University of the West of Scotland

Module Descriptor

Session: 2024/2025

Title of Module: Advanced Machine Learning			
Code: COMP10XXX	**SCQF Level: 10 (Scottish Credit and Qualifications Framework)**	**Credit Points: 20**	**ECTS: 10 (European Credit Transfer Scheme)**
School:	School of Computing, Engineering and Physical Sciences		
Module Co-ordinator:	TBC		

Summary of Module

This module builds on student's previous fundamental data science knowledge and will expand upon the topic of Machine Learning with a focus on specific algorithms as well as the tasks that they are being applied to.

At the end of this module students will obtain a deeper appreciation of modern ML methods and algorithms be aware of recent state-of-the-art methods in the form of neural networks as well as benefits, limitations and open challenges.

The syllabus will include:

- Data Visualisation
    - Principle Component Analysis
    - t-Distributed Stochastic Neighbour Embedding (t-SNE)
- Machine Learning Fundamentals
    - Learning algorithms
    - Learning paradigms: supervised, self-supervised, semi/weakly, and unsupervised
    - Over and Underfitting, Bias-variance tradeoff
    - Cross-Validation
    - Linear and Logistic Regression, Stochastic Gradient Descent
    - Techniques: generalization, transfer learning, active learning, ensembling
    - Algorithms: Decision Tree, Random Forest, Support Vector Machine (SVM), k-Nearest Neighbours (k-NN)
- Clustering algorithms
    - Partitioning (k-means), hierarchical (agglomerative), and density (DBScan)
- Neural Networks and Deep Learning
    - Basics: Layers, loss, optimization, backpropagation
    - Training of neural networks: activations, hyperparameters, training procedures, augmentation
    - Convolutional Neural Networks (CNNs): architecture and layers

- o Recurrent Neural Networks (RNNs): Deep RNN, Long Short-Term Memory (LSTM)
  - o Foundation models and Transformers
- Generative Models
  - o Generative Adversarial Networks (GANs), Autoencoders, Diffusion Models
- Ethical, Transparent, and Sustainable Machine Learning
  - o AI governance and frameworks
  - o Impact of large models
  - o Data and model cards

This will be supported by exercises and demonstrations that bridge theoretical knowledge with hands-on applications, enabling students to:

- Visualize high-dimensional data effectively.
- Implement and evaluate various learning algorithms on real-world datasets for classification, regression, and clustering tasks.
- Perform image analysis, including classification and segmentation, as well as image generation.
- Engage in natural language processing tasks such as sentiment analysis and text generation.
- Explore time series forecasting and modelling techniques for time series data.

This module will work to develop a number of the key 'I am UWS' Graduate Attributes to make those who complete this module:

- • Universal: research-minded; ethically-minded; and socially responsible
- • Work Ready: influential; knowledgeable; and ambitious
- • Successful: innovative; creative; and transformational

Module Delivery Method

Face-To-Face	Blended	Fully Online	HybridC	Hybrid 0	Work-Based Learning
☐	☒	☐	☐	☐	☐

If this module is delivered within the BSc (Hons) IT Software Development Programme the 'Blended' module delivery method applies.

See Guidance Note for details.

Campus(es) for Module Delivery

The module will **normally** be offered on the following campuses / or by Distance/Online Learning: (Provided viable student numbers permit) (tick as appropriate)

Paisley:	Ayr:	Dumfries:	Lanarkshire:	London:	Distance/Online Learning:	Other:
☐	☐	☐	☒	☐	☒	Add name

Term(s) for Module Delivery					
(Provided viable student numbers permit).					
Term 1	☐	Term 2	☒	Term 3	☐

Learning Outcomes: (maximum of 5 statements)
These should take cognisance of the SCQF level descriptors and be at the appropriate level for the module.
At the end of this module the student will be able to:

L1	Demonstrate an understanding of various machine learning tasks and their applications across different domains and differentiate between appropriate approaches for solving specific problems
L2	Develop solutions to given problems using machine learning algorithms, using suitable programming languages and tools
L3	Demonstrate a detailed understanding of a wide range of machine learning algorithms, including their underlying principles, methodologies, and practical applications in real-world scenarios
L4	Critically appraise the limitations, as well as the social, professional, legal, and ethical implications associated with modern machine learning approaches

Employability Skills and Personal Development Planning (PDP) Skills

SCQF Headings	During completion of this module, there will be an opportunity to achieve core skills in:
Knowledge and Understanding (K and U)	SCQF Level **10** A critical understanding of the principal theories, concepts and principles of modern machine learning approaches
Practice: Applied Knowledge and Understanding	SCQF Level **10** Using a few skills, techniques, practices and/or materials that are specialised, advanced and/or at the forefront of machine learning Executing a defined project of development of a machine learning solution and identifying and evaluating its outcomes
Generic Cognitive skills	SCQF Level **10** Critically identify, define, conceptualise and analyse complex/professional problems and issues to select a suitable machine learning approach

Communication, ICT and Numeracy Skills	SCQF Level **10** Present or convey, formally and informally, information about specialised topics to informed audiences Interpret, use and evaluate a wide range of numerical and graphical data to set and achieve goals/targets Use a range of ICT applications to support and enhance work at this level and adjust features to suit purpose
Autonomy, Accountability and Working with others	SCQF Level **10** Exercise autonomy and initiative in some activates at a professional level in selecting and developing a suitable machine learning solution Manage complex ethical and professional issues in accordance with current professional and/or ethical codes or practices.
Pre-requisites:	Before undertaking this module the student should have undertaken the following:
	Module Code: COMP09XXX	**Module Title:** Fundamentals of Data Science
	Other:	
Co-requisites	**Module Code:**	**Module Title:**

*Indicates that module descriptor is not published.

Learning and Teaching	
In line with current learning and teaching principles, a 20-credit module includes 200 learning hours, normally including a minimum of 36 contact hours and maximum of 48 contact hours.	
Learning Activities During completion of this module, the learning activities undertaken to achieve the module learning outcomes are stated below:	**Student Learning Hours** (Normally totalling 200 hours): (Note: Learning hours include both contact hours and hours spent on other learning activities)
Lecture/Core Content Delivery	20
Laboratory/Practical Demonstration/Workshop	24
Tutorial/Synchronous Support Activity	4

Independent Study	152
	200 Hours Total

**Indicative Resources: (eg. Core text, journals, internet access)

The following materials form essential underpinning for the module content and ultimately for the learning outcomes:

Duke, T. (2023) Building Responsible AI Algorithms A Framework for Transparency, Fairness, Safety, Privacy, and Robustness. Apress.

Goodfellow, I., Bengio, Y., & Courville, A. (2016). Deep learning. MIT press.

James, G. et al. (2023) An Introduction to Statistical Learning. Springer.

Raschka, S. et al. (2022) Machine Learning with PyTorch and Scikit-Learn: Develop Machine Learning and Deep Learning Models with Python. Packt Publishing.

Vanderplas, J.T. (2017) Python data science handbook : essential tools for working with data. Beijing Etc.: O'reilly, Cop.

(**N.B. Although reading lists should include current publications, students are advised (particularly for material marked with an asterisk*) to wait until the start of session for confirmation of the most up-to-date material)

Attendance and Engagement Requirements

In line with the Student Attendance and Engagement Procedure: Students are academically engaged if they are regularly attending and participating in timetabled on-campus and online teaching sessions, asynchronous online learning activities, course-related learning resources, and complete assessments and submit these on time.

For the purposes of this module, academic engagement equates to the following:

Attending all timetabled synchronous classes and engagement with asynchronous learning activities and resources.

Equality and Diversity

The University's Equality, Diversity and Human Rights Procedure can be accessed at the following link: UWS Equality, Diversity and Human Rights Code.

Aligned with the overall commitment to equality and diversity stated in the Programme Specifications, the module supports equality of opportunity for students from all backgrounds and with different learning needs. Using our VLE, learning materials will be presented electronically in formats that allow flexible access and manipulation of content (part-time and distant learning students should check with their programme leader for any queries). The module complies with University regulations and guidance on inclusive learning and teaching practice. Specialist assistive equipment,

support provision and adjustments to assessment practice will be made in accordance with UWS policy and regulations.

(N.B. Every effort will be made by the University to accommodate any equality and diversity issues brought to the attention of the School)

Supplemental Information

Divisional Programme Board	Computing
Assessment Results (Pass/Fail)	Yes ☐No ☒
School Assessment Board	Business & Applied Computing
Moderator	TBA
External Examiner	A Jindal
Accreditation Details	n/a
Changes/Version Number	1.0

Assessment: (also refer to Assessment Outcomes Grids below)
Assessment for this module consists of a portfolio of practical work and a presentation.
Assessment 1 – Portfolio of practical work showcasing solutions and rationale to given machine learning problems throughout the course of the module. (60%)
Assessment 2 – Presentation demonstrating the solution and justification of an approach taken to solve a real-world machine-learning problem including coverage of LSEP concerns with the presented solution. (40%)
(N.B. (i) **Assessment Outcomes Grids** for the module (one for each component) can be found below which clearly demonstrate how the learning outcomes of the module will be assessed. (ii) An **indicative schedule** listing approximate times within the academic calendar when assessment is likely to feature will be provided within the Student Module Handbook.)

Assessment Outcome Grids (See Guidance Note)

Component 1

Assessment Type (Footnote B.)	Learning Outcome (1)	Learning Outcome (2)	Learning Outcome (3)	Learning Outcome (4)	Learning Outcome (5)	Weighting (%) of Assessment Element	Timetabled Contact Hours
Portfolio of practical work	x	x	x			60	-

Component 2

Assessment Type (Footnote B.)	Learning Outcome (1)	Learning Outcome (2)	Learning Outcome (3)	Learning Outcome (4)	Learning Outcome (5)	Weighting (%) of Assessment Element	Timetabled Contact Hours
Presentation		x	x	x		40	1

	Combined Total for All Components	100%	1 hours

Change Control:

What	When	Who
Further guidance on aggregate regulation and application when completing template	16/01/2020	H McLean
Updated contact hours	14/09/21	H McLean
Updated Student Attendance and Engagement Procedure	19/10/2023	C Winter
Updated UWS Equality, Diversity and Human Rights Code	19/10/2023	C Winter
Guidance Note 23-24 provided	12/12/23	D Taylor
General housekeeping to text across sections. .	12/12/23	D Taylor

Version Number: MD Template 1 (2023-24)

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