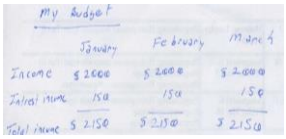
Spreadsheets

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

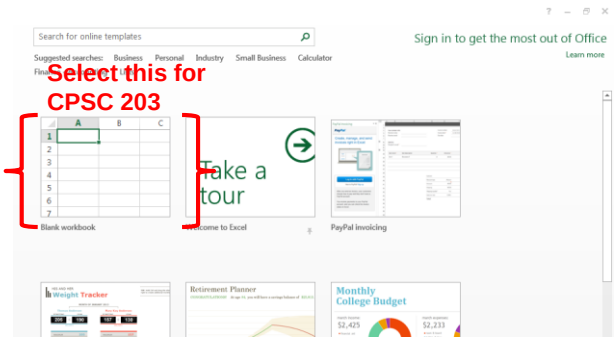
- Electronic spreadsheets evolved out of paper worksheets.



  - 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

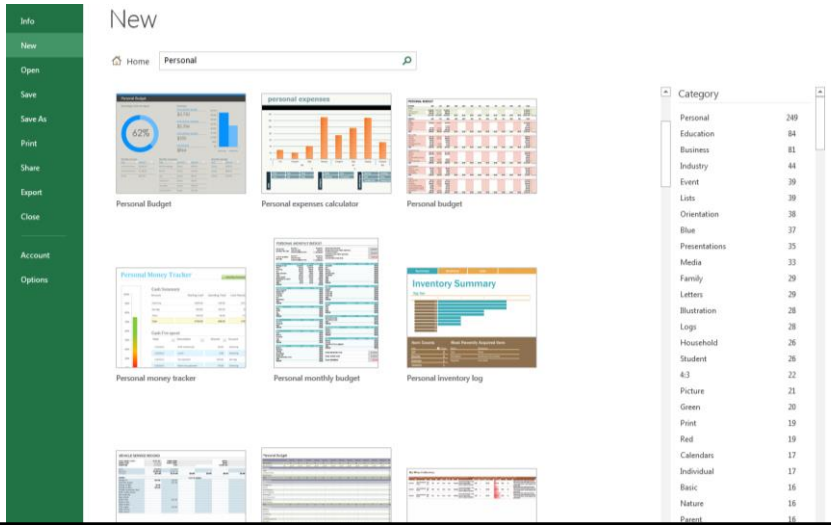
Getting Started: **Creating A New Blank SpreadSheet** (Excel: "Workbook")

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



Templates

- Pre-created spreadsheets for many types of problems



Example Template

Monthly Income

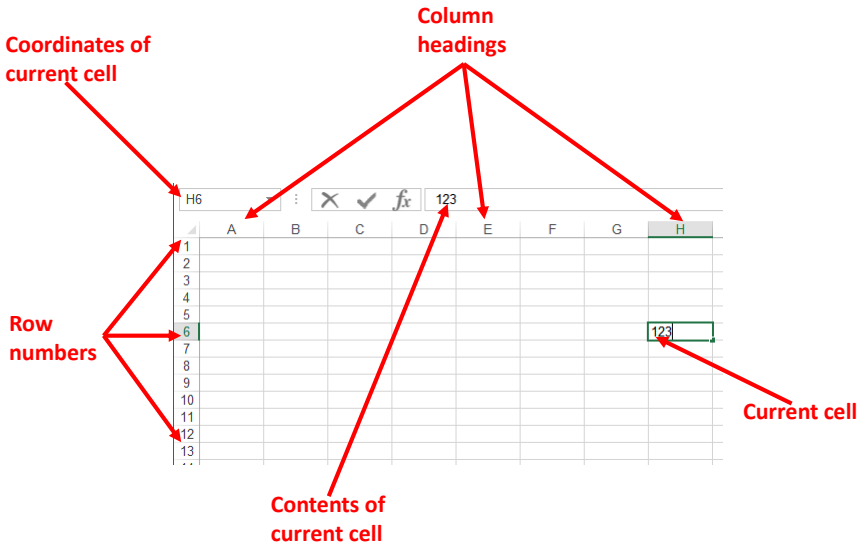
Monthly Income	Projected	Actual	Variance
Income 1	4,000	3,000	-1,000
Income 2	1,300	1,400	100
Extra income	300	300	0
Other			0
TOTAL INCOME	5,600	4,700	-900

Monthly Expenses

Housing Expense	Projected	Actual	Variance
Mortgage or rent	1,000	500	500
Second mortgage or rent	0	0	0
Phone	54	100	-46
Electricity	44	56	-12
Gas	22	28	-6
Water and sewer	8	8	0
Cable	34	34	0
Waste removal	10	10	0
Maintenance or repairs	23	0	23
Supplies	0	0	0
Other	0	0	0
SUBTOTAL	1,195	736	459

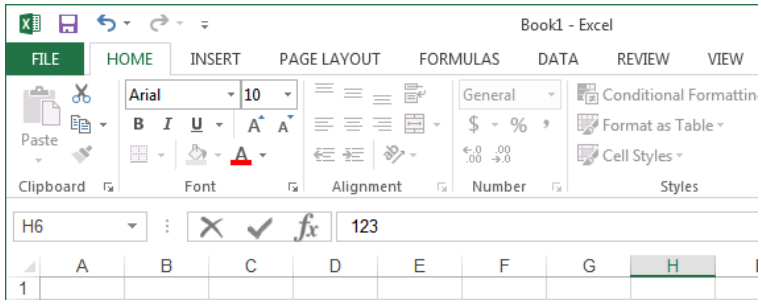
Budget Planner

Spreadsheets 101



The Excel Ribbon

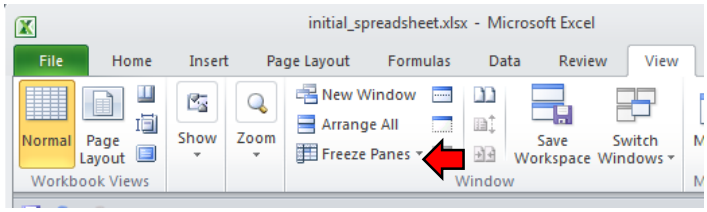
- Tabs are used to group related functions



- More on this in tutorial

"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

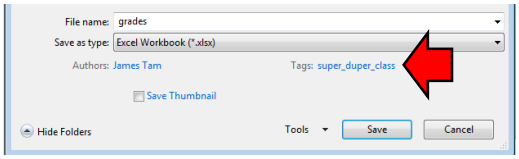
A3 | fx 111

	A	B	C	D	E	F	G	H
1	CPSC 203: fall 2010							
2	**Student ID**	**Faculty**	**A1**	**A2**	**A3**	**A4**	**Midterm**	**Final**
3	111	Science	4	4	4	3.7	3.3	2.3
4	112	Social Sciences	3.3	3.3	3	3	2.7	3
5	113	Social Sciences	3	3.3	3.7	3	3	2.3
6	114	Management	4	4	4.3	4.3	4.3	4.3
7	115	Management	4	4	4	4	1	1
8	116	Management	3.3	2.7	3	2.3	1	0
9	117	Humanities	2.3	3.3	3	2.3	3	3.3
10	118	Social Sciences	3.3	2.7	3.3	2	2	3
11	119	Management	4.3	1.7	3.3	2.3	2.3	2.7
12	120	Management	4.3	4	3.7	3	3.3	3
13	121	Kinesiology	4					

	A	B	C	D	E	F	G	H
1	CPSC 203: fall 2010							
2	**Student ID**	**Faculty**	**A1**	**A2**	**A3**	**A4**	**Midterm**	**Final**
45	153	Humanities	3	3.7	3.3	2.3	3	2.7
46	154	Kinesiology	2.7	4	3.7	3.7	4	4.3
47	155	Social Sciences	1	1.3	0	1	0	0
48	156	Social Sciences	3	3.7	3.3	3	3	2.7
49	157	Management	2.3	3.3	3	2	2.3	3.3
50	158	Social Sciences	3.3	2.7	3	2.3	1.7	0
51								

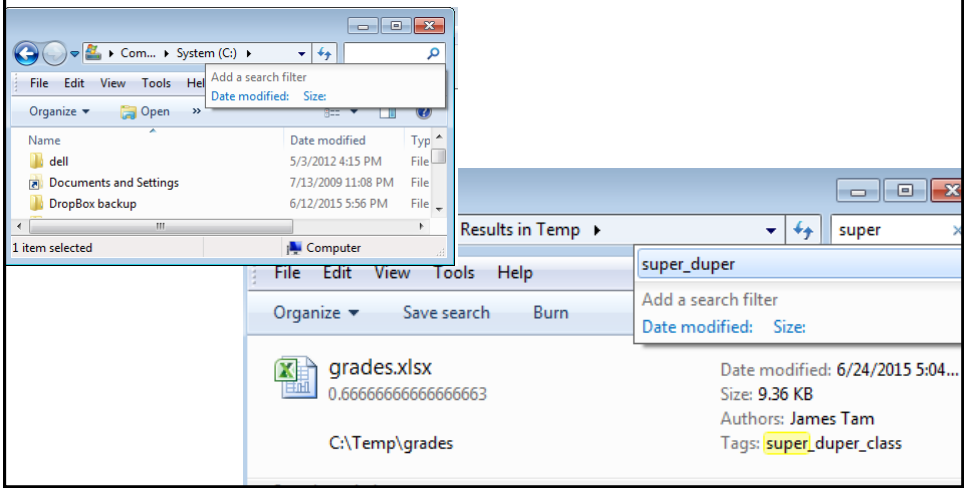
Saving Work

- 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
  - Using MS-Office additional information such as: 'tags' and 'titles' may be entered



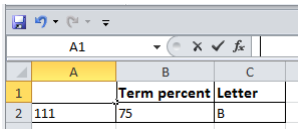
Example Using Tags

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

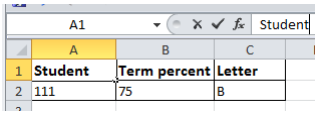


Entering Data

- Click on cell to enter the data

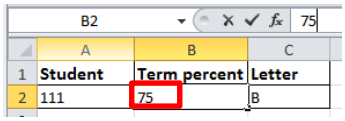


- Type in cell contents

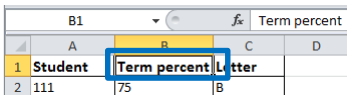


Contents Of A Cell: Types

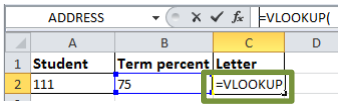
- **Raw data**: also referred to as 'constants'



- **Labels**: describe the contents of another cell



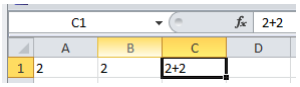
- **Formula**: values derived from the raw data (e.g., calculations, lookup values)



Distinguishing Formulas From Data

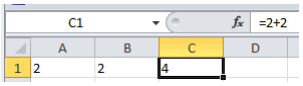
- In Excel all formulas must be preceded by the '**=**' symbol (assignment) to distinguish it from a label
- **Example spreadsheet: `1_formulas`**
  - Label

    2 + 2



  - **Formula**

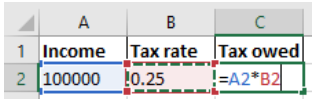
    = 2 + 2



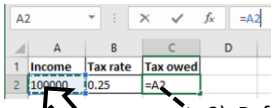
For the sake of brevity, you can assume that all formulas in this section will be preceded by the assignment operator '**=**'

A Formula That Refers To Another Cell Or Cells

- **Approach 1**: type it all in all
  - Click on a cell where you want to enter the formula
  - Type in the formula manually (including the cell reference)



- **Approach 2**: type and click
  - Click on a cell where you want to enter the formula
  - When you get to the part of the formula that refers to another cell then just click on the cell rather than typing in the information.



1) Click here

2) Reference to Cell A2 appears here

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

Order Of Operation

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

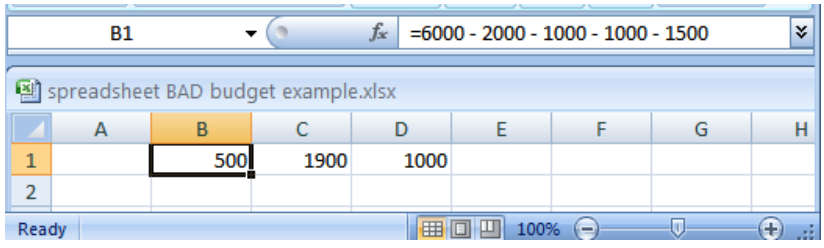
- When a series of operators from same level are encountered in a cell the expression is evaluated from in order in which they appear (left to right).

  2 + 3 * 3 Equals 11

  8 / 2 ^ 2 Equals 2

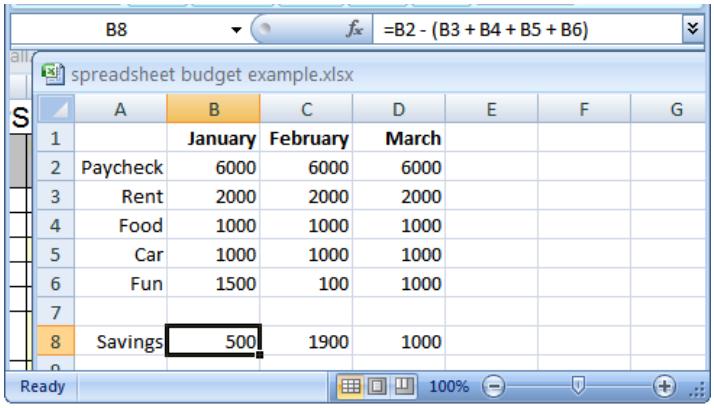
Label Formulas

- 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.



Previous Example: Explicitly Labeled Formulas

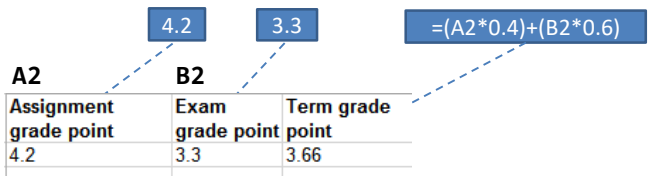
- Whenever possible label the different parts of a calculation to make easier for the reader to interpret and understand your calculations.



	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			

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`?



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)

=CONCATENATE(A2,C2)

=CONCATENATE(A2,B2)

	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
6		Amanda	Bynes	(333)666-9999
7		amanda	amanda	(000)000-0000
8				
9				
10	**Honorific (Canada)**			
11	Ms.Tam			
12	Mr.Thurston			
13	Dr.Jones			
14	Prof.Smith			
15	Bynes			
16				
17	**Honorific (other locations)**			
18	Ms.James			
19	Mr.Robert			
20	Dr.Jane			

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

Example spreadsheet: `3_grades_formulas`

- 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:

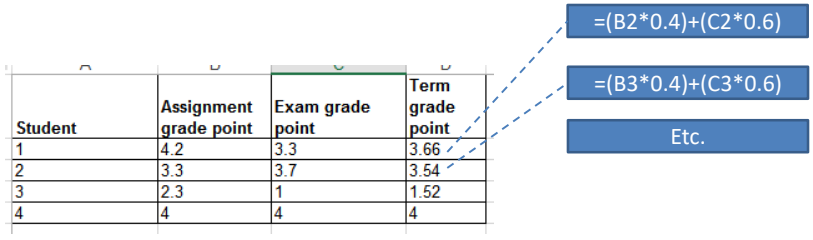
Student	Assignment grade point	Exam grade point	Term grade point
1	4.2	3.3	3.66
2	3.3	3.7	3.54
3	2.3	1	1.52
4	4	4	4

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

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

Etc.

Designing Spreadsheets: Rules Of Thumb (5)

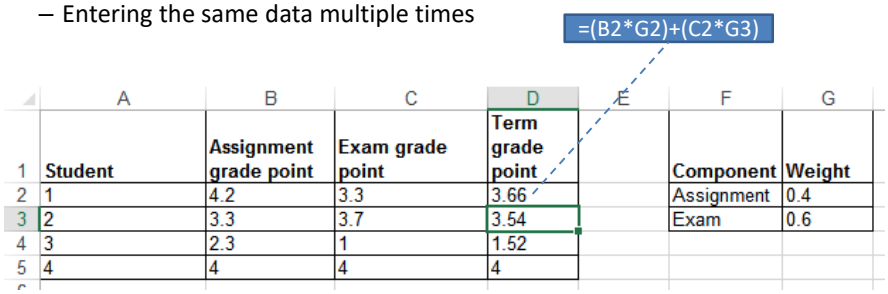


Student	Assignment grade point	Exam grade point	Term grade point
1	4.2	3.3	3.66
2	3.3	3.7	3.54
3	2.3	1	1.52
4	4	4	4

- 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

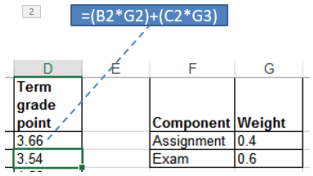
- As the name implies it contains information that needs to be referred to ("looked up") in a part of the spreadsheet.
- Can be used to address some of the issues related to the previous example:
  - Clarity
  - Entering the same data multiple times



	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			

Quick Hint

- If a formula always **refers to the same location** in the spreadsheet:



D	E	F	G
Term grade point		Component	Weight
3.66		Assignment	0.4
3.54		Exam	0.6

- Always precede the cells being looked up with a dollar sign
  - Above example:
  - Previous formula: (B2*G2)*(C2*G3)
  - Modified formula (G2 and G3 needed in calculations for all students): (B2*$G$2)*(C2*$G$3)
- (More on this later: absolute vs. relative cell references)

Mathematical Formulas And Functions

- **Example spreadsheet: 4_grades_lookup**
- 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 (functions) that come built into the spreadsheet.

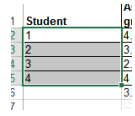
	A	B	C	D
1	**Student**	**Assignment grade point**	**Exam grade point**	**Term grade point**
2	1	4.2	3.3	3.66
3	2	3.3	3.7	3.54
4	3	2.3	1	1.52
5	4	4	4	4
6	AVERAGES	3.45	3	3.18

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

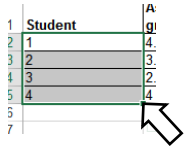
=AVERAGE(D2:D5)

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).

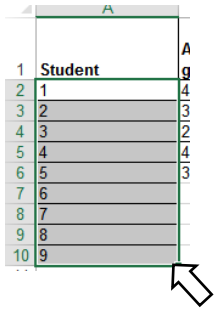


  2. Move the mouse pointer to the 'handle' at the bottom right



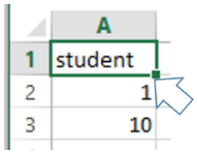
Autofill (2)

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

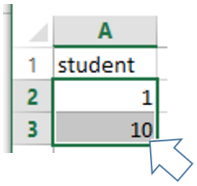


Extra practice: what would be the autofill result of the following.

1

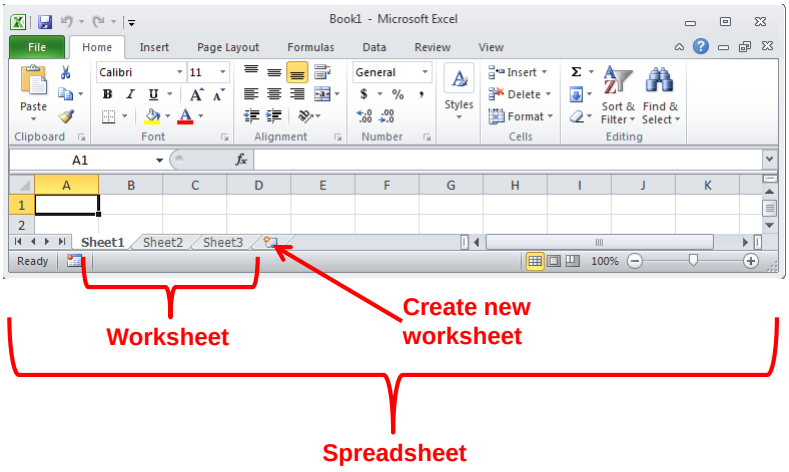


2



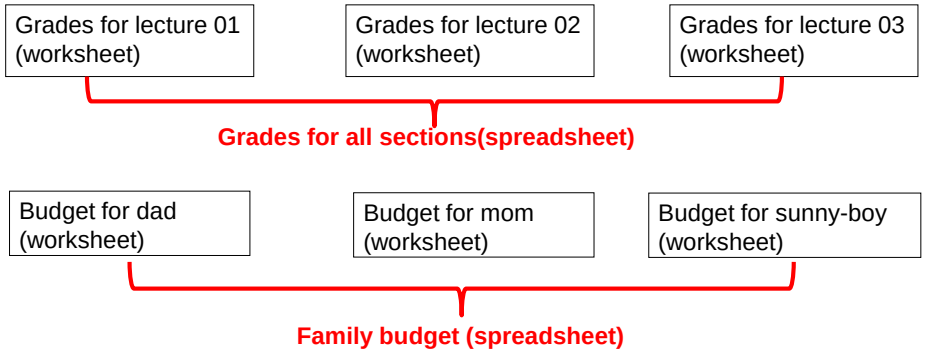
Worksheets

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



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)



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.

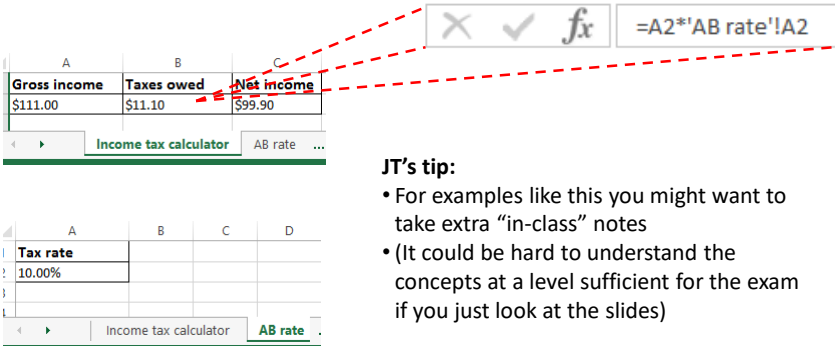
Grades for mom (spreadsheet)

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`**

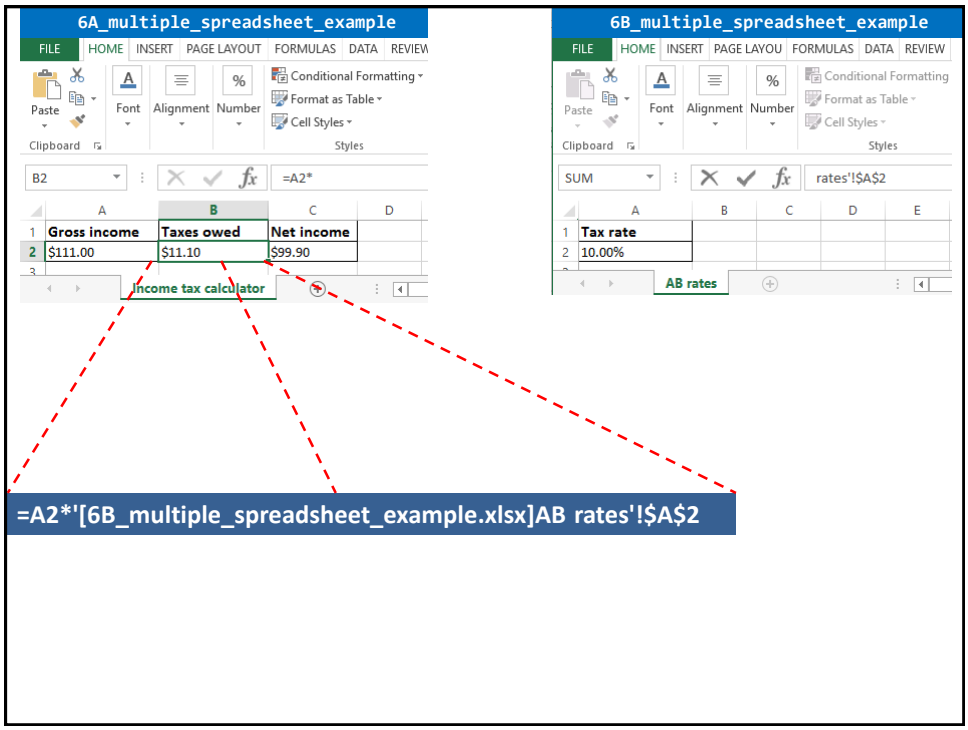


JT's tip:

- 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`**



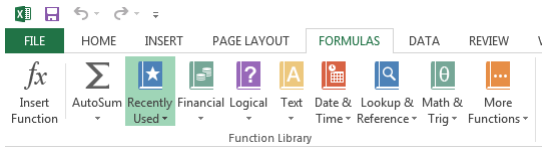
Why Use Cross References?

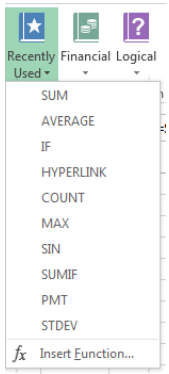
	A	B
1	Min. percent	Letter
2	0	F
3	50	D
4	65	C
5	75	B
6	85	A
7		

Student grades | Cutoffs

- 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)
- Some 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)

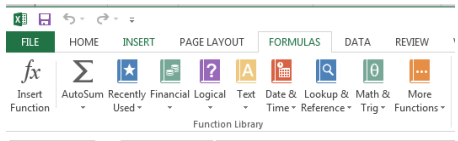
Pre-Created Excel Formulas



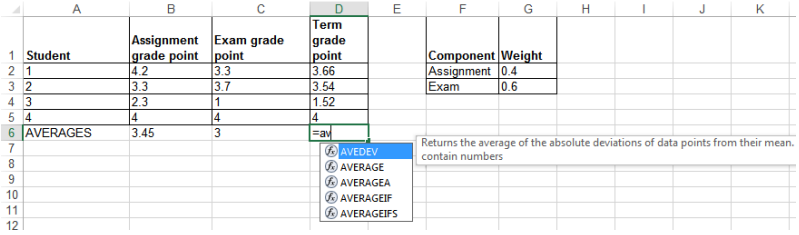


What Function Is Right For Your Situation?

- Excel provides reminders.
- Built in functions are grouped by 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)`
  `=lower("Jim *the JeT* TAM")`

For the exam you can see either form

- **Optional function inputs ("arguments")**
  `Distinguished by the use of square brackets [optional argument]`
  - `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)

- 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)

- 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

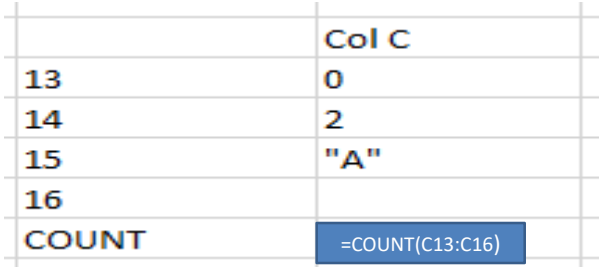
=SUM(C3:E7)

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
- General usage (all these formulas will require this information although one function requires additional data).
  `function(<start cell range> : <end cell range>)`
  - An array (list) of numbers can be the function argument but this is rare except for illustration purposes e.g., `=COUNT(1,"A",2)`

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



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)

Counting Functions: Spreadsheet Example

- **Example spreadsheet: `8_counting_functions`**

	B	C	D	E	F
1		Sales At Each Location			
2		**Sunridge**	**Market Mall**	**Chinook**	**New 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	Categories of store info. Available	4	5	6	1
13					
14	Employee slots filled	12			
15	Employee slots vacant	3			

=COUNT(C3:E7)

=COUNTBLANK(C3:E7)

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

`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)
  - Example word separators: space, dash, underscore
- https://support.office.com/en-US/article/PROPER-function-52A5A283-E8B2-49BE-8506-B2887B889F94

Functions That Convert Text (2)

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

	A	B	C
1	**Conversion function**	**Original text**	**Converted text**
2	Lower	CHUCK NORRIS	chuck norris
3	Lower	BRUCE LEE!	bruce lee!
4	Lower	JaCKie cHaN	jackie chan
5	Upper	JaCKie cHaN?	JACKIE CHAN?
6	Proper	CHUCK NORRIS	Chuck Norris
7	Proper	jet li 2	Jet Li 2

Functions For Extracting And Connecting Text

`trim()`:

- Removes leading or trailing spaces (multiple spaces within text are trimmed to a single space)
- **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)

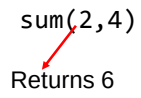
`mid()`:

- 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)
```

Using One Function's Return Value As Input For Another Function (Nesting Functions)

- Breaking down the process into parts
  1. Call a function and that function returns a value



  2. Use the return value of that function as part of the input of another function

=average(,6,12)

Actual formulation of the function
=average(sum(2,4),6,12)

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")

Extracting And Connection Text: More Examples

- **Example spreadsheet: "`10_extracting_connecting_text`"**

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 as well the preceding number sign *#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

– =MID(A10, 5 ,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.

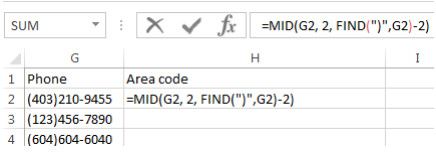
```
FIND("#",A10)
        5
=MID(A10,  ,4)
```

  • Next the index (location) of the number sign 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 (after removing extraneous information) may be time consuming
  – Solve the problem once and then reuse (copy and paste) the trimming formula wherever else it is needed



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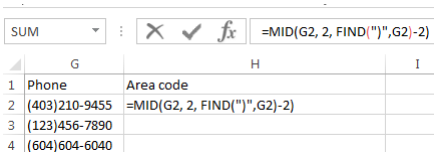


	G	H	I
1	Phone	Area code	
2	(403)210-9455	=MID(G2, 2, FIND(")",G2)-2)	
3	(123)456-7890		
4	(604)604-6040		

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 “Prof. Tam” (Title, Last name)

=CONCATENATE(A2,C2)

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

   - In other countries the proper greeting will be “Prof. James” (Title, First name)

=CONCATENATE(A2,B2)

Honorific (other locations)
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 the assignment ;)

Lecture Exercise #1: String Functions

Lecture Exercise #1: String Functions

Lecture Exercise #2: Tracing String Functions

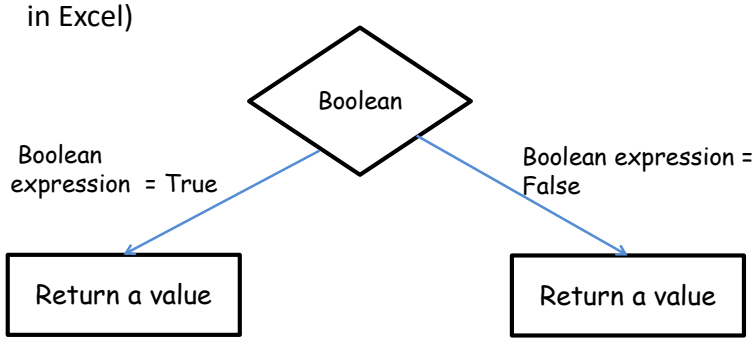
Lecture Exercise #3: String Functions (You Do)

Date And Time Functions

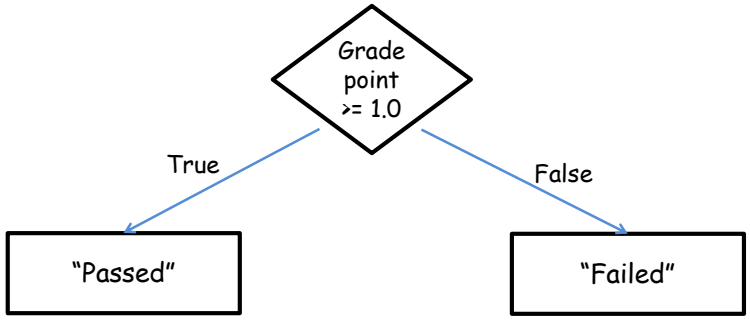
- **Example spreadsheet:**
  "11_date_time"
- `today()`
  - Displays the current date (month/day/year) e.g., `07/15/2015`
- `now()`
  - Displays the current date (as above) and time (hour/minute with a 24 hour clock) e.g., `18:42`
- Both: determine the time/date based on the settings of the computer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

Recall: From The 'Logic' Section

- Booleans can only take on either a true or false value.
- Certain types of questions only produce a Boolean result
  - E.g. 1: Is the grade a passing score?
  - E.g. 2: Does the income equal or exceed the min tax bracket cut-off
- Booleans are used in conjunction with 'branching' (`IF`-function in Excel)



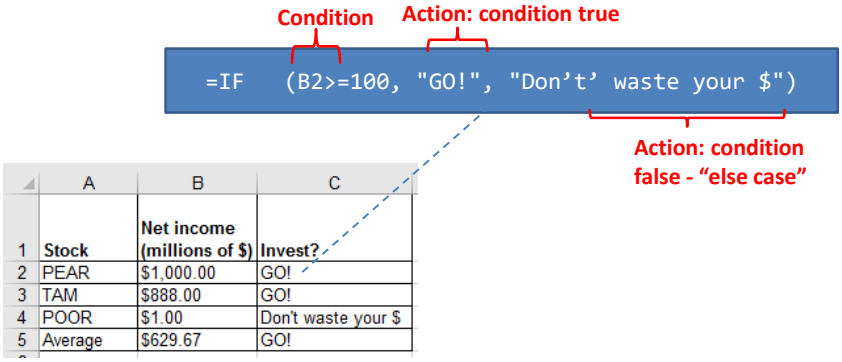
'If-Else' (Branching)



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

Applying Branches: Investing Example

- In column 'E' the sheet will display "GO!" if net income is 100 (millions of $) or greater "Don't waster your $" otherwise.
  - **Example spreadsheet: `12_if_invest_or_not`**



	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!

Format: `IF-Else`

- **Format**:

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

- **Example**:

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

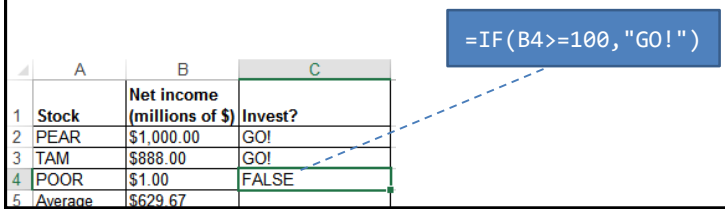
- Note: the return value is not limited only to text
  - Some example return values IF-Else: text, numeric, **a cell reference** e.g. `=IF(A1>1,A1,A2)`
- https://support.office.com/en-US/article/IF-function-69aed7c9-4e8a-4755-a9bc-aa8bbff73be2?CorrelationId=6aeb3056-a94b-47ac-af6e-90dff250a029

Comparators

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

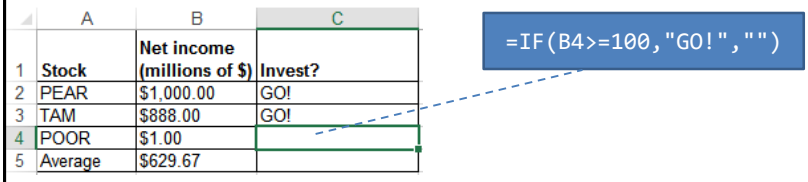
`If`: Specifying Only The True Case (Poor Approach)

- 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 "Don't waste your…" message (False return case in 'Column C' data).



If: Specifying Only The True Case (Better Approach)

- 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 return case' (false that the condition has been met).
- Previous example: amended
  - **Example spreadsheet: `13_if_invest_only`**



	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	

Possible Return Values (Excel IF-Function)

- Numeric: `=IF(A1>0,2)`
- String: `=IF(A1>0,"pass")`
- Boolean: `=IF(A1>B1,True)`
- Contents of a cell: `=IF(A1>=B1,C3,D3)`
- Contents of a cell:
  `=IF(A1<>B1,C3,D3)`
- The return value of a function:
  `=IF(2 = 2, AVERAGE(1,2,3),SUM(1,2,3))`

Nested Conditions

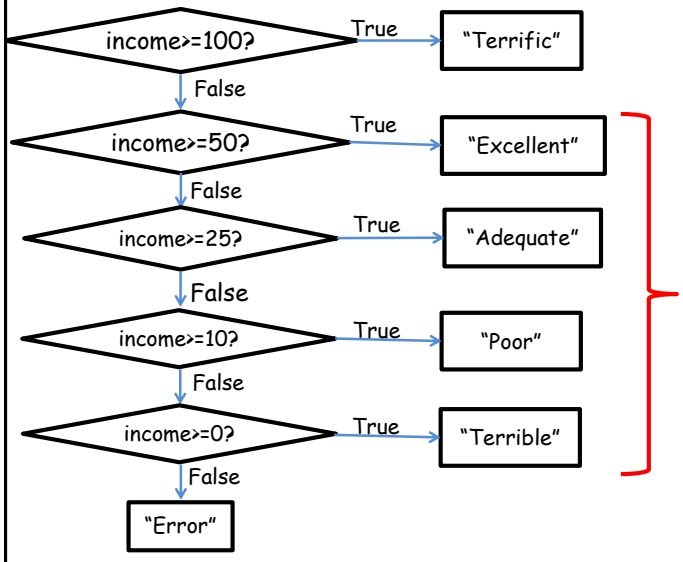
- Conditions that are dependent upon or are affected by previous conditions.
- 'Nest conditions' refers to conditions that are 'inside of other conditions'
- Example (assume that the respondent previously indicated that his or her birthplace was an Alberta city)
- Select the AB city in which you were born
  1. Airdrie
  2. Calgary
  3. Edmonton

     …
  - Selecting Airdrie excludes the possibility of selecting Calgary
  - Cities listed later are 'nested' in earlier selections because they won't be checked if an earlier selection is true)

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 "Terrific" if net income 100 or greater
  - Display "Excellent" if net income is 50 or greater but less than 100
  - Display "Adequate" if net income is 25 or greater but less than 50
  - Display "Poor" if net income is 10 or greater but less than 25
  - Display "Terrible" if net income is 0 or greater but less than 10
  - Otherwise "Error" will be displayed
- **Example spreadsheet: `14_nested_if_investments`**

Previous Example: Specifying Conditions



Nesting

- Later conditions are described as being 'nested' within earlier conditions
- The Net income cases for 50+, 25+, 10+, 0+ are described as being 'nested' within the 100+ 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(B2>=100,"Terrific",                                    )
                       IF(B2>=50,"Excellent","")
```

Previous Example: Initial Cases

- If income>=100 “Terrific”, if 50<=income<100, “Excellent”

TRUE>=100

100<**TRUE**>=50

FALSE>=100

This 2nd expression is implied by the IF (don’t literally type it in expressions after the 1st for nested IFs)

Previous Example: Nested Solution

```
=IF(B2>=100, "Terrific",
   IF(B2>=50,"Excellent",
      IF(B2>=25,"Adequate",
         IF(B2>=10, "Poor",
            IF(B2>=0, "Terrible",
               "Error")))))
```

```
=IF(B2>=100,"Terrific",IF(B2>=50,"Excellent",IF(B2>=25,"Adequate",IF(B2>=10,"Poor",IF(B2>=0,"Terrible","Error")))))
```

	B	C
1	**Net income (millions of $)**	**Invest?**
2	$1,000.00	Terrific
3	$50.00	Excellent
4	$1.00	Terrible
5	$350.33	

Nesting Ifs: Order Is Important

- (Checking numeric ranges): Specify the largest range first
  - Correct
    - `IF (A1 >= 100, "Terrific", IF(A1 >=50,"Excellent", ""))`
    - `A1 contains 175 and “Excellent” appears (right)`
  - Incorrect
    - `IF (A1 >= 50, "Excellent", IF(A1 >= 100,"Terrific", ""))`
    - `A1 contains 175 and “Excellent” appears (wrong)`

Lookup Functions

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

  0 <= Income < 10 : Terrible

  10 <= Income < 25 : Poor

  25 <= Income < 50 : Adequate

  50 <= Income < 100 : Excellent

  Income >= 100 : Terrific
- Previous solution:

```
=IF(B2>=100,"Terrific",IF(B2>=50,"Excellent",IF(B2>=25,"Adequate",IF(B2>=10,"Poor",IF(B2>=0,"Terrible","Error")))))
```

Lookup Functions

- The lookup functions that will be covered this semester will be used in conjunction with a lookup table or tables.
  - Nested `IF`s can and should also use a lookup table
- Two lookup functions covered include:
  - `LOOKUP()` (If there is time)
  - `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

LOOKUP: If There's Time

- **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) : If There's Time

- **Format**:

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

LOOKUP (3) : If There's Time

- **Example spreadsheet: 15_lookup**

	B	C
1	**Net income (millions of $)**	**Invest?**
2	$1,000.00	Terrific

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

- Row 2 data

```
=LOOKUP(B2,    D11:D15,    E11:E15)
```

Cell:
Contains value to find in table e.g., net income

Lookup column:
Start : End
cell coordinates

Result column:
Start : End
Cell coordinates

LOOKUP (4) : If There's Time

=LOOKUP(B3,D11:D15,E11:E15)

	B	C
1	**Net income (millions of $)**	**Invest?**
2	$1,000.00	Terrific
3	$50.00	Excellent
4	$1.00	Terrible
5	$350.33	

	D	E	
	Min income	**Comment**	
11	0	Terrible	>50?
12	10	Poor	>50?
13	25	Adequate	>50?
14	50	Excellent	>50?
15	100	Terrific	>50?..Yes!

← Backup and use this value Return "Excellent"

A lookup table used in conjunction with LOOKUP must be sorted in ascending order

LOOKUP: Multi-Column Lookup Table (If There's Time)

- **Name of example spreadsheet**: **`16_lookup_multiple_columns`**

Lookup table

	C	D	E
10	**Min income**	**Max income**	**Comment**
11	0	<10	Terrible
12	10	<25	Poor
13	25	<50	Adequate
14	50	<100	Excellent
15	100	None	Terrific

LOOKUP function

=LOOKUP(B2,C11:C15,E11:E15)

	B	C	D	E
1	**Net income (millions of $)**	**Invest?**		
2	$1,000.00	Terrific		
3	$50.00	Excellent		
4	$1.00	Terrible		
5	$350.33			

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(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
(1 = first col. 'D',
2 = second col. 'E')

VLOOKUP: Previous Example

```
=VLOOKUP(B2,D11:E15,2)
```

	B	C
1	**Net income (millions of $)**	**Invest?**
2	$1,000.00	Terrific
3	$50.00	Excellent
4	$1.00	Terrible
5	$350.33	

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

Example spreadsheet: 17_vlookup

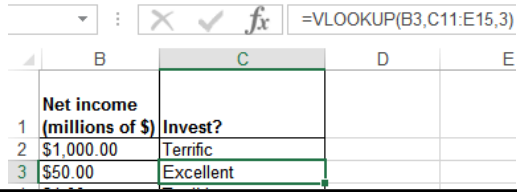
VLOOKUP: Multi-Column Lookup Table

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

Lookup table

	Col 1 C	Col 2 D	Col 3 E
10	**Min income**	**Max income**	**Comment**
11	0	<10	Terrible
12	10	<25	Poor
13	25	<50	Adequate
14	50	<100	Excellent
15	100	None	Terrific

Lookup function



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

- `=VLOOKUP(B3,C11:E15,3,TRUE)`
- TRUE (works like LOOKUP so the lookup table 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.

`Income = 50`

Min income	Comment	
0	Terrible	`>50?`
10	Poor	`>50?`
25	Adequate	`>50?`
50	Excellent	`>50?`
100	Terrific	`>50?..No!`

`←` `Backup and use this value Return "Excellent"`

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

- =VLOOKUP(B2,C11:E15,3,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	**Min income**	**Max income**	**Comment**
11	0	<10	Terrible
12	10	<25	Poor
13	25	<50	Adequate
14	50	<100	Excellent
15	100	None	Terrific

=VLOOKUP(B2,C11:E15,3,FALSE)

	B	C	D	E
1	**Net income (millions of $)**	**Invest?**		
2	$1,000.00	#N/A		
3	$50.00	Excellent		
4	$1.00	#N/A		

  - Table values do not have to be sorted when the False optional argument is passed to the VLOOKUP function.

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

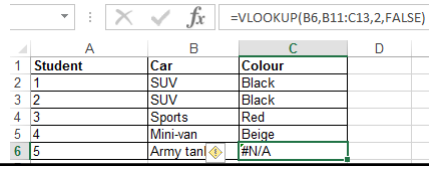
Example: Sensible Use Of False/VLOOKUP

- **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



Looking Values: If Function Vs. Lookup Functions

- Multiple IFs:
  - 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(B2>=100,"Terrific",IF(B2>=50,"Excellent",IF(B2>=25,"Adequate",IF(B2>=10,"Poor",IF(B2>=0,"Terrible","Error")))))
```

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

```
=VLOOKUP(B2,D11:E15,2)
```

Min income	Comment
0	Terrible
10	Poor
…	…

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.
  - Function inputs can be:
    - Boolean constant e.g. `NOT(True)`, `AND(True,False)`
    - Boolean expression e.g. `NOT(C2>0)`, `OR(A1>0,A2>0)`
    - A cell that contains a Boolean value e.g. `NOT(C2)`, `AND (A1,A2)`
- **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)                     # Reverses the logic
```

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: Dean's list
  - Signify when a student has made the Dean's list requirements with an "H", blank cell otherwise.

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

	A	B	C	D
2	Student	Overall GPA	Number courses	Dean's list
3	1	4	1	
4	2	3.9	5	H
5	3	2.3	5	
6	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)
  - (Same spreadsheet as previous example)

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.
  - E.g. Color code cells ('formatting') that meet a certain condition ('conditional')
- 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)

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

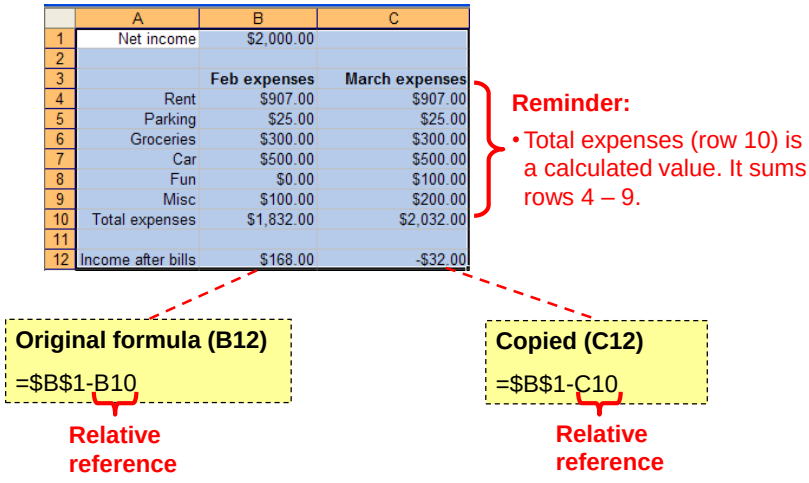
Original formula (B12)

=$B$1-B10

Copied (C12)

=$B$1-C10

Relative Reference (2)

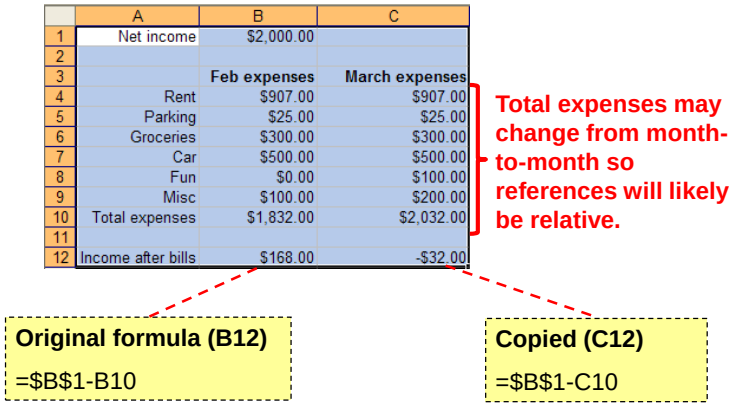


	A	B	C
1	Net income	$2,000.00	
2			
3		**Feb expenses**	**March expenses**
4	Rent	$907.00	$907.00
5	Parking	$25.00	$25.00
6	Groceries	$300.00	$300.00
7	Car	$500.00	$500.00
8	Fun	$0.00	$100.00
9	Misc	$100.00	$200.00
10	Total expenses	$1,832.00	$2,032.00
11			
12	Income after bills	$168.00	-$32.00

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).



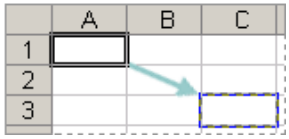
	A	B	C
1	Net income	$2,000.00	
2			
3		**Feb expenses**	**March expenses**
4	Rent	$907.00	$907.00
5	Parking	$25.00	$25.00
6	Groceries	$300.00	$300.00
7	Car	$500.00	$500.00
8	Fun	$0.00	$100.00
9	Misc	$100.00	$200.00
10	Total expenses	$1,832.00	$2,032.00
11			
12	Income after bills	$168.00	-$32.00

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]



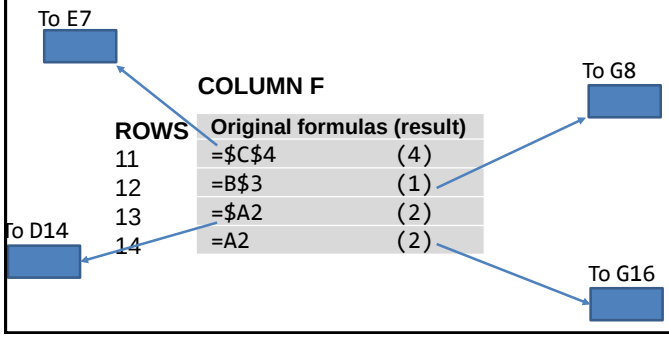
Example	Reference type	Copied result
$A$1	•Absolute column •Absolute row	$A$1
A$1	•Relative column •Absolute row	C$1
$A1	•Absolute column •Relative row	$A3
A1	•Relative column •Relative row	C3

1 Examples from the Excel 2003 Help System

Absolute, Relative References: Example

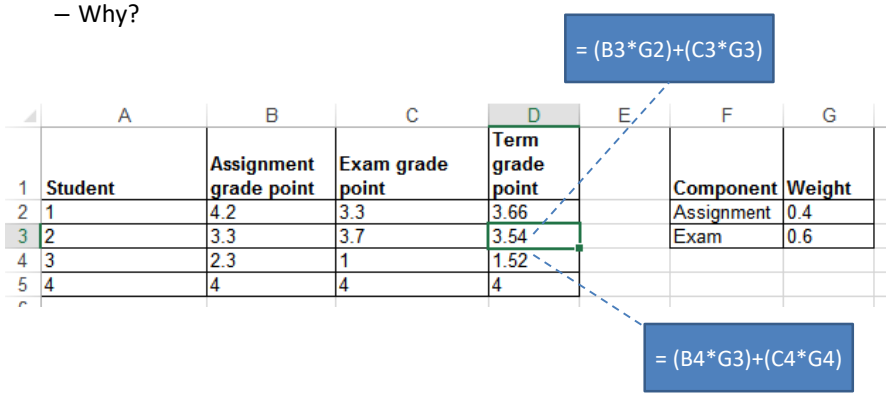
- **Example spreadsheet: `23_absolute_relative`**

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



Absolute/Relative Applied To A Previous Example

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



	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			

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)

= 100 + (30)

= $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)

Absolute, Relative: Exercise (If There Is Time)

- Names of starting spreadsheets
  - 24_Starting_spreadsheet_OK_2_look_at_B4_class
    - Calculate tax for:
      - capital gains tax (capital gains earned "Col B" x capital gain tax rate "H3")
      - Interest tax (interest earned "Col D" x interest tax rate "H4")
  - 25_Starting_spreadsheet_OK_2_look_at_B4_CLASS
    - Determine tax rate (Values for "Col C")
    - Calculate taxes owed based on tax rate (Values for "Col D")
- Names of the spreadsheets with solutions (**don't look at contents before we go over the concepts in lecture**)
  - 24_DON'T_look_at_B4_class
  - 25_DONT_LOOK_B4_CLASS

Taxes Paid (IF There Is Time)

- **Example spreadsheet:**
  `24_Starting_spreadsheet_OK_2_look_at_B4_class`
- How should these values be calculated?

	A	B	C	D	E
1	**Client**	**Capital gains**	**Capital gains tax**	**Interest**	**Interest tax**
2	Alice	$66			
3	Bob	$45			
4	Charlie	$123			

	G	H
1	Tax rates	
2	**Income source**	**Tax rate**
3	Asset investments (capital gains)	10%
4	Interest investments	20%

- First step: make it mathematically correct
  - Capital gains tax rate = 10%
  - Tax on interest = 20%

Taxes Paid (IF There Is Time)

- 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., tax owed is determined by money earned and the tax rate
    - Future grade changes are easier to make
      - Also reduces errors)

	A	B	C
1	**Client**	**Capital gains**	**Capital gains tax**
2	Alice	$66	
3	Bob	$0	
4	Charlie	$123	

Derive it, don't type it

	G	H
1	Tax rates	
2	**Income source**	**Tax rate**
3	Asset investments (capital gains)	10%
4	Interest investments	20%

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

	A	B	C
1	**Client**	**Capital gains**	**Capital gains tax**
2	Alice	$66	
3	Bob	$0	
4	Charlie	$123	

Once

Tax Owed (IF There Is Time)

- **Example spreadsheet:**
  `25_Starting_spreadsheet_OK_2_look_at_B4_CLASS`
- 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
1	**Client**	**Total income**	**Tax rate**	**Tax owed**
2	Alice	$66		
3	Bob	$0		
4	Charlie	$123		

	F	G	H
1	Tax rates		
2	**Min**	**Max**	**Rate**
3	$0	$24	5%
4	$25	$49	10%
5	$50	Unlimited	15%

Graphical Design Principles

- Using color
- Fonts and font effects
- C.R.A.P.

Color: Properly Used

- When used sparingly color can draw attention to important information.

Stock	Open	Close	Change
HAL	255	256	1.00
HAM	256	255	-1.00
FOO	12	13	1.00
TAM	12.25	12.5	0.25
BAR	1001	989	-12.00
BOO	17	16.5	-0.50
WOW	1	177	176.00
GEM	45	50.00	5.00
DUD	12	10.00	-2.00
AAA	10	10.5	0.50
XYZ	12.5	11	-1.50
ZOO	55	56	1.00
FIZ	17.5	17.25	-0.25
BRIK	128	64	-64.00

- This is an especially valuable tool when there is a large amount of information.
  - The information may be "all there" but don't make it any harder than it has to be for the viewer to find it.

Color Misused

Date	Description	IN	OUT	BALANCE
January 1 2013	Balance from 2012	2023.4		2023.4
January 7 2013	Electricity		223	1800.40
January 9 2013	House		910	890.40
January 10 2013	From savings	1280		2170.40
January 13 2013	Gas		110	2060.40
January 15 2013	Cash		20	2040.40
January 31 2014	Interest	2.29		2042.69

- The overuse of color:
  - Reduces it's ability to make information stand out.
  - Makes it harder to understand what information is mapped to a particular color e.g. using different colors to represent faculty and grades

utility
house
From savings
Cash
Salary
Pay credit
Interest

Rule Of Thumb For Color: Make It Subtle

- We have all seen the use of 'loud' and clashing colors that can make text very hard to read.

Ingredients
Sugar, lactose, fructose, corn syrup, glucose…lots of carbohydrates

JT: I've actually seen green-red color combinations on listings of food ingredients

Rule Of Thumb For Color: Subtle But Not Near-Invisible

- The "flip side", lack of contrast between foreground can also be problematic.

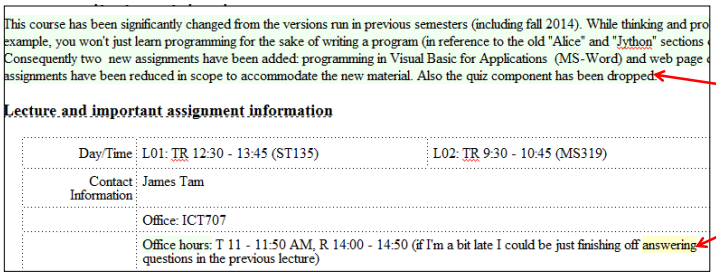
Ingredients
Sugar, lactose, fructose, corn syrup, glucose…lots of carbohydrates

Rule Of Thumb For Color

- Balance the use of color between noticeability and subtlety
  - Make it as subtle as possible while still conveying the necessary information using color

Additional Issues Associated With Color

- Color blindness affects a portion of the population:
  - The majority of people who are color blind are red-green color blind so using only these colors to represent information should be avoided e.g. traffic lights
- Field size
  - The larger the area to be color coded, the more easily that colors can be


This course has been significantly changed from the versions run in previous semesters (including fall 2014). While thinking and pro
example, you won't just learn programming for the sake of writing a program (in reference to the old "Alice" and "Jython" sections
Consequently two new assignments have been added: programming in Visual Basic for Applications (MS-Word) and web page
assignments have been reduced in scope to accommodate the new material. Also the quiz component has been dropped.

Lecture and important assignment information

Day/Time	L01: TR 12:30 - 13:45 (ST135)	L02: TR 9:30 - 10:45 (MS319)
Contact Information	James Tam	
	Office: ICT707	
	Office hours: T 11 - 11:50 AM, R 14:00 - 14:50 (if I'm a bit late I could be just finishing off answering questions in the previous lecture)	

Larger areas: colors can be more subtle

Smaller areas: colors may have to employ greater contrast

Additional Issues Associated With Color (2)

– When objects are small (text or small graphics) and color is used to distinguish information use highly saturated colors.

This is
important
information!

This is
important
information!

Fonts And Font Effects

- Example fonts:
  - Ariel
  - Calibri
  - Helvetica
  - Times New Roman
- Font effects:
  - Italics
  - Bold
  - Underline
  - Normal
- Font sizes

Fonts And Font Effects (2)

- As a rule of thumb use no more than 3 sizes and font effects / font sizes in a particular document.
  - Similar to color, their overuse reduces their effectiveness and makes it harder to interpret meaning.
- Also if you don't know much about fonts just stick to the common or default ones provided (Arial, Calibri, Helvetica, Times New Roman)
  - If you're not sure if a font is a good one for a particular situation then it probably isn't:
    - Extreme example "Wing dings": ♦♓■♍ ♎♓■♍♦
    - But the use of "extreme fonts" are the only pitfall: printing problems, web browser issues, operating system font-issues.
    - Example (from http://docs.oracle.com... /cd/E19728-01/820-2550/printing_pdffonts.html)

Fonts Do Not Print Correctly With PDF Printing

When using PDF printing, users might find that the fonts on the printed output are not what they expected. As PDF printing relies on a combination of Windows printer drivers (when printing from Windows applications), Ghostscript and a PDF viewer to deliver its output, you might have to experiment with the font settings for each of these components to see if this

C.R.A.P.[1]

- Simple design principles that can be applied in a variety of situations
- **C**ontrast
- **R**epetition
- **A**lignment
- **P**roximity

1 From "The non-designers type book" by Robin Williams (Peach Pit express)

Contrast & Repetition

- Contrast:
  - Make different things **look significantly different**
- Repetition (Consistency):
  - Repeat conventions (e.g. fonts, font effects, alignment, colors used) throughout the interface to tie elements together e.g. headings are all formatted consistently

Example: No Contrast

Student ID	Faculty	A1	A2	A3	Midterm	Final	Term Percentage
111	Science	95	90	88	75	66	76.2
112	Social Sciences	80	80	75	70	75	74.5
113	Social Sciences	78	80	85	75	65	72.8
114	Management	100	90	85	80	75	81.5
115	Management	100	95	90	90	95	93.5
116	Management	75	70	75	50	30	49
117	Humanities	65	80	75	70	80	75

Example: Weak Contrast

Student ID	Faculty	A1	A2	A3	Midterm	Final	Term Percentage
111	Science	95	90	88	75	66	76.2
112	Social Sciences	80	80	75	70	75	74.5
113	Social Sciences	78	80	85	75	65	72.8
114	Management	100	90	85	80	75	81.5
115	Management	100	95	90	90	95	93.5
116	Management	75	70	75	50	30	49
117	Humanities	65	80	75	70	80	75

Example: Headings Stand Out

- Good contrast:
  - If contrast is not (or weakly) employed for a small set of data it may not be a large issue.
  - But for larger data sets (“real data”) it may make it more work than is necessary.

Student ID	Faculty	A1	A2	A3	Midterm	Final	Term Percentage
111	Science	95	90	88	75	66	76.2
112	Social Sciences	80	80	75	70	75	74.5
113	Social Sciences	78	80	85	75	65	72.8
114	Management	100	90	85	80	75	81.5
115	Management	100	95	90	90	95	93.5
116	Management	75	70	75	50	30	49
117	Humanities	65	80	75	70	80	75

- Repetition:
  - Same fonts, font sizes and font effects used in the headings vs. the data.
  - Makes it easier to see and understand the structure

Repetition (Previous Example)

- Headings vs. data/body, consistency with:

Student ID	Faculty	A1	A2	A3	Midterm	Final	Term Percentage
111	Science	95	90	88	75	66	76.2
112	Social Sciences	80	80	75	70	75	74.5
113	Social Sciences	78	80	85	75	65	72.8
114	Management	100	90	85	80	75	81.5
115	Management	100	95	90	90	95	93.5
116	Management	75	70	75	50	30	49
117	Humanities	65	80	75	70	80	75

  - Font effect (bold)
  - Font size
  - Font type
  - Alignment

Alignment

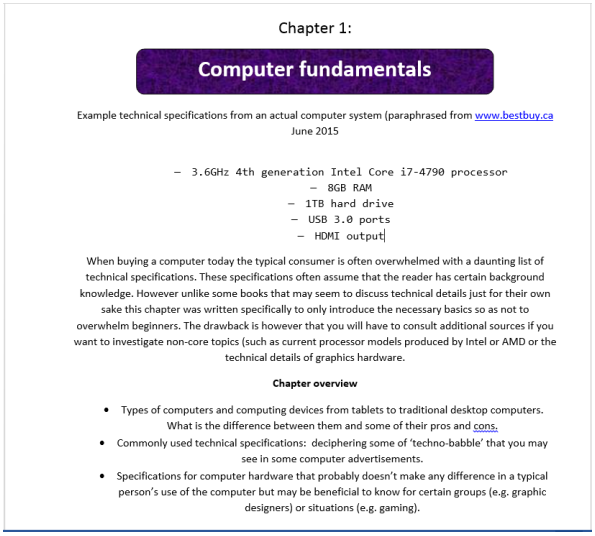
- It can be used to structure a document (represents hierarchical relationships).
  - Heading
    - Sub heading
    - Sub heading
  - Heading
    - Sub heading
    - Sub heading
    - Sub heading
  - Heading

Alignment And Repetition

- Consistent alignment (left or right and not center) can be used to represent relationships.
  - All the data in a column are consistently aligned to signify they belong a group
- Example: movie credits

The Kung Fu master	James “The Bullet” Tam
Arch villain	James (Evil dude) Tam
Kung Fu student #1	Eager Tam1
Kung Fu student #2	Eager Tam2
Thug #1	Cannon-fodder Tam #1
Thug #2	Cannon-fodder Tam #2
Damsel in distress	Jamie Tametta

Center Alignment



Chapter 1:

Computer fundamentals

Example technical specifications from an actual computer system (paraphrased from www.bestbuy.ca June 2015

- 3.6GHz 4th generation Intel Core i7-4790 processor
- 8GB RAM
- 1TB hard drive
- USB 3.0 ports
- HDMI output

When buying a computer today the typical consumer is often overwhelmed with a daunting list of technical specifications. These specifications often assume that the reader has certain background knowledge. However unlike some books that may seem to discuss technical details just for their own sake this chapter was written specifically to only introduce the necessary basics so as not to overwhelm beginners. The drawback is however that you will have to consult additional sources if you want to investigate non-core topics (such as current processor models produced by Intel or AMD or the technical details of graphics hardware.

Chapter overview

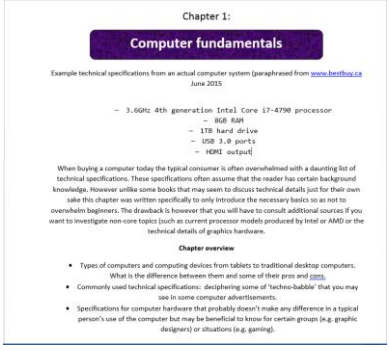
- Types of computers and computing devices from tablets to traditional desktop computers. What is the difference between them and some of their pros and cons.
- Commonly used technical specifications: deciphering some of ‘techno-babble’ that you may see in some computer advertisements.
- Specifications for computer hardware that probably doesn’t make any difference in a typical person’s use of the computer but may be beneficial to know for certain groups (e.g. graphic designers) or situations (e.g. gaming).

Centre Alignment (2)

- Don't use it for hierarchical documents because it removes or hides the organization.
  - In a document that contains structure center alignment can look unorganized (the center alignment appears as no alignment, disorganized)
- **At most**: sparing use can be used to provide contrast e.g., slide titles vs. content.
- Because it removes a common method for structuring a document it can make reading text more difficult.
- At most use it as an exceptional case to make an item stand out.

Center Alignment

- Again: while sparing use of center alignment can be used to provide contrast it should NEVER be used as the default in documents such as spreadsheets.



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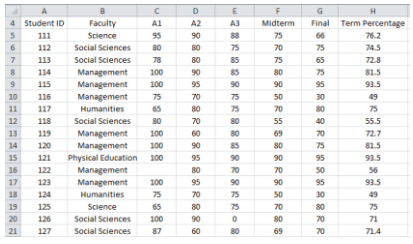

	A	B	C	D	E	F	G	H
4	Student ID	Faculty	A1	A2	A3	Midterm	Final	Term Percentage
5	111	Science	95	90	88	75	66	76.2
6	112	Social Sciences	80	80	75	70	75	74.5
7	113	Social Sciences	78	80	85	75	65	72.8
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9	115	Management	100	95	90	90	95	93.5
10	116	Management	75	70	75	50	30	49
11	117	Humanities	65	80	75	70	80	75
12	118	Social Sciences	80	70	80	55	40	55.5
13	119	Management	100	60	80	69	70	72.7
14	120	Management	100	90	85	80	75	81.5
15	121	Physical Education	100	95	90	90	95	93.5
16	122	Management		80	70	70	50	56
17	123	Management	100	95	90	90	95	93.5
18	124	Humanities	75	70	75	50	30	49
19	125	Science	65	80	75	70	80	75
20	126	Social Sciences	100	90	0	80	70	71
21	127	Social Sciences	87	60	80	69	70	71.4

Example: When Center Alignment Is Probably Okay

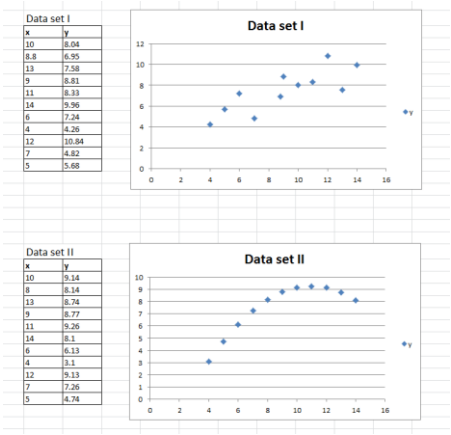
	A	B	C	D	E	F
1		Assignments				
2	TA	A1: Feb 13	A2: Feb 24	A3: Mar 14	A4: April 7	A5: April 19
3						

	A	B	C	D	E	F
1		Assignments				
2	TA	A1: Feb 13	A2: Feb 24	A3: Mar 14	A4: April 7	A5: April 19

A	B	C	D	E	F
Assignments					
TA	A1: Feb 13	A2: Feb 24	A3: March 14	A4: April 7	A5: April 19

Proximity

- Related items are in close proximity
- Unrelated items are separated



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()`

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

After This Section You Should Now Know, Design (6)

- Rules for using and not misusing color as well issues associated with color: color blindness and field size
- Rules of thumb for using fonts and font effects
- C.R.A.P.
  - What does each part mean
  - How it can be used for effective graphic design

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