Zoltán Csörnyei (Ed.)

ABSTRACTS

MaCS'12
9th Joint Conference on
Mathematics and Computer Science

Siófok, Hungary
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Budapest, Hungary

MaCS'12

9th Joint Conference on Mathematics and Computer Science

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János Selye University, Komárno, Slovakia,
Sapientia Hungarian University of Transylvania, Târgu Mureş, Romania,
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University of Pécs, Hungary,
University of Szeged, Hungary,

held in

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Dear Participants,

On behalf of the organizers, it is our great pleasure to welcome you to the 9th Joint Conference on Mathematics and Computer Science (MaCS). Although the conference is hosted by the Faculty of Informatics and the Institute of Mathematics of the Eötvös Loránd University, Budapest, the venue is Siófok, one of the most beautiful town at the shore of Lake Balaton in Hungary. The purpose of the conference is to provide a communication forum of the scientific community covering all branches of mathematics, computer science and their applications. We are waiting for potential participants not only from academic sphere but from industry as well.

The Joint Conference on Mathematics and Computer Science was started in 1994 as a series of biennial conferences by the Eötvös Loránd University in Budapest and the Babeş–Bolyai University in Cluj–Napoca. The previous venues of MaCS were Ilieni/Illyefalva, Romania (1995, 1997), Visegrád, Hungary (1999), Băile Felix/Félixfürdő, Romania (2001), Debrecen, Hungary (2004), Pécs, Hungary (2006), Cluj–Napoca, Romania (2008), Komárno/Komárom, Slovakia (2010).

Following the tradition of the series of MaCS conferences, the present conference is organized by an informal consortium of seven universities, namely the Babeş–Bolyai University in Cluj–Napoca, the Eötvös Loránd University in Budapest, the Sapientia Hungarian University of Trasylvania, the University of Debrecen, the University of Pécs, the University of Szeged, and the Selye János University in Komárno/Komárom.

We are grateful to many people who helped make this conference successful, in particular to the lecturers and to the members of Steering, Scientific and Organizing Committees.

We wish you a successful conference.

László Kozma

Dean of the Faculty of Informatics
Eötvös Loránd University

András Frank

Director of the Institute of Mathematics
Eötvös Loránd University

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Plenary talk

ECG Signals and Hyperbolic Geometry

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One of the widely used methods in ECG signal processing is the so called transformation method that includes Fourier-, wavelet, spline transformations among others. This proved to be generally a productive technique in a range of various signal processing problems. In recent years our research group at the Department of Numerical Analysis at ELTE has been working on a new efficient approach, which is based on orthogonal and biorthogonal bases, for analyzing ECG signals. By means of such systems we have constructed adaptive discrete approximation and interpolation processes that can be successfully applied in ECG processing and compression. By adaptivity we mean that the process itself can be adjusted according to he shape of the individual curve. Such bases turned to be effective in designing algorithms for systems identification as well. In the construction of rational systems we use the Blaschke functions which play fundamental role in the theory of Hardy and Bergman spaces, in the mathematical foundation of control theory and in several other areas. The congruences in the Poincare model of the Bolyai geometry can be identified by means of Blaschke transforms. This relation made it possible for us to highlight the geometric background of the concepts and algorithms used in connection with rational bases. Replacing the group of affine transforms in the classical definition of wavelet transforms by the Blaschke group one can introduce the hyperbolic wavelet transforms. These transforms seem to be more useful in analyzing for instance ECG signals, and signals that frequently occur in control theory than the classical ones. In our presentation we will show an iteration process based on this idea for identifying the poles of rational functions. The set of initial values for convergence and the rate of convergence both can be characterized by concepts of hyperbolic geometry. We have worked out also the hyperbolic variant of the Nelder-Mead algorithm in order to approximate ECG signals by rational functions. In addition to these the construction of hyperbolic fractals will also be considered in the talk. We will show the main ideas of the construction of orthogonal and biorthogonal rational systems in both continuous and discrete cases. Then we will show how these bases can be used for mathematical representation, approximation, interpolation and compression of ECG signals. We consider segments of ECG curves that represent the various phases of heart functioning. In particular a model for the so called QRS complex will be given. We note that a MATLAB toolbox has been constructed that contains the algorithms of the method presented.

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Plenary talk

Applying data mining, geometry, analysis and graph theory in molecular biology

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Molecular biology presents new challenges for mathematics by collecting enormous quantity of measurement data every day in thousands of laboratories worldwide, including new genetic sequences, DNA microarray-, mass spectrometry-, proteomics- and structural data. Answering – or even posting – biological questions related to these raw measurement results needs non-trivial mathematical methods. We will review several problems appearing in connection with three dimensional protein structures deposited in the Protein Data Bank, including protein-ligand docking, structural analysis of proteins and protein networks.

Plenary talk

Hopf-Galois extensions, Morita equivalences and H-Picard groups

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This paper is a survey of some recent results in the representation theory of Hopf-Galois extensions. We mainly consider the following questions. Let H be a Hopf algebra, and A, B right H-comodule algebras. Assume that A and B are faithfully flat H-Galois extensions.

1. If A and B are Morita equivalent, does it follow that the subalgebras of coinvariants A^{coH} and B^{coH} are also Morita equivalent?

2. Conversely, if A^{coH} and B^{coH} are Morita equivalent, when does it follow that A and B are Morita equivalent?

As an application, we investigate H-Morita autoequivalences of the H-Galois extension A, which leads to the concept of H-Picard group. We establish an exact sequence linking the H-Picard group of A and the Picard group of A^{coH}. Among other things, this relies on the study, in this context, of the Dade-Clifford extensions of H-invariant A^{coH}-modules.

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An aspect of storing gene chip data in an efficient schema

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In this article we want to give an overview about our recent work* with Affymetrix's gene chip data from medical examinations. We introduce two possible methods and a storage schema, which allows us to compare the experimental results directly. Without such logic, if we want to determine similarities and differences between two specific groups of results, we should face a difficult problem. Recently our database stores more than 30.000 different examinations from the public NCBI GEO database.

First, we write some details about the Affymetrix's technology and about the CEL file format. After this short introduction we show two auto-load technics, which we developed for filling up our database from the available gene chip resources. Both method works in parallel environment for the better performance. In the end of this section we compare the efficiency of these technics.

Then we write about the structure of the chosen database schema. Here we examine the costs of three typical queries on our database prototype. Finally, we show some outcomes of these developments.

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Towards a faster BitTorrent*

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BitTorrent is the most popular peer-to-peer system for file sharing. In the standard protocol the distributed file is split into pieces and the clients upload and download them to each other. In the original BitTorrent protocol the problem of rare pieces can appear. A promising way of solve this problem is the extension of the original protocol by source coding. This coding method increases piece diversity in the network which accelerates tit-for-tat piece exchange and leads to a lower completion time.

We compared different types of random source coding and proposed a novel deterministic method. We showed several advantages of our new method compared to random source codings. These advantages are also proved theoretically and backed up by simulations.

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On a stronger variant of paramodulation

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Reasoning about equality and other equivalence relations is a central question of automated theorem proving. Its importance stems from the extensive use of equality in mathematical theories and equivalences in many formal methods and theories for software verifications.

To address the problem, Robinson introduced *paramodulation* as a method to reason about theories with equality. To put it simply, this rule substitutes a known equality into another formula. While this inference rule, which is usually combined with the resolution calculus, proved to be much more efficient than using the standard set of axioms for equality, its unrestricted form still allows to much freedom, and since its introduction several solutions has been developed to turn paramodulation into an effecient tool for theorem proving. The most succesful ones of these are usually borrowing methods from the theory of *term rewriting systems*, and restrict the inference rule and thus the size of the search space. Most state-of-the-art reasoning systems use a form of these methods.

In this paper we take another approach to decrease the number of possible rule applications: we introduce a stronger form of paramodulation which substitutes multiple occurrences of the same term instead of just one in a literal. We show its completeness, and investigate its compatibility with the most commonly used strategies for resolution.

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Bilateral inequalities for means

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We remind the definitions of the classical means, namely, for $0 < a < b$

- the *arithmetic*, *geometric* and *harmonic* ones

$$A = \frac{a+b}{2}, \quad G = \sqrt{ab}, \quad H = \frac{2ab}{a+b},$$

as well as

- the *Hölder* and the *anti-harmonic* mean $Q = \left(\frac{a^2+b^2}{2}\right)^{1/2}, \quad C = \frac{a^2+b^2}{a+b}$;
- the *Pólya & Szegő logarithmic* mean, the *exponential* (or *identric*), and the *weighted geometric* mean

$$L = \frac{b-a}{\ln b - \ln a}, \quad I = \frac{1}{e}\left(\frac{b^b}{a^a}\right)^{1/(b-a)}, \quad S = \left(a^a b^b\right)^{1/(a+b)}.$$

Let (M_1, M_2, M_3) be three means in two variables chosen from

$$H < G < L < I < A < Q < S < C,$$

so that $M_1(a,b) < M_2(a,b) < M_3(a,b),\ 0 < a < b$.

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

$$\alpha M_1(a,b) + (1-\alpha)M_3(a,b) < M_2(a,b) < \beta M_1(a,b) + (1-\beta)M_3(a,b).$$

We solve the problem for the triplets (G,L,A), (G,A,Q), (G,A,C), (G,Q,C), (A,Q,C), (A,S,C), (A,Q,S) and give results of the following type.

Theorem 1 $\alpha A(t) + (1-\alpha)C(t) < Q(t) < \beta A(t) + (1-\beta)C(t),\ \forall t > 1$ *if and only if* $\alpha \geq 2 - \sqrt{2}$ *and* $\beta \leq 1/2$.

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Manifolds with gauge-compatible structures

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Definition 1 A *gauge function* F on a manifold M is a function $F\colon TM \to \mathbb{R}_+$ satisfying the following conditions:

(F1) F is smooth on the slit tangent bundle (i.e., on TM with the zero tangent vectors removed);

(F2) F is positive-homogeneous of degree 1 (we have $F(\lambda v) = \lambda F(v)$ for all $v \in TM$, $\lambda \in \mathbb{R}_+$);

(F3) F is subadditive ($F(v+w) \leq F(v) + F(w)$ for any $a \in M$, $v, w \in T_aM$).

Definition 2 A *parallelization* on a manifold M is a smooth mapping

$$P\colon M \times M \to \bigcup_{(a,b)\in M\times M} \mathrm{Lin}(T_aM, T_bM),$$

such that $P(a,b) \in \mathrm{Lin}(T_aM, T_bM)$ and we have

$$P(c,b) \circ P(a,c) = P(a,b), \quad P(a,a) = 1_{T_aM}; \quad a,b,c \in M.$$

A gauge function F is *compatible with* P if

$$(F \restriction T_bM) \circ P(a,b) = F \restriction T_aM \quad \text{for all } a,b \in M.$$

In this talk we investigate the relation between two properties of a manifold endowed with a gauge function:

(i) the gauge function is compatible with a parallelization;

(ii) the gauge function is compatible with a linear connection on M.

It turns out that a suitable local version of property (i) is equivalent to property (ii).

This theorem generalizes and simplifies some results of Y. Ichijyō [1] and L. Tamássy [2].

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Comparison of standard phylogenetic methods and a novel Boolean approach for reconstruction of phylogenetic trees

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A novel discrete mathematical method and corresponding software, called Boolean analysis or BOOL-AN [1,2] is applied for comparative sequence analysis and phylogenetic reconstruction. In contrast to the character-based standard statistical methods (i.e. Maximum Parsimony, Maximum-Likelihood, Neighbor-Joining, and Bayesian analysis) it uses generalized molecular codes and molecular descriptors for encoding the sequence information and its comparative analysis in discrete mathematical terms. The sequence information of biological macromolecules (DNA/RNAs or proteins) is unambiguously represented by systems of binary strings or Boolean functions. In turn, the phylogenetic trees are derived by using graph-distance calculations, based on the Iterative Canonical Form (ICF) of Boolean functions. The performance and reliability of Boolean analysis were tested and compared with the standard phylogenetic methods, using both artificially evolved – or simulated – DNA sequences and natural mitochondrial tRNA genes of great apes [3]. At the outset, we assumed that the phylogenetic relationship between ape species is generally well established, and the guide tree of artificial sequence evolution can also be used as a benchmark. These offer a possibility to compare and test the performance of different phylogenetic methods. Trees were reconstructed by each method from 2500 simulated sequences and 22 mitochondrial tRNA genes. Considering the reliability values (branch support values of consensus trees and Robinson-Foulds distances) we used for simulated sequence trees produced by different phylogenetic methods, BOOL-AN appeared as the most reliable method. Although the mitochondrial tRNA sequences of great apes are relatively short (59-75 bases long) and the ratio of their constant characters is about 75%, BOOL-AN and the Bayesian approach produced the same tree-topology as the established phylogeny, while the outcomes of Maximum Parsimony, Maximum-Likelihood and Neighbor-Joining methods were equivocal. It can be concluded that Boolean analysis is a promising alternative to existing methods of sequence comparison for phylogenetic reconstruction and congruence analysis.

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Full semantics of languages

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Provided that T is an *alphabet*, and $L \subseteq T^*$ is the language to be described, we define the syntax and semantics of both L and $T^* \setminus L$ (the last one is called the *error semantics* of L). Then the semantics of the whole T^* is given. It is called the *full semantics* of L. In this approach, we give equal weight to correct and erroneous inputs. In this way, it is possible to standardize the interpretation of both kind of inputs. It becomes possible to define formally the whole requirements specification of a text processor (for example, a compiler). If this specification is executable, one can develop even a standard black box test of the text processors of the language. In this paper the author gives a detailed explanation of his method, and validates it through a nontrivial example using *definite clause grammars* (DCGs) and *Prolog*.

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A random graph model based on 3-interactions*

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Random graphs evolving by some "preferential attachment" rule are inevitable in modelling real-world networks [1]. There is a vast number of publications inventing and studying different models of that kind, but in most of them the dynamics is only driven by vertex-vertex interactions. However, one can easily find networks (that is, objects equipped with links) in economy or other areas where simultaneous interactions can take place among three or even more vertices, and those interactions determine the evolution of the process.

We consider a random graph model evolving in discrete time-steps that is based on 3-interactions among vertices. Triangles, edges and vertices have different weights; objects with larger weight are more likely to participate in future interactions and to increase their weights. Thus it is also a "preferential attachment" model.

The basic idea of the model is the following. At each step either a new vertex arrives and interacts with two already existing vertices, or three old vertices interact. The choice of the interacting vertices is random; it may be uniform, or may be done according to the actual weights of the objects. This is also decided randomly at the beginning of the step. The weights of interacting vertices, the weights of edges connecting them and the weight of the triangle containing them are increased.

We prove the scale free property of the model; that is, the proportion of vertices of weight w converges almost surely to some constant x_w, where the sequence (x_w) is polynomially decaying. We also find the asymptotics of the weight of a fixed vertex.

Techniques of discrete parameter martingales are applied in the proofs.

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Degree distribution in the lower levels of the uniform recursive tree*

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Let us consider the following random graph model. We start from a single node labelled with 0. At the nth step we choose a vertex at random, with equal probability, and independently of the past. Then a new node, vertex n, is added to the graph, and it is connected to the chosen vertex. In this way a random tree, the so called uniform recursive tree, is built.

This model has a long and rich history dating back to 1967. Recursive trees serve as probabilistic models for system generation, spread of contamination of organisms, pyramid scheme, stemma construction of philology, Internet interface map, stochastic growth of networks, and many other areas of application, see [2] for references. For a survey of probabilistic properties of uniform recursive trees see [1] or [3]. Among others, it is known that this random tree has an asymptotic degree distribution, namely, the proportion of nodes with degree d converges, as $n \to \infty$, to 2^{-d} almost surely.

In the talk we will investigate the lower levels of the uniform recursive tree. We will show that, unlike in many scale free recursive tree models, no asymptotic degree distribution emerges. Instead, for almost all nodes in the lower levels the degree sequence grows to infinity at the same rate as the overall maximum of degrees does. We also investigate the number of degree d vertices in the first level for $d = 1, 2, \ldots$, and show that they are asymptotically i.i.d. Poisson with mean 1.

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Quantifying quality attributes of software products through source code scanners

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In this paper we shall examine in what extent can quality metrics of the static source code scanners PMD and FxCop be classified into the attribute sets of ISO/IEC 9126 and ISO/IEC 25010 quality models. We shall also investigate the relationship between the metric capabilities of these tools and the mentioned quality models.

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Quasi-hyperperfect numbers

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Let $\sigma(n)$ denote the sum of positive divisors of the natural number n. A natural number is perfect if $\sigma(n) = 2n$. This concept was already generalized in the form of hyperperfect numbers

$$\sigma(n) = \frac{k+1}{k}n + \frac{k-1}{k}.$$

A natural number is quasiperfect if $\sigma(n) = 2n + 1$.
We introduce the notion of quasi-hyperperfect numbers

$$\sigma(n) = \frac{k+1}{k}n + \frac{k-1}{k} + 1 = \frac{k+1}{k}n + \frac{2k-1}{k}.$$

In this talk we present some new results, numerical results and establish some conjectures.

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Towards axiom-based test generation in .NET 4 applications

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Unit testing is an important aspect of developing highly reliable and dependable applications. Although theoretically it offers the capability of testing a piece of code (typically a method) in isolation, yet the challenge of constructing a test set that appropriately tests the whole functionality remains open and usually is a task that programmers need to solve on an ad-hoc basis or using extreme approaches like test-driven development. In this paper we propose a way how algebraic software specification can be applied to programs constructed on the .NET platform, how it can serve as the basis of automatic test generation and how it can replace ad-hoc testing throughout the software development process, especially during refactoring. We introduce the definition of a concept and an axiom, and we also overview axiom-based testing in general. We specify a mapping between the abstract definitions and the language constructs of the C# 4 programming language. Platform services like attributes, reflection and call interception will be introduced and employed during implementation. We describe how axioms differ from the contracts of the Eiffel programming language and why they are more suitable for generating test cases. We give the detailed description of the main components of the axiom-based test generation framework which was implemented using .NET 4 /C# 4 and show a case study in order to demonstrate the feasibility of the solution.

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A translation of interaction relationships to SMV models

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Model checking is a widely used verification technology to formally prove that a given system satisfies its specification. In order to make this feasible, either the system design and the properties we are interested in has to be modelled formally. The system under development can be specified by different kinds of Unified Modeling Language (UML) models providing diagrams according to the different views of the system. The 2.0 release of UML introduced Interaction Overview Diagrams (IODs) for supporting the specification of relationships between scenarios in a standard way. This paper concentrates on these relationships and advocates a way of verifying IODs. The presented approach takes into account an extension of Interaction Overview Diagrams that includes additional constructs not normally considered for IODs.

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On more rapid convergence to a density

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Denote by $\mathbb{N}$ the set of all positive integers. For $A \subset \mathbb{N}$ and a real number x let $A(x)$ denotes the counting function of the set A. The asymptotic density of the set of A is defined as

$$d(A) = \lim_{n\to\infty} \frac{A(n)}{n}$$

if the limit exists.

Let the set $A \subset \mathbb{N}$ have positive asymptotic density d and the set $|A(n) - nd|$ is not bounded above. Then for any $d' \in (0, d)$ there exists a $B \subset A$, such that the asymptotic density of B is d' and for infinitely many n we have $|B(n)n^{-1} - d'|$ tends to zero more rapidly than $|A(n)n^{-1} - d|$. This solves an open question of Rita Giuliano at al. [1].

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The commuter's paradox: why it takes longer to get home than to get to work

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We examine a simple model of public transport where under certain conditions, there is an asymmetry in the travelling time between two nodes in the two different directions. This asymmetry is surprising at first sight, as it may also occur when every individual line is symmetric with respect to direction – although only when line changes are made during travel. The time-irreversibility of the journey is caused by a choice made by the passengers, when they choose which line to take if several lines are available at the same stop with similar but not the same route.

We analyze the phenomenon under different assumptions made on the waiting times and the structure of the transport graph. We also consider some simple examples based on line schedules of public transport in Budapest to see if this asymmetry is only a theoretical possibility or observable and significant in real life. Finally, we consider generalizations to models of large graphs.

An extension operator and Loewner chains on the Euclidean unit ball in $\mathbb{C}^n$

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In this talk we are concerned with an extension operator $\Phi_{n,\alpha}$, $\alpha \geq 0$, that provides a way of extending a locally biholomorphic mapping $f \in H(B^n)$ to a locally biholomorphic mapping $F \in H(B^{n+1})$. In the case $\alpha = 1/(n+1)$, this operator reduces to the Pfaltzgraff-Suffridge extension operator. By using the method of Loewner chains, we prove that if $f \in S^0(B^n)$, then $\Phi_{n,\alpha}(f) \in S^0(B^{n+1})$, whenever $\alpha \in [0, 1/(n+1)]$. In particular, if $f \in S^*$, then $\Phi_{n,\alpha} \in S^*(B^{n+1})$, and if f is spirallike of type $\beta \in (-\pi/2, \pi/2)$ on B^n, then $\Phi_{n,\alpha}(f)$ is also spirallike of type β on B^{n+1}. We also prove that if f is almost starlike of order $\beta \in [0, 1)$ on B^n, then $\Phi_{n,\alpha}(f)$ is almost starlike of order β on B^{n+1}. Finally we prove that if $f \in K(B^n)$ and $1/(n+1) \leq \alpha \leq 1/n$, then the image of $F = \Phi_{n,\alpha}(f)$ contains the convex hull of the image of some egg domain contained in B^{n+1}. An extension of this result to the case of ε-starlike mappings will be also considered.

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Some sequence spaces of invariant means defined by modulus function

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Ruckle [8] has investigated the sequence spaces defined by a modulus function f and a generalization of a sequence space of Ruckle can be seen in Bhardwaj [2]. Maddox [9] has discussed some properties of the sequence spaces defined by using a modulus function f, which generalize the well known spaces ω_0, ω and ω_∞ of strongly summable sequences [4, 5, 6]. It may be noted that the spaces of strongly summable sequences were discussed by Maddox [3] and Waszak [9]. In [7], the spaces $\omega_\circ$, ω and ω_∞ were extended to $\omega_0(f)$, $\omega(f)$ and $\omega_\infty(f)$. Some more results on sequence spaces defined by modulus function are due to Altin et. al. [1]. The purpose of this paper is to introduce some sequence spaces which arise from the notion of strongly σ-convergent sequences defined by a modulus function. We also study the concept of uniform σ-statistical convergence and establish the relationship between them.

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The weighted Lebesgue function of Fourier–Jacobi series

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It is known that the Lebesgue functions of an approximation process play an important role in the convergence of that process. The Lebesgue functions $L_n^{(\alpha,\beta)}(x)$ of Fourier–Jacobi series have been studied by many authors.

G. Szegő [5] showed that for every fixed number $\varepsilon \in (0,1)$

$$\max_{x\in[-1+\varepsilon,1-\varepsilon]} L_n^{(\alpha,\beta)}(x) \sim \log(n+1) \quad (n \in \mathbb{N}).$$

H. Rau [4] showed that the order of the Lebesgue functions at the points -1 and 1 is $n^{\sigma+\frac{1}{2}}$, where $\sigma = \max\{\alpha,\beta\}$.

S. A. Agahanov and G. I. Natanson [1] proved the following result: if $\alpha,\beta > -1/2$ then

$$L_n^{(\alpha,\beta)}(x) \sim \log\left(n(1-x)^{\varepsilon(\alpha)}(1+x)^{\varepsilon(\beta)}+1\right) + \sqrt{n}\left(|P_n^{(\alpha,\beta)}(x)| + |P_{n+1}^{(\alpha,\beta)}(x)|\right)$$

$$(x \in [-1,1], \quad n \in \mathbb{N}),$$

where $\varepsilon(t) = 1/2$ $(t \neq 1/2)$, $\varepsilon(1/2) = 0$ and $P_n^{(\alpha,\beta)}(x)$ is the nth Jacobi polynomial.

Our aim was to improve this estimation by using suitable Jacobi weights. In this talk we will present our results (see [2]). We will give conditions for the weight parameters γ and δ such that the order of the weighted Lebesgue functions $L_n^{(\alpha,\beta),(\gamma,\delta)}(x)$ is $\log(n+1)$ on the whole interval $[-1,1]$.

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EM algorithms for generalized Bradley–Terry models

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The Bradley–Terry [2] model is applicable to situations in which paired comparisons are made between individuals in a group. Suppose there are m individuals, and there is a positive parameter λ_i attached to the ith individual, representing his overall ability ($i = 1, \dots, m$). The model then asserts that when comparing individuals i and j, the probability that i is the winner equals

$$P(\text{individual } i \text{ beats individual } j) = \frac{\lambda_i}{\lambda_i + \lambda_j}.$$

This model has widespread applications in areas such as statistics, sports, and machine learning.

The Bradley–Terry model has been generalized in several different ways. One generalization, called the Plackett–Luce [5] model, allows for the comparison and ordering of more than two individuals at a time. Also in this direction, Huang, Weng, and Lin [3] studied a case when two *teams* are compared, where the team's overall ability depends on the abilities of its members. Agresti [1] introduced a model for paired comparisons when one of the contestants has a “home-field advantage”. Rao and Kupper [6] modified the Bradley–Terry model to allow for ties.

The maximum likelihood estimation of the parameters in these models has been an important issue from the start. Under mild conditions the existence of the ML estimator is guaranteed, and it can be found by iterative methods in each case. Hunter [4] proposed the use of MM (minorization–maximization) algorithms, which are simple, fast, and robust.

Our main contribution is that generalized Bradley–Terry models can be formulated using exponentially or geometrically distributed latent variables, and thus it is natural to consider the EM scheme for likelihood maximization. In the talk we show how to derive EM (expectation–maximization) algorithms for all the above listed models, and compare them with Hunter's MM algorithms. We also argue that since EM algorithms are special cases of MM algorithms, they share the convergence properties of the MM algorithms in the literature.

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The progress of the theory of type systems*

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Type free λ-calculus was defined by Church and Curry in the 1930's, and in 1941 Church described the first *type system*. The main purpose of these systems was the modelling of computable functions. It led in the 1950's to the introduction of the first functional programming languages, and within a few years, λ-calculus became the base of functional programming.

The development of type systems made it possible to describe more and more complicated λ-expressions, and description of well-typed programs. Stepping up to higher levels of abstraction, this development led to F_ω, followed by the PTS type system. Type systems were extended according to the requirements of the programming, e.g. by the subtypes and by the notions of object oriented programming.

Recently, the development of the multicore programming also had a big impact on the theory of type systems, the theory of linear and dependent type systems became a central topic of the scientific search. New program languages extensively using these type systems appeared, and we expect that in the future these program languages will spread even more.

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Comparing the computation of Chebyshev polynomials in computer algebra systems

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In this article we compare the efficiency of the computer algebra systems Maple and Sage, using as benchmark the calculation of Chebyshev polynomials with various methods. In most tests, Maple performed better, but Sage is also capable of doing the calculations. We conclude that Sage, although still inferior to Maple in functionality and perfomance, has by now become a reasonable open-source alternative of commercial computeralgebra systems.

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Extended Pattern Matching for Embedded Languages

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Users of embedded languages might want to pattern match on embedded programs. Making this possible requires a considerable effort from the developer of the language, because the underlying data types are usually hidden.

This paper first analyses the available solutions for this problem. As *pattern synonyms* [1] and *function patterns* [2] seem promising, a compromise between these two is proposed: *restricted function patterns*. These are more general than pattern synonyms, but it is still possible to process them at compilation time. It is interesting that this proposal makes Haskell's rules about matching numeric literals more regular. It also provides Erlang's list prefix patterns in a consistent way instead of ad hoc implementations.

Finally, a lightweight prototype implementation is presented, that implements the functionality of the proposal, but cannot give the static guarantees that proper compiler support could achieve.

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Making the cores equal: transforming STG to SAPL

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Crossing the borders of languages by letting them cooperate on source code level has enormous benefits as different languages have distinct languages features and useful libraries to share. This is particularly true for the functional programming world where languages are in constant development being the target of active research. There already exists a double-edged compiler frontend for the lazy functional languages Haskell and Clean which enables the interoperation of features of both languages. This paper presents a program transformation technique to solve the same problem at another level by transforming STG, the core language of the flagship Haskell compiler GHC to SAPL, the core language of Clean. Being SAPL the platform of a highly efficient interpreter technology and a JavaScript compiler, and considering the many unique features of Haskell, both languages can benefit from this transformation.

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Performance analysis of multi-threaded locking in bucket hash tables

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Hash tables used in multi-threaded environments are considered as shared resources where special care is required in order preserve data integrity when modifying data. The traditional solution for avoiding race conditions is the use of mutual exclusion: parts of the data structure are protected by critical sections, which guarantees at all times that at most one thread is allowed to access (read or write) the protected area.

Most operations that access a hash table use only a single bucket, hence access to different buckets seldom cause concurrency problems. Protecting the buckets with individual locks provides high level of parallelism, but comes with the cost of managing hundreds, thousands, or millions of locks. To avoid this the hash table can be divided into blocks containing one of more buckets (with blocks covering the same amount of data) and each of the blocks is protected by a lock. This allows tuning locking resolution depending on the size of the blocks.

We argue that it is unnecessary to lock individual buckets in a hash table. The level of parallelism the hash table supports is directly related to the time the threads spend waiting for entering a critical section. This is, of course, effected by the number of locks (more precisely by the probability of a thread picking a particular lock from the set of locks); but also depends on the frequency that the locks are accessed. This is determined by the time spent within and outside the critical section. These properties can be best captured by a queuing model for the individual locks. We present this model and derive a formula to quantify the probability of the event we call clashing, when a thread is stalled due to not being able to acquire a lock on its first try. The model and the probability for clashing are verified under real-life circumstances.

Next we present a heuristic argument, which describes when adding additional threads to a multi-threaded environment is useful in terms of performance, considering the waiting caused by the mutual exclusions. We argue that whenever a new thread is added to the system it generates performance increase if the cumulated waiting of all the treads (due to the mutual exclusion) is less then the useful time of a single thread. With this approach we estimate the cumulative distribution function of the waiting time in the system with simulations and show how based on this information the optimal number of locks can be established for a bucket hash table.

Discrete orthogonality of the Malmquist Takenaka system of the upper half plane and rational interpolation

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The classical Fourier bases has been proved to be an efficient approach to represent a linear and stationary signals. However it is not efficient to represent a nonlinear and stationary signal. For this purpose it is more efficient the use of some special orthonormal basis of rational functions.

In the case of the unit disc it is used the well known Malmquist- Takenaka system. The first N elements of the Malmquist-Takenaka system are also discrete orthonormal regarding to a discrete scalar product over the unit circle.

There is an analogue of the Malmquist-Takenaka system for the upper half plane. We will prove the discrete orthogonality of the Malmquist Takenaka system for the upper half plane. Based on the discretization we introduce a new rational interpolation operator and we will study the properties of this operator.

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An SQC based model for the quality improvement of computer aided teaching

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Ever since their introduction in the late eighties of the previous century the ISO 9000 standards have resulted in a revolution in the quality assurance issues. Because of their wide range of applicability, today almost half a billion organizations have adopted these standards. However, relatively few educational institutions, and even fewer secondary schools are registered worldwide. This can be partly due to the complexity and difficulty of the "product of education" , i.e. the graduated students and pupils. Another problem can be the lack of clearly defined quantitative tools for measuring the performance of education and establishing the most effective feedback processes. Statistical Quality Control was first introduced by W.A. Shewhart for the control of classical (factory) production processes in the early 1920s. In this paper, following the pioneer SQC based ideas of S. Karapetrovic [1,2] we present a possible adaptation/extension of SQC for secondary school language teaching. We believe that these ideas can be applied in the teaching of many other subjects. Computers play a very important role in the realization.

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An application of polynomial metric spaces in computer network design

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Combinatorial designs have had substantial application in the design of statistical experiments and in the theory of error correcting codes for a long time. Perhaps, because of their very strong symmetrical properties and balance their applications in the computer science have continuously emerged. The interpretation of designs as special subsets of polynomial metric spaces allows us to get rid of the details of the actual combinatorial construction and obtain general results valid even for other type of designs. [2,3] Following some ideas formulated in [1,4] we are going to present some problems and models of congestion free interconnection networks based on combinatorial designs.

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On some analogue of the generalized allocation scheme

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Let $\xi_1, \xi_2, \dots, \xi_N$ be independent identically distributed nonnegative integer valued nondegenerate random variables. In the generalized allocation scheme introduced by V.F. Kolchin [1] random variables $\eta'_1, \dots, \eta'_N$ are considered with joint distribution

$$P\{\eta'_1 = k_1, \dots, \eta'_N = k_N\} = P\Big\{\xi_1 = k_1, \dots, \xi_N = k_N \ \Big| \ \sum\nolimits_{i=1}^{N} \xi_i = n\Big\}.$$

This scheme contains several interesting particular cases such as the usual allocation scheme and random forests.

In this paper we will study random variables $\eta_1, \dots, \eta_N$ with joint distribution

$$P\{\eta_1 = k_1, \dots, \eta_N = k_N\} = P\Big\{\xi_1 = k_1, \dots, \xi_N = k_N \ \Big| \ \sum\nolimits_{i=1}^{N} \xi_i \le n\Big\}.$$

It can be considered as a general allocation scheme when we place at most n balls into N boxes. In this general allocation scheme the random variable $\mu_{nN} = \sum_{i=1}^{N} I_{\{\eta_i = r\}}$ can be considered as the number of boxes containing r balls.

We study laws of large numbers, i.e. the convergence of the average $\frac{1}{N}\mu_{nN}$, as $n, N \to \infty$. We prove local limit theorems, i.e. we study the asymptotic behaviour of $P\{\mu_{nN} = k\}$. We obtain weak limit theorems for the maximum, i.e. we shall consider the asymptotic behaviour of $P\{\max_{1 \le i \le N} \eta_i \le r\}$.

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Object-based image analysis in remote sensing applications using various segmentation techniques*

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At Eötvös Loránd University (ELTE), Faculty of Informatics an extensive education, research and development activity is carried out in several fields of geoinformatics, in cooperation with Institute of Geodesy, Cartography and Remote Sensing (FÖMI). Results gained from this collaboration were comprehensively presented in [3]. The main common area is remote sensing. It includes the teaching of subject "Remote Sensing Image Analysis", research of segment-based classification of remote sensing images and its applications in operational projects.

Basic research of segmentation methods is embedded into the classification problem. The difference between pixel-based and segment-based classification methods is clearly visible in the determination of land cover categories. *Segments* are homogeneous areas of images, consisting of neighboring pixels. Segment membership of pixels conveys valuable geometric information, which can be utilized in ambiguous cases of classification. Results achieved with segmentation methods have been presented in [1] and [2]. In this article a summary is given on several merge-based (bottom-up) and cut-based (top-down) segmentation methods investigated by the authors.

Very High Resolution (VHR) satellite images and ortho-photos gain increasing importance in current operational applications. Individual pixels of these images usually cannot be interpreted in themselves. Therefore, the application of segmentation is not only an option, but a necessity in the solution. The task of delimiting tree groups and scattered trees in pastures will be presented in depth, which is used in relation with agricultural subsidies. Three further applications will be shortly introduced: the surveying of red mud spill, the recognition of ragweed and the recognition of built infrastructure in rural areas. These results have been partially presented in [4].

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Multiplicative loops of quasifields with large kernel

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An affine plane with a transitive group of translations is called a translation plane. Any translation plane can be coordinatized by a planar quasifield. Hence the quasifields are closely related with geometry. Locally compact connected topological quasifields are locally compact topological spaces Q endowed with two binary operations $+$, $\cdot$ such that $(Q,+)$ is a topological abelian group with neutral element 0, $Q^* = (Q \setminus \{0\}, \cdot)$ is a topological loop with identity element 1 and between these operations the left distributive law holds. These quasifields are planar. The kernel $K = \{k \in Q;\ (x+y)\cdot k = x \cdot k + y \cdot k,\ (x \cdot y) \cdot k = x \cdot (y \cdot k) \text{ for all } x, y \in Q\}$ of a locally compact connected quasifield Q is a closed connected topological subfield of Q and Q is a topological right vector space over K. Moreover, $K = \mathbb{R}$ and the dimension of Q over $\mathbb{R}$ is 1, 2, 4, or 8, or $K = \mathbb{C}$ and the dimension of Q over $\mathbb{C}$ is 1, 2, or Q is the skew field of quaternions (cf. [3], Section 29 and [4], 42.6 Theorem). In this talk we consider multiplicative loops Q^* of locally compact connected topological quasifields Q coordinatizing non-desarguesian topological translation planes and having dimension 2 over its kernel. Then the kernel K of Q is isomorphic either to the field $\mathbb{R}$ or to the field $\mathbb{C}$ and $(Q,+)$ is the vector group K^2. Moreover, Q^* is homeomorphic to $\mathbb{R} \times S^i$, where S^1 is the circle if $K = \mathbb{R}$ and S^3 is the 3-sphere if $K = \mathbb{C}$. We determine the structure of Q^*, the group topologically generated by all left translations as well as the group topologically generated by all right translations of Q^*. Moreover, we describe the group of collineations of the translation planes corresponding to Q and the group of automorphisms of Q. For $K = \mathbb{C}$ we use the classification of locally compact connected translation planes given by N. Knarr ([2], Section 6). For $K = \mathbb{R}$ we use the results of paper [1] and Section 29.1 in [3].

This is a joint work with G. Facone and K. Strambach.

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Sets with prescribed upper and lower weighted densities

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Let $f : \mathbb{N} \to (0, \infty)$ be a weight function such that the conditions

$$\sum_{n=1}^{\infty} f(n) = \infty,$$

$$\lim_{n\to\infty} \frac{f(n)}{\sum_{i=1}^{n} f(i)} = 0$$

are satisfed.

For $A \subset \mathbb{N}$ and $n \in \mathbb{N}$ denote $A_f(n) = \sum\limits_{a\in A, a\leq n} f(a)$ and define

$$\underline{d}_f(A) = \liminf_{n\to\infty} \frac{A_f(n)}{\mathbb{N}_f(n)} \quad \overline{d}_f(A) = \limsup_{n\to\infty} \frac{A_f(n)}{\mathbb{N}_f(n)}$$

the lower and upper f-densities of A, respectively.

The asymptotic densities correspond to $f(n) = 1$ and the logarithmic densities correspond to $f(n) = \frac{1}{n}$. We generalize known inequalities between lower and upper asymptotic and logarithmic densities.

Finaly we present relations betwen weighted densities determined by weights $f(n)$ and $g(n)$ where

$$\lim_{n\to\infty} \frac{\frac{g(n)}{\sum\limits_{i=1}^{n} g(i)}}{\frac{f(n)}{\sum\limits_{i=1}^{n} f(i)}} = p > 1.$$

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Combinatorial methods for solving the generalized eigenvalue problem with cardinality constraint for mean reverting trading

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We examine the problem of solving the generalized eigenvalue problem with constraint on the cardinality of the solution vector. This problem has been shown to be equivalent to subset selection, which is proven to be NP-hard. In the presentation, fast heuristic algorithms are introduced to find approximate solutions in polynomial time and their effectiveness is compared with similar algorithms in the literature. Combinatorial heuristic methods (e.g. greedy, truncation and exhaustive methods) are compared to stochastic search methods (e.g. simulated annealing) in terms of runtime and the quality of the obtained results.

One practical application of this problem in the field of algorithmic trading is the selection of sparse, mean-reverting portfolios from multivariate data which maximize portfolio predictability. The economic viability of the heuristics is tested on both generated and real historical time series (SP500 and SWAP rates) and the profitability of a simple convergence trading method is examined through extensive numerical simulations.

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Machine learning methods to enhance artificial opponents

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The man likes challenges, that is why people play against each other. However there are times when no one is available. In these cases whe have to fall back on artificial opponents. Although because of the nature of these intelligences, they are predictable. But playing against predictable opponents is not that satisfactory. In our talk we introduce such opponents which are capable of learning from their mistakes. We tested these agents on the two player board game MensIco. Our goal was to create unpredictable opponents which seems to be stronger each time. In order to achieve, we constructed a possible representation of the game and applied several machine learning tools. We created new variants of the methods to specifically fit to our model. In our talk, we introduce the game and our representation and the developed machine learning variants. Finally we compare and evaluate our results.

An incremental clustering approach to the set covering problem

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The set covering problem is a classical problem in computer science and complexity theory and it serves as a model for many real-world applications especially in the resource allocation area. In an environment where the demands that need to be covered change over time, special methods are needed that adapt to such changes [1]. We reformulate the set covering problem as a clustering problem where the within cluster sum of squared errors to be minimized corresponds to the cost associated to a certain set covering that needs to be minimal. We have developed an incremental clustering algorithm similar to the one from [2] in order to address the set covering problem. As in [2] the algorithm continuously considers new items to be clustered, but this approach uses a different strategy for the cluster formation and agent interaction. Whenever a new data item arrives it is encapsulated by an agent which will autonomously decide to be included in a certain cluster in the attempt to either maximize its cover or minimize the cost. We have introduced the soft agent model in order to encapsulate this behaviour. Initial tests on synthetic datasets suggest the potential of our approach.

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Address standardization

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This paper is about matching non standard format, mistyped addresses against a reference address database. The input addresses are collected from several different, non standardized, non verified, erroneous human inputs.The objective of the process is to "clean" the input address and find it in a standardized address database, or to find the most probable corresponding addresses with their appropriate credibilities. This process is known in the literature as "address cleansing".

We developed an algorithm, which searches and matches the input address fields against the standard address database stepwise, using a rule based system. Our rule base system uses tokens obtained from a specialized tokenization and generates intermediate format addresses, by identifying the missing address field and their values. The rules are grouped into rule sets and applied according to a recognition order. The tokens are matched against the address reference database using a modified Levenshtein distance measure. Our probability calculus uses the modified Levenshtein distance measure matching value and the rule strength to modify with each rule application the intermediate format address credibility.

Our rule base is specialised to work with Hungarian addresses, using the standard reference database.

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A C++ pearl – self-referring streams*

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Since C++ is a multiparadigm language, experimenting with functional programming techniques in this language seems fruitful. Self-referencing data is widely used in lazy functional languages. In the most interesting cases of self-referencing we produce infinite data. In this case it is possible to express infinite data with a finite structure.

Our library provides the necessary classes to define a stream as self-referencing data. As an example, the following code is the Fibonacci sequence.

```
stream<int> fib = 0 <<= fib + (1 <<= fib);
```

Note that the `fib` on the right hand side of the definition is uninitialized, while the return value of `+` operator is temporary. On one hand using uninitialized value gives memory garbage so in the expressions we have to make sure that our dereferenced values have already been initialized. On the other hand temporary values are deallocated after evaluating the expression, so we have to dereference them during the evaluation. To resolve this contradiction we have to answer how to take uninitialized and temporary values apart in compile time. This paper shows a method using rvalue references combined with template metaprogramming [1] to achieve this.

To handle infinite data in C++ we use a graph representation of the stream and a graph reduction algorithm like in lazy functional languages [7]. To make the use of our streams easier we also provide the most common library functions to integrate it to the Standard C++ library [1].

This paper makes the concept of stream-oriented programming [4] available for the C++ programmer. Furthermore, the presented implementation heavily relies on some new features of C++11 [5, 6], such as user-defined literals and rvalue references [3], so it can also be viewed as a demonstration of the new features of C++.

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Maintaining genetic diversity in bacterial evolutionary algorithm

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The Bacterial Evolutionary Algorithm (BEA) is a relatively new type of evolutionary algorithm and shows the typical symptoms of stochastic optimisation methods. Two of them, premature convergence and low convergence speed near the optimum is often in connection with low genetic diversity of the population. Variation of genetic diversity in the original BEA and three parallel variants was observed and documented. Two possible ways of increasing the diversity (niching and constraint mutation) were also studied. Significant enhancement in convergence speed was achived using these methods by maintaining genetic diversity.

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Aperiodic sums of periodic continuous functions

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A known example of the aperiodicity of the sum of two periodic continuous (real) functions is the function $f(x) = sinx + sin(\sqrt{2}x)$. Of course, here $\sqrt{2}$ can be replaced with an arbitrary irrational number. As a generalization of these examples, the author, in his talk given at the conference MatInfo (at the Sapientia Hungarian University of Transylvania, Târgu-Mureş, Romania, June 5th, 2011), proved the following, simple necessary and sufficient condition for an arbitrary, 'generalized' sine polynomial to represent an aperiodic function: In the sine polynomial, there must be two members, whose periods are incommensurable (i.e., their ratio is irrational). Now we continue these investigations, for sums of arbitrary non-constant, periodic continuous functions, in which the periods of any two functions are incommensurable. We show that any such two-member sum is aperiodic. However, if such a sum has more than two members, then, at present we can only prove the aperiodicity of the sum, if its members belong to a restricted (but still rather general) function type, and also for uniformly absolute convergent infinite series, consisting of such functions. We also point out the connections with (simultaneous) Diophantine approximation.

Degree sequences of multigraphs*

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Let $a,\ b$ and n be integers, $n \geq 1$ and $b \geq a \geq 0$. Let an (a, b, n)-*graph* defined as a loopless graph $G(a, b, n)$ on n vertices, in which the vertices are pairwise connected with at least a and at most b edges.

Landau in 1953 published an algorithm deciding whether a nondecreasing sequence of nonnegative integers is the out-degree sequence of a directed $(1, 1, n)$-graph. Havel in 1955, Erdős and Gallai in 1960 proposed an algorithm to decide the same question for undirected $(0, 1, n)$-graphs. Later these results were extended to $(0, b, n)$-graphs by Chungphaisan, Moon and Özkan. The aim of this paper is to overview the known results, to extend them to (a, b, n)-graphs and to propose quicker algorithms than the known ones.

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Superoptimization in LLVM*

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Compilation is more than merely translating higher level programming languages into machine code. All of the practically used compilers are optimizing compilers, which means that besides generating native code the compiler transforms programs in different ways in order to make the generated code more efficient – either run faster or consume less memory.

Typically compilers apply optimizations one after the other, which leads to an iterative optimization technique. However, this simple technique is known to be ineffective in some cases. Superoptimization is a technique to integrate the analyses and transformations of a number of separate optimizations in order to obtain an optimization that is more expressive than the sequential and iterative application of the original optimizations. A case study on handcrafted superoptimizations is given in [1].

Superoptimizations are large and monolithic, and so their complexity makes them unusable in practice. Can we combine the modularity and maintainability of iterative optimization and the effectiveness of superoptimization? A framework to compose optimizations and to share information among them can make this possible. The developers of the Vortex compiler [2] laid down the foundations for such a technique. In [4] a method to combine individual optimizations into a modularly built superoptimization is described, and the semantics of optimization of one instruction is formally given.

Our talk presents a framework supporting the integration of modular optimizations into superoptimization and the implementation for the Low Level Virtual Machine (LLVM) compiler infrastructure [3]. The framework is available for download at http://kp.elte.hu/superoptimization.

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Press-ready deduction trees in classical logic using point-plus-expressions

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The LaTeX system is widely used in scientific journals with semantically rich mathematical expressions. It is suitable not only for high-quality press-ready production, but also it can be applied for the development of dynamic presentations and learning materials containing many nice formulas. The simple, plain text coding of LaTeX formulas allows the use the LaTeX source text/code as inputs for further processing. The above mentioned benefits gives us the idea to develop an application, which can serve the ability to build up several derivation using different proving systems based on classical logic, such as Gentzen style sequent calculus, semantic tableaux method, and the resolution calculus (the present solution is still restricted to the propositional logic), for educational purposes.

The additional goal was to develop a process, which is able to produce a generic derivation, which is able to generate the result of the mentioned proving systems (instead of implementing and using them separately). Basing on an original idea introduced by Dragálin [1] and investigated later deeply by Pásztor-Varga and Várterész [2][3], it makes possible a unified treatment of the relevant calculi using the point-plus meta-language.

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Scattered subwords and compositions of integers

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Let n, d_1, d_2 and s be positive integers, and $u = x_1x_2 \dots x_n \in \Sigma^n$ a word over the alphabet Σ. A word $v = x_{i_1}x_{i_2} \dots x_{i_s}$, where

$i_1 \geq 1$,
$d_1 \leq i_{j+1} - i_j \leq d_2$, if $j = 1, 2, \dots, s-1$,
$i_s \leq n$,

is a (d_1, d_2)***-subword*** of length s of the word u.

For example, in the word *aabcade* the $(2,4)$-subwords are abd, ace, ad.

The number of different (d_1, d_2)-subwords of a word is called (d_1, d_2)***-complexity***.

The $(1, d)$-complexity was studied by Iványi [1] and Kása [2], the (d, n)-complexity by Kása [3]. The (d_1, d_2)-complexity is a special case of scattered subword complexity studied by Kása [4].

In this talk we show the correspondence between the (d_1, d_2)-complexity of a rainbow word and the number of restricted compositions of integers. (In rainbow words the letters are pairwise different. Compositions are partitions in which the order of the integers matter too.)

Instead of the third degree polynomial algorithm given for the scatterd subword complexity in [4], we present here a linear algorithm for the case of the (d_1, d_2)-complexity.

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Neighborhood principle driven ICF algorithm and graph distance calculations

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In the field of Boolean-algebra there are many well known methods to optimize/analyze formulas of Boolean-functions. We would like to present a non-conventional graph-based approach by describing the main idea of the *Iterative Canonical Form* (or ICF) [1,2] of a Boolean-function, and introducing an algorithm that is capable of calculating the ICF. The algorithm is iteratively processing the neighboring nodes inside the n-cube. The iteration step count is linear function of n. Some novel efficient methods for computing distances by matching non-complete bipartite graphs, derived from the ICF and named as ICF-graphs [1,3,4] are proposed. Different metrics between the ICF-graphs are introduced, such as weighted and normalized node count distances, and graph edit distance. For illustration of the ICF-graph based distance calculations some recent results of classification from the field of medical diagnostics are shown.

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Generalized Haar-Fourier Transform

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We give a new generalization for Haar functions. The generalization is starting from the Walsh-like functions and based on the connection between the original Walsh and Haar systems. We generalize the Haar-Fourier Transform too.

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A representation for software libraries in relation to data flow

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One of the most important branches of static source code analysis is data-flow analysis. Data originating from a part of the source code under analysis may, in general, flow through any other part of the code base, including parts of the code that come from software libraries. As the libraries are available separately, it is desirable to perform their analysis separately as well.

In this paper, we give a graph representation of static analysis information that is particularly suitable for representing data-flow connections. We present a method to pre-analyse software libraries, which saves both computational and spatial resources on the side of the end user. We show that all information required for data flow analysis is conserved, and that all executed data flow analyses terminate.

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The Special and Linear Diophantine Equations in the computation solution of the exact 1D, 2D and 3D rectangle cutting-packing (C/P) problems

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The Special Diophantine Equation (SDE) is any linear polynomial equation, which allows the variables to be zero or one. The Linear Diophantine Equation (LDE) allows the repetition of items. For the rectangle C/P problems always can be assigned one or more SDE or LDE, depending on the dimension of the C/P problem (1D, 2D, 3D). Based on the solutions of the equations, we elaborated an iterative algorithm, which solve an exact C/P. The presented algorithm in essence is invariant, when the dimension of the C/P problem varies.

ECG signal generator based on geometrical features

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Electrocardiograms are widely used in biomedical signal processing to diagnose abnormal heart functioning. Number of algorithms have been constructed to analyse, measure and compress these signals. These methods are hard to test because real ECG signals are distorted by several types of noise. In this talk we present an algorithm which generates realistic synthetic ECG signals. This algorithm, among others, can be used for testing new methods in ECG processing.

By using numerical and geometrical parameters, which are of diagnostical importance, the generated signal can be interpreted as a biomedical signal with important diagnostical intervals such as QRS, QT, PR, etc. On the other hand this model gives us a strictly mathematical control over the signal. In our interpretation ECG signals are curves with prescibed parameters, including derivatives, curvature etc. We note that Clifford and McSharry and their coauthors [1], [2], [3] carried out a similar program based on a dynamical model. Our approach is essentially different from theirs.

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Justification of the Fourier method for parabolic equation with Olricz initial conditions in terms of covariance functions

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In the paper I study a conditions of existence solution of the boundary value problem for a parabolic equation of mathematical physics with random initial conditions in terms of covariance functions. Consider a boundary value problem for a parabolic equation with two independent variables $0 \le x \le \pi$ and $t > 0$

$$\frac{\partial}{\partial x}\big(p(x)\frac{\partial V}{\partial x}\big) - q(x)V - \rho(x)\frac{\partial V}{\partial t} = 0 \tag{1}$$

$$V(t,0) = 0, \qquad V(t,\pi) = 0 \tag{2}$$

$$V(0,x) = \xi(x), \tag{3}$$

where $\xi(x)$ is a stochastic process belonging to the Orlicz space $L_U(\Omega)$, such that $E\xi(x) = 0$. Let $X_k(x)$ be eigenfunctions, λ_k be eigenvalues of the Sturm-Liouville problem

$$L(v) = \frac{d}{dx}\left(p\frac{dv}{dx}\right) - qv + \lambda\rho v \quad = \quad 0 \tag{4}$$

$$X(0) = 0, \qquad X(\pi) \quad = \quad 0. \tag{5}$$

Conditions, of covariance functions, under which the following statement hold true are found:

1. the series
$$V(t,x) = \sum_{k=1}^{\infty} \xi_k e^{-\lambda_k t} X_k(x), \tag{6}$$
where $\xi_k = \int\limits_0^\pi \rho(x)X_k(x)\xi(x)\,dx$, converges uniformly in probability for $t > 0$, $x \in [0;\pi]$;

2. The series $V(t,x)$ obtained (6) by termwise differentiability twice with respect to x and once with respect to t converges uniformly also;

3. The solution of problems (1) – (3) exists in probability one and can be represented in the form of the series (6). Moreover $V(t,x) \to \xi(x)$ as $t \to 0$ in probability and uniformly with respect to $x \in [0,\pi]$.

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The Offline Software Framework of the NA61/Shine Experiment

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NA61/SHINE[1] (SHINE = SPS Heavy Ion and Neutrino Experiment) is an experiment at the CERN SPS using the upgraded NA49 hadron spectrometer. Moreover, proton+proton and nucleus +nucleus collisions will be studied extensively to allow for a study of properties of the onset of deconfinement and search for the critical point of strongly interacting matter.

Currently NA61/SHINE uses the old NA49 software framework for reconstruction, simulation and data analysis. The core of this legacy framework was developed in the early 1990s. It is written in different programming languages (C, pgi-Fortran) and provides several concurrent data formats including obsolete parts in the data model. The main ideology was founded on a client-server software architecture to provide a basic user-interface to the core mechanishm. With time the simple system intertwined with several dependencies and hidden knowledge between clients. Thanks to this phenomenon the old software became impossible to move, and hard to use for collaborators.

In this contribution we will introduce the new software framework, called Shine, that is written in C++ and designed on the pattern of the Auger Framework[2], with the purpose to comprize three principal parts: a collection of processing modules which can be assembled and sequenced by the user using XML, an event data model which contains all simulation and reconstruction information based on ROOT[3], and a detector description which provides data on the configuration and state of experiment. To assure a quick migration from to the Shine framework, wrappers were introduced that allow to run legacy code parts as modules in the new framework and we will present first results on the cross validation of the two frameworks.

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A domain based new code coverage metric and a related automated test data generation method

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Since programmers write programs there was always a need to verify the correctness of these programs. Today the most commonly used method is testing, which is a very labor intensive work. There are estimations that a common software development project uses 50-70% of its total resources to achieve the desired software quality.

But simply the fact, that we test our programs does not give any direct quality guarantee on them. The quality of the used test cases have to be determined so as to be able to use the test results to reason about the correctness of the tested program. We need to measure the percentage of the reached features of the program currently under testing. Based on this ratio the usefulness of a particular test base can be easily judged.

Numerous code coverage metrics exist, such as statement coverage, decision coverage, path coverage, etc. The common point of these approaches are that they are working on some kind of syntactic/semantics representation of the analyzed program. These metrics are used in various coverage based testing tools [1] to measure the test case quality, and/or to recognize equivalence classes on the problem space. Existing coverage metrics are more or less suitable for most kind of programs. The expression-heavy ones (e.g. programs written in Feldspar [2] or Matlab) or the functional ones (e.g. Haskell, Feldspar) are exceptions, because these typically lack branching and iteration statements (e.g. `if`, `for`, `while`). Of course functional programs can express these notions by pattern matching or recursion. Additionally a relatively complex arithmetic expression can be written in *one* line. As a result of these properties, the existing code coverage metrics are unsuitable at least but mostly useless for these kind of programs.

The problem with existing coverage metrics is that they are concentrating mostly on control structures (like branching and looping) and statements. The expressions are considered only in those cases, when they have an effect on control flow. But the relation and effect between sub-expressions are never examined.

In this paper we propose a new code coverage (*domain coverage*) metric, which is based on (arithmetic) expressions. The relations and effects among them are taken into account, such as some kind of semantics information about the programming language construct. The paper also presents an automated test data generation method, which is related to *domain coverage*, and aims to reach the highest possible coverage ratio.

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Rational FFT implementation in Matlab

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In this paper we present a MATLAB implementation of the theory related to the fast calculation of Fourier coefficients with respect to a product system of rational complex functions. The elements of the product system used here are defined as compositions of two-factor Blaschke products. We provide new tools for the visualization of the function systems at hand, elaborate the outlined algorithms in [3], describe the methods used for numerical calculation. The work presented here can be applied in signal processing and control theory, future applications include the analysis of ECG signals. Please download the toolbox at:

http://numanal.inf.elte.hu/∼locsi/fftratsys/

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Rational approximation and interpolation toolbox

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There is a wide range of applications of rational function systems. For instance in system, control theories and signal processing [3]. A special class of rational functions, the so-called Blaschke functions and the orthonormal Malmquist–Takenaka (MT) systems are effectively used for representing signals especially in the case of electrocardiographs [1].

In this talk we present our project on a general MATLAB library for rational function systems and their applications. In our project we followed the international standards for MATLAB toolboxes. Our aim was to construct a toolbox that is appropriate to a wide range of applications. For instance it contains the Blaschke functions, MT-systems and biorthogonal systems [2]. We implemented not only the continuous but the discrete versions as well, since in practical applications the latter one is needed [2], [5]. We note that complex and real interpretations are both available. We also built in methods [4] for finding the poles automatically. Also, some interactive GUIs were implemented for visual demonstration that help the users in understanding the effects of certain parameters such as poles, multiplicity etc.

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Testing and enumeration of football sequences

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In his recent monography [2, page 60] András Frank formulated the following open problem.

Research problem 2.3.1 (Iványi) *Decide if a sequence of n integers can be the final score of a football tournament of n teams. The winner of a game gets 3 points, the loser no point, while both teams get 1 point for a draw.*

Working on the solution of this problem we have found that the following simpler problem plays central role in the solution.

Problem 1. *Decide if a sequence of n integers can be the final draw sequence of a football tournament of n teams.*

A sequence of integer numbers $q = (q_1, \ldots, q_n)$ is called *graphical* if there exists a simple graph G such, that q is its degree sequence. Problem 1 is equivalent with the following Problem 2.

Problem 2. *Decide if a sequence of n integers is graphical.*

There are several known answers for Problem 2. The most popular answers are Erdős-Gallai theorem [1] and Havel-Hakimi theorem [3, 4]. The algorithms based on these results require in worst case $\Omega(n^2)$ time. Recently we have found new algorithms Chungphaisan-Erdős-Gallai-Linear and Chungphaisan-Havel-Hakimi-Linear working in all cases in $O(n)$ time [5, 6, 7]. In the talk we present new approximate algorithms to solve Problem 1 and determine the number of football score sequences for new values of n [8]. Our algorithms are based on the new improved versions of Erdős-Gallai and Havel-Hakimi theorems [1, 3, 4, 5, 6, 7].

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Modified joint optimal strategy concept in zero-sum fuzzy matrix games

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In many practical problems, the quantities can only be estimated. In the case when the quantities are coefficients of the zero-sum matrix games, they may be characterized with fuzzy numbers. In this talk we consider zero-sum matrix games with fuzzy payoffs and fuzzy goals. For any pair of strategies, a player receives a payoff represented as a quasi-triangular fuzzy number. For example, when a payoff matrix of a game is constructed by information from a competitive system, elements of the payoff matrix would be ambiguous if imprecision or vagueness exists in the information.

In practice, when one or more coefficients of the optimization problem have uncertain values, then the optimal value will be uncertain. In order to reach the always α-level of optimal value we must take an optimal decision. Although the optimal value is uncertain, the decision must be unambiguous. Therefore, α-optimal solution set contains vectors of real numbers. The concepts of modified joint optimal solution and fuzzy optimal value defined by Makó (2006) do comply with the above presented requirements. These concepts are founded on the notion of joint optimal solution defined by Buckley (1995).

In this talk we aim at utilizing these concepts to define a new generalized model for a matrix game with fuzzy goals and fuzzy payoffs by using possibility distributions approach.

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Tournament solutions

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Consider a tournament which can be represented by a complete oriented graph on the set of players: if a player beats another then there is arc from him to the other. A tournament solution is a nonempty subset of the players (called the winners). If it is a singleton then it is called a Condorcet winner. However, if there is no Condorcet winner then there are various concepts to choose the set of winners and these concepts may lead to quite different results. In the talk we review the standard tournament solutions and discuss their relationships to each other and to voting theory as well.

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A study of storing large amount of inhomogeneus data in workflow management systems*

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In workflow-driven Enterprise Resource Planning (ERP) systems a large variety of documents requires handling and storing of various descriptive data in a single storage facility. The number and type of attributes can vary among different kinds of documents. Storing such inhomogeneous data in a single database is difficult, as querying requires fast retrieval of data based on any present attribute.

In this paper the authors introduce three different approaches to this problem based on relational and document-oriented database systems. The first solution stores data in a decomposed database where the different attribute types are stored in separate tables and the elements are obtained by multiple queries. In the second realization the elements are stored in tables that are generated on the fly. In this case the queries are kept simple, but the creation and modification of the schemes requires database alterations. The third solution is the usage of the semi-structured document-oriented database system called MongoDB, which defines database items as documents that may contain any kind and number of attributes regardless of any predefined structure. All three solutions were compared by implementing and testing them with massive inhomogeneous data and by using a sophisticated cost model.

Since this problem is typical not only in the field of ERP systems, the solution can be applied generally to any domain using inhomogeneous data, like e-commerce systems, document warehouses and GIS systems.

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Chosen ciphertext security of public-key encryption systems

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Nowadays the right security definition of public-key encryption system is related to the notion of chosen ciphertext attacks which means that the system must be protected against active adversaries, who can obtain decryptions of ciphertexts.

We will give in our presentation some security requirements for a public key encryption system, which is based on the hardness of factoring assumption. This assumption states that given the product of two distinct, large prime numbers, it is computationally infeasible to find the two primes.

Precisely the public-key encryption system which we are studying is a slightly modification of the Blum-Goldwasser public-key cryptosystem. Broadly in this system a random seed is used to generate a sequence of pseudorandom number, using the most popular cryptographically secure PRNG, the Blum-Blum-Shub generator. Than the generated random bits are exclusive-ored with the plaintext bits. Finally the last pseudorandom bit is transmitted too, as part of the ciphertext.

The original system was completely insecure against chosen ciphertext attack, but recently have presented some modifications to obtain a cryptosystem which is protected against chosen ciphertext attack, [3], [4], and [5].

In our talk we present the basics requirements related to the length and type of the chosen public-key, after that we present the requirements concerned an authentication tag which we use to protect the ciphertext against a chosen ciphertext attack.

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A generalized variational principle and applications to equilibrium problems in *b*-metric spaces

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In this paper we present a generalized variational principle for b-metric spaces. These spaces are a generalization of the metric spaces: the b-metric satisfies a relaxed triangle inequality $d(x,y) \leq s(d(x,z) + d(y,z))$ for some constant $s \geq 1$, rather than the usual triangle inequality. As a consequence of the above mentioned result we get a weak Zhong's type variational principle in b-metric spaces. We give some applications of the main result, for example an extended Caristi fixed point theorem, and we also extend our generalized variational principle to bifunctions, and we show the existence of equilibria for some generalized equilibrium problems as a consequence of the main result.

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A heuristic process for GUI widget matching across application versions

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Many software applications today use graphical user interfaces (GUIs) to interact with users. Modern GUIs are often comprised of tens of windows and hundreds of widgets, which can constitute as much as 50% of application code [1], making their correct functioning critical. This requires new approaches in the development and testing of such applications.

A particular problem regards building maintainable GUI test cases. As applications evolve, windows are added or removed and GUI widgets are many times changed by moving, resizing or changing the associated icon, text or other properties. Previous work details methods of repairing test cases [2] or changing them to achieve high coverage [3], but they have the drawback of inserting or removing test steps which arbitrarily changes test cases.

Our approach is to find the functionally equivalent GUI elements between targeted application versions enabling proper regression testing by automatically adapting test cases to run on newer versions of the software [4].

The present paper introduces a new configurable heuristic process that achieves high accuracy when matching GUI windows and widgets which provide equivalent functionality across a target application's versions. We present new metrics that enable measuring the accuracy of the process and we perform a thorough analysis of its effectiveness by running it on a software repository consisting of 28 version pairs of popular open-source applications† that we previously enriched with correct match information.

The results we obtain are very encouraging: heuristic decisions are correct in over 94% of cases and more that 96% of equivalent GUI elements are correctly detected in our case study. We believe our results provide the necessary foundation for creating long-lived maintainable GUI test cases and providing new cross-version software visualizations for GUI-driven applications.

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†FreeMind - http://freemind.sourceforge.net/wiki/index.php/Main_Page and jEdit - http://jedit.org

Some modern applications of the Poincare disk model of hyperbolic geometry

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Although the discovery of hyperbolic geometry had a huge impact on mathematical logic, theoretical physics, for a long time seemed to have little to do with everyday practice. Thanks to Escher's works the idea of hyperbolic geometry is much more widespread. Escher's works probably influenced the crystallography. The theory of regular tilings of the hyperbolic plane and space is developed in mathematical crystallography.This relatively new research area appears also in the Emil Molnar's works. Escher's works have well-documented impact on the information visualization. The information visualization has an old history from ancient Greek maps of the world through the London Underground map to the mental maps. The information visualization gives the scientific background for the new aspect of Internet search engines. The linear ordering of the millions of web search results can give just little help for internet users. The thematic net settlement is one of the solution. We can see the forest as well the tree, if we use hyperbolic tree, if we put the graph of web search results on the Poincare disk model of hyperbolic geometry. The realization of this idea needs more researches, where the theory of large graphs has great importance.

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Generalized logic and set theory*

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The traditional or classical logic and set theory are based on Boolean algebra. They use two values and Boolean operations, such as conjunction/intersection, disjunction/union and negation/complementation. There is a widely known and used generalisation of these theories, the fuzzy theory. Actually, it is not only one theory, since the operation can be generalised in various ways from $\{0, 1\}$ to $[0, 1]$. Both in theory and (engineering) applications, Gödelian, Lukasiewicz and product logics are used, and their respective fuzzy sets.

In this work, after overviewing these generalisations, other general systems are addressed. One may use the set of natural numbers as possible (logical) values: this concepts leads to the multisets. However such generalisation of logic/set theory leads some questions: the operations could be generalised in various ways. In logic this concept can be connected to linear descriptive logic, where a formula can only be used once during a proof similarly as a recipient can only be used once during a cooking process. Other representation of a logic with a similar property is the logic of programming language C, or database systems. We would like to mention further generalisations, where the possible values are integers, or some finite subsets (e.g., $\{-n, \cdots, 0, 1, \cdots n\}$ for some natural n). Other extension the interval-valued logic, where the values are unions of subintervals of $[0, 1)$ instead of numbers.

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On the simultaneous number systems of Gaussian integers

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The triple $(Z_1, Z_2, \mathcal{A})$ is called a simultaneous number system of the Gaussian integers, if there exist $a_j \in \mathcal{A}$ $(j = 0, 1, \ldots, n)$ for all $z_1, z_2 \in \mathbb{Z}[i]$ so that:

$$z_1 = \sum_{j=0}^{n} a_j Z_1^j, \quad z_2 = \sum_{j=0}^{n} a_j Z_2^j.$$

In this talk I show that there is no simultaneous number system of Gaussian integers with the canonical digit set, furthermore I give the construction of a new digit set by which simultaneous number systems of Gaussian integers exist.

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Improving efficiency of automated functional testing in agile projects

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Test-Driven Development (TDD) is probably the most important agile engineering practice. Since it was first described in detail in [1], this development practice has been adopted widely. This adoption has been also well supported with tools that provide a framework for defining and executing unit tests on the different development platforms. Test-Driven Development provides a guideline, how to develop applications unit by unit, resulting in well-designed, well maintainable quality software. TDD focuses on units and though it ensures that the atomic building blocks and their interactions are specified and implemented correctly. There is certainly a need for automating other tests as well in order to ensure a working integration environment, to validate performance or to ensure that the application finally behaves as it was specified by the customer. Usually for automating these non-unit tests, developers (mis-)use the unit test frameworks and the unit test execution tools. This paper investigates the potential problems caused by misusing unit test tools for automated functional tests in cases, when these functional tests are defined through the development technique called *Acceptance Test Driven Development* (ATDD). The misuse of the unit testing tools may have direct impact on the testing efficiency and it may also "close the doors" for features specialized for automated functional tests. Some results of this investigation have been prototyped in a tool called SpecRun, which aims to provide better automated functional testing efficiency.

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On the absolute performance ratio of the First Fit algorithm

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In the classical one-dimensional bin-packing problem, we are given a sequence $L = (a_1, a_2, \ldots, a_n)$ of items, each with a size in $(0, 1]$. We are required to pack them into a minimum number of unit-capacity bins.

The bin-packing problem was one of the earliest to use an approximation algorithm and worst case analysis. For a given list L and algorithm A, let $C^A(L)$ denote the number of bins used when A is applied to list L, and $C^*(L)$ denote the optimum number of bins for a packing of L.

The *absolute performance ratio* for A is defined as

$$R_A := \sup_{L \in \mathcal{D}} \frac{C^A(L)}{C^*(L)},$$

where $\mathcal{D}$ is the set of every possible lists L.

For simplicity, we use a_i to denote the size of item a_i. The FF algorithm can be described as follows: When we are packing a_i, we place it in the lowest indexed bin whose current content does not exceed $1 - a_i$. Otherwise, we start a new bin with a_i as its first item.

It is known that $1.7 \le R_{FF}$, and we conjecture that it is exactly $\frac{17}{10}$. The most recent result regarding the upper bounds of the absolute performance ratio of FF is due to B. Xia and Z. Tan: They proved that $R_{FF} \le \frac{12}{7}$.

In this talk we present an improved result regarding this bound. We are going to show that in the previous estimation the case of equality cannot hold, and thus we will be able to give a better estimation:

$$R_{FF} \le \frac{101}{59} \approx 1.7119.$$

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Weighted polynomial interpolation on the roots of four kinds of Chebyshev polynomials

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This talk is devoted to the study of some discrete processes on the roots of four kinds of Chebyshev polynomials. Starting from the Lagrange interpolation polynomials we shall construct wide classes of discrete processes using summations generated by a summation function φ and by loosening the strict condition on the degrees of polynomials.

We will give necessary and sufficient conditions on the function φ ensuring that our processes fulfill some interpolatory properties. We also investigate how can we obtain the well-known Lagrange and Hermite–Fejér types of interpolations. Some other useful applications will be considered as well.

We are going to investigate the uniform convergence of our processes in suitable Banach spaces $(C_w[-1,1], \|\cdot\|_w)$ of continuous functions (w denotes a weight). We formulate a theorem of uniform convergence regarding the summation function φ, which is analogous to the well-known theorem of G. M. Natanson and V. V. Zuk.

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Defining contracts with different tools in software development*

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To create reliable software systems different tools and methods are needed. There are many ways to build better quality software. In this paper we focus on contract based development method and tools which support this kind of development process. Contract based development can be used together with component based development processes where the behaviour of a component could be defined and checked at runtime with the usage of contracts. To analyse the available tools and methods two main software development levels were chosen. The first is the model (UML with OCL, ADL, JML) level. These tools can be used when the system is designed in the early phases of the software development process. It is important because with models different checks can be made. These early checks can help to find software failures, design problems earlier and the errors can be fixed much faster. But the checks at the model level are not enough. Analysis was made on the second, implementation level (Eiffel, Java, .NET) also, where the programming language extensions for contract based development were examined. These tools can help the developers to build the system. With the contracts compile time or runtime errors can be detected which can help in the development, testing or debugging processes. The examined programming languages and tools support the contract based development differently.

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A Maximum Theorem for generalized convex functions

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The classical Maximum Theorem for convex functions states that *if D is a convex set of a linear space and and $f_1, \dots, f_n : D \to \mathbb{R}$ are convex functions such that*

$$0 \le \max(f_1(x), \dots, f_n(x)) \qquad (x \in D),$$

then there exist $\lambda_1, \dots, \lambda_n \ge 0$ with $\lambda_1 + \dots + \lambda_n = 1$ such that

$$0 \le \lambda_1 f_1(x) + \dots + \lambda_n f_n(x) \qquad (x \in D).$$

Given a nonempty set X, a binary operation $\circ : X^2 \to X$, and two positive real constants a, b, a function $f : X \to \mathbb{R}$ is called $(\circ, a, b)$-convex if

$$f(x \circ y) \le af(x) + bf(y) \qquad (x, y \in X).$$

Clearly, convex, Jensen-convex, subadditive functions are convex in this generalized sense. The main results of the talk extend the conclusion of the classical Maximum Theorem to the setting of $(\circ, a, b)$-convexity.

Declarative scheduling of dataflow networks

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As part of our previous work on design and implementation of a coordination language framework for embedded domain-specific languages [1] we have briefly touched the issue of executing specialized task graphs [2]. In our model, we created a set of workers (executors) dynamically pick and execute DSL programs (tasks) as part of a dataflow graph. The number of workers matches the number of processing units of the given hardware in the ideal case. That latter may contribute to lowering the expectations from the supporting run-time environment, eventually making the compiled graphs standalone on top of the bare metal.

However, during the preliminary performance tests, we have observed that our first naïve stab at scheduling execution of graphs does not scale well for multiple workers – which is not surprising as relations between tasks induced by data dependencies in the dataflow graph are not enforced to be respected. To earn guarantees for that, tasks are partitioned into pools, though the optimal organization of pools is hard to achieve automatically.

A sudden insipiration of advantages of embedded domain-specific functional languages mixed with the need for heuristics from the programmer constructing the application that the dataflow graph represents lead us to the concept of *declarative scheduling*. Declarative scheduling allows the implementation of domain-specific scheduling constraints that helps to abstract away from the low level scheduling details and rather focuses on the protocol implementation itself. Recent research work done on the topic in the context of databases [3][4] and cloud computing [5] supports the idea that gives us a motivation to evaluate the concept in our setting too.

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Compile-time advances of the C++ Standard Template Library*

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The *C++ Standard Template Library* (STL) is the flagship example for libraries based on the generic programming paradigm. STL is widely-used, because the library is part of the C++ Standard and consists of many handy generic data structures (like list, vector, map, etc.) and generic algorithms (such as for_each, sort, find, etc.) that are fairly irrespective of the used container. Iterators bridge the gap between containers and algorithms [5]. As a result of this layout we can extend the library with new containers and algorithms simultaneously and the complexity of the library is greatly reduced, as well.

However, the usage of this library is intended to minimize classical C/C++ error, but does not warrant bug-free programs [4]. Furthermore, many new kinds of errors may arise from the inaccurate use of the generic programming paradigm, like dereferencing invalid iterators [1] or erroneous functors [3].

Allocators were originally developed as an abstraction for memory models. Allocators allow the library developers to ignore the distinction between far and near pointers. They allow the users of the STL to customize the allocation and deallocation of the memory. However, the most important restriction of allocators is that they must be *stateless* types [2]. This requirement is tested neither at compilation-time nor at run-time. Usage of stateful allocators may result in memory corruption.

In this paper we present typical scenarios, that can cause runtime problems. These scenarios belong to allocators and iterators. We emit warnings while these constructs are used without any modification in the compiler.

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On generalization of periodic wavelet construction

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In periodic wavelet construction considering $X = C(\mathbb{G})$ functions, where $(\mathbb{G}, +)$ is a locally compact topological group, defining translation operators on functions as $\tau_y f(x) := f(x+y) \quad (x, y \in \mathbb{G})$ and taking a $(\mathbb{G}_n, +) \quad (n = 2, 3, \dots)$ discrete, cyclic subgroup of $(\mathbb{G}, +)$, projections into $X_n := \{\tau_s f \;:\; s \in \mathbb{G}_n\}$ invariant subspace of X, which are given by tools of Fourier analysis (characters and Haar measure of the group, the corresponding translation invariant integral and inner product, (discrete) Fourier transforms, (discrete) convolution) and help of biorthogonal systems, can be given in explicit form and also approximations of $f \in X$. Norm of projections are investigated as projections are uniformly bounded in several spaces (regarded to n).

There are more well known example of the construction, for example $\mathbb{G} = [0, 1)$ with $\dot{+}$ modulo 1 addition. Here $\mathbb{G}_n$ is the equidistant partition of $\mathbb{G}$, the set of trigonometric functions $\{\exp(2\pi int) : (n \in \mathbb{Z}, t \in \mathbb{G})\}$ which is orthonormal with respect to the usual inner product $\langle f, g\rangle = \int_{\mathbb{G}} f(t)\overline{g}(t)\, dt,\ \mathbb{G} := [0, 1)$. Generalization takes place as an argument transformation on $\mathbb{G}$ which is a a strictly monotonically increasing, differentiable bijection. In this paper the periodic wavelet construction will be generalized by the above mentioned argument transform.

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Automated word puzzle generation using topic models and semantic relatedness measures

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We propose a knowledge-lean method to generate word puzzles from unstructured and unannotated document collections. The presented method is capable of generating three types of puzzles: odd one out, choose the related word, and separate the topics. The difficulty of the puzzles can be adjusted. The algorithm is based on topic models, semantic similarity, and network capacity. Puzzles of two difficulty levels are generated: beginner and intermediate. Beginner puzzles could be suitable for, e.g., beginner language learners. Intermediate puzzles require more, often specific knowledge to solve. Domain-specific puzzles are generated from a corpus of NIPS proceedings. The presented method is capable of helping puzzle designers compile a collection of word puzzles in a semi-automated manner. In this setting, the method is utilized to produce a great number of puzzles. Puzzle designers can choose and maybe modify the ones they want to include in the collection.

On imbalances in digraphs*

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The imbalance of a vertex v_i in a digraph as b_{v_i} (or simply b_i) $= d^+_{v_i} - d^-_{v_i}$, where $d^+_{v_i}$ and $d^-_{v_i}$ are respectively the outdegree and indegree of v_i. The imbalance sequence of a simple digraph is formed by listing the vertex imbalances in non-increasing order. D. Mubayi [2] obtained necessary and sufficient conditions for a sequence of integers to be the imbalance sequence of a simple digraph. In this talk, we present the characterizations of imbalance sequences for various classes of digraphs in light of references [1, 3, 4, 5, 6, 7]. Some of these characterizations provide algorithms for construction of the corresponding digraphs. The set of distinct imbalances is called the imbalance set and we also present conditions for the existence of certain digraphs with given sets of integers as imbalance sets.

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Approximation of stochastic differential equations driven by step fractional Brownian motion

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We consider the following stochastic differential equation driven by step fractional Brownian motion

$$X(t) = X_0 + \int_0^t F(X(s), s)ds + \int_0^t G(X(s), s)dB(s), \ t \in [0, T]. \tag{1}$$

We assume that with probability 1 we have $F \in C(\mathbb{R}^n \times [0, T], \mathbb{R}^n), G \in C^1(\mathbb{R}^n \times [0, T], \mathbb{R}^n)$ and for each $t \in [0, T]$ the functions $F(\cdot, t), \dfrac{\partial G(\cdot, t)}{\partial x}, \dfrac{\partial G(\cdot, t)}{\partial t}$ are locally Lipschitz.

The equation (1) will be approximated for each $N \in \mathbb{N}$ through

$$X_N(t) = X_0 + \int_0^t F(X_N(s), s)ds + \int_0^t G(X_N(s), s)dB_N(s), \tag{2}$$

$$\tag{3}$$

where

$$B_N(t) = \sum_{n=1}^{N} \frac{\sin(x_n t)}{x_n} X_n + \sum_{n=1}^{N} \frac{1 - \cos(y_n t)}{y_n} Y_n, \quad t \in [0, 1], N \in \mathbb{N}.$$

We will show that the equation (2) has a local solution, which converges in probability to the solution of (1) in the interval, where the solutions exist. We illustrate the approximation through the model for the price of risky assets from mathematical finance. The figures are generated in GeoGebra.

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Closedness of the solution map for parametric operator equilibrium problems

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The notion of operator variational inequalities it was introduced by Domokos and Kolumbán in 2002. These operator variational inequalities include not only scalar and vector variational inequalities as special cases, but also have sufficient evidence for their importance to study. The operator equilibrium problems was studied by Kazmi and Raouf, Kum and Kim.

In this paper we introduce new definitions of vector topological pseudomonotonicity to study the parametric operator equilibrium problems. The main result gives sufficient conditions for closedness of the solution map defined on the set of parameters.

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Grid and block size based execution time optimization of CUDA programs

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Beign a highly parallel architecture the graphical hardware proved to be suitable for general purpose programming tasks not only for the rendering. The NVIDIA CUDA architecture makes a higher programming level available for programmers: instead of shader based, low-level programming with CUDA a more general paradigm can be used. In this paper we investigate on the optimal number of blocks and number of threads per block at launching a CUDA kernel. We determine the factors which have impact on the runtime, namely the number of registers used by threads and the amount of shared memory. We discuss the contradictory nature of the registers per threads as well: high number of registers per threads is favourable because of the fast access time, but the more registers are assigned to a thread the less blocks can run on a multiprocessor, which decreases the occupancy, and as a result the efficiency of the GPU.

As our practical tests suggest it the local memory, the occupancy, the cache hierarchy built on registers and the number of registers shared among the threads have their own impact on performance. Increasing the number of blocks makes the CUDA-kernel more sensitive to carefully chosen launch parameters. Too many threads with high number of blocks creates in our CUDA-program even more instructions, thus increases execution time.

Transformation with a Blaschke-function and the convergence of Fourier series

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Turán [4] showed that to any $\zeta \in \mathbb{C}$ $(0 < |\zeta| < 1)$ there is a complex function $f_1(z) = \sum_{n=1}^{\infty} a_n z^n$, regular in $\mathbb{D} = \{z \in \mathbb{C} : \ |z| < 1\}$, with convergent power-series for $z = 1$, but the power series of $f_2(z) := f_1(B_\zeta(z)) = \sum_{n=1}^{\infty} b_n z^n$ diverges for the corresponding point $z = B_\zeta^{-1}(1)$, where $B_\zeta(z)$ denotes the Blaschke function with parameter ζ. $\sum_{n=1}^{\infty} a_n \omega^n$ and $\sum_{n=1}^{\infty} b_n z^n$ are called equivalent power series under the transformation $\omega = B_\zeta(z)$. That is, periphery-convergence is not a conformal invariant. Clunie [5] showed that there is a continuous function with the same property. He used the Fejér polynomial to build a proper function. Numerous results saw the light in the last century in this topic.

In this paper analogue questions are concerned on the 2-adic and 2-series fields $(\mathbb{B}, \overset{\bullet}{+}, \bullet)$ and $(\mathbb{B}, \overset{\circ}{+}, \circ)$ using the corresponding Walsh-Fejér polynomial introduced and examined by Ferenc Schipp [1] . Composition with the Blaschke-functions defined on the 2-adic and 2-series field, $B_a(x) = \frac{x \overset{\bullet}{+} a}{e \overset{\bullet}{+} a \bullet x}$ and $B_a(x) = \frac{x \overset{\circ}{+} a}{e \overset{\circ}{+} a \circ x}$ transform a given continuous function with convergent Fourier series into a function with divergent one in the corresponding points. Some properties of composition with Blaschke functions are established.

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A practical survey on programming paradigms*

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Programming paradigm has a key role in software technology as represents the directives in creating abstractions. The paradigm is the principle by which a problem can be comprehended and decomposed into manageable components [2]. During the software development there are several questions regarding abstractions and components. the paradigm which is applied sets up the rules and properties, but also offers tools for developing applications.

Programming paradigms evolved from the early epoch of automatic programming to the current advanced techniques such as aspect-oriented programming [5] and generic programming [1]. During this half century of software technology we introduced and later exceeded paradigms like structured programming [4], then object-orientation [6] and the development is continous.

In this paper we overview the most important programming paradigms and evaluate their strengths and weaknesses using a dynamic approach. We implement the same finite-state machine using the tools and techniques typical for the different programming paradigms to compare the initial effort to create a software product. However, software is changing by time, and the majority of software cost is the cost of maintenance. Therefore we apply the same changes on the finite-state machines to analyse the paradigm's behaviour for positive and negative variability [3].

Our research is intended to make a practical survey to compare the most important software paradigms in a real-world environment where software maintenance and fast response for user requirements have primary importance.

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The equations of homogeneous string vibration with random initial conditions

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We consider a boundary problems of homogeneous string vibration with random strongly Orlicz initial conditions. The main aim of the paper is to propose a new approach for studying partial differential equations with random initial conditions and to apply this approach for the justification of the Fourier method for solving hyperbolic type problems.

Consider the boundary-value problem of the first kind for a homogeneous hyperbolic equation. The problem is whether one can find a function $u = (u\,(x, y)\,,\ x \in [0, \pi]\,,\ \ t \in [0, t])$ satisfying the following conditions:

$$\frac{\partial}{\partial x}\left(p(x)\frac{\partial u}{\partial x}\right) - q(x)u - \rho(x)\frac{\partial^2 u}{\partial t^2} = 0; \tag{1}$$

$$x \in [0, \pi]\,,\ t \in [0, T]\,,\ T > 0;$$

$$u(0, t) = u(\pi, t) = 0,\ t \in [0, T]\,; \tag{2}$$

$$u(x, 0) = \xi(x),\ \frac{\partial u(x, 0)}{\partial t} = \eta(x),\ x \in [0, \pi]\,. \tag{3}$$

Assume also that $(\xi(x),\ x \in [0, \pi])$ and $(\eta(x),\ x \in [0, \pi])$ are strongly Orlicz stochastic processes.

Independently of whether the initial conditions are deterministic or random the Fourier method consists in looking for a solution to the series

$$u\,(x, t) = \sum_{k=1}^{\infty} X_k(x)\left[A_k cos\sqrt{\lambda_k}t + \frac{B_k}{\sqrt{\lambda_k}} sin\sqrt{\lambda_k}t\right],$$

$$x \in [0, \pi]\,,\ t \in [0, T]\,,\ T > 0,$$

where

$$A_k = \int_0^{\pi} \xi(x)X_k(x)\rho(x)dx,\ k \geq 1, \quad B_k = \int_0^{\pi} \eta(x)X_k(x)\rho(x)dx,\ k \geq 1,$$

and where $\lambda_k,\ k \geq 1$, and $X_k = (X_k(x),\ x \in [0, \pi]),\ k \geq 1$, are eigenvalues and the corresponding orthonormal, with weight $\rho(\bullet)$, eigenfunctions of the following Sturm-Liouville problem:

$$\frac{d}{dx}\left(p(x)\frac{dX_k(x)}{dx}\right) - q(x)x(x) + \lambda\rho(x)X(x) = 0, \quad X(0) = X(\pi) = 0.$$

The conditions of existence with probability one of twice continuously differentiated solution of the boundary-value problems of hyperbolic type equations of mathematical physics with strongly Orlicz (1)–(3) stochastic processes are found.

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Some comparison of fractal, spline and Shepard interpolation methods

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The classical methods of real data interpolation can be generalized with fractal interpolation. Our aim is to maid some comparison of the fractal an numerical analysis interpolation methods. The experimental data recruted from healthy children and from clinical records of children with febrile infection diseasis, were processed using fractal interpolation and also spline and some Shepard type interpolation.

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DSL for course scheduling

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Based on the assignment of courses in faculties of universities, we can create plenty of course schedule versions considering a few elementary criteria. For example, an instructor must not get two courses in different classrooms at the same time. By creating a course schedule, we may consider many other conditions to be able to satisfy the demands of instructors and students more precisely.

So far, course schedules for the Faculty of Informatics, University of Debrecen have been created mainly manually. An administrator receives instructors' demands in a simple form, and tries to prepare a course schedule that is mostly student-friendly considering these demands. Their work is hard not only because of time assignment but also due to incomplete information: they must create a planned course schedule at a time when they do not know the exact number of students. They can only forecast this headcount.

The process of creating a course schedule can be automated in a great part, altough not entirely. Instructors may give their demands with the help of a language designed and developed for this purpose. Besides these conditions, demands of students can also be considered. The complexity of creating a course schedule increases exponentially with the number of parameters, but well-formed conditions can restrict possibilities in such a measure that allows creating a course schedule in a much simpler way. Using a domain-specific language (DSL) with a database in the background gives the most flexible and adaptable way to describe such conditions, e.g. optimal loading of servers and other resources.

Our aim is to implement such a DSL with the help of Groovy. It is a dynamic programming language that runs on the Java Virtual Machine (JVM) and supports creating DSLs. Groovy's most powerful tools are closures which allow using code fragments as objects, and meta-programming that allows changing the structure and behavior of objects in runtime. Thanks to Groovy's operator overloading capabilities, not only conditions but commands are easy to formulate. An important benefit is that a DSL implemented in Groovy can be used in most Java environment.

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Monte Carlo method in education and practice

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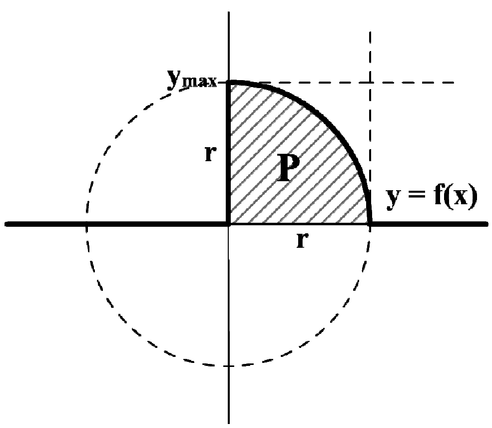
Monte Carlo method is an analytical and statistical method often used in system modelling. It is useful for problem solving, which can be presented graphically with an area. The value of area it is possible to be calculated as a defined integral. Monte Carlo (MC) method belongs between those mathematical methods application of which wouldn't be possible without using computer. The MC method, as it is understood today, encompasses any technique of statistical sampling employed to approximate solutions to quantitative problems. Monte Carlo method and its applications allow solution of many real actual problems, which came be analogues with an area calculation.

The aforementioned method at J. Selye University is included in the subject: Modelling and simulation of computer science teacher master study curriculum. The subject is recommended for student in the first semester of study.

How and why the Monte Carlo method works in educational praxis is demonstrated by calculation of the value π. Generally the several version of Buffon's needle experiment are used for this purpose. The value of π is also possible to calculate from area of circle by generation random number as coordinate of points on computer (see the picture). Generally the Monte Carlo methods are nothing more than an elaborate means of estimating the integral.



$$r^2 = x^2 + y^2 \;\Rightarrow\; y = \sqrt{r^2 - x^2}$$

if $r = 1$ then $y = \sqrt{1 - x^2}$

$$P = \frac{\pi \cdot r^2}{4} \Rightarrow \pi = \frac{4 \cdot P}{r^2}$$

if $r = 1$ then $\pi = 4 \cdot P$

$$\frac{P}{1} = \frac{N}{M}$$

N - number of experiments
M - number of "success" experiments

$$\pi = \frac{N}{M} \cdot 4 = \frac{4N}{M}$$

As a practical application of MC method it was used to assess the development of flat feet. In combination with computer graphics, it is possible by them to determine the extent of flat feet on the foot imprint.

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A new framework for evaluating performance in data stream monitoring applications with StreamInsight: StreamEval

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Nowadays, monitoring applications emerge in a wide array of fields. The key elements in such applications are represented by data streams and continuous queries that execute over continuous incoming data. The field of data stream processing is far from reaching maturity, yet a number of systems that analyse data streams have been developed, both by academic research teams and industrial players.

Data stream processing poses challenges that haven't been encountered before, due to the temporal nature of the data. Limited system resources (*e.g.* memory and CPU usage) allocation is among the issues that need to be properly addressed by Data Stream Management Systems (DSMSs). Strategies like *load shedding* are enforced during bursty periods, so that the system can answer the queries in a timely manner.

In this paper we design and develop a monitoring application using a commercially available DSMS: Microsoft StreamInsight. This DSMS enables developers to develop and deploy Complex Event Processing applications, over high-throughput data streams. We developed a framework that assesses performance variations when different conditions from the environment change (*e.g.* when throttling the data sources that feed the continuous queries on the server): StreamEval. Our experiments yield very good performance indicators for the chosen DSMS. StreamEval can be further extended to evaluate performance on other DSMSs as well.

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Notes on Lazy Evaluation in Visualization

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This paper deals with using a scripting language in visualization. The language chosen is Perl, as visualization core, OpenGL library is used. The power and weaknesses of using such a combination are shown on selected examples. The main goal is to point out the possibility to use a scripting language in the visualization part of a virtual reality system as well as it is known in e.g. the modelling or texture pre-processing phases of visualization preparation, respectively. The main feature of the selected scripting language used in the examples is lazy evaluation allowing on-demand visualization of the objects of the virtual reality scene.

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A probabilistic classification method based on conditional independences

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A central problem in machine learning is identifying a representative set of features and constructing a classification model for a particular task using these features.

We introduce a probabilistic classification method which exploits the conditional independences between the features (random variables). This idea is at the heart of the selection of a special type of informative features. The so called t-informative features are selected from the great amount of observed features in order to diminish the uncertainty of the classification variable and in the same time avoid the over-fitting of the model. We construct a probabilistic function of the selected t-informative variables which classifies a new entity. We present the efficiency of our algorithm on real-life data-set, and compare our method with other classification methods, applied on the same data sets.

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About a condition of starlikeness

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The Alexander integral operator is defined by:

$$A : \mathcal{A} \to \mathcal{A},\ A(f)(z) = \int_0^z \frac{f(t)}{t}\, dt.$$

The authors of [2] (pp. $310 - 311$) proved the following result:

Theorem 1 *Let A be Alexander operator and let $g \in \mathcal{A}$ satisfy*

$$\operatorname{Re} \frac{zg'(z)}{g(z)} \geq \left| \operatorname{Im} \frac{z(zg'(z))'}{g(z)} \right|,\ z \in U. \tag{1}$$

If $f \in \mathcal{A}$ and

$$\operatorname{Re} \frac{zf'(z)}{g(z)} > 0,\ z \in U,$$

then $F = A(f) \in S^*$.

In this paper the above result is improved. The techniques of differential subordinations and extreme points are used.

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On a Grünwald type interpolation process

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Let f be a given real valued function defined on the interval $(a,b) \subset \mathbb{R}$. Consider an interpolatory point system

$$X_n := \{a < x_{n,n} < x_{n-1,n} < \cdots < x_{1,n} < b\} \quad (n \in \mathbb{N}).$$

Géza Grünwald [1] investigated first the interpolation process

$$G_n\,(f, X_n, x) := \sum_{k=1}^{n} f(x_{k,n})\ell_{k,n}^2(X_n, x) \qquad \big(x \in (a,b),\ n \in \mathbb{N}\big),$$

where

$$\ell_{k,n}(X_n, x) = \frac{(x - x_{1,n}) \cdots (x - x_{k-1,n})(x - x_{k+1,n}) \cdots (x - x_{n,n})}{(x_{k,n} - x_{1,n}) \cdots (x_{k,n} - x_{k-1,n})(x - x_{k+1,n}) \cdots (x_{k,n} - x_{n,n})}$$

$$\big(x \in (a,b);\ k = 1,2,\ldots,n;\ n \in \mathbb{N}\big)$$

are the fundamental polynomials of Lagrange interpolation with respect to the point system X_n. He proved the following result: *If X_n $(n \in \mathbb{N})$ is a strongly normal point system and f is a continuous function on $[-1,1]$, then $G_n\big(f, X_n, x\big)$ tends to f for every point $x \in (-1,1)$ and the convergence is uniform on every interval $[-1+\varepsilon, 1-\varepsilon]$ $(0 < \varepsilon < 1)$, moreover there is no convergence – in general – at the points ± 1.*

We shall consider the convergence of the above process in some weighted function spaces on different point systems.

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Improving quality of software analyser and transformer tools using specification based testing

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During the development of either small-scale or industrial-scale software, reengineering tools enabling analysis and refactoring of the source code ease debugging, comprehension, and code reuse, which may reduce costs. However the quality and the reliability of these tools is crucial: imprecise analysis may lead to incorrect program transformations altering the semantics along with the behaviour of the software, which is undesired and inadmissible.

Testing is the most frequently applied method for improving software quality. Nevertheless, in the case of analyser and transformer tools every sort of testing methods gets laborious and problematic due to the fact that both the input and the results of such tools are complete programs or parts of programs. The complexity of the test data apparently makes it difficult both to specify and to verify the properties of the program.

At the same time, reengineering tools usually have some kind of internal representation of the source code in order to model the syntactic and semantic structure of the analysed program. A well-designed representation is fully equivalent to the original code, precisely captures the derivable program properties, and assists code comprehension as well as code transformation.

This paper introduces a specification based testing method for RefactorErl, an analyser and transformer tool for Erlang. This testing method verifies static code analysis by monitoring the consistency of the built program representation. The formal specification of the analysis is transformed into testing properties describing the consistency of the abstract program graph being used for internal representation in RefactorErl. This enables a less difficult way of testing in a high abstraction level, and can improve the reliability by revealing misconceptions between specification and implementation. In order to improve the efficiency of the method, the applied test database contains automatically generated programs as well as manually written cases.

The presented method can be easily adopted to other reengineering tools using high level internal representation.

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The alternating sum-of-divisors function

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We survey arithmetic and asymptotic properties of the alternating sum-of-divisors function β defined by $\beta(p^a) = p^a - p^{a-1} + p^{a-2} - \ldots + (-1)^a$ for every prime power p^a $(a \geq 1)$, and extended by multiplicativity. The function β, as a variation of the sum-of-divisors function σ, was considered by Martin [5], Guy [3], Iannucci [4], Zhou and Zhu [7] regarding the following problem. In analogy with the perfect numbers, n is said to be imperfect if $2\beta(n) = n$. The only known imperfect numbers are 2, 12, 40, 252, 880, 10 880, 75 852, 715 816 960 and 3 074 457 344 902 430 720 (sequence A127725 in [8]).

This function occurs in the literature also in another context. Let $b(n) = \#\{k : 1 \leq k \leq n$ and $\gcd(k, n)$ is a square$\}$. Then $b(n) = \beta(n)$ $(n \geq 1)$, see, e.g., Bege [1, p. 39], Cohen [2, Cor. 4.2], Iannucci [4, p. 12], Sivaramakrishnan [6].

We also pose some open problems. One of them is concerning super-imperfect numbers n, defined by $2\beta(\beta(n)) = n$. This notion seems not to appear in the literature. The numbers 2, 4, 8, 128, 32 768 and 2 147 483 648 are super-imperfect and there are no others up to 10^7. We discuss connections to the Fermat numbers.

The corresponding concept for the σ function is the following. A number n is called superperfect if $\sigma(\sigma(n)) = 2n$. The even superperfect numbers are 2^{p-1}, where $2^p - 1$ is a Mersenne prime (sequence A019279 in [8]). No odd superperfect numbers are known.

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Second order geometric Hermite surface interpolation with rational bi-quadratic patches

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Second order geometric Hermite curve interpolation in the plane can be solved, under certain conditions [2], for integral cubic parametric polynomial curves. The number of constraints (position, tangent line/direction, and curvature) equals to the number of degrees of freedom in this problem, and the resulting interpolant curve has advantageous properties [1].

A generalization of the problem provides a similar equality. Second order geometric Hermite data (position, surface normal, principal curvatures and directions) for four patch corners constraints 32 scalar values, which equals to the number of degrees of freedom of a rational bi-quadratic patch with corner weights set to 1.

We examine the solvability of this generalized problem, and present an algorithm, which constructs a rational bi-quadratic Bézier surface that interpolates the prescribed second order geometric Hermite data in patch corners, when it is possible.

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Fejér-summability of higher-dimensional Fourier series

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The triangular and cubic Fejér summability of higher dimensional Fourier series is investigated. It is proved that the maximal operator of the Fejér means of a d-dimensional Fourier series is bounded from the Hardy space $H_p(\mathbb{T}^d)$ to $L_p(\mathbb{T}^d)$ for all $d/(d+1) < p \leq \infty$ and, consequently, is of weak type (1,1). As a consequence we obtain that the Fejér means of a function $f \in L_p(\mathbb{T}^d)$ converge a.e. and in L_p-norm $(1 \leq p < \infty)$ to f. Moreover, we prove for the endpoint $p = d/(d+1)$ that the maximal operator is bounded from $H_p(\mathbb{T}^d)$ to the weak $L_p(\mathbb{T}^d)$ space.

Rapid prototyping for distributed D-Clean using C++ templates*

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Earlier we have designed two coordination languages D-Clean and D-Box for high-level process description and communication coordination of functional programs distributed over a cluster [1]. D-Clean is the high level coordination language for functional distributed computations. The language coordinates the pure functional computational nodes required by language primitives, and it controls the dataflow in a distributed process-network. In order to achieve parallel features, D-Clean extends the lazy functional programming language Clean with new language primitives [5]. Every D-Clean construct generates a D-Box expression. D-Box is an intermediate level language and describes in details the computational nodes hiding the low level implementation details and enabling direct control over the process-network [4].

Practical experiences of the two language usage showed the difficulties of distributed program development, especially in testing and debugging. This paper aims to provide software comprehension application for a better way of understanding and utilizing the D-Clean language. We present a new modeling approach of the coordination language elements and a new view of the D-Clean distributed system behaviour using C++ templates. The strong type system of C++ templates ([2, 3]) guarantees the correctness of the model. Using templates we can achieve impressive efficiency by avoiding run-time overhead.

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List of lecturers