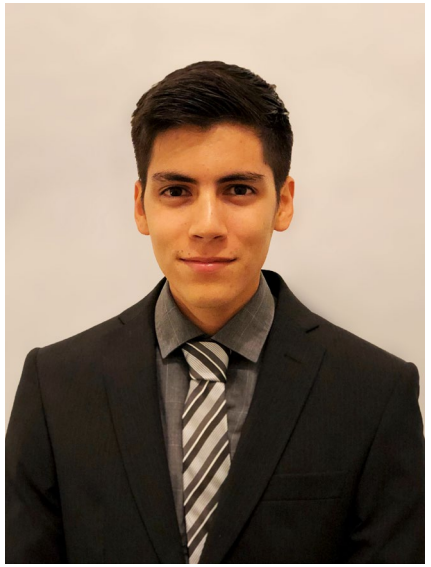
Module 1. JMP Basics

Presented by: QE NPI Andres Ruelas

Instructor: Andres Ruelas

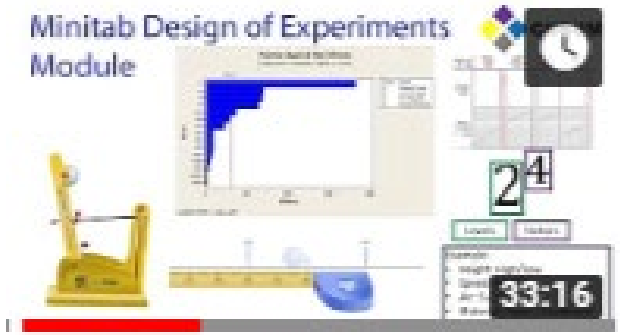


- Quality and New Product Introduction Engineer
- Medical sector (Cardinal Health, Medtronic, Stryker)
- Specialized in molding, extrusion, sealing with Urania and Multivac equipment, and automatic inspection systems
- 7 published textbooks, available at Amazon
  - Quality Engineering for Recent College Graduates (Engineering / Quality)
  - Guía Para la inversión utilizando Cetes Directo (Finance / Costs)
  - Minitab Masters Fundamentals / Validations (Engineering / DOE)

- Cetys University: Diploma in Medical Manufacturing Engineering
- Cetys University: Diploma in Cost Engineering
- Cetys University: Diploma in Project Management
- Eje Institute: Seminar in Scientific Molding
- Minitab YouTube channel with more than 250,000 views and 4,200 training hours given

Training and Courses Given

- YouTube Channel: CUSUM – Training For Professionals
- Views: +250,000 People
- Videos: 6 Videos focused on Minitab
- Hours given: 4,200 hours



Design of Experiments (DOE) - Minitab Masters Module 5

Instructor at Lean Six Sigma Academy – Bit Center

Courses given

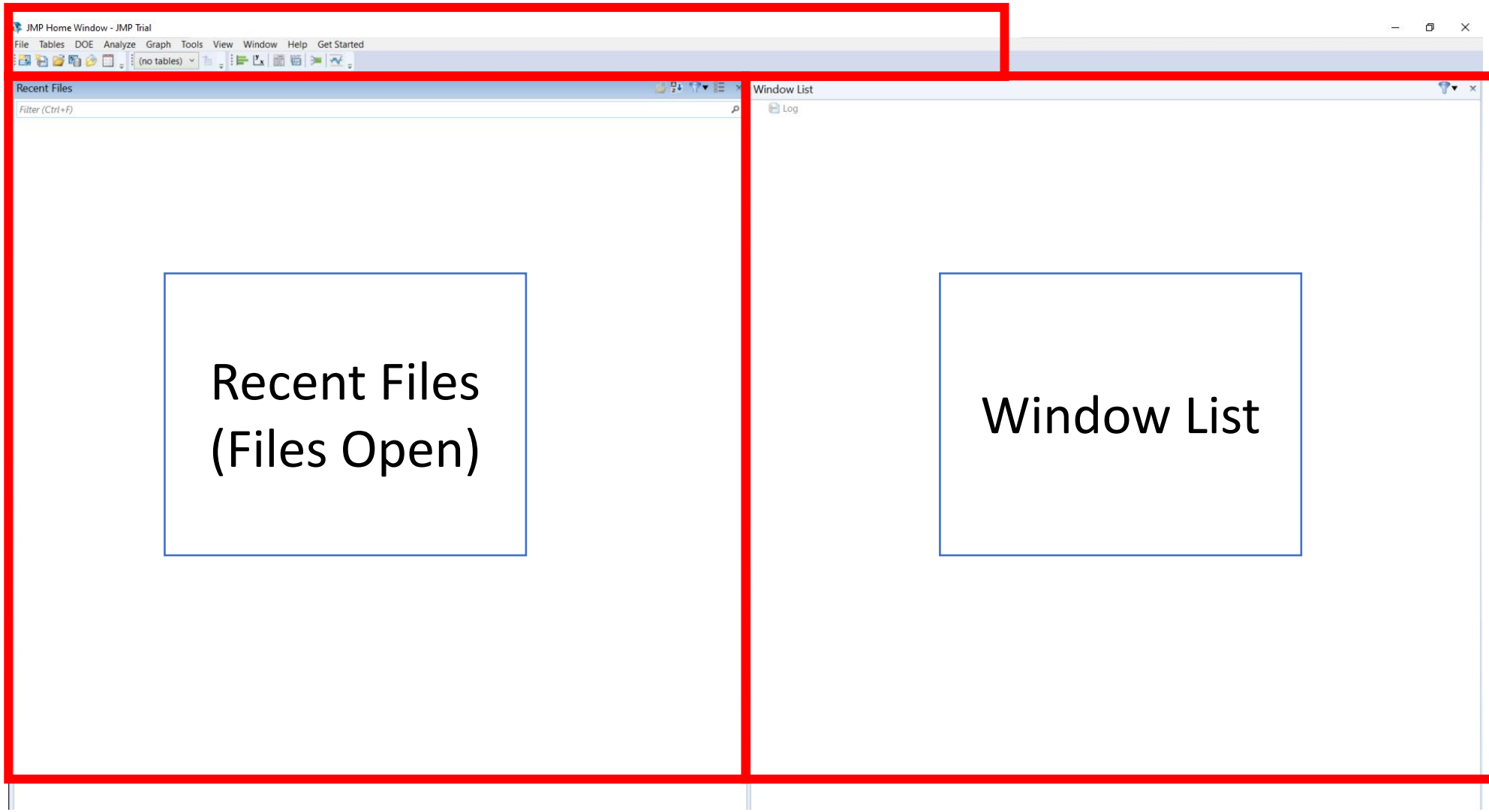
- Root Cause Analysis in Minitab (RCA)
- Statistical Analysis for Validations with Minitab

Note on JMP 16

- To this date, there are multiple JMP versions available
- Most of the studies should be applicable for all versions however we can't guarantee full compatibility.
- JMP 16 has just been launched in 2021, and is not currently being used by most companies. However, the interface and analysis should be similar to other versions.

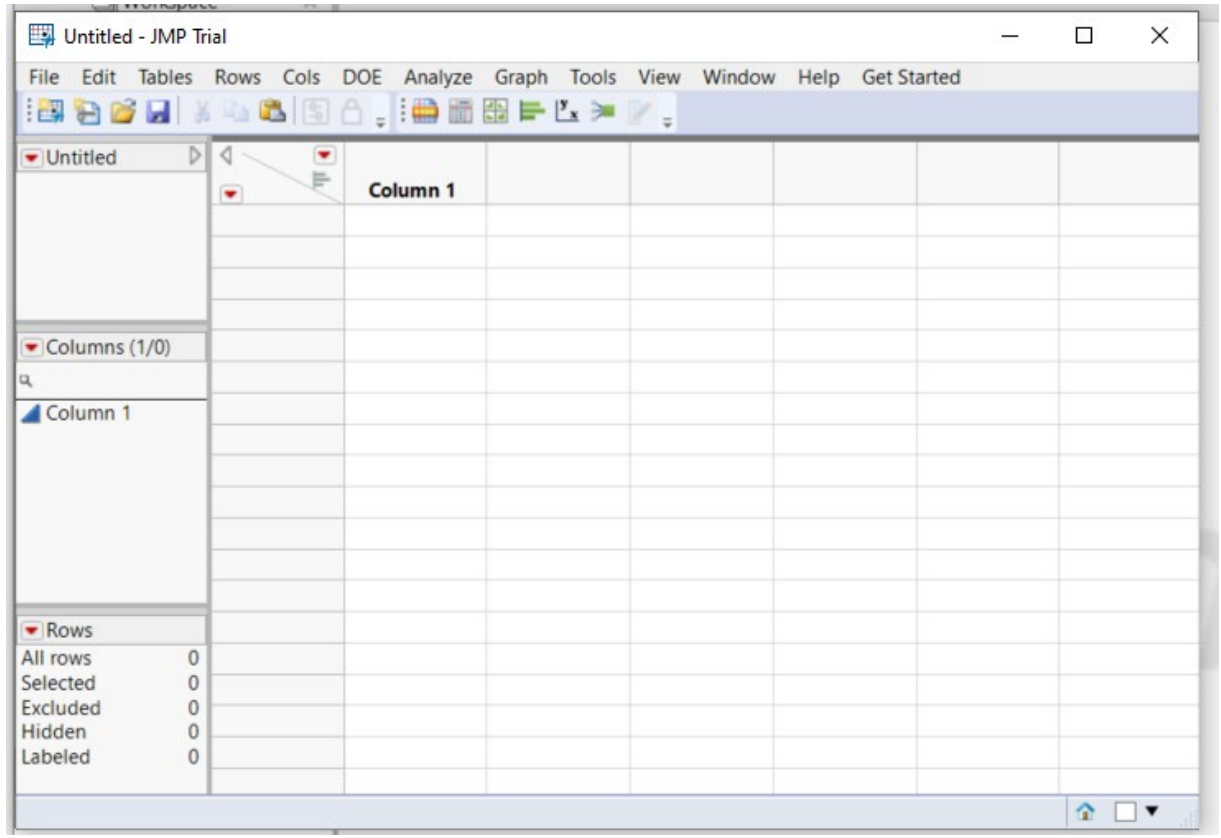
JMP Interface

Toolbars

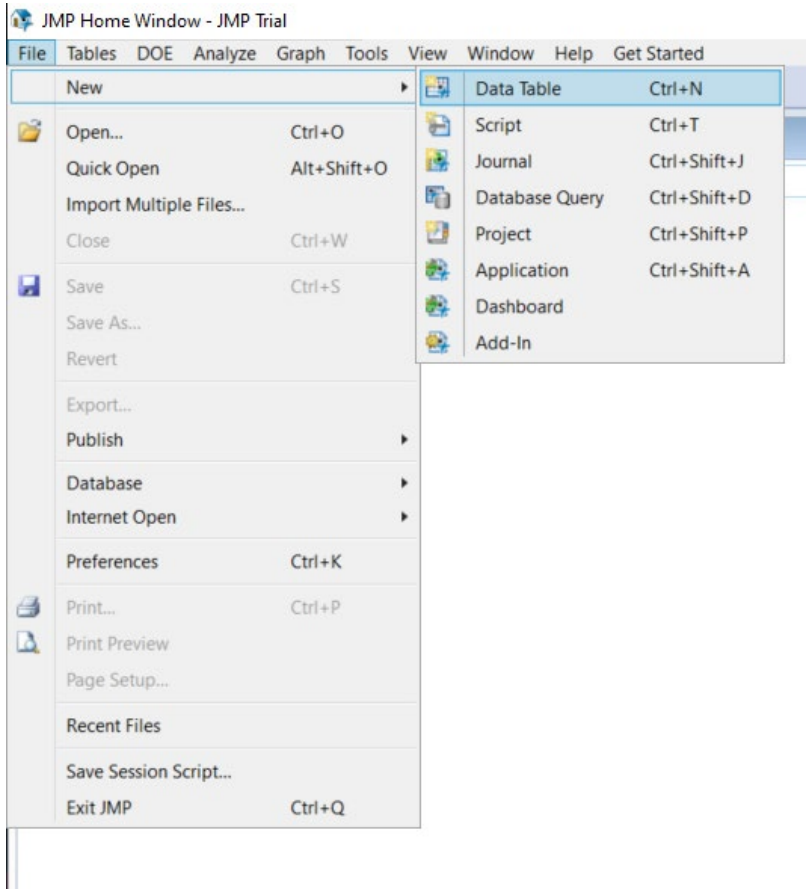


Worksheet Creation

Press Ctrl + N
To create a new worksheet

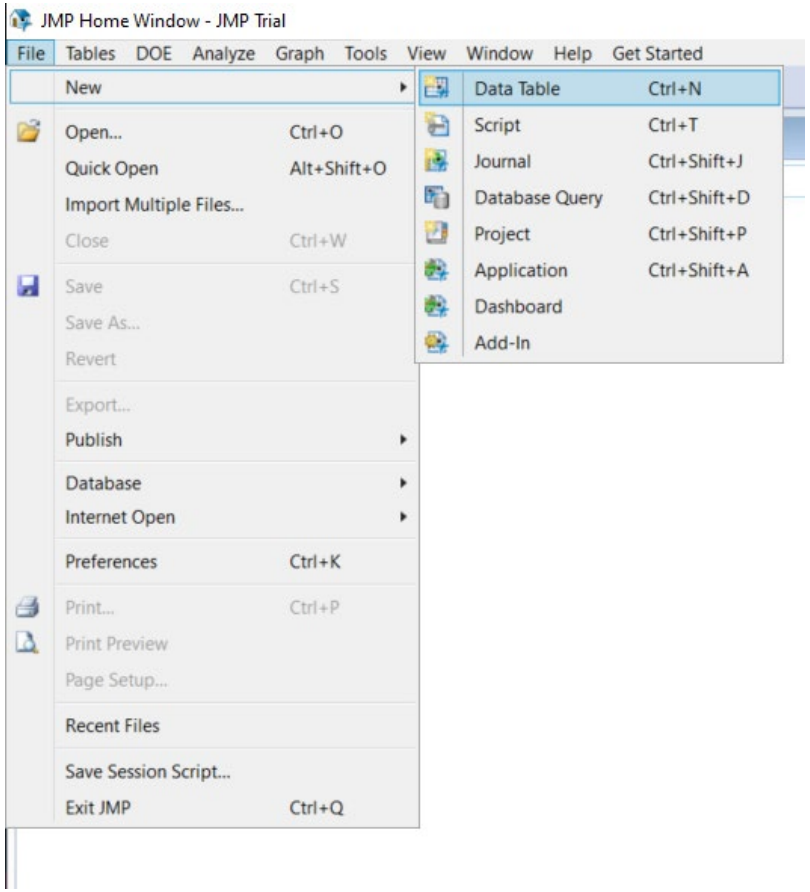


Select File > New > Data Table



Project Creation

Select File > New > Project



Worksheets / Data Tables: Mostly used to make quick analysis

Projects: Can contain multiple data tables and allow for sharing JMP files among users easier.

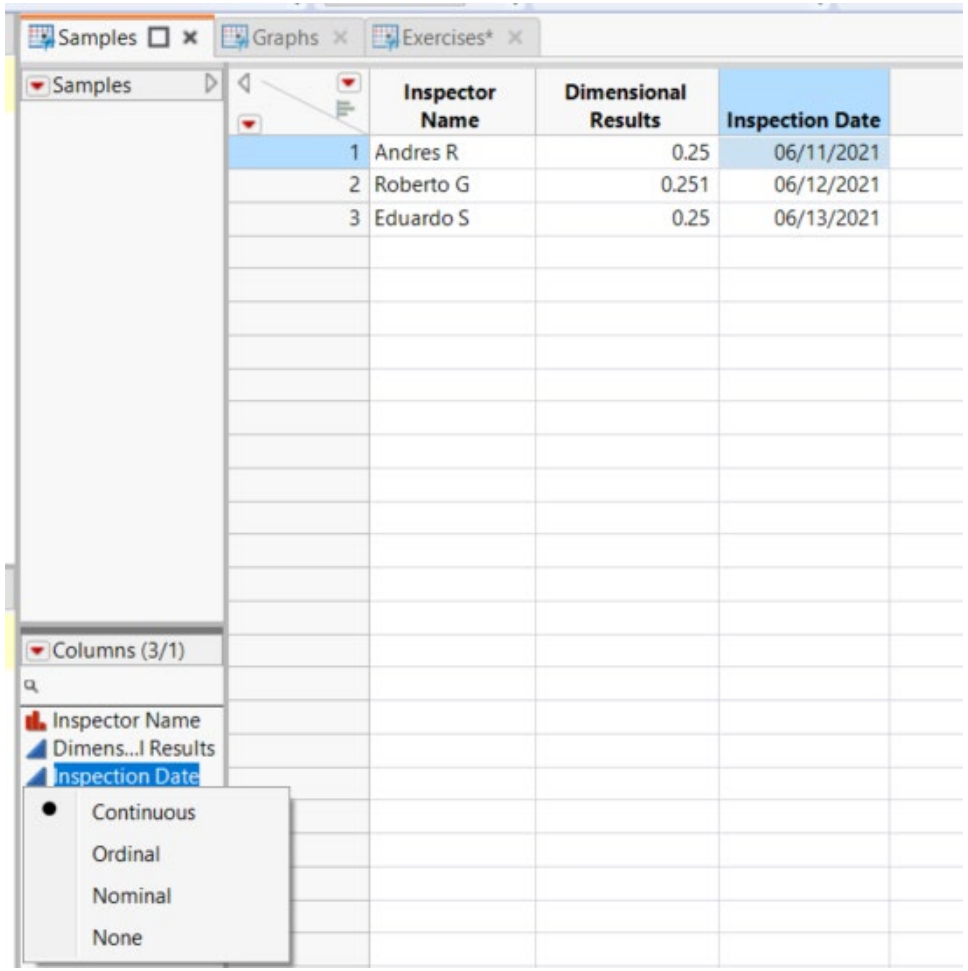
We recommend using projects, when possible, for organizational purposes.

Types of Data

JMP manages all of its data though the use of columns. The columns are arranged as Column 1, 2, 3…. etc.

The left side column will notify you of the type of data contained within.

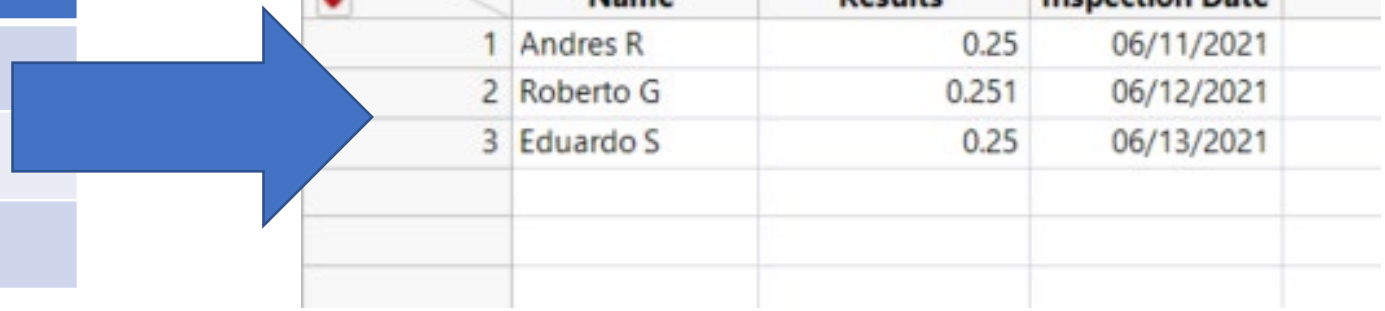
- Nominal: Text based information
- Ordinal: Names or Numbers with order (Satisfaction 1 to 10)
- Continuous: Numbers where distance is important. (Height 1.65 to 2.20 Meters)



Data Input JMP

Exercise: Input the following data in JMP.

Nombre Inspector	Resultado Dimensional	Fecha de Inspección
Andres R	0.250	06/11/19
Roberto G	0.251	06/12/19
Gabriela R	0.250	06/13/19



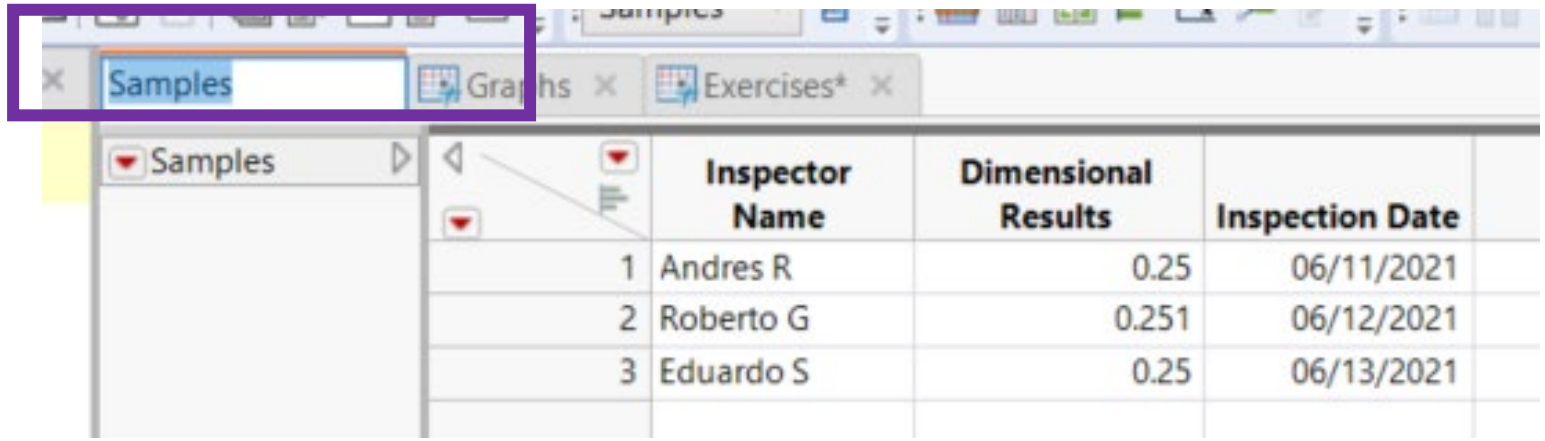
	Inspector Name	Dimensional Results	Inspection Date
1	Andres R	0.25	06/11/2021
2	Roberto G	0.251	06/12/2021
3	Eduardo S	0.25	06/13/2021

Make sure you create a Data Table within your Project!

Organizing Data in JMP

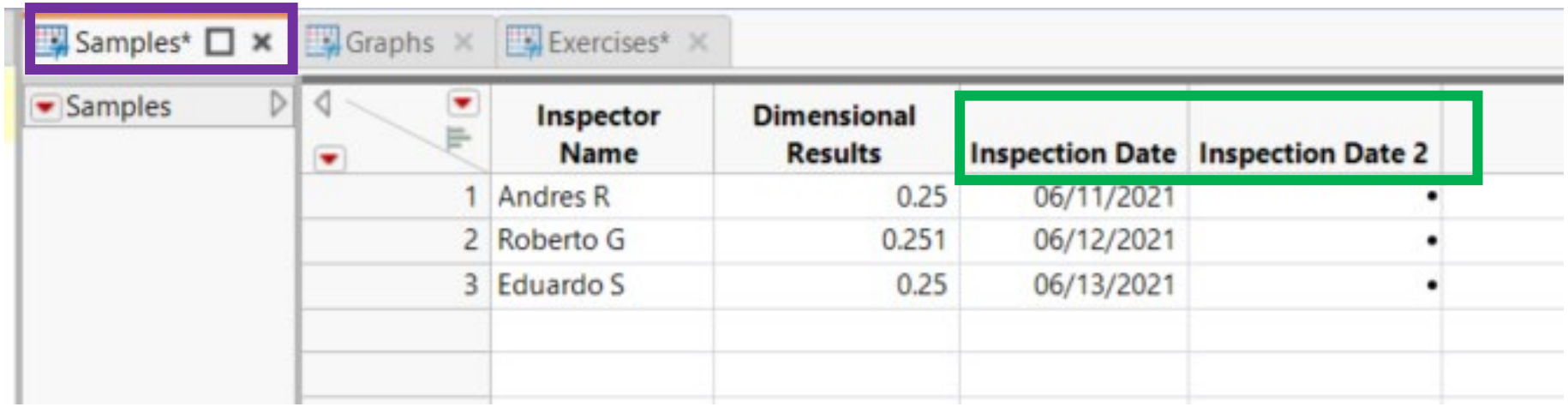
Notice that the Data Table has a name. In this case, it's called "Samples". You can assign a unique name to this data table by double clicking on it.

We recommend organizing data tables based on data origin. For example: "Study ETR2021-015"



Organizing Data in Minitab

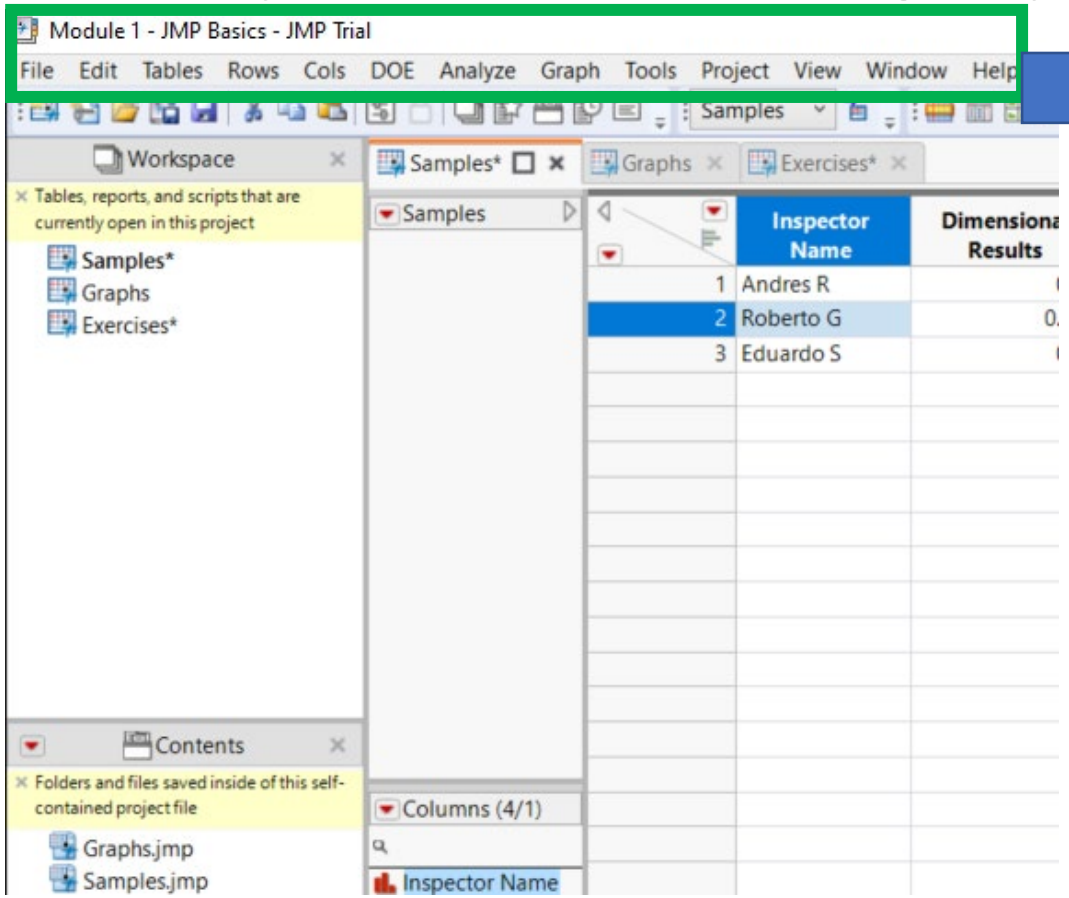
Using Different Data Tables is important because JMP Won't allow two columns to share the same name in the same data table. This can be an issue if you try and place all the information in one data table.

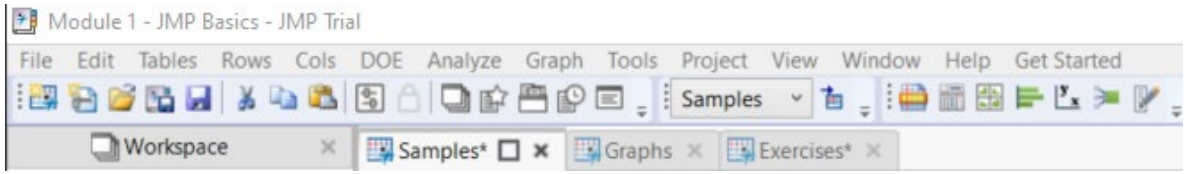


	Inspector Name	Dimensional Results	Inspection Date	Inspection Date 2
1	Andres R	0.25	06/11/2021	•
2	Roberto G	0.251	06/12/2021	•
3	Eduardo S	0.25	06/13/2021	•

Understanding Basic Data Analysis

JMP is a program designed to perform statistical analysis. The top menu includes all analysis available in JMP, grouped in categories.





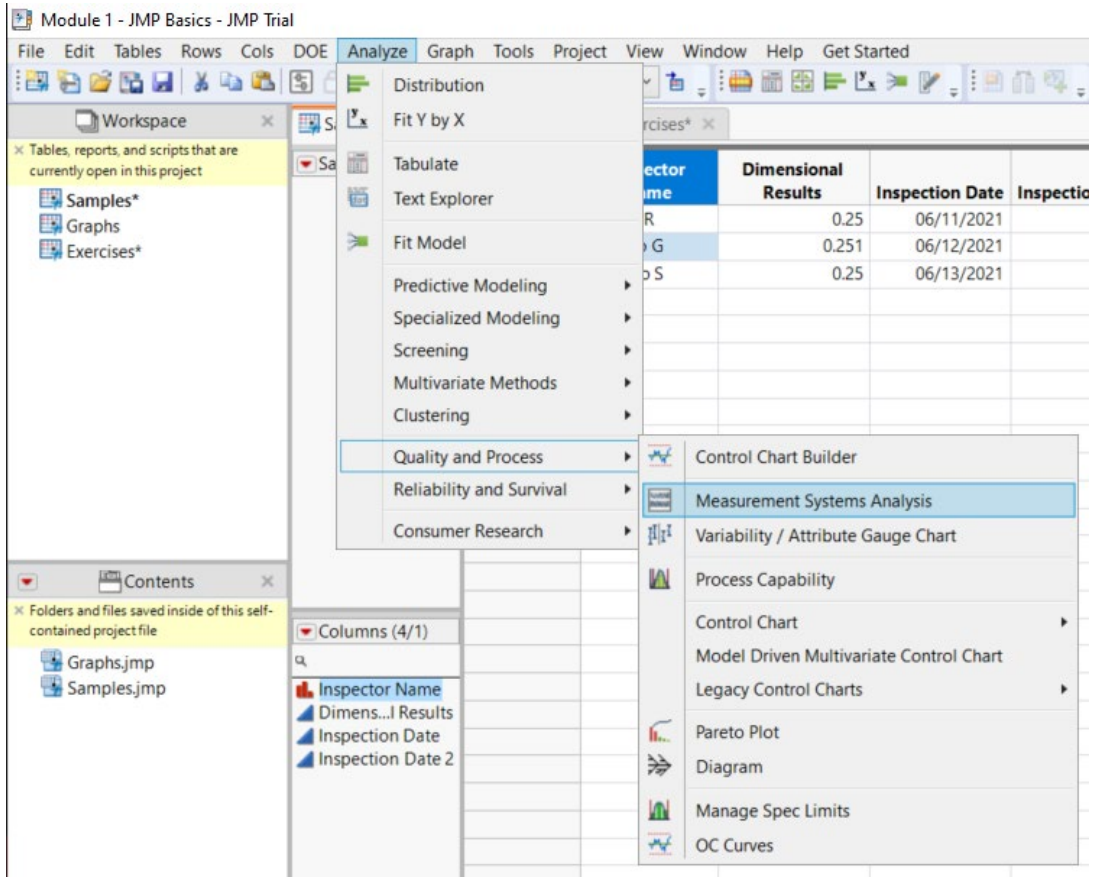
The main menus to run analysis in JMP are Analyze, Graph and DOE.

In summary, the menus contain the following options:

- File and Edit: Tools to open and configure files
- Tables, Rows and Columns: Tools to configure columns
- DOE: Tools to run Design of Experiments
- Analyze: Tools to run statistical analysis
- Graph: Tools to create visual graphs
- Tools, Project, View and Window: Tools to manipulate your workspace.

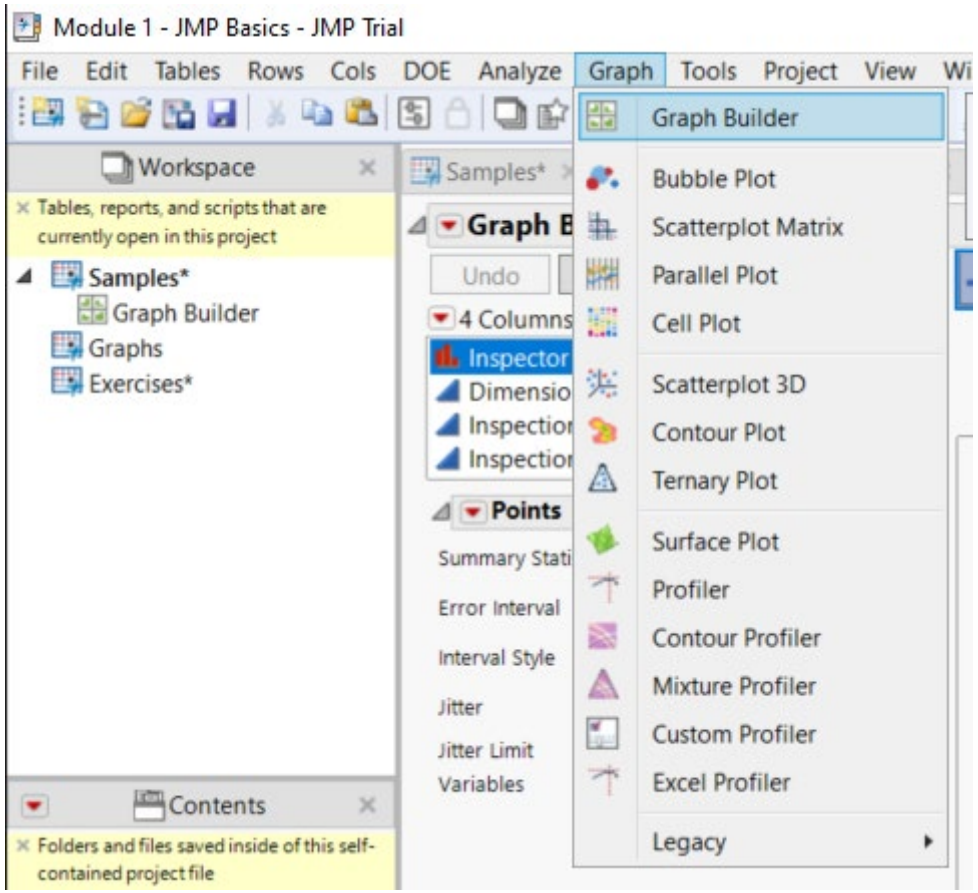
Understanding Basic Data Analysis

Each tool will be explained as soon as it is required. As of now, you can observe that the “Analyze” menu contains many submenus, and these can contain other submenus.



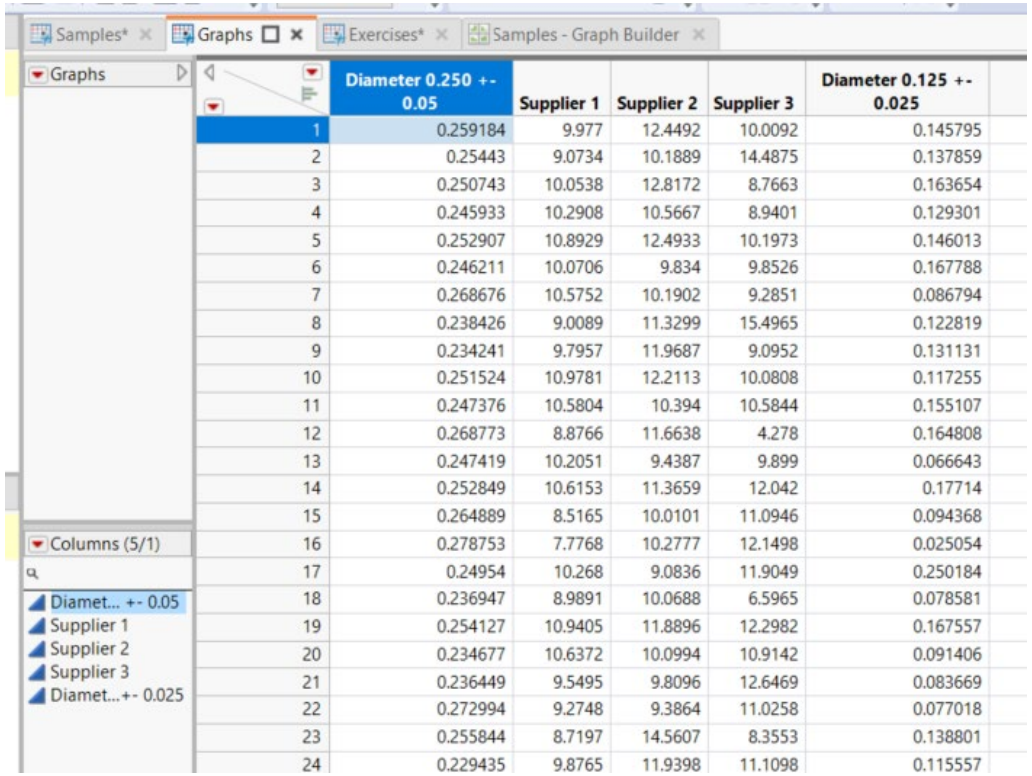
Understanding Basic Data Analysis

The “Graph” menu contains the most common graphs (e.g. histograms, boxplots, interval plots, bar charts and pie charts).



Creating Graphs - Histogram

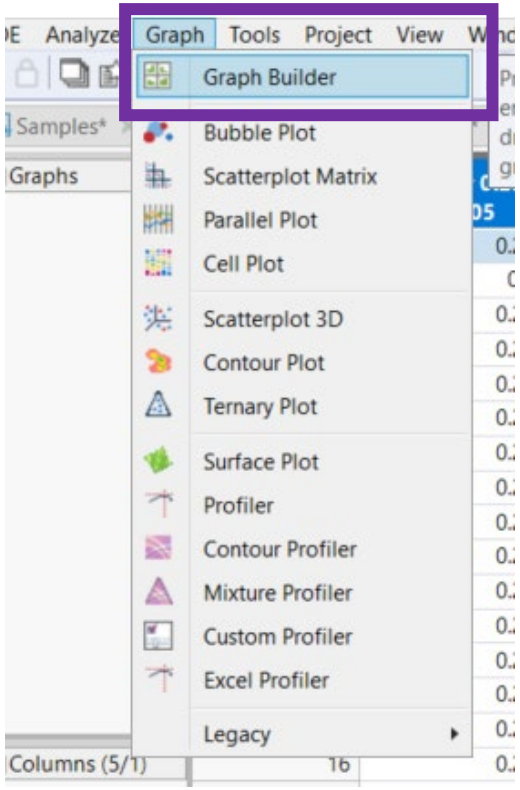
A histogram is a visual representation of your data, where your data is grouped based on value ranges (Bins / Columns). Open the worksheet “Graphs” and observe it contains data in C1 to C5.

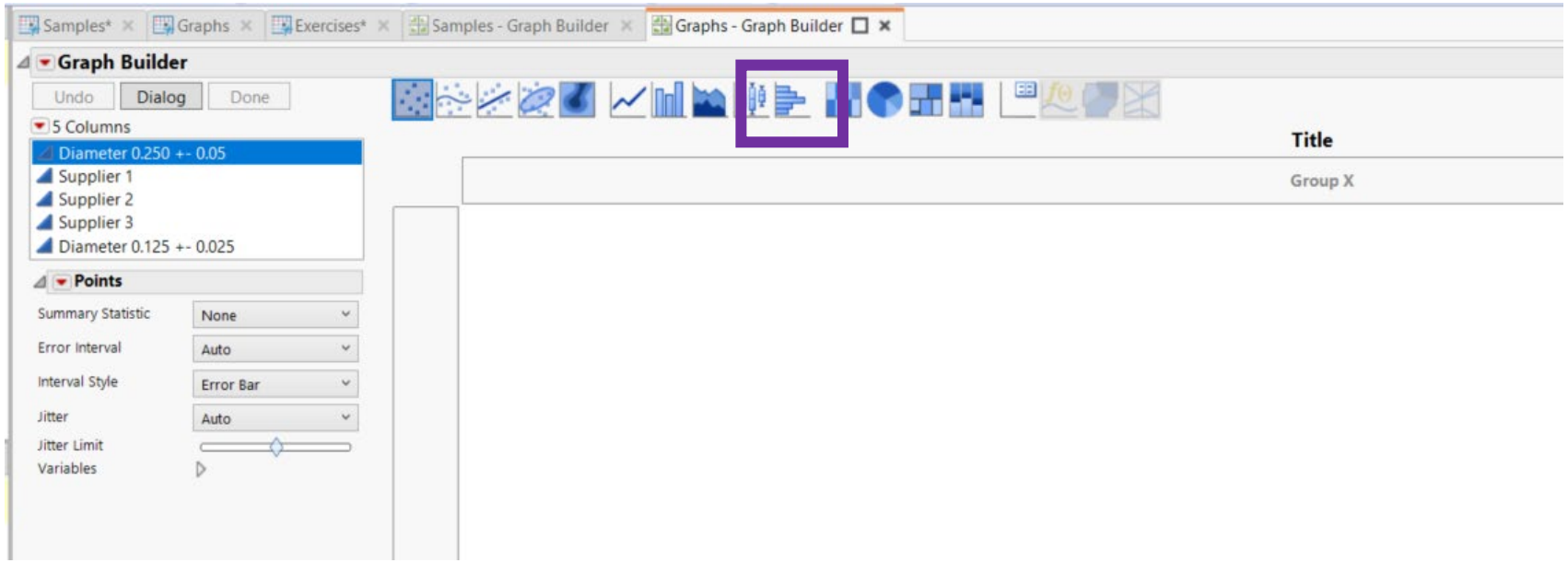


	Diameter 0.250 +- 0.05	Supplier 1	Supplier 2	Supplier 3	Diameter 0.125 +- 0.025
1	0.259184	9.977	12.4492	10.0092	0.145795
2	0.25443	9.0734	10.1889	14.4875	0.137859
3	0.250743	10.0538	12.8172	8.7663	0.163654
4	0.245933	10.2908	10.5667	8.9401	0.129301
5	0.252907	10.8929	12.4933	10.1973	0.146013
6	0.246211	10.0706	9.834	9.8526	0.167788
7	0.268676	10.5752	10.1902	9.2851	0.086794
8	0.238426	9.0089	11.3299	15.4965	0.122819
9	0.234241	9.7957	11.9687	9.0952	0.131131
10	0.251524	10.9781	12.2113	10.0808	0.117255
11	0.247376	10.5804	10.394	10.5844	0.155107
12	0.268773	8.8766	11.6638	4.278	0.164808
13	0.247419	10.2051	9.4387	9.899	0.066643
14	0.252849	10.6153	11.3659	12.042	0.17714
15	0.264889	8.5165	10.0101	11.0946	0.094368
16	0.278753	7.7768	10.2777	12.1498	0.025054
17	0.24954	10.268	9.0836	11.9049	0.250184
18	0.236947	8.9891	10.0688	6.5965	0.078581
19	0.254127	10.9405	11.8896	12.2982	0.167557
20	0.234677	10.6372	10.0994	10.9142	0.091406
21	0.236449	9.5495	9.8096	12.6469	0.083669
22	0.272994	9.2748	9.3864	11.0258	0.077018
23	0.255844	8.7197	14.5607	8.3553	0.138801
24	0.229435	9.8765	11.9398	11.1098	0.115557

Creating Graphs - Histogram

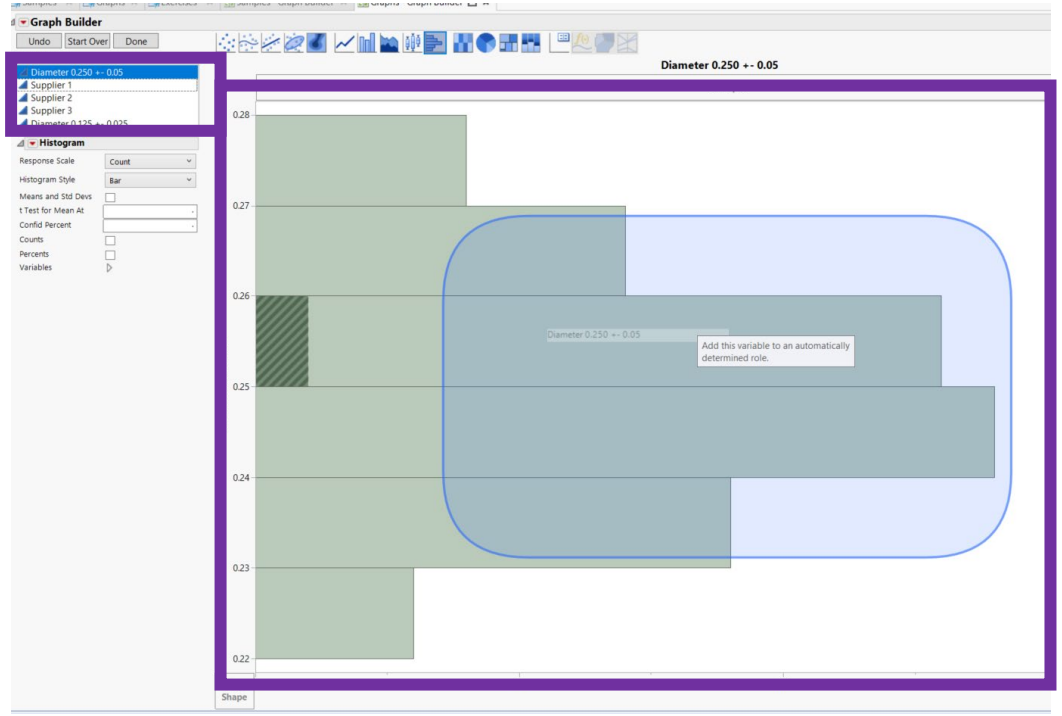
The first step consists in creating a histogram using column C1 data. To do this, just click “Graph > Histogram”. A window will open select the histogram graph option, the Diameter 0.250+- 0.05 column

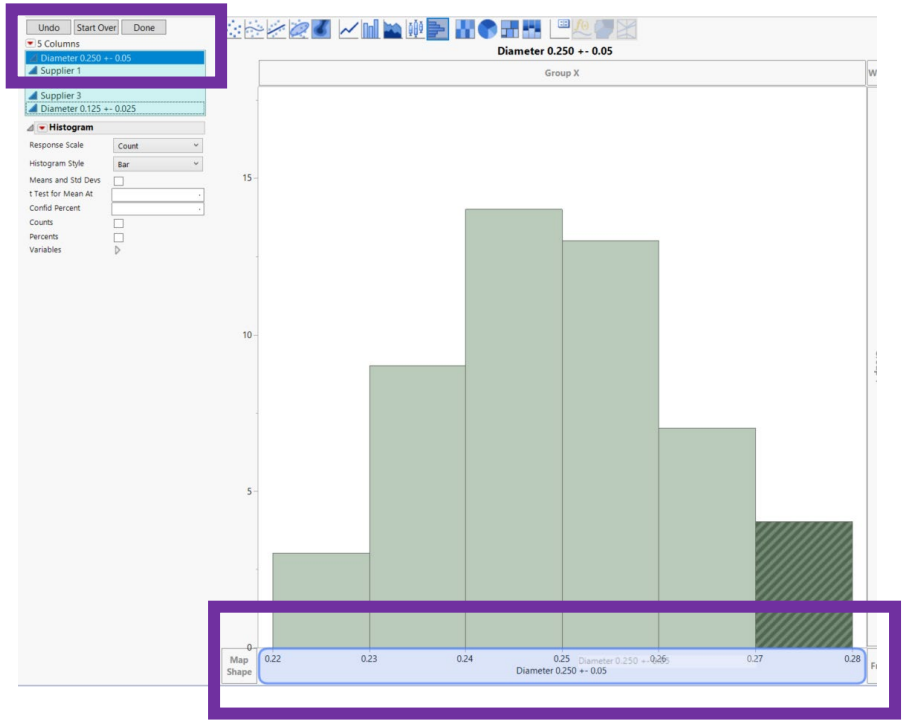




Creating Graphs - Histogram

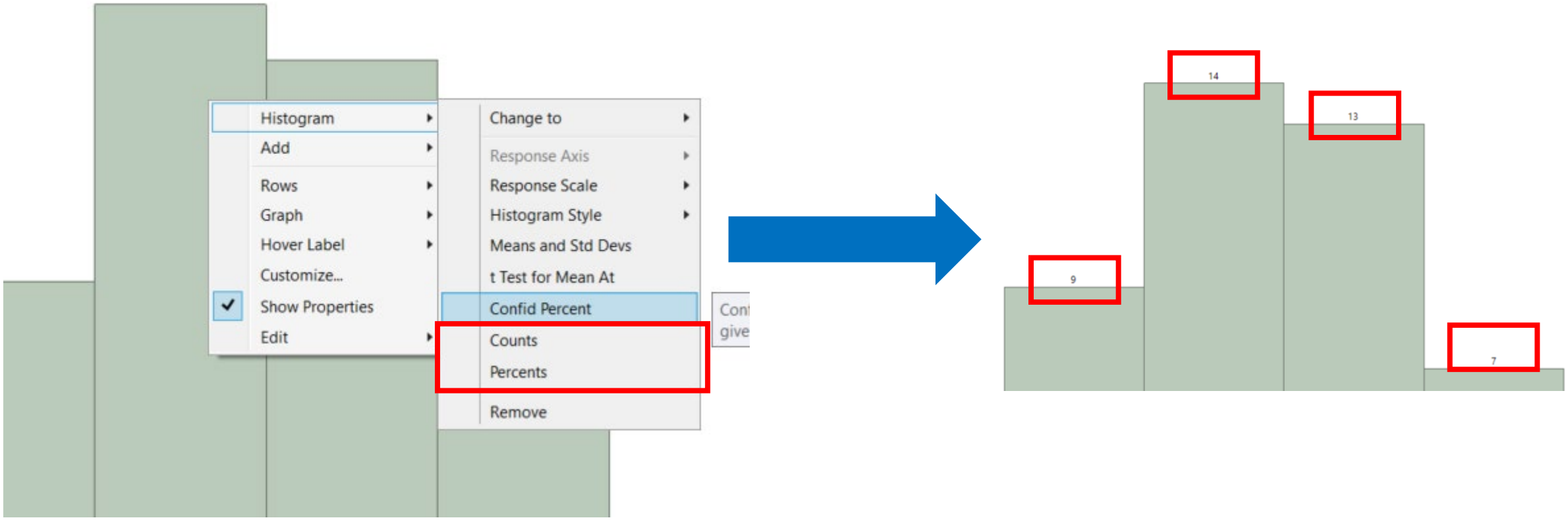
Now Click and Drag the Diameter column into the middle blank portion of the canvas (Middle of the screen). A Histogram should now appear. Note how the bars go left to right instead of up and down. You can modify this behavior by clicking and dragging the column toward the X axis instead of the Y Axis.





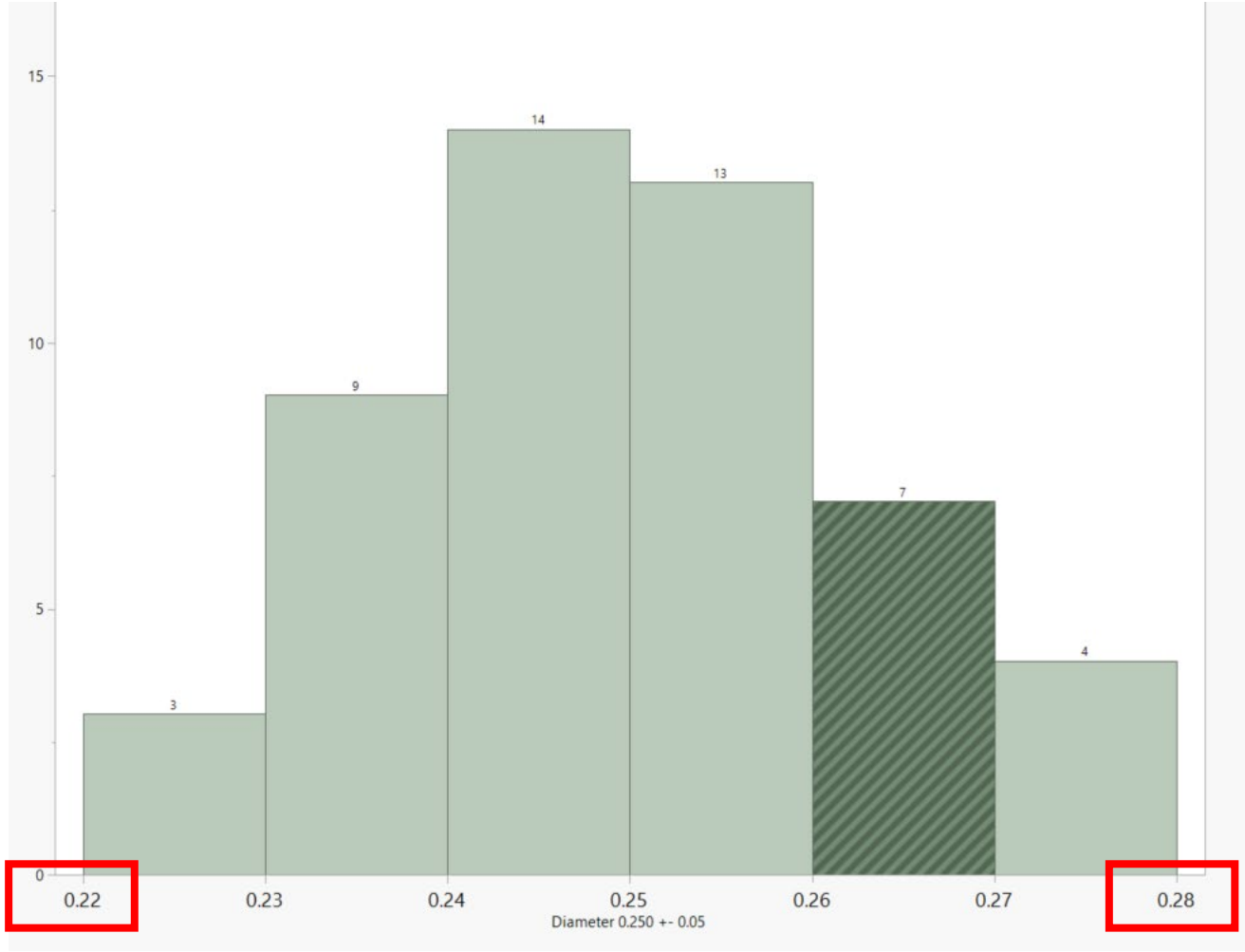
Creating Graphs - Histogram

You can personalize the Histogram by making a right click and selecting the Histogram Option. Within you can add the bar count and bar percent.



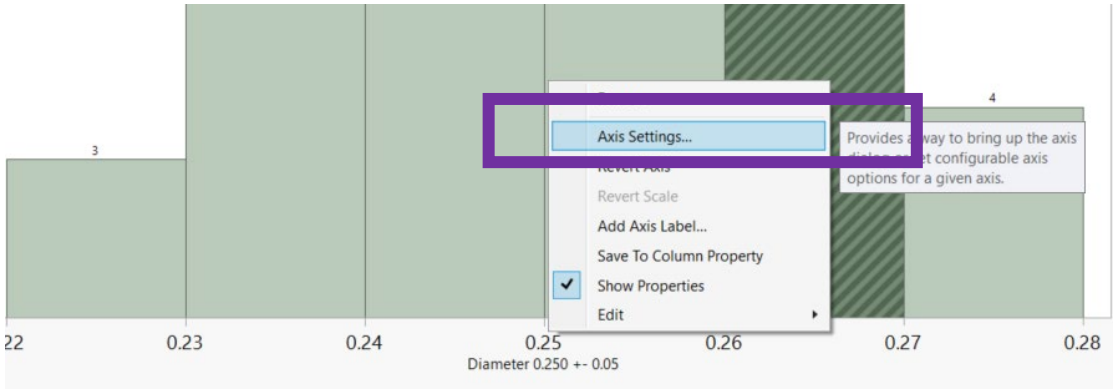
Creating Graphs - Histogram

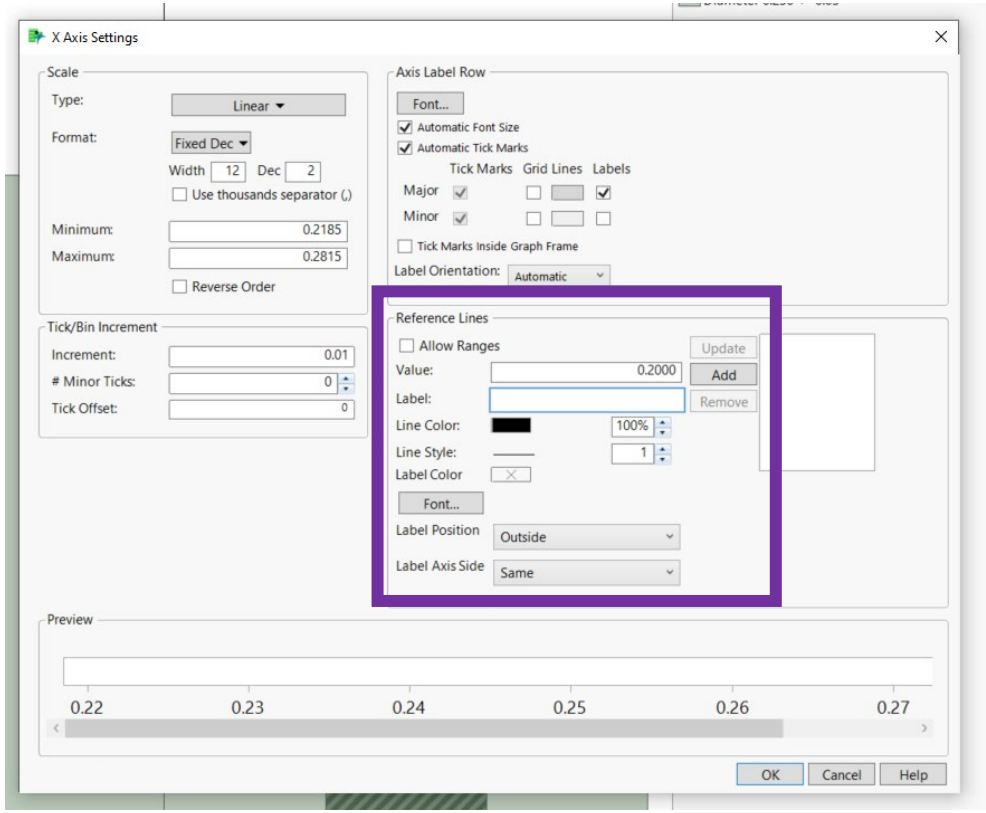
Select “OK”. The graph will be created automatically. The usefulness of an histogram is in that it can show you where your data is grouped. The taller the bar, the more data there is in the corresponding range. Observe that the histogram shows that there’s data from 0.22 to 0.28.



Creating Graphs - Histogram

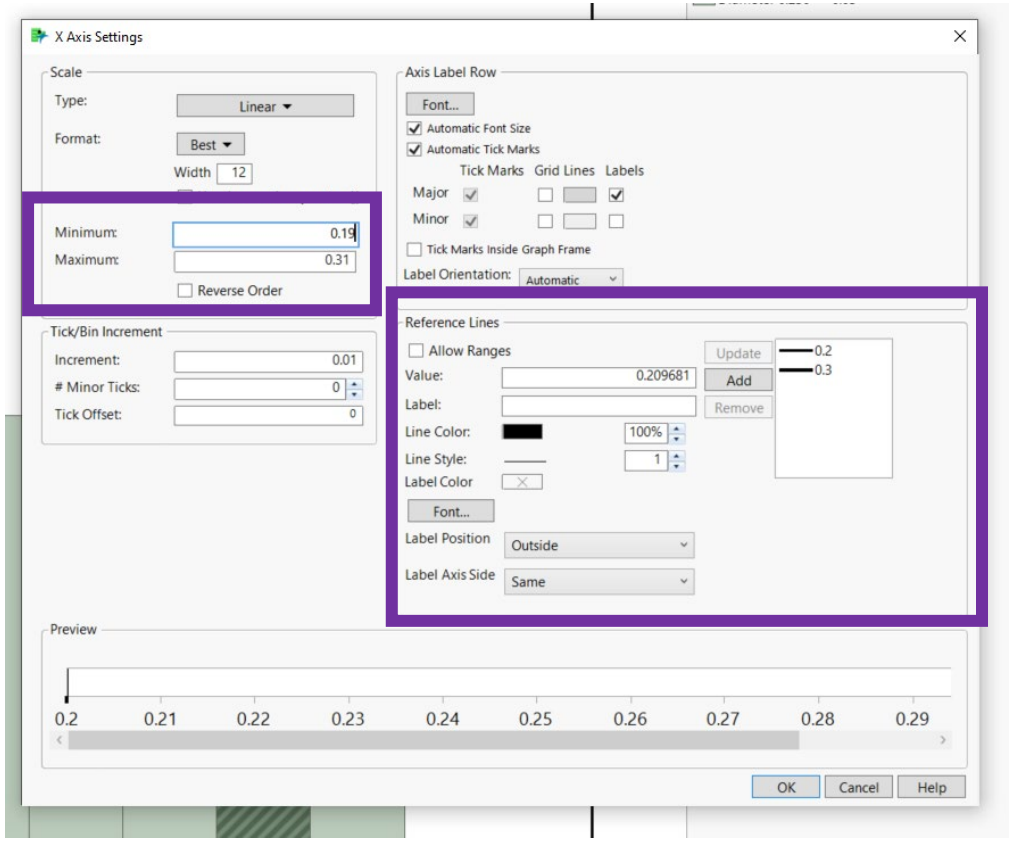
Now, this data was pulled using a specification of 0.250 +- 0.05. This means that the data is acceptable as long its values are between 0.200 and 0.300. To add this information to the data, right click the graph and select “Axis Settings”



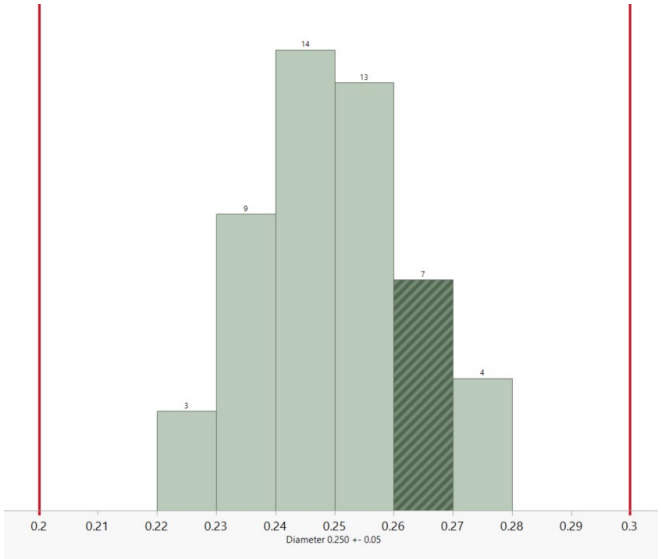


Creating Graphs - Histogram

In the next window, Record the 0.200 and 0.300 reference line marks and click Add. You can also change the line size with the Style option and color.



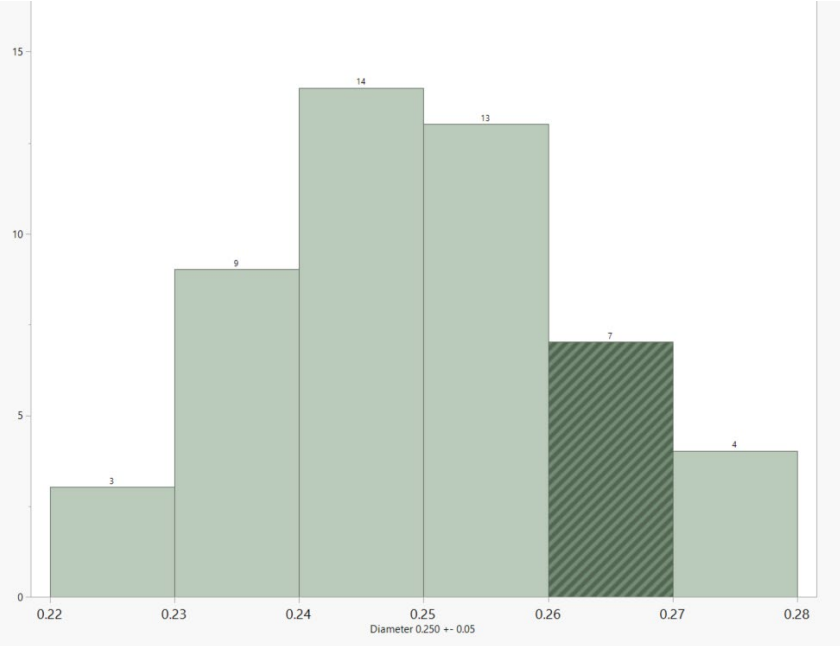
Note: We have also modified the minimum and maximum axis values to 0.19 and 0.31 to provide visibility for the lines.



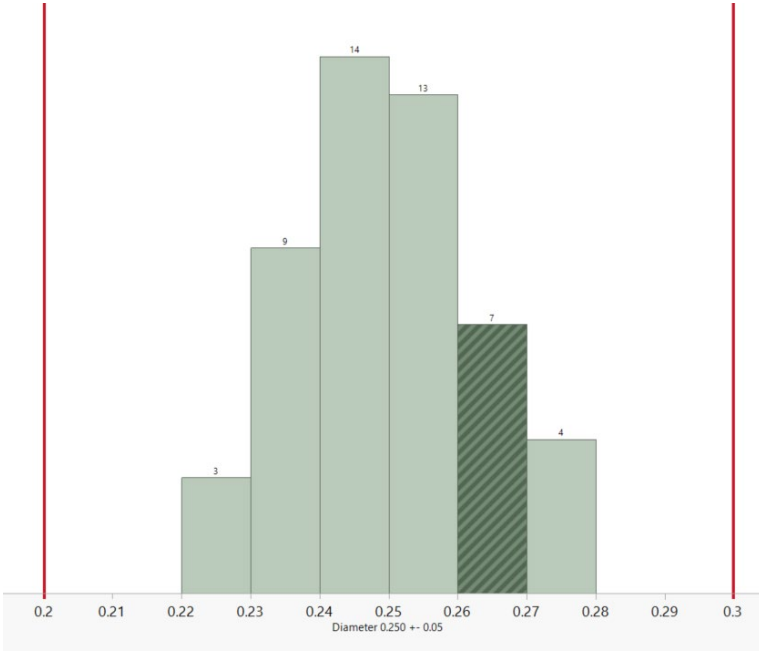
Creating Graphs - Histogram

Observe how two reference lines have been added. Compare this histogram with the original. As a general rule, adding reference lines allows you to see if the process analyzed complies or not with your specification.

Original

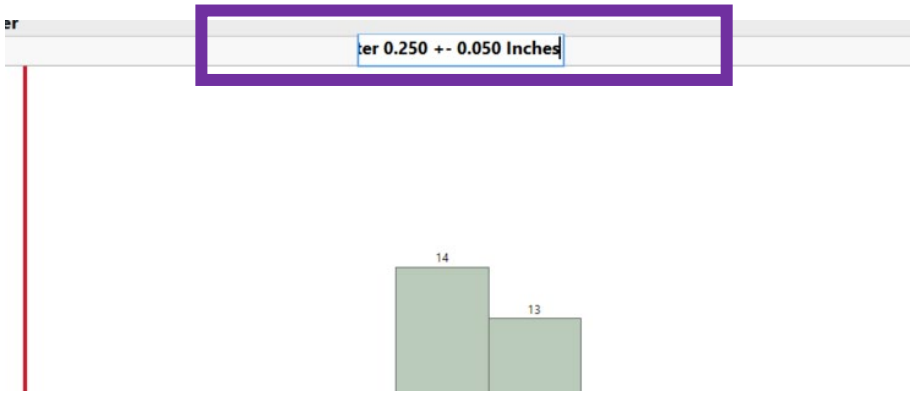


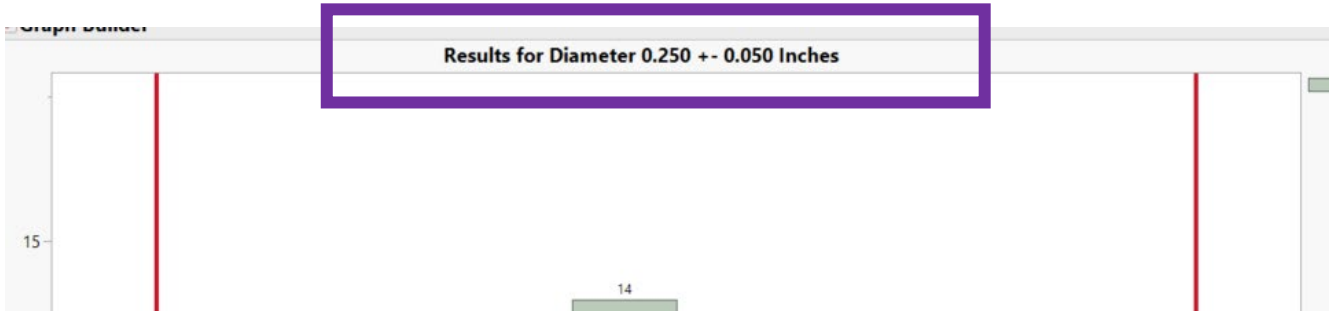
New



Creating Graphs - Histogram

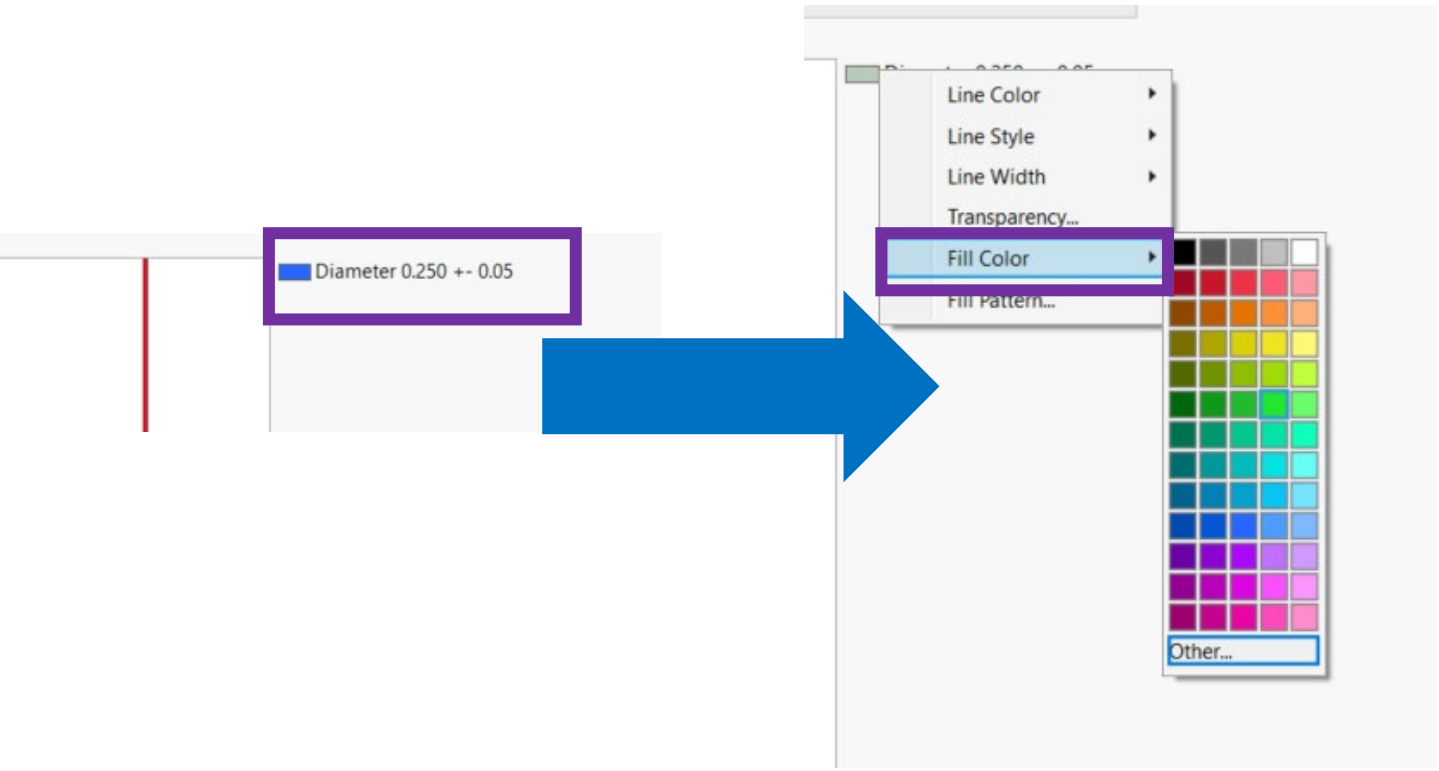
These reference lines can be added to all sorts of graphs, not just histograms. Now, the text in the graph can be edited, too. For example, the title “Dimension 0.250 +- 0.05” can be changed by selecting it with a double click. In the new window you can change the font, size and content of the title.

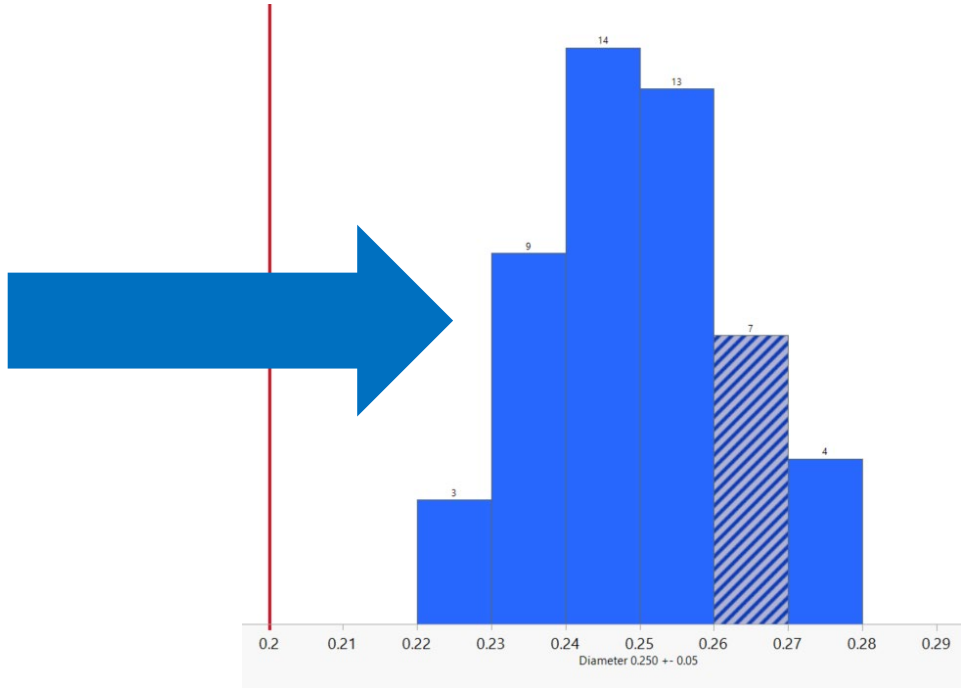




Creating Graphs - Histogram

You can also edit the bar color by making a right click on the legend column.
Within Fill Color select the color for the bars.





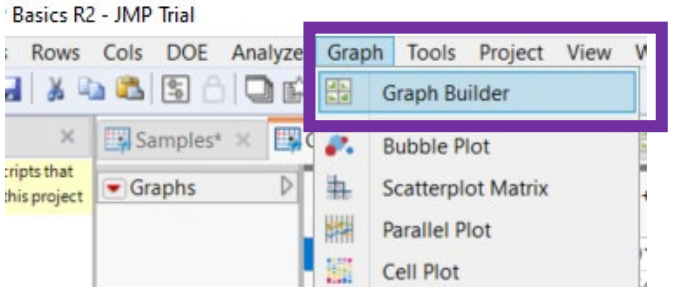
Creating Graphs - Boxplots

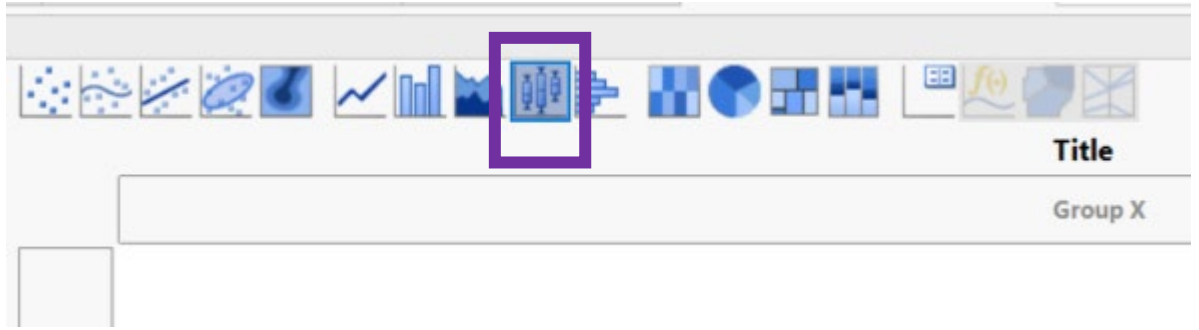
The next basic graph is the boxplot. The boxplot graph is used when you want to know how disperse is your data. You can also use it to compare two or more providers, clients, processes, etc.
Observe the data contained in C2 to C4.

	Diameter 0.250 +- 0.05	Supplier 1	Supplier 2	Supplier 3	iameter 0.125 +- 0.025
1	0.25918	9.977	12.4492	10.0092	0.145795
2	0.2544	9.0734	10.1889	14.4875	0.137859
3	0.25074	10.0538	12.8172	8.7663	0.163654
4	0.24593	10.2908	10.5667	8.9401	0.129301
5	0.25290	10.8929	12.4933	10.1973	0.146013
6	0.24621	10.0706	9.834	9.8526	0.167788
7	0.26867	10.5752	10.1902	9.2851	0.086794
8	0.23842	9.0089	11.3299	15.4965	0.122819
9	0.23424	9.7957	11.9687	9.0952	0.131131
10	0.25152	10.9781	12.2113	10.0808	0.117255
11	0.24737	10.5804	10.394	10.5844	0.155107
12	0.26877	8.8766	11.6638	4.278	0.164808
13	0.24741	10.2051	9.4387	9.899	0.066643
14	0.25284	10.6153	11.3659	12.042	0.17714

Creating Graphs - Boxplots

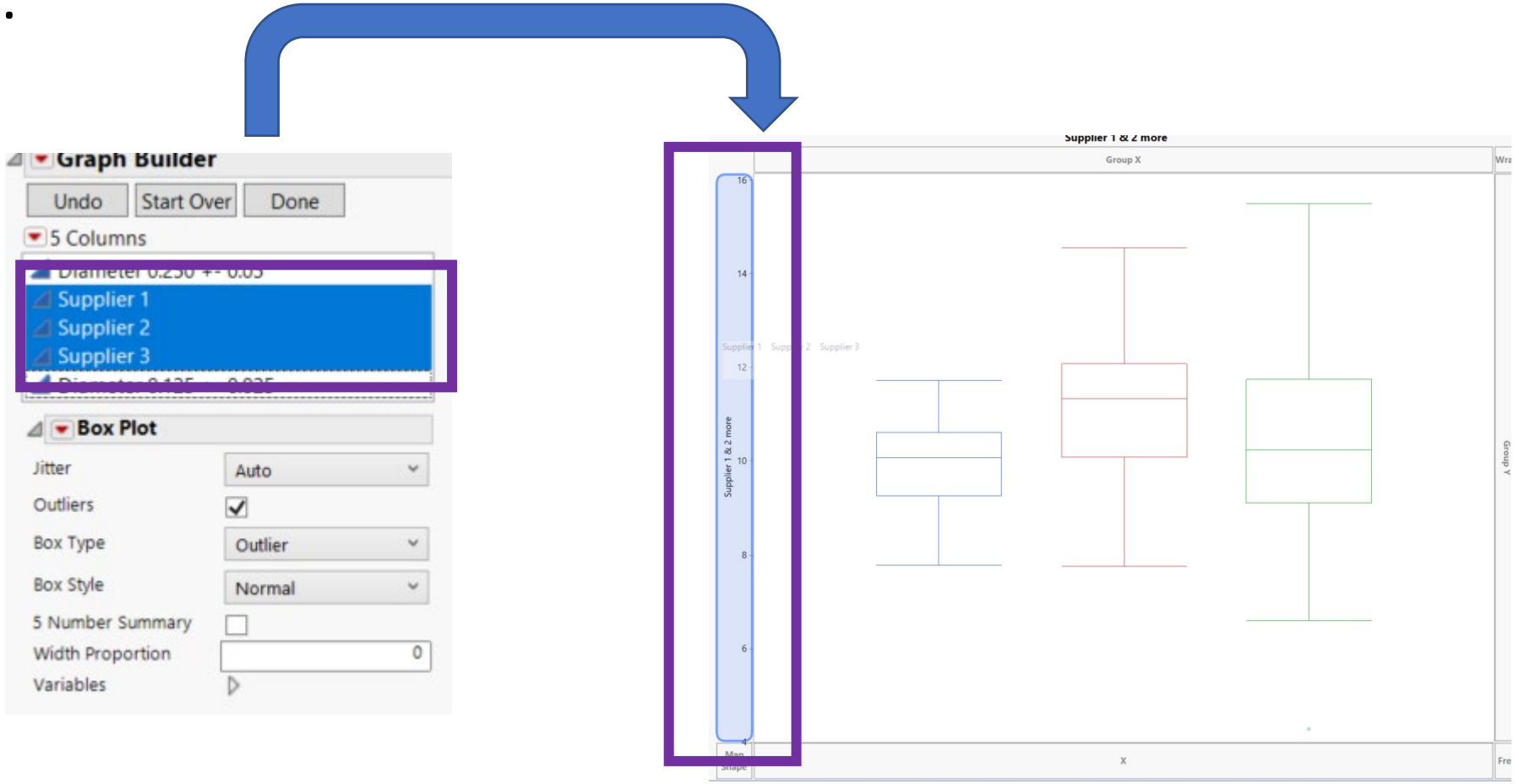
Imagine these three providers are interested in being selected to supply you a new component. Suppose this component is a wooden stick that must measure between 8 and 12 meters long (i.e. 10 meters +- 2 meters). To create a boxplot graph, select “Graph > Graph Builder > BoxPlot





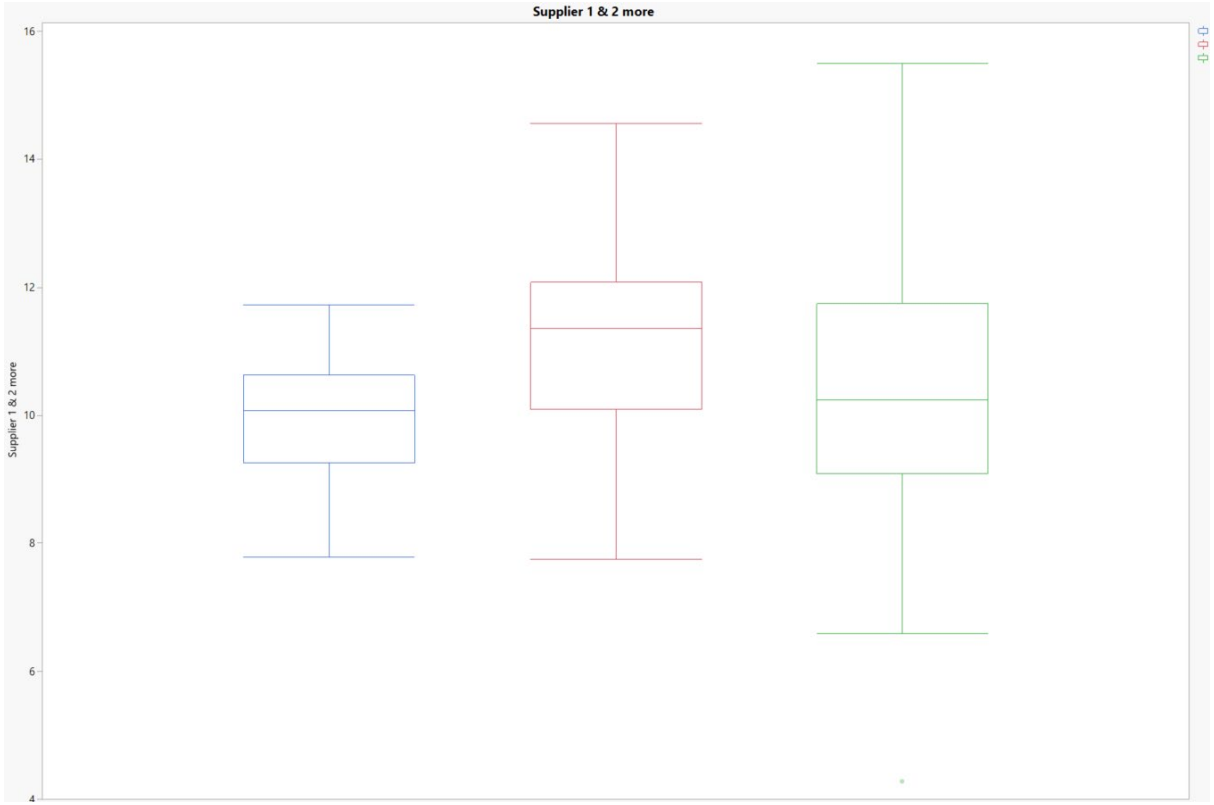
Creating Graphs - Boxplots

Now, select the three providers and add them to the graph's Y Axis with a click and drag.



Creating Graphs - Boxplots

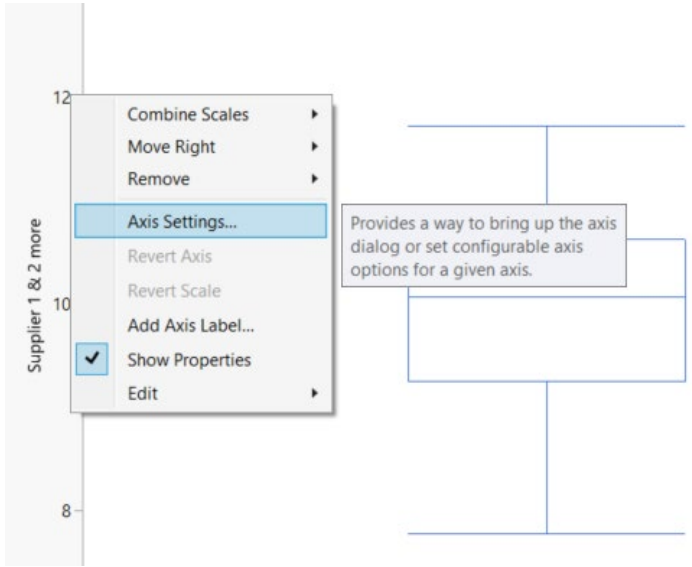
Once the process is completed, a boxplot graph like in the following image will be generated. This graph is a visual representation of your data, grouped in quartiles (more on this later).

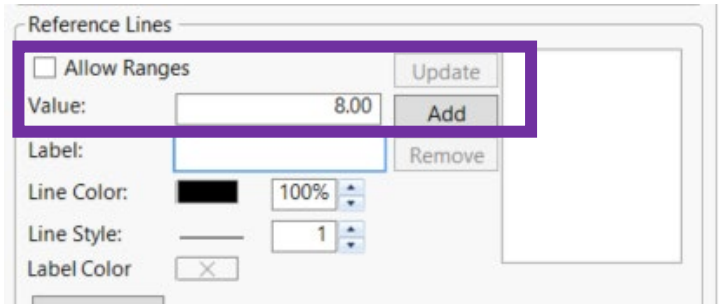


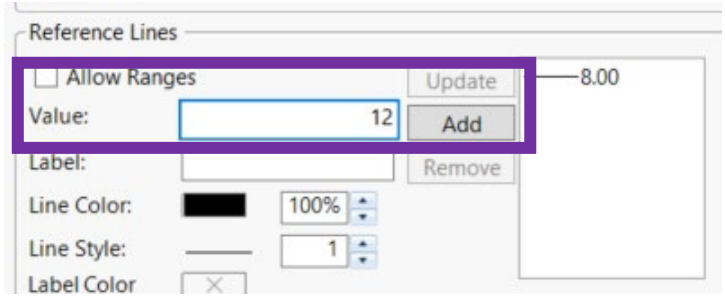
Creating Graphs - Boxplots

Now, the purpose of this graph is to compare which of the providers gives the better results. We know the specification is between 8 meters and 12 meters. You can add this specification by using reference lines.

Remember: Right click Y Axis > Axis Settings > Reference Lines > Y Axis > 8 12 > OK

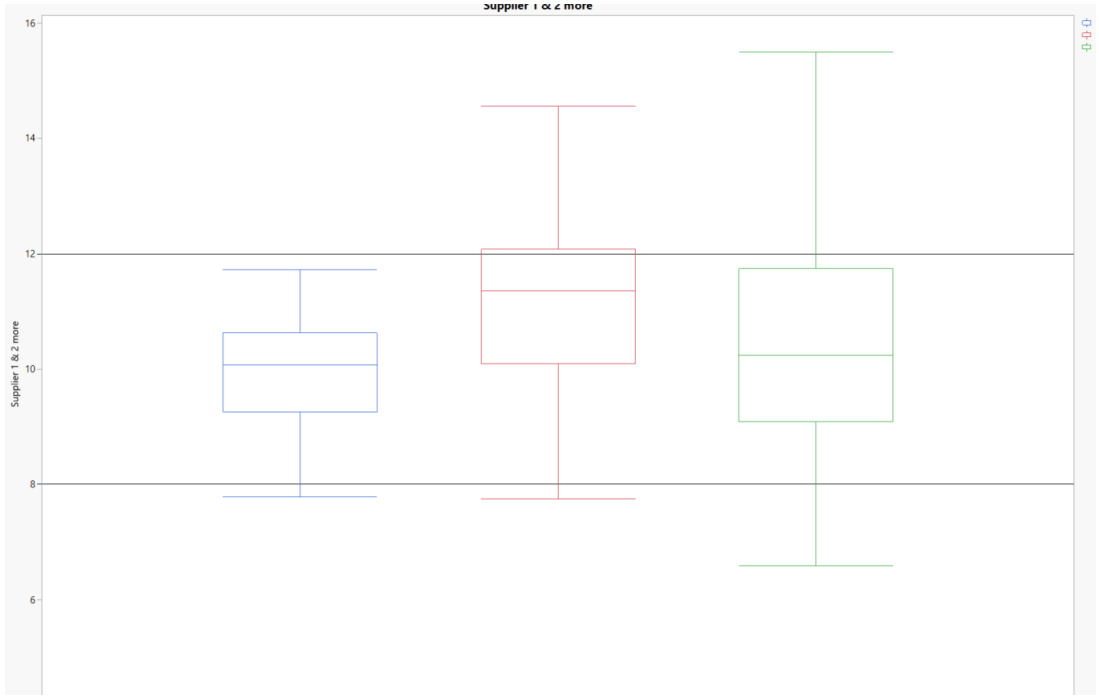






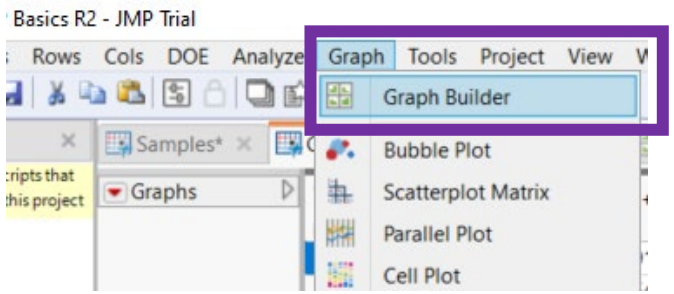
Creating Graphs - Boxplots

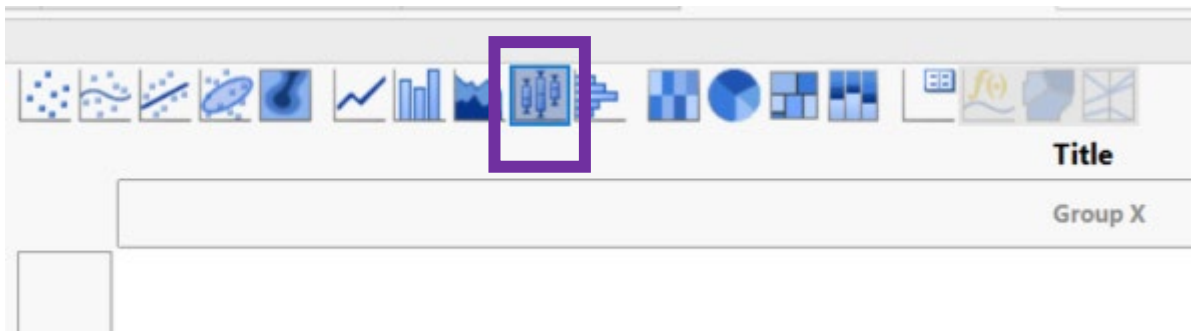
Observe how the reference lines quickly show how the provider “Supplier 2” and “Supplier 3” exceed the specification limits whereas the provider “Supplier 1” supplies most of its product within this specification, with a small portion touching the lower limit.

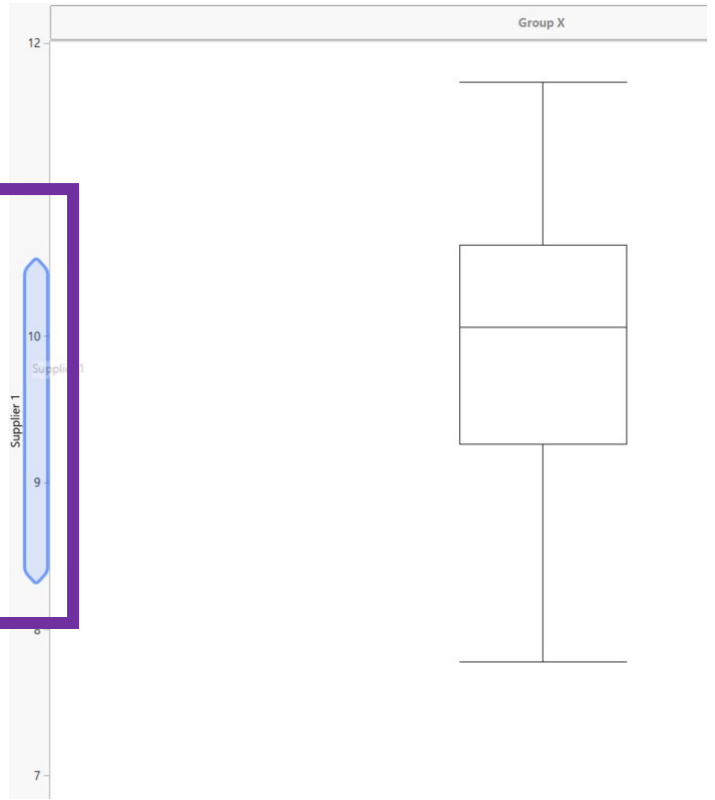


Creating Graphs - Boxplots

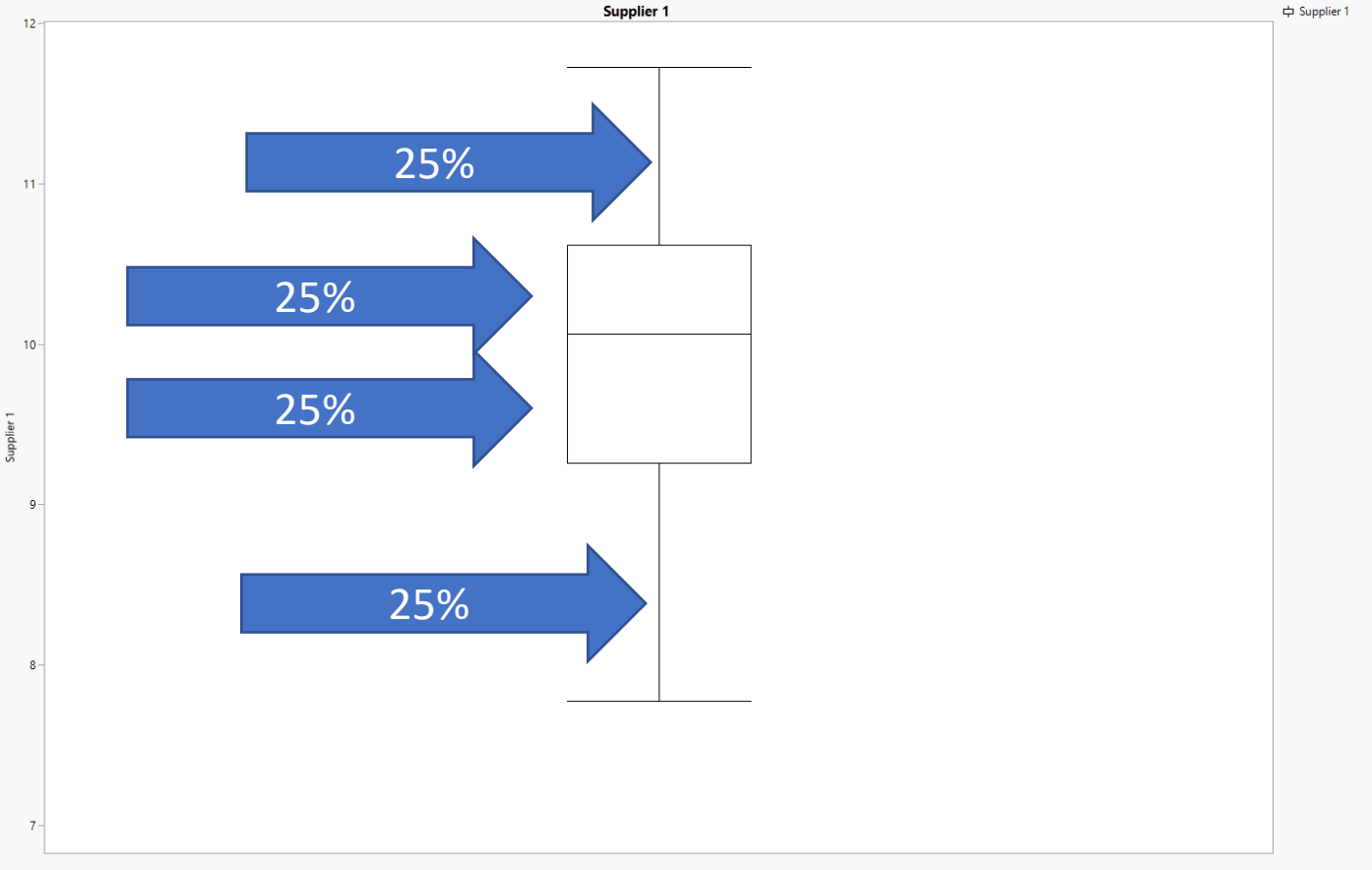
Now, what does the BoxPlot graph represent? Simply the data dispersion. Create a simple boxplot using the data from the provider “Supplier 1”.
Select “Graph > Graph Builder > Drag Supplier Y to Y Column with Boxplot selected”







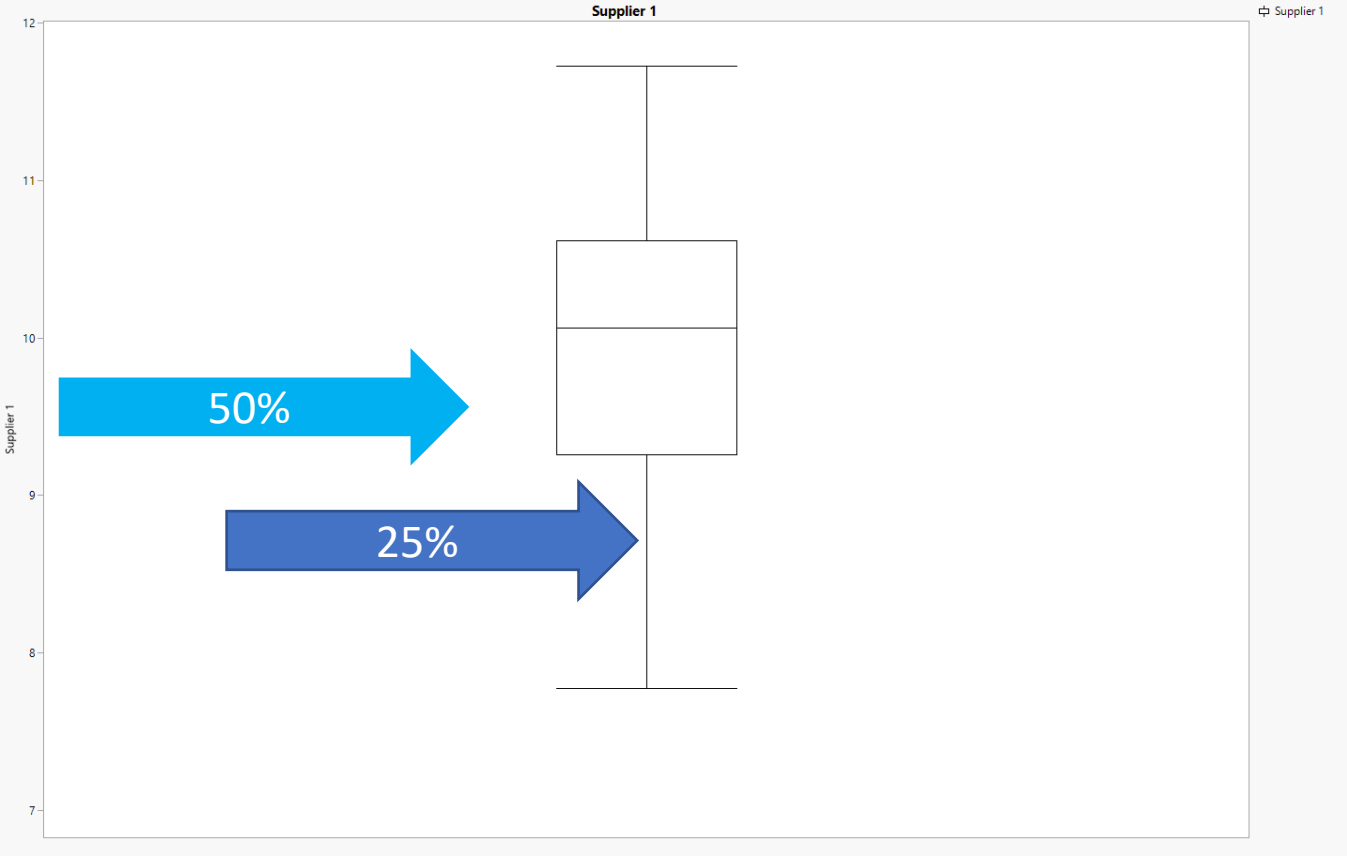
Creating Graphs - Boxplots



Observe the graph created.
The first part represents the first 25% of the data (the 1st quartile).
The second part represents the next 25% (the 2nd quartile).
The third part, the next 25% (the 3rd quartile).
The last part represents the last 25% of the data (the 4th quartile).

In total, these four quartiles represent 100% of the data.

Creating Graphs - Boxplots



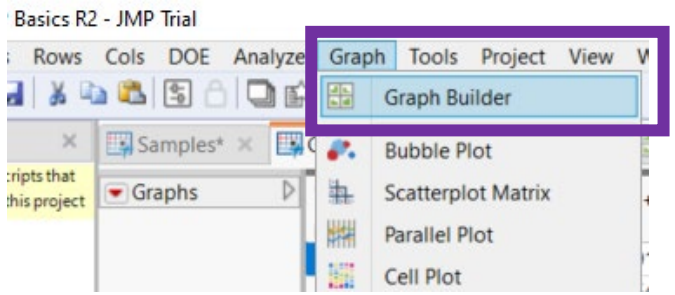
Now, the boxplot graph can show you where is your data, and how far it spreads.

You can also make conclusions like the following:

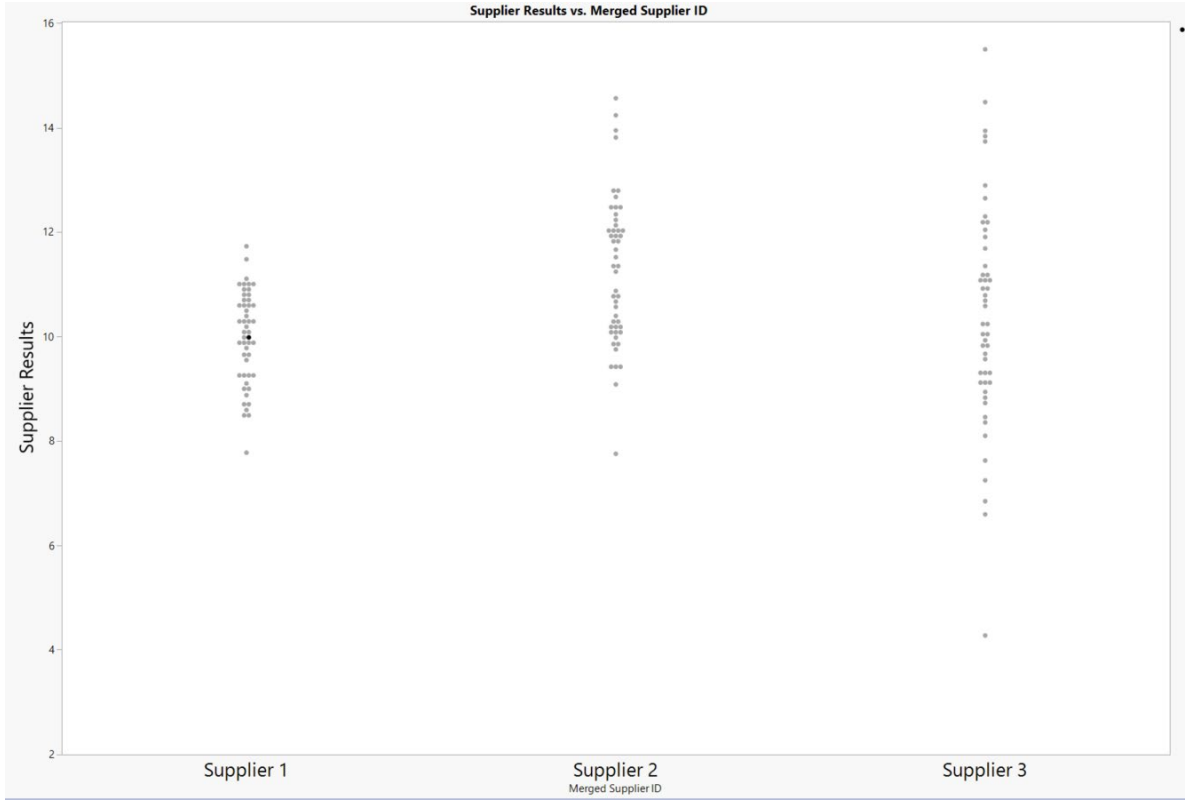
- 25% of the data has a value of 9 or less.
- 50% of the data has a value of 10 or less.

Creating Graphs – Individual Value Plot

A graph similar to boxplots is the Individual Value Plot. To create it, select ”Graph > Graph Builder > Individual Value Plots > Drag the Results to the Y Column” and add the data from C7 to the Y Axis and C6 to the X Axis.

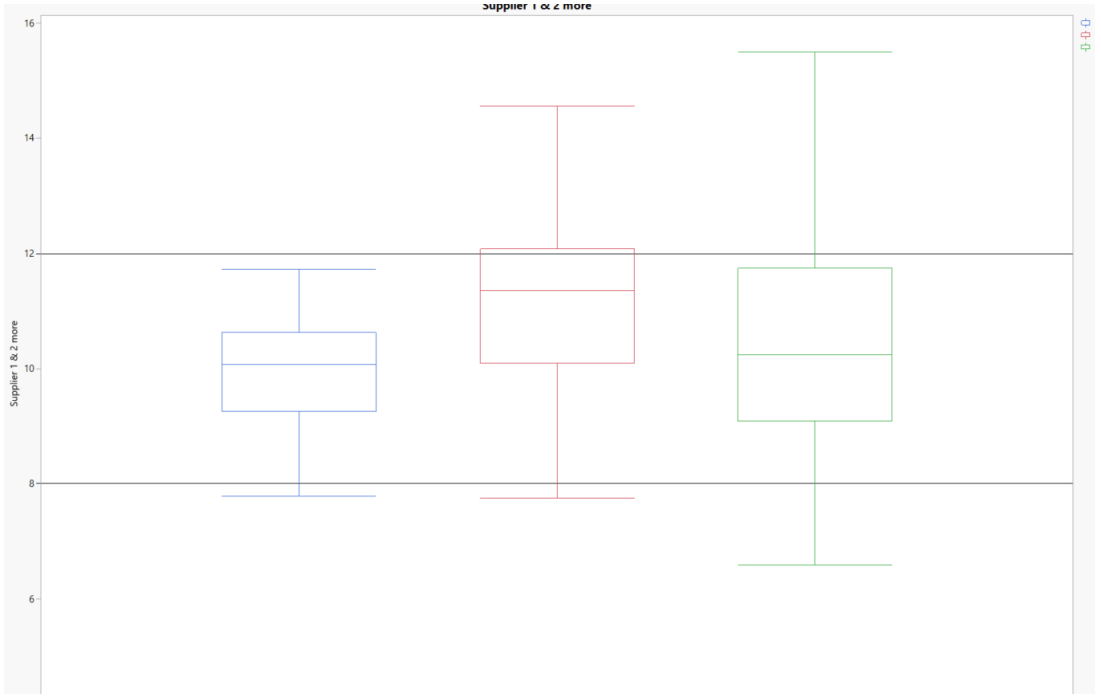


	Diameter 0.250 +- 0.05	Supplier 1	Supplier 2	Supplier 3	Diameter 0.125 +- 0.025	Merged Supplier ID	Supplier Results
1	0.259184	9.977	12.4492	10.0092	0.145795	Supplier 1	9.977
2	0.25443	9.0734	10.1889	14.4875	0.137859	Supplier 1	9.0734
3	0.250743	10.0538	12.8172	8.7663	0.163654	Supplier 1	10.0538
4	0.245933	10.2908	10.5667	8.9401	0.129301	Supplier 1	10.2908
5	0.252907	10.8929	12.4933	10.1973	0.146013	Supplier 1	10.8929
6	0.246211	10.0706	9.834	9.8526	0.167788	Supplier 1	10.0706
7	0.268676	10.5752	10.1902	9.2851	0.086794	Supplier 1	10.5752
8	0.238426	9.0089	11.3299	15.4965	0.122819	Supplier 1	9.0089
9	0.234241	9.7957	11.9687	9.0952	0.131131	Supplier 1	9.7957
10	0.251524	10.9781	12.2113	10.0808	0.117255	Supplier 1	10.9781
11	0.247376	10.5804	10.394	10.5844	0.155107	Supplier 1	10.5804
12	0.268773	8.8766	11.6638	4.278	0.164808	Supplier 1	8.8766
13	0.247419	10.2051	9.4387	9.899	0.066643	Supplier 1	10.2051



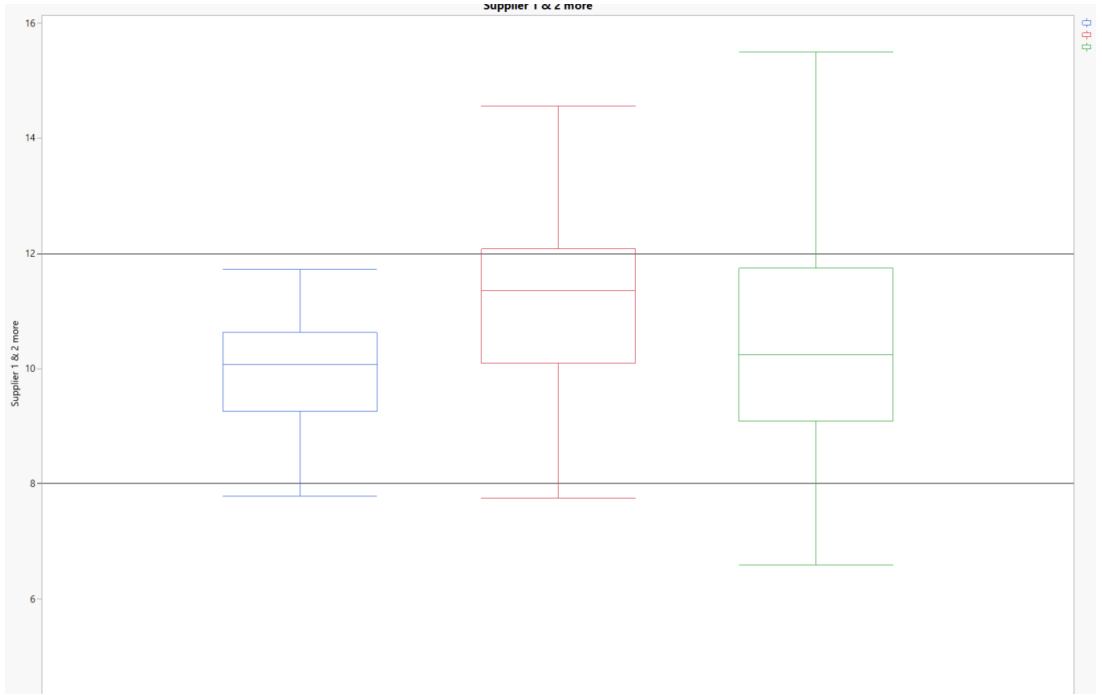
Creating Graphs – Individual Value Plot

Observe the rendered graph. It is different to a boxplot, with the difference that each value is shown individually as a dot, instead of being grouped in a quartile (box).



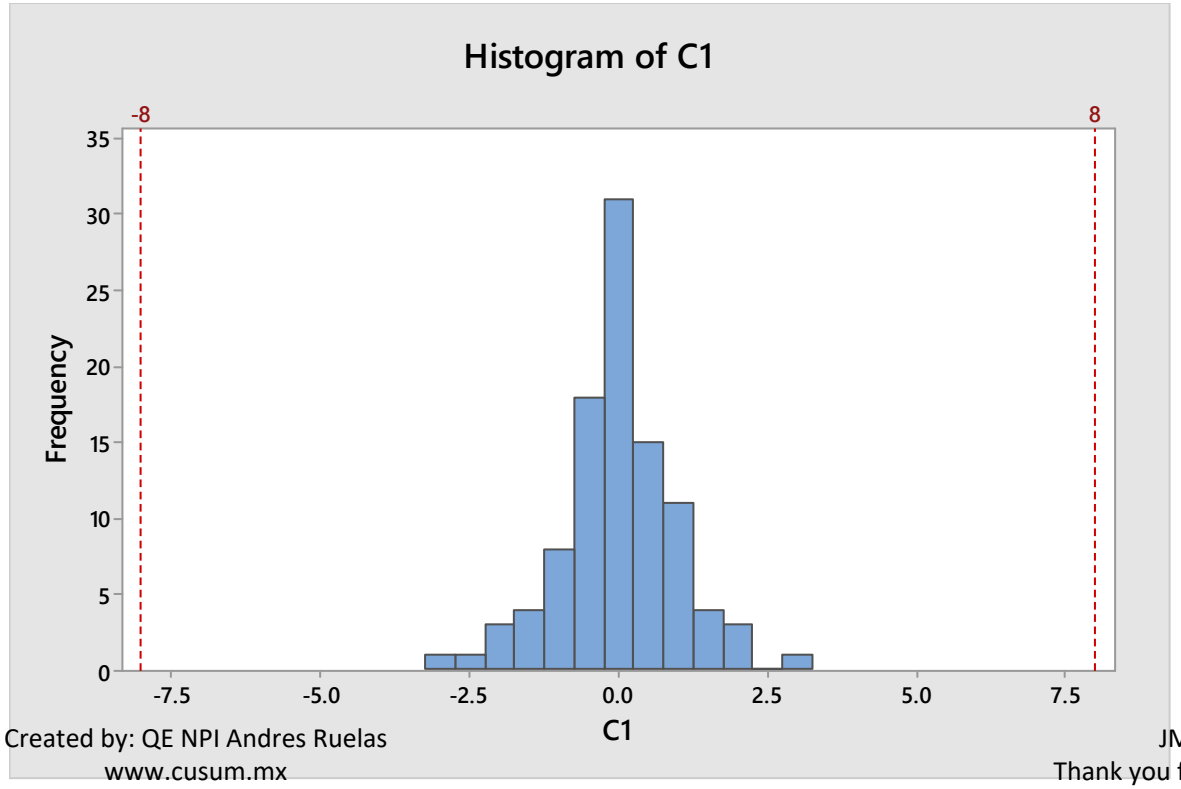
Creating Graphs – Individual Value Plot

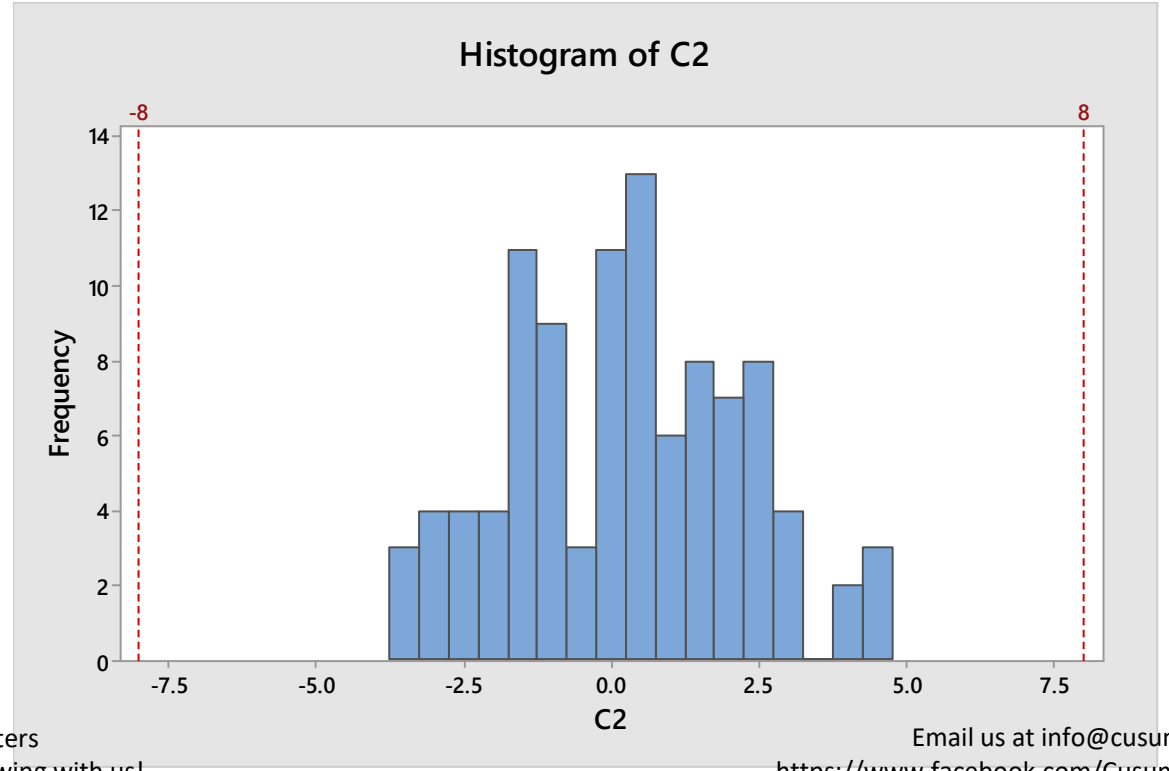
This graph can be modified the same way as the prior ones. You can change the title, add reference lines or choose a different color. It is not as common as the boxplot graph, though, since the latter is visually more simple and easier to interpret.



Basic Data Analysis

So far, we have went over the JMP interface, and created the most common graphs: histograms, boxplots and individual value plots. These graphs will allow you to analyze your data visually, but to truly understand statistical analysis, some essential knowledge is needed. Observe the next two graphs:



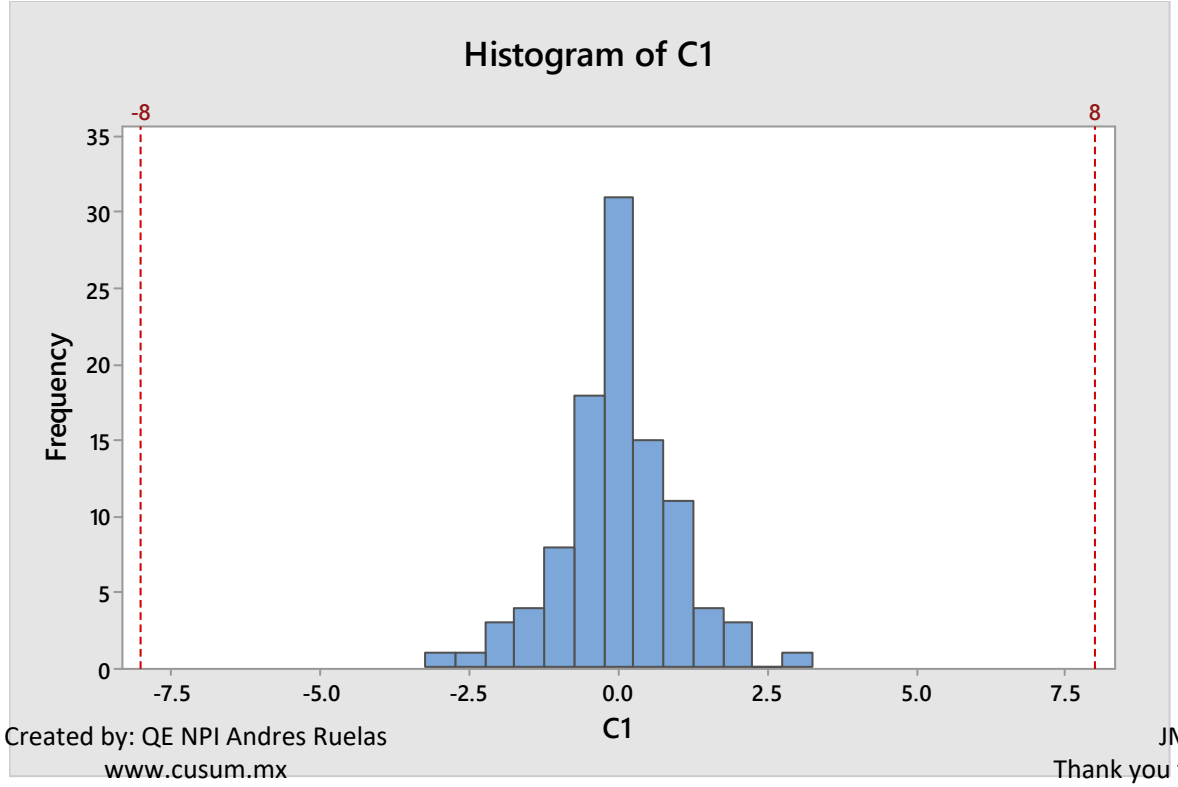


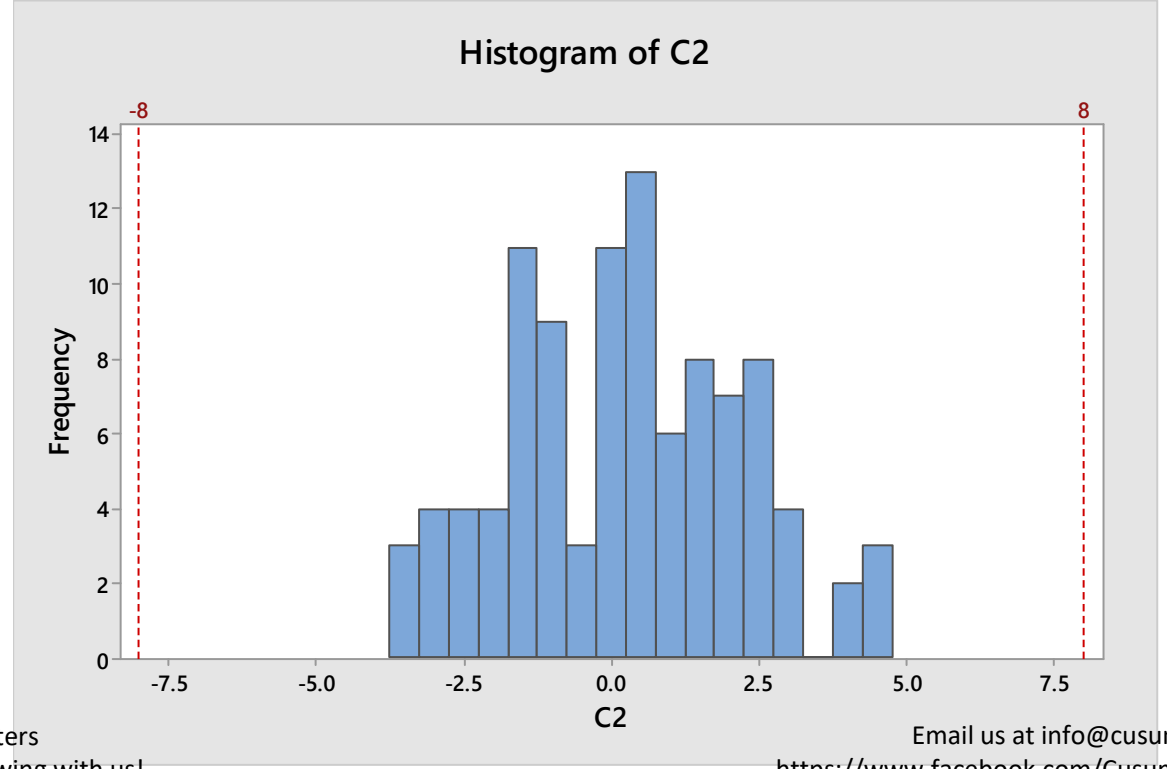
Basic Data Analysis

The basic elements needed to analyze data are the following:

- The Mean: The average of all data.
- The standard deviation: How disperse is the data.

Both graphs (histograms) have the same mean (average), but a different deviation.



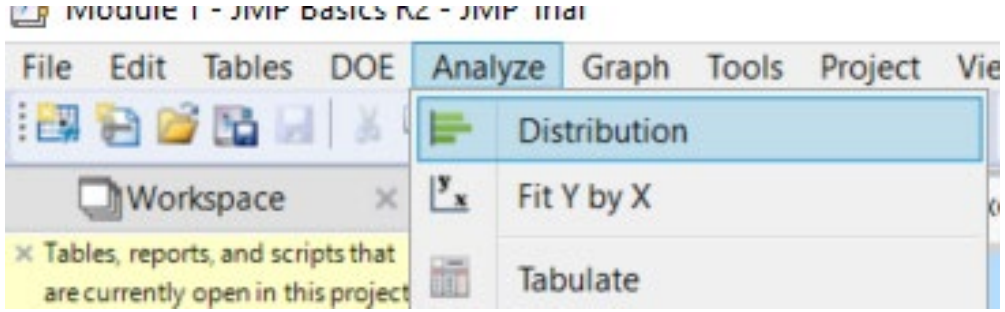


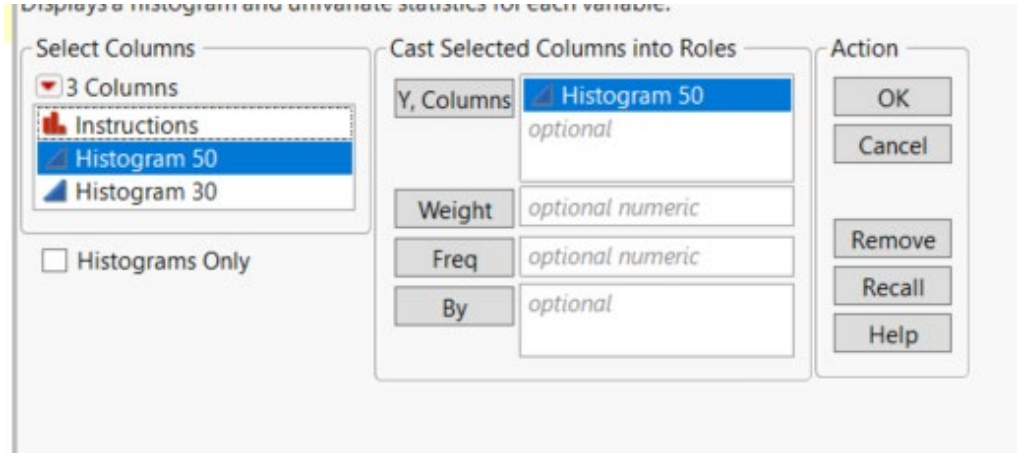
The Importance of the Deviation

The standard deviations is key to assess if a process complies or not with a specification. It allows you to know the amplitude of your process.

You can calculate the mean and standard deviation as follows:

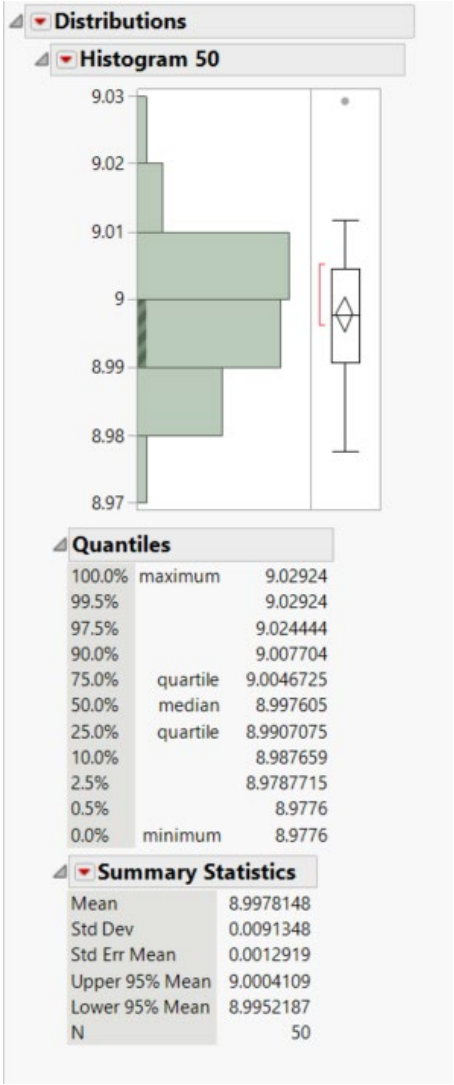
Analyze > Distribution > Select the Results Column (For this example we are using Data Table Exercises column Histogram 50 C1) and click Ok.





The Importance of the Deviation

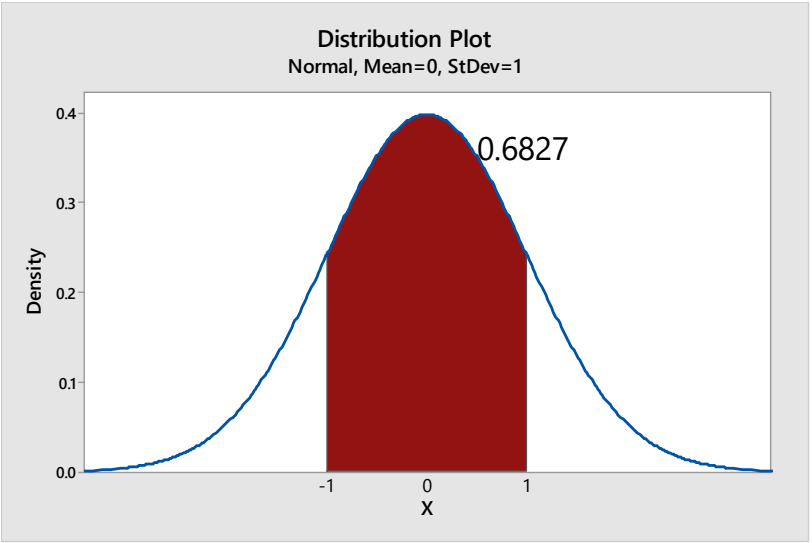
By clicking OK a summary table will be created showing the Summary Statistics Mean, Standard Deviation and quartiles.

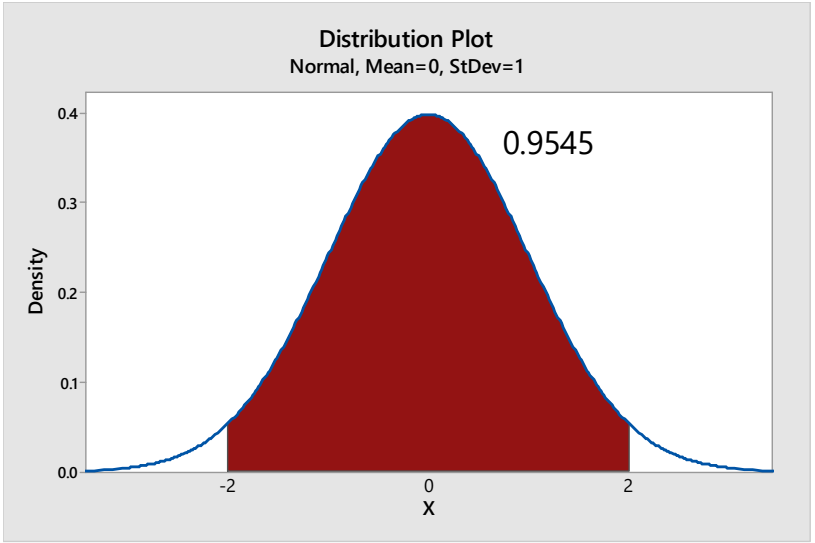


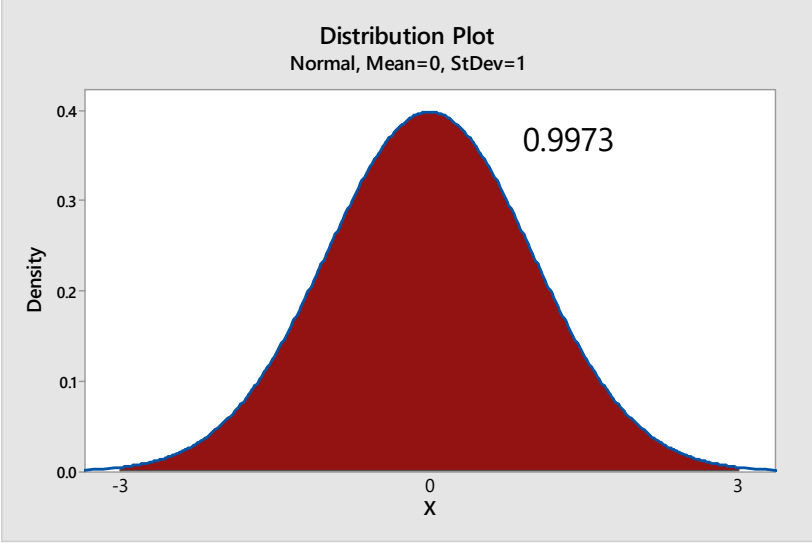
The Importance of the Deviation

The standard deviation is used to know the breadth of data that follows a normal distribution. Commonly, it is said that the Mean +- 3 σ (standard deviations) groups almost all of the data.

Mean +- 1 deviation = 68.27% of the data	Mean +- 2 deviations = 95.45% of the data	Mean +- 3 deviations = 99.73% of the data



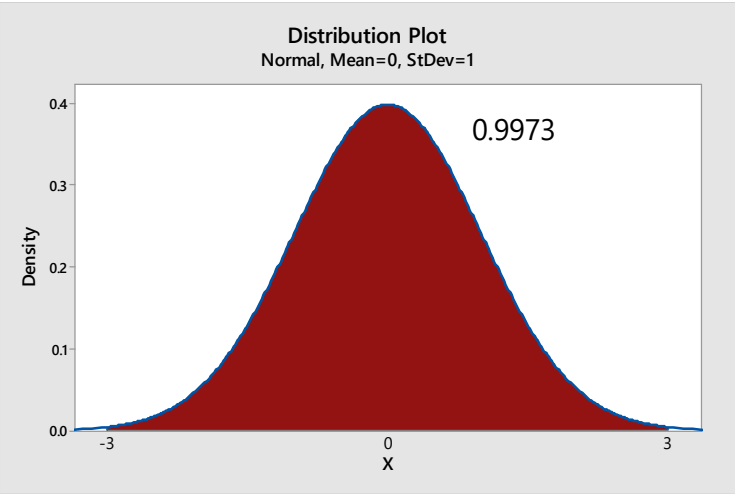


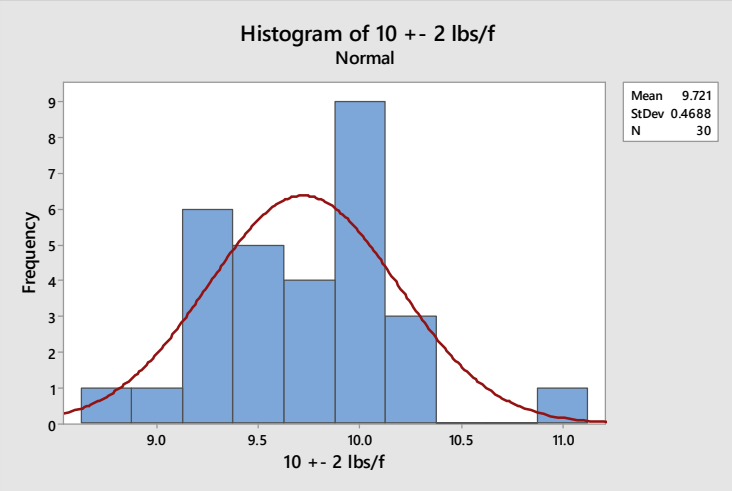


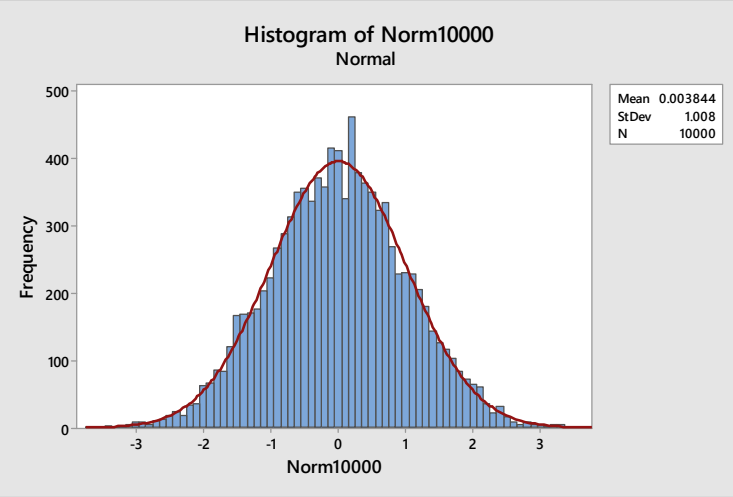
Normal / Gauss Distribution

It is frequently mentioned that the data must be normal. This means that, when we graph such data, it must follow the shape of the Gauss bell. Observe how there's symmetry in the following graphs.

Examples

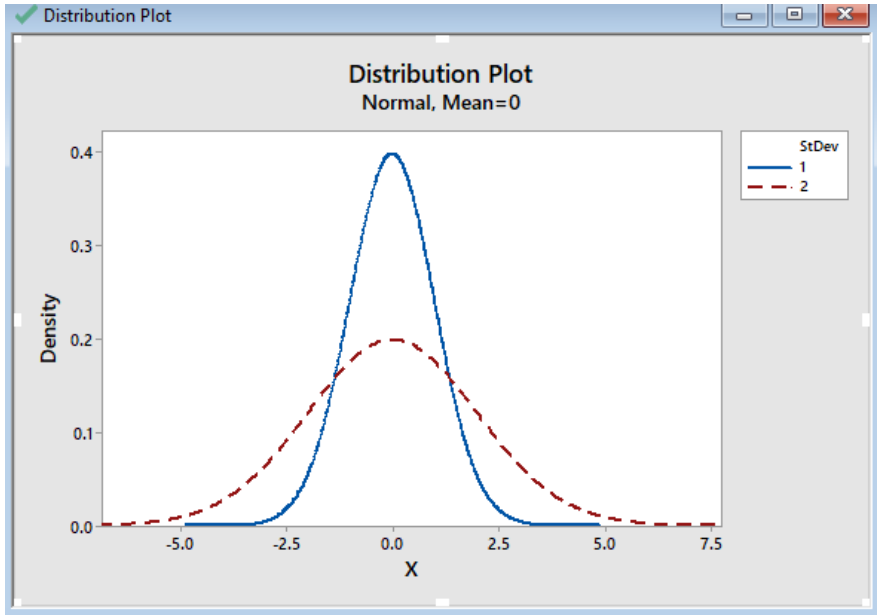






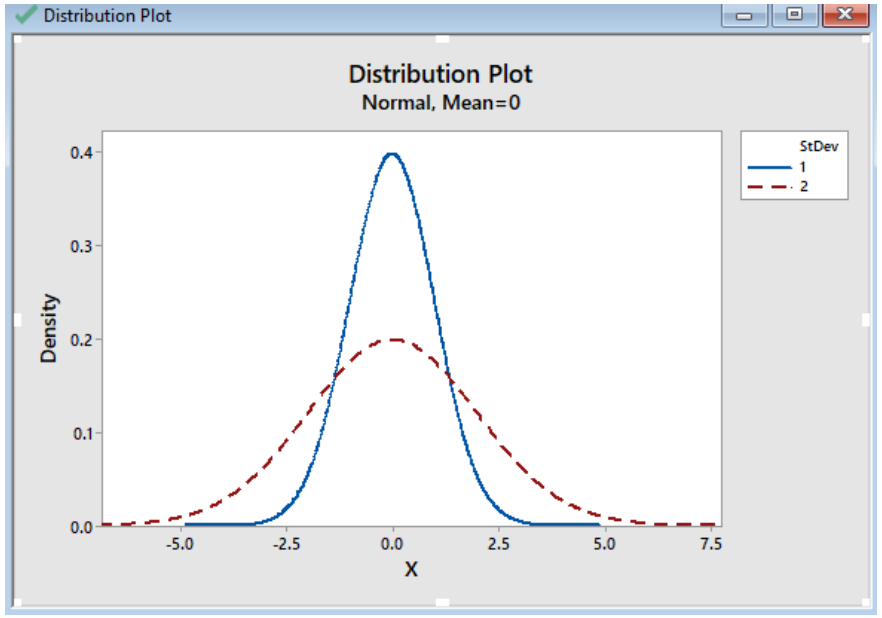
Normal / Gauss Distribution

Normal data follows the shape of a bell, regardless the value of the standard deviation, or the Mean. To demonstrate this, we have created the following graph.



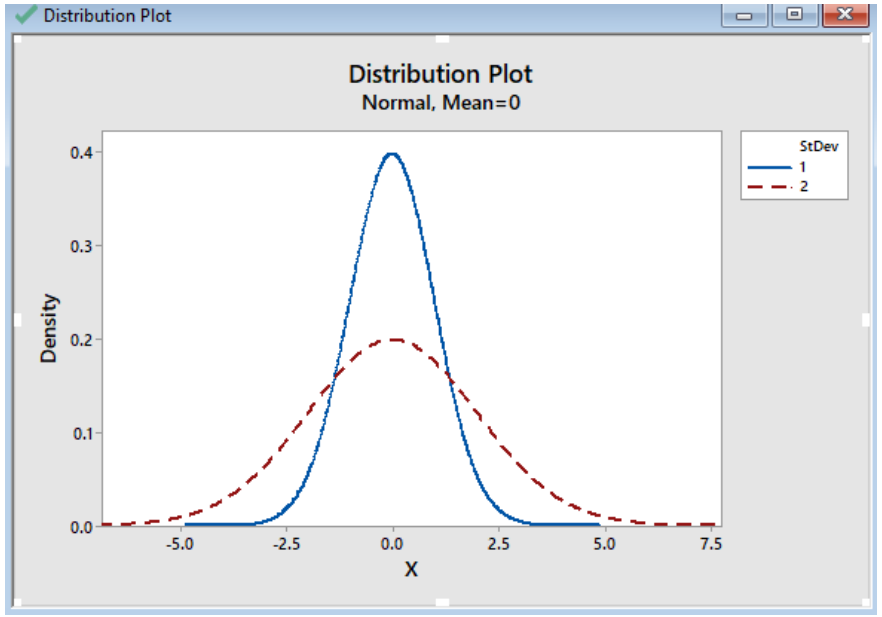
Normal / Gauss Distribution

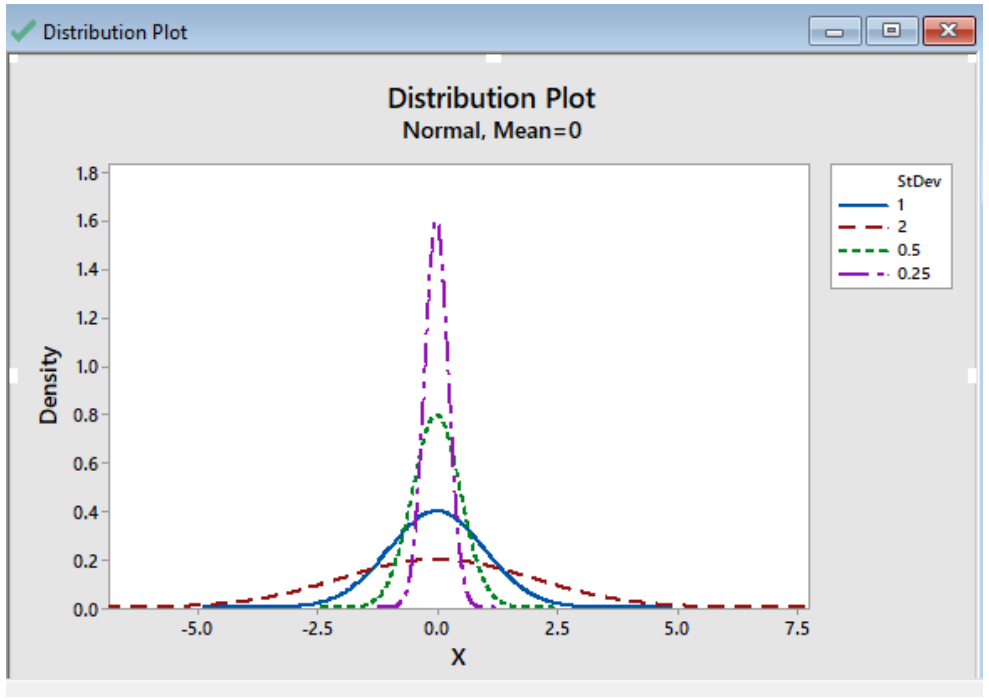
Notice how the blue curve is slimmer than the red curve. This means that the red curve (standard deviation of 2) is more disperse than the blue one (standard deviation of 1). In conclusion, standard deviation is a value that tells us how disperse is the data. Your data will be less disperse when most of the values are similar (e.g. 1.1, 1.2, 1.1) and will be more disperse when your values are very different (e.g. 1, 5, 25).



Normal / Gauss Distribution

We have created additional normal distribution graphs, so you can observe how, as the standard deviation is smaller, the data is more grouped together (the mean being 0).





Module 1. JMP Basics

Presented by: QE NPI Andres Ruelas