Spreadsheets: Part 2
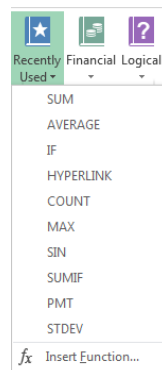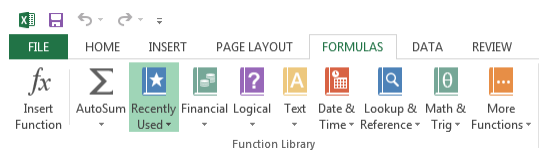
You will learn about some important features of Excel.

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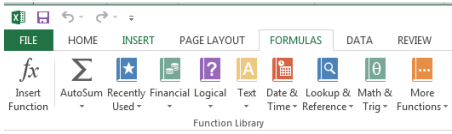https://support.office.com/

Pre-Created Excel Formulas

What Function Is Right For Your Situation?

- Excel provides reminders.
- Built in functions are grouped into the 'formulas' tab on the ribbon

- Also Excel provides "name completion" and "tool tips"

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**)

  For the exam you can see either form

- **Optional function inputs ("arguments")**
  Distinguished by the use of square brackets [**optional argument**]
  =IF (*<condition to check>*,
       <return value: condition true>,
       [*<return value: condition false>*])

Basic Statistics

- **Example spreadsheet:**
  - `10_basic_statistics`

- Example formulas: `SUM()`, `AVERAGE()`, `MIN()`, `MAX()`
- General usage:
  - Each formula requires as input a sequence 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)

- Referring to a range of cells

	A	B	C	
1			Sales	
2			**Chinook**	
3	Sales person	Manager	$105,000.00	
4		Assistant	$117,000.00	
5		Employee1	$66,000.00	
6		Employee2	$75,000.00	
7		Employee3	$55,500.00	
8				
9		STORE STATISTICS		
10		Store: total sales	$418,500.00	`=SUM(C3:C7)`
11		Store averages	$83,700.00	`=AVERAGE(C3:C7)`
12		Store: highest	$117,000.00	`=MAX(C3:C7)`
13		Store: lowest	$55,500.00	`=MIN(C3:C7)`

Basic Statistics (3)

- FYI: Ranges can span multiple rows and columns

	A	B	C	D	E	F	G	H
1			Sales At Each Location					
2			Chinook	Market Mall	Sunridge			
3	Sales person	Manager	$105,000.00	$136,500.00	$100,000.00			
4		Assistant	$117,000.00	$125,000.00	$50,000.00			
5		Employee1	$66,000.00	$64,000.00	$500,000.00			
6		Employee2	$75,000.00	$85,000.00				
7		Employee3	$55,500.00					
8								
9		STORE STATISTICS					OVERALL STATISTICS	
10		Store: total sales	$418,500.00	$410,500.00	$650,000.00		Calgary: total sales	$1,479,000.00
11		Store averages	$83,700.00	$102,625.00	$216,666.67		Calgary: employee average	$123,250.00
12		Store: highest	$117,000.00	$136,500.00	$500,000.00		Calgary: highest employee	$500,000.00
13		Store: lowest	$55,500.00	$64,000.00	$50,000.00		Calgary: lowest employee	$50,000.00

`=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, blank cells…

- General usage:

  FUNCTION(*<start cell range>* : *<end cell range>*)

  – An array (list) of inputs can be the function argument but this is rare except for illustration or examination purposes e.g., =COUNT(1,"A",2)

Counting Functions: COUNT( )

- Counts the number of cells within the specified range that contain a numeric value.
- 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)

Q: What is the result?

Counting Functions: 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)

Q: What is the result?

Counting Functions: 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)

Counting Functions: Spreadsheet Example

- **Example spreadsheet:** 11_counting_functions

	B	C	D	E	F
1		Sales At Each Location			
2		Sunridge	Market Mall	Chinook	Future location
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	**Counting functions**				
10	Number employees	3	4	5	0
11	Number unstaffed positions	2	1	0	5
12				=COUNT(C3:E7)	
13	Employee slots filled	12			
14	Employee slots vacant	3		=COUNTBLANK(C3:E7)	

- – COUNT(): Also used in Row 10
- – COUNTBLANK(): Also used in Row 11

Counting Functions: Spreadsheet Example (2)

– COUNTA( ): Number of cases where the employee name has been entered into the system.

- That is, blank cells can be either for unstaffed positions or cases where the name of the staff member has not yet been entered.

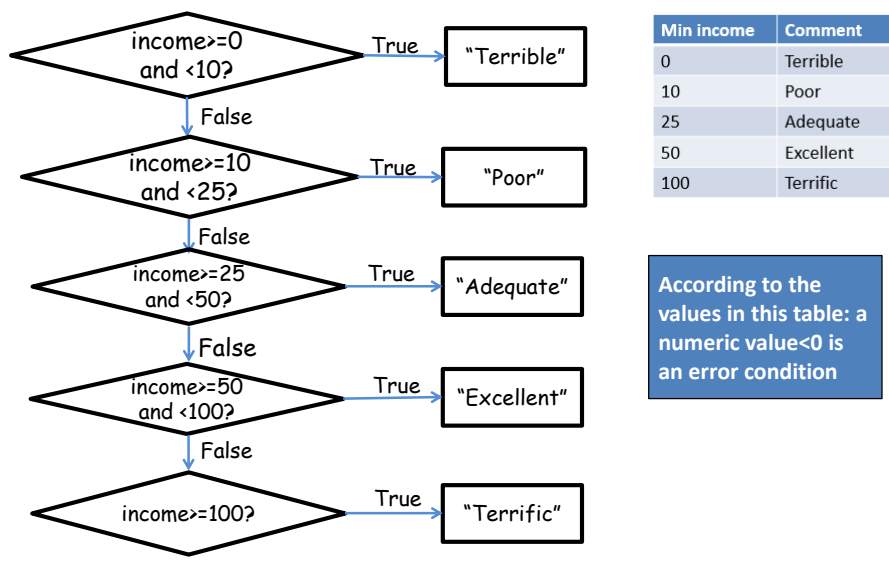|	A	B	C	D	E
1		Sales At Each Location			
2		Sunridge	Market Mall	Chinook	Future location
3	Manager	Ron Ridge	Dean Perkins	Don Torrie	
4	Assistant		James Tam	2cool Person	
5	Employee1		Dave Meek		
6	Employee2				
7	Employee3				
8					
9	**Counting functions**				
10	Current staffing	1	3	2	0
11	Vacancies	4	2	3	5

=COUNTA(B3:B7)

Lookup Functions

- One common use of a lookup function is to determine which category that some numeric value resides.
- Membership in a category is often determined by ranges:
  – Mapping raw scores to a letter grade.
  – Determining your 'tax bracket'.
  – Evaluating your "FICO" credit score.

Lookup Tables

- Lookup functions require a 'lookup table' that specifies the ranges.
  - Example: for your given grade in a course, a lookup table specifies the various cutoffs for the different letter grades.
  - Similar to a lookup table containing constants but these examples are for a range of values (there are strict requirements in the format) rather than a single value.
- **Important format requirements** for the **first column** of the lookup table examples covered this term:
  - table values must be in **ascending order**,
  - column values can only be **numeric**.
- In the example the data in cells **D11 – D15** follow these requirements.

	D	E
10	Min income	Comment
11	0	Terrible
12	10	Poor
13	25	Adequate
14	50	Excellent
15	100	Terrific

Example: Specifying Conditions

income>=0 and <10? — True → "Terrible"
False
income>=10 and <25? — True → "Poor"
False
income>=25 and <50? — True → "Adequate"
False
income>=50 and <100? — True → "Excellent"
False
income>=100? — True → "Terrific"

Min income	Comment
0	Terrible
10	Poor
25	Adequate
50	Excellent
100	Terrific

According to the values in this table: a numeric value<0 is an error condition

VLOOKUP

- Official link for help
  - 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***>)
- **Example**:
  =VLOOKUP(**B2**,   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, fo
this example:
(1 = first col. = 'D',
 2 = second col. = 'E')

VLOOKUP: Investments

- **Example spreadsheet:** 12_vlookup

=VLOOKUP(B2,D11:E15,2)

	A	B	C
1	Stock	Net income (millions of $)	Invest?
2	PEAR	$1,000.00	Terrific
3	TAM	$50.00	Excellent
4	SCAM	$1.00	Terrible

	Col D (1st) Min income	Col E (2nd) Comment
11	0	Terrible
12	10	Poor
13	25	Adequate
14	50	Excellent
15	100	Terrific

VLOOKUP: **Multi-Column** (3+) Lookup Table

- **Name of example spreadsheet**:
  13_vlookup_multiple_columns

Lookup function

Lookup table

Col 1   Col 2   Col 3

Conditional Counting Function

- Increases a tally count if one or conditions have been met
- COUNTIF()

Conditional Counting Function: COUNTIF()

- Counts the number of cells that meets a particular requirement
  - How many employees of a multi-national corporation are Canadian?
  - How many students in a class were awarded an "A+" grade?
  - Example below: Count the number of cells within the range that contain a positive numeric value.

	A
1	0
2	2
3	A
4	=COUNTIF(A1:A3,">0")

  - https://support.office.com/en-US/article/COUNTIF-function-E0DE10C6-F885-4E71-ABB4-1F464816DF34

Conditional Counting Function: COUNTIF(), 2

	A
1	0
2	2
3	A
4	=COUNTIF(A1:A3,"B")

COUNTIF(): Full Example

- **Example spreadsheet:** 14_countif
- Conditions tallied
  - Which employees met quota? (If the cell contains "Yes")
  - Which employees had sales that were deemed as high (above $100,000)

	A	B	C
1	Employee	2017 sales quota met?	2017 sales in $
2	James	Yes	$100,000
3	Dave	Yes	$123,456
4	Ernie		$55,000
5	Ron		$66,000
6	Don	Yes	$118,000
7	Lucie		$75,000

	A	B
9	# Met quota	3
10	High sales	2

`=COUNTIF(B2:B7,"YES")`

`=COUNTIF(C3:C8,">100000")`

Recall: From Word Mail Merge Filters

- Example Mail merge filters covered previously
  - Filter rule based on age:
    - 65 and over: "You get a seniors discount."
    - Under 65: "No seniors discount."
- The If-Then-Else filter checks if a condition has been met e.g. a field in the spreadsheet data source was equal to some value.
  - If the condition has been met (**condition = true**) then display a message.
  - If the condition has not been met (**condition = false**) then display another message.

Insert Word Field: IF   ?   ×

IF

Field name: Comparison: Compare to:
Age   ∨   Greater than or equal ∨   65

Insert this text:
You get a seniors discount.

Otherwise insert this text:
No seniors discount.

New Terminology

- **A Boolean expression** takes a condition (a comparison such as degree being equal to 'B.Sc.'') as input and returns a Boolean value.
  - The conditions must be specified to yield either a Boolean result.
- **Boolean / Boolean value**: must be either true or false

Insert Word Field: IF		? ✕
IF		
Field name:	Comparison:	Compare to:
Age	Greater than or equal	65

The result of this comparison is Boolean (the condition can only be met or not met).

  - Examples of statements that must be true or false:
    - A job applicant has been awarded a B.A. degree.
    - The customer is a senior citizen.
    - It is below freezing [freezing point of water] today.

Format: IF-ELSE

- **Format**:
  ```
  =if (<Boolean expression>,
        <Boolean return value: condition true>,
        [<Boolean return value: condition false>])
  ```
  - Reminder: square brackets [] is the notation used by Microsoft for optional arguments
- **Example**:
  ```
  =IF (B2>=100,"GO!","Don't' waste your $")
  ```

- Official help link
- https://support.office.com/en-US/article/IF-function-69aed7c9-4e8a-4755-a9bc-aa8bbff73be2?CorrelationId=6aeb3056-a94b-47ac-af6e-90dff250a029

Excel IF-Function: Investing Example

- In column 'C' the sheet will display "GO!" if net income is 100 (millions of $) or greater "Don't waste your $" otherwise.
  - **Example spreadsheet:** 15_if_invest_or_not

Boolean expression

=IF (B2>=100, "GO!", "Don't' waste your $")

Return: condition true   **Return: condition false - "else case"**

▲	A	B	C
1	Stock	Net income (millions of $)	Invest?
2	PEAR	$1,000.00	GO!
3	TAM	$888.00	GO!
4	POOR	$1.00	Don't waste your $
5	Average	$629.67	GO!

Comparators

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

Example **Return Values**

Type of return value	Example return value	Example use
Text	*"GO"*	=IF (B2>=100,"GO!", "No go")
Numeric	**4**, **4.0**	=IF (C3="A+",**4.3, -1**)
Cell reference	**A2, A3**	=IF(A1>0,**A2,A3**)
Boolean	**True**, **False**	=IF(1>2,**True,False**)

IF: Specifying Only The True Case (Poor Approach)

- **Example spreadsheet:**
  16_if_else_invest_or_not_NO_FALSE_return
- If only a return value for the true case has been specified:
  - When the condition has not been met (False result from the Boolean expression)…literally the text "FALSE" will be displayed.

`=IF(B4>=100,"GO!")`

	A	B	C
1	**Stock**	**Net income (millions of $)**	**Invest?**
2	PEAR	$1,000.00	GO!
3	TAM	$888.00	GO!
4	POOR	$1.00	FALSE
5	Average	$629.67	

IF: Specifying Only The True Case (Better Approach)

- **Example spreadsheet:** 17_if_else_invest_or_not_ammended
- Consequently:
  - When a message is desired only when the 'if condition case' is true then something, even an **empty message**, should be specified for the 'else return case' (false that the condition has been met).

▲	A	B	C
1	Stock	Net income (millions of $)	Invest?
2	PEAR	$1,000.00	GO!
3	TAM	$888.00	GO!
4	POOR	$1.00	
5	Average	$629.67	

`=IF(B4>=100,"GO!","")`

Logic: What You Learned

- You were informally taught the **AND** as well as the **OR** logical operations in the section covering Internet searches.
- Example:
  - "James Tam" Calgary   Logical **AND** (default)
  - Vs.
  - "James Tam" **OR** Calgary   Logical **OR**
- More formally: AND, OR are logical operators
- Mathematical operators take numbers as input and return a number
- **New term: Logical operators** take a Boolean as input and return a Boolean value.
  - Logical operators can connect compound (2+) Boolean expressions.
  - (Boolean expression) Logical operator (Boolean expression) etc.

Logical AND: All Restrictions

- Used when **all conditions** / Boolean expressions (BE) must be true

- Example:
  - Prerequisites for CPSC 233: Introductory programming course as well as discrete math ("as well as" = AND in this case).
  - `Intro programming grade >= C-  AND  Math grade >= C-`

      **Condition 1 /
      BE 1**   **Condition II
                                                / BE 2**

  - If either course grade is not satisfactory it's false that the requirement is met.
    - With Logical-**AND** if *any* **Boolean Expression is false** then the **entire compound condition is made false**.
  - Only if all course grades satisfactory will it be true that the pre-requisites have been met.
    - With Logical-**AND** only if *all* **conditions are true** will the entire **compound condition be true.**

Logical AND: Many Conditions

- To evaluate the result just extend the general rule:
  - Multiple AND-expressions **must all be true** for the overall **result** to be **true**.
  - If **at least one** expression is **false** then the overall **result** is **false**.

- Example:
  - Internet search: **"James Tam" CPSC Calgary**
    - Before a webpage appears as a search result, all three conditions must be met (the three text phrases must appear in that page).
      - The more search phrases that you include, the more narrow will be your results (fewer).
  - A course with 3 or more prerequisites.
  - Job applicants must meet 3 or more requirements e.g. Applicant must be an adult, awarded a university undergraduate degree (or a superior degree), overall grade point from that degree must be at least 3.0.

Logical OR: At least One Restriction

- Used when **at least one** condition / Boolean expression (BE) must be met (true).
- Example:
  - Prerequisites for CPSC 233: One of CPSC 217 or 231
  - `CPSC 231 GPA >= C-  OR CPSC 217 GPA >= A-`

    Condition 1 / BE 1   **Condition 2 / BE 2**

  - If at least one of: CPSC 217, 231 was completed satisfactorily, then the intro programming requirement was met.
    - With Logical-OR if *any* condition / Boolean Expression is true then the **entire compound condition is made true**.
  - Only if no courses were completed satisfactorily then the programming requirement has not been met.
    - With Logical-OR only if *all* conditions are false will the **entire compound condition be false**.

Logical OR: Many Conditions

- As was the case with Logical-AND to evaluate the result just extend the general rule:
  - If **at least one** expression is true then the overall **result** is **true**.
  - Multiple OR-expressions **must all be false** for the overall **result** to be **false**.
- Example:
  - Internet search: "Wayne Gretzky" **OR** "The Great One" **OR** "Number 99" **OR** "Number ninety nine"
    - A website that includes at least one of the text phrases will be shown as a search result.
      - Increasing the number of OR-expressions will broaden (increase) the number of search results.
  - A course with a choice of prerequisites.
  - Job applicants can be awarded one of a number of degrees e.g. B.A., B.Comm, B.Sc. etc.

Mixed Logical Expressions

- AND, OR conditions can be combined in actual usage.
- Example:
  - Internet search: "Wayne Gretzky" **OR** "The Great One" **OR** "Number 99" **OR** "Number ninety nine" **AND** "Edmonton Oilers"
    - A website will show as a search result if it contains at least one of the three 'names' as well as containing the text "Edmonton Oilers".
  - Course prerequisites: CPSC 233 requires one of: CPSC 217, 231 as well as Math 271
    - In actual usage logical operators may be implicit so you should be able to interpret plain English descriptions in an assignment or during an examination.
    - CPSC 217 OR CPSC 231 AND MATH 271
    - With logic and software 'AND' is a higher order precedence than OR so the above is not evaluated left-right, the above is the same as:
      - CPSC 217 OR (CPSC 231 AND MATH 271)
    - (CPSC 217 OR CPSC 231) AND MATH 271   (To avoid confusion bracket expressions to make things explicit).

Logical Functions In Excel

- The basic logical operations: AND, OR can be invoked as functions in Excel
  - Similar to evaluating logical expressions on paper, all Excel logical function inputs can only be a True or False value.
  - Function inputs can be:
    - Boolean **constant** e.g. AND(**True,False,False**)
    - Boolean **expression** e.g. OR(**A1>0,A2>0,3>2**)
    - A **cell** that contains a Boolean value e.g. AND(**A1,A2**), OR(**B1,Z2**)
- **Format**:
  ```
  AND(<True or False>,<True or False>...)
  OR(<True or False>,<True or False>...)
  ```

# Types Of Inputs: Logic Functions

- **Examples** (spreadsheet name: 18_logic)
  ```
  AND(C1>=45,D1="John Smith")
  OR(C1>=0,D2>=0)
  ```

New Terminology: **Nested Calculation**

- Nested calculation: one calculation is nested within another second calculation when the **result of the first calculation is used to determine the result of the second calculation**.
- Simple example:
  - *Calories expended* = (**height + 7**) * 100
- More complex example:
  - First calculation: determine the total cost of salaries and other expenditures for each Canadian province.
  - Second calculation: determine total for all sources of revenue for each province.
  - Third calculation: calculate the surplus (of deficit) for each province
  - = (**sum all provincial revenues**) – (**total provincial expenditures**)
  - The calculations for revenues and expenditures are nested within (part of) the calculation for the surplus (or deficit)

Nested Functions

- The return **result of one function is used as an argument for another function**.
- Example:
  - Find the maximum grade for each lecture section.
  - Example:
    - Lecture 01: =MAX(A2:A101)
    - Lecture 02: =MAX(B2:B101)
  - Calculate the average of the lecture maximums
    - Average of the maximum scores: = AVERAGE(**MAX(A2:A101)**, **MAX(B2:B101)**)

      =MAX(A2:A101)   **MAX(B2:B101)**

              =AVERAGE(,   )
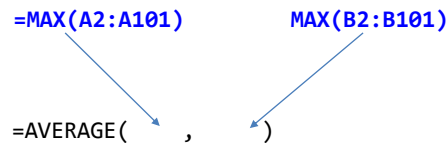
Using One Function's Return Value As Input For Another Function (Nesting Functions: Logic, IF)

- Breaking down the process into parts
  1. **Call a function** and that function **returns** a value e.g. B4 = 3.7, C4 = 4

     AND(B4>=3.7,C4>=5)

     Returns **False**

  2. Use the return value of the first function as part/all of the **input** of a second function
     - The first function is *nested* within the second function.

     =IF(, "H","")
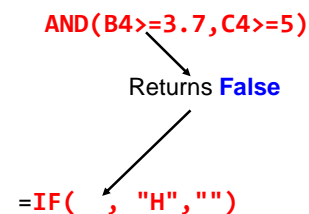
     Actual formulation of the function
     IF(AND(B4>=3.7,C4>=5), "H","")

Logic And IF's: Example

- Being on the Dean's list requires: a grade point of 3.7 or higher and a full load 5 or more courses.
- AND Excel example: Dean's list
  - Signify when a student has made the Dean's list requirements with an "D", blank cell otherwise.

`=IF(AND(B4>=3.7,C4>=5),"D","")`

	A	B	C	D
2	Student	Overall GPA	Number courses	Dean's list
3	1	4	1	
4	2	3.9	5	D
5	3	2.3	5	
6	4	3.7	5	D

- **Example spreadsheet:** `19_if_with_logic`

Logic And IF's: Example (2)

- OR Example: Hired if at least one requirement has been met:
  - work experience of 5+ years,
  - grade 3.7 or higher
  - (Same spreadsheet as previous example)

E12

Total work experience
7

G16

Overall GPA
3.6

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

Conditional Formatting

- **Example spreadsheet:** 20_conditional_formatting
- It can be used to visually highlight data which has met a certain condition.

	A	B
1	**Employee**	**2017 sales in $**
2	James	$100,000
3	Dave	$123,456
4	Ernie	$55,000
5	Ron	$66,000
6	Don	$118,000
7	Lucie	$75,000

Highlight if sales exceeds 100,000

Setting Conditional Formatting

- Home Tab-> (Styles group: Conditional formatting)
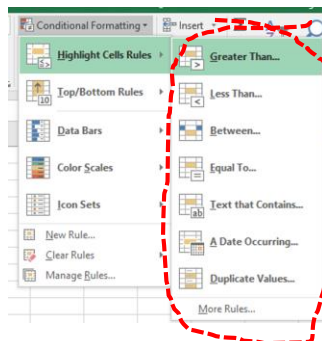
If you don't know much about visual design then keep it simple, stick to the basics!

- With the previous example select:
  - "Greater Than"
  - Enter 99999.99 with "Light Red Fill with Dark Red Text"

Ways Of Graphically Representing Information

- Pie chart

- Bar graph
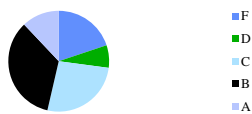 - Excel: Column (vertical), bar (horizontal)
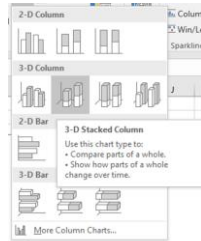
- Line graph

Pie Charts

- Good for showing proportions, how much of the whole does each item contribute.
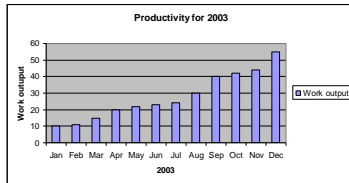
Grade distribution

- F
- D
- C
- B
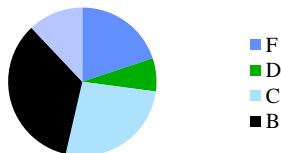
- It's poor for showing exact numeric values.

# of students receiving each grade

- F
- D
- C
- B
- A

Bar And Line Graphs

- For showing trends

- Comparing functions
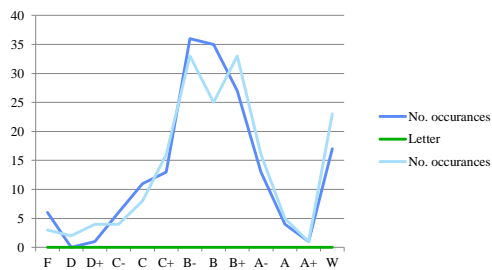
Creating Graphs Using Excel: Specifying Data

- Select the range of cells

| Letter	Range	Occurences
F	0 to less than 1	3
D	1 to less than 1.3	6
D+	1.3 to less than 1.7	5
C-	1.7 to less than 2	4
C	2 to less than 2.3	9
C+	2.3 to less than 2.7	11
B-	2.7 to less than 3	5
B	3 to less than 3.3	2
B+	3.3 to less than 3.7	3
A-	3.7 to less than 4	0
A	4 to less than 4.3	0
A+	4.3 and above	0

Creating Graphs Using Excel: Inserting Graph

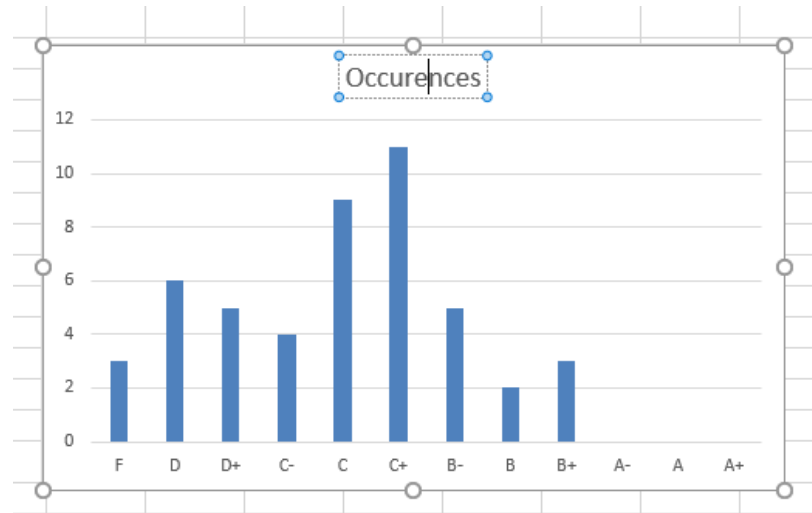- Insert-> (Charts Group: Type of graph e.g. 2D Column)
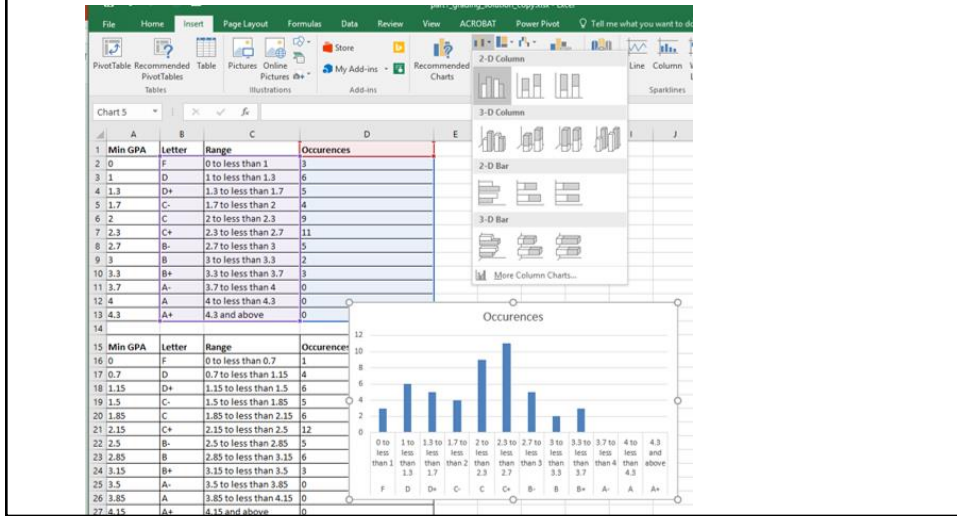
Creating Graphs Using Excel: Choosing Specific Data

- To select non-adjacent columns select the first column, press and don't release control and then select the next column.

1/20/2022
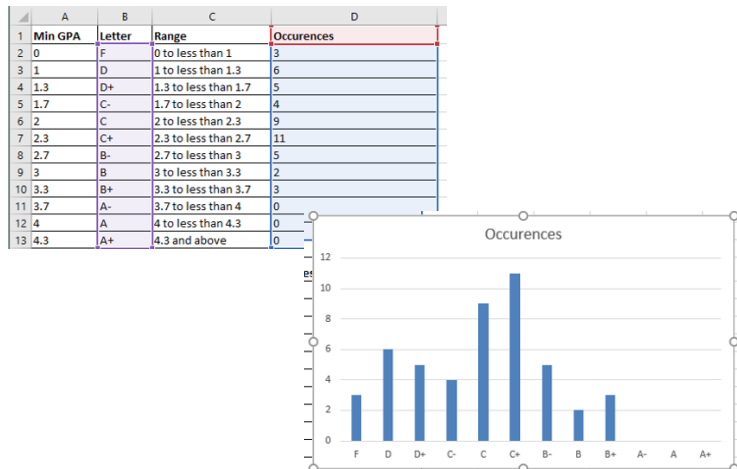
Editing The Graph Title (And Other Parts)

Rules Of Thumb For Graphs

1. What type of graph to use:
   a) Bar graphs are used to plot non-continuous data e.g., the number of patients that go to different hospitals.
   b) Line graphs are used to plot continuous data e.g., mortality trends over time.
2. JT: Avoid or minimize the use 3D graphics! Keep things simple.

After This Section You Should Now Know

- How to use basic statistical formulas: `sum()`, `average()`, `min()`, `max()`
- How to use counting functions: `count()`, `counta()`, `countblank()`, `countif()`
- How to use the lookup function: `vlookup()` and how to properly define lookup tables
- A conditional counting function: `countif()`
- The `'if-else'` function
- Logic functions: `and, or`

After This Section You Should Now Know (2)

- What is a nested function: Using the output of one function become the input of another function, example: `and, or` in conjunction with `if-else`
- How to apply conditional formatting to a spreadsheet
- When to use pie charts vs. bar graphs vs. line graphs
- How to use graphs in Excel

Images

- "Unless otherwise indicated, all images were produced by James Tam

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