Term Project for Computational Optimization
Due: December 11, 2015 by 17:00

1 Introduction

In this project you will be solving a simple class scheduling problem to be used by college/university students to choose their classes/courses. The scheduling problem will involve data organization, creating mathematical models, solving the models in MATLAB or OCTAVE or Microsoft Excel, and making inferences.

Your submission will consist of two parts: (a) A written document (typeset in LaTeX) entitled **Project Report** organized in the following way

1. **Problem statement.** Provide a concise description of the problem you are solving (objective), the requirements (constraints) that need to be satisfied, and strategies for solving the problem (LP/heuristics).
2. **Input Data.** Explain/describe the input data (a sample data is provided to you).
3. **Solution Strategies.** The project asks you to solve the problem using a heuristic and an LP
   (a) **Heuristic.** Use a greedy-heuristic that is easy to implement in MATLAB/OCTAVE/Excel and is computationally efficient. It need not produce the optimum solution.
   (b) **LP.** The heuristic solution should guide you to create an LP model for the scheduling problem. You should explain each decision variable (what it represents) and each constraint (what condition/requirement it enforces) that you use in your LP model. Then provide the complete LP model in one piece using LaTeX `figure` environment.
   (c) **Extensions.** Under this section you will be incorporating additional constraints into your LP model and provide solution to the extended LP. Write a MATLAB/Octave/Excel program that reads in (loads) the input data from a file and solves the LP. Attach the program code /Excel sheet using LaTeX `figure` environment.

(b) the code (or Excel sheet) that you have developed attached with the report as an appendix.

2 Grading

The grading scheme is as below.

1. [70 points] The clarity and style of presentation of **Project Report** , and correctness of LP solutions.
2. [30 points] The documentation of your MATLAB/OCTAVE/Excel code.

3 Project Description

Sarah is a senior majoring in operations management at Takshashila University (TU) with one more semester left to go. After a graduation audit, she was told she has five more courses she needs to take: Business Strategy (MGT 490), International Finance (FIN 358), one service-learning course, and any two finance elective courses. A service- learning course is a requirement at the university that has a community service component. Many of the service-learning courses are offered by the Computer Information Systems Department, and Sarah would like to take one of those. In particular, two courses she finds interesting are Intergenerational Computing (CIS 102T), which involves teaching senior citizens how to use the computer, and Web Design for Nonprofit Organizations (CIS 102W). After looking at the finance course offerings, she noticed four potential finance elective courses: Data Analysis in Finance (FIN 325); Risk Management (FIN 352); Options, Futures, and Swaps (FIN 356); and Fixed Instruments and Markets (FIN 359). Sarah would like to avoid morning classes because her internship requires her to work a few hours most weekday mornings. As she makes up her schedule, Sarah would like to keep in mind her priorities. Her priorities are

1. first, the content of the course,
2. second, the reputation of the instructor, and
3. third, the timing of the course.

She decided she will assign a rating between 1 and 5 to each course section under consideration. From the online class schedule, she has made a list of course sections offered, as shown in Table 1. All of the courses have at least two sections. Some sections meet once a week for three hours, and some meet twice a week alternating between one-hour and two-hour periods. An "hour" at TU is 55 minutes long. Rating the course sections, Sarah took into account three factors (also listed above): content, instructor, and timing. The rating is the weighted average of the three factor ratings. She rated the content of the course based on her interest in it, using a scale from 1 (poor) to 5 (extremely interested). The reputation of the instructor is also a value from 1 to 5, mainly coming from her previous experience with the instructor and word of mouth from classmates. The timing of the course is also a number from 1 to 5, and takes into account things such as the times that most of her friends get together for watching TV shows such as Bing Bang Theory, and the schedule of her volunteer work at a local children activities group. Your job is to write a course scheduling system that accepts input data as depicted in Table 1 and generates a feasible course schedule for Sara (to enable her graduate) and that maximizes the total rating. Below is a itemized description of what needs to be done.

1. **Input Data.** Arrange the input data in a tabular form. One simple strategy is to label the columns with name of the courses (there are 8 different courses in the given data in Table 1) and label the rows with time slots in which a course lecture is scheduled. For example, MGT 490 is offered in 5 sections: three of them are evening sections scheduled from 6 to 8:45 pm on Monday, Tuesday, Wednesday, and Friday, and the remaining two re day sections: MW and TTh. In the table, you have a column for MGT 490 and 6 rows for the 6 different time-slots. Doing same for the other courses we will discover that the courses are offered using 10 different time-slots. Suitable tabular arrangement of data greatly enhances the understanding of the problem.

Table 1: Course Data

Course	Title	Meeting Time(s)	Rating
MGT 490	Business Strategy	M 6 – 8:45 p.m.	4.3
MGT 490	Business Strategy	T 6 – 8:45 p.m.	3.8
MGT 490	Business Strategy	W 6 – 8:45 p.m.	3.5
MGT 490	Business Strategy	F 6 – 8:45 p.m.	3.5
MGT 490	Business Strategy	M 1:25 – 2:20 p.m. W 1:25 – 3:15 p.m.	4.6
MGT 490	Business Strategy	T 1:25 – 2:20 p.m. Th 1:25 – 3:15 p.m.	2.7
FIN 358	International Finance	W 6 – 8:45 p.m.	3.5
FIN 358	International Finance	T 1:25 – 3:15 p.m. Th 1:25 – 2:20 p.m.	3.3
CIS 102T	Intergenerational Computing	W 2:30 – 5:15 p.m.	4.4
CIS 102T	Intergenerational Computing	Th 2:30 – 5:15 p.m.	3.1
CIS 102W	Web Design for Nonprofit Organizations	T 6 – 8:45 p.m.	3.7
CIS 102W	Web Design for Nonprofit Organizations	W 2:30 – 5:15 p.m.	3.5
FIN 325	Data Analysis in Finance	Th 6 – 8:45 p.m.	3.0
FIN 325	Data Analysis in Finance	M 1:25 – 2:20 p.m. W 1:25 – 3:15 p.m.	3.7
FIN 352	Risk Management	M 6 – 8:45 p.m.	3.6
FIN 352	Risk Management	M 1:25 – 3:15 p.m. W 1:25 – 2:20 p.m.	3.9
FIN 356	Options, Futures and Swaps	T 6 – 8:45 p.m.	3.2
FIN 356	Options, Futures and Swaps	T 1:25 – 3:15 p.m. Th 1:25 – 2:20 p.m.	3.4
FIN 359	Fixed Instruments and Markets	M 6 – 8:45 p.m.	3.0
FIN 359	Fixed Instruments and Markets	W 6 – 8:45 p.m.	3.5

2. **Heuristic.** Write a MATLAB/OCTAVE program that reads in data as shown in Table 1, applies some greedy heuristic and produces a feasible schedule. Your program should display the schedule (course name, section, time and date, and the rating) in a readable form. Decide on a suitable file format for the input data (Table 1) such that the data can be read from the file easily by a simple piece of code. If you plan to use MS Excel, you may consider using the CSV (comma separated value) format. A simple greedy heuristic could be to always choose the course section that does not conflict with the selected courses (so far) and has the highest rating.

3. **Linear Program.** Decide on the decision variables that you will need (the heuristic solution should be helpful) and formulate an objective function that will be maximized. Next, identify the constraints (e.g., Sarah needs to take exactly 5 courses, she must take MGT 490, FIN 358, one of CIS 102T, CIS 102W, and so on.). Write down the primal problem.

   Write a MATLAB/OCTAVE program or Excel solver model that uses the simplex method to solve the LP. Show the output of your program (as you have done in the heuristic method). Write down the shadow prices (dual values) for your program. Explain how the shadow prices can be interpreted in a meaningful way.

4. **Extension.** Many students tend to be concerned with limiting the number of days they have to be at school. Sarah would like to see if she can have a schedule that requires her to attend class only three days a week. She feels such a schedule may help her allocate her time better between study and relaxation. She may consider it if this does not lower her maximum rating too much. Determine the maximum rating three-day schedule by extending the LP.