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AN OPTIMAL SOLUTION OF A LINEAR PROGRAMMING PROBLEM WITH AN EXCEL SOLVER

V.T.Lakshmi
Associate Professor
Department of Mathematics
Vinayaka Mission's Kirupananda Variyar Engineering College
Vinayaka Mission's Research Foundation (Deemed to be University), Salem-636 308,
Tamil Nadu, India

Abstract

Mathematical, engineering, scientific, commercial, and economics topics all present optimization challenges. In business operations, the linear programming technique is a critical decision-making tool for maximizing a solution within the restrictions of available resources. The Graphical Method and the Simplex Methods are often employed to solve the linear programming issues. Microsoft Excel comes with a solver add-in, used to solve a system of equations or inequalities to arrive at a solution. This paper shows how to use the Solver to solve a simple LP problem to find the optimal solution.

Keywords

Linear Programming (LP), Optimization, Maximization, Minimization, Microsoft Excel Solver.

INTRODUCTION

Linear Programming (LP) is a technique used in quantitative analysis to help with the decision-making process for business-oriented projects. It is a technique for optimizing a solution within the constraints of available resources. The LP consists of three parts, the objective function, resource restrictions of inequalities, and the non-negative variables. The LP problem can be solved generally in two methods viz the Graphical Method and the Simplex Method. If the LP consists of only two variables, the graphical method of solving the LP problem is simple and easy. However, if a problem has three or more variables, the simplex method is the most appropriate. LP problems can be solved using a variety of computer applications. Microsoft Excel is also used to solve LP problems with its SOLVER application. Hence, the Solver application is needed. This paper explores how to solve a simple LP problem using Microsoft Excel Solver.

Let us begin with a simple illustration:

Consider the following linear programming problem.

Maximize $z = 4x+10y$
Subject to $2x+y\leq50$
$2x+5y\leq100$
$2x+3y\leq90$
& $x,y\geq0$

Input the above data into Microsoft Excel worksheet as in the given model.

	A	B	C	D	E	F
7						
8		Variables	x	y	Maximize	Limits
9		Solution				
10		Maximiz	4	10		
11						
12		Constrai	2	1	<=	50
13			2	5	<=	100
14			2	3	<=	90

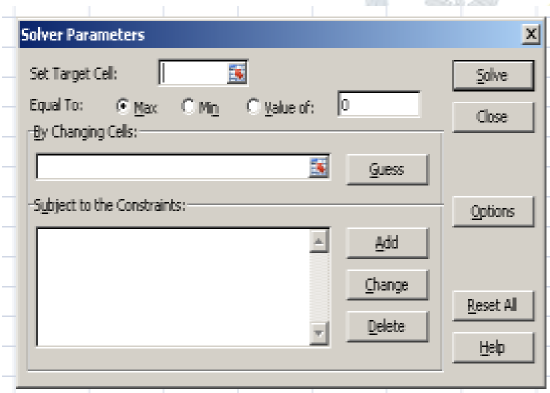
The following formulae can be set out for each cell to get the initial solution.

- E4 = C5*C4+D5*D4
- E8 = C8*C4+D8*D4
- E9 = C9*C4+D9*D4
- E10 = C10*C4+D10*D4

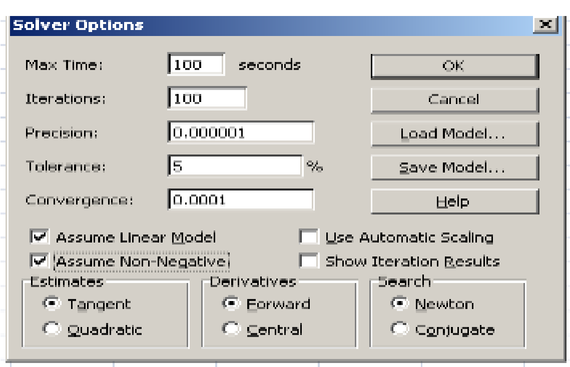
	A	B	C	D	E	F	G
1							
2							
3		Variables	x	y	Maximize		
4		Solution	0	0	0		
5		Contribution	4	10			
6							
7		Constraints					Limits
8			2	1	0	<=	50
9			2	5	0	<=	100
10			2	3	0	<=	90

Now click on the Data tab along the top of the Excel window.

In the analysis panel, please click on the Solver button, then the solver tool will open.

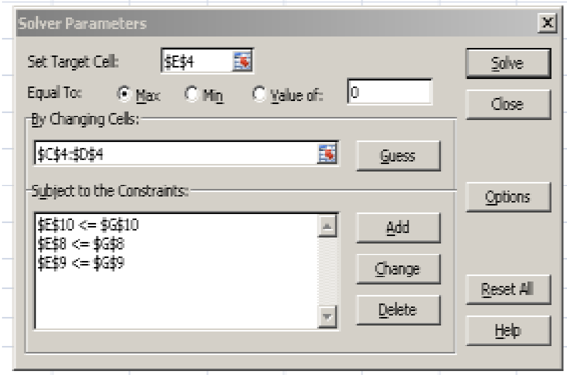


In Solver parameters, click the options button and set" Assume linear model" and "Assume Non-Negative". Please click the OK button to return to the Solver parameter box.

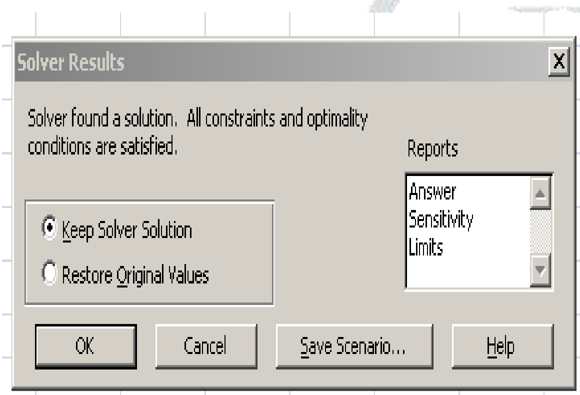


Now in the Solver parameter,

- Set the target cell (E4 in the above table)
- Set the optimization problem (Maximization in this case)
- Set the changing cell (C4 and D4)
- Please click Add in solver to add the constraints.



Please click OK in the Add constraints to get the above table, now click Solve in the Solver parameter, it shows



Please click Keep Solver Solution, Click OK in the Solver Result to get the problem solved in the cell. The result will occur as follows.

	A	B	C	D	E	F	G
1							
2							
3		Variables	x	y	Maximize		
4		Solution	0	20	200		
5		Contribution	4	10			
6							
7		Constraints					Limits
8			2	1	20	<=	50
9			2	5	100	<=	100
10			2	3	60	<=	90

While we are applying the graphical method for the above problem, we may get the same solution only. However, it is quite easy to enter the data in the excel sheet and use the solver to find out the solution in Excel solver.

I think it is not only for two variables. Up to 200 variables, we have to apply this in Excel solver to find the solution very easily.

In one more example, I use Excel Solver to solve the LP problem.
Maximize $Z = 15x_1+6x_2+9x_3+2x_4$
Subject to

$2x_1+x_2+5x_3+6x_4 <= 20$

$3x_1+x_2+3x_3+25x_4 <= 24$

$7x_1+x_4 <= 70$

& $x_1, x_2, x_3, x_4 >= 0$

Enter the data in the Excel worksheet, fix the formula in the required cell, and we get the following table.

					Possibility		
Variables	x1	x2	x3	x4	Maximize		
Solution					0		
Contribution	15	6	9	2			
Constraints							
	2	1	5	6	0	≤	20
	3	1	3	25	0	≤	24
	7	0	0	1	0	≤	70

.

After applying the Solver, we get the following result.

					Possibility		
Variables	x1	x2	x3	x4	Maximize		
Solution	4	12	0	0	132		
Contribution	15	6	9	2			
Constraints							
	2	1	5	6	20	≤	20
	3	1	3	25	24	≤	24
	7	0	0	1	28	≤	70

In the above Excel sheet, the optimal (maximum) value is 132, at x_1=4, x_2=12, x_3=0 and x_4=0

While we are applying the simplex method, we get the same solution only.

CONCLUSION

Finally, I conclude that whether the problem is a maximization case or a minimization case, we have to apply the Microsoft Excel Solver to find the optimal solution for up to 200 decision variables very easily within a short time. Here no mathematical knowledge and complex procedures are needed for solving in Excel Solver. Non-Mathematics students also solved the LP problem by using this solver to obtain the optimal solution easily.

References

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