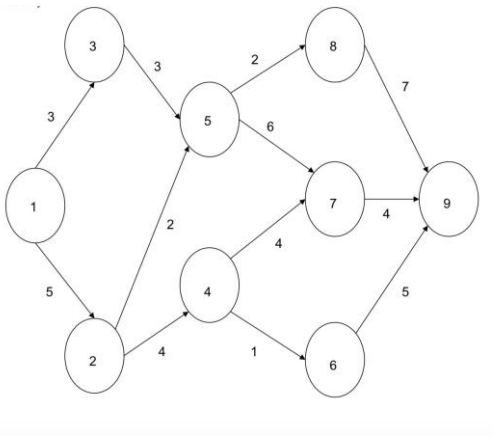
## Summary

**Assignment 6_myusuf2**

**Q1**

Consider the following activity-on-arc project network, where the 12 arcs (arrows) represent the 12 activities (tasks) that must be performed to complete the project and the network displays the order in which the activities need to be performed. The number next to each arc (arrow) is the time required for the corresponding activity. Consider the problem of finding the longest path (the largest total time) through this network from start (node 1) to finish (node 9), since the longest path is the critical path.




**Q1a:** Formulate and solve the binary integer programming (BIP) model for this problem using library "lpsolve" or equivalent in R.H.

**Solution 1a**

*Solution 1a:*

/Objective function/

Max: 5 x12 + 3 x13 + 3 x35 + 4 x24 + 2 x25 + 4 x47 + 1 x46 +2 x58 + 6 x57 + 5 x69 + 4 x79 + 7 x89;

**/ Constraints/**

**/Starting Node/**

x13 + x12 = 1;

**/Intermidiary Node/**

x12 - x25 - x24 = 0;
x13 - x35 = 0;
x25 + x35 - x57 - x58 = 0;
x24 - x46 - x47 = 0;
x58 - x89 = 0;
x46 - x69 = 0;

**/End Node/**
x57 + x47 - x79 = 1;

bin
x12, x13, x35, x24, x25, x47, x46, x58, x57, x69, x79, x89

**Q2**

The Research and Development Division of the Emax Corporation has developed three new products. A decision now needs to be made on which mix of these products should be produced. Management wants primary consideration given to three factors: total profit, stability in the workforce, and achieving an increase in the company's earnings next year from the $75 million achieved this year.

**Q2a**

Selecting an Investment Portfolio An investment manager wants to determine an optimal portfolio for a wealthy client. The fund has $2.5 million to invest, and its objective is to maximize total dollar return from both growth and dividends over the coming year. The client has researched eight high-tech companies and wants the portfolio to consist of shares in these firms only. Three of the firms (S1 – S3) are primarily software companies, three (H1–H3) are primarily hardware companies, and two (C1–C2) are internet consulting companies. The client has stipulated that no more than 40 percent of the investment be allocated to any one of these three sectors. To assure diversification, at least $100,000 must be invested in each of the eight stocks. Moreover, the number of shares invested in any stock must be a multiple of 1000.

The table below gives estimates from the investment company's database relating to these stocks. These estimates include the price per share, the projected annual growth rate in the share price, and the anticipated annual dividend payment per share.

| | Stock | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | S1 | S2 | S3 | H1 | H2 | H3 | C1 | C2 |
| Price per share | $40 | $50 | $80 | $60 | $45 | $60 | $30 | $25 |
| Growth rate | 0.05 | 0.10 | 0.03 | 0.04 | 0.07 | 0.15 | 0.22 | 0.25 |
| Dividend | $2.00 | $1.50 | $3.50 | $3.00 | $2.00 | $1.00 | $1.80 | $0.00 |

1) Determine the maximum return on the portfolio. What is the optimal number of shares to buy for each of the stocks? What is the corresponding dollar amount invested in each stock?

**Solution 2b.**
The anticipated return of stock = D1/P0 + g
S1 =2(1+0.005) /$40 + 0.05 = 10.25

S1 =1.5(1+0.10) /$50 + 0.10 = 13.30
S1 =3.50(1+0.03) /$80 + 0.03 = 7.51
H1 =3.0(1+0.04) /$60 + 0.04 = 9.2
H1 =2.0(1+0.07) /$45 + 0.07 = 11.76
H1 =1.0(1+0.15) /$60 + 0.15 = 16.92
C1 =1.8(1+0.22) /$30 + 0.22 = 29.32
C2 =0.0(1+0.25) /$25 = 0.00

The max. amount invested in one sector = $2.5 m multiplied by 40% = $1.0m
The minimum investment in each stock is 100,000
The Return on the Portfolio when we invest equally would be:
10.25 +13.3 +7.51 +9.2 +11.76 +16.92 +29.32 +0/8 = 12.28

Now, 40% of investment in sector 3 (c1, c2) = C1 = 900,000, C2 = 100,000
40% of investment in sector 2 (H1, H2, and H3) = H1 = 100,000, H2 = 100,000, and H3 = 800,000
The balance in sector 1(S1, S2, and S3) = S1 = 100,000, S2 = 300,000, and S3 = 100,000, S2 = 300,000, S3 = 100,000
The maximum return in portfolio = 10.25* (0.1/2.5) +13.3*(0.3/2.5) +7.51*(0.1/2.5) + 9.2*(0.1/2.5) + 11.76*(0.1/2.5) +16.92*(0.8/2.5) + 29.32*(0.9/2.5) + 0.00*(0.1/2.5) =19.11%

Therefore, the optimum number of shares to buy each of the stock would be"
S1 =100,000/40 =2,500
S2 =100,000/50 =2,000
S3 =300,000/80 = 3,750
H1 =100,000/60 =1,666.67
H2 =100,000/45 =2,222.22
H3 =800,000/60 = 13,333.33
C1 =900,000/30 =30,000
C2 =100,000/25 =4,000

**Q2b:** Compare the solution in which there is no integer restriction on the number of shares invested. By how much (in percentage terms) do the integer restrictions alter the value of the optimal objective function? By how much (in percentage terms) do they alter the optimal investment quantities?

**Solution 2b.**

In removing the integer restrictions from the number of shares, we would take the optimal number of shares invested in the following:
H1 =1,6660

H2 =2,200
H3 = 13,000
The investment on;
H1 = 1,6660*60 =99,600
H2 =2,200*45 =99,000
H3 =13,000*60 =780,000

Therefore, new investment =
100,000+100,000+300,000+99,600+99,000+780,000+900,000+100,000 =2,478,600
%change =(2,500,000-2,478,600)/2,500,000 =0.85%

Our new optimal function =19.04%
The % change is (19.11 – 19.04)/19.11 =0.36%