6.7 Advanced Data Analysis

6.6.1 Headline information about the module

Module title	Advanced Data Analysis
Module NFQ level (only if an NFQ level can be demonstrated)	9
Module number/reference	M7
Parent programme(s) the plural arises if there are embedded programmes to be validated.	Master of Science in Data Analytics
Stage of parent programme	AWARD
Semester (semester1/semester2 if applicable)	2
Module credit units (FET/HET/ECTS)	ECTS
Module credit number of units	10
List the teaching and learning modes	Full time & Part time blended learning
Entry requirements (statement of knowledge, skill and competence)	See Section 4
Pre-requisite module titles	none
Co-requisite module titles	none
Is this a capstone module? (Yes or No)	No
Specification of the qualifications (academic, pedagogical and professional/occupational) and experience required of staff (staff includes workplace personnel who are responsible for learners such as apprentices, trainees and learners in clinical placements)	Academic and Professional: PhD desirable and a minimum of an MSc is required. However, in exceptional cases, NFQ Level 8 in Data Analytics, Computer Science, Software Development, Software Engineering or equivalent may be acceptable when combined with significant industrial experience. Pedagogical: Teaching experience is desired. Completion of postgraduate CPD/Certificate in Teaching and Learning or similar preferred. Experience in blended learning delivery required. In absence of experience, training will be mandatory and will be provided.
Maximum number of learners per centre (or instance of the module)	120
Duration of the module	1 semester
Average (over the duration of the module) of the contact hours per week (see * below)	5 Hours
Module-specific physical resources and support required per centre (or instance of the module)	Physical resource requirements are 1 laptop or PC/workstation per student. On campus and online resources as per programme specification.
Analysis of required learning effort	
*Effort while in contact with staff	

On campus Lecture / Classroom demonstrations		Mentoring and small-group tutoring		Other (Reflective development, directed reading/group work)		Online classes & Directed e-learning (hours)	Independent learning (hours)	Other hours (specify)	Work-based learning hours of learning effort	Total effort (hours)
Hours	Minimum ratio teacher/learner	Hours	Minimum ratio teacher/learner	Hours	Minimum ratio teacher/learner					
10	1:60	10	1:30	10	1:60	30	190	N/A	N/A	250
Allocation of marks (within the module)										
				Continuous assessment		Supervised project	Proctored practical examination	Proctored written examination	Total	
Percentage contribution				100%					100%	

6.7.2 Module aims and objectives

The aims of this module:

1. The theory of cognitive systems.
2. The application and integration of cognitive systems in everyday life.
3. The state of the art in cognitive systems
4. The practical skills required to deploy appropriate cognitive systems to a specific problem.

6.7.3 Minimum intended module learning outcomes

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

1. Debate the theory and application of different types of neural networks. (linked to PLO 1, PLO 2)
2. Evaluate current application of reinforced learning models and their perceived benefit to project stakeholders in relation to legacy systems (e.g., traffic management, resource management, robotics / mechatronics….) (linked to PLO 2, PLO 3)
3. Analyse a set of requirements to determine the type of Neural Network for a particular problem set. Document and justify choices made to stakeholders and peers through insight gained from the process. (linked to PLO 4, PLO 5)
4. Develop a neural network, reliant on temporal data (e.g., social media feed, sensor data) to solve a given problem set. (linked to PLO 1, PLO 2)
5. Critically assess the existing state of the art in Natural Language Processing and propose a strategy toward optimisation. (linked to PLO 1, PLO 2, PLO 4)

6.7.4 Rationale for inclusion of the module in the programme and its contribution to the overall MIPLOs

This module deals with a cornerstone of Data Analytics by building upon the statistical modelling knowledge already gained in adjoining modules. The ability of students to develop a learning system for use as a Data Analysis solution to real world problems ties directly to and builds on the Machine learning module as well as the Statistics for Data Analysis module. As an emerging technology, A.I. is increasingly vital in both academic and commercial decision-making processes and is one of the vital skills a modern Data Analyst requires to deal with the increasing use of temporal data in order to remain market relevant.

Learners are introduced to the new concepts underpinning artificial intelligence.

6.7.5 Information provided to learners about the module

A copy of the Module Descriptor will be provided to learners at the start of the module via the College LMS (Moodle)

6.7.6 Module content, organisation and structure

The following indicative syllabus contains a learner reflective component as outlined in the teaching and learning strategy for this programme.

Syllabus rationale: Cognitive systems integrating Machine learning

Temporal Data (integrated concept: Big Data Storage and Processing / Machine learning

- Acquisition (practical)
- Control (practical)
- Spatial (conceptual / practical)
- Temporal (conceptual / practical)
- Spatiotemporal databases (tracking moving objects) (practical)

Neural Networks (Deep Learning) (integrated concept: Statistics for Data Analysis / Machine learning / Data Preparation and Visualisation)

- Neural Network Theory (conceptual)
- Perceptron (practical)
- Feed forward (practical)
- Radial Basis (practical)
- Deep feed forward (practical)
- Convolutional networks (practical)
- Recurrent networks (practical)
- LSTM networks (long term / short term memory) (practical)
- Sequence-to-Sequence (Auto-Encoders) (practical)

Reinforcement Learning (integrated concept: Statistics for Data Analysis / Machine learning / Data Preparation and Visualisation)

- Definition and applications (conceptual)
- Passive reinforcement learning (conceptual)
- Active reinforcement learning (conceptual)
- GANS (general Adversarial networks) (practical)

Natural Language Processing (integrated concept: Machine learning / Data Preparation and Visualisation)

- **Semantic classification (practical)**
  - Topic classification
  - Intent classification
  - sentiment analysis
- **Semantic extraction (practical)**
  - Keyword extraction
  - Entity extraction
- **Automatic Ticket Classification (practical)**

The above topics (where applicable) will be performed within a testing environment (programming I.D.E / spreadsheet to allow practical integration of theoretical knowledge)

Programming skills are continuously developed throughout this module through practical implementation of module content. Conceptual / theoretical topics will also be practically demonstrated through the use of appropriate tool sets, to emphasise the synergy between theory and programmatic demonstration.

6.7.7 Module teaching and learning (including formative assessment) strategy

To provide the learner with a strong foundation in the core topics covered during the lectures, practical sessions will reinforce lecture content and provide supervised time to complete some assessment tasks. Sessions will be interactive, with instructor-led example exercises highlighting important topics discussed in lectures.

To provide formative assessment for this module the learner will:

- Be provided an opportunity at the beginning of each week to engage in group discussion on the material covered the previous week, thereby allowing reflection and ensuring their competency.
- Complete student-suggested tasks in a peer learning environment to encourage collaboration and allow learners to self-evaluate their current knowledge while gaining new knowledge and insights (this strategy links directly to PLO 7, PLO 8)
- Join additional discussions covering any lab-based exercises which have been provided to the learner.

Course specific online and on campus learning activities according to learning type.

Learning Type	Online activities	On campus activities
Knowledge Acquisition	• Pre-recorded presentations / demonstrations • Multi-media text-based materials • Videos • Guest speakers • Open ed resources	• Face to face lecturers • Practical Demonstrations
Collaboration	• Group projects • Discussion forums • Virtual classroom peer learning • Team virtual lab activities • Group presentations • Mentoring	• Group projects • Team based lab activities / practical workshops • Group presentations
Discussion	• Discussion forums (synchronous and asynchronous) • Zoom breakout room discussions • Online tutorials • Project supervision	• Class discussion • Tutorials • Project supervision • Face to face lab / practical activities

	• Webinars (industry experts) • Reflective activities	
Investigation	• Open ed resources • Lab observations • Project research • Information and data sourcing, analysis and evaluation • Flipped Learning	• data sourcing and analysis
Practice	• Virtual lab • Simulations • Case studies • Analysis of data sets • Presentations • Online quizzes / MCQs	• Labs • Practical workshops • Group work
Production	• E-portfolio • Reflective journal • Assessment outputs • Quiz / MCQs • Case studies • GitHub records	• Exam • Case studies • Student demonstration

6.7.8 Work-based learning and practice-placement

Not Applicable

6.7.9 E-learning

Collaborative blended learning strategies will be utilised for this module to ensure peer learning can be experienced not only through face-to-face traditional learning but also through online approaches. The online element will be achieved through a variety of interactive methods, including discussion forums, collaborative blogs and wikis, virtual labs and classrooms, group online supervision, interactive demonstrations and e-portfolios. This integrated learning approach ensures learning can be both reflective and collaborative while developing the efficacy of the individual student as the module progresses.

6.7.10 Module physical resource requirements

Physical resource requirements are 1 laptop or PC/workstation per student. On campus and online resources as per programme specification.

6.7.11 Reading lists and other information resources

Recommended:

Ian Goodfellow, Yoshua Bengio, Aaron Courville, 2016, Deep Learning, MIT Press [ISBN: 978-0262035613]

Josh Patterson, Adam Gibson, 2017, Deep Learning: A Practitioner's Approach, O'Reilly Media, [ISBN: 978-1491914250]

Dipanjan Sarkar, 2016, 1st Edition, Text Analytics with Python: A Practical Real-World Approach to Gaining Actionable Insights from your Data, Apress, [ISBN: 978-1484223871]

6.7.12 Module summative assessment strategy

Module specific online and on campus assessment activities according to assessment type.

Assessment	Online Assessment	On Campus Assessment
Knowledge Acquisition	• Pre-recorded presentations / demonstrations	• Live presentations / demonstrations
Collaboration	• Group projects • Team virtual lab activities • Group pre-recorded presentations / demonstrations	• Team lab activities • Group presentations / demonstrations
Formative	• Discussion forums (asynchronous) • Project (individual & group) supervision • Reflective activities	• Project (individual & group) supervision
Investigation	• Theoretical and practical project research • Problem Based Learning	• Problem Based Learning
Practical	• Virtual lab • Analysis of data sets • Online quizzes / MCQs • Technical tasks (individual and group)	• Lab • Analysis of data sets • Technical tasks (individual and group)
Production	• Artefacts • Student code repository records	• Artefacts • Student code repository records

For indicative assessment schedule see appendix 8

Mapping of summative and formative assessment: MIMLO to MIPLO

A ✓ indicates that the PLO has been formatively assessed as per the teaching and learning strategy for the programme	Module Learning Outcomes					Programme Learning Outcomes							
	1	2	3	4	5	1	2	3	4	5	6	7	8
Summative Assessment	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓

6.7.13 Sample assessment materials

See appendix 9