# Description and aims

Statistics is not loved, not only by students but by professors as well. Those who excel at math often struggle with statistics and probability theory, and it can be explained. The whole science of mathematics is designed around the purpose of exterminating uncertainty. Statistics is like an unloved child of the large family. Instead of following traditions as old as time it absorbs uncertainty and operates inside it.

Simple theory and simple problem settings but outraging complexity of working your way through solutions – this is how students perceive statistics. Moreover, this is the point we are inclined to change. The course is specially designed to help students link the reality with nameless “X and Y”-s, evolve their critical thinking and provide an insight of what may be expected at the 1-st course along the way.

The course is designed for the high school graduates that have basic knowledge of mathematics and calculus. No prior knowledge of probability theory and statistics is required.

It is highly recommended to students to have a firm grounding in elementary mathematics and algebra at the level high school. It is also expected that students are capable of freely operating with formulas of geometric progression (both finite and infinite) and arithmetic mean. Acquaintance with concepts of weighted mean, derivatives and integral is not obligatory.

After the course students will be able to:

* Describe real data in an analyst-style
* Obtain expected levels of risk and return
* Search for unusual ways of working with uncertainty
* Freely work with probability theory and combinatorics
* Apply main statistical distributions
* Test statistical hypothesis and apply confidence intervals

# Grade evaluation

At the end of the course learners will sit an exam. The exam mark is given on a 100-point scale, which is then converted into 10-point and 5-point scales. The weight of the exam mark is 50%.

Learners are expected to complete home assignments on each topic covered. Each home assignment is marked on a 100-point scale. At the end of the course the average HA mark of each student is calculated, which will contribute 30% to the course grade. There is a project Home Assignment contributed to the final topics (№10, 11, 13, 14), which has 10% of the final grade.

$$GRADE=0.3\*HA+0.1\*ProjectHA+0.5\*EXAM+0.1\*Attendance$$

# Course structure

1. **Introduction.** Basic ideas of probability theory, including probability, operations with random events, conditional probability.
2. **Bayes theorem. Independence.** Concepts of Bayes Theorem and independence.
3. **Combinatorics.** Repetition and order. Finding probability with combinatorics concepts.
4. **Random variables. Moments.** Main characteristics of random variables and operations with them. Expectation and variance.
5. **Joint distribution.** Distribution of two random variables. Covariance and correlation. Independence. Conditional distribution.
6. **Discrete distributions.** Bernoulli, Binomial, Geometric, Hypergeometric.
7. **Probability distributions.** Probability density function and cumulative distribution function. Main properties of continuous distribution.
8. **Normal distribution.** Normal approximation of Binomial distribution.
9. **Estimators.** Estimation of parameters. Efficiency and unbiasedness.
10. **Confidence intervals.** Intervals for one parameter, for two. One-sided confidence intervals. Student distribution.
11. **Hypothesis testing.** Tests for population means and proportions. Two types of errors. Rejection regions and p-values. Standard tests for 2 independent samples.
12. **Goodness of fit test.** Chi-square statistic.
13. **Simple regression.** Ordinary Least Squares (OLS) estimates for alpha and beta. Basic properties of regression. Coefficient of determination.
14. **Descriptive statistics.** Measures of location, dispersion and shape. Histograms, box plots. Main points in describing a sample. Characteristics and features of a sample.
15. **Exam.** The final check of the covered material.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **№** | **Наименование тем:** | **Содержание тем:** | **Лекция** | **Семинар** | **Самостоятельная****работа (в час.)** |
| **1** | **Introduction** | Basic ideas of probability theory, including probability, operations with random events, conditional probability. | 1 | 1 | 2 |
| **2** | **Bayes theorem****Independence** | Concepts of Bayes Theorem and independence. | 1 | 1 | 2 |
| **3** | **Combinatorics** | Repetition and order. Finding probability with combinatorics concepts. C(k n), P(k n), A(k n). | 1 | 1 | 4 |
| **4** | **Random variables Moments** | Main characteristics of random variables and operations with them. Expectation and variance. | 1 | 1 | 2 |
| **5** | **Joint distribution** | Distribution of two random variables. Covariance and correlation. Independence. Conditional distribution.  | 1 | 1 | 1 |
| **6** | **Discrete distributions** | Bernoulli, Binomial, Geometric, Hypergeometric and Uniform distributions.  | 1 | 2 | 4 |
| **7** | **Probability distributions**  | Probability density function and cumulative distribution function. Main properties of continuous distribution. | 0 | 1 | 3 |
| **8** | **Normal distribution** | Normal approximation of Binomial distribution | 1 | 1 | 4 |
| **9** | **Estimators**  | Estimation of parameters. Efficiency and unbiasedness | 1 | 1 | 3 |
| **10** | **Confidence intervals**  | Intervals for one parameter, for two. Student distribution | 2 | 2 | 5 |
| **11** | **Hypothesis testing.**  | Tests for population means and proportions. Two types of errors. Rejection regions and p-values. Standard tests for 2 independent samples | 2 | 2 | 5 |
| **12** | **Goodness of fit test.** | Chi-square statistic | 1 | 1 | 3 |
| **13** | **Simple regression**  | Ordinary Least Squares (OLS) estimates for alpha and beta. Basic properties of regression. Coefficient of determination | 1 | 2 | 5 |
| **14** | **Descriptive statistics**  | Measures of location, dispersion and shape. Histograms, box plots. Main points in describing a sample. Characteristics and features of a sample | 1 | 2 | 2 |
| **15** | **Exam** | Exam on two hours. | 1 | 1 | 3 |

# Literature

* Wonnacott R.J., Wonnacott T.H. *Introductory Statistics for Business and Economics.* John Wiley & Sons, 4th edition, 1990.