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Course: COMP 5413 Topics in Smart Health Informatics
Assignment: 1

Part 1

Time Requirement Table (Doctor 4 and Doctor 5)

	Patient 1	Patient 2
Doctor 4	130	95
Doctor 5	118	83

Objective Function:

$$\text{Min}(z) = 130\,x_{41}+95x_{42}+118x_{51}+83x_{52}$$

Decision Variables:

$x_{41}, x_{42}, x_{51}, x_{52}$

Where

x_{ij} = 0 if doctor i is assigned to patient j

x_{ij} = 1 if doctor i is not assigned to patient j

Constrains:

#Each doctor is assigned exactly 1 patient

$x_{41}+x_{42}=1$

$x_{51}+x_{52}=1$

#Each patient is assigned to exactly 1 doctor

$x_{41}+x_{51}=1$

$x_{42}+x_{52}=1$

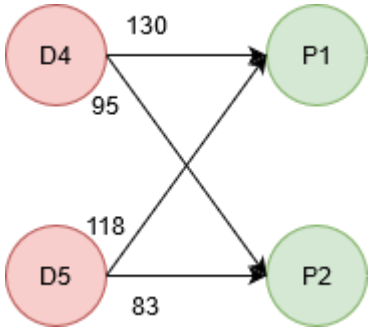
Binary variables

x_{ij}=0 or 1

Thought Process:

Note: Since we have more than 2 variables in the equation, we cannot follow the graphical method.

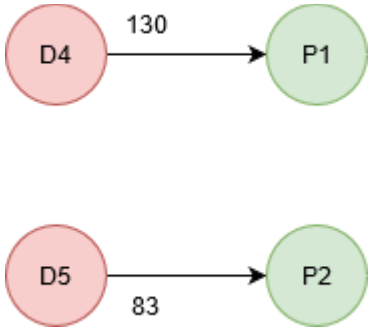
In the given problem we have 2 doctor who are to be assigned 2 patients. Each doctor takes some specific time to operate on each patient as shown below



Now since each patient must be addressed by any one of the available doctors their can be only 2 possible solution for Part 1 problem:

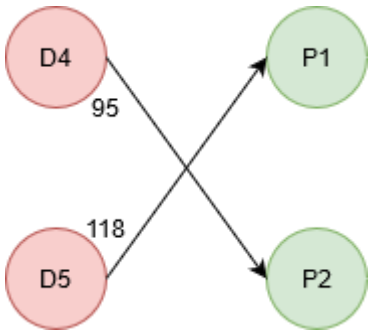
1. (Doctor 4, Patient 1) and (Doctor 5, Patient 2)
2. (Doctor 4, Patient 2) and (Doctor 5, Patient 1)

Case 1: (Doctor 4, Patient 1) and (Doctor 5, Patient 2)



In this case the total time required by ER is = 130+83 = 213

Case 2: (Doctor 4, Patient 2) and (Doctor 5, Patient 1)



In this case the total time required by ER is = 118+95 = 213

As both case 1 and case 2 arrive at the same total time required which is 213, the problem has more than 1 optimal solution.

Gurobi File: 0892691_Part_1.py

Gurobi Solution Screenshot:

```
D:\SmartHealth\Assignment_1>gurobi 0892691_Part_1.py
Using license file C:\Users\shahj\gurobi.lic
Academic license - for non-commercial use only
Gurobi Optimizer version 9.0.2 build v9.0.2rc0 (win64)
Optimize a model with 4 rows, 4 columns and 8 nonzeros
Model fingerprint: 0x45a01e01
Coefficient statistics:
  Matrix range     [1e+00, 1e+00]
  Objective range  [8e+01, 1e+02]
  Bounds range     [0e+00, 0e+00]
  RHS range        [1e+00, 1e+00]
Presolve removed 4 rows and 4 columns
Presolve time: 0.00s
Presolve: All rows and columns removed
Iteration    Objective       Primal Inf.    Dual Inf.      Time
       0    2.1300000e+02   0.000000e+00   0.000000e+00      0s

Solved in 0 iterations and 0.01 seconds
Optimal objective  2.130000000e+02
map[Doctor4,Patient1] 1
map[Doctor4,Patient2] 0
map[Doctor5,Patient1] 0
map[Doctor5,Patient2] 1
obj: 213

D:\SmartHealth\Assignment_1>
```

Part 2

	Patient 1	Patient 2	Patient 3	Patient 4	Patient 5	Patient 6
Doctor 1	52	100	74	143	99	60
Doctor 2	150	76	122	66	96	90
Doctor 3	112	142	54	130	112	75
Doctor 4	130	95	150	112	88	50
Doctor 5	118	83	52	111	56	95
Doctor 6	114	90	72	102	55	100

Objective Function:

Min(z) = $\sum_{i=1}^{i=6} \sum_{j=1}^{j=6} c_{ij} \times x_{ij}$

Here c_{ij} is a constant indicating the time spend my doctor i on patient j

Decision Variables:

x_{ij}

Where

x_{ij} = 0 if doctor i is assigned to patient j

x_{ij} = 1 if doctor i is not assigned to patient j

Constrains:

#Each doctor is assigned exactly 1 patient

$$\sum_{j=1}^{j=6} x_{1j} = 1$$

$$\sum_{j=1}^{j=6} x_{2j} = 1$$

$$\sum_{j=1}^{j=6} x_{3j} = 1$$

$$\sum_{j=1}^{j=6} x_{4j} = 1$$

$$\sum_{j=1}^{j=6} x_{5j} = 1$$

$$\sum_{j=1}^{j=6} x_{6j} = 1$$

#Each patient is assigned to exactly 1 doctor

$$\sum_{i=1}^{i=6} x_{i1} = 1$$

$$\sum_{i=1}^{i=6} x_{i2} = 1$$

$$\sum_{i=1}^{i=6} x_{i3} = 1$$

$$\sum_{i=1}^{i=6} x_{i4} = 1$$

$$\sum_{i=1}^{i=6} x_{i5} = 1$$

$$\sum_{i=1}^{i=6} x_{i6} = 1$$

Binary variables

x_{ij}=0 or 1

Gurobi File: 0892691_Part_2.py

Gurobi Solution Screenshot:

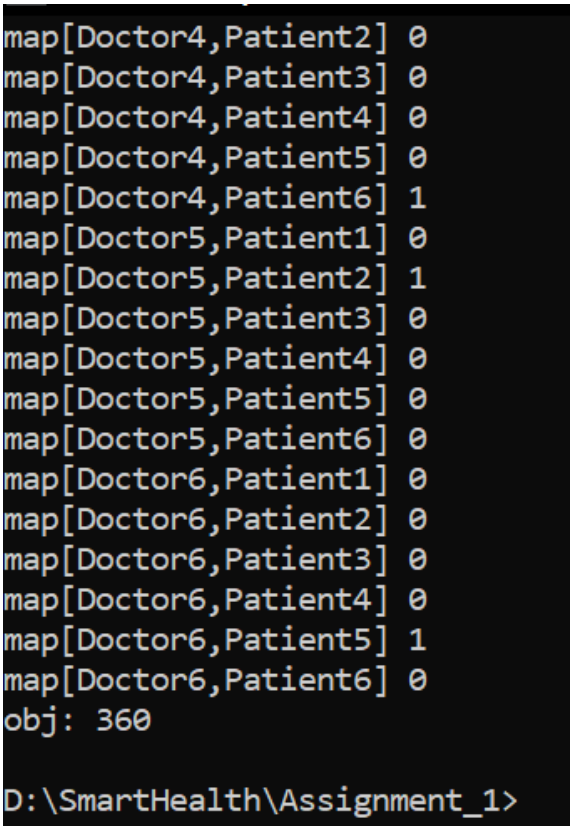
Screenshot 1

```
D:\SmartHealth\Assignment_1>gurobi 0892691_Part_2.py
Using license file C:\Users\shahj\gurobi.lic
Academic license - for non-commercial use only
Gurobi Optimizer version 9.0.2 build v9.0.2rc0 (win64)
Optimize a model with 12 rows, 36 columns and 72 nonzeros
Model fingerprint: 0x10bfa4d9
Coefficient statistics:
  Matrix range     [1e+00, 1e+00]
  Objective range  [5e+01, 2e+02]
  Bounds range     [0e+00, 0e+00]
  RHS range        [1e+00, 1e+00]
Presolve time: 0.00s
Presolved: 12 rows, 36 columns, 72 nonzeros

Iteration    Objective       Primal Inf.    Dual Inf.      Time
       0    3.2900000e+02   2.000000e+00   0.000000e+00      0s
       3    3.6000000e+02   0.000000e+00   0.000000e+00      0s

Solved in 3 iterations and 0.01 seconds
Optimal objective  3.600000000e+02
map[Doctor1,Patient1] 1
map[Doctor1,Patient2] 0
map[Doctor1,Patient3] 0
map[Doctor1,Patient4] 0
map[Doctor1,Patient5] 0
map[Doctor1,Patient6] 0
map[Doctor2,Patient1] 0
map[Doctor2,Patient2] 0
map[Doctor2,Patient3] 0
map[Doctor2,Patient4] 1
map[Doctor2,Patient5] 0
map[Doctor2,Patient6] 0
map[Doctor3,Patient1] 0
map[Doctor3,Patient2] 0
map[Doctor3,Patient3] 1
map[Doctor3,Patient4] 0
map[Doctor3,Patient5] 0
map[Doctor3,Patient6] 0
map[Doctor4,Patient1] 0
map[Doctor4,Patient2] 0
```

Screenshot 2



References:

1. http://www.mathcs.emory.edu/~cheung/Courses/323/Syllabus/Assignment/intro.html
2. https://www.youtube.com/watch?v=6Kb22Rebx9g&t=1s