AALBORG UNIVERSITET

General module information

Title: Multivariate Statistics and Pattern Recognition (Multivariat Statistik og Mønstergenkendelse)

Type: course module
Language of instruction: English

ECTS points: 5 ECTS

Period: 1 September 2015 — 31 January 2016

Placement

1st semester, M.Sc. in Medialogy, M.Sc. in Sound and Music Computing

Module coordinator

Aalborg: Mads Græsbøll Christensen (coordinator), Anne-Marie Rasmussen (secretary)

Copenhagen: Hendrik Purwins (coordinator), Lisbeth Nykjær (secretary)

Esbjerg: Michael Boelstoft Holte (coordinator), Britta Marie Jensen (secretary)

Academic content and relationships to other modules/semesters

The formal study plan description of the module can be found here (page 18):
http://www.sict.aau.dk/digitalAssets/101/101051_91429_msc-medialogi-2014.pdf
Multivariate statistics and pattern recognition (also referred to as 'machine learning' and closely related to 'big data' and 'artificial neural networks') is not only a key technology in engineering but also in particular one of the pillars of media technology. When designing and developing interactive media systems and technology, one is often faced with looking for interesting patterns and trends in data of several dimensions, what is called 'multivariate data.' This course presents basic theoretical concepts and practical tools for analyzing such data and designing pattern recognition methods for multimedia applications. Many of these methods are used in, e.g., automatic speech recognition, automatic driving, face detection, web page ranking (Google), customer behavior analysis etc. This course provides the tools e.g. for music information retrieval (detecting pitch, harmony, rhythm, instrument) taught in the course 'Sound and Music Signal Analysis' (SMC M.Sc. 2nd Semester) and for automatic gesture recognition that is relevant to the courses 'Multimedia Programming' and 'Embodied Interaction' (Medialogy M.Sc. 2nd Semester).

Objectives and learning goals

Students who complete the course module will obtain the following qualifications:

- Basic understanding of machine learning: the students will understand
  - probability theory,
  - description of data with probability distributions,
  - automatic pattern recognition/classification (prediction of discrete attributes) and regression (prediction of continuous attributes),
  - visualization of high-dimensional data,
  - feature extraction (finding the data attributes that are relevant e.g. for recognition of patterns or for prediction),
  - unsupervised learning (e.g. finding 'clusters' in the data, without knowing to which classes the data belongs to),
- Skills: the students will be able
  - to apply machine learning methods to multi-media data, e.g. to automatically recognize faces, sounds, game player types, footsteps recorded with accelerometers,
  - evaluate results obtained with machine learning methods in terms of their performance and reliability,
- Competences: the students will be able
  - to analyze whether machine learning could be relevant to solve a medialogy / sound and music computing problem and reflect and specify how to use it to solve the problem.

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Extent and expected work load
5 ECTS. Roughly this work load splits into lectures (1 ECTS), lecture preparation and exercises in class and at home (2 ECTS), and final individual project (2 ECTS).

Pre-requisites for participation
Knowlege of:

- Linear algebra (e.g. such as taught in 'Mathematics for Multimedia Applications', B.Sc. Medialogy 2nd),
- Programming (e.g. such as taught in 'Introduction to Programming', B.Sc. Medialogy 1st, 'Computer Graphics Programming', B.Sc. Medialogy 5th),
- Basic probability theory and statistics (e.g. such as taught in 'Design and Analysis of Experiments', B.Sc. Medialogy 4th).

The following knowledge is an advantage:

- Signal processing (e.g. such as taught in 'Audio Processing', B.Sc. Medialogy 4th and 'Image Processing', B.Sc. Medialogy 3rd)
- Programming language MATLAB.

The prerequisites for participation are listen in the study plan:
http://www.sict.aau.dk/digitalAssets/101/101051_91429_msc-medialogi-2014.pdf

Examination
Each student is required to complete an individual project in which the methods covered in the course are applied to a real-life classification problem (e.g. from the UCI Machine Learning Repository: http://archive.ics.uci.edu/ml/). To be admitted to the exam the student has do a sufficient amount of the required assignments. To this end, the student must bring a laptop with the prepared slides, MATLAB and the MATLAB code and the data for the mini-project to the exam. In an individual oral exam, the student will present their project to the examiner(s) who will ask questions about the project and the curriculum. The assessment is performed in accordance with the 7-point scale.

Course module description

The course includes the following topics: probability theory (e.g. Bayes' rule, stochastic independence), multivariate probability density functions (e.g. multivariate Gaussians), Bayesian estimation and detection, parameter estimation (e.g. mean and covariance matrix of a Gaussian), assessment of classifiers and estimators (e.g. confusion matrix, overfitting, cross-validation), data fitting / multivariate regression, parametric (e.g. linear and quadratic discriminant analysis) and non-parametric learning (kernel smoother), feature selection and reduction (principal component analysis), and clustering (k-means).