Class scheduling through genetic algorithms

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The scheduling of disciplines in a university may become a problem of great complexity, as many restrictions must be taken into account. Moreover, with the recent changes in society, the students are entering sooner the labour market and have to conciliate study with work. Therefore, a reasonable timetable of disciplines is very important, in order to avoid the students from missing classes, having a bad performance and, in the worst case, leaving university.

In this project, a model for the optimization of a timetable was developed, with the objective to facilitate the conciliation of the students' class hours with their work time, taking also into account the many restrictions of the problem. The tool uses genetic algorithms, which are inspired in the laws of natural evolution and produce better solutions from given initial ones through selection, mutation and crossover.

The problem consists of the optimization of a timetable of disciplines, taking into account the restrictions. As a first approach, in order to check the feasibility of the model, it is restricted to only one semester of the curriculum and only one discipline can be scheduled at certain time. Class scheduling presents a number of restrictions:

- The time availability of the teacher of the discipline;
- The maximum number of credits the student can attend at the period;
- The desired number of credits for the period;
- The period of the day in which the discipline must be scheduled, as certain courses are restricted to the morning, afternoon or night shifts.
- Ideally, no gaps should exist between classes.

The developed tool consists of an excel sheet and the genetic algorithms tool, Evolver 4.0[1], which is used to evolve the timetable.

The "chromosome" to be evolved represents the order in which the disciplines are given to the timetable constructor, which uses heuristics in order to create the timetable. These heuristics are the following:

- First, the constructor searches to schedule the discipline at the first hours of the day, which is done if the hours are vacant;
- All the days of the week are searched before the constructor moves to the next hour;
- If there are disciplines already scheduled at the day, it searches first for the gaps between classes or the beginning or end of the day;
- The same discipline has priority to be scheduled at the same time in different days, preferably with a gap of two days between both scheduled hours, otherwise the fitness of the "chromosome" is penalised;
- The elective disciplines are scheduled only within the limits of the desired number of credits;
- The obligatory disciplines can be scheduled even if the number of desired credits is exceeded, but the maximum number of credits cannot be surpassed.

The function that measures the fitness of the "chromosome" takes into account the number of scheduled credits compared to the number of desired credits, the groupment of classes at the beginning or end of the day, the existence of gaps between classes and the fraction of obligatory classes that are scheduled.

Table I shows a timetable generated after the evolution of 10 "generations" with a "population" of 50 timetables, where the discipline ELE1101 is obligatory and can only be scheduled on Tuesdays and Thursdays from 16hs to 18hs, and the discipline FIS1104-L is also obligatory and can only be scheduled in the morning.

TABLE 1 – The results of the evolution.

Hour of the day	Monday	Tuesday	Wednesday	Thursday	Friday
08:00	FIS1104-L	-	-	-	-
09:00	FIS1104-L	-	-	-	-
10:00	FIS1104-L	-	-	-	-
11:00	-	-	-	-	-
12:00	-	-	-	-	-
13:00	-	-	-	-	-
14:00	-	-	MAT1004	-	-
15:00	MAT1004	-	FIS1104	-	-
16:00	MAT1004	ELE1101	FIS1104	ELE1101	INF1620
17:00	ELE1362	ELE1101	ELE1363	ELE1101	INF1620
18:00	ELE1362	INF1620	ELE1363	MAT1004	FIS1104
19:00	ELE1362	INF1620	ELE1363	MAT1004	FIS1104

The results show a reasonably good timetable where most of the restrictions of the problem are satisfied. Better timetables can be achieved through longer evolution or by adjusting the heuristics and fitness function. These can easily be changed and other heuristics can be added so as to attend the demands of each university. The expansion of the model in order to consider disciplines of other periods or departments is also possible.

References

[1] Evolver User Manual, ver. 4.0.2, Palisade Corporation, 1998.
[2] D. E. Goldberg. Genetic Algorithms in Search, Optimization, and Machine Learning. Reading, MA: Addison-Wesley.
[3] L. Davis. (Ed.) *Handbook of Genetic Algorithms*. Int. Thomson Comp. Press 1996.