

Lecture Note #6: Functions Part 3

BUSI 201: Business Data Analysis

Topic 1. The VLOOKUP Function

Of all functions that we covered up to this point, the VLOOKUP function is one of the most useful. VLOOKUP is a function that searches a table for some specified item, and then returns the items in the same row as the item that was found. The basic syntax should be:

= VLOOKUP(LOOKUP VALUE,
RANGE WHERE LOOKUP VALUE IS LOCATED,
COLUMN NUMBER IN THE RANGE CONTAINING VALUE TO RETURN,
[EXACT/APPROXIMATE MATCH])

It is sometime mildly confusing to simply read the syntax of a function, especially when there are multiple arguments. Please navigate to sheet VLOOKUP in the workbook BUSI201-LEC05-Workbook.xlsx. This worksheet contains a list of items sold in a large retail store, with some internal item codes, make, item name, quantity in stock, and the price. Suppose that you want to look up information about a product based on the internal item codes.

| | A | 1 | 2 | 3 | 4 | 5 | G | H | I | J | K | L |
|----|-----------|-----------------|---------------------------|----------|------------|---|------|------|------|----------|-------|---|
| | Item Code | Make | Item Name | Quantity | Unit Price | | Code | Make | Item | Quantity | Price | |
| 2 | A101 | Samsung | Smart LED TV | 92 | \$ 599.99 | | A101 | | | | | |
| 3 | B102 | JBL | Bluetooth Speaker | 36 | \$ 79.99 | | B102 | | | | | |
| 4 | C103 | Logitech | Wireless Mouse | 12 | \$ 29.99 | | C103 | | | | | |
| 5 | D104 | Hamilton Beach | Coffee Maker | 14 | \$ 39.99 | | D104 | | | | | |
| 6 | E105 | Black & Decker | Toaster Oven | 42 | \$ 49.99 | | E105 | | | | | |
| 7 | F106 | Sony | Wireless Headphones | 86 | \$ 149.99 | | F106 | | | | | |
| 8 | G107 | Nestle | Bliss Bar | 48 | \$ 29.99 | | G107 | | | | | |
| 9 | H108 | Apple | Tablet | 65 | \$ 329.99 | | H108 | | | | | |
| 10 | I109 | HP | Laptop | 55 | \$ 699.99 | | I109 | | | | | |
| 11 | J110 | Whirlpool | Refrigerator | 38 | \$ 399.99 | | J110 | | | | | |
| 12 | K111 | Panasonic | Microwave Oven | 86 | \$ 129.99 | | K111 | | | | | |
| 13 | L112 | Cuisinart | Electric Kettle | 46 | \$ 29.99 | | L112 | | | | | |
| 14 | M113 | Conair | Hair Dryer | 69 | \$ 19.99 | | M113 | | | | | |
| 15 | N114 | Olay | Water Facial Pores | 37 | \$ 179.99 | | N114 | | | | | |
| 16 | O115 | Oral-B | Toothbrush | 92 | \$ 49.99 | | O115 | | | | | |
| 17 | P116 | Canon | Digital Camera | 21 | \$ 399.99 | | P116 | | | | | |
| 18 | Q117 | Samsung | Smart TV | 38 | \$ 799.99 | | Q117 | | | | | |
| 19 | R118 | Amazon Basics | Tablet Stand | 45 | \$ 29.99 | | R118 | | | | | |
| 20 | S119 | Herman Miller | Desk Chair | 45 | \$ 599.99 | | S119 | | | | | |
| 21 | T120 | Sony | Alarm Clock | 38 | \$ 29.99 | | T120 | | | | | |
| 22 | U121 | Brabant | Coffee Maker | 69 | \$ 129.99 | | U121 | | | | | |
| 23 | V122 | KitchenAid | Food Processor | 78 | \$ 149.99 | | V122 | | | | | |
| 24 | W123 | Panasonic | Cellless Phone | 102 | \$ 39.99 | | W123 | | | | | |
| 25 | X124 | LG | Blu-ray Player | 42 | \$ 79.99 | | X124 | | | | | |
| 26 | Y125 | Charmmy | Toilet Brush (6-pack) | 54 | \$ 12.99 | | Y125 | | | | | |
| 27 | Z126 | Tide | Laundry Detergent (64 oz) | 58 | \$ 9.99 | | Z126 | | | | | |
| 28 | A127 | Bounty | Paper Towels (6-pack) | 18 | \$ 12.99 | | A127 | | | | | |
| 29 | B128 | Old Spice | Deodorant (30 oz) | 32 | \$ 4.99 | | B128 | | | | | |
| 30 | C129 | Pantene | Shampoo (16 fl oz) | 32 | \$ 4.99 | | C129 | | | | | |
| 31 | D130 | Herbal Essences | Conditioner (16 oz) | 63 | \$ 4.99 | | D130 | | | | | |
| 32 | E131 | Secret | Deodorant (2.2 oz) | 14 | \$ 2.99 | | E131 | | | | | |
| 33 | F132 | Crest | Toothpaste (6 oz) | 60 | \$ 2.99 | | F132 | | | | | |
| 34 | G133 | Gillette | Shaving Razor | 24 | \$ 9.99 | | G133 | | | | | |
| 35 | H134 | Dove | Body Wash (16 oz) | 35 | \$ 5.99 | | H134 | | | | | |
| 36 | I135 | Simple | Hand Soap (24 oz) | 70 | \$ 1.99 | | I135 | | | | | |
| 37 | J136 | Dixie | Dispenser (24 oz) | 30 | \$ 2.99 | | J136 | | | | | |
| 38 | K137 | Dixie | Paper Plates (100-pack) | 100 | \$ 4.99 | | K137 | | | | | |

Figure 1: VLOOKUP References

Here we demonstrate how to set up a VLOOKUP function that returns the market price of a product based on the internal item code, where the data is organized “vertically.” Cell L3 should have an entry that resembles the following:

= VLOOKUP(\$H3, \$B\$3:\$F\$52, 5, 0)

Note that the first argument uses a mixed reference where the column is kept constant at H, as we may be copying and pasting the cell L3 to the left. Meanwhile, the second argument, which is the range of lookup, remains constant across all cases and uses absolute references. If all goes well, the function should return the price of the Samsung Smart LED TV, which is \$599.99.

The final option of whether you would like to enforce an exact match or not comes with some conditions of its own. Users may choose to allow for an approximate match by specifying the last argument as 1. However, the exact method how VLOOKUP function handles these approximate matches is to return the value from the “previous” value. For instance, if individuals’ ID numbers are sorted, and we are looking for individual 75 where individual 75 does not exist, VLOOKUP will return the values assigned to individual 74. This function is rarely used, but it is useful to know how Excel deals with some of these issues.

Topic 2. The HLOOKUP Function

Similar to the VLOOKUP function we covered in a previous class, the HLOOKUP function returns a certain value. While the VLOOKUP function looks *vertically* down the first column of the table array to find the unique identifier, the HLOOKUP function looks *horizontally* across the first row of the table array to find the identifier.

| | A | B | C | D | E | F | G | H |
|----|--------|---|-------------|----------|----------------|---------------|---|---|
| 1 | Ticker | Asset | Asset Type | Quantity | Purchase Price | Current Price | | |
| 3 | AAPL | Apple Inc. | Stocks | 100 | \$15,000.00 | \$17,500.00 | | |
| 4 | MSFT | Microsoft | Stocks | 75 | \$20,000.00 | \$22,000.00 | | |
| 5 | AMZN | Amazon.com | Stocks | 50 | \$320,000.00 | \$350,000.00 | | |
| 6 | GOOGL | Google | Stocks | 60 | \$250,000.00 | \$270,000.00 | | |
| 7 | IBM | IBM | Stocks | 40 | \$13,000.00 | \$12,000.00 | | |
| 8 | TSLA | Tesla Inc. | Stocks | 30 | \$65,000.00 | \$70,000.00 | | |
| 9 | JNJ | Johnson & Johnson | Stocks | 50 | \$15,000.00 | \$16,000.00 | | |
| 10 | PG | Procter & Gamble | Stocks | 60 | \$13,000.00 | \$14,000.00 | | |
| 11 | XOM | Exxon Mobil | Stocks | 70 | \$6,000.00 | \$6,500.00 | | |
| 12 | NFLX | Netflix Inc. | Stocks | 40 | \$45,000.00 | \$48,000.00 | | |
| 13 | SPY | SPDR S&P 500 ETF | ETFs | 25 | \$40,000.00 | \$42,000.00 | | |
| 14 | XLK | iShares Tech ETF | ETFs | 30 | \$15,000.00 | \$16,000.00 | | |
| 15 | BND | Vanguard Bond ETF | ETFs | 100 | \$8,000.00 | \$8,500.00 | | |
| 16 | EEM | iShares Emerging Markets ETF | ETFs | 35 | \$4,500.00 | \$4,800.00 | | |
| 17 | USGOV | US Treasury | Bonds | 500 | \$100,000.00 | \$102,000.00 | | |
| 18 | CORR | Corporate Bond | Bonds | 300 | \$12,000.00 | \$12,200.00 | | |
| 19 | MUNI | Municipal Bond | Bonds | 200 | \$9,000.00 | \$9,200.00 | | |
| 20 | HYLD | High-Yield Bond | Bonds | 150 | \$7,500.00 | \$7,800.00 | | |
| 21 | TIPS | Treasury Inflation-Protected Securities | Bonds | 75 | \$11,000.00 | \$11,200.00 | | |
| 22 | VNQ | Real Estate ETF | Real Estate | 15 | \$10,000.00 | \$10,500.00 | | |

Figure 2: VLOOKUP

| | A | B | C | D | E | F | G | H |
|----|---|----------------------|-------------|-----------|------------|-----------|---|---|
| 1 | | Property Code | RE001 | RE002 | RE003 | RE004 | | |
| 3 | | State | CA | TX | NY | FL | | |
| 4 | | County | Los Angeles | Harris | Queens | Miami-Dac | | |
| 5 | | City | Los Angeles | Houston | New York | Miami | | |
| 6 | | Square Footage | 2000 | 1800 | 2200 | 1600 | | |
| 7 | | Bedrooms | 3 | 4 | 5 | 2 | | |
| 8 | | Bathrooms | 2.5 | 3 | 4 | 2 | | |
| 9 | | Garage Spaces | 2 | 2 | 3 | 1 | | |
| 10 | | Year of Construction | 1990 | 1985 | 2005 | 1980 | | |
| 11 | | Renovation Year | 2015 | 2020 | 2018 | 2019 | | |
| 12 | | Days on the Market | 30 | 45 | 60 | 15 | | |
| 13 | | Asking Price | \$550,000 | \$400,000 | \$750,000 | \$300,000 | | |
| 14 | | Flooring | Hardwood | Carpet | Hardwood | Tile | | |
| 15 | | Heating | Central | Radiant | Forced Air | Central | | |
| 16 | | Cooling | Central | Central | Central | Window | | |
| 17 | | HOA | \$300 | \$250 | \$400 | \$150 | | |

Figure 3: HLOOKUP

HLOOKUP is used when the unique ID is aligned in a single row, as shown in Figure 3, and VLOOKUP is appropriate when the data is arranged like Figure 2, where the unique ID is aligned in a single column. The syntax of HLOOKUP is similar to that of VLOOKUP.

```
= HLOOKUP(LOOKUP VALUE,
          RANGE WHERE LOOKUP VALUE IF LOCATED,
          ROW NUMBER IN THE RANGE CONTAINING VALUE TO RETURN,
          [EXACT/APPROXIMATE MATCH])
```

Navigate to the worksheet HLOOKUP_DATA in the workbook BUSI201-LEC07-Workbook.xlsx. You should find a table with information on some real estate properties on the market in various regions across the U.S. Suppose you want to extract information on the county the property is located in, the number of bedrooms and bathrooms, and the asking price of four properties: RE008, RE002, RE010, and RE001. Fill out the table located in cells B20 : F24.

| | A | B | C | D | E | F | G | H | I | J | K | L | M |
|----|---|----------------------|-------------|-----------|------------|--------------|-----------|------------|-----------|------------|-----------|------------|---|
| 1 | | | | | | | | | | | | | |
| 2 | | Property Code | RE001 | RE002 | RE003 | RE004 | RE005 | RE006 | RE007 | RE008 | RE009 | RE010 | |
| 3 | | State | CA | TX | NY | FL | IL | AZ | WA | CO | NC | GA | |
| 4 | | County | Los Angeles | Harris | Queens | Miami-Dade | Cook | Maricopa | King | Denver | Wake | Fulton | |
| 5 | | City | Los Angeles | Houston | New York | Miami | Chicago | Phoenix | Seattle | Denver | Raleigh | Atlanta | |
| 6 | | Square Footage | 2000 | 1800 | 2200 | 1600 | 2500 | 1900 | 2800 | 2100 | 2300 | 1950 | |
| 7 | | Bedrooms | 3 | 4 | 5 | 2 | 4 | 3 | 4 | 3 | 4 | 3 | |
| 8 | | Bathrooms | 2.5 | 3 | 4 | 2 | 3.5 | 2.5 | 3.5 | 2.5 | 3 | 2.5 | |
| 9 | | Garage Spaces | 2 | 2 | 3 | 1 | 2 | 2 | 3 | 2 | 2 | 1 | |
| 10 | | Year of Construction | 1990 | 1985 | 2005 | 1980 | 1995 | 2002 | 2010 | 1988 | 1998 | 2008 | |
| 11 | | Renovation Year | 2015 | 2020 | 2018 | 2019 | 2016 | 2021 | 2017 | 2020 | 2015 | 2019 | |
| 12 | | Days on the Market | 30 | 45 | 60 | 15 | 75 | 40 | 90 | 55 | 70 | 50 | |
| 13 | | Asking Price | \$550,000 | \$400,000 | \$750,000 | \$300,000 | \$600,000 | \$350,000 | \$800,000 | \$450,000 | \$475,000 | \$380,000 | |
| 14 | | Flooring | Hardwood | Carpet | Hardwood | Tile | Hardwood | Carpet | Hardwood | Tile | Carpet | Hardwood | |
| 15 | | Heating | Central | Radiant | Forced Air | Central | Radiant | Forced Air | Radiant | Forced Air | Radiant | Forced Air | |
| 16 | | Cooling | Central | Central | Central | Window | Central | Central | Central | Central | Central | Central | |
| 17 | | HOA | \$300 | \$250 | \$400 | \$150 | \$300 | \$200 | \$500 | \$250 | \$300 | \$200 | |
| 18 | | | | | | | | | | | | | |
| 19 | | | | | | | | | | | | | |
| 20 | | Property Code | County | Bedrooms | Bathrooms | Asking Price | | | | | | | |
| 21 | | RE008 | | | | | | | | | | | |
| 22 | | RE002 | | | | | | | | | | | |
| 23 | | RE010 | | | | | | | | | | | |
| 24 | | RE001 | | | | | | | | | | | |
| 25 | | | | | | | | | | | | | |

Figure 4: The HLOOKUP_DATA Sheet

For instance, to find the number of bedrooms for property code RE002 in cell D22, we can use the HLOOKUP function as follows:

$$= \text{HLOOKUP} (\$J2, \$C\$2:\$L\$17, 5, 0)$$

Topic 3. The XLOOKUP Function

We have covered two distinct types of lookup functions: the VLOOKUP for data that are stacked *vertically*, and the HLOOKUP for data that are stacked *horizontally*. It is challenging to think of any other method of organizing data that is comprehensible, while neither being stacked vertically nor horizontally. So, you may wonder, what is the purpose of this XLOOKUP function?

The primary limitation of the VLOOKUP and HLOOKUP functions is that the lookup value (unique identifier) must be located in the first column/row, respectively. This restriction exists because VLOOKUP returns values to the *right* of the lookup value, and HLOOKUP returns values *below* the lookup value. For instance, refer to Figure 5, which represents a hypothetical data sheet from a hospital system, where individuals are uniquely identified by their patient ID number.

| | A | B | C | D | E | F | G | H | I | J | K | L | M | N | O |
|----|-----------|---------------------|-----|------------|----------------------------|-----------|--------|---------|--------|---|---|---|---|---|---|
| 1 | Date | Full Name | Age | Patient ID | Procedure | Cost | Return | Network | Pharma | | | | | | |
| 2 | Aug/07/23 | Emily Johnson | 55 | PID-001 | Blood Pressure Measurement | \$ 27.88 | No | No | Yes | | | | | | |
| 3 | Aug/12/23 | Benjamin Smith | 55 | PID-002 | Blood Tests | \$ 267.61 | Yes | Yes | No | | | | | | |
| 4 | Aug/20/23 | Ava Williams | 17 | PID-003 | X-ray | \$ 103.57 | No | No | No | | | | | | |
| 5 | Aug/24/23 | Liam Anderson | 67 | PID-004 | Ultrasound | \$ 377.08 | No | Yes | No | | | | | | |
| 6 | Aug/28/23 | Olivia Brown | 52 | PID-005 | Electrocardiogram | \$ 273.07 | No | No | Yes | | | | | | |
| 7 | Sep/02/23 | Jackson Martinez | 33 | PID-006 | Colonoscopy | \$ 29.80 | No | No | No | | | | | | |
| 8 | Sep/06/23 | Sophia Davis | 42 | PID-007 | Endoscopy | \$ 370.67 | Yes | Yes | Yes | | | | | | |
| 9 | Sep/10/23 | Noah Wilson | 68 | PID-008 | MRI | \$ 13.96 | No | No | Yes | | | | | | |
| 10 | Sep/13/23 | Emma Garcia | 52 | PID-009 | CT Scan | \$ 303.60 | No | Yes | No | | | | | | |
| 11 | Sep/15/23 | William Jones | 15 | PID-010 | Mammogram | \$ 352.11 | Yes | Yes | Yes | | | | | | |
| 12 | Sep/04/23 | Isabella Taylor | 30 | PID-011 | Biopsy | \$ 354.63 | No | Yes | Yes | | | | | | |
| 13 | Sep/17/23 | James Clark | 62 | PID-012 | Surgery | \$ 276.26 | Yes | No | No | | | | | | |
| 14 | Sep/22/23 | Mia Hernandez | 25 | PID-013 | Laparoscopy | \$ 98.18 | No | Yes | Yes | | | | | | |
| 15 | Sep/31/23 | Jackson Martinez | 33 | PID-006 | Catheterization | \$ 207.10 | Yes | No | Yes | | | | | | |
| 16 | Sep/01/23 | Charlotte White | 50 | PID-015 | Dialysis | \$ 51.72 | No | Yes | No | | | | | | |
| 17 | Sep/05/23 | Ethan Lewis | 45 | PID-016 | Ventilation | \$ 224.30 | No | Yes | No | | | | | | |
| 18 | Sep/08/23 | Harper Hall | 44 | PID-017 | Chemotherapy | \$ 397.83 | Yes | No | Yes | | | | | | |
| 19 | Sep/11/23 | Elijah Turner | 32 | PID-018 | Radiation Therapy | \$ 147.96 | Yes | Yes | Yes | | | | | | |
| 20 | Sep/14/23 | Amelia Scott | 70 | PID-019 | Physical Therapy | \$ 164.92 | Yes | Yes | Yes | | | | | | |
| 21 | Sep/16/23 | Alexander Rodriguez | 57 | PID-020 | Cardiac Bypass Surgery | \$ 114.86 | Yes | Yes | No | | | | | | |

Figure 5: The XLOOKUP_DATA Sheet

While the data is organized *vertically*, we may be tempted to use the VLOOKUP function. However, we can observe that the unique patient ID is located in column E, which is in the middle of the table. Therefore, if we want to use the unique patient ID to look up information about this patient, we can use the XLOOKUP function. The syntax of the XLOOKUP function is as follows:

```
= XLOOKUP(LOOKUP VALUE,
          RANGE WHERE THE LOOKUP VALUE IS LOCATED,
          RANGE WHERE THE RETURN VALUE IS LOCATED,
          [WHAT TO RETURN WHEN LOOKUP VALUE NOT FOUND],
          [EXACT/APPROXIMATE MATCH], [SEARCH DIRECTION])
```

The arguments are similar, but not identical to those of VLOOKUP. Let's go over the correct solution for cell M3, where we attempt to find the full name of PID-006:

```
= XLOOKUP($L3,$E$3:$E$22,$C$3:$C$22,"Not Found",0,1)
```

Please see Figure 6 for the color-coded zones chosen as arguments in the XLOOKUP function.

| | A | B | C | D | E | F | G | H | I | J | K | L | M | N | O |
|----|-----------|---------------------|-----|------------|----------------------------|-----------|--------|---------|--------|---|---|---|---|---|---|
| 1 | Date | Full Name | Age | Patient ID | Procedure | Cost | Return | Network | Pharma | | | | | | |
| 2 | Aug/07/23 | Emily Johnson | 55 | PID-001 | Blood Pressure Measurement | \$ 27.88 | No | No | Yes | | | | | | |
| 3 | Aug/12/23 | Benjamin Smith | 55 | PID-002 | Blood Tests | \$ 267.61 | Yes | Yes | No | | | | | | |
| 4 | Aug/20/23 | Ava Williams | 17 | PID-003 | X-ray | \$ 103.57 | No | No | No | | | | | | |
| 5 | Aug/24/23 | Liam Anderson | 67 | PID-004 | Ultrasound | \$ 377.08 | No | Yes | No | | | | | | |
| 6 | Aug/28/23 | Olivia Brown | 52 | PID-005 | Electrocardiogram | \$ 273.07 | No | No | Yes | | | | | | |
| 7 | Sep/02/23 | Jackson Martinez | 33 | PID-006 | Colonoscopy | \$ 29.80 | No | No | No | | | | | | |
| 8 | Sep/06/23 | Sophia Davis | 42 | PID-007 | Endoscopy | \$ 370.67 | Yes | Yes | Yes | | | | | | |
| 9 | Sep/10/23 | Noah Wilson | 68 | PID-008 | MRI | \$ 13.96 | No | No | Yes | | | | | | |
| 10 | Sep/13/23 | Emma Garcia | 52 | PID-009 | CT Scan | \$ 303.60 | No | Yes | No | | | | | | |
| 11 | Sep/15/23 | William Jones | 15 | PID-010 | Mammogram | \$ 352.11 | Yes | Yes | Yes | | | | | | |
| 12 | Sep/04/23 | Isabella Taylor | 30 | PID-011 | Biopsy | \$ 354.63 | No | Yes | Yes | | | | | | |
| 13 | Sep/17/23 | James Clark | 62 | PID-012 | Surgery | \$ 276.26 | Yes | No | No | | | | | | |
| 14 | Sep/22/23 | Mia Hernandez | 25 | PID-013 | Laparoscopy | \$ 98.18 | No | Yes | Yes | | | | | | |
| 15 | Sep/31/23 | Jackson Martinez | 33 | PID-006 | Catheterization | \$ 207.10 | Yes | No | Yes | | | | | | |
| 16 | Sep/01/23 | Charlotte White | 50 | PID-015 | Dialysis | \$ 51.72 | No | Yes | No | | | | | | |
| 17 | Sep/05/23 | Ethan Lewis | 45 | PID-016 | Ventilation | \$ 224.30 | No | Yes | No | | | | | | |
| 18 | Sep/08/23 | Harper Hall | 44 | PID-017 | Chemotherapy | \$ 397.83 | Yes | No | Yes | | | | | | |
| 19 | Sep/11/23 | Elijah Turner | 32 | PID-018 | Radiation Therapy | \$ 147.96 | Yes | Yes | Yes | | | | | | |
| 20 | Sep/14/23 | Amelia Scott | 70 | PID-019 | Physical Therapy | \$ 164.92 | Yes | Yes | Yes | | | | | | |
| 21 | Sep/16/23 | Alexander Rodriguez | 57 | PID-020 | Cardiac Bypass Surgery | \$ 114.86 | Yes | Yes | No | | | | | | |

Figure 6: An Example of XLOOKUP

The Three “Optional” Arguments

There are three optional arguments in the XLLOOKUP function, and they function as follows:

- 4th Argument:

[WHAT TO RETURN WHEN LOOKUP VALUE IS NOT FOUND]

Value to return when XLLOOKUP cannot find the lookup value in the data.

- 5th Argument:

[EXACT/APPROXIMATE MATCH]

Identical to VLOOKUP. Typically, we use only the exact match, so we usually stick to “0.”

- 6th Argument:

[SEARCH DIRECTION]

The default (1) is a “Top-to-Bottom” search. However, we can also use “-1” if we want Excel to search the data “Bottom-to-Top.”

Topic 4. The AND / OR Functions

Up to this point, we have covered functions that can either take a single condition, such as the IF or VLOOKUP functions, and functions that can evaluate multiple conditions, like the SUMIFS function. For functions that only accept a single condition argument, we can use the AND and/or OR functions to assess multiple conditions in a single line.

| | A | B | C | D | E | F | G | H | I | J | K | L | M | N | O | P | Q |
|----|-----------------|-----------|----------------|----------------|-----------------|---------|----------|-----------|----------|--------|---|---|--------------------------------------|-------------------------------------|--------------------------------------|-------------------------------------|---|
| | Order ID | Date | Customer | Sales Rep | Category | Item ID | Quantity | Revenue | Profit | Margin | | | Revenue > 500 AND Profit Margin > 5% | Revenue > 500 OR Profit Margin > 5% | Revenue < 500 AND Profit Margin < 5% | Revenue < 500 OR Profit Margin < 5% | |
| 3 | ORD202309100001 | 9/1/2023 | John Smith | Alice Johnson | Electronics | E123 | 14 | \$ 742.16 | \$ 36.37 | 4.9% | | | | | | | |
| 4 | ORD202309100002 | 9/10/2023 | Emily Davis | Michael Wilson | Clothing | C456 | 10 | \$ 317.25 | \$ 26.65 | 8.40% | | | | | | | |
| 5 | ORD202309100003 | 9/10/2023 | Robert Brown | Jessica Miller | Home Appliances | H4789 | 1 | \$ 111.46 | \$ 3.90 | 3.50% | | | | | | | |
| 6 | ORD202309100004 | 9/9/2023 | Sarah Johnson | David Smith | Electronics | E123 | 8 | \$ 232.96 | \$ 19.57 | 8.40% | | | | | | | |
| 7 | ORD202309100005 | 9/9/2023 | James Wilson | Jennifer White | Clothing | C456 | 7 | \$ 501.58 | \$ 24.58 | 4.90% | | | | | | | |
| 8 | ORD202309100006 | 9/8/2023 | Linda Davis | Michael Wilson | Home Appliances | H4789 | 13 | \$ 94.57 | \$ 5.01 | 5.30% | | | | | | | |
| 9 | ORD202309100007 | 9/8/2023 | William Brown | Alice Johnson | Electronics | E123 | 9 | \$ 773.49 | \$ 57.24 | 7.40% | | | | | | | |
| 10 | ORD202309100008 | 9/7/2023 | Susan Johnson | Jessica Miller | Clothing | C456 | 8 | \$ 83.67 | \$ 6.86 | 8.20% | | | | | | | |
| 11 | ORD202309100009 | 9/7/2023 | Michael Smith | David Smith | Home Appliances | H4789 | 10 | \$ 351.30 | \$ 18.62 | 5.30% | | | | | | | |
| 12 | ORD202309100010 | 9/6/2023 | Olivia White | Jennifer White | Electronics | E123 | 5 | \$ 685.80 | \$ 25.37 | 3.70% | | | | | | | |
| 13 | ORD202309100011 | 9/6/2023 | Henry Davis | Alice Johnson | Clothing | C456 | 5 | \$ 561.59 | \$ 55.60 | 9.90% | | | | | | | |
| 14 | ORD202309100012 | 9/5/2023 | Emily Davis | Michael Wilson | Home Appliances | H4789 | 11 | \$ 714.00 | \$ 26.42 | 3.70% | | | | | | | |
| 15 | ORD202309100013 | 9/5/2023 | William Wilson | Jessica Miller | Electronics | E123 | 8 | \$ 650.04 | \$ 37.47 | 4.20% | | | | | | | |
| 16 | ORD202309100014 | 9/4/2023 | David Smith | Jennifer White | Clothing | C456 | 10 | \$ 971.59 | \$ 43.78 | 4.50% | | | | | | | |
| 17 | ORD202309100015 | 9/4/2023 | James Brown | Jennifer White | Home Appliances | H4789 | 8 | \$ 724.91 | \$ 7.97 | 1.10% | | | | | | | |
| 18 | ORD202309100016 | 9/3/2023 | Linda Johnson | Alice Johnson | Electronics | E123 | 6 | \$ 189.02 | \$ 2.84 | 1.50% | | | | | | | |
| 19 | ORD202309100017 | 9/3/2023 | Robert Brown | Michael Wilson | Clothing | C456 | 4 | \$ 957.49 | \$ 77.56 | 8.10% | | | | | | | |
| 20 | ORD202309100018 | 9/2/2023 | Sarah Davis | Jessica Miller | Home Appliances | H4789 | 12 | \$ 130.52 | \$ 10.31 | 7.90% | | | | | | | |
| 21 | ORD202309100019 | 9/2/2023 | Olivia Brown | David Smith | Electronics | E123 | 12 | \$ 877.39 | \$ 21.06 | 2.40% | | | | | | | |
| 22 | ORD202309100020 | 9/1/2023 | Michael Wilson | Jennifer White | Clothing | C456 | 7 | \$ 475.29 | \$ 15.21 | 3.20% | | | | | | | |
| 23 | | | | | | | | | | | | | | | | | |
| 24 | | | | | | | | | | | | | | | | | |
| 25 | | | | | | | | | | | | | | | | | |
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Figure 7: The AND_OR Sheet

If we want to populate cell M3 with an indicator to check if the order ID ORD202309100001 generated revenue greater than \$500 and if the profit margin for filling that order was greater than 5%, we can use a simple IF function:

$$= \text{IF}(I3>500, \text{IF}(K3>0.05, 1, 0), 0)$$

Meanwhile, if we aim to fill cell N3:

$$= \text{IF}(\text{I3}>500, 1, \text{IF}(\text{K3}>0.05, 1, 0))$$

When checking between two conditions, this is relatively straightforward. However, we may encounter situations where we need to verify if an entry satisfies dozens of conditions simultaneously or if it satisfies at least one of a dozen conditions. In such scenarios, we can rely on the AND or OR functions to streamline this process.

The AND Function

Consider the worksheet AND_OR in the workbook BUSI201-LEC07-Workbook.xlsx. You will find some sales data, but for this exercise, we will focus on the revenue (column I) and the profit margin (column K). Suppose we want to create a column that acts as an indicator. For example, column M should display:

$$M3 = \begin{cases} 1, & \text{if Revenue} > 500 \text{ and Profit Margin} > 5\% \\ 0, & \text{otherwise} \end{cases}$$

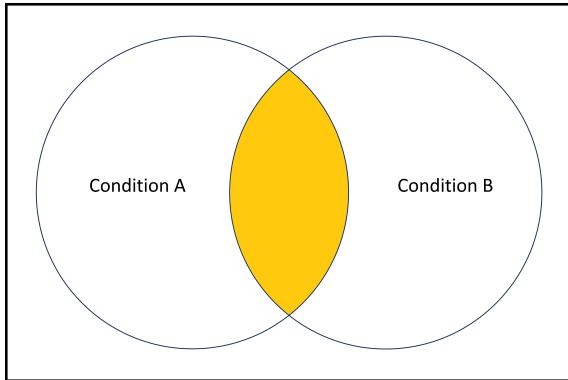


Figure 8: AND Function Diagram

To achieve this goal, we can use the AND function, which returns TRUE if all the conditions provided as arguments are met simultaneously. In other words, the AND function will return TRUE only if all logic tests pass, and it will return FALSE if any of the conditions are not met.

Visualized in a Venn diagram as shown in Figure 8, the AND function will yield TRUE for objects in the shaded zone, representing the intersection of two sets.

The basic syntax of the AND function is as follows:

$$= \text{AND}(\text{LOGIC_TEST_1}, [\text{LOGIC_TEST_2}], \dots)$$

For cell M3, we can use the AND function as follows:

$$= \text{AND}(\text{I3} > 500, \text{K3} > 0.05)$$

Please note that there is no need to use absolute/mixed references in this case, and percentages are represented in the numerical form of 0.05, not as 5%. Try filling the remaining cells in column M using the AND function and column O with the corresponding conditions.

The OR Function

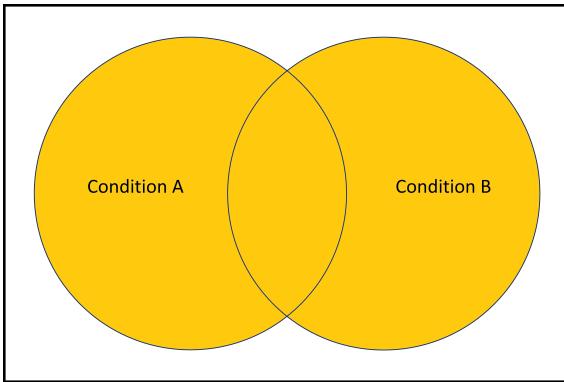


Figure 9: OR Function Diagram

Another useful function to employ when checking multiple conditions simultaneously is the **OR** function. In terms of set theory, the **OR** function is the *union* equivalent of the **AND** function, as shown in Figure 9.

In other words, it returns **TRUE** if *any* of the conditions are met and will return **FALSE** only if *none* of the conditions are met. We can use the **OR** function to fill out the cells in columns N and P.

Since the syntax of the **OR** function is identical to that of the **AND** function, cell N3 should read:

$$= \text{OR} (I3 > 500, K3 > 0.05)$$

We can also combine the **AND** and **OR** functions in conjunction with the **IF** function to output 0 for **FALSE** and 1 for **TRUE**. The syntax will be:

$$= \text{IF} (\text{AND} (\text{LOGIC_TEST_1}, [\text{LOGIC_TEST_2}], \dots), 1, 0)$$

Topic 5. Helper Columns

In many scenarios, especially when dealing with multiple conditions, it's useful to employ what is known as a *helper column*. Please navigate to the **HELPER** sheet, which is essentially a copy of the **AND_OR** sheet with two new columns. We will populate columns M and N with information that can assist us.

| | A | B | C | D | E | F | G | H | I | J | K | L | M | N | O | P | Q | R | S |
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| | < | > | VLOOKUP_DATA | HLOOKUP_DATA | XLOOKUP_DATA | AND_OR | HELPER | + | | | | | | | | | | | |

Figure 10: The HELPER Sheet

In cells M3 and N3 of the **HELPER** sheet, we can utilize the IF function to create "indicator" variables indicating whether the revenue generated from the order exceeds \$500 and whether the profit margin was greater than 5%. You can use the following formulas to achieve the result shown in Figure 11:

$$M3 := IF(I3>500, 1, 0)$$

$$N3 := IF(J3>0.05, 1, 0)$$

Now that the helper columns are ready, filling out the original table becomes more straightforward.

| A | B | C | D | E | F | G | H | I | J | K | L | M | N | O | P | Q | R | S |
|----|-----------------|-----------|----------------|----------------|-----------------|---------|----------|-------------|-----------|--------|---|-----------------|--------------------|--|---------------------------------------|--|---------------------------------------|---|
| 2 | | | | | | | | | | | | | | | | | | |
| 3 | Order ID | Date | Customer | Sales Rep | Category | Item ID | Quantity | Revenue | Profit | Margin | | Revenue > \$500 | Profit Margin > 5% | Revenue > \$500 AND Profit Margin > 5% | Revenue > \$500 OR Profit Margin > 5% | Revenue < \$500 AND Profit Margin < 5% | Revenue < \$500 OR Profit Margin < 5% | |
| 4 | ORD202309100001 | 9/10/2023 | John Smith | Alice Johnson | Electronics | E123 | 14 | \$ 342.16 | \$ 36.37 | 4.90% | 1 | 0 | | | | | | |
| 5 | ORD202309100002 | 9/10/2023 | Emily Davis | Michael Wilson | Clothing | C456 | 10 | \$ 217.25 | \$ 20.65 | 8.40% | 0 | 1 | | | | | | |
| 6 | ORD202309100003 | 9/9/2023 | Sarah Johnson | David Smith | Home Appliances | HA789 | 1 | \$ 123.45 | \$ 13.35 | 3.20% | 0 | 0 | | | | | | |
| 7 | ORD202309100004 | 9/9/2023 | James Wilson | Jennifer White | Electronics | E123 | 8 | \$ 232.50 | \$ 19.57 | 8.40% | 0 | 1 | | | | | | |
| 8 | ORD202309100005 | 9/9/2023 | Michael Wilson | David Smith | Clothing | C456 | 7 | \$ 301.50 | \$ 24.58 | 4.90% | 1 | 0 | | | | | | |
| 9 | ORD202309100006 | 9/8/2023 | Sarah Johnson | Alice Johnson | Home Appliances | HA789 | 13 | \$ 94.50 | \$ 9.45 | 9.90% | 0 | 1 | | | | | | |
| 10 | ORD202309100007 | 9/7/2023 | William Brown | Susan Johnson | Electronics | E123 | 9 | \$ 79.95 | \$ 57.34 | 7.40% | 1 | 1 | | | | | | |
| 11 | ORD202309100008 | 9/7/2023 | Michael Smith | Jessica Miller | Clothing | C456 | 8 | \$ 83.47 | \$ 6.86 | 8.20% | 0 | 1 | | | | | | |
| 12 | ORD202309100009 | 9/7/2023 | David Smith | David Smith | Home Appliances | HA789 | 10 | \$ 351.00 | \$ 18.62 | 5.30% | 0 | 1 | | | | | | |
| 13 | ORD202309100010 | 9/6/2023 | Emily Davis | Alice Johnson | Electronics | E123 | 5 | \$ 561.00 | \$ 56.10 | 3.90% | 1 | 0 | | | | | | |
| 14 | ORD202309100011 | 9/5/2023 | William Wilson | Alice Johnson | Clothing | C456 | 5 | \$ 561.00 | \$ 56.10 | 3.90% | 1 | 1 | | | | | | |
| 15 | ORD202309100012 | 9/5/2023 | Emily Johnson | Michael Wilson | Home Appliance | HA789 | 11 | \$ 714.00 | \$ 26.42 | 3.70% | 1 | 0 | | | | | | |
| 16 | ORD202309100013 | 9/4/2023 | Emily Johnson | Jessica Miller | Electronics | E123 | 8 | \$ 654.00 | \$ 27.47 | 4.20% | 1 | 0 | | | | | | |
| 17 | ORD202309100014 | 9/4/2023 | Susan Davis | David Smith | Clothing | C456 | 10 | \$ 974.00 | \$ 47.72 | 4.50% | 1 | 0 | | | | | | |
| 18 | ORD202309100015 | 9/3/2023 | Linda Johnson | Jessica Miller | Home Appliances | HA789 | 8 | \$ 724.91 | \$ 7.37 | 1.10% | 1 | 0 | | | | | | |
| 19 | ORD202309100016 | 9/3/2023 | Robert Smith | Michael Wilson | Electronics | E123 | 6 | \$ 189.02 | \$ 2.84 | 1.50% | 0 | 0 | | | | | | |
| 20 | ORD202309100017 | 9/2/2023 | Sarah Brown | Robert Smith | Clothing | C456 | 4 | \$ 957.40 | \$ 77.96 | 8.10% | 1 | 1 | | | | | | |
| 21 | ORD202309100018 | 9/2/2023 | Sarah Brown | David Smith | Home Appliances | HA789 | 12 | \$ 1,042.52 | \$ 107.25 | 7.90% | 0 | 1 | | | | | | |
| 22 | ORD202309100019 | 9/2/2023 | Michael Wilson | David Smith | Electronics | E123 | 12 | \$ 877.00 | \$ 11.06 | 2.40% | 1 | 0 | | | | | | |
| 23 | ORD202309100000 | 9/1/2023 | Michael Wilson | Jennifer White | Clothing | C456 | 7 | \$ 475.29 | \$ 15.21 | 3.20% | 0 | 0 | | | | | | |
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Figure 11: Helper Columns Filled Out

For example, consider cell P3, where we want to check if the order generates more than \$500 in revenue and also has a profit margin greater than 5%:

$$= IF(M3+N3=2, 1, 0)$$

The condition $M3+N3=2$ is met only when both the revenue and profit conditions are satisfied. Therefore, it's equivalent to using the AND function or writing out the slightly longer nested IF function.