

# BUS2 194B - Business Analytics. Spring 2021

## Midterm Exam

The instructions for the midterm exam are the following:

1. In this exam, I will evaluate how you would apply what you have learned during the semester in a simulated environment. Two things will be of particular interest:
  - That you utilize the techniques learned in class as a basis.
  - That the techniques utilized are appropriate for the situation under study.
2. Please read the exam and select and address only one of the 3 situations described.
3. Optionally, answer the bonus questions at the end of the exam.
4. The rubrics considered for this exam are available on the last page of this document.
5. The midterm exam will be available from the first minute of March 25, 2021.
6. The solutions of the midterm exam must be submitted by 11:59 PM on March 25, 2021.
7. This is an open book, open notes exam. You can use any tool to solve the exam, including the templates and examples provided during the semester.
8. This is an **INDIVIDUAL** exam. Communicating with other students or people (besides the instructor) will be considered academic dishonesty.
  - You can contact the instructor at anytime via email or Canvas message, and in person from 10:30 AM - 11:45 AM, PST at:

<https://sjsu.zoom.us/j/86431487708?pwd=aUpzVytDakt0d0xLbmdlNW43STI0Zz09>

## Situation 1 - The capstone project!

The SJSU Lucas College and Graduate School of Business (LCoB) has many connections with different businesses in the Silicon Valley area. In one of their senior classes, a capstone project needs to be developed by the students. Professor Jin, who is the instructor for this class, has made contact with 12 enterprises and they have presented their corresponding projects.

The process for assigning each capstone project to each student is as follows:

1. Each of the 10 students of this class needs to prepare and submit their CV to the appropriate system designed by the LCoB, in which they reflect their experience, grade point average (GPA), and professional interests.
2. In parallel, the enterprises upload their project proposals to the same website.
3. The students have access to the project proposals for two weeks.
  - During that time, the students need to rank their top 3 projects in which they want to work.
4. The enterprises have access to the students' CV for two weeks.
  - During that time, the enterprises need to rank their top 5 students that they would like to work on their project.
5. The system then needs to match each student to one project\*.

Up to this point, the system has worked up to step 4 but is struggling to carry out step 5 (matching students to projects). The rankings made by the students are shown in the following table, where project 1 represents the one in which the student has the most interest of the top 3. *If a project does not appear in the top 3 does not necessarily mean that the student cannot work on that project, it just is not on his or her top 3 list.*

Student's last name	Project 1	Project 2	Project 3
Ford	Cisco	Hitachi	Whipsaw
Hou	Hitachi	Adobe	Cisco
Johnson	SunPower	Whipsaw	NIO
Karimi	Whipsaw	SunPower	FICO
Moon	NIO	Cisco	Zoom
Nara	FICO	Togo's	NIO
Pang	Hitachi	SJ Sharks	Whipsaw
Perez	SJ Sharks	SunPower	NIO
Tsipras	SJ Sharks	Cisco	Whipsaw
Yourself			

(\***Note:** The last student is you, the student taking this exam. Please put your top three interests in here.)

The rankings made by the enterprises are shown in the following table, where student 1 represents the person that the company has the most interest in working with of the top 5. Similarly, if a student does not appear in the top 5 does not necessarily mean that the company cannot work with that student, it just is not on its top 5 list.

Enterprise	Sector	Student 1	Student 2	Student 3	Student 4	Student 5
NIO	Automotive	Yourself	Johnson	Moon	Pang	Perez
Whipsaw	Design	Yourself	Pang	Johnson	Tsipras	Nara
Broadcom	Electronics	Yourself	Nara	Ford	Johnson	Pang
Hitachi	Electronics	Yourself	Ford	Nara	Karimi	Perez
SunPower	Energy	Yourself	Johnson	Hou	Karimi	Moon
FICO	Financial	Yourself	Moon	Perez	Johnson	Karimi
Paypal	Financial	Yourself	Tsipras	Moon	Karimi	Johnson
Togo's	Food	Yourself	Tsipras	Moon	Ford	Karimi
Cisco	Networking	Yourself	Ford	Tsipras	Nara	Karimi
Zoom	Internet	Yourself	Karimi	Tsipras	Pang	Perez
Adobe	Software	Yourself	Ford	Nara	Hou	Tsipras
SJ Sharks	Sports	Yourself	Pang	Tsipras	Nara	Johnson

Since you are in first place on all the top 5 lists, the LCoB is asking you for help in order to carry out the fifth step (matching). In one of their meetings, they let you know that is the main interest is to try to align the students' and businesses' interests. Otherwise, the whole ranking process would be meaningless and it would reduce the program's prestige. It is evident that 2 projects will not be able to be carried out because the number of students and projects is not the same.

Please do the following:

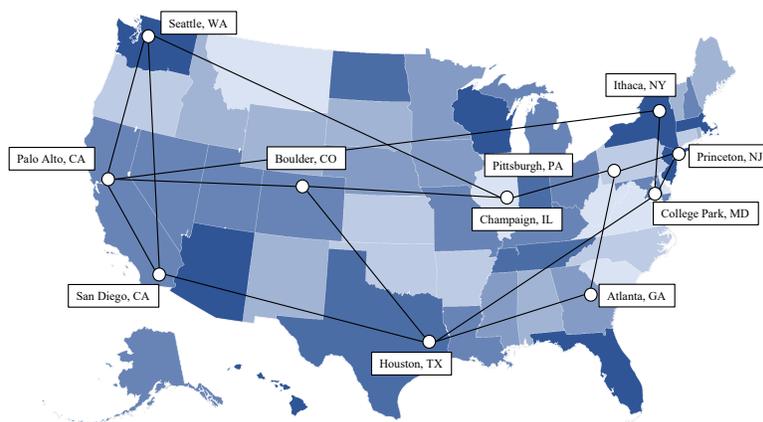
1. Complete the first table with your own interests in the companies
2. Develop an optimization model that maximizes the matching interests
  - Hint: There is not a clear way to measure the total interest given by the description, so you can create any function or scoring system that returns higher values when both interests are best matched, and lower values when the interests are mismatched.

- Hint 2: If you cannot express some parts of the model in the form of equations, express them in the form of words (e.g. **time for playing videogames + time for sleeping  $\leq$  total time**)
3. Return the best matching for this project assignment (i.e., which student will be working on what project)
  4. (2 months in the future) The matching was a success! Now the LCoB would like to apply your model to future generations of students and projects. Please develop the general form of the optimization model, i.e., a model that could be applied to groups with  $n$  students and  $m$  projects.

## Situation 2 - Connecting power networks

The power grid was one of the biggest inventions of the last century. Think about it, almost everything we do in our daily life requires electricity. And that electricity comes from a generator. The way electricity is transmitted from the generator to our houses is through the transmission lines (the ones you can see out of your window at the utility poles).

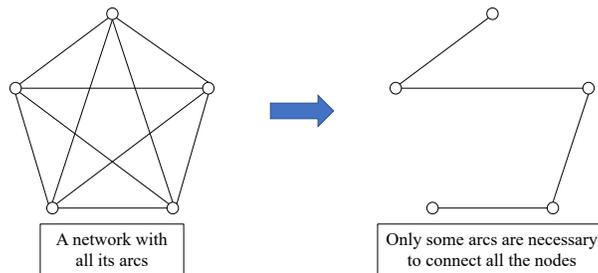
A country can have more than one power grid. For example, there could be one electric grid powering the houses in California, but it operates independently of the power grid in Arizona. Having a unified national power grid has its benefits, for example, is easier to balance the demand and supply of electricity, or coordinating the generators. Nevertheless, it is not an easy task. In the following figure, you can see some of the power grids that exist in the United States, which main operation center is located in the cities indicated in the figure. The lines that connect the cities are *potential* transmission lines, i.e., they don't exist yet, but these are the possible lines under consideration.



We want to connect all these cities by deciding which transmission lines to build among the presented options. Probably, the easiest way would be to build all of them and have everything connected. Nevertheless, it worths mentioning that each mile of transmission line construction costs \$285 thousand dollars. Hence, is probably not the best idea to construct all the lines.

In summary, we want to connect all the power networks' main operators (represented by the

nodes), with the minimum number of miles of transmission lines (represented by arcs). In other words, not all the potential lines are necessary to keep all the nodes connected, as you can see in the following example:



Please do the following:

1. Find the length of the potential transmission lines using your favorite maps software (please indicate which software and method you used).
2. Utilize optimization to connect all the power networks with the minimum number of miles constructed of transmission lines.
  - Hint: There are two ways of seeing it: 1) starting without any line and deciding which lines to add, or 2) starting with all the lines and decide which lines to remove. In any case, the optimization model should be described, at least.
  - Hint 2: If you cannot express some parts of the model in the form of equations, express them in the form of words (e.g. **time for playing videogames + time for sleeping  $\leq$  total time**)
3. Return which lines should be added and its total cost to keep all cities connected
4. (6 months in the future) The process was a success! Now the Department of Energy would like to apply your model to future situations in which new power grids are added. Please develop the general form of the optimization model, i.e., a model that would connect  $n$  power grids when we have  $m$  potential transmission lines.

### **Situation 3 - My favorite rock band is over...**

This is a sad day for me. My favorite rock band Ayreon is over. Let me tell you a little bit about this band: Basically, one person is the main (and only permanent) member. His name is Arjen Anthony Lucassen, and he is a GENIUS! Usually, he thinks about a particular theme and records the guitars and some other instruments. Nevertheless, he's not a one-man orchestra. In some of the previous albums, he has played with super top artists (e.g. Michael Romeo from Symphony X and Bruce Dickinson from Iron Maiden). Hence, the other instruments (like the battery, the bass, and the vocals) are recorded by other artists that are non-permanent members (they are more like invited members). Arjen has played with more than 150 different artists!

The problem is the following: some of the members are in conflict and don't want to play together anymore. This is common in rock bands. But they already announced their next tour! How can you play during a tour if the musicians cannot play together? However, not everything is lost. Arjen knows that some of the members are necessary to play some songs, but other members are necessary for other songs.

For simplicity, let's assume that Arjen has 5 potential singers ( $S_1, \dots, S_5$ ), 3 guitarists ( $G_1, \dots, G_3$ ), 4 bassists ( $B_1, \dots, B_4$ ), 3 flutists ( $F_1, \dots, F_3$ ), 4 keyboard players ( $K_1, \dots, K_4$ ), and 4 drummers ( $D_1, \dots, D_4$ ).

Then, he has a list of possible songs to play based on the popularity shown on Spotify. This list is presented in the following table with the corresponding members that could play each of the songs (Arjen only needs one member of each category, for example, the guitarist  $G_1$  and the guitarist  $G_3$  could play Song 1, then it will be sufficient if guitarist  $G_1$  is invited but guitarist  $G_3$  is not invited):

	<b>Singers</b>	<b>Guitar</b>	<b>Bass</b>	<b>Flute</b>	<b>Keyboard</b>	<b>Drums</b>
<b>Song 1</b>	S3	G1, G3	B4, B2	F3, F1	K1	D3, D1
<b>Song 2</b>	S1, S2	G3, G2	B4, B1	F3, F1	K2, K1	D1
<b>Song 3</b>	S5, S4	G2	B3	F2, F3	K2	D3, D2
<b>Song 4</b>	S2, S1	G1, G3	B1, B4	F2	K4, K2	D3
<b>Song 5</b>	S1, S5	G3	B4, B3	F2, F1	K2, K4	D4, D1
<b>Song 6</b>	S1	G1, G3	B4, B2	F3	K2, K4	D4, D2
<b>Song 7</b>	S1	G2, G3	B4	F2, F3	K4	D4
<b>Song 8</b>	S2, S1	G3, G2	B3, B4	F1	K3, K2	D3, D2
<b>Song 9</b>	S3, S5	G1, G2	B3	F2	K2, K4	D4, D3
<b>Song 10</b>	S4	G1	B1, B2	F2	K2, K4	D4, D2
<b>Song 11</b>	S3, S4	G1, G2	B3, B1	F1, F3	K3, K4	D1
<b>Song 12</b>	S3, S1	G1, G2	B4, B2	F3, F2	K2, K1	D1, D3
<b>Song 13</b>	S3	G3	B2, B1	F1, F3	K2, K1	D2, D3
<b>Song 14</b>	S3, S5	G3, G1	B1, B3	F2, F1	K2, K1	D3, D4
<b>Song 15</b>	S3, S1	G2	B1, B3	F1, F3	K1, K2	D2
<b>Song 16</b>	S5, S3	G2, G1	B2, B3	F2, F1	K1, K4	D1
<b>Song 17</b>	S1	G3, G2	B2	F3, F1	K3	D4
<b>Song 18</b>	S2	G3, G2	B3	F1, F2	K1	D3, D1
<b>Song 19</b>	S4, S5	G2, G3	B3	F3, F1	K4, K1	D2, D4
<b>Song 20</b>	S2, S1	G3	B1, B3	F3, F1	K3, K1	D4, D3

Ayreon really wants this tour to be successful, so they are deciding what members invite to play the most popular songs while avoiding conflict. The conflict can be summarized as follows:

- Singer S1 was married to flutist F3, but not anymore. So they cannot be together.
- Also, the flutist F3 is now married to the drummer D1, so if one of them is invited, both should be invited. Need to mention that singer S1 also hates drummer D1.

- G2 and B2 are brother and sister, so they want to be together.
- K3 got sick and won't be able to attend.

The concert should include at least 8 songs and a maximum of 12 songs.

Please do the following:

1. Utilize optimization to find the best possible formation for the following tour, while prioritizing to play the most popular songs over the less popular ones.
  - Hint: If you cannot express some parts of the model in the form of equations, express them in the form of words (e.g. [time for playing videogames + time for sleeping ≤ total time](#))
2. Return which members should be part of that formation and which songs are going to be played
3. (3 months in the future) The selection was a success! Since this problem can be applied to many types of teams, now you are able to solve team conflicts in different aspects (for example, sports teams). Please develop the general form of the optimization model, i.e., a model that would return a team with  $n$  members to perform  $m$  potential tasks.

## **Bonus section!**

### **Part 1**

**Bonus question! (5 points)** Please provide a comment to one external reading of each Module from 1 through 4. You should provide your comment regarding a total of 4 external readings.

At a minimum, each comment should include:

- a) Your impression on the reading (please indicate the name of the reading); and
- b) How the reading relates to the class and your professional development;

### **Part 2**

Please attend the teaching demonstrations (announced on the Canvas site) on Wednesday (3/24), Thursday (3/25), and Friday (3/26) for the following amount of extra credit:

- Attend 1 session: **4 points in total**
- Attend 2 sessions: **6 points in total**
- Attend 3 sessions: **7 points in total**

**Good Luck!**

## Deadline

The solutions for the Midterm Exam should be submitted to the appropriate section in Canvas at <https://sjsu.instructure.com/>. The deadline for the submission is:

→ **Thursday, March 25, 11:59 PM**

## Rubrics

The solutions for the Midterm Exam will be evaluated utilizing the following *rubrics*:

	Percentage of points assigned			
Assessment	100%	85%	50%	0%
Techniques part	The used techniques are appropriate and sufficient for the case and the assumptions provided	The used techniques are appropriate but not sufficient for the case and the assumptions provided	Some techniques are not appropriate and not sufficient for the case and the assumptions provided	Almost no techniques are appropriate for the case and the assumptions provided
Writing part	Writing is concrete and addresses the problem	The problem is addressed but the writer repeats some phrases unnecessarily	There are contradictions in the writing or in the assumptions	The problem is not addressed