Astronomy 345H, Session 2006-07

Astronomical Data Analysis I

Aims

This course aims to introduce and explore the basic concepts which underpin data analysis in astronomy – indicating those concepts and methods which are shared with other (e.g. laboratory based) physical sciences and highlighting those areas where the approach to astronomical data analysis is different, due to the 'remote sensing' nature of the subject.

After a brief review of the different types of astronomical data now available, the basic tools of mathematical statistics are introduced. This toolbox is then employed to develop methods for estimating model parameters and testing goodness of fit.. The second half of the course focusses on the importance of Fourier methods for astronomical data analysis, particularly in the study of time series. Methods for efficient computation of Fourier transforms, and their limitations, are studied.

Learning Objectives

Students will become familiar with the following concepts, and their application to numerical problems:

- Probability distributions (particularly the Poisson and Gaussian) and their moments
- Marginal and conditional probability, and statistical independence
- Bayes' formula and simple applications of Bayesian inference
- The principles of least squares and maximum likelihood
- The chi-squared goodness of fit test
- Computational methods for optimising functions and generating random numbers
- Discrete and fast Fourier transforms
- Nyquist's theorem and fundamental limits on the sampling of Fourier components
- Period fitting in time series analysis, and the impact of beating and aliasing
- Inverse problems: deconvolution, smoothing and regularisation

Course Website

http://www.astro.gla.ac.uk/users/martin/teaching/ada1/ada1_index.html

Background Reading

See Section 1 handout on course website

MAH, October 2006