University course scheduling problem with traffic impact considerations

LEE Loo Hay · CHEW Ek Peng · NG Kien Ming · HUNG Hui-Chih · WANG Jia · XIAO Hui

Abstract Motivated by a practical problem, we consider a course scheduling problem for a university which is expanding its current campus in our work. In the new part of the campus, various facilities will be built, such as lecture theaters, seminar rooms, educational sport center, residential colleges, etc. The new part is designed to facilitate multi-disciplinary teaching and learning. Therefore, students from different faculties/schools are expected to have equal opportunities to enjoy these facilities. The two parts of campus are connected by a vehicular and pedestrian bridge. Shuttle service will be used to transport students between these two parts of the campus. Some courses may be reallocated to the new part.

Our problem is to assign courses to the new part of campus and to evaluate the responding load for students' having class on transportation system subject to the new course schedule. The goal is to find the best solution which satisfies the following main criteria: 1) Fairness, e.g. provide equal opportunities for students from different faculties/schools to enjoy these new facilities, 2) Priority, e.g. give preference to freshman and sophomore students in the usage of these new facilities, 3) Utilization of resources, e.g. balance the usage of new facilities at certain threshold level. The minimum time for as student to go for his next class is the 15 minute break time.

We first solve this problem by analyzing the historical data on student enrollment in different courses. From this analysis, we cluster courses according to their correlations. We assume a student has equal probability of moving to his next class during the interval from his last class and next. Based on the existing course schedule, we predict the student movement using worst 15 minute movements across campus parts. We build two models with the difference in measuring the movement. The first one considers usual movements, including both lecture and tutorial. The second one only considers lecture. It is because some tutorial has multiple sessions selectable for a student. Through our analysis on historical course schedules that were in the setting of one campus, some students tend to choose the tutorial session mostly close to their last class, which will worsen the traffic in multi-campus-part settings. Thus, the first model reveals the historical data more complete but the second model

LEE Loo Hay
Department of Industrial & Systems Engineering, National University of Singapore, 1 Engineering Drive 2, Singapore 117576, Singapore
Tel.: +65-65162895
Fax: +65-67771434
E-mail: iseleelh@nus.edu.sg

focus on the part less affected by the input variance. For both models, we build a mixed integer programming (MIP) model to decide the courses to be mounted at the new part of campus, so as to minimize the traffic impact.

Numerical experiments in current stage are based on past year data, including nearly 800 courses across the whole universities. Given latest capacity of new campus part in prospect, nearly 200 are selected to the new campus part. It is also revealed that the second MIP model have decreased the objective value from up to 300 into 70, which is believed controllable by the shuttle service. Through the numerical experiment, we have observed that faculty fairness has a great influence on the speed of obtaining the initial feasible solution, and thus it affects the solving time most. On the other hand, the traffic level is highly affected by the percentage of the freshmen and sophomore we set. This can be explained by our course relationship analysis, which reveals that higher-level courses are less correlated among each other compared with that of lower level courses. More freshmen and sophomore lead to lower level courses, therefore, it will eventually induce more traffic.

The future work includes developing and testing the automated and integrated systems ready to select courses in next two years (although only half of the resources are available during the first year) and evaluating the effectiveness of the model through simulation. At the same time, more efficient algorithm is in pursuit to handle larger problem scale potential from future situation.

Keywords University course scheduling · Traffic · Mathematical programming