SOLVING LKINEAR OPTIMIZATION MODEL: USING EXCEL

# EXAMPLE PROBLEM

Jessie and her friend Patrick are working together in their art class to make blankets to sell on the weekend. Their most popular blankets are their classic blue blanket and their royal red blanket. To make their classic blue blanket, it takes them

* 30 minutes to get the supplies ready for the blanket
* 1 hour to make the blanket
* And 30 minutes to finish and box up the blanket

For the royal red blanket, it takes them

* 45 minutes to get the supplies ready for the blanket
* 30 minutes to make the blanket
* And 1 hour to finish and box up the blanket

Jessie and Patrick set 40 hours aside each week for getting their supplies ready to make the blanket. They have an additional 40 hours that they allocate each week for making their blankets. Lastly, they dedicate 60 hours a week to the finishing touches and boxing up their blankets jessie and Patrick sell their classic blue blanket for a $15 profit and their royal blanket for a $20 profit. How many of each type of blanket should jessie and Patrick make to maximize their product

* 40 hours to prepare
* 40 hours to make
* 60 hours to finish
* Blue = 15 profit
* Red = 20 profit

# Setting up the problem on paper

To start, it is helpful to write out your model on paper 1st so that you will have everything you need in front of you when you go to set up your model in Excel. Therefore, for this first section make sure that you write down everything on paper.

1. Identify the problem being solved

Whiles this may seem like and obvious thing to do, making sure that you are solving for the correct problem is important because this will set the foundation for the rest of the problem. Often times this is the goal that is to be achieved.

1. For this example, the problem that needs to be solved is finding “how many of each type of blanket that should be made to maximize their profit.”
2. Identify the decision variables

The decision variables are going to be the values that need to be solved for that will help answer the problem. For this problem we have two decision variables: (1) The number of classic blue blankets to make a, (2) the number of royal red blankets to make. These are the decision variables because you want to know how many of each blanket should be made to produce maximum profit

* 1. To represent each decision variable, you want to let them be equal to a variable to easily use them throughout the problem. For simplicity,
     1. LET X1 = the number of Classic blue blankets to make
     2. LET X2 = the number of royal red blankets to make
  2. Write down these variables to let it be known that you are “letting” these variables be equal to your decision variables. To do this write “LET” at the beginning of your decision variables to show that is what the variables are for. Your decision variables should look like the lines above

1. State the objective function

The objective function will include your decision variables and their respective coefficients that will be necessary to solve the problem that you’re solving, and express if you’re trying to maximize or minimize the answer

* 1. For this problem the coefficients are going to be the profits gained by selling each of the blankets. Since you are trying to maximize profits write” MAX” to identify that is what the goal is and set the equation up with each variable multiplied by its respective profit.
  2. Since there are two decision variables our objective function will look like this

MAX: $15(X1) + $20(X2)

1. State the constraints

The constraints are going to be anything that would limit our ability to make any amount of any decision variable. For this problem there are 3 time constraint as well as non-negativity, which states that you cannot produce a negative amount of blankets. The 3 time constraints are: (1) amount of time allowed to get supplies ready, (2) amount of tie allowed to make blankets, (3) Amount of time allowed to finish blankets

* 1. For the first time constraint, the amount of time to get supplies ready, it takes 30 minutes for the Blue blankets and 45 minutes for the red blasnkets and there are 40 hours per week allowed for this task.
  2. Set up this constraint by lableing it, so that it is known what the constraint is “subject to”, and then show that for every one Blue blanket that is made it will take 30 minutes plus for every Red blanket that is made it will take 45 minutes, and you can’t spend more than 40 hours(2400 minutes) making them. Your first constraint should look like this:
     1. GETTING SUPPLIES READY: 30X1 + 45X2 <= 2400
  3. Set up the other two constraints the same way showing how much time would be used per blanket being made. You need to show that you have these contraints “subject to” what is being constrained, so you need to write “S.T.” to show for that. All together the 3 time contraints should look like this:
     1. S.T.: X1>=0, X2>=0

GETTING SUPPLIES READY: 30X1 + 45X2 <= 2400

MAKING BLANKETS: 60X1 + 30X2 <=2400

FINISHING TOUCHES: 30X1 + 60X2 <=3600

Lets build it in excel now

Similar to how you set up the objective function so that it was right

below and lined up with the decision variables, you are going to

want to line up the values from each constraint with the variables for

which they belong to. To label that you are about to start your

constraints, skip a row between the Objective Function and then

type “Constraints” in cell A7.

a. Type the first constraint (Getting supplies ready) under the

Constraint header you just typed in A7.

b. Add the values to the right that state the amount of time that each

blanket will take to get the supplies ready. (30 for B8, 45 for C8).

c. To the right you need to write a formula that will state how much

of a certain constraint you have used to make sure that you either

use enough (≥), not more than you have(≤), or an exact amount (=).

You can use the same SumProduct formula as used above to find

how much time you will need to spend if you were to make some

given number of blankets. Type in cell D8 “=SumProduct(B3:C3,

B8:C8)” to get the total amount of time that would be spent getting

supplies ready for the total amount of blankets that should be made.

d. Another row over in cell E8 add in the equality that you have for

the given constraint, so that it is easy to see when adding into solver

and looking back. For this constraint you want to use less than or up

to the amount available, so you will type in ≤.

e. Lastly, another row over un cell F8 type in the amount of the

constraint that you have available to be used. For the about of time

allowed to get supplies ready there is 2,400 minutes.

For each of the other constraints that you have (except for the non-

negativity constraint) follow the same steps (a through e) to fully set

up all your constraints. Once you have all your constraints, in cell D7

type in Used to indicate that is how much of the constraint you have

used and type Available in cell F7 to indicate how much of each

constraint you have available to use.

After completing the steps above your model should look similar to

the one in Figure 1 below.

3. Using Solver

Now that you have all of your information typed into Excel and

necessary functions setup, you can go to solver to solve for the

optimal solution to the problem.

a. Go to the Data tab and click on solver.

b. In the “Set Objective” box, click or type in the cell that is

designated for the Objective Function output. For this problem, the

cell is D5.

c. Next click on either Max or Min depending on whether the

problem is asking to minimize or maximize the output. Since the

problem to be solved is to Maximize profit, click on Max.

d. In the “By Changing Variable Cells” box click or type in the cells

that are designated for the decision variables, which are cells B3:C3.

e. Next, click on “Add” to add a constraint. (Though the constraints

are already on the worksheet, you need to now let solver know that

you want certain cells to be greater than, less than, or equal to other

cells.)

f. First to show that you want the values that are used to be less than

the values that are available, in the “Cell Reference” box select the

cells D8:D10, have the sign be ≤ , and in the “Constraint” box select

the cells F8:F10.

g. Click “Add” to add the next constraint.

h. Now you need to add in the constraint for non-negativity. Adding

this will keep the values for the number of units to produce

(blankets) from being an impossible negative number.

i. Similar to the other constraints, for the “Cell Reference” box

highlight the cells that are designated for the decision variables, add

in the appropriate sign, which is ≥, and then say what the values

must be greater than. For this you can type in the value that the

number of blankets you make must be greater than, which is 0.

j. Click “OK” now that you have added you last constraint.

k. Check that all the constraints that you wrote down are now

accounted for in solver.

l. After you have selected “Simplex LP” for the Solving Method, click

Solve.

You should see your decision variables and any value connected to

your decision variables (your Objective Function output and the

amount of your constraints that should be used) change.