

D7.4 RUN-EU JOINT DEGREE PROGRAMMES

December 2023

Partners Responsible: WP-Lead: Vorarlberg University of Applied Sciences; Co-Lead: Technological University of the Shannon: Midlands Midwest and Häme University of Applied Sciences

WP-Members: Polytechnic of Cávado and Ave, Polytechnic of Leiria, Széchenyi István University; NHL Stenden University of Applied Sciences

WP-Inter University Recognition Team Lead: NHL Stenden University of Applied Sciences



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1. Short Introduction

1.1 WP7 Collaborative European Degrees

Within RUN-EU 1.0, the aim of WP7 was to design and develop collaborative European Degrees, which include regionally relevant Double and Joint Degree Programmes (across BSc, MSc and PhD levels respectively). These degrees are based on transnational curricula and focus on the future and advanced skills needs enabling the promotion of flexible transnational mobility of students, innovative pedagogies and blended learning activities.

1.2 Definition of a Joint Degree Programme within RUN-EU

1.2.1 Joint Programme

“An integrated curriculum coordinated and offered jointly by different Higher Education Institutions (HEIs) and leading to a Joint, Double or Multiple Degree.”

1.2.2 Joint Degree

“A single document awarded by HEIs offering the Joint Programme and nationally acknowledged as the recognised award of the Joint Programme.”

1.2.3 Characteristics of a Joint Degree

- Accreditation of the Joint Degree in the respective countries of the participating partners.
- 1 integrated curriculum
- 1 Joint set of examination regulations
- 1 Joint admission requirements
- 1 Joint Degree Certificate issued for the Award

1.3 Goal of RUN-EU Joint Degree Programmes within D7.4

RUN-EU Joint Degree Programmes are designed to be closely linked to the output of the existing Regional Innovation Clusters, the future European Innovation Hubs (WP2) and the RUN-EU Discovery Programme (WP5), enabling students to develop cutting edge knowledge and skills to face future industrial and societal challenges.

In terms of the development of Joint Degrees, RUN-EU 1.0 aimed to establish initially by the end of Year 3, a minimum of three Joint Degrees: one at Bachelors level, one at Masters level and one at PhD level. This deliverable was subsequently amended by mutual agreement (as previously reported within RUN-EU 1.0) to the delivery of a minimum of two Joint Degrees: one at Masters level and one at PhD level.

1.4 Joint Degree Programme Development within RUN-EU 1.0

The following areas outlined in D7.2, D7.5 and D7.6 respectively are relevant to the development of Joint Degree Programmes within RUN-EU 1.0:

- National and Institutional Framework for development of Collaborative Degree Programmes (D7.2)
- Several steps undertaken to bring multiple stakeholders together, establish contact and build mutual trust (D7.5)
- Preparatory work conducted with regards to recognition (D7.6)

In the context of D7.6, one of the key elements of the project proposal was to establish an **Inter-University Recognition Team (IURT)**. This team was established in Year 2 of the project and was very successful in creating a concise manual on the Recognition of Learning within the Alliance, to the extent that the recognition manual was brought in as an extra deliverable.

1.5 Constraints of Mergers of Institutions and National Quality Assurance Regulations on Joint Programme Developments within RUN-EU 1.0

At the commencement of the project, two RUN-EU partners, Limerick Institute of Technology (LIT) and Athlone Institute of Technology (AIT) in Ireland were part of the formal Consortium. Technological University of the Shannon: Midlands-Midwest (TUS), which involved a merger of the two original IoTs was subsequently established on October 1, 2023. With the establishment of the new university, TUS at the date of inauguration did not formally have in place a TUS Policy on Collaborative Provision. The new [TUS Policy and Procedures on Collaborative Provision \(National and Transnational\) 2023-2028](#), was formally approved by the Academic Council of the University on May 29, 2023. The establishment of this policy which aligned with national policy in Ireland on Collaborative Provision, provided the necessary framework for TUS in the development of all future [Joint Programmes under the European Approach](#) within RUN-EU. As a result of this regulatory framework, this necessitated a change in direction for TUS in terms of the nature of the Joint Programmes in which it could participate within RUN-EU 1.0 (and subsequently going forward within RUN-EU 2.0).

Throughout the delivery of the project certain constraints resulting from the required adoption of national Quality Assurance (QA) regulations also caused challenges to the Alliance in the development of Joint Programmes within RUN-EU 1.0, in particular as the Alliance involves a network of universities and Higher Education Institutes (HEIs) of Applied Sciences, with relatively limited experience in developing international Joint Programmes. Specific challenges for the Alliance centred amongst others around different allocation of ECTS credits and differences in Award Titles. These challenges within D7.4 were mostly associated with RUN-EU partners in Finland (HAMK), the Netherlands (NHL Stenden) and the Republic of Ireland (TUS), where National QA regulations had a greater impact on development. Other challenges related to different financing structures related to tuition fees.

2. Joint Degree Programme Agreements

2.1 Development

Collaborative PhD Degree Programmes has been developed, involving joint supervision between RUN-EU partners.

2.2 Concluded Joint Degree Programme Agreements

At the PhD level, foundational work has been laid for several programmes. In November 2023 during the RUN-EU General Assembly a ground-breaking double PhD programme agreement was signed:

- Double PhD degree in Data Science for Sustainability between Polytechnic University of Leiria (IPLeiria) and Polytechnic of Cávado and Ave (IPCA).

PhD Level

- At the PhD level, 5 Joint Collaborative Degree Programmes have been developed, involving joint supervision between RUN-EU partners IPL and TUS respectively, leading to a TUS Single Award.

Additional Note: Erasmus Mundus Masters

- Although not part of the original project submission, it should be noted that an Erasmus Mundus Joint Masters Degree in Integrated STEAM Education (MASTED) has been developed as a two-year multilingual and international master's degree (120 ECTS). This Joint Degree was developed by five universities, across three countries, Portugal, Spain and Brazil and involves RUN-EU partners, IPL and IPCA and future RUN-EU 2.0 partner, Universidad de Burgos.

2.3 Ongoing Joint Degree Programme Developments

As part of D7.4, various partners within RUN-EU 1.0 engaged in the development of a series of Joint Degrees, within a Joint Programme. These programmes are currently at various stages of ongoing development:

- MSc in Applied Machine Learning for Business (HAMK and TUS)

This Joint programme is at a very advanced stage of development and a fully integrated curriculum has been established by the respective programme teams at HAMK and TUS. The programme documentation and the timeline of development is outlined in **Appendix 1**. In the summer of 2023, the Programme Development Team encountered an issue around the intended Award Title of an MSc. Although TUS can award an MSc, HAMK being a University of Applied Sciences in Finland does not have the statutory authority to award an MSc per se. An MBA Degree was discussed but as it is not recognised by the Finnish educational system, it could not

be further considered by HAMK. Another possibility explored by the Programme Development Teams to enable progression of the programme within the framework of the development of Joint Programmes under the European approach involved the granting of a Double Award. As both universities in Finland and Ireland have been very committed to the development of this Joint Programme, different solutions are being explored to overcome the challenge outlined.

- MA in Sustainable Marketing (TUS and NHL Stenden)

Development of this Joint programme is ongoing, and the Programme Development Team is currently working on the potential alignment of ECTS credits in TUS and NHL Stenden (*i.e.*, 90 ECTS at TUS and 60 ECTS at NHL Stenden).

- Other Potential Joint Masters Programmes

A series of meetings has also taken place between HAMK and TUS on the development of a Masters in Nursing and Leadership and Quality Healthcare. This programme was originally considered to be developed as a Double Degree but the focus has since changed direction with the current plan for the programme development to centre on a Joint Degree within a Joint Programme under the European Approach.

A Joint Degree involving an MSc in Applied Computer Networks and Security between IPCA and TUS is also at an early stage of development.

3. Outlook/Conclusion

One of the key outcomes from RUN-EU 1.0 concerning Joint Programme Development amongst partners, was that it clarified for Programme Development Teams across the Alliance the nature and complexities around the establishment of a Joint Programme under the European Approach, leading to a Joint Award, a Double Award or a Multiple Award. RUN-EU 1.0 provided a platform for the universities within the Alliance to explore the feasibility of developing Joint Programmes under the European Approach. This approach will be the hallmark of any future Joint Programme developments within RUN-EU 2.0. RUN-EU 1.0 has also allowed for a greater understanding amongst Consortium members of various national, and regulatory constraints that need to be considered in any future Joint programme developments.

Based on the success of the General Exploratory Missions (GEMs) of Phase 1 of the project as a catalyst for programme collaboration, European Programme Academy (EPA) Missions will be conducted in Phase 2 of the RUN-EU project. The aim in the EPA Missions is to involve a greater number of multiple stakeholders in these missions, compared to the GEMs of Phase 1. Whereas in Phase 1 the focus of participation was on academic staff and directors, in the EPA Missions it is hoped to include a broader spectrum of stakeholders involving associate partners, researchers and students.

Appendix 1: Timeline of Development and Current Draft Programme
Documentation for Masters in Applied Machine Learning – Joint Programme
(between HAMK and TUS)

2nd RUN-EU General Assembly in HAMK 7-11.2022 Programme Development Meeting between HAMK and TUS representatives

15.02.2023 Discussion on the planning process, online meeting

06.03.2023 Curriculum design, online meeting

27.03.2023 Curriculum design, online meeting

10.04.2023 Workshop planning / curriculum design, online meeting

17.-19.5.2023 – Joint curriculum workshop at TUS (Athlone campus)

Programme Documentation



AL_KAPML_9

Master of Science in Applied Machine Learning for Business

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AL_KAPML_9 202400
Master of Science in Applied Machine Learning
for Business

Programme Overview

Full Award Title	Master of Science in Applied Machine Learning for Business		
Exit Award			
Status	Draft	Programme Code	AL_KAPML_9
Level	09	Required Credits	90
Delivered By	Stage - Full Academic Year	Minimum Duration	1
Start Term	202400	ISCED Code	0613 - Software & app dev & analysis
Award Class	Masters (Taught)	Award Type	Master of Science
Award Standard	Quality and Qualifications Ireland	Department	Accounting & Business Computing
Delivery Mode(s)	Online	Min Course Grade	40
Contains Work Placement	No	Work Placement Credits	
Work Placement Models			
Programme Authors	Barry O'Loughlin, Brenda Reilly, Patricia Gunning, Paul Liston, Tao Cui, Jonny O'Dwyer		
Programme Justification and Rationale	<p>The field of Data Analytics has evolved from computer science and business intelligence over the past decade. As more and more data is being generated by a wide variety of devices, the need for skilled practitioners who can make sense of these volumes of data is increasing. This programme will give students advanced knowledge in the area of data analytics, combining mathematics, computer science, visualisation techniques, completed with a substantive (30 ECTS) thesis.</p>		
Alignment with Strategic Direction of Institute and Faculty	Please indicate how this programme aligns with the Strategic Direction of both the Institute and the Faculty.		
Work Placement Description	There is no work placement in this programme.		

Programme Aim

This programme aim is to develop the skills, aptitudes and competencies in the field of applied machine learning, within a business context. Recognising the increasing importance and value of data to organisations, graduates of this programme will be versed in the technologies, processes and knowledge of machine learning while maintaining suitable objectivity on both the opportunities and threats that this technology presents. This programme will be taught synchronously and asynchronously online. Students will have synchronous classes two evenings a week over 3 semesters. The final semester will involve project supervision one on one with each student.

Entry Requirements and Access Routes

(It is mandatory that you enter full details on minimum entry requirements for both Leaving Certificate and QQI Level 5/Level 6 qualifications, specific to this proposal. This must be appropriate for the level and type of the proposed programme.)

Minimum Entry Requirements: Students are expected to have a minimum of a 2.2 Honours Bachelor Degree (Level 8) in Computer Science, Software Engineering or equivalent. Students are additionally required to have a minimum of 2 years working experience in line with Håme University of Applied Sciences masters entry requirement.

In line with institute policies, non-native English speakers are required to have an IELTS or equivalent level of 6.5 or higher.

All applicants will be subject to an interview.

Recognition of Prior Learning

Recognition of Prior Learning (RPL) will be in keeping with the TUS RPL Policy. Applications will be considered on a case by case basis.

Programme Transfer Routes

Transfer will be as per the institution RPL policy.

Progression Pathways

Upon completion, graduates will be eligible to apply to a relevant Level 10 programme.

Teaching & Learning Strategy

Recognising that students on the programme will come from a range of backgrounds and disciplines, the programme builds on this domain-specific knowledge by overlaying the three strands of Applied Machine Learning for Business. The MSc is based on three core elements of this discipline – building business value, developing and maintaining data pipelines, and machine learning for business solutions. The teaching ethos of the programme is to intertwine these three core elements to provide a cohesive and experiential learning environment, striking a balance between the academic and the practical. Moving beyond the level of transmission of information and knowledge, learners will experience a range of teaching methodologies, from hands-on practical exercises, to case studies, project work and presentations, all moderated with elements of peer review and peer feedback. The programme will facilitate the building of an eportfolio by ensuring that all work undertaken across all modules will be entirely in electronic format, from class-based activities, to assessments, group work and reports.

This programme is jointly situated within the Faculty of Business and Hospitality and [insert HAMK Faculty here] and therefore places a strong focus on the development of faculty graduate competences throughout the programme. Focus will be placed on encouraging students to become engaged in the content as active learners, taking responsibility for their own learning, with academic staff assuming a facilitator role. Throughout the programme, self-directed learning will be nurtured through the use of open-ended, real-world and often ill-defined scenarios that will set students on a pathway to independent learning and research. The learning objectives of the syllabi will be achieved by a range of teaching and learning methods, which will include, though may not be limited to:

- **Lectures** will be designed to provide the student with the underpinning theory of the three core domains within the discipline. As this programme will be delivered online, lecturers will be recorded and presented on the Learning Management System (Moodle) and will be supplemented by "live" online tutorials and optional face-to-face sessions where learners will be afforded the opportunity to ask questions
- **Computer-based practical work**: a significant element of the programme will require proficiency in a range of software tools and applications which will be learnt through real-world scenario exercises and authentic assessments using the students own computer

environment.

- **Peer-assessed group work** such as discussions, group projects, presentations will facilitate peer-supported learning, team-working, creativity and leadership
- **Projects and case-studies** will provide the student with an understanding of the practical application of theory applicable to a range of scenarios that they may encounter in the workplace
- **Learning Management system** will be core to the teaching and learning ethos of the programme. Rather than just being utilised as a repository for documentation, it will be used as a learning hub, facilitating peer-discussion (forums), peer-review (workshop), self reflection (journal) and formative feedback (quizzes)
- **E-portfolio:** Over the course of the programme, students will be required to build up an e-portfolio of their work using software such as Student Diary Pro. It is a stated objective of the programme to have all work created and submitted electronically, which in turn will facilitate students building up a substantial portfolio that can be used to evidence work completed

Independent Learning

The role of academic staff will be that of a facilitator, guiding students through the programme, shifting the emphasis from passive learning to active learning. The use of real-world activities and assessment provides an authentic learning experience, developing skills that are in demand by employers. Ill-defined and open-ended problems will be presented, affording students the opportunity to develop that analytical mindset essential to success in the discipline of Data Analytics. Leadership skills will be nurtured by group work, with associated formative and summative peer review, requiring students to organise themselves and divide up complex problems with more than one potential solution. The culmination of this independent learning will be evidenced by the Applied Research Project, a piece of academic research, conducted in conjunction with an approved industry partner, that will make a contribution to the body of knowledge, appropriate for this level.

Integration of Transferable Skills into the Programme

The programme has the dual aims of educating students in the discipline of Applied Machine Learning for Business and develop a range of higher-order skills that are applicable to a wide range of scenarios they may encounter in the workplace of the 21st Century. In recognition of these aims, the design of the programme incorporates a range of activities, formative assessments, summative assessments, group-work, project work and presentations to further develop these skills.

The activities, whatever form they take, address the following transferable skills:

- Critical thinking** – presenting open-ended, ill-defined problems that are modelled on real-world scenarios, demands of the student an ability to consider many often competing and contradictory solutions to such problems
- Analytical mindset** – one of the core tenets of the programme is the requirement for deep analytical competences, which requires a disciplined, methodical and transparent approach to working with such large volumes of data
- Numerical Competency** – the importance of strong mathematical competences is apparent within the discipline and developed throughout the programme
- Technical Literacy** – it is no longer sufficient to use information technology, the workplace of the 2nd century demands graduates who are creative, innovative and proficient in the use of advanced technologies and software tools
- Leadership** – the requirement to not only work in teams, but also develop innovative solutions to ill-defined problems coupled with leadership qualities are attributes that are developed throughout the programme in group work, peer feedback and presentations
- Communication** – Machine Learning is worthless without the ability to develop insights and communicate findings. Interwoven throughout the programme are numerous opportunities for students to develop communications skills, both informally within groups, but also formally through presentations, report writing and software visualisation tools
- Contextual Awareness** – with access to great volumes of data comes great responsibility. Interleaved throughout the core domains of the programme are concepts such as legal responsibilities, social implications and ethical issues of the field of Applied Machine Learning for Business

Programme Assessment Strategy

The programme assessment strategy has been devised to support both the programme and module learning outcomes and to develop the desired knowledge, skills and competences. Striking a balance between assessing theoretical knowledge and practical skills and how these skills are effectively synthesised to develop an effective Applied Machine Learning for Business practitioner, each module will utilise assessments that are multi-modal and multi-faceted while adhering to the ethos of being fair, reliable and consistent. All learners are entitled to a resit of a failed assessment, in line with the institute's policies.

A stated aim of the programme is to have all assessments submitted electronically which in turn will facilitate the creation of an e-portfolio to evidence work completed. Presentations and communication will form a key tenet of the assessment strategy, with students required to present on their findings, while defending both their thinking and their methodologies used.

Employability
<p>Career opportunities for graduates of this programme include:</p> <ul style="list-style-type: none"> • Data Analyst, • Data Scientist, • Machine Learning Product Manager, • Machine Learning Engineer.

Consultation with Employers

Research findings concerning the Programme

Potential Applicant Demand
<p>The field of Applied Machine Learning is of increasing importance to society, where business applications of this technology include banking, finance, marketing, sales, human resources, logistics and many more.</p>

Accreditation Organisation

Profile of Programmes Target Learners

Collaborative or Transnational Provision

Ethical Considerations
<p>Data containing personal information shall be anonymised.</p>

Competencies Specific

Resources Required
<p>Module physical resource requirements: Specifications for module staffing requirements:</p>

Programme Graduate Attribute Mapping

Graduate Attribute	Modules Stage 1	Assessments Stage 1	Modules Stage 2	Assessments Stage 2
In-depth knowledge base and intellectual breadth.	MATH09002 Mathematics for Machine Learning DANL09011 Data Mining and Business Intelligence ANLY09021 Data Engineering DANL09010 Classical Machine Learning	MATH09002 Assessments MATH09002 Final Exam DANL09011 Hands on Assignments on the taught topics DANL09011 Final Project ANLY09021 Research Software Solutions ANLY09021 Implement ETL process DANL09010 Continuous Assessment DANL09010 Project	AI09003 Deep Learning ICT09010 Legal, Social and Ethical Implications of AI BUS09023 Research Methods COMP09011 Applied Research Project	AI09003 Report on State of the Art AI09003 Implementing Deep Learning Pipeline ICT09010 Literature Review Paper ICT09010 Final Exam BUS09023 Thesis proposal COMP09011 Thesis COMP09011 Progress Review Report
Creativity, critical thinking & problem-solving skills.	MATH09002 Mathematics for Machine Learning DANL09011 Data Mining and Business Intelligence ANLY09021 Data Engineering DANL09010 Classical Machine Learning	MATH09002 Assessments MATH09002 Final Exam DANL09011 Hands on Assignments on the taught topics DANL09011 Final Project ANLY09021 Implement ETL process DANL09010 Continuous Assessment DANL09010 Project	AI09003 Deep Learning BUS09023 Research Methods COMP09011 Applied Research Project	AI09003 Report on State of the Art AI09003 Implementing Deep Learning Pipeline BUS09023 Thesis proposal COMP09011 Thesis COMP09011 Progress Review Report
Intra, inter and multi-disciplinary teamwork.			AI09003 Deep Learning	AI09003 Implementing Deep Learning Pipeline
Communication & digital capability.	MATH09002 Mathematics for Machine Learning ANLY09022 Business Machine Learning Case Studies DANL09011 Data Mining and Business Intelligence ANLY09021 Data Engineering DANL09010 Classical Machine Learning	MATH09002 Assessments MATH09002 Final Exam ANLY09022 Report ANLY09022 Practical DANL09011 Hands on Assignments on the taught topics DANL09011 Final Project ANLY09021 Research Software Solutions ANLY09021 Implement ETL process DANL09010 Continuous Assessment DANL09010 Project	AI09003 Deep Learning ICT09010 Legal, Social and Ethical Implications of AI BUS09023 Research Methods COMP09011 Applied Research Project	AI09003 Report on State of the Art AI09003 Implementing Deep Learning Pipeline ICT09010 Literature Review Paper ICT09010 Final Exam BUS09023 Thesis proposal COMP09011 Thesis COMP09011 Progress Review Report

Professionalism and leadership readiness.			AI09003 Deep Learning BUS09023 Research Methods COMP09011 Applied Research Project	AI09003 Implementing Deep Learning Pipeline BUS09023 Thesis proposal COMP09011 Thesis
Ethical, social, intercultural and environmental awareness and responsiveness.			AI09003 Deep Learning ICT09010 Legal, Social and Ethical Implications of AI BUS09023 Research Methods COMP09011 Applied Research Project	AI09003 Report on State of the Art ICT09010 Literature Review Paper ICT09010 Final Exam BUS09023 Thesis proposal COMP09011 Thesis COMP09011 Progress Review Report
Adaptability, self-awareness, emotional intelligence and commitment to lifelong learning.	DANL09011 Data Mining and Business Intelligence ANLY09021 Data Engineering	DANL09011 Final Project ANLY09021 Research Software Solutions ANLY09021 Implement ETL process	AI09003 Deep Learning ICT09010 Legal, Social and Ethical Implications of AI BUS09023 Research Methods COMP09011 Applied Research Project	AI09003 Report on State of the Art ICT09010 Literature Review Paper BUS09023 Thesis proposal COMP09011 Thesis COMP09011 Progress Review Report

Student Feedback Strategy

Individual feedback after submission, group/class feedback after submission. These can be through different approaches, oral, written, video, either in-class or out of class, in meetings (virtual), email can also be used.

Feedback to students prior to submission. These can be through different approaches, oral, written, video, either in-class or out of class, in meetings (virtual), email will also be used.

Online automated feedback, for example, online MCQs / quizzes (with feedback).

Forum to facilitate students to self-monitor and critically evaluate their own work, for example, discussion forums around assignments in class/online. Self-assessment forms when submitting their own work.

Peer review using some examples of other students work, in class/online, review against specification of assignments.

Programme Learning Outcome Mapping

Programme	AL_KAPML_9 Master of Science in Applied Machine Learning for Business
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Stage 1

Delivery	Code	Title	Level	Credit	KB	KK	KR	KS	CC	CR	CL	CI
SEM 1	MATH09002	Mathematics for Machine Learning	09	05	Y	Y	Y	Y				
SEM 1	ANLY09022	Business Machine Learning Case Studies	09	05								
SEM 1	DANL09011	Data Mining and Business Intelligence	09	10	Y	Y	Y	Y				
SEM 2	ANLY09021	Data Engineering	09	10	Y	Y	Y	Y		Y		
SEM 2	DANL09010	Classical Machine Learning	09	10	Y	Y	Y	Y			Y	

KB - Knowledge Breadth, KK - Knowledge Kind, KR - Know How and Skill Range, KS - Know How and Skill Selectivity
CC - Competence Context, CR - Competence Role, CL - Competence Learning to Learn, CI - Competence Insight
Y - Module Learning Outcomes map to Programme Outcomes

Programme Learning Outcome Mapping

Programme	AL_KAPML_9 Master of Science in Applied Machine Learning for Business
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Stage 2

Delivery	Code	Title	Level	Credit	KB	KK	KR	KS	CC	CR	CL	CI
SEM 3	AI09003	Deep Learning	09	10	Y	Y	Y	Y	Y	Y	Y	Y
SEM 3	ICT09010	Legal, Social and Ethical Implications of AI	09	05	Y	Y			Y	Y		Y

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SEM 3	BUS09023	Research Methods	09	05					Y	Y		
SEM 4	COMP09011	Applied Research Project	09	30	Y	Y	Y	Y	Y	Y	Y	Y

KB - Knowledge Breadth, KK - Knowledge Kind, KR - Know How and Skill Range, KS - Know How and Skill Selectivity
CC - Competence Context, CR - Competence Role, CL - Competence Learning to Learn, CI - Competence Insight
Y - Module Learning Outcomes map to Programme Outcomes

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Programme Outcomes

Programme	AL_KAPML_9 Master of Science in Applied Machine Learning for Business
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Programme Outcomes : On successful completion of this programme the learner will/should be able to

Knowledge Breadth: *A systematic understanding of knowledge, at, or informed by, the forefront of a field of learning.*

Demonstrate an advanced knowledge of the theoretical underpinnings of the field of applied machine learning for business.

The above Programme Outcome is achieved by the following Module Outcomes

Module Code	Module Outcomes
MATH09002	1. Effectively use statistics and linear algebra to solve data problems in machine learning. 4. Evaluate machine learning algorithms using various metrics.
ANLY09021	1. Critically evaluate the role of data engineering in organisations
DANL09010	2. Critically evaluate and select appropriate machine learning algorithms for different analytics objectives
AI09003	2. Critically evaluate the effectiveness of design decisions made in solutions to deep learning problems.
ICT09010	4. Consider future implications of AI on law, ethics and society
COMP09011	1. Apply knowledge, skills and competences acquired during the programme of study to the analysis and solution of a defined research area; 2. Utilise the knowledge and skills required to undertake a major research project based upon independent academic research;
DANL09011	1. Identify efficient pattern mining methods, such as Apriori; 2. Learn the concepts of collaborative filtering and content based filtering; 4. Learn the basic concepts of pattern discovery, such as frequent pattern, closed pattern, max-pattern, and association rules; 5. Learn multiple distance or similarity measures for cluster analysis, including Euclidean and Minkowski distances; 6. Learn the concepts of proximity measures for symmetric and asymmetric binary variables; distance measures between categorical attributes, ordinal attributes, and mixed types; proximity measures between two vectors cosine similarity; and correlation measures between two variables covariance and correlation coefficient.

Knowledge Kind: *A critical awareness of current problems and/or new insights, generally informed by the forefront of a field of learning.*

Develop a critical awareness of contemporary issues and opportunities in applied machine learning for business.

The above Programme Outcome is achieved by the following Module Outcomes

Module Code	Module Outcomes
MATH09002	2. Develop a critical awareness of the importance of mathematics for machine learning.
ANLY09021	1. Critically evaluate the role of data engineering in organisations
DANL09010	2. Critically evaluate and select appropriate machine learning algorithms for different analytics objectives
AI09003	4. Critique case studies of applications of deep learning within a business, research or societal context.

ICT09010	<ol style="list-style-type: none"> 1. Evaluate the key ethical issues raised by artificial intelligence. 2. Understand the current and likely future state of EU regulation for artificial intelligence. 3. Evaluate the societal challenges of artificial intelligence.
COMP09011	<ol style="list-style-type: none"> 6. Produce a conclusive, coherent document supported by evidence and a convincing analysis of findings that contributes to the body of knowledge in a specialist area of Applied Machine Learning for Business.
DANL09011	<ol style="list-style-type: none"> 1. Identify efficient pattern mining methods, such as Apriori; 2. Learn the concepts of collaborative filtering and content based filtering; 4. Learn the basic concepts of pattern discovery, such as frequent pattern, closed pattern, max-pattern, and association rules; 5. Learn multiple distance or similarity measures for cluster analysis, including Euclidean and Minkowski distances; 6. Learn the concepts of proximity measures for symmetric and asymmetric binary variables; distance measures between categorical attributes, ordinal attributes, and mixed types; proximity measures between two vectors cosine similarity; and correlation measures between two variables covariance and correlation coefficient.

Know How & Skill Range: *Demonstrate a range of standard and specialised research or equivalent tools and techniques of enquiry.*

Apply a range of research methods, techniques and software tools in the machine learning for business field.

The above Programme Outcome is achieved by the following Module Outcomes

Module Code	Module Outcomes
MATH09002	<ol style="list-style-type: none"> 3. Effectively analyse, visualise and interpret data to discover important insights.
DANL09011	<ol style="list-style-type: none"> 1. Identify efficient pattern mining methods, such as Apriori; 2. Learn the concepts of collaborative filtering and content based filtering; 3. Recall important pattern discovery concepts, methods, and applications; 4. Learn the basic concepts of pattern discovery, such as frequent pattern, closed pattern, max-pattern, and association rules; 5. Learn multiple distance or similarity measures for cluster analysis, including Euclidean and Minkowski distances; 6. Learn the concepts of proximity measures for symmetric and asymmetric binary variables; distance measures between categorical attributes, ordinal attributes, and mixed types; proximity measures between two vectors cosine similarity; and correlation measures between two variables covariance and correlation coefficient.
ANLY09021	<ol style="list-style-type: none"> 2. Develop solutions for extracting values from unstructured data 3. Implement solutions for transforming and loading data 5. Employ a variety of ETL techniques
DANL09010	<ol style="list-style-type: none"> 1. Clean and manipulate datasets in preparation for analysis 3. Evaluate algorithm performance using test data and performance metrics 4. Enhance model performance and/or avoid overfitting by tuning hyperparameters 5. Present and defend a solution to a given business problem using classical machine learning methodologies;
AI09003	<ol style="list-style-type: none"> 1. Demonstrate proficiency in implementing deep learning pipelines using state of the art frameworks.
COMP09011	<ol style="list-style-type: none"> 1. Apply knowledge, skills and competences acquired during the programme of study to the analysis and solution of a defined research area; 2. Utilise the knowledge and skills required to undertake a major research project based upon independent academic research; 4. Conduct research in a rigorous, methodologically sound and ethical manner; 5. Demonstrate the development and utilisation of critical thinking and analytical skills; 6. Produce a conclusive, coherent document supported by evidence and a convincing analysis of findings that contributes to the body of knowledge in a specialist area of Applied Machine Learning for Business.

Know How & Skill Selectivity: *Select from complex and advanced skills across a field of learning; develop new skills to a high level, including novel and emerging techniques.*

Select and apply the appropriate software tools for the specific context, underpinned by appropriate theories and practices relevant to the field of applied machine learning for business.

The above Programme Outcome is achieved by the following Module Outcomes

Module Code	Module Outcomes
MATH09002	1. Effectively use statistics and linear algebra to solve data problems in machine learning. 3. Effectively analyse, visualise and interpret data to discover important insights.
DANL09011	4. Learn the basic concepts of pattern discovery, such as frequent pattern, closed pattern, max-pattern, and association rules; 5. Learn multiple distance or similarity measures for cluster analysis, including Euclidean and Minkowski distances; 6. Learn the concepts of proximity measures for symmetric and asymmetric binary variables; distance measures between categorical attributes, ordinal attributes, and mixed types; proximity measures between two vectors cosine similarity; and correlation measures between two variables covariance and correlation coefficient.
ANLY09021	3. Implement solutions for transforming and loading data
DANL09010	1. Clean and manipulate datasets in preparation for analysis 2. Critically evaluate and select appropriate machine learning algorithms for different analytics objectives 3. Evaluate algorithm performance using test data and performance metrics 5. Present and defend a solution to a given business problem using classical machine learning methodologies;
AI09003	1. Demonstrate proficiency in implementing deep learning pipelines using state of the art frameworks. 2. Critically evaluate the effectiveness of design decisions made in solutions to deep learning problems.
COMP09011	2. Utilise the knowledge and skills required to undertake a major research project based upon independent academic research; 6. Produce a conclusive, coherent document supported by evidence and a convincing analysis of findings that contributes to the body of knowledge in a specialist area of Applied Machine Learning for Business.

Competence Context: *Act in a wide and often unpredictable variety of professional levels and ill-defined contexts.*

Develop a critical awareness of the professional, legal, social and ethical considerations when dealing with data and apply analytical skills, techniques and judgement appropriate to the context.

The above Programme Outcome is achieved by the following Module Outcomes

Module Code	Module Outcomes
AI09003	4. Critique case studies of applications of deep learning within a business, research or societal context.
ICT09010	1. Evaluate the key ethical issues raised by artificial intelligence. 2. Understand the current and likely future state of EU regulation for artificial intelligence. 3. Evaluate the societal challenges of artificial intelligence. 4. Consider future implications of AI on law, ethics and society
BUS09023	3. Demonstrate the competence to conduct research in a methodologically sound and ethical manner while giving due consideration to the social and legal aspects of the research;
COMP09011	4. Conduct research in a rigorous, methodologically sound and ethical manner; 5. Demonstrate the development and utilisation of critical thinking and analytical skills;

Competence Role: *Take significant responsibility for the work of individuals and groups; lead and initiate activity.*

Assess the ethical implications of proposed machine learning-based solutions to business problems.

Initiate, plan, lead and manage projects of significant complexity involving peers from a range of backgrounds while effectively communicating and defending findings and conclusions.

Participate in peer collaboration and evaluation.

The above Programme Outcome is achieved by the following Module Outcomes

Module Code	Module Outcomes
AI09003	3. Present and defend role in deep learning project to non-technical stakeholders.
ICT09010	1. Evaluate the key ethical issues raised by artificial intelligence. 4. Consider future implications of AI on law, ethics and society 5. Use and critically engage with academic sources related to ethics, social issues and regulation of artificial intelligence.
BUS09023	3. Demonstrate the competence to conduct research in a methodologically sound and ethical manner while giving due consideration to the social and legal aspects of the research; 4. Develop an appropriate research schedule outlining in detail the steps necessary to initiate, conduct and report on the research.
COMP09011	3. Display a capability for independent and self-directed learning, while critically evaluating the published research in the field of Applied Machine Learning for Business; 4. Conduct research in a rigorous, methodologically sound and ethical manner; 5. Demonstrate the development and utilisation of critical thinking and analytical skills; 6. Produce a conclusive, coherent document supported by evidence and a convincing analysis of findings that contributes to the body of knowledge in a specialist area of Applied Machine Learning for Business.
ANLY09021	1. Critically evaluate the role of data engineering in organisations

Competence Learning to Learn: *Learn to self-evaluate and take responsibility for continuing academic/professional development.*

Adopt a reflective approach to personal development and embrace the philosophy of continual professional progression and life-long learning in the discipline of applied machine learning for business.

The above Programme Outcome is achieved by the following Module Outcomes

Module Code	Module Outcomes
COMP09011	6. Produce a conclusive, coherent document supported by evidence and a convincing analysis of findings that contributes to the body of knowledge in a specialist area of Applied Machine Learning for Business.
AI09003	2. Critically evaluate the effectiveness of design decisions made in solutions to deep learning problems.
DANL09010	2. Critically evaluate and select appropriate machine learning algorithms for different analytics objectives

Competence Insight: *Scrutinise and reflect on social norms and relationships and act to change them.*

Critically reflect on, and develop an ability to convincingly articulate, the legal, ethical and social implications of the discipline of applied machine learning for business.

The above Programme Outcome is achieved by the following Module Outcomes

Module Code	Module Outcomes
ICT09010	1. Evaluate the key ethical issues raised by artificial intelligence. 2. Understand the current and likely future state of EU regulation for artificial intelligence. 3. Evaluate the societal challenges of artificial intelligence. 4. Consider future implications of AI on law, ethics and society
AI09003	4. Critique case studies of applications of deep learning within a business, research or societal context.
COMP09011	4. Conduct research in a rigorous, methodologically sound and ethical manner;

Approved Programme Schedule - AL_KAPML_9 Master of Science in Applied Machine Learning for Business

Stage 1

Delivery	Code	Module Title	Level	Credit	M/E	OL	OL IL	CA	PJ	PC	FE	PF	Total
SEM 1	MATH09002	Mathematics for Machine Learning	09	05	M	2.00	7.00	40	0	0	60	0	100
SEM 1	ANLY09022	Business Machine Learning Case Studies	09	05	M	2.00	7.00	100	0	0	0	0	100
SEM 1	DANL09011	Data Mining and Business Intelligence	09	10	M	0.00	0.00	50	0	0	50	0	100
SEM 2	ANLY09021	Data Engineering	09	10	M	4.00	14.00	100	0	0	0	0	100
SEM 2	DANL09010	Classical Machine Learning	09	10	M	4.00	14.00	50	50	0	0	0	100
Credit Total				40									

Semesters Per Stage	Elective Rules Per Stage	Credits Required	Award Percentage
2	0	0	0

Key
M/E - Mandatory/Elective, OL - Online, CA - Continuous Assessment, PJ - Project, PC - Practical, FE - Final Exam, PF - Pass/Fail,

Stage 2

Delivery	Code	Module Title	Level	Credit	M/E	OL	OL IL	CA	PJ	PC	FE	PF	Total
SEM 3	AI09003	Deep Learning	09	10	M	4.00	14.00	100	0	0	0	0	100
SEM 3	ICT09010	Legal, Social and Ethical Implications of AI	09	05	M	0.00	0.00	30	0	0	70	0	100
SEM 3	BUS09023	Research Methods	09	05	M	1.00	8.00	0	0	0	0	100	100
SEM 4	COMP09011	Applied Research Project	09	30	M	1.00	53.00	15	85	0	0	0	100
Credit Total				50									

Semesters Per Stage	Elective Rules Per Stage	Credits Required	Award Percentage
2	0	0	0

Key
M/E - Mandatory/Elective, OL - Online, CA - Continuous Assessment, PJ - Project, PC - Practical, FE - Final Exam, PF - Pass/Fail,

Programme Delivery Schedule

Stage 1 - Delivery Mode Online

Delivery	Code	Module Title	Level	Credit	M/E	Lecture	Practical	Independent Learning	Total
SEM 1	MATH09002	Mathematics for Machine Learning	09	05	M	2		7	2.00
SEM 1	ANLY09022	Business Machine Learning Case Studies	09	05	M	2		7	2.00
SEM 1	DANL09011	Data Mining and Business Intelligence	09	10	M				
SEM 2	ANLY09021	Data Engineering	09	10	M		4	14	4.00
SEM 2	DANL09010	Classical Machine Learning	09	10	M		4	14	4.00
Total						4.00	8.00	42.00	

Stage Average Weekly Hours	Semester 1 Average Weekly Hours	Semester 2 Average Weekly Hours
0	0	0

Stage 2 - Delivery Mode Online

Delivery	Code	Module Title	Level	Credit	M/E	Lecture	Tutorial	Practical	Independent Learning	Total
SEM 3	AI09003	Deep Learning	09	10	M	2		2	14	4.00
SEM 3	ICT09010	Legal, Social and Ethical Implications of AI	09	05	M					
SEM 3	BUS09023	Research Methods	09	05	M	1			8	1.00
SEM 4	COMP09011	Applied Research Project	09	30	M		1		53	1.00
Total						3.00	1.00	2.00	75.00	

Stage Average Weekly Hours	Semester 1 Average Weekly Hours	Semester 2 Average Weekly Hours
0	0	0

Programme Theme Mapping

Programme Theme	Stage 1 Modules	Stage 2 Modules
Building Business Value	MATH09002 Mathematics for Machine Learning (05 ECTS) ANLY09022 Business Machine Learning Case Studies (05 ECTS)	ICT09010 Legal, Social and Ethical Implications of AI (05 ECTS) BUS09023 Research Methods (05 ECTS) COMP09011 Applied Research Project (30 ECTS)
Developing and Maintaining Data Pipelines	DANL09011 Data Mining and Business Intelligence (10 ECTS) ANLY09021 Data Engineering (10 ECTS) DANL09010 Classical Machine Learning (10 ECTS)	AI09003 Deep Learning (10 ECTS) COMP09011 Applied Research Project (30 ECTS)
Machine Learning Solutions for Business	ANLY09022 Business Machine Learning Case Studies (05 ECTS) DANL09011 Data Mining and Business Intelligence (10 ECTS) ANLY09021 Data Engineering (10 ECTS) DANL09010 Classical Machine Learning (10 ECTS)	AI09003 Deep Learning (10 ECTS) BUS09023 Research Methods (05 ECTS) COMP09011 Applied Research Project (30 ECTS)

Programme Assessment Matrix

Stage 1 Semester 1

Code	Module Title	M/E	Type	Description	Module Outcomes Assessed	% of Total	Indicative Week
MATH09002	Mathematics For Machine Learning	M	CA	Assessments	1,2,3	40	Week 6
ANLY09022	Business Machine Learning Case Studies	M	CA	Report	1,2,3,4	30	Week 6
DANL09011	Data Mining And Business Intelligence	M	CA	Hands on Assignments on the taught topics		50	Week 7
DANL09011	Data Mining And Business Intelligence	M	FE	Final Project		50	Week 12
MATH09002	Mathematics For Machine Learning	M	FE	Final Exam	1,3,4	60	End of Semester
ANLY09022	Business Machine Learning Case Studies	M	CA	Project	3,4	40	OnGoing
ANLY09022	Business Machine Learning Case Studies	M	CA	Practical	4	30	OnGoing

Stage 1 Semester 2

Code	Module Title	M/E	Type	Description	Module Outcomes Assessed	% of Total	Indicative Week
ANLY09021	Data Engineering	M	CA	Research Software Solutions	2,3,4	50	Week 6
DANL09010	Classical Machine Learning	M	PJ	Project	1,2,3,4,5	50	Week 11
ANLY09021	Data Engineering	M	CA	Implement ETL process	1,2,3,4,5	50	Week 14
DANL09010	Classical Machine Learning	M	CA	Continuous Assessment	1,2,3	50	OnGoing

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Stage 2 Semester 1

Code	Module Title	M/E	Type	Description	Module Outcomes Assessed	% of Total	Indicative Week
ICT09010	Legal, Social And Ethical Implications Of Ai	M	CA	Literature Review Paper	5	30	Week 6
AI09003	Deep Learning	M	CA	Report on State of the Art	4	30	Week 7
AI09003	Deep Learning	M	CA	Implementing Deep Learning Pipeline	1,2,3	70	End of Semester
ICT09010	Legal, Social And Ethical Implications Of Ai	M	FE	Final Exam	1,2,3,4,5	70	End of Semester
BUS09023	Research Methods	M	PF	Thesis proposal	1,2,3,4	100	End of Semester

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Stage 2 Semester 2

Code	Module Title	M/E	Type	Description	Module Outcomes Assessed	% of Total	Indicative Week
COMP09011	Applied Research Project	M	CA	Progress Review Report	2,3	15	Week 6
COMP09011	Applied Research Project	M	PJ	Thesis	1,2,3,4,5,6	85	End of Semester

Approved Modules

Stage	Approved Modules	New Modules
1		MATH09002 Mathematics for Machine Learning ANLY09022 Business Machine Learning Case Studies DANL09011 Data Mining and Business Intelligence ANLY09021 Data Engineering DANL09010 Classical Machine Learning
2		AI09003 Deep Learning ICT09010 Legal, Social and Ethical Implications of AI BUS09023 Research Methods COMP09011 Applied Research Project

Programme Development Team

Programme Name	Master of Science in Applied Machine Learning for Business
Date Created	23-03-2023
Programme Module Authors	Tao Cui
Date School Approved	
Programme Approver	
Date Academic Council Approved	

Programme Module Authors

Stage 1

Delivery	Code	Name	Author/Co-Author
SEM 1	MATH09002	Mathematics for Machine Learning	Barry O'Loughlin, Patricia Gunning
SEM 1	ANLY09022	Business Machine Learning Case Studies	Patricia Gunning, Jonny O'Dwyer, Pearce Harney-Nolan
SEM 1	DANL09011	Data Mining and Business Intelligence	Jonny O'Dwyer, Barry O'Loughlin
SEM 2	ANLY09021	Data Engineering	Brenda Reilly
SEM 2	DANL09010	Classical Machine Learning	Noel Tierney, Patricia Gunning, Dr Trevor Prendergast, Paul Liston

Stage 2

Delivery	Code	Name	Author/Co-Author
SEM 3	AI09003	Deep Learning	Jonny O'Dwyer, Barry O'Loughlin
SEM 3	ICT09010	Legal, Social and Ethical Implications of AI	Jonny O'Dwyer, Barry O'Loughlin
SEM 3	BUS09023	Research Methods	Jonny O'Dwyer
SEM 4	COMP09011	Applied Research Project	Barry O'Loughlin, Brenda Reilly, Patricia Gunning, Paul Liston, Tao Cui, Jonny O'Dwyer

Sponsoring Company/Organisation (for Special Purpose Awards Only)



Stage 1 Modules



MATH09002 202400
Mathematics for Machine Learning

Mandatory Delivered in Stage 1 Semester 1

Full Title	Mathematics for Machine Learning		
Status	Draft	Start Term	202400
NFQ Level	09	ECTS Credits	05
Attendance	N/A %	Contains Must Pass Element	No
Module Code	MATH09002	Duration	Semester - (15 Weeks)
Grading Mode	Numeric/Percentage	Department	Accounting & Business Computing
Module Author	Patricia Gunning		
Co Authors	Barry O'Loughlin		

Module Description

The aim of this module is to introduce students to the mathematical topics relevant to machine learning covering Statistics, Probability and Linear Algebra

Learning Outcomes *On completion of this module the learner will/should be able to;*

1. Effectively use statistics and linear algebra to solve data problems in machine learning.
2. Develop a critical awareness of the importance of mathematics for machine learning.
3. Effectively analyse, visualise and interpret data to discover important insights.
4. Evaluate machine learning algorithms using various metrics.

Indicative Syllabus
<p>Statistics and Probability</p> <p>Collection, preprocessing and manipulation of data</p> <p>Descriptive statistics</p> <p>Hypothesis testing</p> <p>Probability distributions</p> <p>Sampling</p> <p>Linear Algebra</p> <p>Vectors and matrix properties</p> <p>Matrix transpose and inverse</p> <p>Determinants</p> <p>Dot product</p> <p>Eigenvalues and eigenvectors</p> <p>Matrix factorisation</p> <p>Principal component analysis</p> <p>Orthogonality</p>

Teaching and Learning Strategy
<p>This module will be taught online and will provide students with an insight into mathematics for machine learning. Students will gain an understanding of different problem-solving methods for both theoretical and practical situations using appropriate software.</p>

Assessment Strategy
<p>This module will be assessed by in-class assessments worth 40% and a final two-hour exam worth 60% at the end of the semester.</p>

Repeat Assessment Strategies
<p>Where a student fails the module, a repeat exam opportunity will be provided in the Autumn sitting, in accordance with the Repeat Assessment Policy of the Faculty of Business and Hospitality. Where required, a student will repeat the project, the final exam or both. Where necessitated, the repeat assessment may be provided in an alternative assessment format.</p> <p>Further details can be found on TUS Academic Regulations for Taught Programmes.</p>

Coursework & Continuous Assessment:		40 %			
Form	Title	Percent	Must Pass	Week (Indicative)	Learning Outcomes
Assessment	Assessments	40 %	No	Week 6	1,2,3

End of Semester / Year Formal Exam:		60 %			
Form	Title	Percent	Week (Indicative)	Learning Outcomes	

Closed Book Exam	Final Exam	60 %	End of Semester	1,3,4
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Online Average Weekly Workload:			2.00 Hours		
Type	Description	Location	Hours	Frequency	Weekly Avg
Lecture	Lecture	Not Specified	2	Weekly	2.00
Independent Learning	Independent Learning	Not Specified	7	Weekly	7.00

Required Reading Book List
Kroese, P., (2019). <i>Data Science and Machine Learning: Mathematical and Statistical Methods (Chapman & Hall/CRC Machine Learning & Pattern Recognition)</i> . 1st Edition. Chapman and Hall/CRC.
Aggarwal, C., (2020). <i>Linear Algebra and Optimization for Machine Learning: A Textbook</i> . 1st Edition. Springer.
Deisenroth, M., (2020). <i>Mathematics for Machine Learning</i> . 1st Edition. Cambridge University Press.

Online Resources

Programme Membership
AL_KAPML_9 202400 Master of Science in Applied Machine Learning for Business



ANLY09022 202300
Business Machine Learning Case Studies

Mandatory Delivered in Stage 1 Semester 1

Full Title	Business Machine Learning Case Studies		
Status	Draft	Start Term	202300
NFQ Level	09	ECTS Credits	05
Attendance	N/A %	Contains Must Pass Element	No
Module Code	ANLY09022	Duration	Semester - (15 Weeks)
Grading Mode	Numeric/Percentage	Department	Accounting & Business Computing
Module Author	Jonny O'Dwyer		
Co Authors	Patricia Gunning, Pearce Harney-Nolan		

Module Description

The purpose of this module is to expand the student's understanding of techniques employed in machine learning by exposing them to real-world case studies. These case studies may be of approaches that organisations have taken to implement solutions to real problems in the field or based on scenarios which have no prior solutions to allow the students to create their own approach and compare it with other students. One of the main goals of this module will be to expose students to the varied uses of machine learning in different industries.

	Learning Outcomes <i>On completion of this module the learner will/should be able to;</i>
1.	Describe and discuss with authority applications of machine learning within an organisation;
2.	Analyse case studies of applications of machine learning and how they are implemented in the workplace;
3.	Identify issues in a range of disciplines that can be addressed by the application of machine learning
4.	Evaluate the different contributions of people, organisational systems and technologies in organisations. Analyse and evaluate the ways in which machine learning professionals contribute to an organisation.

Indicative Syllabus
<p>The following is indicative of the syllabus that would be covered in this module:</p> <p>Case study techniques:</p> <ul style="list-style-type: none"> • Types of Case Studies • Collecting Data for Case Studies • Designing and Conducting Case Studies • Analysing Case Study Evidence • Reporting Case Studies <p>Innovation in organisations</p> <p>Varied case study content that may include the following industries or topics:</p> <ul style="list-style-type: none"> • Telecommunications • Pharmaceuticals • Finance • Insurance • Customer relationship management • Marketing • Digital media • Open source software • Ethical issues • Geographical Information Systems <p>Manipulation and analysis of data from diverse global cultures.</p> <p>Ethical and General Data Protection Regulation (GDPR) issues. Internationally sensitive data.</p>

Teaching and Learning Strategy
<p>This module will employ teaching methods and learning situations in the traditional roles such as lectures, seminars and tutorials, as well as more innovative, student-based learning methods such as problem solving in groups for both theoretical and practical situations. Students will be encouraged to be pro-active in their approach to learning through the use of case studies and simulation exercises, working independently and in groups. In some cases students will be expected to use computer-based learning material to supplement studies. In-class discussions, review of leading research papers in each topic covered will also contribute towards the practical content. The most appropriate distribution methods will be used to distribute materials to students, between students and from students, e.g. a VLE, forum. Students will be expected to develop independence in, and responsibility for their own learning.</p>

Assessment Strategy
<p>This module is designed to allow the students to create and develop their own approach to solving solutions to real world problems. The module is 100% continuously assessed. Students will have a number of deliverables throughout. They will critique a number of case studies and produce a report. They will have a project where they will develop a solution to a real world problem, and they will complete practical work on an ongoing basis. The coursework is designed to ensure the student addresses the following graduate competences: Self-management, thinking and solving problems, using numbers effectively, using language effectively, using IT effectively and communication.</p>

Repeat Assessment Strategies
<p>Where a student fails the module, a repeat exam opportunity will be provided in the Autumn sitting, in accordance with the Repeat Assessment Policy of the Faculty of Business and Hospitality. Assessment for the repeat opportunity will be determined by the internal examiner and will be an examination or other assessment deemed by the internal examiner to be equivalent to the original failed assessment in terms of demonstrating the student's ability to meet the required learning outcomes. Where necessitated, the repeat assessment may be provided in an alternative assessment format.</p> <p>For further details please refer to TUS Academic Regulations for Taught Programmes.</p>

Coursework & Continuous Assessment:	100 %
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Form	Title	Percent	Must Pass	Week (Indicative)	Learning Outcomes
Written Report	Report	30 %	No	Week 6	1,2,3,4
Individual Project	Project	40 %	No	OnGoing	3,4
Practical Evaluation	Practical	30 %	No	OnGoing	4

Online Average Weekly Workload:			2.00 Hours		
Type	Description	Location	Hours	Frequency	Weekly Avg
Lecture	Lecture	Not Specified	2	Weekly	2.00
Independent Learning	Independent Learning	Not Specified	7	Weekly	7.00

Recommended Reading Book List

Yin, K., (2017). *Case Study Research and Applications*. SAGE Publications, Incorporated.
ISBN 1506336167 ISBN-13 9781506336169

Fvero, L., Belliore, P., (2019). *Data Science for Business and Decision Making*. Academic Press.
ISBN 9780128112175 ISBN-13 0128112174

Dykes, B., (2019). *Effective Data Storytelling*. John Wiley & Sons.
ISBN 9781119615712 ISBN-13 1119615712

Journal Resources

Journal of Sports Analytics (<https://journalofsportsanalytics.com/>)

Big Data Research (<https://www.sciencedirect.com/journal/big-data-research>)

International Journal of Data Science and Analytics (<https://link.springer.com/journal/41060/volumes-and-issues>)

Online Resources

Case Studies - Big Data and Analytics - IBM

https://www.youtube.com/playlist?list=PL7FnN5oi7Ez8ldFg0FYaHWnm_CTa2e0JT

IEEE Big Data

<http://bigdata.ieee.org/>

Data Analytics Case Studies

<https://www.projectpro.io/article/data-science-case-studies-projects-with-examples-and-solutions/519>

Programme Membership

AL_KAPML_9 202400 Master of Science in Applied Machine Learning for Business



DANL09011 202400
Data Mining and Business Intelligence

Mandatory Delivered in Stage 1 Semester 1

Full Title	Data Mining and Business Intelligence		
Status	Draft	Start Term	202400
NFQ Level	09	ECTS Credits	10
Attendance	N/A %	Contains Must Pass Element	No
Module Code	DANL09011	Duration	Semester - (15 Weeks)
Grading Mode	Numeric/Percentage	Department	Accounting & Business Computing
Module Author	Barry O'Loughlin		
Co Authors	Jonny O'Dwyer		

Module Description

This module introduces data mining and business intelligence concepts. Data warehousing, OLAP technology, data preparation, association rule mining, classification and prediction, clustering, mining complex types of data, web mining, multi-relational data mining are the basic concepts covered in this course

Learning Outcomes <i>On completion of this module the learner will/should be able to;</i>	
1.	Identify efficient pattern mining methods, such as Apriori;
2.	Learn the concepts of collaborative filtering and content based filtering;
3.	Recall important pattern discovery concepts, methods, and applications;
4.	Learn the basic concepts of pattern discovery, such as frequent pattern, closed pattern, max-pattern, and association rules;
5.	Learn multiple distance or similarity measures for cluster analysis, including Euclidean and Minkowski distances;
6.	Learn the concepts of proximity measures for symmetric and asymmetric binary variables; distance measures between categorical attributes, ordinal attributes, and mixed types; proximity measures between two vectors – cosine similarity; and correlation measures between two variables – covariance and correlation coefficient.

Indicative Syllabus

1. Introduction, Association Rule Mining
2. Association Rule Mining, Classification Techniques
3. Classification and Clustering Techniques
4. Clustering Techniques, Time Series Analysis
5. Data Preprocessing, Data Warehousing, OLAP
6. Web Mining
7. Web Mining, Recommender Systems
8. Recommender Systems, Mining on Social Networks, Social Media
9. Mining on Social Networks, Social Media
10. Collaborative filtering vs content based filtering
11. Distance Functions, outlier detection

Teaching and Learning Strategy

Assessment Strategy

Repeat Assessment Strategies

Coursework & Continuous Assessment:		50 %			
Form	Title	Percent	Must Pass	Week (Indicative)	Learning Outcomes
Assignment	Hands on Assignments on the taught topics	50 %	No	Week 7	

End of Semester / Year Formal Exam:		50 %		
Form	Title	Percent	Week (Indicative)	Learning Outcomes
Closed Book Exam	Final Project	50 %	Week 12	

Required Reading Book List

Han, J., (2001). *Data Mining*. Morgan Kaufmann.
ISBN 1558604898 ISBN-13 9781558604896

Recommended Reading Book List

Dunham, H., (2003). *Data Mining Introductory and Advanced Topics*. Prentice Hall.
ISBN 0130888923 ISBN-13 9780130888921

Witten, H., Frank, E., Hall, A., (2011). *Data Mining: Practical Machine Learning Tools and Techniques*. Morgan Kaufmann.
ISBN 0123748569 ISBN-13 9780123748560

Tan, P., Steinbach, M., Kumar, V., (2006). *Introduction to Data Mining*. Addison-Wesley.
ISBN 0321321367 ISBN-13 9780321321367

Programme Membership

AL_KAPML_9 202400 Master of Science in Applied Machine Learning for Business



ANLY09021 202400
Data Engineering

Mandatory Delivered in Stage 1 Semester 2

Full Title	Data Engineering		
Status	Draft	Start Term	202400
NFQ Level	09	ECTS Credits	10
Attendance	N/A %	Contains Must Pass Element	No
Module Code	ANLY09021	Duration	Semester - (15 Weeks)
Grading Mode	Numeric/Percentage	Department	Accounting & Business Computing
Module Author	Brenda Reilly		

Module Description

Much of the data produced today is unstructured, such as social media posts, text documents, images and video. Extracting values from unstructured data requires additional tools and techniques, compared with those required to analyse structured datasets.

This module explores the theory and practice of managing data, including identifying and extracting data, data pre-processing, and loading data for analysis. A variety of analytics tools and techniques needed to gain value from unstructured data will be employed, with a particular focus on the practical analysis of textual data.

☰ Learning Outcomes <i>On completion of this module the learner will/should be able to:</i>	
1.	Critically evaluate the role of data engineering in organisations
2.	Develop solutions for extracting values from unstructured data
3.	Implement solutions for transforming and loading data
4.	Evaluate the usefulness of a range of data sources and types in business
5.	Employ a variety of ETL techniques

Indicative Syllabus
<p>Data pipeline</p> <ul style="list-style-type: none"> • Creating pipelines for extracting, loading, and transforming data • Raw data (maybe missing data, or typos in data, etc...) • Clean data as it flows through pipeline • Store in final destination (eg. data warehouse) <p>ETL Cycle</p> <p>Extract:</p> <ul style="list-style-type: none"> • Extracting data from multiple sources of file formats • Extract information from raw data <p>Transform</p> <p>Transforming data into particular data types</p> <ul style="list-style-type: none"> • Data modelling and structures • What knowledge / insight should be extracted from the data • Convert data into appropriate types required for analysis • Impact on design of data model <p>Load</p> <ul style="list-style-type: none"> • Loading data into a single source for analysis • Data warehouse schema • Basics of data warehouse design • Infrastructure • Managing servers <p>Install / configuring software</p> <p>Cloud platform servers - storage solutions</p>

Teaching and Learning Strategy
<p>The module will be delivered online using a virtual classroom and a virtual learning environment (VLE).</p> <p>Asynchronous lectures with independent learning tasks (including study notes and worksheets) will be made available weekly for students to engage with according to their own schedule. An online discussion forum will be made available on the VLE to support any problems/questions that may arise.</p> <p>Formative exercises will be provided regularly with submission of attempts on the VLE.</p> <p>Weekly synchronous tutorials will be delivered online with class engagement activities and exercise solution sessions.</p> <p>Summative assessment will include a research project involving open source applications for data analytics and communication of findings, and a programming project involving researching and exhibiting programming libraries for data analytics, and suggesting alternatives to these libraries.</p>

Assessment Strategy
<p>The module learning outcomes will be assessed through a combination of formative and summative assessment. Formative assessment will take the form of participation and correction of exercises as well as question answer sessions with feedback. Summative assessment will be a combination of research assignments, and in class exams.</p> <p>The module learning outcomes will be assessed through a combination of formative and summative assessment. Formative assessment will take the form of in-class participation and correction of exercises as well as online MCQs with feedback. Summative assessment will be a combination of research and programming assignments.</p>

Repeat Assessment Strategies
<p>Where a student fails the module, assessment for the repeat opportunity will be determined by the internal examiner and will be equivalent to the original failed assessment in terms of demonstrating the student's ability to meet the required learning outcomes. Where necessitated, the repeat assessment may be provided in an alternative assessment format.</p>

Coursework & Continuous Assessment:		100 %			
Form	Title	Percent	Must Pass	Week (Indicative)	Learning Outcomes
Individual Project	Research Software Solutions	50 %	No	Week 6	2,3,4
Individual Project	Implement ETL process	50 %	No	Week 14	1,2,3,4,5

Online Average Weekly Workload:			4.00 Hours		
Type	Description	Location	Hours	Frequency	Weekly Avg
Practical	Practical	Not Specified	4	Weekly	4.00
Independent Learning	Independent Learning	Not Specified	14	Weekly	14.00

Required Reading Book List
<p>Crickard, P., (2020). <i>DATA ENGINEERING WITH PYTHON</i>. ISBN 183921418X ISBN-13 9781839214189</p>
<p>Densmore, J., (2021). <i>Data Pipelines Pocket Reference</i>. O'Reilly Media. ISBN 1492087831 ISBN-13 9781492087830</p>
<p>Kazil, J., Jarmul, K., (2015). <i>Data Wrangling Using Python</i>. O'Reilly Media. ISBN 1491948817 ISBN-13 9781491948811</p>
<p>Dempsey, R., (2015). <i>Python Business Intelligence Cookbook</i>. ISBN 178528746X ISBN-13 9781785287466</p>

Recommended Reading Book List
<p>Psaltis, A., (2017). <i>Streaming Data</i>. Manning. ISBN 1617292281 ISBN-13 9781617292286</p>

Online Resources

<https://www.python.org>
<https://www.anaconda.com>
<https://cloud.google.com>
<https://www.learn.microsoft.com>

Programme Membership

AL_KAPML_9 202400 Master of Science in Applied Machine Learning for Business



DANL09010 202400
Classical Machine Learning

Mandatory Delivered in Stage 1 Semester 2

Full Title	Classical Machine Learning		
Status	Draft	Start Term	202400
NFQ Level	09	ECTS Credits	10
Attendance	N/A %	Contains Must Pass Element	No
Module Code	DANL09010	Duration	Semester - (15 Weeks)
Grading Mode	Numeric/Percentage	Department	Accounting & Business Computing
Module Author	Paul Liston		
Co Authors	Noel Tierney, Patricia Gunning, Dr Trevor Prendergast		

Module Description

This module will introduce students to the classical machine learning algorithms that are used for classification, regression and pattern detection. Students will learn about the core data handling skills necessary to complete the different phases of machine learning implementation. Firstly, students will develop knowledge and skills related to data pre-processing and manipulation, Secondly, students will learn about different machine learning algorithms and the scenarios in which each is appropriate to use. Students will develop the skills to build models and assess their predictive performance. Finally, students will interpret and communicate the results achieved. A goal of this module is to expand the student's knowledge of classical predictive techniques employed in business contexts by exposing them to case studies of approaches that organisations have taken to implement solutions to problems in the field.

	Learning Outcomes <i>On completion of this module the learner will/should be able to;</i>
1.	Clean and manipulate datasets in preparation for analysis
2.	Critically evaluate and select appropriate machine learning algorithms for different analytics objectives
3.	Evaluate algorithm performance using test data and performance metrics
4.	Enhance model performance and/or avoid overfitting by tuning hyperparameters
5.	Present and defend a solution to a given business problem using classical machine learning methodologies;

Indicative Syllabus
<p>The following is indicative of the syllabus that would be covered in this module:</p> <ul style="list-style-type: none"> • Data preparation & analysis <ul style="list-style-type: none"> ◦ Exploratory data analysis ◦ Data modelling <ul style="list-style-type: none"> ▪ Parameter tuning ▪ Overfitting ▪ Cross validation ◦ Evaluating predictive performance <ul style="list-style-type: none"> ▪ Confusion matrices ▪ Specificity, sensitivity, etc. ▪ MAE, MAPE, MSE, RMSE • Predictive modelling techniques <ul style="list-style-type: none"> ◦ Regression techniques <ul style="list-style-type: none"> ▪ Linear regression ▪ Ridge regression ▪ LASSO • Classification techniques <ul style="list-style-type: none"> ◦ Nearest neighbours ◦ Decision trees ◦ Logistic regression ◦ Naive Bayes • Pattern discovery <ul style="list-style-type: none"> ◦ Clustering

Teaching and Learning Strategy
<p>This module will employ teaching methods and learning situations in the traditional roles such as lectures, seminars and tutorials, as well as more innovative, student-based learning methods such as problem-solving in groups for both theoretical and practical situations. Students will be encouraged to be proactive in their approach to learning through the use of case studies and simulation exercises, working independently and in groups. In some cases students will be expected to use computer-based learning material to supplement studies. The practical element of the module will be supported through the medium of supervised and independent practical sessions. Students will be able to explore the characteristics, advantages and limitations of approaches learnt through their application to suitable case studies and simulation exercises. In-class discussions, review of leading research papers in each topic covered will also contribute towards the practical content. Guest lecturers from industry and academia will be invited to expose students to how topics covered in this module are used within organisations. This will be the case studies aspect of the module. The most appropriate distribution methods will be used to distribute materials to students, between students and from students, e.g. a VLE, blogs, a forum. Students will be expected to develop independence in, and responsibility for their own learning.</p>

Assessment Strategy
<p>This module is assessed entirely through continuous assessment using a range of assessment formats.</p> <p>Practical computer based assessments will be used to assess critical evaluation, assessment, selection and use of analytics tools.</p> <p>Project work, with a written report and video, will be used to assess a student's ability to critically analyse and communicate applications of data analytics to business problems.</p> <p>In keeping with best research practises, project documentation will be expected to meet academic writing standards and include formal referencing.</p>

Repeat Assessment Strategies
<p>Where a student fails the module, a repeat exam opportunity will be provided in the Autumn sitting, in accordance with the Repeat Assessment Policy of the Faculty of Business and Hospitality. Assessment for the repeat opportunity will be determined by the internal examiner and will be an examination or other assessment deemed by the internal examiner to be equivalent to the original failed assessment in terms of demonstrating the student's ability to meet the required learning outcomes. Where necessitated, the repeat assessment may be provided in an alternative assessment format.</p> <p>For further details please refer to TUS Academic Regulations for Taught Programmes.</p>

Coursework & Continuous Assessment:		100 %			
Form	Title	Percent	Must Pass	Week (Indicative)	Learning Outcomes
Assessment	Continuous Assessment	50 %	No	OnGoing	1,2,3
Project	Project	50 %	No	Week 11	1,2,3,4,5

Online Average Weekly Workload:			4.00 Hours		
Type	Description	Location	Hours	Frequency	Weekly Avg
Practical	Practical	Not Specified	4	Weekly	4.00
Independent Learning	Independent Learning	Not Specified	14	Weekly	14.00

Required Reading Book List
<p>Lantz, B., (2019). <i>Machine Learning with R - Third Edition</i>. Packt Publishing. ISBN 1788295862 ISBN-13 9781788295864</p>

Recommended Reading Book List
<p>Boehmke, B., Greenwell, M., (2019). <i>Hands-On Machine Learning with R</i>. CRC Press. ISBN 1138495689 ISBN-13 9781138495685</p>
<p>Nwanganga, F., Chapple, M., (2020). <i>Practical Machine Learning in R</i>. John Wiley & Sons. ISBN 9781119591511 ISBN-13 1119591511</p>

Journal Resources
<p>International Journal of Data Science and Analytics (https://link.springer.com/journal/41060/volumes-and-issues)</p> <p>European Journal of Operational Research (https://www.journals.elsevier.com/european-journal-of-operational-research)</p> <p>Computational Statistics & Data Analysis (https://www.journals.elsevier.com/computational-statistics-and-data-analysis)</p>

Online Resources
<p>http://www.kdnuggets.com/</p> <p>http://www.oracle.com/technetwork/database/options/advanced-analytics/odm/index.html</p> <p>http://bigdata.ieee.org/</p>

Programme Membership

AL_KAPML_9 202400 Master of Science in Applied Machine Learning for Business



Stage 2 Modules



AI09003 202300
Deep Learning

Mandatory Delivered in Stage 2 Semester 3

Full Title	Deep Learning		
Status	Pending Approval by Faculty	Start Term	202300
NFQ Level	09	ECTS Credits	10
Attendance	N/A %	Contains Must Pass Element	No
Module Code	AI09003	Duration	Semester - (15 Weeks)
Grading Mode	Numeric/Percentage	Department	Accounting & Business Computing
Module Author	Barry O'Loughlin		
Co Authors	Jonny O'Dwyer		

Additional Authors for this Module

David Leonard

Module Description

This module will build on the foundations laid by the Classical Machine Learning module (Semester 1) and give students a broad overview of the key conceptual ideas and practical skills (Python) necessary to work effectively with deep learning technologies.

☰	Learning Outcomes <i>On completion of this module the learner will/should be able to;</i>
1.	<i>Demonstrate proficiency in implementing deep learning pipelines using state of the art frameworks.</i>
2.	<i>Critically evaluate the effectiveness of design decisions made in solutions to deep learning problems.</i>
3.	<i>Present and defend role in deep learning project to non-technical stakeholders.</i>
4.	<i>Critique case studies of applications of deep learning within a business, research or societal context.</i>

Indicative Syllabus

Fundamental ideas underlying neural networks and deep learning.

Practical implementation of deep learning pipelines: regularisation, hyperparameter tuning and software frameworks (e.g. Tensorflow).

Convolutional Neural Networks, theory and applications (object classification, object detection, face verification).

Recurrent Neural Networks, theory and applications (natural language processing, speech recognition) and related methods (LLM).

Selected advanced topics e.g. Generative Adversarial Networks and Deep Reinforcement Learning.

Teaching and Learning Strategy

This module will employ teaching methods using lectures, lab sessions and tutorials, as well as student-based learning methods such as problem-solving in group sessions. Students will be encouraged to be proactive in their approach to learning through the use of lab exercises, working independently and in groups. The practical element of the module will be supported through the medium of supervised and independent practical sessions. The most appropriate distribution methods will be used to publish materials to students, between students and from students, e.g. a VLE, Moodle, a forum. Students will be expected to develop independence in, and responsibility for their own learning.

Assessment Strategy

This module is assessed entirely through continuous assessment using a balance of assessment formats.

A software based project with a final presentation will be used to assess the student's 1.) technical skills 2.) understanding of implementation and 3.) ability to communicate key outcomes to non-technical stakeholders.

A written report will assess the student's critical understanding of the role of this disruptive technology within a wider context.

In keeping with best practices in industry and academia, project documentation will be expected to meet standards of code annotation and referencing.

Repeat Assessment Strategies

Where a student fails the module, a repeat exam opportunity will be provided in accordance with the Repeat Assessment Policy of the institution. Assessment for the repeat opportunity will be determined by the internal examiner and will be an examination or other assessment deemed by the internal examiner to be equivalent to the original failed assessment in terms of demonstrating the student's ability to meet the required learning outcomes. Where necessitated, the repeat assessment may be provided in an alternative assessment format.

Coursework & Continuous Assessment:		100 %			
Form	Title	Percent	Must Pass	Week (Indicative)	Learning Outcomes
Written Report	Report on State of the Art	30 %	No	Week 7	4
Assignment	Implementing Deep Learning Pipeline	70 %	No	End of Semester	1,2,3

Online Average Weekly Workload:			4.00 Hours		
Type	Description	Location	Hours	Frequency	Weekly Avg
Practical	Practical	Not Specified	2	Weekly	2.00
Lecture	Lecture	Not Specified	2	Weekly	2.00
Independent Learning	Independent Learning	Not Specified	14	Weekly	14.00

Required Reading Book List

Gron, A., (2019). *Hands-on Machine Learning with Scikit-Learn, Keras, and TensorFlow*. O'Reilly. ISBN 1492032646 ISBN-13 9781492032649

Recommended Reading Book List

Goodfellow, I., Bengio, Y., Courville, A., (2016). *Deep Learning*. MIT Press. ISBN 9780262035613 ISBN-13 0262035618

Programme Membership

AL_KAPML_9 202400 Master of Science in Applied Machine Learning for Business




ICT09010 202400
Legal, Social and Ethical Implications of AI

Mandatory Delivered in Stage 2 Semester 3

Full Title	Legal, Social and Ethical Implications of AI		
Status	Draft	Start Term	202400
NFQ Level	09	ECTS Credits	05
Attendance	N/A %	Contains Must Pass Element	No
Module Code	ICT09010	Duration	Semester - (15 Weeks)
Grading Mode	Numeric/Percentage	Department	Accounting & Business Computing
Module Author	Barry O'Loughlin		
Co Authors	Jonny O'Dwyer		

Module Description

This module will provide students with an insight into the legal, ethical and social implications of Artificial Intelligence.

	Learning Outcomes <i>On completion of this module the learner will/should be able to;</i>
1.	Evaluate the key ethical issues raised by artificial intelligence.
2.	Understand the current and likely future state of EU regulation for artificial intelligence.
3.	Evaluate the societal challenges of artificial intelligence.
4.	Consider future implications of AI on law, ethics and society
5.	Use and critically engage with academic sources related to ethics, social issues and regulation of artificial intelligence.

Indicative Syllabus
<p>Legal</p> <ul style="list-style-type: none"> • Current EU regulation pertaining to AI • Data Privacy & Protection • Contracts • Torts <p>Ethical</p> <ul style="list-style-type: none"> • Bias/Discrimination • Privacy/Surveillance • Algorithm transparency and fairness. <p>Social</p> <ul style="list-style-type: none"> • Unemployment and social consequences • Inequality of wealth (social divide) • Unintended consequences <p>Future implications of AI on law, ethics and society</p>

Teaching and Learning Strategy
<p>Electronic lecture notes, relevant articles and case studies will be provided in advance of class via the university's VLE. Classes will be delivered online and will use breakout rooms where suitable. Videos and links to relevant websites and journals will supplement student learning. A flipped classroom approach online will be adopted whereby students engage with the material in advance of lectures and discussion takes place during the lecture.</p> <p>Students will be directed to read relevant books and journals to support lecture material.</p>

Assessment Strategy
<p>The module will be assessed by a 30% CA component and a 70% final exam. The CA element will require students to submit a literature paper on a suitable topic on the subject area that they will be provided with by the lecturer. This paper will be submitted in week 6 and presented to the class in the following weeks.</p> <p>The final exam will be a 2 hour exam with the requirement to answer 3 out of 5 questions.</p>

Repeat Assessment Strategies
<p>Where a student fails the module, a repeat exam opportunity will be provided in the Autumn sitting, in accordance with the Repeat Assessment Policy of the Faculty of Business and Hospitality. Assessment for the repeat opportunity will be determined by the internal examiner and will be an examination or other assessment deemed by the internal examiner to be equivalent to the original failed assessment in terms of demonstrating the student's ability to meet the required learning outcomes. Where necessitated, the repeat assessment may be provided in an alternative assessment format.</p> <p>For further details please refer to TUS Academic Regulations for Taught Programmes</p>

Coursework & Continuous Assessment:		30 %			
Form	Title	Percent	Must Pass	Week (Indicative)	Learning Outcomes
Assignment	Literature Review Paper	30 %	No	Week 6	5

End of Semester / Year Formal Exam:		70 %		
Form	Title	Percent	Week (Indicative)	Learning Outcomes

Closed Book Exam	Final Exam	70 %	End of Semester	1,2,3,4,5
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Blended Average Weekly Workload:			2.00 Hours		
Type	Description	Location	Hours	Frequency	Weekly Avg
Lecture	Lecture	Not Specified	2	Weekly	2.00
Independent Learning	Independent Learning	Not Specified	7	Weekly	7.00

Required Reading Book List
Mantelero, A., (2022). <i>Beyond Data</i> . T.M.C. Asser Press. ISBN 9462655308 ISBN-13 9789462655300
Neuwirth, J., (2022). <i>The Eu Artificial Intelligence ACT</i> . Routledge. ISBN 1032333758 ISBN-13 9781032333755
Boddington, P., (2017). <i>Towards a Code of Ethics for Artificial Intelligence</i> . Springer. ISBN 9783319606484 ISBN-13 3319606484

Journal Resources
Journal of Machine Learning Research (jmlr.org)
Journal of Artificial Intelligence Research (jair.org)
AI An Open Access Journal from MDPI

Programme Membership
AL_KAPML_9 202400 Master of Science in Applied Machine Learning for Business



BUS09023 202300
Research Methods

Mandatory Delivered in Stage 2 Semester 3

Full Title	Research Methods		
Status	Pending Approval by Faculty	Start Term	202300
NFQ Level	09	ECTS Credits	05
Attendance	N/A %	Contains Must Pass Element	No
Module Code	BUS09023	Duration	Semester - (15 Weeks)
Grading Mode	Numeric/Percentage	Department	Accounting & Business Computing
Module Author	Jonny O'Dwyer		

Module Description

This module aims to introduce students to the key concepts involved in research and to develop their understanding of the uses and relevance of the major methodologies employed. The material covered in this module will form the basis for the research dissertation element of the MSc programme, with one of the key outcomes of this module being a valid and robust proposal for an applied research project.

☰ Learning Outcomes <i>On completion of this module the learner will/should be able to;</i>	
1.	Demonstrate a knowledge and critical understanding of research methodologies and techniques, as appropriate to the development of a thesis;
2.	Create a research proposal that will meet the criteria established for the Applied Research Project element of this programme;
3.	Demonstrate the competence to conduct research in a methodologically sound and ethical manner while giving due consideration to the social and legal aspects of the research;
4.	Develop an appropriate research schedule outlining in detail the steps necessary to initiate, conduct and report on the research.

<p>Indicative Syllabus</p> <p>1. Role of Research</p> <p>Introduction to research, nature and purpose of research; nature of business research; hallmarks of scientific research; basic (fundamental) and applied research; descriptive, explorative and explanatory studies; overview of the research process; choosing a research topic; values of the researcher.</p> <p>2. Formulating and Clarifying the Research Topic</p> <p>The research topic; attributes of a good research topic; generating research ideas; refining research ideas; writing and refining research questions / objectives; writing your research proposal. Main content of proposal: background, research question / objectives / literature review, methodology, role of ethics, timescale and resources.</p> <p>3. Critically Reviewing the Literature</p> <p>Purpose of a literature review; literature sources: primary; secondary and tertiary; planning the literature search; defining parameters and generating keywords / terms; conducting the literature search; use of databases in libraries; searching the internet; evaluating the literature; assessing relevance and sufficiency; critically reviewing the literature: purpose, content and structure; bibliography and references; Harvard & IEEE systems of referencing.</p> <p>4. The Role of Ethics</p> <p>Role of ethics in business research, ethical issues related to research process in general, data access, gatekeepers & stakeholders, data collection, data analysis, reporting and presentation; data protection and confidentiality; plagiarism & cheating infringements; received use and referencing of others work.</p> <p>5. Research Methodology</p> <p>Different approaches to research; philosophy of research; different research strategies.</p> <p>6. Primary and Secondary Data Collection</p> <p>Tools for primary data collection - observation; interviews; questionnaires, the focus group; secondary research - desk research, social media as a source of research data</p> <p>7. Sampling</p> <p>Sampling. Probability and non-probability sampling; choosing an appropriate sample size.</p> <p>8. Analysing Qualitative Data</p> <p>Understanding qualitative data; thematic analysis; reliability, validity & generalisability situated; generating themes.</p> <p>9. Analysing Quantitative Data</p> <p>Discrete, categorical and continuous data; descriptive statistics; measures of central tendency and dispersion; correlation versus causation; reporting of quantitative data.</p>
<p>Teaching and Learning Strategy</p> <p>The research module will involve exploring what it means to conduct research at the required level for this programme. Accordingly, there will be an element of teaching core content which will be supplemented with required readings, negotiation of the topic with a supervisor and the evolution of an idea for research into a concrete proposal.</p>
<p>Assessment Strategy</p> <p>The output of the module is an academically appropriate research proposal that will be subsequently used in the Applied Research Project. Therefore, there will be a significant element of reflection, discussion and formative feedback as the students work towards this goal.</p>

Repeat Assessment Strategies
<p>This module is a pre-requisite of the Applied Research Project DANL09001. Therefore, a student must pass this module to progress on to the research project.</p> <p>Where a student fails the module, a repeat exam opportunity will be provided in the Autumn sitting, in accordance with the Repeat Assessment Policy of the Faculty of Business and Hospitality. Assessment for the repeat opportunity will be determined by the internal examiner and will be an examination or other assessment deemed by the internal examiner to be equivalent to the original failed assessment in terms of demonstrating the student's ability to meet the required learning outcomes. Where necessitated, the repeat assessment may be provided in an alternative assessment format.</p> <p>For further details please refer to TUS Academic Regulations for Taught Programmes.</p>

Coursework & Continuous Assessment:		100 %			
Form	Title	Percent	Must Pass	Week (Indicative)	Learning Outcomes
Assessment	Thesis proposal	- %	No	End of Semester	1,2,3,4

Online Average Weekly Workload:			1.00 Hours		
Type	Description	Location	Hours	Frequency	Weekly Avg
Lecture	Lecture	Not Specified	1	Weekly	1.00
Independent Learning	Independent Learning	Not Specified	8	Weekly	8.00

Recommended Reading Book List
Dawson, C., (2019). <i>Introduction to Research Methods 4th Edition</i> . Robinson. ISBN 1408711052 ISBN-13 9781408711057
Creswell, W., Creswell, J., (2017). <i>Research Design</i> . ISBN 1506386768 ISBN-13 9781506386768
Denscombe, M., (2021). <i>The Good Research Guide</i> . Open University Press. ISBN 0335249833 ISBN-13 9780335249831

Online Resources
<p>TUS Online Library Academic, Postgraduate and Researcher Services:</p> <p>https://ait.libguides.com/academicsandresearchers</p> <p>TUS Online Research Ethics Resources:</p> <p>https://www.ait.ie/contact/staff/quality/research-ethics</p> <p>The Thesis Whisperer Academic Dissertation Writing Blog:</p> <p>https://thesiswhisperer.com/</p>

Programme Membership
<p>AL_KDATJ_9 202300 Master of Science in Data Analytics</p> <p>AL_KDATJ_9 202300 Post Graduate Diploma in Data Analytics</p> <p>AL_KDATA_9X 202300 Postgraduate Diploma in Data Analytics (EXIT)</p> <p>AL_KAPML_9 202400 Master of Science in Applied Machine Learning for Business</p>



COMP09011 202300
Applied Research Project

Mandatory Delivered in Stage 2 Semester 4

Full Title	Applied Research Project		
Status	Draft	Start Term	202300
NFQ Level	09	ECTS Credits	30
Attendance	N/A %	Contains Must Pass Element	No
Module Code	COMP09011	Duration	Semester - (15 Weeks)
Grading Mode	Numeric/Percentage	Department	Accounting & Business Computing
Module Author	Jonny O'Dwyer		
Co Authors	Barry O'Loughlin, Brenda Reilly, Patricia Gunning, Paul Liston, Tao Cui		

Module Description

The project builds on the Research Methods module, where the research proposal will have been developed and submitted. The dissertation will consist of 20,000 words, excluding bibliography and appendices. As the capstone component of the programme, this element will help integrate the curriculum content and deliver a significant body of work that will contribute to the body of knowledge in the field of applied machine learning for business. The dissertation will draw on analytical and evaluative competences based upon knowledge and skills developed during the programme. The exercise also provides an opportunity for students to develop their interests in a particular area of Applied Machine Learning, while demonstrating an ability to undertake individual research in an ethical and methodologically sound manner.

☰ Learning Outcomes <i>On completion of this module the learner will/should be able to;</i>	
1.	Apply knowledge, skills and competences acquired during the programme of study to the analysis and solution of a defined research area;
2.	Utilise the knowledge and skills required to undertake a major research project based upon independent academic research;
3.	Display a capability for independent and self-directed learning, while critically evaluating the published research in the field of Applied Machine Learning for Business;
4.	Conduct research in a rigorous, methodologically sound and ethical manner;
5.	Demonstrate the development and utilisation of critical thinking and analytical skills;
6.	Produce a conclusive, coherent document supported by evidence and a convincing analysis of findings that contributes to the body of knowledge in a specialist area of Applied Machine Learning for Business.

Indicative Syllabus

Having completed both the research proposal and schedule in the Research Methods module, this module is where the student will actually conduct the research. Under the guidance of an academic supervisor, the student will deliver a thesis of suitable academic standard that will contribute to the body of knowledge in the discipline of Applied Machine Learning for Business.

Sample Projects

The following are examples of possible areas that students might address in their projects:

1. Design, development, deployment and evaluation of a machine learning model (models) for a specific business application.
2. Research, design, and evaluation of data quality evaluation and/or enhancement techniques.
3. Simulation of machine learning models for business applications.
4. Systematic study and evaluation of processes for machine learning model operationalisation, for example, model monitoring and re-training processes.
5. The design and implementation of data/knowledge discovery, collection and storage systems.

Teaching and Learning Strategy

There is no formal teaching in this module, as the student will be undertaking research. However, the student will be assigned an academic supervisor who will provide mentorship, guidance and direction during the project through regular meetings and informal contact through electronic communication.

Assessment Strategy

The module will consist of three assessments

- a literature review paper (3000 words) during week 6
- the submission of a written thesis of 20,000 words
- a viva with a panel of academics and (where feasible) industry-based members

Repeat Assessment Strategies

On principle, in our student centred approach to assessment within the department, all learners have the right to resit a failed assessment within the same academic year. Given the substantive nature of the Applied Research Project, the resubmission will occur in the following academic semester, subject to the availability of staff and resources.

Coursework & Continuous Assessment:		100 %			
Form	Title	Percent	Must Pass	Week (Indicative)	Learning Outcomes
Written Report	Thesis	85 %	No	End of Semester	1,2,3,4,5,6
Written Report	Progress Review Report	15 %	No	Week 6	2,3

Online Average Weekly Workload:			1.00 Hours		
Type	Description	Location	Hours	Frequency	Weekly Avg
Tutorial	Tutorial	Not Specified	1	Weekly	1.00

Independent Learning	Independent Learning	Not Specified	795	Per Module (Semester)	53.00
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Recommended Reading Book List

James, G., Witten, D., Hastie, T., Tibshirani, R., (2021). *An Introduction to Statistical Learning*. Springer.
ISBN 1071614177 ISBN-13 9781071614174

Bell, E., Bryman, A., Harley, B., (2018). *Business Research Methods*.
ISBN 9780198809876 ISBN-13 0198809875

Goodfellow, I., Bengio, Y., Courville, A., (2016). *Deep Learning*. MIT Press.
ISBN 9780262035613 ISBN-13 0262035618

Murphy, P., (2022). *Probabilistic Machine Learning*. MIT Press.
ISBN 9780262046824 ISBN-13 0262046822

Journal Resources

Journals will be provided by lecturer.

Online Resources

library.ait.ie

Other Resources

Journals (All available online and accessible through the AIT Library homepage):

- Information, Communication & Society (Routledge)
- Computer (IEEE)
- Information & management (Elsevier)
- IEEE Internet Computing (IEEE)
- Decision Support Systems (Elsevier)

Programme Membership

AL_KAPML_9 202400 Master of Science in Applied Machine Learning for Business

Appendix

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