Statistics

Instructor: Antonietta Mira - antonietta.mira@usi.ch

Prerequisites

The course assumes prior knowledge of the following topics: Probability of an event; Discrete and continuous random variables; Probability distribution function, density function and cumulative distribution function; Conditional distribution. Law of total probability, Independence of events, Bayes Theorem. Expectation and variance of a random variable; Moments and central moments, Standardization of random variables, Percentiles. Some specific random variables (Bernoulli, Binomial, Poisson, Geometric, Uniform, Exponential, Gaussian, Student-T, Chi-squared).

During the first two weeks there will be an in class test aimed at verifying the students knowledge of the above topics.

Aim of the course

The course aims to deepen notions of descriptive and inferencial statistics both from a theoretical and an applied point of view. The students will be able to analyze a given data set. The freeware statistical software R Project will be introduced.

Text book

There is no specific text book. Class notes and slides will be distributed during the course. For the theory part of the course, good reference book is *Introduction to the Theory of Statistics* by A. M. Mood, F. A. Graybill, D. C. Boes; Publisher: McGraw-Hill 1974. DOWNLOAD here (the book is out of print). For the applied part of the course students are refereed to the online material available on the R Project website. Lecture notes will also be available.

Structure of the course

There will be theoretical and applied classes. Students are requested to bring their own laptop, if available, to class.

Final grade

There will be graded homework assignments and a final exam. The exam (that will count for 70% of the final grade), will comprise two parts: a theory part and a practical part that will be held in the computer lab (to this aim students are requested to get familiar with the computers available in the computer lab).

1. **Random Variables**
   (a) Review of random variables
   (b) Moments and central moments
   (c) Standardization of random variables
   (d) Joint distributions of two random variables
2. **The exponential family**
   (a) Definition of the exponential family
   (b) Some discrete distribution as members of the exponential family

(c) Some continuous distribution as members of the exponential family

(d) Properties of the exponential family

3. **Asymptotic theory: LLN and CLT**

(a) Markov inequality

(b) Chebyshev's inequality

(c) Weak and Strong Laws of Large Numbers (LLN)

(d) De Moivre-Laplace Theorem

(e) Central Limit Theorem (CLT)

(f) Correction for continuity

(g) Normal approximation to Poisson and Binomial

4. **Statistical inference**

(a) Different approaches to statistical inference

(b) Population and samples

(c) Likelihood function

(d) Point estimation

(e) Properties of point estimators

(f) Methods to compare point estimators

(g) Cramér-Rao Inequality

(h) Method of Moments estimation

(i) Maximum likelihood estimation

(j) Properties of maximum likelihood estimators

5. **Linear regression**

(a) Ordinary Least Square Method

(b) R-sqaured

(c) T-test on parameters