# OMA Assignment 2017-2018

**Examination Time Tabling : Group 03**

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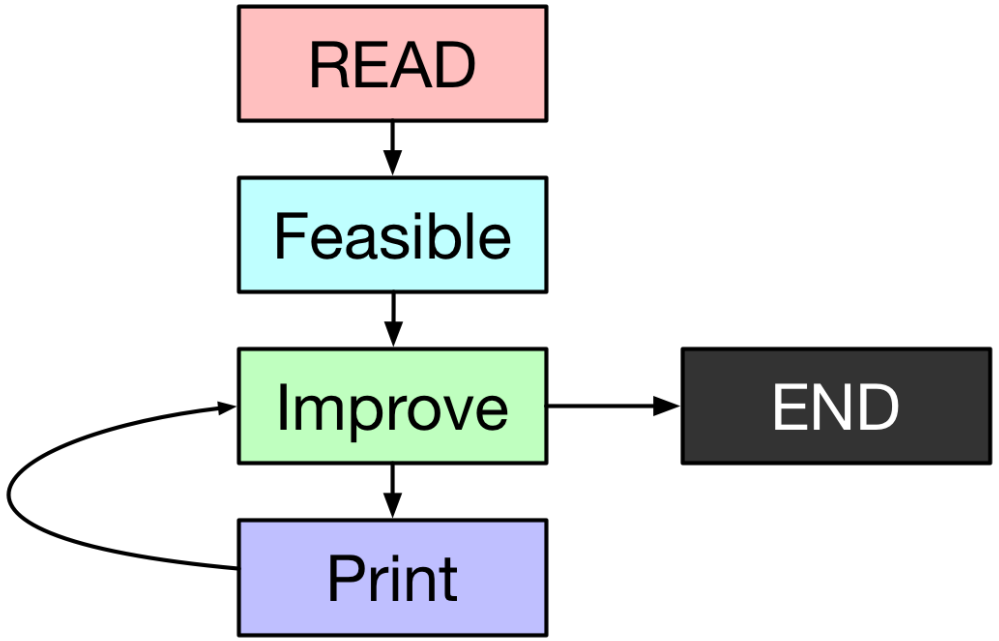
# The Problem

- 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.
- 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] = 1, otherwise -1.
- The TABU is of 1000 moves with 7 iterations.

# 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.
- From ~3 minutes to ~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.
- ADVANTAGES:
  - Very reliable
- DRAWBACKS:
  - Not too fast

# Improve

Used techniques

# 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 next local swap) procedures are used until the solution is improving.

# 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.

# 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

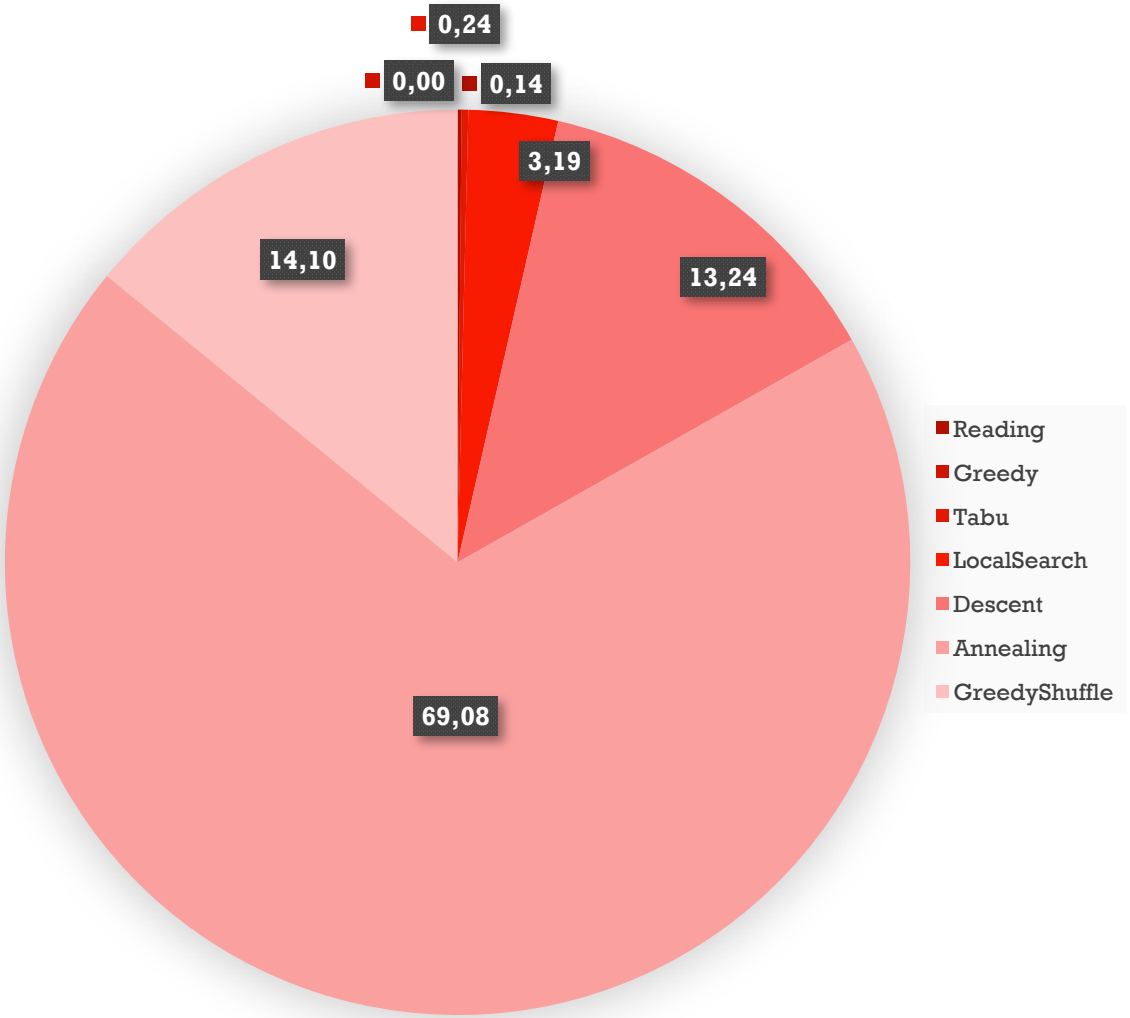
Other techniques tried but not used in the final version…

# Genetic

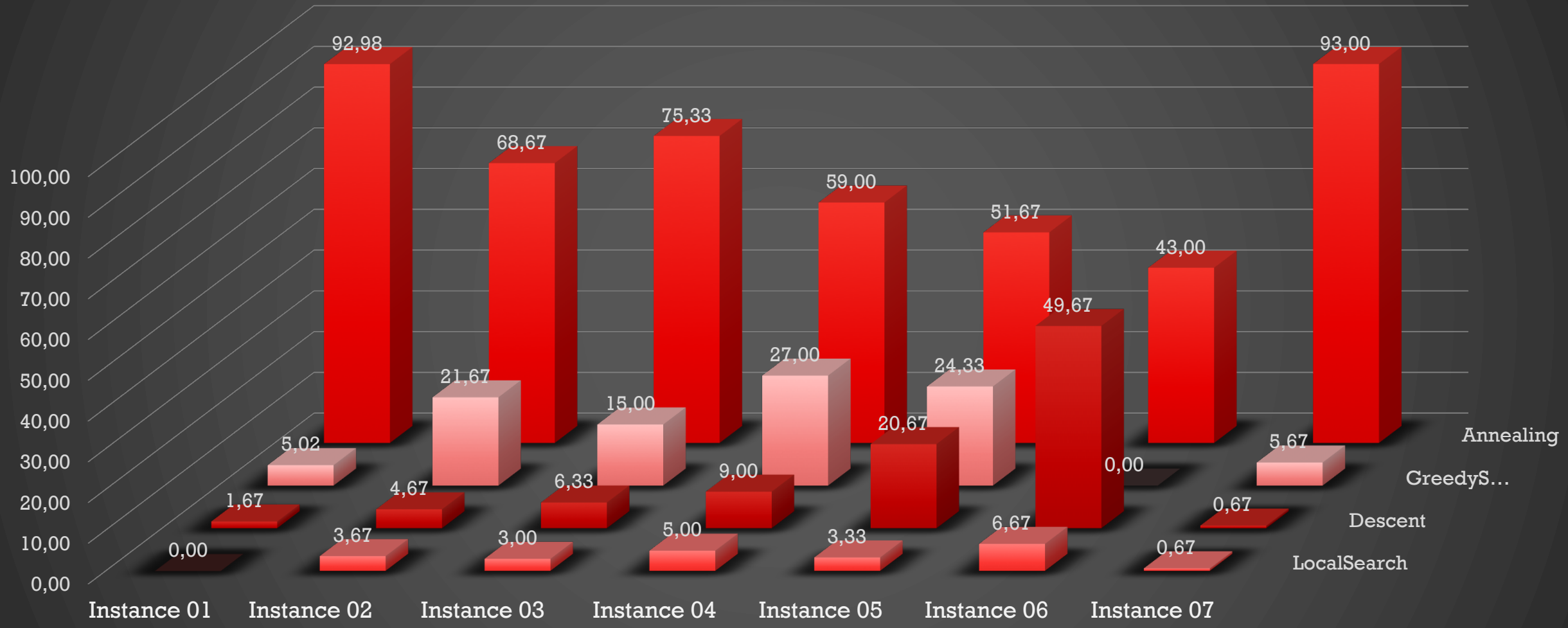
- Starting from two or more parents it performs a cross-over between them and occasionally a mutating.
- This algorithm not fit very well this problem because it could generate a lot of unfeasible solution due to its randomness.
- DRAWBACKS:
  - Not too easy
  - Lot of unfeasible solutions

# Execution

# Average % Algorithm Execution Time



# % Algorithms execution time to instance properties



# Performance

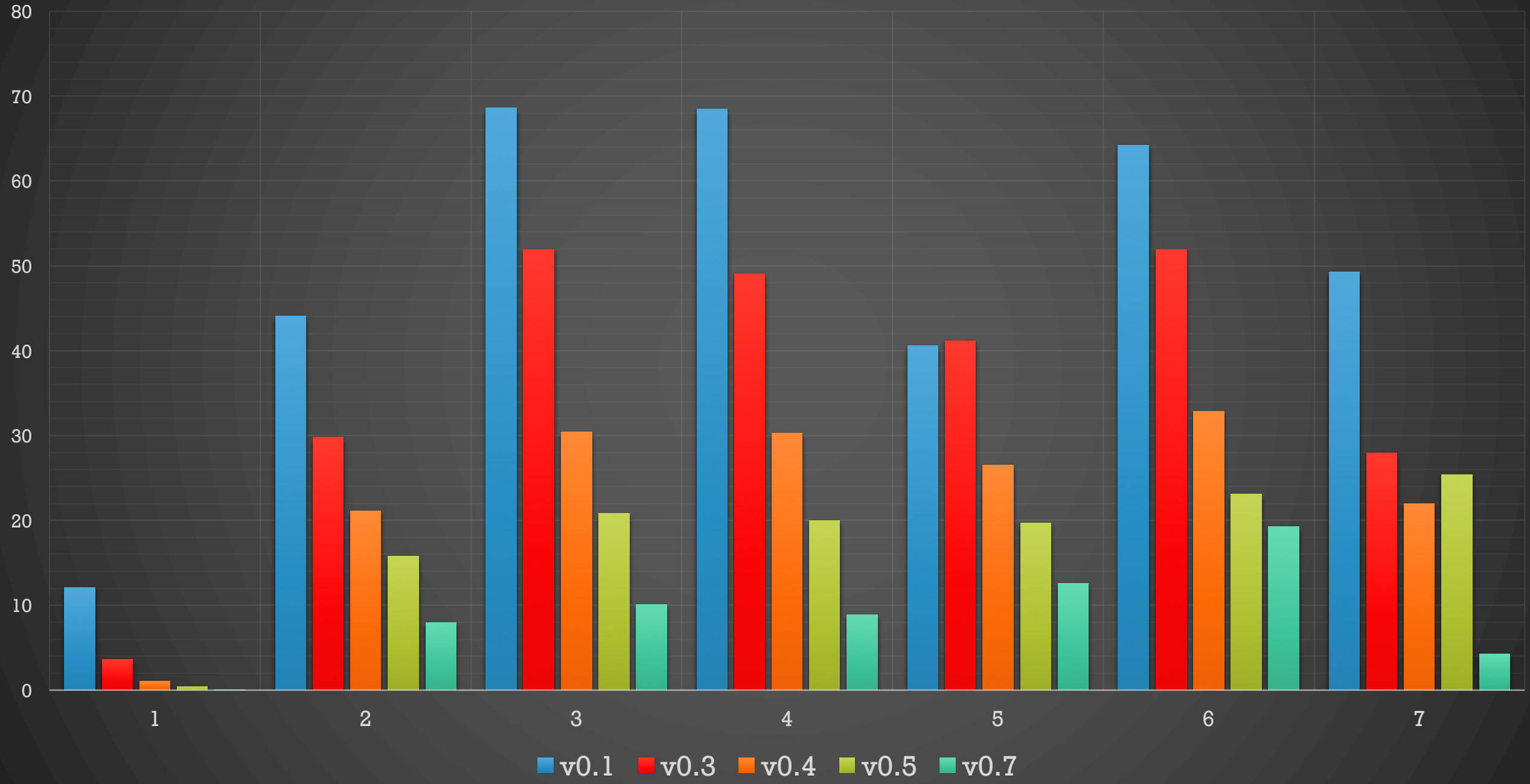
# Benchmark

- 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.

# Execution Time during development for each instances



# Latest Result

| 02/01/2018 | |
|---|---|
| **5** | **Gap %** |
| 157,121 | 0,06 |
| 38,877 | 12,01 |
| 36,471 | 11,78 |
| 8,703 | 12,77 |
| 14,832 | 14,97 |
| 3,668 | 20,48 |
| 10,587 | 5,34 |
| | |
| Best: | 0,06 |
| Avg: | 11,06 |
| Worst: | 20,48 |

# FOTO TEMPORANEA

# Repository

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


https://github.com/Jacopx/OMA_ExamTimeTable

# Thanks for the attention!