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MSDS 460 – Decision Analytics

MSDS 460 – HW #2: DECISION ANALYTICS

1.

This how my decision variables and setting up the problem looks:

The objective function can be figured: by figuring out the profit off each product – the cost for each material. For example:

101-(7\*3 + 2\*5 + 4\*15) is the profit for product A – cost for Material 1

When computing all these the Objective function is

10\*X1 + 10\*X2 + 10\*X3

The constraints are:

3\*X1 + 1\*X2 + 5\*X3 <= 300

2\*X1 + 4\*X2 + 0\*X3 <= 400

4\*X1 + 2\*X2 + 3.5\*X3 <= 200

X1 >= 0

X2 >= 0

X3 >= 10

Application, table, Excel

Description automatically generated

After solving the problem using Solver, I got X1 =0 , X2 = 82.5 , X3 =10

Graphical user interface, application, table, Excel

Description automatically generated

I got a maximum profit of $925.

2.

We know from that we need to find objective function for morning and evening. We know the cost of making a football and baseball in the morning and evening differ. So we have to make 4 decision variables: two for morning – M1 AND M2 representing football and basketball, two for evening representing football and baseball. E1 and E2, then the objective function and constraints are shown below:

Objective function

20M1 + 20M2 + 25E1 + 25E2

Constraints:

0.75M1 + 2M2 =< 5,000

0.75E1 + 2E2 =< 2,000

7M1 + 15M2 =< 15,000

7E1 + 15E2 =< 14,000

0.5M1 + 2M2 =< 2,000

0.5E1 + 2E2 =< 1,500

M1 + E1 >= 1500

M2 + E2 >= 1200

M1, M2, E1, E2 >= 0

This is how to setup the problem in excel:

Table

Description automatically generated

After setting up the problem; the solution is:

Table

Description automatically generated

With the answer in the morning we get that the minimum cost we can get is 60,346.15, with 808 footballs, 623 baseballs made in the morning, and 692 footballs and 576 baseballs made in the evening.

3.Let the decision variables be A, B, C, D, E, F be decision variables

The objective function is

A + B + C + D + E +F where A-F is number of shifts

A – Midnight shift – 4 AM

B - 4 AM- 8 AM

C – 8 AM – 12 Noon

D – 12 Noon – 4 pm

E – 4 pm – 8 pm

F – 8 pm – 12 am

With the following information we can then figure out constraints

A + B >= 6 Since everyone need to get in 8 hours A will overlap with the B shift AND SO ON.

B + C >= 10

C + D >= 12

D + E > = 8

E + F >= 5

F + A >= 5

A-F >= 0

With this information we can setup our Excel spreadsheet:

Graphical user interface, application, table, Excel

Description automatically generated

The solution to this problem is shown below

Graphical user interface, application, table, Excel

Description automatically generated

The minimum number of firefighters against all shifts is 23

For shifts A-F We need 5,1,9,3, 5,0 firefighters respectively.

4.

The decision variables are Xi where i is 1-4 representing month and X represents Standard Rotary Pump. Let Y represent be Heavy Duty Rotary Pump and i is 1-4 representing month making Yi. With this information we can make the objective function and we have to take into account the cost will increase every month. Our goal is to minimize cost.:

Z = 125X1 + 135Y1 + 131.25X2 + 141.75Y2 + 137.8125X3 + 148.8375X3 + 144.70X4 + 156.28X4

We will need to add on cost in inventory for each product so we can use two new variables U for Standard and W for Heavy Duty inventory.

Our new objective function:

125X1 + 135Y1 + 131.25X2 + 141.75Y2 + 137.8125X3 + 148.8375Y3 + 144.70X4 + 156.28Y4 5U1 + 5U2 + 5U3 + 5U4 + 5W2 + 5W3 + 5W4

Now our constraints:

We know only 1800 of both can be in inventory

U2 + W2 ,U3 + W3, U4 + W4 <= 1,800

U4 >= 800

W4 >= 850

1000 =< 0.45X1 + 0.52Y1 =< 1200ADD 200 for 200 extra months

1000 =< 0.45X2 + 0.52Y2 =< 1200

1000 =< 0.45X3 + 0.52Y3 =< 1200

1000 =< 0.45X4 + 0.52Y4 =< 1100 Add only 100

To keep track of inventory

U1 = 0 + X1 – 650

U2 = U1 + X2 – 875

U3 = U2 +X3 – 790

U4 = U3 + X4 -1300

W1 = 0 + Y1 – 900

W2 = W1 + Y2 -350

W3 = W2 + Y3 -1200

W4 = W3 + Y4 -1300

Now we set up the following in Excel:

A screenshot of a building

Description automatically generated

After we solve we get the following solution:

Graphical user interface, application, table, Excel

Description automatically generated

This solution tells us that the minimal cost is $1,211,541.93 assuming the constraints and demand.

5.

A. The number of small and large offices the developer should build are 3 small offices and 44 large offices.

B. The total optimal monthly revenue is: 600\*3 + 750\*3 + 44\*1000 = 1800 + 2250 + 44,000 = 48050.

C. 100,000 – 48,200 = 51,800 square footage will be remained unused.

D. Increasing the rent will not change the allocations; however, it will change the objective function only because we will make more money off the increase rent. We do not want to increase number of small and medium rooms as will lose money as determined by shadow price; however, our profit function will increase by 2400+2250 + 44,000 = 48,650 – 48,050 = 600 dollars. So, this is what increasing rent will have.

E. The additional square footage of 52,800 will have no impact on the optimal solution and office units. We will have more unused area.

F. 48,050 - 650\*3 + 750\*3 + 800\*44 = 8,650

An increase in rent for small offices and decrease in rent in large office rents will have no impact on the optimal solution as it will remain the same. The profit will go down to 39,400, which is a 8,650 decrease.

Extra Credit:

For the solution I first setup the solution in Excel:

Table

Description automatically generated

From this the extreme points is when the objective function is maximized at X1 = 3.3, X2 = 0, and X3 = 1.67 as shown below:

Table, Excel

Description automatically generated

And the extreme points is when objective function is minimized at X1, X2, X3 all = 0.

Table

Description automatically generated