

Financial Modeling in Microsoft Excel

Presented by

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What is Financial modeling?

- Wikipedia - Financial modeling is the task of building an abstract representation (a model) of a real world financial situation. This is a mathematical model designed to represent (a simplified version of) the performance of a financial asset or portfolio of a business, project, or any other investment.
- Investopedia - The process by which a firm constructs a financial representation of some, or all, aspects of the firm or given security. The model is usually characterized by performing calculations, and makes recommendations based on that information. The model may also summarize particular events for the end user and provide direction regarding possible actions or alternatives.



What's the goal of financial modeling?

A financial model should enable us to make a informed decision.

A Brief History of Data Analysis



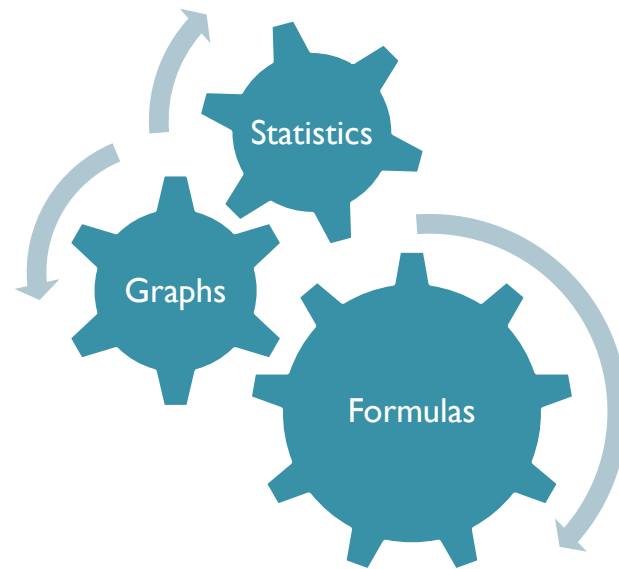
Why Excel?

- Spreadsheets have evolved from electronic ledgers to full-featured analysis software.
- Comprehensive image and drawing tools.
- Word processing capability (not nearly as uncommon as you might think!).
- Advanced file save and sharing.
- Game development (?)

If we're building something...

If we're building a representation, we're gonna need tools. We'll use these tools to build a representation that enables us to make a good decision:

- Formulas
- Graphs
- Statistics
- Pivot Tables





Formulas

The lifeblood of Excel

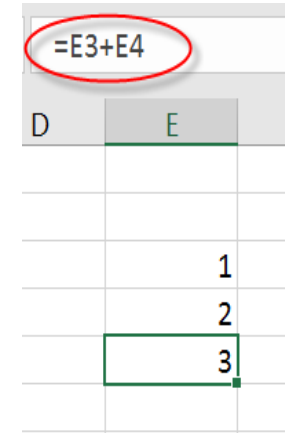
Formulas

How many formulas are there? No one seems to know. There're a bunch of them. And at least 350 functions:

- Logical (IF,AND, OR)
- Text (CLEAN, LEN, TRIM)
- Date & Time
- Lookup and Reference
- Math & Trig
- Statistical, Financial, Engineering,
- And, of course, Financial

What's the difference between a formula and a function?

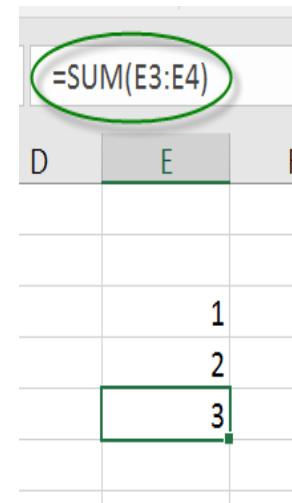
Formulas are expressions that calculate the value of a cell



The image shows a portion of an Excel spreadsheet. The formula bar at the top displays the formula `=E3+E4`, which is circled in red. Below the formula bar, the spreadsheet grid shows columns D and E, and rows 1, 2, and 3. Cell E3 is selected and highlighted with a green border.

D	E
	1
	2
	3

Functions are pre-defined formulas



The image shows a portion of an Excel spreadsheet. The formula bar at the top displays the formula `=SUM(E3:E4)`, which is circled in green. Below the formula bar, the spreadsheet grid shows columns D, E, and F, and rows 1, 2, and 3. Cell E3 is selected and highlighted with a green border.

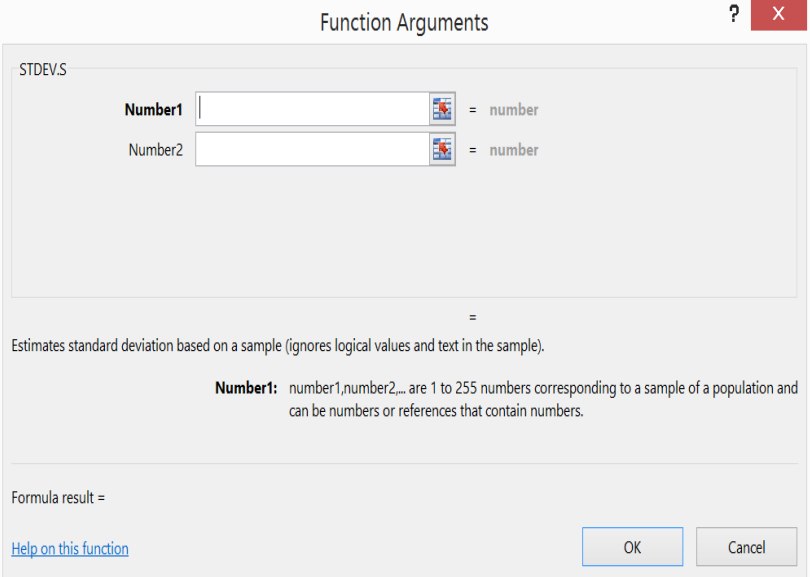
D	E	F
	1	
	2	
	3	

Math made easy(er)

We'll talk about statistics more later. But, for now, let's look at how much easier it is to do complex calculations in Excel.

At top right, Function Arguments can be used to calculate a standard deviation.

The math calculation looks like this:



The screenshot shows the 'Function Arguments' dialog box for the STDEV.S function. The dialog has a title bar with a question mark and a close button. The function name 'STDEV.S' is displayed at the top left. Below it, there are two input fields: 'Number1' and 'Number2', each with a small icon to its right and an equals sign followed by the text '= number'. Below the input fields, there is a description: 'Estimates standard deviation based on a sample (ignores logical values and text in the sample)'. Below the description, there is a note: '**Number1:** number1,number2,... are 1 to 255 numbers corresponding to a sample of a population and can be numbers or references that contain numbers.' At the bottom left, there is a 'Formula result =' label and a blue link 'Help on this function'. At the bottom right, there are 'OK' and 'Cancel' buttons.

$$\sigma = \sqrt{\frac{1}{N} \sum_{i=1}^N (x_i - \mu)^2}$$

Working smarter with formulas

Household budgets are simple financial models. Let's start with a monthly household income of \$5,000. After much discussion, your client has decided to allocate the following:

Monthly Income		\$5,000
Housing	35.00%	
Food	30.00%	
Transportation	20.00%	
Savings	10.00%	
Misc	5.00%	

Using and copying formulas

Now we need to calculate a dollar amount for each category. We could do this for each cell:

Monthly Income		\$5,000
Housing	35.00%	=5000*35%
Food	30.00%	
Transportation	20.00%	
Savings	10.00%	
Misc	5.00%	

Then, press ENTER:

Notice that Excel is smart enough to convert the percent sign

Monthly Income		\$5,000
Housing	35.00%	\$1,750.00
Food	30.00%	
Transportation	20.00%	
Savings	10.00%	
Misc	5.00%	

A smarter kind of formula

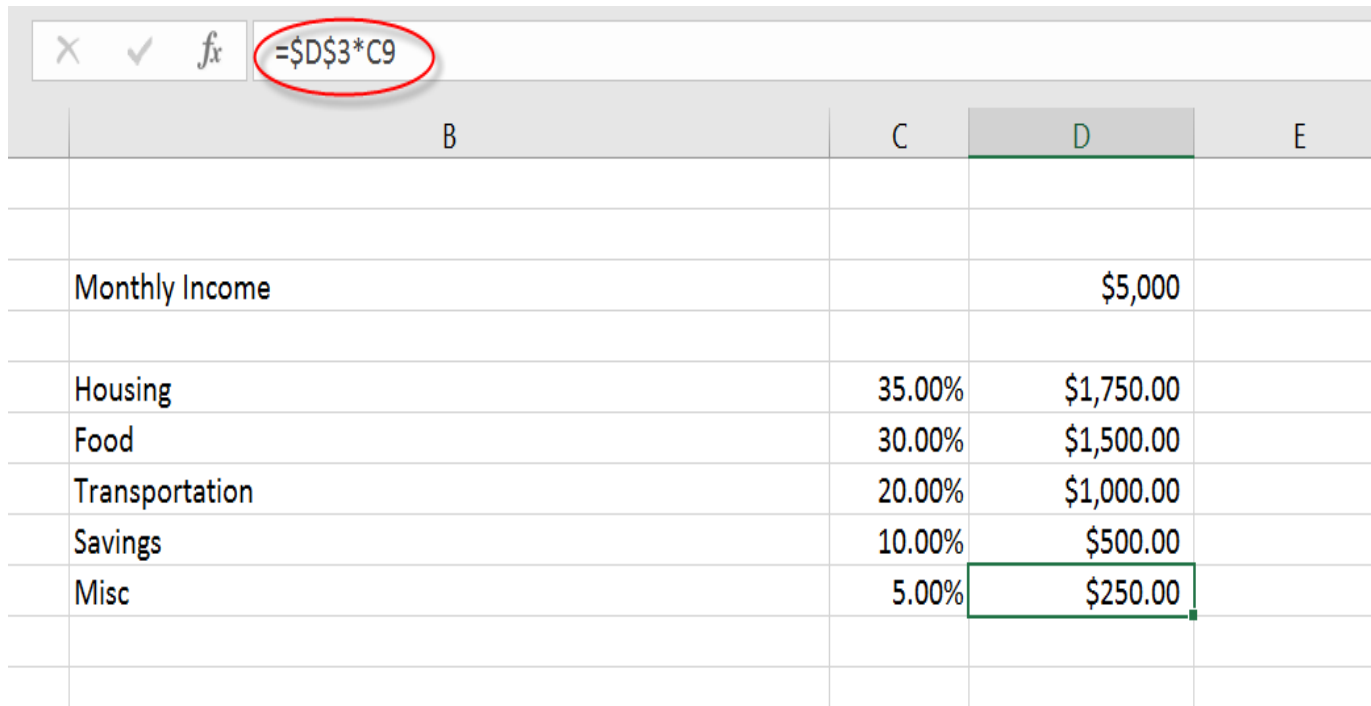
We could also use **cell references** to do the calculations:

Notice that we use an **absolute reference** when referring to household income. This is because we'll use that value to calculate the dollar amount for each category.

	B	C	D	E
	Monthly Income		\$5,000	
	Housing	35.00%	\$1,750.00	
	Food	30.00%		
	Transportation	20.00%		
	Savings	10.00%		
	Misc	5.00%		

Copying formulas

Now that we have a working formula, complete with the correct cell references, copy the formula into each cell.

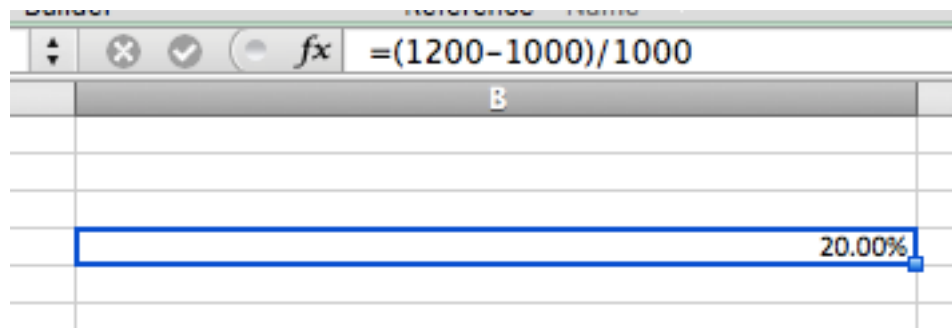


	B	C	D	E
Monthly Income			\$5,000	
Housing		35.00%	\$1,750.00	
Food		30.00%	\$1,500.00	
Transportation		20.00%	\$1,000.00	
Savings		10.00%	\$500.00	
Misc		5.00%	\$250.00	

You'd think....

... that with all of the functions, formulas, and features in Excel, there would be a way to calculate Return on Investment (ROI). But, sometimes there's no substitute for home cooking:

$$\text{ROI} = \text{Net Profit} / \text{Cost of Investment}$$





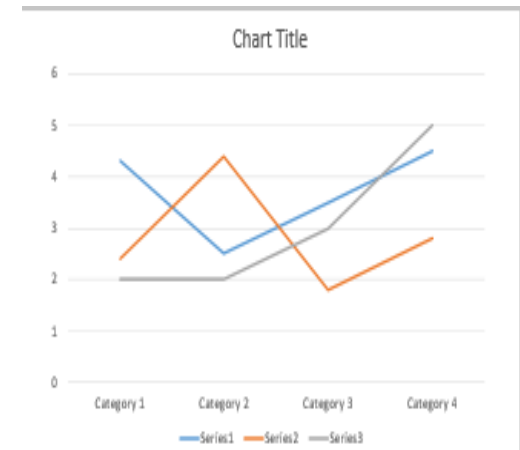
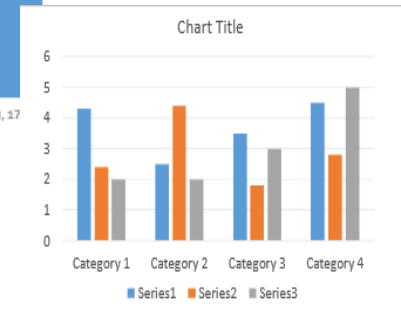
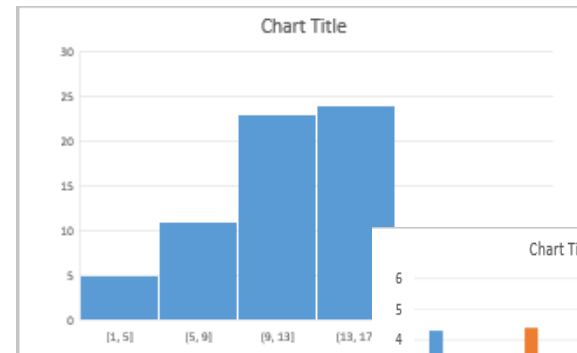
Graphs and Charts

Every picture tells a story

Every picture tells a story

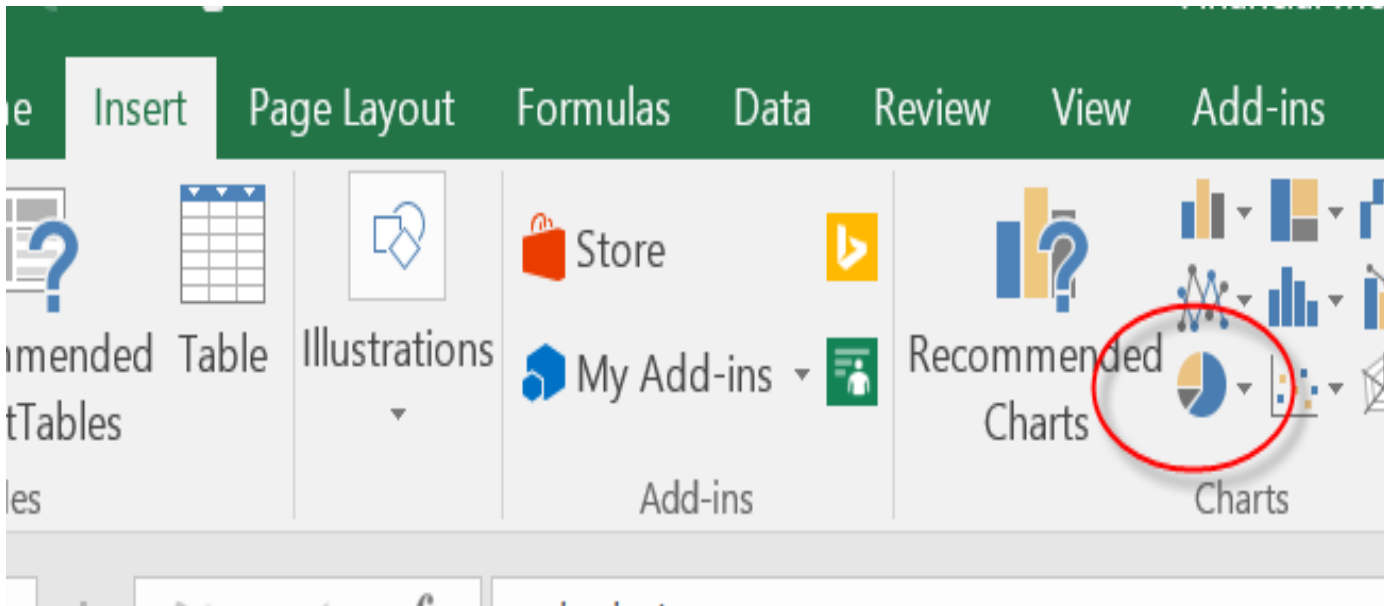
Graphs and charts are pictorial illustrations of inter-relationships between two or more things:

- Column
- Line
- Pie
- Area
- Bar
- Histogram
- Waterfall
- Bar and Whisker



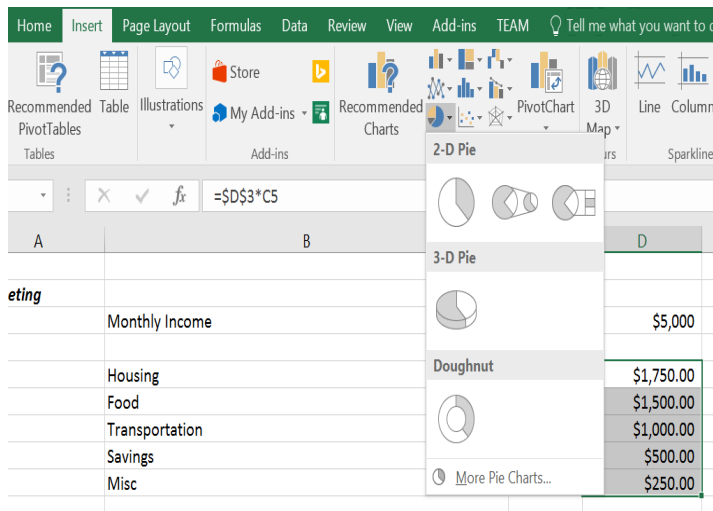
Inserting a chart or graph

To insert a chart or graph into an Excel sheet, click the kind of chart that you want on the **Insert** tab:



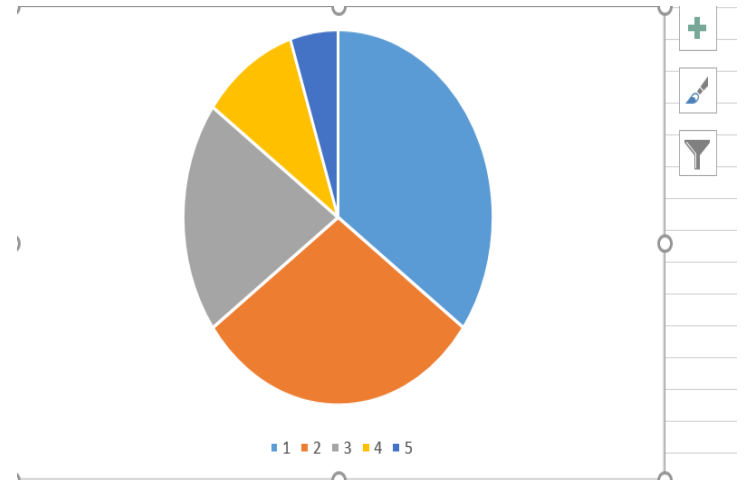
Pie charts

Pie charts are useful for comparing parts to a whole, so we'll use a pie chart to illustrate a household budget.



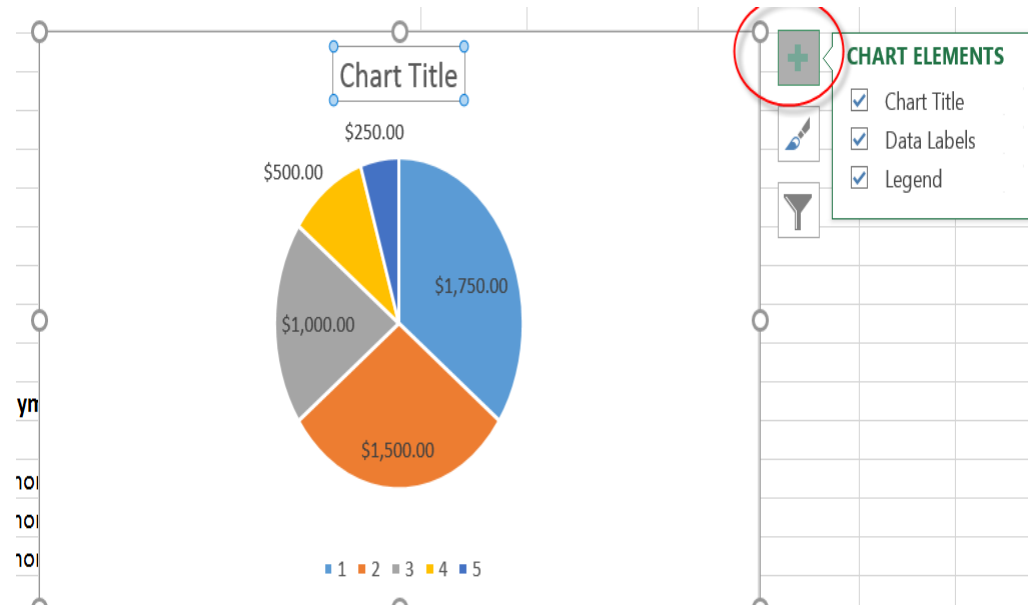
The screenshot shows the Microsoft Excel interface. The ribbon is set to 'Insert' > 'Charts' > 'Pie'. The '2-D Pie' chart type is selected. The data table below shows a household budget with five categories: Monthly Income, Housing, Food, Transportation, and Savings, and Misc. The values are: Monthly Income (\$5,000), Housing (\$1,750.00), Food (\$1,500.00), Transportation (\$1,000.00), Savings (\$500.00), and Misc (\$250.00).

Monthly Income	\$5,000
Housing	\$1,750.00
Food	\$1,500.00
Transportation	\$1,000.00
Savings	\$500.00
Misc	\$250.00



Adding some polish

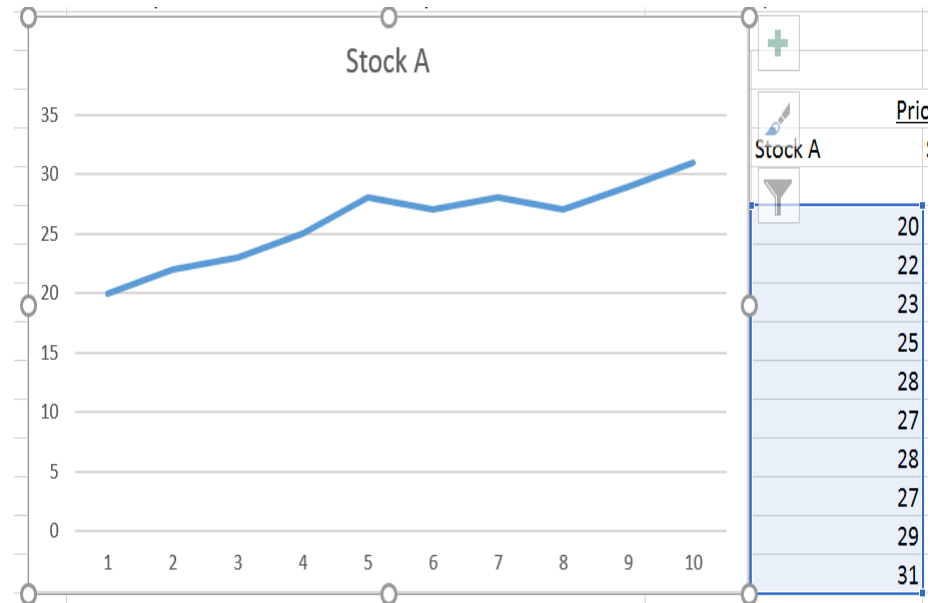
Our chart is useful, but needs some help to be really useful. Let's add some polish. To do this, click the '+' and then click to select the options that you want.



Line charts

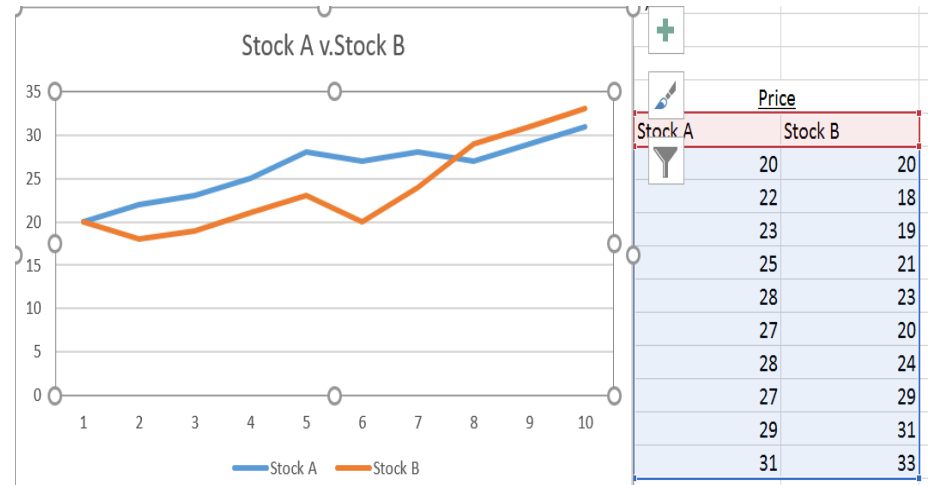
A pie chart works for our household budget, but what about showing the movement of a stock price over time?

Well, a pie chart wouldn't work very well. For that, we'll use a line chart.

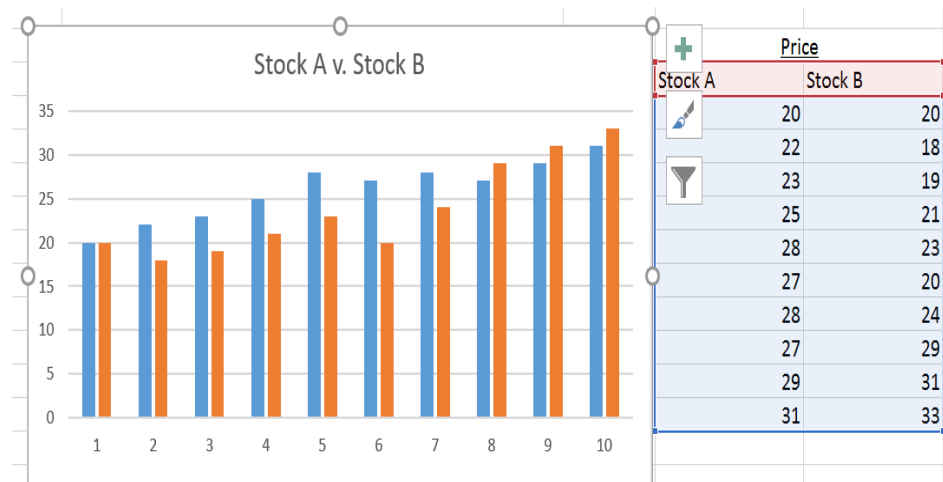


Bar charts

What if we want to compare two stocks over time? We could use a line chart again:



But we could also use a bar chart:





Statistics

The stars might lie but the numbers never do

“There are lies, damn lies, and statistics”

Variations on the above are attributed to both Mark Twain and Benjamin Disraeli.

But we love statistics. Politicians love them. Sports fans REALLY love statistics. The past few years have seen an explosion of sports statistics: Gross Production Averages, Defensive Runs Saved, and Defense Independent Component statistics in baseball. Top speed and acceleration numbers in football.

We'll talk about the following statistical measurements:

- **Mean** – The average. Add up the data points and divide by the count.
- **Forecast** – Lets us predict a future value based on existing values
- **Standard deviation** – Helps us understand the distribution

What does mean mean?

The mean of a data set is the **average**.
Sum the values in a data set, and then divide by the count.

20			
18			
19			
21			
23			
20			
24			
29			
31			
33			
Sum	=SUM(E31:E40)		238
Count	=COUNT(E31:E40)		10
Mean	=H42/h43		23.8
AVERAGE	=AVERAGE(E31:E40)		23.8

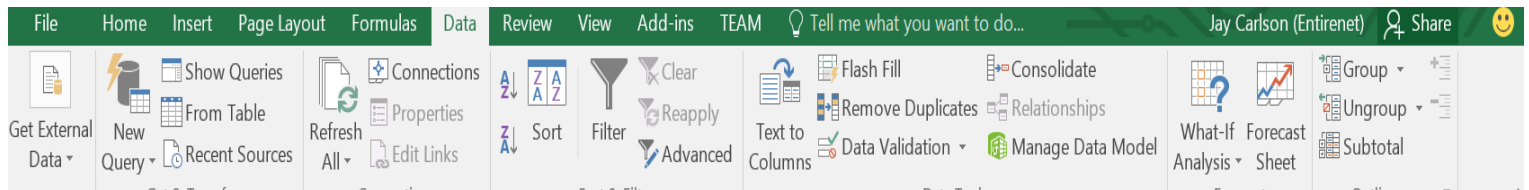
Mean, median, mode

Median and mode are two statistical measures often used with mean (average). What are the median and mode?

- Median – Half the values in the data set are above the median and half are below. Median can be used with the mean to estimate volatility.
- Mode – The value that occurs most often.

Sum	=SUM(E31:E40)	238
Count	=COUNT(E31:E40)	10
Mean	=H42/h43	23.8
AVERAGE	=AVERAGE(E31:E40)	23.8
Mode	'=MODE(E31:E40)	20

Descriptive Statistics – One stop stats



The previous analysis yields some useful information, but there's a lot of mucking about writing formulas and formatting cells. Wouldn't be cool if there was a way to make these calculations with a couple of mouse clicks? Happily, there is a way. For that, we'll use **Descriptive Statistics** in the **Analysis** group on the **Data** tab.

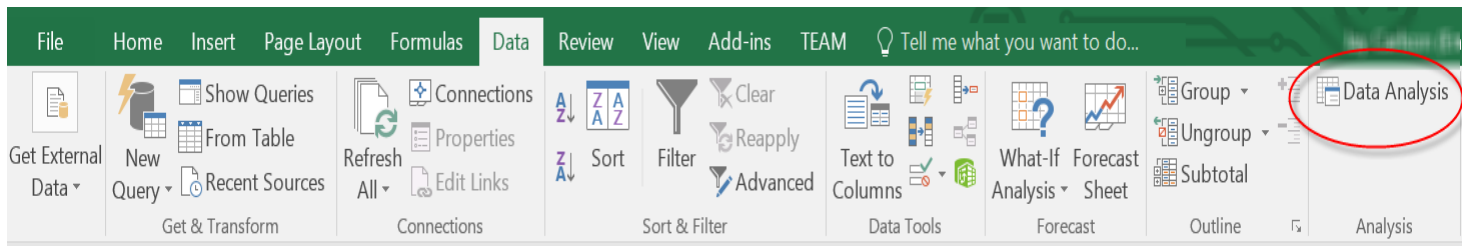
Hmm...

That's odd, I don't see the Analysis group anywhere. That's because we need to load the Analysis ToolPak.

1. Click the **File** tab, and then click **Options**.
2. Click **Add-Ins**, and then in the **Manage** box, select **Excel Add-ins**.
3. Click **Go**.
4. In the **Add-Ins available** box, select the **Analysis ToolPak** check box, and then click **OK**.
 - a) If the **Analysis ToolPak** is not listed in the **Add-Ins available** box, click **Browse** to locate it.
 - b) If you get prompted that the Analysis ToolPak is not currently installed on your computer, click **Yes** to install it.

There it is...

5. After you load the Analysis ToolPak, the **Data Analysis** command is available in the **Analysis** group on the **Data** tab.



Setting Descriptive Statistics options

In the dialog box, set the input and output ranges, select Summary statistics, and then click OK:

Descriptive Statistics

Input

Input Range:

Grouped By: Columns Rows

Labels in first row

Output options

Output Range:

New Worksheet Ply:

New Workbook

Summary statistics

Confidence Level for Mean: %

Kth Largest:

Kth Smallest:

OK
Cancel
Help

Getting the values

After you click OK, several values, including mean, median, and mode, appear in the output range:

	<i>Stock B</i>	
20		
18		
19	Mean	23.8
21	Standard Error	1.69181
23	Median	22
20	Mode	20
24	Standard Deviation	5.349974
29	Sample Variance	28.62222
31	Kurtosis	-0.94948
33	Skewness	0.775168
	Range	15
	Minimum	18
	Maximum	33
	Sum	238
	Count	10

Along with something called Standard Deviation. What the heck is Standard Deviation?

Standard Deviation

Earlier, we talked about using the mean and mode values to estimate volatility. Lower volatility means that the values do not fluctuate as dramatically, but increase or drop at a steadier rate.

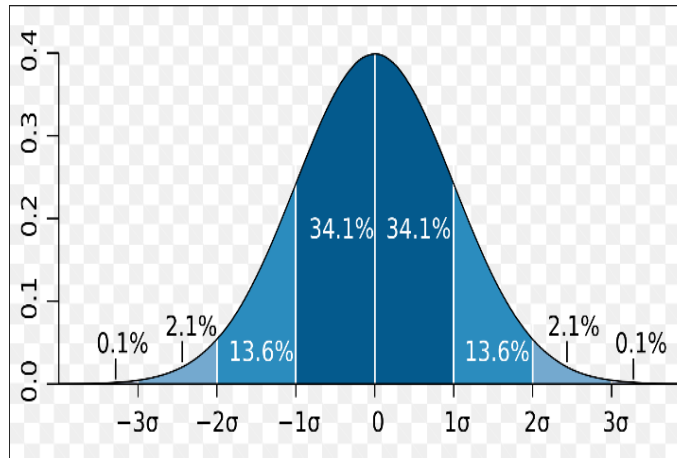
Investopedia says:

What is 'Volatility'

1. A statistical measure of the [dispersion](#) of returns for a given security or [market index](#). Volatility can either be measured by using the [standard deviation](#) or variance between returns from that same security or market index. Commonly, the higher the volatility, the riskier the security.

Understanding Standard Deviation

To understand standard deviation, we need to look at something that we all probably hated in high school. The bell curve, or normal distribution.

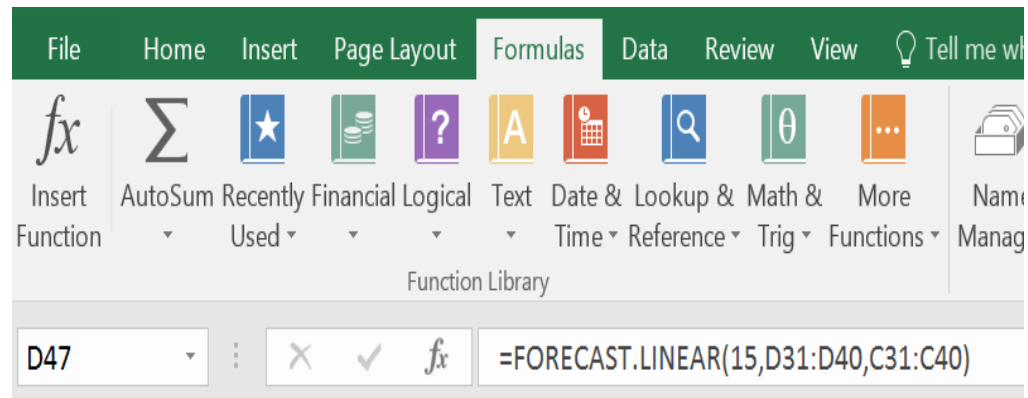


The values along the horizontal axis are standard deviations. This means that, in a normal distribution, we can expect 68.2% of the data points to lie within one standard deviation (plus or minus) from the mean.

Forecasting

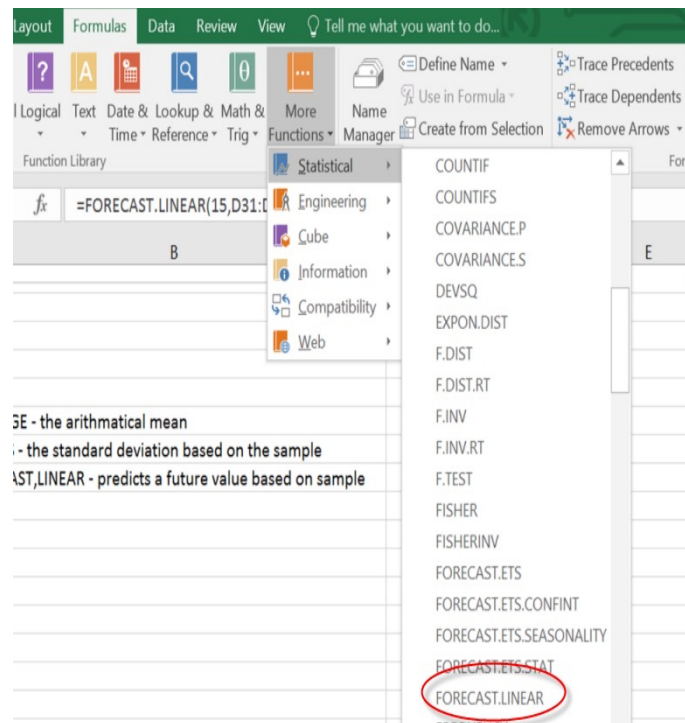
So far, we've used Excel to analyze current and historical data. It would certainly be cool if we could predict future data points.

We can do that. There are actually several predictive functions in Excel, but we'll use the FORECAST,LINEAR formula to see into the financial future.



Using FORECAST,LINEAR

To use FORECAST,LINEAR, select More Functions on the Formulas tab, select Statistical, and then select FORECAST,LINEAR:



Enter the values for FORECAST,LINEAR

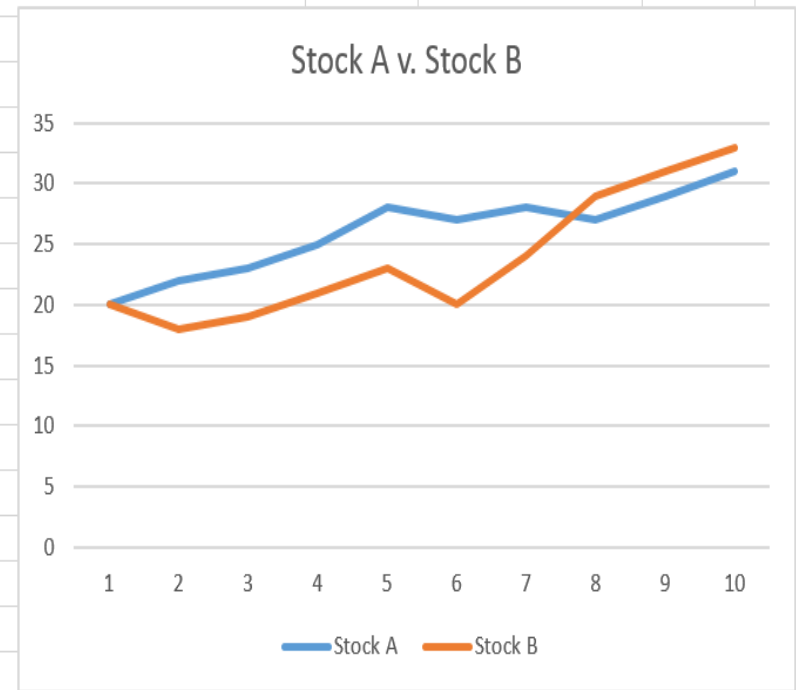
Enter the values in the dialog box. In this example, we have 10 historical data points, and we'll calculate the predicted value at the 15th data point. For example, if the existing data points are monthly values, we'll calculate the value five months from now:

Stock B			
	20	Value in 5 months	39
	18		
	19		
	21		
	23		
	20		
	24		
	29		
	31		
	33		

```
=FORECAST.LINEAR(15,E31:E40,C31:C40)
```

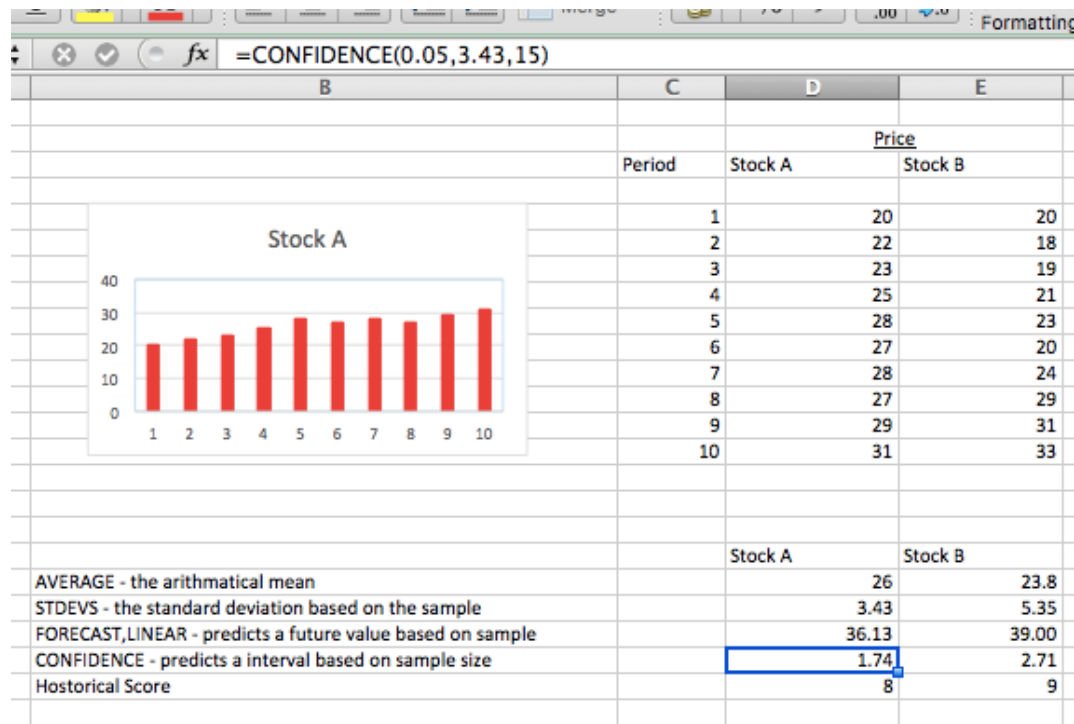
Comparing two stocks

<u>Period</u>	<u>Stock A</u>	<u>Stock B</u>
1	20	20
2	22	18
3	23	19
4	25	21
5	28	23
6	27	20
7	28	24
8	27	29
9	29	31
10	31	33
Mean	26	23.8
Standard Deviation	3.43	5.35
Forecast	36.13	39.00



Adding a little Confidence...

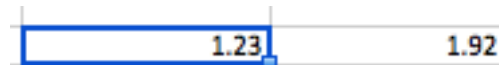
Or perhaps a little uncertainty. By using the CONFIDENCE function, we can say “I’m 95% confident that the number is within this interval”.



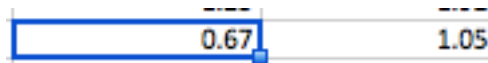
Dang, them Texans was right

The previous confidence intervals were generated using a small data set. What happens if we have a larger data set, say 30 or 100 data points?

```
=CONFIDENCE(0.05,3.43,30)
```



```
=CONFIDENCE(0.05,3.43,100)
```



Multiple Criteria Decision Making (MCDM)


MCDM is pretty much what it sounds like. You define a number of criteria to evaluate.

For example, if we want to evaluate the possibility that a stock price will go up, we might define the three following criteria and then assign a “1” (Yes) or “0” (No) to each criteria:

	Q1			Q2			Q3			Q4			<u>Total</u>
	Profit	Revenue	Dividend	Profit	Revenue	Dividend	Profit	Revenue	Dividend	Profit	Revenue	Dividend	
Stock A	1	1	1	0	0	0	1	1	0	1	1	1	8
Stock B	1	0	0	1	1	0	1	1	1	1	1	1	9

We're getting there...

Now our work is beginning to resemble a financial analysis (minus any narratives to support our analysis):

	Period	Price	
		Stock A	Stock B
	1	20	20
	2	22	18
	3	23	19
	4	25	21
	5	28	23
	6	27	20
	7	28	24
	8	27	29
	9	29	31
	10	31	33
		Stock A	Stock B
AVERAGE - the arithmetical mean		26	23.8
STDEVS - the standard deviation based on the sample		3.43	5.35
FORECAST,LINER - predicts a future value based on sample		36.13	39.00
CONFIDENCE - predicts a interval based on sample size		1.74	2.71
Historical Score		8	9



Pivot Tables and Charts

Data mining on the cheap

What's with the “pivot” thing anyway?

There are a lot of ways to summarize, analyze, and display data in Microsoft Excel 2010. You can order data, filter data, sort data, analyze data by using statistical and financial functions, create pie charts, line charts, scatterplots... on and on.

We can also use pivot tables and pivot charts. Not only are pivot tables and pivot charts really hip buzzwords, it turns out the pivot tables and pivot charts are really cool ways to aggregate and analyze data in new ways. In some respects, you can think of pivot tables and pivot charts as down-level versions of data mining (now there's a buzzword for your next party).

But, why are they called *pivot* tables and charts? Well, because you can pivot columns and rows in a workbook. In other words you can make columns into rows and vice versa.

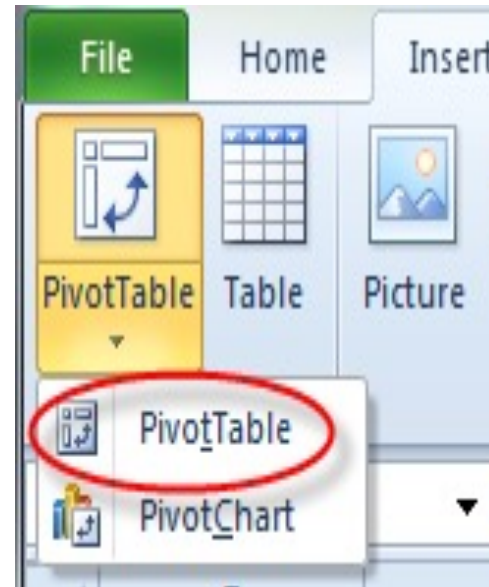
Creating a pivot table

First, we'll need some data:

<u>Sales Region</u>	<u>Product</u>	<u>Sales</u>
North	Cogs	12000
South	Cogs	19000
East	Cogs	24000
West	Cogs	14000
North	Widgets	8000
South	Widgets	31000
East	Widgets	12500
West	Widgets	37500
North	Sprockets	17250
South	Sprockets	4000
East	Sprockets	13750
West	Sprockets	2500
North	Tickers	43000
South	Tickers	29500
East	Tickers	26250
West	Tickers	21375

Insert a pivot table

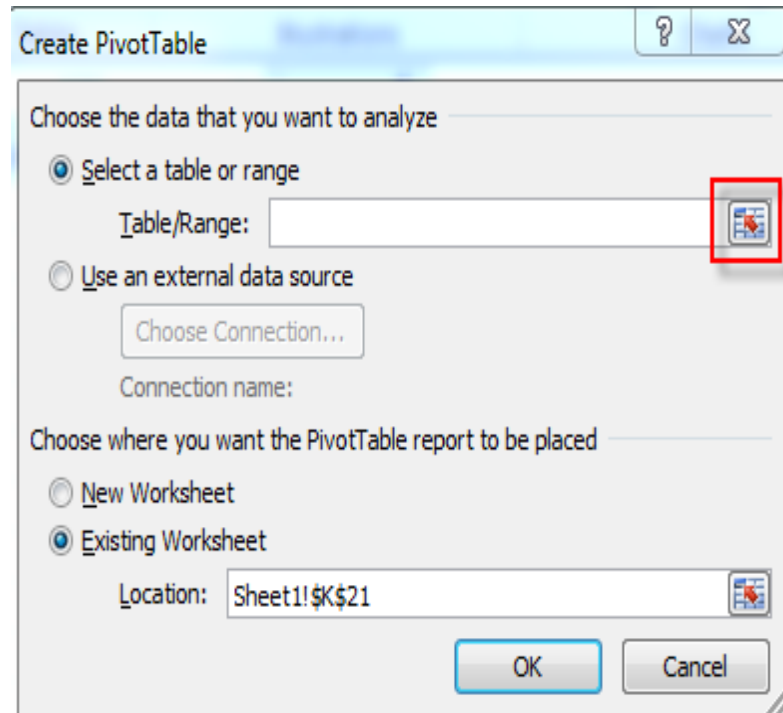
To create a pivot table, click the **Insert** tab, click **PivotTable**, and then click **PivotTable**:



Select the data

In the Create Pivot Table dialog box, click the Table/Range icon to select the data that you want to analyze.

You can either type the cell references for the range of data that you want to analyze, or you can click and drag to highlight the range.



We gotta put it somewhere...

In the Create PivotTable dialog box, click Existing Worksheet, click the cell where you want to insert the pivot table, and then click OK:

Sales Region	Product	Sales
North	Cogs	12000
South	Cogs	19000
East	Cogs	24000
West	Cogs	14000
North	Widgets	8000
South	Widgets	31000
East	Widgets	12500
West	Widgets	37500
North	Sprockets	17250
South	Sprockets	4000
East	Sprockets	13750

Hey, where's my data?

After you click OK, the pivot table, the PivotTable Field List dialog box appears. Notice that there is no data in the pivot table yet. To populate the pivot table, we need to select the data fields that we want

The screenshot shows an Excel spreadsheet with a PivotTable and the PivotTable Field List task pane. The PivotTable is structured as follows:

Sales Region	Product	Sales	Row Labels	Sum of Sales
North	Cogs	12000		69000
South	Cogs	19000	Cogs	
East	Cogs	24000	East	24000
West	Cogs	14000	North	12000
North	Widgets	8000	South	19000
South	Widgets	31000	West	14000
East	Widgets	12500	Sprockets	37500
West	Widgets	37500	East	13750
North	Sprockets	17250	North	17250
South	Sprockets	4000	South	4000
East	Sprockets	13750	West	2500
West	Sprockets	2500	Tickers	120125
North	Tickers	43000	East	26250
South	Tickers	29500	North	43000
East	Tickers	26250	South	29500
West	Tickers	21375	West	21375
			Widgets	89000
			East	12500
			North	8000
			South	31000
			West	37500

The PivotTable Field List task pane is open on the right side of the spreadsheet. It shows the following configuration:

- Choose fields to add to report: Sales Region, Product, Sales
- Report Filter: (Empty)
- Column Labels: (Empty)
- Row Labels: Product, Sales Region
- Values: Sum of Sales
- Defer Layout Update: (Checked)
- Update: (Button)

Manipulating data

Sales Region	Product	Sales
North	Cogs	12000
South	Cogs	19000
East	Cogs	24000
West	Cogs	14000
North	Widgets	8000
South	Widgets	31000
East	Widgets	12500
West	Widgets	37500
North	Sprockets	17250
South	Sprockets	4000
East	Sprockets	13750
West	Sprockets	2500
North	Tickers	43000
South	Tickers	29500
East	Tickers	26250
West	Tickers	21375

We can make the product gross sales comparison even easier if we collapse the detail view for each product:

Sales Region	Product	Sales
North	Cogs	12000
South	Cogs	19000
East	Cogs	24000
West	Cogs	14000
North	Widgets	8000
South	Widgets	31000
East	Widgets	12500
West	Widgets	37500
North	Sprockets	17250
South	Sprockets	4000
East	Sprockets	13750
West	Sprockets	2500
North	Tickers	43000
South	Tickers	29500
East	Tickers	26250
West	Tickers	21375
Grand Total		315625



Changing the view

One way to manipulate the sales data is to display the data by region. To do this, we need to move the “Products” or “Sales Regions” data to a column.

The screenshot shows a PivotTable with 'Sum of Sales' as the value field. The field list on the right includes 'Sales Regions', 'Products', and 'Sales'. A context menu is open over the 'Sprockets' product, with the 'Move' option selected. The 'Move' submenu is visible, and the option 'Move "Product" to Columns' is circled in red.



Sum of Sales	Column Labels				
Row Labels	Cogs	Sprockets	Tickers	Widgets	Grand Total
East	24000	13750	26250	12500	76500
North	12000	17250	43000	8000	80250
South	19000	4000	29500	31000	83500
West	14000	2500	21375	37500	75375
Grand Total	69000	37500	120125	89000	315625

Demonstrations in Excel

- Household budget to introduce formulas and pie charts
- Calculations using financial formulas in Excel
 - PMT function
 - CUMIPMT function
 - FV function
- Creating column charts
- Statistics
 - AVERAGE
 - STDEVS
 - FORECAST,LINERAR
- Pivot Tables

Lessons (I've) Learned

- Know the problem that you're trying to solve
- Know the scope, benefits and limitations of the financial model
- Garbage in garbage out – Be confident in your data set
- Your model should be:
 - Simple
 - Easy to understand
 - Flexible enough to accommodate future revisions.
- Remember the goal: Be able to take a decision based on your financial model