Introduction to Stochastic optimization

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Main goal : introduction to stochastic optimization, that aims to optimize (in the mathematical way) while taking the uncertainty into account.

Plan

- uncertainty and optimization ;
- stochastic programming with recourse ;
- two-stage linear stochastic programming, compact and extended formulations, L-Shaped method ;
- multistage problems ;
- convex and non convex problems
- sampling methods and consistency analysis ;
- stochastic gradient descent – stochastic approximation ;
- optimization by simulation.

Organization

Prerequise

- good mathematical and statistical background ;
- it is advised to have some background in optimization ;
- basic knowledge in programming.

References

Main references

- John R. Birge et François Louveaux, *Introduction to Stochastic Programming*, Springer-Verlag, 1997.
- Warren B. Powell, *Stochastic Optimization and Learning*, `https://castlelab.princeton.edu/`

Suggested books

- Peter Kall et Stein W. Wallace, *Stochastic Programming*, John Wiley & Sons, 1994.
- Andrzej Ruszczynski et Alexander Shapiro, *Stochastic Programming*, Elsevier, 2003.

Additional references will be occasionnally used.

Numerical references

Software

- Julia (`https://www.julialang.org`)
- Gurobi (`https://www.gurobi.com`)

Class material

- `https://github.com/fbastin/SP_Introduction`
- `https://github.com/fbastin/optim`

Discord channel : `https://discord.gg/ycmSAcnC`

Evaluation

- 3 homeworks (20% each) ;
- 1 project (40%)

Objectives

Introduction to stochastic optimization, i.e.

- get familiar with the terminology, the possibilities and main limitations of stochastic programming models ;
- learn how to formulate analytical models incorporating uncertainty as stochastic programs, and how to represent this uncertainty ;
- learn the basic theory ;
- learn the main algorithms used to solved the associated problems.