PhD position at Mines-Paris PSL
in Mathematical Programming

January 26, 2025

Structure-exploiting methods for large-scale stochastic optimization

Subject. The theory and methods of stochastic optimization provide valuable guidance to help decision-makers confront uncertain future outcomes. Unlike deterministic models, stochastic optimization models address unknown parameters using probability distributions. Consequently, the decision variables become random variables rather than fixed quantities. This approach is widely used in energy systems to operate and plan under uncertainty, particularly concerning future demands or renewable production fluctuations.

When the decision variables are encoded as random variables, stochastic optimization problems become infinite-dimensional. One has to resort to discretization methods to render them tractable. Unfortunately, such discretization is subject to the *curse of dimensionality*, which prohibits an exact solution when the dimension of the uncertainties becomes large. As a result, approximation methods become essential to compute *near-optimal* decisions, with the *sampling average approximation* (SAA) being one of the most prominent methods.

This thesis project aims to advance the development of structure-exploiting solvers for large-scale stochastic optimization. To achieve that goal, we will leverage the interior-point method (IPM) to exploit the problem's structure at the linear algebra level. The research will be divided into two phases. (1) First, the student will address the efficient solution of classical two-stage stochastic programs, with uncertainties modeled using the *distributionally robust optimization* formalism. (2) In a second step, we will address the solution of large-scale multistage programs: as soon as we increase the number of time steps from two to many, the problem becomes intractable numerically. For that reason, we will look at improving solution methods that approximate the control policies to make near-optimal decisions at every time step. The project will result in a user-friendly Julia-based package for multistage stochastic optimization, in order to enhance the impact of the student's work.

Keywords. Mathematical programming, stochastic optimization, interior-point methods, numerical optimization, Julia.

Academic supervisors	Dr François Pacaud and Welington de Oliveira
Contact	`francois.pacaud@minesparis.psl.eu`
Doctoral school	ED 621, Ecole des Mines de Paris-PSL
PhD location	60 boulevard Saint-Michel, 75006 Paris
Salary	2300 euros gross + bonus (up to 1/6th of the salary)
Duration and start date	3 years, starting in the fourth quarter of 2025
Employer	Centre Automatique et Systèmes (CAS), Mines Paris-PSL
Academic requirements	University Master-degree in applied mathematics or mathematical optimization
Language requirements	English level B2
Other requirements	Excellent programming skills.

Application. To apply, please send a cover letter and CV to François Pacaud. We will come back to you as soon as possible to propose possible schedules for an interview.