# H9MLFF: Machine Learning for Finance

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| **Module Code:** | H9MLFF |
| **Long Title** | Machine Learning for Finance APPROVED |
| **Title** | Machine Learning for Finance |
| **Module Level:** | LEVEL 9 |
| **EQF Level:** | 7 |
| **EHEA Level:** | Second Cycle |
| **Credits:** | 5 |
| **Module Coordinator:** | Rohit Verma |
| **Module Author:** | Andrea Del Campo Dugova |
| **Departments:** | School of Computing |
| **Specifications of the qualifications and experience required of staff** | Lecturer PhD/Master's degree in a computing or cognate discipline. May have industry experience also.<br>Tutor PhD/Master's degree in a computing or cognate discipline. May have industry experience also. |

**Learning Outcomes**

*On successful completion of this module the learner will be able to:*

| # | Learning Outcome Description |
|---|---|
| LO1 | Retrieve, extract, manipulate, synthesise, explore, and visualise data in preparation for data analysis and machine learning. |
| LO2 | Demonstrate expert knowledge of the theory, concepts and methods associated with the analysis of data using numerical and statistical techniques to assist on decision-making. |
| LO3 | Use fundamental machine learning concepts and techniques to build and evaluate machine learning models on various problem domains. |
| LO4 | Evaluate and employ graphical tools for building comprehensive analytics processes and dashboards. |
| LO5 | Critically analyse, compare, summarise, and present results to support decision making and address requirements in real-world problems. |

**Dependencies**

***Module Recommendations***

No recommendations listed

***Co-requisite Modules***

No Co-requisite modules listed

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| ***Entry requirements*** | Programme entry requirements must be satisfied. |

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## Module Content & Assessment

| Indicative Content |
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| **Regression and Classification Algorithms I**<br>Best-practice for evaluating performance and analysing for bias and variance. KNN and regression and classification. |
| **Regression and Classification Algorithms II**<br>Partial Least Squares Regression. Decision Tree regression and classification. |
| **Regression and Classification Algorithms III**<br>Support Vector Machines regression and classification. |
| **Classification Algorithms**<br>Logistic regression; Naïve-Bayes. |
| **Ensembles**<br>Random Forest; Voting; Stacking; Bagging and Boosting Methods. |
| **Deep Neural Networks I**<br>Neural networks, classic topologies, and activation functions. Forward- and back-propagation. Optimisation algorithms: gradient descent and stochastic gradient descent. Key parameters for neural networks. Multi-layer perceptrons. |
| **Deep Neural Networks II**<br>Initialisation, L2 and dropout regularisation, gradient checking and batch and layer normalisation; convergence algorithms, learning rate scheduling, Hyperparameter tuning. |
| **Convolutional neural network**<br>Overview of convolutional neural networks (CNN). Methodology for stacking layers in a deep network to address multi-class image classification problems. Object detection and the YOLO algorithm. Deep residual learning for image recognition. |
| **Recurrent Neural Network**<br>The basic recurrent unit (Elman unit) and LSTM (long short-term memory) unit. Overview of the GRU (gated recurrent unit). Build and train recurrent neural networks. Approaches for mitigating the vanishing gradient problem. |
| **Transformer**<br>Encoder-decoder Architecture, attention mechanisms, Position embedding, multi-head attention and self-attention layers, pre-trained language models (e.g., BERT) |
| **Application of Deep Learning Models to Finance I**<br>Selected topics from the following areas will be covered, especially on practical applications: computer vision, natural language processing |
| **Application of Deep Learning Models to Finance II**<br>Selected topics from the following areas will be covered, especially on practical applications: computer vision, natural language processing |

| Assessment Breakdown | % |
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| Coursework | 100.00% |

**Assessments**

## Full Time

**Coursework**

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|---|---|---|---|
| **Assessment Type:** | Formative Assessment | **% of total:** | Non-Marked |
| **Assessment Date:** | n/a | **Outcome addressed:** | 1,2,3,4,5 |
| **Non-Marked:** | Yes | | |

**Assessment Description:**
Formative assessment will be provided on the in-class individual or group activities. Feedback will be provided in written or oral format, or on-line through Moodle. In addition, in class discussions will be undertaken as part of the practical approach to learning.

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|---|---|---|---|
| **Assessment Type:** | Project | **% of total:** | 100 |
| **Assessment Date:** | n/a | **Outcome addressed:** | 1,2,3,4,5 |
| **Non-Marked:** | No | | |

**Assessment Description:**
The terminal assessment will consist of a project that will evaluate all learning outcomes. The long-form project which the student produces over the course of the entire semester. Learners will propose and execute an applied research project using appropriate machine learning methods, and critically compare their performance using appropriate evaluation metrics. The proposal should explain the background and context of the investigation with the topic or hypotheses that the learner proposes to investigate. The final submission will consist of a written report that demonstrates data sets used, design and implementation process of the machine learning models, results, discussions, and error analysis.

No End of Module Assessment

No Workplace Assessment

**Reassessment Requirement**

**Coursework Only**
*This module is reassessed solely on the basis of re-submitted coursework. There is no repeat written examination.*

**Reassessment Description**
The repeat strategy for this module is by a project that covers all learning outcomes.

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## Module Workload

**Module Target Workload Hours 0 Hours**

**Workload: Full Time**

| *Workload Type* | *Workload Description* | *Hours* | *Frequency* | *Average Weekly Learner Workload* |
|---|---|---|---|---|
| Lecture | Classroom and demonstrations | 24 | Per Semester | 2.00 |
| Tutorial | Mentoring and small-group tutoring | 12 | Per Semester | 1.00 |
| Independent Learning | Independent learning | 89 | Per Semester | 7.42 |
| | | | Total Weekly Contact Hours | 3.00 |

**Workload: Blended**

| *Workload Type* | *Workload Description* | *Hours* | *Frequency* | *Average Weekly Learner Workload* |
|---|---|---|---|---|
| Lecture | Classroom and demonstrations | 12 | Per Semester | 1.00 |
| Tutorial | Mentoring and small-group tutoring | 12 | Per Semester | 1.00 |
| Tutorial | Directed e-learning | 12 | Every Week | 12.00 |
| Independent Learning | Independent learning | 89 | Per Semester | 7.42 |
| | | | Total Weekly Contact Hours | 14.00 |

**Workload: Part Time**

| *Workload Type* | *Workload Description* | *Hours* | *Frequency* | *Average Weekly Learner Workload* |
|---|---|---|---|---|
| Lecture | No Description | 24 | Per Semester | 2.00 |
| Tutorial | Mentoring and small-group tutoring | 12 | Per Semester | 1.00 |
| Independent Learning | Independent learning | 89 | Per Semester | 7.42 |
| | | | Total Weekly Contact Hours | 3.00 |

## Module Resources

*Recommended Book Resources*

John D. Kelleher,Brian Mac Namee,Aoife D'Arcy. (2020), Fundamentals of Machine Learning for Predictive Data Analytics, second edition, MIT Press, p.853, [ISBN: 978-0262044691].

Ian Goodfellow,Yoshua Bengio,Aaron Courville. (2016), Deep Learning, MIT Press, p.801, [ISBN: 978-0262035613].

Hastie, T., Tibshirani, R., & Friedman, J.. The Elements of Statistical Learning: Data Mining, Inference, and Prediction, 2ND ED. Springer.

*Supplementary Book Resources*

Kevin P. Murphy. (2012), Machine Learning: A Probabilistic Perspective., MIT Press, p.1102, [ISBN: 978-0262018029].

Gareth James,Daniela Witten,Trevor Hastie,Robert Tibshirani. (2014), An Introduction to Statistical Learning, Springer, p.426, [ISBN: 978-1461471370].

Max Kuhn,Kjell Johnson. (2018), Applied Predictive Modeling, Springer, p.600, [ISBN: 978-1461468486].

Shai Shalev-Shwartz,Shai Ben-David. (2014), Understanding Machine Learning, Cambridge University Press, p.415, [ISBN: 978-1107057135].

John Hearty. (2016), Advanced Mastering Learning with Python, Packt Publishing, p.278, [ISBN: 978-1784398637].

*This module does not have any article/paper resources*

*Other Resources*

[Website], Machine Learning Stanford,
https://www.coursera.org/course/ml

[Website], DataCamp,
http://www.datacamp.com

[Website], UCI Repository,
http://www.ics.uci.edu/~mlearn/MLReposit ory.html

[Website], WEKA,
http://www.cs.waikato.ac.nz/ml/weka/

[Website], Kaggle Competitions,
https://www.kaggle.com/competitions

| Discussion Note: | |
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