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| MODULE TITLE | Machine Learning (Professional) | | CREDIT VALUE | 15 |
| MODULE CODE | ECMM458 | | MODULE CONVENER | Dr Fabrizio Costa (Coordinator) |
| DURATION: TERM | 1 | 2 | 3 | |
| DURATION: WEEKS | 11 | 0 | 0 | |
| Number of Students Taking Module (anticipated) | | 90 | | |

DESCRIPTION - summary of the module content

*** This module is a “professional” version of the similar module ECMM422. It is intended to be taught in a short-fat format based around 3-day teaching blocks, as part of the MSc Data Science (Professional) programme. ***

Machine learning has emerged mainly from computer science and artificial intelligence, and draws on methods from a variety of related subjects including statistics, applied mathematics and more specialized fields, such as pattern recognition and neural computation. Applications are, for example, image and speech analysis, medical imaging, bioinformatics and exploratory data analysis in natural science and engineering. This module will provide you with a thorough grounding in the theory and application of machine learning, pattern recognition, classification, categorisation, and concept acquisition.

Pre-Requisite module: ECMM431

Co-requisite modules: None.

AIMS - intentions of the module

In this data-driven era, modern technologies are generating massive and high-dimensional datasets. This module aims to give you an understanding of computational methods used in modern data analysis. In particular, this module aims to impart knowledge and understanding of machine learning methods from basic pattern-analysis methods to state-of-the-art research topics; to give you experience of data-modelling development in practical workshops. Neural Networks, Bayesian methods and kernel-based algorithms will be introduced for extracting knowledge from large data sets of patterns (data mining techniques) where it is important to have explicit rules governing machine learning and pattern recognition. Recent development of techniques and algorithms for big-data analysis will also be addressed.

INTENDED LEARNING OUTCOMES (ILOs) (see assessment section below for how ILOs will be assessed)

On successful completion of this module, you should be able to:

Module Specific Skills and Knowledge:

1. apply advanced and complex principles for statistical machine learning to various data analysis;
2. analyse novel pattern recognition and classification problems; establish statistical models for them and write software to solve them;
3. apply a range of supervised and unsupervised machine learning techniques to a wide range of real-life applications.

Discipline Specific Skills and Knowledge:

4. state the importance and difficulty of establishing a principled probabilistic model for pattern recognition;
5. apply a number of complex and advanced mathematical and numerical techniques to a wide range of problems and domains.

Personal and Key Transferable / Employment Skills and Knowledge:

6. identify the compromises and trade-offs which must be made when translating theory into practice;
7. critically read and report on research papers;
8. conduct small individual research projects.

SYLLABUS PLAN - summary of the structure and academic content of the module

Topics will include:

- Introductory material: Practical motivation for machine learning, basic ideas of supervised and unsupervised learning, classification, regression.
- Describing data.
- Latent descriptions: k-means, maximum likelihood; mixture models; PCA; ICA.
- Unsupervised learning: Clustering.
- Supervised models: k-nearest neighbours, linear and non-linear regression, linear discriminant analysis, logistic regression, SVM (Support Vector Machines) and maximum margin classifiers.
- Loss functions and maximum likelihood estimators.
- Neural networks and deep learning.
- Evaluation of performance, dataset balance.
- Ensemble methods: boosting, bagging, decision trees and random forests Metric learning.

LEARNING AND TEACHING

LEARNING ACTIVITIES AND TEACHING METHODS (given in hours of study time)

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|---|--------------|---------------------------------|--------------|---------------------------------|-------------|
| Scheduled Learning & Teaching Activities | 30.00 | Guided Independent Study | 40.00 | Placement / Study Abroad | 0.00 |
|---|--------------|---------------------------------|--------------|---------------------------------|-------------|

DETAILS OF LEARNING ACTIVITIES AND TEACHING METHODS

| Category | Hours of study time | Description |
|--|---------------------|----------------------|
| Scheduled learning and teaching activities | 20 | Lectures |
| Scheduled learning and teaching activities | 10 | Workshops/practicals |

| Category | Hours of study time | Description |
|--------------------------|---------------------|------------------------------|
| Guided independent study | 20 | Coursework preparation |
| Guided independent study | 20 | Wider reading and self study |

ASSESSMENT

FORMATIVE ASSESSMENT - for feedback and development purposes; does not count towards module grade

SUMMATIVE ASSESSMENT (% of credit)

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|------------|-----|---------------|---|-----------------|---|
| Coursework | 100 | Written Exams | 0 | Practical Exams | 0 |
|------------|-----|---------------|---|-----------------|---|

DETAILS OF SUMMATIVE ASSESSMENT

| Form of Assessment | % of Credit | Size of Assessment (e.g. duration/length) | ILOs Assessed | Feedback Method |
|----------------------|-------------|---|---------------|-----------------|
| Coursework (1 piece) | 100 | 2000-3500 words per piece | All | Written |

DETAILS OF RE-ASSESSMENT (where required by referral or deferral)

| Original Form of Assessment | Form of Re-assessment | ILOs Re-assessed | Time Scale for Re-assessment |
|-----------------------------|-----------------------|------------------|------------------------------|
| Coursework | Coursework | All | Within 8 weeks |

RE-ASSESSMENT NOTES

Deferral – if you miss an assessment for certificated reasons judged acceptable by the Mitigation Committee, you will normally be either deferred in the assessment or an extension may be granted. The mark given for a reassessment taken as a result of deferral will not be capped and will be treated as it would be if it were your first attempt at the assessment.

Referral – if you have failed the module overall (i.e. a final overall module mark of less than 50%) you will be required to re-take some or all parts of the assessment, as decided by the Module Convenor. The final mark given for a module where re-assessment was taken as a result of referral will be capped at 50%.

RESOURCES

INDICATIVE LEARNING RESOURCES - The following list is offered as an indication of the type & level of information that you are expected to consult. Further guidance will be provided by the Module Convener

Reading list for this module:

| Type | Author | Title | Edition | Publisher | Year | ISBN | Search |
|------|--|--|---------|----------------------------|------|-------------------|---------------------------|
| Set | Christopher Bishop | Pattern Recognition and Machine Learning | | Springer | 2007 | 978-0387310732 | [Library] |
| Set | Webb, A. | Statistical Pattern Recognition | 2 | Wiley | 2002 | 0-470-84513-9 | [Library] |
| Set | Shawe-Taylor, J. and Cristianini, N. | Kernel methods for pattern analysis | | Cambridge University Press | 2006 | 521813972 | [Library] |
| Set | Murphy, K. | Machine Learning: A Probabilistic Perspective | 1st | MIT Press | 2012 | 978-0-262-018029 | [Library] |
| Set | David Barber | Bayesian Reasoning and Machine Learning | | Cambridge University Press | 2012 | 978-0-521-51814-7 | [Library] |
| Set | Hastie T., Tibshirani R. & Friedman J. | The Elements of Statistical Learning: Data Mining, Inference, and Prediction | 2nd | Springer | 2009 | 978-0387848587 | [Library] |

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| CREDIT VALUE | 15 | ECTS VALUE | 7.5 |
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| PRE-REQUISITE MODULES | ECMM431 |
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CO-REQUISITE MODULES

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| NQF LEVEL (FHEQ) | 7 |
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| ORIGIN DATE | Tuesday 06 August 2019 |
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| AVAILABLE AS DISTANCE LEARNING | No |
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| LAST REVISION DATE | Monday 12 July 2021 |
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| KEY WORDS SEARCH | Machine learning, statistical modelling |
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