ISyE/CS524 – Problem Set #6

Due Date: **Friday** October 27, 2023. 09.00AM.

Formulate the following problems in GAMS and solve them. Please follow the instructions given in the problems closely. Submit this assignment electronically to the drop box in one zip archive containing exactly 6 files with the following names: `hw6-1.gms, hw6-2.gms, hw6-3.gms, hw6-1.lst, hw6-2.lst, hw6-3.lst`

1 It's Easy as 1,2,3

ABC, Inc., is considering several investment options. Each option has a minimum investment required as well as a maximum investment allowed. These restrictions, along with the expected return are summarized in Table 1 (figures are in millions of dollars).

Option	Minimum investment	Maximum investment	Expected return(%)
1	3	27	13
2	2	12	9
3	9	35	17
4	5	15	10
5	12	46	22
6	4	18	12

Table 1: Investment Options for ABC

Because of the high-risk nature of Option 5, company policy requires that the total amount invested in Option 5 be no more that the combined amount invested in Options 2, 4 and 6. In addition, if an investment is made in Option 3, it is required that at least a minimum investment be made in Option 6. ABC has $80 million to invest and wants to maximize its total expected return on investment.

1.1 Problem

Write a GAMS model to determine which options ABC, Inc. should invest in. What is the maximum total expected return on investment? Display this in a parameter named `expectedReturn`. Display the investment options taken in a set called `investments`. The code below should be used.

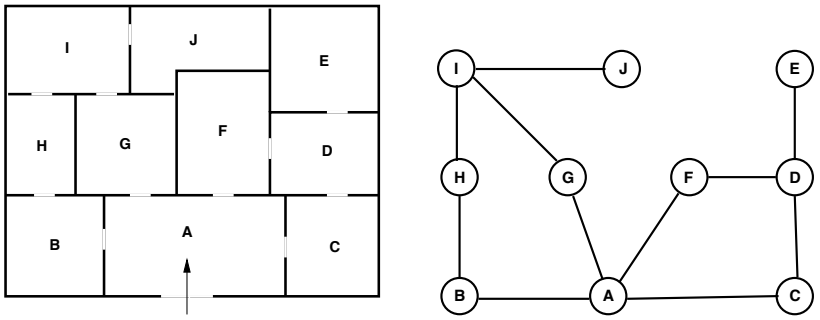
```
parameter expectedReturn;
expectedReturn = z.L; display expectedReturn;

set investments(I);
investments(I) = yes$(invest.L(I) > 0.5);
options investments:0:0:1; display investments;
```

2 Museum guards

A museum director must decide how many guards should be employed to control a new wing. Budget cuts have forced him to station guards at each door, guarding two rooms at once.

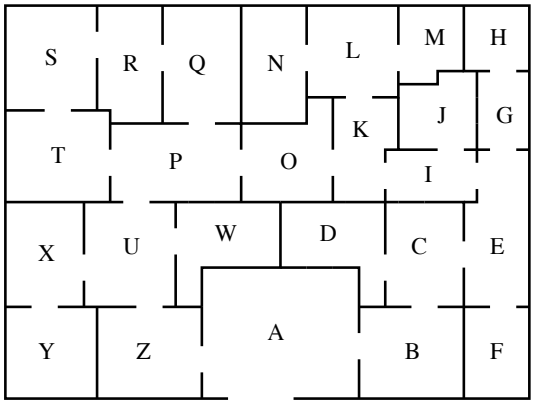
2.1 Problem

Formulate a mathematical program to minimize the number of guards. Solve the problem on the map (or equivalent graph: think of choosing arcs to "cover" nodes) below:



2.2 Problem

Also solve for the data given as



For this second set of data only, report your solution as a two dimensional set `stations` that indicates which doors the guards are placed at. (Note: no room "V")

3 Covering Dark Wizards

Chaos has descended upon the wizarding world, and the Order of the Phoenix is the only group that can stop the outbreak of dark magic. Dumbledore has a budget of 10 million galleon (ɢ) in order to allocate create Order of the Phoenix remote offices throughout the wizarding world. Seven locations are possible for the offices, and each office will only cover/save a certain set of communities from the spread of dark magic. Table 2 gives the construction

cost of each site and the communities the office would cover if constructed. The number of magical inhabitants of each community is listed in Table 3.

Table 2: Properties of Order of Phoenix Remote Offices

Site	**Cost (in million ₲)**	**Communities Covered**
1	1.8	1,2,4
2	1.3	2,3,5
3	4.0	4,7,8,10
4	3.5	5,6,8,9
5	3.8	8,9,12
6	2.6	7,10,11,12,15
7	2.1	12,13,14,15

Table 3: Population

Community	Inhabitants (in 1000)
1	2
2	4
3	13
4	6
5	9
6	4
7	8
8	12
9	10
10	11
11	6
12	14
13	9
14	3
15	6

3.1 Problem

Write a GAMS model to determine the set of offices to open for Dumbledore. Be sure to set parameters so that the resulting MIP is solved optimally:

```
option optcr = 0; option optca = 0;
```

Use `x` as a gams variable indicating whether the office was opened at site `J`, and `pop_covered` as the gams variable indicating the number of people covered, and include the following code after your solution is complete:

```
set open(J); open(J) = yes$(x.L(J) > 0.5);
option open:0:0:1; display open, pop_covered.L;
```