

# Bayesian Machine Learning

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**Timetable:** Course of 20 hours. Tentative schedule: Class meets every Thursday from 14:30 to 16:30 and Friday from 11:30 to 13:30. First lecture on Thursday, 12th January, 2017. Room DEI/G, 3-rd floor, Dept. of Information Engineering, via Gradenigo Building.

**Course requirements:** Basics of Probability Theory. Basics of R Programming.

**Examination and grading:** Homework assignments and final project.

**Aim:** The course will introduce fundamental topics in Bayesian reasoning and how they apply to machine learning problems. In this course, we will present pros and cons of Bayesian approaches and we will develop a graphical tool to analyse the assumptions of these approaches in practical problems.

**Course contents:**

- *Introduction of classical machine learning problems.*
  - Mathematical framework
  - Supervised and unsupervised learning
- *Bayesian decision theory:*
  - Two-category classification
  - Minimum-error-rate classification
  - Bayes risk
  - Decision surfaces
- *Estimation:*
  - Maximum Likelihood Estimation
  - Maximum A Posteriori
  - Bayesian approach
- *Graphical models:*
  - Bayesian networks
  - Two-dimensional probabilistic model
- *Evaluation :*
  - Measures of accuracy
  - Statistical significance testing

## References:

- [1] J. Kruschke, Doing Bayesian Data Analysis: A Tutorial Introduction With R and Bugs, Academic Press 2010
- [2] Christopher M. Bishop, Pattern Recognition and Machine Learning (Information Science and Statistics), Springer 2007
- [3] Richard O. Duda, Peter E. Hart, David G. Stork, Pattern Classification (2nd Edition), Wiley-Interscience, 2000
- [4] Yaser S. Abu-Mostafa, Malik Magdon-Ismail, Hsuan-Tien Lin, Learning from Data, AML-Book, 2012 (supporting material available at <http://amlbook.com/support.html>)
- [5] David J. C. MacKay, Information Theory, Inference and Learning Algorithms, Cambridge University Press, 2003 (freely available and supporting material at <http://www.inference.phy.cam.ac.uk/mackay/>)
- [6] David Barber, Bayesian Reasoning and Machine Learning, Cambridge University Press, 2012 (freely available at <http://web4.cs.ucl.ac.uk/staff/D.Barber/pmwiki/pmwiki.php?n=>
- [7] Kevin P. Murphy, Machine Learning: A Probabilistic Perspective, MIT Press, 2012 (supporting material <http://www.cs.ubc.ca/~murphyk/MLbook/>)