G52AIM Lab 3 – Simulated Annealing and Cooling Report Exercise Sheet

1   REPORT [50 MARKS]

These questions are designed to test your knowledge and intuition. We are only looking for short 1 or 2-line answers. You may include drawings of the search landscape to illustrate your explanations.

Question 1

How does Simulated Annealing (SA) differ compared to the heuristics/metaheuristics implemented in previous labs? You should state the move acceptance classification of SA and compare it to that of Iterated Local Search.

Question 2

A cooling schedule is used to cool the temperature parameter used within the Boltzmann probability equation. Considering the geometric cooling schedule:

Q2a:

What would you <u>expect</u> would happen <u>and why</u> if T_0 was set "optimally" but then α was changed to be extremely small (as close to, but not equal to, zero as possible)?

Q2b:

What would you <u>expect</u> would happen <u>and why</u> if T_0 was set "optimally" but then α was changed to be extremely high (as close to, but not equal to, one as possible)?

Question 3

Metaheuristics contain a set of parameters; appropriate settings of the parameter values are crucial for them to perform well.

Q3a:

List the parameters which you would tune for improving the performance of Simulated Annealing with the geometric cooling schedule.

Q3b:

Name <u>three</u> parameter tuning methods which could be used to tune the parameters identified in Q3a.

Question 4

In previous exercises, you were tasked with comparing the performance of two algorithms using some form of statistically valid reasoning. In this task, you are to use a statistical test to see if Simulated Annealing (SA) <u>with $T_0 = f(s_0)$ and $\alpha = 0.95$</u> performs statistically significantly better than Iterated Local Search (ILS) <u>with $IOM = 5$ and $DOS = 1$</u> for solving

MAX-SAT instance 5 given a confidence interval of 95%, a computational budget of 20 seconds, and at least 30 trials/repetitions performed for each algorithm. You should compare the results of Simulated Annealing to Iterated Local Search using the Wilcoxon Signed Rank Test covered in the lecture "Move Acceptance in Metaheuristics and Parameter Setting Issues" ([calculator here](#)).

You should state if you performed a one-tailed or two-tailed test, the resulting p-value, and what this means regarding the null hypothesis and hence whether SA performs statistically significantly better than ILS (or not). Note that if you choose to use a one-tailed test, the linked calculator by default only conducts a left tailed test. Hence you should be careful, and state which algorithm (SA or ILS) is used for X_a and X_b.

2 MARKING CRITERIA

1. Valid answer with correct classifications of SA and ILS.   [10 marks].
2.
      a. Valid answer.   [5 marks].
      b. Valid answer.   [5 marks].
3.
      a. Valid answer.   [6 marks].
      b. Three correct answers.   [9 marks].
4. Correct answer with all requested information.   [15 marks].

3 SUBMISSION

Deadline: Tuesday 27/02/2018 – 15:00

You should submit a single PDF file called **[username]-lab03-report.pdf** to Moodle under CW3b.