Homework #2:
Local Search Algorithms

Assigned: 26.12.2020 Due: 10.01.2021

1. Objective

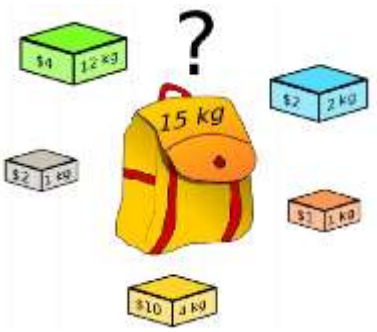
The purpose of this homework is to teach you how to apply local search algorithms while solving a problem and how to evaluate the performance of these algorithms.

2. Specification

In this homework, you will formulate and develop a solution to the below problem by applying several local search algorithms discussed in class: Hill Climbing Search, Hill Climbing with Random Restarts, and Genetic Algorithm.

0-1 Knapsack problem[1]

This famous problem is usually stated as follows: Given a set of items, each with a weight and a value, determine which items to include in a collection so that the total weight is less than or equal to a given limit and the total value is as large as possible. Note that it is not possible to take a portion of an item, you can either decide to take it or not. (See L5_LocalSearch slides and corresponding lecture video.)



Task 1 – Implementation

In this homework, you will use **simpleai** library. You are not allowed to use any other AI library and you are not allowed to implement your own search algorithms or knapsack solver. Your job is to formulate and develop a solution to the knapsack problem as a local search problem.

1. Your program should have a simple console-based menu which takes the following inputs from the user: *number of items, knapsack capacity, weights of each item,* and *values of each item.*
2. Then using simpleai library (you will need *models.py* and *local.py*), define the problem as a search problem (implement required functions actions, result, value, crossover, mutate, generate_random_state) and call local search algorithms (hill_climbing, hill_climbing_random_restarts, and genetic) to solve the problem.
3. Your program should output the result including the list of items selected, total profit of the selected items, and total weight of the selected items.
4. You can get help from the documentation for local search algorithms under the docs directory of simpleai library, to learn how to define and use local search algorithms.

[1] https://en.wikipedia.org/wiki/Knapsack_problem

Task 2 – Report

You will also write a report including the following sections:

A – Problem formulation

In this part, clearly explain the problem formulation. For hill climbing search, you need to explain state representation, possible actions, transition model (result), and objective function (value). For genetic search, you should define state representation (namely chromosome encoding), fitness/objective function (value), crossover and mutation operations.

B – Discussion on the results

This part is the most important part of the report and homework. Run your implementation with different parameters and inputs. Discuss the results of different search algorithms in terms of *completeness*, *optimality*, and *time and space complexity* by giving code outputs. You should try different parameters for the algorithms (i.e. population size, mutation chance, etc.) You can try the test cases in the table. You can use the provided code here to compare your results.

# items	Capacity	Weights	Values
4	12	[5, 3, 7, 2]	[12, 5, 10, 7]
5	15	[12, 2, 1, 1, 4]	[4, 2, 1, 2, 10]
5	25	[24, 10, 10, 7]	[24, 18, 18, 10]
3	50	[10, 20, 30]	[60, 100, 120]
10	20	[12, 2, 1, 1, 4, 5, 7, 5, 8, 10]	[4, 2, 1, 2, 10, 15, 3, 10, 4, 8]
15	50	[24, 10, 10, 7, 2, 8, 6, 5, 9, 12, 20, 18, 13, 5, 4]	[50, 10, 25, 30, 20, 25, 40, 15, 12, 22, 35, 45, 55, 100, 60]

3. Submission

- This homework can be done individually or in groups of maximum 3.
- You will submit your report in pdf format and source files (only the code you implemented, not simpleai library codes).
- Place all your files in a zip archive with name **HW2_StudentID1_ StudentID2_ StudentID3.zip** and submit through the MS Teams submission module.
- Single submission from each group is sufficient.
- If you have further questions, you can send me an e-mail.

4. Academic Honesty Policy

You cannot borrow other's ideas or portions of codes, without giving proper citation. This can be an Internet source or your friend. Clearly indicate which part of your code/report/idea is borrowed from where. Of course, you cannot get all or most of your work from others'. Otherwise you will be penalized.

5. Late Submission Policy

Deadline for homework submissions is **23:59 pm** at the specified date. For each additional day, **25% cut-off** will be applied.