SPORE Course Registration System

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1 Introduction

The existing course registration system at Rice employs a simple combination of waitlists, priority groups, and a lottery system to manage registration for classes in high demand. This is inherently flawed—the factors that influence course allocation at the system level are largely random and unfair. Ideally, as a general heuristic, the students that need or want to take a specific course should be more likely to receive it. Additionally, students should not be required to manage multiple waitlists if a simpler alternative exists. This complexity can lead to missed opportunities where students neglect trying for certain classes due to logistical overhead. The goal of this project is to provide a system for course registration that optimizes for student needs and preferences while satisfying registrar-imposed constraints (including course capacities, registration priority groups, and prerequisites).

2 System Overview

We implement a modified version of the approximate competitive equilibrium from equal incomes (A-CEEI) algorithm[1], which addresses as-is nearly all of the problems with the current registration system. Given student preferences (in a representation detailed below) and course capacity data, our algorithm produces an allocation of schedules that is approximately envy-free and strategyproof while maximizing utility at the agent level.

2.1 Inputs

The inputs to the algorithm are as follows:

- γ: a set of allowable courses
- β: a mapping $\gamma \to \mathbb{N}$ representing the capacity for each course
- x_i: a mapping $\gamma \to \mathbb{R}^+$ representing the utility value for each course for each student

[1] Othman, Sandholm, and Budish 2010

- z_i: a list of sets of courses representing course bundles
- z_i': a mapping $z_i \rightarrow \mathbb{R}^+$ representing the bonus utility for each course bundle, calculated by its ranking

3 Algorithm Sketch

Though the paper our algorithm is based on (Budish, et al., 2010) provides more detail, we provide a short sketch here of our implementation. First, we generate a random budget for each student between 1 and $1 + \frac{1}{N}$. As detailed in the A-CEEI paper, this unequal budget serves only to break ties in cases where strictly fair allocation is impossible. Then, we commence a search in pursuit of assigning a virtual price to each course such that the over- and under-enrollment error (the sum of squares of over- and under-enrollment for "in-demand" classes) is minimized. Each search step begins with a randomly generated price vector. At each step, an ILP is solved at the student level to produce the course bundle with the highest utility that is also affordable (total cost $\leq$ budget) for each student. We then use the aggregation of the outputs of all of the selected bundles to compute the market clearing error and the vector difference between course capacity and enrollment. This vector difference is used as the enrollment gradient vector, which we use to generate a number of price vectors in a neighborhood around the current vector. The search continues at each of the price vectors in the neighborhood. If, at any point, a price vector that has been reached previously reappears, we ignore it to avoid recomputation. If a certain amount of steps pass without improvement on the lower error bound, we reset the search to a random price vector. After sufficient time has passed, we terminate the algorithm and choose the best allocation observed.

3.1 Outputs

The output consists of the allocation of courses (as a set of indices) that produces the lowest over- and under-enrollment error along with the error itself. The algorithm also produces the optimal price vector as an artifact. This may be used to estimate demand for courses post-hoc.