Universidade de Aveiro

Mestrado em Engenharia Informática

Mestrado em Robótica e Sistemas Inteligentes

Simulação e Otimização

Optimization Mini-Project

Academic year 2024/2025 Amaro de Sousa / Nuno Lau

Objectives:

- To develop alternative methods (both metaheuristic and exact) for solving a given optimization problem.
- To solve a given problem instance with all optimization methods.
- To make an analysis of the solutions and running times obtained by the different methods.

Proposed optimization problem:

- Consider a Software Defined Network with a data plane represented by a graph $G = (N, A)$ with switches identified as $i = 1, 2, \ldots, |N|$. 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 SDN controller.

Problem instance:

- Solve the optimization problem for n = 12 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 `Nodes200.txt`, `Links200.txt` and `L200.txt`.

Tasks of the mini-project:

- Implement both GRASP (Greedy Randomized Adaptive Search Procedure) and GA (Genetic Algorithm) algorithms to solve the proposed optimization problem with a stopping criterion based on running time. Through testing on the given problem instance, select the best settings for the each of the two metaheuristic methods.[1]
- Solve the optimization problem with both metaheuristic methods. Run 10 times each method with the best settings and a runtime limit of 30 seconds on each run. Report the minimum, average and maximum objective values obtained among all 10 runs for each method.
- Implement and solve the optimization problem by an exact method using Integer Linear Programming. 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 **`PerfSNS`** 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 (maximum 2 students) describing:

- the name and student number of the group students, and the effort percentage of each student in the development of the mini-project,
- the MATLAB code, duly explained, that generates the LP file used to solve the optimization problem with 'lpsolve',
- the MATLAB codes, duly explained, of both metaheuristic methods,
- the identification and justification of the best settings used by each metaheuristic method,
- the results obtained by all optimization methods,
- the comparative analysis of the results obtained by all optimization methods.

A demonstration of the mini-project must be conducted in the practical part of the last class (3rd of June) with the presence of both students of each group. 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 6th of June**.

Evaluation criteria:

- Correct implementation of GRASP and proposed best settings based on testing (20%)
- Correct implementation of GA and proposed best settings based on testing (20%)
- Strategies that go beyond the standard implementations of GRASP and/or GA (10%).
- Correct implementation of the exact method (20%)
- Description of results, its analysis and drawn conclusions (15%)
- Quality and clarity of the report (15%)