

ICIC Data Analysis Workshop

Principled statistical methods for researchers

A short 3-day course.

Venue: Imperial Centre for Inference and Cosmology (ICIC), Imperial College, South Kensington, London. Workshop in Huxley Building, Room 311.

Dates: 11-13 September 2013

Website: http://astro.ic.ac.uk/data_analysis_worskhop

Summary

We will run a 3-day course/workshop on statistical methods and tools for data analysis, aimed at PhD students, postdocs and any staff interested in understanding Bayesian statistics and numerical techniques of data analysis. The course plan is to combine morning lectures with problem sets and practical work in the afternoons. It will concentrate on setting down firm foundations of principled data analysis, but a feature of the workshop will be a substantial element of hands-on classes where participants will learn how to apply the ideas in practice. It will be hosted by the Imperial Centre for Inference and Cosmology at Imperial College.

Background

Most researchers will at some point be required to perform some form of data analysis. This may be anything from simple line-fitting, through parameter estimation, to complex and computationally-demanding sampling for model selection on large datasets. Anecdotal evidence suggests that many researchers are not well prepared for this, often doing the right thing incorrectly, or picking up an inappropriate statistical tool. The purpose of this course is to provide understanding of principled data analysis, and experience of applying appropriate methods to data.

Preparation

We expect all participants to bring their own laptop, and to do a simple computational exercise in advance (in whatever language suits) to ensure they have appropriate software in place before the workshop starts. More details will come later.

Costs

There will be a small registration fee of £20 to cover refreshments. Participants will be responsible for all other travel and subsistence costs. Inexpensive lunch is readily available on campus.

Registration

The number of places is limited, and places are offered on a first-come first-served basis. Please register by August 11th at <http://www.imperial.ac.uk/click/1682>

If space is still available after this date, the workshop will be advertised more widely.

Draft Programme

Day 1 (Weds 11 September 2013)

- Start of Workshop 9.30 a.m.
- Bayesian Foundations:

- What is probability?
- The Laws of Probability and Bayes' Theorem
- Priors
- Parameter inference
- Marginalization
- Nuisance parameters
- *Problem class: Simple problems*
- *Tutorial: day summary*

Day 2 (Thurs 12 September 2013)

- Bayesian Computation: Parameter Estimation and Sampling
 - Grid-based methods
 - Markov Chain Monte Carlo
 - Metropolis-Hastings algorithm
 - Convergence tests – Rubin-Gelman
 - Hamiltonian Monte Carlo
 - Gibbs Sampling
 - Case Study: Cosmic Microwave Background
- *Hands on: MCMC code from scratch. Cosmology from the Supernova Hubble Diagram.*
- *Tutorial: day summary*

Day 3 (Fri 13 September 2013)

- Model Comparison
 - Bayesian Evidence
 - More on sampling
 - Case study: is the Universe flat?
- *Hands on: model comparison computations &/or complete MCMC/HMC codes.*
- *Tutorial: wrap up the workshop*
- 5 p.m. End of Workshop

Learning outcomes

At the end of the Workshop, the participants should be able to do the following (this is a non-exhaustive list):

- Express stochastic problems in terms of fundamental probability and Bayes' theorem.
- Demonstrate by application to real data understanding of probability, inference, priors, posteriors, marginalisation, parameter estimation, hypothesis testing, model selection, sampling.
- Code and apply a simple MCMC program to physical data.
- Formulate model selection problems in a principled statistical framework, and be capable of executing some methods of solution.

Course Team: Prof Alan Heavens, Prof Andrew Jaffe, Dr Roberto Trotta (ICIC Physics); Dr Daniel Mortlock (ICIC Physics and Mathematics).

Point of contact: Professor Alan Heavens, Director, Imperial Centre for Inference and Cosmology, Blackett Laboratory, Prince Consort Road, London SW7 2AZ. Email a.heavens@imperial.ac.uk Tel. 0207 594 2930.

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