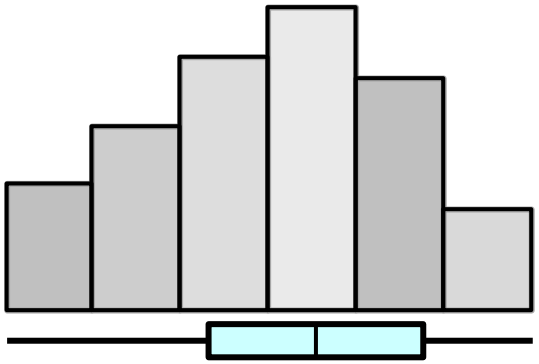
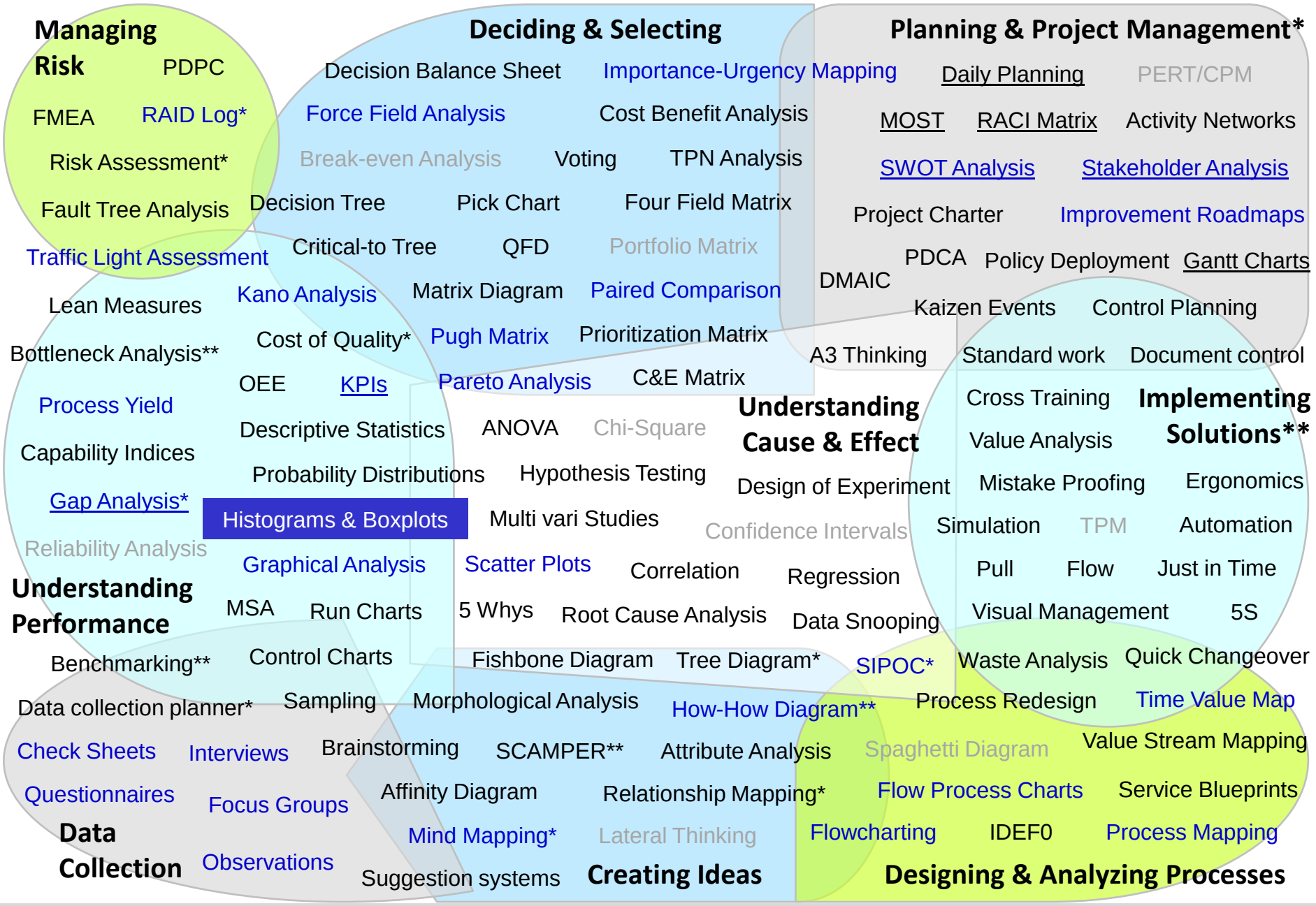
Continuous Improvement Toolkit

Histograms and Boxplots



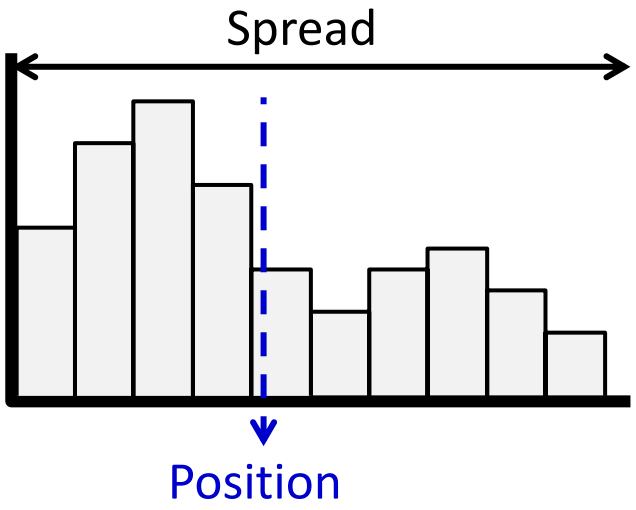
The Continuous Improvement Map



- Histograms and Boxplots

Histograms:

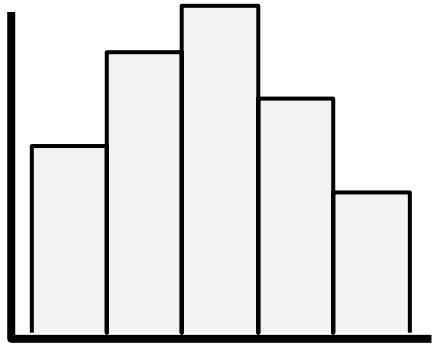
- A **histogram** is a graphical representation of a frequency distribution for numeric data.
- It is a type of bar chart.
- Used as the first step to determine the probability distribution of a data set.
- **It allows to visually and quickly assess:**
  - The shape of the distribution.
  - The central tendency.
  - The amount of variation in the data.
  - The presence of gaps, outliers or unusual data points.



- Histograms and Boxplots

Histograms:

- **Used to identify:**
  - The underlying distribution.
  - Whether you can apply certain statistical tests to perform potential improvement opportunities.
  - Whether the variability in the data is within specification limits.
  - Whether the process is capable or not.
  - The shift in the process.

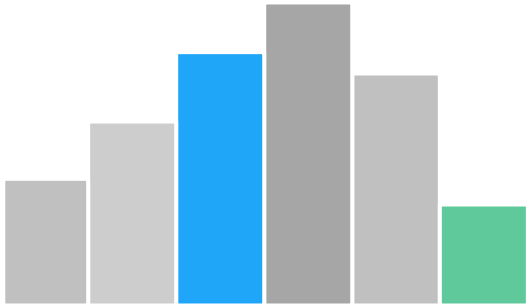


- Used to verify that the changes made were a real improvement.

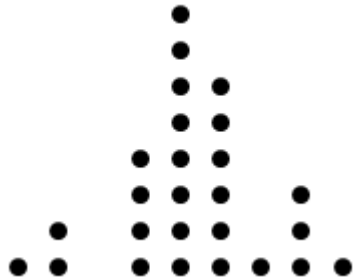
- Histograms and Boxplots

Histograms:

- **Often represents moderate to large amount of continuous data.**
  - Needs at least 25 data points to determine following a particular distribution.



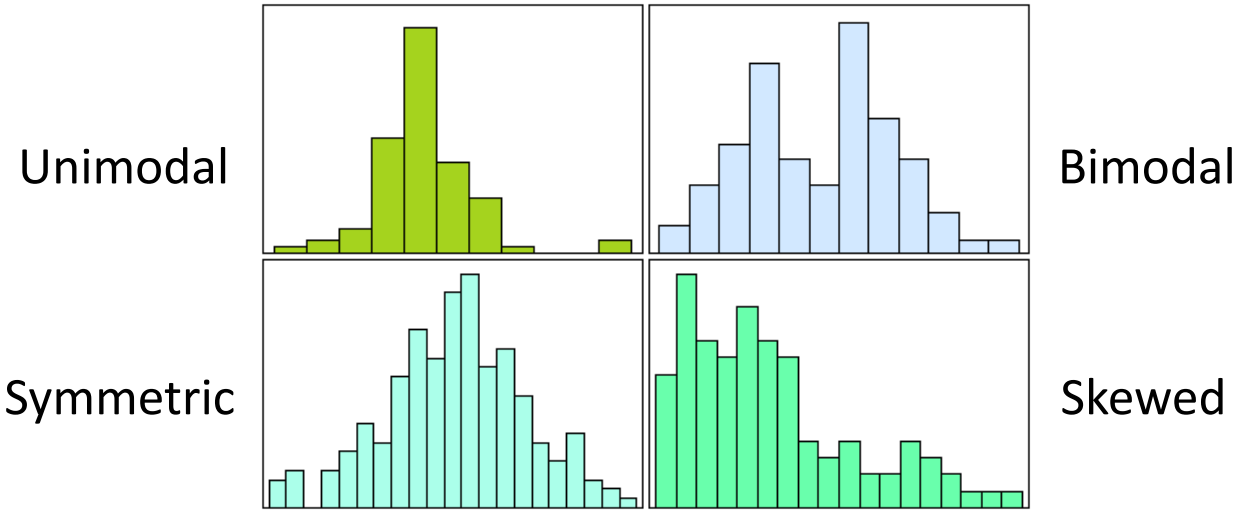
- **It may not accurately display the distribution shape if:**
  - The data size is too small.
  - If the measurement system has a low resolution.
- **Dotplots are preferred over histograms when:**
  - Representing small amount of data.
  - Comparing between multiple distributions.



- Histograms and Boxplots

Histograms:

- **Plot your data in a histogram after collecting the data to know:**
  - The minimum and maximum values.
  - The type of the distribution (normal, exponential, etc.).
  - The shape of the distribution (Symmetric or skewed).
  - Whether it is unimodal, bimodal, or multimodal.



- Histograms and Boxplots

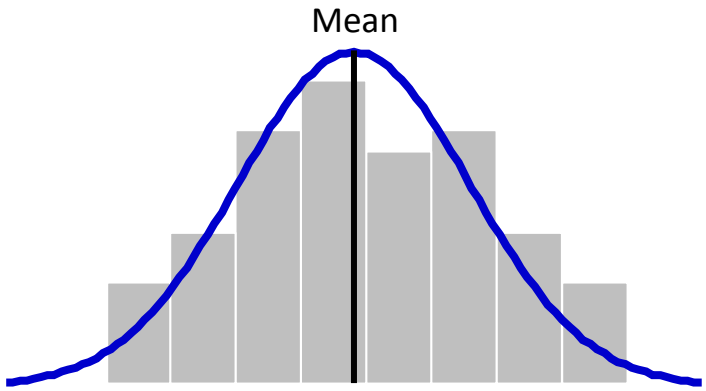
Common Probability Distributions:

- Normal
- Binomial
- Poisson
- Exponential
- Chi-squared
- Student's T
- F
- Uniform

- Histograms and Boxplots

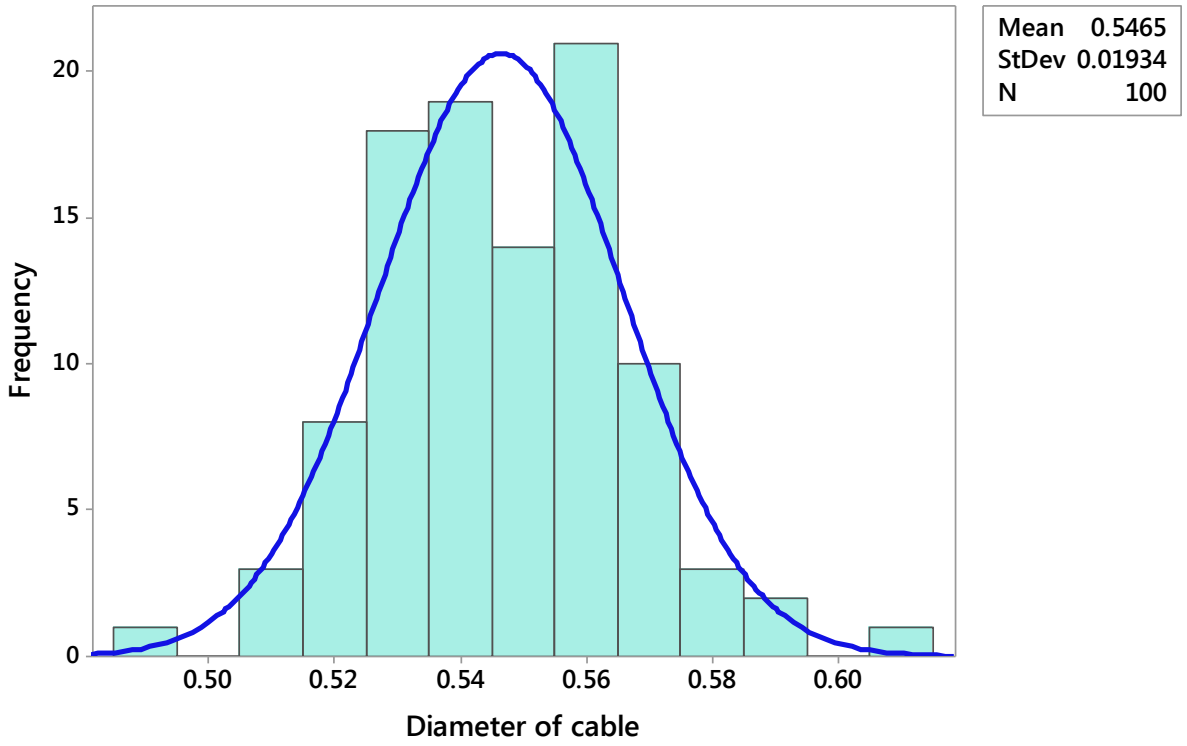
To Construct a Histogram:

- Split the data into intervals called bins.
- Draw bars above each bin to represent the frequency of the data values within each interval.
- The bars should be adjacent with no gaps between them to indicate the continuity of the data.
- The **mean** of the data and the specification limits are often indicated on the histogram.



- Histograms and Boxplots

Example – A histogram that represents the distribution of cable diameters in a manufacturing process:

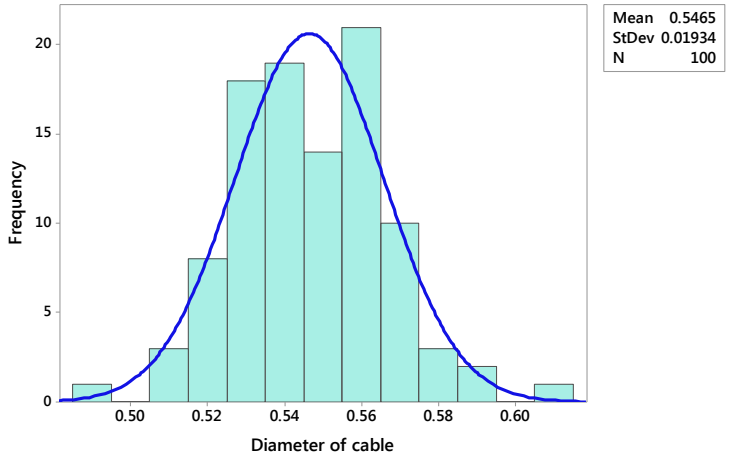


- Histograms and Boxplots

Histograms:

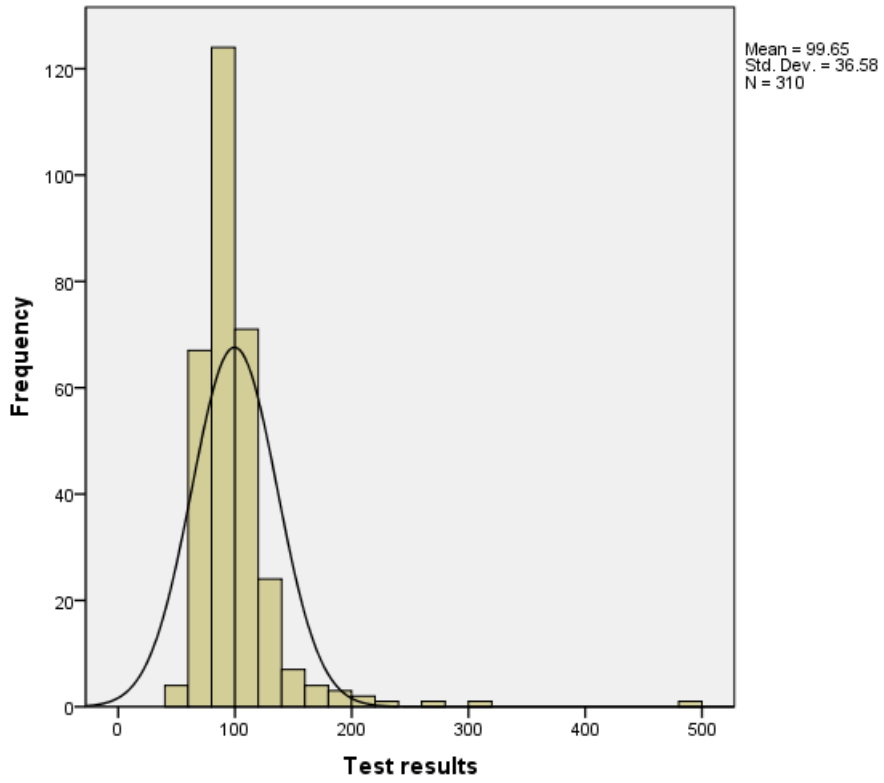
- The result should be summarized using day to day language such as:

  "The distribution looks symmetric around the cable diameter mean (0.546 cm) and appears to fit the Normal Distribution".



- Histograms and Boxplots

Example – An analysis that was conducted for diagnosing the presence of diabetes at a workplace.



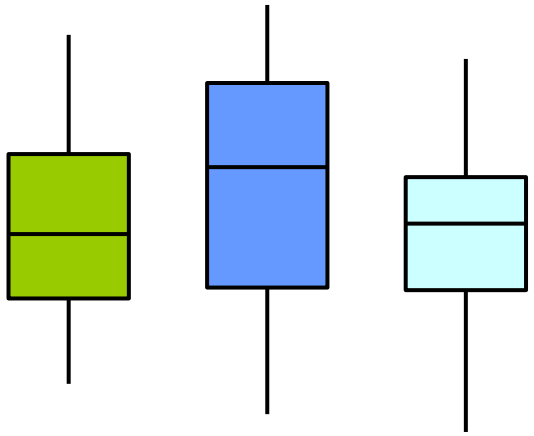
The histogram here shows the distribution of the 310 test results.

It is skewed to the right and it is more like an exponential distribution which is normal for this type of data.

- Histograms and Boxplots

Boxplots:

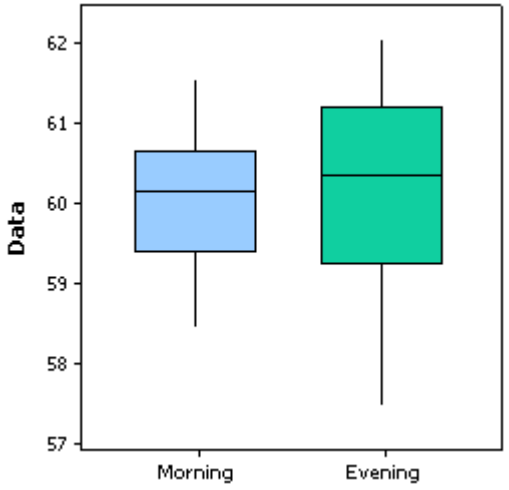
- A graphical way that summarizes the important aspects of the distribution of **continuous data**.
- Useful when comparing between several groups of data sets.
- Used for moderate to large amount of data
  - The size of the boxplot can vary significantly if the data size is too small.
- Less detailed than histograms.
- Take up less space which allows easy comparison of multiple data sets.



- Histograms and Boxplots

Boxplots:

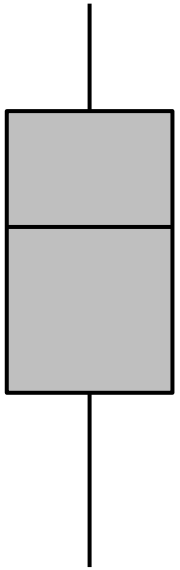
- Primarily used when comparing several distributions.
- They summarize key statistics from the data.
- They display data in a **box-and-whiskers format**.
- They provide a quick way for examining the variation present in the data.
- A wider range boxplot indicates more variability.
- Also used to check if there is a significant difference in the process after implementing a process improvement initiative.



- Histograms and Boxplots

Boxplots:

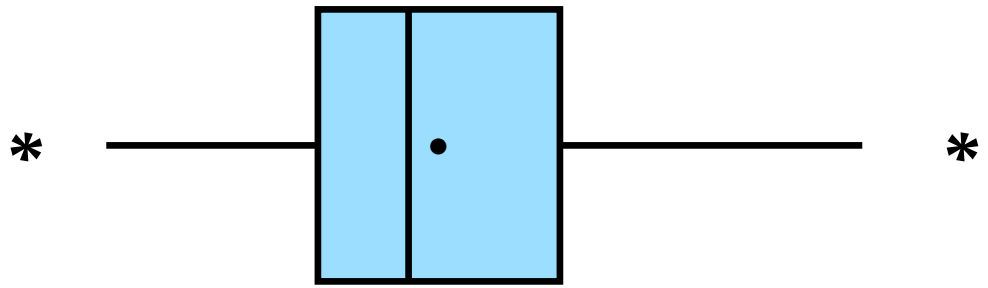
- Tell whether the distribution is symmetrical or skewed.
  - The spacings between the different parts of a boxplot indicate the spread and skewness present in the data.
- Display outliers in the data.
- **The data is plotted such as:**
  - The middle 50% of the data points fits inside the box.
  - The bottom 25% of the data points located below the box.
  - The top 25% of the data points located above the box.
- Each **whisker** may extends up to 1.5 times the length of the box.



- Histograms and Boxplots

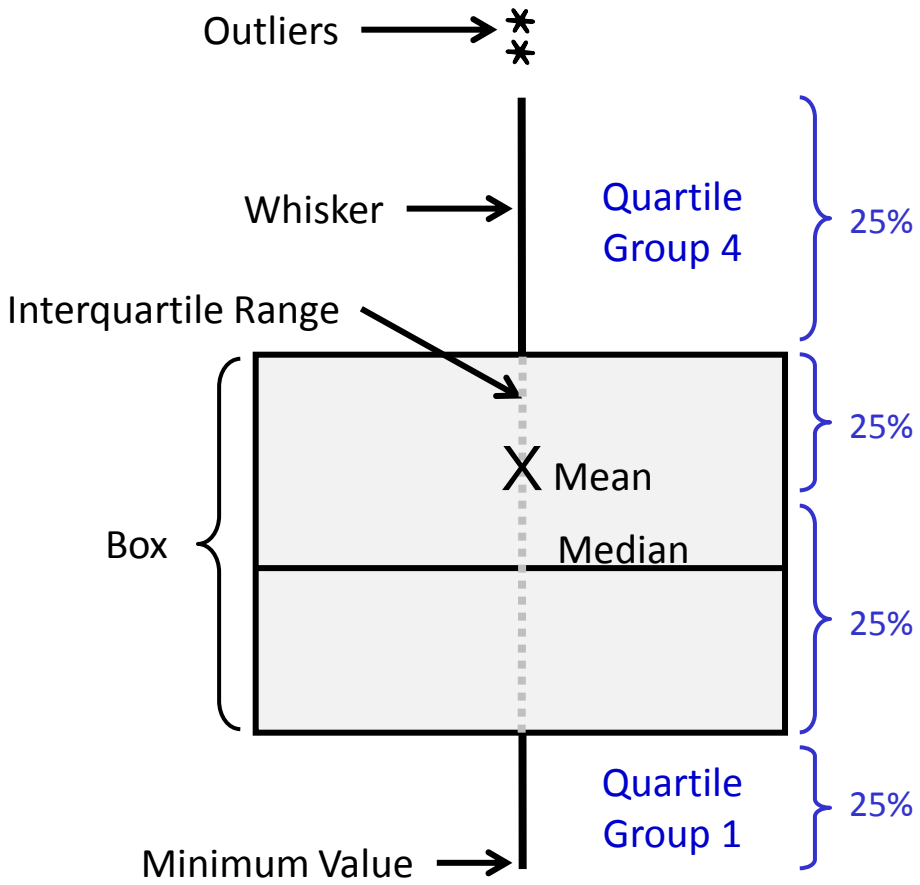
Boxplots:

- The middle line is the median of the data points.
- Sometimes they display the mean with an additional character.
- Any data beyond the whiskers are considered outliers
- Outliers are plotted as asterisks (*).
- Outliers often reflect errors in data recording or data entry.
- If the values are real you should investigate what was going on in the process at the time.



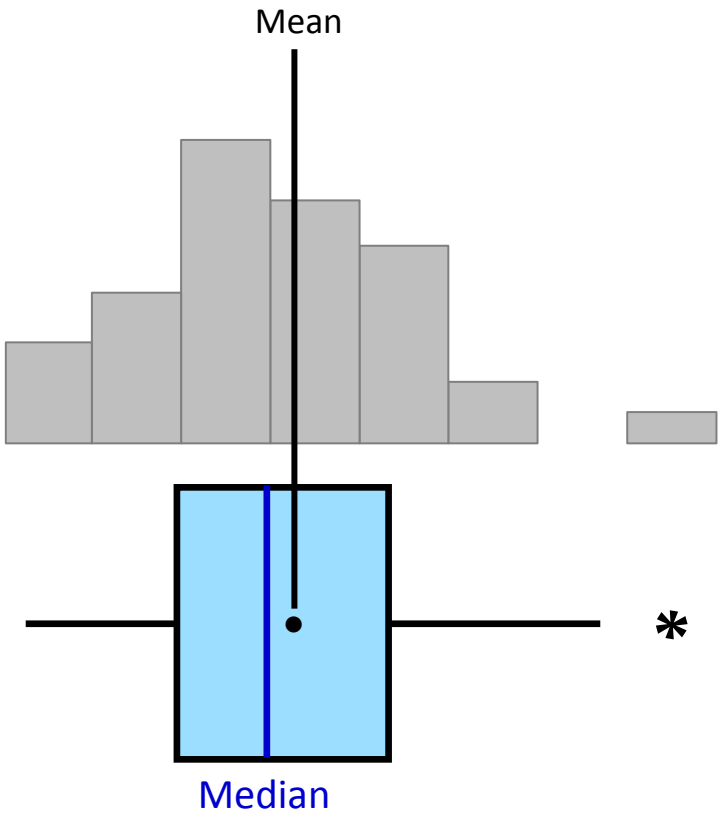
- Histograms and Boxplots

Boxplots:



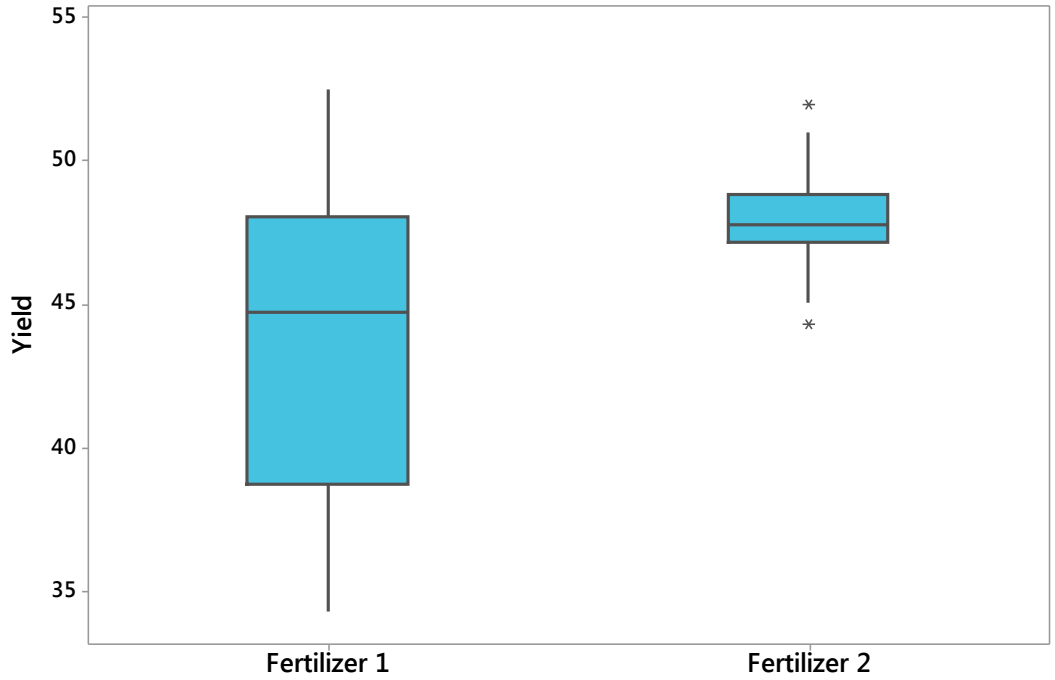
- Histograms and Boxplots

Boxplots and Histograms:



- Histograms and Boxplots

Example – Boxplots that display the yield of a crop after applying two different fertilizers:



Fertilizer 2 appears to have a higher yield than Fertilizer 1

- Histograms and Boxplots

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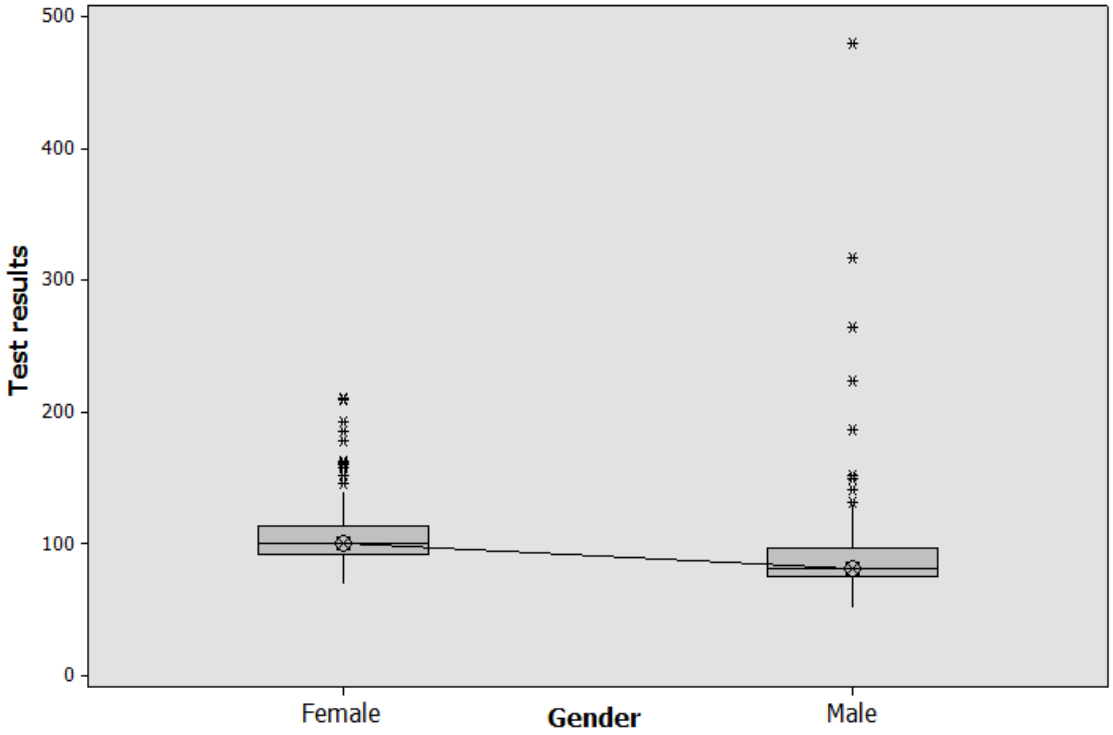

It is evident that the females have in general higher glucose levels than the males.

ANOVA can be used here to test the significance of the factors.

- Histograms and Boxplots

Further Information:

- Histograms are sometimes called Frequency Plots
- Boxplots are referred to as Box-and-Whisker Plots.
- They can be drawn either vertically or horizontally.
- There are many graphical tools that can generate histograms and boxplots quickly and easily (such as Minitab).
- A histogram is normally used for continuous data while a bar chart is a plot of count data.
- Histograms can’t see changes and trends over time.
- Individual Value Plots are preferred over boxplots when representing small amount of data.