Projects for Computational Physics

Bayesian model selection

Project Description

Often, there is a question as to which model might be more appropriate to describe a given set of data. As formulated in Chap. 4 of Ref. [1]:

> *Mr A has a theory; Mr B also has a theory, but with an adjustable parameter* λ*. Whose theory should we prefer on the basis of data* D*?*

Naively, one might think that more complicated models, defined by many parameters, will always be able to give better agreement with the experimental measurements, but most people would prefer the simpler models unless the discrepancy was very large.

Bayesian inference provides quantitive measures for this model-selection problem, *e.g.*, the *Bayes factor* [2] and the *Bayes complexity* [3].

Tasks / hints / interesting problems[1]

- Formulate the Bayes factor and the Bayes complexity in general.
- Formulate an efficient way of implementation of the Bayes factor for a multi-parameter problem
- Apply both measures for suitably chosen data sets and models.
- Present the results of the model comparison for the studied cases.

References

[1] D. S. Sivia and J. Skilling, *Data Analysis – A Bayesian Tutorial*. Oxford University Press, Oxford, UK, 2nd ed., 2006.

[2] R. Trotta, "Applications of Bayesian model selection to cosmological parameters," *Mon. Not. Roy. Astron. Soc.* **378** (2007) 72–82, `arXiv:astro-ph/0504022`.

[3] M. Kunz, R. Trotta, and D. Parkinson, "Measuring the effective complexity of cosmological models," *Phys. Rev. D* **74** (2006) 023503, `arXiv:astro-ph/0602378`.

[1] These tasks should rather be considered a general guideline than a strict requirement. Besides, the list is by no means complete and could easily be extended