Decision Making Using Excel 2016

LEARNING OUTCOMES

1. Describe the use of the IF function.
2. Compare the functions of Goal Seek and Solver.

Introduction

Most of the decision-analysis tools on the market focus on one specific analytical technique, like simulation or decision trees. They may be tailored to a specific industry need, such as insurance claims modeling. Furthermore, the cost of these tools can run into the tens of thousands, even millions, of dollars. Microsoft Excel 2016 is an integrated set of tools that combines the best analytical methods, can be applied to different problems, and is reasonably priced.

The measure of any business intelligence solution is its ability to derive knowledge from data. This plug-in will examine a few of the advanced business-analysis tools that have the capability to identify patterns, trends, and rules and create "what-if" analyses.

This plug-in covers:

1. Using the *IF* function to conduct conditional tests on values and formulas.
2. Using *Goal Seek* to find an unknown value to produce a desired result
3. Calculating an optimum solution using the *Solver* function.

Creating Formulas Using the IF Function

The *IF* logical function will return one value if a condition is TRUE and another value if the condition is FALSE. Use the IF function when you want to compare two items in your workbook. The IF function looks like this:

=IF(logical_test,value_if_true,value_if_false)

Logical operators are used to compare numbers in two or more cells to a constant.	
=	Equal to
<	Less than
>	Greater than
<=	Less than or equal to
>=	Greater than or equal to
<>	Not equal to
NOT	Logical Not
AND	Logical And
OR	Logical Or

FIGURE T4.1

Logical Operators

- **Logical_test** is any value or expression that can be evaluated to TRUE or FALSE. For example, A10 = 100 is a logical expression; if the value in cell A10 is equal to 100, the expression evaluates to TRUE. Otherwise, the expression evaluates to FALSE. This argument can use any comparison calculation operator.
- **Value_if_true** is the value that is returned if the logical_test is TRUE. For example, if this argument is the text string "Within budget" and the logical_test argument evaluates to TRUE, then the IF function displays the text "Within budget." **Note:** Value_if_true can be another formula.
- **Value_if_false** is the value that is returned if the logical_test is FALSE. For example, if this argument is the text string "Over budget" and the logical_test argument evaluates to FALSE, then the IF function displays the text "Over budget." **Note:** Value_if_false can be another formula.

To use the IF function:

1. Select the cell in which you want to enter the function.
2. Click the **Formulas** tab, and then click the **Insert Function** button.
3. Click **IF** from the list of **Logical** functions, and then click **OK.**
4. In the **Function Arguments** dialog box that opens, enter the logical_test argument. This argument states the condition you want to test for. Use cell references and/or values with logical operators. Figure T4.1 displays the list of logical operators.
5. Enter the **Value_if_true** argument. This is the text string or value that will be displayed if the logical_test argument is true.
6. Enter the **Value_if_false** argument. This is the text string or value that will be displayed if the logical_test argument is false.
7. Click **OK.**

For example, in a loan analysis worksheet, you want to write a conditional expression that examines the ratio of a loan amount to a purchase price. The logic for solving this is if the ratio is greater than 0.8, then there is an assessment fee of $300. Otherwise, the assessment fee is $0.

To create a conditional expression:

1. Open the workbook **T4_LoanAnalysis_Data.xlsx** that accompanies this textbook.
2. Click cell **B14,** the cell that will display **Assessment** if the ratio of loan amount to purchase price is greater than 0.8—the same criteria for displaying (or not) an assessment fee of $300.
3. Type **=IF(B13/B4 > 0.8, 300, 0)** and press **Enter.** The cell displays **300** because the loan-to-price ratio is 0.875.

When you are unsure of a function and want help writing it, you can use the Insert Function command. Executing the Insert Function command opens a dialog box that lists functions by categories and helps you build the function.

To write an IF function using the Insert Function command:

1. Click cell **B16** to make it active.
2. Click the **Formulas** tab, and then click the **Logical** button and select **IF.** The **Function Arguments** dialog box opens (see Figure T4.2).
3. Click the **Logical_test** box and type **B13/B4>0.8** (there are no spaces in this line). Notice that the moment you type 0.8, the label TRUE appears to the right of the value. That indicates the current value of the expression based on the condition you just completed.

4. Click the **Value-if-true** box and type **300,** which is the value to return if the condition is true.
5. Click the **Value-if-false** box and type **0,** which is the value to return if the condition is false (see Figure T4.3).
6. Click **OK** to complete the function. Excel places the completed IF function into cell B16, calculates the value of the function, and displays 300 because the ratio of the down payment to the purchase price is greater than 0.8.

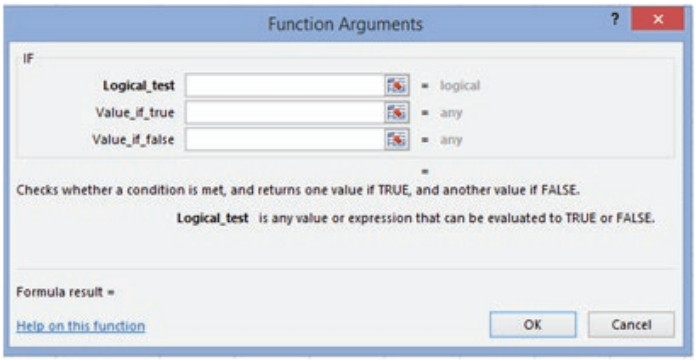


FIGURE T4.2
Function Arguments Dialog Box

Goal Seek

Goal Seek is an analytical function that allows a value in a formula to be adjusted to reach a desired result or answer. Goal Seek can eliminate unnecessary calculations that can be used to determine a single variable value in a formula. For example, a salesperson might participate in a bonus program that pays 3 percent of all sales dollars. The salesperson wants to receive a bonus of at least $2,500 and needs to know the target sales dollar amount needed.

Create a worksheet with the following information (see Figure T4.4 for a layout design):

Label	Cell Address	Value
Sale Dollars	B1	(unknown—leave blank)
Bonus Percentage	B2	3%
Bonus Amount	B3	=B1*B2

When the Goal Seek command starts to run, it repeatedly tries new values in the variable cell to find a solution to the problem. This process is called *iteration,* and it continues until Excel has run the problem 100 times or has found an answer within .001 of the target value specified. The iteration settings can be adjusted by clicking the **Office** button, then clicking **Excel Options,** clicking the **Formulas** button, and adjusting the **Maximum Iteration** options. It calculates so fast, the Goal Seek command can save significant time and effort over the brute force method of trying one number after another in a formula.

USING THE GOAL SEEK COMMAND

The Goal Seek feature is used to fill in the target value of the cell containing the *Sales Dollars* amount. In our example, the Goal Seek values should read Set cell = B3, To value = 2500, By changing cell = B1.

To use the Goal Seek command:

1. Click the **Data** tab. In the **Data Tools** group, click **What-If Analysis,** and then click **Goal Seek.**
2. In the **Goal Seek** dialog box, specify the cell that contains the desired value in the **Set cell:** box. Type in or select **B3.**
3. Enter the desired value or answer in the **To value:** box. Type in **2500.**
4. Enter the cell whose value will be changed in the **By changing cell:** box. Type in or select **B1.**

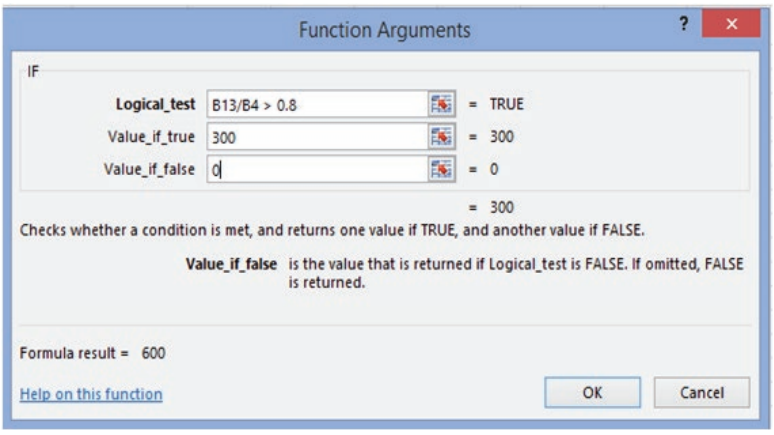
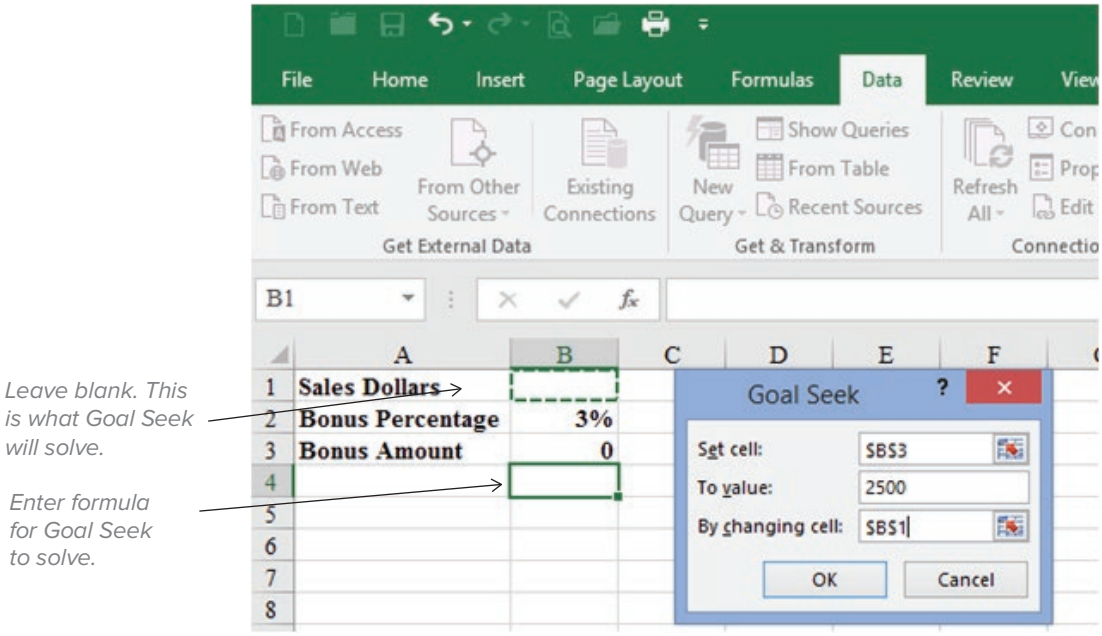


FIGURE T4.3
Function Arguments Dialog Box

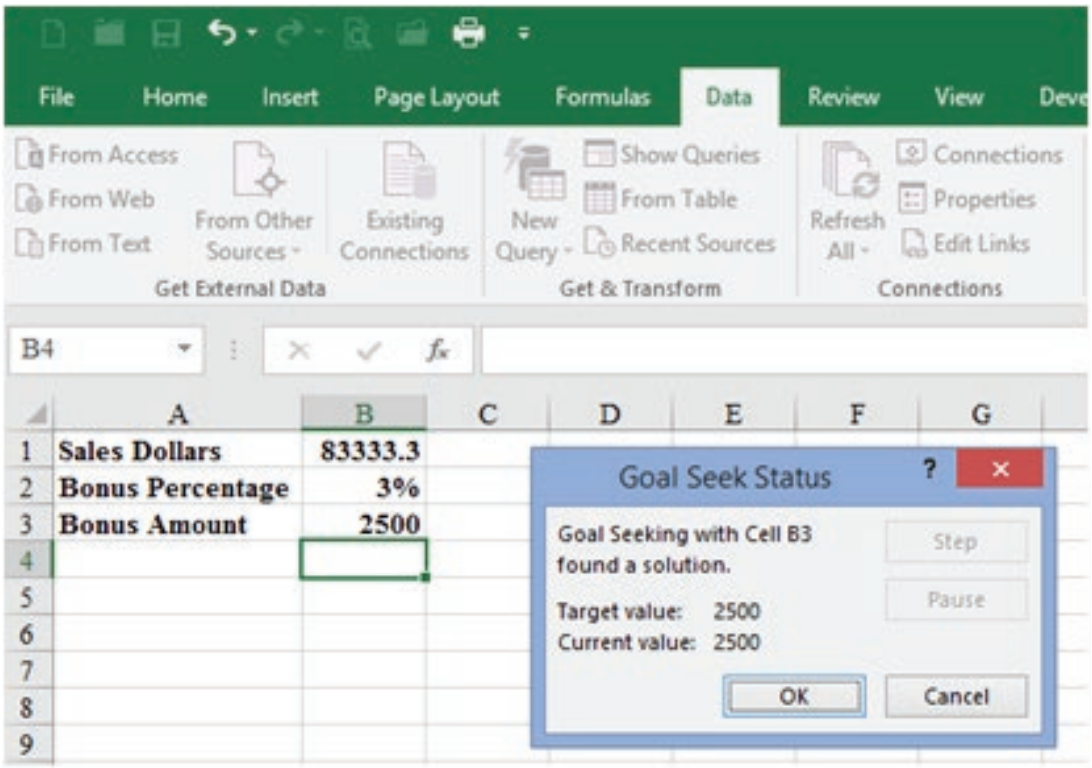
FIGURE T4.4
Goal Seek Worksheet



5. The Goal Seek dialog box should look like Figure T4.4.
6. Choose **OK.**
   a. If a solution is found, the **Goal Seek Status** dialog box appears.
   b. The results are shown in Figure T4.5.
7. Select **OK.**

Goal Seek is used to adjust a single variable in a formula. Use the Solver feature to adjust multiple variables in a formula, as described in the next section.

FIGURE T4.5
Goal Seek Results



Solver

Solver is part of a suite of functions sometimes called *what-if analysis tools* used for optimizing problems that contain more than one variable. The Solver add-in utility is needed to analyze the scenarios in decision-making situations that involve consideration of values and constraints for several variables simultaneously. This powerful function uses multiple changing variables and constraints to find the optimal solution to solve a problem.

For example, consider a coffee shop that currently sells three beverages: (1) regular fresh-brewed coffee, (2) premium caffe latte, and (3) premium caffe mocha. The current price for regular coffee is set at $1.25, caffe latte at $2.00, and caffe mocha at $2.25, but the revenue potential is uncertain. What special emphasis (or marketing) should be given to each of the beverages to maximize revenue? Although the premium coffees bring in more money, their ingredients are more expensive and they take more time to make than regular coffee. Making some basic calculations by hand is easy, but there needs to be some structure to the sales data in a worksheet so that periodic changes can be made and analyzed.

INSTALLING SOLVER

Solver comes with the standard Excel package, but it has to be installed. To install Solver:

1. Click the **File** tab, and then click **Options.**
2. Click **Add-Ins,** and then, in the **Manage** box, select **Excel Add-ins.** Click **Go.**
3. In the **Add-Ins Available** box, select the **Solver Add-in** check box, and then click **OK.**
4. After you load the Solver Add-in, the Solver command is available from the Data tab.

SETTING UP THE PROBLEM

The first step in using the Solver command is to build a "Solver-friendly" worksheet. This involves creating a target cell to be the goal of your problem-for example, a formula that calculates total revenue-and assigning one or more variable cells that the Solver can change to reach the goal.

To use Solver:

1. Set up a worksheet similar to Figure T4.6 (this will follow the scenario presented above).
2. The three variable cells in the worksheet are cells **D5, D9,** and **D13.** These are the cells whose values Solver needs to determine to maximize the weekly revenue.

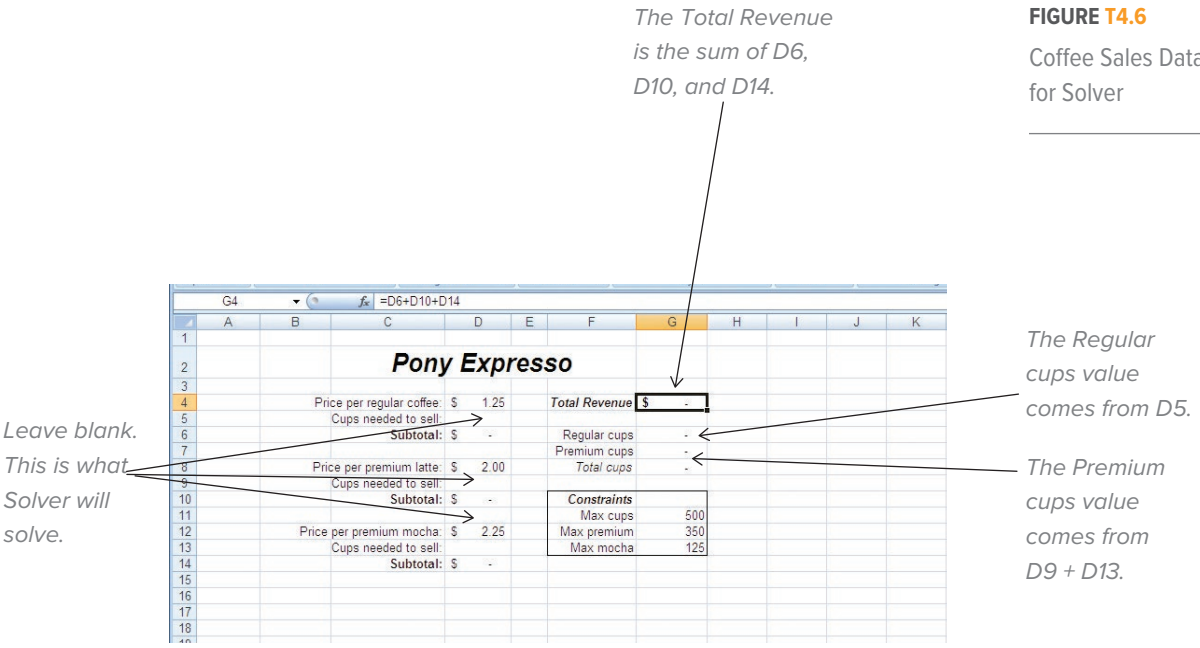


FIGURE T4.6
Coffee Sales Data Sheet for Solver

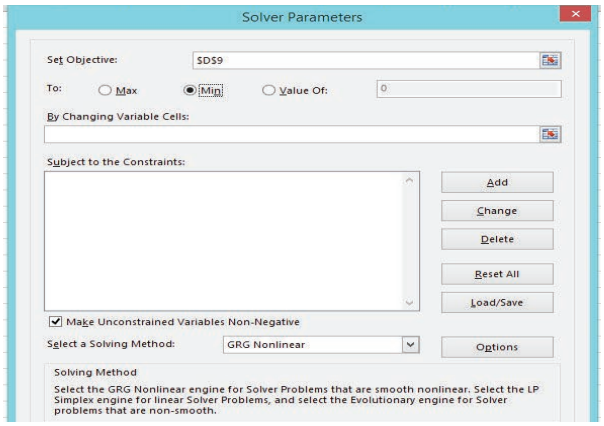


FIGURE T4.7

Solver Parameters Dialog Box

3. In the bottom-right corner of the table is a list of constraints to use for forecasting.
4. The worksheet must contain cells **(G6 through G8)** that include the formulas used as constraints. The limiting values for the constraints are listed in cells **G11 through G13:**
   - No more than **500** total cups of coffee (both regular and premium).
   - No more than **350** cups of premium coffee (both caffe latte and caffe mocha).
   - No more than **125** caffe mochas.
5. The subtotals for cells **D6, D10, D14** need to be calculated, as well as the **Total Revenue** (sum of D6, D10, and D14) in **G4.**
6. The value for cell **G6** should equal the value that will be calculated for D5, and the value for cell **G7** will be the sum of the values from D9 and D13. The calculation of **G8** equals the sum of D5, D9, and D13.
7. Click the target cell **G4**—the one containing the formula that is based on the variable cells you want Solver to determine.
8. Click on the **Data** tab, and then click the **Solver** button. The Solver Parameters dialog box opens, as shown in Figure T4.7. Select the **Set Target Cell:** box (unless it already contains the correct reference), and then click cell **G4** to insert **G4** as the target cell. The **Equal To:** option button, **Max,** is already selected. Do not change this since the problem requests the maximum value for the target cell.
9. Select the **By Changing Cells:** box. Click the **Collapse Dialog** button to the right of the box to collapse the dialog box. Select each of the variable cells by holding down the **CTRL** key and clicking **D5, D9,** and **D13.** This places commas between the three cell entries in the box: **D5, D9, D13** (see Figure T4.8).
10. This problem has three constraints. Click **Add,** in the **Subject to the Constraints:** section, to add the first constraint in the **Add Constraint** dialog box.

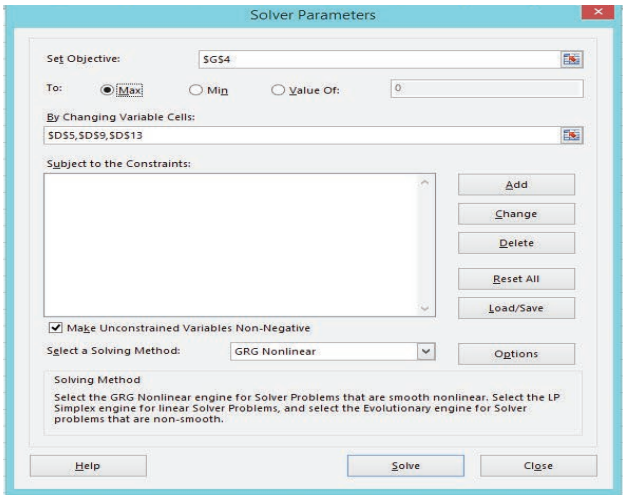


FIGURE T4.8

By Changing Cells Values in Solver Parameters Dialog Box

a. The first constraint is the coffee shop can sell only 500 cups of coffee in one week. To enter this constraint, after clicking in the **Cell Reference:** box, click cell **G8,** click **<=** in the operator drop-down list, and with the insertion point in the **Constraint:** box, type or click cell **G11.**

b. Click **Add** to enter the first constraint and begin the second constraint—the coffee shop can sell only 350 premium coffees in one week. With the insertion point in the **Cell Reference:** box, click cell **G7,** click **<=** in the operator drop-down list, and in the **Constraint:** box, type or click cell **G12.**

c. Click **Add** to enter the second constraint and begin the third—the coffee shop can sell only 125 caffe mochas in one week. Click cell **D13,** click **<=** in the operator drop-down list, and in the **Constraint:** box, type or click cell **G13.**

d. Click **OK** to add all three constraints to the Solver Parameters dialog box as shown in Figure T4.9.

11. Click **Solve** to calculate the result.
12. Solver displays a dialog box describing the results of the analysis. If Solver runs into a problem, an error message will be displayed. If Solver finds a solution, a Solver Results dialog box will appear.
13. To display the new solution in the worksheet, click the **Keep Solver Solution** option button in the Solver Results dialog box, and then click **OK.** Solver places an optimum value in the target cell and fills the variable cells with the solutions that satisfy the constraints specified and provide the optimal result, as shown in Figure T4.10.

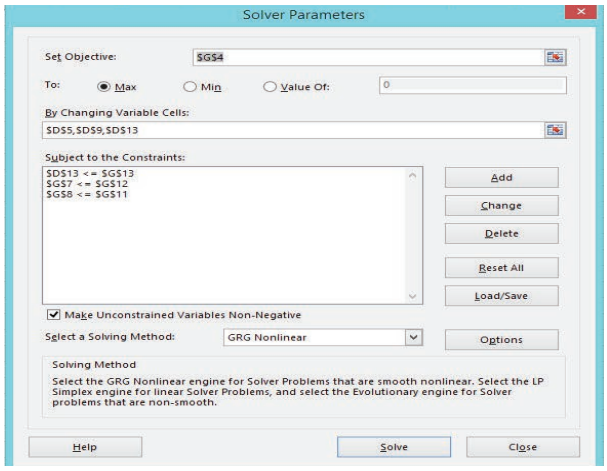


FIGURE T4.9

Solver Parameters with Constraints

EDITING A SOLVER FORECAST

The Solver tool is very useful in modifying the constraints to evaluate new goals and possibilities. For example, if a coffee shop wants to earn exactly $800 per week from coffee drinks, use Solver to "solve" for the optimum combination of drinks. Setting a target value in Solver is a little like using the Goal Seek command to determine a value for an unknown variable, although Solver can use more than one variable.

To edit the Solver forecast to find the variables to reach a specific goal:

1. Select the **Data** tab then select **Solver.** The Solver Parameters dialog box appears, still displaying the variables and constraints of the last Solver problem. These will be adjusted to compute a new forecasting goal.
2. Click the **Value of:** option button and type **800** in the box to the right. The Value of: option button sets the target cell to a particular goal to determine the variable mix needed to reach the milestone. The dialog box should look similar to Figure T4.11.
3. Click **Solve** to find a solution to the problem. When Solver has finished, click **OK** to display the new solution.
4. Figure T4.12 shows the new solution that Solver generates. (**Note:** The results presented in Figure T4.12 are one possible solution that Solver may return.)

FIGURE T4.10

Optimum Revenue for Solver Results

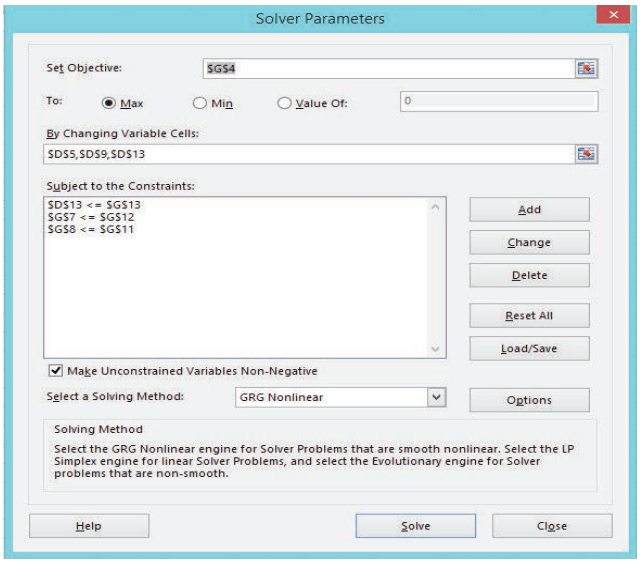
Given the constraints, Solver determined the cups needed to sell.

G4 =D6+D10+D14

	A	B	C	D	E	F	G	H	I
1									
2									
3									
4			Price per regular coffee:	$ 1.25		*Total Revenue*	$ 918.75		
5			Cups needed to sell:	150					
6			**Subtotal:**	$ 187.50		Regular cups	150		
7						Premium cups	350		
8			Price per premium latte:	$ 2.00		*Total cups*	**500**		
9			Cups needed to sell:	225					
10			**Subtotal:**	$ 450.00		***Constraints***			
11						Max cups	500		
12			Price per premium mocha:	$ 2.25		Max premium	350		
13			Cups needed to sell:	125		Max mocha	125		
14			**Subtotal:**	$ 281.25					
15									

FIGURE T4.11

Editing Solver Forecast



Modifying the constraints, Solver adjusted the cups needed to sell.

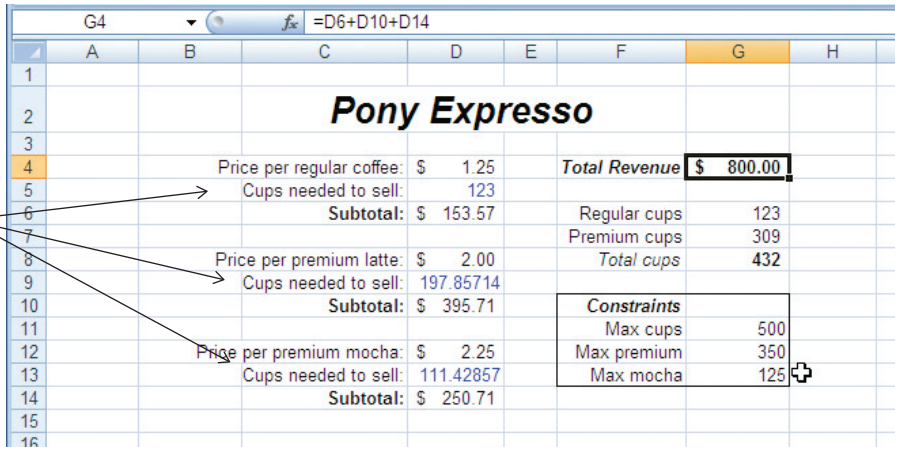


FIGURE T4.12

Solver Solution