# MARSHALL COURSE SCHEDULLING SYSTEM

## An Approach To Process Optimization


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## CURRENT PROCESS

The scheduling system of courses and classrooms at USC has always been consisted of two parts: the fixed schedule from previous years and new schedules for the new academic year/ semester collected from 7 departments' coordinator (who is typically the head administrator for that department): Business Communication (BUCO), Data Sciences and Operations (DSO), Finance and Business Economics (FBE), Leventhal School of Accounting (ACCT), Management and Organization (MOR), Marketing (MKT), and Lloyd Greif Center for Entrepreneurial Studies (BAEP).

However by revising the system in a qualitative perspective in the first hand, we as a team of elite consultants realized that students' requirement is something neglected in the current system so we did an optimization analysis on the current system by quantify what we think from students' perspective has relatively bigger potential to get improved.

## DESIRABLE GOALS

An efficient course scheduling system should incorporate the below aspects:

- ***Efficient Utilization:*** *Efficiently utilize the available space and classrooms to schedule all courses and output a feasible schedule on time, well before registration starts, based on restrictions on land availability*
- ***Student Satisfaction:*** *Satisfy the preferences and needs of students as much as possible, so that:*
    1. *They are able to successfully schedule all their required courses as well as the electives that they most desire.*
    2. *They should be able to get their classes in their preferred time of the day(morning or evening)*
    3. *They have minimum gap between the classes in their respective schedules*

- ***Faculty Preferences:*** *Satisfy the preferences of faculty as much as possible in terms of back to back classes, timings and day preferences*
- ***Reduce Manual Effort:*** *Limit the manual effort needed by Shannon's team in the current process of scheduling*
- ***Adapt to Changing Needs:*** *Adapt to the changing needs of the students and faculty, as the set of courses and the demand for each course changes from one year to the next, and there may be changes in the composition of students as well as turnover among faculty*

We decided to move forward with the second goal of satisfying student preferences as our optimization model's main outcome. Also, from the provided data, it is a feasible solution which is discussed in detail in the next section.

## BIGGEST OPPORTUNITY FOR IMPROVEMENT

Since the current system is made by Shannon and Hal's team by adding faculty and department's requirement manually on the old course agenda from previous years, we decided that the biggest opportunities of the improvements lie in students' preferences in course sections.

We as a consultant team did a quick internal survey inside our team and found out that as students ourselves it is crucial for us to be able to arrange our daily agenda around a relatively compact and preferred course schedule.

Thus, we first did the analysis quantifying the gap among each student's course schedule in Fall semester 2015 and found out that 17% of students suffer from long gap between courses on the same day.

In terms of the time slot preferences, we mostly focused on the courses which has two different sections one in daytime and another in the evening. Since for senior year students both graduates and undergraduates there could be internship and other job opportunity to seek in daytime, they would prefer all of the courses in the evening.

We are going to quantify the preferences as percent of students taking each section in the total enrollment and regarded this percent as the students' preferences for daytime and evening sections.

## METRICS FOR MEASURING GOODNESS

From the available data, we considered the below two metrics that could be used as a measure of 'goodness' for our optimization model:

- *Time Preference:*
  *The ratio of enrolled students to capacity for each section of a course (either morning or evening). Sections with higher enrollment would indicate higher popularity and more preferred*
- *Presence of Schedule Gaps:*
  *Gap in a student's schedule between a class end time and another class begin time. To calculate this metric, for each student, we see if he or she has a class interval larger than 600 seconds in one day. If yes, we say there is a "gap"; if no, we say there is no "gap". We finally calculate the percentage of students who have "gaps" in each week.*

## JUSTIFICATION FOR THE METRICS CHOOSEN

Time preference:

We decided to use this time preference ratio to measure how desirable different sections of different classes are to students. Because our metric is a ratio it is simple to understand and to compare between classes, as well as easily computed because we have data on course enrollment and section capacity. Since we assume sections with higher enrollment would indicate a more popular time preference for students, knowing this metric for each class can help with allocating appropriate AM and PM sections based on what we believe students prefer, and increase understanding of student preferences.

Gaps:

For this metric we define a "gap" as a period of time between classes in a student's schedule that is longer than 10 minutes, which is the standard amount of time between back-to-back classes. We assume that gaps in a schedule are undesirable because student's would rather

have all their classes finished around the same time. While there are many reasons why students would have larger gaps in their schedule (for example, core classes are not offered at the same time of day), we can use this metric to look further at student's schedules and determine if there is a combination of courses that are common in these students' schedules so that they can possibly be offered at the same time of day (morning or evening) to avoid schedule gaps in the future.

## ANALYSIS OF THE AVAILABLE DATA USING THE METRICS

Time Preference:

For an initial analysis of the data available to us we used SQL and Python to write programs that would compute our metrics. For our time preference metric we aggregated all sections of a class in each term and created a table with the total registered students in AM and PM sections, whether the course is Undergraduate or Graduate, the term, and unused seats in AM and PM sections. Then, we found the total percentage of unused seats in AM and PM classes for undergraduate and graduate students, and found that for Graduate courses, about 7% of seats in AM sections are unenrolled, but about 22.7% of seats in PM sections are unenrolled. For undergraduates we noticed the same thing: there are more unenrolled seats in evening sections (6.7% unenrolled seats for AM, 12.2% unenrolled seats for PM).

| | Course | AM | PM | AM Seats | PM Seats | UG/G | term | AM Seats unused | PM Seats unused |
|---|---|---|---|---|---|---|---|---|---|
| **0** | ACCT-370 | 40 | 42 | 42 | 42 | UG | 20153 | 0.047619 | 0.000000 |
| **806** | ACCT-370 | 46 | 84 | 45 | 95 | UG | 20171 | -0.022222 | 0.115789 |
| **559** | ACCT-370 | 50 | 48 | 51 | 51 | UG | 20163 | 0.019608 | 0.058824 |
| **243** | ACCT-370 | 43 | 122 | 44 | 126 | UG | 20161 | 0.022727 | 0.031746 |
| **560** | ACCT-371 | 54 | 48 | 54 | 52 | UG | 20163 | 0.000000 | 0.076923 |
| **807** | ACCT-371 | 90 | 38 | 94 | 39 | UG | 20171 | 0.042553 | 0.025641 |
| **1** | ACCT-371 | 70 | 40 | 84 | 42 | UG | 20153 | 0.166667 | 0.047619 |
| **244** | ACCT-371 | 111 | 51 | 114 | 54 | UG | 20161 | 0.026316 | 0.055556 |

| | UG/G | Unused % of AM Seats | Unused % of PM Seats |
|---|---|---|---|
| **0** | G | 0.069970 | 0.227035 |
| **1** | UG | 0.067814 | 0.121915 |

Gaps:

For our gap metric, we used the student course selection and Marshall course enrollment datasets to identify the presence of a gap longer than 10 minutes in a given student's schedule. For the purpose of this interim deliverable we only looked at Fall 2015 term. We merged the two datasets so that the student course selection included information on the section day and time. For each student schedule we looked at what courses they had on each day of the week, and calculated the time between a course end time and the next course begin time. Schedules with more than 600 seconds, or 10 minutes, between this interval between a class end time and a class begin time were labelled with "gap". For the Fall 2015 term we determined that *17%* of students suffered from gaps in their schedules. While this number itself is not exactly actionable from an administrative standpoint, for later phases of this project we will look more closely into these schedules that have gaps and determine why the student has a gap, for example their core classes are offered in the morning, but a popular elective course is only offered in the evening. With this further analysis we can offer more recommendations for how Marshall can efficiently schedule classes while also working with students' preferences.

More details on the calculation of the above two metrics can be found in the python code attached.

## THE WAY AHEAD

In the next phase of our project, we shall be using these 2 metrics (Time Preference and Gap) to measure the goodness of our optimization model.

We will be simulating different course schedules in Python and then generate a goodness score for each schedule based on our defined metrics. Finally, the highest score would represent the best case scenario of a course schedule, given the constraints of time, capacity, preference, and ad hoc changes on the model.