Decision Science with Probabilistic Programming

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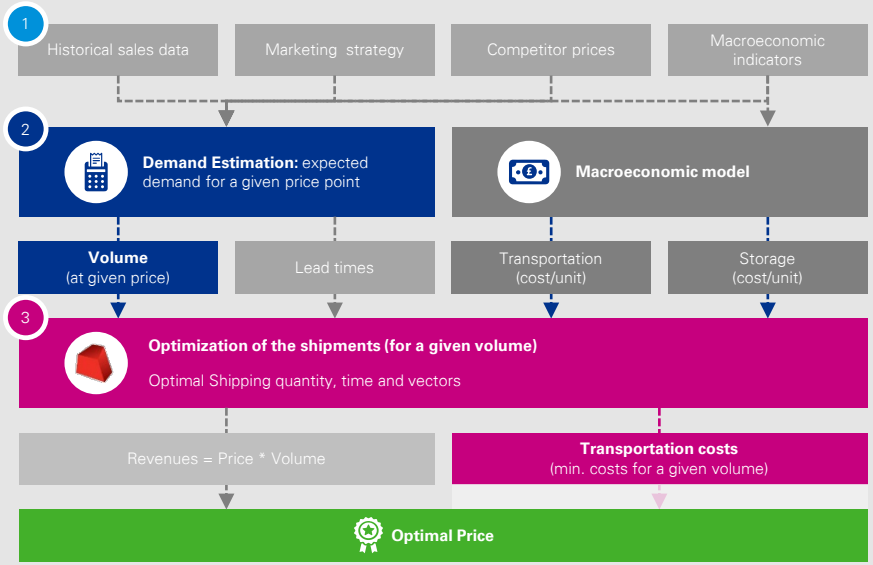
Context and objective

Problem: An industrial goods distributor wants to find the optimal price that maximizes total revenues less transportation costs and storage costs.

Solution: Our solution effectively combines the use of Probabilistic Programming with MILP in a modular architecture that reflects the company value drivers' tree:



Key modules:

- Estimation of the distribution of demand (for a product at a specific price point)
- Estimation of transportation and storage unit costs
- Mathematical Programming module that defines the optimal shipping strategy

Methodological Approach

1 **Identify the key drivers**

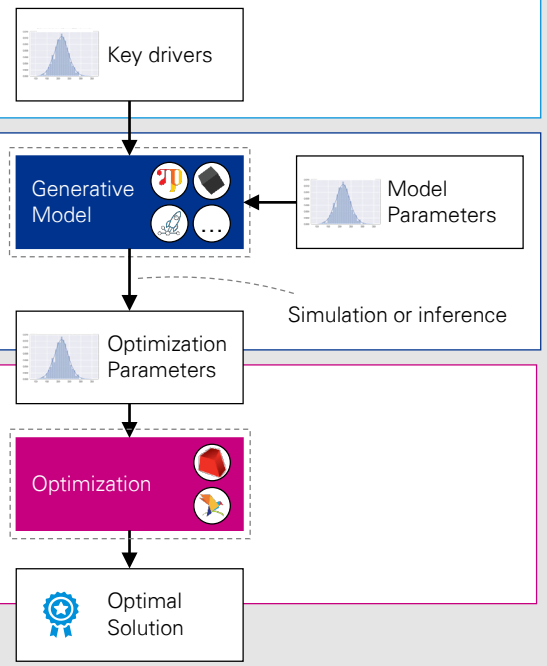
- Endogenous and exogenous
- Fat-tailed distributions

2 **Estimate distribution of key optimization parameters**

- **Generative modelling** with Probabilistic Programming
- Uncertainty in model and model parameters: **Bayesian Machine Learning**
- **MCMC** and **(Variational) Inference** off-the-shelf

3 **Optimization**

- Leverage Python interfaces to solvers (e.g. GurobiPy or Pyomo)
- **Robust** and **Stochastic Programming**
- Alternative methodological approaches: Meta-Heuristics, Reinforcement Learning, ..



Conclusions

- Generative models of key optimization parameters are necessary input to Robust Optimization and Stochastic Programming problems
- Ongoing work: seamless interoperability between Probabilistic Programming frameworks and Python interfaces to solvers

Read more

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