Spreadsheets

You will learn about some important features of spreadsheets, as well as a few principles for designing and representing information.

Online MS-Office information source:
https://support.office.com/

Background

- Electronic spreadsheets evolved out of paper worksheets.

- Calculations were manually calculated and entered in columns and rows on paper often drawn with grids.

- Making changes could be awkward:
  - Correcting errors
  - Attempting variations :
    - e.g., for a personal budget what would be the effect of living in a 1 bedroom vs. 2 bedroom apartment
    - e.g., going on a vacation to Vulcan, Alberta vs. going to Dubai, U.A.E.
    - e.g., how would my term grade change if I received a "B" vs. "B+" on the final exam
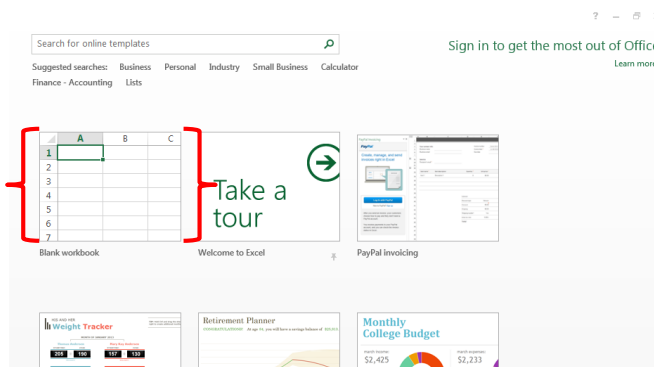
The First Spreadsheet

VISICALC for the Apple II computer: Image from:
http://www.cultofmac.com (last accessed Jan 2015)

- Early versions of electronic spreadsheets were primitive but could still automate calculations.
  - So popular Visicalc was "The software tail that wags (and sells) the personal computer dog." – Ben Rosen (Compaq)
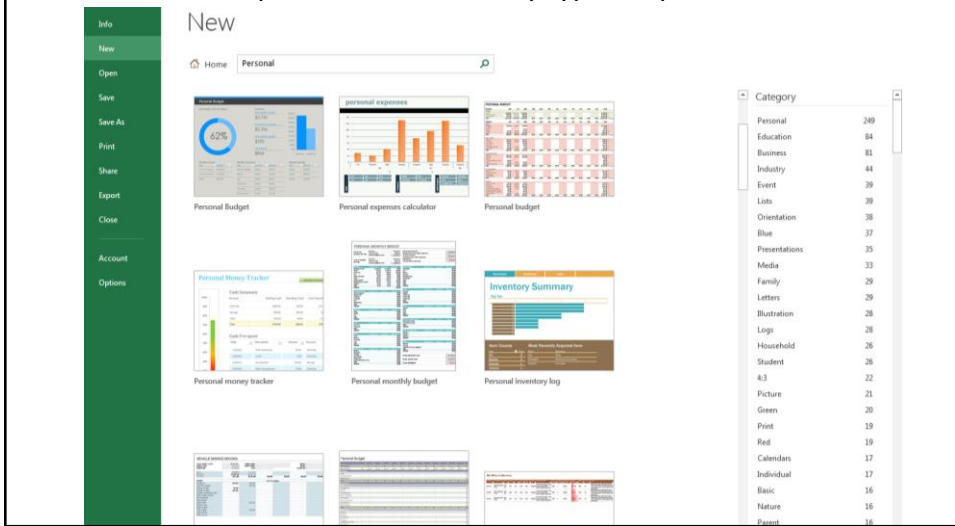
Getting Started: Creating A New Blank SpreadSheet (Excel: "Workbook")

- Starting from Windows 7 (Similar to starting other programs):
  - Start button->All programs->Microsoft Office->Microsoft Excel
- Once Excel started, creating a new sheet:

Templates

- Pre-created spreadsheets for many types of problems

Example Template

Spreadsheets 101

Column headings

Coordinates of current cell

Row numbers

Contents of current cell

Current cell

H6 | fx | 123

The Excel Ribbon

• Tabs are used to group related functions

Book1 - Excel

FILE HOME INSERT PAGE LAYOUT FORMULAS DATA REVIEW VIEW

Arial 10
B I U A A
Paste
Clipboard | Font | Alignment | Number | Styles

General
$ - % ,
Conditional Formatting
Format as Table
Cell Styles

H6 | fx | 123
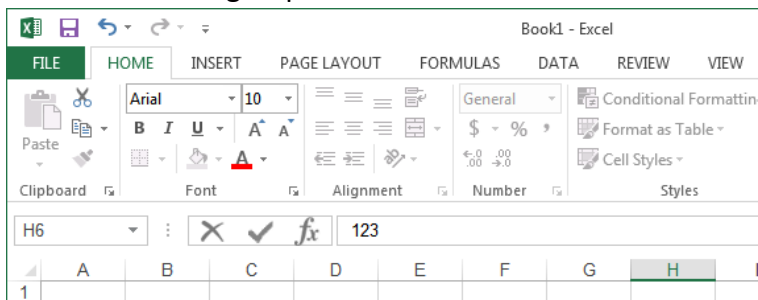
High Level View Of Each Tab

- File **:
  - Functions associated with documents (creating, opening, saving, printing etc.)
- Home (default) **:
  - Many of the most commonly used functions (such as formatting fonts, cells and numerical data)
- Insert:
  - Tables, illustrations, apps, charts, graphs, text, and symbols
- Page layout:
  - Page setup (many similar to print options)
- Formulas *:
  - Location and groupings of the pre-created built-in mathematical formulas
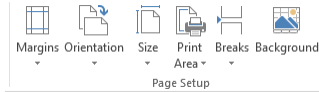
High Level View Of Each Tab (2)

- Data:
  - Arranging, organizing existing data (e.g., sort)
- Review:
  - Spell checking, thesaurus, translation, adding comments, and change tracking
- View (different views of the same data):
  - Workbook Views, Show, Zoom, Window, and Macros
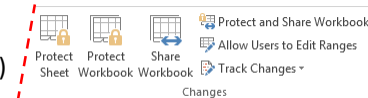
"Freezing" Panes: How/Why

• Often used to lock the view so that crucial labels always stay onscreen regardless of which part of the sheet you are viewing
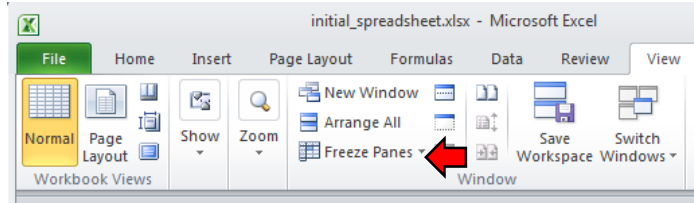
Freezing Panes: Effect On Example Spreadsheet

Customizing The Ribbon

- Select the "File" Ribbon and then "options"
- File -> Options
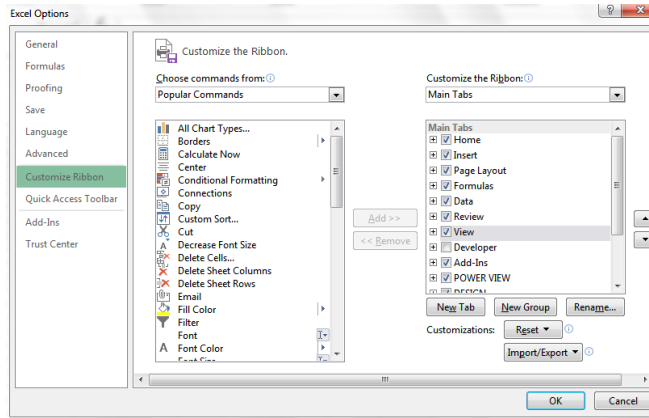
Saving Work

- This feature is implemented in a similar fashion among the different MS-Office products
- "Save": save document under current name
- "Save as": allows the document to be saved under a different name
  - But additional information such as: 'tags' and 'titles' may be entered

9/19/2016
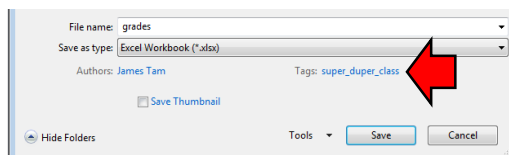
Example Using Tags

- Separate from the file name but may still be used as search criteria
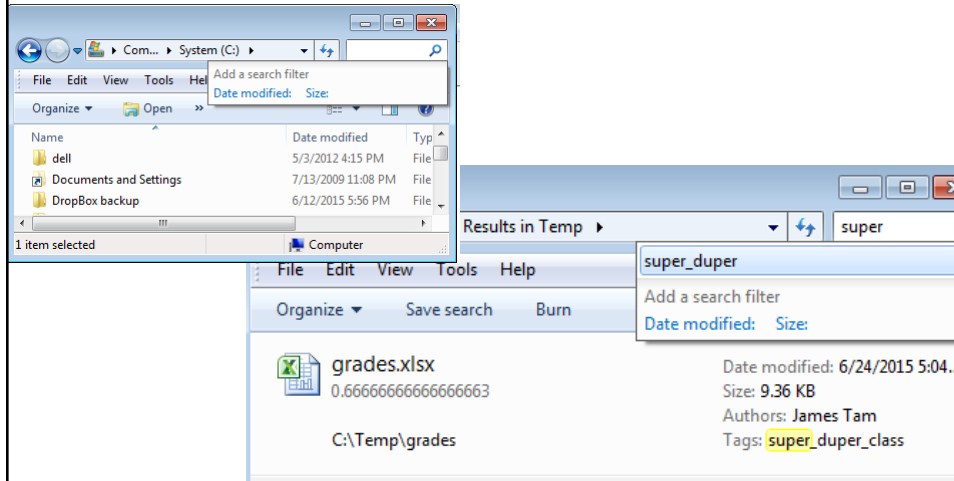
Entering Data

- Click on cell to enter the data

- Type in cell contents

Contents Of A Cell: Types

- Raw data: also referred to as 'constants'

- Labels: describe the contents of another cell

- Formula: values derived from the raw data (e.g., calculations, lookup values)

Specifying Formulas

- In Excel all formulas must be preceded by the '**=**' symbol to distinguish it from a label
- **Example spreadsheet: `1_formulas`**
  - Label
    2 + 2

  - **Formula**
    = 2 + 2

Basic Mathematical **Operators**

- **Example spreadsheet: 2_operators**

Mathematical operation	Excel operator	Example
Assignment	**=**	**=** 888
Addition	**+**	= 2 **+** 2
Subtraction	**-**	= 7 **−** 2
Multiplication	*****	= 3 ***** 3
Division	**/**	= 3 **/** 4
Exponent	**^**	= 3 **^** 2

Label Formulas

- Similar to data unless the formula is very obvious to the reader of the spreadsheet (and not the author) label all parts.
  - Most of the time it won't be obvious so label most everything.

| B1 | | f_x | =6000 - 2000 - 1000 - 1000 - 1500 | ¥ |

spreadsheet BAD budget example.xlsx

	A	B	C	D	E	F	G	H
1		500	1900	1000				
2								

Ready   100% ⊖ ——— ⊕
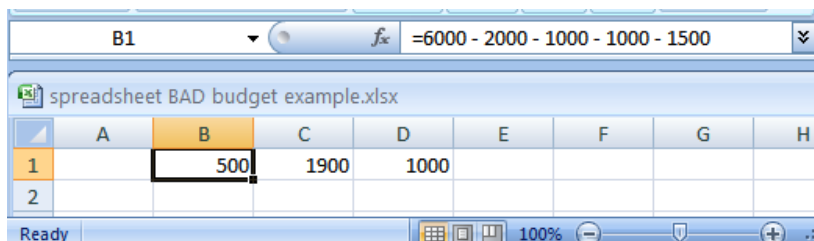
Previous Example: Explicitly Labeled Formulas

- Whenever possible label the different parts of a calculation to make easier for the reader to interpret and understand how your calculations work.

	B8		f_x	=B2 - (B3 + B4 + B5 + B6)			

spreadsheet budget example.xlsx

	A	B	C	D	E	F	G
1		January	February	March			
2	Paycheck	6000	6000	6000			
3	Rent	2000	2000	2000			
4	Food	1000	1000	1000			
5	Car	1000	1000	1000			
6	Fun	1500	100	1000			
7							
8	Savings	500	1900	1000			

Ready   100%

Designing Spreadsheets: Rules Of Thumb

1. Do not directly enter values as data that can be derived from other values (calculation example)
   - Example
     - Assignment grade (assume one assignment) = 4.2 (data in cell A2)
     - Exam grade (assume only one exam) = 3.3 (data in cell B2)
     - Term grade point =(A2*0.4)+(B2*0.6) OR enter 3.66?

4.2		3.3		=(A2*0.4)+(B2*0.6)

A2	B2	
Assignment grade point	Exam grade point	Term grade point
4.2	3.3	3.66

Designing Spreadsheets: Rules Of Thumb (2)

1. Do not directly enter values as data that can be derived from other values (example used to illustrate style, formula explained later)

   • **`10_extracting_connecting_text`** – details of string functions will be described later (just know now that text can also be derived)

Title	First name	Last name	Phone
Ms.	James	Tam	(403)210-9455
Mr.	Robert	Thurston	(702)333-33333
Dr.	Jane	Jones	(614)123-4567
Prof.	Allison	Smith	(123)456-7890
	Amanda	Bynes	(333)666-9999
	amanda	amanda	(000)000-0000
Canadian honorific			
Ms.Tam			
Mr.Thurston			
Dr.Jones			
Prof.Smith			
Bynes			
Middle Eastern honorific			
Ms.James			
Mr.Robert			
Dr.Jane			
Prof.Allison			

=CONCATENATE(A2,C2)

=CONCATENATE(A2,B2)

Designing Spreadsheets: Rules Of Thumb (3)

2. Label information so it can be clearly understood

Assignment grade point	Exam grade point	Term grade point
4.2	3.3	3.66

Designing Spreadsheets: Rules Of Thumb (4)

3. Never enter the same information more than once
   - Advantages: reduces size and complexity of the sheet, making changes can be easier.
   - Seems obvious? Not always
   - Example: What if the previous spreadsheet were used to calculate the grades for a class full of students?
   - Some would create the sheet this way:

Student	Assignment grade point	Exam grade point	Term grade point
1	4.2	3.3	3.66
2	3.3	3.7	3.54
3	2.3	1	1.52
4	4	4	4

=(B2*0.4)+(C2*0.6)

=(B3*0.4)+(C3*0.6)

Etc.

   - Example spreadsheet: `3_grades_formulas`

Designing Spreadsheets: Rules Of Thumb (5)

Student	Assignment grade point	Exam grade point	Term grade point
1	4.2	3.3	3.66
2	3.3	3.7	3.54
3	2.3	1	1.52
4	4	4	4

=(B2*0.4)+(C2*0.6)

=(B3*0.4)+(C3*0.6)

Etc.

   - Issues:
     - Clarity: What does the 0.4 & 0.6 refer to (sometimes not so obvious)?
     - Making changes: What if the value of each component (40% assignments, 60% exams) changed?

Lookup Tables

- As the name implies it contains information that needs to be referred to ("looked up") in a part of the spreadsheet.
- Can be used to address some of the issues related to the previous example:
  - Clarity
  - Entering the same data multiple times

=(B2*G2)+(C2*G3)

	A	B	C	D	E	F	G
1	Student	Assignment grade point	Exam grade point	Term grade point		Component	Weight
2	1	4.2	3.3	3.66		Assignment	0.4
3	2	3.3	3.7	3.54		Exam	0.6
4	3	2.3	1	1.52			
5	4	4	4	4			

Mathematical Functions

- As mentioned calculations must be preceded with an equals sign (actually *an assignment operator*) e.g., = 2 * 2
- The formula can either be directly entered (custom formula) or you can use one of the pre-created ones that come built into the spreadsheet.
- **Example spreadsheet: 4_grades_lookup**

=(D2+D3+D4+D5)/4

=AVERAGE(D2:D5)

	A	B	C	D
1	Student	Assignment grade point	Exam grade point	Term grade point
2	1	4.2	3.3	3.66
3	2	3.3	3.7	3.54
4	3	2.3	1	1.52
5	4	4	4	4
6	AVERAGES	3.45	3	3.18

Order Of Operation

Level	Operation	Symbol	
1	Brackets (inner before outer)	( )	
2	Exponent	^	
3	Multiplication, Division	*	/
4	Addition, Subtraction	+	-

- When a series of operators from same level are encountered in a cell the expression is evaluated from in order in which they appear (left to right).

  2 + 3 * 3   Equals 11

  8 / 2 ^ 2   Equals 2

Autofill

- Allows for a series (constant or addition by a constant amount) to be extended
  - E.g., The series "1, 2, 3" (can be extended to include "…4, 5, 6")
- Steps:
  1. Highlight the cells containing the series to extend (selecting one cell just repeats the contents of that one cell).

  2. Move the mouse pointer to the 'handle' at the bottom right

Autofill (2)

3. Drag the mouse as far down as you wish the series to be extended to.

	A	A g
1	Student	
2	1	4
3	2	3
4	3	2
5	4	4
6	5	3
7	6	
8	7	
9	8	
10	9	

Extra practice: what would be the autofill result of:

1

	A
1	student
2	1
3	10

2

	A
1	student
2	1
3	10

Worksheets

• Each *spreadsheet* can consist of multiple *worksheets.*

Book1 - Microsoft Excel

Create new worksheet

Worksheet

Spreadsheet
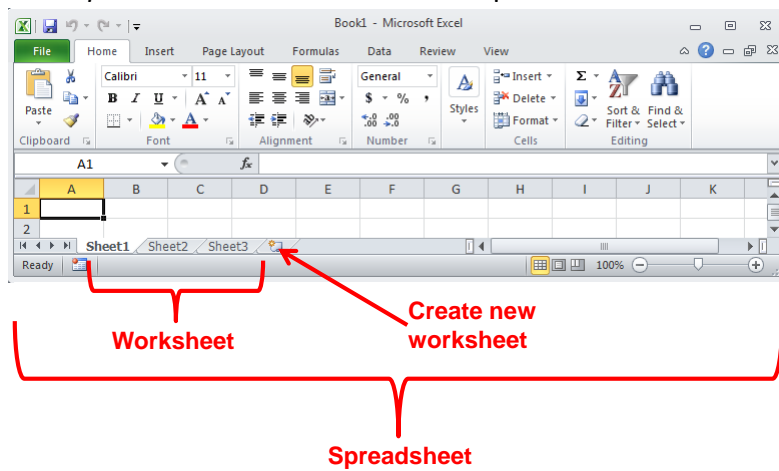
When To Use Multiple Worksheets

- Rules of thumb:
  - When there are multiple sheets of related information, each group of information can be stored in it's own worksheet (self contained)

| Grades for lecture 01 (worksheet) | Grades for lecture 02 (worksheet) | Grades for lecture 03 (worksheet) |

Grades for all sections(spreadsheet)

| Budget for dad (worksheet) | Budget for mom (worksheet) | Budget for sunny-boy (worksheet) |

Family budget (spreadsheet)
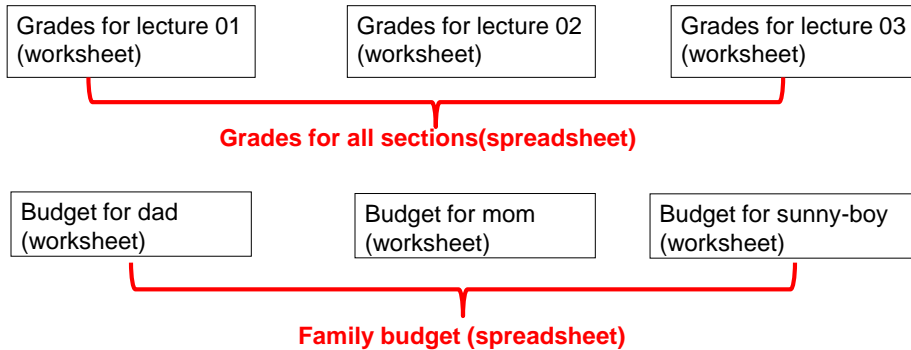
When Not To Use Multiple Worksheets

- If the information consists of groups of unrelated information then the information about each group should be stored in a separate spreadsheet/workbook rather than implementing it a spreadsheet with multiple worksheets.

| Grades for mom (spreadsheet) | Expenses for the family business (spreadsheet) | Daily calorie intake for dad (spreadsheet) |
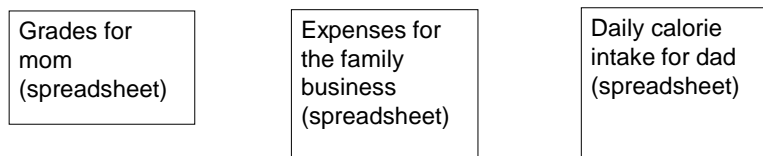
Referring To Other Worksheets

- One worksheet can refer to information stored in another worksheet.
- **Example spreadsheet:**
  - **5_multiple_worksheet_example**

JT's tip:
- For examples like this you might want to take extra "in-class" notes
- (It could be hard to understand the concepts at a level sufficient for the exam if you just look at the slides)

References Between Spreadsheets

- In a fashion similar to using multiple worksheets, one spreadsheet can refer to information stored in another spreadsheet.
- **Example spreadsheets:**
  - **6A_multiple_spreadsheet_example**
  - **6B_multiple_spreadsheet_example**

=A2*'[6B_multiple_spreadsheet_example.xlsx]AB rates'!$A$2

Why Use Cross References?

- A typical reason why one worksheet may refer to another or one spreadsheet may refer to another is that the second worksheet or spreadsheet contains data that needs to be "looked up" (e.g., a lookup table)
- Examples where cross reference lookups may be needed:
  - Grade cutoffs
  - Tax brackets
  - Product numbers (lookup a product number to get more information about the product)

Pre-Created Excel Formulas
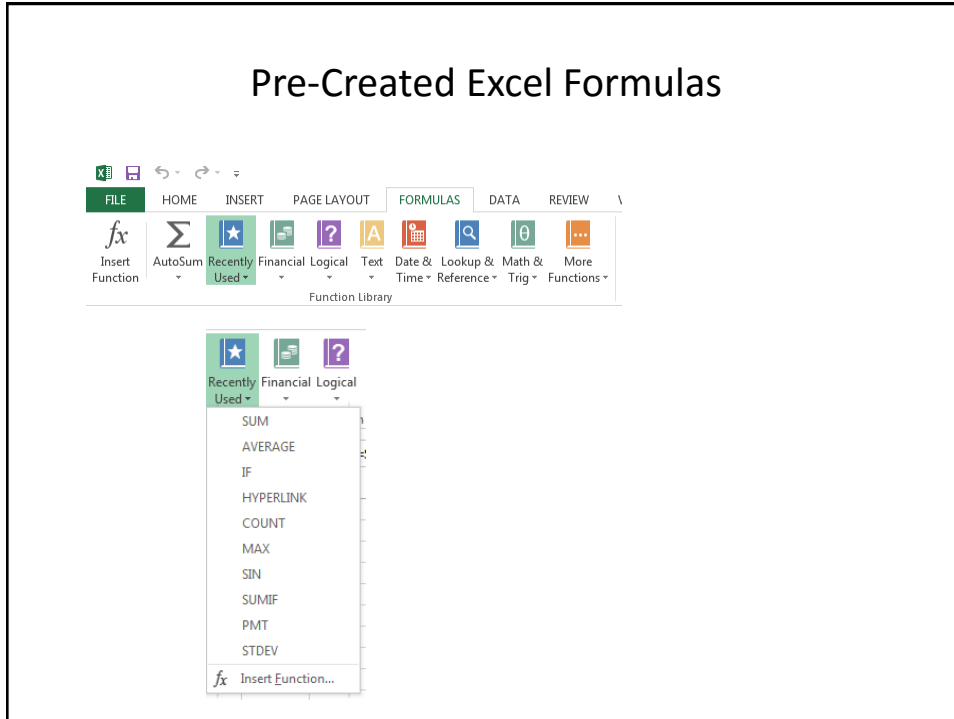
What Function Is Right For Your Situation?

- Excel provides reminders.
- Recall the location of built in functions.
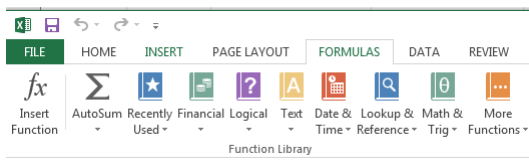
- Also Excel provides "name completion"

Input Format For Excel Functions

- Required input is typically a range of cells
  - **Format**:
    =function(*<start cell>* : *<end cell>*)
  - **Example**:
    =average(A1:A3)
- Alternatively input may be fixed inputs (type data directly into the brackets)
  =average(20,30,10)
  =lower("Jim *the JeT* TAM")
- **Optional function arguments**
  Distinguished by the use of square brackets [option]
  - find(*<find text>*, *<within text>*, *[<start position>]*)

Basic Statistics

- **Example spreadsheet:**
  - **7_basic_statistics**

- Example formulas: sum(), average(), min(), max()
- General usage:
  - Each formula requires as input a series of numbers
  - E.g., formula(1,2,3):
    - Sum = 6   ,   =sum(1,2,3)
    - Average = 2 ,   =average(1,2,3)
    - Min = 1   ,   =min(1,2,3)
    - Max = 3   ,   =max(1,2,3)

Basic Statistics (2)

- The series of numbers can allow refer to a range of cells

  `formula(<start cell> : <end cell>)`

	A	B	C
1			Sales
2			**Sunridge**
3		Manager	$100,000.00
4		Assistant	$50,000.00
5		Employee1	$50,000.00
6		Employee2	
7		Employee3	
8			
9		Store: total sales	$200,000.00
10		Store averages	$66,666.67
11		Store: highest	$100,000.00
12		Store: lowest	$50,000.00

(Column A label: Sales person)

```
=SUM(C3:C7)
=AVERAGE(C3:C7)
=MAX(C3:C7)
=MIN(C3:C7)
```

Basic Statistics (3)

- Ranges can span multiple rows and columns

	A	B	C	D	E	F	G	H
1			Sales At Each Location					
2			Sunridge	Market Mall	Chinook			
3		Manager	$100,000.00	$136,500.00	$105,000.00			
4		Assistant	$50,000.00	$125,000.00	$117,000.00			
5		Employee1	$50,000.00	$64,000.00	$66,000.00			
6		Employee2		$85,000.00	$75,000.00			
7		Employee3			$55,500.00			
8								
9		Store: total sales	$200,000.00	$410,500.00	$418,500.00		Calgary: total sales	$1,029,000.00
10		Store averages	$66,666.67	$102,625.00	$83,700.00		Calgary: employee average	$85,750.00
11		Store: highest	$100,000.00	$136,500.00	$117,000.00		Calgary: highest employee	$136,500.00
12		Store: lowest	$50,000.00	$64,000.00	$55,500.00		Calgary: lowest employee	$50,000.00

(Column A label: Sales person)

`=SUM(C3:E7)`

Counting Functions

- All of these functions tally up the number of cells that do or do not contain a certain type of data e.g., numbers
- General usage (all these formulas will require this information although one requires additional data).
  `function(<start cell range> : <end cell range>)`

  – An array (list) of numbers can be the function argument but this is rare
     e.g., `=COUNT(1,"A",2)`
- **Example spreadsheet:**
  – **8_counting_functions**

Counting Functions: `Count()`

- Counts the number of cells within the specified range that contain numbers
- https://support.office.com/en-US/article/COUNT-function-A59CD7FC-B623-4D93-87A4-D23BF411294C

	Col C
13	0
14	2
15	"A"
16	
COUNT	=COUNT(C13:C16)

Counting Functions: `Counta()`

- Counta()
  - Counts the number of cells within the specified range that *aren't empty*
    - https://support.office.com/en-US/article/COUNTA-function-7DC98875-D5C1-46F1-9A82-53F3219E2509

	Col C
13	0
14	2
15	"A"
16	
COUNTA	=COUNTA(C13:C16)

Counting Functions: `Countblank()`

- Countblank()
  - Counts the number of empty cells within the specified range
    - https://support.office.com/en-US/article/COUNTBLANK-function-6A92D772-675C-4BEE-B346-24AF6BD3AC22

	Col C
13	0
14	2
15	"A"
16	
COUNTBLANK	=COUNTBLANK(C13:C16)

String

- A series of characters which include alphabetic characters, numeric digits and special characters such as space, punctuation or other symbols (#,$...).
- String is another name for text

Excel String Functions

- Functions that act on strings
- **Converting or changing alphabetic text**
  - Change text from one form to another
  - `lower()`, `upper()`, `proper()`
- **Processing text**
  - Remove spaces
  - `Trim()`
- **Connecting text**:
  - connecting a string or a part of that string with another string e.g. title with surname or first name
  - `concatenate()`

Excel String Functions (2)

- **Extract selected portions of text**:
  - A specific number of characters from some position are to be extracted from a string e.g., area code or country code from a phone number
  - left(), right(), mid()
- **Searching text** (useful support function when extracting text)
  - Finds the starting position of one string within another string
  - find()

Functions That Convert Text

- **Example spreadsheet:**
  "9_converting_text"

- lower()
  - Converts non-lower case alphabetic characters to lower case
  - https://support.office.com/en-US/article/LOWER-function-3F21DF02-A80C-44B2-AFAF-81358F9FDEB4

- upper()
  - Converts non-upper case alphabetic characters to upper case
  - https://support.office.com/en-US/article/UPPER-function-C11F29B3-D1A3-4537-8DF6-04D0049963D6

- proper()
  - For alphabetic text it converts the letters to 'proper' format:
    - All letters are lower case except for the first letter of each word (which is capitalized)
  - https://support.office.com/en-US/article/PROPER-function-52A5A283-E8B2-49BE-8506-B2887B889F94

Functions For Extracting And Connecting Text

- **Example spreadsheet:**
  "10_extracting_connecting_text"
- `trim()`:
  - Removes leading or trailing spaces (ignores single spaces within text)
  - **Format**: trim(<string>)
  - Examples:
  - Trim(" james ")
  - Trim("a b ")

  - https://support.office.com/en-US/article/TRIM-function-410388FA-C5DF-49C6-B16C-9E5630B479F9

- `concatenate()`:
  - Connects two or more strings
  - **Format**: concatenate(*string1, string2*…)
  - A string can be fixed e.g., concatenate("wa","sup") or the address of a cell e.g., concatenate(A1,"!")
  - https://support.office.com/en-US/article/CONCATENATE-function-8F8AE884-2CA8-4F7A-B093-75D702BEA31D

Functions For Extracting And Connecting Text (2)

- `left()`:
  - Extracts the specified number of characters from the left side of the specified string.
  - **Format**: left(*<string>, <length>*)
    - String: the source string to extra characters from
    - Length: the number of characters to extract
  - https://support.office.com/en-US/article/Left-Function-D5897BF6-91F5-4BF8-853A-B63D7DE09681
  - **Examples:**
    =left("Foo bar",2)
    =left("Foo bar",0)
    =LEFT("Foo",10)

Functions For Extracting And Connecting Text (3)

- `right()`:
  - Extracts the specified number of characters from the right side of the string
  - **Format**: `right(<string>, <length>)`
    - https://support.office.com/en-US/article/Right-Function-C02A18A8-B224-437E-AABA-1B785C6C61BF
  - **Examples**:
    ```
    =RIGHT("Foo!bar",2)
    =RIGHT("Foo",10)
    ```

Functions For Extracting And Connecting Text (4)

- `mid()`:
  - Starting at the specified position, the function extracts the specified number of characters from the string
  - **Format**: `mid(<string>, <start>, <length>)`
    - String: the source string to extra characters from
    - Start: the position in the string in which extraction should begin
    - Length: the length of the sub-string to extract (sub-string begins at the position specified with the 'start' argument)
    - https://support.office.com/en-US/article/Mid-Function-427E6895-822C-44EE-B34A-564A28F2532C
  - **Examples**:
    ```
    =MID("not too hot",2,4)
    =MID("not too hot",8,55)
    =MID("not too hot",0,5)
    =MID("not too hot",7,0)
    ```

Functions For Extracting And Connecting Text (5)

- `find()`:
  - Finds the starting position of one string within another string
  - **Format:**
  - `find(<find text>, <within text>, [<start position>])`
    - Find text: search for the first occurrence of the *find text* within the *within text*
    - Within text: the string on which the search is performed
    - Start number (optional): the position of the 'within text' that you want the search to being
  - https://support.office.com/en-US/article/FIND-function-06213F91-B5BE-4544-8B0B-2FD5A775436F
  - **Examples:**
  - `=FIND("me", "james")`
  - `=FIND("la","fa-la-la-la-la")`
  - `=FIND("la","fa-la-la-la-la",6)`
  - `=FIND("x","XYZ")`

Combinations: `Find(), Mid()`

- The return value of one function can be used as the argument of another function.
- Consider this example
  - Cell A10 contains the string "Apt #709, 944 Dallas Dr. NW"
  - You wish to extract the apartment number information *#ddd* into a substring
  - Assume that apartment numbers are always preceded by the number sign *#*
  - Also you assume that apartment numbers are three digits in length
  - You cannot make assumptions about the information that precedes the number sign (zero to 'infinity')
  - Find() can be use to determine the start location of the apartment in the string
    - `FIND("#",A10)`
  - The start position of the apartment information can be used as one of the arguments for an extraction function

Combinations: `Find()`, `Mid()`: 2

5

- =MID(A10, ,4)
- But you can't always assume that the apartment information begins at position five.
  - "Apt #709, 944 Dallas Dr. NW"
  - "#123, 4944 Dalton Dr NW"
  - So the return value from find() must be used to first determine the location of the apartment information.

  FIND("#",A10)

  5

  =MID(A10, ,4)

  - Next this information is used as one of the arguments for the `mid()`, string extraction function.
  - All together: "=MID(A10,FIND("#",A10),4)"

Why Bother?

- When would you ever use Excel functions this way?
- Sometimes the data has already been entered into the sheet
  - Data may combine fields or include extraneous information:
  - 403-123-4567 (postal code and phone number combined, dash)
  - (403)111-2222 (as above but adds additional brackets)

1. Labor saving
   - Retyping a large dataset may be time consuming
   - Solve the problem once and then reuse (copy and paste) the trimming formula wherever else it is needed

SUM	▼	:	✕ ✓ f_x	=MID(G2, 2, FIND(")",G2)-2)	
	G		H		I
1	Phone		Area code		
2	(403)210-9455		=MID(G2, 2, FIND(")",G2)-2)		
3	(123)456-7890				
4	(604)604-6040				

Why Bother? (2)

2. Different views of the same data may be needed (from an earlier example sheet): 10_extracting_connecting_text

	A	B	C	D
1	Title	First name	Last name	Phone
2	Ms.	James	Tam	(403)210-9455
3	Mr.	Robert	Thurston	(702)333-33333
4	Dr.	Jane	Jones	(614)123-4567
5	Prof.	Allison	Smith	(123)456-7890

— In Canada the proper greeting will be "Dr. Jones"

=CONCATENATE(A2,C2)

Canadian honorific
Ms.Tam
Mr.Thurston
Dr.Jones
Prof.Smith
Bynes

— In other countries the proper greeting will be "Dr. Harry"

=CONCATENATE(A2,B2)

Middle Eastern honorific
Ms.James
Mr.Robert
Dr.Jane
Prof.Allison

Why Bother? (3)

3. It may useful to be familiar with these functions for the future!
   - Job interviews, the exams, the bonus feature of A2 ;)

Lecture Exercise #1: String Functions

Lecture Exercise #1: String Functions

Lecture Exercise #2: Tracing String Functions

Lecture Exercise #3: String Functions (You Do)

Date And Time Functions

- **Example spreadsheet:**
  "11_date_time"
- today()
  - Displays the current date (month/day/year) e.g., 07/15/2015
- now()
  - Displays the current date (as above) and time (hour/minute with a 24 hour clock) e.g., 18:42
- Both: determine the time/date based on the settings of the computer on which the worksheet is run.
  - Updates occur when the files is opened or when the spreadsheet recalculates new values.

'If-Else' (Branching)
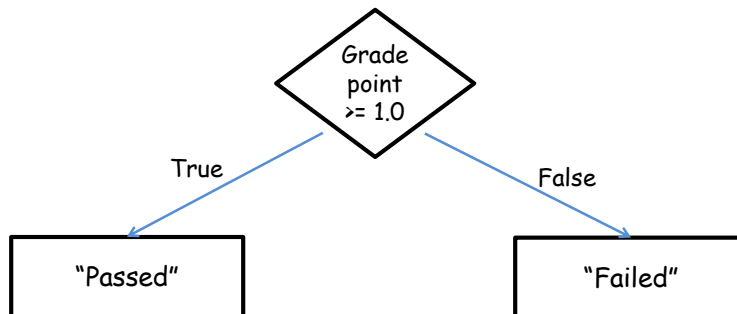
- Function returns one value if a condition has been met.
  - "If condition met do an action"
- Function can return another value if the condition hasn't been met.
  - "Else if the condition not met do another action"
- Boolean (logic): either true or false that the condition was met

Applying Branches: Grade Example

- In column 'E' the sheet will display "Pass" if term grade point is 1.0 or greater "Fail" otherwise.
  - **Example spreadsheet: 12_if_else_pass_fail**

D	E
Term grade point	Comments
1	Pass
3.54	Pass
0.6	Fail
4	Pass
2.285	

Condition   **Action: condition true**

`=IF   (D2>=1,   "Pass",   "Fail")`

Action: condition false - "else case"

Format: If-Else

- **Format**:

  ```
  =if (<condition to check>,
        <return value: condition true>,
        [<return value: condition false>])
  ```

- **Example**:

  ```
  =IF(D2>=3, "Pass", "Fail")
  ```

- Note: the return value is not limited only to text
-

Comparators

Math	Excel	Meaning
<	<	Less than
>	>	Greater than
=	=	Equal to
≤	<=	Less than, equal to
≥	>=	Greater than, equal to
≠	<>	Not equal to

If: Specifying Only The True Case

- If only a return value for the true case has been specified:
  - When the condition has not been met (false that the condition has been met) i.e., "Has the student passed the course?"…literally the text "FALSE" will be displayed.
  - No spreadsheet example has been provided because this implementation is incorrect
    - To see the result you can edit the previous sheet and just delete the false case "Fail" message ('Column E' data).

`=IF(D2>=1,"Pass")`

D	E
Term grade point	Comments
1	Pass
3.54	Pass
0.6	FALSE
4	Pass
2.285	

If: Specifying Only The True Case (2)

- Consequently:
  - Even if a specific return value is desired only for the 'if condition case' (true that the condition has been met)
  - Something, even an empty message, should be specified for the 'else case' (false that the condition has been met).
- Previous example: amended
  - **Example spreadsheet: 13_if_pass_only**

D	E
Term grade point	**Comments**
1	Pass
3.54	Pass
0.6	
4	Pass
2.285	

`=IF(D2>=1,"Pass","")`

Nested Conditions

- Conditions that are dependent upon or are affected by previous conditions.
- 'Nesting' refers to conditions that are 'inside of other conditions'
- Example (assume that the respondent previously indicated that his or her birthplace was an Alberta city)
- Select the AB city in which you were born
  1. Airdrie
  2. Calgary
  3. Edmonton
     …
  - Selecting Airdrie excludes the possibility of selecting Calgary
  - Cities listed later are 'nested' in earlier selections)

Nested Conditions (2)

- Applies when different conditions must be checked but at most only one applies (exactly 0 or 1 conditions can be true)
- Example:
  - Display "Perfect" if grade point is 4.0 or greater
  - Display "Excellent" if grade point is 3.0 or greater but less than 4.0
  - Display "Adequate" if grade point is 2.0 or greater but less than 3.0
  - Display "Pass" if grade point is 1.0 or greater but less than 2.0
  - Otherwise display "Fail"

- **Example spreadsheet: `14_nested_if_grades`**

Previous Grade Example: Specifying Conditions

Nesting
- Later conditions are described as being 'nested' within earlier conditions
- The GPA cases for 3.0, 2.0, 1.0 are described as being 'nested' within the 4.0 case (only checked if the previous case proves to be false)
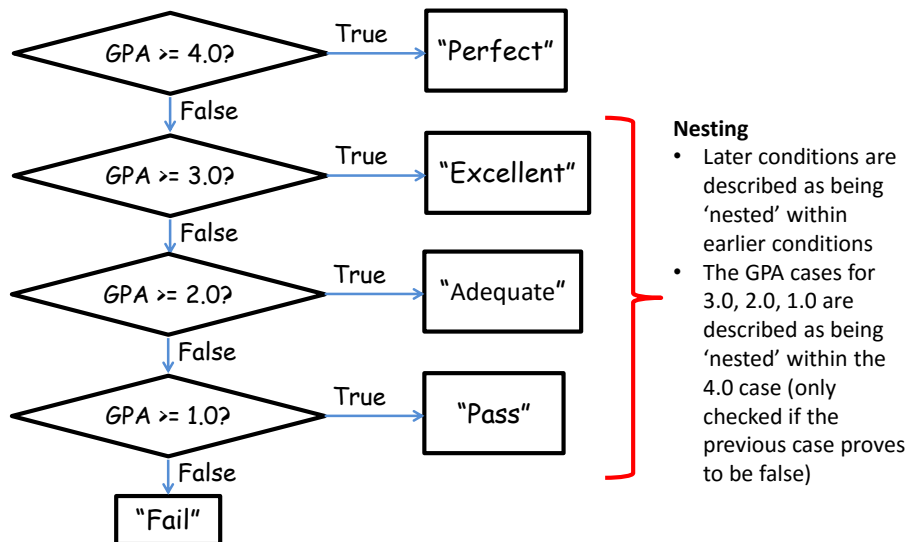
Nested "If's"

- **Format**:

  =IF(*\<condition to check\>*,*\<return: true\>*,[*\<return: condition false\>*])

  Another if-check

  if (*\<condition to check\>*, *\<return: true\>*, *\<return: false\>*)

- **Example**:

  =IF(D5>=4,"Perfect",   )

  IF(D5>=3,"Excellent","")

Previous Example: Initial Cases

- If GPA >= 4.0 "Perfect", if 3.0 <= GPA < 4.0, "Excellent"

  TRUE >= 4.0   **TRUE** >= 3.0

  FALSE >= 4.0

Previous Example: Nested Solution

```
=IF(D2>=4,"Perfect",
    IF(D2>=3,"Excellent",
        IF(D2>=2,"Adequate",
            IF(D2>=1,"Pass",
                "Fail"))))
```

T **F**

```
=IF(D2>=4,"Perfect",IF(D2>=3,"Excellent",IF(D2>=2,"Adequate",IF(D2>=1,"Pass","Fail"))))
```

D	E
Term grade point	Passed course?
3.66	Excellent
3.54	Excellent
1.52	Pass
4	Perfect

Lookup Tables

- Can (should/must) be employed instead of many nested IF's.
  - Easier to enter, update, understand.
- Requirements of previous example:

  0 <= GPA < 1: Fail

  1 <= GPA < 2 : Pass

  2 <= GPA < 3 : Adequate

  3 <= GPA < 4 : Excellent

  GPA >= 4   : Perfect

- Previous solution:

```
=IF(D2>=4,"Perfect",IF(D2>=3,"Excellent",IF(D2>=2,"Adequate",IF(D2>=1,"Pass","Fail"))))
```

Lookup Functions

- The lookup functions that will be covered this semester will be used in conjunction with a lookup table or tables.
- Two lookup functions covered include:
  - LOOKUP( )
  - VLOOKUP( )
  - (Not that the 'IF' is not classified as a lookup function!)
- For a complete list of lookup functions in Excel:
  - https://support.office.com/en-US/article/Lookup-and-reference-functions-reference-8aa21a3a-b56a-4055-8257-3ec89df2b23e

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LOOKUP

- **https://support.office.com/en-US/article/LOOKUP-function-446D94AF-663B-451D-8251-369D5E3864CB**
- **Typical use:**
  - Looking up a value from one column ("a vector")
  - Return a value from another column ("a vector")
  - (According to Microsoft): if you want to look up values from multiple columns ("an array") then the VLOOKUP function should be used instead of LOOKUP.

	A	B	C	D	E	F
1	Employee	Area code	Custom greeting		Generic greeting	Welcome
2	1	403	Welcome AB			
3	2	403	Welcome AB		Area code	Province
4	3	236	Welcome BC		236	BC
5					403	AB

```
LOOKUP(B2,E4:E5,F4:F5)
=CONCATENATE(F1, LOOKUP(B2,E4:E5,F4:F5))
```

LOOKUP (2)

- **Format**:

```
LOOKUP(<Lookup value>,
       <Lookup column (vector) Start : End>,
       <result column (vector) Start : End>)
```

LOOKUP (3)

- **Example spreadsheet: 15_lookup**

	D	E
1	Term grade point	Comments
2	3.66	Excellent

	D	E
10	Min GPA	Comment
11	0	Fail
12	1	Pass
13	2	Adequate
14	3	Excellent
15	4	Perfect

- Row 2 data

```
=LOOKUP(D2,          D11:D15,          E11:E15)
```

Cell:
Contains value to find in
table e.g., a grade point

Lookup column:
Start : End
cell coordinates

Result column:
Start : End
Cell coordinates

LOOKUP (4)

`=LOOKUP(D3,D11:D15,E11:E15)`

	A	B	C	D	E
1	Student	Assignment grade point	Exam grade point	Term grade point	Comments
2	1	4.2	3.3	3.66	Excellent
3	2	3.3	3.7	3.54	Excellent
4	3	2.3	1	1.52	Pass
5	4	4	4	4	Perfect

	D Min. GPA	E Comment	
11	0	Fail	>3.54?
12	1	Pass	>3.54?
13	2	Adequate	>3.54?
14	3	Excellent	>3.54?
15	4	Perfect	>3.54?..Yes!

← Backup and use this value Return "Excellent"

LOOKUP table Values must be sorted in ascending order

LOOKUP: Multi-Column Lookup Table

• **Name of example spreadsheet**: **16_lookup_multiple_columns**

Lookup table

	C Min GPA	D Max GPA	E Comment
10	Min GPA	Max GPA	Comment
11	0	Less than 1	Fail
12	1	Less than 2	Pass
13	2	Less than 3	Adequate
14	3	Less than 4	Excellent
15	4	4	Perfect

LOOKUP function

`=LOOKUP(D2,C11:C15,E11:E15)`

	C Exam grade point	D Term grade point	E Comments	F
1	Exam grade point	Term grade point	Comments	
2	3.3	3.66	Excellent	
3	3.7	3.54	Excellent	

VLOOKUP

- A more complicated (but more powerful) version of a lookup function.
  - https://support.office.com/en-US/article/VLOOKUP-function-0BBC8083-26FE-4963-8AB8-93A18AD188A1
- **Format**:
  ```
  VLOOKUP(<Lookup value>,
          <Lookup table  Start : End>,
          <Lookup table Column specifying the return value>,
          [<Exact match required?>])
  ```
- **Example**:
  ```
  =VLOOKUP(D2,          D11:E15,          2)
  ```

  Cell:
  Contains value to find in table e.g., a grade point

  Lookup table:
  Start : End cell coordinates

  Lookup table:
  Column value to return (1 = first col. 'D', 2 = second col. 'E')

VLOOKUP: Previous Example

`=VLOOKUP(D2,D11:E15,2)`

	A	B	C	D	E
1	Student	Assignment grade point	Exam grade point	Term grade point	Comments
2	1	4.2	3.3	1	Pass
3	2	3.3	3.7	3.54	Excellent
4	3	2.3	1	1.52	Pass
5	4	4	4	4	Perfect
6		3.45	3	2.515	

	D	E
	Min. GPA	**Comment**
11	0	Fail
12	1	Pass
13	2	Adequate
14	3	Excellent
15	4	Perfect

Example spreadsheet: 17_vlookup

VLOOKUP: Multi-Column Lookup Table

- **Name of example spreadsheet**:
  `18_vlookup_multiple_columns`

Lookup table

	C	D	E
10	Min GPA	Max GPA	Comment
11	0	Less than 1	Fail
12	1	Less than 2	Pass
13	2	Less than 3	Adequate
14	3	Less than 4	Excellent
15	4	4	Perfect

Lookup function ⋮ ✕ ✓ *fx* =VLOOKUP(D2,C11:E15,3)

	C	D	E	F
1	Exam grade point	Term grade point	Comments	
2	3.3	3.66	Excellent	

VLOOKUP: Optional Value = TRUE (True = Approximate matches allowed)

- `VLOOKUP(=VLOOKUP(D2,D11:E15,2,TRUE))`
- TRUE (works like LOOKUP so values must be sorted)
  - Look for an approximate match.
  - If an exact match is not found, the next largest value that is less than lookup value is returned.
  - If **T/F** value is omitted then the function assumes a 'TRUE' value.

`GPA = 3.54`

Min. GPA	Comment		
0	Fail	>3.54?	
1	Pass	>3.54?	
2	Adequate	>3.54?	
3	Excellent	>3.54?	← Backup and use this
4	Perfect	>3.54?..No!	value Return "Excellent"

VLOOKUP: Optional Value = FALSE (False = Approximate matches Not allowed, exact matches required)

- VLOOKUP(=VLOOKUP(D2,D11:E15,2,FALSE))
- FALSE:
  - Looks only for an exact match
  - If a match is found then the value at the specified location is returned.
  - Else if no match is found the an error message is displayed.

	C	D	E
10	GPA range	Min GPA	Comment
11	0 <= GPA < 1	0	Fail
12	1 <= GPA < 2	1	Pass
13	2 <= GPA < 3	2	Adequate
14	3 <= GPA < 4	3	Excellent
15	>= 4	4	Perfect

=VLOOKUP(D5,D11:E15,2,FALSE)

	C	D	E	F	G
1	Exam grade point	Term grade point	Comments		
2	3.3	3.66	#N/A		
3	3.7	3.54	#N/A		
4	1	1.52	#N/A		
5	4	4	Perfect		

  - Table values do not have to be sorted.

VLOOKUP: Optional Value = TRUE/FALSE

- TRUE
  - Use when looking a value in a range of values (must be in ascending order) E.g. grades, tax brackets

Income range	Min for range	Tax rate
0 - $20,000	0	0%
> $20,000	20,000	10%

- FALSE:
  - Use when there is an exact value to lookup (order is not important) e.g., SIN numbers, product ID number

Product number	Name	Price
B00KAI3KW2	Xbox One	$449
B00BGA9WK2	Playstation 4	$449

Example: Sensible Use Of False/VLOOKUP

- **Name of example spreadsheet: `19_vlookup_false`**
- Reminder:
  - Use when exact matches are required
  - Lookup table does not have to be sorted

Lookup table

	B	C
10	Car type	Color
11	Sports	Red
12	SUV	Black
13	Mini-van	Beige

Lookup function

`=VLOOKUP(B6,B11:C13,2,FALSE)`

	A	B	C	D
1	Student	Car	Colour	
2	1	SUV	Black	
3	2	SUV	Black	
4	3	Sports	Red	
5	4	Mini-van	Beige	
6	5	Army tank	#N/A	

Looking Values: If Function Vs. Lookup Functions

- Multiple If's:
  - Can be used if there are only a handful of conditions to check (rule of thumb: 2 – 3 max e.g., 2 conditions)

`=IF(D2>=3, "Honors",IF(D2>=0, "Pass","Fail"))`

  - Complex and error prone for anything else (e.g. 5 conditions)

`=IF(D2>=4,"Perfect",IF(D2>=3,"Excellent",IF(D2>=2,"Adequate",IF(D2>=1,"Pass","Fail"))))`

- Lookup functions
  - Steeper learning curve (but a "one-time investment")
  - Once learned the formulas are simpler (no nesting) and less error prone

`=VLOOKUP(D2, D11:E15, 2)`

Min. GPA	Comment
0	Fail
1	Pass
…	…

When To Use The If-Function

- When multiple conditions must be checked
  - Combined with the logical operators (typically AND, OR although NOT may also be used)

Logical Operations In Excel

- The basic logical operations: AND, OR, NOT can be invoked as functions in Excel
  - All function inputs can only be a `True` or `False` value.
- **Format**:
  ```
  AND(<True or False>,<True or False>...)
  OR(<True or False>,<True or False>...)
  NOT (<True or False>)
  ```

- **Examples** (spreadsheet name: 20_logic
  ```
  AND(C1>=45,D1="John Smith")   # Requires all
  OR(C1>=0,D2>=0)     # Requires at least one
  NOT(AA12) # AA12 Must contain a logical: TRUE, FALSE Value
  ```

Logic And IF's: Example

- The honor roll for each semester requires that grade point is 3.7 or greater and a full load of at least 5 courses must be taken.
- AND Example: Honor roll
  - Signify when a student has met the honor roll requirements with an "H", blank cell otherwise.

`=IF(AND(B5>=3.7,C5>=5),"H","")`

	A	B	C	D
1	Student	Overall GPA	Number courses	Honor roll?
2	1	4	1	
3	2	3.9	5	H
4	3	2.3	5	
5	4	3.7	5	H

- **Example spreadsheet: `21_if_logic`**

Logic And IF's: Example (2)

- OR Example: Hiring if at least one requirement met (work experience of 5+ years, grade requirement of 3.7 or higher)

E12

Total work experience
7

`=IF(OR(E12>=5,G16>3.7),"1+ requirement met","")`

G16

Overall GPA
3.6

Lecture Exercise #4: Branching (And Other) Functions

Conditional Counting Functions

- Increases a tally count if one or conditions have been met
- COUNTIF(): count if a particular condition has been met
- COUNTIFS(): count if all conditions have been met

Counting Functions Based On Conditions: Countif()

- Counts the number of cells that meets a particular requirement
  - https://support.office.com/en-US/article/COUNTIF-function-E0DE10C6-F885-4E71-ABB4-1F464816DF34

	Col C
13	0
14	2
15	"A"
16	

COUNTIF (#)	=COUNTIF(C13:C16,">0")

Counting Functions Based On Conditions: Countif(), 2

	Col C
13	0
14	2
15	"A"
16	

COUNTIF (TEXT)	=COUNTIF(C13:C16,"B")

Counting Functions Based On Conditions: Countifs(),3

- Can be used when multiple requirements must be met:
  - Counts the number of cells that meets all in a series of multiple requirements
  - https://support.office.com/en-US/article/COUNTIFS-function-DDA3DC6E-F74E-4AEE-88BC-AA8C2A866842
- Format:
  ```
  =countifs(
     <range 1>, <criteria 1>,
     … <optional additional range>, [<optional additional
        criteria>])
  ```
- **Example spreadsheet:**
  22_conditional_counting_formulas
  - =countifs(A1:A10,"A", B2:B7, ">=100")

Counting Functions: Countifs(),4

		Col C	Col D
		Jan quota met?	Feb quota met?
14	James	Yes	
15	Dave	Yes	Yes
16	Ernie		
17	Ron		Yes
18	Don	Yes	Yes
19	Lucie		

2 months quota met

Specify: count number of employees that met the quota for both months

Conditional Formatting

- A very practical example of how conditional branching "if's" can be applied.
- Use of conditional formatting will be covered in tutorial.

Methods Of Referring To Cells

- Absolute:
  - The formula won't change if you copy/cut and paste the formula or if the spreadsheet changes in size
- Relative
  - The formula changes depending how far that the formula is moved or how much the spreadsheet is changed in size.

Absolute Reference

- When a reference to an cell or range of cells doesn't change when the contents of a cell or cells is copied or the sheet changes in size.

	A	B	C
1	Net income	$2,000.00	
2			
3		Feb expenses	March expenses
4	Rent	$907.00	$907.00
5	Parking	$25.00	$25.00
6	Groceries	$300.00	$300.00
7	Car	$500.00	$500.00
8	Fun	$0.00	$100.00
9	Misc	$100.00	$200.00
10	Total expenses	$1,832.00	$2,032.00
11			
12	Income after bills	$168.00	-$32.00

Assumption

Row 10 sums row 4 – 9.

Original formula (B12)

=$B$1-B10

Copied (C12)

=$B$1-C10

Absolute Reference (2)

$168.00   -$32.00

Original formula (B12)

=$B$1-B10

Absolute reference

Copied (C12)

=$B$1-C10

Absolute reference

Absolute reference because the same (absolute) reference to cell B1 is made when the formula is copied.

Absolute Reference (3)

- Typically it's used in conjunction with constants (data that won't change).

References to B1 are absolute because income doesn't change

	A	B	C
1	Net income	$2,000.00	
2			
3		Feb expenses	March expenses
4	Rent	$907.00	$907.00
5	Parking	$25.00	$25.00
6	Groceries	$300.00	$300.00
7	Car	$500.00	$500.00
8	Fun	$0.00	$100.00
9	Misc	$100.00	$200.00
10	Total expenses	$1,832.00	$2,032.00
11			
12	Income after bills	$168.00	-$32.00

Original formula (B12)

=$B$1-B10

Copied (C12)

=$B$1-C10

Relative Reference

- A reference to a cell or group of cells that may change if the cell/cells are copied or the sheet changes in size.

	A	B	C
1	Net income	$2,000.00	
2			
3		Feb expenses	March expenses
4	Rent	$907.00	$907.00
5	Parking	$25.00	$25.00
6	Groceries	$300.00	$300.00
7	Car	$500.00	$500.00
8	Fun	$0.00	$100.00
9	Misc	$100.00	$200.00
10	Total expenses	$1,832.00	$2,032.00
11			
12	Income after bills	$168.00	-$32.00

Original formula (B12)

=$B$1-B10

Copied (C12)

=$B$1-C10

Relative Reference (2)

	A	B	C
1	Net income	$2,000.00	
2			
3		Feb expenses	March expenses
4	Rent	$907.00	$907.00
5	Parking	$25.00	$25.00
6	Groceries	$300.00	$300.00
7	Car	$500.00	$500.00
8	Fun	$0.00	$100.00
9	Misc	$100.00	$200.00
10	Total expenses	$1,832.00	$2,032.00
11			
12	Income after bills	$168.00	-$32.00

Reminder:
- Total expenses (row 10) is a calculated value. It sums rows 4 – 9.

Original formula (B12)

=$B$1-B10

Relative reference

Copied (C12)

=$B$1-C10

Relative reference

Relative reference because the copied formula will change relative to how far it's copied.

Relative Reference (3)

- Typically it's used with variable data (that may change over time or in different parts of the sheet).

	A	B	C
1	Net income	$2,000.00	
2			
3		Feb expenses	March expenses
4	Rent	$907.00	$907.00
5	Parking	$25.00	$25.00
6	Groceries	$300.00	$300.00
7	Car	$500.00	$500.00
8	Fun	$0.00	$100.00
9	Misc	$100.00	$200.00
10	Total expenses	$1,832.00	$2,032.00
11			
12	Income after bills	$168.00	-$32.00

Total expenses may change from month-to-month so references will likely be relative.

Original formula (B12)

=$B$1-B10

Copied (C12)

=$B$1-C10

Cell References: Important Details

- **Format**: specify absolute cell references with a dollar sign '$'
  immediately in front of the row or column value.

  `[<dollar sign for column>]<column> [<dollar sign for row>]<row>`

- Examples:
  - Relative column, relative row: A1
  - Relative column absolute row: A$1
  - Absolute column, relative row: $A1
  - Absolute column, absolute row: $A$1

Absolute, Relative And Mixed References: Examples[1]

	A	B	C
1			
2			
3			

Example	Reference type	Copied result
$A$1	•Absolute column •Absolute row	$A$1
A$1	•Relative column •Absolute row	C$1
$A1	•Absolute column •Relative row	$A3
A1	•Relative column •Relative row	C3

1 Examples from the Excel 2003 Help System

Absolute, Relative References: Example

- **Example spreadsheet: `23_absolute_relative`**

	A	B	C
1	**Data**		
2	2	7	9
3	3	1	8
4	5	6	4

To E7

To G8

COLUMN F

ROWS	Original formulas (result)
11	=$C$4 (4)
12	=B$3 (1)
13	=$A2 (2)
14	=A2 (2)

To D14

To G16

Absolute/Relative Applied To A Previous Example

- Which part of the formula should be:
  - Absolute?
  - Relative?
  - Why?

= (B3*G3)+(C3*G4)

	A	B	C	D	E	F	G
1	Student	Assignment grade point	Exam grade point	Term grade point		Component	Weight
2	1	4.2	3.3	3.66		Assignment	0.4
3	2	3.3	3.7	3.54		Exam	0.6
4	3	2.3	1	1.52			
5	4	4	4	4			

= (B4*G4)+(C4*G5)

Lecture Exercise #5: Absolute, Relative Addressing (If There Is Time)

Testing Spreadsheets

- Test formulas to ensure that they are correct.
  - Enter a few test values and see if the results match expectations.
  - Simple interest example:
  - Amount = Principle + (Principle * Interest rate * Time)
  - E.g., $100 at 10% for 3 years

  Amount = 100 + (100 * 0.1 * 3)

  $\qquad$ = 100 + (30)

  $\qquad$ = $130

  Some example test cases:
  1. Nothing to invest: principle is nothing, everything else non-zero.
  2. Interest rates are rock bottom: zero interest rates, everything else non-zero
  3. No time passed: time is zero, everything else non-zero.
  4. Normal case: Non zero values for: principle, interest or time.

Example Testing A Formula

	A	B	C	D	E	
1	Case	Principle	Rate	Time	Amount	
2	Normal data	100	0.1	5	150	<- All non-zero
3	No investment	0	0.1	5	0	<- No principle
4	No interest	100	0	5	100	<- No interest
5	No time passes	100	0.1	0	100	<- No time elapsed

Testing Ranges

Min. GPA	Comment
0	Fail
1	Pass
2	Adequate
3	Excellent
4	Perfect

- The following are the *minimum* test cases
- Provide test values for each range
  - In this example try grade points of 0, 1, 2, 3, 4
- Also for at least one of the ranges test the boundaries (just above and below)
  - Example: testing the boundary for 1 / "Pass"
    - Slightly below a boundary value e.g., 0.9 should return "Fail"
    - Slightly above a boundary value e.g., 1.1 should return "Pass"
- Total test cases for this example: 7 tests

Example: Good Design And Testing

- Previous grading example: the following will likely be data (cannot be calculated from other values in the sheet)

	A	B	C	D	E	F	G	H	I
1	Student	Assignment grade point	Exam grade point	Term grade point	Comments			Component	Weight
2	1	4.2	3.3					Assignment	0.4
3	2	3.3	3.7					Exam	0.6
4	3	2.3	1						
5	4	4	4						
6									
7									
8									
9									
10			GPA range	Min GPA	Comment				
11			0 <= GPA < 1	0	Fail				
12			1 <= GPA < 2	1	Pass				
13			2 <= GPA < 3	2	Adequate				
14			3 <= GPA < 4	3	Excellent				
15			>= 4	4	Perfect				
16									

- Values that will be determined by the data
  - Term grade point (calculated), comments (lookup)s

Term Grade Point

- How should this value be calculated?

	A	B	C	D	E	F	G	H	I
1	Student	Assignment grade point	Exam grade point	Term grade point	Comments			Component	Weight
2	1	4.2	3.3					Assignment	0.4
3	2	3.3	3.7					Exam	0.6
4	3	2.3	1						
5	4	4	4						
6									
7									
8									
9									
10			GPA range	Min GPA	Comment				
11			0 <= GPA < 1	0	Fail				
12			1 <= GPA < 2	1	Pass				
13			2 <= GPA < 3	2	Adequate				
14			3 <= GPA < 4	3	Excellent				
15			>= 4	4	Perfect				

- First step: make it mathematically correct
  - Assignment: proportion of term grade = 40%
  - Exam: proportion of term grade = 60%

Term Grade Point (2)

- Second step: make sure that you follow good style:
  - Be 'lazy', minimalize your work!
    - If a value can be determined by existing data then don't manually enter the value e.g., term grade point can be calculated by the grade points of each component and their weights.
      - Future grade changes are easier to make
      - Also reduces errors)

Derive it, don't type it

      - Allow for reuse of the formula (copy-and-paste): correct application of absolute vs. relative addressing

Term Letter Grade

- How should this value be derived?
  - Use the cutoff values in the table below.
  - Remember it must be correct AND it should follow good style conventions.

	A	B	C	D	E
1	Student	Assignment grade point	Exam grade point	Term grade point	Comments
2	1	4.2	3.3		
3	2	3.3	3.7		
4	3	2.3	1		
5	4	4	4		
6					
7					
8					
9					
10			GPA range	Min GPA	Comment
11			0 <= GPA < 1	0	Fail
12			1 <= GPA < 2	1	Pass
13			2 <= GPA < 3	2	Adequate
14			3 <= GPA < 4	3	Excellent
15			>= 4	4	Perfect

Absolute, Relative: Completed Example

- Spreadsheet solution name (**don't look at contents before we go over the concepts in lecture**) `24_DONT_LOOK_B4_CLASS_ vlookup_absolute_relative_addressing`

After This Section You Should Now Know

- The benefit of electronic over paper spreadsheets
- Spreadsheets 101: The basic layout and components of a spreadsheet
- What is a worksheet
  - When to use multiple spreadsheets vs. multiple worksheets
  - How to reference data in other spreadsheets or worksheets (cross references)
- How Excel groups functions according to tabs on the ribbon
  - What are the most commonly used tabs and what some of the functions available on those tabs
- Entering data: manually and via autofill
- How to freeze data

After This Section You Should Now Know (2)

- Tags
  - How to do tag a spreadsheet
  - What is the benefit of using tags
- Common mathematical operators and the order of operation
- What is the difference between constants (data) and calculations (formulas)
  - How is a formula differentiated from data
- The three rules of thumb for designing spreadsheets
  1. Don't make something data if it can be derived
  2. Label everything
  3. Don't duplicate data

After This Section You Should Now Know (3)

- Lookup tables
  - How to create a use a lookup table
- Formulas:
  - Directly entering custom formulas
  - Using built-in pre-created formulas
  - What is the order of operation for common operators
- How to format cells using the "format cell" option
  - What is the effect of different numeric formatting options
- How to use basic statistical formulas: `sum()`, `average()`, `min()`, `max()`
- How to use counting functions: `count()`, `counta()`, `countblank`, `countif()`, `countifs()`

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After This Section You Should Now Know (4)

- How to use string functions: `lower()`, `upper`, `proper()`, `trim()`, `concatenate()`, `find()`, `left()`, `right()`, `mid()`
- How to use the `today()`, `now()` functions
- How to use '`if-else`' for branches that return different values
  - The different ways of expressing logical comparators
  - How to write or evaluate nested '`if`'s'
- Logical operations in Excel: AND, OR, NOT
  - How to write or evaluate logical operations
  - How to apply the logical operations in conjunction with the '`if-else`'
- How to use the `LOOKUP()`, `VLOOKUP` function

After This Section You Should Now Know (5)

- How to come up with set of reasonable test cases for a spreadsheet
  - Formulas and ranges
- What is the difference between an absolute vs. relative cell reference and when to use each one

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