

Homework I

due April 6, 2018

Preliminary: You are supposed to use a programming language such as R, C++ or C#. Other programming languages are also acceptable.

In this homework, you are expected to compare a heuristic approach with dynamic programming approach while solving the 0-1 multi item knapsack problem which aims to maximize the total value of the gathered items in a knapsack subject to the capacity constraint.

Assume a knapsack of maximum capacity W to be used for each problem instance in this homework.

1. First, assume 3 different sets of items S_1 , S_2 and S_3 consisting of 10, 25 and 100 items respectively. Generate values and weights for the items in each set randomly such that the values are uniformly distributed between $[1, 21]$; and weights are again uniformly distributed between $[9, 39]$. While generating these, set the seed to the last 4 digits of your student ID (If your ID is 2013402018, set the seed of random generation to 2018 in your code). You are going to use these values and weights in your heuristic and dynamic programming solutions.
2. You are also expected to experiment on the maximum capacity W of the knapsack in this homework. Determine 3 different maximum capacity value for each problem instance (data set), and implement your solution approaches using these maximum capacities.
3. Construct a heuristic approach to the problem such as proceeding by selecting items that are light in weight but heavy in value. Solve the problem for each set of items using the values and weights generated in the 1st question. Report the computation times along with your solution.
4. Now, solve the 3 instances of the problem by means of top-down dynamic programming approach using the values and weights generated in the 1st question. Report the computation times along with your solution.
5. Finally, use bottom-up dynamic programming approach to solve the problem using the values and weights generated in the 1st question. Report the computation times along with your solution.
6. Compare the solution approaches you took to solve knapsack problem and comment on the quality and time of solution for different sizes of data. Report the quality of your solutions as below:

$$100 * (\text{heuristic objective} - \text{optimal objective}) / (\text{optimal objective})$$

Submit a report including your outputs, comments and your code.