H9MLAI: Machine Learning

Module Code:	H9MLAI
Long Title	Machine Learning APPROVED
Title	Machine Learning
Module Level:	LEVEL 9
EQF Level:	7
EHEA Level:	Second Cycle
Credits:	10
Module Coordinator:	Rejwanul Haque
Module Author:	Shauni Hegarty
Departments:	School of Computing
Specifications of the qualifications and experience required of staff	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	Select, apply, and evaluate machine learning methodologies to facilitate pre-processing and transformation approaches.
LO2	Select, formulate, design, implement, and evaluate machine learning algorithms for solving real-world problems using the latest industry practices and standards.
LO3	Contextualise, investigate, evaluate, and communicate key concepts and advanced techniques for machine and deep learning algorithms.
LO4	Demonstrate expert knowledge of machine learning algorithms, tools, techniques utilised in real world contexts.

Dependencies
Module Recommendations
No recommendations listed
Co-requisite Modules
No Co-requisite modules listed

Entry requirements	Applicants are required to hold a minimum of a Level 8 honours qualification (2.2 or higher) or equivalent on the National Qualifications Framework in either STEM (e.g., Information Management Systems, Information Technologies, Computer Science, Computer Engineer) or Business (e.g., Business Information Systems, Business Administration, Economics) discipline and a minimum of three years of relevant work experience in industry, ideally but not necessarily, in management. Previous numerical and computer proficiencies should be part of their work experience or formal training. Graduates from disciplines which do not have technical or mathematical problem-solving skills embedded in their programme will need to be able to demonstrate technical or mathematical problem-solving skills in addition to their level 8 programme qualifications (Certifications, Additional Qualifications, Certified Experience and Assessment Tests). All applicants for the programme must provide evidence that they have prior Mathematics and Computing module experience (e.g., via academic transcripts or recognised certification) as demonstrated in one mathematics/statistics module and one computing module or statement of purpose must specify numerical and computing work experience. NCI also operates a prior experiential learning policy where graduates with lower, or no formal qualifications, currently working in a relevant field, may be considered for the programme. Applicants must also be able to have their own laptop with the minimum required specification that will be communicated to each applicant through both the admissions and marketing departments.

H9MLAI: Machine Learning

Module Content & Assessment

Indicative Content
Advanced Regression Models Regression revision; Best-practice for evaluating performance and analysing for bias and variance, regularisation and penalised models, Generalised Linear Modelling
Advanced Classification Models Logistic regression; Naïve-Bayes Classification and Linear discriminant analysis
Ensembles 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 I 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 Initialisation, L2 and dropout regularisation, gradient checking and batch and layer normalisation; convergence algorithms, learning rate scheduling, Hyperparameter tuning.
Convolutional neural network 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 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 Encoder-decoder Architecture, attention mechanisms, Position embedding, multi-head attention and self-attention layers, pre-trained language models (e.g., BERT)
Autoencoders and Deep Generative Models Auto-encoders (AEs), Undercomplete, Regularised, Sparse autoencoders; Denoising autoencoders; Variational Autoencoder, Generative adversarial networks (GANs), Min-max cost, Conditional GAN
Active learning (AL); Transfer learning (TL); Practical applications of AL and TL Sampling techniques for stream-based and pool-based active learning; transfer learning strategies, multi-task and zero-shot learning, pre-trained models;
Application of Deep Learning Models Selected topics from the following areas will be covered, especially on practical applications: computer vision, natural language processing
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Assessment Breakdown	%
Coursework	100.00%

Assessments

Full Time

Coursework

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

Assessment Type:	Project	**% of total:**	100
Assessment Date:	n/a	**Outcome addressed:**	1,2,3,4
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.

H9MLAI: Machine Learning

Module Workload

Module Target Workload Hours 0 Hours

Workload: Full Time

Workload Type	*Workload Description*	*Hours*	*Frequency*	*Average Weekly Learner Workload*
Lecture	Lectures	24	Per Semester	2.00
Independent Learning Time	Independent Learning	202	Per Semester	16.83
Practical	Practical/tutorials	24	Per Semester	2.00
			Total Weekly Contact Hours	4.00

Module Resources

Recommended Book Resources

Ian Goodfellow,Yoshua Bengio,Aaron Courville. (2016), Deep Learning, MIT Press, p.800, [ISBN: 978-0262035613].

Hastie, T., Tibshirani, R., & Friedman, J.. (2016), The Elements of Statistical Learning: Data Mining, Inference, and Prediction, 2nd. Springer, [ISBN: 978-0387848570].

Supplementary Book Resources

Kevin P. Murphy. (2012), Machine Learning, MIT Press, p.1104, [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.409, [ISBN: 978-1107057135].

John D. Kelleher,Brian Mac Namee,Aoife D'Arcy. (2020), Fundamentals of Machine Learning for Predictive Data Analytics, second edition, MIT Press, p.856, [ISBN: 978-0262044691].

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:	