

Statistical Analysis

U5 – Analyse

E1 – Exploratory Data Analysis

The element ‘Exploratory Data Analysis’ describes the predictive models using regression techniques to determine the relation between factors on a response.

This element also covers process performance metrics and the method for determining the capability of a process to meet specifications.

Correlation analysis

Correlation studies the degree of correlation between two variables

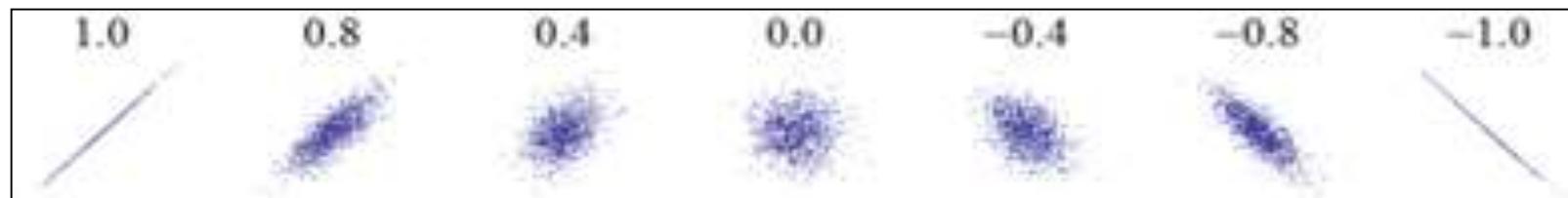
Correlation does not mean that there is a cause and effect relation

Example:

- **Is there a correlation between the age of the patient and efficiency of the administered drug?**

Correlation coefficient

- The Pearson correlation coefficient is used to measure the strength of the linear relationship between two variables
- The correlation coefficient assumes a value between -1 and +1



Correlation coefficient

The correlation coefficient (R) lies between -1 and +1

- '-1' depicts complete inverse (negative) dependence
- '0' depicts complete independence
- '+1' depicts complete direct (positive) dependence

General Rules

- | | | |
|--------------|-------------------------|-------------------|
| • Strong : | correlation coefficient | $ R > 0.8$ |
| • Moderate : | correlation coefficient | $0.5 < R < 0.8$ |
| • Weak : | correlation coefficient | $ R < 0.5$ |

Regression Analysis

Regression analysis investigates the relationship between cause and result

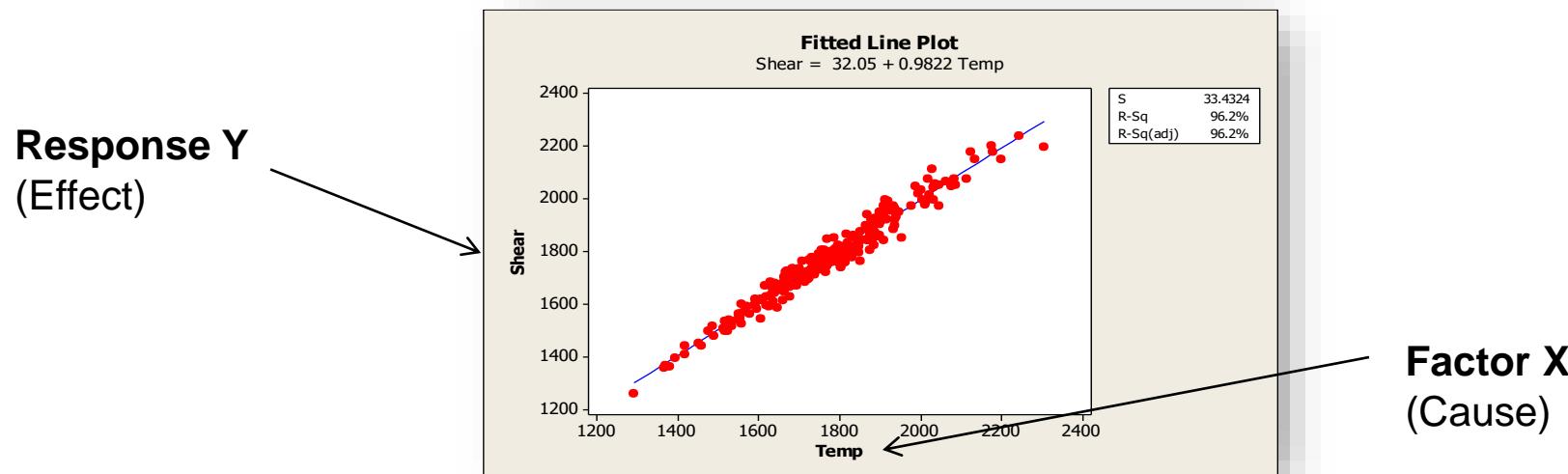
Examples:

- When temperature increases, the process runs faster
- As you get older, more accidents happen
- The warmer it gets, the more ice-cream people eat

Statistical Analysis

Factor and response

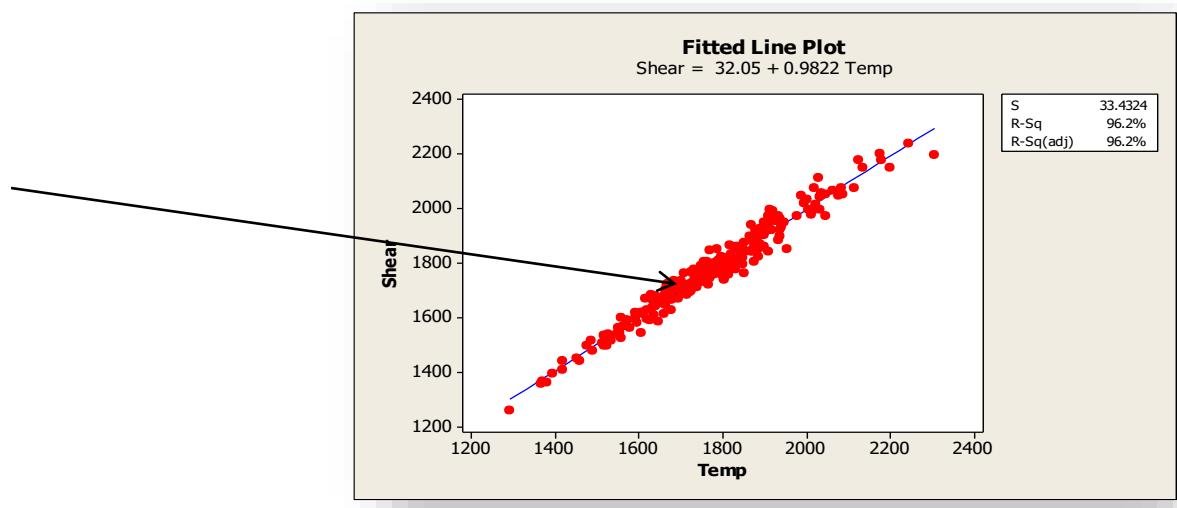
- The ‘Factor’ is the independent variable X
- The ‘Response’ is the value that changes as a result of a changing ‘Factor’
- The ‘Response’ is the dependent variable Y



Mathematical context

- Regression analysis indicates the relation between the dependent Response (Y) and the independent Factor (X)
- Singular Linear Regression investigates the relation between one continuous Y and one continuous X

Regression line



Hypothesis Testing

U5 – Analyse

E2 – Hypothesis Testing

The element ‘Hypothesis testing’ reviews test methods that are used to test a hypothesis. This element also discusses Confidence Intervals that indicate the reliability of test conclusions.

Hypothesis

A hypothesis is a statement that something is true:

- Based on this hypothesis, we predict the expected outcomes of the test
- If the outcome of the test has a low probability (unlikely), we will reject the hypothesis
- However, there will always be a chance that we reject a true hypothesis

Hypothesis testing

In processes, we test hypotheses in the same way:

- We do not want to react to common cause variation
- We only want to react to uncommon (special cause) variation

In our example of the Elderly home centre:

- We do not want to replace the stove when the variation was caused by not efficient walking routes
- We do want to replace the stove when this was the cause of the high variation in the temperature of the meals

Hypothesis testing

'One is presumed innocent until proven guilty'

This also applies to hypothesis testing:

- **The null-hypothesis (H_0) always assumes there is no difference**
Even when we suspect that there actually is a difference!
- **The alternative hypothesis (H_a) describes the difference**
This is an assumption that must be reviewed and proven

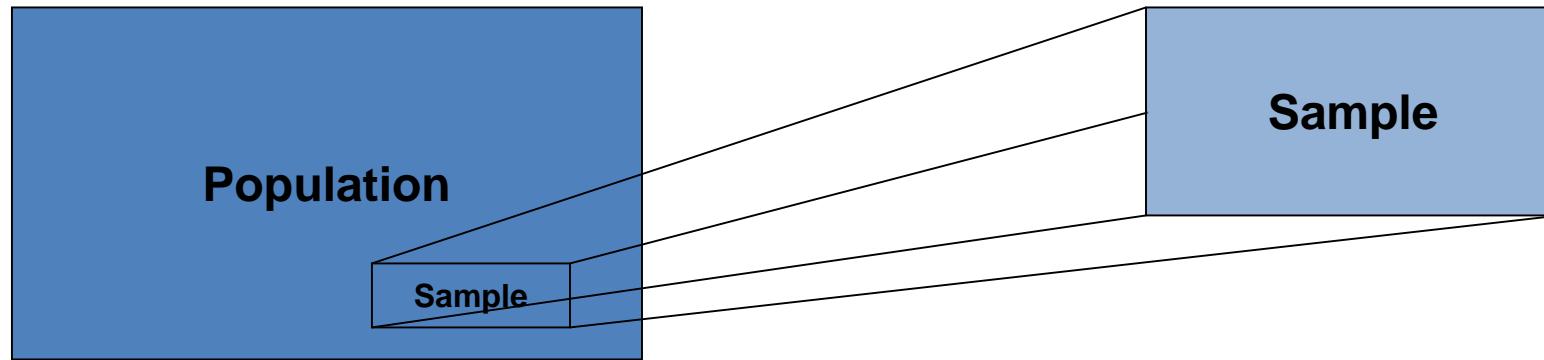


Benefits of hypothesis testing

- Helps to carefully handle uncertainties
- Prevents subjective interpretations
- Helps when making risky decisions
- Statistically quantifies the uncertainty



Hypothesis Testing



Population parameters

μ = Population mean

σ = Population standard deviation

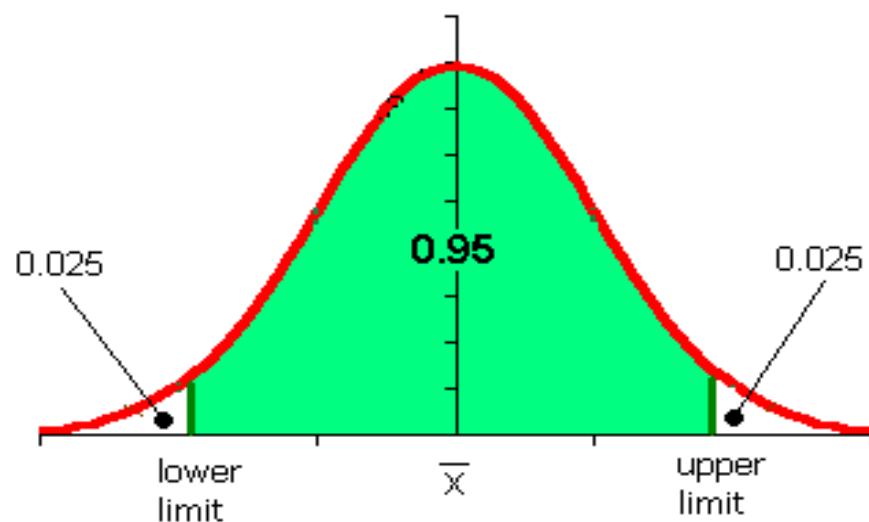
Sample statistics

\bar{x} = Sample mean

s = Sample standard deviation

Confidence interval

- Statistics such as the average (\bar{X}) and standard deviation (s) of the sample are only estimators, not the real values!
- From sample to sample these estimates will differ
- A so-called confidence interval indicates how reliable the estimate is
- 95% is often used as confidence level



Hypothesis Testing

Influence of the sample size

