FACULTY
OF MATHEMATICS
AND PHYSICS
Charles University

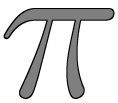
27th Annual Student Conference

Week of Doctoral Students

Book of Abstracts

of the

Week of Doctoral Students
of the School of Mathematics 2018
June 4, 2018



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http://www.karlin.mff.cuni.cz/~rokyta/WDS-M/2018/
http://www.mff.cuni.cz/veda/konference/wds/

Vytisklo Reprostředisko MFF UK Praha

Preface

In the beginning of 2014, the Management of the Faculty of Mathematics and Physics decided that the traditional conference of PhD students called the WDS (Week of Doctoral Students) would not be organized as an activity of the entire faculty. Instead, the decision as to whether to organize the conference or not was left to the respective Schools (of Computer Science, of Mathematics, and of Physics).

Already for the fifth year since then the School of Mathematics organizes its WDS-M (Week of Doctoral Students of the School of Mathematics, `http://www.karlin.mff.cuni.cz/~rokyta/WDS-M/2018/`), this time again as a one-day conference, in the framework, and as a continuation of, the (27th) WDS of the Faculty of Mathematics and Physics (`http://www.mff.cuni.cz/veda/konference/wds/`).

This year, 13 students have registered as active participants to the conference. We believe that this event, which takes place in the "mathematical" Karlín building of the faculty, will attract the attention of the students but also of the broad mathematical audience. We thus encourage all of those interested in the scientific activities of our doctoral students to attend this meeting.

The conference is co-organized by the *School of Mathematics, Faculty of Mathematics and Physics, Charles University*, and *Charles University Chapter of SIAM*.

Prague, June 4, 2018

doc. RNDr. Mirko Rokyta, CSc.
Vice-Dean for Mathematics
Faculty of Mathematics and Physics
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Contents

Contributed talks

Indecomposable integers and universal quadratic forms

Contributed talk

Ing. Magdaléna Tinková

E-mail: tinkova.magdalena@gmail.com
Obor studia: 4M1 – Algebra, teorie čísel a matematická logika
Ročník: 1.
Školitel: Mgr. Vítězslav Kala, Ph.D.

Abstract

This talk will focus on indecomposable integers, totally positive algebraic integers which satisfy one additional condition. These elements play an important role in the study of universal quadratic forms, since they are difficult to represent and we often use them as coefficients of our forms. We will discuss this problem primarily in the case of biquadratic fields. This is joint work with Martin Čech, Dominik Lachman, Josef Svoboda and Kristýna Zemková.

Borel complexity up to the equivalence

Contributed talk

RNDr. Adam Bartoš

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Obor studia: 4M2 – Geometrie a topologie, globální analýza a obecné struktury
Ročník: 4.
Školitel: Mgr. Benjamin Vejnar, Ph.D.

Abstract

We say that two classes $\mathscr{C}$ and $\mathscr{D}$ of topological spaces are *equivalent* if every space in $\mathscr{C}$ is homeomorphic to a space in $\mathscr{D}$ and vice versa. For a class of metrizable compacta $\mathscr{C}$ we consider the collection of all families $\mathscr{F} \subseteq \mathscr{K}([0,1]^\omega)$ equivalent to $\mathscr{C}$, and we denote this collection by $[\mathscr{C}]$.

Usually, complexity of such class $\mathscr{C}$ means the complexity of the saturated family $\max([\mathscr{C}]) \subseteq \mathscr{K}([0,1]^\omega)$. There are many results of this type. We are rather interested in the lowest complexity among members of $[\mathscr{C}]$. This is rarely the complexity of the saturated family. We study this Borel complexity up to the equivalence because of its connection with our notion of *compactifiable classes*. We have shown that every analytic family in $\mathscr{K}([0,1]^\omega)$ is equivalent to a G_δ family and that these correspond to *strongly Polishable classes*. Similarly, closed families correspond to *strongly compactifiable classes*. It is natural to ask about the other complexities – clopen, open, and F_σ.

In the talk we give an overview of the theory and used notions, and we formulate our new results regarding open and F_σ classes.

Goal-oriented error estimates

Contributed talk

Mgr. Ondřej Bartoš

E-mail: ondra.bartosh@seznam.cz
Obor studia: 4M6 – Vědecko-technické výpočty
Ročník: 1.
Školitel: prof. RNDr. Vít Dolejší, Ph.D., DSc.

Abstract

Finite element methods for solving partial differential equations give us approximate solutions which on their own need not resemble closely the actual exact solution. This leads us to seek an estimate of how close the approximation is. If the whole computation is carried out knowing that we look for a value of some functional, e.g. an integral over a part of the boundary of the domain or a value at some point, we can estimate the error of this functional. One way we can do this is by solving an adjoint problem and using a dual weighted residual method. If the error estimate is too high, it can then be used locally as an indicator to refine parts of a computational domain and find a more accurate approximate solution.

From numerical solution of PDEs to graph theory

Contributed talk

Mgr. Tomáš Gergelits

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Obor studia: 4M6 – Vědecko-technické výpočty
Ročník: 5.
Školitel: prof. Ing. Zdeněk Strakoš, DrSc.

Abstract

Suppose a group of N men and a group of N women. Suppose that each woman fancies a subset of men and that each man is happy to pair with any woman who is fond of him. What are the necessary and sufficient conditions to make every person happy? And why anyone studying numerical solution of partial differential equations (PDEs) should be interested in that?

In this talk we show how the answer to the first question, the so-called Hall's marriage theorem, comes naturally into play when studying the convergence and efficiency of adaptive methods for numerical solution of PDEs. Specifically, for a class of elliptic PDEs preconditioned with Laplace operator, we show that the theorem allows to get the computable bounds for *all* eigenvalues of the spectrum of the discretized preconditioned operator.

Towards topics of deep learning

Contributed talk

Mgr. Martin Holeček

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Obor studia: 4M6 – Vědecko-technické výpočty
Ročník: 2.
Školitel: prof. Ing. František Maršík, DrSc.

Abstract

After two so called ‘winters of AI’ comes new wave called ‘deep learning’. Lets look closely at neural networks from the friendly side – as a simple application of gradient descent – all the way up to reasons, why does machine learning using neural networks have its renessance, what problems and methods it tackles, what are the common models and what is the direction for those being interested to get more in depth information.

Structural mathematics and its teaching

Contributed talk

Mgr. Filip Beran

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Obor studia: 4M8 – Obecné otázky matematiky a informatiky
Ročník: 1.
Školitel: prof. RNDr. Ladislav Kvasz, DSc., Dr.

Abstract

Taken from a historic perspective, contemporary 'school mathematics' curricula usually end somewhere in 17th century, in between analytic geometry and differential calculus. What about last three centuries – what concepts of modern mathematics could and should we teach as a part of general education, and, especially, how and why? That is an initial question for my thesis about structural mathematics, which naturally brings to a scene a bundle of problems, linked to a history and philosophy of mathematics. However, the essential target rests in the field of didactics: to provide teachers with a set of useful tools to teach mathematics, as we understand it rather as an art than a science.

Selected methods for asymptotic inference of stochastic geometry models

Contributed talk

Mgr. Daniela Flimmel

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Obor studia: 4M9 – Pravděpodobnost a statistika, ekonometrie a fin. matematika
Ročník: 1.
Školitel: doc. RNDr. Zbyněk Pawlas, Ph.D.

Abstract

Let us denote by $\mathscr{C}^d$ the space of all compact subsets of $\mathbb{R}^d$. We equip this space with the Hausdorff metric and obtain a complete separable metric space. A nonempty element of $\mathscr{C}^d$ is called a particle and a point process on $\mathscr{C}^d \setminus \{\emptyset\}$ is a particle process. If we prescribe the shape of the particles, we obtain some important models, e.g. a segment process. Having a particle process of independent balls with centres being distributed as a Poisson point process and taking the union of these balls, we get the Boolean model with spherical grains. Another fundamental example of a particle process is a random tessellation, i.e. a locally finite random division of $\mathbb{R}^d$. If we add interactions between particles into the model, we speak about a Gibbs particle process.

Often we are interested in the geometrical properties of a given particle process, for instance we want to estimate volume of the typical particle. To do so, we observe the particle process in a bounded window and then study limit behaviour of a suitably chosen functional of this particle process when the window increases. The aim of the talk is to present two methods used for different types of particle processes to prove central limit theorems for the functional. Namely it is the Malliavin–Stein method and the stabilization method.

Generalizations of the LASSO penalty

Contributed talk

Mgr. Samuel Hudec

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Obor studia: 4M9 – Pravděpodobnost a statistika, ekonometrie a fin. matematika
Ročník: 3.
Školitel: prof. RNDr. Gejza Wimmer, DrSc.

Abstract

This presentation discuss the motivation of using LASSO – least absolute shrinkage and selection operator as regression analysis method in machine learning. Method include estimation of parameters and model selection in one step leaded by so-called the penalty. Generalizations the penalty makes method adaptable to various tasks in practice.

Controlled stochastic evolution equations with Levy noise in Hilbert spaces

Contributed talk

Mgr. Karel Kadlec

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Obor studia: 4M9 – Pravděpodobnost a statistika, ekonometrie a fin. matematika
Ročník: 6.
Školitel: prof. RNDr. Bohdan Maslowski, DrSc.

Abstract

In this contribution, controlled linear stochastic evolution equations driven by Lévy processes are presented in the Hilbert space setting. The control operator may be unbounded which makes the results obtained in the abstract setting applicable to parabolic SPDEs with boundary or point control. In the first part, some examples, as various parabolic type SPDEs with point or boundary control, are introduced. The second part contains some preliminary technical results, notably a version of Itô formula which is applicable to weak/mild solutions of controlled equations. In the last part, the ergodic control problem is solved: The feedback form of the optimal control and the formula for the optimal cost are found.

Infinite-dimensional Kalman–Bucy filter

Contributed talk

Mgr. Vít Kubelka

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Ročník: 2.
Školitel: prof. RNDr. Bohdan Maslowski, DrSc.

Abstract

The Kalman–Bucy Filter is a continuous time counterpart to the discrete time linear Kalman Filter. Therefore, it deals with dynamical system described by stochastic differential equations.

First, the continuous time linear filtering problem in finite-dimensional space will be introduced. Afterwards, an extension for signal with values in a Banach space and finite-dimensional observation process will be shown and some interesting examples will be discussed, e.g. the signal processes described by linear stochastic partial differential equations driven by Fractional Brownian motion.

Maximum Volatility Portfolio

Contributed talk

Mgr. Robert Navrátil

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Ročník: 1.
Školitel: RNDr. Jan Večeř, Ph.D.

Abstract

High volatility is usually considered as undesirable property in finance as it is synonymous with risk. Given a reference asset, such as a stock index and its individual components, there is a trading strategy that trades in the individual assets subject to no shorting constraints that maximizes the volatility with respect to the index. Such strategy has many positive properties with regard to several well established concepts of quantitative finance. Moreover, the strategy is closely related with a passport option on the actively traded portfolio. We shall show the performance of the maximal volatility strategy on world currencies.

Nonlinear stability in viscoelastic fluid flows

Contributed talk

Mgr. Mark Dostalík

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Obor studia: 4F11 – Matematické a počítačové modelování
Ročník: 1.
Školitel: Mgr. Vít Průša, Ph.D.

Abstract

We discuss the notion of stability in ordinary/partial differential equations and present some of the classical problems of hydrodynamic stability. We then introduce the notion of viscoelasticity in mathematical modelling of real materials and show some of the peculiar effects which exhibit viscoelastic fluids. We conclude with the nonlinear stability of the steady Taylor–Couette flow of a viscoelastic fluid.

On three dimensional flows of Bingham fluids with variable treshold

Contributed talk

Mgr. Tomáš Los

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Obor studia: 4F11 – Matematické a počítačové modelování
Ročník: 1.
Školitel: prof. RNDr. Josef Málek, CSc. DSc.

Abstract

We are concerned with a system of partial differential equations describing internal flows of homogeneous incompressible fluids of Bingham type with activated boundary conditions. The Bingham activation threshold depends on internal pore pressure in the material, which is governed by an advection-diffusion equation. This model may be suitable for description of certain class of granular water-saturated materials. By suitably extending recent approaches by Chupin and Martin and Bulíček and Málek (see also a closely related work by Maringova and Zabensky), we prove long time and large data existence of weak solutions. This is a joint work with A. Abbatiello, J. Málek, and O. Souček.

On mathematical models capturing flows of non-Newtonian fluids

Contributed talk

Mgr. Erika Maringová

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Ročník: 3.
Školitel: RNDr. Miroslav Bulíček, Ph.D.

Abstract

I will talk on how to create a model of a flow, which states of the fluid and which effects of the flow we are able to capture, what kinds of models we study and what is our next challenge in this direction.

WDS - M, 4. 6. 2018, lecture room K6

Conference schedule

Time *)	Speaker/Programme	Stud. Yr.	Lecture title
9 : 00 - 9 : 05	**Opening**		
9 : 05 - 9 : 25	Ing. Magdaléna Tinková	4M1 1	Indecomposable integers and universal quadratic forms
9 : 25 - 9 : 55	RNDr. Adam Bartoš	4M2 4	Borel complexity up to the equivalence
9 : 55 - 10 : 20	Mgr. Filip Beran	4M8 1	Structural mathematics and its teaching
10 : 20 - 10 : 50	**Coffee Break**		
10 : 50 - 11 : 15	Mgr. Samuel Hudec	4M9 3	Generalizations of the LASSO penalty
11 : 15 - 11 : 40	Mgr. Vít Kubelka	4M9 2	Infinite-dimensional Kalman-Bucy filter
11 : 40 - 12 : 00	Mgr. Robert Navrátil	4M9 1	Maximum Volatility Portfolio
12 : 00 - 12 : 25	Mgr. Daniela Flimmel	4M9 1	Selected methods for asymptotic inference of stochastic geometry models
12 : 25 - 14 : 00	**Lunch Break**		
14 : 00 - 14 : 20	Mgr. Ondřej Bartoš	4M6 1	Goal-oriented error estimates
14 : 20 - 14 : 45	Mgr. Tomáš Gergelits	4M6 5	From numerical solution of PDEs to graph theory
14 : 45 - 15 : 10	Mgr. Martin Holeček	4M6 2	Towards topics of deep learning
15 : 10 - 15 : 40	**Coffee Break**		
15 : 40 - 16 : 00	Mgr. Mark Dostalík	4F11 1	Nonlinear stability of a viscoelastic fluid
16 : 00 - 16 : 25	Mgr. Tomáš Los	4F11 1	On three dimensional flows of Bingham fluids with variable treshold
16 : 25 - 16 : 50	Mgr. Erika Maringová	4F11 3	On mathematical models capturing flows of non-Newtonian fluids
16 : 50 - 17 : 15	Mgr. Karel Kadlec	4M9 6	Controlled stochastic evolution equations with Levy noise in Hilbert spaces
17 : 15 - 17 : 45	**Aftermath**		

*) All speaker schedules include 5 minutes discussion time