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**Advanced statistical methods for Astronomy and Astrophysics**

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**Teaching staff**

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**Program of the course**:

1. Probability and Statistical Distributions. Uncertainties; Axioms of probability; Conditional probabilities; Bayes’ theorem; Independent events; Random variables; Density and distribution functions; Quantile function.
2. Classical Statistical inference. Concepts of statistical inference; Classical vs. Bayesian Statistical Inference. Maximum Likelihood Estimation (MLE). Goodness of fit and Model Selection; Confidence Estimates; Hypothesis Testing; Comparison of distributions; Non-parametric Modeling. Selection effects and luminosity function estimation; Survival analysis.
3. Bayesian Statistical inference. Bayesian priors and posteriors; Uncertainty quantification; Model selections; The Montecarlo Marcov Chain (MCMC) method.
4. Reduction of dimensionality. Principal component analysis (PCA)
5. Regression and model fitting. Formulation of the regression problem; Linear and nonlinear regression; Regression robust to outliers; Gaussian process regression; Overfitting and underfitting.
6. Classification. Principles; K-nearest-neighbor classifier; Decision trees



  

**Bibliography**:

1. Statistics, Data Mining, and Machine Learning in Astronomy, by Z. Ivencić et al. Princeton, NJ: Princeton University Press, 2014
2. Modern Statistical Methods for Astronomy, by Eric D. Feigelson , G. Jogesh Babu, Cambridge, UK: Cambridge University Press, 2012
3. Practical Bayesian Inference: A Primer for Physical Scientists by C. Bailer-Jones, Cambridge UK: Cambridge University Press, 2017