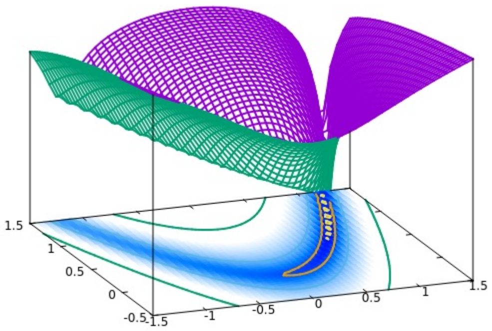
4th International Conference on Optimization Methods and Software 2017



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Plenary Talks

Challenging Problems in Energy in Optimization: the Hydro Unit Commitment

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The Short Hydro Unit Commitment is a well-known, crucial problem in energy optimization that has been studied since decades. Nevertheless, it still represents a challenge for several reasons, for example the wish of better model physical and strategic constraints. In this talk, we focus on some of the challenges arising in the deterministic Hydro Unit Commitment context and present different mathematical programming approaches to tackle them.

Projective Operator Splitting and Convex Optimization

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Until the last decade, operator splitting methods such as the ADMM (alternating direction method of multipliers) were a small niche area within optimization algorithms, but recent interest in large-scale data and image analysis problems has now made them one of the most active areas of current research. This talk reviews the key concepts in operator splitting methods for convex optimization, relating convexity to subgradient monotonicity and nonexpansive maps. Convergence proofs of operator splitting methods typically involve some kind of Fejér monotonic convergence to the solution set, which in the common firmly nonexpansive case implies equivalence to a separator-projection method. We then discuss a relative recent class of splitting methods that involves explicit projection on separators. The most recent work on this class of algorithms shows that they can be implemented in an asynchronous manner, and have some unique features. We present applications to stochastic programming and possibly other problems.

Truncated Primal-Dual Iterative Methods for Large-Scale Nonlinear Least-Squares Problems

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Data assimilation covers techniques where prediction of the state of a dynamical systems is performed using data from various origins. We consider here the optimization problem that lies in the centre of this technique, when so-called variational formulations are considered. Our main interest will be focused on case where the dynamical systems under consideration is described by *stochastic* differential equations. Such a problem is called "Weak-constrained variational Data Assimilation". We will compare the merits of the three main approaches that are considered by the community: state, forcing, saddle-point formulations. They lead to large-scale optimization problems which must be solved iteratively. As it is usually the case in this setting, efficiency will dramatically rely on the ability to design effective parallel implementations of suitably preconditioned, convergent and variationally coherent minimization algorithms. Using these principles we derive a new variant of the saddle point algorithm in which the monotonicity of the likelihood along the iterates is enhanced. A parametric study of the algorithms will be presented both in a sequential and in an idealised parallel environment on two problems : the Burgers equation and the quasi-Geostrophic model both being considered as representative of real models occurring in Meteorology of Oceanography. We show the merits of our new saddle-point formulation and of more classical ones based on the full orthogonalization method.

Relaxing Kink Qualifications and Proving Linear or Quadratic Convergence in Piecewise Smooth Optimization

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We consider nonsmooth objective functions that are compositions of smooth elelemtary functions and piecewise linear univariates like the absolute value. Under a certain linear independent kink qualification (LIKQ) on the local piecewise linearization, generalizations of KKT and SSC have been derived. We show here that under SSC, which does not require convexity, the natural approach of successive piecewise linear mimization with a proximal term yields locally a linear rate of convergence. Moreover, its is shown that when the minimizer is strongly isolated the same method yields locallly quadratic convergence without any kink qualifications and independent of the particular representation of the objective. The theoretical results are verified on a set of test functions with an algorithm based on an extension of ADOL-C. There will be a proximal, secant, and Newton based option.

Exact Solution Approaches for the Resource Constrained Shortest Path Problem and Some Uncertain Versions.

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The Resource Constrained Shortest Path Problem (RCSPP) is a well studied problem in network optimization. It is used to model several real-life applications, arising in the fields of transportation and communications. In addition, it appears as a subproblem when more difficult problems are solved via column-generation approaches. Due to its practical importance, several papers have been published in the scientific literature and heuristic and optimal solution approaches have been proposed for its solution. The solution approaches proposed in the literature for solving the RCSPP to optimality are characterized by three main steps: (1) computation of lower and upper bounds, (2) preprocessing phase and (3) gap closing step, in which the optimal solution is found ([1]). The Lagrangean relaxation is the most commonly used technique to compute valid lower and upper bounds. The preprocessing makes use of such information in order to reduce the dimension of the network, removing nodes and arcs that cannot be part of any feasible and optimal solution. The gap closing procedure is implemented by considering path ranking methods [2, 3], dynamic programming approaches [4, 5], and strategies based on the Branch and Bound scheme [6, 7]. The classical version of the RCSPP supposes that the resource consumptions and the costs are certain and looks for the cheapest feasible path. These parameters are however hardly known with precision in real applications, so that the deterministic solution is likely to be infeasible or suboptimal. Recently, in order to address the problem with uncertain parameters, robust formulations have been proposed [8, 9]. In this talk, we present the most efficient optimal solution approaches to solve the RCSPP and its robust counterpart.

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Total Variation Image Reconstruction on Surfaces

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We present an analog of the total variation image reconstruction approach by Rudin, Osher, Fatemi (1992) for images defined on surfaces, together with a proper analytical framework. The problem is defined in terms of quantities intrinsic to the surface and it is therefore independent of the parametrization. It is shown that the Fenchel predual of the total variation problem is a quadratic optimization problem for the vector-valued predual variable with pointwise constraints on the surface. The predual problem is solved using a function space interior point method, and discretized by conforming Raviart-Thomas finite elements on a triangulation of the surface. As in the flat case, the predual variable serves as an edge detector. Numerical examples including denoising and inpainting problems with both gray-scale and color images on complex 3D geometries are presented.

SCIP-Jack: A Solver for Steiner Tree Problems in Graphs and their Relatives

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The Steiner tree problem in graphs is a classical problem that commonly arises in practical applications as one of many variants. While often a strong relationship between different Steiner tree problem variants can be observed, solution approaches employed so far have been prevalently problem-specific. In contrast, we will present a general-purpose solver that can be used to compute optimal solutions to both the classical Steiner tree problem and many of its variants without modification. In particular, the following problem classes can be solved: Steiner Tree in Graphs (STP), Steiner Arborescence (SAP), Rectilinear

Steiner Minimum Tree (RSMTP), Node-weighted Steiner Tree (NWSTP), Prize-collecting Steiner Tree (PCSTP), Rooted Prize-collecting Steiner Tree (RPC-STP), Maximum-weight Connected Subgraph (MWCSP), Degree-constrained Steiner Tree (DCSTP), Group Steiner Tree (GSTP), and Hop-constrained Directed Steiner Tree (HCDSTP). This versatility is achieved by transforming various problem variants into a general form and solving them by using a state-of-the-art MIP-framework. The result is a high-performance solver that can be employed in massively parallel environments and is capable of solving previously unsolved instances. SCIP-Jack has participated in the 11th DIMACS Implementation Challenge and been demonstrated to be the fastest solver in two categories. Since the Challenge tremendous progress regarding new solving routines such as transformation, preprocessing and heuristics was made, resulting in a reduction of the runtime of more than two orders of magnitude for many instances. The talk will report on the latest developments.

Complexity on the Minimization of Functions whose Evaluation is Intrinsically Inexact

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In many cases in which one wishes to minimize a complicated or expensive function, it is convenient to employ cheap approximations, at least when the current approximation to the solution is far from the correct one. Adequate strategies for deciding the accuracy desired at each stage of optimization are crucial for the overall efficiency of the process. In this paper, a procedure based on Inexact Restoration will be revisited, modified, and analyzed from the point of view of worst-case complexity.

Iterative Linear Algebra for Optimization

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In certain large-scale settings, first derivatives are obtained by solving least-squares or least-norm problems. In factorization-free implementations, those derivatives are inexact beyond the usual limits of floating-point arithmetic. We review conditions under which the convergence of standard optimization methods is preserved when inexact first derivatives are used, and describe adequate linear algebra procedures to compute derivatives while preserving convergence of the optimization scheme.

A Superquadratic Variant of Newton's Method

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We present the first Q-superquadratically convergent version of Newton's method for solving operator equations in Banach spaces that requires only one operator value and one inverse of the Fréchet derivative per iteration. The R-order of convergence is at least 2.4142. A semi-local analysis provides Sufficient conditions for existence of a solution and convergence. The local analysis assumes that a solution exists and shows that the method converges from any starting point belonging to an explicitly defined neighbourhood of the solution called the ball of attraction.

New Perspectives on Clustering Methods for Global Optimization

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Clustering methods have been the first successsful GO methods in the 90's. Despite their original good performance they have later been abandoned when the dimension of GO problems increased. The main idea of clustering method was to start a random sample of the objective function, to concentrate the sample by performing a few descent steps, and to recognize clusters in order to identify regions of attraction of different minima. Unfortunately, despite the very interesting behaviour of these methods on low dimensional problems, their applicability to large scale GO was impossible due to the inherent complexity of covering, by sampling, a large dimensional space. In this talk we will show that the concept of clustering may be re-considered also in modern GO methods and used as a decision tool which allows to choose promising startng points for a full, in-depth exploration of selected local minima. We propose here a feature-based implementation of clustering methods and show its effectiveness in large scale, highly complex, GO problems like Lennard-Jones and Morse atomic cluster optimization (the word cluster here is used in a different context and with a different meaning). We empoyed a very efficient descent algorith for the exploration of minimal energy cluster conformations known as CSS (Cluster Surface Smoothing), using early stopping to generate a concentrated sample. Then we applied the criteria of Multi-Level Single-Linkage applied to a mapping of each atomic configuration into a small dimensional feature space. We have run the resulting algorithm on hard and large scale instances obtaining excellent quality and significative speedups over state of the art methods.

Towards Understanding the Convergence Behavior of Newton-Type Methods for Structured Optimization Problems

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Recently, there has been a growing interest in applying Newton-type methods to solve structured optimization problems that arise in machine learning and statistics. A major obstacle to the design and analysis of such methods is that many problems of interest are neither strongly convex nor smooth. In this talk, we will present some design techniques for overcoming such obstacle and report some recent progress on analyzing the convergence rates of the resulting Newton-type methods using error bounds. We will also discuss some directions for further study.

On Mixed Integer Second Order Cone Optimization

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Mixed Integer Second Order Cone Optimization (MISOCO) gained considerable interest in recent years. Efficient Interior Point Methods are available to solve continuous SOCO problems. The theory of Disjunctive Conic Cuts (DCCs) for MISOCO is well developed, and several recent papers prove the power of DCCs in solving in solving financial optimization layout, and other MISOCO problems. Recent developments include novel, efficient warm start strategies, the identification of pathological disjunctions, and the identification of the optimal partition.

Recent Progress in the Analysis of Evaluation Complexity for Nonconvex Optimization

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The talk will review some recent progress in the analysis of evaluation complexity of algorithm for solving (potentially) nonconvex optimization problems. The use of high-order models will be emphasized and the search of high-order critical points, including associated pitfalls, will be discussed. A new algorithm will also be presented, that uses a regularized third-order Taylor model and has $O(\epsilon^{-2})$ evaluation complexity for finding approximate second-order critical points.

Mixed Integer Linear Programming Formulations of Standard Quadratic Programs

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Standard quadratic programs have numerous applications and play an important role in copositivity detection. We consider reformulating a standard quadratic program as a mixed integer linear programming problem. We discuss the advantages and drawbacks of such a reformulation.

Non-Monotone Properties of the BB Method

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Gradient methods are widely used for large scale optimization. Barzilai-Borwein method is a famous gradient method which chooses the step-size based on weak quasi-Newton condition. Though Barzilai-Borwein method has a nice convergence results and remarkable numerical performance when it is applied to convex quadratic minimization, it is not a monotone method. We analyze non-monotone properties of the BB method and explore which merit functions could ensure the monotonicity of the BB method when it is applied to convex quadratic functions.

Contributed Talks

Adjoint Function as Bisection Heuristic for Guaranteed Global Optimization with Nonlinear Ordinary Differential Equations

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We focus on interval algorithms for computing guaranteed enclosures of the solutions of constrained global optimization problems where differential constraints occur. To solve such a problem of global optimization with nonlinear ordinary differential equations, a branch and bound algorithm can be used based on guaranteed numerical integration methods. Nevertheless, this kind of algorithms is expensive in term of computation. Defining new methods to reduce the number of branches is still a challenge. Bisection based on the smear value is known to be often the most efficient heuristic for branching algorithms. This heuristic consists in bisecting in the coordinate direction for which the values of the considered function change the most "rapidly". We propose to define a smear-like function using the adjoint (or sensitivity) function obtained from the differentiation of ordinary differential equation with respect to parameters. The adjoint has been already used in validated simulation for local optimization but not as a bisection heuristic. We implement this heuristic in a branch and bound algorithm to solve a problem of global optimization with nonlinear ordinary differential equations. Experiments show that the gain in term of number of branches could be up to 30%.

A Sequential Optimality Condition Related to the Quasinormality Constraint Qualification and its Algorithmic Consequences

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In the present paper, we prove that the augmented Lagrangian method converges to KKT points under the quasinormality constraint qualification, which is associated with the exter- nal penalty theory. For this purpose, a new sequential optimality condition for smooth constrained optimization, called PAKKT, is defined. The new condition takes into account the sign of the dual sequence, constituting an adequate sequential counterpart to the (enhanced) Fritz-John necessary optimality conditions proposed by Hestenes, and later extensively treated by Bertsekas. We also provided the appropriate strict constraint qualification associated with the PAKKT sequential opti- mality condition and we prove that it is strictly weaker than both quasinormality and cone continuity property. This generalizes all previous theoretical convergence results for the augmented Lagrangian method in the literature.

Optimal Dynamic Portfolio Liquidation with Lower Partial Moments

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One of the most important problems faced by stock traders is how to execute large block orders of security shares. When liquidating a large position, the trader faces the following dilemma: a slow trading rate risks prices moving away from their current quote, while a faster trading rate will drive quotes away from the current one leading to a large market impact. We propose a novel multi-period model for optimal position liquidation in the presence of both temporary and permanent market impact. Four features distinguish the proposed approach from alternatives. First, instead of the common stylized approach of modelling the problem as a dynamic program with static trading rates, we frame the problem as a stochastic SOCP which uses a collection of sample paths to represent possible future realizations of state variables. This, in turn, is used to construct trading strategies that differentiate decisions with respect to the observed market conditions. Second, our trading horizon is a single day divided into multiple intraday periods allowing us to take advantage of the seasonal intraday patterns in the optimization. This paper is the first to apply Engle's Multiplicative component GARCH to estimate and update intraday volatilities in a trading strategy. Third, we implement a shrinking horizon framework to update intraday parameters by incorporating new incoming information while maintaining standard non-anticipativity constraints. We construct a model where the trader uses information from observations of price evolution during the day to continuously update the size of future trade orders. Thus, the trader is able to dynamically update the trading decisions based on changing market conditions. Finally, we use asymmetric measures of risk which, unlike symmetric measures such as variance, capture the fact that investors are usually not averse to deviations from the expected target if these deviations are in their advantage.

A Nonlinear Optimization Algorithms with Rapid Infeasibility Detection Capabilities

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We present a primal-dual algorithm based on a mixed augmented Lagrangian and a log-barrier penalty function. A special attention is given on the infeasibility detection. An additional parameter is introduced to balance the minimization of the objective function and the realization of the constraints. The global convergence of the algorithm is analysed under some mild assumptions. We also show that under a suitable choice of the parameters along the iterations, the rate of convergence of the algorithm to an infeasible stationary point is superlinear. This is the first local convergence result for the class of interior point methods in the infeasible case. We finally report some numerical experiments to show that this new algorithm is quite efficient to detect infeasibility and does not deteriorate the overall behavior in the general case.

COCO: A Platform for Benchmarking Derivative Free Optimizers

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We present the COmparing Continuous Optimizers platform that aims at automatizing the tedious and repetitive task of benchmarking numerical optimization algorithms to the greatest possible extent. We present the rationals behind the development of the platform as a general proposition for a guideline towards better benchmarking. We detail underlying fundamental concepts of COCO such as the definition of a problem, the idea of instances, the relevance of target values, and runtime as central performance measure. Finally, we give a quick overview of the basic code structure, the currently available test suites and the post-processing plots.

Transportation Management: On the Interplay between Optimization and Equilibrium Problems

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A dilemma often facing motorists is to choose which route should be taken to realise the fastest (i.e. shortest) journey time. The route choices between an origin and destination might typically be a direct main road, a shorter route through narrow side streets in residential areas, or a longer but (potentially) faster journey using a nearby motorway or ring-road. In the absence of effective traffic control measures, an approximate equilibrium travel time results between the routes available. However, this may not be optimal, as faster overall journey times may have resulted had car drivers allocated themselves differently between the routes. In what has become known as the Braess Paradox, this difference between equilibrium and optimal travel times can lead to the decidedly counter-intuitive result, that additions to road capacity, typically through road construction, lead to slower - not faster - car journey times. Here a transportation model where journey time is the only criteria for route choice is solved by dynamic programming, genetic algorithms and numerical or analytical techniques. Results show close links between solutions of certain (discrete and continuous) optimization and equilibrium problems. The effects induced by closing certain road segments are also investigated.

Improved Algorithmic Differentiation of the Open CASCADE Technology CAD Kernel Applied to Gradient-Based Optimisation of TU

Berlin TurboLab Stator with Constraint Imposition

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To perform aerodynamic shape optimisation of a CAD-based model using the gradient-based methods, one requires the calculation of shape sensitivities w.r.t. design parameters of the CAD model. Within a fully developed CAD system, this information is usually not available and obtained using inaccurate and non-robust finite differences. To have exact shape sensitivities, algorithmic differentiation (AD) is applied to the open-source CAD kernel Open Cascade Technology (OCCT), in forward and reverse mode, using the AD software tool ADOL-C (Automatic Differentiation by Overloading in C). The performance of differentiated OCCT is improved. First, a new feature is developed in ADOL-C, named activity analysis, that can dramatically reduce the temporal complexity of the derivative computation as well as the memory requirements. Second, a technique specific to AD called structure exploitation will be investigated on certain parts of the OCCT modeling algorithms in order to modify their code structure and enhance the derivative computation even further. These improvements allow to handle complex geometrical cases, including expensive surface-surface intersection calculations. Enabled by these efficiency gains, differentiated OCCT is coupled with a discrete adjoint CFD solver also produced with the algorithmic differentiation and applied to industrial test-cases. Here, this differentiated design chain is used to perform the gradient-based optimisation of the TU Berlin TurboLab Stator to minimise the total pressure loss. The geometry of TurboLab stator test-case is parametrised in differentiated OCCT, which allows to consider several specified manufacturing constraints directly during optimisation loop. One of them requires the blade to accommodate four mounting bolts (cylinders) of certain width (radius) and depth. These cylinders are used to fix the blade to its casing. At every iteration we search for the best position of the cylinders and validate feasibility of bolts insertion. If some intersections between the blade and the cylinders appear, the constraint is considered to be violated. To satisfy it, we increase the thickness of the blade in the corresponding intersection areas until the cylinders are completely inside the blade. This process is automated using the gradient information provided by the differentiated OCCT kernel.

Sparsity-Constrained Optimization Tools for Structural Variant Detection

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Structural variants (SVs) – rearrangements of an individual's genome – are an important source of genetic diversity and disease in human and other mammalian species. SVs are typically identified by comparing fragments of DNA from a test genome to a given reference genome. Discordant arrangements of these DNA fragments signal structural differences between the test and reference genome, but errors in both the sequencing and mapping lead to high false

positive rates in SV prediction. However, the presence of DNA from multiple related individuals offers the promise to substantially reduce the false positive rate of prediction. To address this inverse problem, we develop an alternating, constrained-optimization method to predict germline structural variants given genomic DNA in a family lineage. Because SVs are thought to have a low rate of spontaneous appearance, any SV present in a child's genome must have occurred in at least one of their parents. We seek to improve standard methods in three main ways. First, to reduce false-positive predictions, we enforce properties of inheritance to constrain the space of admissible solutions and concurrently predict SVs in family lineages. Second, we implement an alternating approach with indicator variables to predict variant zygosity (i.e., 0, 1, or 2 copies). Third, we utilize a gradient-based optimization approach and constrain our solution with a sparsity-promoting l1 penalty (since SVs should be rare). We present results on simulated genomes and family lineages as a special case of sparse, time-series signals governed by the Poisson process.

A Detailed Mathematical Model for the Aircraft Landing Problem on a Multiple Runway System

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The real time Aircraft Landing Problem (ALP) within an Air Traffic Control (ATC) system is typically a large scale problem. Since the modeling is a crucial step in solving the ALP, we are concerned in the following paper with modeling the landing procedure of aircrafts for a multiple runway system. We proposed a detailed Mixed Integer Programming (MIP) model where we treat respectively the three basic decisions, the scheduling of aircraft landings, their assignment to an airport with multiple runways and the control practice.

Improving a Cluster Analysis for Decision Making In an Ornamental Japanese Fish Aquarium

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The aim of this work is to find patterns related to the levels of description and development of Japanese ornamental fish aquariums. These levels correspond to profiles based on the budget, number of staff and space used in these businesses. To achieve this goal, an unsupervised approach is used. In the article, we propose a new clusters approach, since we want to automatically find categories or groups of aquariums based on their autonomy and their information at the beginning of their implementation. All aquariums in a group have

similar patterns. The main function of the approach is to explore the links between the variables and the similarities between the examples (individuals) that allows decision making in new Japanese ornamental fish aquariums. The proposed algorithm uses the technique of analysis and determination of clusters with self-organizing partitions using Manhattan distance, taking into account also variables such as climate, food, water change and quantity of fish per cubic meters.

Semi-Infinite Programming via Generalized Nash Equilibria

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Generalized Nash games (shortly GNEPs) and semi-infinite programs (shortly SIPs) share some similarities that lead to meaningful connections. In this talk we analyse these connections and we show how algorithms for GNEPs can be exploited to solve SIPs. Indeed, SIPs can be reformulated as GNEPs with a peculiar structure under some mild assumptions. Pairing this structure with a suitable partial penalization scheme for GNEPs leads to a class of solution methods for SIPs that are based on a sequence of saddlepoint problems. Any converging algorithm for the saddlepoint problem provides the basic iterations to perform the penalty updating scheme. In particular, a projected subgradient method for nonsmooth optimization and a subgradient method for saddlepoints are adapted to our framework and the convergence of the resulting algorithms is shown. A comparison between the two algorithms is outlined as well. Finally, a problem of production planning under price uncertainty is formulated as a SIP through robustness techniques and solved by the above algorithms.

Locating Separating Hyperplanes with Maximum lp-Norms Margins

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In this work we present new results on the determination of a hyperplane that separate two classes of given data. We deal with the problem of obtaining such a hyperplane when the goal is to maximize the lp-margin(with rational p 1) between the two classes. We provide valid non-linear mathematical programming formulations for the problem involving the minimization of homogenous polynomials over linear regions. The formulation allows us to manage the use of transformations of the data and the resolution of the problem without using the specific knowledge of the transformation but some properties about it. Some methodologies for solving the problem in practice are provided.

Optimal Sample Size for Stratified Sampling: A Numerical Study

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The determination of optimal allocation in stratified sampling is studied considering the use of Mathematical programming. The optimization problem is posed and its solution is considered. Different numerical procedures for solving it are derived. The behavior of the procedures in terms of efficacy and costs is evaluated through the analysis of real life data.

Convergence Analysis of Two Smoothing Approaches for Mathematical Programs with Complementarity Constraints

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The smoothing schemes are one of the most important approaches for solving mathematical program with complementarity constraints. In this paper we compare two of such schemes. The parametric problem they define is analyzed, that is, the types of solutions in the generic case are obtained and an upper bound depending on the parameter is given for the distance between the set of feasible solutions of the parametric problem and the original model, their optimal values and the set of solutions. Conditions under which the limit points(when the parameter goes to zero) of sequences of stationary points satisfies some stationarity concept in the context of MPCCs are also studied.

Dense Initializations for Limited-Memory Quasi-Newton Methods

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We propose a quasi-Newton trust-region method that uses novel dense initial matrices. Our approach is based on an efficient partial eigendecomposition of the L-BFGS compact representation, and applies a non standard norm to the so-called trust-region subproblem. Based on the eigendecomposition we develop dense initial matrices that allow for direct specification of a set of eigenvalues of the quasi-Newton matrix, and lead to a closed form formula for the compact representation.

Limited Memory Algorithms with Cubic Regularization

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We consider a model with a cubic regularization where the cubic term is determined by the eigendecomposition of a limited memory Hessian approximation. Although the model function may potentially have an exponential number of distinct local minima, its global minimizer can be obtained in closed form. The required eigenvalue decomposition is produced using an efficient approach introduced recently for limited memory Hessian approximations. Convergence results are presented for a standard cubic regularization framework. The efficiency of our algorithms is demonstrated by results of numerical experiments.

Presentation of a Framework for Optimisation in the Presence of Uncertainty: COSSAN a General Purpose UQ Software Library

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Cossan is a general purpose open source software package for uncertainty quantification and management, sensitivity analysis, reliability analysis and optimization. Cossan represents over two decades of development by researchers from around the world providing a flexible framework for numerical analysis, and full integration with any third party solvers. Uniquely in the field, Cossan also provides methods for dealing with epistemic uncertainty and imprecise probability. A framework for 'robust' or 'reliability' based design optimization will be presented, with example applications in the optimization of viscous dampers subject to stochastic seismic loading scenarios, the optimization of sweeping scenarios for temperature management inside large nuclear fusion devices, and a methodology for sensitivity analysis of computationally expensive finite element models. Cossan provides an environment for the analysis of any model in the presence of uncertainty. Advanced Monte-Carlo simulation algorithms (including LHS, and MCMC), sensitivity analysis, optimization, system reliability, earthquake engineering, and meta-modeling toolboxes are all implemented in Cossan, and ongoing development gives users access to the most advanced and cutting edge methods from academia. Cossan provides a solution to the challenges of both industry and academia in understanding and dealing with uncertainty. The object orientated nature of the software library allows for huge flexibility on the part of the user, or opportunity for bespoke problem specific solutions to be formulated and provided for end users.

Heuristic based on Simulating Annealing to solve Mixed Chinese Postman Problem MCPP

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Nowadays many real-life applications can be modelled as a Mixed Chinese Postman Problem. That is, given a connected mixed graph G=(V,E,A), where V denotes the vertex set, E the set of edges and A the set of arcs, and the lengths of arcs and edges, the goal of this model is to find the shortest tour which contains every edge and arc of G at least one time. We assume that E and A are both non empty. In this contribution we propose a solution heuristic approach based on the meta-heuristic Simulating Annealing. The algorithm constructs, iteratively, a directed graph and obtain an Eulerian path on it using a polynomial algorithm. By changing the direction of selected edges and adding artificial arcs, a new Eulerian directed path is computed on this neighboring graph. Following the strategy of Simulated Annealing, the new path is accepted or rejected. Computational experiments to evaluate the behavior of the algorithm on test problems are reported. A statistical analysis of the results has been carried out. A real life problem: the design of waste collection routes in Fortaleza, Brazil, illustrates the practical potential utility of the algorithm.

Interior-Point Method for Support Vector Machines through Multiple Variable Splitting

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Multiple variable splitting is a general technique to decompose problems through copies of variables and additional constraints equating their values. The resulting (and likely large) optimization problem can be solved with an specialized interior-point algorithm which exploits the problem structure and computes the Newton directions by direct and iterative solvers (i.e., Cholesky factorizations and preconditioned conjugate gradients). In this work this method is applied to the solution of real-world support vector machine (SVMs) instances, a binary classification technique from the machine learning field. This new approach is compared with state-of-the-art methods for SVMs, either based on interior-point algorithms (such as SVM-OOPS (Woodsend, Gondzio, 2011)) or specific algorithms for SVMs (such as libsvm (Chang, Lin 2011) and liblinear (Fan, Chang, Hsieh, Wang, and Lin, 2011)). The computational results show that the new approach is competitive with previous interior-point methods and libsvm, whereas it is outperformed by liblinear (which, however, solves a similar, but not exactly the same optimization problem).

Soft Margin Polyhedral Conic Functions Algorithm

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In this study, we propose soft margin version of Polyhedral Conic Functions (PCFs) algorithm for binary classification problems. First, PCFs algorithm is analysed to investigate reasons behind overfitting and parameter dependent performance. Then, an analogy is made between PCFs and well known soft margin idea of Support Vector Machines. The idea is adapted to the PCFs algorithm by relaxing constraints and adding an error value to the objective function. The proposed algorithm(s-PCFs) uses a penalty term to control misclassification and a regularization term to avoid overfitting. Finally, the performance of the algorithm is tested on several benchmark data sets. For these data sets, s-PCFs not only outperforms PCFs algorithm but also performs as good as other well-known classification methods.

Separation via Weighted-Norm Cones

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In this study, we consider the problem of discriminating two finite point sets by a weighted-norm cone which can be obtained the generalized form of polyhedral conic functions. Many studies in the literature have shown the success of the polyhedral conic functions on the problem of classification, including real-life problems. However, in these studies, only l-1 norm is used to construct the classifier. By the weighted l-p norm cones we can obtain nonlinear separating surfaces, unlike polyhedral level sets. The weight of the axes in norm equation allows the separating cone to scale in each axis. It has been shown that arbitrary two finite point disjoint sets can be separated by using weighted-norm cones with an algorithm. The classifier parameters are obtained by solving a nonlinear optimization problem. The achievement of the proposed method on real data sets is presented and some future research topics are discussed.

The Data Envelopment Analysis: A Support to Strategic Planning and Optimization of Resources

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The rationalization of the available resources in organizations is a growing requirement, in this sense strategic planning plays an important role, through which all activities are covered, promoting the fulfillment of the objectives that benefit it. On the other hand, efficiency can be seen as the ability to determine appropriate goals and is a measure to evaluate the performance of an organization. The Data Envelopment Analysis (DEA) is an application of the Linear Programming methods and is an optimization technique that is useful to perform an analysis of the relative efficiency between different organizational units that perform a similar activity; that is, they use the same type of resources (inputs) to produce the same group of outputs (products) and present the same goals and objectives. DEA allows to find efficient frontiers and relative efficiency indicators within the population of compared management units. The present work shows an DEA procedure that allows to connect the determination of the efficiency of the processes of an organization with its strategic direction through the use of DEA and is based on the strategic, process and continuous improvement approaches, by covering the integrating elements of strategic planning, consider the indicators to evaluate the objectives derived from the strategies and, take advantage of one of the benefits of DEA; determining the benchmarks to establish a Benchmarking between the organizations or units considered. The fundamental results of the application of the proposed procedure in a Higher Education Center are shown.

The Performance of two Fortran Packages for Piecewise Monotonic Approximation on Large Sequences of Highly Irregular Data

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We consider the performance of two Fortran packages for least squares piecewise monotonic approximation that are applied to some large sequences of univariate data, which contain random errors with substantial differences. The main difficulty in this optimization calculation is that the optimal positions of the joins of the monotonic sections have to be found automatically, but so many combinations of positions can occur that it is impossible to test each one separately. It is remarkable that the underlying method partitions the data quite efficiently into disjoint sets of adjacent data by dynamic programming, solves a monotonic approximation problem for each set in linear time and provides a global solution in quadratic time with respect to the number of the data. The development of the software has been based on two different methodological approaches that may lead to different utilization practices. We find that the packages can manage routinely very large amounts of data and they do provide shorter computation times in practice. For example, the timings have ranged from fractions of a second to few seconds in order to calculate a best fit to 30000 noisy data points, while the number of monotonic sections was between 5 and 100. The piecewise monotonic data fitting method may have many applications. In medicine, for example, there is room for applications in MRI noise reduction and in NMR spectroscopy peak finding. Our numerical results draw attention to some interesting practical questions. Moreover, the problems we present are instructive for investigating relevant applications of the method in science and engineering, and they indicate extensions of the algorithms in order to solve particular problems and cover specialized data analysis needs.

A New Phase I Method for LP Based on Normal Projections.

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A new method of Phase I in linear programming that generates optimal solutions is presented. The method has been developed for problems with equality constraints and the most equal type. It produces optimal results in most of the tested cases. The algorithm is of the iterative type and it is proved that the number of iterates requires a number of iterations that is more equal to the number of variables.

Regularity and Penalization in Constrained Vector Optimization

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In this talk we use a penalization procedure and some regularity assumptions in order to reduce a set-valued optimization problem with functional constraints to an unconstrained one. The penalization results are given in several cases: for weak and strong solutions, in global and local settings, and considering two kinds of epigraphical mappings of the set-valued map that defines the constraints. Then necessary and sufficient conditions are obtained separately in terms of Bouligand derivatives of the objective and constraint mappings.

The Global Complexity of the Inexact Levenberg-Marquardt Method

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In this talk, we investigate the global complexity bound of the inexact Levenberg-Marquardt method. Under reasonable assumptions, we show that the global complexity bound is $O(\epsilon^{-2})$, which is the same as the exact case. We also show that it can be improved to $O(\log \epsilon^{-1})$ under some regularity assumption.

NGAT: Framework for Working with Transport Networks

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Today's society depends to a large extent on the optimization of its processes. Among these is the use of road networks, power lines, gas lines, etc. The correct representation of such networks using Graph Theory is, therefore, an aspect of vital importance in diverse contexts of the world. The present work provides a framework that constitutes a computational solution to represent transport

networks where prohibited turns are considered in a novel, efficient and flexible way in correspondence with the current development of information and communication technologies. The result, therefore, serves as a link between the geographic information systems, information providers on the aforementioned networks and the computer systems designed for the solution of related optimization problems.

Minimizing Piecewise Linear Objective Functions: A Comparison of Stationarity Tests

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Minimizing piecewise linear objective functions is a key ingredient of our optimization method LiPsMin which locates first order optimal points of Lipschitz continuous, piecewise smooth functions by successively generating piecewise linear models as described in [1]. Consequently, the efficient solution of these local models is crucial for the overall performance of LiPsMin. To minimize piecewise linear objective functions we exploit the polyhedral structure of the domain caused by nondifferentiable points. According to [4], every piecewise linear function can be built up by finitely many maximum and minimum functions and therewith, can be expressed in terms of the absolute value function. Hence, the piecewise linear objectives can be rewritten in abs-normal form as described in [2] which proves to be very beneficial for the structure exploitation. The idea of the minimization method for piecewise linear functions is to determine a descent trajectory along a path of essential polyhedra towards a stationary point. Therefore, two problems have to be solved: Firstly, local subproblems have to be defined and solved on each polyhedron along the path. Secondly, the current iterate has to be tested on stationarity which is realized in [1] by a bundle-type method. This approach turns out to be robust but might be computationally expensive. In [3] new first- and second-order optimiality conditions were introduced. Based on these conditions a optimality test can be established that promises to reduce the computational effort. The different stationarity and optimality tests will be introduce and compared in this talk.

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Randomized and Accelerated for Minimizing Relatively Smooth Functions

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Relative smoothness – a notion introduced by Birnbaum et al. (2011) and rediscovered by Bauschke et al. (2016) and Lu et al. (2016) – generalizes the standard notion of smoothness, i.e., Lipschitz continuity of the gradients, typically used in the analysis of gradient type methods. In this work we are taking ideas from the field of convex optimization and applying them to the relatively smooth setting. In particular, we develop stochastic and accelerated algorithms for minimizing relatively smooth functions which outperform the standard methods developed in the papers mentioned above.

Sparse Pseudoinverses via Relaxations of Moore-Penrose

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Pseudoinverses are ubiquitous tools for handling over- and under-determined systems of equations. They are used for calculating least-squares solutions for over-determined systems and minimum-norm solutions for under-determined systems. For computational efficiency in the setting of large matrices, sparse pseudoinverses are highly desirable. Recently, sparse left- and right-pseudoinverses were introduced, using 1-norm minimization and linear programming. But a very classical pseudoinverse is the Moore-Penrose pseudoinverse. It is well known to be the unique solution of the four Moore-Penrose properties, and it enjoys other very nice attributes as well. Three of the Moore-Penrose properties are linear (in the input matrix), and one is a quadratic matrix equation. By enforcing or relaxing various combinations of the properties and using 1-norm minimization, we recently introduced several new sparse pseudo inverses. Omitting the quadratic Moore-Penrose property and enforcing various combinations of the linear Moore-Penrose properties, we are led to various linear-programming based sparse pseudo inverses with nice properties. We are developing and experimenting with many strategies for incorporating relaxations of the quadratic Moore-Penrose property; in particular, McCormick inequalities and semi-definite programming relaxations. Because of the heaviness of the semi-definite programming relaxation, we concentrate on several linearization schemes for further relaxing the semi-definiteness constraint. Initial results are promising.

An Approximate Augmented Lagrangian Algorithm for Fast Bounds on Quadratic Assignment Linearisations

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A crashing technique for linear programming problems is presented. The underlying algorithm is a special case of the Augmented Lagrangian method, with naive approximate minimization in each iteration. As well as considering the effect of exact minimization, this talk considers the scope for more sophisticated approximate minimization techniques. Additional uses of the crash as a way of generating bounds for quadratic assignment problems are presented.

A Proposal for Optimizing Computational Time in 3D Solving Geometric Constraints Problems

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The aim of this paper is to present an algorithmic solution for parameterizing the assembly operations towards developing a 3D Geometric Constraints Solver built on top of the 2D opensource geometric constraint solver FreeCAD. The algorithm was chosen through a literature review and by combining different approaches to provide the optimal way to improve the efficiency of solving the geometric constraint system. Some of the constituent algorithms reduce the equation system in smaller sets, which can be solved using numerical or symbolic methods. The proposal of GCS in 3D of this paper is based on development of the ILMA algorithm that allows to simplify the constraint graph during the analyze phase and recombine the subset solutions.

Optimization of the Results of the Simulation in the Customs of an Airport

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The airport Customs service must be performed quickly and efficiently, executing the control of passengers and baggage as established in the regulations and regulations governing this organization and offering friendly treatment to the passenger. This process includes the control of passengers on departure and arrival at the country, analysis of the customs process of arrival of passengers is the object of this work. The correct performance of this process is very important given that it has a high incidence in the time of stay of the passengers at the airport, time that is currently above what is established in the RAC regulations for the green channel (passengers without articles to declare). The discrete simulation will allow an analysis of the scenarios that occur in the customs process and detect bottlenecks, simulating different work schedules and arrival places

in order to reduce the time spent by passengers at the airport. The results obtained with the simulation showed that in the West salon there are the longest stay times in the customs (TPS) for both the green and the red channels. Then in this work will be addressed the optimization of mentioned places. For this it is proposed to use the ARENA language facilities in its OptQuest module. The generated mathematical model proposes to minimize the time of permanence in the customs, having as restrictions the amount of resources to be used. The results obtained show that optimal solution increases the level of service provided by the customs of an airport, due to the decrease in the average time spent by the passengers in the customs office in 11 minutes and average waiting times at the service points associated with the green channel.

Optimization-Based Convexification of Bilinear Terms

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One of the most fundamental ingredients in mixed-integer nonlinear programming solvers is the well-known McCormick relaxation for a bilinear product of two variables x and y over a box-constrained domain. The starting point of this talk is the fact that these may be far from tight if the feasible region and its convexification projected in the x-y-space is a strict subset of the box. We develop an algorithm that solves a sequence of linear programs in order to compute globally valid inequalities on x and y in a similar fashion as optimization-based bound tightening. We use these valid inequalities in order to tighten the classical McCormick relaxation. We use the constraint integer programming framework SCIP to analyze the impact of the tighter relaxations on instances of the MINLPLib2.

Valid Conic Inequalities for Hyperboloids and Non-Convex Quadratic Cones

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In recent years, the generalization of Balas disjunctive cuts for mixed integer linear optimization problems to mixed integer non-linear optimization problems has received significant attention. Among these studies, mixed integer second order cone optimization (MISOCP) is a special case. For MISOCP one has the disjunctive conic cuts approach. That generalization introduced the concept of disjunctive conic cuts (DCCs) and disjunctive cylindrical cuts (DCyCs). Specifically, it showed that under some mild assumptions the intersection of those DCCs and DCyCs with a closed convex set, given as the intersection of a second order cone and an affine set, is the convex hull of the intersection of the same set with a parallel linear disjunction. The key element in that analysis was the use of pencils of quadrics to find close forms for deriving the DCCs and DCyCs. In this work we use the same approach to show the existence of valid conic inequalities for hyperboloids and non-convex quadratic cones when the disjunction is defined by parallel hyperplanes. For some of the cases, we show that for each of the branches of those sets, which are convex, the intersections with the DCCs or DCyCs still provides the convex hull of the intersection of the branches with a parallel linear disjunction. For other cases, we show that this tecnique provides a second order cone equivalent reformulation for some non convex sets.

Combining Multiple Kernels in Recurrent Least Squares Support Vector Machines

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This paper introduces an adjusted approach for developing time series forecasters: We employ Recurrent Least Squares Support Vector Machines, but unlike the original methodology, our work is built on a combination of multiple kernels. We examine numerical difficulties regarding the underlying optimization problems and compare numerical results for different metrics. Finally, we discuss possible ways for future improvement.

Pointwise and Ergodic Convergence Rates of a Variable Metric Proximal ADMM

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In this talk, we discuss pointwise and ergodic convergence rates for a variable metric proximal alternating direction method of multiplicas (VM-PADMM) for solving linearly constrained convex optimization problems. The VM-PADMM can be seen as a class of ADMM variants, allowing the use of degenerate metrics (defined by noninvertible linear operators). We first propose and study nonasymptotic convergence rates of a variable metric hybrid proximal extragradient (VM-HPE) framework for solving monotone inclusions. Then, the convergence rates for the VM-PADMM are obtained essentially by showing that it falls within the latter framework.

Selection of Software to Solve Linear and Entire Programming Problems: a Multicriterial Approach

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Despite the growing application of optimization techniques in the world, the applications of these techniques in the Cuban business world are still incipient, on the one hand the lack of knowledge of these tools by managers and on the other hand due to the inability to count with software that allows the solution of these problems. However, this situation has changed in recent years due to the high degree of software development in different platforms (free or not). Consequently, in teaching of the subject Operations Research in the Industrial Engineering career, the available software can not always be used because there are not the computer means compatible with these. To determine the software using to solve Linear and Discrete Programming problems is the objective in this work. To support the decision to be made, the use of a multicriteria approach is proposed, specifically the PRESS software based on the method of the same name (Aragonés, 1997), that allows quickly and efficiently performance to decide which software will be the most convenient to be used. In this process the professors linked to the teaching of the subject making an important role in the selection of a set of criteria and preferences.

Optimization of Copper Flotation by a Biobjective DC Programming

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New economic and environmental challenges have recently led to a growing interest in modern mathematical optimization and modeling techniques in order to improve the froth flotation performance. For many years, the flotation process has been controlled empirically by human operators whose decisions may lead to poor performance and the decrease of the concentrate production profitability. In some cases an increase of even several percent in recovery and/or concentrate grade may have a significant economic effect and convert previously subeconomic mineral concentrations into valuable ores. An important issue is that most of corresponding mathematical optimization models are non-convex and involve multiple criteria; hence, conventional convex optimization methods cannot guarantee finding global (Pareto) optimal solutions. We propose a deterministic biobjective mathematical programming framework, combined with experimental design and regression analysis, to optimizing the metallurgical performance and determining the best operating conditions of the rougher flotation process that meet specific needs. Our methodology is based on several advanced modern mathematical programming and multiobjetive optimization

techniques including DC programming and the special global search strategy, an exact penalty method, and the epsilon-constraint algorithm. The aim is to find the operating conditions of the flotation process that lead to the concentrate grade and recovery maximization subject to some technological constraints. As far as we know, this is the first time when a deterministic global optimization method is used to improve the efficiency of this complex technological process. Though the proposed methodology is broadly applicable, our primary motivation is optimization of the performance and operating conditions of rougher flotation circuits. To demonstrate the effectiveness of the proposed approach, we present a case study for the rougher flotation process of copper-molybdenum ores performed at the Erdenet Mining Corporation Mineral Processing Plant (Mongolia).

Approximation of Weak Subgradient and the Weak Subgradient Algorithm in Nonconvex Optimization

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Subgradients are supporting hyperplanes of the convex function at any point. Therefore, the subgradient based methods are not suitable for nonconvex case. Weak subgradients are generalization of the subgradients for nonconvex problems and the definition of weak subgradient is based on the notion of supporting cone of the function at relevant point. For this reason, a method based on weak subgradients does not require any convexity. However, estimating of weak subgradients are not an easy task. For this reason, a method based on directional derivative is developed to approximate weak subgradients through weak subgradient can be written as supremum of directional derivative under some assumptions. Then, the weak subgradient algorithm uses any weak subgradient of the function at every iteration to generate new points. After giving some convergence properties of the weak subgradient algorithm, the performance of the weak subgradient algorithm is discussed on large scale test problems that has 50 and 200 variables and only box constraints.

On the Behavior of Lagrange Multipliers in Convex and Non-Convex Infeasible Interior Point Methods

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This paper analyzes sequences generated by infeasible interior point methods. In convex and non- convex settings, we prove that moving the primal feasibility at the same rate as complementarity will ensure that the Lagrange multiplier sequence will remain bounded, provided the limit point of the primal sequence has a Lagrange multiplier, without constraint qualification assumptions. We also show that maximal complementarity holds, which guarantees the algorithm finds a strictly complementary solution, if one exists. Alternatively, in the convex case, if the primal feasibility is reduced too fast and the set of Lagrange multipliers is unbounded, then the Lagrange multiplier sequence generated will be unbounded. Conversely, if the primal feasibility is reduced too slowly, the algorithm will find a minimally complementary solution. We also demonstrate that the dual variables of the interior point solver IPOPT become unnecessarily large on Netlib problems, and we attribute this to the solver reducing the constraint violation too quickly.

The Value of an Advanced Basis Crash for the Dual Revised Simplex Method

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When the dual revised simplex method for linear programming (LP) problems is started from a basis of slack variables, it is typically accelerated by the use of steepest edge weights on the primal infeasibilities. Crash techniques for the simplex method attempt to find a non-slack basis so that the time overall time required to solve the LP problem is reduced, and are popular when using the primal revised simplex method. In the context of the high performance linear optimization solver h2gmp, this talk will discuss several crash procedures for the dual revised simplex method, their consequences for steepest edge strategies, and the overall effect on solution time.

Optimality Conditions for Nonsmooth Constrained Optimization Problems

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Nonsmoothness arises in many practical optimization problems and can often be recast in so-called abs-normal form where every occurence of nonsmoothness is expressed in terms of the absolute value function. Necessary and sufficient first and second order optimality conditions for this class of unconstrained nonlinear nonsmooth minimization have recently been developed. We discuss illustrative examples and extend the theory to nonsmooth constrained optimization.

A Multistage Stochastic Programming Model for the Optimal Bid of wind-BESS Virtual Power Plants to Electricity Markets.

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The recent cost reduction and technological advances in medium- to large-scale Battery Energy Storage Systems (BESS) makes these devices a true alternative for wind producers operating in electricity markets. Associating a wind power farm with a BESS (the so-called Virtual Power Plant (VPP)) provides utilities with a tool that converts uncertain wind power production into a dispatchable technology that can operate not only in spot and adjustment markets (day-ahead and intraday markets) but also in ancillary services markets that, up to now, were forbidden to non-dispatchable technologies. What is more, recent studies have shown capital cost investment in BESS can be recovered only by means of such a VPP participating in the ancillary services markets. We present in this study a multi-stage stochastic programming model to find the optimal operation of a VPP in the day-ahead, intraday and secondary reserve markets while taking into account uncertainty in wind power generation and clearing prices (day-ahead, secondary reserve, intraday markets and system imbalances). A case study with real data from the Iberian Electricity Market is presented.

Global Convergence Analysis of a Bilinear Model with Applications in the Feed Industry

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This study is the result of an application in the swine industry where we have to model a feeding system for growing-finishing pigs. This model is bilinear and it is well known that a bilinear problem is non-convex and thus can have several local minima. Non linear solvers determine a solution, only declared as a local optimal solution. We prove that this problem, which can be seen as a pooling problem, is strongly NP-hard and we conjecture that this local solution is in reality the only global optimal solution of the bilinear problem applied in pig industry. We consider two instances of the problem, one considering data of 2011 and the other considering data of 2016. In this presentation, we will quickly state how we model the feeding system and how we obtain a bilinear problem. The rest of the presentation will focus on several methods that support the conjecture. Global solvers cannot solve the problem due to its scale (around 250 variables and 6200 constraints) but the solution is identical for smaller instances. It supports the conjecture such as some other methods (relaxations, penalizations and convex relaxations of bilinear terms) that we state in the presentation.

Coupling Popov's Algorithm with Subgradient Extragradient Method for Solving Equilibrium Problems

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Based on the recent works by Censor et al. (2011), Malitsky and Semenov (2014), and Lyashko and Semenov (2016), we propose a new scheme for solving pseudomonotone equilibrium problems in real Hilbert spaces. Weak and strong convergence results are suitably established. Our algorithm improves the recent one announced by Lyashko and Semenov not only from computational point of view, but also in some assumptions imposed on their main result. A comparative numerical study is carried out between the algorithms of Quoc-Muu-Nguyen (2008), Lyashko-Semenov (2016) and the new one. Some numerical examples are given to illustrate the efficiency and performance of the proposed method.

Best Proximity Point Theorems via Simulation Functions

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In this talk, I would like to present the Z-contraction and Suzuki type Z-contraction for non-self mappings with the help of simulation functions and will prove the existence, convergence and uniqueness of optimal approximate solutions and will show our results are unified and extended to many other results already existing in literature and will prove fixed point theorems as special case.

Inexact Newton Methods for Minimizing Large Sums

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We consider an unconstrained minimization problem with the objective function defined as a large sum of functions. Such problems arise in machine learning, stochastic optimization, data fitting and similar applications. The problems are very often convex and structured but applying Newton-type methods tends be inefficient due to the large number of functions in the objective function and hence expensive Hessian computation. On the other hand the elements of the sum are very often reasonably similar and sub-sampled Hessian provides satisfactory approximation. In this paper we investigate inexact Newton method with subsampled Hessian. The inner solver method is CG. We prove local and global convergence under appropriate conditions as well as the convergence in the square mean for random subsampling of the Hessian. Numerical experiments on binary classification problems are presented.

Mixed-integer Programming DEA-based Efficiency Evaluation and Selection

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The success of a project mainly depends on a suitable and qualified project team. Optimal resource allocation on the activities is one of the main challenges arise in project implementation. Special emphasis can be is placed on the deployment of human resources, while respecting the limitations of working hours or qualifications. In that sense, one of the main tasks is the optimal allocation of the available consultants and the formation of a project team. Consultants will be assigned to the project to achieve maximum efficiency in implementation of all projects in terms of time, cost and quality. The problem of selection and allocation is complex given that some consultants may be engaged in several different roles on project and form teams of different structure and efficiency.

The criteria most often taken into consideration are related to the staff personal skills and experience in similar projects. On the other hand, the decision maker could have made an easier decision based on a single performance measure or rank of candidates. However, in a real-world situation, several different criteria should be included in the analysis. Therefore, the problem of efficiency evaluation and consultant assignment are meant to be solved at the same time. For that purpose, we propose DEA based mixed-integer programming model for selecting consultants, and assigning them to the appropriate tasks in order to maximize overall efficiency. The solution assumes calculation of the efficiency of a priori defined each scheme consultant-task observed as decision making units. The inputs and outputs are chosen from the dataset of past performance and evaluations that consultants have received from projects managers and clients. Moreover, the solution offers the selection of consultant-task combinations which maximize overall efficiency as a sum of their efficiencies.

StochDynamicProgramming.jl an Open-Source Library for Multistage Stochastic Optimization

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Stochastic multistage problem appears in multiple application (e.g. stock control, portfolio management, energy management problem...). Sometimes we can write a deterministic equivalent that can be solved by generic or specialized methods, but most of the time we turn to method based on Dynamic Programming. We present an open-source library that implement different numerical methods for multistage stochastic program. In particular the SDDP algorithm, an efficient method to solve linear-convex multistage stochastic optimization problemwidely used for energy management problems, is implemented. In this talk we present the SDDP algorithm with a few acceleration methods (cut selection, regularization...) and present how the algorithm can be used to solve optimization problem through the library.

Random Projections in Linear Programming

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The Johnson-Lindenstrauss lemma allows dimension reduction on real vectors with low distortion on their pairwise Euclidean distances. This result is often used in algorithms such as k-means or k nearest neighbours since they only use Euclidean distances, and has sometimes been used in unconstrained minimization. We introduce random projections to derive an approximate methods for solving large scale linear programs approximately, and exhibit some results on random instances and applications

A Linear-Time Algorithm to Check Convexity of Piecewise Linear-Quadratic Functions

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Functions that are piecewise defined are a common sight in mathematics while convexity is a property especially desired in optimization. Suppose now a piecewise-defined function is convex on each of its defining components - when can we conclude that the entire function is convex? Our main result provides sufficient conditions for a piecewise-defined function f to be convex. We also provide a sufficient condition for checking the convexity of a piecewise linear-quadratic function, which play an important role in computer-aided convex analysis. Finally, we propose a finite algorithm running in linear worst-case time complexity to determine whether the function a bivariate piecewise linear-quadratic function is convex.

Parallel Prey-Predator Algorithm

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Prey predator algorithm a swam intelligence algorithm with an easy way of tuning the degree of exploration and exploitation. Even though it is found to be effective to solve difficult and also constrained problems, it is runtime expensive. Hence, in this paper a parallel version of the algorithm will be proposed. The proposed approach is aiming to archive: (1) to parallelize the algorithm so that its runtime will be improve. (2) to do an intelligent search by adjusting a proper degree of exploration and exploitation. That is done by designing the parallel implementation in a master slave way and the master will adjust the search degrees for each processor based on the performance of the solutions sent to the processors.

Optimization Based Determination of the Set of Multi-state Components Critical to System Reliability

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This paper proposes a new approach to determining the set of k most critical multi-state components concerning system reliability. Unlike traditional importance measures, that determine the criticality of individual components, our approach provides determination of the entire set of k critical multi-state components. We start from the minimal cut sets definition which implies that disabling some undesired component's state eliminates all minimal cut sets containing that component as a potential cause of the system failure. The problem defined in this paper is formulated as a determination of k components whose undesired states' disabling maximizes the total probability of eliminated minimal cut sets. Introducing the threshold concept, such formulation is equivalent to the maximum k-coverage problem. The proposed approach is applied to a group of benchmark instances and the obtained results are compared to components' rankings obtained by using traditional importance measures.

Compact Representation of Quasi-Newton Matrices

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Quasi-Newton methods for minimizing a continuously differentiable function generate a sequence of matrix approximations to the second derivative. Perhaps the most well-known class of quasi-Newton matrices is the Broyden family of updates. Two of the most widely used updates from this family of updates include the Broyden-Fletcher-Goldfarb-Shanno update and the symmetric rank-one update. Byrd et al. (1994) formulated a compact matrix representation of these updates. In this talk, we extend and generalize this result to (i) the Davidon-Fletcher-Powell update (ii) the restricted Broyden class of updates, and (iii) the full Broyden class of updates.

Block Krylov Methods for Accelerating Ensembles of Variational Data Assimilations in Numerical Weather Prediction Systems

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In numerical weather prediction systems (NWP), the initialization of the state is made through data assimilation, which determines the best initial state of the atmosphere from a background state (a previous short range forecast) and a set of observations. This implies an accurate representation of background error statistics, which can be estimated following a Monte-Carlo approach by drawing background perturbations from Ensembles of variational Data Assimilations (EDA). Such EDA consist in a set of data assimilation experiments that use perturbed backgrounds and observations. Minimization of a set of nonlinear cost functions is thus required, and is performed via the numerical resolution of an ensemble of linear systems resulting from a linearization of these cost function gradients. However, these systems have very large dimensions (typically in the order of 10^8), so the computational cost of EDA generally limits the ensemble size. We propose a new class of algorithms for speeding up the minimization of an EDA. It consists in using block Krylov methods to perform simultaneously the minimization for all members of the ensemble, instead of performing each minimization separately. We have developed preconditioned block versions of the Full Orthogonal Method both in primal and in dual spaces. The latter works in observation space that is usually of smaller dimension than the state space, giving thus an advantage in terms of memory requirements and computational cost. Parallelization strategies have also been developed for accelerating the minimization and limiting the amount of communications. These methods have been applied to the EDA system of Météo-France's AROME NWP system at convective scale, both in its standard version (1–25 members, 10^4 – 10^5 observations) and in an extended version simulating future instrumental and computational developments (1–75 members, $10^5 - 10^6$ observations). It is shown that the number of iterations needed to converge is drastically reduced when using the block Krylov approaches, with a relative further reduction when the condition number of the Hessian of the problem increases. Moreover, working in dual space allows to reduce the computational time of the minimization by a factor of 1.5–3 (with 25 members) compared to non-block methods, making our approach attractive for operational use.

On the implementation of the crossover algorithm

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At the end of a barrier optimization a crossover procedure is needed when a basic solution has to be computed. Albeit the crossover procedure has lower complexity than the barrier algorithm, sometimes it requires excessive computational work. In the presentation we outline our crossover implementation which exploits multithreading and special structures in the problem and demonstrate its effectiveness by numerical experiments.

Regularization Methods for Degenerate Non-Linear Program

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Non-linear optimization has now become an unavoidable subject in optimization due to its many applications. Among this large family of problem, mathematical program with complementarity or equilibrium constraints (MPCC) have been the subject of a vivid interest despite the presence of degeneracy in a generic way. Regularization methods have been shown to be an efficient technique to tackle this problem from a practical and theoretical point of view. We discuss here the use of regularization techniques to tackle degeneracy in non-linear problems including complementarity constraints, vanishing constraints and cardinality constraints.

An Efficient BFC Based Matheuristic Algorithm for Solving Multistage Stochastic 0-1 Convex Problems

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We present a matheuristic algorithm to solve multistage mixed 0-1 stochastic problems with nonlinear convex objective function and convex constraints. These problems have continuous and binary variables in each stage and the number of contingencies of the nodes is not the same in at least one stage, i.e. the uncertainty is represented by a nonsymmetric scenario tree. The algorithm is based on the Branch-and-Fix Coordination method (BFC) modified to get a higher efficiency. A branching criterion based on dynamically-guided scheme is considered in order to reduce the number of Twin Node Families visited during the performance of the algorithm. In order to solve each nonlinear convex subproblem generated at each node of the trees of the BFC method we propose the solution of sequences of quadratic subproblems. As constraints are convex we can approximate them by means of outer linear approximations. The algorithm has been implemented in C with the help of Cplex 12.1 to solve quadratic approximations. Test problems have been randomly generated by a C code. Computational tests have been performed and its efficiency has been compared with that of KNITRO and BONMIN codes.

On Glowinski's Open Question of Alternating Directions Method of Multipliers

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The alternating direction method of multipliers (ADMM) was proposed by Glowinski and Marrocco in 1975; and it has been widely used in a broad spectrum of areas, especially in some sparsity-driven application domains. In 1984, Glowinski suggested to enlarge the range of the step size for updating the dual variable in ADMM from 1 to $(0, \frac{1\sqrt{5}}{2})$; and this strategy immediately accelerates the convergence of ADMM for most of its applications. Meanwhile, Glowinski raised the question of whether or not the range can be further enlarged to $(0, 2)$; this question remains open with nearly no progress in the past decades. In this paper, we answer this question affirmatively for the case where both the functions in the objective are quadratic. Glowinski's open question is thus partially answered. We further establish the global linear convergence of the ADMM with the range of $(0, 2)$ for the quadratic programming case under a condition that turns out to be tight.

Sequential Community Detection in Complex Networks

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Clustering methods are usually divided into two large groups: Partitioning methods and Hierarchical methods. However, Sequential (or Single cluster) clustering paradigm could sometimes be the best choice. Given a network, find a set of vertices that are closer to each other than to other vertices, and then remove them from the network; repeat this step until there are similar entities in the new network. Remaining vertices do not belong to any cluster, i.e., they represent noise. In this paper, Sequential clustering paradigm for detecting communities in large network is used for the first time. As criterion for getting similar entities in the cluster, within one iteration of Sequential clustering, we use well known modularity quality function, either some other criteria are discussed. Comparative analysis on usual test instances from the literature are also provided. Interesting properties are observed as well.

Some Assumptions and their Implications on Correctness of MPI Adjoints

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Data flow and activity analysis are an integral part of algorithmic differentiation. Accurate representation of program data flow is essential to ensure correctly differentiated code. In particular, data flow analysis of MPI codes can be tricky to construct. But there are two basic assumptions that ensures an adjoinable MPI code, namely [1], (i) the MPI calls are paired, for example, a send call in one MPI rank has a corresponding receive posted in a neighbouring MPI rank and (ii) the partitioning ensures zero data sharing across MPI ranks, i.e., variable updates happen only in rank local data. Although the former assumption is easily satisfied by avoiding one-sided MPI calls, the latter is more subtle since it depends on the partitioning of data across MPI ranks. Zero-halo mesh partitioning is an efficient data partitioning method that eliminates extra storage and redundant computations present in halo based partitioning. Since the MPI call pattern of zero-halo partitioning is symmetric it is an attractive option for adjoints. But the zero-halo data partitioning violates the second assumption due to the presence of shared nodes across MPI ranks. As a result, none of the so-called MPI AD recipes [2] can be applied even if the complete MPI call structure is exposed to the AD tool. In such situations, manual AD is the only way forward since most MPI AD tools are based on the aforesaid assumptions. Guiding principles or a framework to help with this situation is lacking in the literature. In this work, we provide some examples that violate the second assumption on data-sharing and present few aiding principles to correctly adjoint MPI codes. We then use these examples as building blocks to successfully demonstrate the reverse differentiation of our in-house parallel computational fluid dynamics code based on zero-halo partitioning.

References.

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A Branch-and-Cut Algorithm for Convex-Multiplicative Optimization Problems

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The problem of minimizing a finite product of p positive convex functions over a nonempty compact convex set is considered. Linear multiplicative programming problems (LMP) and linear-multiplicative-fractional programming problems (MFP) fall into this general setting as two important special cases which have a number of important applications in various areas. When $p \geq 2$, the objective function is no longer convex (or quasi-convex), therefore, the problem may have local optimal solutions that are not global optimal solutions. Convex analysis is used to reformulate the problem in the outcome space of an associated p-dimensional convex function as the problem of minimizing a multilinear objective function subject to infinitely many linear inequality constraints. Lower bounding and cutting plane procedures are then employed for handling the multilinear objective function and the convex feasible region of the projected problem, respectively. When combined, these two procedures give rise to an efficient branch-and-cut algorithm for convex-multiplicative optimization. Numerical experiments and comparisons with alternative algorithms show the better computational performance of the proposed algorithm, specially as p (the number of products) increases.

Benders Decomposition and Column-and-Row Generation for Solving Large-Scale Linear Programs with Column-Dependent-Rows

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In a recent work, Muter, Birbil, and B ulb ul (2013) identified and characterized a general class of linear programming (LP) problems, known as problems with column-dependent-rows (CDR-problems). These LPs feature two sets of constraints with mutually exclusive groups of variables in addition to a set of structural linking constraints, in which variables from both groups appear together. In a typical CDR-problem, the number of linking constraints grows very quickly with the number of variables, which motivates generating both columns and their associated linking constraints simultaneously on-the-fly. In this study, we expose the decomposable structure of CDR-problems via Benders decomposition. However, this approach brings on its own theoretical challenges. One group of variables is generated in the Benders master problem, while the generation of the linking constraints is relegated to the Benders subproblem along with the second group of variables. A fallout of this separation is that only a partial description of the dual of the Benders subproblem is available over the course of the algorithm. We demonstrate how the pricing subproblem for the column generation applied to the Benders master problem does also update the dual polyhedron and the existing Benders cuts in the master problem to ensure convergence. Ultimately, a novel integration of Benders cut generation and the simultaneous generation of columns and constraints yields a brand-new algorithm for solving large-scale CDR-problems. We illustrate the application of the proposed method on a time-constrained routing problem.

Aerodynamic Optimisation with NURBS: flexible space and constraints

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A crucial part of shape optimisation is the definition of the design space. Stochastic optimisation methods severely penalise the size of the design space and hence require a carefully selected design parametrisation with few parameters that still

allows to capture the optimum. This approach is not suitable for shape optimisation of increasingly complex models. Gradient-based methods that compute gradients with the reverse mode do not suffer from large design spaces and have spawned interest in automatically derived and adaptively refined design spaces. The group at QMUL has developed the automatic parametrisation NSPCC which derives the design space from the control points of the commonly used Boundary Representation (BRep) in the form of NURBS patches. Movement of these control points can effectively alter the shape of a modelled component. The NSPCC algorithm supports the formulation of geometric constraints such as geometric continuity across patch junctions, box constraints or local curvature. While typically geometric shapes are exchanged between modelling tools as a BRep (e.g. in the STEP or IGES file formats), often the topology and density of the BRep is not appropriate for direct NURBS-based optimisation due to (i) existence of numerous small patches/surfaces and (ii) very dense/coarse control points net (resulting in over-fitting/under-fitting). In this work, we use the shape gradients computed by the algorithmically differentiated CAD kernel OpenCascade to address two major bottlenecks of CAD-based shape optimisation workflows using automatic parametrisation approaches. Firstly, we develop a semi-automatic technique for regeneration of inappropriate NURBS surfaces, which produces BRep topologies that are suitable for aerodynamic optimisation and alleviates shortcomings (i)-(ii). On this step, the original shape is approximated with a surrogate topology by a minimisation of the distances between corresponding uniformly distributed points located on either surface. Secondly, we compare the projected gradient method to a SQP approach (SciPy) for handling of geometrical constraints. The first method, already implemented in NSPCC, was successfully applied to several testcases and comprises a technique to recover from constraint violation. SQP methods have also proved to be effective for constrained optimisation problems, an may result in improved convergence due to their improved approximation of constraints. The paper will analyse the performance of the two optimisation methods and feasibility of their application for a large number of constraints when applied to industrially relevant testcases. Finally, the findings are adopted for aerodynamic shape optimisation of TUB TurboLab Stator testcase.

Splitting a Matrix into the Sparse-Plus-Low-Rank Format: Smoothing Approaches and Applications

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This work addresses the fundamental discrete problem of splitting a given matrix into the sum of a sparse and a low-rank matrix with no further information about sparsity and rank patterns. We apply convex relaxation and smoothing techniques to numerically solve the problem. As it is common in the literature, sparse and low-rank summands are induced by their classic non-smooth convex surrogates (the componentwise ℓ_1-norm and the nuclear norm, respectively), which are here convexly combined to form the objective function. We

propose three distinct approaches for solving the unconstrained reformulation of the resulting convex problem. The first comprehends the smoothing of each norm, thus resulting in a smooth optimization problem, and is solved by a limited memory quasi-Newton algorithm combined with a homotopic adjustment of the smoothing control parameter. Smoothing only one of the two norms leads to each of the other approaches. In case the nuclear norm is smoothed, the problem is solved with an orthant-based successive quadratic approximation method. If the smoothed term is that of the ℓ_1-norm, a proximal strategy for the nuclear norm is used, again adjusting the smoothing parameter in a continuation scheme. Illustrative and comparative numerical experiments with applications in the areas of video surveillance and face recognition are presented. We conclude that as far as the human visual perception is concerned in practice, the third approach can even outperform state-of-the-art first-order methods in terms of both number of iterations and number of singular value decompositions.

Comparison of Monte Carlo and Analytical Approach during Sequential Improvement in Robust Optimization

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Metamodel-based optimization requires an update procedure in order to improve the prediction accuracy of the metamodel. Not only in deterministic optimization but also during the optimization in the presence of uncertainty it's important to use an appropriate method. Stochastic methods are widely used in order to both find the robust optimum and improve the metamodel predictions. The update step is performed severa times in order to achieve a reliable result. Even though the stochastic analysis is being done on a metamodel and is relatively fast, it becomes computationally expensive when we repeat the update step many times. For this purpose an analytical approach has been considered for evaluation of optimum and metamodel update. This approach has been implemented for robust optimization using Kriging metamodels. The results show that the analytical approach has many advantages over stochastic methods e.g. Monte Carlo (MC). One of the main advantages is that the results are accurate and that they are not affected by the randomness of MC sampling. In MC a large number of sampling points is required to achieve a reliable result. Since the analytical approach is the result of a definite integral and the calculations are being done analytically, it is computationally more efficient than MC. Particularly, when the dimension of input parameters is large this method is highly efficient and fast. The method has been successfully implemented for a case study to reduce the scrap rate of a metal forming process.

Optimization Based Determination of the Set of

Multi-state Components Critical to System Reliability

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This paper proposes a new approach to determining the set of k most critical multi-state components concerning system reliability. Unlike traditional importance measures, that determine the criticality of individual components, our approach provides determination of the entire set of k critical multi-state components. We start from the minimal cut sets definition which implies that disabling some undesired component's state eliminates all minimal cut sets containing that component as a potential cause of the system failure. The problem defined in this paper is formulated as a determination of k components whose undesired states' disabling maximizes the total probability of eliminated minimal cut sets. Introducing the threshold concept, such formulation is equivalent to the maximum k-coverage problem. The proposed approach is applied to a group of benchmark instances and the obtained results are compared to components' rankings obtained by using traditional importance measures.

A Hybrid Method Based On Line Search and Genetic Algorithms For Non-Linear Variational Data Assimilation Via Multiple Descent Directions

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In this paper, we propose a hybrid optimization method based on Line Search and Genetic Algorithms for non-Gaussian data assimilation in the 3D-Var context. The iterative method works as follows: among iterations, descent directions of the 4D-Var cost function are obtained by linearising the observation operator about the current solution. The optimal weights for each of them are estimated via Genetic Algorithms. Experimental tests are performed making use of the Lorenz 96 model. The results reveal that, the hybrid method is able to decrease the initial gradient norm in several order of magnitudes and even more, to provide efficient assimilation states in a root-mean-square-error sense for an entire assimilation window.

Diabetes, Complications And Limit Cycles

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We consider a population of diabetics and divide it into two subcategories, one of diabetics with complications and another without complications. From a model examining the complications of individuals diagnosed with diabetes, we associate a non linear optimal control problem. Considering this last one, we prove that there is no cyclical behavior between diabetics with complications, diabetics without complications and the rate at which complications are cured. Moreover we characterize the state equilibrium via Hopf bifurcation theorem adapted to optimal control problem.

Opposition-Based Slap Swarm Optimization for Feature Selection

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In this paper, an improved version of the Slap Swarm Algorithm (SSA) algorithm is introduced through using the Opposition-Based Learning (OBL) strategy to enhance its exploration ability. This improvement is performed through calculating the opposite values for the population solutions. Therefore, the proposed algorithm (called OBSSA) coverage a large region from the search space and this leads to increases the performance of the standard SSA. To investigate the performance of the OBSSA algorithm, two experiments are performed, in the first experiment, it is tested over a set of optimization problems to determine the global solution, and the results are compared with traditional SSA. Meanwhile, in the second experiment, the OBSSA it is used to increase the accuracy of the classification of ten UCI datasets through selecting the relevant features. The experimental results indicate that the proposed OBSSA algorithm is better than the traditional SSA to solve the optimization problems and, also it outperform than other four algorithms to improve the classification performance.

Incomplete Cholesky Factorizations for the Direct Solution of Linear Systems Arising from the Interior Point Methods

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One of the most common used approaches to solve the normal equations system arising in primal-dual interior point methods is its direct solution by computing the Cholesky factorization of the matrix system. The major disadvantage of this approach is the occurrence of fill-in, which can make its use impracticable, due to time and memory limitations. In this work, we propose a method that directly solves an approximated system of normal equations keeping the fill-in under control. In our proposal, in the normal equations system direct solution, we replace the Cholesky factorization by an incomplete Cholesky one. The idea is to compute approximate solutions in the early iterations with linear systems whose matrices are incomplete Cholesky factors, as sparse as possible and in the final iterations, to compute matrices near or equal the complete

Cholesky factorization in such a way that the method convergence is kept. Computational experiments show that the proposed approach significantly reduces the linear systems solution time in the interior points methods early iterations, leading to a reduction in the total running time for many of the test problems.

Factorization-Free Methods for Computed Tomography

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We study X-ray tomographic reconstruction using statistical methods. The problem is expressed in cylindrical coordinates, which yield significant computational and memory savings, with nonnegativity bounds. A change of variables involving a Fourier matrix attempts to improve the conditioning of the Hessian but introduces linear inequality constraints. The scale and density of the problem call for factorization-free methods. We argue that projections into the feasible set can be computed efficiently by solving a bound-constrained linear least-squares problem with a fast operator. This motivates our interest towards projection-based active-set methods for the reconstruction problem, namely a spectral projected gradient method and a trust-region projected Newton method that we generalize to our specific scenario. For the projection subproblem, we consider several projection-based methods for bound-constrained problems. We assess the performance of several algorithm combinations on the reconstruction problem using synthetic data. Our results show that the projected Newton method, combined with efficient projection strategies, applied to the scaled problem in cylindrical coordinates is competitive in terms of run time with a limited-memory BFGS applied to the problem in cartesian coordinates.

The Global Search Theory Approach to Equilibrium and Bilevel Problems with a Bilinear Structure

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It is known that development of new efficient methods for solving nonconvex problems is an ongoing issue in modern Operations Research. In this work we deal with a special class of nonconvex problems and focus on the problems with a bilinear structure, which include polymatrix games, bilinear programming problems, problems of bilinear separability, bilevel problems etc. For the bilinear structure problems, a new approach to the global search is developed. The approach is based on two principal features of bilinear functions: 1) any bilinear function is affine with respect to each of its variables (or a group of variables) when the other variable (or group) is fixed; 2) any bilinear function can be represented as a difference of two convex functions (so, a bilinear function is a d.c. function). Also, the approach takes into account the fact that Operations Research problems under study can be written down as nonconvex optimization problems. Such nonconvex problems can be addressed by the Global Search Theory (GST) developed by A.S. Strekalovsky. The Global Search Theory in problems with a bilinear structure consists of two basic stages: 1) a special local search methods (LSM), which takes into account the first feature of bilinear functions; 2) the procedures, based on the Global Optimality Conditions in d.c. optimization problems, which allow us to improve the point provided by an LSM. In contrast to mainstream approaches to nonconvex problems, such as the Branch and Bound algorithm, Cutting methods, outer and inner approximations, the covering method, simulated annealing methods, genetic algorithms etc., the GST acknowledges achievements of the modern convex optimization and extensively uses effective numerical methods for solving convex problems when designing global search algorithms. With the help of our approach we can solve nonconvex optimization problems of high dimension (up to hundreds variables). Therefore, the new approach allows us to build efficient methods for finding global solutions in problems with a bilinear structure. In this work we developed algorithms for solving hexamatrix games (polymatrix games of three players) and quadratic bilevel problems. Computational testing of the methods developed has shown the efficiency of the approach. This work has been supported by the Russian Science Foundation (Project no. 15-11-20015).

Newton Projection with Proportioning for Model Predictive Control with Long Prediction Horizon

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A Quadratic Programming (QP) solver tailored for Model Predictive Control (MPC) problems is presented in this work. The solver utilizes efficient Newton Projection with Proportioning (NPP) algorithm and exploits structure of a specific QP problem formulation. Consequently, all the computations complexity grows only linearly with prediction horizon length. The solver is then beneficial for control problems with long prediction horizons. The algorithm used therein combines the active set strategy, projection, and the proportioning test, a tool developed in the mathematical community for a large scale optimization as an effective precision control mechanism for a solution of the auxiliary face problems. The proposed algorithm exploits the proportioning test to “look ahead” in order to avoid unnecessary expansion/reduction of the active set while allowing rapid change of the active set via projection. For the minimization in the face, the Newton directions are found solving the sparse problem arising from raw KKT conditions. A solution is computed by the fast Cholesky factors updates. The Newton direction projected path via projected line search is used for both the active set expansion and reduction. The reduction of the active set is allowed via a modified definition of the face problem based on the Lagrange multipliers values. The sparsity structure of the projected direction is exploited leading to O(n) complexity of the gradient update as well as of the projected

line search procedure. The resulting algorithm identifies the optimal active set typically in less than 20 relatively low complex iterations independently of the initial iterate, the QP size, and conditioning. The performance of the proposed algorithm is compared to the state of the art solvers on an academic benchmark of linear MPC. Degrees of freedom of a condensed QP problem can be reduced using Move-Blocking strategy. Additionally, an extension of this method is developed in this work. It allows reformulating a non-condensed problem while the problem sparsity pattern stays preserved.

Comparative Study of Mixed Integer Linear Formulations for the Quadratic Set Covering Problems

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In this paper we present mixed integer linear programming (MILP) formulations for the quadratic set covering problem (QSCP) which is an NP-hard problem. The main focus of this work is the comparative study of different MILP formulations for QSCP. We obtained these MILP formulations of QSCP by using the following linearization strategies: the classical linearization of the quadratic term, the McCormick envelopes to linearize the resulting product of integer and binary variables, first replacing a general integer variable with its binary (base 2) expansion and then using Glover's linearization to linearize the resulting product of binary variables, first replacing a general integer variable with its base 10 expansion and then using McCormick envelopes to linearize the resulting product of integer and binary variables. The last formulation obtained by linearizing a quadratic term using four binary variables. We also present MILP formulations for the fixed rank QSCP by using base 2, base 3, base 5, and base 10 expansions, McCormick envelopes and Glover's linearization. We perform computational experiments using the commercial optimization solver CPLEX to test the comparative strengths of MILP formulations.

Algorithms for Quasi-Equilibria

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We focus on the quasi-equilibrium problem (QEP) which is the natural generalization of the abstract equilibrium problem (EP) where the constraints are given through a set-valued map that describes how the feasible region changes together with the considered point. QEPs are modeled upon quasi-variational inequalities (QVIs) and generalized Nash equilibrium problems (GNEPs). As EP subsumes optimization, multiobjective optimization, variational inequalities, fixed point and complementarity problems, Nash equilibria in noncooperative games and inverse optimization in a unique mathematical model, further "quasi" type models could be analysed through the QEP format beyond QVIs

and GNEPs. Unlikely QVI and GNEP, algorithms for the QEP format did not receive much attention. The goal of the talk is to discuss possible extensions of three classical algorithmic approaches for optimization and VIs to QEPs, i.e., fixed point, extragradient and descent methods. 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. Therefore, a range of convexity, monotonicity and Lipschitz assumptions must be combined suitably in order to control the convergence to a solution.

The Impact of Local Geometry and Batch Size on Convergence and Divergence of Stochastic Gradient Descent

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Stochastic small-batch (SB) methods, such as mini-batch Stochastic Gradient Descent (SGD), have been extremely successful in training neural networks with strong generalization properties. In the work of Keskar et. al (2017), an SB method's success in training neural networks was attributed to the fact it converges to flat minima—those minima whose Hessian has only small eigenvalues—while a large-batch (LB) method converges to sharp minima—those minima whose Hessian has a few large eigenvalues. Commonly, this difference is attributed to the noisier gradients in SB methods that allow SB iterates to escape from sharp minima. While this explanation is intuitive, in this work we offer an alternative mechanism. In this work, we argue that SGD escapes from or converges to minima based on a deterministic relationship between the learning rate, the batch size, and the local geometry of the minimizer. We derive the exact relationships by a rigorous mathematical analysis of the canonical quadratic sums problem. Then, we numerically study how these relationships extend to nonconvex, stochastic optimization problems. As a consequence of this work, we offer a more complete explanation of why SB methods prefer flat minima and LB methods seem agnostic, which can be leveraged to design SB and LB training methods that have tailored optimization properties.

Simple Assembly Line Balancing: what makes an instance difficult

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The simple assembly line balancing problem is a classical optimization problem, which has been widely studied in the literature. While recent effort has been geared towards the identification of difficult instances, the question of what makes them difficult is still open. In this work, several new exact solutions procedures are put forward and their behavior under different instance characteristics is considered. An extensive computational experiment with these methods allows us to close several open instances and to give some insight into the difficulty of solving certain instances.

A Parallel Douglas-Rachford Algorithm for Minimizing ROF-like Functionals on Images with Values in Symmetric Hadamard Manifolds

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We are interested in restoring images having values in a symmetric Hadamard manifold by minimizing a functional with a quadratic data term and a total variation–like regularizing term. To solve the convex minimization problem, we extend the Douglas–Rachford algorithm and its parallel version to symmetric Hadamard manifolds. The core of the Douglas–Rachford algorithm is reflections of the functions involved in the functional to be minimized. In the Euclidean setting the reflections of convex lower semicontinuous functions are nonexpansive. As a consequence, convergence results for Krasnoselski–Mann iterations imply the convergence of the Douglas–Rachford algorithm. Unfortunately, these general results do not carry over to Hadamard manifolds, where proper convex lower semicontinuous functions can have expansive reflections. However, splitting our restoration functional in an appropriate way, we have only to deal with special functions–namely, several distance-like functions and an indicator function of a special convex set. We prove that the reflections of certain distance-like functions on Hadamard manifolds are nonexpansive, which is an interesting result on its own. Furthermore, the reflection of the involved indicator function is nonexpansive on Hadamard manifolds with constant curvature so that the Douglas–Rachford algorithm converges here. Several numerical examples demonstrate the advantageous performance of the suggested algorithm compared to other existing methods such as the cyclic proximal point algorithm and half-quadratic minimization. Numerical convergence is also observed in our experiments on the Hadamard manifold of symmetric positive definite matrices with the affine invariant metric, which does not have a constant curvature.

A Derivative-free VU-algorithm for Convex Finite-max Functions

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Optimization algorithms such as proximal methods have been developed to handle nonsmooth objective functions, but they have slower convergence rates than the gradient-based methods we have for smooth functions. The VU-algorithm is a two-step optimization technique that minimizes convex nonsmooth functions and obtains a quadratic convergence rate. The first part of this presentation introduces the VU-algorithm and explains how it works. Derivative-free optimization (DFO) is growing in research popularity, because often in real-world application the gradients or subgradients of a function are either not available, or problematic/expensive to calculate. In those cases, it is preferable to use a method that does not require gradient information. The main goal of this presentation is to introduce a new minimization algorithm called the DFO VU-algorithm. The classical VU-algorithm has been modified to work in a derivative-free setting, so that we can take advantage of the VU structure while using only approximations to gradients.

Optimization of Workforce Scheduling With Mentoring

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Firms engaged in the development of IT tools compete for highly-skilled candidate employees. Subsequent to hiring new employees, firms typically dedicate substantial efforts into training those employees and indoctrinating the new employee into the firm's standard business practices. During this early period of employment, new employees typically experience steep learning curves and, unless these newly acquired skills are regularly practiced, a skill-fade effect is often observed. Learning effects are typically accelerated through mentoring by a more senior employee in the firm. The issue of workforce allocation becomes more problematic for start-up firms during periods of rapid expansion. Through this period, a firm may struggle to meet market demand for its services. The ensuing optimization model is multi-objective. First, a firm might seek to maximize profit by taking on as many contracts as feasible. Second, to promote knowledge-sharing throughout the firm, workforce scheduling may prioritize mentorship in order to accelerate the learning curve among newer employees. Such problems are known to be NP-hard and consequently, this work will leverage a hybrid metaheuristic to solve.

An Open Newton Method for Piecewise Smooth Equation Systems

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Recent research has shown that piecewise smooth (PS) functions can be approximated by piecewise linear functions with second order error in the distance to a given reference point. A semismooth Newton type algorithm based on successive application of these piecewise linearizations was subsequently developed for the solution of PS equation systems. For local bijectivity of the linearization at a root, a radius of quadratic convergence was explicitly calculated in terms of local Lipschitz constants of the underlying PS function. In the present work we relax the criterium of local bijectivity of the linearization to local openness. For this purpose a weak implicit function theorem is proved via local mapping degree theory. It is shown that there exist PS functions f satisfying the weaker criterium where every neighborhood of the root of f contains a point x such that all elements of the Clarke derivative at x are singular. In such neighborhoods the steps of classical semismooth Newton are not well-defined, which establishes the new method as an independent algorithm. To further clarify their relation, various statements about structure correspondences between a PS function and its piecewise linearization are proved. An example application from electric circuit design is given.

Incremental Optimization and Control of Strongly Distributed Data Streams

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In this contribution, we systematically adopt logical reduction techniques to quantitative handling of distributed data streams. The first technique: Feferman-Vaught reductions, which describe how the queries over a disjoint union of data streams can be computed from queries over the components and queries over the index set. The second one: the syntactically defined translation schemes, which describe possible transformations of data. Combination of these two techniques allows us to consider not only disjoint unions of data streams but rather much richer compositions. We call them strongly distributed quantitative data streams. For such data streams, we extend and generalize the known approaches of incremental optimization, monitoring and control. We use Weighted Monadic Second Order Logic as our quantitative query language. For our best knowledge, this is the first attempt to use logical techniques in the field of incremental optimization and control of streams, especially when talking about quantitative properties. It is applicable to both homogeneous and heterogeneous streams. While, as a rule, the known approaches provide some approximations of the original query, our method derives queries over the components and queries over the index set, such that their proceeding gives a result that is equivalent to the answer of the original query. The method allows unification of the distributed and parallel computation and communication as well as significant reduction of the communication load.

Stochastic Primal-Dual Hybrid Gradient Algorithm with Arbitrary Sampling and Imaging Applications

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We propose a stochastic extension of the primal-dual hybrid gradient algorithm studied by Chambolle and Pock in 2011 to solve saddle point problems that are separable in the dual variable. The analysis is carried out for general convex-concave saddle point problems and problems that are either partially smooth / strongly convex or fully smooth / strongly convex. We perform the analysis for arbitrary samplings of dual variables, and obtain known deterministic results as a special case. Several variants of our stochastic method significantly outperform the deterministic variant on a variety of imaging tasks.

Objective Acceleration for Unconstrained Optimization

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Acceleration schemes can dramatically improve existing optimization procedures. In most of the work on these schemes, such as nonlinear GMRES, acceleration is based on minimizing the l_2 norm of some target on subspaces of $\mathbb{R}^n$. There are many numerical examples that show how accelerating general purpose and domain-specific optimizers with N-GMRES results in large improvements. We propose a natural modification to N-GMRES, which significantly improves the performance in a testing environment originally used to advocate N-GMRES. Our proposed approach, which we refer to as O-ACCEL, is novel in that it minimizes an approximation to the objective function on subspaces of $\mathbb{R}^n$. Comparisons with L-BFGS and N-CG indicate the competitiveness of O-ACCEL. As it can be combined with domain-specific optimizers, it may also be beneficial in areas where L-BFGS or N-CG are not suitable.

An Agile Approach for the Evaluation of VRP Solutions

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If we want to solve a Vehicle Routing Problem (VRP) using heuristic or metaheuristic algorithms it is usually important to be able to evaluate the cost (or fitness) of a given solution for a given instance of the problem. In this work we present an agile approach to the evaluation of any solution for an instance of any VRP. In this context, agile refers to the fact that it is possible to write the code for the evaluation of a solution for a new VRP with very little human effort (in some cases with practically no human intervention). To do this we provide a library with classes, generic functions, and methods that "simulate" all the actions that the vehicles, clients, and depots in the instance of the VRP must execute according to the solution and the characteristics of the specific problem. When this simulation ends, we can obtain all the desired information about the solution, such as cost, feasibility or any other that is required. The class hierarchies, the generic functions and the methods are designed and implemented in CLOS (Common Lisp Object System) in a way that most of the VRP that can be found in the literature can be "evaluated" using the provided classes and methods, and to evaluate new VRP problems it is only necessary to add very little code to the library. This library greatly reduces the time devoted to implement the evaluation of a solution in a new VRP, allowing to allot more resources to explore more interesting aspects of the given VRP, such as how to build good solutions. This library is part of a bigger project aimed at the automatic solution of "new" VRPs.

Combinatorial Optimization Approach to Political Districting in Mexico

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Most scientific approaches to political districting involve the solution of a discrete optimization problem [1], whose objective function usually incorporate fairness criteria for districts, such as population balance, geometric compactness, and conformity to existing administrative boundaries. The district maps are constructed by lumping together contiguous, indivisible territorial units within a geographical region. We present a combinatorial optimization model to help producing district maps in Mexico, as well as heuristic procedures to approximate its optimal solution. In particular, by means of a variant of the Steiner forest problem in a graph, we address the combinatorial difficulties arising from the existent fragmentation of territories that, due to political criteria, are expected to belong to a single district. The preliminary results yielded by a computer implementation of our approach are promising.

[1] F. Ricca, A. Scozzari, B. Simeone, Political districting, Annals of Operations Research 204 (2013), 271-299.

Operational Management of Combined Cycle Plants Applying Multi-Objective Optimization

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The increasing adoption of renewable energy sources (RES) such as wind power and solar photovoltaic, causes electricity fluctuations in the grid due to the inherent characteristics of intermittency and variability of the technologies. To balance these fluctuations, it is necessary for some of the conventional power plants to have adaptive load curves. In this context, combined cycle power plants have proved to be able to adapt to the variable needs of the electricity generation market; since they can rapidly range from an initial state to a final one and the minimum technical stable operation of this type of power plants is low. This paper presents the development of a methodology focused on the optimization of the operational management of combined cycle power plants to increase their competitiveness in the new liberalized electricity markets. The proposed methodology focuses on the generation of optimum operating sequences to be executed by the heat recovery steam generator of a combined cycle power plant to achieve the desired operating conditions so that fuel consumption and load-change time are minimum, without compromising the integrity of the critical equipment. It is a multi-objective optimization problem since it aims to maximize the benefits of the power plant and minimize damage to equipment in load changes. A self-adaptive metaheuristic algorithm (NSGA-II) is used to solve the stated problem, obtaining, as a result, a recommendation on how convenient is to enter the market. Besides, when the result shows it is convenient entering the market, information on the optimum operating curve and the respective operating sequences of the process control valves (from their initial to the final state) is included

Leak Localization in Water Distribution Networks using Differential Evolution

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This paper presents a novel approach for the leak estimation and localization in Water Distribution Networks (WDNs). The proposal is based on a novel optimization method: ridED (real-integer-discrete-coded Differential Evolution). The proposed approach is applied to the Hanoi District Metered Area and the results are compared with traditional methods. Different scenarios are tested by using Monte Carlo simulation to generate uncertainty conditions associated with the customers' demand and the leaks' magnitude at every node of the network.The obtained results confirm the advantages and viability of the proposal.

Mixed-integer Programming DEA-based Efficiency Evaluation and Selection

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The success of a project mainly depends on a suitable and qualified project team. Optimal resource allocation on the activities is one of the main challenges arise in project implementation. Special emphasis can be is placed on the deployment of human resources, while respecting the limitations of working hours or qualifications. In that sense, one of the main tasks is the optimal allocation of the available consultants and the formation of a project team. Consultants will be assigned to the project to achieve maximum efficiency in implementation of all projects in terms of time, cost and quality. The problem of selection and allocation is complex given that some consultants may be engaged in several different roles on project and form teams of different structure and efficiency. The criteria most often taken into consideration are related to the staff personal skills and experience in similar projects. On the other hand, the decision maker could have made an easier decision based on a single performance measure or rank of candidates. However, in a real-world situation, several different criteria should be included in the analysis. Therefore, the problem of efficiency evaluation and consultant assignment are meant to be solved at the same time. For that purpose, we propose DEA based mixed-integer programming model for selecting consultants, and assigning them to the appropriate tasks in order to maximize overall efficiency. The solution assumes calculation of the efficiency of a priori defined each scheme consultant-task observed as decision making units. The inputs and outputs are chosen from the dataset of past performance and evaluations that consultants have received from projects managers and clients. Moreover, the solution offers the selection of consultant-task combinations which maximize overall efficiency as a sum of their efficiencies.

Forming a Simple Cycle to a Level of a Complete K-ary Tree Maximizing Total Shortening Distance

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We have studied several models of adding relations between members of the same level in a pyramid organization for the purpose of revealing optimal additional relations. The pyramid organization structure can be expressed as a rooted tree, if we let nodes and edges in the rooted tree correspond to members and relations between members in the organization respectively. Then the pyramid organization structure is characterized by the number of subordinates of each member, that is, the number of children of each node and the number of levels in the organization, that is, the height of the rooted tree. For a model of adding edges of forming a simple cycle to a level of depth N in a complete K-ary tree of height H under giving priority to edges between two nodes of which the deepest common ancestor is deeper, we have obtained an optimal depth N* to maximize the total shortening distance which is the sum of shortened lengths of the shortest paths between every pair of all nodes by adding edges. A complete K-ary tree is a rooted tree in which all leaves have the same depth and all internal nodes have K children. Maximizing the total shortening distance means that the communication of information between every member in the organization becomes the most efficient. This study discusses a way to form a simple cycle to a level of a complete K-ary tree of height H to maximize the total shortening distance without giving priority to edges between two nodes of which the deepest common ancestor is deeper.

Let's Make Block Coordinate Descent Go Fast

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Block coordinate descent (BCD) methods are widely-used for large-scale numerical optimization because of their cheap iteration costs, low memory requirements, and amenability to parallelization. Three main algorithmic choices influence the performance of BCD methods; the block partitioning strategy, the block selection rule, and the block update rule. We explore these three building blocks and propose variations for each that can lead to significantly faster BCD methods. We support all of our findings with numerical results for the classic machine learning problems of logistic regression, multi-class logistic regression, support vector machines, and label propagation.

Benson's Algorithm for Regularization Parameter Tracking

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In this talk, we study regularized loss minimization problems, where a statistical model is obtained from minimizing the sum of a loss function and weighted regularization terms. These problems are in widespread use in the area of machine learning. The statistical performance of the resulting models depends on the choice of the regularization parameters which are typically tuned by cross-validation. For finding the best regularization parameters, the regularized loss minimization problem has to be solved for the whole parameter domain. A practically more feasible approach is covering the parameter domain with approximate solutions for some prescribed approximation guarantee. The problem of computing such a covering is known as the approximate solution gamut problem. We will apply primal and dual variants of Benson's algorithm for computing those approximate solution gamuts and compare our approach to existing algorithms. We conclude the talk with experiments that demonstrate the effectiveness of Benson's algorithms for regularization parameter tracking.

Contract Design for Supply Chain Coordination under Multiple Objectives

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A supply chain consists of multiple firms such as suppliers, distributors and retailers. To achieve supply chain coordination and optimal system performance, extensive studies have been done on optimal contract design. However, most studies assume a single objective of expected profit maximization. In this paper, we will discuss supply chain coordination under multiple objectives. One particular objective we address is the objective of profit satisficing. That is, at least one firm is interested in maximizing the probability of achieving a predetermined profit target. Under this new objective and multiple objectives, we study the optimal contract design among the different firms along a supply chain. We find that the simple wholesale price contract can achieve supply chain coordination under the objective of profit satisficing. Furthermore, we show how to design contract under multiple objectives.

ParaXpress - A Massively Parallel Mixed Integer Linear Programing Solver with the Potential to Harness over a million CPU cores

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Mixed integer programming (MIP) is a general form to model combinatorial optimization problems and has many industrial applications. The performance of MIP solvers, software packages to solve MIPs, has improved tremendously in the last two decades and these solvers have been used to solve many real-word problems. However, against the backdrop of modern computer technology, parallelization is of pivotal importance. In this way, ParaSCIP is the most successful parallel MIP solver in terms of solving previously unsolvable instances from the well-known benchmark instance set MIPLIB by using supercomputers. In the same way, a new implementation of ParaXpress is realized. Both parallel MIP solvers have been developed by using the Ubiquity Generator (UG) framework, which is a general software package to parallelize any state-of-the-art branch-and-bound based solvers. As for general MIP solver performance, Xpress is superior than SCIP. On top of that, the computational results of ParaSCIP imply that ParaXpress could harness over a million CPU cores. Indeed, ParaXpress solved two previously unsolved instances from MIPLIB2010 in 2017. They are the only instances which were solved in 2017(as of 11th October 2017). In this talk, the new implementation of ParaXpress will be presented.

An Integrated Multicriteria Spatial Decision Support System for Locating a Biogas Plants

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This paper addresses an integrated development of multicriteria spatial decision support systems in locating undesirable facilities. Undesirable facilities, as is the case of biogas plants that use animal manure as a source of biomass, have an unpleasant effect on people living around its location, despite its environmental and economic benefits. The location of biogas plants, therefore, requires a multiobjective approach in order to specify its number, the allocation of these to dairy farms (suppliers of biomass) and its capacity. For this purpose, are develops two complementary strands: the sustainability classification of dairy farms in order to assess the continuity in the activity, and the land-use suitability assessment to locating biogas plants. These assessments are developed through multicriteria spatial decision processes using environmental, economic and social criteria defined by a group of experts and applying the multicriteria ELECTRE TRI method and Geographic Information Systems (GIS). The integration of these two tools, multicriteria and GIS, is essential in multicriteria spatial decision support problems. The paper establishes an integrated and global multicriteria spatial decision process made of three components (with different actors): Which viable locations for possible installation of biogas plants? (spatial analysis of suitability); Which predictable dairy farms to consider? (sustainability analysis); Where to install biogas plants, what types, and what the general scheme of allocation to farms? (multiobjective optimization). In order to illustrate and validate the developed components, we study a problem with real data on the location of biogas plants for treating animal waste from dairy farms in the Entre-Douro-e-Minho region in Portugal.

Optimizing Vaccine Allocations for Pandemic Influenza

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Vaccines are arguably the most important means of pandemic influenza mitigation. We introduce a model for optimizing statewide allocation of multiple vaccine types to multiple priority groups, maximizing equal access. We assume a large fraction of available vaccines are distributed to healthcare providers based on their requests, and then optimize county-level allocation of the remaining doses to achieve equity. We have applied the model to the state of Texas, and incorporated it in a Web-based decision-support tool for the Texas Department of State Health Services (DSHS). Based on vaccine quantities delivered to registered healthcare providers in response to their requests during the 2009 H1N1 pandemic, we find that a relatively small cache of discretionary doses (DSHS reserved 6.8counties in Texas.

Bilinear Assignment Problem: Large Neighborhoods and Experimental Analysis of Algorithms

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The bilinear assignment problem (BAP) is a generalization of the well-known quadratic assignment problem (QAP). In this paper, we study the problem from the computational analysis point of view. Several classes of neighborhood structures are introduced for the problem along with some theoretical analysis. These neighborhoods are then explored within a local search and a variable neighborhood search frameworks with multistart to generate robust heuristic algorithms. Results of systematic experimental analysis have been presented which divulge the effectiveness of our algorithms. In addition, we present several very fast construction heuristics. Our experimental results disclosed some interesting properties of the BAP model, different from those of comparable models. This is the first thorough experimental analysis of algorithms on BAP. We have also introduced benchmark test instances that can be used for future experiments on exact and heuristic algorithms for the problem.

Improvements on the pruning phase of the branch-and-prune algorithm for the molecular distance geometry problem

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The molecular distance geometry problem is related to protein structure calculations using Nuclear Magnetic Resonance (NMR) experiments. The problem is how to compute the atomic positions using NMR distance information. Protein chemistry and NMR data allow us to define an atomic order, such that the distances related to the pairs of atoms (i-1,i), (i-2,i), and (i-3,i) are available, where a combinatorial method, called Branch-and-Prune (BP), can solve the problem iteratively. Because of uncertainty in NMR data, some of the distances d(i-3,i) should be represented by real intervals, instead of precise numbers. In the literature, there is an extension of the BP algorithm to manage the uncertainty in distance information, where the idea is to sample values from the intervals related to the pairs (i-3,i). The main problem of this approach is that if we sample many values, the search space increases drastically, and for small samples, no solution can be found. Based on the geometrical interpretation of the problem as sphere intersections, a new extension of BP is proposed to deal with interval distances. Some computational experiments are presented to illustrate the advantage of this new approach compared to the ones described in the literature.

Exact Values of the Metric Dimension of n-Dimensional Hypercube for up to n=13

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The problem of finding the metric dimension of n-dimensional hypercube Qn is still open, even for small values of n. Namely, exact values of the metric dimension of Qn are only known for up to n=8 and they have been determined by an exhaustive computer search. In this paper we consider some special characteristics of distances between vertices in the n-dimensional hypercube graph Qn, and use the corresponding symmetry properties of its so called resolving sets. We illustrate how these properties can be used in an implementation of a computer search in order to efficiently find the minimal cardinality of a resolving set in Qn, i.e. the metric dimension of Qn. With our approach, we establish 5 new exact values of the metric dimension of Qn, for n=9, n=10, n=11, n=12, and n=13.

Iterative Multiplicative Filters for Data Labeling

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We propose a new iterative multiplicative filtering algorithm for label assignment matrices which can be used for the supervised partitioning of data. Starting with a row-normalized matrix containing the averaged distances between prior features and observed ones, the method assigns in a very efficient way labels to the data. We interpret the algorithm as a gradient ascent method with respect to a certain function on the product manifold of positive numbers followed by a reprojection onto a subset of the probability simplex consisting of vectors whose components are bounded away from zero by a small constant. While such boundedness away from zero is necessary to avoid an arithmetic underflow, our convergence results imply that they are also necessary for theoretical reasons. Numerical examples show that the proposed simple and fast algorithm leads to very good results. In particular we apply the method for the partitioning of manifold-valued images.

Multi-Commodity Location-Routing Problems: Formulations, Solving Approaches and Sustainability Perspectives

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Research on the location-routing problem (LRP) is very active, producing a good number of effective exact and approximated solution approaches. It is noteworthy that most of the contributions present in the literature address the single-commodity LRP, whereas the multi-commodity case has been scarcely investigated. Yet, this issue assumes an important role in many LRP applications, particularly in the ones arising in City Logistics, CL. Indeed, the goods/service demand to be managed in an urban area is highly customized. Hence, the corresponding distribution problem is strongly and inherently a multi-commodity flow problem. This work is aimed at filling this gap on the multi-commodity LRP in a sustainable CL perspective. The design of a single-tier urban freight distribution system is the driving application. The aim of a single-tier system is to prevent the penetration of a large number of commercial vehicles, coming from the primary logistic facilities located on the city outskirts and directed to the city center, stopping them at secondary or intermediate logistic facilities. Here the freight flows of different carriers are deconsolidated, transferred and consolidated into smaller and green vehicles, more suitable to perform the delivery to the final customers. This allows to reduce the vehicle kilometers traveled and to remove vehicles from the urban network. In this context the arising LRP consists in determining, at the same time, the number and the location of the intermediate logistic facilities and the routes to be performed by the vehicles to supply the customer demands, minimizing the total system cost. We define a new multi-commodity LRP, proposing an original integer linear programming model for it. The proposed formulation takes into account the multi-commodity feature of the problem, modeling the strategic location and the tactical routing decisions using the flow intercepting approach. We therefore name this problem the flow intercepting facility location-routing problem. It is solved by a branch-and-cut algorithm based on a row generation procedure for the Generalized subtour inequalities (GSI), to find a lower bound at each node of the enumeration tree, and on the separation of several cuts derived and adapted from the literature: Lifted cover inequalities (LCI); Aggregated generalized subtour elimination constraints (AGSI); and R-cut constraints (R-CUT). The proposed method is successfully experienced and validated on test instances reproducing different network topologies and problem settings. We conclude providing a work framework to integrate other sustainability issues, mainly related to CO_2 emissions, in the proposed approach.

The work has been developed within MOSTOLOG project (A Multi-Objective approach for a SusTainable LOGistic system, DIETI – ALTRI_DR408_2017_Ricerca di Ateneo)

On Some New Methods to Derive Optimality Conditions in Vector Optimization,

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This talk addresses new approaches to necessary and sufficient optimality conditions in constrained vector optimization. In this respect, for the necessary optimality conditions that we derive, we use a kind of vectorial penalization technique, while for the sufficient optimality conditions we make use of an appropriate scalarization method. In both cases, the approaches couple a basic technique (of penalization or scalarization, respectively) with several results in variational analysis and optimization obtained by the authors in the last years. These combinations allow us to arrive to optimality conditions which are, in terms of assumptions made, new.

A New Gradient Method Improving Yuan's Stepsize

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It is popular to solve large scale problems by gradient methods. Based on the idea of coordination transformation, we proposed a new stepsize update strategy for the gradient method, which is the extension of Yuan's stepsize from 2-dimension to 3-dimension. For 3-dimensional convex quadratic function minimization problems, it guarantees to find the optimal solution in 5 iterations. We also modified the strategy to improve the performance. We proved that, for 3-dimensional convex quadratic function minimization problems, the new modified gradient method terminates in finite iterations; for general n dimensional quadratic problems, it converges R-linearly.

A Bi-level Solution Method for a Hierarchical Problem of Pricing and Capacity Decisions Based on a Contract Mechanism between the Government and a Private Hospital

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In this study, a bi-level method is proposed to solve a hierarchical problem of health services pricing between the government and a private hospital in a region. In the system, the examination fee in the private hospital is defined based on the contract mechanism between the government and the private hospital. This price affects patients' preferences in hospital choice and therefore the general condition of the system. In the current state of the system, in the public hospital, although the examination fee is low, there are long waiting times, which decreases the quality of service. In the private hospital, waiting times are low while the quality of service and examination fee are high. To increase the public benefit, the government must re-new the contract mechanism with the private hospital. If a lower examination fee is defined for the private hospital, more people will prefer the private hospital which decreases the crowd level in the public hospital and also the patients will receive a higher quality service in the private hospital. Since the total cost of the examination in the private hospital is fixed, if the price is reduced, the rest value must be paid by the government. Also, if the price is too low, when the capacity is fixed, long waiting queues will occur in the private hospital. In this study, public benefit is defined as a multi-objective function that includes public expenditure, average waiting time of patients and the received quality of service. In addition, the private hospital has a profit function, in which the income of the hospital consists of the financial incentives paid by the government and fees paid by the patients. Also, there is a cost because of the capacity of the private hospital. In case of applying a new contract mechanism, the government will try to increase the public benefit while the private hospital will attempt to increase its own profit. If a new contract proposed by the government is accepted, the private hospital will have to make a new decision about its own capacity, which will also affect the value of public benefit. Hence, two hierarchical decision mechanisms that interact with each other will occur. In this study, a solution method is proposed for this problem. The suggested approach will also provide a basis for similar problems with multiple hospitals.

Derivative-Free Gray-Box Optimization of Structured Problems with BFO

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The talk will present some new results obtained for the minimization of structured partially-separable objective functions using BFO, a derivative-free solver. It will be shown that the structure can be exploited very efficiently, resulting in a fast method for solving problems of significant size. A comparison of various approaches and modeling options will be discussed on the basis on numerical experiments.

Synergy Optimization for the Combinatorial Bidding in Transportation Networks

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This paper deals with the maximization of the synergy within a carrier's transportation network. This key concept of synergy is particularly important when participating in combinatorial auctions for the procurement in full-truckload transportation service. Our ideas derive from the advances achieved in the field of graph theory and are based on the technique of minimizing the distance between the booked and auctioneed lanes. We develop two optimization formulations that mainly differ in the objective function and that have been described by using an illustrative example that has taken from the literature and suitably adapted for the purpose of our application.

The SQP Trust-Region Algorithm ECDFO Applied to the Optimization of an Aero Engine Performance Model

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We would like to present our software package ECDFO which applies a model-based trust-region SQP algorithm for nonlinear equality- and bound-constrained minimization without derivatives. Derivative-free optimization algorithms are widely used in practice for several reasons: the explicit evaluation of the derivatives may be impossible, very time-consuming or very inexact. The algorithm ECDFO has shown competitive performance on analytical test problems (e.g. problems from the testing environment CUTEst), compared to other publicly available derivative-free optimization software packages. Here, the software package ECDFO is applied to the optimization of an aero engine performance model of a two shaft generic turbofan engine. The objective is to minimize the thrust specific fuel consumption with respect to several thermodynamic design parameters and, subject to several bound- and equality-constraints. In order to provide some insight into the optimization problem, results of a parametric study on the problem conducted prior to the optimization are presented briefly. The simulation of the aero engine performance model is performed by the simulation code GTlab-Performance, developed at the German Aerospace Center (DLR). The optimization package ECDFO is compared to the two optimization codes SLSQP (sequential least squares programming algorithm using finite forward differences) and ALPSO (augmented Lagrange multiplier particle swarm optimizer as a purely derivative-free optimization method). In addition, parametric studies on the finite step size were conducted to investigate their influence on the convergence behavior of SLSQP. Runtime measurements for all three approaches as well as plots for the convergence history of the objective function and the non-linear constraints are presented and discussed.

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