Total Questions: 4 + 1
Total Marks: 350

Question No. 1a:
Marks: 5
Level: Easy

Model a and b as parameters, model c as a variable in a Linear System or Linear Program, such that the following relationship holds:

c = max(a,b)

Submission: 1a.txt
Evaluation:
Your model/ system/ LP will be pasted in:
https://online-optimizer.appspot.com/

It should contain following strings:
param a:=
param b:=
var c;

Upon supplying different values to a and b, the variable c should take the max out of both.

Question No. 1b:
Marks: 15
Level: Easy

Solve the above question without using c in the objective. (If you have already solved it the same way in 1a, skip this, marks will be given for both)
Submission: 1b.txt

Evaluation:
Same as Q.1a, but the objective of Q.1b should not contain c.

Question No. 1c:
Marks: 15
Level: Easy

Solve the Q.1a using following objective:

```
maximize profit:c;
```

Submission: 1c.txt
Evaluation:
Same as Q.1a, but objective should be stated.

Question No. 2a :
Marks: 75
Level: Hard

A certain report hard copy is generated at an Industry everyday. A car arrives everyday at the Industry at t^{th} hour of day to collect the report. If the report is generated before t, it is shipped on the car, If the report is generated after t, it is shipped on the next day's car. Car arrive at the same time everyday, whereas the report can be generated only between 1 AM(1 hour) and 10 PM(22 hour). A certain cost is incurred for every hour the report waits for the truck.
Note that between any two reports , there has to be a gap of at least 25 hours, but there has to be a report everyday. (One a day report generates 9 AM, next can be generated at 10 AM next day or later.)

The waiting cost (per hour) of the report is 30, 12, 11, 45, 22, 58, 10 on the 7 days of the week. Find the optimal schedule of Report generation for all 7 days (Only one week). Assume time to be discreet.
w= the time for which the report waits at the Industry

w= (t-p) if t>p
w=24-(p-t) if t<p

Take t=11.

Use the following lines in code, do not change them:

param cost_1:=30;
param cost_2:=12;
param cost_3:=11;
param cost_4:=45;
param cost_5:=22;
param cost_6:=58;
param cost_7:=10;
param t:=11;

[Hint: Use:
set day:=1..7;
var x{day}>=0,integer;
s.t. condition{d in day diff {1}}: x[d]>=x[d-1]+1;]

Submission: 2a.txt

Evaluation: The value of objective will be checked. Different values of params above will be passed and objective value will be matched.

Question No. 2b :
Marks: 40
Level: Medium

Now to reduce the cost of waiting in above example, management has decided to send two cars everyday. Write an LP to find the waiting time for a single day (not week as above) of the Report if

generation of report time and truck arrival times are given as parameters.

For eg:
Let car arrival times be 10 AM and 3 PM.
For Report generation at 8AM, 11AM, 5PM, waiting time would be 2 hours, 4 hours and 17 hours.

Model waiting time as:
var w>=0;
Model arrival of Car 1 as:
param t1:=10;
Model arrival of Car 2 as:
param t2:=15;

Submission: 2b.txt
Evaluation: waiting time of report should be correct for unseen values of parameters.

Question 3:
Marks: 50
Level: Medium

A city has **n** hospitals. The mayor of the city wants to assign a hospital to every house in the city. He states that the hospital for any

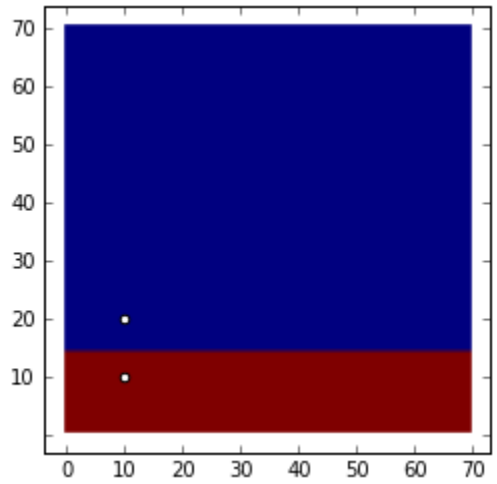
house is the hospital closest to the house using rectilinear distance **`(|x1-x2| + |y1-y2|)`**. If coordinates of the 2 or 3 hospitals are given, write a program to generate a map showing the area for each hospital.

The city is a square with length of its sides as 70 units.
Example:

Hospital 1 Coordinates: (10,10)
Hospital 2 Coordinates: (10,20)

Sample Input:
location=np.array([[10,10],[10,20]])

Output:



Generate above map for following location of Hospitals:

Case 1:

Hospital 1 Coordinates: (10,10)
Hospital 2 Coordinates: (30,30)

Case 2:
Hospital 1 Coordinates: (50,40)
Hospital 2 Coordinates: (30,60)

Submission:
1 sketch/ image (pre submission, ungraded)
Python Code file

Use input as:
location=np.array([[x1,y1],[x2,y2]])

Evaluation:
Code should generate images that resemble the required maps on seen (case 1, and case 2) and unseen inputs.

Question 4:
Marks: 100
Level: Hard
There are n sources of a commodity. A source has three parameters: [Location, Quantity, Date]. The location of the source is the place where the commodity is produced, the date is date of production/ harvest.

For eg: S3[Peth, 200kg, 20-Dec-2020] would mean a source named S3 is located in Peth, produces 200 kg of commodity which is available after 20-Dec-2020.

There are m demand points. A demand point has three parameters: [Location, Quantity, Date]
D4[Borivili, 50kg, 26-Dec-2020]: A demand point identified as D4 is in Borivili needs 50kg of the commodity before 26-Dec-2020.

Given such sources and demand, match the sources and demands such that time constraints are respected.
Develop an algorithm to pair up the sources and demand points efficiently, such that there are minimum assignments(in the output table the number of cells with positive values should be minimum).

Sample Input:
S1[Sangli, 40kg, 10-Feb-2020]
S2[Nasik, 50kg, 15-Feb-2020]
S3[Dhule, 60kg, 26-Feb-2020]
D1[Powai, 10kg, 20-Feb-2020]
D2[Mahim, 50kg, 22-Feb-2020]
D3[Chembur, 60kg, 30-Feb-2020]

Sample Output (Feasible, not optimal):

	D1	D2	D3
S1	10	30	0
S2	0	20	30

S3	0	0	30

Submission:
This problem can be solved as LP, as well as by any appropriately designed algorithm in Python (Heuristics). You may submit a Model or Algorithm.

Evaluation:

Algorithm will be run on unseen data.

Bonus Question:
Marks: 50
Level: Easy

Ram, Raheem and Robert went to a restaurant and came up with the following procedure:

Ram has three red marbles, Raheem has three yellow marbles and Robert has three green marbles in their pockets. Ram picks one marble from his pocket (randomly) and places it in Raheem's pocket, then Raheem picks one marble from his pocket (randomly) and puts in Robert's pocket. Then Robert picks one marble from his pocket (randomly) and places it in Ram's pocket. Each of them will pick a marble from their respective pockets. If two of the balls are of the same colour, the corresponding person will pay the bill. Note

that Ram is identified with Red ball, Raheem with yellow and Robert with green. Is this advantageous to any player? Justify your answer.

Evaluation: Correct Justification will be awarded points.
Submission: No Constraints!

Final Submission: Make a zip file of all the solution code/ model files and upload on the Submission Portal.

ALL THE BEST