Course Allocation System Using Bipartite Graph Matching

Sapna Ganesh

Under the Guidance of Dr. Edith Hemaspaandra

Objectives

- Design and implement a system to allocate courses to students such that:
  - It is optimal, efficient and fair.
  - It maximizes student satisfaction by allocating students’ most preferred courses.
  - It minimizes the number of students who do not get their required number of courses.
  - It is flexible enough to implement additional parameters such as prerequisites and student specializations.

Overview

In the course allocation problem, students submit their preferences of courses. The system will allocate the courses to students by aggregating their preferences. The graph data structure is considered for this problem. We have the freedom to alter parameters such as weights and edge directions to make the system dynamic and flexible enough to include parameters such as specializations and prerequisites.

Algorithm

- Construct a bipartite graph like the Figure below.
- Implement the Edmonds-Karp algorithm with the following changes -
  - We search for an augmenting path from $s$ to $t$ through $s_i$, $i$ increments from 1 to $n$ and then decrements from $n$ to 1. We find the shortest path from $s_i$ to $t$ using Breadth First Search. There can be multiple shortest paths from $s_i$ to $t$. We choose the shortest path that contains the course that appears higher in the order of $s_i$’s preference list.
  - When no augmenting path exists, our final residual graph will contain directed edges from courses to students. Thus the matching is obtained.
- Specializations can be obtained by redrawing the graph with every student connected to the courses that are under his or her specialization and re implementing the algorithm.

Results

The data set contains the course preferences by students at AGU University of Science and Technology. It contains preferences of 146 students over 9 courses. We consider the first 5 preferences.

Figure 1: Initial construction of the graph

Figure 2: Students who obtain their first or second choice courses

Figure 3: Students who obtain less than the required number of courses

Figure 4: Students who obtain no courses

Result Summary

In the bipartite graph matching algorithm the students who get the first or second choice of courses is considerably more than the draft mechanism. It also has fewer students who have no courses allotted than the draft mechanism.

Related Work

- Random Serial Dictatorship (RSD) - Students enroll into all the courses during the random time slot they are assigned. We use this system currently in RIT. Students in the top priority order have an advantage, making it unfair.
- Harvard Business School (HBS) - Allocation takes place in rounds, such that a single course is allotted to every student from their preference list in every round.
- The Proxy draft - Uses the bidding system in order to avoid strategic play by students.
- Course Match - Courses are assigned a market clearing price based on student preferences, and then bidding takes place.

References