Intelligent Systems

Assignment 8: Solving Problems with Metaheuristics

In this task you will put into practice the topics seen on Metaheuristics.

Problem 1

The **Multiple Knapsack Problem (MKP)** is a real world subset problem and it has multiple applications in theory, as well as in practice. It also arises as a subproblem within several algorithms for more complex problems and these algorithms will further benefit from any improvement in the field of MKP. The following major applications can be mentioned as possible formulations of MKP: problems in cargo loading, cutting stock, bin-packing, budget control and financial management.

MKP can be thought as a resource allocation problem, where there are m resources (knapsacks) and n objects and every object j has a profit p_j. Each resource has its own budget c_i (knapsack capacity) and consumption w_j of resource i by object j. The aim is maximizing the sum of the profits, while working within a limited budget.

Consider the instance of MKP defined by
n = 6;
m = 2;
(P_j) = (110, 150, 70, 80, 30, 5);
(W_j) = (40, 60, 30, 40, 20, 5);
(C_i) = (65, 85).

Examples of approximations:
(S1 : {5, 3}, S2: {1, 6}), profit = 95
(S1 : {2}, S2: {3, 4}), profit = 130

Problem 2

This is a **Simple Arithmetic Problem (SAP)** where the algorithm finds numbers that add up to a target value.
Consider the instance of the SAP defined by

- Find three operands that add up to 20.
- The operands can have a value between -19 and 19.

Examples of approximations:

15 + -3 + 2 = 14
1 + 6 + 11 = 18

Solution with a Swarm Intelligence metaheuristic

a) Choose a solution method from covered metaheuristics of Ant System, Bees Algorithm, or Particle Swarm Optimization.
b) Choose a problem type from MKP and SAP.

c) Scale up the selected problem to make it more interesting for solving it in the computer.
d) Document your solution by specifying:
   i) How do you describe and codify the solutions and how will you represent them in Python for the chosen method?
   ii) How do you generate the initial solutions?
   iii) How are the new solutions generated from the current solutions during the execution of the method?
   iv) How do you evaluate the solutions you want to optimize?
e) Modify the Python code provided to solve the problem. Document it internally with Python comments. Indicate how to run it.
f) You must experiment with different values for the parameters required by the chosen metaheuristic, trying to find appropriate values to solve the problem. Summarize the results of the experiments.

Notes:

- Be concise in your report, but at the same time clear: describe only the detail needed to understand what you are presenting.
- For me, it is very important to understand how you represented and evaluated the solutions to the problem, as well as your strategies for generating the new solutions in the search process.

Delivery instructions:

- AIMA files cannot be modified and must not be delivered with the assignment.
- Only one of the team members must upload the completed assignment08.ipynb jupyter notebook file to Blackboard.
- The solution must be contained within the compressed M.zip file, where M must be replaced by the student ids of the team members. For example, A01111111_A00999999.zip should contain the solution of the team whose members are A01111111 and A00999999.
- The notebook must include the team data.

EVALUATION CRITERIA:

The weights assigned to the activities for the evaluation of this activity are:

- Documentation of the solution: 30%
- Code for solving the problem: 25%
- Correct execution of the notebook: 30%
- Summarize the results of the experiments: 15%

The grade will be augmented (awarded) or reduced (penalized) depending on the quality of the notebook documentation with markdown text, the internal documentation of the Python code, and the writing of the conclusions.