Universitat Autònoma de Barcelona

Statistics and Data Analysis **2016/2017**

Code: 42859
ECTS Credits: 6

Degree	Type	Year	Semester
4313861 High Energy Physics, Astrophysics and Cosmology	OB	0	1

Contact

Name: Francisco Javier Rico Castro

Email: FranciscoJavier.Rico@uab.cat

Use of languages

Principal working language: english (eng)

Teachers

Federico Joaquin Sanchez Nieto

Ramon Miquel Pascual

Prerequisites

None

Objectives and Contextualisation

In this course we will learn how to distill scientific knowledge from experimental data, a process that relies on statistical methods. We will learn the basics concepts of Probability and Statistics (in their Frequentist and Bayesian frameworks). In addition, we will study and practice several particular statistical methods and data analysis techniques usually used in the fields of High Energy Physics, Astrophysics and Cosmology.

Skills

- Solve problems in new or little-known situations within broader (or multidisciplinary) contexts related to the field of study.
- Use mathematics to describe the physical world, select the appropriate equations, construct adequate models, interpret mathematical results and make critical comparisons with experimentation and observation.
- Use the adequate software, programming languages and computer packages to research problems related to high energy physics, astrophysics and cosmology.
- Work in a group and take on responsibility, interacting professionally and constructively with other people with complete respect for their rights.

Learning outcomes

1. Apply data analysis techniques to problems in the areas of particle physics, astrophysics and cosmology, as well as other close but different areas.
2. Learn to use the Root statistical analysis tool.
3. Use Monte Carlo techniques to model real problems of physics.
4. Work in small groups to solve problems of data analysis.

Content

Part 1

1. Basic concepts on probability
2. Law of large numbers and convergence
3. Basic probability density functions
4. Monte Carlo techniques

Part 2

1. Parameter estimation
2. Bayesian statistics

Part 3

1. Hypothesis test
2. Unfolding

Methodology

- Theory lectures including practical examples in the fields of High Energy Physics, Astrophysics and Cosmology
- Homework exercises to be solved by students alone or in small groups
- Discussion of problems during classes and tutorials
- Explanation and discussion of sample code/algorithms in ROOT and/or Python programming languages during classes and tutorials

Activities

Title	Hours	ECTS	Learning outcomes
Type: Directed			
Lectures	44	1.76	1, 2, 3
Type: Autonomous			
Discussion, work groups, problem solving	40	1.6	1, 2, 3, 4
Study of theory and practical examples	40	1.6	1, 2, 3

Evaluation

Dedicated homework exercises (to be done alone or in small groups) for each of the three parts of the course

Evaluation activities

Title	Weighting	Hours	ECTS	Learning outcomes
Evaluation homework exercises for Part 1	33.3%	8	0.32	1, 2, 3, 4
Evaluation homework exercises for Part 2	33.3%	8	0.32	1, 2, 3, 4
Evaluation homework exercises for Part 3	33.4%	10	0.4	1, 2, 3, 4

Bibliography

- G. Cowan; "Statistical Data Analysis", 1998, Oxford University Press
- K. A. Olive et al. (Particle Data Group); "Review of Particle Physics", Chin. Phys. C38 (2014) 090001
- A. Bevan; "Statistical Data Analysis for the Physical Science", 2013, Cambridge
- F. James; "Statistical Methods in Experimental Physics", 2nd Edition, 2006, World Scientific
- L. Lyons, "Statistics for Particle and Nuclear Physicists", 1986, Cambridge University Press
- B. P. Roe, "Probability and Statistics in Experimental Physics", 1992, Springer
- A. G. Frodesen, et al., "Probability and statistics in particle physics", 1979, Columbia University Press
- D. Sivia and J. Skilling, "Data Analysis, A Bayesian Tutorial", 2nd ed., 2006, Oxford University Press
- A. Gelman, "Bayesian Data Analysis", 1995, CRC Press
- R. J. Barlow, "Statistics", 1989, J. Wiley
- W.T. Press et al., "Numerical Recipes: The Art of Scientific Computing", Cambridge University Press.
- E.T. Jaynes, "Probability Theory: The Logic of Science", Cambridge University Press.
- A. Stuart et al., "Kendall's Advanced Theory of Statistics", Vol 2A. Wiley.
- F. James, "Monte Carlo Theory and Practice", Rep. Prog. Phys. 43 (1980) 73.