Regulation-based University Course Timetabling

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1 Introduction

Conventional models of course timetabling either rely on enrolment or on fixed curricula [1]. At the University of Bayreuth, enrolment is not desired for political reasons. The university's management insists on a maximum of freedom for students so the post-enrolment timetabling techniques cannot be applied here. However, fixed curricula in the sense of "a group of courses such that any pair of courses in the group have students in common" [2] are not present either. The only systems of rules on which the students' course selection is based on are the examination regulations of their program of study. These regulations are legally necessary information in Germany (§ 16 Abs. 1 HRG) and are already represented in most university management solutions for various purposes. Not even the specialised variations of the curriculum model with support for optional courses [3] suffice for timetabling on the basis of regulations. The objective is to implement conventional timetabling approaches in an environment where neither enrolment information nor fixed curricula are present.

In this contribution, we show how to derive timetabling conflicts from examination regulations as they would actually arise from curricula. Moreover, these conflicts are weighted according to the number of students that are affected by the conflict. With the help of these derivations, the information can then be converted to the standard model and utilised by standard timetabling techniques.

2 Domain Model

The main principle does not make high demands on the domain model. A regulation is basically a tree whose leaves are courses while each course consists of one or more sessions which are the planned entities in the end. The inner nodes of the tree can be modules in the sense of the European Credit Transfer System (ECTS) [4] or any other type of unit used for structuring a program of study like e.g. phases, areas, sections and so on. Every inner node can be equipped with two types of constraints concerning its children: *n-out-of* and *prerequisites*. For a node constraint by *n-out-of* only *n* out of the child nodes have to be selected by the student. The targets of *prerequisites* are the units that have to be attended in a semester before the source unit.

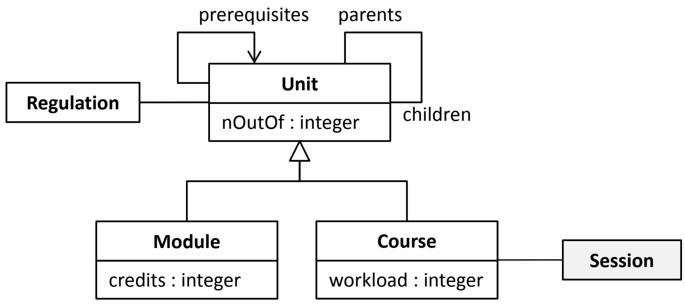


Figure 1. Domain model of examination regulations and sessions

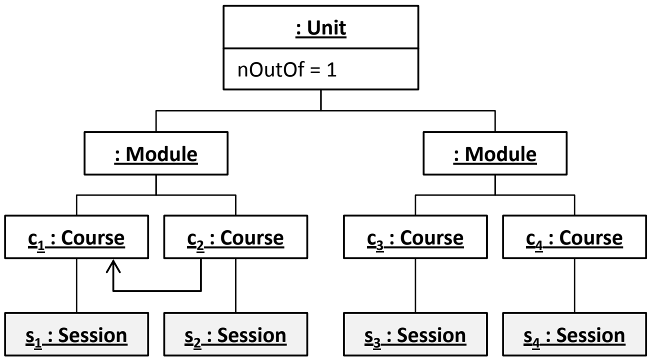
The above domain model for representing examination regulations is compatible with major commercial university management solutions like *CAMPUSonline* [5] and *CampusNet* [6] which eases an integration with these systems.

3 From Regulations to Weighted Conflicts

Initially, no knowledge is applied which means that all the sessions of a regulation are considered conflicting. The idea is now to remove as much conflicts as possible and to weight the remaining ones. This will be demonstrated by examples in the following.

The most frequent pattern in regulations is a specialisation choice which means that there is a node constraint by 1-*out-of* and several child nodes below. This means that a student has to select either one or the other direction (sub-tree) and no student is expected to attend both sets of sessions. As a result, we may safely remove the conflicts between the two branches.

Furthermore, course c_2 references c_1 as a prerequisite which means that c_2 is based on knowledge acquired in c_1. Assuming that sessions last for a full semester, we may infer that no student will attend both, c_1 and c_2, in the same semester. As a result, the conflicts between their sessions can be removed. The remaining conflict affects half the students in the program so that we weight it with a value of 0.5. The interpretation lead from six conflicts to a single weighted one.



	s_1	s_2	s_3	s_4
s_1		-	-	-
s_2			-	-
s_3				**0.5**
s_4				

Figure 2. Example model for the 1-out-of pattern with resulting conflict matrix

A more complex example is a 2-*out-of* choice. In this case, two out of several "packages" have to be selected by the student. As this choice is not of an exclusive kind, we must not remove any conflicts here.

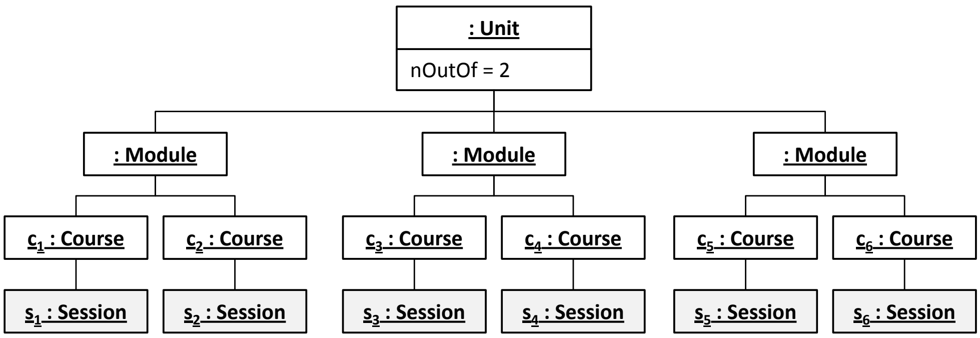


Figure 3. Example model for the 2-out-of pattern

Nevertheless, we gain knowledge by weighting. The conflicts within the three pairs affect two thirds of the students in the program while the others affect only one third of them.

	s_1	s_2	s_3	s_4	s_5	s_6
s_1		**0.66**	0.33	0.33	0.33	0.33
s_2			0.33	0.33	0.33	0.33
s_3				**0.66**	0.33	0.33
s_4					0.33	0.33
s_5						**0.66**
s_6						

Figure 4. Conflict matrix resulting from the 2-out-of example

This information can be used for checking soft constraints in subsequent optimisation approaches.

4 Future Work

This contribution only sketches the basic idea of our approach. There are a lot more patterns in regulations that can be interpreted like, e.g., a minimum sum of credit points to be achieved in certain branches of the program of study. These patterns are to be formalised and efficient implementations for their discovery are to be developed.

Another future task is to investigate the relationship between the number of available regulations and the density of the resulting conflict graph of sessions. On the one hand, this will provide a basis for assessing the benefit and usefulness of our approach. On the other hand, many real-world regulations contain such a high degree of freedom so that huge amounts of conflicts result that cannot be accounted for with regard to limited time and space. The process of creating a regulation could therefore be supported by estimating its effect in advance.

5 Acknowledgements

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