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Volume of extended abstracts

CS^2

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Preface

This conference is the fourth in a series. The organizers have tried to get together those PhD students who work on any fields of computer science and its applications to help them possibly in writing their first abstract and paper, and may be to give their first scientific talk. As far as we know, this is one of the few such conferences. The aims of the scientific meeting were determined on the council meeting of the Hungarian PhD Schools in Informatics: it should

- provide a forum for PhD students in computer science to discuss their ideas and research results,
- give a possibility to have constructive criticism before they present the results in professional conferences,
- promote the publication of their results in the form of fully refereed journal articles, and finally
- promote hopefully fruitful research collaboration among the participants.

The best talks will be awarded with the help of our sponsors. The papers emerging from the presented talks will be forwarded to the journals of Acta Cybernetica (Szeged), and Periodica Polytechnica (Budapest); and the mathematics oriented papers to Publicationes Mathematicae (Debrecen). The deadline for the submission of the papers is the end of August 2004. The manuscripts will be forwarded to the proper journals. To get acquainted with the style of the journals please study earlier issues of them. One sample paper is available at `http://www.inf.u-szeged.hu/~cscs/csallner.tex`.

Although we did not advertise it on the web, a high number of good quality abstracts have been submitted. If you encounter any problems during the meeting, please do not hesitate to contact one of the Organizing Committee members. The organizers hope that the conference will be a valuable contribution to the research of the participants, and wish a pleasant stay in Szeged.

Szeged, June 2004

Tibor Csendes

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Detailed program

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09:00	Szilárd Jaskó: *A new mathematical formalism for the TTCN 3 core language*	Attila Szegedi and Tibor Gyimóthy: *Dynamic Slicing of Programs Compiled for the Java Virtual Machine*
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Web Information Systems Engineering: problems and solutions

Attila Adamkó

Recently a growing demand has arisen for methods for the development of small- and medium scale Web Information Systems (WIS). Web applications are being built in a rapidly changing environment where requirements are usually unstable. Short-time design and implementation are needed in response to the new technologies. Designing and maintaining Web applications are major challenges for today's software industry and researchers.

In this paper, we will try to give some basic ideas about Web site development, discussing modeling issues and techniques. We will consider the current techniques, implementations, and introduce some (conceptual) problems as well.

Our work focuses rather on the design and construction of Web application, than management. Flexibility is a major requirement in such applications, and also in a database-backed environment for the structure and presentation of the sites.

We want to reveal the problems with current methodologies and development approaches, and to introduce a new aspect of the modeling. How to divide the business logic layer into two parts: the pure application logic for managing the workflow of the application and the storage logic responsible for the data structures. We will show the role of XML: why to use XML to support both the reuse of content and context- dependent delivery. The XML documents can be easily transformed with XSLT templates and transformers to achieve universal client access.

We will show some code examples to demonstrate problems with modularity and code mixture of business logic and presentation elements within one software module. This has to be clearly separated into two distinct modules to allow of the reuse of both logic and presentation modules. Following the guidelines of the Model-View-Controller design pattern during the development process makes it possible to achieve a well- structured and modular system.

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Planning and Developing Dynamic Web Sites in different platforms

Attila Adamkó and Csaba Bornemissza

Nowadays tendency is that Web applications are being manufactured in a rush. There is no time for thorough software design and development processes. In the evolution of Web application development there was never such a need for reusable program codes than in this very quickly changing programming environment. This constantly changing environment itself causes a lack of detailed design and implementation time.

We could think that this is a normal expectation in the community of Web Engineering. However, unstructured and rapidly developed systems can not easily follow the always changing requirements.

In this paper, we will try to demonstrate how to plan and realize well-founded software solutions for the Web. We will introduce the Web application designing procedures, discussing the functionality of each tier. During the development process we will follow the guidelines of the Model-View-Controller design pattern, achieving a well-structured and modular system.

After this we will show the advantages of the modularity, especially concentrating on the reusability, redesign and refactoring.

In the last section we will present some code examples to demonstrate implementation techniques in tree different Web platforms. We will try to illustrate the basic and always existing programming steps in Perl, J2EE and Microsoft .NET. We will discuss the task of database access, including stored procedures, consistency checks and validation support of database engines in different environments (Oracle, MS SQL, PostgreSQL).

The next step covers the object-oriented approaches for the business logic layer in all of the above mentioned platforms. Following the MVC pattern to display the information content we show how to use XML data and XSLT transformations for different clients.

Following these development guidelines, we could lower the long-term costs of our Web project, reducing the needed time for the again and again occurring redesign.

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Properties of an Intelligent Cardiovascular Monitoring System

Gábor Balázs and Balázs Végső

The group of cardiovascular diseases is considered as the leading cause of morbidity and mortality in most industrialized nations. The incidence of cardiovascular disease has an increasing importance even in the young age decades, especially in males. Remote monitoring provides a cost-effective and comfortable means of medical care. The basic motivation in our project was to ensure the quality requirements of the vital signal measurements (ECG, blood pressure, weight measuring, motion activity) performed at home. Furthermore a special attention was paid to the personalized analysis of significant and malignant changes in the parameters monitored. The architecture of the system ensures that the relevant information can reach all the participants of a distributed care. In this way all the costs and troubles such as travel from remote locations related to routine medical examinations can be significantly reduced.

There are differences between the hospital based medical care and telemedicine:

1. Measurement taker: The patients cannot be expected to have high-level technical and medical competence. We have to correct the electrode transposition failures and examine the influence of the wrong electrode placement.

2. Place of the measurement: The system has to transmit the information as soon as possible to the intelligent datacenter for evaluation and in case of alarm to the monitoring service for human evaluation. If necessary the ambulance has to be informed. It is also very important to use wireless technique so that our system could be flexible enough to fit different situations. The system has to notify the patients about the incoming measurements via SMS or e-mail.

3. Diagnoses: These measurements are not as precise as the hospital based ones, but they are suitable to detect the malignant changes compared to the starting status. To improve the diagnoses efficiency there is a need for estimating processes.

In our system the patient unit collects the ECG, blood-pressure, motion-activity and weight measuring results. These results are transmitted into the intelligent datacenter and are automatically evaluated by the system. This datacenter stores the Electronic Health Record (EHR). To achieve intelligent monitoring with alarms based on input parameters there is a need for integrated decision support, the aim of which is to provide a medical decisionmaking diagnostic support. These auto-diagnoses draw the attention of the doctor to the possible problems. If the incoming measurement is a reference measurement, the system makes the evaluation by the Minnesota coding system that includes rules for 12 lead ECG for the whole population. In this time 424 rules are defined. If the incoming measurement is follow-up measurement (3 lead ECG) the system makes the evaluation by the personal evaluation process that considers the daily variability and the electrode misplacements of the ECG. Besides the system can detect the electrode transposition and can correct it in several cases. With the help of the estimate process we would like estimate the precordial (V1-V6) leads from the measured I, II, V2 leads to improve the diagnoses efficiency.

In case of an emergency situation, information is sent directly for human evaluation to the Monitoring Service, available 24 hours a day. The medical doctor at the Service can contact the patient, the ambulance or the nearest competent hospital by phone.

The system stores not only the possible diagnoses, but also stores the Minnesota code and ECG parameters that are responsible for the diagnosis. This function will be very useful for doctors and students, because the crucial parameters can be highlighted from the several other parameters. Three types of user interfaces are implemented: a Web based interface, a WAP interface, and a special application with high representing and document generation. These applications can be used in the education. The students can search among the diagnoses, and they can find, not only the diagnose, but also the parameters and rules that are responsible for it.

Reconstruction of Discrete Sets from Four Projections: Decomposable Cases

Péter Balázs and Attila Kuba

One of the most frequently studied problems in the area of discrete tomography is the reconstruction of 2-dimensional discrete sets from few (usually up to four) projections. This problem is usually underdetermined and the number of solutions can be very large. Moreover, the reconstruction in certain classes of discrete sets can be NP-hard. In order to keep the reconstruction process tractable and to reduce the number of solutions a commonly used technique is to suppose having some a priori information of the set to be reconstructed, such as convexity, connectedness and directedness.

In [1] the authors gave an algorithm for reconstructing hv-convex 8-connected but not 4-connected discrete sets from two projections. This algorithm takes the so-called equality positions and checks whether they can be the source position of the first component of a solution. The worst case time complexity of this algorithm due to the possible number of the equality positions is of $O(mn \cdot \min\{m, n\})$ and in some cases the solution is not uniquely determined.

We show that using also the diagonal projections the algorithm can be speeded up having complexity of $O(mn)$ and in this case uniqueness also holds. Then, we consider the possibility to generalise our results to adapt the algorithm to work for broader classes. It is shown that equality positions together with the diagonal projections can be a useful tool to decompose discrete sets into components to facilitate the reconstruction.

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Correctness-proven code generation for MDA

András Balogh

Model Driven Architecture (MDA) is an emerging paradigm in software development, providing a framework for implementation platform independent modelling (PIM) of the target system, and automatic code generation by mapping it to a platform specific model (PSM). The basic idea is to separate the functional aspects of the software from the implementation specific ones. The PIM contains only the previous ones, and is created by the developers. Based on this model and the specification of the target platforms, the PSM is generated automatically using some model transformation methods. From this model, the majority of the source code can be automatically generated.

The correctness of the source code can be checked neither manually, nor with the widely used model-checking systems in large-scale systems. However, the PIM is a relatively small, easier-to-check one, and can be validated against the system requirements. If the source model can be treated as a correct one, the correctness of the final system depends on the correctness of the model transformation and code generation algorithms used in the MDA process. This way the correctness of the final implementation can be proven at the basic technology level.

Abstract State Machines (ASMs) provide a simple way to formally specify and hierarchically refine the behaviour of various dynamic systems. ASMs are widely used in telecommunication, programming language and hardware system design, both in academic and industrial environments.

A method for ASM based correctness proving of transformations is introduced in this paper. Model transformation algorithms (both model-to-model and model-to-code transformations) can be treated as mappings between different levels of abstraction of modelling. Therefore, if the input patterns and mapping results of the transformation are described as ASMs, and a refinement path can be found between them, the correctness of the specific transformation is proved. The basic idea of the proof is that in a rule based transformation, as used in our tool, the large problem of proving the correctness of the transformation can be split up into a set of smaller sub-problems proving the correctness of the individual rules.

A Direct Heuristic Local Search Method - Numerical Results and an Application

János Balogh and András Erik Csallner

Local search methods are widely used for solving nonlinear optimization problems. Most of the implementations of these algorithms exploit the knowledge of more information than simply the values of the objective function in some points, i.e., they need calculations for the gradient or even higher derivatives, and demand sometimes sophisticated programming work. A very simple idea to make local search easier is to sample a starting point in the domain of the objective function - as many other local methods do - and try to step further in a coordinate direction where the function decreases. In contrast to other algorithms this idea does not need any derivatives and is very easy to implement. The basic performance is similar to that of the simplex method for linear search: finite possibilities of steps are considered and the best one is chosen. The principle of coordinatewise search itself is not new, it is nearly half a century old [2]. The basic idea is more general and is known as pattern search. Coordinatewise search can be considered as a special case of this wide family of methods, however, a very robust one which converges for most of the differentiable functions [3]. In the present work a small overview of pattern search methods is given. It is shown under what circumstances this special case, i.e., the coordinatewise direct search algorithm converges and some numerical tests are presented to demonstrate the behavior of this method and its superiority to the well-known gradient method on standard test functions.

Furthermore, we give an application of the proposed methods, on a set of test functions given in [1].

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Numerical methods and experiments of global optimization problems on Stiefel manifolds

János Balogh and Boglárka Tóth

Some global optimization methods are tested on Stiefel manifolds. The structure of the optimizer points is given theoretically and numerically for interesting lower dimensional cases. Some reduction tricks and numerical results are given as well.

In 1935, Stiefel introduced a differentiable manifold consisting of all the orthonormal vector systems $\mathbf{x}_1,\mathbf{x}_2,\dots,\mathbf{x}_k \in \mathbb{R}^n$, where $\mathbb{R}^n$ is the n-dimensional Euclidean space and $k \leq n$ [8]. Bolla et al. analyzed the maximization of sums of heterogeneous quadratic functions on Stiefel manifolds based on matrix theory and gave the first-order and second-order necessary optimality conditions and a globally convergent algorithm [3]. Rapcsák introduced a new coordinate representation and reformulated it to a smooth nonlinear optimization problem, then by using the Riemannian geometry and the global Lagrange multiplier rule [6, 7], local and global, first-order and second-order, necessary and sufficient optimality conditions were stated, and a globally convergent class of nonlinear optimization methods was suggested.

In the present work, solution methods and techniques are investigated for optimization on Stiefel manifolds. Consider the following optimization problem:

$$\min \sum_{i=1}^{k} \mathbf{x}_i^T A_i \mathbf{x}_i \tag{1}$$

$$\begin{aligned} \mathbf{x}_i^T \mathbf{x}_j = \delta_{ij}, \qquad & 1 \leq i,j \leq k, \\ \mathbf{x}_i \in \mathbb{R}^n, \quad i = 1,\dots,k, \qquad & n \geq 2, \end{aligned} \tag{2}$$

where A_i, $i = 1,\dots,k$, are given symmetric matrices, and δ_{ij} is the Kronecker delta. Furthermore, let $M_{n,k}$ denote the Stiefel manifold consisting of all the orthonormal systems of k n-vectors.

In the present talk, we optimize (1)-type quadratic functions with quadratic constraints. In the literature of optimization, there are not too many efficient methods which give a good approximation to this problem, moreover, to provide feasible solutions is also a difficult problem. Some important particular cases are considered in more details. In [2], we gave a series of test problems of arbitrary size (for different n and k values), as test functions with known optimizer points and optimal function value. Furthermore, in [2] a theoretical investigation is made for the discretization of the problem (1-2) which is equivalent to the well-known assignment problem.

We characterize the structure of the optimizer points on $M_{2,2}$ of (1-2), which is a generalization of a result of [1].

The case of diagonal matrices A_i, $i = 1,\dots,k$, is dealt separately where all coordinates of the optimizer points are from the set $\{0,+1,-1\}$.

In the present talk we are focusing on the numerical investigation of the problem, and the results of it. This study is made by using a stochastic method [5] and a reliable one [4]. The aim of the last study was to obtain verified solutions. The result and difficulty of the numerical optimization will be discussed in the talk. If we require reliable solutions, the most of the computational effort in the numerical optimization is the so called "dense constrained" evaluation, i.e. to check whether a point is a feasible solution, according to the constraints (or not). Thus, it seems to be indispensable to use some reduction tricks in order to make the numerical tools effective. Some accelerating changes are suggested in the present work and on the results we obtained. Because of the big computational requirements, it can be interesting the using of non-reliable methods (heuristic-stochastic methods), for example by using penalty functions.

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A verified computational technique to locate chaotic regions of a Hénon system

Balázs Bánhelyi

We present a computer assisted proof of the existence of a horseshoe of the 5th iterate classical Hénon map ($H(x, y) = (1 + y - \alpha x^2, \beta x)$). An earlier, published theorem [3, 4] gives three geometrical conditions to be fulfilled by all points of the solution region, given by 2 parallelograms. We analyze these conditions separately and in case when all of them hold true, the proof is ready. The method applies interval arithmetic and recursive subdivision. This verified technique proved to be fast, and we can use it in a framework program. To find a region that fulfills the respective conditions, the program combines a global optimization procedure and our interval arithmetic [2] based checking technique described earlier. The algorithm obtains the Hénon map and the parallelogram parameters and checks whether these fulfill the c onditions. If not then it provides a penalty for this structure for the optimization procedure. The penalty is zero if the structure doesn't brake any conditions. In this way we have obtained an optimization problem with six parameters. If the program finds the optimum and it is zero, then the search is successful, and we were able to locate a region where the investigated Hénon map instance has a chaotic behaviour. The obtained coordinates of the lower parallelogram vertices for the Hénon transformation parameters $\alpha = 1.939838, \beta = 0.39146881$ are

$$x_a = 0.33298647, x_b = 0.49115518, x_c = 0.50960044, \text{ and } x_d = 0.59020179$$

with $y_0 = 0.01, y_1 = 0.28,$ and $\tan\phi = 2.0.$

In addition to the above result, we have extended the result of [4] in the sense that in stead of their Hénon parameter values of $\alpha = 1.4$ and $\beta = 0.3$, we have determined a set of those parameter values that cause the chaotic behavior for the H^7 transformation with the same parallelograms. The obtained intervals were $\alpha \in [1.377599, 1.401300]$ and $\beta \in [0.277700, 0.310301]$. The technique with which this result was obtained is an earlier interval optimization procedure able to solve tolerance optimization problems [1]. The author is grateful to Barna Garay (BME, Budapest) and Mihály Görbe (GAMF, Kecskemét, Hungary) for their contribution and support.

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Testing aspect in Model Driven Software Development

Gábor Bátori and Domonkos Asztalos

Big changes are occurring in the field of software development. New technologies appear whilst others vanish. The most important motivations of the new technologies are to make the software development lifecycle shorter and to create reusable components. Model-Driven Architecture (MDA [1]) is one approach to this challenge, where the problem domain is modeled at a high level of abstraction, so-called Platform Independent Models (PIMs), and the implementation is derived from these models. The core technology of the MDA is the Unified Modeling Language (UML), which is the standardized modeling language for object-oriented software development. By supporting the MDA with an executable form of the UML, called xUML [2], we can generate 100% of the source code from the high level model with minimal manual intervention. The xUML process is a rigorous and precise development technique. A key part of this process is the ability of simulating and testing the PIMs without any specific platform. This new technology allows to begin the testing process at the early phase of the development lifecycle, but UML technology focuses primarily on the definition of system structure and behaviour and provides only limited means for the testing aspect of the modeled problem. However, testing of the high level models is crucial, because the majority of the software defects (appr. 60-70 per cent) can be eliminated at this level of abstraction.

Aspect-Oriented Programing (AOP [4]) has been proposed as a technique for improving separation of concerns, such as security, logging, error handling etc., in software. Aspect Oriented Software Development techniques allow one to modularize crosscutting concerns into separate "aspects" of a system and integrate those aspects with other kinds of modules throughout the software development lifecycle. Testing is one of these aspects, it is independent of the high level model itself, only depends on the requirements of the software, thus we can define it separately from the application model.

Our main goal is to create a compiler (weaver) which is capable for weaving special code blocks into the platform independent model so that the derived new model can communicate with a tester (e.g. TTCN-3 [3]). These alterations preserve the functionality of the original model, but provide interfaces in order that a tester acquires information about the state of the model. We use "tags" in the UML model to indicate the points where the weaver can insert the special codes. TTCN-3 is used as a test description language in order to reuse these early phase tests at the implementation level, because these functional tests can provide the basis of other types of tests (e.g. performance tests).

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Test Data Optimization Method for TTCN-3

Gábor Bátori, Dung Le Viet, Antal Wu-Hen-Chang and Gyula Csopaki

During the testing of telecommunication protocols it is indispensable to describe complex data structures, because these protocols communicate via a lot of large and complicated messages. In practice, tests and test data are defined in formal languages designed specifically for testing purposes (e.g. TTCN-3 [1], TTCN [2], MSC [3]). The executable test suites are produced from these specifications by the help of a compiler. Consequently, the properties of the resulting executable test set strongly depend on the quality of the source formal description. For example, if the test data definitions are lengthy and redundant in a formal specification, the executable test suite will be larger (and the compilation process will take longer as well) than the one produced from a redundancy-free specification. Furthermore, the way the test data are defined also influences the run-time speed.

Test data specifications can be created either in a manual or in an automatic way, but in neither case is the result optimal, since developers cannot cope with the enormous number of huge data structures, and automatic methods focus primarily on the generation problem. According to our empirical experiences test data definition occupies at least 60-70 percent of a complete test specification and they are highly redundant, therefore by eliminating the redundant and unused data structures the quality of the specification (and the quality of the executable test suite accordingly) can be significantly improved. Related work mainly concentrate on relational databases and test data compression, but as far as we know, not much has been done in the field of test data re-engineering. In our presentation, we introduce an optimization algorithm that can be applied without human intervention to test data defined in TTCN-3.

TTCN-3 is a universal and standardized language for testing distributed systems. This language has a special language element, the template, that provides sophisticated means for describing test data. Templates are used either to transmit a set of distinct values or to test whether a set of received values match the template specification. Moreover, they offer powerful data specification formalism including parameterization and inheritance.

Our main goal is to transform an already existing TTCN-3 test data specification, so that the derived executable test suite becomes more compact, redundancy-free and it has improved run-time characteristics. Naturally, the alterations preserve semantic correctness, only syntactical changes are introduced. In fact, the transformation is a high level reengineering method that operates on the formal description of a test suite, therefore it can optimize the module much more efficiently than any optimization technique that works on a lower level (e.g. on the implementation level). However our method is proposed specifically for TTCN-3, with slight modifications it can be extended, and applied to other similar languages.

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Static Analysis and Optimization Questions of Structural Recursions in Semistructured Databases

András Benczúr and Balázs Kósa

Since both semistructured and XML data are modeled with rooted, labeled, directed graphs, each query language concerning such data types should contain operations for traversing and complex restructuring of data graphs. In our paper we examine such an operation, namely structural recursion introduced in UnQL, whose underlying algebra, UnCal, is a conservative extension of relational algebra over relational data. The role of structural recursions in UnCal can be described, as it is similar to the role of SPR queries in SPJRU algebras on relational databases, i.e., the algebras consisting of the operators: selection, projection, join, rename and union. Bunemann et al. offered powerful optimizations, when two structural recursions is to be computed in sequence. Dan Suciu showed its very advantageous characteristics in distributed systems. In addition it forms the core language of XSL, the first commercial XML query language.

The data model of UnQL, like the relational model, is "value based", i.e. object identifiers are not assigned to nodes. Two data graphs is considered equivalent, if they are bisimilar. Semistructured data is often described as "scema-less" or "self-describing", since information, which are part of the schema in traditional databases, is intermingled with data. However, various methods were developed to represent even partially knowledge of the structure of data. One of them, which suits well the data model of UnQL, uses schema graphs and dual schema graphs.

In the course of static analysis certain properties of queries given with their syntax is examined without running them. One possible question is that, for a given query q whether there exists an instance I s.t. $q(I)$ is not empty. We introduce a new semantics for structural recursions, which is equivalent to that of defined earlier. With the aid of this the previous question can be answered easily in linear time. Partly owing to its relation with optimization questions mentioned formerly, we also examine the above question in that case, when the inputs and outputs of q are restricted by means of schema graphs and dual schema graphs respectively. The auxiliary graphs introduced in the new semantics is turn out to be a very useful tool for representing relationships among schema and data graphs. Our algorithms also give us other optimization methods. The optimization of regular path expressions in the presence of schema graphs was studied earlier. Regular path expressions can be encoded as structural recursions and one of our method in this paper is a generalization of a former result. Others are different from it, but in the background we always use the same technique given by the new semantics.

The usefulness of the new semantics becomes more obvious, when structural recursion with conditions introduced in UnCal are to considered. By means of this the complex relationships among conditions can be described and the unnecessary ones can be recognized. However, the former questions are NP complete in this case. The discussion is presented in another paper.

Portal Building Techniques: Trade-Offs and Design

Ágnes Bogárdi-Mészöly

The enormous amount of information on the Internet must be collected, systematically sorted and filtered. This would not be achievable without appropriate infrastructure. Portals serve this purpose: they collect information of several different sources to a given place.

Nowadays they are already widely used, but in the near future much more enterprises are going to expectedly use intranet portals to complete daily work and much more Internet portals are going to appear on wide variety of topic.

There are several different techniques to build our portal. A typical question is: what kind of portal building techniques should we choose? We can build our portal either from the ground up or with a framework. Both techniques have their advantages and disadvantages. If we build our portal from scratch, the portal will fully meet our requirements. Our portal will be easily adjustable further on, because we know every character of the code. This can only be the optimal solution if we have enough time to develop. The other possibility is to use a framework, which can be ready bought or downloaded. With its help we can easily compile our portal in less time.

This presentation studies the different portal building techniques paying particular attention to their features and services. These most important features and services are multilayer application architecture, distribution, scalability, modular constructions, extensibility, personalization, user profile, localization, globalization, editing with mutual exclusion, automatic notification, search, forums, appropriate environment of installation and administration, third-party application integration, single sign-on, security and mobile client support.

We have compared the most widespread and up-to-date portal building techniques, because in the near future these are the most likely to be adopted widely. These are Oracle Application Server Portal 10g [1], ASP.NET Web Matrix [2], ASP.NET Whidbey [3], Microsoft SharePoint Portal Server 2003 [4] and IBM WebSphere Portal Server 4.2 [5]. There are several PHP solutions [6] in the market, so we can include only the common features and services in the comparison. We emphasized their common and unique advantages as well [7] and as a case study several portals are provided [8].

The documentation of this topic is quite incomplete and scattered; there is no sample code for their summary and comparison. This presentation is intended to help to choose the optimal solution for building a portal.

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Building Dynamic Web Applications in the Microsoft .NET Framework using a pure Model View Controller pattern

Csaba Bornemissza

The world of internet and intranet Web applications is a dynamic, rapidly changing area. Software products must follow the increasing needs as well as in quantity as in quality. New and new components and technologies appear to work with, and it is also common that we need to redesign our existing solutions.

With such a complicated background it is extremely important to build flexible applications, where the change of appearance and the continuous expansion are everyday tasks.

In this paper we will try to cover the vital aspects of developing reusable and easily redesignable Web applications. We will show the effectiveness of the well known Model View Controller design pattern. There are advantages and disadvantages when we follow a pre-made pattern; we show different situations of implementing this design pattern.

We will discuss some features of the Microsoft .NET Framework that are helpful to maintain software flexibility. Using scripting techniques like ASP.NET, or JSP will make the development process easier and quicker, however, in these scripts there is an unavoidable mixing of HTML and program code. Is it acceptable in a Model View Controller system? Can we call such a script-driven application a pure MVC application? Is the MVC approach preventing us to use all the advantages of the Web scripting techniques?

We try to answer the questions above. The XML technology became a popular way of inter-software communication. The XML Web Services give the Web developer community a standardized way of generating display-independent content. Using the XSL Transformations makes it possible to separate the information that is responsible for the presentation of the content (HTML, XHTML, or any format), and the code that generates the output data. We demonstrate how the XML Web Services and the XSLT help the developer to build flexible Web applications, where the software business Model, the Controller, and the View (end user displays, or inter-software interfaces) are perfectly separated, and independently maintained.

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The different effects of the database update during the long execution of continuous queries

Antal Búza

The continuous data streams are native data occurrences. Perhaps ones are more native than the relations in lot of cases. Thus the using of the data streams may have number of advantages. Therefore the expansion of CQL, since being suitable for really situations might be useful. This is the reason for the paper suggests a few expansions of CQL.

The CQL, Continuous Query Language is an expressive SQL-based declarative language for registering continuous queries against streams and updatable relations. CQL is suitable for data stream queries. There are situations when the queries operate on relational databases and on the data streams simultaneously. The execution of CQL query takes a long time (it may be several hours, days or even more). It is not unambiguous which semantic is suitable for the user when the database is updated during the execution of CQL query. For example, when we wish keep an eye on changing the value of an account while the official rates are updated, then CQL system must calculate with the retroactive effect of this update. Another semantic is reasoned when the prices are changed while we use CQL query for observing the trade of a supermarket. In this case the effect of the update is valid from the moment of update. In this paper we give a short description of CQL, characterisation of update-problems, and we offer possible suggestions for the semantically extension of CQL.

Additional interesting question is the explanation of the consistent state. In classical database-theory it is an usually requirement that the "normal" state of a database is the consistent state. The consistency is not a permanent state, during the updates it may be damaged for a short time. Investigations were performed to find out what the effect of the inconsistent state on the currently operating CQL queries is.

Dependability Modeling of Fault-Tolerant Systems Using Aspect-Oriented Modeling Techniques

Péter Domokos and István Majzik

Dependability modelling and analysis is useful for the understanding and assessment of the system in all phases of its life cycle. The two main quantitative dependability attributes of interest for a designer are availability (the delivery of correct service with respect to the alternation of correct and incorrect service) and reliability (the continuous delivery of the correct service). During design phases, dependability models allow to compare different architectural and design solutions, to select the most suitable one, and to highlight dependability problems in the design. Dependability models are mathematical models which describe the failure and repair processes of individual components of the system and the error propagation between the components. This model is used to determine when the failure of individual components leads to a system level failure, that is, to incorrect service.

The analysis is based on the UML model of the system. UML (Unified Modeling Language) is a modeling language which supports the entire design process: the requirement analysis is aided with activity diagrams and statecharts, the system architecture design is supported with class diagrams and object diagrams, the implementation is supported with statecharts and sequence diagrams. The dependability model is automatically derived from the UML model of the system as described in [1],[2].

In the early phase of the design process, architectural models are typically created (eg. class diagrams). This model is extended with the dependability parameters of the components as tagged values (eg. fault occurrence, error latency, ratio of permanent faults, repair delay). The dependability model is automatically derived from the class diagrams by graph transformation. In order to increase the reliability and the availability of dependable systems, fault tolerance structures are usually applied, eg. TMR (Triple Modular Redundancy) in hardware or N-version programming in software, where N different modules solve the same problem and the results are compared by a voter.

The redundancy management forms an independent aspect: the core functionality of the system forms a concern, while the fault-tolerance management layer provides another concern. Aspect-oriented programming is a new approach for separating these independent concerns [3]. Aspect-oriented programming proposes that each concern should be implemented independently and that the final system be derived by weaving these aspects into a single system based on the weaving rules. Such a weaving rule may be for example that a so-called advice (eg. logging) should be executed before the calling of the public functions of a given class. We aim at using aspect-oriented modeling and aspect-oriented programming for the modeling and implementation of fault tolerance structures. We will derive the dependability models from architectural UML models using aspect-oriented extensions for modeling redundancy techniques.

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Non-cooperative games for self-adaptive telecommunication protocols

Tibor Dulai

By this time telecommunication industry has reached an almost saturated stage in their markets, that is the reason for appearing different additional services, which the operator offer to the users. Because of the high-level technological improvement nowadays telecommunication networks transport not only voice but data and multimedia stream as well. Moreover the devices at the endpoints of the network may totally differ from each other. The heterogenity of physical elements and offered services cause difficult challenges to telecommunication engineers and telecommunication software developers.

The main elements of a telecommunication software are protocols, what are the semantic, syntactic and timing rules of the communication, and they can be realized as finite state machines. The software would be ideal if the protocols would be able to adapt to the environmental changes and to the service which they serve, without any human interaction [1]. The main question is: how to find the optimal parameters of these self adaptive protocols at a certain situation.

One possible answer can be: by the use of game theory [2]. There are several users and possibly more services of one user (the players). Every service (or the protocol which serves the service) has some possible choice at its every decision points (e.g. how to set their parameters). When they choose their actions for certain situations, their strategy profile will be determined. Their outcomes will depend not only on their own decision but on those of the other protocols. The different users/different services want to reach their optimal work according to the environment, to the status of the network and they do not care with the others. The players do not cooperate with each other, each one wants to reach its maximal outcome (e.g. QoS).

In the literature of non-cooperative games [2],[3] there are some solutions for determine the equilibrium of a game. In my work I attempt to apply the theory of non- cooperative games for getting a stable system of self-adaptive telecommunication protocols.

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Holonomy Decomposition of Finite State Automata

Attila Egri-Nagy, Chrystopher L. Nehaniv and Pál Dömösi

The hierarchical algebraic decomposition of finite state automata is not just an important part of theoretical computer science but also has many possible applications in all different fields where we deal with hierarchical models of systems: physics [13], software-development [9], artificial intelligence [10], evolutionary biology [12], etc. We are concerned mainly with the formal models of understanding from the artificial intelligence intelligence point of view [10] where the decomposition is regarded as an easy to manipulate (via the coordinates) model of the original automaton.

The original Krohn-Rhodes Theorem has many different formulations (e.g. [7, 8, 6, 4, 5, 11, 1]). The results of the first computational implementation [2] of the theorem showed that in the terms of the length of the decomposition the holonomy method [6, 4, 1] performs better than other algorithms: the number of hierarchical levels is less than the number of states in the original automaton. The improved algorithm [3] for the holonomy decomposition renders the computational investigation of the hierarchical structure of finite state automata feasible.

Here we examine the hierarchical decomposition of different types of finite state automata in terms of their holonomy structures: the pre-order subduction relation on the state set, the size and the number of equivalence classes of the mutual subduction relation, the tiling structure and the holonomy groups. The types of automata are those which have a corresponding characteristic semigroup that is cyclic, full, left or right simple, aperiodic, group, permutation-reset, definite, or reverse-definite. The clarification of the relationship between different automata and their hierarchical decomposition given by the holonomy algorithm helps the elaboration the concept of a formal model of understanding. Beyond the theoretical insights provided by this investigation the results also help in improving the decomposition algorithm itself as special properties can be used when restricted to one particular class of automata.

Further details and the software can be find at `http://graspermachine.sf.net`.

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Preparing Surgical Operation Plans for Finite Element Analysis Using the MedEdit System

Balázs Erdőhelyi, Krisztián Ollé, Endre Varga, Attila Kuba

Skeletal injury operations are in general of high complexity and require extreme accuracy. That is why it seems practical that prior to a surgical intervention a geometric and mechanic model is prepared, which can be used to simulate various operational solutions. We present here a computerized system, which we call MedEdit, that helps the surgeon to plan the operation and with the use of a Finite Element Analysis (FEA) program the effects of the modifications can be measured or compared.

CT images serve as input for the MedEdit system. After the segmentation of the bone from other tissues, a geometric model is built from the 3D volume data. The geometric model consists of a triangle mesh, which is used for fast 3D presentation and navigation. The system provides a variety of tools for planning a surgical operation, like moving, drilling, cutting of bones or inserting implants. To simulate the effects of the planned intervention under specific conditions, finite element analysis is used. To complete the geometric model to a mechanical one, material properties as load and boundary conditions are added to the finite element mesh.

Three types of finite element meshes are investigated and compared. The first takes the triangle mesh of the geometry, and uses 3-node triangular thin shell elements for the analysis. The second model uses 8-node solid finite elements for every voxel in the segmented 3D volume, which enables the simulation of the inner bone tissue and the insertion of implants. The third model combines the previous two by using shell elements for the surface and 2-node elements for the inner structure.

The possibility of inserting implants to connect broken bone pieces is also investigated and presented on different examples (knee joint, pelvic ring and hand).

Innovative Uses of Programming Constructs Supporting Aspect-Oriented Programming

Miklós Espák

Separation of concerns is one of the most important objectives during software development. Unfortunately, the boundaries of the individual concerns of a software do not overlap with the boundaries of the corresponding program modules in most cases. When a concern cannot be mapped unambiguously to a single program module, it is said to crosscut these modules. Aspect-oriented programming (AOP) provides a technique for separating crosscutting concerns into distinct program modules. AOP is a substantially new approach in software development. Due to its novelty, the most appropriate language constructs to support it are yet to be found.

By this time several AOP systems have been developed. Naturally, the implementation of these systems cannot break away from current (non- AO) languages. Instead, the impact of current mainstream languages is very strong on AOP system implementations. These languages - being the base of an AO extension of framework - crab the creation and implementation of the most appropriate AO language constructs.

In the paper I will show how typical object-oriented (OO) languages hinder introducing more innovative AO language constructs, and I will provide solutions for these restrictions.

The paper focuses mainly on the following issues:

- designating execution points
- context exposure
- argument passing modes

I will show that by "rehabilitating" some constructs well-known in declarative languages and introducing them in the OO environment, a more expressive AO environment can be gained.

I will present a sample implementation of the new concepts mentioned. The implementation has been worked out in the Common Lisp Object System (CLOS), and makes a part of a universal low level framework, which serves as a new foundation for current and future AOP systems.

Semantic Web Services in .NET aspect

Péter Farkas and Hassan Charaf

XML Web Services are the new level of service on top of the Internet. To employ their full functionality, suitable standards need to be developed, because the current standards like WSDL, UDDI are lack of expressive power. The goal of Semantic-enabled Web Services is that the properties, interfaces, capabilities and effects of web services are explicitly defined and described in a machine-readable and machine-interpretable way as today's Web was designed primarily for human use, but we are seeking increased automation of Web service interoperation, primarily in B2B and E-Commerce applications.

Tim Berners-Lee, father of the Internet, had two-part vision about making a better way of communication. The Web should be a more collaborative medium and it ought to be understandable and be processable by machines [1].

Web Services provide interoperability solutions, making application integration easier. Because it uses open standards. All of them rely on XML basics, which has widespread support among vendors for its extensibility. Web services are software applications available on the Internet that perform specific functions. They can be described, discovered and accessed by XML-based protocols, referred to WSDL, UDDI, SOAP. It is important that Web Services are completely independent of the presentation and the GUI of application. They send or receive data in XML format, no other way is possible to communicate with them. Because it does not need to focus on presentation, it can be the Business Logic in your distributed application. Other approach is, that XML is the foundation layer of Semantic Web. All standards which providing features for the Semantic Web built on the top of XML. To fit Web Services into the world of Semantic Web advanced features like composition, involving comparison, orchestration of them will be required totally automated way.

Semantic Web Services are harder to build than SOAP services. Using something like Microsoft .NET, you just claim your program is a Web service and it will generate SOAP code for you. However, SOAP may be easier but it has its share of problems: by tying it directly to your function, you risk substantial breakage if anything changes. Semantic Web Services, while requiring some more work at the beginning, make it more likely that your program will last a while and communicate well with others. This paper introduces into the world of Semanticenabled Web Services by categorising the known issues of realizations.

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Time Series Models on Medical Research

Mária Fazekas

Time series analysis has been a well-known method for many years. This method can be applying on medical research as well. The paper demonstrated applications the autoregressive integrated moving average models and application the seasonal decomposition method. The mortality data may be analysed by time series methods such as autoregressive and integrated moving average (ARIMA) modelling. This method is demonstrated by two examples: analysis of the mortality data of isemic heart diseases and analysis of the mortality data of cancer of digestive system. The relationships between time series of mortality rates were studied with ARIMA models. The author with ARIMA models studied the substantial role an exogenous environmental factor of the incidence for the causes of death autocorrelation functions and cross-correlation functions. Mathematical expressions are given for the results of analysis.

We examined the periodicity of the childhood leukaemia in Hungary using seasonal decomposition time series. The analysis of the periodicity of childhood leukaemia was performed on the basis of the date of the diagnosis of the disease. From the time series the cyclic trends, the seasonally adjusted series, the moving averages and the data series of random components. Our results prove the seasonal occurrence of the childhood lymphoid leukaemia in Hungary. These data seem to highlight the role of the environmental effects (viral infections, epidemics, ect) on the onset of the disease. Due to the controversial nature of the available international data, further studies should be carried out.

The analysis of the mortality rates of the examined diseases and the seasonal periodicity of the childhood leukaemia was done with the SPSS statistical program package.

MDA Scalability

Gábor Fényes

OMG's Model Driven Architecture (MDA) is a novel way to increase software developer productivity. Requiring only a completely platform-independent model (PIM) in UML, MDA provides both the tools for transformation into the technology specific PSM and the generators to create the source code ready for final machine specific executable translation. What can we say about the performance of the end-product and how will it scale to changing operating conditions?

First we outline a method for the scalability analysis of MDA based developments. Starting with existing standards and already published results within the area of UML and middleware performance indicators, we judge them upon their relevance to MDA scalability.

Based on explicit trials and case studies we can rank the indicators and identify any missing ones. In essence, the effectiveness of various MDA defined mappings on the initial PIM are evaluated with respect to scalability. At this point we take into consideration how loose an MDA definition is and can see effects of alternative interpretations.

Our aim is to present checks and tests that enable developers to see whether their MDA models will run scalably or not. Given a specific PIM one just needs to look at the indicators and get a single measure of overall scalability. In the end even the question of which technology and platform to choose for an MDA design could be answered with ease.

Benchmarking Advanced Features in Database Systems

András Gábor

Database systems play a fundamental role in information technology ever since the early days. Most often relational databases are used. There has been always a need for benchmarks that helped in deciding on the appropriate RDBMS for a project.

The traditional database benchmarks measure the performance and stability of the relational capabilities in DBMSs. As today most products perform the most basic relational features reliably and fast enough to fulfill most application needs, the database development efforts have shifted towards providing full-featured DBMSs. However developers don't tend to use these features, because of lack of knowledge and mistrust.

The usage of the implemented widely-usable features could save development time, increase maintainability and evolvability and sometimes performance as well. In this paper we will enumerate such features like object relational and other SQL:1999 extensions and propose a benchmark approach to rate them. The good benchmark examples and results can popularize these functionalities.

The proposed features benchmark approach gives bases for comparing different implementations. This is done via specifying typical application scenarios where a concrete set of features can be used beneficially. In these application scenarios multiple implementations can be used traditional ones and those using one or more features. Every implementation can then be tested for performance and this gives a comparison metric. However the final rating must include an adjustment factor representing the assumed development and maintenance benefits gained from the usage of the incorporated features. This simple benchmark framework can be used to specify tests for different functionalities.

In our paper we also explain the following available features: collection types, object types and object tables, virtual private database, domain indexes, table functions, aggregate clauses and analytical functions.

Then we specify a concrete benchmark for collection types, where we will have two implementations: one with a traditional database model and the other using nested tables as collection types. We define the transactions to be run against these databases and the distribution of their workload. We also specify the adjustment factors for each implementation. We estimate what results we may get and how to interpret them. For instance a badly performing nested table (a collection type) implementation can show that in our system the implementation of this feature is not mature enough.

After specifying the benchmark in theory we show some actual benchmark results achieved in different size databases and different database products (e.g.: Oracle, Postgres).

Finally a conclusion and future work plan is provided.

Shape Preserving Bottom-Up Tree Transducers

Zsolt Gazdag

A generalized sequential machine (gsm) is a system $M = (Q, \Sigma, \Delta, q_0, \delta, F)$, where Q is the set of states; Σ and Δ are the input and the output alphabets, respectively; q_0 is the initial state; $F \subseteq Q$ is the set of final states; and δ, the transition function, is a mapping from $Q \times \Sigma$ to the finite subsets of $Q \times \Delta^*$. Then δ extends from $Q \times \Sigma^*$ to the finite subsets of $Q \times \Delta^*$ in a standard way and the translation defined by M is the set $\tau_M = \{(x, y) \in \Sigma^* \times \Delta^* \mid (q, y) \in \delta(q_0, x)$ for some $q \in F\}$.

In general the length of an input string $x \in \Sigma^*$ and of an output string $y \in \tau_M(x)$ is not the same, however if τ_M has this property then M is called a length preserving gsm. For instance if M is a Mealy automaton, i.e., δ maps to the subsets of $Q \times \Delta$, then M is length preserving. It is a well known result that a gsm M is length preserving if and only if it is equivalent to a Mealy automaton [1], [3].

In [2] this result was generalized to top-down tree transducers and it remained an open question whether this result can be generalized to bottom-up tree transducers. While a gsm operates over strings, a bottom-up tree transducer works on terms (or rather trees), which are called also trees.

More exactly, a bottom-up tree transducer is a system $M = (Q, \Sigma, \Delta, q_0, R)$, where Q is the set of states; Σ and Δ are the input and the output ranked alphabets, respectively, and q_0 is the final state. Moreover, R is a finite set of (rewriting) rules of the form $\sigma(q_1(x_1), \ldots, q_k(x_k)) \to q(r)$, where $q, q_1, \ldots, q_k \in Q$, σ is an input symbol of arity k from Σ, and r is a term over Δ which may contain also variables from the set $\{x_i | 1 \leq i \leq k\}$. Using the rewriting rules, an input tree s over Σ, can be rewritten to a term of the form $q_0(t)$ where t is an output tree over Δ. We denote this fact by $s \Rightarrow_M^* q_0(t)$. Now the tree transformation induced by M is the set $\tau_M = \{(s, t) \in T_\Sigma \times T_\Delta \mid s \Rightarrow_M^* q_0(t)\}$, where T_Σ and T_Δ denote the set of trees over Σ and Δ, respectively.

Since trees generalize strings, more or less it should be clear that tree transducers generalize gsm's. Two trees $s \in T_\Sigma$ and $t \in T_\Delta$, have the same shape if the domains of s and t are the same, i.e., they differ only in the labels of their nodes. One can also find out easily that a natural generalization of the length preserving property of gsm's for tree transducers is the shape preserving property. A bottom-up tree transducer M is shape preserving if for every input tree $s \in T_\Sigma$ and output tree $t \in \tau_M(s)$, s and t have the same shape.

As the main result of this paper we show that every shape preserving bottom-up tree transducer is equivalent to a bottom-up relabeling tree transducer, i.e., a bottom-up tree transducer of which the rules have the form $\sigma(q_1(x_1), \ldots, q_k(x_k)) \to q(\delta(x_1, \ldots, x_k))$, where δ is an output symbol of arity k from Δ. This result naturally generalizes the corresponding one for gsm's.

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The analytical approximation of the nilpotent operators and its applications

Zsolt Gera and József Dombi

The Lukasiewicz or nilpotent operator family plays an important role in fuzzy logic. The operators have the following common form:

$$c(x, y) = f^{-1}([f(x) + f(y)])$$

where $f(x)$ is the generator function of the operator, and

$$[x] = \begin{cases} 1, & \text{if } 1 \leq x \\ x, & \text{if } 0 < x < 1 \\ 0, & \text{if } 0 \geq x \end{cases}$$

These operators are widely used in fuzzy logic due to their good theoretical properties, i.e. using the nilpotent class of operators the residual and material implications coincide, the law of excluded middle and the law of non-contradiction both hold, etc.

Despite these good theoretical properties this operator family is rarely used in practice. The reason is the non analytical property of the $[x]$ function.

On one hand a logical expression using nilpotent conjunction and disjunction must be properly discussed to be evaluated, and this is a rather difficult process. On the other hand robotics and fuzzy control generally use the derivatives of the fuzzy operators and the $[x]$ function is not differentiable. As a consequence, using standard, gradient based optimization techniques is impossible.

In this work we propose an approximation of the $[x]$ function by means of sigmoid function:

$$B(x, \lambda) = 1 + \ln \left(\frac{\sigma(x - 1, \lambda)}{\sigma(x, \lambda)} \right)^{1/\lambda}$$

The approximation $B(x, \lambda)$ is differentiable and gives back the $[x]$ function if $\lambda \to \infty$. Another advantage is that $B'(x, \lambda)$ is simple and can be expressed by sigmoid functions. We also investigate the possible uses of this approximately nilpotent operator.

Optimization Methods for Compression in Compiler Programs

Tamás Gergely

Compilers usually optimize their output for code size or code execution speed. But when the available storage space is limited (e.g. in embedded systems), it is usual to store all kinds of data including program code in a compressed form. However current compilers optimize for uncompressed code size and compressing their results does not always result in the smallest possible compressed code size. This means that, when compressed code size is important, the compiled code size is not really relevant. To minimize the size of the compressed code we employ a compiler-based approach which seeks to transform the code into its optimal form ready for compression (optimize for compressibility).

We will describe the kind of code transformations that reduce compressed code size and, in this way, save on storage space. The general idea of the transformations is to increase the redundancy in the code (e.g. by creating repetitious instructions and instruction sequences), which usually result in a larger uncompressed code size, but this also implies better compressibility. The actual effect of these transformations on the uncompressed code size is only secondary.

There are instruction level transformations, e.g. "Replace with Inverse Instruction", where we try to eliminate one kind of instruction by replacing it with its inverse; or "Canonical Form" where we try to force instructions to use the same registers where it is possible. We also describe some instruction-sequence transformations, e.g. "Instruction Reordering" that creates repetitive instruction sequences; "Mix/Separate Dataflow Threads" that tries to create repetitive patterns of instruction-sequences or instructions; or "Register Renaming" that locally makes binary-equivalent instruction-sequences. Finally, there is a "Basic Block Reordering" transformation, that creates repetitions on basic block boundaries.

These transformations can be integrated into compiler programs and may reduce the compressed size of the compiled code. The methods work on a given representation, that has to fulfill certain requirements (e.g. it must be linear, which indicates the order of the instructions; it has to provide enough data for basic blocks and data flow computations, and it must be able to store these information), but otherwise it can be general. (The intermediate representations of the compiler programs usually satisfy these requirements.)

The transformations are mainly suitable for RISC processors where every instruction code has the same length and almost the same format, thus the general compressors (which are usually byte-based) can find the repeating patterns easier, but they are otherwise general (not architecture specific) transformations.

There are two ways implementing these transformations. The first is to keep the transformations themselves general and use some "external" measurement functions (which may be target and/or compressor specific). These "external" functions predict the compressed size reduction on the binary code and help to decide to execute or reject the actual modifications. The second way is to specialize the transformations for a given target and/or compressor combination, which may improve the efficiency of them.

Security Analysis of Sensor Networks

Roland Gémesi and László Zömbik

The development of wireless communication technologies and advances in embedded systems made it possible to build systems that interact with their physical environment and connect observations into a networked system. The growing level of integration and the decreasing cost of required units envision systems that contain a huge number of small units scattered in the environment.

In distributed sensor networks, sensors with integrated CPU, memory, battery and wireless communication units make it possible to distribute the common sensing and computing task. Units of sensor networks are usually heavily resource constrained, so the amount of computing, storage and communication tasks should be minimized. Since the nodes are very small and battery powered devices, operation of the participants is usually unreliable.

The large number of unreliable components call for a self organizing and fault tolerant architecture. Self organizing systems raise serious questions from the security point of view. The cooperation of nodes cannot be assumed, since malicious parties can easily get access to the wireless communication channels.

There are several solutions to achieve security in traditional networks, although those are usually not suitable for sensor networks. The security mechanisms designed especially for sensor networks have not been analysed exhaustively. Existing techniques for the analysis of security protocols usually cannot be used, sensor networks require a different approach.

An analysis technique is process algebra, which can be effectively used to model complex behaviour of distributed systems. The CSP (Communicating Sequential Processes) process algebra give the possibility to formalize systems that are composed from communicating distinct entities. With its help, several properties of distributed systems can be modelled and analysed. Security requirements of sensor networks can also be investigated in this framework.

In the presentation sensor networks and their security threats will be introduced. Fundamentals of the CSP process algebra will be shown to understand its modelling and analysis potential. Focusing on the security properties of distributed sensor networks, several modelling techniques will be presented. The presentation points out that the CSP process algebra can be a very effective framework to model and analyse distributed networks, such as sensor networks. Within this framework, analysis of proposed security protocols will be performed.

A Hierarchical Evaluation Methodology in Speech Recognition

Gábor Gosztolya and András Kocsor

Automatic speech recognition (ASR) is a pattern classification problem [1, 2] in which a continuously varying signal has to be mapped to a string of symbols (the phonetic transcription). Besides the identification of speech segments to grammatical phonemes [3], efficient searching in the induced hypothesis space [4, 5] is of great importance as well. This work is connected to both areas: first we give a hierarchical scheme of the Hungarian phonemes (see Fig.1.), then we try to exploit this structure in the search process.

For this hierarchical classification we used traditional grammatical features (voicedness, roundness, etc.) to characterize phonemes, which came from the physical articulation of speech sounds/phonemes.

Since the hypothesis space in ASR is generally a search tree, standard tree search methods can be applied. In addition to these algorithms, the characteristics of the speech recognition problem has led to the development of search techniques especially suitable for ASR hypothesis spaces [6]. Here we propose a *multi-pass* search method [7] (which belongs to the speech-related family) using the above-mentioned hierarchical partition. In general, multi-pass methods work in two (sometimes more) steps: in the first pass the less likely hypotheses are discarded by using some condition requiring low computational time. Then, in the second pass, only the remaining hypotheses are examined by more complex, reliable evaluations, which will approximate the probabilities of the hypotheses more closely. (In the common search methods – such as *Viterbi beam search* method [8] – the first pass is omitted, so more hypotheses are scanned in the second pass, making the process more time-consuming.) Our method employs conditions using grammatical features for the first pass, because they are strongly associated with the phonemes, so they alleviate the solution of the decision-making task.

Finally, after examining the results, we found that with the proposed hierarchical evaluation methodology we were able to significantly decrease the run time of our speech recognition system [9].

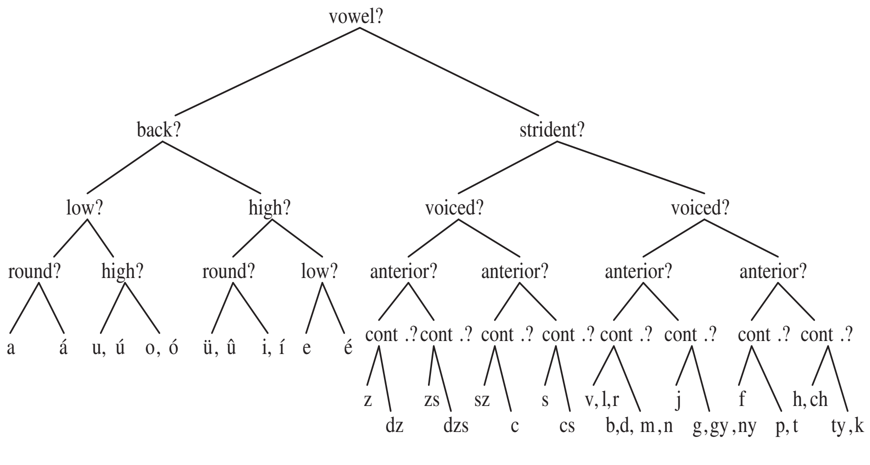

Figure 1: A relatively detailed hierarchical scheme of the Hungarian phonemes

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Building Complex Systems of Web Services

László Gönczy

As use of Internet spreads dynamically in distributed applications there is a growing demand on loosely coupled systems. These integrate services running in heterogeneous environments of different providers without a knowledge of their implementation details. Web services architecture is the most current solution to this problem ([1],[2]). A Web service must use standard XML descriptions.

The main aspects of distributed environments - which should be covered by industry-standard languages or protocols - are the following (the most widespread solutions are given in brackets):

- Describing syntax of services - HOW to invoke it (WSDL).
- Discovering service interfaces - WHERE to find information (UDDI Registry, WSIL).
- Adding semantic description to the service - WHAT it exactly does. Several attempts were made to solve this challenge - such as DAML-S in the world of Semantic Web - but none of them has become mature yet [3].
- Messaging protocol - how to EXCHANGE messages (SOAP and industrial protocols such as JMS).
- Transport protocol - how to TRANSFER information. It is below the messaging protocol and can be almost any Internet protocol, not just one of the TCP/IP transport layer protocols (HTTP, FTP, etc.).

My objective is to examine how process composition, transaction handling, optimization, fault tolerance, reliability, error recovery, etc. of Web services can be ensured. There are some ad hoc initial XML-based specifications for these, but I would rather try to adapt proven methods from other fields of IT. My idea is to use principles, methods, and technologies which are proven in other environments such as:

- P-graphs for optimization. P-graphs (Process graphs, [4]) formulate a structural representation of problems where some inputs, outputs and operators are given. P-graphs are used at optimization of chemical industry processes (where inputs and outputs are materials, operators are distillers, mixers, etc.), and for processor diagnostic (where inputs are states of units, operators are decisions with their probabilities and output is test result [5]). According to my conception the inputs are input data, and the output is the result of service invocation where Web services (described by their interfaces) are the operators of the processes. Several algorithms are known to determine the combination network with minimal cost of used operators producing desired outputs of given inputs.
- System management via web services. There are a lot of system management tools available on the market. Their main problem is that the supported script-based failure recovery has to be implemented manually. If recovery actions were prepared automatically based upon a system model (given in UML or BPM) it would be possible to manage system components in a platform independent way using their Web service interface.

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Model based Optimization and Verification of IT Systems

Szilvia Gyapay

As the proper services delivered by IT systems became more and more crucial to production and the life of the society their correct and efficient operation has to be proven already during the design. Validation and verification methods are known to assure the correctness of the services while optimization may serve both to the proof of the quantitative performance characteristics of a system by estimating its quantitative boundaries and to minimize operation costs. In order to avoid costly redesigns, the problems of fulfillment of the requirements have to be addressed already during the early design phases. Recently, system designers use the Unified Modeling Language (UML) that became the standard modeling language since it provides a semiformal, concise description of complex systems for modeling both its static and dynamic behavior. UML can be extended to incorporate quantitative measures, requirements, and constraints.

On the one hand, UML is a proper means for system and requirements modeling but the analysis itself has to be carried out by using some mathematical model analysis tool. Recent research efforts aim at automated transformation between UML models and mathematical analysis tools [3].

One of the most challenging problems in mathematical analysis of IT systems is the simultaneous analysis of the dynamical behavior of the system and its impact to the quantitative measures, as this meets a combination of a mathematical paradigm describing the control logic of the application and the quantitative impact of it. We propose to use the combination of Petri nets as general purpose logic modeling paradigm and Process Network Synthesis as an optimization framework [1]. Our objective is to derive from the UML specification of the application and to estimate the worst case characteristics of a system upon temporal constraints on its operation sequence.

- At first, an automated, attributed graph grammars based transformation [2] maps the UML models into Petri nets.
- Secondly, all firing sequences representing possible operations (trajectories from an initial state to a given state), that satisfy specific, user defined constraints, are estimated as a basis spanning the state space of the feasible solutions to the optimization objective.
- The next step is to compute a candidate trajectory that represents an optimal operation by combining trajectories generated in the previous step.
- In order to ensure the executability (fireability) of the candidate trajectory, post filtering is executed by model checking (exhaustive simulation).

The new contribution of the current presentation compared to previous ones is the introduction of a multiple level set of feasibility check of algorithms and the benchmark based analysis of the efficiency of the approach.

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Increasing compression performance of block based file systems

Ferenc Havasi

In embedded systems the storage device is mostly based on flash chips. The usage of these devices become more and more general - such as mobile phones, digital cameras, mp3 players, PDAs. One of the most expensive part of this machines is the flash chips, so any technique which can make the usage of the flash to be more efficient can be very important in the future.

In the open source environment there is a file system, which is widely used, and designed specially for flash - called JFFS2 (Journaling Flash File System, version 2).

JFFS2 already has a compression feature - it uses ZLIB. The main goal of our research is to improve this compressing performance as much as possible.

First idea is to replace ZLIB with a compressor framework, which is able to use an arbitrary set of compressors. You can tell this framework what is the most important for you: the compression ratio, the read or write speed. For example if you choose the compression ratio, while compressing a block it will try all compressors and will choose the one, which produces the smallest result. It is easy to extend this framework by a new compressor (only needs to implement an interface).

Another relevant limitation of the efficiency of these compressors is that JFFS2 splits the information into 4KB blocks (because of the behaviour of the flash chips) and compresses them individually. The solution to this problem can be to allow the compressors to use a model. It can be for example a dictionary, a decision tree or neural network. These compressors are called model-based compressors, and can collect information about the file structure before making the file system image, store this information into a model file, and use this model information during (de)compressing blocks.

We implemented this technique and achieved relevant speed up and/or size reduction. It will be open source after March 2004. (`http://www.inf.u-szeged.hu/jffs2/`)

Control Language for Distributed Clean

Zoltán Hernyák, Zoltán Horváth and Viktória Zsók

The present Clean-CORBA interface supports the distributed computing using functional programming paradigms. Our aim is to express computations in the form of distributed process-networks. Nowadays it is very prevailing developing and testing parallel applications on PC clusters [1]. Therefore it became important to provide such distributed environments, which makes possible the investigation of typically distributed applications with client-programs written in any programming language.

In our environment [2],[3] Clean functional client-programs can be interconnected via CORBA, making possible the distribution of the processes and the asynchronous communication. Skeletal programming in the functional language Clean [4] extensively can use the CORBA server objects referenced by the parameterized clients. However for a controlled behaviour of the process-network a strategy description is needed. The distributed evaluation of functions and the communication between clients needs high-level process description and control mechanism [5]. In order to define such behaviour strategies a control language and its semantics is required.

The present paper would like to define high-level language elements for the coordination of the component functions in distributed environment. Parallel compositional strategies and primitives are defined with direct control over the process-network. These elements can be used by programmer for writing applications without knowing the details of the distributed environment.

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Teleonics as a framework for Business Modelling and IT System Design

Gábor Horváth

Teleonics is a goal-oriented process modelling methodology belonging to the multifarious family of System Sciences. It is often considered as a general purpose framework for meta-modelling of goal-oriented biotic and abiotic process systems to study their dynamics in a value conscious, hierarchically arranged environment in order to improve our way-of-doing-things, i.e. our technology. The teleonic vocabulary has developed a few neologisms such as: teleoses, teleons, mei, ethos, doubles, biomatrix, telentropy. A more formalised summary of these terms and several of their relations can be found in: "The mathematico-symbolic formulation of Teleonic principles" Horváth and Járos (accepted for publication in System Research and Behavioural Sciences in 2003).

Summarizing the major Critical Success Factors of Business Modelling and IT System Design in teleonic terms on different levels of complexity is the articles main objective.

It is often the how a system works that people tend to focus on, describing it with interaction models. The study of objectives - the what a business or system does - is often left implicit and sometimes even unclear in the analysis although goals are much less variable than the activities, roles and players in a system. This more stable nature of purposes makes them a perfect starter for requirement analysis and system design. Use cases have been also enhanced with objectives into so called goal cases, and General Goal Patterns have been developed to explicitly capture and describe goals and their relations to each other.

The increasing awareness of professionals has proved the essential nature of bridging between Business Modelling and Object Orientation. The communication between people from the board (managerial) level and the technician/developer level has been improved with the Unified Modelling Language as well. Different extensions of UML help not only the design of IT systems, but also the redesign of organizations and its processes, guaranteeing a homogeneous modelling environment in the whole organization. The same UML extensions are also very useful when we discuss teleonic concepts.

Extending the Sparkle Core language with object

Zoltán Horváth, Tamás Kozsik and Máté Tejfel

Sparkle is a theorem prover specially constructed for the functional programming language Clean. In a pure functional language like Clean the values of the functional variables are constants; variables of functional programs do not change in time. Hence it seems that temporality has no meaning in functional programs. However, in certain cases (e.g. in interactive or distributed programs, or in ones that use IO), we can consider a series of values computed from each other as different states of the same "abstract object". For this abstract object we can prove temporal properties. In this paper we present a method to describe abstract objects and temporal properties in an extended version of the Sparkle Core language. The creation of such descriptions will be supported by a refactoring tool. The descriptions are completely machine processable, and provide a way to automatize the proof of temporal properties of Clean programs with the extended Sparkle system.

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Shallow Parsing for Information Extraction

András Hócza

Current paper presents a new approach to shallow parsing of natural language texts based on machine learning methods. Shallow Parsing (SP) is a complicated task in natural language processing: it requires sequences of words to be grouped together and to be classified. Full parsing builds complete syntactic tree of a sentence, as opposed to SP that provides identified groups of words for other natural language tasks. The linguistic information identified by SP is rich enough to support a number of large-scale natural language processing applications including information ex-traction, phrase identification in information retrieval, named entity identification , and a variety of text-mining operations. In addition, partial parsers are typically very fast when compared to full parsers.

Information Extraction (IE) is a form of text processing, which locates the relevant information in a text document. The architecture of our IE system is a pipeline with the following steps: sentence and word segmentation, morpho-syntactic analysis, part of speech tagging, SP, ontological analysis, and semantic frame recognition. The main task of each step is to provide the best information for the following step with the final aim of improving the results of semantic frame recognition.

An important question in the SP phase is how to recognize noun phrases properly for IE? We believe that our Method - recognition of complete noun phrase trees with regular expressions - is an adequate solution for this problem. The generation of NP recognition rule set contains the following steps:

- Taking complete noun phrase trees (trees under most outer NPs) from training examples
- Making rules with regular expressions by most general unification of trees
- Giving probability values for rules by evaluating training tests

The main task of the NP recognition parser is to find a most possible coverage by backtracking. Rule fitting is processed by a top-down method avoids overgeneration, because it always manages existing trees. Another important advantage is finding the boundaries of most outer NPs with good accuracy. Therefore this NP recognition parser is useful method for IE.

We tested the IE system (including NP recognition) on Hungarian business news. The result of NP recognition was between 80-90% depending on the type of texts. This result can be considered good for Hungarian considering that it is an agglutinating language with very rich morphology and relatively free word-order, which makes the full analysis of the language difficult, compared to other languages, e.g. English.

A new mathematical formalism for the TTCN 3 core language

Szilárd Jaskó

Testing is one of the most important things in our life. This process can be found everywhere. The brain of the human continually checks our movement and our body's working mechanism. The researchers can not build such a complex testing system yet, but this process has started. A simple example gives why this topic is important for everybody. The test cost is half of the whole planning and construction charge in the telecommunication. So a cheaper product would be created with the help of a better and more effective procedure. Therefore it is really important to establish a mathematical formalism for testing and test languages.

Only one standardized test language is used in the area of the telecommunication. The first version of the TTCN was published by ISO at 1992. The full name of TTCN was Tree and Tabular Combined Notation till 2000. The third version of this tool was published at that time including a lot of new test methods and system structures. It has got a new name on account of many changing. This name is Test and Test Control Notations. The main part of this system is the core language. It works similar to an object oriented programming language. Of course it uses a very special order notation. This system is a flexible tool, because modules can be connected to the core language. For example the type of value can be given from a module. The name of the most used this kind of module is ASN.1 (Abstract Syntax Notation Number One) for this functionality. Programming interfaces can be connected to the core with the help of the module structures. The most popular programming surfaces are the following: the tabular and the graphical format, but of course other programming modules can be linked.

The other important component of my work is the CSP. The full name of CSP is Communicating Sequential Processes and it is a useful mathematical tool for processes. Working flow of the communication systems can be described with the help of this mathematical technology. So this tool can be used in the telecommunication and the work of protocols can be described. A test system was created in CSP, that is able to generate automatically simple normal test cases. This is build up by three main parts: The tested machine, the channel and the tester. It was tested with SLP (Service Location Protocol) and it worked. So the first results were good and this fact proved the following: this research way is promising. The next step was to create a connection between the CSP and the TTCN 3. The idea was the following: CSP module would be created to the TTCN 3 to control the core language with the help of a mathematical formalism. It would be a simple module like the graphical or the tabular format. First of all the base of the system was built. The principles are the following:

- Has some basic element (like the definition in math)
- Build complex working flow with the help of them
- Control signal based process flow

The functions of TTCN core language are described in CSP by the previous basic rules. The final goal is to prove the equivalence between the TTCN and this formalism. Than a totally self adaptive system would be created in CSP and this system will create TTCN code without human help. Money and time will be saved with the help of this. So final price of the product will be cheaper and everybody will win with the help of this new technology.

A formal approach for clustering classes in software components

Dan Laurenţiu Jişa

The components based development (CBD) tends to revolutionize the software development process, opening the possibility to construct software applications through the assembling of building blocks, represented by components. A software component must assure a better management of the application complexity, a reducing of the development costs, flexibility for applications. These goals can be achieved through a proper identification of the classes in components.

This paper describes a model for the identification of the software components based on the design models of the application, as well as a genetic algorithm used to achieve the clustering of classes in software components.

t considers a design model which consists of n classes, where n > 1. The goal is to clustering the classes in components, in order to obtain values for the quality attributes of the components as better as possible.

The following model is utilized:

- a matrix $M = (m_{ij})$, which describes the inheritance relationships among the classes of the model, where $i = \overline{1,n}$, $j = \overline{1,n}$;

- a matrix $A = (a_{ij})$, which describes the association relationships among classes, where $i = \overline{1,n}$, $j = \overline{1,n}$, a_{ij} = number of the association relationships between classes i and j.

- a matrix $Msg = (msg_{ij})$, for the exchanged messages among the classes of the model, where $i = \overline{1,n}$, $j = \overline{1,n}$, msg_{ij} = the number of messages sent by class i to class j.

- a matrix $Met_t = (met_{ij})$, where $t = \overline{1,r}$, for each of the internal metrics of the classes (it is made the assumption that are used r internal metrics, r > 0).

$$met_{ij} = \begin{cases} \text{value of the metric t for class i, if i=j} \\ 0, \text{ otherwise} \end{cases}$$

The purpose is to establish k components, where $1 \leq k \leq n-1$. For each component, it imposes constraints for the number of classes (for example: $1 \leq dim \leq n-1$). The classes will be heuristically grouped in components and for each cluster will be computed quality attributes.

The matrix $S = (s_{ij})$ represents a solution, where:

$$s_{ij} = \begin{cases} \text{index of the component to which the class belongs} \\ 0, \text{ if the class does not belong to any component} \end{cases}$$

For the identified components, the sum of the quality attributes (reusability, understandability etc.) values is computed. This will represent the function to be maximized.

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Integer Merge Model Representation of the Graph Colouring Problem

István Juhos

The vertex graph colouring problem or put shortly the Graph Colouring Problem (GCP) plays important role in graph theory. The GCP arises in a number of applications for example timetabling, scheduling or register allocation. It deals with assigning colours to the vertices of an undirected graph such that adjacent vertices do not get the same colour. The primary objective is to minimize the number of colours used. The fewest number of colours necessary to colour the vertices of a graph is the chromatic number. Finding the chromatic number of a graph is an NP-complete problem [3]. Thus, one often relies on heuristics to compute solution or its approximation.

Graph colouring algorithms make use of adjacency checking during colouring, which plays a significant role in performance. The number of checks depends on the representation of the problem and the algorithm based on it. The Integer Merge Model (IMM) introduced here directly addresses these issues. This is a generalization of the efficient Binary Merge Model [2], therefore it gives a good representation of the GCP. Embedding it into a graph colouring algorithm we are able to reduce the number of adjacency checks and define useful heuristics using the model provided information.

Generally, when assigning a colour to a vertex all adjacent vertices must be scanned to check for an equal colouring, i.e., adjacency checks need to be performed. Thus, we have to perform at least as many checks as the number of coloured neighbours and at most as the number of vertices in the graph. In the new model, this number of checks is between one and the number of colours used up to this point. It thanks to the model induced hyper-graphs.

To show performance issues and the ability of defining useful heuristics on the model, IMM was embedded into the DSatur of Brélaz [1], which is a standard among the graph colouring algorithms. An empirical comparison is made between DSatur with and without IMM on a standard suite of problem instances. The results show that IMM gives a compact, general and powerful representation of the problem.

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On Restricted Insertion-Deletion Systems

István Katsányi

The insertion grammars (or semi-contextual grammars) were introduced in [1] (see also [2]) as a model of the constructions of natural languages. It is an important model of formal languages of its own right, but it gained even more significance by the emerging of the field of DNA computing, since using a standard laboratory technique called *PCR site-specific oligonucleotide mutagenesis* insertions or deletions of nucleotide sequences into or from the strands of DNA molecules are possible. Hence by inspecting the practical applicability of the formal models we may gain functioning molecular computers. In the past few years several papers showed, that various generative mechanisms in formal language theory that use insertion and deletion operations are capable of generating any recursively enumerable languages [3, 4, 5, 6, 7, 8, 9, 10, 11]. Since such systems are also models of molecular computing, for practical reasons it is important to examine these systems in a restricted case, in which the number of symbols in the model of the alphabet is limited. In [6] it is showed that we can define the generated language of an insertion-deletion system in such a way, that a two-letter alphabet is enough to generate any recursively enumerable language. In this work we complete this result by showing that the same generative capacity can be obtained even if we define the generated language the traditional way.

An *insertion-deletion system* (or shortly an *insdel system*) is a construct $\gamma = (V, T, A, I, D)$, where V is a finite *alphabet*, $T \subseteq V$ is the *terminal alphabet*, $A \subseteq V^*$ is the finite set of *axioms* and $I, D \subseteq V^* \times V^* \times V^*$ are the finite sets of *insertion and deletion rules*, respectively. For two words $x, y \in V^*$ the relation $x \Longrightarrow_\gamma y$ holds when either $x = x_1uvx_2$, $y = x_1uzvx_2$, $x_1, x_2 \in V^*$ and $(u, z, v) \in I$, or $x = x_1uzvx_2$, $y = x_1uvx_2$, $x_1, x_2 \in V^*$ and $(u, z, v) \in D$. Let $\Longrightarrow_\gamma{}^*$ be the reflexive, transitive closure of $\Longrightarrow_\gamma$. The language generated by γ is $L(\gamma) = \{w \in T^* \mid x{\Longrightarrow_\gamma}^*w, x \in A\}$. In papers [3, 4, 6, 8, 9, 11] we can find different proofs for even stronger variants of the following theorem:

Theorem. 0.1. *The family of languages generated by insertion-deletion systems equals to the family of recursively enumerable languages.*

In the paper we define a new kind of insertion-deletion system which has additional constraints comparing to the regular model described earlier, but more general as the restrained system defined in [6]. We also show that in spite of the restrictions it is capable of universal computation. A *restricted insertion-deletion system* is a construct $\gamma = (V, T, h, A, I, D)$, where V is an *alphabet* consisting of two letters, T is a finite alphabet called the *terminal alphabet*, $h : T^* \to V^*$ is a λ-free morphism, A is a finite subset of V^*, the set of *axioms*, I and D are finite subsets of $V^* \times V^* \times V^*$, the *insertion and deletion rules*, respectively. The role of V, A, I and D coincides with the regular model. The relation $\Longrightarrow_\gamma$ is also defined the usual way. The morphism h is needed to define languages over an arbitrary finite alphabet. The language generated by γ is $L(\gamma) = h^{-1}(\{w \in V^* \mid z{\Longrightarrow}^*w, \text{ where } z \in A\})$.

In the paper we give two different proofs of the following theorem:

Theorem. 0.2. *The family of languages generated by restricted insertion-deletion systems equals to the family of recursively enumerable languages.*

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Compacting XML Documents

Miklós Kálmán and Ferenc Havasi

These days it seems that XML documents are becoming ever more important. The number of applications capable of storing things in XML format is growing quite rapidly. The applicability of the XML format spans medical science (human genome mapping), database storage , military use, component modeling. If the growth continues at this rate, XML documents will span every area in computing.

XML documents can be quite large, but many systems can only handle smaller files (e.g: embedded systems). The size factor is also important when an XML document has to be transferred via a network. One solution to overcome this problem is to compress the documents using a general (e.g. zip) or XML compressor (XMill). Unfortunately the compressed size of the files may still be too large.

Compressors are the most effective when they can find the most dependencies in a set of data and can utilize these dependencies to store the data in a smaller form. XML documents may of course contain dependencies which are not discoverable by the above-mentioned compressors. One of these dependencies could be a relationship between two attributes, where it might be possible to calculate one from the other. Our method offers a solution to this problem, employing a special (SRML: Semantic Rule Meta Language) file format for storing the rules. These SRML rules describe how the value of an attribute can be calculated from the values of other attributes. These rules are quite similar to those of the semantic rules of Attribute Grammars, and can be used to compact the XML document by removing computable attributes.

The generation of these SRML files can be done manually (if the relationship between attributes is known) or via machine learning methods. The method examines the relationship between the attributes and looks for patterns in them using specific rules.

We have implemented our algorithm in JAVA in order to make the modules more portable and platform independent. The whole implementation is based on a framework system (every algorithm is considered as a plug-in).

During the testing of the implementation, the input XML files were compacted to 70-80% of their original size, maintaining further compressibility (e.g. the XMill XML compressor could compress the file after first being compacted making it even smaller). The increased compressibility of XML files is the main advantage of our method, apart from gaining a general understanding of the relationships between attributes.

For testing our approach we used XML documents generated from large C++ programs. XML can be considered as a common format for information exchange between software development tools (e.g: XMI in case of UML documents). This trend can be discovered in the field of reverse engineering, where it is important for tools (e.g: source analyzers, visual modelers, metric calculators, program analyzers) to communicate with each other during the analysis of large "legacy" systems. One of these is the Columbus system, which is a widely used tool for the analysis of C++ programs. This system offers the opportunity of storing derived information in an XML format. The output of this system is an XML based file called CPPML, which contains detailed information about the C++ code that was analyzed and aids developers in the reverse engineering process. The size of CPPML documents can be quite large on real systems. This is why applying the technique mentioned in this article is very important, since compacting CPPML documents using this technique, followed by XMill, the compressibility ratio increased by 10% (of the original compressed size). This could make the new method a useful partner in future XML compressors. The method operates using SRML rules. These rules can be generated by hand or by machine learning methods. The effectiveness of an SRML file created via machine learning can attain that of manual SRML generation. It is also possible to combine the two, making the compaction more effective.

On the Capacity of IP Micromobility Domains

Róbert Kántor, Sándor Sipos, Sándor Imre and Balázs Rózsás

Due to the growing number of mobile communication systems, there is a demand for IP-based mobile networks [1]. Mobile IP provides mobility support in IP-based networks, but in wireless environment new architecture is needed to support fast and frequent handovers. The idea of mobile IP is based on an entity called home agent, which forwards the packets addressed to the given mobile computer being in a foreign network. Registration at the home agent costs a lot of time, if the mobile is far away from its home network. In mobile networks with small cell sizes, the frequent handovers trigger frequent re-registrations and can lead to frequent disconnection. Micro mobility protocols are the solutions for this problem [2]. These protocols improve the performance of mobile IP by hiding user movement inside a well-defined area. There are several solutions to handle this problem, for example Cellular IP and HAWAII and HMIPv6 [3],[4]. For packet delivery they usually use a tree topology of routers.

Mobile users moving in large groups can overload certain parts of the network. Whenever a router receives too many packets it will drop the packets above its capacity. The principal idea of our solution is to use also the less loaded routers of the domain in the case of congestion. To achieve this, we add alternative routes (additional links) to the micromobility domain's router tree (can be seen in Figure 1). These links mean additional connections beside the branches of the tree. The advantage of this solution is the effective utilization of network resources and we can serve the same number of users with less of the link's capacity. We analyzed the performance of these protocols - in function of the number of mobile users, the speed of mobiles - using the OMNET++ simulator.

OMNeT++ [5] is a discrete event simulation system. Using this simulation we compared our method and the basic Cellular IP protocol. In our presentation the results will be shown as well as the structure and some design principles of our suite. Our future plans are the further development of the simulation and also give some analytical results on the effectiveness of our method.

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M/G/1 Queuing System with Two Types of Vacation

Péter Kárász

To determine the equilibrium distribution of different queuing systems, the embedded Markovchain technique is often used, which leads to the PollaczekKhinchin formula, the generating function of ergodic distribution. From mathematical point of view this gives the exact solution of the problem, and probabilities can be derived from it by means of differentiation. This seems to be the most natural way, but it gives very complicated results. These difficulties induced the search for other methods.

In [2] Briére and Chaudhry considered bulkarrival systems, and found a recursive algorithm for different service time distributions. The inversion of generating functions are realized by comparing the coefficients of the corresponding powers of z. Their work also includes both sample numerical results and easily implementable algorithms. Lakatos used another approach, he described queuing systems with the help of Kovalenko's piecewise linear processes [1]. This makes it possible to calculate the desired probabilities on the basis of the mean length of a busy period and the mean value of time spent in different states. In [4] he gave recursive formulae for the equilibrium distribution of the ordinary M/G/1 system. He also found such formulae for the system where after each busy period there is a vacation, and a cycle ends when there are no entering customers during a vacation. In [5] he generalized formulae for bulkarrival systems. In [6] Lakatos investigated such a queuing system where the arrival of the first customer initiates a vacation, and service can only start when the system is prepared for it during the vacation. The abovementioned method made it possible to give recursive formulae for this type of system. In this paper we are going to generalize results for an M/G/1 system, where there are vacations both at the beginning of the service and after each busy period. We give ergodic distribution by calculating the mean value of length of a cycle, and finding recursive formulae for the mean time spent in different states.

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Analytical comparison of the IP mobility protocols

Csaba Keszei

In IP networks the IP address has dual role. Firstly it identifies a node in the IP layer (identifier role). Secondly the IP address is used to locate an IP node in a general IP network topology (locater role). The locater function is effective when prefix based routing is possible which enables aggregation and helps keeping the routing tables in a moderate size.

A fundamental problem in IP level mobility is that the IP address of a mobile node cannot fulfill both roles at the same time. If it changes with node mobility, it is not an identifier. If it does not change at mobility then it looses its location significance. We can categorize the IP mobility protocols based on the way they handle this issue. In the first group of protocols the locater role is given up. This prevents route aggregation which in a general case might result in O(N) sized routing tables in all of the routers where N denotes the number of mobile nodes in the network. This group of protocols obviously cannot scale to the entire Internet. All the ad-hoc routing protocols, CIP and HAWAII are examples of this group.

In the second group the two roles are split to two actual IP addresses. One is a permanent identifier, while the second changes with movement and reflects the current location of the mobile node. The identifier address is typically routed towards a fixed point (anchor) in the Internet. From that point IP-in-IP tunelling is used towards the mobile node's actual location. Since locater role is valid, regular prefix based routing can be used in the network. Moreover, certain routers (called intermediate routers) might not be aware of IP mobility at all. Only a limited number of routers will have mobile node related entries in their routing tables. This is a scalable solution so the size of the IP mobility network is not limited by the size of routing tables. Examples are MIPv4, MIPv6 without route optimization, HMIP and BCMP.

In the third group the main goal is optimal routing. The most important difference compared to the second group is that the identifier address is never used for topologically locating (even roughly) the mobile node. Valid locater addresses are the result of database lookups. Several nodes has to maintain database entries on one mobile node in this group of protocols. Example is the MIPv6 in route optimization mode.

In this paper an analytical comparison of the three groups will be carried out. Investigated values are data path length (routing optimality), signaling overhead caused by mobility or connection setup, number of maintained states in the network (complexity in other words) and handover performance (time to bring the network into consistent state after a mobility event). Since IP mobility protocols are complex, for a fair comparison decomposition is needed. Protocol actions can be split up to parts directly dealing with core IP mobility or to - from this point of view - secondary actions such as handover management (making the handovers fast and smooth for the mobiles), context transfer or AAA actions. This paper points out that in the investigated values related to core IP mobility there are no fundamental differences between the protocols belonging to the same group. The goal is to find analytical formulas for the mentioned values in case of the three groups of protocols for a certain network topology. This enables to find the optimal solution for a given set of requirements. We believe that hierarchical combination of the protocols gives the best results when the goal is to provide a general IP mobility solution.

On Avoidance of Attacks Against the PIN Error Counter of Smart Cards

Zoltán Kincses

Smart cards are generally considered as secure tokens, applicable for storage of long cryptographic keys or usable as keys themselves in different security mechanisms. However usually the access ability or usage of the internal data depends on the knowledge of a short PIN code. Counting the attempts of use with invalid PIN codes usually protects the card against simple brute force attacks.

If this PIN error counter can be somehow circumvented, an easy way opens to access data in the card without proper knowledge of the PIN code. The full paper of this detailed abstract describes attack methods - classical and newly invented also -, and suggests appropriate defensive measures.

Basic standards or programmer's guide supplied with developer kits describe the role and the mechanism of CHV (Card Holder Verification) and AUT (Authentication) bytes in a smart card environment. The access control can be maintained through the management of asset of codes, which are commonly referred to as PIN (Personal Identity Number) codes. In general, the access of the data stored in a smart card is controlled by these PIN codes (PIN as basic code, PIN2 as security code, PUK as unlock code, and other more specific codes, like operator code for higher security access to the chip or even supervisor code).

Smart cards have their well-defined methods to handle the PIN management, from storage of these codes, through change possibility, till the counting of bad attempts.

When the smart card's PIN management system asks for a code to be entered, the presented code is compared with the stored one. If the given code does not match with the stored one, then the operating system will increment the counter of bad attempts. After reaching the maximum number of allowed bad attempts, the OS will deny further attempts by blocking the code. The card can be used only after entering the unblock code. After receiving the correct code, the counter will be reset to initial value.

Analysing the security of the system from the PreDeCo (Preventive-Detective-Corrective) control's point of view, the existing and the missing protection measures can be discovered. This way the weakest points in the security of the implemented system are easily identified. The preventive control against the user access is asking the PIN code. The detective control is the counter of attempts and the corrective is the usage of an unblock code. From an attacker's point of view, however the preventive control is the counter of attempts, but if this control can be circumvented, there is no detective or corrective control.

The question is how it is possible to avoid or block the increment of the counter. The chip must be operational for reading the data and compare the entered and the stored code, while it must not be able writing the new counter value into memory. One is the manipulation of algorithm execution from outside and another is monitoring and manipulation of power consumption. Both have a simple protection method.

The new attack method is the 'low temperature attack'. The aim is to reach that temperature state of the chip when it is able to process reading functions, but it is unable to process the writing functions. Protection measures will be presented against this type of attack, and this protection can be applied in any other systems also, where the written data can be read back for control purposes.

In general, the suggested scheme - that is, the application of a secondary backup counter for checking the correct increment of the error counter - can be applied in all cases when the success of a memory write operation affects the security of the system.

Investigation of the asymptotic behaviour of a closed-circuit grinding system

Piroska B. Kis and Csaba Mihálykó

A discrete mathematical model for a grinding mill-classifier system expressed in the form of delay difference equations was developed. In the model, the mixing of the material to be ground by the axial dispersion model, the breakage kinetics by the first order breakage law, and the classifier by a usual classification function are described.

Closed-circuit grinding system, characterised by external classifier can be used successfully to reduce the energy consumption, and at the same time, to prevent the 'over-grinding' of the product. However, because of the continuous recycling of the coarse material, such a system may exhibit instabilities in the form of oscillations and overloading of the mill, therefore a more detailed analysis of the system behaviour is required.

The closed-circuit grinding system considered in this paper is as follows: the fresh material to be ground enters the mixer and it mixed perfectly with the still coarse material recycled from the classifier. Travelling through the mill, the particles are continuously ground and mixed because of their stochastic motion. The ground material is sent to the classifier, from that the fine component is removed as the finished product, while the coarse material is recycled.

The discrete model developed is the basis of the computer simulation. The whole grinding process can be observed, statistical characteristics of the ground material can be calculated at any moment of time with the aid of simulation. The influence of the parameters of both the mill and the material to be ground can be investigated via simulation.

At this time, we focus on the asymptotic behaviour of the model. For that reason the set of model equations is written in matrix form. The asymptotic behaviour of the grinding mill-classifier system was investigated by means of the eigenvalues of matrices, and the influence of the classification was examined via numerical experiments.

Comparison on Static Slicing of C and Binary Programs

Ákos Kiss

Program slicing is a technique developed for automatically decomposing programs by analysing its control and data flow. Different slicing methods have been intensively studied in recent decades and many applications have been proposed, including maintenance, reverse engineering, testing and debugging. A (backward) slice consists of those parts of a program that potentially affect a set of variables at a specific program point, called the slicing criterion. Static slicing computes slices using static analysis only, without making any assumption regarding the input of the sliced program.

The slicing of programs written in a high-level language has been widely studied in the literature, but the slicing of binary executable programs got attention only in the near past [1]. Since the slicing of binaries is a relatively new topic no previously published work deals with comparing the slices computed from the source code form and the binary executable form of the same program.

In this paper we present our observations comparing slices of C programs and their binary counterparts using a publicly available C slicer and our prototype binary slicer.

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Preprocessing and Discrete Tomographic Reconstruction in Neutron Radiography

Zoltán Kiss, Lajos Rodek, László Ruskó, Attila Kuba and Márton Balaskó

Neutron tomography can be used and applied for non-destructive specimen examination. It is typical that the projection images are noisy. This effect can be reduced by preprocessing. Since projection acquisition is a time consuming and costly procedure, the goal is to perform the reconstruction using only a few projections. However, mathematically not all the classes of functions can be reconstructed from a few projections. The discrete tomography seems to be a suitable tool to solve this problem by the assumption, that the object consists of only a few known materials.

The applied preprocessing steps are introduced, and a discrete tomographic reconstruction method is presented, which considers and solves the problem as a combinatorial optimization task. Their efficiency is demonstrated using phantom and real input data.

Handling the Uncertainty in Resource Managment

Zsolt Tibor Kosztyán and Andrea Bencsik

The duration time of activities of projects cannot very often be estimated correctly in real life. Especially in research and development programs where the duration time of activities is very slightly known and the ex ante and ex post duration times are often different. [1]

In the paper a method is introduced that can determine an optimal resource allocation with minimal total cost from a feasible solution when a target function is given. The duration time, demand of resources and cost of activities can either be deterministic or stochastic.

A new algorithm is introduced by which an optimal resource allocation with minimal total cost for any arbitrary project could be determined. This algorithm could hopefully be widely used in project management, resource planning and in the methodology of small-scale series production management.

The new method schedules the activities in the alternative paths of an admissible resource allocation satisfying a given target function and taking into account that the duration times of the activities are probability variables with an expected value and standard deviation [3],[4]. According to former studies 10- 12% cost can be saved if the duration times of activities are handled as probability variables instead of deterministic values, hence the uncertainty of duration times can be managed and the total project time can approximately be determined if a significance level is given. After all, the total project time is many times influenced by unanticipated events. In case the resources and the duration time of activities are changing at projects in progress, a new resource allocation for the running activities and for those still not started can be determined with this method.

If the uncertainty of the major variables (duration times, cost and resources) is taken into account when scheduling and allocating a project, then the duration times, costs, and resources can be estimated more accurately. Therefore the total project time, total cost and total demands on resources can be determined more accurately, too.

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Classification using sparse combination of base functions

Kornél Kovács and András Kocsor

Tasks in machine learning often lead to classification and regression problems where applying models using convex objective functions could be beneficial. Consider the problem of classifying n points in a compact set $\mathcal{X}$ over $\mathbb{R}^m$, represented by $\mathbf{x}_1, \ldots, \mathbf{x}_n$, according to membership of each point $\mathbf{x}_i$ in the classes $+1$ or -1 as specified by $y_1, \ldots, y_n$. First, let S denote a finite set of continuous base functions

$$S = \{f_1(\mathbf{x}), \ldots, f_k(\mathbf{x})\} \qquad f_i : \mathcal{X} \to \mathbb{R}.$$

Second, consider the following general convex optimization problem of the classification task:

$$\inf_{f(\mathbf{x}) \in Span(S)} \sum_{i=1}^{n} L\left(f(\mathbf{x}_i) y_i\right), \tag{3}$$

where $L : \mathbb{R} \to \mathbb{R}$ a method dependent convex loss function, and $Span(S)$ denotes the linear space generated by the base functions

$$Span(S) = \left\{ h : \mathcal{X} \to \mathbb{R} \mid h(\mathbf{x}) = \sum_{i=1}^{k} \alpha_i f_i(\mathbf{x}),\ \mathbf{x} \in \mathcal{X} \right\}.$$

Taking into account the fact that $f(\mathbf{x}) \in Span(S)$, i.e. $f(\mathbf{x}) = \sum_{i=1}^{k} \alpha_i f_i(\mathbf{x})$, Eq. (3) then has the following form:

$$\inf_{\boldsymbol{\alpha}} g\left(\boldsymbol{\alpha}\right), \tag{4}$$

where $\boldsymbol{\alpha} = (\alpha_1, \ldots, \alpha_k)^T$ and

$$g\left(\boldsymbol{\alpha}\right) = \sum_{i=1}^{n} L\left(\sum_{j=1}^{k} \alpha_j f_j(\mathbf{x}_i) y_i \right).$$

We show that the optimization problem defined in Eq. (4) includes several well-known machine learning algorithms, such as certain variants of boosting methods [1, 2] and Support Vector Machines [3, 4]. The nonlinear Gauss-Seidel (GS) method can be applied to optimize Eq. (4), which alters model parameters one at a time. If $\nabla g\left(\boldsymbol{\alpha}\right)$ has the Lipschitz continuity property in Eq. (4) the convergence of GS can be proved. The GS method has low memory requirements during optimization, but in large real-life problems, the solution is practically infeasible due to the numerous iteration steps.

That is why the application of (heuristic) methods providing approximate solution seem important here. We define a set of heuristic methods which quickly and efficiently determines adequately functioning suboptimal solutions in a classification sense. The algorithms are based on the methods of feature selection, a special field in machine learning. The methods used here are called Sequential Forward Selection, Plus *l*-Take Away *r* and Sequential Forward Floating Selection.

The proposed algorithms looks for solutions that have a predefined number of nonzero components among the model parameters. We provide a justification for them by solving several tasks using data taken from the UCI Repository [5] which is widely used for testing machine learning algorithms.

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Unification for Effective and Finite Semantic Tableaux in First-order Logic: the SOFIA Prover

Gergely Kovásznai

The problem of automated theorem proving in first-order logic has been tried to be handled by the use of semantic tableaux [1], among other tools. Since it is an algorithmically insolvable problem by nature, tableaux meet the problem of the γ-formulae, which is algorithmically insolvable, too. By the use of free-variable semantic tableaux, this insolvability can be overridden. As detailed in [2], even the application of the Most General Unifier (MGU) Atomic Closure Rule for free-variable tableaux effectuates a non-deterministic and ineffective tool for theorem proving, furthermore its execution may stuck in an infinite loop. In our paper, a straightforward and very effective technique is proposed for free-variable tableaux. The main question, namely which MGU should be applied, is replied by the construction of a heuristic measure, which is used for ranking MGUs generated for a branch of a given tableau. The heuristics is a kind of a hierarchical one based on the number of branches and the number of bound variables. Whilst a hardly usable check for depth-limit was performed in [2], our technique proposes a very simple trick in order to avoid infinite loops. In the paper, we propose the Extended Unification Algorithm, which can produce an MGU for formulae (not only for terms), i.e., it reveals if each of them can be transformed to a same formula by the application of a substitution on their parameters. The Extended Unification Algorithm is a generally used tool for all the aforementioned techniques, i.e., not only for the generation of MGUs but also for avoiding infinite loops.

Besides proving a theorem, the proposed prover is especially useful in answering the following question: for a formula A, if a substitution θ exists where $A\theta$ is a theorem. It can be seen, theorem proving is only a special case of this issue, namely the case when $\theta = \emptyset$. Accordingly, the proposed prover could answer Prolog-like questions like `?- A(`X_1`, ... ,`X_k`)`, where A is an arbitrary first-order formula (even a compound one) with the parameters $X_1, \ldots, X_k$ $(k \geq 0)$. This kind of functionality can be easily achieved by the extension of the heuristics on MGUs, namely by making the heuristic measure reactive to the number of free variables.

The proposed prover has been implemented and named SOFIA.

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Seismic wave propagation modelling on emulated digital CNN-UM architecture

Péter Kozma

The solution of partial differential equations (PDE) has long been one of the most important fields of mathematics, due to the frequent occurrence of spatio-temporal dynamics in many branches of physics, engineering and other sciences. One of the most exciting areas is the simulation of seismic wave propagation. It is an important tool to understand wave-field phenomena and how it relates to observations of recorded seismic data. An important aspect of an earthquake is the stresses and deformations of the ground. On the other hand the solution of these equations requires enormous computing power. In this paper a CNN-UM simulation of seismic wave propagation will be presented. Unfortunately the space-dependent equations do not make it possible to utilize the huge computing power of the analogue CNN-UM chips. To improve the performance of our solution an emulated digital CNN-UM is used.

A Cellular Neural Network is a non-linear dynamic processor array. Its extended version, the CNN Universal Machine (CNN-UM), was invented in 1993 [1]. The CNN paradigm is a natural framework to describe the behaviour of locally interconnected dynamical systems which have an array structure. So, it is quite straightforward to use CNN to compute the solution of partial differential equations (PDE). Several studies proved the effectiveness of the CNN-UM solution of different PDEs [2], [3]. But the results cannot be used in real life implementations because of the limitations of the analogue CNN-UM chips such as low precision or the application of space-dependent templates. Emulated digital CNN-UM architectures seem to be more flexible than their analogue counterparts both in cell array size and accuracy while their computing power is just slightly smaller. In this paper a method is given to model the propagation of stress waves in two-dimensional inhomogeneous elastic medium on CNN-UM architectures.

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Stochastic search on decision trees

Ilona Krasznahorkay

The construction of decision trees is an often used and easily applied way of supervised learning. The goal is the prediction of a binary target variable depending on many predictor variables. The algorithm divides the field of predictors along a predictor variable one after another. The aim is to find a partition where the target variables are the most homogeneous. I modified the deterministic CART algorithm developed by Breiman and others [1]– which aims for the minimizing of a concave risk function defined on the partitions generated by the trees. I used the Markov Chain Monte Carlo method so doing stochastic searches on the set of decision trees. (It was first proposed in a Bayesian framework by Chipman and others [2].) By empirical experience finding the optimal tree with this technique is much more effective than the former deterministic methods.

In my talk the main result is the examination of MCMC type stochastic searches on decision trees. I prove the geometric ergodicity of the constucted Markov chains using the drift-criterion technique. I prove exact results on the mixing time of the above Markov chains using different methods like canonical paths, conductance and coupling, see Jerrum, [4] and Jerrum & Sinclair, [5].

I also examine the cost-complexity risk function, where the penalty term depends on the number of the leaves of the tree. In this case the associated Gibbs distribution is studied.

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Routing protocols

Gábor Kuruc and Krisztina Lója

Routing is an important problem, as the new, intelligent systems make it possible to use more alternative paths simultaneously. Our aim is to minimize the latency-based characteristics of the network, that is, the cost. We face the same problems in fix and mobile networks.

The protocols used nowadays find the shortest path, one providing the widest bandwidth or some other one based on a subjective cost. These tend to overrate a route or a section of routes and make its characteristics worse with the exaggerated traffic directed to it. There are QoS-based routing protocols that select more paths in an ad-hoc manner and do not take the interdependence of the traffic into account. The traffic on the different routes forms the flow on the network. A flow is said to be at Nash equilibrium (or is a Nash flow) if no user can change their route to improve its latency. Nash flows always exist and are essentially unique. Since there can be such a flow in which no user can decrease their own latency by changing route, however they can improve the latency of others, the Nash flows are not always optimal considering the total latency (Total latency is what we get by summarizing the product of the latencies and the congestions on every link). Optimal flow minimizes the total latency, but it can be unfair to some traffic, i.e., some traffic might suffer a greater latency in the optimal flow than the Nash flow.

In the literature total latency is minimized. In this paper we take the greatest latency into account. The reason is that in real-time - for example speech traffic - we have to consider the worst supply. The social cost we use is an important characteristics of the flows on telecommunication networks, because every traffic has to reach its destination node in time. The flow minimizing the social cost can eliminate the unfairness properties of the minimum-latency flow and the sub- optimality of the Nash flow.

Effective Implementation of Hyper-Unit Propagation on FPGA and PC

Gábor Kusper and Krisztián Kusper

SAT solver algorithms are based on unit propagation. Unit propagation is a special case of hyper-unit propagation. Hyper-unit propagation is the propagation of an assignment. Usually hyper-unit propagation is implemented as a series of unit propagation by the units of the assignment. This means that it is not utilized that the units can be propagated simultaneously. We report a special literal matrix representation of SAT, which allows us to do hyper-unit propagation at once using only 3 operations per clauses. The 3 operation are 2 binary and operation and a comparison with zero. These operations are simple and allow us to implement hyper-unit propagation efficiently on a dedicated hardware using FPGA and on PC using low level programming languages like assembler. We compare several implementations.

If we use literal matrix representation of SAT we need at least two bits to represent a literal, because a literal is either positive or negative or the corresponding variable is not present (no occurrence literal). The basic idea of the special literal matrix is that we use the two bits as follows. If the first bit is set (1) and the second one is clear (0), it means the literal is positive. If the second bit is set and the first one is clear, it means the literal is negative. If both two bits are set or clear, it means the literal is the no occurrence literal. This is the new idea, because the usual literal matrix representations use only one combination of bits to represent the no occurrence literal.

We utilize this new idea as follows. First, we have to decide whether a clause becomes true or not if we assume, i.e., propagate an assignment. If they have a common literal then the clause becomes true. Second, we have to remove irrelevant literals form clauses that have no common literal with the assignments. This means we remove the negative of the assignment from these clauses. Both operations can be done using binary and operation, but in the first case we have to represent no occurrence literals in the assignment as 00. In the second case we have to use 11 to represent no occurrence literals in the assignment.

We implemented this technique on FPGA and on PC (32 bit x86-architecture).

Metamodel-Based Modeling and Model Transformation Framework Supporting Inheritance and Constrants

László Lengyel, Tihamér Levendovszky and Hassan Charaf

Because of the appearance of high level languages, object-oriented technologies and wide spreading of CASE tools metamodeling becomes more and more important. Metamodeling is one of the most central techniques both in design of visual languages, and reuse existing domains by extending the metamodel level. Visual modeling has become indispensable part of software engineering, with aim to raise efficiency in design period of software engineering. Visual modeling helps to realize systems at a higher abstraction level. It is important to provide solutions, which supports storing models building on each other, and which can handle models uniformly through optional number of layers.

Our implementation called AGSI (Attributed Graph Architecture Supporting Inheritance) is a multipurpose modeling and transformation system, which is able to store models, check them against their metamodel, traverse and transform them using graph rewriting (transformation) rules with tree-based notation, export and import them. In AGSI every model has its metamodel and every model can be the metamodel of its instances. The most important principle in AGSI is the following: traversing and modifying the layers must be transparent; every layer must be handled with the same functions without behaving in a layer-dependent way. In addition to these achievements in metamodel-based graph transformation, this presentation introduces how we extend this concept to support constraint handling and constraint propagation using Object Constraint Language (OCL).

In graph rewriting we have rewriting rules consisting of the left hand side graph (LHS) and right hand side graph (RHS). Applying a graph rewriting rule means finding an isomorphic occurrence (match) of the LHS in the graph the rule being applied to (host graph), and replacing this subgraph with RHS. Replacing means removing elements which are in the LHS but not in RHS, and adding elements which are in RHS but not in LHS. AGSI goes further: we have LHS built from metamodel elements, so an instantiation of LHS must be found in the host graph instead of an isomorphic subgraph. Causality is a relation between LHS and RHS elements, it makes possible to connect an LHS element to an RHS element and to assign an operation to this connection. Causality and its operation describe what must be accomplished during the application of a rewriting rule. It is possible to provide an ordering of the rewriting rules, in other words we control the transformation process by sequencing the rewriting rules. Searching is one of the key algorithms, AGSI always tries to use metamodel-based searching involving node type examination, to accelerate the rewriting algorithm. If it is not possible, because rewriting rule does not contain type information then the algorithm combines depth-first and breath-first searching strategies. Metamodel-based searching means, that we start searching in metamodel, firstly we identify the searched nodes by their type. And then we can immediately obtain an occurrence of the searched nodes in the model by model-metamodel relation. This immediate node identifying - which means only one database select - significantly accelerates the searching algorithm.

This presentation discusses the properties of the constraints and the implementation of their special key classes in detail. These constraints specified on meta-layer restrict the modeling possibilities on instance layer. OCL is a formal language used to express constraints. OCL considers the topology and requires the examination of the constraint propagation as well. It is possible to use OCL for different purposes: (i) to specify invariants on classes and types in the class model, (ii) to describe pre- and post conditions on operations, (iii) to describe guards (iv) and as a navigation language. It is shown how constraints can be used for rewriting rules and how they affect the transformation properties.

An illustrative case study based on constraint specification in rewriting rules is also provided.

Automated excavation and detection of Design Patterns

Szabolcs Marien

The resent specification languages can formalize the patterns using additional language elements like: graphical, formalization tool, but there is no support for detection of Design Patterns in the design phase and excavation of Design Patterns.

If the automatic detection of Design Patterns were solved in the design phase, then the cost end effort of development could be significantly reduced, since the design failures can be eliminated during the design phase.

The excavation of Design Patterns is very hard. There is no solution to do it easier at the moment. The reason of it is that the representing forms of Design Patterns are not applicable for building on them a proofing methodology.

On the one hand, we set up a simple set based language with which we can formulate the Design Patterns as existential logical forms. To be more precise, we formalize the first part: the problem specification part of patterns. The second part: the problem solution, is usually overlooked in the literature. We try to formalize the problem-solution, too. We understand the problem- solution as a constructive proof.

On the other hand, we show the recognized general roles of the type of creational Design Patterns, which can be used for realization the mapping between the UML class diagram and the formulae (mapping theorem). Using the mapping between the UML class diagrams of the design and formulae of the design components and using the logical formulae of Design Patterns, we try to show the automatic detection facilities of Design Patterns.

On the third hand, we show how to realize the automated excavation of Design Patterns using the previously mentioned mapping theorem and the constructive proofing technique.

PIC – a Peer-to-Peer Protocol for Mobile Devices

Kálmán Marossy

In wireless and especially mobile communications the bandwidth and the amount of transferred data become key aspects. Due to the bandwidth limitations wireless devices may join P2P (Peer-to-Peer) content sharing networks only for a limited time period. Enhancements and possibly new protocols are necessary for wireless peer-to-peer applications.

Introducing intelligent search/indexing techniques with the additional cost of implementation complexity we can reduce the amount of traffic in the network and balance user load. The Parallel Index Cluster (PIC) approach is proposed as an efficient candidate, as it is expected a reduction with at least one order of magnitude compared to basic and enhanced Gnutella networks [1].

An important dimension in content sharing is the user group. PIC networks proposed to be used primarily in the closed group scenario, where registered users form communities around topics of interest. The structure of the network topology could be adjusted to match the size of the user group. In a closed user group the goal is to find all content matching search criteria. This allows searching for unique and more rare content that may be necessary e.g. for many business applications. This makes it necessary to adopt a different approach from the case of open user groups, when virtually everybody can become member of the network, like in the case of Gnutella [1].

Practical applications of content sharing could be groups of small (up to 100) or moderately large (up to 10000) size that share various type of contents, like mp3 music, photos taken with mobile devices, text documents or video clips.

In this article a new modeling of P2P systems, the SIL (Search Index Link) [2] method is described, and based on this a new P2P protocol is introduced, which is suitable for mobile devices. For this new protocol (PIC) different cluster topologies are analyzed. To produce minimal network traffic, simulation results and mathematical analysis is given to optimize the cluster sizes in the network.

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Efficiency Test of Multilingual and Expandable Multimedia Software "Dyslearning" Developed for Improving Reading Skills

Rita Mátrai, Zsolt Tibor Kosztyán and Cecília Sik-Lányi

15-25% of children in the world have difficulties with reading. [2] It can be caused by injury of vision or hearing, verbal or linguistic deficiencies, troubles in spatial orientation, recollection debility, debility in dividing talking into elementary parts, lack of concentration, motivation troubles or maybe the parents' relation to reading. [3],[4],[5]

In the presentation a program is introduced which promotes children (especially who suffer from dyslexia) to become acquainted with characters, words and reading. [6] It makes children drill reading as they have to read words several times to solve the actual task. At the same time this happens in a playful form. Children do not feel that they are made read the same thing several times.

The skill-improving program was made for (private) lessons. The teacher can choose a text to be read, set the font type and size; store the results of pupils in separate files that enables tracing of their development.

The program developed by us improves multifarious skills in a playful form. It is a great advantage that every text, picture, bonus prize animation and even the buttons are imported from external files, so these are exchangable and expandable arbitrarily. Reading texts can be written - e.g. in Word - by anyone, pictures can be scanned or drawn, bonus prize animation can be made in the form of animated GIF's or downloaded from the Internet. A further advantage of the exchangability is that the software can be rewritten to other languages (e.g. English, German etc.) without any programming tasks. As an English version of the program is also planned an English name was chosen for it: DysLearning.

The program is being tested by pupils of 6-14 ages in several elementary schools, where an efficiency test is made with a control group. For this efficiency test texts to be read for different age-groups were sent; 7 texts for pupils belonging to the 1-2. classes, 6 ones for pupils belonging to the 3-4. classes and also 6 ones for pupils belonging to the 5-8. classes. In case of the 1-2. classes there is a line after 60 words, in case of the 3-4. classes after 80 words and in case of 5-8. classes after 100 words. It is examined how long pupils need to read these texts to the line before and after using the program, and how many mistakes they have while reading. It is measured whether children who use the program developed by us can read these texts "better" than children who do not use is. The time of reading and the number of mistakes are noted on a result-sheet.

For treating the problems of children suffering from dyslexia were made some programs earlier as well. But for such a program, which is expandable, there were no attempts. Many ardent teachers need to be able to compile tasks suitable for special claims. It is easy with our program. We also plan to prepare a teacher module that makes compiling new tasks even easier. The software will shortly be completed with a map exercise that improves the spatial orientation of children. We hope that this playful skill-improving software will help every child suffering from reading troubles.

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Pedagogical considerations in an e-learning framework

Dániel Muhi

We are developing a framework that supports network based education at the University of Veszprém. It handles learning objects that are discovered by service discovery and described by Learning Object Metadata (LOM). In this article I would like to present the framework and some of its pedagogical aspects.

E-learning has two main aspects:

- The technology that supports the framework of learning
- The pedagogical principles built into the framework

There exist many applications supporting elearning, they are referenced as Learning Management Systems (LMS). Although an LMS can be very rich in functions, if it lacks important pedagogical principles, it becomes useless.

We've developed a framework supporting network based education at the University of Veszprém and I'd like to present this framework in the paper, together with the pedagogical aspects.

To establish an e-learning application the first step is to develop the content [1]. In traditional education content is divided into smaller parts called lessons. E-learning has a similar concept, the learning object (LO). The official definition of this term comes from the Learning Technology Standards Committee (LTSC) of the Institute of Electrical and Electronics Engineers (IEEE). According to the LTSC, a LO is any entity, digital or nondigital, which can be used, reused or referenced during technology supported learning [2]. In other words, a LO is an entity that can be reused and composed with other objects.

To use an analogy you can think of a LO as an atom. We can build more complex structures from one LO just like a molecule builds up from several atoms. There are several rules how a molecule can be created, and different rules apply for LOs too. The most important is the "rule of dependencies", i.e. the LOs depend on each other. For example to begin working with "Distributed systems" LO we have to complete "Computer networks", while in turn "Information networks" must be accomplished to go to "Computer networks". Our framework can represent dependency rules by graphs so they can be easily understood. The graph depicting the example can be seen here:

The next step is to store the LOs created in the previous step. There is a certain amount of time when the LO must be revised and corrected, if needed.

We also need to describe the LOs. This is done by some kind of metadata. Without metadata we would have a lot of objects without any clue what do they contain. It's like we were in a library without any catalogs.

There exist several proposal for educational metadata, I chose the most significant of them, the Learning Object Metadata (LOM), developed by LTSC. It contains nine categories with more than 60 attributes.

After describing the learning objects we have to find them. The framework is distributed which means LOs can be scattered across the network. Traditionally users find a network object by typing its address or using a search engine. A new approach is service discovery. It is not exactly for finding some useful data, it was designed to manage network services in a distributed environment. I regarded the framework elements as network services. Using service discovery they can cooperate without any configuration.

Service discovery is performed by discovery protocols. The four main service discovery protocols are Jini, Salutation, SLP (Service Location Protocol) and UPnP (Universal Plug and Play Protocol). We decided to use SLP, mainly because it was developed by the Internet Engineering Task Force (IETF).

Content packaging is the way LOs are put together to form a specific course. This feature is not implemented yet in the framework.

Using a LO students can bump into problems they can't solve. Some kind of help should be provided for them, most likely communication with the instructor. Our framework contains both synchronous (chat) and asynchronous (forum) communication possibilities.

This is a difficult issue because some forms of assessment are not possible in electronic way. However we can use multiplechoice questions, matching questions and short answers. The most useful of them are multiplechoice questions, because they test students' higher-order thinking skills. It is possible to use this kind of questions in our framework, too.

To establish a working e-learning application we need not only pure technology but also pedagogical principles built into the framework. In this paper I examined these principles through a framework developed at our department. We can conclude that this framework supports many principles, although some extensions are still needed.

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Reconstruction of 2D Binary Objects from a Few Fan-Beam Projections

Antal Nagy and Attila Kuba

This paper studies the reconstruction of the binary matrices from limited number of fan beam projections. The reconstruction of the binary object is carried out by optimizing the mean square error between the projections and the given measurement data.

The minimization method is based on simulated annealing. The implementation of this algorithm contains different kind of speed up features. We are going to show that if we use pyramidal resolution approach, it will improve the speed of this algorithm.

In this paper, we are going to analyze the results of this reconstruction method from different viewpoints: changing parameters of the fan beam projection, different optimization parameters, and the complexity of the binary images.

Finally, we will demonstrate, that using this discrete tomography method for discrete objects we get better result then the traditional reconstruction algorithms (e.g. filtered backprojection).

Primitive Words and Permutations

Benedek Nagy and Szilárd Fazekas

In this paper we will analyse some interesting languages such as the languages of primitive words, Lyndon-words and their commutative closure. The language of primitive words has been the subject of numerous studies. It is the language of the words that are not a proper power of another word. Basicaly the most important question about it is whether it is or is not a context-free language. The conjecture is that it is not context-free, but in this paper our analysis is going to another direction. We will analyse some permutability properties of this language. The languages of Lyndon words contains all primitive words which are minimal under cyclic permutation. It is known that this langauge is a non- context- free, context-sensitive language. In this paper we will consider the commutative closure of these languages, containing all permutations of the letters of their each word. We can consider this language as a multiset language containing Parikh-vectors of the original languages. In this paper we investigate another languages based on primitive words and permutations. Namely, we analyze the language of the words which are primitive and every permutation of them is primitive, in other words the multiset languages which correspond to the maximal commutative language containing only primitive words. A multiset language that contains only primitive words consists of Parikh-vectors made out of relative primes. Given such a language it is interesting to check out how many of the words among those that have the same Parikh-vector are Lyndon words i.e. minimal under cyclic permutation. Another question being analyzed in the talk is whether this multiset language is linear or semi-linear in Parikh-sence.

Note, that the multiset languages play important role in membrane computing and in some other non-classical processing systems.

Some results concerning permutation loops applied to Lyndon words of the forementioned language are also given.

Computer Assisted Image Processing and Navigation System for Orthopedic-Trauma Surgery

Krisztián Ollé, Balázs Erdőhelyi, Endre Varga, György Bekes, Krisztina Maróti and Attila Kuba

Surgery of fractured bones is often a very complex problem. The fixation of these bones has to be designed very carefully. This is the reason why trauma surgeons try to build a geometrical and mechanical model of the treated bone. Following the simulation and analysis of the behavior of the bone, surgeons can test several virtual surgical methods on the virtual bone and they can find the optimal treatment for the patient. A new computer software has been developed by our team, it is called MedEdit.

The system has three main parts: The first part builds geometrical model of the treated bone. CT scans were used for this procedure. Then the segmentation of the bone parts is followed. A 3D structure is constructed from the segmented model. Usually we get a very complex geometrical model so we use some kind of mesh simplification algorithm to eliminate the complexity of the surface. In the third part we created a medical planner where a surgeon can test several surgical ways. We implemented some kind of 3D editing functions like implant insertion, boring, slicing. We show our geometrical model generated from the patient CT scans and the medical planner user interface which is easy to use for the surgeon.

The system works in an experimental way. It is able to perform all tasks, but there are still points where some user interaction is needed. For example, the segmentation of the bones starts by setting seed points manually, its result should be checked by the surgeon. The communication with FEA (Finite Element Analysis) is not automatic; it is solved by a session file. The system has been implemented and worked. Generally, it is able to create the geometric and mechanical models in ca. 5 minutes including the user interactions. The FEA takes roughly 6 minutes for a pelvis 3D volume study (on a 2 GHz computer with 1,5 GB memory). Our stress results seem to match the clinical expectations, although quantitative tests and measurements are still to be done.

We plan to extend our system with the ability to help the surgeon during the operation to find the right points and angles. With three or more cameras installed in the operating theater we could identify some special marked points and give real-time information where and in which angle the surgeon has to insert the implants.

Classifier Combination Schemes In Speech Impediment Therapy Systems

Dénes Paczolay, László Felföldi and András Kocsor

In the therapy of the hearing impaired one of the central problems is the handling of the lack of proper auditive feedback which impedes the development of intelligible speech. Our Phonological Awareness Teaching System, the "SpeechMaster" package, seeks to apply speech recognition technology to speech therapy [7, 8]. It provides a visual phonetic feedback for replacing the insufficient auditive feedback of the hearing impaired. We designed and implemented computer-aided training software that uses an effective phoneme recognizer and provides a real-time visual feedback in the form of flickering letters on calling pictures. The brightness of the letters is proportional to the speech recognizers output.

The effectiveness of the therapy relies heavily on accurate phoneme recognition. Phoneme recognition is a special pattern recognition problem [1, 2, 11] where the continuously varying speech signal has to be mapped to a symbol of a phoneme. Because of the environmental conditions, simple recognition algorithms may have a weak classification performance, so various techniques such as normalization and classifier combination are applied to increase the recognition accuracy.

Speaker normalization reduces the variance in the speech data of different speakers caused by their different vocal tract lengths. Vocal Tract Length Normalization techniques [3, 10] transform the speech data to the space of the "standard" speaker. This transformation is determined by a warp factor correlated with the speaker's vocal track length. In an earlier paper [9] we demonstrated how to estimate this warp factor in real-time.

Classifier combinations [6, 12] aggregate the results of many classifiers, overcoming the possible local weakness of the individual inducers, thus producing a more robust classification performance. In this paper the traditional (*Prod*, *Sum*, *Min*, *Max*, etc.) [5], linear (*simple-*, *weighted-*, and *AHP-based* [4] *averaging*), nonlinear (*kernel*) and stacked combination rules are examined.

From experimental tests we found that classifier combinations did prove effective in real-time speech recognition, fulfilling the special requirements of the task of therapy.

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Real-time Optimization of Access Control Lists

Sándor Palugyai and Máté J. Csorba

Nowadays the Internet usage is progressing at a great pace. More and more people become potential users and require faster connections. Recently security has also become an important issue in business networks and at home too. Because of these facts devices have to be designed and created, which allow us to build and maintain a more secure network and their operation also has to be optimized. In this work a method is proposed for the optimization of Access Control Lists used in routers, which maintain the operation of sometimes-huge networks.

Several network devices are used nowadays in access networks, like routers. These devices control the traffic, which crosses them with the so-called Access Control Lists (ACLs). ACLs can be assigned to the input or output of one or more interfaces. Of course, the input and output lists can be applied on the incoming or outgoing packets of the router respectively. The ACLs are examined sequentially in a router, because of their nature. So the router has to check every list-entry for each packet until it finds an entry, which matches the packet. After the first match the search is stopped. In the list-entries the administrator can allow or prohibit particular hosts or networks. If an entry is at the end of a list, which can be very long in certain cases, our packet will suffer noticeable delays and if the router does not find any match, the packet will be rejected.

In our work two kind of ACLs were analyzed, the Standard and the Extended Access Lists. During filtering Standard ACLs examine only the source address of a packet, Extended Access Lists on the other hand allow us to filter by other parameters as well, like the destination address, port address, protocol id and many other attributes of the packet. With these kinds of lists packet filtering can be refined as needed. The aim of this work is to optimize the input and output lists on all interfaces of the router on-line.

At first a test suite was created to measure basic performance attributes of a router, which uses different kinds of Access Control Lists. The tests are implemented in TTCN-3 (Testing and Test Control Notation version 3) language, which can be used very efficiently for packet-based measurements and tests.

The program developed by us examines cyclically the existing lists and optimizes them (if it is necessary) according to the actual network traffic, then it waits for and adjustable time. If there is no change in the number of hits of the examined lists the frequency of the periodical examination can be set automatically to a longer time.

The optimization algorithm is implemented in TTCN-3 and Perl languages. The developed software considers guidelines, such as how can be the position of a permit-, and a deny rule changed in the list in case the network segment covered by them has common parts. Besides it also uses algorithms to reduce the redundancy in the ACLs if possible. The cyclical examination of the input/output lists is organized in a way that in case the administrator alters an element in the ACLs the software can automatically adopt the changes and use the new lists.

The implementation generates bursty network traffic during the examination and list-modification period, which produces some negligible delay. Nevertheless it is worth mentioning that the optimization could actually work much faster implemented in a router.

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UML2 and Model-Driven Development

Ágnes Papp

Specifications by OMG summarize principles of data storing and modeling in a four level architecture. The first level is the meta-meta model that defines UML at metamodel level. The second level is the metamodel that describes the UML syntax. In the third level there are the models created by the users, and in the fourth level there are the object instances or records. UML has been widely accepted as an object oriented analysis and design method. An application-neutral interchange format allows UML models to be interoperable between development tools and developers. The XML is an appropriate format for transferring data via the Internet. The XML based XMI standard allow for different types of applications to interchange their data or models in a standardized way.

There is a new way of developing applications, the Model Driven Architecture. The MDA specification consists of a platform-independent UML based model (PIM), and one or more platform-specific models (PSM). With MDA, an application system is modeled once and only once. The MDA also will take advantage of XMI when it defines the mapping from PIM to XML.

An enhanced version of the language, which will be called UML 2.0 is in the process of being finalized by the OMG. UML 2.0 is likely to provide improved support for current technologies resulting in better productivity and quality.

It should deliver the following benefits:

Improved support for developing component-based software

- Better support for modeling architecture of software
- More options to build tools with simulation and code generation
- Superior support for executable models and dynamic behavior
- Improved diagram interchange between tools
- Enhanced scalability

In this paper I would like to summarize UML2 features supporting Model Driven Architecture and exchange of model information.

Creation of the database and the main menu of the Cognitive Computer Aided Therapy Software

Attila Páll, Julianna Szabó, Cecília Sik-Lányi and Ilona Pataky

In this paper we introduce a computer controlled method, which enables - as a difference to methods used internationally - not only the establishment of the diagnosis, but permits measurement of the therapy.

- To produce a database of the patients that contains not only their personal data but also the results of the tests, their drawings and audio recordings.

The following data are stored in the database of the software
Personal data:

- Name (maiden name as well)
- Name of mother
- Date of birth
- TAJ number (Hungarian social insurance number)
- Address
- Telephone number
- Name of next of kin
- Accessibility (Tel., e-mail)
- Left or right handed (this has to be known for the best strategy of some tasks)

Data obtained from tests:

- Results of the tests
- Strategy of solution
- Drawings prepared by the patient
- Audio recordings.
- Remarks of the neuropsychologist

The main menu of the HELEN program is constructed in such a way that the row of the tasks that was given in the beginning of the therapy can be changed any time depending on the patient's performance.

We have designed such an interactive multimedia software that helps the testing and rehabilitation of brain vain patients.

Abstract Model-Based Checkpoint and Recovery

Gergely Pintér

The most frequent cause of service unavailability in computer systems is related to transient hardware or software faults. A common way for addressing these issues is based on introducing a checkpoint and recovery schema. Checkpoint generation means the periodic saving the process state into a stable storage. This image can be used for restarting the process from the previously saved state reducing this way the processing time loss to the interval between the checkpoint creation and the failure. Although the core idea is relatively simple, its implementation can get very complicated in case of complex internal data structures since the representation of an object model in the non-volatile storage and the transmission between the memory and the storage requires significant programming effort.

This paper aims at proposing an automatic code generation scheme that provides a transparent and platformindependent facility for persisting object structures of arbitrary complexity in stable storage.

There are several function libraries supporting the checkpoint creation and state recovery directly. These approaches typically do not address the problem of storage and reconstruction of complex data structures, usually provide the capability of saving and loading unstructured blocks of memory only [1]. These low-level methods make the persistent storage of many interconnected objects difficult and error-prone. The solution proposed in [2] depends on a service of the UNIX operating system for saving the entire memory image and register set in a file. The drawback of this strategy is the dependence on a specific operating system feature therefore lack of portability.

The object serialization facility provided by popular languages and class libraries should be taken into consideration as well. Classes implementing the (empty) Serializable interface in the Java language are persisted transparently by the framework. This powerful and elegant feature is not portable to other languages. The Microsoft Foundation Classes library provides a C++ base class with a virtual member function Serialize that should be overridden by subclasses. Although the core idea is portable, this approach is no more than a coding convention that enables the seamless integration to the framework requiring the programmer to explicitly implement the serialization routines.

To put it together the approaches discussed here can not deal with complex data structures, rely on non-portable features or require significant programming effort therefore are not feasible for our purposes. A sophisticated checkpoint and recovery system should be based on the identification of core data modeling concepts instead of exploiting nonportable platform-specific features, a transparent mapping to the non-volatile medium and on a generic object-oriented pattern for implementation. The proposal should enable the automatically generation of low-level data exchange routines.

In our approach the data modeling concepts of the Meta Object Facility (MOF) were used that identifies four fundamental artifacts: classes representing key modeling concepts with appropriate attributes, aggregation and reference relations and inheritance. Classes can be collected into packages.

The mapping to the non-volatile medium is similar to the one specified by the XML Metadata Interchange (XMI) standard. Objects are mapped to XML sub-trees. The name of the class and the package hierarchy containing it is coded in the name of the XML node. The node is labeled with an XML attribute specifying the unique textual identifier of the instance. The class attributes are sub-nodes named after the name of the attribute. Sub-trees according to aggregated objects are recursively embedded in the nodes of the appropriate container instance. References are represented by empty XML nodes containing the textual identifier of the referenced instance.

Our design pattern consists of three key classes. An abstract base class provides some basic housekeeping functionalities for application-specific classes. A singleton model class acts as the container of objects that are not explicitly contained by other instances. Checkpoint and recovery means this way the storage and retrieval of the single model instance. Maintaining unique textual identifiers and matching them to objects is also the responsibility of the model class. The serialization of application-specific classes is performed by the factory class. The straightforward mapping to XML according to the XMI conventions enables the automatic generation of the serialization routines.

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Optimal Deterministic and Stochastic Resource Allocation in a Distributed System

Szabolcs Póta and Zsolt Tibor Kosztyán

In real life the duration time of project activities very often cannot be estimated correctly. Especially in research and development programs where the duration time of activities is very slightly known and the ex ante and ex post duration times are often different. [4],[6]

In the paper a new algorithm is introduced by which an optimal resource allocation with minimal total cost for any arbitrary project could be determined. This algorithm could hopefully be widely used in project management, resource planning and in the methodology of small-scale series production management [5],[6].

In this paper a distributed problem solving environment is also introduced that implements the above mentioned optimal resource allocation algorithm with a parallel branch and bound method. The system is built on the Jini technology [3]. It is a dynamic, service-oriented infrastructure that utilizes spare cycles of networked workstations in an efficient way and solves computation intensive problems more easily due to the parallelization.

In our system we use a parallel B&B that can significantly decrease the computation time or can achieve more accurate result in the same time. Moreover, the distribution of the task to different computation sites will result in lower resource (e.g. CPU, memory) consumption at each site, thus can make a problem solvable that was unsolvable on a single machine because of the resource limitations. At a certain class of applications (e.g. at the ones needing many synchronization and inter-process communication) the parallelization does not decrease, rather increase the execution time, but the benefit of resource sharing can be more important. The parallelization issues of the B&B algorithm were discussed in many papers [1],[2], the one that we use in our distributed problem solving environment is also the result of our research.

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Modelling container distribution with fuzzy logic

Gabriel Raicu

During the last decades, we have witnessed an increasing refinement of logical models in transport research, especially due to the need of a better understanding of the mechanisms underlying the better transport management. Even if the relationships between transport demand and human activities are well documented in the literature and it is unanimously recognized that the transport has to be analyzed in an integrated set of decisions regarding the other human activities, the models are not fully developed, especially due to the complexity of the phenomena.

This paper focuses on the activities timetable, and the changes involved by the trip time variability on the daily activities. A delay in a trip or an early arrival can contribute to changes in the timing, location of the next activities, to the deletion/addition of some activities. The changes are related to the dimension of the time savings/delays, to the nature and location of the linked activities, and to the personal and household characteristics.

The model presented in the paper uses fuzzy logic rules for "explaining" the effect of variability in travel time on the benefits perceived by an individual with the changes, and to model different actions that the individuals take in order to re-establish the steadiness of the timetable (routine of the family activities).

Reconstruction of 3D Objects Containing Spheres and Cylinders from a Few Projections

Lajos Rodek, Zoltán Kiss and Attila Kuba

The following problem has been studied during non-destructive testing: A 3D object consisting of homogeneous materials is to be reconstructed from its projections (e.g. from X-ray or neutron radiographs). The object is a tube enclosing some solid spheres or cylinders (such as balls, pipes). It should be taken into account that the projections are distorted due to noise, while the aim is to reconstruct the object using as few projections as possible.

Our solution strategy reformulates the reconstruction problem as an optimization task. A configuration of cylinders and spheres is to be found whose projections are different from the input measurements as small as possible. It is measured using the sum of squared differences. In order to accelerate the algorithm and to ensure a successful reconstruction, the procedure starts by building a suitable initial configuration, and approaches the solution iteratively. The implemented algorithm is based on simulated annealing. To test the efficiency of our method, the program has been incorporated into the system DIRECT being developed at our department. DIRECT is a framework for studying various discrete tomographic methods. In simulated and physical experiments we investigated the effects of several parameters: number of projections, noise level, and complexity of the object to be reconstructed. We present some experiments and results of the algorithm.

Generic functions

Raluca Oana Scarlatescu

The programs complexity, their high quality and the short time requested for writing and implementing them ask now for a new approach that is oriented to the reusing of the algorithms or parts of them, after rebuilding them with an elevate degree of standardisation.

Frequently a programmer performs the same logic with different types. In this case the standardisation process of the algorithms refers to the data types associated with the functions' parameters. Sometimes, the generality of the algorithms can be obtained using functions that allow reusing programs by adding a small piece of type-specific code. The choice of the applied method depends on the facility of the programming language (in C/C++, by example, there are some well- known techniques to do this: using pointers, processing directive, templates or virtual functions). Some of these suppose that the data types are known at the processing moment.

The paper introduces another solution in order to build generic functions, when the data types are unknown. The solution uses a matrix of standard types. The functions are written such as they include the correct behaviour for each considered type in the matrix. During the execution, after the identification of the data type, the function will choose the part of the algorithm adapted for it. Some examples are included in the paper.

The method «Programming by steps» [1] needs generic macro-functions in order to work efficiently. The paper presents a solution for the memory allocation that is necessary to be used for the parameters of a generic function, when the main application doesn't know the type of the parameters, but only the number of them. The main application will read the parameters' values from a database during the execution and will apply the same process for each function included in the logical flow, indifferently to the number or types of their parameters. The paper refers to a generic function necessary for reading the information from a database table using a programming language, other that the database' one.

The paper defines a "cell" in a table as the intersection between a record and a column where the elemental information is memorised, it describes the cell's characteristics and different approaches in order to retrieve the information, and it represents graphic the cell. A generic function is built, in order to read the data of the cell and to scatter it in the function parameter. The paper contains examples built in SQLServer2000 as database management system and C/C++ as programming language. An inherited class is presented, that uses a generic function in order to read data from a cell, indifferently of the data type, and to solve some problems occurred using the parent class (CRecordSet).

The method «Programming by steps» extends the notion of a generic function at a conceptual level: a function becomes an independent part of the algorithm that has to be executed without importance on how it runs or what it generates. Using the same structures and data memorised for the method «Programming by steps», but a different main application, the graphical representation of the logical flow is obtained. The generic functions are drawn, together with their parameters, linked in the logical succession foreseen by the flow. The conclusions refer to the domain of applicability of the generic functions.

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Model Checking of Visual Modeling Languages

Ákos Schmidt

In the past few years the Model Driven Architecture (MDA) has become a leading directive in the field of software engineering. According to the main concept of MDA, at the first phase during the design of the software system, a platform independent abstract model (PIM) is produced in a visual modeling language (mostly UML). The concrete platform specific models (defined by different visual modeling languages of UML dialects, for example for .NET, CORBA, or J2EE) can be derived from this abstract platform independent model by automatic model transformations. Finally, automatic code generators produce the majority of the final source code of the implementation.

Nowadays the wide use of visual modeling languages (such as UML) in software engineering has caused the quick spread of metamodeling and graph transformation techniques, as being an expressive and visual, but mathematically precise specification technique. Despite the mathematical accuracy it cannot guarantee that the components of the system model (the concrete model instances of the modeling languages) are free of design or modeling faults, which (without detection and correction) might deteriorate the safety or reliability of the system. The later a fault is detected during the design period, the more and more its correction will cost.

Typically, a wide range of model checkers (like, for instance, SMV, SAL, Murphi, or SPIN) are used in software engineering applications to detect such faults in the modeling phase automatically (where system properties are checked without human interaction). As their input specification language is a low-level and textual description instead of visual modeling languages widely used by engineers, several transformation has been developed to derive model checker input specifications from behavioral UML models automatically.

I present a method (with tool support of CheckVML [1]) for model checking arbitrary visual models defined by metamodeling and graph transformation techniques. First, a model checker independent mathematical representation (a transition system) is derived from our initial model, which is a common mathematical formalism that serves as the input specification of various model checker tools. For the second step of the transformation the tool generates a Promela description (into a file) from the transition system which can serves as the input for the SPIN model checker.

The model checking process for models of visual modeling languages consists of two steps: first, the model checker (SPIN in our case) input specification is generated by our tool (CheckVML). Finally, SPIN can verify different system properties (like safety, liveness, or deadlock freeedom), which can be expressed as LTL (Linear Temporal Logic) formulas.

I demonstrate the feasibility of the approach and transformation tool CheckVML on a well-known verification benchmark; namely transforming the model of dining philosophers into a SPIN specification, and verifying safety properties on the generated Promela code. The result of the runtime assessments [2] shows that the verification of a simple property by SPIN takes much longer than the transformation of the model from the visual description using CheckVML.

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Signaling Compression

István Siket, Gábor Sey and Vilmos Bilicki

Wired line networks have been used for a long time, thus applied techniques and protocols are well tested and widely implemented so the early difficulties have already been solved. The rapid development of mobile phones exposes an increased data exchange between mobile and wired line networks.

Due to these reasons third generation mobile phones have been planned to be able to use the well known protocols of wired line networks. Beside the similarities, there are several differences between wired and mobile networks. The most important one is bandwidth, and it is also the bottleneck of mobile core systems. If present systems which apply the new protocol were used without changes, there would be unbearable time-lags in data traffic. Certainly, there are several solutions to this problem.

During a Nokia founded project in 2002-2003. one of the possible solutions was examined. The basic idea is that messages are compressed, thus the required time can be reduced. The method is Signaling Compression (SigComp), and it defines a new layer directly below the Application. This subject is relatively new, as the final version of SigComp was accepted in 2003. The method has several advantages, as it is planned to be able to use a number of compression algorithms. We presented the early results two years ago and this time we will describe the structure of SigComp first, afterwards the new compression algorithms and their efficiency in our work.

Uniform Computation of Complexity Metrics in the .NET Platform

Ádám Sillye and Zoltán Porkoláb

Structural complexity metrics play important role in modern software engineering. Testing, bug-fixing cover more and more percentage of the software lifecycle. The cost of software maintenance is mostly depends on the structural complexity of the program. A good complexity measurement tool can trigger critical parts of the software even in development phase.

Several implementations of the famous metrics exist for the most popular development environments like Eclips [1], but surprisingly few targeting the Microsoft .NET platform [2]. In this typical multi-language environment it is essential to be able to compare the complexity of modules that are implemented in different programming languages. The only reliable way to achieve the comparability is to calculate the metrics in uniform – paradigm independent – way. The CIL command set of the .NET platform is suitable for this purpose [3].

Our tool computes several well-known structural and object-oriented metrics [4] and some newly developed paradigm-independent ones [5], and summarizes them in assembly, module, class, and method level. The results are exported in some easily reusable formats.

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On Continuity Preserving Weighted Finite Transducers

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Weighted finite automata (WFA) can be used as devices for computing real functions from $[0,1]$ to $\mathbb{R}$ by reading infinite words. Properties of a special type of WFA called level automata were examined in [1] and [2]. Sufficient and necessary conditions for the function f_A computed by WFA A to be continuous were given, as well as a characterization for continuity of the 2-state level automaton.

The generalized k-tape WFAs are called weighted finite transducers (WFT) in the case $k = 2$. WFTs make versatile tools for image manipulation and function transformation in general, and they have been studied mostly with the first-mentioned aspect in mind (cf. [3]). An application of a k-state WFT M to a l-state WFA A gives another WFA $M(A) = B$ with kl states, which then computes some function $f_B : [0,1] \to \mathbb{R}$.

In this work, we further discuss the continuity of WFA, and introduce the concept of *continuity preserving* property of WFT. The transformation induced by WFT M is continuity preserving, if continuity of f_A implies continuity of f_B. We show how to find 2-state WFT that are continuity preserving with respect to level automata. We also give examples as well as characterizations of WFT with this property.

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Dynamic model for the system testing process

Gábor Stikkel

Software testing process consumes a considerable part of software project resources. This fact motivates research in the field of planning, estimating and tracking testing effort. The modelling approach presented here is based on concepts from dynamical system theory. Several kinds of testing activities can occur during a software development project. Well-known types are unit test, function test system integration test and operational test. Existing dynamic models [1], do not specify the type of the testing activity. However, different failure detection rates (the number of failures found in a time period) can be experienced at unit testing than at system integration testing.

Dynamic models describing testing activities has attracted attention recently [1], [2], [3], [4], [5]. Modelling the software testing process by differential equations also appeared in the work of Cangussu et.al. [2]. Number of residual faults in a software system was used as an internal variable whose behaviour was determined by a second order ordinary differential equation. The model resulted that the number of failures found over calendar time follows an exponential decreasing trend which is not supported by the experience of the author.

Gompertz and Logistic differential equations are applied by Satoh [3], [4] for reliability growth modelling. The proposed models show good fit on real life experience, however do not take into account the type of testing and testing effort. (Same problem arises with the stochastic model sug- gested by Yamada et.al. [5].) Proposed differential equations has different solutions (exponential and S-shaped). It is not explained under which circumstances the models are applicable. This paper aims to solve the previously mentioned problems concerning dynamic modelling of software testing process. The generalization of the model presented in [1] is elaborated and applied on system testing process data of three telecommunication software systems. The new model suits best among the examined approaches. Based on the model a new method for system testing process control is suggested.

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Algebraic studies of giant chromosomes in genus Chironomus

Szabolcs Surányi

The genus Chironomus (midge) is widely variable genetically due to frequent mutations. The Chironomus species can be identificated by the banding patterns of the giant chromosomes in the salivary gland cells of the larvae, which form groups in 7 arms. The banding patterns consist of atomic and unique bands. In practice, band sequences change in a very special way during mutation: analysis of band sequences of hundreds of species shows that only so called inversion produces new species. Specifically, when inversion occurs during the copy process, some continuous part of the sequence is cut out, turned around and sticked back in its original position but in opposite direction.

Given the band sequences of about $100 - 200$ species, the main problem is to produce the most likely philogenetic tree for the species. The most likely philogenetic tree is a directed graph, such that every vertex represents a species, and every edge points from a species to its most likely ancestor species. Obviously, to solve this problem it is inevitable to have a method by which we can find quickly all possible inversion series, which could produce a given species from another.

To deal with the notions and problems mentioned above, we have created a mathematical model based on the theory of symmetric groups. Arms of n bands are represented as permutations of S_n, and we define the set $P(S_n) = \{1, 2, \ldots, n, n+1\}$ as the points of S_n, which can be the possible locations, where the sequence is cut, as shown below:

$$\psi = \begin{pmatrix} | & 1 & | & 2 & | & 3 & | & \ldots & | & n & | \\ \scriptstyle 1 & & \scriptstyle 2 & & \scriptstyle 3 & & \scriptstyle 4 & & \scriptstyle \mathrm{n} & & \scriptstyle \mathrm{n+1} \\ | & i_1 & | & i_2 & | & i_3 & | & \ldots & | & i_n & | \end{pmatrix}.$$

Thus the $[p, q]$ inversion between the $p, q \in P(S_n)$, $p \leq q$ points is defined as follows: if $p = q$ then $[p, q]$ is the identical element, otherwise it is the following permutation:

$$[p, q] = \begin{pmatrix} 1 & 2 & \ldots & p-1 & p & p+1 & \ldots & q-2 & q-1 & q & \ldots & n-1 & n \\ 1 & 2 & \ldots & p-1 & q-1 & q-2 & \ldots & p+1 & p & q & \ldots & n-1 & n \end{pmatrix}.$$

Using these notations we say that a $[p_1, q_1], [p_2, q_2], \ldots, [p_k, q_k]$ ($p_i, q_i \in P(S_n)$) inversion series of length k is a derivation from $\psi \in S_n$ to $\phi \in S_n$, if $\phi = \psi \cdot \prod_{i=1}^{k} [p_i, q_i]$.

It is assumed that in nature superfluous inversions does not occur. According to this assumption, our problem can be described as a brief question: For given $\psi, \phi \in S_n$ permutations how can we find a derivation from ψ to ϕ of minimal length.

We have proved that for arbitrary $\psi, \phi \in S_n$ a derivation from ψ to ϕ of length n can be found, which on the other hand proves that the set of inversions $I \subseteq S_n$ generate S_n. In practice this bound can be improved such a way that the bound is not a function of n, but m, where m is the number of so called breakpoints in ψ according to ϕ.

The set of breakpoints in ψ according to ϕ can be defined based on neighbourhood of elements: The left neighbourhood of point $p \in P(S_n)$ in $\psi \in S_n$ denoted by $N_L(\psi, p)$ is 0 if $p = 1$, $\psi(p-1)$ otherwise. Analogously, the right neighbourhood of point $p \in P(S_n)$ in $\psi \in S_n$ denoted by $N_R(\psi, p)$ is $n + 1$ if $p = n + 1$, $\psi(p)$ otherwise. Thus, the neighbourhood of point $p \in P(S_n)$ in $\psi \in S_n$ is the set $\{N_L(\psi, p), N_R(\psi, p)\}$. Using these definitions the set of breakpoints in $\psi \in S_n$ according to $\phi \in S_n$ can be defined as the set $B(\psi, \phi) = \{p \in P(S_n) \mid \neg\exists q \in P(S_n) \text{ such that } N(\phi, p) = N(\psi, p)\}$.

We have given an algorithm, which produces for arbitrary $\psi, \phi \in S_n$ a derivation from ψ to ϕ of length m, where $m = |B(\psi, \phi)|$. Considering that $m \leq n + 1$, this bound gives us a much better bound in almost every case, furthermore we have proved that it is a better bound in every case.

Besides these results we have proved the existence of a lower bound, which is $\lceil\ |B(\psi, \phi)|\ /\ 2\ \rceil$ for a given $\psi, \phi \in S_n$, thus the number of inversions required to derive a species from another is squeezed between quite strict bounds.

After sending the abstract it turned out that these results are rather old, refer to John D. Kececioglu and David Sankoff, Exact and Approximation Algorithms for the Inversion Distance Between Two Chromosomes, Lecture Notes In Computer Science, 87-105, 1993.

Creation of the tasks of the Cognitive Computer Aided Therapy Software

Julianna Szabó, Attila Páll, Cecília Sik-Lányi and Ilona Pataky

In this paper we introduce a computer controled method, which enables - as a difference to methods used internationally - not only the establishment of the diagnosis, but permits measurement of the therapy.

- It is an intensive therapeutic test which contains tutorial programs too.

The HELEN interactive therapeutic test and teaching software contains the following tasks:

- Memory game
- Puzzle game
- Where
- How many cubes do you see?
- How many pictures do you see?
- How many black and white checked drawings do you see?
- Concealed pictures
- Stories similar to the Binet pictures
- Amendment of half pictures
- Identify!
- Story
- Ordering of pictures
- Ordering of sentences
- Logical cards
- Clock
- Situation practice
- Recognition of faces
- Recognition of emotions
- Blind map
- Ordering according to form and colour

The single tasks contain decision-making situations, for these the system provides material of assistance. The methods, how the patient solves the problems shows how he or she thinks about the question, in case of failure the system provides the possibility of a new trial. For these we had to elaborate such interactive procedures, which enable the solution along different concepts.

We have designed such an interactive multimedia software that helps the testing and rehabilitation of brain vain patients.

Packing Equal Circles in a Square — bounds, minimal polynomials and classification

Péter Gábor Szabó

In sciences, engineering and real life several problems lead to the question of finding the densest packing of equal objects in a bounded region of a special geometrical shape. Sometimes these kind of questions can be generalized in the following way: Which is the largest $\overline{m}_n$ distance of n distinct points, so that all points are in a compact convex subset of the Euclidean plane and the distance between any two of them greater or equal than $\overline{m}_n$. If one considers the points as centers of n circles with equal radii, the problem is equivalent to determine the largest radius $\overline{r}_n$ these circles can have, neither overlapping each other nor putting off the region.

This work studied the following problem: Locate n equal and non-overlapping circles in a square, such that the radius of the circles be maximal. Originally this question arise from the discrete geometry, but it is in connection with the subject of facility location theory in operations research too. In the investigation many branches of mathematics and operations research meet: deterministic and stochastic optimization, numerical mathematics, interval mathematics, graph theory, Groebner bases theory, number theory, etc.

This investigation organized for three subjects: improving the theoretical bounds, algebraic investigation of minimal polynomials of packings, and studying a classification of circles packing based on minimal polynomials.

Up to $n = 5$ circles the problem is trivial and there are solutions for n=6, 8, 9, 14, 16, 25 and 36 using only mathematical tools. Since 1990 proof of optimality of circles packing were made by computer aided methods. Using deterministic optimization techniques, the optimal packings are known up to $n = 30$. There are theoretical lower and upper bounds of $\overline{m}_n$ and $\overline{r}_n$, I have improved some of them.

THEOREM 1. For all $n \geq 2$

$$\sqrt{\frac{2}{\sqrt{3}n}} < \overline{m}_n,$$

$$\overline{r}_n \leq \min\left(\frac{1}{\sqrt{2\sqrt{3}n + (4\lfloor\sqrt{n}\rfloor - 2)(2-\sqrt{3})}}, \frac{1+\sqrt{1+\frac{2}{\sqrt{3}}(n-1)}}{2n+2\sqrt{1+\frac{2}{\sqrt{3}}(n-1)}}\right).$$

Stochastic optimization methods can be used to find approximate packings for higher n values. It is important to realize that an approximate packing found by the computer is not always sure its existence in mathematical sense. The structure suggested by the numerical result is only a kind of conjecture, because the rounding errors can produce serious mistakes. We have to prove that the structure of a given packing really exists. A possible approach for the proof is to find the corresponding suitable quadratic system of equations to the packing and try to solve it. Sometimes the computer algebra systems can help the investigation based on algebraic, symbolic computations.

An interesting parameter of circles packing is its minimal polynomial. The minimal polynomial $P_n(m)$ of a packing is a polynomial with minimal degree and integer coefficients, where the first positive root of the polynomial is $\overline{m}_n$. I have given more possible way to determine a minimal polynomial of a packing.

Based on minimal polynomials can be give an exact classification of optimal packings accord to the structure of packings.

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Combining metric and topological navigation of simulated robots

Richárd Szabó

Mobile robotics and robot navigation is a growing area of scientific research. Robot simulators are useful designing and analyzing tools of this domain.

Webots ([1]) is a well-known representant of these programs, a three-dimensional mobile robot simulator. Various guidance principles can be developed in C/C++ or Java programming language with the use of Webots controller programs.

During the current talk a short overview is given about the problems arising in the process of the navigation, and a short taxonomy is presented about the possible problem solving methods ([2]). A brief introduction to the probabilistic navigation techniques concerning Kalman filter and expectation maximization is included with a special focus on occupancy grid. Another representational aspect of the navigation – also mentioned – is whether the map is metric or topological.

In CSCS'2002 the authors presented a metric navigation method based on occupancy grid working in the Webots simulation environment ([3]). As a continuation of that research the authors created an enhancement of the former processes, a hybrid metric-topological navigation mechanism. A topologic layer is introduced in the environment exploration phase replacing the older value iteration ([4]). The implementation of a topologic graph of the explorable places using the metric map enables the robot to navigate in a more efficient manner. A comparison of the pure metric and the new hybrid methods is also given.

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Prototype Environment for Refactoring Clean Programs

Rozália Szabó-Nacsa, Péter Diviánszky and Zoltán Horváth

We present here the prototype of an interactive environment where one can incrementally carry out programmer-guided meaning-preserving program transformations in functional languages. We discuss an alternative approach to the problems of storing and extracting the syntactic and also the static semantic information in order to be enough to perform the desired transformations. In our approach the program to be redesigned is stored in a relational database.

Several transformation case studies will help us to demonstrate how this database can be used to transform programs, check the preconditions and make compensation steps to ensure correct transformations.

We also show an interactive environment which will help the programmer to choose the appropriate refactoring step and its parameters. During redesign process the programmer is faced with one of the selected "views" extracted from the database. Different transformations can be carried out on different views, depending on which view is preferable for the programmer and/or which view is more suitable for the given transformation.

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Mining interactions in bibliographical data with domain ontologies

László Szathmáry

Galois (or concept) lattices provide a natural and formal setting to discover and represent concept hierarchies. In this paper we investigate the application of formal concept lattices on different data sources (like bibliographical items, web documents) in order to extract knowledge units from data. These knowledge units are represented as formal concepts and they are organized within a lattice. The concept lattice can then be used for reasoning and problem solving, e.g. information retrieval. Concept lattices can be considered as classification tools for knowledge units in concept hierarchies. Furthermore, Galois lattices can be used with domain ontologies in parallel to build more precise and more concise concept ontologies, and for guiding the knowledge discovery process. In general, ontologies provide a shared and common understanding of a domain for communicating between people and heterogeneous application systems.

Iceberg concept lattices is a mathematical theory for building Galois lattices with respect to an ontology of properties, used in data analysis, information retrieval, and knowledge discovery. Iceberg concept lattices show only the top-most part of a concept lattice. They can be used as a visualization method (especially for very large databases), as a representation of frequent itemsets, or as a base of association rules.

We have connected iceberg concept lattices with ontologies. We have made experiments with iceberg concept lattices and ontologies over bibliographical items of our research team. Detecting correlations and interactions between members of the team provides a global view of the team functioning. It can help us to find interconnections between the members, to see which are the main/marginal works within the team, etc. We have also investigated what information is revealed by descending in the ontology and increasing its granularity, combined with the visualisation support of iceberg lattices.

Dynamic Slicing of Programs Compiled for the Java Virtual Machine

Attila Szegedi and Tibor Gyimóthy

In this paper, we present a technique for obtaining dynamic slices of programs compiled for the Java virtual machine. The presented technique is independent of source language, therefore works for programs written in any language that can be compiled to Java virtual machine bytecode. In contrast with existing published techniques [1] that require a customized Java compiler (which also implies access to the source code and being limited to the Java language) our approach works with programs compiled with arbitrary third party compilers designed for arbitrary source level language. As a consequence, our method does not require access to the source code during any point of the slicing process. However, we still retain the ability to express the slicing criterion and the resulting slice in terms of source code locations using the line number information present in compiled code.

We do not instrument the source nor the compiled bytecode, but instead use a special instrumented virtual machine. An advantage of the approach is that we can successfully track dependencies generated through execution of third-party library code, standard Java library code, and even code that was dynamically generated during program execution (dynamically generated code is an ever more frequently used Java technique), as well as operations performed in virtual machine's native code (i.e. object cloning). Since our ultimate goal is covering all of the internal dependencies that can possibly occur during the execution of a program in a Java virtual machine, we cover specific aspects like reverse interprocedural flow dependencies (from callees to callers) introduced by catching exceptions in caller methods thrown by their callees, inter-thread notifications, and even limited ability for tracking dependencies in external native code called through the JNI interface. The presented execution history format provides full-fidelity representation for multithreaded execution, which is also a natural feature of the Java virtual machine that must be fully supported. We also present the static preprocessing steps for slicing that are specific to the method: constructing the left-hand-side expressions in assignment instructions without relying on source code, as well as the control flow calculations that take into account exception handlers. The slicing algorithm used is a variant of the forward global method for computing backward dynamic slices based on work presented in [2].

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Graphical Web application development environment

István Székely

In the beginning applications were made on demand. The monolithic development was general. The spreading of the computers resulted in the emerging of new requirements. Applications had to be created rapidly which were reliable and could be used by men in the street. Developers realized it can be done by using suitable methodologies and tools.

Monolithic programming was changed by structured programming. It has exact mathematical background and the correctness of programs can be proved with the assistance of it, that is quality control became possible. Other paradigms and the languages built on these appeared. Nowadays one can hear more and more about aspect-oriented programming as well as component-based software.

In my paper it will be explained what a component is and when one or the other part of an application can be dealt as it were a component. The properties of the components and the expectations will be described as well, for instance re-usability and interchangeability.

In recent years the Internet became widely used so much, that more and more applications chose it as the platform of them. These kind of applications can be developed in industrial size only if developers use appropriate methodologies and tools.

In my paper I would like to present a framework. By the aid of this tool one can create web applications. The key elements of the development environment are components. The Web pages forming the application can be built from these components using a graphical user interface.

The development tool is also aWeb application. The client is a browser which communicates with the server during the assembly of the pages. The components are provided by this so-called component server, which reads the list of available components from an XML file along with all the necessary helper information. The finished pages are then sent back to the server, which takes care of their storage.

A Web application consists of a number of Web pages. Communication between the client and the server is accomplished by navigating through the Web pages. Therefore, developers have to take care of it during the Web application planning. The last part of my paper deals with it.

Decision trees and disjoint covers

Balázs Szörényi and György Turán

We investigate the relation between two complexity measures used for a Boolean function: the decision tree size (DTS), which is the minimal number of leaves of a decision tree for the function, and the disjoint cover size (DCS), which is the minimal number of subcubes needed to cover the n-dimensional cube $\{0,1\}^n$, such that the subcubes are disjoint and the cover is consistent with the function (i. e., for each subcube, the function evaluates the same on each vertex of the subcube). Note that $\mathrm{DTS} \geq \mathrm{DCS}$, and that determining a disjoint cover for a function f is just the same as determining for f and for $\neg f$ a pair of disjunctive normal forms (DNFs) in which each two distinct terms conflict in at least one variable.

Our investigation is motivated by the paper of Jukna et al [2]. They have shown that there is superpolynomial gap between the DTS and the cover size of the Boolean functions, where the cover size (CS) is the same as the DCS without requiring the subcubes to be disjoint—note again that determining a cover for a function f is just the same as determining for f and for $\neg f$ a pair of DNFs. More specifically, they have presented a Boolean function for which $\mathrm{DTS} = \exp\left(\Omega\left((\log \mathrm{CS})^2\right)\right)$. Their result almost matches the upper bound, $\mathrm{DTS} = \exp\left(\mathrm{O}\left((\log \mathrm{CS})^2 \log \mathrm{n}\right)\right)$, which was proved by Ehrenfeucht and Haussler in [1] to hold for any Boolean function. A question raised by their result is whether one can prove a similar separation between DCS and DTS. The Fourier technique used in their result cannot be used for this purpose.

In our paper we show that there is a superpolynomial gap between the DCS and the DTS. More specifically we present a Boolean function for which $\mathrm{DTS} = \exp\left(\Omega\left((\log \mathrm{DCS})^\delta\right)\right)$ for any positive $\delta < \log_{\left(1+\sqrt{3}\right)} 3 \approx 1.093$. For this, of course, we have to develop a technique, different from the one used in [2], to lower bound the DTS. We also show that our technique gives "essentially" the same lower bound on the DTS of the example used by Jukna et al. in [2] as their method.

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Quality Driven Software Development

Ákos Szőke

In today's world of management of software engineering, we come across a feature called imprecision, which is associated with the following main characteristics of the software development process: costs, schedules, and quality. Now, with state-of-the-art technology we are able to provide plentiful functionality, and customers demand it at high quality. The narrow definition of the quality is "conforms to requirements and is fit to use". From the customer's view, satisfaction after the delivering of the product is the ultimate validation of the product quality. From the producer's perspective, developing and producing the product in accordance with the specifications is the path to achieving quality.

Unified Modeling Language (UML) is capable of modeling software product. Every product is made of less or more units which realize different part of the problem that we should solve. Software Process Engineering Metamodel (SPEM [1]) is an UML compatible metamodel, so UML is capable of modeling software development process itself too. Therefore, we can describe both software development process and product to serve input parameters of the well-known COCOMO II [2] cost estimator which can help us to estimate the cost of developing software product using product and development project cost factors.

The concept of defect removal effectiveness and its measurement are in the centre of software development. Increasing defect removal effectiveness can conduct to product quality improvement and reductions in development time. Since defect removal and its efficiency is one of the top expenses in any software project and it greatly affects schedules, static validation techniques and quality management models are worth considering.

The UML provided visual programming and automatic code generation are capable of eliminating numerous design and programming defects. But this approach can not provide semantic correction of the specification, which is the one of the major factor of defects. The more defects are reveled later, the more expensive and time-consuming of the correction. With the help of static validation of the specification (without running of the program which developed according to the specification) we are able to check the completeness of the specification which is written in UML notation.

Other important methods for improving quality are Quality Management Models which monitor and manage the quality of the software while it is under development, therefore these models can provide early signs of warning or improvement so that timely actions can be planned and implemented in due term [3].

As contest in the software industry became sharp, the importance of productivity and quality in software development have started to increase more and more. So we should complement the classical "what" and "how" questions of design decision with "why" and "how much" questions to find the optimal cost, schedule, human resource allocation and quality values according to the customer's and the producer's aspect.

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Multiplatform software developing in connection with the ASF Creator and SAT programs

Róbert Tornai

This paper covers the problems and their possible solutions arising at multiplatform software developing. Multiplatform developing is necessary at medical and biological developments since there are a lot of Apple Macintosh computers attached to special machines. So, the demand that the new softwares shall support this platform is natural. However, IBM compatible personal computers are getting widespread in these fields in present days. This means that a software that is targeting these fields has to be ported to multiple platforms.

I have worked on the implementation of the MMA technology. (MMA stands for the Multiple Microbead Assay term.) The basic problem in this technology is to evaluate the results of flow-cytometry measurements. Our team has developed two softwares in corporation with Soft Flow Kft. In this paper the problems, the possible solutions and the applied techniques of a multiplatform development will be introduced.

On solving a Huff-type facility location and design problem

Boglárka Tóth, José Fernández, Frank Plastria, and Blas Pelegrín

A chain wants to locate a new facility in a market where there already exist m facilities providing the same service. k of those facilities belong to the chain, and the rest to competitors. The location and design problem for the new member of the chain is considered [1].

This talk will deal with the impact of different changes in the Huff-type competitive model in both the profit and the set of optimal locations. The studies are made on a real data set from the Autonomous Region of Murcia, a region in the South-East of Spain. The changes to be studied are:

- Agglomeration of "closely sited" demand points.
- Changes in the flatness of the objective function depending of the number of facilities belonging to the chain.
- Variations in the quality of the existing facilities.
- Changes in the function which translates the market share into expected sales: comparison of a linear versus a convex smooth function.
- Changes in the function giving the operational costs of the facility: how much does it affect to the quality and the location.
- Impact of the budget: solving the Huff-type model for different values of a fixed investment budget.

To solve the problems, we use an interval branch-and-bound algorithm. Changes in profit are evaluated by comparing the (interval) values of the profit function at the different sets of optimal locations; and changes in location are evaluated by comparing the sets of optimal locations with the help a new measuring function.

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Developing applications for testing left-handed people in virtual environments

Tamás Umenhoffer, Ádám Tilinger and Cecília Sik-Lányi

The great bulk of mankind is right-handed, only 10 percent prefer to use their left hand. We can well observe in our everyday life the differences between left- and right-handed people's motion and in the use of utensils. It is the consequence of the asymmetry of the human brain. Left-handed and ambidextrous encounter difficulties in their daily lives that most right-handers do not. The majority of these difficulties are only annoying and frustrating, but some of them can lead to serious psychic or physical injuries. Utensils must be made both for right- and left-handed people. As today the use of the virtual reality became prevalent, we must examine it in respect of left-handedness. With our research we would like to help the designers to create user-friendly virtual worlds both for left- and right-handed.

The goal of our recent two experiments at the University of Veszprém was to find the characteristics and differences of left and right handed people in motion and behaviour in virtual worlds. This will help to design virtual worlds suitable both for right- and left- handed people. To do this we needed to create a program to display our virtual worlds. This software has many other tasks (i.e.: treat sounds, movement and interactions; store the movement,). In this paper we will describe the method we used to solve some of the difficulties we encountered while creating this application. One of these problems is collision detection, which is solved by binary space partitioning. We'll also speak about the experiments in details, and our results.

In the first research we have built two virtual galleries - one with paintings of Dutch landscape painters and the other with human statues - with the purpose of comparing and analyzing the navigation and orientation of left- and right-handed people. This scenarios display considerably symmetric rooms with no prominent places to draw attention and corrupt the results. The program stores the precise location in the three- dimensional world and the view direction in every second for further investigations. Our other investigation is about equipping virtual worlds. In this research we have compared the ways right- and left-handed people furnish virtual rooms and fit out other virtual environments. The result of this comparison could give us design requirements of virtual worlds for left-handed.

Designing and Creating a 3D Display Software

Tamás Umenhoffer, Ádám Tilinger and Cecília Sik Lányi

At the Department of Image Processing and Neurocomputing at the University of Veszprém there are several researches, in which we examine the user's behavior in virtual worlds. These researches can help to understand various occurrences (for example: different kind of phobias: claustrophobia, agoraphobia etc.; left handedness, examining reaction time under different circumstances etc.). Up to now for each research we had to write a suitable display software, we didn't have such a program, which can display almost any kind of virtual world, can treat the interaction between the user and the virtual world and can record the user's actions for further examination.

Creating such a program brings on to a lot of problem and question. One of the basic questions is how to build our virtual world. The most comfortable way is to create the world in a well known and efficient three dimensional modeling software, and export it in a format that can be read by the display software. So we build our virtual worlds in professional modeling software called Maya. The exported data is not directly read by the display software, it is processed by an editor program wrote by us. This program is needed because of the better optimalization, as those objects in our worlds which are responsible for the interactivity (such as buttons, timers, movable, rotatable objects) have no corresponding in Maya. So the properties of these objects will be set in this editor. We also set the material and light source properties here. This is because the display software uses OpenGL instructions for drawing, and this is the most exact way to suit these properties to the OpenGL's shading technique.

One of the most basic interactions between the user and the environment, and the objects of the virtual world is the detecting of collisions and the physically realistic treating of collision responses. To solve this problem we use the technique of space partitioning. The binary tree structures needed for this technique are also created in our editor program as they have to build only once during the display.

One of the most important tasks of the display software is the recording of the user's actions. We can set the data to be stored, which depend on the examined phonemes. These can be: the user's movement, the path of walk, the exact time of reaching a control point, the time taken to notice an object, reaction time etc.

On the conference we would like to speak about the details of described problems and their solutions and our future plans. If facilities are provided we'll show our programs in action.

Schedule on parallel machines in the case of individual machine-set

Zsuzsanna Vaik

There is a less researched area of the parallel machines scheduling, when there is an M_j machine-set for each job j, where it can be scheduled. We would like to minimize the latest job's finishing time, that is the makespan, C_{max} so, that each job can be processed only by one machine at a time and one machine can process at most one job at a time. This problem is $\mathcal{NP}$-complete, since its special case, the $P\|C_{max}$ problem, (when each job can be processed by each machine), is known to be $\mathcal{NP}$-complete [1]. If we have restrictions for the M_j machine-sets, the well-known list-schedule gives a nearly optimal solution. We give a better approximation algorithm for the optional problem.
M. Pinedo [2] has studied that special case of the problem, when the job's processing times are 1, and he has showed that,if the M_j sets are laminals, then an easy list-schedule gives an optimal solution. We show for the general case, when the M_j sets are optional ($P|M_j, p_j = 1|C_{max}$), that it is a network-flow-problem. Moreover, from this, we have an algorythm for that special case, when we allow the preemtion for the jobs ($P|M_j, pmtn|C_{max}$). From this algorithm we have received a minimax formula for the optimal makespan too.
We study the problem when we allow a special preemption, called $pmtn^*$, when a job can be split, but it should be processed immediately by another machine. This special preemption gives a better solution, that we show in an example, that the optimal value of the problem $P|M_j, pmtn^*|C_{max}$ is less than the equivalent $P|M_j|C_{max}$ problems optimal value. But we can observe, that if $M_j = M$ for each job, than the special preemption gives no better optimal value, so in this case the problem is equivalent with the $P\|C_{max}$ problem, which is $\mathcal{NP}$-complete. We have a 2-approximate algorythm for this problem too.

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Incremental Graph Transformation in Relational Databases

Gergely Varró

The theory of graph transformation [2] was originally developed as a generalization of Chomsky grammars from strings to graphs. Methods, techniques, and tools from the area of graph transformations have already been studied and applied in many fields of computer science such as formal language theory, pattern recognition and generation, compiler construction, software engineering, etc.

Despite the large variety of existing graph transformation tools, the implementation of their graph transformation engine typically follows the same principle. In this respect, first a matching occurrence of the left-hand side (LHS) of the graph transformation rule is being found by some sophisticated graph pattern matching algorithm. Then the engine performs some local modifications to add or remove graph elements to the matching pattern, and the entire process starts all over again.

Since graph pattern matching leads to the subgraph isomorphism problem that is known to be NP complete in general, this step is considered to be the most crucial in the overall performance of a graph transformation engine. Current tools (e.g., PROGRES [4]) use different efficient strategies for the graph pattern matching phase.

However, I argue that the overall complexity of a graph transformation engine is not necessarily equal to the complexity of the graph pattern matching phase, especially for long transformation sequences. During the execution of a transformation step, instance models are only modified locally in the context of the matching occurrence of the LHS and the rest of the instance model left unchanged. Thus any implementation that does not reuse the information collected for the previous matching and that restarts the complex and expensive pattern matching phase from scratch is not optimal.

I propose a technique based on incremental updates [3] which, in itself, is not a new idea, since it has been widely accepted and successfully used in relational databases, but it provides a new philosophy for implementing efficient graph transformation engines.

The main idea of incremental updates in graph transformation systems is to keep track of all possible matchings of graph transformation rules (e.g., in database tables) to make the graph pattern matching step very fast. Afterwards when a rule is applied we update data in all locations it is required. Since graph transformation typically manipulates only a small fragment of the instance model, incremental updates require minor changes to the stored data. Naturally, the initialization phase needs some considerable amount of pre-processing prior to the transformation, but the subsequent transformation process itself becomes much faster.

Relational databases give several supporting features (e.g., foreign key constraints, database views) for preserving data consistency. A view is a query that defines a computed relation in the database (see [1] for details). It is updated incrementally in most off-the-shelf relational databases. Our idea is to build a graph transformation engine on the top of a relational database to exploit various results of database theory.

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Building the Instances of Columbus Schema for C/C++ Preprocessing

László Vidács

Preprocessor directives are widely used in C/C++ programs and have various purposes. Virtually there is no real C program without file inclusion, macro expansion and conditional compilation. The preprocessor has proven useful to programmers for over two decades, but it has also a number of drawbacks. The fundamental problem about preprocessing from a program comprehension point of view is that the compiler gets the preprocessed code and not the original source code that the programmer writes. In many cases the two codes are quite different (according to a case study of UNIX software packages, 8.4% of the source code of the programs consist of preprocessor directives). Program code with lots of directives often causes difficulties in program understanding. To aid program comprehension we designed a C/C++ preprocessor schema which describes the usage of preprocessor directives in the source code. We also implemented a preprocessor which is able to generate schema instances from the source code. Using a schema instance the connection between the original source and the compiled source can be understood in concrete cases (for instance a macro expansion can be followed step-by-step from the macro call to the `#define` directive which defines it).

Conditional compilation allows the programmer to create several configurations in one source. Depending on the environment of the compilation the compiler gets different code, but always only one configuration (for example different code pieces belong to different operating systems). According to the conditional compilation we defined two kinds of schema instances: dynamic instances that describe directives inside one configuration, and static instances which are configuration-independent. Building dynamic instances is straightforward because the work of the preprocessor is followed accurately. However, a static instance shows relations also between configurations and can be built in various ways. Here the natural building strategy is the pessimistic approach (every possible relation is shown between directives), which can be much improved by dropping some unnecessary relations. Determining weather two directives belong to the same configuration is an important improvement to the building method of static instances. In our preprocessor, besides the pessimistic method, we experienced with more powerful building strategies as well.

Reliable global optimization on atom clusters

Tamás Vinkó

Given a cluster of n atoms define $x_i \in \mathbb{R}^3$ $(i = 1, \ldots, n)$ as the center of the ith atom. The potential energy function of the cluster $x = (x_1, \ldots, x_n) \in \mathbb{R}^{3n}$ is defined by the summation of the two-body inter-particle pair potentials over all of the pairs, i.e.

$$E(x) = \sum_{i<j} v(\|x_i - x_j\|) \quad (i, j = 1, \ldots, n)$$

where $\|.\|$ is the Euclidean distance and $v : \mathbb{R} \to \mathbb{R}$ is the pair-potential function. The global optimization of a potential energy function describing an atom cluster is a challenge for the scientific computing. Recently many papers deal with this problem, especially the so called Lennard-Jones problem, where the pair-potential function is defined as

$$v(r) = \frac{1}{r^{12}} - \frac{2}{r^6}$$

where r is the atom-pair distance. However, one can find no paper about reliable method for finding the optimal structure of Lennard-Jones atom clusters. Branch-and-bound type methods based on interval arithmetic could produce reliable solution for global optimization problems. In this talk the Lennard-Jones atom cluster problem will be considered with the reliable point of view. First, we establish good lower bound for the minimal inter-atomic distance in the optimal structure (independently from the number of atoms). From this result a guaranteed lower bound for the global optimum will be given which is a linear function of the number of atoms. Using this results and geometrical considerations we will introduce an optimization method producing guaranteed globally optimal solutions.

Family Polymorphism in JAVA

István Zólyomi and Zoltán Porkoláb

Family polymorphism – strongly investigated by Erik Ernst and others [1] – takes traditional polymorphism to the multi-object level. The object-oriented paradigm provides safe and flexible use of objects of classes arranged to inheritance hierarchies. Late binding ensures that we use the appropriate function body when we call a method on an actual object via polymorphic reference. In the same time we have compile-time guarantees to use only valid calls.

The problem arises when we use two or more independent hierarchies of classes together. In this case the collaborating "families" may consist of similar but not interchangeable classes. Because there can be subtype relationship between classes in the different groups, it is not obvious to implement a constraint ensuring that only classes of the same family are used together. Traditional object-oriented languages are not able to handle this situation. Proposed solutions vary from run-time assertions to extensions of existing programming languages (like gbeta [2]).

In an earlier article [3] we discussed the solution in declarative way based on generative programming facilities of C++. C++ is rich in generative language tools, like templates. In Java however only version 1.5 introduces *generic* facilities and its expressive power is significantly differs from C++. In this article therefore we provide a different solution in Java for the family polymorphism problem.

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Revealing of Location in IP Mobility Networks

László Zömbik

Cellular telecommunication networks provide the location freedom of communication within their coverage area. In order to achieve similar freedom in IP based communication several IP mobility protocols are developed.

However, cellular networks give not only position freedom, but they provide it in a secure way. They guarantee that communication remains secret and sound, the communicating peers are mutually authenticated. Furthermore, network providers share no information about the current position of their users to unauthorised parties. Besides, those systems are designed so that no such information could be leaked. Therefore the privacy of the location is ensured.

In IP mobility, there is enormous research activity to ensure secure communication. Thus, several solutions are designed. They mainly concentrate on solving issues, which are raised, when a user intends to log in to a mobile access network. Such issues are the authentication, authorisation, and accounting or exchange of keys for later communication. They give solutions how the mobility related signalling and the user data should be protected. As well as the secure transport of the set of information, needed for handover procedure (the so-called mobile context) is also considered. Furthermore they try to utilise the features of the different kind of lower layers to achieve security efficiently.

However, none of the solutions deals with the location privacy issue.

Until the appearance of mobile IP protocols, the host IP address had been identified unambiguously the position of the host in the network. Since the number of mobile nodes still infinitesimal, the Internet community has been less interested to hide the position of a host, thus they has been concentrated just on the confidentiality of the communication.

Unfortunately, encrypted channels do not provide guarantees to location privacy, since even if the contents of the messages cannot be interpreted, the traffic shape can carry additional information for the attacker.

The aim of this presentation is to draw attention to the location privacy issues in Internet environment. As the IP based mobile communication starts to spread through the users, the need for location privacy starts to grow.

In this presentation location revealing attack is introduced, without looking into the communication itself. Based on traffic shape, different investigations (pattern matching, adaptive filtering) are performed. The efficiency and the limits of this attack are presented, as well as some effective countermeasures against it.

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