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Developing Creativity and Broad Mental Outlook in the Information Society

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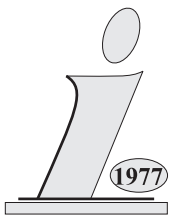

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Editor's Introduction to the Special Issue Developing Creativity and Broad Mental Outlook in the Information Society

1 Introduction

The modern information society has provided numerous new material possibilities for the millions of people. Simultaneously, it has been possible to observe a number of negative shifts in the systems of values of people, in particular, the increase of a gap between the intellectual and spiritual development of many people, the evolution of the systems of values towards commercialized values; such gap and evolution have numerous negative consequences – from underdeveloped ecological consciousness to the failures in the private life. Besides, many national cultures encounter considerable problems in the age of globalization.

With respect to the above said, two basic ideas underlie this Special Issue: (1) many sciences are to join efforts in order to elaborate a common fundamental approach to compensating the mentioned shifts in the systems of values, to supporting and developing the creativity and emotional sphere of the person, (2) Informatics (or Computer Science) has a lot to do in this direction.

2 Overview of the Issue

This Special Issue contains eight articles prepared by the authors from three continents (Africa, Europe, North America) and six countries: Botswana, Canada, Italy, The Netherlands, Romania, Russia. Seven articles are based on the papers presented at the Third International Workshop "Developing Creativity and Broad Mental Outlook in the Computer Age – CBMO-2006" in conjunction with the 10th Conference of the International Society for the Study of European Ideas – ISSEI 2006 (University of Malta, July 24 - 29, 2006). The article by Dr. Roger Moore from Canada was kindly recommended by Dr. Linda Turner, a Co-Chair of the Second International Workshop "Developing Creativity and Broad Mental Outlook in the Computer Age – CBMO-2002" in conjunction with the International Conference ISSEI 2002 (The University of Wales, Aberystwyth, UK, July 22 - 27, 2002).

The article Cognitonics as a New Science and Its Significance for Informatics and Information Society by Vladimir A. Fomichov and Olga S. Fomichova contains an updated definition of Cognitonics as a new science which, in particular, is studying and looking for the ways of improving cognitive mechanisms of processing information and supporting and developing emotional sphere. The paper outlines a possible structure of Cognitonics and proposes its formal tool - the notation of conceptual-visual dynamic schemes, being an extension of the notation of semantic nets. The optimal preconditions of successful introducing young children to computers are formulated as a consequence of discovering by the authors of one of the possible ways of achieving in teaching the goals of Cognitonics. Finally, a new, large-scale goal for the software industry is formulated: to construct a new generation of culture-oriented computer programs – the programs destined for supporting and developing creativity, cognitive-emotional sphere, the appreciation of the roots of the national cultures, the awareness of the integrity of the cultural space in the information society, and for developing symbolic information processing and linguistic skills, associative and reasoning abilities of children.

The next two papers describe the structure and applications in education of the programs belonging to a new generation of the culture-oriented computer programs. The paper "ADDIZIONARIO": a New Tool for Learning between Metacognition and Creativity by Maria Assunta Zanetti, Giovanna Turrini, and Daniela Miazza analyses the experience of using the hypermedia linguistic laboratory Addizionario by Italian children for creating conceptual maps, generally recognized as an important means of knowledge acquisition and organization. The content of children's activities was to accumulate and organize the knowledge about Pavia, their native town. The experiment carried out by the authors is described in a broad context of modern psychological theories concerning meaningful learning, emotional learning, intentional learning, development of creativity. The article AddizionarioPLUS: a Creative Approach to Linguistic and Intercultural Education by Giovanna Turrini, Paola Baroni and Alessandro Paccosi describes the multimedia system AddizionarioPLUS, being an updated, multilingual version of Addizionario.

Roger Moore in the paper Don Quixote 1605-2005: Teaching Don Quixote on WebCT in the 21st Century describes an experience of developing reasoning abilities and mental outlook of the university students by means of a hybrid course Don Quixot 1605 – 2005, based on the E-learning platform WebCT. The analysis of the selected students' comments given in the final part of the article helps to understand the role of studying the classic literature in developing the personality of the student.

The article Modern Methods for Stimulating Creativity in Education by P.Chakalisa, D.Mapolelo, E.D.Totev, D.M.Totev contains a short survey of the scientific literature studying the phenomenon of creativity and describes an experience of developing independent thinking and creativity of students with the help of using the programmable logic controllers (or programmable micro-controllers) in the teaching/learning process. Sandro Girolamo Tropiano in the article New and Old Technologies: a Suitable Combination for Obtaining Efficient Educational Results shows how the combined use of "old" and "current" technologies for

studying the same physical process helps to grasp the principal regularities of this process and to highlight the development of the scientific thought. It is done on the examples of introducing students to non-linearity and of measuring time.

The paper How Learner's Proficiency May Be Increased Using Knowledge about Users within an E-Learning Platform by Dumitru Dan Burdescu and Marian Cristian Mihăescu describes a method of analysing data gathered from an E-learning Web-based platform destined for guiding students in the educational process. The article Surfing Hypertexts with a Metacognition Tool by Giuseppe Chiazzese, Simona Ottaviano, Gianluca Merlo, Antonella Chifari, Mario Allegra, Luciano Seta, and Giovanni Todaro describes the results of testing the system Did@browser destined for supporting the process of constructing knowledge by students during their surfing and learning on the World Wide Web.

I am grateful to the authors of the articles, the reviewers, and Dr. Linda Turner from the St. Thomas University (Canada) for their efforts helping to prepare this Special Issue.

Vladimir Fomichov

Cognitonics as a New Science and Its Significance for Informatics and Information Society

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An updated definition of Cognitonics as a new science which, in particular, is studying and looking for the ways of improving cognitive mechanisms of processing information and supporting and developing emotional sphere is introduced. The paper outlines a possible structure of Cognitonics and describes its formal tool. It is the notation of conceptual-visual dynamic schemes (CVD-schemes) - an extension of the notation of semantic nets, being popular in the artificial intelligence theory. A general approach to the use of CVD-schemes for inventing effective analogies in order to introduce difficult pieces of studied theoretical materials is illustrated. The optimal preconditions of successful introducing young children to computers are formulated as a consequence of discovering by the authors of a possible way of achieving in teaching the goals of Cognitonics. With this aim, the concept of the 'Thought-Producing Self' of the child is defined. The paper describes a scheme of the proposed method of the harmonic humanitarian development of the child allowing for realizing the 'Thought-Producing Self' of each normal, average child by the age of seven - nine, where the starting age is five to six years. The method has been personally tested by one of the authors during 16 years, the total number of successfully taught young children and teenagers exceeds four hundred. Finally, a new, large-scale goal for the software industry is formulated: to construct a new generation of culture-oriented computer programs (in the collaboration with educators, linguists, art historians, psychologists) – the programs destined for supporting and developing creativity, cognitive-emotional sphere, the appreciation of the roots of the national cultures, the awareness of the integrity of the cultural space in the information society, and for developing symbolic information processing and linguistic skills, associative and reasoning abilities of children.

Povzetek: Opisana je kognitonika kot nova zvrst znanosti.

1 Introduction

Since the middle of the twentieth century, Informatics (or Computer Science) has been one of the most quickly progressing fields of professional activity. Of course, today many leaders in the software industry are only-profit-oriented, that is why we see so many computer games of aggressive character being sold in various countries. However, there are also the leading professionals in the field with a broader mental outlook, analyzing the social role of Informatics in the modern world and looking for the ways of increasing social significance of the technical progress in the field. For instance, Bill Gates in an interview shown on the Russian TV in fall 2006 expressed the intention to pay a considerable attention to stimulating the progress in education and to increasing the contribution of informational technologies to this progress.

This paper, going beyond the scope of Informatics, indicates new problems for Informatics, in particular, for the software industry in such a way that solving these problems would contribute to supporting and developing creativity, cognitive-emotional sphere, appreciating the roots of the national cultures, and, as a consequence, to compensating the observed shift in the people's systems of values from eternal to commercialized values, to creating appropriate cognitive preconditions of the ongoing process of globalization in the modern information society.

On the level of every-day life, a lot of people believe that there is a connection between the state of minds of people in a society and the development of the society. This vague idea received a scientific treatment, was considerable deepened and refined in the paper (Hiwaki, Tong, 2006). The analysis carried out in this paper by Prof. K. Hiwaki on the example of the current situation in Japan showed that a long-term negligence to national culture, the lack of efforts (on the state level) to teach the young generation to appreciate the values of national culture, the desire to mechanically adapt the values of a different, market-oriented culture may have a severe negative influence not only on the moral state of the society but also on its economics.

Proceeding from our analysis of the increasing gap between the intellectual and spiritual development of many people in the modern information society, of the evolution of the systems of values of people towards commercialized values (such gap and evolution have numerous negative consequences – from underdeveloped ecological consciousness to the failures in the personal life), of the problems encountered by national cultures in the age of globalization, and from the analysis carried out in (Hiwaki, Tong, 2006), we substantiate in this paper the necessity and possibility of creating a new science called Cognitonics. This problem was formulated for the first time in the papers (Fomichova, Fomichov, and Udalova, 2004, 2005)[1] and was analyzed in the works (Fomichova, Fomichov, and Udalova, 2006; Fomichov and Fomichova, 2006; Fomichova and Fomichov, 2006).

This paper is a considerably modified and expanded version of two our papers presented at the Third International Workshop "Developing Creativity and Broad Mental Outlook in the Computer Age – CBMO 2006" in conjunction with the 10th Conference of the International Society for the Study of European Ideas - ISSEI 2006 (University of Malta, Malta, July 24 - 29, 2006).

In this paper we formulate an updated definition of Cognitonics as a new science conducing, in particular, to overcoming an increasing gap between spiritual and intellectual development of the person in the new reality of swift changes in the modern information society, technological challenges, and globalization. This new science is to study and look for the ways of improving cognitive mechanisms of processing information and supporting and developing the emotional sphere of the personality – the ways aiming at compensating some negative shifts (analyzed below) in the system of values of people and, as an indirect consequence, for the ways of developing symbolic information processing skills of the learners, linguistic mechanisms, associative and reasoning abilities, being important preconditions of successful work practically in every sphere of professional activity in information society.

Then we outline a possible structure of Cognitonics as a science consisting of seven interrelated components. Two of these components are directly connected with Informatics. The first one is formed by the studies aimed at finding an optimal age (or a diapason of ages) and cognitive preconditions of systematic introducing children to computers. The second component is theoretical foundations of designing computer information technologies and systems of a new generation aimed at supporting and developing creativity, cognitive-emotional sphere, appreciation of the roots of the national cultures, and developing symbolic information processing and linguistic skills, associative and reasoning abilities.

We propose in this paper not only an updated definition and possible structure of Cognitonics but also its formal tool. This tool is *the notation of conceptual-visual dynamic schemes (CVD-schemes)*, introduced in our papers published in Informatica (Fomichov and Fomichova, 1994; Fomichova and Fomichov, 1996) and in (Fomichov and Fomichova, 1995). The notation of CVD-schemes is an extension of the notation of semantic nets, being popular in the artificial intelligence theory. The CVD-schemes allow for inventing effective dynamic conceptual mappings, or correspondences, between a bright fragment of the inner world's picture of the leaerner and the mental representation of a piece of theory to be studied, so the CVD-schemes help to invent effective ways of introducing difficult pieces of learned theoretical materials (in other words, help to find effective teaching analogies).

We managed to find one possible way of achieving the goals of Cognitonics in practice. It has been proved by successful 16-year-long educational experiment carried out in Moscow by one of the authors. The total number of successfully taught young Russian children and teenagers exceeds four hundred, the age of the students varies from 5 years to 21 years.

These practical results are based on our *Theory of Dynamic Conceptual Mappings (the DCM-theory) and the Methods of Emotional-Imaginative Teaching (the EIT-methods)*; the starting basic papers on the DCM-theory and the EIT-methods were published in Informatica (Fomichov and Fomichova, 1994, 1997; Fomichova and Fomichov, 1996). Now the DCM-theory and the EIT-methods are presented in over forty our publications in English; the principal references are (Fomichov and Fomichova, 1994 - 2006; Fomichova and Fomichov, 1996 – 2006). Besides, the ideas of the DCM-theory and the EIT-methods are presented in (Fomichova et Fomichov, 2001; Fomichova, 2000, 2002).

Since the DCM-theory and the EIT-methods provided the theoretical basis for finding one possible way (among, it seems, many possible ways taking into account the peculiarities of the national culture of the learners) of achieving in practice the goals of Cognitonics, we formulate in this paper the hypothesis that Cognitonics does already exist, and its current configuration is formed by the publications on the DCM-

[1] The second paper was presented at the 17th International Conference on Systems Research, Informatics and Cybernetics held August 1 – 7, 2005 in Baden-Baden, Germany and received The Outstanding Paper Award of The International Institute for Advanced Studies in Systems Research and Cybernetics.

theory and the EIT-methods. Such different fields as Philosophy, Artificial Intelligence Theory, Cognitive Linguistics, Cognitive Psychology, Cognitive Biology have contributed to the birth of Cognitonics.

We describe in the paper the scheme of one, found and well tested by us, possible way of achieving in practical teaching the goals of Cognitonics. This way can be considered as a realization in practice of a new, humanities-based method of developing the personality of the child: his/her creativity, symbolic information processing skills (including linguistic skills, the ability to decode metaphors), associative and reasoning abilities, emotional sphere (see, in particular, Fomichov and Fomichova, 1997, 1998, 2001).

However, it turned out to be that this humanities-based method has much to say about the social role of Informatics in the modern world. There are numerous evidences of the tendency in various countries to permanently diminish the starting age for introducing children to computers, even to use computers in pre-school education (see, e.g., Tatkovic, Ruzic, Pecaric, 2006). But our observations and the observations of our colleagues in many countries show that too early, not thoroughly thought over acquaintance of young children with computer very often negatively influences the development of the personality of the child, his/her creativity and curiosity, hampers the development of the emotional sphere. The principal problem is that the young child, as a rule, has no tasks of creative character to be investigated and solved, using a computer as a good assistant.

That is why, unfortunately, for too many young children in the world the main direct consequence of early acquaintance with computer is the access to computer games (often provoking the aggressiveness) and, as a result, the hampering of the child's creativity and curiosity, "eating up" the time needed for normal education and additional activities developing the personality of the child (reading, music, painting, foreign languages, sport, etc.).

In the final part of this paper we describe the discovered optimal preconditions for introducing young children to computers; this part of the paper gives a new angle of look at this problem. With this aim, we use the concept of Thought-Producing Self, introduced in our papers (Fomichov and Fomichova, 2000; Fomichova, 2000; Fomichova and Fomichov, 2000).

We say that the Thought-Producing Self of the young child is realized when the child has received an experience of observing a delight, a pleasure, an approval, etc. of his/her peers and/or adults caused by an original, beautiful thought just born in the mind of the child. From this moment, the child begins to appreciate the work of his/her mind and begins to look for the ways of experiencing once more the wonderful moments of generating new, socially significant thoughts.

The essence of the new look at the problem of finding optimal cognitive preconditions of introducing children to computers can be formulated as follows: it is necessary to develop the personality of the child until the stage of realizing the Thought-Producing Self and only after this moment to systematically introduce the child to computer. The final part of the paper schematically describes one possible way discovered and well tested by us during 16 years to realize the Thought-Producing Self of practically each Russian child with normal, average abilities by the age of seven-eight. Since the essence of the first step of this discovered way is early teaching children to fluently read and discuss complicated texts in English as a second language, to use a very rich sublanguage of English for expressing the impressions from the beauty of the nature (in particular, by means of metaphors), this way (after some adaptation) can be used practically in every country in order to escape a damage from too early, not thought-over acquaintance of children with computer.

Finally, we outline a new, large-scale goal for the software industry. This goal is to construct a new generation of culture-oriented computer programs (in the collaboration with educators, linguists, art historians, psychologists) – the programs destined for supporting and developing creativity, cognitive-emotional sphere, the appreciation of the roots of the national cultures, the awareness of the integrity of the cultural space in the information society, and for developing symbolic information processing and linguistic skills, associative and reasoning abilities of children.

2 Three Shifts in the System of Values

The quick technological development of modern civilization has brought a lot of precious things to the millions of people: nice cars, TV, cell telephones, etc. However, every coin has two sides. One of the most important negative aspects of the quick technological development is the observed shifts in the system of values of people. Let's define three main shifts.

The first shift is the shift from the eternal values to commercialized values. This shift has been noticed by many scholars, in particular, by Professor K. Hiwaki from Tokyo International University (Hiwaki, 2003; Hiwaki and Tong, 2006) and by many other participants of the symposia on Sustainable Development of the Global Community and of the symposia on Personal and Spiritual Development in the World of Cultural Diversity in conjunction with the International Conferences on Systems Research, Informatics and Cybernetics (InterSymp conferences) in Baden-Baden, Germany.

The second shift is a consequence of the underestimation of the value of national cultures in contrast to the overestimation of the on-going processes of globalization by the young generation, in particular.

The third shift is dealing with the existing gap between the intellectual and spiritual development of the personality. The notion "human being" can't be regarded without considering such notions as "body", "soul", "spirit". The expanding gap destroys the integrity of the human nature. Spiritual values are rooted in the developed emotional sphere of the personality. The emotional sphere is closely connected with the sensitivity. Modern education is focused on the

development of cognitive mechanisms being necessary for improving the information processing abilities of the child. As for developing the emotional sphere of the child, there is no *evident* necessity for it. Informational technologies *don't require* the spiritual development of the person. But it is clear that every intellectual discovery should be followed by equal to it spiritual discovery, lest the present time and challenging prospects should split off the eternity.

3 The Definition of Cognitonics

We believe that the modern information society has accumulated a lot of such problems concerning the development/underdevelopment of the personality that for solving these problems it is necessary and possible to elaborate a unified, fundamental approach. This approach is to be the creation of a new science which may be called Cognitonics. In (Fomichova, Fomichov, and Udalova, 2004, 2005), Cognitonics is defined as a new branch of the humanities which is studying and looking for the ways of improving cognitive mechanisms of processing information with the aim of creating cognitive preconditions of sustainable development of the global community. This new science is to be based on the symbolic approach to teaching language (natural language, language of poetry, language of painting) as a tool of thinking. It is to combine the achievements of philosophy, psychology, linguistics, and artificial intelligence theory (because it explicates many mechanisms of human thinking) and to use literature, poetry, and painting as the basic material for revealing Self, because Self lies at the center of mental life and spiritual development.

Taking into account the above said, we would like to update the definition of Cognitonics as follows. Cognitonics is a new science aimed at keeping the integrity of the nature of the human being (that is the integrity of body, spirit, and soul) and, consequently, conducing to overcoming a gap between spiritual and intellectual development of the person in the new reality of swift changes, technological challenges, and globalization. Cognitonics is studying and looking for the ways of improving cognitive mechanisms of processing information and emotional sphere of the personality – the ways aiming at compensating three indicated shifts in the system of values and, as an indirect consequence, for the ways of developing symbolic information processing skills of the learners, linguistic mechanisms, associative and reasoning abilities, being important preconditions of successful work practically in every sphere of professional activity in information society.

Cognitonics as a new science grew out of the necessity to answer the challenge of Time in the field of education. The task of Cognitonics is to combine the material and ideal levels of the one and the same process of globalization in the consciousness of people, young generation in particular. The application domain of Cognitonics are Education and Informatics. It means that with the help of the new approaches elaborated under the framework of Cognitonics and based on the ideas of constructivist theory it appears to be possible to put into practice the achievements of Cognitonics.

Before discussing the proposed structure of Cognitonics, let's analyze in more details the mentioned three shifts in the system of values. This analysis will help to explicate a number of ideas underpinning our vision of the structure of Cognitonics.

4 The Changed Look at Time and the Shift to Commercialized Values

An important peculiarity of the 21st century which Cognitonics is dealing with is a transformation of such fundamental notion as "time". The perception of the category of time is changed. The existing perception of time as a flood of images in the race of events prevents humans from spiritual development. We are not sipping the information – we are gulping it. We are plunging into another culture, regarding it as a new source of information, without perceiving it in a philosophical way; we are careless with language. We are not walking – we are racing; we are not living in space and time, but the space is transformed to a virtual space, and time is becoming the most precious present we may afford.

The perception of the world is closely connected with the perception of time. In the time of antiquity humans addresses God, and time for them was equal to eternity. When Leeuwenhock, a famous Dutch scientist, discovered in 1673 the moving world in the drops of water, blood, the perception of the world changed, and the painters immediately started "twisting" time" on the canvas (for example, Magnasco, 1667 – 1749, an Italian painter). At the end of the XIXth century, the impressionists tried to catch a moment. Nowadays the mental representation of time is transferred into the flood of images, and it is revealed, for instance, in a great number of art installations.

Poetry, literature, painting, philosophy help the students to see and realize the flood of time and to understand the difference in perception influenced by the way people regard time. It is a thought-provoking impression stimulating integral perception of the situations and the process of thinking in general. Creativity is rooted in the combination of contemplation and action. It correlates with the necessity to have self-paced activity regardless to the rapid changes of the society and to be skillful enough to keep pace with time. On the other hand, regarding the human being as a point of intersection of *two worlds – eternal and temporal* makes it easy *to restrain the extension of the existing shift from eternal values to commercialized values.*

5 Cognitonics and Globalization Processes in the Modern Information Society

It is clear that the system of education should be adapted to the modern civilization and should meet the requirements of the new information society, revealing

strong tendency to globalization. But on the other hand, the humanity shouldn't start from the "tabula rasa", and the young generation shouldn't be pushed to denying its own culture in order to be inscribed into the global world. On the contrary, the process of entering the global world and searching for a sounder and more satisfactory lifestyle for our global community requires an appropriate response in the field of education.

The human being is a precondition of thought and the center of the human thought in general. The thought is regardless to the national belonging and time. The ever existing creative space with the circulation of the ideal entities, such as thoughts, images, metaphors, ideas embodied in scientific discoveries, sculpture, painting, music, poems, literature, architecture is recognized by the humanity as a pulsating alive spring of creative energy.

This ever existing creative space may be defined as a reflection of globalization on the spiritual level. Globalization is a material pragmatic process, and the creative space existing on the spiritual level and being ideal is manifested in the masterpieces created in all the fields of science and art and is being appreciated by the humanity. The integrity of the cultural space is clear, and *it should be clearly reflected in the digital space of information society.*

The task of Cognitonics is to combine the material and ideal levels of the forthcoming process in the consciousness of people, young generation in particular. It makes possible to create cognitive preconditions of sustainable development, when a person realizes him/herself as a link between generations, who has to maintain the chain of generations by means of placing him/herself in the space of the human thought and spirit.

6 The Structure and Current Configuration of Cognitonics

The ideas stated above and in our previous works on the Theory of Dynamic Conceptual Mappings and the System of the Methods of Emotional-Imaginative Teaching (Fomichov and Fomichova, 1994 - 2006; Fomichova and Fomichov, 1996 -2006; Fomichova, 2000, 2002) enable us to outline the following structure of Cognitonics. This new science includes the theoretical foundations and methods of:

(1) teaching natural language (mother tongue and foreign languages), focusing on language as a tool of thinking and a tool of constructing social reality (see Searle 1995) but not only as a tool of communication;
(2) realizing the unified symbolic approach to teaching both natural language and symbolic language of art (mainly, painting), in particular, for supporting and extending the figurative reasoning skills of the learners, their symbolic information processing abilities, and for enabling them to decode the messages conveyed by the world-known masterpieces; that provides the possibility to plunge into the world of art and to establish mental and spiritual ties with the masterpieces;
(3) the stimulation of effective knowledge acquisition by the learners, in particular, by means of creating the formal means and methods destined for helping to invent effective teaching analogies;
(4) inscribing the notions of beauty, harmony into the conceptual pictures of the world (first of all, into the system of values) of children, teenagers, and college students, where the beauty, harmony are understood in a maximally broad sense: as the beauty of thoughts, acts, interrelations of people, etc.;
(5) improving the system of values of the learners by means of realizing an integral, going right through all ages (from early childhood to the college years) approach to the analysis of poetry, literature, painting, and sculpture, i.e. by threading the various mental representations and images revealing eternal values on the system of values of the learners; one of the principal aims is the formation of the feeling that a person is only one link in the long chain of previous and future generations as an important precondition of sustainable development;
(6) finding an optimal age (or a diapason of ages) and cognitive preconditions of systematic introducing children to computers without damaging the creative abilities of children (because the dominant part of the users do realize the given algorithms while working with the computers);
(7) opening new prospects for the modern computer informational technologies on the way of implementing a part of the methods elaborated in the directions (1) – (5), creating special computer programs destined for supporting and developing creativity, cognitive-emotional sphere, the appreciation of the roots of the national cultures, the awareness of the integrity of the cultural space in the information society, and for developing symbolic information processing and linguistic skills, associative and reasoning abilities, for correlating painting and literature, architecture and poetry, poetry and mathematics, etc.

The philosophical basis of Cognitonics in its current stage is formed by the ideas of the famous Russian philosophers Nikolay Berdjaev (1874 – 1948), Vladimir Solovyov(1853 – 1900), and Vyacheslav Ivanov (1866 – 1949); partially this basis is reflected in (Fomichova, Fomichov, and Udalova, 2004, 2006; Fomichov and Fomichova, 2006). The ideas of these thinkers have no national coloring. For instance, the following fact illustrates a broad humanitarian significance of these ideas: in 1947, Nikolay Berdjaev received the degree "doctor honoris causa" from the Cambridge University, UK.

One of the principal goals of this paper is to show that the idea of creating a new science – Cognitonics – is constructive, workable. We would like to say even more: in fact, the initial configuration of Cognitonics does already exist; it is given by our Theory of Dynamic Conceptual Mappings (the DCM-theory) and the System

of Methods of Emotional-Imaginative Teaching. These new theory and methods of teaching are described in over 40 our publications in English, in three papers in French, and in two monographs in Russian.

We believe that our theory and the results of a 16-year-long large-scale experiment (totally over four hundred students – young children and teenagers) on realizing the ideas of the DCM-theory in practice convincingly prove the possibility of achieving the goals formulated in the definition of Cognitonics.

7 Conceptual-Visual Dynamic Schemes as a Common Formal Tool for Cognitonics and the Scholarship of Teaching and Learning

Not all sciences have formal means, especially this applies to the branches of the humanities. However, usually the scholars appreciate the emergence of formal tools playing an essential role in a science. Though it may sound surprisingly, one of the fields contributed to the birth of Cognitonics is the Artificial Intelligence theory. The principal contribution of this field to the development of Cognitonics consists in providing a starting point for the elaboration of its formal tool.

Let's agree that the term "a teacher" may designate a school teacher or a university professor or the author of a textbook, etc., so this term is considered in a generalized meaning. In such situations when the existence of a considerable gap between the inner world's picture, or conceptual system (CS), of a teacher and the CS of a learner is obvious in the context of introducing a new piece of knowledge, a teacher is to go beyond the set of notions traditionally used for introducing the information of the kind and is to invent (better preliminary) some new ways of explaining the material to be studied. Looking for these new ways, a teacher is to take into account the knowledge about the full CS of a learner. A teacher must try to find in the CS of a learner such fragments which reflect situations being similar (or isomorphic) in some generalized sense to the situations taking place in the materials to be grasped.

As a rule, it is possible to do. If such similar situations are discovered, a teacher must invent the ways being clear for a learner (the learners) and enabling him/her to establish the correspondences between each such generalized situation and the situation expressed by the teaching material. Then a teacher should select or invent such an analogy which seems to be an optimal one from the standpoint of introducing a new piece of knowledge pertaining to the studied discipline.

We propose here the special formal means for helping teachers to invent effective dynamic correspondences between an existing fragment of the CS of a learner and the fragments to be created in the mental model of the learner and corresponding to the introduced piece of knowledge. With this aim we introduce below the notion of a conceptual-visual dynamic scheme, proceeding from the notion of semantic net.

In the Artificial Intelligence theory, one uses most often semantic nets (SN) for visual representing conceptual structures and knowledge about the world. A SN is defined as an oriented graph with marked vertices and edges. The marks of vertices correspond to the things, situations, concepts, the values of colours, the numbers, etc. The marks of edges denote the relations between things, concepts, things and concepts, the functions, the relations between the meanings of the fragments of natural language texts. During more than thirty years, numerous variants of SN have been elaborated; in particular, conceptual graphs proposed by J. Sowa (Sowa, 1984) can be interpreted as a particular kind of SN. A survey of conceptual graphs and of earlier versions of semantic nets can be found, in particular, in the Chapter 6 of (Luger, 2002).

Following the works (Fomichov and Fomichova, 1994, 1995), we define the notation of *conceptual-visual dynamic schemes* in the following way.

1. We'll use the blocks with single contour to designate: diverse physical objects, situations, processes; concepts qualifying objects; sets of objects, sets of concepts; the names of functions, the names of relations between the objects, concepts or between the objects and concepts; the names of relations between the meanings of the fragments of texts.
2. The inner visual images of diverse objects and situations are a very essential component of the inner world's pictures, or conceptual systems, of people. Consider the following example. Let Collette and Mary be two friends from the first grade, and they go in for swimming together. Mary has the beautiful rose dress and the blue dress. Then the inner world's picture of Collette contains, in particular, the following components A, B, C, D, E: A and B denote respectively the concept "a girl" and the friend Mary; C is the inner visual image (IVI) of Mary in the rose dress, D is the IVI of Mary in the blue dress, and E is the IVI of Mary in the swimming dress. That is why we'll use the blocks with double contour for denoting the inner visual images of objects.
3. Let X be the set of components of the conceptual system of a person and include, in particular, (a) the representations of concepts and objects, (b) the IVI of objects. Then for designating a binary relation R between some elements of X, we'll use a single arrow -> with the label R. Let's agree that one of possible representations may be an arrow intersecting a block with the label R. Such a label R may designate, e.g., the relations "Part-Whole", "Agent of an action", "Property".
4. We propose to employ double arrows === > for designating *dynamic conceptual mappings, or correspondences*. The orientation of an arrow of the kind doesn't matter to us: a block in the

beginning of such an arrow denotes an entity (an object, a concept, a situation) perceived quite clear by a learner (being well known to a learner or being a very bright just created fragment of the conceptual system), and a block in the ending of the arrow denotes an entity which is to be inscribed into the inner world's picture of a learner.

The configurations built in accordance with the items 1 – 4 will be called *Conceptual-Visual Dynamic Schemes (CVD-schemes).* This notion was introduced in the work (Fomichov and Fomichova, 1994).

Example. The figure 1 contains a CVD-scheme elaborated for the study of one element of the English language phonetics – explaining the pronunciation in the words of the letter "Y". It is known that the rules of reading form a complicated component of the syllabi of teaching young children to read in English as a second language. However, it was necessary to teach the six-year-old Russian children to read, because it was the only possibility to give them from the very beginning the confidence of successful progress in learning English. The difficulty consisted in explaining in a way being clear for five-six-year-old children why the different letters "Y" and "I" denote the same sound in the words "time", "ice", "cry", "fly", etc. (let's assume that by this moment the children already know the rule of reading the letter "I"). The given CVD-scheme establishes an analogy between a situation from the known fairy-tale about the Wolf and the Seven Little Kids and the studied piece of theory.

Only several years ago a new field of academic activity called the scholarship of teaching and learning received a formal status. Proceeding from the works (Boyer, 1990; Glassick *et. al*. 1997; Schulman, 1993), the scientists write about the necessity of seeing the academic work in a broader context which incorporates four distinct types of scholarship: the scholarship of discovery research; the scholarship of integration, including the writing of textbooks; the scholarship of service, including the practical application of knowledge; and the scholarship of teaching.

One of the principal tasks of Cognitonics is to contribute to the progress of the scholarship of teaching and learning by means of delivering effective methods of preparing not only future teachers working with children and teenagers but also specialists in various fields aimed at enhancing the ethical component in their every-day professional activity, the responsibility for the future generations.

It is impossible not to agree with the following idea: "We believe the aim of scholarly teaching is … simple: it is to make transparent how we have made learning possible." (Trigwell *et al.* 2000, p. 156). That is why the notation of conceptual-visual dynamic schemes seems to be of high significance for the scholarship of teaching and learning, because it can be used in practice as formal

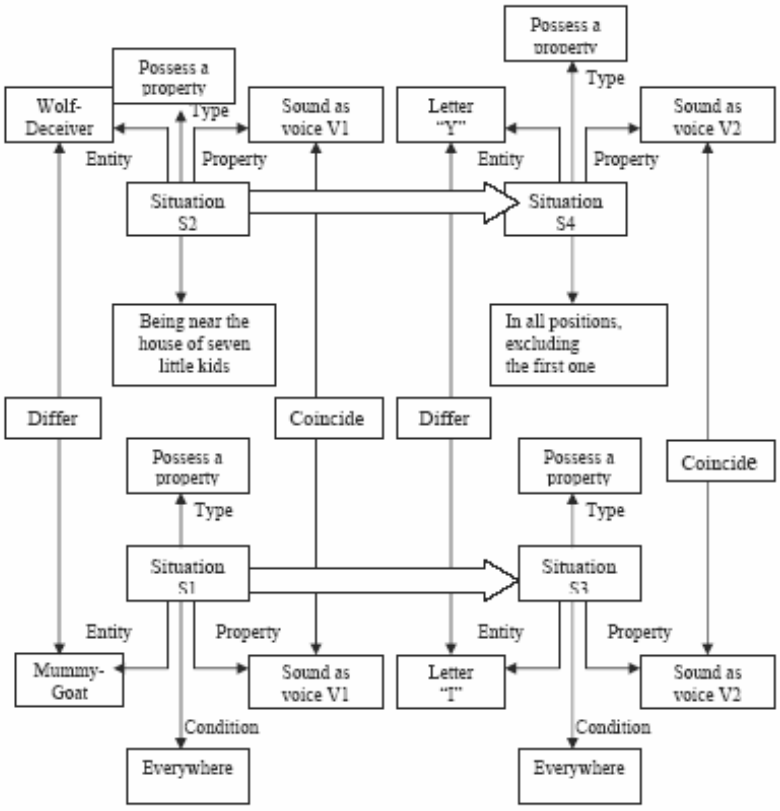

Figure 1: A conceptual-visual dynamic scheme used for inventing a way to teach young Russian children to pronounce in the words the letter «Y".

tool of inventing effective dynamic correspondences between the existing or just created but a bright and stable fragment of the conceptual system of the learner and a fragment being a mental representation of the piece of knowledge to be introduced.

8 Cognitonics and Optimal Cognitive Preconditions of Introducing Children to Computers

8.1 General Characterization of One Discovered Way of Achieving the Goals of Cognitonics in Practice

We've managed to discover one possible way to achieve the goals of Cognitonics. The other scholars can find new ways with respect to the peculiarities of their theoretical background and national culture.The notation of CVD-schemes introduced above became a starting mechanism for obtaining a chain of scientific and practical results enabling us to say today about the workability of the concept "Cognitonics".

Proceeding from the DCM-theory, we elaborated an original, highly effective extra-scholastic program of harmonic humanitarian development of the child. The program is destined for teaching children during twelve years, where the starting age is five to six years. The program has been personally tested in Moscow with great success by one of the authors over a period of 16 years. It includes the following series of lessons: (1) a two-year course (the age of learners is 5 to 7 or 6 to 8 years) of studying foundations of reading and speaking English as a foreign language (FL), including learning basic elements of English grammar (Present Simple and Past Simple Tenses); (2) a course on understanding the language (a part of FL) of describing the nature and feelings evoked by nature; (3) a course on understanding the symbolic language of painting; (4) a course on understanding the language of poetry (with the accent on understanding metaphors and descriptions of nature); (5) a course aimed at (a) first acquaintance with sciences and (b) developing the abilities to argument their own opinion, to raise objections, etc.; (6) a course on improving the knowledge of English grammar (during mainly the fifth year of studies). In fact, the lessons of courses (2) to (6) may interchange.

The kernel of our program is an original method of teaching 5-6-year-old children to read fluently in English as a FL and to discuss complicated texts written in Present Simple or Past Simple Tenses. The key to achieving this success was given by the notation of CVD-schemes: the analogies provided by the specially composed fairy-tales enable a teacher to establish effective correspondences (or dynamic conceptual mappings) between a situation from a fairy-tale or every-day life and the studied fragment of English grammar.

The EIT-methods have been successfully used during 16 years in Moscow in extra-scholastic teaching English as a second language, the symbolic language of poetry and painting, literature and poetry in Russian and English, communication culture. The total number of successfully taught students exceeds four hundred, their age varies from 5 to 21 years.

8.2 The Realization of the Thought-Producing Self as the Cognitive Precondition of Introducing Children to Computers

The fact of a deep penetration of computers and information technology into the system of school education and, in some countries, into the system of pre-school education should be recognized, because it is embedded in the language of modern life. Indeed, a new word has emerged: "screenager" instead of "teenager". Specialists in cognitive science, education theory, and computer science should *jointly* take responsibility for introducing children to computers in an optimal way. Primarily, they should help the pre-primary educational system and school system to support and extend the creative potential of the young generation so as to equip them to use computers as tools to support and extend their thinking.

In recent years, the problem of discovering and creating optimal cognitive preconditions that enable children successfully to interact with computers has acquired a high social and political significance. This is due to government policy in several economically well-developed countries (e.g., in Japan and U.S.A.) to acquaint primary school students with computers. They even recommend the use of complementary interactive Internet-based learning tools in the classrooms with children as young as 5-6. This paper presents a new constructive look at this problem, extending the ideas set forth earlier in (Fomichov and Fomichova, 2000; Fomichova and Fomichov, 2000). For this, the concept of "Thought-Producing Self" is introduced and analyzed.

Psychologists define a number of Selves, such as Ecological Self (it emerges as a result of interactions with the environment), Interpersonal Self (the self defines itself as a social being through social interactions), Self-Narrative (around the third year children become interested in the past and in the future and begin to acquire the memory skills on which narrative depends), and the Emotional Self (Snodgrass and Thompson, 1997).

But it appears that this definition does not include one of the most important Selves, the "Thought-Producing Self." The importance of it is now clear at the beginning of the XXI century - a century of the new information society, of screenagers, and of computers as integral members of the domestic family. *The "Thought-Producing Self" defines itself in the mirror of our appreciating ourselves.* The child has to understand that his/her brain produces *socially important thoughts and rationalisations*. This moment is the beginning of defining himself/herself as a personality who is able to think in such a way that the result of his/her thinking causes appreciation and praise.

It should be stressed that the "Thought-Producing Self" is defined here *not* as the ability of the child to understand that he/she can think. By definition, "Thought-Producing Self" is realized in the child *only* if he/she is able to generate ideas that have a relatively high social significance. As such, they are greatly appreciated by other persons (usually, adults), because the ideas are, for example, nice, bright metaphoric descriptions of some situations or pictures or because they help to solve some practical problem. In all cases, the action of producing thoughts receives a positive response. This stimulates the child to continue to think in this way.

The intensive use of computers by the child *before* the realization of his/her Thought-Producing Self may prevent the child from being able to develop as a creatively thinking personality. The role of the computer in information processing can retards and restrains the child's cognitive development, for example, as in the use of calculators in mathematics. That is why we put forward the *hypothesis that realizing the "Thought-Producing Self" of the child is the principal cognitive precondition for the successful, systematic involvement of the child with the computer.*

If this precondition is satisfied, systematic interaction with computer will not prevent the child from realizing his/her potential of creative thinking. In our opinion, this hypothesis needs to be widely discussed by computer scientists, cognitive scientists, educators, because it is of great importance for new information society.

Our sixteen-year-long large-scale study enables us to believe that our methods of emotional-imaginative teaching allow for realizing the "Thought-Producing Self" of each normal, average child by the age of seven - nine, where the starting age of extra-scholastic studies is five to six years. It has been achieved within the context of language-enriched lessons in language, literature, poetry and art - the areas of studies generally accepted as central to young children's cognitive development.

8.3 The Scheme of a Discovered Way of Realizing the Thought-Producing Self of the Young Child

Our starting point was as follows. We believed that natural language is the principal tool for introducing beauty into the conceptual picture of the world of the child. We put forward the hypothesis that the age five – six years is an optimal one from this standpoint (later we proved this hypothesis). For achieving our goal, we proposed a way seeming to be a paradoxical one: the way of introducing beauty by means of a second language (English in our study) with the final goal to enable the students to find and appreciate beauty in nature, in poetry and literature both in mother tongue and in foreign languages, in painting and sculpture.

While finding this paradoxical way of solving our problem, we proceeded from one idea of the famous Russian psychologist Leo Vygotsky (Vygotsky 1982). He wrote about two stages in the process of cognition: the formation of *spontaneous notions* and the formation of *scientific notions*. The directions of the development of these two processes are different. The first one is going from the bottom to the top, that is from the identification of the concrete thing from every-day experience to the generalization (for instance, from a concrete table to the notion of furniture). The direction of the formation of scientific notions is opposite: it is going from a defined general notion back to the every-day experience; for example, from the notion of etiquette to the "good morning" greeting.

Vygotsky indicated the peculiarity of mastering a mother tongue (MT) and a foreign language (FL). He said that the child is mastering the MT unintentionally, but as for a FL, it happens vice versa. The child does it on purpose, the starting point of this process is that he/she is learning FL deliberately. Consequently, the acquisition of the MT is going in the same direction as the formation of spontaneous notions – from the bottom to the top, that is from a concrete thing to the notion in general. As for the acquisition of FL, it is going in the opposite direction – from mastering a model (a notion) back to the everyday practice.

So the first step of achieving our goal was to invent a way to teach five-six year old Russian children to read rather complicated texts (the fairy-tales containing over five hundred words) in English as a second language (SL), to master the rules of using Simple Present and Simple Past Tenses and the rules of putting and answering questions. For solving this problem, we invented effective analogies for introducing the pieces of theory. The CVD-schemes helped us to invent such analogies (see Fomichov and Fomichova, 1994, 1995; Fomichova and Fomichov, 1996). It should be stressed that this formal tool can be used in every field of studies, with the learners of every age (the starting age is 5 – 6 years) for finding the ways of stimulating effective knowledge acquisition by the learners.

Our approach to learning a SL is conditioned by earlier forming scientific notions (in comparison with the period of time recommended by Vygotsky) as an answer to the challenge of time. Such kind of activity is grounded on the strong curiosity of children, on the one hand, and on positive responses to an intellectual activity, on the other hand. This intellectual activity in its way evokes strong feelings, stimulates the development of emotional sphere. And as for the spiritual values, they are rooted in the developed emotional sphere of the personality.

We'll show schematically what new prospects were opened by the basic obtained result – teaching children to read and discuss complicated texts in second language.

Reading and discussing complicated texts in English as a SL at the age of 5 –6
➔ mastering a rich sublanguage of SL for expressing the beauty of nature and the feelings evoked by nature
➔ development of figurative reasoning + development of the awareness of the social role of Natural Language
➔ understanding poetical metaphors
➔ creating metaphors
➔ understanding the symbolic language of painting

➔ development of the ability of decoding the messages conveyed by the masterpieces
➔ improvement of the feeling that a person is a link in the long chain of previous and future generations.

The experience accumulated by one of the authors during 16 years of extra-scholastic teaching shows that the elaborated method of the harmonic humanitarian development of the child allows for realizing the "Thought-Producing Self" of each normal, average child by the age of seven - nine, where the starting age is five to six years.

9 Culture-Oriented Computer Programs of a New Generation

We must underline that the formulated optimal preconditions of introducing children to computers concern the dominant part of existing computer programs. However, there are reasons to believe that it is possible and expedient to create a new generation of computer programs which may be called *culture-oriented programs*. A subclass of such programs can be destined for contributing to the realization of the Thought-Producing Self of the child by the age of seven – nine. The "intellectual filling" of these programs can be based on the fairy-tales, thrilling stories, landscapes, seascapes, portraits, etc.

The computer systems *Addizionario* (Turrini, Cignoni, and Paccosi, 2001) and *AddizionarioPlus* (Turrini, Baroni, Paccosi, 2006) can be considered as the examples of the culture-oriented programs of a new generation contributing to the realization of the Thought-Producing Self of the child. *Addizionario* is a multi-media tool suggesting innovative and appealing ways for improving the linguistic and cognitive development of primary school children. It is a hypermedia linguistic laboratory in which children being from 5 to 12 years old can study the Italian as their native or second language at various levels of difficulty and from different points of view. *AddizionarioPlus* is a multilingual version of *Addizionario*, it was implemented in 2003 and allows the user for customizing the tool in his/her own language or dialect, starting from the already available languages (Italian, English, French, Spanish, and German).

Children taught in accordance with our methods of emotional-imaginative teaching during five, seven, or more years have one distinctive feature concerning their attitude to computers. These children are used to enjoying the intellectual activities; in fact, they consider intellectual activity as a game. That is why these children are interested in the work with only such computer systems which have an "intellectual filling". Besides, these children highly appreciate the existence of ethical and aesthetical components in the computer programs.

Proceeding from these observations, we can conclude that a large-scale realization in practice of the goals of Cognitonics will create a demand for *the culture-oriented computer programs of a new generation* – with an "intellectual filling", ethical and aesthetical components, supporting and developing the creativity of children, broad mental outlook, figurative thinking, the appreciation of national culture, the understanding of different cultures.

10 Conclusion

The ongoing processes such as a shift from eternal values to commercialized values, globalization, the lack of balance between spiritual and intellectual development condition the change in the conceptual picture of the world of the young generation. The process of entering the global world and searching for a sounder and more satisfactory lifestyle for our global community requires the appropriate responses both in science and in the field of education, including e-education.

Education has the advantage to provide the opportunity for self-paced activity and improves the skills being necessary for keeping pace with time. If education is successful in fulfilling the social task to reproduce culture and make the child "to fly with two wings" (that is spiritual development and intellectual development), then the global information society may expect from the person a response which meets the requirements of sustainable development and takes into account the interests of future generations.

Cognitonics, appealing to the achievements of Philosophy, Artificial Intelligence, Linguistics, Psychology, Art, applies these achievements to the process of learning in order to make an endeavour to compensate the on-going systemic shifts to commercialized values, globalization in its vulgar way, and intellectual discoveries without equal to them spiritual ones.

The notation of conceptual-visual dynamic schemes (or CVD-schemes), considered in this paper as a formal tool of Cognitonics, can find numerous applications in Web-based distance education. The many-year experience of Web-based distance teaching mathematics accumulated by one of the authors has shown that a considerable part of online university students encounter difficulties while studying theory by means of a text-book and Web-based topic notes. We suppose that the CVD-schemes can be used for inventing effective teaching analogies in various disciplines in order to make easier successful learning for online students. In the same way, the CVD-schemes can help to invent thrilling teaching analogies for the use in Intelligent Tutoring Systems (as components of Web-based E-learning systems too).

Under the framework of Cognitonics, a solution is suggested to the fundamental problem of formulating and creating the optimal cognitive preconditions of introducing children to computers. The concept of the "Thought-Producing Self" of the child is described. A way of realizing the "Thought-Producing Self" of average 7-9 year olds is outlined. The key idea is the early development of children's symbolic information processing skills, creativity, and emotional sphere, where the basic elements are natural-language-processing abilities and figurative thinking. The suggested approach has been successfully used during 16 years of teaching

totally more than four hundred 5 - 21 year old pupils in languages (mainly English and also Russian), literature, poetry, and art. Underpinning this approach are the Theory of Dynamic Conceptual Mappings (the DCM-theory) and the System of the Methods of Emotional-Imaginative Teaching. The creation of DCM-theory was influenced by the ideas from Artificial Intelligence theory, Philosophy of Language, Cognitive Linguistics, Cognitive Psychology, and Cognitive Biology.

We believe that the concept of Cognitonics will stimulate the educators, scholars working in the humanities and natural sciences, and the designers of computer informational technologies and systems to join the efforts for better understanding of the advantages and disadvantages of the computer age in order to put together the cultural and digital spaces from the very initial stage of introducing children to computers up to the age of spiritual and intellectual maturation. One of the principal ways of achieving this goal can be the creation of the culture-oriented computer programs of a new generation.

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"ADDIZIONARIO": a New Tool for Learning between Metacognition and Creativity

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This paper describes a project aimed at using Addizionario (a hypermedia linguistic laboratory designed at the Institute for Computational Linguistics of National Research Council in Pisa in collaboration with the Department of Computer Sciences of Turin University) to create conceptual maps as a strategy to favour the comprehension of descriptive texts and to improve the personal processing and cross-disciplinary use of information. Metacognitive theory considers learning as the result of the activation of several conscious processes. Furthermore, our project intends to support meaningful learning by means of Addizionario and to investigate the processes involved in motivated learning. Motivation to learn is favoured also by a general strategic attitude towards learning, especially when in learning we consider the intellectual peculiarities of the child. This hypothesis is well illustrated in the concept of "multiple intelligence" of H. Gardner, according to which each person has a preference for a symbolic code and through such a code manages more easily to learn and take interest in disciplines, activities etc.

Using Addizionario, we tried, furthermore, to support the development of divergent patterns: in fact, the access and the development of more different symbolic and known universes is anyway an important means of transforming the multiple potentialities of the single child into real abilities, also for creativity and divergent thought. We believe that creative behaviour in childhood is a factor favouring the processes of learning and the psychological well-being of the child.

Povzetek: Opisan je nov način učenja s pomočjo metakognicije.

1 Introduction

Human behaviour is naturally goal-directed, and there are several strategies to support the child in identifying and organising the necessary steps for reaching learning goal (goal setting): among these, in this paper, we have focused our attention on the conceptual maps (Novak, 2001; Novak, Gowin, 1989, Guastavigna, 2000).

Conceptual maps are generally recognised as an important means of information acquisition and memorization, as their visual register helps to focus on major concepts and organize information into an integrated and coherent structure.

The idea of 'conceptual map' was introduced by Novak and Gowin in 1989, and its role as one of the strategies that allow the organization of knowledge has been widely accepted, in particular, in the field of teaching (Buzan, 2000). The core idea was that a graphical representation of knowledge makes the meanings that are inherent in the learning materials emerge (Novak, Gowin, 1989, p.19) and forces reflection on the nature of knowledge as well as on derivative relations.

Similarly to a topographical map that facilitates orienteering in a land, a conceptual map is a tool that helps construct knowledge through the individualization of key concepts and of the relations that are used to develop concepts into reasoning. Therefore, a conceptual map can be described as a graphical representation where concepts (synthetically expressed as individual words) are represented as geometrical forms (nodes) connected by lines (arrows) that show relations between nodes through linking words. This general description encompasses maps of different types and structures, each type depending on the aim for which the map is created.

Using maps we can encourage the schematisation of information and the thought about the meanings that are hidden in a network of sentences, thus making key concepts more prominent and relevant (Jonassen, 1989, 2003).

2 Conceptual maps and meaningful learning: how to build an intentional learning

Meaningful learning takes place only when a potentially meaningful material is integrated and re-organized into previously acquired knowledge and extends it through integration and elaboration processes

The result is personal processing of input, which becomes apparent in the pupil's final summary of what s/he has learnt. Meaningful learning is the result of an intentional process, characterized also by perseverance in reaching goals in general and choosing learning objectives in particular. For this reason, when the goal is the accomplishment of a task, it is important that it is clearly defined, desirable, and desired by the pupils themselves. Meaningful learning is often accompanied by a general increased ability in the use of divergent thought (Williams, 1993) which on its turn is connected to the metacognitive approach.

Cognitive psychology focused on the problem how the ability to use symbolic representation is connected with the development of higher information processing, such as the formation of 'conceptual categories', where perceived characteristics are used to infer other characteristics. Symbolic representation codifies reality in terms that go beyond given information. This is the real essence of the cognitive activity: the human ability to go beyond interaction with objects and manage information to create hypotheses, concepts, and theories.

Ausubel's (1968) theory stretches along this perspective when he claims that cognitive learning not only refers to the acquisition and usage of knowledge, but also entails emotional learning. This is to say that an important interaction exists between information coming from internal signals and cognitive learning – an interaction that has been highlighted also by recent studies in neuropsychology. Ausubel's standing is clearly in line with Novak (2001) when the latter stresses the importance of the interaction of thought, feelings, and actions.

According to Atkinson (1972), the optimal way to provide information is by inserting it into a program that allows individual users to pace the elaboration of the given material in a flexible way, and specify the actions that the computer and the user should take. This method helps both more and less promising students gaining as much as possible from the learning activity, each one at their own pace.

New knowledge is supported by intentional learning; the newly acquired pieces of information help the child reconsider their own thought and see them in a different light. This means that the mind reflects upon itself, to use Vygotskij's (1978) terminology, and becomes ever more able to re-think the contents of its own thought.

2.1 Metacognitive Approach and Vygotskij's Theory: Building Meaningful Learning with Addizionario

The most recent metacognitive theoretical models of learning have focused on the centrality and importance of these processes. Clearly, before one can control voluntarily a specific function, one must possess that function.

To give an answer to this issue, Vygotskij (1978) introduced the concept of zone of proximal development. This concept explains how a person with greater competence can help a younger, less competent person reach a higher level of knowledge, such as the level of abstract thinking. By zone of proximal development we mean the distance between one's actual developmental level, measured in terms of autonomous problem solving abilities, and the level of potential development, determined by the ability to solve problems under the guidance of an adult or in collaboration with a more expert peer. In this perspective, the human learning ability presupposes a specific social component through which subjects become ever more expert masters of their actions and the reasons for the actions.

Vygotskij believes that knowledge is constructive: his perspective is not antithetical to the cognitive theories that are at the basis of our study. Learning is not simply storing information, but rather linking new pieces of information to other pieces stored in long term memory. Thus knowledge is constructed, not recorded or received. The construction of knowledge is influenced by the way previously acquired knowledge has been structured and by the interaction between the individual and the environment. This perspective shows us why activity is essential but insufficient for meaningful learning: the children must reflect on the activity and their observations and interpret them.

Meaningful learning could be the better way to increase new ability, using also divergent thought (Williams, 1993), specially in problem-solving tasks.

We think that meaningful learning (Ausubel, 1968, Buzan, 2000) and creativity aspects can, therefore, be facilitated by the use of dedicated software which allows pupils to follow individual content-processing paths. Addizionario (Turrini et.al, 2001) belongs to this type of software because it presents many of the characteristics advocated by Atkinson (Atkinson et al. 1972): in this way, the new knowledge is really supported by intentional learning and the child achieves deep understanding of complex ideas that are relevant for his/her life.

2.2 Computer Lab and Creativity: Is There Any Relation?

According to the theory of multiple intelligence proposed by H. Gardner (1982, 1983), for developing a programme to promote divergent thought and creativity, we focused our attention on the following aspects: attitudes and behaviour adopted by the teachers; attention to the

combination of the different disciplines that form part of the curriculum of studies of the pupil; focusing on the real cognitive and emotive factors of the divergent thought.

Finally, a particular attention towards the metacognitive aspects of the learning was maintained in this work: to stimulate and promote the development of the creative abilities means in fact leading the child towards a route of learning, and in every process of learning the metacognitive aspects play a fundamental role.

Creativity is a resource that can be used profitably within the scholastic field, also in computer lab, to favour a learning that is not simple assimilation or development of competences, but implies instead a personal re-elaboration of every matter or experience. In learning, this means stimulating a behaviour of research in general, giving an incentive for the attitude and the routine to carry out and search for new categorisations and associations between matters and concepts even when these are already known, inserting them into a new structure of knowledge, together with the knowledge of the world already possessed by the student, associations that allows a more authentic assimilation of the knowledge.

This process allows the student to restructure also problematic situations as well, observing them from different and more original points of view.

Creativity, as well as representing an essential factor for the well-being of the child and of the future adult, forms an important resource in order to learn. It is, in fact, a factor of substantial importance in promoting a learning that doesn't remain "inert", relegated to the carrying out of the sometimes artificial requests of the scholastic evaluation, but knows how to come in contact with the live structure and dynamic of the mind." (Antonietti, 1996, p. 10).

According to Petter (1992), in the school (during childhood and the primary school) there are many activities aimed at developing rational activity, but there should also be a lot of activities aimed specifically at favouring the development of the activities of the imagination,: "not only storytelling and literature, (...) but the invention of stories, the drawing from the imagination, symbolic games with unstructured or partially structured matters, (...) the interpretation of a piece of music, or experiences of brainstorming in group discussions , or games like the construction of chains of ideas in freedom, (...) can broadly develop and reinforce the capacity for fantastical elaboration." (Petter, 1992, p. 181). Rationality and imagination have an equal importance: that is the thought, as a structuring activity, can manifest in two different ways: "the two ways are complementary to each other and often present in the very thought processes" (Petter, 2002, p.10).

The procedures of the teaching of creativity utilised in the past have always inspired, instead, more or less explicitly, a few directions of the psychological research.

Creativity, in our perspective, is considered as potentiality, to be precise or dimension or complexity of the psychological dimensions of the individual that allow him, in given circumstances, to carry out specific elaborations of ideas aimed at producing appreciated and original results. The creative thought is understood as a process, or to be precise a specific type of mental function or elaboration usually not active. In this way, we suppose that creative thought is made to reside in the activation of particular strategies, and Addizionario can favour in every child the activation of creative processes, not only of cognitive processes..

In this way, we think that Addizionario (Turrini et al., 2001) can be a useful tool for improving creative aspects and divergent thought, in particular. Finally, we want remember that in the past, proposals rarely followed the simultaneous development of multiple intellectual components, but the works were all centred around the direct practice of particular operations (restructurization, combination, free production, etc.) and gives scarce attention to the abilities of the control of such operations. Using Addizionario, the conscious control of such operation becomes a necessity.

2.3 Creativity between Convictions and Beliefs

Dweck (2000) has conducted instead a broad research on the aspects connected with personal convictions and with beliefs, such as the implicit theories and the learning objectives that can lead people to perceive themselves as competent or as inadequate in various situations, independently from the real abilities they possess. It then deals specifically with the relationship between implicit theories and intelligence, the development of these theories and how these influence the relationships of failure, through their effects on motivation, and in particular, on the acceptance of challenges, on behaviour in the face of difficult tasks and on the attributive style (Henderson and Dweck, 1990; Stone, 1988; Elliot and Dweck, 1988).

On these elements or fields, Dweck’s theory seems to build a bridge between metacognition, the theories of the self and creativity.

A specific link with these topics has been highlighted by researchers that analyzed gifted children. Exploring the phenomenon of child prodigies is probably a way to find new developments on the reasoning of this topic, if not an answer: these children, that are unique expressions of certain human processes of development and evolution, represent a phenomenon that “allows us to cast a look at the workings of the human mind.” in its entirety (Feldman, 1991 pag.6). According to Feldman’s theory these children represent a notable connection of biological inclination and of cultural availability in answer to their inclinations. Both more classical studies and more recent studies converge in affirming how the phenomenon of the "Gifted" is determined from the interaction of biological and environmental factors: Sternberg and Lubard (1991) on this subject sheds light on the complexity of the creative thought, affirming how the creative performance is the result of the confluence and of the interactive (and not additive) combination of six elements: intellectual processes, knowledge,

intellectual style, personality, motivation, and environmental context".

2.4 Goals

The project, titled 'Getting to know my town, Pavia', aimed to integrate several school subject matters into the framework of the pupils' everyday life. The first aim was to promote meaningful learning of descriptive texts through the creation of conceptual maps in both traditional and multimedia format (Addizionario, Turrini et al., 2001). A second aim was to guide the children on a knowledge tour around the town, by making them explore, actively and personally, its major historical, geographical and cultural features. The town of Pavia was therefore conceived as a 'world' and studied from four different perspectives: history, geography, science and visual arts. These topics were all in keeping with the school curriculum. From a general methodological perspective, the children were spurred to share their knowledge with their peers, and were allowed adequate time for self-paced individual and group work.

Our program referred also to the 3-dimensional model of Williams (1993), according to whom the fields for developing a programme capable of promoting the creativity must be the following: attitudes and behaviour adopted by the teachers; attention to the combination of the different disciplines that form part of the curriculum of studies of the pupil; focusing on the real cognitive and emotive factors of the divergent thought. Last but not least, an attention towards the metacognitive aspects of the learning was maintained. to stimulate and promote the development of the creative abilities means in fact leading the child towards a route of learning, and in every process of learning the metacognitive aspect plays a fundamental role (Cornoldi, 1995, Dweck, 1999).

2.5 Subjects

The pupils taking part in the project were 21 ten-year-old children, (males = 12, females = 9). The children were subdivided into three groups of 7 pupils each; each group was heterogeneous in terms of learning (Zanetti, Miazza, 2002), computer, and social skills.

2.6 Procedure: Tools and methods

2.6.1 Addizionario

Addizionario (Turrini et al., 2001) is a software implemented at the Institute for Computational Linguistics of CNR (National Research Council) in Pisa in collaboration with the Department of Computer Sciences of Turin University. This product is a hypermedia linguistic laboratory to be used by children in the six to fourteen year range for the study of the Italian language at various levels of difficulty and from different points of view.

The laboratory is made up of two interacting tools: "Addizionario", a computer dictionary for children, written and illustrated by the children themselves, and a multimedia Activity Book in which the child, working by himself or in collaboration with others, can create his own personal dictionary.

The idea of getting the child involved in the creation of a dictionary specific to his own needs derived from the reflection on the current state of children's lexicography.

Although an essential didactic tool for language acquisition, the dictionary has not always managed to fulfill the requirements of the users.

With some exceptions, the products for young children available on the market seem to be abridged versions of adults' dictionaries, without taking in due consideration the tastes and interests of the young readers.

We feel that in Addizionario (Turrini et.al, 2001) the above requests have been satisfied, and the modes of expression of the children respected as much as possible. The children have less difficulty in understanding the definitions contained in the dictionary and therefore use the product with greater pleasure and enthusiasm.

The core dictionary, which is for consultation only, contains an approximate 1,000 concrete and abstract nouns, verbs and adjectives, chosen according to usage frequency criteria, for which around 400 Italian children from the last three years of primary and first two years of junior high schools have provided their own definitions, examples, associations and drawings.

Apart from the most obvious spelling mistakes which have been removed, the material was maintained as much as possible in its original form, so as to respect the children's modes of expression, descriptions of family and school environment, presentation of everyday life and experiences.

All the material available in the look-up dictionary was arranged by us not only in alphabetical order but also in "worlds of words". These worlds are eighteen, and include that of animals, food, clothes, but also of emotions, and reflect different semantic areas, which do not always coincide with the categorizations of the children.

By using the Activity Book at his disposal, the child can "create" worlds which correspond to his personal ways of classifying reality, organizing his lexical knowledge in such a way that he can retrieve his own material easily when necessary.

The possibility of constructing special groupings of words can also be exploited during the lessons by the teacher, for example to help the child overcome particular spelling difficulties.

The Activity Book is the authoring component of the laboratory linked to the core dictionary, but at the same time independent, where the child can work at the construction of his own personal dictionary. He can perform both linguistic and non-linguistic activities,

transporting into his Activity Book any of the material available in Addizionario (paradoxically, even copy all the contents!), tailoring it to his own needs.

For the linguistic activities, the system puts at the disposal of the child writing environments to produce the definition, examples, free associations, idiomatic expressions, synonyms and antonyms if they exist, as well as verbs and adjectives somehow associated with

the word in question. The non-textual activities concern drawings and sounds, which the child can produce personally or he can use the material already available in the archives of the system. Furthermore, the child himself can record the pronunciation of a word using his own voice, or assign a sound to an object or to its parts.

The drawings are one of the most stimulating aspects for the children, and a suitable site for making connections. These are particular links between words and drawings, useful not only for navigation, but also to encourage the child in the creation of new words.

The drawings can be enlarged, reduced, or changed in colour, using the elements contained in the drawing ambience. Once all the information relevant to the newly introduced words has been completed, the child can take inspiration from the drawing, in order to write a story interacting with the drawing itself.

The various tasks should preferably be carried out at the presence of the teacher, acting as guide and supervisor, and directing the work of the children according to the types of activities involved. The children should work individually or collaborate together around the computer in small groups, on a give-and-take basis, where each individual in the group can benefit from the knowledge and experiences of the others. The children can create their own paths through the system, sharing them with their classmates.

Further information can be achieved from the solicitation or aid given by the teacher, who can plan varied programs of study in which each child can express himself at his best. The Activity Book with its typical characteristics of interactivity, updating, multiple-access, etc., is an extremely appealing and flexible tool, easy-to-use, which can help the children participate eagerly in the various language activities. The child takes a lively interest in this tool where he is allowed freedom of action, and is encouraged to take the initiative. Acquisition and enrichment of vocabulary – often felt as tedious and boring – become pleasant tasks, able to grip the attention of the users.

2.6.2 Fases

The project required subdivision into phases, in order to allow the children to become familiar with the software tool. In this preliminary 'playing' phase in the use of Addizionario (Turrini et.al, 2001), the children made their own discoveries and shared them with the rest of the group. This favoured establishing a positive climate in the classroom, in which each individual discovery would become a common revelation. A second phase saw each child create a conceptual map in traditional pen-and-paper format, starting from a common basic schema. The resulting graph, that included drawings, postcards, photos and other types of images, served as guiding structure in the subsequent phase where the information were reorganized in electronic format.

Pen and paper activities started with History and Visual Arts. This project work started with a search for, selection, and preparation of useful materials and were carried out during class hours and integrated into ordinary curricular activities.

The history teacher brought books, photos, magazines and brochures to class and invited the children to search their houses for further similar resources about the history of Pavia and bring them to school. All the materials thus available were collectively examined and the most interesting ones were selected. Then, the teacher read out legends of the origin of Pavia and invited the pupils to compare them to historical documents dealing with the birth of the town. This preliminary investigative phase was followed by a collective discussion during which the children were helped understand the basic and most important elements in the selected texts. The children were then asked to summarize the texts. These activities resulted in a series of written materials that included both individually- and collectively-produced texts and documents.

As part of the Visual Arts curriculum, the children were made in charge of taking digital photos of the Romanic churches, the medieval castle, the covered bridge and other major monuments of Pavia. The photos were then shown in class and the children were asked to compare the monuments and observe similarities and differences in terms of architectural style, building material, and other features. Finally, the children made and scanned drawings and edited the digital pictures, producing personalized visual materials to populate the worlds in Addizionario.

The following historical events and artistic landmarks were analysed: legend of the origin of the town, the Ticino river and the history of the town, life in the pre-Roman village, religion, the Roman period and its legend, the covered bridge, the Barbarian invasion, under the reign of Theodoricus, the Longobardic period (king Alboin and his wife, queen Theodolinda; king Liutprand), the Romanic period: churches and the crowning of kings, Commune: the towers; life in the commune, from commune to seignory: Gian Galeazzo Visconti and the castle

As part of geography and science curriculum, the children were helped locate Pavia on a map of Italy, and on a map of Lombardy. Subsequently, on a political map of the region, they highlighted the province of Pavia and the other major towns in Lombardy. Finally, the attention shifted to the town itself and to the four areas into which the town is divided (heritage of the ancient Roman urban structure). The children where helped locate their school and the landmarks that they would visit in the following months.

During science classes, the children talked about the four watercourses that cross or touch the town and studied the natural habitat of one of them, the one closest to the school. The route of the watercourse was analysed from spring to mouth, both in terms of its physical characteristics (meanders, banks, marshes, and terraced areas) and its flora (trees, bushes, herbs, and fungi).

Special attention was dedicated to trees. The children went to the area around the watercourse, observed and photographed the trees and then, for each type of tree (ash-tree, alder, plane-tree, weeping willow, crab, and

poplar), created a sort of 'passport' describing its features (shape, bark, leaves, flowers, and fruits). With the help of a professional mycologist, detailed attention was also given to fungi. A similar approach was adopted for the local fauna: several animals that were either known to the children or easily observable, such as the woodpecker, the pheasant, and the hare, were classified and described in terms of class, physical characteristics, habitat, feeding and breeding habits .

The pen-and-paper material produced by each child was collected into a personal book called "Pavia, my town".

The third and last phase of the project was carried out in the school computer lab, where the three subgroups took turns in the use of Addizionario. Under the supervision of teachers and a psychology expert in the use of Addizionario, the children created worlds and populated them using their conceptual maps as guideline. This project work started in mid November 2003 and ended in June 2004, i.e. at the end of the school year (weekly timetable included three hours of work in the computer lab and eight hours of 'traditional' class work, two for each subject).

3 Results

The children were monitored throughout the school year and the results of this learning project were assessed according to the following parameters: their ability to create a conceptual map was assessed in terms of number of details and links in the final product on CD-Rom; their final level of knowledge was assessed by means of questions; the increase in the child's knowledge was assessed by comparing the first and the second versions of the graph, in terms of number of pieces of information and links.

Assessment of individual productions (CD-Rom, graphs, oral presentations to the class, written texts, and the all pen-and-paper material produced by each child was collected into a personal book called "Pavia, my town") showed a general increase in the children's knowledge about the town of Pavia, not only as far as the number of pieces of information is concerned but also in terms of their ability to make links between data and organize them in hierarchical form (schema–driven knowledge). Furthermore, the children showed increased skills in the use of the software tool and in collaborating with each other.

To conclude, the creation of conceptual maps with Addizionario in the framework of this interdisciplinary research project proved a valid teaching method. We think that it helped facilitate the acquisition of data as well as of important skills, too. With this work, it became possible to widen knowledge of a topic from different perspectives, by applying metacognitive procedures and strategies. This is a collaborative work, in both pen-and-paper and multimedia tasks, that allows the development of individual potential abilities in the classroom context of both horizontal and vertical tutoring. This is the ideal context for the children to reach their 'zone of proximal development'.

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AddizionarioPLUS: a Creative Approach to Linguistic and Intercultural Education

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*This paper describes A*ddizionarioPLUS*, the updated and extended version of* Addizionario*.* Addizionario *– a hypermedia linguistic laboratory in which children being from 5 to 12 years old can study Italian as their native or second language at various levels of difficulty and from different points of view – was developed by the Institute for Computational Linguistics of the National Research Council (ILC-CNR.), in collaboration with the Department of Computer Science of the University of Turin, and was successfully tested in Italy and abroad. The main changes that have been introduced into the software concern: a) the graphic interface with the user, b) the programming language, c) the system architecture, d) the possible activities, e) the organization of the working environments, f) a module for the teacher, g) the available ready-to-use material and learning paths, h) the possible helps for both pupils and the teacher.*

Povzetek: Opisan je kreativen način učenja jezika.

1 Introduction

Addizionario [1], a multi-media tool suggesting innovative and appealing ways for improving the linguistic and cognitive development of primary school children [2], was devised in 1998 by ILC-CNR, with the collaboration of the Department of Computer Science of Turin University, and was at first successfully tested in several Italian schools.

In 2003, a multilingual version of *Addizionario* was implemented, which allowed any user to customize the tool in his own language or dialect, starting from the already available languages (Italian, English, French, Spanish and German).

This possibility opened up interesting new prospects [3] for the use of *Addizionario*, which also began to be used in Italy for teaching Italian to foreigners who were to be integrated into our schools and society as well as in other countries.

Abroad, in particular, the software was exploited by the Universidad Autónoma Metropolitana of Mexico City, in collaboration with ILC-CNR, within the scope of an Intercultural Education project aiming at stimulating primary school children of P'urhépecha indigenous communities living in the Mexican meseta of Michoacán to construct the first monolingual dictionary of their native language[1].

2 The reasons for the updating

Being designed in the late nineties, *Addizionario* has now become technologically out-of-date.

Moreover, during the testing phase of the software in Italian and foreign schools, a lot of interesting ideas arose and several improvements were suggested by the users.

As a result, the developers of *Addizionario* have decided to implement a second version of the software, which has been named *AddizionarioPLUS*[2].

3 The main changes introduced

The main changes brought about in the new version of the software are the following ones:

- a new graphic interface with the user;
- a new programming language;
- a new system architecture;
- new possible activities;
- a new organization of the working environments;
- the creation of a module for the teacher;
- the availability of ready-to-use material arranged into learning paths already traced out;
- the availability of "on-line" helps for both pupils and the teacher.

[1] P'urhépecha is a mainly oral language of the Michoacán area, which is nowadays at the risk of extinction.

[2] This new version of the software was again developed within the framework of a cooperation project between ILC-CNR and the Department of Computer Science of the University of Turin.

3.1 A new graphic interface with the user

The graphic interface with the user has been considerably changed as a result of the loss of attraction suffered by the previous version of the software for children by now used to the high graphic quality of the videogames and cartoons that are available on the market.

3.2 A new programming language

A different programming language has been adopted as well.
The choice of the developers has fallen on C#.NET, a modern and flexible language that generates software able to run on different platforms.

3.3 A new system architecture

One of the most important changes brought about in *AddizionarioPLUS* concerns the modality of the system architecture, which is no longer Stand-alone, but has become Client-Server.

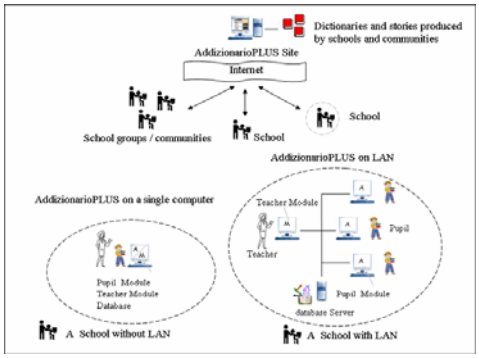

Figure 1: the system architecture.

In *Addizionario*, the software was designed to be installed on single computers (Stand-alone modality), and could therefore only be used by one pupil at a time or by a small group of pupils (usually two or three), who had to use the mouse and the keyboard in turns.
The data produced during each working session were stored only in the computer used by the pupil and, as a consequence, the material produced by different pupils was physically stored in different computers.
In *AddizionarioPLUS*, on the contrary, the software is designed to be installed and used on a network, both on a Local Area Network (LAN) and on the Internet (Client-Server modality).
Data and users modules (*Pupil Module* and *Teacher Module*) are memorized in a database stored on one particular computer (referred to as "server" or "computer server" or "database server"), which can be easily accessible from the different workstations of the network (referred to as "client servers") by pupils and the teacher at the same time (each of them with his own goals and data views).
For a greater effectiveness of the system, it is advisable to memorize data and users modules on the computer server instead of the client servers.
For want of a LAN, of course, the software can still be installed and used on single computers.
In this case, however, as in the case of *Addizionario*, each computer will contain in its memory both the users modules and the data produced by pupils and/or the teacher during the working sessions.
The architecture of *AddizionarioPLUS*, where all the data are centralized and accessible by means of a database server, offers considerable advantages to both pupils and the teacher.
Pupils have the opportunity of sharing their materials, examining and using the material produced by other pupils and carrying out appealing collaborative activities (such as constructing a "Class Dictionary" or writing the text of a fairy-tale or a story together).
On the other hand, the teacher can easily supervise and monitor the material produced by his/her pupils, manage the security copies of the data collected and organize group activities and possible collaborative activities by using the information resources placed at his/her disposal through the network (concerning, for instance, the possible ways of forming and managing working groups, of organizing work-shifts, of assigning tasks and responsibilities etc.).
Moreover, if an access to the Internet is available, it is possible to publish the material produced on a Web site specially created by the authors of *AddizionarioPLUS*, whether the software is installed on a single computer or on a LAN.
This possibility is extremely important, since it gives pupils the satisfaction of displaying their works on line and, at the same time, offers the teacher the opportunity of examining, discussing and re-elaborating the material produced by other users (pupils as well as teachers).
The use of *Addizionario* on a LAN and on the Internet was an improvement suggested by the Mexican test participants.
Network resources were required because of the peculiarity of the Indigenous Education, which tends to emphasize the collaborative character of the learning process[3].
Moreover, the P'urhépecha communities consider network resources to be essential for the collective construction of a dictionary being able to represent their language, which is a task that requires collaboration and frequent discussion.
The fact that these communities live far away from each other was another reason for their request for connection resources.

3.4 New possible activities

AddizionarioPLUS differs from *Addizionario* also in the number and types of activities to be performed.
While in the first version of the software the activities were granted to the creativity and initiative of the teacher, in the second one they are more supported (for both pupils and the teacher).

[3] Indigenous education often makes use of the figure of the child-tutor, that is to say, an older, more experienced child, who frequently stands in for the teacher during everyday teaching activities in multi-level classes, taking care of younger children that need support and guidance.

In *AddizionarioPLUS* there are many possible activities which may be more free and creative (as in *Addizionario*) or more supported and organized in detail (differently from *Addizionario*).
Activities are arranged into four working environments (which will be described in the next paragraph) and are developed at differing levels of difficulty in each of these environments.

3.5 A new organization of the working environments

The working environments of *AddizionarioPLUS* are the following ones:

1) *My Dictionary*;
2) *My Stories* (or *My Storybook*);
3) *My Drawings* (or *My Drawingbook*);
4) *The Children's Dictionary compiled by children* (which is equivalent to the "Core Dictionary" of *Addizionario*).

Another novelty of the second version of the software is that its working environments are presented in separate modules, even though they are interconnected.
That offers the pupil the possibility of using the software even only for writing stories or drawing, without necessarily passing through his dictionary (which he/she had to do in *Addizionario*).
From his/her book of stories or a drawing album, however, the pupil can always access his dictionary in order to insert new words and/or images as well as for a consultation.

Figure 2: the working environments.

My Dictionary, *My Stories* and *My Drawings* are contained in the *Backpack* (which is highlighted in the figure 2, since it is open).
The foreseen activities can be carried out both in an individual way and in a collaborative one.
In response to the invitation of the teacher or the system assistant (an amusing but never domineering *on/off Parrot*), the pupil can choose the kind of activity – either individual or collaborative – to carry out and, subsequently, the environment in which he prefers to work.
Collaborative activities can be proposed by the teacher through the *Blackboard*, which can be considered as the fifth working environment of *AddizionarioPLUS* in every respect.

Figure 3: the *Blackboard*.

3.5.1 My Dictionary

My Dictionary is the creative module corresponding to the "Activity Book" of *Addizionario*.
In fact, it re-proposes in a richer form many of the functions already present in the latter.
Thanks to these functions renewed and enriched, the pupil becomes the author of his/her own dictionary, defining the words, drawing them, assigning them a sound and putting them together in conceptual groups called "worlds".
Unlike *Addizionario*, however, *AddizionarioPLUS* offers the pupil the possibility of constructing his/her dictionary following different approaches as well as the possibility of carrying out activities aiming at extending and organizing his vocabulary.
Moreover, *My Dictionary* is the ideal environment in which many of the activities that can be carried out are such that they can be performed in a cooperative manner.
Three of the approaches for constructing one's dictionary can be chosen directly in the "Construct" menu.

Figure 4: *My Dictionary* "Construct" menu.

Here one's dictionary can be constructed:

a) word after word starting from a blank page (as in *Addizionario*);
b) starting from the so-called "containers of words"[4] (namely, homogeneous sets of words that can be empty or to be completed, such as the glossary of Geography, the words of affection etc.);

[4] The expression "container of words" is less poetic but more immediate and functional than the expression "world of words" at first selected by the authors of *AddizionarioPLUS*.

c) starting from the so-called "pictures of words" (namely, illustrations of environments of different type, where images of persons, animals or things are visible, to which their names, pronunciation and possible typical sounds can be associated).

Following the first approach, the pupil can start off from single words not necessarily connected together (for instance, words attracting his attention or creating difficulties of understanding while he is reading a text or listening to a lesson).
Following the second approach, the pupil can start off from words belonging to a specific semantic field (for instance, the one of feelings).
Following the third approach, the pupil can start off from words denoting people, animals or things, whose representations are "set" in the same graphic context, that is to say, in the same picture (for instance, the illustration of a farm, a street, a school etc.).
Moreover, the pupil can construct "pictures of words" *ex novo* or explore and complete "pictures of words" already constructed or half-constructed and can insert new words in his dictionary as well.
A particularly interesting possibility offered to the pupil within this module is the one of interconnecting different graphic environments by creating some accessing points for "entering" the objects represented in a picture (in the context of a "farm", for instance, the pupil can construct an accessing point to the "roost" and examine its inside).
Other approaches for constructing one's dictionary (not included in the "Construct" menu) foresee:

d) to start from texts, where the user can locate the words he considers worth inserting in his dictionary or working on;
e) to expand and complete the material produced by the pupils who created the "Core Dictionary" of *Addizionario* with one's material (definitions, examples, drawings and sounds), which may be useful to give pupils the opportunity of not starting from a (often discouraging) blank page.

When the software is used on a network (both a LAN and the Internet), another approach (not included in the "Construct" menu) foresees:

f) to construct the *Class Dictionary* with the contents of the *Fellow school children's Dictionaries* considered the best ones by the pupils themselves according to a collaborative logic and under the supervision of the teacher.

3.5.2 My Stories and My Drawings

During the testing of *Addizionario*, the request was often made to have the possibility to access the software only in order to either write stories or draw.
My Stories and *My Drawings* are the two working environments of *AddizionarioPLUS* responding to these requirements (being they presented as separate modules).

3.5.2.1 My Stories

With the introduction of *My Stories* as a separate module, *AddizionarioPLUS* offers the pupil not only the chance of writing a story (as *Addizionario* did), but also the one of constructing a real book of stories (including its cover) following different approaches.
Three approaches for constructing one's book of stories can be chosen directly in the "Construct" menu.

Figure 5: *My Stories* "Construct" menu.

Here it is possible to write three different kinds of stories:

a) classic stories composed only of a text and emphasizing characters and places;
b) stories facilitated by the use of images and words;
c) stories illustrated with captions.

Each kind of story can stimulate and develop different abilities in the pupil.
Moreover, *My Stories* could be one of the most appropriate environments for the organization of group activities, such as writing a story together or compiling simplified texts (for instance, texts where pupils are invited to explain the meaning of difficult words or to substitute them with synonyms that are easier to understand).
The construction and the possible consultation of a story facilitated by the use of images and words can be illustrated with the example reported below ("The Magic Pipe").

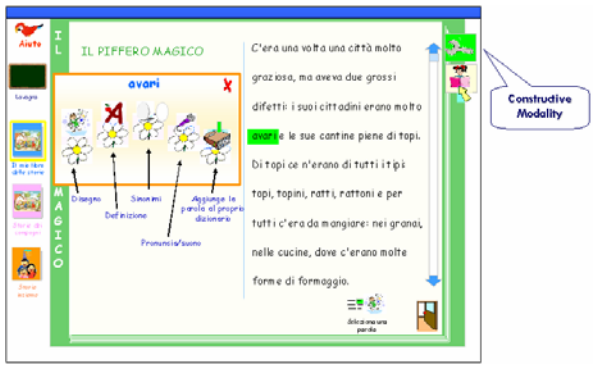

Figure 6: "The Magic Pipe" (Constructive Modality).

The teacher can prepare his/her lessons by simplifying an excerpt (extracted from a book or downloaded from the Internet) with definitions, synonyms and pronunciations or sounds, either by himself (as in the case of a remedial teacher) or involving his pupils.

After that the title, the text and the graphic context of the story proposed have been notified to the user (who can be a pupil as well as the teacher), some possibilities are offered to him:

- he can simplify the story by replacing a word with the corresponding image (which can be drawn by himself or selected by him within the "Drawing Gallery");
- he can write the definition of a word;
- he can substitute a word with a synonym;
- he can record the pronunciation or the sound of a word;
- he can insert a word in his dictionary.

Figure 7: "The Magic Pipe" (Consultative Modality).

By selecting the button "Make the word jumping" (which is symbolized by a *Frog* and represents the link between *My Stories* and *My Dictionary*), the user can verify if the word selected is or is not present in his dictionary and, in the negative case, he can insert the word selected in his dictionary.

The work performed by pupils may be also useful for either foreign children or children with cognitive disabilities.

In this connection, it should be underlined that children are always favourably disposed to take part in these kinds of activities, which involve friendship and offer them the possibility of helping their fellow school children.

3.5.2.2 My Drawings

With the introduction of *My Drawings* as a separate module, *AddizionarioPLUS* offers the pupil not only the chance of drawing (as *Addizionario* did), but also the one of constructing a real drawing album by making use of numerous tools.

This environment already existed in *Addizionario*, but has been improved in *AddizionarioPLUS*, where new functions and specials effects have been added.

In particular, some possibilities are offered to the user:

- he can work on an expandable drawing table (against the fixed and too small drawing table available in *Addizionario*);
- he can use an increased quantity of ready-to-use material (against the scarce quantity of ready-to-use material available in *Addizionario*);
- he can use an interesting space for the creation of simple examples of animation (where, for instance, by using only two still pictures, it is possible to represent graphically the meaning of certain kinds of antonyms, such as "close/open", "switch on/switch off" etc.).

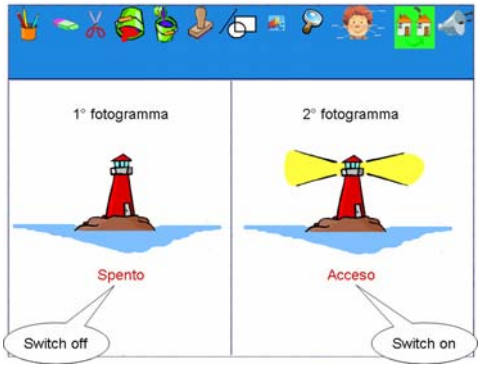

Figure 8: a graphic representation of an antonym.

3.5.3 The Children's Dictionary compiled by children

The fourth working environment of *AddizionarioPLUS* is the *Children's Dictionary compiled by children*.

This dictionary re-proposes to the users of the new version of the software the material previously produced by the pupils who created the "Core Dictionary" of *Addizionario* [4].

What is expected here is that pupils expand and complete it with material of their own production (definitions, examples, drawings, pronunciations and sounds).

This didactic approach can stimulate pupils to read and use what other pupils have created and, at the same time, can help them to overcome the anxiety that can arise in them when they start from a blank page (for instance, by providing them with a list of words to start from in the construction of their dictionary and possible examples that may give them an inspiration).

3.6 The creation of a module for the teacher

Another novelty introduced in *AddizionarioPLUS* is the *Teacher Module*.

Whereas in *Addizionario* the teacher was considered as an external and detached controller of pupils' activities, in the new version of the software he/she is considered as a user in every respect.

The same possibilities offered to the pupil within the *Pupil Module* are provided to the teacher within the *Teacher Module*.

Here the teacher can:

- monitor his pupils' work, control the work performed and stimulate his pupils to reflect on it;
- manage the "Class Dictionary" by publishing the best material;
- start collaborative activities through the *Blackboard*;
- prepare customized learning paths for his pupils by using the facilities supplied by the system;
- manage the security copies of the data collected.

Moreover, the teacher has his own dictionary, which is not visible to pupils except when the teacher resorts to the *Blackboard*.

3.7 The availability of ready-to-use material arranged into learning paths already traced out

In an attempt to accommodate users' requirements arisen during the testing of the previous version of the software, a larger quantity of prepared material (texts, drawings, sounds, "containers of words" and "pictures of words") have been included in *AddizionarioPLUS* (which, among other things, may be useful to spare pupils the so-called "discouragement for a blank page").
As already mentioned, in each working environment it is possible to either carry out free creative activities or follow learning paths suggested by the system (which facilitate and "enrich" the possible activities).
Many of the possible choices – left to the initiative and inventiveness of the teacher in *Addizionario* – are already traced out in the new version of the software, thus facilitating the teacher's task.
The main learning paths proposed include the creation of:

- glossaries of various disciplines;
- a sensorial vocabulary;
- the so-called "Tra-di(c)tionary", a multilingual storage space for the documentation, preservation and oral and written transmission of values, cultural models, usages and customs.

3.8 The availability of "on-line" helps for both pupils and the teacher

Compared with *Addizionario* (where help devices were scarce and very simple), *AddizionarioPLUS* also offers the possibility of guiding pupils' creativeness.
For this purpose, a wide selection of ready-to-use help devices (some dedicated to pupils and others dedicated to the teacher) is contemplated.
Pupils can rely upon the constant help of the already mentioned *on/off Parrot*, which is always ready to give them:

- encouragement (by helping them not to lose hearth and not to lose themselves in the software environments);
- technical support (by explaining the functions of the various icons to them and giving them information about the possibilities offered by the software).

On the other hand, the teacher can benefit from:

- technical explanations about the use of the software;
- suggestions for including the software in daily teaching (individual as well as collaborative) activities – including informative material supporting the management of collaborative activities (concerning, for instance, the setting up and administration of working groups, the management of work-shifts, the subdivision of tasks and responsibilities etc.) – and indications about the aims that may be achieved by means of these activities;
- a specific environment – a Web site specially created by the authors of *AddizionarioPLUS* – for interacting with other teachers (discussing with them about the difficulties encountered while testing the software and reading and/or publishing the material produced by pupils, other teachers or himself).

4 Conclusion

The prototype of *AddizionarioPLUS* – the updated and extended version of *Addizionario* – has now reached an advanced stage of development.
The new version of the software has been completely re-designed, bearing in mind the suggestions and ideas arisen during the testing of the previous version of the software in schools both in Italy and abroad.
A particular attention was paid to the requests made by a group of indigenous schools using the P'urhépecha language in the Mexican meseta of Michoacán and intending to construct the first monolingual dictionary of their native language by means of *Addizionario*.
As in the case of *Addizionario*, the work is being carried out in close contact with pupils and teachers.
In particular, the Mexican school children are involved in preparing graphic material and texts, which are destined to enrich the intercultural learning paths provided by the software.
As we look at the future, we hope that, in spite of the present difficulties in raising funds, *AddizionarioPLUS* can succeed in reaching its aims and, in particular, that it can arouse and develop in pupils a greater curiosity and a bigger love for their languages and cultures than those produced by *Addizionario*.

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Don Quixote 1605-2005: Teaching Don Quixote on WebCT in the 21st Century

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This paper presents some basic ideas about different ways of teaching literature at the university level in the computer age. It outlines the structural organization of Don Quixote 1605-2005, a hybrid or blended course recently taught using computer technology, in this case, WebCT. This course turned out to be an interesting experiment in web based teaching and this paper presents and analyzes some of the results of that experiment. Finally, this paper presents some of the more important teaching (professor) and learning (students) reactions to the course.

Povzetek: Opisane so izkušnje učenja spleta na inovativen način.

1 Introduction

Classic literature gives the examples of intrinsic beauty, spiritual maturation, and knowledge of human nature. It is an essential part of world inheritance and the world experience of presenting and solving ethical problems. Modern information society claims well-educated people in the field of computer science. But an underdeveloped emotional sphere, a strongly rational approach to making a choice and taking a decision may make a human being rather lop-sided.

So 400 years later Don Quixote sets out again to perform another miraculous deed: to evoke strong curiosity in his way of perceiving the world, in his awareness of human relationships, and in his kindness and generosity.

It is important to study great works of literature like Don Quixote, especially in the age of computers and online learning, precisely because reading a substantial classic like Don Quixote and presenting ideas online enables students to organize their reading, teaches them time management, involves them in online writing and debate, and opens to students of humanities, even at the humblest levels, an insight into the uses and functions of information technology.

The structure of this paper is relatively straightforward: beginnings and organization of the course, the establishment of a marking scheme, the development of an online protocol for discussions, examples of discussions and themes, an analysis of student postings broken down by frequency, and some conclusions on the nature of workload and the success of the course.

2 Beginnings

This paper begins by stating that the Don Quixote course was not initially scheduled to be taught on the WebCT platform. That came about by accident. There were 17 students enrolled in the course, all from different levels and different backgrounds. These included students completing a minors, majors, or honors, as well as students from the science program of a neighboring university. Because of these varied academic backgrounds, there was no single time at which the class could meet. The students with a scientific program had course schedules that conflicted with those in a humanities program on account of their labs and practical work; these were unable to attend a traditional course at standard times. However, when the class met for the first time, it was possible to establish two separate hours per week when two groups of 9 and 8 students could meet. One group meeting for an hour late on Tuesday night and the second group met for an hour early on Wednesday morning. The instructor's challenge was to experiment with WebCT and gain experience as a course designer while reviewing WebCT as a teaching and learning experience. From these beginnings this hybrid or blended course was born.

3 Organization

At the initial meeting, seeing the tremendous discrepancies in language levels and cultural backgrounds, it was agreed that the text of Don Quixote could be read in Spanish (Don Quijote), English (Don Quixote), or French (Don Quichotte), according to the language abilities and preference of the students. A specific translation was not recommended. Students were allowed to choose a translation. The online annotated text

of Don Quixote, as it on the website of Cervantes Visual was the virtual text for the course. This was an interesting experiment in itself, for, as students became aware of the discrepancies in their translations, so the referral back to the original text, in Spanish, became more and more necessary.

Videos of Part I of Don Quixote (1605) were shown and the text was commentated two days a week. Students were to attend at least one of these sessions. One student in fact attended both sessions all term and was amused to find that, since this was not a lecture course but a discussion group, the information offered by the instructor varied in each session according to student questions. As a result, different information was available to both groups. This showed up in the essays and online discussions.

Students are empowered by being asked to discuss the course structure and marking scheme. Multiple possibilities for course outlines are presented, and students agree upon the one that will be used. This act of empowerment enables the students to take part ownership in a course. It also encourages them to commit to something they themselves have helped design.

In the Don Quixote course, then, all students had an opportunity to do three important things: (1) to design the course; (2) to achieve face to face contact with the instructor; and (3) to view the video. The visual aspects of narrative have become extremely important when encouraging students to engage with literature as this generation of students is visually, more than textually, engaged. The experience of literature must be lived and not taught. The face to face contact with the instructor is also extremely important, especially in the Humanities and must be treasured. A hybrid, or blended course, is therefore preferable, in the Humanities, to one that is strictly taught on line, with no human contact other than by discussion and e-mail.

4 Structure

The structure of the course responded, to a certain degree, to the basic problem which any course on Don Quixote sets: how does one persuade students, who are hooked on visual presentations and multi-media, to sit down and read a 1,000 page novel in 13 weeks, be it in English, French, or Spanish? One answer is to invite them to discuss and agree on a plan and then to stick to a reading program. In this fashion, the students agreed to read 2 chapters a day, five days a week for thirteen weeks. This achieved the prime task of reading the 126 chapters which combine to form the novel. It also developed time management skills and stressed the individual responsibility of each student to keep up with the work.

The class now consisted of one hour video and human contact and two hours devoted to posting and reading the postings of others. This was clearly an ambitious and demanding schedule, but since these were committed students, they agreed that it could be done. Assessment was also agreed upon mutually: three essays, posted online, 1 a month at 20% each, and 40% for individual online postings. Postings were to be on the topics outlined in the discussions tool; they would be scored at a maximum of 4 points a week for 10 weeks, as governed by a published protocol, and they would be marked accordingly.

5 Class Languages

As for class languages, New Brunswick is Canada's only official bilingual province. Three languages, English, French, and Spanish, were therefore available for students and professor. All three of them were used during the course, but there were bonus points for reading, writing, quoting, and posting in Spanish.

6 Departmental Strategy

All four upper level courses in Spanish in the second term (January to April, 2005) were taught by the same instructor. Although this was a great deal of work, it was also an incredibly rewarding experience; for instead of four different points of view in four separate courses, the instructor was able to link Spanish literature and culture together in a way that has often been talked about but seldom demonstrated. The translation course linked directly to the course on Don Quixote, for those who were reading it in translation. Don Quixote was linked directly into the Generation of 1898 with its exploration of the roots of modern Spanish culture and its emphasis on the rediscovery of Spain and Spanish literature. The Generation of 1898 led directly into the Generation of 1927 with its rediscovery of the use of metaphor in the poetry of Góngora (died 1627; tercentenary 1927; and hence the foundation of the generation). The Generation of 1927 also tied directly into the use of surrealism for the creation of metaphor in the Advanced Reading course where surrealism and the creation of metaphor in the poetry of Octavio Paz and Federico García Lorca were studied. Surrealism itself via, automatic writing, metaphor, meditation, and the use of dream symbolism, led back to Don Quixote – Mambrino's Helmet, the Cave of Montesinos, and the question of reality / illusion, and the nature of metatheatre. This led directly to the meaning of meaning, the effectiveness of translation, and one of the central cultural issues of both Don Quixote and the Generation of 1898: "What is the cultural reality of Spain?"

7 Workload

As a result of this, the teaching term was very difficult in terms of preparation and background reading; however, it was also extremely enriching and rewarding, especially for those students who were able to take all their fourth year courses with just one instructor.

Of the four course preparations, the one that created most work was the course on Don Quixote as WebCT was new to the instructor. The structure of earlier Don Quixote courses had to be adapted to this new format and became the main teaching vehicle and communication forum for students and instructor.

Each week, from 4 and 6 topics, with commentaries, were prepared, and students were invited to discuss them online. Some topics sprang from student questions or comments, some were related directly to the text itself, and some grew out of the critical readings which accompanied the text. These discussions were worth up to four marks per week and students were asked to complete ten weeks of discussions for forty marks which counted as 40% of the course grade.

A protocol was established to rank the type of discussions in which the students participated. Discussion marks also served as a participation and attendance grade.

8 Protocol and Grading

The protocol for using the discussion and e-mail tools was established during the initial class discussions. The discussion tool can be thought provoking and can help students to organize their ideas and present them to a wider audience. Students were expected to use it regularly, and participation was demanded on a weekly basis. Participation consisted of regular readings of the postings and as many postings a week as were necessary to accumulate the 4 marks on offer.

Each of the thirteen weeks was numbered in the discussion group, and a series of topics was posted for each week. Students were required to be brief in their comments and were awarded marks from 1-4 for each posting. Students were also required to use their discussion groups frequently, but above all to use them sensibly. Ideas and research were presented at four very different levels, which correspond to the marks designated above:

1 mark: A relevant but coloquial commentary on the words of other students (1 point).

2 marks: General information of use to the other members of the class— “I have found a useful website which offers an annotated text of Don Quixote and allows you to listen to and read Spanish online. This is what I read and here is the URL.”

3 marks: Intellectual contributions to the class discussion, backed up by direct quotes from the text — “I don’t agree with Dr. Moore’s interpretation of the episode of the Cave of Montesinos. Individuals are confronted by their own version of reality and should not be bound by a social hierarchy which dismisses the personal and individual in its interpretation of interior events. For example ...”

4 marks: Presentation of critical ideas from a reliable academic source (with correctly annotated quotation) — "I have just read Salvador de Madariaga’s book on Don Quixote. In it he presents the idea that Don Quixote and Sancho Panza interchange ideas to such an extent that they draw nearer to each other. Thus, in the words of Madariaga, we can speak of the Sanchification of Don Quixote and the Quixotification of Sancho Panza. Some of the examples he uses for this process are ……”

E-mail was recommended for private correspondence between individual members of the group. Comments such as “I agree with you” or “That’s what I think” were relayed in email form to the individual student concerned. Personal comments (and replies) that are specific to one or two people were also privately communicated by email.

Contributions to the discussion group were graded regularly. The grading system was 40% for these weekly discussions and this was joined to 60% for three formal essays delivered monthly, each essay being due on the last day of the month. Essay topics were circulated well in advance of the due date, and students were given a variety of topics and were encouraged to draw from (a) critical articles and (b) quotes from the online discussions. In addition, students had the choice of writing three separate essays or of developing their essay topics, with critical readings, over the course to present a fully researched academic paper, written and developed over three installments. Several students chose this option.

9 Examples of Topics

Examples of discussion topics, drawn from the first three weeks of the course, follow.

Week 1 – Don Quixote, Part I, Chapters 1-10:
Topics: (1) The first sortie; (2) Gotta luv him; (3) Chivalry; (4) The scrutiny of the library; (5) Cide Hamete Benegeli.

Week 2 – Don Quixote, Part I, Chapters 11-20:
Topics: (1) The second sortie; (2) “Ni sé leer ...” / ”I don’t know how to read ...”; (3) Pastoral with goat herds; (4) Marcela.

Week 3 – Don Quixote, Part I, Chapters 21-30:
Topics: (1) A double act: Sancho Panza and Don Quixote; (2) El yelmo de Mambrino / Mambino’s helmet; (3) Los galeotes / the galley slaves; (4) Slang, double meanings, and the picaresque.

Most of these topics sprang naturally from the reading sequence; some, however, came from students and merit further discussion. The topic entitled Gotta luv him, for example, came from an in class revelation that Don Quixote, the character, seemed to be just like one class member’s old, bumbling, loveable grandfather, and that “we gotta luv him” in spite of all his difficulties and ambiguities. This turned out to be a prolific topic and an extremely personal link between novel and individual reader was established very early on. This personal and subjective interpretation of the text was not discouraged, since one of the goals of the course was to enable students to commit to, and read, a long novel.

A side effect of one topic, the scrutiny of the library, with its presentation, for the first time, of el sabio

Frestón, the evil magician who spirits away Don Quixote's library, was to open up the theme of magic and magicians. This led directly to a series of comparisons with some of the novel series that the students had encountered. These included The Lord of the Rings and the Harry Potter sequence, both of which had been seen first, and then read, thus reinforcing, once more, the symbiotic relationship between vision and reading.

Topics were chosen with great care. They were designed to point out the vital signposts along the reading route of Don Quixote. When presenting a topic, various questions were asked and specific problems were posed in such a way that each topic could be examined from several points of view; these embraced both the subjective and personal readings of gotta luv him and the more objective critically researched, in depth readings which were developed by the most committed students as the course advanced.

10 An In Depth Look at Selected Topics

Here is a brief examination of the first topic which corresponds to the first sortie. Here are the initial questions posed for introducing the first discussion:

The First Sortie is very brief and lasts only 4 chapters (DQ, I, 2-5). Several questions as to the sortie's structure arise:

(1) On the evidence of this first sortie, did Cervantes start out with the intention of writing a long novel?

(2) Cervantes also wrote short stories: what evidence is there that this first sortie might actually have started out as a short story? Look, for example, at chapter headings and text divisions.

(3) What is the relationship between this first sortie and the anonymous entremés de los romances which it seems to copy?

(4) What is the role of the narrator at this stage of the novel and, by extension, can the narrative voice be easily identified?

Some students showed great powers of observation, even in these early moments of the course; however, others experienced a great deal of difficulty with this topic. Quite simply, they didn't yet have -- nor were they expected to have -- either the analytical skills or the background knowledge to go beyond a relatively simple reading of the text. The questions outlined above attempt to illustrate both the text's complexities and the efforts made, through topics, questions and commentaries, to develop from an initial subjective reading, through in-depth reading, to the basic skills of critical analysis. In fact, the text's difficulties will readily come through to any mixed audience; clearly, a mixed audience, containing people who are unfamiliar with Don Quixote, people who have read it, but have neither taught nor studied it, and people who are specialist Cervantistas and have read the original text in Spanish on more than one occasion, will all draw on different knowledge bases. In order to present the complexities that are inherent within the text, the early topics began with an open-ended question and terminated, at the end of the week, with a brief summary of what might be termed the "current state of the problem." In this fashion, after open and flowing discussion, both the text's complexities and the necessity for further critical reading were illustrated.

11 Thematic Linking of Topics

The topics were also thematically linked. The tectonic, or structural approach, began with the conversion of a short story to a novel. It continued with the invention of Cide Hamete Benengeli, reintroduced when the first sortie (one protagonist – Don Quixote) was compared with the beginning of the second sortie (two protagonists and hence the introduction of a continuous dialogue – Don Quixote and Sancho Panza), and was presented again with the story of Marcela (the first of the intercalated tales which break – or do they?) the narrative structure of the novel.

Structure, of course, emerges again from the peripatetic nature of the picaresque tales included within the chapter on the galley slaves / los galeotes. The picaresque itself, with its different definitions in Spanish and English, also made for a topic of debate: "In what ways does the English picaresque novel differ from the Spanish picaresque novel?" Structural themes continue with the presence of the relatively clumsy, yet decidedly effective, metatheatre which is present throughout the whole episode of Dorotea and her role as the Princess Micomicona. Here, in fact, the nature of structure ties directly into the theme of illusion and reality as it is initiated in Part I of the book.

12 Flexibility

These discussion topics gave enormous flexibility to the teaching and this enabled the instructor to work individually with students. This course and this way of teaching generated more individual, one on one discussions than any other, and the instructor was able to reach out to students at very flexible levels according to their preparation, their reading and their intellectual and academic development and interest.

For example, the topic "Ni sé leer ..." permitted the introduction of the theories of Walter Ong, as represented in Orality and Literacy, to a group of students who were working with human rights and developmental themes in Latin American countries. Don Quixote became, for these students, at one level, a representation of that strange literary meeting place in which half the characters are literate and can read and write, while the other half can neither read a scrap of paper nor sign their names. The placing together, in this novel, of selected moments at which literate and oral world views approach each other in ever greater proximity, is a master-piece of artistic achievement that has been little studied and which moves directly into the empowerment theories (knowledge as power) of Paolo Freire and Michel Foucault.

13 Thematic Links with Other Courses

Thematic linkage occurred at several levels within the Don Quixote course. At the most basic level, instead of beginning with themes and tracing their development throughout the novel, the reading system employed allowed the discussion of themes as they arose. These were then repeated and elaborated as they reoccurred. Thus, the reiterated theme of Don Quixote's madness – is he, isn't he, in what way is he? – became closely linked to the Sanchification / Quixotification process which in turn was linked into the development of metatheatre, which again became linked to the development of inter-textual commentary, relativism and perspectivism, and the shared views of characters, historian, translator, narrator, and commentator, all of whom discuss and dispute along with the students in the discussions, the textual facts of the presentation of madness.

At the second level, this linkage was enhanced by the texts selected by those students who were also following the course on twentieth century literature. Texts chosen for study, for example, in the twentieth century literature course included Azorín: La ruta de don Quixote, two texts from Miguel de Unamuno: Vida de Don Quixote y Sancho Panza, and "Don Quixote in the Contemporary European Tragi-comedy," the last chapter from Unamuno's The Tragic Sense of Life; Ramiro de Maeztu's study entitled Don Quijote o el amor, and José Ortega y Gasset's classic: Meditaciones del Quijote.

The readings from one course injected life and meaning into the second course, thus enhancing the process of linkage whilst underlining the constant presence of Quixotic themes in the life and literature of the early twentieth century.

At the third level, the relevance of Don Quixote to the early twenty-first century was clearly seen in the number of public references to Don Quixote which appeared in Canada, especially around January 16, 2005, the date of the fourth centenary of the publication of Don Quixote, as the event was celebrated on CBC radio, CBC television, and in the pages of various newspapers. When these events were linked to items from online discussion groups (H-Cervantes, for example) selections of which were regularly posted on WebCT, then the contemporary value of the literary text was underlined as well.

14 Bridging the Intellectual Gaps

There is a clear and enormous gap between the subjective and limited gotta luv him and the instructor's approach which, beginning with hermeneutics and phenomenology, leads to the tectonic theory of structuralism and the establishment, via metatheatre, of a dual reality. Were students able to bridge that gap and how were they able to do so?

The process used to assist them was a basic step by step build up: first read the text; then recognize the structures and themes of what is being read; then apply the correct critical names to those structures and themes; then go out and read what other people have written about those themes and structures. Thus, reading is the bait and continued interest is the hook and the other skills hopefully – and in theory – develop from there. But do they?

The answer is an emphatic yes. The hard evidence of skills development was, and still is, available in terms of the chronological postings and their growing sophistication. Writing became clearer; criticism and analysis became sharper; and questions became markedly more pointed and acute.

15 Tracking Students

The figures offered by the WebCT student tracking tool give food for thought. The total number of discussions posted by students was 580. The track record of what the students read is also very informative, with 3 out of 17 students reading all 580 postings and 5 reading more than 500 of them. 13 students read more than half the postings, and when questioned about this pattern, several students replied that they had little time to read and had been selective in their readings, choosing only those postings from friends whom they respected or good students whom they appreciated and neglecting the "online ramblings" (their words) from others.

16 Postings Read by Number

Here are the relevant figures.

All 580 postings were actually read by only 3 students!

Over 500 postings were read by 2 students
[553 - 1; 539 - 1].

2 students read over 400 postings
[480 - 1; 408 - 1].

5 students read more than 50% of the postings
[367 - 1; 359 - 1; 357 - 1; 341 - 1; 292 - 1]

5 students read less than half the postings
[272 - 1; 250 - 1 ; 218 - 1; 201 - 1; with a low of 136 postings read by 1 student].

The number of articles and discussions posted follows a slightly different pattern, but it should be noted that quality took precedence over quantity, and that those who posted well and researched their postings (at 4 marks a posting) did not need to post as often as those who posted on a less academic scale or who established a dialogic discussion with one or more interlocutors. The instructor read every posting; some were well researched, with four and five articles quoted accurately and sharp critical arguments summarized and discussed. Others were subjective in their nature; some readers did not -- for a variety of reasons -- break from the subjective mode of reading, and this was, to some extent, a lesson in how students developed and which students needed the most individual help.

17 Intellectual Competition

In this type of course, weaker students will hopefully learn from stronger ones. However, some students realized that either they could not compete intellectually or that they did not have the time to do the reading and research that was necessary to do so. As a result, they declared their unwillingness to write online as they became embarrassed and frustrated by their lack of time and skills. The instructor tried to work one on one with these students. Goals were made more manageable and their written work was accepted privately by email. Clearly, these factors change the balance and objectivity of any numerical analysis of postings.

18 Postings by Number

Here are the numbers for the postings.

66
51
47 45 42
37 36
25 23 23
17 16 15 14
09 07 05

19 Hits by Number

The number of hits follows the same type of pattern.

Over 1000 / 3 [1274, 1026, 1003]
Over 900 / 2 [991, 949]
Over 700 / 1 [790]
Over 600 / 1 [606]
Over 500 / 5 [593, 579, 570, 565, 545]
Over 400 / 1 [410]
Over 300 / 2 [387, 364]
Over 200 / 2 [293, 203]

20 Analysis of Hits

Some of these figures bear examining. 2-3 postings a week, as required by the course, would have seen an average of 20 - 30 postings over the ten weeks necessary to accumulate the 40 points offered for this part of the course.

Technically, 10 good postings at 4 marks each – and the postings were graded weekly, as a minimum, so that students almost always knew exactly where they stood – could have accounted for the grade.

The student who posted 66 times was assiduous in the computer work and logged on 1274 times, reading all 580 postings. A model student in many ways -- and yet, 1247 hits means that this student logged on approximately 100 times a week at an average of 14 times a day over a 13 week period.

Five students logged on over 900 times and that means 70 times a week or 10 times daily. At this stage, it is vital to ask the question: what is happening to the students?

21 Teaching Workload

The instructor spent every Saturday and Sunday morning, for about 4-6 hours each day, for 13 weeks, monitoring this course, grading these discussions, and working electronically one on one with these students. Quite simply, to complete the course effectively and to gain full benefit from it, the time and effort needed was exemplary, possibly way beyond the call of duty. Yet, such is the power and influence of Don Quixote, that instructor and students made just that commitment, and more.

11 of the 17 students who actually started the course, finished the book on, or ahead of, time. Of these 11, 3 finished on the final day and one student "fudged" the issue by assuming that the instructor wouldn't recognize input from various summarized versions of the text.

22 Reasons for not Reading

Of the 6 who didn't finish the reading exercise, the reasons were all similar: students fell behind in their reading, took one look at the large back up of postings as it was building up, and panicked.

2 students who panicked, came to see the instructor early, broke down, and were put back together by the simple expedient of either increasing the chapters that they read daily, or by increasing the number of days they read per week. The instructor also selected passages of the text that could be omitted. As a result, certain of the intercalated novels, for example, The Curious Impertinent, were avoided. Using a judicious blend of these strategies and short cuts, both students caught up albeit with some difficulty, and were soon back to speed.

While not everybody managed to finish the whole book (Parts I and II), all students completed Don Quixote Part I (the 1605 edition, hence the fourth centenary celebrations). In various communications, it became clear that students who did not complete the readings on their own needed the group encouragement and the class presence more than the others.

Students who completed Don Quixote Part I had read what they had seen on the videos and hence had read what they already understood. The videos and in class discussions were absolutely essential to this group, but they found it extremely difficult to progress beyond the point at which the videos and the in class discussions ended. This was one of the more interesting discoveries of the course, that a large group of 11 students could self-pace and self-manage, but that a tidy minority of 6 (33% of the class) had found it most difficult to do so.

23 Skills improvement

Those who were totally committed to the reading and writing process outlined above expanded their reading and writing abilities enormously. There were clear and objective improvements in thought process, reading skills, analytical skill, research skills, and writing skills.

24 Self-assessment

Students finished the term with an assessment of their own development within the course. They recognized the patterns and skills that they had evolved. Even the students who only finished Don Quixote, Part I, gained substantial and important knowledge of themselves, and of their reading and planning processes. Don Quixote became a topic of conversation throughout the Spanish section and was repeated in the summer of 2005 as an Independent Studies course for some students who were unable to take it during the term. In addition, a surprising number of students not enrolled in the course purchased copies of Don Quixote and are asking for the course to be re-offered again.

25 Course evaluations

Course evaluations were excellent and outlined the commitment of students and instructors to the course.

26 Student Comments

Here are selected comments from one specific student essay. In this essay, the student challenges the traditional approach to education. The Don Quixote course offered an epiphany and the opportunity to self-assess was taken in unique fashion. Here are the selected comments.

1. One must question everything, one must question authority.
2. Interestingly, my own perceptions of realities have changed drastically in the past few months. The "truth" that I no longer accept as real is the absolute validity of formal education.
3. The schooling system in place teaches children to conform and obey authorities, and deters original thought. Anyone who doesn't shape themselves to fit into the mold is seen as a problem -- people who think critically are dangerous to the maintenance of the system.
4. I realized only recently that I myself have not been equipped with critical thinking skills.
5. I feel that my whole experience in the schooling system can be compared to a meta- theatre of sorts.
6. After the seventeen years that I have been schooled, I only realized recently that there were negative aspects to being schooled. From kindergarten on, I received positive reinforcement for being a "good student", which really meant that I accepted the authority of my teachers, and did not question what they told me. I was unaware (as almost all students are) of the hidden curriculum of conformity and the perpetuation of class differences within our society.
7. University is a continuation of this formal education, packaging schooling with certification (as Ivan Illich would say). I am glad that I went to university, yet at the same time I am glad that I have come to the realization that it is not reflective of my actual intelligence or skill level. It is, however, a reflection of my relative privilege within our society, and my ability to conform to the ideas of my educators (consciously or unconsciously). It was in university that I was exposed to this very idea, so it's not all bad. At the same time, it is a shame that it took me so long to realize the truth about the formal education which has been my life up until this point.

27 Critical Analysis

Occasionally, as a teacher, one reaches out and realizes that teaching is more than the transference of facts; the analytical and critical thought patterns of some students can be transformed. It is in the light of this transformation and realization that the above student comments were selected. Such moments of enlightenment are rare and must be celebrated. The course on Don Quixote, more than any other, makes demands upon students that awaken them to the falsities inherent in the world around them. While the instructor would love to claim part, or all, of the credit, it is in fact the opening of the world classics to young minds that brings this about. The ensuing discussion, if organized and stressed in optimum fashion, causes a transformational change in the mind's of both educators and educated. The future of the humanities depends upon educators providing as many opportunities as possible for such awakenings.

28 Conclusions

Teaching this hybrid course on WebCT allowed students and instructor to communicate in meaningful ways. These included in class discussions, online discussions, personal interviews, emails, and the constant exchange of ideas via regular postings. Students learned valuable lessons in organization, time management, writing and thinking skills, critical and analytical skills, and also in the need for an established protocol, first in their postings and then in their research. Subjective and objective points of view were established and discussed. Finally, the door to the larger world of scientific research and criticism was opened. Visual and textual experiences were combined, and the majority of the students learned to proceed beyond the visual (video) into the purely textual world of words.

29 Appendix: Some Relevant Web-sites

[1] Course outline – http://www.stu.ca/~rgmoore/courses/DonQuix.htm
[2] Hybrid courses http://courses.durhamtech.edu/tlc/www/html/Special_Feature/hybridclasses.htm
[3] Hybrid courses discussion group http://www.mcli.dist.maricopa.edu/ocotillo/retreat02/cafe.php?id=4
[4] Hybrid courses bibliography and examples http://www.merlot.org/merlot/materials.htm?keywords=hybrid+courses&category=
[5] Society of Teaching and Learning in Higher Education presentation http://www.stu.ca/~rgmoore/DQSTLHE.htm

[6] Student self-assessment essay http://www.stu.ca/~rgmoore/Scholteach/FeverDQ.htm
[7] Tectonic theory http://www.stu.ca/~rgmoore/Scholteach/GLSHahn.htm

Modern Methods for Stimulating Creativity in Education

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Motivation and creativity are ones of the primary educational objectives, quite volatile by nature, difficult to understand and theorise. There are many studies treating creativity and motivation from different points of view and philosophical background. With respect to their interpretation of creativity, they could be classified into two major groups: considering creativity as a unique, sensitive phenomenon or as a quantitative entity of Education Theory respectively. The former approach is guiding the proposed study. This paper is based on the reports and research results of The Third International Workshop "Developing Creativity and Broad Mental Outlook in the Computer Age – CBMO-2006" in conjunction with the 10th Conference of International Society for the Study of European Ideas – ISSEI 2006, organized by the University of Malta, 24-29 July, 2006.

Povzetek: Opisane so metode za spodbujanje stimulacije pri učenju.

1 Introduction

The commonly accepted definition of creativity has three parts:

- Creativity is a complex process, subject to studies by Behavioral Psychology, Social Psychology, Psychometrics, Cognitive Science, Artificial Intelligence, Philosophy, Economics, Business and Management, etc.
- Creativity is an interpretation of past knowledge and experience in a new way
- Creativity contributes to the enrichment of the existing knowledge base

George Keller expressed this definition as "Creativity, it has been said, consists largely of re-arranging what we know in order to find out what we do not know" [1].

Some researchers of creativity consider the creative process as a five-step one: [2]

- Fact-finding
- Problem-finding
- Idea-finding
- Solution-finding
- Acceptance-finding.

Certain cognitive characteristics contribute to the one's creative behaviour [3]:

- Fluency
- Flexibility
- Visualisation
- Imagination
- Expressiveness
- Openness.

Such skills could be learned or they may be situational. Fluency is related to the number of meaningful responses to a challenge, while flexibility reflects the diversity of the responses provided. These features are involved in the psychometric study of creativity too [4].

In order to achieve the objectives related to creativity, education theorists are debating different pedagogical methods and alternatives to the officially favoured Learner – centredness. Some scholars explore new ways of approaching the problem introducing culturally oriented pedagogies:

"There can be no justification for a universal and homogenising pedagogy if indeed teaching and learning are contextual activities. A universalised pedagogy necessarily marginalizes pedagogies based on alternative epistemologies. For example, by treating learner-centred pedagogy as a one-size-fits-all approach to teaching and learning, pedagogies that are based on indigenous knowledge systems are marginalized " [5].

In addition to the above said, the list of all five steps of the creativity process requires certain access to information and communication facilities. Such prerequisites imply further marginalisation of some social layers, promote the development of the spirit of individualism, rationalism, laissez-fare economics, just to mention a few [6]. In the sense of this trend, some authors (Prof. Hiwaki, Prof. Tong) consider creativity as a distorted feature of the contemporary world and offer an alternative that plays the role of a "social immune system" and "social glue and lubricant" [7].

Prof. Hiwaki's philosophical treatment of the subject matter tries to link cultural values and creativity in order

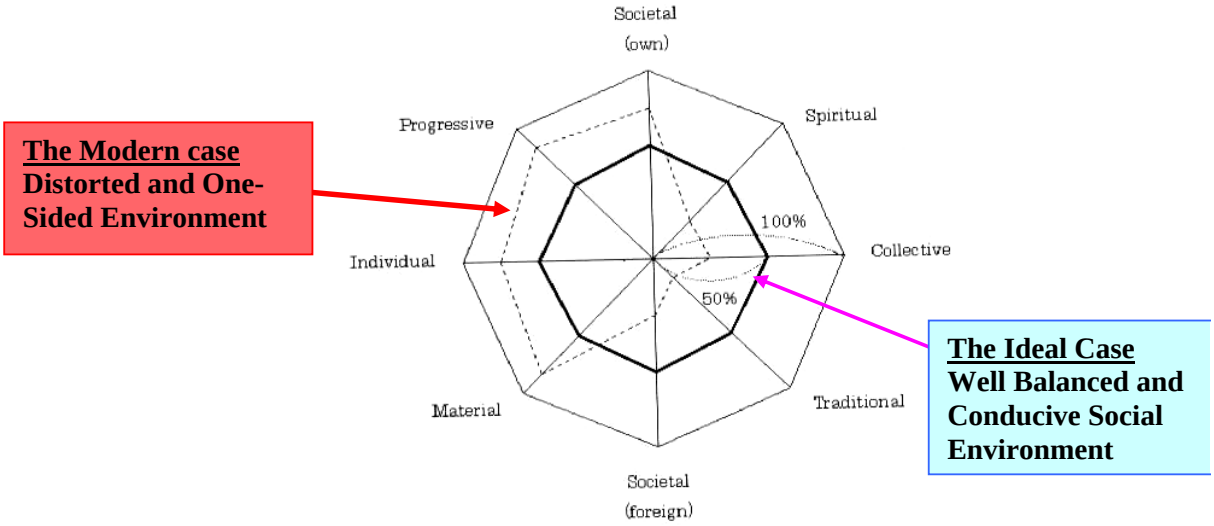

Figure 1

to create a well balanced and conducive environment for the society as a whole. His view could be illustrated with the diagram, Figure 1.

The distorted social and educational environment of today, all over the world, could be clearly seen from the following chart [8], Fig. 2:

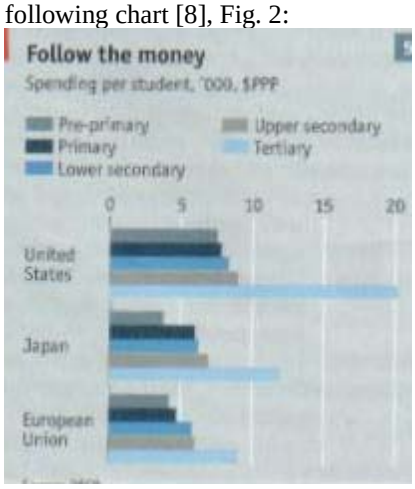

Figure 2

Funds allocated to pre-primary, primary, lower secondary and senior secondary education are approximately one half of the money spent per student of tertiary education, despite their obvious importance, especially of primary education [9]. Some researchers are attempting various ways to fix such a discrepancy, mainly with the use of multimedia. In particular, the paper [10] describes AddizionarioPLUS (see Figure 3), an updated and extended version of Addizionario - a multimedia tool for improving the linguistic and cognitive development of primary school children. Addizionario was developed by the Institute for Computational Linguistics of the National Research Council (C.N.R.) in collaboration with the Department of Computer Sciences of the University of Turin in the late 1990's. This system has been successfully tested in several schools in Italy and abroad.

Figure 3

The advantages of multimedia and simulation methods could be illustrated by the research of an Italian team [11], Fig. 4.

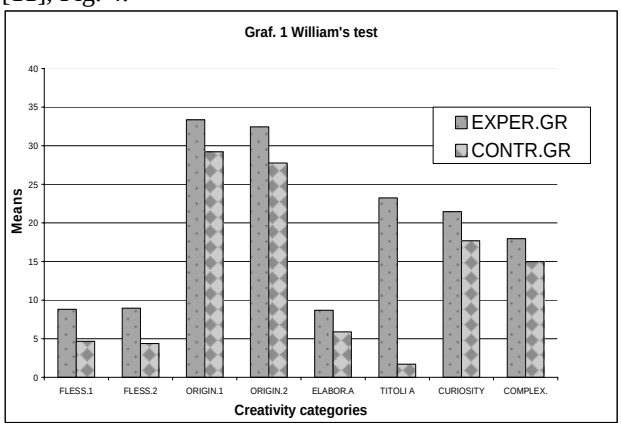

Figure 4

On the other hand, the sophistication of modern technology creates a divide between Production and Consumer with quite a negative impact on almost all ways of life, e.g. monopolization, technological dependency, corruption, etc.

2 A Computer Studies Course and Development of Creativity

Education is one of most affected areas of the modern society, especially in the developing world. The current situation favours a narrow and defocused mindset, mainly oriented to consumerism and "push-button" culture, shifting the main goal of creativity towards lower priority objectives. This tendency could result in activities with serious and dangerous social consequences. From a pedagogical point of view, more and more the Black Box approach is applied to the explanation of fundamental ideas of physics, biology, computing by teachers in secondary schools. Such a prevailing practice could be illustrated with the compilation of teaching materials for Computer Studies course offered by most of secondary schools and teacher's colleges. Typical examples are the topics oriented to the general structure of computers and the central processing unit (CPU) and their class interpretation. The CPU is defined as the Heart of a computer system and is described with a few features in the spirit of the Black Box paradigm [12]. Such a simplification is justified to a certain extent only, because it could suppress the creativity and nurture a sense of technological dependability. The side effects of the simplification could be appeased if pupils are intellectually and emotionally challenged by the provision of new information concerning a certain topic in the form of virtual (e.g. multimedia) or physical demonstration.

Programmable Microcontrollers could be very useful when software and firmware are explained to students. They are very cheap and easy to attach to commercially available computers through a parallel, USB or serial ports [13]. Most commonly, Programmable Microcontrollers are known as Programmable Logic Controllers (PLCs), and PLCs could be considered as the only real "Plug and Play" devices, because installation software and hardware requirements are not necessary. Arguably, PLCs are the most popular microelectronic components today. Their invention in 1968 marked a milestone in the development of theoretical and practical computing – the structural decentralization of hardware and software products. Today it is unthinkable any process control application to be organized without PLCs. PLCs are everywhere – from household appliances, to endless industrial and entertainment facilities, to deep space explorations. In education PLCs could be used instead of the traditional paper media and could be re-cycled many times passing them on from student to student, from class to class. The teaching technology is relatively simple – every student, doing a course related to PLCs or complemented by PLCs, is provided with a microchip, Flash/EEPROM type. There are cheaper types, but they either require more time to be erased (Ultra Violet light erasable, UV type), if necessary, or are not suitable (One-Time-Programmable PLCs) for training purposes [14].

Programmers for the available PLCs are connected to a few computers in a student lab, reflecting the curriculum requirements and the assessment practice of a school or tertiary institution, Fig. 5.

Figure 5

A simple computer - a tester for student's work – is provided as well, Fig. 6.

The System Time is emulated by a Light Emitting Diode (LED) blinking every second. The Display Unit (DU) is another LED that is controlled by a student's program. Students are given tasks with different numeric values, e.g. the design of a time interval of XX microseconds. The marking procedure is a mixture of an

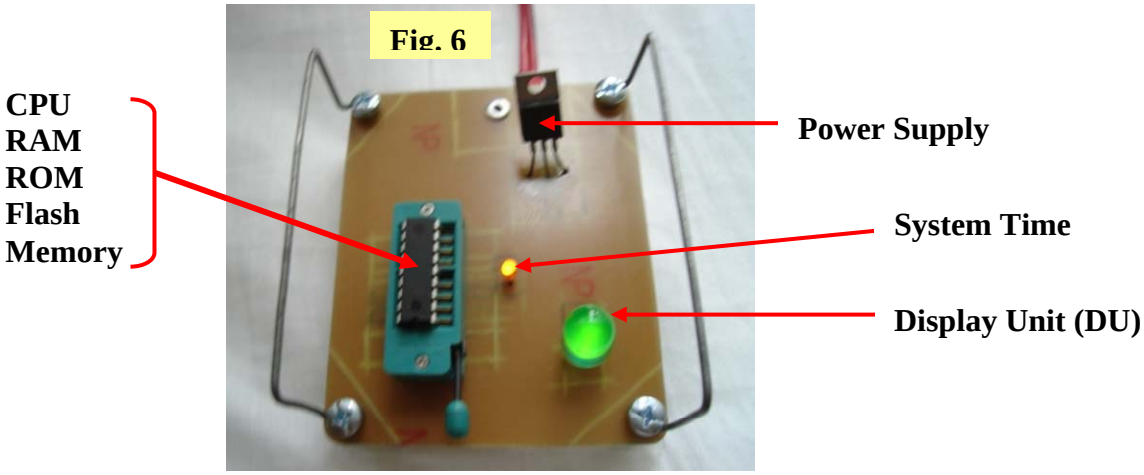

Figure 6

oral examination/presentation and demonstration of a working PLC as per the task given. The revival of a traditional pedagogical method (oral examination) allows students to share ideas and teachers to find better ways to organise the course.

The minimal software and knowledge requirements should reflect the following points:

- Hexadecimal and Octal systems of Calculation.
- Data types
- Elementary Programming Skills
- Operation Codes (OPCODEs) of the PLC provided
- Software of the PLC Programmer available, Simulator software inclusive
- General structure of computers – Classic and Harvard configurations
- The operating system installed on the computer connected to the Programmer.

The OPCODEs of PLCs vary from manufacturer to manufacturer, but in general their number is quite limited. For example, 16F84A processor used in this presentation has 35 OPCODEs only with quite suggestive abbreviations [15]. The following codes illustrate the simplicity of programming PLCs:

- INCF means INCrement memory File register
- INCFSZ means INCrement memory File register and Skip if the new value is Zero
- A program segment that generates 500 microsecond time delay/interval (4 MHz processor, OPCODEs have 1 microsecond performance time, if not branching, otherwise 2 microseconds) has five (5) program lines only [16]:

```
. . . . . .
    MOVLW       D'165'
    MOVWF       counter
    DECFSZ      counter, f
    GOTO        $-1
    NOP
. . . . . .
```

Such a simple program is quite suitable for technical college or undergraduate students. For secondary school pupils a ready made program could be given and they should play around with the output signals of the PLC changing its functionality only, applying basic skills, e.g. Copy-Paste technique:

```
. . . . . .
L1:
    BSF     Output      ; DU turned/set ON
    CALL    Delay1s     ;One second ON
    CALL    Delay1s     ;One second ON
    BCF     Output      ; DU turned/cleared OFF
    CALL    Delay1s     ;One second OFF
    GOTO    L1
. . . . . .
```

In the above program segments the output is ON for two seconds and after that OFF for one second, repeating the sequence continuously. Pupils could just increase/decrease the preset timing by inserting/deleting CALL statements and program the processor on their own.

The performance of Operating Systems (OS) as the Computer Resource Managers could be discussed and simulated processing Flash Memory storage and Internal Time interrupts. The necessary firmware is more complicated, but still within students learning capability. Here, the basic assumption is that OS is managing two processes: the System Time and Flash Memory access respectively. To introduce the topic, a new variables is necessary - readyYn is the outcome of the interrupt processing routine. Bit Zero (0) of this variable is reserved for the control of the computer Secondary Storage (Flash Memory in our case) and bit One (1) is for the System Time. The interrupt processing routine sets up the corresponding bits when the respective process needs attention (it is ready for a new operation).

The following program segment shows the initialization of OS:

```
. . . . . .
        org     0x10
start
        MOVLW D'242'    ; to get 400 microsec
                        ; time interval
        MOVWF TMR0      ; the Internal Time
                        ; Register is initialised.
. . . . . .
```

Students should calculate the initial value of TMR0 register (242 in our case) bearing in mind the frequency of the internal R-C time pulses wiring. Another short segment illustrates that when the System Interrupts are involved in the management of the configuration resources, OS counts the number of time interrupts to produce the System Time:

```
. . . . . .
        MOVLW   D'10'       ; the internal R-C
                            ; frequency is 33.3KHz
        MOVWF   counter
        BTFSS   readyYn, 1  ; O.S. is continuously
                            ;  checking through
        GOTO    $-1         ; readyYn if a time
                            ; interrupt has occurred
        BCF     readyYn, 1
        DECFSZ  counter
        GOTO    $-4
. . . . . .
```

The above segment generates 4 msec time interval.

The interrupt exercise could be generalized and organized in another way, but it requires more time than a single class session.

The essence of such a practice is to decompose the training process into smaller steps that could suit psychologically and mentally all students. For example, the majority could express curiosity only, a smaller group could be motivated to go further, but the necessary effort and knowledge will stop them at that point. A very few could manage to meet the intellectual and technical requirements of the whole process to design processors and control computerised equipment, in general. Therefore, challenging students allow teachers to gradually move from mere curiosity to more sophisticated learning stepping stones related to motivation, to the final stage of the process – Creativity, a process based on the natural facilities of students and their cultural background.

3 Conclusion

Creativity, as a teaching objective and a very sensitive and fragile phenomenon, should not be forcefully imposed upon teachers and students applying one pedagogical method or another. The teaching process should be flexible, allowing quick changes depending on the progress of students. In such a way the independent thinking and creativity of students could be stimulated in any teaching environment. In the case of computer related courses such objectives could be achieved relatively easy with the help of PLCs, without the need of big investment [17], just curriculum updates.

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New and Old Technologies: a Suitable Combination for Obtaining Efficient Educational Results

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The daily use of sophisticated technologies and devices could hide the physical meaning of everyday observations on natural phenomena. The technological solutions continuously proposed by the market, also for the teaching applications, are more and more sophisticated. The result is that more time is actually spent on the learning of the tools than in exploiting the didactic content that may be contained in the programs themselves. The aim of this paper is to show how a comparative analysis of "old" and "current" techniques, applied to the same problem, could allow to study in depth its scientific contents and to highlight both the development and the methods of scientific thought. Two different cases are considered here: a simple analogue mechanic system for introducing students to non-linear systems and the use of the dark room meridian. Both papers were presented at the Second and Third International Workshops "Developing Creativity and Broad Mental Outlook in the Computer Age" (CBMO-2002 and CBMO-2006) in conjunction with the 8th and10th Conference of the International Society for the Study of European Ideas – ISSEI 2002 (Aberystwyth, University of Wales, 22-27 July 2002) and ISSEI 2006 (University of Malta, July 24 - 29, 2006).

Povzetek: Ali moderna orodja dejansko izboljšujejo učenje?

1 A Simple System to Introduce High School Students to Nonlinearity

1.1 Introduction

As a consequence of the use and diffusion of the automatic calculus, the solutions to non-linear systems become daily present: see, for example, the weather forecast. Nonlinear systems are quite complex to handle with simple mathematics. Nevertheless one of the simplest non-linear systems, an oscillator, could be used to introduce these systems in secondary schools. In this paper it is shown how it is possible to realise a simple nonlinear oscillator and observe the behaviour of the main nonlinear characteristics from a mechanical (and mathematical) point of view. To emphasise the differences, you can observe a gradual transition "linear–nonlinear" and detect the threshold value for this transition of the control parameter.

The aim of the mechanical devices presented is to make non–linear systems affordable by non-specialised people, and in the same time to keep strictly the correctness of observations and conclusions.

Before the introduction of computers, at the middle of the past century, analytical predictions of physical systems were limited to the solution of linear (differential) equations. But linear equations describe very simple and often non real systems. Real systems are more complex and need non linear differential equations, generally not easy to solve.

Numerical methods for the solution of non-linear differential equations running on a computer enable us to solve many kinds of equation describing real systems without the need for linearization that means simplification or abstraction and the consequent loss of information and generality. This has brought about, starting from the sixties, the growth of a broad field of studies concerning the numerical modelling of systems involving several science fields as physics, chemistry, biology, and especially climatology. From the development of the above activities, a new approach to the phenomena whose name is enlightening was born: *experimental mathematics* [1]. This approach is the study of phenomena by means of their computer simulation. The parameters representing quantities or real entities are simulated by numerical variables. Laws are expressed by equations or equation sets (generally non-linear). In this way "simulated experiments" are carried out and the results or previsions obtained may be compared, when possible, with the results of real experiments.

Theoretical attempts to extend these changes to the school environment are made using mathematical non-linear systems[2, 3], electronic circuits[4, 5], mechanical systems like a chaotic pendulum[6]. Some mathematical systems were published in textbooks prepared with the assistance of the National Council of Teachers of Mathematics in USA [7] .

Here is a mechanical apparatus is presented which allows us to visualise a linear system in its gradual conversion toward non-linearity. This apparatus allows a full control of its dynamical state as the visualisation of the corresponding potential energy. The study of this non-linear system is carried out without the use of differential calculus or other mathematical tools not usually treated at high school. This study consists in the observation of the system's behaviour and characteristics and in the comparison with the corresponding linear system.

This presentation is only a trace, any possible application could be enlarged, completed and adapted to the pupils. The language, the tools, and the kind of representations used here are chosen to stimulate and to come into play spatial ability rather than logical and formal ones[8].

1.2 Harmonic oscillator

The harmonic oscillator is a traditional argument in the study of the mechanics. Our attention will be devoted to the system and to its potential. Differential equation's solution will not be directly studied.

To build a harmonic oscillator is simple: any stable system which tends to return to its equilibrium position, if set out of it (of a small quantity), can be regarded as a harmonic oscillator. In our case the harmonic oscillator is a steel plate fixed at its ends. The system realised allows us to have such a linear system and to "switch" it, when needed, to non-linear condition.

1.3 Description of the Apparatus

The system is shown in figure 1. A steel strip **P** is fixed on a wooden support just like a bucksaw: whereas the blade saw is in traction, in our case the strip P is working in compression through the spring **S** adjusted by nut **N**. When a force F is applied perpendicular to the steel strip, as shown in figure 1, the system tends to return to its equilibrium position. The reaction of the strip is proportional to its displacement x:

$$F = – k x \qquad (1)$$

k is the elastic constant.

The corresponding potential can be obtained from the work spent by an external force to give a displacement x.

$$W = 1/2\ k*x^2 \qquad (2)$$

this way, we find that the shape of the potential is a parabola.

To understand the meaning of this curve, we may observe that as x increases, potential energy increases as x square. This happens on the Earth when a body moves in a well whose section is parabolic. Then if we let a ball roll on the bottom of a similar well, we are simulating a harmonic potential. Figure 2 shows the mechanical simulation of this potential. This apparatus also consists of a wooden support and two flexible iron wires hanging by their ends from the wells of a wooden support. Under the wires, there is a support that can be lifted in such a way to hold up and lift the centre of the wires, as to the function of this support.

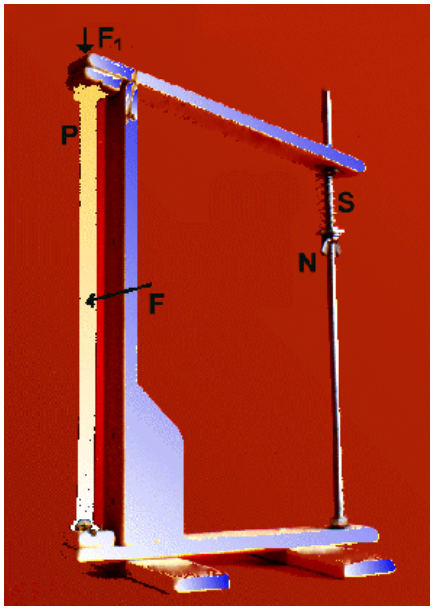

Figure 1. A harmonic oscillator realised with a steel strip **P** fixed at its ends. When a force **F** is applied perpendicular to the strip, the system tends to return to its equilibrium position. The spring **S** can apply a force $\mathbf{F_1}$ regulated by the nut **N**.

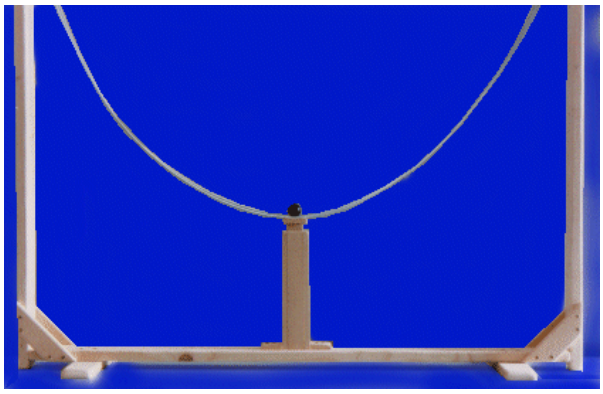

Figure 2. Mechanical simulation of a harmonic potential. The curve of the metallic guides is actually closer to a catenary than to a parabola, but for our purposes the approximation is good enough. If we move the ball along the guide, it tends to return to its equilibrium position.

1.4 Towards Non-linear Behaviour

The device shown in figure 1 allows to apply a longitudinal force ($\mathbf{F_1}$) on the strip. As this longitudinal force is due to the spring **S**, its intensity is given by the contraction of the spring itself.

We can observe that when increasing the longitudinal force $\mathbf{F_1}$, as we turn the nut **N**, the stable equilibrium point remains x = 0. (figure 3) until a critical value $\mathbf{F_c}$ is reached.

As we overcome this value $\mathbf{F_c}$ and try to put the strip in the zero position, the strip quickly start to bend in one direction or the other.

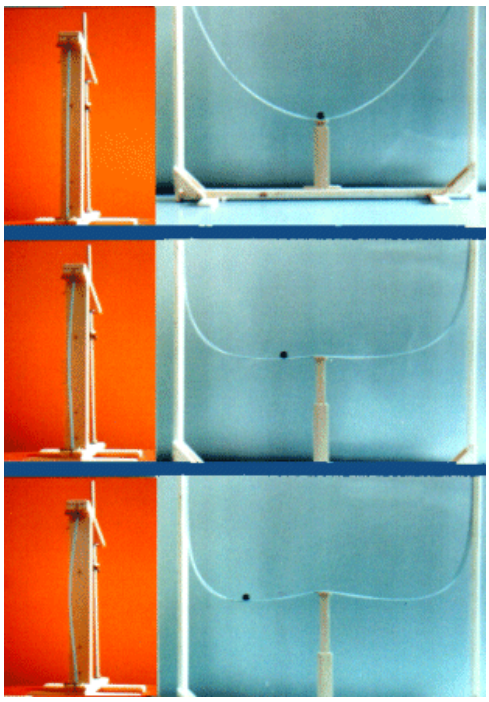

Figure 3. Pictures show the real physical system on the left-hand side, and its mechanical simulation potential on the right-hand one. Beyond the critical value **Fc**, the strip starts to bend towards either one of the two possible directions. The corresponding simulating potential changes from a single well to a double well shaped function

In such a situation the system is said to have a bifurcation. For x = 0, we have an unstable equilibrium point and two new symmetrical stable equilibrium points. In this way the bifurcation is directly visualised and the relative potential shape can be obtained: the situation is well represented by a double well potential (figure 4).

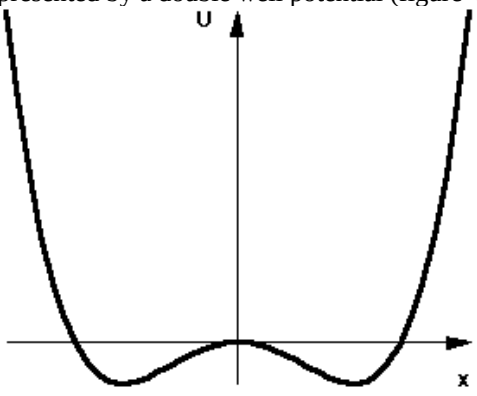

Figure 4. Plot of a potential function of the oscillator when $\mathbf{F_1} > \mathbf{Fc}$. The stable equilibrium point is moved from x = 0 to one of the two possible directions. This shape is known as double-well potential and is the representation of the equation (3). The value of the parameter r controls the deepness of the two lateral wells.

The changing between the potential of the system when $F_1 < F_c$ and the potential $F_1 > F_c$ is simulated by the rise of the central part of the well and the consequent progressive displacement of the ball, representing our reference position, towards one of the two lateral wells. At this point the system "makes a choice": the symmetry is broken (figure 5).

To emphasise the differences, it is possible to observe a gradual transition “linear–nonlinear” and detect the threshold value for this transition of the control parameter.

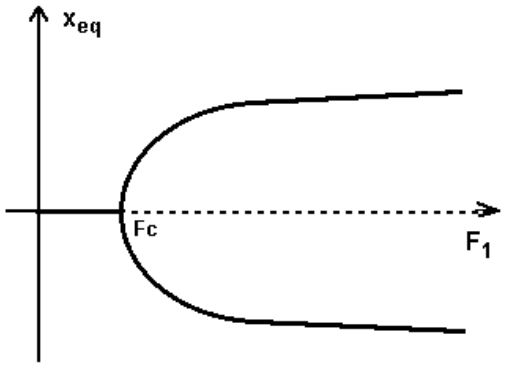

Figure 5. Plot of the strip equilibrium position with respect to the longitudinal force $\mathbf{F_1}$ applied to the same strip. The solid line represents the stable equilibrium points, while the dashed line represents the unstable equilibrium points. In this kind of diagrams the equilibrium position represents the **order parameter**, while the independent variable $\mathbf{F_1}$ is the **control parameter**. The point corresponding to $\mathbf{F_1} = \mathbf{Fc}$ is a **bifurcation point**.

1.5 A simple computer simulation

By using basic language tools it is possible to write a simple code with elementary graphics to visualize the curve depicted in figure 4 represented by the function

$$U(x) = 1/2\ (1 - r)\ x^2 + 1/4\ x^4\ . \quad (3)$$

By changing the value of r, you can see how this parameter is related to the difference between the central maximum and the two minima. If r < 1, the curve looks like (but is not actually) a parabola since it has one minimum only, and the oscillator behaves as it were a harmonic one, in the sense that if moved from its equilibrium position, it tends to return there.

The potential well grows from small starting values of r, until the critical value r = 1 is reached. Above this threshold, two lateral minima appear, and the central value becomes a maximum (unstable equilibrium point). When r further increases, the minima get deeper and farther.

From the observations described above, it is easy to relate the parameter r to the longitudinal force $\mathbf{F_1}$ applied to the strip.

In order to see an actual change of the system (and of its potential) due to the parameter r, we can increase the

longitudinal force acting on the spring (of the device shown in figure 1), lifting at the same time the central part of the device in figure 2. This process is shown in figure 3.

The physical system represented by this potential is called "nonlinear oscillator".

We can try to plot a diagram of the system's equilibrium position $\mathbf{x_{eq}}$ (the equilibrium position of the strip centre or equilibrium position of the little ball of the simulated potential) varying the longitudinal force $\mathbf{F_1}$ as done in figure 5.

In a broad class of non linear systems, the parameter $\mathbf{x_{eq}}$, that in our case is the stable equilibrium position, is the order parameter;

$\mathbf{F_1}$, on which $\mathbf{x_{eq}}$ depends, is called order parameter.

In the point where two stable equilibrium positions stem from one, we have a bifurcation.

2 Dark Room Meridian

2.1 Introduction

This section describes a project devoted to the application of the above expressed approach in the field of the time observation, measurement and regulation through the comparison between dark room meridians and modern instruments as GPS or telescopes. The dark room meridian is taken in the paper as a case study of an ancient instrument of observation. The knowledge and use of this old instrument and the comparison with current techniques can broaden the mental outlook and stimulate pupils to discover the deep characteristics of the scientific culture evolution. Due to the location of the meridians in historical buildings, this project could emphasize also the connections of science, arts and history.

The achievements of science and development of technologies made easy and in some way “natural” to obtain results coming from years or centuries of research work and attempts. The determination of our position in space and in time is made easy by the use of new technologies as having a look on a calendar or on a watch.

2.2 Position in Space

The knowledge of our position on the earth (i.e. geographic coordinates) can be done by pushing a button on a portable low-cost GPS (Global Positioning System) receiver. The position in a 3-dimensional space is done: latitude, longitude & altitude. In addition an electronic compass gives the north direction.

In spite of the seeming simplicity of the receiver (dimensions and appearance are similar to a cell phone, an antenna of an inch across only is enough to receive the signals), the GPS consists in a fleet of 27 satellites and 10 stations over the world. Each satellite has atomic clocks on board the precision of wich is ±1 second in 1 million years and is necessary for the functioning of the system.

The system is controlled by the US Army with a master central station and 10 more monitor stations over the world.

Actually determining the position on the Earth (latitude and longitude coordinates) has a long and meaningful history and has been discussed both in scientific and popular literature[9].

2.3 Position in Time

To obtain the time with an accuracy of a second is enough to connect with the site: http://wwp.greenwichmeantime.com/ , or to have a look on a radio-controlled watch. In spite of the simplicity of this action, our time position is due to the duration of a tropical year watched by the IERS (International Earth Rotation Service) that updates the national institutes and sets the variations of the Universal Time Coordinates (UTC) to keep the earth’s rotation linked with the day. On 31st December 2005 one leap second has been added, and in the recent past several leap seconds have been added (eight seconds from 1989).

2.4 This Work

Here we focalize our attention on an instrument used for the determination of the tropical year (the time between two spring equinoxes) that belongs to the history of the astronomy and the evolution of the calendar. The evolution of the calendar has been broadly discussed in literature. The study of this instrument involves geometrical, physical properties and astronomical knowledge.

The difficulty in the determination of the date is due to the fact that the ratio between the duration of the year and the duration of a day is not an integer number. This brings the date of the equinoxes to shift of several days over some hundred years.

One of the first instruments designed to resolve the question was the dark room meridian.

2.5 The Instrument

A dark room meridian consists in an indoor space where the light is penetrating through a small hole (the pinhole). So an image of the sky is projected on the floor of this space. Below the hole a line oriented to the North is traced on the same floor. In spite of the simple structure of the device, the results obtained allow high accuracy and reliability. In fact, the accuracy depends on the hole height and dimensions and on the accuracy of line orientation. The reliability depends on the stability of the building hosting the room

This instrument works as time regulator on two different scales: daily and annual.

The passage of the sun on the meridian line is a time reckoning at daily scale. This passage was setting the noon for each city or village until the end of the XVIII century.

Seasonal variation of the sun inclination and hence the longitudinal position on the meridian line sets the time over a year, in particular the extremities of the line,

summer and winter solstices, and the equinoxes, spring and autumn.

The inclination of the sun changes of about 0.36 degrees over a day, across the equinoxes. If the gnomon is 20 m high (at 45° of latitude), the difference on the line is about 25 cm, this means that it is possible to know the moment of the equinox within half an our if the edge of the image is about 1 cm. With a sundial it is impossible to have an image so sharp because the sun is a disk with an angular aperture of half degree. In a dark room the edge of the image is half of the diameter of the hole, that means 1 cm in this case.

The reliability depends on the stability of the building where the room is located, for this reason these instruments are located in old and solids monuments.

These ancient devices were used since XV until the end of the XVIII century, today most of them are abandoned even if they are inside historically and artistically important buildings.

2.6 History

In the second half of the XVI century Cosimo dei Medici, pursuing his project of transformation of the Duke of Florence in the Duke of Tuskany, commissioned embellishment of many civil and religious buildings. One of the artists employed in these activities was the astronomer and cartographer Ignazio Danti.

Cosimo discussed with Danti the problem of the calendar reform (at that time the equinox fell 10 days before the 21st of march). Danti needed to make accurate measurements of the tropical year. He mounted two instruments on the face of S.M.Novella in Florence[10].

The accuracy of these instruments was not enough to give a close estimation of the year length. Danti made a hole in the face of S.M.Novella about 21 m high and traced a line on the pavement of the church. In this way the church works as a “camera obscura”.

But when Cosimo I died in 1574. this work was not finished.

Danti was reassigned in Bologna, and here he built another meridian in S.Petronio church.

Seventy-five years later the wall where Danti placed the hole was removed to enlarge the church. G. D. Cassini Jesuit mathematician and astronomer, suggested to put another hole and to trace a new line in S. Petronio. The line was traced during a public demonstration on the 21st and 22nd of June 1665.

Cassini works on this “heliometer” gave information on several astronomical and physical values included sun eccentricity, refraction of the light in the atmosphere, parallax error, variation of the obliquity, etc.

Dozens of meridians have been made in Europe, most of them in important historical buildings, see for example St. Maria del Fiore in Florence, St. Petronio in Bologna, St. Sulpice in Paris[11], El Escorial in Madrid[12] or the Grand Master Palace in Malta[13, 14].

2.7 The Beauty of the Meridian

The charm of the meridian is due to the antiquity of its origins, the essentiality of its construction, and perhaps to its substantial immateriality: it is a light beam passing through a hole. The meridian realizes the aim of the Geography: to represent a spherical body (the sun) on a plane surface (a circle). In addition the meridian transforms a circular movement into a (locally) linear movement, it makes visible an object (the sun) by naked eye, hard to observe otherwise, and it makes visible also a movement not sensibly visible[15].

2.8 The Project

The described project is devoted to the pupils of primary and secondary schools with different educational objectives and methods.

The program includes both learning (as geometrical error theory, optics, astronomy, etc.) as well as design and manual pupils' activities (as the construction of a “camera obscura” to observe the sun and the pinhole characteristics, the drawing of the meridian line, the search for disappeared meridians and/or the “adoption” of an existing one). These activities are divided by school level: primary and secondary.

Let’s consider the examples of learning activities.

For primary and secondary school the subjects are: pinhole and dark room general properties, historical overview of the mean dark room meridians, visiting, if possible, some important dark room meridians.

For secondary school only: geometrical optics, diffraction limits of the pinhole, error theory.

The examples of practical activities for primary and secondary school are: the construction of pinholes with different diameters and shapes to observe that the image of the sun has same dimensions and shape, the drawing of the meridian line using different methods:

1) Through the knowledge of the official time, latitude and time equation it is possible to mark (several times along the year, for example, September, October, etc.) the image of the sun at the local noon. The line passing on these points is the meridian line.
2) Tracing the line using a compass and taking account of the magnetic declination (secondary school only).
3) Tracing a circle with the centre on the perpendicular to the hole. The image of the sun intercepts the circle in two points. The axe of the segment done by these two points is the line (secondary school only).

As a secondary effect this project involves the participation of public institutions. In fact, due to the loose of interest as scientific instrument, many of such devices are abandoned, damaged or cancelled by restoration works of the buildings hosting them.

These activities can contribute to valorising cultural and artistic goods of a local territory.

3 Conclusion

Considering both examples of comparison between old and new technologies, we can underline the following:

- the approach to the problem using old techniques is a door to enter the phenomena comprehension;

- the light use of computer technologies and programming tools makes the complex and abstract concepts more affordable for students;
- the student scientific culture could be improved by using, building or remaking a simple instrument that involves mechanical and physical or geographical and astronomical knowledge;
- comparing “old” and “current" techniques for the same purposes emphasizes the scientific progress and contributes to reducing barriers between scientific and humanistic culture.

All these activities can stimulate students' involvement in and awareness of both natural and cultural environments where we all live.

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How Learner's Proficiency May Be Increased Using Knowledge about Users within an E-Learning Platform

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Representing knowledge about the user of a web application by decision trees can offer remarkable information regarding a dataset. We have designed and developed an E-Learning platform that has built in the capability of monitoring and storing user traffic. A model of analysis of user traffic by building decision trees from gathered data is proposed. The analysis has two outcomes. Firstly, decision tree structure can give an objective measure of the interestingness and quality of the data. In this analysis we may see whether or not the data is representative or not and whether we may obtain sound knowledge. Secondly, the analysis may reveal the learner's behaviour in the continuous learning environment. The possible outcomes of this analysis are the learner's proficiency, accumulated knowledge, or learning curve.

Povzetek: Analiziran je vpliv uporabe spleta na hitrost učenja.

1 Introduction

During last decade it has been possible to observe the quick growth of interest in Web-based education. The purpose of the paper is to present a method of analysing data gathered from an e-Learning platform. The platform itself is a web application used by secretaries, professors, students and an administrator in a collaborative manner to accomplish a learning process. Each of these four roles has assigned a set of allowed actions. All users have to authenticate with a username and password and then the role and the set of allowed actions are determined.

The administrator, secretaries and professors have mainly management duties that set up the platform (i.e. sections, disciplines, course materials, tests, exams, etc.). The students, on the other hand, download course materials, communicate with secretaries and professors, and take tests and exams. All student activities are monitored and saved for off-line analysis. The goal is to employ different analysis methods on monitored data in order to accomplish user modelling and characterization. In this connection we present a method of building decision trees from gathered data.

The goal of the platform is to guide students in the educational process. The enforced educational technologies have two main outcomes. Firstly, the student benefits from the continuous learning environment in the way that his/her creativity and mental outlook skills are supported and even improved. On the other hand, this process is monitored with the purpose of obtaining performance assessments. The platform itself is a complex system with many capabilities that are at student's disposal. Monitoring user traffic and building decision trees represents a way of analysing data gathered from our e-learning platform with the aim of measuring how efficient was the learning process.

2 The E-Learning Platform

The main goal of the platform is to give students the possibility to download course materials, take tests or pass final examinations and communicate with all involved parties. To accomplish this, four different roles were defined for the platform: sysadmin, secretary, professor and student.

The main task of sysadmin users is to manage secretaries. A sysadmin user may add or delete secretaries, or change their password. He may also view the actions performed by all other users of the platform. All actions performed by users are logged. In this way the sysadmin may check the activity that takes place on the application. The logging facility has some benefits. An audit may be performed for the application with the logs as witness. Security breaches may also be discovered.

Secretary users manage sections, professors, disciplines and students. On any of these a secretary may perform actions like add, delete or update. These actions will finally set up the application such that professors and students may use it. As conclusion, the secretary manages a list of sections, a list of professors and a list of

students. Each discipline is assigned to a section and has as attributes a name, a short name, the year of study and semester when it is studied and the list of professors that teach the discipline which may be maximum three. A student may be enrolled to one or more sections.
The secretaries have also the task to set up the structure of academic years for all sections. The structure of an academic year is made of a list of periods. All periods that define the academic year are disjunctive in time and are characterized by a name, start date and end date. For each period there are also set up the exams that may be taken and the grants that are needed. For example, in winter examining session there may be taken only exams from the first semester and there is no need for grant from either professor or secretary. This way of defining what the student can do and when proved to be very flexible and easy to understand and use.
The main task of a professor is to manage the assigned disciplines while s discipline is made up of chapters. The professor sets up chapters by specifying the name and the course document. Only students enrolled in a section in which a discipline is studied may download the course document and take tests or examinations. Besides setting up the course document for each chapter, the professor manages test and exam questions. For each chapter the professor has to define two pools of questions, one used for testing and one used for exams. He specifies the number of questions that will be randomly extracted to create a test or an exam. Let us suppose that for a chapter the professor created 50 test questions and 60 exam questions and he has set to 5 the number of test questions and to 10 the number of exam questions that are to be randomly withdrawn. It means that when a student takes a test from this chapter 5 questions from the pool of test question are randomly withdrawn. When the student takes the final examination at the discipline from which the chapter is part, 15 questions are randomly withdrawn: 5 from the pool of test question and 10 from the pool of exam question. This manner of creating tests and exams is intended to be flexible enough for the professor.
All tests and exams are taken under time constraints. For each chapter the professor sets up a number of seconds necessary to answer questions that chapter. When a test or exam is taken all the seconds are summed thus obtaining a maximal interval of time in which the student has to finish the test. The elapsed and remaining time are managed on server side and presented to the student after each answered question.
Tesys application offers students the possibility to download course materials, take tests and exams and communicate with other involved parties like professors and secretaries.
Students may download only course materials for the disciplines that belong to sections where they are enrolled. They can take tests and exams with constraints that were set up by the secretary through the year structure facility.
Students have access to personal data and can modify it as needed. A feedback form is also available. It is composed of questions that check aspects regarding the usability, efficiency and productivity of the application with respect to the student's needs.

3 How and What Data are Monitored

The platform has two methods of monitoring user activity. First one is through a log file which records each executed action. Each action has a resulting row in the log file.
Since the business logic of the platform is Java based, log4j utility package was employed as a logging facility and is called whenever needed within the logic of the application. The utility is easy to use; logging process is managed by log4j.properties file. The next lines present how the utility was set up.

```
log4j.appender.R.File=D:/devel/Tomcat/idd.log
log4j.appender.R.MaxFileSize=1000KB
log4j.appender.R.MaxBackupIndex=5
```

These lines state that all the logging process will be done in idd.log file and will have a maximum file size of 100KB in maximum five files.
The main drawback of this technique is that the data from the file is in a semi structured form. This makes the information retrieval to be not so easy task to accomplish. On the advantages, logging activity may be very helpful in auditing the platform or even finding security breaches. This logging facility is also very helpful when debugging during development or when analysing peculiar behaviour during deployment.
To overcome the semi structured shape of logged activity a structured way of gathering activity information was enforced. The activity table was added in the database and all actions were recorded in the manner of one record per action. In the next table the structure of activity table is presented.

Field	Description
id	primary key
userid	identifies the user who performed the action
date	stores the date when the action was performed
action	stores a tag that identifies the action
details	stores details about performed action
level	specifies the importance of the action

Table 1: Structure of activity table

After five months of deployment, the activity table contains more than 50,000 records and we suppose that until the end of the learning cycle there will be close to 100,000 records. All this logged activity may also be very helpful in an audit process of the platform. The records from the activity table represent the raw data that will be further analysed.

The activity of a student may be seen as a sequence of sessions. A session starts when the student logs in and finishes when the student logs out. A session may be seen as a sequence of actions. The next figure presents

the activity diagram from platform point of view. Within the platform each student has an associated activity diagram.

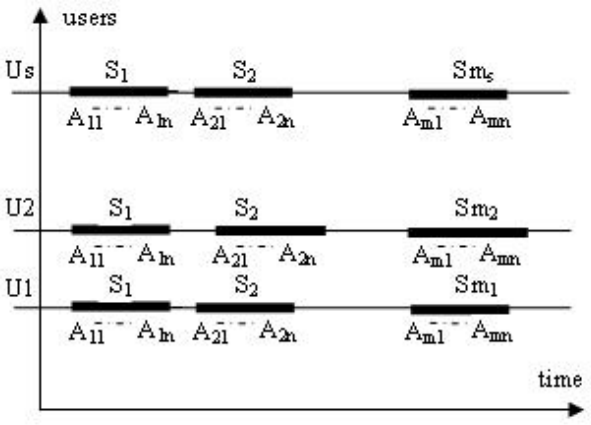

Figure 1: The activity diagram for platform users

In the diagram it may be seen the activity of all s users (U1,, U2, …, Us). The activity of each user is composed of a number of sessions. User Us in the diagram has m_s associated sessions. At finest level, a session is composed of a number of actions, session Sm_s has m_n associated actions. In a session, the first action is to login and the last one is logout. After one hour of inactivity the user is automatically logged out such that user sessions can be precisely determined.

4 Building Decision Tree from Data

Choosing between two learning algorithms given a single dataset is not a trivial task [4]. From all these representations we think decision trees are a very good start in the process of data analysis. Decision trees, as structures, may give a very conclusive idea regarding the "goodness" of data we try to analyse. Starting an analysing process with shaping the data in the form of decision trees gives a very good idea whether or not the data that we have may lead to conclusive or important results. Still, the whole process is much more than choosing an algorithm. Many learning schemes have various parameters, and suitable values must be chosen for these. In most cases, results can be improved markedly by a suitable choice of parameter values, and the appropriate choice depends on the data at hand. For example, decision trees can be pruned or unpruned and, in the former case, a pruning parameter may have to be chosen. More generally, the learning scheme itself will have to be chosen from a range of available schemes. In all cases, the right choices depend on the data itself [1].

A decision tree is a flow-like-chart tree structure where each internal node denotes a test on an attribute, each branch represents an outcome of the test and leaf nodes represent classes [1]. So, the first step is to define a list of attributes that may be representative for modelling and characterizing student's activity. Among the attributes there may be:

- the number of logins,
- the number of taken tests,
- the average grade for taken tests,
- the exam results
- the number of messages sent to professors.

The basic algorithm for decision tree induction is a greedy algorithm that constructs decision trees in a top-down recursive divide-and-conquer manner. The basic strategy is as follows. The tree starts as a single node representing the training samples. If the samples are all of the same class, then the node becomes a leaf and is labeled with that class. Otherwise, an entropy-based measure known as information gain is used for selecting the attribute that will best separate the samples into individual classes. This attribute becomes the "test" or "decision" attribute at the node. A branch is created for each known value of the test attribute, and the samples are partitioned accordingly. The algorithm uses the same process recursively to form the decision tree. Once an attribute has occurred at a node, it need not be considered in any of the node's descendents. The recursive partitioning stops only when one of the following conditions is true. All samples for a given node belong to the same class. There are no remaining attributes on which the samples may be further partitioned. This involves converting the given node into a leaf and labeling it with the class in majority among samples [1].
Impurity measures are an important parameter regarding the quality of the decision tree. Many different measures of impurity have been studied. Some algorithms measure "impurity" instead of "goodness" the difference being that goodness should be maximized while impurity should be minimized [5, 6, and 7].
The first step is to create a set of instances that hold the attributes. In the database there are 20 tables that hold the necessary data. Each student will represent an instance and each instance will be defined by its own attributes.
The next step effectively builds the decision tree. The computational cost of building the tree is O(mn log n)[2]. It is assumed that for n instances the depth of the tree is in order of log n, which means the tree is not degenerated into few long branches.
The information gain measure is used to select the test attribute at each node in the tree. We refer to such a measure an attribute selection measure or a measure of goodness of split. The algorithm computes the information gain of each attribute. The attribute with the highest information gain is chosen as the test attribute for the given set [1].

5 Results

In the study the relations that contain needed data are:

activity – here there are stored all actions performed by users;

test_results – here there are stored the results of all tests passed by all students;

messages – here there are stored all the messages sent or received by all users of the platform;

The next important step is attribute definition. In this study each student represents an instance we have to set

up the attributes that define each instance. From our relations there may be defined a large number of attributes which may have more or less importance regarding overall predictive power. In this study each instance is defined by four attributes:

nLogings – number of loggings of the user. This number may be associated also with the number of sessions;

nTests – number of taken tests passed by the student;

avgTests – average of grades for passed tests;

nSentMessages – number of messages sent by the students.

We developed a dedicated application called DatabaseRetriever for querying the database and creating an arff file.

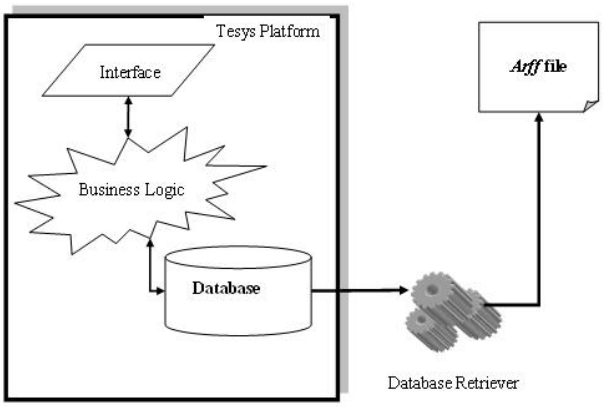

Figure 2: The functionality of DatabaseRetriver application

A system called Weka [3], which implements the decision tree building algorithm, uses arff format. In the next figure it is presented how the activity.arrff file is loaded into Weka workbench.

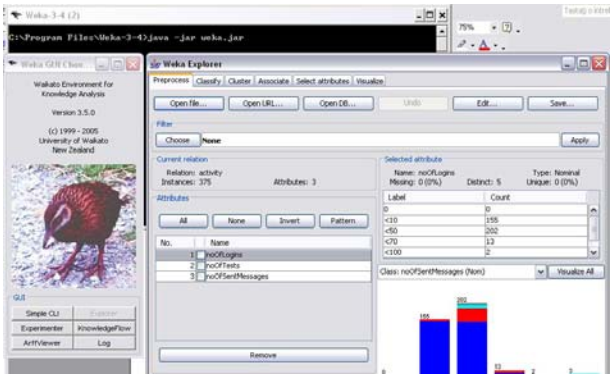

Figure 3: Loading the activity.arff file

In Figure 4 it is presented how J48 algorithm runs in Weka workbench after the *arff* file has been loaded.

The activity.arff file has a standard format which is composed of two sections. In the first one there is defined the name of the relation and the attributes. For each attribute there is defined the set of nominal values it may have. In the next lines it is presented the first section of the file.

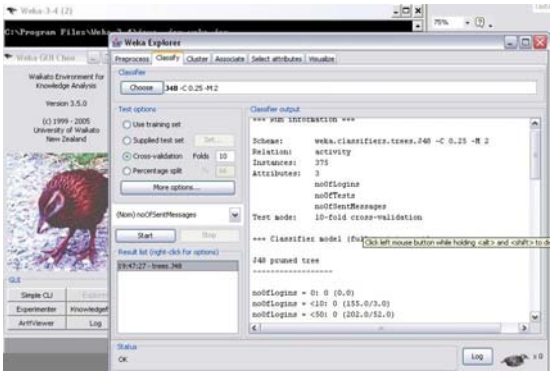

Figure 4: Running J48 algorithm

Here is a sample of the *arff* file.

@relation activity
@attribute nLogings {<10,<50,<70,<100,>100}
@attribute nTests {<10,<20,<30,<50,>50}
@attribute avgTests {<3,<6,<10}
@attribute nSentMessages {<10,<20,<30,<50,>50}

In this section of the file all attributes are defined. An important decision that is needed is to establish the granularity for each attribute which is represented by the number of nominal values it may take. As it can be seen from the above presented lines we consider five intervals for nLogings parameter: less than ten, less than fifty, less than seventy, less than one hundred and greater than one hundred. In the same way there is defined the set of possible values for each of the attributes.

The second section of the activity.arff file is represented by the data itself. Here are all the instances that will enter the classification process. In the next lines there are presented few instances that may be found in this section.

@data
<50,<20,<3,<10,
<50,>50,<6,<20,
<10,<20,<3,<10,
<50,<10,<3,<10,
<100,<50,<10,<50,

Each row represents an instance. For example, the first row represents an instance (a student) which entered the platform less than fifty times, took less than twenty tests, obtained an average of grades for taken tests less than three and sent less than ten messages to professors. In the same way there can be interpreted all other instances.

The activity.arff has 375 instances, each one corresponding to a student.

After running the algorithm the obtained tree had 17 leaves (which represent in fact classes) and 25 nodes. The time to build the model was 0.13 seconds.

The *decisionTreeModel.txt* file contents the obtained decision tree. Figure 4 presents the obtained model.

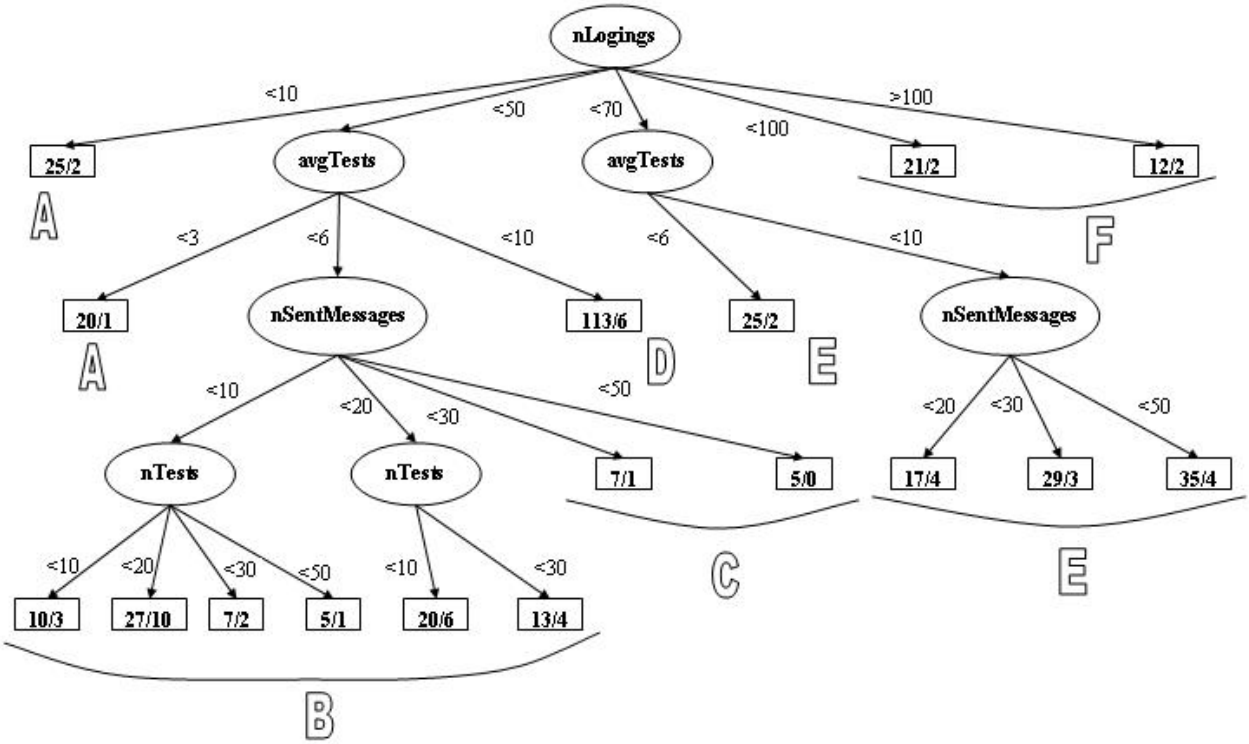

Figure 4: The decision tree in graphical form

```
=== Run information ===

Scheme:       weka.classifiers.trees.J48 -C 0.25 -M 2
Relation:     activity
Instances:    375
Attributes:   4
              nLogings
              nTests
              avgTests
              nSentMessages
Test mode:    10-fold cross-validation

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

J48 pruned tree
------------------

nLogings = <10: (25/2)
nLogings = <50
|  avgTests = <3 (20/1)
|  avgTests = <6
|  |  nSentMessages= <10
|  |  |     nTests = <10 (10/3)
|  |  |     nTests = <20 (27/10)
|  |  |     nTests = <30 (7/2)
|  |  |     nTests = <50 (5/1)
|  |  nSentMessages= <20
|  |  |  nTests = <10 (20/6)
|  |  |  nTests = <30 (13/4)
|  |  nSentMessages= <30 (7/1)
|  |  nSentMessages= <50 (5/0)
|  avgTests = <10 (113/6)
nLogings = <70
|  avgTests = <6 (11/3)
|  avgTests = <10
|  |  nSentMessages= < 20 (17/4)
|  |  nSentMessages= < 30 (29/3)
|  |  nSentMessages= < 50 (35/4)
nLogings = <100 (21/2)
nLogings = >100 (12/2)

Number of Leaves  :         17

Size of the tree :   25

Time taken to build model: 0.13 seconds

=== Stratified cross-validation ===
=== Summary ===

Correctly Classified Instances         321               85.6    %
Incorrectly Classified Instances        54               14.4    %
Kappa statistic                          0.7085
Mean absolute error                      0.0664
Root mean squared error                  0.1994
Relative absolute error                 40.9    %
Root relative squared error             70.4213 %
Total Number of Instances              375

=== Detailed Accuracy By Class ===

TP Rate   FP Rate   Precision   Recall  F-Measure   Class
 0         0          0         0         0        
 0.844     0.09       0.938     0.844     0.888    <10
 0.9       0.166      0.764     0.9       0.826    <20
 0         0.005      0         0         0        <30
 0         0          0         0         0        <50
 0         0          0         0         0        >50
```

=== Confusion Matrix ===

```
  a b c 1 d e f     <-- classified as
45 1 0 2 0 0       |  a = 0
  1 80 10 7 4 1    |  b = <10
  0 0 12 0 0 1     |  c = <20
  0 2 2 13 0 2     |  d = <30
  7 7 1 0 92 0     |  e = <50
  2 0 1 0 1 93     |  f = >50
```

The most important part is the data analysis, which ensures that the model is valid and provides solid knowledge. The stratified cross-validation evaluation technique revealed that 321 (85.6 %) instances were correctly classified and 54 (14.4%) were incorrectly classified. The confusion matrix showed exactly the distribution of incorrectly classified instances among classes.

6 Conclusion

An e-Learning platform is currently deployed and used by almost 400 students and 15 professors. The platform embeds mechanisms for monitoring and storing user's activity. The platform's architecture is based on MVC (Model-View-Controller) paradigm ensuring application's scalability in development process. There are two implemented ways of monitoring activity: through log files and into relations that represent the model of the platform.

This platform has implemented capabilities of monitoring and saving user activities. An off-line application creates a data file in arff format that is used as input data for classification algorithms implemented in Weka system.

The results of running classification algorithms on recorded data showed that student's activity may be successfully classified as a function of specific activities. This may be the first step in modelling user activity and characterizing his/her learning proficiency based on past activity.

We may say that we have implemented an e-Learning platform that implements specific functionalities but which also benefits from the knowledge obtained in presented analysis process. The final outcome of the analysis module is that it may be regarded as a decision support system that feedbacks knowledge into the original e-Learning system in order to achieve certain goals. This approach may be a great benefit for students of the platform since their activity may be guided and coordinated in order to achieve pedagogical or psychological goals.

The next step may involve performance evaluation of the algorithm but with another set of attributes or even running other algorithms on data obtained from the current e-Learning platform. The final goal is to obtain a robust, scalable and accurate activity characterization model from which student's behavioural patterns may be extracted.

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Surfing Hypertexts with a Metacognition Tool

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This paper presents a pilot study for the testing of the Did@browser system, a tool developed for supporting the knowledge construction process of students during their studies on educational hypermedia. The system adopts a strategy of posing metacognitive questions and receiving answers from students in order to improve their awareness in their surfing abilities and cognitive strategies used during the learning process on the Net. The paper describs the tools used, the experimentation carried out with the students and the relative evaluation of the results.

Povzetek: Predstavljena je analiza koristnosti metaorodja za spletno delo.

1 Metacognition and hypertext

The new technologies for distance learning have, in the last ten years, offered new opportunities to create innovative models for teaching and learning which can be integrated into traditional educational contexts. In developing these models web technologies have contributed to the use of hypermedia as learning tools [12, 15]. During the use of the hypertexts the learner controls his own process of knowledge construction independently, even if he is often unaware of his surfing behaviour and of the cognitive strategies he adopts in order to surf and learn at the same time [11].

We believe that this lack of awareness can effect the surfing and learning behaviour of contents.

Basing on the considerations of studies by [7, 8], we define a student's surfing behaviour as a dynamic process in which he/she adopts cognitive strategies both for learning the web contents and for improving his/her surfing skills for interacting with the interface of a web site.

By surfing skill we mean a complex set of actions which the learner adopts for checking and deciding how to proceed in the surfing process in order to satisfy the learning goal. During surfing activity users often unconsciously ask themselves questions and take decisions: What key word shall I choose? Shall I select this link or that one? Shall I go on? How Shall I move in this page? Should I modify the search? Shall I read or not? Does this information meet my needs?

Some of the skills that the pupil adopts while he/she is surfing the Net are knowing how to distinguish a need for information, how to surf within a site, how to carry out a search, which key words to insert, which categories to choose, how to make hypotheses, how to integrate previous experiences of surfing with new ones, how to use skimming and scanning mechanisms, how to interpret meaningfully what he reads or hears[4].

These surfing skills are used during the educational hypermedia interaction but may produce a cognitive overload for the user [18, 3] and consequently a sense of being lost in hyperspace [5].

Some research [1, 7, 16] has explored this perception of disorientation on the web, defining it as a cognitive problem in which the user lacks a clear conception of the relationship between the elements of the system, is unable to identify his/her position within the hypermedia structure and finds it difficult to continue surfing in a way which is coherent with his goals.

Therefore to take advantage of the hypermedia with respect to the traditional learning activities the users must be able to exploit their functionalities and to apply cognitive strategies for the acquisition of knowledge through online study.

Besides, to reduce the risk of the user losing himself, surfing randomly or not reaching his learning goals effectively, it is necessary for him to be trained in the effective use of the tools in order to support learning and stimulate the improvement of cognitive strategies involved in the learning processes.

Various scholars have studied the use of hypertexts in education, examining their effectiveness in facilitating students' learning. To do this, a variety of theoretical frameworks were employed and several cognitive issues related to learning were analysed. In general, these studies underline the relevance of metacognitive and self-regulatory skills to explain differences in students' performance[2].

As a result of these considerations some researchers have used computer based learning environments both to deliver information and to strengthen students' control over their individual learning processes. In this respect the research has proposed different tools to support student learning during web activities. The common

starting point of these studies is the development of tools to support the acquisition of metacognitive skills and stimulate students to reflect on their learning processes.

In the literature [9, 10, 12, 13, 17, 19] there are some examples of metacognitive tools which aim at facilitating the surfing activities and at reaching the learning goals.

In some cases the metacognitive aids, or cues, are provided at the end of the activity, at other times tools assist the students during the search activity, providing them with some suggestions about the actions to take when surfing; other systems provide interactive web maps to create graphical representations of surfing paths, and tools for adding notes, for creating new connections between visited links and for sharing documents.

Some of these researchers [9, 10, 12] were interested in analysing the effect of the metacognitive prompts on hypertext comprehension and in testing the transfer of the knowledge acquired to problems in the real world. Others [17] considered whether the effects of metacognitive prompting are mediated by metacognitive or motivational processes.

Very rarely [13, 19] a research has been aimed at studying the effects of metacognitive prompting on the surfing behaviour of students involved in a learning activity.

Moreover, the majority of existing tools enable the students to reflect both on their interaction with the system and on their cognitive strategies for learning. We have found that some systems do not support the subject during browsing when the process of knowledge acquisition is taking place but in general they stimulate the metacognitive skills before and/or after the surfing activity.

Believing that the cognitive strategies used when studying hypertexts change dynamically during the surfing process and the knowledge construction according to the assigned task, we argue that it is useful to support the user during these processes from the beginning to the end of surfing.

In order to create this situation where the student is able to monitor his surfing behaviour, we have developed a system that stimulates metacognitive reflection on both surfing and cognitive strategies for learning during the whole surfing process.

Starting from these considerations, we introduce a pilot study which aims at experimenting the use of the Did@browser system with middle school students.

2 Did@browser, a metacognitive tool

The Did@browser system is a new technological solution developed by the Institute for Educational Technology of the CNR in Palermo in order to support students during surfing and learning on the Net.

The system is based on a client-server architecture, and it is composed of the server and two client components: the student and teacher client which are both available in Internet Explorer.

The system stimulates the self-monitoring of the cognitive processes used by students for surfing and learning by posing metacognitive questions during web surfing. Moreover, the teacher can customize a set of questions for each student in order to evaluate their activities and to stimulate their surfing skills, thus facilitating the effective achievement of learning goals.

The set of questions was planned according to the didactic activities that the students are required to carry out and the web site selected by the teacher. The sets of metacognitive questions used during the experimentation are given below:

-Why have I clicked on this link?

-What information do I expect to find?

-What other surfing tools were there on the page?

-Why have I selected this link rather than the others on the page?

-Have I already explored the other objects on the page (images, links, text)? If not, do I expect to do so?

-Do I intend to return to this page? Why/Why not?

-Why have you returned to this page?

-Has the image which I've seen helped me to understand better?

-Have I found the information I expected on this page?

-What has interested me most on this page?

The questions were selected by the researchers and associated to specific nodes of hypertext. The association between the nodes and questions was made so that the students could improve their awareness of strategies employed during surfing. When the student clicked on the link the system showed the question in a window. The student's surfing was interrupted and the system invited him to answer the question.

The system recorded in the log file the information related to the pages visited, the duration of the visits and the student's answers.

3 The pilot study

The pilot study of the Did@browser system took place during the year 2004-05 with the collaboration of the Alberigo Gentile School in Palermo. The work sessions were organized in the computer laboratory of the school for a total of 24 hours. The 27 students involved in the research experiment were attending the second class at the middle school and they were divided into two groups, experimental (EG) and control (CG).

The subjects of the two groups were divided up, balancing the level of scholastic competences, gender and familiarity with the PC.

3.1 The tools used

To investigate the cognitive strategies employed during surfing, a Surfing Behaviour Questionnaire was used to obtain considerations about surfing the web, as well as the Conceptual Maps to assess learning and comprehension of the structure of the websites used for the experimentation.

To analyse the surfing behaviours, we used the data stored in log files and graphical representations for the nodes of the hypertexts visited by the students during the surfing activity.

3.1.1 The Surfing behaviour questionnaire

The aim of the questionnaire was to evaluate how the subject perceives his surfing behaviour.

The questionnaire consisted of 9 questions concerning:

-the self-examination of surfing behaviour;

-the subjective evaluation of the efficacy of content presentation in the hypermedia;

-the subject's awareness of strategies used during surfing.

3.1.2 Conceptual maps

The Conceptual Maps, as a tool for knowledge representation, allow students to construct the network of the relationship between concepts and to highlight the key ideas. The construction of the conceptual maps of a hypertext is useful for evaluating whether the student:

- has understood the structure of the hypertext studied;

- has identified the navigational areas relevant to the didactic aims;

- has organized the information correctly and completely.

3.2 Experimental procedure

In order to verify if and how Did@browser facilitated monitoring of the surfing behaviour of the subjects involved, we assigned the same tasks to both groups, but only the experimental group was presented with the metacognitive questions.

Each group worked for 6 sessions of 2 hours each during which the students in pairs used the PC for surfing and studying the sites that we structured ad hoc.

In each session a specific didactic aim was established. The activities in every session were structured in the following way: at the beginning of each session we introduced the task, the time and the activities to be developed. At the end of the experimental activities we organized two other sessions for discussion with the students and to give them feedback about the experience; in these sessions the above mentioned tools, the Surfing Behaviour Questionnaire and the Conceptual Maps, were also administered.

The contents of the activities were previously agreed on by researchers and the teacher. In particular, we created two didactic sites, one focused on the circulation of the blood (Table 1) and the other one on Genetically Modified Organisms (Table 2). The topics illustrated in the hypertexts had never been dealt with before by the teacher in the traditional class setting.

Concerning the second tool, students were asked to reproduce conceptual maps which describe the links between the different areas of the hypertexts studied.

In this way it was possible to assess whether the students' conceptual map corresponded to the real structure of the two sites and whether some fundamental concepts essential for surfing (links, nodes, toolbar, etc.) had been understood.

Group	Task	Assessments
CG	1. Free surfing (10') 2. Seeking principal topics (10') 3. Find information about a specific topic, save and copy in a text file	Text file
EG	See above	Text file
CG	1.Use the hypermedia to study the topic (15') 2.Answer questions in the course book	Test
EG	See above	Test
CG	1.Use the hypermedia to study the topic (15') 2.Use the hypermedia to study a specific aspect	Test and conceptual map
EG	See above	Test and conceptual map

Table 1. The sessions of the activities on the circulation of the blood

Group	Task	Assessments
CG	1. Free surfing of the sites (20') 2. Find information about a specific topic	
EG	See above	
CG	1.Use the hypermedia to study the topic (15') 2.Find information about a specific topic and copy the most relevant in a text file	Text file
EG	See above	Text file
CG	1.Use the hypermedia to study the topic (15') 2.Use the hypermedia to study a specific aspect (20') 3.Create a document summarizing the topic studied	Document Conceptual maps
EG	See above	Document Conceptual maps

Table 2. The sessions of the activities on the GMO

4 Results

The evaluation of the system was finalized to asses whether the metacognitive questions activated during the surfing process had been a useful tool for the self-monitoring of the student.

In particular, the evaluation was based on the analysis of the answers given by students and on the surfing pattern analysis where the following parameters were considered: number of visited links, number of transitions between the pages, duration of visits according to the assigned task of the surfing session. For example, in Table 3 we present some statistics for two sessions; the results for the other sessions are very similar.

From these data some differences between the two groups emerge: while the total number of pages visited is the same for the two groups, the subjects in the experimental group performed fewer transitions and their surfing behaviour appears more uniform (smaller standard deviation).

		Control Group		Experimental Group	
		Mean	Standard deviation	Mean	Standard deviation
II session	n. of transitions	64	±39.25	48	± 21.14
	n. of pages visited	18	±10.41	21	± 7.6
III session	n. of transitions	95	± 38	53	± 13.55
	n. of pages visited	21	± 11.35	23	± 5.34

Table 3. Some evidence from the log files

The nodes were classified according to topic areas of the hypertext, identifying the visited nodes and relative frequency of the visited links for each area. This information was evaluated considering the relevance and coherence with reference to the assigned task.

Moreover, the focus of attention was on the number, frequency, typology, position of metacognitive questions and the relative answers provided by students.

The analysis of the answers indicated that on the whole the use of metacognitive questions was perceived by students as a useful monitoring tool of their activity.

The analyzed data show that this way of posing questions to the students creates two problems: the first is the inability to describe their cognitive strategies and the second is the functional limitation of the system in associating questions to links. In the first case some students gave content focused answers to questions concerning metacognitive processes, while others had problems describing the procedures.

In the second case, this version of the system is unable to pose questions related to a specific element of the page and this can be misleading for the students. In fact, the questions on surfing, apparently unconnected to the context of study and to their task, created irritation or confusion in the subjects when they were unable to understand their relevance.

The quality evaluation of surfing paths was carried out using the visualization software GraphViz [6]. This tool was chosen thanks to its versatility and the possibility to modify the visualization parameters and due to the clarity with which the graphics are represented. It was used to assess the structure and the relationships between the visited links of a hypertext. Besides, to find temporal data all the log files created during the Did@browser experimentation sessions were analyzed.

In particular, during every surfing session, for each user and for each group, a calculation was made of the real time spent on the visited pages and of the absolute and average time spent on the pages of a specific area of the site.

To assess the paths, a distinction was made between the episodic structure of the hypertexts, that is the choices that a single user made during surfing, and the emergent structure, or rather all the accumulated episodic structures of the whole group of users [14]. This method provides a generalized and representative surfing pattern of a whole user group. The top two graphs in Figure 1 represent the entire surfing of the two groups as a whole during a single session. The nodes are the pages visited and the arcs are the transitions performed by the subjects. Each arc represents a set of transitions, and we can weight each arc with respect to the number of times this transition was performed by one member of the groups. We have not indicated these weights in the figure.

The following graphs in Figure 1 were obtained by eliminating the arcs with lower weights one at a time.

The analysis indicates that in the EG the surfing activity was more goal-oriented. In fact, it appears that the members of the EG were able to recognize the structure of the web site after fewer transitions; they surfed between the pages in detail and a pattern emerged sooner.

The CG surfing behavior appears to be more erratic. In fact, at the same level, the emergent structure for the CG is more complex with more transitions and the surfing activity does not look as if it is clearly goal-oriented.

It was observed that the emergent structures of the users' surfing were relevant to the assigned tasks. In fact, the subjects spent the majority of their time on the nodes of the assigned study area. However, the number of subjects involved was too small to affirm that this result is an effect of the metacognitive prompts, but we can conclude that the presence of metacognitive prompts did

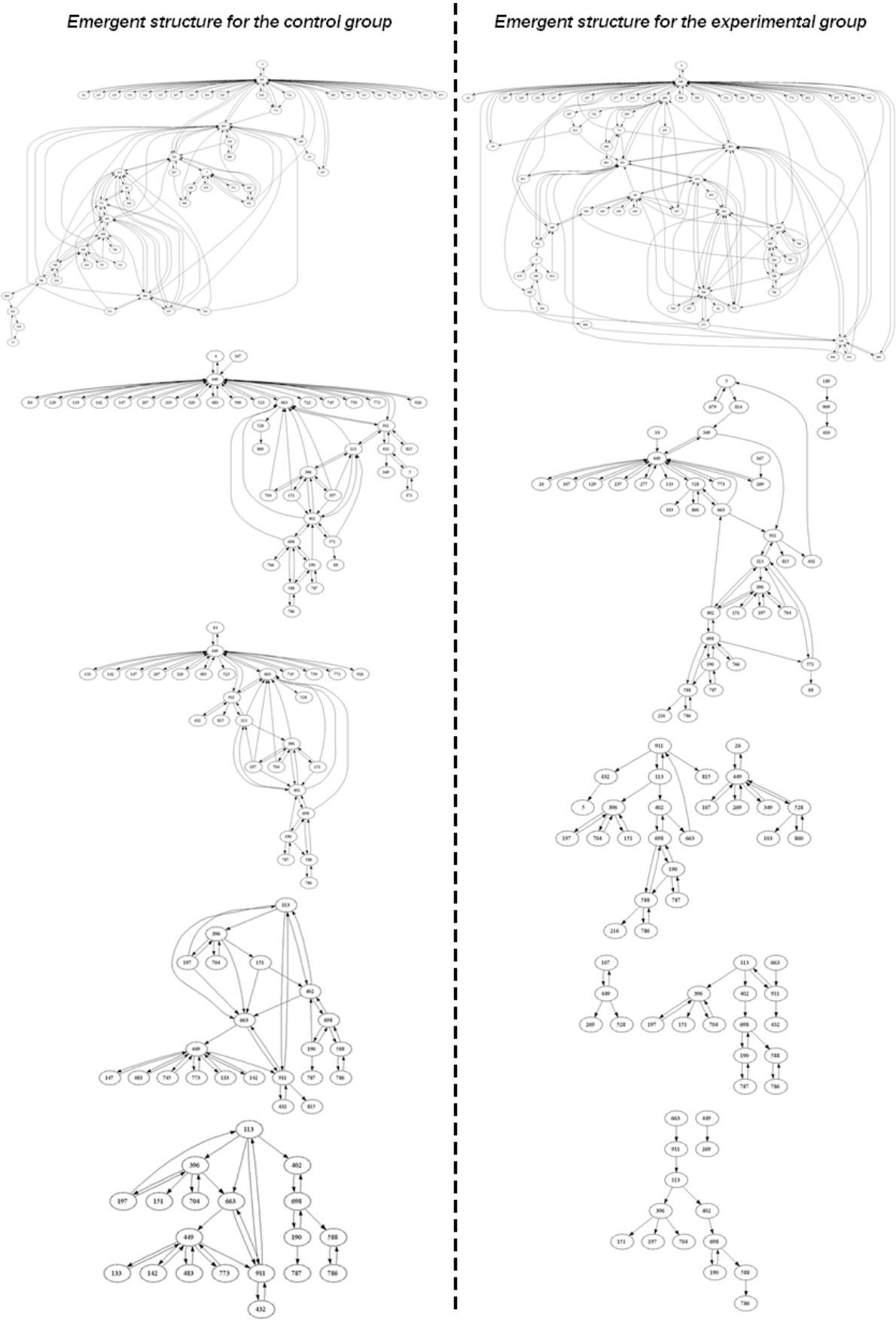

Figure 1. The emergent structures for the two groups during a session

not disturb the students' surfing or their learning processes.

From the answers to the Surfing Behaviour Questionnaire the following observations emerged.

The visual components are the most attractive parts of the hypermedia. In fact, the images are a means to facilitate the comprehension of the contents; they make the presentation more attractive and exciting. Students' answers were supported by the tracking data which showed that the pages with images were visited more frequently.

The pages containing a lot of links and written text proved to be less attractive and less visited, and the pages containing many technical terms were particularly uninteresting for the students.

The questionnaire also revealed the principal cognitive learning strategies adopted by the subjects. The subject read the whole text carefully before beginning another activity. If he/she had difficulty in understanding, he/she tended to reread the text several times, using didactic tools such as glossaries and dictionaries to increase his/her comprehension.

The analysis of the answers to the question: "If you had to surf the websites again, which actions would you repeat and which would you not repeat?" revealed that the subjects recognized that they would modify the strategies they had adopted previously.

In conclusion, the results of the questionnaire allowed us to study the students' surfing behaviour and suggest some ways to improve the system.

The analysis of the Conceptual Maps revealed notable differences between the two research groups. It was carried out by evaluating the representation and the interconnections among the nodes of the maps, considering how many strategic points were reproduced and the depth of the level of the graphic representation. Besides, the experimental group produced maps in greater detail compared to the control group, which frequently omitted some essential nodes. On average, the experimental group proposed a higher number of links which correctly described the hierarchical structure of the areas of the site studied. So, the metacognitive stimulus may have influenced the attention and the mnemonic performance of the subjects involved.

5 Conclusions and forthcomings

The pilot study of the Did@browser system showed that the users' surfing was pertinent to the assigned tasks and that the metacognitive questions did not disturb the students' surfing and learning processes. In fact, the students in the experimental group improved their comprehension of the intrinsic structure of the hypermedia and created more accurate conceptual maps.

Finally, the students considered the system to be a useful self-monitoring tool.

The system we have proposed can be improved in a number of different ways: by integrating into the system other tools related to particular metacognitive skills which are useful for surfing didactic hypermedia; developing tools within the system for monitoring and assessing student behaviour and permitting teachers to adapt the system according to the class and the learning activity planned.

We intend to implement some of these improvements in the next version of the Did@browser system.

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SI-PRON Pronunciation Lexicon: a New Language Resource for Slovenian

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We present the efforts involved in designing SI-PRON, a comprehensive machine-readable pronunciation lexicon for Slovenian. It has been built from two sources and contains all the lemmas from the Dictionary of Standard Slovenian (SSKJ), the most frequent inflected word forms found in contemporary Slovenian texts, and a first pass of inflected word forms derived from SSKJ lemmas. The lexicon file contains the orthography, corresponding pronunciations, lemmas and morphosyntactic descriptors of lexical entries in a format based on requirements defined by the W3C Voice Browser Activity. The current version of the SI-PRON pronunciation lexicon contains over 1.4 million lexical entries. The word list determination procedure, the generation and validation of phonetic transcriptions, and the lexicon format are described in the paper. Along with Onomastica, SI-PRON presents a valuable language resource for linguistic studies and research of speech technologies for Slovenian. The lexicon is already being used by the Proteus Slovenian text-to-speech synthesis system and for generating audio samples of the SSKJ headwords.

Povzetek: Članek opisuje nov jezikovni vir za slovenščino, slovar izgovarjav SI-PRON.

1 Introduction

Consistent specification of word pronunciation is critical to the success of many speech technology applications. Most state-of-the-art Automatic Speech Recognition (ASR) and Text-To-Speech (TTS) systems rely on lexicons, which contain pronunciation information for many words. To provide for a maximum coverage of the words, multi-word expressions or even phrases, which commonly occur in a given application-domain, application-specific word or phrase pronunciations may be required, especially for application-specific proper nouns, such as personal names or location names.

Several guidelines have been reported to define the structure of a pronunciation lexicon, ranging from simple two-column ASCII lexicons providing the mapping between graphemic and phonemic transcriptions, to more general de-facto standards and new standardization attempts, which are also handling multiple orthographies and multiple pronunciations.

The ISO-TC37 initiative, which started at LREC 2002, initiated work on a family of ISO standards related to natural language processing (Romary et al., 2006). Currently these standards are available in working drafts of high-level specifications for word segmentation, feature structures, annotations, and also for lexicons. The high-level specifications build on lower-level specifications in form of language and country codes, data categories, code scripts, and Unicode. Lexicon specifications are covered by the "Lexical Markup Framework" under ISO 24613 (Romary et al., 2006). The same description structure in terms of morphology, syntax and semantics (and translation) applies to monolingual up to multilingual lexicons. Multi-word expressions are given special attention.

Another initiative, the W3C Voice Browser Activity, has recently issued a last-call working draft of the Pronunciation Lexicon Specification (PLS) Version 1.0 (W3C PLS Version 1.0, 2006), which is expected to be soon submitted as a W3C candidate recommendation. The PLS document was designed to enable interoperable specification of pronunciation information for both ASR and TTS engines within voice browsing applications. The mark-up language allows one or more pronunciations for a word or phrase to be specified using a standard pronunciation alphabet or if necessary using vendor specific alphabets. Pronunciations are grouped together into the PLS document which may be referenced from other markup languages, such as the Speech Recognition Grammar Specification (SRGS) and the Speech Synthesis Markup Language (SSML).

The Pronunciation Lexicon Markup Language, based on PLS, is designed to allow open, portable specification of pronunciation information for speech recognition and speech synthesis engines. The language is intended to be easy to use by developers while supporting the accurate specification of pronunciation information for international use.

The LC-STAR project consortium published another set of recommendations for speech technology lexicons, with an emphasis on application in machine translation, speech recognition and speech synthesis (Shamas & van den Heuvel, 2004; Fersøe et al., 2004). A Slovenian lexicon, produced at the University of Maribor, has been built in the scope of the project (Verdonik et al., 2004). Compared to the LC-STAR lexicon specifications the current version of PLS lacks description specifications for more complex features, such as morphological, syntactic, and semantic features of lexical entries.

In Slovenian, lexical stress can be located on almost any syllable and it obeys hardly any rules. The stressed syllable in Slovenian may form the ultimate, the penultimate or the preantepenultimate syllable of a polysyllabic word. Speakers of Slovenian have to learn lexical stress positions along with learning the language. As a consequence, a pronunciation lexicon that indicates lexical stress positions for as many Slovenian words as possible is crucial for the development of speech technology applications and linguistic research. Such a lexicon can be used either in its full-blown form or as a training material for machine learning techniques aimed at automatically predicting word pronunciations.

Several attempts towards pronunciation lexicon construction for Slovenian have been reported so far (Derlić & Kačič, 1997; Gros & Mihelič, 1999; Gros et al., 2001; Šef et al., 2002; Verdonik et al., 2002; Mihelič et al., 2003). However, none of them has used the full lemma set as given in the Dictionary of Standard Slovenian (SSKJ) (SSKJ, 1991).

The paper describes the construction of a comprehensive reference pronunciation lexicon for Slovenian based on two sources: the information from the SSKJ and another list of the most frequent inflected word forms, which has been derived by an analysis of contemporary Slovenian text corpora.

2 The SI-PRON Lexicon

2.1 SI-PRON Wordlist

The work on designing a new pronunciation lexicon begins with the selection of words, multi-word expressions or phrases, which will be represented in the lexicon. Several word-list selection procedures are known (Ziegenheim, 2003).

The construction of the SI-PRON lexicon started with the complete lemma word list of 93,154 entries from the SSKJ provided by the Fran Ramovš Institute of the Slovenian Language, furnished with basic lexical stress information on the stressed vowels and pronunciation exceptions. The complete word pronunciations still had to be determined.

In order to further expand the SI-PRON word list, we are augmenting the SSKJ lemma descriptions with part-of-speech information and declension/conjugation categories (Toporišič, 1991), specifying the inflectional paradigms of the lemmas. Irregular inflected word forms are processed separately. Using automatic procedures, we are fully expanding the lemmas into inflected word forms. So far, over 1 million lexemes containing lexical stress information have been derived.

Since SSKJ contains many words derived from literary texts, not so common in everyday situations, we decided to upgrade the SI-PRON pronunciation lexicon with a list of 50,000 most frequent inflected word forms whose lemmas are not covered by the SSKJ word list. This additional word list has been derived from a statistical analysis of a contemporary Slovenian text corpus. The corpus comprising over 3 million Slovenian words was composed mainly from fiction and mainstream Slovenian newspaper texts: Delo, Večer, and the former Slovenec. After tokenization and the elimination of numerals, named entities, acronyms, and abbreviations, the remaining text corpus included over 3 million tokens. Acronyms, abbreviations, and named entities were stored into separate word lists.

A statistical analysis performed on the text corpus showed that about 50.000 most frequent words accounted for approaching 95% of all non-SSKJ words used in the text corpus (Gros & Mihelič, 1999). These words form the main additional word list. They were equipped with part-of-speech tags indicating the part-of-speech function of the words in the text corpus.

2.2 Collocations and Multi-word Expressions

The identification of collocations, i.e. current combinations of words as they appear in context, can considerably increase the naturalness of synthetic speech. In human speech, collocations act as prosodic units and are subject to a higher degree of reduction and internal coarticulation than they would be had they been ordinary, separate words. We have chosen a lexical approach for handling collocations. The most common collocations or multi-word expressions, reflexive verbs included, are stored in a separate pronunciation lexicon.

3 Phonetic Transcriptions

We have developed a tool to automatically derive word pronunciations for the SSKJ inflected words, by looking-up their stem pronunciation and appending that of the correct inflection from inflectional paradigms and morphological rules of Slovenian (Toporišič, 1991).

Therefore, the pronunciation of lexemes has been derived automatically for the SSKJ and SSKJ inflected word lists (about 2,500 entries, mainly words of foreign origin that do not obey the general Slovenian pronunciation rules, have been manually transcribed), and semi-automatically for the remaining part of the word list. Automatic lexical stress assignment and automatic

grapheme-to-phoneme conversion rules have been used to process the latter.

3.1 Lexical Stress Assignment

The automatic lexical stress assignment algorithm for unseen words, which we applied is to a large extent determined by (un)stressable affixes, prefixes, and suffixes of morphs and is based upon observations by linguists (Toporišič, 1991).

For words that do not belong to these categories, the most probable stressed syllable is predicted using the results from a statistical analysis of stress position depending on the number of syllables within a word (Gros & Mihelič, 1999).

3.2 Grapheme-to-Phoneme Rules

Context-free grapheme-to-allophone rules from the Proteus standard words rule set (Žganec Gros, 2006) translate each grapheme string into a series of allophones.

The rules are accessed sequentially until a rule that satisfies the current part of the input string is found. The transformation defined by that rule is then performed, and a pointer is incremented to point at the next unprocessed part of the input string. The procedure is repeated until the whole string has been converted.

The context free rules are rare and they include a one-to-one correspondence, two-to-one correspondence and one-to-two correspondence.

The vast majority of the rules for grapheme-to-allophone transcription for Standard Slovene are context-sensitive. This means that a grapheme or a string of graphemes is transcribed differently according to its phonetic environment. Certainly all rules for determining which allophone of a certain phoneme is to be used in a phonetic sequence are context-dependent.

Each context-sensitive rule consists of four parts: the left context, the string to be transcribed, its right context and the phonetic transcription. A number of writing conventions has been adopted in order to keep the number of rules relatively small and readable. The left and the right context may contain code characters describing larger phonetic sets, e.g.: '#' stands for vowels, '$' for consonants, '_' for white space.

The rules for consonants are rather straightforward, while those for vowels must handle vowel length and the variant realizations of the orthographic /e/ and the orthographic /o/ in stressed syllables.

A typical grapheme-to-allophone rule in the Proteus standard words rule set has the following structure:

left context	grapheme string	right context	allophone string
$	*/er/*	–	[@r]
=	/**n**/	k	[N]

The first rule says that the word final /er/ preceded by a consonant is transcribed as [@r] (e.g. /gaber/ -> [*ga:.b@r]). The second rule implies that any /n/ followed by /k/ is transcribed into [N] ([N] is the allophone of [n] when followed by /k/ or /g/, e.g. in /anka/ -> [*a:N.ka]).

The initial rule set based on the one produced in 2001 (Gros et al., 2001) was built by taking into acconut various observations of expert linguists, e.g. (Toporišič, 1991), and other basic rule sets for Slovenian grapheme-to-allophone transcription (Gros & Mihelič, 1999).

The initial set of rules has been undergoing continuous refinement ever since and resulted in 194 rules of the Proteus standard words rule set (Žganec Gros, 2006). Rules for coarticulatory pronunciation corrections of words according to the words' left context and to the right context are included.

In the recent years, telecommunication applications of ASR and TTS have increased in importance, e.g. automatic telephone directory inquiry systems. Names of locations (cities, streets, etc.) and other proper names cannot be mentally reconstructed from the context when listening to the messages, and correct name pronunciation is required. The Proteus standard word rules developed for a standard Slovenian vocabulary do not lead to satisfactory results when applied to names. Therefore, additional 'name-specific' rules were added to the final Proteus standard words rule set resulting in the Proteus names rule set.

3.3 Transcription Accuracy Experiment

The phonemization errors were determined by comparing the automatic transcription outputs to manually verified pronunciation lexicon transcriptions.

A performance test applied on the SI-PRON SSKJ-based word list pronunciation lexicon showed error rates of about 25% in the stress assignment of unknown words and consequently in the phonetic transcription. If stress assignment and the transcriptions of graphemic /e/ and /o/ in stressed syllables was manually verified or known in advance, a transcription success rate of 99.1% was achieved for standard SSKJ words.

A closer examination of the mismatches revealed that the majority of the errors could be attributed to inconsistencies in manual labelling during the preparation of the original SSKJ.

As a consequence, we argue that, in order to semi-automatically derive phonetic transcriptions for Slovenian words not covered by the lexicon with a 0.3% error rate, manual validation of the stress position and its type have to be carried out, starting from automatically predicted stress positions. The rest can be performed automatically by applying our upgraded grapheme-to-phoneme conversion rule set.

4 SI-PRON Format

The SI-PRON lexicon format complies with the Pronunciation Lexicon Specification (PLS) Version 1.0, a W3C Voice Browser Activity working draft of syntax specification for pronunciation lexicons (W3C PLS Version 1.0, 2006). This lexicon specification has been recommended for use by speech recognition and speech synthesis engines in voice browser applications.

```
<?xml version="1.0" encoding="UTF-8"?>
<lexicon version="1.0" xml:lang="si-SI" alphabet="x-sampa-SI-reduced">
  <lexeme>
    <grapheme>dober</grapheme>
    <phoneme>"d/o:-b@r</phoneme>
    <!-- This is an example of the x-sampa-SI-reduced string
      for the pronunciation of the Slovenian word: "dober",
      meaning "good" in English -->
  </lexeme>
</lexicon>
```

Figure 1. An example of a simple lexicon file with a single lexeme within SI-PRON.

The element <lexeme> represents a lexical entry and may include multiple orthographies and multiple pronunciation information. An example of a simple lexicon file with a single lexeme within SI-PRON would be as shown in Fig. 1.

In the Pronunciation Lexicon Specification, the pronunciation alphabet is specified by the alphabet attribute of the <phoneme> element. We are using the "x-sampa-SI-reduced" phonetic alphabet, a subset of the X-SAMPA set as defined for Slovenian (Zemljak et al., 2002), augmented with additional markers for Slovenian lexical stress accents (acute, circumflex, and grave) and tonemic accents (tonemic acute and tonemic circumflex). Both primary and secondary stress positions are marked.

The <alias> element is used to provide the pronunciation of an acronym or an abbreviation in terms of an expanded orthographic representation.

4.1 Homographs

Homographs or words with the same spelling but different pronunciations can be treated in two ways. If we do not want to distinguish between the two words then we can represent them as alternate pronunciations within the same <lexeme> element. In the opposite case, two different <lexeme> elements need to be used. In both cases the application, which is making use of the lexicon, will not be able to decide when to apply the first or the second transcription unless additional information, such as context-specific attributes or part-of-speech information is provided.

4.2 Multiple Pronunciations

Providing multiple pronunciations for items that share the same orthography and meaning is important for speech recognition lexicons because they provide information on variations of pronunciation within a language. Therefore, for many lexemes, words, and multi-word expressions, multiple standard pronunciations are specified, including those, which consider possible coarticulation effects at word boundaries. Multiple pronunciations are indicated by subsequent <phoneme> elements within one <lexeme> element.

Pronunciation preference – extensions needed?

In TTS applications, typically only one pronunciation among the multiple pronunciation possibilities is required. Therefore, to indicate default pronunciation variation, the prefer attribute can be used in PLS. In SI-PRON, unless marked otherwise, the default pronunciation is the first pronunciation from SSKJ.

However, sometimes several pronunciation variations in SSKJ are (almost) equally preferred, whereas the actual preferred pronunciation for the TTS engine may depend on the application. This is not to be confused with application-specific pronunciations, which can be handled in separate application-specific pronunciation lexica. What we have in mind is that there may exist several almost equally preferred pronunciations for a given grapheme, and the developers would like to have a mechanism that would enable them to systematically choose the preferred one.

Typically one of the two almost equally preferred pronunciations yields better rendering of input text if the application requires either overarticulated or fluent pronunciation. Therefore, we would welcome a new optional attribute to the <phoneme> element in PLS, the: pron-style attribute indicating the preferred pronunciation variation of a lexeme with respect to the desired pronunciation style. The two attribute values, which would be useful for SI-PRON, are "fluent" and "overarticulated".

In addition, the pron-style optional attribute would need to be introduced into SSML, as a defined attribute for the <voice>, <speak>, <p>, and <s> elements.

For the same elements in SSML: <voice>, <speak>, <p>, and <s>, another optional attribute, emotion, would be useful (e.g. for computer games, where emotion changes occur frequently).

Example: For Slovenian male nouns, ending with a consonant followed by "ilec", SSKJ often provides one of the following single or multiple pronunciations of the "ilc" sequence within the genitive form of the noun: [iUts]/[ilts], [ilts]/[iUts], [ilts], or [iUts]; examples would be Slovenian words "nosilca", "krotilca", "darovalca",

etc. Many other cases of such pronunciation variations are known for Slovenian, and are marked in SSKJ.

Whenever there are two pronunciation variations in SSKJ they typically account for an overarticulated (e.g. [ilts]) or a more fluent (e.g. [iUts]) pronunciation variation. The pronunciation order as indicated in SSKJ indicates a slight pronunciation preference in standard usage and should still be indicated by the prefer attribute. In order to enable high-quality TTS such pronunciation differentiations should be captured in the text rendering process.

This would avoid the confusion of having a multitude of TTS pronunciation lexicons with different variations of the default pronunciation as given by the prefer attribute. The multiple lexicons are impossible to edit synchronously, and the proposed approach would allow us to use one master pronunciation lexicon.

4.3 Multiple Orthographies

Sometimes multiple orthographies of a word share the same meaning and pronunciation. They are presented with subsequent <grapheme> elements within a single <lexeme> element.

4.4 Part-of-Speech Tags

The most recent specification of the PLS focuses on the major features described in the PLS requirements document. Many more complex features, such as those providing morphological, syntactic and semantic information associated with pronunciations are expected to be introduced in a future revision of the PLS specification.

Therefore, proprietary <lemma> and <morphsynt> elements have been additionally defined for SI-PRON. Multext-East morphosyntactic descriptors for the Slovenian language, as described in (Erjavec, 2004), were used to provide the part-of-speech information of the lexemes, along with the lemmas.

5 SI-PRON Validation

Finally, the SI-PRON lexicon has been subjected to an automatic validation as a way to ensure that the structure of the document is well-formed and conforms with the chosen Document Type Definition (DTD).

Additionally, manual validation of both phonemic transcriptions and morphosyntactic descriptions was performed on a subset of the lexicon comprising 5.000 lexical entries. A subset from the LC-STAR lexicon specifications for lexicon validation criteria was used (Shamas and den Heuvel, 2002).

A lexicon editing tool with a user-friendly interface has been designed to allow inspecting, editing, browsing and automatic validation of the pronunciation lexicon.

6 Conclusion

Due to free lexical stress position, pronunciation lexica are of crucial importance for development of speech technology applications and linguistic research for Slovenian. They are not only used for providing application-specific pronunciations or pronunciations of names, but are indispensable in any TTS or ASR system.

The task of constructing a master pronunciation lexicon is very tedious and time-consuming and should not be repeated often. Therefore, a master-lexicon approach is best suited for Slovenian TTS, in which many speaking-style pronunciation nuances are captured. We propose refined extensions to both PLS and SSML, which are described in section 4, and mainly deal with multiple pronunciations and morphosyntactic descriptions.

Along with Onomastica, SI-PRON presents a valuable language resource for linguistic studies as well as for research and development of speech technologies for Slovenian. The lexicon is already being used by the Proteus Slovenian text-to-speech synthesis system (Žganec Gros, 2006) and for generating audio samples of the SSKJ word list, which are available at the very end of every SSKJ lexical entry description (SSKJ audio, 2006).

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A System Generating CV through Intelligent Agents and Apache Cocoon

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The aim of this paper is to present a dynamic system for the automatic and dynamic generation of CV documents in an academic and research environment. In particular, this system has been developed in the FES Department of the University of La Laguna, Spain. For that purpose, the authors have integrated Multiagent Systems (MAS) with XML and Apache Cocoon, designing a web portal where the users – in this case, professors and research students- can manage their CV data. Regarding to the use of Apache Cocoon and apart from showing its great potential, one of the main contributions of the work presented in this paper consists of the dynamic generation of the web environment, since the forms presented to the user change as soon as the structure of the XML files is modified. In other aspect, the agents will ensure the privacy and safety of the data.

Povzetek: Predstavljen je sistem za avtomatsko generiranje CV.

1 Introduction

The Spanish Universitary model requires its members to manage a big amount of personal data, such as publications in journals and conferences attended. Different official institutions – Ministry of Education and Science, regional governments, universities – often require researchers and students for these data in order to different purposes such as awarding a contract or research fellowship, annual reports, etc. Unfortunately, it is usual that each institution has its own template to fill, so researchers are often condemned to waste their time typing the same data in different documents. It has been calculated that the generation of a CV takes an average 3-hour period and that an automated system could save at least $25,000 per 100 generated CV's.

This scenario immediately brings XML back. This standard language provides a well-supported and powerful technology for the described scenario. Users would only need to type their data once in a XML file and apply a different XSL transformation in order to generate each type of document. Unfortunately, there are a good number of users in this scenario that find XML extremely difficult. For example, it is hard to imagine a standard Philosophy Ph.D. student typing a XML file and applying a XSL transformation to it. Thus, it would be desirable a user-friendly web environment in which researchers and students could manage their personal data – enter/delete/look for/update a publication, course, etc. – and generate their updated CV with only a click.

For that purpose, the authors have decided to use Apache Cocoon as base of the designed web environment. An interesting tool provided by Apache Cocoon is its forms (Cocoon forms or CForms), a XML way to build forms that can be filled by the users. In this sense, and this is one of the main contributions of this paper, it would be desirable that the forms were generated in a dynamic way. In other words, that the structure of the form should change as soon as the data architecture is modified, as several fields can be added in the CV data request by the official institutions. In addition to this, the data introduced through these forms should be validated against the restrictions codified in XML, e.g., maxInclusive in numeric data.

This system for the dynamic generation of CV documents has been integrated in a Multiagent System, originally developed for the automatic management of agendas in a Universitary Scenario [1][2][3]. This system, called MASplan, has been designed using FIPA specifications [4] and its aim is to help the members of the Universitary Scenario to organize internal meetings and to get resources such as portable computers and projectors. For the integration of the web environment into that system, the authors have implemented several agents whose behaviour can be studied in an independent way. In addition to this, the agents in MASplan, and therefore the new agents, take the advantage of the use of ontologies, expressed in a highly expressive language, OWL.

Why do the authors use agents in the generation of CV documents when it seems that a simple database for each user could be sufficient? Some researchers may think

that the decision of developing a MAS in this case is questionable. They could think that employing MAS is a bit like using a sledge-hammer on a thumb-tack. The answer lies in the human behaviour. Firstly, it has been observed that sometimes the corresponding author of an article forgets to communicate the acceptance of that paper to the rest of the authors. Even if the corresponding author sends, e.g., an e-mail to a co-author communicating the good news, this co-author is usually so busy that he/she prefers to update his/her CV database later, taking the risk of 'losing' the paper in his/her CV. This behaviour implies that each user sends an e-mail to every related colleague, looking for that 'lost' publications, whenever he/she needs to present a CV document, wasting a lot of time in this way. Thus, a general database – an initial attempt was initially implemented in Apache Cocoon-, covering all the users' merits, could be a good solution. However, once more the authors have bumped into the human behaviour. In spite of the security offered by the database manager, a significant number of members of the Universitary Scenario were reluctant to insert their data, claiming that they did not want leave their data in a centralized system where they could be accessed by malicious people. In this context, the features provided by the multiagent systems – distribution, reliability, proactivity, autonomous and reactive behaviour, etc.- seem to be especially useful.

The remainder of this paper is structured as follows. Firstly, state of the art in the three involved aspects in this paper – multiagent systems, Apache Cocoon and generation of CV documents- are described. After that description, the authors will detail the changes introduced in the original MASplan system in order to manage the desired environment. The next step will be the description of the web environment, paying special attention to those aspects related to the dynamic generation of CForms. After a brief inform about the experience using the designed system, some conclusions will be reported.

2 State of the art in MAS, Apache Cocoon and Generation of CV documents

As stated above, this section is dedicated to describing the state in the art of the main elements of the development of the system.

2.1 Multiagent systems and ontologies

Agents and Multi-Agent Systems (MAS) are part of a new programming paradigm. They have been successfully used in a wide range of applications such as robotics, e-commerce, agent-assisted user training, military transport or health-care. However, why using agents? This is not a trivial question, as there is not a uniform and widely accepted definition of agent. In fact, agents are often characterized by describing their features (long-lived, autonomous, reactive, proactive, collaborative, ability to perform in a dynamic and unpredictable environment…). Users can delegate to agents tasks that are designed to be carried without human beings intervention, for instance, as resource managers or personal assistants that learn from its user.

In most of applications, a standalone agent is not sufficient for carrying out the task: agents are forced to interact with other agents, forming a multi-agent system. Due to their capacity of flexible autonomous action, MAS can treat with open – or at least highly dynamic or uncertain- environments. On the other hand, MAS can effectively manage situations where distributed systems are needed: the problem being solved is itself distributed, data are geographically distributed, managed by different control systems and/or difficult to share, systems with many components and huge content…

In this context, having a shared ontology that all the agents utilize in their inter-agent communication is critical to successful communication because a shared ontology provides the common format in which express data and knowledge. An ontology is a set of classes, relations, functions, etc. that represents knowledge of a particular domain.

Ontologies have made a number of applications which are more capable of handling complex and disparate information. Agents do not offer any advantage if they are not intelligent and ontologies represent an intelligent way to manage knowledge. The main advantages of the use of both MAS and ontologies are extensibility and communication with other agents sharing the same language. These advantages are shown in the case of open systems, that is, when different MAS from different developers interact. Moreover, agents can use the information stored in the ontology (not only vocabulary, but instances and constraints/axioms) for achieving their goals.

There are several ontology languages such as KIF or OKBC (although this is actually the name of an API). Nevertheless, the authors prefer those languages known as "markup languages". The last generation of these languages (RDF, DAML+OIL, OWL) offers several advantages: source files are compact and portable, easy to learn and use, flexibility...

In this sense, OWL is on the top of the ontologies languages, although there are other markup languages, such as DAML+OIL that are sufficiently expressive for carrying out the project described in this paper. As W3C indicates:

"Where earlier languages have been used to develop tools and ontologies for specific user communities (particularly in the sciences and in company-specific e-commerce applications), they were not defined to be compatible with the architecture of the World Wide Web in general, and the Semantic Web in particular. OWL uses both URIs for naming and the description framework for the Web provided by RDF to add the following capabilities to ontologies: ability to be distributed across many systems, scalability to Web needs, compatibility with Web standards for accessibility and internationalization and openness and extensibility. OWL builds on RDF and RDF Schema and adds more

vocabulary for describing properties and classes: among others, relations between classes (e.g. disjointness), cardinality (e.g. "exactly one"), equality, richer typing of properties, characteristics of properties (e.g. symmetry), and enumerated classes."
OWL is usually recommended for ontology developments due to the following reasons:

- It is based on well-known existing technologies: XML, RDF, DAML+OIL...
- There are many tools with regard to OWL such as editors, reasoners, consistence checkers and translators from other ontology languages (DAML+OIL).
- It allows the representation of instances, not only classes and/or relations.
- It is the most likely candidate to lead Semantic web. In this sense, it is a recent W3C recommendation.

Nevertheless, some disadvantages have been found:

- Tools are at very early stage, especially for the most expressive subset (OWL Full).
- There are some limitations on what can be expressed, especially in the subsets called OWL Lite and OWL DL.
- Unfortunately, OWL does not allow developers to express all the constraints they would like, for instance, those related to the limitation in the range of a value or constraints between values. In this way, A MAS system could manage these situations, for instance, taking advantage of the fact that OWL datatype properties may make use of simple types defined in accordance with XML Schema datatypes.

It is noted that the main aim of this paper is not to justify the use of MAS and ontologies in a strict way (there is a lot of literature about that fact), but to present the software experience when using them in the development of an example application [5,6].

2.2 Apache Cocoon

The second component used in this work is Apache Cocoon. This is a mature and popular web development framework, developed in Java and based on the Servlet API model, that has been built around Separation of Concerns (SoC) and component-based development (COP), providing pipelined SAX processing. From a more formal point of view, Cocoon is said to adopt the "pyramid model of web contracts"(Figure 1). This model is composed of four separated contexts (management, logic, content and style) and five contract contents (the lines depicted in the figure) between the different contexts. As can be seen, the contract between style and logic is removed, as it is considered as a bugging web site development since the beginning of the Web.
It introduces design patterns, evolutionary guidelines and software that make easy the creation of web services, using a cache system in order to get a better performance. This technology, interfacing with many different back-end and data formats, is focused on human resource management rather then technological details, left in the middleware level. Apache Cocoon is a well-supported Open source project, as there can be found a good number of resources in the Internet, such as newsgroups, Wiki, etc. On the other hand, its modular structure and Model-view-controller (MVC) architecture, based on XML files, makes the development extremely customizable with minimal coding. Furthermore, there is a really plethora of tools and XML derivates that can interact with Apache Cocoon. In this sense, one of these XML languages is XML-FO (Formatting Objects), a XML namespace that allows to describe the way to build a document, that is, how to draw and place the text on screen on paper (size of the document, fonts, paragraphs, tables, etc.) and to generate different outputs (PDF, RTF, HTML, etc.).
From a practical point of view, Apache Cocoon uses a centralized configuration mechanism called the sitemap, a declarative XML document describing a set of pipelines that will be invoked upon a URI pattern match. A pipeline consists of three main components: a generator (which produces SAX events), one or more transformers (which operate on the SAX event stream, transforming it into some other grammar) and a serializer (which transforms the SAX event stream into an output stream for the client browser or file) [9].
In spite of Apache Cocoon started as a simple servlet for static XSL styling, it has become a powerful tool as many features have been included. One of these features is their CForms. It consists of an advanced forms framework that provides a solid basis for building interactive web applications. Describing the structure of the forms involves the definition of the widgets it consist of. A widget is an object that knows how to read its state from a Request object, how to validate itself, and can generate an XML representation of itself. Using widgets, developers can indicate, for example, that a specific field should contain an integer or a date [10]. In order to create a CForm, a developer needs to define two XML files: a form model – that describes the structure of the form- and a form template – that informs the place a widget is desired to appear in the form. An optional third file is the form binding, which avoids having to write actual code for the edition of things like the properties of a bean or data from an XML document [7,8,9].

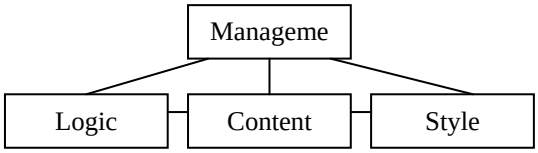

Figure 1: Pyramid model of web contracts

2.3 Generation of CV's

The problem of the automatic generation of CV's is not new. A good number of institutions and companies have realized that users often waste a lot of time when writing, updating and - not less important- formatting their CV's. For example, collecting the CV's of a relatively high number of members of an institution for an annual information and giving the impression of style homogeneity could become a heroic effort, even when strict guidelines were given. Thus, several developers have tried to solve this problem through different software. The authors will cite in this work three significant approaches.

Vitae is a free Tcl/Tk-based curriculum vitae management tool for use with the Illinois Computer Affiliates Program, whose purpose is to standarize the format of CV's provided to visitors to the annual Illinois Computer Affiliates Program Conference. Another cited system is a more general application developed by i-Linksoft solutions for the Faculty of Medicine of the University of Malaya. Among other features, the system allows the faculty staff to avoid writing their CV's every time it is needed for submission. Finally, University of Windsor is said to save thousands of dollars using a commercial application, IntelliPRINTPLUS, for reporting from Lotus Notes applications. This tool is used for the automatic generation of CV's, eliminating manual CV processes.

All these attempts seem to be limited to an only style of CV and they do not take any of the advantages of using the XML technology. Moreover, two of them are based on commercial products, so a user is laid when a structural change in the application is desired. In this aspect the design of a system, based on XML and open-source technologies is justified.

3 MAS Architecture and Development

The application of MAS to this problem is justified by the following reasons.

- The environment is dynamic. For instance, the number of users and their preferences can change in an unpredictable way. The agents should adapt themselves to these situations.
- The agents form a distributed system and it is not necessary a permanent connection. The agents are who interact, not the users.
- Extensibility. Using both MAS and ontologies, new types of agents (or new instances of the same agents, even implemented by different developers) can be added easily to the system, making its functionality grow in a dynamic way. In general, this easiness cannot be reached by centralized systems, for example, a central server that every user interacts with via their Web browser.

For the development, the authors adopted FIPA specifications because they have become a stronger standard in MAS development and involves not only agent language specifications but agent management, conversations …

FIPA (Foundation for Intelligent Physical Agents) is an organisation whose purpose is to promote the development of specifications of generic agent specifications (Faratin et. al, 1998). Its agent management reference model provides the normative framework within which FIPA agents exist and operate. The Directory Facilitator (DF) provides yellow pages services to agents that query it to find out services offered by other agents. The Agent Management System (AMS) offers white pages services and maintain a directory, which contain transport addresses for agents registered in the Agent Platform (AP). The Message Transport Service (MTS) is the default communication between agents on different APs (FIPA Agent Management Spec.).

These specifications allow users not to be worried about technical aspects such as a detailed communication implementation. As indicated above, agent-based computing provides the decomposition, organization and abstraction of multifaceted applications in heterogeneous networks.

The authors have implemented a MAS for planning and scheduling in a University Research Group. This MAS, called *MASplan*, should help group members to find the best possible time frames to perform a meeting and to designate the use of the common resources. Originally the system MASplan was composed of 6 different types of agents. The agents for CV generation have been integrated in this system, thus the authors consider its brief description as illustrative.

User Agent (UA): This agent is an end-user interface, which shows the schedule to its related user and allows it to ask for a meeting or a resource. When it occurs, this agent tries to locate its negotiator agent and communicates what user needs. Once the negotiator has finished its work, the user agent receives the result and shows it to the user.

Negotiator Agent (NA): The implementation of the meeting and resource negotiation algorithm is applied via this agent. When it is asked by its related user agent for a meeting negotiation, it looks in the DF for the negotiator agents of the rest of the intended attendees. Then, the negotiation process begins. Alternatively, in the case of a resource negotiation, it looks for the resource agent.

Ontology Agent (OA): It provides ontology services to an agent community, so that the identification of a shared ontology for communication between two agents is facilitated. The definition of an external ontology, managed by an OA, provides numerous general advantages: it permits consultation with regard to concepts, the updating and use of ontologies and it eliminates the need to program the entire ontology in every agent, hence reducing required resources.

Resource Agent (RA): This agent is invoked when a resource negotiation occurs. Firstly, it asks the Ontology Agent for the instances of the selected resource type.

Mail Agent (MA): When an agenda change is confirmed, the Mail Agent is requested by the respective negotiator agent to send an email to the user via the mail

software. For this purpose, it asks to OA for the email address of the user, as these data are stored in the ontology.

Rule Agent (RuA): This agent provides the system with the ability of learning from the users. The RuA is consulted whenever there is an agenda change in order to organize a meeting. The NA will consult with this agent in order to determine whether or not the user is supposed to agree to a possible agenda change.

In this scenario, several mobile agents have been integrated. Each user owes its own mobile agent, called CVSearchAgent (CVSA) that is periodically migrating in the network looking for new merits in which its user is involved. It is clear from the nature of the scenario that the CVSA's do not need to be always active as users do not need to be continuously submitting their CV. Thus, their activity is reduced to a few hours each 7-15 days. This fact and the characteristic of mobility make that the network is not overloaded, as the interaction with other agents and the search of new merits can be done off-line.

Whenever a new merit is found, the CVSA asks the MASplan MA for sending an e-mail to the corresponding user, informing of the result of the search. This way, the user can obtain a copy of the found data for other purposes different to the generation of CVs. Apart from this interaction, the CVSA send these data to the UA for its inclusion in the local user CV database.

The implementation of these local databases does not affect the dynamic generation of the forms as the XSD's are accessed from a remote server.

As stated in the introduction of the paper, a centralized database could have been a good solution. Nevertheless, and in spite of the security offered by the database manager, a significant number of members of the Universitary Scenario were reluctant to insert their data, claiming that they did not want leave their data in a centralized system where they could be accessed by malicious people. Thus, each user owes its own database, stored in the local system and accessed through the Cocoon web portal environment with an authorization and verification process. That database should be managed by an agent in the system. In order to reuse code and resources, the authors have implemented that management functions in the UA code. Thus, the CVSA interacts with the corresponding UA when it is necessary. One of the actions to be carried out is to avoid redundancy in the merits.

CVSA's have been implemented using JADE tool. This is a well-supported agent framework and the authors consider that its use is more adequate for this implementation, as it allows a better management of the agent life cycle (active/inactive), although keeping in mind the restrictions mentioned above. The fact of having implemented agents in different frameworks (the original agents were implemented in FIPA-OS tool) is not a problem as both frameworks are FIPA-compliant.

The original MASplan one has complemented with the inclusion of new concepts related to CV activities. As example of these new definitions, the following OWL code points that research activities related to the Philosophy area are disjoint with those related to Biomedicine.

```
    <owl:Class
rdf:about="#Philosophy_Research_Activity">
      <rdfs:subClassOf>
        <owl:Class rdf:about="#Research_Activity"/>
      </rdfs:subClassOf>
      <owl:disjointWith>
        <owl:Class rdf:about="#Biomedicine_
Research_Activity "/>
      </owl:disjointWith>
    </owl:Class>
```

This type of definitions makes easier the interaction among the CVSA's and the UA's. When both agents start a conversation, they compare the research areas of their corresponding users. In case of disjointness, there is no need of search in the XML database, avoiding its computational cost, and maybe more important, avoiding future unproductive conversations. A more refined version, currently in progress, will consist in using the DF functionality as a yellow pages service of research activities.

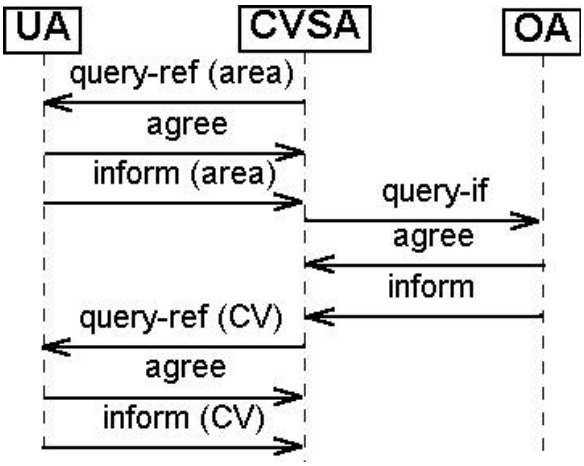

Figure 2: Message flow in the system

Another open line in this project consists of providing more intelligence to the system. The purpose would be that the CVSA's themselves were able to extract the rules of interaction among users regarding analogue research areas- for example, if two areas are compatible or not – from the list of keywords in the titles of publications or common authors in the merits. For that purpose, several well-known techniques can be used, e.g., Dempster-Shafer method [10]. After that deduction, the CVSA would interact with the RuA and OA for the inclusion of the deduced axiom in the ontology.
Figure 2 shows a standard simplified message flow between the CVSA and UA agents.

4 Description of Cocoon Web portal

In this section, the Cocoon web portal will be described. It is noted, as stated above, that the interaction of the web portal with the MAS is done via the UA's. The Cocoon distribution offers a good number of useful developing examples. From one of these examples, in particular from the address *samples/blocks/portal-fw/sunspotdemoportal*, the authors have developed their web environment.
After an initial verification process, the user is presented a frame configuration where several parts can be distinguished. The most important one is located on the left, including a set of controls. Clicking on the controls, a user can insert, modify, look for and update their data, as generating several formats of CV. An example of generated CV CForm is shown in Figure 3. It is important to remark that the number of the identity card is the parameter used to match the data with the corresponding user. This is necessary due to it is clearly not desirable that a user could access data related to other users. The use of this parameter in the session is not trivial and requires modifying some XML and XSL files, such as *sunrise-newuser.xml*, *sunrise-changeuser.xml*, *portal.xsl* and *sunriseconfHTML.xsl*.
The data involved in the structure of the system have been divided into four categories, declared in their respective schemas.

- Courses (lectures, seminaries): name of the course, recommended bibliography, etc.
- Personal data: name, address, spoken languages, etc.
- Merits: list of the merits to be included in a CV, such as publications in journals, conferences, books, chapters, research activities, etc.
- Groups: list of research groups, members, address, director, etc. – accessed only by the administrators of the system.

It is noted that for avoiding repetition in this structure, each document includes a reference field, a kind of main key in a database. This key is the number of identity card (DNI) of the user.
As stated above, the web environment is generated in a dynamic way. It is interesting that the information could change following the structure of the XML files, in other words, following the changes produced in the XML schemas. This purpose has been reached through the design of a set of XSL transformations that allow generating Cocoon forms. As expected, a change in the XML schema involves a change in the corresponding CForm.
For this purpose, three transformation files were designed: *form-template*, *form-definition* and *form-binding*. These transformations are applied to the XSD files in order to generate the forms presented to the user. A possible problem could be that the application of three transformations whenever a form is generated could be excessively slow. Fortunately, Cocoon offers an effective cache system. When a form is loaded for the first time, the rest of forms can be showed in a more quick way. This methodology has been simultaneously used by other developers, in particular, Arje Cahn and Max Pfingsthorn from Hippo.nl. However, that implementation is even much more limited than the presented in this work. As example, the date type is treated as a mere string.
The mentioned files collect the XSD structure and extract recursively the data and turn it into a CForm structure. All of them have a similar structure, based on recursive invocations with attribute inheritance and recollection in groups of information. Thus, the differences are not in their structure but in their content, due to their specific syntax using their respective namespaces.
It is noted that for each transformation three possible simple types have been considered:

- Those defined as *xs:simpleType*.
- Those defined as complex type, but they are *xs:extension*.
- Those types that have directly defined from the complex type, for example, a complex type with attribute *type="xs:string"*.

It has been observed that there are some fields that are rather difficult to manage. A significant case is that of the "author" field in the file including the CV Merits. This field should include the number of the identify card of each author involved in the merit (for example, the list of authors of a paper accepted for publication in a journal). Nevertheless, these numbers are difficult to remember by the users. It would be desirable an easier way for the inclusion of the authors. This problem has been resolved including a new attribute, called "src", to the tags *xs:element* and *xs:attribute*, called "Combo-Professor" when it is necessary. This name is related to the match actions -in the sitemap file located in the directory forms- that indicate that users should be inserted through a combo widget instead of a textfield one.
As example of design of XSL transformation, the authors will describe the transformation in order to get the form template file.

4.1 Design of the form template

The algorithm for the creation of this form is based on the following steps:

- When a complex type is found
  - For each element, a group of items is created:
    - If (maxOccurs=1) and (minOccurs=1):

- Recursive call
- Else:
  - Add a repeater
  - Recursive call.
  - Add bottoms for its management.
- For each attribute, recursive.

- When a simple or similar type is found
  - Add a widget with a field "id", that is a parameter inherited from the previous recursive calls. This field is the chain of the id's of the previous elements that make up a unique path to the node. That also allows to establish the style of the widget.

Mainly, the idea consists in reading the schema from the root element to its children elements, at the same time as each child element inherits the attributes of its parent element. This structure will be used whenever the system needs to extract information from a XSD document.

4.2 Restrictions in the transformations

The designed transformations do not cover all the possible XSD syntax. As it is said in Apache web site "The difficulty with schemas is that they can contain an implicit structure by means of references to elements" However, due to the designed structure, it is possible to make easily updates and code improvements. The main restrictions in the XSD structure are summarized as follows:

- There can be as many complex and simple types as desired, but it is not allowed that the root element – or their children – has those types as children elements.
- Each immediately children element of the root element must define an attribute "xs:ID", that identifies univocally that element. The name of that **ID element must be the same for all the elements of the same document.** This element is used due to two reasons:
  - Avoiding repeated id's.
  - Allowing the search of elements for modifications and deletions.

Figure 3: A detail of generated CV form

- In a complex type the following defined elements are included xs:sequence/xs:element|xs:choice/xs:element|xs:all/xs:element|xs:simpleContent/xs:extension.
- In a complex type the following defined attributes are included: xs:attribute|xs:simpleContent/xs:extension/xs:attribute.
- Datatypes ,documentation, cardinality and validation tags can be applied to a simple type. In the case of the validation tags, they are restricted to xs:pattern, xs:minLength, xs:maxLength, xs:maxInclusive, xs:minInclusive.

The first phase of the project was only focused on this web environment. When a user desires to generate an updated CV, a XSL-FO transformation is applied in order to get that CV which is accessed in the browser. The system has been used successfully for the generation of the documentation regarding the PhD studies program of three departments of the University of La Laguna. That program covers nearly 100 professors, thus the recollection of information of the lectures and giving homogeneity to the presentation of that information could involve a great amount of time without that web environment (as stated above, the mean time for the generation of a CV has been calculated as 3 hours). Moreover, the users can get their CV with only a click when it is required or generate their web page with their research data.

5 Conclusions

In this paper, the authors have presented a multi-agent system for the automatic generation of CV's for a Universitary scenario. The agents related to this purpose have been integrated with a previously designed system, called MASplan, for planning and scheduling in a University Research Group Scenario. The included agents, called CVSA, are mobile- one for each user in the system- and their task consists of the search of merits related to their corresponding user. This search is carried out interacting with other agents, called UA, in charge of the management of local merits databases. The main reason for this distribution, and thus for the use of a multiagent system, lies in the human behaviour. Firstly, it has been observed that sometimes the corresponding author of an article forgets to communicate the acceptance of that paper to the rest of the authors and that a co-author is usually so busy that he/she prefers to update his/her CV database later, taking the risk of 'losing' the paper in his/her CV. Secondly, a significant number of members of the Universitary Scenario were reluctant to insert their data, in a centralized system. In this context, the features provided by the multiagent systems – distribution, reliability, proactivity, autonomous and reactive behaviour, etc.- seem to be especially useful.

The original MASplan system included an ontology for the automatic meeting negotiation in an intelligent way amongst several researchers, among other several features. This ontology was implemented in OWL, a

highly expressive markup language. In the context of this work, some new concepts have been introduced, for example axioms related to the disjointness of different research areas, facilitating the interaction among the agents involved. Currently, the authors are working on the addition of new interesting features in the system, as the ability of the agents of deducing axioms on-line.

Other interesting aspect of this work is the implementation of a dynamic web environment for the management of the CV generation. The development of this environment has been carried out using Apache Cocoon, a mature and popular web development framework, developed in Java and based on the Servlet API model. The web environment is generated in a dynamic way. The information changes follow the structure of the XML files, in other words, following the changes produced in the XML schemas. This purpose has been reached through the design of a set of XSL transformations that allow to generate Cocoon forms. As expected, a change in the XML schema involves a change in the corresponding CForm.

The system has been used successfully for the generation of the documentation regarding the PhD studies program of three departments of the University of La Laguna, Spain. That program covers nearly 100 professors, so the use of this web environment has saved a lot of time in the data treatment.

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Statistical Dependency Parsing of Four Treebanks

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Multilingual dependency parsing is gaining popularity in recent years for several reasons. Dependency structures are more adequate for languages with freer word order than the traditional constituency notion. There is a growing availability of dependency treebanks for new languages. Broad coverage statistical dependency parsers are available and easily portable to new languages. Dependency parsing can provide useful contributions in areas such as information extraction, machine translation and question answering, among others. In addition, syntactic head-dependent pairs are a good interface between the traditional phrase structures and semantic theta roles. In this paper we present the learning curves of a statistical dependency parser for four languages: Arabic, Bulgarian, Italian and Slovene. We discuss issues that mostly concern the employed annotation scheme for each treebank with an emphasis on coordinated structures.

Povzetek: Opisano je večjezično odvisnostno skladenjsko razčlenjevanje štirih jezikov.

1 Introduction

Contrary to a constituency (or phrase structure) grammar, a dependency grammar (e.g. [11]) does not view syntactic structures as nested sets of constituents but as a set of binary head-dependent relations. In most dependency grammar formalisms there are several restrictions for the dependency relations: They should build up a connected acyclic graph; For each dependent, there should be only one head; There should be a single word in the sentence without a head – the root word. A syntactic label, such as subject, object etc. is usually associated with each relation in the graph.

Projectivity is another issue that is often considered as a constraint to dependency graphs. A simple non-formal definition for projectivity of a connected dependency graph is: if one connects the root word of a sentence with an artificial root placed before the first word, there should not be crossing dependency arcs. While most of the dependency parsers can parse only projective structures, the need for non-projective relations is recognised in nearly all dependency treebank annotation schemes.

State-of-the art statistical dependency parsers have been evaluated on 13 different treebanks (for 13 different languages) at the CoNLL-X shared task on statistical dependency parsing [2][1]. While the treebanks had been parsed with many parsers, all the parsers had been implementations of a limited number of parsing models.

This paper gives the learning curves for four languages (Arabic, Bulgarian, Italian and Slovene) of one of the parsers tested at the CoNLL-X shared task – Maltparser [12]. The parser has a high attachment score (accuracy), and it is robust. The treebanks for Arabic, Bulgarian, Italian and Slovene had been annotated by different research groups, using four different annotation schemes.

The paper is structured as follows: Section 2 explains our motivation to choose Maltparser among the CoNLL-X shared task parsers for our experiments. Then, in Section 3 we briefly describe the properties of each treebank that we give learning curves of. We give a short description of Maltparser and the parsing feature model that we used in our experiments in Section 4. The learning curves are given in tabulated form and discussed in Section 7. We conclude in Section 6.

2 Motivation for our choice of a parser

We chose Maltparser [12] from the pool of CoNLL-X shared task parsers because of its high (second best) overall accuracy in the CoNLL-X shared task. Furthermore, it has a number of desired properties which are consistent with our long term goal – to use a broad coverage automatic parser as a model of the human parsing mechanism. Such properties include the ability different types of information to be used in feature models.

Maltparser employs one of the two most commonly used parsing models at the shared task. The dependency graph is built using a stack for storing the words of the sentence and four actions: shift, reduce, left-arc and right-arc. Projectivity of the treebank to be learned and parsed can be 'enforced' using pre and post processing graph transformations. However, we did not take benefit from that option since we do not believe that such transformations are plausible in the human parsing sense.

[1] http://nextens.uvt.nl/∼conll/

3 Treebanks

We used four treebanks in our experiments: The Prague Arabic Dependency Treebank (PADT) [7], the BulTreeBank (BTB) [13], the Turin University Treebank (TUT) [1] and the Slovene Dependency Treebank (SDT) [6]. PADT, TUT and SDT are original dependency treebanks while BTB was converted from Head-driven Phrase Structure Grammar (HPSG) format to dependency graphs in [3].

3.1 The Prague Arabic Dependency Treebank

We used the CoNLL-X shared task version of the PADT[2] which differs slightly from the original treebank. It is separated in training (1,460 sentences; 54,379 tokens) and test (146 sentences; 5,373 tokens) set. The number of part-of-speech tags and the number of dependency tags are respectively 21 and 27. The average number of tokens per sentence is 37.2. The PADT annotation scheme is closely related to the one of the Prague Dependency Treebank (PDT) [8].

One of the idiosyncrasies of the PDT annotation is the treatment of coordinated structures. In PDT-related annotation schemes the coordinating conjunction (or punctuation) is the head of the coordinated words.

3.2 The BulTreeBank

BulTreeBank is an HPSG-based treebank but head-dependent relations between words are not stated explicitly. It has been converted to dependency graph representations in [3]. We use the CoNLL-X shared task dependency version of the BTB for our results to be comparable to those from the CoNLL-X shared task.

The BulTreeBank is separated in training (10,911 sentences; 159,395 tokens) and test (2,310 sentences; 36,756 tokens) set. The average number of words per sentence is 14.8. The number of part-of-speech labels is 570[3] and the number of dependency labels is 20.

Coordinated structures are annotated differently from those in the PADT. In the BTB encoding the first coordinated word is annotated as the head of the coordinating conjunction (or punctuation) and as the head of the second coordinated word.

3.3 The Turin University Treebank

The TUT was not included in the CoNLL-X shared task mainly because of its limited size – 1,500 sentences (44,616 tokens). The average number of tokens per sentence is 27.7. Although the treebank is small and n-fold cross-validation is usually used in such cases, here we report results on a test set of 150 sentences (4,172 tokens) and a training set of 1,350 sentences (37,444 tokens) in order the TUT experiments not to differ from the experiments on the other treebanks in this study.

We used a version of the TUT with removed traces and reduced tag sets [4] (90 part-of-speech tags and 18 dependency tags). Italian dependency tags are semantically 'deeper' than those from the other treebanks in this study. Coordination is annotated with the coordinating conjunction (or punctuation) being the head of the second coordinated word and a dependent of the first coordinated word.

3.4 The Slovene Dependency Treebank

SDT has an annotation scheme which is similar to those of the PDT and PADT. We used the CoNLL-X version of the treebank for our results to be comparable with those from the shared task. The data is divided in a training set (1,534 sentences, 28,750 words) and a test set (402 sentences, 6,390 words). The average number of tokens per sentence is 18.2. The number of the part-of-speech tags used in the annotation of SDT is 30. The number of dependency labels is 26. Like in PADT, coordinated structures are treated with the coordinating conjunction (or punctuation) being the head of the coordinated words.

4 The parser

We used version 0.4 of Maltparser[4]. Maltparser does not use an explicit probabilistic grammar but implements a data-driven parsing approach. What is learned is the actions that the parser must take in order to build the dependency graph of the sentence. We used the Support Vector Machines (SVM) learner [5] which is included in Maltparser 0.4. PoS tags, words as well as dependency labels which have already been assigned by the parser on the run can be used in feature models for learning.

We employed a common feature model (m7) which consists of six part-of-speech features, four dependency features and four lexical features. More information about the parser and feature models can be found on the Maltparser web page. The Maltparser team reported the second best result at the CoNLL-X shared task [12] (the difference from the best result is not statistically significant).

5 Results

In this section we list related work, describe preliminary settings, present in tabular form and discuss the learning curves for Arabic, Bulgarian, Italian and Slovene. The measure that we use for evaluation is labelled attachment score (labelled accuracy) measured excluding punctuation. We also report unlabelled attachment score (unlabelled accuracy). For a definition of these measures, the reader is referred to [10].

[2] PADT is distributed by the Linguistic Data Consortium: http://www.ldc.upenn.edu/

[3] We used the original BTB part-of-speech tags.

[4] http://w3.msi.vxu.se/∼nivre/research/MaltParser.html

5.1 Previous studies

In this section we give only dependency (and not constituency) parsing results because they are immediately relevant to the study.

5.1.1 Arabic

The PADT has been learned and parsed by various teams at the CoNLL-X shared task on dependency parsing. Results vary from 50.7% to 66.9% labelled accuracy [2].

5.1.2 Bulgarian

A dependency version of the BulTreeBank has also been used at the CoNLL-X shared task. Labelled accuracy is within the range 67.6% – 87.6%. Labelled accuracy of 79.5% was reported for another conversion of the original HPSG-based BulTreeBank but those results did not differ significantly from the results reported on the CoNLL-X conversion using the same parser and feature model (79.2%) [3].

5.1.3 Italian

We will compare the learning curves for Italian with [4] where a previous version of the Maltparser was used together with another learner. The reported accuracy is 81.8%. A rule-based dependency parser for Italian is described in [9]. Even though its evaluation is only partial, its accuracy is comparable to the one reported in [4].

5.1.4 Slovene

Slovene, like Arabic and Bulgarian, was one of the languages for the CoNLL-X shared task. Results for Slovene varied from 50.7% to 73.4% labelled accuracy [2].

5.2 Settings

All the experiments were performed on training and test sets with gold standard PoS tags. The same feature model and the same learning and parsing settings were used in all the tests with the exception of an option that we used only for the Arabic and Slovene treebanks where graphs may be interpreted as having multiple roots.

The BulTreeBank learning curve is set for training sets that start from 1,000 sentences and increase up to the full size of the treebank, where at each step the size of the training set is increased by 1,000 sentences. The learning curves for the other languages start from a training set of 600 sentences and the sizes continue to grow up to the full number of sentences of the treebanks with increase of 200 sentences at each step.

Two additional learning curves are included for Arabic and Slovene after a simple graph transformation on the coordinated structures was applied on the training sets for these languages. Parsing output was then converted back to the original coordination encoding and evaluated on the gold standard PADT and SDT.

A description of the coordination transformation procedure follows:

Coordinated structures are identified by the dependency label of the coordinating conjunction (or punctuation) which, according to the PDT annotation scheme, is the head of the coordinated words. If there are two words with the same dependency labels among the dependents, one of them being before the head and the other – after the head, they are recognised as coordinated. Then the first coordinated word takes the head word of the coordinating conjunction (punctuation) and the coordinating conjunction or punctuation is made to point to the first coordinated word.

The inverted transformation is performed in a similar way. After the coordinated structure is identified, the head of the first coordinated word is transferred to be the head of the coordinating conjunction (or punctuation) and the first coordinated word is made dependent on the coordinating conjunction (or punctuation). Note that the back transformation can be accurate only for properly parsed coordinated structures.

5.3 Learning curves

The learning curves are given in tabular form in Tables from 1. to 4. The first column shows the training set size in sentences. AS_L and AS_U stay respectively for labelled and unlabelled attachment score.

Size	AS_L	(c.t.)	AS_U	(c.t.)
600	61.1%	61.9%	73.0%	74.0%
800	62.4%	64.2%	74.2%	76.0%
1,000	63.9%	65.2%	75.1%	76.6%
1,200	65.2%	67.1%	75.7%	78.1%
1,400	65.6%	67.4%	76.2%	78.2%
1,460	66.0%	67.4%	76.3%	78.0%

Table 1: Learning curves for the PADT (Arabic). c.t. = Coordination transformation applied.

For training data of 1,000 sentences labelled accuracies for Bulgarian, Slovene and Arabic are similar. Labelled accuracy for Italian is the highest for this size of training data. If the comparison is done using the unlabelled accuracy measure, the per cent for Bulgarian is lower than those for Arabic and Slovene due to the bigger difference between labelled and unlabelled accuracy for PADT and SDT.

There are a number of reasons for the differences in accuracy for the different treebanks, from numbers of tokens per sentence for each treebank to sizes of the tag sets and idiosyncrasies of the annotation schemes. For example, the small number of part-of-speech tags for the Arabic and Slovene treebanks might have been the reason for the lower accuracy, in comparison with the bigger number of

Size:	AS_L	AS_U
1,000	64.8%	71.6%
2,000	69.4%	75.8%
3,000	75.6%	81.3%
4,000	77.5%	83.1%
5,000	78.4%	83.8%
6,000	79.8%	85.0%
7,000	80.0%	85.2%
8,000	80.4%	85.6%
9,000	80.9%	86.0%
10,000	81.5%	86.5%
10,911	81.8%	86.8%

Table 2: Learning curves for the BTB (Bulgarian).

Size:	AS_L	AS_U
600	80.9%	86.5%
800	82.3%	87.7%
1,000	82.8%	88.2%
1,200	83.0%	88.3%
1,350	83.7%	88.6%

Table 3: Learning curves for the TUT (Italian).

PoS tags for the Italian treebank, given that the number of dependency tags is similar in all the three treebanks. In fact, this is not the case. We did an additional experiment on the Italian data. We used a PoS set of only 17 coarse grained tags and labelled accuracy was still above 81% for the biggest training set.

The Arabic and Slovene data sets had their transformed versions learned and parsed better than the original ones. The difference in labelled accuracy is over 1% for nearly all the sets. The biggest training set gives worse results than the second biggest for the transformed Slovene training data. This is due to loss of accuracy in the inverted transformation.

The number of non-projective trees in the treebanks have influenced parsing accuracy since the parser cannot parse non-projective arcs. Non-projective trees are 175 (10.9%) in PADT, 962 (7.3%) in BTB, 91 (6.1%) in TUT[5] and 1,289 (66.6%) in SDT. The number of sentences with the hard-to-parse coordinated structures in the PADT and SDT are respectively 1,041 (64.8%) and 989 (51.1%).

The results for Arabic reported in this paper are slightly higher (0.5%) than the best results reported at the CoNLL-X shared task even though a more sophisticated feature model for the Maltparser was used there.

Results for Bulgarian are lower, if compared to the Maltparser results obtained at the CoNLL-X shared task where it employed a better feature model. The accuracy that we report here is higher than the one reported in [3] because they used an option of the SVM learner which split the data on smaller parts for faster learning with the cost of decrease in performance.

[5]Originally the TUT does not have non-projective sentences but after traces were removed in [4] non-projective arcs were introduced.

Size:	AS_L	(c.t.)	AS_U	(c.t.)
600	62.3%	63.7%	73.8%	74.1%
800	64.0%	65.6%	74.8%	75.7%
1,000	64.6%	66.4%	75.2%	75.9%
1,200	65.6%	67.0%	75.9%	76.4%
1,400	66.8%	68.3%	77.0%	77.5%
1,534	67.1%	68.2%	77.4%	77.6%

Table 4: Learning curves for the SDT (Slovene). c.t. = Coordination transformation applied.

Compared to the other treebanks the parser learned the TUT very well with a limited amount of training data. The reason for the high accuracies is likely to be the treebank annotation scheme. It is different from those of the other treebanks in its 'deeper' syntactic dependency relations. The distance between the dependents and their heads is usually short which facilitates processing. The number of sentences in TUT which have non-projective graphs is very small – only 91. That may have contributed to the high parsing accuracy. Compared to previous studies we report higher accuracy (nearly 2% increase).

Our results for Slovene somehow lag behind the results for that language which were obtained using Maltparser at the CoNLL-X shared task. The reasons are the use of a simpler feature model for the parser and the big number of non-projective arcs in the Slovene treebank which we did not pre/post processed.

Results are on the average 1% higher than those for the PADT. Possibly this difference can be explained with the very small number of tokens per sentence for the SDT – only 18.2, compared to 37.2 for the Arabic treebank. As in the case with PADT, coordination transformations increased parsing accuracy.

6 Conclusion and future work

We presented the learning curves for four different treebanks using the same feature model for learning a statistical dependency parser. We showed that often parsing results differ significantly for different languages and the reasons can be various properties of the concrete treebank. We performed treebank transformations for Arabic and Slovene to report parsing accuracy for Arabic that is slightly higher than the best results reported at the CoNLL-X shared task.

Future work includes investigation of various treebanks to find out which annotation scheme keeps parsing accuracy high for a vast majority of languages. In addition we believe that adding different kind of information as features in the learning model can lead to broad coverage models of the human sentence parsing mechanism whose implementations must be good multilingual NLP parsers.

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Knowledge vs. Simulation for Bidding in Tarok

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Two approaches for bidding in games are presented: knowledge-based approach and simulation-based approach. A general knowledge-based decision model for bidding in games with its strategy encoded in a Bayesian network was designed. A program for playing four-player tarok was implemented incorporating a specialised instance of the decision model and a simulation module for bidding. Both approaches were compared. The knowledge-based decision model was further compared to human experts, showing that it performs on par with them.

Povzetek: V članku predstavljamo in primerjamo dva pristopa k reševanju problemov licitiranja v igrah: pristop s predznanjem in pristop s simulacijo.

1 Introduction

Bidding is a part of various card games, for example bridge, poker, tarok and whist. Before the actual card play, players offer to play more and more difficult types of games with the one making the most ambitious offer choosing the type that will be played. Bidding involves exchange of information between partners (e.g. in bridge) or not (e.g. in tarok or poker). The winner of bidding is the one who actually scores in the game. Since bidding requires the prediction of the final outcome of each type of a game, it is in a way more difficult than card play itself.

In this paper we present and compare two approaches to bidding in tarok [9]: knowledge based-approach and simulation-based approach. For the purpose of comparison and evaluation we developed the Tarok7 program [10] for four-player tarok. The program uses both (i) an implementation of a decision model based on Bayesian networks and (ii) simulation for bidding. We also examined the program's performance under different bidding strategies, and compared it with human experts.

The paper is organized as follows. Rules of bidding in general and in four-player tarok and the most common approaches to bidding in computer games are presented in Section 2. An overview of related work is given in Section 3. Complexity of different games with bidding is discussed in Section 4. The decision model is described in Section 5. Section 6 presents bidding with simulation as it is performed by Tarok7 program. Section 7 describes the comparison of the two approaches and evaluation of the decision model compared to human experts. A conclusion is presented in Section 8.

2 Bidding in Games

In bidding, players bid in a sequence divided into rounds. In one round each player makes one bid. Each bid must be higher than the previous one. Bidding is finished when all players but one pass i.e. do not continue with higher bids. The remaining player is called the declarer. With each type of bid a particular type of game is associated: the higher the bid, the greater the difficulty and the score of the game. The game that corresponds to the last bid of the declarer is played after bidding. These rules hold for most card games such as bridge or tarok. From the strategic point of view, a player has to determine the most difficult type of game which he expects to be able to win according to his strength.

In *four-player* tarok, one of the most common games in central Europe, a declarer can play against the other three players teamed together, or choose one partner, depending on his last bid. Teams of players are formed after bidding, which means that players do not know their partners at bidding time. Bids influence formation of teams, and set the type of game to be played after bidding. Each type of game has a score bonus which is positive when the declarer wins and negative when he loses. There are 13 types of bids in four-player tarok. We describe 7 of them; others are played rarely. Bonuses are written in parentheses; the higher the bonus, the higher the bid:

- three (10), two (20), one (30): after bidding the declarer is obliged to exchange the corresponding number of cards with talon. Talon consists of six cards, which remain face down on the table after dealing. The declarer determines a partner as the one with the king card of the declarer's choice;

Player	The hands of cards
GEORGE	$\mathcal{T}$: 13, 11, 10, 8, 3, **1** $\mathcal{H}$: **K**, Q, 4 $\mathcal{C}$: 8 $\mathcal{S}$: B, 9
RINGO	$\mathcal{T}$: 19, 17, 12, 5, 2 $\mathcal{H}$: C $\mathcal{C}$: **K**, B, 10 $\mathcal{D}$: C $\mathcal{S}$: **K**, 8
PAUL	$\mathcal{T}$: **22**, **21**, 20, 18, 9, 6, 4 $\mathcal{D}$: **K**, B, 1, 2, 3
JOHN	$\mathcal{T}$: 16, 15, 7 $\mathcal{H}$: B, 2 $\mathcal{C}$: Q, C $\mathcal{D}$: Q, 4 $\mathcal{S}$: Q, 10, 7

Table 1: The hands of cards.

Player	1st round bids	2nd round bids	3rd round bids
GEORGE	three	pass	already passed
RINGO	two	one	pass
PAUL	one	solo three	-
JOHN	pass	already passed	-

Table 2: An example of bidding.

– solo three (40), solo two (50), solo one (60), solo zero (80): the corresponding number of cards is exchanged with talon. The declarer plays alone.

An example of bidding in a four-player tarok game is presented in Table 2. The hands of all players are presented in Table 2. The symbol $\mathcal{T}$ stands for trumps called taroks, $\mathcal{H}$ stands for hearts, $\mathcal{C}$ for clubs, $\mathcal{D}$ for diamonds and $\mathcal{S}$ for spades. Abbreviations K, Q, C and B mean the cards king, queen, cavalier and boy respectively.

In the example bidding, Paul holds the strongest cards followed by Ringo and George with John having the weakest hand. Bidding begins with George, who bids 'three', which is obligatory for the first bidder. Ringo bids higher choosing 'two'. Paul raises to 'one'. John passes. At the beginning of round two George passes also. Ringo estimates that his advantage over Paul is high enough, so he continues bidding. Since his first bid was before Paul's first bid, the rules of tarok allow him to continue with the same bid as Paul. Paul decides that he can play a solo game and raises to 'solo three'. In the third round Ringo passes also, which ends the bidding. Paul becomes the declarer. Note that the described bidding for all players was performed by our Tarok7 program.

The strategy of a bidder is to choose the most appropriate bid according to the strength of his hand and the estimated strength of his partners and opponents. Generally, the types of games associated with high bids require the bidder to have a higher advantage over the opponents to win the game. The strength of the opponents can be estimated from their previous bids. Another important task for the bidder is to find an appropriate level of risk. Prior estimates of the quality of other players from previous games must also be considered.

In general, there are two ways of solving bidding problems: knowledge-based and simulation-based approaches. In knowledge-based systems prior human knowledge serves as the basis for decision making. A knowledge base can be represented by a hand-crafted set of bidding rules, a decision structure built manually or with help of various machine learning algorithms. Simulation-based systems use game search. A bid determines the type of game to be played. When a bidder has to make a decision, the system internally simulates several games for each bid. Simulation yields expected final scores for each bid and the bid which leads to the best score is chosen by the bidder.

The advantages of knowledge-based systems are in their better explicability. Decisions of simulation-based systems usually cannot be easily understood and consequently these systems are difficult to modify. Another advantage is the speed of the decision process. In highly complex non-perfect information games simulation-based systems consume a lot of time. Since the amount of time to make a decision is limited in real games, usually the number of simulated games has to be reduced. This directly affects the quality of decision making.

On the other hand it is a lot easier to build a simulation-based system, because no knowledge acquisition and implementation is needed. The game program that plays the part of the game following bidding itself can be used as a simulation engine. A system using simulation is not confined to hard-coded knowledge and can adapt to new opponents easily. Simulation can also find solutions which were not foreseen by the designer of a knowledge-based system.

3 Related Work

Bridge is probably the best-known game with bidding and GIB [5] the best-known bridge-playing program. GIB uses a database of bidding strategies, but its principal bidding mechanism is simulation. The results of simulation, though, can only serve for determining the strength of the hand of cards. A very important aspect of bidding in bridge is information exchange with the partner. By choosing a particular bid, the bidder conveys a certain message about his cards to his partner. This cannot be adequately modelled with a simulation so GIB uses the database of bidding strategies to incorporate decisions about message exchange. Another well-known program for playing bridge

is Bridge Baron, described in [15], where authors do not discuss bidding. There are also some other programs for playing bridge such as Quick bridge [12] and Q-plus bridge [13]. Due to their commercial nature it is not know publicly how they work.

Whist is also a card game that includes bidding. [7] describes a program for playing whist that uses game search for card play. Experiments to perform bidding with simulation have been performed. The author reports poor results so bidding was not included in the program. Two further examples of programs for playing whist, both commercial, are Bid Whist [2] and Nomination Whist [11].

Betting in *poker* is also a form of bidding. Poki, a program for playing poker described in [1] bases its decisions on simulation aided by statistical modelling of opponents. The program Monash BPP [8] uses Bayesian networks to represent (i) the relationships between current hand type, (ii) final hand type after the five cards have been dealt and (iii) the behaviour of the opponent. Thus the posterior probability of winning a game is obtained. The approach to playing poker that has had most success lately is approximating game-theoretic optimal strategies. It is used by both PsOpti [3], the successor of Poki, and GS2 [4].

Another game that includes bidding is *three-player* tarok. Silicon tarokist, a program for three-player tarok described in [9, 16], also employs simulation for bidding.

4 Complexity of Games with Bidding

Average and worst-case complexity of different games are presented in Table 4. In general, complexity is measured by the number of possible courses of a game. Tarok and bridge are split into two parts: bidding and card play. We consider card play in tarok to include the part of the game immediately following bidding: choosing a partner (four-player tarok only), exchanging cards with talon, announcements and counter-announcements. A game of poker is treated as a whole.

The *average complexity of bidding* in four-player tarok and bridge was approximated by the average number of real-game choices to the power of the average length of bidding process. The source of data for all the categories, average and worst-case, for three-player tarok is [9]. The source of data for four-player tarok were several hundreds of games played by the Tarok7 program, while for bridge we examined several tens of games played at World Championships in Montreal, Canada in 2002 [17].

The *worst-case complexity of bidding* was calculated by taking into account all bids allowed by the rules. We calculated the worst-case complexity of bidding in bridge and four-player tarok with a special-purpose program. Bidding is most complex in bridge and least complex in three-player tarok.

The *complexity of card play* in four-player tarok was calculated according to the same principles as in three-player tarok. The average complexity was again computed from several thousands of games of Tarok7 program, while the worst-case complexity was calculated by constructing such hands of cards that yield the largest number of possible courses of card play allowed by the rules. The source of figures for bridge is [15]. Card play is most complex in three-player tarok and least complex in bridge.

The *overall complexity* of a game is the product of the complexity of bidding and card play. The least complex game according to [1] is poker.

Since we are dealing with imperfect information games, simulation is even more difficult than the figures in Table 4 suggest. In bridge this is somewhat alleviated by the fact that one player's cards are visible to all others. In four-player tarok, there is even more uncertainty at the time of bidding since the declarer's partner is only revealed during card play. In addition, the complexity of card play in tarok is significantly higher than the complexity of card play in bridge and the overall complexity of poker. Since using simulation for bidding means that several entire games have to be played out, this approach, while successful in bridge and poker, might not be suitable for tarok. A knowledge-based approach might be more appropriate than simulation.

5 Decision Model for Bidding Using Bayesian Networks

5.1 Bayesian Networks

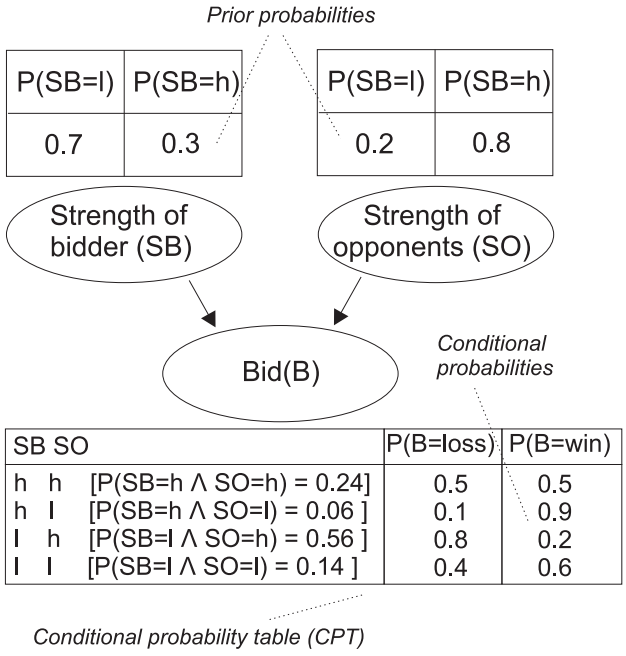

Figure 1: An example Bayesian network.

Bayesian networks with the inference rules are com-

	Bidding		Card play		Overall	
	Average	Worst	Average	Worst	Average	Worst
Three-player tarok	≈ 20	506	$\approx 10^{30}$	$2.6 \cdot 10^4$	$\approx 10^{31}$	$1.3 \cdot 10^{47}$
Four-player tarok	≈ 100	$1.3 \cdot 10^6$	$4.7 \cdot 10^{23}$	$2.0 \cdot 10^{41}$	$\approx 4.7 \cdot 10^{25}$	$2.6 \cdot 10^{47}$
Bridge	$\approx 10^5$	$\approx 1.4 \cdot 10^{13}$	$5.6 \cdot 10^{19}$	$1.6 \cdot 10^{31}$	$\approx 5.6 \cdot 10^{24}$	$\approx 2.3 \cdot 10^{44}$
Poker	-		-		$\approx 10^{18}$	

Table 3: Complexity of bidding.

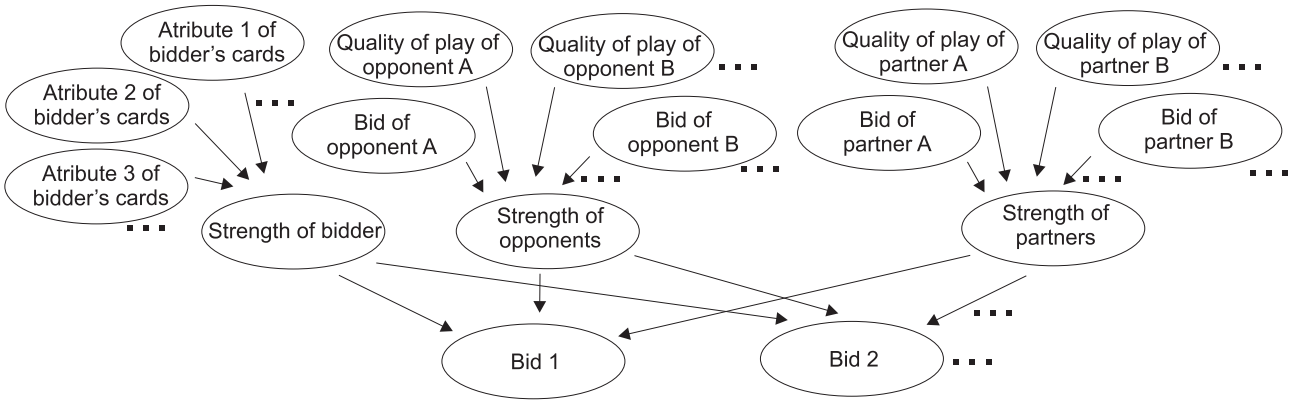

Figure 2: Decision model for bidding using Bayesian network.

monly used when dealing with probabilistic events [14, 6]. An example in Figure 5.1 illustrates an application of Bayesian networks in bidding. The network represents a particular situation from bidding, where the bidder has to decide whether a certain bid is suitable, i.e. whether it is expected to win the game associated with the bid or not. The bidder estimates his strength and the strength of the opponents. The top-level nodes represent the bidder's knowledge about his strength and the strength of the opponents. The bottom-level node represents the expected final result of the game.

With each node one random variable is associated. Each of the variables SB and SO can have two values: 'high' (h) and 'low' (l). The variable B can have the values win and $loss$. For example, in our case the bidder estimates that the opponents' strength is high with probability 0.8. The links between the nodes determine the way the probabilistic variables are conditionally related. In the conditional probability table (CPT), there are the conditional probabilities that quantify the relation between the random variables. They are set by the designer of the network, and together with the structure of the network reflect the general knowledge about bidding. At the time of bidding decision, prior probabilities in top level nodes are set according to the current state of the game and the probabilities of loss and win are computed by Equation 1.

If loss is more probable than win, this bid should not be chosen. In this particular case the probability of a win would be 0.37, which indicates that the bid might not be sensible.

$$\begin{aligned} \mathrm{P}(B = win) = & \mathrm{P}(B = win | SB = h, SO = h) \\ & \cdot \mathrm{P}(SB = h \wedge SO = h) \\ & + \mathrm{P}(B = win | SB = l, SO = h) \\ & \cdot \mathrm{P}(SB = l \wedge SO = h) \\ & + \mathrm{P}(B = win | SB = h, SO = l) \\ & \cdot \mathrm{P}(SB = h \wedge SO = l) \\ & + \mathrm{P}(B = win | SB = l, SO = l) \\ & \cdot \mathrm{P}(SB = l \wedge SO = l) \end{aligned} \quad (1)$$

5.2 Description of the Model

The knowledge-based decision model for bidding is presented in Figure 5.1. The top-level nodes represent the state of the game at the moment when a player has to make a bid. The mid-level nodes semantically integrate the attributes in the top-level nodes. They are not strictly necessary, but they make the network more compact and easier to design. Each bottom-level node represents one of possible bids and therefore the type of game associated with that bid. The random variables associated with the bottom-level nodes represent the final scores of the game.

To determine the optimal bid, the prior probabilities of all top-level are set according to the current state of the game. Assume that the node N, 'Bid of opponent A' has three possible values: 'pass' (pa), 'low bid' (l) and 'high bid' (h). If the opponent's last bid was a high bid, then

$$P(B = v_b) = \tag{2}$$
$$\sum_{j_1=1\ldots n_1,\ldots,j_k=1\ldots n_k} P(v_b|M_1 = v_{M_1}^{j_1},\ldots,M_k = v_{M_k}^{j_k})P(M_1 = v_{M_1}^{j_1})\ldots P(M_k = v_{M_k}^{j_k})$$

$P(N = pa) = 0, P(N = l) = 0, P(N = h) = 1$. Probabilities of the other top-level nodes are set in the same way.

Posterior probabilities of the values in the bottom-level nodes are calculated according to the inference rules of Bayesian networks. The values of the bottom-level nodes are assigned discrete numeric values ranging from -1 to 1. Expectations of probability distributions of bottom-level nodes are calculated. The bid that is associated with the highest expectation is chosen. If all expectations are negative, pass is the reasonable choice. The algorithm for determining the optimal bid with the Bayesian network is presented in Figure 5.2

The particular structure of the Bayesian network allows us to use an adapted version of general inference rules. Let v_b be a value of a bottom-level node B. Let $M = \{M_1, M_2, ..., M_k\}$ be the set of k parent nodes of the node B. Let $V_{m_i} = \{v_{M_i}^1, ..., v_{M_i}^{n_i}\}$ be the set of n_i values of the parent node M_i. $P(B = v_b)$ is then calculated by Equation (2). Probabilities of mid-level nodes are calculated recursively with the same formula.

5.3 Tuning the Decision Process

The model incorporates three essential factors of bidding decisions: (i) the strength of players (in the mid-level nodes, which summarise bidder's cards and previous bids of other players), (ii) the values of the types of the games associated with bids and (iii) the level of risk. The second and the third factor are incorporated in the probability distributions in the CPTs of the bottom-level nodes.

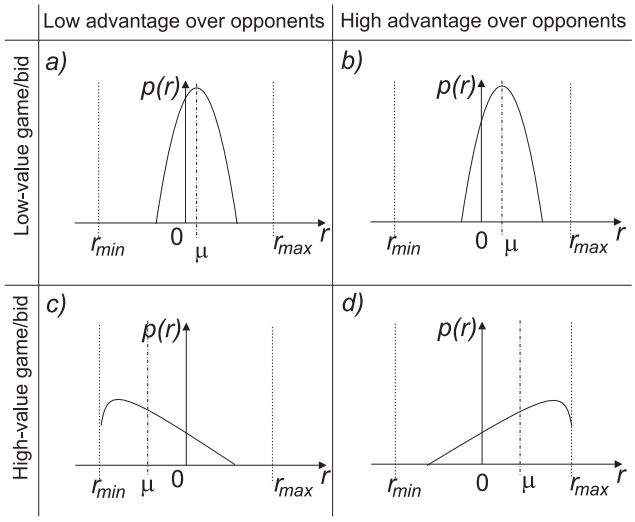

Figure 4: Four basic cases of probability distributions in the bottom-level nodes.

Figure 5.3 illustrates how the model deals with the factors (i) and (ii) with four simple cases regarding the advantage of a bidder over his opponents (low/high; i) and the game value (low/high; ii). Each of the probability density functions represents the discrete probability distribution in a bottom-level node, as calculated in the decision process. To make the example more informative we present it using continuous values, although discrete values are used in the real model.

On the horizontal axis r there are expected game scores. The lower and the upper score limits are denoted by r_{min} and r_{max}. Probability density functions associated with these scores are on the vertical axes and are denoted by $p(r)$. The expectations are denoted by μ. Note that this is only a schematic representation of probability distributions and that actually the following equation would have to hold:

$$\int_{r_{min}}^{r_{max}} p(r)dr = 1$$

Two decision situations are depicted in Figure 5.3. In the left column, the bidder and his partner are slightly stronger or at least not much weaker than the opponents; in the right column the bidder estimates that together with the partner they possess much better cards than the opponents. In both situations the bidder can choose a low-value bid where low negative or positive scores are expected, a high-value bid with high scores expected or pass.

The bidding decision is performed in two steps: First, a particular situation, e.g. 'Low advantage' is determined. Then, μ for the low-value bid (a) and μ for the high-value bid (b) are computed. The bidder will evidently choose the bid corresponding to higher value of μ. If μ is negative, pass is the reasonable choice.

Over multiple games, e.g. in the course of a tournament, new information is obtained to change the bidder's strategy. This can be easily modelled by modifying the probability distributions in the CPTs of the bottom-level nodes, making bidding more or less aggressive. An example in Figure 5.3 shows two distributions, encouraging less (a) or more (b) risky bidding.

As we have already mentioned in Section 1 and Section 2, bidding in some games include information exchange among players. Our model does not cover this aspect of bidding. If we wanted to use it for a game like bridge, it would have to be augmented to deal with information exchange properly.

```
*  B: {BID1, BID2,..., BIDn}
*  Expect:  array [1..n]
*    #Array of expectations of probability distributions for each bid
*  PostrProb(value)
*    #Function calculates the posterior probability of a value
*
*  Set values of top-level nodes
*  foreach BIDi ∈ B
*    foreach value of BIDi
*      Expect[BIDi]:= v · PostrProb(value) + Expect[BIDi]
*
*  if ∃ BIDi ∈ B such that Expect[BIDi]>0
*    choose BIDi:  ∀ BIDj ∈ B: Expect[BIDi] >= Expect[BIDj]
*  else
*    pass
```

Figure 3: The optimal bid algorithm with Bayesian network.

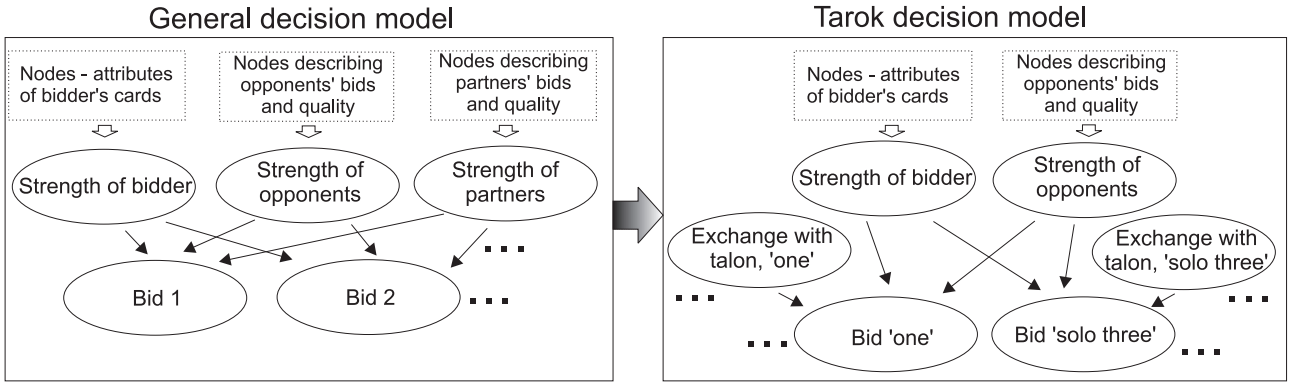

Figure 6: Bidding decision model for four-player tarok.

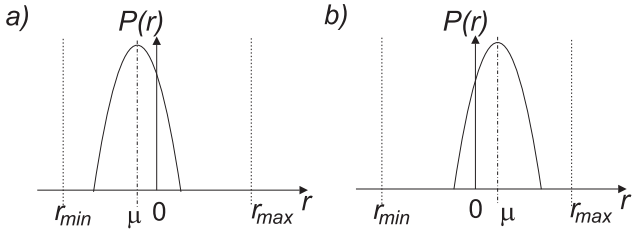

Figure 5: Modelling of risk.

5.4 Implementation of the Model for Four-Player Tarok

To evaluate the decision model we derived a special implementation of it for bidding in four-player tarok as presented in Figure 5.4. Only mid-level and bottom-level nodes are presented in detail. The tarok decision model is part of Tarok7 program.

The top-level nodes are presented as groups ('Nodes-attributes of bidder's cards',...). In the tarok decision model on the right side of Figure 5.4, these nodes represent concrete attributes of bidder's cards and previous bids of other players.

In four-player tarok partners and opponents are not known at the time of bidding. This makes modelling partners' and opponents' strength more difficult. To simplify the decision process we have decided to omit the nodes describing bids of partners in the tarok decision model. The strength of other players is thus reflected in the nodes describing opponents.

The node 'Strength of bidder' can have five values ranging from 'very low' to 'very high'. The node 'Strength of opponents' can have the values 'low' and 'high'. Immediately after bidding, exchange of cards with talon - a set of six cards - is performed by the bidder. Seven special-purpose nodes 'exchange with talon X' were added to the model related to exchanging cards with talon. They can have values 'not suitable', 'suitable', 'very suitable'. These nodes do not influence the bidder's strength directly.

The values of the bottom-level nodes are discretised to 'high defeat', 'moderate defeat', 'moderate win' or 'high

SOB	SOP	EWT	P(HD)	P(MD)	P(MW)	P(HW)
VL	H	S	70	30	0	0
VL	H	VS	65	35	0	0
L	L	NS	50	39	11	0
L	L	S	45	43	12	0
L	L	VS	40	47	13	0
L	H	NS	65	34	1	0
L	H	S	60	38	2	0
L	H	VS	55	42	3	0
M	L	NS	55	10	5	30

Table 4: CPT of the node 'Bid solo three'.

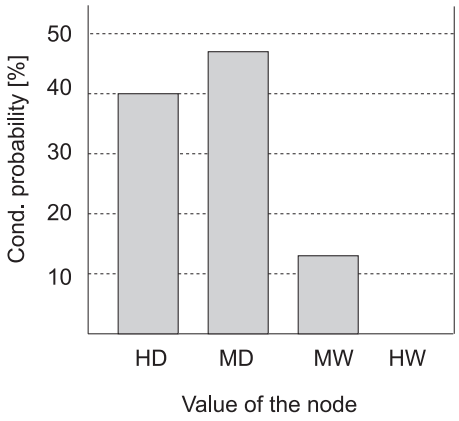

Figure 7: Graphical representation of a conditional probability distribution.

win'. In order to calculate expectations of scores for each bid, the values are assigned the numbers -1, -1/3, +1/3 and 1, respectively. In total in the tarok decision model there are seven nodes of the type 'exchange with talon X' and seven bottom-level nodes representing bids. Only two of each type are presented in Figure 5.4.

In Table 5.4 we present a part of the CPT of the node 'Bid solo three'. The first three columns represent conditions 'Strength of bidder', 'Strength of opponents' and 'Exchange with talon' with their possible values. The other four columns represent the conditional probabilities of the values of the node expressed in percentages. A simplified way of understanding, for example, of the fifth row of this CPT would be: if strength of the bidder is low, strength of the opponents is also low and exchange of cards with talon is very suitable, then the probability of a high defeat, moderate defeat, moderate win and high win are 40%, 47%, 13% and 0%, respectively. The first 4 and the last 17 rows of the CPT with values of the condition SOB 'VL', 'M', 'H' and 'VH' are missing. The conditional probability distribution for the fifth row is presented graphically in Figure 5.4. This is a concrete example of the case which is presented schematically in Figure 5.3 c).

6 Simulation

Another approach to bidding is simulation. To estimate whether a bid is suitable, the bidder internally simulates the part of the game following bidding assuming that he won the bidding and the type of game associated with his bid is played. The problem is that the bidder does not know the cards of the other players. In the case of known cards of the other players it would theoretically be possible to generate all the possible moves for each of the other players and build the whole game tree. The final outcome of each bid could then be determined exactly. However, such an approach is practically impossible due to far too many possibilities.

Monte Carlo method makes simulation reasonably efficient, meanwhile retaining its statistical significance. Several games are internally simulated by the bidder, all starting at the end of bidding assuming that the bid under consideration was successful. Each game the other players are dealt a randomly selected set of cards excluding those in the bidder's hand. Over many games a statistically significant distribution of cards can be achieved. The more games are simulated, the more representative are the results.

In the program Tarok7 we also implemented simulation for bidding decisions. The bidder simulates other players using the same strategy he does. Since simulation is time consuming, we combined it with the tarok decision model described in Section 5.2. The bidder first uses the tarok decision model to calculate the expectations of the game scores for each bid allowed by the rules. Then the bidder runs a simulation of 10 games for those 3 bids which appeared the most promising according to the decision model. The bid that yields the best results in simulation is chosen at the end. If all bids result in a negative average score, pass is the reasonable choice for the bidder. In Figure 6 the simulation algorithm is depicted.

7 Evaluation

For evaluation purposes we used the Tarok7 program. Bidding was implemented with the tarok decision model described in Section 5.2. Card play was realised with the minimax algorithm [10]. We performed three tests described in the following sections.

7.1 Bidding with Simulation

In this test we compared our knowledge-based decision model and simulation at bidding. The basis for comparison of the approaches was their impact on the final game score. The test was performed with four computer players: one of them was normal, while the other three were perfectly informed players (PIP). A PIP in our case uses the same playing strategy as the normal player, but during card play he can see the cards of the other players. Thus, he actually plays a perfect information game and therefore provides a stable reference point. The player observed in the test was the normal player compared to the PIP immediately succeeding it in the order of card play.

The normal player made bidding decisions based partly on the results of the decision model, partly on simulation.

```
*  B: {BID1, BID2,..., BIDn}
*  InitExp:  array [1..n];
*  FinalExp:  array [1..3];
*  tarok_dec_model(params.  of current game state);
*    # Function returns expectations for all possible bids
*  simulate_game(bid)
*    # Function simulates one game.  It returns weighted
*    # game score in the interval [-1,1]
*
*  InitExp:= tarok_dec_model(params.  of curr.  game state)
*  Bsim ⊂ B such that
*    |Bsim| = 3 and
*    ∀BIDi ∈ Bsim, ∀BIDj ∈ B-Bsim:  InitExp[BIDi]>=InitExp[BIDj]
*
*  foreach BIDi ∈ Bsim
*    foreach [1..10]
*      FinalExp[BIDi]:= simulate_game(BIDi)/10 + FinalExp[BIDi]
*
*  if ∃BIDi ∈ Bsim such that FinalExp[BIDi]> 0
*    choose BIDi:  ∀BIDj ∈ Bsim:  FinalExp[BIDi]>=FinalExp[BIDj]
*  else
*    pass
```

Figure 8: Simulation algorithm.

First the tarok decision model was used to calculate the expectations of the game scores for each possible bid. Then, simulations of 10 games for the three most promising bids were run. From the results of the simulation another set of game score expectations was calculated. The results of simulation and the decision model were then combined to yield the final decision.

Let us illustrate these calculations with an example. Suppose that the decision model yielded the following game score expectations (μ_m): 0.15, 0.25, 0.28, 0.30, -0.1, -0.3 and -0.8 for the bids 'three', 'two', 'one', 'solo three', 'solo two', 'solo one' and 'solo zero', respectively. Note that the value -1 means the highest possible defeat and the value 1 the highest possible win. Then simulations were run for the bids 'two', 'one' and 'solo three', which resulted in expectations (μ_s) 0.28, 0.31 and 0.25. Expectations μ_m and μ_s were then combined with a special coefficient k_s which determined the weight of simulation in the decision process. The greater the coefficient, the greater the influence of the simulation. Final expectations μ were then calculated by the formula: $\mu = k_s\mu_s + (1 - k_s)\mu_m$ Let k_s in our case be 0.7. This means that the bidder chose the bid 'one' with the greatest final expectation μ = 0.30.

In Table 7.1 we present the results of the test. We conducted five experiments. In experiment A simulation was not included and 30,000 complete games, bidding and card play were played. In each of the other experiments only 1,000 complete games were played, because simulation is a time consuming process. In each experiment we chose a different value for k_s which is written in the first row. This way we changed the influence of simulation. In the second row is the measure of quality of play which we calculated the following way: for each experiment we determined two values: (i) the average number of points per game achieved by the normal player p_h and (ii) the PIP immediately succeeding the normal player p_c. The measure of the quality of the normal player is the difference $p_c - p_h$. The smaller the difference, the better the play.

Experiment	A	B	C	D	E
k_s	0	0.25	0.5	0.75	1
$p_c - p_h$	2.0	2.2	3.4	3.7	3.6

Table 5: Simulation in the decision process at bidding.

When comparing results of experiment A to the result of any other experiment, standard error equals approximately 1. We can thus conclude with more than 67% certainty that player A is better than players C, D and E. Comparison with player B is not statistically significant. The results of the test show that in our case it is not sensible to use simulation for making bidding decisions. One possibility to get better results would be to significantly increase the number of simulated games. This probably would not be feasible in practice because of the response time constraints.

7.2 Estimating the Optimal Risk at Bidding

This test was performed to estimate the optimal risk at bidding. The framework for the test was the same as in the

Experiment	A	B	C	D	E	F
w/d	0.75	0.73	0.65	0.64	0.60	0.57
$p_c - p_h$	3.1	2.5	2.0	2.0	2.5	2.9

Table 6: Estimating optimal level of risk.

test described in Section 7.1: four computer players, three of them were PIPs, the fourth one was a normal player. We observed the quality of play of the normal player and compared it to the PIP immediately succeeding it in the order of card play. The normal player was evaluated under different risk strategies. The test consisted of six experiments. In each of them the normal player played with different risk at bidding. Setting the risk is described in Figure 5.3. Meanwhile, the PIPs were always the same. In each experiment 30,000 complete games, bidding and card play, were played.

The results of the experiments are presented in Table 7.2. The level of risk is shown in the first row as the ratio w/d, where d is the number of games where the normal player was the declarer, and w is the number of these games that he and his partner also won. The measure of the quality of the normal player shown in the second row is $p_c - p_h$ and was calculated the same way as in the test in Section 7.1.

The standard error of the difference between the average scores per experiment is 0.25. Statistically one can be 95% sure that the normal players in the experiments C and D play better than those in B and E, and more than 99% sure that they play better than the normal players in A and F. It seems that the bidding parameters of normal players in the experiments C or D are close to optimal.

It is worth mentioning that the level of risk which appears to be the best in the test can only serve as an estimate in real games where the opponents are also normal players. In fact, it is impossible to find a particular level of risk that would always be appropriate. A player has to adapt the risk to every particular opponents.

7.3 Tarok7 Compared to Human Experts

In this test, four computer players and an expert human player were bidding at the same time. When it was the fourth player's turn to bid, first the expert made a bid followed by the fourth computer player. In this way the human and the computer player were put in exactly the same position at bidding.

Table 7.3 summarizes the results of the test. Bidding of Tarok7 is compared to three human experts: A, B and C. Expert A made 500 bids, while the other two made 100 bids each. The percentages in the first row denote the proportion of bids when the program and the humans chose the same action. The result 100% would mean complete match. The second row represents the cases when the difference between the program's bid and the expert's bid was more than one degree, for example, when the program bid 'three', and the expert bid 'one'. For the cases when the experts and the program bid differently, the fourth row shows the percentages of bids when the program bid higher than the human. The value 100% would mean that the program always bid higher than the expert when they bid differently.

Expert	A	B	C
Matching of the program with the experts	92%	82%	80%
Percentage of the bids with difference of more than one degree	1%	2%	2%
Percentage of the program's more aggressive bids when the program and the expert bid differently	35%	75%	72%

Table 7: Comparison of bidding of the Tarok7 program with human experts.

Bidding of Tarok7 is more similar to expert A than to the other experts, which was expected since expert A designed the decision model for bidding. According to the results in the fourth row, expert A bid slightly more aggressively than the program, while the other two experts were less aggressive. Overall, there are very few cases when the experts and the program disagree strongly in their decisions.

8 Conclusion

In this paper we presented a comparison of two approaches to bidding in four-player tarok one of the most common games in central Europe: the knowledge-based approach and the approach with simulation.

In our tests the knowledge-based model significantly outperformed the simulation. Compared to simulation-based techniques, our decision model offers two additional advantages. First, it does not use any time consuming search for making decisions. This is probably the main reason why it performs better than the simulation. The decision model seems to be suitable for any game with bidding regardless of how complex its game-play is. Second, the structure of the model is clearly explicable, so it is easy to fine-tune, as we have shown in Section 5.3, when we explained how to achieve the appropriate level of risk. The capacity for fine-tuning and adapting to the opponents could be further exploited by trying to learn the conditional probabilities of CPTs automatically. The feedback for a learning algorithm would be bids and scores of games played under these bids.

Other experiments have shown that the program plays quite similarly to human experts and that it is easy to optimize for particular opponents. The source code of the decision model and the Tarok7 program can be obtained from the authors.

In our opinion the knowledge-based approach is particularly suitable for four-player tarok, because bidding less informed than in other games and the complexity of card play makes simulation particularly time-consuming. Ex-

periments of some other authors [1] indicate that simulation might be better for other games.

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Fully Automatic Assessment of Speech of Children with Cleft Lip and Palate

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Cleft lip and palate (CLP) may cause functional limitations even after adequate surgical and non-surgical treatment, speech disorder being one of them. Until now, an automatic, objective means to determine and quantify the intelligibility did not exist. We have created an automatic evaluation system that assesses speech, based on the result of an automatic speech recognizer. It was applied to 35 recordings of children with CLP. A subjective evaluation of the intelligibility was performed by four experts and confronted to the automatic speech evaluation. It complied with experts' rating of intelligibility. Furthermore we present the results obtained on a control group of 45 recordings of normal children and compare these results with those of the CLP children.

Povzetek: S programom in ljudmi je analizirana razumljivost otrok z zajčjo ustnico.

1 Introduction

Cleft lip and palate (CLP) is the most common malformation of the head. It can result in morphological and functional disorders [WR02], whereat one has to differentiate primary from secondary disorders [MR01, RE02]. Primary disorders include e.g. swallowing, breathing and mimic disorders. Speech and voice disorders [SS94] as well as conductive hearing loss that affect speech development [SLS$^+$99], are secondary disorders. Speech disorders can still be present after reconstructive surgical treatment. The characteristics of speech disorders are mainly a combination of different articulatory features, e.g. enhanced nasal air emissions that lead to altered nasality, a shift in localization of articulation (e.g. using a /d/ built with the tip of the tongue instead of a /g/ built with back of the tongue or vice versa), and a modified articulatory tension (e.g. weakening of the plosives /t/, /k/, /p/) [HG98]. They affect not only the intelligibility but therewith the social competence and emotional development of a child. In clinical practice, articulation disorders are mainly evaluated by subjective tools. The simplest method is the auditive perception, mostly performed by a speech therapist. Previous studies have shown that experience is an important factor that influences the subjective estimation of speech disorders leading to inaccurate evaluation by persons with only few years of experience [PRSS$^+$05]. Until now, objective means exist only for quantitative measurements of nasal emissions [KSS$^+$03, LBB$^+$02, HD04] and for the detection of secondary voice disorders [BSM$^+$98]. But other specific or non-specific articulation disorders in CLP as well as a global assessment of speech quality cannot be sufficiently quantified. In this paper, we present a new technical procedure for the measurement and evaluation of speech disorders and compare the results obtained with subjective ratings of a panel of expert listeners.

2 Automatic Speech Recognition System

For the objective measurement of the intelligibility of children with speech disorders, an automatic speech recognition system was applied, a word recognition system developed at the Chair for Pattern Recognition (Lehrstuhl für Mustererkennung) of the University of Erlangen. In this study, the latest version as described in detail in [Ste05] was used. The recognizer can handle spontaneous speech with

mid-sized vocabularies of up to 10,000 words. As features we use Mel-Frequency Cepstrum Coefficients (MFCC) 1 to 11 plus the energy of the signal. Additionally 12 delta coefficients are computed over a context of 2 time frames to the left and the right side (56 ms in total). The recognition is performed with semi-continuous Hidden Markov Models (SCHMMs). The codebook contains 500 full covariance Gaussian densities which are shared by all HMM states. The elementary recognition units are polyphones [STNE+93]. The polyphones were constructed for each sequence of phones which appeared more than 50 times in the training set.

In order to improve the recognition accuracy we applied a unigram language model. So we include just a minimum of linguistic information into the recognition process to put more weight on the acoustic features. We used two types of unigram language models according to the application scenario (cf. Section 5).

The speech recognition system had been trained with acoustic information from spontaneous dialogues of the VERBMOBIL project [Wah00] and normal children's speech. The speech data of non-pathologic children's voices (30 female and 23 male) were recorded at two local schools (age 10 to 14) in Erlangen and consisted of read texts. The training population of the VERBMOBIL project consisted of normal adult speakers from all over Germany and thus covered all dialectal regions. All speakers were asked to speak "standard" German. 90 % of the training population (47 female and 85 male) were younger than 40 years. During training an evaluation set was used that only contained children's speech. The adults' data was adapted by vocal tract length normalization as proposed in [SHSN03].

Supervised MLLR adaptation [GPW96] with the patients' data lead to further improvement of the speech recognition system. The reference transliteration was chosen according to the scenario (cf. Section 5).

3 Data

All children were asked to name pictures that were shown according to the PLAKSS test [Fox02]. This German test consists of 99 words shown as pictograms on 33 slides. With this test, the speech of children can be evaluated even if they are quite young since they do not need the ability to read. However, the children could take advantage of being able to read since the reference words were shown as subtitles. The test includes all possible phonemes of the German language in different positions (beginning, center and end of a word, cf. Figure 1).

The patients' group consisted of 35 children and adolescents (13 girls and 22 boys) with CLP at the age from 3.3 to 18.5 years (mean 8.3 $\pm$ 3.6 years). The examination was included in the regular out-patient examination of all children and adolescents with CLP. These speech samples were recorded with a close-talking microphone (dnt Call 4U Comfort headset) at a sampling frequency of 16 kHz and quantized with 16 bit. For these data no further post-processing was done.

Furthermore a control group with 45 normal children was recorded at a local elementary school. In total, data from 27 girls and 18 boys were collected. The children were in the age from 7.4 to 10.7 (mean 9.5 $\pm$ 0.9 years). The data were collected at 48 kHz with 16 bit quantization. To match the patients' data a resampling to 16 kHz was done. For the control group a Sennheiser close-talking microphone (handgrip K3U with ME 80 head) was used. These data were post-processed: In some cases the voice of the instructor was audible on the sound track. So the instructor's voice was removed in all occasions. Furthermore all of the children's speech data was transliterated.

Informed consent had been obtained by all parents of the children prior to the recording. All children were native German speakers, some using a local dialect.

4 Subjective Evaluation

Four voice professionals subjectively estimated the intelligibility of the children's speech while listening to a playback of the recordings. A five point scale (1 = very high, 2 = rather high, 3 = medium, 4 = rather low, 5 = very low) was applied to rate the intelligibility of all individual turns. In this manner an averaged mark – expressed as a floating point value – for each patient could be calculated.

5 From Semi-automatic to Fully Automatic Evaluation

In order to measure the accuracy of a word recognizer the test data have to be transliterated completely. However, if the method should be applicable in clinical practice, this procedure is infeasible. So we tried to develop a new fully automatic evaluation method which yields similar results to the semi-automatic method reported in [SMH+06]. According to semi-automatic and the fully automatic evaluation procedures two scenarios can be formed:

In the first scenario the transliteration is available. All the data have to be transliterated in order to measure the performance of the recognizer correctly. In this case additional words appear in the transliteration which are not in the set of the reference words. The main cause for these additional words are *carrier sentences* like "This is a ..." (cf. reference in Table 1). So these words have to be added to the language model in order to enable their recognition. Since each word can follow each word, the probability of the target words is increased by an empirical factor of 2. Thus the size of the vocabulary changes from speaker to speaker. To attenuate this effect we could have created a single language model for all speakers containing all the words which appear in the transliteration as it was done in [SMH+06]. However, this would mean that the recogni-

Figure 1: Pictograms of the PLAKSS test [Fox02] for the phoneme /r/ with the German target words T**r**ecker, Zit**r**one, Jäge**r** (tractor, lemon, hunter)

tion results of all speakers depend on this language model. Thus, all results would have to be computed again if we add a single speaker who utters a new word to the system which did not already appear in the transliteration of the other speakers. So we chose to create an individual language model per speaker which has the disadvantage that the test set perplexity of the language model differs for each speaker.

In the second scenario—the fully automatic case—the transliteration is assumed to be unknown. Since we developed a new recording and evaluation software we now know the exact time when the reference slide was moved to the next slide. We can exploit this information to approximate a reference word chain. This reference word chain contains just the words which are shown on the slide. So we created a basic language model which was trained with just the reference words of the test since no further information is available. This model has a perplexity of 43 on the reference text. At present no garbage model was employed.

6 Evaluation Measurements

For the agreement computations between different raters on the one hand and raters/recognizer on the other hand we use the Pearson product-moment correlation coefficient [Pea96]. It allows to compare two number series which are of different scale and margin like in the given case. So the ratings of the human experts and those of the speech recognition system can be compared directly without having to define a mapping between the result of the recognizer and the experts' scores. In order to compare the raters to the recognition system the average rating of the experts was computed for each speaker. For the recognition rate of the speech recognition system we investigated the word accuracy (WA) like in [HSN+04], [SNH+05], [MHN+06], or [SMH+06] and the word recognition rate (WR). The WA is defined as

$$WA = \frac{C - I}{R} \cdot 100\,\%$$

where C is the number of correctly recognized words, I the number of wrongly inserted words and R the number of words in the reference text. The WR is defined as

$$WR = \frac{C}{R} \cdot 100\,\%.$$

Both measurements need a reference text in order to determine the number of correctly recognized words. However, since the reference are pictures, the text is not known a priori. One solution to this problem is to transliterate all the data like it is done in the first scenario (cf. Section 5).

Unfortunately the reference of the second scenario (cf. Section 5) is not sufficient to calculate a good word accuracy since most of the children use *carrier sentences*. So the carrier words are regarded as wrongly inserted words even if the recognition would be perfect. In order to avoid this problem we applied the word recognition rate instead since it does not weight the effect of inserted words. The difference between these methods is shown in Table 1.

7 Results

Since the control group was completely transliterated and recorded with our new software (cf. Section 5) we could investigate the difference between the automatic measurements and those based on the transliteration. As can be seen in Table 2 the word recognition rate correlates to both transliteration-based measurements. The automatic word accuracy, however, matches poorly with the transliteration-based measurements (cf. Table 1). Therefore we expected

measurement	recognized word chain	reference	%
transliteration WA	This is moon, bucket and a a ball	This is a moon, a bucket, and a tree	55.5
transliteration WR	This is moon, bucket and a a ball	This is a moon, a bucket, and a tree	66.6
automatic WA	tiger moon bucket apple ball	moon bucket tree	0
automatic WR	tiger moon bucket apple ball	moon bucket tree	66.6

Table 1: Example of the effects of the automatic reference on the WA and WR. We assume that the spoken utterance is "This is a moon, a bucket, and a tree". Thus, the automatic reference is "moon bucket tree"

measurement	transliteration WA	transliteration WR
automatic WA	0.40	0.21
automatic WR	0.60	0.60

Table 2: Correlation between the different measurements regarding the control group. The automatic WR yields the results with the best correlation to the transliteration-based measurements

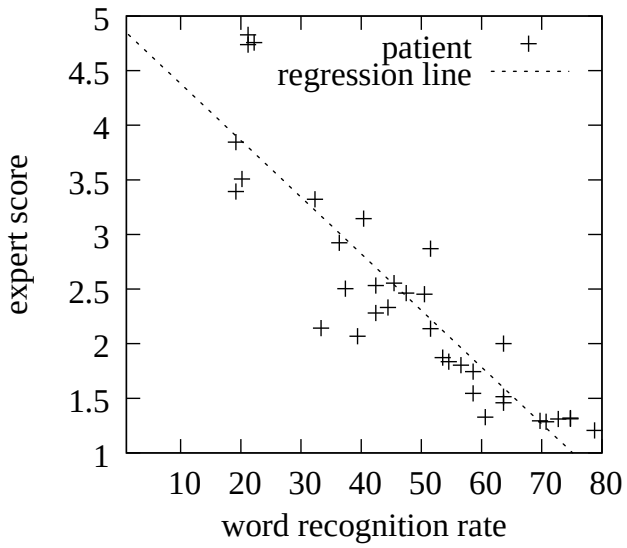

Figure 2: Word recognition rates in comparison to the scores of the human experts for the patient group ($r = -0.90$)

rater	avg.	# of raters
rater S	**0.95**	3 raters
rater M	0.92	
rater L	0.93	
rater W	0.90	
automatic WA	-0.82	4 raters
automatic WR	**-0.90**	

Table 3: Correlation r between the different raters and the automatic measurements

the WR to show a good agreement with the results presented in [MHN+06].

The recordings of the CLP children showed a wide range of intelligibility (see Figure 2). Subjective speech evaluation showed good consistency. The best rater achieved a correlation coefficient to the average of the other raters of 0.95. The results for the correlations of the WA, the WR and the subjective speech evaluation are shown in Table 3. When compared to the average of the raters, the WA for the recognizer has a correlation of -0.82 while the WR even correlates with -0.90. The coefficients are negative because high recognition rates come from "good" speech with a low score number and vice versa (note the regression line in Figure 2).

Figure 3 shows the word recognition rates of children in the same age range of both groups (20 patients and 45 normal children; 6 to 12 years old). As can be seen, almost all 45 children of the control group have high recognition rates. The distribution of the patients' group shows a high variance. This is due to the fact that the patients' group contained a wide range of intelligibility. Some of the patients were as intelligible as normal children (cf. Figure 2). The correlation between the age and the word recognition rate is 0.2 for the children of the control group and 0.3 for the children of the patient group. So there is just a weak connection between the age and the recognition rate when appropriate HMM models for children are used as also observed in [GG03].

8 Discussion

First results for an automatic global evaluation of speech disorders of different manifestations as found in CLP speech are shown. The speech recognition system shows high consistency with the experts' estimation of the intelligibility. The use of prior information about the speech test and its setup allows us the create a fully automated procedure to compute a global assessment of the speaker's intelligibility. In difference to [MHN+06] no manual post-processing was done. Still the experts' and the recognizer's evaluation show a high correlation.

Using a control group we could show that our measure is sufficient to differentiate normal children's speech from pathologic speech. Furthermore we could show the consistency of our new measure to the transliteration-based evaluation methods.

The technique allows an objective evaluation of speech

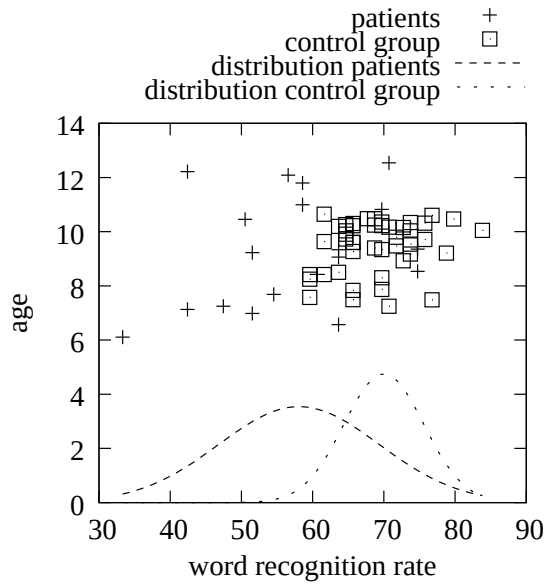

Figure 3: Distribution of the patients and the control group over the word recognition rate. Only members with about the same age were considered.

disorders and therapy effects. It avoids subjective influences from human raters with different experience and is therefore of high clinical and scientific value. Automatic evaluation in real-time will avoid long evaluation proceedings by human experts. Further research will lead to the classification and quantification of different speech disorders. This will allow to quantify the impact of individual speech disorders on the intelligibility and will improve therapy strategies for speech disorders.

9 Conclusion

Automatic speech evaluation by a speech recognizer is a valuable means for research and clinical purpose in order to determine the global speech outcome of children with CLP. It enables to quantify the quality of speech. Adaptation of the technique presented here will lead to further applications to differentiate and quantify articulation disorders. Modern technical solutions might easily provide specialized centers and therapists with this new evaluation method.

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Morphosyntactic Tagging of Slovene Legal Language

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Part-of-speech tagging or, more accurately, morphosyntactic tagging, is a procedure that assigns to each word token appearing in a text its morphosyntactic description, e.g. "masculine singular common noun in the genitive case". Morphosyntactic tagging is an important component of many language technology applications, such as machine translation, speech synthesis, or information extraction. In the paper we report on an experiment on morphosyntactic tagging of Slovene, on a sample of Slovene legal language. We evaluate the accuracy of the TnT tagger, which had been trained on the MULTEXT-East language resources for Slovene. The test data come from the freely available parallel English-Slovene corpus SVEZ-IJS, which contains the Slovene translation European Union legal acts. Presented are the details of the manually corrected test corpus and an analysis of the tagging errors. The paper also discusses a simple transformation-based program that fixes some of the more common errors, and concludes with some directions for future work.

Povzetek: V prispevku je opisan poskus oblikoslovnega označevanja na vzorcu slovenskih pravnih besedil.

1 Introduction

Morphosyntactic tagging, also known as part-of-speech tagging or word-class syntactic tagging (van Halten, 1999) is a process in which each word appearing in a text is assigned an unambiguous morphosyntactic tag. This process is, in general, composed of two parts: the program first assigns, on the basis of a morphological lexicon, all the possible tags that a word form can be associated with, and then chooses the most likely tag on the basis of the context in which the word form appears in the text. For instance, the Slovene word form hotel has three possible tags: two (nominative and accusative singular) of the noun lemma hotel, and one verbal (masculine past participle), of the lemma *hoteti* (to want). Yet in the sentence *Šel je v hotel* (*He went to a hotel*), the token hotel should be tagged as a noun in accusative case.

Morphosyntactic tagging was first developed for the English language, where the set of morphosyntactic tags is relatively small (~50, depending on the specific tagset used). English is an inflectionally poor language, so problems arise mainly in connection with ambiguities at the word class (part-of-speech) level, e.g. in determining whether "left" should be tagged as an adjective (my left hand), a noun (on your left), or a verb (he left early). Taggers and (manually) tagged corpora were later developed also for morphologically richer languages, such as Czech (Hajič and Hladka, 1998) and Slovene (Erjavec et al., 2000). Such languages typically distinguish more than a thousand morphosyntactic tags, and the largest problem, at least at first sight, is caused by having to disambiguate between the large number of syncretic inflectional forms within word classes. For example, nouns can be four ways ambiguous regarding their inflectional properties: the word form *človeka* (from the lemma *človek / man*) can function either as singular genitive or accusative, or the dual nominative or accusative.

Most contemporary taggers learn the model of a given language from a manually tagged corpus, possibly supported by a morphosyntactic lexicon. Such programs are robust, but they do make mistakes. The accuracy of tagging depends on the properties of the language, the tagset used, size of learning corpus, the similarity of the training corpus with the text to be tagged, and of course the particular tagger.

Our attempts regarding automated tagging of Slovene were connected to the morphosyntactic resources developed in the MULTEXT-East project (Erjavec, 2004), http://nl.ijs.si/ME/, which contain a morphosyntactic specification (defining the tagset), a morphological lexicon and a small (100,000 words) manually tagged corpus, which contains the novel „1984" by G. Orwell. The first experiments (Erjavec et al., 2000) showed that from four publicly accessible taggers the best results were achieved by TnT (Brants, 2000). TnT is a Hidden Markov Model tri-gram tagger, which also implements an unknown-word guessing

module. It is fast in training and tagging, and is able to accommodate the large tagset used by Slovene. In subsequent work (Erjavec and Džeroski, 2004) we also tackled lemmatisation (so, *hotela* → *hotel* or *hoteti*, depending on the tag), concentrating esp. on unknown words. For this, we used the program CLOG, based on Inductive Logic Programming, which had been trained on the MULTEXT-East lexicon. The program learns rules (decision lists) for each morphosyntactic tag separately, and is thus dependent on prior morphosyntactic tagging.

In the present paper we describe an evaluation of tagging (and lemmatisation) completed on another dataset, namely on a sample from the SVEZ-IJS corpus of legal language (Erjavec, 2006). We were interested in the accuracy of tagging on a corpus that is very different from the training corpus, as this shows how best to improve the tagging accuracy in the future. We wanted to know what kind of errors are the most frequent ones, and whether it is possible - and if yes, to what extent - to correct them in a simple way.

In the remainder of this paper we first introduce the experiment set-up, i.e. the tagger and the dataset. This is followed by the analysis of errors and the description of a transformation-based program that corrects some most frequent errors, a comparison of accuracy levels reached in different experiments and finally, some conclusions.

2 Test data

The experiments use the "totale" program (which invokes the TnT tagger) and a sample of the Slovene part of the SVEZ-IJS corpus. The sample was first tagged automatically, and the results manually corrected.

2.1 Tagging with totale

For linguistic tagging we use the program "totale" program (tokenisation, tagging, and lemmatisation) (Erjavec et al., 2005), which:

1. tokenizes the text, that is, it splits it into words, punctuation marks and sentences
   (with the m1Token module, a part of totale)
2. assigns morphosyntactic tags to words
   (with the TnT tagger, (Brants, 2000))
3. lemmatizes the text
   (with CLOG (Erjavec and Džeroski, 2004))

Both TnT and CLOG are programs that learn language models from previously prepared data, namely from a manually tagged corpus and a morphosyntactic lexicon. Our morphosyntactic tagging model was learned on the MULTEXT-East corpus, the „1984" (100,000 tokens), and a small sample of IJS-ELAN corpus (5,000 tokens). The lemmatiser was trained on the MULTEXT-East morphosyntactic lexicon (the complete inflectional paradigms of 15,000 lemmas).

2.2 The SVEZ-IJS corpus

The SVEZ-IJS parallel English-Slovene corpus, http://nl.ijs.si/svez/ (Erjavec, 2006) contains EU legal texts, the so called Acquis Communautaire. Version 1.0 of this corpus contains 2×5 million words and was made in 2004 on the basis of the translation memory produced by the Translation Department at SVEZ (The Office of the Government for European Affairs) (Erbič et al., 2005). The corpus was compiled from the parallel English- Slovene translation units, where each such unit typically contains one sentence or a part of a sentence, e.g. an item in a list.

2.3 The sample

For the evaluation of tagging we made a sample of the totale automatically tagged corpus, in which we included 3 consecutive Slovene segments out of every 1000 segments; this gave us 3‰ of the Slovene part of the corpus. The sample was then converted into an Excel table and was manually corrected, while preserving the automatically assigned tags and lemmas. This file serves as the dataset from which the numbers given in the present paper were extracted.

Unit	n	Ratio	
Characters	513.650		A
Segments	821	625 A/B	B
All tokens	15.765	19 C/B	C
Punctuation (tokens)	2.346	15 % C	D
Words (tokens)	13.419	85 % C	E
Words (types)	5.189	2.59 E/F	F
Lemmas (types)	3.062	4.38 F/G	G
Morph. tags (types)	452	29.69 E/H	H

Table 1. Test data, basic statistics

An analysis of the sample size is given in Table 1, which shows, e.g., that the sample contains around half a million characters and 15,000 tokens, of which 13,000 are words. These consist of around 5,200 word forms or 3,000 lemmas. All the lemmas are written in lower-case, therefore e.g. the word forms *koren* and *Koren* have the same lemma, although the second can be a proper name. The last line in the table shows the test set contains a surprisingly small number of tags, less than 500.
The column Ratio shows the proportions between various measures and contains e.g. the average segment length in characters (821) and tokens (19), and the average number of different word forms per lemma (4.4).

Table 2 shows the distribution of words in more detail. We can see that around 15% of all the tokens and more than 18% of the words are unknown to the tagger, which highlights the difference between MULTEXT-East and SVEZ-IJS corpora, but is also the result of the small size of the MULTEXT-East corpus used for training. The table also shows the statistics over the word classes: most frequent words in the text are nouns, adjectives and prepositions, together covering around half of all the tokens. This means that the overall tagging

accuracy depends largely on the ability of the tagger to correctly interpret these three word classes, esp. the nouns.

The last two word classes given in the table are important for two reasons. First, abbreviations (Y) and residuals (X) and are not parts-of-speech; from a (morpho)syntactic point of view Y typically covers nouns (e.g. *Dr.*), although it can describe whole phrases (e.g. *etc.*). X (residual) is used to tag foreign words, and often appears successively, e.g. *carte de séjour de résident privilégié de Monaco*, so, from the morphosyntactic point of view, a series of X tags functions as a noun phrase. The second characteristic of these two categories is the relatively large number of tokens they cover (4.5%) in the SVEZ-IJS sample. As discussed later, these two categories are responsible for a significant part of errors in the automated tagging.

	n	tokens	words
Words	13.419	85.1 %	100 %
Known	10.996	69.7 %	81.9 %
Unknown	2.423	15.4 %	18.1 %
Noun (N)	4.928	31.3 %	36.7 %
Verb (V)	1.287	8.2 %	9.6 %
Adjective (A)	1.694	10.7 %	12.6 %
Adverb (R)	373	2.4 %	2.8 %
Numeral (M)	795	5.0 %	5.9 %
Pronoun (P)	743	4.7 %	5.5 %
Conjunction (C)	1.102	7.0 %	8.2 %
Preposition (S)	1.787	11.3 %	13.3 %
Particle (Q)	107	0.7 %	0.8 %
Abbrev. (Y)	474	3.0 %	3.5 %
Residual (X)	128	0.8 %	1.0 %

Table 2: Test data, (un)known words and distribution per word class.

3 Analysis of automated tagging

On the basis of the manually tagged sample we evaluated the accuracy of automated tagging with the MULTEXT-East trained totale. Table 3 shows the absolute number of various types of errors, as well as giving them as a percentage of tokens or words respectively. We further split each error type according to the overall error, as well as the error for known and unknown words separately.

Table 3 gives the precision for three types of linguistic annotation performed by totale. The first is the error rate of the morphosyntactic tagging itself, where, according to the strictest metric, the system achieves an 89.6% overall accuracy. The second type is the accuracy of tagging for the word class only. This means that the tagger might have assigned the wrong tag but did at least manage to correctly identify the word class, i.e. the first letter of the tag. It is useful to distinguish these two types of errors, as many applications or users require only the word category, and do not make use of, say, inflectional features.

The third type of annotation we analyse is the lemmatisation. It is interesting to note that the accuracy of lemmatization is higher than for morphosyntactic tagging, which means that tagging errors do not necessary influence the lemmatization. Nevertheless, as the last two rows show, the errors of lemmatization are almost exclusively due to erroneous morphosyntactic tags: there are only three instances, where the morphosyntactic tag is correct, but the lemma is wrong.

	n	Token acc.	Word acc.
Wrong m.s. tag	1,799	88.6 %	86.6 %
For known words	950	92.9 %	91.4 %
For unknown words	849	65.0 %	65.0 %
Wrong word class	748	95.3 %	94.4 %
For known words	155	98.8 %	98.6 %
For unknown words	593	75.5 %	75.5 %
Wrong lemma	220	98.6 %	98.4 %
For known words	88	99.3 %	99.2 %
For unknown words	132	94.6 %	94.6 %
For wrong tag	217	87.9 %	87.9 %
For correct tag	3	99.8 %	99.8 %

Table 3: Accuracy of automated tagging.

3.1 Errors in word class tagging

Because of the importance of word class tagging, we will discuss this topic separately from errors of morphosyntactic description. In Table 4 we give a matrix showing errors according to actual word class (horizontally) and according to the word-class assigned by the tagger (vertically). The diagonal thus gives the numbers for errors which happen internally to a word class and do not affect the word class accuracy, while the other cells give the confusions between different parts-of-speech; they show, e.g. that nouns were interpreted as verbs in 95 cases.

The table shows that the tagging of open word classes (written in bold letters) is significantly less successful than tagging of function words, which is understandable as the most of the latter group is known to the tagger. To a certain extent pronouns are an exception, but only regarding error rate within word class. The reason for small absolute accuracy of tagging of pronouns is their especially rich inflectional structure: pronouns cover around half (more than thousand) of all the morphosyntactic tags.

In most of the cases erroneous interpretation is assigned to nouns, numerals, residuals and abbreviations. In case of nouns the relative number of errors is small, however due to their large number, the effect on the overall accuracy is significant. Misinterpretation of the nouns as verbs is possibly due to the nature of learning data base.

	N	***V***	***A***	***R***	***M***	*P*	*C*	*S*	*Q*	***I***	***X***	***Y***	*
N	**609**	6	9	4	47	0	1	1	0	0	69	241	987
V	95	**18**	2	1	28	2	2	0	0	0	35	17	200
A	28	1	**275**	12	8	3	0	0	0	0	14	9	350
R	14	1	4	**15**	0	1	1	1	0	0	6	11	54
M	0	0	1	0	**11**	6	0	0	0	0	0	18	36
P	1	0	1	0	2	**105**	0	0	0	0	0	1	110
C	0	1	0	3	0	0	**0**	0	10	0	0	11	25
S	1	0	0	0	1	0	0	**18**	0	0	1	6	27
Q	0	0	0	3	0	0	2	0	**0**	0	0	0	5
I	1	0	0	0	0	0	0	0	0	**0**	1	0	2
X	0	0	0	0	0	0	0	0	0	0	**0**	0	0
Y	0	0	0	0	1	0	0	0	0	0	2	**0**	3
*	749	27	292	38	98	117	6	20	10	0	128	314	1799

Table 4: Confusion table of word class errors. N = nouns, V = verb, A = adjective, R = adverb, P = pronoun, S = preposition, C = conjunction, Q = particle, I = interjection, M = numeral, Y = abbreviation, X = residual.

The other three problematic word classes (numerals, residuals and abbreviations), have similar reasons for causing such a large number of errors. On the one hand, words of these classes are almost always unknown, as they are present neither in the training corpus nor in the lexicon, except for a limited number of numerals, on the other hand they do not have a consistent morphosyntactic interpretation, especially true for residuals and abbreviations, which makes them harder to predict. We come back to this problem in sections 4 and 5.

3.2 Errors within word classes

In this section we will take a closer look at errors within word classes. As seen in the diagonal of Table 4, most of these errors appear with nouns, which include, according to the MULTEXT-East specification, five attributes for Slovene: type, gender, number, case and animacy. Around 85% of the errors are connected to case combined with number, and similar behaviour can be observed with adjectives and pronouns. A more detailed analysis of these errors showed that in most of the cases it is impossible to assign correct tags on the basis of the local morphosyntactic context, as used by TnT. The tagging of other word classes is less problematic. In case of verbs, mostly gender and number are erroneously tagged.

4 Rule-based transformation tagging

The main question is, of course, how to improve tagging accuracy. As an attempt in this direction we implemented a program, which corrects some errors made by the TnT tagger. In this section we describe this program and the improvement on accuracy when using it.

The program is written in Perl and takes automatically tagged text as input data. The program has access to data about the form of the word, its tag assigned by TnT, and whether the word is known to TnT. For each word, the program runs a cascade of hand-written rules, where rules have the following format: „if *condition* then *assign a morphosyntactic tag*, else *next rule*." In the conditions we use a function called feature, which takes a feature for its first argument and a token as second, and returns the value of the feature for the token. We give the first two rules as an example:

```
        ...
elsif ($freq == 0  and
       feature("idwrd",$sent[$focus])=~/^[IVX]+$/)
   {$outmsd="Mc---r"}
elsif ($freq == 0 and
       feature("case",$sent[$focus]) eq 'uc' and
        not (feature("case",$sent[$focus-1])  eq  'uc' or
        feature("case",$sent[$focus+1]) eq  'uc'))
   {$outmsd="Y"}
        ...
```

The first rule deals with Roman numerals, as their mis-recognition was one the largest problem of tagging numerals. The condition says that the word is required to be unknown ($freq == 0), and the form (feature idwrd) of the focus token ($sent[$focus]), has to be composed only of characters *I, V* and *X* (regular expression /^[IVX]+$/). The rule thus fires for tokens such as *MCMLXX*, and will change their tag (whatever it was) into Mc---r, which stands for word class=numeral, type=cardinal, form=roman.

The second rule corrects the word tag by changing it for Y, i.e. it tags the word as an abbreviation if the word is unknown, contains only capital letters, and the word immediately to its left or right is not capitalized. The rule will thus apply to cases such as: *Čist dobiček ECB se prenese …*, (*The net profit ECB is transferred…*) but will not incorrectly tag unknown words like *RAZČLENITEV PO ODDELKIH …* (*BREAKDOWN BY DIVISION*).

Currently we have implemented five rules, based on the analysis of some frequent and also easily correctable

errors. The first two rules have already been described. The third changes the tag to abbreviation, if the unknown word includes numbers and not more than three letters (e.g. *2002/917/ES*), regardless of context. The fourth changes the tag of all supines to nominal masculine nominative, and the last changes the tag of *a* (which was always tagged as a conjunction) to abbreviation, if it is followed by a punctuation mark, e.g. *Annex IV a. OJ No L 71*.

Table 5 gives the results for the dataset first tagged by TnT and then corrected by the program implementing the above five rules. The first column gives the numbers of tokens that had their word classes changed, and the second of tokens with changed morphosyntactic tag. The first line shows the number of tags that were wrong, but the program changed to the correct ones, the second gives the numbers of those tokens which TnT tagged correctly, but the Perl program subsequently corrupted. The third line shows the number of tokens that had an incorrect tag assigned by TnT, were changed by the Perl program, yet the changed tag was also wrong. The last line shows those instances where the TnT tag was wrong and was subsequently "changed" to the same tag, i.e. a rule fired, but to no effect. The values shown in Confused and Identical rows do not influence tagging accuracy, although it is preferable to have a small number of confusions, as the new errors are likely to be more complex than original ones. The absolute number of corrected errors by the Perl tagger comes from subtracting the second line from the first; the overall improvement is given in the last line.

	Word class	Morpho-syntactic tag
Corrected	291	289
Corrupted	4	4
Confused	14	16
Identical	2	2
Improvement	287	285

Table 5: Result of automated error correction.

The numbers show that, for the case of full morphosyntactic tags, the relative error decreases by 16% and the tagging accuracy grows from 86.6% to 88.9%. This difference is not high, however, it was not our aim to maximize the accuracy of the morphosyntactic tagging; it will have been noted that all the rules strictly correct the word class tags; and the improvement of accuracy for word class tagging is much more significant: using only five transformation rules the accuracy grows by 38.4% relative, from 94.4% to 96.6% absolute accuracy.

5 Comparison of tagging accuracy

In Table 6 we give a short summary and comparison of morphosyntactic and word class tagging accuracies for the various experimental settings and compare the results from this paper to previous research on Slovene. The first line gives the results reported in Erjavec et al. (2000), in which the MULTEXT-East corpus, i.e. "1984" was used (with ten-fold cross validation) both for training and testing. The second line shows the evaluation of tagging as presented in this paper, therefore with on a corpus significantly different from the training one. The Tnt+Trans gives the results obtained after the application of the transformation program described in the previous section.

	Morpho-syntactic tag	Word class
1984: TnT	89.2 %	96.6 %
SVEZ-IJS: TnT	86.6 %	94.4 %
SVEZ-IJS: TnT+Trans	88.9 %	96.6 %
SVEZ-IJS - X,Y: TnT	89.4 %	97.6 %
ZRC SAZU: TreeTagger	83.6 %	?

Table 6: Overview of tagging accuracies for Slovene

It should be noted that the very common errors of abbreviations and residuals (foreign words) are caused not so much by the tagger, but rather in the tokenization. A robust solution to the problem of tagging X and Y would thus be rather in adding to the tokenisation a special module which would identify abbreviations and foreign words and add them to the lexicon used by the tagger. From this perspective it is interesting to take a look at the accuracy rates obtained by omitting X and Y tokens from the evaluation. Line four (SVEZ-IJS - X,Y) of the table shows that under these conditions accuracy of TnT tagging would reach 89.4% for morphosyntactic tagging and 97.6% for word class tagging, i.e. would be greater than on "1984" itself.

Finally, the last row of the table shows the results of tagging Slovene as presented in Lönneker (2005), which is, to our knowledge, the only other research aiming at the evaluation of automated morphosyntactic tagging for Slovene. Lönneker describes the usage of TreeTagger (Schmid, 1994) on the ZRC SAZU manually tagged corpus (Jakopin and Bizjak, 1997) of one million words. This experiment differs from ours in a number of parameters: the tagger used, the tagset, the size of learning corpus and the structure of test corpus. It is therefore difficult to make a direct comparison, nevertheless, the difference in the results is surprising, especially with regard to the fact that the ZRC SAZU training corpus contains more than million words of mixed genre texts, while "1984" has only 100,000 and contains one novel only. Lönneker (2005) makes some hypotheses as to why the accuracy is lower in her tests then in the ones reported in Erjavec et al. (2000): one reason could be the more detailed ZRC SAZU tagset, which e.g. distinguishes different types of names (personal, country, mythological), the other less consistency in the manual tagging of the ZRC SAZU corpus, which was performed by different people over a long period of time, and without detailed guidelines or a firmly fixed tagset. A further reason could be that the TnT tagger is better than TreeTagger, esp. at tagging unknown words.

6 Conclusions

In the paper we analyzed the accuracy of automated morphosyntactic tagging with TnT trained on the MULTEXT-East morphosyntactic resources for Slovene. The evaluation took a manually corrected sample from the Slovene part of SVEZ-IJS corpus of legal EU texts, which comprised around 15.000 tokens, and includes around 15% words not included in the training set. The evaluation showed that the absolute accuracy regarding word tokens in the sample is 86.6%, for the whole tagging and 94.4% for word class tagging. If we improve tagging with a transformational program, which corrects some frequent but simple errors, the accuracy increases to 88.9% for the morphosyntactic tags and 96.6% for word class tagging.

We have mentioned one way to improve accuracy, which includes pre-processing to identify abbreviations and foreign words. Higher accuracy would also certainly be obtained if we were to use a larger training corpus, consisting of a variety of text types. The main problem to this kind of solution is the lack of available manually tagged corpora for Slovene.

There are several other options on how to improve tagging accuracy. An interesting approach and a publicly accessible program is described by Brill (1992), which was also the inspiration for our transformational program. A significant difference is that we wrote the rules manually, while the Brill tagger learns rules from a training corpus. A different approach used for languages with a rich tagsets and small training corpora is described in Tufiş (2006), which proposes a method for tagset reduction, so improving the data density for the tagger, yet in such a way that the original tags can be reconstructed via the lexicon.

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JOŽEF STEFAN INSTITUTE

Jožef Stefan (1835-1893) was one of the most prominent physicists of the 19th century. Born to Slovene parents, he obtained his Ph.D. at Vienna University, where he was later Director of the Physics Institute, Vice-President of the Vienna Academy of Sciences and a member of several scientific institutions in Europe. Stefan explored many areas in hydrodynamics, optics, acoustics, electricity, magnetism and the kinetic theory of gases. Among other things, he originated the law that the total radiation from a black body is proportional to the 4th power of its absolute temperature, known as the Stefan–Boltzmann law.

The Jožef Stefan Institute (JSI) is the leading independent scientific research institution in Slovenia, covering a broad spectrum of fundamental and applied research in the fields of physics, chemistry and biochemistry, electronics and information science, nuclear science technology, energy research and environmental science.

The Jožef Stefan Institute (JSI) is a research organisation for pure and applied research in the natural sciences and technology. Both are closely interconnected in research departments composed of different task teams. Emphasis in basic research is given to the development and education of young scientists, while applied research and development serve for the transfer of advanced knowledge, contributing to the development of the national economy and society in general.

At present the Institute, with a total of about 700 staff, has 500 researchers, about 250 of whom are postgraduates, over 200 of whom have doctorates (Ph.D.), and around 150 of whom have permanent professorships or temporary teaching assignments at the Universities.

In view of its activities and status, the JSI plays the role of a national institute, complementing the role of the universities and bridging the gap between basic science and applications.

Research at the JSI includes the following major fields: physics; chemistry; electronics, informatics and computer sciences; biochemistry; ecology; reactor technology; applied mathematics. Most of the activities are more or less closely connected to information sciences, in particular computer sciences, artificial intelligence, language and speech technologies, computer-aided design, computer architectures, biocybernetics and robotics, computer automation and control, professional electronics, digital communications and networks, and applied mathematics.

The Institute is located in Ljubljana, the capital of the independent state of S**love**nia (or S♡nia). The capital today is considered a crossroad between East, West and Mediterranean Europe, offering excellent productive capabilities and solid business opportunities, with strong international connections. Ljubljana is connected to important centers such as Prague, Budapest, Vienna, Zagreb, Milan, Rome, Monaco, Nice, Bern and Munich, all within a radius of 600 km.

In the last year on the site of the Jožef Stefan Institute, the Technology park "Ljubljana" has been proposed as part of the national strategy for technological development to foster synergies between research and industry, to promote joint ventures between university bodies, research institutes and innovative industry, to act as an incubator for high-tech initiatives and to accelerate the development cycle of innovative products.

At the present time, part of the Institute is being reorganized into several high-tech units supported by and connected within the Technology park at the Jožef Stefan Institute, established as the beginning of a regional Technology park "Ljubljana". The project is being developed at a particularly historical moment, characterized by the process of state reorganisation, privatisation and private initiative. The national Technology Park will take the form of a shareholding company and will host an independent venture-capital institution.

The promoters and operational entities of the project are the Republic of Slovenia, Ministry of Science and Technology and the Jožef Stefan Institute. The framework of the operation also includes the University of Ljubljana, the National Institute of Chemistry, the Institute for Electronics and Vacuum Technology and the Institute for Materials and Construction Research among others. In addition, the project is supported by the Ministry of Economic Relations and Development, the National Chamber of Economy and the City of Ljubljana.

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