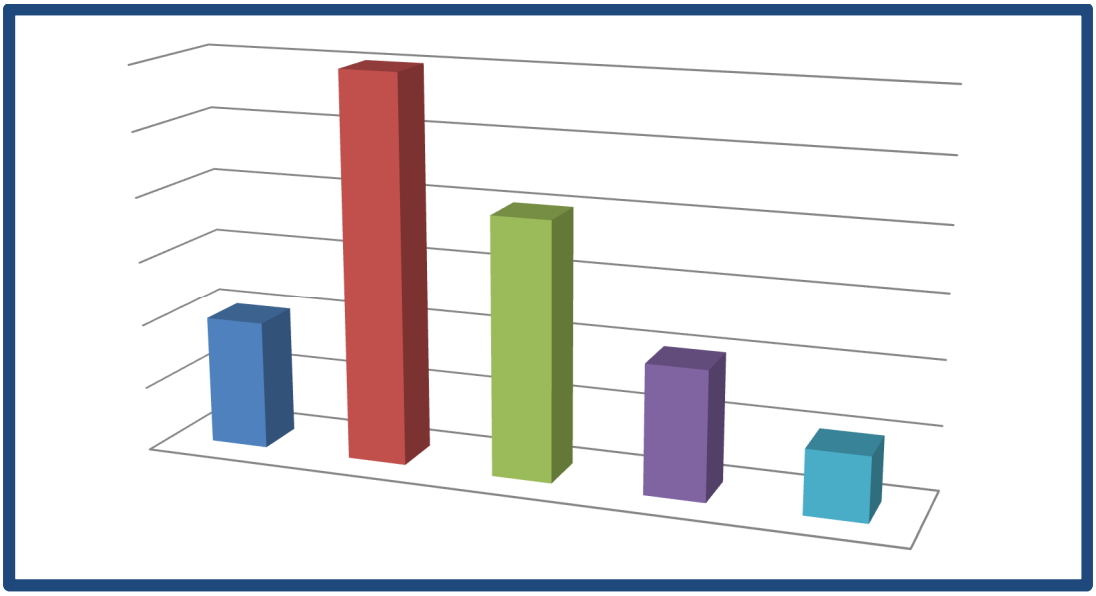
HUMBER
Liberal Arts & Sciences
Department of Mathematics

Created by Prof. Tan Le & Hang Lai

STATISTICS – EXCEL 2013 INSTRUCTIONS



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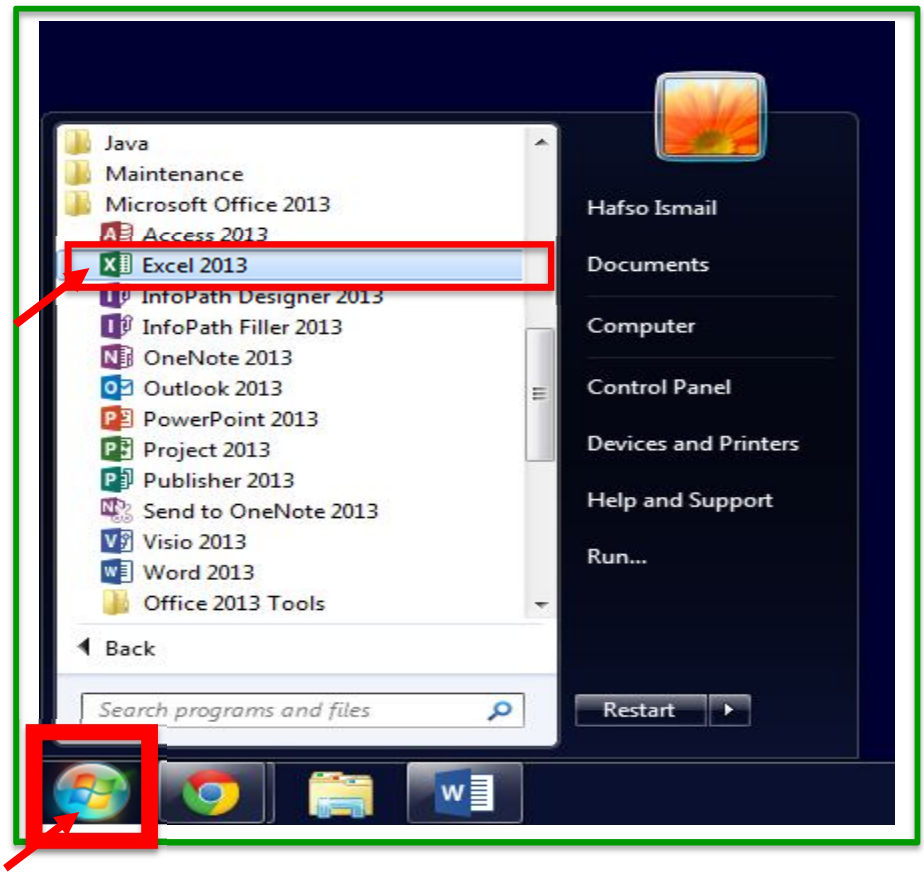
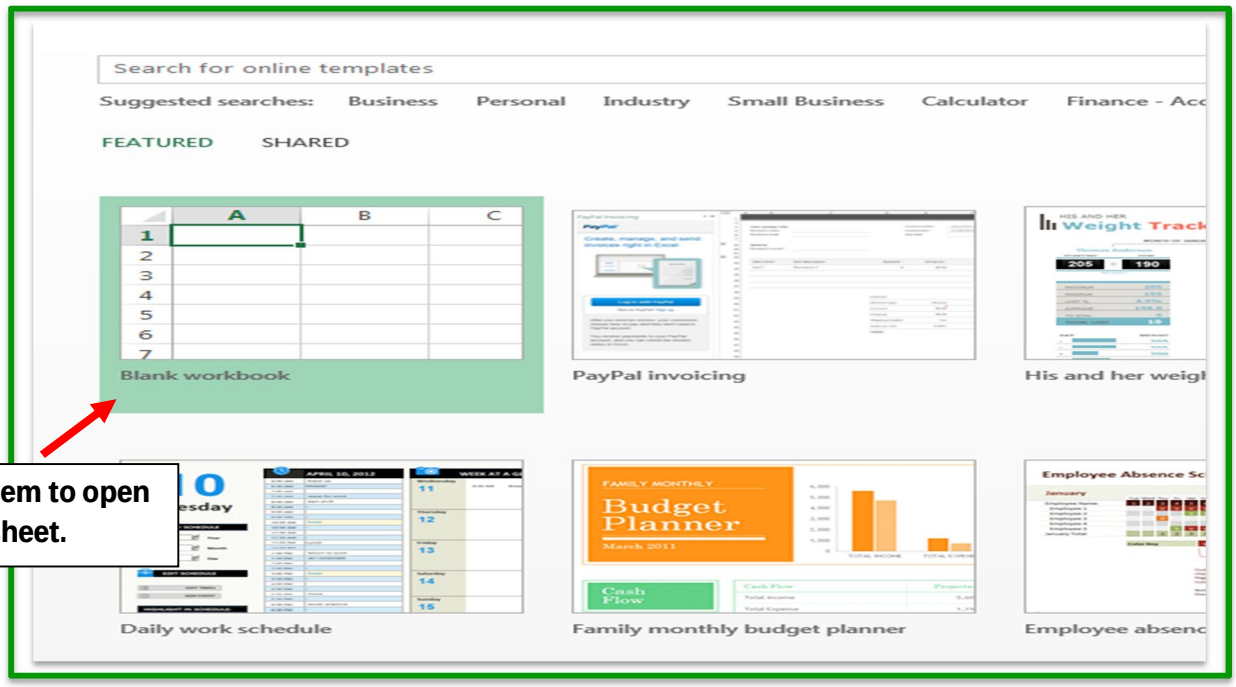
1. Open Microsoft Excel

Start → All Programs → Microsoft Office 2013 → Excel 2013





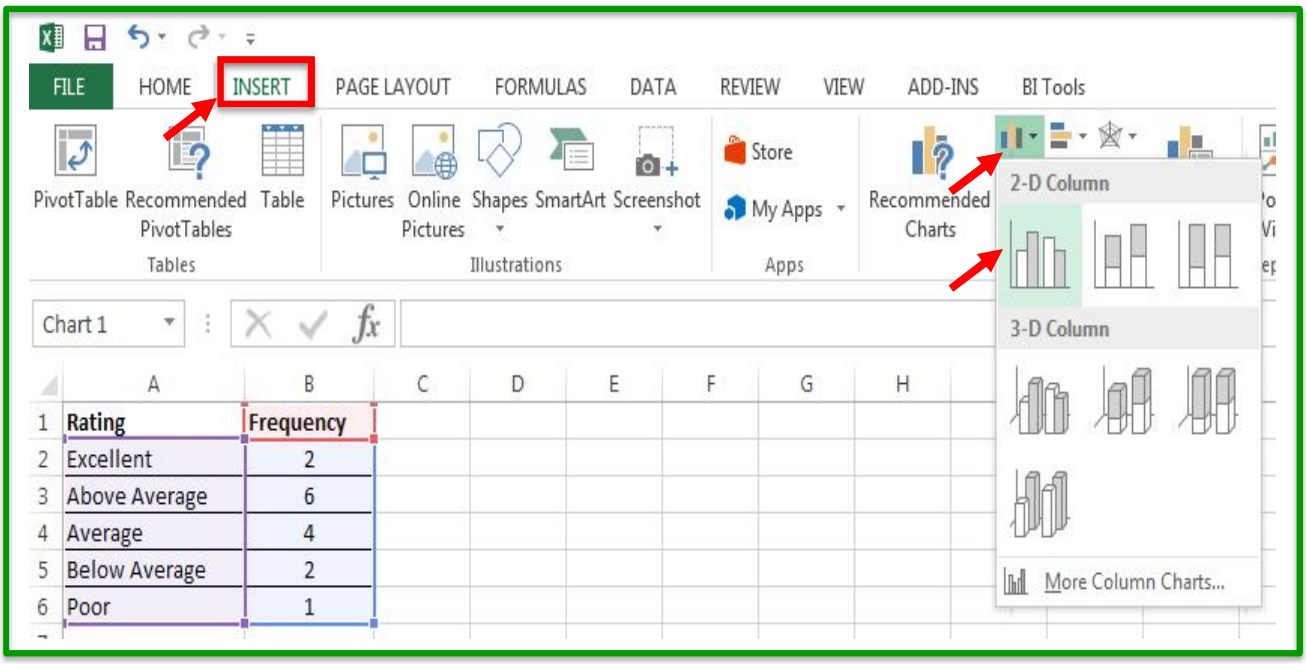
Click on this item to open a blank worksheet.

2. Bar Charts

Case 1: When data given are summarized in a Frequency Table.

Enter the Frequency Table in a spread sheet

Highlight the data, open the **INSERT** tab on the Excel ribbon, click on **Column** then choose the **2-D column** chart as shown below.



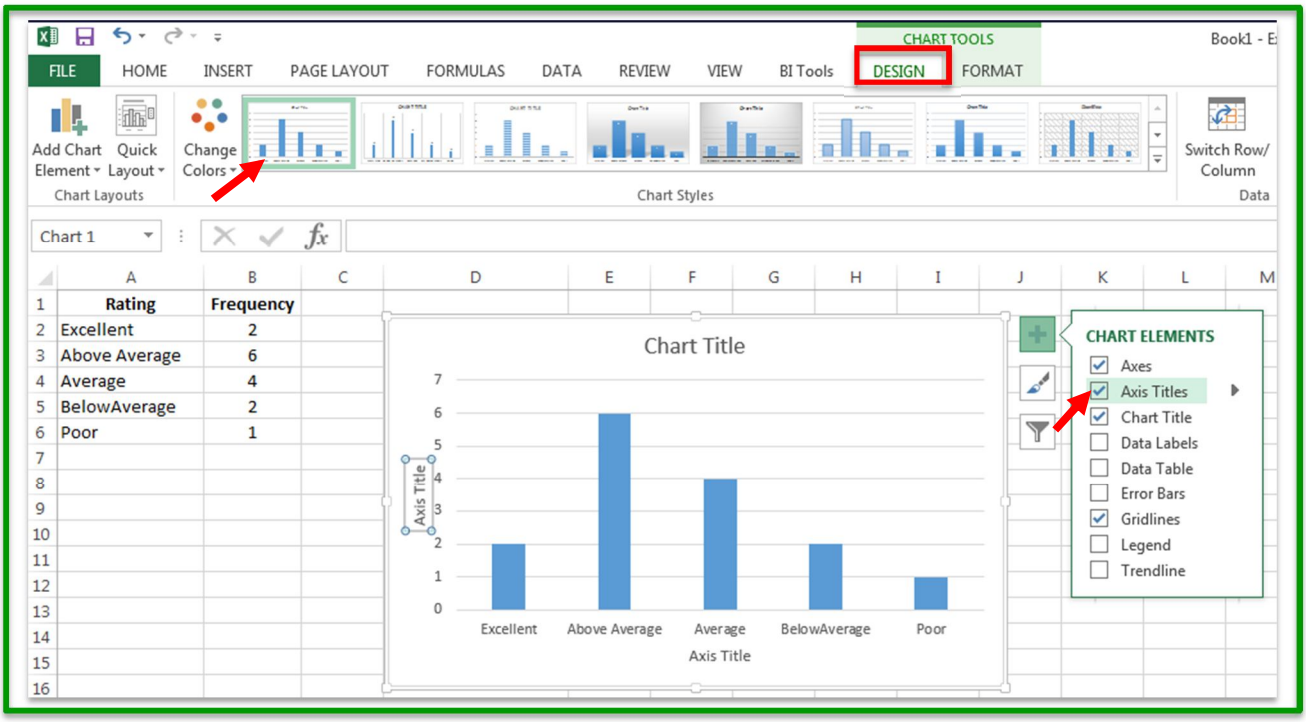
Now click on the graph to make **CHART TOOLS** visible at the top of your spreadsheet. Click on **DESIGN** and choose the designed chart. For example**,** choose the first chart as shown in the figure below.

To enter the chart title, just simply click on **Chart Title** and type the desired title.

How to add the Axis Title?

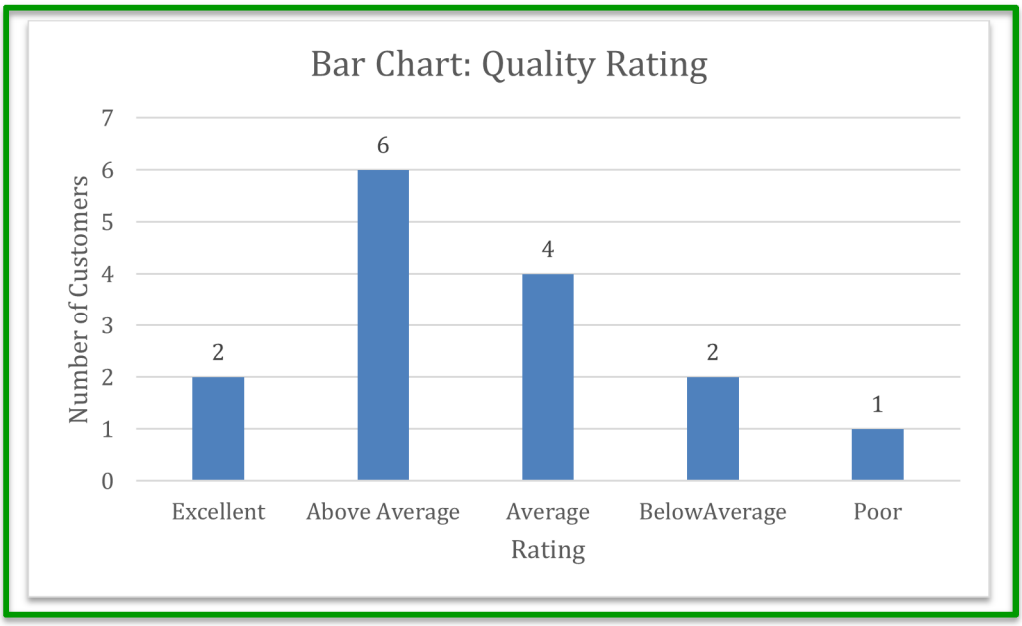
Click on the plus sign (**+**) on the right of the chart and check the box next to **Axis Titles**.

Now just type in the desired title for the horizontal and vertical axes.



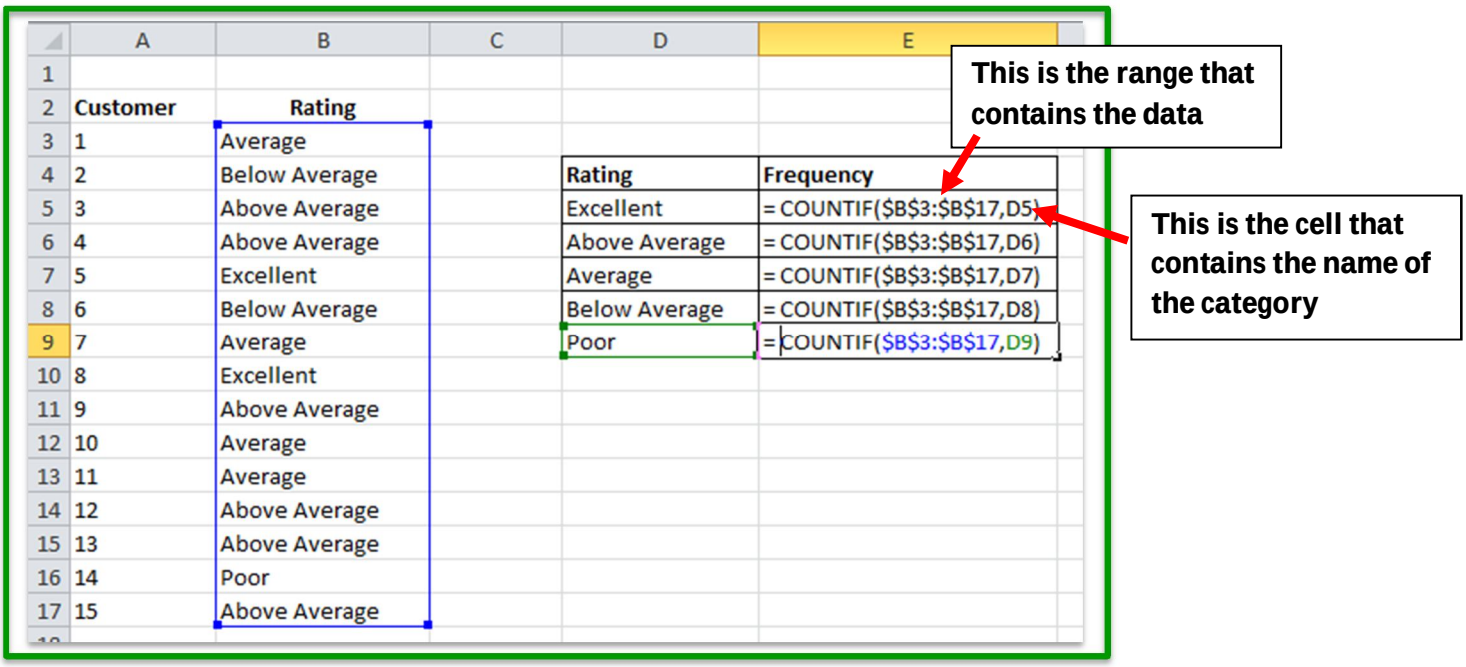
If you want to display the data on the chart, click on any bar, then right-click, choose **Add Data Labels**.

And here is the picture you should now obtain:



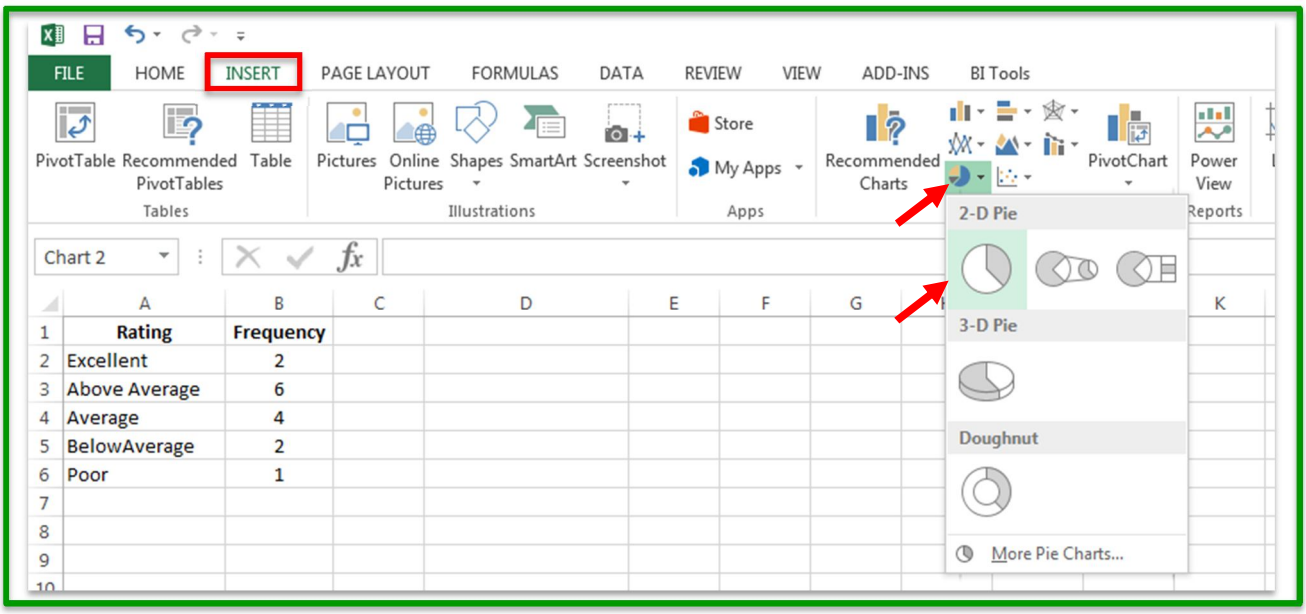
Case 2: When data given are raw data.

In this case, you first need to create a frequency table using **COUNTIF** function in Excel. Then you create a bar graph as above. Please see the figure below:

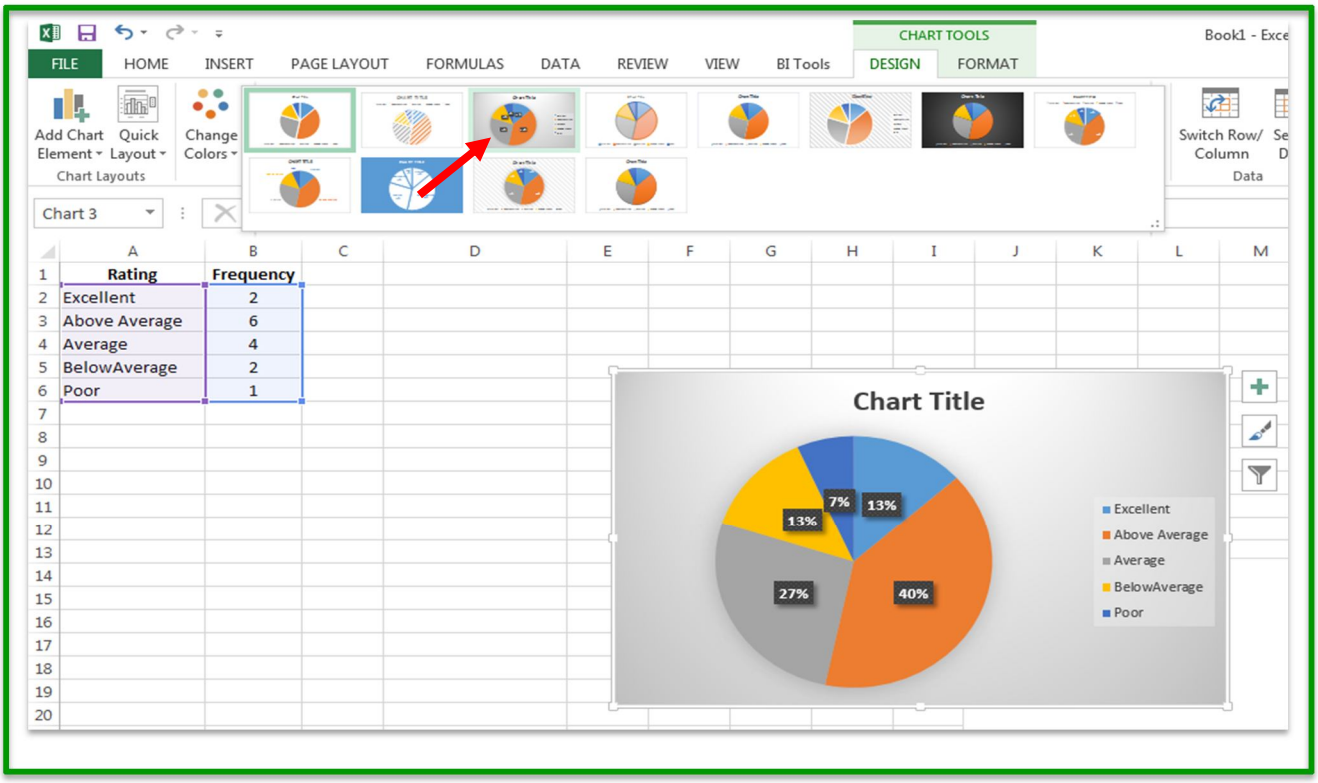


3. Pie Charts

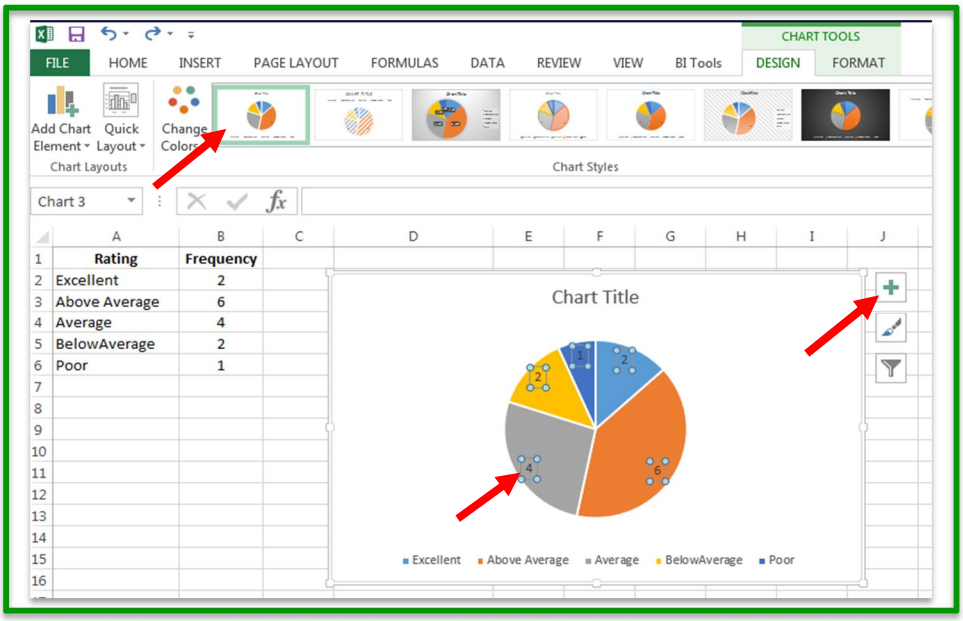
Highlight the data and click on the **INSERT** tab. Click on the **Pie** symbol to open the charts gallery, and then click the first pie chart in the **2-D Pie** section.



Now you should see a pie chart. Click on the chart; click on **DESIGN** and choose the desired chart. For example, choose the third chart as shown below:

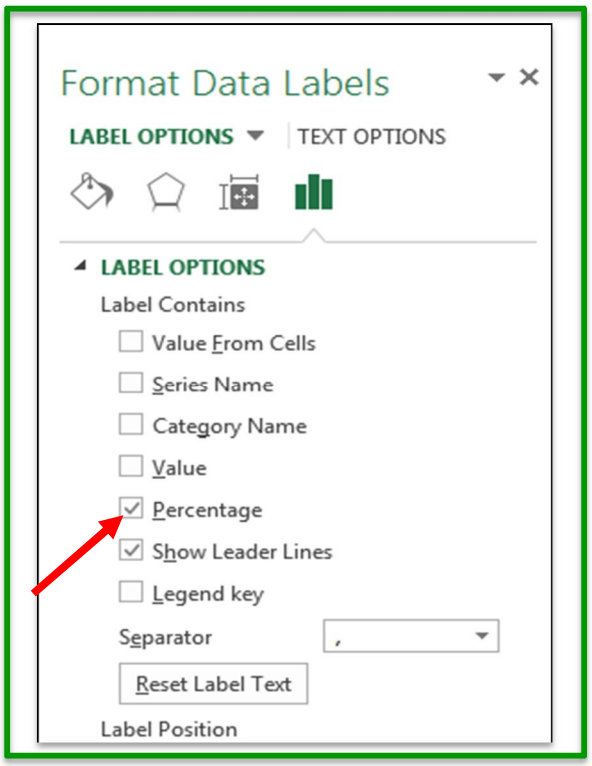


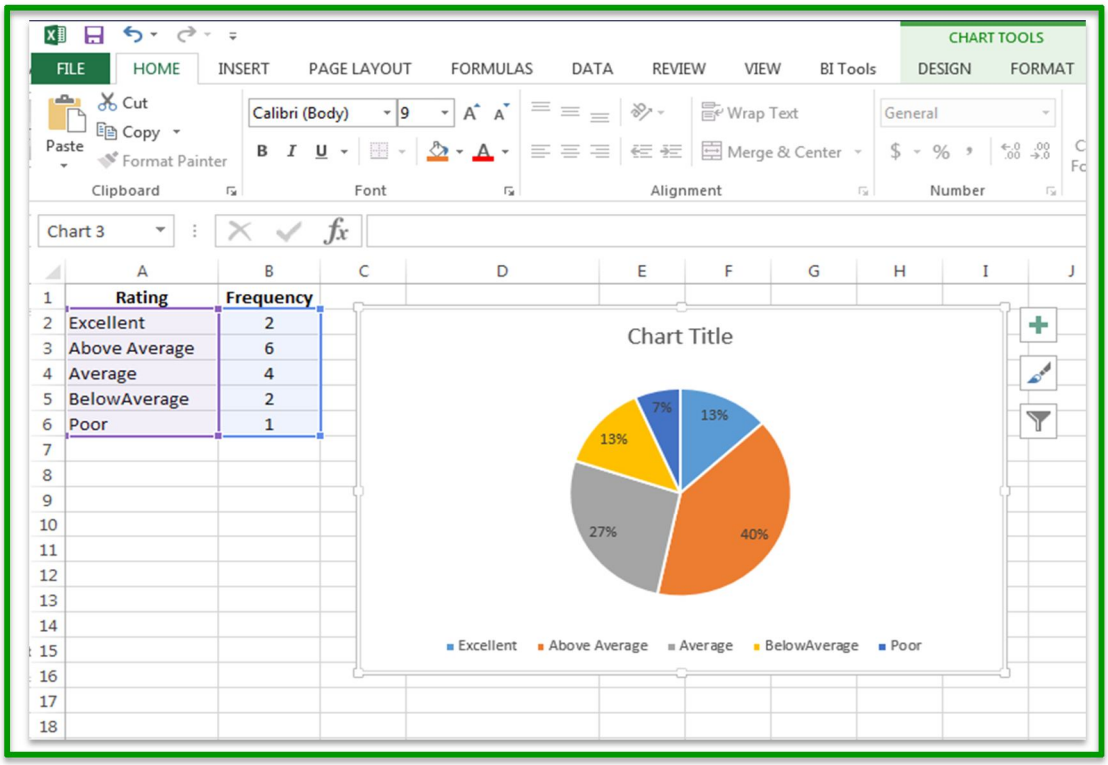
Enter the title for the chart. You can ***right-click*** on the chart to **copy** and **paste** the chart to a Word Document to prepare for a report if required.



Alternatively, click on the chart; click on **DESIGN** and choose the first chart. Click on the plus sign on the right of the pie chart and check the box next to **Data Labels**.

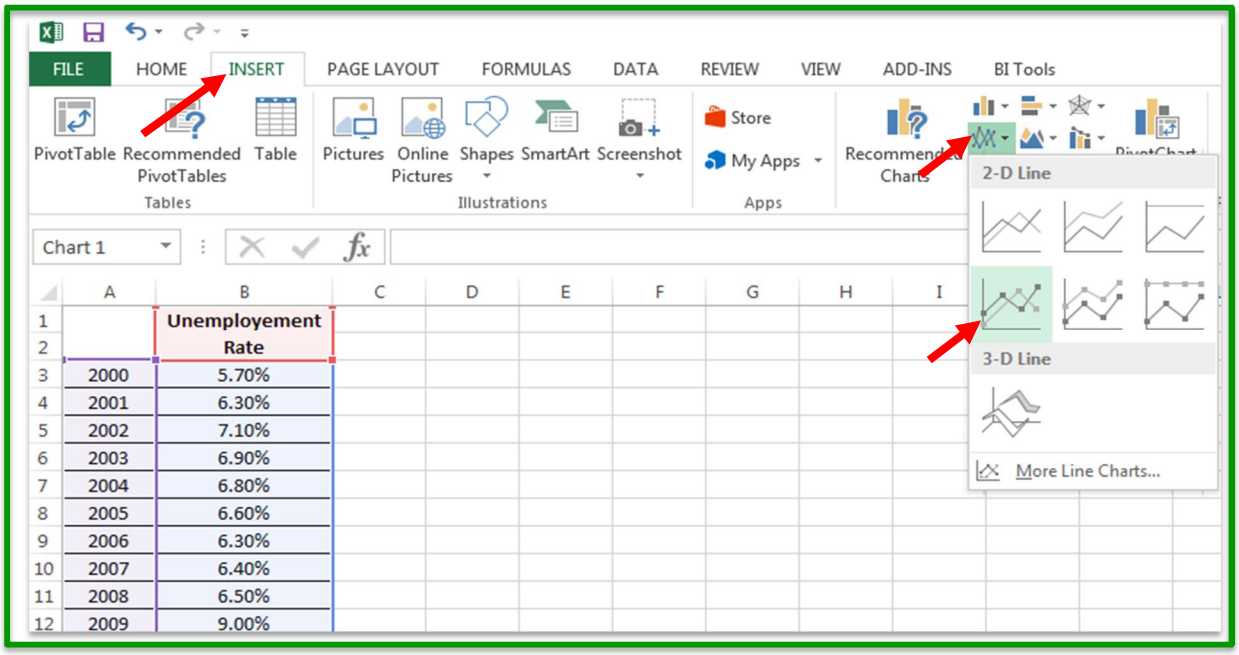
Click on any number on the chart and select the box next to **Percentage** and deselect the box next to **Value**.





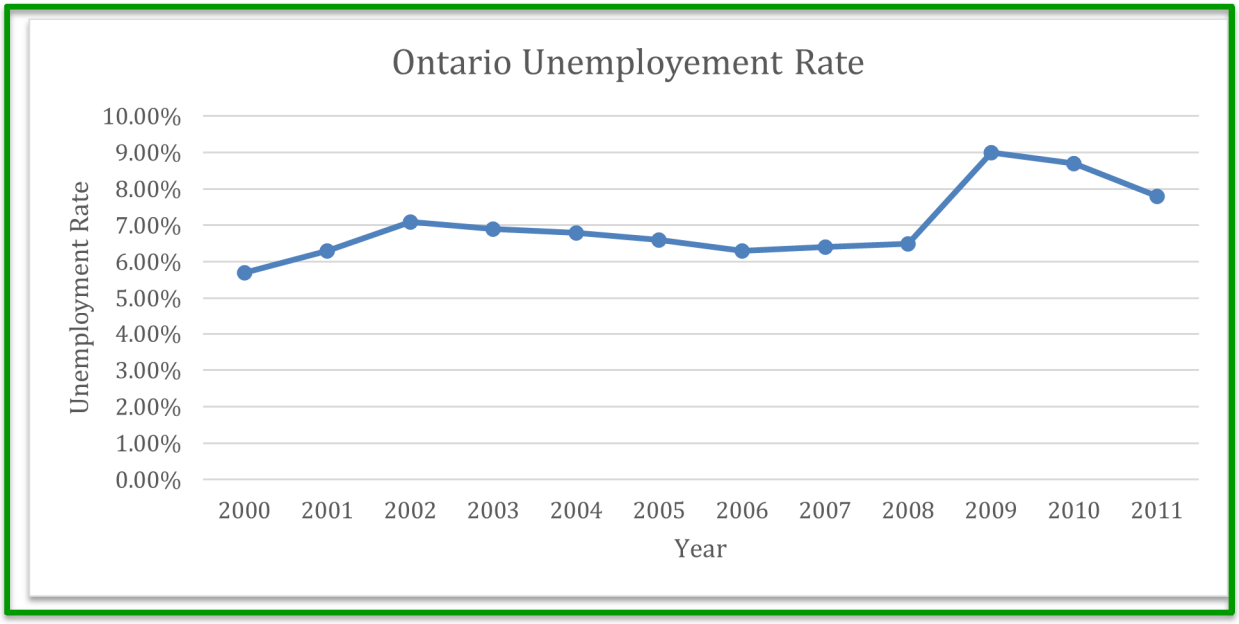
4. Line Charts

Highlight the data area including the headings, click on the **Insert** tab on the Excel ribbon, click on **Line** as shown below; then choose the **first symbol** on the **second row**.



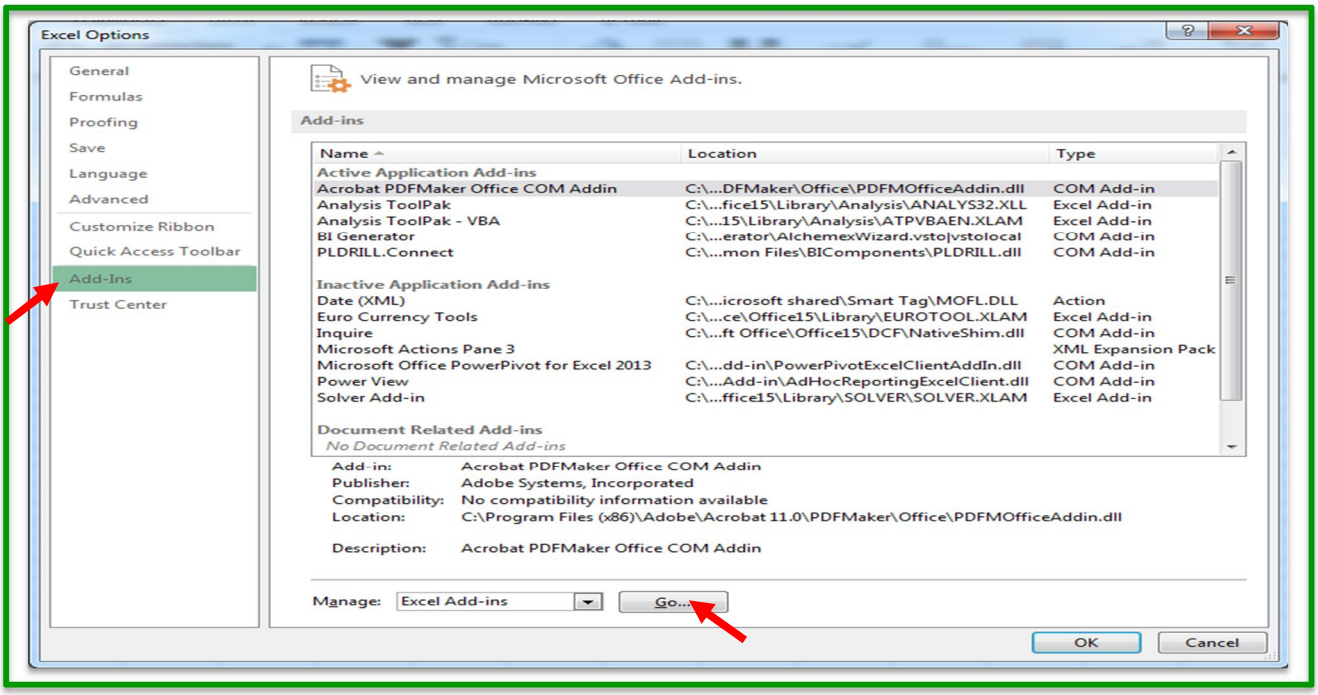
Tip: When you create a Line Graph, omit the heading (if given) of the column (or row) that contains the time values.

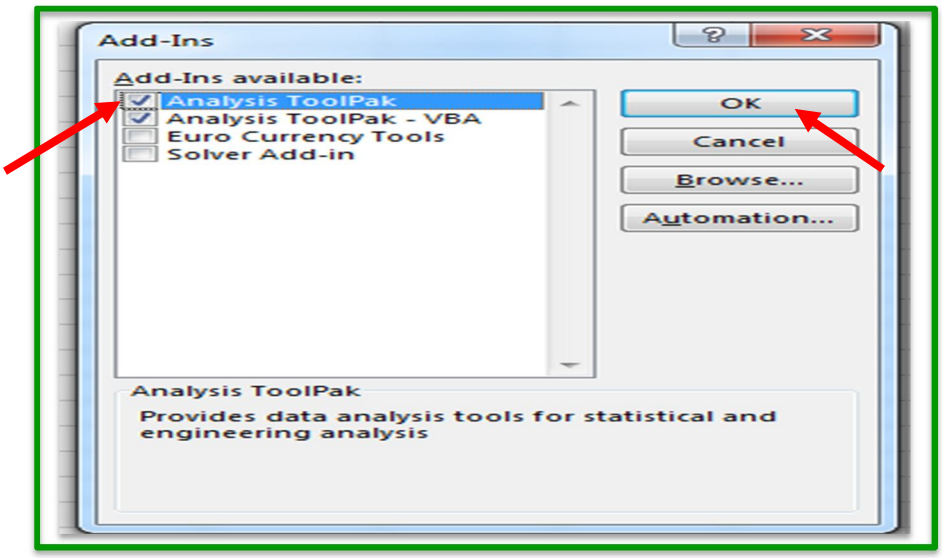
To add the Graph Title and Axis Title you follow the instructions as shown on page 5.



5. How to install the Data Analysis Package in Excel 2013?

1. Open an Excel spreadsheet; click on **File**, and then click on **Options** (on the left of the screen).
2. When Excel options table appears, click on **Add-Ins** (on the left of the table).
3. In the **Manage** box, choose **Excel Add-ins**, and then click on **Go**.
4. In the pop-up table, select **Analysis ToolPak**; then click **OK**.



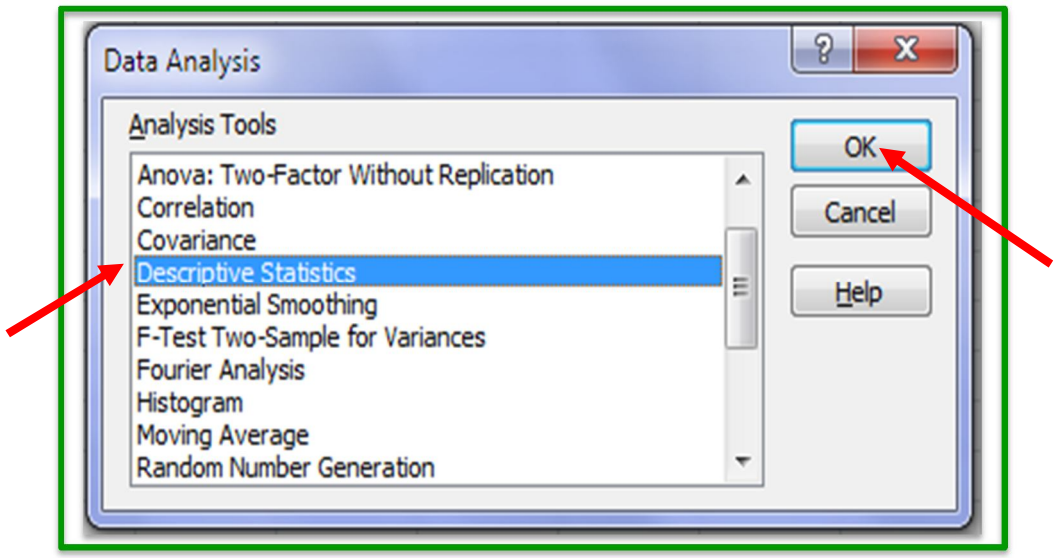


Now click on the **Data** tab, you should see **Data Analysis** at the end of the row.

6. Descriptive Statistics

Method 1: Using **Descriptive Statistics** feature in Excel

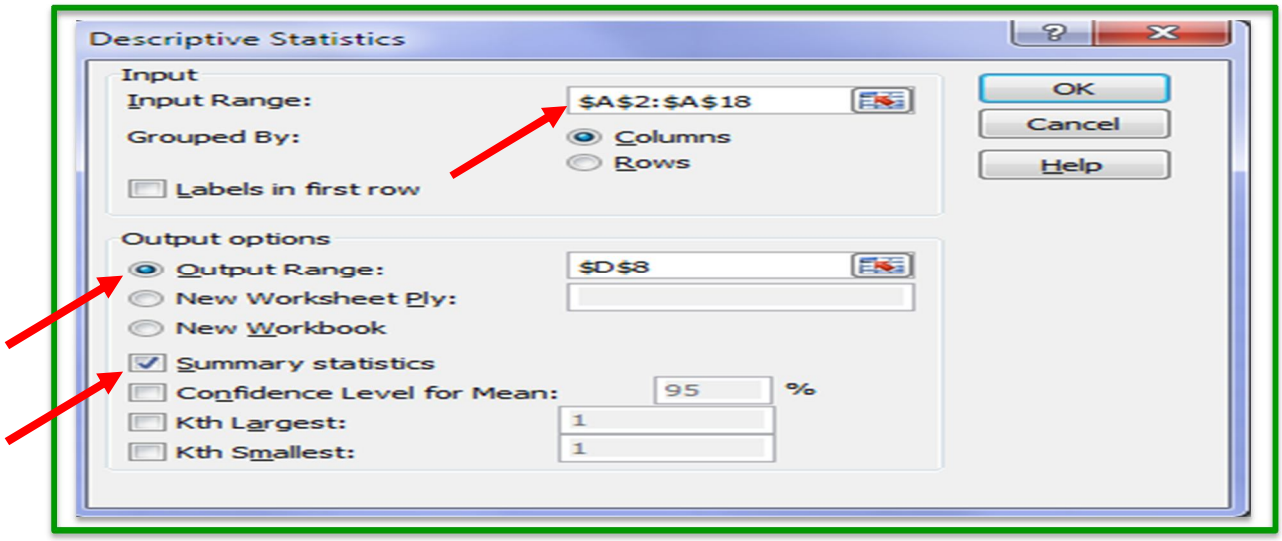
Click on the **Data** tab on the Excel ribbon, click **Data Analysis**, choose **Descriptive Statistics**, and click **OK**.



Now highlight the column (or row) that contains the data to enter the data into **Input Range**.

Select **Summary Statistics**.

Choose **Output Range** and place the cursor in the box next to **Output Range**; then click on any cell on the spread sheet where you want to place your output, and click **OK**.



Note: If you want to include the column heading, then check the box next to **labels in first row**.

And here is the Excel Output you should now obtain:

Test Score	
Mean	66.35
Standard Error	4.61
Median	72
Mode	72
Standard Deviation	19.02
Sample Variance	361.87
Kurtosis	-0.57
Skewness	-0.69
Range	61
Minimum	29
Maximum	90
Sum	1128
Count	17

Method 2: You can use statistical functions in Excel to calculate Mean, Median, Mode, Variance, and Standard Deviation for a sample data directly. Assume that **your actual data are located at A2:A18**, then

Mean	= AVERAGE(A2:A18)
Median	= MEDIAN(A2:A18)
Mode	= MODE.SNGL(A2:A18)
Variance	= VAR.S(A2:A18)
Standard Deviation	= STDEV.S(A2:A18)

7. Histograms

To make a histogram using Excel, you first need to create the **Bin** range.

How to create the desired Bin (Classes) for a histogram?

First you find the maximum value of the data set by choosing any cell and enter the formula: **= MAX(A2:A18)**, and the minimum value, **= MIN(A2:A18)**. Then find the range, which is the difference between the maximum value and the minimum value. (Assume that **your actual data are located at A2:A18)**

Decide on **the number of classes** you want to have.

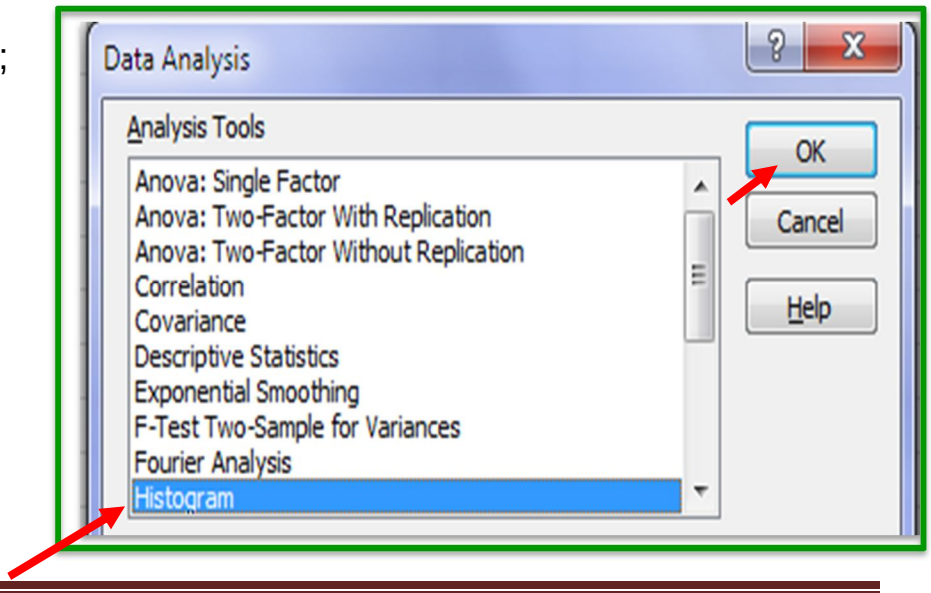
Then, you divide the range by the number of classes, and round up to the next whole number or round up to a convenient number to get the class width.

You choose the lower limit of the first class; this number must be less than or equal the minimum value of the data set. Then, you add the first lower class limit to the class width to find the upper class limit of the first class. You continue to add the class width to the first upper class limit to find the upper class limit of the second class and so on until you get all upper class limits. Note: the last upper class limit should be greater than or equal to the maximum data value to make sure that all the data values are included.

The Bin range of the histogram includes all the upper class limits you created.

Now you can create a histogram:

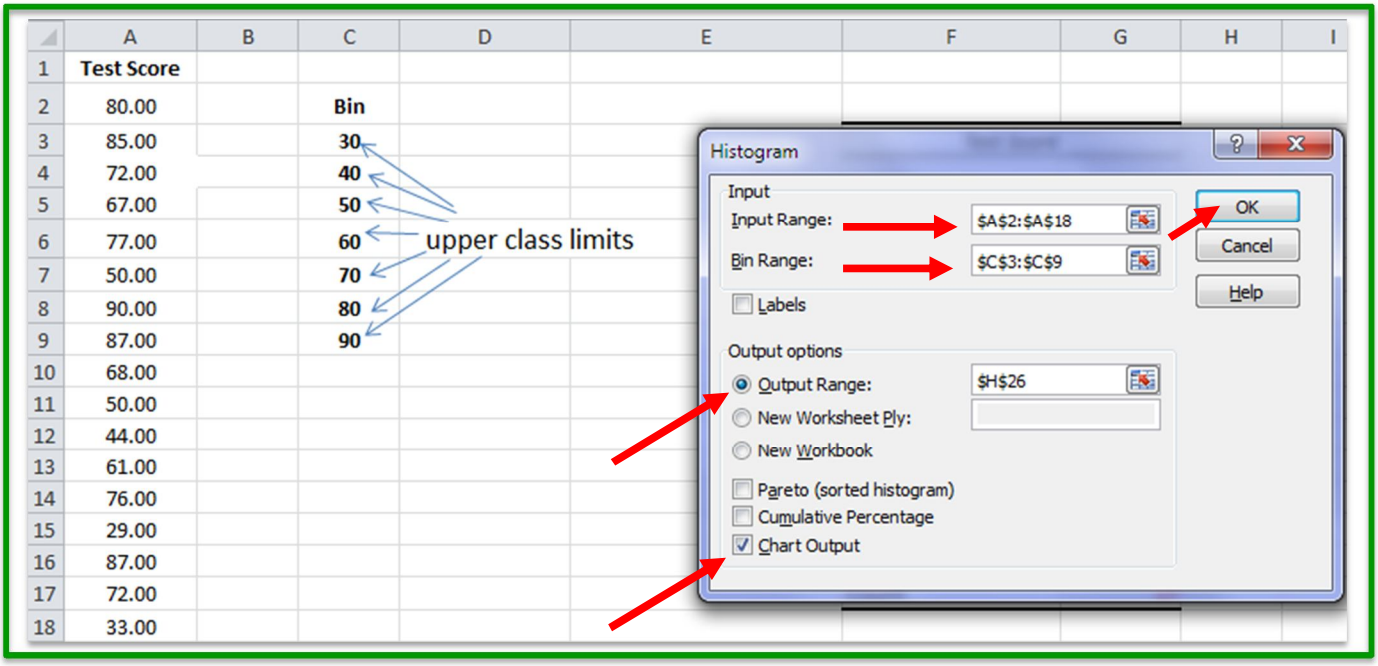
Click on the **Data** tab on the Excel ribbon, click **Data Analysis**; then scroll down to choose **Histogram** and click **OK.**



When the **Histogram** box appears:

Highlight the column that contains the data to enter the data into **Input Range**.

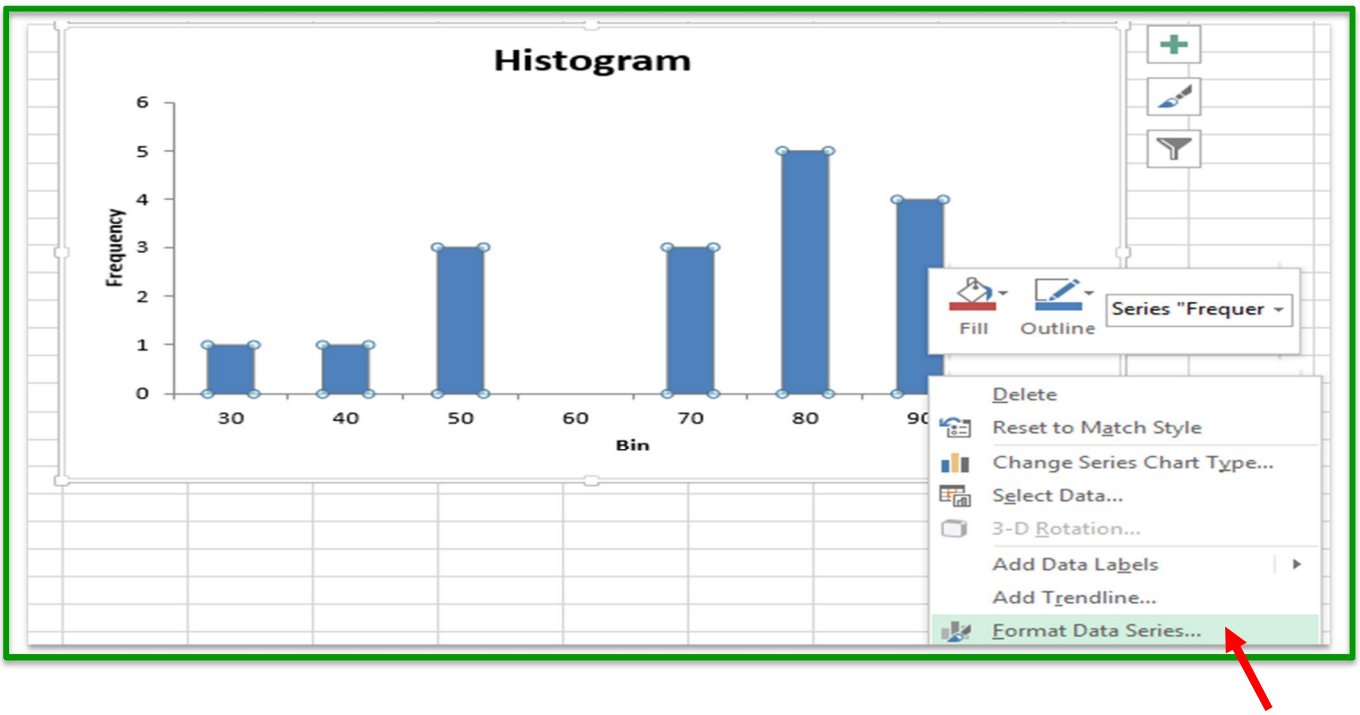
Highlight the desired **Bin** range**.** Check the box next to **Chart Output**.



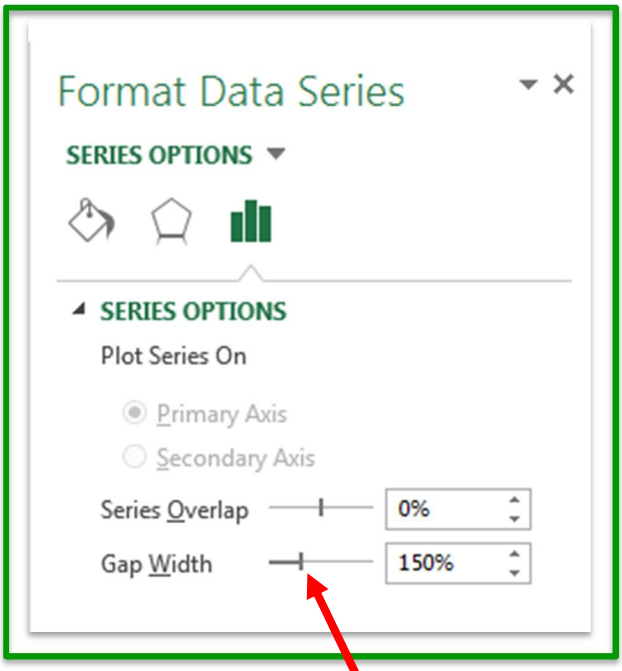
Choose **Output Range** and place the cursor in the box next to **Output Range**; then click on any cell on the spread sheet where you want to place your chart, and click **OK**.

How to edit a Histogram chart?

Right- click on any bar of the histogram, choose **Format Data Series**

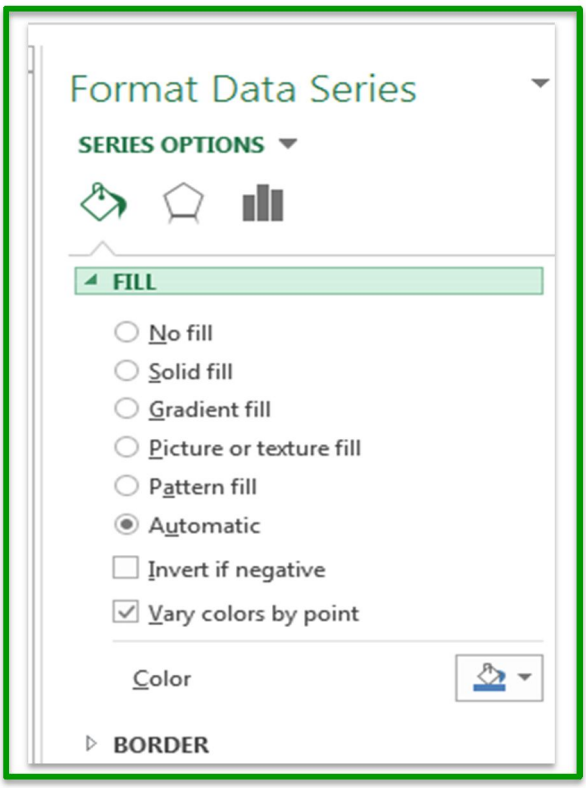


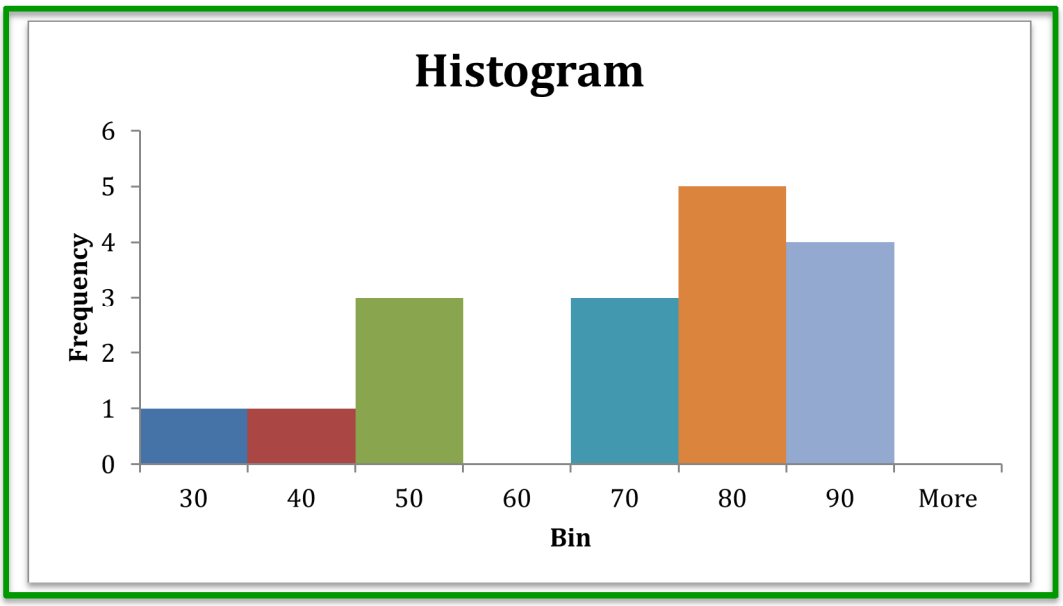
and move the **Gap Width** to the left to make all the bars stand next to each other.



Move the Gap Width to the left

On the right hand side, click on the Paint symbol, click on **Fill**, then select **Vary colors by point**.

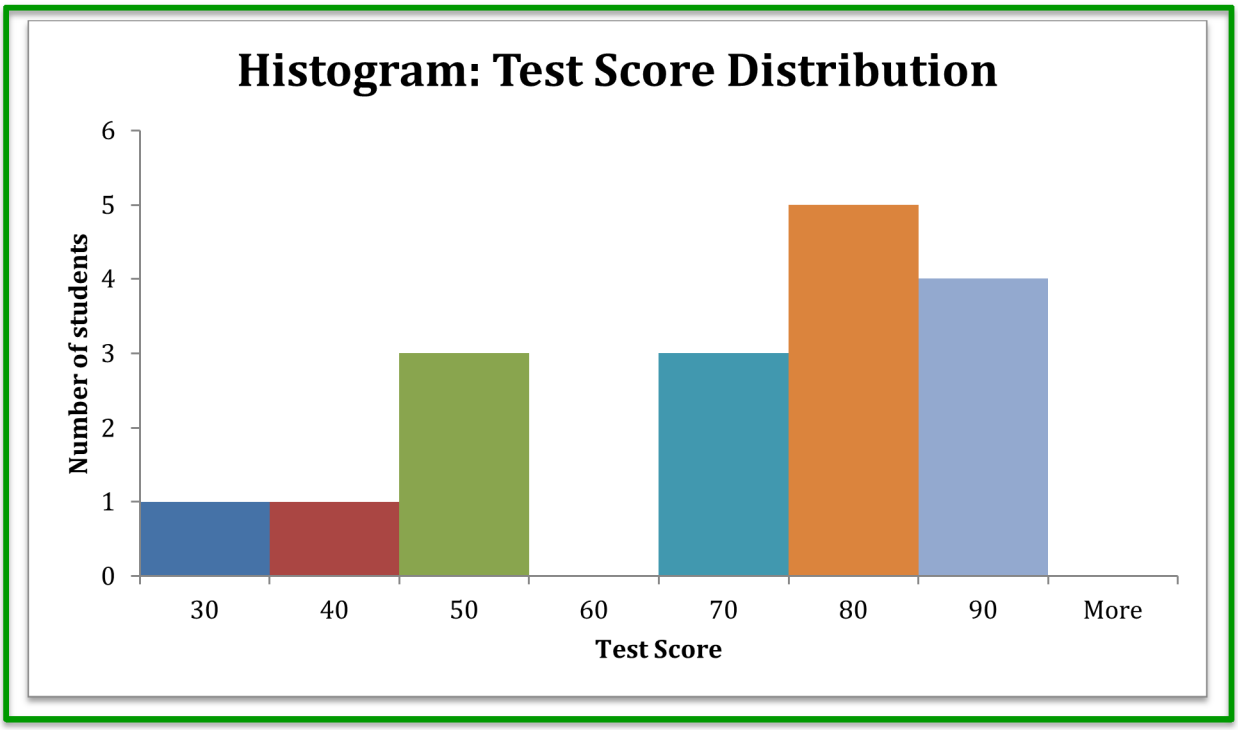




Add the Chart Title and Axis Title to your graph by clicking on the plus sign (+) on the right of the chart and check the box next to **Axis Titles**.

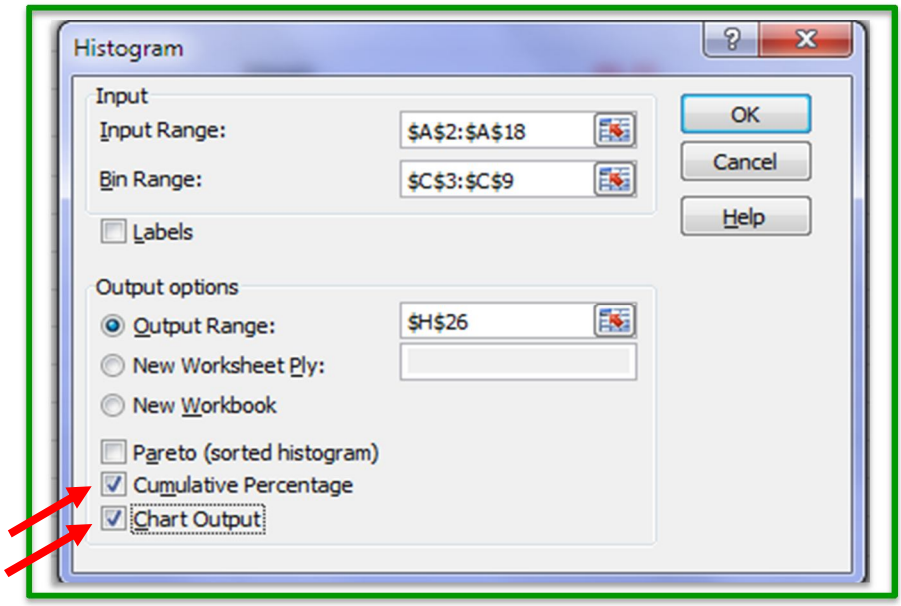
Now you just need to type in the desired title for the horizontal and vertical axes.

Excel will count all data values that are greater than the lower class limit and less than or equal to the upper class limit as the frequency of that class.
Here is the histogram you should now obtain:

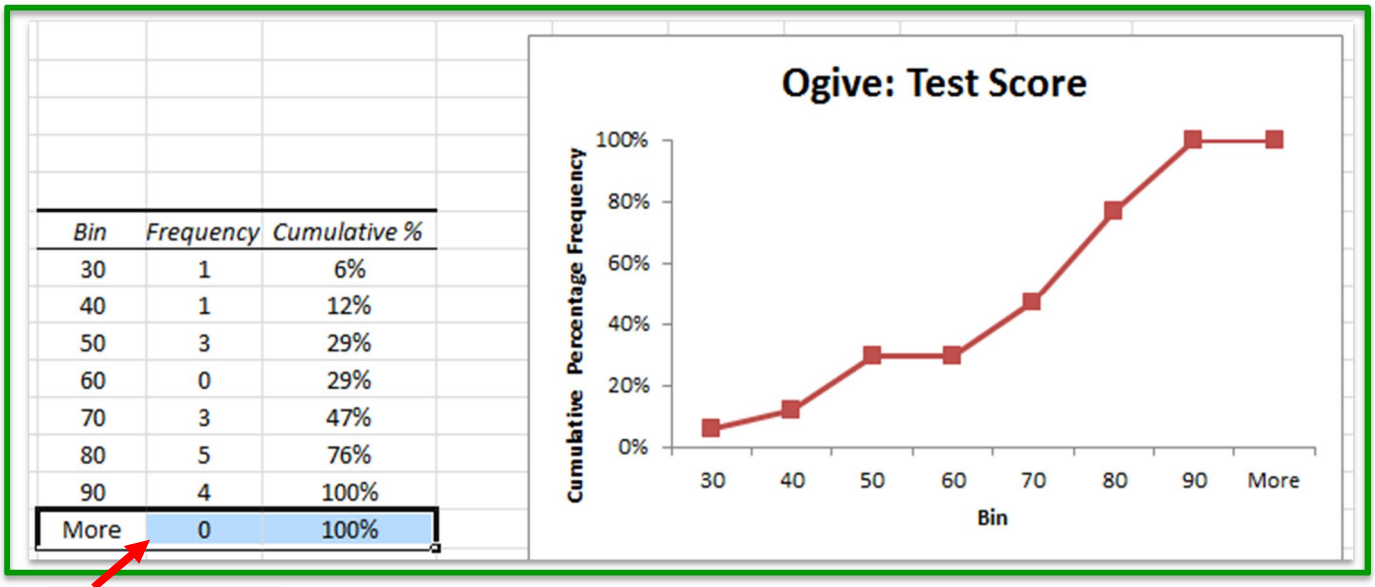


8. Making an Ogive

To make an **Ogive** using Excel, you do as with creating a Histogram but when you check **Chart Output** box, remember to check **Cumulative Percentage** box, too. Then click **Ok**.



Once you see the graph, click on any bar of the histogram; right-click and click **Delete**;
Clear the **More** category in the output.
Change the chart title and axis tittles and adjust the axis scales if necessary.



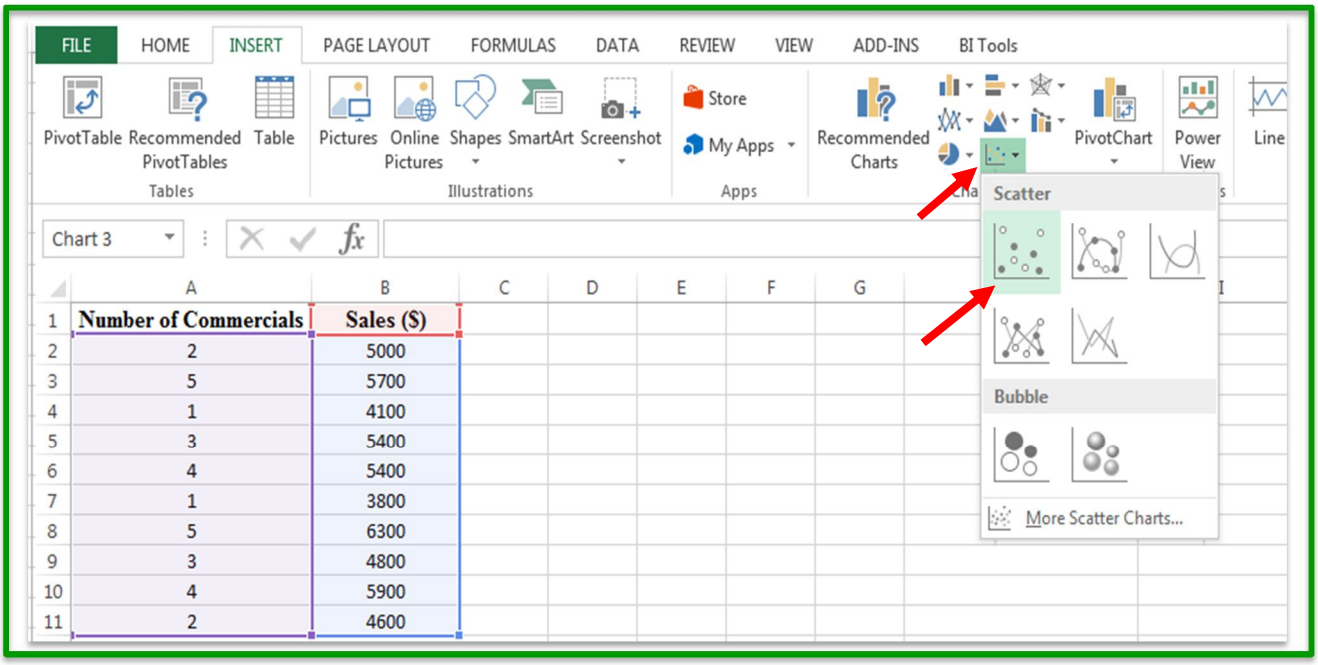
Bin	Frequency	Cumulative %
30	1	6%
40	1	12%
50	3	29%
60	0	29%
70	3	47%
80	5	76%
90	4	100%
More	0	100%

Clear this row

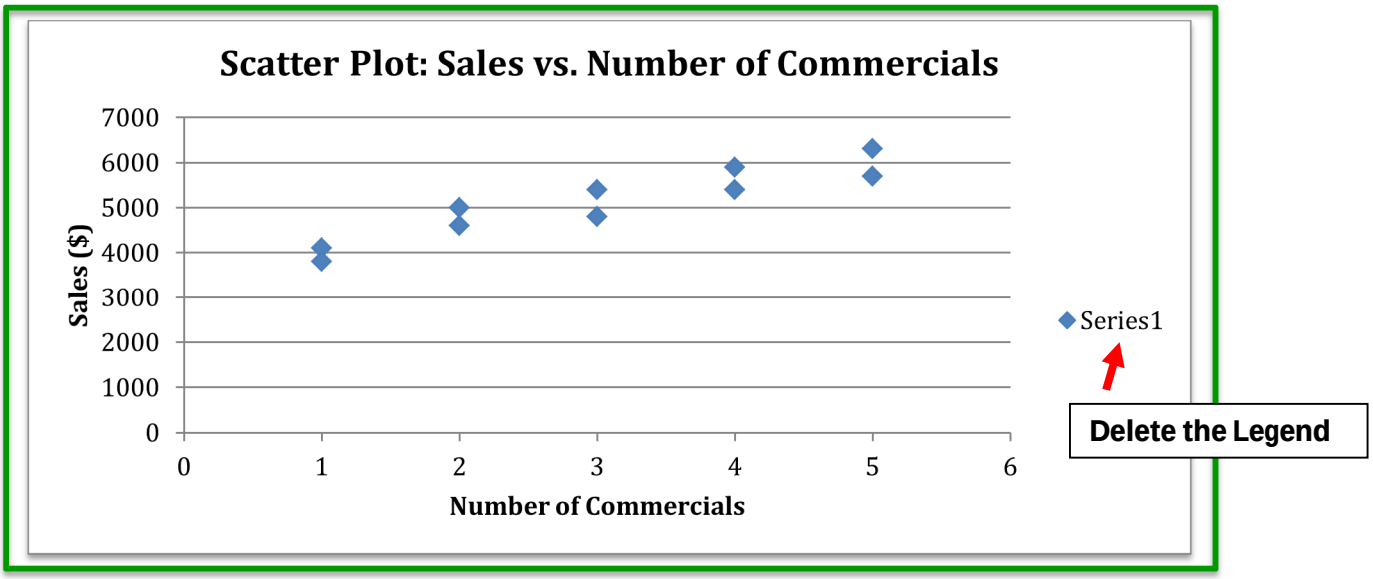
9. Scatter Plots

Highlight two columns (X first, then Y) that contain the data you want to represent in the scatter plot.

Open the **Insert** tab on the Excel ribbon, click **Scatter** Plot Symbol, then select the first item (as shown below), from this group.

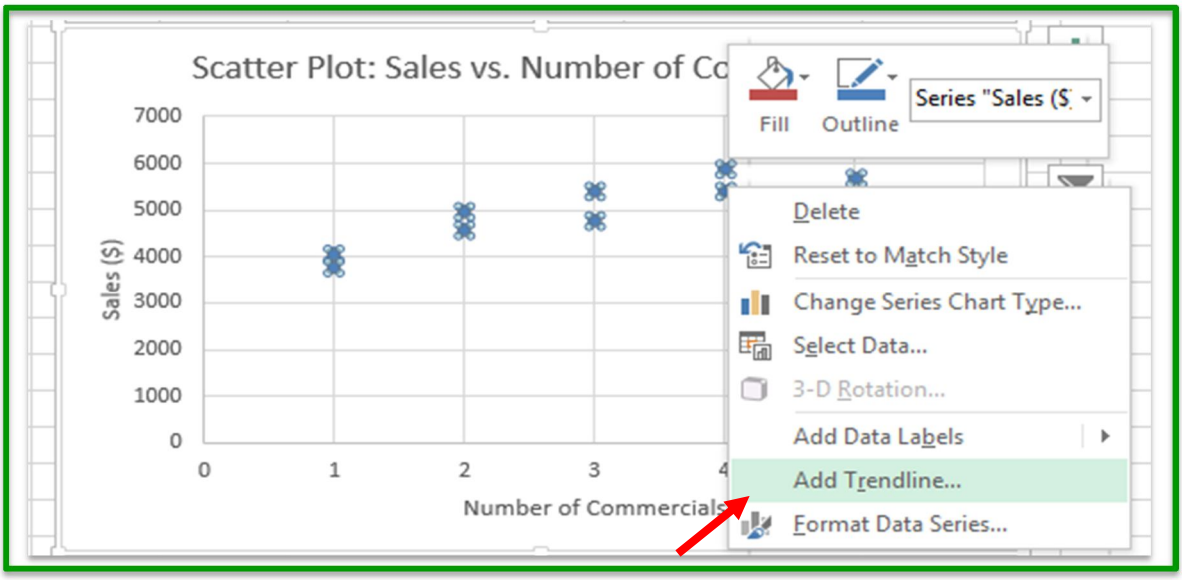


When the chart is created, delete the Legend and add the Chart Title and Axis Title to the chart by the plus sign (**+**) on the right of the chart and check the box next to **Axis Titles**.

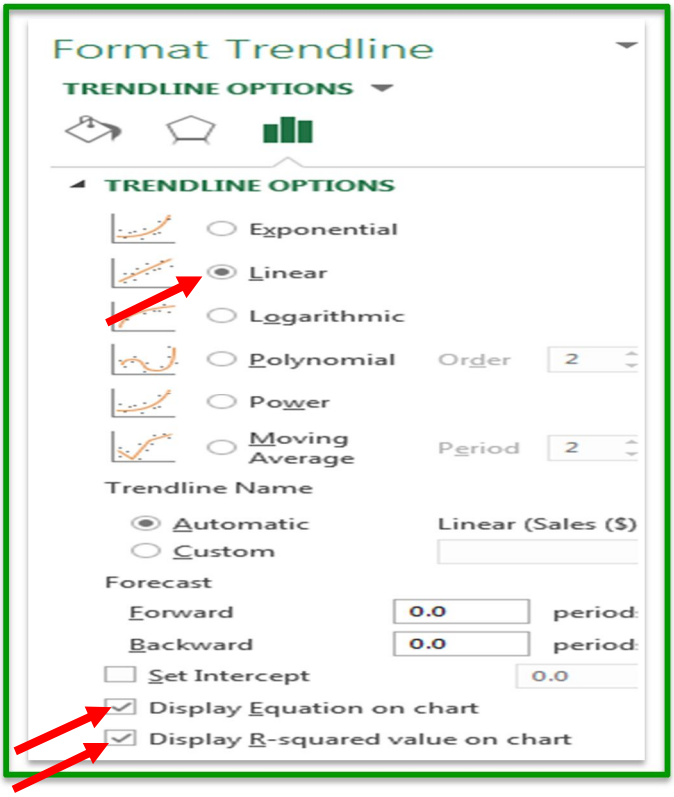


How to add the Regression Line to the chart?

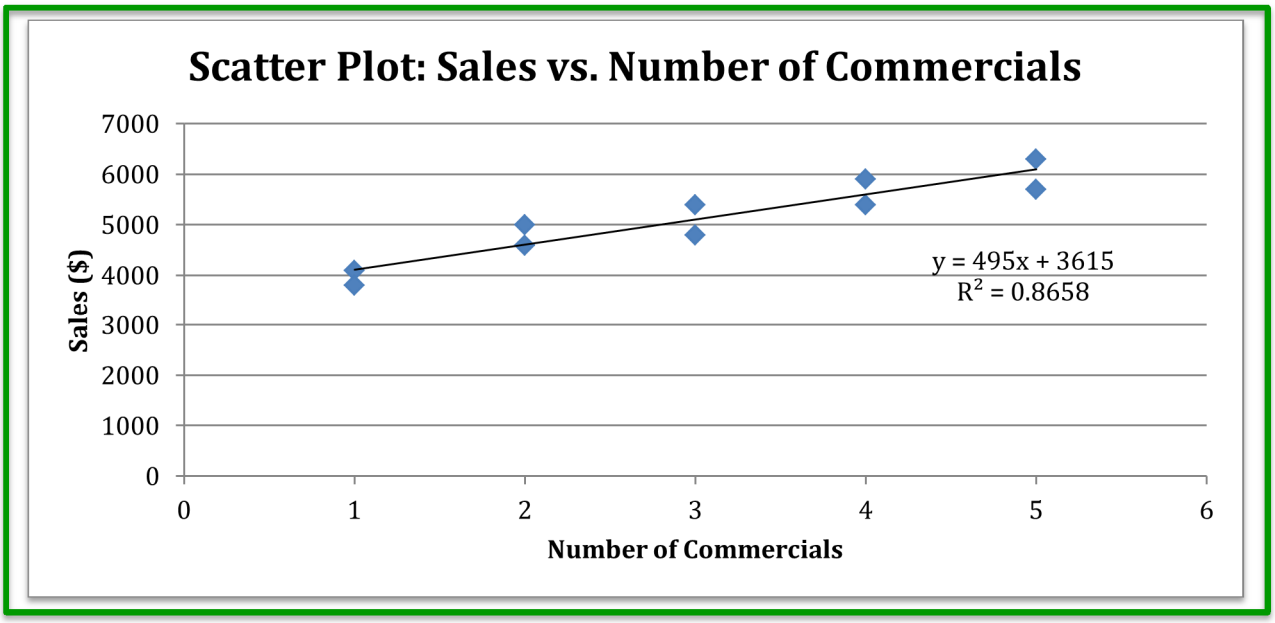
Click on any data point in the graph, right click, choose **Add Trendline**, choose **Linear**.



On the right hand side, you will see the following box appears. Check **Display Equation on chart** and **Display R-squared value on chart**.



And here is the scatter plot with the regression line you should now obtain.



Well done!

10. Covariance and Correlation Coefficient

Assuming that the data for X are located at A2:A11 and the data for Y are located at B2:B11.

X ***Y***

	A	B
1	Number of Commercials	Sales ($)
2	2	5000
3	5	5700
4	1	4100
5	3	5400
6	4	5400
7	1	3800
8	5	6300
9	3	4800
10	4	5900
11	2	4600

a) Sample Covariance between X and Y

Choose any cell; then type in the formula below.

= COVARIANCE.S(A2:A11,B2:B11) and then press **Enter**.

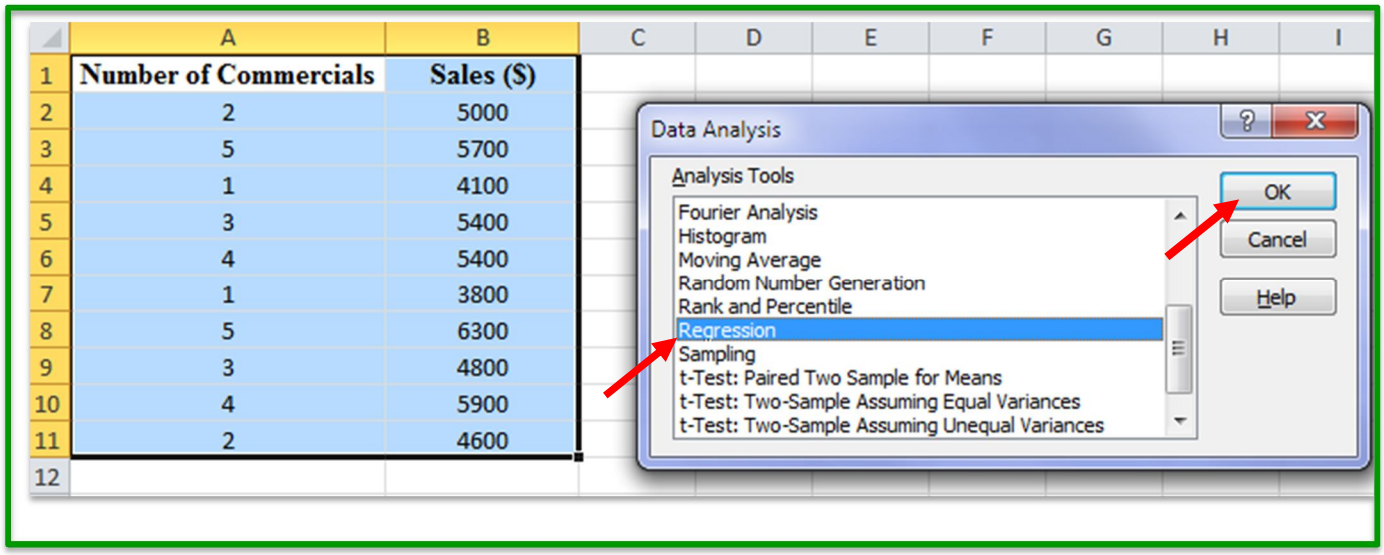
b) Sample Correlation Coefficient between X and Y

Choose any cell; then type in the formula below.

= CORREL(A2:A11, B2:B11) and then press **Enter**.

11. Linear Regression

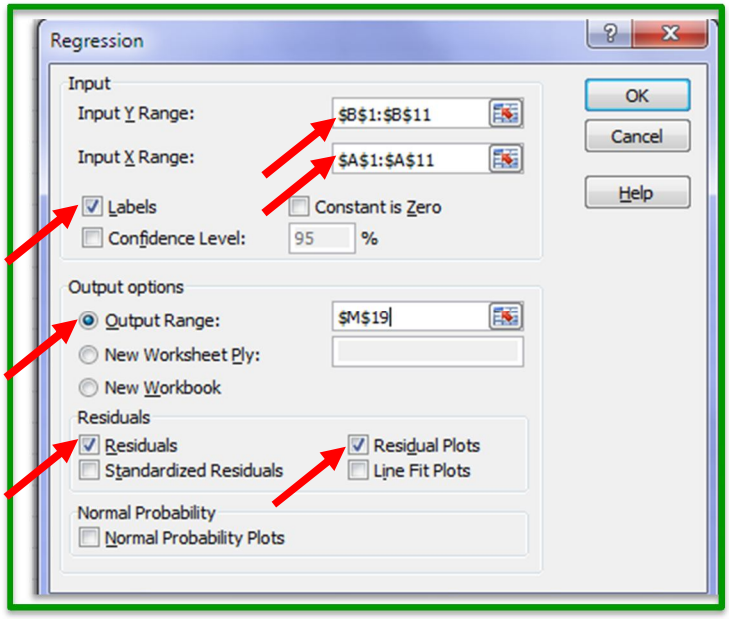
Click on the **Data** tab on the Excel ribbon, click **Data Analysis**; Scroll down to choose **Regression,** and click **OK**



Click on **Input Y Range** box and highlight the range for Y values

Click on **Input X Range** box and highlight the range for X values
Check the box next to **Labels** if the column headers are included.

Choose **Output Range** button, and place the cursor in the box next to **Output Range**; then click on any cell on the spread sheet where you want to place your output;



Check **Residual** (if you want to see the residuals) and **Residual Plots** and click **OK**.

And here is part of the Excel output you should now obtain:

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.930
R Square	0.866
Adjusted R Square	0.849
Standard Error	308.119
Observations	10

This is the correlation coefficient between two variables

This is the coefficient of determination

This is the number of pairs (X, Y) in the sample

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	4900500	4900500	51.61817	9.38553E-05
Residual	8	759500	94937.5		
Total	9	5660000			

This is the p-value for the F-test

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	3615	228.507385	15.82006	2.55E-07	3088.061025	4141.938975
Number of Commercials	495	68.8975689	7.184579	9.39E-05	336.1219212	653.8780788

This is the y-intercept

This is the slope

This is the 95% confidence interval for the slope, β_1

12. Confidence Interval for a Population Mean

Assume that **your actual data are located at A2:A65**.

a) When sigma, σ (the population standard deviation), is known:

Use **Average** function, **= AVERAGE(A2:A65)**, to compute the Sample Mean (the point estimate)

Use **Confidence.Norm** function to compute the margin of error, **E**. Choose any cell, then enter the formula **= CONFIDENCE.NORM(alpha, sigma, n)** and press **Enter**

Note: alpha = 1 – Confidence Level (*in decimal form*).

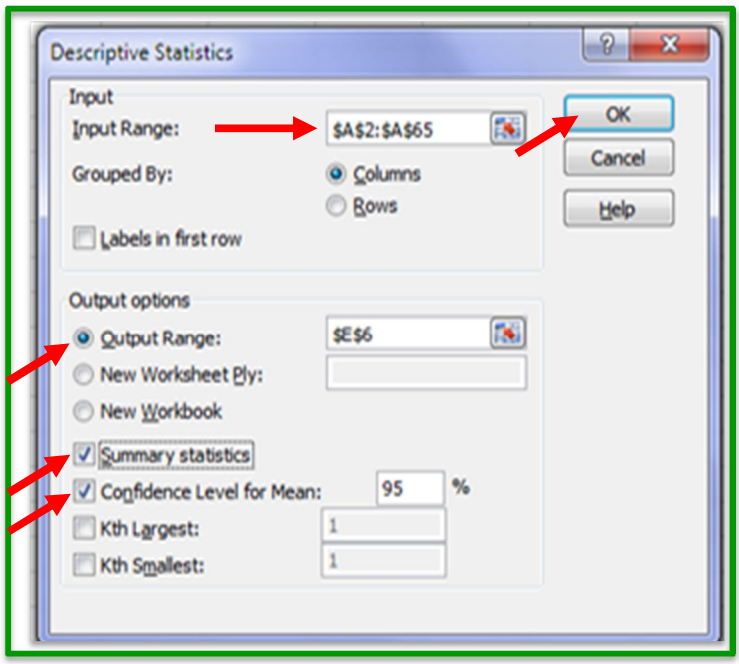
Results: **The Confidence Interval = Sample Mean ± E**

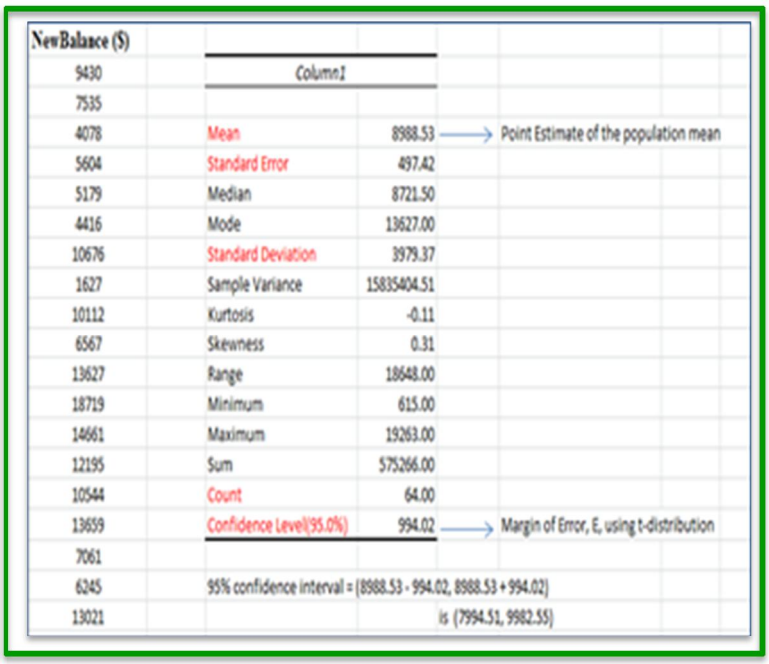
b) When sigma, σ, is unknown:

Click on **Data** tab on the Excel ribbon, click **Data Analysis**, choose **Descriptive Statistics**, and click **OK.**

Check **Summary Statistics** and **Confidence Level for Mean** boxes.

Enter the desired **Confidence Level**; by default it is 95%; and click **OK.**





NewBalance ($)			
9430	Column1		
7535			
4078	Mean	8988.53	→ Point Estimate of the population mean
5604	Standard Error	497.42	
5179	Median	8721.50	
4416	Mode	13627.00	
10676	Standard Deviation	3979.37	
1627	Sample Variance	15835404.51	
10112	Kurtosis	-0.11	
6567	Skewness	0.31	
13627	Range	18648.00	
18719	Minimum	615.00	
14661	Maximum	19263.00	
12195	Sum	575266.00	
10544	Count	64.00	
13659	Confidence Level(95.0%)	994.02	→ Margin of Error, E, using t-distribution
7061			
6245	95% confidence interval = (8988.53 - 994.02, 8988.53 + 994.02)		
13021		is (7994.51, 9982.55)	

Note: We can also use the formula **=CONFIDENCE.T(alpha, sample standard deviation, n)** to calculate the margin of error, E, for this case.

13. Hypothesis Tests about a Population Mean: z-Test

Case 1: The population standard deviation, σ, is known: Use **Z.TEST** function in Excel

Right-tailed test

General Formula

= Z.TEST (data range, hypothesized value, population standard deviation)

Example: = Z.TEST(A2:A65, 8000, 4000) and press **Enter**.

This function gives the p-value for a **right**-tailed test

Left-tailed test

General Formula

= 1- Z.TEST (data range, hypothesized value, population standard deviation)

Example: = 1 - Z.TEST(A2:A65, 10000, 4000) and press **Enter**

This function gives the p-value for a **left**-tailed test

Two-tailed test

To find the p-value of a **two-tailed** test for this case:

- Find the p-value for a right-tailed test as above
- Find the p-value for a left-tailed test as above
- Take the lower value of these two results.
- Multiply the lower value by 2; and this is the p-value for a two-tailed test.

14. Hypothesis Tests about a Population Mean: t-Test

Case 2: The population standard deviation, σ, is known

Method 1:

When the population standard deviation, sigma, is not given, we do the same as in the case with sigma given. The only difference is that we don't enter the value for sigma in the formula. Excel will automatically enter the **sample** standard deviation instead.

The name of the test is still Z.TEST but, in fact, Excel is using **t-distributions**.

Right-tailed test

General Formula **= Z.TEST (data range, hypothesized value)**

Example: = Z.TEST(A2:A65, 8000)

This function gives the p-value for a **right**-tailed test

Left-tailed test

General Formula **= 1- Z.TEST (data range, hypothesized value)**

Example: = 1 - Z.TEST(A2:A65, 10000)

This function gives the p-value for a **left**-tailed test

Two-tailed test

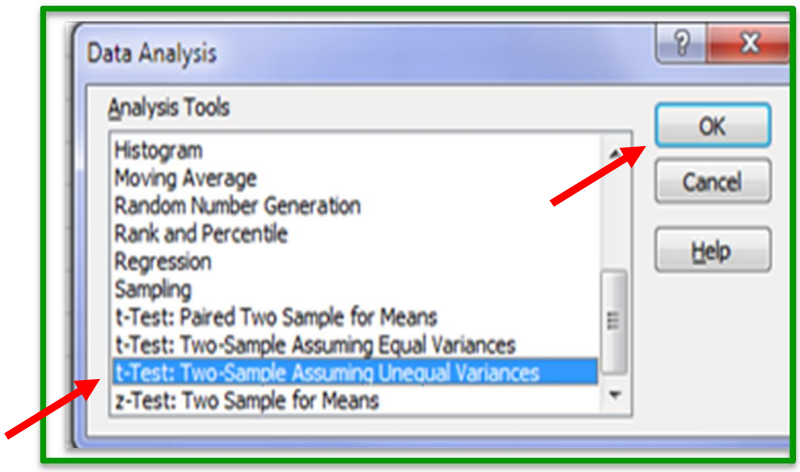
To find the p-value of a **two-tailed** test for this case:

- Find the p-value for a right-tailed test as above
- Find the p-value for a left-tailed test as above
- Take the lower value of these two results.
- Multiply the lower value by 2; and this is the p-value for a two-tailed test.

Method 2: Use t-Test: Two-Sample Assuming Unequal Variances and "fool" Excel approach

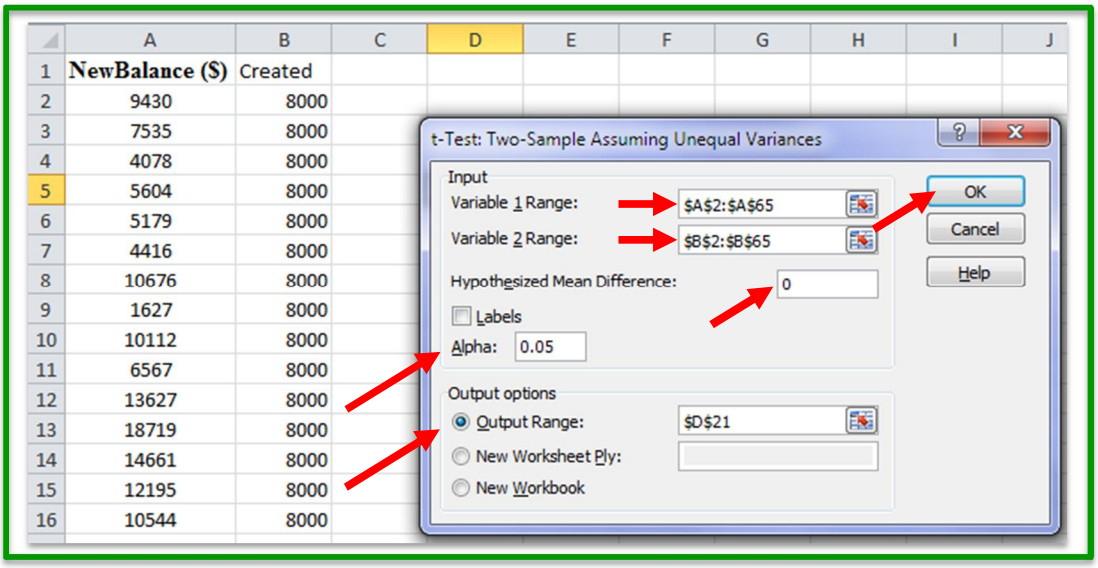
In this approach, we will create a new column such that all the values of this column are the same as the hypothesized mean value and the number of values is equal to the sample size, n. (*Please see the figure below.)*

Click on **Data**, click on **Data Analysis**, scroll down then choose **t-Test: Two-Sample Assuming Unequal Variances.**



Enter the data range of the sample given in the problem into **Variable 1 Range**;

Enter the data range of the created column into **Variable 2 Range**;



Enter **0** as the **Hypothesized Mean Difference**;

Enter the value for the significance level **alpha**; assume that it is 0.01 in this example;

Choose **Output Range**, place the cursor in the box next to **Output Range** and click on any cell where you want to keep your output.

Here is the Excel Output you should now obtain:

t-Test: Two-Sample Assuming Unequal Variances

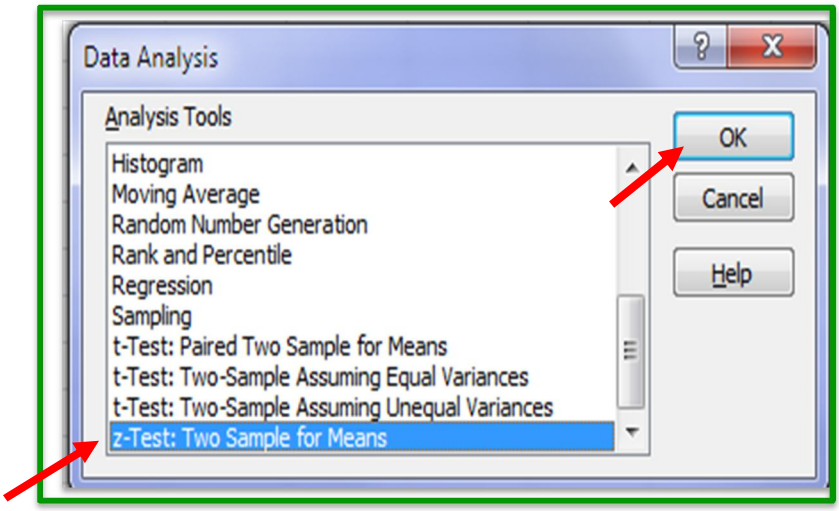
	Variable 1	*Variable 2*	
Mean	8988.53	8000	
Variance	15835404.51	0	
Observations	64	64	
Hypothesized Mean Difference	0		
df	63		
t Stat	1.9873	←	This is the t-statistic value
P(T<=t) one-tail	0.0256	←	This is the p-value for a one tailed test
t Critical one-tail	1.6694	←	This is the t-critical value for a right-tailed test
P(T<=t) two-tail	0.0512	←	This is the p-value for a two-tailed test
t Critical two-tail	1.9983	←	This is the positive t-critical value for a two-tailed test

Note: The **t-Test: Two- Sample Assuming Unequal Variances** we used above is, in fact, a procedure used to conduct a hypothesis test about the difference between two population means given **two** independent samples. Since we have only one sample, we created a new column to "fool" Excel. Instead of testing whether **μ** is greater than 8000, we test whether (**μ** – 8000) is greater than 0. For this reason, we enter 0 as the Hypothesized Mean Difference.

15. Two Independent Samples: z-Test

Assume that two population standard deviations, σ_1 and σ_2, are known.

Click on **Data**, click on **Data Analysis**, scroll down then choose **z-test: Two sample for Means** and click **OK**.

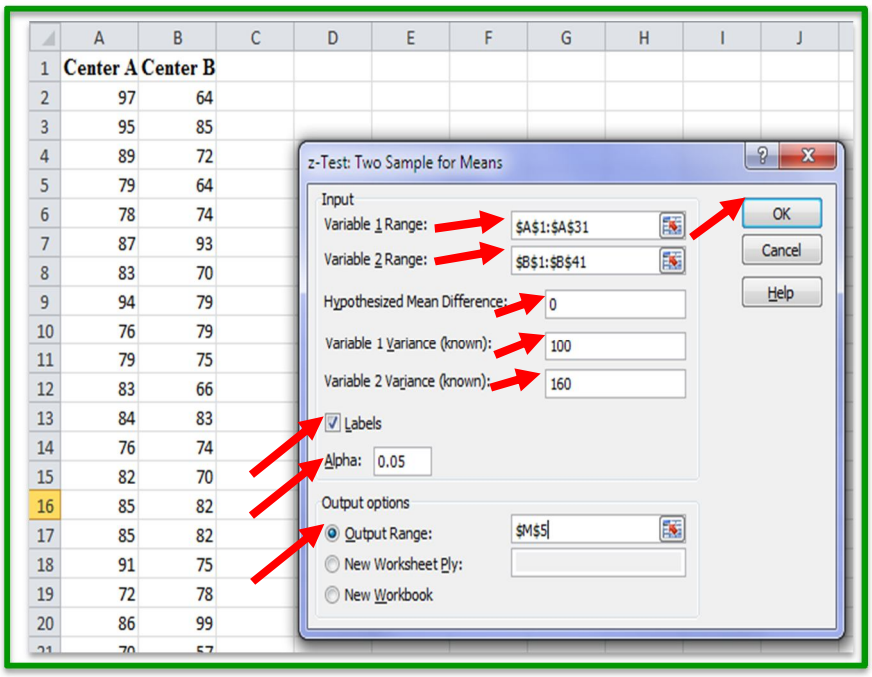


***Example**: We want to test whether the mean exam score of students who study at Center A (population 1) is different from the mean exam score of students who study at Center B (population 2). Assume that σ_1 is 10; σ_2 is 40; and $\alpha = 0.05$.*

Enter the data range of the sample drawn from population 1 (Center A) into **Variable 1 Range**;

Enter the data range of the sample drawn from population 2 (Center B) into **Variable 2 Range**;

Enter the **Hypothesized Mean Difference** (*this is the hypothesized difference between the two population means in the null hypothesis*).



Enter the known values of sigma 1 squared into the box next to **Variable 1 Variance (known)** and sigma 2 squared into the box next to **Variable 2 Variance (known)**.

Check the **Labels** box if the column headers are included.

Enter the value for the significance level **alpha**; By default it is 0.05.

Choose **Output Range**, the move the cursor to the box next to **Output Range** and click on any cell where you want to keep your output, and then click **OK**.

Here is the Excel Output you should now obtain:

z-Test: Two Sample for Means

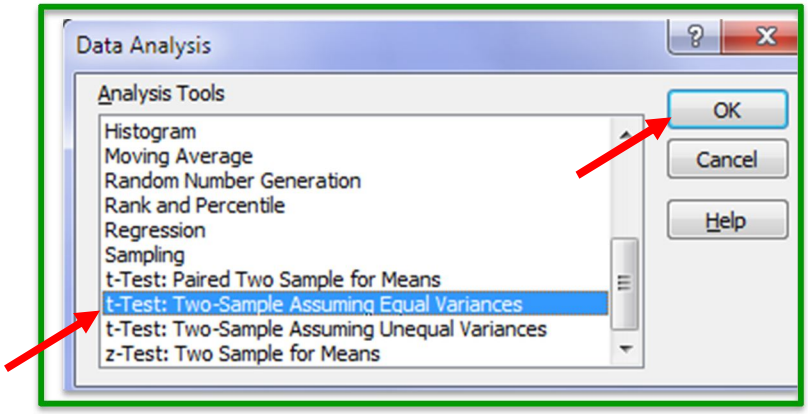
	Center A	*Center B*	
Mean	82	78	
Known Variance	100	160	
Observations	30	40	
Hypothesized Mean Differ	0		
z	1.48	←	This is the z-statistic value
P(Z<=z) one-tail	0.07		
z Critical one-tail	1.64		
P(Z<=z) two-tail	0.14	←	This is the p-value for a two tailed test
z Critical two-tail	1.96	←	This is the positive z-critical value for a two tailed test

In this example, the hypothesis test is a two-tailed test. The value of the test statistic is 1.48. P-value = 0.07 > 0.05; Therefore, we fail to reject the null hypothesis. There is not enough evidence to infer that the mean scores of the two centers are significantly different.

16. T-Test: Two-Sample Assuming Equal Variances

Assuming two population standard deviations, σ_1 and σ_2 , are unknown and $\sigma_1 = \sigma_2$ *(Equal Variances)*

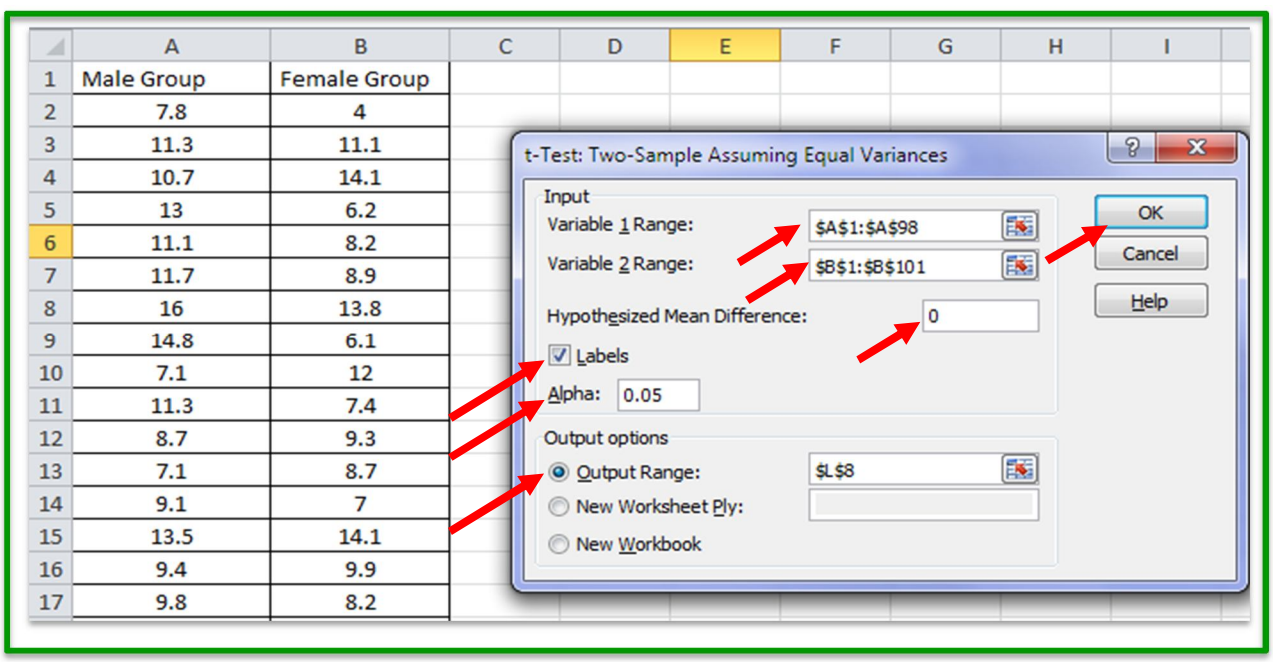
Click on **Data**, click on **Data Analysis**, scroll down then choose **t-Test: Two-Sample Assuming Equal Variances.**



***Example**: We want to test whether male drivers have a greater number of miles driven per year than female drivers with α = 0.05. (Data are given in thousands of miles)*

Enter the data range of the sample from population 1 (Male Group) into **Variable 1 Range**;

Enter the data range of the sample from population 2 (Female Group) into **Variable 2 Range**;



	A	B
1	Male Group	Female Group
2	7.8	4
3	11.3	11.1
4	10.7	14.1
5	13	6.2
6	11.1	8.2
7	11.7	8.9
8	16	13.8
9	14.8	6.1
10	7.1	12
11	11.3	7.4
12	8.7	9.3
13	7.1	8.7
14	9.1	7
15	13.5	14.1
16	9.4	9.9
17	9.8	8.2

Enter the **Hypothesized Mean Difference;**

Check the **Labels** box if the column headers are included in the data range.

Enter the value for the significance level **alpha**; by default it is 0.05;

Choose **Output Range**, then move the cursor to the box next to **Output Range** and click on any cell where you want to keep your output. And click **OK**.

Here is the Excel Output you should now obtain:

t-Test: Two-Sample Assuming Equal Variances

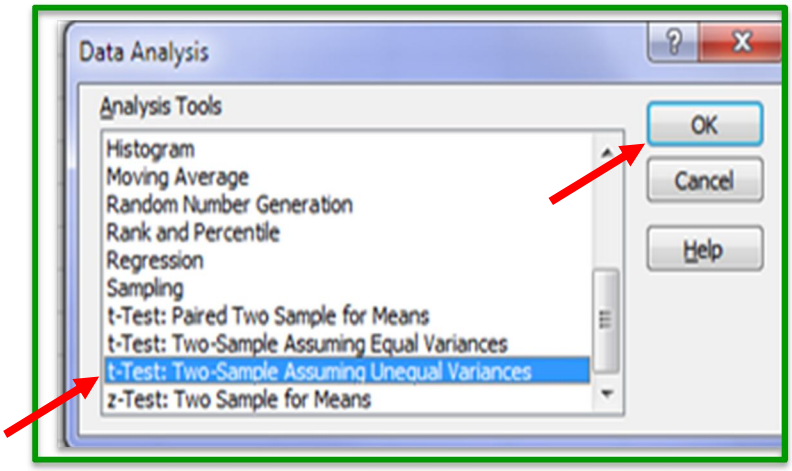
	Male Group	*Female Group*	
Mean	10.258	9.659	
Variance	8.41	8.38	
Observations	97	100	
Pooled Variance	8.40		
Hypothesized Mean Difference	0		
df	195	←	This is the number of degrees of freedom for the t-distribution
t Stat	1.450	←	This is the t-statistic value
P(T<=t) one-tail	0.074	←	This is the p-value for one tailed test (i.e., right-tailed or left-tailed)
t Critical one-tail	1.653	←	This is the critical value for a right-tailed test
P(T<=t) two-tail	0.149		
t Critical two-tail	1.972		

In this example, the hypothesis test is a right-tailed test. The value of the t-test statistic is 1.45. P-value = 0.074 > 0.05 (the significance level); Therefore, we don't reject the null hypothesis at the 5% significance level. The sample data do not provide enough evidence to infer that male drivers have a greater number of miles driven per year than female drivers.

17.T-Test: Two-Sample Assuming Unequal Variances

Assume that σ_1 and σ_2 are unknown and not equal *(Unequal Variances)*

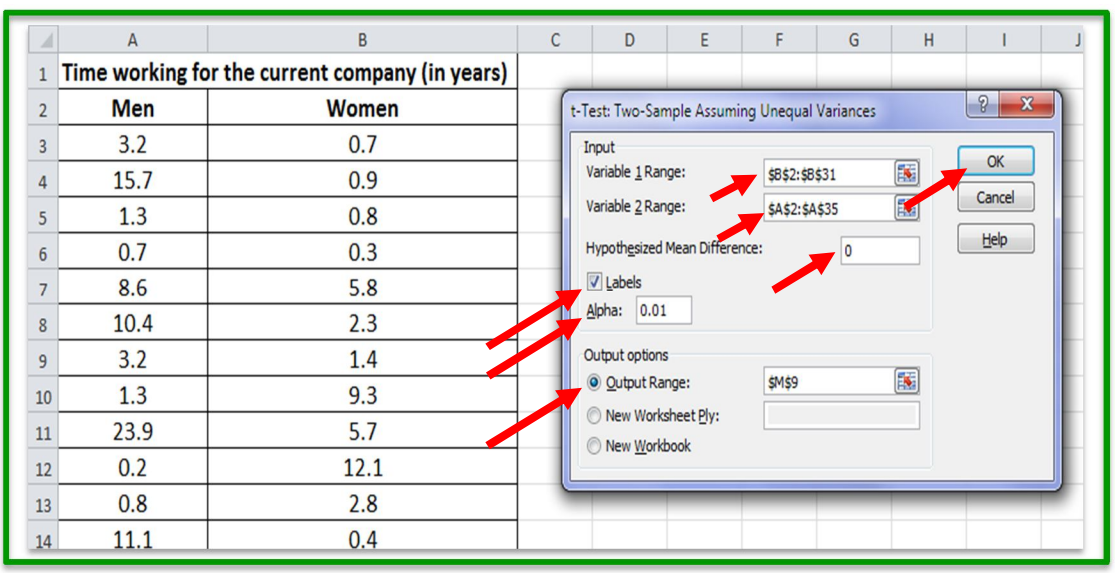
Click on **Data**, click on **Data Analysis**, scroll down then choose **t-Test: Two-Sample Assuming Unequal Variances.**



***Example**: We want to test whether the mean working times for women is less than the mean working time for men with α = 0.01.*

Enter the data range of the sample from population 1 (Women) into **Variable 1 Range**;

Enter the data range of the sample from population 2 (Men) into **Variable 2 Range**;



	A	B
1	Time working for the current company (in years)	
2	Men	Women
3	3.2	0.7
4	15.7	0.9
5	1.3	0.8
6	0.7	0.3
7	8.6	5.8
8	10.4	2.3
9	3.2	1.4
10	1.3	9.3
11	23.9	5.7
12	0.2	12.1
13	0.8	2.8
14	11.1	0.4

Enter the **Hypothesized Mean Difference**;

Check the **Labels** box if the column headers are included;

Enter the value for the significance level **alpha**; it is 0.01 in this example;

Choose **Output Range**, place the cursor in the box next to **Output Range** and click on any cell where you want to keep your output.

Here is the Excel Output you should now obtain:

t-Test: Two-Sample Assuming Unequal Variances

	Women	*Men*	
Mean	6.021	6.970	
Variance	43.897	34.468	
Observations	29	33	
Hypothesized Mean Difference	0		
df	56	←	This is the number of degrees of freedom for the t-distribution
t Stat	-0.593	←	This is the t-statistic value
P(T<=t) one-tail	0.278	←	This is the p-value for a one tailed test
t Critical one-tail	2.395	←	This is the t-critical value for a right-tailed test
P(T<=t) two-tail	0.555		
t Critical two-tail	2.667		

Note: Excel always reports ***t Critical one-tail*** which is the t-critical value for a right-tailed test. If you are conducting a left-tailed test then the t-critical value is the opposite of ***t Critical one-tail***.

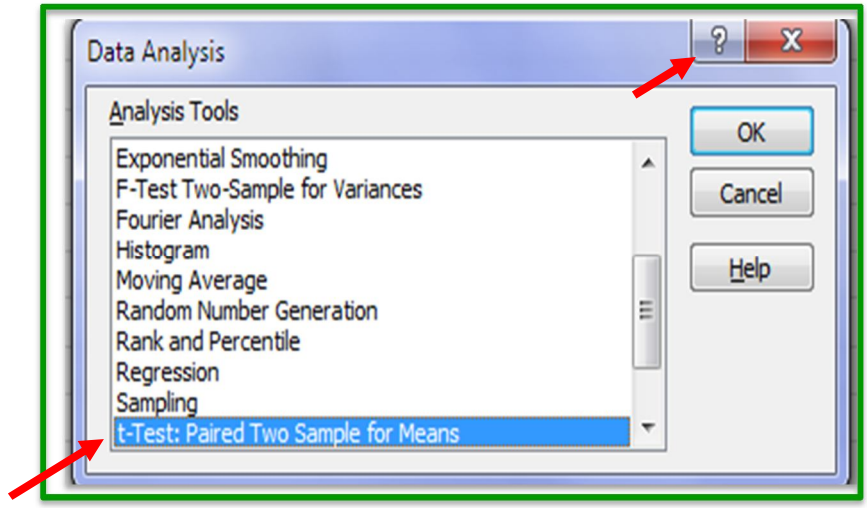
In this example, we are conducting a left-tailed test. Therefore, the t-critical value should be (– 2.395).

The hypothesis test in this example is a left-tailed test. P-value = 0.278 > 0.01; we fail to reject the null hypothesis and the test is not statistically significant at the 1% significance level. The sample data do not support the claim that the mean working times for women is less than the mean working time for men. The value of the t-test statistic is -0.593.

18. T-Test: Paired Two Sample for Means

Assuming two dependent samples (matched samples).

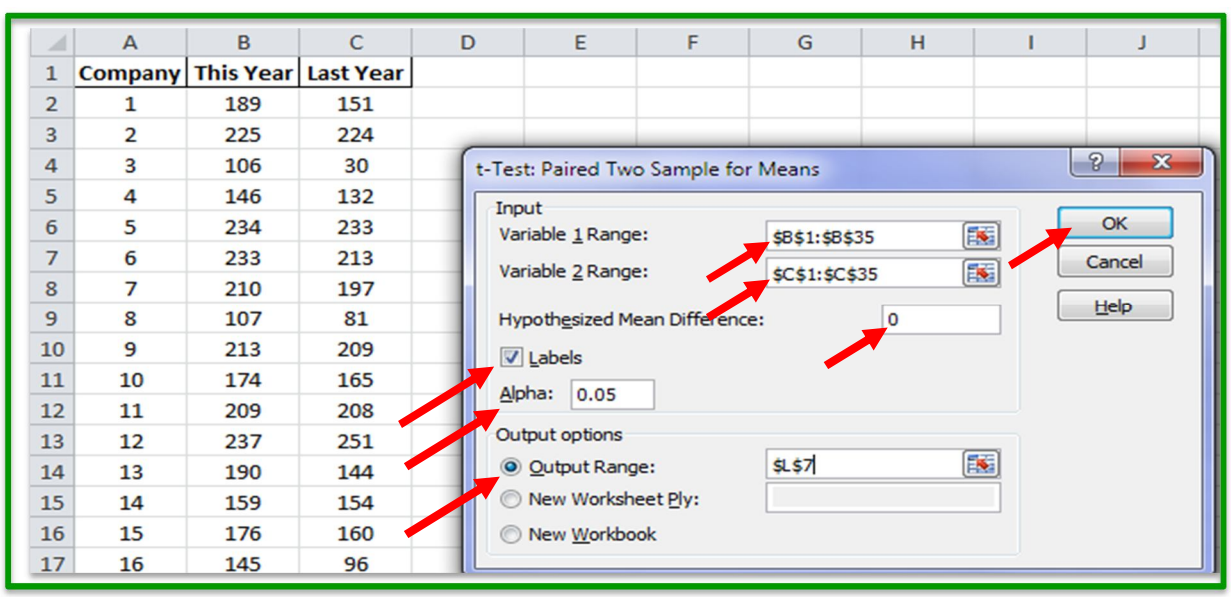
Click on **Data**, click on **Data Analysis**, scroll down then choose **t-Test: Paired Two Sample for Means.** ***Difference,***



Example*: We want to test whether advertising in the Yellow Pages improves sales (in thousands of dollars) with α = 0.05*. Difference, ***D = This Year – Last Year.***

Enter the data range of the sample from population 1 (**This Year**) into **Variable 1 Range**;

Enter the data range of the sample from population 2 (**Last Year**) into **Variable 2 Range**;



Enter the **Hypothesized Mean Difference**;

Check the **Labels** box if the column headers are included. Enter the value for the significance level **alpha**, by default it is 0.05;

Choose **Output Range**, then move the cursor to the box next to **Output Range** and click on any cell where you want to keep your output.

You should now get the excel output as the following:

t-Test: Paired Two Sample for Means

	This Year	*Last Year*	
Mean	195.65	175.74	
Variance	1674.96	2816.50	
Observations	34	34	
Pearson Correlation	0.8258		
Hypothesized Mean Difference	0		
df	33		
t Stat	3.8614	←	This is the t-statistic value
P(T<=t) one-tail	0.0002	←	This is the p-value for a one tailed test
t Critical one-tail	1.6924	←	This is the t-critical value for a right-tailed test
P(T<=t) two-tail	0.0005		
t Critical two-tail	2.0345		

In this example, we are conducting a right-tailed test. The p-value for this test is 0.0002.

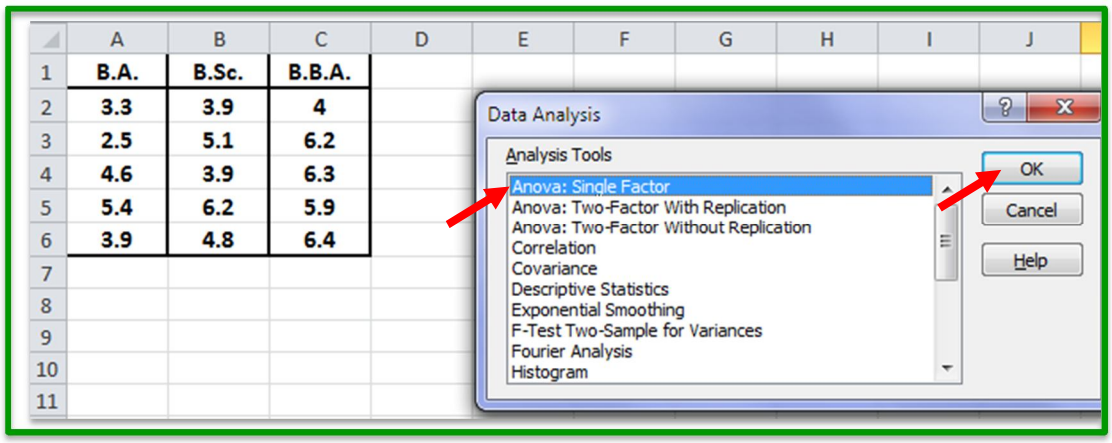
We have strong evidence to reject the null hypothesis. The sample data support the claim that advertising in the Yellow Pages improves sales. The test is statistically significant; t-statistic is 3.86 and p-value = 0.0002.

19. One-Way Analysis of Variance (ANOVA)

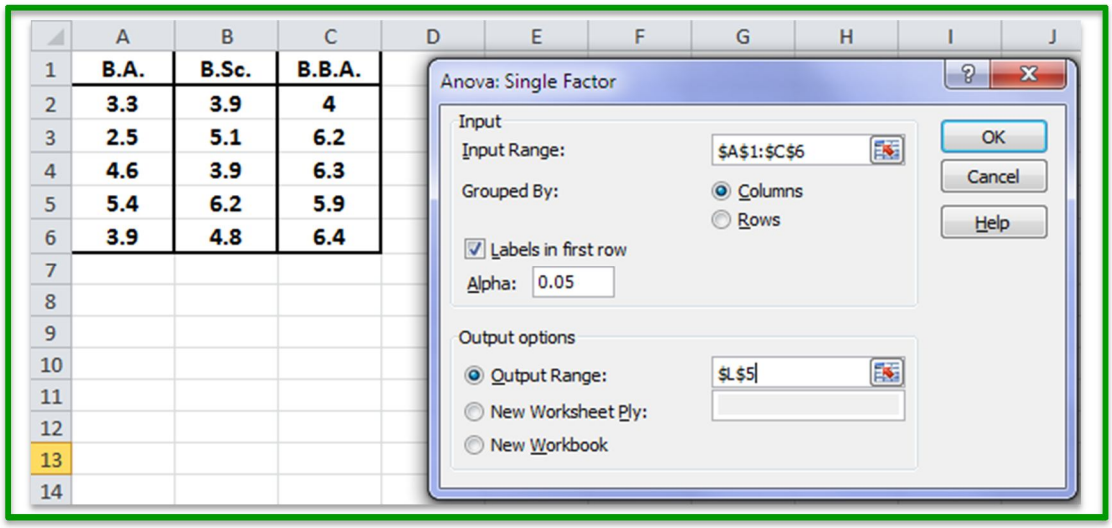
The analysis of variance procedure is used to determine whether differences exist between **two or more** population means.

***Example**: A random sample of 5 students in the BA, BSc, and BBA programs were asked to report what they earned the previous summer. The results (in $1,000s) are in the figure below. Can we infer at the 5% significance level that students in different degree programs earn different amounts?*

Click on **Data**, click on **Data Analysis**, click on **Anova: Single Factor**, and click **OK**.



When the **Anova: Single Factor** table appear, click on the box next to **Input Range**, then highlight all the data including the labels to input the data.



Check the box next to **Labels in first row**; enter the significance level alpha into the box next to **Alpha**. Check the button next to **Output Range**, then move the cursor to the box next to **Output Range** and click on any cell where you want to place your output.

Here is the output you should now obtain:

Anova: Single Factor

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
B.A.	5	19.7	3.94	1.263
B.Sc.	5	23.9	4.78	0.917
B.B.A.	5	28.8	5.76	1.003

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	8.2973	2	4.1487	3.9101	0.0493	3.8853
Within Groups	12.732	12	1.061			
Total	21.0293	14				

This is the F-critical Value

This is the F-statistic Value

This is the p-value of the F-test

Interpretation: In this sample data, F-statistic = 3.9101 which is greater than the F-critical value (3.8853). Therefore, at the 5% significance level, we can reject the null hypothesis. The sample data seem to support the alternative hypothesis that differences exist between population means. However, the p-value is 0.0493 which is very close to the significance level 0.05. This means that the evidence in the sample data is not very strong. We also notice that the sample sizes are small (n = 5 for each sample). Therefore, more data should be collected to have a more conclusive decision.