Module Descriptor

Title	Advanced Machine Learning		
Session	2025/26	**Status**	Published
Code	COMP10088	**SCQF Level**	10
Credit Points	20	**ECTS (European Credit Transfer Scheme)**	10
School	**Computing, Engineering and Physical Sciences**		
Module Co-ordinator	Graeme McRobbie		

Summary of Module

his 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
  - 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	**On-Campus**[1] ☐	**Hybrid**[2] ☒	**Online**[3] ☐	**Work -Based Learning**[4] ☐
Campuses for Module Delivery	☐ Ayr ☐ Dumfries	☒ Lanarkshire ☐ London ☐ Paisley	☒ Online / Distance Learning ☐ Other (specify) Online Delivery / Distance Learning applies to delivery in the BSc (Hons) Data, AI and Software	

[1] Where contact hours are synchronous/ live and take place fully on campus. Campus-based learning is focused on providing an interactive learning experience supported by a range of digitally-enabled asynchronous learning opportunities including learning materials, resources, and opportunities provided via the virtual learning environment. On-campus contact hours will be clearly articulated to students.

[2] The module includes a combination of synchronous/ live on-campus and online learning events. These will be supported by a range of digitally-enabled asynchronous learning opportunities including learning materials, resources, and opportunities provided via the virtual learning environment. On-campus and online contact hours will be clearly articulated to students.

[3] Where all learning is solely delivered by web-based or internet-based technologies and the participants can engage in all learning activities through these means. All required contact hours will be clearly articulated to students.

[4] Learning activities where the main location for the learning experience is in the workplace. All required contact hours, whether online or on campus, will be clearly articulated to students

					Engineering programme only	
Terms for Module Delivery	Term 1	☐	Term 2	☒	Term 3	☐
Long-thin Delivery over more than one Term	Term 1 – Term 2	☐	Term 2 – Term 3	☐	Term 3 – Term 1	☐

Learning Outcomes	
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
L5	N/A

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 10** SCQF Level 10 A critical understanding of the principal theories, concepts and principles of modern machine learning approaches
Practice: Applied Knowledge and Understanding	**SCQF 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 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 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 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.

Prerequisites	**Module Code** COMP09118	**Module Title** Fundamentals of Data Science
	Other	
Co-requisites	**Module Code**	**Module Title**

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** (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
Please select	
Please select	
TOTAL	200

Indicative Resources

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:** The School of Computing, Engineering and Physical Sciences considers attendance and engagement to mean a commitment to attending, and engaging in, timetabled sessions. You will scan your attendance via the scanners each time you are on-campus and you will login to the VLE several times per week. Where you are unable to attend a timetabled learning session due to illness or other circumstance, you should notify the Programme Leader that you cannot attend. Across the School an 80% attendance threshold is set. If you fall below this, you will be referred to the Student Success Team to see how we can best support your studies.

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 University's commitment to equality and diversity, this module supports equality of opportunity for students from all backgrounds and learning needs. Using the VLE, material will be presented electronically in formats that allow flexible access and manipulation of content. This module complies with University regulations and guidance on inclusive learning and teaching practice. This module has lab-based teaching and as such you are advised to speak to the Module Co-ordinator to ensure that specialist assistive equipment, support provision and adjustment to assessment practice can be put in place, in accordance with the University's policies 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**
Overall Assessment Results	☐ **Pass / Fail** ☒ **Graded**
Module Eligible for Compensation	☐ **Yes** ☒ **No** **If this module is eligible for compensation, there may be cases where compensation is not permitted due to programme accreditation requirements. Please check the associated programme specification for details.**
School Assessment Board	Business & Applied Computing
Moderator	Tahir Mahmood
External Examiner	A Jindal
Accreditation Details	
Module Appears in CPD catalogue	☐ **Yes** ☒ **No**

Changes / Version Number	1.01

Assessment (also refer to Assessment Outcomes Grids below)
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%)
Assessment 3
(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.)

Component 1							
Assessment Type	**LO1**	**LO2**	**LO3**	**LO4**	**LO5**	**Weighting of Assessment Element (%)**	**Timetabled Contact Hours**
Portfolio of practical work	☒	☒	☒	☐	☐	60	

Component 2							
Assessment Type	**LO1**	**LO2**	**LO3**	**LO4**	**LO5**	**Weighting of Assessment Element (%)**	**Timetabled Contact Hours**
Presentation	☐	☒	☒	☒	☐	40	1

Component 3							
Assessment Type	**LO1**	**LO2**	**LO3**	**LO4**	**LO5**	**Weighting of Assessment Element (%)**	**Timetabled Contact Hours**
	☐	☐	☐	☐	☐		
Combined total for all components						100%	1 hours

Change Control

What	**When**	**Who**
Attendance and Engagement Procedure and Equality and Diversity	17/1/25	F.Valentine
