Exercises

April 27, 2022

Knapsack Problem The following two exercises, and the related content, can be found in lecture_notes.ipynb. These are pen and paper exercises to test your understanding of the knapsack formulation.

Exercise 1.1 (Knapsack Game)

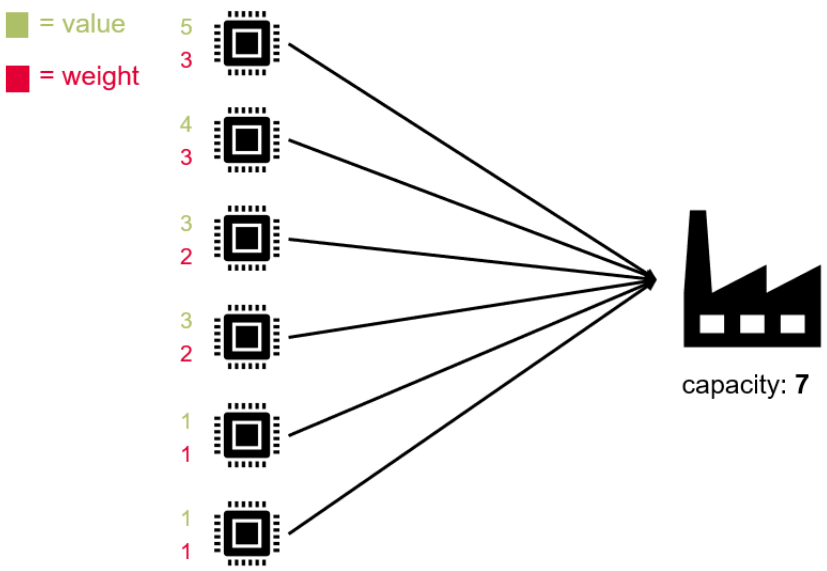

Figure 1: Knapsack instance

Try different configurations for packing the knapsack (or choosing the customer orders). Your goal is to maximize the total value while not violating the capacity constraint.

Exercise 1.2 (Weighting Factors)
In the jupyter notebook we derived the energy expression

$$E = A(1 - \sum_n y_n)^2 + A(\sum_i w_i x_i - \sum_n n y_n)^2 - \sum_i c_i x_i.$$

How would you choose the weighting factor, A, for the penalty term in our energy expression? Choose from

(a) $A = 1$

(b) $A = 10$

(c) $A = 10000$

and explain your choice.

Traveling Salesperson Problem In this exercise you will follow through the homework_tsp.ipynb file, read the material, and complete the missing code segments. The goal of this exercise is to learn another combinatorial optimization formulation, the TSP formulation, and to learn how to build your own QUBO formulations for optimization problems. The following exercises can be found in the ipynb listed above.

Exercise 2.1 (Variable Assignment - Pen and Paper)
Given a graph G with vertices, $V = [0, 1, 2]$. Given the tour order, $O = [2, 0, 1]$, what would the corresponding assignments of $x_{i,j}$ be?
$x_{0,0} =$
$x_{0,1} =$
$x_{0,2} =$
$x_{1,0} =$
$x_{1,1} =$
$x_{1,2} =$
$x_{2,0} =$
$x_{2,1} =$
$x_{2,2} =$

Exercise 2.2-2.7 (QUBO Formulation Code)
In these exercises we ask you to fill in the missing blanks in the code in homework_tsp.ipynb to create your own QUBO formulation for the TSP problem.