Engineering Tripos Part IIB, 4F10: Statistical Pattern Processing, 2015-16

Leader

Prof M Gales [1]

Lecturer

Prof M Gales

Timing and Structure

Michaelmas term. 14 lectures + 2 examples classes. Assessment: 100% exam

Prerequisites

Part IIA Modules 3F1 and 3F3 advisable

Aims

The aims of the course are to:

- describe the basic concepts of statistical pattern processing and some of the current techniques used in pattern classification.

Objectives

As specific objectives, by the end of the course students should be able to:

- understand the basic principles of pattern classification.
- understand Expectation-Maximisation as a general optimisation technique.
- understand current classification schemes such as Support Vector Machines and Gaussian Processes.
- apply pattern processing techniques to practical applications.

Content

Introduction (1L)

Statistical pattern proecessing, Bayesian decision theory, generalisation.

Multivariate Gaussian Distributions and Decision Boundaries (1L)

Multivariate Gaussian PDFs, maximum likelihood estimation, decision boundaries, classification cost, ROC curves.

Gaussian Mixture Models (1L)

Mixture models, parameter estimation, EM for discrete latent variables.

Expectation Maximisation (1L)

Latent variables both continuous and discrete, proof of EM, factor analysis.

Mixture and Product of Experts (1L)

Combining multiple classifiers/predictors, gating functions, products versus mixtures.

Resticted Boltzman Machines (1L)

Structure of restricted Boltzman machines, contrastive divergence.

Linear Classifiers (1L)

Single layer perceptron, perceptron learning algorithm, Fisher's linear discriminant analysis, limitations.

Multi-Layer Perceptrons (2L)

Basic structure, posterior modelling, regression, error back propogation, learning rates, second order optimisation methods, "deep" topologies, network initialisation.

Support Vector Machines (2L)

Maximum margin classifiers, handling non-separable data, training SVMs, non-linear SVMs, kernel functions.

Classification and Regression Trees (1L)

Decision trees, query selection, multivariate decision trees.

Non-Parametric Techniques (1L)

Parzen windows, K-nearest neighbours, nearest neighbour rule.

Speaker Recognition and Verification (1L)

Speaker recognition/verification task, GMMs and MAP adaptation, SVM-based verification.

Booklists

Please see the Booklist for Group F Courses [2] for references for this module.

Examination Guidelines

Please refer to Form & conduct of the examinations [3].

UK-SPEC

This syllabus contributes to the following areas of the UK-SPEC [4] standard:

Toggle display of UK-SPEC areas.

GT1

Develop transferable skills that will be of value in a wide range of situations. These are exemplified by the Qualifications and Curriculum Authority Higher Level Key Skills and include problem solving, communication, and working with others, as well as the effective use of general IT facilities and information retrieval skills. They also include planning self-learning and improving performance, as the foundation for lifelong learning/CPD.

IA1

Apply appropriate quantitative science and engineering tools to the analysis of problems.

IA2

Demonstrate creative and innovative ability in the synthesis of solutions and in formulating designs.

KU1

Demonstrate knowledge and understanding of essential facts, concepts, theories and principles of their engineering discipline, and its underpinning science and mathematics.

KU2

Have an appreciation of the wider multidisciplinary engineering context and its underlying principles.

E1

Ability to use fundamental knowledge to investigate new and emerging technologies.

E2

Ability to extract data pertinent to an unfamiliar problem, and apply its solution using computer based engineering tools when appropriate.

E3

Ability to apply mathematical and computer based models for solving problems in engineering, and the ability to assess the limitations of particular cases.

P1

A thorough understanding of current practice and its limitations and some appreciation of likely new developments.

P3

Understanding of contexts in which engineering knowledge can be applied (e.g. operations and management, technology, development, etc).

P8

Ability to apply engineering techniques taking account of a range of commercial and industrial constraints.

US1

A comprehensive understanding of the scientific principles of own specialisation and related disciplines.

US2

A comprehensive knowledge and understanding of mathematical and computer models relevant to the engineering discipline, and an appreciation of their limitations.

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Links
[1] mailto:mjfg100@cam.ac.uk
[2] https://www.vle.cam.ac.uk/mod/book/view.php?id=364101&chapterid=55921
[3] https://teaching26-27.eng.cam.ac.uk/content/form-conduct-examinations
[4] https://teaching26-27.eng.cam.ac.uk/content/uk-spec