In Class Exercises (3/22)

It is okay if you do not finish everything in class, as learning new things take time. But please try to finish at home, otherwise you will not learn.

Exercise I: DataFrames and Excel (15 Min)

1. Read in the "Fulfilment Centers" sheet from "small_data.xlsx" as a DataFrame and call it `fcs`.
2. Create a dictionary called `cap` that maps each "FC_name" in `fcs` to two times its capacity. (i.e., `caps['A']` should be `2000`.) You should use a loop rather than doing this manually. The notation for doing this is.

```
cap={}
for center in XXX:
    cap[center]=YYY
```

(Replace XXX with the list of FC_names and YYY with an expression that calculates two times the capacity of the `center`.)

3. Read in the "Distances" sheet from "small_data.xlsx" as a DataFrame and obtain a Series called `s` corresponding to the column sums. (If you are not getting the right sheet, try to replace `sheet_name` with `sheetname`.)
4. Create a table (as a list of lists) in which the first column corresponds to each "FC_name" (index set of `fcs`), the second column contains the values of the dictionary `caps` for the FC, and the third value corresponds to the value of the Series `s` for the FC. Using this table, create a new DataFrame called `df` with this data, and the column names "FC_name","Twice Capacity", "Sum of distances".
5. Output an Excel file called "exampleOutput.xlsx", in which the first sheet is named "FCs" and is the same as the `fcs` DataFrame, and the second sheet is named "Results" and is the same as the `df` DataFrame from step 4. Inspect the Excel file to make sure the formatting is the way you want it.
6. Run the entire Jupyter notebook again after changing the input file to "data.xlsx"

Exercise II: Modeling with Binary Variables (15 min)

Alice, Bob and Charlie are three professors who each teach 2 sections, but must share the same special room. For simplicity, there are 6 time slots at the room, indexed from 0 to 5. (Slot 0 represents Monday morning, 1 represents Monday afternoon, 2 represents Monday evening, 3 represents Tuesday morning, 4 Tuesday afternoon, and 5 Tuesday evening.)

Decision Variables: Let a_0 be a binary variable denoting whether Alice teaches in slot 0, Similarly define $a_1, \cdots, a_5$ and the same for Bob and Charlie. Let m_a be a binary variable denoting whether Alice teaches on Mondays. Similarly define m_b, m_c, as well as t_a, t_b, t_c for Tuesdays.

Model each of the following using a linear expression or a series of linear constraints:

1. Linear expression: The total number days Alice teaches, plus the total number of days Bob teaches, plus the total number of days Charlie teaches. (Think of this as the objective to minimize, as professors want to get all teaching done in the same day.)

2. Constraint: slot 0 can have at most one person assigned. (Similarly for slots 1 through 5.)

3. Constraint: Alice must be assigned to exactly 2 slots. (Similarly for Bob and Charlie.)

4. Constraints: Bob cannot teach in the mornings. Moreover, Charlie works at another job on Mondays and cannot teach Monday mornings and afternoons.

5. Constraints: Alice and Bob cannot teach on the same day.

6. Constraints: If Alice teaches two slots on a given day, they must be consecutive slots.

7. Logical Constraints: If Alice teaches Monday mornings (a_0), then she must also necessarily teach on Mondays (m_a). Similarly, if she teaches Monday afternoons (a_1), then she must be teaching on Mondays (m_a). Write the 6 logical constraints connecting $a_0, a_1, \cdots, a_5$ to m_a and t_a.

Note: in a problem with more people, you may want to define decision variable x_{a0} for whether Alice teaches in slot 0, rather than a_0. In other words, x_{ij} would be a binary variable denoting whether person i teaches in slot j.