Syllabus – PhD Course Proposal

Course Title:

A gentle introduction to the Bayesian inference

Instructor:

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Course Description:

We provide a gentle introduction to the Bayesian inference. We introduce the main elements of a Bayesian analysis with three approaches: from an engineering point of view (i.e., a regularization appraoch), from an extended likelihood study, and a classical introduction. Monte Carlo sampling methods are also described in order to perform a complete Bayesian analysis in real-world applications.

Learning Outcomes:

At the end of the course, students will be able to:

1. Knowledge of the basic actors in Bayesian Inference

2. Knowledge of Monte Carlo quadratures for integral approximations

3. Ability of programming MCMC methods and importance sampling schemes

Prerequisites:

Basic statistics.

Course Structure and Schedule (15 hours):

Session	Topic	Key Readings
1	Bayesian inference, an introduction (part 1)	- C. Robert, The Bayesian Choice: From Decision-Theoretic Foundations to Computational Implementation, Springer Texts in Statistics, 2007. - A. Gelman, J. B. Carlin, H. S. Stern, D. B. Duson. Bayesian Data Analysis. Chapman & Hall/CRC Texts in Statistical Science, 2013. - Tipping, M.E. (2004). Bayesian Inference: An Introduction to Principles and Practice in Machine Learning. https://www.miketipping.com/papers/met-mlbayes.pdf
2	Bayesian inference, an introduction (part 2)	- Tipping, M.E. (2004). Bayesian Inference: An Introduction to Principles and Practice in Machine Learning.

		https://www.miketipping.com/papers/met-mlbayes.pdf
3	Estimators, uncertainty quantifications, benefits and drawbacks	- C. P. Robert and G. Casella. Monte Carlo Statistical Methods. Springer, 2004
4	Numerical approximations, Monte Carlo sampling methods	- C. P. Robert and G. Casella. Monte Carlo Statistical Methods. Springer, 2004 - D. Luengo, L. Martino, M. Bugallo, V. Elvira, S. S arkka, "A Survey of Monte Carlo Methods for Parameter Estimation", EURASIP Journal on Advances in Signal Processing, Article number: 25, 2020
5	Direct methods, Rejection sampling, MCMC, Importance Sampling	- L. Martino, D. Luengo, J. Míguez, "Independent Random Sampling Methods", Springer, 2018; - L. Martino, V. Elvira. "Metropolis Sampling", Wiley StatsRef: Statistics Reference Online, 2017. - V. Elvira, L. Martino, "Advances in Importance Sampling", Wiley StatsRef: Statistics Reference Online, 2020.

Teaching Methods:

Lectures and coding classes with practical exercises

Assessment:

Presentation and coding in MATLAB

Bibliography:

- C. P. Robert and G. Casella. Monte Carlo Statistical Methods. Springer, 2004
- D. Luengo, L. Martino, M. Bugallo, V. Elvira, S. S arkka, "A Survey of Monte Carlo Methods for Parameter Estimation", EURASIP Journal on Advances in Signal Processing, Article number: 25, 2020
- L. Martino, D. Luengo, J. Míguez, "Independent Random Sampling Methods", Springer, 2018;
- L. Martino, V. Elvira. "Metropolis Sampling", Wiley StatsRef: Statistics Reference Online, 2017.
- V. Elvira, L. Martino, "Advances in Importance Sampling", Wiley StatsRef: Statistics Reference Online, 2020.

Preferred Bimester:

Select one: November–December (or May–June)