Assignment 2

Due: 21st May 2020, 11:30PM

Total Marks: 100

Note: You have to do all programs in Google OR Tools. Make a different program file for different question. The name of the file should be the same as problem name (for example problem1, problem2 and so on). In case of problem 2, the output should be exported into a separate text or csv file according to your preference. Then, make a zip file with all the programs, necessary input and output files. Finally, submit the zip file. The name of the zip file should be your firstname_lastname.zip (for example, Salimur_Choudhury.zip).

Expectations: It is a general expectation that your code should have enough comments. Variable and functions name are meaningful (e.g., camel notation). If you need to add any special instructions on how to run your code, you can add a readme file too. Please make sure that your program runs without error.

Problem 1 (30):

Suppose, there is a wedding at Kings Landing. You are in charge of making the seating arrangements for the guests. Some of the guests are enemies with each other. Enemies hate each other and cannot sit at the same table. Among the guest lists, there are some friends as well, who want to sit in the same table. You will have to distribute table numbers among all the guests and ensure that no enemies are assigned the same table, while friends sit at the same table.

Guests	Friends	Enemies
Jaime	Cersei	Jon
Beth	Tyrion	-
Jon	Daenerys	Jaime, Tyrion
Daenerys	Jon	Cersei
Cersei	Jaime	Daenerys, Sansa
Sansa	-	Cersei
Tyrion	Beth	Jon

Please design a constraint satisfaction programming model and use Google OR tools to get the solution (how many total number of tables are required).

Problem 2 (40):

Suppose, you are required to make an exam timetable schedule for Lakehehead University. There are total 500 students and 20 different courses in total. There are four different timeslots for each day (e.g., 10:00 AM - 12:00PM, 1:00 PM- 3:00 PM, 3:00PM – 5:00 PM, 5:00- 7:00PM) and the scheduling period for all the exams is for 60 days in total. The university has six available rooms per day to schedule the exams. Each room has a total capacity of accommodating 50 students. To know which student is taking which course, you will have to import Course_Student_Association_Matrix.csv (you have to consider this input only) file into your code. The csv file

contains a matrix of size 20×500, where rows represent course number and columns represent students. A value of 1 in a matrix cell, for example, <3, C> represents that course "3" is being taken by student "C". A value of 0 in a matrix cell, for example, <2, A> represents that course "2" is not being taken by student "B".

Following is a snapshot of the provided csv data file:

	A	B	C	D	E	F	G
1	1	0	0	0	0	0	
2	0	0	0	0	0	0	
3	0	0	1	0	0	0	
4	0	0	0	0	0	0	
5	0	0	0	0	0	0	
6	0	0	0	0	0	0	
7	1	1	1	0	0	0	
8	0	0	0	0	0	0	
9	0	0	1	0	0	0	
10	0	0	0	0	0	0	
11	0	0	0	0	0	0	
12	0	0	0	0	0	0	

In the above dataset fragment snippet, it has been shown that course 7 is being taken by student A.

Schedule each course exam into a timeslot of a day for a specific room.

Following are the constraints (hard and soft) you will have to consider to get a scheduling solution:

- **Exam conflict**: 2 exams that share students must not occur in the same period. (hard constraint)
- **Room capacity**: A room's seating capacity must suffice at all times. (hard constraint)
- **Shared conflict**: Exam should not have to share its room with any other exam. (hard constraint)
- **Exam number limit constraint:** The same student should not have more than 2 exams per day. (hard constraint)
- **No consecutive exam constraint**: The same student should not have 2 exams in a row. (hard constraint)
- The number of days required for scheduling all the exams should be as minimum as possible. (soft constraint)

Please design a constraint satisfaction programming model and use Google OR tools to get the solution:

- How many total number of days are required to schedule the exams before and after using the soft constraints?
- Moreover, print the whole solution and save it as a tabular format into a csv or text file to show which course has been assigned to which day and timeslot.

Problem 3 (30):

Due to the COVID-19 pandemic, the world needs a solution to distribute PPE (Personal Protective Equipment) to staffs in various hospitals according to the severity level (1-5) of the patients and number of patients and staff present in a hospital.

Parameters:

Parameter	Values
Total PPE	700
Hospital	5
Patients	Hospital #1= 30 Hospital #2= 20 Hospital #3= 35 Hospital #4= 34 Hospital #5= 15
Staff	Hospital #1= 50 Hospital #2= 55 Hospital #3= 65 Hospital #4= 72 Hospital #5= 45
Severity Level	Initialize severity level for each patients randomly in the range of 1-5

Following are the constraints (hard and soft) you will have to consider to obtain a solution:

- All staff should be given at least one PPE. (hard constraint)
- No two staff can share a single PPE. (hard constraint)
- No PPE should remain un-allocated. (hard constraint)
- The hospital dealing with the most severe patients will have more PPEs allocated to there. (soft constraint)
- The hospital with the higher number of staffs will have more PPEs allocated to there. (soft constraint)

Please design a constraint satisfaction programming model and use Google OR tools to report how many PPE have been assigned to which hospital.