Exercise - Stochastic programming

Day 1 - 04-07-2022

Investment and production

Suppose an American production company wants to build a new factory in Europe to sell their products $p \in P$ at price r_p. The company needs to decide how many machines of type $m \in \mathcal{M}$ they should buy at price c_m^M for the new factory to produce the products.

- Not each product can be produced on each machine. Parameter $A_{p,m}$ indicates compatibility ($A_{p,m} = 1$, if product p can be produced on type m, 0 otherwise).
- The production costs are c_p^P for each $p \in \mathcal{P}$.
- The space is limited to a maximum of $\overline{M}$ machines and the investment budget is limited to $\overline{B}$.
- The demand $d_{p,s}$ for each product $p \in \mathcal{P}$ for the next year is unknown, but the analytics department of the company provides a set of possible scenarios $s \in \Omega$.
- The production time of product $p \in \mathcal{P}$ is given by $t_{p,m}$ and each machine of type $m \in \mathcal{M}$ provides T_m hours.
- In the case of under-production, the company has the possibility to order the missing amount from the US at a cost of c_p^I per product $p \in \mathcal{P}$ and then sell the products for the normal price r_p on the European market.
- All products that are in excess of the demand can not be sold at the normal price but at a lower price r_p^{low}.

Tasks:

1. Formulate the above described planning problem as a deterministic mixed-integer program (assume the demand is known).
2. Identify the first-stage and second-stage decisions in this planning problem.
3. Reformulate the above described planning problem as a two-stage stochastic program.
4. Solve the model using Julia JuMP and Gurobi and the data given in `production_model.jl`