

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.

	January	February	March
Income	\$ 2000	\$ 2000	\$ 2000
Total income	150	150	150
Total expense	\$ 2150	\$ 2150	\$ 2150

- Calculations were manually calculated and entered in columns and rows on paper often drawn with grids.
- Making changes could be awkward:
 - Correcting errors
 - Attempting variations :
 - e.g., for a personal budget what would be the effect of living in a 1 bedroom vs. 2 bedroom apartment
 - e.g., going on a vacation to Vulcan, Alberta vs. going to Dubai, U.A.E.
 - e.g., how would my term grade change if I received a “B” vs. “B+” on the final exam

The First Spreadsheet

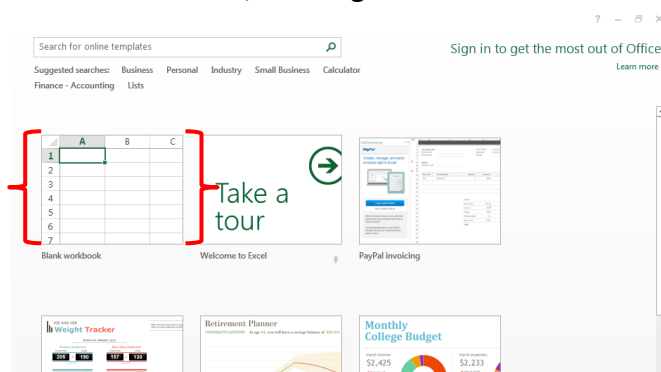
ITEM	NO.	UNIT	COST
MUCK RAKE	43	12.95	556.85
BUZZ CUT	15	6.75	101.25
TOE TONER	250	49.95	12487.50
EYE SNUFF	2	4.95	9.90
SUBTOTAL			13155.50
9.75% TAX			1282.66
TOTAL			14438.16

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

- Early versions of electronic spreadsheets were primitive but could still automate calculations.
 - So popular Visicalc was “The software tail that wags (and sells) the personal computer dog.” – Ben Rosen (Compaq)

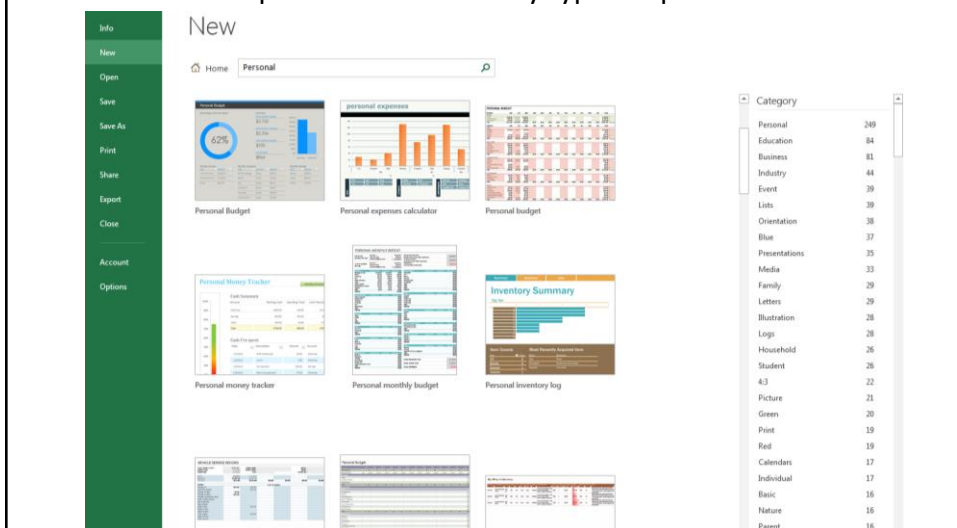
Getting Started: Creating A New Blank Spreadsheet (Excel: “Workbook”)

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



Templates

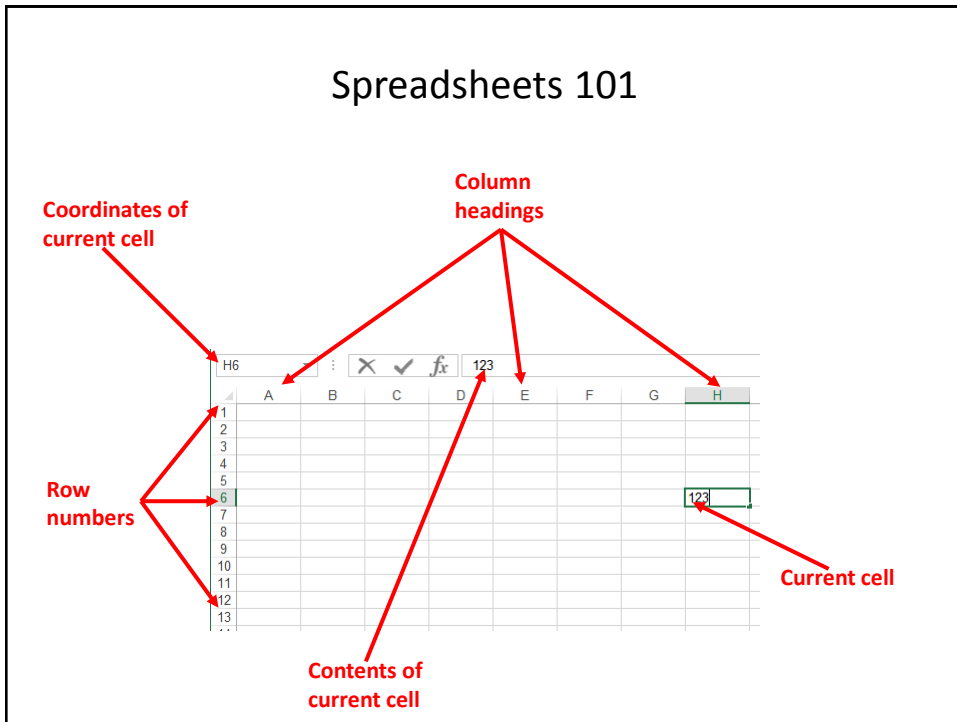
- Pre-created spreadsheets for many types of problems



Example Template

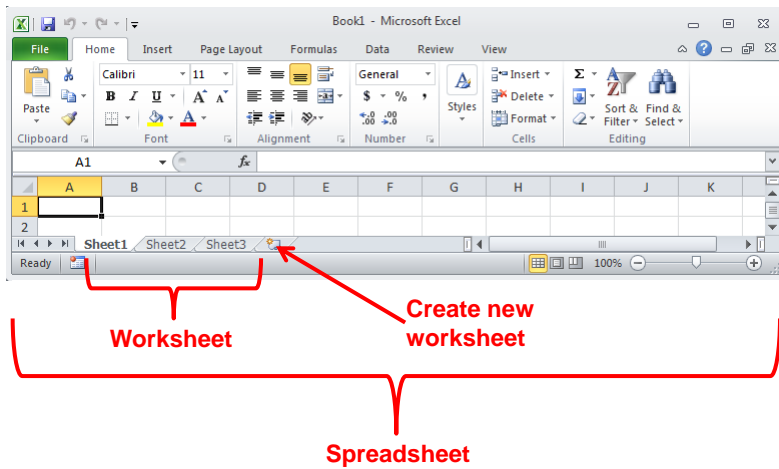
	B	C	D	E	F	G
16						
17	Monthly Income	Monthly Income	Projected	Actual	Variance	
18		Income 1	4,000	3,000	-1,000	
19		Income 2	1,300	1,400	100	
20		Extra income	300	300	0	
21		Other			0	
22		TOTAL INCOME	5,600	4,700	-900	
23						
24	Monthly Expenses	Housing Expense	Projected	Actual	Variance	
25		Mortgage or rent	1,000	500	500	
26		Second mortgage or rent		0	0	
27		Phone	54	100	-46	
28		Electricity	44	56	-12	
29		Gas	22	28	-6	
30		Water and sewer	8	8	0	
31		Cable	34	34	0	
32		Waste removal	10	10	0	
33		Maintenance or repairs	23	0	23	
34		Supplies	0	0	0	
35		Other	0	0	0	
36		SUBTOTAL	1,195	736	459	

Spreadsheets 101



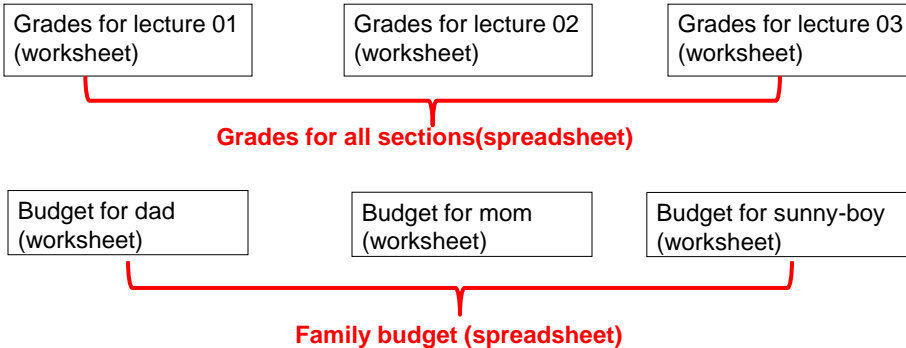
Worksheets

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



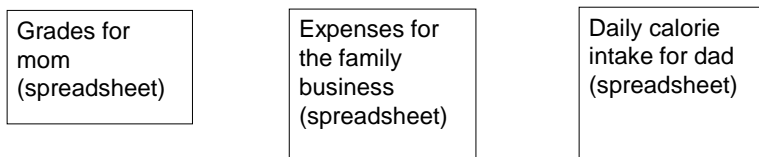
When To Use Multiple Worksheets

- 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.



Referring To Other Worksheets

- One worksheet can refer to information stored in another worksheet.
- Name of example spreadsheet:
 - 1_multiple_worksheet_example

The screenshot shows two worksheets: 'Student grades' and 'Cutoffs'.

Student grades

Student	Term percent	Letter
111	75	B

Cutoffs

Min. percent	Letter
0	F
50	D
65	C
75	B
85	A

The formula bar shows: `=VLOOKUP(B2,Cutoffs!A2:B6,2)`

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.
- Name of example spreadsheets:
 - 2A_multiple_spreadsheet_example
 - 2B_multiple_spreadsheet_example

The image displays two Excel workbooks side-by-side, illustrating a cross-reference formula. The left workbook, titled '2A_multiple_spreadsheet_example.xlsx', shows a sheet named 'Student grades' with columns A (Student), B (Term percent), and C (Letter). The right workbook, titled '2B_multiple_spreadsheet_example.xlsx', shows a sheet named 'Cutoffs' with columns A (Min. percent) and B (Letter). Red dashed lines indicate the relationship between the formula in cell C3 of the left workbook and the data in the right workbook. A blue box contains the formula: `=VLOOKUP(B2, [2B_multiple_spreadsheet_example.xlsx]Cutoffs!A2:B6, 2)`.

Lecture Exercise #1: Cross References Between Multiple Worksheets

Why Use Cross References?

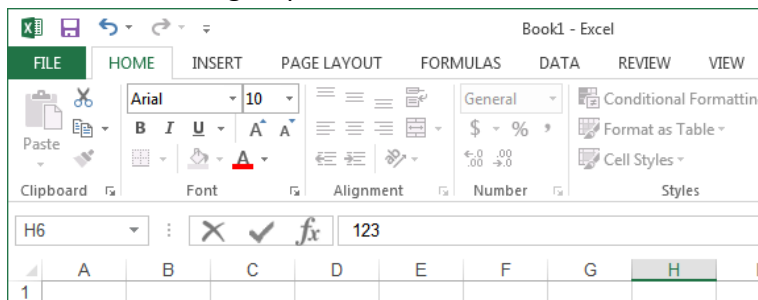
- A typical reason why one worksheet may refer to another or one spreadsheet may refer to another is that the second worksheet or spreadsheet contains data that needs to be “looked up” (e.g., a lookup table)
- Examples where cross reference lookups may be needed:
 - Grade cutoffs
 - Tax brackets
 - Product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

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

Student grades | Cutoffs

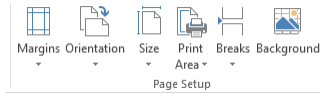
The Excel Ribbon

- Tabs are used to group related functions



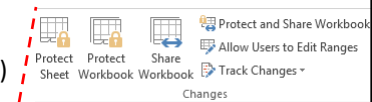
High Level View Of Each Tab

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



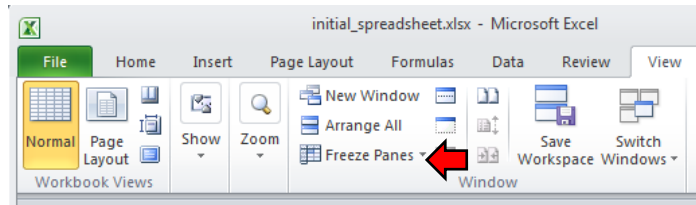
High Level View Of Each Tab (2)

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



“Freezing” Panes: How/Why

- Often used to lock the view so that crucial labels always stay onscreen regardless of which part of the sheet you are viewing



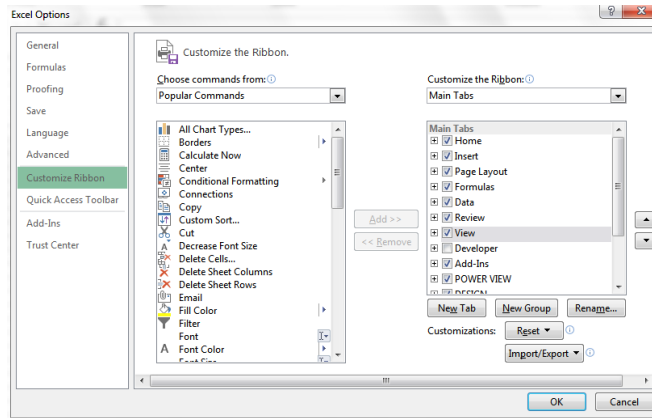
Freezing Panes: Effect On Example Spreadsheet

	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						
14	122	Management						

	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								

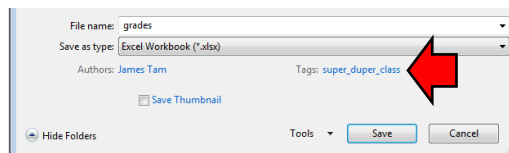
Customizing The Ribbon

- Select the “File” Ribbon and then “options”
- File -> Options



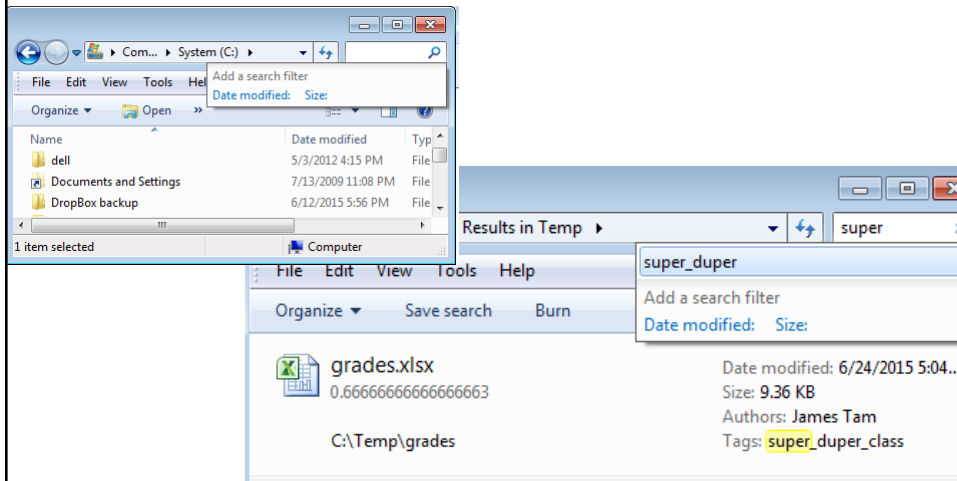
Saving Work

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



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

	A	B	C
1		Term percent	Letter
2	111	75	B

- Type in cell contents

	A	B	C
1	Student	Term percent	Letter
2	111	75	B

Contents Of A Cell: Types

- Raw data: also referred to as 'constants'

B2			
	A	B	C
1	Student	Term percent	Letter
2	111	75	B

- Labels: describe the contents of another cell

B1				
	A	B	C	D
1	Student	Term percent	Letter	
2	111	75	B	

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

ADDRESS				
	A	B	C	D
1	Student	Term percent	Letter	
2	111	75	=VLOOKUP	

Specifying Formulas

- In Excel all formulas must be preceded by the '=' symbol to distinguish it from a label

- Label

2 + 2

C1				
	A	B	C	D
1	2	2	2+2	

- Formula

= 2 + 2

C1				
	A	B	C	D
1	2	2	4	

Basic Mathematical Operators

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

Autofill

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

	A
1	Student
2	1
3	2
4	3
5	4
6	5
7	6

2. Move the mouse pointer to the ‘handle’ at the bottom right

	A
1	Student
2	1
3	2
4	3
5	4
6	5
7	6

Autofill (2)

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

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

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.

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

Previous Example: Explicitly Labeled Formulas

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

	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

- 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?

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

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

Designing Spreadsheets: Rules Of Thumb (2)

1. Do not directly enter values as data that can be derived from other values (data example, preview of 8_extracting_connecting_text)

Title	First name	Last name	Phone
Ms.	James	Tam	(403)210-9455
Mr.	Robert	Thurston	(702)333-3333
Dr.	Jane	Jones	(614)123-4567
Prof.	Allison	Smith	(123)456-7890
	Amanda	Bynes	(333)666-9999
	amanda	amanda	(000)000-0000
Canadian honorific			
Middle Eastern honorific			

=CONCATENATE(A2,C2)

=CONCATENATE(A2,B2)

Designing Spreadsheets: Rules Of Thumb (3)

2. Label information so it can be clearly understood

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

Designing Spreadsheets: Rules Of Thumb (4)

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

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

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

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

Etc.

- spreadsheet example name: 3_grades_formulas

Designing Spreadsheets: Rules Of Thumb (5)

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

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

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

Etc.

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

Lookup Tables

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

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

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

Mathematical Functions

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

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

`=AVERAGE(D2:D5)`

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

– spreadsheet example name: 4_grades_lookup

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

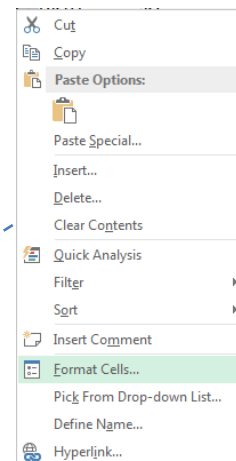
$8 / 2 ^ 2$ Equals 2

Formatting Cells

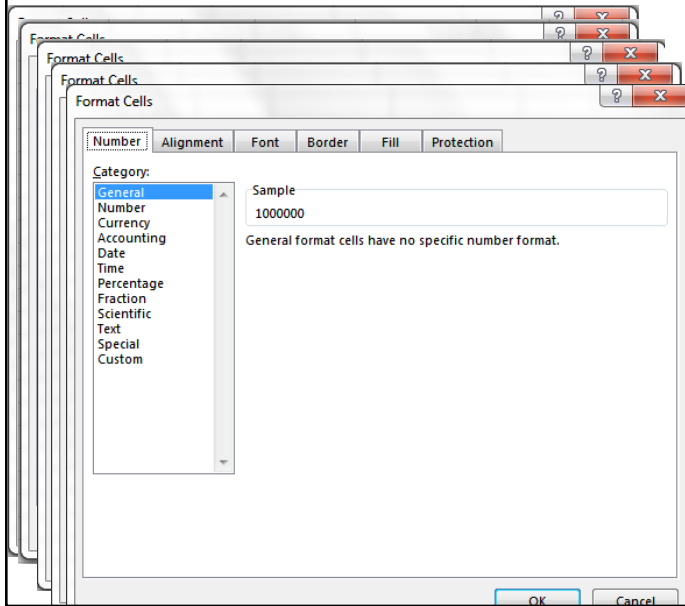
- Excel provides the ability to format the spreadsheet in various locations of the ribbon.
- You also can access these functions in the context of a cell or cells in the spreadsheet.
 - Select a cell or cells for which you wish to apply similar formatting effects.

750000	75000	10
1000000	100000	14
2000000	200000	28
3000000	300000	42
4000000	400000	57

- Right click and select "Format Cells"

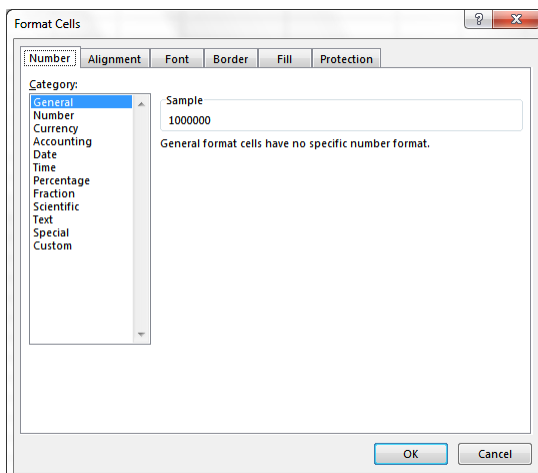


Formatting Cells (2)



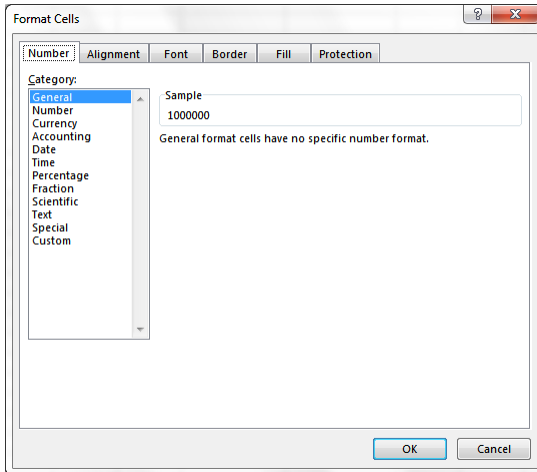
- General: no special format
- Number:
 - number of decimal places.
 - Separator (every 3 digits)

Formatting Cells (3)



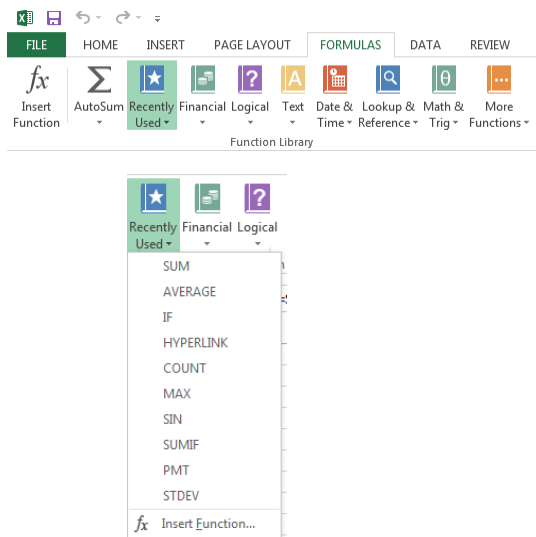
- Currency:
 - Currency sign
 - Several options for displaying negative numbers
 - Columns aligns decimal points
- Accounting:
 - Similar to currency but no special options for displaying negative values
- Date, Time:
 - Both allow display in different formats
- Percentage: %
- Fraction: /

Formatting Cells (3)



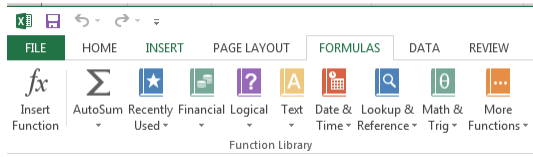
- Scientific:
- Text:
 - Treats everything (even numbers) as text
 - Cell is displayed exactly as entered.
- Special:
 - Country specific information (zip)
- Custom:

Pre-Created Excel Formulas



What Function Is Right For Your Situation?

- Excel provides reminders.
- Recall the location of built in functions.



- Also Excel provides “name completion”

	A	B	C	D	E	F	G	H	I	J	K
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							
6	AVERAGES	3.45	3	=av							
7				AVERAGE							
8				AVERAGEA							
9				AVERAGEIF							
10				AVERAGEIFS							
11											

Returns the average of the absolute deviations of data points from their mean. contain numbers

Basic Statistics

- Name of example spreadsheet:
 - 5_basic_statistics
- Example formulas: `sum()`, `average()`, `min()`, `max()`
- General usage:
 - Each formula requires as input a series of numbers
 - E.g., formula(1,2,3):
 - Sum = 6 , =sum(1,2,3)
 - Average = 2 , =average(1,2,3)
 - Min = 1 , =min(1,2,3)
 - Max = 3 , =max(1,2,3)

Basic Statistics (2)

- The series of numbers can allow refer to a range of cells
formula(<start cell> : <end cell>)

	A	B	C	
1			Sales	
2	Sales person		Sunridge	
3		Manager	\$100,000.00	
4		Assistant	\$50,000.00	
5		Employee1	\$50,000.00	
6		Employee2		
7		Employee3		
8				
9		Store: total sales	\$200,000.00	=SUM(C3:C7)
10		Store averages	\$66,666.67	=AVERAGE(C3:C7)
11		Store: highest	\$100,000.00	=MAX(C3:C7)
12		Store: lowest	\$50,000.00	=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	Sales person		Sunridge	Market Mall	Chinook			
3		Manager	\$100,000.00	\$136,500.00	\$105,000.00			
4		Assistant	\$50,000.00	\$125,000.00	\$117,000.00			
5		Employee1	\$50,000.00	\$64,000.00	\$66,000.00			
6		Employee2		\$85,000.00	\$75,000.00			
7		Employee3			\$55,500.00			
8								
9		Store: total sales	\$200,000.00	\$410,500.00	\$418,500.00		Calgary: total sales	\$1,029,000.00
10		Store averages	\$66,666.67	\$102,625.00	\$83,700.00		Calgary: employee average	\$85,750.00
11		Store: highest	\$100,000.00	\$136,500.00	\$117,000.00		Calgary: highest employee	\$136,500.00
12		Store: lowest	\$50,000.00	\$64,000.00	\$55,500.00		Calgary: lowest employee	\$50,000.00

=SUM(C3:E7)

Counting Functions

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

function(<start cell range> : <end cell range>)

– An array (list) of numbers can be the function argument but this is rare
e.g., =COUNT(1,"A",2)

- Name of example spreadsheet:
 - 6_counting_functions

Counting Functions: Count ()

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

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

Counting Functions: Counta()

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

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

Counting Functions: Countblank()

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

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

String

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

Excel String Functions

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

Functions That Convert Text

- Name of example spreadsheet:
"7_converting_text"
- `lower()`
 - Converts non-lower case alphabetic characters to lower case
 - <https://support.office.com/en-US/article/LOWER-function-3F21DF02-A80C-44B2-AFAF-81358F9FDEB4>
- `upper()`
 - Converts non-upper case alphabetic characters to upper case
 - <https://support.office.com/en-US/article/UPPER-function-C11F29B3-D1A3-4537-8DF6-04D0049963D6>
- `proper()`
 - For alphabetic text it converts the letters to 'proper' format:
 - All letters are lower case except for the first letter of each word (which is capitalized)
 - <https://support.office.com/en-US/article/PROPER-function-52A5A283-E8B2-49BE-8506-B2887B889F94>

Functions For Extracting And Connecting Text

- Name of example spreadsheet:
"8_extracting_connecting_text"
- `trim()`:
 - Removes leading or trailing spaces (ignores single spaces within text)
 - **Format:** `trim(<string>)`
 - Examples:
 - `Trim(" james ")`
 - `Trim("a b ")`
 - <https://support.office.com/en-US/article/TRIM-function-410388FA-C5DF-49C6-B16C-9E5630B479F9>
- `concatenate()`:
 - Connects two or more strings
 - **Format:** `concatenate(string1, string2...)`
 - A string can be fixed e.g., `concatenate("wa","sup")` or the address of a cell e.g., `concatenate(A1,"!")`
 - <https://support.office.com/en-US/article/CONCATENATE-function-8F8AE884-2CA8-4F7A-B093-75D702BEA31D>

Functions For Extracting And Connecting Text (2)

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

Functions For Extracting And Connecting Text (3)

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

Functions For Extracting And Connecting Text (4)

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

Functions For Extracting And Connecting Text (5)

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

Combinations: Find(), Mid()

- The return value of one function can be used as the argument of another function.
- Consider this example
 - Cell A10 contains the string “Apt #709, 944 Dallas Dr. NW”
 - You wish to extract the apartment number information #ddd into a substring
 - Assume that apartment numbers are always preceded by the number sign #
 - Also you assume that apartment numbers are three digits in length
 - You cannot make assumptions about the information that precedes the number sign (zero to ‘infinity’)
 - Find() can be used 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 this information is used as one of the arguments for the mid(), string extraction function.
- All together: “=MID(A10, FIND("#", A10), 4)”

Why Bother?

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

1. Labor saving

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

	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)

	A	B	C	D
1	Title	First name	Last name	Phone
2	Ms.	James	Tam	(403)210-9455
3	Mr.	Robert	Thurston	(702)333-3333
4	Dr.	Jane	Jones	(614)123-4567
5	Prof.	Allison	Smith	(123)456-7890

- In Canada the proper greeting will be “Dr. Jones”

=CONCATENATE (A2, C2)

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

- In other countries the proper greeting will be “Dr. Harry”

=CONCATENATE (A2, B2)

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

Why Bother? (3)

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

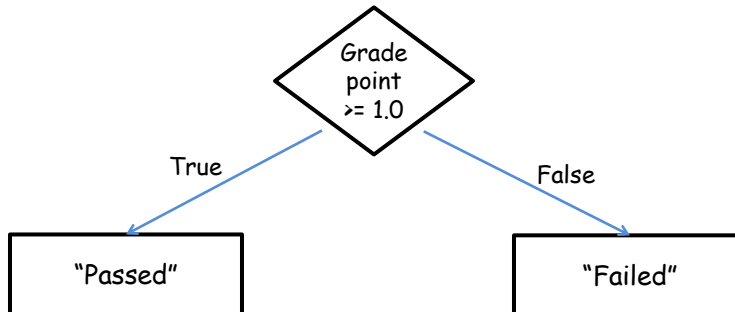
Lecture Exercise #2: String Functions

Lecture Exercise #3: String Functions (If There Is Time)

Date And Time Functions

- Name of example spreadsheet:
"9_date_time"
- `today()`
 - Displays the current date (month/day/year) e.g., 07/15/2015
- `now()`
 - Displays the current date (as above) and time (hour/minute with a 24 hour clock) e.g., 18:42
- Both: determine the time/date based on the settings of the computer on which the worksheet is run.
 - Updates occur when the files is opened or when the spreadsheet recalculates new values.

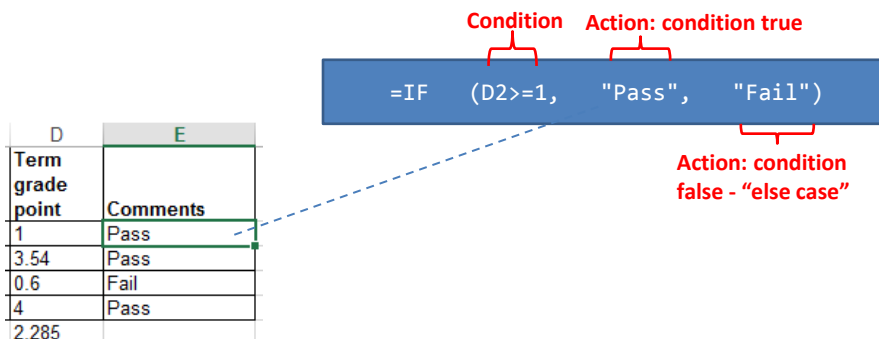
'If-Else' (Branching)



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

Applying Branches: Grade Example

- In column 'E' the sheet will display “Pass” if term grade point is 1.0 or greater “Fail” otherwise.
 - spreadsheet example name: 10_if_else_pass_fail



Format: If-Else

- **Format:**

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

- **Example:**

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

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

- <https://support.office.com/en-US/article/IF-function-69aed7c9-4e8a-4755-a9bc-aa8bbf73be2?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

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

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

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

If: Specifying Only The True Case (2)

- Consequently:
 - Even if a specific return value is desired only for the ‘if condition case’ (true that the condition has been met)
 - Something, even an empty message, should be specified for the ‘else case’ (false that the condition has been met).
- Previous example: amended
 - spreadsheet example name: 11_if_pass_only

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

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

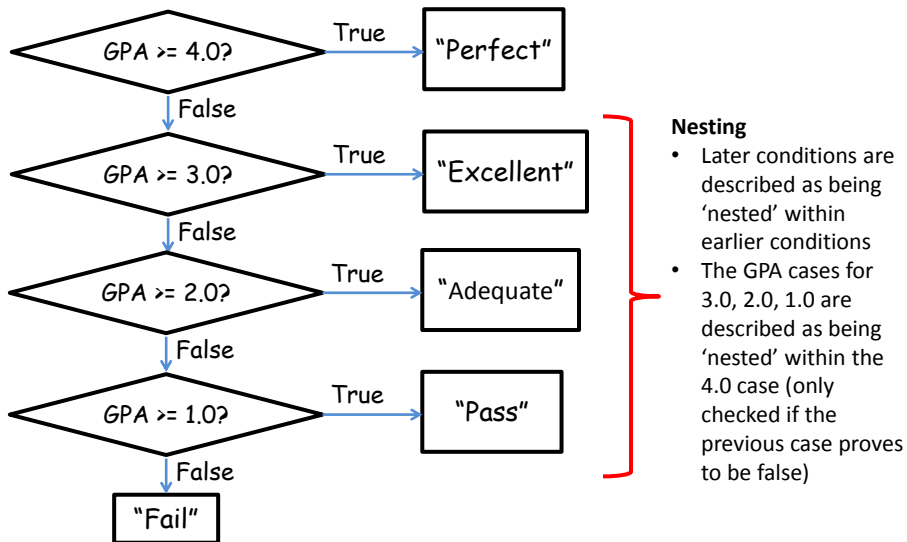
Nested Conditions

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

Nested Conditions (2)

- Applies when different conditions must be checked but at most only one applies (exactly 0 or 1 conditions can be true)
- Example:
 - Display “Perfect” if grade point is 4.0 or greater
 - Display “Excellent” if grade point is 3.0 or greater but less than 4.0
 - Display “Adequate” if grade point is 2.0 or greater but less than 3.0
 - Display “Pass” if grade point is 1.0 or greater but less than 2.0
 - Otherwise display “Fail”
- Spreadsheet example name: 12_nested_if_grades

Previous Grade Example: Specifying Conditions



Nested "If's"

- **Format:**

=IF(<condition to check>, <return: true>, <return: condition false>)

Another if-check

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

- **Example:**

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

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

Previous Example: Initial Cases

- If GPA ≥ 4.0 "Perfect", if $3.0 \leq \text{GPA} < 4.0$, "Excellent"

TRUE ≥ 4.0

TRUE ≥ 3.0

FALSE ≥ 4.0

Previous Example: Nested Solution

```

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

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

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

Lookup Tables

- Can be instead of many nested IF's.
 - Easier to enter, update, understand.
- Requirements of previous example:
 - 0 <= GPA < 1: Fail
 - 1 <= GPA < 2 : Pass
 - 2 <= GPA < 3 : Adequate
 - 3 <= GPA < 4 : Excellent
 - GPA >= 4 : Perfect
- Previous solution:

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

LOOKUP

- <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
1	Area code	Province
2	236	British Columbia
3	403	Alberta

- **Format:**

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

LOOKUP (2)

- Name of example spreadsheet: 15_lookup

	D	E
	Term grade point	Comments
1	3.66	Excellent

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

- Row 2 data

=LOOKUP(D2,

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

D11:D15,

Lookup column:
Start : End cell coordinates

E11:E15)

Result column:
Start : End Cell coordinates

LOOKUP (3)

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

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

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

← Backup and use this value Return "Excellent"

LOOKUP table Values must be sorted in ascending order

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?>])

– A star * indicates a required value, brackets [] specify optional values

- **Example:**

=VLOOKUP(D2, D11:E15, 2)

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

Lookup table: Start : End cell coordinates

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

VLOOKUP: Previous Example

=VLOOKUP(D2,D11:E15,2)

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

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

Spreadsheet example name:
16_vlookup.xlsx

VLOOKUP: Optional Value = TRUE

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

GPA = 3.54

Min. GPA	Comment	
0	Fail	>3.54?
1	Pass	>3.54?
2	Adequate	>3.54?
3	Excellent	>3.54?
4	Perfect	>3.54?..No!

← Backup and use this value Return "Excellent"

VLOOKUP: Optional Value = FALSE

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

Term grade point	Comments	Comments
1	Pass	Pass
3.54	Excellent	#N/A
1.52	Pass	#N/A
4	Perfect	Perfect

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

- Table values do not have to be sorted.

VLOOKUP: Optional Value = TRUE/FALSE

- TRUE

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

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

- FALSE:

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

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

Recap: If Function Vs. Lookup Functions

- Multiple If's:

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

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

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

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

- Lookup functions

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

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

Min. GPA	Comment
0	Fail
1	Pass
...	...

Logical Operations In Excel

- The basic logical operations: AND, OR, NOT can be invoked as functions in Excel
 - All function inputs can only be a True or False value.
- Format:**
 - AND(<True or False>,<True or False>...)
 - OR(<True or False>,<True or False>...)
 - NOT (<True or False>)
- Examples:**
 - AND(C1>=45,D1="John Smith") # Requires all
 - OR(C1>=0,D2>=0) # Requires at least one
 - NOT(AA12) # AA12 Must contain a logical: TRUE, FALSE Value

Logic And IF's: Example

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

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

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

- Spreadsheet example name: 13_if_logic

Logic And IF's: Example (2)

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

E12

Total work experience
7

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

G16

Overall GPA
3.6

Lecture Exercise #4: Branching (And Other) Functions

Conditional Counting Functions

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

Counting Functions Based On Conditions: Countif()

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

	Col C
13	0
14	2
15	"A"
16	
COUNTIF (#)	=COUNTIF(C13:C16,">0")

Counting Functions Based On Conditions: Countif(), 2

	Col C
13	0
14	2
15	"A"
16	

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

Counting Functions Based On Conditions: Countifs(), 3

- Can be used when multiple requirements must be met:
 - Counts the number of cells that meets all in a series of multiple requirements
 - <https://support.office.com/en-US/article/COUNTIFS-function-DDA3DC6E-F74E-4AAE-88BC-AA8C2A866842>
- Format:


```
=countifs(
  <range 1>, <criteria 1>,
  ... <optional additional range>, <optional additional
  criteria>)
```
- Example: 14_conditional_counting_formulas
 - =countifs(A1:A10,"A", B2:B7, ">=100")

Counting Functions: Countifs(), 4

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

2 months quota met

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

Conditional Formatting

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

Methods Of Referring To Cells

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

Absolute Reference

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

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

Assumption

Row 10 sums row 4 – 9.

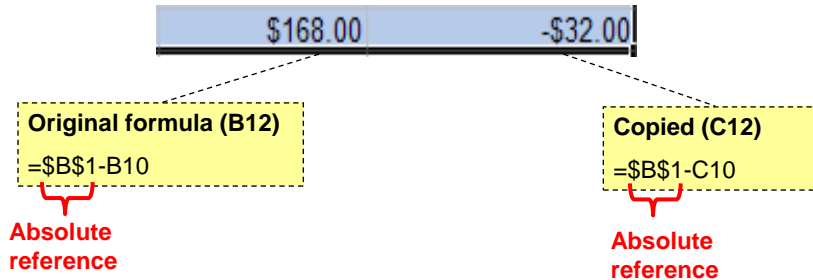
Original formula (B12)

=B\$1-B10

Copied (C12)

=B\$1-C10

Absolute Reference (2)



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).

	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

References to B1 are absolute because income doesn't change

Original formula (B12)

`= B1-B10`

Copied (C12)

`= B1-C10`

Relative Reference

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

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

Original formula (B12)

=B\$1-B10

Copied (C12)

=B\$1-C10

Relative Reference (2)

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

Reminder:

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

Original formula (B12)

=B\$1-B10

**Relative
reference**

Copied (C12)

=B\$1-C10

**Relative
reference**

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

Relative Reference (3)

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

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

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

Original formula (B12)

=B\$1-B10

Copied (C12)

=B\$1-C10

Cell References: Important Details

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

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

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

Absolute, Relative And Mixed References: Examples¹

	A	B	C
1			
2			
3			

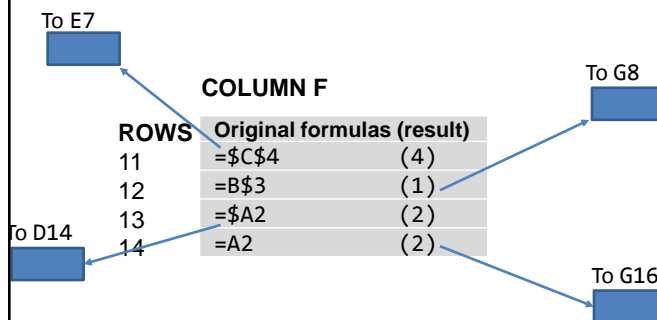
Example	Reference type	Copied result
\$A\$1	<ul style="list-style-type: none"> •Absolute column •Absolute row 	\$A\$1
A\$1	<ul style="list-style-type: none"> •Relative column •Absolute row 	C\$1
\$A1	<ul style="list-style-type: none"> •Absolute column •Relative row 	\$A3
A1	<ul style="list-style-type: none"> •Relative column •Relative row 	C3

¹ Examples from the Excel 2003 Help System

Absolute, Relative References: Example

- Example: 17_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?

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

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

Lecture Exercise #4: 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
- $$\begin{aligned} \text{Amount} &= 100 + (100 * 0.1 * 3) \\ &= 100 + (30) \\ &= \$130 \end{aligned}$$

Some example test cases:

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

Example Testing A Formula

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

Testing Ranges

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

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

Example: Good Design And Testing

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

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

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

Term Grade Point

- How should this value be calculated?

	A	B	C	D	E	F	G	H	I
1	Student	Assignment grade point	Exam grade point	Term grade point	Comments			Component	Weight
2	1	4.2	3.3					Assignment	0.4
3	2	3.3	3.7					Exam	0.6
4	3	2.3	1						
5	4	4	4						
6									
7									
8									
9									
10									
11									
12									
13									
14									
15									
16									

GPA range	Min GPA	Comment
0 <= GPA < 1	0	Fail
1 <= GPA < 2	1	Pass
2 <= GPA < 3	2	Adequate
3 <= GPA < 4	3	Excellent
>= 4	4	Perfect

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

Term Grade Point (2)

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

	A	B	C	D
1	Student	Assignment grade point	Exam grade point	Term grade point
2	1	4.2	3.3	

Derive it, don't type it

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

	A	B	C	D
1	Student	Assignment grade point	Exam grade point	Term grade point
2	1	4.2	3.3	
3	2	3.3	3.7	
4	3	2.3	1	
5	4	4	4	

Once

Term Letter Grade

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

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

Absolute, Relative: Completed Example

- Spreadsheet solution name (**don't look at contents before we go over the concepts in lecture**)
18_vlookup_absolute_relative_addressing

Graphic Design And Spreadsheets

- Using color
- C.R.A.P.
- Fonts and font effects
- Text vs. graphs and charts

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
BRK	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.

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 ingredients

- 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.
- Field size
 - The larger the area to be color coded, the more easily that colors can be distinguished.

This course has been significantly changed from the versions run in previous semesters (including fall 2014). While thinking and programming, 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!

- Conventions
 - “Commonly accepted” conventions can vary widely by culture and their use should be carefully considered

Color And Cultural Associations

	Egypt	China	Japan	India	France
Red	• Death	• Happiness	• Anger, Danger	• Life, creativity	• Aristocracy, Freedom, Peace
Blue	• Virtue, Faith, Truth	• Heavens, Clouds	• Villainy		• Freedom, peace
Green	• Fertility, Strength	• Ming Dynasty, Heavens, Clouds	• Future, Youth, Energy	• Prosperity, Fertility	• Criminality
Yellow	• Happiness, Prosperity	• Birth, Wealth, Power	• Grace, Nobility	• Success	• Temporary
White	• Joy	• Death, Purity	• Death	• Death, Purity	• Neutrality

From "How Fluent is Your Interface? Designing for International Users" Proceedings of the INTERCHI'93. Russo P. and Boor S.

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 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": ♦)(■)♣ ♠)(■)♣♦

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 throughout the interface to tie elements together

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

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.

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).

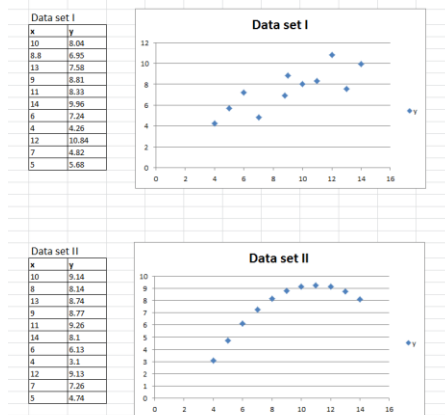
Chapter overview

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- 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).

	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
8	114	Management	100	90	85	80	75	81.5
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	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

Proximity

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

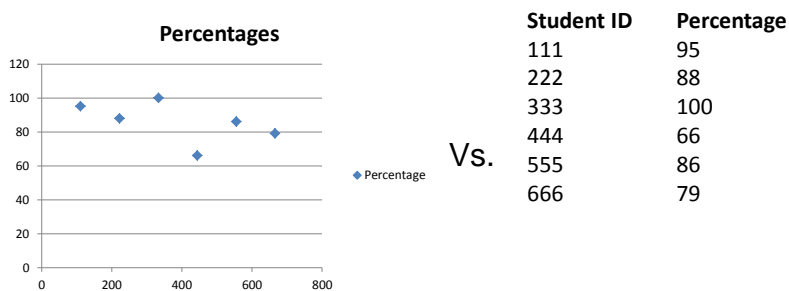


Text Or Graphics?

- Text?
- A graph or chart?
 - What type to use? (Pie, bar, line etc.)

The Benefits Of Using Text

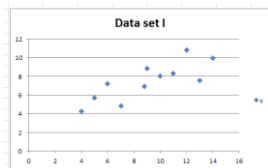
- Text is the best representation to use when accuracy is paramount.
- Example term grades for individual students.



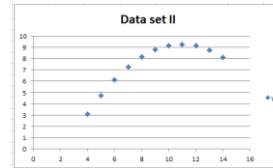
Benefits Of Graphics

- Graphics:
 - Useful for illustrating relationships or visualizing patterns
- Example: Anscombe's Quartet¹
 - Shown one way (a set of numbered pairs) it's hard to analyze the information e.g., is there any trends or patterns?

Data set I	
x	y
10	8.04
8.8	6.95
13	7.58
9	8.81
11	8.33
14	9.96
6	7.24
4	4.26
12	10.84
7	4.82
5	5.68



Data set II	
x	y
10	9.14
8	8.14
13	8.74
9	8.77
11	9.26
14	8.1
6	6.13
4	3.1
12	9.13
7	7.26
5	4.74

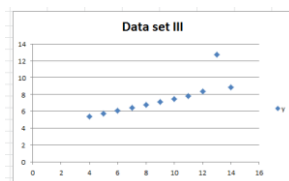


[Anscombe, F. J.](#) (1973). "Graphs in Statistical Analysis". *American Statistician* 27 (1): 17–21

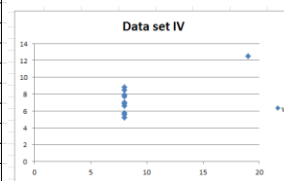
Benefits Of Graphics (2)

- Example: Anscombe's Quartet (continued)

Data set III	
x	y
10	7.46
8	6.77
13	12.74
9	7.11
11	7.81
14	8.84
6	6.08
4	5.39
12	8.35
7	6.42
5	5.73



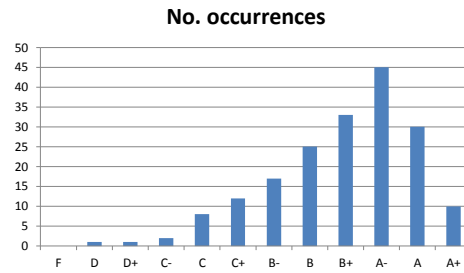
Data set IV	
x	y
8	6.58
8	5.76
8	7.71
8	8.84
8	8.47
8	7.04
8	5.25
19	12.5
8	5.56
8	7.91
8	6.89



Benefits Of Graphics (3)

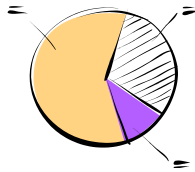
- Graphical representations can make a powerful impression!

Letter	No. occurrences
F	0
D	1
D+	1
C-	2
C	8
C+	12
B-	17
B	25
B+	33
A-	45
A	30
A+	10



Ways Of Graphically Representing Information

- Pie chart



- Bar graph



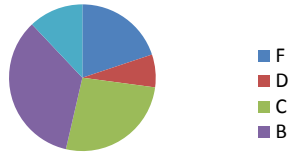
- Line graph



Pie Charts

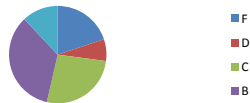
- Good for showing proportions, how much of the whole does each item contribute.

Grade distribution



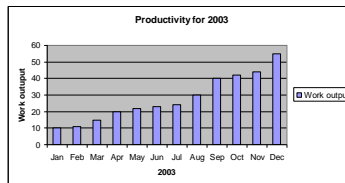
- It's poor for showing exact numeric values.

No. of students receiving each grade

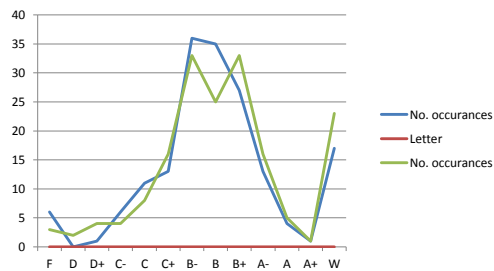


Bar And Line Graphs

- For showing trends

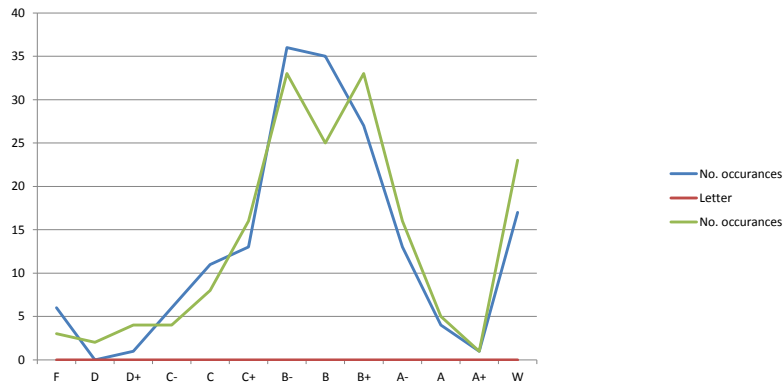


- Comparing functions



Rules Of Thumb For Graphs

1. The X axis is used to plot known data (e.g., letter grades), while the Y axis is used to plot the unknown data (e.g., the number of students who received particular letter grades).



Rules Of Thumb For Graphs (2)

2. Bar graphs are used to plot non-continuous data
 - e.g., the number of patients that go to different hospitals.
3. Line graphs are used to plot continuous data
 - e.g., mortality trends over time.

Keep Your Graphs Simple

- Similar to using multiple types of fonts and font effects unless you are a skilled graphic designer it's best to keep it simple (clarity over 'fancy effects').



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
- Rules for using and not misusing color
- Issues associated with color: color blindness, field size, conventions for color
- 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

After This Section You Should Now Know (6)

- When to use text vs. graphics
- When to use a pie chart vs. bar graph vs. line graph

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