one model – text of XPDL to PIM.

XPDL (XML Process Definition Language) developed by WfMC (Workflow Management Coalition) [24] is a language both textual and graphical that allows us to model the business processes but focus ourselves more on how it may be the work-flow, in order to achieve business goals. One of the most important XPDL advantages is the interoperability that offers between all the tools that support it, as far as it is a XML file that represents even the coordinates X and Y of all the elements that need graphical representation. We use XPDL 2.0 because its version 1.0 as it is said in [25,26] has little expressiveness and does not support all the BPMN elements.

Once done the transformations BPMN to XPDL and XPDL to PIM, we obtain the input XML file which is sent to the PIM. In this moment we will already have everything which is necessary for the application independently of the platform in an only XML file. Therefore we can already generate our application. Principally we have to comment that our application is not orientated to services due to requirements of the user, what means an added difficulty with regard to the architectures taken as point of departure.

We follow the paper on those points that involve an added difficulty at the moment of applying our architecture.

#### A. The Simple Business Process Modeling Notation - SBPMN

As it is commented in [22], nowadays BPMN is a notation understood by analysts and business users but never a business user is able to make a diagram with BPMN himself, due it contains terms and properties with technical character. For this reason it is proposed the use of SBPMN (Simple Business Process Manager Notation) that follows the standard defined by BPMN excluding and changing those concepts that could need technical knowledge. With this goal we develop an editor for SBPMN Fig. 3. This editor has as an objective to provide major simplicity and to help the business user at the moment of creating a SBPMN diagram. Someone of the points most distinguished of this editor are:

- Contextual helps for every notation element, allowing the user to know all the possibilities offered by each element.

- Control of errors, indicating the possible solutions that the user should take to solve the error.
- Validation of the diagrams, verifying that the represented diagram fits the notation SBPMN and certainly BPMN.
- Reduces the decision tasks on the part of the of business user at the moment of selecting one element or another.
- Exportation of the diagram to XPDL 2.0 format, allowing to extend this functionality to include any other format as WS-BPEL.

Later we show a picture of the editor SBPMN.

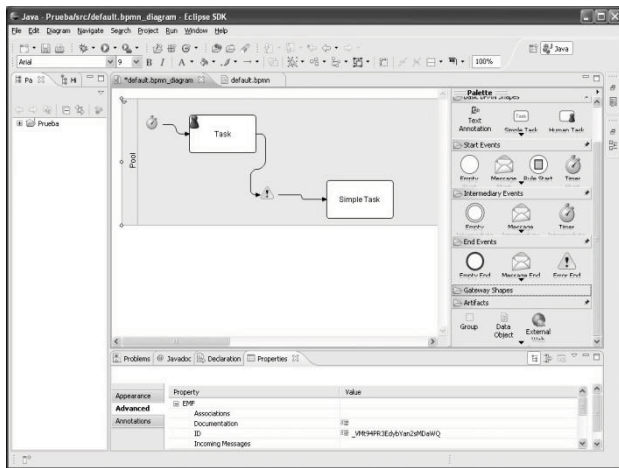


Fig. 4 Editor SBPMN

One of the points that reduces the decision tasks in the business user's side, is the use of gateways or tasks elements.

Among the main elements of the notation we make a reform in the offered tasks in BPMN. Actually BPMN only offers one element, Simple Task. In SBPMN we classify the tasks in three types: Human Task, Automatic Task and Simple Task, these task provide us more semantic information about the type of the process. This type of additional information had been really important for the authors of the work [10] where they created a group of primitives in the business process modeling for the creation of a navigability diagram through BPMN. Next we show in the Table 1 the different type of tasks in SBPMN.





BPMN	SBPMN
	 Simple Task
	 Human Task
	 Automatic Task

Table 1 BPMN Task and SBPMN Tasks

In BPMN the user is about to choose the gateway that fits his problem, on the other hand in SBPMN the user choose an unique gateway and, it depends on the needs required by it, the user will introduce some kind of parameters or other ones in order to define the functionality of it. Later with these parameters as a point of departure, the editor will transform in the exportation process to the most suitable BPMN gateway.


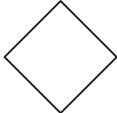



BPMN	SBPMN
 Gateway AND	 Gateway
 Gateway Complex	
 Gateway OR	
 Gateway Event-based	

Table 2 BPMN Gateways and SBPMN Gateway

The help to the user is emphasized in the elements utilization that allow to the user to recognize in the notation those needs without to require big efforts, for it an example is the icons utilization that indicate the functionality of a familiar way in the elements so called events.











BPMN	SBPMN
 Event Cancel	 Event Cancel
 Event Exception	 Event Exception
 Event End	 Event End
 Event Timer	 Event Timer
 Event Start	 Event Start

Table 3 BPMN Events and SBPMN Events

On the other hand we discard the model proposed by the work [22] since this one allowed to the user to define the requirements and functionalities of the application with a textual format. Therefore this information never could be

represented in a formal language.

1) *Evaluating the notation*

All characteristics of this notation have been evaluated though of two tests. These tests are one about BPMN and another about SBPMN. These tried to evaluate the same aspects with each notation to demonstrate that SBPMN is simpler, easy to learn and use and agile than BPMN. The tests were structured in three blocks: Notation elements identification, Notation elements matching from the needs and Identification of process modeling mean from notation. The tests were realized by 75 people with different levels in the business process modelling. Below we show a figure that represents the total percentage of skills and failures for every notation without considering the division proposed depending on the level of the users.

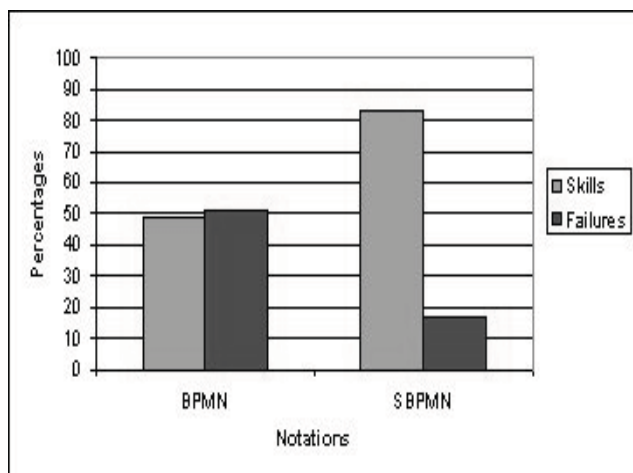


Fig. 5 Graphic of the Global results

Analyzing the results obtained in the three blocks we can establish that the facility of use and understandable of the SBPMN notation is better than in BPMN in all user levels. Even more the users with low and medium levels present more difficulties to understand the use that each one of the elements that BPMN has.

The notation SBPMN represents the most important element of our architecture so that it allows the user to modify his business processes.

*B. Necessary Semantics for business process modeling*

One of the problems that we initially consider was if we could represent through the BPMN all the necessary semantics. The answer turned out to be affirmative, since to define the necessary semantics of our application we use SBPMN. This notation is a extension of BPMN therefore it has rich and clear semantics since it allows the graphical representation of abnormal execution flows, capture of exceptions, events and compensations as well as the representation of conditions and complex structures, therefore we will be able to reflect the whole semantics of our application as it is commented in [22].

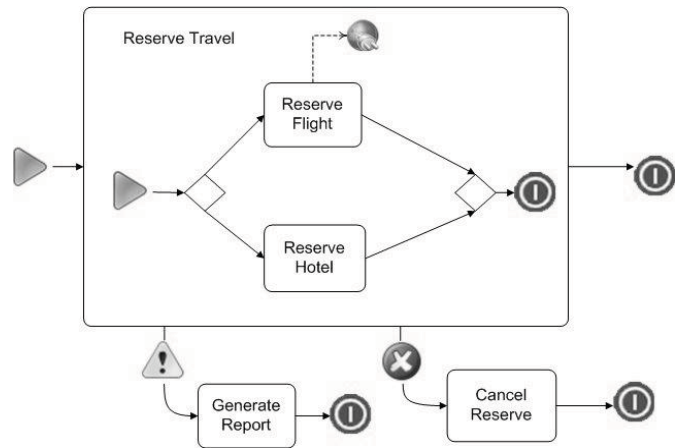


Fig. 5 Example of the notation SBPMN

As it is possible to observe in the figure 4 we can define through SBPMN all the necessary semantics. In this case we can represent the capture of exceptions, flows with condition, utilization of artifacts.

*C. Navigation model*

One of the initial questions was the navigation model. With the study of the works [10,27] we discovered a methodology to elaborate the navigation model starting from the business process model. In the works [10,27] was commented that in the business processes described in any diagram there are three kind of processes: executed by the user, automatic and external services. All these types of processes are defined in the business process diagram through BPMN, therefore those processes which need human interaction may appear defined in the navigation model.

To carry out the model – model transformation it was established the transformation between the business process model and the navigation model and later it was necessary a second transformation, in this case a model - text transformation which changes the existing navigation model to the presentation technology chosen for the application.

*D. Information rendered*

In this point we have to bear in mind that as we have an application for an company, they have templates with a determined format for the information rendered, that is why it is drastically reduced the complexity that this point showed at the beginning.

On the other hand for the forms design it will be used XForms [28] that will allow the creation of forms for those processes that need the active partition of the user.

*E. Transformations model-model and model-text*

In the CIM level it takes place two transformations modelBPMN - modelXPDL and modelXPDL - textPIM. These transformations could have been solved rapidly through the use of BPDM (Business Process Definition Metamodel) [4, 29]. BPDM is a metamodel proposed by

OMG for the MDA paradigm. This metamodel has not been declared as a standard yet but a lot of works so assure that it will finally does. It tries to establish the logical relations between the different types of business process modelled independently of notation or methodology, trying to define the connections between terms and concepts. Therefore any notation like BPMN or the UML 2.0 activity diagrams would be able to use the BPDm metamodel as a bridge to any other metamodel for example to UML class diagrams or to XPDL metamodel.

This technology has not been used due to the fact that there is no official specification and it still has not been adopted as standard by OMG. Therefore to make these transformations ATL has been used defining the transformation rules manually. ATL is a language of transformation model based on the standards OMG [2], MOF [17], QVT [17] and OCL 2.0 (Object Constraint Language). It is a hybrid language since it works with declarative and imperative constructions. The declarative constructions are the option preferred to write transformations, since they are clear and precise. They allow to express correspondences, between the elements of the source model and of the target model, from a series of compositions of rules. Additionally the imperative constructions provide builders to make easy the specification of correspondences that in a declarative way would be much more complex.

1) Transformation from model BPMN to model XPDL

Beginning with the use of ATL as a transformation metamodel between both models we have to emphasize that MDA forces the use of upper models such as metamodels. In our case we will use MOF, Ecore (Eclipse Modeling Framework). To facilitate the work and avoid the transformation from a KM3 model to a Ecore metamodel, as it was commented in [31], we decide to use Ecore's existing metamodels for BPMN 1.0 and XPDL 2.0 that can be downloaded from Eclipse. Finally we use the ATL transformation rules defined between both models obtaining the XPDL model.

```
rule SequenceFlow2Transition{
    from
        b : BPMN!SequenceFlow
    to
        out : XPDL!Transition(
            quantity <- b.quantity,
            from_element<- b.from_element,
            to_element <- b.to_element
        )
}
```

Fig. 6 Example of the file of transformation atl

The objective of using XPDL 2.0 owes especially to its interoperability power and to the critical fact of expressing all the necessary semantics that BPMN owns. For the

creation of this transformation we have born in mind the experiences of the works [30,31], obtaining a complex but efficient transformation.

2) Transformation from model XPDL to model PIM

For this last transformation we have also used ATL and the XPDL model obtained in the previous transformation. Therefore it is only necessary to define the ATL equivalence rules between the XPDL model and the input XML format to the PIM of our MDA. The result is a XML text file that will be the necessary for our PIM level.

```
<PIM>
<actions>
<action Id="ACTION_RECEPCION_LECHE" NumberId="1"
Relation="1_1" Simple="ITEM_RAW_LECHE|ITEM_RECEPCION_LECHE" Multiple="" Must="" Main="" Info="">
<inputs>
<input Id="ITEM_RAW_LECHE" />
</inputs>
<outputs>
<output Id="ITEM_RECEPCION_LECHE" />
</outputs>
<constraints>
<constraint ErrorMessage="CONSTRAINT_ACTION_COUNT_1-1"
Type="count" Mode="strong">{$ITEM_RAW_LECHE $EQUAL 1 $AND $ITEM_RECEPCION_LECHE $EQUAL 1}</constraint>
<constraint ErrorMessage="CONSTRAINT_ACTION_EXPRESSION_LOCATION_TEMPERATURA"
Type="expression"
Mode="strong">{$ITEM_RAW_LECHE.PROPERTY_TEMPERATURA $GREATER -100} $AND {$ITEM_RAW_LECHE.PROPERTY_TEMPE
</constraints>
<devices>
<device Id="DEVICE_ETIQUETADORA_1" Interface="WEB" Operation="LABELPRINTER" />
<device Id="DEVICE_ETIQUETADORA_1" Interface="DEVICE_BIZERBA_1" Operation="LABELPRINTER" />
</devices>
</action>
```

Fig. 7 Example of XML of the PIM

IV. GENERATION OF THE APPLICATION

Once overcome the points that represented a difficulty in the creation of the architecture, we can establish that from the transformations commented in the point 3.5 we obtain the complete CIM. The output provided by the CIM corresponds with the XML necessary for the PIM, from the PIM our MDA it is capable to generate all the application. The generation of the application through MDA is commented with more detail in the work [1].



Fig. 8 Example of a screen of the application

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V. CONCLUSIÓN

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The designed architecture in this paper pretends to offer an system over the current technologies, to be able to allow to the user to modify the behavior of his application through a business process notation simple and understandable without need of technical knowledge. To confront such a challenge we tried to find technologies that were bringing us the most possible over the fulfillment of our goals for this reason we mix the power of BPM and the capacity of applications generation of MDA. These two technologies were bringing us over to the resolution of the problem, but themselves they were not solving it.

Therefore we had that to extend BPMN, to obtain a notation that was understood by the business user, for this reason we created SBPMN.

Later we checked that the pass between the SBPMN diagram and the PIM of our MDA. It was difficult because it required complex transformations and the same time SBPMN would have to be able to represent more aspects as the navigation, semantics.

We think that this architecture represents a point of departure for the business application generation that allows the immediate and simple adjustment the changes without need of costly tasks.

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VI. FUTURE WORK

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Inside the future work of this paper we need to finish the SBPMN editor of the CIM layer. Also we want to improve those points where we have detected a higher percentages of failures that provoked confusion or the lost of time in the users when they made the tests.

Others of the possible points of investigation it is the information rendered since at the moment we focus on only in the use of existing templates, with what we reduce drastically the possible errors that could arise at the moment of the information rendered beginning with the navigation model generated from the business process model.

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REFERENCES

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- [1] V. García-Díaz, H. Fernández-Fernández, E. Palacios-Gonzalez, C. Pelayo G-Bustelo, J.M. Cueva Lovelle. "Intelligent tracability system of Cabrales cheese using MDA TALISMAN". University of Oviedo, 2007.
- [2] Object Management Group, <http://www.omg.org/>.
- [3] Douglas C. Schmidt. "Model-Driven Engineering". Vanderbilt University, Feb-2006.
- [4] Harmon Paul. "The OMG's Model Driven Architecture and BPM". Business Process Trends, Page numbers (1-12), May-2004.
- [5] J. Paulo Barros, Luis Gomes. "From Activity Diagrams to Class Diagrams". University Nova of Lisboa, Page numbers (2), 2003.
- [6] David Skogan, Roy Gronmo, Ida Solheim. "Web Service Composition in UML". SINTEF Information and Communication Technology, Page numbers (1-12), 2004.
- [7] Business Process Modeling. OMG, <http://www.bpmn.org/>.
- [8] Lauri Eloranta, Eero Kallio, Ilkka Terho. "A Notation Evaluation of BPMN and UML Activity Diagrams"; Page Numbers (1-45), 2006.
- [9] Juan Diego P.J., Amador D.T., Antonio R.C. "¿Por qué OMG ha elegido BPMN para modelar los Procesos de Negocio si ya existe UML?". University of Salamanca, 2007.
- [10] Victoria Torres, Vicente Pelechano. "Building Business Process Driven Web Applications". Technical University of Valencia, 2007.
- [11] Miguel Ángel Sánchez Vidales, Ana Hermoso García, Luis Joyanes Aguilar. "Una recomendación basada en MDA, BPM y SOA para el desarrollo de software a partir de procesos de negocio en un contexto de Negocio Bajo Demanda". University Pontificia of Salamanca, 2006.
- [12] Stephen A. White. "Using BPMN to Model BPEL Process". IBM Corp., 2005.
- [13] Join White. "WS-BPEL Extension for People – BPEL4People". IBM and SAP, Jul-2005.
- [14] Yi Gao. "BPMN-BPEL Transformation and Roud Trip Engineering". eClarus Software, Page numbers (1-6), 2006.
- [15] Alfonso Rodriguez, Eduardo Fernández Medina, Mario Piattini. "Hacia la obtención de Clases de Análisis y Casos de Uso desde modelos de Procesos de Negocio". University of Castilla-La Mancha, 2006.
- [16] Wararat Rungworawut, Twittie Senivongse. "Using Ontology Search in the Design of Class Diagram from Business Process Model", 2006.
- [17] Meta Object Facility (MOF) Query/View/Transformation Specification, Versión 2.0, OMG, <http://www.omg.org/cgi-bin/doc?ptc/2007-07-07>.
- [18] Henk Jonkers, Maarten W.A. Steen, Lex Heerink, Diederik van Leeuwen. "Bridging BPM and MDE: On the integration of BiZZdesigner and OptimalJ", 2007.
- [19] BiZZdesigner. <http://www.bizzdesign.nl/html/bizzdesigner.html>.
- [20] OptimalJ, Compuware. <http://www.compuware.com/>
- [21] Eclipse Modeling Framework. Eclipse EMF, <http://www.eclipse.org/modeling/emf/>
- [22] Michael Hevay. "Keeping BPM Simple for Business Users", Business Process Management Trends, Jan-2006.
- [23] Atlas Transformation Language (ATL). <http://www.science.univ-nantes.fr/lina/atl/>
- [24] Workflow Management Coalition, "Process Definition Interface - XML Process Definition Language", version 2.0, <http://www.wfmc.org/>, Oct-2005.
- [25] Wil M.P. van der Aalst. "Patterns and XPDL: A Critical Evaluation of the XML Process Definition Language". Eindhoven University of Technology, 2004.
- [26] Robert M. Shapiro. "XPDL 2.0 Integrating Process Interchange & BPMN". WfMC, Apr-2007.
- [27] Victoria Torres, Pau Giner, Vicente Pelechano. "Web Application Development Focused on BP Specifications". Technical University of Valencia, 2006.
- [28] Richard Cardone, Danny Soroker, Alpina Tiwari. "Using XForms for Simplify Web Programming". IBM, 2004.
- [29] OMG Group. "Business Process Management with OMG Specifications". OMG, Oct-2007.
- [30] Beatriz Mora, Francisco Ruiz, Félix García, Mario Piattini. "Experiencia en transformación de modelos de procesos de negocios desde BPMN a XPDL". University of Castilla-La Mancha, 2006.
- [31] CAPE VISIONS. "XPDL with BPMN Extensión.", 2004. biography.

# Business Process Re-engineering in Saudi Arabia: A Survey of Understanding and Attitudes

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[33]

**Abstract** — This survey was conducted in the Kingdom of Saudi Arabia (KSA) to investigate the level of awareness of BPR. Respondents (customers, employees, and managers) had different educational backgrounds and were from private and public sectors. Findings of the study indicate a general awareness of BPR in KSA.

**Keywords:** Business Processes, Business Process Re-engineering, BPR, Information Technology

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## I. INTRODUCTION

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**B**USINESS process reengineering (BPR) is the result of a new process-orientation that is trying to overcome some of the problems raised by Taylor's traditional view of structural specialisation. It stresses the radical change of processes concerning different departments. However, the redesign of processes is only one aspect of the management of business processes. At least three different kinds of process management can be identified: the management of ongoing business processes, the improvement of business processes and the re-engineering of business processes [1]. In order to reengineer a business process, both internal and external process capabilities; such as product development, production, distribution suppliers and markets, and inter-organisational relationships; especially in a global manufacturing environment, need to be integrated.

The purpose of re-engineering is to achieve lean production by integrating production activities into self-contained units along the production flow, with Information Technology an important element [4]. Information Technology holds a key integral factor in developing data integration strategies in various legacy systems and current technology frameworks. Systems need to reflect a Service-Oriented-Architecture approach to effectively manage resources to enhance work practices, and provide optimal feedback mechanisms to improve efficiency and conform to ISO environmental standards [21].

Universal middleware standards, including Web Services play a key role in integrating autonomous systems in a global scale for multinational companies.

By harmonising data exchange mechanisms, real-time information can be relayed to a managing authority that can

respond to changes in system behaviour before tolerance thresholds reach unacceptable levels, potentially avoiding environmental tragedies in volatile industries such as petroleum refineries.

Transformation involves changing many of our assumptions and principles of management and re-examining the nature of work and workers. Jobs should be organised around outcomes, not tasks. Individuals should be empowered to use discretion and judgment in performing their duties and obligations. Control, accountability, and processing must be built into the work process so that individual efforts contribute directly to the success of the organisation [2]. There are several reasons for organisations to re-engineer their business processes:

1. to re-invent work methods to satisfy customers;
2. to be consistently competitive;
3. cure systemic process and behavioural problems;
4. enhance capability to expand in other industries;
5. to accommodate an era of change;
6. to satisfy their customers, employees, and other stakeholders who want them to be dramatically different and/or to produce different results,
7. to survive and be successful in the long term; and
8. to invent the "rules of the game" [3].

In Hammer and Champy [20], they argue the labour division model designed in the nineteenth century simply do not work as companies enter the twenty-first century. They present concepts of redesigning business processes and propose to move the organisation from a narrow mesh of task-oriented jobs to one comprised of multi-dimensional jobs where workers are expected to think, take responsibility, and act accordingly [5]. They cite three reasons:

- Firstly, Processes tied with 21<sup>st</sup> century products and services are complex and require many tasks.
- Secondly, several management layers are needed for coordination, which creates "distance" between customers and management.
- Finally, as task decomposition and coordination becomes an intricate process, adapting it to changes in environment becomes more difficult.



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## II. DEFINITION OF BPR

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Hammer and Champy [20] noted that in the business environment, nothing is constant or predictable—not market growth, customer demand, product life spans, technological change, or the nature of competition. As a result, customers, competition, and change have taken on entirely new dynamics in the business world. Customers now have choice, and they expect products to be customised to their unique needs. Competition, no longer decided by "best price" alone, is driven by other factors such as quality, selection, service, and responsiveness. In addition, rapid change has diminished product and service life cycles, making the need for inventiveness and adaptability even greater. This mercurial business environment requires a switch from a task orientation to a process orientation, and it requires re-inventing how work is to be accomplished. As such, reengineering focuses on fundamental business processes, as opposed to departments or organisational units [2]. According to Hammer and Champy, reengineering is defined as "The fundamental rethinking and radical redesign of business processes to achieve dramatic improvements in critical contemporary measures of performance, such as cost, quality, service and speed". In other words, they proposed a radical shift: rather than defining a business by the products or services it produces, businesses are defined by what they do well. They believed such a view of business barriers to growth as businesses found new ways to adapt what they did well to new markets. It also eliminated the gap between strategy and implementation since senior management no longer simply set goals but had to understand exactly what goals to achieve. Reengineering, like restructuring, is a method of revolutionary change and thus embodies all general features of such radical changes [6].

BPR has contributed to the provision of techniques for continuous improvement [20]. Since technology is constantly advancing, and the business environment is constantly changing, processes and the systems supporting them are in need of methods to facilitate and guide their parallel improvement. This in turn enables businesses to focus on the customer and adapt to the customer's changing requirements (Hammer, 1993; Harrington, 1991). In a business environment, where the customers' needs are driving forces, BPR provides business organisations with the opportunity to adjust dynamically to customer demands [7].

Chan and Peel (1998) conducted a survey of 37 companies in 17 different industries to investigate the causes and the impact of BPR. They concluded that the primary reasons for BPR are increasing efficiency (internal) and improving customer service (external). Francis and McIntosh (1997) identified causes for the emergence of BPR such as customers, competition (global), technological development and IT. Most companies are function or department-oriented, and not process-oriented. Often, many people are involved in order fulfilment, but nobody tracks a product and reports the status of an order directly. Reengineering makes one individual responsible for the

complete business process (Self, 1995). In another study, the success of BPR is related to the creativity of the people in the organisation (Paper, 1997). Some of the factors that will prevent reengineering and hence innovation and growth are:

- i. correcting the process instead of changing it;
- ii. loss of nerve;
- iii. the barons;
- iv. change of company champion;
- v. settling for minor results;
- vi. culture, attitudes and skill-base;
- vii. skimping on resources; and
- viii. pulling back when people resist change [8].

---

## III. SUCCESSFUL IMPLEMENTATIONS OF BPR

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Business process reengineering means moving from the 'assembly-line approach' to the bundled-responsibility or task-subsuming approach, where a process is overseen and handled by key people doing this job from start to end [9]. The fundamental pattern is to widen individual responsibility in the sense of job enlargement in order to meet market-driven needs. This is an extension of Herzberg's concept of job enlargement [10]. Reengineering is the fundamental rethinking and radical redesign of business processes to achieve dramatic improvements in critical, contemporary measures of performance, such as cost, quality, service and speed. BPR advocates that enterprises go back to the basics and re-examine their very roots. It doesn't believe in small improvements, but rather it aims at total reinvention.

As for results, BPR is clearly not for companies who want a 10% improvement. It is for those who need a ten-fold increase. BPR can succeed only when the importance of both people skills and technical skills is fully recognised, and both are properly applied. Many attempts at reengineering have failed because this has not been understood [11]. Empirical studies provide mixed evidence regarding the success of BPR

On the one hand, researchers at Computer Sciences Corporation index (CSCIndex) reported that approximately one-fourth of the re-engineering projects they had studied in North America were not meeting their goals (Cafasso, 1993). In another industry survey conducted by Deloitte & Touché in 1993, Chief Information Officers (CIOs) indicated that the actual benefits of BPR projects had generally fallen short of expectations [12].

According to Hammer and Champy [20]; BPR focuses on processes and not on tasks, jobs or people. It endeavours to redesign the strategic and value added processes that transcend organisational boundaries [13]. An organisation creates value through its processes. BPR provides a method for work groups to identify and prioritise issues and concerns in work processes. Many articles point out that BPR must have the full support of top management to succeed. If resistance is encountered, the leader must be willing to drive change, even to the point of ruthlessness. Managers in a company undergoing reorganisation must

work to quell the fears of employees and resistance to change (despite the fact that they may have their own apprehensions) [14]. It also provides a structure for employees for all levels in the organisation to have open dialogue regarding those issues and concerns. BPR causes an organisation to become introspective and assess how it does its business and utilises its staff. BPR also helps business units to begin preparing for managed competition by streamlining processes and optimising the use of employees [15].

The progression of BPR concept from theory to sustained practice is dependent on the development of its theoretical base, and the introduction of methodological approaches that are capable of being used by practitioners [16]. Andrews and Stalick (1992) have argued for a systemic approach to BPR, suggesting that "reengineering...should be based upon numbers and facts, not guts and politics". BPR projects cannot be planned meticulously and organised into precise steps which can be prescribed as universally applicable in all situations (Caron et. al., 1994; Hammer, 1990). Nevertheless, since BPR requires a fundamental reappraisal of business operations, a methodology which can act as an anchoring framework to coordinate the complex web of BPR activities is essential. A clear and committed approach to BPR is necessary, but a possible danger identified in the literature is that those involved in the BPR project will confuse motion with progress, and charge about in random directions hoping that any recommended changes can be

successfully implemented as a matter of course (Evans, 1993). Caron et. al. (1994) state that implementing BPR recommendations may require a fundamental change in organisational culture and mind-set and this cannot be left to chance, but must be carefully managed. They also argue that visibility into the BPR exercise is vital and must intensify as the project proceeds. Thus, the adoption of some methodological support is appropriate [17].

There are nine major elements considered by experts to be stepping stones to successful business process reengineering. They cover a wide range of activities, such as identifying customer needs and performance problems, reassessing strategic goals, defining reengineering opportunities, managing reengineering projects, controlling risks and maximising benefits, managing organisational changes, and successfully implementing new processes. Taken together, these nine elements provide a general framework for assessing a reengineering project, from initial strategic planning and goal-setting to post-implementation assessments [17]. According to the BPR Online Learning Centre, more than half of early reengineering projects failed to be completed or did not achieve bottom-line business results, and for this reason business process re-engineering "success factors" have become an important area of study. The success factors below are derived from benchmarking studies with more than 150 companies over a 24 month period. Success factors are a collection of lessons learned from reengineering projects.

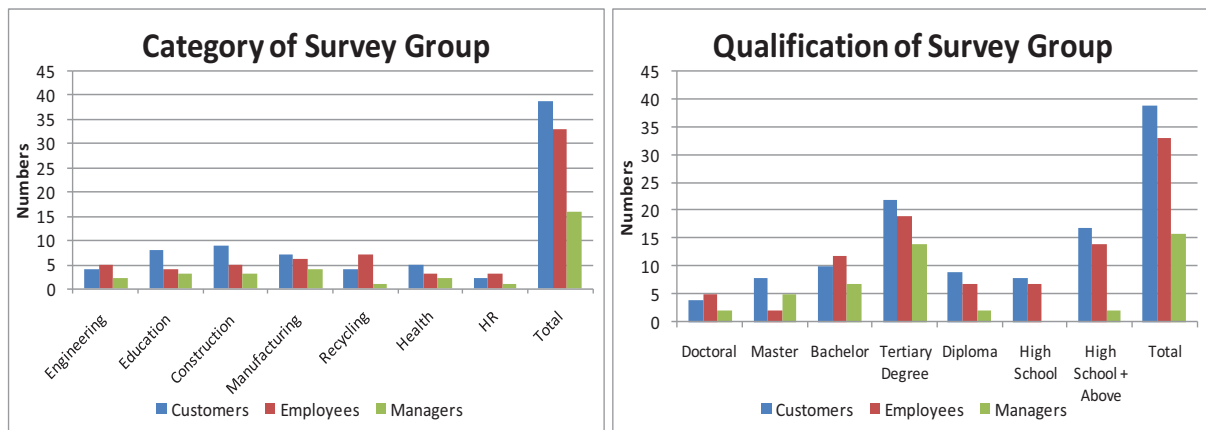


Figure 1(a)(b): Histogram of Survey Group Background and Qualifications

Type of Industry	Public	Private	Customers	Employees	Managers	Total
Engineering	6	5	4	5	2	11
Education	9	6	8	4	3	15
Construction	9	8	9	5	3	17
Manufacturing	10	7	7	6	4	17
Recycling industry	7	5	4	7	1	12
Health	4	6	5	3	2	10
Human resource	2	4	2	3	1	6
Total	47	41	39	33	16	88
%			44.25	37.50	18.25	100

Table 4: Categorising Survey Groups to Industry and Economic Sectors

Qualifications	Customers	%	Employee	%	Managers	%	Total	%
Doctoral	4	36.36	5	45.45	2	18.18	11	12.50
Master	8	53.33	2	13.33	5	33.33	15	17.05
Bachelor	10	34.48	12	41.38	7	24.14	29	32.95
Higher degree	22	40.00	19	34.55	14	25.45	57	62.50
Diploma	9	50.00	7	38.88	2	11.11	18	20.45
Higher school	8	53.33	7	46.67	0	0	15	17.05
High school & above	17	51.51	14	42.42	2	6.06	33	37.50
Total	39		33		16		88	100.00

Table 5 Categorising Survey Groups to Educational Level

These success factors are [18]:

- Top Management Sponsorship (strong, consistent involvement).
- Strategic Alignment (strategic direction)
- Compelling Business Case for Change (with measurable objectives).
- Proven Methodology (includes a vision process)..
- Effective Change Management (address cultural transformation)
- Line Ownership (pair ownership with accountability).
- Reengineering Team Composition (in both breadth and knowledge).

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#### IV. BUSINESS PROCESS RE-ENGINEERING CONCEPTS IN KSA

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It is well known that the concept of BPR is currently very topical and is ubiquitous in recent organisational, management and information technology literature. The extent of the widespread popular interest in the BPR can be gauged from the fact that Hammer and Champy's recent book on Business process reengineering featured at the top of the US best-seller lists [19]. The researcher conducted a survey from January 2007 to October 2007 to study the level of awareness of BPR in Saudi Arabia and to what extent this concept is perceived as a fundamental approach to design business processes. This comprised of 88 respondents from Saudi and non-Saudi individuals, from the private and public sector in three groups:

- a. Customers,
- b. Managers, and
- c. Employees (Refer to Table 1).

Respondents had different educational backgrounds, ranging from doctoral certifications to high school level. In Table 2, it shows respondents categories and their educational level.

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#### V. ANALYSIS OF THE RESULTS

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The questionnaire including six general questions was sent by hand, electronically, and by post or facsimile (Table 3). Table 4 shows responses of the three groups to the six general questions aimed at investigating:

1. The understanding and contexts of Business Process Re-engineering in their business domain;
2. The need for recycling resources and fortuitous improvements in efficiency;
3. The acceptance of new technology in their current systems;
4. Overall mentality about changes in management and impacts on current work structures;
5. The correlation between process performance and product quality, both in terms of direct and indirect influences and;
6. The acceptance of changes in management, in terms of the change in strategies and ideas.

In particular, the survey indicates that while respondents were overall positive about the need for management to change their work ideas and structures, a lesser number acknowledged there is a correlation between process performance and product quality. Furthermore, a lesser number understood the context of business process re-engineering in their current work practice, indicating a reduced appreciation of how proper BPR practice can influence improvement in product quality and control.

In these circumstances, there is a concern that while people acknowledge that change is necessary in the mindset of management, a lesser number indicate an empowerment to explore how business process re-engineering can positively affect their current business strategies. Managers are not actively responsive to realising that Information technology serves as a critical resource when factoring business process strategies, and how supply-chain processes can be enhanced with Service Oriented Architectures (SOA).

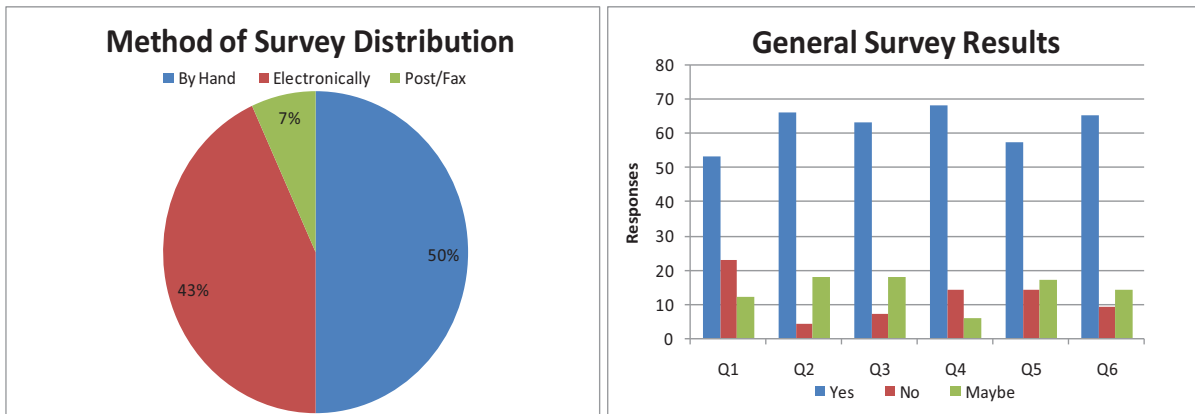


Figure 2(a)(b): Chart of Survey Distribution and Histogram of Survey Results

	By Hand	Electronic / Email	Postal / Faxes	Total
Number	44	38	6	88
%	50%	43.18%	6.82%	100%

Table 6 Distribution Methods of Survey Questionnaire

General Question	Q1	Q2	Q3	Q4	Q5	Q6	Total	%
Yes	53	66	63	68	57	65	372	70.45
%	60.23	75.00	71.57	77.27	64.77	73.86		
No	23	4	7	14	14	9	71	13.45
%	26.14	4.55	7.95	15.91	15.91	10.23		
Maybe	12	18	18	6	17	14	85	16.10
%	13.64	20.45	20.45	6.82	19.32	15.91		
							528	100

Table 7 Responses of Groups to General Questions

## VI. CONCLUSION

The responses show attitudes of the respondents (managers, employees and customers) towards the issues of understanding

BPR, acceptance of new technologies and mentalities about changes in management. Responses revealed that there is a positive attitude towards these issues, with 75% of respondents agreeing with the importance of Recycling business approaches and 71.57% respondents would readily accept new technologies. However, this is contradicted by the fact that only 60.32% of respondents understood and had a positive attitude towards Business Process Re-engineering. Furthermore, only 64.77% of the respondents understood the importance of the correlation between process performance and product quality. The contrast between respondents agreeing with acceptance of new technologies, but at the same time a lower percentage of respondents do not see the how business process re-engineering can improve product quality is a notable difference of opinion among respondents.

This difference could be explained by the fact that people do not see their own roles in promoting or having any positive influence on the overall situation. The discrepancy of the results indicates that there is a degree of disconnect with managers understanding the nature of their current business

processes on product delivery and quality; or employees and customers are not adequately voicing their concerns to improve product service and quality above minimum expectations, or a combination of both these factors.

A strategy focussed on improving current business process strategy needs to be maintained in order to improve performance thresholds on environmental concerns, such as recycling resources and minimising wastage through continuous monitoring and control, which will eventually result in improving the financial performance of the organisation. Furthermore, this strategy needs to be reinforced in all levels of the organisation for any long-term benefit. Environmental sustainability in any industry is critical in all regards, not just in terms of credentials and marketability, but also the economic performance of the organisation.

In conclusion, while there is an overall positive awareness of the importance of BPR between the three groups investigated in this study, the culture of improving current business process models in the industries of Kingdom of Saudi Arabia requires greater transparency for respondents to have a positive influence in promoting BPR strategies. The verification and validation of operational systems relies on proactive SOA middleware infrastructure that can adhere to corporate policy governance and enduring environmental sustainability.

## VII. REFERENCES

- [1] Kutschker M. (1994), *Re-engineering of Business Processes in Multinational Corporations*, Research presented at the Institute's International Research Conference, 2 November 1994.
- [2] OSD Comptroller Center (2008), *Reengineering: A Radical Approach to Business Process Redesign*, URL: <http://www.defenselink.mil/comptroller/icenter/learn/reeng.htm>, Last Visited 14 May 2008
- [3] Encyclopaedia of Management, (2008) *Business Processes Reengineering*, URL: <http://www.referenceforbusiness.com/management/Bun-Comp/Business-Process-Reengineering.html>, Last Visited 6 May 2008
- [4] Gunasekaran A., Kobu B. (2002), *Modelling and Analysis of Business Process Reengineering*, International Edition, Vol. 40, No. 11.
- [5] Kim H.M., Ramkaran R. (2004), *Business Process Management Journal*, Vol. 10, Issue 1.
- [6] Dubrovski D. (2005), *Restructuring and Business Reengineering in Integrative Processes*, Managing Global Transitions, Volume 3, Number 1, Spring 2005, pp81.
- [7] Xenakis A., and Macintosh A. (2005), *Using Business Process Reengineering (BPR) for the Effective Administration of Electronic Voting*, Electronic Journal of e-Government Volume 3 Issue 2 2005, pp94-95
- [8] Gunasekaran A., B. Kobu (2002), *Citation from [4]*, pp25-24.
- [9] Hammer M (1990), *Reengineering Work: Don't Automate, Obliterate*, Harvard Business Review, July-August 1990, pp104-110.
- [10] Jahnke B, Clifford T., Y. Tjiok (2002), *Business Process Reengineering and Software Systems Strategy*, Abteilung für Betriebswirtschaftslehre insb Wirtschaftsinformatik Universität Tübingen.
- [11] Berztiss A. (1997), *Software Methods for Business Reengineering*, Springer Publishing, p10.
- [12] Boudreau M., Robey D. (1996), *Coping with Contradictions in Business Process Re-engineering*, Information Technology & People, MCB University Press, Vol. 9 No. 4 1996, p40.
- [13] Muthu S., Whitman L., Hossein Cheraghi S. (1999), *Business Process Reengineering: A Consolidated Methodology*, Proceedings of The 4th Annual International Conference on Industrial Engineering Theory, Applications and Practice November 17-20 1999, San Antonio, Texas, USA, p2.
- [14] Weicher M., Chu W.W., Ching W., et al (1995), *Business Process Reengineering Analysis and Recommendations*, A paper written by a group of MBA and MS students at Baruch College, City University of New York, 1995, URL: [www.netlib.com](http://www.netlib.com). Last Visited 8 May 2008
- [15] City of San Diego (2008), *2008 Fiscal Year Annual Budget*, Business Process Reengineering, p32
- [16] Fitzgerald B., Murphy C. (1996), *Business Process Reengineering, The Creation and Implementation of a Methodology*, Executive Systems Research Centre, University College, Cork, Ireland.
- [17] United States General Accounting Office (1997), *Accounting and Information Management Division Business Process Reengineering Assessment Guide*, May 1997, Version 3.
- [18] BPR Online Learning Centre (2008), URL: <http://www.isixsigma.com/offsite.asp?A=Fr>, <http://www.prosci.com/factors.htm>, on 2nd March, 2008.

# Prototype of assignment intelligent adaptive of service providers inside of ESB with data mining

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**Abstract** —The SOA philosophy can address new business challenges, become more competitive and provide integrated information systems. In addition, technologies such as BPM, BAM and Web Services are essential complements to SOA. This work aims to use several of these technologies integrated into a single application that will allow in a phase of a previously defined business process, to perform the analysis of input suppliers to the company through the generation of a decision tree using embedded code of the free tool Weka for data mining in order to feedback the business process and evaluate these results to improve the process. For the realization of this prototype we worked with the jBPM suite, the API from Weka to get the J48 algorithm, the postgresql database, the format for data exchange JSON and the web service.

**Keywords**— Business Process Management (BPM), Data mining, Enterprise service bus (ESB), jBPM, Services Open Architecture (SOA), Web services.

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## I. INTRODUCTION

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THE evolution of information technologies have had, in recent years, linked to different aspects of the global economy that requires companies to be more competitive and to focus efforts on reducing costs at all fronts in order to maximize utilities, have enabled a constant search and optimization of business processes. This field brought up a revolution in the late 90's, on how to coordinate the internal activities of organizations, has changed dramatically, expanding at a B2B environments that facilitate collaboration among different organizations and today are used in environments designed according to the paradigm of the computing oriented service.

In this context, the business process management systems (BPMS) arise and the workflow management systems thanks to its property of reuse can develop the logic of a business process adaptable to any domain. Although these tools can allow virtually all business process, there are steps in these processes which still remain dependent on human

performance; in these scenarios spot out the idea of contributing to the automation of a business process that requires the selection of input suppliers, this task is performed by a human workflow and its result is feed back to the business process for continuation. Here lies the motivation of this work, building a prototype for the allocation of suppliers, using different technologies, on a hand a BPMS, which contains all business process logic and on the other, a data mining application that use a decision tree for this selection, in this process, the data are stored in a database, the data exchange with the different technologies is done with standard formats like XML or JSON. The approach of this solution is made possible by relying on the oriented-service architecture that allows applications developed with different technologies to share data and functionality supporting the creation of new systems with separate applications working together in a decoupled way. The paper looks at related works, indicates the different technologies included for the completion of the prototype and shows the proposed architecture and its implementation with the difficulties encountered and finally, the conclusions and future work.

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## II. CONCEPTUALIZATION AND WORK RELATED

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This paper aims to show as possible the application that integrates different technologies and get results in transparent way for the user, i.e., we will indicate as from a suite BPM (jBPM) may involve a process of data mining with a call from a stage of a business process and get the results at the stage of the process that made the call.

There are several works that have been focused on the topic of BPM and data mining, but not as an integrated application but as separate processes that provide services. The work presented by [1] shows how starting from a process model as it is possible to discover by conventional process mining algorithms, they analyze how data attributes influence the choices made in the process based on past process executions, aims at the detection of data dependencies, also, describes how machine learning techniques can be leveraged for this purpose. Likewise, it is the work presented by [2] that describe the design and implementation of a system that manages data mining model assets of an organization that can

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support business processes in making real-time decisions and forecasts. This same author presented the work [3] which describes a data mining model management system that addresses the challenges of model aging, management scalability, timely-communication among parties on model changes, semantic gap on interpreting models, and business process integration to support sustainable and operationalized.

There is also the work proposed by [4] which identifies the challenge of case prediction, which for a specific case under the control of a BPMS deals with the estimation of the remaining time until it is completed. An accurate case prediction facility is a valuable tool for the operational control of business processes, as it enables the pre-active monitoring of time violations.

Conceptually, we rely on the Service Oriented Architecture (SOA) and its functioning through services as fundamental elements to integrate and develop applications, in regard to this context we present a general definition developed by [5] "A software architecture as a set of definitions that describe the software components and assigned the functionality of the system components to this components. Describe the technical structure, constraints and characteristics of the components and interfaces between them".

In the same vein, we discuss the concept of Business process modeling and its importance in the development of any industry and as an improvement in a business process positively affects the production and consequently, the products developed, reviewed the work submitted by [6].

Emphasis was placed on the characteristics that differentiate a BPM of a WfMS, at the stage of diagnosis and definition of processes, aspects neglected in a WfMS [7].

The trend today is toward a process-oriented paradigm, where applications should cover the entire business enterprise and the tools are the Business process management systems (BPMS). Establishing the characteristics that must be satisfied the BPMS, will be the centerpiece of development of this project. The BPMS selected must provide:

Process modeling: to capture business requirements in its initial stage and make it available for the rest of the development process.

Running processes: the process execution engine of the BPM system, import the modeling process (defined using BPEL) and then runs and manages instances of processes to meet operational requirements.

Process monitoring: This capability includes the summary view of running processes, of the completed, see states of processes, suspend and resume processes, give warnings and reallocation processes.

Business Activity Monitoring (BAM): analyzes the events generated by business activity and allows give metric.

Afterward, for the integration of different applications was covers the work of [8] about an ESB and the idea of a standard based on the architecture for the integration of heterogeneous systems as proposed by JBI [9], also we discussed the architecture of service components, based on [10] and the use of service data objects (SDO) in accordance with [11].

### III. DESCRIPTION OF PROTOTYPE

As stated at the outset of this paper, the idea is to adapt in transparent way an enterprise business process that is modeling in a BPM system, this business process has a stage of vendor selection that used a decision tree generated through free data mining tool Weka, the result is stored in the database and fed back to the stage of the business process where will make the best decision based on the results obtained, will be used in this coupling, universal communication standards and Web services.

Initially different open source applications were evaluated to perform business process modeling, Intalio, Bonita, Enhydra Shark and jBPM, due to jBPM is one of the most robust solutions with a large and growing community, were decided to select this tool. jBPM is a component of large set of business solutions that composing JBoss.

To generate the decision tree was analyzed the API of the data mining tool of the University of Waikato in New Zealand to extract the necessary collection of libraries that make up the J48 algorithm that is an adaptation of the C4.5 and to embed in the application. Weka (Waikato Environment for Knowledge Analysis) is free software released under the GNU-GPL.

The input data for the evaluation of the decision tree are stored in the database postgresql and delivered to the algorithm using the JSON format for data exchange between database and weka. Because weka uses a file structure called ARFF, acronym of Attribute-Relation File Format it became necessary to convert the JSON format to ARFF, so that data with the criteria for the selection of suppliers delivered to the business process are exchanged between different technologies transparently.

Additionally, we included in this prototype a Web service that is responsible for making available the entire business process management to be consulted by a client through an interface created for this purpose.

### IV. PROTOTYPE ARCHITECTURE

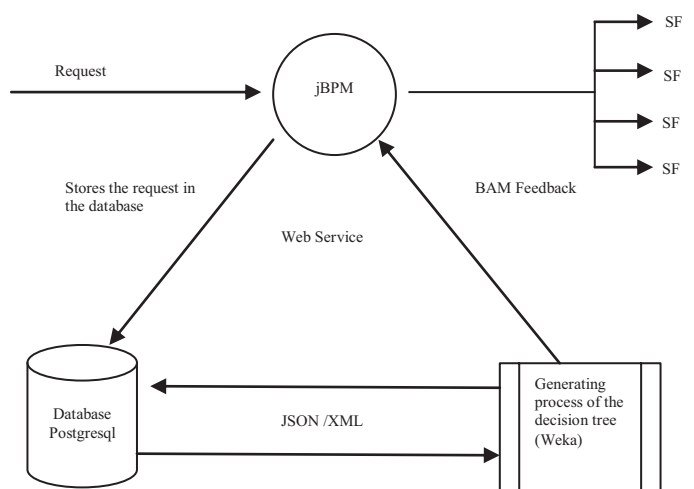


Fig 1. Prototype architecture

A simple business process was designed on the jBPM suite and one of the nodes was associated with an action (action handler) that invokes the process of evaluating different suppliers, in this process were taken the data associated with each potential supplier and stored in the Postgresql database in the table movements. These data are transformed into JSON format in order to make the exchange with the decision tree algorithm. After generating the decision tree results in a confusion matrix was added which contains the number of manufacturers of each class meeting the criteria to be suppliers, the suppliers for each class are taken and carried back to the database, as many tables as suppliers are, tables were created and stored by the supplier and their amount, subsequently, these data are carried to business process node and consulted through a web service.

The following diagram shows the flow between the different components that forming the prototype

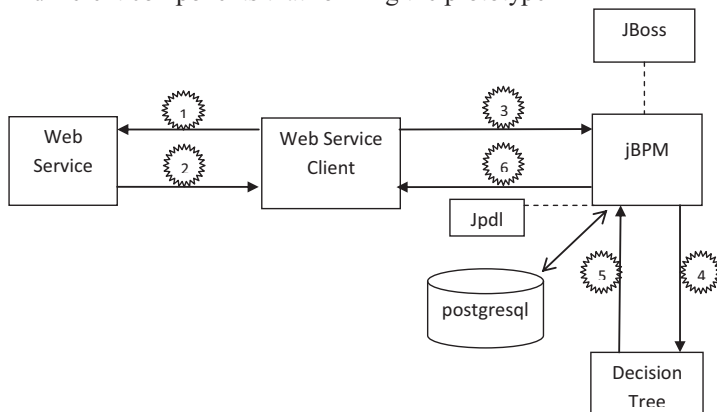


Fig 2. Flow diagram of the prototype

In the user interface is requested read from the Web service, the active business process.

The server executes the request and sends to the user, the defined business process.

The user begins the process by invoking jBPM, with the business process that owns the supplier selection stage.

The information with the criteria for supplier selection is processed in the decision tree using the J48 algorithm.

The resulting confusion matrix is returned to the business process using JSON.

The result is displayed in the user interface and is stored in the database postgresql.

V.PROTOTYPE IMPLEMENTATION

For the integration of the different components, is starting with the module of design of business process of the tool jBPM, here we implemented each of the elements that form the integrated system, using the design platform Eclipse, which is achieved by obtaining a modular system that integrates the components of BPM, Data Mining, JSON and Web services.

The implementation is performed through object-oriented system; this construct consists of a model of classes organized

by packages and development projects.

Development projects comprise the following elements:

- jbpmAnalysis
- Minería
- WebServiceProject

A. jbpmAnalysis

The JbpmAnalysis project is organized in such a way that runs through a previous modeling, a business process. This design is modeled in jpdL, Figure 2 represents the case implemented in this suite the file containing the process is processdefinition.xml.

As general structure a project is proposed having as main element the clsProveedor class, which, by the method activaProceso() starts reading the business process for its further implementation.

As shown in Figure 2, the clsProveedor class uses the definition of jBPM in the MessageActionHandler as the relation of the messages sent between nodes. This is the fundamental basis for the call of the procedures to ensure data mining, which are conducted through clsMineria class.

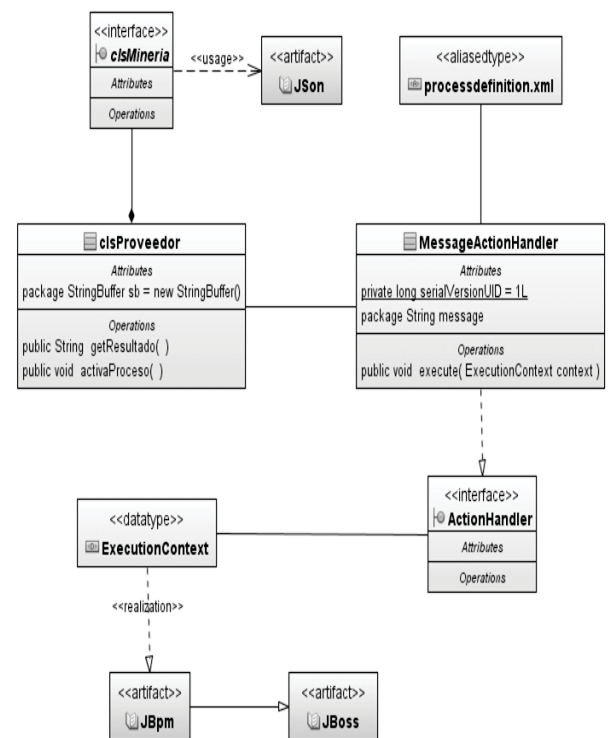


Fig 3. jBPM analysis Project

B. Minería

For the analysis and selection of suppliers, was implemented the J48 algorithm of Weka tool. Its operation is based on the clsMineria class. As shown in Figure 3, the method convierteSB () is used by a web service to publish the results when requested by the client.

For the storage and exchange of data is uses postgresQL database. The connection to this database is done in the class clsMineria() by the method genera(), which is also responsible



for adapting the Json standard to the ARFF format, which requires weka for its operation.

After generating the decision tree, is obtained a confusion matrix that is stored again in the database, generating a table for each manufacturer. This information will be returned to the node designed in the business process using clsProveedor class.

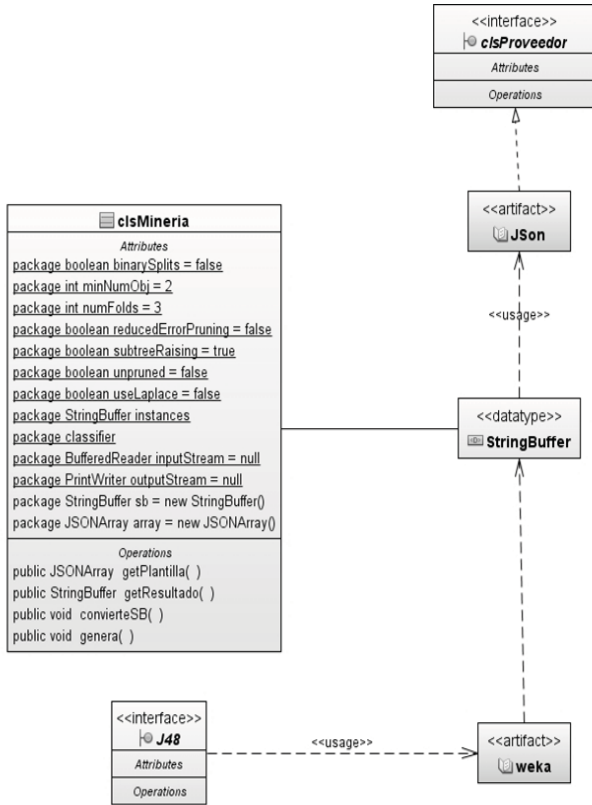


Fig 4. IA Project

### C. WebserviceProject

After generating the processing elements of the business process and data mining, must be created a project that offers through a Web service, the results requested by a particular customer.

The publication of the service is generated via file named clsMain.wsdl, its structure is published offering the generaBPM operation, which allows access through the Endpoint clsMain. The access structure to the Endpoint generated as a service is invoked by the client using classes clsMainService () and clsMainServiceLocator ().

## VI. RESULTS

When generating the request in the business process that has been diagramed in jBPM, at the initial some data are sent that entering the movements table of the database. This table has the following fields (manufacturer, part, preciomin, preciomax, time) with this data is generated decision tree, based on the criteria preciomin, preciomax and time. The class to evaluate is manufacturer.

The result of the decision tree, delivers the confusion matrix discriminated by the manufacturer with the number of manufacturers that meet the criteria, i.e. we assume the tree is provided with the following information:

(intel, 'processor', '100', '300', '5'),  
 (amd, 'processor', '100', '300', '7'),  
 (nvidia, 'processor', '100', '300', '7'),  
 (via, 'processor', '100', '300', '8'),  
 (intel, 'mainboard', '200', '400', '7'),  
 (amd, 'mainboard', '200', '400', '6'),  
 (nvidia, 'mainboard', '200', '400', '5'), and so on, the confusion matrix will deliver the number of manufacturers that meet the criteria for be potential suppliers.

a b c d <-- classified as  
 1 7 3 4 | a = intel  
 2 1 4 6 | b = amd  
 3 5 3 4 | c = nvidia  
 4 3 3 4 | d = via

From here we obtain the total per manufacturer, i.e. for the manufacturer intel are 15 potential suppliers, to the manufacturer amd will have 13 potential suppliers, etc. These data are in ARFF format are transformed into JSON format to be stored in the database by creating a table for each manufacturer, the table name is the name of the manufacturer.

These same data are presented in the stage of the business process that generated the request for evaluation with the decision tree using for this purpose a web service with Apache Axis.

## VII. CONCLUSIONS AND FUTURE WORK

In this paper we proposed a prototype that would improve the performance of a business process using data mining techniques, as seen through various open technologies, can integrate different applications using standard formats for exchanging data between two different applications into a single integrated system.

Although the integration of different applications is demonstrated, the results obtained returned the number of the suppliers delivered to the decision tree, meet the criteria for a possible selection but does not indicate which of them fits best. Nevertheless it may be advised to use a different technique or supplement along with the decision tree to carry the this evaluation out.

Undoubtedly, the principles of SOA have allowed the development and promotion of this area, however, for this project the technology of Web services has made the system more complicated and slower. This is critical if we think of companies working to support real-time business.

Companies are focusing on designs make their business processes but it is important to determine whether the process conceived and designed fitting adequately to the needs for which it was generated, process mining enables us to discover the process itself, through the recording and analysis of information generated by events and determine their weaknesses, composition, execution and allows us to grow and strengthen the process and its management.

The business world and the world of IT can relate best with the incorporation of a semantic processing, combining semantic web and semantic web services with BPM [12]. SBPM Systems.

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REFERENCES

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- [1] A. Rozinat y W.M.P. van der Aalst, "Decision mining in business processes," BPM Center Report BPM-06-10, BPMcenter. org, 2006.
- [2] I. Ari, J. Li, J. Jain, y A. Kozlov, "Management of Data Mining Model Lifecycle to Support Intelligent Business Services". 2008
- [3] I. Ari, J. Li, A. Kozlov, y M. Dekhil, "Data Mining Model Management to Support Real-time Business Intelligence in Service-Oriented Architectures". 2008
- [4] H.A. Reijers, "Case Prediction in BPM systems: A Research Challenge," Journal of the Korean Institute of Industrial Engineers, vol. 33, 2006, págs. 1–10.
- [5] D. Krafzig, K. Banke, y D. Slama, Enterprise SOA: Service-Oriented Architecture Best Practices (The Coad Series), Prentice Hall PTR Upper Saddle River, NJ, USA, 2004.
- [6] J.G. Molina, M.J. Ortín, B. Moros, J. Nicolás, y A. Toval, "De los Procesos del Negocio a los Casos de Uso," Jornadas de Ingeniería del Software y Bases de Datos. Pág. 2000, págs. 103-116.
- [7] W.M.P. Van der Aalst, A.H.M. Hofstede, y M. Weske, "Business process management: A survey," Lecture Notes in Computer Science, 2003, págs. 1-12.
- [8] S. Desmet, B. Volckaert, S. Van Assche, D. Van Der Weken, B. Dhoedt, y F. De Turck, "Throughput evaluation of different enterprise service bus approaches," Proceedings of the 2007 International Conference on Software Engineering Research in Practice (SERP'07), 2007.
- [9] S. Vinoski y I. Technologies, "Java business integration," IEEE Internet Computing, vol. 9, 2005, págs. 89-91.
- [10] M. Beisiegel, H. Blohm, D. Booz, J.J. Dubray, A. Colyer, M. Edwards, D. Ferguson, B. Flood, M. Greenberg, y D. Kearns, "Service Component Architecture. Building Systems using a Service Oriented Architecture," BEA, IBM, Interface21, IONA, Oracle, SAP, Siebel, Sybase, white paper, version 0.9 edition, 2005.
- [11] R. Weaver y S. Specialist, "The Business Value of the Service Component Architecture (SCA) and Service Data Objects (SDO)," IBM Whitepaper, November, 2005.
- [12] Z. Laliwala, R. Khosla, P. Majumdar, y S. Chaudhary, "Semantic and Rules Based Event-Driven Dynamic Web Services Composition for Automation of Business Processes," IEEE Services Computing Workshops, 2006. SCW'06, 2006, págs. 175–182.

# SALCER's Project

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**Abstract**—SALCER (in Spanish: Sistema de Asesoramiento y Localización de Centrales de Energía Renovables) could be translated as Counseling and Location of Renewable Energy Power Station's System. Its objective is to develop a system capable of finding the most suitable place for the construction of renewable power stations, taking into account such things as: budget, topography, amount of energy needed, among others. The most relevant aims of the project are: study of a certain variety of renewable energy technologies, designing an accurate topology system, restraining decisions to demand forecasts and finally performance of an energy plan for a specific region.

**Keywords**—Energy management, renewable energies, energy plan, topography analysis, energy demand forecast.

## I. INTRODUCTION

NOWADAYS, Spain is the European country with the highest level of energy purchase, importing 80% of the energy consumed by our population. Our demand is way higher than our production, so importing it seems our only solution. Our small self-supply (1%) bases itself in nuclear energy methods and products such as coal and gas. Therefore, Spain is inevitably an energy-dependent country, due to the lack of other sources such as oil. In addition, Spanish coal has high sulfur content and a low calorific value, so that great quantities of coal are needed to produce little energy.

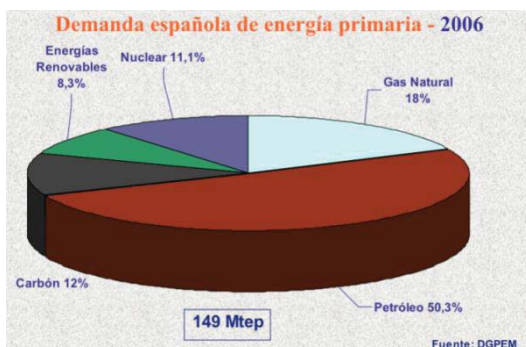


Fig. 1

One positive aspect of Spain's situation is that the lack of oil and other basic energy raw materials has launched the development of renewable energy to fight against our handicap. Although Spain still has a high dependence on nuclear energy and petroleum products, renewable energy are rapidly emerging.

We are the third country in the world and the second in European wind power production and we have a leading industry of photovoltaic energy and resources for all

renewable technologies. The purpose of this Information technology system is to develop renewable energy and increase its empowerment, developing a forecast as accurately as possible for Spanish long-term energy demand and perform and energy plan, according to a capital investment.

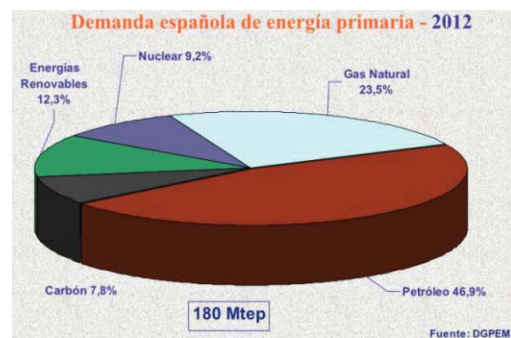


Fig. 2

This will raise the question of profitability. Is it more profitable to keep importing energy or should we invest in power station constructions to reduce the costs of production in the future? That is a question our energy plan will be willing to answer. The whole development of the application described below, will split into 3 main systems:

1. Power Stations location sites System (SALCER SLE).
2. Demand Forecast System (SALCER SPD).
3. Energy's Decision Plan System (SALCER SDPE)

## II. STATE OF ART

We will carry out an approach based on Spain but always bearing in mind the overall perspective. Spanish current situation is quite good. In no other activity apart from renewable energies will our country reach such a leading position. We are third in the world, second in Europe, in wind power; we have a leading photovoltaic industry and abundant resources for all renewable technologies. This policy towards renewable energy culminates with the plan launched by the Ministry of public works in 1999, which set targets for each of these technologies, which should help to ensure that by 2010, 12% of primary energy is obtained from renewable sources.

Our country is one of those who suffer from greater reliance on outside the EU and the high demand growth in recent years has meant that these goals for 2010 have fallen short, it provides an installed capacity in 2010 13,000 MW of wind power compared to 9000 under the 1999 plan. For all this we have developed SALCER, in order to contribute to the

improvement of our planet. SALCER is a pioneer in its field, since no similar application (that includes three ensemble subsystems) exists nowadays. It is true that you can find those three subsystems, but always separately. On the Demand Forecast System (SPD), we can find applications that calculate short term energy demand such as the proposal on the website of “Red Eléctrica de España” which makes a prediction for a time interval of a week or even less. CERMA (free energy efficiency prediction application), can be another example. In this case the application presents an exhaustive study in order to improve the energetic efficiency prediction using CALENER VYP. But never one that calculates such an accurate long-term prediction as SALCER’s SPD. About the Power Stations location sites System (SLE), more alternatives become available such as any Geographic Information System (GIS) to perform similar calculations to those made by our system or geospatial database. What matters here is the exhaustive analysis of data, but SALCER can boast of having a fairly large and effective catalog of data. In what concerns the last sub-system Energy’s Decision Plan System (SDPE), no similar software has been found mostly due to the fact, mentioned earlier, that there is one application that unifies these subsystems and the system is responsible for unifying the outputs of the previous two and providing a solution.

### III. DEMAND FORECAST SYSTEM (SALCER SPD)

#### A. Functionality

The SPD is responsible of SALCER’s energy demand forecast system using historical data for long-term forecasting energy demand. This forecast will affect independently autonomous region and will include the following:

- Information about the annual average power consume of each autonomous region.
- Annual energy growth in the respective regions.
- Annual population growth of each autonomous region.
- Annual industrial growth which has developed each autonomous region:
  - Price MW/h
  - Growth price MW/h in recent years
  - Meteorological Aspects.
  - Growth in the weather.

#### B. Forecast techniques

##### 1) Artificial Neural Networks

Most neural network approaches to the problem of forecasting use a multilayer network trained using the back propagation algorithm. Consider a time series, where it is required to forecast the value of. The inputs to the multilayer network are typically chosen as the previous values and the output will be the forecast. The network is trained and tested on sufficiently large training and testing sets that are

extracted from the historical time series. In addition to previous time series values, one can utilize as inputs the values or forecasts of other time series (or external variables) that have a correlated or causal relationship with the series to be forecasted.

For our river flow problem such time series could be the rainfall at the river’s origins. For the majority of forecasting problems such external inputs are not available or are difficult to obtain. We have not used any external inputs except an input indicating the season. [2] As is the case with many neural-network applications, preprocessing the inputs and the outputs can improve the results significantly. Input and output preprocessing means extracting features from the inputs and transforming the target outputs in a way that makes it easier for the network to extract useful information from the inputs and associate it with the required outputs.

Preprocessing is considered an “art,” and there are no set rules to choose it. Even some very intuitively appropriate transformations may turn out of no value when checking the actual results. For our case the main inputs are the previous time series values. We have used some preprocessing of the inputs, but also some of the methods described next sections are based also on different ways to preprocess the data. In short, the input that we used is historical energy consumption for nine years. [3] The network is trained for 5000 iterations. We have performed simulations, and found the following observations.

- There is a strong correlation between the training error and the testing error. This means that there is good generalization. Choosing a network/input set that gives a low training error will almost surely result in a low testing error.

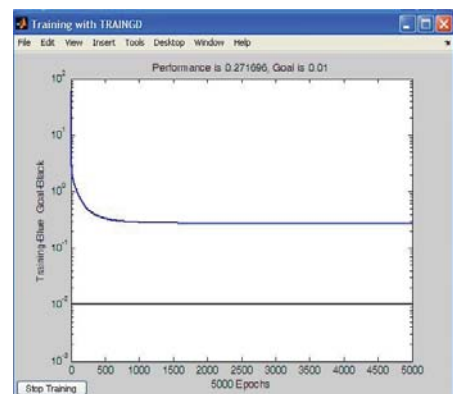


Fig 3 - Artificial neural network training result.

- In several exploratory runs we have found that no validation set was needed to determine optimal stopping point in training. The error for the test set goes down uniformly with iteration and does not bottom out.
- For the majority of input combinations the results were somewhat similar. Most cases gave higher errors, so we can state this method is not the best for long-term forecasting.
- The forecasts for all periods were not accurate at all.

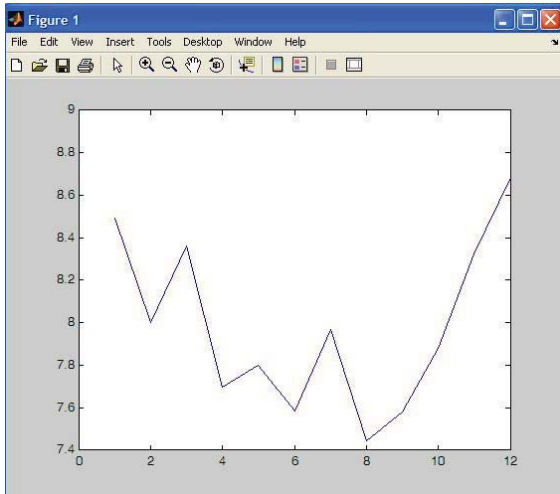


Fig 4 -Artificial neural network result.

2) Exponential Smoothing

Exponential smoothing is based on a pragmatic approach to forecasting. It’s a formalization of the familiar learning process, which is a practical basis for statistical forecasting. Higher orders of smoothing are defined by the operator: If one assumes that the time series of observation  $\{x_i\}$  is of the form [formula] where  $n_i$  is a sample from some error population, then least squares estimates of coefficients  $a_i$  can be obtained from linear combinations of the operators  $S, S^2, \dots, S^{N+1}$ .

Explicit forms of the forecasting equations are given for  $N=0, 1$  and  $2$ . This result makes it practical to use higher order polynomials as forecasting models, since the smoothing computations are very simple, and only a minimum of historical statistics need be retained in the file from one forecast to the next [4]. We have performed simulations, and found the following observations:

- This method is the most accurate of the three alternatives.
- Performs good results for month and year periods for long-term energy demand forecast.

3) Time Series

Most data in macroeconomics and energy come in the form of time series—a set of repeated observations of the same variable, such as GNP or a stock return. We can write a time series as

$$\{x_1, x_2, \dots, x_T\} \text{ or } \{x_t\}, t = 1, 2, \dots, T$$

We will treat  $x_t$  as a random variable. In principle, there is nothing about time series that is arcane or different from the rest of econometrics. The only difference with standard econometrics is that the variables are subscripted  $t$  rather than  $i$ . For example, if  $y_t$  is generated by

$$y_t = x_t\beta + e_t, E(e_t | x_t) = 0,$$

then OLS provides a consistent estimate of  $\beta$ , just as if the

subscript was "i" not "t". The word "time series" is used interchangeably to denote a sample  $\{x_t\}$ , such as GNP from 1947:1 to the present, and a probability model for that sample—a statement of the joint distribution of the random variables  $\{x_t\}$ . A possible probability model for the joint distribution of a time series

$$\{x_t\} \text{ is } xt = c_t, e_t \sim i.i.d. N(0, \sigma^2_e)$$

i.e.  $x_t$  normal and independent over time. However, time series are typically not iid, which is what makes them interesting. For example, if GNP today is unusually high, GNP tomorrow is also likely to be unusually high.

It would be nice to use a nonparametric approach—just use histograms to characterize the joint density of  $\{\dots, x_{t-1}, x_t, x_{t+1}, \dots\}$ . Unfortunately, we will not have enough data to follow this approach in macroeconomics and energy for at least the next 2000 years or so. Hence, time-series consists of interesting parametric models for the joint distribution of  $\{x_t\}$ .

The models impose structure, which you must evaluate to see if it captures the features you think are present in the data. In turn, they reduce the estimation problem to the estimation of a few parameters of the time-series model.

We have performed simulations, and found the following observations:

- This method is the most accurate of the three alternatives.
- Performs bad results for month periods.
- Performs good results for year periods.

C. Development Tools

1) For Artificial Neural Networks

MATLAB R2007bis is a development environment based on MATLAB language. "MATLAB® is a high-level language and interactive environment that enables you to perform computationally intensive tasks faster than with traditional programming languages such as C, C++, and Fortran." [1]. This language can be used in many different fields such as signal or image processing; communications; test and measurement, as well as other scientific fields of investigation.

On this development environment it is possible to manage code, files, and data. It includes many functions for statistics, optimization, and numeric data integration and filtering.

There are also great amounts of functions that facilitate the manipulation of bi-dimensional and three-dimensional images.

2) For Time Series and Exponential Smoothing

Both time series and exponential smoothing algorithms were coded using standard Integrated Development Environment for Java and C#.NET programming languages.

D. Data

From the beginning of the analysis (for the SPD subsystem) we decide to use the less variables as possible to perform the energy demand forecast. Finally we succeeded using:

- Electric energy consumed for Spain and its regions.
- Population data for the Spanish regions.

This data was extracted from the National Statistics Institute (INE) of Spain. [5]

IV. POWER STATIONS LOCATION SITES SYSTEM (SALCER SLE).

A. Functionality

This system will be responsible for establishing the optimum point to locate an energy power station construction, a place where you can obtain the highest production rate at the lowest cost. In order to do this we will consider such data as:

- Topological geographic study of the area and its surroundings.
- Legislative and politic details to find out where and under what conditions can the power stations be built.
- Meteorological data to establish the station’s purpose.
- Infrastructure details: power supply, access to the area and materials transport.
- Details of the construction of the power station, maintenance, improvements and dismantled, insurance against accidents, environmental impact, and so on.

B. Location techniques

1) Bayesian Networks

A Bayesian network is a graphical model that encodes probabilistic relationships among variables of interest. When used in conjunction with statistical techniques, the graphical model has several advantages for data analysis. One, because the model encodes dependencies among all variables, it readily handles situations where some data entries are missing. Two, a Bayesian network can be used to learn causal relationships, and hence can be used to gain understanding about a problem domain and to predict the consequences of intervention. Three, because the model has both a causal and probabilistic semantics, it is an ideal representation for combining prior knowledge (which often comes in causal form) and data. Four, Bayesian statistical methods in conjunction with Bayesian networks offer an efficient and principled approach for avoiding the over fitting of data.

We designed two Bayesian networks for the two types of power stations included in this study. The input information is introduced into the Bayesian network by setting evidences on the input nodes. We decided to implement three evidence

levels for each input node.

Input nodes for the solar power station:

- Communications distance
- Distance to population
- Solar radiation indicator
- Rain gauge (pluviometer)
- Thermometer

Input nodes for the wind power station:

- Communications distance
- Distance to population
- Rain gauge (pluviometer)
- Airspeed indicator

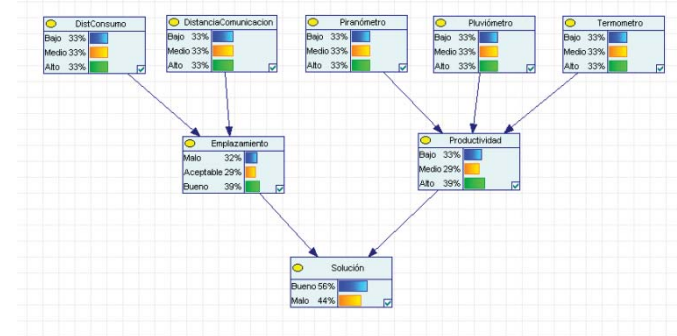


Fig 5 – Solar Stations Bayesian Network.

The main goal we tried to achieve was to obtain a single rate from a set of parameters, to determine (in a zero to one scale) the best placements for a specific station type.

2) Topographic analysis algorithm

The topographic analysis is performed for 420 ha’s (hectare) areas, and according to the established site characteristics, its purpose is to cut out or select the polygon’s emplacement in a specific area. To perform this topographic analysis we use the information in some kind of matrix shape, in which every numeric element represents average altitude of a 625m<sup>2</sup> area. (Additional altitude information can be seen on Data.) The next step is to transform the altitude matrix, to end up with three categories: boundary, interior and non-selected. On the image (Fig 6) we can see the result of an altitude matrix transformation on which the darker areas represent the selected polygons for this territory.



Fig 6 - Altitude Matrix transformation result

The next step is cutting out the polygons selected in the previous steps. To develop this algorithm we tried different types of programming styles to meet the characteristics the process should have: Computational efficient, errorless and accurate as possible.

Our first choice was an iterative algorithm to meet the computational efficiency requirement. This algorithm turned out to be rather efficient but rate errors were extremely high (over 40%) and could not perform the task correctly. Responsible for this problem was the algorithm's error resiliency. Then we tried a recursive algorithm based on backtracking techniques, this allowed us to obtain all possible solutions, so we could select the best one. To meet the computational efficiency requirement we decide to keep path (to cut out the polygon) length calculations in another matrix. Finally this algorithm satisfied our computational efficiency expectative and reduce error rate down lower than 5 percent.

On figures 7 and 8 we can see the positive results of the topographic analysis algorithm. Google maps was used to represent the information.



Fig 7 - Piece of land selectet by the topographic analysis algorithm. (represented on google maps)



Fig 8 - Piece of land selectet by the topographic analysis algorithm. (represented on google maps)

### 3) Site Characteristics

Derived from a performed investigation study, we established the main characteristics a site should have to be eligible for building a station.

For Solar stations:

- Area between 60ha's and 270ha's
- Height difference: maximum 20 meters

For Wind power stations:

- Area between 4ha's to and 18ha's
- Minimum altitude of 1200 meters (0.7456 miles)
- Height difference: maximum 60 meters

Finally we established common useful characteristics, such as proximity to populations and communication infrastructures.

### C. Development Tools

#### 1) GENIE

Genie (Graphical network interface) is a software tool developed at the University of Pittsburgh for Microsoft Windows and available free of charge at Genie. It is useful for decision analysis and for graphically representing the union of probability and networked occurrences [16]. Particularly, Genie can be used for the analysis of Bayesian networks, or directed acyclic graphs (i.e. occurrences in a web of happenings are conditionally independent of each other). Bayesian networks or Dynamic Bayesian Networks (DBNs) are relevant to engineering controls because modelling a process using a DBN allows for the inclusion of noisy data and uncertainty measures; they can be effectively used to

predict the probabilities of related outcomes in a system. In Bayesian networks, the addition of more nodes and inferences greatly increases the complexity of the calculations involved and Genie allows for the analysis of these complicated systems. Additionally, the graphical interface facilitates visual understanding of the network.

2) Database engine implementing OGC (Open Geospatial Consortium) spatial specifications

We needed a good storage system for the great amount of data that we handle and an adequate tool to make geographic operations and calculations. This is possible using a database engine which implements the OGC spatial specifications. With these tools now we are capable of operations like the following:

- Within: tells us if a geometry instance is completely within another geometry instance.
- Intersects: tells us if a geometry instance intersects another geometry instance
- Envelope: tells us the minimum axis-aligned bounding rectangle of the instance.
- Area: tells us the total surface area of a geometry instance.
- Distance: tells us the shortest distance between a point in a geometry instance and a point in another geometry instance.

This specification allows using new data types in our relational database designs. Finally we decide to use geometry spatial data type but there are other types available like geography spatial data types.

#### *D. Data*

1) Meteorological information: data use mainly by the Power stations location sites System (SLE subsystem) as an important input to the Bayesian networks. Extracted from the Spanish national statistics institute (INE). [5]

2) Electric Energy Information: Data used by the Demand Forecast System (SPD subsystem) for the forecast process using exponential smoothing. Extracted from the Spanish national statistics institute (INE). [5]

3) Population and town's information: The Demand Forecast system needs population data to provide an energy demand forecast. Power stations location sites System (SLE subsystem) needs both population and town's information, this data is used at the same time, so we can find out the population in a specific geographic point. We calculate what we call population index, we divide the area into concentric circles and multiply the population within these circles by a modifier and then we sum it all. We established the following values: 10Km, 30Km and 80Km (green, blue, orange) for the radius of the circles and 0.5, 0.3 and 0.2 (green blue, orange) for the population modifier applied for those areas. The population index is a very important input for the Bayesian

networks of the Power stations location sites System (SLE subsystem). Extracted from the Spanish national statistics institute (INE) [5] and from the Spanish national institute of geography (IGN, Ministerio de Fomento) [6].

4) Administrative limits, Hydrographic and communications infrastructure information: Data stored into our relational data model as geometry spatial data type used to make operations related to the Power stations location sites System (SLE subsystem), this operations determine (in some way) the eligibility of a placement, and for example the distance to the nearest motorway is an input to the Bayesian Network. Extracted from the Spanish national institute of geography (IGN, Ministerio de Fomento) [6].

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#### V. ENERGY DECISION PLAN SYSTEM (SALCER SDPE)

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This system is responsible for the last step of the process; this system will collect the outputs of the other two (SALCER SPD and SLE) and perform the energetic action plan. This will be done with the forecasted energy demand of all the locations, taking into account profitability to decide whether it is worth it or not. The following data will be needed at this point:

- Countries Energy production.
- Long -term Energy Demand (SPD)
- Possible locations for specific power stations (SLE).
- Investment.
- Simulation Schema (eg Kyoto Treaty).
- Energy Imports.

#### *B. Workflow techniques*

##### *1) Engine Workflow*

Workflow engine is a software application meant to manage and execute modeled computer processes. It is a key component in workflow technology. It will typically make use of a database server.

The workflow engine will interpret events such as documents submitted to the server or due dates expiring and act on these events according to the defined computer processes. The actions may be anything from saving the document in a document management system to issuing new work by sending an e-mail to users or escalating overdue work items to management. In other words, one can say that a Workflow Engine facilitates the flow of information tasks and events or one can say that it is the heart of a workflow application.

This tool was discarded because of the disappointing results obtained. Following SALCER's instructions in order to determine an adequate emplacement (considering SPD's and SLE's outputs), workflow's engine had to generate a complex activity flow, which in the end did not show optimum results.



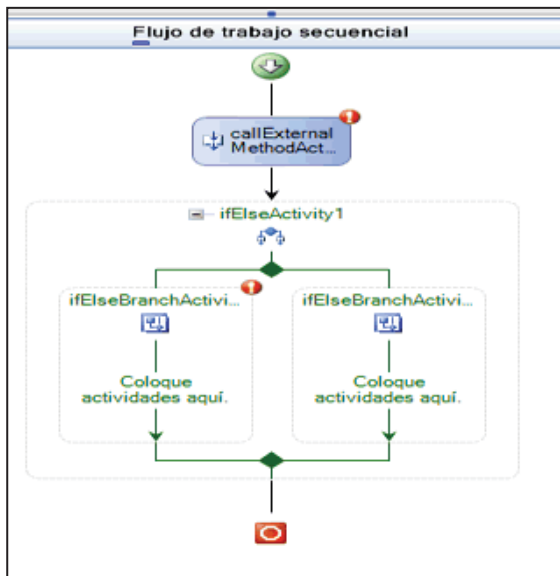


Figure 9 - SALCER Workflow example

## 2) SDPE Algorithm

We created and assigned this algorithm data statistical studies. For such purpose it takes into account:

- The type of station chosen.
- The amount of investment and the amount of energy needed.

Adjusting as well to certain criteria (explain below), in order to organize sites from high to low adequacy.

- The first inputs received are the results of SLE's selection. Depending on the type of energy some parameters will be chosen in order to identify the best sites:

- Wind Power: chosen sites will be those that generate higher productivity, are closer to distribution points and are close enough to a town or city (10km).
- Solar Power: same as above.

- The second input received is the monetary investment or a percentage of energy that must be met. In this case we can have many emplacements as long as we respect investment and energetic restrictions. The algorithm used is similar to the Knapsack.

## C. Development Tools

### 1) WWF

Windows Workflow Foundation (WF) is a Microsoft technology for defining, executing, and managing workflows. This technology was first released in November 2006 as a part of .NET Framework 3.0. [19].

should be improved even more so decision making could be even more efficient. Many other fields of science could introduce systems like these, increasing efficiency in business processes.

## REFERENCES

- [1] Matworks TM, *MATLAB product information*. [Online] Available at: <http://www.mathworks.com/products/matlab/>
- [2] M.H. Hassoun, *Fundamentals of Artificial Neural Networks*, MIT Press, 1995.
- [3] K. Gurney, *An introduction to neural networks*, CRC Press, 1997.
- [4] R.J., Koehler, A.B., Ord, J.K., Snyder, R.D., *Forecasting with Exponential Smoothing The State Space Approach Hyndman*, Springer, 2008.
- [5] INE, *National Statistics Institute*. [Online] Available at: <http://www.ine.es/>
- [6] IGN, *National Geographic Institute*. [Online] Available at: <http://www.ign.es/ign/en/IGN/home.jsp>
- [7] IDEE, *Spanish Spatial Data Infrastructure's*. [Online] Available at: [http://www.idee.es/show.do?to=pideep\\_pidee.EN](http://www.idee.es/show.do?to=pideep_pidee.EN)
- [8] MARM, *Environment ministry* [Online] Available: <http://www.marm.es/>
- [9] PSN, *Parques Solares de Navarra*. [Online] Available: <http://www.parquessolaresdenavarra.com/>
- [10] REE, *Red Electrica de España*. [Online] Available at: <http://www.ree.es/>
- [11] ENERFIN, *Enerfin Sociedad de Energía S.A* [Online] Available at: <http://www.enerfin.es/>
- [12] Infoeolica, *Infoeolica*. [Online] Available at: <http://www.infoeolica.com/parques.html>
- [13] Solar Millennium, *Solar Millennium AG*. [Online] Available at: <http://www.solarmillennium.de/index-a-1.html>
- [14] SCHOTT, *SCHOTT AG*. [Online] Available at: <http://www.schott.com/iberica/spanish/solar/>
- [15] ACCIONA, *Acciona*. [Online] Available at: <http://www.acciona.es/>
- [16] GENIE, *Genie & Smile*. [Online] Available at: <http://genie.sis.pitt.edu/>
- [17] SOCIALENERGY, *Renewable Energy Solutions*. [Online] Available at: <http://www.socialenergy.net/>
- [18] FOTONA, *Grupo Fontona*. [Online] Available at: <http://www.fotona.es/>
- [19] MSDN, *Windows Workflow Foundation*. [Online] Available at: <http://msdn.microsoft.com/>
- [20] M. Ortega, *Energias Renovables*, Thomson Paraninfo, 2002.

## VI. CONCLUSION

We have made an investigation study of an important topic: Renewable Energies and Sustainable Development; we are satisfied with the improvements made to the current situation, although we think this kind of decision support systems

# Uncoolness factor of collaborative Web Mining Tools (WMT)

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*Online&Offline, Ltd.*

**Abstract** - The recent development of social mining is a useful and direct analogy to talking about the less visible part of the adoption of successive waves of social software. The striking fact of visibility decrease as each type of social software matures should be taken into account for any comprehensive analysis of the relation between collectives and Internet technologies. One of the main results of this relation is the social data mining of Internet, which both gives sense to virtual communities and produces contents via feedback. We are just at the beginning of the adoption of new ways of social data mining, which will be significant when grow mature and become invisible.

**Keywords:** *Web Mining, Web 2.0*

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## I. UNCOOLNESS FACTOR

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THE global dimension of an English-spoken Internet makes the Attention Economy the main filter of importance, relevance and survivalness of cases and even entire types of social software [3]. Few months after the seminal work of [7], one of the main buzzwords of the time was "Tag". Besides "participation", "many-to-many", etc., every new competitor in the Attention Economy race needed to include tags not only at its core interface, but also for explaining it.

Tags [1] were the main and most popular source and destiny of social mining. For the sake of concreteness, it would be interesting to quote the most literal meaning of the term: Social mining is a relatively new trend of community development in certain areas of the Third World. Those areas are not attractive for mining companies, but contains marginal reserves of gold and other valuable resources. Communities organize themselves with the assistment of NGO and international institutions in order to cooperate in the main steps of mineral production and commercialization. Although results are not commercially attractive, they are enough for sustain the basic needings of the communities.

Tags worked, and still do, in a way similar to "pure" social mining. They are a cooperation effort intended to produce and maintain a valuable information resource. At the same time, this information resource is consumed by their producers and by a greater number of users. If there are strategic corporate players in one side of the mining of the data produce by social software, in the other side there is the synergic sum of the tiny efforts of thousands and thousands of users [2].

Tagging in the Web 2.0 way gave full sense to very popular social software like flickr: from a simple but huge set of personal photo galleries, tags permitted users to locate the pictures they want to watch with both great efficiency and serendipity. Other social software examples were directly based in tagging: social bookmarking, for instance, its all about sharing tags connected with URL.

But Attention Economy [5] is merciless. A long ago, Web 2.0 proponents had to strife with new proposals, or adhere to new trends in order to stay visible. All the web 2.0 hype is long gone. Its main dimensions are assimilated in the main sphere of Social Software. So, as the economy of attention moved away from the initial topics of Web 2.0, the uncoolness factor of tagging grew to its maturity: tags didn't support venture capital's attraction anymore, media attention is totally gone and developers implemented it without any bells and whistles (it seems not to be needed in some cases).

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## II. BUT WHAT ABOUT USERS

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Web 2.0 never was about users. It was about bloggers, digerati [4], whatever fancy name you want to use with early adopters and tech fashion victims. Each new wave of social software attracted attention for a short number of quarters, and... it standed. Each innovation continued to be used (blogs, wikis, whatever) to the present day.

Meanwhile, the whole spectre of social software was maturing (i.e., being adopted and fully exploited), each type progressing at its own pace across the tech adoption curve (Hoogenboom, Kloos, Bouman and Jansen:2007). Keep it Simple principle worked in a way, the simplest forms of social software continued to be used, even adquired more popularity (i.e. forum). This simplicity has been capital in order to mine the web and capture layers and layers of meaning using dialogue and even flame wars.

Indeed, communities of practice are operative social data mining engines. In other words, topic-focused communities are built around a constant activity of data harvest and share.

Social software can have different shapes and functionalities, but essentially it is a tool with collective purposes. The main result of this fact is that it is just not feasible to isolate a concrete social software, since all of them are interconnected. From a blog to a forum, through microblogging and mailing list, maybe facebook or myspace discussions, wall and all the stuff, information is not only

shared, but redistributed and shape shifted in order to pass through the different social software. At the end, there are just purposes, shared objectives and topics, not tools. And for sure, there is collective identity, but it escapes totally the purpose of this introduction.

In these days, two kinds of social software related with social data mining are growing at a phenomenal rate: On the one hand, internet connected mobile apps, specially augmented reality apps, which permit to harvest and to share bits of factual, offline reality into social software. As mobile OS is moving from the pico-desktop paradigm to the full Internet experience and integration, each terminal propelled by a modern mobile OS (OSX, Android, WebOS, Maemo, etc.) is a double-edged tool: it both contribute to mine the social online information, and it mine offline information into online platforms. Actually at any moment and place, citizens are using their camera apps, microblogging and blogging apps and social network mobile clients, and one of the main objectives is to mine all class of information for their communities and networks.

On the other hand, Google wave. This piece of software that is more easy to use than to explain carries a serious claim on it: to reform utterly the way people uses computers to communicate and collaborate, with that astounding mashup of real-time messaging, offline, email-like communication, collective document building and... more. In a lot of cases, specially corporate and company related, collaborate is about information share and remix. Under this point of view, and keeping in mind the huge spectre of possibilities that Wave is opening, it can be taken for sure that Wave is going to introduce brand new ways of collective data mining.

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### III. CONCLUSION

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As a conclusion: social mining is alive, well and mature. It is assumed as one of the main causes of collective internet activity. As it happens with Amazon's Mechanical Turk, a lot of users are mining tiny amounts of information as the initial step towards information shaping and consuming. Indeed, it could be said that social software which is now at the center of the Attention Economy, the "social networks", is propelled by social mining. Social mining initially was the result of the first maturity of Internet in the 2.0 days. Although their tools are not attractive nor fashionable anymore, they are still used and new tools mine information in new and exciting ways.

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### REFERENCES

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- [21] Anderson, P. (2007) "What is web 2.0". Ideas, technologies and implications for education, 60
- [22] Bielenberg, K., and Zacher, M.(2005) "Groups in social software: Utilizing tagging to integrate individual contexts for social navigation". Digital Media 120. Bremen,University of Bremen.
- [23] Eagle, N. and Pentland, A. (2005) "Social serendipity: Mobilizing social software". IEEE Pervasive Computing v.4, n°2, pp.28-34
- [24] Fumero, A.(2006) "Next-Generation Web. Building a social middleware for Knowledge Society". Proceedings of the I-KNOW'06, 6th International Conference on Knowledge Management

- [25] Goldhaber, M.H.(1997) "The attention economy and the net". First Monday 2(4-7)
- [26] Hoogenboom, T., Kloos, M, Bouman, W., and Jansen, R.(2007) "Sociality and learning in social software". International Journal of Knowledge and Learning 3(4)
- [27] O'reilly, T. (2005) "What is Web 2.0: Design Patterns and Business Models for the Next Generation of Software". Communications & Strategies, No. 1, p. 17.
- [28]

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# PredicForex. A tool for a reliable market. Playing with currencies.

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**Abstract** — The Forex market is a very interesting market. Finding a suitable tool to forecast currency behavior will be of great interest. It is almost impossible to find a 100 % reliable tool. This market is like any other one, unpredictable. However we developed a very interesting tool that makes use of WebCrawler, data mining and web services to offer and forecast an advice to any user or broker. (October, 2009)

**Keywords** — Data minning, Dollar, Euro, Forex, Web crawlers, Web services, Weka.

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## I. INTRODUCTION

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THE currency market also known as FOREX market stands for The Foreign Exchange Market is the biggest and most liquid financial market on earth, with a daily sales revenue of about US \$  $1,5 \cdot 10^{18}$  against the \$  $25 \cdot 10^{12}$  traded on the New York Stock Market, leaving the stock Market in the second place. [2]

It is the market where currencies are being sold. In fact, it is the Market where money is being bought and sold. In other words, Forex is the market where a currency is sold and another one is bought. World currencies quote in a floating exchange rate and they are always handled in pairs, for instance EURO/USD or USD/YEN. This market was born in 1971, in the moment when currencies stop working in a fixed rate. This market works 24 hours per day and 5 days every week. It is a non stooping market. [2]

In the Forex Market, transactions are taken within central banks, governments, currencies gamblers, multinational companies, large organizations, small sized banks and so on. This provides the market of great liquidity and allows participants to execute their great value transactions without affecting significantly the prize of the coin.

The currency market does not operate from a given fixed

position, although there are several places of great importance like New York, London, Tokyo or Frankfort. It is a market that works through internet and the phone. [2]

Long time ago, in order to make a FOREX transaction it was necessary to have great quantities of money in order to operate and only the large companies and governments or central banks were capable of this. Nowadays everybody can take the advantages of the Forex system. Internet provides the necessary infrastructure to make this possible.

The exchange of currencies is a high value element in giving support to global economic commerce and as the currencies move ones against the others, great opportunities will arise. Although big dealers play with huge amounts of money such as millions of dollars, small players can also find opportunities in making money in this market.

Any given person has the opportunity to take part in this market and with a little bit of money and the necessary time to learn in order to operate in the currency markets, it is possible to enjoy of great revenues dealing with currencies.

The most common currencies in the Forex Market are the American Dollar USD \$, the Euro €, the Japanese Yen JPY ¥, the English Pound GBP £, the Swiss Franc CHF and the Australian Dollar AUD \$. [3]

Although it is possible to realize transactions with any given pair of currencies, 60 % of all transactions involve the Euro and the Dollar, what makes them the most used currencies with a big margin.

In the Forex market we can find gamblers which are basically betting against a coin. Hoping that some coins are going to increase their value while others will decrease.

There are many controversies about the job being done by the gamblers. Sometimes they can influence in the value of a currency or even affecting the whole economy of an entire country. [3]

Some people think they only move by their avarice and because they want to make profit, manipulating countries inside politics in their own benefit, being careless about the social consequences this can have.

However, defenders state that they help to adjust currencies all over the world.

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## II. WHY WE WANTED TO INVEST IN THE FOREX MARKET

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Nowadays we live an uncertain moment about the world economy. The stock market is not reliable any more. Only the raw materials, gold, and public debit seem to be enough reliable or at least considered as save values. And there is a non existing tool capable of helping investors to take decisions weather to invest in the Euro/Dollar pair will be of great interest.

The economists use several theories about how the stock market changes, the market cycles and so on. They mix it with statistics and then they find the solution. The problem is that there are a lot of data to keep in mind at the same time and they can “forget” any of them, so that, *Predicforex* can be the solution, because it can make a prediction without missing any important thing. This is why we felt motivated to develop this tool.

---

## III. WHAT WE AIMED AND HOW WE MADE IT

---

In the given project we had as objective to achieve the simulation or approximation of a program that can forecast or at least try to guess what the trend is going to be in the Dollar and the Euro.

Therefore we used the existing technologies: Netbeans as the Java platform where the code was developed and the data mining tool Weka. In addition to all these we used spiders or web crawlers to search for the information or data through the internet.

Our tool achieves to be suitable for investors or even gamblers helping them to have a better perception about the Forex Market and all the factors or conditions that can affect their investments and preventing lost in patrimony.

In order to make this possible we need three different subsystems. One subsystem is to acquire the information from web pages, another subsystem is to process all these information to make the desired recommendations and the last one is to show the advice on the given currencies on a web page. How we made it?

- We decided to recollect the information with the help of web crawlers.
- Process Data with mining tool Weka.
- Show information using a JEE server.

We needed all the information stored in *arff* files. This is because Weka works with this kind of files. We had to translate the data into this format. All this is string conversion code. From a Java API and with its correspondent code we call the necessary Weka processes. [1]

The *arff* files have the following structure:

```
@RELATION forex
@ATTRIBUTE DJ numeric
@ATTRIBUTE SyP numeric
@ATTRIBUTE USDGBP numeric
@ATTRIBUTE AMEX_Oil numeric
@ATTRIBUTE NASDAQ100 numeric
@ATTRIBUTE decision {compra,vende,nose}
@DATA
```

```
8331.72,891.2,0.6575,932.97,1359.54,compra
5000,891.2,0.6575,932.97,1359.54,vende
```

“Compra” is the Spanish term for sale while “vende” is for buy. “Nose” is the doubt.

At the end of the file, in the last two lines, you can find some quantities (five to be exact) separate per commas and followed for one of the words mentioned above. These quantities are the value of each factor which takes part on the process. The factors are: “Dow Jones” (DJ), “S&P 500” (SyP), Dolar/Pound price (USDGBP), “Oil Barrel” (AMEX\_Oil), “Nasdaq” (NASDAQ100) respectively. These values are used to train the neuronal net. We introduce some of the data and we classify them in the three possible places: “compra”, “vende”, and the last one “nose”. Now, the neuronal net has a model to classify the following situations, the ones the crawlers will choose.

But, how the crawlers work? In a very easy way. Each one minute (or the time you want) the crawlers surf the net (some given URLs, like “www.eleconomista.es”, <http://finance.yahoo.com>, and so on) looking for new data. We introduce these data at the end of our file with the prediction to increase it. Whereas, our tool uses this file for training the neuronal net with all the historic data of previous rates and another one with a single line working as the instances that wants to be predicted. Here is shown the output of the net training:

```
==== Run information ====
```

Scheme:

```
weka.classifiers.functions.MultilayerPerceptron -L 0.3 -M 0.2
-N 500 -V 0 -S 0 -E 20 -H a -G -R
```

Relation: forex

Instances: 3

Attributes: 6

DJ

SyP

USDGBP

AMEX\_Oil

NASDAQ100

Decision

Test mode: user supplied test set: size unknown (reading incrementally)

```
==== Classifier model (full training set) ====
```

Sigmoid Node 0

Inputs Weights

Threshold -2.7531661267028182

Node 3 2.0176783647722734

Node 4 2.122999469333026

Node 5 1.7215560277261523

Node 6 1.0053816557295714

Sigmoid Node 1

Inputs Weights

```

Threshold 2.7567411013790055
Node 3 -2.066370442548119
Node 4 -2.0495607009915946
Node 5 -1.7471105876114683
Node 6 -1.012914205526177
Sigmoid Node 2
Inputs Weights
Threshold -2.5074816470045764
Node 3 -0.7720623255127751
Node 4 -0.849179639879635
Node 5 -0.8813380163659676
Node 6 -0.8949421547493384
Sigmoid Node 3
Inputs Weights
Threshold -0.13860864232277748
Attrib DJ 2.862352542187435
Attrib SyP -0.03533983423534818
Attrib USDGBP -0.039550931374902835
Attrib AMEX_Oil 0.049072278571478306
Attrib NASDAQ100 0.03172970714093244
Sigmoid Node 4
Inputs Weights
Threshold -0.13028474378381705
Attrib DJ 2.8951004190015275
Attrib SyP -0.04767618775161106
Attrib USDGBP 0.012514636346555932
Attrib AMEX_Oil -0.0012767152969857185
Attrib NASDAQ100 0.033889035004701834
Sigmoid Node 5
Inputs Weights
Threshold -0.15659666445987427
Attrib DJ 2.6007965004089377
Attrib SyP 0.004673975719846554
Attrib USDGBP -0.008920380450893828
Attrib AMEX_Oil 0.024624140532233052
Attrib NASDAQ100 0.002669943460486615
Sigmoid Node 6
Inputs Weights
Threshold -0.14999743751166328
Attrib DJ 1.9011025605260115
Attrib SyP 0.04644868606768501
Attrib USDGBP 0.02763122912749326
Attrib AMEX_Oil 0.02331520701949938
Attrib NASDAQ100 0.039933501161149354
Class compra
Input
Node 0
Class vende
Input
Node 1
Class nose
Input
Node 2

```

Time taken to build model: 221.59 seconds

==== Predictions on test set ====

```

inst#, actual, predicted, error, probability distribution
1 3:nose 1:compra + *0.901 0.092 0.007

```

==== Evaluation on test set ====

==== Summary ====

```

Correctly Classified Instances    0    0 %
Incorrectly Classified Instances  1   100 %
Kappa statistic                   0
Mean absolute error               0.6617
Root mean squared error           0.7758
Relative absolute error           119.1142 %
Root relative squared error       130.7858 %
Total Number of Instances        1

```

==== Detailed Accuracy By Class ====

	TP Rate	FP Rate	Precision	Recall	F-Measure	
ROC Area Class						
	0	1	0	0	?	compra
	0	0	0	0	?	vende
	0	0	0	0	?	nose
Weighted Avg.	0	0	0	0	0	0

==== Confusion Matrix ====

```

a b c <-- classified as
0 0 0 | a = compra
0 0 0 | b = vende
1 0 0 | c = nose

```

Finally, you can see the tree which has been generated as the result. However, we used Weka through Weka libraries. In the following URL we found all the information necessary to make use of the correspondent libraries. It's necessary to import *weka.jar* to our Netbeans project.

<http://weka.sourceforge.net/doc.dev/>

There it's stated the class used with its most important methods during the development of our project. We found the class *MultilayerPerceptron* inside *weka.classifiers.functions* package [5], the one we used to implement a part of *Predicforex*.

```

java.lang.Object
weka.classifiers.Classifier
weka.classifiers.functions.MultilayerPerceptron

```

We decided to use this algorithm because we thought this is the one who fixed the best with the aim we were looking for. As you can read in the web, the algorithm is "A Classifier that uses backpropagation to classify instances. This network can be built by hand, created by an algorithm or both. The network can also be monitored and modified during training time. The nodes in this network are all sigmoid

(except for when the class is numeric in which case the output nodes become unthresholded linear units).” [5], so that, as you can, it could be the better one. Inside our code, the first line that refers to the *MultilayerPerceptron* algorithm is as follows:

```
Classifier miclassifier = new MultilayerPerceptron();
```

Here we use the *MultilayerPerceptron* constructor:

```
public MultilayerPerceptron();
```

Later on, you find the following sentence:

```
miclassifier.buildClassifier(instancias);
```

With this sentence we build the neuronal network. We make it by calling *buildClassifier*:

```
public void buildClassifier(Instances i);
throws java.lang.Exception;
```

The following line is very important. It calls this function to predict the class of an instance once a classification model has been built with the *buildClassifier* call.

```
A = miclassifier.distributionForInstance(i);
```

It returns a double array filled with the probabilities of each class type.

The broker, once started the application will see the following window with the *expected* advice.

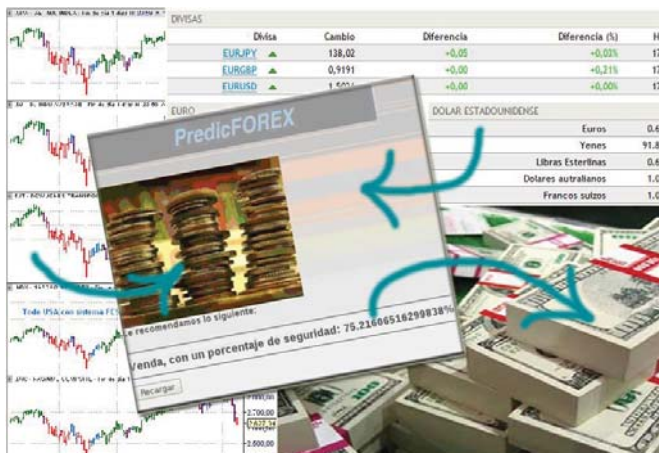


Fig. 4: PredicForex interface

All the application layers, subsystems and processes are hidden, the broker cannot see them.

#### IV. CONCLUSION

With this project we acquired a lot of knowledge in the neuronal-network field. We learned both theoretical knowledge and practical knowledge. Through this process we

aimed and achieved the goal of forecasting currencies. *Predicforex* was made successfully. Anyone interested in making investment in the currency markets can use this application.

We consider this tool to be of great interest to anyone. We believe it is reliable and trustworthy.

If the broker can access to a large enough data base will benefit of more reliability and will have enough proved information to gamble against competitors.

How do we evaluate our project? Well, it depends on what you are looking for. As we said, *Predicforex* is a very good tool to predict the mentioned data and it works successfully. But, as our poor knowledge in the economy field, the data we used to train the neuronal net are not real. If you want real values, you'll have to contact to a professional on it to make the tool a very reliable one.

#### V. ACKNOWLEDGMENT

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#### REFERENCES

- [1] Class Notes from PhD. J. Soto
- [2] <http://www.forex.es>
- [3] <http://es.dailyforex.com/>
- [4] <http://www.cs.waikato.ac.nz/ml/weka/>
- [5] <http://weka.sourceforge.net/doc.dev/>

# Route planning algorithms: Planific@ Project

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**Abstract** — Planific@ is a route planning project for the city of Madrid (Spain). Its main aim is to develop an intelligence system capable of routing people from one place in the city to any other using the public transport. In order to do this, it is necessary to take into account such things as: time, traffic, user preferences, etc. Before beginning to design the project is necessary to make a comprehensive study of the variety of main known route planning algorithms suitable to be used in this project.

**Keywords**— ADL, HTN, JSHOP2, JSHOP2GUI, Method, Moviliz@, Operator, PDDL, Planific@, SHOP, STRIPS

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## I. INTRODUCTION

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NOWADAYS, more people live in cities and much of this population uses public transport every day to move everywhere. It is noticeable that there is a lack of information for the citizen, who does not know all the options available when making a journey.

This leads to distrust and less use of public transport. Unless citizens are sure to know beforehand how to get to a place, they will never go by bus or subway. Also, the lack of information precludes the option of combining these two ways of transport, losing their effectiveness as a whole. People will only combine bus and subway in everyday situations, which are familiar to them.

In turn, the difficulty of calculating times for journeys using public transportation tend to be a handicap when you have to decide on this type of transportation. Madrid. EMT (Empresa Municipal de Transportes) and Metro de Madrid, the public transport companies operating in Madrid, provide trip estimates on its web pages, however there is no connection between them, nor provided through mobile devices that is where, in most cases, the system will be useful for the traveler.

We find that the optimal implementation of this functionality is in mobile device, since the vast majority of people use to carry one on at all times and it is precisely when you are not at home when this functionality is most times needed. For this reason the development will be oriented towards these devices.

The main problem in this Project is how to calculate the optimal route between two locations within a city, taking into account all potential bus and subways routes.

To resolve this problem we must create an algorithm that

takes into account all the possibilities offered by public transport in the city of Madrid. This involves planning routes that may include several stages in different modes of transport (subway, bus and walking). It must also take into account the route preferences set by the user such as prices, maximum number of transfers, shortest, cheapest, etc.

The desired result is a novel and very useful product for the citizens who know well the city as well as for tourist people, as it facilitates and encourages the use of public transport in the city. Equally interesting from the technological point of view to giving added value to mobile devices which could become the best city guide.

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## II. MOTIVATION

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In this section we discuss those factors that have influenced in the choice of the development of this project. We could classify the reasons for our decision opted into two main branches: on the one hand we see great interest and potential in the urban transport sector, on which there are many things to do and improve. On the other hand we are interested in logistics field and the route planning algorithms used in this field.

### A. International economic and social situation

The world today is under the influence of globalization. There is no developed country that is not clearly influenced. This influence derives, among other things, in a migration to the cities of the population living in rural areas. Consequently there is a growth in these, and is thus an improvement in public transport services.

### B. Environment

Another factor to consider is the environment. For many years man has been aware of the influence that society has on the environment. However, until recently, no one talked about global warming, environmental awareness, etc.. Therefore, we conclude that all those issues that help improve the situation of the environment, while encouraging the use of public transport to replace private transport are of great importance.

### C. Status of public transport

In large cities, public transport becomes a daily essential element. From the standpoint of government, public transport has become a very complex system, only manageable with information technology.



From the standpoint of people who decide to commute by such cities in their own car we can see that appears a large number of problems such as traffic, parking problems, fuel costs, etc.. A priori, the most immediate and simple solution that could give the user would be using public transport.

However, as we mentioned a few lines above, we have identified some shortcomings in this system, such as poor or even no information that the user has on rates, commuting times, distances in time and transfers, number of stops to destination, etc. Furthermore, the user does not have a system that will efficiently provide the interconnections between different modes of transport, and more importantly, there is currently no system that combines the different transport networks of a city to offer the user the optimal route.

Such claims may be or not met in more or less degree by the government, but reality is that there are deficiencies. While these deficiencies continue to exist, the current public transport users and potential users will try to improve this situation with alternative solutions such as the application we want to accomplish.

#### D. Technology

All previous motivations that make us challenge the current system of public transport in big cities need some help. But this aid passes inexorably by the application of new technologies.

Today we can find on the market mobile devices with GPS, wifi and high data processing capability. They have touch screens and highly usable interfaces. Furthermore, the development of such applications has been facilitated by the development of very simple to operate SDKs. Other factors to consider are that people are more and more familiar with this type of device, its affordable price and that there is not any application in the market that offers a system for mobile devices that lets you know what is the best option to reach your destination.

---

### III. OBJETIVE

---

In the following sections we will concentrate on the scheduling algorithm necessary to carry out the project. In particular, we will perform a comprehensive analysis of planning in Artificial Intelligence, the main existing planning algorithms and their characteristics. With this study we will be able to choose the algorithm that best suits our problem. Once located, dig into their characteristics, both technical and operational, with the aim of acquiring the knowledge needed to solve the problems mentioned above.

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### IV. SPECIFICATIONS LANGUAGES

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To achieve efficient planning is so important to have good modeling languages, with good algorithms. The language of STRIPS [1] has conditioned the vast majority of planning work since the early '70s, due to its effective solution to the problem context [1] and his support for the strategies of divide - and - conquer. This section briefly describes this language as well as its two major extensions: ADL [2] and PDDL [3].

#### A. STRIPS

In artificial intelligence, STRIPS (Stanford Research Institute Problem Solver) is an automated planner developed by Richard Fikes and Nils Nilsson in 1971. The same name was later used to refer to the formal language of the inputs to this planner. This language is the base for most of the languages for expressing automated planning problem instances in use today. This section only describes the language, not the planner.

An operator  $o$   $O$  is defined on STRIPS as a tuple (Name, Pre, Eff). Name is the name of the operator and is represented by a syntactic expression of the form  $o(X_1, X_2, \dots, X_n)$  where each  $X_i$  is a variable symbol is called a parameter of the operator. Pre and Eff are respectively the preconditions and effects of the operator, and are represented by:

- An atomic formula (predicate\_name arg1, ... argn), where the predicate describes the type of fact and arguments are symbolic variables that correspond to the parameters of the operator. An atomic formula can also occur if it appears negated the effects of the operator.

- A conjunction of atomic formulas. An action is obtained after replacing all the parameters of an operator for specific values. An action, therefore, is a specific instance of an operator. Pre (a) is a set of facts that represents the preconditions of the action. The effects of the action Eff (a) are the facts that add and remove action. The positive effects are represented as Add (a), and negative effects such as Del (a). The result, therefore, to apply a sequence of actions on a state can be formalized as shown below:

$$\begin{aligned} \text{result}(S, \{\}) &= S \\ \text{result}(S, \{a\}) &= \begin{cases} (S - \text{Del}(a)) \cup \text{Add}(a) & , \text{ si } \text{Pre}(a) \subseteq S \\ S & , \text{ en caso contrario} \end{cases} \\ \text{result}(S, \{a_1, a_2, \dots, a_n\}) &= \text{result}(\text{result}(S, \{a_1\}), \{a_2, \dots, a_n\}) \end{aligned}$$

For convenience, any action can be initiated within a state, but only takes effect if their preconditions are met. If its preconditions are met, the positive effects of the action are added to the state, while the negative effects are eliminated.

A plan  $P$  is defined as a sequence of sets of actions applicable ( $A_0, A_1, \dots, A_n$ ), and indicates the order in which the actions of these sets will run. If a set of actions  $A_i$  contains more than one action, such actions can be executed in parallel. Therefore, if  $|A_i| = 1 \quad i = 1 \dots n$  says that the plan  $P$  is sequential and parallel otherwise. A plan  $P$  is a solution to a planning problem if  $\text{result}(I, P)$  is a state objective, ie, if  $G \subseteq \text{result}(I, P)$ .

#### B. ADL

Although the STRIPS language is very limited for most complex domains, allows a high degree of enlargement. A major expansion has been carried out is language ADL (Action Description Language [2]). ADL is more expressive than STRIPS and is based on an algebraic model to

characterize the states of the world. The main extensions added are:

- Types: ADL allows assigning types to objects of the problem and the parameters of the operators. This facilitates understanding of problems and reduces the number of predicates (fact types) needed.

- Preconditions and negated goals: ADL can include negated atomic formulas in the preconditions of an operator. Similarly, you can specify negated literals in the goals to represent those who do not want facts in an objective state.

- Disjunctive Preconditions: ADL allows a precondition can be a disjunction of atomic formulas.

- quantified preconditions: preconditions may include quantified formulas, both existential (exists) as universal (forall).

(forall (? v1 • v2 ...) [formula])

(exists (? v1 • v2 ...) [formula])

- Comparisons: ADL introduces a new type of atomic formula in the pre-conditions (= arg1 arg2), which is satisfied when its two arguments are equal. This equality predicate (called Equality) symbols compares variables within an operator.

- Effects conditionals in ADL domain, operators can contain conditional effects (when condition [formula]). Conditional effects have effect only if specified condition is satisfied in the state on implementing the action. Conditional effects are mainly situated in quantified formulas.

These extensions can reduce the number of instantiated actions, because each action is possible to express a wider range of situations. You can take this advantage to improve the efficiency of many planning systems [2].

### *C. PDDL*

ADL has been one of the extensions of STRIPS most used by planners, but not alone. For example, FStrips (Functional STRIPS) is a first-order language, without quantification, working with constants, functions and relational symbols - but not symbols variables - and increases the expressiveness of the language. However, the extent of greatest success has undoubtedly been PDDL (Planning Domain Definition Language [3]). PDDL was developed for the international planning competition in 1998 [McDermott 2000] with the aim of providing a common notation for modeling planning problems and evaluate the performance of the planners. Since its inception, PDDL has been a point of reference as modeling language for the vast majority of planners.

Apart from STRIPS and ADL, PDDL has been influenced by many other formalisms: SIPE-2, Prodigy 4.0, UCMP, Unpop and UCPOP [1]. The PDDL goal is to express the physics of a domain, ie which predicates are, what actions can be performed and what are its effects, without providing any additional knowledge about it. PDDL provides a wide variety of features, among which are:

- Model-based action STRIPS.

- Conditional effects and universal quantification, as proposed in ADL.

- Specification of hierarchical actions. The actions are broken down into sub-actions and sub goals that can contribute to more complex problems.

- Definition of domain axioms. The axioms are logical formulas that establish relationships between things that are satisfied in a state (as opposed to equity, which define relations between successive states).

- Specification of security restrictions. These restrictions allow to define a set of objectives to be met throughout the planning process.

Given the large number of features that PDDL can express virtually any existing planner is able to handle them all. PDDL brings these features into a set of requirements. In this way, planners can quickly check if they can handle a particular domain.

### *D. PDDL Extensions*

One of the main contributions of the competition in 2002 was planning a new version of PDDL language: v2.1 PDDL [4]. The most important characteristics are incorporating the ability to define actions with duration and to describe the effects that time has on stocks. It also modifies the treatment of numeric expressions and to specify, as part of the problem itself, an objective function (called metrics) that establishes the criteria for optimizing the plan.

PDDL v2.1 is organized into the following four levels:

- Level 1: includes propositional and ADL levels of the previous version of PDDL.

- Level 2: establishing a definitive syntax for handling numeric expressions. The numerical expressions are constructed by arithmetic operators and numeric functions.

These functions associate numerical values to tuples of objects of the problem. The numerical terms the actions are always comparisons between pairs of numeric expressions, while the effects can modify the values of numerical functions.

- Level 3 makes use of discrete durative actions. Thus, it is possible to indicate the moments during and after the implementation of an action effect occurs.

- Level 4: Allows durative actions that have continuing effects. To model this effect, introduce the symbol # t which represents the continuum over time during the execution of a durative action.

More recently, a new extension called PDDL+ a fifth level. This level allows you to model efficiently the occurrence of events during the execution of a plan. PDDL+ also supports modeling of business processes that are activities that, while they last, cause continuous changes in the values of numerical expressions.

---

V. CHOICE OF THE SCHEDULING ALGORITHM

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After analyzing the world of planning in Artificial Intelligence, the main existing algorithms and the requirements for carrying out the main project exposed before, we can reach an important conclusion. The most appropriate algorithm for our problem is JSHOP2. The reasons that led us to this choice are detailed below.

The main difference between SHOP2 and most other HTN planners is that SHOP2 plans tasks in the same order will be executed knowing the current status of each step of the planning process. This reduces the reasoning complexity by removing the large uncertainty degree about the domain and allows to easily incorporate power of expression to SHOP2.

Besides the common HTN methods and operators, the description includes SHOP2 domain axioms, mixed symbolic and numerical conditions and external function calls. The planning process is complete according to Turing, consistent and complete for a typology of planning problems.

Like other HTN planning systems, SHOP2 plans decomposing tasks into subtasks. A key idea in the use of any HTN planner is to design a set of methods that encode standard operating procedures catching several passes techniques for refining a task. Some features of the domain are expressed in a much more natural in a notation that HTN in a stock-based notation.

JSHOP2 is SHOP2 Java implementation. From a global standpoint, it is important to consider the programming language being used in the project. We have decided to use J2EE to develop the main solution, so JSHOP2 becomes the most appropriate algorithm.

---

VI. SHOP2: SIMPLE HIERARCHICAL ORDERED PLANNER 2

---

### A. Introduction

SHOP2, Simple Hierarchical Ordered Planner 2 [5] is a domain-independent planning system based on Hierarchical Task Network (HTN) planning. In the 2002 International Planning Competition, SHOP2 received one of the top four awards, one of the two awards for distinguished performance. This paper describes some of the characteristics of SHOP2 that enabled it to excel in the competition.

Like its predecessor SHOP, SHOP2 generates the steps of each plan in the same order that those steps will later be executed, so it knows the current state at each step of the planning process. This reduces the complexity of reasoning by eliminating a great deal of uncertainty about the world, thereby making it easy to incorporate substantial expressive power into the planning system. Like SHOP, SHOP2 can do axiomatic inference, mixed symbolic/numeric computations, and calls to external programs.

SHOP2 also has capabilities that go significantly beyond those of SHOP:

- SHOP2 allows tasks and subtasks to be partially ordered; thus plans may interleave subtasks from different tasks. This

often makes it possible to specify domain knowledge in a more intuitive manner than was possible in SHOP.

- SHOP2 incorporates many features from PDDL, such as quantifiers and conditional effects.

- If there are alternative ways to satisfy a method's precondition, SHOP2 can sort the alternatives according to a criterion specified in the definition of the method. This gives a convenient way for the author of a planning domain to tell SHOP2 which parts of the search space to explore first. In principle, such a technique could be used with any planner that plans forward from the initial state.

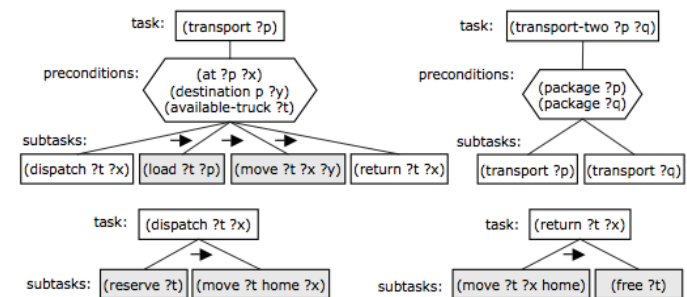
- So that SHOP2 can handle temporal planning domains, we have a way to translate temporal PDDL operators into SHOP2 operators that maintain bookkeeping information for multiple timelines within the current state. In principle, this technique could be used with any non-temporal planner that has sufficient expressive power.

The rest of this paper is organized as follows. Section 2 gives some background on HTN planning, and Section 3 describes SHOP2's features and planning algorithm. Section 4 describes how to write domain descriptions for SHOP2: in particular, Section 4.1 discusses basic problem-solving strategies, and Sections 4.2 and 4.3 describe aspects of SHOP2 that are specific to handling temporal and metric domain features. Section 5 discusses SHOP2's performance in the competition, Section 6 discusses related work, and Section 7 gives a summary and conclusion. Appendix A contains a SHOP2 domain description for one of the problem domains in the planning competition.

### B. HTN Planning

HTN planning is like classical AI planning in that each state of the world is represented by a set of atoms, and each action corresponds to a deterministic state transition. However, HTN planners differ from classical AI planners in what they plan for, and how they plan for it.

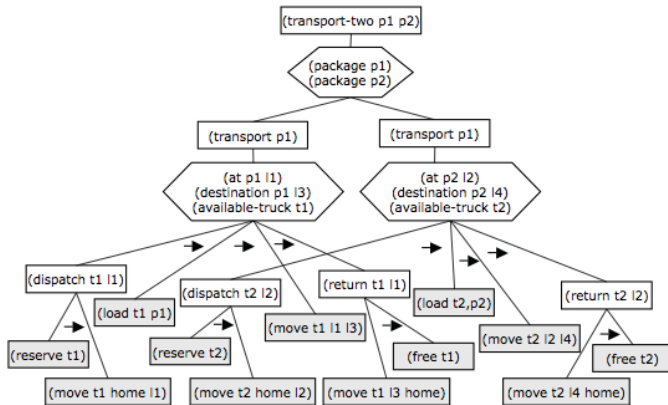
The objective of an HTN planner is to produce a sequence of actions that perform some activity or task. The description of a planning domain includes a set of operators similar to those of classical planning, and also a set of methods, each of which is a prescription for how to decompose a task into subtasks (smaller tasks). Figure below gives a simple example.



Given a planning domain, the description of a planning problem will contain an initial state like that of classical planning—but instead of a goal formula, the problem

specification will contain a partially ordered set of tasks to accomplish.

Planning proceeds by using the methods to decompose tasks recursively into smaller and smaller subtasks, until the planner reaches primitive tasks that can be performed directly using the planning operators. For each nonprimitive task, the planner chooses an applicable method, instantiates it to decompose the task into subtasks, and then chooses and instantiates methods to decompose the subtasks even further, as illustrated in figure below.



If the plan later turns out to be infeasible, the planning system will need to backtrack and try other methods.

HTN methods generally describe the “standard operating procedures” that one would normally use to perform tasks in some domain (e.g., see Figure 1) Most HTN practitioners would argue that such representations are more appropriate for many real-world domains than are classical planning operators, as they better characterize the way that users think about problems.

Like most other HTN planners, SHOP2 is “hantailorable:” its planning engine is domain-independent, but the HTN methods may be domain-specific, and the planner can be customized to work in different problem domains by giving it different sets of HTN methods. The ability to use domain-specific problem-solving knowledge can dramatically improve a planner’s performance, and sometimes make the difference between solving a problem in exponential time and solving it in polynomial time. In experimental studies, handtailorable planners have quickly solved planning problems orders of magnitude more complicated than those typically solved by “fully automated” planning systems in which the domain-specific knowledge consists only of the planning operators.

### C. JSHOP Characteristics

This section describes SHOP2’s planning algorithm and some of SHOP2’s distinctive features. The Basic Elements of a Domain Description are:

- 1) Tasks: A task represents an activity to perform. Syntactically, a task consists of a task symbol followed by a list of arguments. A task may be either primitive or compound. A primitive task is one that is supposed to be accomplished by a planning operator: the task symbol is

the name of the planning operator to use, and the task’s arguments are the parameters for the operator. A compound task is one that needs to be decomposed into smaller tasks using a method; any method whose head unifies with the task symbol and its arguments may potentially be applicable for decomposing the task. The details are discussed in the following subsections.

- 2) Operators: Each operator indicates how a primitive task can be performed. The operators are very similar to PDDL operators: each operator  $o$  has a head  $head(o)$  consisting of the operator’s name and a list of parameters, a precondition expression  $pre(o)$  indicating what should be true in the current state in order for the operator to be applicable, and a delete list  $del(o)$  and add list  $add(o)$  giving the operator’s negative and positive effects. Like in PDDL, the preconditions and effects may include logical connectives and quantifiers. The operators also can do numeric computations and assignments to local variables. Just as in PDDL, no two operators can have the same name; thus for each primitive task, all applicable actions are instances of the same operator. Each operator also has an optional cost expression (the default value is 1). This expression can be arbitrarily complicated and can use any of the variables that appear in the operator’s head and precondition. The cost of a plan is the sum of the costs of the operator instances.
- 3) Methods: Each method indicates how to decompose a compound task into a partially ordered set of subtasks, each of which can be compound or primitive. The simplest version of a method has three parts: the task for which the method is to be used, the precondition that the current state must satisfy in order for the method to be applicable, and the subtasks that need to be accomplished in order to accomplish that task.
- 4) Axioms: The precondition of each method or operator may include conjunctions, disjunctions, negations, universal and existential quantifiers, implications, numerical computations, and external function calls. Furthermore, axioms can be used to infer preconditions that are not explicitly asserted in the current state. The axioms are generalized versions of Horn clauses, written in a Lisp-like syntax: for example,  $(:- head tail)$  says that head is true if tail is true. The tail of the clause may contain anything that may appear in the precondition of an operator or method.

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## VII. PLANNING TOOLS: JSHOP2

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As we said before, planning was conducted using JSHOP2. JSHOP2, is a planning system based on HTN (Hierarchical Task Network).

A. JSHOP2: Design and Implementation Details

As specified in previous paragraphs, JSHOP2 is based on PDDL. However, it does not recognize the PDDL literally. Therefore, it is used an equivalent PDDL language written in LISP.

The domain is composed of operators, methods, and axioms. Domain components (operators, methods, and axioms) are logical expressions. These logical atoms combine logical expressions in a variety of forms (conjunctions, disjunctions, etc.). The atoms incorporated symbols of predicate logic plus a list of terms. Task lists the problems are composed of atoms of tasks.[6]

The problem consists of logical atoms (initial state) and a list of tasks (high-level actions).

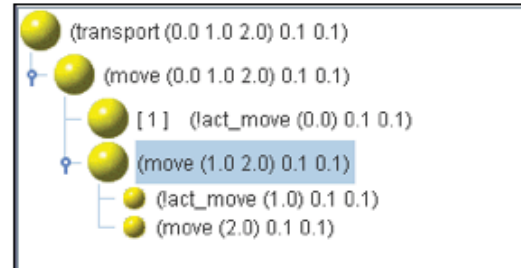
B. JSHOP2GUI 1.0.1

Although the JSHOP2 command line is enough to obtain a planning, it is difficult to analyze the different steps that the planner performs during the planning process. The Graphical User Interface (GUI) for JSHOP2 solves this problem by offering the user a way to analyze the task decomposition tree.

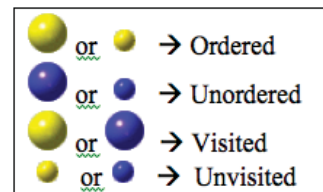
The goal of any GUI is to bring users a fast, easy and intuitive way to work with a program. In this case, the GUI allows you to see graphically the steps that planning is composed of. Its main advantage is that it facilitates analysis of the results and finds possible errors in the algorithm. [7]

The actions performed by JSHOP2 to achieve a planning are represented by the GUI as a series of steps. These steps can be traversed forwards using the corresponding buttons. The main window of the GUI shows the task decomposition tree. In the information window shows data on the state of the world domain and the action undertaken.

The main window of the GUI shows the task decomposition tree where each node represents a task atom. The task atoms that appear in the tree are always the initial stages of the most high that are used to find the current plan. Nodes can vary in size.

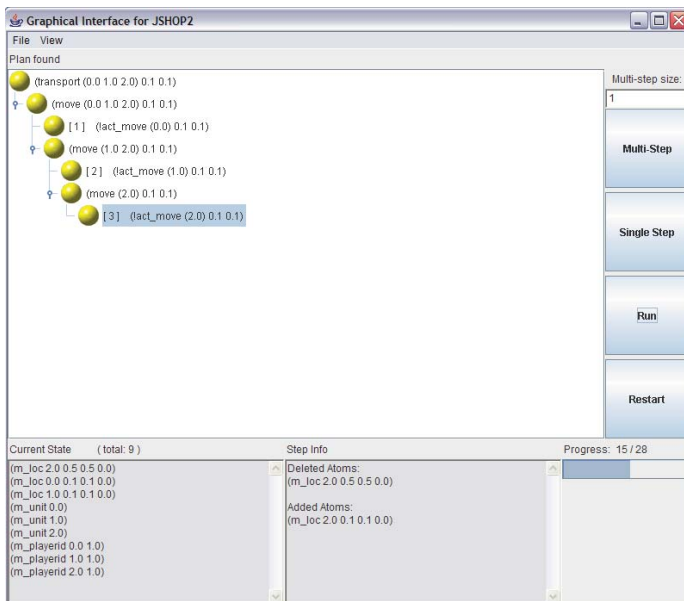
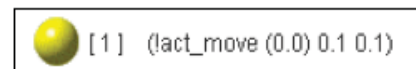


A large node is a visited node, while small ones correspond to those for which has not been yet visited. Furthermore, nodes may be of a different color. Yellow indicates a node that is part of a total order among their brothers. A blue node indicates a unordered task. If the cursor is on any node of the tree, and ordered states visited node will be shown in a popup window.



Leaf nodes have a number surrounded by brackets preceding the name of the atom of its task. Indicates the position of the primitive action in the sequence of actions that create the planning.

Initially it is assumed that each node is a leaf node when it first reached. If the task represented by that node becomes a complex task, the number of the sheet is removed from the task and is decomposed into subtasks.



VIII.PLANIFIC@ PROJECT

So far we have focused on testing the different algorithms and techniques in the route planning field and optimal paths. Once you have decided which suites best to the needs imposed by our project, we will use JSHOP2 based on PDDL. The application that we want to develop is called Planific@ and will be integrated into a bigger and more ambitious project called Moviliz@. The project Moviliz@ is a web and mobile application that guides people through Madrid (Spain) using the public transport of the city.

All HTN-PDDL project consists of two files. One defines the domain and the other the problem.

- In Domain file are defined the methods and operators (or actions) that call the methods.
- In Problem file it could be found objects that are going to take part in the problem, the initial state of all components, as well as the objectives.

#### *A. Domain definition*

At the beginning of this document we describes the motivations and features of the project Moviliz@. Now, we are going to define the elements involved in the design of the planner and their interdependencies.

The vehicles needed to carry out the project are bus, subway and on foot.

- **Bus.** The application will consist of a series of buses and lines. Each line consists of several buses that cannot get out of that line. A bus belongs to a single line and a line can have multiple buses.

- **Subway.** The application will consist of a series of trains and lines. Each line consists of several trains that cannot get out of that line. A train is in a single line and a line can take several trains.

- **Foot.** Another option is to travel on foot. A user can move between two points in the city on foot. In most cases where we plan a route, the user's point of origin will not match the bus or subway station near you. It will therefore be necessary to plan a path to walk to the bus stop. Another possible option is to get off at any intermediate stops of the tour, either subway or bus, and walk to another stop to get on other transportation.

- **Lines.** The system consists of several lines for different modes of transport, not for on foot routing. The lines are finite, they have several stops, and can be circular or not. The vehicles move along these lines between different stops.

The lines are the sections in charge of merging two stops. When calculating the ideal route these lines are the key decision. More than lines, the weights associated with each of the stages are the key element. You have to mark each section with weight and a long distance. It will take into account the buses or trains timetable, as well as the time it takes from the street to the corresponding platform. This time is really necessary, especially when making changeovers.

- **Stops.** A stop is the point where a line is accessed. The user must get to that station on foot and wait for the appropriate transport vehicle. Once this vehicle has arrived, the user must upload this vehicle, the vehicle moves to the next stop. The operations are equal for both, bus and subway, so we only need to kind of one type of stop. To determine whether the stop belongs to subway or bus, we can see the route through which we reach this stop.

- **Interchange.** It is possible to change the public transport in the middle of planning. This feature implies a change of line. The change can be performed in two ways:

- Change on foot: in any of the stops the user can move off and walk to a nearby stops if planner decide that.
- Interchange: some of the stops of the model are matched with other lines. It is in these places where the user can change the line without needing to shift on foot, but with a penalty. You have to get out of your current vehicle and wait for a new one.

#### *B. Problem definition*

The problem, as stated in previous paragraphs, is the file that describes the environment that will be applied to the Domain. That is, the problem initializes the variables with which to work and the relationships that exist between different model components.

It would be necessary to define the graph of the planning application. Make an association between stops, both subway and bus, with their respective relationships, indicating the weights as explained in previous paragraphs. It is necessary to define the relationship between stops and lines, that is, to tell which stop belongs to which particular line. This is necessary because, although we have said that transportation and his stops behave the same way, we must always know the line the user is moving on, in order to guide him/her to the destination correctly.

Having defined the graph on the schedules were implemented, we must define the elements within it. First we must define the position of the moving parts. Buses and trains are in different positions each time so the system has to behold it. In addition, the start position from which the user wants to be indicated varies with each plan. The same applies to the destination position.

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## IX. DIFFERENT SOLUTIONS

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This section sets out a series of practical examples that demonstrate the operation of simplified models. These models let analyze the overall operational of the system by a reduced example that gradually approach the desired solution.

First, the route-planning problem was addressed using SHOP, particularly JSHOP2. JSHOP2 is a planner that obtained a certain impact on the 2002 International Planning Competition because it was able to resolve all problems on the proposed domains and it got one of four first prizes.

But beyond this fact, JSHOP2 is not widespread and only exists a few resolved problems running that those which where proposed in the competition discussed above.

After an arduous research work we accomplished a close approximation of the problem solution. Two necessary files, domain and problem, were written in order to calculate how to get from one point to another using various means of public transport.

The conduct and outcome of this research is collected on the research document attached to this article. Despite the

results obtained using JSHOP2 we decided to take a second track because of the problems that by their very nature caused us when we tried to integrate the route reached with this planner into the Web portal and Google Maps Mashup, the interface from which users will interact with the system.

It was therefore decided to initiate a parallel investigation to resolve the problem. The other idea was to use Dijkstra's algorithm for solving the planning, integrate this algorithm into a web portal created to implement and manage route planning, and finally integrate these planning results in a Google Maps Mashup. [8], [9].

Having explained the reason for both approaches, we proceed to detail them.

#### A. JSHOP2 Solution

The definition of the problem domain takes place in the file D\_Planifica and comprises methods and operators that specify the tasks and subtasks to perform even a solution to solve a planning problem.

Moreover P\_Planifica file contains the specific problem to be solved. In this file were created many problems to solve that will be discussed below. The methods specify tasks and subtasks to be performed. A method in turn can contain several methods to execute if it meets a number of conditions. These methods are included in other subtasks of the task.

The nesting of methods creates a structure of tasks and subtasks that concludes with the execution of primitive operators. These operators, entities of lower levels of abstraction, are responsible for carrying out actions that will resolve the problem. The solution to it is precisely the sequence of all primitive operations are carried out to achieve the objective.

The methods and operators used to define the problem domain that also contain all the search logic of routes are described in the documentation attached to this article. However, below you could find some figures of the execution of and example with some transport lines.



#### B. Dijkstra – Google Maps Solution

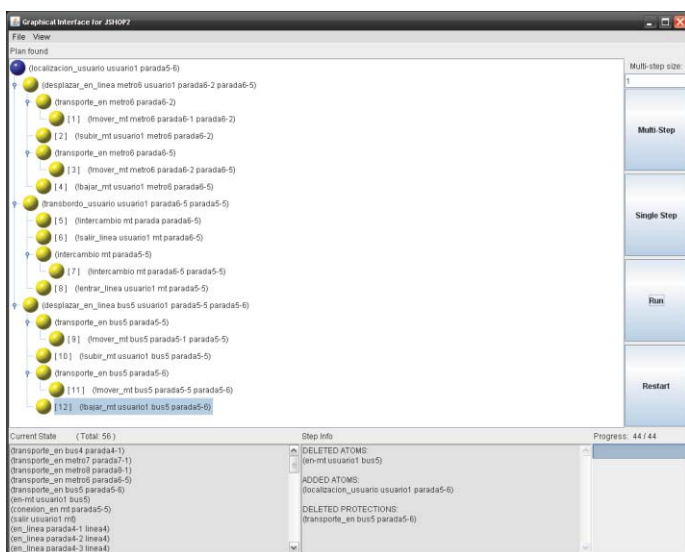
As it was said at the beginning of this section, with the first approach did not obtain the expected results. This is the reason for what we decided to tackle the problem from another point of view. Not the best way to deal with solving a complex problem, as are all combinations of public transportation services at Madrid, but it does provide a good approximation of what would be the end result.

- **Dijkstra.** Dijkstra algorithm is implemented in J2EE, it is integrated into a web portal and the results are displayed in the Google Maps Mashup that is integrated into the web portal.

Dijkstra's algorithm, conceived by Dutch computer scientist Edsger Dijkstra in 1959, is a graph search algorithm that solves the single-source shortest path problem for a graph with nonnegative edge path costs, producing a shortest path tree. This algorithm is often used in routing. An equivalent algorithm was developed by Edward F. Moore in 1957.

For a given source vertex (node) in the graph, the algorithm finds the path with lowest cost (i.e. the shortest path) between that vertex and every other vertex.

It can also be used for finding costs of shortest paths from a single vertex to a single destination vertex by stopping the algorithm once the shortest path to the destination vertex has been determined. For example, if the vertices of the graph represent cities and edge path costs represent driving distances between pairs of cities connected by a direct road, Dijkstra's algorithm can be used to find the shortest route between one city and all other cities. As a result, the shortest path first is widely used in network routing protocols, most notably IS-IS and OSPF (Open Shortest Path First). [8]



• **Google Maps.** The Google Maps API allows you to embed Google Maps in your own web pages with JavaScript. The API provides several utilities for manipulating maps and adding content to the map using various services, allowing you to create robust maps applications on your site.

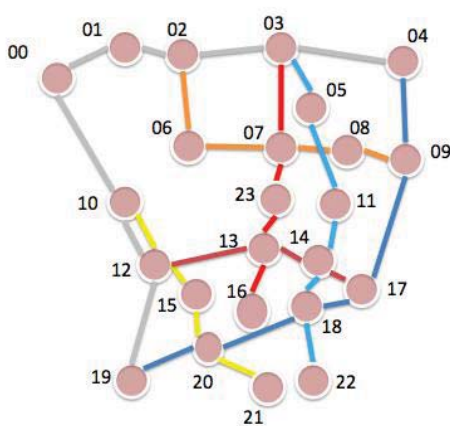
Google Maps is a GIS application by Internet company Google, which its potential for this type of project is very high. Therefore, we have decided to show route planning performed by Dijkstra's algorithm using this API. Moreover, this application will be integrated into a web portal as a Mashup. [9]

The possibilities offered by the Google Maps API are many, but not being the main objective of this work we will not deepen them. However, if you want to do more research on the subject, this link may be helpful: <http://code.google.com/intl/es-ES/apis/maps/>

• **Planific@.** In order to simplify the comprehension of the whole project we are going to limit the public transport of Madrid to the following graph.

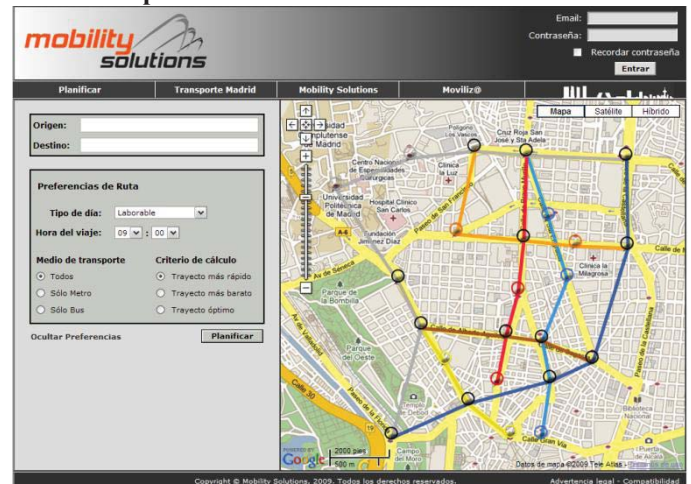


The same graph in a schematic way will be as follow:

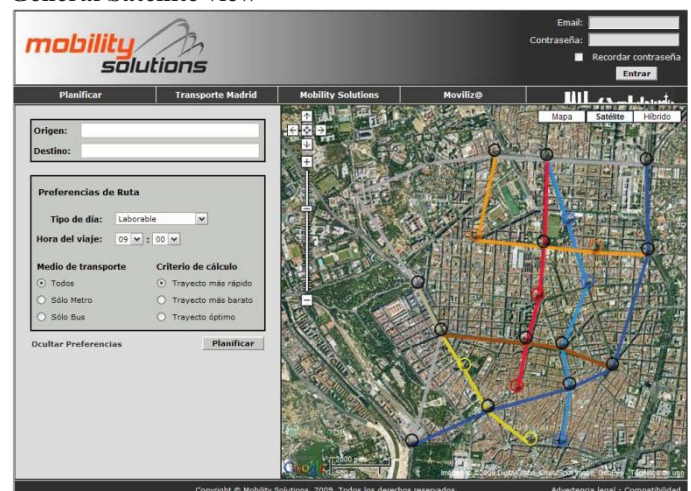


More details about implementation and web portal integration could be found at the attached document. However, below you could find some images of the final solution.

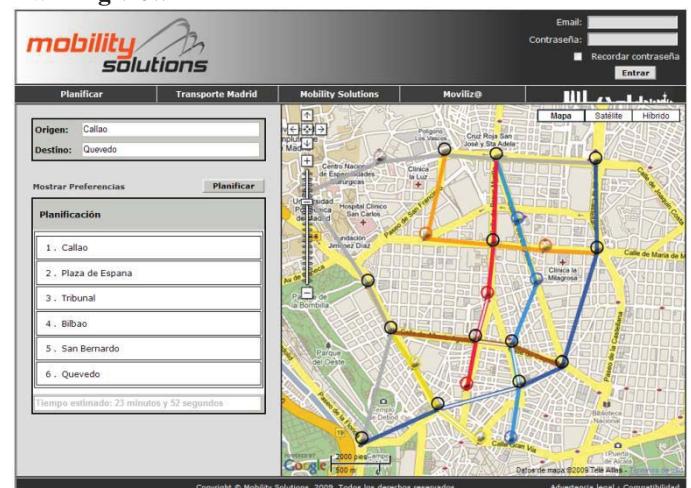
### General map view



### General Satellite view



### Planning view





## X. CONCLUSION

This paper shows the investigation study carried out about the different ways to perform route planning. After searching all possible solutions to resolve this problem we could say that HTN-PDDL and JSHOP2 is apparently the best way to reach the objective proposed based on the studied algorithms. So we started to design the PDDL domain that represented the proposed problem and it was seemingly easy and powerful.

However, it has to be noted that in PDDL there is a clear distinction between the description of parameterized actions that characterize the behavior of the domain and descriptions of specific objects, initial conditions and goals that characterize a particular problem. While, PDDL domain description is robust enough to model the behavior, we think that language has certain shortcomings when is needed to express the initial state and the objectives to be achieved in certain types of problems, for example, PDDL is unable to indicate a multiple initial state that allows not only minimize the objective function.

Moreover the language is not flexible when it necessary to instantiate the predicates and functions describing the initial state of a problem, which is quite tedious and impractical, especially when defining the problems as our case in which initialization involves a large number of nodes. It would be appreciate a reference to instances of more generic predicate to avoid having to make an exhaustive list. As for the tool used, JSHOP2, worth mentioning that the abstraction in which we must write the file and problem domain is based on LISP. This implies that clarity offered by PDDL defining operators, methods and designing the problem is lost, making more complicated to design the solution. We cannot fail to mention the great help that involved the use of graphical user interface used, JSHOP2GUI 1.0.1, which allowed us to do a larger number of tests because of its ease of use and the ease of debugging code.

Another problem with JSHOP2 was the great difficulty that we found to integrate the route reached with this planner into the Web portal and Google Maps Mashup, the interface from which users will interact with the system. After seeing all this difficulties that we find in this approximation to the solution, we tried a second via to solve the problem. We think that the best way to accomplish this is by using the Dijkstra algorithm written in J2EE, the same platform used for the web portal. It was easier to integrate the planning results with the Google Maps Mashup and these results were efficient and accurate enough.

As a final conclusion, we would like to say that throughout this investigation we have noticed that PDDL is a very powerful tool in order to write planning domains, but there is no planner that use it directly, transferring the domain information in the same language. We think that it would be very interesting to research on planners that use all the capacity that it owns. JSHOP2 is an ambitious academic project with great potential, but nowadays it is quite difficult to solve a problem that demands some complexity with this planner.

## REFERENCES

- [1] Okhtay Ilghami; Dana S. Nau.. A general approach to synthesize problem- specific planners. Technical Report CS-TR-4597, Department of Computer Science, University of Maryland. USA. Oct 2003.
- [2] Dana S. Nau; Muñoz-Avila, Héctor; Cao, Y; Lotem, A; and S. Mitchell. Aug 2001. "Total-order planning with partially ordered subtasks". In Proceedings of the Seventeenth International Joint Conference on Artificial Intel ligence, Seattle, WA, August 2001.
- [3] Nau, Dana. "Simple Hierarchical Ordered Planner. SHOP Automated Planning." . University of Maryland. USA. 17 Feb 2005 [Online]. Available: <http://www.cs.umd.edu/projects/shop/>
- [4] D. Nau, T.-C; Au, O; Ilghami, U; Kuter, J. W; Murdock, D; Wu, and F; Yaman. "SHOP2: An HTN planning system. Journal of Artificial Intelligence Research". Dec 2003.
- [5] D. S. Nau, Y. Cao, A. Lotem, and H. Muñoz-Avila. "SHOP: Simple hierarchical ordered planner". Proceedings of the International Joint Conference on Artificial Intelligence (IJCAI), Morgan Kaufmann Publishers. 06 Aug 1999.
- [6] Ilghami, Okhtay. "Documentation for JSHOP2". 24 Aug 2009. [Online]. Available: <http://ourcforge.net/projects/shop>
- [7] Shin, J. "A Graphical Interface for JSHOP2". Department of Computer Science University of Maryland, College Pak. Jun 2006
- [8] Wikipedia. "Dijkstra Algorithm". Aug 2009. [Online]. Available: [http://en.wikipedia.org/wiki/Dijkstra's\\_algorithm](http://en.wikipedia.org/wiki/Dijkstra's_algorithm)
- [9] Google Map. "Google Maps API". Aug 2009 [Online]. Available: <http://code.google.com/intl/en/apis/maps/>

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# Using Recommendation System for E-learning Environments at degree level

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**Abstract**—Nowadays, new technologies and the fast growth of the Internet have made access to information easier for all kind of people, raising new challenges to education when using Internet as a medium. One of the best examples is how to guide students in their learning processes.

The need to look for guidance from their teachers or other companions that many Internet users experience when endeavoring to choose their readings, exercises or practises is a very common reality. In order to cater for this need many different information and recommendation strategies have been developed. Recommendation Systems is one of these.

Recommendation Systems try to help the user, presenting him those objects he could be more interested in, based on his known preferences or on those of other users with similar characteristics.

This document tries to present the current situation with regards to Recommendation Systems and their application on distance education over the Internet.

**Keywords**—E-learning, Recommendation Systems, CMS, Internet, Learning Objects

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## I. INTRODUCTION

WITH the new technologies, and particularly with the fast growth of the Internet, users find a great variety of books, newspaper articles, pages or movies, without the need for prior precise knowledge of the contents of every one of them. Users find themselves overwhelmed by the overload of information and seek help to identify the objects which may be more interesting for them. Most of the time, users solve this problem following other people's recommendations, or selecting the objects that look similar to what they are looking for.

A Recommendation System is an application capable of presenting a user a suggestion for an object, obtained on the basis of his previous preferences and the preferences of a community which has likings and opinions similar to his. For Batul, Recommendation Systems help us reduce the overload of information we suffer nowadays, providing, at the same time, customized access to information for a specific domain.

Recommendation Systems are used in areas such as e-commerce, leisure or digital libraries in order to solve the information overload they produce. However, there are many other fields that present a similar problem, such as those domains related to education and learning object.

Lets suppose that, in a teaching environment, a student finds at his disposal a great number of learning objects, such as practices or exercises. The student has at his disposal many more objects than he is able to use, and has no idea where he should begin, so bearing in mind the learning objects are classified by categories, he decides to begin with the basic level. The student browses through all these educational objects for their topics and remembers a friend told him how much he had liked those learning objects related with an specific topic. The student decides to start with those objects, and once he has finished with them he calls his friend so he can recommend him more since the ones he has already gone trough did match what he was looking for.

If we move this process to the field of distance learning, how can a student find the objects he will like the most? In order to resolve the information overload problem different techniques can be used, and one of them is based on Recommendation Systems.

Our investigation tries to prove the feasibility of using Recommendation Systems applications in educational environments. This article introduces the work that is being done to provide the educational environment with a recommendation system.

The rest of this work is organized as follows: section 3 will comment on the current state of distance learning and the problems it presents, section 4 justifies the use of a recommendation system as a solution to the problems we are facing, section 5 presents the general aims of the investigation, section 6 has a description and a presentation of the results obtained in the first stage of the investigation and section 7 closes this paper, presenting the conclusions drawn.

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## II. EDUCATION THROUGH THE INTERNET AND THE LEARNING-OBJECTS

A Recommendation System is an application capable of presenting a user a suggestion for an object, obtained on the basis of his previous preferences and the preferences of a community which has likings and opinions similar to his. For

Batul, Recommendation Systems help us reduce the overload of information we suffer nowadays, providing, at the same time, customized access to information for a specific domain

#### A. Definitions

Looking through specialized literature we find many different definitions for education through the Internet:

- 1) "An Internet formation is an environment created in the Web, in which students and teachers can perform teaching and learning tasks. It is not only a mechanism to distribute information through to students; it also supports tasks related with communication, students evaluations and class management " [6].
- 2) "Formation through the Internet is a hypermedia program that uses attributes and resources from the Internet to create significative learning environments, where training is improved and leveraged" [5].

Formation through the Internet poses several problems, such as the rising cost of design and creation of curricular material, the impossibility of reutilization and the interoperability of the curricular material just mentioned [8]. Learning objects (LO) are proposed as a possible solution to these problems.

According to Wiley a Learning Object is "any digital resource that can be reutilized to make learning easier" [10]. In this author's opinion, digital resource is defined as anything that can be distributed through the net, no matter how small or large it might be. Examples for small reusable digital resource are images, small portions of text, or small Web applications. Bigger size reusable digital resource examples are Web pages that combine text, images and other means of communication.

#### B. Distance learning and the learning-objects advantages

The principal advantage of distance learning and the use of learning-objects are:

- 1) Access easiness: a great amount of people can access the formation, making temporal and geographic barriers disappear. Time problems disappear as the Internet is available at any time. The movement problems disappear as well as a person can be formed without the need of travelling several kilometres or to another city.
- 2) Costs saving: many more people can be formed with fewer resources.
- 3) Customized formation: most of the courses are interactive allowing the user to choose the way of his formation according to his needs or personal interests.
- 4) Possibility of being in contact with other students, allowing a greater collaboration and information interchange.

#### C. Distance learning and learning-objects problems

The principal problem posed in the distance learning through the Internet with great learning object collections is that students can find themselves overwhelmed with the overload of information. As it has already been expounded, a possible solution are the Recommendation Systems

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### III. RECOMMENDATION SYSTEMS

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The recommendation systems help the users to choose objects they can find useful or of their interest. A recommendation system is "the system that has, as principal task, to choose certain objects that meet the users requirements [9]. These objects can be any kind of information or articles, such as books, movies, songs, Web pages, blogs, etc.

The main operation of these systems is to ask the user to evaluate a series of objects. These evaluations will be used by the recommendation system to predict the user's evaluation of the object or the evaluations the user has done in the past. The more evaluations the users make, the better the results will be.

The recommendation system must provide a mechanism to compile the biggest amount possible of information from the users in order to make better recommendations. This process is called "retroalimentación.

#### A. Classification

In order to realize the recommendations there are two types of algorithms that give way to two big recommendation systems groups. [1], [2]:

- 1) Based in the content: the system recommends similar objects to those the user has liked in the past.
- 2) Collaboratives: the systems recommends the user objects that have been liked by users with similar likings.

A **recommendation system based in the content** is defined as: "system in which the recommendations are done based only in the profile made taking into consideration the object content analysis the user has evaluated in the past"[2].

The key of the systems based in the content is that the objects which can interest the user must be similar to the objects he has liked in the past.

The recommendation systems based in the content are mainly used to recommend documents, Web pages, publications, jokes or news. Some examples are: SYSKILL & WEBERT, which recommend Web pages [7] or PTV [4] which recommends TV programs to the user.

A collaborative recommendation system is defined as "the system in which recommendations are made based only in the similarity degree between users" [2].

The collaborative recommendation systems are based in the fact the objects a user likes can be liked by other users with similar likings.

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### IV. PROJECT OBJECTIVES

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This investigation's main objective is to solve the information overload problem produced in big learning objects collections.

The information overload problem has been solved in other systems, as for example commercial systems such as Amazon, or entertainment systems, such as Movilens, using recommendation systems. This is why the idea of integrating Recommendation Systems to the distance learning by means of internet services assistance was taken into consideration. Because these systems adapt themselves consistently to the properties an object recommendation processing must fulfil.

A. Stages of the project

The Project has the following stages:

- 1) Develop a prototype in which the users are provided with large learning object collections and state the problem of information overload..
- 2) Develop a prototype using a Recommendation System and check its validity.
- 3) Make a comparison between the algorithm used in the prototype and other types of prototypes used in other environments, looking for the algorithm that better adjusts to an educational environment.
- 4) Make a study of the advantages a Recommendation System has in place of a “Expert System” in education.

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V. STAGE 1. DEVELOPMENT OF A PROTOTYPE IN WHICH THE PROBLEM OF INFORMATION OVERLOAD IS CONFIRMED

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A. Objectives

The main objectives in stage 1 of the project are:

- 1) To state the problem of the large learning object collections.
- 2) Verify the feasibility for the Recommendation Systems application to the large learning collections in order to solve the problem of information overload.
- 3) Collect data to bring into service a Recommendation System.

B. Methodolgy

The study has been made with student from “Universidad Pontificia de Salamanca”, both Madrid and Majadahonda campus. 45 students registered in a certain course have been used as reference.

A portal has been developed in which the students have 41 practises of the course at their disposal. The access to the portal is made by user id and password. Once in, the system provides practises by a random method. When a student finishes a practise he must evaluate it so the system can obtain the information we will use in future developments to make recommendations. The student will not be able to do another practise until he evaluates the current one.

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VI. OBTAINED RESULTS

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The practise portal has been used for two weeks by 86 users, who have done and evaluated 1.178 practises. Figure 1 shows the number of users that have done each of the practises.

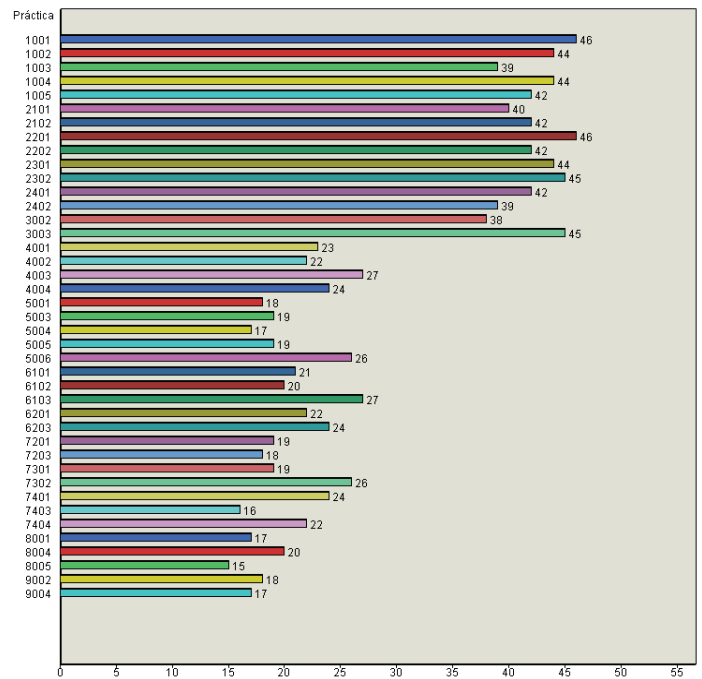


Fig. 1. Number of students that have done each practise

213 of the 415 registered students answered a system use survey. 68 of them had used the system.

The results obtained from the survey show the reason why most of the students did not use the system was they did not know it existed, not that they did not find it useful.

Figure 2 shows a chart with the reasons why the students that did not use the portal did so.

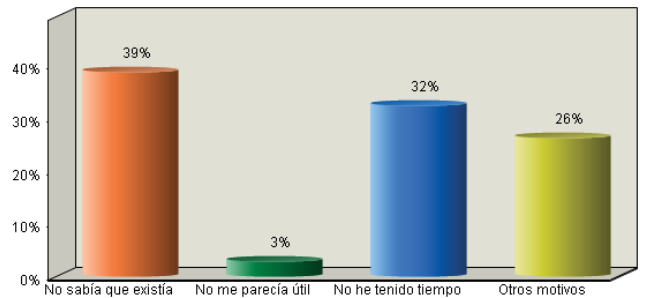


Fig. 2. Why didn't you use the portal of practises?

We have asked the students to mark from 0 to 4 the utility of the system in order to do practises of the course and prepare for the exam. Most of the students which used the system thought it had been useful for their practises and for preparing them for the exam.

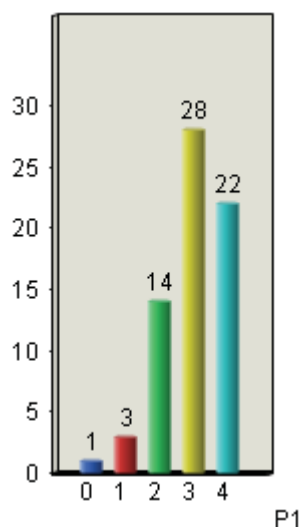


Fig. 3. Did you find useful the portal to do the practises of the course? 0->Not useful at all. 4-> Very useful

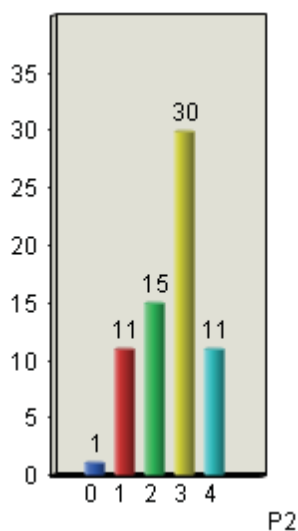


Fig. 4. Did you find useful the portal for preparing you for the exam? 0->Not useful at all. 4-> Very useful

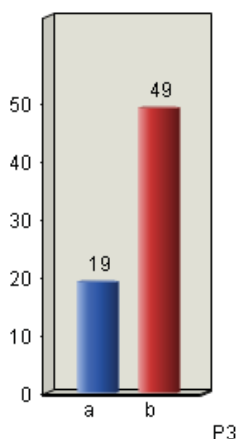


Fig. 5. Would you use a similar platform if you had it available for other courses? a) Yes, but only for courses with practises, b) Yes, I would use it for any course, c) No

All of the students surveyed expressed their wish of having a similar system for other courses including theoretical courses where all that can be offered is bibliography and documentation.

Regarding the number of practises they would be willing to do, most of the students indicated between 20 and 30.

## VII. CONCLUSION

The great amount of information that exists in the Internet makes the use of techniques that help the user find what he is looking for necessary. Recommendation Systems are used efficiently to solve the problem of information overload in areas such as electronic commerce and leisure time.

Our investigation shows the problem of the information overload is also present in distance educational environments. The obtained results show most of the users are not willing or can't do all of the practises the system puts at their disposal, that is why they would find help useful in order to decide which practises they should do.

## REFERENCES

- [1] Adomavicius G., Tuzhilin A. 2005. "Toward the Next Generation of Recommender Systems: A Survey of the State-of-the-Art and Possible Extensions". *IEEE Transactions on Knowledge and Data Engineering*, Vol. 17, No 6. Junio 2005.
- [2] Balabanovic, M., Shoham, Y. 1997. "Fab: Content-based, collaborative recommendation". *Communications of ACM* 40,3 (Marzo), 66-72.
- [3] Batul J.M., 2001. *Jumping Connections: A Graph-Theoretic Model for Recommender Systems*. Blacksburg, Virginia, USA.
- [4] Cotter, P., Smyth, B. 2000. "WAPing the Web: Content Personalisation for WAP-Enabled Devices". *Adaptative Hypermedia and Adaptative Web-Based Systems* Springer-Verlag.
- [5] Khan, B. 1997. "Web-Based Instruction (WBI): What Is It and Why Is It?". En B. Khan (Edit.) *Web-Based Instruction*. New Jersey, Englewood Cliffs, pp. 5-18.
- [6] McCormack, C., Jones, D. 1998. "Building a Web-Based Education System". New York, Wiley Computer Publishing.
- [7] Pazzani, M., Muramatsu, J., Billsus, D. 1996. "Syskill & Webert: Identifying interesting web sites". *AAI Spring Symposium on Machine Learning in Information Access*. <http://www.parc.xerox.com/istl/projects/mlia/papers/pazzani.ps>
- [8] Roig, R., Lledó, A., Grau, S. 2004. "Objetos de Aprendizaje (Learning Objects) como respuesta educativa al alumnado con altas capacidades de la inclusión digital". <http://www.tecnonet.org/docs/2004/1-12004.pdf>
- [9] Wang, P. 1998. "Why recommendation is special? En *Papers from the 1998 Workshop on Recommender Systems*, part of the 15<sup>th</sup> National Conference on Artificial Intelligence (AAAI-98, Madison, Wisconsin, EUA), 111-113.
- [10] Wiley, D. 2001. "Connecting learning objects to instructional design theory: A definition, a metaphor, and a taxonomy", *AIT/AECT, The Instructional Use of Learning Objects*, Association for Instructional Technology, 1-35

# WoT model for authenticity contents in virtual learning platforms

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**Abstract** — The following research proposal seeks to bring a model of security software on virtual learning platforms LCMS under all SCORM specifications to ensure the authenticity of content created under concepts of digital signature and identification of protocols and mechanisms to ensure such activities.

**KeyWords** — Security, authenticity mechanisms, virtual learning platforms, LCMS, SCORM, digital signatures, certificates of authentication.

## I. INTRODUCTION

IN the schemes of software security the representation of the authenticity is one of the principles of this line of work. In this way, it is seen in the future, in the area of digital certificates, as one of the basis to guarantee the sent documents validity through a Web of communications between client-computer and of course taking into account internet. This principle of security is the base to propose common models and alternatives of works to multiple businesses. Thus, there are going to be a lot of mechanisms to achieve the authenticity of information that is managed, day by day, for each one of the communication systems in all the computers. In the research that will show this project we can summarize that to implement the virtual objectives of learning (LO) to guaranty the use of the content under all SCORM specifications there must exist three elements: adaptability, usability, and accessibility. Although, adaptability is not for all systems according to reference [6]. In this case, the Moodle platform is one of the best CLMS to have a good adaptation [9]. For this reason, this is the most important element to analyze the security to get to information and contents through SCORM.

## II. THE REAL SECURITY ABOUT LCMS PLATFORMS

### A. About LCMS

LCMS (Learning Content Management System) have been an evolution for the systems based on contents CMS (Content

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Management System). These systems were created to manage and control the users' information in a corporative level. From the moment it appeared, this has been a product of integration of different kind of groups. These groups have permitted, in a global way, to support the initiative of standardizing the development processes of platforms. According to reference [17] these platforms have represented an important factor to facilitate some methodologies to study different from the traditional ones based on just training CBT (Computer Based Training), IBT (Internet Based Training) y WBT (Web Based Training). The view in relation to software security and the use of tools and platforms that have been developed to support learning is not encouraging.

It is clear that exist a lot of mechanisms and are useful for this kind of activities. The grade of confidence to identify the authority and creation of academic contents in this kind of platforms is not totally controlled by any technological devise. This gives some academic instructions and represents a fundamental topic in the process of formation and evaluation in learning. All the previous ideas want to reinforce the previous facts through the results of the analysis in relation to software authentications in more that 300 companies. There are some very important companies that deal with health, financial areas and education. This analysis was made by the CSI (Computer Security Institute) helped by its director Richardson [26] at the end of 2008. This analysis presents that the improper use of the information is one of the most important factors in the use of software applications. For this reason education represents the second vulnerable area to be attacked by the use of tools of communication and learning. In this way, education is in the virtual platforms of learning LCMS. In the figure number 1, it is possible to notice that the most important problems are the viruses on internet, but the improper use of information (Insider Abuse) and the financial

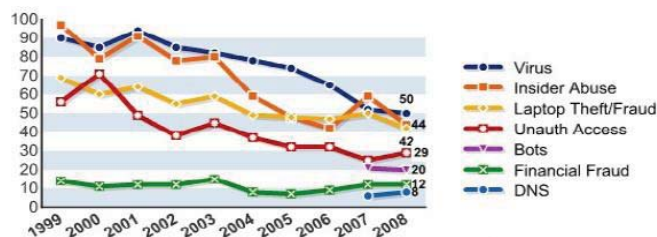


Fig. 1. Number of problems in the ten last years in areas such as government, business, help, and education. Source [26]

frauds are problems are impossible to control with companies' security rules.

Therefore, we can identify that most of the software answers, in the security area, are focused on diminishing problems dealing with issues like authentication and access controls. But, the part of data certifications shows that the results are not rewarding. Consequently, security is not clear. In the marketing it will always exists methods to attack the weak areas of computer systems.

III. SECURITY SCHEMES ABOUT SOFTWARE APPLICATIONS.

One of the elements that are important to take into account, before taking about the area of security in software technologies in relation to the Authenticity of Contents, is to know the condition and model of security representation that is in the market therefore, to talk about the whole contents Authenticity. We will base on a software security model proposed by [3]. This model is located in a telematic context. It says that to guarantee a software service there must be a model of representation to identify the security elements to apply. For this reason, the next model allows locating us in a global context to represent the kind of security that it is necessary to determine in relation to informatics applications

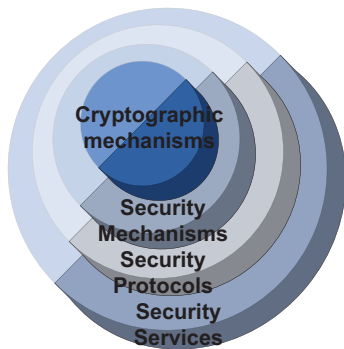


Fig. 2 Elements to provide security mechanisms. Source: [3]

and at the same time it helps us to be in the authenticity of contents.

The previous model represents the base that locates the security in the communication system. This model locates each security according to the elements that are important to its appliance. It begins with cryptographic mechanisms and mechanisms of security to write in code the information and authenticate the same mechanisms. It continues with some protocols of communication to send data and finally, the security service that is all the structure that guaranties the contents authenticity on a LCMS platform taking into account all the SCORM specifications.

A. Authenticity Services

The concept of authenticity is in relation to the principle of Confidentiality. It is also known as confidential levels and another principle that is confidentiality of contents in a

communication context. The word "Confidentiality" in software world has a lot of elements that have been treated by a lot of authors to give them a different view to apply. This is because Confidentiality, Authenticity, Integrity, Acceptance and Controls of Access have been considered as important elements of a sure communication. This is a topic that we are going to discuss from an academic and scientific point of view with help of some technological areas.

From the academic point of view some authors [7] work this concept under the possibility of "the transmitter and receiver must be able to understand the content of the message". For this reason it is important to certificate the encryption and decoding of the message through a number of clues that are used in a process of communication between two entities. On the other hand, [5] talks about confidentiality as the base of privacy. So, "the information that has been received for the web will not be intercepted and read by any other entity". This ensures the origin of the information. The reference [3] affirms that confidentiality does not have to be related with privacy, because these words are similar but have a different meaning. The use of these words, in a context of software security, change a lot taking into account "the coordinate use of judgments and security services that are available." To implement this concept it is necessary to think about its fundamental state that is in relation to the cryptographic principles that are mentioned below.

B. Cryptographic systems

A Cryptographic System is a security mechanism that assures information between two entities that want to hold a communication canal. The process of hiding a message is considered the how and has a particular characteristic. This is both clues and algorithms are used to hide the secret message. In this sense, we can find that the components of a cryptographic system are:

- 1 Original message  $M$
- 2 Message written in code  $C$
- 3 Secret key  $K$
- 4 Operation to write the code  $E_k$
- 5 Operation to decode  $D_k$

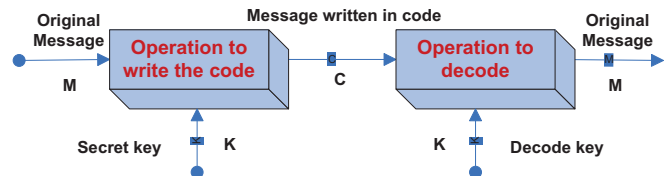


Fig 3 Classic cryptographic system

The previous figure represents a normal operation to write messages in code. This process represents the Classic Cryptographic scheme. One of the cryptographic characteristics is that it is composed by two branches. These ones are used depending on the conditions of the system that is going to be used. These branches are known as





mechanism states the idea to allow and accept user's identity in a communication system when the user is known by another user of the system that guarantees some minimal conditions of confidence to accept him in the communication scheme of the platform that they are sharing. Under these circumstances, there is a new concept that allows the interaction of users about social nets and it is in relation to the project SIF (Social Interaction, Framework) [10]. In this framework an agent evaluates another agent's reputation based directly on observations of some witnesses that are participating in the same system. It was different for the traditional electronic systems because participants have to use external mechanisms that were used as intermediary between the people that were holding a communicative process. One technological issue that was used from some years ago is in relation to browsers. In this case, the most common browser because of its characteristics is Firefox through the WOT component. It is possible to download this component to the user's computer. This avoids problems in relation to internet such as: advices that are not sure or necessary, steered identities, no trusted commercial web pages, problems with link security before clicking on them, and so forth. There are some prototypes that are developed with this model of web of trust. They are reflected in the model of reference [13] a web of trust and some prototypes worked by reference [14]. These prototypes need users to give a qualification of them and in this way it is possible to have a central organism (direct punctuations) to other trusted users (collaborative punctuations). Therefore, central system pursues users that do punctuations of each one and utilizes this punctuation to create a reputation in relation to a specific user. These systems need previous social relations between the users of an electronic community. It is not clear the way relations are established and how qualifications are spread through this community. These previous characteristics have created some projects that allow us reinforcing the proposal to find a trusted system with digital contents about a LCMS based on a series of specifications through SCORM. This is going to be discussed in the next point.

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## VI. MODEL TO PACK DATA

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When virtual platforms of learning began to be stronger in the academic community as one of the available and valid alternatives to control non presential activities there was a study that allowed stating some rules in order to generate contents and different functions from the platform of work. For this reason, a lot of international groups appeared. This allows determining a group of rules to deal with the contents. In this case, we can base on works developed like SCORM through ADL [16], IMS Content Packaging [18] for the definition of the structure of contents, IMS Simple Sequencing [23] for the structure of contents of learning and the evaluation of these ones through Learning Design [21] and giving them through IMS Model Data [22] with the objective of the creation of a data structure in a representation of different stages for its application with different

pedagogical points of view and elements proposed by [2].

### A. Objectives and representation of contents

In the model to pack data to contents on virtual platforms of learning LCMS, there are some references that are a base to determine each function of content. In this way, we can base on works developed by [1] to draw the most important specifications in IMS through [19]. It is important to base on works developed by SCORM through [16] and the works developed by reference [8]. The last one presents some characteristics and specifications that are in the market and that were mentioned before. To identify some functional parts of any specification it is important to highlight the concept of learning objective from the point of view of programming. This one, mentioned by [8] in his works, exalts the idea of the relation of the contents to their creation. For this reason, he says that the concept has changed so as to work with RLO (Reusable Learning Object). This topic was developed under IEEE specifications with [25] by the author [10] to define the metadata and the elements to define the contents. Any way, these ones adapt the E-learning world to offer a paradigm focusing on the objectives in the use of components with the definition of most of the specifications.

According to [8] "The RLO objective is to have a lot of learning material pieces to combine each other and reutilize them in different contexts. Although, the reutilization of learning objectives have more problems that the reutilization of software objectives". These problems are in relation to the identification of a standard to use; under these circumstances they are important in the creation of contents.

### B. A group of SCORM specifications

SCORM (Shareable Content Object Reference Model) was an idea supported by defense departments of the United States in 1997. The critical proposal of this entity is to support itself on the previous initiatives to form its own group of specifications. This group is formed by IMS, IEEE through LOM, AICC specifications, but there are more.

### C. SCORM Operative Model

The second version for 2004 is been prepared. It has [16] some important differences from the first version in the marketing. Content Aggregation Model (CAM). According to the specification [16] of this model, it defines the way to join, ticket, and pack content. As SCORM objective is focused on objects, it is necessary a good description of how these objects can be connected. Run-Time Environment (RTE). RTE describes the process and development for a CLMS with a SCO and the process of communication between them. A student just has an active SCO in a moment. Sequencing and Navigation (SN). SCORM model describes the sequence and interaction with RTE. Although, the description of the process and the sequence is made using IMS (Simple Sequencing) specifications described in [24]. Therefore, the model [24] is oriented to the relation and purpose of the pedagogical models used and the use of methodological strategies in relation to instructions. In this way, the process of learning is going to be

guarantee for the student with guidance. The objective of SCORM, under platforms LCMS, is to be a local storage to pack contents. This is to use the content in the platform as a manager of services of content. In this way, a user is going to use the content by watching it. In SCORM specifications for LCMS, it is necessary an architecture based on the browser and with boundaries to the use of contents used by an user so as to learn. Therefore, a learning process is guaranteed through a SCORM sequence. In this way, there are a lot of

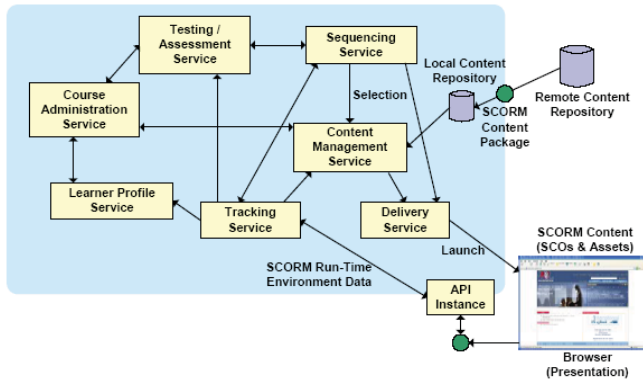


Fig. 5. SCORM model in LCMS platforms source: [16]

rules to specify and use the content in a sequence following the students' process of learning.

#### D. Looking at security in standards

There must be three elements to state virtual objectives of learning to guarantee the use of content by following some specifications. These are: Adaptability, reusability, and accessibility. Adaptability is here, but there are many systems that are not compatible with it reference [6]. On the other hand, reusability, and accessibility are analyzed by [6] in terms of bases for standards. He concludes that the platform LRN bears a variety of standards next to educative level such as the SCORM model, the IMS specifications and the Moodle platform. All of these are helped to guarantee requirements for accessibility to some content resources. In the SCORM specifications there are some elements that are used to work in a strategic way and to adapt the content to authenticity through packing it. This is going to be a guideline to analyze. It depends on the language used to develop authenticity through Digital Sign and for this case the definitions given by XML that are commented below.

### VII. XML-SECURITY

XML was proposed by W3C (World Wide Web Consortium) (originally known as the consortium for editorial revision of SGML proposed by IBM) in 1996. In 1998 it became a standard and it has been one of the most important contributions for software to manage, import, and export data on internet and on any kind of platform. This has showed new alternatives for the distribution of information in a clear and organized way for software systems. This is a standard for this kind of process. For this case, this paragraph is focused on the analysis of this standard and it is related to the qualities of

security to support the XML Security project activities of authenticity. This project has three important elements that allow the identification of appropriated formats to manage digital signs in a communication system. On one hand, there are some characteristics given by XML-Signature [30] for digital signs of documents. On the other hand, there is the encryption operation through XML-Encryption Syntax and Processing [28]. Finally, it is the distribution of keys through XML-Key Management [29].

#### A. XML- Signature

The specification given by XML Digital Signature according to [30] uses some technologies for encryption of contents. In this process we can find some asymmetric algorithms and a generation of keys through HASH functions using alternatives such as SHA1, RSA and others. Under these guidelines for encryption it is necessary a structure for the distribution of public keys to provide the elements for this mechanism in relation to identity and no negation. In a general way, we can find some elements in the Digital Sign that define three fundamental guidelines:

- The following image represents an example of digital sign for the acquisition of a product on internet.
- Enveloping Signature: the sign XML involve the content that is signed.
- Detached Signature: The signed object is separated from XML sign.

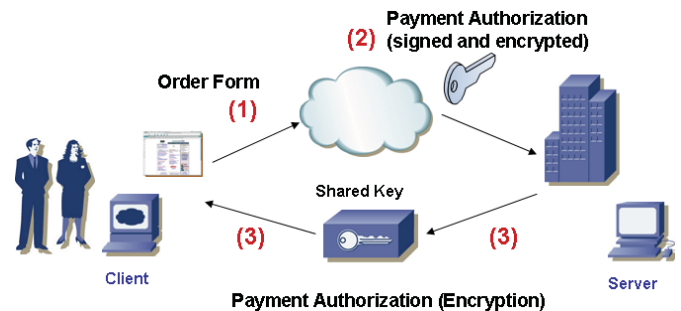


Fig. 7. Example of a digital sign for a transaction on the Web.

- Enveloped Signature: the signed content involves the sign.

In this case there is a banking transaction to ask for products on internet. This transaction is made with a credit card:

1. The client makes his demand through a form given by a bank.
2. When the form is filled, the client send it and it is encrypted with a key that is shared by the client and the bank. Therefore, the form is signed by the client and it is sent to the bank.
3. The bank processes the form and confirms the client's information (identity card, last name, etc.) then, the credit card encrypted information is processed to confirm the data and the clients demand continues its process.

B. XML-Encryption

XML-ENCRYPTION according to [28], describes the way in which singed data have to be written in code by the Web. This is with the objective to avoid the easy detection by external agents in the process of communication. In the encryption and decode process defined by [28] it is possible to identify the following roles:

- **Application:** the demand makes an application of encryption XML through giving enough data and guidelines for the process.
- **Encryption:** this is an implementation of the XML encryption to encrypt data.
- **Decode:** implementation of the XML encryption to decode data.

VIII.METHODOLOGY TO WORK

To develop the statement of the model we will base on security standards proposed in the market. In our case, the international standard given by ISO/IEC 27002 and proposed for the year 2007 for the use of information including international standards about requirements, risk analysis, measures and guidelines for the implementation of the software security that is an important element is what we want to assure in LCMS platform through authenticity mechanisms.

How to assure information with ISO/IEC 27002 in SCORM specifications To think about the model it is necessary to take into account some ISO/IEC 27002 considerations in relation to the classification from the legal point of view through these

```
<EncryptedData Id? Type? MimeType? Encoding?>
  <EncryptionMethod/?>
  <ds:KeyInfo>
    <EncryptedKey?>
    <AgreementMethod?>
    <ds:KeyName?>
    <ds:RetrievalMethod?>
    <ds:*?>
  </ds:KeyInfo?>
  <CipherData>
    <CipherValue?>
    <CipherReference URI??>
  </CipherData>
  <EncryptionProperties?>
</EncryptedData>
```

Code 1. Representation of XML-Encryption. Source:[28].

three elements:

A. Data protection and privacy of personal information

In the strategy that will be proposed about authenticity it is important to have a mechanism that assures protection and privacy of information through a group of rules defined by XML-ENCRYPTION. This is to have the protection of:

- Person’s information that creates the environment to work.
- Person’s information that creates that creates the virtual instruction resource.
- Person’s information that uses the shared resource in

the virtual instruction.

B. Protection of the organization record

For the protection of the organization record some enterprises are going to be taken into account because they make digital certifications that mention a particular academic institution. This is with the objective of legalizing all the contents in the institution.

C. Intellectual property Wright.

To valid people’s data in a process of communication it is important to highlight wrights and intellectual property of the created content. In this case, it is important to use XML-SIGNATURE to identify their validity. The cases to evaluate are:

- Person’s information that creates the environment to work.
- Person’s information that creates that creates the virtual instruction resource.
- Person’s information that use the shared resource in the virtual instruction.

D.Security proposal about SCORM evident archive

To follow these three elements it will implement XML-SECURITY through XML-SIGNATURE and XML-ENCRYPTION to try to counteract these problems.

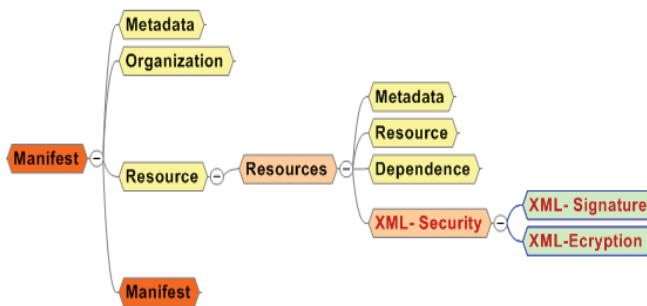


Fig. 8 Archive evident with security guidelines about the authenticity of content

To follow these characteristics it is important to highlight the idea that the most important archive to develop the process with the SCORM specifications is known as evident through the following representation:

This evident archive has an important role in the creation, opening, and search process of the learning objective on a LCMS platform under SCORM specifications.

This allows a connection to get all learning object characteristics. Therefore, it represents the element that is going to make easy the identification and ticketing on the content with the LOM standard security.

E. Security proposal about LOM

LOM work is to identify, in the ticket called Wrights, the sing characteristics that is add to the content. To do this, XML-SECURITY is based on the standard for this proposal that is represented in figure 9.

LOM will be the base for authenticity content process. The

standard for this is just mentioned, as it was mentioned in the previous chapters, and security guidelines are not included to strengthen the authenticity of the author's content.

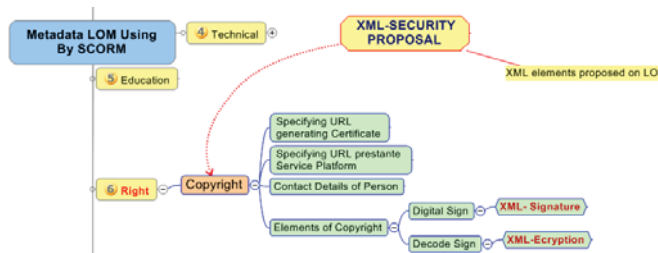


Figure 9 - Proposal of security ticket about author's Wright elements

F. Proposal of Security model for contents

The proposed model is based on toll and elements functional representation that are in a group of guidelines to defined contents by SCORM. Bellow, there is a model of the proposal to be developed and it has to the fig 11. This model must be framed in a plan of security through the use of ISO/IEC 27002 standard already discussed. Thus, it must be based on a company security mechanisms. This will generate sings about contents under SCORM specifications and at the same time, it is based on a LCMS virtual platform for learning. To state the previous proposal it is necessary to understand the creation of the model from the representation of each one of the identified roles in a communication process (Manager, Teacher, Student, and Guest).

In a general way, we can say that the model wants to get the following cases:

Therefore, the proposal is a software prototype to establish an architecture for the generation of digital certifications through PKI infrastructures. This is going to allow the LCMS virtual learning platform to manage the content authenticity through user manager, teacher, student, and guest's activities on SCORM specifications.

IX. CONCLUSION

We can say that there are a lot of organizations, in the market, based on research groups that work on standard components about software applications through security Web architectures. These groups emphasize the importance of

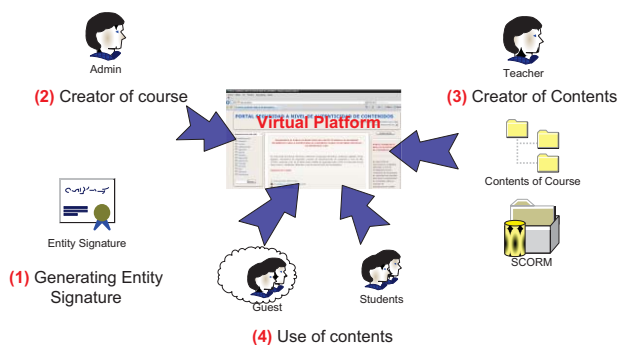


Fig. 10 - Kinds of sings created on LCMS platforms

XML language as one of the critical elements to guarantee the communication process in a Web environment. Therefore, the importance of [25], IETF, W3C and other contributions by some authors on a research level as [1], [5] is exalted. Many other highlight the idea of facilities offered by XML to create a secure environment for communication and to assure the integrity of information. This is connected with the SCORM specifications, realizing an adaptation to the model that works on the creation of content on LCMS platforms.

About security to guarantee the authenticity of generation of contents there is not any specification because security is focused on administrative issues to ticket content, generation of content, and from the pedagogical point of view the case of each one of the previous activities already discussed. The IMS consortium has worked on security too. But, it gives no relevant proposals in relation to authenticity for users and mechanisms to access to different kind of LCMS platforms under communications models focused on the WEB. All this is possible through protocol communication support and help from mechanisms such as: SSL, SLT VPN systems, among other alternatives, with reference [23] specifications. For communication between platforms it gives an authentication proposal. In its characteristics it is considered a new specification to deal with security of contents on a level of metadata. LOM, in a particular way, has a ticket in which there is a reference to the use of intellectual property of learning. This is known as Wrights. It describes property intellectual wrights and the conditions to use the object of learning that is used. But, as the standard says, these conditions have been proposed without taking into account security of the object that is used. In this case, it is a strong candidate to implement mechanisms of authenticity.

For our particular case, SCORM seems to have a lot of important advantages in relation to the analyzed specifications. In SCORM structure is the LOM standard. This standard, as it was mentioned before, has a metadata known as Wrights and it deals with object intellectual wrights for learning. This is not deep, but it works as a beginning for the objectives of this project, that will be valid in SCORM specifications. In these ones, we find some elements that are used to work in a strategic way to adapt the packing of content to the learning objectives authenticity. At the same time, this is going to be an analysis guideline that depends on the language that is going to be managed to work authenticity through Digital Sign. In this case we have the definitions by XML-Security. In the stated software security model it is important to highlight its well development on a confident structure through the WOT concept. At the same time, it is important to highlight its keys use and distribution through PKI with a known institution support that will let the generation of each one of the certifications for the user's access to the platform. This allows managing a group of SCORM specifications to create a virtual space and contents by a manager or a teacher. But, LCMS platform needs security mechanisms to deal with user's profile for each particular situation. This is what guarantee an authenticity model security of contents with SCORM specifications and

based at the same time, on external mechanisms to guarantee a good development through each one of the participants in a communication process. This one is formed by: managers, designers, teachers, students, guests, staff, etc.

Finally, we can determine that a plan for authenticity security mechanisms of contents on LCMS platforms depends on a group of specifications that is in the market. But the problem is that the plan is new and it is not able to state all the specifications. For this reason, it is important to determine that just a digital sign is not going to be taken into account, in a LCMS environment, but people's content validity to create a virtual space. These people are the ones in charge of the creation of the content for the teachers and the generation of a sign for the ones who use the material. This will create a high security level of the available contents in a LCMS. In this way, it is possible to state a concept about the kind of platforms that are used in social nets known as Web of Trust WOT. This will allow the generation of a more confident environment to work with an available material in these learning environments.

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#### REFERENCES

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- [1] Burgos, D. Doctoral Thesis. Estudio de la estructura y del comportamiento de las comunidades virtuales de aprendizaje no formal sobre estandarización del e-learning. Madrid, España: Tesis Doctoral. Universidad Europea de Madrid. (2006)
- [2] Burgos, D., Tattersall, C., & Koper, R. How to represent adaptation in eLearning with IMS Learning Design. *Interactive Learning Environments*, 15(2), 161-170. (2007)
- [3] Carracedo, J. Seguridad en Redes Telemáticas. Ed. McGraw-Hill. ISBN: 84-481-4157-1. Pág. 549. (2004).
- [4] González MJ. "B-Learning utilizando software libre, una alternativa viable en Educación Superior", *Revista Complutense de Educación*, Vol. 17, Nro. 1, pp. 121-133. Spain. (2006).
- [5] Halsall, F. *Redes de Computadores e Internet*. Ed. Quinta Edición. Pearson – Addison Wesley. ISBN 10: 84-7829-083-5. Pág. 858.(2006)
- [6] Kareal, F & Klema, J, Adaptivity in e-learning. In A. Méndez-Vilas, A. Solano, J. Mesa and J. A. Mesa: *Current Developments in Technology-Assisted Education*, Vol. 1, pp. 260-264. (2006)
- [7] Kurose, J, & Ross, K, *Redes de Computadores un Enfoque Descendente Basado en Internet*. Ed. Pearson - Addison Wesley. ISBN: 84-7829-061-3. Pág. 768. (2004)
- [8] Marquez, J. Estado del arte del eLearning. Ideas para la definición de una plataforma Universal. Trabajo de Investigación Doctoral. Universidad de Sevilla. Departamento de Lenguajes y Sistemas Informáticos. Marzo (2007)
- [9] Santos, O.C. Technology Enhanced Life Long eLearning for All. In K. Maillat and R. Klamma: *Proceedings for the 1st Doctoral Consortium on Technology Enhanced Learning*. European Conference on Technology Enhanced Learning, p.66-71, (2006).
- [10] Schillo, M., & Funk P. Who can you trust: Dealing with deception. In *Proceedings of the workshop Deception, Fraud and trust in Agent Societies at the Autonomous Agents Conference*, pages 95-106. (1999)
- [11] Vélez, J. Arquitectura para la Integración de las Dimensiones de Adaptación en un Sistema Hipermedia Adaptativo. Trabajo de Investigación Doctoral. Universitat de Girona. Departament de Electrònica, Informàtica i Automàtica. Marzo (2007)
- [12] Wiley D. & Edwards K. Online self-organizing social systems: The decentralized future of online learning. *Quarterly Review of Distance Education*, 3:33-46. (2002)
- [13] Yenta, L, & Foner 1997, A multi-agent, referral-based matchmaking system. In *Proceedings of the 1st International Conference on Autonomous Agents*, pages 301-307.
- [14] Yu, B 2000, Mahadevan Venkatraman, Munindar P. Singh. An adaptive social network for information access: Theoretical and experimental results.
- [15] Zimmermann, H 1980, OSI: Open System Interconnection, *IEEE Transactions on Communications*, vol. 28, no. 4, pp. 425 - 432.(1980)
- [16] ADL, [2004], *Advanced Distributed Learning*. SCORM 2004 Sharable Content Object Reference Model. [Viewed April 2009], <<http://www.adlnet.org/Pages/Default.aspx>>
- [17] Boneu, J. ( 2007), "Plataformas abiertas de e-learning para el soporte de contenidos educativos abiertos". *Revista de Universidad y Sociedad del Conocimiento (RUSC)*. Universidad Oberta de Catalunya. 1698-580X. Vol. 4 Nro. 1. pg. 36-47, [Viewed April 2009], <<http://www.uoc.edu/rusc/4/1/dt/esp/boneu.pdf>>
- [18] IMS-CP, 2005, Global Learning Consortium. IMS Content Package. Version 1.2. Public Draft Specification, [Viewed April 2009], <<http://www.imsglobal.org/content/packaging/index.html>>
- [19] IMS-GC, (2009), Global Learning Consortium. [Viewed April 2009], <<http://www.imsglobal.org>>
- [20] IMS-GWS, (2005), Global Learning Consortium. IMS General Web Service [Viewed April 2009], <<http://www.imsglobal.org>>
- [21] IMS-LD, (2003), Global Learning Consortium. IMS Learning Design. Version 1. [Viewed April 2009], <<http://www.imsglobal.org/learningdesign/index.cfm>>
- [22] IMS-MD, (2006), Global Learning Consortium. IMS Meta Data. Version 1.3 Final. [Viewed April 2009], <<http://www.imsglobal.org/metadata/index.html>>
- [23] IMS-SS, (2003), Global Learning Consortium. IMS Simple Sequence. Version 1.0 Final Specification, [Viewed April 2009], <<http://www.imsglobal.org/simplesequencing/index.html>>
- [24] LTSC. (2002). Learning Technology Standards Committee. Draft Standard for Learning Object Metadata. IEEE Standard 1484.12.1, New York: Institute of Electrical and Electronics Engineers, [Viewed April 2009] <<http://ltsc.ieee.org/wg12/20020612-Final-LOM-Draft.html>>
- [25] OASIS,( 2009), *Advancing Open Standards for the information society*, [Viewed May 2009] <<http://www.oasis-open.org/home/index.php>>
- [26] Richardson, (2008). CSI: Computer, Crime & Security Survey. Computer Security Institute. Thirteen Annual. Published by Computer Secure Institute. [Viewed May 2009] <<http://www.gocsi.com/>>
- [27] W3C-ARCH. (2004).Web Services Architecture W3C Working Group Note 11 February 2004. [Viewed May 2009], <<http://www.w3.org/TR/ws-arch/>>
- [28] W3C-ENC. (2002). XML Encryption Syntax and Processing. W3C Recommendation 10 December 2002 [Viewed May 2009], <<http://www.w3.org/TR/xmlenc-core/>>
- [29] W3C-KEY, (2001). XML Key Management Specification (XKMS). W3C Note 30 March 2001 [Viewed May 2009]. <<http://www.w3.org/2001/XKMS/>>
- [30] W3C- SIGN. (2008). XML Signature Syntax and Processing (Second Edition). W3C Recommendation 10 June 2008. [Viewed May 2009], <<http://www.w3.org/TR/xmlsig-core/>>

# Security Guidelines for the Development of Accessible Web Applications through the implementation of intelligent systems

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**Abstract** - Due to the significant increase in threats, attacks and vulnerabilities that affect the Web in recent years has resulted the development and implementation of tools and methods to ensure security measures in the privacy, confidentiality and data integrity of users and businesses. Under certain circumstances, despite the implementation of these tools do not always get the flow of information which is passed in a secure manner. Many of these security tools and methods cannot be accessed by people who have disabilities or assistive technologies which enable people to access the Web efficiently. Among these security tools that are not accessible are the virtual keyboard, the CAPTCHA and other technologies that help to some extent to ensure safety on the Internet and are used in certain measures to combat malicious code and attacks that have been increased in recent times on the Web. Through the implementation of intelligent systems can detect, recover and receive information on the characteristics and properties of the different tools and hardware devices or software with which the user is accessing a web application and through analysis and interpretation of these intelligent systems can infer and automatically adjust the characteristics necessary to have these tools to be accessible by anyone regardless of disability or navigation context. This paper defines a set of guidelines and specific features that should have the security tools and methods to ensure the Web accessibility through the implementation of intelligent systems.

**Keywords:** PSDCA, PSDAWA, PSDTVA, Web Security, Web accessibility, CAPTCHA, Virtual keyboards, Intelligent Systems.

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## I. INTRODUCTION

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THE use of the Internet every day it becomes more imperative to conduct the activities of everyday life, where we can make all types of transactions from our computer (Purchases, Sales, banking, exchange of information (videos, photos, music, voice and so on.) and a lot of different types of transactions that are done daily via the Web) and the boom that is taking social networking (Collaborative Web or Web 2.0) make every day the content of the Web will increase

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substantially due the collaboration of those Internet users who are mostly those who use, distribute, share and eat the contents of the Web. Due to this significant increase in the use of the Web in its full context, we have the following question Do all persons with disabilities (permanent or temporary) have access to such content? Obviously the answer is Not because there are significant barriers to accessibility on most web sites that hinder access to such content to a large number of people worldwide who have disabilities.

Referring to Disabilities the World Health Organization, known more commonly as WHO in [1] defines it as “Is an umbrella term, covering impairments, activity limitations, and participation restrictions. Impairment is a problem in body function or structure; an activity limitation is a difficulty encountered by an individual in executing a task or action; while a participation restriction is a problem experienced by an individual in involvement in life situations”. This means that any disabled person can use efficiently the Web so that you can access information from the accessed Web resource without any limitations that may be caused by some deficiency, either handicap or disability of vision, hearing, physical, cognitive, neurological, speech, or environmental technology in a natural way or through the use of assistive technology.

Assistive technologies can be defined according to ISO 9999 in [2], as “Products, Tools, and Equipment or technical systems manufactured specifically for use by people with disabilities and/or older; available on the market to prevent, compensate, mitigate or neutralize a diversit”.

A Web accessible not only benefits people with disabilities as above, but also to individuals and organizations according to certain circumstances transitional or definitive access to the Web but are limited either because of knowledge, experience, language, hardware, software, slow connections to the Web, geographic location, or simply people who have an accident that has caused some physical fracture and cannot use the Web as usual.

On the other hand, Internet users who currently use the Web not only affected by the problems presented by the accessibility to Web applications, but also security issues that

affect the privacy, confidentiality and integrity of data transmitted through on the Web, causing considerable economic losses to individuals and companies that are victims of attacks and malicious activities carried out by cybercriminals.

Security in web applications aimed at satisfying the needs of information transmitted via the web in precise, concise, timely, confidential and secure, ensuring the protection and privacy of information during the exchange and transmission of information between the client and server.

The boom that has taken in recent years the use of the Internet and the need to transmit information and conduct transactions via the Web led to a number of threats and attacks (phishing, malware, virus, spam, and so on.) that compromise the security of information and computational resources of clients and businesses. These attacks and threats are made by unauthorized persons and is usually performed on vulnerabilities exist in web applications. To ensure the exchange of information and conduct secure transactions through the Web and ensure that users are free from any threat either intersection, interruption, alteration or invention of information that may be caused by unauthorized persons is use different security mechanisms and techniques for solving these problems that affect the security of transmitting information across the Web.

The statistics on security in the Web show that is an immediate need to use technology in some way help to control or minimize these attacks and ensure greater security in the protection of confidential data from users, for them there are many tools security on the Web that are used to protect user information from possible attacks of malicious code such as the Virtual Keyboard, the CAPTCHA, and so on.

The problem we found on the Web at present is that many of these security methods and tools that are used to ensure the protection of confidential information to some degree provide security in the transmission of information, but it's may not offer adequate levels of accessibility to an application can be used by anyone regardless of their navigation and therefore impossible for any person with a kind of permanent or temporary disability cannot access content and services available in the Web. For these reasons a study of the security tools that affect web accessibility, analysis tools and methods used by security institutions dedicated to e-commerce, online banking and other activities on the Web.

This paper raises a number of criteria or recommendations to be followed the Web applications to ensure that the security tools that are accessible, and that through the implementation of intelligent systems is to analyze, interpret and adapt the characteristics of the devices and tools (hardware & software) that are used by users to navigate and interact on the Web in different contexts, allowing in this way to achieve a convergence between security and Web accessibility, ensuring that no one act over another.

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## II. SECURITY TOOLS THAT INFLUENCE ON THE WEB ACCESSIBILITY.

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Nowadays on the Web there are a number of tools and security methods that are used to ensure privacy, confidentiality and data integrity to protect the users and enterprises from threats and attacks that affect the Web. Many of these tools and methods influence web accessibility since they are not accessible to persons with disabilities.

To Symantec in [3] the Web is now the primary conduit for attacks and theft of confidential information and that managers and vendors of tools for network security have fortified the perimeters defenses with the use of tools such as firewalls, intrusion detection systems and prevention systems, so instead of trying to penetrate the networks attackers have centered most of their techniques to the various attacks computers via the Web.

These security tools that are not accessible are the virtual keyboard, and the CAPTCHA and others, for which discusses and defines a set of guidelines and characteristics that contribute to making these tools and methods can be accessed by anyone regardless of disability or navigation context. These tools are used as countermeasures to minimize the attacks that are stealing confidential information from users. When we speak of countermeasures according to OWASP in [4] is any defensive technology that is used to detect, detain or deny attacks in applications.

### *A. CAPTCHA (Completely Automated Public Turing test to tell Computers and Humans Apart)*

CAPTCHA is a security tools or program that is automatically generated from a test or challenge to an answer that humans are able to resolve but the machines can not.

These security programs which consists of decoding a text is composed of distorted images to be decrypted to enter or register on the website, and some researchers from the Carnegie Mellon University in Pittsburgh who are the pioneers in developing and implementing this method say that a machine is not able to understand and decode the text correctly and that only a human could achieve.

These distorted images that the majority of cases are not understood by humans because of the high degree of complexity that is generated with the text and that is a serious problem for Web Accessibility is not only because people with disabilities cannot access them, but also non-disabled person would have trouble identifying and understanding the text of the distorted image. See Figures 1, 2, are examples of distorted images that require much effort to understand and identify its contents.



Figure 1 CAPTCHA generated by Gmail  
Source: Gmail



Figure 2: CAPTCHA generated by Youtube  
Source: Youtube

The CAPTCHA is a security tool on the web but is not the panacea of anti-spam and Web security say W3C is a security tool that provides its bit for the security and privacy of data on people and businesses on the Web. In the work [5] the authors mentioned some important features that these tools have by definition:

- Code and data used by a CAPTCHA should be publicly available. This indicates that a CAPTCHA to ensure security, because although they know exactly how it is very difficult for someone to develop a software that can pass the test generated by a CAPTCHA. All that was hidden in the tool is the randomness used to generate the evidence.
- The CAPTCHA is a Turing tests automated. This test is to distinguish humans from one computer to be achieved through a series of questions in which a judge has to identify one another. At the original trial judge in Turin is a human and in the CAPTCHA the judge is a computer.
- Are completely automated. This creates a number of benefits both in cost and reliability as it does not require any maintenance or human intervention for its implementation and use.
- The breaking of a CAPTCHA is a problem in artificial intelligence. The problem of breaking a CAPTCHA is a problem in artificial intelligence, because as this uses an public algorithm the problem is not the complexity of breaking an algorithm secret.

This is questioned by many features as some research has succeeded in breaking CAPTCHA systems some results which indicate that these systems can be defeated by computers with 88% and 100% accuracy using optical character recognition [6]. In the work [7] the authors say that the CAPTCHA in general are designed to prevent bots (computer programs that attempt to mimic human behavior through the implementation of various functions) abuse of Internet services. These bots are driven to sell and register thousands of email accounts per minute, sending millions of spam messages. With these infiltrating chat rooms, collecting personal information and post links to promotional Web sites. They also generate worms, break password systems and invade the privacy of information. These automated Bots are a real problem for the privacy and security of information on the Web so it is very important to resolve this problem through the use of security tools (like CAPTCHA), but without affecting the other important areas on the Web, such as accessibility and usability. In the works [8] [9] the authors say that the CAPTCHA have various applications in use as a tool to support security on the Web, these may be appointed as follows:

- Protection of registration of Web sites. The majority of companies that offer e-mails using CAPTCHA to ensure that only humans can get a free email account and thus avoid automated script that can create thousands of accounts automatically.
- Protection of email addresses of Scrapers. The CAPTCHA provide an effective mechanism to hide the email address of Scrapers through the idea of requiring users to solve a CAPTCHA before showing your email address.
- Prevent dictionary attacks. The CAPTCHA can also be used to prevent dictionary attacks in password systems by the idea that instead of locking the password after a number of start of section without success, the user is encouraged to solve a CAPTCHA to validate the user and prevent an attacker to block accounts at will.
- Search engine bots. Sometimes it is desirable to maintain the web pages not indexed to prevent other people can find it easily. There is an html tag to prevent search engine bots from reading web pages. The label, however, does not guarantee that the robots do not read a web page
- Worms and spam. The CAPTCHA also offer a plausible solution against email worms and spam: "I will only accept an email if you know that there is a human being behind the other team.". A few companies are already marketing this idea.
- Preventing comment spam in blogs. Most bloggers are familiar with programs that provide false feedback, usually with the aim of raising the rank in search engines for some sites. By using a CAPTCHA, only a human can enter comments on a blog. There is no need for users to register before entering a comment.
- CAPTCHA tests are based on open problems in



artificial intelligence (AI): In the paper [8] the authors say “*decoding distorted images of text, for example, goes far beyond the capabilities of modern computers. Therefore, the offer CAPTCHA challenges defined for AI community, and lead to security researchers, and other malicious programs, to advance the work in the field of artificial intelligence. CAPTCHA, therefore, is a win-win situation: for if a CAPTCHA is broken and there is no way to differentiate humans from computers then a problem of artificial intelligence is resolved.*”

#### 1) *Accessibility problems in the CAPTCHA.*

Because these tools are used and implemented to ensure some level of safety on the Web in many areas, the reality is that although they are designed and intended to be interpreted by human beings to access protected resources on the Web, really these prevent them can be accessed and understood by humans and especially for people with disabilities such as people with hearing, visual or learning disabilities like dyslexia, but they can be used in some cases solutions artificial intelligence such as voice recognition software, characters or images to access the CAPTCHA.

Another problem that adds to the accessibility of CAPTCHA is to be a tool designed specifically to be performed by beings humans, assistive tools used by people with disabilities such as Braille keyboards and other tools that are used to access the Web cannot interpret the contents of the CAPTCHA, and so these tools are locked at the time they are faced with this security system and therefore the user can not access the web resources.

This is impossible for people with disabilities to interact with freedom on the Web as they are with the disadvantages that they cannot do business online, participate in social networks, etc. create accounts., Which leads to the idea of involving users to the web what is now known as Web 2.0 is affected by the idea of these types of security systems do not consider people with disabilities as "human beings" but as "machines" because the block resources, or block access to the same users are being treated like machines.

#### 2) *Security guidelines for the development of accessible CAPTCHA (PSDCA)*

Although W3C in the document [6] recommends the use of other systems of access control mechanism that can be more accessible and more effective as the heuristic checks for the presence of users Robot by collecting volumes of data, IP addresses, signatures and other information can be collected at the time of the user to access the Web resource, or the spam filter used by the applications of "Hot Words" to indicate the content of spam, or other Bayesian filtering to detect patterns consistent with the spam, as well as the use of Logical Puzzle, sound output, biometric systems, etc.

The reality is that if we can develop a security system based on the methodology CAPTCHA in combination with any of

the aforementioned safety systems and standards for Web accessibility and security that exists in today's market, taking into consideration that the it does not develop at the expense of other technologies that today and tomorrow are the cornerstone of development and advancement of the Web such as accessibility, usability, Web 2.0, the Semantic Web and so on. Not only combat the problems of spam that is the main idea that was conceived with the CAPTCHA, but other security problems currently affecting the security and privacy of the people as the problem of PHISHING that one of the security problems which currently affects millions of more users and causes economic losses to many individuals and businesses.

The reality is that just as security is not possible to achieve 100% accessibility to the Web because there are cases of people with disabilities who require higher requirements than others to access the Web, such as for example a person who is blind, deaf mute is almost impossible for a person with these types of disabilities combined access to the Web, because the major iteration of the Web are based on sight, sound and voice recognition. So that it can try to combine different options to ensure that increasing numbers of people with disabilities can access the Web and this is done by a series of recommendations for systems that rely on CAPTCHA can minimize problems Accessibility facing at the moment but this can be achieved with the implementation of intelligent systems to assess, collect and process information from different devices (hardware and software) involved in the process of user interaction with the Web by combining this system with other security features and built-in properties and by combining it with other security systems. Here we mention some features or capabilities that must have a security system based CAPTCHA to be accessible:

#### *B. Virtual Keyboard*

Currently most of the attacks and malicious code created in the last few months are going to the Web with the purpose of stealing confidential information and passwords to users from cyber criminals for the purpose of financial gain. According to statistics from the threats and attacks on the Web in recent months published by Symantec in [3] Trojans represent the highest percentage (71%) of malicious codes that are distributed over the Internet. In the same way phishing attacks is the malicious activity that has increased in recent years, specifically increased 167% compared to last survey. These attacks are designed to steal confidential user information, specifically data related mostly to personal information, passwords, credit cards, and so on., That is private information that are used mostly in electronic commerce, online banking, and so on. Another important fact is that most of these attacks are directed at a high rate to the financial area, specifically 66% of all attacks were directed this area.

These statistics show us that it is an immediate need to use some form of technology that contribute to combat or

minimize these attacks and to ensure greater security to protect confidential data from users is that many of these banks use the “Virtual Keyboard” to try to minimize these types of attacks specifically protected from phishing attacks.

The virtual keyboard: is a tool that allows users to enter sensitive data in the Web securely, without the need to use a physical keyboard, thus avoiding a keylogger that can capture keystrokes on the keys and make a phishing attack. (See Figure 3 and Figure 4)



Figure 3: The Virtual Keyboard used by Santander Group



Figure 4: The virtual keyboard used by Caixa Sabadell Spain

This is a security system that protects you from phishing attacks confidential information of users to a certain level, because there are trojans that can record or take pictures of each of the movements of the cursor keys and thus steal confidential information from users . But despite this, The virtual keyboard in some form helps to security on the Web, but not working with the Web Accessibility because the virtual keyboards are not accessible to persons with disabilities.

1) *Advantages and disadvantages of virtual keyboards on the web*

Like other security tools the virtual keyboards are advantages and disadvantages to consider in determining the feasibility of using this tool in web environments.

Advantages:

- The use of virtual keyboard protects users from malware type Trojans key logger which specifically capture the

keystrokes of keys on a normal keyboard can steal confidential information from the user.

- Can be implemented as device entries in the given case a failure of the normal computer keyboard.
- Provides more sense of security to users.

Disadvantages:

- Are not accessible to persons with disabilities.
- Does not guarantee the protection of confidential information of Trojans that can record the movements of the cursor around the screen.

2) *Security guidelines for the development of accessible virtual keyboard (PSDTVA)*

The main problem with the virtual keyboard is not accessible to persons with disabilities so that the tool has a negative impact on safety and accessibility. Because it is a tool that helps combat the security problems that affect the Web and especially phishing attacks. Below are quoted some special characteristics that should be the virtual keyboard to be used as security tools and also be accessible to persons with disabilities:

- Allow access to keypad through assistive tools for people with motor disability. That a means that data capture can be through a mouse or a mouse adapted for people with disabilities.
- Allow user to change the contract size and the letters in each of the keys. For people with low vision disabilities.
- Providing a sound system for the virtual keyboard that could identify the letters of keyboard to move the mouse cursor over it. For people suffering from blindness.
- Give the virtual keyboard a word prediction system to expedite the processing capability that allows the text and reduce the number of keystrokes.
- Give the virtual keyboard a voice recognition system.

Other Guidelines and important features to make a virtual keyboard a feasible security tool and significantly increase the protection of the user before the attacks on the Web quote below:

- The virtual keyboard to scroll the screen in each keypress to prevent a key logger to capture the coordinates of the screen and see where we move when pressed with the mouse and click.
- Allow the keyboard to increase or decrease the contrast to make it difficult to display a short distance, and thus prevent anyone near the user can see the information you are typing.
- An important feature of this system security but that largely depends on the user and avoiding the theft of confidential data and the password of the user, is that the user enter data using combinations of movements, ie at the time Enter the password that the user can enter in part using a virtual keyboard and another using a standard input device.

For example if a key has 10 digits you can enter 5-digit using the virtual keyboard and 5 using the normal keyboard, which lets you have a trojan that captures keystrokes capture the key is not complete, or if a trojan records cursor movements not record all typed characters.

### *C. Security guidelines for the development of accessible web applications (PSDAWA)*

As we have seen in previous issues of security problems we are facing today with regard to loss and theft of confidential information caused by threats and attacks on the Web are serious and the majority of problems are caused by malicious codes and activities such as phishing and Trojans that steal confidential information from users who perform transactions through electronic pages are devoted to electronic commerce or banking. These entities to ensure the protection of confidential information using security tools that provide security largely on the execution of transactions, but in many cases, these security measures are not accessible to persons with disabilities. In the above items mentioned some safety guidelines to make the CAPTCHA and virtual keyboards accessible, then cite some security measures and methods used by institutions engaged in commerce or electronic banking and also make several recommendations or criteria that should be continue to ensure that safety features are accessible, ie, not acting safety and accessibility at the expense of one another.

#### *1) SSL Connection (Secure Socket Layer)*

Connect using SSL encryption algorithm with a key of 64 bits, 128 bits, 256 bits and so on. provides a secure connection between the client and the server data processing company, ensuring that information security and integrity by avoiding travel to outsiders intercept, modify or steal the information.

#### Recommendations:

At the time the user is accessing a Web application that uses the SSL security protocol; this has to be able to tell the user that is going to make a secure connection with a secure server, indicating the following criteria:

- Indicate to which server you are connecting.
- Indicate institution belongs to the server.
- This information should be accessible to assistive tools.
- The information provided should be equipped with this sound for people with visual disabilities.
- Is this secure server where the user really wants to connect?.
- Would you be the victim of phishing attacks and accessing a server that is not the one that really wants to access?
- The certificate is valid?

- Is this certificate issued by a valid certificate authority?

In reality there are many questions that the user is performed when accessing the application, it is important that the user can easily find the answer to these questions in the most simple and straightforward as possible. For this is a series of recommendations to improve accessibility and access to key information.

#### Recommendations:

When the user is connecting to a secure server, the application must indicate the most visible and clearly as possible the most important data indicating that the certificate is being used in the connection is good, valid, and ensures the identity of the remote server.

#### Following or giving the following considerations:

- This should indicate that the digital certificate is issued by a valid certificate authority.
- Display data of the certification authority
- Show the effective date of the digital certificate.
- This information must be accessible by assistive tools.
- The information provided must be equipped with this sound for people with visual disabilities.
- The application should not require the user to click on the icon of the certificate (closed padlock or key) to view this information. Should be visible somewhere in the application that the user can view it without an extra effort

#### 3) Mechanisms of secret keys

Banking institutions mechanisms secret keys used to secure user authentication, are usually composed of the following elements:

- User: Code that identifies the person, which may be a personal number or a personal identification document. (Passport, DNI, NIF, NIE, and so on.).
- Password: Code secret that together with user ID allows the authenticated in the Internet Banking. Many banks defined as numeric and not require the user to be a strong key (consisting of numbers, characters and special characters)
- Digital Signature: usually when making a transaction is requested by the user typing values on the random positions of the same, never to complete full signature of the key digital signature
- Password Confirmation: For some operation the user must confirm a key in the system that is sent through a mobile phone.

This safety mechanism ensures the privacy and security of people because they offer an effective mechanism for security concerns, but at certain points due to accessibility to Web using validation methods that are not accessible to persons

with disabilities and for people who do not own the means necessary to complete the identification and validation of the user.

In the case of the digital signature do not have methods to indicate to the user with blindness that position the firm to modify or to extend or adapt the size and color of the letters to people with low vision. The confirmation code is sent to user via SMS (see Figure 6) prevents some people complete the validation of the operation because it is a platform independent and completely separate from the application. This makes this form of validation is not accessible because it limited to certain users to perform operation. This method of validating user is not accessible in the following cases:

- For a blind person who cannot see the key on the mobile phone.
- The user does not have a mobile phone to receive the message.
- The user has mobile phone coverage but no because you're on the road (in another country and does not have automatic roaming).
- The user has the mobile switched off because the battery is discharged.
- Mobile phone was damaged and I need to make a transfer an account to make a purchase.

## 2) Server Authenticity Certificate:

The authenticity certificate ensures that the user is connected to a secure server. By indicating a closed padlock or key in the entire bottom of the browser (see Figure 5). This ensures that the user is connected to a secure server, but in reality the following questions arise.

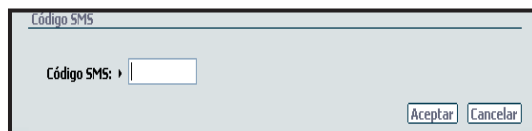


Figure 6: Entry screen confirmation code sent by SMS

In reality there are many cases that make this type of user authentication is not accessible for many reasons are cited the following recommendations for improving accessibility in this authentication method. Recommendations:

- When you apply the digital key to the user, which is random positions requires the user to enter must have the following characteristics:
- The information must be accessible by assistive tools.
- The information provided must be equipped with sound for people who have visual impairments, indicating the positions at random and change the position in which the user's cursor at the time.
- Allow the user to change size and contrast the positions of the digital signature. For people with low vision disabilities or daltonism.
- Allow data entry via voice recognition devices, such as a microphone. For people with motor disabilities.

- An application should not rely solely on an external tool to operate, thus the customer must provide alternatives to ensure that in certain cases be able to access the application without any inconvenience. Ie, the application must have a signature confirmation that is not through SMS messages, such as a system of questions and answers set by the users is stored and the user is passed in encrypted form and that example is presented to the user through an alternate accessible CAPTCHA.
- Perform an authentication mechanism that combines security tools used in the Web, without external tools depend. Examples combine the properties of the virtual keyboard and perform the validation with an accessible CAPTCHA instead of a confirmation by the mobile device.
- These tools must be developed with open security standards such as safety standards based on XML.

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## III. CONCLUSION

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The information described in this article see the need to use tool and security methods to ensure that information flows through the Web safely, due to the increase in threats, attacks and vulnerabilities affecting Web applications.

When performing the verification of the statistics in the documents [3] and [10] published by Symantec and Panda Labs on attacks, threats and vulnerabilities affecting security, it is determined that the majority of attacks target Web applications, specifically targeting the theft of confidential information users, and that 71% of malicious code developed in recent months relate to the Trojans, which increased 136% in the last half of 2007 compared with the first half of the year and 571% over the second half of 2006, just as the attacks on the Web that have increased are Phishing Attacks and everything-based Trojans Keyloggers are used to steal information, plus 66% of these attacks were directed at the financial sector.

Due to the result of these statistics this article focuses on some methods and tools of security that guarantee safety on the Web, which is located between two specific security tools that are used to combat such attacks as the "Virtual Keyboard "used to share the Trojans kind Keyloggers and "CAPTCHA " used to ensure that those who are accessing or requesting information on the Web is a human and not a robot.

For these tools, which are not accessible, they have some security weaknesses, but they are tools that ensure a certain level of security defined a series of guidelines and/or features that should have these tools and to help improve security the accessibility of them.

Although some experts recommend using other security mechanisms in place of the CAPTCHA and the Virtual Keyboard for the weaknesses that are related to security and accessibility. With the guidelines defined in this paper to improve these tools provide a valuable contribution to

improving both the accessibility and security of these tools and other security mechanisms used on the Web.

The reality is that problems or at risk from any tool to be used in your environment or as simple as it should not stop using, but try to improve and correct any problems that present. A very simple example is that with the development and progress that have taken over all these centuries of military weapons (machine guns, battle tanks, long-range missiles, and so on.). But the soldiers continued to use the most ancient and simple their safety, "The Knife". So what can be said of the security tools discussed in this article is that they are simple, have their disadvantages but somehow contribute to security, that's why we make the necessary recommendations for the definition and implementation of safety guidelines for developing accessible Web applications.

The use and implementation of these guidelines to help correct and combat effectively the various attacks and vulnerabilities affecting the security of Web applications and thus protect and guarantee the security of the transmission of confidential and valuable information for users, and while ensuring that anyone regardless of disability or browsing context can access and use these tools efficiently and safely.

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#### REFERENCES

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- [1] World Health Organization WHO, "Health topics", <<http://www.who.int/topics/disabilities/en/>>, [consulted in March 2009]
- [6] Roca Dorda, Joaquín \*, Roca González, Joaquín \* and Del Campo Adrián, María. E. \*\*, "For technical assistance to Assistive Technology", \* G.I " Industrial Electronics and Medical" (EIMED) Politécnica de Cartagena University (UPCT), \*\* National University of Distance Education (UNED) ETSII of Cartagena: <<http://tecnoneet.org/docs/2004/2-12004.pdf>>
- [7] Symantec Corporation, "Symantec Global Internet Security Threat Report. Trends for July–December 07", Volume XII, Published in April 2008.
- [8] Open Web Application Security Project (OWASP), "Security Countermeasure", <<http://www.owasp.org/index.php/Category:Countermeasure>>, [consulted in January 2009]
- [9] Von Ahn Luis, Manuel Blum, and John Langford, "Telling Humans a Computer Apart Automatically", Communications of the ACM, February 2004/Vol. 47, No. 2, ACM 0002-0782/04/0200.
- [10] World Wide Web (W3C), "Inaccessibility of CAPTCHA", <<http://www.w3.org/TR/turingtest/>>, November 2005, [Consulted in January 2009]
- [11] Palo Alto Research Center, "PARC's CAPTCHA", <<http://www2.parc.com/istl/projects/captcha/index.htm>>, [Consulted in January 2009]
- [12] Carnegie Mellon University, all rights "CAPTCHA: Telling Humans and Computers Apart Automatically", < [www.captcha.net/](http://www.captcha.net/)>, 2000-2007
- [13] Von Ahn, Luis, Blum Manuel, J. Hopper Nicholas, and Langford John, "CAPTCHA: Using Hard AI Problems For Security", Computer Science Dept., Carnegie Mellon University, Pittsburgh PA 15213, USA, 2 IBM T.J. Watson Research Center, Yorktown Heights NY 10598, USA, [Consulted in August 2008].
- [14] Panda Security, Quarterly reports Panda Labs (2008 April-June), June 2008

# Automated code generation support for BI with MDA TALISMAN

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**Abstract** – Model Driven Engineering (MDE) is gaining ever more strength due to the fact that with MDE the software development can be much more productive and this is the way to go closer to real software industrialization. With MDA TALISMAN, we have succeeded in creating complex software solutions for food traceability adapted to different customers, ready to be deployed. We rely on the approach to MDE most extended at present, MDA (Model-Driven Development) but as we shall see, we also use the main pillars that support the Software Factories, The proposal from Microsoft to MDE. Besides, in this paper we present five cases of success with MDA TALISMAN.

**Keywords:** *Intelligent, Automatic, MDA, MDD, MDE, Software Factory, Traceability.*

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## I. INTRODUCTION

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IT is well known that Model-Driven Engineering (MDE) is an approach of the Software Engineering that is gaining more strength each day and that tries to achieve the generation of the code of applications either automatically or semi-automatically. MDE is a generic term that refers to paradigms like Software Factories [1], the proposal of Microsoft based on MDE or the Model-Driven Architecture (MDA) [2], the proposal of the Object Management Group (OMG), that is who is giving further impetus to MDE, at least in terms of the number of publications. There are some others approaches and some others architectures [3], but currently they do not have great relevance. We will explain briefly these two concepts now.

The remaining paper is structured as follows: In the following lines we will talk about the principles of MDA and Software Factories. In Section 2 we explain what the food traceability and what the origin of our work are. In section 3 we will explain the architecture of our system, the MDA TALISMAN. Section 4 is related to cases of study in which MDA TALISMAN can generate others systems for food traceability depending on the type of cheese. In section 5 we comment the conclusions and future work, and finally we show the references to other papers.

### A. MDA Principles

The proposal is based mainly on reducing the weight of the implementation and increase the weight that has the modeling of the system, this follows a similar approach to other engineering that are not equal to the computer science. For example the entire world agrees that to building a bridge requires a detailed plane of the bridge, that is, its model.

The use of models has several advantages, increases portability, interoperability and reusability of systems. The idea, is to start with some models of a high level of abstraction (CIM, Computational Independent Model) that pick up the requirements of the system without using a computer language. Later, becomes a transformation lowering the level of abstraction to a computer model but independent of the computer platform used (PIM, Platform Independent Model) which represent solutions at design level for the requirements of the CIM. The PIM can be transformed into one or more models dependent on the computing platform used (PSM, Platform Specific Model) that provides specific models of one or more desired technological solutions. The last transformation is to convert the various PSM to source code, ready to be used or refined before being used.

Finally, we want to comment that the OMG has more defined standards that serve as basis for the definition of MDA. MOF [4], UML [5], XMI [6], OCL [7], and QVT [8]. To know about real application of Model-Driven Architecture, we recommend [9].

In [1] after comparing software engineering with others, such as civil engineering, its authors have identified the following reasons why the traditional software development has problems:

- One-off development.
- Monolithic systems and increasing system complexity.
- Process immaturity.
- Growing demand for software systems.

In order to try to solve these problems Microsoft has created the concept of Software Factory. To explain this concept we have to talk about the four pillars of Software Factories [10] showed in Fig. 1

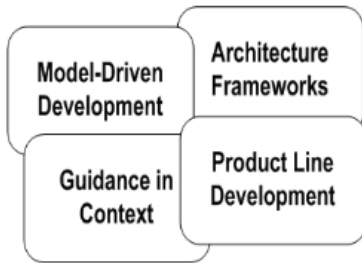


Figure 1. The four pillars of the Software Factories

- Architecture Frameworks. It refers to that we should implement the common features of a system on a basic Framework, which has to provide extension points where components can be integrated and extended.
- Product line Development. It refers to that a product line should only attempt to cover a specific domain or market segment without attempt to cover all the possible domains.
- Model-Driven Development. It is the closest point regarding MDA, Also it is closely related to domain-specific languages (DSL) [11].
- Guidance in Context. It refers to that we should include facilities such as code samples, how-to help pages, articles, and so on.

It should be keep in mind that there are always two perspectives from which we can see the Software Factories, on the one hand is the viewpoint of the developer of the Software Factory (author's view), and on the other hand is the viewpoint of the developer who uses the Software Factory to create software (consumer's view).

The idea is not to create a system whereby we can create all kinds of applications automatically as aspires MDA. The Software Factories are more realistic and although they raise a lot the level of abstraction respect of traditional software, they do not do it like MDA. Authors such as [12] or [13] say that MDA is too pretentious and compare it with the ideas offered by CASE tools that failed in their attempt.

## II. FOOD TRACEABILITY

The food traceability is becoming more important in our days and that is the reason why we consider important introduce that term and by the way, what the origin of our work is. To explain what food traceability is we will give a simple example. If you have ever been wondering yourself what was the origin of any food, for instance, the cow that gave the milk that is in your cheese, then you have been wondering about the traceability of this cheese. To tell the truth, on January 1, 2005 (in accordance with article 18 of the European regulation 1782002) [14] all food businesses should have a traceability system but, unfortunately, today the reality is quite different. It can be concluded that food traceability is a need with which to tackle the problems that can give products for the food consumption. It consists of collecting data during all phases of the production process of an article and whether health authorities require it, to have such

information. Information is beginning to store with the raw materials used in manufacturing (origin, quantity, supplier, and any other information that may be of interest). Later will be stored intermediate processes that occur in the manufacturing of articles (e.g. dates or temperatures) and finally, who sold the article before arriving at the hands of the end-user (such as an intermediary or a supermarket). The idea is to have fully determined the history of an article. The goal is to have stored information and that can be used by health authorities, but it may also be of interest to the producer to store statistics, ensure product quality or determine responsibilities, and of course the ultimate consumer may be interested in know the origin of what they eat. For that reason might be a good choice to provide consumers with mechanisms to be able to get some kind of information on the articles they consume, as this will increase confidence through transparency. One of the main causes of the introduction of food traceability is that when there is an alert food we must locate and withdraw from the chain supply any product that might be affected in some way, from effectively and efficiently, because so far no one can say that things are not well without food traceability systems but neither anyone can prove that the companies are doing well and of course a failure in a food business for a particular item (e.g. chicken meat) can affect the image and thus in the economic aspect of all other companies who market the same or similar articles.

## III. MDA TALISMAN

The MDA TALISMAN [15], our proposal based on MDE, use the approach promoted by the OMG, doing separations at different levels of abstraction. The highest level of abstraction, CIM, is transformed to a PIM manually, and since then the process is automatic, the PIM is refined and becomes another PIM, the PIM becomes a PSM, the PSM is refined and becomes another PSM, and finally the PSM is transformed directly into source code. Although we have adapted it to the real case presented in this paper, its basic architecture is shown in the following figure.

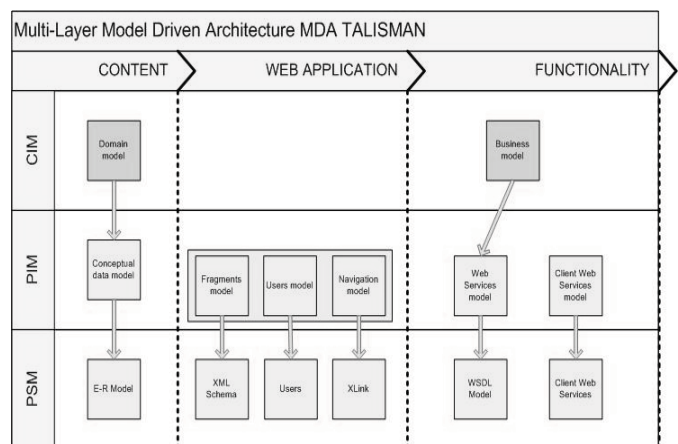


Figure 2. Basic architecture of the MDA TALISMAN

There are three distinct layers, Content, Web Application (we are orientated towards Web applications), and Functionality. Each one of the three layers can be divided into

the three views promoted by MDA (CIM, PIM, and PSM):

- Content. This layer defines the data to create the business layer and the main structure of the database.
- Web Application. This layer is responsible for creating the structure of the pages viewed by the end-user and the relationships between them. It is also responsible for user profiles, and users who can access the cited pages or portions thereof.
- Functionality. Thanks to this layer it is able to offer Web Services to the outside or may use other Web Services supplied from other URLs.

#### A. Architectural features

Initially, MDA TALISMAN was conceived as an architecture for Web applications. After that, it was found its flexibility to adapt to complex software solutions involving Web applications, Windows services and hardware of various kinds, generating software solutions ready to be deployed (Fig. 5). UML, by itself, does not have the power required to generate solutions so sophisticated. There are UML profiles, which can be adapted to the needs of those who used them and continue to rely on MOF as well as UML but the complexity of development increases too much to achieve the level of detail needed to make food traceability software, and that is our goal with MDA TALISMAN. So the solution was to create a basic framework. MDA Talisman focuses on the family of applications for food traceability and the basic framework will have generated all the common features to all applications for food traceability. Then what will be done, is to inject the parties variables code in the basic framework. Our idea, perfectly house with three of the basic pillars of Software Factories that we commented at the beginning of this work:

- Product line Development. MDA TALISMAN focuses on the family for food traceability applications.
- Architecture Frameworks. MDA TALISMAN uses a framework to provide all the common functionality that not vary across products of the production line (across each cheese factory).
- Model-driven development. MDA TALISMAN uses a model for generating all the functionality that changes from one product to another of the production line.

#### B. Inputs

To do their tasks MDA TALISMAN needs a series of artifacts that will discuss below:

##### 1) eXtensible Process Definition Markup Language (XPDMML)

To achieve our goals we have set up a DSL called XPDMML (eXtensible Process Definition Markup Language) which is a subset of XML (eXtensible Markup Language) and that is the heart of our system. The reason for creating a new language is to have a language with the concepts of the domain in order to facilitate ways in which producers adapt the application to their needs. This language has evolved constantly since the beginning of MDA TALISMAN adapting to new needs required by customers (owners of the dairies)

that have been added and adjusted progressively over the past year. Currently, to define the variable aspects of a dairy we use a document with eight sections. XPDMML (displayed in Figure 3) is in its version 1.0 and has the following:

```
<?xml version="1.0" encoding="utf-8"?>
<XPDMML version="0.015" client="Vega de Ario">
  <actions>...
  <items>...
  <devices>...
  <lists>...
  <reports>...
  <labels>...
  <traceabilityPoints>...
  <TAGs>...
</XPDMML>
```

Figure 3. XPDMML example as XML document

```
<action Id="ACTION_RECEPTION_MILK"
  NumberId="1" Relation="1_1"
  Simple="ITEM_RAW_MILK|ITEM_RECEPTION_MILK"
  Multiple="" Must="" Main="" Info="">
  <inputs>...
  <outputs>...
  <constraints>...
  <devices>...
</action>
```

Figure 4. Action specification in XPDMML

- Actions. This section describes in unambiguous manner all actions that will be on development process. One action, as well as its attributes, has to indicate what products will receive as input and what products will appear in the output after running the action. It should be seen as a graph in which a node has entrances and has exits (e.g. milk mixture consists of mixing milk, rennet and salt and as a result we get curd). In addition, to control the various operations (e.g. the range of temperature of the milk that is received at the factory) restrictions can be defined for each. Another interesting thing is the list of hardware devices to intervene in an action (for example when a cheese is packed, it will generate a label with a labeler). In Figure 4 can be seen a snippet of code which defines an action. Other sections are defined using snippets similar to this section
- Items. As important as the actions are the articles, because the actions (nodes) will have articles at the entrance, and articles at the exit (arcs). For instance we will talk about the cheese commercialized. The products have other sub-definable features such as properties (for example, who customer has bought the cheese or on what date), definition of forecasts for production calculating (e.g. how many kilos of cheese will be produced with x litres of milk), definition of locations (e.g. different drying caves where cheeses



can lead), and lastly the hardware devices associated with that article (a scale weighing would be an example). For the above example, it has not been necessary to define forecasts, locations or hardware devices, but it will be necessary for other articles.

- Devices. For the system to work properly it is necessary that the server and other hardware interact. A device could be defined through an Ethernet connection to an IP address and a determined port. In one case the hardware is a terminal (could be another, such as a labeler).
- Lists. We used different lists of items to give functionality to the system. For instance the list of possible designs for a label to be printed, initially, there will be two possible designs, design one and design two, respectively stored in two different files. In addition to this list, there will be very different lists with other information such as customers, suppliers, business data, types of milk, and so on.
- Reports. The reports are very important, because collect and display necessary information about the system. There are several types of reports, check list of the status of facilities, cleaning, product description, temperature control, etc.
- Labels. It is necessary that all factories have a labeling system to label their products before selling them to an intermediary or a final customer. To define a label for a client and a for a definite article, we should indicate diverse information, such as label design, the style of the label, the type of bar code, the initial digits of the bar code, or a series of fields which give descriptions.
- TraceabilityPoints. Traceability is essential in the implementation generated by the MDA TALISMAN. In this section we indicate interesting point that we want to register. We will indicate the product for which we want to record information and the property that we want to save (for example, we might want to save the date and time when creating a new batch of cheese).
- Tags. Here are listed all possible TAGs strings of 16 digits that have the chips that are used for identification) associated with an identification number in the database. It will achieve two things, on the one hand be able to work from identifiers, which are much shorter than the TAGs, and on the other hand if it breaks down a chip during a process, may be substituted by another with its identifier.

It is important to realize that the information contained in Figure 3 is the same information that is contained in the graphic representation of the model (an example of graphical representation of the model is shown in Figure 6). Indeed, in addition to the graphic representation of information that can be seen in the figure, there are other important information to be added to the XPDML document that enrich the definition of a particular dairy.

## 2) Language files

The system that generates MDA TALISMAN is a multilanguage system. For that reason, we need to provide files with the translation into the language or languages desired. Basically there will be a file called Basic.XML containing translations valid for the entire production line, and another called Language.XML that will be specific to the variable part and therefore it will change from one system to another. In addition to the two files described there will be others who depend on the architecture, for instance ASP.NET has files associated with each of their pages in order to change the culture of a system without too much difficulty.

## 3) Labels

During product development, there will be several points on which may require the printing of a label. Obviously, these labels will be configured with preferences or requirements of each producer and therefore they will be used with the MDA TALISMAN to generate the system for a specific customer.

## 4) Style Sheet

You can also use a stylesheet line with the preferences of the client to generate Web pages to your liking and not having to make changes afterwards. Its use provides a fast and flexible way to change the whole aspect.

## 5) Images

There will be pictures such as the logo which will also be used with MDA TALISMAN, returning well, to avoid having to make any changes afterwards. We use around ten images for each client.

## C. Outputs

MDA TALISMAN produces a series of artefacts which are listed below:

### 1) Complete Solution

As a result of the MDA TALISMAN process you will obtain a software solution consisting of seven projects ready to be compiled and deployed (In Figure 5 can be seen the aspect of the solution created automatically by MDA TALISMAN working with Visual Studio).

### 2) Data Base Script

The output will also contain a file called DataBase.sql, which is a file used to create all the static and dynamic information from the database, that is, both tables and the information necessary to operate the system.

### 3) Log Files

MDA TALISMAN uses Log4net to create log files that contains information from all processes it has accomplished during his transformations. In addition to MDA TALISMAN, log4net is also used for systems generated with MDA TALISMAN.

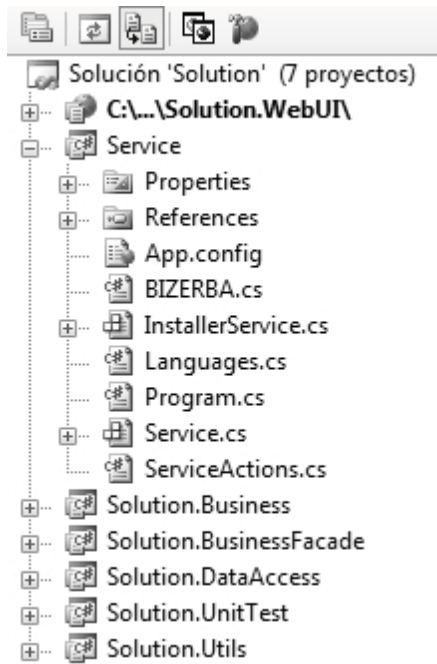


Figure 5. Visual Studio Solution generated by MDA TALISMAN

#### 4) Transformations

The heart of MDA TALISMAN is the XPDML language. With it, there are a number of transformations that lead to the solution previously commented. At this point we try to discuss these changes so that, to make it clear. First of all it should be noted that the XPDML file corresponds to the PIM stage of the MDA philosophy, and that is why the document XPDML is called PIM.XML. The idea is to introduce in this file all the platform independent information and therefore begin the process of transformation. The second step will be to convert the PIM.XML file into PIMtoPIM.XML file since the new model created from the previous is also platform-independent but now the information it contains is no longer XPDML, it is a document in XML format in which UML and UML profiles information are serialized, and thus a part of the system is already under the umbrella of the MDA guidelines. It should be noted that the reason for using XML standard instead of XMI as proposed by the OMG group is none other than the fact that there are several XMI formats, mutually incompatible, and that the tools with which UML diagrams can be created also tend to use their own XMI format incompatible with the other existing tools on the market. In the PIMtoPIM.XML file we can find the following:

- Conceptual data model. It is part of the Content layer and with it are specified aspects needed to achieve the persistence of data.
- Users model. It is part of the Web Application layer and specifies the users and the profiles of the system.
- Fragments model. It is part of the Web Application layer and indicates the different web pages.
- Navigation model. It is part of the Web Application layer and specifies the navigation possibilities on the site.

- Services model. It is part of the Business layer and specifies the Web services offered to other sites.
- Client services model. It is part of the Business layer and specifies Web services for which the system is a customer.

Then, the PIMtoPIM.XML file is transformed into the PSM.XML file that already is a platform dependent model. An example of transformation that can be given in this step is to convert a platform independent data type in a platform specific data type. In our case, .NET would be the target platform and CSharp would be the used language. Thus, for example in PIMtoPIM.XML we have a TEXT data type and in PSM.XML that data type becomes a String. The major transformations taking place in this step are:

- The Conceptual data model becomes the Entity-relationship model.
- The Fragments model becomes XMLSchemas documents, which contain the information to be displayed on Web pages.
- The Navigation model becomes XLink document, which contain information of links between elements.

MDA TALISMAN also takes into account a transformation from PSM.XML to PSMtoPSM.XML, however for the time being done without any processing. It is taken into account because it is one of the MDA steps and we may give it some kind of use in the future. Finally, we need to generate code from the PSM.XML file and put it together with the code already generated with the basic framework. The new code is generated with text templates that has the ExpertCoder library [16] that give a lot of flexibility and avoid having to generate code by hand. For example, the Users model contains information of different users and user profiles that can use the web Application and for this reason generate code is necessary to this model fulfill its purpose. Thus, part of the code will be placed in the Web.config file that is the file where it was introduced security policies for each of the different web pages but it will also be necessary, for example, take into account the different profiles and users to create a script that initializes the database to be used. To appoint another of the transformations taking place we will discuss the Entity-relationship model. From that model, MDA TALISMAN generates the tables in the database that match the model, but also it generates the Business and Business Facade projects with all the necessary files to work with them, using NHibernate for independent access to data.

#### 4 Five cases of real usage

When we gave this work the first thing we did was a survey of dairies that there are different in Asturias (Spain), their common points (from which we get our basic Framework) and points where they differ (from which we get our XPDML).

After the analysis we have done, we realized that despite the relatively small size of factories, how to make cheese is quite different from one company to another. Even companies that manufacture the same type of cheese have many points of disagreement in the manufacture. In addition, MDA

TALISMAN could generate, with no problem, traceability systems for other food industries different from those dairies, since all follow the same basic principles. We want to briefly explain some of the differences between the different cheeses for better understanding the needs of adaptation of software, and so far, the five types of cheese for which we have developed their system are as follows:

- Cabrales. It is the cheese for which we made the first prototype of all. It is a cheese made from milk of sheep, goat or cow (also can be any of the three combinations) that after a maturation period of approximately 60 days in the caves of the Picos de Europe is sold at a price that depends on its size. The treatment is done by units of cheese, so a cheese from the same batch may for instance be inserted on the site where they are going to dry before another. That is why chips are used (they have the size of a currency euro) which identifies each cheese and that are read by RFID reader devices. There are 21 different possible subtypes of cheese.
- Casin. It is a cheese that is produced quite faster than Cabrales cheese. For its production, some different raw material is used to those of Cabrales cheese such as calcium and ferments. It comprises three different types of kneading of products that are getting increasingly close to the cheese. The treatment is done by groups of cheese and to achieve it, an RFID label is printed with a label printer and then placed on different shelves for each batch. All cheeses are sold at the same price and have the same size.
- Afuega'l pitu. It is similar to Casin cheese but have differences such as that in addition to cheese, also is prepared cottage cheese, and that there are several different types of cheese depending on the type of paprika being used. In addition there are boxes (to which we add RFID labels) that are marked in order to move the cheese and not mixing batches.
- Gamoneu. The main difference between this cheese and Cabrales cheese is that the production of the dairies of Gamoneu is much greater in number than those of Cabrales, hence, it will be necessary to bring an organization using batch of cheeses instead of individual cheeses but at the time of packaging is necessary weight each of the cheeses. There are 6 possible subtypes of different cheeses. The type of chips is similar to Cabrales.
- Beyos. The Beyos cheese can be seen as a mixture of Afuega'l pitu cheese and Casin cheese with some changes in the various processes. Some RFID tags are printed in one of the steps that are placed on shelves where the cheese is placed during different stages of their manufacture.

Basically all of them need specific software generated by MDA TALISMAN, SQL server data base, a computer, a scale, a printer, a label printer, RFID readers, industrial terminals, and lots of chips. But depending on the mode of

manufacturing the number of items may change, or for example the client could require various other devices such as RFID printers or RFID labels. What never changes is that our software is the one who controls and manages all mentioned hardware.

To better understand the process, Figure 6 shows the graph that we created after some visits to a dairy of Afuega'l pitu. This graph shows the most important aspects (in the absence of many details) of the process of development and is taken as the main base for the generation of XPDML file which in turn serves for the generation of the specific traceability system. Then, one of the things that MDA TALISMAN automatically generated from the entry into XPDML format, is a graph with all the different actions (processes) and items (elements) that there is throughout the whole process of preparing the cheese. That is a SVG format file that contains the graph generated from the input of Afuega'l pitu.

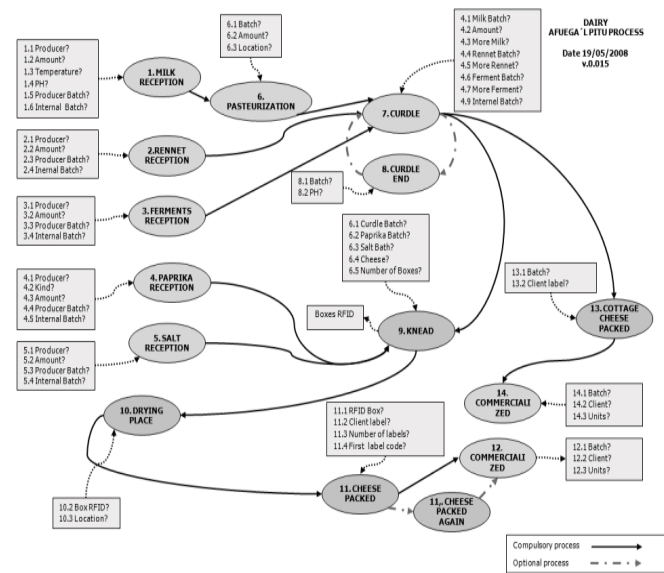


Figure 6. Graphic representation of the model of Afuega'l pitu cheese

This graph is very useful because people can quickly understand all the steps that have the manufacturing process and most importantly of all is that any changes made in the XPDML file is reflected in the graph, changing automatically the parts of the graph as may be necessary. In addition, the image is modified at runtime so that depending on the user profile that is being used in the application at any given time, will activate links to undertake some or other actions (to be able to carry out the action straight from the graph).

#### IV. CONCLUSIONS AND FUTURE WORK

Our MDA TALISMAN serves to generate applications automatically following the steps of the MDA specification. What happens is that to generate complete software solutions such complex and heterogeneous, ready to deploy in an environment, is today impossible, then we used a framework to inject the code generated through MDA transformations.

This injection of code in a framework leads our MDA TALISMAN towards the ideas promulgated by defenders of the Software Factories. This fact makes that the target of our next job is being to analyze the pros and cons of MDA and the Software Factories to see how we can improve MDA TALISMAN to be capable of generating all kinds of software solutions using the best MDE practices. Also, it is clear that our MDA TALISMAN begins its process with a PIM (A representation of the manufacturing process of each individual case). For this reason we are developing a method thanks to which we will automatically go from CIM to PIM and this would greatly facilitate the task, because people outside the world of computers could generate their own applications for food traceability from their specific requirements independent of computing (CIM) easily. More at [17]

Finally, this work has been done with the contract FUEM-120-07 "Software Development for the realization of traceability", working together the University of Oviedo and the company LINK

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#### REFERENCES

- [1] J. Greenfield., K. Short, S. Cook, S. Kent, J. Crupi "Software Factories: Assembling Applications with Patterns, Models, Frameworks, and Tools". Wiley Computer Publishing, Sep 2004
- [15] Object Management Group (OMG). "MDA Guide. V1.0.1"; <http://www.omg.org/docs/omg/03-06-01.pdf>, Jun 2003
- [16] Leist, S, Zellner, G "Evaluation of current architecture framework". Proceeding of the 2006 ACM symposium on Applied computing, 2006.
- [17] Object Management Group (OMG). "Meta Object Facility (MOF) Core Specification. v2.0"; <http://www.omg.org/docs/formal/06-01-01.pdf>, Jan 2006
- [18] Object Management Group (OMG). "OMG Unified Modelling Language Infrastructure. v2.1.1"; <http://www.omg.org/docs/formal/07-11-04.pdf>, Nov 2007
- [19] Object Management Group (OMG). "MOF 2.0 XMI Mapping. v2.1.1.pdf"; <http://www.omg.org/docs/formal/07-12-01.pdf>, Dec 2007
- [20] Object Management Group (OMG). "Object Constraint Language. v2.0"; <http://www.omg.org/docs/formal/06-05-01.pdf>, May 2006
- [21] Object Management Group (OMG). "Meta Object Facility (MOF) 2.0 Query View Transformation Specification"; <http://www.omg.org/docs/ptc/07-07-07.pdf>, Jul 2007
- [22] M. Guttman, J. Parodi "Real-Life MDA: Solving Business Problems with Model Driven Architecture". Morgan Kaufmann, 2007.
- [23] G. Lenz, R. Wienands "Practical Software Factories in .NET". Apress, 2006
- [24] S. Cook, G. Jones, S. Kent, A. Wills "Domain-Specific Development with Visual Studio DSL Tools". Addison-Wesley, 2007
- [25] D. Thomas "MDA: Revenge of the modelers or UML utopia?". IEEE Software, 21, 2004
- [26] S. Cook "Domain-specific modelling and model driven architecture". MDA Journal, 2004
- [27] The European Parliament and the Council of the European Union. "REGULATION (EC) No 178/2002 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL"; [28] [http://eurlex.europa.eu/pri/en/oj/dat/2002/l\\_031/l\\_03120020201en00010024.pdf](http://eurlex.europa.eu/pri/en/oj/dat/2002/l_031/l_03120020201en00010024.pdf)
- [29] C. G-Bustelo. "TALISMAN: Desarrollo Ágil de Software con Arquitectura Dirigida por modelos". PhdTesis, University of Oviedo, 2007
- [30] Expertcoder. <http://expertcoder.sourceforge.net>
- [31] H. Hernández-Fernández, V. García-Díaz, E. Palacios-González, C. G-Bustelo, J. Cueva Lovelle "Design of intelligent business applications based on BPM and MDE". The 2008 World Congress in Computer Science, 2008

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# Collaborative Geographic Information Systems for Business Intelligence

Juan José Ramirez

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**Abstract** – This paper shows a number of sceneries where information (specifically, geographical-related information) is lost because there is no method for storing or sharing it. This research has been done with the aim to solve those scenery problems in a general way, by means of a geographical information system that can store geographical-related information and publish it in order to avoid loss of information and enabling geographical information sharing.

**Keywords** - *Geographical Information System, Business Intelligence, collaboration, universal access.*

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## I. INTRODUCTION

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In most organizations often occur the same problems in different places. As organizations are focused on a field or in several related fields, it is normal that their workers have to face daily with similar problems. However, they always spend a lot time with problems that never before have been happened and, once solved, is easier to deal with them again if they return. But this will only happen if the problem is found by the same person or someone that knows how to resolve it. If the person that found the problem hadn't been found before he/she will spend some resources thinking about a solution to what an amount of time was already spent. Furthermore, it is illogical to think that problems will always meet the same person.

There are many situations where:

- There are communication difficulties between employees, especially when they aren't in the same department.
- Work is done twice because nobody knows that before someone solved the same or similar problem.
- Once a work is done it is forgotten forever.
- In a company, there are people, and even departments, that are overloaded while others are idle.
- Work is sometimes somewhat inhumane because there isn't communication nor there is a chance to collaborate with people who worked on it.

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It is also common that people within that organization do not have time or space to talk about them and realize that many problems can be solved if everyone cooperates by offering its experience. Power of Knowledge [6] is a common topic, especially within a company, but as famous ad asserts, Power is nothing without control.

In any case it is well known that communication between people or within an organization can improve them in multiple ways, due that improve performance, resolve problems faster, impulses innovation and creates a better working environment [1]. Business Intelligence along with Geographical Information Systems can achieve these goals.

This document will explain a real problems and real solutions that are able to solve the loss of information in an organization. First, solution features will be presented. Then state of the art will be studied. A real prototype that solves the problem will be explained. Finally, future research will be presented.

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## II. COLLABORATIVE GIS

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As introduced, there is a problem of dialogue / collaboration in most organizations. Before making any development following should be considered:

- Does this problem exist in real world?
- Is there software to solve the problem?

To answer the first question two real cases will be explained.

### *A. Solidarios para el Desarrollo (Solidarity for Development)*

Solidarios para el Desarrollo is an spanish NGO established in 1987 that works in more than 150 social programs. Program of Care for Homeless People is one of those programs. The volunteers meet in the facilities Complutense Univesity in Madrid, where they prepared food like sandwiches, coffee, soup ... Each volunteer is assigned in a group that, once food is prepared, they follow a predetermined route through the streets. With the excuse of a sandwich or a hot coffee, volunteers come to homeless people to engage in a conversation with them and make them feel like a person and not like urban furniture [14].

In this program geographical information is very important. To perform a good following of homeless people is very difficult if there aren't suitable tools. At these routes, a lot of problems are encountered by volunteers. Many of these situations had been solved by other volunteers, but due to lack

of tools, that knowledge is lost. Sometimes the situation is never repeated, but when it has been common among the volunteers, they have found good solutions that would not have succeeded without such collaboration.

At other times the organization wondered about the social reality that is being addressed, i.e. do not have sufficient means to measure how many people are assisted, how they spread, why they are clustered in certain areas, which are the most problematic cores etc.... Most of this ignorance is given by lack of communication between members of the NGO. Actually one of the largest disappointment is that a volunteer doesn't know if her/his work is encompassed within another larger, which really can change a situation of social injustice.

### *B. Comboni Missionaries*

The Comboni Missionaries are a religious order that assist several social problems around the world following the idea of helping the most abandoned without frontiers, started by Daniel Comboni [4]. Comboni Missionaries work around the world, especially in those places where there are more basic needs. They work in very different places, but when two missionaries are together and talk about problems they realize that their mutual experience would have been very useful if they would contact before. For example, on one occasion a comboni missionary performing their work in Ecuador, specifically in Esmeraldas, met a local person who had visual problems. His entire family depended on him. If he couldn't see he couldn't perform his work and his family wouldn't have any other resource to live.

The only place where they could heal his disease was in Quito, but transport, lodging and surgery costs were much more expensive for what they could be pay. The missionary didn't have enough resources to solve this problem, so at the moment it was unresolved. Some days later he met another missionary accidentally, who worked in another different area. They were talking about their problems and when commented that visual problems, his partner said that a team of doctors were operating for free near.

### *C. State of the art*

With the advent of Web 2.0 and mashups, it is possible to solve many problems which have been stated in the previous examples. Here are some possible solutions to assess the problems proposed.

Openguides [12] is a technology that enables user for making custom maps about a topic. For example, there is a guide for Boston city [2] that contains a lot of geographical information about Boston. This solution enables collaboration, but has some problems:

- There is only one marker allowed on each map.
- Collaboration is limited because there is no way to put comments on a marker.
- It hasn't time management.

Community Walk [5] is a mashup where users can create maps, markers with photographs, comments, link, etcetera. This software is the closest solution to problems, since enables users to collaborate with other users about problems.

However, being a good solution for most problems, it still does not cover the following aspects:

- Google Maps is the only map source allowed.
- A user can only insert markers and routes.
- Do not enable any kind of analysis.
- It isn't free software.
- It hasn't time management.

GMap [9] is an extension for wikis that enable maps in wiki articles. Combined with a wiki, it may be a good solution for geographical collaboration. However, it is very difficult to create a full application over gmap-generated maps, so maps aren't dynamic.

There are many other solutions, among more representatives and widely uses in companies are ESRI and Intergraph.

ESRI ArcIMS [7] is a web based geographical information system. ArcIMS provides a set of powerful tools and can obtain data from any ESRI solution, which involves a wide range of formats and information sources. Although ArcIMS is a very professional solution, it has a high cost because it needs other ESRI tools in order to work properly and is hard to customize for the requirements that are described in this article.

Intergraph Geomedia WebMap [10] is the web map solution provided by Intergraph. Like ESRI ArcIMS, Intergraph Geomedia WebMap provides a set of powerful tools and can benefit from other Intergraph products. But like ESRI ArcIMS, it has a high cost and is hard to modify for GIS collaboration.

### *D. Proposed solution*

Once there have been able to observe what problems may exist in an organization (mainly lose of knowledge), and some possible solutions, an ideal solution must provide:

- Easy collaboration between people.
- Georeference events and display them on a map.
- Analysis and studies based on data supplied by users.
- Be accessible through the Internet.
- Provide support for older/basic clients.
- Have a simple interface for those who are unfamiliar with GIS, but yet powerful to be able to perform useful analysis.
- Overlay data from different sources in the maps.
- Georeference routes.
- Manage maps, events, and users.
- Establish safety limits on the maps in terms of access and modification.
- Managing time in the data supplied to the maps.
- Being able to import / export data in formats that can use other systems.

An event is the term used for problems that an user has found at a certain place, resources whose location and details are available to other users, a point of a route, notices...

CoGIS (Collaborative GIS) is a solution designed to meet all these requirements. Its features are:

- It enables users to create custom maps.
- It enables users to put events on a map.

- There is a security management of users, maps and events.
- Events can be commented by any user that has access to the map.
- It can manage any map provider through its API. Currently google maps, yahoo maps, virtual earth, openlayers...
- Maps can contain many map layers (WMS).
- CoGIS have analysis tools like distance to points or layers opacity.
- Events have time management, so position changes in time can be analyzed.
- CoGIS can present maps even on javascript-disabled browsers.
- Places can be found by using reverse geocoding.

As stated by P. A. Burrough, "a Geographic Information System is a set of tools for collecting, storing, retrieving at will, transforming and displaying spatial data from the real world for a particular set of purposes" [3], so CoGIS is a specialized GIS that collects, stores, shows and analyze geographical data provided by its users, allowing them to collaborate in common or global tasks.

CoGIS is composed of two subsystems:

- Coordination and Management Subsystem.
- Maps and Collaboration Subsystem.

Coordination and Management Subsystem is responsible of managing users, data, maps information, news etc..., ie web application management: add, remove, modify and any issues relatives to non-geographic data (map management includes user visibility and security permissions, map descriptions..., ie, any non-geographical information of the maps). Maps and Collaboration Subsystem is the geographical implementation of the system: web mapping client configuration, map events management (add, remove, modify and queries), WMS overlay, route creation, analysis (point to point distance, point buffers, point history ...), messages management, meta-map creation, etcetera.

CoGIS uses following technologies:

- It is a java web application, running over tomcat application server, using struts architecture.
- CoGIS uses tiles to be browser independent.
- Google Maps is used by default
- Database used is PostGIS / PostgreSQL.

Why support multiple map sources? Google maps is a well known technology, it is very popular and it has a big company supporting it. However, seeing it from GIS perspective, google maps is not as good as expected.

Google Maps didn't define clearly its map projection used. T. Fernandez made a small study on the possible projection that Google Maps could have concluded that it was a Carrée Plate, so Google changed its projection over time [8]. Currently, Google Maps uses Mercator projection [13]. Besides, scale in Google Maps is unknown and it is very variable depending on the zoom and geographical place. Radiometric uniformity is another problem because there are many orthophotographs which have discontinuity int its unions (i.e., luminosity is not the same across images). That is

why Google Maps cannot be used as a precision mapping system. In fact anyone can see big differences in some areas between the satellite images and map layer. This problem is not Google's fault but companies that have created the data to Google Maps. There isn't a perfect web mapping system (well designed, cheap, browser-proof, with a good mapping source...), so the solution proposed by CoGIS is provide a method to enable using any web mapping system, making easy to support additional web mapping systems. This is achieved by using mapstraction [11]. Mapstraction is a javascript library that supports a high number of web mapping systems through a common API. That API can be modified easily, so adding support to custom web mapping systems is not a problem. CoGIS takes advantage of this feature in order to support any web mapping system.

There is one more point to keep in mind. In early example of Comboni Missionaries, a common problem to use any solution is that hardware used to access services can be very different. Almost always this is not a problem, but there is a case in which it is a serious problem: when technology used is too old to use most of current web mapping systems. This is known as digital divide. One of CoGIS objectives is "present maps even on javascript-disabled browsers". This is achieved by using java tiles technology. Tiles is a java library that allows J2EE applications to build a very versatile and personalized view of the web application. Using tiles, CoGIS can detect browser and present a mapstraction interface or a javascript-disabled interface. Imagine a situation where an Internet Explorer 6.0 browser access to the application. Internet Explorer 6 is able todo things (especially with Javascript) that an Internet Explorer 3.0 cannot. Detecting the source in the JSP client application can decide which template (tile) is more appropriate to use for each client. A simple example for this might be:

```
<%@ taglib prefix="c"
uri="http://java.sun.com/jsp/jstl/core" %>
<c:choose>
<c:when test=" ${header['User-Agent']} == 'Mozilla/4.0
(compatible; MSIE 6.0;
Windows NT 5.0)}"
<tiles:insert definition="ie6_map" flush="true"/>
</c:when>
<c:otherwise>
<tiles:insert definition="basic_map " flush="true"/>
</c:otherwise>
</c:choose>
```

Thus tiles makes possible to use templates based on browser client capabilities. That is why tiles is very useful for collaborative browser independet GIS, because it makes development easy, reusable and efficient, supporting multiple browsers or views. For example, if basic\_map template uses other template, it is possible to include a script (an additional element of the mosaic) that, if the browser hasn't got some javascript features, those functions can be emulated by prototype functions. However, many other parts of the application will be compatible, so it is only necessary to specify those templates that browser needs.

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### III. FUTURE RESEARCH

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Throughout this article, common organizational problems have been exposed: waste of work, loss of knowledge, lack of organization control... A solution is proposed in this article to avoid them, especially in those organizations where geographical information plays an important role. There are many tools that everyone can use to solve some of these problems, but it's also true that there isn't one only valid tool that solves all problems stated in this article. CoGIS aims to solve all these problems through a set of features. Collaboration is a powerful tool to avoid knowledge loss in organizations. Community collaboration (understanding community as people inside an organization, or every person who can access the application) in any environment is one of these. It's so important the collaboration as enabling a good environment to make possible that collaboration. CoGIS enables using any browser, no matter if browser used to access application comes with last version or it's an old one. Only an internet connection is required. CoGIS has a set of analysis tools that gives more information to the organization, so not only avoid loss of knowledge, but also gives new information that could be very important. WMS layers adds many information that, combined with overlapping layers, makes CoGIS a powerfull tool. Also, it has an easy interface, so people who never has used a GIS before can benefit from all of its features. Time management is a hard issue in geographical information systems. CoGIS is event time oriented. Showing changes in an event everyone can figure out what changes has been made for an event. On the other hand, there are tools to export events in KML format, so events can be viewed in Google Earth. However, there is still much work to do. While the tool enables collaboration among people to avoid the loss of knowledge in organizations providing multimodal access to any client, there are certain characteristics that are not yet implemented. Some of these features are:

- Tools to insert other types of data, such as polylines, polygons, images, text...
- Tools to select items that meet a given condition.
- Tools for analysis of event attributes.
- Tools for time control, such as a scrollable bar to show and hide events according to the date, creation, event changes.
- Tools to provide GeoRSS.
- Ability to incorporate external data sources such as shapes, other geographic databases, KML files, GeoRSS and raster data through sources different from WMS.
- Integration with other web mapping clients like MapGuide.
- Implementation of a web client that works in handset clients like PDA, iPhone...
- Analysis tools that can generate raster images, like gradients.
- Analysis Tools for using algorithms such as routing.

In relation to the points shown on the map, CoGIS have not got any tool for grouping items or specify the scale at which they will be visible. There are many tools for both features

(particularly for the scale of viewing Google has its own API). As for the 3D visualization would be possible to use a separate tool like Google Earth, providing the same functionality as the web application but in an environment where the elevation is present and a set of tools are present in order to view events. Another aspect left for future work is more sophisticated collaborative tools. A forum is very simple and much more functionality could be implemented. An example of this is a wiki that would enable geographical article searching.

Developing collaborative tools makes possible intelligently avoid loss of knowledge in organizations, because makes an individual effort a collective result. However there is one aspect that has not been introduced: the rejection of technology. Even with best technology in the world if technology is not introduced appropriately to those who will use it, it will be a waste of time. This is, as far as I know, as essential as the technology itself. It is a great challenge to provide a good system that is both easy and pleasant to use, a system that it is not perceived as a threat and that also solves the problem for which it was designed. Failure in software projects has a high rate, and that is partly due to this risk. Future work will be not only get a good system, but also a system that cover and avoid such "human" problems.

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### REFERENCES

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- [1] Alarcón Aguín, Jose Manuel: "La política de comunicación interna: oportunidades y amenazas". Online available at [http://www.microsoft.com/spain/empresas/rrpp/politica\\_comunicacion.mspx](http://www.microsoft.com/spain/empresas/rrpp/politica_comunicacion.mspx)
- [2] Boston Openguides. Online available at <http://boston.openguides.org/>
- [3] Burrough, P.: "Principles of Geographical Information Systems for Land Resources Assessment". Clarendon Press, Oxford.
- [4] Misioneros Combonianos. <http://www.combonianos.com>
- [5] Community Walk. Online available at <http://www.communitywalk.com/>
- [6] De Cagna, Jeff: "The Power of Knowledge Sharing in Organizations", Information Outlook Vol. 5 Num. 5, May 2001.
- [7] ESRI ArcIMS. Online available at <http://www.esri.com/arcims>
- [8] Fernández, T: "Google Maps o la negación de la Cartografía".
- [9] Google Maps Extensions. Online available at [http://en.giswiki.net/wiki/Google\\_Maps\\_Extensions](http://en.giswiki.net/wiki/Google_Maps_Extensions)
- [10] Intergraph Geomedia WebMap <http://www.intergraph.com/gmwm>
- [11] Mapstraction. Online available at <http://mapstraction.com/>
- [12] Openguides Software. Online available at <http://openguides.org/page/software>
- [13] Savage, Charlie: "Google Maps deconstructed". Online available at <http://cfis.savagexi.com/articles/2006/05/03/google-maps-deconstructed>
- [14] Solidarios para el Desarrollo: "Programa de Atención a Personas sin Hogar". Online available at [http://www.ucm.es/info/solidarios/voluntariado/personas\\_sin\\_hogar.htm](http://www.ucm.es/info/solidarios/voluntariado/personas_sin_hogar.htm)





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- AI in Games.
- AI for Software Engineering.
- AI for Ubiquitous Computing.
- AI for Web Intelligence Applications.
- AI Parallel Processing Tools (hardware/software).
- AI Tools for CAD and VLSI Analysis/Design/Testing.
- AI Tools for Computer Vision and Speech Understanding.
- AI Tools for Multimedia, Cognitive Informatics.
- Data Mining and Machine Learning Tools.
- Heuristic and AI Planning Strategies and Tools,
- Visual Perception.
- Knowledge-Based/Expert Systems.
- Knowledge Management and Processing Tools.
- Knowledge Representation Languages.
- Natural Language Understanding.
- Semantic Web.
- Semantic Reasoners.
- Upper ontologies.
- OpenCyc in real applications.
- Social networks.
- Reasoning using belief networks (MSBNx, GENIE, BNJ, Weka, etc...).
- Neural Networks for AI.
- Fuzzy logic systems.
- Case base reasoning systems.

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## **IJIMAI 2010 - CALL FOR PAPERS**

### **SPECIAL ISSUE ON INTELLIGENT CONTROL SYSTEMS FOR NATURAL RESOURCES MANAGEMENT**

**Scope:**

Over-exploitation of natural resources by developed and developing countries resulted in various severe problems: destruction of vegetation, land degradation, denudation, soil erosion, landslides, floods, drought and unbalanced ecosystems. This special issue provides an international and multidisciplinary forum for the publication of original contributions and the exchange of knowledge and experience on the management of natural resources using artificial intelligence techniques.

**Important Dates:**

Abstract submission: 15 March, 2010  
 Paper submission: 10 May, 2010  
 Acceptance notification: 28 May, 2010  
 Final papers: 30 June, 2010



*Our Children's Future Is More Important Than Anything Else.*

