Book of Modules for Programme

MSCDA - MSc in Data Analytics

College: School of Computing

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APPROVED

Award Class	Master Degree

Awards	
Title	*Body*
Master of Science	QQI

Programme Code	MSCDA	**Programme Duration**	1
Programme Level	9	**EQF Level**	7
Programme Credits	90		

Semester Duration	12 Week(s)
Language of Instruction	English
Valid From	2024 (July 2024)
Departments	School of Computing

Professional Body

Professional Body	*Recognition Status*	*Effective From*	*Interim Date*	*Professional Bodies*	*Contact Person*	*Evidence*
QQI	Active	01 April 2018				

Is Semesterised?	Yes
Enrol international learners?	Yes
Accept Erasmus exchange students?	No
Articulation Arrangements involving advanced entry	n/a
Names of Centres where programmes are to be provided	National College of Ireland, IFSC Campus
Target Learner Groups	The MSc in Data Analytics is aimed at graduates of numerate disciplines e.g., Computing, Engineering, Economics, Business, Accounting, etc.).
Programme Extra Information	Approved

Requisite Type	***Entity Title***	***Entity Type***
No requisites exist.		

Programme MSCDA - MSc in Data Analytics

Blocks

Stage 1

Block Code MSCDA1
Student Quota 0
Block Award Master of Science
Is Exit Award No

Programme Outcomes

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

Description
Conduct substantial and extensive independent research and analysis in the field of Data Analytics.
Formulate and implement a novel research idea using the latest industry practices.
Demonstrate expert knowledge and a critical understanding of data analysis, statistics, and the tools, techniques and technologies of Data Analytics utilised in both technical and business contexts.
Critically assess, evaluate and communicate business & technical strategies for Data Analytics.
Formulate, design, assess, and implement effective business & technical solutions for Data Analytics.
Critically assess and evaluate security, privacy, sustainability, and ethical issues associated with the storage, transfer, and processing of data for analytical purposes.

Delivery Type Range

			Credits			Modules	
C/O	*Title*	*Description*	*Min*	*Max*	*AND/OR*	*Min*	*Max*

Associated Modules

Stage	*Semester*	*C/O*	*Elective Streams*	*Code*	*Title*	*Version*	*Credits*
1	Semester 1	Core Subject		9APDV	Analytics Programming & Data Visualization	1.0	5
1	Semester 1	Core Subject		9HDGS	Data Governance, Ethics, and Sustainability	1.0	5
1	Semester 1	Core Subject		9DMML	Data Mining & Machine Learning	1.0	10
1	Semester 1	Core Subject		H9SAO	Statistics & Optimisation	1.0	10
1	Semester 2	Core Subject		H9BIBA	Business Intelligence and Business Analytics	2.0	10
1	Semester 2	Core Subject		H9DLGA	Deep Learning & Generative AI	1.0	10
1	Semester 2	Core Subject		9INTERN	Internship	1.0	30
1	Semester 2	Group Elective 1		9DISS1	Data Intensive Scalable Systems	1.0	5
1	Semester 2	Group Elective 2		9MODSIM1	Modelling & Simulation	1.0	5
1	Semester 2	Group Elective 3		9DAPP1	Domain Applications	1.0	5
1	Semester 2	Group Elective 4		9RPM	Research Practicum	1.0	30
1	Semester 3	Core Subject		9INTERN	Internship	1.0	30
1	Semester 3	Group Elective 1		9DISS2	Data Intensive Scalable Systems	1.0	5
1	Semester 3	Group Elective 2		9MODSIM2	Modelling & Simulation	1.0	5
1	Semester 3	Group Elective 3		9DAPP2	Domain Applications	1.0	5
1	Semester 3	Group Elective 4		9RPM	Research Practicum	1.0	30

LO Mapping

Stage	*Semester*	*Code*	*Title*	*Version*	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6
1	Semester 1	9APDV	Analytics Programming & Data Visualization	1.0						
1	Semester 1	9DMML	Data Mining & Machine Learning	1.0						
1	Semester 1	9HDGS	Data Governance, Ethics, and Sustainability	1.0						
1	Semester 1	H9SAO	Statistics & Optimisation	1.0						
1	Semester 2	9DAPP1	Domain Applications	1.0						
1	Semester 2	9DISS1	Data Intensive Scalable Systems	1.0						
1	Semester 2	9INTERN	Internship	1.0						
1	Semester 2	9MODSIM1	Modelling & Simulation	1.0						
1	Semester 2	9RPM	Research Practicum	1.0						
1	Semester 2	H9BIBA	Business Intelligence and Business Analytics	2.0						
1	Semester 2	H9DLGA	Deep Learning & Generative AI	1.0						
1	Semester 3	9DAPP2	Domain Applications	1.0						
1	Semester 3	9DISS2	Data Intensive Scalable Systems	1.0						
1	Semester 3	9INTERN	Internship	1.0						
1	Semester 3	9MODSIM2	Modelling & Simulation	1.0						
1	Semester 3	9RPM	Research Practicum	1.0						

Detailed LO Mapping

Medical Graduate Profile

	Intellectually Curious	Environmentally Aware	Socially Conscious	Resilient	Enterprise Focussed	Ethically Oriented	Theoretical knowledge	Technical knowledge	Cognitive skills	Technical skills	Problem solving skills	Communication skills	Research skills	Application of knowledge and skills
1. Conduct substantial and extensive independent research and analysis in the field of Data Analytics.														
2. Formulate and implement a novel research idea using the latest industry practices.														
3. Demonstrate expert knowledge and a critical understanding of data analysis, statistics, and the tools, techniques and technologies of Data Analytics utilised in both technical and business contexts.														
4. Critically assess, evaluate and communicate business & technical strategies for Data Analytics.														
5. Formulate, design, assess, and implement effective business & technical solutions for Data Analytics.														
6. Critically assess and evaluate security, privacy, sustainability, and ethical issues associated with the storage, transfer, and processing of data for analytical purposes.														

MGP Dimensions

Medical Graduate Profile	Programme Description
Intellectually Curious	Intellectually Curious
Environmentally Aware	Environmentally Aware
Socially Conscious	Socially Conscious
Resilient	Resilient
Enterprise Focussed	Enterprise Focussed
Ethically Oriented	Ethically Oriented
Theoretical knowledge	Theoretical knowledge
Technical knowledge	Technical knowledge
Cognitive skills	Cognitive skills
Technical skills	Technical skills
Problem solving skills	Problem solving skills
Communication skills	Communication skills
Research skills	Research skills
Application of knowledge and skills	Application of knowledge and skills

Programmatic Review

1.2 Outline of the Programme

Brief synopsis of the programme

This programme is a MSc degree aimed at graduates of NFQ level 8/equivalent degree programmes, in numerate disciplines. It will run both on a part-time and a full-time basis 1 year (12 months) for full time delivery and 2 years (24 months) for part time delivery. The programme leads to a NFQ level 9 award of MSc in Data Analytics awarded by QQI. Graduates of the programme take up roles as data scientists and data analysts across a wide range of private companies, public sector organisations and research organisations.

Outline of staffing requirements

Lecturers will have a Masters or PhD in Computer Science or a related discipline

Outline the physical resource requirements

The MSc in Data Analytics programmes will be offered at the College's IFSC campus (Mayor Street and Spencer Dock buildings). The Mayor Street campus building is a purpose-built facility opened in 2002. The Spencer Dock building (acquired in 2023) houses the college library and additional teaching spaces.

Resource
Appropriate learning spaces to facilitate the teaching, learning & assessment strategy of the programme.
Modules on this programme will require access to classrooms and labs with projector, lectern PC, lectern laptop connectivity, and microphones.
Learners must have access to appropriate personal study space. NCI will facilitate study spaces within the library and other study rooms for either individual or group study.
Access to public cloud resources.
Learners must comply with the BYOD requirements of the programme.
Proctored online exam software, RPNow.
Live classroom/lab host technology.
Learning Management System.
Library Access (physical and online) to books / journals etc.

Maximum number of intake groups/cohorts per annum

null

Educational and training objectives and minimum intended programme and module learning outcomes

Programme aims and objectives

The programme aims to produce high-quality, technically competent, innovative graduates that will become leading practitioners in the field of Data Analytics.

Rationale for the choice of QQI named award stem sought and for the named award title

The rationale for the choice of the QQI named award is based on the school strategy to create undergraduate and postgraduate programmes in Data Science and Data Analytics to meet industry needs.

QQI awards standards used

The QQI Science Award Standards for NFQ Level 9 have been used. These standards were used as Data Analytics is an inherently inter-disciplinary scientific field incorporating techniques from Computer Science, Mathematics and Statistics.

Comparing the MIPLOS with those of comparable programmes

A comparison with other programmes currently offered by other institutions from Ireland include:

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<li aria-setsize="-1" data-aria-level="1" data-aria-posinset="2" data-font="Symbol" data-leveltext="" data-list-defn-props="{"335552541":1,"335559685":720,"335559991":360,"469769226":"Symbol","469769242":[8226],"469777803":"left","469777804":"","469777815":"hybridMultilevel"}" data-listid="49" role="listitem"> University College Dublin (UCD), MSc Data & Computational Science

<li aria-setsize="-1" data-aria-level="1" data-aria-posinset="3" data-font="Symbol" data-leveltext="" data-list-defn-props="{"335552541":1,"335559685":720,"335559991":360,"469769226":"Symbol","469769242":[8226],"469777803":"left","469777804":"","469777815":"hybridMultilevel"}" data-listid="49" role="listitem"> Maynooth University, MSc Data Science and Analytics

<li aria-setsize="-1" data-aria-level="1" data-aria-posinset="4" data-font="Symbol" data-leveltext="" data-list-defn-props="{"335552541":1,"335559685":720,"335559991":360,"469769226":"Symbol","469769242":[8226],"469777803":"left","469777804":"","469777815":"hybridMultilevel"}" data-listid="49" role="listitem"> University College Cork (UCC), MSc Data Science and Analytics

<li aria-setsize="-1" data-aria-level="1" data-aria-posinset="5" data-font="Symbol" data-leveltext="" data-list-defn-props="{"335552541":1,"335559685":720,"335559991":360,"469769226":"Symbol","469769242":[8226],"469777803":"left","469777804":"","469777815":"hybridMultilevel"}" data-listid="49" role="listitem"> National University of Ireland, Galway (NUIG) , MSc in Computer Science (Data Analytics)

<li aria-setsize="-1" data-aria-level="1" data-aria-posinset="6" data-font="Symbol" data-leveltext="" data-list-defn-props="{"335552541":1,"335559685":720,"335559991":360,"469769226":"Symbol","469769242":[8226],"469777803":"left","469777804":"","469777815":"hybridMultilevel"}" data-listid="49" role="listitem"> Trinity College Dublin (TCD). MSc in Computer Science (Data Science)

<li aria-setsize="-1" data-aria-level="1" data-aria-posinset="7" data-font="Symbol" data-leveltext="" data-list-defn-props="{"335552541":1,"335559685":720,"335559991":360,"469769226":"Symbol","469769242":[8226],"469777803":"left","469777804":"","469777815":"hybridMultilevel"}" data-listid="49" role="listitem"> Dublin City University (DCU), MSc in Computing (Data Analytics)

<li aria-setsize="-1" data-aria-level="1" data-aria-posinset="8" data-font="Symbol" data-leveltext="" data-list-defn-props="{"335552541":1,"335559685":720,"335559991":360,"469769226":"Symbol","469769242":[8226],"469777803":"left","469777804":"","469777815":"hybridMultilevel"}" data-listid="49" role="listitem"> Dublin Institute of Technology (TUD): MSc in Computer Science (Data Science)

<li aria-setsize="-1" data-aria-level="1" data-aria-posinset="9" data-font="Symbol" data-leveltext="" data-list-defn-props="{"335552541":1,"335559685":720,"335559991":360,"469769226":"Symbol","469769242":[8226],"469777803":"left","469777804":"","469777815":"hybridMultilevel"}" data-listid="49" role="listitem"> Griffith College, MSc in Big Data Management and Analytics

<li aria-setsize="-1" data-aria-level="1" data-aria-posinset="10" data-font="Symbol" data-leveltext="" data-list-defn-props="{"335552541":1,"335559685":720,"335559991":360,"469769226":"Symbol","469769242":[8226],"469777803":"left","469777804":"","469777815":"hybridMultilevel"}" data-listid="49" role="listitem"> Dublin Business School (DBS), MSc in Data Analytics

<li aria-setsize="-1" data-aria-level="1" data-aria-posinset="11" data-font="Symbol" data-leveltext="" data-list-defn-props="{"335552541":1,"335559685":720,"335559991":360,"469769226":"Symbol","469769242":[8226],"469777803":"left","469777804":"","469777815":"hybridMultilevel"}" data-listid="49" role="listitem"> University of Warwick, MSc Data Analytics

UCD provides two MSc programmes in the Data Analytics domain. Firstly, their MSc Data Analytics is a Level 9 NFQ, online 3 year part time online programme where the learning outcomes of the programme focus on data collection methods, statistical method development, knowledge and application of machine learning techniques, computer programming and scientific visualization. The program is run by the UCD School of Mathematics and Statistics. In year 1, students are introduced to statistical and mathematical concepts in data analytics and data mining, and statistical programming with data. In year 2 students study predictive analytics and dealing with data sets at scale using multivariate techniques. The final year covers advanced statistical modelling methods such as Stochastic models and Bayesian analysis. A Professional Diploma in Data Analytics can also be gained in 9 months by obtaining 20 out of the 90 credits required for the MSc. This programme is intended for applicants with a degree in a numerate subject. An upper second-class honours or international equivalent is required. Those without this requirement, but with equivalent experience in industry, will also be considered on a case-by-case basis.

Secondly, their MSc Data & Computational Science also run by the UCD School of Mathematics and Statistics is designed for students from highly quantitative disciplines who wish to work in data analytics or computational science. This is a 1-year full time Level 9 NFQ course where the focus in an understanding of the interface of applied mathematics, statistics and computational science. The course includes core modules such as Optimisation in Machine Learning, Applied Matrix Theory, and Data Programming, as well as core modules in statistics and data analytics (Probability and Statistics, Predictive Analytics, Multivariate Analysis, Bayesian Analysis, Statistical Machine Learning). This programme is intended for applicants who have an Upper Second-class honours degree or higher, or the international equivalent, in a highly quantitative subject such as Mathematics, Physics, Statistics, Engineering.

The MSc in Data Science and Analytics at Maynooth University is a 12-month NFQ level 9 conversion course designed to give students the knowledge and skills to collect, process analyse and visualise data in order to extract useful information, explore patterns and evaluate models. Modules cover programming, statistics and databases, and advanced topics in modern statistical machine learning. The course includes material on the social and ethical consequences of the use of data and the implications for business and government. The course is a collaboration between the Departments of Mathematics & Statistics, Computer Science and the National Centre for Geocomputation. Applicants must have a recognised primary degree which is considered equivalent to Irish university primary degree level. The degree should be at level 8 in any subject with some mathematical content.

The MSc in Data Science & Analytics at UCC is jointly offered by the Department of Computer Science and the Department of Statistics and is provided on a 1 year full time basis . Content is focused on computing and statistics and students develop skills in database management, programming, summarisation, modelling and interpretation of data. The course provides pathways for students who have and have not previous programming and databases experience. Candidates must have obtained either a honours level 8 primary degree (minimum 2H1 honours or equivalent) in computer science or mathematical sciences or an honours level 8 primary degree (minimum 2H1 honours or equivalent) with a strong numerate content (e.g. engineering, finance, physics, biosciences or economics). Applicants who do not meet the above standard entry requirements will also be considered if they have an undergraduate degree (at Level 8) and a minimum of 5 years verifiable relevant industrial experience. Applicants who do not have a primary degree will only be considered with a minimum of 10 years verifiable relevant industrial experience.

NUIG offers an MSc in Computer Science (Data Analytics) run by the School of Engineering & Informatics. The course can be undertaken on a 1 year full time or 2 year part time basis. A 1-year part-time Diploma is also offered. The content includes topics such as large-scale data analytics, advanced data-mining and machine learning, applied regression modelling, information retrieval techniques, natural language processing, data visualisation, Web mining, linked-data analytics, simulation and modelling, digital image processing. The course attracts 30 students per year. This MSc is targeted at high- performing graduates of level 8 computer science programmes or level 8 science or engineering programmes that offer sufficient training in computing. The minimum requirement for entry to the full-time and part- time programme is normally a 2.1 degree. Additionally, part-time applicants should have 3+ years of relevant industry experience. On an exceptional basis, candidates who do not meet the requirements stated above but are deemed by the programme director to have reached an equivalent standard may also be considered.

TCD's MSc in Computer Science (Data Science) is offered on a 1 year full time basis. In the first semester, students study research methods, innovation, data analytics and machine learning. In addition, students study specialist modules in their chosen strand which for Data Science includes optimisation algorithms for data analysis, applied

statistical modelling and data visualisation. For entry to the course, candidates are required to have an A II.1 (60-69%) grade or higher from a reputable university in Computing or strongly related discipline. Candidates also need to be able to be fully competent in programming in C, C++ or Java.

DCU offers an MSc in Computing (with Data Analytics as a Major option) on a 1 year full time or 2 year part time basis. Core content includes software engineering, operating systems and networks and specialist data science modules in data analytics and data mining, machine learning and statistical data analysis. The entry requirements for this programme are a 2.1 or higher in computer science or a closely related discipline. Students with a 2.2 may, in exceptional circumstances be considered but may have to attend DCU for an interview or may be asked to carry out a short exercise to ascertain their suitability for this programme (to demonstrate their mathematical and programming ability).

The MSc in Computer Science (Data Science) at TUD is a specialist is offered on either a 1 year or 1.5 year basis. The core content includes modules in probability and statistical inference, machine learning, working with data, data management, data mining and visualisation. There are also a number of option modules such as Geographic Information Systems, Programming for Big Data, Deep Learning etc.

Griffith College offers a QQI validated M.Sc. in Big Data Management and Analytics on a 1 year full time basis. The core modules are big data analytics, information retrieval and web search, concurrent and parallel programming, cloud computing, big data management, data mining algorithms and techniques, applied data science and research methods. Candidates applying for the course should have a 2.2 Level 8 honours degree in Computing Science, or a 2.2 Higher Diploma in Computing or related discipline or international equivalent and/or relevant work experience.

DBS offers a QQI validated MSc in Data Analytics at NFQ Level 9 on a 1 year full time or 2 year part time basis. Core modules include programming for data Analysis, processing and visualisation, statistics for data analytics, data storage solutions for data analytics, data mining, machine learning, applied research process for data analytics and data visualisation. Eligible applicants must hold a related science/technology/computing/business/finance degree (level 8, 2.2 or higher) granted by an institution recognised in the country where it operates. [Note: the DBS MSc degree is currently under programme review.]

The University of Warwick (Computer Science dept.) offers a 1 year full-time MSc Data Analytics taught Master's degree programme. This degree targets graduates from computer science, mathematics, and the physical sciences. The programme covers topics related to computer science, business, engineering, and mathematics. Entry requirements are a First Class Honours degree or a high 2.1 undergraduate degree in Computer Science, Statistics, Mathematics, Physics, or other quantitative disciplines. Core modules include a Dissertation Project, Research Methods, Foundations of Data Analytics, Foundations of Computing, and Data Mining. A number of optional modules are also available (e.g., High Performance Computing, Agent Based Systems, Social Informatics, Natural Language Processing).

Other matters

Programme Schedule: MSc Part Time on-campus schedule

Name of Provider:	National College of Ireland					
Programme Title *(Principal)*	MSc Data Analytics	**QQI Award Title**	Master of Science in Data Analytics		**ECTS**	90
Stage (1,2,3, Award etc)	1	**Exit Award Title** *(if relevant)*	Postgraduate Diploma in Science in Data Analytics		**Stage ECTS**	90

Programme Delivery Mode - *one as appropriate.*	**Face to Face**	**Blended**	**Hybrid**	**Online**	**Workplace Learning**
			N/A		

Teaching and Learning Modalities – *one or more as appropriate.*	**In-person face-to-face**	**Synchronous**	**Asynchronous**	**Work Based**

Assessment Techniques Utilised in Stage – *one or more as appropriate.*	**Continuous Assessment**	**Proctored Exam – in person**	**Proctored Exam – online**	**Project**	**Practical Skills Demonstration**	**Work based**

Modules in this stage (add rows as required)

				Total Student Effort Module (hours)						**Assessment – Allocation of Marks** *(from the module assessment strategy)*					
Module Title	**Semester**	**Mandatory (M) or Elective (E)**	**Credits (ECTS)**	**Total Hours**	**In person**	**Synchronous**	**Asynchronous**	**Independent Learning**	**Work Based**	**Continuous Assessment %**	**Proctored Exam – in person %**	**Proctored Exam – online %**	**Project %**	**Practical Skills Demonstration %**	**Work Based %**
Statistics and Optimisation	1	M	10	250	48			202		35	65				
Analytics Programming and Data Visualization	1	M	5	125	48			77		30			70		

Data Governance, Ethics and Sustainability	1	M	5	125	36			89		40	60				
Business Intelligence and Business Analytics	2	M	10	250	48			202		20			80		
Data Mining and Machine Learning	2	M	10	250	48			202					100		
Deep Learning and Generative AI	3	M	10	250	48			202			50		50		
Data Intensive Scalable Systems (1)	3	E	5	125	48			77		40			60		
Modelling and Simulation (1)	3	E	5	125	48			77			40		60		
Domain Applications (1)	3	E	5	125	36			89			50		50		
Research Practicum	4	E	30	750	48			702					100		

Internship	4	E	30	750	48			366	336				100		
Special Regulations: Availability of elective modules will be conditional on i) timetable arrangements, and ii) that the number of students electing to take the module exceeds a given minimum number. A learner must choose two elective modules in semester 3. The Research Practicum / Internship modules cannot be compensated.															

Access, transfer and progression procedures, criteria and arrangements for the programme

Information to be made available to learners about the programme

4.1 Access: Information to be made available to learners about the programme

Information Type	Available (Yes/No)	Where to be Available	When to be available
Programme and Award Titles	Yes	Online prospectus and Non-EEA Recruitment Agents	Immediately upon revalidation
Graduate Outcomes	Yes	Online prospectus and Non-EEA Recruitment Agents	Immediately upon revalidation
Target Learner Profile	Yes	Online prospectus Non-EEA Recruitment Agents	Immediately upon revalidation
Entry Criteria	Yes	Online prospectus Non-EEA Recruitment Agents	Immediately upon revalidation
Advanced Entry - arrangements and criteria	Yes	Online prospectus Non-EEA Recruitment Agents	Immediately upon revalidation
Programme duration and delivery mode(s)	Yes	Online prospectus Non-EEA Recruitment Agents	Immediately upon revalidation
Information in Plain English?	Yes		

Entry procedures and criteria for the programmes including procedures recognition of prior learning

NCI's institutional admissions procedures are described at the following URL: https://www.ncirl.ie/Courses/How-to-Apply .

Applicants may apply directly to the College through its website. International (non-EEA) Applicants may apply directly or through international agents who work closely with NCI Recruitment staff members who are assigned to specific international markets.

Minimum requirements for discipline-specific learning

Applicants are normally required to hold a minimum of a level 8 honours qualification (2.2 or higher) or equivalent on the National Qualifications Framework in a cognate discipline. Given the target technical market for graduates of this programme, candidates will be required to demonstrate technical or mathematical problem-solving skills as part of previous programme learning. Graduate 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 programming experience (e.g., via academic transcripts or recognised certification).

Standard applicants for the programme are those holders of technical, numerate degrees. Such applicants are likely to gain a higher ranking in any order of merit for admission to the programme. Typically, these would be applicants who have gained a minimum of a Level 8 qualification in a numerate discipline. Typical disciplines which would fall into this category would be Computing and Informatics. Such applicants with a level 8 qualification (2.2 or higher) or equivalent are eligible for direct entry onto the programme.

Following Computing and Informatics graduates, we next assign priority to candidates with a background in Engineering, Mathematics, Physics and Chemistry. Consideration of these applications would be assessed by detailed examination of the subject content, assessments and syllabi of the programmes from which applicants have been awarded their primary degrees. Such candidates may also be assessed via an interview to ensure that they can successfully participate on the programme.

Additionally, applications will be considered for those who have gained a minimum of a Level 8 qualification in a programme with a significant IT component and/or significant numerate element. Typical programmes which would fall into this category could include Management Information Systems, Accounting, Economics, Marketing Management, Sociology and Biology. Such programmes in this second category may vary greatly in mathematical and information technology content. Consideration of these applications would be assessed by detailed examination of the subject content, assessments and syllabi of the programmes from which applicants have been awarded their primary degrees. In addition, the programme director may call candidate learners with qualifications in this second category of disciplines to be assessed via an interview to ensure that (in coming from a less technical or non-technical background) they can successfully participate on the programme.

Minimum experiential requirements (if applicable)

Applicants who do not fall into either the first or second categories above may also be admitted based on Recognition of Prior Experiential Learning (RPEL). RPEL will be assessed based on a minimum of 3 years' work experience and by portfolio or other appropriate method to establish their eligibility as measured against level 8 award standards.

Minimum language proficiency requirements

Applicants whose first language is not English must attach a certified qualification of proficiency in English. The following qualifications will fulfil the College's minimum requirements for postgraduate programmes:

IELTS	TOEFL (PBT)	TOEFL (CBT)	TOEFL (IBT)	CEF	Irish Leaving Certificate	UK GCSE
6.0	600	200	100	B2	OC	Pass

Minimum mathematical proficiency requirements

Standard applicants for the programme are those holders of technical, numerate degrees **having achieved** a minimum of a level 8 honours qualification (2.2 or higher) or equivalent on the National Qualifications Framework in a cognate discipline. Typical disciplines which would fall into this category would be Computing and Informatics. Such applicants with a level 8 qualification (2.2 or higher) or equivalent are eligible for direct entry onto the programme and are deemed to have met the minimum mathematical proficiency requirements. Consideration of applications from candidates with a background in Engineering, Mathematics, Physics and Chemistry would be assessed by detailed examination of the subject content, assessments and syllabi of the programmes from which applicants have been awarded their primary degrees. Typically, such candidates will have completed a number of mathematics or statistics-based modules and will also be deemed to have met the minimum mathematical proficiency requirements. For other applicants, consideration of these applications would be assessed by detailed examination of the subject content, assessments and syllabi of the programmes from which applicants have been awarded their primary degrees. In these cases, applicants' transcripts are reviewed by the Programme Director to ensure that candidates have completed mathematics/statistics-based modules to a level that is deemed to meet the minimum mathematical proficiency requirements (i.e., at least two modules in topics such as Operations Research, Discrete Mathematics, Probability and Statistics, Quantitative Analysis, Reasoning under Uncertainty, etc.). In addition, the Programme Director may call candidate learners to be assessed via an interview to ensure that (in coming from a less technical or non-technical background) they can successfully participate on the programme.

Progspecific RPL criteria&arrangements: entry, module exemptions,advanced entry&direct award access

Programme MSCDA - MSc in Data Analytics

Admissions, Registration and Student Support Policies (ncirl.ie)

Application FAQs | National College of Ireland (ncirl.ie)

Recognition of Prior Experiential Learning (RPEL) | NCI (ncirl.ie)

Applicants who do not have the advertised minimum academic qualifications for entry will be assessed based on prior learning and work experience, combined with a demonstrated commitment towards meeting the academic requirements of the programme. Entry will be assessed using a written application from the candidate and by interview.

Recognition of Prior (Experiential) Learning (RPEL) will be assessed in accordance with college policy (https://www.ncirl.ie/Courses/How-to-Apply/Recognition-of-Prior-Experiential-Learning). This may require a portfolio of evidence and/interview or other assessment as determined by the programme team. RPL/RPEL candidates will be required to demonstrate suitable technical or mathematical problem-solving skills. Formal recognition of knowledge or ~~experience that has been gained from work, life or previous study will be assessed~~ using the QQI Computing or Science Awards Standards at level 8.

Where there is insufficient evidence of numeracy skills, applicants may be required to complete an assessment to determine their suitability to the programme.

Applications for RPEL consideration are made directly to the College. All applicants seeking RPEL entry will be asked to attend an interview and will be requested to produce a portfolio describing the prior experience in the context of potentially creditable learning outcomes. The portfolio is evaluated and compared against the module to provide evidence of:

- Validity: Does the evidence supplied by the applicant meet all/part of the outcomes/assessment criteria?
- Sufficiency: Is the evidence sufficient proof of the outcomes or assessment criteria?
- Currency: Is the evidence recent? NCI normally expects learners experience or qualifications have been gained within the last 3 years
- Authenticity: Is the evidence provided the learners own work?

In assessing whether learning gained from experience matches learning outcomes for a particular module, the assessors apply the following criteria:

- Has the appropriate balance between theory and practical application been attained?
- Is the learning achieved transferable?
- Has the appropriate academic level of learning been achieved?

Documents

No Documents

Competency Mapping

PO Departments	Programme Learning Outcome	Competencies
POT1 - Knowledge - Breadth (An understanding of the theory, concepts and methods pertaining to a field (or fields) of learning)	1. Conduct substantial and extensive independent research and analysis in the field of Data Analytics.	
POT1 - Knowledge - Breadth (An understanding of the theory, concepts and methods pertaining to a field (or fields) of learning)	2. Formulate and implement a novel research idea using the latest industry practices.	
POT1 - Knowledge - Breadth (An understanding of the theory, concepts and methods pertaining to a field (or fields) of learning)	3. Demonstrate expert knowledge and a critical understanding of data analysis, statistics, and the tools, techniques and technologies of Data Analytics utilised in both technical and business contexts.	
POT1 - Knowledge - Breadth (An understanding of the theory, concepts and methods pertaining to a field (or fields) of learning)	4. Critically assess, evaluate and communicate business & technical strategies for Data Analytics.	
POT1 - Knowledge - Breadth (An understanding of the theory, concepts and methods pertaining to a field (or fields) of learning)	5. Formulate, design, assess, and implement effective business & technical solutions for Data Analytics.	
POT1 - Knowledge - Breadth (An understanding of the theory, concepts and methods pertaining to a field (or fields) of learning)	6. Critically assess and evaluate security, privacy, sustainability, and ethical issues associated with the storage, transfer, and processing of data for analytical purposes.	

9APDV: Analytics Programming & Data Visualization (Core Subject)

Module Code:	9APDV
Long Title	Analytics Programming & Data Visualization APPROVED
Title	Analytics Programming & Data Visualization
Module Level:	LEVEL 9
EQF Level:	7
Valid From:	2024 (July 2024)
Language of Instruction:	English
Duration:	1 Semester
Credits:	5
Field of Study:	0610 - Information and Communication Technologies (ICTs) not further defined or elsewhe
Learning Outcome Taxonomy	Blooms
Module Author:	Eileen Long
Authors	Long Eileen (10 July 2024 to ---)

Is this a capstone module?	No

Learning Outcomes

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

#	Learning Outcome Description
LO1	Analyse, compare, contrast and critically evaluate the characteristics of programming languages, programming environments and database systems commonly utilised for data analytics solution implementation.
LO2	Critically assess the challenges associated with processing big data datasets and compare and contrast programming for big data vis-à-vis programming for conventional datasets.
LO3	Evaluate tools and techniques for managing the data pipeline and preparing data for further analysis through data wrangling, cleaning, and validation.
LO4	Evaluate, design and implement solutions for processing datasets by using key programming patterns and constructs for data analytics, relevant programming languages, and suitable database systems.
LO5	Critically evaluate and apply data visualization design principles and interaction strategies in order to effectively communicate information to both technical and non-technical audiences.

Learning Outcome Taxonomy Blooms					
#	LO1	LO2	LO3	LO4	LO5
C1					
C2	Y				
C3					
C4	Y		Y		
C5					
C6	Y		Y		
P1					
P2					
P3					
P4					
P5					
P6					
P7					
A1					
A2					
A3					
A4	Y				
A5					

Learning Outcome Taxonomy Reference Blooms		
#	**Taxonomy Description**	**Taxonomy Group**
C1	Knowledge	Cognitive
C2	Comprehension	Cognitive
C3	Application	Cognitive
C4	Analysis	Cognitive
C5	Synthesis	Cognitive
C6	Evaluation	Cognitive
P1	Perception	Psychomotor (Technical Skills)
P2	Set	Psychomotor (Technical Skills)
P3	Guided Response	Psychomotor (Technical Skills)
P4	Mechanism	Psychomotor (Technical Skills)
P5	Complex Overt Response	Psychomotor (Technical Skills)
P6	Adaptation	Psychomotor (Technical Skills)
P7	Origination	Psychomotor (Technical Skills)
A1	Receiving to Phenomena	Affective (Humanities)
A2	Responding to Phenomena	Affective (Humanities)
A3	Valuing	Affective (Humanities)
A4	Organizing Values	Affective (Humanities)
A5	Internalizing Values	Affective (Humanities)

Programme Module Dependencies
No requisites

Dependencies

Module Content & Assessment

Indicative Content
1. Introduction to Analytics Programming & Data Visualization 1.1) Overview of programming languages, tools and frameworks for data analytics, and productionalizing tools (e.g., GitHub). Programming types (imperative, declarative, functional, logic, etc.). Data analytics methodologies. What is Data Visualization? History and relation of data visualization to other disciplines. Characteristics of data, datatypes and Information.
2. Overview of the data programming language 2.1) Algorithm design. Syntax and semantics. Expressions and statements. Basic datatypes. Conversion and coercion. Built-in data structures (arrays, matrices, lists, etc.). Indexing data structures. Program flow control and iteration.
3. Input/Output and Functions 3.1) Program I/O. Input/output data from structured/semi-structured file formats (csv, xml, json). Input data from the Internet (e.g., APIs, web scraping). Defining functions. Lambdas for functional programming.
4. More Advanced Data Operations 4.1) Dealing with NA values. Exception handling. Use of support libraries (e.g., Pandas, Numpy, dfply). Regular Expressions. 4.2) Programming for text analytics.
5. Database Programming – Relational Databases 5.1) Database system technologies. Relational databases and RDBMS. DDL and DML. Create/Read/Update/Delete (CRUD) Operations. Programmatically connecting to databases. SQL Optimization, Indexing and Normalization.
6. Database Programming – NoSQL Databases 6.1) Categories of NoSQL databases: Document Model, Key-Value Model, Column Family, Aggregates, Graph Model, etc. NoSQL data modelling concepts. Query languages for data in NoSQL systems.
7. ETL, ELT and Data Pipelines 7.1) Data cleaning, deduplication, wrangling and validation. Developing programs for data processing activities (e.g., data extraction, cleaning, merging, aggregation, analysis, reporting). Data wrangling techniques.
8. Big Data Programming 8.1) Challenges associated with programming for big data. Parallelism for computational processes. Distributed computing platforms for big data processing. Design patterns for big data processing.
9. Data Streaming 9.1) Stream input sources. Live data streams. Window-based transformations. Combination of batch and stream computations.
10. The Visualization Process 10.1) Visual channels. Information that 'stands out'. Cognition. Weber's Law & Steven's Law. Gestalt Principles. Planning and designing visualizations. Visual variables. Taxonomies. Effectiveness of visualizations. Tufte's design principles. Accessibility and design for visual impairment.
11. Visualization Techniques and Applications 11.1) Spatial data. Geospatial data. Multivariate data. Trees, graphs, networks. Text and document. Plotting libraries (e.g., Matplotlib, ggplot). Dashboard frameworks (e.g., Plotly).
12. Productionalizing Data Analytics 12.1) Tools. Testing, Portable Format for Analytics (PFA). Integrating machine learning models into production. Data drift and monitoring.

Assessment Breakdown	%
Coursework	100.00%

Assessments

Coursework

Assessment Type:	Continuous Assessment	**% of total:**	30
Pass Marks:	0	**Assessment Date:**	Sem 1 End
Outcome addressed:	4	**Briefing:**	Sem 1 End
Feedback:	n/a	**Assessment Mode:**	Not yet determined
Assessment Medium:	Not yet determined	**Role:**	Not yet determined
Mandatory:	False	**Assessor:**	Not yet determined
Feedback Type:		**Non-Marked:**	No
Assessment Difficulty:	Not yet determined	**Central Admin:**	No
Language Proficiency:			

Assessment Description:
This assessment will consist of practical tasks in the form of an in-class test. This will assess learners' knowledge and competences on programmatically processing and analysing datasets including operations with database connectivity.

Assessment Type:	Project	**% of total:**	70
Pass Marks:	0	**Assessment Date:**	Sem 1 End
Outcome addressed:	1,2,3,4,5	**Briefing:**	Sem 1 End
Feedback:	n/a	**Assessment Mode:**	Not yet determined
Assessment Medium:	Not yet determined	**Role:**	Not yet determined
Mandatory:	False	**Assessor:**	Not yet determined
Feedback Type:		**Non-Marked:**	No
Assessment Difficulty:	Not yet determined	**Central Admin:**	No
Language Proficiency:			

Assessment Description:
The terminal assessment will consist of a project that will evaluate all learning outcomes. Learners will have to identify and carry out a series of analyses of a large dataset (or a collection of large datasets that are somehow related or complement each other), utilising appropriate programming languages, tools and techniques (e.g., data wrangling) for data preparation, programming environments, database systems, and data visualization. The final submission will consist of an academic research paper style report as well as the implemented data analytics artefact.

Coursework

Assessment Type:	Continuous Assessment	**% of total:**	30
Pass Marks:	0	**Assessment Date:**	n/a
Outcome addressed:	4	**Briefing:**	n/a
Feedback:	n/a	**Assessment Mode:**	Not yet determined
Assessment Medium:	Not yet determined	**Role:**	Not yet determined
Mandatory:	False	**Assessor:**	Not yet determined
Feedback Type:		**Non-Marked:**	No
Assessment Difficulty:	Not yet determined	**Central Admin:**	No
Language Proficiency:			

Assessment Description:
This assessment will consist of practical tasks in the form of an in-class test. This will assess learners' knowledge and competences on programmatically processing and analysing datasets including operations with database connectivity.

Assessment Type:	Project	**% of total:**	70
Pass Marks:	0	**Assessment Date:**	n/a
Outcome addressed:	1,2,3,4,5	**Briefing:**	n/a
Feedback:	n/a	**Assessment Mode:**	Not yet determined
Assessment Medium:	Not yet determined	**Role:**	Not yet determined
Mandatory:	False	**Assessor:**	Not yet determined
Feedback Type:		**Non-Marked:**	No
Assessment Difficulty:	Not yet determined	**Central Admin:**	No
Language Proficiency:			

Assessment Description:
The terminal assessment will consist of a project that will evaluate all learning outcomes. Learners will have to identify and carry out a series of analyses of a large dataset (or a collection of large datasets that are somehow related or complement each other), utilising appropriate programming languages, tools and techniques (e.g., data wrangling) for data preparation, programming environments, database systems, and data visualization. The final submission will consist of an academic research paper style report as well as the implemented data analytics artefact.

Module Workload

Module Target Workload Hours 50 Hours

Full Time hours per semester

Workload Type
Lecture
Independent Learning
Tutorial
125.00

This module has no Apprenticeship workload.

This module has no Blended workload.

This module has no Block workload.

This module has no Distance/Correspondance workload.

This module has no Evening workload.
This module has no Online workload.

Part Time hours per semester
Workload Type
Lecture
Tutorial
Independent Learning
Directed E-Learning
125.00

MLO Competency Mapping

Learning Outcomes	Competencies
LO1: Analyse, compare, contrast and critically evaluate the characteristics of programming languages, programming environments and database systems commonly utilised for data analytics solution implementation.	
LO2: Critically assess the challenges associated with processing big data datasets and compare and contrast programming for big data vis-à-vis programming for conventional datasets.	
LO3: Evaluate tools and techniques for managing the data pipeline and preparing data for further analysis through data wrangling, cleaning, and validation.	
LO4: Evaluate, design and implement solutions for processing datasets by using key programming patterns and constructs for data analytics, relevant programming languages, and suitable database systems.	
LO5: Critically evaluate and apply data visualization design principles and interaction strategies in order to effectively communicate information to both technical and non-technical audiences.	

Module Resources

Recommended Book Resources

Mckinney W. (2017), Python for Data Analysis: Data Wrangling with Pandas, NumPy, and IPython, 2nd Edition, O'Reilly Media, ISBN: 978-1491957660.

Lakshmanan V. (2020), Machine Learning Design Patterns: Solutions to Common Challenges in Data Preparation, Model Building, and MLOps, O'Reilly Media, ISBN: 978-1098115784.

Kirk A. (2019), Data Visualisation: A Handbook for Data Driven Design, Second Edition (Revised Edition), SAGE Publications Ltd., ISBN: 978-1526468925..

Supplementary Book Resources

Triguero I., Galar M. (2023), Large-Scale Data Analytics with Python and Spark: A Hands-on Guide to Implementing Machine Learning Solutions, Cambridge University Press, ISBN: 978-1009318259.

Other Resources

[Website], MIT Open Courseware, Introduction to Computational Thinking and Data Science, https://ocw.mit.edu/courses/electrical-e ngineering-and-computer-science/6-0002-i ntroduction-to-computational-thinking-an d-data-science-fall-2016/.

[Website], DataCamp, Learn R, Python & Data Science Online https://www.datacamp.com/.

Review

Module Aims and Objectives

The objective of this module is to enable learners to acquire the necessary key programming skills required to develop applications for processing data. Furthermore, learners will be able to identify and illustrate the challenges associated with developing programs and applications for data analytics. Learners will gain practical experience in programming for data analytics through the use of a range of relevant and appropriate programming languages for given processing tasks (e.g., data extraction, aggregation, reporting, etc.). The module also addresses the importance of data visualization as an effective means to communicate the results of data analytics processing to both technical and non-technical audiences. Additionally, learners will acquire skills for programmatically establishing connectivity to data storage and data management systems. Learners will also develop skills associated with software development methodologies to facilitate the robust design and effective implementation of application solutions.

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

Information provided to learners about the module

The module specification is replicated in Akari Document, which is the College's repository of programme and module information. In order to ensure that this information is consistently presented, this is viewed as the primary source of information and is linked to in all systems, e.g. website links and Moodle, the College's virtual learning environment, Moodle etc. This is also the source of information for teaching staff in terms of guidance around assessment structure and requirements.

These specifications once approved are available via http://courses.ncirl.ie

This specification, where appropriate, is also used as the primary source of information for printed materials e.g. prospectus. In this case, until the module is approved in the context of the programme, information is indicative.

This information is further supplemented on an instance by instance basis by the individual lecturer teaching the module through the module handbook, which may be made available electronically via Moodle or in printed format. This document ensures that week by week activities, updated reading list and cohort specific information is current.

Module content, organisation and structure

Introduction to Analytics Programming & Data Visualization

Overview of programming languages, tools and frameworks for data analytics, and productionalizing tools (e.g., GitHub). Programming types (imperative, declarative, functional, logic, etc.). Data analytics methodologies. What is Data Visualization? History and relation of data visualization to other disciplines. Characteristics of data, datatypes and Information.

Overview of the data programming language

Algorithm design. Syntax and semantics. Expressions and statements. Basic datatypes. Conversion and coercion. Built-in data structures (arrays, matrices, lists, etc.). Indexing data structures. Program flow control and iteration.

Input/Output and Functions

Program I/O. Input/output data from structured/semi-structured file formats (csv, xml, json). Input data from the Internet (e.g., APIs, web scraping). Defining functions. Lambdas for functional programming.

More Advanced Data Operations

Dealing with NA values. Exception handling. Use of support libraries (e.g., Pandas, Numpy, dfply). Regular Expressions.

Programming for text analytics.

Database Programming – Relational Databases

Database system technologies. Relational databases and RDBMS. DDL and DML. Create/Read/Update/Delete (CRUD) Operations. Programmatically connecting to databases. SQL Optimization, Indexing and Normalization.

Database Programming – NoSQL Databases

Categories of NoSQL databases: Document Model, Key-Value Model, Column Family, Aggregates, Graph Model, etc. NoSQL data modelling concepts. Query languages for data in NoSQL systems.

ETL, ELT and Data Pipelines

Data cleaning, deduplication, wrangling and validation. Developing programs for data processing activities (e.g., data extraction, cleaning, merging, aggregation, analysis, reporting). Data wrangling techniques.

Big Data Programming

Challenges associated with programming for big data. Parallelism for computational processes. Distributed computing platforms for big data processing. Design patterns for big data processing.

Data Streaming

Stream input sources. Live data streams. Window-based transformations. Combination of batch and stream computations.

The Visualization Process

Visual channels. Information that 'stands out'. Cognition. Weber's Law & Steven's Law. Gestalt Principles. Planning and designing visualizations. Visual variables. Taxonomies. Effectiveness of visualizations. Tufte's design principles. Accessibility and design for visual impairment.

Visualization Techniques and Applications

Spatial data. Geospatial data. Multivariate data. Trees, graphs, networks. Text and document. Plotting libraries (e.g., Matplotlib, ggplot). Dashboard frameworks (e.g., Plotly).

Productionalizing Data Analytics

Tools. Testing, Portable Format for Analytics (PFA). Integrating machine learning models into production. Data drift and monitoring.

Module Teaching and Learning (including formative assessment) Strategy

The learning strategy involves the use of lectures, tutorials and practical labs as appropriate. Students will bring their own devices (BYOD) but will also have access to college facilities such as Moodle and Virtual Desktops. Each week students will attend a 2-hour lecture and a 2-hour lab/tutorial. The module uses a learner-centred approach that acknowledges the variety of learning preferences in the classroom. Lectures will be a mix of presentation and practical work conducted by students with the assistance of the lecturer and teaching assistants. It is highly interactive incorporating opportunities for learning by doing. Students will be assigned tasks and exercises related to lecture content so that they can connect the theory to practice and learn to work with various database and programming tools for data analytics and visualization(e.g., Python, R/RStudio, MongoDB, plotting libraries etc.). Students will benefit from mentoring and formative feedback during classes. The learning materials will be made available to students through Moodle, the College's learning management system. To support student's independent learning the lecture notes and lab materials will be supported through additional links available on the Internet (e.g., documentation/manuals for tools and programming languages, YouTube videos, DataCamp tutorials, etc.).

Work-based learning and practice placement

E-Learning

Module Physical resource requirements

Specifications for module staffing requirements

Sample assessment materials

Timetabling, learner effort and credit

Module assessment rationale

Affiliated Entities

Entity Code	Entity Title	Entity Version	Entity Type	Via	Outcome
MSCDA	MSc in Data Analytics	3.0	Programme		Yes
MSCDA	MSc in Data Analytics	4.0	Programme		Yes
PGDDA	Post Graduate Diploma in Science in Data Analytics	3.0	Programme		Yes

Documents

No Documents

9HDGS: Data Governance, Ethics, and Sustainability (Core Subject)

Module Code:	9HDGS
Long Title	Data Governance, Ethics, and Sustainability APPROVED
Title	Data Governance, Ethics, and Sustainability
Module Level:	LEVEL 9
EQF Level:	7
Valid From:	2024 (July 2024)
Language of Instruction:	English
Duration:	1 Semester
Credits:	5
Field of Study:	0610 - Information and Communication Technologies (ICTs) not further defined or elsewhe
Learning Outcome Taxonomy	Blooms
Module Author:	Eileen Long
Authors	Long Eileen (10 July 2024 to ---)
Is this a capstone module?	No

Learning Outcomes	
On successful completion of this module the learner will be able to:	
#	**Learning Outcome Description**
LO1	Demonstrate critical understanding of the governance and regulatory frameworks associated with the key data lifecycle stages for an effective and ethical management of data assets.
LO2	Demonstrate critical awareness and interpretation of the fundamental principles and regulatory regimes of data protection and data privacy in socio-technical environments.
LO3	Critically analyse and evaluate the main ethical, legal, sustainability, and social implications of using data-driven technologies.
LO4	Demonstrate critical understanding of, evaluate, and apply core concepts of data management and governance, ethical thinking, data protection, and sustainable development to address sustainability challenges in a global context and to support ethical and sustainable decision making.
LO5	Investigate and appraise the interplay of fairness, accountability, and transparency in algorithmic decision-making systems and demonstrate critical awareness of operational and technical solutions to address these concerns.

Learning Outcome Taxonomy Blooms					
#	LO1	LO2	LO3	LO4	LO5
C1					
C2					
C3	Y	Y		Y	
C4					Y
C5					
C6					
P1					
P2					
P3					
P4					
P5	Y	Y		Y	
P6					
P7					
A1					
A2					
A3	Y	Y		Y	
A4					
A5					

Learning Outcome Taxonomy Reference Blooms		
#	**Taxonomy Description**	**Taxonomy Group**
C1	Knowledge	Cognitive
C2	Comprehension	Cognitive
C3	Application	Cognitive
C4	Analysis	Cognitive
C5	Synthesis	Cognitive
C6	Evaluation	Cognitive
P1	Perception	Psychomotor (Technical Skills)
P2	Set	Psychomotor (Technical Skills)
P3	Guided Response	Psychomotor (Technical Skills)
P4	Mechanism	Psychomotor (Technical Skills)
P5	Complex Overt Response	Psychomotor (Technical Skills)
P6	Adaptation	Psychomotor (Technical Skills)
P7	Origination	Psychomotor (Technical Skills)
A1	Receiving to Phenomena	Affective (Humanities)
A2	Responding to Phenomena	Affective (Humanities)
A3	Valuing	Affective (Humanities)
A4	Organizing Values	Affective (Humanities)
A5	Internalizing Values	Affective (Humanities)

Programme Module Dependencies
No requisites

Dependencies

Module Content & Assessment

Indicative Content
1. Data Management and Governance I 1.1) Data management principles and challenges. Data lifecycle. Data quality. Data provenance. Data integrity.
2. Data Management and Governance II 2.1) Data policies, standards, guidelines, and procedures. Business metrics and KPIs. Roles and responsibilities. DG maturity levels. Data governance frameworks, operating models, and tools.
3. Data Management and Governance III 3.1) How to implement a data governance program (e.g., Ladley's methodology). Fundamentals of Research Data Management (e.g., research data lifecycle, data sharing, research data management planning).
4. Governance for Sustainable Development 4.1) Sustainability Terminologies and Meanings. UN Sustainable Development Goals (SDGs). Environmental, social, and corporate governance (ESG). Sustainable IT.
5. Regulatory Compliance I 5.1) Brief history of human rights. Types of EU legislation. The Right to Privacy. Key legislative frameworks.
6. Regulatory Compliance II 6.1) Key provisions in the GDPR (e.g., data protection principles, privacy by design; data subjects rights, data processor and data controller, international data transfers, informed consent, data protection impact assessment).
7. Ethical Issues Pertaining to Data I 7.1) Nature and sources of ethics (e.g., personal, professional, social, business). Branches of normative ethics (deontology, utilitarianism, virtue theory, social justice, etc.). Frameworks for ethical design and decision making (e.g., Ethical Impact Assessment).
8. Ethical Issues Pertaining to Data II 8.1) Ethical perspective of data governance (how DG supports ethics, principles, and modes of governance with ethics considerations). Ethics in Research: considerations Before, During, and After. Codes of ethics and professional conduct (e.g., ACM).
9. Ethical Issues Pertaining to Data III 9.1) Ethic concerns in various technologies and sustainable socio-technical systems (e.g., IoT, machine learning). IT Ethics in specific sectors (e.g., spam, anonymity, cyberbullying, copyright, etc.).
10. Model Governance and Explainable AI - Part 1 10.1) Principles of AI Governance: the meaning of fairness, accountability, and transparency with respect to algorithmic systems. Unconscious Bias and techniques to address it. Perceptions of algorithmic bias and unfairness. Interventions to mitigate biases in systems. Methods and tools for enhancing fairness in algorithms (e.g., IEEE P7003 TM).
11. Model Governance and Explainable AI - Part 2 11.1) Principles and Strategies for designing accountable algorithms and systems. Trade-offs between privacy and transparency. Tools and methodologies for conducting algorithm audits (e.g., Algorithmic Impact Assessments).

Assessment Breakdown	%
Coursework	40.00%
End of Module Assessment	60.00%

Assessments

Coursework			
Assessment Type:	Continuous Assessment	**% of total:**	40
Pass Marks:	0	**Assessment Date:**	Sem 1 End
Outcome addressed:	1,2,3,4	**Briefing:**	Sem 1 End
Feedback:	n/a	**Assessment Mode:**	Not yet determined
Assessment Medium:	Not yet determined	**Role:**	Not yet determined
Mandatory:	False	**Assessor:**	Not yet determined
Feedback Type:		**Non-Marked:**	No
Assessment Difficulty:	Not yet determined	**Central Admin:**	No
Language Proficiency:			

Assessment Description:
This assessment will assess learners' insights and evaluation of data management and governance, legal, and sustainability issues relating to situational contexts and scenarios. Students will work in groups.

End of Module Assessment

Assessment Type:	Terminal Exam	**% of total:**	60
Pass Marks:	0	**Assessment Date:**	End-of-Semester
Outcome addressed:	1,2,3,4,5	**Briefing:**	End-of-Semester
Feedback:	End-of-Semester	**Assessment Mode:**	Not yet determined
Assessment Medium:	Not yet determined	**Role:**	Not yet determined
Mandatory:	False	**Assessor:**	Not yet determined
Feedback Type:		**Non-Marked:**	No
Assessment Difficulty:	Not yet determined	**Central Admin:**	No
Language Proficiency:			

Assessment Description:
The examination will be of two hours duration and may include a mix of: theoretical, applied and interpretation questions.

Coursework

Assessment Type:	Continuous Assessment	**% of total:**	40
Pass Marks:	0	**Assessment Date:**	n/a
Outcome addressed:	1,2,3,4	**Briefing:**	n/a
Feedback:	n/a	**Assessment Mode:**	Not yet determined
Assessment Medium:	Not yet determined	**Role:**	Not yet determined
Mandatory:	False	**Assessor:**	Not yet determined
Feedback Type:		**Non-Marked:**	No
Assessment Difficulty:	Not yet determined	**Central Admin:**	No
Language Proficiency:			

Assessment Description:
This assessment will assess learners' insights and evaluation of data management and governance, legal, and sustainability issues relating to situational contexts and scenarios. Students will work in groups.

End of Module Assessment

Assessment Type:	Terminal Exam	**% of total:**	60
Pass Marks:	0	**Assessment Date:**	End-of-Semester
Outcome addressed:	1,2,3,4,5	**Briefing:**	End-of-Semester
Feedback:	End-of-Semester	**Assessment Mode:**	Not yet determined
Assessment Medium:	Not yet determined	**Role:**	Not yet determined
Mandatory:	False	**Assessor:**	Not yet determined
Feedback Type:		**Non-Marked:**	No
Assessment Difficulty:	Not yet determined	**Central Admin:**	No
Language Proficiency:			

Assessment Description:
The examination will be of two hours duration and may include a mix of: theoretical, applied and interpretation questions.

Module Workload

Module Target Workload Hours 50 Hours

Full Time hours per semester
Workload Type
Lecture
Independent Learning
Tutorial
125.00

This module has no Apprenticeship workload.

This module has no Blended workload.

This module has no Block workload.

This module has no Distance/Correspondance workload.

This module has no Evening workload.

This module has no Online workload.

Part Time hours per semester
Workload Type
Lecture
Tutorial
Independent Learning
Directed E-Learning
125.00

MLO Competency Mapping

Learning Outcomes	Competencies
LO1: Demonstrate critical understanding of the governance and regulatory frameworks associated with the key data lifecycle stages for an effective and ethical management of data assets.	
LO2: Demonstrate critical awareness and interpretation of the fundamental principles and regulatory regimes of data protection and data privacy in socio-technical environments.	
LO3: Critically analyse and evaluate the main ethical, legal, sustainability, and social implications of using data-driven technologies.	
LO4: Demonstrate critical understanding of, evaluate, and apply core concepts of data management and governance, ethical thinking, data protection, and sustainable development to address sustainability challenges in a global context and to support ethical and sustainable decision making.	
LO5: Investigate and appraise the interplay of fairness, accountability, and transparency in algorithmic decision-making systems and demonstrate critical awareness of operational and technical solutions to address these concerns.	

Module Resources

Recommended Book Resources

DAMA International (2017). DAMA-DMBOK: Data Management Body of Knowledge (2nd ed.). Technics Publications. [ISBN:978-1634622349]..

Ladley, J. (2019). Data governance: How to design, deploy, and sustain an effective data governance program. Academic Press. [ISBN: 9780128158319].

O'Keefe, K. & O Brien, D. (2018). Ethical Data and Information Management. Kogan Page. [ISBN: 978-0749482046]..

Sharma, S. (2019). Data Privacy and GDPR Handbook. Wiley. [ISBN: 978-1119594246]..

Barocas, S., Hardt, M. and Narayanan, A., (2019). Fairness and Machine Learning: Limitations and Opportunities. fairmlbook.org..

Supplementary Book Resources

Smallwood, R. F. (2019). Information Governance: Concepts, Strategies and Best Practices. Wiley. [ISBN: 978-1119491446]..

Kearns, M. & Roth, A. (2019). The Ethical Algorithm: The Science of Socially Aware Algorithm Design. Oxford University Press. [ISBN: 978-0190948207]..

Tavani, H. T. (2015). Ethics and Technology: Controversies, Questions, and Strategies for Ethical Computing. Wiley. [ISBN: 978-1119355311]..

Reynolds, George W (2019). Ethics in Information Management (sixth edition). Cengage Learning (Inc.), Boston. [ISBN: 978-337-40587-4].

West, S.M., Whittaker, M. and Crawford, K., 2019. Discriminating systems. AI Now..

Eberhardt, J.L., 2020. Biased: Uncovering the hidden prejudice that shapes what we see, think, and do. Penguin Books. [978-0735224957].

Review

Module Aims and Objectives

This module aims to provide learners with the knowledge and skills around the complex issues of data management and governance in an organisational and social context, including current issues such as open data access and management, data protection, automated data analysis, algorithmic decision making, and misuse of data and analytics. Learners will explore and evaluate the ethical, legal, sustainability, and social implications of using data-driven technologies such as big data, analytics, and machine learning. The students will learn how to establish processes and systems that consider data management and governance for sustainable development.

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

Information provided to learners about the module

The module specification is replicated in Akari Document, which is the College's repository of programme and module information. In order to ensure that this information is consistently presented, this is viewed as the primary source of information and is linked to in all systems, e.g. website links and Moodle, the College's virtual learning environment, Moodle etc. This is also the source of information for teaching staff in terms of guidance around assessment structure and requirements.

These specifications once approved are available via http://courses.ncirl.ie

This specification, where appropriate, is also used as the primary source of information for printed materials e.g. prospectus. In this case, until the module is approved in the context of the programme, information is indicative.

This information is further supplemented on an instance by instance basis by the individual lecturer teaching the module through the module handbook, which may be made available electronically via Moodle or in printed format. This document ensures that week by week activities, updated reading list and cohort specific information is current.

Module content, organisation and structure

Data Management and Governance I

Data management principles and challenges. Data lifecycle. Data quality. Data provenance. Data integrity.

Data Management and Governance II

Data policies, standards, guidelines, and procedures. Business metrics and KPIs. Roles and responsibilities. DG maturity levels. Data governance frameworks, operating models, and tools.

Data Management and Governance III

How to implement a data governance program (e.g., Ladley's methodology). Fundamentals of Research Data Management (e.g., research data lifecycle, data sharing, research data management planning).

Governance for Sustainable Development

Sustainability Terminologies and Meanings. UN Sustainable Development Goals (SDGs). Environmental, social, and corporate governance (ESG). Sustainable IT.

Regulatory Compliance I

Brief history of human rights. Types of EU legislation. The Right to Privacy. Key legislative frameworks.

Regulatory Compliance II

Key provisions in the GDPR (e.g., data protection principles, privacy by design; data subjects rights, data processor and data controller, international data transfers, informed consent, data protection impact assessment).

Ethical Issues Pertaining to Data I

Nature and sources of ethics (e.g., personal, professional, social, business). Branches of normative ethics (deontology, utilitarianism, virtue theory, social justice, etc.). Frameworks for ethical design and decision making (e.g., Ethical Impact Assessment).

Ethical Issues Pertaining to Data II

Ethical perspective of data governance (how DG supports ethics, principles, and modes of governance with ethics considerations). Ethics in Research: considerations Before, During, and After. Codes of ethics and professional conduct (e.g., ACM).

Ethical Issues Pertaining to Data III

Ethic concerns in various technologies and sustainable socio-technical systems (e.g., IoT, machine learning). IT Ethics in specific sectors (e.g., spam, anonymity, cyberbullying, copyright, etc.).

Model Governance and Explainable AI - Part 1

Principles of AI Governance: the meaning of fairness, accountability, and transparency with respect to algorithmic systems. Unconscious Bias and techniques to address it. Perceptions of algorithmic bias and unfairness. Interventions to mitigate biases in systems. Methods and tools for enhancing fairness in algorithms (e.g., IEEE P7003 TM).

Model Governance and Explainable AI - Part 2

Principles and Strategies for designing accountable algorithms and systems. Trade-offs between privacy and transparency. Tools and methodologies for conducting algorithm audits (e.g., Algorithmic Impact Assessments).

Module Teaching and Learning (including formative assessment) Strategy

The classroom teaching and learning strategy in the Data Governance, Ethics, and Sustainability module will consist of lectures, tutorials, case studies, paper reviews, and practical work where learners will engage with and explore various real-world scenarios in topics including data management and governance, sustainability, ethics, privacy and data protection, and algorithmic decision-making systems. Each week students will attend a 2-hour lecture and a 1-hou tutorial session. Lectures will include active learning components such as group discussions, problem solving, and class feedback. Tutorials will comprise group work and individual learning and will focus on critical analysis of research papers and case studies on related topics. Learners will also have access to research documents and publications as required. The module will include formative assessments, which will consist of the analysis of case studies and group activities answering to open-ended questions. In-class discussions and oral feedback will be provided throughout these activities.

All module resources are made available to learners via the Moodle learning management system. These will typically consist of lecture notes, exercise files, case studies, news items (e.g., a story relating to algorithmic bias in the news), links to online resources (e.g., videos, quizzes), and structured assignments with opportunities for feedback.

Work-based learning and practice placement

E-Learning

Module Physical resource requirements

Specifications for module staffing requirements

Sample assessment materials

Timetabling, learner effort and credit

Module assessment rationale

Affiliated Entities

Entity Code	Entity Title	Entity Version	Entity Type	Via	Outcome
MSCDA	MSc in Data Analytics	3.0	Programme		Yes
MSCDA	MSc in Data Analytics	4.0	Programme		Yes
PGDDA	Post Graduate Diploma in Science in Data Analytics	3.0	Programme		Yes

Documents

No Documents

9DMML: Data Mining & Machine Learning (Core Subject)

Module Code:	9DMML
Long Title	Data Mining & Machine Learning APPROVED
Title	Data Mining & Machine Learning
Module Level:	LEVEL 9
EQF Level:	7
Valid From:	2024 (July 2024)
Language of Instruction:	English
Duration:	1 Semester
Credits:	10
Field of Study:	0610 - Information and Communication Technologies (ICTs) not further defined or elsewhe
Learning Outcome Taxonomy	Blooms
Module Author:	Eileen Long
Authors	Long Eileen (10 July 2024 to ---)
Is this a capstone module?	No

Learning Outcomes	
On successful completion of this module the learner will be able to:	
#	**Learning Outcome Description**
LO1	Critically analyse fundamental data mining and knowledge discovery methodologies in order to assess best practice guidance when applied to data mining problems in specific contexts.
LO2	Extract, transform, explore, and clean data in preparation for data mining and machine learning.
LO3	Build and evaluate data mining and machine learning models on various datasets and problem domains.
LO4	Extract, interpret and evaluate information and knowledge from various datasets.
LO5	Critically review current data mining research and assess research methods applied in the field.

Learning Outcome Taxonomy Blooms					
#	LO1	LO2	LO3	LO4	LO5
C1					
C2					
C3			Y		
C4					
C5					
C6					
P1					
P2					
P3			Y		
P4			Y		
P5			Y		
P6					
P7			Y		
A1					
A2					
A3					
A4					
A5					

Learning Outcome Taxonomy Reference Blooms		
#	**Taxonomy Description**	**Taxonomy Group**
C1	Knowledge	Cognitive
C2	Comprehension	Cognitive
C3	Application	Cognitive
C4	Analysis	Cognitive
C5	Synthesis	Cognitive
C6	Evaluation	Cognitive
P1	Perception	Psychomotor (Technical Skills)
P2	Set	Psychomotor (Technical Skills)
P3	Guided Response	Psychomotor (Technical Skills)
P4	Mechanism	Psychomotor (Technical Skills)
P5	Complex Overt Response	Psychomotor (Technical Skills)
P6	Adaptation	Psychomotor (Technical Skills)
P7	Origination	Psychomotor (Technical Skills)
A1	Receiving to Phenomena	Affective (Humanities)
A2	Responding to Phenomena	Affective (Humanities)
A3	Valuing	Affective (Humanities)
A4	Organizing Values	Affective (Humanities)
A5	Internalizing Values	Affective (Humanities)

Programme Module Dependencies
No requisites

Dependencies

Module Content & Assessment

Indicative Content
1. Overview of Data Mining and Machine Learning 1.1) History and Evolution. Data science methodologies: KDD, CRISP-DM. Data Security. Taxonomy and overview of data mining and machine learning techniques. Regression and classification. Supervised, unsupervised, semi-supervised learning.
2. General data pre-processing and transformation strategies 2.1) Introduction to prediction/predictive models. Identifying and handling missing values. Looking for outliers. Transformations for single/multiple predictors. Adding/removing predictors. Binning. Feature selection.
3. Prediction models evaluation 3.1) Data Splitting and Sampling Methods (Holdout, Cross-fold Validation, Stratification, etc.). The Variance/Bias trade-off. Bootstrap and Jackknife. Evaluation metrics. Model tuning and overfitting. Determining the best model. Challenges with imbalanced data (e.g., fraud detection datasets).
4. Classification Models I 4.1) K-Nearest Neighbours. Naïve Bayes.
5. Classification Models II 5.1) Decision Trees. Pruning. Measures of node purity. Bagging. Boosting. Random Forests. Ensemble methods.
6. Classification Models III 6.1) Perceptron learning. Support Vector Machines. Kernel methods. Reproducing Kernel Hilbert Space.
7. Regression Models I 7.1) Quantitative methods of performance. Applications of Linear Regression models in data mining and machine learning contexts. K-Nearest Neighbours Regression. Rule-based Models. Regression Trees. Computing considerations.
8. Text Analytics I 8.1) Natural Language Processing (NLP). Text tokenisation. Stemming. Lemmatization. Parts of Speech (POS) Tagging. Parsing. Bag of Words Model. Named Entity Recognition. Text Vectorisation. Document Representation.
9. Text Analytics II 9.1) Topic Modelling. Latent Semantic Indexing. Latent Dirichlet Allocation. Document Summarisation. Sentiment Analysis.
10. Unsupervised Machine Learning 10.1) Notions of distance and similarity. Euclidian vs. non-Euclidian spaces. Clustering: k-means, k-medoids. Clustering for outlier detection. Plotting and understanding clusters. Cluster evaluation measures: DBIndex, WSSSE, scree plots. Hierarchical clustering approaches.
11. Association Rule Mining 11.1) Association Patterns. Frequent item-sets. Support, Confidence, and Lift. Association Rules Generation. Apriori Algorithm.
12. Recommender Systems 12.1) Collaborative Filtering. Content-based filtering. Hybrid and Knowledge-based approaches. Cold start problem. Scalability. Sparsity. Machine Learning techniques. Meta-data. Performance measures. Reproducibility and other factors.

Assessment Breakdown	%
Coursework	100.00%

Assessments

Coursework

Assessment Type:	Project	**% of total:**	100
Pass Marks:	0	**Assessment Date:**	Sem 1 End
Outcome addressed:	1,2,3,4,5	**Briefing:**	Sem 1 End
Feedback:	n/a	**Assessment Mode:**	Document
Assessment Medium:	Not yet determined	**Role:**	Not yet determined
Mandatory:	False	**Assessor:**	Not yet determined
Feedback Type:		**Non-Marked:**	No
Assessment Difficulty:	Not yet determined	**Central Admin:**	No
Language Proficiency:			

Assessment Description:
Produce a portfolio of studies that critically compare the performance of different machine learning methods applied to at least 3 related large datasets.

Coursework			
Assessment Type:	Project	**% of total:**	100
Pass Marks:	0	**Assessment Date:**	n/a
Outcome addressed:	1,2,3,4,5	**Briefing:**	n/a
Feedback:	n/a	**Assessment Mode:**	Not yet determined
Assessment Medium:	Not yet determined	**Role:**	Not yet determined
Mandatory:	False	**Assessor:**	Not yet determined
Feedback Type:		**Non-Marked:**	No
Assessment Difficulty:	Not yet determined	**Central Admin:**	No
Language Proficiency:			

Assessment Description:
Produce a portfolio of studies that critically compare the performance of different machine learning methods applied to at least 3 related large datasets.

Module Workload

Module Target Workload Hours 100 Hours

Full Time hours per semester	
Workload Type	
Lecture	
Independent Learning	
Tutorial	
	250.00

This module has no Apprenticeship workload.

This module has no Blended workload.

This module has no Block workload.

This module has no Distance/Correspondance workload.

This module has no Evening workload.

This module has no Online workload.

Part Time hours per semester	
Workload Type	
Lecture	
Tutorial	
Independent Learning	
Directed E-Learning	
	250.00

MLO Competency Mapping

Learning Outcomes	Competencies
LO1: Critically analyse fundamental data mining and knowledge discovery methodologies in order to assess best practice guidance when applied to data mining problems in specific contexts.	
LO2: Extract, transform, explore, and clean data in preparation for data mining and machine learning.	
LO3: Build and evaluate data mining and machine learning models on various datasets and problem domains.	
LO4: Extract, interpret and evaluate information and knowledge from various datasets.	
LO5: Critically review current data mining research and assess research methods applied in the field.	

Module Resources

Recommended Book Resources

Witten I. H., Frank E., Hall M. A. & Pal C. J. (2020). Data Mining: Practical machine learning tools and techniques. (4th ed.). Morgan Kaufmann. ISBN: 978-9351073895..

Lantz B. (2019). Machine learning with R. (3rd ed.). Packt Publishing Ltd. ISBN: 978-1788295864..

Kelleher, J. D., Mac Namee B., & D'Arcy A. (2020). Fundamentals of machine learning for predictive data analytics: algorithms, worked examples, and case studies. MIT Press. ISBN: 978-0262044691..

Supplementary Book Resources

Mueller A. C., Guido S. (2016). Introduction to machine learning with Python. O'Reilly. ISBN: 978-1449369415..

Han J., Pei J., & Kamber M. (2022). Data mining: concepts and techniques. (4th ed.). Morgan Kaufmann. ISBN: 978-0128117606..

Other Resources

[Website], UC Irvine Machine Learning Repository,
http://archive.ics.uci.edu/ml/

[Website], Kaggle platform for predictive modelling competitions,
https://www.kaggle.com/

[Website], Datasets for Data Mining and Data Science,
http://www.kdnuggets.com/datasets/index. html

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

[Website], Bloomberg,
https://www.bloomberg.com/europe

[Website], Yahoo! Finance,
https://uk.finance.yahoo.com

[Website], Google Finance,
https://www.google.com/finance

[Website], Central Statistics Office,
http://www.cso.ie

[Website], Eurostat,
http://ec.europa.eu/eurostat

[Website], Data.gov,
https://www.data.gov

[Website], Amazon Web Services Public Datasets,
https://aws.amazon.com/datasets

[Website], DataMarket,
https://datamarket.com

[Website], The Pew Research Centre,
http://www.pewresearch.org/data

[Website], The Fama-French Data Library,
http://mba.tuck.dartmouth.edu/pages/facu lty/ken.french/data_library.html

[Website], Federal Reserve Economic Data (FRED),
https://fred.stlouisfed.org

Review

Module Aims and Objectives

The objective of the Data Mining and Machine Learning module is to endow learners with practical skills in the areas of statistical learning, data mining, machine learning; and the related data preparation processes: handling missing values, dirty data, imbalanced data etc. This module will be framed within the KDD and CRISP-DM data mining methodologies as appropriate for the problems studied. In undertaking this module, learners will gain hands on experience with a range of fundamental techniques for prediction and classification problems using a variety of open data sets. Furthermore, a range of both supervised and unsupervised machine learning schemes are addressed. Core skills are developed in the area of text analytics, natural language processing, association rules mining, and recommender systems.

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

Information provided to learners about the module

The module specification is replicated in Akari Document, which is the College's repository of programme and module information. In order to ensure that this information is consistently presented, this is viewed as the primary source of information and is linked to in all systems, e.g. website links and Moodle, the College's virtual learning environment, Moodle etc. This is also the source of information for teaching staff in terms of guidance around assessment structure and requirements.

These specifications once approved are available via http://courses.ncirl.ie

This specification, where appropriate, is also used as the primary source of information for printed materials e.g. prospectus. In this case, until the module is approved in the context of the programme, information is indicative.

This information is further supplemented on an instance by instance basis by the individual lecturer teaching the module through the module handbook, which may be made available electronically via Moodle or in printed format. This document ensures that week by week activities, updated reading list and cohort specific information is current.

Module content, organisation and structure

Overview of Data Mining and Machine Learning

History and Evolution. Data science methodologies: KDD, CRISP-DM. Data Security. Taxonomy and overview of data mining and machine learning techniques. Regression and classification. Supervised, unsupervised, semi-supervised learning.

General data pre-processing and transformation strategies

Introduction to prediction/predictive models. Identifying and handling missing values. Looking for outliers. Transformations for single/multiple predictors. Adding/removing predictors. Binning. Feature selection.

Prediction models evaluation

Data Splitting and Sampling Methods (Holdout, Cross-fold Validation, Stratification, etc.). The Variance/Bias trade-off. Bootstrap and Jackknife. Evaluation metrics. Model tuning and overfitting. Determining the best model. Challenges with imbalanced data (e.g., fraud detection datasets).

Classification Models I

K-Nearest Neighbours. Naïve Bayes.

Classification Models II

Decision Trees. Pruning. Measures of node purity. Bagging. Boosting. Random Forests. Ensemble methods.

Classification Models III

Perceptron learning. Support Vector Machines. Kernel methods. Reproducing Kernel Hilbert Space.

Regression Models I

Quantitative methods of performance. Applications of Linear Regression models in data mining and machine learning contexts. K-Nearest Neighbours Regression. Rule-based Models. Regression Trees. Computing considerations.

Text Analytics I

Natural Language Processing (NLP). Text tokenisation. Stemming. Lemmatization. Parts of Speech (POS) Tagging. Parsing. Bag of Words Model. Named Entity Recognition. Text Vectorisation. Document Representation.

Text Analytics II

Topic Modelling. Latent Semantic Indexing. Latent Dirichlet Allocation. Document Summarisation. Sentiment Analysis.

Unsupervised Machine Learning

Notions of distance and similarity. Euclidian vs. non-Euclidian spaces. Clustering: k-means, k-medoids. Clustering for outlier detection. Plotting and understanding clusters. Cluster evaluation measures: DBIndex, WSSSE, scree plots. Hierarchical clustering approaches.

Association Rule Mining

Association Patterns. Frequent item-sets. Support, Confidence, and Lift. Association Rules Generation. Apriori Algorithm.

Recommender Systems

Collaborative Filtering. Content-based filtering. Hybrid and Knowledge-based approaches. Cold start problem. Scalability. Sparsity. Machine Learning techniques. Meta-data. Performance measures. Reproducibility and other factors.

Module Teaching and Learning (including formative assessment) Strategy

Learning will take place in a classroom environment and will feature both lectures and practical sessions for each topic. Materials and resources will be placed on Moodle, the College's virtual learning environment. Such materials may include: lecture notes, lab/tutorial descriptions, assessments, datasets, discussion groups, videos (e.g., created by lecturers or from external sources such as YouTube or Datacamp.com). The learners will also be provided with software tools (e.g., Python SciKit-Learn, R/RStudio, RapidMiner, Weka), for conducting the practical data analysis, mining and machine learning tutorials. Students may be required to work in groups during the labs/tutorials. Moodle may also be used to both interact with students and in some instances to provide formative assessments and feedback. Learners will have access to library resources, both physical and electronic, outside of the classroom where required. Students will also have access to learning, computing and maths support services.

Work-based learning and practice placement

E-Learning

Module Physical resource requirements

Specifications for module staffing requirements

Sample assessment materials

Timetabling, learner effort and credit

Module assessment rationale

Affiliated Entities

Entity Code	Entity Title	Entity Version	Entity Type	Via	Outcome
MSCDA	MSc in Data Analytics	3.0	Programme		Yes
MSCDA	MSc in Data Analytics	4.0	Programme		Yes
PGDDA	Post Graduate Diploma in Science in Data Analytics	3.0	Programme		Yes

Documents

No Documents

9INTERN: Internship
(Core Subject)

Module Code:	9INTERN
Long Title	Internship APPROVED
Title	Internship
Module Level:	LEVEL 9
EQF Level:	7
Valid From:	2024 (July 2024)
Language of Instruction:	English
Duration:	2 Semesters
Credits:	30
Field of Study:	0610 - Information and Communication Technologies (ICTs) not further defined or elsewhe
Learning Outcome Taxonomy	Blooms
Module Author:	Eileen Long
Authors	Long Eileen (05 September 2024 to ---)

Is this a capstone module?	No

Learning Outcomes

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

#	Learning Outcome Description
LO1	Propose a research question, project objectives and methodology.
LO2	Analyse, synthesise, and critically evaluate the state of the art.
LO3	Propose, architect, implement, and evaluate an ICT solution related to the programme area.
LO4	Investigate potential future research and invention disclosures.
LO5	Present and defend the project findings through a viva, artefact/product demo, and report.
LO6	Identify, assess, and resolve the ethical issues that need to be addressed when conducting research.
LO7	Demonstrate initiative whilst working alone or part of a team, and appropriate communication and interpersonal skills.

Learning Outcome Taxonomy Blooms

#	LO1	LO2	LO3	LO4	LO5	LO6	LO7
C1					Y		
C2					Y		
C3					Y		Y
C4				Y			
C5	Y				Y		
C6							
P1							
P2							
P3							
P4							
P5							Y
P6							
P7							
A1							
A2					Y		
A3	Y						Y
A4							
A5	Y						

Learning Outcome Taxonomy Reference Blooms		
#	**Taxonomy Description**	**Taxonomy Group**
C1	Knowledge	Cognitive
C2	Comprehension	Cognitive
C3	Application	Cognitive
C4	Analysis	Cognitive
C5	Synthesis	Cognitive
C6	Evaluation	Cognitive
P1	Perception	Psychomotor (Technical Skills)
P2	Set	Psychomotor (Technical Skills)
P3	Guided Response	Psychomotor (Technical Skills)
P4	Mechanism	Psychomotor (Technical Skills)
P5	Complex Overt Response	Psychomotor (Technical Skills)
P6	Adaptation	Psychomotor (Technical Skills)
P7	Origination	Psychomotor (Technical Skills)
A1	Receiving to Phenomena	Affective (Humanities)
A2	Responding to Phenomena	Affective (Humanities)
A3	Valuing	Affective (Humanities)
A4	Organizing Values	Affective (Humanities)
A5	Internalizing Values	Affective (Humanities)

Programme Module Dependencies
No requisites

Dependencies

Module Content & Assessment

Indicative Content
1. Research Questions and Literature Review and Novel Contribution 1.1) Structure and purpose of a literature review. Search tools and sources. Selecting and coping with literature. Identifying novel contribution.
2. Scientific Methodology, Research Questions and Literature Review 2.1) Exploring different research methodologies and assessing the context for these research methodologies. Formulating a research question. Ethics in research.
3. Computing Community and Resources 3.1) Planning software development and evaluation. User involvement. Descriptive, theory oriented and applied projects. Time and project management, making efficient use of time and resources to manage multiple tasks at the same time and reach the goals.
4. Academic Writing I 4.1) Proposal structure. Selection and assessing the quality of literature.
5. Academic Writing II 5.1) Project structure. Citations and referencing.
6. Academic Writing III 6.1) Presenting qualitative data. Presenting quantitative data.
7. Academic Writing IV 7.1) The importance of ethics and reproducibility in research.
8. Academic Writing V 8.1) Scientific writing and style considerations. Plagiarism and self-plagiarism.
9. Technical Information 9.1) Reading, understanding and summarising technical material, including source code, academic articles, patents, and documentation. Writing effective technical documentation and materials.
10. Ethics 10.1) Ethics considerations around human participants, secondary datasets. Ethics approval process.
11. Communication 11.1) Dynamics of oral, written, and electronic team and group communication
12. Project Proposal and Ethics Approval (Semester 2) 12.1) A project proposal must describe what the learner will investigate, the importance and relevance of the topic to the programme area, and how the learner intends to fulfil the project goals. The format of a project proposal varies between fields, but most proposals should contain at least these elements: introduction, research question, research objectives, literature review, artefact/approach design, evaluation methodology, implications and contribution to knowledge, and reference list. The proposal should address the ethics of the proposed study and the proposal should have ethics approval.
13. Internship activity report (Semester 3) 13.1) The internship activity report is a weekly summary of what the student has learned. The internship activity report must be completed by the students and signed off by the industry supervisor. A template of the internship activity report will be provided to the students.
14. Internship Project Report (Semester 3) 14.1) The internship project report is a paper style report. The report shall comprise up to 20 pages (4,000 to 6,000 words) and describes the individual research and production of an ICT solution. It shall follow the following format: introduction, background, design, implementation, results and discussion, and conclusion. A literature review should be included to situate the work in existing research. Learners are also required to critically analyse insights gained throughout the development and evaluation of their research application. In addition, learners should also identify future commercialisation opportunities and further research possibilities.

Assessment Breakdown	%
Coursework	100.00%

Assessments

Coursework

Assessment Type:	Project	**% of total:**	10
Pass Marks:	0	**Assessment Date:**	n/a
Outcome addressed:	1,2,3,4,5,6,7	**Briefing:**	n/a
Feedback:	n/a	**Assessment Mode:**	Not yet determined
Assessment Medium:	Not yet determined	**Role:**	Not yet determined
Mandatory:	False	**Assessor:**	Not yet determined
Feedback Type:		**Non-Marked:**	No
Assessment Difficulty:	Not yet determined	**Central Admin:**	No
Language Proficiency:			

Assessment Description:
Project proposal and Ethics Approval

Assessment Type:	Project	**% of total:**	5
Pass Marks:	0	**Assessment Date:**	n/a
Outcome addressed:	1,2,3,4,5,6,7	**Briefing:**	n/a
Feedback:	n/a	**Assessment Mode:**	Not yet determined
Assessment Medium:	Not yet determined	**Role:**	Not yet determined
Mandatory:	False	**Assessor:**	Not yet determined
Feedback Type:		**Non-Marked:**	No
Assessment Difficulty:	Not yet determined	**Central Admin:**	No
Language Proficiency:			

Assessment Description:
Project Specification

Assessment Type:	Project	**% of total:**	10
Pass Marks:	0	**Assessment Date:**	n/a
Outcome addressed:	1,2,3,4,5,6,7	**Briefing:**	n/a
Feedback:	n/a	**Assessment Mode:**	Not yet determined
Assessment Medium:	Not yet determined	**Role:**	Not yet determined
Mandatory:	False	**Assessor:**	Not yet determined
Feedback Type:		**Non-Marked:**	No
Assessment Difficulty:	Not yet determined	**Central Admin:**	No
Language Proficiency:			

Assessment Description:
Literature Review

Assessment Type:	Project	**% of total:**	30
Pass Marks:	0	**Assessment Date:**	n/a
Outcome addressed:	1,2,3,4,5,6,7	**Briefing:**	n/a
Feedback:	n/a	**Assessment Mode:**	Not yet determined
Assessment Medium:	Not yet determined	**Role:**	Not yet determined
Mandatory:	False	**Assessor:**	Not yet determined
Feedback Type:		**Non-Marked:**	No
Assessment Difficulty:	Not yet determined	**Central Admin:**	No
Language Proficiency:			

Assessment Description:
Artefact/Product Development

Assessment Type:	Project	**% of total:**	25
Pass Marks:	0	**Assessment Date:**	n/a
Outcome addressed:	1,2,3,4,5,6,7	**Briefing:**	n/a
Feedback:	n/a	**Assessment Mode:**	Not yet determined
Assessment Medium:	Not yet determined	**Role:**	Not yet determined
Mandatory:	False	**Assessor:**	Not yet determined
Feedback Type:		**Non-Marked:**	No
Assessment Difficulty:	Not yet determined	**Central Admin:**	No
Language Proficiency:			

Assessment Description:
Artefact/Product Evaluation and Analysis

Coursework

Assessment Type:	Project	**% of total:**	10
Pass Marks:	0	**Assessment Date:**	n/a
Outcome addressed:	1,2,3,4,5,6,7	**Briefing:**	n/a
Feedback:	n/a	**Assessment Mode:**	Not yet determined
Assessment Medium:	Not yet determined	**Role:**	Not yet determined
Mandatory:	False	**Assessor:**	Not yet determined
Feedback Type:		**Non-Marked:**	No
Assessment Difficulty:	Not yet determined	**Central Admin:**	No
Language Proficiency:			

Assessment Description:
Document Presentation/Structure, Referencing, and Configuration Manual

Assessment Type:	Presentation	**% of total:**	10
Pass Marks:	0	**Assessment Date:**	n/a
Outcome addressed:	1,2,3,4,5,6,7	**Briefing:**	n/a
Feedback:	n/a	**Assessment Mode:**	Not yet determined
Assessment Medium:	Not yet determined	**Role:**	Not yet determined
Mandatory:	False	**Assessor:**	Not yet determined
Feedback Type:		**Non-Marked:**	No
Assessment Difficulty:	Not yet determined	**Central Admin:**	No
Language Proficiency:			

Assessment Description:
Viva

Coursework

Assessment Type:	Project	**% of total:**	10
Pass Marks:	0	**Assessment Date:**	n/a
Outcome addressed:	1,2,3,4,5,6,7	**Briefing:**	n/a
Feedback:	n/a	**Assessment Mode:**	Not yet determined
Assessment Medium:	Not yet determined	**Role:**	Not yet determined
Mandatory:	False	**Assessor:**	Not yet determined
Feedback Type:		**Non-Marked:**	No
Assessment Difficulty:	Not yet determined	**Central Admin:**	No
Language Proficiency:			

Assessment Description:
Project proposal and Ethics Approval

Assessment Type:	Project	**% of total:**	5
Pass Marks:	0	**Assessment Date:**	n/a
Outcome addressed:	1,2,3,4,5,6,7	**Briefing:**	n/a
Feedback:	n/a	**Assessment Mode:**	Not yet determined
Assessment Medium:	Not yet determined	**Role:**	Not yet determined
Mandatory:	False	**Assessor:**	Not yet determined
Feedback Type:		**Non-Marked:**	No
Assessment Difficulty:	Not yet determined	**Central Admin:**	No
Language Proficiency:			

Assessment Description:
Project Specification

Assessment Type:	Project	**% of total:**	10
Pass Marks:	0	**Assessment Date:**	n/a
Outcome addressed:	1,2,3,4,5,6,7	**Briefing:**	n/a
Feedback:	n/a	**Assessment Mode:**	Not yet determined
Assessment Medium:	Not yet determined	**Role:**	Not yet determined
Mandatory:	False	**Assessor:**	Not yet determined
Feedback Type:		**Non-Marked:**	No
Assessment Difficulty:	Not yet determined	**Central Admin:**	No
Language Proficiency:			

Assessment Description:
Literature Review

Coursework

Assessment Type:	Project	**% of total:**	30
Pass Marks:	0	**Assessment Date:**	n/a
Outcome addressed:	1,2,3,4,5,6,7	**Briefing:**	n/a
Feedback:	n/a	**Assessment Mode:**	Not yet determined
Assessment Medium:	Not yet determined	**Role:**	Not yet determined
Mandatory:	False	**Assessor:**	Not yet determined
Feedback Type:		**Non-Marked:**	No
Assessment Difficulty:	Not yet determined	**Central Admin:**	No
Language Proficiency:			

Assessment Description:
Artefact/Product Development

Assessment Type:	Project	**% of total:**	25
Pass Marks:	0	**Assessment Date:**	n/a
Outcome addressed:	1,2,3,4,5,6,7	**Briefing:**	n/a
Feedback:	n/a	**Assessment Mode:**	Not yet determined
Assessment Medium:	Not yet determined	**Role:**	Not yet determined
Mandatory:	False	**Assessor:**	Not yet determined
Feedback Type:		**Non-Marked:**	No
Assessment Difficulty:	Not yet determined	**Central Admin:**	No
Language Proficiency:			

Assessment Description:
Artefact/Product Evaluation and Analysis

Assessment Type:	Project	**% of total:**	10
Pass Marks:	0	**Assessment Date:**	n/a
Outcome addressed:	1,2,3,4,5,6,7	**Briefing:**	n/a
Feedback:	n/a	**Assessment Mode:**	Not yet determined
Assessment Medium:	Not yet determined	**Role:**	Not yet determined
Mandatory:	False	**Assessor:**	Not yet determined
Feedback Type:		**Non-Marked:**	No
Assessment Difficulty:	Not yet determined	**Central Admin:**	No
Language Proficiency:			

Assessment Description:
Document Presentation/Structure, Referencing, and Configuration Manual

Assessment Type:	Presentation	**% of total:**	10
Pass Marks:	0	**Assessment Date:**	n/a
Outcome addressed:	1,2,3,4,5,6,7	**Briefing:**	n/a
Feedback:	n/a	**Assessment Mode:**	Not yet determined
Assessment Medium:	Not yet determined	**Role:**	Not yet determined
Mandatory:	False	**Assessor:**	Not yet determined
Feedback Type:		**Non-Marked:**	No
Assessment Difficulty:	Not yet determined	**Central Admin:**	No
Language Proficiency:			

Assessment Description:
Viva

Module Workload

Module Target Workload Hours 300 Hours

Full Time hours per semester

Workload Type	
Lecture	
Independent Learning Time	
Workbased learning	
Tutorial	
Lecturer Supervised Learning	
	750.00

This module has no Apprenticeship workload.

This module has no Blended workload.

This module has no Block workload.
This module has no Distance/Correspondance workload.
This module has no Evening workload.
This module has no Online workload.

Part Time hours per semester
Workload Type
Lecture
Tutorial
Lecturer Supervised Learning
Independent Learning
Workbased learning
750.00

MLO Competency Mapping

Learning Outcomes	Competencies
LO1: Propose a research question, project objectives and methodology.	
LO2: Analyse, synthesise, and critically evaluate the state of the art.	
LO3: Propose, architect, implement, and evaluate an ICT solution related to the programme area.	
LO4: Investigate potential future research and invention disclosures.	
LO5: Present and defend the project findings through a viva, artefact/product demo, and report.	
LO6: Identify, assess, and resolve the ethical issues that need to be addressed when conducting research.	
LO7: Demonstrate initiative whilst working alone or part of a team, and appropriate communication and interpersonal skills.	

Module Resources

Recommended Book Resources

John W. Creswell,J. David Creswell. (2022), Research Design, Sage Publications, Incorporated, p.0, [ISBN: 978-1071817940].

Justin Zobel. (2015), Writing for Computer Science, Springer, p.0, [ISBN: 978-1447166382].

Christian Dawson. (2015), Projects in Computing and Information Systems, Prentice Hall, p.0, [ISBN: 978-1292073460].

Supplementary Book Resources

Gary Thomas. (2017), How to Do Your Research Project, SAGE Publications Limited, p.0, [ISBN: 978-1473948860].

Justin Kitzes,Daniel Turek,Fatma Deniz. (2018), The Practice of Reproducible Research, Univ of California Press, p.364, [ISBN: 978-0520294745].

David Evans,Paul Gruba,Justin Zobel. (2014), How to Write a Better Thesis, Springer, p.167, [ISBN: 978-3319042855].

Diana Ridley. (2012), The Literature Review, SAGE Publications, p.233, [ISBN: 978-1446201435].

Other Resources

[Website], http://www.patentsoffice.ie,
http://www.patentsoffice.ie

[Website], http://www.epo.org/searching/free/espace net.html,
http://www.epo.org/searching/free/espace net.html

[Website], Prof Alan Bundy, University of Edinburgh How to Write an Informatics Paper,
http://homepages.inf.ed.ac.uk/bundy/how- tos/writingGuide.html

Review

Module Aims and Objectives

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

Information provided to learners about the module

Module content, organisation and structure

The module content is organised over two semesters with workshops and assignment of supervisors taking place in Semester 2, while Semester 3 consists exclusively of supervision.

For classroom-based teaching in semester 2 the internship is scheduled based on 1-hour lecture and 2 hours lab over 12 weeks. In semester 3 the classroom is scheduled based on supervising the student for 1 hour per week over 12 weeks.

For online learning in semester 2 the internship is scheduled based on 1-hour lecture and 1-hour lab and 1-hour directed eLearning over 12 weeks. In semester 3 the classroom is scheduled based on supervising the student for 1 hour per week over 12 weeks.

An indicative schedule of topics to be addressed each week in Semester 2 is outlined below:

Research Questions and Literature Review and Novel Contribution

Structure and purpose of a literature review. Search tools and sources. Selecting and coping with literature. Identifying novel contribution.

Scientific Methodology, Research Questions and Literature Review

Exploring different research methodologies and assessing the context for these research methodologies. Formulating a research question. Ethics in research.

Computing Community and Resources

Planning software development and evaluation. User involvement. Descriptive, theory oriented and applied projects. Time and project management, making efficient use of time and resources to manage multiple tasks at the same time and reach the goals.

Academic Writing I

Proposal structure. Selection and assessing the quality of literature.

Academic Writing II

Project structure. Citations and referencing.

Academic Writing III

Presenting qualitative data. Presenting quantitative data.

Academic Writing IV

The importance of ethics and reproducibility in research.

Academic Writing V

Scientific writing and style considerations. Plagiarism and self-plagiarism.

Technical Information

Reading, understanding and summarising technical material, including source code, academic articles, patents, and documentation. Writing effective technical documentation and materials.

Ethics

Ethics considerations around human participants, secondary datasets. Ethics approval process.

Communication

Dynamics of oral, written, and electronic team and group communication

In Semester 2, learners submit a portfolio that consists of a project proposal with Ethics Approval. In Semester 3, learners submit an internship project report, an artefact/product, a user configuration manual, a presentation to be defended in a viva, and an invention disclosure form (if applicable). A demonstration of the artefact/product developed may presented in the viva.

Learners that wish to commercialise their project work or a project related technology can explore this path. In this case, the learner will be required to complete an invention disclosure form (IDF) that identifies the potential commercial opportunities and explores the related markets.

The work for the project will be carried out in an ICT related business environment and an internship activity report also must be submitted. This report is completed monthly and describes learner's activities and the designated business environment.

Project Proposal and Ethics Approval (Semester 2)

A project proposal must describe what the learner will investigate, the importance and relevance of the topic to the programme area, and how the learner intends to fulfil the project goals. The format of a project proposal varies between fields, but most proposals should contain at least these elements: introduction, research question, research objectives, literature review, artefact/approach design, evaluation methodology, implications and contribution to knowledge, and reference list. The proposal should address the ethics of the proposed <span style="-webkit-user-drag:none;padding:0px;user-select:text;background-position:0px 100%;background-repeat:repeat-x;background-image:var(--urlContextualSpellingAndGrammarErrorV2,url('data:image/svg+xml;border-bottom:1px solid transparent;">study and the proposal should have ethics approval.

Internship activity report (Semester 3)

The internship activity report is a weekly summary of what the student has learned. The internship activity report must be completed by the students and signed off by the industry supervisor. A template of the internship activity report will be provided to the students.

Internship Project Report (Semester 3)

The internship project report is a paper style report. The report shall comprise up to 20 pages (4,000 to 6,000 words) and describes the individual research and production of an ICT solution. It shall follow the following format: introduction, background, design, implementation, results and discussion, and conclusion. A literature review should be included situate the work in existing research. Learners are also required to critically analyse insights gained throughout the development and evaluation of their research application. In addition, learners should also identify future commercialisation opportunities and further research possibilities.

Throughout the project learners are required to engage in formative assessments to evaluate their progress. The format of a project report varies between fields, but most reports should contain at least these elements:

<li aria-setsize="-1" data-aria-level="1" data-aria-posinset="10" data-font="Symbol" data-leveltext="" data-list-defn-props="{"335552541":1,"335559685":720,"335559991":360,"469769226":"Symbol","469769242":[8226],"469777803":"left","469777804":"","469777815":"hybridMultilevel"}" data-listid="19" role="listitem" style="-webkit-user-drag:none;margin:0px 0px 0px 24px;padding:0px;user-select:text;clear:both;cursor:text;overflow:visible;position:relative;direction:ltr;display:block;font-size:11pt;font-family:Calibri, Calibri_MSFontService, sans-serif;vertical-align:baseline;"> Abstract: The role of the abstract is to summarise the project undertaken in a concise manner, highlighting the scope of the project, the objectives, the methodology and its finding and results.
<li aria-setsize="-1" data-aria-level="1" data-aria-posinset="11" data-font="Symbol" data-leveltext="" data-list-defn-props="{"335552541":1,"335559685":720,"335559991":360,"469769226":"Symbol","469769242":[8226],"469777803":"left","469777804":"","469777815":"hybridMultilevel"}" data-listid="19" role="listitem" style="-webkit-user-drag:none;margin:0px 0px 0px 24px;padding:0px;user-select:text;clear:both;cursor:text;overflow:visible;position:relative;direction:ltr;display:block;font-size:11pt;font-family:Calibri, Calibri_MSFontService, sans-serif;vertical-align:baseline;"> Introduction: The main purpose of the introduction is to motivate the contribution of the research work. It should include background on the topic, the justification for the topic, and what gap in the literature it seeks to fill, the main research questions and objectives, novel contribution, and the organisation of the report.
<li aria-setsize="-1" data-aria-level="1" data-aria-posinset="12" data-font="Symbol" data-leveltext="" data-list-defn-props="{"335552541":1,"335559685":720,"335559991":360,"469769226":"Symbol","469769242":[8226],"469777803":"left","469777804":"","469777815":"hybridMultilevel"}" data-listid="19" role="listitem" style="-webkit-user-drag:none;margin:0px 0px 0px 24px;padding:0px;user-select:text;clear:both;cursor:text;overflow:visible;position:relative;direction:ltr;display:block;font-size:11pt;font-family:Calibri, Calibri_MSFontService, sans-serif;vertical-align:baseline;"> Literature Review: The literature review should demonstrate evidence of independent research critically analysing the potential of an application/idea and provide insights into how it can be implemented and evaluated.
<li aria-setsize="-1" data-aria-level="1" data-aria-posinset="13" data-font="Symbol" data-leveltext="" data-list-defn-props="{"335552541":1,"335559685":720,"335559991":360,"469769226":"Symbol","469769242":[8226],"469777803":"left","469777804":"","469777815":"hybridMultilevel"}" data-listid="19" role="listitem" style="-webkit-user-drag:none;margin:0px 0px 0px 24px;padding:0px;user-select:text;clear:both;cursor:text;overflow:visible;position:relative;direction:ltr;display:block;font-size:11pt;font-family:Calibri, Calibri_MSFontService, sans-serif;vertical-align:baseline;"> Design Specification: The techniques and/or architecture/framework that underlie the implementation and the associated requirements are discussed.
<li aria-setsize="-1" data-aria-level="1" data-aria-posinset="14" data-font="Symbol" data-leveltext="" data-list-defn-props="{"335552541":1,"335559685":720,"335559991":360,"469769226":"Symbol","469769242":[8226],"469777803":"left","469777804":"","469777815":"hybridMultilevel"}" data-listid="19" role="listitem" style="-webkit-user-drag:none;margin:0px 0px 0px 24px;padding:0px;user-select:text;clear:both;cursor:text;overflow:visible;position:relative;direction:ltr;display:block;font-size:11pt;font-family:Calibri, Calibri_MSFontService, sans-serif;vertical-align:baseline;"> Implementation/Solution Development: Learners develop a solution that addresses the research question(s)/objective(s). This may involve the development of an application prototype, the design of an algorithm, the implementation of an innovative service or component of a system.
<li aria-setsize="-1" data-aria-level="1" data-aria-posinset="15" data-font="Symbol" data-leveltext="" data-list-defn-props="{"335552541":1,"335559685":720,"335559991":360,"469769226":"Symbol","469769242":[8226],"469777803":"left","469777804":"","469777815":"hybridMultilevel"}" data-listid="19" role="listitem" style="-webkit-user-drag:none;margin:0px 0px 0px 24px;padding:0px;user-select:text;clear:both;cursor:text;overflow:visible;position:relative;direction:ltr;display:block;font-size:11pt;font-family:Calibri, Calibri_MSFontService, sans-serif;vertical-align:baseline;"> Experiments: Learners outline the proposed approach, method, and experiments used to generate the results, as well as demonstrating how the method will be applied to answering/achieve the research question(s)/objective(s).
<li aria-setsize="-1" data-aria-level="1" data-aria-posinset="16" data-font="Symbol" data-leveltext="" data-list-defn-props="{"335552541":1,"335559685":720,"335559991":360,"469769226":"Symbol","469769242":[8226],"469777803":"left","469777804":"","469777815":"hybridMultilevel"}" data-listid="19" role="listitem" style="-webkit-user-drag:none;margin:0px 0px 0px 24px;padding:0px;user-select:text;clear:both;cursor:text;overflow:visible;position:relative;direction:ltr;display:block;font-size:11pt;font-family:Calibri, Calibri_MSFontService, sans-serif;vertical-align:baseline;"> Results and Discussion: A comprehensive evaluation must be conducted by each learner using multiple strategies, example; an algorithm may be benchmarked by performance specific metrics whilst an internet application or mobile application may be evaluated using suitable usability testing techniques. Statistical tools should be used when appropriate to critically evaluate, assess, and analyse the experimental research outputs and levels of significance.
<li aria-setsize="-1" data-aria-level="1" data-aria-posinset="17" data-font="Symbol" data-leveltext="" data-list-defn-props="{"335552541":1,"335559685":720,"335559991":360,"469769226":"Symbol","469769242":[8226],"469777803":"left","469777804":"","469777815":"hybridMultilevel"}" data-listid="19" role="listitem" style="-webkit-user-drag:none;margin:0px 0px 0px 24px;padding:0px;user-select:text;clear:both;cursor:text;overflow:visible;position:relative;direction:ltr;display:block;font-size:11pt;font-family:Calibri, Calibri_MSFontService, sans-serif;vertical-align:baseline;"> Conclusion and Future Work: Learners must arrive at a conclusion from their research question(s)/objective(s) as defined. A detailed future work section must be included showing the learners understanding of their own research and opportunities for future improvements.
<li aria-setsize="-1" data-aria-level="1" data-aria-posinset="18" data-font="Symbol" data-leveltext="" data-list-defn-props="{"335552541":1,"335559685":720,"335559991":360,"469769226":"Symbol","469769242":[8226],"469777803":"left","469777804":"","469777815":"hybridMultilevel"}" data-listid="19" role="listitem" style="-webkit-user-drag:none;margin:0px 0px 0px 24px;padding:0px;user-select:text;clear:both;cursor:text;overflow:visible;position:relative;direction:ltr;display:block;font-size:11pt;font-family:Calibri, Calibri_MSFontService, sans-serif;vertical-align:baseline;"> References: Correct citation references must be included.

Artefact/Product

An artefact/product can represent a software application that demonstrates a novel invention. An artefact/product can also represent a phenomenon that is observed in a scientific investigation or experiment that is not naturally present but occurs <span style="-webkit-user-drag:none;padding:0px;user-select:text;background-position:0px 100%;background-repeat:repeat-x;background-image:var(--urlAdvancedProofingIssueV2,url("data:image/svg+xml;border-bottom:1px solid transparent;">as a result of the preparative or investigative procedure.

User Configuration Manual

The configuration manual shall describe the required software tools and settings to successfully replicate the experimental setup. This manual is submitted separately from the research paper style <span style="-webkit-user-drag:none;padding:0px;user-select:text;background-position:0px 100%;background-repeat:repeat-x;background-image:var(--urlContextualSpellingAndGrammarErrorV2,url("data:image/svg+xml;border-bottom:1px solid transparent;">report and it will not count towards the suggested word count. It should not discuss only how to install standard software or tools.

Viva

The viva shall involve a presentation of the research work carried out and a demonstration of the results including a demo of the developed artefact/product.

Invention Disclosure Form

IDF identifies the potential commercial opportunities and explores the related markets. The IDF describes the invention, highlights the novelty/patentable aspect, what the problem is and how the invention solves the problem, identifies the companies that are interested in the invention, and potential commercial application of the invention.

Module Teaching and Learning (including formative assessment) Strategy

The learning strategy entails the use of workshops and academic seminars to provide learners with a solid foundation of the latest computing research avenues in the knowledge domain of the given programme.

Learning will may place in a classroom or blended environment and will feature both lectures and practical sessions for each topic. Materials and resources will be placed on Moodle, the College's virtual learning environment. Such materials may include lecture notes, lab/tutorial descriptions, assessments, datasets, discussion groups, videos (e.g., crea by lecturers or from external sources such as YouTube). Where appropriate, this module may make use of the flipped classroom approach.

The learners will also be directed to software tools appropriate to specific topics in the module, e.g.

<li aria-setsize="-1" data-aria-level="1" data-aria-posinset="4" data-font="Symbol" data-leveltext="" data-list-defn-props="{"335552541":1,"335559685":720,"335559991":360,"469769226":"Symbol","469769242":[8226],"469777803":"left","469777804":"","469777815":"hybridMultilevel"}" data-listid="20" role="listitem" style="-webkit-user-drag:none;margin:0px 0px 0px 24px;padding:0px;user-select:text;clear:both;cursor:text;overflow:visible;position:relative;direction:ltr;display:block;font-size:11pt;font-family:Calibri, Calibri_MSFontService, sans-serif;vertical-align:baseline;"> Scopus, Google Scholar, Mendeley, Zotero, <span style="-webkit-user-drag:none;padding:0px;user-select:text;background-position:0px 100%;background-repeat:repeat-x;background-image:var(--urlSpellingErrorV2,url("data:image/svg+xml;border-bottom:1px solid transparent;">JabRef, etc. for executing and organising the results of literature searches
<li aria-setsize="-1" data-aria-level="1" data-aria-posinset="5" data-font="Symbol" data-leveltext="" data-list-defn-props="{"335552541":1,"335559685":720,"335559991":360,"469769226":"Symbol","469769242":[8226],"469777803":"left","469777804":"","469777815":"hybridMultilevel"}" data-listid="20" role="listitem" style="-webkit-user-drag:none;margin:0px 0px 0px 24px;padding:0px;user-select:text;clear:both;cursor:text;overflow:visible;position:relative;direction:ltr;display:block;font-size:11pt;font-family:Calibri, Calibri_MSFontService, sans-serif;vertical-align:baseline;"> Tools such as <span style="-webkit-user-drag:none;padding:0px;user-select:text;background-position:0px 100%;background-repeat:repeat-x;background-image:var(--urlSpellingErrorV2,url("data:image/svg+xml;border-bottom:1px solid transparent;">Jupyter Notebooks, Git/GitHub for literate programming, reproducible research, and version control
<li aria-setsize="-1" data-aria-level="1" data-aria-posinset="6" data-font="Symbol" data-leveltext="" data-list-defn-props="{"335552541":1,"335559685":720,"335559991":360,"469769226":"Symbol","469769242":[8226],"469777803":"left","469777804":"","469777815":"hybridMultilevel"}" data-listid="20" role="listitem" style="-webkit-user-drag:none;margin:0px 0px 0px 24px;padding:0px;user-select:text;clear:both;cursor:text;overflow:visible;position:relative;direction:ltr;display:block;font-size:11pt;font-family:Calibri, Calibri_MSFontService, sans-serif;vertical-align:baseline;"> Microsoft Project and <span style="-webkit-user-drag:none;padding:0px;user-select:text;background-position:0px 100%;background-repeat:repeat-x;background-image:var(--urlContextualSpellingAndGrammarErrorV2,url("data:image/svg+xml;border-bottom:1px solid transparent;">open source tools <span style="-webkit-user-drag:none;padding:0px;user-select:text;background-position:0px 100%;background-repeat:repeat-x;background-image:var(--urlAdvancedProofingIssueV2,url("data:image/svg+xml;border-bottom:1px solid transparent;">for the production of project plans and Gantt charts.

Learners may be required to work in groups during the labs/tutorials. Moodle may also be used to both interact with learners and in some instances to provide formative assessments and feedback. Learners will have access to library resources, both physical and electronic, outside of the classroom where required.

Supervisors monitor the individual progress and provide guidance on the project. Techniques such online notes/information available on Moodle, links to extra material available on the Internet, Moodle forum may be used. Learners may also use collaborative tools for the development of the project. All documents required to be provided as part of the assessment will be submitted online on Moodle. The use of Git repositories will be encouraged as a collaborative tool to enable students to work on the development of the project. It will also improve the transparency of projects for markers as it will enable them to clearly identify the work carried out by students as part of the project.

Work-based learning and practice placement

E-Learning

Module Physical resource requirements

Specifications for module staffing requirements

Sample assessment materials

Timetabling, learner effort and credit

Module assessment rationale

Affiliated Entities

Entity Code	Entity Title	Entity Version	Entity Type	Via	Outcome
MSCDA	MSc in Data Analytics	3.0	Programme		Yes
MSCDA	MSc in Data Analytics	4.0	Programme		Yes

Documents

No Documents

H9SAO: Statistics & Optimisation
(Core Subject)

Module Code:	H9SAO
Long Title	Statistics & Optimisation APPROVED
Title	Statistics & Optimisation
Module Level:	LEVEL 9
EQF Level:	7
Valid From:	2024 (July 2024)
Language of Instruction:	English
Duration:	1 Semester
Credits:	10
Field of Study:	0610 - Information and Communication Technologies (ICTs) not further defined or elsewhe
Learning Outcome Taxonomy	Blooms
Module Author:	Shauni Hegarty
Authors	Hegarty Shauni (10 July 2024 to ---)
Is this a capstone module?	No

Learning Outcomes	
On successful completion of this module the learner will be able to:	
#	**Learning Outcome Description**
LO1	Apply appropriate statistical inference techniques to the analysis of data across a variety of domains.
LO2	Interpret the results from statistical software packages and programming languages and report on them in a comprehensive, ethical and professional manner.
LO3	Critically evaluate, select and apply regression models appropriate to a given problem domain.
LO4	Critically appraise, select and apply suitable modelling and forecasting techniques for time series data.
LO5	Comprehend, select and apply appropriate optimisation strategies according to chosen criteria.

Learning Outcome Taxonomy Blooms					
#	LO1	LO2	LO3	LO4	LO5
C1					
C2		Y			
C3	Y	Y			
C4					
C5					
C6		Y			
P1					
P2					
P3					
P4					
P5					
P6					
P7					
A1					
A2					
A3					
A4					
A5		Y			

Learning Outcome Taxonomy Reference Blooms		
#	**Taxonomy Description**	**Taxonomy Group**
C1	Knowledge	Cognitive
C2	Comprehension	Cognitive
C3	Application	Cognitive
C4	Analysis	Cognitive
C5	Synthesis	Cognitive
C6	Evaluation	Cognitive
P1	Perception	Psychomotor (Technical Skills)
P2	Set	Psychomotor (Technical Skills)
P3	Guided Response	Psychomotor (Technical Skills)
P4	Mechanism	Psychomotor (Technical Skills)
P5	Complex Overt Response	Psychomotor (Technical Skills)
P6	Adaptation	Psychomotor (Technical Skills)
P7	Origination	Psychomotor (Technical Skills)
A1	Receiving to Phenomena	Affective (Humanities)
A2	Responding to Phenomena	Affective (Humanities)
A3	Valuing	Affective (Humanities)
A4	Organizing Values	Affective (Humanities)
A5	Internalizing Values	Affective (Humanities)

Programme Module Dependencies
No requisites

Dependencies

Module Content & Assessment

Indicative Content
1. Review of Fundamental Statistical Concepts 1.1) Hypothesis testing – the t test and Analysis of Variance (ANOVA). Sampling estimation & confidence intervals, effective size and statistical power. Non-parametric tests.
2. Linear Regression I 2.1) Model accuracy. Qualitative variables. Transformations. Collinearity & collinearity diagnostics / VIF Diagnostics for leverage and influence. Heteroscedasticity in regression models. Correlation of error terms Non-linearity of data. Use of statistical software & R/Python to estimate regression models.
3. Linear Regression II 3.1) Principles of regression model building. Model selection using adjusted R2, AIC, BIC and Mallow's Cp. Variable selection techniques. Modelling interactions. Use of statistical software & R/Python to estimate regression models.
4. Logistic Regression 4.1) Principles of binary logistic regression. Odds & odds ratios. The logit transformation. Maximum likelihood estimation. Interpreting logistic regression coefficients. Evaluating contribution of predictors using the Wald statistic. Practical estimation of and prediction using logistic regression models using statistical software & R/Python.
5. Advanced Regression Models 5.1) Partial Least Squares regression, Regularised regression, Generalised Linear Models and Generalised Additive Models.
6. Time Series I 6.1) Time Series decomposition. Stationarity. Data transformations. Mean & Linear Trend models. Random walk models. Simple smoothing models. Auto-regressive and moving average models. Orders of AR and MA terms. Applications of time series forecasting. Estimation of basic time series models.
7. Time Series II 7.1) Non-seasonal and seasonal ARIMA models. Estimation of ARIMA models.
8. Time Series III 8.1) Regression with ARIMA errors (ARIMAX). Vector Autoregressive (VAR) models and the Vector Error Correction Model (VECM).
9. Discrete optimisation 9.1) Integer programming, Linear Programming, Constraint programming
10. Multi-objective optimisation 10.1) Classical methods, advanced methods, Pareto optimality.
11. Metaheuristic optimisation techniques 11.1) Fitness landscapes. Local search. Simulated annealing. Tabu search. Variable neighbourhood search
12. Evolutionary algorithms for optimisation 12.1) Genetic algorithms. Swarm intelligence. Memetic algorithms, Swarm intelligence.

Assessment Breakdown	%
Coursework	35.00%
End of Module Assessment	65.00%

Assessments

Coursework

Assessment Type:	Continuous Assessment	**% of total:**	35
Pass Marks:	0	**Assessment Date:**	Sem 1 End
Outcome addressed:	1,2,3,4	**Briefing:**	Sem 1 End
Feedback:	Sem 1 End	**Assessment Mode:**	Document
Assessment Medium:	Written	**Role:**	Not yet determined
Mandatory:	False	**Assessor:**	Not yet determined
Feedback Type:		**Non-Marked:**	No
Assessment Difficulty:	Not yet determined	**Central Admin:**	No
Language Proficiency:			

Assessment Description:
Learners will be directed towards appropriate datasets and asked to produce a statistical report that incorporates the estimation of statistical models and reports findings in an appropriate manner. Estimation using some/all of multiple linear regression, logistic regression, time series analysis and dimension reduction techniques is likely to be required.

End of Module Assessment

Assessment Type:	Terminal Exam	**% of total:**	65
Pass Marks:	0	**Assessment Date:**	End-of-Semester
Outcome addressed:	1,2,3,4,5	**Briefing:**	End-of-Semester
Feedback:	End-of-Semester	**Assessment Mode:**	Exam
Assessment Medium:	Written	**Role:**	Not yet determined
Mandatory:	False	**Assessor:**	Not yet determined
Feedback Type:		**Non-Marked:**	No
Assessment Difficulty:	Not yet determined	**Central Admin:**	No
Language Proficiency:			

Assessment Description:
End of semester examination session The examination will be of two hours duration and may include a mix of: theoretical, applied and interpretation questions.

Coursework

Assessment Type:	Continuous Assessment	**% of total:**	35
Pass Marks:	0	**Assessment Date:**	n/a
Outcome addressed:	1,2,3,4	**Briefing:**	n/a
Feedback:	n/a	**Assessment Mode:**	Not yet determined
Assessment Medium:	Not yet determined	**Role:**	Not yet determined
Mandatory:	False	**Assessor:**	Not yet determined
Feedback Type:		**Non-Marked:**	No
Assessment Difficulty:	Not yet determined	**Central Admin:**	No
Language Proficiency:			

Assessment Description:
Learners will be directed towards appropriate datasets and asked to produce a statistical report that incorporates the estimation of statistical models and reports findings in an appropriate manner. Estimation using some/all of multiple linear regression, logistic regression, time series analysis and dimension reduction techniques is likely to be required.

End of Module Assessment

Assessment Type:	Terminal Exam	**% of total:**	65
Pass Marks:	0	**Assessment Date:**	End-of-Semester
Outcome addressed:	1,2,3,4,5	**Briefing:**	End-of-Semester
Feedback:	End-of-Semester	**Assessment Mode:**	Not yet determined
Assessment Medium:	Not yet determined	**Role:**	Not yet determined
Mandatory:	False	**Assessor:**	Not yet determined
Feedback Type:		**Non-Marked:**	No
Assessment Difficulty:	Not yet determined	**Central Admin:**	No
Language Proficiency:			

Assessment Description:
End of semester examination session The examination will be of two hours duration and may include a mix of: theoretical, applied and interpretation questions.

Module Workload

Module Target Workload Hours 100 Hours

Full Time hours per semester
Workload Type
Lecture
Independent Learning
Tutorial
250.00

This module has no Apprenticeship workload.

This module has no Blended workload.

This module has no Block workload.

This module has no Distance/Correspondance workload.

This module has no Evening workload.

This module has no Online workload.

Part Time hours per semester
Workload Type
Lecture
Tutorial
Independent Learning
Directed E-Learning
250.00

MLO Competency Mapping

Learning Outcomes	Competencies
LO1: Apply appropriate statistical inference techniques to the analysis of data across a variety of domains.	
LO2: Interpret the results from statistical software packages and programming languages and report on them in a comprehensive, ethical and professional manner.	
LO3: Critically evaluate, select and apply regression models appropriate to a given problem domain.	
LO4: Critically appraise, select and apply suitable modelling and forecasting techniques for time series data.	
LO5: Comprehend, select and apply appropriate optimisation strategies according to chosen criteria.	

Module Resources

Recommended Book Resources

James G., Witten D., Hastie T., Tibshirani R. (2022). An Introduction to Statistical Learning, Springer, 2nd Edition. [ISBN: 978-1071614204]..

Härdle W. K., Simar L. (2019). Applied Multivariate Statistical Analysis, 5th edition, Springer Science & Business Media, p.570, [ISBN: 978-3030260057].

Hyndman R. J., Athanasopoulos G. (2021). Forecasting: Principles and Practice, 3rd edition, Otexts, p.442, [ISBN: 978-0987507136]..

Other Resources

[Book], Andy Field (2024), Discovering statistics using IBM SPSS statistics, 6th edition. SAGE, London. [ISBN: 978-1526419521].

[Book], Kaptein M., van den Heuvel E. (2022), Statistics for Data Scientists: An Introduction to Probability, Statistics, and Data Analysis, Springer. [ISBN: 978-3030105303].

[Book], Zhang X., Cheng R., Jin Y. (2024). Evolutionary Large-Scale Multi-Objective Optimization and Applications, Wiley-IEEE Press. [ISBN: 978-1394178414].

[Book], Dan Simon (2013), Evolutionary Optimization Algorithms, Wiley, p.784 [ISBN: 978-0470937419].

[Book], Dimitris Bertsimas, John N. Tsitsiklis (1997), Introduction to Linear Optimization, Athena Scientific, p.608, [ISBN: 978-1886529199].

[Book], Jyotsna K. Mandal, Somnath Mukhopadhyay, Paramartha Dutta (eds) (2018), Multi-Objective Optimization: Evolutionary to Hybrid Framework, Springer, p.318, [ISBN: 978-9811346392].

Review

Module Aims and Objectives

Statistics is a core component of a data analyst's toolkit. The objective of this module is to embed the fundamental statistical theory and techniques necessary to arrive at appropriate conclusions from the analysis of real world datasets. Learners will address the essentials of null hypothesis significance testing and the estimation of linear regression models, classification models and time series models. Bayesian approaches will also be addressed as will techniques to address dimension reduction. Furthermore, the module addresses discrete, multi-objective, and metaheuristic optimisation techniques.

Emphasis will be placed on appropriate interpretation of statistical findings and professional communication and reporting of results.

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

Information provided to learners about the module

The module specification is replicated in Akari Document, which is the College's repository of programme and module information. In order to ensure that this information is consistently presented, this is viewed as the primary source of information and is linked to in all systems, e.g. website links and Moodle, the College's virtual learning environment, Moodle etc. This is also the source of information for teaching staff in terms of guidance around assessment structure and requirements.

These specifications once approved are available via http://courses.ncirl.ie

This specification, where appropriate, is also used as the primary source of information for printed materials e.g. prospectus. In this case, until the module is approved in the context of the programme, information is indicative.

This information is further supplemented by the individual lecturer teaching the module through the provision of a module handbook and lecture plan detailing week by week activities which is made available electronically via Moodle. Module materials including directed reading, lecture notes, presentations, and assessment strategy is made available on Moodle.

Module content, organisation and structure

Review of Fundamental Statistical Concepts

Hypothesis testing – the t test and Analysis of Variance (ANOVA). Sampling estimation & confidence intervals, effective size and statistical power. Non-parametric tests.

Linear Regression I

Model accuracy. Qualitative variables. Transformations. Collinearity & collinearity diagnostics / VIF Diagnostics for leverage and influence. Heteroscedasticity in regression models. Correlation of error terms Non-linearity of data. Use of statistical software & R/Python to estimate regression models.

Linear Regression II

Principles of regression model building. Model selection using adjusted R2, AIC, BIC and Mallow's Cp. Variable selection techniques. Modelling interactions. Use of statistical software & R/Python to estimate regression models.

Logistic Regression

Principles of binary logistic regression. Odds & odds ratios. The logit transformation. Maximum likelihood estimation. Interpreting logistic regression coefficients. Evaluating contribution of predictors using the Wald statistic. Practical estimation of and prediction using logistic regression models using statistical software & R/Python.

Advanced Regression Models

Partial Least Squares regression, Regularised regression, Generalised Linear Models and Generalised Additive Models.

Time Series I

Time Series decomposition. Stationarity. Data transformations. Mean & Linear Trend models. Random walk models. Simple smoothing models. Auto-regressive and moving average models. Orders of AR and MA terms. Applications of time series forecasting. Estimation of basic time series models.

Time Series II

Non-seasonal and seasonal ARIMA models. Estimation of ARIMA models.

Time Series III

Regression with ARIMA errors (ARIMAX). Vector Autoregressive (VAR) models and the Vector Error Correction Model (VECM).

Discrete optimisation

Integer programming, Linear Programming, Constraint programming

Multi-objective optimisation

Classical methods, advanced methods, Pareto optimality.

Metaheuristic optimisation techniques

Fitness landscapes. Local search. Simulated annealing. Tabu search. Variable neighbourhood search

Evolutionary algorithms for optimisation

Genetic algorithms. Swarm intelligence. Memetic algorithms, Swarm intelligence.

Module Teaching and Learning (including formative assessment) Strategy

Teaching and learning will take place primarily through consideration of theoretical material, application of statistical models and practical group exercises.

Exploration of statistical theory and demonstration of techniques will be addressed in lectures, while labs/tutorials will focus on the application of statistical knowledge using a problem-based learning approach / practical group exercises. Students will be directed to appropriate web resources as part of independent learning.

Tutor support is also available through the Mathematics Support Office. Extra tutorials will be delivered by this office in the lead up to end of semester exams. One-to-one sessions, and on-line tutorials can be provided as the need arises.

Tutor support is also available to learners through the Mathematics Support Office. Extra tutorials will be delivered by this office in the lead up to end of semester exams. One-to-one sessions, and on-line tutorials can be provided as the need arises.

Work-based learning and practice placement

E-Learning

Module Physical resource requirements

Specifications for module staffing requirements

Sample assessment materials

Timetabling, learner effort and credit

Module assessment rationale

Affiliated Entities

Entity Code	Entity Title	Entity Version	Entity Type	Via	Outcome
MSCDA	MSc in Data Analytics	3.0	Programme		Yes
MSCDA	MSc in Data Analytics	4.0	Programme		Yes
PGDDA	Post Graduate Diploma in Science in Data Analytics	3.0	Programme		Yes

Documents

No Documents

9DISS2: Data Intensive Scalable Systems (Group Elective 1)

Module Code:	9DISS2
Long Title	Data Intensive Scalable Systems APPROVED
Title	Data Intensive Scalable Systems
Module Level:	LEVEL 9
EQF Level:	7
Valid From:	2024 (July 2024)
Language of Instruction:	English
Duration:	1 Semester
Credits:	5
Field of Study:	0610 - Information and Communication Technologies (ICTs) not further defined or elsewhe
Learning Outcome Taxonomy	Blooms
Module Author:	Eileen Long
Authors	Long Eileen (10 July 2024 to ---)
Is this a capstone module?	No

Learning Outcomes	
On successful completion of this module the learner will be able to:	
#	**Learning Outcome Description**
LO1	Critically compare and contrast multiple distributed system models and their associated enabling technologies and demonstrate in-depth knowledge of different types of processing on different data-intensive computational resources.
LO2	Critically analyse the features of high performance computing platforms, how they enable parallel and distributed programming paradigms, and demonstrate in-depth knowledge of parallel algorithms on large amounts of data.
LO3	Critically compare and contrast different data-stream processing and specialised algorithms.
LO4	Critically analyse mining and clustering algorithms on large multi-dimensional datasets and identify and categorise search techniques including similarity search and search engine technologies.
LO5	Develop and implement efficient programming solutions for problems relating to processing data at scale.

Learning Outcome Taxonomy Blooms					
#	LO1	LO2	LO3	LO4	LO5
C1					
C2					
C3					
C4					
C5					Y
C6					
P1					
P2					
P3					
P4					
P5					
P6					
P7					
A1					
A2					
A3					
A4					
A5					

Learning Outcome Taxonomy Reference Blooms		
#	**Taxonomy Description**	**Taxonomy Group**
C1	Knowledge	Cognitive
C2	Comprehension	Cognitive
C3	Application	Cognitive
C4	Analysis	Cognitive
C5	Synthesis	Cognitive
C6	Evaluation	Cognitive
P1	Perception	Psychomotor (Technical Skills)
P2	Set	Psychomotor (Technical Skills)
P3	Guided Response	Psychomotor (Technical Skills)
P4	Mechanism	Psychomotor (Technical Skills)
P5	Complex Overt Response	Psychomotor (Technical Skills)
P6	Adaptation	Psychomotor (Technical Skills)
P7	Origination	Psychomotor (Technical Skills)
A1	Receiving to Phenomena	Affective (Humanities)
A2	Responding to Phenomena	Affective (Humanities)
A3	Valuing	Affective (Humanities)
A4	Organizing Values	Affective (Humanities)
A5	Internalizing Values	Affective (Humanities)

Programme Module Dependencies
No requisites

Dependencies

Module Content & Assessment

Indicative Content
1. Principles and Characteristics of Distributed and Cloud Computing Systems 1.1) Distributed systems. Multi/Many core, Clusters, Grids, and Clouds. Cloud service and deployment models. NIST model: Elastic provisioning, resource metering, pools, etc. Big data ecosystems. SLAs/QoS, Availability, Mobility, and Optimisation for Cloud.
2. Cloud Infrastructure and Platform Services I 2.1) Computation, storage and general resource deployment. Public cloud services (e.g. AWS, GC, Azure service offerings). Machine Learning support.
3. Cloud Infrastructure and Platform Services II 3.1) Mobile devices and edge computing. Mobile clouds and colocation. Mobile networks. IoT interaction frameworks. Social media industrial applications. Social media networks and APIs. Graph analysis. Mashup architectures. Dynamic composition of services.
4. Data-intensive Storage Management 4.1) CAP Theorem. ACID vs BASE characteristics. Distributed file systems (e.g., HDFS). Dataset processing for big data (e.g., RDDs).
5. Structured Parallel Programming & Parallel Patterns for Data-intensive Computations 5.1) Algorithmic skeletons and structured parallelism. Scalable models. fine-grained vs. coarse-grained parallelisation. Data-enabled patterns and skeletons: map, reduce, broadcast, scan, gather scatter. MapReduce compute engine. MapReduce computations.
6. MapReduce Extensions & Cost Models 6.1) Recursive and workflow systems for MapReduce. Complexity and cost models for MapReduce with emphasis on communication costs and task networks.
7. Near Neighbour Search, Shingling, and Hashing 7.1) Collaborative filtering and similarity sets. Document shingling and sub-strings. Locality-sensitive hashing and distance measures. Additional methods for higher degrees of similarity.
8. Streams and Graphs I 8.1) Structured sources. Data streams. Stream programming, libraries and applications. Stream queries and processing. Sampling data. Filtering, counting, combining and estimating. Graphs. Centrality and degrees. Graph programming, libraries, and applications. Building complex pipelines and models.
9. Streams and Graphs II 9.1) Graphs. Centrality and degrees. Graph programming, libraries, and applications. Building complex pipelines and models.
10. Clusters for Streams and Parallelism 10.1) Bucket initialisation and merging. Parallel clustering.
11. Using Scalable Services 11.1) Deploying concurrent stream processing and batch processing pipelines. Resource Negotiation.
12. Non Von Neumann Architectures for Machine Learning 12.1) GPGPU. Neuromorphic hardware. TensorFlow. Cognitive services. Quantum Machine Learning.

Assessment Breakdown	%
Coursework	100.00%

Assessments

Coursework

Assessment Type:	Continuous Assessment	**% of total:**	40
Pass Marks:	0	**Assessment Date:**	n/a
Outcome addressed:	1,2	**Briefing:**	n/a
Feedback:	n/a	**Assessment Mode:**	Not yet determined
Assessment Medium:	Not yet determined	**Role:**	Not yet determined
Mandatory:	False	**Assessor:**	Not yet determined
Feedback Type:		**Non-Marked:**	No
Assessment Difficulty:	Not yet determined	**Central Admin:**	No
Language Proficiency:			

Assessment Description:
This practical assessment will evaluate the learners' knowledge and understanding of data intensive scalable systems' architectures and patterns.

Assessment Type:	Project	**% of total:**	60
Pass Marks:	0	**Assessment Date:**	n/a
Outcome addressed:	3,4,5	**Briefing:**	n/a
Feedback:	n/a	**Assessment Mode:**	Not yet determined
Assessment Medium:	Not yet determined	**Role:**	Not yet determined
Mandatory:	False	**Assessor:**	Not yet determined
Feedback Type:		**Non-Marked:**	No
Assessment Difficulty:	Not yet determined	**Central Admin:**	No
Language Proficiency:			

Assessment Description:
Produce a portfolio of studies that critically compare the data and computing architectures, programming models, and storage concepts.

Coursework

Assessment Type:	Continuous Assessment	**% of total:**	40
Pass Marks:	0	**Assessment Date:**	n/a
Outcome addressed:	1,2	**Briefing:**	n/a
Feedback:	n/a	**Assessment Mode:**	Not yet determined
Assessment Medium:	Not yet determined	**Role:**	Not yet determined
Mandatory:	False	**Assessor:**	Not yet determined
Feedback Type:		**Non-Marked:**	No
Assessment Difficulty:	Not yet determined	**Central Admin:**	No
Language Proficiency:			

Assessment Description:
This practical assessment will evaluate the learners' knowledge and understanding of data intensive scalable systems' architectures and patterns.

Assessment Type:	Project	**% of total:**	60
Pass Marks:	0	**Assessment Date:**	n/a
Outcome addressed:	3,4,5	**Briefing:**	n/a
Feedback:	n/a	**Assessment Mode:**	Not yet determined
Assessment Medium:	Not yet determined	**Role:**	Not yet determined
Mandatory:	False	**Assessor:**	Not yet determined
Feedback Type:		**Non-Marked:**	No
Assessment Difficulty:	Not yet determined	**Central Admin:**	No
Language Proficiency:			

Assessment Description:
Produce a portfolio of studies that critically compare the data and computing architectures, programming models, and storage concepts.

Module Workload

Module Target Workload Hours 50 Hours

Full Time hours per semester

Workload Type
Lecture
Independent Learning
Tutorial
125.00

This module has no Apprenticeship workload.

This module has no Blended workload.

This module has no Block workload.

This module has no Distance/Correspondance workload.

This module has no Evening workload.

This module has no Online workload.

Part Time hours per semester
Workload Type
Lecture
Tutorial
Independent Learning
Directed E-Learning
125.00

MLO Competency Mapping

Learning Outcomes	Competencies
LO1: Critically compare and contrast multiple distributed system models and their associated enabling technologies and demonstrate in-depth knowledge of different types of processing on different data-intensive computational resources.	
LO2: Critically analyse the features of high performance computing platforms, how they enable parallel and distributed programming paradigms, and demonstrate in-depth knowledge of parallel algorithms on large amounts of data.	
LO3: Critically compare and contrast different data-stream processing and specialised algorithms.	
LO4: Critically analyse mining and clustering algorithms on large multi-dimensional datasets and identify and categorise search techniques including similarity search and search engine technologies.	
LO5: Develop and implement efficient programming solutions for problems relating to processing data at scale.	

Module Resources

Recommended Book Resources

J. Leskovec, A. Rajaraman, J.D. Ullman (2020). Mining of Massive Datasets, Cambridge University Press; 3rd edition [ISBN: 1108476341].

L. George, J. Kunigk, P. Wilkinson, I. Buss (2018). Architecting Modern Data Platforms. O'Reilly Media [ISBN-10: 149196927X].

Menon P. (2022). Data Lakehouse in Action: Architecting a modern and scalable data analytics platform. Packt Publishing. [ISBN: 978-1801815932]..

Supplementary Book Resources

A.E. Chis, H. González-Vélez (2024) 32nd Euromicro International Conference on Parallel, Distributed and Network-Based Processing, PDP 2024, Dublin, Ireland, March 20-22, 2024. IEEE. [ISBN: 979-8-3503-6307-4].

M. Kleppmann (2017). Designing Data-Intensive Applications: The Big Ideas behind Reliable, Scalable, and Maintainable Systems, O'Reilly Media; 1st Edition [ISBN: 1449373321].

J. Reis, M. Housley (2022). Fundamentals of Data Engineering: Plan and Build Robust Data Systems, O'Reilly Media; 1st edition [ISBN-10: ‎1098108302]..

D. Comer (2023) The Cloud Computing Book: The Future of Computing Explained. Chapman and Hall/CRC; 1st edition [ISBN-10: ‎0367706849].

E. Gamma, R. Helm, R. Johnson , J. Vlissides (1995) Design patterns : elements of reusable object-oriented software. Addison-Wesley [ISBN-10: ‎0201633612].

Supplementary Article/Paper Resources

M. Wilkinson, et al. (2016) The FAIR Guiding Principles for scientific data management and stewardship. Scientific Data 3, 160018..

P. Rocca-Serra, et al. (2023) The FAIR Cookbook - the essential resource for and by FAIR doers. Scientific Data 10, 292..

A. González–Cebrián, M. Bradford, A.E. Chis, H. González-Vélez (2024). Standardised Versioning of Datasets: a FAIR–compliant Proposal. Scientific Data 11, 358..

B. Veloso, F. Leal, H. González-Vélez, B. Malheiro, J-C. Burguillo (2018). Scalable data analytics using crowdsourced repositories and streams. Journal of Parallel and Distributed Computing, 122: 1-10..

J. Eckroth (2018). A course on big data analytics. Journal of Parallel and Distributed Computing, 118: 166-176..

J. Dean, S. Ghemawat (2010). MapReduce: a flexible data processing tool. Commun. ACM 53(1): 72-77..

H. González-Vélez, M. Leyton (2010). A survey of algorithmic skeleton frameworks: high-level structured parallel programming enablers. Software: Practice and Experience. 40(12): 1135-1160..

Review

Module Aims and Objectives

The module aims to give the learner systematic understanding of storage and processing architectures and programming models for data-intensive computing. Learners shall examine how different data analytics techniques can help to solve real-world enterprise-class problems.

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

Information provided to learners about the module

The module specification is replicated in Akari Document, which is the College's repository of programme and module information. In order to ensure that this information is consistently presented, this is viewed as the primary source of information and is linked to in all systems, e.g. website links and Moodle, the College's virtual learning environment, Moodle etc. This is also the source of information for teaching staff in terms of guidance around assessment structure and requirements.

These specifications once approved are available via http://courses.ncirl.ie

This specification, where appropriate, is also used as the primary source of information for printed materials e.g. prospectus. In this case, until the module is approved in the context of the programme, information is indicative.

This information is further supplemented on an instance by instance basis by the individual lecturer teaching the module through the module handbook, which may be made available electronically via Moodle or in printed format. This document ensures that week by week activities, updated reading list and cohort specific information is current.

Module content, organisation and structure

Principles and Characteristics of Distributed and Cloud Computing Systems

Distributed systems. Multi/Many core, Clusters, Grids, and Clouds. Cloud service and deployment models. NIST model: Elastic provisioning, resource metering, pools, etc. Big data ecosystems. SLAs/QoS, Availability, Mobility, and Optimisation for Cloud.

Cloud Infrastructure and Platform Services I

Computation, storage and general resource deployment. Public cloud services (e.g. AWS, GC, Azure service offerings). Machine Learning support.

Cloud Infrastructure and Platform Services II

Mobile devices and edge computing. Mobile clouds and colocation. Mobile networks. IoT interaction frameworks. Social media industrial applications. Social media networks and APIs. Graph analysis. Mashup architectures. Dynamic composition of services.

Data-intensive Storage Management

CAP Theorem. ACID vs BASE characteristics. Distributed file systems (e.g., HDFS). Dataset processing for big data (e.g., RDDs).

Structured Parallel Programming & Parallel Patterns for Data-intensive Computations

Algorithmic skeletons and structured parallelism. Scalable models. fine-grained vs. coarse-grained parallelisation. Data-enabled patterns and skeletons: map, reduce, broadcast, scan, gather scatter. MapReduce compute engine. MapReduce computations.

MapReduce Extensions & Cost Models

Recursive and workflow systems for MapReduce. Complexity and cost models for MapReduce with emphasis on communication costs and task networks.

Near Neighbour Search, Shingling, and Hashing

Collaborative filtering and similarity sets. Document shingling and sub-strings. Locality-sensitive hashing and distance measures. Additional methods for higher degrees of similarity.

Streams and Graphs I

Structured sources. Data streams. Stream programming, libraries and applications. Stream queries and processing. Sampling data. Filtering, counting, combining and estimating. Graphs. Centrality and degrees. Graph programming, libraries, and applications. Building complex pipelines and models.

Streams and Graphs II

Graphs. Centrality and degrees. Graph programming, libraries, and applications. Building complex pipelines and models.

Clusters for Streams and Parallelism

Bucket initialisation and merging. Parallel clustering.

Using Scalable Services

Deploying concurrent stream processing and batch processing pipelines. Resource Negotiation.

Non Von Neumann Architectures for Machine Learning

GPGPU. Neuromorphic hardware. TensorFlow. Cognitive services. Quantum Machine Learning.

Module Teaching and Learning (including formative assessment) Strategy

Classes in the Data Intensive Scalable Systems module will be delivered in either a lecture theatre, classroom, or lab environment with learners bringing their own devices (BYOD). Each week learners will attend three hours of class – broken down into one 3-hour lecture. Lectures will be a mix of presentation and practical work conducted by learners. Learners will be assigned specific tasks related to lecture content so that they can drill into concepts by applying some tools such as simulators, memory managers, and cloud resource calculators. An example of a typical task is to critically compare two different non Von Neumann architectures using simulators e.g. quantum vs. GPGPU computing. Learners will discover concepts relating to the architecture of Data Intensive systems using an algorithmic approach to conceive different computing solutions based on architectures and parallel patterns (algorithmic skeletons) with emphasis on clouds. Learners will discover concepts of Scalable Systems programming using a data-intensive algorithmic approach. This strategy will enhance learner understanding of how to conceive different computing solutions based on complexity and suitability of different data analytics algorithms. Learners will have full access to necessary resources (outlined below) to complete each task. Lecturers and those providing assistance will have a high level of competency in each of the methods and concepts used.
All module resources are made available to learners via the Moodle Content Management System. These will typically consist of lecture notes, exercise files, data sets, case studies, news items (e.g. a Big Data story in the news), discussion groups, and feedback.
Learners are encouraged to attend and participate in all classes, as each session is intended to build upon previous classes in a practical, non-intimidating, informative, and enjoyable way. Throughout the module, the foundations of Data Intensive Scalable Systems are applied to real life data to form learning of the fundamental ideas and the most commonly used techniques to choose the most suitable architecture and deployment model to make sense of data.
Learners will have full access to necessary resources to complete each learning task. Each tutorial can be both computer and pen & paper based–learners will benefit from coaching and feedback during each session.

Work-based learning and practice placement

E-Learning

Module Physical resource requirements

Specifications for module staffing requirements

Sample assessment materials

Timetabling, learner effort and credit

Module assessment rationale

Affiliated Entities

Entity Code	Entity Title	Entity Version	Entity Type	Via	Outcome
MSCDA	MSc in Data Analytics	3.0	Programme		Yes
MSCDA	MSc in Data Analytics	4.0	Programme		Yes

Documents

No Documents

9MODSIM2: Modelling & Simulation (Group Elective 2)

Module Code:	9MODSIM2
Long Title	Modelling & Simulation APPROVED
Title	Modelling & Simulation
Module Level:	LEVEL 9
EQF Level:	7
Valid From:	2024 (July 2024)
Language of Instruction:	English
Duration:	1 Semester
Credits:	5
Field of Study:	0610 - Information and Communication Technologies (ICTs) not further defined or elsewhe
Learning Outcome Taxonomy	Blooms
Module Author:	Eileen Long
Authors	Long Eileen (10 July 2024 to ---)
Is this a capstone module?	No

Learning Outcomes	
On successful completion of this module the learner will be able to:	
#	**Learning Outcome Description**
LO1	Create a mathematical model for a given application problem and design a simulation model based on a given mathematical model and a problem formulation.
LO2	Categorise different types of simulation technologies
LO3	Implement and test a simulation model using a simulation tool or a standard programming language
LO4	Critically analyse and interpret output data produced by the simulation system.
LO5	Integrate the simulation system into an optimisation or machine learning context.

Learning Outcome Taxonomy Blooms					
#	LO1	LO2	LO3	LO4	LO5
C1					
C2					
C3					
C4		Y			
C5	Y	Y			Y
C6					
P1					
P2					
P3					
P4					
P5					
P6					
P7	Y				
A1					
A2					
A3					
A4					Y
A5					

Learning Outcome Taxonomy Reference Blooms		
#	**Taxonomy Description**	**Taxonomy Group**
C1	Knowledge	Cognitive
C2	Comprehension	Cognitive
C3	Application	Cognitive
C4	Analysis	Cognitive
C5	Synthesis	Cognitive
C6	Evaluation	Cognitive
P1	Perception	Psychomotor (Technical Skills)
P2	Set	Psychomotor (Technical Skills)
P3	Guided Response	Psychomotor (Technical Skills)
P4	Mechanism	Psychomotor (Technical Skills)
P5	Complex Overt Response	Psychomotor (Technical Skills)
P6	Adaptation	Psychomotor (Technical Skills)
P7	Origination	Psychomotor (Technical Skills)
A1	Receiving to Phenomena	Affective (Humanities)
A2	Responding to Phenomena	Affective (Humanities)
A3	Valuing	Affective (Humanities)
A4	Organizing Values	Affective (Humanities)
A5	Internalizing Values	Affective (Humanities)

Programme Module Dependencies
No requisites

Dependencies

Module Content & Assessment

Indicative Content
1. Introduction to Modelling & Simulation 1.1) Concept of system, model and simulation. Discrete and continuous processes. Monte Carlo, agent-based, system dynamics. Games and virtual worlds. Digital twins.
2. Modelling I 2.1) Modelling in Statistics: develop an explicit notion of different models and the use of simulation in statistics. Probability distribution functions, Estimation of statistical parameters.
3. Modelling II 3.1) Modelling in Economics and Ecology: use of different models for time series. Develop relate forecasting in timeseries (without explicit model) to model based forecasting. Modelling in Physics: develop a model for a simple mechanical system like a monoped hopper, using a control strategy as input parameter.
4. Modelling III 4.1) Modelling in Machine Learning: synthetic data, simulation-assisted ML, ML-assisted simulation.
5. Discrete Event Simulation I 5.1) Simulation Systems. Components of discrete event simulation. Generators (e.g., using Python). Interarrival Distributions. System Trajectory. stable and instable systems.
6. Discrete Event Simulation II 6.1) Characteristic of a queueing system. Simulation of single server queueing system. Kendall Notations: M-M-1 Systems, M-D-1 Systems, M-G-1 Systems, M-M-c Systems.
7. Discrete Event Simulation III (Part A) 7.1) Simulation of an industrial facility, using a control strategy as input parameter.
8. Discrete Event Simulation III (Part B) 8.1) Using optimisation strategies to find the optimal configuration for a simulated industrial facility. Verification, validation and credibility of simulation models.
9. Continuous Simulation I 9.1) Differential Equations, Volterra Equations and Ecological Modelling. Euler Method. Runge-Kutta Integration.
10. Continuous Simulation II 10.1) Simulation of Infectious Diseases
11. Continuous Simulation III 11.1) Simulation of Mechanical Systems (like a monoped hopper) with a simple control strategy.
12. Continuous Simulation IV 12.1) Using of Reinforcement Learning to construct a self-learning and improving robust system.

Assessment Breakdown	%
Coursework	60.00%
End of Module Assessment	40.00%

Assessments

Coursework			
Assessment Type:	Project	**% of total:**	60
Pass Marks:	0	**Assessment Date:**	n/a
Outcome addressed:	1,3,4,5	**Briefing:**	n/a
Feedback:	n/a	**Assessment Mode:**	Not yet determined
Assessment Medium:	Not yet determined	**Role:**	Not yet determined
Mandatory:	False	**Assessor:**	Not yet determined
Feedback Type:		**Non-Marked:**	No
Assessment Difficulty:	Not yet determined	**Central Admin:**	No
Language Proficiency:			

Assessment Description:
Long-form project which the student produces over the course of the entire semester. Student is required to model and simulate a process (production scheduling, planning, gaming, traffic, operating theatre) using a simulation tool using an open source simulation tool

End of Module Assessment

Assessment Type:	Terminal Exam	**% of total:**	40
Pass Marks:	0	**Assessment Date:**	End-of-Semester
Outcome addressed:	1,2,4	**Briefing:**	End-of-Semester
Feedback:	End-of-Semester	**Assessment Mode:**	Not yet determined
Assessment Medium:	Not yet determined	**Role:**	Not yet determined
Mandatory:	False	**Assessor:**	Not yet determined
Feedback Type:		**Non-Marked:**	No
Assessment Difficulty:	Not yet determined	**Central Admin:**	No
Language Proficiency:			

Assessment Description:
Terminal assessment exam taken over 2 hours with four questions of which the student must answer three to address the students' understanding of the underlying theories and concepts.

Coursework

Assessment Type:	Project	**% of total:**	60
Pass Marks:	0	**Assessment Date:**	n/a
Outcome addressed:	1,3,4,5	**Briefing:**	n/a
Feedback:	n/a	**Assessment Mode:**	Not yet determined
Assessment Medium:	Not yet determined	**Role:**	Not yet determined
Mandatory:	False	**Assessor:**	Not yet determined
Feedback Type:		**Non-Marked:**	No
Assessment Difficulty:	Not yet determined	**Central Admin:**	No
Language Proficiency:			

Assessment Description:
Long-form project which the student produces over the course of the entire semester. Student is required to model and simulate a process (production scheduling, planning, gaming, traffic, operating theatre) using a simulation tool using an open source simulation tool

End of Module Assessment

Assessment Type:	Terminal Exam	**% of total:**	40
Pass Marks:	0	**Assessment Date:**	End-of-Semester
Outcome addressed:	1,2,4	**Briefing:**	End-of-Semester
Feedback:	End-of-Semester	**Assessment Mode:**	Not yet determined
Assessment Medium:	Not yet determined	**Role:**	Not yet determined
Mandatory:	False	**Assessor:**	Not yet determined
Feedback Type:		**Non-Marked:**	No
Assessment Difficulty:	Not yet determined	**Central Admin:**	No
Language Proficiency:			

Assessment Description:
Terminal assessment exam taken over 2 hours with four questions of which the student must answer three to address the students' understanding of the underlying theories and concepts.

Module Workload

Module Target Workload Hours 50 Hours

Full Time hours per semester
Workload Type
Lecture
Independent Learning
Tutorial
125.00

This module has no Apprenticeship workload.

This module has no Blended workload.

This module has no Block workload.

This module has no Distance/Correspondance workload.

This module has no Evening workload.

This module has no Online workload.

Part Time hours per semester
Workload Type
Lecture
Tutorial
Independent Learning
Directed E-Learning
125.00

MLO Competency Mapping

Learning Outcomes	Competencies
LO1: Create a mathematical model for a given application problem and design a simulation model based on a given mathematical model and a problem formulation.	
LO2: Categorise different types of simulation technologies	
LO3: Implement and test a simulation model using a simulation tool or a standard programming language	
LO4: Critically analyse and interpret output data produced by the simulation system.	
LO5: Integrate the simulation system into an optimisation or machine learning context.	

Module Resources

Recommended Book Resources

Birta L.G., Arbez G.(2019). Modelling and Simulation – Exploring Dynamic System Behaviour, Springer, 3rd Edition. ISBN: 978-3030188689..

Ören T., Zeigler B.P., Tolk A. (eds)(2023). Body of Knowledge for Modeling and Simulation. Springer. ISBN: 978-3031110849..

Zeigler, B.P.; Muzy, A., Kofman, E. (2018). Theory of Modeling and Simulation. 3rd ed. Academic Press. ISBN: 978-0128133705.

Supplementary Book Resources

Medhi J.(2003). Stochastic Models in Queueing Theory, Academic Press, 3rd Edition. ISBN: 0-124874622..

Borshchev, A. (2014), The Big Book of Simulation Modeling: Multimethod Modeling with Anylogic 6, Lightning Source Inc. ISBN: 978-0989573177..

Dobson, S. (2020). Epidemic Modelling. Independent Publishing Network. ISBN: 978-1838535650..

Choi, B.K. & Kang, D. (2013), Modeling and Simulation of Discrete Event Systems. Wiley Press. ISBN: 978-1118386996..

Banks , J. ,Carson II J.S., Nelson B.L., Nicol D.M. (2014), Discrete-Event System Simulation, Pearson Education, 5th Edition. ISBN: 978-1292024370..

Kelton, W.D., Sadowski, R., and Zupick, N. (2023), Simulation with Arena, 7th Edition, McGraw-Hill. ISBN: 978-1266275722..

Review

Module Aims and Objectives

The objective of the Modelling & Simulation module is to introduce students to the concepts, techniques and applied aspects of the development and analysis of simulation models. The course deals with all the important aspects of simulation with particular emphasis on applications in services and computing. Two main approaches for modelling problems bound by uncertainty (stochastic behaviour) will be covered: Monte-Carlo Simulation (static problems) and Discrete Event Simulation (dynamic problems). Students will also learn how to use simulation tools for strategic decision making.

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

Information provided to learners about the module

The module specification is replicated in Akari Document, which is the College's repository of programme and module information. In order to ensure that this information is consistently presented, this is viewed as the primary source of information and is linked to in all systems, e.g. website links and Moodle, the College's virtual learning environment, Moodle etc. This is also the source of information for teaching staff in terms of guidance around assessment structure and requirements.

These specifications once approved are available via http://courses.ncirl.ie

This specification, where appropriate, is also used as the primary source of information for printed materials e.g. prospectus. In this case, until the module is approved in the context of the programme, information is indicative.

This information is further supplemented on an instance by instance basis by the individual lecturer teaching the module through the module handbook, which may be made available electronically via Moodle or in printed format. This document ensures that week by week activities, updated reading list and cohort specific information is current.

Module content, organisation and structure

Introduction to Modelling & Simulation

Concept of system, model and simulation. Discrete and continuous processes. Monte Carlo, agent-based, system dynamics. Games and virtual worlds. Digital twins.

Modelling I

Modelling in Statistics: develop an explicit notion of different models and the use of simulation in statistics. Probability distribution functions, Estimation of statistical parameters.

Modelling II

Modelling in Economics and Ecology: use of different models for time series. Develop relate forecasting in timeseries (without explicit model) to model based forecasting. Modelling in Physics: develop a model for a simple mechanical system like a monoped hopper, using a control strategy as input parameter.

Modelling III

Modelling in Machine Learning: synthetic data, simulation-assisted ML, ML-assisted simulation.

Discrete Event Simulation I

Simulation Systems. Components of discrete event simulation. Generators (e.g., using Python). Interarrival Distributions. System Trajectory. stable and instable systems.

Discrete Event Simulation II

Characteristic of a queueing system. Simulation of single server queueing system. Kendall Notations: M-M-1 Systems, M-D-1 Systems, M-G-1 Systems, M-M-c Systems.

Discrete Event Simulation III (Part A)

Simulation of an industrial facility, using a control strategy as input parameter.

Discrete Event Simulation III (Part B)

Using optimisation strategies to find the optimal configuration for a simulated industrial facility. Verification, validation and credibility of simulation models.

Continuous Simulation I

Differential Equations, Volterra Equations and Ecological Modelling. Euler Method. Runge-Kutta Integration.

Continuous Simulation II

Simulation of Infectious Diseases.

Continuous Simulation III

Simulation of Mechanical Systems (like a monoped hopper) with a simple control strategy.

Continuous Simulation IV

Using of Reinforcement Learning to construct a self-learning and improving robust system.

Module Teaching and Learning (including formative assessment) Strategy

Classes in the Modelling & Simulation module will be delivered in a classroom and/or lab. Each week learners will attend 4 hours of class – broken down into one 2-hour lecture and 2-hour practice/tutorial class. Lectures will mix the theory with practical exercises, analysis on the case studies and they are design to be highly interactive and to stimulate in-class discussions. During the tutorial sessions, learners will be assigned specific tasks related to lecture content so that they can better assimilate the concepts and gain experience working with the latest technologies. All module resources are made available to learners via the Moodle Content Management System. These will typically consist of lecture notes, explanatory videos, links to different resources, exercise files, data sets, case studies, sample assessments, assignments, and feedback.

Work-based learning and practice placement

E-Learning

Module Physical resource requirements

Specifications for module staffing requirements

Sample assessment materials

Timetabling, learner effort and credit

Module assessment rationale

Affiliated Entities

Entity Code	Entity Title	Entity Version	Entity Type	Via	Outcome
MSCDA	MSc in Data Analytics	3.0	Programme		Yes
MSCDA	MSc in Data Analytics	4.0	Programme		Yes

Documents

No Documents

9DAPP2: Domain Applications (Group Elective 3)

Module Code:	9DAPP2
Long Title	Domain Applications APPROVED
Title	Domain Applications
Module Level:	LEVEL 9
EQF Level:	7
Valid From:	2024 (July 2024)
Language of Instruction:	English
Duration:	1 Semester
Credits:	5
Field of Study:	0610 - Information and Communication Technologies (ICTs) not further defined or elsewhe
Learning Outcome Taxonomy	Blooms
Module Author:	Eileen Long
Authors	Long Eileen (10 July 2024 to ---)
Is this a capstone module?	No

Learning Outcomes	
On successful completion of this module the learner will be able to:	
#	**Learning Outcome Description**
LO1	Critically analyse and explore the application of data analytics, AI, and machine learning across a range of domains including Information Retrieval, Geographic Information Systems, and industry contexts.
LO2	Investigate and evaluate key concepts and the application of advanced analytics techniques in a range of domains.
LO3	Contextualise, research and utilise current data approaches, applications and technologies in order to develop predictive analytics strategies to address a variety of real world situations.
LO4	Conduct independent research into emerging technologies utilising advanced data analytics and machine learning approaches.

Learning Outcome Taxonomy Blooms				
#	LO1	LO2	LO3	LO4
C1				
C2				
C3				
C4		Y		
C5				
C6				
P1				
P2				
P3				
P4				
P5				
P6				
P7				
A1				
A2				
A3				
A4				
A5				

Learning Outcome Taxonomy Reference Blooms		
#	**Taxonomy Description**	**Taxonomy Group**
C1	Knowledge	Cognitive
C2	Comprehension	Cognitive
C3	Application	Cognitive
C4	Analysis	Cognitive
C5	Synthesis	Cognitive
C6	Evaluation	Cognitive
P1	Perception	Psychomotor (Technical Skills)
P2	Set	Psychomotor (Technical Skills)
P3	Guided Response	Psychomotor (Technical Skills)
P4	Mechanism	Psychomotor (Technical Skills)
P5	Complex Overt Response	Psychomotor (Technical Skills)
P6	Adaptation	Psychomotor (Technical Skills)
P7	Origination	Psychomotor (Technical Skills)
A1	Receiving to Phenomena	Affective (Humanities)
A2	Responding to Phenomena	Affective (Humanities)
A3	Valuing	Affective (Humanities)
A4	Organizing Values	Affective (Humanities)
A5	Internalizing Values	Affective (Humanities)

Programme Module Dependencies
No requisites

Dependencies

Module Content & Assessment

Indicative Content
1. Information Retrieval I 1.1) Key concepts in Information Retrieval (IR). Boolean model. Term-Document matrix. Postings and inverted indexes. Vector Space model. TF-IDF. Evaluation in IR
2. Information Retrieval II 2.1) Probabilistic model. Bayesian approaches. Latent Semantic Indexing. Link Analysis.
3. Geographic Information Systems I 3.1) Core geospatial concepts. Data layers. Spatial data creation and management. Metadata. Geospatial analysis and geoprocessing. Visualising and interpreting spatial data.
4. Geographic Information Systems II 4.1) Cartographic enhancement. Thematic mapping. GIS tools and technologies (e.g., ArcGIS).
5. Social Media and Web Analytics 5.1) Collecting and extracting social media data. Case studies. Social listening. Audience/Performance/Competitive/Behaviour analytics. Sentiment analysis. Segmentation.
6. Industry Use-case I 6.1) Domain applications in Pharma, Medicine, and Healthcare. Case studies.
7. Industry Use-case II 7.1) Domain applications in Retail, Manufacturing and Supply-chain. Case studies.
8. Industry Use-case III 8.1) Domain applications in IoT, communications and networks. Case studies.
9. Industry Use-case IV 9.1) Domain applications in Sports. Case studies.
10. Industry Use-case V 10.1) Domain applications in Finance and Banking. Fraud Detection. Case studies.
11. Industry Use-case VI 11.1) Domain applications in Blockchain & DeFi. Case studies.
12. Quantum Machine Learning 12.1) Introduction to Quantum Computing(QC) and key take-aways. Algorithmic patterns for QC. Application for QC in a machine learning context.

Assessment Breakdown	%
Coursework	50.00%
End of Module Assessment	50.00%

Assessments

Coursework

Assessment Type:	Project	**% of total:**	50
Pass Marks:	0	**Assessment Date:**	n/a
Outcome addressed:	1,3,4	**Briefing:**	n/a
Feedback:	n/a	**Assessment Mode:**	Not yet determined
Assessment Medium:	Not yet determined	**Role:**	Not yet determined
Mandatory:	False	**Assessor:**	Not yet determined
Feedback Type:		**Non-Marked:**	No
Assessment Difficulty:	Not yet determined	**Central Admin:**	No
Language Proficiency:			

Assessment Description:
Project focusing on a particular domain area, requiring survey of start-of-the-art, and implementing appropriate data mining/machine learning tools and techniques particular to the domain to perform an analysis of associated data.

End of Module Assessment

Assessment Type:	Terminal Exam	**% of total:**	50
Pass Marks:	0	**Assessment Date:**	End-of-Semester
Outcome addressed:	1,2,3	**Briefing:**	End-of-Semester
Feedback:	End-of-Semester	**Assessment Mode:**	Not yet determined
Assessment Medium:	Not yet determined	**Role:**	Not yet determined
Mandatory:	False	**Assessor:**	Not yet determined
Feedback Type:		**Non-Marked:**	No
Assessment Difficulty:	Not yet determined	**Central Admin:**	No
Language Proficiency:			

Assessment Description:
Terminal assessment exam taken over 2 hours with four questions of which the student must answer three to address the students' understanding of the underlying theories and concepts.

Coursework

Assessment Type:	Project	**% of total:**	50
Pass Marks:	0	**Assessment Date:**	n/a
Outcome addressed:	1,3,4	**Briefing:**	n/a
Feedback:	n/a	**Assessment Mode:**	Not yet determined
Assessment Medium:	Not yet determined	**Role:**	Not yet determined
Mandatory:	False	**Assessor:**	Not yet determined
Feedback Type:		**Non-Marked:**	No
Assessment Difficulty:	Not yet determined	**Central Admin:**	No
Language Proficiency:			

Assessment Description:
Project focusing on a particular domain area, requiring survey of start-of-the-art, and implementing appropriate data mining/machine learning tools and techniques particular to the domain to perform an analysis of associated data.

End of Module Assessment

Assessment Type:	Terminal Exam	**% of total:**	50
Pass Marks:	0	**Assessment Date:**	End-of-Semester
Outcome addressed:	1,2,3	**Briefing:**	End-of-Semester
Feedback:	End-of-Semester	**Assessment Mode:**	Not yet determined
Assessment Medium:	Not yet determined	**Role:**	Not yet determined
Mandatory:	False	**Assessor:**	Not yet determined
Feedback Type:		**Non-Marked:**	No
Assessment Difficulty:	Not yet determined	**Central Admin:**	No
Language Proficiency:			

Assessment Description:
Terminal assessment exam taken over 2 hours with four questions of which the student must answer three to address the students' understanding of the underlying theories and concepts.

Module Workload

Module Target Workload Hours 50 Hours

Full Time hours per semester
Workload Type
Lecture
Independent Learning
Tutorial
125.00

This module has no Apprenticeship workload.

This module has no Blended workload.

This module has no Block workload.

This module has no Distance/Correspondance workload.

This module has no Evening workload.

This module has no Online workload.

Part Time hours per semester
Workload Type
Lecture
Tutorial
Independent Learning
Directed E-Learning
125.00

MLO Competency Mapping

Learning Outcomes	Competencies
LO1: Critically analyse and explore the application of data analytics, AI, and machine learning across a range of domains including Information Retrieval, Geographic Information Systems, and industry contexts.	
LO2: Investigate and evaluate key concepts and the application of advanced analytics techniques in a range of domains.	
LO3: Contextualise, research and utilise current data approaches, applications and technologies in order to develop predictive analytics strategies to address a variety of real world situations.	
LO4: Conduct independent research into emerging technologies utilising advanced data analytics and machine learning approaches.	

Module Resources

Recommended Book Resources

Baeza-Yates R., Ribeiro-Neto B. (2010). Modern Information Retrieval: The Concepts and Technology Behind Search, Addison-Wesley, 2nd Edition. ISBN: 978-0321416919..

McHaffie P., Hwang S., Follett C. (2023). GIS: An Introduction to Mapping Technologies, CRC Press, 2nd Edition. ISBN: 978-1032308975..

Tang C. (2016). The Data Industry: The Business and Economics of Information and Big Data, Wiley. ISBN: 978-1119138402.

Supplementary Book Resources

Spector A. Z., Norvig P., Wiggins C., Wing J. M. (2022). Data Science in Context: Foundations, Challenges, Opportunities, Cambridge University Press. ISBN: 978-1009272209..

Nguyen A. (2022). Hands-On Healthcare Data: Taming the Complexity of Real-World Data, O'Reilly Media. ISBN: 978-1098112929..

Tatsat H., Puri S., Lookabough B. (2021). Machine Learning and Data Science Blueprints for Finance: From Building Trading Strategies to Robo-Advisors Using Python, O'Reilly (Wiley UK). ISBN: 978-1492073055..

Combarro E. F., González-Castillo S. (2023). A Practical Guide to Quantum Machine Learning and Quantum Optimisation: Hands-on Approach to Modern Quantum Algorithms, Packt Publishing. ISBN: 978-1804613832..

Review

Module Aims and Objectives

The objective of the Domain Applications module is to endow learners with hands on experience of contemporary approaches to data analytics in practical settings such as information retrieval, geographic information systems, banking, ICT, health, retail, supply-chain & manufacturing, sports, and online services. This module will be framed within the KDD and CRISP-DM data mining methodologies as appropriate for the problems studied. The module encourages research in state-of-the-art solutions (e.g., quantum machine learning) across various domains and utilises case-studies to illustrate the application of such solutions.

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

Information provided to learners about the module

The module specification is replicated in Akari Document, which is the College's repository of programme and module information. In order to ensure that this information is consistently presented, this is viewed as the primary source of information and is linked to in all systems, e.g. website links and Moodle, the College's virtual learning environment, Moodle etc. This is also the source of information for teaching staff in terms of guidance around assessment structure and requirements.

These specifications once approved are available via http://courses.ncirl.ie

This specification, where appropriate, is also used as the primary source of information for printed materials e.g. prospectus. In this case, until the module is approved in the context of the programme, information is indicative.

This information is further supplemented on an instance by instance basis by the individual lecturer teaching the module through the module handbook, which may be made available electronically via Moodle or in printed format. This document ensures that week by week activities, updated reading list and cohort specific information is current.

Module content, organisation and structure

Information Retrieval I

Key concepts in Information Retrieval (IR). Boolean model. Term-Document matrix. Postings and inverted indexes. Vector Space model. TF-IDF. Evaluation in IR.

Information Retrieval II

Probabilistic model. Bayesian approaches. Latent Semantic Indexing. Link Analysis.

Geographic Information Systems I

Core geospatial concepts. Data layers. Spatial data creation and management. Metadata. Geospatial analysis and geoprocessing. Visualising and interpreting spatial data.

Geographic Information Systems II

Cartographic enhancement. Thematic mapping. GIS tools and technologies (e.g., ArcGIS).

Social Media and Web Analytics

Collecting and extracting social media data. Case studies. Social listening. Audience/Performance/Competitive/Behaviour analytics. Sentiment analysis. Segmentation.

Industry Use-case I

Domain applications in Pharma, Medicine, and Healthcare. Case studies.

Industry Use-case II

Domain applications in Retail, Manufacturing and Supply-chain. Case studies.

Industry Use-case III

Domain applications in IoT, communications and networks. Case studies.

Industry Use-case III

Domain applications in Sports. Case studies.

Industry Use-case III

Domain applications in Finance and Banking. Fraud Detection. Case studies.

Industry Use-case III

Domain applications in Blockchain & DeFi. Case studies.

Quantum Machine Learning

Introduction to Quantum Computing(QC) and key take-aways. Algorithmic patterns for QC. Application for QC in a machine learning context.

Module Teaching and Learning (including formative assessment) Strategy

The learning strategy involves the use of lectures, tutorials, case studies, paper reviews and practical work where learners will engage with and explore domain applications of data analytics in real-world scenarios. Lectures will include active learning components such as paired discussion, problem solving, and class feedback. Practical sessions will comprise of group work and individual learning. Learners will also have access to research documents and publications as required. Tutorials will focus on case studies from the industry where data analytics, AI, and machine learning has been applied successfully.
Learners will have 36 hours a semester of college-based classroom contact. Lectures and any practical work will use a variety of teaching and learning techniques including direct instruction, in-class group work, case studies, and problem-solving.

Work-based learning and practice placement

E-Learning

Module Physical resource requirements

Specifications for module staffing requirements

Sample assessment materials

Timetabling, learner effort and credit

Module assessment rationale

Affiliated Entities

Entity Code	Entity Title	Entity Version	Entity Type	Via	Outcome
MSCDA	MSc in Data Analytics	3.0	Programme		Yes
MSCDA	MSc in Data Analytics	4.0	Programme		Yes

Documents

No Documents

9RPM: Research Practicum
(Group Elective 4)

Module Code:	9RPM
Long Title	Research Practicum APPROVED
Title	Research Practicum
Module Level:	LEVEL 9
EQF Level:	7
Valid From:	2024 (July 2024)
Language of Instruction:	English
Duration:	2 Semesters
Credits:	30
Field of Study:	0610 - Information and Communication Technologies (ICTs) not further defined or elsewhe
Learning Outcome Taxonomy	Blooms
Module Author:	Eileen Long
Authors	Long Eileen (10 July 2024 to ---)
Is this a capstone module?	Yes

Learning Outcomes	
On successful completion of this module the learner will be able to:	
#	**Learning Outcome Description**
LO1	Propose a research question, project objectives and methodology.
LO2	Analyse, synthesise, and critically evaluate the state of the art.
LO3	Propose, architect, implement, and evaluate an ICT solution related to the programme area.
LO4	Investigate potential future research and invention disclosures.
LO5	Present and defend the project findings through a viva, artefact/product demo, and report.
LO6	Identify, assess, and resolve the ethical issues that need to be addressed when conducting research.
LO7	Demonstrate initiative whilst working alone or part of a team, and appropriate communication and interpersonal skills.

Learning Outcome Taxonomy Blooms							
#	LO1	LO2	LO3	LO4	LO5	LO6	LO7
C1					Y		
C2					Y		
C3					Y		Y
C4				Y			
C5	Y				Y		
C6							
P1							
P2							
P3							
P4							
P5							Y
P6							
P7							
A1							
A2					Y		
A3	Y						Y
A4							
A5	Y						

Learning Outcome Taxonomy Reference Blooms		
#	**Taxonomy Description**	**Taxonomy Group**
C1	Knowledge	Cognitive
C2	Comprehension	Cognitive
C3	Application	Cognitive
C4	Analysis	Cognitive
C5	Synthesis	Cognitive
C6	Evaluation	Cognitive
P1	Perception	Psychomotor (Technical Skills)
P2	Set	Psychomotor (Technical Skills)
P3	Guided Response	Psychomotor (Technical Skills)
P4	Mechanism	Psychomotor (Technical Skills)
P5	Complex Overt Response	Psychomotor (Technical Skills)
P6	Adaptation	Psychomotor (Technical Skills)
P7	Origination	Psychomotor (Technical Skills)
A1	Receiving to Phenomena	Affective (Humanities)
A2	Responding to Phenomena	Affective (Humanities)
A3	Valuing	Affective (Humanities)
A4	Organizing Values	Affective (Humanities)
A5	Internalizing Values	Affective (Humanities)

Programme Module Dependencies
No requisites

Dependencies

Module Content & Assessment

Indicative Content
1. Research Questions and Literature Review and Novel Contribution 1.1) Structure and purpose of a literature review. Search tools and sources. Selecting and coping with literature. Identifying novel contribution.
2. Scientific Methodology, Research Questions and Literature Review 2.1) Exploring different research methodologies and assessing the context for these research methodologies. Formulating a research question. Ethics in research.
3. Computing Community and Resources 3.1) Planning software development and evaluation. User involvement. Descriptive, theory oriented and applied projects. Time and project management, making efficient use of time and resources to manage multiple tasks at the same time and reach the goals.
4. Academic Writing I 4.1) Proposal structure. Selection and assessing the quality of literature.
5. Academic Writing II 5.1) Project structure. Citations and referencing.
6. Academic Writing III 6.1) Presenting qualitative data. Presenting quantitative data.
7. Academic Writing IV 7.1) The importance of ethics and reproducibility in research.
8. Academic Writing V 8.1) Scientific writing and style considerations. Plagiarism and self-plagiarism.
9. Technical Information 9.1) Reading, understanding and summarising technical material, including source code, academic articles, patents, and documentation. Writing effective technical documentation and materials.
10. Ethics 10.1) Ethics considerations around human participants, secondary datasets. Ethics approval process.
11. Communication 11.1) Dynamics of oral, written, and electronic team and group communication
12. Project Proposal and Ethics Approval 12.1) A project proposal must describe what the learner will investigate, the importance and relevance of the topic to the programme area, and how the learner intends to fulfil the project goals. The format of a project proposal varies between fields, but most proposals should contain at least these elements: introduction, research question, research objectives, literature review, artefact/approach design, evaluation methodology, implications and contribution to knowledge, and reference list. The proposal should address the ethics of the proposed study and the proposal should have ethics approval.
13. Research Practicum Project Report 13.1) The research practicum project report is a paper style report. The report shall comprise up to 20 pages (4,000 to 6,000 words) and describes the individual research and production of an ICT solution. It shall follow the following format: introduction, background, design, implementation, results and discussion, and conclusion. A literature review should be included to situate the work in existing research. Learners are also required to critically analyse insights gained throughout the development and evaluation of their research application. In addition, learners should also identify future commercialisation opportunities and further research possibilities.
14. Artefact/Product 14.1) An artefact/product can represent a software application that demonstrates a novel invention. An artefact/product can also represent a phenomenon that is observed in a scientific investigation or experiment that is not naturally present but occurs as a result of the preparative or investigative procedure.
15. User Configuration Manual 15.1) The configuration manual shall describe the required software tools and settings to successfully replicate the experimental setup. This manual is submitted separately from the research paper style report and it will not count towards the suggested word count. It should not discuss only how to install standard software or tools.
16. Viva 16.1) The viva shall involve a presentation of the research work carried out and a demonstration of the results including a demo of the developed artefact/product.
17. Invention Disclosure Form 17.1) IDF identifies the potential commercial opportunities and explores the related markets. The IDF describes the invention, highlights the novelty/patentable aspect, what the problem is and how the invention solves the problem, identifies the companies that are interested in the invention, and potential commercial application of the invention.

Assessment Breakdown	%
Coursework	100.00%

Assessments

Coursework

Assessment Type:	Proposal	**% of total:**	10
Pass Marks:	0	**Assessment Date:**	n/a
Outcome addressed:	1,2,3,4	**Briefing:**	n/a
Feedback:	n/a	**Assessment Mode:**	Not yet determined
Assessment Medium:	Not yet determined	**Role:**	Not yet determined
Mandatory:	False	**Assessor:**	Not yet determined
Feedback Type:		**Non-Marked:**	No
Assessment Difficulty:	Not yet determined	**Central Admin:**	No
Language Proficiency:			

Assessment Description:
Project Proposal and Ethics Approval

Assessment Type:	Project	**% of total:**	5
Pass Marks:	0	**Assessment Date:**	n/a
Outcome addressed:	1,2,3,4	**Briefing:**	n/a
Feedback:	n/a	**Assessment Mode:**	Not yet determined
Assessment Medium:	Not yet determined	**Role:**	Not yet determined
Mandatory:	False	**Assessor:**	Not yet determined
Feedback Type:		**Non-Marked:**	No
Assessment Difficulty:	Not yet determined	**Central Admin:**	No
Language Proficiency:			

Assessment Description:
Project Specification

Assessment Type:	Project	**% of total:**	10
Pass Marks:	0	**Assessment Date:**	n/a
Outcome addressed:	5,6,7	**Briefing:**	n/a
Feedback:	n/a	**Assessment Mode:**	Not yet determined
Assessment Medium:	Not yet determined	**Role:**	Not yet determined
Mandatory:	False	**Assessor:**	Not yet determined
Feedback Type:		**Non-Marked:**	No
Assessment Difficulty:	Not yet determined	**Central Admin:**	No
Language Proficiency:			

Assessment Description:
Literature Review

Coursework

Assessment Type:	Project	**% of total:**	30
Pass Marks:	0	**Assessment Date:**	n/a
Outcome addressed:	5,6,7	**Briefing:**	n/a
Feedback:	n/a	**Assessment Mode:**	Not yet determined
Assessment Medium:	Not yet determined	**Role:**	Not yet determined
Mandatory:	False	**Assessor:**	Not yet determined
Feedback Type:		**Non-Marked:**	No
Assessment Difficulty:	Not yet determined	**Central Admin:**	No
Language Proficiency:			

Assessment Description:
Artefact/Product Development

Assessment Type:	Project	**% of total:**	25
Pass Marks:	0	**Assessment Date:**	n/a
Outcome addressed:	5,6,7	**Briefing:**	n/a
Feedback:	n/a	**Assessment Mode:**	Not yet determined
Assessment Medium:	Not yet determined	**Role:**	Not yet determined
Mandatory:	False	**Assessor:**	Not yet determined
Feedback Type:		**Non-Marked:**	No
Assessment Difficulty:	Not yet determined	**Central Admin:**	No
Language Proficiency:			

Assessment Description:
Artefact/Product Evaluation and Analysis

Assessment Type:	Project	**% of total:**	10
Pass Marks:	0	**Assessment Date:**	n/a
Outcome addressed:	5,6,7	**Briefing:**	n/a
Feedback:	n/a	**Assessment Mode:**	Not yet determined
Assessment Medium:	Not yet determined	**Role:**	Not yet determined
Mandatory:	False	**Assessor:**	Not yet determined
Feedback Type:		**Non-Marked:**	No
Assessment Difficulty:	Not yet determined	**Central Admin:**	No
Language Proficiency:			

Assessment Description:
Document Presentation/Structure, Referencing, and Configuration Manual

Coursework

Assessment Type:	Presentation	**% of total:**	10
Pass Marks:	0	**Assessment Date:**	n/a
Outcome addressed:	5,6,7	**Briefing:**	n/a
Feedback:	n/a	**Assessment Mode:**	Not yet determined
Assessment Medium:	Not yet determined	**Role:**	Not yet determined
Mandatory:	False	**Assessor:**	Not yet determined
Feedback Type:		**Non-Marked:**	No
Assessment Difficulty:	Not yet determined	**Central Admin:**	No
Language Proficiency:			

Assessment Description:
Viva

Coursework

Assessment Type:	Proposal	**% of total:**	10
Pass Marks:	0	**Assessment Date:**	n/a
Outcome addressed:	1,2,3,4	**Briefing:**	n/a
Feedback:	n/a	**Assessment Mode:**	Not yet determined
Assessment Medium:	Not yet determined	**Role:**	Not yet determined
Mandatory:	False	**Assessor:**	Not yet determined
Feedback Type:		**Non-Marked:**	No
Assessment Difficulty:	Not yet determined	**Central Admin:**	No
Language Proficiency:			

Assessment Description:
Project Proposal and Ethics Approval

Assessment Type:	Project	**% of total:**	5
Pass Marks:	0	**Assessment Date:**	n/a
Outcome addressed:	1,2,3,4	**Briefing:**	n/a
Feedback:	n/a	**Assessment Mode:**	Not yet determined
Assessment Medium:	Not yet determined	**Role:**	Not yet determined
Mandatory:	False	**Assessor:**	Not yet determined
Feedback Type:		**Non-Marked:**	No
Assessment Difficulty:	Not yet determined	**Central Admin:**	No
Language Proficiency:			

Assessment Description:
Project Specification

Coursework

Assessment Type:	Project	**% of total:**	10
Pass Marks:	0	**Assessment Date:**	n/a
Outcome addressed:	5,6,7	**Briefing:**	n/a
Feedback:	n/a	**Assessment Mode:**	Not yet determined
Assessment Medium:	Not yet determined	**Role:**	Not yet determined
Mandatory:	False	**Assessor:**	Not yet determined
Feedback Type:		**Non-Marked:**	No
Assessment Difficulty:	Not yet determined	**Central Admin:**	No
Language Proficiency:			

Assessment Description:
Literature Review

Assessment Type:	Project	**% of total:**	30
Pass Marks:	0	**Assessment Date:**	n/a
Outcome addressed:	5,6,7	**Briefing:**	n/a
Feedback:	n/a	**Assessment Mode:**	Not yet determined
Assessment Medium:	Not yet determined	**Role:**	Not yet determined
Mandatory:	False	**Assessor:**	Not yet determined
Feedback Type:		**Non-Marked:**	No
Assessment Difficulty:	Not yet determined	**Central Admin:**	No
Language Proficiency:			

Assessment Description:
Artefact/Product Development

Assessment Type:	Project	**% of total:**	25
Pass Marks:	0	**Assessment Date:**	n/a
Outcome addressed:	5,6,7	**Briefing:**	n/a
Feedback:	n/a	**Assessment Mode:**	Not yet determined
Assessment Medium:	Not yet determined	**Role:**	Not yet determined
Mandatory:	False	**Assessor:**	Not yet determined
Feedback Type:		**Non-Marked:**	No
Assessment Difficulty:	Not yet determined	**Central Admin:**	No
Language Proficiency:			

Assessment Description:
Artefact/Product Evaluation and Analysis

Coursework

Assessment Type:	Project	**% of total:**	10
Pass Marks:	0	**Assessment Date:**	n/a
Outcome addressed:	5,6,7	**Briefing:**	n/a
Feedback:	n/a	**Assessment Mode:**	Not yet determined
Assessment Medium:	Not yet determined	**Role:**	Not yet determined
Mandatory:	False	**Assessor:**	Not yet determined
Feedback Type:		**Non-Marked:**	No
Assessment Difficulty:	Not yet determined	**Central Admin:**	No
Language Proficiency:			

Assessment Description:
Document Presentation/Structure, Referencing, and Configuration Manual

Assessment Type:	Presentation	**% of total:**	10
Pass Marks:	0	**Assessment Date:**	n/a
Outcome addressed:	5,6,7	**Briefing:**	n/a
Feedback:	n/a	**Assessment Mode:**	Not yet determined
Assessment Medium:	Not yet determined	**Role:**	Not yet determined
Mandatory:	False	**Assessor:**	Not yet determined
Feedback Type:		**Non-Marked:**	No
Assessment Difficulty:	Not yet determined	**Central Admin:**	No
Language Proficiency:			

Assessment Description:
Viva

Module Workload

Module Target Workload Hours 300 Hours

Full Time hours per semester

Workload Type	
Lecture	
Independent Learning	
Tutorial	
Lecturer Supervised Learning	
	750.00

This module has no Apprenticeship workload.

This module has no Blended workload.

This module has no Block workload.

This module has no Distance/Correspondance workload.

This module has no Evening workload.

This module has no Online workload.

Part Time hours per semester
Workload Type
Lecture
Tutorial
Lecturer Supervised Learning
Independent Learning
750.00

MLO Competency Mapping

Learning Outcomes	Competencies
LO1: Propose a research question, project objectives and methodology.	
LO2: Analyse, synthesise, and critically evaluate the state of the art.	
LO3: Propose, architect, implement, and evaluate an ICT solution related to the programme area.	
LO4: Investigate potential future research and invention disclosures.	
LO5: Present and defend the project findings through a viva, artefact/product demo, and report.	
LO6: Identify, assess, and resolve the ethical issues that need to be addressed when conducting research.	
LO7: Demonstrate initiative whilst working alone or part of a team, and appropriate communication and interpersonal skills.	

Module Resources

Recommended Book Resources

Creswell, J.W. & Creswell, J.D. (2022). Research Design: Qualitative, Quantitative, and Mixed Methods Approaches (6th ed.). SAGE Publications. [ISBN: 978-1071817940]..

Zobel, J. (2015). Writing for Computer Science (3rd ed.). Springer. [ISBN: 978-1447166382]..

Dawson, C. (2015). Projects in Computing and Information Systems: A Student's Guide (3rd ed.). Pearson. [ISBN: 978-1292073460]..

Supplementary Book Resources

Thomas, G. (2017). How to Do Your Research Project: A Guide for Students (3rd. ed.). Sage Publications. [ISBN: 978-1473948860]..

Kitzes, J., Turek, D., & Deniz, F. (2017). The Practice of Reproducible Research: Case Studies and Lessons from the Data-Intensive Sciences. University of California Press. [ISBN: 978-0520294745]..

Evans, D., Gruba, P. & Zobel, J. (2014) How to Write a Better Thesis (3rd ed.). Springer. [ISBN: 978-3319042855]..

Ridley, D. (2012). The Literature Review: A Step-by-Step Guide for Students (2nd ed.). Sage Publications. [ISBN: 978-1446201435]..

Other Resources

[Website], http://www.patentsoffice.ie,
http://www.patentsoffice.ie

[Website], http://www.epo.org/searching/free/espace net.html,
http://www.epo.org/searching/free/espace net.html

[Website], Website. Prof Alan Bundy, University of Edinburgh How to Write an Informatics Paper,
http://homepages.inf.ed.ac.uk/bundy/how- tos/writingGuide.html

Review

Module Aims and Objectives

This module aims to allow learners to consolidate the knowledge, skills and competence acquired in a programme of study by carrying out a practicum that combines both research and technical skills to investigate, design, produce and evaluate an innovative ICT solution related to a programme area

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

Information provided to learners about the module

The module specification is replicated in Akari Document, which is the College's repository of programme and module information. In order to ensure that this information is consistently presented, this is viewed as the primary source of information and is linked to in all systems, e.g. website links and Moodle, the College's virtual learning environment, Moodle etc. This is also the source of information for teaching staff in terms of guidance around assessment structure and requirements.

These specifications once approved are available via http://courses.ncirl.ie

This specification, where appropriate, is also used as the primary source of information for printed materials e.g. prospectus. In this case, until the module is approved in the context of the programme, information is indicative.

This information is further supplemented on an instance by instance basis by the individual lecturer teaching the module through the module handbook, which may be made available electronically via Moodle or in printed format. This document ensures that week by week activities, updated reading list and cohort specific information is current.

Module content, organisation and structure

The module content is organised over two semesters with workshops and assignment of supervisors taking place in Semester 2, while Semester 3 consists exclusively of supervision.

For classroom-based teaching in semester 2 the practicum is scheduled based on 1-hour lecture and 2 hours lab over 12 weeks. In semester 3 the classroom is scheduled based on supervising the student for 1 hour per week over 12 weeks.

For online learning in semester 2 the practicum is scheduled based on 1-hour lecture and 1-hour lab and 1-hour directed eLearning over 12 weeks. In semester 3 the classroom is scheduled based on supervising the student for 1 hour per week over 12 weeks.

An indicative schedule of topics to be addressed each week in Semester 2 is outlined below:

Research Questions and Literature Review and Novel Contribution

Structure and purpose of a literature review. Search tools and sources. Selecting and coping with literature. Identifying novel contribution.

Scientific Methodology, Research Questions and Literature Review

Exploring different research methodologies and assessing the context for these research methodologies. Formulating a research question. Ethics in research.

Computing Community and Resources

Planning software development and evaluation. User involvement. Descriptive, theory oriented and applied projects. Time and project management, making efficient use of time and resources to manage multiple tasks at the same time and reach the goals.

Academic Writing I

Proposal structure. Selection and assessing the quality of literature.

Academic Writing II

Project structure. Citations and referencing.

Academic Writing III

Presenting qualitative data. Presenting quantitative data.

Academic Writing IV

The importance of ethics and reproducibility in research.

Academic Writing V

Scientific writing and style considerations. Plagiarism and self-plagiarism.

Technical Information

Reading, understanding and summarising technical material, including source code, academic articles, patents, and documentation. Writing effective technical documentation and materials.

Ethics

Ethics considerations around human participants, secondary datasets. Ethics approval process.

Communication

Dynamics of oral, written, and electronic team and group communication

In Semester 2, learners submit a portfolio that consists of a project proposal with Ethics Approval. In Semester 3, learners submit a practicum project report, an artefact/product, a user configuration manual, a presentation to be defended in a viva, and an invention disclosure form (if applicable). A demonstration of the artefact/product developed may be presented in the viva.

Learners that wish to commercialise their project work or a project related technology can explore this path. In this case, the learner will be required to complete an invention disclosure form (IDF) that identifies the potential commercial opportunities and explores the related markets.

Project Proposal and Ethics Approval (Semester 2)

A project proposal must describe what the learner will investigate, the importance and relevance of the topic to the programme area, and how the learner intends to fulfil the project goals. The format of a project proposal varies between fields, but most proposals should contain at least these elements: introduction, research question, research objectives, literature review, artefact/approach design, evaluation methodology, implications and contribution to knowledge, and reference list. The proposal should address the ethics of the proposed study and the proposal should have ethics approval.

Research Practicum Project Report (Semester 3)

The research practicum project report is a paper style report. The report shall comprise up to 20 pages (4,000 to 6,000 words) and describes the individual research and production of an ICT solution. It shall follow the following format: introduction, background, design, implementation, results and discussion, and conclusion. A literature review should be included to situate the work in existing research. Learners are also required to critically analyse insights gained throughout the development and evaluation of their research application. In addition, learners should also identify future commercialisation opportunities and further research possibilities.

Throughout the project learners are required to engage in formative assessments to evaluate their progress. The format of a project report varies between fields, but most reports should contain at least these elements:

- **Abstract**: The role of the abstract is to summarise the project undertaken in a concise manner, highlighting the scope of the project, the objectives, the methodology and its finding and results.
- **Introduction**: The main purpose of the introduction is to motivate the contribution of the research work. It should include background on the topic, the justification for the topic, and what gap in the literature it seeks to fill, the main research questions and objectives, novel contribution, and the organisation of the report.
- **Literature Review**: The literature review should demonstrate evidence of independent research critically analysing the potential of an application/idea and provide insights into how it can be implemented and evaluated.
- **Design Specification**: The techniques and/or architecture/framework that underlie the implementation and the associated requirements are discussed.
- **Implementation/Solution Development**: Learners develop a solution that addresses the research question(s)/objective(s). This may involve the development of an application prototype, the design of an algorithm, the implementation of an innovative service or component of a system.
- **Experiments**: Learners outline the proposed approach, method, and experiments used to generate the results, as well as demonstrating how the method will be applied to answering/achieve the research question(s)/objective(s).
- **Results and Discussion**: A comprehensive evaluation must be conducted by each learner using multiple strategies, example; an algorithm may be benchmarked by performance specific metrics whilst an internet applicati or mobile application may be evaluated using suitable usability testing techniques. Statistical tools should be used when appropriate to critically evaluate, assess, and analyse the experimental research outputs and levels o significance.
- **Conclusion and Future Work**: Learners must arrive at a conclusion from their research question(s)/objective(s) as defined. A detailed future work section must be included showing the learners understanding of their own research and opportunities for future improvements.
- **References**: Correct citation references must be included.

Artefact/Product

An artefact/product can represent a software application that demonstrates a novel invention. An artefact/product can also represent a phenomenon that is observed in a scientific investigation or experiment that is not naturally present but occurs as a result of the preparative or investigative procedure.

User Configuration Manual

The configuration manual shall describe the required software tools and settings to successfully replicate the experimental setup. This manual is submitted separately from the research paper style report and it will not count towards the suggested word count. It should not discuss only how to install standard software or tools.

Viva

The viva shall involve a presentation of the research work carried out and a demonstration of the results including a demo of the developed artefact/product.

Invention Disclosure Form

IDF identifies the potential commercial opportunities and explores the related markets. The IDF describes the invention, highlights the novelty/patentable aspect, what the problem is and how the invention solves the problem, identifies the companies that are interested in the invention, and potential commercial application of the invention.

Module Teaching and Learning (including formative assessment) Strategy

The learning strategy entails the use of workshops and academic seminars to provide learners with a solid foundation of the latest computing research avenues in the knowledge domain of the given programme.

Learning will may place in a classroom or blended environment and will feature both lectures and practical sessions for each topic. Materials and resources will be placed on Moodle, the College's virtual learning environment. Such materials may include lecture notes, lab/tutorial descriptions, assessments, datasets, discussion groups, videos (e.g., created by lecturers or from external sources such as YouTube). Where appropriate, this module may make use of the flipped classroom approach.

The learners will also be directed to software tools appropriate to specific topics in the module, e.g.

- Scopus, Google Scholar, Mendeley, Zotero, JabRef, etc. for executing and organising the results of literature searches
- Tools such as Jupyter Notebooks, Git/GitHub for literate programming, reproducible research, and version control
- Microsoft Project and open source tools for the production of project plans and Gantt charts.

Learners may be required to work in groups during the labs/tutorials. Moodle may also be used to both interact with learners and in some instances to provide formative assessments and feedback. Learners will have access to library resources, both physical and electronic, outside of the classroom where required.

Supervisors monitor the individual progress and provide guidance on the project. Techniques such online notes/information available on Moodle, links to extra material available on the Internet, Moodle forum may be used. Learners may also use collaborative tools for the development of the project. All documents required to be provided as part of the assessment will be submitted online on Moodle. The use of Git repositories will be encouraged as a collaborative tool to enable students to work on the development of the project. It will also improve the transparency of projects for markers as it will enable them to clearly identify the work carried out by students as part of the project.

Work-based learning and practice placement

E-Learning

Module Physical resource requirements

Specifications for module staffing requirements

Sample assessment materials

Timetabling, learner effort and credit

Module assessment rationale

Affiliated Entities

Entity Code	Entity Title	Entity Version	Entity Type	Via	Outcome
MSCDA	MSc in Data Analytics	3.0	Programme		Yes
MSCDA	MSc in Data Analytics	4.0	Programme		Yes

Documents

No Documents

H9BIBA: Business Intelligence and Business Analytics (Core Subject)

Module Code:	H9BIBA
Long Title	Business Intelligence and Business Analytics APPROVED
Title	Business Intelligence and Business Analytics
Module Level:	LEVEL 9
EQF Level:	7
Valid From:	2024 (July 2024)
Language of Instruction:	English
Duration:	1 Semester
Credits:	10
Field of Study:	0610 - Information and Communication Technologies (ICTs) not further defined or elsewhe
Learning Outcome Taxonomy	Blooms
Module Author:	Shauni Hegarty
Authors	• Carson Jenette (10 July 2024 to 10 July 2024) • Hegarty Shauni (10 July 2024 to ---)
Specifications of the qualifications and experience required of staff	MSc/PhD in a computing or cognate discipline. May have industry experience also.

Is this a capstone module?	No

Learning Outcomes	
On successful completion of this module the learner will be able to:	
#	**Learning Outcome Description**
LO1	Critically analyse advanced Business Intelligence and Business Analytics methodologies in order to assess best practice guidance when applied to operational data of a business
LO2	Investigate and evaluate key concepts and advanced Business Intelligence and Business Analytics techniques and assess how to apply which technique on complex datasets and practical problem domains.
LO3	Contextualise, research and utilise current data approaches, applications and technologies in order to develop Business Intelligence and business analytics strategies to address the operational and analytical requirements of an organisation
LO4	Critically review and apply appropriate data mining research and assess research methods in business contexts

Learning Outcome Taxonomy Blooms				
#	LO1	LO2	LO3	LO4
C1				
C2				
C3				
C4		Y		
C5				
C6				
P1				
P2				
P3				
P4				
P5				
P6				
P7				
A1				
A2				
A3				
A4				
A5				

Learning Outcome Taxonomy Reference Blooms		
#	**Taxonomy Description**	**Taxonomy Group**
C1	Knowledge	Cognitive
C2	Comprehension	Cognitive
C3	Application	Cognitive
C4	Analysis	Cognitive
C5	Synthesis	Cognitive
C6	Evaluation	Cognitive
P1	Perception	Psychomotor (Technical Skills)
P2	Set	Psychomotor (Technical Skills)
P3	Guided Response	Psychomotor (Technical Skills)
P4	Mechanism	Psychomotor (Technical Skills)
P5	Complex Overt Response	Psychomotor (Technical Skills)
P6	Adaptation	Psychomotor (Technical Skills)
P7	Origination	Psychomotor (Technical Skills)
A1	Receiving to Phenomena	Affective (Humanities)
A2	Responding to Phenomena	Affective (Humanities)
A3	Valuing	Affective (Humanities)
A4	Organizing Values	Affective (Humanities)
A5	Internalizing Values	Affective (Humanities)

Programme Module Dependencies
No requisites

Dependencies	
Entry requirements	A level 8 degree or its equivalent in any discipline

Module Content & Assessment

Indicative Content
1. Intelligent Enterprises 1.1) Agile Enterprises, Operating Strategies, Continuous Improvement Programs
2. Enterprise Systems 2.1) Evolution – MRP, CL MRP, MRP II, ERP, ES Packages, Balanced Scorecard
3. BI and Dashboards 3.1) Views v Reports, Types of Dashboards, Advantages of Dashboards, The Funnel
4. Consumer Behaviour models 4.1) Behaviourist v Cognitivist, Lawson's, EKB, and Howard and Sheth's models
5. Operational CRM Systems 5.1) Overview and demonstration of a commercial system (e.g., Salesforce, Microsoft Dynamics CRM). AI and CRM.
6. Implementing Enterprise BI systems 6.1) Data Warehousing and Data Marts, Data mining, Online Analytical Process (OLAP). Handling unstructured and semi-structured data in the modern enterprise. Data Lakes.
7. Implementing CRM systems 7.1) Fit-Gap Analysis, Integration with Heterogeneous systems, Data integration, Information Lifecycle Management, Data protection, security and ethical considerations
8. Customer-Centric Enterprise with CRM/ Customer-Responsive Enterprise with SCM 8.1) Customer Experience, Customer Loyalty, Customer Relationships, Customer Life Cycle, Customer Value Management. Supply Chain Management, Customer-Responsive Management, B-Webs, Activity Costing techniques.
9. Renewing Enterprise with PLM/ Collaborative Enterprise with BPM 9.1) Components and Advantages of PLM, Porter's Framework, Product Life Cycle. BPM, BPR, Business Processes with SOA, Workflows, Analytics.
10. Informed Enterprise with BI 10.1) Context-Aware Applications, Decision Patterns and Data mining
11. Data Insights 11.1) Using social media data. Insights from Consumer Behaviour, Financial Data, Healthcare etc. Importance of business meaning.
12. QA Systems & Uplift 12.1) QA systems. Natural Language Processing. Structured data. Unstructured collections. Persuasion modelling. Incremental modelling. Uplift decision trees. Applications – Upsell, Cross-sell, Customer Retention.

Assessment Breakdown	%
Coursework	100.00%

Assessments

Coursework

Assessment Type:	Continuous Assessment	**% of total:**	20
Pass Marks:	0	**Assessment Date:**	Week 8
Outcome addressed:	3	**Briefing:**	n/a
Feedback:	n/a	**Assessment Mode:**	Not yet determined
Assessment Medium:	Not yet determined	**Role:**	Not yet determined
Mandatory:	False	**Assessor:**	Not yet determined
Feedback Type:		**Non-Marked:**	No
Assessment Difficulty:	Not yet determined	**Central Admin:**	No
Language Proficiency:			

Assessment Description:
Multiple-Choice Questions, similar to Industry Certification exams

Assessment Type:	Project	**% of total:**	80
Pass Marks:	0	**Assessment Date:**	Week 12
Outcome addressed:	1,2,3,4	**Briefing:**	n/a
Feedback:	n/a	**Assessment Mode:**	Not yet determined
Assessment Medium:	Not yet determined	**Role:**	Not yet determined
Mandatory:	False	**Assessor:**	Not yet determined
Feedback Type:		**Non-Marked:**	No
Assessment Difficulty:	Not yet determined	**Central Admin:**	No
Language Proficiency:			

Assessment Description:
Analyse Requirements, Design and Implement an end-to-end BI and Analytics system for an organisation.

Coursework

Assessment Type:	Continuous Assessment	**% of total:**	20
Pass Marks:	0	**Assessment Date:**	n/a
Outcome addressed:	3	**Briefing:**	n/a
Feedback:	n/a	**Assessment Mode:**	Not yet determined
Assessment Medium:	Not yet determined	**Role:**	Not yet determined
Mandatory:	False	**Assessor:**	Not yet determined
Feedback Type:		**Non-Marked:**	No
Assessment Difficulty:	Not yet determined	**Central Admin:**	No
Language Proficiency:			

Assessment Description:
Multiple-Choice Questions, similar to Industry Certification exams

Assessment Type:	Portfolio	**% of total:**	80
Pass Marks:	0	**Assessment Date:**	n/a
Outcome addressed:	1,2,3,4	**Briefing:**	n/a
Feedback:	n/a	**Assessment Mode:**	Not yet determined
Assessment Medium:	Not yet determined	**Role:**	Not yet determined
Mandatory:	False	**Assessor:**	Not yet determined
Feedback Type:		**Non-Marked:**	No
Assessment Difficulty:	Not yet determined	**Central Admin:**	No
Language Proficiency:			

Assessment Description:
Analyse Requirements, Design and Implement an end-to-end BI and Analytics system for an organisation.

Module Workload

Module Target Workload Hours 100 Hours

Full Time hours per semester

Workload Type	
Lecture	
Independent Learning	
Tutorial	
	250.00

This module has no Apprenticeship workload.

This module has no Blended workload.

This module has no Block workload.

This module has no Distance/Correspondance workload.

This module has no Evening workload.

This module has no Online workload.

Part Time hours per semester
Workload Type
Lecture
Tutorial
Independent Learning
Directed E-Learning
250.00

MLO Competency Mapping

Learning Outcomes	Competencies
LO1: Critically analyse advanced Business Intelligence and Business Analytics methodologies in order to assess best practice guidance when applied to operational data of a business	
LO2: Investigate and evaluate key concepts and advanced Business Intelligence and Business Analytics techniques and assess how to apply which technique on complex datasets and practical problem domains.	
LO3: Contextualise, research and utilise current data approaches, applications and technologies in order to develop Business Intelligence and business analytics strategies to address the operational and analytical requirements of an organisation	
LO4: Critically review and apply appropriate data mining research and assess research methods in business contexts	

Module Resources

Recommended Book Resources

Ramesh Sharda,Dursun Delen,Efraim Turban. (2017), Business Intelligence, Pearson, p.512, [ISBN: 978-0134633282].

Vivek Kale. (2016), Enhancing Enterprise Intelligence, CRC Press, Taylor & Francis Group, CRC Press is, p.0, [ISBN: 978-1498705974].

Lorien Pratt,Nadine Malcolm. (2023), The Decision Intelligence Handbook, O'Reilly Media, p.0, [ISBN: 978-1098139650].

Eric Siegel. (2016), Predictive Analytics, John Wiley & Sons, p.395, [ISBN: 978-1119145677].

Supplementary Book Resources

Iiba. Guide to Business Data Analytics, [ISBN: 978-1927584200].

Abbott D., Applied BI and Consumer Relationship Analytics: Principle and Techniques for the Professional Data Analyst (Wiley, 2014)..

Abbott D., Applied Predictive Analytics: Principle and Techniques for the Professional Data Analyst (Wiley, 2014).

Gordon S. Linoff,Michael J. A. Berry. (2011), Data Mining Techniques, John Wiley & Sons, p.891, [ISBN: 978-0470650936].

Deborah J. Nightingale,Donna H. Rhodes. (2024), Architecting the Future Enterprise, MIT Press, p.197, [ISBN: 978-0262552462].

Review

Module Aims and Objectives

The objective of the Business Intelligence and Business Analytics module is to endow learners with hands on experience of contemporary approaches to applying Business Intelligence and Business Analytics in practical settings such as banking, retail and online services. This module will be framed within the KDD and CRISP-DM data mining methodologies as appropriate for the problems studied. In undertaking this module, learners will gain hands on experience with a range of Business Intelligence and Business analysis techniques using real world case studies.

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

Information provided to learners about the module

This module specification is replicated in Akari Document, which is the College's repository of programme and module information. To ensure that this information is consistently presented, this is viewed as the primary source of information and is linked to in all information systems, e.g. website links and Moodle, the College's virtual learning environment. This is also the source of information for teaching staff.
These specifications once approved are available via http://courses.ncirl.ie.
This specification, where appropriate, is also used as the primary source of information for printed material, e.g. Prospectus. In this case, until the module is approved in the context of the programme, information is indicative.

Module content, organisation and structure

Intelligent Enterprises

Agile enterprises. Operating strategies. Continuous Improvement Programs.

Enterprise Systems

Evolution – MRP, CL MRP, MRP II, ERP, ES Packages. Balanced Scorecard.

BI and Dashboards

Views v Reports, Types of dashboards, Advantages of dashboards, The Funnel.

Consumer Behaviour Models

Behaviourist v Cognitivist. Lawson's, EKB, and Howard and Sheth's models.

Operational CRM Systems

Overview and demonstration of a commercial system (e.g., Salesforce, Microsoft Dynamics CRM). AI and CRM.

Implementing Enterprise BI systems

Data Warehousing and Data Marts, Data mining, Online Analytical Process (OLAP). Handling unstructured and semi-structured data in the modern enterprise. Data Lakes.

Implementing CRM systems

Fit-Gap Analysis, Integration with Heterogeneous systems, Data integration, Information Lifecycle Management, Data protection, security and ethical considerations.

Customer-Centric Enterprise with CRM/ Customer-Responsive Enterprise with SCM

Customer Experience, Customer Loyalty, Customer Relationships, Customer Life Cycle, Customer Value Management. Supply Chain Management, Customer-Responsive Management, B-Webs, Activity Costing techniques.

Renewing Enterprise with PLM/ Collaborative Enterprise with BPM

Components and Advantages of PLM, Porter's Framework, Product Life Cycle. BPM, BPR, Business Processes with SOA, Workflows, Analytics.

Informed Enterprise with BI

Context-Aware Applications, Decision Patterns and Data mining.

Data Insights

Using social media data. Insights from Consumer Behaviour, Financial Data, Healthcare etc. Importance of business meaning.

QA Systems & Uplift

QA systems. Natural Language Processing. Structured data. Unstructured collections. Persuasion modelling. Incremental modelling. Uplift decision trees. Applications – Upsell, Cross-sell, Customer Retention.

Module Teaching and Learning (including formative assessment) Strategy

The learning strategy involves the use of lectures, tutorials, case studies, paper reviews and practical work where learners will engage with and explore Business Intelligence and Business Analytics in real-world scenarios. Lectures will include active learning components such as paired discussion, problem solving, and class feedback. Practical sessions will comprise of group work and individual learning. Learners will also have access to data analytics research documents and publications as required. Tutorials will focus on case studies from the business world where Business Intelligence and Business Analytics have been applied successfully.

Work-based learning and practice placement

N/A

E-Learning

Module Physical resource requirements

Specifications for module staffing requirements

Sample assessment materials

Timetabling, learner effort and credit

The Business Intelligence and Business Analytics module is scheduled to take place in Semester 2.

Module assessment rationale

Summative Assessment Strategy for this module		
MIMLOs	Technique(s)	Weighting
3	Continuous Assessment Week 8 Multiple-Choice Questions, similar to Industry Certification exams	20%
1, 2, 3, 4	Project Week 12 Analyse Requirements, Design and Implement an end-to-end BI and Analytics system for an organisation.	80%

Affiliated Entities

Entity Code	Entity Title	Entity Version	Entity Type	Via	Outcome
MSCDA	MSc in Data Analytics	3.0	Programme		Yes
MSCDA	MSc in Data Analytics	4.0	Programme		Yes
PGDDA	Post Graduate Diploma in Science in Data Analytics	3.0	Programme		Yes

Documents

No Documents

H9DLGA: Deep Learning & Generative AI (Core Subject)

Module Code:	H9DLGA
Long Title	Deep Learning & Generative AI APPROVED
Title	Deep Learning & Generative AI
Module Level:	LEVEL 9
EQF Level:	7
Valid From:	2024 (July 2024)
Language of Instruction:	English
Duration:	2 Semesters
Credits:	10
Field of Study:	0610 - Information and Communication Technologies (ICTs) not further defined or elsewhe
Learning Outcome Taxonomy	Blooms
Module Author:	Shauni Hegarty
Authors	Hegarty Shauni (10 July 2024 to ---)
Is this a capstone module?	No

Learning Outcomes	
On successful completion of this module the learner will be able to:	
#	**Learning Outcome Description**
LO1	Investigate and evaluate key concepts relating to artificial neural networks in both supervised and unsupervised machine learning contexts.
LO2	Investigate and evaluate advanced deep learning techniques and assess when to apply such techniques on complex datasets and problem domains.
LO3	Contextualise, research and utilise state of the art deep learning and generative AI applications and technologies in order to provide and implement strategies to address processing of datasets with a variety of characteristics.
LO4	Critically review, assess and apply appropriate research methods to conduct research in deep learning and generative AI.

Learning Outcome Taxonomy Blooms				
#	LO1	LO2	LO3	LO4
C1				
C2				
C3				
C4	Y	Y		
C5				
C6				
P1				
P2				
P3				
P4				
P5				
P6				
P7				
A1				
A2				
A3				
A4				
A5				

Learning Outcome Taxonomy Reference Blooms		
#	**Taxonomy Description**	**Taxonomy Group**
C1	Knowledge	Cognitive
C2	Comprehension	Cognitive
C3	Application	Cognitive
C4	Analysis	Cognitive
C5	Synthesis	Cognitive
C6	Evaluation	Cognitive
P1	Perception	Psychomotor (Technical Skills)
P2	Set	Psychomotor (Technical Skills)
P3	Guided Response	Psychomotor (Technical Skills)
P4	Mechanism	Psychomotor (Technical Skills)
P5	Complex Overt Response	Psychomotor (Technical Skills)
P6	Adaptation	Psychomotor (Technical Skills)
P7	Origination	Psychomotor (Technical Skills)
A1	Receiving to Phenomena	Affective (Humanities)
A2	Responding to Phenomena	Affective (Humanities)
A3	Valuing	Affective (Humanities)
A4	Organizing Values	Affective (Humanities)
A5	Internalizing Values	Affective (Humanities)

Programme Module Dependencies
No requisites

Dependencies

Module Content & Assessment

Indicative Content
1. Introduction to Artificial Neural Networks 1.1) History & Evolution. Ethical concerns. Perceptron Learning. Non-linearity and activation functions. Multi-Layer Perceptron. Feed-forward networks. Introduction to gradient descent techniques.
2. Back Propagation & ANN Training 2.1) Review of partial differentiation, the chain rule, and the vector gradient. Derivation of Back Propagation algorithm. The delta rule and gradient descent. Network topology. Stochastic gradient descent. Batch considerations. Stopping. Validation data. Hyperparemeter optimisation.
3. Deep Learning – Convolutional Neural Networks 3.1) Deep Learning networks. Universal Approximation Theorem. The convolution (cross-correlation) operation. Strided convolutions and padding. Sparse interaction. Parameter sharing. Equivariant representations. Pooling. Data considerations.
4. Recurrent Neural Networks 4.1) Static vs Dynamic networks. Memory. Sequential and variable length data. Parameter sharing. Unfolding. Computational graph. Forward pass and back propagation through time. Vanishing/Exploding gradients.Types of RNN. LSTM and GRU.
5. Autoencoders 5.1) Encoder and Decoder. Undercomplete autoencoders. Representational Power, Layer Size and Depth. Regularized autoencoders. Sparse Autoencoder (SAE). Denoising Autoencoder (DAE). Contractive Autoencoder (CAE). Applications.
6. Generative Models 6.1) Generative modelling and probabilistic models. Maximum Likelihood Estimation. Variational autoencoders. Manipulating latent space. Generative Adversarial Networks. The generator and the discriminator. Training process for GANs. GAN challenges.
7. ANNs Unsupervised Learning 7.1) Competitive Learning/ Hebbian Learning. Kohonen's Self Organising Maps (SOMs). Winner Takes All strategy. Learning rule and variations. Restricted Boltzmann Machine. Training RBMs. Gibbs Sampling. Deep Belief Networks.
8. Attention Networks 8.1) Cognitive attention. Soft weights. Parallel and sequential weight calculation. Transformers. Correlations. Global and local attention. Hard and soft attention. Self-attention. Use in language translation. Variants. Use with CNNs. Encoders and Decoders.
9. Language Models I 9.1) NLP techniques. Probabilistic models of language. N-gram language models. Maximum entropy models. Skip-gram model. Masked Language Model. Next Sentence Prediction.
10. Language Models II 10.1) Word2Vec and Doc2Vec. Global Vectors for Word Representation (GloVe). Bidirectional Encoder Representations from Transformers(BERT).
11. Language Models III 11.1) Large Language Models (LLMs). GPT. Other LLMs.
12. Emerging Technologies in Generative AI 12.1) Review of state of the art in generative AI technology.

Assessment Breakdown	%
Coursework	50.00%
End of Module Assessment	50.00%

Assessments

Coursework

Assessment Type:	Project	**% of total:**	50
Pass Marks:	0	**Assessment Date:**	n/a
Outcome addressed:	3,4	**Briefing:**	n/a
Feedback:	n/a	**Assessment Mode:**	Not yet determined
Assessment Medium:	Not yet determined	**Role:**	Not yet determined
Mandatory:	False	**Assessor:**	Not yet determined
Feedback Type:		**Non-Marked:**	No
Assessment Difficulty:	Not yet determined	**Central Admin:**	No
Language Proficiency:			

Assessment Description:
Week 13 Propose and execute a research project using deep learning and generative AI techniques as a team of 3-4 participants.

End of Module Assessment

Assessment Type:	Terminal Exam	**% of total:**	50
Pass Marks:	0	**Assessment Date:**	End-of-Semester
Outcome addressed:	1,2	**Briefing:**	End-of-Semester
Feedback:	End-of-Semester	**Assessment Mode:**	Not yet determined
Assessment Medium:	Not yet determined	**Role:**	Not yet determined
Mandatory:	False	**Assessor:**	Not yet determined
Feedback Type:		**Non-Marked:**	No
Assessment Difficulty:	Not yet determined	**Central Admin:**	No
Language Proficiency:			

Assessment Description:
Terminal Examination End of semester exam session The examination will be a minimum of three hours in duration and may include a mix of: short answer questions, vignettes, essay based questions and case study based questions requiring the application of core module competencies. Marks will be awarded based on clarity, appropriate structure, relevant examples, depth of topic knowledge, and evidence of outside core text reading.

Coursework

Assessment Type:	Project	**% of total:**	50
Pass Marks:	0	**Assessment Date:**	n/a
Outcome addressed:	3,4	**Briefing:**	n/a
Feedback:	n/a	**Assessment Mode:**	Not yet determined
Assessment Medium:	Not yet determined	**Role:**	Not yet determined
Mandatory:	False	**Assessor:**	Not yet determined
Feedback Type:		**Non-Marked:**	No
Assessment Difficulty:	Not yet determined	**Central Admin:**	No
Language Proficiency:			

Assessment Description:
Week 13 Propose and execute a research project using deep learning and generative AI techniques as a team of 3-4 participants.

End of Module Assessment			
Assessment Type:	Terminal Exam	**% of total:**	50
Pass Marks:	0	**Assessment Date:**	End-of-Semester
Outcome addressed:	1,2	**Briefing:**	End-of-Semester
Feedback:	End-of-Semester	**Assessment Mode:**	Not yet determined
Assessment Medium:	Not yet determined	**Role:**	Not yet determined
Mandatory:	False	**Assessor:**	Not yet determined
Feedback Type:		**Non-Marked:**	No
Assessment Difficulty:	Not yet determined	**Central Admin:**	No
Language Proficiency:			

Assessment Description:
Terminal Examination End of semester exam session The examination will be a minimum of three hours in duration and may include a mix of: short answer questions, vignettes, essay based questions and case study based questions requiring the application of core module competencies. Marks will be awarded based on clarity, appropriate structure, relevant examples, depth of topic knowledge, and evidence of outside core text reading.

Module Workload

Module Target Workload Hours 100 Hours

Full Time hours per semester
Workload Type
Lecture
Independent Learning
Tutorial
250.00

This module has no Apprenticeship workload.

This module has no Blended workload.

This module has no Block workload.

This module has no Distance/Correspondance workload.

This module has no Evening workload.

This module has no Online workload.

Part Time hours per semester
Workload Type
Lecture
Tutorial
Independent Learning
Directed E-Learning
250.00

MLO Competency Mapping

Learning Outcomes	Competencies
LO1: Investigate and evaluate key concepts relating to artificial neural networks in both supervised and unsupervised machine learning contexts.	
LO2: Investigate and evaluate advanced deep learning techniques and assess when to apply such techniques on complex datasets and problem domains.	
LO3: Contextualise, research and utilise state of the art deep learning and generative AI applications and technologies in order to provide and implement strategies to address processing of datasets with a variety of characteristics.	
LO4: Critically review, assess and apply appropriate research methods to conduct research in deep learning and generative AI.	

Module Resources

Recommended Book Resources

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

David Foster. Generative Deep Learning, [ISBN: 978-1098134181].

Denis Rothman. (2022), Transformers for Natural Language Processing, Packt Publishing, p.564, [ISBN: 978-1803247335].

Charu C. Aggarwal. (2023), Neural Networks and Deep Learning, Springer, p.0, [ISBN: 978-3031296413].

Supplementary Book Resources

Lewis Tunstall,Leandro von Werra,Thomas Wolf. (2022), Natural Language Processing with Transformers, Revised Edition, O'Reilly Media, p.406, [ISBN: 978-1098136796].

Sinan Ozdemir. (2023), Quick Start Guide to Large Language Models, Addison-Wesley Professional, p.0, [ISBN: 978-0138199197].

Review

Module Aims and Objectives

The objective of the Deep Learning & Generative AI module is to endow learners with hands on experience of contemporary approaches to artificial neural networks learning in non-trivial analytical settings such as high dimensional and complex data. The module investigates deep learning approaches in supervised and unsupervised machine learning including convolutional neural networks, recurrent neural networks, autoencoders, generative adversarial networks, and self-organising maps. Moreover, this module addresses attention based transformer networks and the evolution of large language models. In undertaking this module, learners will gain hands on experience with a range of high capacity machine learning techniques for prediction, classification, clustering and generative AI problems using a complex, non-standard, and/or high dimensionality data sets.

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

Information provided to learners about the module

The module specification is replicated in Akari Document, which is the College's repository of programme and module information. In order to ensure that this information is consistently presented, this is viewed as the primary source of information and is linked to in all systems, e.g. website links and Moodle, the College's virtual learning environment, Moodle etc. This is also the source of information for teaching staff in terms of guidance around assessment structure and requirements.

These specifications once approved are available via http://courses.ncirl.ie

This specification, where appropriate, is also used as the primary source of information for printed materials e.g. prospectus. In this case, until the module is approved in the context of the programme, information is indicative.

This information is further supplemented by the individual lecturer teaching the module through the provision of a module handbook and lecture plan detailing week by week activities which is made available electronically via Moodle. Module materials including directed reading, lecture notes, presentations, and assessment strategy is made available on Moodle.

Module content, organisation and structure

Introduction to Artificial Neural Networks

History & Evolution. Ethical concerns. Perceptron Learning. Non-linearity and activation functions. Multi-Layer Perceptron. Feed-forward networks. Introduction to gradient descent techniques.

Back Propagation & ANN Training

Review of partial differentiation, the chain rule, and the vector gradient. Derivation of Back Propagation algorithm. The delta rule and gradient descent. Network topology. Stochastic gradient descent. Batch considerations. Stopping. Validation data. Hyperparemeter optimisation.

Deep Learning – Convolutional Neural Networks

Deep Learning networks. Universal Approximation Theorem. The convolution (cross-correlation) operation. Strided convolutions and padding. Sparse interaction. Parameter sharing. Equivariant representations. Pooling. Data considerations.

Recurrent Neural Networks

Static vs Dynamic networks. Memory. Sequential and variable length data. Parameter sharing. Unfolding. Computational graph. Forward pass and back propagation through time. Vanishing/Exploding gradients.Types of RNN. LSTM and GRU.

Autoencoders

Encoder and Decoder. Undercomplete autoencoders. Representational Power, Layer Size and Depth. Regularized autoencoders. Sparse Autoencoder (SAE). Denoising Autoencoder (DAE). Contractive Autoencoder (CAE). Applications.

Generative Models

Generative modelling and probabilistic models. Maximum Likelihood Estimation. Variational autoencoders. Manipulating latent space. Generative Adversarial Networks. The generator and the discriminator. Training process for GANs. GAN challenges.

ANNs Unsupervised Learning

Competitive Learning/ Hebbian Learning. Kohonen's Self Organising Maps (SOMs). Winner Takes All strategy. Learning rule and variations. Restricted Boltzmann Machine. Training RBMs. Gibbs Sampling. Deep Belief Networks.

Attention Networks

Cognitive attention. Soft weights. Parallel and sequential weight calculation. Transformers. Correlations. Global and local attention. Hard and soft attention. Self-attention. Use in language translation. Variants. Use with CNNs. Encoders and Decoders.

Language Models I

NLP techniques. Probabilistic models of language. N-gram language models. Maximum entropy models. Skip-gram model. Masked Language Model. Next Sentence Prediction.

Language Models II

Word2Vec and Doc2Vec. Global Vectors for Word Representation (GloVe). Bidirectional Encoder Representations from Transformers(BERT).

Language Models III

Large Language Models (LLMs). GPT. Other LLMs.

Emerging Technologies in Generative AI

Review of state of the art in generative AI technology.

Module Teaching and Learning (including formative assessment) Strategy

The learning strategy involves the use of lectures, tutorials, case studies, paper reviews and practical work where learners will engage with and explore generative AI and deep learning models in real-world scenarios. Lectures will include active learning components such as paired discussion, problem solving, and class feedback. Practical sessions will comprise of group work and individual learning. Learners will also have access to research documents and publications as required.

Work-based learning and practice placement

E-Learning

Module Physical resource requirements

Specifications for module staffing requirements

Sample assessment materials

Timetabling, learner effort and credit

Module assessment rationale

Affiliated Entities

Entity Code	Entity Title	Entity Version	Entity Type	Via	Outcome
MSCDA	MSc in Data Analytics	3.0	Programme		Yes
MSCDA	MSc in Data Analytics	4.0	Programme		Yes
PGDDA	Post Graduate Diploma in Science in Data Analytics	3.0	Programme		Yes

Documents

No Documents

9INTERN: Internship
(Core Subject)

Module Code:	9INTERN
Long Title	Internship APPROVED
Title	Internship
Module Level:	LEVEL 9
EQF Level:	7
Valid From:	2024 (July 2024)
Language of Instruction:	English
Duration:	2 Semesters
Credits:	30
Field of Study:	0610 - Information and Communication Technologies (ICTs) not further defined or elsewhe
Learning Outcome Taxonomy	Blooms
Module Author:	Eileen Long
Authors	Long Eileen (05 September 2024 to ---)

Is this a capstone module?	No

Learning Outcomes

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

#	Learning Outcome Description
LO1	Propose a research question, project objectives and methodology.
LO2	Analyse, synthesise, and critically evaluate the state of the art.
LO3	Propose, architect, implement, and evaluate an ICT solution related to the programme area.
LO4	Investigate potential future research and invention disclosures.
LO5	Present and defend the project findings through a viva, artefact/product demo, and report.
LO6	Identify, assess, and resolve the ethical issues that need to be addressed when conducting research.
LO7	Demonstrate initiative whilst working alone or part of a team, and appropriate communication and interpersonal skills.

Learning Outcome Taxonomy Blooms

#	LO1	LO2	LO3	LO4	LO5	LO6	LO7
C1					Y		
C2					Y		
C3					Y		Y
C4				Y			
C5	Y				Y		
C6							
P1							
P2							
P3							
P4							
P5							Y
P6							
P7							
A1							
A2					Y		
A3	Y						Y
A4							
A5	Y						

Learning Outcome Taxonomy Reference Blooms		
#	**Taxonomy Description**	**Taxonomy Group**
C1	Knowledge	Cognitive
C2	Comprehension	Cognitive
C3	Application	Cognitive
C4	Analysis	Cognitive
C5	Synthesis	Cognitive
C6	Evaluation	Cognitive
P1	Perception	Psychomotor (Technical Skills)
P2	Set	Psychomotor (Technical Skills)
P3	Guided Response	Psychomotor (Technical Skills)
P4	Mechanism	Psychomotor (Technical Skills)
P5	Complex Overt Response	Psychomotor (Technical Skills)
P6	Adaptation	Psychomotor (Technical Skills)
P7	Origination	Psychomotor (Technical Skills)
A1	Receiving to Phenomena	Affective (Humanities)
A2	Responding to Phenomena	Affective (Humanities)
A3	Valuing	Affective (Humanities)
A4	Organizing Values	Affective (Humanities)
A5	Internalizing Values	Affective (Humanities)

Programme Module Dependencies
No requisites

Dependencies

Module Content & Assessment

Indicative Content
1. Research Questions and Literature Review and Novel Contribution 1.1) Structure and purpose of a literature review. Search tools and sources. Selecting and coping with literature. Identifying novel contribution.
2. Scientific Methodology, Research Questions and Literature Review 2.1) Exploring different research methodologies and assessing the context for these research methodologies. Formulating a research question. Ethics in research.
3. Computing Community and Resources 3.1) Planning software development and evaluation. User involvement. Descriptive, theory oriented and applied projects. Time and project management, making efficient use of time and resources to manage multiple tasks at the same time and reach the goals.
4. Academic Writing I 4.1) Proposal structure. Selection and assessing the quality of literature.
5. Academic Writing II 5.1) Project structure. Citations and referencing.
6. Academic Writing III 6.1) Presenting qualitative data. Presenting quantitative data.
7. Academic Writing IV 7.1) The importance of ethics and reproducibility in research.
8. Academic Writing V 8.1) Scientific writing and style considerations. Plagiarism and self-plagiarism.
9. Technical Information 9.1) Reading, understanding and summarising technical material, including source code, academic articles, patents, and documentation. Writing effective technical documentation and materials.
10. Ethics 10.1) Ethics considerations around human participants, secondary datasets. Ethics approval process.
11. Communication 11.1) Dynamics of oral, written, and electronic team and group communication
12. Project Proposal and Ethics Approval (Semester 2) 12.1) A project proposal must describe what the learner will investigate, the importance and relevance of the topic to the programme area, and how the learner intends to fulfil the project goals. The format of a project proposal varies between fields, but most proposals should contain at least these elements: introduction, research question, research objectives, literature review, artefact/approach design, evaluation methodology, implications and contribution to knowledge, and reference list. The proposal should address the ethics of the proposed study and the proposal should have ethics approval.
13. Internship activity report (Semester 3) 13.1) The internship activity report is a weekly summary of what the student has learned. The internship activity report must be completed by the students and signed off by the industry supervisor. A template of the internship activity report will be provided to the students.
14. Internship Project Report (Semester 3) 14.1) The internship project report is a paper style report. The report shall comprise up to 20 pages (4,000 to 6,000 words) and describes the individual research and production of an ICT solution. It shall follow the following format: introduction, background, design, implementation, results and discussion, and conclusion. A literature review should be included to situate the work in existing research. Learners are also required to critically analyse insights gained throughout the development and evaluation of their research application. In addition, learners should also identify future commercialisation opportunities and further research possibilities.

Assessment Breakdown	%
Coursework	100.00%

Assessments

Coursework

Assessment Type:	Project	**% of total:**	10
Pass Marks:	0	**Assessment Date:**	n/a
Outcome addressed:	1,2,3,4,5,6,7	**Briefing:**	n/a
Feedback:	n/a	**Assessment Mode:**	Not yet determined
Assessment Medium:	Not yet determined	**Role:**	Not yet determined
Mandatory:	False	**Assessor:**	Not yet determined
Feedback Type:		**Non-Marked:**	No
Assessment Difficulty:	Not yet determined	**Central Admin:**	No
Language Proficiency:			

Assessment Description:
Project proposal and Ethics Approval

Assessment Type:	Project	**% of total:**	5
Pass Marks:	0	**Assessment Date:**	n/a
Outcome addressed:	1,2,3,4,5,6,7	**Briefing:**	n/a
Feedback:	n/a	**Assessment Mode:**	Not yet determined
Assessment Medium:	Not yet determined	**Role:**	Not yet determined
Mandatory:	False	**Assessor:**	Not yet determined
Feedback Type:		**Non-Marked:**	No
Assessment Difficulty:	Not yet determined	**Central Admin:**	No
Language Proficiency:			

Assessment Description:
Project Specification

Assessment Type:	Project	**% of total:**	10
Pass Marks:	0	**Assessment Date:**	n/a
Outcome addressed:	1,2,3,4,5,6,7	**Briefing:**	n/a
Feedback:	n/a	**Assessment Mode:**	Not yet determined
Assessment Medium:	Not yet determined	**Role:**	Not yet determined
Mandatory:	False	**Assessor:**	Not yet determined
Feedback Type:		**Non-Marked:**	No
Assessment Difficulty:	Not yet determined	**Central Admin:**	No
Language Proficiency:			

Assessment Description:
Literature Review

Assessment Type:	Project	**% of total:**	30
Pass Marks:	0	**Assessment Date:**	n/a
Outcome addressed:	1,2,3,4,5,6,7	**Briefing:**	n/a
Feedback:	n/a	**Assessment Mode:**	Not yet determined
Assessment Medium:	Not yet determined	**Role:**	Not yet determined
Mandatory:	False	**Assessor:**	Not yet determined
Feedback Type:		**Non-Marked:**	No
Assessment Difficulty:	Not yet determined	**Central Admin:**	No
Language Proficiency:			

Assessment Description:
Artefact/Product Development

Assessment Type:	Project	**% of total:**	25
Pass Marks:	0	**Assessment Date:**	n/a
Outcome addressed:	1,2,3,4,5,6,7	**Briefing:**	n/a
Feedback:	n/a	**Assessment Mode:**	Not yet determined
Assessment Medium:	Not yet determined	**Role:**	Not yet determined
Mandatory:	False	**Assessor:**	Not yet determined
Feedback Type:		**Non-Marked:**	No
Assessment Difficulty:	Not yet determined	**Central Admin:**	No
Language Proficiency:			

Assessment Description:
Artefact/Product Evaluation and Analysis

Coursework

Assessment Type:	Project	**% of total:**	10
Pass Marks:	0	**Assessment Date:**	n/a
Outcome addressed:	1,2,3,4,5,6,7	**Briefing:**	n/a
Feedback:	n/a	**Assessment Mode:**	Not yet determined
Assessment Medium:	Not yet determined	**Role:**	Not yet determined
Mandatory:	False	**Assessor:**	Not yet determined
Feedback Type:		**Non-Marked:**	No
Assessment Difficulty:	Not yet determined	**Central Admin:**	No
Language Proficiency:			

Assessment Description:
Document Presentation/Structure, Referencing, and Configuration Manual

Assessment Type:	Presentation	**% of total:**	10
Pass Marks:	0	**Assessment Date:**	n/a
Outcome addressed:	1,2,3,4,5,6,7	**Briefing:**	n/a
Feedback:	n/a	**Assessment Mode:**	Not yet determined
Assessment Medium:	Not yet determined	**Role:**	Not yet determined
Mandatory:	False	**Assessor:**	Not yet determined
Feedback Type:		**Non-Marked:**	No
Assessment Difficulty:	Not yet determined	**Central Admin:**	No
Language Proficiency:			

Assessment Description:
Viva

Coursework

Assessment Type:	Project	**% of total:**	10
Pass Marks:	0	**Assessment Date:**	n/a
Outcome addressed:	1,2,3,4,5,6,7	**Briefing:**	n/a
Feedback:	n/a	**Assessment Mode:**	Not yet determined
Assessment Medium:	Not yet determined	**Role:**	Not yet determined
Mandatory:	False	**Assessor:**	Not yet determined
Feedback Type:		**Non-Marked:**	No
Assessment Difficulty:	Not yet determined	**Central Admin:**	No
Language Proficiency:			

Assessment Description:
Project proposal and Ethics Approval

Assessment Type:	Project	**% of total:**	5
Pass Marks:	0	**Assessment Date:**	n/a
Outcome addressed:	1,2,3,4,5,6,7	**Briefing:**	n/a
Feedback:	n/a	**Assessment Mode:**	Not yet determined
Assessment Medium:	Not yet determined	**Role:**	Not yet determined
Mandatory:	False	**Assessor:**	Not yet determined
Feedback Type:		**Non-Marked:**	No
Assessment Difficulty:	Not yet determined	**Central Admin:**	No
Language Proficiency:			

Assessment Description:
Project Specification

Assessment Type:	Project	**% of total:**	10
Pass Marks:	0	**Assessment Date:**	n/a
Outcome addressed:	1,2,3,4,5,6,7	**Briefing:**	n/a
Feedback:	n/a	**Assessment Mode:**	Not yet determined
Assessment Medium:	Not yet determined	**Role:**	Not yet determined
Mandatory:	False	**Assessor:**	Not yet determined
Feedback Type:		**Non-Marked:**	No
Assessment Difficulty:	Not yet determined	**Central Admin:**	No
Language Proficiency:			

Assessment Description:
Literature Review

Coursework

Assessment Type:	Project	**% of total:**	30
Pass Marks:	0	**Assessment Date:**	n/a
Outcome addressed:	1,2,3,4,5,6,7	**Briefing:**	n/a
Feedback:	n/a	**Assessment Mode:**	Not yet determined
Assessment Medium:	Not yet determined	**Role:**	Not yet determined
Mandatory:	False	**Assessor:**	Not yet determined
Feedback Type:		**Non-Marked:**	No
Assessment Difficulty:	Not yet determined	**Central Admin:**	No
Language Proficiency:			

Assessment Description:
Artefact/Product Development

Assessment Type:	Project	**% of total:**	25
Pass Marks:	0	**Assessment Date:**	n/a
Outcome addressed:	1,2,3,4,5,6,7	**Briefing:**	n/a
Feedback:	n/a	**Assessment Mode:**	Not yet determined
Assessment Medium:	Not yet determined	**Role:**	Not yet determined
Mandatory:	False	**Assessor:**	Not yet determined
Feedback Type:		**Non-Marked:**	No
Assessment Difficulty:	Not yet determined	**Central Admin:**	No
Language Proficiency:			

Assessment Description:
Artefact/Product Evaluation and Analysis

Assessment Type:	Project	**% of total:**	10
Pass Marks:	0	**Assessment Date:**	n/a
Outcome addressed:	1,2,3,4,5,6,7	**Briefing:**	n/a
Feedback:	n/a	**Assessment Mode:**	Not yet determined
Assessment Medium:	Not yet determined	**Role:**	Not yet determined
Mandatory:	False	**Assessor:**	Not yet determined
Feedback Type:		**Non-Marked:**	No
Assessment Difficulty:	Not yet determined	**Central Admin:**	No
Language Proficiency:			

Assessment Description:
Document Presentation/Structure, Referencing, and Configuration Manual

Assessment Type:	Presentation	**% of total:**	10
Pass Marks:	0	**Assessment Date:**	n/a
Outcome addressed:	1,2,3,4,5,6,7	**Briefing:**	n/a
Feedback:	n/a	**Assessment Mode:**	Not yet determined
Assessment Medium:	Not yet determined	**Role:**	Not yet determined
Mandatory:	False	**Assessor:**	Not yet determined
Feedback Type:		**Non-Marked:**	No
Assessment Difficulty:	Not yet determined	**Central Admin:**	No
Language Proficiency:			

Assessment Description:
Viva

Module Workload

Module Target Workload Hours 300 Hours

Full Time hours per semester

Workload Type	
Lecture	
Independent Learning Time	
Workbased learning	
Tutorial	
Lecturer Supervised Learning	
	750.00

This module has no Apprenticeship workload.

This module has no Blended workload.

This module has no Block workload.
This module has no Distance/Correspondance workload.
This module has no Evening workload.
This module has no Online workload.

Part Time hours per semester
Workload Type
Lecture
Tutorial
Lecturer Supervised Learning
Independent Learning
Workbased learning
750.00

MLO Competency Mapping

Learning Outcomes	Competencies
LO1: Propose a research question, project objectives and methodology.	
LO2: Analyse, synthesise, and critically evaluate the state of the art.	
LO3: Propose, architect, implement, and evaluate an ICT solution related to the programme area.	
LO4: Investigate potential future research and invention disclosures.	
LO5: Present and defend the project findings through a viva, artefact/product demo, and report.	
LO6: Identify, assess, and resolve the ethical issues that need to be addressed when conducting research.	
LO7: Demonstrate initiative whilst working alone or part of a team, and appropriate communication and interpersonal skills.	

Module Resources

Recommended Book Resources

John W. Creswell,J. David Creswell. (2022), Research Design, Sage Publications, Incorporated, p.0, [ISBN: 978-1071817940].

Justin Zobel. (2015), Writing for Computer Science, Springer, p.0, [ISBN: 978-1447166382].

Christian Dawson. (2015), Projects in Computing and Information Systems, Prentice Hall, p.0, [ISBN: 978-1292073460].

Supplementary Book Resources

Gary Thomas. (2017), How to Do Your Research Project, SAGE Publications Limited, p.0, [ISBN: 978-1473948860].

Justin Kitzes,Daniel Turek,Fatma Deniz. (2018), The Practice of Reproducible Research, Univ of California Press, p.364, [ISBN: 978-0520294745].

David Evans,Paul Gruba,Justin Zobel. (2014), How to Write a Better Thesis, Springer, p.167, [ISBN: 978-3319042855].

Diana Ridley. (2012), The Literature Review, SAGE Publications, p.233, [ISBN: 978-1446201435].

Other Resources

[Website], http://www.patentsoffice.ie,
http://www.patentsoffice.ie

[Website], http://www.epo.org/searching/free/espace net.html,
http://www.epo.org/searching/free/espace net.html

[Website], Prof Alan Bundy, University of Edinburgh How to Write an Informatics Paper,
http://homepages.inf.ed.ac.uk/bundy/how- tos/writingGuide.html

Review

Module Aims and Objectives

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

Information provided to learners about the module

Module content, organisation and structure

The module content is organised over two semesters with workshops and assignment of supervisors taking place in Semester 2, while Semester 3 consists exclusively of supervision.

For classroom-based teaching in semester 2 the internship is scheduled based on 1-hour lecture and 2 hours lab over 12 weeks. In semester 3 the classroom is scheduled based on supervising the student for 1 hour per week over 12 weeks.

For online learning in semester 2 the internship is scheduled based on 1-hour lecture and 1-hour lab and 1-hour directed eLearning over 12 weeks. In semester 3 the classroom is scheduled based on supervising the student for 1 hour per week over 12 weeks.

An indicative schedule of topics to be addressed each week in Semester 2 is outlined below:

Research Questions and Literature Review and Novel Contribution

Structure and purpose of a literature review. Search tools and sources. Selecting and coping with literature. Identifying novel contribution.

Scientific Methodology, Research Questions and Literature Review

Exploring different research methodologies and assessing the context for these research methodologies. Formulating a research question. Ethics in research.

Computing Community and Resources

Planning software development and evaluation. User involvement. Descriptive, theory oriented and applied projects. Time and project management, making efficient use of time and resources to manage multiple tasks at the same time and reach the goals.

Academic Writing I

Proposal structure. Selection and assessing the quality of literature.

Academic Writing II

Project structure. Citations and referencing.

Academic Writing III

Presenting qualitative data. Presenting quantitative data.

Academic Writing IV

The importance of ethics and reproducibility in research.

Academic Writing V

Scientific writing and style considerations. Plagiarism and self-plagiarism.

Technical Information

Reading, understanding and summarising technical material, including source code, academic articles, patents, and documentation. Writing effective technical documentation and materials.

Ethics

Ethics considerations around human participants, secondary datasets. Ethics approval process.

Communication

Dynamics of oral, written, and electronic team and group communication

In Semester 2, learners submit a portfolio that consists of a project proposal with Ethics Approval. In Semester 3, learners submit an internship project report, an artefact/product, a user configuration manual, a presentation to be defended in a viva, and an invention disclosure form (if applicable). A demonstration of the artefact/product developed may presented in the viva.

Learners that wish to commercialise their project work or a project related technology can explore this path. In this case, the learner will be required to complete an invention disclosure form (IDF) that identifies the potential commercial opportunities and explores the related markets.

The work for the project will be carried out in an ICT related business environment and an internship activity report also must be submitted. This report is completed monthly and describes learner's activities and the designated business environment.

Project Proposal and Ethics Approval (Semester 2)

A project proposal must describe what the learner will investigate, the importance and relevance of the topic to the programme area, and how the learner intends to fulfil the project goals. The format of a project proposal varies between fields, but most proposals should contain at least these elements: introduction, research question, research objectives, literature review, artefact/approach design, evaluation methodology, implications and contribution to knowledge, and reference list. The proposal should address the ethics of the proposed <span style="-webkit-user-drag:none;padding:0px;user-select:text;background-position:0px 100%;background-repeat:repeat-x;background-image:var(--urlContextualSpellingAndGrammarErrorV2,url('data:image/svg+xml;border-bottom:1px solid transparent;">study and the proposal should have ethics approval.

Internship activity report (Semester 3)

The internship activity report is a weekly summary of what the student has learned. The internship activity report must be completed by the students and signed off by the industry supervisor. A template of the internship activity report will be provided to the students.

Internship Project Report (Semester 3)

The internship project report is a paper style report. The report shall comprise up to 20 pages (4,000 to 6,000 words) and describes the individual research and production of an ICT solution. It shall follow the following format: introduction, background, design, implementation, results and discussion, and conclusion. A literature review should be included situate the work in existing research. Learners are also required to critically analyse insights gained throughout the development and evaluation of their research application. In addition, learners should also identify future commercialisation opportunities and further research possibilities.

Throughout the project learners are required to engage in formative assessments to evaluate their progress. The format of a project report varies between fields, but most reports should contain at least these elements:

<li aria-setsize="-1" data-aria-level="1" data-aria-posinset="10" data-font="Symbol" data-leveltext="" data-list-defn-props="{"335552541":1,"335559685":720,"335559991":360,"469769226":"Symbol","469769242":[8226],"469777803":"left","469777804":"","469777815":"hybridMultilevel"}" data-listid="19" role="listitem" style="-webkit-user-drag:none;margin:0px 0px 0px 24px;padding:0px;user-select:text;clear:both;cursor:text;overflow:visible;position:relative;direction:ltr;display:block;font-size:11pt;font-family:Calibri, Calibri_MSFontService, sans-serif;vertical-align:baseline;"> Abstract: The role of the abstract is to summarise the project undertaken in a concise manner, highlighting the scope of the project, the objectives, the methodology and its finding and results.
<li aria-setsize="-1" data-aria-level="1" data-aria-posinset="11" data-font="Symbol" data-leveltext="" data-list-defn-props="{"335552541":1,"335559685":720,"335559991":360,"469769226":"Symbol","469769242":[8226],"469777803":"left","469777804":"","469777815":"hybridMultilevel"}" data-listid="19" role="listitem" style="-webkit-user-drag:none;margin:0px 0px 0px 24px;padding:0px;user-select:text;clear:both;cursor:text;overflow:visible;position:relative;direction:ltr;display:block;font-size:11pt;font-family:Calibri, Calibri_MSFontService, sans-serif;vertical-align:baseline;"> Introduction: The main purpose of the introduction is to motivate the contribution of the research work. It should include background on the topic, the justification for the topic, and what gap in the literature it seeks to fill, the main research questions and objectives, novel contribution, and the organisation of the report.
<li aria-setsize="-1" data-aria-level="1" data-aria-posinset="12" data-font="Symbol" data-leveltext="" data-list-defn-props="{"335552541":1,"335559685":720,"335559991":360,"469769226":"Symbol","469769242":[8226],"469777803":"left","469777804":"","469777815":"hybridMultilevel"}" data-listid="19" role="listitem" style="-webkit-user-drag:none;margin:0px 0px 0px 24px;padding:0px;user-select:text;clear:both;cursor:text;overflow:visible;position:relative;direction:ltr;display:block;font-size:11pt;font-family:Calibri, Calibri_MSFontService, sans-serif;vertical-align:baseline;"> Literature Review: The literature review should demonstrate evidence of independent research critically analysing the potential of an application/idea and provide insights into how it can be implemented and evaluated.
<li aria-setsize="-1" data-aria-level="1" data-aria-posinset="13" data-font="Symbol" data-leveltext="" data-list-defn-props="{"335552541":1,"335559685":720,"335559991":360,"469769226":"Symbol","469769242":[8226],"469777803":"left","469777804":"","469777815":"hybridMultilevel"}" data-listid="19" role="listitem" style="-webkit-user-drag:none;margin:0px 0px 0px 24px;padding:0px;user-select:text;clear:both;cursor:text;overflow:visible;position:relative;direction:ltr;display:block;font-size:11pt;font-family:Calibri, Calibri_MSFontService, sans-serif;vertical-align:baseline;"> Design Specification: The techniques and/or architecture/framework that underlie the implementation and the associated requirements are discussed.
<li aria-setsize="-1" data-aria-level="1" data-aria-posinset="14" data-font="Symbol" data-leveltext="" data-list-defn-props="{"335552541":1,"335559685":720,"335559991":360,"469769226":"Symbol","469769242":[8226],"469777803":"left","469777804":"","469777815":"hybridMultilevel"}" data-listid="19" role="listitem" style="-webkit-user-drag:none;margin:0px 0px 0px 24px;padding:0px;user-select:text;clear:both;cursor:text;overflow:visible;position:relative;direction:ltr;display:block;font-size:11pt;font-family:Calibri, Calibri_MSFontService, sans-serif;vertical-align:baseline;"> Implementation/Solution Development: Learners develop a solution that addresses the research question(s)/objective(s). This may involve the development of an application prototype, the design of an algorithm, the implementation of an innovative service or component of a system.
<li aria-setsize="-1" data-aria-level="1" data-aria-posinset="15" data-font="Symbol" data-leveltext="" data-list-defn-props="{"335552541":1,"335559685":720,"335559991":360,"469769226":"Symbol","469769242":[8226],"469777803":"left","469777804":"","469777815":"hybridMultilevel"}" data-listid="19" role="listitem" style="-webkit-user-drag:none;margin:0px 0px 0px 24px;padding:0px;user-select:text;clear:both;cursor:text;overflow:visible;position:relative;direction:ltr;display:block;font-size:11pt;font-family:Calibri, Calibri_MSFontService, sans-serif;vertical-align:baseline;"> Experiments: Learners outline the proposed approach, method, and experiments used to generate the results, as well as demonstrating how the method will be applied to answering/achieve the research question(s)/objective(s).
<li aria-setsize="-1" data-aria-level="1" data-aria-posinset="16" data-font="Symbol" data-leveltext="" data-list-defn-props="{"335552541":1,"335559685":720,"335559991":360,"469769226":"Symbol","469769242":[8226],"469777803":"left","469777804":"","469777815":"hybridMultilevel"}" data-listid="19" role="listitem" style="-webkit-user-drag:none;margin:0px 0px 0px 24px;padding:0px;user-select:text;clear:both;cursor:text;overflow:visible;position:relative;direction:ltr;display:block;font-size:11pt;font-family:Calibri, Calibri_MSFontService, sans-serif;vertical-align:baseline;"> Results and Discussion: A comprehensive evaluation must be conducted by each learner using multiple strategies, example; an algorithm may be benchmarked by performance specific metrics whilst an internet application or mobile application may be evaluated using suitable usability testing techniques. Statistical tools should be used when appropriate to critically evaluate, assess, and analyse the experimental research outputs and levels of significance.
<li aria-setsize="-1" data-aria-level="1" data-aria-posinset="17" data-font="Symbol" data-leveltext="" data-list-defn-props="{"335552541":1,"335559685":720,"335559991":360,"469769226":"Symbol","469769242":[8226],"469777803":"left","469777804":"","469777815":"hybridMultilevel"}" data-listid="19" role="listitem" style="-webkit-user-drag:none;margin:0px 0px 0px 24px;padding:0px;user-select:text;clear:both;cursor:text;overflow:visible;position:relative;direction:ltr;display:block;font-size:11pt;font-family:Calibri, Calibri_MSFontService, sans-serif;vertical-align:baseline;"> Conclusion and Future Work: Learners must arrive at a conclusion from their research question(s)/objective(s) as defined. A detailed future work section must be included showing the learners understanding of their own research and opportunities for future improvements.
<li aria-setsize="-1" data-aria-level="1" data-aria-posinset="18" data-font="Symbol" data-leveltext="" data-list-defn-props="{"335552541":1,"335559685":720,"335559991":360,"469769226":"Symbol","469769242":[8226],"469777803":"left","469777804":"","469777815":"hybridMultilevel"}" data-listid="19" role="listitem" style="-webkit-user-drag:none;margin:0px 0px 0px 24px;padding:0px;user-select:text;clear:both;cursor:text;overflow:visible;position:relative;direction:ltr;display:block;font-size:11pt;font-family:Calibri, Calibri_MSFontService, sans-serif;vertical-align:baseline;"> References: Correct citation references must be included.

Artefact/Product

An artefact/product can represent a software application that demonstrates a novel invention. An artefact/product can also represent a phenomenon that is observed in a scientific investigation or experiment that is not naturally present but occurs <span style="-webkit-user-drag:none;padding:0px;user-select:text;background-position:0px 100%;background-repeat:repeat-x;background-image:var(--urlAdvancedProofingIssueV2,url("data:image/svg+xml;border-bottom:1px solid transparent;">as a result of the preparative or investigative procedure.

User Configuration Manual

The configuration manual shall describe the required software tools and settings to successfully replicate the experimental setup. This manual is submitted separately from the research paper style <span style="-webkit-user-drag:none;padding:0px;user-select:text;background-position:0px 100%;background-repeat:repeat-x;background-image:var(--urlContextualSpellingAndGrammarErrorV2,url("data:image/svg+xml;border-bottom:1px solid transparent;">report and it will not count towards the suggested word count. It should not discuss only how to install standard software or tools.

Viva

The viva shall involve a presentation of the research work carried out and a demonstration of the results including a demo of the developed artefact/product.

Invention Disclosure Form

IDF identifies the potential commercial opportunities and explores the related markets. The IDF describes the invention, highlights the novelty/patentable aspect, what the problem is and how the invention solves the problem, identifies the companies that are interested in the invention, and potential commercial application of the invention.

Module Teaching and Learning (including formative assessment) Strategy

The learning strategy entails the use of workshops and academic seminars to provide learners with a solid foundation of the latest computing research avenues in the knowledge domain of the given programme.

Learning will may place in a classroom or blended environment and will feature both lectures and practical sessions for each topic. Materials and resources will be placed on Moodle, the College's virtual learning environment. Such materials may include lecture notes, lab/tutorial descriptions, assessments, datasets, discussion groups, videos (e.g., crea by lecturers or from external sources such as YouTube). Where appropriate, this module may make use of the flipped classroom approach.

The learners will also be directed to software tools appropriate to specific topics in the module, e.g.

<li aria-setsize="-1" data-aria-level="1" data-aria-posinset="4" data-font="Symbol" data-leveltext="" data-list-defn-props="{"335552541":1,"335559685":720,"335559991":360,"469769226":"Symbol","469769242":[8226],"469777803":"left","469777804":"","469777815":"hybridMultilevel"}" data-listid="20" role="listitem" style="-webkit-user-drag:none;margin:0px 0px 0px 24px;padding:0px;user-select:text;clear:both;cursor:text;overflow:visible;position:relative;direction:ltr;display:block;font-size:11pt;font-family:Calibri, Calibri_MSFontService, sans-serif;vertical-align:baseline;"> Scopus, Google Scholar, Mendeley, Zotero, <span style="-webkit-user-drag:none;padding:0px;user-select:text;background-position:0px 100%;background-repeat:repeat-x;background-image:var(--urlSpellingErrorV2,url("data:image/svg+xml;border-bottom:1px solid transparent;">JabRef, etc. for executing and organising the results of literature searches
<li aria-setsize="-1" data-aria-level="1" data-aria-posinset="5" data-font="Symbol" data-leveltext="" data-list-defn-props="{"335552541":1,"335559685":720,"335559991":360,"469769226":"Symbol","469769242":[8226],"469777803":"left","469777804":"","469777815":"hybridMultilevel"}" data-listid="20" role="listitem" style="-webkit-user-drag:none;margin:0px 0px 0px 24px;padding:0px;user-select:text;clear:both;cursor:text;overflow:visible;position:relative;direction:ltr;display:block;font-size:11pt;font-family:Calibri, Calibri_MSFontService, sans-serif;vertical-align:baseline;"> Tools such as <span style="-webkit-user-drag:none;padding:0px;user-select:text;background-position:0px 100%;background-repeat:repeat-x;background-image:var(--urlSpellingErrorV2,url("data:image/svg+xml;border-bottom:1px solid transparent;">Jupyter Notebooks, Git/GitHub for literate programming, reproducible research, and version control
<li aria-setsize="-1" data-aria-level="1" data-aria-posinset="6" data-font="Symbol" data-leveltext="" data-list-defn-props="{"335552541":1,"335559685":720,"335559991":360,"469769226":"Symbol","469769242":[8226],"469777803":"left","469777804":"","469777815":"hybridMultilevel"}" data-listid="20" role="listitem" style="-webkit-user-drag:none;margin:0px 0px 0px 24px;padding:0px;user-select:text;clear:both;cursor:text;overflow:visible;position:relative;direction:ltr;display:block;font-size:11pt;font-family:Calibri, Calibri_MSFontService, sans-serif;vertical-align:baseline;"> Microsoft Project and <span style="-webkit-user-drag:none;padding:0px;user-select:text;background-position:0px 100%;background-repeat:repeat-x;background-image:var(--urlContextualSpellingAndGrammarErrorV2,url("data:image/svg+xml;border-bottom:1px solid transparent;">open source tools <span style="-webkit-user-drag:none;padding:0px;user-select:text;background-position:0px 100%;background-repeat:repeat-x;background-image:var(--urlAdvancedProofingIssueV2,url("data:image/svg+xml;border-bottom:1px solid transparent;">for the production of project plans and Gantt charts.

Learners may be required to work in groups during the labs/tutorials. Moodle may also be used to both interact with learners and in some instances to provide formative assessments and feedback. Learners will have access to library resources, both physical and electronic, outside of the classroom where required.

Supervisors monitor the individual progress and provide guidance on the project. Techniques such online notes/information available on Moodle, links to extra material available on the Internet, Moodle forum may be used. Learners may also use collaborative tools for the development of the project. All documents required to be provided as part of the assessment will be submitted online on Moodle. The use of Git repositories will be encouraged as a collaborative tool to enable students to work on the development of the project. It will also improve the transparency of projects for markers as it will enable them to clearly identify the work carried out by students as part of the project.

Work-based learning and practice placement

E-Learning

Module Physical resource requirements

Specifications for module staffing requirements

Sample assessment materials

Timetabling, learner effort and credit

Module assessment rationale

Affiliated Entities

Entity Code	Entity Title	Entity Version	Entity Type	Via	Outcome
MSCDA	MSc in Data Analytics	3.0	Programme		Yes
MSCDA	MSc in Data Analytics	4.0	Programme		Yes

Documents

No Documents

9DISS1: Data Intensive Scalable Systems (Group Elective 1)

Module Code:	9DISS1
Long Title	Data Intensive Scalable Systems APPROVED
Title	Data Intensive Scalable Systems
Module Level:	LEVEL 9
EQF Level:	7
Valid From:	2024 (July 2024)
Language of Instruction:	English
Duration:	1 Semester
Credits:	5
Field of Study:	0610 - Information and Communication Technologies (ICTs) not further defined or elsewhe
Learning Outcome Taxonomy	Blooms
Module Author:	Eileen Long
Authors	Long Eileen (10 July 2024 to ---)
Is this a capstone module?	No

Learning Outcomes	
On successful completion of this module the learner will be able to:	
#	**Learning Outcome Description**
LO1	Critically compare and contrast multiple distributed system models and their associated enabling technologies and demonstrate in-depth knowledge of different types of processing on different data-intensive computational resources.
LO2	Critically analyse the features of high performance computing platforms, how they enable parallel and distributed programming paradigms, and demonstrate in-depth knowledge of parallel algorithms on large amounts of data.
LO3	Critically compare and contrast different data-stream processing and specialised algorithms.
LO4	Critically analyse mining and clustering algorithms on large multi-dimensional datasets and identify and categorise search techniques including similarity search and search engine technologies.
LO5	Develop and implement efficient programming solutions for problems relating to processing data at scale.

Learning Outcome Taxonomy Blooms					
#	LO1	LO2	LO3	LO4	LO5
C1					
C2					
C3					
C4					
C5					Y
C6					
P1					
P2					
P3					
P4					
P5					
P6					
P7					
A1					
A2					
A3					
A4					
A5					

Learning Outcome Taxonomy Reference Blooms		
#	**Taxonomy Description**	**Taxonomy Group**
C1	Knowledge	Cognitive
C2	Comprehension	Cognitive
C3	Application	Cognitive
C4	Analysis	Cognitive
C5	Synthesis	Cognitive
C6	Evaluation	Cognitive
P1	Perception	Psychomotor (Technical Skills)
P2	Set	Psychomotor (Technical Skills)
P3	Guided Response	Psychomotor (Technical Skills)
P4	Mechanism	Psychomotor (Technical Skills)
P5	Complex Overt Response	Psychomotor (Technical Skills)
P6	Adaptation	Psychomotor (Technical Skills)
P7	Origination	Psychomotor (Technical Skills)
A1	Receiving to Phenomena	Affective (Humanities)
A2	Responding to Phenomena	Affective (Humanities)
A3	Valuing	Affective (Humanities)
A4	Organizing Values	Affective (Humanities)
A5	Internalizing Values	Affective (Humanities)

Programme Module Dependencies
No requisites

Dependencies

Module Content & Assessment

Indicative Content
1. Principles and Characteristics of Distributed and Cloud Computing Systems 1.1) Distributed systems. Multi/Many core, Clusters, Grids, and Clouds. Cloud service and deployment models. NIST model: Elastic provisioning, resource metering, pools, etc. Big data ecosystems. SLAs/QoS, Availability, Mobility, and Optimisation for Cloud.
2. Cloud Infrastructure and Platform Services I 2.1) Computation, storage and general resource deployment. Public cloud services (e.g. AWS, GC, Azure service offerings). Machine Learning support.
3. Cloud Infrastructure and Platform Services II 3.1) Mobile devices and edge computing. Mobile clouds and colocation. Mobile networks. IoT interaction frameworks. Social media industrial applications. Social media networks and APIs. Graph analysis. Mashup architectures. Dynamic composition of services.
4. Data-intensive Storage Management 4.1) CAP Theorem. ACID vs BASE characteristics. Distributed file systems (e.g., HDFS). Dataset processing for big data (e.g., RDDs).
5. Structured Parallel Programming & Parallel Patterns for Data-intensive Computations 5.1) Algorithmic skeletons and structured parallelism. Scalable models. fine-grained vs. coarse-grained parallelisation. Data-enabled patterns and skeletons: map, reduce, broadcast, scan, gather scatter. MapReduce compute engine. MapReduce computations.
6. MapReduce Extensions & Cost Models 6.1) Recursive and workflow systems for MapReduce. Complexity and cost models for MapReduce with emphasis on communication costs and task networks.
7. Near Neighbour Search, Shingling, and Hashing 7.1) Collaborative filtering and similarity sets. Document shingling and sub-strings. Locality-sensitive hashing and distance measures. Additional methods for higher degrees of similarity.
8. Streams and Graphs I 8.1) Structured sources. Data streams. Stream programming, libraries and applications. Stream queries and processing. Sampling data. Filtering, counting, combining and estimating. Graphs. Centrality and degrees. Graph programming, libraries, and applications. Building complex pipelines and models.
9. Streams and Graphs II 9.1) Graphs. Centrality and degrees. Graph programming, libraries, and applications. Building complex pipelines and models.
10. Clusters for Streams and Parallelism 10.1) Bucket initialisation and merging. Parallel clustering.
11. Using Scalable Services 11.1) Deploying concurrent stream processing and batch processing pipelines. Resource Negotiation.
12. Non Von Neumann Architectures for Machine Learning 12.1) GPGPU. Neuromorphic hardware. TensorFlow. Cognitive services. Quantum Machine Learning.

Assessment Breakdown	%
Coursework	100.00%

Assessments

Coursework

Assessment Type:	Continuous Assessment	**% of total:**	40
Pass Marks:	0	**Assessment Date:**	n/a
Outcome addressed:	1,2	**Briefing:**	n/a
Feedback:	n/a	**Assessment Mode:**	Not yet determined
Assessment Medium:	Not yet determined	**Role:**	Not yet determined
Mandatory:	False	**Assessor:**	Not yet determined
Feedback Type:		**Non-Marked:**	No
Assessment Difficulty:	Not yet determined	**Central Admin:**	No
Language Proficiency:			

Assessment Description:
This practical assessment will evaluate the learners' knowledge and understanding of data intensive scalable systems' architectures and patterns.

Assessment Type:	Project	**% of total:**	60
Pass Marks:	0	**Assessment Date:**	n/a
Outcome addressed:	3,4,5	**Briefing:**	n/a
Feedback:	n/a	**Assessment Mode:**	Not yet determined
Assessment Medium:	Not yet determined	**Role:**	Not yet determined
Mandatory:	False	**Assessor:**	Not yet determined
Feedback Type:		**Non-Marked:**	No
Assessment Difficulty:	Not yet determined	**Central Admin:**	No
Language Proficiency:			

Assessment Description:
Produce a portfolio of studies that critically compare the data and computing architectures, programming models, and storage concepts.

Coursework

Assessment Type:	Continuous Assessment	**% of total:**	40
Pass Marks:	0	**Assessment Date:**	n/a
Outcome addressed:	1,2	**Briefing:**	n/a
Feedback:	n/a	**Assessment Mode:**	Not yet determined
Assessment Medium:	Not yet determined	**Role:**	Not yet determined
Mandatory:	False	**Assessor:**	Not yet determined
Feedback Type:		**Non-Marked:**	No
Assessment Difficulty:	Not yet determined	**Central Admin:**	No
Language Proficiency:			

Assessment Description:
This practical assessment will evaluate the learners' knowledge and understanding of data intensive scalable systems' architectures and patterns.

Assessment Type:	Project	**% of total:**	60
Pass Marks:	0	**Assessment Date:**	n/a
Outcome addressed:	3,4,5	**Briefing:**	n/a
Feedback:	n/a	**Assessment Mode:**	Not yet determined
Assessment Medium:	Not yet determined	**Role:**	Not yet determined
Mandatory:	False	**Assessor:**	Not yet determined
Feedback Type:		**Non-Marked:**	No
Assessment Difficulty:	Not yet determined	**Central Admin:**	No
Language Proficiency:			

Assessment Description:
Produce a portfolio of studies that critically compare the data and computing architectures, programming models, and storage concepts.

Module Workload

Module Target Workload Hours 50 Hours

Full Time hours per semester

Workload Type
Lecture
Independent Learning
Tutorial
125.00

This module has no Apprenticeship workload.

This module has no Blended workload.

This module has no Block workload.

This module has no Distance/Correspondance workload.

This module has no Evening workload.

This module has no Online workload.

Part Time hours per semester
Workload Type
Lecture
Tutorial
Independent Learning
Directed E-Learning
125.00

MLO Competency Mapping

Learning Outcomes	Competencies
LO1: Critically compare and contrast multiple distributed system models and their associated enabling technologies and demonstrate in-depth knowledge of different types of processing on different data-intensive computational resources.	
LO2: Critically analyse the features of high performance computing platforms, how they enable parallel and distributed programming paradigms, and demonstrate in-depth knowledge of parallel algorithms on large amounts of data.	
LO3: Critically compare and contrast different data-stream processing and specialised algorithms.	
LO4: Critically analyse mining and clustering algorithms on large multi-dimensional datasets and identify and categorise search techniques including similarity search and search engine technologies.	
LO5: Develop and implement efficient programming solutions for problems relating to processing data at scale.	

Module Resources

Recommended Book Resources

J. Leskovec, A. Rajaraman, J.D. Ullman (2020). Mining of Massive Datasets, Cambridge University Press; 3rd edition [ISBN: 1108476341].

L. George, J. Kunigk, P. Wilkinson, I. Buss (2018). Architecting Modern Data Platforms. O'Reilly Media [ISBN-10: 149196927X].

Menon P. (2022). Data Lakehouse in Action: Architecting a modern and scalable data analytics platform. Packt Publishing. [ISBN: 978-1801815932]..

Supplementary Book Resources

A.E. Chis, H. González-Vélez (2024) 32nd Euromicro International Conference on Parallel, Distributed and Network-Based Processing, PDP 2024, Dublin, Ireland, March 20-22, 2024. IEEE. [ISBN: 979-8-3503-6307-4].

M. Kleppmann (2017). Designing Data-Intensive Applications: The Big Ideas behind Reliable, Scalable, and Maintainable Systems, O'Reilly Media; 1st Edition [ISBN: 1449373321].

J. Reis, M. Housley (2022). Fundamentals of Data Engineering: Plan and Build Robust Data Systems, O'Reilly Media; 1st edition [ISBN-10: ‎1098108302]..

D. Comer (2023) The Cloud Computing Book: The Future of Computing Explained. Chapman and Hall/CRC; 1st edition [ISBN-10: ‎0367706849].

E. Gamma, R. Helm, R. Johnson , J. Vlissides (1995) Design patterns : elements of reusable object-oriented software. Addison-Wesley [ISBN-10: ‎0201633612].

Supplementary Article/Paper Resources

M. Wilkinson, et al. (2016) The FAIR Guiding Principles for scientific data management and stewardship. Scientific Data 3, 160018..

P. Rocca-Serra, et al. (2023) The FAIR Cookbook - the essential resource for and by FAIR doers. Scientific Data 10, 292..

A. González–Cebrián, M. Bradford, A.E. Chis, H. González-Vélez (2024). Standardised Versioning of Datasets: a FAIR–compliant Proposal. Scientific Data 11, 358..

B. Veloso, F. Leal, H. González-Vélez, B. Malheiro, J-C. Burguillo (2018). Scalable data analytics using crowdsourced repositories and streams. Journal of Parallel and Distributed Computing, 122: 1-10..

J. Eckroth (2018). A course on big data analytics. Journal of Parallel and Distributed Computing, 118: 166-176..

J. Dean, S. Ghemawat (2010). MapReduce: a flexible data processing tool. Commun. ACM 53(1): 72-77..

H. González-Vélez, M. Leyton (2010). A survey of algorithmic skeleton frameworks: high-level structured parallel programming enablers. Software: Practice and Experience. 40(12): 1135-1160..

Review

Module Aims and Objectives

The module aims to give the learner systematic understanding of storage and processing architectures and programming models for data-intensive computing. Learners shall examine how different data analytics techniques can help to solve real-world enterprise-class problems.

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

Information provided to learners about the module

The module specification is replicated in Akari Document, which is the College's repository of programme and module information. In order to ensure that this information is consistently presented, this is viewed as the primary source of information and is linked to in all systems, e.g. website links and Moodle, the College's virtual learning environment, Moodle etc. This is also the source of information for teaching staff in terms of guidance around assessment structure and requirements.

These specifications once approved are available via http://courses.ncirl.ie

This specification, where appropriate, is also used as the primary source of information for printed materials e.g. prospectus. In this case, until the module is approved in the context of the programme, information is indicative.

This information is further supplemented on an instance by instance basis by the individual lecturer teaching the module through the module handbook, which may be made available electronically via Moodle or in printed format. This document ensures that week by week activities, updated reading list and cohort specific information is current.

Module content, organisation and structure

Principles and Characteristics of Distributed and Cloud Computing Systems

Distributed systems. Multi/Many core, Clusters, Grids, and Clouds. Cloud service and deployment models. NIST model: Elastic provisioning, resource metering, pools, etc. Big data ecosystems. SLAs/QoS, Availability, Mobility, and Optimisation for Cloud.

Cloud Infrastructure and Platform Services I

Computation, storage and general resource deployment. Public cloud services (e.g. AWS, GC, Azure service offerings). Machine Learning support.

Cloud Infrastructure and Platform Services II

Mobile devices and edge computing. Mobile clouds and colocation. Mobile networks. IoT interaction frameworks. Social media industrial applications. Social media networks and APIs. Graph analysis. Mashup architectures. Dynamic composition of services.

Data-intensive Storage Management

CAP Theorem. ACID vs BASE characteristics. Distributed file systems (e.g., HDFS). Dataset processing for big data (e.g., RDDs).

Structured Parallel Programming & Parallel Patterns for Data-intensive Computations

Algorithmic skeletons and structured parallelism. Scalable models. fine-grained vs. coarse-grained parallelisation. Data-enabled patterns and skeletons: map, reduce, broadcast, scan, gather scatter. MapReduce compute engine. MapReduce computations.

MapReduce Extensions & Cost Models

Recursive and workflow systems for MapReduce. Complexity and cost models for MapReduce with emphasis on communication costs and task networks.

Near Neighbour Search, Shingling, and Hashing

Collaborative filtering and similarity sets. Document shingling and sub-strings. Locality-sensitive hashing and distance measures. Additional methods for higher degrees of similarity.

Streams and Graphs I

Structured sources. Data streams. Stream programming, libraries and applications. Stream queries and processing. Sampling data. Filtering, counting, combining and estimating. Graphs. Centrality and degrees. Graph programming, libraries, and applications. Building complex pipelines and models.

Streams and Graphs II

Graphs. Centrality and degrees. Graph programming, libraries, and applications. Building complex pipelines and models.

Clusters for Streams and Parallelism

Bucket initialisation and merging. Parallel clustering.

Using Scalable Services

Deploying concurrent stream processing and batch processing pipelines. Resource Negotiation.

Non Von Neumann Architectures for Machine Learning

GPGPU. Neuromorphic hardware. TensorFlow. Cognitive services. Quantum Machine Learning.

Module Teaching and Learning (including formative assessment) Strategy

Classes in the Data Intensive Scalable Systems module will be delivered in either a lecture theatre, classroom, or lab environment with learners bringing their own devices (BYOD). Each week learners will attend three hours of class – broken down into one 3-hour lecture. Lectures will be a mix of presentation and practical work conducted by learners. Learners will be assigned specific tasks related to lecture content so that they can drill into concepts by applying some tools such as simulators, memory managers, and cloud resource calculators. An example of a typical task is to critically compare two different non Von Neumann architectures using simulators e.g. quantum vs. GPGPU computing. Learners will discover concepts relating to the architecture of Data Intensive systems using an algorithmic approach to conceive different computing solutions based on architectures and parallel patterns (algorithmic skeletons) with emphasis on clouds. Learners will discover concepts of Scalable Systems programming using a data-intensive algorithmic approach. This strategy will enhance learner understanding of how to conceive different computing solutions based on complexity and suitability of different data analytics algorithms. Learners will have full access to necessary resources (outlined below) to complete each task. Lecturers and those providing assistance will have a high level of competency in each of the methods and concepts used.
All module resources are made available to learners via the Moodle Content Management System. These will typically consist of lecture notes, exercise files, data sets, case studies, news items (e.g. a Big Data story in the news), discussion groups, and feedback.
Learners are encouraged to attend and participate in all classes, as each session is intended to build upon previous classes in a practical, non-intimidating, informative, and enjoyable way. Throughout the module, the foundations of Data Intensive Scalable Systems are applied to real life data to form learning of the fundamental ideas and the most commonly used techniques to choose the most suitable architecture and deployment model to make sense of data.
Learners will have full access to necessary resources to complete each learning task. Each tutorial can be both computer and pen & paper based–learners will benefit from coaching and feedback during each session.

Work-based learning and practice placement

E-Learning

Module Physical resource requirements

Specifications for module staffing requirements

Sample assessment materials

Timetabling, learner effort and credit

Module assessment rationale

Affiliated Entities

Entity Code	Entity Title	Entity Version	Entity Type	Via	Outcome
MSCDA	MSc in Data Analytics	3.0	Programme		Yes
MSCDA	MSc in Data Analytics	4.0	Programme		Yes
PGDDA	Post Graduate Diploma in Science in Data Analytics	3.0	Programme		Yes

Documents

No Documents

9MODSIM1: Modelling & Simulation (Group Elective 2)

Module Code:	9MODSIM1
Long Title	Modelling & Simulation APPROVED
Title	Modelling & Simulation
Module Level:	LEVEL 9
EQF Level:	7
Valid From:	2024 (July 2024)
Language of Instruction:	English
Duration:	1 Semester
Credits:	5
Field of Study:	0610 - Information and Communication Technologies (ICTs) not further defined or elsewhe
Learning Outcome Taxonomy	Blooms
Module Author:	Eileen Long
Authors	Long Eileen (10 July 2024 to ---)
Is this a capstone module?	No

Learning Outcomes	
On successful completion of this module the learner will be able to:	
#	**Learning Outcome Description**
LO1	Create a mathematical model for a given application problem and design a simulation model based on a given mathematical model and a problem formulation.
LO2	Categorise different types of simulation technologies
LO3	Implement and test a simulation model using a simulation tool or a standard programming language
LO4	Critically analyse and interpret output data produced by the simulation system.
LO5	Integrate the simulation system into an optimisation or machine learning context.

Learning Outcome Taxonomy Blooms					
#	LO1	LO2	LO3	LO4	LO5
C1					
C2					
C3					
C4		Y			
C5	Y	Y			Y
C6					
P1					
P2					
P3					
P4					
P5					
P6					
P7	Y				
A1					
A2					
A3					
A4					Y
A5					

Learning Outcome Taxonomy Reference Blooms		
#	**Taxonomy Description**	**Taxonomy Group**
C1	Knowledge	Cognitive
C2	Comprehension	Cognitive
C3	Application	Cognitive
C4	Analysis	Cognitive
C5	Synthesis	Cognitive
C6	Evaluation	Cognitive
P1	Perception	Psychomotor (Technical Skills)
P2	Set	Psychomotor (Technical Skills)
P3	Guided Response	Psychomotor (Technical Skills)
P4	Mechanism	Psychomotor (Technical Skills)
P5	Complex Overt Response	Psychomotor (Technical Skills)
P6	Adaptation	Psychomotor (Technical Skills)
P7	Origination	Psychomotor (Technical Skills)
A1	Receiving to Phenomena	Affective (Humanities)
A2	Responding to Phenomena	Affective (Humanities)
A3	Valuing	Affective (Humanities)
A4	Organizing Values	Affective (Humanities)
A5	Internalizing Values	Affective (Humanities)

Programme Module Dependencies
No requisites

Dependencies

Module Content & Assessment

Indicative Content
1. Introduction to Modelling & Simulation 1.1) Concept of system, model and simulation. Discrete and continuous processes. Monte Carlo, agent-based, system dynamics. Games and virtual worlds. Digital twins.
2. Modelling I 2.1) Modelling in Statistics: develop an explicit notion of different models and the use of simulation in statistics. Probability distribution functions, Estimation of statistical parameters.
3. Modelling II 3.1) Modelling in Economics and Ecology: use of different models for time series. Develop relate forecasting in timeseries (without explicit model) to model based forecasting. Modelling in Physics: develop a model for a simple mechanical system like a monoped hopper, using a control strategy as input parameter.
4. Modelling III 4.1) Modelling in Machine Learning: synthetic data, simulation-assisted ML, ML-assisted simulation.
5. Discrete Event Simulation I 5.1) Simulation Systems. Components of discrete event simulation. Generators (e.g., using Python). Interarrival Distributions. System Trajectory. stable and instable systems.
6. Discrete Event Simulation II 6.1) Characteristic of a queueing system. Simulation of single server queueing system. Kendall Notations: M-M-1 Systems, M-D-1 Systems, M-G-1 Systems, M-M-c Systems.
7. Discrete Event Simulation III (Part A) 7.1) Simulation of an industrial facility, using a control strategy as input parameter.
8. Discrete Event Simulation III (Part B) 8.1) Using optimisation strategies to find the optimal configuration for a simulated industrial facility. Verification, validation and credibility of simulation models.
9. Continuous Simulation I 9.1) Differential Equations, Volterra Equations and Ecological Modelling. Euler Method. Runge-Kutta Integration.
10. Continuous Simulation II 10.1) Simulation of Infectious Diseases
11. Continuous Simulation III 11.1) Simulation of Mechanical Systems (like a monoped hopper) with a simple control strategy.
12. Continuous Simulation IV 12.1) Using of Reinforcement Learning to construct a self-learning and improving robust system.

Assessment Breakdown	%
Coursework	60.00%
End of Module Assessment	40.00%

Assessments

Coursework			
Assessment Type:	Project	**% of total:**	60
Pass Marks:	0	**Assessment Date:**	n/a
Outcome addressed:	1,3,4,5	**Briefing:**	n/a
Feedback:	n/a	**Assessment Mode:**	Not yet determined
Assessment Medium:	Not yet determined	**Role:**	Not yet determined
Mandatory:	False	**Assessor:**	Not yet determined
Feedback Type:		**Non-Marked:**	No
Assessment Difficulty:	Not yet determined	**Central Admin:**	No
Language Proficiency:			

Assessment Description:
Long-form project which the student produces over the course of the entire semester. Student is required to model and simulate a process (production scheduling, planning, gaming, traffic, operating theatre) using a simulation tool using an open source simulation tool

End of Module Assessment

Assessment Type:	Terminal Exam	**% of total:**	40
Pass Marks:	0	**Assessment Date:**	End-of-Semester
Outcome addressed:	1,2,4	**Briefing:**	End-of-Semester
Feedback:	End-of-Semester	**Assessment Mode:**	Not yet determined
Assessment Medium:	Not yet determined	**Role:**	Not yet determined
Mandatory:	False	**Assessor:**	Not yet determined
Feedback Type:		**Non-Marked:**	No
Assessment Difficulty:	Not yet determined	**Central Admin:**	No
Language Proficiency:			

Assessment Description:
Terminal assessment exam taken over 2 hours with four questions of which the student must answer three to address the students' understanding of the underlying theories and concepts.

Coursework

Assessment Type:	Project	**% of total:**	60
Pass Marks:	0	**Assessment Date:**	n/a
Outcome addressed:	1,3,4,5	**Briefing:**	n/a
Feedback:	n/a	**Assessment Mode:**	Not yet determined
Assessment Medium:	Not yet determined	**Role:**	Not yet determined
Mandatory:	False	**Assessor:**	Not yet determined
Feedback Type:		**Non-Marked:**	No
Assessment Difficulty:	Not yet determined	**Central Admin:**	No
Language Proficiency:			

Assessment Description:
Long-form project which the student produces over the course of the entire semester. Student is required to model and simulate a process (production scheduling, planning, gaming, traffic, operating theatre) using a simulation tool using an open source simulation tool

End of Module Assessment

Assessment Type:	Terminal Exam	**% of total:**	40
Pass Marks:	0	**Assessment Date:**	End-of-Semester
Outcome addressed:	1,2,4	**Briefing:**	End-of-Semester
Feedback:	End-of-Semester	**Assessment Mode:**	Not yet determined
Assessment Medium:	Not yet determined	**Role:**	Not yet determined
Mandatory:	False	**Assessor:**	Not yet determined
Feedback Type:		**Non-Marked:**	No
Assessment Difficulty:	Not yet determined	**Central Admin:**	No
Language Proficiency:			

Assessment Description:
Terminal assessment exam taken over 2 hours with four questions of which the student must answer three to address the students' understanding of the underlying theories and concepts.

Module Workload

Module Target Workload Hours 50 Hours

Full Time hours per semester
Workload Type
Lecture
Independent Learning
Tutorial
125.00

This module has no Apprenticeship workload.

This module has no Blended workload.

This module has no Block workload.

This module has no Distance/Correspondance workload.

This module has no Evening workload.

This module has no Online workload.

Part Time hours per semester
Workload Type
Lecture
Tutorial
Independent Learning
Directed E-Learning
125.00

MLO Competency Mapping

Learning Outcomes	Competencies
LO1: Create a mathematical model for a given application problem and design a simulation model based on a given mathematical model and a problem formulation.	
LO2: Categorise different types of simulation technologies	
LO3: Implement and test a simulation model using a simulation tool or a standard programming language	
LO4: Critically analyse and interpret output data produced by the simulation system.	
LO5: Integrate the simulation system into an optimisation or machine learning context.	

Module Resources

Recommended Book Resources

Birta L.G., Arbez G.(2019). Modelling and Simulation – Exploring Dynamic System Behaviour, Springer, 3rd Edition. ISBN: 978-3030188689..

Ören T., Zeigler B.P., Tolk A. (eds)(2023). Body of Knowledge for Modeling and Simulation. Springer. ISBN: 978-3031110849..

Zeigler, B.P.; Muzy, A., Kofman, E. (2018). Theory of Modeling and Simulation. 3rd ed. Academic Press. ISBN: 978-0128133705.

Supplementary Book Resources

Medhi J.(2003). Stochastic Models in Queueing Theory, Academic Press, 3rd Edition. ISBN: 0-124874622..

Borshchev, A. (2014), The Big Book of Simulation Modeling: Multimethod Modeling with Anylogic 6, Lightning Source Inc. ISBN: 978-0989573177..

Dobson, S. (2020). Epidemic Modelling. Independent Publishing Network. ISBN: 978-1838535650..

Choi, B.K. & Kang, D. (2013), Modeling and Simulation of Discrete Event Systems. Wiley Press. ISBN: 978-1118386996..

Banks , J. ,Carson II J.S., Nelson B.L., Nicol D.M. (2014), Discrete-Event System Simulation, Pearson Education, 5th Edition. ISBN: 978-1292024370..

Kelton, W.D., Sadowski, R., and Zupick, N. (2023), Simulation with Arena, 7th Edition, McGraw-Hill. ISBN: 978-1266275722..

Review

Module Aims and Objectives

The objective of the Modelling & Simulation module is to introduce students to the concepts, techniques and applied aspects of the development and analysis of simulation models. The course deals with all the important aspects of simulation with particular emphasis on applications in services and computing. Two main approaches for modelling problems bound by uncertainty (stochastic behaviour) will be covered: Monte-Carlo Simulation (static problems) and Discrete Event Simulation (dynamic problems). Students will also learn how to use simulation tools for strategic decision making.

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

Information provided to learners about the module

The module specification is replicated in Akari Document, which is the College's repository of programme and module information. In order to ensure that this information is consistently presented, this is viewed as the primary source of information and is linked to in all systems, e.g. website links and Moodle, the College's virtual learning environment, Moodle etc. This is also the source of information for teaching staff in terms of guidance around assessment structure and requirements.

These specifications once approved are available via http://courses.ncirl.ie

This specification, where appropriate, is also used as the primary source of information for printed materials e.g. prospectus. In this case, until the module is approved in the context of the programme, information is indicative.

This information is further supplemented on an instance by instance basis by the individual lecturer teaching the module through the module handbook, which may be made available electronically via Moodle or in printed format. This document ensures that week by week activities, updated reading list and cohort specific information is current.

Module content, organisation and structure

Introduction to Modelling & Simulation

Concept of system, model and simulation. Discrete and continuous processes. Monte Carlo, agent-based, system dynamics. Games and virtual worlds. Digital twins.

Modelling I

Modelling in Statistics: develop an explicit notion of different models and the use of simulation in statistics. Probability distribution functions, Estimation of statistical parameters.

Modelling II

Modelling in Economics and Ecology: use of different models for time series. Develop relate forecasting in timeseries (without explicit model) to model based forecasting. Modelling in Physics: develop a model for a simple mechanical system like a monoped hopper, using a control strategy as input parameter.

Modelling III

Modelling in Machine Learning: synthetic data, simulation-assisted ML, ML-assisted simulation.

Discrete Event Simulation I

Simulation Systems. Components of discrete event simulation. Generators (e.g., using Python). Interarrival Distributions. System Trajectory. stable and instable systems.

Discrete Event Simulation II

Characteristic of a queueing system. Simulation of single server queueing system. Kendall Notations: M-M-1 Systems, M-D-1 Systems, M-G-1 Systems, M-M-c Systems.

Discrete Event Simulation III (Part A)

Simulation of an industrial facility, using a control strategy as input parameter.

Discrete Event Simulation III (Part B)

Using optimisation strategies to find the optimal configuration for a simulated industrial facility. Verification, validation and credibility of simulation models.

Continuous Simulation I

Differential Equations, Volterra Equations and Ecological Modelling. Euler Method. Runge-Kutta Integration.

Continuous Simulation II

Simulation of Infectious Diseases.

Continuous Simulation III

Simulation of Mechanical Systems (like a monoped hopper) with a simple control strategy.

Continuous Simulation IV

Using of Reinforcement Learning to construct a self-learning and improving robust system.

Module Teaching and Learning (including formative assessment) Strategy

Classes in the Modelling & Simulation module will be delivered in a classroom and/or lab. Each week learners will attend 4 hours of class – broken down into one 2-hour lecture and 2-hour practice/tutorial class. Lectures will mix the theory with practical exercises, analysis on the case studies and they are design to be highly interactive and to stimulate in-class discussions. During the tutorial sessions, learners will be assigned specific tasks related to lecture content so that they can better assimilate the concepts and gain experience working with the latest technologies. All module resources are made available to learners via the Moodle Content Management System. These will typically consist of lecture notes, explanatory videos, links to different resources, exercise files, data sets, case studies, sample assessments, assignments, and feedback.

Work-based learning and practice placement

E-Learning

Module Physical resource requirements

Specifications for module staffing requirements

Sample assessment materials

Timetabling, learner effort and credit

Module assessment rationale

Affiliated Entities

Entity Code	Entity Title	Entity Version	Entity Type	Via	Outcome
MSCDA	MSc in Data Analytics	3.0	Programme		Yes
MSCDA	MSc in Data Analytics	4.0	Programme		Yes
PGDDA	Post Graduate Diploma in Science in Data Analytics	3.0	Programme		Yes

Documents

No Documents

9DAPP1: Domain Applications (Group Elective 3)

Module Code:	9DAPP1
Long Title	Domain Applications APPROVED
Title	Domain Applications
Module Level:	LEVEL 9
EQF Level:	7
Valid From:	2024 (July 2024)
Language of Instruction:	English
Duration:	1 Semester
Credits:	5
Field of Study:	0610 - Information and Communication Technologies (ICTs) not further defined or elsewhe
Learning Outcome Taxonomy	Blooms
Module Author:	Eileen Long
Authors	Long Eileen (10 July 2024 to ---)

Is this a capstone module?	No

Learning Outcomes	
On successful completion of this module the learner will be able to:	
#	**Learning Outcome Description**
LO1	Critically analyse and explore the application of data analytics, AI, and machine learning across a range of domains including Information Retrieval, Geographic Information Systems, and industry contexts.
LO2	Investigate and evaluate key concepts and the application of advanced analytics techniques in a range of domains.
LO3	Contextualise, research and utilise current data approaches, applications and technologies in order to develop predictive analytics strategies to address a variety of real world situations.
LO4	Conduct independent research into emerging technologies utilising advanced data analytics and machine learning approaches.

Learning Outcome Taxonomy Blooms				
#	LO1	LO2	LO3	LO4
C1				
C2				
C3				
C4		Y		
C5				
C6				
P1				
P2				
P3				
P4				
P5				
P6				
P7				
A1				
A2				
A3				
A4				
A5				

Learning Outcome Taxonomy Reference Blooms		
#	**Taxonomy Description**	**Taxonomy Group**
C1	Knowledge	Cognitive
C2	Comprehension	Cognitive
C3	Application	Cognitive
C4	Analysis	Cognitive
C5	Synthesis	Cognitive
C6	Evaluation	Cognitive
P1	Perception	Psychomotor (Technical Skills)
P2	Set	Psychomotor (Technical Skills)
P3	Guided Response	Psychomotor (Technical Skills)
P4	Mechanism	Psychomotor (Technical Skills)
P5	Complex Overt Response	Psychomotor (Technical Skills)
P6	Adaptation	Psychomotor (Technical Skills)
P7	Origination	Psychomotor (Technical Skills)
A1	Receiving to Phenomena	Affective (Humanities)
A2	Responding to Phenomena	Affective (Humanities)
A3	Valuing	Affective (Humanities)
A4	Organizing Values	Affective (Humanities)
A5	Internalizing Values	Affective (Humanities)

Programme Module Dependencies
No requisites

Dependencies

Module Content & Assessment

Indicative Content
1. Information Retrieval I 1.1) Key concepts in Information Retrieval (IR). Boolean model. Term-Document matrix. Postings and inverted indexes. Vector Space model. TF-IDF. Evaluation in IR
2. Information Retrieval II 2.1) Probabilistic model. Bayesian approaches. Latent Semantic Indexing. Link Analysis.
3. Geographic Information Systems I 3.1) Core geospatial concepts. Data layers. Spatial data creation and management. Metadata. Geospatial analysis and geoprocessing. Visualising and interpreting spatial data.
4. Geographic Information Systems II 4.1) Cartographic enhancement. Thematic mapping. GIS tools and technologies (e.g., ArcGIS).
5. Social Media and Web Analytics 5.1) Collecting and extracting social media data. Case studies. Social listening. Audience/Performance/Competitive/Behaviour analytics. Sentiment analysis. Segmentation.
6. Industry Use-case I 6.1) Domain applications in Pharma, Medicine, and Healthcare. Case studies.
7. Industry Use-case II 7.1) Domain applications in Retail, Manufacturing and Supply-chain. Case studies.
8. Industry Use-case III 8.1) Domain applications in IoT, communications and networks. Case studies.
9. Industry Use-case IV 9.1) Domain applications in Sports. Case studies.
10. Industry Use-case V 10.1) Domain applications in Finance and Banking. Fraud Detection. Case studies.
11. Industry Use-case VI 11.1) Domain applications in Blockchain & DeFi. Case studies.
12. Quantum Machine Learning 12.1) Introduction to Quantum Computing(QC) and key take-aways. Algorithmic patterns for QC. Application for QC in a machine learning context.

Assessment Breakdown	%
Coursework	50.00%
End of Module Assessment	50.00%

Assessments

Coursework

Assessment Type:	Project	**% of total:**	50
Pass Marks:	0	**Assessment Date:**	n/a
Outcome addressed:	1,3,4	**Briefing:**	n/a
Feedback:	n/a	**Assessment Mode:**	Not yet determined
Assessment Medium:	Not yet determined	**Role:**	Not yet determined
Mandatory:	False	**Assessor:**	Not yet determined
Feedback Type:		**Non-Marked:**	No
Assessment Difficulty:	Not yet determined	**Central Admin:**	No
Language Proficiency:			

Assessment Description:
Project focusing on a particular domain area, requiring survey of start-of-the-art, and implementing appropriate data mining/machine learning tools and techniques particular to the domain to perform an analysis of associated data.

End of Module Assessment

Assessment Type:	Terminal Exam	**% of total:**	50
Pass Marks:	0	**Assessment Date:**	End-of-Semester
Outcome addressed:	1,2,3	**Briefing:**	End-of-Semester
Feedback:	End-of-Semester	**Assessment Mode:**	Not yet determined
Assessment Medium:	Not yet determined	**Role:**	Not yet determined
Mandatory:	False	**Assessor:**	Not yet determined
Feedback Type:		**Non-Marked:**	No
Assessment Difficulty:	Not yet determined	**Central Admin:**	No
Language Proficiency:			

Assessment Description:
Terminal assessment exam taken over 2 hours with four questions of which the student must answer three to address the students' understanding of the underlying theories and concepts.

Coursework

Assessment Type:	Project	**% of total:**	50
Pass Marks:	0	**Assessment Date:**	n/a
Outcome addressed:	1,3,4	**Briefing:**	n/a
Feedback:	n/a	**Assessment Mode:**	Not yet determined
Assessment Medium:	Not yet determined	**Role:**	Not yet determined
Mandatory:	False	**Assessor:**	Not yet determined
Feedback Type:		**Non-Marked:**	No
Assessment Difficulty:	Not yet determined	**Central Admin:**	No
Language Proficiency:			

Assessment Description:
Project focusing on a particular domain area, requiring survey of start-of-the-art, and implementing appropriate data mining/machine learning tools and techniques particular to the domain to perform an analysis of associated data.

End of Module Assessment

Assessment Type:	Terminal Exam	**% of total:**	50
Pass Marks:	0	**Assessment Date:**	End-of-Semester
Outcome addressed:	1,2,3	**Briefing:**	End-of-Semester
Feedback:	End-of-Semester	**Assessment Mode:**	Not yet determined
Assessment Medium:	Not yet determined	**Role:**	Not yet determined
Mandatory:	False	**Assessor:**	Not yet determined
Feedback Type:		**Non-Marked:**	No
Assessment Difficulty:	Not yet determined	**Central Admin:**	No
Language Proficiency:			

Assessment Description:
Terminal assessment exam taken over 2 hours with four questions of which the student must answer three to address the students' understanding of the underlying theories and concepts.

Module Workload

Module Target Workload Hours 50 Hours

Full Time hours per semester
Workload Type
Lecture
Independent Learning
Tutorial
125.00

This module has no Apprenticeship workload.

This module has no Blended workload.

This module has no Block workload.

This module has no Distance/Correspondance workload.

This module has no Evening workload.

This module has no Online workload.

Part Time hours per semester
Workload Type
Lecture
Tutorial
Independent Learning
Directed E-Learning
125.00

MLO Competency Mapping

Learning Outcomes	Competencies
LO1: Critically analyse and explore the application of data analytics, AI, and machine learning across a range of domains including Information Retrieval, Geographic Information Systems, and industry contexts.	
LO2: Investigate and evaluate key concepts and the application of advanced analytics techniques in a range of domains.	
LO3: Contextualise, research and utilise current data approaches, applications and technologies in order to develop predictive analytics strategies to address a variety of real world situations.	
LO4: Conduct independent research into emerging technologies utilising advanced data analytics and machine learning approaches.	

Module Resources

Recommended Book Resources

Baeza-Yates R., Ribeiro-Neto B. (2010). Modern Information Retrieval: The Concepts and Technology Behind Search, Addison-Wesley, 2nd Edition. ISBN: 978-0321416919..

McHaffie P., Hwang S., Follett C. (2023). GIS: An Introduction to Mapping Technologies, CRC Press, 2nd Edition. ISBN: 978-1032308975..

Tang C. (2016). The Data Industry: The Business and Economics of Information and Big Data, Wiley. ISBN: 978-1119138402.

Supplementary Book Resources

Spector A. Z., Norvig P., Wiggins C., Wing J. M. (2022). Data Science in Context: Foundations, Challenges, Opportunities, Cambridge University Press. ISBN: 978-1009272209..

Nguyen A. (2022). Hands-On Healthcare Data: Taming the Complexity of Real-World Data, O'Reilly Media. ISBN: 978-1098112929..

Tatsat H., Puri S., Lookabough B. (2021). Machine Learning and Data Science Blueprints for Finance: From Building Trading Strategies to Robo-Advisors Using Python, O'Reilly (Wiley UK). ISBN: 978-1492073055..

Combarro E. F., González-Castillo S. (2023). A Practical Guide to Quantum Machine Learning and Quantum Optimisation: Hands-on Approach to Modern Quantum Algorithms, Packt Publishing. ISBN: 978-1804613832..

Review

Module Aims and Objectives

The objective of the Domain Applications module is to endow learners with hands on experience of contemporary approaches to data analytics in practical settings such as information retrieval, geographic information systems, banking, ICT, health, retail, supply-chain & manufacturing, sports, and online services. This module will be framed within the KDD and CRISP-DM data mining methodologies as appropriate for the problems studied. The module encourages research in state-of-the-art solutions (e.g., quantum machine learning) across various domains and utilises case-studies to illustrate the application of such solutions.

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

Information provided to learners about the module

The module specification is replicated in Akari Document, which is the College's repository of programme and module information. In order to ensure that this information is consistently presented, this is viewed as the primary source of information and is linked to in all systems, e.g. website links and Moodle, the College's virtual learning environment, Moodle etc. This is also the source of information for teaching staff in terms of guidance around assessment structure and requirements.

These specifications once approved are available via http://courses.ncirl.ie

This specification, where appropriate, is also used as the primary source of information for printed materials e.g. prospectus. In this case, until the module is approved in the context of the programme, information is indicative.

This information is further supplemented on an instance by instance basis by the individual lecturer teaching the module through the module handbook, which may be made available electronically via Moodle or in printed format. This document ensures that week by week activities, updated reading list and cohort specific information is current.

Module content, organisation and structure

Information Retrieval I

Key concepts in Information Retrieval (IR). Boolean model. Term-Document matrix. Postings and inverted indexes. Vector Space model. TF-IDF. Evaluation in IR.

Information Retrieval II

Probabilistic model. Bayesian approaches. Latent Semantic Indexing. Link Analysis.

Geographic Information Systems I

Core geospatial concepts. Data layers. Spatial data creation and management. Metadata. Geospatial analysis and geoprocessing. Visualising and interpreting spatial data.

Geographic Information Systems II

Cartographic enhancement. Thematic mapping. GIS tools and technologies (e.g., ArcGIS).

Social Media and Web Analytics

Collecting and extracting social media data. Case studies. Social listening. Audience/Performance/Competitive/Behaviour analytics. Sentiment analysis. Segmentation.

Industry Use-case I

Domain applications in Pharma, Medicine, and Healthcare. Case studies.

Industry Use-case II

Domain applications in Retail, Manufacturing and Supply-chain. Case studies.

Industry Use-case III

Domain applications in IoT, communications and networks. Case studies.

Industry Use-case III

Domain applications in Sports. Case studies.

Industry Use-case III

Domain applications in Finance and Banking. Fraud Detection. Case studies.

Industry Use-case III

Domain applications in Blockchain & DeFi. Case studies.

Quantum Machine Learning

Introduction to Quantum Computing(QC) and key take-aways. Algorithmic patterns for QC. Application for QC in a machine learning context.

Module Teaching and Learning (including formative assessment) Strategy

The learning strategy involves the use of lectures, tutorials, case studies, paper reviews and practical work where learners will engage with and explore domain applications of data analytics in real-world scenarios. Lectures will include active learning components such as paired discussion, problem solving, and class feedback. Practical sessions will comprise of group work and individual learning. Learners will also have access to research documents and publications as required. Tutorials will focus on case studies from the industry where data analytics, AI, and machine learning has been applied successfully.
Learners will have 36 hours a semester of college-based classroom contact. Lectures and any practical work will use a variety of teaching and learning techniques including direct instruction, in-class group work, case studies, and problem-solving.

Work-based learning and practice placement

E-Learning

Module Physical resource requirements

Specifications for module staffing requirements

Sample assessment materials

Timetabling, learner effort and credit

Module assessment rationale

Affiliated Entities

Entity Code	Entity Title	Entity Version	Entity Type	Via	Outcome
MSCDA	MSc in Data Analytics	3.0	Programme		Yes
MSCDA	MSc in Data Analytics	4.0	Programme		Yes
PGDDA	Post Graduate Diploma in Science in Data Analytics	3.0	Programme		Yes

Documents

No Documents

9RPM: Research Practicum
(Group Elective 4)

Module Code:	9RPM
Long Title	Research Practicum APPROVED
Title	Research Practicum
Module Level:	LEVEL 9
EQF Level:	7
Valid From:	2024 (July 2024)
Language of Instruction:	English
Duration:	2 Semesters
Credits:	30
Field of Study:	0610 - Information and Communication Technologies (ICTs) not further defined or elsewhe
Learning Outcome Taxonomy	Blooms
Module Author:	Eileen Long
Authors	Long Eileen (10 July 2024 to ---)
Is this a capstone module?	Yes

Learning Outcomes	
On successful completion of this module the learner will be able to:	
#	**Learning Outcome Description**
LO1	Propose a research question, project objectives and methodology.
LO2	Analyse, synthesise, and critically evaluate the state of the art.
LO3	Propose, architect, implement, and evaluate an ICT solution related to the programme area.
LO4	Investigate potential future research and invention disclosures.
LO5	Present and defend the project findings through a viva, artefact/product demo, and report.
LO6	Identify, assess, and resolve the ethical issues that need to be addressed when conducting research.
LO7	Demonstrate initiative whilst working alone or part of a team, and appropriate communication and interpersonal skills.

Learning Outcome Taxonomy Blooms							
#	LO1	LO2	LO3	LO4	LO5	LO6	LO7
C1					Y		
C2					Y		
C3					Y		Y
C4				Y			
C5	Y				Y		
C6							
P1							
P2							
P3							
P4							
P5							Y
P6							
P7							
A1							
A2					Y		
A3	Y						Y
A4							
A5	Y						

Learning Outcome Taxonomy Reference Blooms		
#	**Taxonomy Description**	**Taxonomy Group**
C1	Knowledge	Cognitive
C2	Comprehension	Cognitive
C3	Application	Cognitive
C4	Analysis	Cognitive
C5	Synthesis	Cognitive
C6	Evaluation	Cognitive
P1	Perception	Psychomotor (Technical Skills)
P2	Set	Psychomotor (Technical Skills)
P3	Guided Response	Psychomotor (Technical Skills)
P4	Mechanism	Psychomotor (Technical Skills)
P5	Complex Overt Response	Psychomotor (Technical Skills)
P6	Adaptation	Psychomotor (Technical Skills)
P7	Origination	Psychomotor (Technical Skills)
A1	Receiving to Phenomena	Affective (Humanities)
A2	Responding to Phenomena	Affective (Humanities)
A3	Valuing	Affective (Humanities)
A4	Organizing Values	Affective (Humanities)
A5	Internalizing Values	Affective (Humanities)

Programme Module Dependencies
No requisites

Dependencies

Module Content & Assessment

Indicative Content
1. Research Questions and Literature Review and Novel Contribution 1.1) Structure and purpose of a literature review. Search tools and sources. Selecting and coping with literature. Identifying novel contribution.
2. Scientific Methodology, Research Questions and Literature Review 2.1) Exploring different research methodologies and assessing the context for these research methodologies. Formulating a research question. Ethics in research.
3. Computing Community and Resources 3.1) Planning software development and evaluation. User involvement. Descriptive, theory oriented and applied projects. Time and project management, making efficient use of time and resources to manage multiple tasks at the same time and reach the goals.
4. Academic Writing I 4.1) Proposal structure. Selection and assessing the quality of literature.
5. Academic Writing II 5.1) Project structure. Citations and referencing.
6. Academic Writing III 6.1) Presenting qualitative data. Presenting quantitative data.
7. Academic Writing IV 7.1) The importance of ethics and reproducibility in research.
8. Academic Writing V 8.1) Scientific writing and style considerations. Plagiarism and self-plagiarism.
9. Technical Information 9.1) Reading, understanding and summarising technical material, including source code, academic articles, patents, and documentation. Writing effective technical documentation and materials.
10. Ethics 10.1) Ethics considerations around human participants, secondary datasets. Ethics approval process.
11. Communication 11.1) Dynamics of oral, written, and electronic team and group communication
12. Project Proposal and Ethics Approval 12.1) A project proposal must describe what the learner will investigate, the importance and relevance of the topic to the programme area, and how the learner intends to fulfil the project goals. The format of a project proposal varies between fields, but most proposals should contain at least these elements: introduction, research question, research objectives, literature review, artefact/approach design, evaluation methodology, implications and contribution to knowledge, and reference list. The proposal should address the ethics of the proposed study and the proposal should have ethics approval.
13. Research Practicum Project Report 13.1) The research practicum project report is a paper style report. The report shall comprise up to 20 pages (4,000 to 6,000 words) and describes the individual research and production of an ICT solution. It shall follow the following format: introduction, background, design, implementation, results and discussion, and conclusion. A literature review should be included to situate the work in existing research. Learners are also required to critically analyse insights gained throughout the development and evaluation of their research application. In addition, learners should also identify future commercialisation opportunities and further research possibilities.
14. Artefact/Product 14.1) An artefact/product can represent a software application that demonstrates a novel invention. An artefact/product can also represent a phenomenon that is observed in a scientific investigation or experiment that is not naturally present but occurs as a result of the preparative or investigative procedure.
15. User Configuration Manual 15.1) The configuration manual shall describe the required software tools and settings to successfully replicate the experimental setup. This manual is submitted separately from the research paper style report and it will not count towards the suggested word count. It should not discuss only how to install standard software or tools.
16. Viva 16.1) The viva shall involve a presentation of the research work carried out and a demonstration of the results including a demo of the developed artefact/product.
17. Invention Disclosure Form 17.1) IDF identifies the potential commercial opportunities and explores the related markets. The IDF describes the invention, highlights the novelty/patentable aspect, what the problem is and how the invention solves the problem, identifies the companies that are interested in the invention, and potential commercial application of the invention.

Assessment Breakdown	%
Coursework	100.00%

Assessments

Coursework

Assessment Type:	Proposal	**% of total:**	10
Pass Marks:	0	**Assessment Date:**	n/a
Outcome addressed:	1,2,3,4	**Briefing:**	n/a
Feedback:	n/a	**Assessment Mode:**	Not yet determined
Assessment Medium:	Not yet determined	**Role:**	Not yet determined
Mandatory:	False	**Assessor:**	Not yet determined
Feedback Type:		**Non-Marked:**	No
Assessment Difficulty:	Not yet determined	**Central Admin:**	No
Language Proficiency:			

Assessment Description:
Project Proposal and Ethics Approval

Assessment Type:	Project	**% of total:**	5
Pass Marks:	0	**Assessment Date:**	n/a
Outcome addressed:	1,2,3,4	**Briefing:**	n/a
Feedback:	n/a	**Assessment Mode:**	Not yet determined
Assessment Medium:	Not yet determined	**Role:**	Not yet determined
Mandatory:	False	**Assessor:**	Not yet determined
Feedback Type:		**Non-Marked:**	No
Assessment Difficulty:	Not yet determined	**Central Admin:**	No
Language Proficiency:			

Assessment Description:
Project Specification

Assessment Type:	Project	**% of total:**	10
Pass Marks:	0	**Assessment Date:**	n/a
Outcome addressed:	5,6,7	**Briefing:**	n/a
Feedback:	n/a	**Assessment Mode:**	Not yet determined
Assessment Medium:	Not yet determined	**Role:**	Not yet determined
Mandatory:	False	**Assessor:**	Not yet determined
Feedback Type:		**Non-Marked:**	No
Assessment Difficulty:	Not yet determined	**Central Admin:**	No
Language Proficiency:			

Assessment Description:
Literature Review

Coursework

Assessment Type:	Project	**% of total:**	30
Pass Marks:	0	**Assessment Date:**	n/a
Outcome addressed:	5,6,7	**Briefing:**	n/a
Feedback:	n/a	**Assessment Mode:**	Not yet determined
Assessment Medium:	Not yet determined	**Role:**	Not yet determined
Mandatory:	False	**Assessor:**	Not yet determined
Feedback Type:		**Non-Marked:**	No
Assessment Difficulty:	Not yet determined	**Central Admin:**	No
Language Proficiency:			

Assessment Description:
Artefact/Product Development

Assessment Type:	Project	**% of total:**	25
Pass Marks:	0	**Assessment Date:**	n/a
Outcome addressed:	5,6,7	**Briefing:**	n/a
Feedback:	n/a	**Assessment Mode:**	Not yet determined
Assessment Medium:	Not yet determined	**Role:**	Not yet determined
Mandatory:	False	**Assessor:**	Not yet determined
Feedback Type:		**Non-Marked:**	No
Assessment Difficulty:	Not yet determined	**Central Admin:**	No
Language Proficiency:			

Assessment Description:
Artefact/Product Evaluation and Analysis

Assessment Type:	Project	**% of total:**	10
Pass Marks:	0	**Assessment Date:**	n/a
Outcome addressed:	5,6,7	**Briefing:**	n/a
Feedback:	n/a	**Assessment Mode:**	Not yet determined
Assessment Medium:	Not yet determined	**Role:**	Not yet determined
Mandatory:	False	**Assessor:**	Not yet determined
Feedback Type:		**Non-Marked:**	No
Assessment Difficulty:	Not yet determined	**Central Admin:**	No
Language Proficiency:			

Assessment Description:
Document Presentation/Structure, Referencing, and Configuration Manual

Coursework

Assessment Type:	Presentation	**% of total:**	10
Pass Marks:	0	**Assessment Date:**	n/a
Outcome addressed:	5,6,7	**Briefing:**	n/a
Feedback:	n/a	**Assessment Mode:**	Not yet determined
Assessment Medium:	Not yet determined	**Role:**	Not yet determined
Mandatory:	False	**Assessor:**	Not yet determined
Feedback Type:		**Non-Marked:**	No
Assessment Difficulty:	Not yet determined	**Central Admin:**	No
Language Proficiency:			

Assessment Description:
Viva

Coursework

Assessment Type:	Proposal	**% of total:**	10
Pass Marks:	0	**Assessment Date:**	n/a
Outcome addressed:	1,2,3,4	**Briefing:**	n/a
Feedback:	n/a	**Assessment Mode:**	Not yet determined
Assessment Medium:	Not yet determined	**Role:**	Not yet determined
Mandatory:	False	**Assessor:**	Not yet determined
Feedback Type:		**Non-Marked:**	No
Assessment Difficulty:	Not yet determined	**Central Admin:**	No
Language Proficiency:			

Assessment Description:
Project Proposal and Ethics Approval

Assessment Type:	Project	**% of total:**	5
Pass Marks:	0	**Assessment Date:**	n/a
Outcome addressed:	1,2,3,4	**Briefing:**	n/a
Feedback:	n/a	**Assessment Mode:**	Not yet determined
Assessment Medium:	Not yet determined	**Role:**	Not yet determined
Mandatory:	False	**Assessor:**	Not yet determined
Feedback Type:		**Non-Marked:**	No
Assessment Difficulty:	Not yet determined	**Central Admin:**	No
Language Proficiency:			

Assessment Description:
Project Specification

Coursework

Assessment Type:	Project	**% of total:**	10
Pass Marks:	0	**Assessment Date:**	n/a
Outcome addressed:	5,6,7	**Briefing:**	n/a
Feedback:	n/a	**Assessment Mode:**	Not yet determined
Assessment Medium:	Not yet determined	**Role:**	Not yet determined
Mandatory:	False	**Assessor:**	Not yet determined
Feedback Type:		**Non-Marked:**	No
Assessment Difficulty:	Not yet determined	**Central Admin:**	No
Language Proficiency:			

Assessment Description:
Literature Review

Assessment Type:	Project	**% of total:**	30
Pass Marks:	0	**Assessment Date:**	n/a
Outcome addressed:	5,6,7	**Briefing:**	n/a
Feedback:	n/a	**Assessment Mode:**	Not yet determined
Assessment Medium:	Not yet determined	**Role:**	Not yet determined
Mandatory:	False	**Assessor:**	Not yet determined
Feedback Type:		**Non-Marked:**	No
Assessment Difficulty:	Not yet determined	**Central Admin:**	No
Language Proficiency:			

Assessment Description:
Artefact/Product Development

Assessment Type:	Project	**% of total:**	25
Pass Marks:	0	**Assessment Date:**	n/a
Outcome addressed:	5,6,7	**Briefing:**	n/a
Feedback:	n/a	**Assessment Mode:**	Not yet determined
Assessment Medium:	Not yet determined	**Role:**	Not yet determined
Mandatory:	False	**Assessor:**	Not yet determined
Feedback Type:		**Non-Marked:**	No
Assessment Difficulty:	Not yet determined	**Central Admin:**	No
Language Proficiency:			

Assessment Description:
Artefact/Product Evaluation and Analysis

Coursework

Assessment Type:	Project	**% of total:**	10
Pass Marks:	0	**Assessment Date:**	n/a
Outcome addressed:	5,6,7	**Briefing:**	n/a
Feedback:	n/a	**Assessment Mode:**	Not yet determined
Assessment Medium:	Not yet determined	**Role:**	Not yet determined
Mandatory:	False	**Assessor:**	Not yet determined
Feedback Type:		**Non-Marked:**	No
Assessment Difficulty:	Not yet determined	**Central Admin:**	No
Language Proficiency:			

Assessment Description:
Document Presentation/Structure, Referencing, and Configuration Manual

Assessment Type:	Presentation	**% of total:**	10
Pass Marks:	0	**Assessment Date:**	n/a
Outcome addressed:	5,6,7	**Briefing:**	n/a
Feedback:	n/a	**Assessment Mode:**	Not yet determined
Assessment Medium:	Not yet determined	**Role:**	Not yet determined
Mandatory:	False	**Assessor:**	Not yet determined
Feedback Type:		**Non-Marked:**	No
Assessment Difficulty:	Not yet determined	**Central Admin:**	No
Language Proficiency:			

Assessment Description:
Viva

Module Workload

Module Target Workload Hours 300 Hours

Full Time hours per semester

Workload Type	
Lecture	
Independent Learning	
Tutorial	
Lecturer Supervised Learning	
	750.00

This module has no Apprenticeship workload.

This module has no Blended workload.

This module has no Block workload.

This module has no Distance/Correspondance workload.

This module has no Evening workload.

This module has no Online workload.

Part Time hours per semester
Workload Type
Lecture
Tutorial
Lecturer Supervised Learning
Independent Learning
750.00

MLO Competency Mapping

Learning Outcomes	Competencies
LO1: Propose a research question, project objectives and methodology.	
LO2: Analyse, synthesise, and critically evaluate the state of the art.	
LO3: Propose, architect, implement, and evaluate an ICT solution related to the programme area.	
LO4: Investigate potential future research and invention disclosures.	
LO5: Present and defend the project findings through a viva, artefact/product demo, and report.	
LO6: Identify, assess, and resolve the ethical issues that need to be addressed when conducting research.	
LO7: Demonstrate initiative whilst working alone or part of a team, and appropriate communication and interpersonal skills.	

Module Resources

Recommended Book Resources

Creswell, J.W. & Creswell, J.D. (2022). Research Design: Qualitative, Quantitative, and Mixed Methods Approaches (6th ed.). SAGE Publications. [ISBN: 978-1071817940]..

Zobel, J. (2015). Writing for Computer Science (3rd ed.). Springer. [ISBN: 978-1447166382]..

Dawson, C. (2015). Projects in Computing and Information Systems: A Student's Guide (3rd ed.). Pearson. [ISBN: 978-1292073460]..

Supplementary Book Resources

Thomas, G. (2017). How to Do Your Research Project: A Guide for Students (3rd. ed.). Sage Publications. [ISBN: 978-1473948860]..

Kitzes, J., Turek, D., & Deniz, F. (2017). The Practice of Reproducible Research: Case Studies and Lessons from the Data-Intensive Sciences. University of California Press. [ISBN: 978-0520294745]..

Evans, D., Gruba, P. & Zobel, J. (2014) How to Write a Better Thesis (3rd ed.). Springer. [ISBN: 978-3319042855]..

Ridley, D. (2012). The Literature Review: A Step-by-Step Guide for Students (2nd ed.). Sage Publications. [ISBN: 978-1446201435]..

Other Resources

[Website], http://www.patentsoffice.ie,
http://www.patentsoffice.ie

[Website], http://www.epo.org/searching/free/espace net.html,
http://www.epo.org/searching/free/espace net.html

[Website], Website. Prof Alan Bundy, University of Edinburgh How to Write an Informatics Paper,
http://homepages.inf.ed.ac.uk/bundy/how- tos/writingGuide.html

Review

Module Aims and Objectives

This module aims to allow learners to consolidate the knowledge, skills and competence acquired in a programme of study by carrying out a practicum that combines both research and technical skills to investigate, design, produce and evaluate an innovative ICT solution related to a programme area

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

Information provided to learners about the module

The module specification is replicated in Akari Document, which is the College's repository of programme and module information. In order to ensure that this information is consistently presented, this is viewed as the primary source of information and is linked to in all systems, e.g. website links and Moodle, the College's virtual learning environment, Moodle etc. This is also the source of information for teaching staff in terms of guidance around assessment structure and requirements.

These specifications once approved are available via http://courses.ncirl.ie

This specification, where appropriate, is also used as the primary source of information for printed materials e.g. prospectus. In this case, until the module is approved in the context of the programme, information is indicative.

This information is further supplemented on an instance by instance basis by the individual lecturer teaching the module through the module handbook, which may be made available electronically via Moodle or in printed format. This document ensures that week by week activities, updated reading list and cohort specific information is current.

Module content, organisation and structure

The module content is organised over two semesters with workshops and assignment of supervisors taking place in Semester 2, while Semester 3 consists exclusively of supervision.

For classroom-based teaching in semester 2 the practicum is scheduled based on 1-hour lecture and 2 hours lab over 12 weeks. In semester 3 the classroom is scheduled based on supervising the student for 1 hour per week over 12 weeks.

For online learning in semester 2 the practicum is scheduled based on 1-hour lecture and 1-hour lab and 1-hour directed eLearning over 12 weeks. In semester 3 the classroom is scheduled based on supervising the student for 1 hour per week over 12 weeks.

An indicative schedule of topics to be addressed each week in Semester 2 is outlined below:

Research Questions and Literature Review and Novel Contribution

Structure and purpose of a literature review. Search tools and sources. Selecting and coping with literature. Identifying novel contribution.

Scientific Methodology, Research Questions and Literature Review

Exploring different research methodologies and assessing the context for these research methodologies. Formulating a research question. Ethics in research.

Computing Community and Resources

Planning software development and evaluation. User involvement. Descriptive, theory oriented and applied projects. Time and project management, making efficient use of time and resources to manage multiple tasks at the same time and reach the goals.

Academic Writing I

Proposal structure. Selection and assessing the quality of literature.

Academic Writing II

Project structure. Citations and referencing.

Academic Writing III

Presenting qualitative data. Presenting quantitative data.

Academic Writing IV

The importance of ethics and reproducibility in research.

Academic Writing V

Scientific writing and style considerations. Plagiarism and self-plagiarism.

Technical Information

Reading, understanding and summarising technical material, including source code, academic articles, patents, and documentation. Writing effective technical documentation and materials.

Ethics

Ethics considerations around human participants, secondary datasets. Ethics approval process.

Communication

Dynamics of oral, written, and electronic team and group communication

In Semester 2, learners submit a portfolio that consists of a project proposal with Ethics Approval. In Semester 3, learners submit a practicum project report, an artefact/product, a user configuration manual, a presentation to be defended in a viva, and an invention disclosure form (if applicable). A demonstration of the artefact/product developed may be presented in the viva.

Learners that wish to commercialise their project work or a project related technology can explore this path. In this case, the learner will be required to complete an invention disclosure form (IDF) that identifies the potential commercial opportunities and explores the related markets.

Project Proposal and Ethics Approval (Semester 2)

A project proposal must describe what the learner will investigate, the importance and relevance of the topic to the programme area, and how the learner intends to fulfil the project goals. The format of a project proposal varies between fields, but most proposals should contain at least these elements: introduction, research question, research objectives, literature review, artefact/approach design, evaluation methodology, implications and contribution to knowledge, and reference list. The proposal should address the ethics of the proposed study and the proposal should have ethics approval.

Research Practicum Project Report (Semester 3)

The research practicum project report is a paper style report. The report shall comprise up to 20 pages (4,000 to 6,000 words) and describes the individual research and production of an ICT solution. It shall follow the following format: introduction, background, design, implementation, results and discussion, and conclusion. A literature review should be included to situate the work in existing research. Learners are also required to critically analyse insights gained throughout the development and evaluation of their research application. In addition, learners should also identify future commercialisation opportunities and further research possibilities.

Throughout the project learners are required to engage in formative assessments to evaluate their progress. The format of a project report varies between fields, but most reports should contain at least these elements:

- **Abstract**: The role of the abstract is to summarise the project undertaken in a concise manner, highlighting the scope of the project, the objectives, the methodology and its finding and results.
- **Introduction**: The main purpose of the introduction is to motivate the contribution of the research work. It should include background on the topic, the justification for the topic, and what gap in the literature it seeks to fill, the main research questions and objectives, novel contribution, and the organisation of the report.
- **Literature Review**: The literature review should demonstrate evidence of independent research critically analysing the potential of an application/idea and provide insights into how it can be implemented and evaluated.
- **Design Specification**: The techniques and/or architecture/framework that underlie the implementation and the associated requirements are discussed.
- **Implementation/Solution Development**: Learners develop a solution that addresses the research question(s)/objective(s). This may involve the development of an application prototype, the design of an algorithm, the implementation of an innovative service or component of a system.
- **Experiments**: Learners outline the proposed approach, method, and experiments used to generate the results, as well as demonstrating how the method will be applied to answering/achieve the research question(s)/objective(s).
- **Results and Discussion**: A comprehensive evaluation must be conducted by each learner using multiple strategies, example; an algorithm may be benchmarked by performance specific metrics whilst an internet applicati or mobile application may be evaluated using suitable usability testing techniques. Statistical tools should be used when appropriate to critically evaluate, assess, and analyse the experimental research outputs and levels o significance.
- **Conclusion and Future Work**: Learners must arrive at a conclusion from their research question(s)/objective(s) as defined. A detailed future work section must be included showing the learners understanding of their own research and opportunities for future improvements.
- **References**: Correct citation references must be included.

Artefact/Product

An artefact/product can represent a software application that demonstrates a novel invention. An artefact/product can also represent a phenomenon that is observed in a scientific investigation or experiment that is not naturally present but occurs as a result of the preparative or investigative procedure.

User Configuration Manual

The configuration manual shall describe the required software tools and settings to successfully replicate the experimental setup. This manual is submitted separately from the research paper style report and it will not count towards the suggested word count. It should not discuss only how to install standard software or tools.

Viva

The viva shall involve a presentation of the research work carried out and a demonstration of the results including a demo of the developed artefact/product.

Invention Disclosure Form

IDF identifies the potential commercial opportunities and explores the related markets. The IDF describes the invention, highlights the novelty/patentable aspect, what the problem is and how the invention solves the problem, identifies the companies that are interested in the invention, and potential commercial application of the invention.

Module Teaching and Learning (including formative assessment) Strategy

The learning strategy entails the use of workshops and academic seminars to provide learners with a solid foundation of the latest computing research avenues in the knowledge domain of the given programme.

Learning will may place in a classroom or blended environment and will feature both lectures and practical sessions for each topic. Materials and resources will be placed on Moodle, the College's virtual learning environment. Such materials may include lecture notes, lab/tutorial descriptions, assessments, datasets, discussion groups, videos (e.g., created by lecturers or from external sources such as YouTube). Where appropriate, this module may make use of the flipped classroom approach.

The learners will also be directed to software tools appropriate to specific topics in the module, e.g.

- Scopus, Google Scholar, Mendeley, Zotero, JabRef, etc. for executing and organising the results of literature searches
- Tools such as Jupyter Notebooks, Git/GitHub for literate programming, reproducible research, and version control
- Microsoft Project and open source tools for the production of project plans and Gantt charts.

Learners may be required to work in groups during the labs/tutorials. Moodle may also be used to both interact with learners and in some instances to provide formative assessments and feedback. Learners will have access to library resources, both physical and electronic, outside of the classroom where required.

Supervisors monitor the individual progress and provide guidance on the project. Techniques such online notes/information available on Moodle, links to extra material available on the Internet, Moodle forum may be used. Learners may also use collaborative tools for the development of the project. All documents required to be provided as part of the assessment will be submitted online on Moodle. The use of Git repositories will be encouraged as a collaborative tool to enable students to work on the development of the project. It will also improve the transparency of projects for markers as it will enable them to clearly identify the work carried out by students as part of the project.

Work-based learning and practice placement

E-Learning

Module Physical resource requirements

Specifications for module staffing requirements

Sample assessment materials

Timetabling, learner effort and credit

Module assessment rationale

Affiliated Entities

Entity Code	Entity Title	Entity Version	Entity Type	Via	Outcome
MSCDA	MSc in Data Analytics	3.0	Programme		Yes
MSCDA	MSc in Data Analytics	4.0	Programme		Yes

Documents

No Documents