Astrostatistics (L24)

Professor K. Mandel

This interdisciplinary course will cover applied statistical methods necessary to properly interpret today's increasingly complex datasets in astronomy. Particular emphasis will be placed on principled statistical modelling of astrophysical data and statistical computation of inferences of scientific interest. Statistical techniques, such as latent variable and measurement error models, Bayesian inference, Monte Carlo sampling methods, hierarchical models, Gaussian processes, and model selection, will be examined in the context of applications to modern astronomical data analysis. Topics and examples will be motivated by case studies across astrophysics and cosmology.

Prerequisites

Students of astrophysics, physics, statistics or mathematics are welcome. Astronomical context will be provided when necessary. Students who may need to brush up on their statistics background should familiarise themselves with the material in Feigelson & Babu, Chapters 1-4, and Ivezić et al., Chapters 1, 3-4, (listed below) by the beginning of the course. (Note that the two textbooks cover many of the same topics). These texts are freely available online to Cambridge students via the library website. Alternatively, they may find it useful to audit the relevant Michaelmas-term courses in the MPhil for Data-Intensive Science.

Literature

1. E. Feigelson and G. Babu. *Modern statistical methods for astronomy: with R applications.* Cambridge University Press, 2012.

2. Z. Ivezić, A. Connolly, J. VanderPlas & A. Gray. *Statistics, Data Mining, and Machine Learning in Astronomy.* Updated edition, Princeton University Press, 2020.

3. Gelman et al. *Bayesian Data Analysis.* 3rd edition, Chapman & Hall, CRC Press, 2013. Also available at: http://www.stat.columbia.edu/~gelman/book/

4. C. Bishop. *Pattern Recognition & Machine Learning.* Springer-Verlag, 2006. Also available at: https://www.microsoft.com/en-us/research/people/cmbishop/#!prml-book

5. D. MacKay. *Information Theory, Inference, and Learning Algorithms.* Cambridge University Press, 2003. Also available at: http://www.inference.org.uk/mackay/itila/book.html

6. C. Schafer. *A Framework for Statistical Inference in Astrophysics.* 2015, Annual Review of Statistics and Its Application, 2: 141-162.

7. E. Feigelson, et al. *21st Century Statistical and Computational Challenges in Astrophysics.* 2020, Annual Review of Statistics and Its Application, 8. https://arxiv.org/abs/2005.13025

Additional support

Four examples sheets will be provided and four associated examples classes will be given. There will be a one-hour revision class in the Easter Term.