

UNIVERSITÀ DEGLI STUDI DI MILANO-BICOCCA

COURSE SYLLABUS

Statistical Data Analysis

2425-1-F1701Q096

Aims

provide the student with the needed data analysis techniques for a degree thesis in physics

Contents

data analysis techniques:

- introduction to probability and statistics
- introduction to Montecarlo techniques
- parameter estimation
- unfolding techniques
- data acquisition techniques
- MVA analysis

Detailed program

Numerical calculus

Introduction to numerical calculus, computer aritmethics, algorithm stability, treatment of calculus errors.

Examples of numerical techniques: numerical integration, interpolation methods, splines, function minimization, smoothing (*).

Introduction to data acquisition

Introduction to data acquisition. Analog signal conversion. Introduction to the CAMAC and VME standard. Examples of DAQ systems. Introduction to an experiment slow control and Labview (*).

. Resume of probability and statistics :

Fundamental concepts, Bayes theorem and bayesian interpretation of probability. Examples of probability functions with applications. Error propagation. Characteristic functions and central limit theorem (CLT). Treatment of systematic errors.

· Statistical tests and parameter estimation :

Hypothesis test with examples. Neyman-Pearson test, linear statistics and Fischer discriminant. Non linear statistics and neural networks. Kolmogorov Smirnov test. Estimation of parameters.

Introduction to Monte Carlo methods :

Introduction. Random numbers generators. Montecarlo methods. Applications.

Introduction to the pakage GEANT4 (*)

· Confidence levels:

Classical confidence levels, multidimensional confidence levels. Applications.

• Metodi di Unfolding e filtraggio dei dati :

The unfolding problem, regularization functions (MaxEnt, Tikhonov). Data filtering. Applications.

Introduction to multivariate techniques (MVA) :

Introduction. Statistical tests. Neuronal nets. The perceptron and the NN multilayers. Pattern classification. Examples with applications. Decision trees.

- **Introduction to econophysics (*)
- 1. Introduction to graph theory. Knots theorems. Examples. Graphs kinds: random, loopless, scaling-free.
- 2. Stochastic processes. General considerations. CLT theorem.. Distributions with infinite variance: Levi processes. Fractional derivative of random walk.
- 3. Introduction to finance and stock markets. Characteristics. Distribution of returns. Stock market prices models: ARCH. Correlations between financial securities. Applications.
- 4. Stock market prices model with 4 parameters. Fractional derivative to simulate volatility correlations. Skewness and leverage effect. Volatility behavior and variation of stock market index

Introduction to signals treatment(*):

- Signal classification

- sampling theorem and aliasing
- discrete Fourier transform and Fast Fourier Transform
- Digital filtering
- Wavelets
- Applications

Items marked with (*) are optionals

Prerequisites

courses of Physics bachelor degree, with emphasis on calculus and laboratory ones

Teaching form

classroom lectures

Textbook and teaching resource

suggested textbooks:

for the Statistical Analysis section:

- W.H. Press, B.P. Flannery, S.A. Teukolsky, W.T. Vetterling
- "Numerical Recipes in C++, The Art of Scientific Computing",

Cambridge University Press

- M.Cugiani ``Metodi dell' analisi numerica'', edizioni UTET
- L. Lista `` Statistical Methods for Data Analysis in Particle Phylsics",

Springer Verlag

- L. Lyons "Statistics for Nuclear and Particle Physicists",

Cambridge University Press

- R. Barlow ``Statistics: A guide to the use of Statistical

Methods in the Physical Sciences", J. Wiley

- Hertz, A. Krogh, R.G. Palmer	Introduction to the Theory of Neural
Computation ", Addison Wesley	

for programming:

- J.J. Barton, Lee R. Nackman `` Scientific and Engineering C++", Addison Wesley
- D. Yevick ``A First Course in computational Physics and Object-Oriented

Programming with C++", Cambridge University Press

Semester

2nd semester

Assessment method

oral examination based on a seminar + discussion of homework exercises

Office hours

contact by e-mail

Sustainable Development Goals

QUALITY EDUCATION