METHOD CHOOSER

Minitab 15 Statistical Software

Measurement System Analysis

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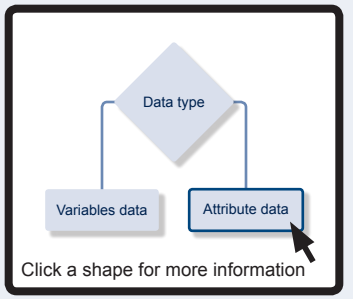
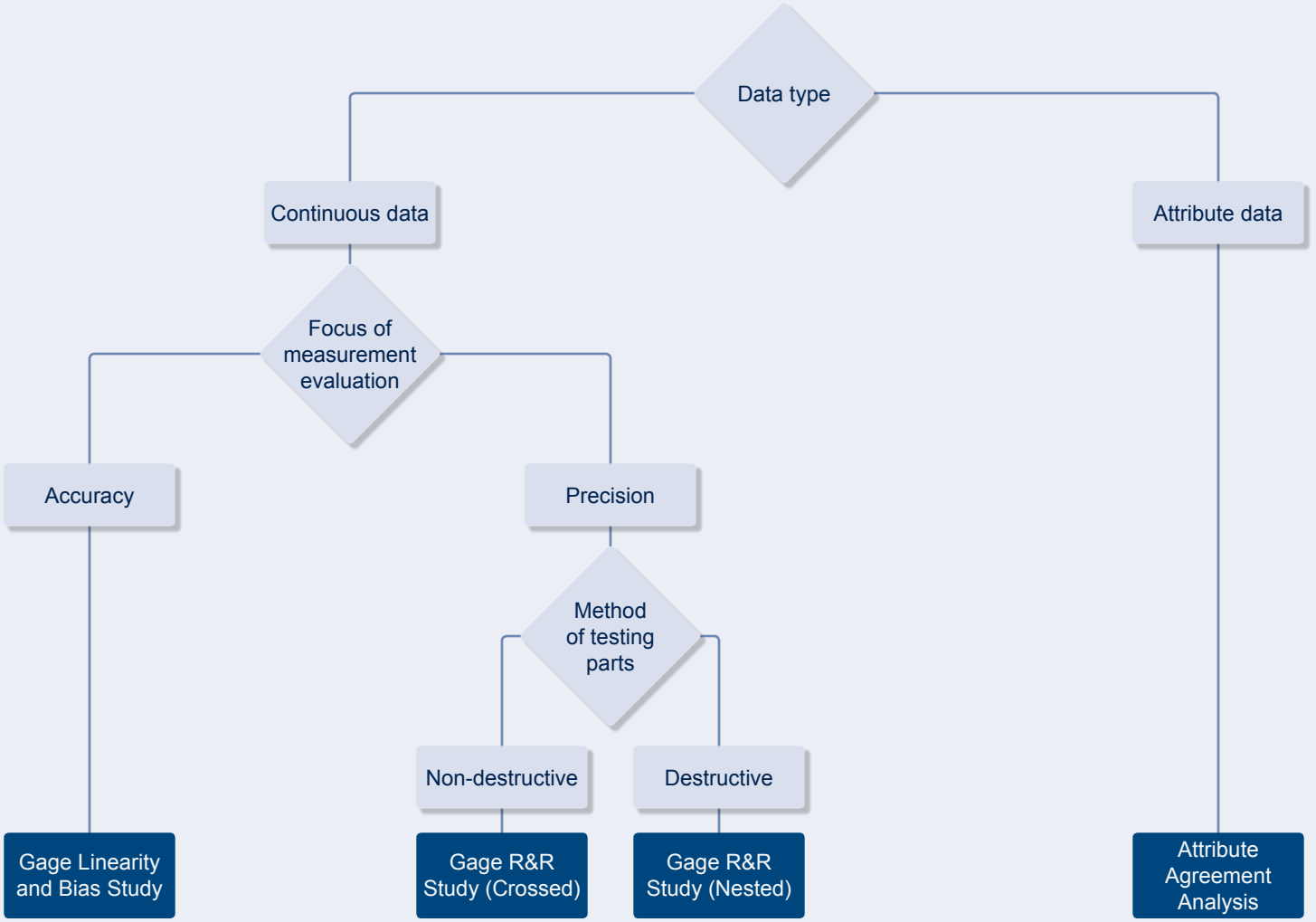
Minitab
QUALITY. ANALYSIS. RESULTS.

Measurement System Analysis





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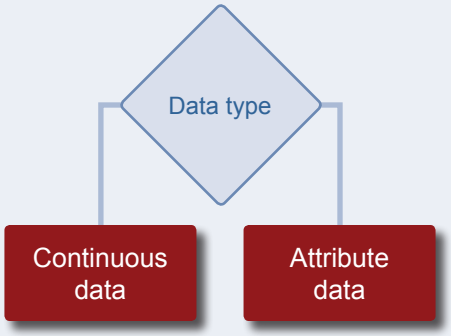
Do you have continuous data or attribute data?

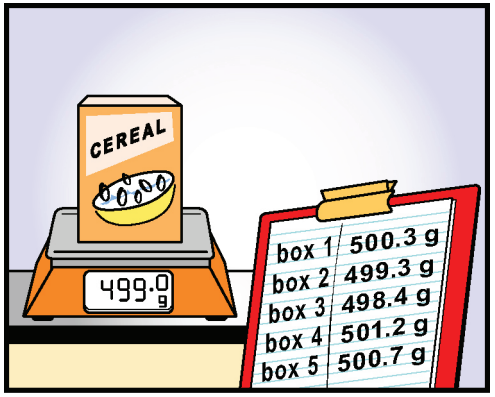


Continuous data

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

Example

A food manufacturer wants to evaluate a scale that weighs cereal boxes to the nearest tenth of a gram.

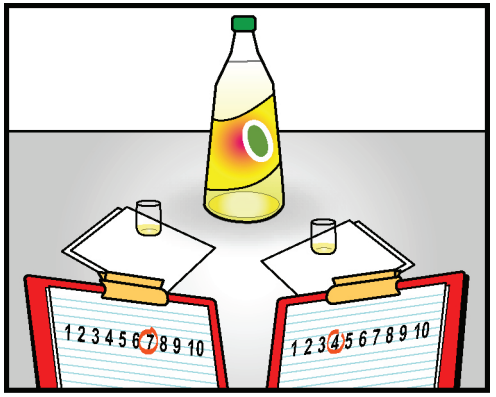


Attribute data

Classifies people, things, or events into categories. Attribute data are often subjective ratings by appraisers.

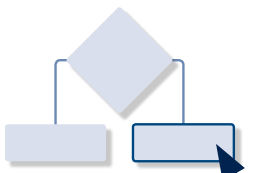
Example

A quality analyst wants to evaluate the rating system that is used to assess the flavor of olive oil. Professional taste testers rate the fruitiness of each olive oil sample on a scale from 1 to 10.



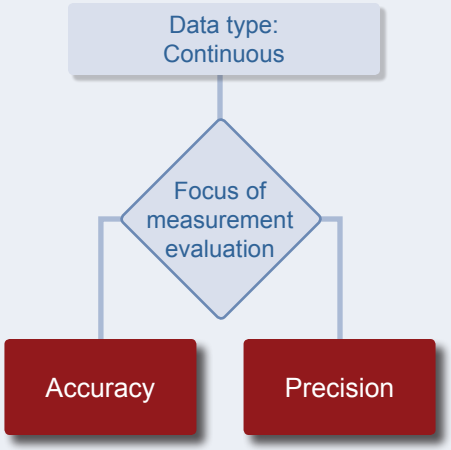
Attribute data can be in the following forms and classifies data into:

- Binary – Two categories, such as pass-fail or yes-no
- Nominal – Three or more categories with no natural ordering, such as red, blue, or black
- Ordinal – Three or more categories with ordering, such as a rating scale of 1 to 10, or with ranked values, such as excellent, good, fair, poor


Click a shape to move through the decision tree


Click this icon on any page to return to Start.

Do you want to evaluate accuracy or precision?

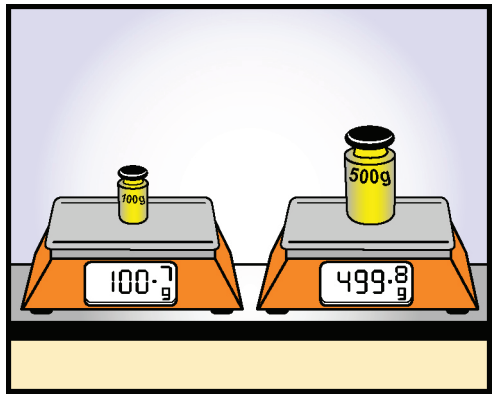


Accuracy

Evaluates how close the measurements are on average to a known reference value or standard. Determines whether the measurement system tends to measure too high or too low.

Example

A food processing company packs products in different sized jars. An engineer wants to make certain that the scales can accurately weigh standard reference weights for all the jar sizes: 50 g, 100 g, 250 g, 500 g, and 1000 g.

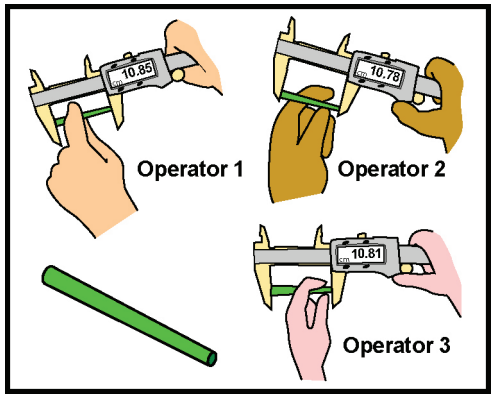


Precision

Assesses the variation in the measurements that is caused by the operators and the measuring device. Determines whether the measurement system is precise enough to distinguish between different parts.

Example

An engineer at a pen company wants to evaluate the variation in the measurements of pen barrels. Three operators use the same caliper to measure the length of pen barrels.

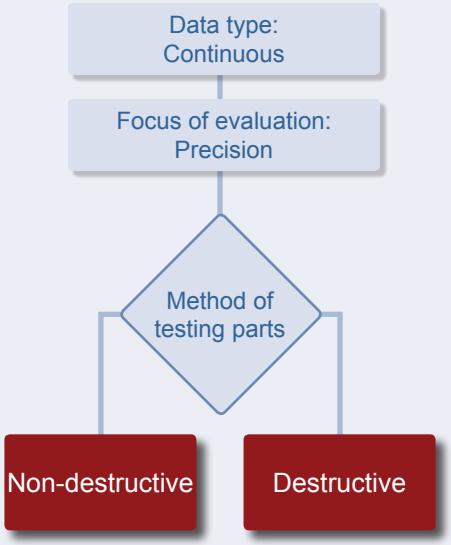


To evaluate accuracy, you must have reference values for each part, and the parts should cover the operating range of the measurement system. The Automotive Industry Action Group (AIAG) recommends using at least five parts.

To evaluate precision, have operators measure the same parts in random order under the same conditions. Then, you can assess two sources of variation:

- Reproducibility – The variation observed when different operators measure the same part under the same conditions (same environment, same machine, and so on).
- Repeatability – The variation observed when the same operator measures the same part repeatedly under the same conditions.

Are you using a destructive or non-destructive test to measure the parts?

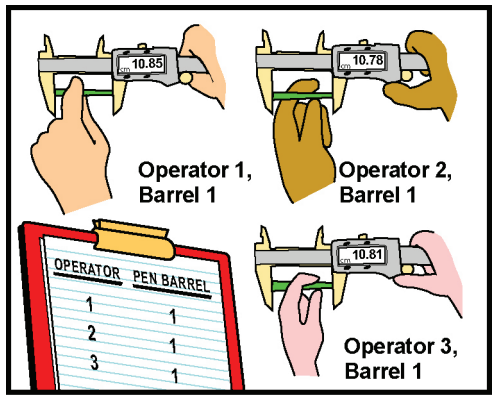


Non-destructive test

Each part is measured by more than one operator because the method of testing does not destroy the part.

Example

A pen company wants to determine whether its measurement system is consistent and precise enough to assess the length of pen barrels. Three operators use the same caliper to measure the same 10 pen barrels in random order under the same conditions.

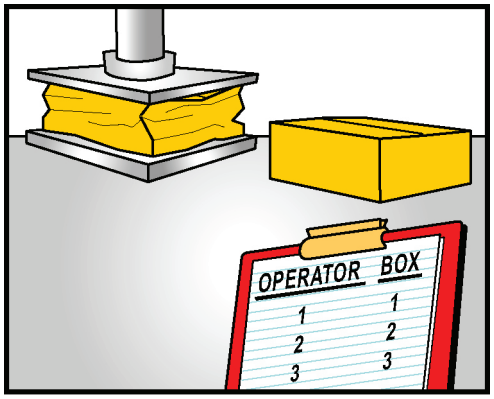


Destructive test

Each part is measured by only one operator because the part is destroyed by the test or because a process produces a small batch which cannot be measured by all operators.

Example

A manufacturer wants to make sure it can consistently and precisely measure the crush strength of boxes. Operators assess crush strength by measuring the force needed to break each box. Each box is destroyed by testing, so each operator must measure the crush strength of different boxes.



When possible, have operators measure the same parts. You may be able to treat different parts as the same in these cases:

- If parts are produced in large homogeneous batches, such as a cough syrup or a food additive, you may be able to treat distinct samples from the same batch as the same part.
- If you can provide enough comparable parts for different operators to measure in a destructive test, you may be able to treat those parts as the same part and consider the test non-destructive.

When you treat distinct parts as the same part, any differences between the parts are attributed to variation in the measurement system. If the distinct parts are not actually the same, you may overestimate the amount of variation that exists in your measurement system.

Data type: Continuous
Focus of evaluation: Precision
Method of testing parts: Non-destructive
Gage R & R (Crossed)

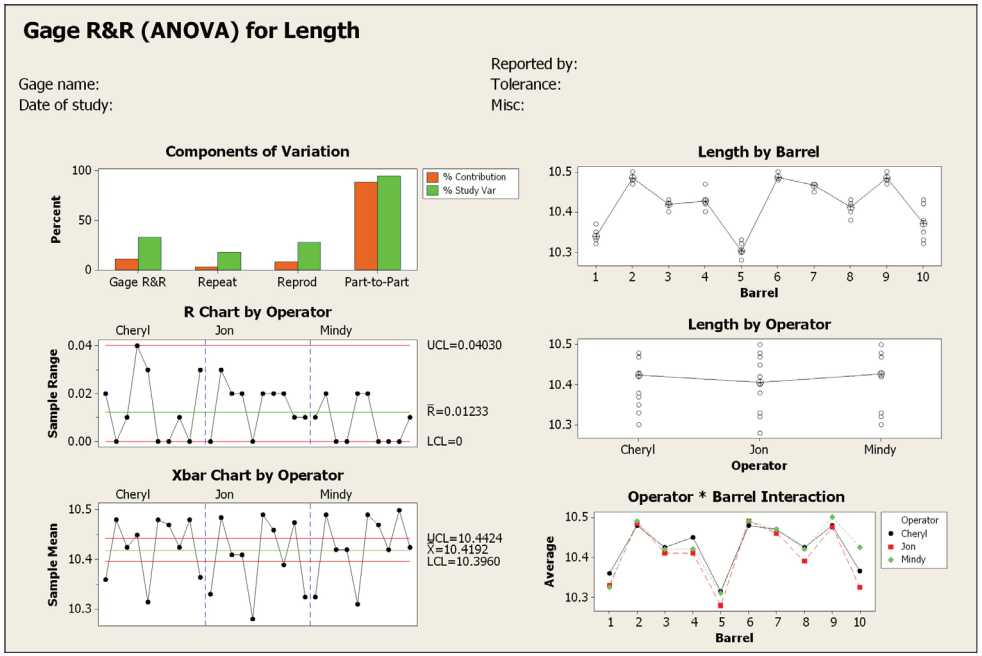
Gage R & R Study (Crossed)

A crossed gage R & R study determines how well the measurement system distinguishes between parts and how much variation is due to the measurement system when each part is measured multiple times by each operator.

Example

At a pen assembly plant, three operators measure the same 10 pen barrels in random order under the same conditions. An analyst uses a crossed gage R & R study to determine how well the measurement system distinguishes between pen barrels.

To perform a crossed gage R & R study in Minitab, choose **Stat** > **Quality Tools** > **Gage Study** > **Gage R & R Study (Crossed)**.



For best results, select the parts for the crossed study from across all sources of process variation (machines, shifts, time, and so on).

You can use Minitab's Create Gage R&R Worksheet to plan your gage R&R study. This tool helps you to organize the worksheet and to create a random order for data collection.

To assess hard-to-see patterns of variation in your data, such as nonrandom variation due to a time-order effect, you may also want to display a Gage Run Chart.

Data type: Continuous
Focus of evaluation: Precision
Method of testing parts: Destructive
Gage R & R (Nested)

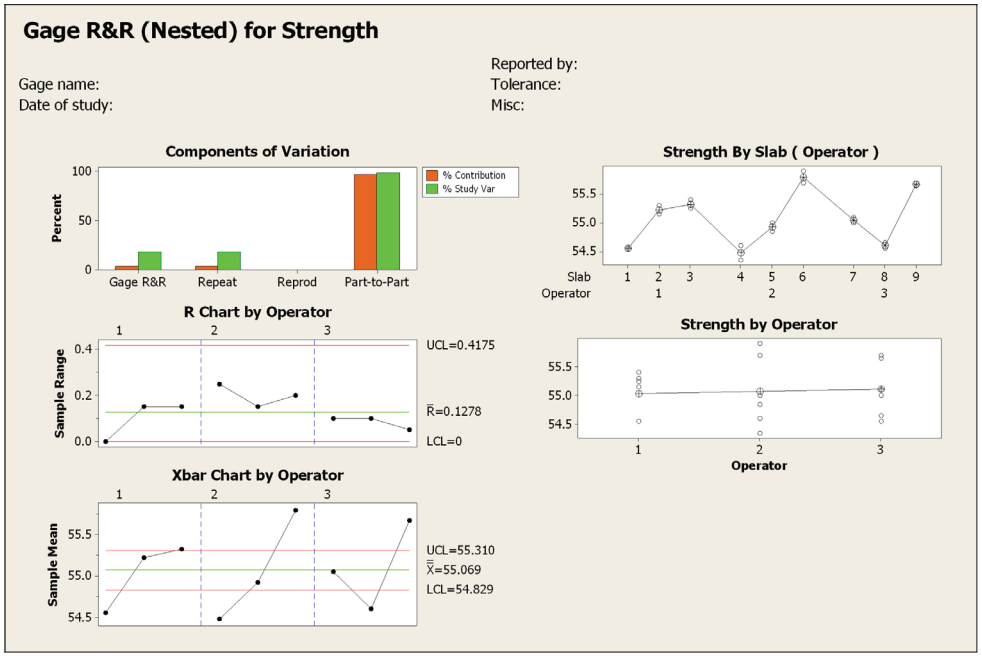
Gage R & R Study (Nested)

A nested gage R & R study determines how well the measurement system distinguishes between parts and how much variation is due to the measurement system when each part is measured by only one operator.

Example

At the plant, operators assess crush strength by measuring the force needed to break each box. An analyst uses a nested gage R & R study to determine how well the measurement system distinguishes between the boxes.

To perform a nested gage R & R study in Minitab, choose **Stat** > **Quality Tools** > **Gage Study** > **Gage R & R Study (Nested)**.



In a nested study, you should randomly assign parts to operators. If parts are not randomly assigned, your results may be inaccurate. For example, if you don't randomly assign boxes to the operators, you could accidentally assign all of the weaker boxes to the same operator. Then, it would appear that one operator makes consistently lower measurements than the other operators, which can cause you to overestimate the difference in measurements between the operators.

Measurement System Analysis

Gage Linearity and Bias Study

Data type: Continuous

Focus of evaluation: Accuracy

Gage Linearity and Bias Study

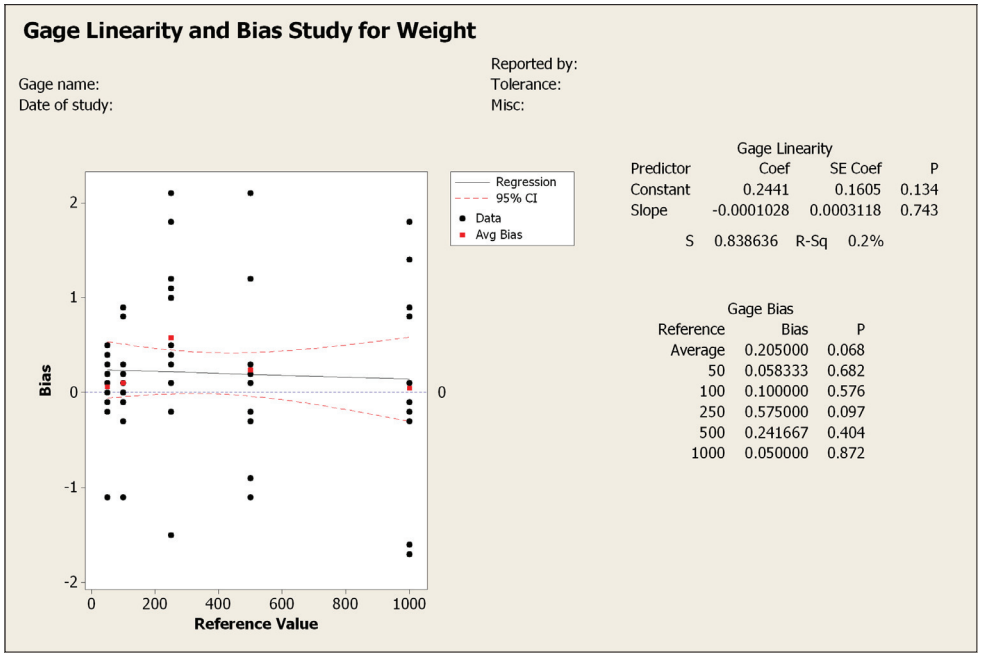
Gage Linearity and Bias Study

A gage linearity and bias study evaluates the accuracy of the measurement system across the range of measurements in your process.

Example

An operator at a food processing company weighs reference weights that represent products in jar sizes of 50 g, 100 g, 250 g, 500 g, and 1000 g. A quality analyst uses a gage linearity and bias study to determine whether the scale accurately measures weight across all of the jar sizes.

To perform a gage linearity and bias study in Minitab, choose **Stat** > **Quality Tools** > **Gage Study** > **Gage Linearity and Bias Study**.



Bias is the difference between an actual value and the average measurement of that value.

To determine whether your measurement system has the same bias for all sizes, you calculate linearity–the linear change in bias over the range of measurement values. For example, a gage that measures the diameter of a wheel rim may have a bias that increases as the rim becomes wider.

Data type:
Attribute

Attribute Agreement Analysis

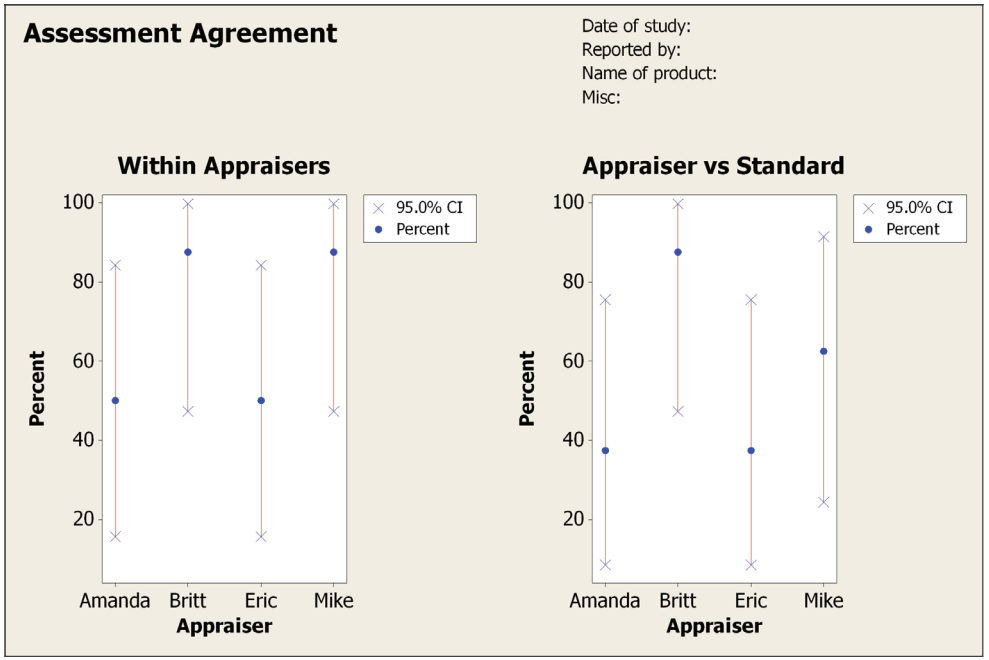
Attribute Agreement Analysis

An attribute agreement analysis evaluates the consistency of ratings for each appraiser, across appraisers, and versus a standard or known value.

Example

Four taste testers rate the fruitiness of samples of extra virgin olive oil using a 1 to 10 scale. An analyst uses attribute agreement analysis to evaluate the consistency of ratings across the testers and against standard rating values.

To perform an attribute agreement analysis in Minitab, choose **Stat** > **Quality Tools** > **Attribute Agreement Analysis**.



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