Open Institute of Technology

Master of Science in Responsible Artificial Intelligence
Fact Sheet

Overall Program Description

The rapid advancements in Artificial Intelligence (AI) have led to transformative changes across various sectors, from healthcare and finance to transportation and education. However, the human element often gets overshadowed by the technical complexities. There is a growing need for AI systems that are not just technically proficient but also ethically responsible and centered around human needs and behaviors. The MSc in Responsible AI aims to fill this gap by developing technical prowess and stressing ethical implications of the modern AI technologies on our society (and the society of the future).

The program is designed to cover foundational and advanced technical concepts in AI (while not focusing on its mathematical side) and to offer views on applications in various fields, taken from the point of view of domains like natural language processing, computer vision, business, large systems of heterogeneous sensors, and industry automation. The program also offers an overview of advanced computing architectures enabling modern AI systems, stressing their sustainability and impact on the environment. Ethical considerations and social responsibilities of AI systems are stressed for every application discussed in the program.

The main objectives of the program are:

Technical Proficiency: To equip students with the technical skills to design, implement, and manage advanced AI systems.

Ethical Responsibility: To instill a strong understanding of AI technologies' ethical implications and social responsibilities.

Human-Centered Design: To teach the principles of designing AI systems centered around human needs, behaviors, and ethical considerations.

Interdisciplinary Approach: To provide a comprehensive education that intersects with fields like machine learning, ethics, advanced computing hardware for AI, smart cities, business, and automation, among others.

Real-world Application: To prepare students for the practical challenges they will face in the industry through a substantial Capstone Project and Dissertation.

The program has two exit paths (see more details in Section "Exit Awards/Qualifications") with a common part comprising 60 ECTS of taught modules. The two paths differ in the last part, during the Capstone Project and Dissertation. In the first case (Option A), the Capstone Project and Dissertation is a 1 Term effort worth 30 ECTS. However, students can opt to continue working

on their MSc thesis project for 2 Terms (Option B) and instead collect 60 ECTS from the Capstone Project and Dissertation, ultimately leading to an MSc degree with 120 ECTS. Below is a more schematic description of the options:

Option A (18 months) - 90 ECTS
60 ECTS of taught modules
+
30 ECTS of Capstone Project and Dissertation

Option B (2 years) - 120 ECTS
60 ECTS of taught modules
+
60 ECTS of Capstone Project and Dissertation

Target Audience

Ages 19 – 30	☒	Age 31 – 65	☒
Age 65+	☒		

Target Group

The target audience for this program includes:

- Working Professionals: Those in the tech industry looking to upskill and specialize in Artificial Intelligence (AI).
- Recent Graduates: Individuals who have recently completed undergraduate studies in computer science or related Science, Technology, Engineering, and Mathematics (STEM) fields and are looking to specialize in AI.
- Entrepreneurs: Individuals with a tech background not necessarily centered around computer science that are interested in leveraging AI for new venture creation.

Entry Requirements

The admission requests from new applicants are received by the Students Secretary Office, which will conduct an interview with the applicants.

Students will need to provide the following documents for admission:

1. Updated CV in English;
2. Copy of a valid ID (front and back);

Qualifications:

3. University degrees (MQF level 6 or higher) in Computer Science, Computer and Electrical Engineering, Mechanical Engineering, Aerospace Engineering, Physics, Mathematics, Statistics, Chemistry, Biology, Geosciences, Economics, Law, Liberal Arts, Medical Sciences.

Since all OPIT programs are taught in English, a proof of language proficiency is needed. Any of the following options is accepted as a proof of English proficiency:

1. Being a English native speaker;
2. Having completed a previous degree entirely taught in English;
3. Having passed one of the following English tests:
    - TOEFL (minimum 80 points)
    - IELTS (minimum Level 6)
    - Duolingo English Test (minimum 95 points)
    - Cambridge Certificate (minimum B2 grade overall)

Students, who do not hold the requested level must sit for the English Entry Test in order to certify the students' competences.

All the enrolled students will follow an Induction Module before the beginning of the chosen training. This will explain to the student all the policies and procedures outlined in this handbook, and specific information related to the training, such as learning outcomes and expectations.
Study Guidelines will also be shared. Induction will also include a handbook and/or a tutorial lesson related to the different functionalities of the Virtual Learning Environment and how to use it. If students have any specific requirements or needs, they should inform the Students Support Office.
During the admission process of students wishing to enroll to the program, we will also ensure that such students have the required basic digital competence to successfully complete such a course. We will do so by administering to such students a standardized questionnaire that will cover aspects including, but not limited to: the availability of a PC with a webcam and speakers, the availability of an adequate internet connection, basic knowledge of operating systems and web browsers.

The program is designed by assuming some technical proficiency (in terms of programming and mathematical skills) and some preliminary understanding of modern AI systems. However, the program offers an entry path that allows to fill possible gaps in terms of such requirements (e.g. for students coming from Business, Law, Liberal Arts, Medical Sciences, Humanities).

Direct Entry: At least a BSc from an accredited institution in a STEM field with a substantial computer science background and some knowledge of modern AI. Notably, in their previous degrees, candidates applying under the Direct Entry path will have passed courses equivalent to the following OPIT's courses:

COMP-2001 Foundational Mathematics

Topics: Basic Math Review; Elements of Calculus; Elements of Probability; Elements of Combinatorics; Descriptive and Inferential Statistics; Elements of Linear Algebra; Linear Regression; Logistic Regression and Classification.

Desired Outcomes. Students will review basic mathematical notions in different fields, like Calculus and Linear Algebra. The main aim is to give them a wide overview of the main mathematical tools used in today's technologies, without going into the technical details of the mathematical developments and proofs.

COMP-3003 Programming Paradigms

Topics. Introduction to Programming Paradigms; Overview of Programming Paradigms: Imperative, Object-Oriented (OO), Functional, Parallel/Concurrent; OO Programming Emphasis; Hands-on Experience on Software Projects.

Desired Outcomes. Students will get familiar with different programming paradigms. Notably, they will particularly focus on Object Oriented design patterns and functionalities.

COMP-4002 Introduction to Machine Learning

Topics. Overview and fundamentals of machine learning concepts and applications; Introduction to Python and its relevance in machine learning; Understanding and utilizing the Numpy library for handling multidimensional arrays; Introduction to the data-driven approach in building models for machine learning; Techniques for data cleaning, transformation, and visualization for effective model building; Understanding model complexity and the significance of cross-validation in machine learning; Exploring and implementing simple models for classification tasks; Understanding and applying simple regression models for predictive analysis; Introduction to clustering algorithms and their applications; Hands-on experience with Jupyter notebooks for coding machine learning projects; Guidelines and practices for documenting and presenting findings from machine learning experiments.

Desired Outcomes. Students will get familiar with basic Machine Learning concepts, like model complexity, classification and regression. Students will learn how to run simple Python programs in Jupyter notebooks to validate well-known Machine Learning models taken from established libraries.

Alternative Entry: Applicants who hold degrees (at least a BSc) in other fields but can showcase strong analytical skills, can also apply. In order to ensure success in the program, such applicants will be required to undergo specialized assessments to evaluate their foundational skills. The Basic Competencies Assessment (BCA) will be based on the following preparatory modules taken

from OPIT programs, which are offered free of charge during summer, before the start of the first Term:
COMP-2001 Foundational Mathematics
COMP-3003 Programming Paradigms
COMP-4002 Introduction to Machine Learning

The BCA consists of a test with a mix of multi-choice and open-ended questions. If a student fails more than 50% of the questions, the test is considered as failed. Students not clearing the BCA will have an opportunity for a retake after a dedicated period of remedial guidance, within the same academic year.

Recognition of Prior Learning
OPIT recognizes previous academic and professional experience in different ways. Procedures that describe the mechanisms related to admission and RPL are entirely described at the following webpage:

https://www.opit.com/fee-admission/

Learning Outcomes for Knowledge obtained at the end of the programme	The learner will be able to: a) Recall foundational AI principles and their relevance in contemporary digital ecosystems b) Highlight and describe relevant AI methodologies and their applications c) Tag and identify prevalent ethical issues with modern AI methods d) Spread AI-related knowledge through blogs and media, providing insights on the applicability of established AI methods in various settings e) Search and list AI methods to deal with specific applications f) Comment on the ethical implications of using generative models in applications involving Natural Language Processing and Computer Vision g) Highlight and describe the peculiarities of high-dimensional and complex datasets h) Write clear explanations, translating intricate AI challenges for a broader audience
Learning Outcomes for Skills obtained at the end of the programme	The learner will be able to: a) Communicate ethical implications of modern AI tools b) Identify the principles of a responsible AI c) Apply established AI methods to different real application scenarios d) Design AI pipelines and strategies tailored to specific industry needs, integrating best practices e) Demonstrate proficiency in using advanced AI tools f) Demonstrate the ability to design novel AI tools based on the existing ones g) Conduct research involving AI methods and applications h) Compose detailed research reports, synthesizing complex data and findings into actionable recommendations i) Investigate the complexities of modern high-dimensional and structured datasets

90 ECTS

Hours of Total Learning

1 ECTS is equivalent to 25 total hours of learning, inclusive of contact hours, supervised placement and practice hours, self-study hours and assessment hours.

Total Contact Hours [1] 509 (Contact Hours are hours invested In learning new content under the Direction of a tutor/lecturer (e.g. lectures, participation in online forums, video-lectures)	Supervised Placement and Practice Hours 504 (During these hours the learner is supervised, coached, or mentored. Tutorial hours may be included here)
Self-Study Hours 1105 (Estimated workload of research and study)	Assessment Hours 128 (Examinations/ presentations/ group work/ projects, etc.)
Total Learning Hours	**2250 Hours**

120 ECTS

Hours of Total Learning

1 ECTS is equivalent to 25 total hours of learning, inclusive of contact hours, supervised placement and practice hours, self-study hours and assessment hours.

Total Contact Hours [2] 691 (Contact Hours are hours invested In learning new content under the Direction of a tutor/lecturer (e.g. lectures, participation in online forums, video-lectures)	Supervised Placement and Practice Hours 637 (During these hours the learner is supervised, coached, or mentored. Tutorial hours may be included here)
Self-Study Hours 1544 (Estimated workload of research and study)	Assessment Hours 128 (Examinations/ presentations/ group work/ projects, etc.)
Total Learning Hours	**3000 Hours**

[1] In the case of online learning, synchronous and asynchronous learning activities under the direction and control of an instructor are considered as contact hours.
[2] In the case of online learning, synchronous and asynchronous learning activities under the direction and control of an instructor are considered as contact hours.

The Program Structure						
Module/ Unit Title	**Compulsory (C) or Elective (E)**	**ECTS**	**MQF Level**	**Mode of Teaching**	**Mode of Assessment**	**Term**
Introduction to AI and Ethics	Compulsory	6	7	Live lectures, asynchronous contents	Exercises, Tests	1
Data Analytics and Visualization	Compulsory	6	7	Live lectures, asynchronous contents	Exercises, Tests	1
Human-Centered AI Design	Compulsory	6	7	Live lectures, asynchronous contents	Exercises, Tests	1
Programming for AI	Compulsory	6	7	Live lectures, asynchronous contents	Exercises, Tests	1
Machine Learning	Compulsory	6	7	Live lectures, asynchronous contents	Exercises, Tests	1
Natural Language Processing	Compulsory	6	7	Live lectures, asynchronous contents	Exercises, Tests	2
Computer Vision	Compulsory	6	7	Live lectures, asynchronous contents	Exercises, Tests	2
Computing Architectures for AI	Compulsory	6	7	Live lectures, asynchronous contents	Exercises, Tests	2
AI for IoT and Automation	Compulsory	6	7	Live lectures, asynchronous contents	Exercises, Tests	2
AI in Business, Strategy, and Entrepreneurship	Compulsory	3	7	Live lectures, asynchronous contents	Exercises, Tests	2
Research Methods and Tools	Compulsory	3	7	Live lectures, asynchronous contents	Exercises, Tests	2
Capstone Project and Dissertation - for students completing MSc at 90 ECTS	Compulsory	30	7	-	Project, Dissertation	3
Capstone Project and Dissertation - for students completing MSc at 120 ECTS	Compulsory	60	7	-	Project, Dissertation	3 - 4
Total ECTS for Program Completion		**90/120 ECTS**				

Introduction to AI and Ethics
Compulsory
6 ECTS
Term 1

Course Description

Artificial Intelligence (AI) has rapidly transformed our world, introducing new capabilities, challenges, and ethical dilemmas.
This module gives an overview of the AI landscape, its history and evolution, basic algorithms, and problem-solving techniques. Then, it delves into the ethical considerations and societal impacts of AI. In addition to developing a good knowledge of the AI landscape, the students will gain a comprehensive understanding of the ethical frameworks that guide AI development, deployment, and regulation, and develop the critical thinking skills needed to address AI-related ethical issues in various domains.

Topics include:

- Foundations of Technology Ethics
- Ethical Toolkit in Technology
- Introduction to Data Science and Artificial Intelligence
- Machine Learning Explainability
- Bias and Fairness in AI Models
- Disinformation, Privacy and Surveillance
- AI Regulations
- Other Regulations Related to AI

Applying Knowledge and Understanding

At the end of the module/unit the learner will have acquired the following skills:

a) Recall basic and modern AI methods
b) Identify ethical and societal implications of AI methods
c) Define the concepts of bias and explainability in AI

Module-Specific Learner Skills

At the end of the module/unit the learner will be able to

a) Demonstrate a comprehensive understanding of the AI landscape
b) List the main ethical challenges of AI
c) Define guidelines for implementing responsible AI applications
d) Analyze AI software projects from an ethical perspective

Module-Specific Digital Skills and Competences

At the end of the module/unit, the learner will be able to

a) N/A

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Data Analytics and Visualization
Compulsory
6 ECTS
Term 1

Course Description

Modern AI applications have to deal with complex data characterized by many, possibly heterogeneous variables; such complex datasets are usually very large as well. One usually wants to perform preliminary exploratory analyses to make a first assessment of the data in order to design the most suitable AI pipeline. However, such complex datasets are impossible to understand in their native form.
This module focuses on techniques for visualizing large and complex datasets. The module uses the Python programming language.

Topics include:

- Data preprocessing and cleaning
- Data storytelling and communication
- Linear dimensionality reduction
- Nonlinear dimensionality reduction
- Manifold learning
- Visualization of graph-structured data

Applying Knowledge and Understanding

At the end of the module/unit the learner will have acquired the following skills:

a) Apply techniques to clean datasets
b) Apply techniques to visualize complex data
c) Design complex data visualization pipelines

Module-Specific Learner Skills

At the end of the module/unit the learner will be able to

a) Design data visualization methods based on linear and nonlinear methods
b) Use tools to clean datasets
c) Demonstrate expertise in highlighting the pros and cons of various data visualization methods

Module-Specific Digital Skills and Competences

At the end of the module/unit, the learner will be able to

a) Use Python libraries for reducing the dimensionality of complex data, such as scikit-learn
b) Create human-interpretable plots with pandas

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Human-Centered AI Design
Compulsory
6 ECTS
Term 1

Course Description

In an era where Artificial Intelligence (AI) is reshaping industries and society, it is essential to prioritize the human experience in AI-driven solutions. This module aims to equip students with the knowledge and skills required to develop AI systems that prioritize and respect human values, needs, experiences, and foster inclusivity. The module's plan is to rigorously investigate and design forms of human-AI interactions and experiences that enhance and extend human capabilities for the good of society at large.

Topics include:

- Introduction to Human-Centered AI Design
- From Responsible AI (RAI) to Human-Centered AI (HCAI)
- Rationalism versus Empiricism
- Uses and Abuses of the Automation Paradigm
- Putting Humans at the Centre
- A Theoretical Framework and Some Design Guidelines
- Human-Machine Division of Labor
- Finding AI Opportunities and Assessing Them
- Building Human-Centered AI Products: Trust
- Building Human-Centered AI Products: Feedback and Errors
- Building Human-Centered AI Products: Prototyping

Applying Knowledge and Understanding

At the end of the module/unit the learner will have acquired the following skills:

a) Discuss usability goals and user experience goals for designing an interactive product
b) Apply suitable methods for evaluating interactive technologies
c) Use suitable methods for establishing requirements

Module-Specific Learner Skills

At the end of the module/unit the learner will be able to

a) Conduct usability tests and gather feedback from users to iterate and improve AI systems
b) Discuss the conceptual, practical, and ethical issues involved in using AI methods and designing interfaces and interaction methods with humans
c) Discuss the advantages and disadvantages of low-fidelity and hi-fidelity prototypes
d) Design prototypes of interactive products based on AI

Module-Specific Digital Skills and Competences

At the end of the module/unit, the learner will be able to

a) Create unbiased and ethical design solutions based on AI tools in Python
b) Design methods like personas, scenarios, user journeys, storyboards, wireframes, mockups, usability testing

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Programming for AI
Compulsory
6 ECTS
Term 1

Course Description

In the age of Artificial Intelligence (AI), programming is the key to unlocking the potential of intelligent systems. This module focuses on providing the programming tools essentials for modern AI systems, such as programming concepts (including advanced data structures like dictionaries), object oriented and functional programming paradigms, jupyter notebooks, advanced numpy, data visualization libraries, and an introduction to scikit-learn. The language of choice will be Python.

Topics include:

- Introduction to Python
- Jupyter notebooks with Python
- Advanced string functions
- Dictionaries and advanced data structures
- OO design
- Functional programming with Python
- Numpy
- Pandas
- Scikit-learn
- Version control systems such as GitHub

Applying Knowledge and Understanding

At the end of the module/unit the learner will have acquired the following skills:

a) Demonstrate advanced software design skills in Python
b) Use advanced string functions in Python
c) Use main functionalities for managing multidimensional arrays with numpy
d) Use data handling and visualization methods in pandas
e) Create simple machine learning models with scikit-learn

Module-Specific Learner Skills

At the end of the module/unit the learner will be able to

a) Design software using OO and functional programming paradigms
b) Use functionalities to manipulate multidimensional arrays
c) Demonstrate expertise with basic machine learning models

Module-Specific Digital Skills and Competences

At the end of the module/unit, the learner will be able to

a) Use Python for AI applications
b) Use basic and advanced numpy functions to manipulate arrays
c) Assemble software pipelines in Python to connect with scikit-learn

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Machine Learning
Compulsory
6 ECTS
Term 1

Course Description

The Machine Learning module gives students advanced knowledge on different data-driven methodologies. Notably, in this module students will look at different machine learning models and related learning algorithms that deal with classification, regression, clustering, and generation tasks. They will learn the core principles and how to use standard frameworks to train, evaluate, and use them with real-world examples. Students will explore different methodologies of increasing complexity, starting from relatively simple models like support vector machines, and concluding with modern deep learning models. The conceptual and theoretical notions will be accompanied by practical examples using scikit-learn and keras, two well-known Python frameworks.

Topics include:

- Data pre-processing and validation.
- Training paradigms in machine learning
- Support vector machines and kernel methods
- Clustering
- Multilayer perceptrons
- Convolutional and graph neural networks.
- Recurrent neural networks.
- Autoencoders
- Generative models

The module will stress the use of jupyter notebooks for developing code for machine learning projects and writing reports.

Applying Knowledge and Understanding

At the end of the module/unit the learner will have acquired the following skills:

a) Apply novel machine learning methods in applications
b) Compare different machine learning methodologies within sound frameworks
c) Design and implement machine learning models for applications
d) Create human-readable reports of the performance of machine learning methods

Module-Specific Learner Skills

At the end of the module/unit the learner will be able to

a) Design and implement kernel methods
b) Design and implement neural networks for processing images and graph-structured data
c) Design and implement neural networks for processing sequences
d) Design and implement basic generative neural networks

Module-Specific Digital Skills and Competences

At the end of the module/unit, the learner will be able to

a) Use scikit-learn
b) Use keras
c) Use tensorflow

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Natural Language Processing
Compulsory
6 ECTS
Term 2

Course Description

In a world driven by data and communication, understanding and processing human language is a game-changer.
In this course, students will acquire the fundamental knowledge and practical skills needed to work with natural language data and develop applications that understand, generate, and interpret human language.
This module also introduces specialized libraries and tools for Natural Language Processing (NLP) based on modern deep learning methods.

Topics include:

- Text mining
- Sentiment analysis
- Language generation
- Machine translation
- Symbolic methods for NLP
- Deep learning models for NLP
- Ethical considerations on AI-based NLP

Applying Knowledge and Understanding

At the end of the module/unit the learner will have acquired the following skills:

a) Design AI-driven NLP applications
b) Analyze the effectiveness of AI in tasks involving NLP
c) Implement AI models and tools to enhance data-driven pipelines involving NLP components
d) Gain insights into the ethical aspects of AI-driven NLP, including bias, privacy, and responsible AI development

Module-Specific Learner Skills

At the end of the module/unit the learner will be able to

a) Apply NLP techniques to real-world applications, such as social media sentiment analysis, customer support automation, healthcare text mining, and more
b) Design advanced methods for text generation, abstractive summarization, and document classification using AI
c) Demonstrate an understanding of ethical considerations in AI for NLP

Module-Specific Digital Skills and Competences

At the end of the module/unit, the learner will be able to

a) Use popular NLP libraries and tools, including NLTK, spaCy, Gensim, Hugging Face Transformers, and TensorFlow
b) Create chatbots and virtual assistants using AI, enabling them to engage in meaningful and context-aware conversations

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Computer Vision
Compulsory
6 ECTS
Term 2

Course Description

Computer vision, the art of enabling machines to see and understand the visual world, has made remarkable strides with the advent of deep learning. The module aims to teach how to unleash the power of visual intelligence with modern deep learning methods.
The module will start by giving a strong foundation in computer vision principles, including image processing, feature extraction, and object detection. Then, it delves into modern methods based on convolutional and generative neural networks. The students will get familiar with popular deep learning frameworks like TensorFlow and PyTorch and learn how to use them for computer vision projects. Finally, the module will stress ethical implications and challenges in computer vision, including privacy, bias, and responsible AI development.

Topics include:

- Foundations of computer vision
- Convolutional neural networks
- Generative neural networks
- Transfer learning
- Object detection and localization
- Semantic segmentation
- Image captioning
- Visual recognition applications
- Deep learning models for computer vision
- Ethical considerations

Applying Knowledge and Understanding

At the end of the module/unit the learner will have acquired the following skills:

a) Design robust convolutional and generative neural networks for computer vision tasks
b) Design techniques for identifying and localizing objects within images using state-of-the-art approaches based on deep learning
c) Design techniques for generating visual data

Module-Specific Learner Skills

At the end of the module/unit the learner will be able to

a) Learn to design, train, and fine-tune convolutional neural networks for various visual recognition tasks
b) Develop the ability to perform pixel-level image segmentation, enabling you to identify and delineate objects within an image
c) Apply generative networks to tasks like image generation, style transfer, and super-resolution

Module-Specific Digital Skills and Competences

At the end of the module/unit, the learner will be able to

a) Explore the power of transfer learning by leveraging pre-trained deep learning models (e.g., ResNet, Inception) for custom computer vision projects

b) Apply popular deep learning frameworks such as TensorFlow and PyTorch, and learn to implement computer vision models using these tools

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Computing Architectures for AI
Compulsory
6 ECTS
Term 1

Course Description

As Artificial Intelligence (AI) continues to shape the technological landscape, understanding the hardware and computing architectures that drive AI innovation is essential. This module covers various types of computing architectures for enabling the execution of AI models and applications, including clusters, cloud systems, graphic processing units (GPUs) and tensor processing units (TPUs), neuromorphic hardware, photonic computing systems, and quantum computers. The module stresses the pros and cons of the different computing architectures and highlights their sustainability in terms of power consumption, CO2 production, and related impact on the environment.

Topics include:

- Clusters and high-performance computing
- Cloud environments for AI
- GPUs and TPUs
- Neuromorphic hardware
- Photonic computing systems
- Quantum computers and quantum machine learning
- Sustainability and environmental impact of computing architectures

Applying Knowledge and Understanding

At the end of the module/unit the learner will have acquired the following skills:

a) Plan the deployment of AI applications on specific architectures
b) Show pros and cons of different computing architectures for AI applications
c) Demonstrate the impact of computing architectures on the environment

Module-Specific Learner Skills

At the end of the module/unit the learner will be able to

a) Apply principles of good practice to design data centers with dedicated servers and GPUs for AI research and application
b) Plan distributed computing clusters with multiple GPUs or TPUs for training large deep learning models
c) Demonstrate pros and cons of AI-specific hardware, such as field-programmable gate array and photonic systems
d) Show the advantages and challenges of quantum computing
e) Apply quantitative and qualitative measures to select among possible computing architectures for AI
f) Demonstrate an understanding of pros and cons of different computing architectures for AI

Module-Specific Digital Skills and Competences

At the end of the module/unit, the learner will be able to

a) Use the AWS cloud system to explore a range of AI and machine learning services, along with GPU-accelerated instances for training and inference

b) Use IBM Qiskit: https://www.ibm.com/quantum/qiskit-runtime

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AI for IoT and Automation
Compulsory
6 ECTS
Term 2

Course Description

In today's rapidly evolving technological landscape, the combination of Artificial Intelligence (AI), the Internet of Things (IoT), and automation is transforming industries and redefining the way we interact with our environment. This course delves into the synergy between AI, IoT, and automation, equipping students with the knowledge and skills to design and implement intelligent, automated systems.

Topics include:

- Introduction to the significance of AI in IoT and automation
- Types of IoT sensors and data sources
- Edge computing in IoT and AI
- Integrating AI for automation
- Computer vision applications in IoT: Object detection, recognition, and tracking
- Video analytics for surveillance and automation
- Case studies and real-world applications: Smart cities, healthcare, agriculture, and more
- Future technologies: Edge AI, 5G, and AIoT
- Ethical considerations, privacy concerns, and regulatory aspects

Applying Knowledge and Understanding

At the end of the module/unit the learner will have acquired the following skills:

a) Design data collection methods for IoT devices
b) Analyze data from IoT devices
c) Deploy models to edge devices
d) Analyze case studies of AI applications in industrial automation
e) Define relevant challenges in smart cities and smart factories

Module-Specific Learner Skills

At the end of the module/unit the learner will be able to

a) Apply supervised and unsupervised machine learning techniques to IoT data
b) Perform feature engineering on IoT data to extract meaningful information
c) Address missing and noisy data in IoT datasets
d) Implement real-time and streaming data processing for IoT systems
Demonstrate the significance of edge AI, 5G, and the AIoT (AI of Things)

Module-Specific Digital Skills and Competences

At the end of the module/unit, the learner will be able to

a) Design supervised and unsupervised machine learning methods using Python for analyzing data from IoT devices
b) Use the AWS IoT Device Simulator: https://aws.amazon.com/solutions/implementations/iot-device-simulator/

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AI in Business, Strategy, and Entrepreneurship
Compulsory
6 ECTS
Term 2

Course Description

In the era of digital transformation, businesses and entrepreneurs are discovering unprecedented opportunities through the integration of Artificial Intelligence (AI). This module is designed to equip students with the knowledge to leverage AI technologies for competitive advantage and entrepreneurial success. Notably, the module will focus on developing the strategic insights that are needed to make use of AI technologies in various business sectors.

Topics include:

- Understanding AI in various business sectors
- AI strategy and leadership
- AI-Driven innovation
- Supply Chain Optimisation with AI
- AI in Financial Analysis
- AI in Marketing and customer engagement
- Entrepreneurship and AI startups
- Legal and ethical implications
- Case studies and industry insights

Applying Knowledge and Understanding

At the end of the module/unit the learner will have acquired the following skills:

a) Recall the legal and ethical aspects of AI in business, including data privacy, compliance, and responsible AI use
b) Describe how AI can enhance marketing strategies, customer analytics, and personalized customer engagement
c) Describe how AI can enhance Supply Chain Optimisation
d) Describe how AI can be used for Financial Analysis

Module-Specific Learner Skills

At the end of the module/unit the learner will be able to

a) Analyze real-world case studies and hear from industry experts about AI's impact on their businesses
b) Learn to identify AI-driven innovation opportunities and harness them to create business value and sustainable growth
c) Explore how entrepreneurs are disrupting industries by founding AI startups, and learn how to take an AI idea to market

Module-Specific Digital Skills and Competences

At the end of the module/unit, the learner will be able to

a) N/A

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Research Methods and Tools
Compulsory
3 ECTS
Term 2

Course Description

This Module consists of a number of lectures and seminars intended to provide students with an understanding of research methodologies required, and tools available, to undertake research in computer science. The module will offer guidance on how to undertake literature reviews, how to plan a research project, how to collect, process and analyze data, both quantitative and qualitative, and how to use appropriate conventions to write up research reports and a graduate-level thesis.

Applying Knowledge and Understanding

At the end of the module/unit the learner will have acquired the following skills:

a) Plan a research assignment, including the formulation of a research question, the development of a proposal or hypothesis, and the design of a process to test such hypothesis
b) Use electronic library resources
c) Design a sampling programme, an interview or a questionnaire
d) Analyze research results, quantitatively or qualitatively as appropriate
e) Write research reports clearly, in a style appropriate to purpose and in accordance with accepted standards
f) Know how to properly reference existing literature
g) Prioritize transparency, collaboration, and openness in scientific research
h) Verify data sources and privacy regulations

Module-Specific Learner Skills

At the end of the module/unit the learner will be able to

a) Undertake a literature review, and handle and critically evaluate sources, as well as properly reference such sources
b) Use appropriate tools to optimize the creation of research documents, and the presentation of research results
c) Determine what is expected from an MSc dissertation

Module-Specific Digital Skills and Competences

At the end of the module/unit, the learner will be able to

a) Use presentation tools such as Powerpoint

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Capstone Project and Dissertation - for students completing MSc at 90 ECTS
Compulsory
30 ECTS
Term 3

Course Description

The Capstone Project and Dissertation is the most significant project assigned to students throughout their program. It is intended to consolidate the skills gained during the program through a research project. Each student, together with an OPIT supervisor, will work on a project proposal that will then be realized through the final terms of their program. The project needs to be a research work of industrial relevance that investigates methodological and/or practical aspects in any of the domains discussed in the program and beyond. Students will also have the opportunity to conduct internships with industrial partners as a way to work and complete their Capstone Project and Dissertation module. In general, the dissertation document should show that the student has achieved mastery of the field and is fully conversant with the relevant literature.

The capstone project is the longest and most challenging project assigned to a student, requiring a long preparation and hard work. The supervisor's role is to guide the student since most of the project should be carried on as an independent work. Students are required to prepare a document where they will describe the project goals and the obtained results. The results should provide enough depth within a particular field of application and be consistent with the original plan agreed with the supervisor. At the end of the process, the student would have learnt to conduct independent research, problem-solving, numerical mastery, project management, time management, and self-discipline, amongst others.

The thesis will be presented to an examining committee. The student will be expected to defend the work done and the results presented. This happens typically via an oral examination called a viva, where the student presents their work and answers questions from the committee.

The final thesis manuscript should consist of 10,000 - 20,000 words.

Applying Knowledge and Understanding

At the end of the module/unit the learner will have acquired the following skills:

a) Apply research methodologies to explore, analyze, and address complex cybersecurity challenges
b) Practice structured writing techniques to produce a comprehensive research document
c) Demonstrate a deep understanding of a chosen cybersecurity topic, substantiating claims with evidence
d) Show the ability to critically review existing literature and identify gaps or areas of improvement
e) Plan and execute a research project within a stipulated time-frame, ensuring milestones are met

f) Design experiments or simulations, as applicable, to validate hypotheses or research questions
g) Operate relevant cybersecurity tools and platforms to gather, analyze, and present data
h) Assemble and organize research findings in a coherent and logical manner, ensuring a flow of ideas
i) Use feedback from peers and advisors to refine and improve the research process and outcomes
j) Construct arguments and discussions backed by empirical evidence or theoretical frameworks
k) Prepare and present findings to both technical and non-technical audiences, ensuring clarity and understanding
l) Create actionable recommendations or solutions based on research findings, ensuring they are practical and implementable
m) Compose a comprehensive document that adheres to academic standards and is free from plagiarism
n) Arrange findings, discussions, and conclusions in a structured manner, ensuring the document is reader-friendly and organized

Module-Specific Learner Skills

At the end of the module/unit the learner will be able to

a) Manage their own learning process, setting research goals, and milestones in line with the project's objectives
b) Negotiate with potential stakeholders, if applicable, to gather necessary data or insights for the research
c) Supervise and ensure the ethical collection and use of data, respecting privacy and confidentiality standards
d) Guide discussions and arguments in the research, ensuring they are grounded in evidence and sound reasoning
e) Authorize and finalize the submission of the research, ensuring all academic and institutional criteria are met

Module-Specific Digital Skills and Competences

At the end of the module/unit, the learner will be able to

a) Operate specialized software or platforms relevant to the research topic, ensuring accurate data collection and analysis
b) UtilizeUtilise digital tools for literature review, citation management, and plagiarism checking
c) Arrange and visualize data using appropriate digital tools, ensuring clear representation of findings
d) Design and run simulations or models, if applicable, to validate hypotheses using dedicated software
e) Apply cybersecurity tools to protect research data, ensuring its integrity and confidentiality
f) Compose the research document using digital word processing software, adhering to specified formatting standards

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Capstone Project and Dissertation - for students completing MSc at 120 ECTS
Compulsory
60 ECTS
Term 3 - 4

Course Description

The Capstone Project and Dissertation is the most significant project assigned to students throughout their program. It is intended to consolidate the skills gained during the program through a research project. Each student, together with an OPIT supervisor, will work on a project proposal that will then be realized through the final terms of their program. The project needs to be a research work of industrial relevance that investigates methodological and/or practical aspects in any of the domains discussed in the program and beyond. Students will also have the opportunity to conduct internships with industrial partners as a way to work and complete their Capstone Project and Dissertation module. In general, the dissertation document should show that the student has achieved mastery of the field and is fully conversant with the relevant literature.

The capstone project is the longest and most challenging project assigned to a student, requiring a long preparation and hard work. The supervisor's role is to guide the student since most of the project should be carried on as an independent work. Students are required to prepare a document where they will describe the project goals and the obtained results. The results should provide enough depth within a particular field of application and be consistent with the original plan agreed with the supervisor. At the end of the process, the student would have learnt to conduct independent research, problem-solving, numerical mastery, project management, time management, and self-discipline, amongst others.

The thesis will be presented to an examining committee. The student will be expected to defend the work done and the results presented. This happens typically via an oral examination called a viva, where the student presents their work and answers questions from the committee.

The final thesis manuscript should consist of 150,000 - 30,000 words.

The module instance described here is worth 60 ECTS. The main differences between a 30 and a 60 ECTS Capstone Project and Dissertation are the duration and the value of the results reached by the students. Students opting for the 60 ECTS version will be required to work two full Terms (instead of one) on the module and will be expected to produce results that are publishable in relevant journals and/or conference proceedings. On the other hand, students working on the 30 ECTS version are not expected to reach that level of quality at the time of graduation.

Applying Knowledge and Understanding

At the end of the module/unit the learner will have acquired the following skills:

a) Apply research methodologies to explore, analyze, and address complex cybersecurity challenges

b) Practice structured writing techniques to produce a comprehensive research document

c) Demonstrate a deep understanding of a chosen cybersecurity topic, substantiating claims with evidence

d) Show the ability to critically review existing literature and identify gaps or areas of improvement

e) Plan and execute a research project within a stipulated time-frame, ensuring milestones are met

f) Design experiments or simulations, as applicable, to validate hypotheses or research questions

g) Operate relevant cybersecurity tools and platforms to gather, analyze, and present data

h) Assemble and organize research findings in a coherent and logical manner, ensuring a flow of ideas

i) Use feedback from peers and advisors to refine and improve the research process and outcomes

j) Construct arguments and discussions backed by empirical evidence or theoretical frameworks

k) Prepare and present findings to both technical and non-technical audiences, ensuring clarity and understanding

l) Create actionable recommendations or solutions based on research findings, ensuring they are practical and implementable

m) Compose a comprehensive document that adheres to academic standards and is free from plagiarism

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Module-Specific Learner Skills

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d) Design and run simulations or models, if applicable, to validate hypotheses using dedicated software

e) Apply cybersecurity tools to protect research data, ensuring its integrity and confidentiality

f) Compose the research document using digital word processing software, adhering to specified formatting standards

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