

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

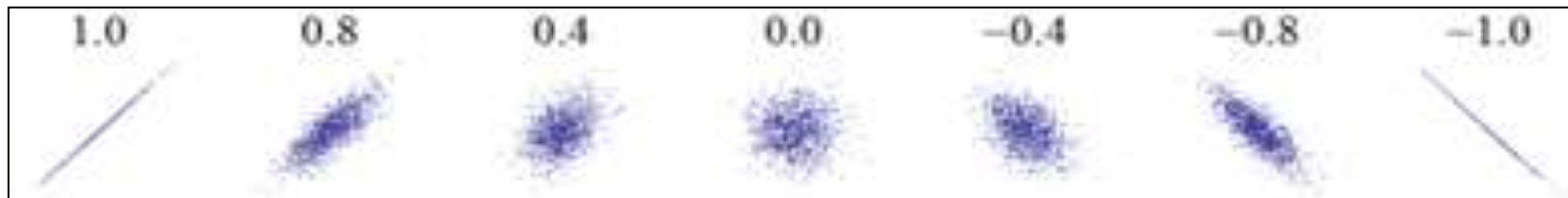
Correlation does not mean that there is a cause and effect relation

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

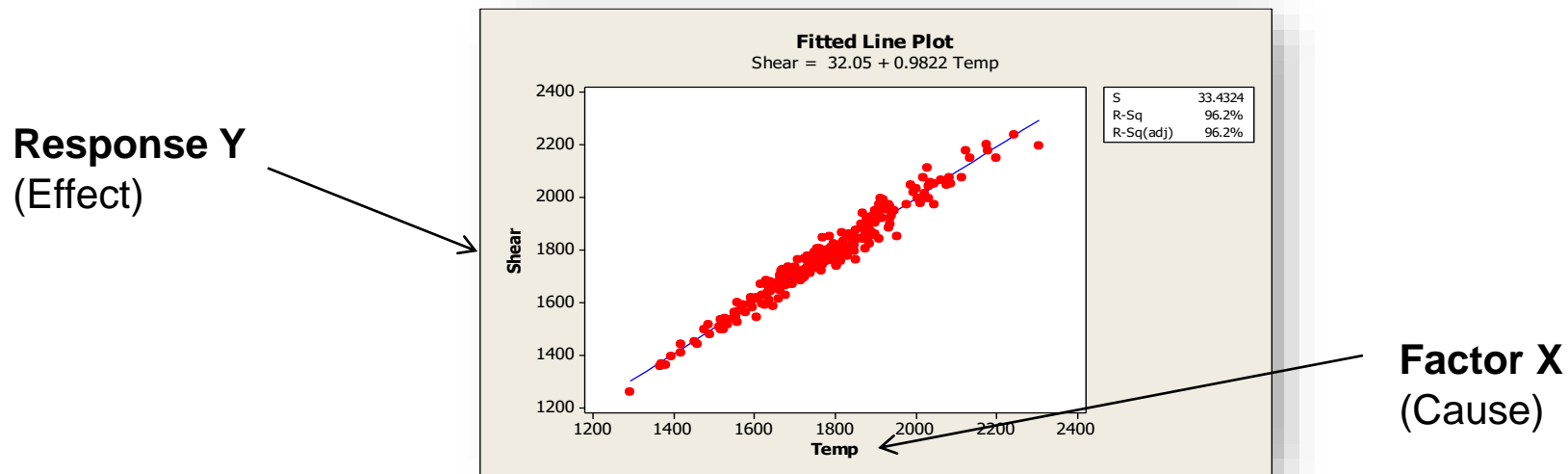
Regression analysis investigates the relationship between cause and result

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**

Factor and response

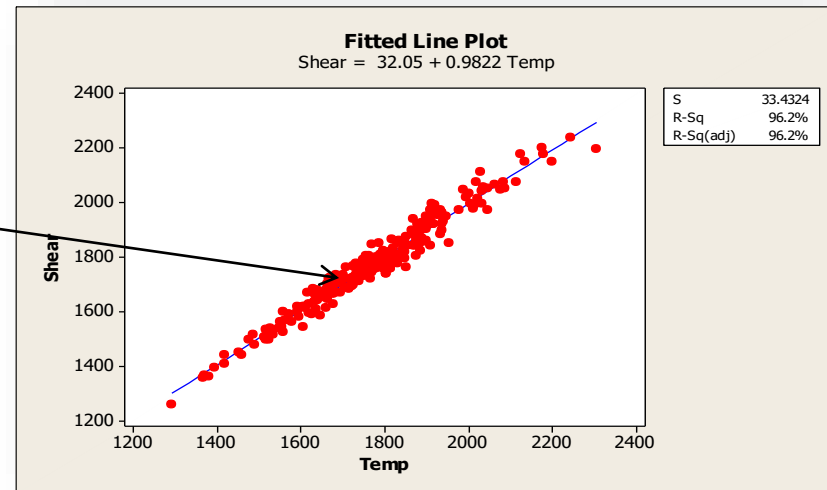
- The 'Factor' is the independent variable X
- The 'Response' is the value that changes as a result of a changing 'Factor'
- The 'Response' is the dependent variable Y



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

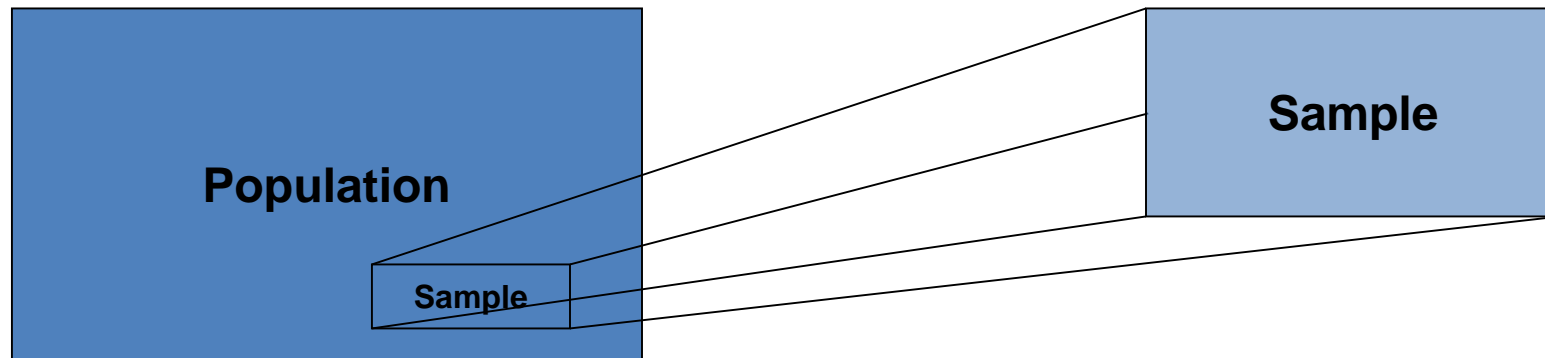


Benefits of hypothesis testing

- 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

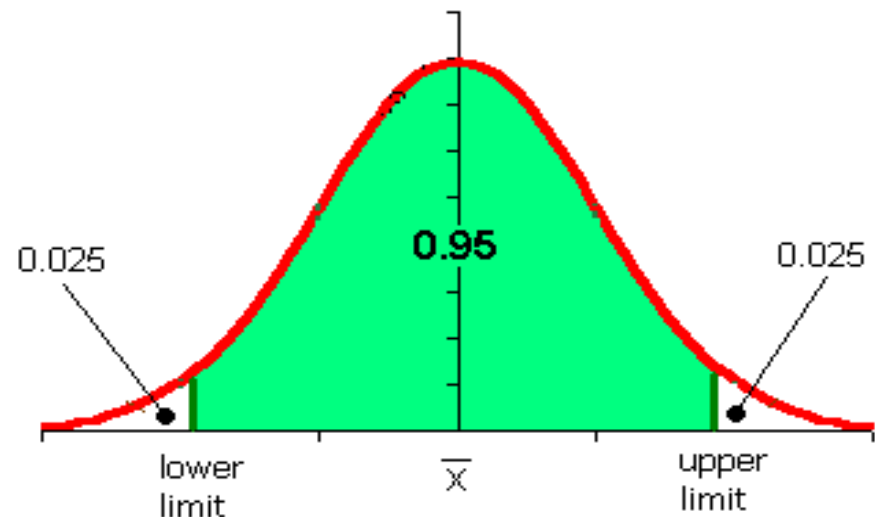
Sample statistics

\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

