Markovian modelling and Bayesian learning, fall 2011

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Lecturer

Jukka Corander

Scope

5 cu.

Type

Advanced studies

Prerequisites

Basic calculus, linear algebra, introductory course on probability and statistical inference are absolutely necessary. First course level knowledge on algebra, probability and inference will be recommendable for many parts of the course.

Lectures

Weeks 44-50, Tuesday 12-14 and Thursday 12-14 in room B120. NB! No lectures during weeks 48 and 49. These lectures are replaced by the following ADDITIONAL lectures in room B120 during weeks 47 and 50: Mon 21.11. 14-16, Wed 23.11. 12-14, Mon 12.12. 14-16. Exercise sessions will be held normally during weeks 48,49.

Exercises.

During weeks 45-49 there will be a weekly exercise session in room C124 on Fridays between 12-14. The teacher responsible for the exercise sessions is Ali Amiryousefi (amiryous@mappi.helsinki.fi).

Exercises for week 45 are available here
Exercises for week 46 are available here
Exercises for week 47 are available here
Exercises for week 48 are available here
Exercises for week 49 are available here

Exams

To gain the credits from this course, it is necessary to do at least 50% of the exercises and a home exam. Additional solved exercises will yield bonus points for the grade. The home exam will consist of a number of larger assignments that must be returned by May 1st 2012 to the lecturer. Home exam assignments are available here.

Lecture diary

Week 44:
Tue 1.11.
Teaser trailer, Eye-opener on conditional probabilities and Bayes' theorem, basic properties of Markov chains. This excerpt from the HMM book by T. Koski is mainly used during the lectures and also this short excerpt on periodicity from the book of Isaacson & Madsen, Markov chains. For further illustrations and mathematical details on Markov chains, see the link to Sirl and Norris in Bibliography.
Thu 3.11.
Basic properties of Markov chains continued. To get going with the basics of simulating Markov chains, you might find these Matlab codes useful.
Week 45:
Tue 8.11.
Properties of Markov chains continued. Basics of ML and Bayesian learning, see this excerpt from the HMM book by T. Koski.
Thu 10.11.
Statistical learning for DTMC's, see this excerpt from the HMM book by T. Koski. Also, this appendix from the HMM book is useful for refreshing details on various distributions.
Week 46:
Tue 15.11.
Bayesian learning of the order of a DTMC, continuous-time Markov chains (see the e-book by Koski.).
Thu 17.11.
Continuous-time Markov chains.
Week 47:
Continuous-time Markov chains, basic properties of hidden Markov models, see: Ch. 10,Ch. 12,Ch. 13,Ch. 14 from the HMM book.
Weeks 48-49: No lectures
Week 50: CTMS and HMMs continued, Variable Length Markov chains (see the article by Mächler & Buhlmann mentioned in the bibliography)

Bibliography

Various references will be used during the course. The lecture diary will also include links to some additional materials. Parts of the following books will be considered:

Baclawski, Kenneth. Introduction to probability with R. Chapman & Hall, 2008.
Timo Koski. Hidden Markov models for bioinformatics. Kluwer, 2001.
Timo Koski & John M. Noble. Bayesian networks: An introduction. Wiley, 2009.
Timo Koski. Lectures at RNI on Probabilistic Models and Inference for Phylogenetics. Free e-book available here.

In addition, we will consider a number of articles & tutorials (articles not directly linked here are generally available form JSTOR collection or are otherwise online):

Braun, J.V. & Muller, H-G. Statistical methods for DNA sequence segmentation. Statistical Science, 13, 142-162, 1998.
Sirl, D. Markov Chains: An Introduction/Review. pdf.
Norris, J. Markov chains. CUP, see online resource.
Gu, L. Notes on Dirichlet distribution with relatives. This document provides a concise recapitulation of some of the central formulas that are needed in the exercises and assignments when doing Bayesian learning. More comprehensive derivations can be found in several books on Bayesian modeling, e.g. in Koski & Noble (2009), which is listed above.
Mächler, M. & Buhlmann, P. Variable length Markov chains: Methodology, computing and software. Journal of Computational and Graphical Statistics 13, 435-455, 2004. Preprint available here
Kass, R.E. & Raftery, A.E. Bayes factors. Journal of the American Statistical Association, 90, 773-795, 1995.
Smith, A.F.M. & Gelfand, A.E. Bayesian statistics without tears: A sampling-resampling perspective. The American Statistician, 46, 84-88, 1992.
Jordan, M.I. Graphical models. Statistical Science, 19, 140-155, 2004. Preprint available here

Registration

Did you forget to register? What to do.

Exercise groups

Group	Day	Time	Place	Instructor
1.				
2.				
3.				
4.				
5.				
6.				