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# Algorithmic Methods for Mathematical Models

## – COURSE PROJECT –

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A public hospital needs to design the working schedule of their nurses. As a first approximation, we are asked to help in designing the schedule of a single day. We know, for each hour  $h$ , that at least  $demand_h$  nurses should be working at the hospital. We have available a set of  $nNurses$  nurses and we need to determine at which hours each nurse should be working. However, there are some limitations that should be taken into account:

- Each nurse should work at least  $minHours$  hours.
- Each nurse should work at most  $maxHours$  hours.
- Each nurse should work at most  $maxConsec$  consecutive hours.
- No nurse can stay at the hospital for more than  $maxPresence$  hours (e.g. if  $maxPresence$  is 7, it is OK that a nurse works at 2am and also at 8am, but it not possible that he/she works at 2am and also at 9am).
- No nurse can rest for more than one consecutive hour (e.g. working at 8am, resting at 9am and 10am, and working again at 11am is not allowed, since there are two consecutive resting hours).

The goal of this project is to determine at which hours each nurse should be working in order to minimize the number of nurses required and satisfy all the aforementioned constraints.

### 1. Work to be done:

- Formally state the problem.
- Devise an integer linear programming model for the optimization problem and implement it in OPL.
- Because of the complexity of the optimization problem, heuristic algorithms are needed. We are considering both GRASP and BRKGA meta-heuristics. Implement them in the programming language you prefer.
- Compare the performance of solving the model and the heuristics in terms of computation time and quality of the solutions. To that end, generate increasingly larger problem instances until solving the ILP model takes around 30 minutes.
- Compare the performance of the two meta-heuristics in terms of solving time and quality of the solution for even larger problem instances.

### 2. Report

Prepare a report (8-10 pages) including:

- Problem statement.
- Integer lineal model, including the definition of the sets and parameters, the model itself and a short description of the objective function and every constraint.
- For the meta-heuristics, the pseudo-code of the GRASP *constructive* and *local search phases* algorithms, the greedy function and the equation describing the RCL. For BRKGA, the chromosome structure and the pseudo-code of the *decoder* algorithm.
- Comparative results.
- Together with the report, you should also provide all sources and instructions on how to use them, so that results can be easily reproduced.