

E-Learning at the Free University Berlin

Establishing New Ways of Teaching and Learning Statistics

The e-learning project "New Statistics" has been initiated by the Freie Universität Berlin with the intention to establish a new, multimedia-, and web-based learning environment for elementary studies in Statistics. The main focus of the project is to develop a more explorative and experimental way of learning and to enable students to learn in a problem-oriented way, using computing devices for data analysis. The project consortium consists of over 10 German Colleges and Universities and is managed by the Center of Digital Systems (CeDiS) at the Free University Berlin (main contractor).

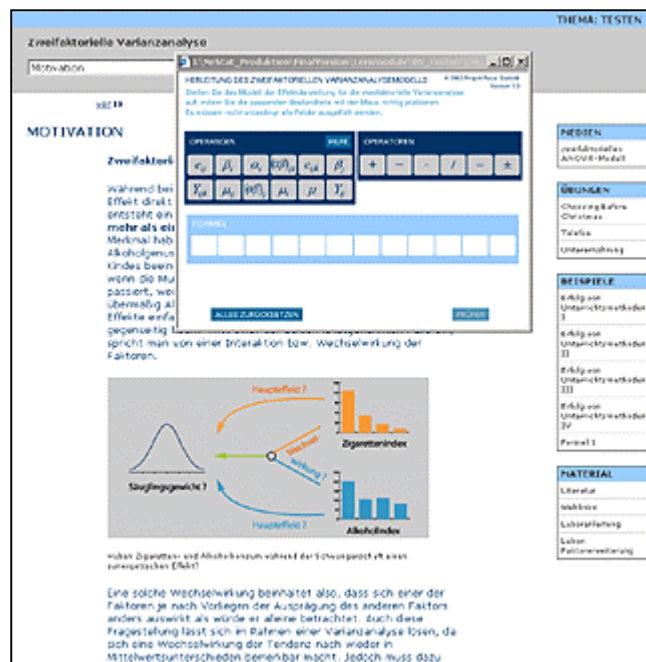
Project aims:

- Modernization of elementary studies in Statistics for different disciplines: Economics, Social Sciences, Psychology, Earth Sciences, Medicine and Veterinary Medicine
- The development of interactive, multimedia-based learning material
- The establishment of new standards in educating Statistics with new media

Content:

Important topics include:

- **Descriptive Statistics** explains Basic Terms, Data Analysis, Measures of Location Scales, Dispersion Measures, Correlations and the Analysis of Time Series
- **Probability Theory** explores Discrete and Common Probability Distribution, Distribution Models, and Combinatorics
- **Surveys** includes the Sampling Theory and different samples, like Simple Random Samples, Stratified Sampling and Cluster Sampling
- **Estimation** demonstrates Estimation Basics, Point Estimators and Additional Estimators, Robustness, and Confidence Intervals
- **Testing** comprises Error Probabilities, The Procedure of Testing, Introduction to a Variety of One and Two Sample Tests, Test Quality Level, as well as One and Two Factor Analysis of Variance
- **Regression:** describes Empirical Regression, Simple and Multiple Linear Regression Model



Zweifaktorielle Varianzanalyse

MOTIVATION

THEMA: TESTEN

TESTEN

- ANOVA-Modell
- ANOVA-Modell

GRUNDEN

- Chi-Quadrat-Test
- Chi-Quadrat-Test
- Chi-Quadrat-Test
- Chi-Quadrat-Test
- Chi-Quadrat-Test

BEISPIELE

- Erfolg von Unterrichtsmethode I
- Erfolg von Unterrichtsmethode II
- Erfolg von Unterrichtsmethode III
- Erfolg von Unterrichtsmethode IV
- Erfolg von Unterrichtsmethode V
- Erfolg von Unterrichtsmethode VI

MATERIAL

- Literatur
- Literatur
- Literatur
- Literatur
- Literatur
- Literatur

Diagramm: Ein Diagramm zeigt die Wechselwirkung zwischen zwei Faktoren: 'Tauglingsgewicht I' (mit einer Normalverteilungskurve) und 'Alkoholkonsum' (mit einem Balkendiagramm). Pfeile weisen auf 'Zigarettenindex' und 'Alkoholextrakt' hin, die ebenfalls als Balkendiagramme dargestellt sind.

Text: *Wahrend bei Effekt drei: ERSTERE sind mehr als ein Merkmal hab Alkoholgenuss Kindes beim wohn die Mul passiert, weil übermäßig all Effekte erfa gegenständig spricht man von einer Interaktion bzw. Wechselwirkung der Faktoren.*

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In the [appendix](#) you find a more detailed excerpt of the curriculum.

Learning modules:

Along with their university lectures, students have access to **68 learning modules** dealing with different areas of Descriptive and Inductive Statistics.

Around **50 animations** and more than **60 java-applets** offer an interactive and playful way for students to understand Statistics.

Referring to real statistical problems, **case studies** for different academic disciplines motivate students to deal with statistical theories and methods.

A **variety of sample problems and exercises** can be solved within an interactive working environment, the Statistical Lab.

A **glossary** and a **collection of formula** increase the students' understanding of the material presented.

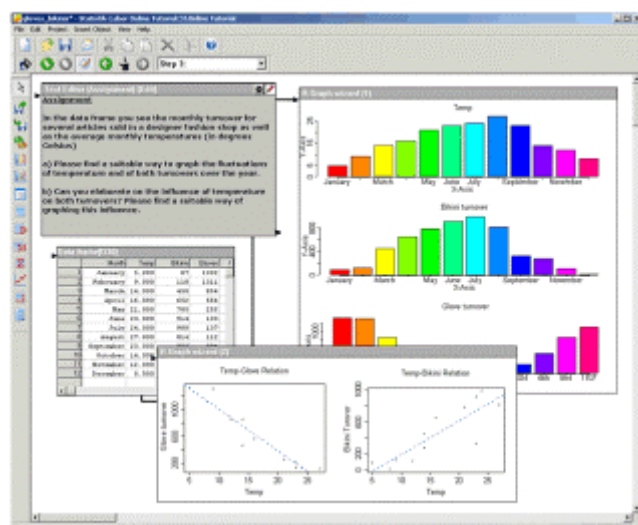
The flexibility of the learning environment allows different learning and teaching strategies. The different elements of "New Statistics" can improve traditional instructional methods, and enable blended learning scenarios, but they are particularly designed to establish new ways of problem-based learning.



A tool for learning and teaching Statistics:

The **Statistical Lab** is an interactive working environment for the support of students in actively finding solutions for statistical problems. It is one of the most important elements of "New Statistics". The Lab is an interactive and explorative application based on the statistical programming language R. It enables an authentic, problem-based approach to statistical methods. Simple as well as complex statistical problems can be presented in manageable steps. This way, statistical thinking can be practiced and applied.

However, not only students benefit from the flexibility of the Statistical Lab: Teachers and instructors obtain a powerful tool for developing statistical exercises and real-life scenarios. Even sophisticated simulations and animations work efficiently. Instructors can also provide exercises with sample solutions. Wherever the basic functionality of the Statistical Lab and the pool of a worldwide developer community is not suffi-



cient, teachers and instructors can create and add new programs and functions to the Lab according to their own needs.



The Statistical Lab is winner of the international media award Medida-Prix 2003: www.medidaprix.org

Participants:

In the project "New Statistics" the Free University's Center for Digital Systems is working with high-ranking professors from 13 departments at 10 German universities:

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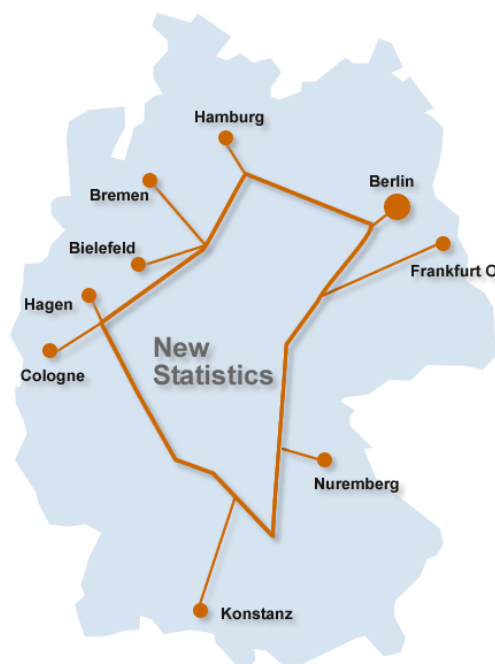
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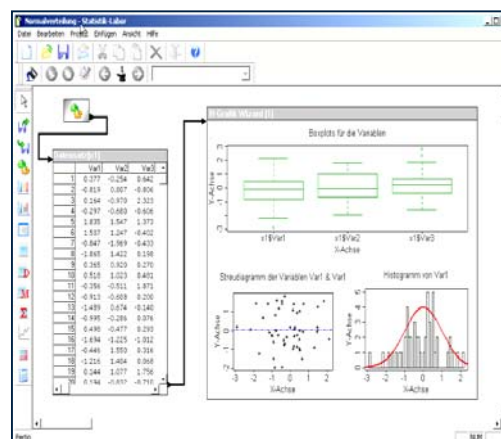
Teaching "New Statistics":

The content created in the project "New Statistics" is in regular use at several German universities since 2000, for instance:

- **Free University Berlin**, Departments of Economics, Educational Science, Psychology, Veterinary Medicine and Earth Sciences
- **University of Bielefeld**, Department of Economics
- **University of Hamburg**, Department of Economics
- **European-University Viadrina Frankfurt/Oder**, Department of Economics
- **Friedrich-Alexander University Erlangen-Nuremberg**, Department of Economics and Social Sciences
- **University of Applied Sciences Cologne**, Department of Economics
- **University Bonn**, Studienreform 2000+
- **Virtual University of Applied Sciences**

"New Statistics" is in use for different **learning scenarios**:

- Simulations developed with the Statistical Lab, animations and java-applets visualize specific statistical concepts in **face-to-face courses**
- Assisted by supervisors in **multimedia tutorials**, students learn to work on complex assignments and to solve statistical problems with the Statistical Lab
- Students explore statistical methods in **problem-based courses** working with case studies
- All students have web-based access to the "New Statistics" material for **self-study** and **group work**
- The Statistical Lab is also in use as an **examination tool** every semester at several of our partner universities.



Examples and Demonstrations of the "New Statistics" learning material are available at <http://www.neuestatistik.de/en>.

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 URL: <http://www.cedis.fu-berlin.de>

Appendix: Curriculum "New Statistics"

1. Descriptive Statistics (in German)

- 1.1. Basic Terms
- 1.2. Data Analysis: Raw Data
- 1.3. Data Analysis: Frequency Tables
- 1.4. Classified Data
- 1.5. Measures of Location Scales
- 1.6. Dispersion Measures
- 1.7. Mean and Variance
- 1.8. Concentration Measuring
- 1.9. Contingency Tables
- 1.10. Correlation in a 2x2 Table
- 1.11. Scatter Plots and Correlation
- 1.12. Index Calculations
- 1.13. Analysis of Time Series

2. Probability Theory (in German and English)

- 2.1. Statistical Probability
- 2.2. Discrete Probability Distribution
- 2.3. Common Probability Distribution
- 2.4. Discrete Distribution Models
- 2.5. Continuous Distribution Models
- 2.6. Normal Distribution
- 2.7. Digression into Combinatorics

3. Surveys (in German)

- 3.1. Introduction to Sampling Theory
- 3.2. Probabilistic Selections
- 3.3. Simple Random Samples
- 3.4. Stratified Sampling
- 3.5. Cluster Sampling

4. Estimation (in German)

- 4.1. Estimation Basics
- 4.2. Basic Properties of Point Estimators
- 4.3. Additional Properties of Point Estimators
- 4.4. Robustness
- 4.5. Introduction to Additional Estimators
- 4.6. Selection of Estimation Functions
- 4.7. Confidence Interval for μ in a Normal Distribution (σ known)
- 4.8. Confidence Interval for μ in a Normal Distribution (σ unknown)
- 4.9. Confidence Interval for σ in a Normal Distribution
- 4.10. Confidence Interval for p
- 4.11. Bootstrap Confidence Intervals

5. Testing (in German)

- 5.1. Basic Considerations
- 5.2. The Concept of Testing
- 5.3. Error Probabilities
- 5.4. Testing Decisions
- 5.5. Procedure of Testing
- 5.6. One and Two Sample Tests
 - 5.6.1. Wilcoxon Rank Sum Test
 - 5.6.2. Gauss' Two Sample Test
 - 5.6.3. T-Test for Two Sample Case
 - 5.6.4. Welch's Test
 - 5.6.5. Gauss-Test and T-Test for One Sample Case
 - 5.6.6. Sigma-Square Test
 - 5.6.7. P Test
 - 5.6.8. Sign Test (Associated Samples)
- 5.7. Test Quality Level
- 5.8. Tests in Contingency Tables
- 5.9. One Factor Analysis of Variance
- 5.10. Two Factor Analysis of Variance

6. Regression (in German)

- 6.1. Empirical Regression
- 6.2. Simple Linear Regression Model
- 6.3. Estimating Regression Coefficients
- 6.4. Model with Normal Errors
- 6.5. Model Evaluation
- 6.6. Multiple Linear Regression Model
- 6.7. Evaluation of Multiple Linear Regression