

Grauer Chapter 2 – Formulae & Functions

Objectives

- Use semi-selection to create a formula
- Use relative, absolute, and mixed cell references in formulae
- Avoid circular references
- Insert a function
- Total values with the SUM function
- Insert basic statistical functions
- Use date functions
- Determine results with the IF function
- Use lookup functions
- Calculate payments with the PMT function
- Create and maintain range names
- Use range names in formulae

Using Semi-Selection to Create a Formula

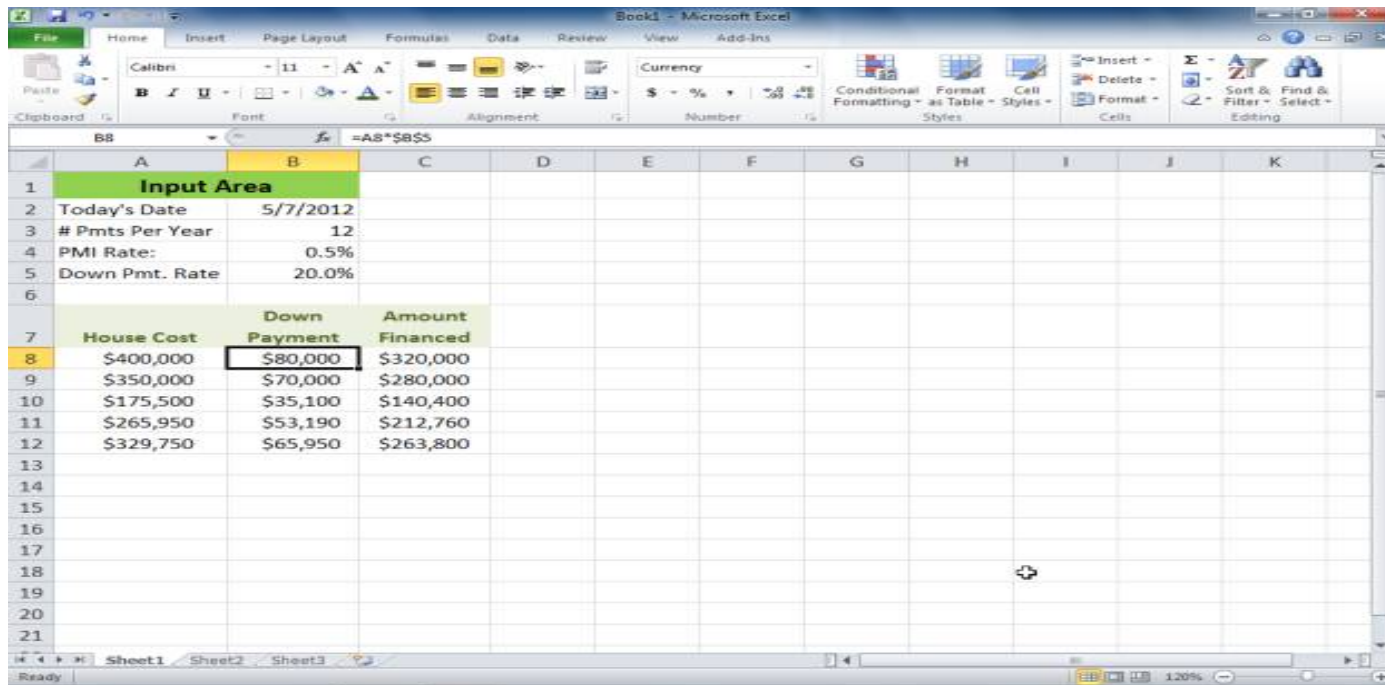
- **Semi-selection** uses the mouse pointer to build a formula containing cell references or ranges
- This technique is also called **pointing**
- To build a formula to add the numbers in cells A1 and A2:
 - Click cell where you will build the formula
 - Type an = sign
 - Click cell A1
 - Type a + sign
 - Click cell A2
 - Press *Enter*

Cell References

- Excel offers three types of cell references for use when a formula is copied
 - **Absolute** \$A\$1
 - **Relative** A1
 - **Mixed** \$A1 or A\$1
- \$ indicates that the row number or column letter will not be modified during a copy

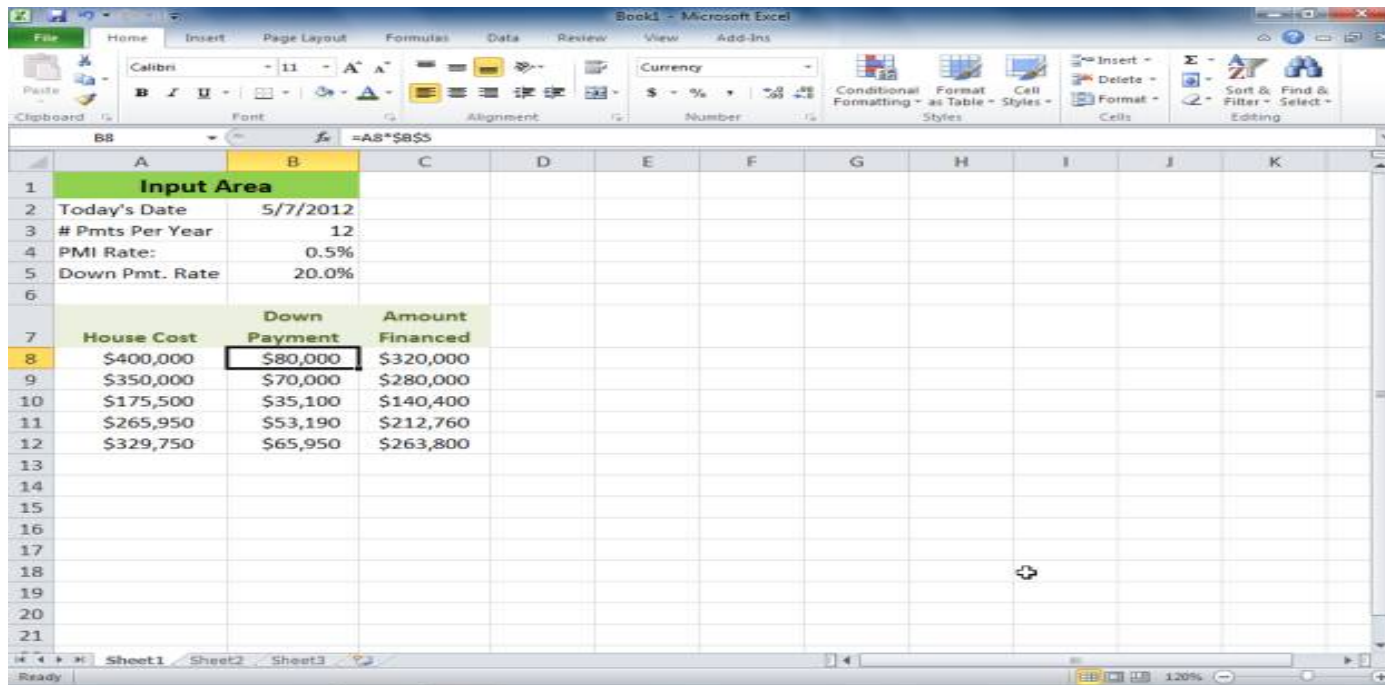
Relative Cell References

- When the formula shown in the formula bar is copied, relative address A8 is modified



Absolute Cell References

- When the formula shown in the formula bar is copied, absolute address \$B\$5 is fixed

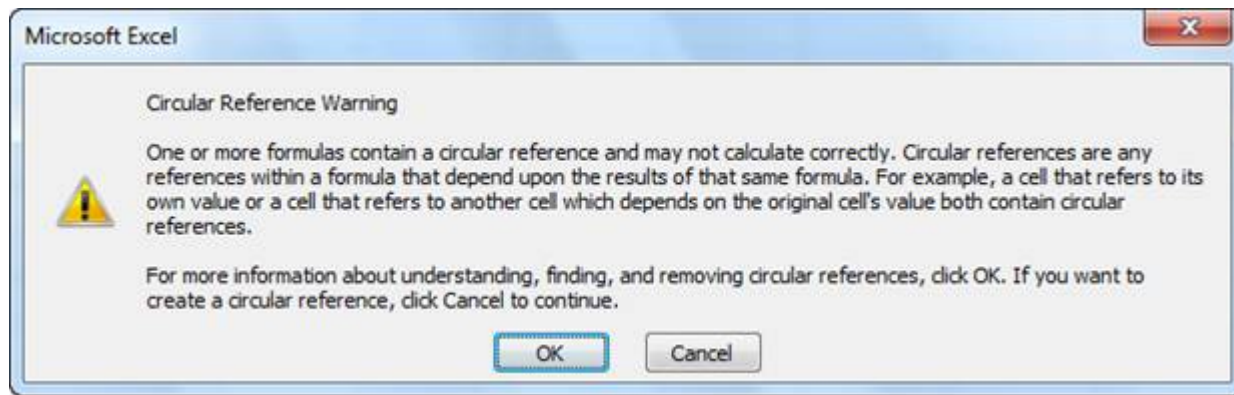


Mixed Cell References

- In **mixed reference** \$A1, the column is fixed, but the row may be altered during a copy
- In **mixed reference** A\$1, the row is fixed, but the column may be altered during a copy
- Mixed references useful for row and column header values in a table of values calculated using the 'same' formula
- To switch between the different types of reference, click in the reference, and press F4 (Windows) or ⌘T (Mac): A1 → \$A\$1 → A\$1 → \$A1 → A1

Avoiding Circular References

- A **circular reference** error occurs if a formula refers to itself
- E.g. type =A8-C8 in cell C8 ...



Function Basics

- An Excel **function** is a predefined formula that performs a calculation

Category	Description
Compatibility	Contains functions compatible with Excel 2007 and earlier.
Cube	Returns values based on data in a cube, such as validating membership or returning a member's ranking.
Database	Analyzes records stored in a database format in Excel and returns key values, such as the number of records or averages value in a field.
Date & Time	Provides methods for manipulating date and time values.

Function Basics (continued)

Category	Description
Engineering	Calculates values commonly used by engineers, such as conversions.
Financial	Performs financial calculations, such as payments, rates and present/future values.
Information	Provides information about the contents of a cell, typically displaying TRUE if the cell contains a particular data type, such as a value.
Logical	Performs logical tests and returns the value of the tests. Includes logical operators such as AND, OR, and NOT.
Lookup & Reference	Looks up values, creates links to cells, or provides references to cells in a worksheet.
Math & Trig	Performs standard math and trigonometry calculations.
Statistical	Performs statistical calculations, such as averages or standard deviation.
Text	Manipulates text strings, by combining words or converting cases.

Function Terminology

- **Syntax** is the set of rules that govern correct formation of a function. You have to follow the rules or Excel won't understand what you are trying to tell it.
- The rules for a function formula:
 - function formula \rightarrow =functionName(argumentList)
 - argumentList \rightarrow argument, ..., argument

Different functions need different sorts of arguments.

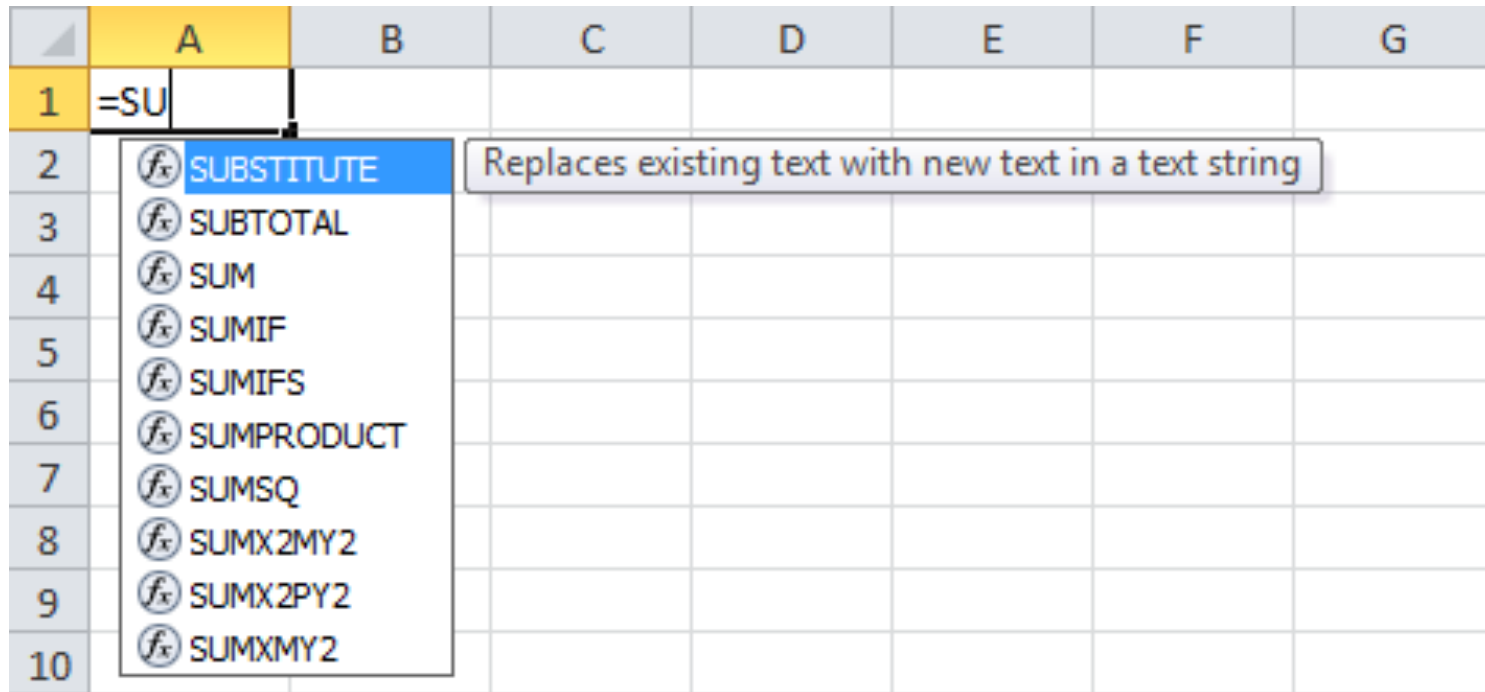
- An **argument** is an input, such as a cell or range
- A function begins with the equal sign (=) followed by the function name and arguments in parentheses

Example: =SUM(A1:A3)

- Function arguments are sometimes single cells (like A3), but also sometimes *ranges*, like here (A1:A3)

Inserting a Function

- When a function is *typed*, **Formula AutoComplete** displays a list of functions matching the partial entry



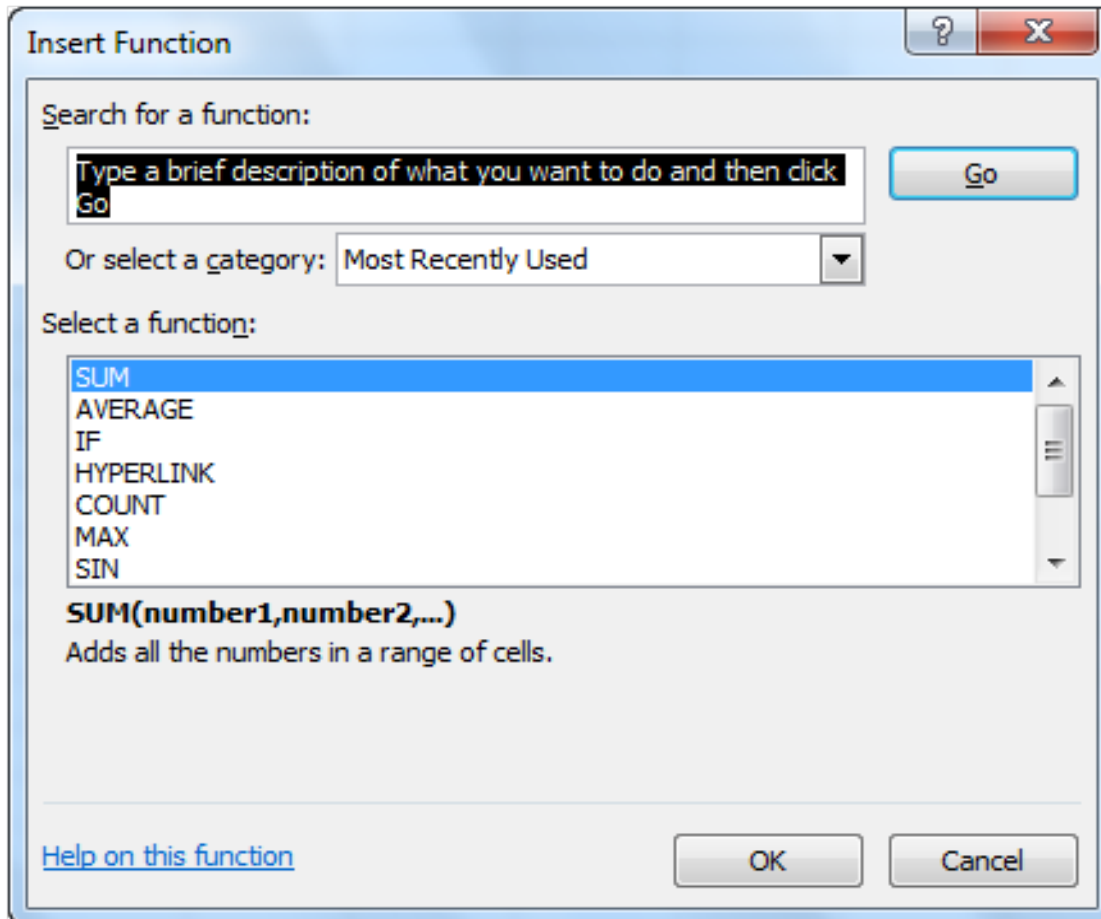
Inserting a Function

- A **function ScreenTip** is a small pop-up description that displays the function arguments

	A	B	C	D	E	F	G
1	=SUM(
2	SUM(number1, [number2], ...)						
3							

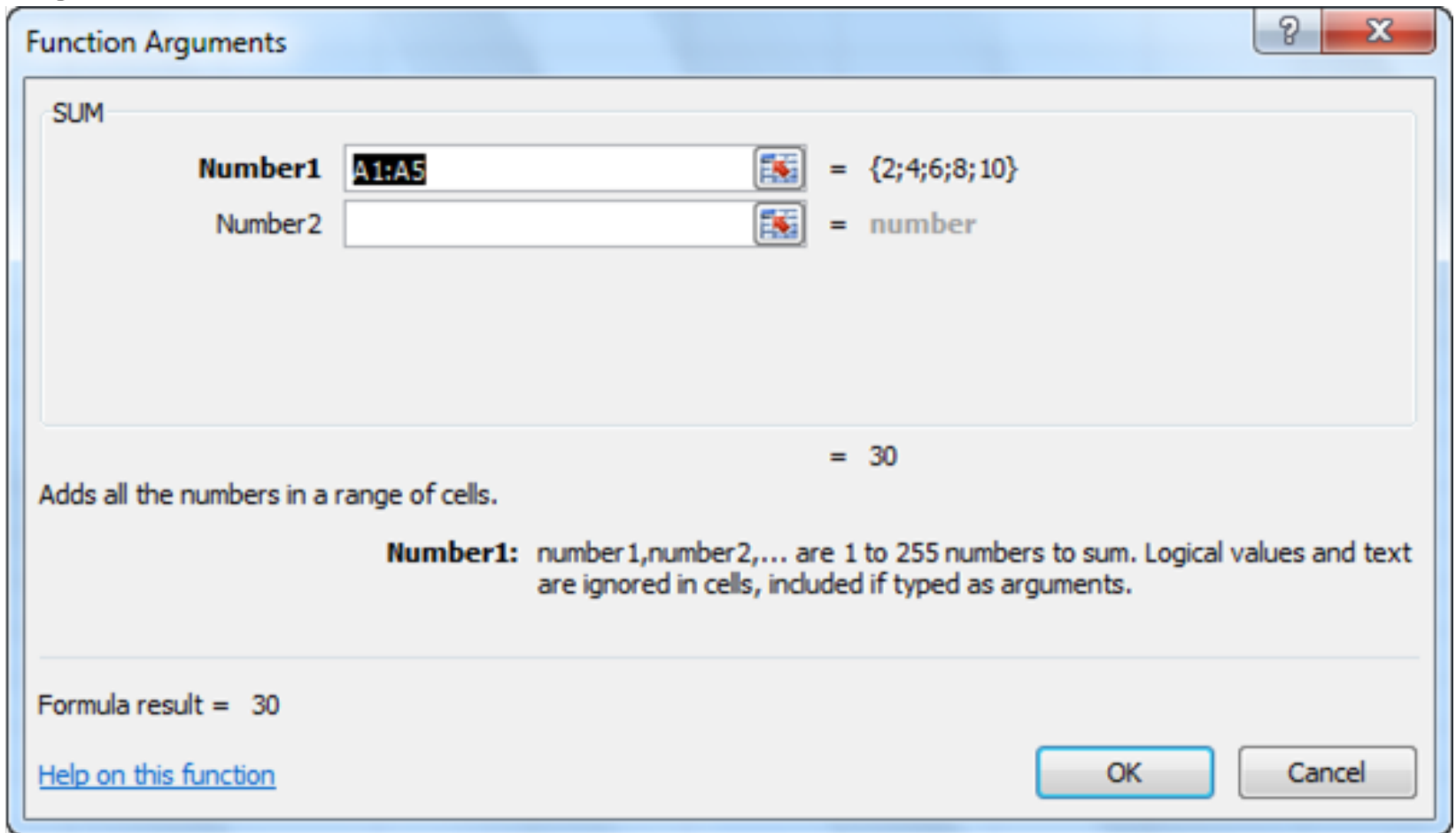
Insert Function Dialog Box

- Use the **Insert Function** dialog box to search for a function or select one from a list



Function Arguments Dialog Box

- The **Function Arguments** dialog box offers help on each argument



Totaling Values with SUM

- The SUM function returns the mathematical sum of some number of cells or ranges; for example:

=SUM(A1:A3)

=SUM(A1,B3,C5)

=SUM(A1:B3,C5:E8)

Basic Statistical Functions

- Common statistical functions include:
 - AVERAGE arithmetic mean
 - MEDIAN midpoint value
 - MIN minimum value
 - MAX maximum value
 - COUNT number of values in range
 - COUNTA number of nonempty cells
 - COUNTBLANK number of empty cells

Basic Statistical Functions

	A	B	C	D	E	F
1	Scores		Measure	Statistic	Formula	
2	98		Total of All Scores	898	=SUM(A2:A14)	
3	94		Average Score	81.63636	=AVERAGE(A2:A14)	
4	92		Median Score	86	=MEDIAN(A2:A14)	
5	92		Low Score	50	=MIN(A2:A14)	
6	N/A		High Score	98	=MAX(A2:A14)	
7	90		No. of Numeric Cells	11	=COUNT(A2:A14)	
8	86		No. of Empty Cells	1	=COUNTBLANK(A2:A14)	
9			No. of Non-Empty Cells	12	=COUNTA(A2:A14)	
10	84					
11	82					
12	80					
13	50					
14	50					
15						

Sheet1 Sheet2 Sheet3

Ready Average: 81.63636364 Count: 12 Sum: 898 100%

Other Math & Trig Functions

Function Syntax	Description
=ABS(number)	Displays the positive value of a number.
=FREQUENCY(data_array, bins_array)	Counts how often values appear in a given range.
=INT(number)	Rounds a value down to the nearest whole number.
=MODE.SNGL(num1, [num2],...)	Displays the most frequently occurring value in a list.
=PI()	Returns the value of pi accurate to 15 digits.
=PRODUCT(num1, [num2],...)	Multiplies all values within the argument list.
=RANDBETWEEN(bottom, top)	Generates a random number between two values. Bottom and top are whole numbers.

Other Math & Trig Functions

Function Syntax	Description
=RANK.AVG(number,ref,[order])	Identifies a value's rank within a list; returns average rank for identical values.
=RANK.EQ(number,ref,[order])	Identifies a value's rank within a list; the top rank is identified for identical values.
=ROUND(number, num_digits)	Rounds a value to a specific number of digits.
=SUMPRODUCT(array1,[array2],...)	Finds the result of multiplying values in one range by related values in another column and adding products.
=TRIMMEAN(array,percent)	Returns the average of the internal values in a range by excluding a specified percentage at the upper and lower ends.
=TRUNC(number,num_digits)	Returns the integer equivalent of a number by truncating the fractional part.

Useful Functions and Features

- **COUNTIF**: Counts the number of cells within a range that meet the given criteria
 - Example: **COUNTIF**(C2:C8, "<10") equals 2
- **SUMIF**: Adds the cells specified by a given criteria.
 - Example: **SUMIF**(B2:B8,"Absent", C2:C8) equals 29

	A	B	C
1	Name	Labs Total	Assignments
2	Linda	75	19
3	Sue	Absent	17
4	Paul	40	8
5	Rob		5
6	John	66	15
7	Jesse	Absent	12
8	Rita	78	18

Useful Functions and Features

Converting Units

- Often we need to convert values from one system units to another.
- Excel offers a very useful function called **CONVERT**, that could be used to carry out **simple and complex** unit conversions.
- For example:
 - `CONVERT(525, "mi", "m")`
 - `CONVERT(B45, "g", "lbm")`
 - `CONVERT(A10, "gal", "l")`
 - `CONVERT(34, "C", "F")`
 - Etc .. Etc ...

Date Functions

- Since dates are numeric, calculations can be performed, such as subtraction
- The **TODAY()** function displays the current date
- The **NOW()** function displays the current date and time

Making Decisions with the IF Function

- =IF(logical_test, value_if_true,value_if_false)
- The IF function has three arguments:
 - A logical test or condition that is true or false
 - The resulting value if the condition is true
 - The resulting value if the condition is false

Using the IF Function

	A	B	C
1	Input Values		
2	\$1,000		
3	\$2,000		
4	10%		
5	5%		
6	\$250		
7			
8			
9	IF Function	Evaluation	Result
10	=IF(A2=A3,A4,A5)	1000 is equal to 2000: FALSE	5%
11	=IF(A2<A3,A4,A5)	1000 is less than 2000: TRUE	10%
12	=IF(A2<A3,A5*A2,MAX(A3*A4,A6))	1000 is less than 2000: TRUE	\$50
13	=IF(A2<>A3,"Not Equal","Equal")	1000 and 2000 are not equal: TRUE	Not Equal
14	=IF(A2*A4=A3*A5,A6,0)	100 (A2*A4) is equal to 100 (A3*A5): TRUE	\$250

Evaluation of IF(test,thenPart,elsePart)

- Only one of the thenPart and the elsePart will be evaluated in any particular case: e.g.
- =IF(A1=0, B1*A1, B1/A1)

Designing the Logical Test

- The **logical test** is built from the logical operators

Operator	Description
=	Equal to
<>	Not equal to
<	Less than
>	Greater than
<=	Less than or equal to
>=	Greater than or equal to

Using Functions as Arguments

- A **nested function** occurs when one function is embedded as an argument to another function; for example:

=IF(A1<A2,MIN(B1:B5),MAX(B1:B5))

- The MIN(...) and MAX(...) are nested function evaluations
- Compute the MIN function if A1 is less than A2
- Compute the MAX function if A1 is not less than A2

Useful Functions and Features

Conditional Functions:

- **AND**: Returns TRUE if all its arguments are TRUE; returns FALSE if one or more arguments is FALSE. Example:

IF(**AND**(B2>75, C2>15), "Very Good", "Not Good!")

- **OR**: Returns TRUE if any argument is TRUE; returns FALSE if all arguments are FALSE. Example:

IF(**OR**(B2>75, C2>15), "Good", "Not Good!")

- **NOT**: Reverses the value of its argument, a logical expression. Example:

-

IF(**NOT**(C5<50), "PS", "FL")

Using Lookup Functions

- **Lookup functions** are used to look up values in a table to perform calculations or display results
 - For example, a teacher may want to look up an average in order to assign a grade

Range	Grade
90-100	A
80-89	B
70-79	C
60-69	D
Below 60	F

Creating a Lookup Table

- When searching a range, the **breakpoint** is the lowest value
- A **lookup table** typically lists breakpoints in one column and return values in a second column

Range	Grade
0	FL
50	PS
65	CR
75	DN
85	HD

VLOOKUP Function

- The **VLOOKUP** function searches a lookup table for a value and returns the result from the related column
- VLOOKUP has three required arguments:
 - Lookup value – e.g. the student's mark
 - Table array (range of lookup table)
 - Column index of return value – e.g. 2 for grade (PS, etc.)
- Use of numeric column *index* is slightly bizarre, since Excel uses letters for columns. <Shrug>

Using the VLOOKUP Function

F3		fx		=VLOOKUP(E3,\$A\$3:\$B\$7,2)			
	A	B	C	D	E	F	G
1	Grading Scale			Partial Gradebook			
2	Breakpoint	Grade		Names	Final Score	Letter Grade	
3	0	F		Abbott	85	B	
4	60	D		Carter	69	D	
5	70	C		Hon	90	A	
6	80	B		Jackson	74	C	
7	90	A		Miller	80	B	
8				Nelsen	78	C	

HLOOKUP Function

- The **HLOOKUP** function is used when the breakpoints and return data are placed in rows
- The third argument now lists the *row* index of the return value

0	60	70	80	90
F	D	C	B	A

Calculating Payments with the PMT Function

- The **PMT** financial function calculates the periodic payment for a loan with a fixed interest rate and term length
- PMT has three required arguments:
 - Interest rate
 - Number of periods
 - Present value (amount of loan) (aka Principal)

Using the PMT Function

B9		f_x	=PMT(B6,B8,-B3)	
	A	B	C	D
1	Purchase Price	\$25,999.00		
2	Down Payment	\$ 5,000.00		
3	Amount to Finance	\$20,999.00		
4	Payments per Year	12		
5	Interest Rate (APR)	5.250%		
6	Periodic Rate (Monthly)	0.438%		
7	Term (Years)	5		
8	No. of Payment Periods	60		
9	Monthly Payment	\$ 398.69		
10				

Range Names

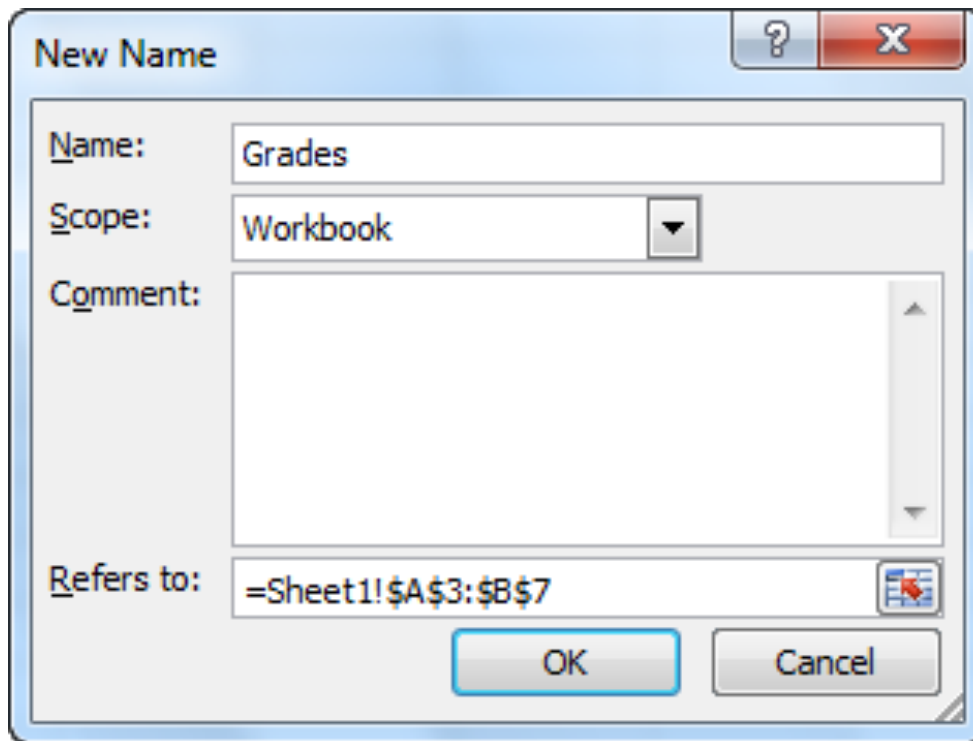
- A **range name** is a word or phrase used to identify a cell or cell range
- Range names make formulae easier to read

Range Name Rules

- Range names use the following rules:
 - 1 to 255 characters
 - Begin with a letter or underscore (_)
 - Contain letters, digits, period, underscore
- Valid names include Rate, Tax_Rate, Rate_2012

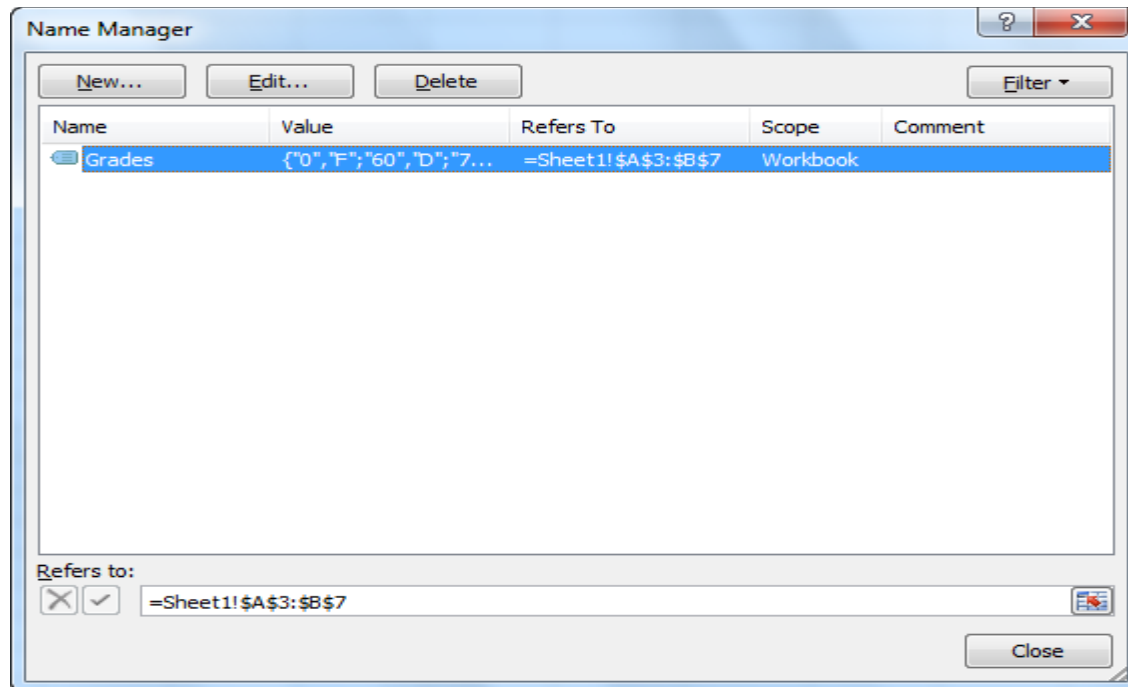
Creating a Range Name

- Excel offers a variety of methods to enter a range name after selecting the cells:
 - Type the range name in the **Name Box** area
 - Enter the name using **New Name** dialog box (Formulas tab / Defined Names group / Define Name)



Maintaining Range Names

- Use the **Name Manager** dialog box to edit or delete a range name (Formulas tab / Defined Names group / Name Manager)



Testing/Debugging/Auditing Spreadsheets

- In spreadsheets, computational steps are often scattered across a wide range of cells and even across many spreadsheets.
- It is very **easy to make mistakes** while developing a solution in Excel. Therefore, it is essential to **thoroughly test** your solutions.

\$24-million spreadsheet “clerical error”

June 03, 2003 TORONTO (Reuters) - TransAlta Corp. said on Tuesday it will take a \$24 million charge to earnings after a bidding snafu landed it more U.S. power transmission hedging contracts than it bargained for, at **higher prices than it wanted to pay**.

[...] the company's computer spreadsheet contained mismatched bids for the contracts, it said. "It was **literally a cut-and-paste error** in an Excel spreadsheet that **we did not detect** when we did our final sorting and ranking bids prior to submission," TransAlta chief executive Steve Snyder said in a conference call. "I am clearly disappointed over this event. The **important thing is to learn from it**, which we've done."

Testing/Debugging/Auditing Spreadsheets

- From “How do you know your spreadsheet is right?: Principles, Techniques and Practice of Spreadsheet Style” by Philip L. Bewig, July 28, 2005 (available at <http://www.eusprig.org/hdykysir.pdf>) :
 - A **missing minus** sign caused Fidelity’s Magellan Fund to overstate projected earnings by **\$2.6 billion (yes, billion)** and miss a promised dividend.
 - Falsely-linked spreadsheets permitted **fraud totaling \$700 million** at the Allied Irish Bank.
 - **Voting** officials reported spreadsheet **irregularities** in New Mexico and South Africa.
- More examples (again a few years old) from the same source *European Spreadsheet Risks Interest Group* (yes, the organisation does exist):
<http://www.eusprig.org/stories.htm>
- Survey of error rates in spreadsheets:
<http://panko.shidler.hawaii.edu/ssr/My papers/whatknow.htm>

Testing/Debugging/Auditing Spreadsheets

- So..... **Test, Test, Test**, your solutions!!
- Test your solution for **obvious mistakes**, like:
 - invalid or missing data in a cell
 - formula is replaced a constant in a cell
 - incorrect cell references in a formula (due to incorrect usage of relative/mixed/absolute addressing while copy and past actions)
 - Etc .. Etc ..

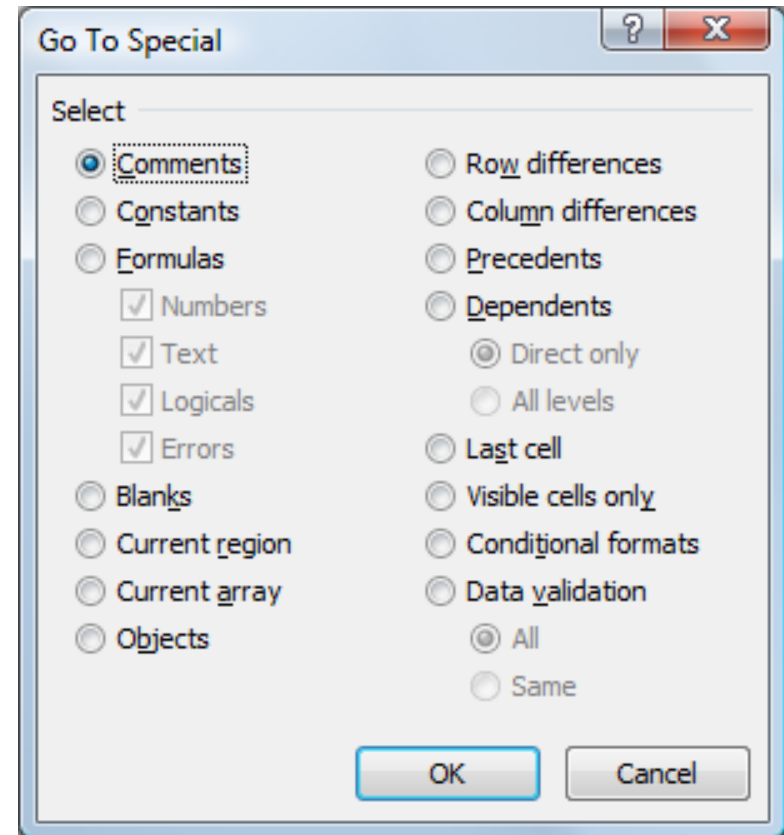
Testing/Debugging/Auditing Spreadsheets

- Test your solutions for **different input values**. In particular, use borderline cases and abnormal input values.
- **IMPORTANT**: use an **alternative method** (say by hand or using a different approach) to compute few answers, and make sure that your solutions are correct
- Try to keep **input**, **processing** and **output** regions of your spreadsheet **separate**.
- Be creative!... use IF statements, Conditional Formatting, Statistical functions, etc to **locate errors**.
- Test, Test, Test... !!

Testing/Debugging/Auditing Spreadsheets

Excel Provides some **debugging tools**:

- Debugging by Using **Cell Selection**
 - Select **Home/Editing/Find and Select/Go To Special**
 - You can now locate cells with blanks, formulas, constants, etc.
 - You can locate cells that are “**different**” in a given range
 - You can also locate **Precedents** and **Dependents** of a given cell



Testing/Debugging/Auditing Spreadsheets

- Debugging by **Using Tracing**
 - Select **Formula/Trace Precedence** and **Formula/Trace Dependents**

The screenshot shows the Microsoft Excel interface with the 'Formulas' ribbon selected. The 'Formula Auditing' group contains 'Trace Precedents' and 'Trace Dependents' buttons, which are highlighted with a red rectangle. The spreadsheet data is as follows:

	A	B	C	D	E	F	G	H	I	J	K	L	M
1													
2		Name	StudentID	Labs Total	Assignments	Session Mark	Exam	Total	Final		Statistics (simple)		
3		Abigail	59231727	70	12	82	38	60.0	60				
4		Agus	59542174	60	25	85	83	84.0	84		Average	68.45	
5		Albertus	59602854	44	19	63	89	76.0	76		Max	89.5	
6		Ameng	40849710	78	11	89	11	50.0	50		Min	40	
7		Brian	33481845	61	6	67	89	78.0	78		Count	43	
8		Camille	60349877	47	12	59	27	40.0	40				
9		Carolin	59186002	56	10	66	36	51.0	51				
10		Chang	59306924	61	13	74	36	55.0	55				
11		Christopher	60698860	41	12	53	78	65.5	66				
12		Dan	60576007	75	10	85	31	58.0	58			Bin	
13		Daniel	60058461	64	12	76	75	75.5	76				
14		David	59765519	79	19	98	34	66.0	66				
15		Fatmeh	59342707	75	17	92	51	71.5	72		FL	49	
16		Hady	12345678	43	17	60	61	60.5	61		PS	64	
											CR	74	

Blue arrows in the spreadsheet trace the calculation path for the formula in cell H11, showing dependencies on cells F11, G11, and H10.

Summary

- In this chapter, you have learned to write formulae using relative, absolute, and mixed cell references.
- You have learned about statistical and date functions, such as SUM, AVERAGE, and TODAY.
- You have explored the IF, VLOOKUP, and PMT functions.
- You learned to create and use range names.

- Practical exercise