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On Learning in Engineering and Science When Old

Perl, L., Martin (1995 Nobel Laureate in Physics)

I just celebrated my eightieth birthday and in the past few years I have faced the problem of the older student who is an engineer or scientist and who wants to learn a new technical subject or who wants to get current in a subject that has changed drastically. This paper is concerned with learning for research or for teaching or for technical management, not for cultural pleasure.

I have had one grand success, learning how to design instruments using diffractive optics, and one dismal failure, an attempt to learn the rudiments of the string theory of elementary particles. In the process of these studies I learned about the problems facing the older student.

The major problem is that the time required for serious technical learning is not a few hours a week, it is of the order of ten hours per week. After all, in graduate or undergraduate school one spends of the order of ten hours per week, or more, on a technical course.

The next problem is how to learn. If there is suitable course and you will be accepted as an auditor whose homework and tests will be graded, this is the best but such opportunities are rare. My recourse is self-directed study using one or two books.

I have found that it is better to use newer textbooks or new editions rather than one's thirty or forty year old student textbook [1]. Exposition has improved with time and in a rapidly changing field newness is important. Also computer based calculations are now part of many textbooks, broadening applications and helping understanding. Mathematica, MATLAB, and Maple are all very useful. But in the learning stage one should avoid highly detailed, 'blackbox' software written for specific applications.

It is crucial to work through the examples and the derivations in the text and to do the exercises. The older student's limited time for study tends to encourage skipping. You think "this theorem is true, I don't have to know its derivation". I find it is best to pretend that the homework will be marked and that there will be tests. In fact if you intend to use this new knowledge you will be tested by the success of

your research or teaching or your management decisions. Incidentally it is very useful to have the answer book for the text, sometimes it can be bought, sometimes it can be obtained by asking the author or publisher. Sometimes if I am stuck on working out an exercise I ask a colleague, but unless they are teaching the subject they usually cannot help. They know the theorems but have forgotten the derivations and the tricks used in applications. A student taking the course is the best helper.

Sometimes there is a particularly fruitful joint learning situation. About five years ago a bright young man, Irwin Lee, was working with me as a graduate student on a search for elementary particles with fractional electric charge using a new technology version of the Millikan oil drop method [2]. Irwin was taking a course in fluid mechanics and I had to learn the fluid mechanics involved in our experiment [2]. I bought the book being used and he gave me a copy of each problem set. We worked out the problem sets separately and then compared our work. Irwin, now Dr. Lee, was of great help to me and I hope I was a little help to him

A few word's on the use of the Internet for self-study. There are Web Sites that offer high level engineering and science courses. My preference is to work with a textbook and a paper notebook (not a computer notebook) using the notebook's pages to do the exercises and to fill in missing steps in the textbook. Of course one can use the textbook and a computer notebook or just use the a computer if the course is on a Web Site. I prefer a real book that I can carry with me and I like the pile of real papers with my work written out.

Now what about my attempt to learn the rudiments of string theory. I dropped my self-directed course in the middle because that the time required conflicted with the strength of my motivation. From the beginning I had no hope of contributing to string theory itself, I am not sufficiently mathematically agile. I did hope that I would learn enough to find a new way to experimentally test some parts of the theory. And here is where being eighty was a limitation for me. I was not willing to spend my limited time. And my skepticism about the relevance of string theory, at least in my lifetime, made me wonder if I was wasting my time.

When I was a Columbia Ph. D. student, it was

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different, there seemed to be infinite time for learning. About 1952 I took a general relativity course under Llewellyn Thomas of Thomas precession fame. It was hard work because Thomas was a notoriously poor teacher. I never expected to contribute to the field of general relativity because I had already realized my limited mathematical agility. But theoretical and observational work in general relativity was growing and I wanted to be able to follow that work.

Now I am deciding what self-directed course to take next. Eric Lee [3], I, and our colleagues have just completed a decade long series of searches for elementary particles with fractional electric charge. We found nothing but did develop the technology of working with small liquid drops, about 25 μm in diameter. I am working on ideas for extending our technology to searches for hypothetical, very massive, stable charged particles trapped in bulk matter [4]. There are two new technologies that may help me: microfluidics and nanophotonics, I have bought text books in both areas [5,6] and am deciding which area to study first.

Also I want to be more knowledgeable in statistical mechanics. Perhaps some subtlety of statistical mechanics will allow me to look for these hypothetical massive particles. My statistical mechanics course at Columbia was taught by the Nobel Laureate Isadore Rabi who was my thesis advisor. Rabi was also a notoriously poor teacher and our textbook was Richard Tolman's Principles of Statistical Mechanics ; a thick book, long on philosophy but short on how to calculate. The book was useless to me. So I have acquired a stimulating new statistical mechanics book [7] .

For the next few of my semesters I'll study microfluidics, nanophotonics and statistical mechanics. Meanwhile if string theory is verified by a measurement equivalent to Eddington's verification of the factor of 2 in Einstein's formula for the bending of light, I can go back to studying string theory.

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Semantic Integration in Conceptual Modeling of Service Architectures

Gustas, Remigijus

Abstract — *The primary goal of service architecture is to align the business design with the information technology innovations in order to make both organisational and technical system parts more effective. Thus service architecture is not necessarily bound to the technical aspects of system development. It can be defined by using conceptual models that are independent of any implementation technology. Service-oriented architecture (SOA) provides principles of system decomposition into reusable, sharable and interoperable components, which require high degree of business data consistency. Unfortunately, the conventional information system analysis and design methods cover just a part of required modeling notations for engineering of service architectures. They do not provide effective support to maintain semantic integrity between business processes and data. Service-orientation is a paradigm that can be realized as a set of novel principles that can be used in conceptual modeling of enterprise architectures. Realizing a future vision on service-oriented analysis and design requires reassessment of existing conceptual modeling theories, concepts and practices. The most fascinating idea about service concept is that it applies equally well to organizational as well as to technical components. Principles of service-orientation could be successfully used for separation of concerns by breaking down enterprise system functionality into coherent non overlapping subsystems, which are represented by a set of service requesters and service providers. The concept of service is rather well understood in different domains and it can be expressed in different traditional modeling dimensions. Therefore, service-oriented descriptions can be used for semantic integration of the static and dynamic aspects of enterprise architectures.*

Index Terms — *Conceptual modeling, Enterprise architecture, Intersubjective and objective views in system analysis and design, Semantic integrity, Service-Oriented modeling*

1. INTRODUCTION

Enterprise systems are evolving by adopting new configurations of service architectures, which prescribe and motivate various IT solutions. Service orientation promotes flexibility and interoperability by minimizing requirements for shared understanding. Enterprise architectures (EA) can be changed by replacing or recomposing more specific services. Traditionally, graphical representations of EA are built fragment by fragment and when all is done, then typically business and technical design does not fit each other. It is quite expensive and time consuming to maintain integrity and consistency of multiple specification fragments. Service architectures are intrinsically complex engineering products that can be defined on different levels of abstraction and represented by using several dimensions. One of the reasons why the traditional information system engineering methods do not provide effective support is that service architectures are difficult to visualize across disparate modeling dimensions such as the "why", "what", "who", "where", "when" and "how" [1]. Another problem is that the same implementation dependent artifacts are used in both system analysis and system design phases. It makes descriptions of service architectures less comprehensible for business experts.

The idea of computation independent modeling was introduced by the Object Management Group [2]. Two levels of computation independent models can be distinguished: semantic and pragmatic. The pragmatic requirements correspond to the "why" dimension. They typically refer to desirable or undesirable situations, which are expressed as intentions of stakeholders in terms of goals, problems and opportunities [3]. Pragmatics is supposed to motivate and drive the overall system analysis and design process. One of the main challenges in service-oriented analysis and design is mapping from the pragmatic to semantic modeling level. Semantic descriptions of services must follow the basic conceptualization principle

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by representing only computation independent aspects. Such representations are less complex and more comprehensible for business process experts. They can be successfully used by non-technicians who play a key role in system integration. It is recognized that UML support for such task is quite vague, because semantic integration principles of different diagram types are still lacking [4].

Service-oriented analysis and design does not exclude the object-oriented (OO) point of view that is adopted by RUP, but rather suggest two additional semantic and pragmatic levels above the syntactic level of abstraction. Computation oriented modeling languages abstract from concrete implementation artifacts. This is a reason why specifications at the syntactic level are more comprehensible for software designers, but not readily accessible and understandable for business consultants and managers.

2. TWO SYSTEM DEVELOPMENT TRADITIONS

There are two significant qualities that characterize system development traditions: intersubjectivity and objectivity. Methods that put into foreground modeling of the external behavior have the intersubjective bias [5]. From the intersubjective point of view, service is a unit of functionality, which is exposed to environment. External behavior helps to understand a usage aspect of self-contained service components. Intersubjective bias is especially obvious in the enterprise modeling language Archimate [6]. Services can be also characterized by internal state changes [7]. Semantics of changes are typically represented by using state transition links. Transitions are triggered by operations, which specify the permissible ways for changes to occur in different classes of objects. Various types of OO diagrams that are intended for conceptual modeling of static and dynamic aspects have the objective bias to system development. Such tradition is very strong in the conventional system development approaches.

The static aspect of intersubjectivity can be defined by using inheritance, composition and classification relations among enterprise actors. The dynamic aspect of intersubjectivity is expressed by interaction dependencies [8], which represent physical, information or a decision flows between two kinds of actors involved. Service providers are actors that typically receive service requests, over which they have no direct control, and transform them into responses that are sent to service requesters. Each *Service Response* is a function of a *Service Request*. This idea illustrated graphically in figure 1.

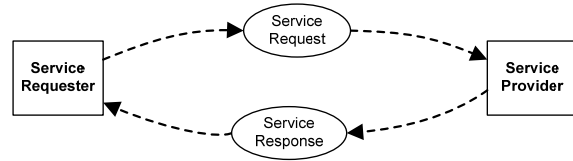


Figure 1: Intersubjective view of service

From the objective stand point, an action is changing business data from one consistent state to another. Quite often service outputs depend not only on inputs, but also on availability of stored data that result from other services. Such data are supposed to constrain service responses to the present or future inputs. For instance, if a reservation of trip is created, then it can be paid by using a trip payment service. Moving flows together with request and response actions, which create or remove objects of various classes, are crucial to understand the semantic aspects of services. This idea is illustrated by figure 2.

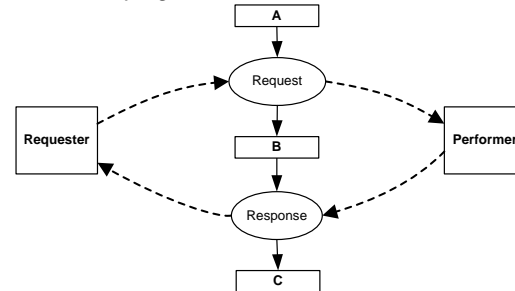


Figure 2: Intersubjective and objective views in a service interaction loop

The objective view of action can be defined by using transition links. The transition link from a class illustrates termination of an object and – to a class represents creation of object. For instance, a request action is supposed to remove an object from class A and to create an object in class B. Creation of object B is a precondition for initiation of response action by performer, which is supposed to remove business data about object B and create an object in class C. It should be noted that either precondition or poscondition class of action may be missing, but not both of them. Otherwise, an action makes no sense. Such action has no effect on the internal behavior of objects.

3. SEMANTIC INTEGRATION OF STATIC AND DYNAMIC ASPECTS

The most conventional system development methodologies are biased on the objective tradition. They use totally different diagram types for defining separately an external and internal behavior. For instance, a used case diagram is capable to express just an external view of

system functionality. Most of the conventional methods typically use various diagram types for representation of many internal modeling dimensions in isolation. Nevertheless, there is an overlapping among them to some degree. For instance, the concept of operation in UML is represented in a class diagram ("what" dimension), activity diagram ("how" dimension), sequence diagram ("where" dimension) and state-transition diagram ("when" dimension). Furthermore, the atomic operations are typically aggregated into higher granularity functions that are represented as the elements of a use case diagram ("who" dimension). It should be noted that some use cases even can be interpreted as goals at the pragmatic level of abstraction. Interplay between the external and internal views of enterprise systems and services create big challenges even for the recently developed system analysis and design methods [8], which deal with an integrated modeling of static and dynamic aspects.

Enterprise models traditionally define how business, data, software application and technology architecture is perceived by different stakeholders. Since different modeling views and dimensions are highly intertwined, it is crucial to maintain integrity and consistency across multiple diagrams on various levels of abstraction. Traceability of changes from one diagram type to another is a bottleneck in traditional enterprise modeling approaches. Service-orientation can be applied for verification and validation of diagrams that are represented on the pragmatic, semantic and syntactic levels. Intersubjective and objective aspects of service loops are defined equally well for organizational as well as technical system parts. Organizational system parts can be represented by individuals, companies, divisions or roles, which denote groups of people. Technical parts are represented by data, software and hardware components.

Intersubjective semantics of services are captured by interaction loops, which are able to express the main workflow patterns such as sequence, selection, synchronization and iteration [9]. The objective tradition can be effectively used for defining an internal behavior of objects. An object lifecycle in service-oriented approach is represented by using initial, intermediate and final classes, which are analyzed in the context of interactions between organizational and technical system components. Semantics of objective changes is expressed by using three types of actions: reclassification, creation and termination [9]. A creation action, which is characterized by a missing precondition class, corresponds to a starting point. A termination action, which is characterized by a

missing postcondition class, corresponds to the end point in object's lifecycle.

Intersubjective view predefines very basic structure of conceptual representation of service architecture. It is expressed by using service request and response flows into opposite directions, which can be successfully used for separation of concerns in system analysis and design. Typically, a coherent set of interactions are delegated to one independent technical component. All coherent interactions that fit together for the achievement of a common goal are used for breaking down enterprise system into coherent non overlapping subsystems that can be implemented as autonomous services. Since the concept of service is rather well understood in different domains, it has a potential to integrate intersubjective and objective views into one comprehensive notation. In such a way service-oriented diagrams are able to address semantic integrity and consistency problems of business data. It is not sufficient to represent what type of objects are created and terminated when an action is triggered. Service graphical descriptions are capable to express more generic classes, which are referred by using inheritance links. Such classes are typically characterized by an additional set of persistent attributes, on which an action of more specific class has no effect. Composition links are also of a great importance, since they represent related classes of objects, which are synchronously removed or created when an action takes place.

Information flows are reminiscent of arrows in dataflow diagrams [10], because they are representing moving data between enterprise system components, which may be interpreted as data sources and sinks. If a system is implemented without any computer support, then information flows may be understood as moving documents and pre/post-condition classes can be viewed as archived data at rest. Precondition and postcondition classes can be viewed as database files or data stores in the computerised system. It should be noted that the presented modelling approach is useful for graphical description of service architectures, which are not prescribing any implementation details. Semantic constructs follow the basic conceptualization principle by representing only computation neutral aspects.

4. CONCLUSIONS

The understanding of enterprise architecture relies on knowing how different subsystems are interconnected. Semantic relations among enterprise system components and objects define conceptual representations of service architectures. Interplay of intersubjective and

objective views in one service-oriented diagram facilitates better semantic integrity control between the static and dynamic aspects. There are typically many stakeholders involved during the architecture engineering process. For systematic analysis of service architectures, it is crucial to maintain a holistic representation, where external and internal views are visualized together. It is not reasonable to duplicate the same concepts many times in different diagrams just because such separation is required from a technical design point of view. Semantic integrity of static and dynamic aspects of service descriptions is achieved by superimposing the intersubjective and objective perspectives together.

Service-oriented paradigm should open a totally new way for enterprise engineering of service components that span across the organisational and technical system boundaries. Conceptual models of enterprise system architecture can be defined as a set of loosely coupled components. Service-orientation has the potential for organizations to reduce system architecture evolution complexity and to improve learning capacity. A new service-oriented approach for system analysis and design should bring significant benefits including: improved ability for organizations to maintain strategic knowledge in a systematic way, reduced costs for a systematic analysis of new IT solutions before they are implemented, improved integrity and traceability of knowledge within companies by providing comprehensible service architecture descriptions. Our experience in analyzing system specifications by using

computation independent notation demonstrates that service-oriented descriptions are more comprehensible for personnel without a technical background. Service-oriented paradigm has no implementation bias and therefore it can be used for bridging a communication gap among system designers and business analysis experts.

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Consumer Driven Multivariate Landing Page Optimization: Overview, Issues, and Outlook

Gofman, Alex

Abstract - *Although widely recognized as highly important in increasing a websites' conversion rate and overall ROI, landing page optimization (LPO) was for a long time a domain of subjective predilections. A simple approach such as an A/B split test cannot provide reliable data as it involves a very limited set of alternatives. This article shows the development, classification, advantages and shortcomings of the most advanced form of LPO, Multivariate Landing Page Optimization, and its variations. The approach allows for the testing of thousands of web page prototypes with consumers and finds real optimal solutions on an aggregated, segmented and individual basis. The latter paves the road to individually optimized pages and 1-on-1 marketing in the near future.*

Index Terms— *bounce rate, conjoint analysis, landing page, multivariate, optimization, Rule Developing Experimentation (RDE), survey.*

1. INTRODUCTION

MULTIVARIATE Landing Page Optimization (MVLPO) is the experimental design based process of improving a visitor's perception of a website by optimizing its content and appearance in order to make the pages more appealing to the target audiences as measured by the marketing goals such as conversion rate or others.

2. CONSUMER DRIVEN WEB PAGES OPTIMIZATION

The average bounce rate on a website is about 37% (White, 2006), while many sites have a rate well above 50%, with the conversion rate in low single digits or even a fraction of 1%.

A more serious problem according to some sources is derelict conversion. According to *MarketingSherpa* data, the average ecommerce shopping cart has about a 59.8% abandonment rate (compare this to *three out of five* department store shopping carts left abandoned in the aisles) (Booth, 2006).

For a long time, the only solution to improve the aesthetics of a website was based on the subjective predilections of web designers. This dependence on individual preferences, extended to heterogeneous internet audience, is prone to

mistakes and neglecting to anticipate the effect of all the variables. As people's perception differs, a potential loss of not optimizing the landing pages may be staggering. Furthermore, many website designers do not consider the aesthetics of payment pages as being important. However, simple changes to those pages could bring a substantial improvement to revenue per visitor with some reporting boosting conversion rates as much as 600% (www.web-site-evaluations.com, 2007).

A recent study by researchers in Canada showed that the snap decisions Internet users make about the quality of a web page have a lasting impact on their opinions. They also reported that impressions were made in the first 50 milliseconds of viewing (Lindgaard et al, 2006). The implication of these findings is that it is *mostly the main features and the general appearance of the landing page that make a difference, not necessarily the actual content.*

In the last few years, an approach called *Landing Page Optimization (LPO)* became prevalent. The underpinning of it is multiple experimentally designed prototypes tested with the consumers. In the most trivial case, the A/B Split Test approach, there may be only two variations of a page. Alternatively, MVLPO, the most advanced form of LPO, involves thousands and thousands of the prototypes. Although MVLPO was developed in the late 1990s, it didn't get the deserved attention until very recently, especially after the introduction of the Google Website Optimizer (www.google.com, 2007).

3. DESCRIPTION AND CLASSIFICATION OF MVLPO

A typical MVLPO involves multiple experimentally designed variations of a web page and evaluates the difference in the reaction or behavior of the consumers who visit these pages. It structurally handles a combination of multiple groups of elements (graphics, text, etc.) on the page. Each group comprises multiple executions (options). For example, a landing page may have n different options of the title, m variations of the featured picture, k options of the company logo, etc. An experimental design is applied to the elements of the page and the resulting prototypes are served to customers.

MVLPO is the most consistent scientific based

approach to understanding the customers mind and using it to optimize their experience. It evolved into an easy to use approach in which not much programming and IT configuration is needed. In many cases, a few lines of JavaScript on the page allow the remote servers of the vendors to control the changes, collect the data and analyze the results. Moreover, it provides a foundation for a continuous learning experience.

At the same time, MVLPO is prone to distorted results if the original materials are not chosen carefully (a so-called GIGO effect - 'garbage in, garbage out'). Another limitation is that MVLPO usually optimizes one page at a time. Website experiences for most sites are complex multi page affairs. For a typical e-commerce website, a successful purchase involves visiting around 12 to 18 pages; a support site engrosses even longer. For the holistic experience optimization, the *Total Experience Optimization* approach could be considered (Kaushik, 2006).

MVLPO can be executed in a Live (production) Environment (e.g., Google Website Optimizer, Optimost.com, etc.) or through a Market Research Survey / Simulation (e.g., StyleMap®.NET).

In *Live Environment MVLPO Execution*, a special tool (server) makes dynamic changes to the web site, so the visitors are directed to different executions of landing pages created according to an experimental design. The system keeps track of the visitors and their behavior (including their conversion rate, time spent on the page, etc.) and with sufficient data accumulated, estimates the impact of individual components on the target measurement (e.g., conversion rate).

With an adequate number of observations, this approach is very reliable because it tests the effect of variations as a real life experience, generally transparent to the visitors and it is evolving towards a relatively simple and inexpensive approach (applies to Google Optimizer only at the writing time). On the other hand, it may take a long time to achieve statistical reliability caused by variations in the amount of traffic, which generates the data necessary for the decision. It may not be appropriate for low traffic / high importance websites when the site operators do not want to lose any potential customers because of the suboptimal design of some experimental pages.

Simulation (survey) based MVLPO is built on advanced market research techniques called *Rule Developing Experimentation (RDE)* – a new paradigm developed in cooperation with Wharton Business School (University of Pennsylvania) and introduced in *Selling Blue Elephants* (Moskowitz, Gofman, 2007).

In the *research phase*, the respondents are directed to a survey, which presents them with a set of experimentally designed combinations of the landing page executions. The respondents rate each execution (screen) on a rating question (e.g.,

interest or purchase intent). At the end of the phase, regression model(s) are created (either individual or for the total panel). The outcome relates the presence/absence of the elements in the different landing page executions to the respondents' ratings and can be used to synthesize new pages as combinations of the top-scored elements optimized for subgroups, segments, etc.

This approach in most cases is much faster and easier to prepare and execute compared to the live environment optimization. It works for both high and low traffic websites and usually produces more robust and rich data because of a higher level of control of the design. On the other hand, there is the possibility for bias of a simulated environment as opposed to a live one and a necessity to recruit and optionally incentivise the respondents (Gofman, 2007).

The MVLPO paradigm is based on an experimental design (e.g., conjoint analysis, Taguchi methods, etc., Green, Srinivasan, 1978) which tests a structured combination of elements. Some vendors use a full factorial approach (e.g., Google Optimizer that tests all possible combinations of elements). This approach requires very large sample sizes (typically, many thousands) to achieve statistical importance. Fractional designs typically used in simulation environments require the testing of small subsets of possible combinations. Some critics of fractional designs raise the question of possible interactions between the elements of the web pages and the inability of most fractional designs to address the issue.

Advanced simulation methods based on the RDE paradigm have resolved these limitations (Moskowitz, Gofman, 2007). RDE creates individual models for each respondent using a permuted fractional design, discovers all and any synergies and suppressions between the elements (Gofman, 2006), uncovers attitudinal segmentation, and allows for databasing across tests and over time.

The first application of an experimental design to website optimization was done by Moskowitz Jacobs Inc. in 1998 in a simulation demo-project for the Lego website (Denmark), although MVLPO did not become a commercialized approach until c. 2003-2004.

4. CONCLUSION

Individual models afforded by RDE also pave the road to real-time 1-to-1 marketing on the websites by matching new visitors to the probable segments based on a decision tree developed during the simulation stage. This allows website operators to *individually* optimize landing pages based on whatever information is available about the visitor (the more information that is available, the more precise may be the optimization) (Moskowitz, Gofman, 2003).

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Developing Best Practices for Facilitating Online Learning Communities: A Case Study at New York University

Davidson, R., Anthony; Sosulski, Kristen

Abstract— *This paper presents a framework for replicating the online learning community framework that is central to the award-winning Management and Systems distance education graduate programs offered by the Division of Programs in Business at New York University's School of Continuing and Professional Studies. Through a case study analyzing use of this framework it is anticipated that a set of best practices will illustrate the affordances of synchronous and asynchronous technologies to support collaboration, teaching, and effective forms pedagogy.*

Index Terms— *Distance Education, Online Learning, Community Building*

1. INTRODUCTION

THE term, distance education, is not new; however, in recent years it has taken on new meaning. Initially, distance education was synonymous with correspondence courses used to meet the needs of rural areas. The steady evolution of telecommunications and multimedia has considerably influenced the development of distance learning (Johnson, 2003). The first and second generation of distance education delivery systems were capable of distributing learning materials and asynchronous communication, however provided limited opportunities for live communication between students and faculty. The third generation of distance education technology includes a combination of the following tools and applications: Wikis, Blogs, the integration of dynamic learning content, instant messaging, discussion forums, and interactive synchronous audio and video-based environments. Teaching and learning in the online environment has been transformed from a content-driven delivery environment to an interactive student-centered learning space.

New York University's School of Continuing and Professional Studies (SCPS) has been

offering distance education since late 1950s with Sunrise Semester (New York University's Office of Information Services, 1958). The NYU SCPS Distance Learning group is an entity within SCPS that facilitates the offering online of courses, certificates, undergraduate and graduate degrees.

In trying to conceive of the best methods for building a community within the online Management and Systems program, many options were explored. Some of these included online clubs, forums and other informal student-led activities. The option that sustained itself and was most favorably received by faculty and students was to provide opportunities for community building within, rather than outside of, the classroom. The rationale underlying adoption of this approach to community building was simply because the community of faculty and students were comprised of working professionals. The students, in particular, had little or no time to devote to extracurricular community-building activities. In addition, many of the faculty members who taught the program's courses held full-time, high status positions in industry.

Other similar programs in business have moved towards executive education and other forms of convenient education for working adults looking to earn an advanced degree. The Management and Systems program differs in that it is offered completely online, but still shares the similarities to other business programs with specific class meeting times and dates. However, all the class meetings are conducted via distance using multimedia environment with voice-over IP technology and the ability to display visual, aural, textual, and graphical artifacts. The assumption underlying many asynchronous forms of learning is that students can learn merely from written forms of communication. According to Mayer (2003) it is essential to engage multiple senses in teaching to facilitate learning. Moreover, to promote initial bonding amongst students Haythornthwaite, Kazmer, Robins, & Shoemaker (2000) advocate the use of synchronous technologies. Through the examination of the Management and Systems program the researchers seek to demonstrate the forms of pedagogy to promote learning

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communities that are supported by the course management system.

2. THE CASE STUDY

This case study to be undertaken aims to demonstrate the affordances of synchronous and asynchronous technologies to support formal and informal learning while contemporaneously building learning communities. An “educational learning community is a group of people who interact, learn together, build relationships, and in the process, develop a sense of belonging and mutual commitment” (Buffington, 2003, ¶ 16). The program aimed to build a strong community of learners to promote collaborative learning, sense of belonging, and dynamic online classroom interactions. Specifically, “when the development of a community is encouraged, the educational experience is more inspired as strong relationships develop amongst students” (Palloff & Pratt, 2003, p. 15).

2.1. Proposed Solution

Community-building in an online environment is essential for student engagement with peers and faculty (Johnson, 2003). To address the challenge of developing online learning community was to design the courses and overall curriculum to allow for social interactions among peers and faculty within the course environment. The community-building efforts were based upon principles and best practices recommending the construction of groups of students into cohorts, drawing upon the individual differences among students, providing opportunities for student interaction with experts in the field of management and systems, and establishing expectations of faculty as to the importance of community building within the program. These principles and best practices provided the foundation for community building in the virtual classroom.

2.2. Student Cohorts

“Research on learning in cohorts indicates that cohorts foster a sense of belonging, create an environment of mutual response, promote risk taking, and provide a forum for critical reflection an shared understanding, and encourage and sustain multiple perspectives” (Huber & Lowry, 2003, p. 81). The Management and Systems master’s students, although they had never met in person, self-evolved into cohorts that progressed through the curriculum together. The cohorts structure established the foundation for social learning and community-building within the classroom.

2.3. Capitalizing On The Individual Differences Among Students

The community of faculty and students in the

program are unique. For example, a driving principle of the program is to draw upon the individual differences among its students. The program’s students come from diverse backgrounds and represent a variety of professional and academic experiences. The common denominator is that they are all seeking to update and upgrade their skill sets by assimilating the latest management techniques into their arsenal of talents. A powerful way of accomplishing this truly holistic approach is to mine the experiences of both program faculty and students and amalgamate students’ individual differences into a collective repository of best practices.

2.4. Faculty Expertise and Commitment

Faculty members in the program understand that their contributions to the social and team aspects of the class is crucial to adoption by students. “Faculty must work to create a sense of community within the class” (Johnson, 2003, p. 113). The faculty member, in addition to being the knowledge expert, also must be able to facilitate the discussion at times to allow students to construct their own understanding of knowledge, rather than deliver it strictly through lecture. However, in order for this aspect to be successful, it requires an introduction to this type of learning based on the best practices with the student responsibilities and instructional techniques to facilitate community formation such as attributes of openness, flexibility, honesty, willingness to take responsibility for community formation, and willingness to work collaboratively (Palloff & Pratt, 2003). The Division of Programs in Business consists of some full-time professors but relies heavily on an adjunct faculty. Its approach to hiring faculty entails having a continual, robust recruitment process that focuses heavily on professional achievements at a senior management level or as a consultant in addition to superlative communication skills. Mentoring of these newly recruited faculty members is provided by colleagues and the Divisional Dean as well as through the support services offered under the auspices of the Office of Faculty Affairs. The creation and development of various documents and templates imparting instructional guidelines for teaching in the Virtual College has greatly aided the synchronous and asynchronous online tools used in training faculty. However, not all faculty members who are successful in a traditional classroom setting are able to adapt to the interactive, learning-based approach that is required in the online educational model used at NYU SCPS.

3. ANTICIPATED FINDINGS

The program places a strong emphasis on peer-to-peer learning and teamwork supported using a robust learning management system.

The system encourages various forms of communication through voice, written text, and chatting. A particular strength is the voice-over IP synchronous environment that allows for real time discussions between faculty and students. By examining how students take the same classes and seminars together, gravitating towards self-formed cohorts, it is hoped that the results can demonstrate how a foundation for social learning and community building within the classroom can be established. It will also be vital to analyze the differences between students and capitalize on the added value to the learning process that diversity brings.

For example, students in the program desire opportunities to network and learn from experts in the field just as they would in a traditional classroom. As a core component of the pedagogical design of the program the expertise of the faculty, professionals in the field, and student expertise is embedded is central to the student experience in the classroom. In the program the technology enables students to easily network with their peers, build relationships, and share experiences during opportune times. One way that the program supports community building is through drawing on students' shared experiences in the workplace. For example, students shared how they dealt with the repercussions of a hurricane or 9/11. Students collaborated and compared their experiences to establish a common understanding of the salient issues, ways to address those issues, and methodologies for sharing best practices.

Students often measure their satisfaction with a program by how its curriculum helped them become more accomplished in their professional careers. By providing them with a thorough understanding of core business competencies, access to faculty expertise, and highly specialized knowledge in a systemic approach, it is possible aggregate the experiences of both program faculty and students into a warehouse of business paradigms.

4. CONCLUSION

Most traditional online programs in the United States focus primarily on asynchronous forms of communication. The most prevalent reason for student dissatisfaction is the lack of interaction, both between students and with the professor, creating a sense of detachment from the learning community. The Management and

System program supports multiple methods of engagement with the course content and strives to engage and stimulate the learner through text, voice and visuals. By studying a successful distance education program that offers a variety of perspectives and approaches to education and incorporates them into the online platform and pedagogy, it is anticipated that a model of best practices for online continuing education programs will be developed and that such a model would factor in the need for informal learning and learning communities that extend learning outside of the classroom and promote life-long learning for the adult learner.

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Multilingual Web with E-speranto

Tomazič, Sašo

Abstract— *This paper presents the idea of E-speranto, a Hyper Text Description Language (HTDL) which will act as an extension of Hyper Text Markup Language (HTML) for multilingual documents. Documents written in E-speranto will be interpreted in Web browsers in a chosen natural language, and thus anyone will be able to read these documents in his/her own language. This will eventually bring an end to the "language divide".*

Index Terms— *Esperanto, language, multilingual, translation, Web, interpreter.*

1. INTRODUCTION

IN the mid-1990s the term "digital divide" came into regular use to refer to the gap between those with regular access to digital and information technology, and those without this access. Now, seventeen years later, the digital divide is closing. Never before there have been so many people with access to electronic communication technologies and the Internet. However, another divide is becoming more and more apparent. We can call it the "language divide". It divides those who understand English and those who do not.

Virtually any kind of information can be found on the World Wide Web (WWW), available to any one who can understand it. In most cases, Web pages are in English, or at least their English translations are available. So, understanding English is a necessary prerequisite for finding desired information on the Web; however, it is not sufficient. It can often happen that the information we are searching for only exists in a regional language we do not understand.

The digital divide was relatively easy to overcome. All that was necessary was to develop new technologies, cheap enough to be affordable for everyone. On the other hand, it is much more difficult to teach everyone English, and it is clearly impossible to teach everyone every language in the world.

One avenue to the goal of overcoming language barriers and bringing the language divide to an end is the use of automatic translation tools. There are already many of them available on the Web. Some of them can even be used free of charge for on-line translation of

visited pages or for translation of text inserted in a text input box. The main drawback of this approach is that these tools only work with pairs of languages, and only major world languages are supported. Google, for example, offers translations between English and Arabic, Chinese, French, Italian, Korean, Japanese, Russian, Spanish and Portuguese. The only pair that does not include English is from German to French and vice versa.

If you do not happen to understand some of the above languages, or even if you do and come across a page written in another language, Slovenian for example, you are doomed. It is not very likely that automatic translation between pairs of marginal languages, e.g. Slovenian to/from Vietnamese, will be available in the foreseeable future. Moreover, in order to have automatic translation between all pairs of 6700 existing languages, a total of 44,883,300 compilers would be needed (two for each pair).

A much better solution to this problem can be found in the world of computer communications. Each computer understands its own machine language; however, there is no need to understand machine languages of other computers in order to communicate with them. All that is needed is a common language – a standardized communication protocol – which is then locally interpreted on each computer in a language understandable to the computer processor.

With regard to the Web, Hyper Text Markup Language (HTML), together with its underlying communication protocols, is an excellent example of such a language. There is no need for documents on the Web to be in a format specific to a certain computer or operating system as long as a suitable HTML interpreter (Web browser) is installed on the computer. The interpreter reads the HTML documents and interprets them in a language understandable to the computer-specific graphics card in order to be shown on that computer's specific screen.

The introduction of HTML was a success story – the World Wide Web was born. Many extensions to HTML have been made since then to enable a richer design of documents and to make the design process easier. However, HTML is still a language that only allows interpretation of the document format. The text itself remains in its original language.

It is now time to take the next logical step: to design a common Hyper Text Description Language (HTDL) which will allow interpretation

in different natural languages. Documents written in HTML/HTDL will not only be correctly shown on the computer screen but will also be interpreted in a language understandable to the user browsing them.

2. E-SPERANTO

To avoid tedious use of the acronym HTDL for Hyper Text Description Language, I have named it E-speranto (pronounced i:spærae'ntou). The name is derived from Esperanto (pronounced espærae'ntou) [1]. Esperanto is a constructed international auxiliary language proposed by L. L. Zamenhof in 1887 as a universal second language that would enable people of different nations to communicate and understand each other. E-speranto can be considered an electronic version of Esperanto.

Although the concepts of E-speranto and Esperanto share a common goal, there is one substantial difference between them. To understand Esperanto one must learn it, whereas it would be sufficient to have an interpreter installed on a computer to understand E-speranto. This difference can make E-speranto succeed where Esperanto failed.

As already mentioned, Esperanto was intended as a universal second language. To this end, everyone should learn it. However, learning a new language is a difficult and time-consuming task. One usually decides to learn a new language only when she/he feels that it would be very useful in her/his business or private life. As only a relatively small number of enthusiasts currently speak Esperanto, one cannot expect to be able to conduct business in Esperanto nor to be understood when ordering food or buying clothes. The critical mass of Esperanto speakers was not reached.

On the other hand, interpreters for E-speranto could be integrated in Web browsers so that anyone would be able to see documents written in E-speranto in her/his own language without even being aware that they are written in E-speranto. Only one interpreter needs to be developed for each language. For small nations and/or small ethnic groups it would be much more feasible to develop a single E-speranto interpreter than to develop compilers for all languages of interest.

3. DESIRED PROPERTIES

E-speranto does not exist. It has yet to be designed. To be successful and to best serve its purpose, certain properties are desirable and should be considered when designing E-speranto. These properties are the following:

1. A meaning that can be expressed in a natural language can also be expressed in E-speranto. This is the basic requirement for any synthetic language for communication among people and, as such, is also a property of

Esperanto.

2. As E-speranto is intended to be interpreted by computers, its syntax should be computer friendly. This implies that all words in E-speranto have only one form and that grammar is expressed explicitly in the form of tags.

3. E-speranto documents will be mostly designed by humans. Tools for editing E-speranto documents and E-speranto interpreters will also be developed by humans. Thus, E-speranto documents should be readable by humans. For this purpose, eXtended Markup Language (XML)-based syntax seems a good choice.

4. To simplify the development of interpreters, the grammar of E-speranto must have no exceptions. For that purpose it can be based on the grammar of Esperanto, only that it must be expressed explicitly (by tags), not implicitly (by prefixes, suffixes, etc.) as in Esperanto.

5. E-speranto vocabulary should contain unique concepts, i.e. words with a single meaning and no synonyms. In natural languages, some words represent many different concepts and some concepts can be represented with many different words. Both must be avoided in E-speranto. E-speranto vocabulary can also be based on Esperanto, but probably English is a better choice, because more developers (computer programmers) understand English than Esperanto.

6. The meaning and the style of the language must be separated. Style can be expressed in some kind of translation hint, which would tell the interpreter which style to use for interpreting the text of the document (e.g. dialect, slang, poetical, etc.). If all translation hints are ignored, the basic meaning of the text must remain. This is similar to the separation of document structure in HTML and style in CSS.

4. CONCLUSION

According to the above-presented idea of HTDL we embarked on development of E-speranto at the Faculty of Electrical Engineering, University of Ljubljana. The home page of E-speranto [3] is under construction and will be available soon. We would initially like to design E-speranto syntax and grammar in such a way that a human would be able to translate documents written in E-speranto to his/her language. If a human cannot do it, a computer cannot do it. In parallel we began development of tools for writing documents in E-speranto and also began researching algorithms for interpreting E-speranto in three Slavic languages: Slovenian, Serbian and Russian. The last and most difficult phase will be the development of translators from natural languages to E-speranto. When and if such translators are developed for different natural languages, any document would be easily translated from/to any of those languages using E-speranto as an intermediate

language.

I hope that this or other similar efforts (e.g. [4]) will bear fruit and that some form of HTDL will be standardized to break down language barriers and close the language divide, thus bringing different nations closer together.

ACKNOWLEDGMENT

It was largely owing to my colleague and friend Franci Demšar that I came to the idea of E-speranto. He, not being from the field, was convinced that automatic translation from some kind of simplified language into different natural

languages should be an easy task in the age of computers. This brought the idea of using Esperanto as a basis of such a language.

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Intelligent Systems Already Influence Our Lives

Gams, Matjaž; Krivec, Jana

Abstract— *In this paper we present our recent research in the area of intelligent systems dealing with real-life problems and how that affects actual life worldwide and in Slovenia. Three applications are discussed: the influence of high knowledge on GDP worldwide, predictions of oil prizes and predictions of demographic trends in Slovenia with detailed demographic analysis. It was concluded that a) high knowledge is of major importance for a country's wealth; b) oil prices are not going to be low ever again and c) Slovenia is fast moving towards a demographic suicide which is common thing in most liberal, rich western countries. All these subjects were also presented in media thus hopefully having some impact on the future.*

Index Terms— *artificial intelligence, intelligent systems*

1. INTRODUCTION

IN comparison with classical AI academic orientation, the term Intelligent Systems denotes a similar area in a more general, technically and practical oriented way, using AI methods [2,3], classical computational approaches and some cognitive ideas [6], thus adding to computational brute force some “human” intelligence. Ubiquitous computing technologies, systems and solutions are influencing our everyday world and their impact on society is becoming increasingly prevalent. Intelligent systems were first developed for, and often by, industry leaders in the following sectors: manufacturing, mining, forestry, energy production and agri-food [2].

Machine learning and lately data mining are among the most successful application areas of artificial intelligence and intelligent systems [2]. Whenever there are lots of learning examples, these systems learn properties of domain and make predictions about future cases. The constructed knowledge is often in the form of understandable trees, rules and other readable representations. An example of a successful scientific and engineering SW tool are Weka [15] and Orange [4]. These systems are a collection of machine learning algorithms/programs for

solving real-world data mining problems. They both contains tools for data pre-processing, modeling and data exploration techniques with learning algorithms and evaluation methods (classification, regression, clustering, association rules, visualization). Last but not least they are very powerful data analytical tools. Especially Orange is very convenient also for advanced research, since it allows users to implement their own analysis methods or even use an existing algorithm and replace some of its standard components with their own ones since it is an open source system / platform.

In the rest of the paper we describe three relevant practical applications demonstrating the power of intelligent systems for real life.

2. HIGH KNOWLEDGE AND GDP

In our first practical case we used methods of intelligent systems to design an accurate decision tree showing relevance of science and education for country success. The dataset with learning examples was extracted from various statistical databases, provided by The World Bank, UNESCO Institute for Statistics, USAID (Global Educational Database) and WIPO Patent Scope. It consist of 158 examples (countries) with 50 indicators from the year 2001 of which 7 represent economic indicators (e.g. GDP per capita, GDP growth, GNI per capita...), 14 R&D indicators (e.g. Researchers per million inhabitants, GERD per capita, Grants of patents...), 24 educational indicators (e.g. Tertiary students per 100,000 inhabitants, Public expenditure on education as percentage of GDP, School life approximation...) and 5 general indicators (e.g. Fixed line and mobile phone subscribers per 1000 people, Internet users per 1000 people, Military expenditure as percentage of GDP). All indicators are numeric except one discrete. Discrete indicator Gross National Income (GNI) per capita was chosen for the class. GNI prizes the total value of goods and services produced within a country (i.e. its Gross Domestic Product) together with its income received from other countries (notably interest and dividends) and less similar payments made to other countries. The indicator can take one of the three values, i.e. low, middle or high. From the ML and DM techniques available in Weka and Orange we have chosen J48, the implementation of Quinlan's C4.5 [15], a

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technique used for the induction of classification trees. We conducted four experiments using different sets of indicators, trying to find as accurate and informative classification tree as possible. In all experiments default values of the classifier parameters set in Weka and Orange were used. We experimented with the usage of reduced error pruning, but the obtained classification trees were less accurate. To estimate the accuracy of the trees, we used 10-fold cross-validation.

One of the most interesting and accurate (70.25%) trees we've got is shown in Figure 1. In this case we have concentrated on higher education and R&D, and chosen 26 relevant indicators. It can be seen from the tree (Figure 1) that the high income countries invest more in R&D, have advanced tertiary education, more granted patents and higher percentage of high-technology exports. On this base we can conclude that high knowledge plays one of the most important roles in economic welfare. As usual in case of classification trees, we can use it also for predicting the income group of some new country on the basis of indicators of education and R&D. Some exceptions were observed, e.g. countries rich in oil that were much richer than compared to the above criteria. Detailed analysis is presented in [14].

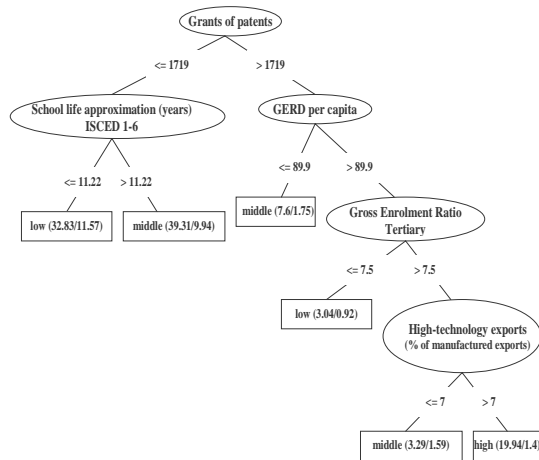


Figure 1: The influence of science and education on GNI per capital.

3. OIL PRICES

Intelligent systems are of major importance also when prediction of future events is concerned. They are able to find out typical patterns of events in the past and use them to make projections for the near future.

In September 2004, the first author of this paper presented a popular paper in the Delo daily [7]. With the help of various separate methods of intelligent systems, combing them with some basic background knowledge and constraints such as supply and reserves of cheap and over-all oil, it was soon becoming clear that new developing countries/economies like China are already increasing consumption/demand to a level where production can not generate extra reserves, thus oil prices will not ever be cheap as

they used to be for most of the last 50 years (see Figure 2).

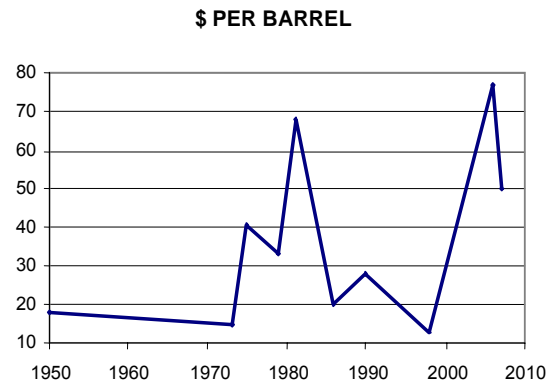


Figure 2: Oil prices

At that time, at least half of the oil experts, among which L. Raymond and J. Browne, both CEO's of major oil companies, predicted differently. They claimed that the oil prices will eventually decrease, even more, that they will return to 35\$ per barrel. At the same time, most of the experts predicted that the peak of oil production will be reached in around two decades.

The prices of oil in 2007 were around 60-100\$ per barrel and there is no real indication that they will drop significantly with the exception of normal fluctuations. Essential for the prediction was to realistically estimate relations through various methods and make a common-sense integration. Simple predictions without taking in concern this essential background knowledge have proven to be useless.

While alternative fuels will and are popping at costs around 70\$ per barrel, the overall effect of the rising new underdeveloped countries is bringing havoc to the developed world and standard. It is estimated that most of the population in the developed world now lives worse than 5 years ago in terms of energy and food (not in terms of informatics and communications since these areas are not directly related to prices of oil.)

4. SLOVENIAN DEMOGRAPHY

In another application we analyzed Slovenian demographic trends. First, we predicted the number of citizens in Slovenia (see Figures 3 and 4) in the next 50 years. Again, there was some background knowledge such as a generally accepted equation for citizen growth in a period of time (a year for example):

$$\text{Growth} = \text{births} + \text{incomings} - \text{deaths} - \text{outcomings}$$

where incomings and outcomings are known as migration. A typical property of this kind of equations is that predictions tend to be exponentially growing or declining.

The basic dataset was collected from Statistical office of the Republica Slovenia (Stat.Base). Three key parameters were concerned: fertility, migrations and life expectancy incensement. They were first set to project overall population in Slovenia, giving the same result as UN and Eurostat predictions (see Figure 3) [5,12,13].

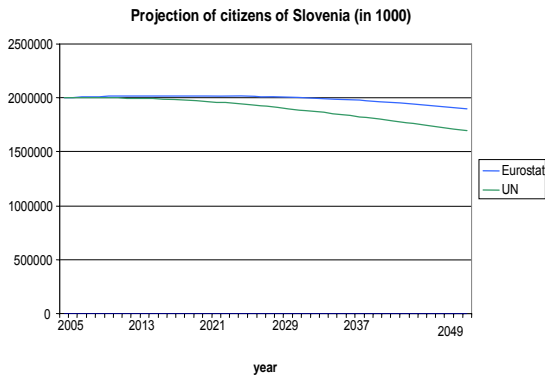


Figure 3: Prediction of number of citizens in Slovenia

Overall, these predictions show that the number of citizens of Slovenia will not fade drastically by the year of 2050. However, we concluded that increased migrations drastically affected the final result. Furthermore we wanted to find out what will happen with the native Slovenians in the future.

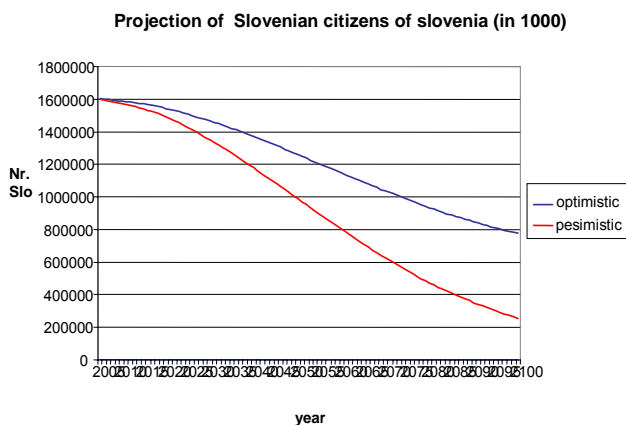


Figure 4: Prediction of number of Slovenian citizens in Slovenia

With this object to investigate we took data structure of native Slovenians in the year 2002 (census of population), and projected them on the year 2100. The first graph in Figure 4 is adopted to the Eurostat model with the next corrections: fertility 1.2 (as in the year 2005) growing to 1.5 (in the year 2050), constant (after 2050); life expectancy is extending 1 year per 7 years and migration to be 0. This is meant to be a rather optimistic evaluation. The other settings of these parameters is reasonably pessimistic: assuming that migration is -1000, fertility 1.1 and no life expectancy extensions. Both predictions indicate serious problems for economy and

quality of life.

4.1. Demographic Analysis of the Causes

Our next attempt was to find out what are the reasons for differences in fertility ratio in different world countries. The analysis was made for 145 countries, on 95 attributes, which we thought might influence the fertility rate of a country. Attributes could be consolidated in 4 groups: country politic/society (39 attributes like country attitude toward maternity leave, heterosexuality, religion, abortion, military,...), economical status (12 attributes like unemployment rate, GDP,...), education and R&D (28) and biological factors (6, for example number of citizens, number of men on 1000 women, etc.). Data were extracted from Wikipedia, UN and Eurostat sources [5,13,16,17]. For the class we have chosen an average number of children that a woman had in her fertility period, assuming that she has more than 49 years [11]. The class indicator can take one of the two values: increase (if the rate is two or more) or decrease (if the rate was less than two).

We analyzed influences of various attributes using machine learning techniques mentioned in the introduction (J48), experimented with selected number of countries and attributes. To estimate the accuracy of the trees, we used 10-fold cross-validation as common.

One of the interesting trees is presented in Figure 5. In this case we took in consideration all the countries and extracted only 11 attributes determining social attitudes towards common life questions like homosexuality status, number of suicides on 1000 people, abortion status, divorces frequency, percentage of women in the parliament, etc.. Our main finding in this case was that fertility rate is higher in more conservative countries (that don't allow abortions, homosexual adoptions etc.) and lower in more liberalistic countries.

Since the countries considered as liberalistic are mostly economically developed, one should be cautious with quick conclusions regarding social relevance. But economical factors proved out not to be among the most important indicators (for further details see [23]).

Additionally we extracted main factors that influence fertility rate within the countries with high economical growth (1000\$ per habitant among year 2002 and 2007). 39 such countries appeared. One of the most controversial and accurate (89,74) tree that emerged in this case is presented in Figure 6.

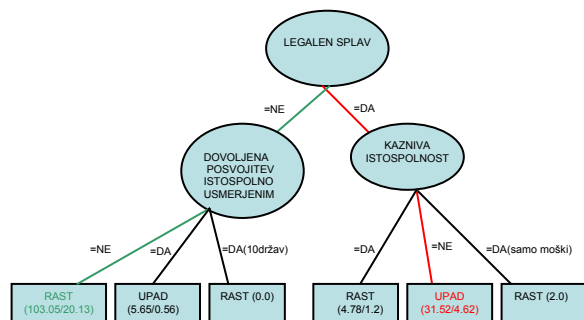


Figure 5. General social attitude towards common life questions.

Does this mean that we can claim with 89,74 accuracy that the length of maternity leave is in correlation with decreased fertility rate? Doubtfully, since other factor like economical status influence the results and furthermore, the trees do not indicate the direction of relation. This shows us that we have to be very careful with jumping to conclusions from ML results. We have to interpret them rationally, with safe amount of caution. Still, there is a hypothesis that lengthening a maternity leave is not the most efficient way of increasing fertility rate.

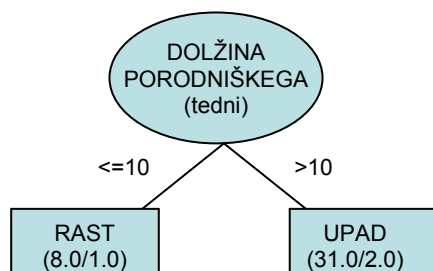


Figure 6. Influence of the maternity leave length on fertility rate.

Our general analysis confirmed former expert predictions and interpretations that fertility rate to a great length depends on economical status of the country. However, more detailed analyses pointed out some even more important factors like general social opinion about personal values and health insurance. Some of the discovered relations are original and rather easy to implement. At the same time it should be noted that the demographic problem is of a long-term nature and that it can not be solved either quickly or easily.

With some publications of the results in mass media [8] we attracted attention of our society and politicians.

5. CONCLUSION

The importance of intelligent systems steadily grows in recent decades. We have shown the effectiveness of intelligent systems for a couple of relevant questions in Slovenia and world-wide. In particular we have shown that:

- high knowledge is of major importance for a country's wealth, thus silencing critics claiming that less funds should be devoted to science and high education,
- Slovenia should be at least aware that the

demographic trends show not only national, but also commercial dark future, so major attention and an action plan are highly desired,

- some of the demographic actions seem pretty cheap and efficient yet introduce major political dilemmas: conservative countries are much successful in terms of fertility rate while rich liberal countries are facing a demographic suicide.

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Symbolic Pattern Matching and Rule-Based Programming Paradigm

Tošić, V., Dejan

Abstract—Present-day computer algebra systems offer programming paradigms that can solve many scientific and engineering problems more efficiently, with less effort from the programmer, than the classic programming styles, such as procedural or object-oriented programming. This contribution focuses on a real-life engineering problem that is nicely solved by using symbolic pattern matching and rule-based programming. The benefits of the new approach are highlighted and the entire code in *Mathematica* is presented and explained. The symbolic programming language is suggested for rapid software development and algorithm prototyping in the field of scientific research and engineering practice.

Index Terms—computer algebra system, Foster's theorem, *Mathematica*, symbolic pattern matching, rule-based programming

1. INTRODUCTION

A common approach taken in modern software engineering is to combine various programming paradigms, such as procedural programming or object-oriented programming, to achieve the desired goals. Since the appearance of computer algebra systems (CAS), programming has become a task of knowledge accumulation that tells the computer what to know, when to use information, and how to apply the knowledge in solving problems. Contemporary CAS integrated a suite of software tools and programming concepts that are particularly useful for engineers and physicists. The leader in implementing CAS, *Mathematica* by Wolfram Research, launched an original programming language, which gives a different perspective to software realization of scientific and engineering algorithms [1,2,3].

2. MATHEMATICA PATTERN MATCHING

At the core of *Mathematica* are its highly developed symbolic language and the foundational idea that everything – data, programs, mathematical formulas, lists, graphics, and documents – can be represented as symbolic expressions. The advanced notion of

expressions is a crucial unifying principle and it is the fact that every object has the same underlying structure.

Expressions are used to specify operations and to maintain a structure, which can then be acted on by the operations. A prototypical example of an expression is $f[x,y]$, where the symbol f is the head of the expression, the symbols x and y are the arguments, and the square brackets are delimiters; the head and the arguments itself can be expressions, as well. The parentheses are used exclusively for grouping following standard mathematical notation to specify the precedence of operators. The use of distinct delimiters for arguments is a unique concept important for symbolic programming and it adds a new level of flexibility to the very concept of programming: the pattern matching and transformation rules can be applied to both expression heads and expression arguments.

Patterns are used to represent classes of expressions with a given structure. The main power of patterns comes from the fact that many operations can be done not only with single expressions, but also with patterns that represent whole classes of expressions.

It might be useful to mention that (1) a pattern will match a particular expression if the structure of the pattern is the same as the structure of the expression, (2) even though two expressions may be mathematically equal, they cannot be represented by the same pattern unless they have the same structure.

The fact that patterns specify the structure of expressions is crucial in making it possible to set up transformation rules which change the structure of expressions, while leaving them mathematically equal [4,5,6].

3. APPLICATION TO ELECTRICAL ENGINEERING

Symbolic pattern matching and rule-based programming (and the combining of various programming paradigms) are actually explored in the AI community for many years, but are not widespread in the engineering community. Therefore, the following example illustrates this paradigm from the electrical engineering viewpoint and demonstrates the uniqueness and benefits of the symbolic language concept.

Consider an essential problem of electrical network synthesis and practical filter design [7,8]:

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given a transfer function, e.g. $H = \frac{s^4 + 3s^2 + 3}{s^5 + 5s^3 + 6s}$, determine whether the function can be realized as a driving-point impedance of an electrical network of interconnected capacitors and inductors.

According to the Foster's reactance theorem, an algebraic rational function to be realizable as the driving-point impedance of a lossless one-port electrical network can always be expanded

$$\text{as } H = \frac{a_{-1}}{s} + a_0 s + \sum_i \frac{a_i s}{b_i s^2 + c_i}, \quad \text{where all}$$

coefficients are positive. *Mathematica* code that performs the required test, based on the Foster's

theorem, is given in Fig. 1. The code is concise, elegant, readable, easy-to-maintain, and self-explanatory.

The function `Apart` expands the transfer function (H) into partial fractions and the function `List` converts the expansion to a list of terms (`partialFractions`). The function `MatchQ` performs the desired pattern matching, term by term, under the conditional rule that the coefficients should be positive numbers; it returns a list of logical constants (`patternMatchTest`). The function `And` returns true if all terms pass the pattern match, otherwise it returns false. The intermediate results are shown in Fig. 2.

```

In[1]:= $Version
Out[1]= 6.0 for Microsoft Windows (32-bit) (June 19, 2007)

In[2]:= H =  $\frac{s^4 + 3 s^2 + 3}{s^5 + 5 s^3 + 6 s}$ ;

In[3]:= partialFractions = List @@ Apart [H];
patternMatchTest =
MatchQ[#, ((s : (_?NumericQ) : 1) /; Positive[a]) |
(  $\frac{(a : (_?NumericQ) : 1)}{s}$  /; Positive[a]) |
(  $\frac{(a : (_?NumericQ) : 1) s}{(b : (_?NumericQ) : 1) s^2 + (c : (_?NumericQ) : 1)}$  /;
Positive[a] && Positive[b] && Positive[c]) ] & /@partialFractions;

And@@patternMatchTest
Out[3]= False

```

Figure 1: *Mathematica* code that performs the test based on the Foster's theorem.

```

In[4]:= Apart [H]
Out[4]=  $\frac{1}{2 s} - \frac{s}{2 (2 + s^2)} + \frac{s}{3 + s^2}$ 

In[5]:= partialFractions
Out[5]=  $\left\{ \frac{1}{2 s}, -\frac{s}{2 (2 + s^2)}, \frac{s}{3 + s^2} \right\}$ 

In[6]:= patternMatchTest
Out[6]= {True, False, True}

```

Figure 2: Results of the test shown in Fig. 1.

4. CONCLUSION

Symbolic pattern matching and rule-based

programming paradigm is an important issue and a choice of preference for rapid software development and algorithm prototyping in the fields of science and engineering. It is the key programming paradigm involved in the development and implementation of *SchematicSolver* [9].

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An Intelligent Web Browser Plug-In for Automatic Translation to Ajax Approach

Hanakawa, Noriko

Abstract— *We can receive large information from various web sites on Internet society. The web sites are important means to collect information in researching, learning, and even commercial activities. Importance of web browsers grows increasingly as web sites increase. Web browsers are powerful tools to refer to web sites. However, due to necessary of synchronous communication with web servers, operability of web pages on web browser is not better than operability of desktop applications. Therefore, we propose a new intelligent web browser plug-in for Ajax approach. The browser plug-in can improve operability as same as desktop applications without revising program codes of web applications. A feature of the browser plug-in is asynchronous communication with web servers. As a result, we have confirmed improvement of operability of “Yahoo auction sites” on the web browser plug-in when load of the Yahoo web server is heavy.*

Index Terms— *Browser plug-in, Ajax approach, Asynchronous communication, JavaScript*

1. INTRODUCTION

RECENTLY, we have received valuable benefits from large amount of web sites on Internet. Much information is provided through web sites. Net-surfing is more important means to search valuable information. Moreover, web sites are useful in cases not only searching for information but also commercial activities such as Net-shopping and Net-auctions. Even education in universities and schools can not ignore information from web sites. Web sites are indispensable information resources on various scenes in current societies. On the other hands, most usual tools to refer to web sites are web browsers such as Internet Explorer (IE) and Firefox. Web browsers generate a visible web page while browsers are analyzing HTML source codes. This is a typical client-server system called “web application”. Everyone can access easy web applications through web browsers.

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However, we have problems of web applications on web browsers. Operability of web applications on web browsers is less than operability of desktop applications. Slow performance and limited interactivity of operability on web application. Desktop applications mean that all programs are installed to a user computer. Desktop applications are able to achieve quick responses to user's requests because desktop applications do not need communication with servers on other computers, and waiting for calculations in server computers. Especially, if it takes long time for communicating with servers in web applications, a visible web page on a web browser may become a white-out page that has no texts and no images. The white-out page frequently occurs when a user requests “Reload” under heavy loaded servers. The white-out web page leads to not only no-better operability but also users' confusions because users lose sight of operation on a web page.

To resolve the weakness of operability of web applications, Ajax (Asynchronous JavaScript + XML) technology is adopted to web applications [1][2]. If a web application is constructed based on Ajax technology, white-out web pages will be avoided because client programs (e.g. JavaScript) in HTML source asynchronously communicates with web servers. Client programs in HTML source do not need to wait for finish of communication with servers. Because Ajax technology can improve operability of web applications, many developers adopt Ajax technology to their projects. A most famous web application is Google Map [3]. The web application of Google map avoids status of white-out web pages because of asynchronous communication with web servers.

Although Ajax approach is a better way of improving operability of web applications, there is a significant problem. Usually, developers have to change program codes of client software and server software of web applications. End users can not receive benefits from Ajax approach in existing web applications unless the developers modify current program codes of web applications. General end users only do nothing but waiting for modifying program

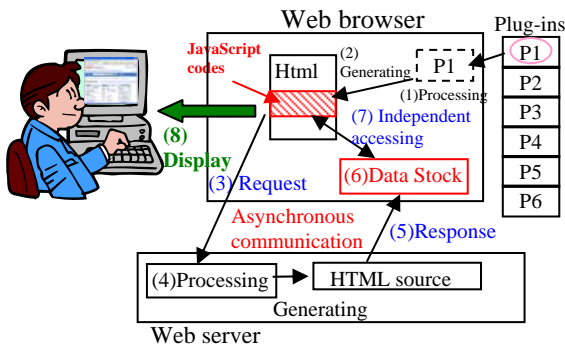


Figure1: A conceptual asynchronous communication model

codes of the existing web applications. However, there are a large number of web sites and web applications on the Internet society. Because opportunities to receive benefits from Ajax depend on progress of modification of the program codes, users need to wait long time for receiving benefits from Ajax approach in current web applications.

Therefore, we propose a new intelligent web browser plug-in based on an asynchronous communication model. The browser plug-in supports asynchronous communication with web server computers like Ajax approach. If users access web applications using the browser, users will be able to receive similar benefits from Ajax even if the web applications do not adopt Ajax approach. The browser has a function of translating automatically JavaScript codes that can communicate asynchronously with web servers. The function can improve operability of web applications that do not adopt Ajax approach.

Section 2 shows related works, section 3 presents a basic idea of the browser plug-in, and the detail of the asynchronous communication model of the plug-in. Section 4 shows experiment results of comparing current normal web browsers such as Internet Explore. In section 5, we discuss usefulness and possibility of the browser. Section 6 summaries our research.

2. RELATED WORK

Many useful Internet technologies have been proposed for improving performance of web applications. Sieminski focused on local system cache of Internet Temporary files [4]. Analysis of local cache is useful for not only estimating upper limit of caching efficiency but also measuring changeability of web objects. The changeability is derived from values of the cacheability factor (CF) of caches. Using the changeability, CF is a simple measure of susceptibility to caching and could be used to predict latency. Moreover, Li et al. also studied local system cache of Internet object for improving browser performance [5]. They proposed a peer-to-peer web document sharing technique, called a "browser-aware proxy server". To improve performance of loading web pages, a browser searches not only own local caches but also other computers' caches through

network. Therefore, even if a user has never seen a web page, the web page will be able to be displayed on a browser using caches of other computers. Performance of displaying previous web pages is dealt with on both researches. Performance of viewing web pages that have once displayed on web browsers is improved. However, the browser can improve performance in updating partially a current web page that has never displayed anywhere.

On the other hand, intelligent web browsers have been proposed. Many useful functions are embedded to web browsers for improving user operability. Bergasa-Suso et al. have proposed a new browser embedded a filtering function, a function of inferring learning style, and a function of recommending relevant web pages [6]. Shigesada et al. constructed a new type of browser called BKB (BTRON Kiosk Browser) that has a function of presenting WWW content through a user interface suited to kiosk terminal [7]. Matsuda et al. developed a graphical history browser. The purpose of the browser is to help a user to utilize Undo selectively and easily [8]. These browsers have valuable functions in a case of a specific situation. The browser is also a kind of these browsers including a special function. Each browser is suitable to each situation. When a user views a web page which is updated partially and frequently, the browser will be useful as same as these browsers.

In addition, Ajax approach can be adaptable to other useful techniques. Lei et al. have proposed a integrated system Ajax and Web service for Web-based cooperative image editing[9]. The system can search web components interoperable machine-to-machine interaction over a network. Castro et al. have proposed an integration Ajax approach with client state management services [10]. The client state management services can provide a single page that can possible modify its own presentation based on data exchanged with a server. The browser is also a result of integration of Ajax approach and browser techniques. Ajax approach can be integrated to various techniques.

3. A NEW WEB BROWSER PLUG-IN

3.1. An Asynchronous Communication Model

Ajax technology has various possibilities of operability on web applications. For example, "Google suggestion" [11] can generate a new candidate list as users input characters to a text box. In Google Map site [12], when users click on a map image of Google Map, only a part of map image is updated without reloading the whole web page. Users can continuously operate the map site without waiting for processing in Google Map web servers. Therefore, white-out web pages of the site never occur because client programs on a web browser do not need to wait

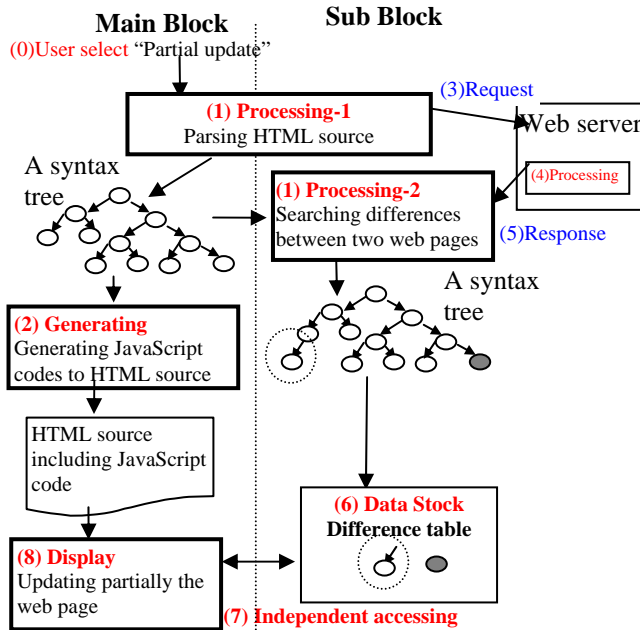


Figure2: An example of the model for partial updating

for communication with web servers.

The browser plug-in is based on an asynchronous communication model. The model can behave like various operations implemented by Ajax approach. A most important feature of the model is no change of client and sever program codes of web applications. Because the model is embedded to a web browser, developers of web applications do not need to revise the current web applications. In addition, the model can asynchronously communicate with web servers in order to achieve smooth operability of web application on web browsers. The details of the concept of the model are shown in Figure 1. The typical steps are as follows;

(0) Selecting Plug-in: Users select a favorite Plug-in from supported plug-ins of a web browser.

(1) Processing of the Plug-in: The program of the selected Plug-in is processing in the browser.

(2) Generating JavaScript codes: By processing of the Plug-in, a new JavaScript codes are generated. The JavaScript codes can achieve functions of the Plug-in on specific web pages. The JavaScript codes are automatically embedded to original HTML source codes of specific web pages.

(3) Request: the embedded JavaScript codes request any function to web server. The requests occur by user operations, or automatic requests in the plug-in.

(4) Processing in web server: Corresponding to the request from the JavaScript codes, the web server is normally processing.

(5) Response: results of the processing in the web server are returned to the web browser.

(6) Data Stock: the returned results from the web server are stocked in Data Stock area. That is, the response from the server does not immediately reflect to the web page. At once, the response is accumulated to the stock area.

(7) Independent accessing: The embedded JavaScript codes access to the data stock area. Because the accessing is independent from response timing of the web server, the web page can behave like Ajax approach. That is, the web page does not need to wait for response from the web server.

(8) Display: By the execution of the embedded JavaScript codes, users can smoothly operate the web page like web application supported Ajax technique.

Various Plug-ins for Ajax approach can be prepared for web browsers. Each Plug-in has an original processing that generate appropriate JavaScript codes. The following sub-section shows a function of updating partially a web page without reloading wholly. Even if users click "Reload" button, the web page avoids updating wholly a web page.

3.2. The Model for Partial Updating

Figure 2 shows the asynchronous communication model for partial updating a web page without wholly reloading. The model of Figure 2 is established in accordance with a conceptual asynchronous communication model of Figure1. "(1) Processing" of Figure 1 consists of two processing in Figure2, "Parsing HTMLsource" and "Searching differences between two web page". "(2) Generating" of Figure1 is "Generating JavaScript codes" of Figure2. "(6) Data Stock" of Figure 1 matches with "Difference table" of Figure 2. "(8) Display" of Figure 1 matches with "Updating partially the web page" of Figure 2. The following sub sections describe each part of the model.

3.2.1. Processing-1 (Parsing HTML Source)

HTML source is analyzed by a parser based on HTML tags. Syntax trees are generated by the parser. Nodes of syntax tree mean HTML tags, leaves of syntax tree mean text contents such as texts, numerical, and JavaScript codes. Because the analysis is based on HTML tags, other elements such as Script codes are dealt with as general texts (leaves of syntax tree). In addition, to update partially a web page, a new tag's property named "ID" is inserted to each node of syntax trees. When a web page is updated partially, the browser distinguishes update parts from non-update parts of web page using "ID" property.

3.2.2. Generating (Generating JavaScript Codes)

An original HTML source does not have a function of partial updating. Therefore, new JavaScript codes are added to the original HTML source. JavaScript codes refer to a difference table of "Data Stock". JavaScript codes include "innerHTML" method. Figure 3 shows an example of JavaScript codes. The JavaScript codes consist of 2 functions, LoadText() and

```

1 var change;+
2 var loader = new Jamritas.Loader;+
3 var changeTxtArray = new Array();+
4 function loadText(){+
5
6     loader.loadText('difference.txt', function(text) {+
7         change = text;+
8
9     });+
10    if(change == null) {+
11
12        return; }+
13    var txtArray = change.split("\n");+
14    for(i = 0; i < txtArray.length; i++) {+
15        var txtTemp = txtArray[i].toString();+
16        var txtArray2 = txtTemp.split("@:0-----0:0");+
17    };+
18    changeTxtArray[i] = new Array();+
19    changeTxtArray[i][0] = txtArray2[0];+
20    changeTxtArray[i][1] = txtArray2[1];+
21 };+
22 function changeHTML(){+
23     loadText();+
24     for(k = 0; k < changeTxtArray.length; k++) {+
25         if(document.all("fontID" + changeTxtArray[k][0]) != null)
26         {document.all("fontID" + changeTxtArray[k][0]).innerHTML+
27             = changeTxtArray[k][1];}+
28     };+
29     setTimeout("changeHTML()",1000);+
30 };+

```

Figure3:JavaScript codes in HTML source

ChangeHTML(). The function of ChangeHTML() is called when a user selects "update partially" plug-in. The function of ChangeHTML() calls a function of LoadText() (See 23rd line of Figure3). The function of LoadText() searches a difference table of "Data Stock". The file name of the difference table is "difference.txt"(See the 6th line). A reason of usage of a file "difference.txt" not on memory is that JavaScript program on HTML can not directly access memory areas of the browser. The information of the difference table saves to a two-dimensional variable named "changeText Array[][]" (See from 17th line to 19th line). The value of "changeTextArray [k][0]" means "ID" property given to each node of syntax tree, the value of "changeTextArray [k][1]" means a new text having "ID" property. The new text is a leaf of syntax tree. In 25th line, using document.all().innerHTML" method, partial updating actually execute. The tag having "ID" (change TextArray [k][0]) of HTML source is modified by the new property (changeTextArray[k][1]). At a moment of execution of "document.all(). innerHTML" method, the web page has been updated only tags having specific values of "ID" propoerty. In addition, the function of Change HTML() includes "setTimeout()" method at the last line of the JavaScript codes. The function of ChangeHTML() is repeated at constant intervals. In short, the function of ChangeHTML() refer to the different table at constant intervals, after that, if there are some difference between a current web page and a following web page, the two-dimensional variable is created. By the two-dimensional variables, "document.all(change TextArray[k][0]). innerHTML" method runs.

Because "ID" properties have been assigned to nodes of syntax trees, common JavaScript codes are available to various HTML sources. A

"JS" file including the JavaScript codes in Figure 3 is prepared beforehand. New line that should be inserted to an original HTML source is only "<SCRIPT onload=xxx.js></SCRIPT>". After that, the browser wholly updates once again the web page including the JavaScript codes. The "changeHTML()" runs at constant intervals. The value of constant interval can change in an option menu of the browser plug-in. The various intervals can be set according to various web pages. For example, at near the closing time of Yahoo auction, interval time is set to 1 second, because the value of "current bid" on the web page may be frequently updated.

3.2.3. Processing-2

With comparing two syntax trees, difference between two web pages is detected. There are many researches about difference calculation between two tree-structures. In the model, xmdiff algorithm [13] is adopted to detect difference. In the xmdiff algorithm, delta scripts (insert, delete, and update) and costs are used. The delta scripts mean construction process of a tree. The costs mean weights of the construction process using the delta scripts. Edit Graph (dynamic programming) is achieved using the delta scripts and costs. Nodes of one tree in depth first searching are plotted to on x-axis of the Edit Graph. Nodes of another tree in depth first searching are plotted to on y-axis of Edit Graph. Horizontal members of Edit Graph mean "delete" of a node. Vertical members of Edit Graph mean "insert" of a node. The hypotenuse members of Edit Graph indicate "update" of a node or leaves. Each edit script (delete, insert, and update) is set to each weight named "cost". Path with minimum cost among plots on Edit Graph means a most adaptable delta scripts. According to adaptable delta script, different nodes and leaves are determined. If you want to see details of xmdiff algorithm, please see [13].

In our model, cost of each edit script is defined as; "Insert" script is costI, "Delete" script is costD, "Update" script is costU. In addition, we have to determine whether a following web page wholly updates. If difference between two web pages is large, partial updating of a current web page is meaningless. Therefore, in searching algorithm, we set a threshold value for judgment of whole updating. If value of sum of costs on minimum path in Edit Graph is greater than a threshold value, the searching algorithm selects "wholly updating". The judgment is the following;

$$\sum_{node} (costI + costD + costU) > A \text{ then whole updating, (1)}$$

cost: cost of edit script such as "insert", "delete", "update"

node: the total number of the node of two syntax trees.

A : threshold value

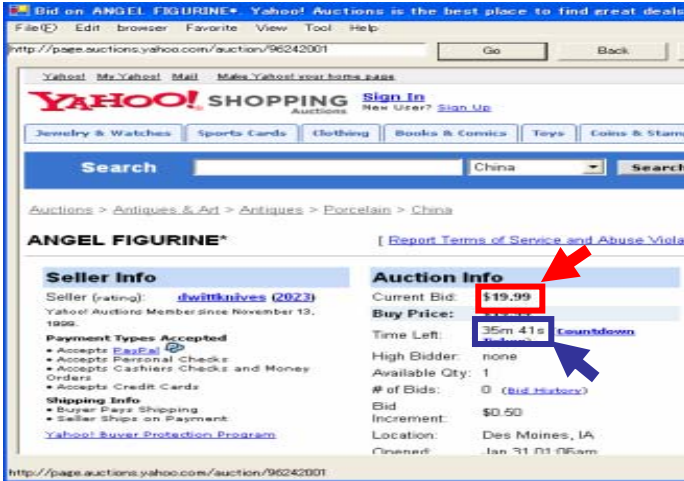


Figure4. The browser displaying USA Yahoo auction web page

After that, if partial update of the web page is required, a difference table is generated. The difference table includes difference node information such as tag name, ID, tag's properties, text.

3.2.4. Display

By the difference table, a current web page embedded JavaScript codes can partially update. JavaScript codes refer to the different table. Only elements of HTML tags that are set to the different table are refreshed by "InnerHTML()" method of JavaScript codes. Users can continue to operate a web page without user's confusion caused by wholly refreshing a web page.

The semantic inconsistencies may occur rarely. However, usually, the constant interval of accessing web server is more than the constant interval of accessing the different table. The two intervals' values can be set by users using optional menu. If large inconsistencies occur, that is, a web page can not display for HTML error, users will stop "partial-update", then, select "refresh" wholly.

3.3. Implementation of the Browser Plug-In

Based on the asynchronous communication model for partial updating, a new web browser plug-in has been implemented in C# language. Of course, various plug-ins should be prepared. However, in this paper, a plug-in for partial updating is implemented, and evaluated. Figure 4 shows a screenshot of the web browser including partial updating plug-in. The browser has especial buttons, "Partial-update", "Auto-update". At once, the browser displays normally a web page. If a user improves an operability of the web page, user clicks the "Partial-update" button. The HTML source of the web page is modified in the asynchronous communication model mentioned above. A JavaScript code "<SCRIPT onload= xxx.js></SCRIPT>" is added to the original HTML source. Based on the modified HTML source, the web page is wholly updated

once again on the browser. The new JavaScript code is started in the web page using "SetTimeout" method (See the last line of Figure3). Therefore, in the JavaScript code, the web page refers to the difference table at constant intervals.

After that, when user clicks "Update" button, the browser requests a following web page to a web server. The following web page is analyzed in the asynchronous communication model. A syntax tree of the following web page is generated in the browser. Next, a difference table is generated in the browser. Because the modified web page (the original web page added JavaScript codes) is accessed to the difference table, the web page is partially updated. In Figure4, only a red rectangular area is updated without wholly updating.

In addition, if the web page is frequently modified such as Yahoo auction web page at near the closing time, users can select "Auto-update" mode. The browser requests automatically a next web page to a web server at constant intervals. Therefore, the browser updates partially the web page without users' clicking "Update" button, automatically.

If the browser judges a whole updating for a following web page, the following web page has few relationships with the current web page. For example, when a following page moves to other URL link, difference of two syntax tree becomes large. Analysis at the model judges whether wholly updating is better than partial updating. This case is caused almost by changing URLs. Although change of URLs can indicate "wholly updating" of a web page, sometimes URL has parameters to web servers such as "http://portal.hannan-u.ac.jp/login.do;jsessionid=893E". In this case, the URL is different from the previous URL, although the following web page has changed partially. Therefore, the browser can not judge wholly updating using only change of URLs. Of course, the judgment of wholly updating is available at "On" status of "Partial-update" button on the browser.

4. EXPERIMENTS

4.1. Updating Texts in Yahoo Auction Sites

In Yahoo auction site [14], we have confirmed partial update of a web page on the browser plug-in. Figure 4 shows a web page of Yahoo auction. "Angel figurine" item is exhibited to Yahoo auction. Seller is "dwittknives", current bid is "\$19.99". In the web page, the value of time left such as "35m 41s" (See blue rectangle area of Figure 4) changes without "Reload" event because the value of time left is written in JavaScript codes in original HTML sources. However, the value of current bid such as "\$19.99" does not update because "\$19.99" is a simple text content from the web server. The

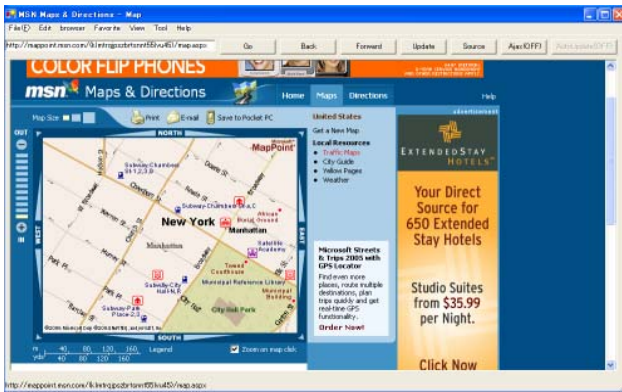


Figure5: USA's MSN map site on the browser

value of "\$19.99" is not updated as long as user doesn't click "Reload" button on a browser. When a user clicks "Reload" button, a whole web page is updated even if a value of current bid did not change. A flickering of the web page occurs when the web page is wholly updated. Therefore, the web page of Yahoo auction is displayed on the browser. When a user clicks the "Partial-update" button on the browser, only value of current bid is updated without wholly updating. Of course, if the value of current bid does not change, nothing occurs on the web page.

In addition, if a web page is modified frequently such as Yahoo auction web page at near the closing time, users can select "Auto-update" plug-in. Just before the closing time, many bidders bid for a bidding item. Therefore, although almost parts of the auction web page do not change, only value of current bid is frequently updated. If a user clicks "Auto-update" button on the browser, only value of current bid is updated automatically and continuously. In short, although Yahoo auction site's programs have not adopted Ajax approach, Yahoo auction site was able to behave like a web page adopting Ajax approach on the browser.

4.2. Updating Images in MSN Map Sites

Map sites on Internet are useful. However, even if a user wants to move a central of map, the web page is wholly updated. Because the web page including map images flickers by the whole updating, users often lose a sight of a specific point on a map image. Because Google map site adopts Ajax technology, the operability of the map site is smooth. However, the other map sites such as Japanese MSN map do not adopt Ajax technology.

For example, Figure 5 shows a web page of USA's MSN map site adopted Ajax technology. When a user clicks at a point of the map image, only the map image is updated without updating the whole web page. In contrast, in Japanese MSN map site (See Figure 6), when a user clicks at a point of the map image, the whole web page including not only the map image but also all contents of the web page is updated. The operability of Japanese MSN map site is less than the operability of USA's MSN map site. Therefore, we display a web page of Japanese

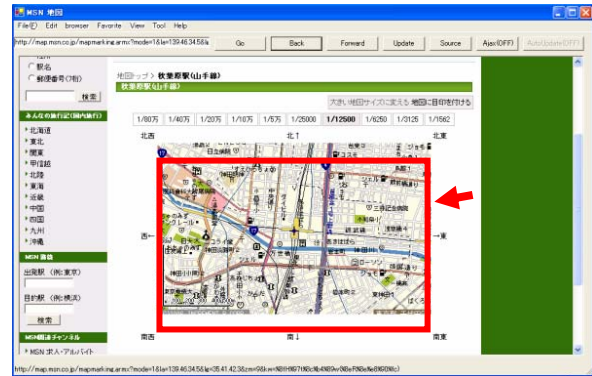


Figure6: Japanese MSN map site on the browser

MSN map site on the browser. We expect that only the map image (See the red rectangle area of Figure 6) is updated when a user clicks at a point of the map image. As a result, the area of the map image is updated with no-updating the other contents.

5. DISCUSSION

A most important feature of the browser plug-in is to improve operability of applications that was not developed under Ajax approach. The proposed model implemented to a web browser can asynchronously communicate with web servers. In this paper, the model for partial updating is implemented as a plug-in of a web browser. The browser avoids flickering a web page by "Reload" and "Update". However, the proposed asynchronous communication model has some problems. In this section, we discuss problems and possibility of the plug-in based the model.

5.1. Performance On a Heavy Load Server

Although the browser plug-in can partially update without revising programs of web applications, we focus on two performance problems, speed of partial updating, and correctness of judging the whole web page. At first, we evaluate updating time of a web page under comparing with the existing web browser Internet Explorer. Of course, because Internet Explorer displays web pages in normal, the web page is wholly updated. The conditions of the experiments are as follows;

- (1) The web server is Apache ver.1.3.4
- (2) The web pages of Yahoo auction site are downloaded to local files of a home directory of the web server.
- (3) The updating time means a period from an event occurring time to finishing time to update partially or wholly.
- (4) Comparing three types; IE's updating, partial-updating on the browser, and auto-updating on the browser.
- (5) The server is given various loads by other tasks. The tasks are the downloading files using Wget software [15].
- (6) The variation of the loads is generated by

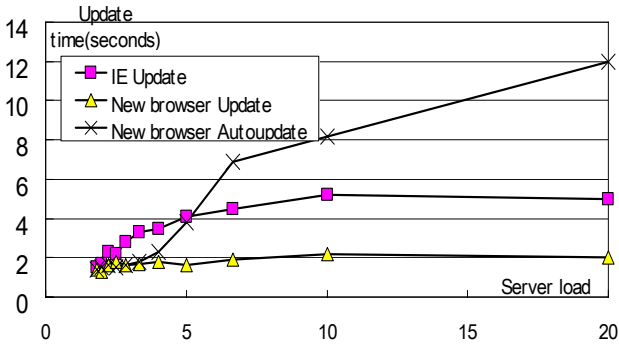


Figure7: Performance of the browser

the number of executions of the tasks from 2 times per 10 seconds to 20 times per 10 seconds.

(7) To compare performances, caches (Internet temporary files) for Internet Explorer are cleared.

(8) When “Auto-update” is ON in the browser, the browser requests the web server at one second intervals.

Figure 7 shows results of the experiments of speed performance of updating time. The x-axis of Figure 7 means the server load. The unit of the X-axis is “the number of file-downloading by Wget”(see the above(5)) per 10 seconds. The y-axis of Figure 7 means the updating time as mentioned above (6). When the load is between 2 times and 5 times, the effect of the browser is clear. Updating on the browser is quicker than updating on IE. In addition, updating on IE in 8 times or more loads leads to a white-out page. However, our web browser leads to no white-out page even if the load is large. In auto-updating on the browser, when the server load is bigger than 5, the performance suddenly decreases. It is because that sum total of server load of the other tasks of file-downloading and request from the browser became more than performance limitation of the web server. We confirm that auto-updating of the browser is also not suitable when server load is large.

Next, we discuss correctness of judgment of updating wholly. In the experiments, according formula (1) in section 3.2.3, “Insert” script’s cost is set to 2.0, “Delete” script’s cost is set to 2.0, “Update” script’s cost is set to 0.5, and the threshold value is set to 0.3. When 30 % of HTML source is different between a current web page and a following web page, the current web page should be wholly updated in replacing to the following web page. In Yahoo auction site, and MSN map site, the correctness of judgment is 70%. The correctness of the other web sites such as MSN top page is less than 50%.

The miss-judgment of wholly updating is caused by meaningless contents of a web page. For example, meaningless contents are codes for displaying commercial advertisements, blank code such as “ ”, carriage return code such as “\n”, and comment lines in HTML source. Especially, many advertisements of a web page strongly lead miss-judgment. Therefore, a

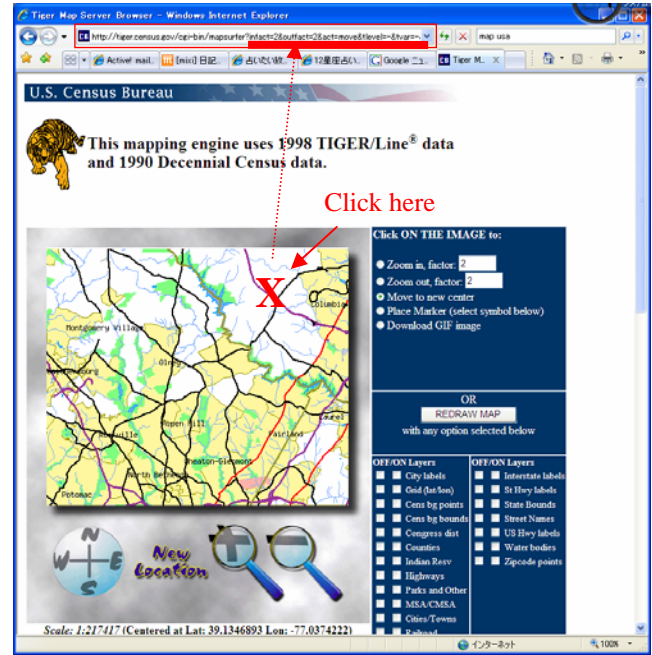


Figure8: Location information in U.S. Census Bureau map site

function of omitting meaningless contents such as advertisements will be implemented to the browser plug-in. Moreover, our judgment way may be more applicable to web pages including specific targets such as auction sites than general information web pages such as top page of MSN. However, because of various types of web pages, we have to improve the values of the costs and the values of the threshold, and the way of judgment of whole updating.

5.2. Performance On No-load Server

We discuss performance of the browser plug-in when server’s load is a little. When “Partial-update” button becomes “On” status in the browser, the additional calculations for making syntax trees, detecting difference based on xmdiff algorithm is required. Of course, the calculations need certain time. Other web browsers such as Internet Explorer do not need such calculation time. Therefore, speed performance of the browser is lower than normal browsers when users click “Partial-update” button on the browser. Especially, when server load is a little, low performance of the browser is clarified. Time to wait for communication with servers in normal browsers is less than time to wait for calculation on the browser. This is demerit of the browser including the plug-in.

However, a most important feature of the browser plug-in covers the demerit of speed performance. A most important feature is to improve operability of web application. Especially, when a web page has no change between a previous web page and a following web page, nothing occurs on the web page on the browser. In addition, even if the web page changes a little, almost all parts of the web page do not change on the browser. The flickering of meaningless of a web page is avoided. Although

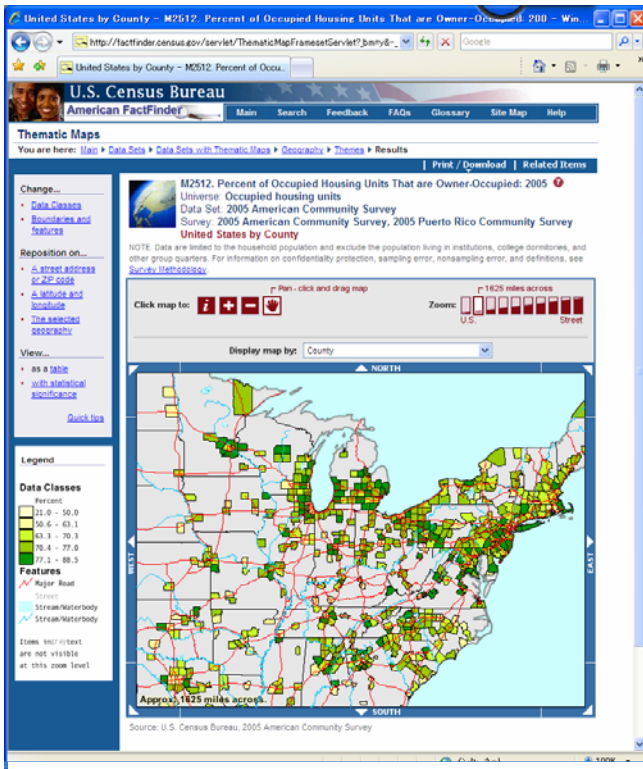


Figure9: Interactive map with Percent of Occupied Housing Units in U.S. Census Bureau map site

the calculation in the browser plug-in is required, users can usually continue to operate the web pages on the browser. Because communication with servers and the calculations (making tree, xmdiff algorithm) in the browser are independently executed from response of the servers (See Figure 2), users will not feel significant inconvenience caused by synchronous communication with servers. Users can operate a web page as same operation as web applications adopted by Ajax technique.

5.3. Possibility of Map Sites With Interactive Operation

Recently, almost map sites have been supported Ajax approach. Operability of map sites is smooth using "drag and drop" operation by a mouse. However a few map sites need the browser plug-in. For example, U.S. Census Bureau provides "Tiger Map Server" (<http://tiger.census.gov/cgi-bin/mapbrowse-tbl/>, See Figure 8). A web page including map image on the Tiger Map Server refreshes wholly when a user clicks a point of a map image. A new location of the following map is "input" tag of HTML source. If a user clicks at a point of a map image, the following request to the web server is based on "input" tag's information. The "input" tag has "src" property of URL address indicating a current image map. The URL has map location (latitude and longitude) like "39.1346893". An example of the "input" tag as follows;

```
<input type=image name=map src=http://tiger.census.gov/cgi-bin/mapper/map.gif?lat=39.1346893&lon=-77.0374222>
```

Therefore, the difference between a current

web page and a following web page is values of the map locations and the URLs.

However, because almost popular map sites such as YahooMap, GoogleMap, and MultiMap have been already supported Ajax approach, the above technique like "Tiger Map Server" is meaningless. Therefore, the other possibility of the above technique is discussed. Figure 9 shows a USA map with percent occupied housing units from U.S. Census Bureau. Map images are displayed with statistical data resources of the percent occupied housing units. Graphical images of the statistical data on a map are more understandable than a numerical data in a textual table. Users can grasp intensively a rough tendency of statistical data. Especially, if the statistical data is related with location of a map, the usefulness of graphical statistical data on a map will increase.

However, the combination map site such as Figure 9 is not yet adapted to Ajax approach. For example, the web page including the map with percent occupied housing units such as Figure 9 is refreshed wholly even if a user would like to move a little the map image. Flickering of the web page occurs. Therefore, the web page is displayed on the browser. Only map image refreshes without whole flickering of the web page. Operability of the web page is improved by the browser.

In future, such combination web site of statistical data with maps will increase because graphical understanding of web pages is better than textual understanding. Engineers of statistical data web sites will be able to avoid being worried about a new technique of Ajax by the browser.

6. CONCLUSION

We have proposed a new web browser plug-in. The browser plug-in is based on an asynchronous communication model. The model can establish smooth operation like web application adopting Ajax approach. In addition, a plug-in function for partial updating is implemented to a web browser. Because the browser plug-in asynchronously communicates with web servers, partial updating a web page is possible while user continue to operate the web page. As a result of experiments, a web page of Yahoo auction, and a web page of MSN map can be partially updated on the browser plug-in. Moreover, when a server load is heavy, benefits of the browser plug-in have been recognized. In future, speed performance of the browser plug-in will be improved, at same time the correctness of the judging whole updating will be improved.

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Modeling Prediction using Quacol Algebra in Web-driven Business Environment

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Abstract— Prediction of time series data for chaotic and web driven business transactions. Prediction technologies: linear regression, artificial neural networks, genetic algorithms and Quacol algebra. Dilemma in prediction technique: functional or stochastic model. Fit composition of prediction functions – Quacol predictor model. Elaboration on rank exclusivity, on continuity of n-point graph and theorem on sign independent algebraic operations. Practical prediction data from chaotic behavior in a ferroresonant circuit. Elaboration on prediction of web driven trading process. Modeling prediction error in Quacol algebra using triangle inequality.

Index Terms— explicit model, qualitative algebra, prediction model, rank exclusivity, rank continuity

I. INTRODUCTION

PREDICTION is usually treated through probabilistic Bayes formula. If we know the probability of outcome B and the joined probability of occurrence of both the outcomes A and B, we can calculate the conditional probability that outcome B occurs if outcome A has occurred [1]. That is a simple and powerful set-based prediction method. Although probability of such an outcome relies on past data it is bravely hypothesized that the continuation of the past can be predicted by modeling. In most crucial cases where prediction is pragmatically sought this condition is not fulfilled. Two schools of prediction philosophy are usually followed: those using stochastic or those using functional patterns of previous data behavior. There are odds in favor of each one of them. We will make a model of the data behavior using different techniques based on algebraic construction of various data-based analytical prediction forms.

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This work consists of: comparison of linear and nonlinear models, case of chaotic data prediction, comparison between deterministic chaos and business transactions, introduction to prediction technologies: artificial neural networks, genetic algorithms and circular qualitative correlation algebra (Quacol algebra) [2]. Prediction by a fit composition of analytical functions in Quacol algebra will be given in more detail as the focus of this work. Results are also given by prediction of data from a chaotic ferroresonant circuit and from a web driven trading process. Analyses of the prediction error from the standpoint of sampling interval, correlation and prediction time horizon are discussed. Also, a pragmatic modeling method for prediction error in Quacol algebra and the consistency of error is defined.

The organization of this work is as follows: Chapter 2 deals with different prediction methods and chapter 3 presents the results of prediction in several applications. Chapter 4 shows the approach for estimating prediction error in Quacol algebra.

1. PREDICTION MODELING TECHNOLOGIES

2.1 Linear and Nonlinear Models

The most simple prediction model is a linear autoregression model. Here the future x_k component of the signal is given with the expression

$$x_k = \sum_1^i \alpha_i x_{k-i} + w_k \quad (1)$$

where:

x_{k-i} - signal component determined in the i-th previous prediction interval

w_k - unknown white noise component at the prediction instant (assumed normal distribution)

α_i - coefficients of the time series expansion of previous time instants.

Standard error of estimation, used in prediction, is given by:

$$s = \sqrt{\frac{\sum (x_i - x_i')^2}{n - k - 1}} \quad (2)$$

where n is the number of samples, k is the number of preceding values of observed value x_i , x_i' are the theoretically predicted values.

This model is still in use for various technical estimations and prediction purposes such as given in [3] and [4]. Different approach is presented by Fox and coauthors who considered a prediction method using regression analysis and artificial neural network [5]. Using long term data the system predicts weather from three days to 15 months in advance with typical accuracy of weekly weather forecasts around 70%. Using correlation of previous weather data and POS store transactions data the system advises retailer on the managerial actions to be taken. In such a way hidden patterns of weather behavior have been pre-selected by the ANN.

In order to generate patterns in advance the method has been proposed by Koza [6] whereby a composition of problem solving entities has been generated and combined in a genetic algorithm version of the problem solution. Such a combination of functions can be used for training of the prediction possibilities which was not developed by the above mentioned author. Still genetic algorithms can be used for constructing models fit for prediction.

Models of chaotic processes are the most difficult for prediction because of their dynamic nonlinearity. Diambra [7] has proposed the equation for sampling width, prediction horizon, and functional for a chaotic process, but without stating neither the horizon accuracy nor the functional nature. Perlovsky [8] on the other hand advocates functional approach to modeling unknown processes in the nature and human activities.

2.2 Quacol (Qualitative Correlation) Algebra Predictor

2.2.1. Qualitative Explicit Model

Qualitative data in Quacol algebra approach can be obtained from quantitative data by a simple ranking procedure. The positive ranking assignment is applied to a set of variables. When ranked, these variables are called n -point graphs (or n -graphs) in Quacol algebra. The ranking is usually performed on a set of time series data, however, the ranking can be applied to any quantitative variable. For example, a measurement vector $v_1 = (3.69, 7.15, 4.37,$

$15.73, 0.18)$ is transformed into its corresponding n -point graph $V_1 = (4, 2, 3, 1, 5)$, a v_2 to V_2 etc. Any desirable variable that is investigated can be defined as goal function, e.g. $g_1 = (27.97, 10.06, 15.28, 37.66, 0.12)$ is transformed into the corresponding goal n -point graph $G_1 = (2, 4, 3, 1, 5)$. Spearman rank correlation coefficient for ordinal variable equals to [9]:

$$\rho_{V,G} = 1 - \frac{6 \sum \Delta^2}{n(n^2 - 1)}, \quad (3)$$

where $\sum \Delta^2$ equals the sum of correspondent squares of rank differences for two n -point graphs, Thus for the illustrated series $\rho_{V_1, G_1} = 0.6$.

The selection performed according to (3) from a greater number of variables and their inverses results in an n -point graph with the highest rank correlation coefficient. Difference in ranks between this n -point graph and the goal function n -point graph is used to generate another artificial goal function to be entered as the algebraic counterpart of the missing rank difference, i.e. this is a rank difference between goal function and model variable, equal to

$$\Delta(G_1 - V_1) = (-2, 2, 0, 0, 0) = g_{2improper}, \quad (4)$$

where the subscript "improper" designates rank difference function, i.e. the value that has not been yet properly ranked. After shifting (4) by adding a positive constant vector such as $v = (3, 3, 3, 3, 3)$, the corresponding quantitative function $g_2 = (1, 5, 3, 3, 3)$ can be obtained. Mixing g_2 values with a small positively defined strictly increasing additive „background noise” $\eta = (0.01, 0.02, 0.03, 0.04, 0.05)$ and after ranking one obtains the proper difference goal function $G_{2n} = (1, 5, 2, 3, 4)$.

After that the following relations hold, adapted from [10]:

$$\begin{aligned} G_1 \text{ corresponds } R(v_1 + kv_i), \\ v_i \text{ corresponds } R(G_{2n}), \end{aligned} \quad (5)$$

where $R(.)$ is the already explained rank operator and the *corresponds* operator first searches the most similar variable v_i according to its ranks to the corresponding G_{2n} goal

function ranks. After v_i has been found according to maximum of rank correlation coefficient amount (3), then a search for k is performed such that it minimizes the difference between the ranks of the sum $(v_1 + kv_i)$ and G_1 .

2.2.2. Quacol Algebra

Two principles of modeling in Quacol algebra, such as given for example in equation (5), have to be adopted:

First is the principle of rank exclusivity which states that any n -point graph should not have any equal ranks, e.g. $V_k = (1, 2, 3.5, 3.5, 5)$ is not allowed. Rank correlation coefficient for equally ranked values would have to be calculated using an adapted formula [9,ibid], which is generally not used because of somewhat higher calculation demand for longer data series .

The second is the principle of continuity of the n -point graph for specific algebraic operations of multiplication and division. The formal definitions follow.

Definition 1. (Rank exclusivity)

The rank values of two values in any n -point graph or goal function are not allowed to be equal, i.e. $R(v_i(j)) \neq R(v_i(k)), \forall i, j \neq k$.

The possible equal data in any variable are solved by the addition of a very small amount of noise to each data in each variable, and theoretically to each variable pair. The addition of noise enforces the distinction of values, with the price being the decrease in determinism of models with highly similar variable values and the gain is the ability to rank the values more efficiently.

Definition 2. (Continuity of n -point graph)

Any algebraic operation between any two

variables can not influence on the rank continuity of any particular variable.

This is a fundamental demand that changes the multiplication and division operation in Quacol algebra where the operations are defined according to Table 1. The proof of result from Table 1 is fairly simple: it stems from a theorem in Quacol algebra that states:

Theorem 1. (Sign independent algebraic operations) If the multiplication and division operations in Quacol algebra are defined according to Table 1, then the ranking operation performed on variables in positive domain is the same as one performed on variables with no restrictions on the domain, i.e.,

$$R(v_1 \text{ op } v_2) = R((v_1 + c_1) \text{ op } (v_2 + c_2)),$$

if $(v_1 + c_1)_i > 0$ and

$$(v_2 + c_2)_i > 0, c_{xi} > 0, c_{xi} = c_{xj}, \forall i, j, \quad (6)$$

where $\text{op} = \{+, -, *, /\}$ is executed upon vector components and c_x are constant vectors. For example, let us take two variables: $v_1 = (2.5, -4, -5, 1); V_1 = (1, 3, 4, 2)$ and $v_2 = (-3, -4, 2, 3); V_2 = (3, 4, 2, 1)$.

If we perform multiplication $v_1 v_2$ according to Table 1 and rank the result, we obtain: $R(v_1 v_2) = R(-7.5, -16, -10, 3) = (2, 4, 3, 1)$.

If we apply the traditional definition of multiplication operation, we would obtain:

$$R'(v_1 v_2) = R'(-7.5, 16, -10, 3) = (3, 1, 4, 2)$$
 .

We perform a "lifting" operation upon variables v_1 and v_2 such that we translate their values into

TABLE 1: MULTIPLICATION AND DIVISION OPERATIONS IN QUACOL ALGEBRA

$v_3 = v_1 v_2$ or $v_3 = \frac{v_1}{v_2}$	$v_{1i} \geq 0$	$v_{1i} < 0$
$v_{2i} \geq 0$	$v_{3i} \geq 0$	$v_{3i} < 0$
$v_{2i} < 0$	$v_{3i} < 0$	$v_{3i} < 0$

the positive domain, e.g. $v_1 + (6, 6, 6, 6) = (8.5, 2, 1, 7)$ and

$v_2 + (5, 5, 5, 5) = (2, 1, 7, 8)$. We then perform the same multiplication operation upon these altered variables and rank them. Thus, we obtain:

$$(v_1 + c_1)(v_2 + c_2) = (17, 2, 7, 56) \text{ and}$$

$$R(17, 2, 7, 56) = (2, 4, 3, 1).$$

This is the same result as without raising the variables' values into the positive domain.

It should be again noted that it is irrelevant whether we perform the alteration of the variables and calculate them in positive domain or we use the special rules for multiplication and division according to Table 1, because the end result is the same. Caution has to be exerted on the values of the variables if standard operations are used, because their values would have to be positive in that case.

2.2.3. Quacol Predictor Model

Let us define as the prediction goal function any desirable goal function (variable) g_k of the depth n , where k is the total number of variables of a system, including the goal function, i.e. $\{g_k, v_i\}, i = 1, \dots, k-1$. Goal model can then be expressed as:

$$M_{g_k} = \{op\}_m \left[v_{m,i}^{\{ord,inv\}}, v_{m,j}^{\{ord,inv\}}, op_m, k_m \right]_{mean(m)}$$

where $\{op\}_m$ is a sequence of m algebraic operations performed on model in square brackets, with respect to theorem 1; $v_{m,i}^{\{ord,inv\}}$ is the first variable in the m -th model, with index $i, i = 1, \dots, k-1$, that may or may not have inverted values; $v_{m,j}^{\{ord,inv\}}$ is the second variable in the m -th model, with index $j, j = 1, \dots, k-1$; op_m is the algebraic operation between i -th and j -th variable and k_m is the weight of the second variable. All of the operations are performed on the variables that have been normalized to a common mean value for that model, denoted by $mean(m)$.

An example of the model is:

$$M_{g^4} = \frac{[v_1 + 0.5inv(v_2)]_{mean1}}{[v_2 - 0.25inv(v_3)]_{mean2}}$$

In circular Quacol algebra, M_{g^4} could be

declared as a new variable and entered into the next cycle of goal estimation [10].

By using a prediction vector x_{n+1} we can predict a future value of g_k when x_{n+1} is added as a last component to each $v_i, i = 1, \dots, k-1$ (all of the variables except g_k), thus $predictor(g_k) = M_{g_k, x_{n+1}}$.

Number of iterations following the procedure described under expression (7) is sometimes limited due to numeric instability of the procedure because of repetitious increase of the differences and mean values in the algebra [11].

2. PRACTICAL INVESTIGATIONS

Predictor limits were tested under following unfavorable conditions:

In chapter 3.1, there was only one system variable and that one had to be predicted from its past values. This is illustrated for the voltage signal of the ferroresonant circuit [12].

In chapter 3.2, the time horizon was tested for small variable set, $k = 4$, the case of trading variable prediction.

In chapter 3.3, the prediction precision was tested for different prediction interval d for small trading variable set, $k = 4$.

(7)3.1. Predicting Chaotic Behavior of the Ferroresonant Circuit

Synthetic functions have been used such as $v_{k-1}v_{k-2}$ or $\sqrt{v_{k-1}}$ or similar analytical forms, by a win – lose method.

Prediction data for ranks of the ferroresonant circuit are given in Table 2. Mean prediction error of the linear model was around 277% and the mean prediction error of the Quacol synthesized predictor was around 108%. The actual voltage levels were between -0,1969V and 0,3464V. The worst case for linear predictor was predicting 2.5929V instead of 0.00825V and the worst case of the Quacol predictor was predicting the value between -0.0176 and 0.024V instead of 0.01892V.

3.2. Determining the Prediction Horizon For Small Number of Trading Variables

Four trading variables were observed: opening,

TABLE 2: PREDICTION RANKS AND RANK RANGES FOR THE FERRORESONANT CIRCUIT IN CHAOTIC BEHAVIOR [10]

	T 1	T 2	T 3	T 4	T 5	T 6	T 7	T 8	T 9	T 10	T 11	T 12	T 13	T 14	T 15	T 16	T 17	T 18
Goal rank	1	2	5	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
Quacol model rank	2	1	5	8	6	9	10	11	12	13	14	15	16	17	18	19	20	21
Linear model Rank	3	2	1	6	9	10	11	12	13	14	15	16	17	18	19	20	21	22
Quacol model rank range	1-3	1-3	4-6	6-9	5-8	8-10	9-11	10-12	11-13	12-14	13-15	14-17	15-18	16-17	17-16	18-8	19-5	20-5

TABLE 3: TRADING FORECAST FOR TEN CASES OF THE „OPENING“ VARIABLE

Case	1	2	3	4	5	6	7	8	9	10
Predicted value	<2105	285-325	585-605	>945	225	>205	385-415	605-615	885-905	385-415
Prediction class	B	A	A	B	C	A	C	A	A	B
Actual value	1995	325	595	985	235	225	375	605	895	435

closing, high and low values of a stock market index. The intervals of scanning were one hour and the time duration was 24 hours. The 25-th value was predicted with varying accuracy, Table 3, for ten different trading situations (last three or four digits were given). Synthetic analytical variables were not used, because multivariable case is less sensitive to such improvements. Prediction class is formed according to rank correlation coefficient span: A>0.99, B (0.97-0.99) and C (0.95-0.97). When the horizon was extended to two-hour periods the correlations have decreased to the values between 0.70 and 0.80 (prediction class F) or smaller thus decreasing the prediction accuracy.

3.3. Prediction Accuracy For Small Number of Prediction Variables and Different Variable Lengths

Two cases have been studied: accuracy of n=25 data series and n=75 data series. Data on shorter model showed overall accuracy around 20% and are not considered here. We present the results for the longer data series. A resulting model n-point graph for a 75 days period is given in Figure 1. Data on prediction accuracy are

given in Table 4. When we predicted the value for two days horizon, we took every second day in consideration, and for three days, every third day was taken. Table 4 shows that when one increases the prediction horizon, the error also shows a geometric increase. Obviously, it is more difficult to predict the value of a stock for more than one day in advance.

4. PREDICTION ERROR MODELING

Goal G_1 and goal difference functions G_{2n} are linear independent variables, meaning that they are principally collected from mutually inverse variables and calculated in geometric way toward goal function fulfillment.

A relative error of predictive model m in Quacol algebra is calculated using standard formula:

$$Error(m) = \frac{\bar{x}_{calc} - x_{real}}{x_{real}}, \quad (8)$$

where \bar{x}_{calc} is the average value of the rank interval for the goal variable, i.e. "Predicted value" in Table 3, x_{real} is the real value of the

goal variable.

Finally, we define the consistency of an error of prediction in Quacol algebra.

Definition 3. (Error consistency)

An error in prediction $Error(m)$ using Quacol algebra is consistent if for each model member of the n -point graph (v_1) and for every successor variable n' -point graph ($v_2 = v_1^{-1}$) obtained

from its difference toward the goal function g , the estimated error of reaching the goal from n -point graph is no greater than the error of obtaining the goal from getting to n' plus the estimated error of reaching the goal from n' (triangle inequality):

$$Error(m) \leq Error(v_1) + Error(v_2), \quad (9).$$

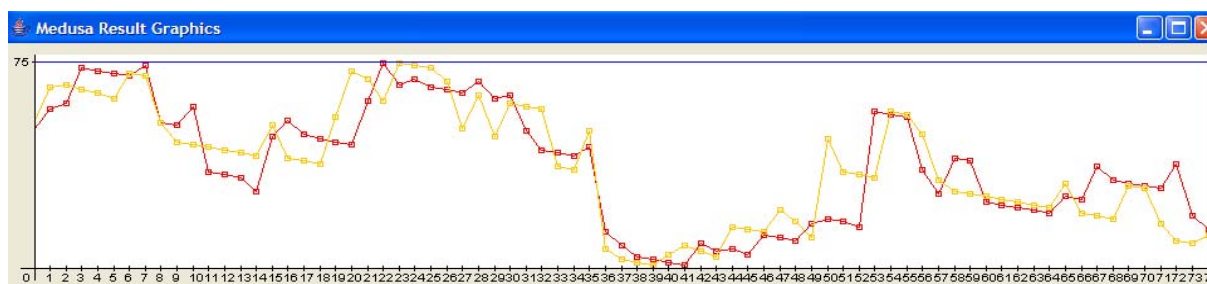


Figure 1. Model rank graph for 75 days period, yellow is the goal variable (opening), red is the model. $MODEL(opening) = high + 0.90low$

TABLE 4. 75, 38 AND 25 PERIODS PREDICTION DATA FOR ATPL STOCK ON THE CROATIAN STOCK MARKET*

Variable	Prediction	Real value	Variable span	Relative error	Correlation coefficient	Prediction horizon
Opening (76)	906-910	910	872-925	-3,78%	0.88	1 day
Opening (39)	906-906	909,99	872-925	-7,53 %	0.84	2 days
Opening (26)	901-901	909,99	872-925	-16,96 %	0,88	3 days

* Data for spring 2007 period;

5. DISCUSSION

Prediction accuracy and correlation of models are highly connected. It can be observed from (9) that prediction error is lower in simpler models, although the error is not additively growing with the model complexity. Ideally for 100 equidistant values and completely discovered goal function the accuracy is of the order of 1 %. Realistic expectations are far less favorable. Neither there are long enough data series that are without large chaotic behavior nor are any linearity in the goal data distribution. Widespread chaotic behavior lowers prediction accuracy while lowering model correlation. Ranking operation is insensitive to irregularities in data scales, but they differ significantly in value changes. Predicting from ranks is much more accurate for linear case. Still predictions of smaller data series (>25

data series) can be expected with about 10% accuracy which can be favorable for many practical applications on the web. There remains the task of more formal proof of theorem 1 and the elaboration of correlation in prediction error of single-variable systems. Errors in such systems are not statistically independent in respect to variable sampling and analytical operations.

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Fair On-Line Civil Trial: An Important Aspect of E-Government

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Abstract— *Incorporation of Information and Communication Technologies (ICTs) into eGovernment and eAdministration is designed to be a method for reducing time and costs of services for both citizens and Public Administration and to realize at the same time an efficient system. An important aspect of eGovernment is the on-line civil trial, in other words, the insertion of ICTs into justice administration to realize a judicial trial in which the different subjects involved in a process can create documents and communicate through information and communication technologies. This phenomenon calls for increasing attention and poses a pressing need, especially with regard to the legal effects arising from the use of advanced technologies in judicial process. However, most existing work is devoted only to technical aspects; no current work deals specifically with the issue under discussion. At the moment there are only various European projects with the aim of publishing the results of their research. The purpose of this work is to underline the advantages and problems of developing ICT use in justice administration. Finally, this paper proposes some suggestions to update ICT use in the judiciary system towards a fair on-line civil trial.*

1. THE ON-LINE CIVIL TRIAL

THE experience of on-line civil trial in front of courts has been extended to judiciary claims - not only small claims - through the use of advanced technologies. In practice, this judiciary procedure is designed to bring suits electronically, to transfer and to send procedural acts and documents, to deliver documents, to record case files digitally and, in general, to support file management and case management [Rußmann, 1999].

The aims of technological proceedings are several: a reduction in justice time, promotion of ease of transport and facilitation of drafting subsequent judgements. Electronic and on-line judicial proceedings, in addition to the aforementioned advantages, can assume different roles. On the one hand, this new technology can be merely a support to the court organization. On the other, this technology could take over primary and leading functions of

a process such as judicial decision-making.

All over the world there are many different approaches in the use of advanced technology in judicial proceedings.

At the moment, in the USA electronic procedure is devoted merely to small claims, like a sort of automatic dispute resolution.

In Europe, many countries' projects on the integration of advanced technologies into the legal system with the intent of creating a digital public administration and a new information technology for courts and justice administration [Zuckerman, 1999], which may be considered the maximum examples of eGovernment, have been experimented [Fabri and Woolfson, 2001; Oskamp, Lodder and Apistola, 2004]. In particular, in Italy¹ the Ministry of Justice has invested many resources in ICT projects for the judiciary to improve the effectiveness of a justice system in constant crisis [Di Federico, 1998; Guarnieri and Zannotti, 2006].

A very encouraging experience of e-justice has been experimented with in Singapore², where the judiciary system has been digitalized since 1990 with excellent results [Tin, 1999].

The depth of ICT employment in judiciary administration depends on the legal validity of the on-line civil trial and is related to the validity of electronic documents and signatures not only for assuring a high level of security, but also for respecting the handwritten form when it is necessary.

At the moment, the legal validity and effectiveness of electronic documents are ruled in many European countries in compliance with European law.³

On an international level there are other law acts, especially the US regulation the UTAH [UTAH] and SEAL [SEAL] acts and the Digital Signature Guidelines from the American Bar Association, Section of Science and Technology.

¹ In Italy the law d.p.r. 13 febbraio 2001, n. 123. An on-line summary judgement is in function at the Court of Milano. It came about through a strict collaboration with the Bar Association of Milano and the Court to allow all lawyers involved in the on-line summary judgements to access digital signature and technical devices for the on-line judicial proceedings. This summary judgement concerns the claims accrued which are not only small claims but also those with a noticeable economic value and it is characterized by a preliminary instruction based upon only documentary evidence.

² www.ecitizen.gov.sg, www.psi.gov.sg, www.gebiz.gov.sg.

³ Directive 1999/93/CE of the European Parliament and of the Council of 13 December 1999 on a Community framework for electronic signatures.

In addition to these aforementioned legal acts the electronic signature's legal rules are also addressed by both the Organization for Economic Co-operation and Development and United Nations Commission on International Trade Law (UNCITRAL) through their Model laws on Electronic Commerce in 1996 and on Electronic signatures (2001).

The on-line trial has the following requirements: security, confidentiality, integrity, and authentication of transmission documents also within the provisions of privacy law.

The mechanism of the digital signature based upon a cryptography system (e.g., RSA or DSS signatures) and is able to guarantee the aforementioned on-line trial requirements. The same technology with a different role may also be used in a system of certified e-mail to assure the identification of the author of the e-mail, because the e-mail is also signed and sealed, and to certify the moment of sending and delivering a message and its attachments [Abadi, Glew, Horne, and Pinkas, 2002; Blundo, Cimato and Prisco].

2. THE FACTORS BEHIND THE ON-LINE TRIAL

In Europe, the variety of solutions adopted by individual countries, both technically and managerially, offers a unique insight into judicial applications of information and communication technology (ICT). It also demonstrates the size of the challenge facing Europe if it is to harmonize systems across national boundaries (Fabri and Langbroek, 2000) and now the gap is now deep between what has been projected and what has been so far realized.

In fact, this phenomenon unites lawyers and technicians all over the world and it is also important the role of the most important organisms of justice administration that has to be assessed in addition to the representative organism of Bar Associations is also important.

As mentioned above, one of the strong points of this phenomenon is based upon the legal relevance of electronic document and technical requirements such as the digital signature, which is able to guarantee the identification of the signer, and the integrity and security of the documents and transmissions⁴. The use of these electronic means is not accepted by all citizens, and this creates "categories of exclusion"⁵, the phenomenon called "digital divide"⁶.

More important than inserting the new technologies into judicial proceedings is to make it (ICT) acceptable to all citizens (Heeks, 2000;

Korac-Kakabadse, N., Kozumin, 2000, Noiret 2005).

The digital divide of professional categories related to the judiciary system has been one of the cause for failure of the initial trial of on-line civil trial.

Indeed, on-line civil trial works directly with the judiciary organization and with the style of work of lawyers, judges, clerks and process servers for achieving efficiency and fast judicial proceedings.

In exercising these purposes it is necessary to create the basis so that on-line judicial proceedings are able to assure an adequate knowledge in civil society.

3. THE ON-LINE CIVIL TRIAL HAS TO BE A FAIR ON-LINE TRIAL

The efficiency of justice is based upon two elements: reducing costs for both the State and citizens, and reducing procedural time.

The principles of a fair trial can be assessed in the following aspects: the equal position of the parties involved in a judicial proceeding, the same opportunities of controverting, a due process of law, and, finally, the reduction of procedural time.

To achieve the purpose of this last element in compliance with par. 6 of the European Convention on Human Rights, it is appropriate to organize justice administration with the new advanced technology.

The ambitious project of on-line civil trial is based upon documents and data interchange, web access, a court management system, and network infrastructure for connecting all courts, as well as interoperability with other Public Administrations, such as the Tax Agency and the State Attorney, which have the same infrastructure and the same standards for increasing data and information transfer amongst themselves.

Attention is also focused on the problem of reducing the complexity and formalism of ordinary procedure and on the introduction of simplified summary procedures or the rationalization of those already existing.

The technical needs arising from the digitized reform have relevant effects on legal rules for civil procedural law: in particular, the rules of on-line civil trials in compliance with civil procedural law with regard to the time taken for issuing judicial acts and orders and the delivery of documents.

Aside from the indisputable advantages of ICT in judicial activity, we have here to deal with the legal issues arising outside of this application. In some European countries the project on on-line trial excludes any given party representing themselves in on-line legal proceedings without an attorney.

A fair trial cannot allow limiting justice to those lawsuits that require the presence of a defence

⁴ The digital signature is a signature based upon an asymmetric cryptography system created by a secure device, which assures the provenance and the integrity of the document on which it is put.

⁵ Par. 8 d.lgs. 7 March 2007, n. 82, Code of Digital Administration.

⁶ Declaration E/2000/L9 of Economic and Social Council of United Nations

attorney, generating a disparity of treatment with reference to the all citizens. A judicial procedure based upon information technology should be faster and cheaper than traditional judgement and all citizens must have the right to take part in an on-line trial.

4. POSSIBLE SOLUTION

Judicial proceedings must assure an equal and balanced position between parties. This guarantee is mainly obtained by correctness and compliance with the right to a fair trial rules and by access to the technical form by all citizens.

Only in this way is it possible to achieve the purpose of a due process of law as a canon of interpretation of those principles in a lawful, fair and impartial trial. Currently, it is possible to put the hypothesis forward of allowing the citizen to participate personally in on-line trial without the assistance of the technical defence of an attorney: this implies the use of a system of certified e-mail. Through this system it would be possible to identify with certainty the plaintiff or the opposing party, because the e-mail is signed and sealed and certifies the moment of sending and delivering message and its attachments. Indeed, these certificates are evidence not rebuttable with another evidence, but only with a special action for fraud. Every message created by the e-mail system is digitally signed in an automated way.

Owing to all these consideration, it is possible to state that advanced technology is able to solve some legal aspects that do not need particular or further procedural requirement to achieve the aims of judicial proceedings.

5. GENERAL CONCLUSIONS

There is no doubt that the on-line civil trial project is ambitious. Many attempts have been made to create suitable conditions for it.

The broad diffusion of highly secure and complex technological methods such as digital signatures, for this project has been considered unnecessary. I disagree with these views. This is mainly because the digital signatures and secure technology are mandatory in the judiciary system to avoid any kind of infringement. I think that at the beginning the problems were viewed as cultural and organizational matters in addition to a social context of digital divide.

Lawyers and judges must accept a new concept of the justice system with electronic devices and innovative methods of working without altering the principles of procedural law, in particular the respect of a fair trial.

The citizen who wants to bring lawsuit electronically can use the existing certified e-mail system as a method for participating in an on-line trial in compliance with the principle of a fair trial and a due process of law.

The rising volume of litigations has caused a

substantial increase in costs and protracted delays. ICT measures could be a way to simplify the rules and the structure of civil proceedings as the summary judgements have proved in Italy, with a noticeable reduction of time and costs of the procedure.

Dissatisfaction with the administration of justice has stimulated the use of various remedies for solving the problems of the judiciary system. However, this encouraging fact, some problems result, such as the access to justice by the parties personally without technical assistance. By this aspect could be easily resolved introducing some corrections to the civil procedural law that would allow all citizens plain and accessible on-line civil justice, including for small claims.

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Controlling Certificates for Grid Security Authentication and Authorization System

May Phyo Oo; Thinn Thu Naing

Abstract—*Grid authentication and authorization services are aimed at verifying the identity of an entity, managing certificates and to restrict from unauthorized accesses to grid resources. Hence, it plays a vital role to get the system availability as well as to prevent the attackers who tries to gain the unauthorized accesses to resources. In fact, this paper proposes the secure certificate framework to improve the security of the certificates based on Grid Security Infrastructure by making each server and each client keep track of how many times a certificate is used and accepted. The main contribution of this paper is using the counting process to secure Authorization and Authentication service for Grid Application.*

Index Terms—*Counting Process, Certificate, Authentication, Authorization and Grid Security Infrastructure*

1. INTRODUCTION

IN a grid, member machines are configured to execute programs rather than just to move data. This makes an unsecured grid potentially fertile ground for viruses and Trojan horse programs [3]. For this reason, sharing of resources is important to control them strongly. Resource providers and

resource consumers need to negotiate resource sharing arrangements, defining the conditions of sharing, such as what is shared and who is allowed to access the shared resources. A set of individuals and institutions participating in such sharing relationships are referred to as a Virtual Organization (VO) [5]. The Certificate Authority (CA) is one of the most important aspects of maintaining strong grid security. A CA is used to hold these public keys and to guarantee who they belong to [15]. Authorization is needed to allow legitimate grid users to access confidential grid information and resources. Thus, Controlling Certificates for Grid Security Authentication and Authorization System (CC_GAA) using matching method and counting method are developed. It is the new managing certificate scheme for grid environment. In this system, Certificate Authority (CA) performs two types of certificate and limits the range of using certificate counts for grid users. In order to put much more trust among sender, receiver and CA, the frequencies of certificates including time stamps are restricted by counting method. These approaches will be applied into Grid Security Infrastructure (GSI) in our system. This paper focuses on authorization, authentication, certificates formats and how security has been made for the benefit of grid users.

There are many benefits in this secure system due to the result of advanced counting service. When a grid user enters

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grid logon, counting service counts the number of units using user certificate and checks either invalid or valid account. Moreover, CC_GAA calculates the limiting counts from CA and returns to the grid user. When grid users face invalid events, they can recover themselves by changing new certificate from CA. So the proposed secure system can control valid certificates regularly in time by replacing counting service in grid logon service. CC_GAA can reduce the risks of stealing certificates. Authentication service as well as authorization in Grid can be supported by adding this counting service in grid logon service. If the attackers enable to get user private key, they can make invalid certificates and they can get other's certificates. And they can use these certificates and access resource until expiration of time. This is the important fact in the role of using certificate. Counting service controls the frequency of using certificate between sender and receiver and restricts the frequency of using certificate among CA, Client and Server. Moreover grid users can check using time of their certificates according to the facility of CC_GAA. To have trust Certificate Authority (CA) of the security infrastructure, counting service is used in the responsibility of CA. Limiting the frequency of Certificates can protect unauthorized access of masquerading attackers because both client and server can check their frequency of using certificates each other vice visa. When they know errors among them as the result of counting process, they can recover themselves by using secondary certificates instantly. So we develop secure certificates in authentication and authorization acceptable to virtual organizations rather than existing certificates.

The remainder of this article is organized as follows. In section 2 related work and problem issues are described. In section 3 proposed framework and models for authorization and authentication assumption are introduced. In section 4 the performance evaluation of CC_GAA system is presented.

Section 5 concludes with a brief discussion and future work.

2. RELATED WORK AND PROBLEM ISSUES

Every user and service on a Grid is identified via a certificate, which contains information vital to identifying and authenticating the user or service [4]. A GSI certificate includes four primary pieces of information: A subject name, issuer (identity of CA), public key (belonging to the subject) and the digital signature of the named CA [8]. CA is used to certify the link between the public key and the subject in the certificate [1]. GSI certificates are encoded in the X.509 certificate format, a standard data format for certificates established by the Internet Engineering Task Force (IETF) [2]. Authentication is important for authorization, confidentiality, auditing, and access control. Authentication aims at verifying the identity of an entity [4]. If the CA's private key is compromised, the digital certificates will not be reliable anymore [13]. In addition, existing certificates rely on private key, public key, and validity of the expiration. If attackers get user private key, they can make false certificates and can access resources without registration till it expires. Moreover, there is another problem when grid users request to CA to issue new certificate for their expired certificates, CA may face the bottle neck of network connection. So CA's reply may delay for important users. If a user wants to send important message, he can face delaying process while waiting for the reply from CA [14].

In order to solve the above problems, an authentication and authorization system for grid users using counting process and creating two types of certificate are proposed. That is one reason why two types of certificate are needed to use for reducing those above risks. According to this idea, issuing two types of certificate is intended to use between Certificate Authority and Authentication Service. Counting Process

might also manage the range of using counts to control their certificates among CA and grid nodes. The CA makes two types of certificate named primary and secondary certificate with the range of using counts to check the true identity of a grid user and their grid requests. Moreover, it plays the important role of access control in order to complete jobs in time. So, we can recover exactly delaying events in time by creating two types of certificate and using the counting process for grid users.

3. SYSTEM FRAMEWORK

In this system, there are six main components like figure 1. They are Virtual Organization, Grid Authorization, Authentication, Access control, Certificates and Counting Process. The security aspects of using counting process and creating two types of certificate for grid users are proposed and controlling certificates for authentication and authorization system within grid environment is built. The secure method of Grid Security Infrastructure for authorization and authentication is an extension of GSI. In order to recover and control Certificates, we should be aware of not only using counting process, creating two types of certificate but also some of the other resources and policies defined in GSI.

3.1 Virtual Organizations

In this system, a typical scenario of a Grid application is a military environment. We describe the following facts:

[1] How the members of VO are interacted in subsystems.

[2] According to the system assumption, each military command is performed as virtual sub organization nodes such as Army, Air Force, Navy and Police.

[3] In Army nodes, there are some branches employed such as Central Command, Eastern Command, Western Command, and Southern Command and so on.

[4] In Air Force (AF) Node, there are some branches employed such as AF1, AF2 and etc.

[5] In Navy Node, it also consists of some branches command.

[6] In Police Node, police command is also organized by some branches such as Special Bureau Command (SB1), SB2 and so on.

3.2 Process Flow of VO Members

In this section, we describe the process flow of VO members for CC_GAA system as following algorithm.

1. Army.Defence \rightarrow Rg:{VO}
2. VO \rightarrow Defence{Verify :Army.Defence}
3. SC.Army: Confirm {Id}_{Army.Defence} ,
where SC is site contact.
4. VO \rightarrow CA {issue Cer_{Army.Defence}}
5. PL \rightarrow Contact {Police.Home Affair}:
Create {SubNAccount_{Cer}}_{Army.Defence}
where PL is project leader.
6. VO \rightarrow Army.Defence{Account.Police}

In step 1, Army Command registers with the VO to get a certificate. In step 2, the VO will contact Army Command in order to verify that the information of Army Command is true or not. In step 3, the site contact in Army confirms the Army Command's identity. And the VO asks the CA to issue a digital certificate for Army command in step 4. Then the project leader contacts all VO sites to create a local account for Army command based on the Subject name in his Certificate like an account of Police. Later, Army Command is sent to a confirmation that his account with the VO has been established according to step 7. In this way, Army Command becomes a Virtual Organization member. This is a component of our system.

3.3 Authorization and Authentication Model and Assumption

In this secure model, it could prove the secure authorization and authentication system as follows.

$$z(x) = \sum_{i=1}^n s_i - c_i \begin{cases} \text{accept, if } z(x)=0 \\ \text{reject, otherwise} \end{cases}$$

Let $z(x)$ = authorization function
 s = user's attributes from registration process

c = attributes on user's certificate
 If the user's attributes such as registration number, user name and so on, are the same as the attributes of the registration process, then CA accepts the user as an authorized user and issues two types of certificate. Otherwise, the user's request will be rejected.

$$v(x) = \sum_{i=1}^n g_i - u_i \begin{cases} \text{accept, if } v(x)=0 \\ \text{reject, otherwise} \end{cases}$$

Let $v(x)$ = certificate verification function
 u = attributes of user's primary

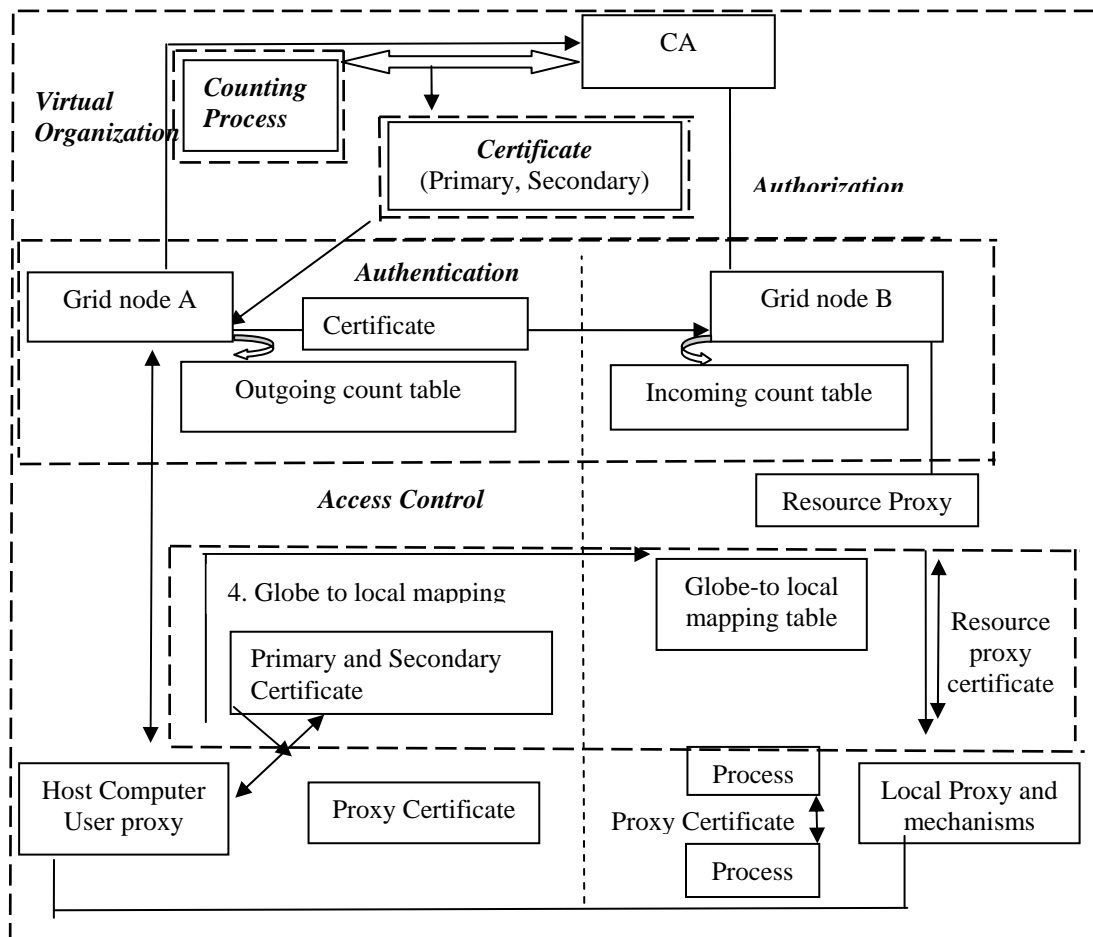
certificate

g = policy information agreed from CA

When grid server receives client's primary certificate, server verifies attributes of user's primary certificate matching with agreed policy information of CA. If the attribute of user's primary certificate is the same as information agreed from CA, certificate revocation function reports to grid server like a true certificate. Hence, grid server accepts it as a real certificate. Otherwise, server assumes it as a false one and rejects the certificate. In addition, errors are checked by using the matching function.

$$f(x) = b_i - a_i \begin{cases} \text{accept, if } b_i - a_i = 0 \\ \text{reject, otherwise.} \end{cases}$$

Figure1: Components of CC_GAA System



$f(x)$ = matching function

a = number of frequency of outgoing certificate

b = number of frequency of incoming certificate

There are two facts in this model: If the difference between the number of frequency of outgoing certificate and the number of frequency of incoming certificate is equal to zero, there is no error. So both the user and grid server will continue communicating and trust each other. Otherwise, there is an error. If that happens, both the user and the grid server understand that it is an invalid event. Depending on the result of matching function, grid server decides whether to allow resources for the user or not.

Again, the counting method has been built for checking restricted frequency of certificate as shown in the following secure simulation model.

$$g(x) = r - \sum_{i=1}^n i \begin{cases} \text{accept, if } g(x) = 0 \\ \text{reject, otherwise} \end{cases}$$

$g(x)$ = counting function of using certificate

n = the sum of using counts from grid user

r = the restricted range of using counts from CA

In this secure counting model, two facts are found out. If the difference between the total frequencies of using certificate from the user and the restricted range of using counts from CA is greater than or equal to zero, there is no error. So both the client and the server will continue to communicate and trust each other. Otherwise there will be invalid events.

TABLE 1: NOTATION USED IN THIS PAPER

$C_{\text{Restrict}}, \text{SubN}$	Restricted Certificate , Subject name
C_{req}, R_g, F_c	certificate request, register, frequency of using certificate
$C_{\text{pri}}, C_{\text{Sec}}, \text{Sig}$	primary certificate, signing secondary certificate

4. PERFORMANCE EVALUATIONS

We evaluated the performance of CC_GAA system as the following results.

4.1 Mechanism Using Counting Process

In this system, there are the restricted counts of using certificate for each user. We analyze the statistics of over counts. We show the performance evaluating results in figure 2.

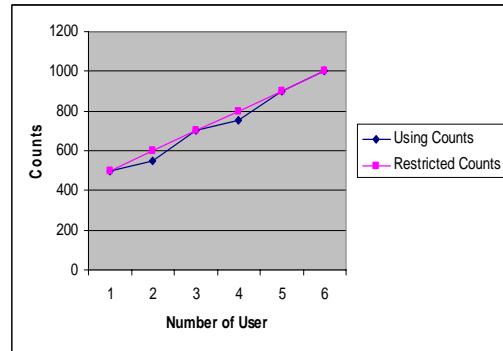


Figure 2: Restricted Counts and Using Counts

According to figure 2, when users overuse their number of using counts, counting algorithm can detect over counts and give message as user's certificate is expired. As soon as users know their expired certificate, user can use secondary certificate. Counting service of CA can protect attacks to have trusted certificate by controlling the range of using counts.

4.2 Mechanism Using Matching Method

Matching method is applied in grid authentication system which grants sender and receiver by managing the frequency of incoming and outgoing certificate. We show the performance evaluation results in figure 3.

Whenever users send their certificates to Grid Server, user's outgoing count table record user's certificate counts. On other hand, the frequency of certificate is also recorded by incoming count table of Grid Server. In fact that frequency of user's certificate can not be known by any one. Whenever hacker tries to access resources using user's certificate, hacker may face access denied from server due to the result of matching algorithm and counting algorithm. Even hackers get user's private key and they can access resource; users can know that their certificates have problems due to the result of matching algorithm. Hence, user can request a new certificate by changing key. Hence, these results detect the invalid events and protect unauthorized users to access resources.

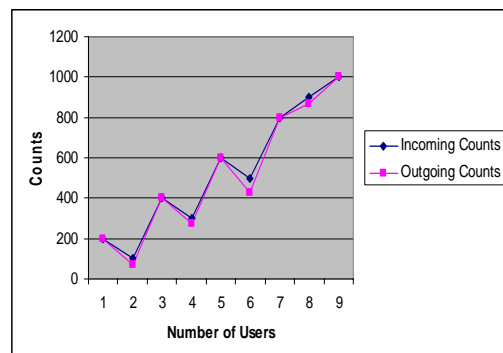


Figure 3: Incoming Counts and Outgoing Counts

5. CONCLUSION AND FUTURE WORK

This paper presents a recovery method for authorization and authorization architecture that based on Grid. The Security Framework, thorough research on Certificates in the Grid environment has been developed. We are also focusing on Grid security authentication and methods about how to improve authorization with trust managing certificate on Grid. The certificate of this secure system is certainly more reliable than existing certificates for Grid Users. The counting process could manage which secured credentials make it easier for authorized user to use their certificates. It can also be argued that when users face invalid events, they can use secondary certificates to access the resources recovering themselves. As the result of CC_GAA, access control will also be provided in the future. This system can be applied not only in Grid environment but also in any application such as Sensor Network, Mobile Computing and so on.

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Ida Freund: Teacher, Educator, Feminist, and Chemistry Textbook Writer

Palmer, Bill

Abstract— *In the nineteenth century the importance of the following women textbook writers deserves recognition: Jane Marcet (Chemistry and natural philosophy); Mary Somerville (Physical sciences); and Mrs Lincoln Phelps (Biology and chemistry). They were all prolific writers who were recognised in the highest scientific circles.*

Ida Freund, in the early twentieth century, was another textbook writer in this tradition. She wrote two major chemistry books but these were virtually her total life's work. However a well known historian of chemistry said that her work "is to be classed among the really great works of chemical literature".

This paper will focus on the life and work of this great woman chemist and educationalist, whose ideas on physical and chemical change and of the value of practical work in teaching chemistry put her ahead of her time.

1. INTRODUCTION

IDA Freund's life and work is not widely known, so her story is worth telling. Ida Freund's two books relate to chemical change as was the doctoral thesis of the writer of this study. Some comparisons can be made between her work and the work of Henry Edward Armstrong (Palmer, 1998). However they expressed opposite views on science education issues (Brock, 1996, Footnote 71: Jenkins, 1979, p. 175). Brock (1996) indicates that Armstrong supported *heurism* whereas Freund opposed *heurism*. The problem here is that Armstrong was far from consistent in defining *heurism* and that Freund's painfully careful experimentation was hardly suited to science teaching for all. However both were extremely competent chemists with a passion for experimental work. Jenkins indicates that Armstrong and Freund also had opposed views on domestic science curricula. In this case Armstrong's views were probably not soundly based on experience: it was a part of his personality to express strong views about 'everything'. Ida Freund had a wide variety of skills that would have enabled her to give instruction in domestic science had she wished to

do so, but as will be seen later she was not supportive of domestic science curricula.

Ida Freund enjoyed a varied life in spite of physical handicaps; her determination to succeed transcended her disabilities. Little biographical detail is available. No biography or autobiography is available. A Cambridge University Scholarship (URL: [Ida Freund Memorial Prize](#)) is named after her. The two books that she wrote and the regard in which she was held by colleagues and students are her memorial. Some information about her can be found in dictionaries such as Oglivie and Harvey, (2000) and Oglivie (2004), though many, such as Cooney (1996), Kass-Simon and Farnes (1993) and Yount (1997), do not mention her. Other sources include an article (Hill and Dronsfield, 2004) and Benfey's introduction (Benfey, 1968) to the 'Dover' reprint of her book *The study of chemical composition*. She is mentioned in some of the histories of the Cambridge women's colleges, such as Gardiner (1914), Welsh (1914) and Grimshaw (1979). The preface by Hutchinson and Thomas to Freund's book *The experimental basis of chemistry: suggestions for a series of experiments illustrative of the fundamental principles of chemistry* is a personal tribute by kind friends. There are also a number of obituary notices and various studies of women chemists (Rayner-Canham, and Rayner-Canham, 1998, pp. 69-71; Fara, 2005, pp. 156-159) are helpful. Patricia Gould has provided the author of this study with information about Freund whilst Gould (1997b) was researching women physicists of the period. A brief vignette of Freund's very interesting life follows.

2. EARLY LIFE

Ida Freund was born in Vienna, Austria on 5 April 1863, but she was left an orphan when young and was raised by her maternal grandmother there (Shorter, 2005, p. 181). She attended a state school and then trained for teaching obtaining the Austrian State Diploma for teachers. After this her grandparents died one after the other in spite of Freund 'nursing them tenderly' (Gardiner, 1914, p. 34). So, in 1881, at the age of eighteen she came to England to keep house for her uncle Ludwig Strauss, a violinist.

Her uncle had influential friends who

recommended that she be sent to Girton. He agreed as he had long recognised her talents, so she prepared for the 'Little-Go' examinations at a private institution. Greek, Latin and mathematics were all new to her. In July 1882 she was admitted to Girton College, Cambridge (Anon, 1948), but it can hardly be said that this was what she wanted – in fact she bitterly opposed the idea of going to college (Welsh, 1914, p. 9). However she did put her heart and soul into her work in science. Here she achieved a first division in both the first and the second part of the Natural Sciences Tripos in 1885/1886. It was a remarkable achievement considering that she was working in a second language and that at the time it was difficult for women to get advanced instruction in practical chemistry. Physics was her second subject for part of the Natural Sciences Tripos and she did this almost as brilliantly as her beloved chemistry.

3. CAREER

In 1886, she became a lecturer in Cambridge Training College. In 1887, she was appointed Demonstrator in chemistry at Newnham College. However, in 1890, she underwent an operation which left her lame for life (Welsh, 1914, p. 10) and she temporarily left Cambridge to support her uncle in London. There are three slightly different versions of the cause of her lameness. An informant with access to the University Library at Cambridge states that amongst the William Bateson Correspondence (Cambridge University Library) in a letter from Bateson to Anna Bateson, of 16 Jan 1890, Bateson wrote: 'Poor Miss Freund has had a leg amputated for disease of some sort. I believe, Trumpington Street is laid with straw for her.' On the other hand, Benfey (1968) states that 'she lost a leg in a carriage accident'. Wilson (1905) says 'In her youth she had a cycling accident and lost a leg; she had an artificial one...' and this latter version of events is confirmed by Mary Creese (Creese, 1991, p. 287).

Freund stayed in London until 1893 and when her health improved, she returned to Cambridge with her uncle whose health was failing. She resumed work at Newnham and she looked after her uncle until 1899, when he passed away.

Her chief interest was her work at Newnham College, particularly practical chemistry. In 1903 she won the Gamble prize (Anon, 1948, pp. 21-22) for her essay on *The history prior to 1800 of theories concerning the ultimate constitution of matter*. This is unavailable but it would seem likely that much of it is contained in her first book, which was entitled *The study of chemical composition* and was published in 1904. It is a massive piece of work of about 650 pages in length of which M. M. Pattison Muir says '... is to be classed among the really great works of chemical literature...' (quoted Gardiner, 1914, p. 36)

Considerable information is available about her teaching responsibilities and schedule:

The Cambridge University Reporter shows that she taught practical chemistry at the lab in Newnham for two hours, three mornings a week, from Easter Term 1887 until Lent Term 1898 inclusive. After this date, the timetable for chemistry seemed to alter considerably. For example, in Easter Term 1898 she lectured on Chemical Theory (treated historically) at the Balfour laboratory for 1 hour, three times a week; lectured on physical chemistry in a room at Newnham 8pm on Thursday evenings; practical chemistry classes as before. (P. A. Gould, 1997b)

4. MISS FREUND'S CHEMICAL WRITING

As stated earlier Miss Freund wrote two major books, namely *The study of chemical composition* and *The experimental basis of chemistry* and a few articles on chemistry.

Contemporary reviews of these seem uniformly favourable, for example a review of *The study of chemical composition* states:

The author quotes very freely from original sources, the experiments of the writers being described and their reasoning given in their own words wherever possible, and this gives to the book a peculiar freshness which will be appreciated by every reader... (Stokes, 1906, p. 282)

Kahlenberg (1905, p. 567), himself an experienced chemistry textbook writer, provides a very favourable review of *The study of chemical composition* for students and others who need an accurate summary of existing views of chemical composition.

This viewpoint is confirmed by the number of scholars citing Freund's book *The study of chemical composition*. Freund is often cited by historians of science, such as Thomas Kuhn (Kuhn, 1952, p. 12, footnote 2: for her evaluation of atomism in chemistry), Richard Sharvy (Sharvy, 1983, p. 439, footnote 1: concerning Aristotle's ideas on mixtures), Guerlac (Guerlac, 1961, p. 535, footnote 6: for her opinions on Dalton), Aaron Idhe (Idhe, p. 96, footnote 4: for her table of data on Richter's analytical results) and Benfey's (Benfey, 1974, p. 353, footnote: brief biography of Julius Lothar Meyer). There is no doubt that Freund acts as a greatly appreciated secondary source for the views of earlier chemists on the chemical composition of matter, a source which later historical scholars have built upon.

The book, *The experimental basis of chemistry*, was originally planned by Ida Freund to have been 20 chapters in length; she continued writing until a few days before her death, completing ten chapters. Her friends (Mr Hutchinson and Ms Beatrice Thomas) edited these ten chapters, remarking how little editing was necessary (Hutchinson and Thomas, 1920,

p. viii); the book was published in 1920, six years after her death. Brock (2000, p. 418) regards this book as influential in reinforcing 'the significance of illustrative experiments in teaching the fundamental laws of chemistry'. Freund in her writing considered that 'the use of terms such as research, discovery and proof in connection with experimental work' of students was inappropriate (Brock, 2000, p. 418).

Apart from her two books it is difficult to trace Freund's other publications in full. She did research on the neutralisation of a number of salts and published her results in a lengthy article (58 pages) in *Zeitschrift für physikalische chemie* (Freund, 1909). The article was written by Freund in English as Effect of temperature on the volume change accompanying neutralization in the case of a number of salts at different concentrations (Benfey, 1968, p. xi) and translated into German by W. Neumann. The paper was also communicated to an English audience, being read to the Royal Society (Freund 1908). Producing quality research in the limited laboratory conditions available at Newnham College and combined with her physical handicap was an amazing achievement. Richmond (1977, footnote 13) quoting from Freund and from a student of the period, points out the inadequacies of the Cambridge women's college laboratories in terms of size 'no one could tell whether it was the post-office box, a safe, or a draught-cupboard' and in terms of heating in the winter 'I still quiver with cold as I remember those raw days in the laboratory...'.¹

These would have been the conditions in which Ida Freund produced her research. Berry and Moelwyn-Hughes (1963, pp. 357-392) tell the story of the revival in 1901 of the old Cambridge Chemical Club which included all those who lectured in chemistry at the university and at the colleges (1963, p. 357). Ida Freund would have been a member of the club as she was in charge of the Newnham College laboratory (1963, p. 358). Many prominent chemists including H. E. Armstrong presented papers to the club, which had an average attendance of thirty for its meetings. These meetings would have provided Ida Freund with an opportunity to hear the latest research and to present her own research. 'A valuable paper entitled "Double Salts" was given by Miss Ida Freund (Lecturer at Newnham College)'. No detail of this paper appears available but the main points are described by Berry and Moelwyn-Hughes (1963, p. 361) and a number of these headings can be found in *The study of chemical composition*, so some idea of the paper may be obtained.

Freund also had a piece of laboratory apparatus (Fowles, 1957, p. 371) named after her as her invention, though the apparatus is no longer in common use. The apparatus was a variation on Ostwald's gas measuring tube, see

Fowles (1957, p. 324). This does indicate that Ida Freund was a skilled laboratory chemist and practical researcher as well as a chemical writer.

5. STUDENTS' VIEWS OF MISS FREUND'S LIFE

Some comments by friends and students give an indication of the esteem in which Ida Freund was held:

Miss Freund was a terror to the first-year student with her sharp rebukes for thoughtless mistakes. One grew to love her as time went on, though we laughed at her emphatic and odd use of English. Yet how brave she was trundling her crippled and, I am sure often painful body about in her invalid chair smiling, urging, scolding us along to 'zat goal to which we are all travelling which is ze Tripos'. (Ball, 1905, p. 76)

In my day Miss Freund reigned supreme in the Chemistry Lab. in the garden. She was a great character. (Wilson, 1905, p. 72)

Everyone who worked with Miss Freund knows that her high standard and stringent requirements gave you a new idea of the demands of science; you were not allowed to think that you understood, when you did not understand, or to be satisfied with a result which was not the most accurate that you could obtain. (Gardiner, 1914, p. 35)

Gardiner (1914, p. 35) also refers to a student who speaks of Miss Freund's power of encouraging the timid, showing them what they could achieve. All these comments indicate the regard in which Ida Freund was held by her students.

6. PEDAGOGY

Ida Freund's pedagogy is perhaps one of the most interesting facets of her life, yet it is not clear that she had any great influence on the direction that science education was taking at a time when debate in this area was fierce. As previously indicated she certainly seems to have crossed swords with Henry Edward Armstrong on the issues of *heurism* in science teaching describing it as 'nothing better than make-believe, fraught with grave intellectual danger (Freund, quoted Fowles, 1957, p. 513). From a distance of a hundred years, the differences on *heurism* do not seem that great. Freund appears to have been against discovery learning, which she considered fraudulent.

Miss Freund had a dread of thoughtless experimenting and slipshod thinking. She felt strongly that much that passes for training in science has little relation to scientific method and is of small educational value.

(Hutchinson and Beatrice Thomas, 1920, p. vi)

Surely, therefore, the more honest, intellectually bracing and eventually more fruitful course is to sweep away all delusions as to what pupils can discover for themselves... (Freund, 1920, p.8)

But as things are, the attitude of many teachers of elementary chemistry who are considered most progressive and most truly scientific has much in common with the Alchemists of an earlier age... (Freund, 1920, p. 9)

These statements may have been written specifically to annoy Armstrong and no doubt would have done so, but by the time the Freund's book was published he was already a spent force due to the practical difficulties of implementing heurism on a large scale. Ironically one doubts that the sort of critical understanding of chemistry that Freund desired for teachers and their students was brought any nearer by the gradual diminishing of Armstrong's influence. In fact, the outcome was of a cheaper, learn-by-rote science that would not have satisfied the ideals of either Armstrong or Freund.

Ida Freund strongly opposed the replacement of science in the curricula of girl's schools by domestic science:

But powerful opposing forces, including other women such as Ida Freund, who was herself a science graduate and a fellow of Girton College, Cambridge, ridiculed the idea that cooking could ever attain the status of science in her attacks on the King's College course during 1911-12. (Bird, 1998)

During her teaching career Ida Freund was responsible for helping undergraduates pass Part 1 of the Natural Sciences Tripos in chemistry, where frequently they had not studied chemistry before, so she is one of the earliest science teacher educators. In 1897, Ida Freund held a vacation course for physics teachers at Newnham College, because several of her former students who were now teaching 'complained of the scarcity and inferiority of the apparatus at their disposal'. They learned 'how to construct the simpler kinds of instruments for themselves.' (Gardner, 1921, pp. 121-122). Thereafter she organised regular courses for science teachers, fulfilling the teacher educator's role of assisting the teaching profession, whenever possible. Ida Freund's influence was limited because she mainly worked at an individual level, concentrating her energies on a few students rather than getting involved in serving on committees and writing articles publicising her views.

Ida Freund (Freund, 1905) wrote briefly about her chocolate periodic table, which serves as an exemplar of her pedagogy. She had made a periodic table from Edinburgh Rock and chocolate when 'the elements were iced cakes each showing its name and atomic weight in icing... We divided it up between us' (Wilson, 1905, p. 72).

Freund modestly describing the same event said:

Whether it [Freund's chocolate periodic table] is of a kind that would lend itself to extended use as an adjunct to the study of chemistry must be

considered doubtful. (Freund, 1905)

The chocolate periodic table was made with care and skill, combining a knowledge of chemistry with ability as a cook and craftsman; it was a labour of love and evidently each year she prepared a different treat for her students. This example is certainly a precursor to much current work in making lessons interesting (often through food), so her pedagogy is excellent. It is Freund's excellent example as a teacher with her own distinctive pedagogy as well as her intellect and her sincere concern for her students that makes her a model for teacher educators.

Freund appears to have reservations about the accuracy of the periodic table from a theoretical perspective – perhaps not surprising as the table as then known was constructed on different principles from those used today (atomic weight rather than atomic number). However, her reservations can be seen more clearly in one chapter of *The study of chemical composition* where she points out some of the periodic table's deficiencies (see Freund, 1904, pp. 504-5, Wyruboff's criticisms). Nonetheless the criticism of the periodic table may surprise those present day educationalists who see the periodic table as central to the study of school chemistry.

Ida Freund retired due to ill health in 1912 and died in 1914 (Anon, 1914a: 1914b), but up to the day before her death was still working on the manuscript for her book *The experimental basis of chemistry*. The Ida Freund Memorial fund was subscribed by friends after her death and the proceeds were given to Newnham College to raise the standard of physical science teaching in schools by giving teachers opportunities for further study. This was in accordance with Freund's life-work.

7. FREUND'S OTHER WRITING AND HER POLITICAL VIEWS

It is said (Gould, 1997a) that Austria, where Freund had received her early education had been supportive of the educational and social progress of women, whereas English social conventions of the time gave women's education only limited support and virtually no political influence. She was active on many social issues; she was a member of the women's suffrage movements (Hill and Dronsfield, 2004); she financially supported the Southwark Settlement for the mentally handicapped and knitted clothing for the soldiers in the Boer War. She was well-travelled as, whilst her uncle was alive, they used to go on trips around Britain and Europe together. After his death she went on cycling holidays to Europe (she used a tricycle, powered by her arms) and went as far afield as Scotland, Switzerland, Germany, Austria and Italy.

Her views on education for girls, particularly in science, were strongly and sincerely felt, but her desire also for scientific accuracy, individual effort and examination success would not

necessarily endear her to women's movements today. It should be remembered that tempering her surface hardness, there was a deep compassion for people.

As a committed feminist, Freund wrote in a number of different journals and gave evidence to a Parliamentary committee. Two examples follow: in 1911, Freund who was seriously concerned about academic standards in girls' schools, wrote a lengthy contribution for *The Englishwoman* (Freund, 1911) pointing out the dangers of trying to teach science in an applied, 'domestic form' (Dyhouse, 1977, p. 29); Vickery (1999, p. 155) states that when the question of whether domestic science should replace science as a discipline in women's colleges such as Newnham College was raised, Ida Freund responded angrily arguing that domestic science could in no way prepare a student to think and analyse in the proper scientific method.

8. CONCLUSION

There is something particularly remarkable about Ida Freund's life and many people find Freund's life inspirational. For example Susan Gasser, Director of the Friedrich Miescher Institute for Biomedical Research in Basel, writes:

My other heroes include a set of women scientists, Ida Freund, Marie Curie, Barbara McClintock and Dorothy Hodgkin. They pursued the research that they loved and tolerated whatever they had to bear to do it, ignoring that science was not 'something appropriate' for women. I admire their force of character. (Gasser, 2007)

Her interest in the teaching of chemistry, her concern for accurate practical work and her interest in chemical composition naturally lead to her work on physical and chemical change, which is a particular interest of the author of this study (Palmer, 2003).

Although she wrote just two books and some articles, a contemporary Cambridge chemist Matthew M. Pattison Muir said that her work 'is to be classed among the really great works of chemical literature' (quoted by M. I. Gardiner, 1914). Her obituary in *Nature* (A correspondent, 1914, p. 327) remarked that 'science has lost a devoted follower, chemistry an enthusiastic and original teacher, investigator and writer, and her friends a wise, warm-hearted and gentle woman'.

It is worth noting that she is one of only fifteen British women chemists mentioned in *The Oxford Dictionary of National Biography*, which contains biographies of 514 British male chemists (Kauffman, 2004) amongst the total of 50,000 biographies. This distinction places Ida Freund in context as achieving great distinction in her chemistry in an era where it was not easy for a woman to excel in the sciences and she accomplished this in spite of severe physical difficulties. She also found time and energy to be

active politically to ensure women a place in the science of the future.

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