Optimization of Sustainable Energy Systems

Tutorial 2 - Programming

2024

Recall the newsvendor problem from Tutorial 1.

Sets	
$\mathcal{K}$	Scenarios
Parameters	
c	Ordering cost for one product [EUR]
p	Selling price for one product[EUR]
s	Scrap value of unsold product [EUR]
D_k	Demand in scenario k [pieces]
π_k	Probability of scenario k
Variables	
x	Number of products ordered
y_k	Number of products sold in scenario k

Table 1: Symbols

$$max \quad -cx + \sum_{k \in \mathcal{K}} \pi_k \left[p y_k + s(x - y_k) \right] \qquad \text{(Maximize profit)} \tag{1}$$

$$s.t. \quad y_k \leq x \qquad \forall k \in \mathcal{K} \qquad \text{(Limit by ordered amount)} \tag{2}$$

$$y_k \leq D_k \qquad \forall k \in \mathcal{K} \qquad \text{(Limit by demand)} \tag{3}$$

$$x \geq 0 \tag{4}$$

$$y_k \geq 0 \qquad \forall k \in \mathcal{K} \tag{5}$$

Tasks

1. The data of the example case from Tutorial 1 is given in the csv file `small_case.csv` with the structure shown in Figure 1. Read the data from the csv file in Python to be used in a model implementation.

   You can use e.g. Pandas command `read_csv`.

   ```
   import pandas as pd
   ```

   ```
   data = pd.read_csv("<filename.csv>", sep="<separator symbol>", index_col=<id of column used for indexing>, header=<id of header row>)
   ```

   If you define the index column, then the data afterwards can be called by `data["<column name>"][<index>]`.

2. Implement the news vendor problem (1)-(5) and solve it using the data from the `small_case.csv` file. Check with the solution from Tutorial 1, if your implementation is correct.

3. Extend the model so that it can handle several newsvendors at the same time. Each of them has a different demand value per scenario. For now assume that each news vendor orders products individually before the demand becomes known.

4. Implement the extended model and solve using the data in `large_case_ext.csv` (including 5 newsvendors and 200 scenarios). The outline of the csv files is shown in Figure 2.

5. Make a copy of the model and change the model to calculate the expected value solution (taking the expected value of the data before the optimization). Fix the first-stage solution in the stochastic program to calculate the VSS.

6. Change the model so that a central unit is ordering the products. The newsvendors can use the central unit to restock or return products (without additional cost) depending on the demand.

7. Implement the extended model and calculate the VSS using the data in `large_case_ext.csv`.

8. Which model has the higher VSS and why?

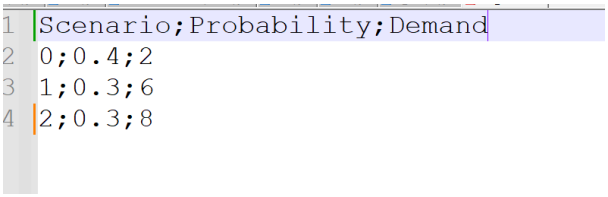

Figure 1: CSV file for small example

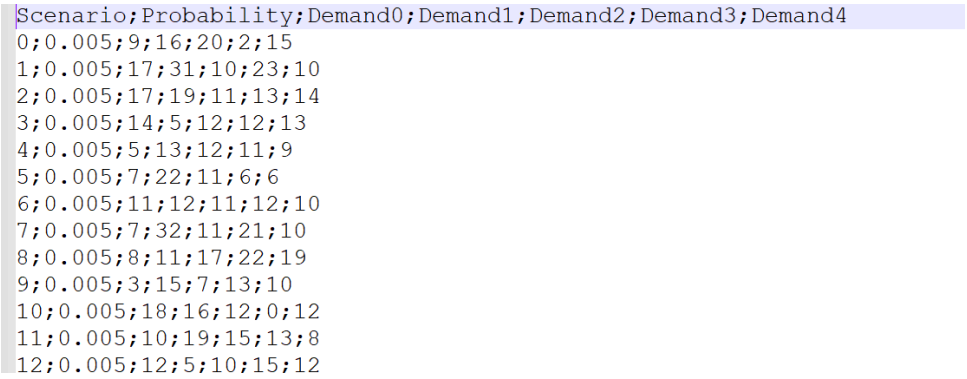

Figure 2: CSV file for the large case