Real-time Student Sectioning

Keith Murray and Tomáš Müller
Purdue University, West Lafayette IN 47907, USA,
kmurray@purdue.edu, muller@purdue.edu

1 Introduction

Student sectioning is often considered as a subproblem in course timetabling. Once a timetable has been developed, the object is to assign students to specific sections of courses in order to minimize conflicts. Several approaches have been applied to this problem [1, 3], often iterating between sectioning and timetabling during the solution process. There have also been experiments with more interactive approaches such as course bidding systems [4]. One thing all of these techniques have in common is that the optimization is performed on all student schedules at a single point in time. There is often a need, however, to section additional students to classes or make schedule revisions. In the system being developed at Purdue University [2], the timetable is created and most students are sectioned based on demand data in student schedule requests, but the course requests of beginning students are unknown at the point in time when the timetable is created.

2 Sectioning during the Timetabling Process

The real-time sectioning algorithm introduced here has been designed to be used in conjunction with an optimized batch sectioning conducted at the end of the course timetabling process. Construction of the timetable considers actual course demand from students who have submitted schedule requests plus the projected demand for students who are anticipated to enroll. This projected demand is in the form of a conflict matrix describing which courses must be taken in common for each student. At the conclusion of the timetable construction it is therefore possible to identify class assignments made to actual students versus class space requirements generated on the basis of enrollment projections. For every class, this results in space being allocated to: (1) scheduled students and (2) future students. Some class space may also remain unallocated (see Fig. 1).

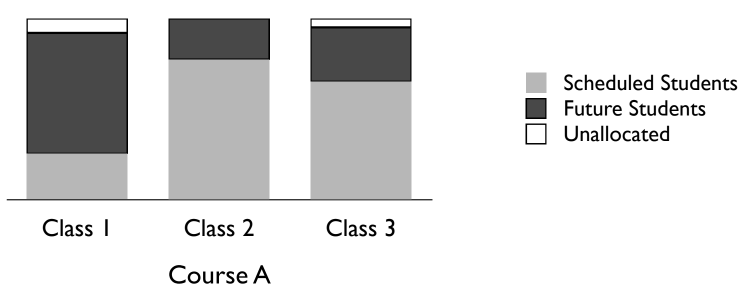

Figure 1: Illustration of possible space allocation in three equal sized class sections associated with a course at conclusion of timetabling process.

The extent to which individual classes are filled, or have space available, depends upon the combinations of courses selected by students, their time preferences, and conflicts caused by how individual classes overlap in time. There should be fewer student conflicts with an efficient timetable.

3 Real-time Sectioning

The real-time sectioning algorithm is used with the class spaces allocated to future students plus any unallocated spaces. Class space is essentially reserved for students who are anticipated to submit scheduling requests at a later date (e.g., first year students, transfers, procrastinators). Unallocated spaces are available either to these projected future students or for currently scheduled students who wish to make class changes.

As students submit schedule requests, each course is ranked in priority order. During real-time sectioning, the search for individual student class schedules employs a backtracking process considering possible assignments beginning with those classes associated with the student's highest priority course. As it evaluates each possible assignment, it compares class spaces available (i.e., those for future students or unallocated) with a projection of the demand for each class by later enrolling students. This difference between available class spaces in the timetable and the expected need for each class time is used to direct students away from class assignments that would result in excess demand.

The expected demand for each class is calculated by examining the combinations of courses taken by students enrolled during the previous like term. For example, if the pattern of courses taken by a student in the previous term would require the student to be sectioned into a class at one specific time in the current timetable, then one student is added to the expected need for that class. If the student could feasibly have been assigned to either of two different classes associated with a course offering, then one half student is added to the expected demand for each of the two classes. Furthermore, if the projected number of enrollments within certain categories of students is anticipated to be greater or less than in the previous term, the expected demand generated by each student may be weighted by the ratio of projected to past students in that category. In this way the expected need for each class can be pre-computed before the real-time sectioning process begins.

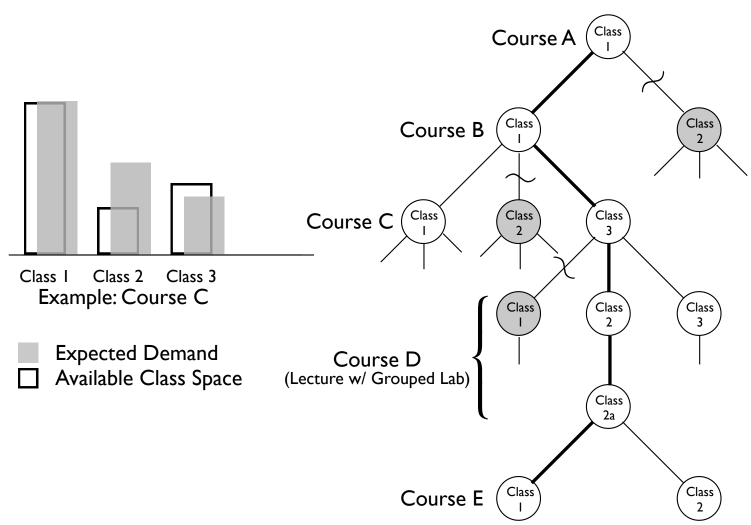

Figure 2: Illustration of use of expected demand in search process. Search progresses in order of priority assigned to each course (A to E). For Course C, Class 2 has expected demand greater than available space so it is only included if no other option exists. Course D illustrates case where a required grouping between two parts of a course restricts options.

The first step for the sectioning algorithm is to determine which class spaces are available to a student. This is based on student attributes (e.g., program area, semester classification) and any course or class specific reservations. The courses a student is eligible to attend are sorted in priority order and a branch and bound search is then conducted for the schedule that best satisfies the student's request (see Fig. 2). From among the available classes, the object is to assign the student to a set that fulfills the student course request and is least likely to create time conflicts for students who will be scheduled later. Other student preferences, such as the need for free time, or for a compact versus a distributed schedule, can also be considered in the search.

Potential class assignments within a course where the expected demand is greater then the available space are assigned a penalty based on the amount of excess demand. Branches beginning with such classes only need to be searched if the total penalty for the best current solution is greater than the penalty for including this class. In no case is an eligible student blocked from scheduling a course offering as a result of expected future demand. As students are assigned to specific classes during the sectioning process, the expected demand for each class is adjusted to reflect the assignment. The availability of space in each class and the expected demand are thus dynamically adjusted throughout the process.

4 Conclusions

An algorithm for allowing real-time sectioning of students to a class timetable has been proposed that allows spaces to be maintained in classes at appropriate times to meet the expected demand by all students. This process may be summarized as: (1) initial availability of class spaces and potential demand at each time is determined as a result of automated timetabling process based on actual and expected student demand; and (2) class assignments for additional students are optimized based on the potential an assignment will create future conflicts, determined by the difference between space available and expected need, and by student course and time preferences. The result is a sectioning process that can take advantage of what is known about the combinations of courses taken by students to avoid making assignments that prevent later students from enrolling in classes they may need. While it is impossible to achieve a truly optimal sectioning using this approach, it is believed that it will significantly improve on the section balancing method currently utilized. This system is currently in the process of development with the expectation that experimental results using actual timetables and student course requests will be available for presentation and discussion in the near future.

References

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