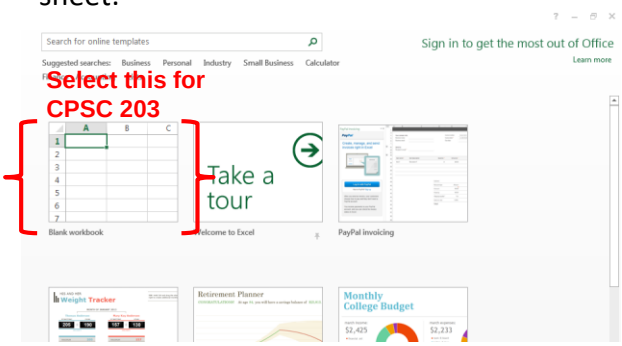
Spreadsheets: Part 1

You will learn about some important features of Excel.

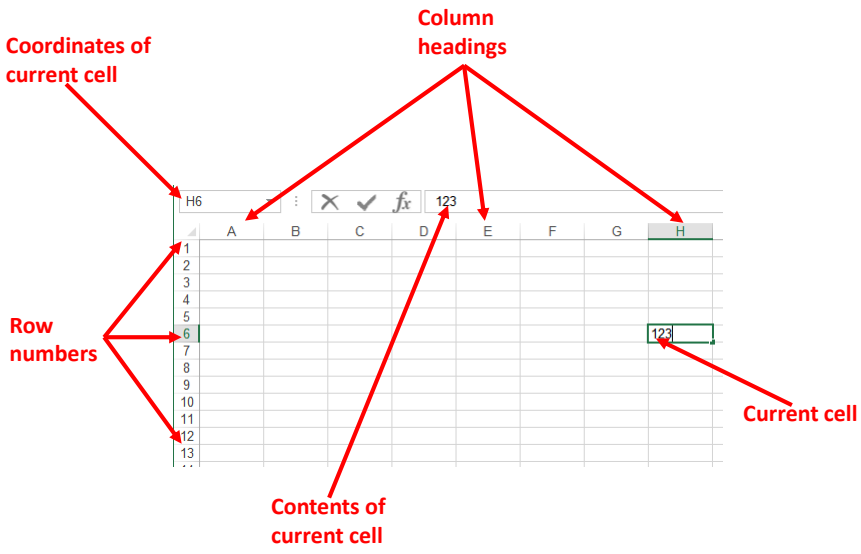
Online MS-Office information source:
https://support.office.com/

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

- Once Excel has started, select the option for creating a new sheet:

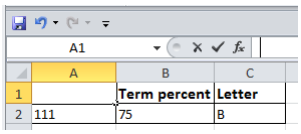


Spreadsheets 101 (Basics)

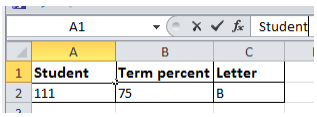


Entering Data

- Click on cell to enter the data (in the example: selected cell A1)

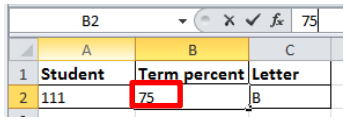


- Type in cell contents (data entered in the example: ‘Student’)

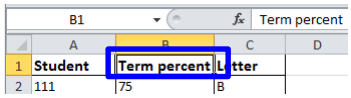


Contents Of A Cell: Types

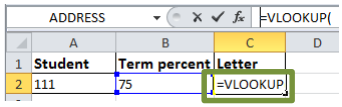
- **Raw data**: also referred to as 'constants'



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



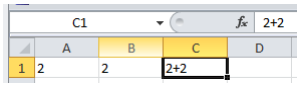
- **Formula**: values derived from the raw data (e.g., calculations: =2+2, lookup values: =D2*2, functions: =sum(B2,B9))



Distinguishing Formulas From Text

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

    2 + 2



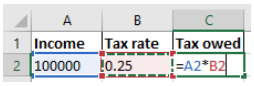
  - **Formula**

    = 2 + 2

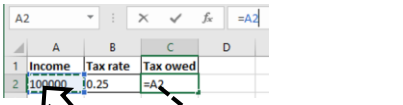
For the sake of brevity, you can assume that all formulas in this section will be preceded by the assignment operator '='

Entering 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 e.g. click on C2
  - Type in the formula manually e.g. type =A2*B2



- **Approach 2**: type and click
  - Click on a cell where you want to enter the formula e.g. click on C2
  - When you get to the part of the formula that refers to another cell then just click on the cell (being referred to) rather than typing in the cell address e.g. click on A2 after typing the '=' in C2



1) Click here

2) Reference to Cell A2 appears here

Formatting Cells

- For other information for the other tabs (right clicking on a cell to 'format cells')
  - Similar to the basic features of Word these features will be assumed prior knowledge or knowledge that students can pick up on their own.
  - These features won't be covered in lecture nor will they be covered in tutorial.
  - For more information please refer to the tutorial notes: "`excel_basic_features`".

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

Design rule of thumb: use brackets to make the ordering explicit.

Level	Operation	Symbol
1	**B**rackets (inner before outer)	( )
2	**E**xponent	^
3	**D**ivision, **M**ultiplication,	/ *
4	**A**ddition, **S**ubtraction	+ -

- Operations on a higher level are evaluated first

  `8 / 2 ^ 3` Equals `8 / 8 or 1`

- When a sequence of operators from same level (e.g. addition, subtraction) are encountered in a cell the expression is evaluated from in order in which they appear (left to right).

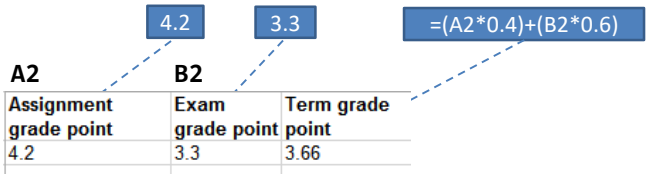
  `2 + 2 - 1` Equals `4 – 1 or 3`

Designing Spreadsheets: Rules Of Thumb

1. Use brackets to make ordering clear
   - Do this even if order can be determined using the specified rules of operation.
     - **NO**
       - `C1 + C2 * D2 / E2`
     - YES (brackets help to visually group information as well making ordering clear)
     - **YES**
       - `C1 + ((C2 * D2) / E2)`

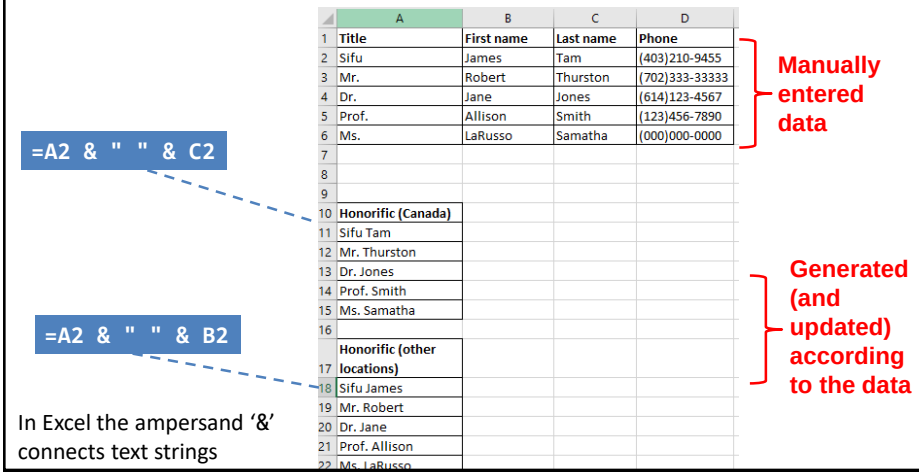
Designing Spreadsheets: Rules Of Thumb

2. Do not directly enter values as data that can be derived from other values (this is a numerical calculation example)
   - Example
     - Assignment grade (assume one assignment worth 40%) = `4.2` (data in cell A2)
     - Exam grade (assume only one exam worth 60%) = `3.3` (data in cell B2)
     - Calculate term grade point `=(A2*0.4)+(B2*0.6)` OR directly enter `3.66`?



Designing Spreadsheets: Rules Of Thumb

1. Do not directly enter values as data that can be derived from other values (the '&' operator connects text)
   - **Example:** 3_generating_honorifics



	A	B	C	D
1	**Title**	**First name**	**Last name**	**Phone**
2	Sifu	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	Ms.	LaRusso	Samatha	(000)000-0000
7				
8				
9				
10	**Honorific (Canada)**			
11	Sifu Tam			
12	Mr. Thurston			
13	Dr. Jones			
14	Prof. Smith			
15	Ms. Samatha			
16				
17	**Honorific (other locations)**			
18	Sifu James			
19	Mr. Robert			
20	Dr. Jane			
21	Prof. Allison			
22	Ms. LaRusso			

In Excel the ampersand '&' connects text strings

Designing Spreadsheets: Rules Of Thumb

3. **Label information** so it can be clearly understood

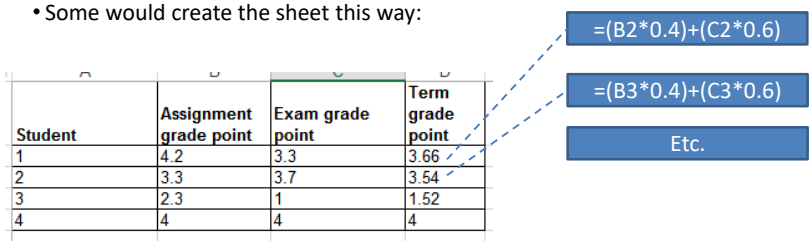
Assignment grade point	Exam grade point	Term grade point
4.2	3.3	3.66

Designing Spreadsheets: Rules Of Thumb (4)

4. Never enter the same information more than once

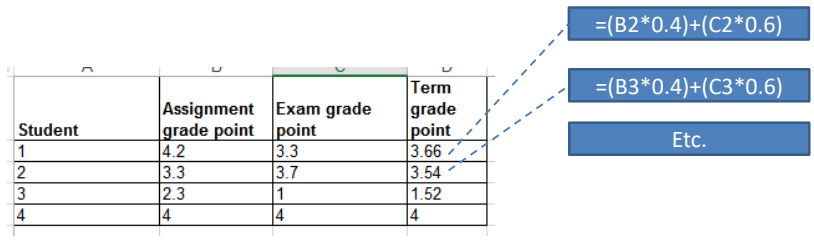
Example spreadsheet: `4grades_formulas`

- 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

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:

- Making changes: What if the value of each component (40% assignments, 60% exams) changed?
  - –Retyping/modifying all formulas is inefficient (at least a copy-paste is needed)
- Clarity: What does the 0.4 & 0.6 refer to (sometimes it's not so obvious)? It violates the "label information" rule of thumb.

Lookup Tables

- **Example spreadsheet**: `5_grades_lookup`
- 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			
6	AVERAGES	3.45	3	3.18			

Quick Hint #1: When To Use the $ Sign (Absolute Cell Reference)

- If a formula always **refers to the same location** in the spreadsheet (e.g. lookup table or lookup cell)

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

	D	E	F	G
1	Term grade point		Component	Weight
2	3.66		Assignment	0.4
3	3.54		Exam	0.6

Changing the lookup table values automatically changes all **cells** that refer to the table (i.e. term GPAs update)

	D	E	F	G
1	Term grade point		Component	Weight
2	3.48		Assignment	0.2
3	3.62		Exam	0.8

- Always precede references to cells being looked up with a dollar sign
  - Values in G2 and G3 are needed in calculations for *all* students so the row and column are preceded by a dollar sign: (B2*G2)*(C2*G3)
  - The dollar signs ensure that when the formula is copy-pasted, other student's term grade points always refers to grade weightings specified in the lookup table defined in Cell G2 and Cell G3.

Quick Hint #2: When NOT To Use the $ Sign (Relative Cell Reference)

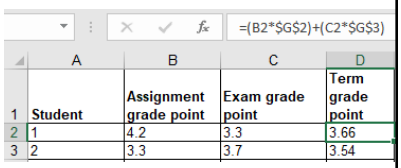
- If a formula will refer to ***different*** cells if it is copy-pasted (or moved) to another part of the spreadsheet.
  - E.g. assignment and exam GPA used to calculate term grade.

Original formula =(**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			

Formula copied down 1 row (**row +1**) =(**B3***G2)+(**C3***G3)

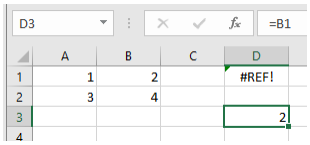
Relative Cell Reference: No $ Sign



- General rule:
  - If the formula is moved/copied '**down**' by 'a' rows then the relative row references **increases** by 'a' amount.
    - Previous example: formula is copied down by 1 row so the cell references increased by 1: from B2 to B3 (+1) for the assignment component and from C2 to C3 (+1) for the exam component.
    - Thus the formula changed:
      - From: =(**B2***G2)+(**C2***G3)
      - To: =(**B3***G2)+(**C3***G3)
  - If the formula is moved/copied '**up**' by 'a' rows then the relative row references **decreases** by 'a' amount.
  - If the formula is moved/copied '**left**' by 'c' rows then the relative cell references **decreases** by 'c' amount.
  - If the formula is moved/copied '**right**' by 'd' rows then the relative cell references **increases** by 'd' amount.

Relative Cell Reference: Errors

- If a relative cell reference produces a row or column reference outside the valid range (e.g. below 'A' or '1') an error message will appear.
- Example: copy the relative cell reference from D3 to D1.

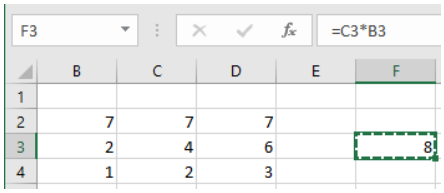


  - The new formula would refer to Cell =B1 minus two rows (not possible).
- Maximum number of cells in an Excel spreadsheet[1]
  - 1,048,576 rows by 16,384 columns
  - (This information is included for your own reference rather than something you should know as a requirement for the exam).

1 Source: https://support.office.com/en-us/article/excel-specifications-and-limits-1672b34d-7043-467e-8e27-269d656771c3

Cell References: Example Exam Question

- What's the result of copying the expression from F3 to G4?



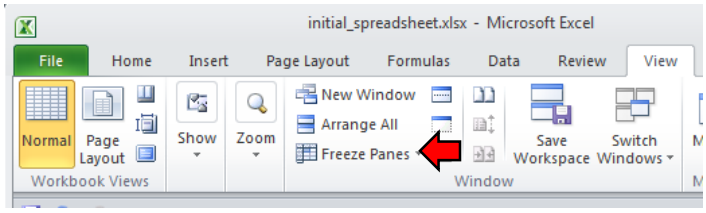
- Note: **References to empty cells** (e.g. B1) that are **used in a mathematical expression return 0**.
  - Example `B1 + C1 = 0`

Data Too Big For Your View

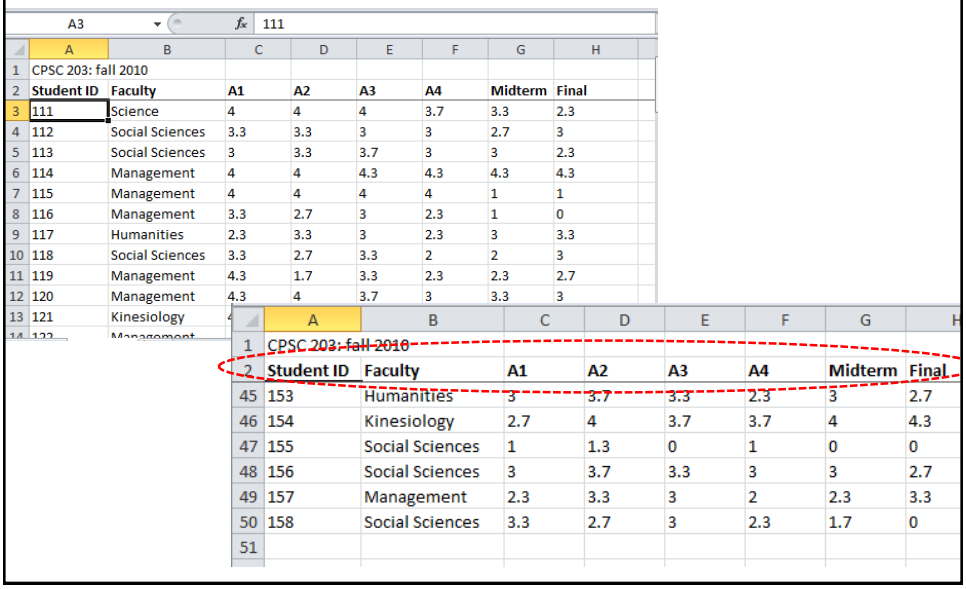
- Covered in this section of lectures notes
  - Freezing panes
  - Simple merging of cells (merging cells on a single row).
- Covered in the introductory tutorial notes
  - Resizing rows or columns
  - Wrap the data
  - Merge data (merging multiple rows as well as multiple columns)

"Freezing" Panes: How/Why

- Often used to lock the view so labels always stay onscreen regardless of which part of the sheet you are viewing.
- Obviously this is useful for cases that contain column (or row) headings.
- Running the Freeze Panes feature: `View -> Window: Freeze Panes`



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						

	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								

Freeze Panes: Procedure

- Move to the row below the row to be 'frozen'.
- In the previous example with student grades it would be Row 3.
- Select:
  - `View -> Window : Freeze Panes` and then select the "`Freeze Pane`" option among the options.

Merging The Columns Along A Single Row

- Combines the columns into one wider column.
- Before the merge

	A	B	C	D	E
1	CPSC 203: winter 2063				
2	**A1 grade**	**A2 grade**	**A3 grade**	**Midterm**	**Final exam**

- (Merging Row 1: Col A – E)
- After "`Merge & Center`" (merge and **center align**)

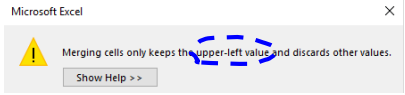
	A	B	C	D	E
1	CPSC 203: winter 2063				
2	**A1 grade**	**A2 grade**	**A3 grade**	**Midterm**	**Final exam**

- After the `Merge Across`, `Merge Cells` (merge and retain **previous alignment settings**)

	A	B	C	D	E
1	CPSC 203: winter 2063				
2	**A1 grade**	**A2 grade**	**A3 grade**	**Midterm**	**Final exam**

Merge Columns (Each Containing Data)

- Only the **data in the top left-most cell of the merged range is retained**.



- Before the merge.

	A	B	C
1	CPSC 203: winter 2063		L01

- After the merge: Merge and center ("L01" is lost)

	A	B	C
1	CPSC 203: winter 2063		

- After the merge: Merge across, Merge cells (data "L01" is lost)

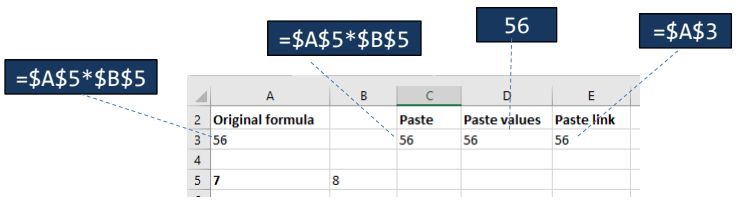
	A	B	C
1	CPSC 203: winter 2063		

Copy-Paste: Explanation

- A single cell or a range of cells can be copied (or cut) and pasted.
- There are a number of options for how the originating cell or cell is pasted into the new location.
- We will cover a few of the options for this class
  - "**Paste**": copies the formula (which may be modified if the cell references are relative)
    - May update final values if the data changes (relative references used).
  - "**Paste values**": includes only data or the final result of a formula.
    - If the formula changes then the pasted data won't be updated.
  - "**Paste link**"(always updates to the current value in the source cell)

Copy-Paste: Example

- **Example spreadsheet:** 6_copy_paste
  - Copy paste from A3 into C3 (paste current formula), D3 (paste current data), D3 (paste link)



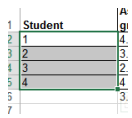
  - Changes in **data** in the source cell: if the values in A5 & B5 change to **9** and **6** respectively what will the values be in C3, D3, E3 and why.
  - Changes in the **formula** in the source cell: Contents of A3 was changed to =**9*3**

Copy-Paste

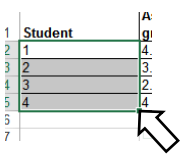
- For your information: Multiple cells (an entire row, column or even a range of cells e.g. A1:C10 can by copied-pasted)

Autofill

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

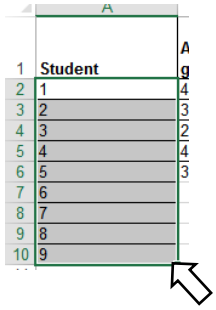


  2. Move the mouse pointer to the 'handle' at the bottom right



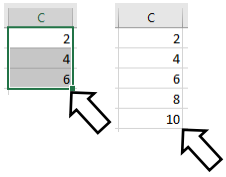
Autofill (2)

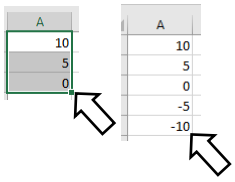
3. Drag the mouse as far down as you wish the sequence to be extended to.



Autofill (3)

- It's best to only extend a sequence that only employs addition (e.g. +1, +3, -1, -10) or a constant sequence using autofill handles.



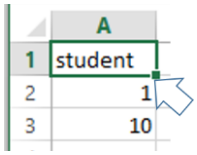


- To extrapolate other sequences (e.g. multiplication) don't use autofill:
  - https://support.office.com/en-us/article/project-values-in-a-series-5311f5cf-149e-4d06-81dd-5aaad87e5400

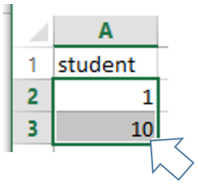
Autofill: Practice

- What would be the autofill result of the following.

E.g.1

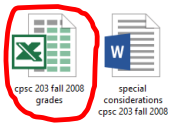


E.g. 2

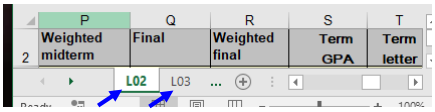


Terminology

- Spreadsheet (referred to as a "workbook" by Microsoft)
  - A Microsoft **Excel file**

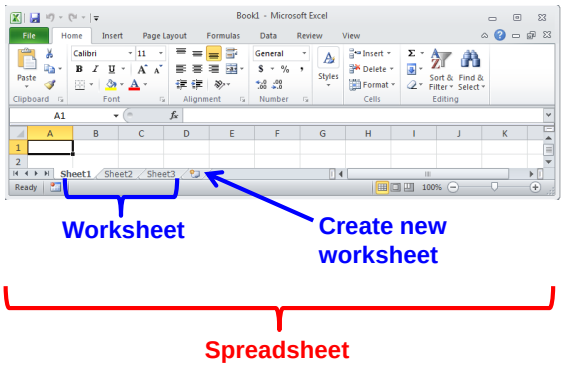


- **Worksheet**
  - A part of a spreadsheet



Worksheets

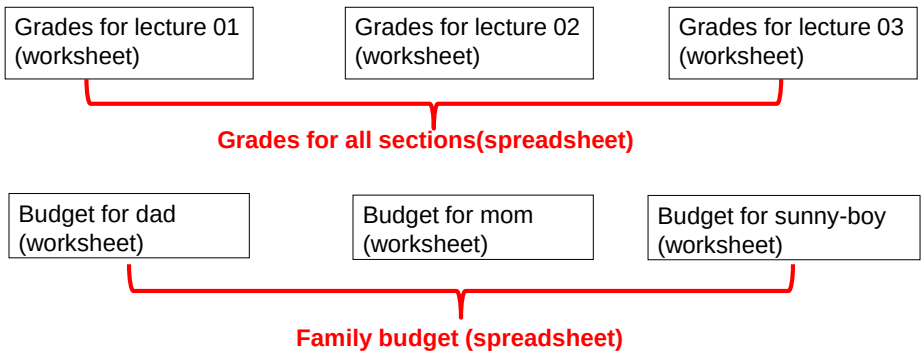
- Each ***spreadsheet*** can consist of multiple ***worksheets***.



  - Example:
    - Spreadsheet: all my CPSC 203 grades for the **CPSC 203 fall 2008 term**.
    - Worksheets for each of the **two lectures** taught by this instructor that term.

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)



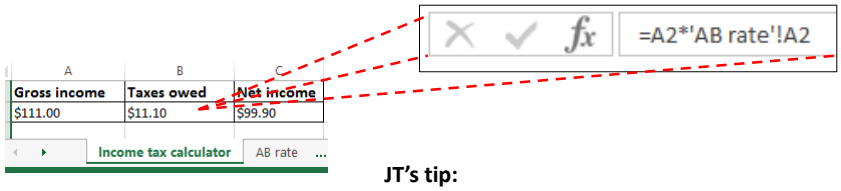
When Not To Use Multiple Worksheets

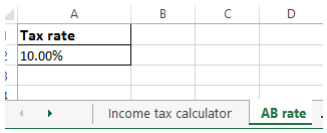
- If the information consists of groups of unrelated information then the information about each group should be stored in a separate spreadsheet/workbook rather than implementing it a spreadsheet with multiple worksheets.

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:**
  - `7_multiple_worksheet_example`



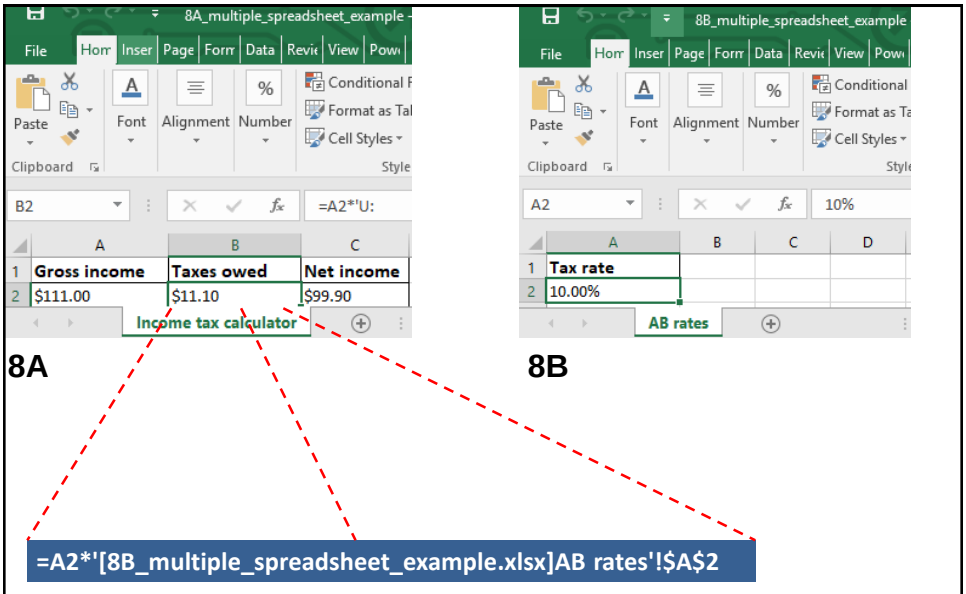


JT's tip:

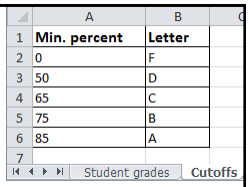
- For more complex examples you might want to take extra "in-class" notes.
- (It could be hard to understand the concepts at a level sufficient for the exam or remember notation/symbols if you just look at the slides).

References Between Spreadsheets

- In a fashion similar to using multiple worksheets, one spreadsheet can refer to information stored in another spreadsheet.
- **Example spreadsheets:**
  - `8A_multiple_spreadsheet_example`
  - `8B_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

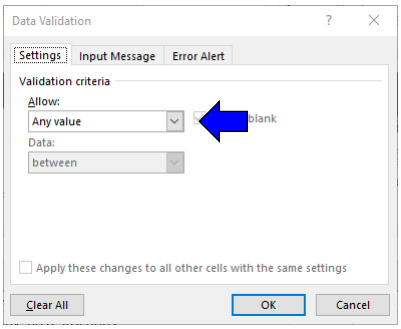
- Cross references:
  - a worksheet refers to another worksheet,
  - a spreadsheet refers to another spreadsheet,
- …may be used when:
  - the second worksheet or spreadsheet contains data that needs to be "looked up" (e.g., a lookup table)
- Some examples where cross reference lookups may be needed:
  - Grade cutoffs
  - Tax brackets
  - Product numbers (lookup a product number to get more information about the product)

Data Validation

- Ensures that the data falls within a valid range (e.g. Age must be 0 – 116) or that a specific type of data is entered (e.g. whole number only).
- Invoking:
  - `Data->Data Tools: Data Validation`
- **Example spreadsheet:** `9_data_validation`
  - Name: no restrictions e.g. "`James Tam`", "`James Tam  2`", "`James Goldstein-Chan`" "`James.org`"
  - Age: number years (whole number) from 1 – 116
  - Income: can include any value from $0.00 - $1,000,000.00 (cents can be entered)
  - Make sure you include good error messages when setting up data validation rules..
    - Tell the user what range of values and/or the type of values that can be entered.

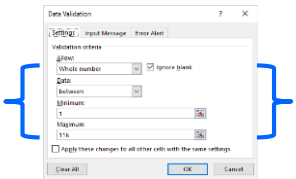
Data Validation Example: Name

- No restrictions on input (this is the default in Excel)

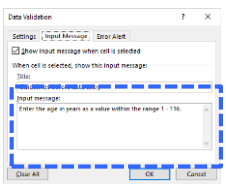


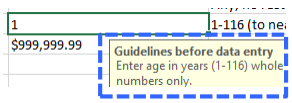
Data Validation Example: Age

- Age must be a whole number from 1 – 116.
- Tools to **prevent errors** in input
  - **Restricting the input**



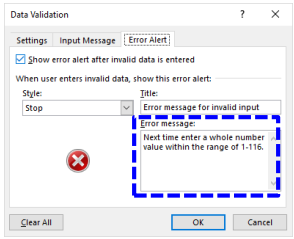
  - **Tooltip** help before data entry

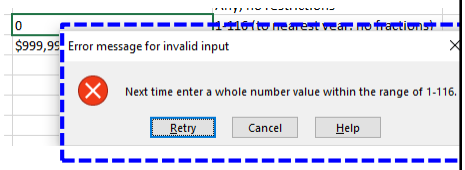




Data Validation Example: Age

- A tool to react **after** bad data has been entered.
  - **Popup error message** appears after the input restrictions have not been met.





Data Validation Example: Income

- Income allow for any value from $0.00 - $1,000,000.00 (cents may be entered – this is a clue that the input should not be restricted only to whole numbers).

After This Section You Should Now Know

- The benefit of electronic over paper spreadsheets
- Spreadsheets 101: The basic layout and components of a spreadsheet
- Entering data: manually and via autofill
- Raw data vs. labels vs. formulas
  - How formulas are distinguished from text
  - Specifying formulas that refer to other cells
- Formatting cells
- Common mathematical operators and the order of operation
- The rules of thumb for designing spreadsheets
  1. Bracket everything
  2. Don't make something data if it can be derived
  3. Label everything so it can be understood
  4. Don't duplicate data

After This Section You Should Now Know (2)

- Lookup tables
  - How to create and use a lookup table
  - Includes lookup tables with constant values and lookup tables to be used in conjunction with lookup function
- When to use absolute vs. relative cell references in formulas
  - How do formulas using absolute vs. cell references change when copied elsewhere
- Ways of changing views when the data is too large for the display
  - Freezing panes
  - Merging cells

After This Section You Should Now Know (3)

- Different forms of copy paste:
  - Paste
  - Paste values
  - Paste link
- What is a worksheet
  - When to use multiple spreadsheets vs. multiple worksheets
  - How to reference data in other spreadsheets or worksheets (cross references)
- How to prevent errors using data validation

Images

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

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