

Graphical and Hidden Markov Models

Academic Year: (2023 / 2024)

Review date: 17-07-2023

Department assigned to the subject: Statistics Department

Coordinating teacher: WIPER , MICHAEL PETER

Type: Electives ECTS Credits : 3.0

Year : 1 Semester : 2

REQUIREMENTS (SUBJECTS THAT ARE ASSUMED TO BE KNOWN)

Probability and conditional probability; stochastic processes (Markov chains); statistical inference; Bayesian inference

OBJECTIVES

Graphical representation of conditional independence; Learning when to use and how to fit both discrete and Gaussian graphical models; fitting and interpreting log linear models; hidden Markov models; estimation and interpretation of hidden Markov models; use of statistical software for model fitting.

DESCRIPTION OF CONTENTS: PROGRAMME

- 1) Basic concepts of graphical models
 - a) Directed and non-directed graphs.
 - b) Conditional independence and its graphical representation
 - c) Representing graphical models in R
 - d) The naive Bayes classifier as a graphical model
- 2) Log-linear models
 - a) Representation as graphical models
 - b) Fitting log-linear models
 - c) Practical example
- 3) Bayesian networks
 - a) Representation
 - b) Classical and Bayesian approaches
 - c) How to infer causality
 - d) Practical example
- 4) Gaussian networks and mixed networks
 - a) Representation and adjustment
 - b) Practical example
- 5) More complex graphical models
 - a) Algorithms
 - b) Examples
- 6) Hidden Markov models
 - a) Structure.
 - b) Algorithms for estimation.
 - c) Interpretation of hidden states.
 - d) Practical examples.
 - e) Quick fitting of hidden Markov models: filters.

LEARNING ACTIVITIES AND METHODOLOGY

Theoretical and computer practical classes with presentation and resolution of real problems, individual and group work.

ASSESSMENT SYSTEM

Participation in class: 10%

Individual and group projects 90%

The extraordinary evaluation will follow a similar design to the ordinary evaluation

% end-of-term-examination:	0
% of continuous assessment (assignments, laboratory, practicals...):	100

BASIC BIBLIOGRAPHY

- D. Bellot Learning Probabilistic Graphical Models in R, PACKT Publishing, 2016
- Dechter, R, Brachman, RJ & Rossi, F Reasoning with Probabilistic and Deterministic Graphical Models: Exact Algorithms (2nd. ed.), Morgan and Claypool Publishers, 2019
- I Visser & M Speekenbrink Mixture and Hidden Markov Models with R, Springer, 2022
- J. Chapmann Markov Models: Introduction to Markov Chains, Hidden Markov Models and Bayesian Networks, CreateSpace Independent Publishing Platform, 2017
- L Nguyen Visión General de la Red Bayesiana, Ediciones Nuestro Conocimiento, 2022
- L. Sucar Probabilistic Graphical Models: Principles and Applications, Springer, 2015
- W Zucchini, IL MacDonald & R Langrock Hidden Markov Models for Time Series: An Introduction Using R (2nd. ed.), Chapman and Hall, 2021

ADDITIONAL BIBLIOGRAPHY

- L. Sucar Probabilistic Graphical Models: Principles and Applications, Springer, 2015
- Roverato, A. Graphical Models for Categorical Data, Cambridge University Press, 2017
- S. Hojsgaard, D. Edwards, S. Lauritzen Graphical Models with R, Springer, 2012
- Sucar, LE Probabilistic Graphical Models: Principles and Applications (2nd ed.), Springer, 2020

BASIC ELECTRONIC RESOURCES

- . R Studio: <https://www.rstudio.com/>
- CRAN . The R Project for Statistical Computing: <https://www.r-project.org/>