Interim Deliverable 1 for Group Project

DSO 570 - Spring 2018
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Executive Summary

Course scheduling continues to be a large, unsolved problem at all universities. The objective of this project is to improve the administrative aspects of course scheduling at USC- Marshall School of Business, such as assigning courses to rooms and time slots. There are many resources involved in the scheduling process, such as students, rooms, instructors, and administrators. In this project we will focus on the administrative aspects of course scheduling and try to optimize classroom usage during prime-time hours.

Specifically for the Marshall School of Business, the issue of course scheduling is compounded with the renovation plans for classrooms in the Bridge and Accounting buildings, that will leave a large number of currently available resources (classrooms) unusable. The objective of the first phase of our project will thus be to define a robust metric that maximizes classroom availability, subject to the constraints of course administration. Maximizing classroom availability is particularly beneficial because the "blank space" can be utilized to accommodate other classes.

Based on our analysis of the data, two of the biggest challenges faced by the administration are optimizing classroom capacity and ensuring efficient usage of classrooms available during prime time hours. A common problem that the current system has is that classes with low enrollment rate are held in large classrooms, leaving many empty seats that could be better put to use by a more in demand class. As classrooms and seats at Marshall are of limited supply and high demand, it would benefit everyone to optimize class size compared to classroom capacity in order to allow classes in high demand to increase enrollment if desired. Another common problem we found is very few empty classrooms available during prime-time hours. This could possibly be improved by better optimizing classroom usage as discussed above, and we are looking at many possible solutions for this problem throughout our analysis.

Description: Measure of Goodness

The 5 major stakeholders are: Student, Faculty, Program, Department, and Management.

We focus on a goodness metric that aids Management. The rationale for choosing Management as our major stakeholder stems from the fact of (temporary) diminishing resources in the future. This is not to state that metrics such as location and student-faculty convenience are unimportant; but that in light of administration from a university perspective - the successful administration of coursework takes precedence. It is also important to know that some course at USC Marshall are divided into sections. Some courses may only have one section, but others may have several sections. This usually depends on the number of students needing. Sections of the same course may also not be held in the same room and/or at the same time.

Our measure of goodness is Net Classroom Availability (NCA), and we proceed to define the same below:

Let PO_i = Number of hours a classroom 'i' is engaged in class/between classes from 8AM to 10PM. This is the "primetime" occupancy.
Let H_j = Number of hours of "primetime" available on day of the week 'j'. 'j' varies from Monday to Friday (coded 1-5).
If $O_{ij} = PO_i/H_j$, then O_{ij} gives the Occupancy Rate of Classroom 'i' on day 'j', and 1 - O_{ij} gives us the Availability.

Thus we have, in its most naive form the metric NCA that we seek to maximize:

$$NCA = \sum_{j=1}^{5} \sum_{i=1}^{m} 1 - O_{ij}$$

where 'm' is the total number of classrooms, subject to the constraints of course administration

We can improve this metric by considering a simple fact. Suppose we were trying to increase the availability for classroom 1 on Monday (that had an occupancy rate of 0.9). If we decreased the occupancy by 5% points, by offloading class load to another classroom 2 with a lower utilization rate (i.e 0.5), the benefit that the administrative system would gain from this 5% decrease in occupancy for classroom 1 would surpass the negative effect of increasing the occupancy of classroom 2 by 5% points. This relation is captured well by the quadratic function. Thus, another formulation of NCA could be:

$$NCA = \sum_{j=1}^{5} \sum_{i=1}^{m} 1 - O_{ij}^{2}$$

The goodness metric we use for our analysis can be computable for available data, actionable, simple to understand and interpret, and enlightening corresponds.

Table: Appropriate Metric

Goodness Metric	Category	Computable	Actionable	Simple to understand/Interpret	Enlightening
Net Classroom Availability (NCA)	Management	Numerical variable: Continuous	NCA could lead to more flexibility in scheduling. It provides an efficient distribution of time, and multiple constraints may be layered on without hampering the metric. NCA can be maximized further	Easy to understand and interpret	Maximize NCA to enable better room maintenance, utilization for non-pedagogy purposes (company presentations, etc).

NCA is easy to compute, since it is based on scheduled start times and end times of sessions. It offers a lot of flexibility in that the effect of "reshuffling" course-sessions from one class to another may be easily recorded.

To compute NCA, we require: (a) Marshall_Room_Capacity_Chart.xlsx (b) Marshall_Course_Enrollment.xlsx (c) Cancelled_Courses.xlsx.

We create a dataframe that contains present information regarding start and end times for all courses, write a method to (a) Compute the NCA for the present schedule, and (b) Compute the new NCA when a class is rescheduled.

Conclusion

Some of the challenges that arise during course scheduling are:

1. Efficient usage of classroom capacity
2. Efficient usage of classrooms available during prime time hours

The solution procedure for solving USC Marshall course scheduling problem can be first broken down into two main steps:

- -retrieve historical data to construct and analyze a “prime time” table
- -improve the room assignment by measuring and improving NCA (Net Classroom Availability)

The next step involves building a Linear Programming model to solve the optimization problem and improve the initial course scheduling at USC Marshall while addressing the challenges that were highlighted above.

Appendix

Figure 1: Top 6 Rooms with the Highest Room Capacity.

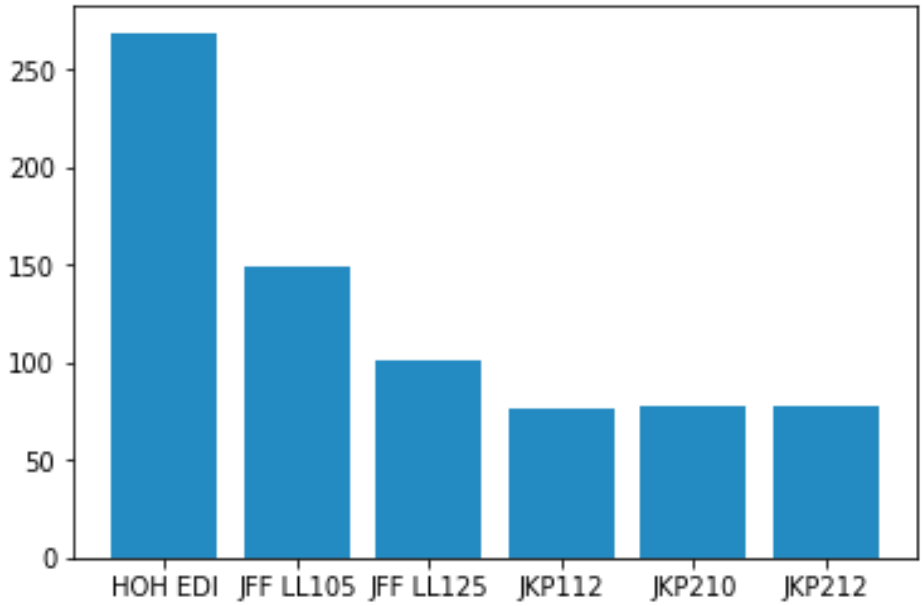


Table: Top Prime Time

First Days	First Begin Time	First End Time	Total Course
MW	14:00:00	15:50:00	190
TH	14:00:00	15:50:00	180
TH	10:00:00	11:50:00	179
TH	16:00:00	17:50:00	178
TH	12:00:00	13:50:00	175
MW	10:00:00	11:50:00	173
MW	16:00:00	17:50:00	165
MW	12:00:00	13:50:00	162
W	18:30:00	21:30:00	112
M	18:30:00	21:30:00	111
MW	8:00:00	9:50:00	110
T	18:30:00	21:30:00	107
FS	8:50:00	16:30:00	102
TH	8:00:00	9:50:00	96

Analysis for First Prime time: 14:00:00 - 15:50:00 on MW

Figure 2: Top 6 Rooms with the Lowest Utilization Rate during First Prime Time: 14:00:00 - 15:50:00 on MW

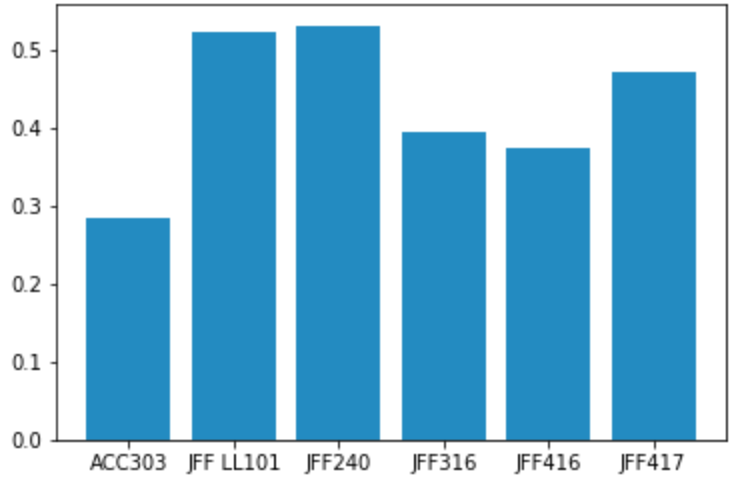
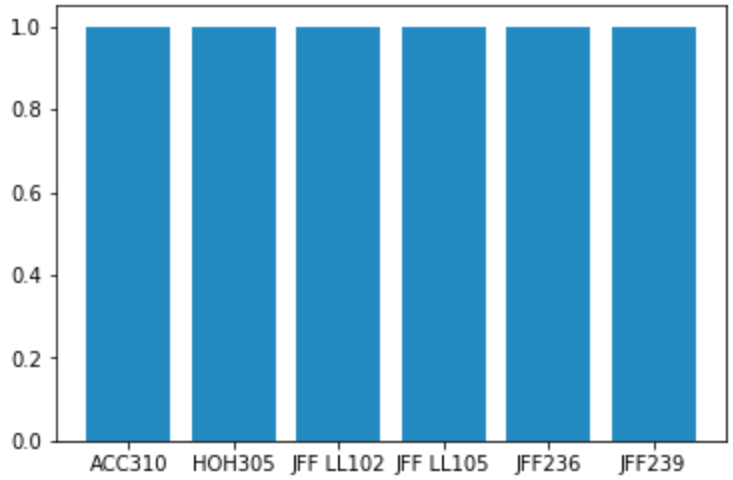


Figure 3: Top 6 Rooms with the Highest Utilization Rate during First Prime Time: 14:00:00 - 15:50:00 on MW



Analysis for Second Prime time: 14:00:00 - 15:50:00 on TH

Figure 4: Top 6 Rooms with the Lowest Utilization Rate during Second Prime Time: 14:00:00 - 15:50:00 on TH

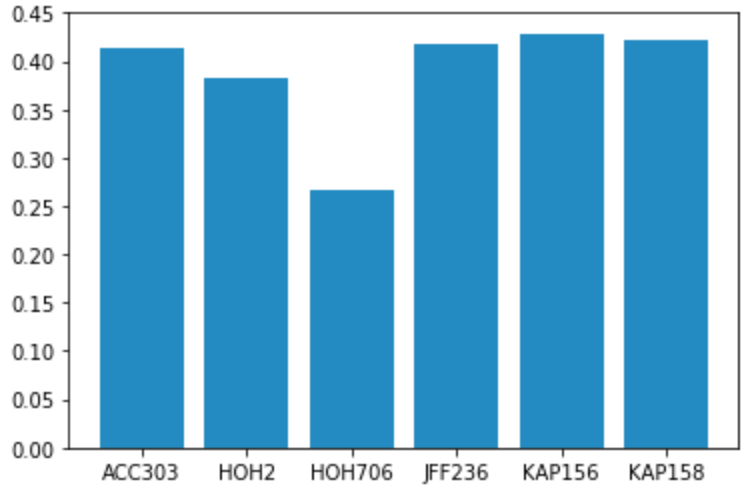


Figure 5: Top 6 Rooms with the Highest Utilization Rate during Second Prime Time: 14:00:00 - 15:50:00 on TH

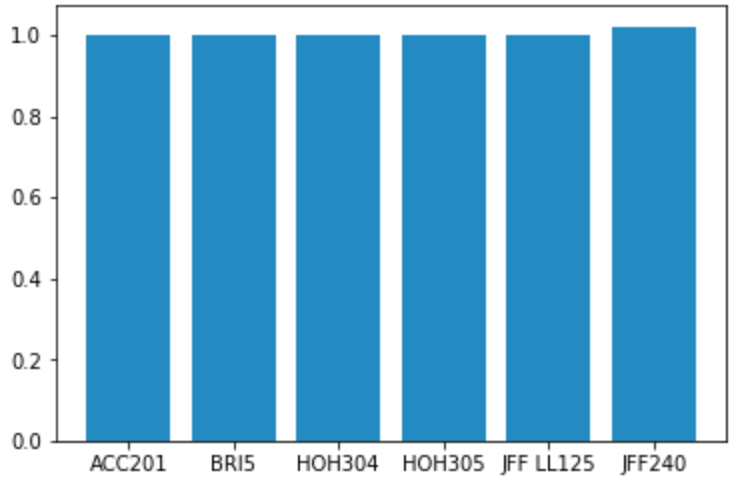


Table 2: Room with the Lowest Average Utilization Rate

Room	Average Utilization rate
ACC 306B	0
ACC306B	0
JFF417	0.118519
JFF414	0.203704
JFF LL105	0.218981
HOH706	0.223148
HOH506	0.224074
JFF233	0.238889
JFF LL102	0.240741

Table 3: Room with the Highest Average Utilization Rate

Room	Average Utilization Rate
HOH2	0.730556
HOH1	0.699074
ACC303	0.633333
HOH	0.552315
JKP210	0.55
JKP202	0.549074
ACC201	0.548148
JKP204	0.514815
ACC310	0.508333

Jupyter Notebook Code:

Please refer to the attached .pdf!