ECOLES D'ETE FRANCE EXCELLENCE

COURSE SYLLABUS

1. Random variables and conditioning

This short course aims to introduce the basic notions of probability and random variable on a general space, including the conditioning and the conditional expectation.

Content :
- Probability on a countable space, conditioning and independence
- Probability on a general space, Lebesgue measure theory, random variable
- Conditioning: conditional distribution, conditional expectation (of Gaussian vectors in particular)

2. Inferential statistics, hypothesis testing

The aim of this course is to present general tools of statistical inference and their applications to classical problems of estimation and statistical hypothesis testing.

Content :
- Basic concepts of estimation
- Hypothesis testing
- Review of classical tests in a parametric framework
- Goodness of fit tests, testing for normality

3. Regression modeling for financial analysis

The aim of this course is to present regression tools for financial analysis.

Content :
- Linear regression modeling with application to risk analysis in finance
- Evaluating the volatility of stocks within a portfolio: coefficients alpha and beta, R-square
- Least-squares estimation method
- Regression over time and application to stock market prediction
- Maximum likelihood method and confidence intervals

The course will be illustrated with numerous real data sets (Source: Yahoo!Finance) by using the open-source statistical software R.

4. Statistical learning, graphical models

This course will deals with graphical models. These models are useful to highlight dependencies in big data problems. They have an enormous range of application domains, which include: web search, medical and fault diagnosis, image understanding, reconstruction of biological networks, speech recognition, natural language processing, decoding of messages sent over a noisy communication channel, robot navigation, and many more. The

probabilistic graphical model framework provides an essential tool for anyone who wants to learn how to reason coherently from limited and noisy observations.

Content :
- Introduction to Gaussian graphical models
- Inference for graphs with a known structure
- Inference when the structure is unknown
- Sparse models

The course will be illustrated with numerous real data sets by using the open-source statistical software R.

5. Introduction to Markov chains

Markov chains are a class of random processes that are used to model systems that are evolving in time according to particular transition rules. Such models appear in various areas of applied mathematics, for instance in genetics, finance or in computer science. We will present theoretical results, along with several examples, in the case where the state space, i.e. the space where the system is evolving, is finite. In particular, we will describe the behaviour of such processes in long time and prove convergence results. We will finish the course by presenting the particular model of autoregressive processes, for which the state space is continuous, and which are of particular interest in statistics.

Content :
- Definition and examples
- Asymptotic behavior
- Autoregressive models