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Dear Participants,

On behalf of the organizers, it is my pleasure to welcome you to the 10th Joint Conference on Mathematics and Computer Science. The conference, hosted by the Faculty of Mathematics and Computer Science of the Babeş-Bolyai University, Cluj, is being held between May 22-25, 2014. The conference program, with four plenary talks and over 80 announced session talks, offers a great variety of excellent contributions in major areas of mathematics and computer science.

This meeting will build on the success of the previous nine Joint Conferences on Mathematics and Computer Science first initiated by Eötvös Lóránd University and the Babeş-Bolyai University.

The conference could not have happened without the dedicated work of the Organizing Committee and the conference secretaries, to whom I express my deep gratitude. Thanks are also due to the organizing and sponsoring institutions: Babeş-Bolyai University, Cluj, Eötvös Lóránd University, Budapest, Ministerul Educaţiei Naţionale and Farkas Gyula Society for Mathematics and Computer Science, Cluj.

The social events (banquett and excursion) offer ample opportunities to interact with colleagues, meet old friends and make new ones.

We wish you a pleasant and productive conference.

Chair of the Organizing Committee,
Conf. dr. Anna Soós

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11:30 – 12:15	Invited talk
13:00 – 15:00	Coctail Party
15:00 – 16:20	Section talks
16:20 – 16:40	Coffee break
16:40 – 18:00	Section talks
18:30 – 21:00	Cultural event: Ruggero Leoncavallo: Pagliacci

Friday, May 23

9:00 – 9:45	Invited talk
9:45 – 10:30	Invited talk
10:30 – 11:00	Coffee break
11:20 – 13:00	Section talks
15:00 – 16:40	Section talks
16:40 – 17:00	Coffee break
17:00 – 19:00	Section talks
19:00 – 22:00	Banquett

Saturday, May 24

8:00 – 20:00	Trip (Turda, Alba Iulia, Aiud)

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Invited Talk

Kolmogorov Complexity and The Digital Universe

András Benczúr

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Next year Kolmogorov complexity will have 50th anniversary. Since its origin mankind gave born to a new universe, the Digital Universe. The majority of our data and information is inside it somewhere and in digital form of some kind. It is huge. We know that a few zettabyte of information is collected in the Digital Universe. The Digital Universe contains only the substitutions, or encodings of information, independently of whatever information means. Inside the Digital Universe the physical processes are either transformations of signals from one form to other one or they are materialized computations. So Digital Universe belongs to the territory of algorithmic information theory. The measure of the algorithmic information quantity, the Kolomogorov entropy is not good for the direct investigation of the Digital Universe. We explain that it is not the measure itself; but method of the selection and use of a Universal Reference Machine is important. We can use it as a measurement tool in finding approximation in quantitative analyses of the behavior of the Digital Universe.

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Invited Talk

Results and problems in the regularity theory of functional equations *

Antal Járai

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In this talk we survey results and open problems concerning regularity of solutions of functional equations. Although some results concerning composite equations and implicite equations will be mentioned, our central topic is theorems proving that "week" regularity (for example measurability or Baire property) implies "strong" regularity (for example C^∞ or analyticity) of the solutions f of functional equation

$$f(x) = h\Big(x, y, f(g_1(x, y)), \dots, f(g_n(x, y))\Big),$$
$$(x, y) \in D \subset \mathbb{R}^r \times \mathbb{R}^s.$$

We give a survey of results and open problems, connections with Hilbert fifth problem, and with regularity problem of partial differential equations and variational problems. We consider also algorithmic methods implemented in computer algebra systems.

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Invited Talk

Fixed points and multivalued fractals for generalized contractions

Adrian Petrusel

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The purpose of this talk is to review several fixed point results for generalized contractions of Ćirić-Reich-Rus type in complete metric space. Then, the properties of the fractal operator generated by a multivalued generalized contraction are discussed. The existence, the uniqueness and the approximation of the multivalued fractal are also proved. The results generalize some existing theorems in the literature.

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Invited Talk

Fuzzy Data Analysis. Case Studies

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The aim of this talk is to review a series of most interesting results and applications of fuzzy data analysis. After a small introduction in fuzzy sets and its origins, we present various classes of fuzzy robust methods of data analysis. We describe and analyse relevant applications and experiments of fuzzy sets and fuzzy logic, including fuzzy periodical system of chemical elements, robust detection of heteroscedasticity, fuzzy principal components analysis of toxicity in northern Romanian Carpathians Mountains, and a fuzzy model of uninominal elections.

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Strong differential superordination results using a generalized Sălăgean operator and Ruscheweyh operator

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In the present paper we study the operator $DR_\lambda^m f(z,\zeta)$ the Hadamard product of the extended generalized Sălăgean operator $D_\lambda^m f(z,\zeta)$ and extended Ruscheweyh operator $R^m f(z,\zeta)$, given by $DR_\lambda^m f(z,\zeta) : \mathcal{A}_\zeta^* \to \mathcal{A}_\zeta^*$, $DR_\lambda^m f(z,\zeta) = \left(D_\lambda^m * R^m\right) f(z,\zeta)$, $z \in U$, $\zeta \in \overline{U}$, and $\mathcal{A}_{n\zeta}^* = \{f \in \mathcal{H}(U \times \overline{U}) : f(z,\zeta) = z + a_{n+1}(\zeta)z^{n+1} + \ldots,\ z \in U,\ \zeta \in \overline{U}\}$ with $\mathcal{A}_{1\zeta}^* = \mathcal{A}_\zeta^*$,is the class of normalized analytic functions . We obtain several strong differential superordinations regarding the operator DR_λ^m.

Rodrigues formula for the Cayley transform of the groups SO(n) and SE(n)

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The Cayley transform of the group of rotations $\mathbf{SO}(n)$ of the Euclidean space $\mathbb{R}^n$ is defined by $Cay : \mathfrak{so}(n) \to \mathbf{SO}(n), Cay(A) = (I_n + A)(I_n - A)^{-1}$, where $\mathfrak{so}(n)$ is the Lie algebra of $\mathbf{SO}(n)$. Because the inverse of the matrix $I_n - A$ can be written as $(I_n - A)^{-1} = I_n + A + A^2 + \dots$ on a sufficiently small neighborhood of O_n, from the well-known Hamilton-Cayley Theorem, it follows that $Cay(A)$ has the polynomial form

$$Cay(A) = b_0(A)I_n + b_1(A)A + \cdots + b_{n-1}(A)A^{n-1},$$

where the coefficients $b_0, b_1, \dots, b_{n-1}$ depend on the matrix A and are uniquely defined. By analogy with the case of the exponential map (see [1] and [2]), they are called *Rodrigues coefficients* of A with respect to the Cayley transform.

Using the main result in [3] (see also [4]), in this paper we present a method to derive the Rodrigues coefficients for $\mathbf{SO}(n)$. The case of the Euclidean group $\mathbf{SE}(n)$ is also discussed.

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Bilateral Inequalities for Harmonic, Geometric and Hölder Means

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For $0 < a < b$, the *harmonic*, *geometric* and *Hölder* means are given by

$$H(a,b) = \frac{2ab}{a+b}, \quad G(a,b) = \sqrt{ab}, \quad Q(a,b) = \left(\frac{a^2+b^2}{2}\right)^{1/2}.$$

They are special cases ($p = -1, 0, 2$) of power means

$$M_p(a,b) = \begin{cases} \left(\frac{a^p+b^p}{2}\right)^{1/p}, & \text{for } p \neq 0 \\ \sqrt{ab}, & \text{for } p = 0. \end{cases}$$

We consider the problem of finding $\alpha,\ \beta \in \mathbb{R}$ for which

$$\alpha H(a,b) + (1-\alpha)Q(a,b) < G(a,b) < \beta H(a,b) + (1-\beta)Q(a,b).$$

Similar problems for other means have been studied in [1], [2], [3].These inequalities are equivalent to

$$\beta < \frac{Q(a,b) - G(a,b)}{Q(a,b) - H(a,b)} < \alpha,$$

and, denoting by $t = b/a$, $t > 1$, the problem reduces to find $\inf f$ and $\sup f$, where

$$f(t) = \frac{Q(1,t) - G(1,t)}{Q(1,t) - H(1,t)}.$$

We find the best bounds for α and β using the motonicity of the function f. Then we replace Q by M_p, $p \geq 2$ and address the same problem.

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Identity information revealed from mobile touch gestures

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Due to the powerful sensors incorporated, the new generations of smartphones have become capable of many sophisticated biometrics. Touchscreen based biometrics is a new type of biometrics showing great potential. In this paper we review the studies already conducted in this direction, then present our study aimed to find the best method for touch data based authentication. We collected a large touch dataset from 71 users using 8 different mobile devices: tablets and phones. Touch data were divided in strokes and several classification schemes like k-NN, Random Forests and SVM were investigated on this dataset. Measurements show that several strokes are required for accurate user identification. Besides different classification results, statistical analysis of the collected data is presented.

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Group testing algorithms for inaccurate sensor detection: theoretical results and simulations

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In this paper we present new group testing algorithms which can be used for malfunctioning wireless sensor detection. Instead of separate tests on each sensor, which can be expensive and ineffective, we test a set of sensors by request them to send a special signal at the same time. The received signal is inaccurate if and only if at least one of the sensors is defected. The goal is to find a predefined number of malfunctioning sensors using the minimum number of tests. We present theoretical results, determine the maximum and the average number of test required by the algorithms and show simulation results. The performance of our algorithms are close to the theoretical lower bound.

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Mining Mistakes from Evaluation Tests Data - From Software Platform to Mathematical Model

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Data gathered from evaluation test papers can be [1],[2] subjected to data association analysis and association rules can be extracted. These represent patterns of mistakes and the rationale is that when a student mistakes some of the items from the frequent item set of an association rule, there is a computable chance [3] that the student will also mistake the rest of the items from that particular item set.

The goal of this paper is to present both a software platform concept and its corresponding mathematical model of mining mistakes from evaluation test papers. One particular item from the test papers can belong to several frequent item sets with a variable and computable membership degree. The software platform will aid in the actual implementation of various algorithms that can be compared with respect to data processing, while the mathematical model will add a layer of abstractness in order to go beyond the implementation details.

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From outsourcing based business and software engineering to own solutions and products through innovation

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In the present article the main and most important characteristics of the IT sector from Cluj, Romania are described. One of the main goals of the cluster ClujIT, which comprises the most relevant IT companies and related universities and institutions from Cluj, is to foster the changes from the dominant business model of the IT related companies, i.e. the outsourcing to an own service provider, product development and product based business model. This paradigm change of the IT companies concur with the important element of the strategy plan of the European Union for 2014-2020: sustainable development growth based on innovation.

This paper presents a concrete case study of the local IT companies, evoline SA in partnership with the Kozmutza Flora special school as they could set up through innovation own products. Through the case study the main challenges are enumerated: assessing and introducing new processes, methods in software engineering and business models besides the old ones.

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Towards More Safe Programming Language Constructs

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Most of the current programming languages inherit their syntax and semantics from technology from the 20th century. Due to the backward compatibility, these properties are still unchanged, however newer technologies require different language constructs and different semantics. Instead of redefining the programming language, the developers patch the language with new library functions, or they add some – occasionally ambiguous– elements to the syntax [1]. Some languages provide very loose syntax, which is harmful, because it leads to critical errors [2, 3]. In other case the interleaving "normal" code and exception handling code can obfuscate the developer itself and the subsequent developers.

This paper presents several aspects of language elements such as basic and potentially unsafe elements of the syntax, control flow constructs, elements used in const-correctness, type-system, elements of multi-paradigm programming –generative and functional–, capabilities of embedding a DSL, parallelism support, and taking account of branch prediction. These aspects determine the usablity, safety and learnability of a language. This paper also gives recommendation for a new and safe experimental programming language.

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Reconstructibility of free trees from subtree size frequencies

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Let T be a tree on n vertices. The subtree frequency vector (STF-vector) of T, denoted by $\mathrm{stf}(T)$ is a vector of length n whose kth coordinate is the number of subtrees of T that have exactly k vertices. For example, if P_5 denotes a path of length 5 and S_4 a star with 4 leaves, then we have $\mathrm{stf}(P_5) = [6, 5, 4, 3, 2, 1]$ and $\mathrm{stf}(S_4) = [5, 4, 6, 4, 1]$. We present algorithms for calculating the subtree frequencies: a combinatorial one and an algorithm using generating polynomials. We give a combinatorial interpretation for the first few and last few entries of the STF-vector.

The main question we investigate – motivated by the problem of determining molecule structure from mass spectrometry data – is whether T can be reconstructed from $\mathrm{stf}(T)$. This problem falls in the broad family of combinatorial reconstruction problems. We show that there exist examples of non-isomorphic pairs of free (i.e. unlabled, unrooted) trees that are STF-equivalent, i.e. have identical subtree frequency vectors. Using exhaustive computer search, we determine all such pairs for small sizes. We show that there are infinitely many non-isomorphic STF-equivalent pairs of trees by constructing infinite families of examples. We also show that for special kinds of trees (e.g. paths, stars and trees containing a single vertex of degree larger than 2), the tree is reconstructible from the subtree frequencies.

We consider a version of the problem for rooted trees, where only subtrees containing the root are counted. We also show examples of equivalent pairs in this sense. Finally, we formulate some conjectures and open problems and outline further research directions.

Study on Foreground Segmentation Methods for a 4D Studio

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A 4D reconstruction studio is an intelligent environment that enables 3D modelling of moving actors and deformable objects. The visual quality of the final 3D model, in terms of both geometry and texture, is greatly influenced by the precision and accuracy of the segmented foreground object. This paper extends our previous work on the image segmentation methods developed for the 4D studio at MTA SZTAKI, Budapest, Hungary. The studio uses a three-step approach for extracting the foreground silhouette: (i) background subtraction using spherical coordinates, (ii) foreground post-processing using a colour filtering approach based on the background colour, (iii) detection and removal of casted shadows. We give an overview of these techniques and perform a comparative evaluation in terms of both quantitative measures and qualitative analysis. We discuss our results in various imaging conditions, such as illumination variations.

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An Evolutionary Approach for Generating 2D and 3D Fractal Art

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Research in evolutionary art explores mathematical models for systems that are able to evolve aesthetically pleasing and unpredictable computer artworks. This paper presents a genetic algorithm for evolving new shapes of fractals. We explore various representations of variable-length chromosomes for encoding 2D and 3D forms of fractal art using Iterated Function Systems (IFS). Measures from fractal theory, such as correlation dimension, are used to evaluate aesthetics of the evolved forms. In addition, the users are able to assign scores to various shapes according to their preference. We show that our approach can generate a large variety of complex and interesting art shapes.

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A translation of interaction relationships into SMV language

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In this paper a translation of a particular scenario-based model into SMV language will be presented. SMV is the input language of the NuSMV model-checker tool[6]. Model checkers in general provide a verification way to prove that a given system meets its specification[4, 5]. By using model checking, errors of the system can be detected even in the very early phases of the software development process.

The Unified Modeling Language (UML) provides diagrams to describe the same system from different aspects. The notion of Interaction Overview Diagram (IOD) was introduced in the second version of UML for specifying the relationships between UML interaction diagrams and the control flow passing between them.

In this paper an algorythm for the translation of a hierarchical construct containing IODs will be presented. The top level diagram will be represented by the main module in SMV.

The idea of using model checking for verification is not new. There are various algorythms converting UML diagrams into SMV language[2, 3]. The novelty of this paper is, that the base of the translation are IODs. Moreover, the transition takes into account additional constructs which are not part of UML, but are used by various authors[1].

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Reduction of Regression Tests for Erlang Based on Impact Analysis

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Legacy codes are changed in software maintenance processes to introduce new functionality, modify existing features, eliminate bugs etc. or by refactorings while the main original properties and the behaviour of the system should be preserved. Developers apply regression testing with highest degree of code coverage to be sure about it, and thus they retest the software after some modifications. Our research focuses on impact analysis of changes in applications written in the dynamically typed functional programming language, Erlang. To calculate the affected program parts, we use dependence graph based program slicing, therefore we have defined the Dependence Graphs with respect to the semantics of Erlang. Applying the results, we may shrink the set of test cases selected for regression testing for ones which are affected by the changes.

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Nonlinear elliptic problems on the Sierpinki gasket

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The Sierpinski gasket (SG, for short) in the n-dimensional Euclidean space is a natural generalization of the Sierpinski triangle in the plane, a well-known fractal whose construction goes back to the Polish mathematician Waclaw Sierpinski. Due to the work of J. Kigami, it turned out that one may study PDEs on the SG in spite of its highly non-smooth structure. By introducing, in his pioneering paper [5], the harmonic functions as well as the Laplace operator on the SG, Kigami developed a suitable framework, allowing the study of elliptic problems on this fractal. Kigami's paper was the starting point for subsequent papers devoted to PDEs on the SG. A list of them, including also several recent contributions, may be found in the introduction of the paper [4]. The talk, based on the papers [1]–[4], emphasizes that, even if the structure of this fractal differs considerably from that of open domains of Euclidean spaces, PDEs defined on it may be studied (as in the case of open domains) by means of certain variational methods and of appropriate abstract multiplicity theorems. There are presented several results concerning the existence of multiple weak solutions of Dirichlet problems defined on the SG.

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Operator equations and systems with potential-type nonlinearities

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Some recent results on the variational characterization of the fixed points of contraction-type operators are applied in this paper to semilinear operator equations and systems with linear parts given by positively defined operators, and nonlinearities of potential-type. Mihlin's variational theory is also involved. Applications are given to elliptic semilinear equations and systems.

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Extension operators that preserve certain geometric and analytic properties

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In this talk we are concerned with certain extension operators which take a univalent function f on the unit disc U to a univalent mapping F from the Euclidean unit ball B^n in $\mathbb{C}^n$ into $\mathbb{C}^n$, with the property that $f(z_1) = F(z_1, 0)$. This subject began with the Roper-Suffridge extension operator, introduced in 1995, which has the property that if f is a convex function of U then F is a convex mapping of B^n.

We consider certain generalizations of the Roper-Suffridge extension operator. We show that these operators preserve the notion of g-Loewner chains, where $g(\zeta) = (1-\zeta)/(1+(1-2\gamma)\zeta)$, $|\zeta| < 1$ and $\gamma \in (0, 1)$. As a consequence, the considered operators preserve certain geometric and analytic properties, such as g-parametric representation, starlikeness of order γ, spirallikeness of type δ and order γ, almost starlikeness of order δ and type γ.

Moreover, we use the method of Loewner chains to generate certain subclasses of normalized biholomorphic mappings on the Euclidean unit ball B^n in $\mathbb{C}^n$, which have interesting geometric characterizations.

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Monotone operators and some of their applications

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We expose several well-known applications of the Minty-Browder monotonicity. We also extend the class of Minty-Browder monotone operators to some generalized monotonicity which is accompanied by a certain application.

On some generalizations of Nadler's contraction principle

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The purpose of this work is to present some generalizations of the well known Nadler's contraction principle. More precisely, using an axiomatic approach of the Pompeiu-Hausdorffmetric we will study the properties of the fractal operator generated by a multivalued contraction.

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Visualization Techniques of Components for Large Legacy C/C++ software

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C and C++ languages are widely used for software development in various industries including Information Technology, Telecommunication and Transportation since the 80-ies. Over this four decade, companies have built up a huge software legacy. In many cases these programs become inherently complicated by implementing complex features (such as OS kernels or databases), and consisting several millions lines of code. During the extended development time, not only the size of the software increases, but a large number (i.e. hundreds) of programmers get involved in the project. Mainly due to these two factors, the maintenance of these software products becomes more and more time consuming and costly.

To handle the above mentioned complexity issue, companies apply source code cross-referencers to help in the navigation and visualization of the legacy code. In our article we present a visualization methodology that assists programmers in the process of comprehending the functional dependencies of artifacts in a C++ source. Our novel graph representation not only reveals the connections between C/C++ implementation files, headers and binaries, but also visualizes the relationships between larger software components – e.g directories –, and provides a method for architecture compliance checking. The applied technique does not require any modification or documentation of the source code, hence it solely relies on the compiler generated *Abstract Syntax Tree* and the build information to analyze the legacy software.

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Evaluating Comment-to-AST Assignment Heuristics for C++ Programs

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Comments are integral part of the source code of software. They preserve the intentions of the developers, document constraints and highlight implementation details. Good comments help us to understand the codebase and make maintainance easier. Most of the software tools ignore comments because they take no part in code generation. However, there are cases when comments should be taken into account: refactoring tools need to move code along with their comments [1] and code comprehesion tools need to show comments related to a given context [2]. Since these tools are working on the AST, comments should be assigned to the appropriate AST nodes.

Assigning comments to AST nodes is a non-straightforward task. Most methods use heuristics that place the comment to the proper AST node. This article improves existing heuristics. We identify corresponding AST nodes by distance and type. We also manage to contract consecutive connected comments. Macro-related comments are handled in a special way.

We quantify the correctness of comment assignments and evaluate the different solutions on open source C++ projects comparing our method with existing tools. Our method may be useful for other programming languages with respective modifications.

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A New Short-Update Interior-Point Algorithm for Monotone Linear Complementarity Problems

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We introduce a new primal-dual interior-point algorithm for solving monotone linear complementarity problems. In order to follow the central path we apply Newton's method to obtain the search directions. We define a special displacement vector which can be obtained by a linear combination of the standard primal-dual direction [2], and the one introduced in [1]. In each iteration the algorithm performs only full-Newton steps. Using a new proximity measure to the central path we deduce that the Newton process is quadratically convergent. We prove that the method yields an ϵ-solution in polynomial time.

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Fast algorithm to split and reconstruct triangular meshes for real time applications

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In this paper we show a fast and efficient algorithm for cut and split a triangular mesh by a plane, and fully reconstruct the cutting surface. After the cut some of new triangular meshes will be created at the same format as the input mesh. Our approach is not to use complex data structures, just a vertex stream and an index stream keeping the algorithm simple, and ensuring the wide range of usability. We suggest a model for describe the boundary of a solid mesh to obtain advantages as a consequence of geometric topology. If we suppose the streams satisfy some reasonable restrictions, we find our algorithm has linear time complexity including the precomputation, splitting section, reconstruction and the decomposition.

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A quasilinear elliptic problem involving critical Sobolev exponents

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In the present talk we consider the following quasilinear elliptic equation

$$\begin{cases} -\Delta_p u = |u|^{p^*-2}u + g(u), & \text{in } \Omega \\ u = 0, & \text{on } \partial\Omega \end{cases}$$

where Ω is a bounded domain of $\mathbb{R}^N$ with smooth boundary $\partial\Omega$, g is a continuous function with suitable growth condition. The main obstacle in dealing with existence and multiplicity results for quasilinear problems with critical nonlinearity is represented by the lack of compactness of the embedding $W_0^{1,p}(\Omega) \hookrightarrow L^{p^*}(\Omega)$.

We will prove the existence of a weak solution for problem by combining semicontinuity argument with direct methods of calculus of variations. The existence of a local minimum for the energy functional is ensured provided a suitable algebraic inequality is fulfilled.

A nondeterministic parser for $Perm_2$ grammars

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Permutation grammars are context-free grammars extended with permutation rules of type $A_1A_2...A_n \to A_{\sigma(1)}A_{\sigma(2)}...A_{\sigma(n)}$, where $A_1, A_2, ..., A_n$ are nonterminal symbols of the grammar, σ is a permutation and $n \geq 2$. If the non context-free rules in a specific grammar have at most n symbols on either side, than it is called a permutation grammar of order n and it generates a language among the $Perm_n$ language family. In [3] was shown that these language families strictly contain the context-free class and they are strictly contained in the context-sensitive class. In [2] an infinite and strict hierarchy was proved between $Perm_{4n-2}$ and $Perm_{4n-1}$ for all $n \geq 1$.

A nondeterministic polynomial time CYK-based parser is proposed to deal with the parsing problem of permutation grammars of order 2, namely to parse a context-free grammar extended by interchange rules of type $AB \to BA$. Firstly, the known CYK parser [1] is modified to parse context-free grammars which contain chain productions, those of the form $A \to B$, then the algorithm is further modified to apply the available interchange rules randomly. The first modification is necessary because it is not known whether unit productions could be eliminated from a permutation grammar or not.

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Hörmander–Mihlin multipliers in Hardy spaces

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In this talk we are concerned with Hörmander–Mihlin multipliers. They can be viewed as natural generalizations of the classical Marcinkiewicz multiplier conditions which are known to be sufficient for the corresponding multiplier operator be bounded on $L^p_{2\pi}$ provided $p > 1$. We show that for Hörmander–Mihlin multipliers the scale of Hardy spaces is a more proper choice than that of the Lebesgues spaces. Both the trigonometric and the dyadic versions of the problem will be addressed.

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Using Concern Spaces to Measure Requirements Similarities

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The software artefacts are crucial during the development cycle of a software product and tracing them is important to the development process. The model used, the requirements document, and the code, are artefacts that can be updated or reused in different projects. Different types of notations are used to add traceability to artefacts, providing versatility in searching, indexing, updating, or retrieving them.

MultiCoS is an approach based on separation of concerns (SoC) in multiple spaces. The concern spaces are defined by grouping concerns by common interest. The relationships between concerns and entities provide to the concern a degree of meaning for an entity. Defining and using concerns to properly describe software components add semantic to artefacts such as specification documents, requirements documents, project documents, and code modules. Given this, the concerns and their relationships can provide traceability to higher level entity spaces, such as the application model, the views, and the design documents of a software application.

The MultiCoS metamodel is validated reusing web applications artefacts. In addition to other tracing methodologies, MultiCoS can add semantic value to artefacts and can strengthen the relationships to concerns or between artefacts by taking into account similarity coefficients.

In contrast to other methodologies, MultiCoS supports complex tracing systems by creating multiple relationships of different degrees between entities, based on metric that measures the impact of a concern to an entity.

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First Price and Second Price Auction Games. Equilibria detection.

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Conventioal (Nash [1], strong Nash [3]) and unconventional (t-immune strategies [5]) equilibria for first price and second price auction games are computed by the use of generative relations [2] and evolutionary computation. The different game equilibria of auction games express different player behavior and rationality. We use numerical examples to analyze and discuss the implications of using different equilibria types for auction games.

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On consecutive numbers divisible by powers of their largest prime factors

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In [1], the following problem is considered: do there exist k consecutive integers such that they are all divisible by the rth power of their (respective) largest prime factors? The authors of the paper prove that there are infinitely many examples for $k = 2$, $r = 2$, provide some examples for $k = 3$, $r = 2$ and $k = 2$, $r = 3$. They also give heuristic arguments in favor of the existence of such numbers for every pair of positive integers k and r. We describe a computational search method for the $k = 3$, $r = 3$ case that narrows the search space and provides the first known examples. Our method also gives a heuristic lower bound on the number of such configurations in the general case, assuming some plausible number theoretical arguments.

We also consider possible generalizations to algebraic number fields and polynomials with examples and propose some new open questions.

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Direct marketing optimization using client relational graphs

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In the present paper we give an insight into some problems which occur in a bank and can be represented by graphs. We will show the network building possibilities on specific data and apply them to enhance or replace the present methods of the sector. We give a detailed examination of the corporate transaction graph and a retail client relational graph based on data of the OTP Bank. Our main result is the optimization of the response rates of Direct Marketing (DM) campaigns using the relational network (built on the known attributes such as common telephone number, same family name, etc.). According to our new approach - in contrast to the traditional banking methods - we did not use the clients personal data itself or their account behaviours, we only used the structure of networks to find the consequences. Networks can also give us forecasting models: we constrict sending DM offers only to certain clients who are meeting with some graph theoretical requirements. By our method we raised the DM offer acceptance rate by 1.5-2 times the average of the previous DM campaigns.

Positive solutions to first order differential systems with nonlocal conditions

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In the present paper we study the existence and the localization of positive solutions to nonlocal boundary value problems for first order differential systems. The localization is established by the vector version of Krasnosel'skiĭ's fixed point theorem in cones.

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Enclosing the solution set of overdetermined systems of interval linear equations

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We describe two methods to bound the solutions of interval full rank least squares problems $\|\mathbf{A}x-\mathbf{b}\|$ where $\mathbf{A} \in \mathbb{IR}^{n\times m}$, $n \geq m$ is an $n \times m$ full rank interval matrix and $\mathbf{b} \in \mathbb{IR}^n$ is an interval vector. The methods are based on the concept of generalized solution of overdetermined systems of linear equations. We use two type of preconditioning the $n \times m$ system: multiplying the system with the generalized inverse of the midpoint matrix or with the transpose of the midpoint matrix. It results an $m \times m$ system which we solve using Gaussian elimination or the method provided by J. Rohn in [2]. We give some examples in which we compare the efficiency of our methods and compare the results with the interval Householder method [1].

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Score sets of graphs

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We consider the following problems:

1. How to test the potential score sets of different types of graphs?
2. How to enumerate score sets?
3. How to reconstruct score sets?

We analyze the approximate algorithms Balancing, Shortening, Shifting, Hole and exact algorithms Sequencing, Partitioning.

Among others we improve the results of Reid [9], Hager [3], Yao [10] and the paper [4].

The simulation programs and their results can be downloaded from

http://elekjani.web.elte.hu/score-set.

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Developing Sorting Algorithms using Proof–Based Synthesis

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An alternative to the classical approach to certified programming (algorithm design followed by formal verification) is the development in parallel of the following formal items:

- the *object theory* relevant for the objects manipulated by the algorithm,
- the *specification* of the problem to be solved, and
- the *proof* that a solution to the problem exist, from which the *algorithm* can be extracted.

We describe a case study of automatic assistance to this process in the case of sorting by the automated reasoning environment Theorema (www.theorema.org), which allows to define and organize the logical formulae expressing the mathematical theory, the specification, and the algorithm, as well as automatic proofs of necessary properties. In particular, the system allows to prove the formalization of the *synthesis statement* "for any list, there exists a sorted version of it" and to extract automatically the algorithm from it. The algorithm is expressed as set of conditional equalities and it is executable by the system.

We construct an object theory of lists, consisting in basic axioms and proven properties, in a process which may be seen as *theory exploration*. In parallel, we formalize the specification of the sorting problem and we develop the proof of the synthesis statement. By user choice of the appropriate knowledge given to the prover, as well as of various proof strategies and induction principlee, this results in four different known sorting algorithms: selection-sort, insertion-sort, merge-sort, and quick-sort, plus one which is a new variation of merge-sort.

The theory is constructed in first order logic, and most of the properties are equivalent to Horn clauses, thus in principle most parts of the proofs could be carried out by SLD resolution, however this leads to very large proofs. Therefore we followed the Theorema tradition of generating proofs in natural style, by using novel proof techniques for lists. This leads to much shorter and human readable proofs. Thus several interesting proof techniques for lists have been revealed during the construction of an appropriate prover. For instance we discovered specific inference rules and strategies for reasoning with the equivalence relation over lists (induced by the predicate "have the same elements") and with various ordering relations on lists (induced by the ordering among elements). We also use a novel treatment of the failed proof branches on goals containing no lists, in order to improve the proof and find case distinctions in the algorithms. Also, we experimented with the use of various induction principles as expressions of various algorithms structures.

Acknowledgements. This is joint work with Isabela Dramnesc, and extends previous work done by Bruno Buchberger.

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Finding, Managing and Enforcing CFDs and ARs via a Semi-Automatic Learning Strategy

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This paper describes our strategy, which finds Conditional Functional Dependencies (CFDs) and Association Rules (ARs), and instead of using them to clean dirty data we use them to prevent their appearance in the database. We achieve this by differentiating permanent CFDs/ARs from temporary CFDs/ARs. If we know about a CFD/AR that it will be valid in the future, we can rely on them by creating constraints which guarantee that the CFD-rule will not be breached by insertions or modifications. Along with complete management of CFDs/ARs our implemented application called DependencyManager also uses Formal Concept Analysis (FCA) methods to analyze the permanent CFDs/ARs and draw useful conclusions, helping the users of the application to prevent inconsistencies, fix bugs and optimize their queries and applications by providing a lattice of CFDs/ARs, using usefulness as the relation. We consider a CFD/AR to be more useful than the other if it needs less information to determine more information.

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Some Improvements of the Extended Breadth-First Search Algorithm

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Extended breadth-first search (EBFS) is an algorithm developed to give remedy to some problems related to the classical state-space representation used in artificial intelligence. This algorithm was initially intended to give us the ability to handle huge state spaces. The authors have shown a number of examples of the practical use of EBFS since it was developed. Based on their experiences, they found some ways for improving the algorithm. This paper presents the new algorithm, which contains these improvements.

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k-Dyck words: generation and application

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Let $B = \{0, 1\}$ be a binary alphabet and $x_1x_2 \dots x_n \in B^n$ a word. Let $h : B \to \{-1, 1\}$ be a valuation function with $h(0) = 1$, $h(1) = -k$, where $k \geq 1$ is a given natural number, and

$$h(x_1x_2 \dots x_n) = \sum_{i=1}^{n} h(x_i)$$

A word $x_1x_2 \dots x_{(k+1)n} \in B^{(k+1)n}$ is called a *k-Dyck word* (similarly as in [2]) if satisfy the following conditions:

$$\begin{aligned} &h(x_1x_2 \dots x_i) \geq 0, \qquad \text{for } 0 \leq i \leq (k+1)n - 1, \\ &h(x_1x_2 \dots x_{(k+1)n}) = 0. \end{aligned}$$

The number of k-Dyck words of length n is the so-called k-Catalan number [4]:

$$C_n^k = \frac{1}{kn+1}\binom{(k+1)n}{n}.$$

In this paper we deal with the generation of k-Dyck words and codification of $(k+1)$-ary trees using k-Dyck words for $k > 1$. The case $k = 1$ was treated in [1, 3].

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d-VDBf: Dynamic Programming Solver

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The programming part of dynamic programming problem solving process commonly means that specialized software is developed for every problem in particular. To save software development costs some authors proposed software tools to automatically solve the functional equation. Apart from a few codes designed for some very specific dynamic programming problems no general-purpose dynamic programming computer codes are available. In this paper we present a method and a software tool that successfully automates the dynamic programming process in case of several discrete, finite space problems (Monadic/Polyadic, Serial/Nonserial, Cyclic/Acyclic, Deterministic/Stochastic, Finite/Infinite horizon).

Translating Event-B models into Elisa - A Case Study in Railway Automation

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Automatic translation of the verified formal models into programming languages is the foundation of the correct-by-construction approach, used to develop safety critical systems. Making connection between a formal method, like Event-B and a modern programming language, like Elisa, can open new research areas, and also can improve the software development of safety critical systems. We have made a deep analysis of this translation process, taking into account different aspects of translation, like software maintainability and human understandability. For this reason we tried different translation approaches to improve the translation process. We analysed the opportunity to generate the verification code, to prove the translation correctness, and also to give the opportunity to the developer to modify the source code and to check the modification correctness corresponding to the Event-B invariants.

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On the application of rational function systems

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Methods based on rational functions were proved to be efficient in various fields such as system identification, signal processing, etc. In previous works the number of the poles were fixed, and the optimization algorithms have been provided with respect to the positions of the poles only. In this talk we present a new optimization method that applies for the best positions and the number of the poles as well. Examples for theoretical and practical applications will be provided. They include ECG and EEG signal processing, and solving simple Laplace equation by using Dirichlet boundary condition on simply connected regions.

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Embedded resource tool in Haskell

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In our previous work [1], we have created a way to check size annotations of higher-order polymorphic functional programs supporting nested lists. By extending the lambda-calculus, these annotations are able to express the relations between sizes of arguments and those of the cooresponding results of functions. These relations are exact, and can be non-linear and non-monothonic polynomials.

We provided a way for verification condition generation as well. This paper focuses on how it is possible to implement the proposed verification condition generation, and how close we can get to a size-checking functional programming language.

Our approach is based on creating a deep embedding of the lambda calculus into Haskell, and creating two different interpreters of the embedded language. The first one executes the code, while the second one is able to infer verification conditions from the code. VCs are then checked by the Z3 solver [2].

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Circular mappings with minimal critical set

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The circular φ-category of a manifold M is introduced in the paper [1]. It is defined as the φ-category of the pair (M, S^1) corresponding to the family $C^\infty(M, S^1)$, where S^1 is the unity circle. That is

$$\varphi_{S^1}(M) = \min\{\mu(f) : f \in C^\infty(M, S^1)\},$$

where $\mu(f)$ denotes the cardinality of the critical set of mapping $f : M \to S^1$. Taking into account the inequality $\varphi_{S^1}(M) \leq \varphi(M)$, where $\varphi(M)$ denotes the real φ-category of M, one of the main goals of this paper is to provide classes of manifolds M satisfying the equality $\varphi_{S^1}(M) = \varphi(M)$. The circular version of the Ganea conjecture is also discussed.

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C++ Compile-time Reflection and Mock Objects

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Reflection is an important tool in the hands of programmers since a while. Serializing objects, creating mock objects for testing or creating object relational mappings are just a few use cases. Writing generic code in Java or in Python for such use cases is possible today. Though, using reflection in these managed languages is doable only in runtime, therefore this implies runtime penalty. Currently C++ has a very limited capability of runtime reflection (operator typeid). [1]

ISO C++ started a study group (SG7) to examine the possibilities of compile-time reflection in C++. [2] With compile-time reflection it would be possible to have a generic library for serialization or for object relational mappings. There are several potential notions about how to approach this kind of reflection. For example introducing high-level new lingual elements like `static for`, or creating library interfaces which are hiding compiler intrinsics for each specific reflection subtask.

Without standardized C++ compile-time reflection, creating proxy objects or mock test objects is a repetitive and error-prone task. In this paper an alternative C++ compile-time reflection approach is discussed in favor of finding a generic solution for this task. The approach is based on introducing new library elements. Under the hood these library element implementations has to be compiler specific intrinsics (compiler specific expressions). With these expressions, variables and functions could be declared and defined from results of reflection queries.

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Pseudorandomness of binary threshold sequences derived from multiplicative inverse

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Let p be a prime and $c_1, c_2, \ldots, c_h \in \mathbb{Z}_p$ be fixed elements. For initial values $x_1, \ldots, x_h \in \mathbb{Z}_p$ consider the sequence (x_n) defined by the linear recursion

$$x_n = c_1 x_{n-1} + \cdots + c_h x_{n-h}, \quad n > h.$$

The aim of the talk is to study the pseudorandom properties of the following finite binary sequence $E_T = \{e_1, e_2, \ldots, e_T\} \in \{1, -1\}^T$ built from the linear recursive sequence (x_n) by the rule

$$e_n = \begin{cases} 1 & \text{if } p \nmid f(x_n) \text{ and } 0 < f^{-1}(x_n) < p/2 \\ -1 & \text{otherwise,} \end{cases}$$

where $f^{-1}(x_n)$ is the multiplicative inverse of $f(x_n)$ modulo p.

Comparison of Riemann solvers in fluid dynamics by weighted error number

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After using a numerical method our eyes are good witnesses whether that method is good or not. We aim to provide, for first order hyperbolic systems, a number that measures, determines the quality of a method instead of deciding by figures. This number is based on the ℓ_1 vector norm of the error vector, combined with weighting. This weight vector has bigger values near discontinuities and kinks because most of the Riemann-solvers have difficulties (including numerical diffusion and oscillations) in solving the equations near these states.

On the optimal guidance for planar Lunar ascent

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The paper is focused on the equations of the optimal guidance for planar Lunar ascent. We point out some computational and graphical aspects and remove some errors from other papers.

Endgame Strategies and Simulation Results for the Liar's Dice game

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The Liar's dice is a dice game where deception and the ability to detect the opponents' deception play a crucial role. We analyze this game from different perspectives. First, two-player endgames are analyzed and optimal strategies are calculated. Second, using simulation methods, we examine heuristic playing strategies based on their success against each other.

In the simulations, we first let deterministic strategies compete against each other in several configurations and evaluate their results in the series of games. In another approach, we consider mixed strategies that depend on parameters, populate a parameter space with strategies and perform evolutionary simulation on the strategy population.

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The effects of using exception handling on software complexity

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Exception handling is the definitive way to handle errors of any kind and exceptional circumstances in modern software. There has been a long way before software methodlogy arrived to creating and using the notion of *exceptions*. We automatically assume that using exception handling makes our software more readable, more maintainable and easier to understand – i.e. less complex than when we use any other error management (let it be using return values, ERRNO or any other kind). Is this really the case?

Measuring *software complexity* can be done using software metrics. There are several trivial, well-known candidates – lines of code, cyclomatic complexity or McCabe-metrics and A-V – for this purpose.

In this paper, we extend the definitions of two metrics to the case of exceptions (lines of code is trivial in this matter) and analyze how these extensions affect what our metrics state about software products. We also examine real-world software to try to prove that our definitions have no negative effect on the complexity measured by these metrics.

Properties of the Lemoine point in Hyperbolic geometry

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The purpose of this paper is to analyse several of the classical properties of the Lemoine point from a hyperbolic point of view. Using Barycentric and trilinear coordinates in hyperbolic geometry we will investigate the existence of the Lemoine point and how some of the properties are changed while working in the hyperbolic plane.

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Modeling Dynamic Type Systems in Statically Typed Languages

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Each general-purpose programming language has its unique properties which make some of them more favorable compared to others in the respect of solving specific problems. We often write big programs using one general-purpose programming language that is good enough for the most of our intentions, but often might not be the best choice on a few but essential areas. To overcome such complications, we can piece our program together using components written in different programming languages, resulting in a mixed construction that can be an optimal solution for that problem domain.

In this paper, we choose two programming languages: Erlang [3] and C++ [3]. On one hand, Erlang is a good choice to achieve greater productivity and easy cluster communication, or to write soft real-time applications. On the other hand, with C++, one can produce more efficient programs, since the emitted machine code is much more optimized and performs better than interpreted and platform-independent bytecode. Putting these languages together can be a good choice if the computation-intensive parts of a distributed application is written in C++ while the rest in Erlang. However there is one fundamental difference between the two languages: these have completely different type systems [1]; while Erlang is dynamically typed, C++ is statically typed. In order to implement parts of our program in C++, modeling the type system of Erlang is required since the algorithms implemented with both languages have to operate on the same data. In order to ensure seamless transitions from one to the other and vice versa, we should be able to specify the type of data even when we do not know in advance what the data is.

Here, a definition of a dynamic type system is presented that preserves strong typing rules in respect of its semantics along with the programming techniques needed to achieve the same runtime behavior that it has in its original language environment. A reference implementation is also introduced using the language constructs of the statically typed language to demonstrate the feasibility of the results presented by our research.

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Lattice-like subsets of Euclidean Jordan algebras

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While studying some properties of linear operators in a Euclidean Jordan algebra, Gowda, Sznajder and Tao have introduced generalized lattice operations based on the projection onto the cone of squares. In two recent papers of the authors of the present paper it has been shown that these lattice-like operators and their generalizations are important tools in establishing the isotonicity of the metric projection onto some closed convex sets. These kinds of results are motivated by metods for proving the existence of solutions of variational inequalities and methods for finding these solutions in a recursive way. It turns out, that the closed convex sets admitting isotone projections are exactly the sets which are invariant with respect to these lattice-like operations, called lattice-like sets. In this paper it is shown that the Jordan subalgebras are lattice-like sets, but the converse in general is not true. In the case of simple Euclidean Jordan algebras of rank at least three the lattice-like property is rather restrictive, e.g., there are no lattice-like proper closed convex sets with interior points.

1991 A M S Subject Classification: Primary 90C33, Secondary 15A48; *Key words and phrases:* positive semidefinite cone, extended lattice operations, isotone projection onto a closed convex set, invariant sets with respect to extended lattice operations, variational inequalities.

Feedback for estimated Ordination Destination Matrix by expert and simulation.

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The Origin/Destination (OD) matrix [1] is an essential input for all traffic simulations. This matrix determines how many vehicles traveled from point X to point Y, where X and Y can be either a whole city or some kind of traffic zone. We can use different algorithms to estimate the OD matrix. But, generally, the calculations of these estimations are very difficult, because we don't have the sufficient amount of information for a precise prediction. As an improvement, we ask the experts about the correctness of the result, and then we are able to add this feedback information to the estimation process. So, we are going to extend the estimation process with this validation step as a part of an iteration in order to improve the results for the next iteration with information from feedbacks.

In most cases, an expert can't discover all errors within an OD matrix, because the matrices are usually too large to handle by one person. So, we have to ensure a possibility for experts with which one can point to some crossroads, and can add some hint about quantity and direction of traffic. In this paper, we will introduce a solution for expert's feedback handling. We use a probability based estimation for generating an OD matrix in each iteration, we ask some question from the expert, and then we will use probabilities of estimation to choose some values from OD to questions.

In cases, when we have some information over the real traffic flows, for example traffic counting [2] or FCD data, we can also use these as a feedback. In these cases, we get the sufficient feedbacks from questions over the available real data set. With them, the OD may show more realistic picture over the traffic. We will show how we should use few information for modifying a whole matrix. We will show, that we need at least three value to change for significant changes in OD matrix. So, as a summary, we worked out a new method to improve the correctness of an estimated OD matrix. This method is define an easy way to get feedback from expert or from queries over quantitative traffic data.

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Type inference for Core Erlang

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Erlang [2] is a dynamically typed, functional, concurrent programming language. *Core Erlang* [4] is a pure functional variant of the base language, where any construct of Erlang can be easily expressed in Core Erlang, whilst preserving most of the static semantic properties, like types.

In Erlang, types of variables and functions are not defined in the program. Although the compiler performs some strict type checks (i.e. no implicit type conversions can happen), if a function (or an operator) is invoked with an unexpected type of data, only a run-time exception is thrown. Such programming errors are a tedious task to reveal, therefore several tools have been made to help programmers finding possible discrepancies in the program, i.e. situations where type mismatch can happen. However, the language allows polymorphic return types for branching expressions, which makes the type system very complex, and the types uneasy to comprehend. In order to overcome this issue, *success typing* [5] has been introduced, reducing the aforementioned complexity by substituting an upper bound type for complex union types and making types readable; on the other hand, it loses static type information.

Success typing become the de-facto type inference algorithm for Erlang. It yields an overapproximation of types, which increases readability, but decreases accuracy. We cannot use success types, for example, for test data generation, since they are too general, so that the data we get based on success typing will likely be improperly typed. Our goal is to make a type inference system for Erlang that derives types accurate enough for test data generation. In particular, we transform these types to *QuickCheck* [3] data generators that can supply functions with random arguments, which we utilize to build an Erlang benchmarking system.

By introducing a new, more precise type system to Core Erlang, the information loss can be decreased for the price of long type expressions. As stated already, Erlang programs can be easily turned into static semantically equivalent Core Erlang programs, where the functions preserve their types. The long, but way more accurate types are more suitable for random argument generation. We define type inference rules and the full algorithm is described. A comparison of our achievements with earlier results is provided, as well as a proposal to extend the results for the full Erlang language is given.

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Performance metrics to characterize parallel programs

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To speed up the solution of the problem it's not enough to have a parallel computing system. Besides, still need for such a system to create a special parallel program. In order that the algorithm can be efficiently implemented as a parallel program, it must have an internal parallelism. The purpose of this talk is to present performance for parallel programs on the Moldova State University cluster.

Coincidence point theorems for rational contractions

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The purpose of this talk is to present some coincidence point theorems for singlevalued and multivalued rational contractions. A comparative study of different rational contraction conditions is also presented. Our results extend some recent theorems in the literature.

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Differential subordinations for non-analytic functions

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In paper [4], Petru T. Mocanu has obtained sufficient conditions for a function in the class $C^1(U)$, respectively $C^2(U)$ to be univalent and to map U onto a domain which is starlike (with respect to origin), respectively convex. Those conditions are similar to those in the analytic case. In paper [5], Petru T. Mocanu has obtained sufficient conditions of univalency for complex functions in the class C^1 which are also similar to those in the analytic case. Having those papers as inspiration, we try to introduce the notion of subordination for non-analytic functions of classes C^1 and C^2 following the classical theory of differential subordination for analytic functions introduced by S.S. Miller and P.T. Mocanu in papers [1] and [2] and developed in the book [3].

Let Ω and Δ be any sets in the complex plane $\mathbb{C}$, let p be a non-analytic function in the unit disc U, let p be a function in the class $C^2(U)$ and let $\psi(r;s;t;z) : \mathbb{C}^3 \times U \to \mathbb{C}$. In this article we consider the problem of determining properties of the function p, non-analytic in the unit disc U, such that p satisfies the differential subordination

$$\left\{\psi\left(p(z);izDp(z);iz^2D'p(z);z\right)\right\} \subset \Omega \Rightarrow p(U) \subset \Delta.$$

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A contraction principle in generalized metric spaces

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One of the generalizations of the Banach Fixed Point Theorem is due to Matkowski, who replaced contractivity by a weaker but still effective property. The aim of this note is to extend the contraction principle in this spirit for such semimetric spaces that are equipped with a natural generalization of the standard triangle inequality. The stability of fixed points is also investigated in this setting. As applications, fixed point results are presented in ultrametric spaces.

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Construction of analytic wavelets

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In this talk I will present a multiresolution analysis in the Hardy space of the unit disc, respectively of upper half plane. The construction is an analogy of the discrete affine wavelet multiresolution, and in fact it can be derived from the discretization of the continuous voice transform generated by a representation of the Blaschke group. The levels of the multiresolution are generated by analytic wavelets i.e. by the Malmquist-Takenaka system, with a special localization of the poles. The n-th level of the multiresolution has finite dimension (in classical affine multiresolution this is not the case) and still we have the density property, i.e. the closure in norm of the reunion of the multiresolution levels is equal to the Hardy space. The projection operator to the n-th resolution level is in the same time a rational interpolation operator on a finite subset of quasi lattice points. If we can measure the values of the function on the points of the quasi lattice the discrete wavelet coefficients can be computed exactly. This makes our multiresolution approximation very useful from the view of the computational aspects. The multirezolution approximations can be used in system theory to describe the spectral behavior of discrete, respectively continuous-time-invariant systems.

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A Simple Process Abstraction and Communication Pattern

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In software systems the communication methods have crucial importance. This paper introduces a communication pattern and a corresponding process abstraction.

The proposed approach results a system which shows many similarities with mikrokernel based operating systems. The adaptation of the model to lower level implementation has advantages in the aspect of performance and overall system design also. From these reasons we need to discuss extensibility and scalability of these systems ([1], [2]).

We assume that clean design makes the system development and maintainance easier without performance penalties.

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Maximum degree minimum covering graphs

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For a graph G with vertex set $V(G) = \{v_1, v_2, \ldots, v_n\}$, let S be the covering set of G having the maximum degree over all the minimum covering sets of G. Let $N_S[v] = \{u \in S : uv \in E(G)\} \cup \{v\}$ be the closed neighborhood of the vertex v with respect to S. We define a square matrix $A_S(G) = (a_{ij})$, by $a_{ij} = 1$, if $\left|N_S[v_i] \cap N_S[v_j]\right| \geq 1, i \neq j$ and zero, otherwise. The graph G^S associated with the matrix $A_S(G)$ is called the maximum degree minimum covering graph (MDMC-graph) of the graph G. In this paper, we give conditions for the graph G^S to be bipartite and Hamiltonian. We obtain a bound for the number of edges of the graph G^S in terms of the structure of G. Further we obtain an upper bound for covering number (independence number) of G^S in terms of the covering number (independence number) of G.

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Study of Voronoi diagrams with means of stochastics

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The purpose of this work is to present a special birth process of Voronoi cells. In one- and two-dimensional space the points with integer coordinates of a bounded domain are taken and they become active step by step according to given rules, creating Voronoi cells. The size of a cell is defined as the number of points containded and the size distribution of the Voronoi cells is studied. After the definition of the special birth process and the resulting Voronoi cells the process is simulated and the cells sizes are analyzed. With the maximum likelihood method the parameters of three distributins are computed for the data, from these parameters the mean and variance is estimated and then z- and t-tests are used to test if the obtained values fit the original data. After a number of computer simulations the gamma distribution is proposed as the most suitable approximation for the cell-size ditribution.

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On a conjecture of Kiermaier and Kurz

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In (*Discrete Math.* **309** (2009), 4564–4575) Kiermaier and Kurz gave $(q(q-1)r)^2$ integral automorphisms of the affine plane $AG(2,q)$ where $q \equiv 1 (\mathrm{mod}\ 4)$, and conjectured that these comprise all integral automorphisms if $q \notin \{5,9\}$. In this talk we prove the conjecture, and by this complete the classification of integral automorphisms of every affine plane $AG(2,q)$.

Stability of multi-step fixed point iterative methods

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Problem 1 (Limit shadowing property problem) *Let (X, d) be a metric space and $f : X \to X$ an operator. Let $x_n \in X$, $n \in \mathbb{N}$, be such that:*

$$d(x_{n+1}, f(x_n)) \to 0 \text{ as } n \to +\infty.$$

In which conditions there exists $x \in X$ such that

$$d(x_n, f^n(x)) \to 0 \text{ as } n \to +\infty \text{ ?}$$

By definition if f is a solution of the above problem, then we say that *the operator f has the limit shadowing property with respect to Picard iteration*.

Problem 2 (The stability problem) *Let (X, d) be a metric space and $f : X \to X$ an operator. Let us consider the Picard iteration algorithm for f*

$$x_0 \in X,\ x_{n+1} = f(x_n),\ n \in \mathbb{N}.$$

By definition, the Picard iteration algorithm is stable with respect to f if it is convergent (i.e., f is WPO) and f has the limit shadowing property with respect to this algorithm. The problem is to give conditions on f which imply that the Picard iteration algorithm is stable.

Let (X, d) be a metric space and $T : X^k \to X$ an operator. Let us consider the following multi-step algorithm for f

$$x_0, x_1, \ldots, x_{k-1} \in X,\ x_{n+k} = T(x_n, x_{n+1}, \ldots, x_{n+k-1}),\ n \in \mathbb{N}.$$

We define the operator $A_T : X^k \to X^k$

$$A_T(u_1, \ldots, u_k) = (u_2, \ldots, u_k, T(u_1, \ldots, u_k)).$$

It is easy to see that for $x_0, x_1, \ldots, x_{k-1} \in X$ we have

$$(x_{n+1}, x_{n+2}, \ldots, x_{n+k}) = A_T^n(x_0, x_1, \ldots, x_{k-1})$$

In this paper we give conditions on $T : X^k \to X$ such that the Picard iteration algorithm for the operator $A_T : X^k \to X^k$ is stable.

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Reconstructing graphs from a deck of all distinct cards

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If v is a vertex of graph G, then $G - v$ is the graph obtained from G by deleting the vertex v and its incident edges. We call $G - v$ a *vertex-deleted subgraph* of G, or the *card* associated with vertex v. The *deck* of G is the multiset of the cards associated with all of its vertices. One of the most well-known unsolved problems of graph theory asks wether a graph can be reconstructed up to isomorphism from its deck. The conjecture that the answer is true for all graphs having at least three vertices was formulated by Kelly and Ulam in 1942, but very little progress has been made towards its general proof since then. See [1] and [2] for two extensive surveys on the graph reconstruction problem. In this paper we show that graph G is uniquely reconstructible from its deck, provided that the deck of G is a *set*, that is, there are no two distinct vertices in G having the same card associated with them. Since any duplication of cards indicates the presence of a kind of symmetry within graph G, our result is in accordance with [3] saying that the probability that a randomly chosen graph on n vertices is not reconstructible goes to 0 as n goes to infinity.

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The Enterprise Software Development Process: Methods, Tools, Patterns and Quality Assurance

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Enterprise software development implies multiple activities and usually several development teams. In this process it is essential to use proper methods, patterns, tools and technologies. The presentation is a short overview of the domain. The main topics are: development methodologies, issue tracking and project management, source code management, continuous integration and quality management. Related tools and technologies are enumerated and some best practices and tips are also presented.

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On systems of semilinear hyperbolic functional equations

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The aim of the talk is to consider systems of second order semilinear hyperbolic partial differential equations where the lower order (nonlinear) terms contain functional (non-local) dependence on the unknown function. Existence of solutions for $t \in (0, T)$, $t \in (0, \infty)$ and some qualitative properties of the solutions in $(0, \infty)$ will be shown. Further, examples will be considered.

Creating an efficient and incremental IDE for TTCN-3

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In this article we present methods and algorithms for constructing an efficient IDE in the sense that the processing costs of re-analyzing source code after change is minimal. Moreover, we show that these methods and algorithms can be designed in a way that they support iterative realization, hence, they fit better to the current trends of iterative software development life-cycle. We also show how these algorithms can be built into an existing system and we show measurements on performance benefits. The proposed methods were validated in the telecommunication area for compiling Testing and Test Control Notation - 3 (TTCN-3 [1]) code.

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On Representation and Usage of Requirements in Self-* Systems

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There is much more emphasis on architecture than on knowledge representation in self-* system development. We think that there should be more attention given to knowledge selection and representation, because self-adaption or self-healing cannot be implemented without a knowledge about the requirements and architecture of the system. We focus this paper on requirement knowledge representation and usage in self-* systems. Our goal is to present an approach, which takes different software development methods into consideration. Using them, we find the proper form of requirement representation. We also show related methods of knowledge extraction from the selected requirement representation – which are user stories. Finally, for the presented representation, we outline our usage model prototype, which is also used to show further research and development directions by selecting its strong and weak components.

Almost everywhere and norm convergence of the inverse continuous wavelet transform in variable Lebesgue spaces

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The so called variable Lebesgue spaces is studied intensively in the last few years. Instead of the classical L_p-norm, the variable $L_{p(\cdot)}$-norm defined by

$$\|f\|_{p(\cdot)} := \inf\left\{\lambda > 0 : \int_{\mathbb{R}^d} \left(\frac{f(x)}{\lambda}\right)^{p(x)} dx \le 1\right\}$$

and the variable $L_{p(\cdot)}$ spaces contains all f measurable functions, which $\|f\|_{p(\cdot)} < \infty$. The variable Lebesgue spaces have a lot of common property with the classical Lebesgue spaces (see in Cruz-Uribe, Fiorenza [1]).

The continuous wavelet transform of f with respect to a wavelet g is defined by

$$W_g f(x,s) := |s|^{-d/2} \int_{\mathbb{R}^d} f(t)\overline{g}(s^{-1}(t-x))\, dt = \langle f, T_x D_s g\rangle,$$

($x \in \mathbb{R}^d$, $s \in \mathbb{R}$, $s \neq 0$), when the integral does exist. The inversion formula holds for all $f \in L_2(\mathbb{R}^d)$:

$$C_{g,\gamma} \cdot f = \int_0^\infty \int_{\mathbb{R}^d} W_g f(x,s) T_x D_s \gamma \, \frac{dxds}{s^{d+1}},$$

where $C_{g,\gamma}$ is a constant depend on g and γ, but independent of f. Moreover under some conditions

$$\lim_{S\to 0} \int_S^\infty \int_{\mathbb{R}^d} W_g f(x,s) T_x D_s \gamma \, \frac{dxds}{s^{d+1}} = C_{g,\gamma} \cdot f$$

with convergence in L_p-norm, almost everywhere and each Lebesgue points for all $f \in L_p(\mathbb{R}^d)$ $(1 < p < \infty)$ see in Weisz [2].

In this paper we will investigate the convergence of the inversion formula in the $L_{p(\cdot)}$ spaces some sense, for example the norm and almost everywhere convergence or the convergence at the Lebesgue points.

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About a result due to Professor P.T. Mocanu

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A result regarding the starlikeness of the image of the Alexander operator is improved in this paper. The technique of differential subordinations is used.

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Model-based Testing for Reactive Systems. Intelligent Approaches

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Testing is a crucial step in the software development life-cycle. It is common to dedicate at least 50% of the project resources to this step. Model-based testing is a testing approach that can facilitate the automatic test-case generation and thus testing costs can be significantly reduced.

The goal of this thesis is to address some of the fundamental problems of automatic test-case generation in safety critical, reactive systems. The research involved also focuses on the development and analysis of intelligent methods for the optimization of the automatic test-case generation process. Some of the main areas of interest are: statistical testing, evolutionary testing and estimation of distribution algorithms used in test-automation.

The practical part of the thesis aims to test the proposed methods and algorithms on problems within the domain of railway automation.

Range Characterization of the attenuated Radon transform of compactly supported tensor fields in the plane

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Characterization of the range of the (non-attenuated) Radon transform of zero-tensors has been known since the works of Gelfand-Graev, Helgason, and Ludwig since 1960's. In the case of the attenuated Radon transform, some range conditions (also for sufficiently smooth functions) have been established by Novikov in 2012. These constraints, known as the moment conditions, are in terms of the angular variable. I will present new range conditions for non/attenuated Radon data of tensors of an arbitrary order. They are in terms of a Hilbert transform associated with A-analytic maps a lá Bukhgeim. As an application I will explain how the attenuation allows for the Doppler data to be mistaken for some X-ray data. These results are joint work with Kamran Sadiq.

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Distributed computing of n-dimensional simultaneous Diophantine approximation problems

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In this talk we compare different architectures for solving a non-trivial number-theoretic challenge. The algorithms demonstrated will be used for solving n-dimensional simultaneous Diophantine approximation problems. The codes are optimized for different architectures and based on the results of recent researches. The investigated architectures were (1) a Sandy Bridge Intel Core i5-2450M, (2) a supercomputer cluster with 90x Intel Xeon E5520 Nehalem Quad Core and (3) ATI Radeon 7970 GPU Card. We show that in some particular applications the Lenstra-Lenstra-Lovász (L^3) algorithm can be substituted by the presented ones in order to reduce their practical running time.

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Counting solutions of quadratic congruences in several variables revisited

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Consider the quadratic congruence $a_1x_1^2 + \ldots + a_kx_k^2 \equiv n \pmod{r}$, where $\mathbf{a} = (a_1, \ldots, a_k) \in \mathbb{Z}^k$, $n \in \mathbb{Z}$, $r \in \mathbb{N}$. Let $N_k(n, r, \mathbf{a})$ denote the number of its incongruent solutions. In the talk I sketch short direct proofs, using the Gauss quadratic sum for certain less known compact formulas on $N_k(n, r, \mathbf{a})$, valid for r odd. These formulas are in terms of the Ramanujan sum and the Jacobi symbol, and go back to the work of Paul Bachmann [1], Eckford Cohen [2] and Hermann Minkowski [3]. I also discuss some other related identities and asymptotic formulas which seem to not appear in the literature.

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Utilising the software metrics of RefactorErl to identify code clones in Erlang

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Code clones [5], the results of "copy&paste programming", are special types of bad smells. They have a negative impact on software development and maintenance lifecycle. The usual way to detect bad smells is to calculate software metrics. RefactorErl [1, 2] is a source code analysis and transformation tool for Erlang [3]; it provides several software metrics to measure the complexity of the source code, and finds structures that violate some existing requirements or standards, or points out bad smells based on the results of them. Hereupon, it has an automatic analyser mode to check the values of certain metrics during software development and maintenance and report warnings when some of them violate the predefined rules [4].

In this paper we introduce an efficient, parallel, software metric based clone detection algorithm for the functional programming language Erlang. We describe how we can utilise the metrics of RefactorErl to describe the lexical, syntactic and semantic structure of different source code parts. Our algorithm identifies code clones based on the similarity and equality of these metric values and presents only accurate results. We have successfully evaluated it on various open-source projects.

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An interval fuzzy multicriteria decision making method based on the expected value

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This paper presents a multicriteria decision making method in the event that at least one decision-maker does not respond to a specific question with exactly one choice, but choose two variants of answer or give an intermediate response. Allowing these situations, we avoid the introduction in the surveys of too many levels for the variation of responses. The methods elaborated in [1] and [4] are extended.

Interpretation of an answer consists on two choices or an intermediate choice is given by using intervals of fuzzy numbers.

As a simple method with suitable properties, the expected value is often used for the ranking of fuzzy numbers (see [2]). We introduce the expected value of an interval of fuzzy numbers, following the idea in [3]. We prove the most important properties, we calculate it in the case of intervals of trapezoidal fuzzy numbers or product of intervals of trapezoidal fuzzy numbers. We elaborate an algorithm of rankings of alternatives versus criteria and weights of criteria given by intervals of trapezoidal fuzzy numbers.

Theoretical considerations are illustrated by an example taken from [1] and [4] and modified accordingly.

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A Proposal to Building the Adaptive Reference System: A Challenge for Managers

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Making decisions is all about references and making good decisions is all about good references. Making good decisions in the context of a certain entity (be that a private company or public institution) is all about the reference system you build within the context and the constraints of that specific entity. Building the right reference system within a given context will prove you in time the agility of that context. Well, TIME is not always the variable to play with, so building a reference system becomes a challenge and a vital attribute for the most exposed people in terms of responsibility: THE MANAGERS.

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Augmented Reality with interactive interfaces

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The Augmented Reality (AR) merges a real world and a virtual environment. A virtual object is added into a real world in order to improve or to add more information for an observer. AR is computer-generated data integration with the real world, which among others can be done with computer graphics rendering on a real-time footage. The paper presents a concept of design AR system used two head mounted displays (HMD). Two users can see via HMD the same virtual scene in their own real environment. The users can change 3D objects in AR scene directly using data gloves. We develop interactive AR system for the communication between user and a virtual environment in LIRKIS (Laboratory of Intelligent Interfaces of Communication and Information Systems).

The largest known Cunningham chain of length 3 of the first kind

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Cunningham chains of length n of the first kind are n long sequences of prime numbers $p_1, p_2, \ldots, p_n$ so that $p_{i+1} = 2p_i + 1$ (for $1 \leq i < n$). In [1] we have devised a plan to find large Cunningham chains of the first kind of length 3 where the primes are of the form $p_{i+1} = (h_0 + cx)2^{e+i} - 1$ for some integer x with $h_0 = 5\,775$, $c = 30\,030$ and $e = 34\,944$.

The project was executed on the super computer of NIIF in Pécs, Hungary. In this paper we report on the obtained results and discuss the implementation details. The search consisted of two stages: sieving and the Fermat test. The sieving stage was implemented in a concurrent manner using lockfree queues, while the Fermat test was trivially parallel.

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Usage of development guidelines for optimizing the energy consumption of mobile applications

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The market of mobile devices and the power of mobile computation has increased significantly over the last years. Although the technology has evolved a lot the main issue of mobile devices is that they are and will remain severely limited by their battery life. The need to preserve this critical resource has driven mobile devices OSes to take into consideration the power management and has driven the developers of mobile applications to optimize the energy consumption of the applications.The two main fields of research in this area are finding solutions to estimate the energy consumption of an application and finding ways to determine applications and bugs that lead to energy consumption and unexpected battery drain.
In this paper we will show how we can use development guidelines for mobile applications in order to determine the pieces of code that could generate a bug and could lead to an abnormal batery drain. We will analyze the impact generated by the unappropriate usage or the lack of usage of certain development guidelines on the energy consumption. We will show how the development guidelines and the best practices can be used to ensure that a mobile application is more efficient, has a better performance and consumes less energy.

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