Optimization, Control and Applications in the Information Age

June 15-20, 2014

Meliton Hotel, Porto Carras, Neos Marmaras, Sithonia

Chalkidiki
Central Macedonia
Greece

Conference organized in honor of the 60th birthday of Professor **Panos M. Pardalos**

Conference co-Chairs

Sergiy Butenko
Industrial & Systems Engineering,
Texas A&M University

Athanasios Migdalas
Industrial Logistics,
Luleå Technical University
&
Civil Engineering,
Aristotle University of Thessaloniki

Scientific Committee

Vladimir Boginski

Christodoulos Floudas

Dalila Fontes

Pavlo Krokhmal

Dmytro Matsypura

Oleg Prokopyev

Themistocles Rassias

Mauricio Resende

NOTES

Professor Panos M. Pardalos

NOTES

Conference Schedule

Sunday, June 15
20:00 Welcome Reception

Monday, June 16
08:30-10:30 Session M1
- Anna Nagurney
- Monica Gabriela Cojocaru
- Vyacheslav V. Chistyakov
- Mikhail Batsyn
- Pablo San Segundo
- Sergiy Butenko

10:30-11:00 Coffee Break
11:00-13:00 Session M2
- Nenad Mladenovic
- Yannis Marinakis
- Valery Kalyagin
- Alexander Koldanov
- Dionne M. Aleman
- Alla Kammerdiner

13:00-14:30 Lunch

Tuesday, June 17
08:30-10:30 Session T1
- Antanas Žilinskas
- Yaroslav D. Sergeyev and Dmitri E. Kvasov
- Julius Žilinskas
- Anatoly Zhigljavsky
- Luis Nunes Vicente
- Steffen Rebennack

10:30-11:00 Coffee Break
11:00-13:00 Session T2
- Marco Carvalho
- Ashwin Arulselvan
- Pavlo Krokhmal
- Vladimir Boginski
- Oleg Prokopyev
- Stefan Pickl

13:00-14:30 Lunch
19:00 Gala Dinner &
Presentation by Stefan Pickl
on behalf of the German OR Society.

Wednesday, June 18
09:00-18:00 Excursion, discussions

Thursday, June 19
08:30-10:30 Session R1
- Stan Uryasev
- Roman Belavkin
- Dmytro Matsypura
- Hamid Khorasani
- Mahdi Pourakbari-Kasmaeia
- Sandra D. Ekşioğlu

10:30-11:00 Coffee Break
11:00-13:00 Session R2
- Erick Moreno-Centeno
- Dalila B.M.M. Fontes
- Alexander Ponomarenko
- Boris Mirkin
- Theodore Trafalis
- Alexey Myachin

13:00-14:30 Lunch

Friday, June 20

08:30-11:10 Session F1
- I. C. Demetriou
- Marios Poulos
- Fernando A.C.C. Fontes
- Vitaliy Yatsenko
- Nina Ovcharova
- Mario R. Guarracino
- Leonidas Pitsoulis
- Athanasia Karakitsiou

11:00 Adjournment

NOTES

Monday, June 16

Session M1: Monday, 8:30-10:30
Chair: Sergiy Butenko

Supply Chain Network Competition in Time-Sensitive Markets, Anna Nagurney[1,2], Min Yu[3], Jonas Floden[2], and Ladimer S. Nagurney[4], [1]*Department of Operations and Information Management Isenberg School of Management, University of Massachusetts, Amherst, Massachusetts 01003,* [2]*School of Business, Economics and Law University of Gothenburg, Gothenburg, Sweden,* [3]*Pamplin School of Business Administration, University of Portland, Portland, Oregon 97203,* [4]*Department of Electrical and Computer Engineering, University of Hartford, West Hartford, CT 06117*. E-mail: nagurney@gbfin.umass.edu.

Timely delivery of products are essential to consumer satisfaction as well as to a companys reputation. Vivid recent real-world failures in timely deliveries have demonstrated the practical impacts. Markets in which consumers are willing to pay a higher price for lower delivery times are referred to as being time-sensitive. In this paper, we develop a game theory model for supply chain network competition for time-sensitive markets in which consumers respond to the average time of delivery associated with the various firms products which represent brands. The behavior of the firms is captured, along with the supply chain network topologies, with the governing equilibrium concept being that of Nash equilibrium. We derive the variational inequality formulation of the equilibrium conditions and provide several illustrative examples. We also identify special cases that demonstrate how this framework may be used in distinct applications. An algorithm is provided, with nice features for computations, and the framework further illustrated through a case study for competitive freight service provision in which we explore varying sensitivities to the average time of delivery of products at the demand markets.

Generalized Nash Games and Evolutionary Variational Inequalities, Monica Gabriela Cojocaru, *Department of Mathematics & Statistics, University of Guelph, Canada*. E-mail: mcojocar@uoguelph.ca.

We show in this paper how a new parametrization technique can be introduced via the so-called evolutionary variational inequality (EVI) problems, such that by restricting the solution sets of such specialized EVI problems, together with complementarity conditions, we obtain a clear description of the solution set of a generalized Nash (GN) game with shared constraints. We give examples of how the technique is used and show that it solves GN previously not solved by existing VI parametrization techniques. We apply the method to several examples, including a vaccinating game in a heterogenous population where policy decisions are modelled as shared constraints.

Lipschitz maps in the modular sense and Banach's contraction principle, Vyacheslav V. Chistyakov, *Department of Applied Mathematics and Computer Science, National Research University Higher School of Economics, 25/12 Bol'shaya Pechërskaya Street, Nizhny Novgorod 603155, Russian Federation*.

In the context of the theory of Modular Metric Spaces developed by the author since 2006 [e.g., *Nonlinear Analysis* **72** (2010) 1–30] we discuss the notion and properties of counterparts of classical Lipschitz maps. A variant of the Banach contraction principle is presented in this context along with unexpected applications. Supported by LATNA Laboratory, NRU HSE, Russian Federation govenment grant, ag. 11.G34.31.0057.

A Simple Approach for Essential Improvement of the State-of-the-art Exact Algorithms for the Maximum Clique Problem, Mikhail Batsyn, Alexey Nikolaev, Panos M. Pardalos, Pablo San Segundo. E-mail: mbatsyn@hse.ru.

In this talk we present a straightforward and widely used in combinatorial optimization approach which improves any branch-and-bound algorithm essentially. The idea is to run a high-quality meta-heuristic before the main branch-and-bound algorithm in order to obtain a good initial solution and then use it to prune branches efficiently. In spite of its simplicity this powerful technique is not applied by any of the state-of-art algorithms for the maximum clique problem. We consider three most successful algorithms: BBMC (Segundo et al., 2013), MAXSAT (Li et al., 2013), and MCS (Tomita et al., 2010). Running the ILS heuristic (Andrade et al., 2010) before each of these branch-and-bound algorithms we considerably reduce the search tree size and the total computational time for each algorithm on DIMACS and BHOSLIB benchmark instances.

Computing Subchromatic Bounds in Exact Maximum Clique Search, Pablo San Segundo, Mikhail Batsyn, Aleksey Nikolaev.

Many efficient exact branch and bound maximum clique solvers use approximate coloring to compute an upper bound on the clique number for every subproblem. This technique promises reasonably tight bounds on average, but never tighter than the chromatic number of the graph. Recently a procedure to improve pruning by encoding the subgraph at each node of the search tree to Max-SAT has been described. Based on this idea, this paper shows an efficient way to produce tighter bounds directly in the graph domain. The algorithm improves the performance of BBMC, a leading solver in the field.

On Provably Best Construction Heuristics for Hard Combinatorial Optimization Problems, Sergiy Butenko, *Industrial & Systems Engineering, Texas A & M University*. Email: butenko@tamu.edu.

We define a heuristic to be *provably best* if, assuming P$\neq$NP, no other heuristic always finds a better solution (when one exists). This extends the usual notion of "best possible" approximation algorithms to include a larger class of heuristics. To illustrate the idea we show that some simple construction heuristics for maximum clique, maximum k-club, minimum (connected) dominating set, and minimum vertex coloring are provably best. The construction heuristics analyzed esemble those commonly used within popular metaheuristics. This is a joint work with Sera Kahruman-Anderoglu, Austin Buchanan, and Oleg Prokopyev.

Session M2: Monday, 11:00-13:00
Chair: Alla Kammerdiner

New MIP Model for Multiprocessor Scheduling Problem with Communication Delays, Nenad Mladenovic, *LAMIH, University of Valenciennes, France.*

In this research we first consider scheduling tasks on a homogeneous multiprocessor system, taking into account communication delays. We propose a new mixed integer formulation that drastically reduces both the number of variables and the number of constrains, when compared to the best mathematical programming formulations from the literature. In addition, we propose pre-processing procedures that generates cuts and bounds on all variables, reducing the solution space of the problem as well. Cuts are obtained by using forward and backward Critical path method inspired by Project management field, while the upper bound is derived from the new greedy heuristic. Computational experience shows advantages of our approach. Then, some extended new models are proposed, that also include heterogeneous architecture and their implementation in embedded systems.

This is a joint work with A A El Cadi, R B Atitallah, S Hanafi and A Artiba.

Adaptive Tunning of All Parameters in a Multi-Swarm Particle Swarm Optimization Algorithm. An Application to the Probabilistic Traveling Salesman Problem, Yannis Marinakis[1], Magdalene Marinaki[1] and Athanasios Migdalas[2], [1] *School of Production Engineering and Management, Technical University of Crete, 73100 Chania, Greece,* [2] *Department of Civil Engineering, Aristotle University of Thessalonike, 54124 Thessalonike, Greece,* `samig@civil.auth.gr`*, and Industrial Logistics, Luleå Technical University, 97187 Luleå, Sweden* . E-mail: marinakis@ergasya.tuc.gr, magda@dssl.tuc.gr, athmig@ltu.se.

One of the main issues in the application of a Particle Swarm Optimization (PSO) algorithm and of every evolutionary optimization algorithm is the finding of the suitable parameters of the algorithm. In this paper, we use a parameter free version of a Multi-Swarm PSO algorithm where random values are assigned in the initialization of all parameters (including the number of swarms) of the algorithm and, then, during the iterations the parameters are optimized together and simultaneously with the optimization of the objective function of the problem. This idea is used for the solution of the Probabilistic Traveling Salesman Problem (PTSP). The PTSP is a variation of the classic Traveling Salesman Problem (TSP) and one of the most significant stochastic routing problems. In the PTSP, only a subset of potential customers needs to be visited on any given instance of the problem. The number of customers to be visited each time is a random variable. The proposed algorithm is tested on numerous benchmark problems from TSPLIB with very satisfactory results. It is compared with other algorithms from the literature, and, mainly with a Multi-Swarm Particle Swarm Optimization with parameters calculated with a classic trial - and - error procedure and they are the same for all instances.

Market Graph and Markowitz Model, Valery Kalyagin, Alexander Koldanov, Petr Koldanov, and Viktor Zamaraev, *Higher School of Economics, Nizhny Novgorod, Russia*. E-mail: vkalyagin@hse.ru.

Market graph is known to be a useful tool for market network analysis. Cliques and independent sets of the market graph give an information about concentrated dependent sets of stocks and distributed independent sets of stocks on the market. In the present paper the connections between market graph and classical Markowitz portfolio theory are studied. In particular, efficient frontiers of cliques and independent sets of the market graph are compared with the efficient frontier of the market. The main result is: efficient frontier of the market can be well approximated by the efficient frontier of the maximum independent set of the market graph constructed on the sets of stocks with the highest Sharp ratio. This allows to reduce the number of stocks for portfolio optimization without the loss of quality of obtained portfolios. In addition it is shown that cliques of the market graphs are not suitable for portfolio optimization.

Statistical Uncertainty of Different Markets, A. P. Koldanov and V. A. Kalyagin, *National Research University Higher School of Economics, Nizhny Novgorod, Russia*. E-mail: alex.koldanov@gmail.com.

Network models of financial markets attract a growing attention in recent years [1,2]. Usually in network representation of the stock market each stock corresponds to a vertex and a link between two vertices is estimated by sample Pearson correlation of returns of corresponding stocks. In order to simplify the network and preserve the key information various filtering techiques are used. Applications of such filtering procedures lead to different network structures, e.g. minimum spanning tree (MST), planar maximally filtered graph (PMFG), market graph (MG), maximum clique (MC), maximum independent set (MIS) in a market graph.

Estimations of Pearson correlations are constructed by financial time series. A stochastic nature of this data raises a question of statistical uncertainty of obtained results. Measures of statistical uncertainty were proposed in [3]. These measures were used for analyzing statistical uncertainty of network structures for a model of US stock market. In this model vector of stock returns had multivariate normal distribution with given correlation matrix. In [3] the correlation matrix was obtained from real observations on stock returns of US market (NYSE and NASDAQ). The motivation of this work is to check whether the results obtained in [3] are specific for US market or there is a common feature for different markets. For this purpose we compare statistical uncertainty of network structures for the above model of the following markets: France (Paris) , Germany (Frankfurt), Great Britain (London), Italy (Milan), Russia (Moscow), USA (NYSE, NASDAQ). We study statistical uncertainty of the following network structures:

MST is a spanning tree of a network which consists of important links associated with the highest degree of similarity.

PMFG is obtained from MST by iteratively connecting the most similar nodes until the resulting graph is planar.

MG is constructed from the original network by removing all edges with correlations less than given threshold $\theta \in [-1, 1]$.

MC is a maximum subset of pairwise adjacent vertices of MG.

MIS is a maximum subset of vertices no two of which are adjacent in MG.

For different markets we observe a dissimilarity of correlation matrices and diversity of levels of statistical uncertainty of above mentioned structures. Our main finding is that despite this fact the levels of statistical uncertainty of structures follow the same order for all considered markets. This gives rise to conjecture that there is some unknown common feature in different market networks. In other words there are common properties of correlation matrices associated with different stock markets which have specific impact on statistical uncertainty.

Research was partially supported by LATNA Laboratory, NRU HSE, RF government grant, ag. 11.G34.31.0057.

[1] BOGINSKI V., BUTENKO S., PARDALOS P.M. Statistical analysis of financial networks *Computational Statistics & Data Analysis*. 48 (2) (2005) 431–443.

[2] TUMMINELLO M., ASTE T., MATTEO T.D., MANTEGNA R.N. A tool for filtering information in complex systems *Proceedings of the National Academy of Sciences*. 102 (30) (2005), 10421–10426.

[3] KALYAGIN V.A., KOLDANOV A.P., KOLDANOV P.A., PARDALOS P.M., ZAMARAEV V.A. Measures of uncertainty in market network analysis *arXiv:1311.2273*

Rule Mining for Implementable Public Policies, Dionne M. Aleman, *Department of Mechanical & Industrial Engineering, University of Toronto, Canada*. E-mail: aleman@mie.utoronto.ca.

Optimization of public policies that require intervention in individuals can be challenging as the input data may not exactly represent the population; the data is likely to be a statistical representation of a population, and even when particular data inputs correspond to exact individuals, it is unlikely that identifying information is present to tie a data point to a real person. We therefore examine the application of rule mining to optimization results to create simple, implementable rules that capture the optimal solutions properties. We specifically focus on the use of the critical node detection problem (CNDP) to optimally identify individuals to vaccinate to prevent pandemic disease spread based on the populations contact network. After obtaining optimal vertices to remove (individuals to vaccinate), we mine the demographic information of those individuals to obtain rules that can be followed to remove vertices without requiring exact graph structure knowledge. Results are shown for a five million-node contact network representing the Greater Toronto Area, Ontario, Canada.

Application of Optimization in Sensor-based Monitoring for Healthy Aging, Alla Kammerdiner, *New Mexico State University*. E-mail: alla@nmsu.edu.

Falls in older adults is a globally recognized health problem. In older population, falls lead to serious injuries and death. Thus, falls pose a major barrier for healthy aging. Wearable sensors are proven useful for detection of falls. The complementary information from sensors placed at different locations on a body can be used to improve the detection. Most methods are offline algorithms based on machine learning. We study continuous monitoring and real-time detection of falls with multiple complementary sensors. We formulate this as optimization problem. We introduce an example to illustrate our approach.

Tuesday, June 17

Session T1: Tuesday, 8:30-10:30
Chair: Steffen Rebennack

On the Statistical Models-Based Multi-Objective Optimization, Antanas Žilinskas, *Vilnius University, Lithuania*. E-mail: antanas.zilinskas@mii.vu.lt.

Multi-objective optimization problems with expensive, black-box objectives are difficult to tackle. For such type of single-objective global optimization problems, the algorithms based on the statistical models of objective functions and the concept of rational decision theory, are well suitable. In the present paper that approach to constructing of single-objective algorithms is generalized and extended to multi-objective optimization. An algorithm, based on the proposed approach, is implemented. Several numerical examples are presented to illustrate the performance of the implemented algorithm.

Global Optimization Methods Using the Lipschitz Condition, Yaroslav D. Sergeyev and Dmitri E. Kvasov, *DIMES, University of Calabria, Via P. Bucci, 42C – 87036, Rende (CS), Italy; Software Department, N. I. Lobachevsky State University, Nizhni Novgorod, Russia*. E-mail: yaro@si.dimes.unical.it, kvadim@si.dimes.unical.it.

Global optimization is a thriving branch of applied mathematics and an extensive literature is dedicated to it (see, e. g., [1–26]). In this lecture, the global optimization problem of a multidimensional function satisfying the Lipschitz condition over a hyperinterval with an unknown Lipschitz constant is considered. It is supposed that the objective function can be "black box", multiextremal, and non-differentiable. It is also assumed that evaluation of the objective function at a point is a time-consuming operation. Many algorithms for solving this problem have been discussed in literature. They can be distinguished, for example, by the way of obtaining information about the Lipschitz constant and by the strategy of exploration of the search domain. Different exploration techniques based on various adaptive partition strategies are analyzed.

The main attention is dedicated to two types of algorithms. The first of them is based on using space-filling curves in global optimization. A family of derivative-free numerical algorithms applying space-filling curves to reduce the dimensionality of the global optimization problem is discussed. A number of unconventional ideas, such as adaptive strategies for estimating Lipschitz constant, balancing global and local information to accelerate the search, etc. are presented.

Diagonal global optimization algorithms is the second type of methods under consideration. They have a number of attractive theoretical properties and have proved to be efficient in solving applied problems. In these algorithms, the search hyperinterval is adaptively partitioned into smaller hyperintervals and the objective function is evaluated only at two vertices corresponding to the main diagonal of the generated hyperintervals. It is demonstrated that the traditional diagonal partition strategies do not fulfil the requirements of computational efficiency because of executing many redundant evaluations of the objective function.

A new adaptive diagonal partition strategy that allows one to avoid such computational redundancy is described. Some powerful multidimensional global optimization algorithms based on the new strategy are introduced. Results of extensive numerical experiments performed on the GKLS-generator (see [2]) to test the proposed methods demonstrate their advantages with respect to traditional diagonal algorithms in terms of both number of trials of the objective function and qualitative analysis of the search domain, which is characterized by the number of generated hyperintervals.

A number of directions of possible developments is discussed briefly. Among them we can mention problems with Lipschitz derivatives, problems with multiextremal partially generated constraints, the usage of parallel non-redundant computations, and theoretical results on the possible speed-up.

This research was partially supported by the INdAM–GNCS 2014 Research Project of the Italian National Group for Scientific Computation of the National Institute for Advanced Mathematics "F. Severi".

[1] C. A. Floudas and P. M. Pardalos, *State of the Art in Global Optimization*. Kluwer, Dordrecht, 1996.

[2] M. Gaviano, D. E. Kvasov, D. Lera, and Ya. D. Sergeyev, "Algorithm 829: Software for generation of classes of test functions with known local and global minima for global optimization", *ACM Transactions on Mathematical Software*, **29**(4):469–480, 2003.

[3] S. Yu. Gorodetsky, "Several approaches to generalization of the DIRECT method to problems with functional constraints", *Vestnik of Lobachevsky State University of Nizhni Novgorod*, **6**(1):189–215, 2013. In Russian.

[4] D. R. Jones, C. D. Perttunen, and B. E. Stuckman, "Lipschitzian optimization without the Lipschitz constant", *Journal of Optimization Theory and Applications*, **79**: 157–181, 1993.

[5] R. Horst and P. M. Pardalos, *Handbook of Global Optimization*, Kluwer, Dordrecht, 1995.

[6] D. E. Kvasov, D. Menniti, A. Pinnarelli, Ya. D. Sergeyev, and N. Sorrentino, "Tuning fuzzy power-system stabilizers in multi-machine systems by global optimization algorithms based on efficient domain partitions", *Electric Power Systems Research*, **78**(7):1217–1229, 2008.

[7] D. E. Kvasov and Ya. D. Sergeyev, "A univariate global search working with a set of Lipschitz constants for the first derivative", *Optimization Letters*, **3**(2):303–318, 2009.

[8] D. E. Kvasov and Ya. D. Sergeyev, "Lipschitz gradients for global optimization in a one-point-based partitioning scheme", *Journal of Computational and Applied Mathematics*, **236**(16):4042–4054, 2012.

[9] D. E. Kvasov and Ya. D. Sergeyev, "Univariate geometric Lipschitz global optimization algorithms", *Numerical Algebra, Control and Optimization*, **2**(1):69–90, 2012.

[10] D. Lera and Ya. D. Sergeyev, "Lipschitz and Holder global optimization using space-filling curves", *Applied Numerical Mathematics*, **60**(1-2):115–129, 2010.

[11] D. Lera and Ya. D. Sergeyev, "An information global minimization algorithm using the local improvement technique", *Journal of Global Optimization*, **48**(1):99–112, 2010.

[12] D. Lera and Ya. D. Sergeyev, "Acceleration of univariate global optimization algorithms working with Lipschitz functions and Lipschitz first derivatives", *SIAM Journal on Optimization*, **23**(1):508–529, 2013.

[13] R. Paulavičius and J. Žilinskas, *Simplicial Global Optimization*, Springer, New York, 2014.

[14] R. Paulavičius, Ya. D. Sergeyev, D. E. Kvasov, J. Žilinskas, "Globally-biased DISIMPL algorithm for expensive global optimization",*Journal of Global Optimization*, to appear.

[15] J. Pintér, *Global Optimization in Action (Continuous and Lipschitz Optimization: Algorithms, Implementations and Applications*, Kluwer, Dordrecht, 1996.

[16] Ya. D. Sergeyev, "An information global optimization algorithm with local tuning", *SIAM Journal on Optimization*, **5**(4):858–870, 1995.

[17] Ya. D. Sergeyev, "Global one-dimensional optimization using smooth auxiliary functions", *Mathematical Programming*, **81**(1):127–146, 1998.

[18] Ya. D. Sergeyev, P. Pugliese, D. Famularo, "Index information algorithm with local tuning for solving multidimensional global optimization problems with multiextremal constraints", *Mathematical Programming*, **96**(3):489–512, 2003.

[19] Ya. D. Sergeyev and D. E. Kvasov, "Global search based on efficient diagonal partitions and a set of Lipschitz constants", *SIAM Journal on Optimization*, **16**(3):910–937, 2006.

[20] Ya. D. Sergeyev and D. E. Kvasov, *Diagonal Global Optimization Methods*, FizMatLit, Moscow, 2008. In Russian.

[21] Ya. D. Sergeyev and D. E. Kvasov, "Lipschitz global optimization", in J. J. Cochran et al., (Eds.), *Wiley Encyclopedia of Operations Research and Management Science (in 8 volumes)*, John Wiley & Sons, New York, **4**:2812–2828, 2011.

[22] Ya. D. Sergeyev, R. G. Strongin, and D. Lera, *Introduction to Global Optimization Exploiting Space-Filling Curves*, Springer, New York, 2013.

[23] R. G. Strongin, *Numerical Methods in Multi-Extremal Problems (Information-Statistical Algorithms)*, Nauka, Moscow, 1978. In Russian.

[24] R. G. Strongin and Ya. D. Sergeyev, *Global Optimization with Non-Convex Constraints: Sequential and Parallel Algorithms*, Kluwer, Dordrecht, 2000.

[25] A. A. Zhigljavsky, *Theory of Global Random Search*, Kluwer, Dordrecht, 1991.

[26] A. A. Zhigljavsky and A. Žilinskas, *Stochastic Global Optimization*, Springer, New York, 2008.

On Bounding Fronts in Multi-objective Branch and Bound, Julius Žilinskas, *Vilnius University*. E-mail: julius.zilinskas@mii.vu.lt.

In multi-objective optimization bounding front is a set of bounding vectors dominating all possible objective vectors corresponding to the subset of feasible solutions. Bounding fronts may be used to detect subsets of feasible solutions which cannot contain Pareto optimal solutions. This is the case when each bounding vector in the bounding front is dominated by at least one already known decision vector in the current solution set. In this talk we discuss and investigate bounding fronts for some multi-objective optimization problems.

Statistical Inference in Stochastic Global Optimization with Applications to Multi-Objective Optimization and Devising Stopping Rules, Anatoly Zhigljavsky, ZhigljavskyAA@cardiff.ac.uk.

We describe the main procedures of making statistical inferences about the minimum of the objective function that could be used in the algorithms of global random search. We show that the precision of these inferences gets exponentially worse as the dimension of the optimization problem increases. This makes the inferences unapplicable when this dimension becomes too large. We argue, however, that a typical multi-objective optimization problem can be reduced to a very large number of relatively simple problems of global optimization where these statistical inferences perform well and therefore may become very useful. We also show how one can estimate improvement in the precision of these statistical inferences if a certain amount of new evaluations of the objective function is to be made. A compromise between this improvement and the cost of new observations will therefore define a natural stopping rule that can be used in many algorithms of stochastic global optimization.

Direct Search Based on Probabilistic Descent, Luis Nunes Vicente *University of Coimbra, Portugal*. E-mail: lnv@mat.uc.pt.

Direct-search methods are a class of popular derivative-free algorithms characterized by evaluating the objective function using a step size and a number of (polling) directions. When applied to the minimization of smooth functions, the polling directions are typically taken from positive spanning sets which in turn must have at least $n+1$ vectors in an n-dimensional variable space. In addition, to ensure the global convergence of these algorithms, the positive spanning sets used throughout the iterations must be uniformly non-degenerate in the sense of having a positive (cosine) measure bounded away from zero.

However, recent numerical results indicated that randomly generating the polling directions without imposing the positive spanning property can improve the performance of these methods, especially when the number of directions is chosen considerably less than $n+1$.

In this talk, we analyze direct-search algorithms when the polling directions are probabilistic descent, meaning that with a certain probability at least one of them is of descent type. Such a framework enjoys almost-sure global convergence. More interestingly, we will show a global decaying rate of $1/\sqrt{k}$ for the gradient size, with overwhelmingly high probability, matching the corresponding rate for the deterministic versions of the gradient method or of direct search. Our analysis helps to understand numerical behavior and the choice of the number of polling directions.

This is joint work with Clément Royer, Serge Gratton, and Zaikun Zhang.

Natural Hazard Management for Post-Wildfire Debris Flows via Global Optimization, Steffen Rebennack[1], Vitaliy Krasko[1], Kevin McCoy[1], Paul Santi[1], and Daniel Kaffine[2], [1]*Colorado School of Mines, Golden, USA*, [2]*Department of Economics, University of Colorado at Boulder*.

Post-wildfire debris flows present a serious hazard in the western United States, causing destruction of buildings, degradation

of habitat and water quality, and loss of human life. We derive a coupled natural-social science optimization model that provides guidance for allocation of scarce management resources towards reducing the economic impacts of debris flows. The model minimizes expected damages by optimally allocating resources into mitigation treatments that decrease the probability of an event, reduce the volume conditional on occurrence, and/or protect elements at risk for every drainage basin, subject to a budget constraint. A case study of Santa Barbara following the 2009 Jesusita wildfire is presented. The probability of debris flow occurrence and potential volume are estimated for each drainage basin using models from literature, potential debris flow damages are estimated using an ArcGIS inundation mapping program, and mitigation strategies are quantified based on available data. The result is a highly nonconvex, nonlinear optimization program that allocates resources toward various mitigation strategies (e.g. mulching, check dams, straw wattles) across specific drainage basins in the site.

Session T2: Tuesday, 11:00-13:00
Chair: Stefan Pickl

Learning the Structure of Transportation Systems for Monitoring and Control, Marco M. Carvalho, *Computer Sciences at the Florida Institute of Technology, in Melbourne, FL/USA*. Email: mcarvalho@cs.fit.edu.

Real-time traffic accident prevention is important for both safety and economic reasons. Modern intelligent transportation systems (ITS) and advanced traffic management systems (ATMS) provide unprecedented capabilities, which may enable new technologies for tracking accident likelihood trends in order to properly anticipate corrective control actions. Previous research in the field has utilized real-time traffic data to identify changes in traffic patterns that might occur as result of an accident (accident detection), and to identify changes in traffic patterns that are indicators or precursors of traffic accidents (accident prediction).

The online prediction of traffic accidents is often based on models obtained from historical data that associate local traffic conditions with reported accidents. The underlying assumption is that traffic accidents are preceded by abnormal (or disruptive) traffic conditions that can be identified in real time. Once identified, such traffic conditions can be used as indicators or precursors of traffic accidents.

The prevention of traffic accidents, however, requires more than just accurate and timely prediction capabilities. It also depends on the capacity to identify the control actions that should be taken reduce accidents, and the capacity to predict any potential adverse effects that such actions could cause.

In this context, control action refers to the manipulation of traffic conditions in real-time including dynamic message signing, prepositioning of roadside service vehicles, changing ramp access signals, dispatching traffic control officers, and even temporary diversion or interrupting traffic. Decisions about such actions are traditionally taken by traffic control operators at the onset of disruptive traffic conditions, based on pre-defined procedures or contingency plans as well as their expertise and knowledge about the traffic network. In these circumstances, traffic management center operators, provide expertise about short-term potential causes of the undesirable traffic conditions.

In this talk we will introduce and discuss a semi-supervised, data-driven machine learning algorithms to identify the causal structure of traffic networks (at multiple spatial and temporal scales) to a) predict the emergence of disruptive traffic conditions that will increase the likelihood of traffic accidents, b) identify controllable causes, and c) recommend corrective actions that will mitigate the problem without causing adverse effects in the traffic network.

Network Flow in Orientable Graphs, Ashwin Arulselvan, Email: ashwin.arulselvan@gmail.com.

Nash-Williams famous orientation result states that every undirected graph has an orientation of its edges as arcs that retains at least half of its connectivity. We study a variation in which, we have nodes with supplies and demands and edges with capacities. We are expected to solve a transhipment problem after orienting the edges. While the static flow version of the problem is trivial, several interesting results ensues in the dynamic flow version of the problem. We show several hardness and existence results for the quickest and maximum flow versions of the problems. We also provide algorithms for special cases.

Risk-Averse Combinatorial Optimization Problems on Random Graphs, Pavlo Krokhmal, *Department of Mechanical and Industrial Engineering, University of Iowa, Iowa City, IA, USA*. E-mail: krokhmal@engineering.uiowa.edu.

We discuss a family of risk-averse combinatorial optimization problems on randomized graphs, where either vertex weights or edges are assumed to be uncertain with a known distribution. The goal is to obtain a subgraph of minimum risk that satisfies a given property. We employ a stochastic programming framework that is based on the formalism of modern theory of risk measures in order to find minimum-risk structures in graphs with stochastic vertex weights, and a two-stage stochastic optimization framework to construct minimum-risk subgraphs that are robust with respect to edge failures. Graph-based branch-and-bound algorithms for solving the proposed problems are developed and illustrated on special cases of risk-averse stochastic maximum clique problem. Numerical experiments on randomly generated Erdos-Renyi graphs demonstrate the computational performance of the developed branch-and-bound methods.

Node Interdiction in Coupled Interdependent Networks with Cascading Failures, Vladimir Boginski, *University of Florida*. E-mail: boginski@reef.ufl.edu.

We consider node interdiction problems in two-layer interdependent networks with cascading node failures that can be caused by two common types of interdependence ("one-to-many" and "many-to-one"). Previous studies on interdependent networks mainly addressed the issues of cascading failures from a numerical simulations perspective, whereas this work proposes a rigorous optimization-based approach for identifying an optimal subset of nodes, whose deletion would effectively disable both network layers through cascading failure mechanisms. We discuss computational complexity issues, mathematical programming formulations, related theoretical results, and

possible extensions of the considered problems. We also present computational experiments that illustrate interesting properties of interdependent networks with different types of interdependence.

An Integer Programming Framework for Critical Elements Detection in Graphs, Oleg Prokopyev, *University of Pittsburgh*. E-mail: droleg@pitt.edu.

In this talk we present an integer programming framework for minimizing the connectivity and cohesiveness properties of a given graph by removing nodes and edges subject to a joint budgetary constraint. The connectivity and cohesiveness metrics are assumed to be general functions of sizes of the remaining connected components and node degrees, respectively. We demonstrate that our approach encompasses, as special cases (possibly, under some mild conditions), several other models existing in the literature, including minimization of the total number of connected node pairs, minimization of the largest connected component size, and maximization of the number of connected components. We consider computational complexity issues, derive linear mixed integer programming (MIP) formulations, and describe additional modeling enhancements aimed at improving the performance of MIP solvers. We also discuss results of our computational experiments with real-life and randomly generated network instances under various settings that reveal interesting insights and demonstrate advantages and limitations of the proposed approach. This is a joint work with Alexander Veremyev and Eduardo L. Pasiliao.

Control of Computational Networks in Aviation Management – Simulation and Optimization of Complex Systems, Stefan Pickl. E-mail: stefan.pickl@unibw.de.

Aviation Management becomes more and more an important topic for Operations Research and especially Computational Management. This talk gives an overview on the simulation and optimization challenges of complex networks which occur in aviation management. Certain specific problems will be introduced. New methods like computational intelligence, evolutionary algorithms and system dynamics are presented and compared to classical solutions. In Lozovanu (2005) strategies to determine such optimal solutions are determined. General techniques are derived to determine certain specific equilibria within such networks. Furthermore, in Pickl (1999) a general algorithmic treatment of polytopes is used to determine stable and unstable regions within such a dynamic network structure. The approach is based on an algorithmic principle which is based on Brayton (1979). Both approaches together may lead to a general procedure in multi-layered control problems in aviation management.

[1] Brayton, R. K. and C. H. Tong; Stability and Dynamical Systems: A Constructive Approach, IEEE Transactions on Circuits and Systems, 26(4), 1979

[2] Lozovanu, D., Pickl, S. (2005) Nash Equilibria for Multiobjective Control of Time-Discrete Systems and Polynomial-Time Algorithms for k-Partite Networks, Central European Journal of Operations Research, Vol. 13, Issue 2, 127-146.

[3] Oliveira, C. and Pardalos, M.P. Mathematical Aspects of Network Routing Optimization, Springer, (2011)

[4] Pickl, S. (1999); Der -value als Kontrollparameter. Modellierung und Analyse eines Joint-Implementation Programmes mithilfe der kooperativen dynamischen Spieltheorie und der diskreten Optimierung. Shaker Verlag, Aachen.

Thursday, June 19

Session R1: Thursday, 8:30-10:30
Chair: Sandra D. Ekşioğlu

The Fundamental Risk Quadrangle and Applications, Stan Uryasev, *Industrial and Systems Engineering, University of Florida, Gainesville*. Email: uryasev@ufl.edu.

This presentation discusses the "Fundamental Quadrangle of Risk" framework including basic mathematical objects: Errors, Regrets, Risks, and Deviations. This framework suggests a consistent approach for defining and optimizing stochastic functions in various application areas.

Random variables that stand for cost, loss or damage must be confronted in numerous situations. Dealing with them systematically in risk management, optimization and statistics is the theme of this presentation, which brings together ideas coming from many different areas. Measures of risk can be used to quantify the hazard in a random variable by a single value. Such quantification of risk can be portrayed on a higher level as generated from penalty-type expressions of "regret" about the mix of potential outcomes. A trade-off between an up-front level of hazard and the uncertain residual hazard underlies that derivation. Regret is the mirror image of utility, a concept for dealing with gains instead of losses. Measures of error can associate with any hazard variable a "statistic" along with a "deviation" which quantifies the variable's nonconstancy. Measures of deviation, on the other hand, are paired closely with measures of risk exhibiting "aversity." A direct correspondence can furthermore be identified between measures of error and measures of regret. The Fundamental Quadrangle of Risk puts all of this together in a unifed scheme.

Distance to Optimum in Stochastic Landscapes, Roman Belavkin, *Copmputer Science Department, Middlesex University, London*. E-mail: r.belavkin@mdx.ac.uk.

Many optimization algorithms are based on computations of the gradient of an objective function or its approximations. However, the majority of continuous functions are nowhere differentiable, so that the gradient-based methods are not applicable. Instead, heuristics can be used provided that the objective function communicates some useful information. We study landscapes defined over metric spaces, and show that the values of the objective function communicate information about the distance to optimum in some neighbourhood.

A Robust Optimisation Approach to Bushfire Fuel Management, Dmytro Matsypura and Oleg Prokopyev.

Bushfires represent a real and continuing problem that can have a major impact on people, wildlife and the environment. One way to reduce the severity of their effect is through fuel management which usually consists of mechanical thinning and prescribed burning of the landscape. We propose a general methodology to address the problem of optimal resource allocation for bushfire fuel management subject to landscape connectivity and stochastic fuel regeneration. In this work we draw inspiration from the literature on robust optimisation, network interdiction and critical element detection in graphs. We develop a number of mixed integer programming formulations that are based on various landscape connectivity metrics. We then extend the formulations using robust optimisation to incorporate stochastic fuel regeneration in discrete time. The proposed approach takes into account the uncertainty of the fuel regeneration without assuming a specific distribution, while remaining highly tractable and providing insight into the corresponding optimal policy. It also allows adjustment of the level of conservativeness of the solution to trade off performance and protection against uncertainty. The attractiveness of the proposed approach is two-fold. First, the use of various connectivity metrics in the objective function adds to the modelling flexibility. Second, the robust problem is of the same difficulty as the nominal problem, i.e., it requires the same amount of computational effort. We also show that for some objective functions, the optimal policy obtained in the robust approach is identical to the optimal policy obtained in the nominal case for a modified and explicitly computable budget. We present extensive computational experiments that reveal interesting insights and demonstrate advantages and limitations of the proposed framework.

Security-Constrained Static Transmission Network Expansion Planning via a Hybrid Metaheuristic Algorithm, H. Khorasani, M. Pourakbari-Kasmaei, and R. Romero, *Dept. of Electrical and Computer Engineering, Universidade Estadual Paulista Ilha Solteira-SP, Brazil*. E-mail: khorasani.hamid@gmail.com, {mahdi@aluno, ruben@dee}.feis.unesp.br.

Transmission network expansion planning (TNEP) is one of the most important issues in the field of power systems and especially in deregulated power systems environment. TNEP is a non-linear mixed integer programming problem which encountered with some difficulties such as, the time consuming nature of the problem as well as need a non-convex optimization techniques. Due to the complicated combinatorial optimization problem and also there exist many local minima for such problem, it consider as a time consuming problem. As the conventional mathematical programming does not necessarily work so well, therefore various meta-heuristic optimization techniques have been tried out for this problem. However, scope for even better algorithms still remains. As a try to solve these problems of algorithms in this report a hybrid algorithm is presented to solve TNEP considering security constraints. The proposed methodology is based on the tabu search (TS) and genetic algorithm (GA). The hybrid algorithm incorporate some improved strategies to decrease the number of neighbors and consequently it decrease the number of linear programming problems required to be solved iteratively to find the final solution.

A Normalization-Based Approach to Solve Dynamic Economic and Emission Active-Reactive OPF, Mahdi Pourakbari-Kasmaeia, Marcos Julio Ridera, and Jose Roberto Sanches Mantovania, *Department of Electri-*

cal and Electronic Engineering, Universidade Estadual Paulista (UNESP), Ilha Solteira, Brazil.

This paper presents a novel normalization-based approach (NBA) to solve multi-objective optimization problems. In power system, economic and emission active-reactive optimal power flow (AROPF), as the kernel of a power system, is one of the most important multi-objective optimization problem. This problem is a highly nonlinear problem, and the dynamic consideration of such problems makes it even more complicated and extra-high nonlinear. Usually to find an acceptable compromise point for such problems a heuristic-based or enumerative approaches are useful, while these method are time consuming and are not practical. As the proposed approach is solvable via a commercial solver and it works based on the system topology, a real-time and acceptable compromise solution can then be the result that may use in a market-based power system. In the proposed NBA, instead of traditional pollution control cost (TPCC), a flexible pollution control cost (FPCC) is used to consider the system topology. By using a normalization process and FPCC, a uniform compromising procedure is obtained. Two test systems such as IEEE 14-bus, and IEEE 30-bus are conducted under various system conditions such as normal, outage, and critical conditions and results are compared with the traditional compromising approach. Results show the usefulness, effectiveness and superiority of the NBA methodology to find an acceptable compromise point.

Optimization Models in Support of Biomass Co-firing Decisions in Coal Fired Power Plants, Sandra D. Ekşioğlu and Hadi Karimi, *Department of Industrial & Systems Engineering, Mississippi State University, MS 39762, USA*. E-mail: sde47@ise.msstate.edu.

We present an optimization model to aid with biomass co-firing decisions in coal fired power plants. Co-firing is a strategy that can be used to reduce greenhouse gas emissions at coal plants. Co-firing is a practice that also impacts logistics-related costs, capital investments, plant efficiency, and tax credit collected. We present a nonlinear mixed integer programming model that captures the impact of biomass co-firing on the logistics-related costs, capital investments, plant efficiency, tax credit collected, and emission reductions. We also present a linear approximation of this problem which is easier to solve. We test the performance of the models proposed on a case study developed using data from the State of Mississippi. We perform a sensitivity analyses in order to evaluate the impact of biomass purchasing costs, biomass transportation costs, investment costs, and production tax credit on the cost of renewable electricity.

Session R2: Thursday, 11:00-13:00
Chair: Alexey Myachin

Matching Misaligned Two-resolution Metrology Data, Erick Moreno-Centeno, *Industrial and Systems Engineering, Texas A&M University, College Station, TX 77843-3131*. E-mail: e.moreno@tamu.edu.

By integrating metrology data with two different resolutions one can predict better the true surface of manufactured parts. The two datasets are: a scarce high-resolution (HR) dataset measured on a Coordinate Measuring Machine (CMM) with mechanical touch probe and a dense low-resolution (LR) data measured by an Optical CMM (OCMM). The LR dataset captures both local and global features of the part, while the HR dataset captures more accurately the overall surface. To integrate the two datasets, a critical step is to match each HR point to a LR point that measures roughly the same physical surface location. This matching is challenging because the CMM and OCMM have different coordinate systems, and thus the same coordinates refer to distinct physical locations. We formulate this problem as a quadratic assignment problem (QAP) and solve large scale instances (1500 by 100 points) by combining a MIP solver with a hierarchical method. This is joint work with Yaping Wang and Yu Ding.

A Genetic Algorithm for Scheduling Projects with Alternative Tasks Subject to Technical Failure, Dalila B.M.M. Fontes and José Fernando Gonçalves, *Faculdade de Economia da Universidade do Porto and LIAAD INESC TEC Rua Dr. Roberto Frias, 4200-464 Porto, Portugal*.

Nowadays, organizations are often faced with the development of complex and innovative projects. This type of projects often involves performing tasks which are subject to failure. Thus, in many such projects several possible alternative actions are considered and performed simultaneously. Each alternative is characterized by cost, duration, and probability of technical success. The cost of each alternative is paid at the beginning of the alternative and the project payoff is obtained whenever an alternative has been completed successfully. For this problem one wishes to find the optimal schedule, i.e. the starting time of each alternative, such that the expected net present value is maximized.

This is problem has been recently proposed by Ranjbar and Davari (2013), where a branch-and-bound approach is reported. Here we propose to solve the problem using genetic algorithms.

This research has been partially supported by ERDF (FEDER) and COMPETE through FCT project FCOMP-01-0124-FEDER-037281 and by North Portugal Regional Operational Programme (ON.2 O Novo Norte), under the National Strategic Reference Framework.

Comparative Analysis of Data Structures for Approximate Nearest Neighbor Search, Alexander Ponomarenko, *Junior Research Fellow, Laboratory of Algorithms and Technologies for Networks Analysis (LATNA), Russia*. E-mail: aponom84@gmail.com.

Search in a metric space has a vast range of applications in various fields of computer science. Many methods have been proposed for exact search, but they all surfer from the curse of dimensionality and are not applicable to high dimensional spaces. To avoid this restriction the methods for approximate search have been developed. Unfortunately the complexity for most of them is not known and only some empirical results exist. One of the way to figure out which algorithm is better, is to implement it and run tests on the same data sets. In this paper we present a comparative analysis of data structures dedicated to approximate nearest neighbor search in high dimensional metric spaces. We also provide a comparison with our recently published algorithm.

Semi-Average Criterion for Individual Clusters: Frameworks and Methods, Boris Mirkin, *Department of Data Analysis and Machine Intelligence, Higher School of Economics, Moscow Russia; Department of Computer Science, Birkbeck University of London, United Kingdom*. E-mail: bmirkin@hse.ru.

The semiaverage criterion is the product of the average within-cluster similarity and the number of elements in the cluster. Being quite convenient intuitively, the criterion emerges in at least three different approximate clustering frameworks: (i) finding a single cluster with a single intensity to maximally approximate a given similarity matrix; (ii) K-means clustering, (iii) consensus clustering.

An Add/Remove suboptimal search method is proposed to locally optimize the criterion. Three different extensions for extracting multi-cluster structures from data are proposed. These work well in practical computations. An extensive experimental comparison with existing consensus clustering algorithms, jointly with A. Shestakov, demonstrates superiority of the algorithm.

SVM Classification of Uncertain and Imbalanced Data Using Robust Optimization Multi-Kernel Methods, Theodore Trafalis[1] and Raghav Pant[2], [1]*University of Oklahoma, United States*, [2]*University of Oxford, United Kingdom*.

In this study we have developed a Robust Support Vector Machines (SVM) scheme of classifying uncertain and imbalanced data. In SVM classification data uncertainty is not addressed efficiently. Also, imbalanced data exist while performing analysis of rare events, in which the minority class becomes critical. Furthermore, while traditional SVM methods use a single kernel for learning, multiple kernel schemes are being developed to incorporate a better understanding of all the data features. We combine the multiple kernel learning methods with the robust optimization concepts to formulate the SVM classification problem as a semi-definite programming problem and develop its robust counterparts under bounded data uncertainties. We enhance our analysis by including multiple kernels for handling the data and investigate the robust formulations for such problems. Initial experimental results are presented.

Pattern Analysis and Its Application to Electoral Data in Russia, Fuad Aleskerov[1] and Alexey Myachin[2], *Academic supervisor of School of Applied Mathematics and Information Science, Head of International Laboratory of Decision Choice of Analysis, Professor*, [2]*Researcher of International Laboratory of Decision Choice of Analysis, Phd student of National Research University High School of Economics*. E-mail: alesk@hse.ru, amyachin@hse.ru

The method of pattern analysis is studied with new algorithms for patterns construction. This method is based on identifying the explicit and implicit relationships between studied objects by conducting clustering and dynamic analysis. As modifications using 2 methods: linear pattern classification and ordinal-invariant pattern clustering. Linear pattern classification will be determined by a single relation describing the studied object attributes that allows correlation in the same class objects on a single predefined order. Ordinal-invariant pattern clustering based on a consideration of all possible combinations of parameters being studied and developed in order to identify clusters described by these patterns.

The algorithms are applied to the pattern analysis of electoral behavior of the regions of Russian Federation. Timely detection of the common sentiment of citizens allows us to analyze not only political stability but also the socio-economic conditions, identify problem areas, which will take the necessary measures and prevent crises. As a result , in this paper we define patterns of electoral behavior in the Russian Federation, and also study the relationship of socio-economic conditions and political preferences of citizens.

Friday, June 20

Session F1: Friday, 8:30-11:10
Chair: Athanasia Karakitsiou

Sensitivity Analysis in Least Squares Data Fitting by Nonnegative Second Differences, I. C. Demetriou, *Department of Economics, University of Athens*. E-mail: demetri@econ.uoa.gr.

Let measurements of a real function of one variable be given. If the function is convex, but convexity has been lost due to errors of the measuring process, then it may be suitable to make the least sum of squares change to the data so that the second divided differences of the smoothed data are nonnegative. It is a quadratic programming calculation, where the constraints enter by the assumption of non-decreasing returns of the underlying function. The piecewise linear interpolant to the smoothed data is a convex curve. Convexity is a property that occurs in several disciplines, as, for example, in estimating a utility function that is represented by a finite number of observations that are corrupted by random errors. Other examples arise from optimal control data involving approximation by convex functions and from estimating the dopant profile in semiconductors, for instance. Some theorems are given that investigate the sensitivity of the smoothed data with respect to changes in the constraints and the data.

Stable EEG Features, Marios Poulos, *Laboratory of Information Technologies, School of Information Science and Informatics, Ionian University*. E-mail: mpoulos@ionio.gr.

Time-Frequency analysis of electroencephalogram (EEG) through several mental tasks received significant consideration. As EEG is non-stationary, time-frequency analysis is crucial to analyze brain states during different mental tasks. Further, the time-frequency information of EEG signal can be used as a feature for classification in brain-computer interface (BCI) applications [1-7] or for Diagnostic Purpose [8].

To accurately model the EEG, band-limited multiple Fourier linear combiner, a linear combination of segmented multiple Fourier series models using symmetry spectral properties is employed. A state-space model for autocorrelation coefficients is developed to obtain accurate adaptive estimation [9]. By virtue of functions construction with autocorrelation coefficients, a trust-region method [10] is adopted in order to personalize the EEG using cross-sectional [11] spectral symmetry data.

The proposed method is computationally fast and is suitable for real-time BCI applications and diagnostic purposes such as epilepsy. Furthermore, significant stable points are detective using this procedure.

Results show that the proposed algorithm can provide an optimal time-frequency resolution using autocorrelation procedure in order to highlight stable EEG points around a trust-region. The next step is the evaluation of this procedure beyond of BCI applications and specifically in the field of the relationship between the variables and EEG values.

[1] Poulos, M., Rangoussi, M., Alexandris, N., 1999a. Neural network based person identification using EEG features, in: Acoustics, Speech, and Signal Processing, 1999. Proceedings., 1999 IEEE International Conference on. IEEE, pp. 11171120.

[2] Poulos, M., Rangoussi, M., Chrissikopoulos, V., Evangelou, A., 1999b. Parametric person identification from the EEG using computational geometry, in: Electronics, Circuits and Systems, 1999. Proceedings of ICECS99. The 6th IEEE International Conference on. IEEE, pp. 10051008.

[3] Poulos, M., Rangoussi, M., Chrissikopoulos, V., Evangelou, A., 1999c. Person identification based on parametric processing of the EEG, in: Electronics, Circuits and Systems, 1999. Proceedings of ICECS99. The 6th IEEE International Conference on. IEEE, pp. 283286.

[4] Poulos, M., Rangoussi, M., Chrissikopoulos, V., Evangelou, A., Georgiacodis, F., 2004. Comparative analysis of the computational geometry and neural network classification methods for person identification purposes via the EEG: Part 1. Journal of Discrete Mathematical Sciences and Cryptography 7, 319347.

[5] Palaniappan, R., 2005. Brain computer interface design using band powers extracted during mental tasks, in: Neural Engineering, 2005. Conference Proceedings. 2nd International IEEE EMBS Conference on. IEEE, pp. 321324.

[6] Felzer, T., 2001. On the possibility of developing a brain-computer interface (bci). Technical University of Darmstadt, Department of Computer Science.

[7] Marcel, S., Milln, J. del R., 2007. Person authentication using brainwaves (EEG) and maximum a posteriori model adaptation. Pattern Analysis and Machine Intelligence, IEEE Transactions on 29, 743752.

[8] Poulos, M., Georgiacodis, F., Chrissikopoulos, V., Evagelou, A., 2003. Diagnostic Test for the Discrimination between Interictal Epileptic and Non-Epileptic Pathological EEG Events using AutoCross-Correlation Methods. American journal of electroneurodiagnostic technology 43.

[9] Poulos, M., Papavlasopoulos, S., 2013. Automatic stationary detection of time series using auto-correlation coefficients and LVQNeural network, in: Information, Intelligence, Systems and Applications (IISA), 2013 Fourth International Conference on. IEEE, pp. 14.

[10] Mendonca, M.W., 2009. Multilevel Optimization: Convergence Theory, Algorithms and Application to Derivative-Free Optimization. Phd thesis, Facults Universitaires Notre-Dame de la Paix, Namur, Belgium.

[11] McArdle, J.J., Hamagami, F., 1992. Modeling incomplete longitudinal and cross-sectional data using latent growth structural models. Experimental aging research 18, 145166.

A Dynamically Adaptive Mesh-grid Algorithm for Continuous-time Model Predictive Control, Fernando A.C.C. Fontes and L. T. Paiva, *ISR-Porto, Universidade do Porto, Rua Dr. Roberto Frias, 4200-465 Porto, Portugal.*

In a model predictive control (MPC) scheme, a sequence of optimal control problems has to be solved on-line, typically within a certain computational time limit. To guarantee stability of an MPC scheme requires, among other conditions, that the sequence of (sub)optimal costs obtained is monotonically decreasing at a certain rate. In this work, we build upon an algorithm for time-mesh refinement of optimal control problems and adapt it to MPC, taking into account the computational time limit and the stability guarantee requirement.

Modeling and Optimization of Laser Docking System for Space Satellites, Vitaliy Yatsenko, *Space Research Institute of NASU-SSAU, Kiev, Ukraine*. E-mail: vyatsenko@gmail.com

This report deal with a possible alternative concept of laser docking system for space satellites. The scope of the analysis was to determine the capability of optimization and modeling methods for Autonomous Docking Satellite Systems, and to develop the new concept. Our approach is based on modeling and global optimization approach to autonomous on-orbit assembly in space with unique vision and sensor driven docking mechanism. The autonomous system is a smart system that incorporate a vision and pattern recognition systems used for identifying, tracking, locating and mating the transferring device to the receiving device. The following subsystems have been simulated: (1) coupler for the transfer of the fuel, (2) advanced sealing technology for isolation and purging of resulting cavities from the mating process and/or from the incorporation of other electrical and data acquisition devices used as part of the overall smart system; (3) imaging sensors and computer vision technologies for detection a target spacecraft at a distance of several hundreds meters and to guide the approaching spacecraft to contact; (4) novel LIDAR technologies and computer vision algorithms. Such systems will be capable of autonomously detecting a target satellite at a distance of a few kilometers, estimating its bearing, range and relative orientation under virtually any illumination, and in any satellite pose. The mathematical model of vision system that uses a scanning LIDAR to estimate pose of a known satellite has been proposed.

Numerical Simulation of the Double Cantilever Beam (DCB) Test Problems by Using Nonconvex Bundle Method and Regularization Techniques, Nina Ovcharova and Joachim Gwinner, *Institute of Mathematics, Department of Aerospace Engineering, Universität der Bundeswehr München, Werner-Heisenberg-Weg 39, 85577 Neubiberg*. E-mail: nina.ovcharova@unibw-muenchen.de, joachim.gwinner@unibw.de.

We consider problems with structual adhesive bonding which lead in their mathematical formulation to boundary value problems that involve nonmonotone and multivalued laws in the boundary conditions. These laws can be expressed by means of the Clarke subdifferential of a nonconvex, nonsmooth but locally Lipschitz function, the so-called superpotential. The variational formulation of these boundary value problems involving such laws gives rise to hemivariational inequalities with minimum superpotential. Since the mathematical analysis of the hemivariational inequalities is well established, we focus on their efficient numerical simulation. In general, there are two approaches for the numerical treatment of these nonconvex nonsmooth variational problems. The first one uses a regularization of the nonsmooth functional leading to a smooth variational problem, see [3]. The second one relies after discretization by finite element methods on nonsmooth optimization methods, like bundle types methods. In this work, we compare the nonconvex bundle method [1,2] with the regularization method [3,4] in terms of their efficiency, see also [5], and demonstrate the applicability of those methods in numerical simulation of the Double Cantilever Beam (DCB) Test Problems. We compute the unknown normal displacement on the contact boundary and the corresponding normal component of the stress vector. The latter is very important for the needs of the industry to predict the eventual failure of the structure by delamination.

[1] Noll, D., Prot, O., Rondepierre, A., *A proximity control algorithm to minimize nonsmooth and nonconvex functions*, Journal of Convex Analysis, Vol.16 (2009), 641 - 666.

[2] Noll, D.: *Cutting plane oracles to minimize non-smooth non-convex functions*, Journal of Set-Valued and Variational Analysis Vol. 18 (2010), 531-568.

[3] Ovcharova, N., *Regularization Methods and Finite Element Approximation of Hemivariational Inequalities with Applications to Nonmonotone Contact Problems*, PhD Thesis, Universitt der Bundeswehr Mnchen, Cuvillier Verlag, Göttingen 2012.

[4] Ovcharova, N., Gwinner. J., *A Study of Regularization Techniques of Nondifferentiable Optimization in View of Application to Hemivariational inequalities*, J. Optim. Theory Appl., DOI 10.1007/s10957-014-0521-y

[5] Dao, M.N., Gwinner, J., Noll, D. Ovcharova, N. *Nonconvex bundle method with application to a delamination problem*, submitted to SIOPT

Robust Optimization in Eigenvaluebased Classification, Petros Xanthopoulos[1] and Mario R. Guarracino[2], [1]*Industrial Engineering and Management Systems Department, University of Central Florida, USA*, [2] *High Performance Computing and Networking Institute, National Research Council of Italy, Naples, Italy*.

Uncertainty induces bias and degrades performance in classification tasks. Robust optimization I often used for incorporating the uncertainty effect into the classifier and provide with solutions able to handles noisy datasets. In this presentation we present some recent result of robust optimization in supervised learning for classifiers such as support vector machines and a robust eigenvalue based learning model.

Community Structure in Networks and Modularity, Leonidas Pitsoulis, *Department of Electical and Computer Engineering, University of Thessaloniki, Greece*. E-mail: pitsouli@auth.gr.

Community structure in a graph is an important large scale characteristic and detection of community structure remains up to this date a computationally challenging problem. The modularity value of a set of vertex clusters in a graph is a widely used quality measure for community structure. In this talk we prove that modularity can fail to detect community structure by

showing the existence of a family of graphs upon which modularity maximization underestimates the number of clusters. We also examine alternative quality functions based on a random model.

Discrete Competitive Facility Location: Modelling and Optimization Approaches Athanasia Karakitsiou and Athanasios Migdalas, *Industrial Logistics*. Email: athkar@ltu.se, athmig@ltu.se

Competitive facility location problems are concerned with the following situation: a firm wants to locate a predefined number of facilities to serve customers locate in some region where there already exist (or will be) other firms offering the same service. Both new and existing firms compete for optimizing their market share of profit. A discrete version of such problems arises when it is assumed that there is a (rather small) finite number of candidate locations and the markets consist of point demands. We review modeling and optimization approaches for this type of problems and we emphasize and develop the bi-level programming methodology.