Case-Study HFT-Stuttgart: Master Software-Technology – summer term 2010
Repository: http://code.google.com/p/timetablinghft

Heuristic of an Evolutionary Algorithm to solve the curriculum based course timetabling problem

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Idea of the heuristic:

Generator:
Fills up the solution table with feasible solutions generated by the *algorithm of Martin Josef Geiger*[1].
The generator also brings in new genes into the population during the evolution-process.
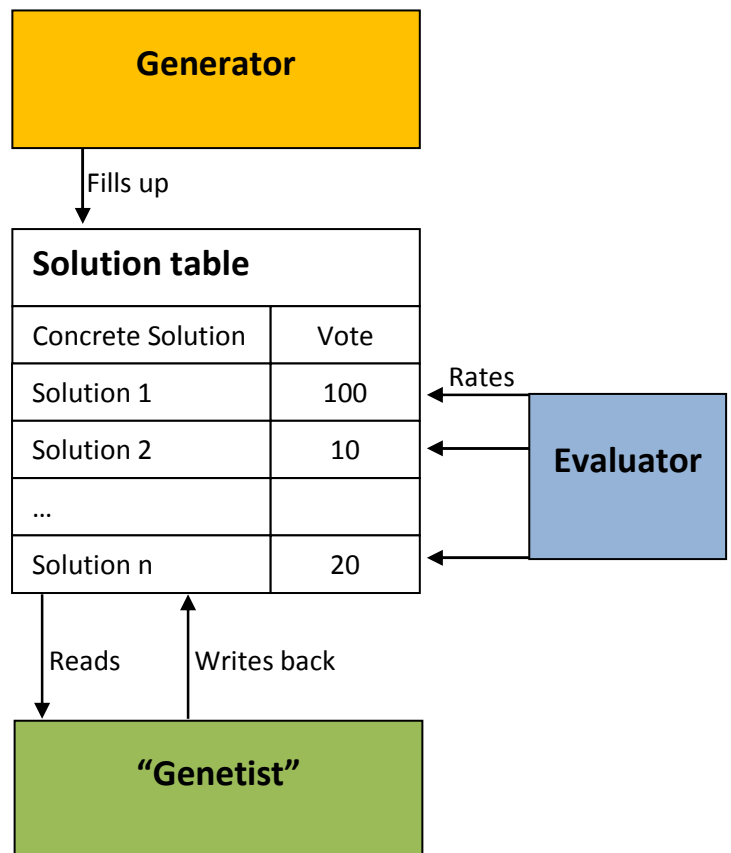
Evaluator:
Evaluates each solution by one concrete curriculum. Based on this rating the reproduction-strategy will take place. The higher the rating is, the higher is the possibility for reproduction of the concrete solution.

"Genetist":
This module reads several solutions from the solution table and creates new (mostly better) solutions via
- Recombination
- Mutation

This module uses the *Neighborhood Analysis by Zhipeng Lü, Jin-Kao Hao and Fred Glover*[2].

Voting-mechanism in detail – Negotiation approach:

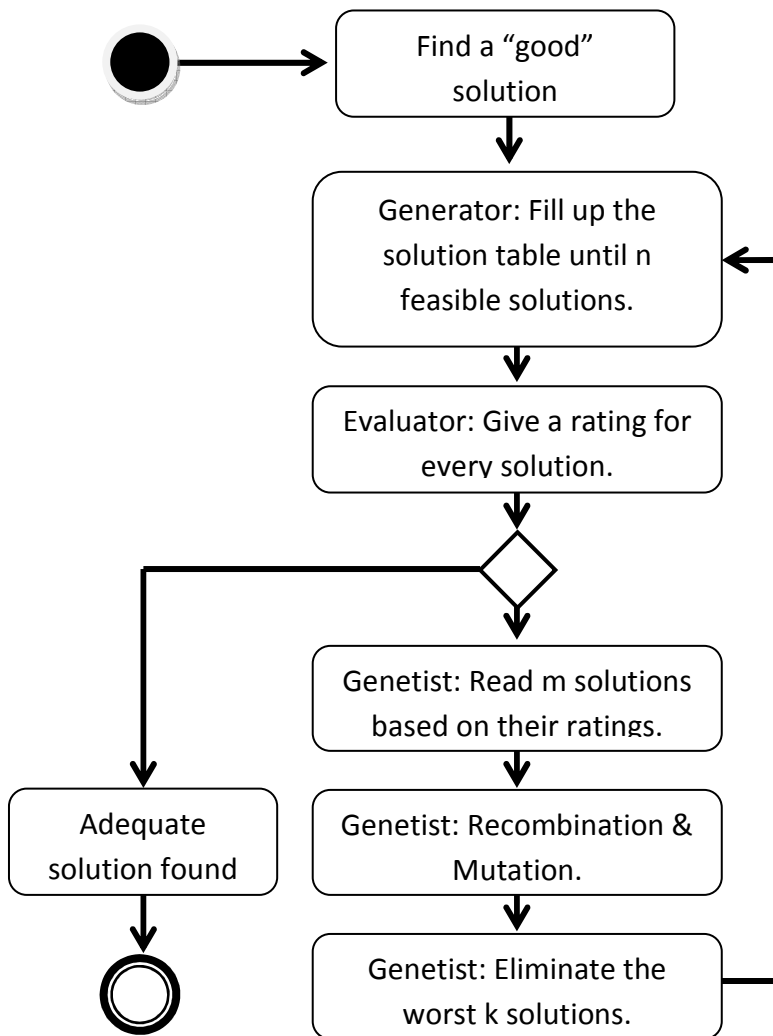|	Solution #				Rank
Curr1	3	1	1	…	**1**
Curr2	1	5	2		**2**
Curr3	9	6	3		3

The evaluator generates one *"negotiator"* (Curr1, Curr2, …) for each curriculum. Each *"negotiator"* votes for every solution in its own interest.
At the end of the negotiation process the highest rated solutions will be used for recombination and mutation.

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[1] http://w1.cirrelt.ca/~patat2008/PATAT_7_PROCEEDINGS/Papers/Geiger-TC1d.pdf
[2] http://www.info.univ-angers.fr/pub/hao/papers/JoH2010.pdf

Activity Diagram:

Find a "good" solution → **Generator: Fill up the solution table until n feasible solutions.** → **Evaluator: Give a rating for every solution.** → (decision) → **Genetist: Read m solutions based on their ratings.** → **Genetist: Recombination & Mutation.** → **Genetist: Eliminate the worst k solutions.** (loops back to Generator)

Decision branch → **Adequate solution found** → (end)

Definition of fairness:

For each solution you can calculate the soft constrains for every curriculum.

Soft constr. Curr1	Soft constr. Curr2	Soft constr. Curr3	Fairness
200	200	200	0
500	50	50	450

The fairness points are calculated based on the absolute difference and the average difference to the other curricula.
The lower the fairness points are, the fairer is the solution.

Not only the highest rated solutions, but also the fairest solutions have a higher possibility for reproduction.

Measurements:

To represent the quality of our heuristic, here are some significant results of the algorithm. A detailed list with multiple runs on each instance can be found in the repository (address on top of page1). Significant values are marked. In the table of measurements you can see, that (sadly) fair solutions must not have a low penalty value :-(

Instance	# of Iterations	Best solution penalty	Fairness of best solution	Fairest solution penalty	Faireness of fairest solution
1	100	1301	446	1998	384
1	1000	1077	671	3256	75
8	100	8560	149	11308	113
8	1000	7388	2279	8829	533
11	100	1828	663	4194	6
11	1000	1448	297	2288	10

Summary:

Based on the negotiation approach, not the best solutions will be used for reproduction, but the fairest solutions.
All in all the Algorithm will approximate to the fairest all in all solution.