
Resilient Course and Instructor Scheduling in the Mathematics Department at the United States Naval Academy

Stephen J. Ward · Joseph Foraker ·
Nelson A. Uhan

Keywords course and instructor timetabling · disruptions · resilience

Extended Abstract

Colleges and universities continually face the problem of constructing a schedule for courses, instructors, and students that respects various constraints and objectives such as room availability, curriculum conflicts, and the preferences of students and faculty. Such *university timetabling* problems have been widely studied for the past several decades.

Creating schedules for courses and instructors at the United States Naval Academy (USNA), the undergraduate college of the United States Navy, has some interesting challenges. One such challenge is the uncertainty of available manpower: an instructor may or may not be available to teach in the upcoming semester. This happens often with USNA's military officer instructors, whose start and end dates at USNA can be uncertain for a variety of reasons, such as extended deployments and sudden reassignments. The availability of instructors, both civilian and military, is also affected by events such as unexpected long-term illnesses and family crises.

At USNA, the course and instructor schedule for the next semester is published near the end of the previous semester. Students (called *midshipmen* at USNA) register for their courses around the same time. Unfortunately, disruptions to the published schedule, such as the sudden loss of an instructor,

S. J. Ward
Naval Postgraduate School
Monterey, CA, USA
E-mail: sjward94@gmail.com

J. Foraker, N. A. Uhan
Mathematics Department
United States Naval Academy
Annapolis, MD, USA
E-mail: {foraker,uhan}@usna.edu

can occur between registration and the start of the next semester. However, in most cases, a course cannot simply be canceled if the instructor is no longer available to teach. Through an act of the United States Congress, the academic program at USNA is 47 months (8 semesters) of study, and no more (1). This fixed length program requires USNA to put the highest priority on ensuring students can take their required classes. This involves, among many things, adjusting the course and instructor schedule. When a disruption occurs, the schedule must change to guarantee that students can take the courses they need to meet their graduation requirements on time. Generally speaking, course offerings are handled at the department level. This means that even a minor disruption can cause widespread changes to an existing schedule, creating a trickle-down effect that requires significant effort across multiple departments to address. As a result, having a timetable that is *resilient* – one that requires a minimum number of changes in the face of disruption – is an important consideration.¹

In this work, we study the problem of scheduling the courses and instructors in the Mathematics Department at USNA in a resilient manner. Every semester, the department needs to schedule around 70 instructors and 150-180 course sections into 30 class periods and 30 rooms. We formulate a stochastic integer linear program that schedules these courses, instructors, and rooms. In addition to maximizing instructor preferences and room stability, this stochastic integer linear program minimizes the expected number of changes required in the schedule if a disruption were to occur, given a subjective probability distribution over a finite set of possible disruption scenarios. We run our model on a number of instances derived from actual data from the past six semesters, and investigate the effect of emphasizing different parts of the objective function on the resulting schedules and the time required to solve our model.

Full paper

For a detailed description of our problem, stochastic integer programming formulation, experiment setup, and results, please see our our full paper, located here: http://www.optimization-online.org/DB_HTML/2017/09/6218.html

References

1. United States Naval Academy: Academic Dean and Provost Notice 5420.1: Periodic Program Review/Visiting Committee Additional Information (2016)

¹ This property is sometimes referred to as *robustness* in the scheduling literature. To avoid any confusion with *robust optimization* techniques, which we do not use here, we use the term *resilient*.