Mapping Majors at Carnegie Mellon University: What majors walk how much, where, and when?

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Abstract

The total distance that university students walk to pursue their academics is an often overlooked variable in the college experience. The distance traveled to attend lectures, recitations, and laboratory sessions varies greatly across different semesters, course loads, and majors. Students often do not pay attention to the classrooms and times when registering for the upcoming semester and the paths traveled during the day contain substantial overlaps. They also have to deal with certain constraints, such as prerequisites, major requirements, and course availability within each semester. This paper will examine the walking distances for students at Carnegie Mellon University and use Dijkstras Algorithm to create an eight-semester schedule for various majors that optimizes the total distance walked while fulfilling all academic requirements. It will also compare the distances traveled for different majors and discuss trends as the students' academic careers progress.

1 Introduction

There is a common perception that the distance walked to attend all of one's classes is biased towards certain days, semesters, majors, and course loads. However, students often feel that they cannot control these fluctuations or optimize their travel. Our objective is to permute the different scheduling possibilities for each major and find an optimal course sequence for students of different majors that satisfy all degree requirements. We also compare the differences in walking distance across different semesters and majors and explain different trends in the data. We will use Carnegie Mellons requirements for a degree in Business Administration, Civil Engineering with an additional major in Engineering and Public Policy, and Mathematical Science with a concentration in Operations Research as a representative sample of majors due the breadth and variety of each major's respective curriculum. We will compute the distances between every scheduled class and use Dijkstras algorithm to search for the shortest path from a start location to each class within a semester to create a list of shortest paths for each semester that minimizes the total distance walked.

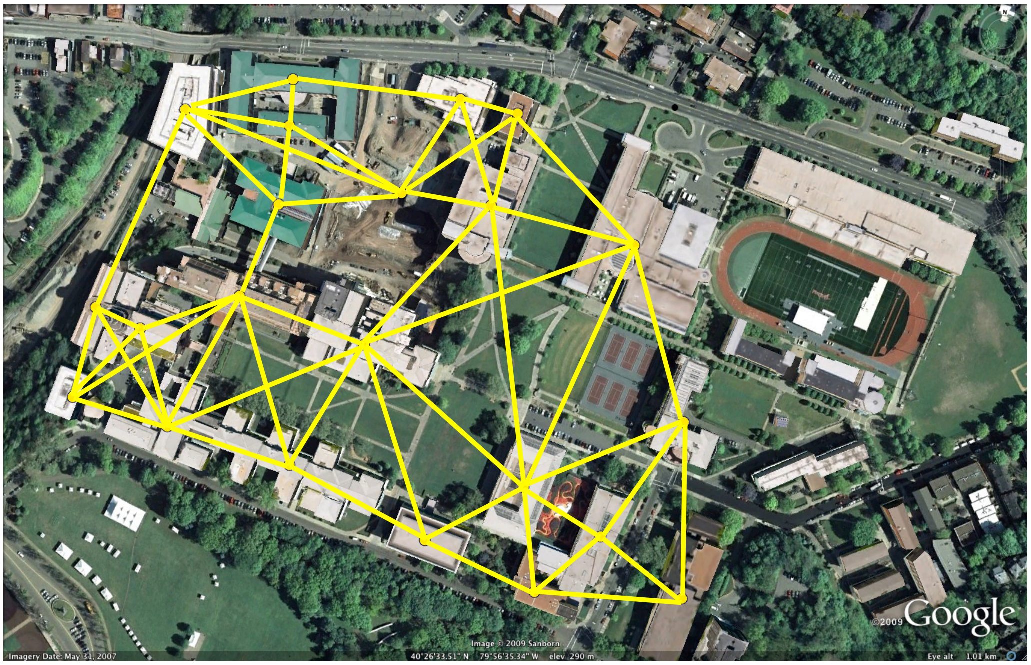

Figure 1: This graph represents the map of campus used when computing the distances between to classes. Note that the Gates-Hillman Center is not completed in the image so its approximate location was used.

2 Methodology

We used the Schedule of Classes for all departments for the Fall 2009 and Spring 2010 semesters[1] as a representative sample of the breadth of courses offered by the university. We compiled and ordered the course number, lecture days, building, classroom number, and recitation sections for each course. The pooled list for two consecutive semesters covered courses that were only offered for one semester per academic year, and classroom changes for common courses offered in both the fall and spring. We then modeled a course plan for each of the eight semesters for three different majors using the suggestions outlined in the Carnegie Mellon Course Catalog[2]. A satellite map of campus was used as the basis for the campus map[3]. We then placed nodes in the center of each academic building, including one at the recently completed Gates-Hillman Center. Every building was linked with a straight line path to all other buildings accessible by foot. This graph can be seen in Figure 1. The distances in pixels[4] between connected vertices were then recorded using an image editor and were used as the arc weights for the graph.

After retrieving the course lists and information for the three majors, we did fifty per-

[1] Available online from the Carnegie Mellon Hub.

[2] Where the course catalog was out-of-sync with current classes we made appropriate substitutions based on the major's requirements

[3] Cropped from a Google Maps location.

[4] One pixel is equivalent to 0.5 meters in the original measurements.

mutations of the schedule for every semester, and twenty-five permutations which randomly matched a class with a possible lecture and respective recitation section. This produced 1,250 orderings for every semester per major, but not all permutations were necessarily unique. We generated the distance walked by averaging the 1,250 orderings for each semester.

We made several assumptions to simplify the creation of a viable schedule for each major without eliminating key aspects of the problem. First, we assumed that all students would follow the exact schedule outlined provided by the course catalog for all eight semesters, and students with the same major would enroll in the same electives. We also removed the scheduled times for each course; this was done to simulate the effect of class times changing over various semesters. We assumed that all courses scheduled for any room within the building were located at their respective buildings vertex, and that students did not do any extra walking during midday breaks or take detours outside of the shortest path. Therefore, the distance traveled to attend a course in the same building as the current course is zero, and the distance from any room located in building A to any room in building B was the length of the arc from node A to node B.

We also assumed that every student started and ended the day at the University Center. This standardized the distance traversed by eliminating extraneous traveling from assorted housing locations to campus and the first class of the day. None of the students in the problem enrolled in courses beyond the minimum number required by their major. The courses taken were evenly distributed among each of the first seven semesters, and the eighth semester was used to complete any remaining obligations for the major. The normal academic calendar of 15 weeks with holidays was simplified to a rigid 14 week, 70 day scheduled. The final exam classroom assignments were not made official beforehand and generally differed from those during regular class hours, so the final exam period was omitted.

3 Results

Business Administration majors are required to take 37 classes to receive a degree. They were assigned five courses for each of the first seven semesters and two for the final semester. They averaged 908 meters per day over the four year span. The distance walked did not vary much between semesters, with the exception of the eighth semester, due to the lighter schedule. Students had to cover the most distance during their second semester, walking an average of 1146 meters per day, and a peak of 1703 meters on Fridays, which was the longest average day over the four years. Mondays, Wednesdays, and Fridays in semester two had average walking distances of over 1500 meters per day. The longest path traveled occurred in semesters three and five, where students walked back to the University Center after attending their final class of the day in Scaife Hall. Most classes in Business Administration held lectures on Mondays, Wednesdays, and Fridays. The travel distance was skewed towards those days except for the third and fourth semesters, which had roughly equal days, and the last semester, which contained two classes that met Tuesdays and Thursdays.

Students who pursued a major in Civil Engineering with an additional major in Engineering and Public Policy (EPP) had to complete a minimum of 44 courses, with six courses in each of the first seven semesters and two in the last semester. The fifth semester required the most travel, with an average of 1104 meters per day, and every full semester averaged between 865 and 1104 meters per day. Students walked over 1500 meters per day on Tuesdays and Thursdays in the second semester, but had schedules of no more than 1265 meters per day for any other day during any other semester. The second semester was heavily weighted towards Tuesday-Thursday classes, as well as both courses in the final semester, while the other six semesters had slight biases towards Tuesdays and Thursdays. Despite having a heavier course load than that of business administration students, the "double major" students covered slightly less distance over four years, averaging 895 meters per day.

The Mathematical Science major with a concentration in Operations Research required 44 courses to obtain their degree matching that of the civil engineering and EPP double major. Semester four had the greatest walking distance, with an average of 1186 meters per day. Every full semester except the seventh had a mean distance greater than 1000 meters per day. There were significantly more Monday-Wednesday-Friday classes taken for this major over four years than Tuesday-Thursday classes, and every semester except the sixth showed this disparity. The longest path observed was a walk from Margaret Morrison Hall to Scaife Hall in the seventh semester. The mean daily distance for operations research majors was around 1000 meters, which was noticeably higher than that of business administration majors or civil engineering and EPP double majors.

4 Discussion

After carefully analyzing the data, we observed some interesting trends that apply to all majors. The walking distances during the freshman year were very similar for all majors examined. Students tend to complete many of their general education requirements during the early part of their college careers, hence the schedules for the three groups of students had many courses in common. The most difficult schedules in terms of walking took place during the sophomore year for all majors. The daily walking distance gradually declined after the second year, as upper level courses had infrequent recitations compared to introductory courses. Courses generally followed either a Monday-Wednesday-Friday or Tuesday-Thursday format, but since lectures and recitations were normally scheduled in different rooms, and there was an unequal ratio of courses with recitations to courses without them, the days within each group rarely had equal amounts of walking.

We also assumed that everyone starts and ends the day in the University Center. Obviously this is not true. Similar assumptions exist to reduce the complexity of the model and also to make the calculation easier, but we can further improve our model by eliminating these assumptions and gathering more realistic data. For example, one assumption used is that everyone has a block of consecutive classes; there is no lunch time and free time between classes. Thus while people go to library between classes in this model it is not accounted for. To correct this, we could gather real schedules instead of following the course catalog, and then we will check if there is free time in between classes. If so, we can randomly select a food court on campus as a place for lunch, and if there are more the one vacant time slot, we can put libraries or other study locations into the walking distance calculations. In this way we can generate a much more representative walking distance over the course of one's time at Carnegie Mellon. A refined model should also take weather into consideration. People select routes differently based on different weather conditions and personal preferences. For example on a rainy day students are more likely to favor an indoor route, yet on a sunny day people generally would like to use routes outside. Other refinements include making the paths follow sidewalks and assigning a probability for a student to not go to a particular class on any given day.

After taking everything into account, we should be able to build a more accurate and complex model predicting how much distance each major needs to walk to get their degree.

5 Conclusion

Overall, we believe that this represents an accurate picture of the walking done by a Carnegie Mellon student over the course of their four years on campus. While simplifying assumptions had to be made, in the future the removal of some of these assumptions could provide an interesting follow-up to this work. In addition, the code base used for this project is easily adaptable to other shortest path problems and is available from Lucian Cesca (ljcesca@cmu.edu). The code is written is Java and provides constructs for building and maintaining graph representations of objects and find shortest paths between nodes using Dijkstra's algorithm.

6 Acknowledgments

- Carnegie Mellon Schedule of Classes
- Carnegie Mellon Course Catalog
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