METHOD CHOOSER

Minitab 15 Statistical Software

# Capability Analysis

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Minitab
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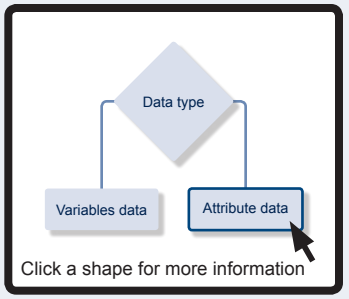
# Capability Analysis




Data type

Continuous data

Data distribution

Normal distribution

Nonnormal distribution

Approach for nonnormal data

Transform the data

Type of transformation

Box-Cox transformation

Johnson transformation

Fit a nonnormal distribution

Attribute data

Type of flaws counted

Defective units

Defects per unit

Normal Capability Analysis

Normal Capability Analysis

Nonnormal Capability Analysis

Nonnormal Capability Analysis

Binomial Capability Analysis

Poisson Capability Analysis

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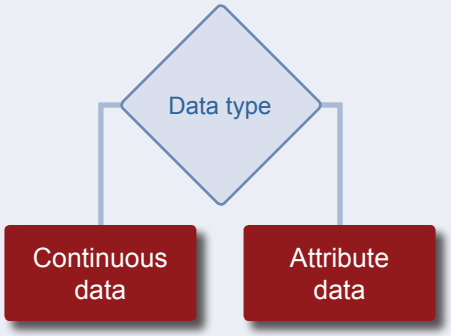
# Do you have continuous data or attribute data?

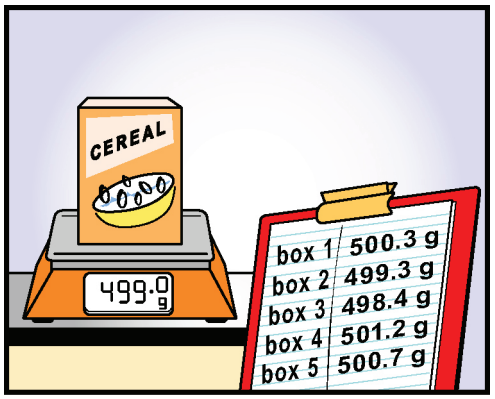



## Continuous data

Measures a characteristic of a part or process, such as length, weight, or temperature. The data often includes fractional (or decimal) values.

**Example**

A food manufacturer wants to investigate whether the weight of a cereal product is consistent with the label on the box. To collect data, a quality analyst records the weights from a sample of cereal boxes.

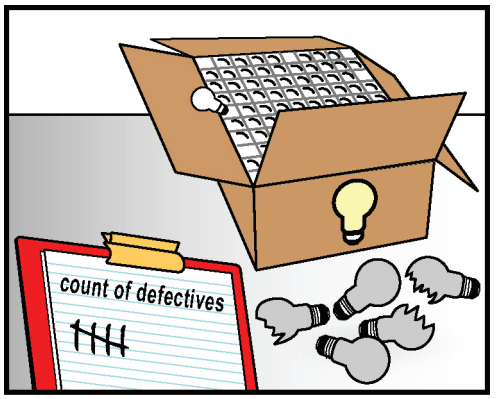



## Attribute data

Counts the presence of a characteristic, such as the number of defective units or defects per unit. The count data are whole numbers.

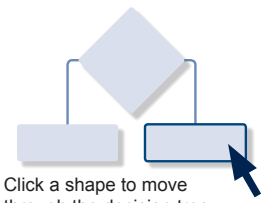
**Example**

Inspectors examine each light bulb and assess whether it is broken. They count the number of broken bulbs (defective units) in a shipment.




If possible, collect continuous data because they provide more detailed information. However, sometimes attribute data adequately describe the quality of a part or a process. For example, if you are tracking broken light bulbs, you don't need to measure a characteristic of the bulb to evaluate whether it's broken or not. What matters is only the number of bulbs that are broken (counts).

With continuous data, the capability analysis estimates the process spread and compares it with the specifications. With attribute data, the capability analysis determines the percentage of defective units or mean defects per unit (DPU).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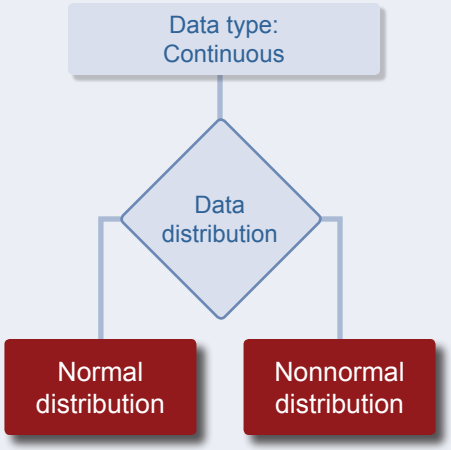
# Does your data follow a normal or nonnormal distribution?

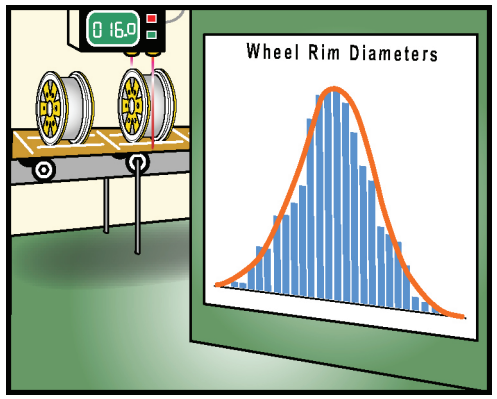



## Normal distribution

Data that follow a symmetric, bell-shaped distribution.

**Example**

An auto parts company manufactures wheel rims to be 16 inches in diameter. Inspectors randomly sample 100 wheel rims and measure their diameters. They determine that the diameters follow a normal distribution.

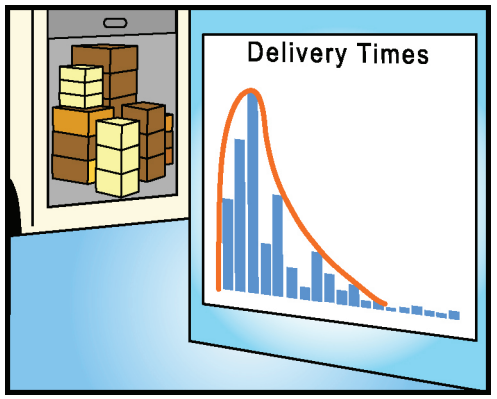



## Nonnormal distribution

Data that follow a distribution that either is not symmetric or is symmetric but not bell-shaped.

**Example**

A shipping company guarantees delivery of domestic packages within 72 hours. Inspectors randomly sample 150 orders and record the delivery times. They determine that the times are not symmetrically distributed.




The distribution of your data often depends on your process. For example, data that track cycle time for service processes, such as the time needed to process an application, serve a customer, or deliver a product, often do not follow a normal distribution.

Although the normal distribution is always bell-shaped, not all bell-shaped distributions are normal. To determine whether your data follow a normal distribution, use normal probability plots, histograms, or normality tests such as the Anderson-Darling test. You can also use Minitab's Individual Distribution Identification to evaluate normality.

Data type:
Continuous

Data distribution:
Normal

**Normal Capability Analysis**

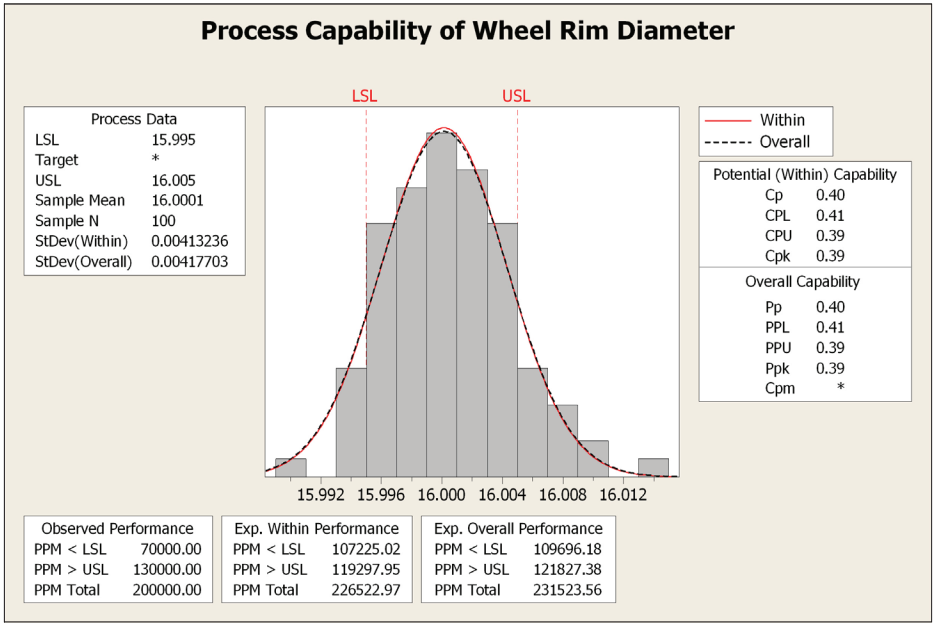
## Normal Capability Analysis

Normal capability analysis evaluates how well a process meets specifications.

### Example

An auto parts company tracks the diameter of wheel rims and determines that the data follow a normal distribution. Inspectors use normal capability analysis to evaluate how well the process meets the product specification of 16 cm for the wheel rim diameters.

To perform a normal capability analysis in Minitab, choose **Stat** > **Quality Tools** > **Capability Analysis** > **Normal**.

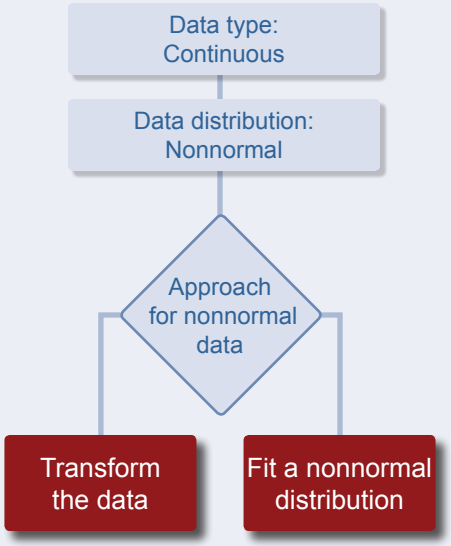



Before you perform a capability analysis, you should evaluate the stability and normality of your process data. Minitab's Capability Sixpack allows you to evaluate normality, process stability, and capability at the same time.

For more specialized or advanced analyses, you may want to use other capability assessments to:

- Compare capability measures for multiple variables on one graph (multiple variables capability analysis)
- Evaluate the capability of a batch process that exhibits considerable variation from batch to batch (between/within capabilty analysis)

# Do you want to transform your data or fit a nonnormal distribution?

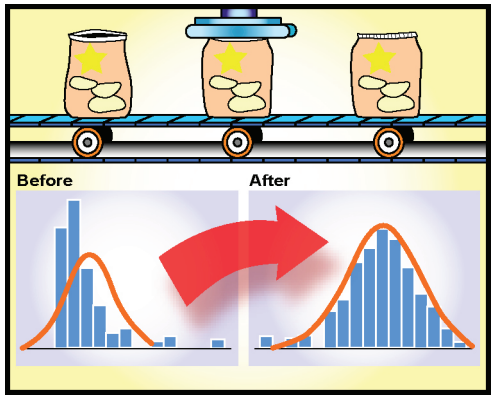



## Transform the data

Apply a function to make the data fit a normal distribution.

### Example

Inspectors at a food processing plant randomly sample snack bags and measure their seal strength. The data are not symmetrically distributed and therefore not normal. Based on organizational preference, the inspectors decide to transform the data.

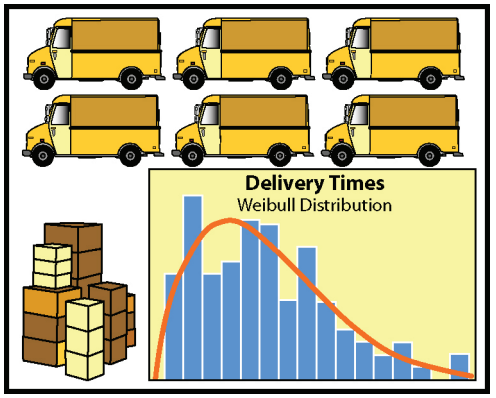



## Fit a nonnormal distribution

Use a nonnormal distribution to model the data.

### Example

A shipping company guarantees delivery of domestic packages within 72 hours. Inspectors randomly sample orders and record the delivery times. They determine that the data follow a Weibull distribution.



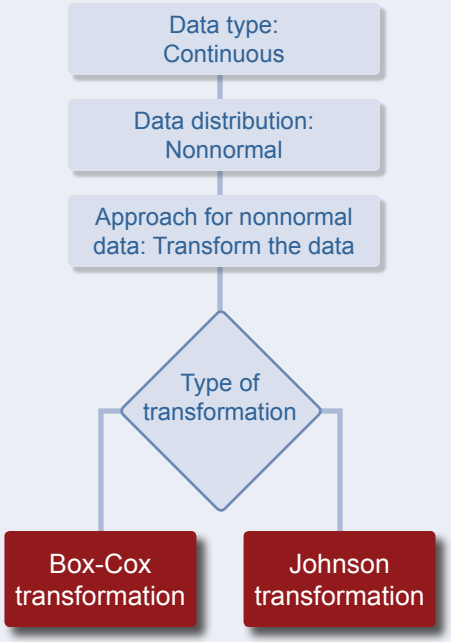

Minitab's Individual Distribution Identification includes probability plots and goodness-of-fit tests that help you determine the effectiveness of each transformation and the fit of each distribution. Generally, a p-value greater than 0.05 indicates that a transformation makes your data normal or that a distribution fits your data. If several distributions or transformations are appropriate, consider additional criteria, such as organizational preference and process knowledge.

If no transformations or nonnormal distributions are appropriate, consider these possible reasons:

- Your data may not come from a single source (population). For example, products produced by two machines may follow different distributions, and you may need to evaluate them separately.
- Your process may not be in control. Assess its stability with control charts before you evaluate capability.
- Your data may contain outliers. Evaluate whether you can remove them.

If you still cannot find an appropriate distribution or transformation, you may need to use a simpler measure of capability for your data, such as percentage out of specification.

# Do you want to use the Box-Cox or the Johnson transformation?

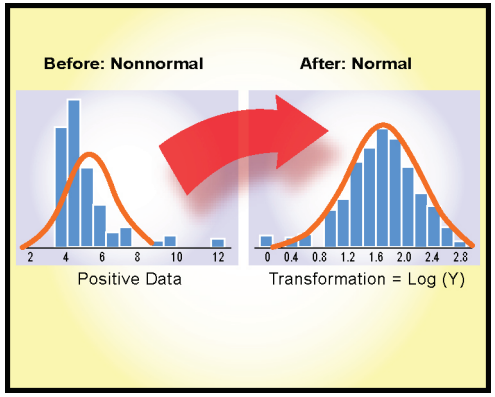



## Box-Cox transformation

Uses a simple function that is easy to understand. Cannot be used if your data contains negative numbers or zeros.

### Example

Inspectors at a food processing plant randomly sample snack bags and measure their seal strength. The data are not symmetrically distributed and therefore not normal. Because the Box-Cox transformation is often effective for their process data, they apply the transformation to make the data normal.

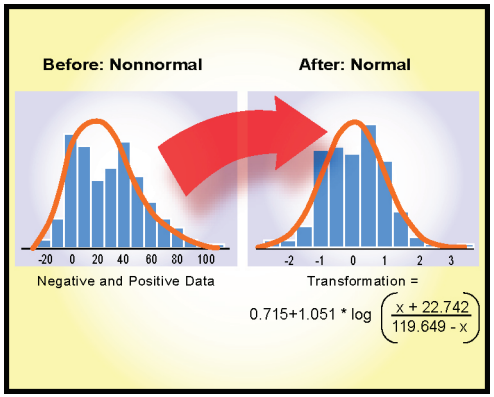



## Johnson transformation

Uses a complex function, but transforms a wider variety of nonnormal data than the Box-Cox transformation. Can be used with data that contains negative numbers and zeros.

### Example

A bookstore evaluates how accurately its Web site estimates the delivery date for online orders. For each order, analysts calculate the difference between the actual arrival date and the estimated arrival date. The data are nonnormal and contain negative values (some orders arrive earlier than expected), so the analysts use the Johnson transformation.




Minitab's Individual Distribution Identification includes probability plots and goodness-of-fit tests that help you determine the effectiveness of each transformation. Generally, a p-value greater than 0.05 indicates that a transformation makes your data normal.

If both the Johnson and the Box-Cox transformation are effective for your data, consider these additional criteria:

- Only the Box-Cox transformation provides within-subgroup analysis (Cpk and Cp values)
- The Box-Cox transformation is easier to explain to others and to apply manually
- A transformation may be preferred based on process knowledge or organizational practice

Data type: Continuous
Data distribution: Nonnormal
Approach for nonnormal data: Transform the data
Type of transformation: Box-Cox
**Normal Capability Analysis**

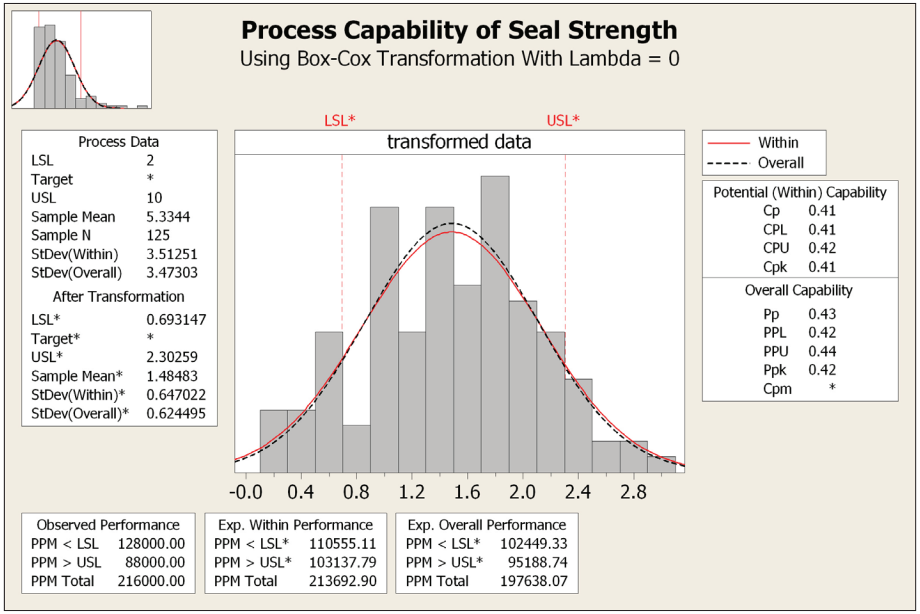
## Normal Capability Analysis

Normal capability analysis evaluates how well a process meets specifications.

### Example

Inspectors at a food processing plant randomly sample 250 snack bags and measure their seal strength. Because the data do not follow a normal distribution, the inspectors perform normal capability analysis with the Box-Cox transformation to evaluate how well the process meets the specifications for seal strength.

To perform a normal capability analysis on nonnormal data in Minitab, choose **Stat** > **Quality Tools** > **Capability Analysis** > **Normal**. Click **Box-Cox** and choose **Use optimal lambda**.




Before you perform a capability analysis, you should evaluate the stability and normality of your process data. Minitab's Capability Sixpack allows you to evaluate normality, process stability, and capability at the same time.

For more specialized or advanced analyses, you may want to use other capability assessments to:

- Compare capability measures for multiple variables on one graph (multiple variables capability analysis)
- Evaluate the capability of a batch process that exhibits considerable variation from batch to batch (between/within capabilty analysis)

Data type: Continuous
Data distribution: Nonnormal
Approach for nonnormal data: Transform the data
Type of transformation: Johnson
**Nonnormal Capability Analysis**

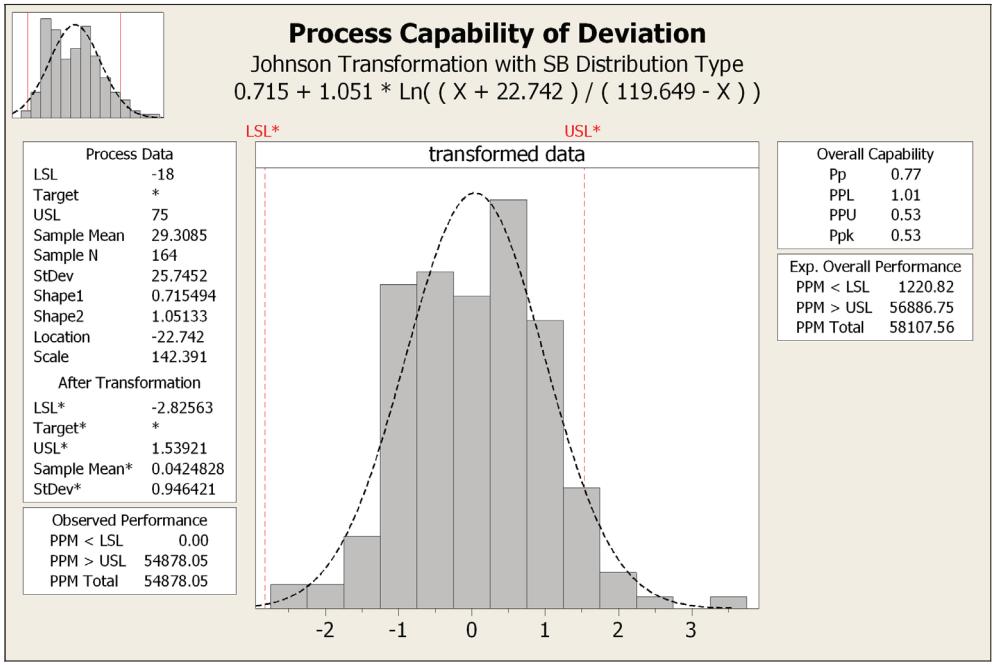
## Nonnormal Capability Analysis

Nonnormal capability analysis evaluates how well a process meets specifications.

### Example

A mail-order catalog company wants to evaluate how accurately its Web site estimates the delivery date for products that customers order online. For each order, analysts calculate the difference between the estimated arrival date and the actual arrival date. They perform nonnormal capability analysis with the Johnson transformation to evaluate how well the process meets the specifications for delivery estimates.

To perform a nonnormal capability analysis with the Johnson transfomation in Minitab, choose **Stat > Quality Tools > Capability Analysis > Nonnormal**. Under **Fit data with**, choose **Johnson transformation**.

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To compare capability measures for multiple variables on one graph, use multiple variables capability analysis.

Data type:
Continuous

Data distribution:
Nonnormal

Approach for nonnormal data:
Fit a nonnormal distribution

**Nonnormal Capability Analysis**

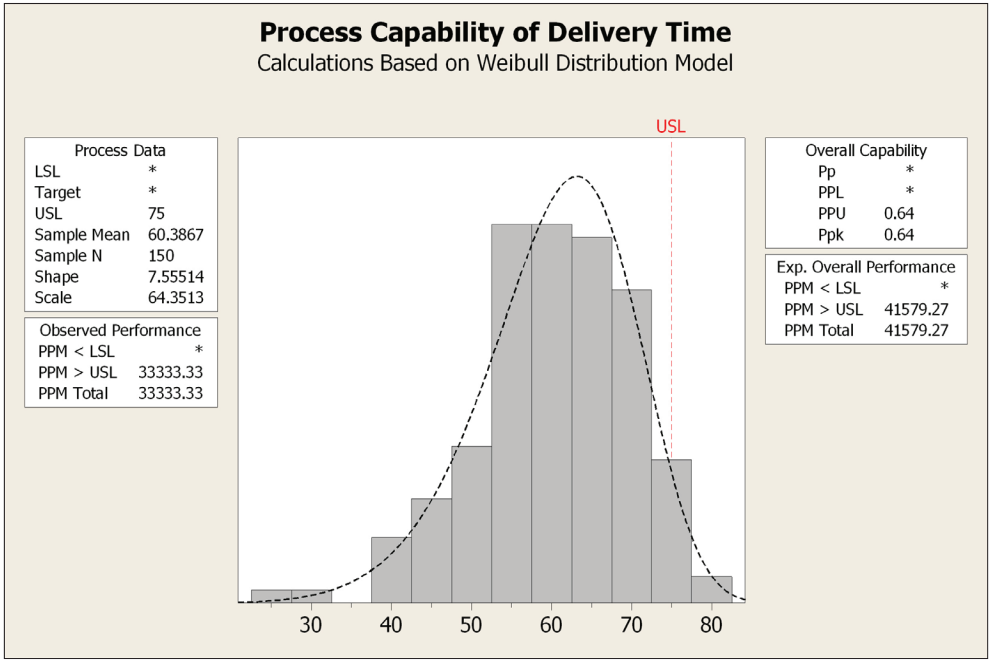
## Nonnormal Capability Analysis

Nonnormal capability analysis evaluates how well a process meets specifications.

### Example

Inspectors at a shipping company track the delivery time of packages and determine that the data follow a Weibull distribution. They use nonnormal capability analysis to evaluate how well the shipping process meets the specifications for delivery time.

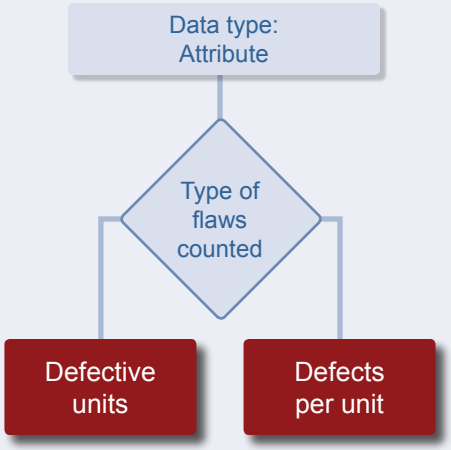
To perform a nonnormal capability analysis in Minitab, choose **Stat** > **Quality Tools** > **Capability Analysis** > **Nonnormal**. Under **Fit data with**, choose **Distribution**, and then choose the nonnormal distribution you want to use to model your data.




Before you perform a capability analysis, you should evaluate the stability and normality of your process data. Minitab's Capability Sixpack allows you to evaluate normality, process stability, and capability at the same time.

To compare capability measures for multiple variables on one graph, use multiple variables capability analysis.

# Are you counting defective units or defects per unit?

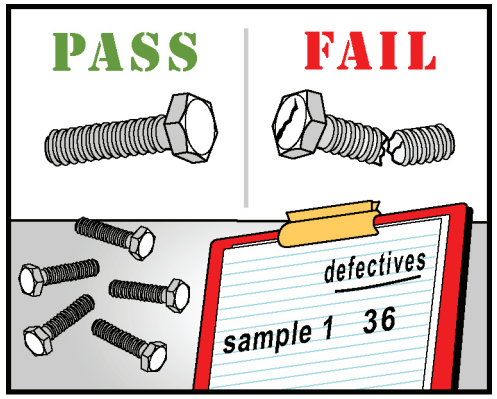



## Defective units

Counts items that are classified into one of two categories such as pass/fail or go/no-go. Often used to calculate a proportion (%defective).

**Example**

An automated inspection process examines samples of bolts for severe cracks that make the bolts unusable. For each sample, analysts record the number of bolts inspected and the number of bolts rejected.

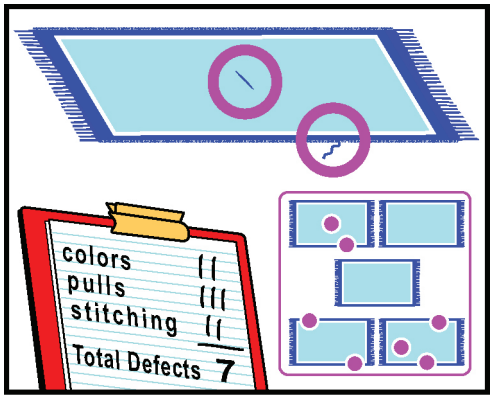



## Defects per unit

Counts defects, or the presence of undesired characteristics or activities for each unit. Often used to determine an occurrence rate (defects per unit).

**Example**

Inspectors sample 5 beach towels every hour and examine them for discolorations, pulls, and improper stitching. They record the total number of defects in the sample. Each towel can have more than 1 defect, such as 1 discoloration and 2 pulls (3 defects).




A defective unit (also called a defective or nonconforming unit) is a part with a flaw so severe that it is unacceptable for use, such as a broken light bulb or cracked bolt.

Defects (also called nonconformities) are flaws, such as scratches, dents, or bumps on the surface of a car hood. A part can have more than one defect, and the defects do not necessarily make the part unacceptable. You can count defects over a length of time (complaints received during an 8-hr shift), over an area (stains on every 50 yards of fabric), or over a set number of items (defects in a sample of 5 beach towels).

In some situations, you may want to define defectives or defects as successful occurrences rather than failures or flaws. For example, you may want to track the proportion of customers who respond to a mass mailing by applying for a credit card.

Data type:
Attribute

Type of flaws counted:
Defective units

**Binomial Capability Analysis**

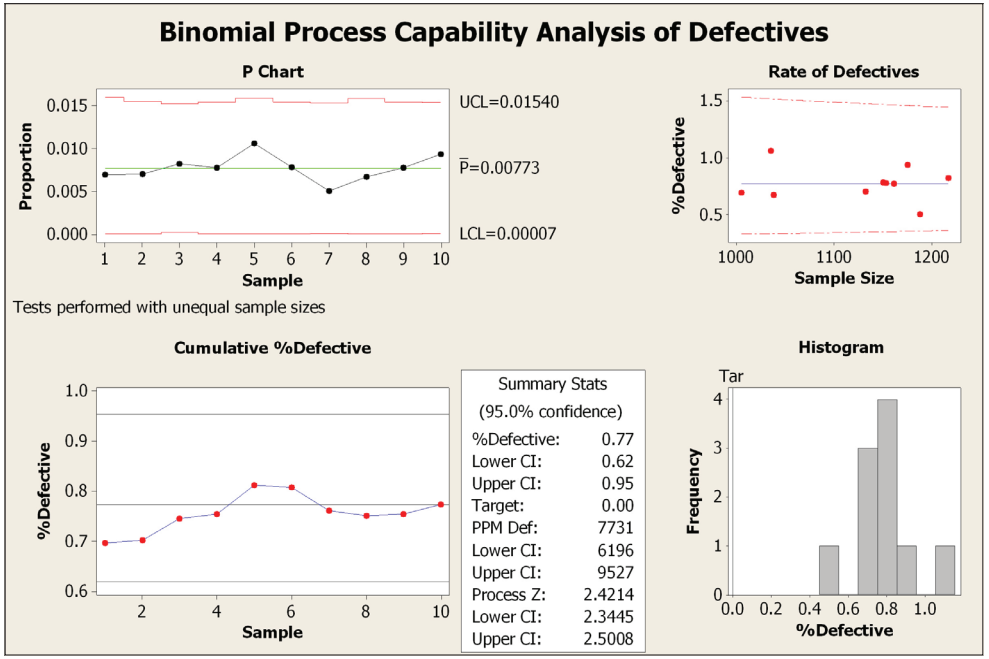
## Binomial Capability Analysis

Binomial capability analysis evaluates the percentage of defective units.

### Example

An automated inspection process examines samples of bolts and counts how many bolts are rejected due to a severe crack. Inspectors use binormial capability analysis to evaluate the percentage of defective bolts.

To perform a binomial capability analysis in Minitab, choose **Stat** > **Quality Tools** > **Capability Analysis** > **Binomial**.




Before you perform a capability analysis, you should evaluate your data with control charts to make sure that your process is stable. Minitab's Binomial Capability Analysis includes a P chart to evaluate the stability of your process.

# Capability Analysis
## Poisson Capability Analysis

Data type:
Attribute

Type of flaws counted:
Defects per unit

**Poisson Capability Analysis**

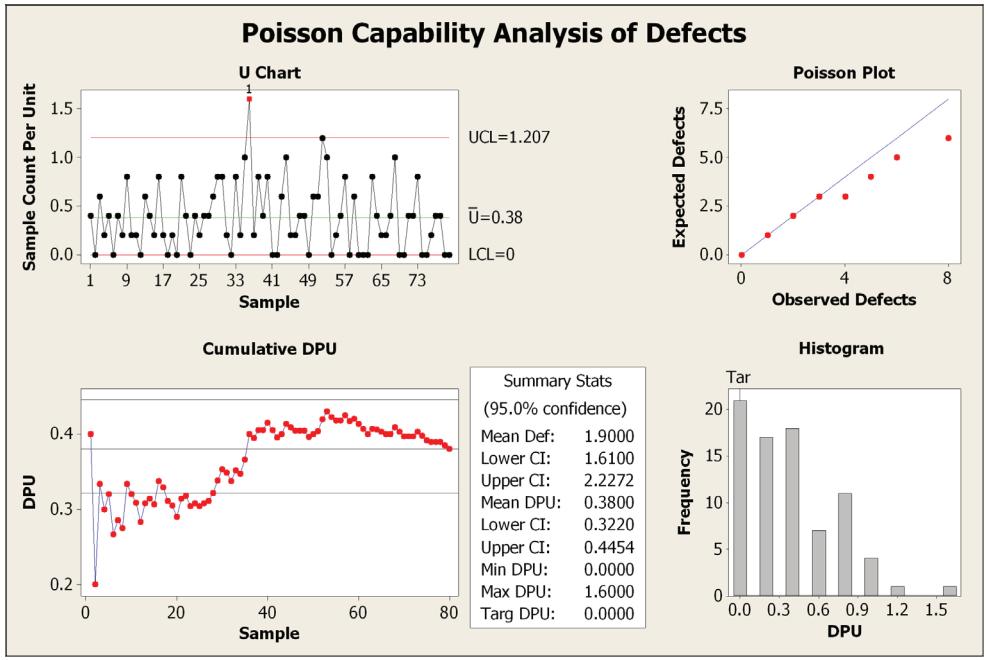
## Poisson Capability Analysis

Poisson capability analysis evaluates the rate of defects per unit.

### Example

A towel manufacturer tracks these defects in each sample of five beach towels: discoloration, pulls, and improper stitching. Inspectors use Poisson capability analysis to evaluate the rate of defects per sample.

To perform a Poisson capability analysis in Minitab, choose **Stat** > **Quality Tools** > **Capability Analysis** > **Poisson**.




Before you perform a capability analysis, you should evaluate your data with control charts to make sure that your process is stable. Minitab's Poisson Capability Analysis includes a U chart to evaluate the stability of your process.

# Contacts

## Minitab World Headquarters


### Minitab Inc.

Quality Plaza
1829 Pine Hall Road
State College, PA 16801-3008
USA


Minitab is a global company with subsidiaries and representatives around the world. To find a Minitab partner in your country, visit www.minitab.com/contacts.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