Online-Workshop

ASIP – APPLICATIONS OF SEMI-INFINITE OPTIMIZATION

20th & 21st May 2021

Invited talks

No.		Title of talk		Speaker
1		*Semi-infinite Optimization in Machine Learning*		Süreyya Aküz, Bahçeşehir University Istanbul
2		*Dealing with Probust Constraints in Stochastic Optimization*		René Henrion, WIAS Berlin
3		*Contingency Screening for Power Grids Using Existence-Constrained Semi-Infinite Program*		Alexander Mitsos, RWTH Aachen
4		*A Stochastic Maximum Principle for a Markov Regime-Switching Jump-Diffusion Model with Delay and an Application to Finance*		Gerhard-Wilhelm Weber, Poznan University of Technology
5		*Non, je ne regrette rien*		Ralf Werner, University of Augsburg

Semi-infinite Optimization in Machine Learning

Süreyya Aküz

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There is a great interplay between optimization and machine learning where optimization is in the core of machine learning models. For instance, building a learning model for a given training instances takes place by minimizing the error function. As learning from data becomes more difficult task with the increase in size of data and because of the complexity nature of real world problems, advanced and special optimization models are required to obtain reliable performances close to exact values. Semi-infinite programming is one of the inspiring optimization methods across semi-definite programming in machine learning applications. It was first used in multiple kernel learning models to speed up the original semi-definite model. Then it was generalized to infinite kernel learning by semi-infinite programming.

In this talk, semi-infinite optimization models arise in machine learning problems will be discussed. As the nature of data is heterogeneous in real world, kernel function, which defines the similarity of data points, require to express heterogeneity in terms of simple convex combination. This leads to additional variables, coefficients of corresponding kernel functions, to be determined simultaneously with other constraints like maximum margin principle. The overall model with these constraints can be modelled as multiple kernel learning and later in general as infinite kernel learning using semi-infinite optimization. Experimental validation with various data sets will be discussed at the end of the talk.

* Speaker

Dealing with Probust Constraints in Stochastic Optimization

René Henrion

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Introduced some 60 years ago, probabilistic constraints represent nowadays a standard tool of dealing with (finite) random inequality systems within a stochastic optimization problem. Recently, driven by applications in energy management (optimization in gas networks, reservoir control) or in PDE constrained optimization with random state constraints, the extension to the case of continuously indexed inequality systems as they occur in SIP or GSIP has attracted increasing interest. Here, the continuous index could play the role of time or space. Alternatively, it could represent an additional uncertain parameter which in contrast to the given random parameter is not endowed with statistical information and rather treated in a worst case (robust) manner. A typical example is gas network optimization, where one is simultaneously faced with stochastic (e.g. loads at the exits) and non-stochastic (non-measurable friction coefficients in pipes underground) uncertainty. This aspect gave rise to introduce the class of probust (probabilistic/robust) constraints. The talk presents the model, some applications, some basic structural properties including differentiability of the associated probability function as well as some algorithmic ideas.

* Speaker

Contingency Screening for Power Grids Using Existence-Constrained Semi-Infinite Programs

Hatim Djelassi, Stéphane Fliscounakis, Patrick Panciatici, Alexander Mitsos*

Department of Chemical Engineering - Chair for Process Systems Engineering,
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We consider the problem of categorizing contingencies in power grids under uncertainty in order to support the provision of (n-1)-reliability. Following previous work (Fliscounakis et al. in IEEE Transactions on Power Systems 28(4):4909-4917, 2013), our aim is to categorize contingencies according to the preventive control actions that are required to guarantee nominal operation of a power grid under uncertainty and optimal corrective control actions. This problem formulation results in an existence-constrained semi-infinite program (ESIP), which is akin to an adjustable robust optimization problem. As a power grid model, we employ the DC power flow approximation together with disjunctive models for load distribution, bus merging and splitting, and phase shifting transformers (Djelassi et al. in Power Systems Computation Conference, 2018). Due to the lack of rigorous algorithms for the solution of ESIPs, prior considerations of the categorization problem were limited to solving a feasibility problem. In contrast, our recently proposed algorithm for the global solution of ESIPs absent convexity assumptions (Djelassi and Mitsos in Journal of Optimization Theory and Applications, submitted 2019) enables the solution of the categorization problem.

In the talk we first discuss the ESIP algorithm. We specialize the algorithm for the contingency categorization problem and perform a contingency screening on a large-scale power grid instance, where we solve the categorization problem for each member of a set of contingencies. We discuss the information that can be gained from categorization of contingencies as well as the tractability of the proposed approach for large-scale contingency screenings.

* Speaker

A Stochastic Maximum Principle for a Markov Regime-Switching Jump-Diffusion Model with Delay and an Application to Finance

Gerhard-Wilhelm Weber*, Emel Savku

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Poznan University of Technology,
Poznan, Poland

We study a stochastic optimal control problem for a delayed Markov regimes-witching jump-diffusion model. We establish necessary and sufficient maximum principles under full and partial information for such a system.

We prove the existence-uniqueness theorem for the adjoint equations, which are represented by an anticipated backward stochastic differential equation with jumps and regimes. We illustrate our results by a problem of optimal consumption problem from a cash flow with delay and regimes. In optimal control, a natural connection with semi-infinite optimization is given by the "flow" of the dynamics. In its stochastic counterpart, the "event" or "scenario", being an element of the probability space, parametrizes the flow. When "delay" enters into the dynamics, (initial) states are replaced by "initial functions" as a flow variable.

* Speaker

Non, je ne regrette rien

Patrick Groetzner, Ralf Werner*

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Augsburg, Germany

In this presentation, we consider multi-objective decision problems under uncertainty. In the single criteria case, robust optimization methodology can help to identify solutions which remain feasible and of good quality for all possible scenarios. An alternative method is to compare possible decisions under uncertainty against the optimal decision with the benefit of hindsight, i.e. to minimize the (possibly scaled) regret of not having chosen the optimal decision. In this exposition, we extend the concept of regret to the multi-objective setting and introduce a proper definition of multivariate (relative) regret.

While all early attempts in such a setting mix scalarization and modelling efforts, we clearly separate both steps, such that after an optimal decision is taken, "there is nothing to regret". We demonstrate that in contrast to existing approaches, we are not limited to finite uncertainty sets or interval uncertainty, but instead computations remain tractable in important special cases. Tractability here means that we can formulate related convex semi-infinite problems which can be solved with standard (feasible!) SIP methods.

Finally, if time allows, we show that our notion of regret is subject to a subtle caveat. A careful discussion will then show that a slightly improved modelling of regret will then lead to GSIPs instead of ordinary SIPs.

* Speaker