

International Journal of Interactive Multimedia and Artificial Intelligence

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*I can't understand why people are frightened
by new ideas. I'm frightened of old ones.*

John Cage

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- What version do I use?
- How do I upgrade applications?

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- What is being used?
- How much does it cost?

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- 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?

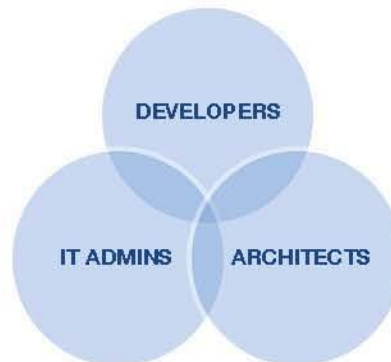
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- ✓ Versioning
- ✓ Platform Management

Infrastructure Control

- ✓ Cost Analysis
- ✓ Policy Management
- ✓ Traceability

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Editor's Note

I. INTRODUCTION

This special issue goes far beyond artificial intelligent tools and is at the forefront of many of the hottest areas of Artificial Intelligence. Our reviewers have been selected articles that expose the latest innovative techniques applied in automated diagnosis, prospective scenarios, security, geographical intelligent information systems, and semantic web.

Imai research group addresses concerns in applied research and applications of interactive multimedia and artificial intelligence. Articles highlight advances in uses of AI systems for solving tasks in management, industry, engineering, administration, and education; evaluations of existing AI systems and tools, emphasizing comparative studies and user experiences; and the economic, social, and cultural impacts of AI. Over the years, we have seen how artificial intelligence techniques have been applied in different scenarios ranging from business analysis tools, intelligent image processing, semantic web, to industry latest technologies.

On top of that, the challenge of extracting data from the rudimentary databases of four decades ago was significant. Early AI implementations would spit out reams of data, most of which wasn't sharable or adaptive to different business needs. Nowadays business intelligent tools can generate incredible enterprise web applications and executive dashboards from a data warehouse, including active charting, high-speed calculations, and rich interfaces. AI is more practical today for businesses than it has ever been.

Nowadays IMAI Research Group is currently concerned about 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. We provide 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. This journal acts as a medium for exchanging ideas and thoughts about impacts and results of AI and Multimedia research. Papers from multidisciplinary researchers and other relevant material are welcome.

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

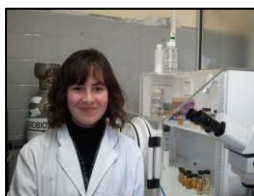
II. WELCOME TO NEW MEMBERS



Raman Maini. Associate Professor, Punjabi University, Patiala(Punjab)-147002, India. His current area of research is Computer Vision (Specialty Noise Reduction in Medical Images, Edge Detection and Image Enhancement), Security Concerns in Multicast Routing and Development of Database Packages for Commercial Use, Software Engineering, Management Information Systems, Computer Networks, Image Processing, Neural Networks and Fuzzylogic. Currently, he is working on Ultrasound Images for breast Cancer Detection.



Juan José Ramírez has a degree in Computer Science Engineering with a Master in Geographical Information Systems. He has developed several GIS software for NEAT Group. He also has worked in UK for Santander UK and is currently working for Vector Information Technologies in the R&D Department.



Ana Soto. University Complutense of Madrid. She is PhD in veterinary science, expert in Biotechnology for manufacture of functional products enrichment with calcium. Bioavailability and effects on the Human Health. Her professional experience covers a wide range of issues: probiotics and glycolysis, their relationship and effects on human models. Manufacture of new meat products enrich with calcium. Bioavailability of the mineral in an in vitro method and research in deer parasitosis and its effects on the environment.

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Comparative Study of Classification Techniques on Breast Cancer FNA Biopsy Data

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Abstract - Accurate diagnostic detection of the cancerous cells in a patient is critical and may alter the subsequent treatment and increase the chances of survival rate. Machine learning techniques have been instrumental in disease detection and are currently being used in various classification problems due to their accurate prediction performance. Various techniques may provide different desired accuracies and it is therefore imperative to use the most suitable method which provides the best desired results. This research seeks to provide comparative analysis of Support Vector Machine, Bayesian classifier and other Artificial neural network classifiers (Backpropagation, linear programming, Learning vector quantization, and K nearest neighborhood) on the Wisconsin breast cancer classification problem.

Keywords: Artificial Neural Networks, Classification, Breast cancer diagnosis

I. INTRODUCTION

The development of automated diagnostics was instigated by the need to aid the physician in decision making. There application in healthcare has spanned from the electrocardiograms to ultrasounds etc. The traditional set-up for error detection and monitoring of disease progression heavily rest on the technicians within the healthcare. The increase in the number of patients within healthcare who require continuous assessment has led to the technical development of the automated systems. Transformations of the qualitative information to quantitative measures are at the forefront in solving classification problems. Breast cancer has been identified as the second largest cause of cancer deaths among women of age 40 and 55. The number of breast cancer diagnosis is estimated to be 1.2 million among women every year according to projections by the World Health Organization [4]. According to statistics by the American cancer society in 2001, about 40,200 deaths are caused by the breast cancers and 192,000 cases consist of women

who are newly diagnosed [8]. Additional statistics as of 2006 estimated 214,460 new cancer diagnosis and total death at least 41,000 within the US [10]. Early detection and accurate diagnosis has been crucial in reducing the number of deaths which has increased the survival rate of those diagnosed with breast cancer [8].

The challenging effect of the identification of the cancerous cells in a patient is highly subjective and it is reliant on the physician expertise. This may lead to inaccurate predictions since the experiments are prone to human and visual error and may be affected by blurred mammogram visuals [11]. The aforementioned challenges necessitate the need for accurate tools for detection and classification of the breast cancer cells. There have been effective systems such as the machine decision support systems (MDSS) used in aiding breast cancerous cells detection [8]. Machine learning techniques have been instrumental in providing evidence in support of the accuracy of the classification of breast cancer patients. Once the breast cancer diagnosis has been performed the prognosis is subsequently determined to predict the future development and characteristics of the cancerous cells. Prognosis has been determined to be more complex due to the censoring of data [9].

Diagnosis is employed to significantly and accurately discern between malignant and benign cancerous patterns. Some of the conventional used approaches for breast cancer detection/diagnosis include mammography; surgical biopsy and fine needle aspirate [9]. The sensitivity results from the aforementioned approaches in accurately identifying the malignant lumps ranges as follows, mammography 68%-79%, fine needle aspirate 65%-98% and surgical biopsy about 100% [9]. The surgical biopsy despite being an effective approach has been determined as a costly procedure which induces negative psychological behavior on the patients [10]. Another effective method to diagnose breast masses is based on Fine Needle Aspiration biopsy, which is a technique to extract cell samples from lump and conduct vision observation on the cellular under microscope [1]. Diagnosis conclusion (benign and malignant) can be drawn according to the judgment of domain experts [2].

Currently, artificial intelligence techniques, which deal with the diagnosis as a pattern classification problem with the cellular nuclei shape information from cell slides images, have been introduced into this area, to improve the accuracy, consistency and efficiency of this diagnosis process.

A. Research Objective

The objective of this research is to provide a comparative study on the utilized potential classification tools (linear programming, back-propagation neural network, support vector machine and Bayesian network) on the problem by a benchmark dataset which consist of numeric cellular shape features extracted from preprocessed Fine Needle Aspiration biopsy image of cell slides.

B. Research scope

This research will first implement Support Vector Machine (SVM) and Bayesian network solution on the benchmark dataset. Then a comparison on this benchmark dataset between the former adopted techniques (linear programming and back-propagation neural network) and these two newly developed modeling approaches will be conducted. The measurement of this comparative study will be selected according to the proposed measures by the latest publication on this problem [4]. These will include classification accuracy, sensitivity, specificity, positive predictive value and negative predictive value. K-fold cross-validation [5] will also be used to evaluate the overall performance of each model built by aforementioned approaches. The organization for the rest of this research will be as follows, Section 2: provides detail information on the literature review, Section 3 introduces the strategies employed by the SVM and Bayesian network classifier, Section 4 discusses detail analysis on the results, the complexity of modeling process and the computation expenditure of these approaches, and Section 5 provides the summary and conclusion of the research.

II. LITERATURE REVIEW

The increase in the number of deaths determined within the healthcare systems has led to the development of medical diagnostic support systems to aid the medical personnel's in decision making process [10]. Various experts systems and machine learning algorithms have been utilized to provide supporting information based on the input knowledge. Some of the significant developments include 2D and 3D medical imaging, feature extraction, pattern analysis and classification have been used in providing solutions for edge detection and region growing among other problems [10]. According to Pena-Reyes and Sipper (1999) an effective diagnostic systems should be able to provide higher accuracy of

disease identification as malignant or benign. In addition, the systems should also be able to determine with a degree of confidence indicating the accuracy of diagnosis with some levels. Another major important aspect is the systems interpretability which provides information on the steps followed resulting to the outcomes generated. The Artificial neural network on the other hand has been determined to be an effective tool in classification though the operations within the network structure are hidden.

Classification problem seems to have generated interests among researchers. The classification approach is used in data analysis and pattern recognition problems. This approach involves classifier modeling which is used as a function that associates a class to different attributes. The concept of association based on similarities or trained performance has been embedded in various approaches such as neural networks, decision trees, decision graphs and etc [14]. The methodology of the neural networks can be performed in two phases i.e. training and testing. The training phase involves feature extraction and computation utilizing the classification rules. On the other hand, testing data is used for performance evaluation on the accuracy of the classification process determined by the training data [10]. Breast cancer diagnosis and prognosis has instigated the research interest and has been explored utilizing various artificial neural networks such as Radial Basis Function, Multilayer perceptrons, Backpropagation, and Learning Vector Quantization network. Other methods which have been utilized to determine the breast cancer diagnosis includes Fuzzy systems and Evolutionary algorithms. The fuzzy systems are used to represents different degrees of the disease (malignant or benign) a patient suffers from; on the other hand, the evolutionary algorithms are used to perform search to determine the most suitable fuzzy systems [6].

Isotonic separation which is a linear programming technique is based on the underlying assumption of maintaining same consistency in diagnosis. For example the Breast cancer dataset (Wisconsin) a patients being diagnosed with malignant tumor based on certain characteristics of the cell structures, for other patients showing similar symptoms with more damage to the cells would end up receiving the same diagnosis [7] and Rank nearest neighbor technique (k-RNN) [11]. The k-RNN has been determined as technique used in approximating the densities based on the evaluations of the nearest neighbors [11]. The aforementioned technique has been applied in univariate and multivariate data in examining various classifications problems including breast cancer. In order for a patient to receive the appropriate breast cancer treatment, it is necessary that accurate classification of the cells be determined. This has lead researchers to combine and employ various machine learning techniques and select the one with the highest prediction accuracy [16]. The comparative analysis of the ANN ranges from two to

six networks or more being evaluated to determine the most appropriate technique. Integration of different ANN networks has lead to improve performance measures. The RBF properties when applied to tuning the SVM has been determined to provide higher prediction accuracy for breast cancer data [12].

III. METHODOLOGY

There have been numerous artificial neural network approaches used for examining the classification of breast cancer cells, some of these approaches are Bayesian classifier and SVM. This section provides descriptive discussions on the SVM and Bayesian classifier framework. In addition, it examines the strategies employed and some of the parameters that are used for effective classification of patterns.

A. 3.1 Support Vector Machine Stratagem

Support Vector Machine (SVM) was introduced by Vapnik and it is a technique based on the statistical learning theory and has been applied for solving classification and regression problems [15]. The objective of the SVM is to separate two classes by determining the linear classifier that maximizes the margin and it is referred to as the optimal separating hyperplane [15]. SVM has been employed in various classification problem and mostly current interest in breast cancer detection due its robustness. The regularization parameter and kernel function are the two major components that have to been determined before conducting training. Some of the significant researches employed using the SVM for breast cancer detection utilized heuristics SVM approaches such as the smooth SVM, the linear SVM and general non linear SVM [12]. The goal of SVM is to determine a suitable hyperplane with maximum margin which can be computed as an optimization problem [10].

B. 3.2 Bayesian Network Approach

Bayesian networks are characterized by the use of the probabilistic approach in problem solving and encompass the uncertainty of certain occurrences. Its origin is based on the probability distribution which can be depicted graphically. The Bayesian network classifier is composed of a set of variables related to each other by directed edges. The variables represent the data attributes, class and arcs, which when applied to the conditional probability table depicts their relationship in a visual format. The Bayesian network classifiers are also referred to as directed acyclic graphs that provide information on joint probability distribution on various random variables [14]. It has been determined that the Bayesian network classifier, the connecting arcs between different nodes provides an independence assumption that is associated with the different random variables. The independence

assumption provides information on the probability distribution that is represented within the network. Generally, the probability distribution within the networks must initially be specified from the root nodes followed by the condition probabilities of the remaining non-root nodes based on the direct predecessor's combinations [13]. The conditional probabilities can only determine based on the fact that information on some of the nodes in the network have been identified.

The Bayesian network classifier uses the unsupervised learning algorithm, where the class target is unknown though we have the inputs (attributes) [14] and the classifier learning algorithm can be structured into two phases (i) Function for assessment of a certain network based on a data and (ii) an approach for examining space within the networks. There are various learning algorithm employed to the Bayesian network this includes AD (All dimensions) Trees, TAN (Tree Augmented Naïve Bayes) and K2. K2 has been used in breast cancer classification problems due to its fast convergence ability. Bayesian nets have been utilized in providing solutions to medical diagnosis, heuristic search and map learning problems among other challenges [13]. The Bayesian network is based on independence assumption between the nodes.

C. 3.3 Data Structure

The benchmark dataset in this research will obtained from the UCI Irvine machine learning repository <http://archive.ics.uci.edu/ml/index.html>. This dataset was originally created by Dr. Wolberg, Street and Mangasarian all from University of Wisconsin. Data items in the dataset are composed of ID number, the diagnosis which will either be classified as malignant (M) or benign (B) and numeric shape features of extract cellular nuclei such as radius, texture, perimeter, area, smoothness, compactness, concavity, concave points, and symmetry and fractal dimension. The dataset was composed of a total of 569 observations with benign and malign cases being 357 and 212 observations respectively. Each of the dataset in the observation is composed of 30 variables and 10 of the featured variables are related to the aforementioned characteristics [3].

IV. RESULTS AND DATA ANALYSIS

This section provides discussion on the result and analysis for SVM, Bayesian, LVQ, KNN and BNT _Clustering. Furthermore, a comparative analysis of the aforementioned approaches is presented. The SVM and Bayesian network classifier approach were developed using MATLAB, and the 10 variables (see section 3.3) were experimented with within the classifiers.

A. 4.1 Support Vector Machine

Training for the SVM was conducted by varying a variety of C and gamma (γ) values based on 10 fold cross

validation. The ranges of C and γ were selected within the range of 2^{-15} - 2^5 and 2^3 - 2^{15} respectively [18]. The two major SVM classifiers evaluated were C-SVM and Nu-SVM and the kernel functions that were used include polynomial, sigmoid and radial basis function. By examining the C-SVM employing the polynomial kernel function, the value of $C=1$ and $\gamma=2^{-3}$ showed 98.07% prediction accuracy which was the best from all other combinations. Figure 1 shows the surface plot for the varieties of C and γ . The initial values examined shows a flat surface which represents that the classification accuracy remained constant at 62.74% and progressively better predictions above 90% were determined.

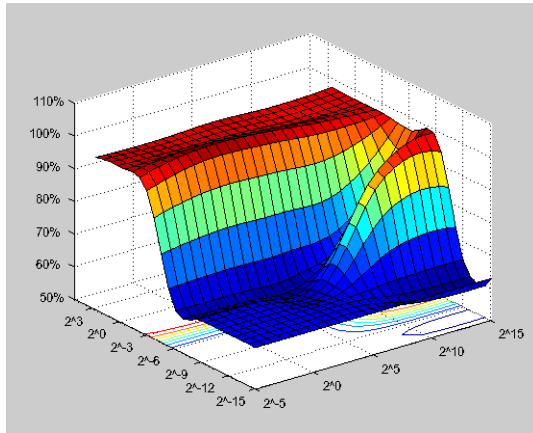


Figure 1: Surface plot for the C-SVM and Polynomial kernel function

The RBF kernel function was also examined and it showed better prediction accuracy as compared to the polynomial kernel function as shown in Figure 2. $C=2^{15}$ and $\gamma=2^{-15}$ showed a higher prediction accuracy of 98.24%. From Figure 2, the flat regions at the top indicate high accuracy prediction. The best prediction accuracy of 97.54% for the C-SVM using sigmoid kernel functions was determined between two regions (see Figure 3), i.e., when $C=2^{10}$ and $\gamma=2^{-6}$ and when $C=2^{10}$ and $\gamma=2^{-9}$.

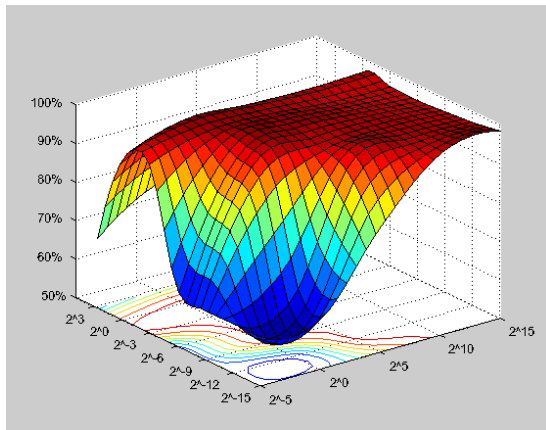


Figure 2: Surface plot for the C-SVM and RBF kernel functions

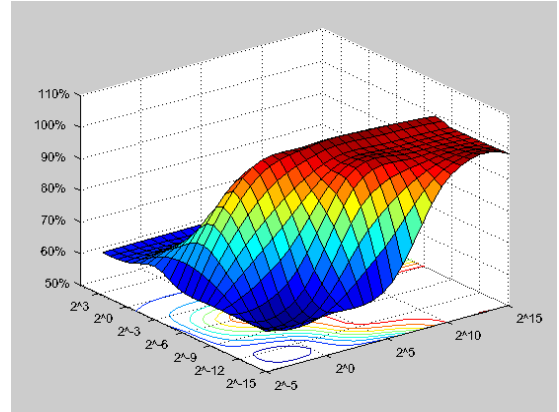


Figure 3: Surface plot for the C-SVM and sigmoid kernel function

Similar discussions were also presented using the Nu-SVM classifier with the polynomial, sigmoid and RBF kernel functions. The prediction accuracy of 92.79% was determined between the regions where $C=2^{-1}$ and $\gamma=2^{-6}$, $C=2^{15}$ and $\gamma=2^3$ as shown Figure 4. The flat topmost regions which lies between the boundaries $C=2^{15}$ and $\gamma 2^{-9}$ and 2^3 and $\gamma 2^3$ showed a consistent prediction accuracy of more than 90%. Figure 5 shows the surface plot for the Nu-SVM and RBF kernel function which has a flat feature map with a small raised region due to high prediction accuracy above 90% obtained for the C and γ parameters. Prediction accuracy of 95.08 where $C=2^1$ and $\gamma=2^3$, $C=2^5$ and $\gamma=2^1$. A higher prediction accuracy of 93.67% using Nu-SVM and sigmoid kernel function was determined within the region where $C=2^{15}$ and $\gamma=2^{-15}$ as shown in Figure 6 below. Low prediction accuracy of less than 70% was obtained for values of $C=2^{-5}$ - 2^{15} and $\gamma=1$, and $\gamma=8$

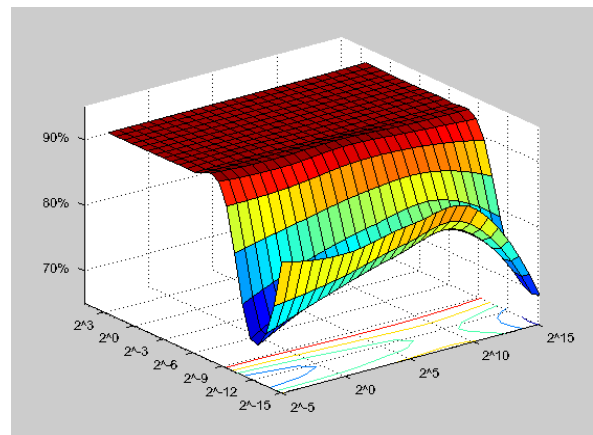


Figure 4: Surface plot for the Nu-SVM and polynomial kernel function

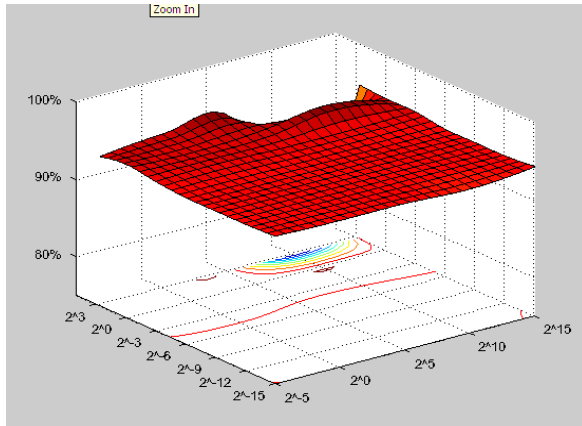


Figure 5: Surface plot for the Nu-SVM and RBF kernel function

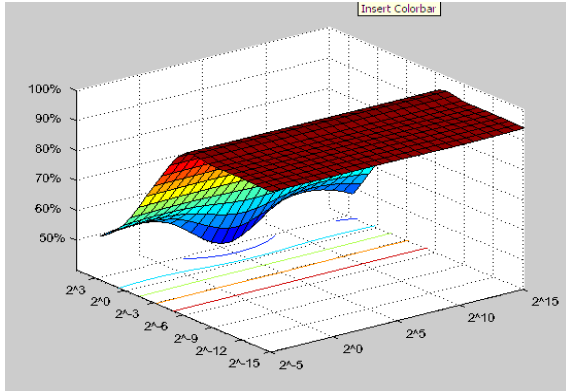


Figure 6: Surface plot for the Nu-SVM and sigmoid kernel function

B. Bayesian Network

The Bayesian network utilizes the Davies-Bouldin index during data preprocessing to change continuous data to discrete. In addition, Davies-Bouldin index assists in determining the appropriate cluster to be used in evaluating the network. The smaller the bouldin index indicates the most appropriate selection of the clusters. Figure 7, shows the Davies-Bouldin index which was utilized in this project.

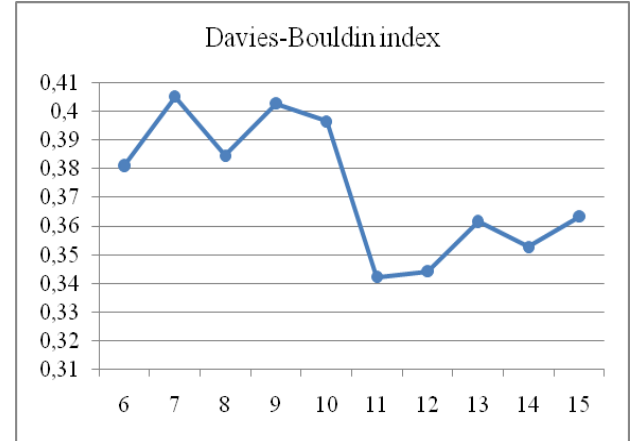


Figure 7: Davies-Bouldin index for different clusters on mean radius data item

The Bayesian network classifier was used for breast cancer classification. Three types of Bayesian network i.e., Naïve, K2 and Bdeu were examined to determine best network with higher prediction accuracy. The topologies for these different networks are shown in Figures 8 and 9. The topology for Naïve Bayes (see Figure 8) shows no learning takes place between input variables in the network. On the other hand, for K2 and Bdeu (see Figure 9) there is learning of relationship between the input variables. The experiments for each of the network were conducted by examining all the input features (All), mean and standard deviation (Mean+SE) and Mean. Results obtained from the network as illustrated in Figure 10 shows that Bdeu network with (All) had a higher prediction accuracy of 91.31%, followed by Naïve (All) at 89.55% and K2(Mean+SE) at 88.41%.

Figure 8: Naïve Bayesian network topology

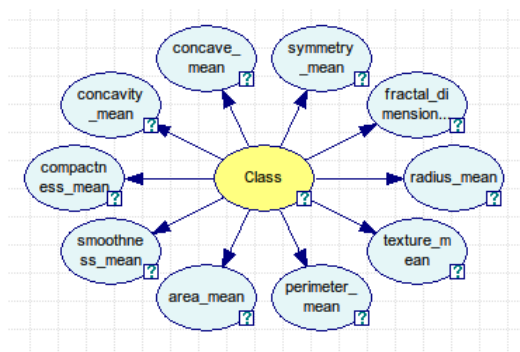
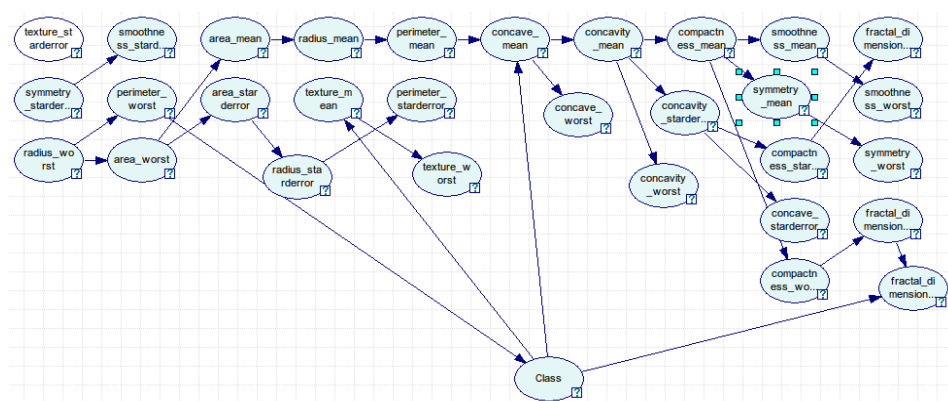


Figure 9: K2 and Bdeu network topology

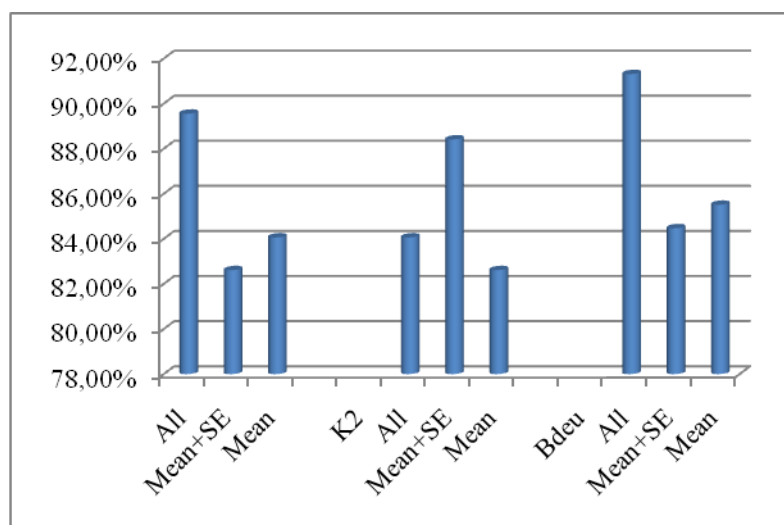


Figure 10: Bayesian network prediction results

C. Learning Vector Quantization

A combination of parameters of hidden neurons (5, 10, 15, 20, 25, and 30) and learning parameters (0.01, 0.1, 0.5, and 1) were varied against each other. The number of iterations for the network was set at 50. A higher prediction accuracy of 90.47% was determined with learning rate of 0.1 and 5 hidden neurons. Figure 11, shows the LVQ surface plot with low and high regions varying with the increase of learning rate and hidden neurons.

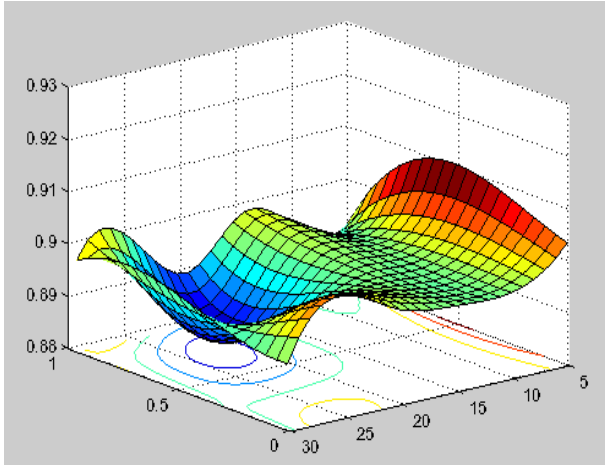


Figure 11: LVQ accuracy prediction surface plot

D. K-Nearest Neighborhood (KNN)

The KNN was evaluated using the Euclidean and Cityblock distance approach. The K (neighbors) evaluated ranged from 1 to 15. Figure 12 shows the results obtained and with a higher prediction accuracy being observed using both approaches. The Euclidean distance approach showed a prediction accuracy of 100% with K=5, 10 and 11, similarly to the Cityblock distance approach with K=13.

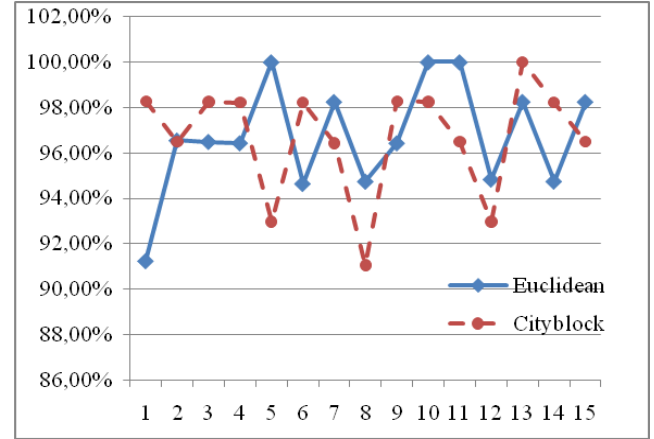


Figure 12: KNN prediction accuracy

E. Comparative Analysis

Table 1 shows a comparative analysis for the six different networks i.e., Support vector machines (SVM), Bayesian network (BNT), K nearest neighborhood (KNN), Learning vector quantization (LVQ), Linear programming (LP) and Backpropagation network (BPN). Based on the results in Table 1, the K nearest neighborhood had a higher prediction accuracy of 100%, followed by the SVM using the RBF kernel function with prediction accuracy of 98.24%. The K2 Bayesian network had poor prediction accuracy compared to all the networks evaluated. The results shows that machine learning techniques can provide accurate prediction and may enable proper classification of patient's condition and improve their quality of life. Although the Bayesian network classifier performance was poor compared to the SVM, the CPU time it took to produce the output results was low compared to other network. Table 2 shows the training and prediction time associated by each of the network observed in this project. The Bayesian network shows a low prediction time of 0.07seconds.

Table 1: Comparative performance of breast cancer

Type	SVM		BNT			KNN		LVQ	LP	BPN
Kernel	C-SVM	Nu-SVM	Naïve	K2	Bdeu	Euclidean	CityBlock			
Polynomial	97.54%	92.79%	89.55 %	88.41 %	91.31%	100%	100%	91.04 %	97.50 %	95.33% [17]
RBF	98.24%	95.08%								
Sigmoid	97.72%	93.85%								

Table 2: Networks CPU time

Type of Network	Training/Prediction Time (seconds)
SVM	(2.11s)/0.94s
Bayesian Network Classifier	(4.27+1.51)s/0.07s
Learning Vector Quantization	67.18s/1.45
K Nearest neighbor	N/A/0.08s

V. DISCUSSION AND CONCLUSION

Early detection of breast cancer cells can be predicted accurately by the use of machine learning techniques. This may result in the decrease of health cost and may enhance time required for a patient to receive treatment. In this project the SVM and the Bayesian network have been discussed in providing diagnostic and prognosis assessment for breast cancer. The SVM has been determined to be more superior to Bayesian network since it provides higher prediction accuracy. By comparing the performance of both networks to other neural network approaches, the KNN has been examined to provide 100% classification. The prediction accuracy of the networks discussed in this project emphasizes the need of employing the machine learning techniques not only on the prediction of breast cancer data but on other medical conditions in which predictions of conditions are difficult to diagnose.

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A crystal ball made of agents

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Abstract — This article presents an agent-based solution to model the opinions of an experts group with the aim of predicting possible future scenarios.

The need to envision the future is not new; it has existed since the beginning of human-kind. What it is new is the applicable technology that is available in a specific period of time.

It is not usual to find a critical social system which evolves according to predictable guidelines or tendencies. Because of that reason, technical prediction based on past and present data is not reliable.

This paper includes the process description of eliciting information from a group of experts and a real case study.

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

I. INTRODUCTION

THIS article introduces the application of the agents technology in the field of prediction. Mathematical models are useful to foresee how dynamic systems evolve. A social environment evolves as a dynamic system, with phases of stability, instability, or even worse, of a chaotic nature. However, regarding the study of future social scenarios mathematical modelization is not applicable. This field has been classically treated by Prospective [8]. Prospective studies have been usually developed by using statistical methods. The Delphi [6] and the Cross impacts [15] methods are standards in the field of Prospective.

What is new in this paper is the use of agents [10] based on Artificial Intelligence procedures, instead of statistical methods.

The method and its response are being validated with real case studies. This paper introduces a real case study that deals with the future of the Common Policy of Security and Defense in Europe in the temporal horizon of the year 2020.

II. WAYS TO FORESEE THE FUTURE

The necessity to foresee the future is not new. Man has always felt the necessity to predict what is going to happen. We can gather the different methods to foresee the future in

four main groups: Supernatural, Hermeneutics, Technical and Anticipatory.

Future facts or situations known by revelation, prophecy or even astrology can be included as a supernatural way to foresee the future. Unfortunately, this group does not include serious and trustable procedures, so it is not advisable to rely on such techniques.

Hermeneutics is related to social interactions focused to discuss about the future. Opinions, utopian situations and even science fiction can be included in this group.

Within the Technical group we can find mathematical models that are developed to extrapolate past and present data in order to predict future results. The study of tendencies permits us to approximate future situations in stable dynamic systems. Econometrics, demography and meteorology are sciences that can be included in this group.

Unfortunately, social systems don't always behave in a stable way; normally they evolve in an unstable or chaotic way. Furthermore, when a situation includes a great deal of different and heterogeneous variables, technical prediction becomes complex and unaffordable.

Anticipatory techniques [2] try to avoid the problem of using technical prediction in unstable systems by using the opinion of a group of human experts. The expert's opinion embodies relations among events or variables based on his/her personal experience; so complex relationships among heterogeneous events are mentally treated as a whole.

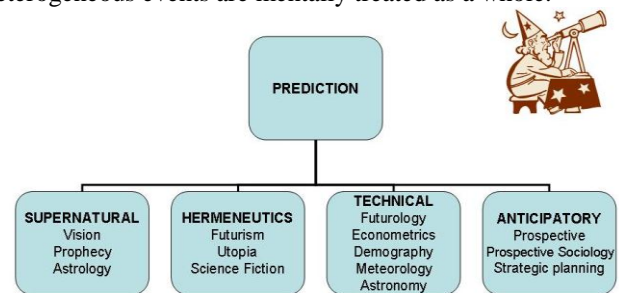


Figure 1. Ways to foresee the future

Technical prediction techniques are efficient in the creation of future scenarios based on stable dynamic systems 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, 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 technical prediction. Normally, the

scenarios of crisis are created due to an accumulation of events that would otherwise be ineffective in isolation; however when occurring together they create an unsustainable and critical scenario.

In our every day lives there are many events, from domestic economy, incidence of criminality, social integration, to radical terrorist attacks. All these events belong to a specific scenario in which we are involved. We can study the future as the development of past and present events through the time. From a conceptual point of view, our research is going to be developed under Prospective proceedings (instead of technical prediction). The final aim is to develop a technology which is able to identify and alert us to the generation of possible social scenarios of risk or crisis.

III. BUILDING THE CRYSTAL BALL

In this section, we illustrate a new approach for prospecting the future based on a Multi-Agent System [1] [7]. The objective consists of the construction of a model that faces the problem of modelling future scenarios from a different perspective from the classical statistical prospective methods. We use possibilities graded by linguistic tags instead of probabilities, we take a different track towards the problem compared to classical methods.

We have followed the MECIMPLAN [5] methodology to construct a software prototype that help us obtain results. This methodology describes the different steps and procedures to construct a MAS-oriented software prototype in this kind of domain. Nevertheless, MECIMPLAN can be used to develop intelligent systems, in both strategic [4] or tactical [3] planning.

A. Methodology steps

A methodology [5] that permits us to solve a wide range of planning problems is used in this section. In general, we can assume that the way in which we apply the method depends on a thorough analysis of the results obtained at each step. In certain circumstances, it is necessary to go back to previous states if the desired results are not obtained at a specific step.

To clarify the development of the software that supports our research we illustrate two specific phases of the methodology: Selection of agents and Model building.

B. Selection of Agents

We have used a neuro-fuzzy network [9] [14] 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 experts 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.

C. 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 analyzing the proposed events. Each agent of the MAS has been developed to carry out a specific function; all of them are based on Artificial Intelligence procedures [11] [13].

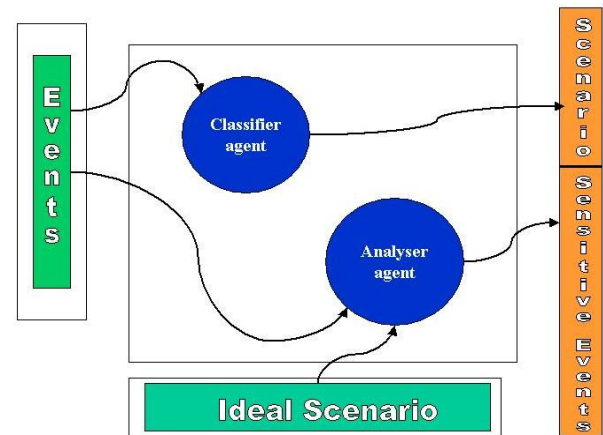


Figure 2. Conceptual Model

The knowledge extracted from the experts 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 experts group has been transferred to the Multi-agent System (MAS). 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 [16] 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 2, 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 or hinder 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.

IV. WORKING WITH EXPERTS

One of the key points of the process is to establish the method to elicit the information from each member of the experts group.

In order to extract the information from the experts group and with the intention of developing a MAS as a new solution, we suggest to follow the following steps:

- To select the experts group. The number of experts depends on the problem and the level of expertise they have. Usually a number of experts between 10 and 15 is accepted. If they actually are experts, to add more members to the group would produce redundant information.
- To generate a set of questionnaires comprising the whole field of different future scenarios.
- The experts will answer the questionnaires by using specific adjectives from the natural language instead of probabilities.
- Most likely each expert will have a particular view about the proposed scenario. Consequently, there will be different opinions inside the group of experts. From a technical point of view, the aim is to elicit the information from each expert and to develop a knowledge module able to give a response about future scenarios like the group of experts as a whole.
- Analysis of the most possible future scenario produced by the MAS as a result of the information given by the group of experts.
- Study and identification of the events that have a major influence in creating the scenario.

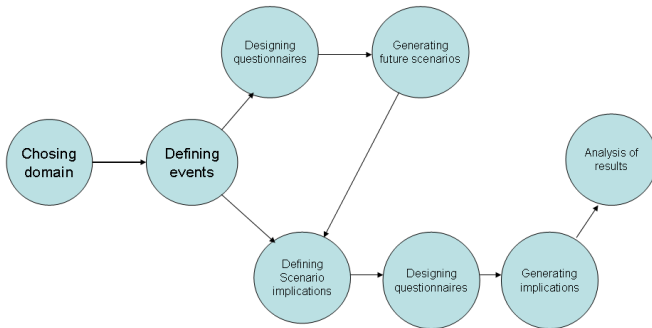


Figure 3. Map of processes

The above figure shows two branches. The upper branch describes the different processes that should be developed in order to generate future scenarios according to the opinions of a group of experts. In case we want to analyze the implications of the scenario generated in the upper branch or to study a specific scenario, we should proceed with the processes showed in the lower branch of the figure. We study the influence of external events not directly related to the scenario, on the possible scenario that is the objective of our study.

V. A CASE STUDY FOR FORESEEING THE FUTURE OF THE COMMON POLICY OF SECURITY AND DEFENSE IN EUROPE

In this section we present a work that is being developed by the Spanish Institute of Strategic Studies and Tecnalia.

The objective of this exercise of prospective is to foresee the future of the Common Policy and Defense in Security (CSDP) under the horizon of the year 2020.

A. Defining the domain

A group of analysts from the Spanish Institute of Strategic Studies chose the domain in which we should develop a prospective study. In this particular case, the objective consists of envisioning the future of the European Policy of Security and Defense in the year 2020.

B. Defining events

The same group of analysts with the assistance of a group of technical experts from Tecnalia defined the general events that are related to the domain. We chose the list of events paying special attention to their independence among them. A number of seven events were identified and are listed below:

Event 1: The public opinions of the member states press its governments for a major development of the CSDP.

Event 2: the structures are rationalized to promote the planning and execution of the missions of the CSDP, with an integrated employment of the civil and military capacities.

Event 3: a change takes place in the architecture of euro Atlantic security as consequence of a redefinition of the roles of the NATO and EU, and a change in the position of key actors as the USA and Russia.

Event 4: The ECSP (European Common Security Policy) develops of coherent form in accordance with the instruments foreseen in the Lisbon Treaty.

Event 5: The European Council decides for unanimity to implement a common European defense, in the terms established in the article 27.2 of the Lisbon Treaty.

Event 6: The Capabilities Headline Goals (military and civilian), which are established by the EU to substitute those of 2010, are accomplished.

Event 7: The EC constitutes a number of forces adequately trained and equipped, and ready to be used by flexibility in crisis management.

C. Designing questionnaires

Once the domain and the events were defined, we designed the questionnaires to be answered by the experts group. The number of questionnaires cannot be numerous and have to represent the whole range of possible scenarios.

The group of experts was chosen by the Institute of Strategic Studies. Fourteen experts on international policy were selected.

In order to facilitate the knowledge extraction process a website was developed for the experts to answer the questionnaires on-line (www.escenariosprospectiva.info).

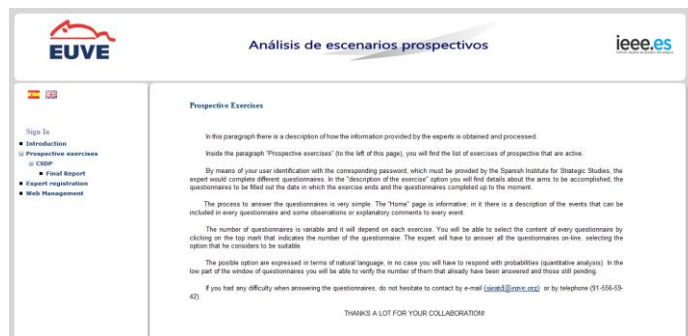


Figure 4. Eliciting information from experts

The number of events identified by the group of analysts is seven. Consequently, the number of possible scenarios is 128. This number is the result of the different combinations of the events (2 raised to the power of 7). From the 128 possible scenarios a number of fifteen has been selected as the most representative of them. Each expert has to express his opinion about the existence of each scenario in terms of possibility as ‘very high’, ‘high’, ‘medium’, ‘low’ and ‘very low’.

D. Generating future scenarios

After having studied the whole set of questionnaires, a number of fifty nine rules have been identified as the main elements to be treated as part of the multi-agent system. Namely, these fifty nine rules will be the core of the classifier agent. Currently, this task is still in process.

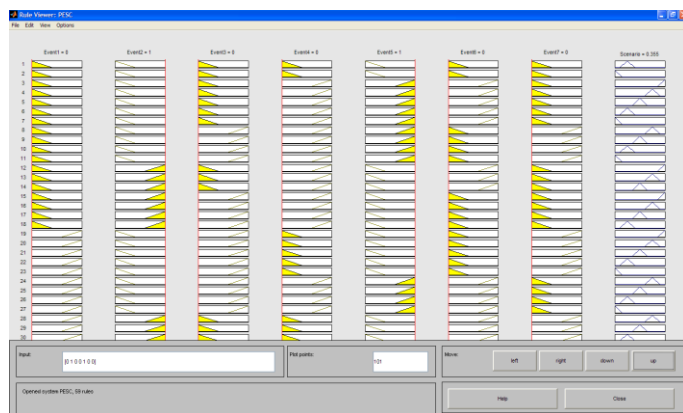


Figure 5. Rules generated by the experts

As describe in figure 2, the upper part of the map of processes is about to be completed. There are two tasks left to complete: the identification of the most possible scenario and the validation of the whole process.

Shortly, we are going to start with the lower part of the ‘Map of processes’ to study the implications of the most possible scenario and the analysis of factors to support the creation of the scenario or to prevent it from happening.

VI. PREVENTING CRISIS SCENARIOS IN SECURITY

The technology presented in this paper is applicable to any field; especially in those that prevention plays an important role. That is the case of security in which when preventing a

crisis or undesired scenario is crucial to avoid negative or fatal repercussions.

By treating adequately the opinion of human experts groups, it is possible to envision critical or undesired scenarios in the field of security. For example, this technology could be applied to detect emerging scenarios of terrorism in which different social events are involved.

Combining this technology with others like pattern recognition, tracing human groups’ behaviour or analysis of tendencies most of the prevention activities in the field of security would be covered.

We are available to collaborate with any research group or governmental institution to validate the result of this research work for preventing future scenarios in the field of security.

VII. FUTURE WORKS

The method and agent-based architecture permits not only to envision the most possible scenario but also to study its implications regarding other international and initially non-related scenarios.

At the present, we are tackling the study of the implications of the most possible scenario regarding the processes shown in the lower branch of figure 3.

In order to validate the architecture and new approach showed in this article, in 2011 we are going to develop some prospective studies together with the Spanish Institute of Strategic Studies.

We are also planning to present a large scale European Project with the participation of four different Institutions of Strategic Studies from other European countries.

VIII. CONCLUSION

One of the most important advantages that this work can offer is the possibility of foreseeing future scenarios with the use of the agent-based technology.

Furthermore, by comparing our work with classical methods, we find the following advantages:

- The use of possibilities based on a natural use of linguistic tags instead of probabilities to define the possibility or intensity of events.
- 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.

In this article, the applicability of the method is illustrated with a real case study that is still in process.

IX. ACKNOWLEDGMENTS

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Social and Cultural Dimensions of Digital Inclusions.

Dr. Juan Luis Chulilla, CEO of OnLine and OffLine

Abstract — The state of Internet Adoption Curve in 2011 for the developed countries reveals an apparently optimistic picture: the majority of European and North American populations have adopted main online tools and resources. However, as access of the majority of these populations doesn't mean universal access, we review some of the main proposals about Digital Divide and the use of EU Digital inclusion perspective in order to focus on the main obstacles for universal access to Internet.

Palabras clave— Cultural and Social Dimensions of Digital Divide, Digital Divide, Digital Inclusion, Internet Adoption Curve.

I. INTRODUCTION

Digital Inclusion is one of the most important strategic policies of the European Union, as it is mentioned in a 10-year series of Programs – the last one is the Communication from the commission to the european parliament, the council, the european economic and social committee and the committee of the regions: **A Digital Agenda for Europe** [10]. The most brilliant aspect of this concept (as opposed to other related concepts such as Digital Divide) is that Digital Inclusion encompasses both the problem and its solution:

- There are population profiles (persons with disabilities, homeless people, etc.) which suffer different grades and aspects of social exclusion.
- The progress on adoption curve of Internet is such that nowadays online technologies are essential for different dimensions of citizens' quality of life, opportunities and personal development. Individuals who lack an appropriate level of digital inclusion suffer not only digital exclusion but actual social exclusion too.
- People experiencing social exclusion more often suffer a situation of digital exclusion. In addition, for these individuals digital exclusion and social exclusion feed back each other and each contributes to maintaining the other one.
- However, digital inclusion is not only a strong benefit in itself but an efficient ally in overcoming the various aspects of social exclusion, from personal (communication and the like) to professional and citizenship.

II. DIGITAL DIVIDE, SOLVED?

It is very suggestive that this concept, so operative, is not very mentioned and used outside of research programs related with European Union policies. Its impact in the population is clearly negligible, specially when we compare it with the "tradicional" concept, **digital divide**. Without fear of double-quote-abusing, "traditionally" Digital Divide its a capability knife which parts societies and the entire World in two: *having* and *not having* people.

Until some years ago, it was cristal-clear: some people have access to computers and Internet connection, some haven't. Some people have the skills and knowledges needed not only for Internet access, but for obtaining significant benefits from it. Because of it, both public and private institutions invested a lot of resources and efforts in fighting against what was perceived as a severe social problem. Compaine [1] focused a provocative piece of work denouncing the excesses which were being committed fighting against digital divide. He sustained that Digital divide was being clearly exaggerated in 2001 (yes, in 2001) and was at least in part a believe more than a fact. Therefore, the so-called problem was going to be solved by itself, just with time, and public intervention was not needed nor justified.

Such extreme position was clearly nor acceptable at that time. Even in America, digital inclusion was far from solved - don't even mention the rest of the developed countries. Let's remember that this statement was made four years before O'Reilly [4] definition and launch of Web 2.0. Maybe Compaine was right about Digital divide, but not with the date. Is digital divide solved in 2011?

III. DIGITAL DIVIDE AND SOCIAL INCLUSION

As we can see with the sucession of European Union programs, not in its absolute sense. Reducted to absurd, if Digital Inclusion was solved, more and more public programs were not needed. However, Digital divide is not a popular concept anymore. Maybe Compaine is socially right. Concern for digital divide matters to very few people. As Internet adoption curve has progressed and it has reached late majority stage, it seems to be more and more clear that, as Internet has

been accepted in a majority of companies and homes, digital divide is not a problem anymore... in the developed world. And, of course, in the underdeveloped world, (<irony>) Digital divide is not a problem compared with hunger (</irony>).

Fortunately, other authors have not lost respect for the digital divide and, on the contrary, they point out different dynamics which show clearly that this is an ongoing problem. Warschauer, stresses [7,8] the urgent need to abandon the idea of one-dimensional and binary digital divide in order to adopt a multidimensional concept and gradual. In 2011, a binary concept is completely unacceptable and is disconnected from reality; however, the concept of digital divide is strongly connected to a binary meaning. Norris [3] remarks that, without intervention, digital divide is going to deepen and is going to reinforce social exclusion too taken its solution for granted is a very good recipe for social disaster. Van Dijk [5,6] points out a growing paradox: although physical access can be taken for granted more and more, it happens almost the opposite with the knowledge and benefits derived from Internet use. Van Dijk connect this paradox with Matthew effect [2], in the sense that the more knowledge someone has, the easier for him to obtain more.

Although the works cited above were written some years ago, their base is maintained. Indeed, all of them are pointing several aspects of digital inclusion related with the beliefs of societies about technology, or how other beliefs obscures some facts about the reality of digital inclusion.

Internet adoption curve is a fact. There can be used a lot of different metrics in order to define in which point of the curve are our societies now, but there is no discussion about the basic stage: in all the developed world, we have surpassed the early majority. This situation has a result: Internet access and use is taken for granted. Therefore, digital inclusion is not a very visible problem. As citizens of democracies, it should be mandatory to conceive Internet as an universal service and even right, so even if a small minority of the population is digitally excluded, this is a problem.

Anyways, the lack of visibility of Digital Inclusion is a cultural trend. This is only of the many cultural trends that affects Internet usage in a very significant way. As Internet has been integrated in the very core of our societies, is not a neutral technology anymore. People have make the internet full of different meanings and values, some of them positives and some not. A good set of the negative values related to the Internet are very influent because they are very and not easy to detect lack of visibility of digital divide is a good example.

In 2004, Warschauer proposes [8] a conceptual mark for good and efficient Digital Inclusion policies in which cultural factor have a strong role. It's painfully clear and simple: any local or sectorial initiative oriented to improve Digital

Inclusion is unlikely to succeed without taking into account basic cultural trends of each specific group. If it's not paid attention to active involvement of people, if beliefs and practices related with technology are not taking into consideration, the initiative won't answer actual needs.

IV. AN ANNOUNCEMENT

In www.emadrid2011.es, we are going to publish a 18 month long ethnographic research about social and cultural dimensions of Digital Inclusion and a complete methodology and good practices in order to encourage the groups, collectives and associations to help themselves to improve their digital empowerment. We have detected a good number of social and cultural trends which strongly influence the digital inclusion of collectives. The results are going to be published in the 2nd quarter of 2011, and we sincerely hope that the monography will encourage other researchers to improve the knowledge about this essential problem.

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Trust Levels Definition on Virtual Learning Platforms Through Semantic Languages

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Abstract — *Trust level concept is a topic that has opened a knowledge area about the profile evaluation and the people participation in Social Networks. These have presented a high knowledge profit, but at the same time it is necessary to analyze a group of variables to determine the trust participants' degree.*

In addition, this is a topic that from some years ago has been presenting a big expectation to settle some alternatives to generate confidence in an activer community on internet. To establish these parameters it is important to define a model to abstract some variables that are involved in this process. For this, it is relevant to take into account the semantic languages as one of the alternatives that allow these kinds of activities. The purpose of this article is to analyze the Trust Levels definition in the contents that are shared on Open Source Virtual learning Platforms through the use of a model of representation of semantic languages. The last ones allow determining the trust in the use of learning objects that are shared in this kind of platforms.

Key Words — Trust-Levels, FOAF, Web Service Security. WS-Trust, Ontology's

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I. INTRODUCTION

The gradually growing of services about Open Source virtual learning platforms has permitted a dynamic access to a huge range of contents represented through learning objects. At the same time this demands a lot of time consuming for the creation and the definition of strategies about the validation of contents that are not plagiarized by a user. This implies first, that in academic terms there is not any contribution to the learning student's process and second that there is not any possibility to validate the contents authenticity presented by an author.

In some educative entities this kind of activities are carried out by an external authority through manual processes before the publication of the content. In this case it is done by the formation of an academic committee that checks and validates

the content that is going to be published on these platforms. In the function of the academic committees, it is necessary to settle a group of policies to manage each one of the activities which involve a lot of time consuming for the checking and the publication.

To avoid this kind of delays, this document settles a strategy from the semantic point of view so as to identify the variables needed to highlight the trust levels of the contents that are published and shared on a LCMS platform (Learning Content Management System). This creates the possibility to check the contents before they are published on a virtual site.

II. LCMS PLATFORMS SECURITY

One of the most important information technology contributions, in educational terms, is the development of e-learning environment. With this it is possible to carry out the creation of strategies for all the educative entities, for the knowledge and for training through computer tools that are used on the communicative networks.

These learning environments are supported by different platforms that are invented with the purpose of giving access to educative contents that are part of the managing learning systems.

Nevertheless, the necessity of having the same kind of production, socializing and communication of contents allows an evolution from this kind of systems to others that are focused on the managing of contents. These are known as LCMS learning systems. However, the three processes mentioned before imply an additional task that is in relation to the authenticity of them through the possibility of acknowledging some theories of contents. It is possible to do this from the different computer techniques and the specifications that allow the creation of didactic material through the concept of learning objects.

The outlook that is worked on LCMS platforms in terms of computer security of content levels and their authenticity is not an explored area[3]. It is true that there are some security devices that are managed with certain data trust degree, but this is one of the weak points in most of the Open Source platforms. This means an unknown factor in order to try to identify the academic contents origin and its creation[3]. This kind of problems has not been controlled yet by the computer

devices. For the academic institutions this represents an important topic in the previously mentioned formation processes and their evaluation strategies.

So as to create strategies to carry out this kind of activities from the technological point of view it is better to work it from the same platform. This avoid the checking times, validation and authenticity of the contents and the formation of external academic committees that are in charge of the previous activities on a platform.

In order to do this activity in a virtual learning platform it is necessary to define a deeper language so as to associate and represent these activities. Ontology's models and semantic languages will allow creating a pertinent representation of the variables involved in this process. This implies an evaluation of the current platforms to identify if they are able to bear this kind of representations and at the same time the confidence in terms of computer science for the validation of contents and the authors possession to determine trust levels.

The new challenge is to determine the way in which learning objects, resources and digital contents are valid according to a group of parameters such as: profiles, trust levels and other kind of activities that are in relation to getting in touch with the following topics. Taking all this into account, it is necessary to define some processes related with these users' activities on a virtual platform so as to identify these groups of characteristics and to begging the identification of this kind of characteristics start with the definition of a strategy for its development.

III. IDENTIFICATION OF TRUST LEVELS ON A VIRTUAL LEARNING PLATFORM

To locate the processes which permit the definition of activities and the identification of trust levels about contents created by an author on a virtual learning platform; it is necessary to adapt the workflow definition proposed by WPMC (Workflow Management Coalition) [4], [5], [6] to the platform characteristics in relation to a user on the same platform.

On figure 1 there are some processes that are carried out for the definition of trust levels. These are represented by ontology's model according to the user's profile and content published by him. These characteristics are going to take into account the following items.

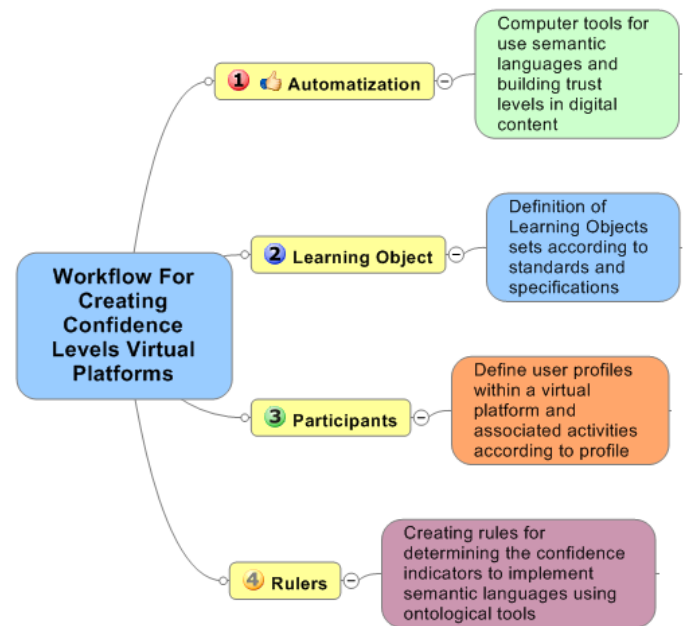


Fig 1. process for the definition of trust levels on a virtual platform.
(Author)

A. Definition of Automation Processes

In this stage it is carried out the selection of technological tools for the creation and definition of ontology's rules; that allows the definition of a language representation outline for the definition of trust levels on LCMS platforms. These processes represent the simplicity and optimization of the complex processes that are going to be taken into account:

- **Contents Quality:** To improve the contents quality to have all the important information available and reducing the time to consult.
- **Reduction of checking time content:** The reduction of time processes by an academic committee and an external inspector. This process will be carried out by the platform through the ontology's representation of trust level about content.
- **Profiles definition:** According to the content reliability published on a LCMS.
- **Definition of languages and tools:** Next there are presented some alternatives to work on the representation of processes on a LCMS platform:

In language ontology's selection we use the ontology's definition language OWL and the graphic representation through Protégé. This information is expanded with more details in the Rules Process Definition.

B. Learning Objectives Definition Processes

Learning objectives concept is in relation to a key element for the definition of contents that is represented through a group of SCORM specifications (Sharable Content Object Reference Model) defined by [7]. This allows the relation with the user's characteristics.

Learning object and representation of contents

So as to identify functional parts it is important to highlight the concept: Learning Objectives from the programming point of view. In its works [8] it is relevant the idea of the representation of contents reflected through the creation of contents. In this way, the current concept has changed to work with RLO (Reusable Learning Object). This topics were developed under advices given by [9] and by [10] on the definition metadata and valid elements for the definition of contents. The last ones are adapted to E-learning to offer a program focused on objects to about components for the definition of most of the specifications.

C. Participants definition processes

For the definition of the user's actions it is necessary to take into account the concept of trust levels. In general, this concept is related to the user's participation on Social Networks. In this way, we are going to present a lot of proposals that have been showed for the definition of the concept already mentioned according to the necessities of our proposal.

Standard WS-Trust

This rule is a standard proposed by OASIS (Organization for the Advancement of Structured Information Standards). This is an organization that with other computer companies are devoted to define access standards for Web Services on Internet; known as WS-Trust 1.4 [11].

This initiative was created by IBM, Microsoft, and VeriSign. These present a communication infrastructure to make easier Web security applications. Now it is developed, on internet, by an interdisciplinary group known as OASIS. In this group there are more than 700 organizations that are supporting this initiative in order to try to standardize all the communication processes in a secure way on the Web. This representation has a group of standards that describe basic security devices in relation to Web services through extensions like SOAP (Simple Object Access Protocol) [12]. These extensions give some characteristics of integrity and reliability to the message.

Another characteristic of this standard is the one in relation to extensions. These consist on the expansions of the security devices capacity. This is important for the application, tokens security swap and the definition of the trust relations.

Security tokens interchange allows the emission and the spread of documents in different trust controls. This could be valid from the definition of PKI (Public Key Infrastructure) [13] and CA (Certificate Authority) that allows the digital certifications through digital signs in contents. In Figure 2 shows the group of security specification.

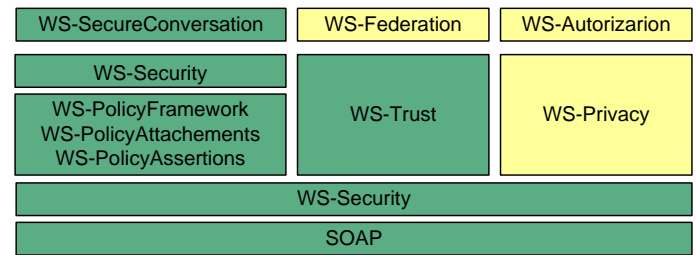


Fig. 2 Group of security specifications WS [2].

The trust level defined by this standard presents one important characteristic. One authority is willing to trust in another one so as to carry out a group of actions and set some statements. This standard defines three kind of trust:

- **Direct Trust:** it is when one piece of trust accepts all or one piece of request as true. This is in the token sent by the addresser.
- **Direct Negotiated Trust:** it is when one part trusts in a second part that at the same time trusts in a third part.
- **Indirect Negotiated Trust:** It is a variation of the direct negotiated trust. A second part negotiates with a third part or additional parts to evaluate their trust.

This is not the only proposal about trust levels. The proposal developed by [14] defines the following kinds of trust:

- **Certified trust:** It is the user's trust in a user as notary. The code is shared in a personal and confidential way.
- **Hierarchical trust:** It is the confidence in certified authorities.

This Project shows one way to guaranty the user's authenticity without the need of certified authorities. Trust levels appears with PGP (Pretty Good Privacy) [1] device. This is used for the communication via e-mail. This device defines 4 trust levels presented in the figure number 3.

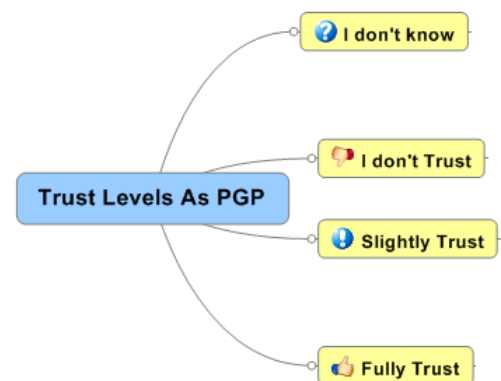


Fig. 3 Group of security specifications WS

One limitation factor of this model is that it is based on a direct trust and, in this way; there is no connection whit the needs of LCMS platforms. One answer to this problem is through the definition of nine trust levels. Table I.

TABLE I
TRUST LEVELS DEFINE BY [10]

Trust Level	Worth	Trust Level	Worth
Absolute distrust	1	Slightly trust	6
High Slightly trust	2	Moderate trust	7
Slightly distrust	3	High trust	8
Slightly distrust	4	Absolute trust	9
Neutral	5		

FOAF Project

Based on the vocabulary given by (Friend of a Friend) defined in [15] we have one description of the vocabulary used on the Semantic Web through RDF languages (Resource Description Framework) and OWL (Ontology Web Language) and the case of the ontology's WOT (Web of Trust) [16]. Next there is a set of characteristics that give an adequate vocabulary to use a set of computer tools with cryptographic public code. This has the purpose of defining some rules to get the user's trust level on a virtual platform according to the given signs by the certificated trust or the certificated trust if there are a lot of developed activities.

D. Processes Definition about Rules Level

After the identification of security models devices based on trust levels applied to the current platforms we see that they do not cope with the virtual platform necessities because they do not have a vocabulary to express the different kind of users, relations, resources (Learning Objects), etc., What is more, they are not able express anything about the environments where the other elements are.

It is not possible to measure the trust level by the number of signs, the certifier trust level and the kind of signs on a virtual platform. It is because each user has a specific role that changes according to the environment where he is. For example: one user is a teacher on a virtual site and a student in another. If there is a user in the same conditions and his trust relation with the first user is student-teacher on a site this relation could not be generalized to the entire platform because other site could be for student-student. Here there is a clear necessity for the creation of ontology's model based on trust levels with a vocabulary that allows:

- The implementation of a security device based on trust levels.
- The permission to do activities according to the trust level.
- The quality measure of the learning objects on the platform.
- Making decisions based on the users' actions and their development on the LCMS platform. The system makes autonomous decisions.
- The measure personalization of trust levels that are in agreement with the one who implements LCMS organizational rules.

Next a proposal is presented to establish trust levels on virtual platforms presenting the term *Trust Indicator* to measure the user's trust level in a certain environment.

a. Confidence users' indicators

So as to define these characteristics some variables were cleared taking into account, trust levels, profiles, user's abilities and moods on a virtual platform.

In figure number 4 there are some trust indicators for a user depending on his role, student or teacher on a virtual platform.

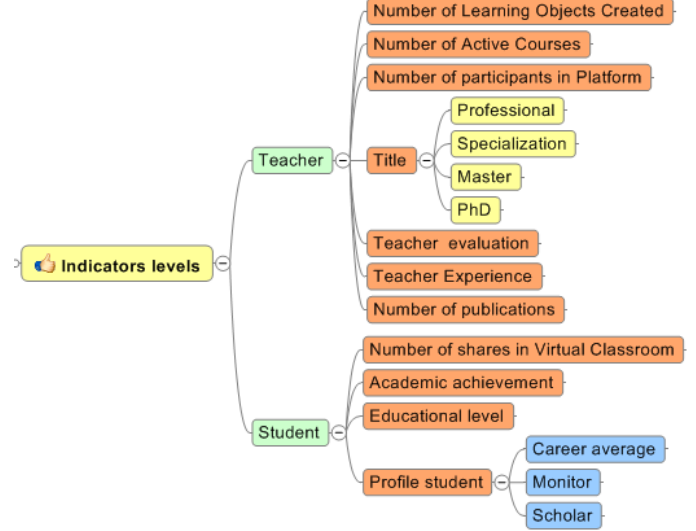


Fig. 4 Indicators Levels of a User

In figure number 5, a user is able to have different profiles on a virtual platform. Also, it is possible to measure some abilities to create a course out the curriculum of a career or a project. For example:

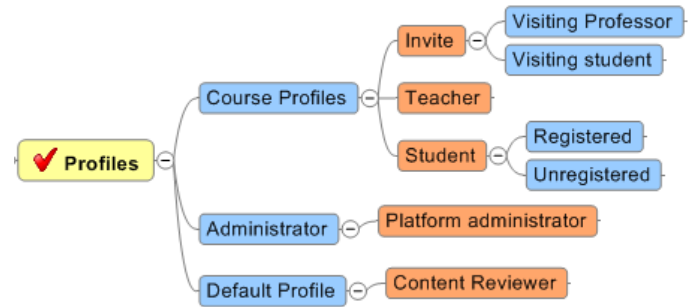


Fig. 5 Profiles Levels of a User

In Figure 6 shows the profiles of abilities of a user within a virtual platform:

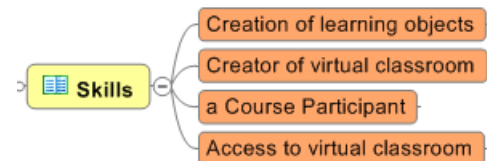


Fig.6 Skills profiles of a user

A user with a general teacher role and the necessary trust

level to create courses wants to create an elective course to present a new topic or create a new subject.

At the same time some kind of guests were defined because they can come from another institution platform and there are some trust indicators defined. These may help to measure the user's trust level depending on his profile on the virtual platform.

Once the user's variables were identified, it is necessary to identify the variables to define trust indicators to courses.

In figure 7 shows the indicators of the characteristics and status of a user within a virtual platform

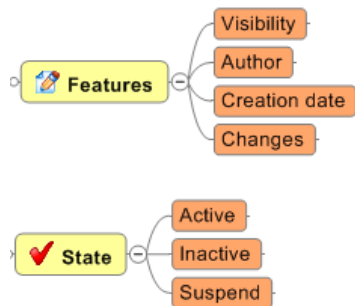


Fig.7 Skills profiles of a user

b. Trust Indicators for Courses

The variables are defined so as to measure the trust level for a course from the point of view of the use so as to give to a user ability or condition on a platform depending on his profile.

Finally, some trust indicators are defined for the contents presented through learning objectives.

c. Trust Indicators to Learning Objectives

For the variables it is important to define associated characteristics for the creation of these contents form a group of specifications or standards to define rules. In Figure 8 arise trust indicators defined for the creation of an online course:

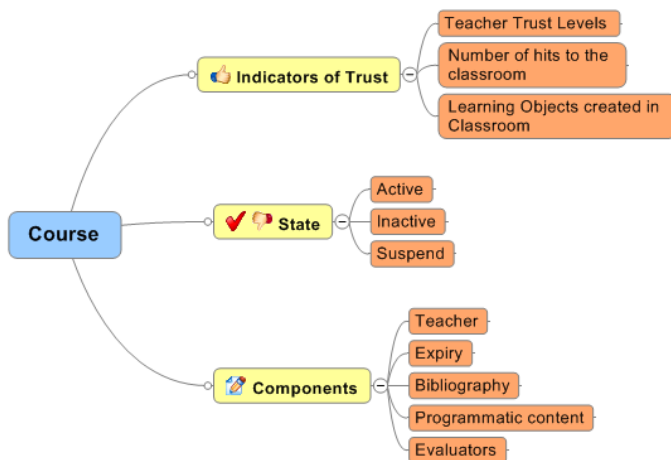


Fig. 8 Courses elements and components on a virtual classroom

trust indicators and learning objects. These indicators work as tools to measure trust levels and their settlement. In Figure 9 shows the trust indicators defined for the creation of learning objects.

Any kind of indicators might have the following characteristics:

- They have to be registered in a theoretical framework
- Specific
- Explicit
- Relevant and appropriate

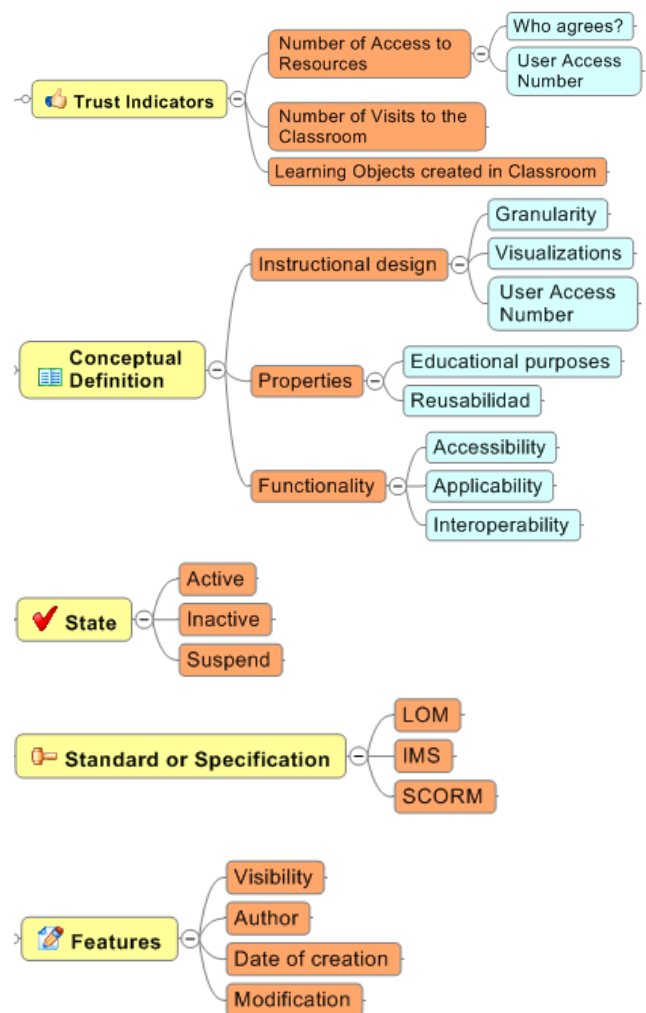


Fig. 9 Trust indicators for Learning Objects

- The indicators are not only for one specific action
- They are clear and easy to comprehend

Taking into account all the previous aspects, trust levels are not only devices for a secure communication with platform tools such as: forums, internal e-mail, blogs, etc. Also, they

Under the previous schemes we can mention the well known

work as support for the learning objects quality management, courses, frums, etc.

Trust indicators give us a measurement to give a trust level to a user in a specific context. After the announcement we give a value to the indicator to evaluate the impact on the trust level. This is according to the organizational rules implemented by a LCMS.

IV. DEVELOPMENT OF LCMS PLATFORM ONTOLOGY'S MODEL BASED ON TRUST LEVELS.

Because of the difficulty of the trust levels and indicators introduced on a platform it is necessary the creation of an ontology's model based on trust levels in order to have a vocabulary of terms and the semantic expressiveness to make easier:

- The implementation of a security device based on trust levels.
- The automation to give permissions so as to do activities according to the trust level.
- The learning objects quality measurement on a learning platform
- To make autonomous decisions by the system
- To personalize the trust levels measurement so that they can be in agreement with the organizational rules implemented by a LCMS

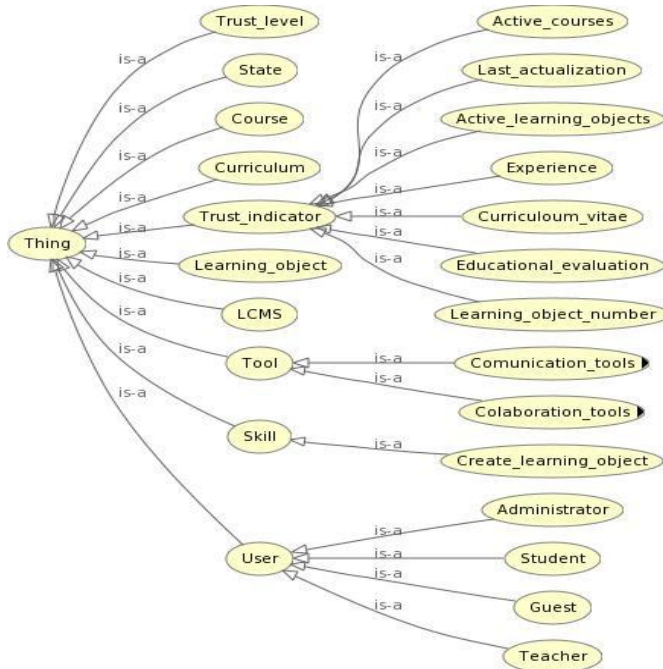


Fig. 10 Class Hierarchy Ontological Model

Taking into account the previous rules it is necessary to settle an ontology's model for the representation of trust levels that are planned to work in a virtual platform using OWL-DL language [17] created by W3C Web Ontology (WebOnt) Working Group.

In order to develop its methodologist part it was based on

Metontology proposed by the Ontology group of Universidad Politécnica de Madrid. This allows the creation of ontology's about knowledge. This was proposed by Foundation for Intelligent Physical Agents (FIPA). It promotes the inner-operability through some applications based on agents and clear work proposed by [18].

In figure number 10 it is presented one approximation to the model that it is good to develop. This is showed by a Frames model (classifying it according to its internal richness).

In Figure 11 can display the properties of ontology model classes created.

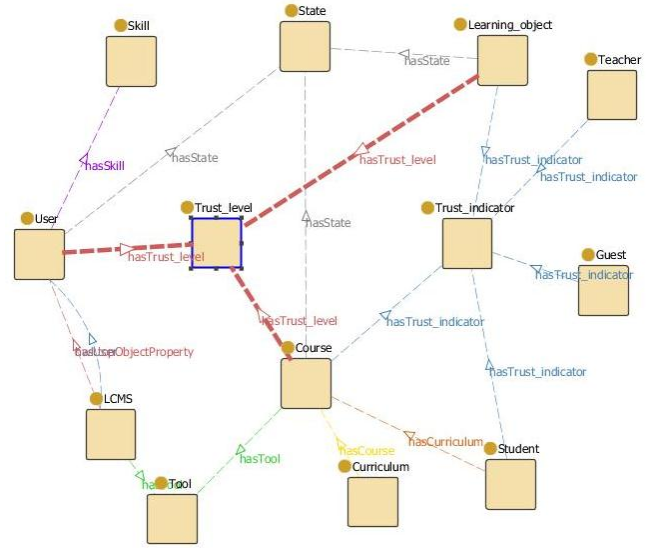


Fig. 11 Properties of Class Model

Finally we represent in Figure 12 at the properties of the relations of ontological model created

V.CONCLUSION

So as to define a trust level on virtual platforms, it was taken into account processes through Workflow. This is an alternative to identify activities and to define actions developed by a user on a virtual platform. So, workflow on the platform was identified through a Workflow Management System (WMS). This system is able to interpret the definition of the process, interact with the workflow participants, and if it is necessary, to call the use of technology information tools and computer applications to define the business nature to work on virtual platforms.

The identification through workflow processes allows the identification of the actions carried out by the users. These were permissions, actions and routes to follow for the representation of the trust levels on the virtual platform. This is one of the alternatives for the creation of rules that are that are with trust levels and to define the processes in relation to the users' activities and behavior on a virtual platform according to the definition of each one of the profiles.

The previous proposal points at the definition of a "Semantic Web Security Learning Content Management

System” SWS LCMS in which it is possible to manage the knowledge from the definition of trust levels through some variables such as: trust levels through content specification, users’ profiles and courses characteristics. These create the development of a virtual learning platform based on intelligent agents to give value to this kind of contents based on a set of rules defined on ontology’s model with learning objects based on a group of specifications.

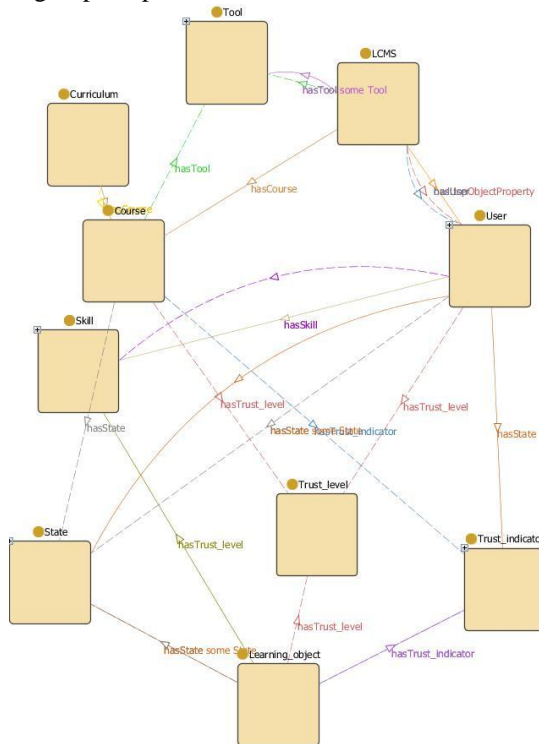


Fig. 12 Model and Property Relations

The rules for the semantic vocabulary were defined under FOAF and a combination of Trust Levels on Social Networks, but at the same time it is necessary to identify the activities that were carried out on a virtual platform what makes difficult to create connections because of the difficult activities that a user is able to do on a virtual platform.

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A New Technique in saving Fingerprint with low volume by using Chaos Game and Fractal Theory

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Abstract — Fingerprint is one of the simplest and most reliable biometric features of human for identification. In this study by using fractal theory and by the assistance of Chaos Game a new fractal is made from fingerprint. While making the new fractal by using Chaos Game mechanism some parameters, which can be used in identification process, can be deciphered. For this purpose, a fractal is made for each fingerprint, we save 10 parameters for every fingerprint, which have necessary information for identity, as said before. So we save 10 decimal parameters with 0.02 accuracy instead of saving the picture of a fingerprint or some parts of it. Now we improve the great volume of fingerprint pictures by using this model which employs fractal for knowing the personality.

Keywords — Fractal Theory, Chaos Game, Fingerprint Storage, Fingerprint Compression.

I. INTRODUCTION

These days, identification is known as an issue which is so interrelated with human biometric features that signature, face, voice, iris, fingerprint, etc. in human are used for this purpose [1]. Undoubtedly, one of the simplest and most reliable identification methods based on human biometric features is fingerprint which has been in use for more than a hundred years in human identification and the reason can be its stability and unity. Identification based on fingerprint is considered as one of popular methods in identification of individuals and simplicity of the mechanism is the cause of this popularity. Sir Francis Galton and Sir Edward Henry were the first people who worked on identification based on fingerprint [2, 3]. Galton focused his studies on fingerprint features and the results of his study led to definition and identification of some features in fingerprint and he called them Minutiae. Some of these features are shown in figure 1. Unlike him, Henry studied the general structure of fingerprint and the

results of his studies led to classification of fingerprints into five categories; figure 2 shows this classification for fingerprints. Studies of these two were so much deep and clear that even after a hundred years they are used in researches. Issue of mechanical and automatic identification of fingerprint after extensive studies was authorized by FBI in 1969 and after that this task was given to National Institute of Standards and Technology (NIST). Some other works have been carried out on this subject, for instance we can point to what Maltoni has done for this purpose. He and his colleagues, relying on techniques based on Minutiae which Galton had introduced, worked on basic features of fingerprint and did the identification by the aid of these features [4]. In another work which was presented by Polikarpova, he analyzed fingerprint with fractal outlook. In this report fractal method is used for identification [5]. Also in an article which Karaki presented with the assistance of his colleagues in 2007, like Maltoni by analyzing Minutiae and improvement of popular methods he worked on identification based on fingerprint [6, 7 and 8].

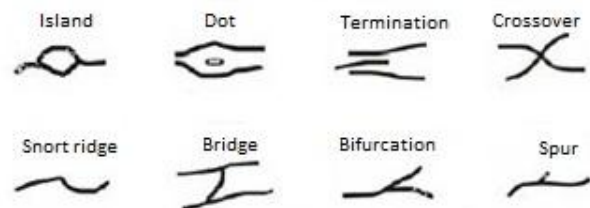


Fig. 1 the most common *minutiae* types.

II. FINGERPRINT

Ins and outs on tip of fingers are called fingerprints. Based on studies of Galton, there are some features in fingerprint which are different in various samples of fingerprints. These features are called Minutiae and averagely there are about 50 to 80 features in each fingerprint [9]. Core, delta, extension, ridge, cross, and island are some of these features.

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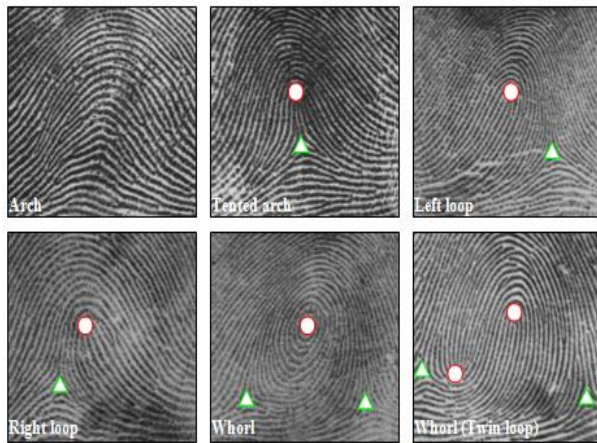


Fig. 2 Henry fingerprint classification, include: (a) Right loop, (b) Left loop, (c) Whorl, (d) Arch, (e) Tented Arch [4]

A. Fingerprint Identification Methods

Fingerprint identification methods are often divided into two main groups [10, 11 and 12]:

- 1) *Minutiae Based Algorithm (MBA)*
- 2) *Pattern Based Algorithm (PBA)*

In the first type a fingerprint becomes ready for processing in a pre-processing stage and then by obtaining features of fingerprint it is compared to features in base with fingerprints. So it needs to save the minutiae's for using in mechanism. As determined, each fingerprint has 50-80 features. If 12 items of them adjust, it'll show fingerprint adjustment or that special case. Although more than 12 items protect for saving in base.

However, in pattern based method pattern of fingerprint sample is compared to other samples, level of conformity is calculated and on the basis of that a decision is made. In this method, protect the fingerprint or compressing form of it, is needed. In comparison to previous method, here we require more memory.

III. FRACTAL THEORY

The term *fractal* was introduced by Mandelbrot for the first time in 1975 [13, 14] and refers to geometry of objects which have the following features:

1. Self-similarity
2. Iterative Formation
3. Fractional Dimension

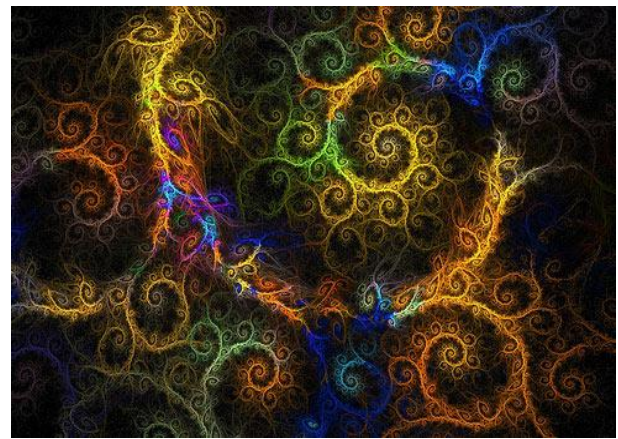


Fig. 3 I Sleep only (www.smashingmagazine.com)

It means that components of a fractal object are similar to whole of that object and are produced with a repetitive procedure and more importantly, if we calculate dimension of these objects, unlike objects like a line which has just one dimension or plate for which dimension is two, dimension of fractal objects is a decimal number[15]. In figure 3 a sample fractal is shown, also figure 4 shows another fractal which is known as Sierpinski Triangle and it has a dimension of 1.58 [16, 17]

A. Chaos Game Theory

Chaos Game theory was presented by Barnsley in 1988 [18, 19]. This theory on the strength of Shannon Theorem is presented in a way that by using Random Walk mechanism and by the aid of a polygon a fractal can be produced. This theory has two important points: first, by performing Chaos Game mechanism on a fractal a new fractal can be produced. Second and more important, while performing Chaos Game mechanism for producing the new fractal, besides properties of fractal some parameters can be deciphered which would be useful in identification process.

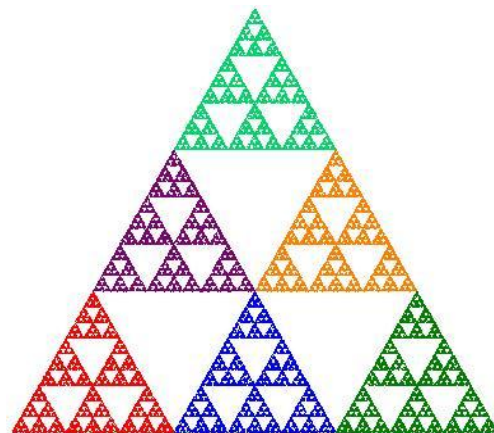


Fig. 4 Triangle, that its dimension is 1.58

B. Chaos Game Mechanism

If we perform Chaos Game mechanism on a triangle, the procedure will be as the following: first, an accidental point is chosen. This point is the start point and it is not important in what situation it is. Then, in the second step an accidental number in the scope of $[1..3]$ is chosen. If 1 is chosen it means summit A, if 2 is chosen it means summit B, and eventually if 3 is chosen it means summit C in triangle. Then, from the present point we step forward half way toward chosen summit and draw a new point. Again, we make an accidental choice and repeat the same process for several times (for example 50000 times). This way a shape which is the very Sierpinski Triangle is drawn. In figure 5 four steps of Chaos Game mechanism are shown.

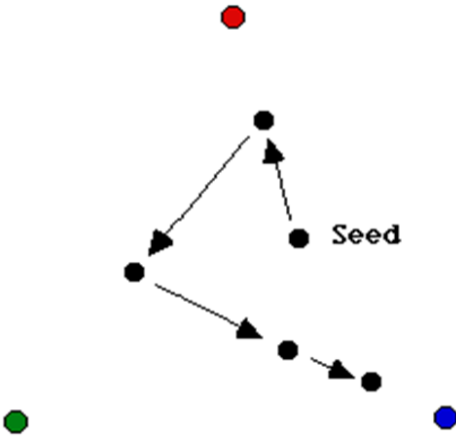


Fig. 5 Chaos Game mechanism on triangle that generate Sierpinski triangle

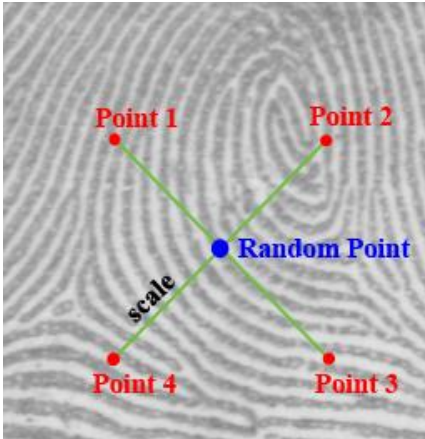


Fig. 6 Position of four assistant point's base on Random Point

IV. MAKING NEW FRACTAL BASED ON FINGERPRINT

Fingerprint is a fractal and from fractal outlook it has fractal dimension parameter which is not sufficient for identification. As mentioned in 3-2, by the aid of Chaos Game a new fractal

can be made and while making the new fractal more parameters can be obtained. As a result, based on a fingerprint and a pattern which will be pointed at afterwards the new fractal is made. Mechanism is in the way that a pixel of fingerprint is selected by chance. A point has 2 states: first, the pixel can be an in or zero or it might be an out or 1. Both of these states cannot be sufficient for identification, so an accidental point is chosen and based on a new parameter which is called Scale we find four points around the aforementioned accidental point. If accidental point is $A[i,j]$, four points will be:

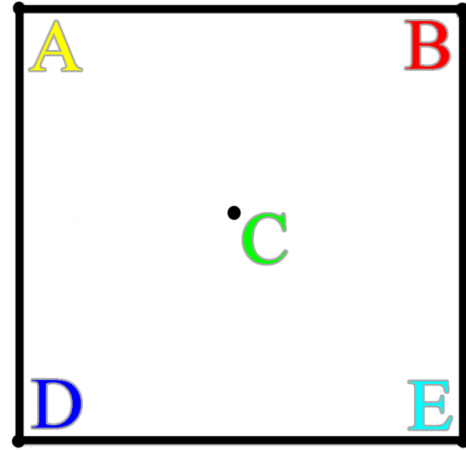


Fig. 7 five points that are mapped on five Categories in table1

$$\text{Point1} = A [i - \text{Scale}, j - \text{Scale}]$$

$$\text{Point2} = A [i + \text{Scale}, j - \text{Scale}]$$

$$\text{Point3} = A [i + \text{Scale}, j + \text{Scale}]$$

$$\text{Point4} = A [i - \text{Scale}, j + \text{Scale}]$$

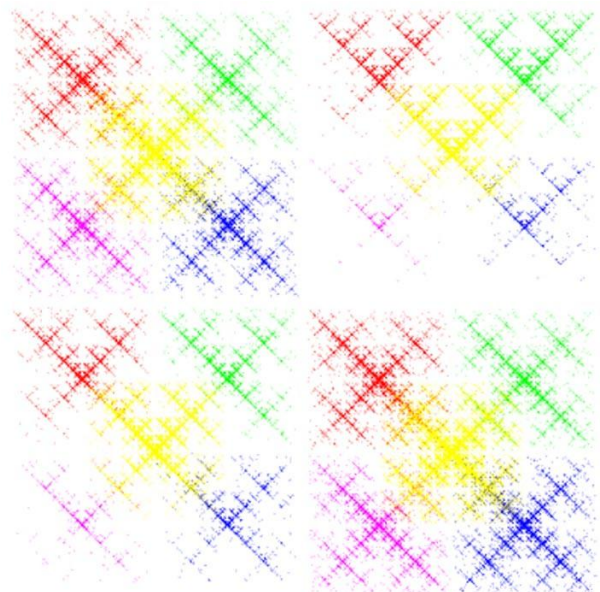


Fig. 8 four fractals that generated from four fingerprints

These four points are shown in figure 6. Having these four points, 16 states are made which we divide into five distinct groups. First group is the state where pixels of all these four points are white, second group is the state where just one pixel from the mentioned points is black and all others are white. Third group is the state where the number of points with black pixels is two, fourth group is the state where the number of points with black pixels is three, and finally fifth group is a group where all four points have black pixels. Considering binary structure, these four points and creation of sixteen possible states, all of them and their assortment based on the mentioned classification are shown in table 1. 16 created states in table 1 make five groups and for making a new fractal in Chaos Game process we use a square which is shown with five tips in figure 7. These five tips are named with alphabets to make the new fractal image which is gotten from the fingerprint. Result of fractal which is made by the above procedure for several samples of fingerprints is shown in figure 8.

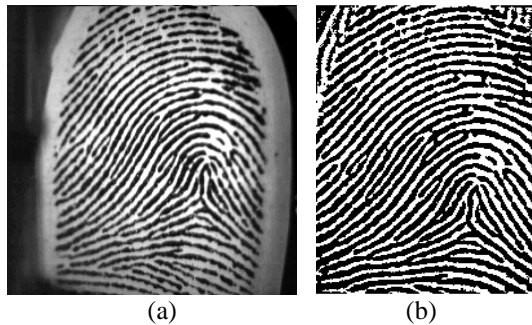


Fig. 9 a) before pre-processing, b) after pre-processing

Table 1 Categories modes may be relevant parts of the pixels

Points 1 - 4	Category	Points 1-4	Category
0 0 0 0	1	1 0 0 0	2
0 0 0 1	2	1 0 0 1	3
0 0 1 0	2	1 0 1 0	3
0 0 1 1	3	1 0 1 1	4
0 1 0 0	2	1 1 0 0	3
0 1 0 1	3	1 1 0 1	4
0 1 1 0	3	1 1 1 0	4
0 1 1 1	4	1 1 1 1	5

V.PARAMETER EXTRACTION

As mentioned before, while making new fractal Chaos Game mechanism deciphers new parameters which can be useful in identification. In part four it was cited that regarding four defined points for pixels of those points, five states can be created which are classified into category1 to category5. Then, we repeat Chaos Game mechanism 100000 times and in each

repetition by identifying four pixels of the points one of possible states is chosen and one unit is added to the counter of that category. This way, at the end of Chaos Game mechanism total of all five categories is equal to the number of repetitions, i.e. 100000. By dividing each of categories by 100000 they are standardized and we state them in the zero to one span. Therefore, for each fixed quantity for Scale parameter, which is the distance of points to the accidental point, five parameters are calculated. As five parameters with accuracy of (0.02) are not enough for identification, the above mentioned procedure is calculated for quantities of 10 and 15 for Scale.

As a result, we will have 10 parameters and considering the accuracy of 0.02 in the span of zero to one we will have 50 varieties. By having 10 parameters we will reach $50^{10} = 9.76 \times 10^{16}$ varieties for fingerprints which guarantees unity of fingerprints. On the other hand, if we calculate Scale with different quantities for a fingerprint, we will have five independent spectrums and with the accuracy of 0.02 these spectrums are able to identify fingerprint based on the given mechanism. Figure 9 illustrates spectrums of parameters which are obtained from a sample fingerprint.

VI. IMPLEMENTATION

The presented technique in this report has been carried out by MATLAB and has been experimented on 600 samples of fingerprint [20] from each of which there are four samples. A sample of used images is shown in figure 10.

$$y = 17.64x + 266 \quad (2)$$

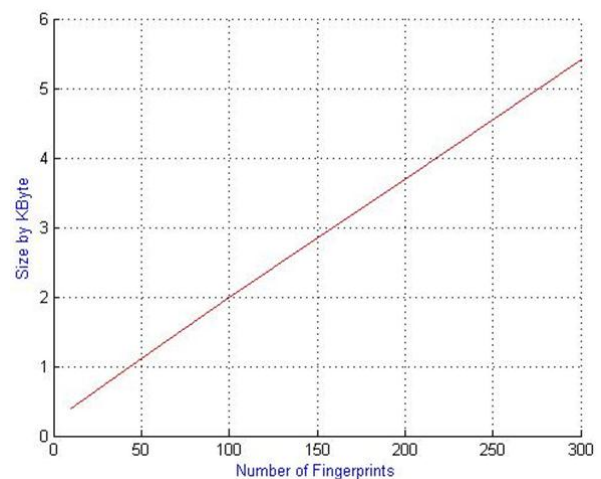


Fig. 10 linear growth rate of usage for storing Fingerprints

Results which are obtained show 100% success for this technique. In another experiment 50 samples of fingerprints 20% of image of which were accidentally deleted were analyzed with the remaining parts and again 100% success was obtained and this shows stability of the presented method

encountering deletion of some parts of image. Table 2 illustrates data related to time of searching in a base which includes 600 samples and also information related to time of deciphering and saving features of fingerprint in a database for some fingerprint samples. It must be noted that the experimenting system had a CPU Intel Celeron 2.60, 512 MB RAM and Windows XP as its operating system.

Table 2 Amount of space for storing consumer features Fingerprint

Number of Fingerprints	Size on disk (KB)
10	0.40
50	1.12
100	1.98
150	2.84
200	3.70
300	5.41

VII. CONCLUSION

Identification process by fingerprint based on popular methods such as Minutiae Based Algorithm and Pattern Based Algorithm, require fingerprint image information saving or features is derivation saving in minutiae style. The determined style in this article, fingerprint recognition will be done by using a new technique followed with fractal analyzing, only 10 parameters of fingerprint required to save, it causes less saving space compared with other methods. Also, in this article, it has been showed that by 10 parameters saving, we could find that specified fingerprint correctly in next search. The singularity of fingerprint has been determined. The result of used space for saving the fingerprint (KB) compared to the number of fingerprint has been showed in table 2 saving space increases by increasing in the number of fingerprint.

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Biometry, the safe key

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Abstract: — *Biometry is the next step in authentication, why do not we take this step forward in our communication security systems? Keys are the main disadvantage in the cryptography, what if we were our own key?*

Keywords: — *biometry, cryptography, iris, IrisCode, key, safety, security.*

I. INTRODUCTION

Cryptography has been used since the beginning of the classic times. Since the age of the great conquerors there has been a need for the capacity to communicate between commanding staff and ground troops avoiding the enemy compromising those orders.

In present times safe data transfers have become a primary issue way above the military field, reaching companies and families on a daily basis. New technologies have delivered us a wider number of communication channels, along with these technologies the need for new ways to protect data flow from hacking have emerged.

That's the reason because cryptography has evolved from the Greek scitalla used by Spartans during their campaigns to communicate, throughout the Caesar's code transposition attributed to the Roman emperor and up to the famous Enigma machine, used by the German army during World War II.

Cryptographic systems that have been developed through history are based on mathematical algorithms, over time they have become increasingly complex and, therefore, safer. Evolving from plain alphabetical transpositions, to the current systems of vast complexity, where the use of a key linked to the text made it possible for a safe data transfer, even if the algorithm is compromised.

Mathematics and cryptographic sciences have made it possible for ciphering systems to be almost unbreakable. Curiously, as cryptology grew in complexity, so did cryptoanalysis, the science responsible for breaking encrypting systems. The continuous struggle among these contenders has taken these sciences to such a level of complexity that they've become matters of study all by themselves.

As an example of how mathematics has advanced the ciphering systems, we can look into RSA cipher algorithm key generation process:

1. Choose two distinct prime numbers with 200 digits, p and q .
2. Computed $n = p \cdot q$.
3. Compute $\varphi(n) = (p - 1)(q - 1)$, φ is Euler's totient function.

4. Choose an integer e such $1 < e < \varphi(pq)$ and $\varphi(pq)$ are coprime.
5. Determine d (using modular arithmetic) which satisfies the congruence relation.
 $de \equiv 1 \pmod{\varphi(n)}$.
Finally the public key will be (n, e) and the private key will be (n, d) .

II. STATE OF THE ART

At present there are two mainstream approaches regarding coding systems, symmetric encryption and asymmetric encryption. Both systems have sending information through safe or unsafe channels, while still being illegible by any third party, as its main purpose.

Symmetric encryption has evolved from encryption systems that only used an algorithm to cipher data. A key was added to the use of the algorithms in order to cipher and decipher. This has become standard procedure; therefore the Scientific Community is grateful for their continuous effort and improvement of this technology. Nowadays the security of encryption systems relies on the key length as well as on the algorithm in use. This is where these systems have a certain handicap, increasing the key length has an increase in security, but it implies a burden on the user, because long keys are hard to remember and use on a daily basis.

Asymmetric encryption was born as an evolution of symmetric encryption systems. In these systems, the users have a pair of keys, one of them as public key and the other as private. Each key only could decipher a text that has been cipher with the other. These encryption cipher system allowed the digital sign system's born. The disadvantage of these encryption systems is the time used in the cipher and deciphers process, because the use of complementary key forces the algorithm to do too many operations. As result the algorithms use a sort keys to reduce this time, allowing so a cryptanalysis attack.

Despite such progress in the encryption field, we are still far from the point where the algorithmic encryption is invulnerable. Just as important as the key length is the care jealousy with which the key is managed and stored; this implies that the use of very long keys is not as safe as it could be expected, as the average user tends to write down long keys in order to avoid remembering them, a terrible security flaw regarding the fact of the existence of social engineering.

Logic says us to use bigger key, because short keys are subject to brute force attacks (the strength of these attacks depends on

the capacity of the computers from which they are launched). The bigger computer's capacity gets longer keys to be used, in order to be safe from these attacks.

As said before, storage is one of the main issues when dealing with security; in fact, current studies talk about a three leveled based security.

When we talk about security, in the cryptography field, we are trying to find how to achieve the three levels of security. Those three levels are:

- Something that you know (password),
- Something that you have (like an ID card or a security token),
- Something that you are (biometry).

There are already a lot of well developed products regarding step b, however current development is focused on step c.

The main objective is to fully identify the user beyond reasonable doubt. New technologies offer the possibility to do this through biometric recognition. These systems are based on the mathematical study of some unique biological features.

The characteristics that all biometric features must meet are:

- **Universality:** any and all human beings must have it. Everyone, by the fact to be people, must have it.
- **Uniqueness:** it must be unique for every individual.
- **Continuance:** the biometric characteristic from the individual must stay unchanged over time or, at least, for a limited timestamp.
- **Perennial:** unaltered by external factors (like weather alters the outer appearance of hair).
- **Measurable:** it must be possible to quantify it.

In the biometric field, there are two main groups in biometry studies, depending on the feature under analysis: static biometric systems and dynamic biometric systems. The first are focused on physical features as fingerprints, iris, retina, hand geometry or face geometry. The second are focused on the behavioral features, like written signature, voice, gesture and body language.

From safety point of view biometry is a part of the security third level. With biometry we can take a step forward, because before the beginning of biometry we only could identify people: Does this password, ID card or token belong to this person? Now with biometry we can raise the following question: Is this person really who says to be? This supposes a great increase in the safety.

The following table shows in comparative manner different biometric systems, their features, their acceptances and possible interferences in order to have a wider, more accurate, view on them.

	Voice	Writing	Fingerprint	Retina	Iris
Reliability	High	High	High	Very high	Very high
Usability	High	High	High	Low	High
Attack	Medium	Medium	High	Very	Very

prevention				high	High
Acceptance	High	Very high	Medium	Medium	High
Stability	Medium	Medium	High	High	High
Identification	No	Yes	Yes	Yes	Yes
Authentication	Yes	Yes	Yes	Yes	Yes
Interference	Noise, cold	Easy signature	Injuries, dirt	Special cases	Special cases

Table 1 Comparative of biometry systems

In order to fully understand the advantages that iris recognition system has to offer, we proceed to explain the previous table, and its stated characteristics, in detail.

Reliability: Human iris acquires its signature pattern during prenatal development, being unaltered throughout its whole life, becoming an unerring identity print. Even more, iris's digitalization is a concise and accurate process, implying therefore optimum rates of false positives and false negatives.

User friendly: Due to the minimum requirements of the system, a superficial eye image, they are neither intrusive nor hurtful for the user.

Attack prevention: As with retina recognition systems, in the iris recognition systems the hardware is directly controlled, so this biometric pattern becomes difficult and complex to misappropriate, due to the fact that obtaining a mock iris to place before the system requires substituting the original one from the forger, what's more, this forgery must be an exact copy of the original from the supplanted owner. These techniques are, although possible, not cost effective by any chance, because they require an extensive medical and technical knowledge.

Acceptance: Thanks to the systems simplicity and non-intrusiveness, clients forced to use it are fully satisfied. This is one of the main reasons of the comparative advantage of the iris recognition systems in the biometric verification market.

Stability: From its very start, the iris recognition systems algorithms have had a great acceptance in the market, ensuring its standard use. Besides, the existence of numerous successful iris recognition systems guarantees a bright future for these techniques and technologies.

Identification: Iris is a univocal biometric pattern that doesn't require any specific action taken by the user, whose pattern is spotted and captured with great precision, therefore granting a positive identification of the system's user.

Authentication: Those systems capable of identifying a user, which also have information regarding the user's biometric patterns, will be able to authenticate.

Interferences: Being this a method that requires superficial pictures to be taken, there are several factors that could cause "noise" within the data needed to make a positive identification. Due to the great progress made concerning the filtering of such mentioned noise, these systems embody the biometric recognition option which would be the least affected by these external factors.

It's because of this that the use of iris biometric recognition systems offer a great benefit-usability rating. To fully

understand the advantages of the iris recognition system, it is imperative to study deeper into the process. This process is integrated by the following stages:

1. **Segmentation:** the relevant information on the captured image is located (that which belongs to the iris), it is targeted and cropped, disregarding the excess of unrelated data. This stage is extremely important, for if the information isn't correctly located, the next stages won't be using the appropriate data.



Fig. 2 Segmentation process

2. **Normalization:** this stage is where, basically, an image transformation takes place. Regardless of the size or bearing of the input image, we'll obtain a rectangular image of fixed dimensions, according to the polar coordinates of the iris's original ring shape.

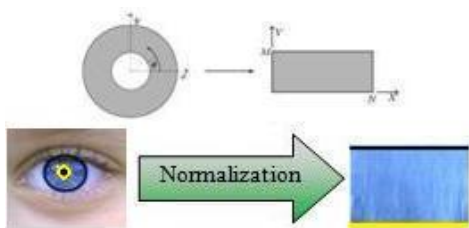


Fig. 3 Normalization process

3. **Codification:** each pattern is processed in order to retrieve its data, the iris pattern is coded in a binary file (2048 bits) each iris pattern is treated to extract its information. The detailed patterns are codified/crypt in a 256 bytes (2048 bits) binary array, which represents all the texture's detail. It's what is known as IrisCode.



Fig. 4 Codification process

One of the systems special features is that two IrisCode from the same user will hardly be identical. This happens due to the different external conditions that take place when the pictures are taken, not only that, also the eye angle may vary; all of this translates in a shift of position of the bits of the IrisCode. However, the unique patterns that identify the user are still located and checked univocally.

III. OUR RESEARCH

The traditional key system, where the key storage is the user's responsibility, allows for these keys to be used for different objectives with only its length as a restriction, as

most systems only take keys that have a certain length.

Biometric systems just as they are at the moment only allow authentication. The reason behind biometric systems no being used on modern cipher algorithms is its bits coding from the biometric pattern, like the one from recognizing the iris, which is never exactly the same, even there are similar IrisCodes, it's through the calculus of the distance between patterns how you can determine the property of the binary array to the user or not.

If we take the basic sketch of a symmetric encryption system its the one that appears in the figure and is based on applying a same key on a text, there may or not be different procedures to cipher and decipher, you will get the original text.

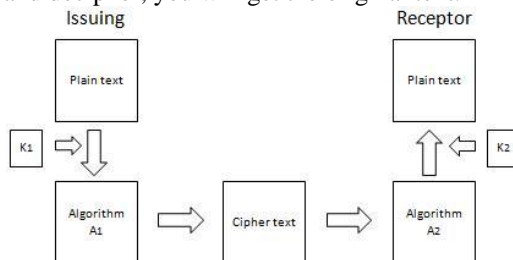


Fig. 5 Basic sketch of the encryption

$$T_{Issuing} = T_{Receptor} \Leftrightarrow (K_1 = K_2 \wedge A_1 = A_2)$$

As explained, both, the algorithm and the key, have to be exactly the same, in order to use a biometric system for the encryption of the content we find ourselves against a rather simple problem.

$$(K_1 \cong K_2 \wedge A_1 = A_2) \Rightarrow T_{Issuing} \neq T_{Receptor}$$

As explained, both, the algorithm and the key, have to be exactly the same, in order to use a biometric system for the encryption of the content we find ourselves against a rather simple problem.

So the keys are practically identical but not exactly the same, therefore the recovered will never be the same one that was originally sent. Not a functional system.

The answer obviously must find a way for the procedure to receive biometric keys and still return a single key, as long as the biometric keys belong to the same subject; which means we're looking for a transformation.

$$f(K_n) = K_0 \forall K_n \in S$$

This way the system would be configured as depicted on the image.

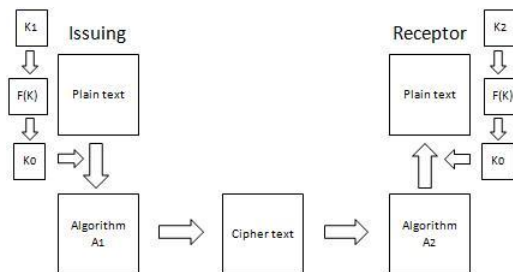


Fig. 6 Expanded sketch of the encryption

It is thanks to this system that the problem is solved, as the encoding algorithm always gets the same key, as long as the function $f(K)$ receives the data from the same subject.

$$T_{Issuing} = T_{Receptor} \Leftrightarrow$$

$$\Leftrightarrow (f(K_1) = f(K_2) \wedge A_1 = A_2)$$

There's no need for an extensive knowledge on the authentication process through biometric values to figure out that the equalizer function's $f(k)$ process will be different depending on the pattern used, due to the inherent differences and the uncorrelated data it's impossible to implement a $f(k)$ that will allow us to extract an identical key from a person starting with fingerprints from different fingers, the comparison between the eye's iris or even the iris and the fingerprint; this is simply impossible, for starters the biometric element must be the same, and the treatment in order to obtain the single key anytime the biometric pattern is used will be extremely related with the special features of each parameter.

It's also trivial the fact that the k_0 key acquired by these functions $f(k)$ will always contain less information than the originally obtained key, for it's a certain kind of hash algorithm that process the entry to produce a common exit for a certain range of entries. The data that differ each of the keys k_n will get lost on having produced the key k_0 .

Biometric patterns offer the advantage of having such an amount of information data that it allows us to reduce it in order to create a unique key per user, and still have a key length that makes attacks unfeasible through brute force.

In our case, we're going to concentrate on iris recognition systems due to their several advantages.

Keys generated from iris recognition are made from the patterns present on the user's iris, and the differences between IrisCodes captured from the same user consist on small pattern displacements. This is due to the inclination changes, lens proximity, environmental luminosity, etc.

So, even though the stripe patterns are basically the same, their position may vary and due to environmental elements its size can suffer small variations, but still we can identify, with enough precision, the number of patterns present and their dimension.

The suggested approach to create the mentioned transformation $f(K_n) = K_0 \forall K_n \in S$ is to make the most the stripe patterns present on the IrisCodes. In other words, as we can consider the number of patterns (N_p) as a constant from the same individual but a variable for different individuals, it's easy to set out a first equation f_1 capable of getting back of IrisCode key patterns as such:

$$\begin{aligned} f_1(K_n) &= N_0 \forall K_n \in S_1 \\ &\wedge \\ \exists S_2 \mid f_1(K_n) &\neq N_0 \forall K_n \in S_2 \end{aligned}$$

Likewise the dimensions of every pattern will be a very stable element, though not exactly the same one, always they will be in the same range for the same person, so if we do not measure

the exact dimensions of a pattern, but his belonging or not to a certain range of size, we will obtain a new perfectly stable measure inside the same person. It is perfectly considerable $f_2(K_n, X)$ that such a pattern X in the IrisCode K_n is capable of returning always the same value.

Once explained these concepts it is necessary to do a consideration in the matter: the smaller the spectrum of ranges in use is, more possible it is that they give similar values for different individuals, whereas the bigger that the spectrum is, the least the loss of information will be, and therefore the capacity of distinction will increase.

In any case, the f_2 equation shape shall be as follows:

$$\begin{aligned} f_2(K_n, X) &= Q \forall K_n \in S_1 \wedge X \in \mathbb{R} \\ &\wedge \\ \exists S_2 \mid f_2(K_n, X) &\neq Q \forall K_n \in S_2 \wedge X \in \mathbb{R} \end{aligned}$$

Anyway, these obtained values will be treated according to the value of the patters of the bits to which they correspond, so that the values obtained by f will make the results more consistent, and therefore the whole process. We will call then $g(X)$ the function that will treat the values obtained of f to identify them according to the pattern to which they correspond.

Therefore realizing a linear combination of f_1 and f_2 we will obtain the already mentioned $F(K)$ one that will allow us to obtain always the same key for the same individual though we part from slightly different initial keys.

$$F(K) = [f_1(K_n) * g(X)] + \begin{cases} \sum_{x=0}^{f_1(K_n)} f_2(K_n, X) 10^{x+1} * g(X) & \text{if } f(K_n, x)/10 < 1 \\ \sum_{x=0}^{f_1(K_n)} f_2(K_n, X) 10^{x+2} * g(X) & \text{if } f(K_n, x)/10 \geq 1 \end{cases}$$

To better understand this process, we will explain it, with an image of real IrisCode, the functioning of the described algorithm.



Fig. 7 Image with the patterns marked from an IrisCode

In the present image an IrisCode can be observed, to which an algorithm has been applied to highlight those zones, that is to say patterns that we want to highlight to apply the mentioned algorithm. These patterns will have to be treated according to the spectrum of ranges raised, in order to unify these values so that the small variations of atmospheric noise do not alter the result. Let's bear in mind that the obtained value will be used as key in the communications, and it is necessary that this value is unique, both to the emitter as to the receiver.

In the previous IrisCode it is possible to observe the existence of patterns that due to their dimension are insubstantial, since they do not contribute relevant information to the key creation algorithm, since this one can lead to possible mistakes at the moment of the patterns process due to the fact that they can

belong to small sheens or alterations of the original image (the picture of the user).

As an example, simplifying the procedure, we can suppose that from an IrisCode seven patterns have been obtained and each of them is classified according to its size, on having these treated with the type associated with the pattern, a series of values will be obtained, its final operation will give, as a result, the key with the one to work with the encrypting algorithm. The spectrum of sizes has been simplified by the following values: very small, small, medium, big and very big; in the same way, to illustrate better the example instead of speaking about zeros or some as pattern values of one, we tag them as white or black, since they are the colors that they appreciate in an image of IrisCode.

Following there are two tables to show how, for the same sequence patterns and their associated characteristics, in spite of the fact there are displacement due to the obtaining of the original image, it will produce anyway the same key value.

Pattern	Size	Type	Vlue
1	Medium	White	150
2	Small	White	100
3	Medium	Black	300
4	Big	White	200
5	Very Large	Black	500
6	Very Small	Black	100
7	Medium	White	150
clave:			1500

Table 2 Normal pattern

Pattern	Size	Type	Vlue
6	Very Small	Black	100
7	Medium	Black	150
1	Medium	Black	150
2	Small	White	100
3	Medium	Black	300
4	Big	White	200
5	Very Large	Black	500
clave:			1500

Table 3 Shifted pattern

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Modeling and Comparison Study of Modules in Open Source LMS Platforms with Cmapstool

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Abstract — This work is part of a first phase of the project “DOMAIN SPECIFIC MODELING FOR THE LEARNING OBJECTS BUILD PLATFORM-INDEPENDENT” and seeks to make a comparison between Open Source LMS to get a first approximation of common modules them, and then start building the ontology compatible with all LMS studied, for that reason this paper is organized as follows: 1. Select Tools to work. 2. Contextualization of LMS tools to work. 3. Learning Objects. 4. Structure of the LMS. 5. LMS ratings. 6. Creating the map of knowledge for each LMS. 7. Comparison between the LMS modules modeled and 8. Conclusions.

Key Words — MDA, MDE, DSL, Ontology, LMS, maps of knowledge. Learning Objects.

I. INTRODUCTION

This work is part of the research line in Model Driven Engineering (MDE) of the Phd Programme in Computer Engineering of the University of Oviedo, Spain, the name of the project is “DOMAIN SPECIFIC MODELING FOR THE LEARNING OBJECTS BUILD PLATFORM-INDEPENDENT” and is looking for domain specific modeling for the construction of learning objects platform-independent, the stages of this project are: 1. Generate an ontology for modeling courses under a standard, 2. Using the ontology generated for create a Domain Specific Languages (DSL), 3.

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Finally with Model Driven Engineering (MDE) and applying the appropriate transformations are achieved from a platform independent model a module deployed into a LMS built on a standard.

This work is part of the first stage of the project and the aim is to make a comparison between all LMS to work to get a first approximation of the common modules between them, and then start building of the ontology compatible with all LMS.

II. ANALYZE OF TOOLS

At present there are many Learning Management Systems (LMS), these LMS usually taking some form of standardization in its construction, according to [1] there are more of the 101 standards, regulations or recommendations regarding the e-learning, developed by 23 different organizations, we will conduct a detailed study to analyze from the standpoint of computing, the content of some Virtual Learning Platforms (LMS) to define a comparison table between them, the main criterion for selecting the platforms is the adoption of GPL licensing and open source, this condition with the aim of facilitate the analysis of his behavior and its modules. For the selection of virtual learning platforms, were used the studied realized in the thesis doctoral [2] for the definition of a universal learning platform, open and scalable approaches in social, political, economic and educational, with a view to identify from these points of view, tools that have evolved hand in these contexts, as well as from the methodological point of view the work of [3] to identify mechanisms that support the learning process of students in these environments work. In the same way it took into account reports by the group [4] SIG Open-Source Software for Education in Europe, which is funded by the e-learning program of the European Commission in consortium of several research groups and European universities, which present functional studies of computer free platforms, using a methodology developed by this project and sheltered by the ISO IEC 9126, identifying patterns of evaluation through elements such as: functionality, usability, reuse, efficiency, maintainability and portability, these platforms must support standards in your development and specifications of content, that is an issue of paramount importance to the goal we wish to

study end.

From the standpoint of the movement and use of free software, it pays to rescue the working done by [5] which presents important factors, this factors together with previous work concerning from the standpoint of allowing computer content define the following platforms of study: DotLRN, SAKAI, ATutor, Claroline and Moodle, which for purposes of collaborative work by the group [4] represent a good degree of acceptance and a good evaluation in most communities and working groups devoted to topics related to management course content and strategies in learning.

III. CONTEXTUALIZATION OF LMS TOOLS TO WORK.

A. Sakai

This project originated at the University of Michigan and Indiana University, which later joined the MIT and Stanford University, along with other organizations and foundations in 2004. It is an LMS, which from the beginning has worked under IMS standards, which puts him in a favorable position relative to other LMS, this is because some of the masterminds of Sakai are the institutions carrying out these standards. Sakai provides a modular structure built to specifications of Java code which aims to integrate training and communication capabilities.

B. Atutor

This platform started as an initiative of the University of Toronto in 2002 in their school Adaptive Technology Resource Centre (ATRC). According to studies by the group [4] the development of this platform has paid particular attention to accessibility, becoming the only LMS that meets the accessibility specifications mandated by the W3C by standard WCAG 1.0 Level AA , which indicates the ability of the platform to allow entry to people with disabilities.

C. Claroline

It was a project sponsored by the University of Louvain in Belgium in 2000. It is considered a project for work on the approach of training through e-learning strategy and collaborative work using e-working strategy to be presented also as a content management system CMS.

According to the results obtained from the group [4] many universities appreciate the collaborative learning environment enabling teachers and educational institutions to create and manage Web-based courses. The tools provided by the system are many and give users the possibility of establishing a variety of learning scenarios.

D. Moodle

This project is one that has been more accepted in most academic and research community worldwide. As one of the first projects under the initiative GNU which gave its creator Martin Dougiamas. its host in the community was so good, that from the start began to adapt methodologies from the pedagogical point of view, social constructivism works and

tries to implement some recommendations of the standards.

Structurally is a platform that has all the characteristics apply to the development of components that allow interoperability with different levels of functionality to work. Its same name describe him as a Module Object-Oriented Dynamic Learning Environment

E. DOTLRN

DotLRN or .LRN was initially developed by MIT. DotLRN is currently supported by a worldwide consortium of educational institutions, nonprofit organizations, enterprises and open source developers. DotLRN is appropriate for learning and research communities, it has management skills courses, online communities, content management and learning. Consortium member institutions working together to support progress of each, to accelerate and broaden adoption and development of dotLRN.

IV. LEARNING OBJECTS

It is not easy to find a definition of what a Learning Object but McGreal Roy in [6] dares to define them as educational resources that can be used in any technology to support education, a learning object allows and facilitates the use of educational content through internationally accepted standards and specifications to achieve interoperability and reusability in different applications and different learning environments.

Andreas Holzinger in his article entitled Multimedia Learning Systems based on IEEE Learning Object Metadata (LOM) [7] defines the structure of the LOM into three parts one element at the top called the root, which contains additional sub-elements called branches and these in turn have other sub-elements called leaves they no longer have anything else, has this hierarchical structure is called a tree, graphically displayed in Figure 1.

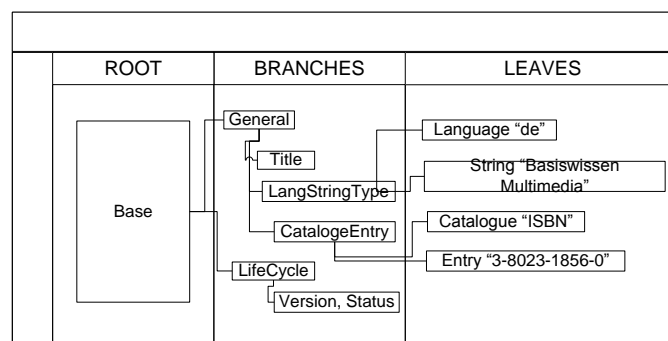


Figure 8 A hierarchical model of LOM given by the IEEE based in [7], Source Author

V. STRUCTURE OF A LMS

According to McGreal Roy [6] learning experiences classes or groups are considered as modules. A module usually consists of at least 10 hours of learning. When the lessons are more than 10 hours or if they consist of more than one module is considered as a course. A group of courses leading to a

certificate or diploma is considered as a program, Figure 2 shows the proposed plan.

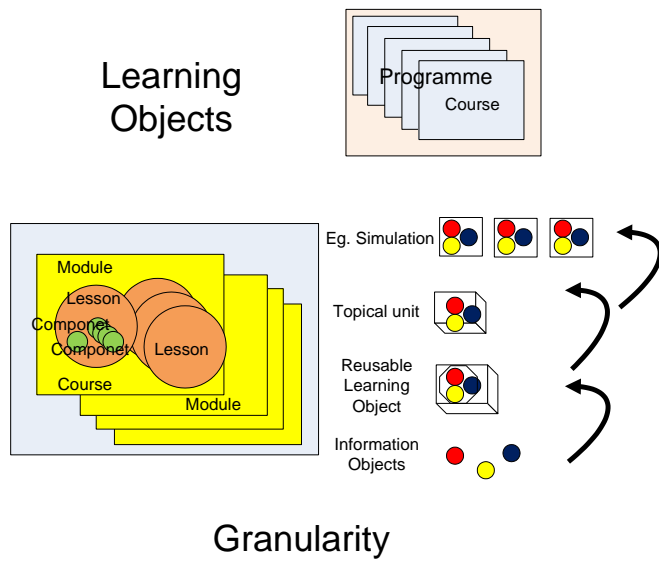


Figure 9 Granularity of learning objects, based in [6], Source Author

In the work “*Package and Visualization of SCORM LO into OpenSource LMS's*” [8] performed a content packaging under SCORM 1.2 on the ReLOAD software and then imported the package from Dokeos, ATutor, ILIAS and Moodle, one of the conclusions of this work is that the use of content publishers still not easy enough, because the concepts of learning objects and standards are not widely known, also the editor in ReLOAD software, is in English, and although there is the option to change into other languages, is inadequate as it modifies only a few terms. All this makes building, editing and packaging of digital learning content in SCORM, it remains underutilized.

EduTools is an entity that offers independent reviews at LMS platforms, comparisons between LMS and consulting services to help decision making in e-learning, about what LMS selecting according your need[9], the Table 1 show the result of the query made in the portal Edutools.com, with the filter Instructional Design Tools and Instructional Standards Compliance belonging to the area of Content Development Tools, there is evidence of the existence of design tools that help instructors creating learning sequences and adoption of standards in the selected LMSs, all the LMS have standards adopted, but each implements the standard according to your needs, and this is causing compatibility problems between them, to end this chapter in the Wiki [10] speak of the problem that concerns us “*problem Integration of LMS components, interoperability across multiple LMS*”.

Product Name	Content Development Tools	
	Instructional Design Tools	Instructional Standards Compliance

Claroline 1.8.1		IMS Content Packaging 1.1.3, IMS Content Packaging 1.1.4, IMS QTI 2.0, SCORM 1.2, SCORM 1.3
dotLRN/OpenACS	Instructors can organize learning objects, course tools, and content into learning sequences that are reusable.	IMS Content Packaging 1.1.3, IMS Content Packaging 1.1.4, IMS QTI 1.2.1, IMS Enterprise 1.1, SCORM 1.2
Moodle 1.9	Instructors can organize learning objects, course tools, and content into learning sequences that are reusable. Instructors can create linear learning sequences organized hierarchically by course, lesson, and topic. Instructors can reuse courses as templates for future lessons.	AICC IMS Content Packaging 1.1.3, IMS Content Packaging 1.1.4, IMS QTI 1.2.1, IMS Enterprise 1.1, SCORM 1.2, SCORM 1.3
Sakai Community Release 2.5	Instructors can organize learning objects, course tools, and content into learning sequences that are reusable. Instructors can create linear learning sequences organized hierarchically by course, lesson, and topic. Instructors can reuse courses as templates for future lessons.	IMS Content Packaging 1.1.4, IMS QTI 1.2.1, IMS QTI 2.0, SCORM 1.3
ATutor 1.6.3	Instructors can organize learning objects, course tools, and content into learning sequences that are reusable. Instructors can create linear learning sequences organized hierarchically by course, lesson, and topic. Instructors can reuse courses as templates for future lessons.	IMS Content Packaging 1.1.3, IMS Content Packaging 1.1.4, IMS QTI 1.2.1, IMS Metadata 1.2.2, IMS Metadata 1.3, SCORM 1.2

Table 3 Product Comparison [9]

VI. RATINGS OF THE LMS

For the taxonomic classification of the components of the LMS's, we will use an experiment-practice method, that

method was to work with each of the platforms and through its use and management, determine the taxonomy of their components, to the work of layout was decided to use a software tool that would provide easy graphical representation through maps and of freely distributed at this stage basically studied two; FreeMind [11] [13] and CmapTools [12], CmapTools finally opted for offering more ease for collaborative work Web, which has a variety of formats for exporting the map and a good number of projects such as [14] [15] [16] [17] [18], worked with her. To work with this tool is defined the following pattern:

- The relations between the LMS and the first elements are "*resources*."
- Concepts: The names of the concepts should always begin with an uppercase letter if the name is composed by more than one word the second, third and nth word must be written all in lowercase, to make the description of the component, this should be performed in the same component after his name and in parentheses, for example: "This is a concept (component description)" The concepts identified functional modules of the LMS and all concepts that are leaves (terminal concepts) must correspond to elements of the GUI (Graphical Interface User) that the user accessed directly, this elements were classified according to Table 2.

Text box (Caja de texto)	Explorator (Explorador)	Calendar date (Dato calendario)	Event (Evento)
Combo box (Menu desplegable)	View (Vista)	Text area (Área de texto)	Link (Vinculo)
Non editable text area (Area de texto no editable)	Button (Boton)	Radio button (Boton de opcion)	Color palette (Paleta de colores)
Tree (Arbol)	Check button (Boton de chequeo)	List (Lista)	Calendar (Calendario)

Table 4 Concepts leaves (terminals) in an LMS, Source Author

- Word Link: The name of the linking words should always be lowercase and no spaces, for example: "thisisalink". We define three types of links in accordance with the following assumptions: all leaves nodes must be of some type of the GUI (tipo). The resources (recursos) and sub-resource (subrecursos) must be composed of other sub-resource (subrecursos) or leaves nodes. The resources initial of the LMS will be called resources (recursos) and thereafter will be called sub-resource (subrecursos). The Table 3 classifies the links.

Word link	Description
resource (recurso)	The resources initial of the LMS
sub-resource (subrecurso)	Intermediate relationships, that are not first relation and are not leaves nodes.
Type (tipo)	All leaves nodes, must be some type of the GUI

Table 5 linking words for classification of LMS, Source Author

- The actions of accept (ok, aceptar) and Cancel (Cancelar) are in all the moment and are not modeling in this case, but must be considered.
- Since all LMS offer a variety of users, this work use the teacher user or equivalent.

A. Creating the map of knowledge for each LMS

Below are showing very generic global maps of each LMS to ascertain their generic structure, it is clarified that this article are not show all maps, because it is a job too many long and not is the purpose. the work is identify the modules of LMS based on acquired knowledge and experience, of having worked with each, finally determine the common modules between the LMS studied.

1) Knowledge map for Atutor

Atutor mainly used PHP for the development, the assembly for testing was done with a Apache Web server, PHP and a database engine MySQL, the browser used for testing was Firefox3.

ATutor offers a page that contains the next modules: My Courses, Browse courses, Profile, Preferences, Networking, Inbox, Find and Help. These modules in turn lead to others modules, the main view of the map can be displayed in Figure 3.

The ATutor modules obtained are shown in Table 4, which shows the hierarchy tree of each module.

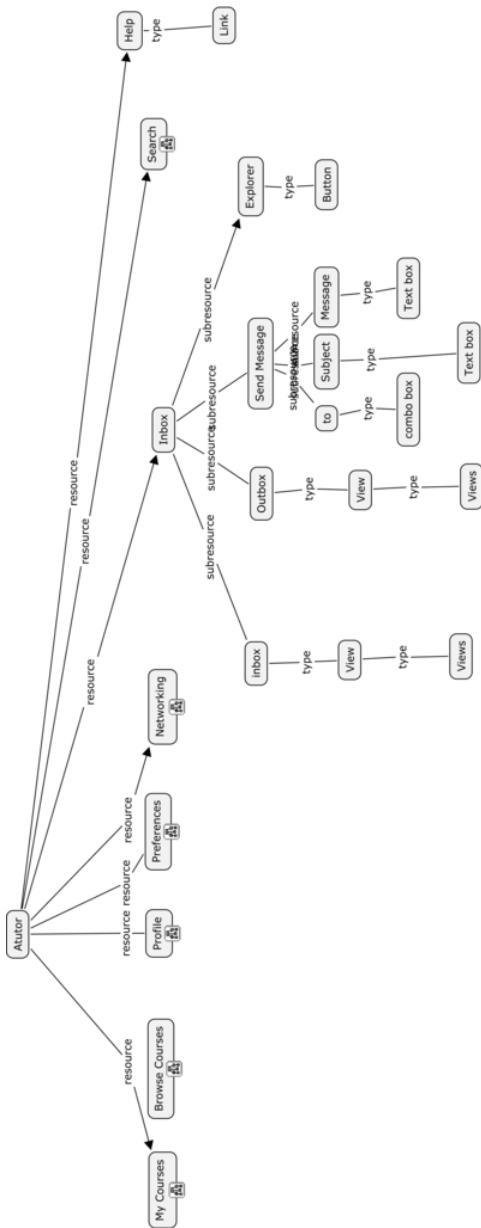


Figure 10 Initial knowledge map of Atutor, Source Author.

Atutor – Level 0	Level 1	Level 2	Level 3
My courses			
	Course		
		My tests and surveys	
		Directory	
			Groups
		Forums	
		Networking	
			Photo Gallery
		Site Map	
		Photo Gallery	
		Student Tools	
			Glossary
			Content Explorer

			Chat
			Links
			Forums
			Quiz
			FAQ
			Groups
			Reading list
			File Storage
			Test and task
			Photo Gallery
			Directory
			Search in repository
			Site map
			My Monitoring
		Administrator	
			File Administrator
			Announcements
			Chat
			Contents
			Backup
			Quiz
			Email Course
			Statistics
			Test and Quiz
			Forums
			Glossary
			Groups
			Course tools
			Student tools
			Registration
			Reading list
			FAQ
			Properties
			Test and task
			Tasks
	Course creation		
Browse Courses			
Profile			
Preferences			
Networking			
Inbox			
Search			
Help			

Table 6 Atutor modules, Source Author.

2) Knowledge map for Claroline

Claroline mainly used PHP for the development, assembly for testing was done with a Apache Web server, PHP and a database engine MySQL, the browser used for testing was Firefox3.

Claroline, shows at the beginning a page that contains the modules of: Evaluation system, Calendar, Homepage of the

course, Course description, Announcements, Documents, Exercises, Learning Path, Jobs, Forums, Groups, Wiki, Discussion and Users, the main view of the map can be visualized in Figure 4.

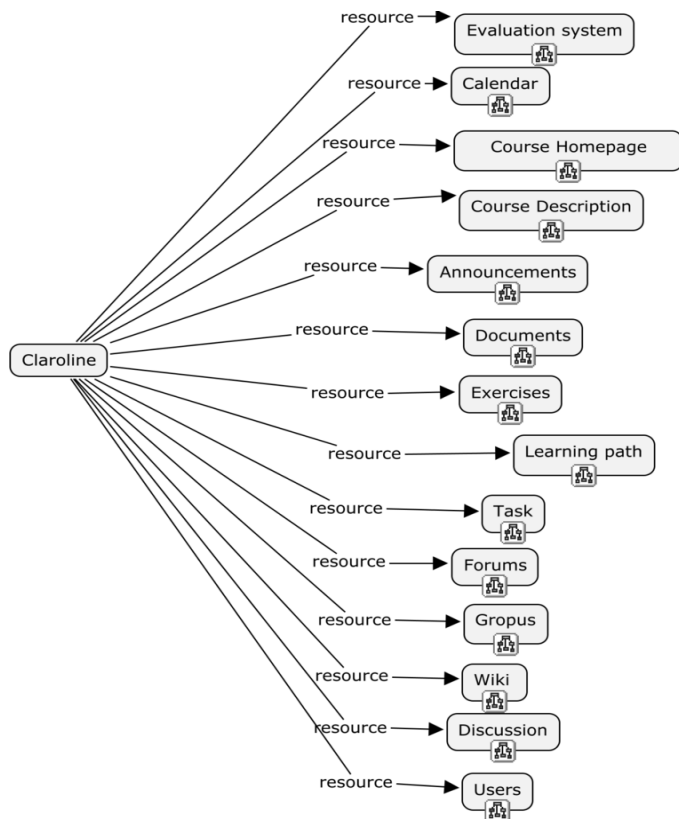


Figure 11 Initial knowledge map of Claroline, Source Author.

The Claroline modules obtained are shown in Table 5, which shows the hierarchy tree of each module.

Claroline Level 0
Evaluation System
Calendar
Course Homepage
Course Description
Announcements
Documents
Exercises
Learning path
Task
Forums
Groups
Wiki
Discussion
Users

Table 7 Claroline modules, Source Author.

3) Knowledge map for Moodle

Moodle mainly used PHP for the development, assembly for testing was done with a Apache Web server, PHP and a

database engine MySQL, the browser used for testing was Firefox3.

Moodle, shows at the beginning a page that contains the modules of:categories of courses, online users and site administration, the main view of the map can be visualized in Figure 5.

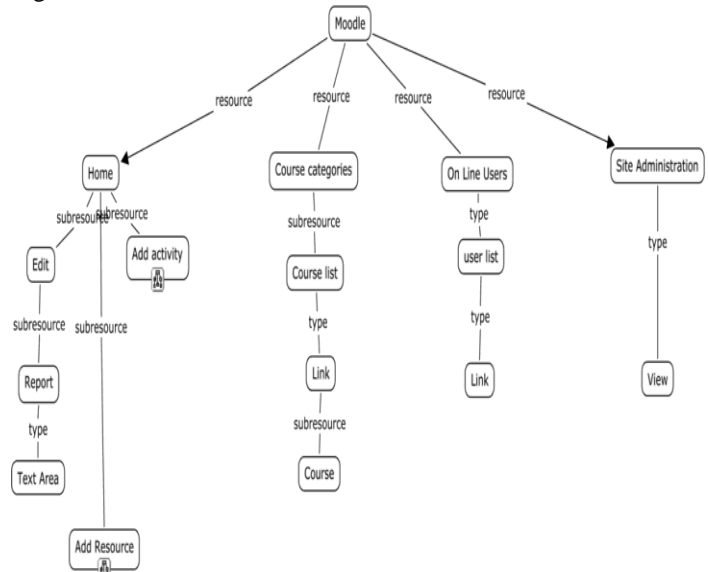


Figure 12 Initial knowledge map of Moodle, Source Author.

The Moodle modules obtained are shown in Table 6, which shows the hierarchy tree of each module.

Moodle Level 0	Level 1	Level 2
Home		
	Add resources	
		Insert Tag
		Compose a text page
		Compose a Web page
		Files or Web link
		Deploying IMS Content Package
	Add activity	
		Data Base
		Chat
		Browse
		Questions
		Quiz
		Forums
		Glossary
		Topic
		Scorm
		Advanced File Uploading
		Upload File
		Activity offline
		Wiki
		Course Categories
		Online Users
		Administration

	Courses categories	
	Online Users	
	Site Administration	

Table 8 Moodle modules, Source Author

4) Knowledge map for DotRLN

DotRLN, used a database engine PostgreSQL, a Web AOL Server (American On Line), upper this is mounted Open ACS (Architecture Community System), this is the heart that offers functions to upper layers and finally above all is LRN, the operating system is Ubuntu server, the browser used for testing was Firefox3.

DotRLN, shows at the beginning a page that contains the modules of: Home, Professional, Community and Control Panel, the main view of the map can be visualized in Figure 6.

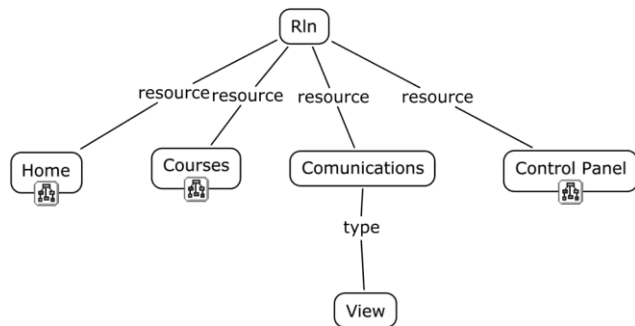


Figure 13 Initial knowledge map of DotRLN, Source Author.

The DotRLN modules obtained are shown in Table 7, which shows the hierarchy tree of each module.

RLN Level 0	Level 1	Level 2	Level 3	Level 5	Level 6
Home					
	My portal				
		Groups			
			Curses		
				Forums	
				FAQ	
				News	
				Course information	
				Learning Content	
				Teachers	
				Subgroups	
				Schedules	
				Calendar	
				Tasks	
				Quiz	
				Chat	
				Weblogger	

			Calendar		
			Documents		
			Class material		
				Assignments	
					Tasks
					Projects
					Test
				Evaluations	
					Manage my allowance rates
					Request notifications
					Tasks
					Projects
					Test
			Administration		
				Groups Administration	
				Forums Administration	
				FAQ Administration	
				Portlets Administration	
				Tasks Administration	
				Evaluations Administration	
				Chat Administrator	
				Xowiki Portlet Administration	
				Documents Administration	
				Calendar Administration	
				News administration	
				Mail Service	
				Quiz Administration	
				Learning Content Administration	

				Weblogg er Administ ration	
		Forum			
		FAQ			
		News			
		Calendar			
		Quiz			
		Chat			
		Weblogg er			
	My calendar				
	My documen ts				
		Documen ts			
Courses					
Commun ities					
Control Panel					
	My account				
	Photo				
	Privacy				
	Help				

Table 9 DotRLN modules, Source Author

5) Knowledge map for Sakai

Sakai is Java based. by this Sakai is multiplatform, for its functioning is recommended to install java SE 6, Apache Tomcat (Version 5.5.30) as servlet container, the database engine MySQL 5.1 and the driver of connection to the database data, the browser used for testing was Firefox3.

Sakai, shows at the beginning a page that contains the modules of: Home, My communications, My tools with Resources, Portfolios, News, Web content, Search, and Evaluation System, y My settings with Profile2, Membership, Preferences, Account and Site setup, the main view of the map can be visualized in Figure 7.

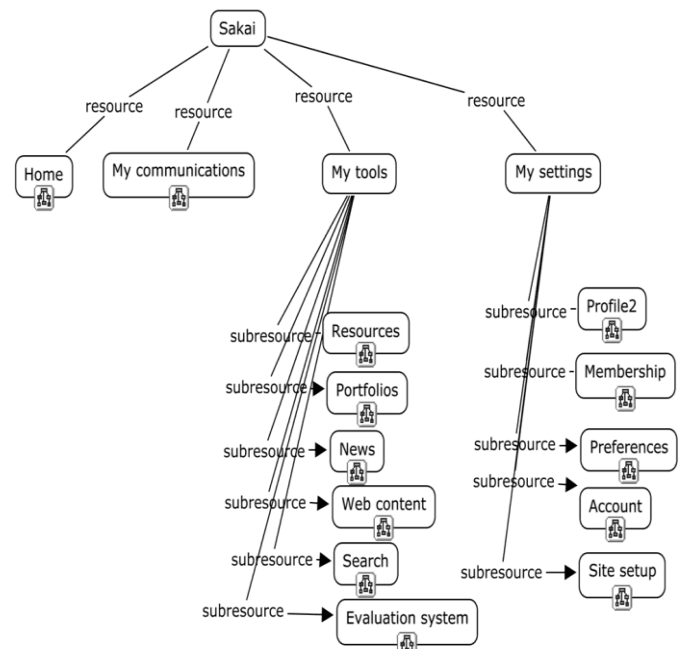


Figure 14 Initial knowledge map of Sakai, Source Author.

The Sakai modules obtained are shown in Table 8, which shows the hierarchy tree of each module.

Sakai Level 0	Level 1
Home	
	Menssage of the day
	My workspace information
	Recent announcements
	Calendar
	Message y forums notification
My communications	
	Calendar
	Announcements
	Help
My tools	
	Resources
	Portfolios
	News
	Web content
	Search
	Evaluation system
My settings	
	Profile2
	Membership
	Preferences
	Account
	Site setup

Table 10 Sakai modules, Source Author

VII. COMPARISON BETWEEN THE LMS MODULES WORKED.

Taken as a starting point the modules each LMS and based on experience I provide for having working each in

mode teacher, was made a comparison process between the modules of the LMS's, and finally generating Table 8 , which shows a first approximation of potential modules compatible into LMS's and a generic name for them.

Comparison Modules LMS					
Generic	Atutor	Claroline	Moodle	RLN	Sakai
File manager	File Administrator	Documents	Add resources	Documents	Resources
Announcement	Announcements	Announcements	Home		Announcement
Help	Help	Help	Help	Help	Help
Chat	Chat		Chat	Chat	
Management Curricula	Contents		Add resource	Class material	Resources
			Add activity	Learning contents	
Educational Design	Administration	Learning path	Site Administration	Control panel	Portfolios
					Preferences
Course	Course	Course claroline	Module	Course	Portfolios
Authentication	Directory	Users	Users	Teachers	Accounts
Survey	Quiz		Quiz		
Evaluation System	Tests and Quiz	Evaluation System	Questions	Evaluations	Evaluation System
				Questions	
Forums	Forums	Forums	Forums	Forums	Messages and Forums
Glossary	Glossary		Glossary		
Groups	Groups	Groups		Groups	
Work Group	Networking			Communities	Profile2
FAQ	FAQ			FAQ	
Activity calendar		calendar	Activities	My calendar	Calendar
News				News	News
Wiki		Wiki	Wiki		
Rating system	Test and task	Exercises	Module	Evaluates	Event
		Task	Advanced File Uploading	Test	
			Upload File	Projects	
				Task	
Administration	Preference	Yes	Site Administration	Control Panel	Membership (Site administration)
Comparison Modules LMS					

Table 11 Comparison modules LMS, Source Author

The table 9 displays the generic modules File Management, Help, Management Course, Courses, Users, Systems evaluation, Forums, Jobs and Platform

Management, in a first comparative exist in all LMS's.

VIII. CONCLUSIONS

All LMS's have a similar core, this is the management of courses and activities treated there, and somehow these activities are associated with a calendar.

All LMS's have different users but essentially have three that are the platform administrator, teacher and student. It is very important to clarify that the teacher should not be responsible for managing the platform, your mission in the LMS is managing your course, these tasks are often confused.

All Platforms work with internet orientation, have a database for storage, and a web server to be deployed.

As much as there is some similarity between the modules of LMS's platforms, each of the LMS's implemented and managed in a particular your module, for example the module of user or forums. This implies that modules are different between platforms.

This work is the foundation and gives free rein to the possibility of constructing ontology for modeling courses based a standard.

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Semantics of immersive web through its architectural structure and graphic primitives

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Abstract — Currently, practices and tools for computer-aided three-dimensional design, do not allow the semantic description of objects constructed in some cases specified notations as handling layers, or labeling of each development itself. The lack of a standard for the description of the elements represents a major drawback for using advanced three-dimensional environments such as the automation of search and construction processes that require semantic knowledge of its elements.

This project proposes the development the semantic composition from the hierarchy of three-dimensional visualization of graphics primitives used to construct three-dimensional objects, taking into account the geometric composition architecture of standard 19775-1 of the International Electrotechnical Commission of the International Organization for Standardization

For the development of semantic composition use the methodology methontology proposed by the Universidad Politécnica de Madrid, because it allows the construction of ontologies about specific domains, limiting the domain by defining classes and subclasses, relationships and the generation of instances a framework for resource description on web ontology language.

Keywords— Computer aided design, Geometry, Artificial intelligence.

I. INTRODUCTION

To build a building first, it identifies the place where it will be built, then a study of the topography and is adapted to resist the structure then becomes the frame of the building, which is covered with either concrete, bricks or other material, to the end make the veneer of floors, walls and ceilings. In an immersive virtual environment, no restrictions, buildings can be built where the income is on the top floor and first floor or a pyramid with the point adversely to heaven, something that in reality would be impossible, because it hinders the usability of the building.

Therefore it is necessary 3D objects with simple structures, but consistent and above all reusable, and at this point where a hierarchy and semantic construction is relevant, because an object with proper semantic definition will allow the

generation of new objects, simplifying development and saving computation and memory space [15].

The hierarchical construction was developed taking into account the hierarchical model proposed by Donald Hearn [10] with base in OpenGL library, and the hierarchy of render and visualization O3D, VRML, X3D, Java3D and Xj3D [8].

The hierarchy defines a tree of object construction, which makes up the immersion environment, taking a universal reference system common, on which to make the necessary transformations to give consistency to the 3D environment.

Based on the axiom that an environment is composed of objects, you must first present the construction of an object, because of complex objects to develop is the human figure, especially the face, this will be the example to be taken for object construction, while simulating a landscape for the construction of outdoor environments and the living room of a palace for interior construction.

II. GRAPHICS PRIMITIVES

The software used in the production of computer graphics in general have two groups, one special purpose which is designed to generate graphs or diagrams in any area of application without worrying about the procedures necessary to produce graphic images which normally has a work area and a series of menus and submenus that allow the development of a task graph specifies [11]. The other group is the general purpose provides a library of graphics functions that can be used in programming languages such as C, C++ or Java, the basic functions of a graphics library include those to specify components of the image as lines, polygons or areas, set the color, select a view of a scene and applying rotations or other transformations, some examples of general graphical programming packages are GI, OpenGL [2], VRML and Java 3D, a set of graphic functions is called application programming interface for computer graphics (CG API) [6].

For two-dimensional graphics applications, visualization is achieved through the transfer of the positions of the reference frame in world coordinates to pixel to positions in the plane of the screen, a process called pipeline [14]. The Three-Dimensional visualization operations are more complex because there are many more options for representation of the

scene, because at the time of modeling a three dimensional object, this is defined by a closed set of surfaces. And for some applications may also need to enter information about the internal structure of the object [10].

To describe an image is first necessary to establish a suitable Cartesian coordinate system, called the reference coordinate system. For example, it defines a line segment giving the position of the two end points, while a specified polygon given the set of positions of its vertices. These coordinates are stored in the description of the scene, along with the box outline, which are the values x , y , maximum and minimum for each object [9].

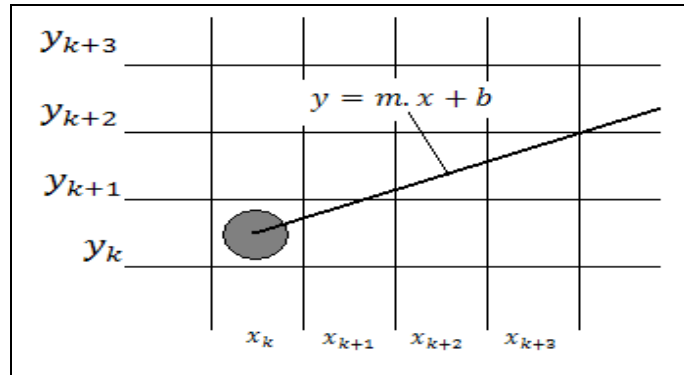


Figure 1. K-th step of the algorithm Bresenham [10].

Figure 1 illustrates the k-th step, where you draw the pixel in position (x_k, y_k) and must decide to draw pixel in column $x_{k+1} = x_k + 1$, where options are the positions $(x_k + 1, y_k)$ and $(x_k + 1, y_k + 1)$. In order to decide, be perform positions sampling $x_k + 1$, labeling the vertical separation of the pixels with respect to linear mathematical way, by assigning y_{low} and y_{up} , which are calculated as follows:

$$\begin{aligned} y &= m(x_k + 1) + b \\ y_{low} &= y - y_k = m(x_k + 1) + b - y_k \\ y_{up} &= (y_k + 1) - y = y_k + 1 - m(x_k + 1) - b_k \end{aligned} \quad (1)$$

To determine which of the two pixels is closer to the line, can make a very efficient test based on the difference between the two separations of pixels:

$$y_{low} - y_{up} = 2m(x_k + 1) - 2y_k + 2b - 1 \quad (2)$$

Can submit an implementation of this algorithm for slopes within the range $0 < m < 1,0$. The pixel coordinates, are introduced at the ends of the line and the pixels are drawn starting from the leftmost [19].

In the circles is defined from any point (x, y) on the border of a circle of radius r that satisfies the equation $f_{circ}(x, y) = 0$. If the point is inside the circle, the function will take a negative value, while if the point is outside the circle, the value of the function is positive [19]. The relative position of any point

(x, y) can be determined by checking the sign of the generating function of the circle:

$$f_{circ}(x, y) \begin{cases} < 0 \text{ if } (x, y) \text{ inside the circle} \\ = 0 \text{ if } (x, y) \text{ on the circumference} \\ > 0 \text{ if } (x, y) \text{ outside the circle} \end{cases} \quad (3)$$

The function (3) presents the intermediate points located in the vicinity of the circular path at every step of sampling. Thus the generating function of the circle is a decision parameter midpoint algorithm, and can determine the incremental calculations required for this function [10].

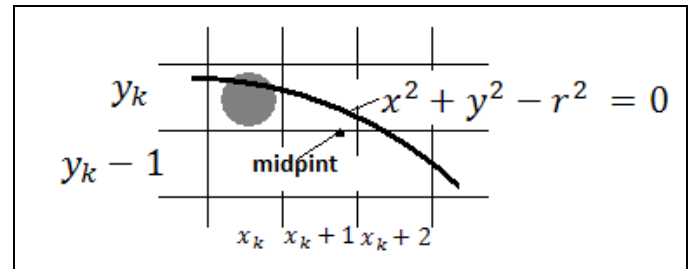


Figure 2. Midpoint between candidate pixels [10].

Figure 2 shows the midpoint between the two candidates for the position pixel sampling [1].

For the ellipse, begun of a modified circle whose radius varies from a maximum value in one direction until a minimum value in the perpendicular direction. The segments drawn inside the ellipse in both directions are called the major axis and minor axis [3].

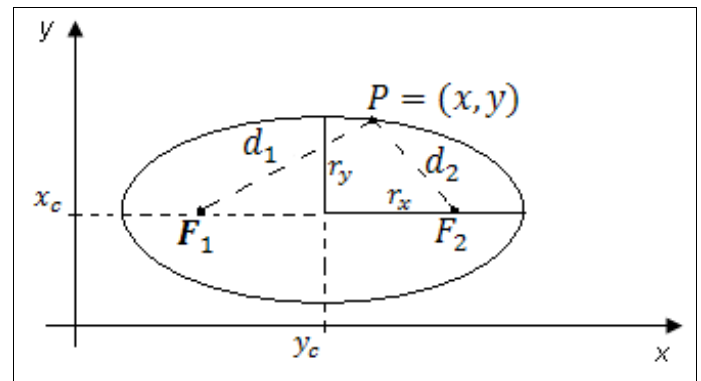


Figure 3. Generated ellipse with foci F_1 and F_2 [10].

The polynomials are useful in several graphics applications, including the design of object shapes, the specification of animation paths and representation of trends from a discrete set of data points. The design shapes of objects or paths of motion is usually done by first specifying a few points to define the general shape of the curve and then adjusting the selected points by a polynomial [5]. A polynomial of degree n in x is defined as:

$$y = \sum_{k=0}^n a_k x^k = a_0 + a_1 x + \dots + a_{n-1} x^{n-1} + a_n x^n \quad (4)$$

Where n is a nonnegative integer and a_k values are consistent with $a_n \neq 0$. One way to perform the curve fitting is to construct a cubic polynomial curve section between each pair of points specified. Each curved section is described in parametric form as follows:

$$\begin{aligned} x &= a_{x0} + a_{x1}u + a_{x2}u^2 + a_{x3}u^3 \\ y &= a_{y0} + a_{y1}u + a_{y2}u^2 + a_{y3}u^3 \end{aligned} \quad (5)$$

Quadratic surfaces are objects that are described from quadratic equations, such as spheres, ellipsoids, bulls, paraboloids and hyperboloids, these surfaces can be played by rational splines [7].

Bezier curves are line segments that are curved depending on the movement of control points. The Bezier polynomial degree is determined by the number of control points to be approximated and their relative position. You can specify the path of the curve in the vicinity of the control points using combination functions, an array of characterization, or the boundary conditions [4].

Can set the polynomial relationship generating $n + 1$ control points, indicated as $P_k = (x_k, y_k, z_k)$, with k ranging from 0 to n , the points are combined to produce the position vector $P(v)$, which describes the trajectory of a polynomial approximation function Bézier between P_0 and P_n .

$$P(v) = \sum_{k=0}^n P_k BEZ_{k,n}(v), \quad 0 \leq v \leq 1 \quad (6)$$

Where function Bezier combination $BEZ_{k,n}(v)$ are the Bernstein polynomials [10].

$$BEZ_{k,n}(v) = C(n, k) v^k (1 - v)^{n-k} \quad (7)$$

Where the parameter $C(n, k)$ arises from the binomial coefficients:

$$C(n, k) = \frac{n!}{k!(n-k)!} \quad (8)$$

Normally a Bezier curve is a polynomial of degree less than the number of designated checkpoints, this is the case that three points, generate a parabola, four points a cubic curve and so on [20].

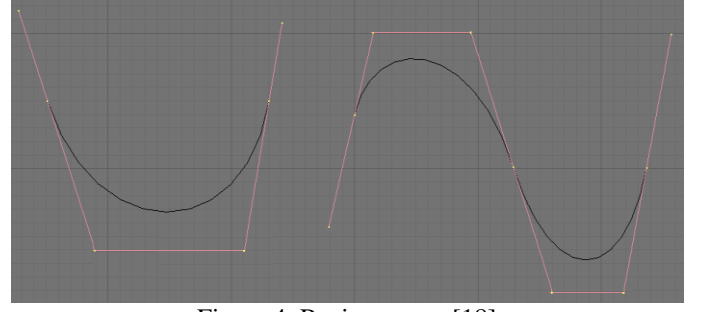


Figure 4. Bezier curves [18]

Two groups of Bezier curves can be used for the construction of the surface of an object. Vector parametric function of a Bezier surface is created with the Cartesian product of the combination of Bezier functions:

$$P(u, v) = \sum_{j=0}^m \sum_{k=0}^n P_{j,k} BEZ_{j,m}(v) BEZ_{k,n}(u) \quad (9)$$

Where $P_{j,k}$ specifies the location of the $(m + 1)$ by $(n + 1)$ control points. In a Bézier surface, control points are connected by dashed lines, and lines show the curves with constant u and v constant. Each curve is drawn with constant or varying v in the range of 0 to 1, keeping a fixed value or within the unit interval. The zero-order continuity is obtained by matching the control points within the limits [16].

III. WEB 3D STANDARD

Extensible 3D is based on the search for a specification for building interactive 3D environments, some of the technology XML (Extensible Markup Language) which emerged in 1996 incorporating a standard subset of SGML (Standard Generalized Markup Language) designed to enable the exchange of information between different platforms, hardware, software and various storage and filing systems (databases, electronic publishing, etc.) regardless of their complexity. XML 1.0 specification presents a special type for the definition of documents called DTD (Document Type Definition) The DTDs were designed for document-centric systems, and are suitable for electronic publishing applications SGML [13]

When taking the representation of 3D worlds and objects achieved with the VRML language and bring it to an orderly and rigorous specification for reading XML as it has obtained the X3D specification that enables implementation and development of 3D environments with different programming languages according to script as it uses Java libraries such as OpenGL [17].

X3D is standardized by ISO 19775, 2004 consists of two parts the first introduces and details the components and architecture bases X3D while the second delves into the interface to the scene, has been supplemented with 3 standards, the first is ISO 19776, 2005 which specify the encoding of the fields, nodes and scenarios in VRML generated from XML Schema, the second is the ISO 19777 standard in 2005 that provides a format for building interactive services with 3D

scenes from ECMAScript format which is the basis for Netscape's JavaScript and Adobe ActionScript, and the second part of this standard provides the format for building Java from SUN Microsystems, finally it complements the ISO 19774 standard named Humanoid Animation is an abstract representation for modeling three dimensional human figures, which can be created with modeling tools using motion capture data [12].

IV. HIERARCHICAL CONSTRUCTION MODEL

A 3D object is composed of graphics primitives, such as the coordinate system, the line segment, splines, circles, polyhedra, blobby objects among others [10]. The basic object that displays a three-dimensional cube is a cube graph and need a universal reference system, a local reference system, eight vertices and twelve line segments, such as 2D objects are contained between objects 3D, can say that there are two different levels, but each of these levels can be subdivided into other levels, such as lines, and splines, since a line can be a special type of spline.

Therefore suggest the levels of hierarchy from the graphics primitives that are used and other higher level from combinations of these primitives, thus able to model the 3D universe and have it nested, it is clear that environment consists of 3D objects, but there are exterior and interior environments and objects that are specific to each one, for example a tree is an object of external nature or a chair that is of internal nature, at this point it would conduct an investigation statistical and see how many and what type objects are exterior and interior type which in the present investigation this idea is left raised and the relationship of objects made from the experience of the authors [15].

1. Level 0 Reference System

Universal reference system: (SRU) Since this system is built around the immersive virtual environment, is the first thing to be defined at the time of building an immersive virtual environment, this environment can have settings like a park, a palace, a forest, a street The moon, in short, many scenarios, the classification of these scenarios belong to a lower level.

Local reference system: (SRL) This is characteristic of each object, whether they are scenes like that are only objects, including those that still other objects are part of larger objects such as door and the wall or the wall and a picture of Van Gogh. Static objects take the frame of the dynamic object to which they belong, in order to optimize memory spending, at this point is a new problem is that once assigned a static object to a dynamic object, this will be a single object and not be separated, to separate, the only way is to remove the entire object and re-import it alone, which requires access to a library of objects

2. Level 1 Surfaces

Polyhedra based surface: (SBP): These areas are unique in that they are open and can see only a part of such surfaces are part of a table top, doors and in further building the walls, as shown in Figure 5.



Figure 5. Object interior environment, based polyhedral

Based on quadratic surfaces: (SBC) These areas are closed, and normally only uses a portion of the object that generates, and can be used in the construction of domes, balloons, cups entity other.

Spline based surface: (SBS) Most objects are made from splines surfaces, these are irregular and not follow a precise mathematical formula but obey polynomial mathematical functions, find the equation to build the landscape can generate a set of equations that cannot be resolved

3. Level 2 objects environment

Regular environment objects (OER) At this level, it is very difficult to classify the object because there is not a discrete and finite number of how many there are and what they are, but you can define a property from property and is that these objects are those which limit the environment, such as walls, floor and ceiling of a room.

Irregular environment objects (OEI) Just as objects with regular geometric structures, there will be environments with non-regular geometric structures, constructed from randomly modified meshes.

Environment objects compounds (OEC) Most objects are composed of a regular and other irregular, such as the facade of a house

4. Level 3 Dynamic objects

Receive dynamic feature, because they are objects that can be other objects, but by themselves are objects in the environment, such as a chair in a room by itself is an object, but four or six of them along with a dining table are a might think that the dining room is a 3D object, and should be considered the table and chairs as separate objects, but the same happens with a door and a house or the eyes, nose and face, so these objects are dynamic and allow the same object to obtain more copies, for example of the same face can get two characters as presented in Figure 6.

Like the environment objects, dynamic objects can be classified into regular dynamic objects, such as a car tire in irregular dynamic objects, like the face of figure 6 and composite dynamic objects such as a hat

- *Dynamic objects regularly (SDR)*
- *Dynamic objects irregular (SDI)*
- *Dynamic objects compounds (SDC)*

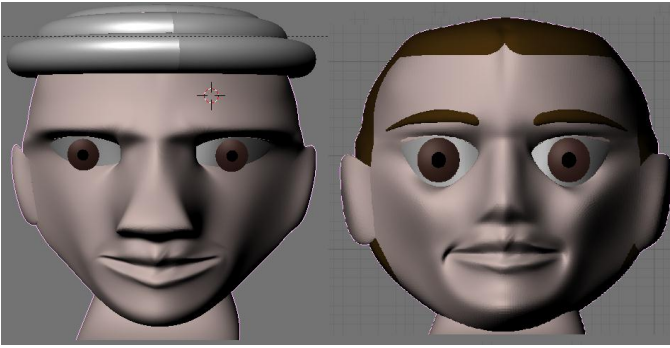


Figure 6. Dynamic objects

V. EXAMPLE OF A TREE HIERARCHY

Every 3D object needs a universal reference system and the local reference system of the object from which it generates a surface such as polyhedron, then this is deformed to build a Bézier surface, to finally build a dynamic object compound.

The path from the root of a static scene graph to the specified node is the path to static scene graph node. As a path of a scene graph is exactly one static node, there is a scene graph path for each node static on stage. All scene graph path in a scene graph completely specifies the node state information static. This information includes the location, orientation and size in the object reference. Consequently, the visual attributes of each object depend only on its scene graph path. The visualization pipeline takes advantage of this and displays the static nodes in the most efficient order. The graphical representations of a scene graph can serve as a design tool or documentation for the 3D buildings. To design an environment draws a scene graph using a set of standard symbols. After completing the design, this scene graph is the specification for the program. After completing the program, the same scene graph is a concise representation of the program. It is possible to design an illegal scene graph. As you can see in Figure 7. This scenario is illegal because it violates one of the design properties. The problem is the two objects SRL (Local Reference System) with the same subject TC (TrasformCoord) as a child. There can be only one path from the object coordinate to the static object. You might think that the structure shown in Figure 7 defines three visual objects in a virtual universe. But the scene graph defines two visual objects using the visual re (SDC) on the right side of the figure. Conceptually, each object that PBS sponsors share the SDC issue could put an image in the visual object in different locations. However, it is an illegal scene graph because the parent-child arc is not a tree. In this example, the result is that the object SBP has more of a father.

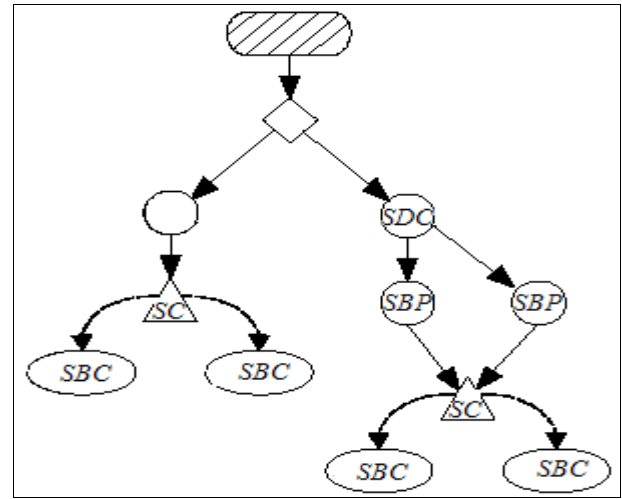


Figure 7 Illegal Construction

The explanations of the tree and the structures are correct. However, the system reports the error in terms of child-parent relationship. One result of the limitation of the tree structure is that each object SBP is limited to one parent. Figure 8, with a parent for each object PBS, shows a possible solution to this scene graph.

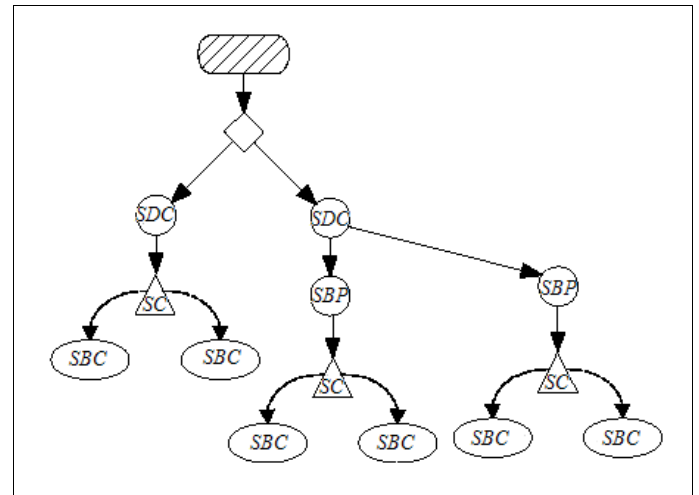


Figure 8 Correction illegal construction

Each scene graph has only one Universal Reference System (SRU). This object has a reference list of Local Systems (SRL), which provides a reference to a point in the virtual universe.

A dynamic object is the root of a sub-graph, or branch graph. There are two categories of graphics sub-scenarios: the view branch graph and the content branch graph. The content branch graph specifies the contents of the virtual universe - geometry, appearance, behavior, location, sound and lights. The view branch graph specifies the viewing parameters, such as viewing position and direction. Together, the two branches most of the work specified in order to make the display

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Relative Radiometric Normalization of Multitemporal images

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Abstract — A correct radiometric normalization between both images is fundamental for change detection. MAD method and its IR-MAD extension in an implementation on multispectral aerial images is described in this paper.

Keywords — Change detection, Iteratively reweighted multivariate alteration detection (IR-MAD), and Multispectral imagery.

I. INTRODUCTION

This paper analyzes results of the application of an automatic method of radiometric normalization between two multitemporal images of the same zone. This radiometric adjustment is part of the preprocessing of image changes detection. Any surface in two images recorded with the same sensor should ideally appear with similar values in their digital levels, but in real practice it doesn't happen due to several reasons, among them different atmospheric conditions, and different lighting from different recorded dates. That is the reason why pixels from the same terrain can show different radiance values, and, therefore, different values in their digital levels. In satellite images radiometric normalization must determine ground absolute reflectivity through correction algorithms as well as atmospheric properties related to the moment of the acquisition of the image [1]. For aerial images (in which atmospheric effects are not as prominent as in satellite images), and for many applications of change detection lineal radiometric normalization of multitemporal is enough. To this end one of the images is taken as reference and the necessary radiometric correction is applied to the other in order to make the tone of its pixels with those of the reference image. The behaviour of the spectral signals of a reflective lambertian surface with times t_1 and t_2 can be accepted as a lineal function. This way the pixels of the image at time t_1 must be corrected to get radiometric normalization:

$$ND_k = a^k ND_k + b^k$$

where ND_k is the grey value in the k band of the image in row i and columns j at time t_1 . ND_k normalized pixel value in band k at time t_1 and a^k, b^k radiometric normalization constants for

band k . According to the values taken by the coefficients, called gain and bias too[2], different normalization values will be obtained. Different methods have been analyzed in similar studies[3], which has been ordered in the following list from greater to less effectiveness:

- No-Change Regression Normalization.
- Dark Set-Bright Set Normalization.
- Simple Regression Normalization.
- Haze Correction Normalization.
- Mean-Standard Deviation Normalization.
- Minimum-Maximum Normalization.
- Pseudo-Invariant Normalization.

In aerial images can be difficult to get an absolute normalization due to the lack of atmospheric information associated to the image. Relative normalization based on the intrinsic radiometric information of the images is an alternative method, in which it is not necessary to know the absolute reflectivity of images[4]. In order to implement the relative radiometric normalization, it is assumed that the relationship between the radiance obtained by the sensors in two different instants from regions with constant reflectivity can be approximated by a linear function. The critical issue of the method is the determination of time invariant characteristics which can be the base of normalization

The MAD (Multivariate Alteration Detection) transformation applied to both images from different times is invariant to arbitrary linear transformations of the intensities of the pixels involved in the transformation. That is the reason why in the implementation of the change detection method (MAD) preprocessing with radiometric normalization is superfluous. This work proposes combined use of MAD transformation applied to not-normalized multitemporal images to select NOT-changed pixels and then their utilization for a relative radiometric normalization. This is a simple, quick and completely automatic procedure, compared with methods requiring manual selection of characteristics that do not change with time. Upon completion this method could be combined, if results are not satisfactory under visual exploration of radiometric changes in the normalized image, with a histogram based transformation that modify the digital level of one pixel of the image being corrected, taking one of the two images as reference, so the final histogram of the image is similar to the histogram chosen as base. El que los histogramas sean similares significa que el brillo medio,

contraste y distribución de niveles digitales sean también parecidos.

The IDL programming language has been used to implement this method in the ENVI software environment along with RADCAL-RUN extension. The method requires a previous transformation: IR-MAD (modification of MAD transformation [5]), which improves the location of no-change pixels. The quality of normalized images is evaluated in terms of the joint of t-test and F-test in order to compare the mean and the variance respectively. The MAD change detection procedure will be explained concisely in section II.

II. THE MAD AND IR-MAD TRANSFORMATIONS

The Multivariate Alteration Detection method (MAD) is a new change analysis method in multispectral images originally proposed by [6]. The purpose of this method is that the data of two bitemporal multispectral image will be transformed in such a way that the maximum variance in every band will be explained at the same time in the difference image. This transformation generates a set of mutually orthogonal difference images (MAD components), which have the same spectral dimension as the original multispectral images that were transformed.

The method is based on correlation analysis. Linear correlation are obtained from two data sets, in such a way that the difference between the two first linear correlations correspond to the biggest correlation. This is called the first canonical correlation. The two corresponding linear combinations are the first canonical components.

The transformation is as follows [7]: first two N-dimensional multispectral images are represented (where N means the number of bands) of a scene acquired in times t_1 and t_2 with two random vectors, called \vec{X} and \vec{Y} , assuming a gaussian normal distribution:

$\vec{X} = (X_1, \dots, X_N)^T$, $\vec{Y} = (Y_1, \dots, Y_N)^T$. For the first image a lineal combination of the intensities can be established for every spectral band of the image, thus generating a scalar characterized by the random variable $\vec{U} = \vec{a}^T \cdot \vec{X}$. The same is done with the second image $\vec{V} = \vec{b}^T \cdot \vec{Y}$, and afterwards the scalar difference between both images is computed $\vec{U} - \vec{V}$. La información del cambio existente está ahora contenida en una sola imagen. Vectors \vec{a}^T and \vec{b} can be determined by using Principal Components (PC) analysis on \vec{X} and \vec{Y} . Another procedure consists of defining simultaneously the set \vec{a}^T and \vec{b} through maximizing the variance of $\vec{U} - \vec{V}$ with the criterion $\text{var}(\vec{U}) = \text{var}(\vec{V}) = 1$. It is assumed that both $\vec{a}^T \cdot \vec{X}$ and $\vec{b} \cdot \vec{Y}$ have positive correlation. The determination of the difference between the linear combinations with maximum variance is the same as the

determination of the linear combinations with minimal and positive correlation. This is implemented through the standard Canonical Correlation Analysis (CCA). Both \vec{U} and \vec{V} are called canonical variables.

A. Canonical Correlation Analysis

This analysis includes a linear transformation of each set of multispectral images such as, instead of being ordered by its wavelength, transformed components are ordered according to their mutual correlation. The greatest mutual correlation between the images is called first canonical variable (CV) and so on orderly second, third, etc.

For the first image (\vec{X}) , \sum_{XX} is the variance-covariance matrix, and for the second image (\vec{Y}) , \sum_{YY} , the covariance between them is \sum_{XY} and the la correlation between \vec{U} and \vec{V} $\rho = \text{corr}(U, V)$:

$$\begin{aligned} \sum_{XY} \sum_{YY}^{-1} \sum_{YX}^T \vec{a} &= \rho^2 \sum_{XX} \vec{a} \\ \sum_{YX}^T \sum_{XX}^{-1} \sum_{XY} \vec{b} &= \rho^2 \sum_{YY} \vec{b} \end{aligned} \quad (1)$$

Thus the pair (U_1, V_1) has the maximal correlation; the pair (U_2, V_2) has the next maximal correlation subject to be orthogonal (uncorrelated) to (U_1, V_1) and so on with the other pairs.

B. MAD transformation

Once the CCA has been exposed in the last paragraph, the MAD transformation defined as:

$$\begin{pmatrix} X \\ Y \end{pmatrix} \rightarrow \begin{pmatrix} a_1^T X - b_1^T Y \\ \vdots \\ a_N^T X - b_N^T Y \end{pmatrix} \quad (2)$$

The first MAD component has maximum variance in the intensity of its pixels. The absolute value of the last MAD component shows always the domain of the greatest undergone change. The correlation among the input bands and the MAD components make the interpretation of the mode of change easier. For 12 input bands (this is the case with two multitemporal images LANDSAT) the input is 6 MAD components, with which after the selection of a significant change threshold, the change-no change image can be represented. Depending on the type of present change, any of its components may exhibit significant change information. In fact one of the more interesting aspects of this method is that it orders different change categories in different uncorrelated components of the image.

MAD transformation is invariant to linear transformations applied to the original image (affine transformation type). This means too that it is invariant to radiometric and atmospheric corrections that could be applied. That is why it is considered a very robust method to detect changes. This invariance offers the possibility to use the MAD transformation to implement automatically a relative radiometric normalization onto multitemporal images, as it will be described subsequently.

C. Iteratively reweighted multivariate alteration detection (IR-MAD)

This transformation can be implemented in an iterative schema, in which, when means and covariance matrices are calculated for the next iteration of the MAD transformation, weights are applied to observations according to the probability of determining the NO-change in the preceding iteration. It all begins with the original MAD transformation by assigning, for example, the same weight =1 to every pixel. In order to choose the weight of pixel j in the next iteration w_j , the Z variable is used to represent the sum of the squares of the standard MAD components:

$$Z = \sum_{i=1}^N \left(\frac{MAD_i}{\sigma_{MAD_i}} \right)^2 \in \chi^2(N) \quad (3)$$

Where σ_{MAD_i} is given by equation:

$$\sigma_{MAD_i}^2 = 2(1 - \rho_{N-i+1}) \quad (4)$$

NO-change observations are expected to distribute themselves normally and to be uncorrelated. The random variable Z should have a CHI-squared distribution with N degrees of freedom. For each iteration, weights determined by the CHI-squared distribution can be applied to observations, calling:

$$w_j = \Pr(\text{No-change}) = 1 - P_{\chi^2; N(Z)} \quad (5)$$

Here $\Pr(\text{No-change})$ is the likelihood that a pixel Z located in the CHI-squared distribution could be big or very big. A small value for Z implies a corresponding big probability. The iteration of the MAD transformation continues until it stops because it meets the criteria, such as the lack significant changes in the canonical correlation

$\rho_i, 1 \dots N$ [4].

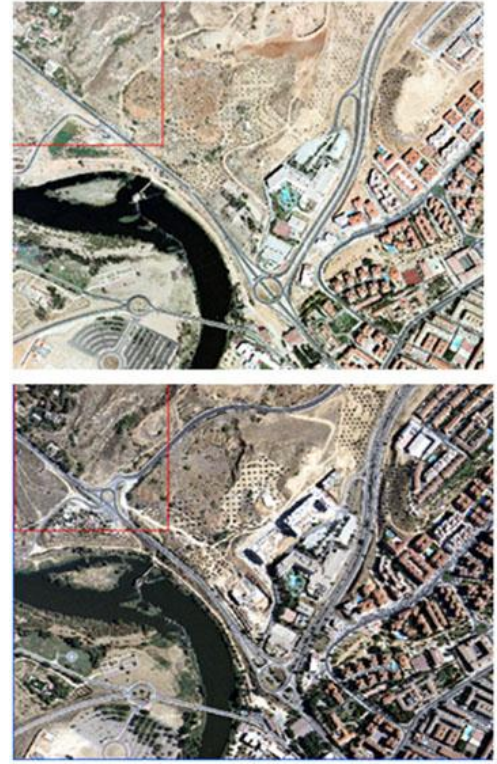


Fig. 1 Images from Toledo 1995 above, 2005 below

III. IMAGERY

RGB color images were employed that come from a photogrammetric flight over the city of Toledo (Spain) in dates of 1995 and 2005. The sensor was that of an analogical aerophotogrammetric camera WILD RC30, flight scale 1:20000. They are therefore multispectral images with three bands corresponding to the visible part of the electromagnetic spectrum. The images were scanned by the Zeiss/Imaging photogrammetric scanner with resolution of 21 microns. After the aerotriangulation of the set of images, orthophotographs were taken with GSD value of 1 meter using DIGI3D software. Visually, in figure 1, the changes experimented in those years can be observed, also the difference in shades between the images.

IV. RADIOMETRIC NORMALIZATION

In order to implement the radiometric normalization the RADCAL_RUN extension [4] developed by Dr. M. J. Canty PhD and programmed in IDL language over the digital image processing software ENVI 4.7 is used. As reference image has been used that of the year 1995.

With the aim of carrying out a radiometric normalization those pixels that satisfy $\Pr(\text{No-change}) \geq t$ are chosen, where t is a decision threshold, usually 95%. The steps involved in the radiometric normalization are the following: [7]

- Chose the values of weights equal to one for every pixel in the bitemporal scene.

- Repeat until the canonical correlations stop changing significantly:
 - Carry out a weighted sample of the bitemporal image so as to determine its mean vector and the covariance matrix.
 - Run CCA and build the MAD components M_i , $i=1,...,N$.
 - Recalculate the weights according to the equations (3) y (5).

The IR-MAD method is applied to the images. The development of the iterations of the canonical correlations is shown in figure 2. As it can be observed, the first iterations are the more important ones. It stabilizes itself from the seventh one on.

In order to evaluate the process of normalization the program saves one in every three pixels of NO-change to carry out a reliability test. The mean and the variance are calculated before and after the normalization as well as the statistical hypothesis test of invariant pixels in both images.

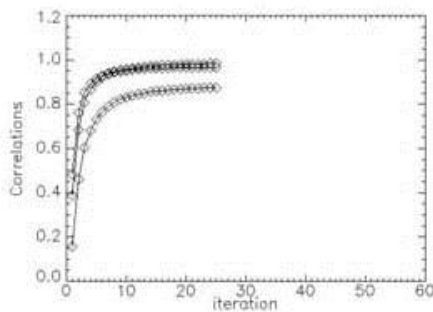


Fig. 2 Canonical correlations over 28 iterations

1794 pixels for the normalization and 898 pixels for the statistical tests were used. The results for the Student test for the mean in the red, green, and blue bands are -0.0077, -0.5409 and 0.1284 respectively. With these values the confidence interval has a p-value between 0.89 and 0.99 for red and blue bands and 0.58 for the green band. As it can be seen in figure 4 in red, the part of the reject of the test covers almost all the distribution. In this case we reject radiometric normalization. By means of a visual analysis the bad result is confirmed because it doesn't equal the radiometric values between the reference image, time 1 and the normalized one, time 2.

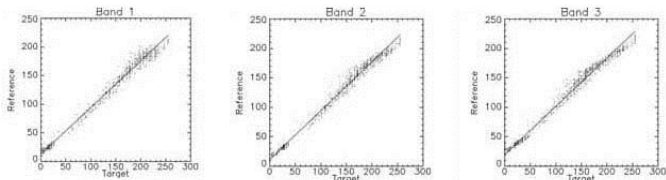


Fig. 3 Regressions on RGB spectral bands of the images.

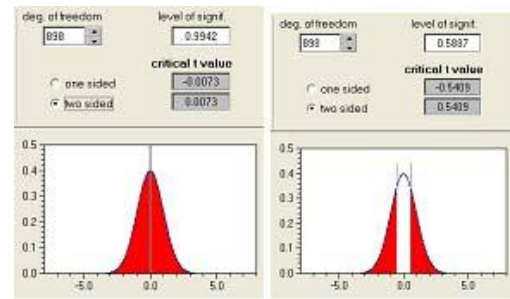


Fig. 4 T-Student results in standardization, left for the red band, green band right

The process is repeated but this time with the a priori condition of probability of belonging to NO-change pixels of 99%. With this premise the number of used pixels for the radiometric normalization has decreased considerably down to 368 and for the tests only 184 have been used. That means that the degrees of freedom have diminished for the calculation of confidence intervals. The results can be seen in table 2. They have clearly improved in respect with the previous test. The radiometric normalization can be accepted then.

Table 1
Comparison of means and variances for 898 test pixels, with paired t-test and F-test.

	Band 1	Band 2	Band 3
Target mean	108,28	109,87	103,46
Ref. mean	100,75	102,09	104,49
Norm. mean	100,75	102,20	104,46
t-stat	-0,0077	-0,5409	0,1284
p-value	0,9942	0,5887	0,8979
Target var.	7602,22	6630,20	5890,32
Ref. var.	4993,57	4506,05	3909,07
Norm. var	5016,76	4538,78	3937,31
F-stat	1,0046	1,0073	1,0072
p-value	0,9447	0,9137	0,9142

Table 2
New normalization, comparison of means and variances for 184 test pixels, with paired t-test and F-test.

	Band 1	Band 2	Band 3
Target mean	104,54	106,33	101,87
Ref. mean	97,43	99,05	103,53
Norm. mean	98,15	99,50	103,53
t-stat	-1,4692	-1,0096	-1,8733
p-value	0,1435	0,3140	0,0626
Target var.	7833,07	6823,08	6249,76
Ref. var.	5102,16	4634,28	4128,26
Norm. var	5270,16	4762,56	4293,28
F-stat	1,0329	1,0277	1,0400
p-value	0,8267	0,8537	0,7912



Fig. 5. Result of radiometric normalization. Reference image is on the left 1995, and normalized on the right 2005.

V. CHANGE DETECTION

One application among others of change detection is the updating of Geographic Databases. According to [8] the two main approaches to update a Database are: first to set up gradually a new Database that replaces the old one and the second approach is to detect, identify, and update only the changes. This option is faster and more convenient. That is the reason why automatic change detection is the first and most important step in the updating of Geographic Databases. The result of MAD transformation generates three components, see figure 6. Maximal change areas show white pixels (positive change) and black pixels (negative change). Through a colour combination of the three MAD components a new image is obtained where change is shown in magenta colour, the new road and the new buildings. A change classified image can be finally set up by establishing thresholds and postprocess filters. Correlation among components and original bands are shown in table 3. The greatest correlation corresponds to MAD 3, with negative correlation in the bands of the year 2005 and positive ones in the year 1995. MAD 1 component shows a noise image; in the MAD 2 one can be seen in black colour the negative change because of the new buildings and the new road. At last the MAD 3 component shows in white colour the positive change due mainly to the different orientation of the shadows of the buildings. This change will be eliminated later by means of the application of a shadows mask.

Table 3
Correlation matrix of the MAD components with the original bands.

		MAD 1	MAD 2	MAD 3
Toledo 1995	R	0,079	0,084	0,465
	G	0,158	0,193	0,432
	B	0,052	0,279	0,413
Toledo 2005	R	-0,303	-0,171	-0,397
	G	-0,385	-0,237	-0,333
	B	-0,242	-0,337	-0,343

In [9] and [10] MAD method is used as a technique of change detection between satellite multispectral images.

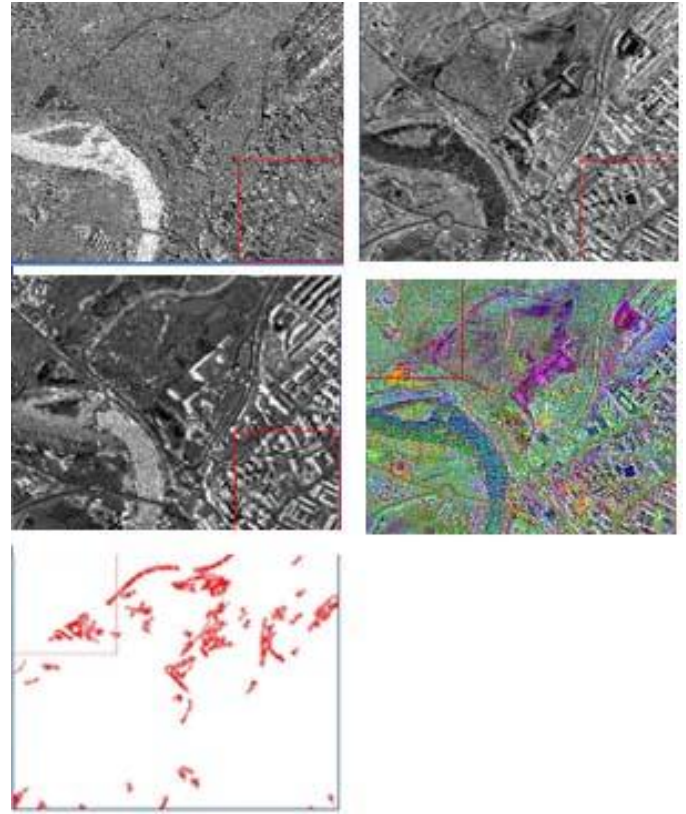


Fig. 6 MAD components and color composition where, in magenta, the detected change is observed. Exchange classified image below.

VI. CONCLUSIONS

Radiometric normalization among multitemporal multispectral images using the IR-MAD transformation gives good results. This transformation selects invariant pixels in the presence of changed pixels. The associated statistics to the applied transformation with a t threshold, tables 1 and 2, has the utility of validate or reject the normalization. In the case of the aerial images in this work, a final threshold $t \geq 99\%$ was chosen to search for invariant pixels.

Finally, MAD transformation as method of change detection has highlighted existing changes. This technique depends on the chose threshold to highlight changes in each component. These thresholds have to be selected by means of an empiric method through observation by the image analyst.

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A prototype for linear features generalization

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Abstract — A computer application designed to generalize linear elements in a vector formatted cartographic set by means of two of the most contrasted line generalization algorithms, Douglas-Peucker simplification and Bézier curves based smoothing, is presented in this paper. Regarding codification, the simultaneous treatment of different lineal geometry entity classes and the conservation of their original topological relationships among them are considered. It is recommended in processes that produce small scale reductions (in a 1:2 relationship or similar). The application allows changing the characteristic parameters of the referred algorithms and proposes a report of the results obtained after every transformation. That way it supplies an additional facility as a trial tool to choose the parameters that give the best results in every process.

Keywords — Geographic information system, linear features, map generalization, simplification, smoothing, topological relationships.

I. INTRODUCTION

Cartography is a graphic expression mean whose main function consists in transmitting information (geographic, in this case) and in helping to understand it. In order to achieve this double aim, the map has to maintain the equilibrium between the clarity of the information, its richness, and the exactitude in its localization. So the cartographer affronts two fundamental questions: on the one hand the affluence of information presented by the geographic reality obliges to select the elements to be represented; on the other hand, its dimensions impose a reduction to make them comprehensible, which implies a greater accumulation of adjacent elements, a growing complexity in forms, and, in general, a loss of clarity [1]. These two issues —selection and reduction— require a set of transformations that preserve the rigor of the results. The whole of these transformations conforms the so called **cartographic generalization process** [2], that intervenes in a decisive way in the **basic** (from direct observations) and **derived** (from the latter through scale reduction) cartographic production. In short, generalization is a natural process and it is necessary when building a map [1], so that both concepts are intimately related [3].

The cartographic generalization process must ensure the following essential requirements:

1. Achievement of a suitable positional exactitude.
2. Implementation of a treatment of the set of different entity classes that preserves their mutual topological relationships.
3. Allowance for the study of the goodness of the obtained results.

The numerous efforts dedicated to the research of the automation of the process, all of them based in geographical information systems technology (GIS), have permitted to dispose today of specific commercial programs of generalization («*Radius Clarity*» of the British firm ISpatial; «*CTP*», of the *Institute of Cartography and Geomatics* of Leibniz University in Hannover, Germany) and generalization modules or tools in existing GIS programs. In general, these solutions propose methodologies for the application of different algorithms of generalization and present the following characteristics:

- They establish a *semiautomatic* process of generalization using a set of automatic operations that must be completed afterwards with a manual treatment.
- They are oriented to the generalization of geometry elements or concrete characteristics: contour lines, communication routes, built-up areas, etc.
- They treat geographic information in an independent way, without considering it in its whole and within the geographic context in which it finds itself. Therefore they do not keep topological relationships (intersections, inclusions, etc.) among the different entity classes, even among the elements of the same class. All in all the resulting set losses geometric consistency, global sense and, in many cases, harmony with respect to the original.
- They do not produce reports of the obtained results, which makes difficult the analysis of its goodness.

These characteristics allow the conclusion that, regarding the three already mentioned essential requirements of the generalization process, every available solutions assure the first one, some of them take into account partially the second one, and none of them the third one, which suggests the elaboration of a specific computer application to achieve them.

On the other hand, most of the mentioned algorithms are meant to achieve the generalization of linear elements in vector format, because the entities that make up a map are represented mainly through lines and polygons, and these are limited by lines [4]. According to Thapa [5] they are approximately the 80% of the elements in a cartographic representation. In order to generalize these elements, one of the solutions that provide best results consists of *simplifying* its geometry (elimination of points) and *smoothing* afterwards the obtained result. Among the line simplification algorithms, the **Douglas-Peucker algorithm** [6] is the best considered for small scale reductions [7]-[8]. Concerning smoothing algorithms, also called «curvature filtering», the ones based on **Bézier curves** make one of the most commended alternatives [9]-[10].

As a contribution to these researches, in this paper a computer application is presented, which allows to:

- Generalize linear elements in vector format so as to obtain small scale reductions (in the 1:2 relationship or similar) by applying the Douglas-Peucker algorithm and the one based on **Bézier curves** and preserving their mutual topological relationships.
- Change characteristic parameters of mentioned algorithms.
- Present a report over each one of the applied transformations: number of obtained axes, number initial and final points and processing time.

II. DOUGLAS-PEUCKER ALGORITHM

The **Douglas-Peucker algorithm** implemented in this application is the second of the line simplification methods presented in 1973 by the Canadian teachers David H. **Douglas** (Ottawa) and Thomas K. **Peucker** (Simon Fraser University, British Columbia) [6]. Besides it is used in most current GIS commercial tools that include generalization tools (*ArcInfo* from ESRI, *GeoMedia Professional* from Intergraph or Bentley *MicroStation GeoGraphics*).

It is based on the treatment as a whole of all the points that compose the geometry of each line. That is the reason why the line simplification algorithms are included under the so called «global» ones [11].

The fundament of the algorithm consists of selecting in the original line specific points that are called *critical* or *anchor points* which will build the generalized line. In order to select them, a tolerance factor de tolerance $T > 0$ is established beforehand. It is called simply **tolerance** and is expressed in length units. The process can be resumed in the following steps (see example in figure 1) [1]:

1. Tolerance is set to $T > 0$.
2. A first segment AZ between initial node A and final one Z on the line is traced.
3. The distances d_i of the vertices to segment AZ are calculated. If no distance is greater than the tolerance ($d_i < T$), the process ends and the generalized line will be composed by points A and Z. On the contrary, if vertex B is more distant from AZ ($d_{\max} = dB$), it will be selected as a critical point and two new segments AB y BZ will be generated.
4. The distances d_i of the rest of the intermediate vertices to segments AB and BZ are calculated and the selection procedure from the previous step is applied.
5. This criterion is repeated recursively in the two parts in which the segments are divided after every selection, as far as the division possibilities of the segments are exhausted.
6. Finally, a generalized line is obtained from the selected points in each step.

If the *lines* are *closed*, the first and last points do not define a line because A and Z coincide for their having the same coordinates, the maximum distance to initial segment is replaced by the greatest distance to these points. Nevertheless, in this case it is controversial to select as critical point a point

of the curve just for having been digitalized in the first or in the last place.

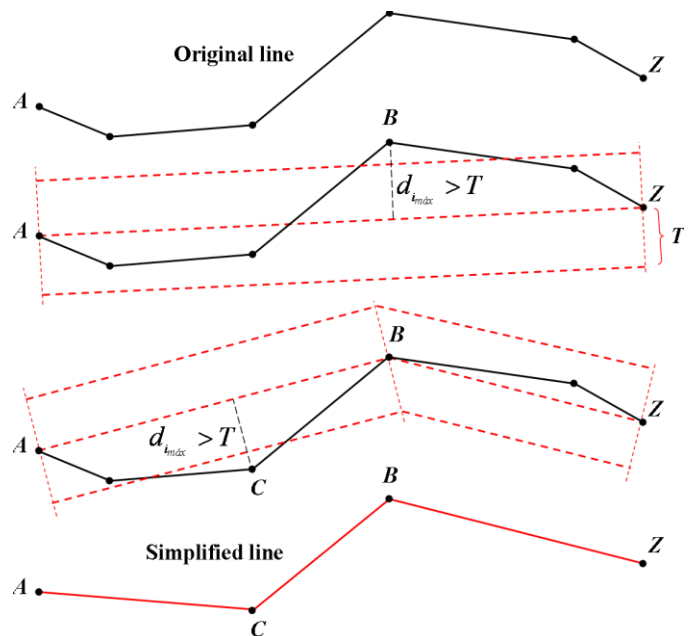


Fig. 1. Example of the application of de Douglas-Peucker algorithm [1].

Some authors designate as *additive* this type of simplification algorithms, while the so called *subtractive* ones remove successively several points in each step [11].

Apart from the simplicity provided by the algorithm, both in its codification and in the simplification process that it sets out, one of its main advantages consists in allowing the positional control of the generalized line with respect to the original one, because the tolerance T determines the greatest displacement between them.

On the other hand, the increase of T affects the obtained result in the following aspects (table I):

Table I. Consequences of the increase of the value of t .

Aspect	Variation
Points of the resultant line	Diminishes
Processing time	Diminishes
Smoothing	Diminishes
Topological conflicts	Increases
Adaptations to the original line	Diminishes

That is why, it becomes necessary to evaluate the obtained results to achieve in each process the tolerance that would provide equilibrated results in the mentioned aspects.

III. BÉZIER CURVES

In the cartographic generalization process, smoothing algorithms are used to improve the esthetic appearance of a line, reducing the angularities which were produced with simplification algorithms. In general, they act shifting the points on the original line to other positions, so they are able to reduce or eliminate these angularities respecting the characteristic tendencies of the line. According to the applied procedures, these algorithms can be classified in three groups [12]: spatial *convolution* (arithmetic mean, average through

shifting [11], Gaussian filtering [13], Boyle [14]), *frequency domain* (Fourier series, *wavelets*) and *mathematical approximations*. Due to the interest of our study, we will center in the third group. Its fundament consists in obtaining an approximation to the original line by *adjusting* with respect to it some of the plane curves defined by polynomial equations of degree greater than one (circumferences, parables, cubic arcs, etc.). One of the most used methods is the one based on the *splines* [15], which are curves defined by segments by means of polynomials. **Bézier curves** make up the base for the best known and most used smoothing algorithms too.

The theoretical fundaments of the Bézier curves were developed by the French engineer Pierre **Bézier** (1910-1999) during the 60s of last century [16]. These fundaments will be briefly referred next [17].

In the context of linear algebra, the approach to the mentioned adjustment is the following: given a function $y = f(x)$ whose value is known in $n + 1$ points (P_0, P_1, \dots, P_n) , and its value is approximated in an another arbitrary point P . To achieve that, a polynomial of degree less than n which would adopt the known values $f(x_i)$ for $i = 0, 1, \dots, n$ is used. This is the so called classic *polynomial adjustment* or *polynomial interpolation* problem¹. There exist solutions of global adjustment (*Lagrange* formula, *Newton* formula) which consider all known data, and solutions of segment adjustment (*splines*), which interpolate a curve between every two given points.

In the field of graphic design, the parametric equations are the most used for representing curves, due, among other reasons, to the convenience of make independent the definition of the curve from the used coordinate system. In the same trend, the adjustment problems usually are solved beginning from the parametric equations. Centering in our problem and considering in the plane —the surface we are interested in— the $n + 1$ points of known coordinates $(x_0, y_0), (x_1, y_1), \dots, (x_n, y_n)$, the obtained curve after the adjustment (global or by segments), expressed in parametric form, will have this form:

$$\begin{cases} x = P_n(t) \\ y = Q_n(t) \end{cases} \quad (1)$$

where $P_n(t)$ adjusts the values (t_i, x_i) and $Q_n(t)$ adjusts in (t_i, y_i) , being $t_i = i/n$, with $i = 0, 1, \dots, n$.

This adjustment presents, among others, the inconvenient of not allowing the control of the form of the curve the user is designing. In order to avoid this conflict, one of the most used resources is the Bézier curves, based on the *Bernstein polynomials*.

The Bernstein polynomials of degree n , called $B_{0,n}(t), B_{1,n}(t), \dots, B_{n,n}(t)$, are defined by the following expression:

$$B_{i,n}(t) = \binom{n}{i} (1-t)^{n-i} t^i, \quad (2)$$

with $i = 0, 1, \dots, n$.

So, for example, the Bernstein polynomials of degree 3 are:

$$\begin{cases} B_{0,3}(t) = (1-t)^3, & B_{1,3}(t) = 3(1-t)^2 t \\ B_{2,3}(t) = 3(1-t) t^2, & B_{3,3}(t) = t^3 \end{cases} \quad (3)$$

In figure 2 its graphic representation can be seen, with $t \in [0, 1]$.

A Bézier curve associated to $n + 1$ points of the plane (P_0, P_1, \dots, P_n) is the denomination of the curve defined for $t \in [0, 1]$ whose parametric equations adopt the following expression:

$$\begin{cases} x(t) = \sum_{i=0}^n B_{i,n}(t) x_{P_i} \\ y(t) = \sum_{i=0}^n B_{i,n}(t) y_{P_i} \end{cases} \quad (4)$$

being $B_{i,n}(t)$ the Bernstein polynomials of degree n .

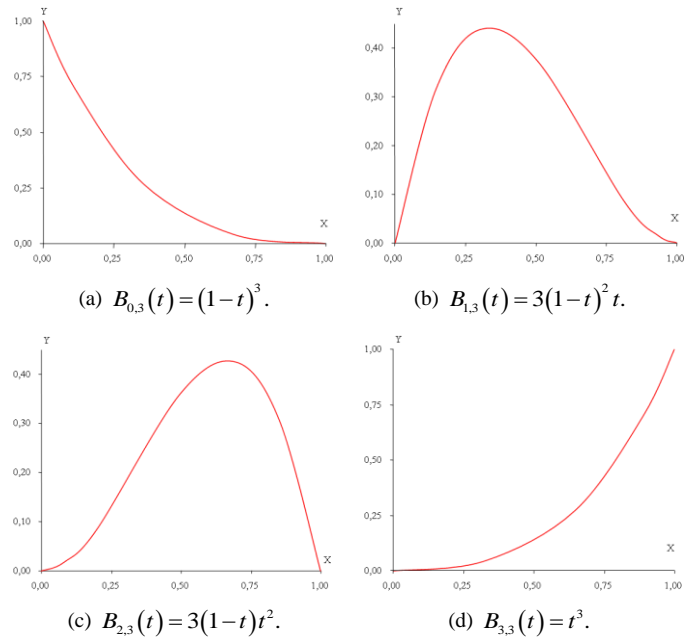
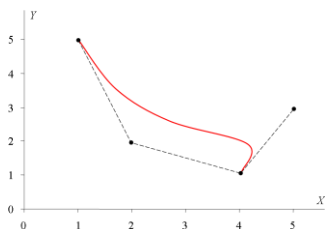


Figure 2. Bernstein polynomials of degree 3.

The points P_0, P_1, \dots, P_n that determine a Bézier curve are called *control points* and, as it can be deduced from expression 4, its order is fundamental: its tracing passes only through initial P_0 and final P_n points, while the rest mark its «tendency» without forming part of it (figure 3). Graphically, this means that the Bézier curve associated to the precedent $n + 1$ points supposes a smoothed polygonal line formed by these ones. Therefore, in the context of cartographic generalization different smoothing algorithms have appeared which use mathematical approximations based on the Bézier curves.

On the other side, as it has been signaled above, the parameter t that intervenes in the parametric equations that define a Bézier curve adopts a value included in the $[0, 1]$ interval, so that each value of t provides a point of the curve. That way, when the number of parameter values the curve will become smoother.

¹ Besides this one there exist other adjustment problems (Taylor, Hermite, etc.) that will not be treated here because they will take far away from the pretentions of this article.



(a) $P_0 = (1, 5)$, $P_1 = (2, 2)$,
 $P_2 = (4, 1)$ y $P_3 = (5, 3)$.

(b) $P_0 = (1, 5)$, $P_1 = (2, 2)$,
 $P_2 = (5, 4)$ y $P_3 = (4, 1)$.

Figura 3. Curvas de Bézier.

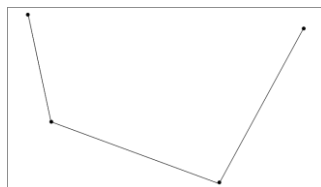
As a consequence, in order to use Bézier curves as smoothing algorithm, it is necessary to establish previously the number of values that the mentioned parameter should adopt, considering the following criteria:

- The original curve can be smoothed out keeping its tendency starting from a number of values of t equal to the number of points of the curve, which will constitute the control points of the resulting Bézier curves.
- The layout of the Bézier curves improves, if well distributed values of t inside the indicated interval are chosen. In table II some examples are included.

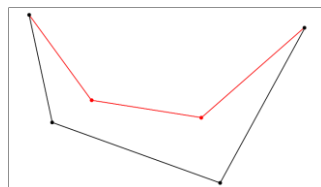
Table II. Appropriate values of parameter t in function of the number of control points.

Number of control points	Values of t				
3	0	0,50	1		
4	0	0,33	0,66	1	
5	0	0,25	0,50	0,75	1

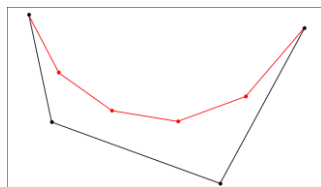
- The more the number of values of t are, the more the smoothing effect improves. From now on, k will be the number of values of t added to the number of points of the curve (control points). This growth supposes an increment of points of the final curve and a more laborious calculation process. These issues oblige to evaluate the obtained results to attain an equilibrium solution among the added number of values, the processing time and the aesthetics of the resulting smoothing (figure 4 and table III).



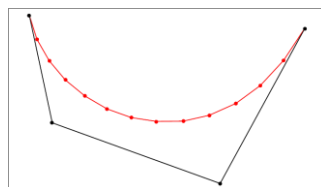
(a) Original line (4 points).



(b) Smoothed line
($k = 0 \Rightarrow 4$ points).



(c) Smoothed line
($k = 2 \Rightarrow 6$ points).



(d) Smoothed line
($k = 10 \Rightarrow 14$ points).

Figure 4. Bézier Curves.

Table III. Appropriate values of parameter t with different values of k ($n = 3 \Rightarrow 4$ control points).

k	Values of t													
0	0	0,33	0,66	1										
2	0	0,20	0,40	0,60	0,80	1								
10	0	0,08	0,15	0,23	0,31	0,38	0,46	0,54	0,62	0,69	0,77	0,85	0,92	1

At last, the number of control points should be reduced for two main reasons:

1. In the algebraic expression of the Bernstein polynomials (equation 2), on which the Bézier curves are based, each one of the parametric equations $x(t)$ and $y(t)$ includes $n + 1$ combinatorial numbers that are calculated by means of factorials, being n the number of control points. The calculation capacity of the computer systems limits the number of possible factorials and, in definitive, the number of control points.
2. In this sense, the conditions of obtaining a resulting line adapted as much as possible to the tracing of the original becomes more restrictive. When the number of control points increases, the mean distances between both of them rise up to unacceptable values.

For that reason the criterion of using the so called **cubic Bézier curves** with four control points was adopted.

IV. GENERAL CHARACTERISTICS OF THE PROGRAM

Next the general characteristics of the application will be presented, as it will detailed afterwards [18]:

- It is a command of the GIS application GeoMedia Professional (Intergraph), valid for the last versions (6.0 y 6.1).
- The Visual Basic .Net language has been used for its codification, with the development environment Microsoft Visual Studio 2005. Although there exist subsequent versions of that environment (2008 y 2010), the programming of the command require the employment of the complement GeoMedia Command Wizard which at the moment can only be used on 2005 version.
- It codes the Douglas-Peucker algorithm and the one based on the Bézier curves aforementioned, allowing the variation of the characteristic tolerance of the first one and the number of points added in the second one.
- It admits vector files in .mdb format, which is specific of GeoMedia, generated with the data base manager system Access. They are relational databases (DB) that store the geographic information in tables, so that on each table the elements belonging to the same entity class or to several ones of the same themes are recorded. In a table, each recorded or row corresponds to an element of the class, whose attributes and coordinates are stored in the different fields or columns that constitute the record.
- It offers the possibility of applying the former algorithms in an independent or successive order (first, Douglas-Peucker; next, Bézier curves).

- It permits the treatment as a whole of several entity classes (tables), when they are linear, keeping the topologic relationships among them.
- It presents a report on the screen after processing each file and it allows saving in a text file the obtained results.

V. INFORMATION PROCESSING

Once the program is installed and the access from the application is created, the command gets activated when establishing any connection in read-write mode to a DB (.mdb file). It consists of a main dialogue window with four functionality areas (figure 5):

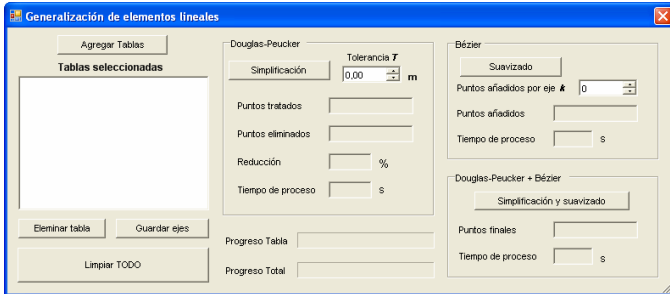


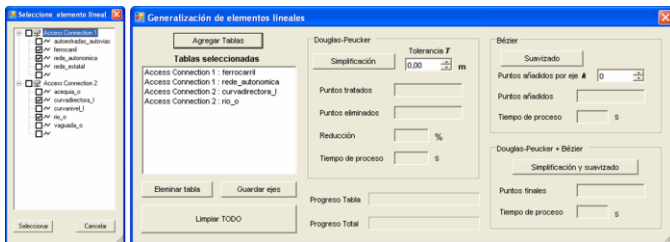
Fig. 5. Main dialogue window of the generalization command.

1. Table management (in the DB of the established connections).
2. Douglas-Peucker.
3. Bézier.
4. Douglas-Peucker + Bézier.

Two bars centered on the inferior part show the progression in the application of each process: «Progreso Tabla» shows progress of the treatment of each table individually; «Progreso Total» shows the progress of the whole process.

The «Gestión de tablas» area presents the options that are next described:

- «Agregar Tablas». It shows another dialogue window with the established connections. When deploying them, the tables with the elements of linear geometry that form each connected database come up. The selected tables (figure 6a) are visualized in the main panel after clicking the «Seleccionar» button (figure 6b).
- «Eliminar Tabla». It permits to delete one by one any of the tables selected before.



(a) Selection. (b) Visualization in the main dialogue window.

Fig. 6. Selection tables from different DB.

- «Guardar ejes». It builds a topology among the elements of the selected tables and it saves the coordinates of the resulting axes in a text file (.txt) (figure 7).

- «Limpiar TODO». It deletes all the selected tables and the results appear on the windows after any the algorithms is applied.

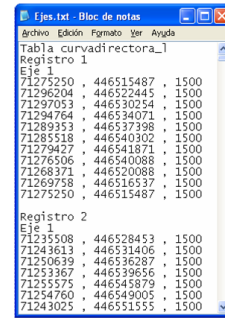


Fig. 7. Building of the topology: resulting axes are shown.

The «Douglas-Peucker» area allows the application of this algorithm independently. Once the tables are selected in the previous area, it includes the following options:

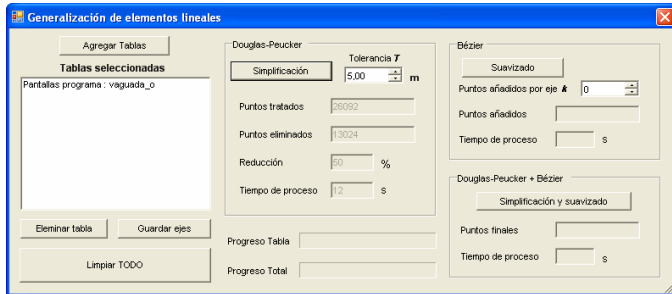
- «Tolerancia T». It permits to select the tolerance in meters.
- «Simplificación». It implements the following successive operations:
 5. It records the time at which the process.
 6. It loads the selected tolerance.
 7. It starts the progression bars.
 8. It builds up the topology among the elements of the selected tables by cross comparing the tables with one another and with themselves. That way the nodes that make up the crosses among elements are obtained and their position remains the same as it should. Every two consecutive nodes constitute an axis.
 9. With each one of the axes,
 - a) It counts the number of points.
 - b) It applies the algorithm with the selected tolerance, checking before two questions:
 1. Whether the initial and final nodes coincide (it is a closed line). In this case, it dispenses with the final node, it applies the algorithm to the rest of the points and finally it adds the final node to the resulting line.
 2. Whether it has less than three points, in which case it is not applied and the axis remains invariable.
 - c) It counts the number of points of the final axis.

As it was indicated, the resulting lines keep the initial and final points of the original lines, so that it is guaranteed to conserve the position of the extreme nodes of each axis.

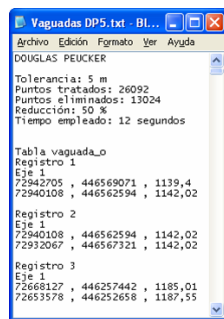
10. After the generalization of every axis, it combines them to rebuild the geometry of each final line.
11. It saves this geometry by modifying the tables that contain now the new elements.
12. It records the final instant of the process.
13. It calculates the deleted the points, the reduction in the number of points and the processing time, and it presents the results in the respective text panels of the main dialogue window. Besides it adds the number of treated points, obtained by gathering the points of each axis (5a) (figure 8a).

14. Finally, by means of a dialogue window with the «SÍ» and «NO» command buttons, propose to store the results in a text file:

- d) The «SÍ» option permits to save in a file the information about the carried out process and to terminate the process (figure 8b).
- e) With the «NO» option the process exits.



(a) Report in the main dialogue window.



(b) The file as shown.

Fig. 8. Results from the application of the Douglas-Peucker algorithm ($T = 5$ m).

As regards the «Bézier» area it permits the independent application of the algorithm based on the Bézier curves. Once selected the tables previously in the «Gestión de tablas» area, it includes the following options:

- «Puntos añadidos por eje k ». It allows the input of the number of points to add by resulting axis, which it has been called k .
- «Suavizado». It runs successively the following operations:
 1. It records the time at which the process starts.
 2. It loads the added points input by axis.
 3. It starts the progress bars.
 4. It builds up the topology among the elements of the selected tables with the same procedure as in the previous case.
 5. With each axis:
 - f) It counts the number of points.
 6. It divides it in segments of four points.
 7. It calculates the parametric equations of the resulting Bézier curves considering as control points the four points that make up each segment.
 8. It calculates the points of the Bézier curve associated to the four points of the segment assigning different values to the parameter t . If the value of the «Puntos añadidos por eje» windows is not modified (by default, $k = 0$), t adopts four values in the $[0, 1]$ interval, so that with $t = 0$ and $t = 1$ initial and final points will be the same, respectively,

and the rest of the values are symmetrically distributed in that interval. If a $k > 0$ value is introduced, the program assigns $4 + k$ different values for t , which are distributed the criterion above.

The resulting curves keep the same initial and final points of the original lines, according with what has been discussed above. Therefore, the initial topology keeps the same.

9. As in the previous case, after the generalization of every axis, it combines them, rebuilding the geometry of each resulting line and modifying the tables that contain the new elements.
10. It records the finalization time of the process.
11. It calculates the processing time and the total number of added points (k times the number of points obtained in the topologic construction). It presents the results in the respective text boxes of the main dialogue window (figure 9).
12. Besides, once finalized the process, the program proposes to save the results in a text file following the above mentioned procedure.

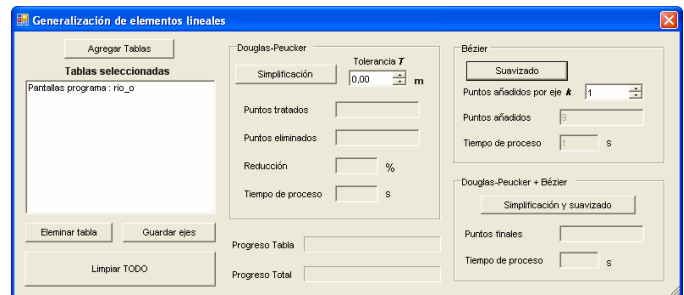


Fig. 9. Application of the algorithm based on the Bézier curves ($k = 1$).
Report in the main dialogue window.

As regards the «Douglas-Peucker + Bézier» area, it permits the successive application of both algorithms. Once previously selected the tables in the «Gestión de tablas» area and introduced the values of «Tolerancia T » and the number of «Puntos añadidos por eje k » in the «Douglas-Peucker» and «Bézier» areas, respectively, the «Simplificación y suavizado» option carries out the following sequence of operations:

1. It records the start time of the process.
2. It loads the added points by axis.
3. It loads the selected tolerance.
4. It starts the process bars.
5. It builds up the topology with the same procedure as in the above cases.
6. With each axis:
 - g) It applies the Douglas-Peucker algorithm, following independently the process.
 - h) It applies the algorithm based on the Bézier curves, conforming to the independent process.
7. As in the former cases, it combines the transformed axis rebuilding the geometry of every resulting line and modifying the tables that contain the new elements.
8. Likewise, it presents the option of saving the results in a text file (figure 10).

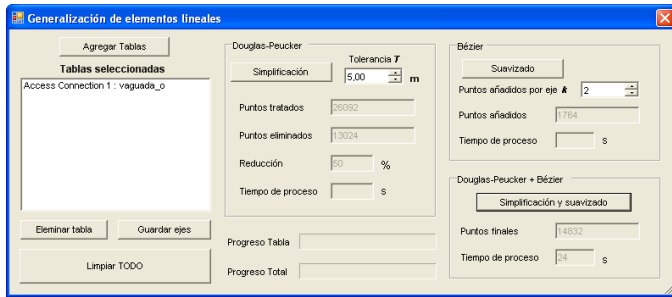


Fig. 10. Douglas-Peucker Algorithm ($T = 5$ m) based on Bezier curves ($k = 2$). Report on the main dialog box.

VI. CONCLUSIONS

The described computer application, recommended in processes that suppose small scale reductions (in a 1:2 relationship or similar), offers two main capacities:

1. The generalization of the linear elements of a cartographic set in vector format. In order to attain this, the application codes the Douglas-Peucker simplification algorithm and the smoothing one based on the Bézier curves, considering the simultaneous treatment of different geometry entity classes and preserving the original topological relationships among them.
2. The analysis of the obtained results after the transformation made by the previous process, by means of the trial with different parameters and the contrast of the results. In order to get that, the application permits to change the characteristic parameters of the concerned algorithms and it offers a report of the results after each process: treated, deleted, added or final points, in every case, as well as the processing time.

VII. ACKNOWLEDGMENT

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