Ollscoil na Gaillimhe
UNIVERSITY OF GALWAY

Coláiste na hEolaíochta agus na hInnealtóireachta
College of Science and Engineering
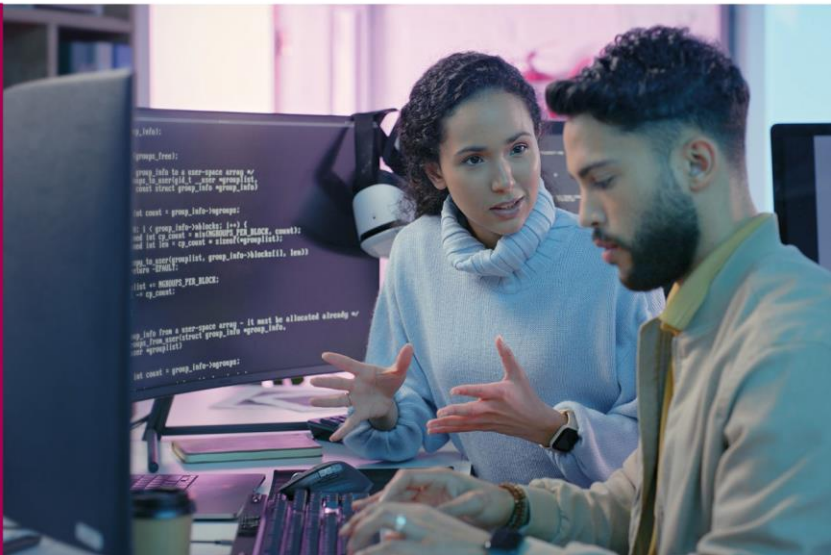
Scoil na Ríomheolaíochta
School of Computer Science



Ollscoil na Gaillimhe
UNIVERSITY OF GALWAY | Scoil na Ríomheolaíochta
School of Computer Science

ACS1

Adaptive Cybersecurity

Masters of Science

cs.UniversityofGalway.ie

# MSc. in Computer Science (Adaptive Cybersecurity)

# STUDENT HANDBOOK 2024 | 2025

**School of Computer Science, Computer Science (CS) Building, University of Galway**

University of Galway School of Computer Science requires all students to have exclusive use of a laptop for use in lectures and labs, for home use of online materials and for participation in online sessions.

The minimum and recommend spec are detailed at:
https://www.universityofgalway.ie/science-engineering/school-of-computer-science/currentstudents/laptops/.

We also operate a laptop loan scheme for students who cannot afford a suitable laptop (see same address).

# Table of Contents

**Please note:** This handbook is for information only and is correct at time of compilation. However, processes and procedures may change throughout the academic year.  Please contact the relevant websites and Administrative Offices for up to date information.

# Section 1: Programme Description

**MSc in Computer Science (Adaptive Cybersecurity)**

This 12-month full-time programme provides cutting edge technical training and research opportunities in the emerging area of AI-driven and data analytics-driven cybersecurity. It is a unique offering that is only matched by a small number of European and US-based Universities and builds on the vast research experience and technical skills of renowned, interdisciplinary experts based in the School of Computer Science, University of Galway.

**Exit award PG Dip in Computer Science (Adaptive Cybersecurity)**

This exit award will only be made available to students that have successfully completed 60 ECTS of taught content in Semester 1 and 2, but who are not able to complete the 30 ECTS capstone project.

# Section 2:    General Information

## 2.1    Academic Calendar 2024-2025

The Academic Calendar is available on:
https://www.universityofgalway.ie/registry/academic-term-dates/#d.en.186426

| Academic Year 2024-2025 | |
|---|---|
| **Semester 1** | |
| Start of Teaching (UG years (excluding Year 1) and Postgraduate Taught programmes) | Monday 9th September 2024 |
| End of Teaching all years | Friday 29th November 2024 |
| Study Week (All Years, UG & PGT) | Monday 2nd December - Friday 6th December 2024 |
| Semester 1 Exams | Monday 9th December – Friday 20th December 2024 |
| **Semester 2** | |
| Teaching (All Years, UG & PGT) | Monday 13th January – Friday 4th April 2025 |
| **Easter** | **Good Friday 18th April – Easter Monday 21st April 2025** |
| Field Trips | Monday 7th April – Thursday 10th April 2025 |
| Study Week (All Years, UG & PGT) | Friday 11th April – Thursday 17th April 2025 |
| Semester 2 Exams | Tuesday 22nd April – Friday 9th May 2025 |
| Autumn Repeat Exams | Tuesday 5th August - Friday 15th August 2025 |
| **Easter Holidays: Good Friday 18th April to Easter Monday 21st April 2025**<br><br>**Bank Holidays: Monday 28th October 2024 / Monday 3rd February 2025 / Monday 17th March 2025 / Monday 5th May 2025 / Monday 2nd June 2025 / Monday 4th August 2025** | |

## 2.2 Key Contact Details

### Programme Director

| Programme | Programme Director | Room | E:mail |
|---|---|---|---|
| M.Sc. Adaptive Cybersecurity | Dr. Ihsan Ullah | CSB-3040 | Ihsan.ullah@universityofgalway.ie |

### Administrative and Technical Staff

| Administrative Staff | | Room | E-mail |
|---|---|---|---|
| Ms Deirdre King | School Manager | CSB-3013 | Deirdre.king@universityofgalway.ie |
| | | | |
| Ms Thérèse McIntyre | School Operations Officer | CSB-3014 | Therese.mcintyre@universityofgalway.ie |
| | | | |
| Ms Geraldine Healy | Administrative Assistant | CSB-3014 | Geraldine.healy@universityofgalway.ie |
| **IT Technical Staff** | | | |
| Mr Peter O'Kane | Chief Technical Officer | CSB-3038 | Peter.okane@universityofgalway.ie |
| | | | |
| Mr Joe O'Connell | Senior Technical Officer | CSB-3037 | Joe.oconnell@universityofgalway.ie |
| | | | |
| Mr Pearse Carroll | Senior Technical Officer | CSB-3037 | pearse.carroll@universityofgalway.ie |

**The School of Computer Science is located in the Computer Science (CS) Building
For directions to the CS Building please click (Ctrl+Click)** here

**Student Registry Help Desk**

The Student Registry Help Desk provides the following services:

- Admissions, Registration, Exams and Conferring queries
- Prospectus pick up
- Replacement ID Cards
- Exam Transcript requests
- Course Withdrawal / Leave of Absence
- Validation and Stamping of Forms e.g. social welfare, medical card application
- Change of Name/ Change of Address requests
- Registration and Statements
- Employment and verification requests

**Student Registry Help Desk**: Location: Ground floor, Áras Uí Chathail, which is situated on the main campus.  Tel: (091) 495999 / askregistry@universityofgalway.ie

Registered Students can visit the Front Desk service which is open Monday to Friday 9:30am-12:30pm & 1:30pm-4:00pm.  Web link for further details as follows:
https://www.universityofgalway.ie/student-registry-helpdesk/


**Useful Contact Numbers** (https://www.universityofgalway.ie/about-us/contact-us/)

| | |
|---|---|
| Student Registry Help Desk | (091) 495999 |
| ISS Help Desk | (091) 495777 |
| Admissions Office | (091) 495999 |
| Accommodation & Welfare Office | (091) 493540 |
| Disability Support Service | (091) 492813 |
| Fees Office | (091) 492386 |
| Health & Safety Office | (091) 492678 |
| Campus Security / Emergency | (091) 493333 |
| Student Counselling | (091) 492484 |
| Student Health Unit | (091) 492604 |
| Students Union Shop | (091) 492411 |
| General Emergency | 999 / 112 |
| Local Garda Station | (091) 538 000 |
| Hospital (UHG) | (091) 524222 |
| Samaritans | 116 123 (freephone 24/7) |


**Student Support**

For a summary of supports and services available to students please click (Ctrl+Click)  here

**College of Science & Engineering Student Support Officer**

Kelly Moore is the Student Support Officer in the College of Science & Engineering, and provides support for students during their time at university. The role of the Student Support Officer is to provide confidential, non-judgmental support and an empathetic space for students to share their concerns. In addition, a student advisor can offer personal support and advice on topics such as study planning, time management and any personal challenges that may compromise their ability to study.  For further details please visit the following web link: COSE Student Support Officer - University of Galway

**Student Support Officer**: Location: Mondays, Wednesdays and Thursdays in Room 218, Arts/Science Concourse Building.  Tuesdays in Room 1046, Alice Perry Engineering Building.  Fridays available remotely via online meetings.
Direct Tel: 086 0834435 / Email: kelly.l.moore@universityofgalway.ie

## 2.3    Registration

Online registration opens on **Thursday, 15th August 2024** for postgraduate taught students. Details of relevant dates can be found on: (https://www.universityofgalway.ie/registration/quick-links/registration-dates/).
Students will receive an email from Registration before online registration opens inviting students to register online.  Students should register as soon as possible for their programme and following receipt of an email from ISS, activate their University of Galway campus account (see paragraph 2.4 below).  Further registration details can be found on: https://www.universityofgalway.ie/registration/.

## 2.4    Activating your University of Galway Campus Account

New students will receive a welcome email from ISS "*Activating your new University of Galway campus account*" which will be sent to a student's personal email address following registration.

This email will provide students with a **University of Galway email address** and a **temporary activation password**. It also describes the steps new students need to take to activate their new University of Galway campus account. A campus account will allow students to access many important services during their time at University of Galway.

Further details on the steps to follow to activate a new student campus account can be found here: https://www.universityofgalway.ie/information-solutions-services/studentrecordssystem/studentaccess/newstudents/

For existing students, please follow the steps outlined in the following link: https://www.universityofgalway.ie/information-solutions-services/studentrecordssystem/studentaccess/existingstudents/

## 2.5    Student ID Cards

Students can collect their ID cards from the Student Reghelp Desks, first floor, Áras Uí Chathail from the start of term: https://www.universityofgalway.ie/registration/quick-links/id-cards/. Alternatively, students can request their ID card to be posted: https://www.universityofgalway.ie/registration/quick-links/id-cards/1styearpostgraduatestudentidcarddistribution/

## 2.6    Maps

University of Galway Campus maps can be located on the University's website at: https://www.universityofgalway.ie/buildings/maps/

## 2.7    Examinations

The Examinations Office posts all results to the home address of each candidate.  It is the responsibility of students to ensure that their home address is correct on their record. Click on the link for info on how to register an address change. Please note you must allow 2 weeks for your change of address request to be processed.

### *Results*
Results will **NOT** be given on the telephone to candidates, or to anyone acting on their behalf.

### *Examination Timetables*
Examination timetables may be viewed on the University of Galway web page at the following address: https://www.universityofgalway.ie/exams/timetable-advice/examtimetable/. Students personalised timetables will be available on the WEB **here** on a date to be advised by the Exams Office and Exam Timetable and Amendments can only be accessed either On-Campus or via Remote Access.

**Timetables will NOT be posted to students.**

Please be advised:
- Check the Amendments web page OFTEN as changes may occur up to day of exam.
- Revisions to timetables will be published only on the Examinations Office web page.
- Revisions to timetables will not be posted to individuals or appear on personal timetables.

### *Repeat, Appeals and Re-checks*
Strict deadlines apply for appeals and re-checks and completed online application forms must be submitted to the Examinations Office by the relevant deadlines as detailed on the website links as follows:   https://www.universityofgalway.ie/exams/results/appeals/ and  https://www.universityofgalway.ie/exams/results/rechecks/.  A fee must be lodged

with both the Appeal and Re-check Forms. Fees are refunded if the outcome is positive. Further detailed information is provided in the above links.

### *Exam Board Sittings*
The examinations board will sit in June and October where relevant examination, project and theses grades will be processed by the College of Science & Engineering.

### *Deferral of Exams*
A guide for exam deferrals is available at: https://www.universityofgalway.ie/exams/timetable-advice/deferrals/. This guide is to assist students with the process and provides a direct link to the College of Science & Engineering's online specific Deferral Form.

## 2.8    Student Services
Coming to University is a major milestone in your life and a point of changeover in your life. You are facing into some challenges and many opportunities. You will encounter the enjoyment and challenges of independence and decision-making and responsibility for your  own well-being and lifestyle.

Student Services is a team that are core to the personal and academic development of students.  Student Services is under the management of the Vice President for the Student Experience.  Student Services is committed to enhancing the individual student experience by providing an  excellent service which supports the holistic development of the person, thereby enabling each  student to achieve their full academic potential. Through valuing, recognising and supporting  each staff member and by forging strong alliances within the University Community, Student  Services will assist University of Galway to become a truly Student Centred University.

Student Services provides many services as follows:
- Access Centre; Career Development Centre; Societies and Sports; Welfare and Wellbeing.

Further detailed information and contact details on all the Student Services offered by University of Galway may be found at: https://www.universityofgalway.ie/student-services/.

## 2.9    Student Counselling
The counselling service is part of a network of support services offered by University of Galway. It provides professional counselling, which is **free** and **confidential** to all students of University of Galway.  Life as a student is exciting and challenging, an achievement usually gained after much hard work and preparation. It can also be stressful at times. You may find you are experiencing personal difficulties which are affecting your ability to study and to take full advantage of the opportunities available to you at University of Galway. This is

where student counselling can help. Student counselling are a team of qualified and experienced counsellors and psychotherapists. The service operates within the Code of Ethics and Practice agreed by their respective accrediting bodies including IACP, IAHIP and PSI. The services provided include:

- Pre-counselling assessment, individual counselling and psychotherapy
- Group work
- Information and referral
- A consultation service for those who may have concerns about a student.

Further information including available online services and emergency contact details can be located on the following weblink: https://www.universityofgalway.ie/counsellors/

**Counselling Services**: Location: No. 5 Distillery Road, University of Galway
Direct Tel**:** 091 492484 Ext**.** 2484
E-mail**:** counselling@universityofgalway.ie

## 2.10   International Students

The **International Office** provide advice, information and support service for all International Students. For incoming international students information is available on https://www.universityofgalway.ie/international-students/

All international students are strongly encouraged to attend English for Academic Purposes (EAP) classes which are specifically designed to equip international students with specific English skills to help them with their studies. Please refer to https://www.universityofgalway.ie/englishlanguage/ for more details.

The International Student Officer, Ms. Louise Kelly may be contacted at International Office, University of Galway, Tel 353 91 493581, E-mail: louise.kelly@universityofgalway.ie.  Ms. Kelly acts as an identifiable point  of contact with the various Student Services in the University to ensure that any problems of  adjustment are  minimised. She helps International Students adjust as quickly as possible to  their new environment, so that they can derive maximum benefit and enjoyment from their life  at University of Galway.

## 2.11   Computer Science Account and Swipe Card Access to Labs

The School of Computer Science has several undergraduate and postgraduate rooms which are available for use by our students. The rooms have hot swap desks, with laptop docking stations allowing use of external monitor, keyboard, mouse and the high-speed network. Students must provide their own laptops https://www.universityofgalway.ie/science-engineering/school-of-computer-science/currentstudents/laptops/.  All students who are taking a module/course with the School of Computer Science are entitled to use the open access labs in the CS Building outside of scheduled timetable use (Note: CSB-G001 is

available to all University of Galway students using main University of Galway account). Depending on their course, they may also have swipe card access to further project rooms in the CS Building.

Computer Science students are also given access to print on our shared printers, and to use our web and database servers which can be used for course or project work. To gain access to these resources, students will be given Computer Science accounts automatically after a student registers for one of our modules/courses, and students will receive an email to their University of Galway email to indicate the account is ready for use. The initial password is included in the email. Students can login to our intranet to setup the web/database/linux resources https://web1.cs.universityofgalway.ie/intranet/

Students who have issues with their Computer Science computer account, docking stations, monitors or swipe card access in the Computer Science Building should log a call to Computer Science Technical officers at: support@cs.universityofgalway.ie.  Useful links for further related info: https://www.universityofgalway.ie/science-engineering/school-of-computer-science/currentstudents/.

Students who have issues with their main University of Galway account, Wi-Fi, Canvas, personal laptops or any PC/printer on the rest of campus should refer to the University of Galway helpdesk: https://www.universityofgalway.ie/information-solutions-services/services-for-students/.

## 2.12   DISC - Computer Programming Drop-In Support Centre

Computer DISC is a Computer Programming Drop-In Support Centre for all University of Galway students who are taking any programming/software development courses. The DISC is a free service that supports all students with their self-directed learning in computing topics at all years and levels in University of Galway.  The centre is located in room CBS-1001 on 1st floor of the Computer Science (CS) Building.

What services does Computer DISC provide to students?
- Facilities for students to sit and work on programming problems
- One-to-one advice and support for students, and focused small group tutorials
- Books, courseware, web links, and other learning resources for programming students
- A website with information and an email service for all queries
- Advice for students who wish to learn new programming languages autonomously
- Assistance with new technologies for project work such as Final Year Projects.

DISC Website: https://www.universityofgalway.ie/science-engineering/school-of-computer-science/currentstudents/computerdisc/

## 2.13   Canvas

Canvas is the Virtual Learning Environment (VLE) used at University of Galway. Canvas is a modern, user-friendly VLE that allows students to access learning materials, reading lists, assessment information and other course-related content.
https://universityofgalway.instructure.com/

When a student registers for a course or module with the University of Galway, they are automatically enrolled on the corresponding course on Canvas. Enrolments are recognised by Canvas within 24 hours of registration.  If students have problems accessing Canvas, they should contact the Library and IT Service Desk. The Service Desk can assist students with queries regarding problems with their password, e-mail account or logging in to Canvas.

If students are unable to see courses when they log into Canvas, they will need to check their registration statement to ensure they are correctly registered. Within Canvas, University of Galway students have access to 24x7x365 support via the Help menu.  This Canvas support team can answer most queries related to the Canvas environment including how to submit assignments, how to see the gradebook, and where to access course materials.  They also provide advice on how Canvas features can be used.

## 2.14   Plagiarism

Plagiarism refers to copying another author's work without due reference or acknowledgement of the author. Plagiarism is not acceptable. It is essential that candidate acknowledge other people's work, when used by the student.  The submitted work must be prepared by the candidate alone, and must be the result of the candidate's own effort, skills and knowledge.  It is unacceptable for candidates to knowingly permit others to copy their work. University of Galway has a strict Code of Practice for dealing with Plagiarism, please refer to the following link for further details: https://www.universityofgalway.ie/plagiarism/.

## 2.15   Information Solutions and Services (ISS)

ISS aim to provide students with access to the ICT facilities which they need to succeed in their studies at University of Galway. These facilities include high speed Internet access, a University Galway email account, and access to the resources of the James Hardiman Library and assist with accessing Canvas, the virtual learning environment. These services are accessible from the on-campus PC suites and from suitably equipped laptops using the on-campus wireless network.  A Campus Account (CASS) provides students access using a single User ID and Password to  all computing services, other than E-mail. To activate your Campus Account *(see paragraph 2.4 above)*, students should follow the instructions as outlined in the following weblink: https://www.universityofgalway.ie/information-solutions-services/studentrecordssystem/studentaccess/.

**ISS Service Desk**: Location: Ground floor of the James Hardiman Library
Contact by raising a service ticket: [Service Desk Ticketing System](#)
Direct Phone: 091 495777 or the Library & I.T. Service Desk: 091 495399

## 2.16   Career Development Centre

The Career Development Centre provides students of University of Galway with a quality career guidance and information service focused on facilitating and empowering students to manage their own career development and empowering students to make successful transitions towards fulfilling careers.

Details of the services provided to students by the Career Development Centre include:

Guiding students in their career journey through:
- One-to-one career guidance
- Career seminars and events
- Psychometric testing
- Dedicated careers information hub for students (on-campus and virtual)
- Self-guided modules

Connecting students with employers through:
- Jobs fairs and employer events
- Job vacancy system
- Networking opportunities

Helping students to compete in the jobs market to the best of their ability through:
- CV workshops, e-learning, and unlimited AI feedback
- Interview skills workshops, e-learning, and software to practice and improve
- Applications advice: including Postgraduate and Job Applications
- Employment skills workshops and employability award

Further information on the range of services provided by the Careers Development Centre can be found at: [https://www.universityofgalway.ie/career-development-centre/](https://www.universityofgalway.ie/career-development-centre/).

**Career Development Centre:** Location: Arts/Science Building (1st Floor)
Tel: +353 (0)91 493589

## 2.17   Out of Hours Working

Out of hours work refers to all University operations conducted outside normal hours.
For up to date details on the University's Safety Statement Policy and Out of Hours Working, please click on the following web link: [University of Galway Safety Statement](#)

## 2.18 Parking on Campus

Parking spaces in University of Galway fall into a number of categories:

- Staff Only; Student Only; Shared use (staff & student permit holders); Visitor/non-permit holder; Pay-and-display/Pay by Phone (P&D) spaces; "Reserved" spaces and loading bays.

Student parking permits are available for registered students, details as below.

To purchase/renew your Student Parking Permit carefully read the instructions contained in the following guide PermitApplicationsGuide2024 then visit the Online Payment System to book your permit.

If you park in a "Pay and Display" space, you must buy a ticket from the nearby machines or use the Pay by Phone option and display your ticket on your dashboard face up, regardless of what other type of permit you might have.  If you buy a P&D ticket you can only park in spaces marked with blue lines and text ("P&D/Í&T").

A park and ride service operates from Dangan car park. Further information and timetable details are available from: Park & Ride Bus Timetable

Parking at University of Galway is operated by APCOA Ireland. If you have a parking related query please contact: Ireland.permits@apcoa.ie / telephone: 0818 462899.

## 2.19 Library

The Student ID card also acts as a Library card.  Students must have a current card in order to gain entrance to the Library.  Details on the services provided by the library are available at Library - University of Galway. The Library and IT Service Desk are located on the ground floor of the library and provides advice and support to students on both Library and IT services (e.g., User ID/passwords, book loans, printing Wifi access).

## 2.19  Module Descriptions

**Modules:  Semester 1**

| Core/ Optional | Modules | ECTS Credits |
|---|---|---|
| **Core** | CT5189 Introduction to Cybersecurity | Credits: 5 |
| **Core** | CT5191 Network Security & Cryptography | Credits: 5 |
| **Core** | CT5190 Societal Impact of AI and Cybersecurity | Credits: 5 |
| **Core** | CT5165 Principles of Machine Learning | Credits: 5 |
| **Core** | CT5132 Prog. and Tools for AI | Credits: 5 |
| **Optional** | CT5141 Optimisation | Credits: 5 |
| **Optional** | CT5120 Natural Language Processing | Credits: 5 |
| **Optional** | CT561 System Modelling and Simulation | Credits: 5 |
| **Optional** | CT5105 Tools & Techniques for Large Scale DA | Credits: 5 |

**CT5189 Introduction to Cybersecurity**

The introductory module covers the importance of cybersecurity by considering the comprehensive overview of all cybersecurity categories. It will provide learners with a foundation of advanced topics in cybersecurity through the theoretical and practical aspects of Cybersecurity. Learners will develop a strong understanding of the current cybersecurity landscape and best practices for protecting against cyber-attacks. It will also cover the importance of risk management and incident response. By the end of this module, learners will have the knowledge and skills to design and implement secure information systems, assess the security of existing systems, and respond to security incidents.

**CT5191 Network Security & Cryptography**

The module is designed to provide learners with a comprehensive understanding of the principles and practices of securing networks and data through firewalls, VPNs, secure communication protocols, and cryptography. Throughout the module, learners will have the opportunity to apply their knowledge through hands-on exercises and projects, such as configuring firewall rules, implementing encryption, and simulating security breaches in network security.

**CT5190 Societal Impact of AI and Cybersecurity**

The module is designed to provide learners with a comprehensive understanding of the social, ethical, and legal implications of advancements in AI and cybersecurity. Throughout

the module, learners will be exposed to various real-world examples, case studies, and discussions to understand the impact of AI and cybersecurity on data, society, organizations, humans, and privacy laws. The course will also equip learners with the knowledge and skills to critically evaluate the social, ethical, and legal implications of AI and cybersecurity and to contribute to the development of responsible and sustainable AI and cybersecurity practices.

**CT5165 Principles of Machine Learning**

Definitions of Machine Learning, Data Mining and the relationship between them; the CRISP Data Mining process model; major tasks including classification, regression, clustering, association learning, feature selection, and reinforcement learning; algorithms for these tasks that may include decision tree learning, instance-based learning, probabilistic learning, support vector machines, linear and logistic regression, and Q-learning; open-source software tools for data mining; practical applications such as sensor data analysis, healthcare data analysis, and text mining to identify spam email; ethical issues and emerging trends in data mining and machine learning.

**CT5132 Prog. and Tools for AI**

This module is about programming and computational tools required for artificial intelligence. It uses the Python language as the main vehicle, but focusses on conceptual material rather than just the language itself. It moves fast through introductory Python workings. It covers several important Python libraries in detail. It discusses approaches to building re-usable, high quality code but not on software engineering. It also visits some extra topics such as version control and an introduction to the R language for statistics. The module is core for the University of Galway MSc in Artificial Intelligence (MSc AI) Part-time (online) and Full-time (classroom). The syllabus and assessment will be the same for both. We will use a hybrid of lecture-style and lab-style delivery. The lecture-style delivery will be via video (for the part-time/online version) or classroom (for the full-time version). Practical exercises will be interleaved with the lecture-style delivery.

**CT5141 Optimisation**

This module covers optimisation -- "the science of better". Optimisation is used in a huge variety of applications, including: finding time-saving transport routes; scheduling exams without conflicts; reducing weight and cost in engineering design; designing portfolios of financial investments; finding numerical data models with low expected error; and many more. In this module we will aim to understanding a broad range of applications and a unifying view of the field, and concentrate on two main types of methods: (1) metaheuristic optimisation and (2) exact methods for constrained optimisation. In this module we will not cover gradient descent and related methods, as they are covered in machine learning modules available on the MSc AI. We will spend time in-class on practical implementations, writing our own optimisation programs from scratch and also using state-of-the-art libraries.

**CT5120 Natural Language Processing 1**

Introduction to natural language processing, including foundations in linguistics, statistical analysis and applications.

**CT561 System Modelling and Simulation**

Simulation is a quantitative method used to support decision making and predicting system behaviour over time. This course focuses the system dynamics approach. The course covers the fundamentals of simulation, and describes how to design and build mathematical models. Case studies used include: software project management, public health policy planning, and capacity planning.

**CT5105 Tools & Techniques for Large Scale DA**

Pre-requisite for selecting CT5105: Existing knowledge of Java

Large-scale Data Analytics is concerned with the processing and analysis of large quantities of data, typically from distributed sources (such as data streams on the internet). This module introduces students to state-of-the-art approaches to large-scale data analytics. Students learn about foundational concepts, software tools and advanced programming techniques for the scalable storage, processing and predictive analysis of high- volume and high-velocity data (including stream data), and how to apply them to practical problems.

*This module uses Java as programming language. Existing knowledge of Java is a pre-requisite for participation in this module.*

Planned topics include: Definition of large-scale computational data analytics; Overview of approaches to the processing and analysis of high volume and high velocity data from distributed sources; Applications of large-scale data analytics; Foundations of cluster computing and parallel data processing; The Hadoop and Spark ecosystems. MapReduce; Advanced programming concepts for large-scale data analytics; Concepts and tools for large-scale data storage; Stream data processing and analytics. Techniques and open-source tools for large-scale data analytics; Statistics and machine learning with large-scale data processing frameworks such as Spark.

**Modules: Semester 2**

| Core/ Optional | Modules | ECTS Credits |
|---|---|---|
| Core | CT5133 Deep Learning | Credits: 5 |
| Core | CT5100 Data Visualisation | Credits: 5 |
| Core | CT5192 Secure DevOps | Credits: 5 |
| Core | CT5193 Case Studies in Cybersecurity Analytics | Credits: 5 |
| Core | CT5194 Malware and Intrusion Detection | Credits: 5 |
| Core | CT5195 Adaptive Cybersecurity Project | Credits: 30 |
| Optional | CT5121 Advanced Topics in NLP | Credits: 5 |
| Optional | CT5113 Web & Network Science | Credits: 5 |
| Optional | CT5187 Knowledge Representation | Credits: 5 |
| Optional | CT5134 Agents, Multi-Agent Systems and Reinforcement Learning | Credits: 5 |

**CT5133 Deep Learning**

This is an advanced module in machine learning, focusing on neural networks (NNs), deep NNs, and connectionist computing. Students learn about the basic principles and building blocks of deep learning, and how to implement a deep neural network 'from scratch'. They also learning about software libraries and tools, and gain experience of applying deep learning in a range of practical applications. The module includes substantial practical programming assignments.

**CT5100 Data Visualisation**

This module with teach the fundamentals of data visualization. It will cover basic design principles and the principles underlying human perception, color theory and narrative. It will focus on the use of open standards for the presentation of data on the Web such as HTML, CSS, SVG, JavaScript through the use of libraries such as D3.js, jQuery.js and Dimple.js.

**CT5192 Secure DevOps**

This module will enable learners to gain expertise in the end-to-end secure software development i.e., from project specification to implementation phases. It facilitates the learners in understanding and practicing secure software development lifecycles (SecDevOps) using different libraries/APIs of programming languages. It covers the best practices for identifying potential threats, implementing cybersecurity measures throughout the software development lifecycle, secure coding principles and techniques

for application development, and techniques for verifying and validating the security of software systems.

**CT5193 Case Studies in Cybersecurity Analytics**
As part of the applied learning opportunities for learners, this module incorporates learning from lectures by invited speakers from academia and industry as well as through team-based and research-oriented elements. Through the integration of curriculum content, the purpose of the module is to provide students real world case studies as well as a chance to complete an applied research and development project on cybersecurity-specific research problems. Learners will work as part of small focused teams on this targeted interdisciplinary project integrating AI / ML with Cybersecurity. As a team, learners will investigate the literature in a systematic manner and then implement and analyse a solution for identified problem statement. As a result, this module will also enable learners to produce a research paper on current topics relevant to industry practices in cybersecurity.

**CT5194 Malware and Intrusion Detection**
This module is designed to provide a comprehensive security understanding that requires a multi-layered approach, including threat detection, incident response, and penetration testing. It covers the topics that provide a holistic understanding of how to protect an organization from cyber-attacks. Techniques and tools used to detect and identify potential threats, including signature-based detection, heuristic detection, and behavioural analysis. This module assists in improving an organization's security posture and best practices for implementing and maintaining a comprehensive security system, including compliance with industry standards and regulations. This module is intended for security professionals to deepen their knowledge and skills in identifying, analysing, and mitigating cyber threats at the organisational level.

**CT5195 Adaptive Cybersecurity Project**
In this module the student demonstrates their ability of carrying out an in-depth analysis, problem-solving, and reporting of a cybersecurity problem using machine learning and data analytics techniques.

**CT5121 Advanced Topics in NLP**
Advanced topics in natural language processing, including deep learning for NLP, machine translation and language resources.

**CT5113 Web & Network Science**
This module will provide the student with the skills to extract, clean and analyse data from the Web. The focus will be graph and network analytic approaches to Web-mining. Topics include: graph theory, network modelling, social network analysis, community-finding techniques, models of information diffusion, link prediction, evaluation techniques. There

will be practical sessions on using graph-data bases and graph visualisation tools such as Gephi. The student will learn how to apply Web mining techniques to applications such as recommender systems, adaptive personalisation, authority ranking.

**CT5187 Knowledge Representation**

This module introduces students to Knowledge Representation in AI. Knowledge representation is concerned with the efficient formal representation of information and its utilization for automated problem-solving tasks. Planned topics: Foundations of knowledge representation. Propositional and first-order logic. Deductive and probabilistic reasoning. Industry-strength logical reasoning: SAT Solving. Logic programming and Answer Set Programming. Graphical models and probabilistic logics. Foundations of Machine Learning with formal background knowledge.

**CT5134 Agents, Multi-Agents Systems and Reinforcement Learning**

The topic of Agents and Multi-Agent Systems, examines environment that involve autonomous decision making software actors to interact with their surroundings with the aim of achieving some individual or overall goal. A typical agent environment could be a trading environment where an agent attempts to optimise energy usage, or the profitability of a transaction. More recently, significant global attention has focussed on the vision of autonomous vehicles, which also follows the core principle of an agent attempting to achieve a set of defined goals.

This module begins by examining the underpinnings of what is an Agent, and how we can better understand the principles of an agent and its autonomy. Multi-Agent Systems are then explored, as a means of understanding how many agents can interact with each other in a complex environment. Agents are commonly modelled using Game Theory, and in this module a range of Game Theoretic Models will be studied.

The module will examine Adaptive Learning Agents through the use of Reinforcement Learning algorithms an area of Machine Learning, which focuses on training learners to choose actions which yield the maximum reward in the absence of prior knowledge. The module takes a hands-on, practical approach to reinforcement learning theory, beginning with Markov Decision Processes, detailing practical learning examples in discrete environments and how to formulate a reinforcement learning task. It then extends this to continuous problem spaces, detailing Deep Reinforcement Learning with a practical implementation of a Deep Q Network using Keras.