Tutorial 7: Using Advanced Functions and Conditional Formatting

Microsoft® Excel® 2010
Objectives

• Use the IF function
• Use the AND function
• Use the OR function
• Use structured references in formulas
• Nest the IF function
• Use the VLOOKUP function
Objectives

• Review the HLOOKUP function
• Use the IFERROR function
• Use conditional formatting to highlight duplicate values
• Summarize data using the COUNTIF, SUMIF, and AVERAGEIF functions
When you create a formula that references all or parts of an Excel table, you can replace a specific cell or range address with a structured reference, which is the actual table name or column header.

The **AND function** is a logical function that returns a TRUE value if all of the logical conditions are true, and a FALSE value if any or all of the logical conditions are false.

The Function Arguments dialog box makes it simpler to build an IF function with a nested AND function (shown here) or a nested OR function for the logical test.
Logical Functions

The IF function is a logical function that evaluates a condition, and then returns one value if the condition is true and a different value if the condition is false.

In this formula, the structured reference [Annual Salary] references the cells in column K of the Employee table.

When a formula is entered in a cell within an Excel table, the formula is automatically copied to all cells in that column. The column is referred to as a calculated column.

A logical condition is an expression such as H2=“Y” that returns either a TRUE value or a FALSE value.

To test two or more conditions and determine whether all conditions are true, you use the AND function as the logical test of the IF function.

To test two or more conditions and determine whether any condition is true, you use the OR function as the logical test of the IF function.

The OR function is a logical function that returns a TRUE value if any of the logical conditions are true, and a FALSE value if none of the logical conditions are true.

New Perspectives on Microsoft Excel 2010
Working with Logical Functions

• Logical functions (IF, AND, and OR) determine whether a condition is true or false
• Conditions use a comparison operator (<, <=, =, <>, >, or >=) to compare two values
• Combine two or more functions in one formula to create more complex conditions
Inserting Calculated Columns in an Excel Table

• Entering a formula in one cell of a column automatically copies the formula to all cells in that column

• To modify the formula in a calculated column:
  – Edit the formula in any cell in the column
  – Formulas in all cells in the column are modified

• To edit only one cell in a calculated column:
  – Enter a value or a formula that is different from all others in that column
Creating Excel Table Fields

• Create fields that require the least maintenance
• Store smallest unit of data possible in a field
• Apply a text format to fields with numerical text data
Using the IF Function

- A logical function that evaluates a single condition and results in only one value
- Returns one value if the condition is true and another value if the condition is false
- Syntax: `IF(logical_test, [value_if_true], [value_if_false])`

```
False
  Add Life
  Ins = "Y"

Ins Premium = 0

True

Ins Premium = Annual Salary X Premium Rate
```
Using the IF Function

function arguments applied to the employee in the current row of the table

Checks whether a condition is met, and returns one value if TRUE, and another value if FALSE.

Value_if_false is the value that is returned if Logical_test is FALSE. If omitted, FALSE is returned.
Using the IF Function

A formula to calculate the life insurance premium is shown in cell N2:

\[ =IF(H2="Y",K2*0.001,0) \]

This formula checks if cell H2 contains "Y". If it does, it calculates the life insurance premium as \( 0.001 \times \text{K2} \), otherwise, it returns 0.

The calculated column in the spreadsheet is labeled "Life Ins Premium". All rows in column N are filled with the IF function as described.

A dash indicates 0 in the Accounting number format.
Using the AND Function

• A logical function that tests two or more conditions (up to 255) and determines whether all conditions are true
• Returns the value TRUE if all logical conditions are true and the value FALSE if any or all logical conditions are false
• Syntax: `AND(logical1 [,logical2,]...)`
Using the AND Function

- **False**: 401(k) Cost = 0
- **True**: 401(k) Cost = 3% X Salary

- Full-Time Employee AND employed 1 or more years
Using the AND Function

**Purpose:** To determine employee eligibility for the company’s 401(k) plan

**Logic Scenario:** An employee is eligible for the 401(k) plan if the employee’s status is full time (FT) AND the employee’s years of service total one or more years.

**Formula:** AND function with two conditions

```
=AND(G2="FT", M2>=1)
```

**Data:**
- cell G2 stores Employee Status
- cell M2 stores Years Service

**Example:**

<table>
<thead>
<tr>
<th>Data</th>
<th>Condition1</th>
<th>Condition2</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cell G2</td>
<td>Cell M2</td>
<td>G2=&quot;FT&quot;</td>
<td>M2&gt;=1</td>
</tr>
<tr>
<td>FT</td>
<td>1</td>
<td>True</td>
<td>True</td>
</tr>
<tr>
<td>FT</td>
<td>0</td>
<td>True</td>
<td>False</td>
</tr>
<tr>
<td>PT</td>
<td>5</td>
<td>False</td>
<td>True</td>
</tr>
<tr>
<td>PT</td>
<td>0</td>
<td>False</td>
<td>False</td>
</tr>
</tbody>
</table>
Using the AND Function

AND function used as the logical test

expression used if the logical test is false

expression used if the logical test is true

logical test is true for the employee in row 2

result for the employee in row 2
Using the OR Function

• A logical function that returns a TRUE value if any of the logical conditions (up to 255) are true and a FALSE value if all the logical conditions are false

• Syntax: \( \text{OR}(\text{logical1 [,logical2,]...}) \)
Using the OR Function

Purpose: To determine who is eligible for a discount

Logic Scenario: Discount is 10 percent for seniors (65 or older) or college students (Status = STU)

Formula: OR function with two conditions

=OR(B1>=65, B2="STU")

Data: cell B1 stores Age
      cell B2 stores Status (STU, FAC, STF)

Example:

<table>
<thead>
<tr>
<th>Data</th>
<th>Condition1</th>
<th>Condition2</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cell B1</td>
<td>Cell B2</td>
<td>B1&gt;=65</td>
<td>B2=&quot;STU&quot;</td>
</tr>
<tr>
<td>22</td>
<td>STU</td>
<td>False</td>
<td>True</td>
</tr>
<tr>
<td>65</td>
<td>FAC</td>
<td>True</td>
<td>False</td>
</tr>
<tr>
<td>67</td>
<td>STU</td>
<td>True</td>
<td>True</td>
</tr>
<tr>
<td>45</td>
<td>STF</td>
<td>False</td>
<td>False</td>
</tr>
</tbody>
</table>
Using Structured References to Create Formulas in Excel Tables

- Replace specific cell or range address with the actual table name or column header
  - Names or headers are simpler to identify than cell addresses
- A formula that includes a structured reference can be fully qualified or unqualified
Using Structured References to Create Formulas in Excel Tables

OR function used as the logical test (box is not wide enough to display the entire function)

Formula uses structured references to calculate the salary increases

Salary increases for employees
**Visual Overview**

A **nested IF function** is when one IF function is placed inside another IF function to test an additional condition, such as calculating employee bonuses based on pay grade.

The **lookup value** is the value you are trying to find. In this case, the lookup value is the code in the Health Plan column.

The invalid code in the Health Plan column causes the #IFERROR message to appear in the Health Cost column.

A **lookup table** is a table that organizes data that you want to retrieve into different categories, such as health plan codes. This lookup table is named “HealthPlanRates” and is used in the VLOOKUP function.

The compare values, the categories for a lookup table, are located in the table’s first column or row.
Nested IFs and Lookup Tables

When the lookup value matches a compare value, the corresponding value from the lookup table is returned to the cell with the lookup formula.

The VLOOKUP function (vertical lookup function) searches vertically down the first column of the lookup table (where the compare values are stored) and retrieves the appropriate value from the table.

This VLOOKUP function looks up Monthly Premium in a table of HealthPlanRates to calculate employee health cost.

The IFERROR function can determine if a cell contains an error value and then display the message you choose rather than the default error value, such as "Invalid code."
Creating Nested IFs

• To allow for three or more outcomes
• One IF function is placed inside another IF function to test an additional condition
• More than one IF function can be nested
Creating Nested IFs

Purpose: To determine the fee for a driver’s license

Logic Scenario: Driver’s license fee varies by age
- Below 16: "Too Young"
- 16-45: $30
- 46-60: $25
- 61 and older: $20

Formula: Nested IF functions
\[ =IF(B1<16,"Too Young",IF(B1<=45,30,IF(B1<=60,25,20))) \]

Data: cell B1 stores the driver’s age

Example:

<table>
<thead>
<tr>
<th>Data</th>
<th>Condition 1</th>
<th>Condition 2</th>
<th>Condition 3</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>B1</td>
<td>B1&lt;16</td>
<td>B1&lt;=45</td>
<td>B1&lt;=60</td>
<td>(Fee)</td>
</tr>
<tr>
<td>15</td>
<td>True</td>
<td>Not evaluated</td>
<td>Not evaluated</td>
<td>Too Young</td>
</tr>
<tr>
<td>25</td>
<td>False</td>
<td>True</td>
<td>Not evaluated</td>
<td>30</td>
</tr>
<tr>
<td>55</td>
<td>False</td>
<td>False</td>
<td>True</td>
<td>25</td>
</tr>
<tr>
<td>65</td>
<td>False</td>
<td>False</td>
<td>False</td>
<td>20</td>
</tr>
</tbody>
</table>
Creating Nested IFs

- Structured references make the formula easier to write.
- Use an absolute reference because this value is the same for all rows.
- Use a nested IF function to calculate the value_if_false.

The formula uses a nested IF function and structured references to calculate the bonus amount.

First IF function:

```
=IF([Pay Grade]=1, SY$2, IF([Pay Grade]=2, SY$3, SY$4))
```

Second (nested) IF function:

```
=IF([Pay Grade]=1, SY$2, 7500)
```

Bonus amounts for employees:
Using Lookup Tables and Functions

• **Lookup functions**
  – Allow you to use tables of data to “look up” values and insert them in another worksheet location

• **Lookup tables**
  – Store data and organize it into categories (compare values)
  – Can be constructed as either exact match or approximate match lookups
Using Lookup Tables and Functions

• Lookup values (value you are trying to find)
  – Need to match one of the compare values
  – Can be used as part of a formula
Using the VLookup Function to Find an Exact Match

• Searches a lookup table and, based on what you entered, retrieves the appropriate value from that table

• Searches vertically down the first column of the lookup table

• Syntax:

\[
\text{VLOOKUP}(\text{lookup_value}, \text{table_array}, \text{col_index_num}, [\text{range_lookup}])
\]
Using the VLookup Function to Find an Exact Match

- **Lookup_value**: Health plan code for the employee in row 2
- **Table_array**: Table that contains the data you want to look up
- **Col_index_num**: Column in the HealthPlanRates table that stores the monthly cost
- **Range_lookup**: FALSE makes the function an exact match lookup (this argument is optional)
- **Result**: Cost of the health plan for the employee in row 2 of the Employee table
Using the VLOOKUP Function to Find an Approximate Match

• Returns a value based on an approximate match lookup

• Searches the first column of the table until it locates the largest value that is less than the lookup value

• Then moves across the row in the table to retrieve the corresponding value
Using the VLOOKUP Function to Find an Approximate Match

omitting the range_lookup entry makes VLOOKUP an approximate match lookup
Looking Up Values Using the HLOOKUP Function

• Searches horizontally across top row of lookup table and retrieves the value in the column you specify

• Use when comparison values are located in the first row of the lookup table and you want to look down a specified number of rows to find the data to enter in another cell

• Syntax:

```
HLOOKUP(lookup_value, table_array, row_index_num, [range_lookup])
```
Looking Up Values Using the HLOOKUP Function

• Major difference between HLOOKUP and VLOOKUP functions is the way lookup tables are organized
Using the IFERROR Function

• Error value
  – Indicates that an element in a formula or a cell referenced in a formula is preventing Excel from returning a calculated value
  – Begins with a number sign (#) followed by an error name that indicates the type of error
Excel Error Values

- Excel error values are not particularly descriptive or helpful

<table>
<thead>
<tr>
<th>Error Value</th>
<th>Description of Error</th>
</tr>
</thead>
<tbody>
<tr>
<td>#DIV/0!</td>
<td>The formula or function contains a number divided by 0.</td>
</tr>
<tr>
<td>#NAME?</td>
<td>Excel doesn’t recognize text in the formula or function, such as when the function name is misspelled.</td>
</tr>
<tr>
<td>#N/A</td>
<td>A value is not available to a function or formula, which can occur when an invalid value is specified in the LOOKUP function.</td>
</tr>
<tr>
<td>#NULL!</td>
<td>A formula or function requires two cell ranges to intersect, but they don’t.</td>
</tr>
<tr>
<td>#NUM!</td>
<td>Invalid numbers are used in a formula or function, such as text entered in a function that requires a number.</td>
</tr>
<tr>
<td>#REF!</td>
<td>A cell reference used in a formula or function is no longer valid, which can occur when the cell used by the function was deleted from the worksheet.</td>
</tr>
<tr>
<td>#VALUE!</td>
<td>The wrong type of argument is used in a function or formula. This can occur when you supply a range of values to a function that requires a single value.</td>
</tr>
</tbody>
</table>
Using the IFERROR Function

• Displays a more descriptive message that helps users fix the problem
• Can determine if a cell contains an error value and then display the message you choose rather than the default error value
• Enables you to easily find and handle formula errors
• Syntax: `IFERROR(expression, valueIfError)`
Using the IFERROR Function

VLOOKUP function can’t find HMOG in the HealthPlanRates lookup table so #N/A is displayed.

IFERROR function used to check for error values.

Resulting error value.

Descriptive error message.

Data entry error.

Invalid code.
Visual Overview

Highlighting duplicate values adds formatting to cells that have the same entry. In this instance, a yellow fill highlights cells with the same employee ID.

The Conditional Formatting button provides access to the Duplicate Values conditional format and the Manage Rules option, which opens the Conditional Formatting Rules Manager dialog box.

Each time you apply a conditional format, you are defining a conditional formatting rule. You can also create a new rule from this dialog box by clicking the New Rule button.

A conditional formatting rule specifies the condition, the formatting, and the cell or range to apply the rule to. This rule highlights duplicate values with a yellow fill in the range A2:A101.

You can edit existing conditional formatting rules from the Conditional Formatting Rules Manager dialog box. Click the Edit Rule button and make the appropriate changes.
### Conditional Formatting

The **COUNTIF** function calculates the number of cells in a range that match criteria you specify, such as counting the number of company employees located in Austin.

The **SUMIF** function adds the values in a range that match criteria you specify, such as adding the total salary paid to Austin employees.

The **AVERAGEIF** function calculates the average of values in a range that match criteria you specify, such as calculating the average salary paid to employees in each city.

This formula must be fully qualified because the Employee table is located in a different worksheet.

These formulas use fully qualified structured references to make them easier to create and understand.

<table>
<thead>
<tr>
<th>Location</th>
<th>Count</th>
<th>Total Salary</th>
<th>Average Salary</th>
</tr>
</thead>
<tbody>
<tr>
<td>Austin</td>
<td>57</td>
<td>$3,969,426</td>
<td>$69,639</td>
</tr>
<tr>
<td>Home</td>
<td>7</td>
<td>$113,713</td>
<td>$16,244</td>
</tr>
<tr>
<td>Nashville</td>
<td>21</td>
<td>$33,795</td>
<td>$1,609</td>
</tr>
<tr>
<td>New Orleans</td>
<td>15</td>
<td>$1,513,526</td>
<td>$104,233</td>
</tr>
<tr>
<td>Total</td>
<td>100</td>
<td>$6,368,664</td>
<td>$63,645</td>
</tr>
</tbody>
</table>
Conditional Formatting

• Changes a cell’s formatting when its contents match a specified condition

• Can be used to:
  – Highlight cells based on their values
  – Add data bars that graph relative values in a range
  – Highlight duplicate values in a column of data
Using the Conditional Formatting Rules Manager

• A conditional formatting rule specifies:
  – Type of condition
  – Type of formatting when that condition occurs
  – Cell or range the formatting is applied to

• Use Conditional Formatting Rules Manager dialog box to edit existing conditional formatting rules
Using the Conditional Formatting Rules Manager

- Rules displayed for the Employee table
- Current rule formats cells with duplicate ID values with a red background fill
- Click to edit an existing rule
Using the Conditional Formatting Rules Manager

- Selected rule type
- Preview of the formatting for the selected rule type
- Click to open the Format Cells dialog box
Using the Conditional Formatting Rules Manager

![Excel screenshot showing conditional formatting rules](image)

- Background color of duplicate value is yellow.

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New Perspectives on Microsoft Excel 2010
Summarizing Data Conditionally

- Use COUNTIF, SUMIF, and AVERAGEIF functions to calculate a conditional count, sum, or average using only cells that meet a particular condition.
Using the COUNTIF Function

• Calculates the number of cells in a range that match specified criteria
• Sometimes referred to as a **conditional count**
• Syntax: `COUNTIF(range, criteria)`
Using the COUNTIF Function

- **beginning values in the Location column**
- **number of cells in the range that contain the criterion “Austin”**
- **criterion to determine which employee records to count**

Completed COUNTIF function:

- **number of employees located in Austin**
Using the SUMIF Function

- Adds values in a range that meet your criteria
- Also called a **conditional sum**
- Syntax: `SUMIF(range, criteria [, sum_range])`

![Diagram showing the use of the SUMIF function](image)
Using the AVERAGEIF Function

• Similar to SUMIF function
• Calculates the average of values in a range that meet criteria you specify
• Syntax: \texttt{AVERAGEIF(range, criteria [, average_range])}
Using the AVERAGEIF Function

- **Beginning values in the Location column:**
  - Employee[Location] = ("Austin"; "Home"; "New Orleans"; "Austin"

- **Criterion to determine how to filter the employee records:**
  - B4 = "Austin"

- **Data to average in the filtered records:**
  - Employee[Annual Salary]

- **Average annual salary for Austin employees:**
  - $69,639

- **Completed AVERAGEIF function:**
  - =AVERAGEIF(Employee[Location], B4, Employee[Annual Salary])

- **Average salary of employees located in Austin:**
  - $69,639

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New Perspectives on Microsoft Excel 2010