Design and Analysis of Algorithms Practice
LAB 6
Date: 24^{th} September 2024

General instructions:

1. Students have to write the pseudo code first in their notebooks and implement it after that. Students can use either C / C++.

2. The point of contact (Member 1 as submitted in Gform) from the group has to submit all the programs. You may ask the TA, if you forgot the point of contact (Member 1).

3. Submit all the programs as a single Zip file in Google Class Room (GCR).

4. Pseudo code, Demonstration and Viva will be evaluated by the TA for 10 marks each and a total of 30. Pseudo code and Viva will be evaluated in the lab itself.

5. If the students wish to submit the programs later, then they can do it with in 2 days (i.e., if the lab is on Tuesday, then programs need to be submitted by Thursday 11:59 PM by point of contact (Member 1).). This evaluation will be considered for Demonstration 10 marks.

All about the Greedy Paradigm

Q1) **0/1 Knapsack Problem:** Given a set of n objects $S = \{X_1, X_2, ..., X_n\}$ associated with their profits $\{P_1, P_2, ..., P_n\}$, weights $\{W_1, W_2, ..., W_n\}$ and Capacity constraint (C) of the Knapsack. The following equation is a formulation of 0/1 knapsack problems.

$$\text{Maximize } \sum_{i=1}^{n} P_i X_i$$
$$\text{Such that } \sum_{i=1}^{n} W_i X_i \leq C,$$
$$X_i \in \{0, 1\}$$

Design and implement any three greedy strategies and evaluate their associated time complexities in terms of Asymptotic Notations (Big O / Theta).
Attached problem instances are described in the following data format in .kp file.
n
C
P_1, W_1
P_2, W_2
..
P_n, W_n

Q2) For the purpose of this problem, imagine you are a kids' camp counselor in charge of teaching the kids how to play hockey. You have a stock of n hockey sticks of varying sizes available for the n kids, also of varying sizes. To make things simpler, let us say that a size 1 stick should be used by a size 1 kid, a size 2 stick with a size 2 kid, and so on. However, any kid can theoretically use any available hockey stick, but with a bit uncomfortably. You want to figure out a way to distribute the hockey sticks to minimize the total difference between all the kids and their paired sticks. The following equation is a formulation of the problem where H_i is the size of the hockey stick and K_i is the size of the kid.

$$\text{Minimize } \sum_{i=1}^{n} |H_i - K_i|$$

Generate the instances randomly. Design and implement any three greedy strategies and evaluate their associated time complexities in terms of Asymptotic Notations (Big O / Theta).

Note: Students who have finished the above programs in less time can explore coin change problem using different logics. The same 0/1 knapsack problem we shall see while discussing about dynamic programming.