Engineering Tripos Part IIB, 4F10: Deep Learning & Structured Data, 2021-22

Module leader

Prof M Gales [1]

Lecturer

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Timing and Structure

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

Prerequisites

Part IIA Modules 3F1, 3F3 and 3F8 advisable

Aims

The aims of the course are to:

- This module aims to teach the basic concepts of deep learning and forms of structure that can be used for generative and discriminative models. In addition, the use of models for classifying structured data, such as speech and language, will be discussed

Objectives

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

- Understand the basic principles of pattern classification and deep learning;
- Understand generative and discriminative models for structured data;
- Understand the application of deep-learning to structured data;
- Be able to apply pattern processing techniques to practical applications.

Content

Introduction (1L)

Links with 3F8 and 4F13. General machine learning, examples of structured data, DNA, vision, speech and language processing.

Decision Boundaries and Probability of Error (1L)

Definition of a decision boundary and forms that result from Gaussian class-conditional probability density functions. Calculation of probability of Error.

Graphical Models and Conditional Indpendence (1L)

Graphical models and Bayesian networks. Simple inference examples.

Latent Variable and Sequence Models (3L)

Gaussian mixture models and factor analysis; hidden Markov models and expectation maximisation.

Deep Learning (2L)

Generative and discriminative deep models. Forms of network and activation functions. Convolutional neural networks, mixture-density neural networks. Optimisation approaches (first/second order methods, adaptive learning rates) and initialisation.

Deep Learning for Sequences (2L)

Recurrent neural networks, and long-short-term memory models. Variants of RNN including bidirectional RNNs. Use in generative and discriminative models.

Ensemble Methods (1L)

Ensemble methods: random forests, bagging, boosting and model combination.

Support Vector Machines (2L)

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

Kernels over Structured Data (1L)

String kernels, graph kernels and Fisher kernels.

Booklists

Please refer to the Booklist for Part IIB Courses for references to this module, this can be found on the associated Moodle course.

Examination Guidelines

Please refer to Form & conduct of the examinations [2].

UK-SPEC

The UK Standard for Professional Engineering Competence (UK-SPEC) [3] describes the requirements that have to be met in order to become a Chartered Engineer, and gives examples of ways of doing this.

UK-SPEC is published by the Engineering Council on behalf of the UK engineering profession. The standard has been developed, and is regularly updated, by panels representing professional engineering institutions, employers and engineering educators. Of particular relevance here is the 'Accreditation of Higher Education Programmes' (AHEP) document [4] which sets out the standard for degree accreditation.

The Output Standards Matrices [5] indicate where each of the Output Criteria as specified in the AHEP 3rd edition document is addressed within the Engineering and Manufacturing Engineering Triposes.

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Links
[1] mailto:mjfg100@cam.ac.uk
[2] http://teaching.eng.cam.ac.uk/content/form-conduct-examinations
[3] http://www.engc.org.uk/ukspec.aspx
[4] http://www.engc.org.uk/standards-guidance/standards/accreditation-of-higher-education-programmes-ahep/
[5] http://teaching.eng.cam.ac.uk/content/output-standards-matrices