Graphical and Hidden Markov Models

Academic Year: (2024 / 2025) **Review date: 25-04-2024**

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

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

Participation in class and solution of exercises: 10%
Individual and group projects 90%

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

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/