DECISION ANALYTICS.

Lab03: Bin packing / Pandas

BACKGROUND.

The bin packing problem is a direct generalisation of the knapsack problem. Instead of only one knapsack the bin packing problem tries to fit items into multiple bins of a given capacity while maximising the value. More formally, we are given n items of size $w_1, \ldots, w_n$ and value $v_1, \ldots, v_n$ that we want to distribute across m bins of capacity $M_1, \ldots, M_m$. If we use the Boolean decision variables $x_{11}, \ldots, x_{ij}, \ldots, x_{nm}$ to indicate if an item i is to be packed in bin j we can formulate this problem as maximising the total value

$$V = \sum_{i,j} x_{ij} v_i$$

Subject to the constraints that each item is only in one box

$$\sum_j x_{ij} \leq 1 \qquad i = 1, \ldots, n$$

And that the capacity of each box is not exceeded

$$\sum_i x_{ij} w_i \leq M_j \qquad j = 1, \ldots, m$$

Task 1.

The Excel-file "Lab03_data.xlsx" on Canvas contains the input data, both a list of available containers as well as a list of items that need to be packed. Load the excel file and extract all relevant information.

(Hint: Use https://pandas.pydata.org/pandas-docs/stable/reference/api/pandas.read_excel.html to load the file into a Pandas DataFrame object)

Task 2.

Create a CP-SAT model and add all necessary decision variables to that model.

Task 3.

Add the constraints to the model to ensure that each item can only go into one container.

Task 4.

Add the constraints to the model to ensure that the container capacities are not exceeded.

Task 5.

Add the objective function to the model and solve it using the CP-SAT solver.

Task 6.

Answer the question, how much value can be transported, both absolute and in percent of the total value of items?

Task 7.

Save the following results into two sheets of an excel table:

- For each item, which container it needs to be packed in
- For each container, how much capacity is used (both absolute and in percent of the total capacity) and how much value is packed in there (both absolute and in percent of the total value of all transported items)

(Hint: To save data to an excel table use https://pandas.pydata.org/pandas-docs/stable/reference/api/pandas.DataFrame.to_excel.html)