OMA Assignment 2017-2018

Examination Time Tabling : Group 03

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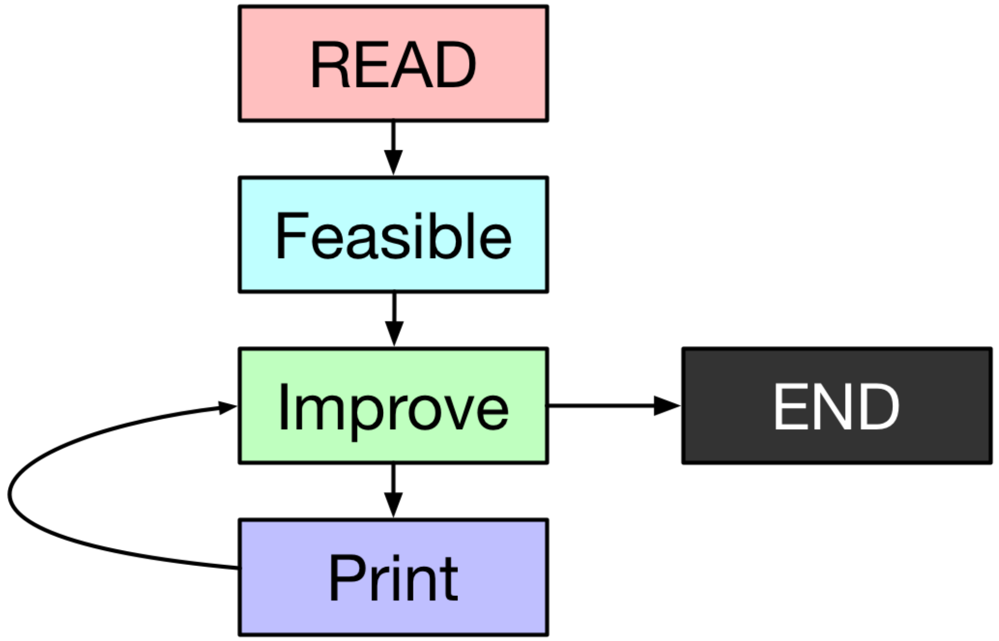
The Problem

- Solving a time scheduling problem trying to minimize the penalties of exam proximities.
- Step:
  1. Read & Store data input
  2. Finding a feasible solution
  3. Improving founded feasible



Data Structure

- The software is written in **C** due to its high performance.
- We have not implemented multithreading to focusing on algorithms development.
- The main structure is a **GRAPH** built on a adjacency matrix.
- When two exams CAN'T be sustained in the same time slot adjM[e1][e2] = n (# of students enrolled in both exams), otherwise -1.

Feasible

Finding Feasible

- The initial idea was to implement a **TABU** SEARCH over the data. Starting with this strategy resulted a little bit slow with those instances that have an high grade of complexity and conflicts.
- The final version use a **GREEDY** algorithm to reduce the complexity and then it pass this partial solution to the **TABU** implementation.
- <u>From</u> ~3 minutes <u>to</u> ~10 seconds.

Greedy

- Trying to **reduce** ”the complexity” of the problem.
- Initial data is sorted from the exam with more collision to the the fewer ones.
- **Workflow**:
  - Use the FIRST available (no collision) time slot for each exam.
  - If there aren’t enough timeslots with this configuration it adds more timeslots.
- The added timeslots will be removed with the next step.

Tabu Search

- It reduces the number of added (by the greedy) time slot till the correct number.
- **Workflow:**
  1. Reduce the timeslots
  2. Try to resolve conflict with the reduced number of timeslots.
     1. If is not able to solve: BACKTRACK
     2. Otherwise: Restart from point 1.
- The TABU is of 1000 moves with 7 iterations.
- ADVANTAGES:
  - Very reliable
- DRAWBACKS:
  - Not too fast

Improve

Used techniques

Local Swap

- Implements a STEEPEST DESCENT STRATEGY.
- Evaluates Neighborhood N(x) of the current optimal solution x.
- **Workflow**:
  - Switches exams scheduled in a timeslot with those contained in any another to find a new feasible solution x'.
  - If x' has a better benchmark than that of x, then x=x'.
  - Loop until there is no improvement anymore
- Slower than FIRST IMPROVEMENT strategy but more efficient.

Local Search

- Our local search implements 3 different algorithms:
  1. **Move Exam**: Change the timeslot of an exam.
  2. **Swap Exams**: Swap the timeslots of two exams.
  3. **Bounded Shift**: Shift a portion of timeslots.
- These 3 (+ the previous local swap) procedures are used until the solution is improving.

Simulated Annealing

- **Workflow**:
  1. Start from a feasible solution.
  2. Move an exam to another timeslots.
  3. If WORST or UNFEASIBLE accept the solution, with probability, depending on temperature.
  4. Reduce temperature to converge to a minimum.
  5. Reuse the TABU SEARCH to restore the feasibility.
  6. Apply local search to find a minimum.

Greedy Slot Shuffle

- Starting from a feasible, it adds, one at a time a timeslot evaluating the benchmark.
- ADVANTAGES:
  - Random
  - Fast

Improve

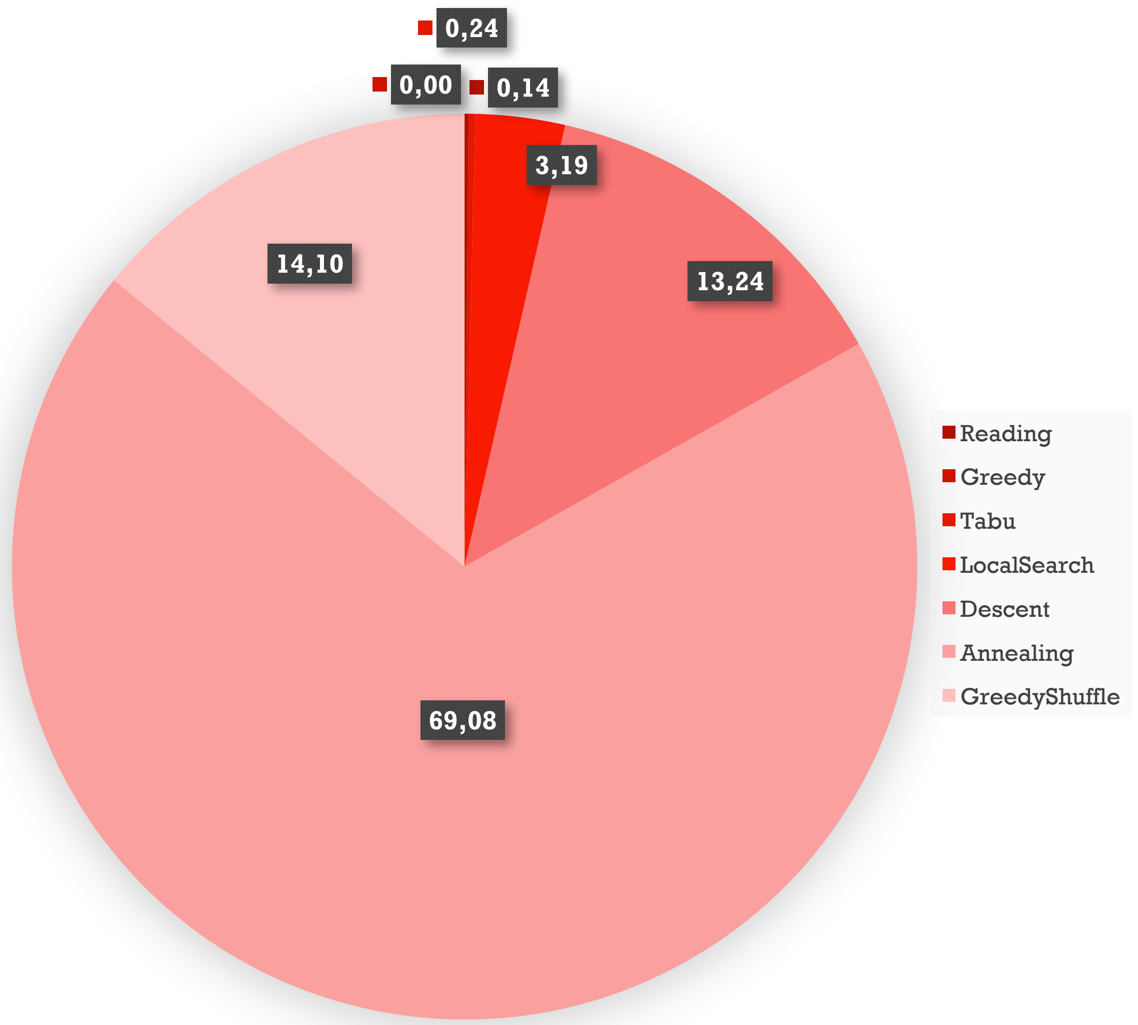
Other techniques tried but not used in the final version…

Genetic

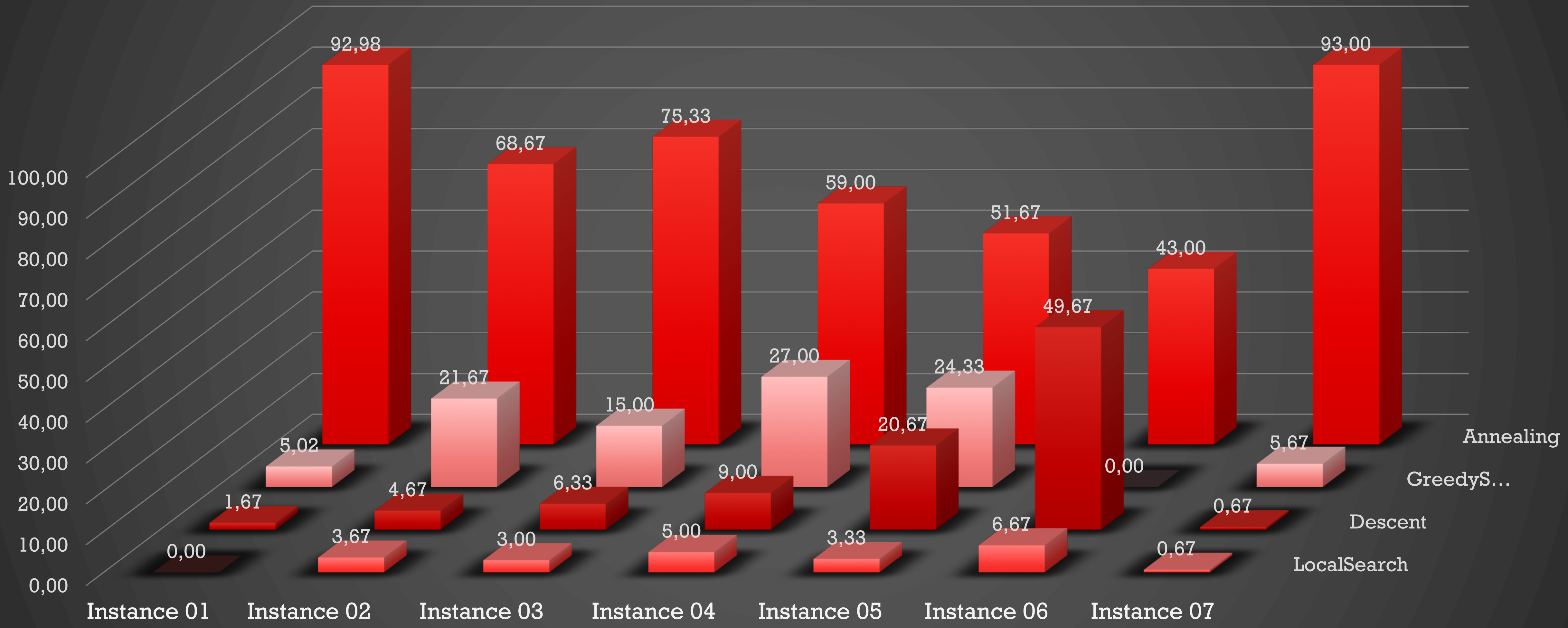
- Starting from two or more parents it performs a cross-over between them and occasionally a mutating.
- This algorithm not fit very well this problem because it could generate a lot of unfeasible solution due to its randomness.
- DRAWBACKS:
  - Not too easy
  - Lot of unfeasible solutions

Execution

Average % Algorithm Execution Time



% Algorithms execution time to instance properties



Performance

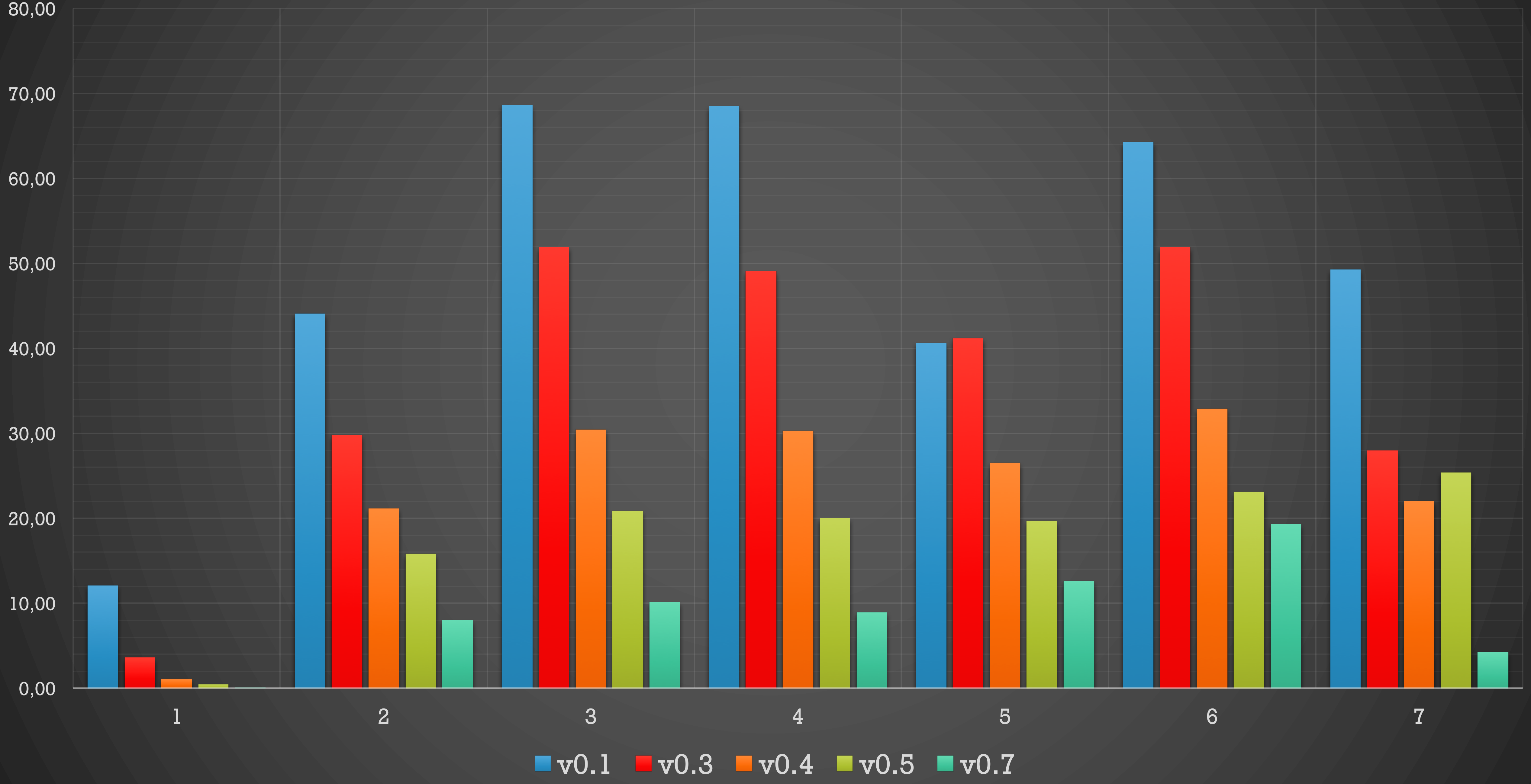
Benchmark

- Our algorithms is flown over 5 different steps:

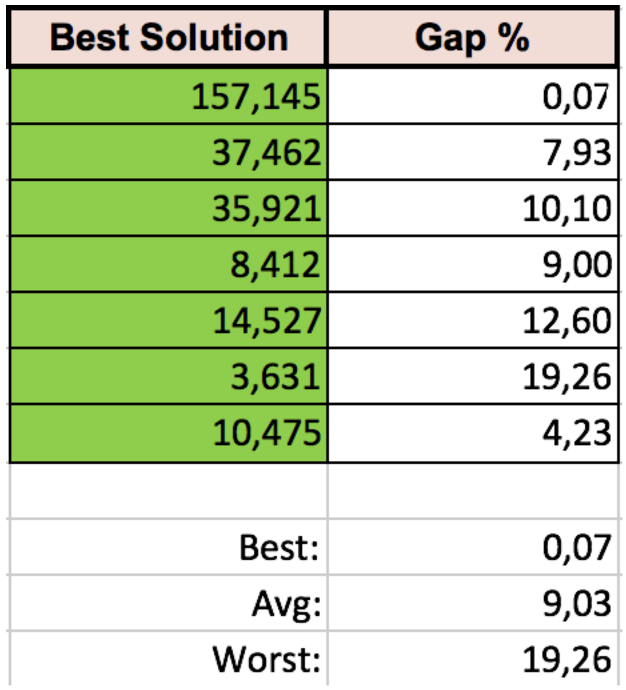
1. v0.1: Tabu List search
2. v0.3: Greedy Preparation at begin
3. v0.4: Adding Simulated Annealing and local search
4. v0.5: Implementing Local Swap
5. v0.6: Various Tuning

- In the next graph is possible to view the benchmark results at each step.

Benchmark % gap during development for each instances



Latest Result



Best Solution	Gap %
157,145	0,07
37,462	7,93
35,921	10,10
8,412	9,00
14,527	12,60
3,631	19,26
10,475	4,23
Best:	0,07
Avg:	9,03
Worst:	19,26

Repository

- The whole project with code, math model, instances, presentation and benchmark results are available on a **GitHub** public repository:

GitHub

https://github.com/Jacopx/OMA_ExamTimeTable

Thanks for the attention!