Generalized Balance Academic Curriculum Problem

Problem specification
for the project of the course
Advanced Scheduling Systems (2015-16)
version 1.0 (Dec 30, 2015)

The Balanced Academic Curriculum Problem (BACP) is an assignment problem, defined by Castro and Manzano [1], that arises in universities, and consists in assigning courses to teaching periods satisfying prerequisites and balancing students’ load.

We consider the Generalized Balance Academic Curriculum Problem (GBACP) defined by Chiarandini et al [2], which is an extension of BACP.

The GBACP instances available are real ones, coming from University of Udine and proposed in [2].

Problem formulation

The main features of the problem are:

Courses: Each course has an integer number of credits, and it has to be taught during the planning horizon of the university degree.

Periods: The planning horizon is composed by a given number of teaching periods that have to be assigned to courses. Periods are divided in years, and each year is divided in a fixed number of terms. For example, a 3-year degree organized in four trimesters per year has 12 periods.

Curricula: A curriculum is a set of courses representing a possible complete selection of a student. For each single curriculum, courses have to be balanced and limited in number. Curricula can share some of the courses.

Load limits: For each curriculum, for each period there is a minimum and a maximum number of courses that can be assigned to it (independently of the credits).

Prerequisites: Based on their content, some courses have to be taught before other courses. This means that we are given a set of pairs of courses, such that the period assigned to the first course has to be strictly less than the period assigned to the second. Obviously, prerequisite relation is transitive and cannot contain cycles.

Preferences: Professors can express preferences about their teaching periods. Specifically, a teacher can express preferences for a specific term of the year but not for the year. A preference of a course for a given term results in a penalty for any
assignment of the course to a period which is not in that term. Preferences are not strict, and therefore they contribute to the objective function (soft constraints).

The problem consists in assigning courses to teaching periods satisfying the load limits and prerequisite constraints minimizing the preference violations and balancing the student workload in terms of credits as explained in the following.

The load cost that we consider sums up all the deviations (positive and negative) from the average number of credits per period for each curriculum. More precisely, for each curriculum we compute $\alpha$ as the total number of credits of a curriculum divide by the number of periods (not necessarily integer-valued). A number of credits per period equal to $\lfloor \alpha \rfloor$ or $\lceil \alpha \rceil$ has penalty 0. All values below $\lfloor \alpha \rfloor$ or above $\lceil \alpha \rceil$ are penalized. In order to avoid large discrepancies from $\alpha$, the penalty is quadratic. That is, a deviation of 1, 2, or 3 counts as 1, 4, and 9 points of penalty respectively (and so on for larger values).

Load limits are evaluated for each single curriculum and summed up. Conversely, prerequisites remain expressed at the global level. In order to have a single objective function, we assign to each violation of a preference 5 points of penalty.

File formats

The input files are provided in text-only data format, with the structure that can be deduced from the following example. C++-style comments are inserted here for clarity, but not present in the files.

YEARS: 2
PERIODS_PER_YEAR: 2
NUM_COURSES: 6
NUM_CURRICULA: 3
MIN_MAX_COURSE_LOAD_PER_PERIOD: 0 2
NUM_PRECEDENCES: 3
NUM_UNDESIRED_PERIODS: 2

COURSES: // name and number of credits
A 5
B 10
C 5
D 4
E 20
F 7

CURRICULA: // name, number of courses and list of courses
Q1 4 A B C D
Q2 4 B C D F
Q3 4 A B E F

PRECEDENCES: // first course must be before second course
D C
D E
A solution is written as a sequence of pairs course/period, one in each line. The following file is a solution of the instance shown above.

```
A 0
B 3
C 1
D 0
E 1
F 2
```

The cost of this solution is current is 191, as shown by the output of the solution validator provided.

```
Too many credits (9/6) for curriculum Q1 in period 0 (cost = 9)
Too few credits (5/6) for curriculum Q1 in period 1 (cost = 1)
Too few credits (0/6) for curriculum Q1 in period 2 (cost = 36)
Too many credits (10/6) for curriculum Q1 in period 3 (cost = 16)
Too few credits (4/6) for curriculum Q2 in period 0 (cost = 4)
Too few credits (5/6) for curriculum Q2 in period 1 (cost = 1)
Too many credits (10/7) for curriculum Q2 in period 3 (cost = 9)
Too few credits (5/10) for curriculum Q3 in period 0 (cost = 25)
Too many credits (20/11) for curriculum Q3 in period 1 (cost = 81)
Too few credits (7/10) for curriculum Q3 in period 2 (cost = 9)
```

Violations of Period Load (hard) : 0
Violations of Prerequisites (hard) : 0
Cost of Load Spreading (soft) : 191
Cost of Preferences (soft) : 0

References
