# ANUNCIO DE SEMINARIO

*Día*: Jueves 20 de Septiembre de 2018
*Hora*: 10:30
*Lugar*: Sala de Planta Baja de INGAR – Avellaneda 3657
*Tema*: Recent Theoretical and Computational Advances in the Optimization of Process Systems under Uncertainty

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## Abstract

Optimization under uncertainty has been an active area of research for many years. However, its application in Process Systems Engineering has faced a number of important barriers that have prevented its effective application. Barriers include availability of information on the uncertainty of the data (ad-hoc or historical), determination of the nature of the uncertainties (exogenous vs. endogenous), selection of an appropriate strategy for hedging against uncertainty (robust optimization vs. stochastic programming), handling of nonlinearities (most work addresses linear problems), large computational expense (orders of magnitude larger than deterministic models), and difficulty in the interpretation of the results by non-expert users. In this paper, we address two specific challenges: a) what is the theoretical relation between flexibility analysis and robust optimization; b) how to effectively solve multistage MILP stochastic programming problems with both exogenous and endogenous parameters.

In this talk, we explore first the relationship between flexibility analysis and robust optimization for linear systems. First, a historical perspective is given, which shows that some of the fundamental concepts in robust optimization have already been developed in the area of flexibility analysis in the 1980s long before the start of the era of robust optimization in the late 1990s. To compare the different approaches, we consider the three classical problems from flexibility analysis: the flexibility test problem, the flexibility index problem, and the design under uncertainty with flexibility constraints. The concepts that form the theoretical basis for the three different approaches are compared with adjustable robust optimization. It is shown that the latter can be seen as a special case of flexibility analysis that is more restrictive, and therefore may be overly conservative. For linear systems with a given general structure, two new solution approaches are proposed, where the first derives duality-based reformulations of the traditional active-set MILP formulations, and the second applies the concept of affinely adjustable robust optimization. We apply the three different approaches to several numerical examples, verifying some of the theoretical properties of the proposed formulations. The results show that concepts of robust optimization may help to increase the computational efficiency for solving the three types of flexibility analysis problems.

We next address the generalization of multistage MILP stochastic programming to the case of both exogenous and endogenous parameters. We propose a composite scenario tree that accommodates both types of uncertainty from which we derive non-anticipativity constraints (NACs) to obtain the deterministic equivalent formulation. Since the number of NACs grows exponentially as the number of time periods, uncertain parameters, or realizations increases, most problems are too large to be solved directly. We exploit the unique structure of the composite tree to derive new theoretical properties based on adjacency and grouping of scenarios that can drastically reduce the number of NACs. Since the reduced MILP model is often still intractable, we propose two special solution approaches. The first is a sequential scenario decomposition heuristic in which we sequentially solve endogenous MILP subproblems to determine the binary investment decisions, fix these decisions to satisfy the first-period and exogenous NACs, and then solve the resulting model to obtain a feasible solution. The second is Lagrangean decomposition. We present numerical results for a process network and an oilfield development planning problem. The results demonstrate the efficiency of the special solution methods over solving the reduced model directly. Finally, we briefly discuss extensions for stochastic MINLP problems

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