SESO 2016 Winter School
Smart Energy and Stochastic Optimization
on
Numerical Methods for Multistage Stochastic Optimization:
Application to Energy Storage Management
2 to 7 November 2016

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Abstract

Energy companies witness a rapidly changing landscape: increase of intermittent, variable and spatially distributed power sources (wind, sun); expansion of markets and actors at all spatial and temporal scales; penetration of telecom technologies (smart grids). These new factors challenge the management of energy systems and impact the practice of optimization, towards more stochastic and more decentralized optimization. Data on energy demand and on meteorological conditions will be more and more abundant. How to formulate mathematical optimization problems that take into account the variability of data? What are the proper formats to feed such data in optimization problems? What are optimization methods adapted to storage management problems? How to handle multiple stocks? Are there ways to decentralize an optimal solution to local agents? These are the type of questions addressed in the SESO 2016 Winter Course *Numerical Methods for Multistage Stochastic Optimization: Application to Energy Storage Management.*

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The SESO *Smart Energy and Stochastic Optimization* events — International Thematic Weeks and Winter Courses — offer to the academic community and to industrials the state of the art of optimization in the energy transition. Mid-year, the SESO International Thematic Week alternates tutorials, scientific workshops and an industry day; it is aimed at a mixed public, in academy and in industry. End of year, the SESO Winter Course alternates courses and computer sessions; it is aimed at a mixed public, in academy and in industry. The academic organizers are ENSTA ParisTech and École des Ponts ParisTech, with the financial support of the Gaspard Monge Program for Optimization and operations research (PGMO).

Keywords: energy transition, renewables, intermittency, flexibility, storage, decentralization, optimization

`Link: http://cermics.enpc.fr/~delara/courseSESO2016/courseSESO2016/`

`Registration: https://goo.gl/forms/dsZtBDENPu9a6hHw2`

Eligibility/Pre-requisites.

- Mathematical skills. Computer skills.
- Continuous optimization: linear programming, convexity, duality, first-order optimality conditions.
- Probability calculus: probability space, probability, random variable, distribution law of a random variable, indicator function, mathematical expectation, independence, law of large numbers.

Computer and software.

- Bring your personal laptop for afternoon computer practical sessions.
- Install software Scicoslab (else, install software Scilab).
- Do auto-training with the scientific software Scicoslab.

Contents

1 Wednesday 2 November 2016: Two-stage Stochastic Programming — at ENPC ParisTech

- Title: "Two-stage Stochastic Programming"
- Location: École des Ponts ParisTech (ENPC), Champs sur Marne, France

  `How to get there: http://www.enpc.fr/en/school-practice`

- Planning:
  - Morning: amphitheater Navier, Bâtiment Carnot
    Tutorial: *"Two-stage Stochastic Programming "* (Michel De Lara)
    - 08:30–09:00 - Welcome coffee
    - 09:00–10h30 -
      - Three examples of micro-grid management problems: metro station, domestic district, aggregator
      - The newsvendor problem, without and with backorder; worst case vs. expectation risk criteria
      - Two stage stochastic programming (linear case); initial and recourse decision variables; formulation on a tree
    - 10h30–11:00 - break
    - 11:00–12h30 -
      - Two stage stochastic programming (strongly convex case); scenario decomposition algorithm
      - Two stage stochastic programming (linear case); Progressive Hedging algorithm
  - Afternoon:
    Computer session (Pierre Carpentier, Jean-Philippe Chancelier, Michel De Lara, Vincent Leclère)
    - 14h00–17h00 - *"Two Stage Stochastic Optimization for Fixing Energy Reserves"*
      - Problem statement
      - Formulation on a tree (with linear costs, then quadratic convex costs) and direct resolution
      - Formulation on a fan (with quadratic convex costs, then linear costs) and resolution by scenario decomposition and by Progressive Hedging

2 Thursday 3 November 2016: Stochastic Dynamic Programming — at ENPC ParisTech

- Title: "Stochastic Dynamic Programming"
- Location: École des Ponts ParisTech (ENPC), Champs sur Marne, France

  `How to get there: http://www.enpc.fr/en/school-practice`

- Planning:
  - Morning: amphitheater Navier, Bâtiment Carnot
    Tutorial: *"Stochastic Dynamic Programming"* (Vincent Leclère)
    - 08:30–09:00 - Welcome coffee
    - 09:00–10h30 -
      - Examples of stock management problems; notion of discrete-time controlled dynamical systems with noise
      - Stochastic optimal control problem formulation; resolution by dynamic programming when noise are white
    - 10h30–11:00 - break
    - 11:00–12h30 -
      - Curse of dimensionality, complexity
      - Example of optimal plant growth (Michel De Lara)
  - Afternoon: rooms P 312 and P 320
    Computer session: depending on skills and tastes, we propose different computer practical works (Pierre Carpentier, Jean-Philippe Chancelier, Michel De Lara, Vincent Leclère)
    - 14h00–17h00 -
      - *"A Toy Problem in Dynamic Programming"*
      - *"Dam Optimal Management Under Uncertainty"*
      - *"Subway Stations Optimal Energy Management"*
      - *"Optimal Control of a Domestic Micro-grid"*
- 17h30 - Private cocktail for industrials

3 Friday 4 November: Dual Approximate Dynamic Programming (DADP) — at ENPC ParisTech

- Title: "Dual Approximate Dynamic Programming (DADP)"
- Location: École des Ponts ParisTech (ENPC), Champs sur Marne, France

  `How to get there: http://www.enpc.fr/en/school-practice`

- Planning:
  - Morning: amphitheater Navier, Bâtiment Carnot
    Tutorial: *"Dual Approximate Dynamic Programming"* (Pierre Carpentier)
    - 08:30–09:00 - Welcome coffee
    - 09:00–10h30 -
      - Goals and examples
      - Optimization background and decomposition/coordination
      - About decomposition in the stochastic case
    - 10h30–11:00 - break
    - 11:00–12h30 -
      - Dual approximate dynamic programming
      - Applications to large scale hydro valleys
  - Afternoon: free

4 Monday 7 November 2016: Stochastic Dual Dynamic Programming (SDDP) — at ENSTA ParisTech

- Title: "Stochastic Dual Dynamic Programming (SDDP)"
- Location: ENSTA ParisTech, Palaiseau, France

  `How to get there:`
  `https://www.ensta-paristech.fr/en/getting-ensta-paristech`

- Planning:
  - Morning: Vincent Leclère
    Tutorial: *"Stochastic Dual Dynamic Programming"*
    - 08:30–09:00 - Welcome coffee
    - 09:00–10h30 -
    - 10h30–11:00 - break
    - 11:00–12h30 -

– Afternoon: Pierre Carpentier, Jean-Philippe Chancelier, Michel De Lara, Vincent Leclère
Computer session: *"Stochastic Dual Dynamic Programming"*

  * 14h00–17h00 -