EUROPT 2018
July 12- 13 Almería, Spain

Program

16th EUROPT Workshop on Advances in Continuous Optimization (EUROPT2018)

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Patrocinan

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Thursday, 8:30 - 9:00

■ TA-01

Thursday, 8:30 - 9:00 - Aula Magna

Opening Session

Stream: Opening Session
Plenary session

Thursday, 9:00 - 9:50

■ TB-01

Thursday, 9:00 - 9:50 - Aula Magna

Plenary I : Coralia Cartis

Stream: Plenary III
Plenary session
Chair: *Emilio Carrizosa*

1 - Optimization with expensive and uncertain data - challenges and improvements
Coralia Cartis

Real-life applications often require the optimization of nonlinear functions with several unknowns or parameters - where the function is the result of highly expensive and complex model simulations involving noisy data (such as climate or financial models, chemical experiments), or the output of a black-box or legacy code, that prevent the numerical analyst from looking inside to find out or calculate problem information such as derivatives. Thus classical optimization algorithms, that use derivatives (steepest descent, Newton's methods) often fail or are entirely inapplicable in this context. Efficient derivative-free optimization algorithms have been developed in the last 15 years in response to these imperative practical requirements. As even approximate derivatives may be unavailable, these methods must explore the landscape differently and more creatively. In state of the art techniques, clouds of points are generated judiciously and sporadically updated to capture local geometries as inexpensively as possible; local function models around these points are built using techniques from approximation theory and carefully optimised over a local neighbourhood (a trust region) to give a better solution estimate. In this talk, I will describe our improvements and implementations to state-of-the-art, model-based trust-region, methods. In the context of the ubiquitous data fitting/least-squares applications, we have developed an approach that uses flexible local models in terms of number of points and evaluations needed to construct them; this allows us to make progress in the algorithm from very little problem information when the latter is preciously expensive. Furthermore, it employs restart strategies in the presence of noisy evaluations, that are an inexpensive alternative to sample averaging and regression, with superior performance. I will also prove convergence of these methods, even when the noise is biased or when sampling may not be sufficiently accurate, hence when we only have accurate local models occasionally. Despite derivative-free optimisation methods being able to only provably find local optima, we illustrate that, due to their construction and applicability, these methods can offer a practical alternative to global optimisation solvers, with improved scalability.

This work is joint with Lindon Roberts (Oxford), Katya Scheinberg (Lehigh), Jan Fiala (NAG Ltd) and Benjamin Marteau (NAG Ltd).

Thursday, 10:00 - 10:50

■ TC-01

Thursday, 10:00 - 10:50 - Aula Magna

EUROPT Fellow Lecture

Stream: EUROPT Fellow Lecture
Plenary session
Chair: *Julius Žilinskas*

1 - EUROPT Fellow Lecture.
Europt Fellow 2018

EUROPT honors outstanding researchers in continuous optimization by awarding the EUROPT Fellowship. The Fellowship is presented to the awarded researcher annually, at the EUROPT Workshop. The Fellow is invited to present the EUROPT Fellow Lecture as a plenary talk at the Workshop. Each EUROPT member is eligible to nominate candidates for the Fellowship. The nomination must include a nomination letter of no more than two pages and a short CV of the candidate. The nomination material must be sent in electronic form to the current Chair of the EUROPT Managing Board no later than January 31 in the year when the Fellowship will be awarded. The EUROPT Managing Board serves as the selection committee. Based on the nominations and the resulting votes, the selection committee chooses the EUROPT Fellow.

Thursday, 11:30 - 13:00

■ TD-01

Thursday, 11:30 - 13:00 - Room 5

Efficient Bounding and Approximation in Conic Optimization and Copositivity

Stream: Conic and Copositive Optimization
Invited session
Chair: *Paula Amaral*

1 - Strong and Cheap SDP and SOCP Hierarchies for Polynomial Optimization
Bissan Ghaddar, Xiaolong Kuang, Luis Zuluaga, Joe Naoum-Sawaya

In this talk, we propose alternative SDP and SOCP approximation hierarchies to obtain global bounds for general polynomial optimization problems (POP), by using SOS, and SDSOS polynomials to strengthen existing hierarchies for POPs. Specifically, we show that the resulting approximations are substantially more effective in finding solutions of certain POPs for which the more common hierarchies of SDP relaxations are known to perform poorly. Numerical results based on the proposed hierarchies are presented on non-convex instances form the literature as well as on instances from GLOBAL Library.

2 - On regular simplices and monotonicity in copositivity detection
Eligius M.T. Hendrix, Leocadio G. Casado, Jose Manuel Garcia Salmeron

During the last few years, we have been investigating the potential of using refinement via regular simplices in a branch and bound procedure for copositivity detection. We found how monotonicity considerations can speed up the search process in order to reduce dimension. Recently we looked into the use of eigenvalues over de different facets of the unit simplex. We report on our findings. This research has been funded by national project TIN2016-66680 in part financed by the European Regional Development Fund (ERDF).

3 - Efficient Bounds for Min-Max fractional problems
Paula Amaral, Immanuel Bomze

Fractional min-max problem occurs, among others, in the study of worst-case analysis when different scenarios are under evaluation. Fractional programs are in general non-convex programs and good lower bounds play a crucial role, for instance, in exact methods. We present completely positive formulations and study the properties of the doubly positive (DP) relaxations. Computational experience is reported.

4 - A Copositive Approach for Decision Rule Approximations of Multi-Stage Robust Optimization Problems
Guanglin Xu, Grani A. Hanasusanto

We study decision rule approximations for a multi-stage adaptive robust linear optimization (ARLO) problem. We consider the linear decision rule approximation for the case when the objective coefficients, the recourse matrices, and the right-hand sides are uncertain and consider the quadratic decision rule approximation for the case when only the right-hand sides are uncertain. The resulting optimization problems are NP-hard but amenable to copositive programming reformulations that give rise to tight conservative approximations. We provide both theoretical and numerical results.

■ TD-02

Thursday, 11:30 - 13:00 - Room 6

Convex optimization

Stream: Convex optimization
Contributed session
Chair: *Eligius M.T. Hendrix*

1 - Second order asymptotic functions
Alfredo Iusem

We introduce a new second order asymptotic function which gives information on the convexity (concavity) of the original function from its behavior at infinity. We establish several properties and calculus rules for this concept, which differs from previous notions of second order asymptotic function. Finally, we apply our new definition in order to obtain necessary and sufficient optimality conditions for quadratic programming and quadratic fractional programming.

2 - Improved optimality conditions for fuzzy mathematical programming
Beatriz Hernández-Jiménez, Rafaela Osuna-Gómez, Yurilev Chalco-Cano, Gabriel Ruiz-Garzón

We present optimization problems where both the objective and constraints are given by fuzzy functions. In order to solve them, we introduce a new and wider stationary point concept that generalizes all existing concepts so far. It is based on the gH-differentiability and has many computational advantages. The gH-derivative for a fuzzy function is a more general concept than the ones that are usually used. With this new differentiability concept, we prove a necessary optimality condition that is more operational and less restrictive that the few ones we can find in the literature so far.

3 - On Lipschitz Lower Semicontinuity Properties of Feasible Set Mappings in Parametric Optimization Problems
Maria Jesús Gisbert Francés, Maria Josefa Cánovas, Rene Henrion, Juan Parra

It is well-know that the stability of the feasible set mapping associated to a parametric optimization problem can be studied through its behavior under perturbations of the nominal data in terms of Lipschitz' type properties. In this talk, we focus on the intermediate property between Aubin's and Lipschitz lower semicontinuity, which we call Lipschitz lower semicontinuity*. Specifically, we study the relevancy of this property and its relationship between the others in different contexts of problems and under varied kind of perturbations.

■ TD-03

Thursday, 11:30 - 13:00 - Room 7

Optimal Control and Optimization in Economics and Finance I

Stream: Optimal Control and Optimization in Economics and Finance
Invited session
Chair: *Gerhard-Wilhelm Weber*

1 - On controlling the flux map of solar power tower plants through global optimization
N.c. Cruz, Juana Lopez Redondo, J.d. Álvarez, Manuel Berenguel, Pilar M. Ortigosa

A solar power tower plant has a set of sun-tracking mirrors, called heliostats, and a radiation receiver. Heliostats concentrate solar radiation on the receiver, in which flows a fluid to be heated to generate electricity. The flux map projected on the receiver must be adjusted to avoid thermal stress and maximize the system efficiency. By using analytical flux models, it is possible to define an optimization problem aimed at minimizing the difference between the achieved flux map and the desired one. However, modeling errors must be corrected dynamically through feedback.

2 - Robust portfolio decisions for financial institutions
Ioannis Baltas, Anastasios Xepapadeas, Athanasios Yannacopoulos

We study a robust control problem arising in the management of financial institutions: an economic agent manages the wealth of a financial firm, however, she does not fully trust the model she faces, hence she decides to make her decision robust. By employing dynamic programming techniques, we provide closed form solutions for various utility functions. We also provide a detailed study of the limiting behavior, of the associated stochastic differential game, which, in a special case, leads to break-down of the solution of the resulting HJBI equation. We conclude with a detailed numerical study

3 - Stochastic optimal control in the presence of regime switches, paradigm shifts jumps and delay, in finance, economics and medicine
Gerhard-Wilhelm Weber, Emel Savku

We contribute to modern OR by hybrid (continuous-discrete) dynamics of stochastic differential equations with jumps and their optimal control. These systems permit the representation of random regime switches or paradigm shifts, and are of growing importance in science, biology, economics, medicine and engineering. We introduce several new approaches to this area of stochastic optimal control and present results. These are analytical, finding of optimality criteria, of closed-form or numerical solutions. We discuss the occurrence of delay, of partial information and games, and give examples.

■ TD-04

Thursday, 11:30 - 13:00 - Room 8

Numerical Methods and Software I

Stream: Numerical Methods and Software
Contributed session
Chair: *Janos D. Pinter*

1 - An Inertial Forward-Backward Method for Solving Vector Optimization Problems
Sorin-Mihai Grad

We present an iterative proximal inertial forward-backward method with memory effects, based on recent advances in solving scalar convex optimization problems and monotone inclusions, that is employed for determining weakly efficient solutions to convex vector optimization problems consisting in vector-minimizing the sum of a differentiable vector function with a nonsmooth one, by making use of some adaptive scalarization techniques. Computational results are presented as well.

2 - Young-programming: algorithms and applications
Anita Varga, Tibor Illés, Levente Mályusz

Young-programming (YP) is a convex optimization problem class introduced by Klafszky and Kas (1997) as approximation of linear programming problem and developed duality theory of it. Mályusz (1998) showed many applications of YP. The first algorithm for YP is a row-action algorithm (RAA) developed by Csiszár (1993). Convergence of the RAA for YP has been discussed. Boratas et al. (2002) showed that for some type of YP usual barrier functions do not possess self-concordant property. Solvability of wide class of YP problem has been revisited. We present our new results.

3 - Composite Test Functions for Benchmarking Nonlinear Optimization Software
Janos D. Pinter

We introduce a framework for defining flexible combinations of global optimization test functions with known solutions. The difficulty of composite test functions is greatly influenced by their components: therefore their controllable difficulty can vary from "easy" to "challenging". Treating a composite problem as a "black box" hides the underlying structure from the solver engine used: therefore composite test functions can be put to use in software benchmarking. The approach is illustrated by solving a collection of composite test problems in the AMPL optimization environment.

■ TD-05

Thursday, 11:30 - 13:00 - Room 9

Multiobjective Optimization: Outer Approximation Techniques

Stream: Multiobjective Optimization
Invited session
Chair: *Gabriele Eichfelder*

1 - Tractability of Convex Vector Optimization Problems in the Sense of Polyhedral Approximations
Firdevs Ulus

We consider a solution concept for convex vector optimization problems (CVOPs) which generates polyhedral inner and outer approximations to the Pareto frontier. A CVOP with compact feasible region is known to be bounded and there exists a solution of this sense to it. However, it is not known if it is possible to generate polyhedral inner and outer approximations to the Pareto frontier of a CVOP if the feasible region is not compact. We show that not all CVOPs are tractable in that sense and give a characterization of tractable problems in terms of the weighted sum scalarization problems.

2 - Approximating Projected Spectrahedra and Applications
Daniel Ciripoi, Andreas Löhne

The talk will introduce general concepts concerning spectrahedral convex sets, their projections and their numerical representation. We will deal with calculus operations defined on spectrahedra. It turns out that the result of many calculus operations for spectrahedral sets can be expressed as projected spectrahedra. Thus, the relevant computational effort of those operations consists in computing projections of spectrahedra. Doing this exactly is very challenging, thus we are interested in approximating those sets. Among others, this enables us to approximately solve multi-objective SDPs.

3 - Convergence Results for a Branch-and-Bound based Algorithm for Nonconvex Multiobjective Optimization
Julia Niebling, Gabriele Eichfelder

In this talk a global solution method for smooth nonconvex multiobjective optimization (MO) problems will be introduced. This branch-and-bound based algorithm uses a new discarding test which combines techniques from the alphaBB method from global scalar-valued optimization with outer approximation techniques from convex MO and the versatile concept of local upper bounds from combinatorial MO. The new procedure is able to calculate an approximation of the efficient set of the MO problem with a given quality. We give the main steps to prove this convergence result.

■ TD-06

Thursday, 11:30 - 13:00 - Room 10

Variational problems and applications I

Stream: Variational problems and applications
Invited session
Chair: *Simone Sagratella*

1 - Fixed point and extragradient algorithms for quasi-equilibria
Mauro Passacantando, Giancarlo Bigi

We propose fixed point and extragradient algorithms for the quasi-equilibrium problem (QEP). The main difficulties arise from having a feasible region that changes: the iterates belong to different sets and any solution of QEP has to be a fixed point of the constraining set-valued map. A range of convexity, monotonicity and Lipschitz continuity assumptions will be combined suitably in order to guarantee the convergence of the above algorithms to a solution and to provide estimates of their rate.

2 - Generalized tensor variational inequalities applied to an economic model
Annamaria Barbagallo

The aim of the talk is to introduce a new class of variational inequalities in which every operator is defined in a tensor Hilbert space, called generalized tensor variational inequalities. We investigate under which suitable assumptions the existence and, then, the uniqueness of solutions to generalized tensor variational inequalities are guaranteed. These variational inequalities express a generalized Cournot-Nash equilibrium condition of a general oligopolistic market equilibrium model in which every firm produces several commodities.

Joint paper with Serena Guarino Lo Bianco.

3 - A dominance maximization approach to multi objective optimization
Lorenzo Lampariello, *Francesco Cesarone*, *Simone Sagratella*

We present a nonlinear programming approach for problems with multiple criteria. In the context of no-preference methods, we propose to compare among all the feasible solutions by choosing the ones that maximize the product of the distances between the corresponding objectives values and those of a reference point. We show that this approach has distinctive and remarkable features. Furthermore, although our no-preference strategy generally requires the solution of a nonconvex single-objective problem, we show how a resulting (global) optimal solution can be easily and efficiently computed.

4 - Numerically tractable optimistic bilevel problems
Simone Sagratella, *Lorenzo Lampariello*

We consider a class of optimistic bilevel problems. Specifically, we address bilevel problems in which the lower level objective function is fully convex. We show that this nontrivial class of mathematical programs is sufficiently broad to encompass significant real-world applications and proves to be numerically tractable. From this respect, we establish that the critical points for a relaxation of the original problem can be obtained addressing a suitable generalized Nash equilibrium problem. The latter game is proven to be convex and with a nonempty solution set.

Thursday, 14:30 - 16:00

■ TE-01

Thursday, 14:30 - 16:00 - Room 5

Copositive Optimization - Models and Applications

Stream: Conic and Copositive Optimization
Invited session
Chair: *Immanuel Bomze*

1 - Copositive Approach to adjustable robust optimization
Markus Gabl

Adjustable robust optimization aims at solving problems under uncertainty in a first stage; the second stage decisions can be adjusted after the fact. The objective is to find the best solution among those which in any case allow for feasible adjustment of the second stage variables. There is greater flexibility than in a general uncertainty setting, but the computational cost rises, also for problems where the constraint-coefficients of the second stage variables are affected by uncertainty as well (uncertain recourse). We tackel these issues by applying copositive optimization techniques.

2 - Trust your data or not - StQP remains StQP
Michael Kahr, Immanuel Bomze, Markus Leitner

We consider the robust variant of the Standard Quadratic Problem (RStQP), in which a (possibly indefinite) quadratic form is extremized over the standard simplex (which is considered certain), and the quadratic form is uncertain. The uncertain data realizations are assumed to lie in known uncertainty sets modeled by, e.g., specrahedra, ellipsoids or polyhedra. We discuss cases in which the copositive relaxation of the RStQP is exact and reduces to an instance of a deterministic StQP. Computational results motivated by community detection in social networks are presented.

3 - Copositive optimization on location models and cooperative games
Justo Puerto

We present applications of copositive optimization to: Location Analysis(LA) and Cooperative Game Theory (CGT). The goal is to show how applying the powerfulness of copositive reformulations one can obtain new insights on classic problems and questions taken from different fields. In L.A. we present an exact alternative reformulation of the Discrete Ordered Median problem as a continuous, linear conic problem. Additionally, we elaborate on the core of cooperative games extending linear production and location games and we prove core-nonemptiness conditions based on general conic programs.

4 - Notoriously hard (mixed-)binary QPs: new CP approaches and empirical evidence
Immanuel Bomze, Jianqiang Cheng, Peter Dickinson, Liu Jia, Abdel Lisser

For mixed-binary QPs, many copositive reformulations were proposed. Most ofthem can be used as proper relaxations, if intractable cones are replaced by their tractable approximations. Based upon on a recent discussion of variants of copositive reformulations and their relaxations avoiding memory problems in IP algorithms employed, we present a small study on some hard quadratic problems. Our observations add empirical evidence on performance differences among the above mentioned variants. We also analyze an alternative approach using penalization of various classes of (aggregated) constraints.

■ TE-02

Thursday, 14:30 - 16:00 - Room 6

Continuous Location I.

Stream: Continuous Location
Invited session
Chair: *Boglárka G.-Tóth*

1 - Application of continuous optimisation techniques in solar power tower plants
Thomas Ashley, Emilio Carrizosa, Enrique Fernández-Cara

Concentrated Solar Power used by a Solar Power Tower plant is one technology that continues to be a promising research topic for advancement. The distribution of temperature on an SPT plant receiver directly affects the lifespan of the structure and energy generated by the plant. Temperature peaks and uneven distributions can be caused by the aiming strategy enforced on the heliostat field. In this work, an optimised aiming strategy is found using a continuous optimisation approach, which maximises energy gained whilst maintaining a homogeneous flux distribution on the receiver.

2 - A heuristic algorithm for solving a competitive facility location and design MINLP problem
Laura Anton Sanchez, Juana Lopez Redondo, Jose Fernandez, Pilar M. Ortigosa

A chain wants to expand its presence in a given geographical area of the plane, where it already owns some facilities. The chain can open one new facility and/or modify the qualities of some of its existing facilities and/or close some of them. In order to decide the location and quality of the new facility (in case it is open) as well as the new qualities for the existing facilities (a quality level equal to 0 means that the facility is close), a MINLP is formulated. A heuristic algorithm, which includes a ranking procedure, is implemented.

3 - An interval branch-and-bound method for solving a MINLP competitive facility location and design problem
Boglárka G.-Tóth, *Jose Fernandez*, *Juana Lopez Redondo*, *Pilar M. Ortigosa*

A chain wants to expands its presence in a given area of the plane, where it already owns some facilities. Other competing chains operate in the market, too. The available budget can be employed in opening one new facility and/or modifying the quality of the existing facilities and/or closing some of them. The objective is to maximize the profit of the chain (revenue obtained from the market share captured minus operational costs). This facility location and design problem is formulated as a MINLP problem. An interval branch-and-bound method is put forward to solve the problem.

■ TE-03

Thursday, 14:30 - 16:00 - Room 7

Optimal Control and Optimization in Economics and Finance II

Stream: Optimal Control and Optimization in Economics and Finance
Invited session
Chair: *Gerhard-Wilhelm Weber*

1 - Coupling decomposition with dynamic programming for a stochastic spatial model for medium-term energy management problem
Luc Marchand, *Philippe Mahey*, *Jean-Pierre Dussault*

The problem we work on is about medium-term energy management from hydro and thermal sources on a medium time scale with multiple zones. Demand and water inflow are considered stochastic. Water level in the barrages is aggregated, stochastic and coupled by time, whereas zones are coupled with the possibility to transfer energy at a low cost. This presentation will make a short review of stochastic optimization methods to solve this kind of problem. We will show computational results of ADMM decomposition used to decouple the zones, then use Dynamic Programming to solve the zonal problems.

2 - Optimal sales-mix and generation plan for a risk averse electricity producer
Paolo Falbo, *Carlos Ruiz*

A bilevel stochastic programming problem is used to model the optimal decision of a risk averse electricity producer, interacting on the generation market with cost minimizers competitors. His decision variables include the sales-mix (how much generation to commit to bilateral contracts and spot market) and the generation plan (which technologies to operate). To enhance computation times, the bilevel problem is transformed into a Mixed-Integer Linear Problem (MILP). Demand, RES generation and operating costs are sources of uncertainty subject to varying correlation levels.

3 - Renewables, Allowances Markets, and Capacity Expansion in Energy-Only Markets
Cristian Pelizzari, *Paolo Falbo*, *Luca Taschini*

We propose a simple representation of the long-term capacity expansion decision involving fossil fuel and renewable production, under an Emissions Trading System (ETS) and in an energy-olny market with uncertain demand. We find that a higher share of renewable production can be priced at the higher marginal cost of fossil fuel production, yet the likelihood of achieving higher profits is reduced because more electricity demand is met by cheaper renewable production. An example shows that producers withhold investments in renewables, calling into question the long-term effectiveness of an ETS.

■ TE-04

Thursday, 14:30 - 16:00 - Room 8

Numerical Methods and Software II

Stream: Numerical Methods and Software
Contributed session
Chair: *Ana Maria A.C. Rocha*

1 - The Traffic Assignment Problem: A comparison of route-based and link-based approaches
Sam O'Neill, *Ovidiu Bagdasar*, *Stuart Berry*, *Nicolae Popovici*

The Traffic Assignment Problem (TAP) aims to find Wardrop equilibria on routes between given origin/destination pairs. This can also be formulated as a convex optimisation problem via the Beckmann transformation, however its solution is link-based. The convex formulation can be solved via a modified Frank Wolfe algorithm, however convergence can be an issue. Route-based approaches such as Bar-Gera's Origin-Based Algorithm offering an increasingly popular alternative. Here we investigate the suitability of various approaches for solving equilibrium problems.

2 - Review of the recent enhancements for the global optimization bilevel BASBL solver
Remigijus Paulavičius, *Claire Adjiman*

In this talk, we present the most recent implementation of the general Branch-And-Sandwich BiLevel solver (BASBL). The BASBL solver is implemented within the open-source MINOTAUR toolkit and is based on the global optimization Branch-and-Sandwich algorithm. The performance of BASBL has been investigated using the bilevel test problems from our BASBLib collection (http://basblsolver.github.io/BASBLib/), and problems derived from practical applications. The results demonstrate the promising performance of BASBL. The further possible directions are summarized at the end of the talk.

3 - Practical convergence of metaheuristics in the context of a smoothed penalty
Ana Maria A.C. Rocha, M. Fernanda P. Costa, Edite M.G.P. Fernandes

This paper presents a smoothed penalty framework for constrained global optimization problems. The smoothed penalty function depends on two parameters, a penalty weight for constraint violation and a smoothing parameter. We aim to analyze the performance of the smoothed penalty framework when different metaheuristics are used. In general, metaheuristics are simple to implement and use, perform quite well and generate good quality solutions. Numerical experiments show that the proposed smoothed penalty framework is effective in finding global optimal solutions to constrained problems.

■ TE-05

Thursday, 14:30 - 16:00 - Room 9

Multiobjective Optimization: Numerical Methods

Stream: Multiobjective Optimization
Invited session
Chair: *Gabriele Eichfelder*

1 - A method for constrained multiobjective optimization based on SQP techniques
A. Ismael F. Vaz, Joerg Fliege

We propose an SQP type method for constrained nonlinear multiobjective optimization. The proposed algorithm maintains a list of nondominated points that is improved both for spread along the Pareto front and optimality by solving single-objective constrained optimization problems. Under appropriate differentiability assumptions we discuss convergence to local optimal Pareto points. We provide numerical results for a set of unconstrained and constrained multiobjective optimization problems in the form of performance and data profiles, where several performance metrics are used.

2 - Solving Multiobjective Optimal Control Problems by Means of Model Predictive Control
Marleen Stieler, Lars Grüne

Multiobjective optimal control problems (OCPs) on a very long or infinite horizon are generally difficult or even impossible to solve. For scalar-valued OCPs a numerical method called Model Predictive Control (MPC) is nowadays a well established control strategy that is used to approximate such OCPs. In this talk we show that MPC is well suited for multiobjective OCPs, too. Our main result is that every Pareto-optimal solution of the original OCP can be approximated arbitrarily well by means of MPC in terms of the objective functions. Our findings will be illustrated on numerical examples.

3 - A new method to find the full integer Pareto frontier in convex problems
Giorgio Grani, Laura Palagi, Marianna De Santis, Marianna De Santis

In this talk we tackle bi-objective optimization problems with integer variables. We present a criterion space search algorithm that is able to construct the full Pareto frontier, solving a finite number of subproblems each of them returning a Pareto optimal point. Beside integer linear bi-objective optimization problems our approach can be easily extended to handle pure integer convex bi-objective problems. We report preliminary numerical experiments on a benchmark of integer linear programming instances and give a comparison with existing state-of-the-art methods.

4 - A Multiobjective Trust Region Method for Expensive and Cheap Functions
Gabriele Eichfelder, Jana Thomann

In this talk we focus on multiobjective optimization problems where one of the functions is assumed to be an expensive black-box function while the other objective functions are analytically given. The proposed method uses the basic trust region approach by restricting the computations in every iteration to a local area. The objective functions are replaced by suitable models which reflect the heterogeneity of the functions. The next iteration point is computed by using the ideal point and the Pascoletti Serafini scalarization. Convergence results and numerical experiments are presented.

■ TE-06

Thursday, 14:30 - 16:00 - Room 10

Variational Inequalities in Economic Problems I

Stream: Variational Inequalities in Economic Problems
Invited session
Chair: *Annamaria Barbagallo*

1 - Cutting surface algorithms for equilibria
Giancarlo Bigi, Giandomenico Mastroeni, Mauro Passacantando

A pseudomonotone equilibrium problem is equivalent to minimize the Minty gap function. Though it is convex, the evaluation of its values require the resolution of a nonconvex program. The talk aims at presenting cutting type methods for minimizing the Minty gap function, relying on lower convex approximations which are easier to compute. These methods amount to solving a sequence of convex programs, whose feasible region is refined by nonlinear convex cuts at each iteration. Convergence is proved under monotonicity or concavity assumptions. The results of numerical tests are reported.

2 - Dual decomposition approach for dynamic spatial equilibrium models: an analysis of the spot gas markets
Giorgia Oggioni, *Elisabetta Allevi*, *Adriana Gnudi*, *Igor Konnov*

We consider the general problem of managing a dynamic system of spatially distributed auction markets of a homogeneous commodity that are joined by transmission lines in a network. At each market, traders and buyers are represented by their offer/bid price functions and volume bounds. We propose a set of equilibrium type conditions for this system of markets and show that it is equivalent to a single-level variational inequality problem. We apply a dual type method to find the equilibrium solution. The analysis is conducted on the spot gas markets in the UK and in the Netherlands.

3 - Optimality conditions for optimization problems on convex intersections of non necessarily convex sets
Rossana Riccardi, *Elisabetta Allevi*, *Juan Enrique Martínez-Legaz*

We present necessary and sufficient optimality conditions for the minimization of pseudoconvex functions over convex intersections of non necessarily convex sets. We first introduce the notion of local normal cone and we state some useful properties. Then, necessary optimality conditions for this class of minimization problems are obtained in terms of tangential subdifferentials of the oriented distance of the given sets.

Thursday, 16:30 - 18:00

■ TF-01

Thursday, 16:30 - 18:00 - Room 5

Mathematical optimization in the real world

Stream: Mathematical optimization in the real world
Contributed session
Chair: *Sonia Cafieri*

1 - Optimal pump series design via semi-infinite programming
Helene Krieg, Jan Schwientek, Dimitri Nowak, Karl-Heinz Küfer

The task of designing a series of pumps can be formulated as continuous set covering problem: The area of nominal operating points has to be covered by operation ranges of as few as possible pumps such that the overall efficiency is maximized. The reformulation of the coverage constraint results in a semi-infinite optimization problem (SIP). Unfortunately, the lower level problem is neither smooth nor convex. Our solution approach combines appropriate smoothing and efficient discretization techniques. Furthermore, a reformulation of set covering problems as GSIP seems to be very interesting.

2 - Aerodynamic Design Optimization of Wind Turbine Airfoils under Uncertainty
Edmondo Minisci

This work is about different approaches to design wind turbine airfoils accounting for the uncertainty affecting the input parameters of the numerical models used to assess the airfoil performance. Subject to a set of aerodynamic and structural constraints, the uncertain response of the airfoil is optimized by means of both probabilistic and evidence based approaches. The main aim of the work is to show how different techniques to treat uncertainties can be used for the design of airfoils, depending on the available information, and the associated computational costs.

3 - VDesign: a new optimization environment dedicated to preliminary design
Jean BIgeon, Emmanuel Bigeon

VDesign is a preliminary design environment based on the separation of concern concept. The three identified phases of the process are separated. The description of physical models is done through a set of mathematical equations without any programming language. The specifications and objective are described through a dynamic interface that do not require actual knowledge of the equations but only of the variables. The environment is also designed for easy addition of implementations of optimization methods and variants. Interoperability is also possible with scilab, mathlab, excel.

4 - A continuous optimization approach for aircraft conflict avoidance via speed and heading angle deviations
Sonia Cafieri, Andrew Conn, Marcel Mongeau

We propose a continuous optimization approach to address a challenging problem arising in Air Traffic Management, namely that of keeping at all times throughout their flight, the separation between any pair of aircraft trajectories above a threshold value. We address the problem by adjusting both aircraft speeds and heading angles simultaneously. We propose a model based on a penalty function, designed to deal with the complex aircraft separation constraints. The infinite-dimensional feature of these constraints is removed by a reformulation. Numerical results show the benefits of our approach

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■ TF-02

Thursday, 16:30 - 18:00 - Room 6

Continuous Location II.

Stream: Continuous Location
Invited session
Chair: *Boglárka G.-Tóth*

1 - Incorporating discarding tests in an evolutionary algorithm: application to a competitive facility location and design problem
Rafael Villegas, Jose Fernandez, Juana Lopez Redondo, Pilar M. Ortigosa, Boglárka G.-Tóth

Heuristic algorithms are the only way to cope with some location problems. In particular, UEGO (Universal Evolutionary Global Optimization) has been applied to several competitive location problems. In some cases, the CPU time required by UEGO may be very long. In order to accelerate the algorithm, we propose to discard areas of the feasible set where no optimal solution exists so that it focus its search only in the promising areas. In particular, we included discarding tests commonly used in interval branch-and-bound methods. Preliminary results show the usefulness of the approach.

2 - Necessary optimality conditions for some nonconvex facility location problems
Marcus Hillmann

The problem of locating a new facility with existing attraction and repulsion points is a problem with great practical relevance. We will present a new approach to derive necessary optimality conditions for some scalar cases of this problem by using the nonconvex subdifferentials by Ioffe and Kruger/Mordukhovich and taking advantage of the special structure. Furthermore, we will show some new scalarization results and use them to establish necessary optimality conditions for the multicriteria case.

■ TF-03

Thursday, 16:30 - 18:00 - Room 7

Data Science and MINLP & Applications

Stream: Data Science and MINLP & Applications
Invited session
Chair: *Fatma Gzara*

1 - Distributed Column-Generation for large scale Mixed-Integer programming
Mathieu Tanneau, Miguel F. Anjos, Andrea Lodi

Column-generation algorithms, in conjunction with Dantzig-Wolfe decomposition, have been successful at solving various large mixed-integer programs. In this work, we integrate two interior-point frameworks to address scalability issues when dealing with numerous sub-problems in column-generation. We show that the restricted master problem can be solved efficiently using a parallel interior-point algorithm. In particular, columns can be handled locally, lifting memory requirements on the master. The methodology's practical performance is evaluated on various large-scale applications.

2 - Mathematical programming models for Multiple Instance Learning
Annabella Astorino, Antonio Fuduli, Giovanni Giallombardo, Giovanna Miglionico

Multiple Instance Learning (MIL) is a variation of supervised learning for problems with incomplete knowledge about labels of training data. In fact, differently from supervised classification problems, where each training point is assigned with a label, in MIL the objective is to categorize bags of points (instances) and the labels are only assigned to the bags. In this work we analyse two optimization models for a binary MIL classification problem: a mixed integer nonlinear programming model and a nonconvex nonsmooth unconstrained optimization one. Some numerical results are reported.

3 - Simulation base optimization for capacity scheduling in e-warehousing.
Fatma Gzara, Samir Elhedhli, Daniel Ulch, Paulo Carvalho

With an ever growing e-retailing industry, e-warehouses play a central role in the order fulfillment process. Although automated, most e-warehouses still rely on manual labor. Workers typically rotate between a variety of tasks depending on the day's demand. This task shifting is highly unpredictable, but should be planned for a priori in order to meet daily fulfillment targets. Motivated by an industrial project and based on real data, we model the capacity planning problem in an e-warehouse as a robust optimization problem and solve it using simulation based optimization.

■ TF-04

Thursday, 16:30 - 18:00 - Room 8

Numerical Methods and Software III

Stream: Numerical Methods and Software
Contributed session
Chair: *Ester M Garzon*

1 - On solving the equilibrium equations for rectangular RC Members at failure
Andrzej Stachurski, Marek Lechman

The task is to solve several sets of nonlinear equations. There exists linear intervals of singular points. Unknown variables are subject to box constraints. The least squares method was applied. Local algorithms were run from net of starting points. Often several local minima were found. Clustering was applied to split them into clusters. The equations bind the normal strains, stresses, axial force and the bending moment (derived by integrating the equilibrium equations). Numerical results on practical data are presented. In some cases multiple global solutions were found.

2 - Continuous-GRASP with 2 levels for large-scale nonlinear global optimization with general nonlinear constraints
João Lauro Faco', Ricardo Silva, Mauricio Resende

We address nonlinear global optimization problems with nonlinear constraints where the numbers n of continuous bounded variables, and m constraints are large. Consider a feasible starting solution where we can eliminate m of n variables. A reduced problem in (n-m) independent variables can be solved by a C-GRASP method for bounded variables. The m constraints are incorporated into the objective function by quadratic penalty terms. Once a near optimal solution is obtained, we verify the m basic variables feasibility by solving the system of m NL equations by a 2nd level C-GRASP.

3 - BFGS-like udpates of constraint preconditioners in quadratic optimization
Luca Bergamaschi, Angeles Martinez, Daniela di Serafino, Valentina De Simone

The Interior Point (IP) method applied to large constrained convex optimization problems requires the repeated solution of a number of indefinite saddle-point type linear systems, whose solution can be obtained by appropriately preconditioned iterative methods. The constraint preconditioners (CPs), though yielding fast convergence in terms of number of iterations, may be extremely costly to compute at each IP iteration. We propose to avoid large part of this computational burden by computing only selectively the CP and by correcting it via a BFGS-like update formula.

■ TF-05

Thursday, 16:30 - 18:00 - Room 9

Multiobjective Optimization: Robustness and Set-Valued Optimization

Stream: Multiobjective Optimization
Invited session
Chair: *Gabriele Eichfelder*

1 - Robust multiobjective optimization: Comparing different concepts and their solutions
Anita Schöbel, Yue Zhou-Kangas

In uncertain multiobjective optimization, different concepts what a 'robust efficient' solution is have recently been published, among them minmax or light robustness. But it is hard to compare the resulting robust efficient sets. We propose to use the upper set-less order from set-valued optimization to compare such solution sets. Based on it we show that lightly robust efficient solutions are good compromises between nominal efficient solutions and minmax robust efficient solutions. We also develop a measure to quantify the price of robustness of a solution in the multiobjective case.

2 - Set-valued/multiobjective optimization perspective in bilevel optimization
Alain Zemkoho

Bilevel optimization refers to optimization problems with a hierarchical structure featuring a leader (upper-level player) and a follower (lower-level) player. There has been a growing literature on establishing close relationships between bilevel optimization and multiobjective optimization and this year marks 25 years since Janos Fulop proved the first result confirming this close link between the two problem classes. In this talk, a brief review of the topic will be provided while also highlighting connections between bilevel optimization and set-valued optimization.

3 - Set optimization problems under asymptotic analysis
Ruben Lopez, Elvira Hernández

We define a notion of asymptotic map for set-valued maps that is suitable for studying set type solutions of set optimization problems. We study its properties, calculus rules and formulas. We calculate it for some useful set-valued maps. Finally, by using the asymptotic map and an approximation procedure, we obtain coercive properties and a coercive existence result for set optimization problems

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■ TF-06

Thursday, 16:30 - 18:00 - Room 10

Derivative-Free Optimization

Stream: Derivative-Free Optimization
Invited session
Chair: *Sébastien Le Digabel*

1 - Global convergence of a derivative-free inexact restoration filter algorithm for nonlinear programming
Francisco Sobral, Priscila Ferreira, Elizabeth Wegner Karas, Mael Sachine

An algorithm is presented for solving constrained optimization problems which does not explicitly use objective function derivatives. The algorithm mixes an inexact restoration framework with filter techniques. Each iteration is decomposed into two phases: the feasibility phase reduces an infeasibility measure and the optimality phase reduces the objective function value. The optimality step is computed by derivative-free trust-region internal iterations. Under classical assumptions, global convergence results are ensured. Numerical experiments show the effectiveness of the method.

2 - Improved DIRECT-type algorithm for constrained global optimization problems
Linas Stripinis, Julius Žilinskas, Remigijus Paulavičius

In this talk, we consider a general global optimization problem. The well-known derivative-free global optimization DIRECT(DIvide a hyper-RECTangle) algorithm performs well on a subclass of box-constrained problems. However, the DIRECT does not naturally address additional linear or nonlinear constraints, and only in recent years, few promising DIRECT-type extensions were proposed, including our approach. An extensive experimental investigation revealed the potential and competitiveness of our method.

3 - NOMAD, a blackbox optimization software
Sébastien Le Digabel, Charles Audet, Viviane Rochon-Montplaisir, Christophe Tribes

A blackbox is a system which can be viewed in terms of its inputs and outputs, without any knowledge of its internal workings. NOMAD is a software for the optimization of such problems. It implements the Mesh Adaptive Direct Search (MADS) derivative-free optimization algorithm. This talk briefly introduces the MADS algorithm and then details the NOMAD software usage, tuning, and results. NOMAD is intended to be easy to use. It is designed for solve real-world optimization problems from the industry. It works out of the box, as long as the objective and constraints are provided.

Friday, 9:00 - 9:50

■ FA-01

Friday, 9:00 - 9:50 - Aula Magna

Plenary II: Angelika Wiegele

Stream: Plenary II
Plenary session
Chair: *Pilar M. Ortigosa*

1 - Algorithmic Approaches for Semidefinite Programming Applied to Combinatorial Optimization
Angelika Wiegele

Semidefinite Programming (SDP) is an extension of Linear Programming (LP). A matrix-variable is optimized over the intersection of the cone of positive semidefinite matrices with an affine space. It turns out, that SDP can provide significantly stronger practical results than LP and that it can be applied in a lot of different areas, like combinatorial optimization, control theory, engineering, or polynomial optimization.

Due to the numerous areas of applications, solving SDPs became a widely studied subject. Interior point methods are the most popular algorithms nowadays. However, for large-scale SDPs interior point methods are impractical, either due to the large number of constraints or due to the matrix size.

In this talk we will present alternative methods for solving large-scale SDPs. These methods are based on bundle methods or follow the concept of an augmented Lagrangian algorithm. The experiments show that these methods can solve SDPs that are out of reach by interior-point methods. Moreover, using these algorithms as bounding routines inside a branch-and-bound scheme provides advantages like early pruning or warm start. Hence, exact solvers having these algorithms inside can solve instances of, e.g., max-cut problems or other integer quadratic problems where no other method is able to do so.

Friday, 10:00 - 10:50

■ FB-01

Friday, 10:00 - 10:50 - Aula Magna

Plenary III. Frederic Messine.

Stream: Plenary I
Plenary session
Chair: *Leocadio G. Casado*

1 - Mathematical Optimization for Innovative Electromagnetical Designs
Frederic Messine

Nowadays, in order to provide interesting and innovative designs for electromagnetic actuators (like electrical machines and space thrusters), the industrial companies have to define and to solve difficult optimization problems. These problems are non-linear, non-convex (NLP), sometimes mixed-integer (MINLP) and they possibly contain some black-box constraints.

Indeed, in electromagnetism, the models come from the Maxwell (partial derivative) equations which generally have to be solved by using 2D or 3D finite element method codes. In a few cases, explicit analytical formulas which approximate the Maxwell equations, can be provided.

In this talk, I will discuss how the design of electromagnetic actuators can be optimized in industrial contexts. This involves some highly technical optimization issues: - association between models (analytic and numeric) and optimization codes (global, local, heuristic, mesh-adaptive based); - successive relaxation techniques; -efficient choices of starting points; -homotopic optimization methods. At the end of this optimization process, the purpose is to provide one or a few optimized actuators (satisfying all the industrial constraints) in order to make a first prototype the most efficient as possible.

This talk will be illustrated by two industrial design examples where two prototypes were made and tested: -a Poki-Poki electrical machine for Mitsubishi and -a plasma space thruster for SAFRAN-CNES.

Friday, 11:30 - 13:00

■ FC-01

Friday, 11:30 - 13:00 - Room 5

Multi-objective optimization and applications I

Stream: Multi-objective optimization and Applications
Contributed session
Chair: *Juana Lopez Redondo*

1 - A multi-objective approach for determining the parameters of epidemiological models
Miriam Ruiz Ferrández, Juana Lopez Redondo, Benjamin Ivorra, Angel Manuel Ramos, Pilar M. Ortigosa

In this work, we propose a multi-objective methodology for estimating the parameters of some epidemiological models. The main idea is to achieve that the considered model fits the observed behavior of the disease outbreak using available data of the cumulative number of detected cases and of deaths. The efficiency of this methodology is shown for models describing the propagation of a disease inside an isolated country but, also, for the Between-Countries Disease Spread (Be-CoDiS) model, which considers a set of countries connected by migratory movements.

2 - On Linear Programming Approximations of Mean-Variance Pareto Fronts
Janusz Miroforidis, Przemysław Juszczuk, Ignacy Kaliszewski, Dmitry Podkopaev

We investigate the idea to approximate mean-variance Pareto fronts by solving systems of linear equations. We depart from the observation that following the usual approach to treat the mean return objective function as a constraint, it is possible to replicate any portfolio with a portfolio of the same return with just four assets. We have experimented with mean-variance test problems from Beasley OR Library. The results show that whenever approximate Pareto optimal portfolios are acceptable, the approaches we followed are viable options to solving quadratic optimization problems.

3 - Stretched Simulated Annealing for multi-objective programming
Ana I. Pereira

The Stretched Simulated Annealing is a multi-local method that combines simulated annealing algorithm with a stretching function technique in order to identify the multiple solutions in a nonlinear optimization problem. This work presents an extension of the Stretched Simulated Annealing method to solve multi-objective programming problems, identifying the Pareto-optimal solutions. Numerical results and comparisons with the fast elitist multi-objective genetic algorithm (NGA II) are presented.

■ FC-02

Friday, 11:30 - 13:00 - Room 6

Progress in interior-point methods and their applications

Stream: Progress in interior-point methods and their applications
Invited session
Chair: *Tibor Illés*

1 - Improving the linear relaxation of maximum k-cut with semidefinite-based constraints
Vilmar Rodrigues de Sousa, Miguel F. Anjos, Sébastien Le Digabel

We consider the maximum k-cut problem for which the semidefinite programming (SDP) relaxation is known to give strong bounds. Because solving the SDP is computationally expensive, we study the performance of SDP and linear programming (LP) relaxations using combinatorial facet-defining inequalities within a cutting-plane algorithm that exploits early termination in the interior-point method. The LP relaxation is further strengthened using SDP-based inequalities. Computational results suggest that the LP with SDP-based inequalities performs better for some classes of max k-cut.

2 - Condition number estimation for switching preconditioners in interior point methods
Aurelio Oliveira, Kelly Cadena, Carla Ghidini

An expensive step in interior point methods concerns the linear systems solution at each iteration. For some large-scale linear programs the most efficient choices are iterative methods. Finding a preconditioner that works well in all iterations is not a simple task as the systems get very ill conditioned. Thus, hybrid preconditioning approaches are in place. An issue is to find the iteration for switching preconditioners. We present a new idea using the system matrix condition number estimation. Computational results with large-scale problems show a good performance of the proposed approach.

3 - A non-symmetric cone optimization approach to sum-of-squares optimization
David Papp, Sercan Yildiz

We present an interior-point method to solve sum-of-squares (SOS) optimization problems by combining non-symmetric cone optimization and polynomial interpolation. Optimizing directly over the SOS cone and its dual, the conventional semidefinite optimization (SDP) formulation is avoided. As a result, the algorithm is more stable and has substantially lower time and space complexity than the SDP approach. SOS certificates of the optimal solutions can also be computed with little additional effort. Computational results confirm the expected benefits over using SDP. Joint work with Sercan Yildiz.

■ FC-03

Friday, 11:30 - 13:00 - Room 7

Decomposition in MINLP

Stream: Decomposition in MINLP
Invited session
Chair: *Ivo Nowak*

1 - On decomposition and dimension reduction in MINLP problems in order to solve them in parallel
I. Garcia, Eligius M.T. Hendrix, Leocadio G. Casado

Our first investigations on mixture design combine an integer and linear objective with quadratic constraints. Our question was how to decompose multi-product design problems in such a way that we can run sub-problems in parallel mainly in a B&B environment. We found that the search space can be reduced, but combining trees of sub-search spaces provides a big challenge. This stimulated further investigation in considering monotonicity issues to reduce dimension and with that the size of the search trees. This research is funded by national project TIN2016-66680 in part financed by ERDF.

2 - Decogo - A new decomposition-based MINLP solver
Pavlo Muts, Ivo Nowak, Vitali Gintner

Most modern MINLP-solvers use a branch-and-bound tree, which may grow rapidly. We introduce Decogo, a new MINLP-solver, based on decomposition-based successive approximation. Before starting the solution method, the original nonconvex MINLP is automatically decomposed into subproblems. Then, inner- and outer-approximations are successively improved using column and cut generation. Subproblems are solved using a novel adaptive MIP-outer-approximation method, which is based on a convex-concave reformulation of a MINLP. We present numerical results obtained with Decogo.

3 - Decomposition-based Successive Approximation Methods for MINLP
Ivo Nowak, Eligius M.T. Hendrix, Pavlo Muts

Motivated by column generation methods for solving transport scheduling problems with over 100 million variables, we present a new deterministic global optimization approach, called Decomposition-based Inner- and Outer-Refinement (DIOR). The new solution approach is based on successively improving approximations by parallel solving sub-models. DIOR can be applied to general modular and/or sparse MINLPs. We present preliminary numerical results with Decogo, a new MINLP solver.

■ FC-04

Friday, 11:30 - 13:00 - Room 8

Machine Learning and Optimization and Applications I

Stream: Machine Learning and Optimization and Applications
Invited session
Chair: *Laura Palagi*

1 - Feature Selection with SVM and SVR for Functional Data
M. Asuncion Jimenez-Cordero, Rafael Blanquero, Emilio Carrizosa, Sebastian Maldonado, Belen Martin-Barragan

The interest in Functional Data Analysis and univariate functional regression has grown steadily in recent years. Functional predictors may be obtained by selecting a set of time instants used to predict a response via Support Vector Regression. In addition, the classification rates of hybrid functional data, i.e. multivariate data with functional and static covariates, is improved thanks to the use of feature selection and Support Vector Machine. In this talk we express these problems using continuous optimization and we solve them by means of a heuristic on synthetic and benchmark real data.

2 - Continuous Optimization for Randomized Classification Trees
Cristina Molero-Río, Rafael Blanquero, Emilio Carrizosa, Dolores Romero Morales

Random Forests are a popular prediction tool obtained by bagging decision trees. Classic decision trees consist of a recursive, and greedy, procedure. The use of a greedy strategy yields low computational cost, but may lead to myopic decisions. Advances in Optimization have result in a growing research on building optimal classification trees. In this talk, we propose a nonlinear continuous programming formulation. Numerical results show that our approach outperforms classification trees and is close to Random Forests, being much more flexible as class performance constraints are easily added.

3 - A new Frank-Wolfe away-step SVM algorithm for multiclassification problems
Pedro Duarte Silva, Immanuel Bomze

Crammer and Singer's SVM is one the most successful tools in large multiclassification tasks. For a k-group problem with m examples, the original training algorithm uses an outer/inner loop iterative scheme, with search directions defined at the example level, and each step involving a k-variable optimization subproblem. Here, it will be proposed an unique loop Frank-Wolfe algorithm, with search directions based on example/class combinations, where each step requires a fast analytic univariate quadratic optimization. Computational experiments will illustrate the advantages of this proposal.

4 - A fully distributable Lagrangian reformulation for SVMs training
Tommaso Colombo, Simone Sagratella

We present a fully distributable Lagrangian reformulation of the Support Vector Machines training problem and a convergent Gradient Projection-based method to solve it. We propose a Lagrangian reformulation allowing to eliminate the constraint coupling the dual variables, thus unlocking block-coordinate decomposition methods. We further propose a Projected Gradient-type algorithm with no need for (approximately) solving the subproblem at each iteration. Convergence to Saddle Points of the Lagrangian function, and therefore to optimal solutions of the SVMs training dual problem, is also proved.

■ FC-05

Friday, 11:30 - 13:00 - Room 9

Multiobjective Optimization: Scalarizations and Location Problems

Stream: Multiobjective Optimization
Invited session
Chair: *Gabriele Eichfelder*

1 - Algebraic nonlinear scalarization in ordered linear spaces
César Gutiérrez, Vicente Novo, Juan Luis Ródenas

In this talk, an algebraic approach to scalarize some ordered optimization problems is showed. It is based on certain algebraic counterparts of topological concepts and also on the so-called smallest strictly monotonic functional. As an application, an Ekeland variational principle to vector equilibrium problems is obtained

2 - A general tool for the investigation of scalarizations in multiobjective optimization
Petra Weidner

Many procedures in multiobjective optimization use scalarizing problems. We present a general tool for the investigation of their properties. It is based on the fact that solutions of vector optimization problems can be completely characterized as minimizers of Gerstewitz functionals. By considering subclasses of these functionals, we get different scalarizations for multiobjective optimization problems. The basic scalarization can also be formulated as a generalization of the scalarizing problem by Pascoletti and Serafini.

3 - Pareto efficient solutions in multi-objective optimization involving forbidden regions
Christian Günther

In this talk, the aim is to compute Pareto efficient solutions of multi-objective optimization problems involving forbidden regions. In particular, we study a well-known multi-objective location problem where the aim is to locate a new facility in the presence of a finite number of demand points. For the choice of the new location point, we are taking into consideration a finite number of forbidden regions. By using a new vectorial penalization approach, we give a complete geometrical description for the set of Pareto efficient solutions of this nonconvex multi-objective location problem.

■ FC-06

Friday, 11:30 - 13:00 - Room 10

High Performance Computing in Global Optimization I

Stream: High Performance Computing in Global Optimization
Invited session
Chair: *Pilar M. Ortigosa*

1 - A genetic solution for scheduling on unrelated heterogeneous parallel machines
Gloria Ortega, Francisco José Orts Gómez, Antonio Manuel Puertas, Inmaculada Garcia Fernandez, Ester M Garzon

One of the main characteristics of modern clusters is their heterogeneity. It makes difficult an efficient scheduling of parallel tasks on them. In this work, a scheduling strategy on unrelated parallel machines is formally defined as a global optimization problem which minimizes the makespan (parallel runtime). A new heuristic based on a Genetic Algorithm has been developed to solve such scheduling. An active microrheology model has been considered as a case study because it requires many simulations for different system sizes on heterogeneous clusters.

2 - SMACOF algorithm to compress hyperspectral images
Francisco José Orts Gómez, Ernestas Filatovas, Gloria Ortega, Olga Kurasova, Ester M Garzon

MultiDimensional Scaling (MDS) methods are defined as global optimization's problems. They are used for dimensionality reduction. That is, data from a high-dimensional space are mapped into a lower-dimensional space, such that the between-data distances are preserved in both spaces as well as possible. SMACOF is a well-known and precise algorithm to solve MDS problems. Since SMACOF is computationally demanding, parallel computing is essential in its implementation. In this work, a specific scope of MDS is studied: the compression of bands of a hyperspectral image using SMACOF.

3 - New Parallel Non-Dominated Sorting to accelerate Evolutionary Multiobjective Optimization on Modern Computers
Juan José Moreno Riado, Gloria Ortega, Ernestas Filatovas, J.a. Martinez, Ester M Garzon

Non-Dominated Sorting (NDS) is involved in many evolutionary multiobjective optimization algorithms. Due to its high computational complexity, approaches to reduce its cost have been extensively studied. Recently, the Best Order Sort (BOS) algorithm for NDS has been presented as one of the most efficient ones. This work is focused on the acceleration of NDS on modern architectures introducing parallel versions of BOS for CPU and GPU platforms. The experimental results show that the new parallel versions improve the performance of the sequential algorithm in relevant factors.

Friday, 14:30 - 16:00

■ FD-01

Friday, 14:30 - 16:00 - Room 5

Multi-objective optimization and applications II

Stream: Multi-objective optimization and Applications
Contributed session
Chair: *Gloria Ortega*

1 - An Envelope Theorem for Convex Vector Programming
Miguel Angel Melguizo Padial, Fernando García Castaño

The goal of this talk is to formulate an envelope theorem for vector convex programs with inequality constrains. Given a family of parameterized programs, we analyze the quantitative behavior of certain set of optimal values characterized to become minimum when the objective function is composed with a positive homomorphism. The analysis is carried out by using the four main notions of tangency used in set-valued analysis, i.e, the contingent, adjacent, circatangent and paratingent derivatives. This result contains the classical Lagrange multiplier theorem as a particular case in it.

2 - An application of multiobjectve programming to linear programming problems with fuzzy numbers
Manuel Arana-Jiménez

Fuzzy numbers can be used to model uncertainty on parameters and variables in a mathematical programming problems. In this work, on one hand, it is discussed recent methods for solving linear programming problems whose parameters and variables are triangular fuzzy numbers via ranking functions, with their pros and cons. On the other hand, it is commented a resolution by means of solving a multiobjective programming problem. To this matther, it is shown the equivalence between the nondominated solutions of these problems.

3 - On sets of lower bounds
Alberto Zaffaroni

We study sets of lower bounds in an ordered vector space. These sets are usually defined from 'outside' by means of translates of the ordering cone. We give a characterization from 'inside' by means of the following properties: L is a set of lower bounds if and only if it is downward, bounded from above, and sup-containing, i.e. it contains the supremum of any of its subsets which admits one. The main result, together with some other dual characterizations, is proved when the ordering cone is polyhedral, and then extended to Archimedean spaces with an order unit.

■ FD-02

Friday, 14:30 - 16:00 - Room 6

Advances in Interior Point Methods and Linear Complementarity Problems

Stream: Advances in Interior Point Methods and Linear Complementarity Problems
Invited session
Chair: *Miguel F. Anjos*

1 - Generating sufficient matrices
Sunil Morapitiye, Tibor Illés

The class of sufficient matrices (SU) have important role in the area of linear complementarity problems (LCP). Although, many different interior point algorithms (IPA) have been published for SU-LCPs, in most of these there is no numerical examination of the IPAs. Main reason for this lies in the fact that only few SU matrices are known that does not fall into the classes of PSD- and P-matrices. Our goal is to generate different SU matrices that does not belong to the classes of PSD and P. We present preliminary result of our work, namely some recently constructed SU matrices.

2 - Primal-dual Newton barrier interior point algorithm for sufficient linear complementarity problems
Tibor Illés

The algebraic equivalent transformation (AET) of the system which defines the central path has been introduced by Darvay (2003) for linear programming problem (LPP) resulting new search directions for interior point algorithms (IPA). Recently, Darvay et al. (2016) published a new AET for IPA of LPP.

We present a generalization of Darvay's new direction for short step IPA for sufficient linear complementarity problem (LCP). Using EP-theorems of Illés et al. (2010) in a special way the algorithm can be extended to solve general LCPs in EP-sense.

3 - Predictor-corrector interior-point algorithms for sufficient linear complementarity problems
Petra Renáta Rigó, Tibor Illés, Zsolt Darvay

The algebraic equivalent transformation (AET) of the system which defines the central path has been introduced by Darvay (2003) for linear programming problem resulting new search directions for interior point algorithms (IPA). Generalization of AET for some types of IPAs for sufficient linear complementarity problems (SU-LCP) can cause difficulties, especially for predictor-corrector (PC) ones. After overcoming these difficulties we introduce new PC-IPAs for SU-LCPs. Moreover, we present a unified discussion of the effect of different AETs on proposing and analyzing new IPAs for SU-LCPs.

■ FD-03

Friday, 14:30 - 16:00 - Room 7

Global Optimization and Semidefinite Programming

Stream: Global Optimization and Semidefinite Programming
Invited session
Chair: *Juan Campos Salazar*

1 - Worst-case examples for Lasserre's measure-based hierarchy for polynomial optimization
Etienne De Klerk, *Monique Laurent*

We study the convergence rate of a hierarchy of upper bounds for polynomial optimization problems, proposed by Lasserre [SIAM J. Optim., 21(3), 2011), pp. 864-885], and a related hierarchy by De Klerk, Hess and Laurent [SIAM J. Optim., 27(1), (2017), pp. 347-367].

We show lower bounds on the respective convergence rates by studying specific examples. For the second hierarchy, the relevant lower bound is tight.

Interestingly, the convergence rates for the examples are precisely determined by the distribution of extremal zeroes of certain families of orthogonal polynomials.

2 - On the Complexity of Testing Attainment of the Optimal Value in Nonlinear Optimization
Amir Ali Ahmadi, *Jeffrey Zhang*

We prove that unless P=NP, there exists no polynomial time (or even pseudo-polynomial time) algorithm that can test whether the optimal value of a nonlinear optimization problem where the objective and constraints are given by low-degree polynomials is attained. If the degrees of these polynomials are fixed, our results imply that exactly one of two cases can occur: either the optimal value is attained on every instance, or it is strongly NP-hard to distinguish attainment from non-attainment. We also present SDP-based sufficient conditions for attainment of the optimal value.

3 - A Multigrid Approach to SDP Relaxations of Sparse Polynomial Optimization Problems
Juan Campos Salazar, *Panos Parpas*

We propose a multigrid approach to solve global optimization polynomial optimization problems with sparse support, using semidefinite programming (SDP) relaxations. The problems we consider arise from the discretization of infinite dimensional optimization problems, such as PDE optimization problems, boundary value problems, and some global optimization applications. We propose prolongation operators to relate the primal and dual variables of the SDP relaxation between levels in the hierarchy of discretizations, and use them in a warm start type algorithm to solve the higher level SDP.

■ FD-04

Friday, 14:30 - 16:00 - Room 8

Machine Learning and Optimization and Applications II

Stream: Machine Learning and Optimization and Applications
Invited session
Chair: *Laura Palagi*

1 - Decentralized Dictionary Learning over Time-Varying Digraphs
Francisco Facchinei

We study Dictionary Learning problems wherein the learning task is distributed over a multi-agent network. We develop a decentralized algorithmic framework for this class of nonconvex problems, and we establish convergence to stationary solutions. The new method hinges on Successive Convex Approximation techniques, coupled with a decentralized tracking mechanism. To the best of our knowledge, this is the first provably convergent decentralized algorithm for Dictionary Learning over (time-varying di)graphs that adequately addresses the peculiarities of the problem.

2 - Optimization Models for Feature Selection in Machine Learning
Joe Naoum-Sawaya

In this talk we present new optimization models for feature selection which is an important aspect for data analysis. These problems are mostly challenging due to the scale of the underlying formulations as well as the binary restrictions. We present use cases from the literature and highlight recent results in this area.

3 - Decomposition methods for Deep Networks
Ruggiero Seccia, *Laura Palagi*

In this talk we present new Block Coordinate Decomposition (BCD) algorithms for Deep Feedforward Neural Networks (DNs). The aim is to exploit the natural block decomposition underlying the optimization problem of such models in order to solve simpler and structured optimization problems and organize calculations efficiently. Different decomposition strategies are tested to comprehend whether such techniques can lead to better solutions (e.g. avoiding some local minima) and reduce the amount of time needed for the optimization process. Numerical results are presented on a benchmark test bed.

■ FD-05

Friday, 14:30 - 16:00 - Room 9

Facility Layout and Related Problems

Stream: Facility Layout
Invited session
Chair: *Manuel V. C. Vieira*

1 - A data-driven solution approach for the Facility Layout Problem
Samir Elhedhli, Daniel Ulch

We propose a hierarchical solution approach for the Facility Layout Problem based on patterns in the instance data. Detected patterns are used to decompose the problem into a hierarchy of small layout problems with a maximum of 5 departments, and to determine the order in which they are solved. Depending on the size of the problem, several layers may be needed. The hierarchical solution approach is organized as a tree where, at the lowest level, the original departments are laid out. The approach finds high quality solutions that compete with the best algorithms in the literature

2 - The container loading problem in a shoes manufacturer
Manuel V. C. Vieira

In this talks we describe a real life application of a container loading problem for a shoes manufacturer. Shoe boxes are packed in several cardboard boxes with variable dimensions. We present a MINLP model which decides how to pack the shoe boxes and the size of cardboard boxes. This container loading problem is classified as an open dimension problem, with three open dimensions. We approximate the MINLP model with a MILP and we compare it by using BARON on the nonlinear model and we run CPLEX on the linear model.

3 - Continuous Formulations for Facility Layout on Rows with Rectilinear Distance
Miguel F. Anjos, Manuel V. C. Vieira

Multi-row layout are facility layout problems in which departments are to be placed optimally in two or more rows. We propose a new mixed integer linear optimization model that uses continuous values for both the row assigned to each department and the position of departments within a row. We prove that there is at least one optimal solution with integer values for the row assignments, even though they are represented by continuous variables. We also propose a two-stage approach based on the new formulation, and report results showing that it finds high-quality solutions for large instances.

■ FD-06

Friday, 14:30 - 16:00 - Room 10

High Performance Computing in Global Optimization II

Stream: High Performance Computing in Global Optimization
Invited session
Chair: *Leocadio G. Casado*

1 - An scalable CPU-GPU Parallelization of UEGO for predicting De Novo Protein Tertiary Structure
J.m. García-Martínez, Ester M Garzon, Pilar M. Ortigosa

Recent surveys published shows while some areas of protein modeling have experienced an impressive progress, others areas have changed very few in last years. Template free methods perform well for small targets but it has not appeared to scale to larger structures. In this paper we present our method and implementation for solving this issue, proposing a framework that allows scalation with HPC platforms for larger proteins using H-P model y 3D lattice. Our last developments in UEGO increases parallelizable code and obtains more accurate results determining new optimum Energy conformation.

2 - Optimizing electrostatic similarity using a global evolutionary algorithm
Savíns Puertas Martín

Techniques of Virtual Screening have been used in many works recently. Most of them have focused on properties based on compound structure. One of them is electrostatic potential which gives information about how loads are distributed in compounds. In this work, we propose a new method to optimize which consists of an evolutionary algorithm to optimize electrostatic similarity without considering other properties of the compounds as other algorithms do. In addition, the paralyzation of the method has been considered to reduce the computation time while a comprehensive exploration is kept.

3 - Parallel global optimization and optimization for parallel computations
Julius Žilinskas

In this talk we will discuss branch and bound algorithms and parallel computations. We will review strategies for parallelization of branch and bound algorithms and investigate examples of implementations. Parallel computing not only makes solution faster, but also enables solution of larger problems. On the other hand, optimization is important in high performance computing. Efficient exploitation of high performance computing systems enables considerable saving of resources. We will formulate and discuss some related optimization problems and ways to solve them using branch and bound.

4 - On parallelization of a facet-based copositivity detection algorithm
Jose Manuel Garcia Salmeron, Leocadio G. Casado, Eligius M.T. Hendrix

Recent studies show that in the copositivity detection we can focus on facets of the unit simplex due the existence of an interior minimum value of the standard quadratic program based on eigenvalues and methods to calculate its value. Due to the large number of facets as the dimension increases, parallelization is an appealing tool to reduce the computational execution time. Facets can be evaluated in parallel, but information of already evaluated facets have to be shared among processes in order to avoid unnecessary computation. We study the most efficient way to parallelize this problem.

Friday, 16:30 - 17:30

■ FE-01

Friday, 16:30 - 17:30 - Aula Magna

Closing Session

Stream: Closing Session
Invited session

STREAMS

Advances in Interior Point Methods and Linear Complementarity Problems

Tibor Illés
Budapest University of Technology and Economics
illes@math.bme.hu

Tamás Terlaky
Lehigh University
terlaky@lehigh.edu

Track(s): 2

Closing Session

Track(s): 1

Conic and Copositive Optimization

Paula Amaral
Universidade Nova de Lisboa
paca@fct.unl.pt

Immanuel Bomze
University of Vienna
immanuel.bomze@univie.ac.at

Track(s): 1

Continuous Location

Jose Fernandez
Universidad de Murcia
josefdez@um.es

Boglárka G.-Tóth
University of Szeged
boglarka@inf.szte.hu

Track(s): 2

Convex optimization

Track(s): 2

Data Science and MINLP & Applications

Andrea Lodi
École Polytechnique de Montréal
andrea.lodi@polymtl.ca

Laura Palagi
La Sapienza Università di Roma
palagi@dis.uniroma1.it

Track(s): 3

Decomposition in MINLP

Eligius M.T. Hendrix
Universidad de Málaga
eligius@uma.es

Track(s): 3

Derivative-Free Optimization

Sébastien Le Digabel
École Polytechnique de Montréal
sebastien.le-digabel@polymtl.ca

Track(s): 6

EUROPT Fellow Lecture

Track(s): 1

Facility Layout

Miguel F. Anjos
GERAD & Polytechnique Montreal
anjos@stanfordalumni.org

Manuel V. C. Vieira
Universidade Nova de Lisboa
mvcv@fct.unl.pt

Track(s): 5

Global Optimization and Semidefinite Programming

Juan Campos Salazar
Imperial College
juan.campos-salazar12@imperial.ac.uk

Ruth Misener
Imperial College London
r.misener@imperial.ac.uk

Track(s): 3

High Performance Computing in Global Optimization

Leocadio G. Casado
Universidad de Almeria (ceiA3)
leo@ual.es

Pilar M. Ortigosa
University of Almería
ortigosa@ual.es

Track(s): 6

Machine Learning and Optimization and Applications

Laura Palagi
La Sapienza Università di Roma
palagi@dis.uniroma1.it

Track(s): 4

Mathematical optimization in the real world

Track(s): 1

Multi-objective optimization and Applications

Track(s): 1

Multiobjective Optimization

Gabriele Eichfelder
Technische Universität Ilmenau
Gabriele.Eichfelder@tu-ilmenau.de

Track(s): 5

Numerical Methods and Software

Track(s): 4

Opening Session

Track(s): 1

Optimal Control and Optimization in Economics and Finance

Diogo Pinheiro
Brooklyn College of the City University of New York
dpinheiro@brooklyn.cuny.edu

Gerhard-Wilhelm Weber
Poznan University of Technology
gerhard-wilhelm.weber@put.poznan.pl

Track(s): 3

Plenary I

Track(s): 1

Plenary II

Track(s): 1

Plenary III

Track(s): 1

Progress in interior-point methods and their applications

Track(s): 2

Variational Inequalities in Economic Problems

Annamaria Barbagallo
Universitá di Naples "Federico II"
annamaria.barbagallo@unina.it

Track(s): 6

Variational problems and applications

Giancarlo Bigi
Universita' di Pisa
giancarlo.bigi@unipi.it

Simone Sagratella
La Sapienza Università di Roma
sagratella@dis.uniroma1.it

Track(s): 6

Session Chair Index

Author Index

ica, Region Arica y Parinacota, Chile

Mahey, Philippe TE-03
philippe.mahey@isima.fr
ISIMA, Université Blaise Pascal, Aubière, France

Maldonado, Sebastian FC-04
smaldonado@uandes.cl
School of Engineering and Applied Sciences, Universidad de los Andes, Santiago, Chile

Marchand, Luc TE-03
luc.marchand@usherbrooke.ca
Mathematics, University of Sherbrooke, Canada

Martínez-Legaz, Juan Enrique TE-06
JuanEnrique.Martinez.Legaz@uab.cat
Departament d'Economia, Universitat Autònoma de Barcelona, Bellaterra, Spain

Martin-Barragan, Belen FC-04
belen.martin@ed.ac.uk
Business School, The University of Edinburgh, Edinburgh, United Kingdom

Martinez, Angeles TF-04
acalomar@math.unipd.it
Department of Maths "Tullio Levi-Civita", University of Padua, Padova, Italy

Martinez, J.a. FC-06
jmartine@ual.es
Computer Architecture and Electronics, University of Almeria, Almeria, Spain

Mastroeni, Giandomenico TE-06
gmastroeni@di.unipi.it
Computer Science, University of Pisa, Pisa, Italy

Mályusz, Levente TD-04
lmalyusz@ekt.bme.hu
Construction Management and Technology, Budapest University of Technology and Economics, Budapest, Hungary

Melguizo Padial, Miguel Angel FD-01
ma.mp@ua.es
Applied Mathematics, Uniiversity of Alicante, Alicante, Comunidad Valenciana, Spain

Messine, Frederic FB-01
Frederic.Messine@n7.fr
ENSEEIHT-IRIT, TOULOUSE, France, France

Miglionico, Giovanna TF-03
gmiglionico@dimes.unical.it
DIMES, Università della Calabria, Arcavacata di Rende, Italy

Minisci, Edmondo TF-01
edmondo.minisci@strath.ac.uk
MEchanical and Aerospace Engineering, University of Strathclyde, Glasgow, United Kingdom

Miroforidis, Janusz FC-01
janusz.miroforidis@ibspan.waw.pl
Department of Intelligent Systems, Systems Research Institute of the Polish Academy of Sciences, Poland

Molero-Río, Cristina FC-04
mmolero@us.es
IMUS - Instituto de Matemáticas de la Universidad de Sevilla, Spain

Mongeau, Marcel TF-01
marcel.mongeau@enac.fr
ENAC, Toulouse, France

Morapitiye, Sunil FD-02
sunil@math.bme.hu
Institute of Mathematics, Budapest University of Technology and Economics, Budapest, Pest, Hungary

Moreno Riado, Juan José FC-06
juanjomoreno@ual.es
Universidad de Almería, Spain

Muts, Pavlo FC-03
pavlo.muts@haw-hamburg.de
HAW Hamburg, Germany

Naoum-Sawaya, Joe TD-01, FD-04
jnaoumsa@uwaterloo.ca
Ivey Business School, Canada

Niebling, Julia TD-05
julia.niebling@tu-ilmenau.de
Insitute for Mathematics, Technische Universität Ilmenau, Ilmenau, Germany

Novo, Vicente FC-05
vnovo@ind.uned.es
Matematica Aplicada, Universidad Nacional de Educacion a Distancia, Madrid, Spain

Nowak, Dimitri TF-01
dimitri.nowak@itwm.fraunhofer.de
Fraunhofer ITWM, Kaiserslautern, Germany

Nowak, Ivo FC-03
ivo.nowak@haw-hamburg.de
M+P, HAW Hamburg, Hamburg, Germany

O'Neill, Sam TE-04
s.oneill@derby.ac.uk
Department of Electronics, Computing and Mathematics, University of Derby, Derby, United Kingdom

Oggioni, Giorgia TE-06
giorgia.oggioni@unibs.it
Department of Economics and Management, University of Brescia, Italy, Brescia, Italy, Italy

Oliveira, Aurelio FC-02
aurelio@ime.unicamp.br
Computational & Applied Mathematics, University of Campinas, Campinas, SP, Brazil

Ortega, Gloria FC-06
gloriaortega@ual.es
Informatics, University of Almería, Almería, Spain

Session Index

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