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MSDS 460 – Decision Analytics

HOMEWORK #1

Problem #1

For the first problem let X_1 be Italian Cabinet Style, let X_2 be French Country, and let X_3 be Caribbean

To Maximize his daily profits, **the objective function** is:

$72X_1 + 65X_2 + 78X_3$

The **constraints** are for Carpentry, Painting, and Finishing are:

$3X_1 + 2.25X_2 + 2.50X_3 <= 1,360$

$1.50X_1 + X_2 + 1.25X_3 <= 700$

$0.75X_1 + 0.75X_2 + 0.85X_3 <= 430$

Where

$X_1, X_2, X_3 >= 60$

There seems to be no other constraints, so we are now done setting up this problem.

Problem # 2

Let the Decisions variables be for in house

A - Gear A

B - Gear B

C - Gear C

D -Gear D

Let A’ B’ C’ D’ be for outsourcing Gears A-D

To Figure out objective function to maximize we first have to figure out profits which can be determined by

(Revenue - Hours Per Gear*Cost Per Hour – (Outsourcing))

This is the same as the profit function which is

P(x) = R(x) – C(x)

The Inhouse Cost was subtracted from Revenue:

Revenue Cost of Processes

(12.50A + 15.6B + 17.4C + 19.3D) – (6.55A + 7.89B + 7.956C. + 8.565D)

To get the function below which is in the form

(In house – Outsource Cost) which is the function you are trying to maximize for profits

With this in mind our objective function to maximize is:

Inhouse Revenue – Cost Combined - Outsource Cost

5.95A + 7.71B + 9.435C + 10.735D – (7.10A’ + 8.10B’ + 8.40C’ + 9.00D’)

The constraints for this problem are:

A <= 400

B <= 500

C <= 450

D <= 600

(Represents constraint for demand for each gear)

0.30A + 0.36B +0.38C + 0.45C <= 500 (represents 500 hrs available for forming)

0.20A + 0.30B +0.24C + 0.33C <= 300 (represents 300 hrs available for hardening)

0.30A + 0.30B +0.35C + 0.25C <= 310 (represents 310 hrs available for deburring)

A, B, C, D >= 0

The constraints for outsourcing are:

A’ <= 300

B’ <= 300

C’ <= 300

D’ <= 300

A’, B’, C’, D’ >= 0

Problem # 3

We first want to write out the distances between each machine and the new machine which can represent the objective function:

$Z = |X_1 -3| + |X_2| + |X_1| + |X_2 + 3| + |X_1 -2| + |X_2-1| + |X_1-1| + |X_2-4|$

Once we know our objective function the next thing to do is create decision variables which can be substituted into the function:

So our decision variables can be:

$X_1 -3^+ , X_1 -3^-$

X_2^+, X_2^-

X_1^+, X_1^-

$X_2 +3^+ , X_2 +3^-$

$X_1 -2^+ , X_1 -2^-$

$X_2 -1^+ , X_2 -1^-$

$X_1 -1^+ , X_1-1^-$

$X_2 -4^+ , X_2-4^-$

With this information we can define the set of absolute values above to:

$|X_1 -3| = X_1 -3^+ + X_1 -3^-$

$|X_2| = X_2^+ + X_2^-$

$|X_1| = X_1^+ + X_1^-$

$|X_2 + 3| = X_2 +3^+ + X_2 +3^-$

$|X_1 -2| = X_1 -2^+ + X_1 -2^-$

$|X_2-1| = X_2 -1^+ + X_2 -1^-$

$|X_1-1| = X_1 -1^+ + X_1-1^-$

$|X_2-4| = X_2 -4^+ + X_2-4^-$

After defining the set above, we can then reconstruct the objective function:

$Z = X_1 -3^+ + X_1 -3^- + X_2^+ + X_2^- + X_1^+ + X_1^- + X_2 +3^+ + X_2 +3^- + X_1 -2^+ + X_1 -2^- + X_2 -1^+ + X_2 -1^- + X_1 -$

$1^+ + X_1-1^- + X_2 -4^+ + X_2-4^-$

The only constraint is that the variables all have to be greater than >= 0

$X_1 -3^+ , X_1 -3^-$

X_2^+, X_2^-

X_1^+, X_1^-

$X_2 +3^+ , X_2 +3^-$

$X_1 -2^+ , X_1 -2^-$

$X_2 -1^+ , X_2 -1^-$

$X_1 -1^+ , X_1-1^-$

$X_2 -4^+ , X_2-4^-$

>= 0

Problem # 4

Let the Decision Variables be

B – City of Miami Municipal Bonds

C – American Smart Cars

E – GreenEarth Energy

P – Rosslyn Pharmaceuticals

R – Real Co Real Estate

The objective function to maximize is:

$0.053B + 0.088C + 0.049E + 0.084P + 0.104R$

The constraints are:

We know the brokerage is obligated to invest a total of 500,000 so:

$B + C + E + P + R <= 500,000$

The other constraints are:

$B >= 0.25(B + C + E + P + R)$ signifies at least 25% in municipal bonds

$R + P >= 0.10(B + C + E + P + R)$ signifies at least 10% in Real estate and Pharmaceuticals

$E + C >= 0.40(B + C + E + P + R)$ signifies at least 40% in Energy and automobile stocks

$E >= 0.15(B + C + E + P + R)$ signifies at least 15% in Energy

$C >= 0.15(B + C + E + P + R)$ signifies at least 15% in Automobile

$(R + P) =< 0.50(E + C)$ Signifies no more than 50% of the total amount invested in energy and automobile stocks in a combination of real estate and pharmaceutical company stock

$B, C, E, P, R >= 0$

There seems to be no other constraints, so we are now done setting up this problem.

Problem # 5

We have:

Objective Function $5X_1 + 4X_2$

Subject to $X_1+2X_2 <= 6$

$-2X_1+x_2 <= 4$

$5X_1+3X_2 <= 15$

X_1, X_2

To solve using the graphical method:

1. We first want to figure out a corresponding equation:

Corresponding equations are:

$X_1+2X_2 = 6$

$-2X_1+x_2 = 4$

$5X_1+3X_2 = 15$

2. Next we want to be able to find X and Y Intercept coordinates to graph:

To find x-intercept simply plug in 0 for X_2

This gives us three y-intercept coordinates for the corresponding equations above:

(6,0)

(-2, 0)

(3, 0)

Next find all the y-intercepts by plugging in 0 for X_1 in the equation in Step 1, and the corresponding coordinates are:

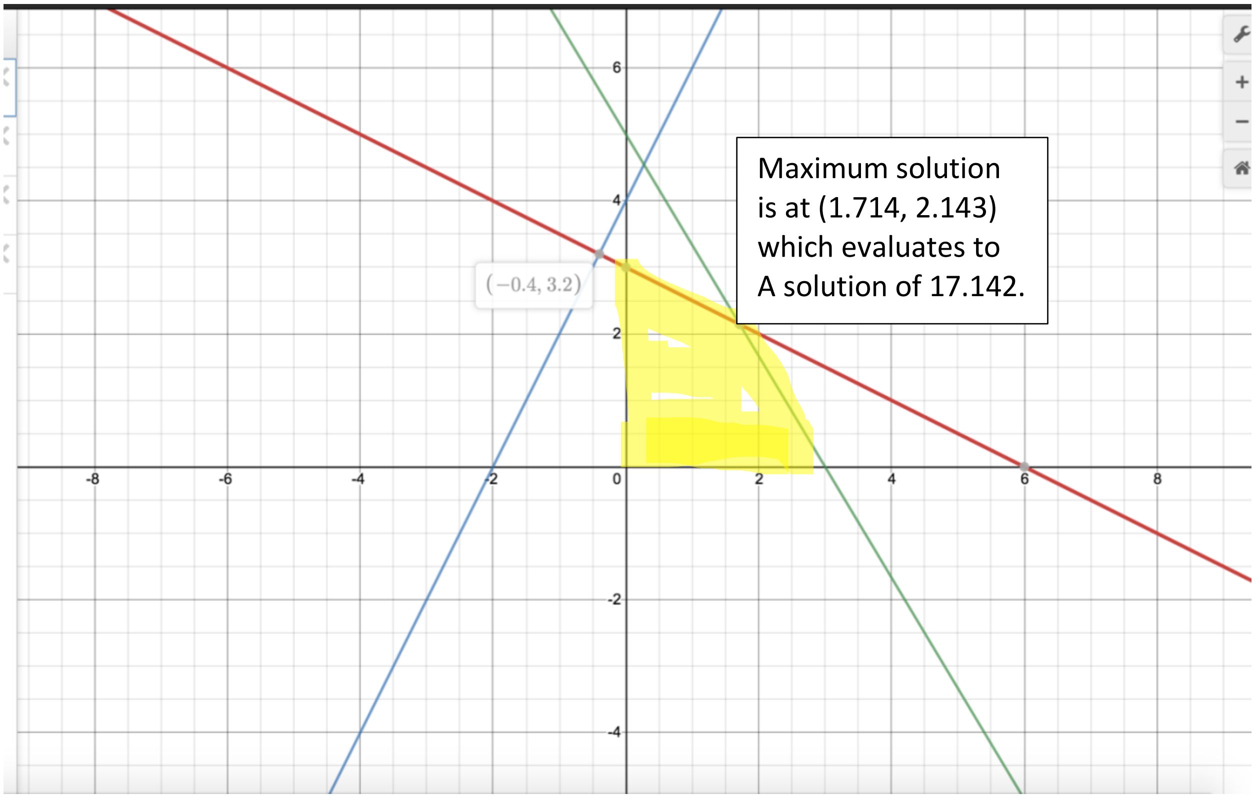
(0, 3)

(0, 4)

(0, 5)

3. We can then find the correct graph depicted below

Feasible region is in yellow



Extra Credit:

To reform we instead the objective function to say

We introduce new variables to substitute in

$Z_1 \ldots Z_n$, where n = 3

This makes our objective function

$W = 2Z_1 + Z_2 + 3Z_3$ which we want to minimize

We then have to define what Z1…ZN stand for which is

$Z_1 >= Y_1^+ + Y_1^-$

$Z_2 >= Y_2^+ + Y_2^-$

$Z_3 >= Y_3^+ + Y_3^-$

We then reconstruct the constraints:

Subject to

$x_1 + 2x_2 + x_3 + Y_1^+ - Y_1^- = 5$,

$-x_1 + 8x_2 - 2x_3 + Y_2^+ - Y_2^- = 2$,

$-2x_1 + x_2 + 4x_3 + Y_3^+ - Y_3^- = 8$,

$x_1 + 3x_2 + x_3 \qquad = 10$,

$x_1, x_2, x_3, Y_1^+, Y_1^-, Y_2^+, Y_2^-, Y_3^+, Y_3^- \geq 0$.