Universidade de Aveiro

Mestrado em Engenharia Informática

Mestrado em Robótica e Sistemas Inteligentes

Simulação e Otimização

Optimization Mini-Project

Academic year 2022/2023 Amaro de Sousa / Nuno Lau

Objectives:

- To develop two alternative methods for solving a given optimization problem: (i) a metaheuristic method and (ii) an exact method based on integer linear programming.
- To solve a given problem instance with both optimization methods.
- To make a comparative analysis of the solutions and running times obtained by both methods.

Proposed optimization problem:

- Consider a SDN (Software Defined Network) network with a data plane represented by a graph $G = (N, A)$ with switches identified as $i = 1, 2, \dots, |N|$. Each link has an associated length l_{ij}.
- Consider an integer parameter $n < |N|$ and a length parameter C_{max}. The aim is the selection of n switches to connect one SDN controller to each of them guaranteeing that the shortest path length between any pair of SDN controllers is not higher than C_{max}.
- The objective is to minimize the average shortest path length from each switch to its closest controller.

Problem instance:

- Solve the optimization problem for n = 10 nodes and $C_{max} = 1000$ in the graph of the figure presented in the next page with $|N| = 200$ nodes and $|A| = 250$ links.
- The data associated with the graph is in files `Nodes2.txt`, `Links2.txt` and `L2.txt`.

Tasks of the mini-project:

- Implement either GRASP (Greedy Randomized Adaptive Search Procedure) or GA (Genetic Algorithm) or both. Through testing on the given problem instance, select the best settings for the metaheuristic method(s) of your choice. The stopping criteria is by runtime limit.[1]
- Solve the optimization problem with the metaheuristic method(s). Run 10 times your metaheuristic method(s) with the best settings with a runtime limit of 30 seconds on each run, and register the minimum, average and maximum objective values obtained among all 10 runs.
- Solve the optimization problem by the exact method (use the ILP modelling techniques learned in the classes). Run 'lpsolve' with a running time limit of 5 minutes. Register the solution found, its objective value and the running time of the 'lpsolve'.
- Compare the results and running times obtained by all methods and draw all relevant conclusions.

[1] To help the implementation, a MATLAB function **`AverageSP_v2`** is provided that computes: (i) the average shortest path length from each node to its closest server node and (ii) the maximum shortest path length between any pair of server nodes.

Deliveries and deadlines:

A report must be written by each group describing:

- the MATLAB code, duly explained, that generates the LP file used to solve the optimization problem with 'lpsolve',
- the MATLAB codes, duly explained, of the developed metaheuristic method(s),
- the identification and justification of the best settings used in the metaheuristic method(s),
- the results obtained by all optimization methods,
- the comparative analysis of the results obtained by all optimization methods.

A compressed file with the report (in PDF format) and with all MATLAB implementations must be submitted in the 'elearning' platform of the course unit **until the end of 2nd of June**.

Evaluation criteria:

- Correct implementation of the exact method (25%)
- Correct implementation of one metaheuristic method and proposed best settings based on testing (25%)
- Description of results, its analysis and drawn conclusions (20%)
- Quality and clarity of the report (10%)
- Implementation of both metaheuristic methods instead of only one of them (20%)