National and Kapodistrian University of Athens
Department of Economics

Conference on Approximation and Optimization: Algorithms, Complexity, and Applications

June 29–30, 2017, Athens, Greece
http://caoaca.com/

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June 24, 2017

National and Kapodistrian University of Athens, Rectorate

Gryparion Hall, Venue

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Information for Participants

Gryparion Hall, Lecture Room 416, Department of Economics, National and Kapodistrian University of Athens. Address: 1 Sofokleous and Aristidou Street, Athens, 10559, Greece (See map of the surroundings below. Note that street name signs are bilingual, Greek/English.)

Getting to the Venue (see Metro map below): by exiting the Metro Station "Panepistimio", i.e. University (red line), at Korai Square you see the University Rectorate Building. The other direction is Stadiou Street. Walk along Stadiou at the righthand side for about 100 metres, meet Pesmazoglou Street, go left and you see Gryparion Hall at the corner 1 Sofokleous and Aristidou Street.

On-site Arrival

The registration to the Conference is by invitation only. Arrival of participants at the venue on June 29 from 9:00 to 09:30.

Internet

 WI–FI is available in the venue area.

Account's information:
Username: user-conf
Password: 4873
This account will remain active until 30/06/2017

Account's information:
Username: icd-user
Password: 2838
This account will remain active until 30/06/2017

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Athens Metro Map

MetroEasy.com
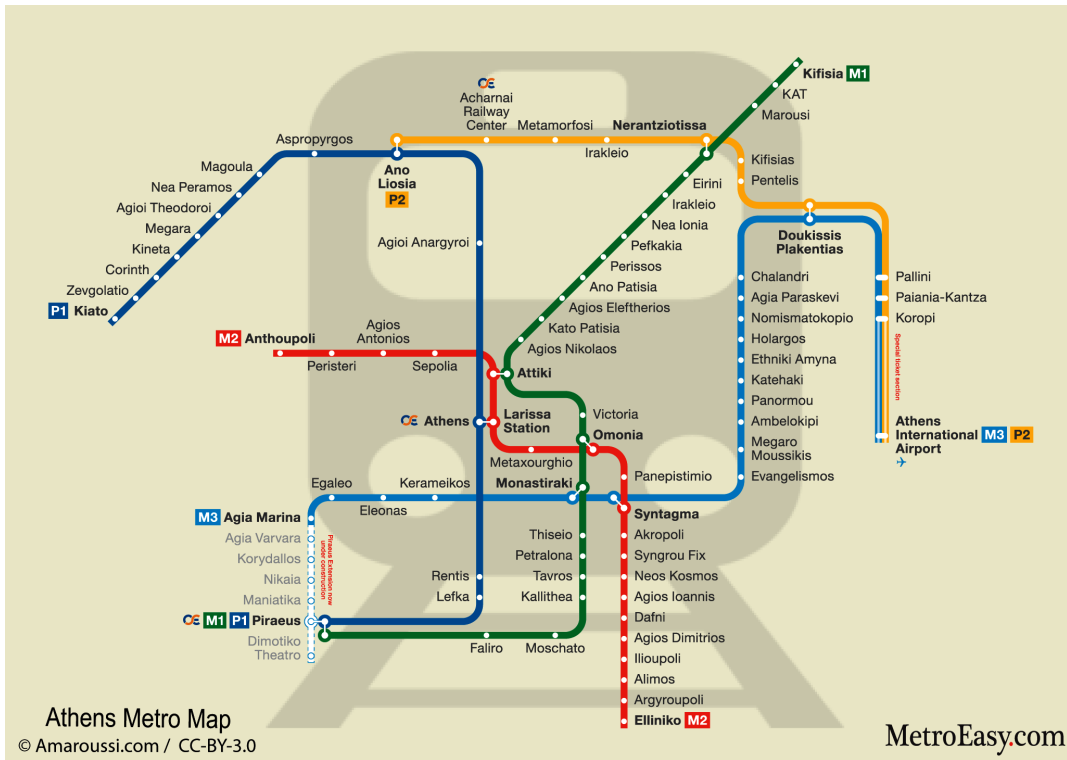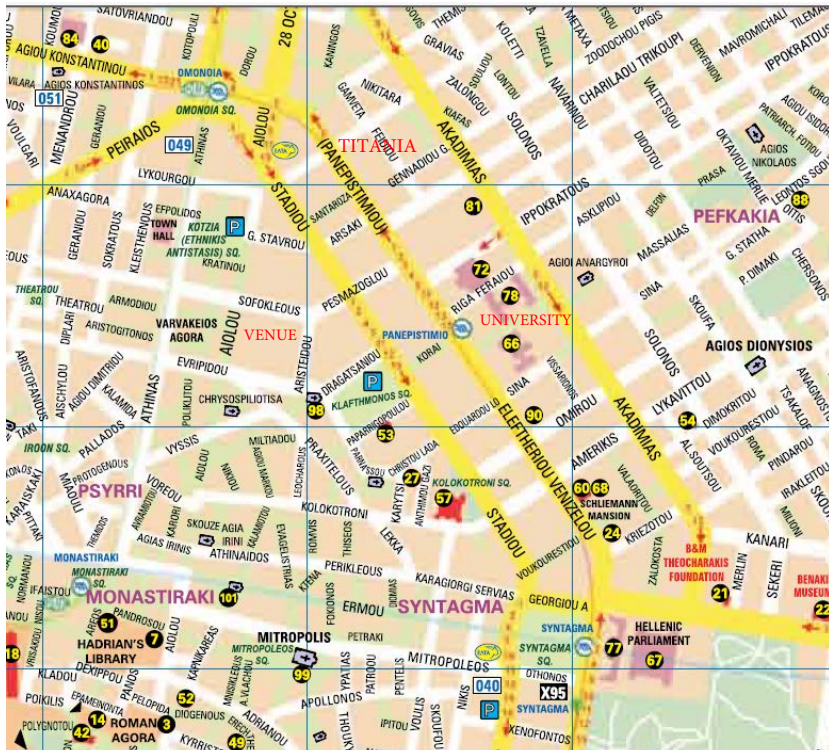
Sponsors

The official sponsor of the conference is the Postgraduate Programme of Applied Economics, Department of Economics, National and Kapodistrian University of Athens

Organizing Committee

COMMITTEE

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CONFERENCE SECRETARY

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Invited Speakers

1. Andrey Bogatyrev (Russian Academy of Sciences and Moscow Institute of Physics and Technology)

2. Coralia Cartis (University of Oxford)

3. Rev. Michael Cullinan (Maryvale Higher Institute of Religious Sciences)

4. Ioannis Demetriou (National and Kapodistrian University of Athens)

5. Dimitri Hristou-Varsakelis (University of Macedonia)

6. Valery Kalyagin (National Research University - Higher School of Economics, The Nizhny Novgorod branch)

7. Ilias Kotsireas (Wilfrid Laurier University)

8. Panos Pardalos (University of Florida)

9. Michael Rassias (University of Zürich)

10. Georgios Stavroulakis (Technical University of Crete)

11. Michael Vrahatis (University of Patras)

12. Zaikun Zhang (Hong Kong Polytechnic University)

Conference Program

June 29, Thursday

09:00–09:30 Registration
09:30–09:45 Welcome address, photo

Chair: Ioannis Demetriou
09:45–10:30 Panos Pardalos *On the Passage from Local to Global in Optimization: New Challenges in Theory and Practice*
10:30–11:15 Valery Kalyagin *Optimal Portfolio Selection and Estimation of Covariance Matrix: Bias-efficiency tradeoff*

11:15–11:45 Coffee break

Chair: Panos Pardalos
11:45–12:30 Andrei Bogatyrev *Optimal Multiband Electrical Filters: an approach of Analytical Ansatz*
12:30–13:15 Georgios Stavroulakis *Optimal Design of Piezocomposites including Fuzzy Control*

13:15–15:00 Lunch break

Chair: Valery Kalyagin
15:00–15:45 Michael Vrahatis, *Generalizations of the Bolzano Theorem*
15:45–16:30 Dimitri Hristou-Varsalelis *Tax Evasion as an Optimal Control Problem: Markov-based Models and Computational Challenges*

16:30–17:00 Discussion

20:00–23:00 Conference Banquet

June 30, Friday

Chair: Andrei Bogatyrev
09:30–10:15 Michael Cullinan *Piecewise Convex-Concave Approximation in the Minimax Norm*
10:15–11:00 Coralia Cartis *Complexity of Nonconvex Optimization: the story so far*

11:00–11:30 Coffee break

Chair: Michael Vrahatis
11:30–12:15 Zaikun Zang *A Space Transformation Framework for Nonlinear Optimization*

12:15–13:00 Michael Rassias *Open Problems in Mathematics with John F. Nash*

13:00–14:30 Lunch break

Chair: Michael Cullinan

14:30–15:15 Ilias Kotsireas *Low Autocorrelation Binary Sequences*

15:15–16:00 Ioannis Demetriou *Least Squares Piecewise Monotonic Data Approximation: Algorithms, Software and Applications*

16:00–16:15 End of the Conference

20:00–23:00 Dinner

Abstracts

On the Passage from Local to Global in Optimization: New Challenges in Theory and Practice

Panos M. Pardalos

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Large scale problems in the design of networks and energy systems, the biomedical field, finance, and engineering are modeled as optimization problems. Humans and nature are constantly optimizing to minimize costs or maximize profits, to maximize the flow in a network, or to minimize the probability of a blackout in the smart grid. Due to new algorithmic developments and the computational power of machines, optimization algorithms have been used to solve problems in a wide spectrum of applications in science and engineering. In this talk, we are going to address new challenges in the theory and practice of optimization, including exact approaches, approximation techniques, and heuristics. First, we have to reflect back a few decades to see what has been achieved and then address the new research challenges and directions.

Optimal Portfolio Selection and Estimation of Covariance Matrix: Bias-efficiency tradeoff

Valery Kalyagin and Sergey Slashinin

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Optimal portfolio selection in the stock market is an important problem in financial analysis. It attracts a permanent attention since the seminal work by H. Markowitz. Two criteria are usually used for the portfolio selection: efficiency and risk. In Markowitz model the stocks returns are represented by random variables. Efficiency of the stock is therefore measured by expectation of its return and efficiency of a portfolio is measured by expectation of the random variable associated with it. Measures of risk are more sophisticated. In the original work of Markowitz it was proposed to use standard deviation as a measure of risk. In this case the risk of portfolio is calculated as a quadratic form associated with the covariance matrix of

stocks returns. The problem of portfolio selection became a convex optimization problem and can be solved by different quadratic optimization techniques.

However, in practice, the expectations and the covariance matrix of stock returns are not known. One can use a sample of observations to estimate these parameters and then by means of the estimations to calculate the optimal portfolio. The main goal of the talk is to discuss how different are true and estimated optimal portfolios. We use data from different stock markets and state of the art estimations of the covariance matrix. A new interesting phenomenon is observed: there is a bias in efficiency for the estimated portfolio. This phenomenon will be discussed in detail.

Optimal Multiband Electrical Filters: an approach of Analytical Ansatz

Th. June 29,
11:45-12:30

Andrei Bogatyrev

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and Moscow Institute of Physics and Technology, Russia, ab.bogatyrev@gmail.com

The best uniform rational approximation of the Sign function on two intervals was explicitly found by Russian mathematician E.I. Zolotarev in 1877. Half a century after that the progress in math led to the progress in technology: German electrical engineer and physicist W.Cauer invented low and high-pass electrical filters known today as elliptic or Cauer-Zolotarev filters and possessing the unbeatable quality. We discuss an approach for the solution of optimization problem naturally arising in the synthesis of multi-band (analogue, digital or microwave) electrical filters. The approach is based on techniques from algebraic geometry and generalizes the construction of Zolotarev fraction.

Th. June 29,
12:30-13:15

Optimal Design of Piezocomposites including Fuzzy Control

Georgios E. Stavroulakis[a], Georgios Tairidis[b] and Georgia Foutsitzi[c]

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Piezocomposites are a prototype model of smart structures. First a detailed multi-layer plate and higher order beam and plate bending theories including piezoelectric layers have been developed, based on Hamiltons theory. The corresponding finite element model has been created and verified. Furthermore, delamination or damage in the glue layers have been added, so that realistic models of partially damaged layered structures can be created. Then a fuzzy control has been added. The performance of the resulting smart system has been optimized by using adaptive fuzzy techniques (ANFIS) and applicable global optimization (i.e. genetic algorithms and particle swarm optimization). The effectiveness of the optimized fuzzy controller has been numerically verified on partially delaminated structures.

Generalizations of the Bolzano Theorem

Michael N. Vrahatis

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Generalizations of the Bolzano theorem (also called intermediate value theorem) are presented. These generalized theorems are particular useful for the existence of a solution of a system of nonlinear equations in several variables as well as for the existence of fixed points of functions and the localization of extrema of objective functions.

The only computable information required by the hypotheses of these generalized theorems is the algebraic sign of the function that is the smallest amount of information (one bit of information) necessary for the purpose needed, and not any additional information. Thus, these theorems are of major importance for tackling problems with imprecise (not exactly known) information. This kind of problems occurs in various scientific fields including mathematics, economics, engineering, computer science, biomedical informatics, medicine and bioengineering among others. This is so, because, in a large variety of applications, precise function values are either impossible or time consuming and computationally expensive to obtain.

Key words: Bolzano theorem, intermediate value theorem, existence theorems, roots, fixed points, extrema, nonlinear equations, optimization, imprecise problems.

Tax Evasion as an Optimal Control Problem: Markov-based Models and Computational Challenges

D. Hristu-Varsakelis[a], P. Papadopoulou[b] and N. Goumagias[c]

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This work is part of a research program aimed at studying tax evasion as a dynamic optimization problem, for the purposes of informing tax policy. We will discuss a series of Markov-based models that capture the evolution of self-interested taxpayers, within a tax system that includes random audits, penalties for under-reporting income, and occasional tax amnesties at some cost to the taxpayer. Finding the taxpayers optimal strategy vis-a-vis tax evasion (and the effect on that strategy of various changes to the tax systems parameters) may be computationally tractable, or may require the use of powerful approximation techniques, depending on the taxpayers risk preferences and the amount of information they possess (e.g., example, whether a tax amnesty is imminent). We will discuss a range of optimization problems in this context and will focus in particular on how the tax systems statute of limitations on auditing past tax returns affects the taxpayers optimal strategy.

Piecewise Convex-Concave Approximation in the Minimax Norm

Fr. June 30,
9:30-10:15

Michael P. Cullinan

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Suppose that $f \in \mathbb{R}^n$ is a vector of n error-contaminated measurements of n smooth function values measured at distinct, strictly ascending abscissæ. The following projective technique is proposed for obtaining a vector of smooth approximations to these values. Find y minimizing $\|y - f\|_\infty$ subject to the constraints that the second order consecutive divided differences of the components of y change sign at most q times. This optimization problem (which is also of general geometrical interest) does not suffer from the disadvantage of the existence of purely local minima and allows a solution to be constructed in only $O(n \log n \ q)$ operations. A new algorithm for doing this is developed and its effectiveness is proved. Some results of applying it to undulating and peaky data are presented, showing that it is economical and can give very good results, particularly for large densely-packed data, even when the errors are quite large.

Complexity of Nonconvex Optimization: the story so far

Fr. June 30,
10:15-11:00

Coralia Cartis

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Establishing the global rate of convergence of standard algorithms or their global evaluation complexity for nonconvex smooth optimization problems is a natural but challenging aspect of algorithm analysis. In the last decade, substantial progress has been made and continues to be made, in this direction. We review some of the key developments, illustrating the crucial role played by cubic regularisation methods, a credible alternative to linesearch and trust-region. We then focus on two recent results. Firstly, we consider a general/new class of adaptive regularization methods, that use first- or higher-order local Taylor models of the objective regularised by a(ny) power of the step size. We investigate the worst-case evaluation complexity of these algorithms, when the level of sufficient smoothness of the objective and its derivatives may be unknown or may even be absent, and we find that the methods accurately reflect in their complexity the (unknown) degree of smoothness of the objective/derivatives and satisfy increasingly better bounds with the order of the derivatives available. We then focus on the antipodal context, when no derivatives of the objective are available, and the local models in adaptive cubic regularisation methods are constructed for example, by sampling of function values. We show that the evaluation complexity of the ensuing methods do not change in the order of the accuracy from their deterministic counterparts, increasing only by a constant factor which depends on the probability of the sampled models being sufficiently accurate, occasionally.

A Space Transformation Framework for Nonlinear Optimization

Zaikun Zhang[a], Serge Gratton[b] and Luis Nunes Vicente[c]

[a]Hong Kong Polytechnic University, [b]ENSEEIHT, France, [c]Universidade de Coimbra, Portugal

We present a space transformation framework for nonlinear optimization. Instead of tackling the problem in the original space, each iteration of this framework seeks for a trial step by modeling and approximately solving the optimization problem in another space. We establish the global convergence and worst case iteration complexity of the framework. Then we show that the framework can be specialized to a parallel space decomposition framework for nonlinear optimization, which can be regarded as an extension of the domain decomposition method for PDEs. A feature of the decomposition framework is that it incorporates the restricted additive Schwarz methodology into the synchronization phase of the method. We will illustrate how this decomposition framework can be applied to design parallel algorithms for optimization problems with or without derivatives.

Open Problems in Mathematics with John F. Nash

Michael Th. Rassias

University of Zürich, michail.rassias@math.uzh.ch

Dr. Rassias will refer to his collaboration with John F. Nash at Princeton during the academic year 2014-2015 for the preparation of their volume "Open Problems in Mathematics" (Springer, 2016). He will also talk about the Nyman-Beurling approach to the Riemann Hypothesis.

Low Autocorrelation Binary Sequences (LABS)

Ilias Kotsireas

Wilfrid Laurier University

We will describe the LABS problem, a challenging optimization problem that arises in mathematics, communications engineering and statistical physics. We will discuss the state-of-the-art algorithmic techniques to solve this problem as well as some complexity estimates derived from experimental work by various authors. The algorithmic techniques used in the LABS problem include branch and bound methods, group theory and high-performance (parallel) computing. We will also mention the open problems in the realm of LABS, as well as some recent new ideas.

Least Squares Piecewise Monotonic Data Approximation: Algorithms, Software and Applications

Ioannis C. Demetriou

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Algorithms, software and applications are presented for the following data approximation problem. Let a sequence of n univariate data that include random errors be given and let k be a prescribed integer. The problem of calculating the least squares change to the data subject to the condition that the first differences of the estimated values have at most $k - 1$ sign changes is considered. It is straightforward to see that the estimates form a n-vector with k monotonic sections in its components, alternately increasing and decreasing. The main difficulty in this optimization calculation is that the optimal positions of the joins of the monotonic sections have to be found automatically, but the number of all possible combinations of positions can be of magnitude n^{k-1}, so that it is not practicable to test each one separately.

However, the problem has been solved quite efficiently. The case $k = 1$ gives a monotonic fit to the data that is calculated in only $O(n)$ computer operations. The case $k > 1$ reduces to partitioning the data into at most k disjoint sets of adjacent data by a dynamic programming method and solving a $k = 1$ problem for each set. Two methodologically different algorithms have been developed that take advantage of certain properties that are implied by the optimization calculation. The first one requires $O(kn^2)$ computer operations. The other algorithm reduces the complexity to $O(n^2 + kn \log_2 n)$ operations, when $k \geq 3$, by taking advantage of some ordering relations between the indices of the joins during the data partition process. These two algorithms may lead to different utilization practices.

In relation to these algorithms, two Fortran software packages have been written by the author and some of its numerical results will be given. Each package consists of about 1500 lines including comments. One package is available from the Algorithms Collection of ACM Trans. Math. Software. The other package, based on some recent results, is not yet available to the public. The packages can manage routinely very large amounts of data. For example, they require few seconds to calculate a best fit with 10 or 100 monotonic sections to 30000 very noisy data on a common pc, which suggests that the packages are highly suitable.

Our method may have many applications, in various contexts in several disciplines. Besides that it reveals monotonicity relationships in subranges of the data, it may estimate automatically a prescribed number of turning points of a sequence of noisy data that represent an unknown function. The latter is highly useful to peak estimation, a subject of continuous interest in spectroscopy, chromatography, signal processing and time series, for instance. Other examples of applications arise from medical imaging, i.e. in reducing the noise in magnetic resonance imaging (MRI) and computed tomography (CT) due to smoothing efficacy, as well as in achieving shorter processing times due to efficiency, when multiple serial examinations are needed in the same patient, compared to contemporary technological standards. A selection of application results will be presented.

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