Advanced Business Decision Support Systems
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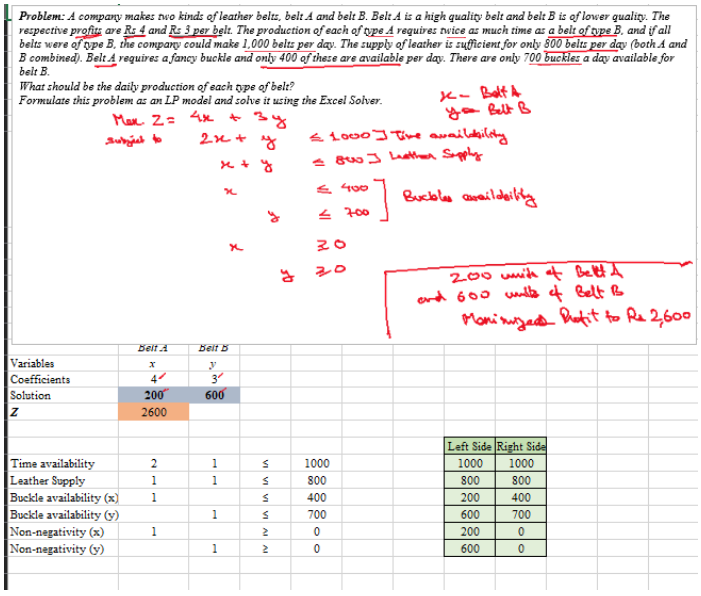
Lecture 20
Linear Programming Graphical Method, MS Excel Demonstration

Welcome to the next lecture on Linear Programming. We have discussed the problem formulation, the graphical method in the previous lectures. So, now I have opened my excel sheet here, where I will try to solve the simplex problem statement which is mentioned here.



This is also taken from the references which I just mentioned. A company makes two leather belts belt A and belt B. Belt A is a high quality belt and belt B is of lower quality.

The respective profits are rupees 4 and rupees 3 per belt which means, belt A and belt B are given for which, corresponding profits are given. And, we can say that, my x denotes belt A and y denotes belt B. It is given, try to formulate the problem so that, we get the radial production for each type of belt, it should be a maximization problem. The production of each of type A belt requires twice as much as a belt type B and if all belts were of type B, the company makes 1000 belts per day.

You can see, how is it given the supply of leather is sufficient for only 800 belts. So, both A and B combined the supply is 800 belts. Belt A requires fancy buckle. Now, the buckling problem or the buckle is there one of the constraints. Fancy buckle and only 400 of these buckles are available per day that is for belt A and 700 buckles a day are available for belt B.

What should be the daily production of each type of belt? So, we need to maximize the production. So, this is definitely a maximization problem because there is a profit involved maximize the production that maximize the profit as well. So, we try to formulate the problem here as, maximize z is equal to rupees 4 * x and rupees 3 * y. 4x + 3y subject to the constraints. The constraints are given in three forms here.

One is type A requires twice as much of the time as type B and we can make maximum of 1000 belts per day that means, whatever the value for B I put here, I need to put two times the value of A that is, $2x + y \leq$ total units could be 1000. Now, second constraint for this is, my time availability. Now, the second constraint is for the leather supply. They say leather supply is only for 800 belts for both A and B combined that means, if I manufacture x numbers of A and y units of B ≤ 800, which is my leather supply, this is time availability.

Now, also there are buckle constraints for the belt A, the number of buckles available are only 400 and for the belt B, the number of buckles which are available are only 700 the max. This is my buckles availability. Yes, we should definitely have the non negativity constraints that is, $x \geq 0$ and $y \geq 0$. I have formulated the problem statement completely here. Let us try to solve this using the excel solver now.

So, I will just try to put it in a table here or generator table here. I would say belt A and belt B, I would like to put the variables here and coefficients to those variables to get my objective function value z. So, the variables here are x and y. The coefficients to these variables are given in the objective function is 4 and 3. So, this objective function is there, before even having objective functions, I need to put my solution here.

The solution is something, where the change would come and we will get the values here in these two cells so that, we optimize the value of z. So, what is the value of z here, this = the product of the coefficients to the solution value. So, I could put here. So, this = 4 times the solution value of x and 3 times the solution value of y. I can put separate formulas or let me try to put here sum product formula.

So, sum product, I will select from here sum product of what I would select B19 to C19 multiplied by I put comma B20 into C20 bracket close, enter. So, this value is 0 because we do not have any values for solution as of now. So, this is how we start our simplex problem formulation in excel. Now, we have three kinds of constraints, one is the time

availability, then we have supply of leather, supply of buckles and non-negativity. I have to put each of the constraints in a separate row.

So, let me try to name the constraints which I have one is time availability. Time availability constraint, I will just take these values from here $2x + 1y \leq 1000$. So, 2x that means, I will put value 2 here for x, 1 for y and this right hand side value is 1000. This is time availability. I will also put the expression here.

This expression is less than equal to, so I have put a constraint expressions here. I will just copy and put this expression does not mean here in solver anything but just because I need to select these expressions in the solar program, I will try to put that in the solar program as well. So, there is a selection option available there. So, I just need to know this, what this value is. So, similarly the second constraint is the Leather Supply.

Leather supply, we have $1x + 1y \leq 800$ that means, 1x and $1y \leq 800$ is right hand side. Then we have buckles availability for x. This is here, I have 1 for x and 0 for y, 1 for x and nothing for $y \leq 400$. Then, buckle availability, I will just copy this and just put the letter y here. So, buckle availability for y is 0 for x and 1 for y in the equation $y \leq 700$.

Now, non negativity constraints and non negativity for x and for y both of them, I will put non negativity for x would be $1x + 0y \geq$. So, $\geq$ sign, I have put signs here already. I will just copy and paste this sign here. This is greater than equal to 0 and for y, this is y this is $0x + 1y \geq 0$.

All of them are center aligned and this is how I get my data entered into the excel. Now, to get the data for the solver, I will try to put the constraints that is, what is on the left side and what is on the right side for my solver. On the left side, what I have the solution that I get is from the product of the corresponding change coefficients for x and y to my solution values. Solution values are given in the cells B20 and C20 and for time availability, the change coefficients are given in the cells B24 and C24. What I will say, I like to have a sum product of the corresponding change coefficient values for time availability with my solution values, close the bracket and enter.

So, as of now, there is no number in the cells B20 or C20. So, the value has come as 0. Similarly, for the leather supply, again I say, I need to have some product. I could do it separately like, for the leather supply, I will again select these two coefficients and multiply it them with the solution variables. This is a separate calculation or what can I do because the solution values would be here.

All the time same, I can just lock this value, I will put dollar sign before B and 20 and before C and 20 as well this is locked and I drag this formula here for all of them. This is left side is generated, right hand side is nothing, but directly, I copy the right hand side value. This equal to 1000, this equal to 800, it is a same cell or I just drag the formula

from here. So, now only this small table, I will just border it properly. This is used to get a solution here.

So, I will color it by solution, let me say is having this color and maximization problem or the maximum value would have a color, I would put a light orange color here and these are the values. I need to select I will also put some color here. So, only the colored portion that you could see is used in my solver. To start with the solver, I need to see, whether solver is there in my excel program or not, which is an additional add in. This add in is there in the data tab here.

So, you can see, in the top data tab is there, I go to these tabs. So, data tab, if I click on the extreme right hand side, the solver should be there, which I do not see as of now. So, what I do, I go to the file menu and try to locate the options. Here the options are down here. So, this is the newer version of MS excel

In the options, I try to go to add in, you can see General, Formula, Data, Proofing everything is available. I go to add ins, then we need to manage the add ins here this selection menu here. So, it is asking excel com, what kind of add in do you need to do? I need to have excel add ins and I say go. So, make sure, this in this popped up window solver add in is checked. So, one I have selected it and I say ok, the solver should come here.

Now, we can see solver has come on the right hand side. Now, I select the solver and you can see, there are options available whether, we need to maximize or minimize, this is objective function, this is a solution, where do we need to get and we can put the constraints and we can select the method. There are certain methods available GRG, non-linear simplex and linear programming or evolutionary simplex linear programming is my focus of attention in this lecture. The objective function, I will just select it from here. The objective function value is here, this is cell B21 and I say enter.

Now, changing variable values, I click on the right hand side arrow here, which says, upload the changing variable cells here. So, here I try to add the solution values, which are the cells B20 and C20 and again, I press enter then, we start adding the constraints. For each constraint, I can add individually or I can even add a group of constraints, let me try to add constraint individually. So, this is left hand side of the constraint is this and the sign is less than equal to which is already there. So, this expression could be less than equal to more than equal to integer binomial or differential anything could be selected from here.

So, this is less than equal to, so what is the constraint right hand side value, this is 1000. I say enter and I add another constraint in which, left hand side less than equal to, right hand side value is 800. I say this add then, I add another constraint left hand side less

than equal to and right hand side is 400. Left hand side is given here then, it need to select or upload the left right hand side value which is 400.

I press enter and add similarly, I will add constraint for the buckle availability of y, the cell reference is given here, the value the expression is less than = right hand side of the constraint is 700 which I select again, I would only now add the non negativity constraints cell reference, here is 0 for the left hand side.

Now, I need to change this expression because this is non negativity constraint. This is greater than = the last constraint is left, this is greater than = nonnegativity constraint. Now, all the constraints are added and I can see H24, 25, 26, 27, 28, 29, you can see in the column H cell numbers 24, 25, 26, 27, these are all added and the corresponding RHS values that is, I24, 25, 26, 27, 28, 29 are added for the first four constraint the expression is less than equal to for the last two constraint, the expression is greater than equal to everything seems to be perfect.

Let me now try to solve using the MS excel solver, solve the objective cell must contain a single cell on the active sheet. There was a small issue in the objective cell, it says the two cells cannot come.

So, somehow, two cells were given here, so I would just reselect small errors do come, but we need to correct them. So, this is objective cell a single cell, where the objective function is to be calculated and given finally. So this is a cell number B21 and I press enter. Now, this should be clear. So, let me now try to click the solve button. Hope everything is perfect.

Okay, yes it has completely solved the problem statement. You can see, it has now suggested 200 units of belt A and 600 units of belt B gives me the maximum value of the objective function that is, 2600 rupees profit is taken which is here. So, I can say, here the solution is 200 units of belt A and 600 units of belt B maximizes profit to rupees 2600. So, this is a problem statement that is solved using MS excel. With this, week is over and we have discussed Linear Programming.

So, certain extended part of the very basic simplex method are not covered in detail in this week. For example, for the minimization problem, Big M method is here, two phase method is here. Sometimes, degeneracy also do come. These all could be taken by yourself, try to refer to the books, which are given in the reference slide of the provided notes to you and if you have any issues, try to come up in the forum.

We will try to cater to your problems or your issues in the forum to the best of our ability and we will try to meet in the next week. We will try to see the transportation problem and assignment problem which are also deterministic models, which are also related to Linear Programming. Let us meet in the next week now. Thank you.