



D4.2 Specific Curriculum



MACHINE LEARNING ENGINEER EQF 6



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Project information

The Artificial Intelligence Skills Alliance (ARISA) fast-tracks the upskilling and reskilling of employees, job seekers, business leaders, and policymakers into AI-related professions to open Europe to new business opportunities. It is a four-year transnational project funded under the EU’s Erasmus+ programme. For more information, contact info@aiskills.eu | aiskills.eu

Project Partners



List of abbreviations

AI	Artificial Intelligence
ARISA	Artificial Intelligence Skills Alliance
EQF	European Qualification Framework
EU	European Union

Table of contents

1. GENERAL INFORMATION 4

2. DESCRIPTION OF THE STRUCTURE 5

3. OVERVIEW OF LEARNING UNITS..... 6

4. DETAILS OF LEARNING UNITS 7

4.1. MACHINE LEARNING FOUNDATION 7

4.2. DEEP LEARNING 9

4.3. MACHINE LEARNING OPERATIONS (MLOPS)..... 11

4.4. AI APPLICATIONS (NLP, CODING TOOLS, CV, SPEECH, CYBERSEC, ETC.)..... 13

4.5. GENERATIVE AI..... 15

4.6. EXPLAINABLE AI 17

4.7. AI FOR BUSINESS..... 19

4.8. AI ETHICS..... 21

4.9. PROJECT AND THESIS WORK..... 23

1. General information

Name	Machine Learning Engineer
EQF level	EQF 6
Goals	<p>The intent of the EQF 6 Machine Learning (ML) Engineer curriculum is to provide a solid base in ML techniques, develop machine learning and AI skills, and ensure the ability to join teams that build and manage ethical and secure AI systems.</p> <p>Its aim is to produce graduate professional who are ready to enter the job market as entry-level ML Engineers, capable of assisting in tackling complex problems and contributing to advancements in technology and society, as well as being capable of applying their knowledge to real-world problems.</p>
Scope	<p>The curriculum is aimed at people who intend to become entry-level ML Engineers. It can also be used to upskill or reskill individuals that already have a background in computer science and want to specialize in ML.</p> <p>It is also intended to both articulate how to instantiate this curriculum for both microcredentials/short courses as well as a specialisation for conventional first-cycle degree courses, as both options are valid for aspiring ML Engineers (for example if they possess a related degree already)</p> <p>It is also agnostic as regards platforms and APIs so to allow customisation to local requirements</p>
Entry requirements	<p>As expected from the first two years of a bachelor's degree in computer science or a related subject, specifically:</p> <p>Python programming, basic data preprocessing, basic databases</p> <p>Linear Algebra</p> <p>Calculus</p> <p>Probability theory</p> <p>Resources such as the following may be used for already competent programmers who wish to familiarise themselves with Python beforehand:</p> <p>https://cs231n.github.io/python-numpy-tutorial/</p> <p>https://pandas.pydata.org/pandas-docs/stable/user_guide/10min.html</p>
Programme learning outcomes (PLOs)	<p>1 - Deep Learning (EQF 6)</p> <p>2 - AI Technologies (EQF 6)</p> <p>3 - ML Ops (EQF 6)</p>

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4 - Machine Learning (EQF 6)
5 - Explainable AI (EQF 6)
6 - AI Ethics (EQF 6)
7 - AI Awareness (EQF 6)
8 - Cyber and Data Security (EQF 5)
9 - Generative AI (EQF 6)
11 - Soft Skills (EQF 6)

2. Description of the structure

The two learning units ML Foundations and Deep Learning comprise a base that covers the key concepts that underpin the role.

Thereafter there are two sets of extension learning units. The first set deepens and broadens ML technical knowledge and skills in important areas (MLOps, Generative AI, Explainable AI). An AI Applications learning unit has also been articulated to allow customisable delivery in specific application areas such as cybersecurity and NLP.

Following from this, two additional extension learning units are aimed at developing aspiring graduate ML Engineers to be effective deliverers of technological solutions to clients (AI for Business and AI Ethics).

It is worth noting that it is assumed that soft skills will be developed through the curriculum.

Though 5 ECTS is assumed as a default to support conventional first-cycle studies, a range is given. For example, a microcredential aimed at upskilling established developers might require fewer ECTS as some of the outcomes could be deemed to have been already met to some degree.

There is a capstone Project and Thesis Work learning unit. This supports both a traditional academic project typical of first-cycle studies, as well as a work-based or industrial project. It could also be used as a concluding unit in a microcredential-based scheme that leads to a larger award. A minimum of 5 ECTS is suggested to allow for an extended piece of work to be produced.

3. Overview of Learning Units

Learning unit title	Hours/ECTS	EQF level	Assessment(s)
Machine Learning Foundation	5-10 ECTS	EQF 6	Exam and/or Practical Assignment, Project work
Deep Learning	2-8 ECTS	EQF 6	Exam and/or Practical Assignment, Project work
Machine Learning Operations (MLOps)	2-5 ECTS	EQF 6	Exam and/or Practical Assignment, Project work
AI Applications (NLP, coding tools, CV, Speech, cybersec, etc.)	1-5	EQF 6	Exam and/or Practical Assignment, Project work
Generative AI	2-5 ECTS	EQF 6	Exam and/or Practical Assignment, Project work
Explainable AI	2-5 ECTS	EQF 6	Exam and/or Practical Assignment, Project work
AI for Business	1-5 ECTS	EQF 6	Exercises based on the analysis of case studies and/or realistic scenarios (can be under exam conditions if required, also scope for groupwork)
AI Ethics	1-5 ECTS	EQF 6	Exercises based on the analysis of case studies and/or realistic scenarios (can be under exam conditions if required, also scope for groupwork)
Project and Thesis work	5+ ECTS	EQF 6	Project report, presentation/demonstration.

4. Details of Learning Units

4.1. Machine Learning Foundation

Description

The "Machine Learning foundation" learning unit is designed to provide students with a deep understanding of machine learning foundations, including supervised and unsupervised learning techniques. Students will learn how to develop, evaluate, and optimize predictive models to solve various classification and regression problems, and to identify clusters, reduce dimensionality, and extract useful features from data.

Topics:

1. Types of machine learning (e.g. supervised, unsupervised, self-supervised, reinforcement learning)
2. (1) k-NN, Linear and Logistic regression, (2)
3. Decision Trees, Random Forrest, XGBoost and & SVM, (3)
4. Model Evaluation and Validation, (4)
5. Hyperparameter Tuning and Model Optimization and (5) AutoMLK-means and Hierarchical Clustering, (3)
6. DBSCAN,
7. GMM,
8. Dimensionality Reduction: PCA, t-SNE and UMAP,
9. Anomaly Detection Model Evaluation and Validation,

Related Programme Learning Outcome(s)

- 1 - Deep Learning (EQF 6)
- 2 - AI Technologies (EQF 6)
- 3 - ML Ops (EQF 6)
- 4 - Machine Learning (EQF 6)
- 5 - Explainable AI (EQF 6)
- 7 - AI Awareness (EQF 6)
- 8 - Cyber and Data Security (EQF 5)
- 9 - Generative AI (EQF 6)
- 11 - Soft Skills (EQF 6)

Unit learning outcomes

- Analyzes the fundamental principles of neural networks
- Selects appropriate AI frameworks and libraries for specific project needs
- Develops AI models using chosen frameworks and libraries
- Analyses the performance and efficiency of AI models and technologies
- Adapts existing AI models to new contexts and problems

- Demonstrates an ongoing commitment to advancing skills and knowledge
- Adapts machine learning models to evolving data and requirements
- Applies fundamental machine learning concepts and algorithms
- Evaluates machine learning models using established metrics and validation techniques
- Designs data pre-processing and feature engineering strategies
- Assesses the ethical implications of machine learning projects
- Develops AI models using explainable AI techniques to ensure transparency and interpretability
- Analyses existing AI models to assess and measure their explainability
- Implements strategies to improve the explainability of existing AI models
- Evaluates the impact of explainable AI on model performance
- Conveys the principles and benefits of explainable AI to stakeholders
- Understands the basic concepts and technologies underlying artificial intelligence
- Identifies key AI applications in the programming application market
- Knowledge of current trends in AI technology
- Engages in continuous learning to keep pace with rapid advancements in AI technology
- Conveys the principles and potential of generative AI to a broad audience
- Engages in continuous learning and professional development
- Collaborates within teams, contributing positively to group efforts
- Solves problems creatively and efficiently
- Delivers impactful presentations
- Cultivates an innovative mindset, embracing and fostering creativity
- Communicates effectively across a variety of platforms and media
- Thinks critically, analysing situations, evaluating diverse perspectives

Delivery method(s)

In-class / Blended learning

Materials

Learning materials: presentation slides and example practical exercises.

Suggested materials:

- Bishop, C. M., & Nasrabadi, N. M. (2006). Pattern recognition and machine learning (Vol. 4, No. 4, p. 738). New York: sSpringer.
- [Géron, A. \(2022\). Hands-on machine learning with Scikit-Learn, Keras, and TensorFlow. " O'Reilly Media, Inc."](#)
- [Stuart Russell, Peter Norvig \(2021\), Artificial Intelligence: A Modern Approach, 4th edition, Pearson](#)

4.2. Deep Learning

Description

The "Deep Learning" learning unit is focused on introducing students to the fundamentals of neural networks, a cornerstone of modern artificial intelligence, the deep learning paradigm and related methods. This unit covers the architecture, functioning, and practical applications of different types of neural networks.

Topics:

1. Introduction: Perceptrons and MLP,
2. Frameworks: TensorFlow, PyTorch, Keras,
3. Activation Functions,
4. Feedforward NN,
5. Training NN: Backpropagation and Gradient Descent,
6. Adaptive optimization techniques and fine-tuning,
7. Regularization methods,
8. Deep learning frameworks,
9. Convolutional Neural Networks (CNNs),
10. Recurrent Neural Networks (RNNs),
11. Transformer networks,
12. Applications (e.g. speech, natural language, vision, etc.).

Related Programme Learning Outcome(s)

- 1 - Deep Learning (EQF 6)
- 2 - AI Technologies (EQF 6)
- 3 - ML Ops (EQF 6)
- 4 - Machine Learning (EQF 6)
- 5 - Explainable AI (EQF 6)
- 7 - AI Awareness (EQF 6)
- 8 - Cyber and Data Security (EQF 5)
- 9 - Generative AI (EQF 6)
- 11 - Soft Skills (EQF 6)

Unit learning outcomes

- Analyzes the fundamental principles of neural networks
- Identifies suitable applications for deep and shallow neural architectures
- Designs deep learning models by selecting appropriate architectures
- Implements deep learning models using relevant frameworks and libraries
- Applies deep learning techniques to solve problems
- Selects appropriate AI frameworks and libraries for specific project needs
- Develops AI models using chosen frameworks and libraries

- Analyses the performance and efficiency of AI models and technologies
- Adapts existing AI models to new contexts and problems
- Demonstrates an ongoing commitment to advancing skills and knowledge
- Adapts machine learning models to evolving data and requirements
- Applies fundamental machine learning concepts and algorithms
- Evaluates machine learning models using established metrics and validation techniques
- Designs data pre-processing and feature engineering strategies
- Assesses the ethical implications of machine learning projects
- Develops AI models using explainable AI techniques to ensure transparency and interpretability
- Analyses existing AI models to assess and measure their explainability
- Implements strategies to improve the explainability of existing AI models
- Evaluates the impact of explainable AI on model performance
- Conveys the principles and benefits of explainable AI to stakeholders
- Understands the basic concepts and technologies underlying artificial intelligence
- Identifies key AI applications in the programming application market
- Knowledge of current trends in AI technology
- Engages in continuous learning to keep pace with rapid advancements in AI technology
- Identifies AI-generated content, employing analytical methods and tools
- Conveys the principles and potential of generative AI to a broad audience
- Engages in continuous learning and professional development
- Collaborates within teams, contributing positively to group efforts
- Solves problems creatively and efficiently
- Delivers impactful presentations
- Cultivates an innovative mindset, embracing and fostering creativity
- Communicates effectively across a variety of platforms and media
- Thinks critically, analysing situations, evaluating diverse perspectives

Delivery method(s)

In-class / Blended learning

Materials

Learning materials: presentation slides and example practical exercises.

Suggested materials:

- Chollet, Francois. Deep learning with Python. Simon and Schuster, 2021. Online: <https://www.manning.com/books/deep-learning-with-python-second-edition>
- Ian Goodfellow and Yoshua Bengio and Aaron Courville, Deep Learning, 2016, MIT Press, online: <http://www.deeplearningbook.org>
- [Bishop, C. M., & Bishop, H. \(2023\). Deep learning: Foundations and concepts. Springer Nature.](#)

4.3. Machine Learning Operations (MLOps)

Description

The "MLOps" (Machine Learning Operations (MLOps) learning unit is designed to introduce students to the principles and practices of deploying, monitoring, and maintaining machine learning models in production environments. This unit covers the end-to-end lifecycle of machine learning projects, focusing on the operational aspects of ML systems.

Topics:

1. Introduction to MLOps: ML lifecycle, challenges, and types of MLOps,
2. Data Engineering for ML: Data pipelines, feature stores, and data versioning,
3. ML Model Development: Model training, hyperparameter tuning, and experiment tracking,
4. Model Evaluation and Validation: Performance metrics, cross-validation, and model selection,
5. Model Deployment: Containerization, orchestration, and serving infrastructure,
6. Model Monitoring: Data drift, concept drift, and model performance monitoring
7. Model Maintenance: Model retraining, versioning, and continuous improvement,
8. ML Pipelines: Orchestrating end-to-end ML workflows,
9. ML Observability: Logging, tracing, and debugging ML systems,
10. CI/CD for ML: Continuous Integration and Continuous Deployment pipelines for ML
11. MLOps Tools and Platforms: Overview of popular MLOps tools and platforms (e.g., MLflow, Kubeflow, TensorFlow Extended).

Related Programme Learning Outcome(s)

- 1 - Deep Learning (EQF 6)
- 2 - AI Technologies (EQF 6)
- 3 - ML Ops (EQF 6)
- 7 - AI Awareness (EQF 6)
- 9 - Generative AI (EQF 6)
- 11 - Soft Skills (EQF 6)

Unit learning outcomes

- Analyzes the fundamental principles of neural networks
- Identifies suitable applications for deep and shallow neural architectures
- Selects appropriate AI frameworks and libraries for specific project needs
- Analyses the performance and efficiency of AI models and technologies
- Adapts existing AI models to new contexts and problems
- Demonstrates an ongoing commitment to advancing skills and knowledge
- Implements AI projects by applying foundational ML Ops principles
- Utilizes project management techniques specific to ML Ops
- Integrates continuous integration and continuous delivery (CI/CD) pipelines

- Applies AI quality control measures throughout the machine learning project lifecycle
- Adapts machine learning models to evolving data and requirements
- Understands the basic concepts and technologies underlying artificial intelligence
- Identifies key AI applications in the programming application market
- Analyses the implications of AI on business processes
- Assesses the strategic considerations for integrating AI into business operations
- Engages in continuous learning and professional development
- Collaborates within teams, contributing positively to group efforts
- Solves problems creatively and efficiently
- Delivers impactful presentations
- Cultivates an innovative mindset, embracing and fostering creativity
- Communicates effectively across a variety of platforms and media
- Thinks critically, analysing situations, evaluating diverse perspectives

Delivery method(s)

In-class / Blended learning

Materials

Learning materials: presentation slides and example practical exercises.

Suggested materials:

- Mark Treveil et al., *Introducing MLOps: How to Scale Machine Learning in the Enterprise*, O'Reilly, 2021
- [MLOps: Continuous delivery and automation pipelines in machine learning \(2023\), online: https://cloud.google.com/architecture/mlops-continuous-delivery-and-automation-pipelines-in-machine-learning](https://cloud.google.com/architecture/mlops-continuous-delivery-and-automation-pipelines-in-machine-learning)
- [Mark Treveil, Nicolas Omont, Clément Stenac, Kenji Lefevre, Du Phan, Joachim Zentici, Adrien Lavoillotte, Makoto Miyazaki, Lynn Heidmann \(2020\). *Introducing MLOps*, O'Reilly Media, Inc.](#)

4.4. AI Applications (NLP, coding tools, CV, Speech, cybersec, etc.)

Description

This learning unit has been articulated to allow customisable delivery in specific AI application areas. The broad aim of the learning unit is to showcase how AI is transforming products and services. The narrower aim of the learning unit is to introduce students to the latest AI solutions, mainly based on deep learning models, and to give them practice in developing project-based AI solutions, developing their prompt engineer skills. Application areas within this learning unit may include

- conversational AI applications,
- natural language processing (NLP) aided applications and coding tools,
- computer vision-based applications,
- speech and audio processing,
- cybersecurity,
- anomaly detection.

Related Programme Learning Outcome(s)

- 1 - Deep Learning (EQF 6)
- 2 - AI Technologies (EQF 6)
- 3 - ML Ops (EQF 6)
- 4 - Machine Learning (EQF 6)
- 7 - AI Awareness (EQF 6)
- 8 - Cyber and Data Security (EQF 5)
- 9 - Generative AI (EQF 6)
- 11 - Soft Skills (EQF 6)

Unit learning outcomes

- Identifies suitable applications for deep and shallow neural architectures
- Designs deep learning models by selecting appropriate architectures
- Applies deep learning techniques to solve problems
- Selects appropriate AI frameworks and libraries for specific project needs
- Develops AI models using chosen frameworks and libraries
- Analyses the performance and efficiency of AI models and technologies
- Adapts existing AI models to new contexts and problems
- Adapts machine learning models to evolving data and requirements
- Applies fundamental machine learning concepts and algorithms
- Evaluates machine learning models using established metrics and validation techniques
- Designs data pre-processing and feature engineering strategies
- Assesses the ethical implications of machine learning projects
- Understands the basic concepts and technologies underlying artificial intelligence

- Identifies key AI applications in the programming application market
- Analyses the implications of AI on business processes
- Assesses the strategic considerations for integrating AI into business operations
- Knowledge of current trends in AI technology
- Engages in continuous learning to keep pace with rapid advancements in AI technology
- Analyses the landscape of cyber threats and vulnerabilities
- Implements advanced security measures
- Develops and tests robust cybersecurity policies and procedures
- Manages incident response and recovery operations
- Evaluates the effectiveness of security protocols through regular audits and updates
- Designs generative AI models to create novel content
- Identifies AI-generated content, employing analytical methods and tools
- Integrates generative AI into diverse applications
- Conveys the principles and potential of generative AI to a broad audience
- Engages in continuous learning and professional development
- Collaborates within teams, contributing positively to group efforts
- Solves problems creatively and efficiently
- Delivers impactful presentations
- Cultivates an innovative mindset, embracing and fostering creativity
- Communicates effectively across a variety of platforms and media
- Thinks critically, analysing situations, evaluating diverse perspectives

Delivery method(s)

In-class / Blended learning

Materials

Learning materials: presentation slides and *example practical exercises, resources document*.

4.5. Generative AI

Description

The "Generative AI" learning unit focuses on creating new data instances that resemble training data or that interacts with the user. This area includes techniques that allow models to generate novel images, texts, music, and other forms of media, simulating human-like creativity. Topics:

1. Deep learning for generative AI:
 - a. GANs and VAEs, Generative Adversarial Networks
 - b. Variational Autoencoders
 - c. Diffusion
2. Natural language and code generation,
3. Image and video generation,
4. Audio generation.

Related Programme Learning Outcome(s)

- 1 - Deep Learning (EQF 6)
- 2 - AI Technologies (EQF 6)
- 3 - ML Ops (EQF 6)
- 4 - Machine Learning (EQF 6)
- 7 - AI Awareness (EQF 6)
- 9 - Generative AI (EQF 6)
- 11 - Soft Skills (EQF 6)

Unit learning outcomes

- Analyzes the fundamental principles of neural networks
- Identifies suitable applications for deep and shallow neural architectures
- Designs deep learning models by selecting appropriate architectures
- Implements deep learning models using relevant frameworks and libraries
- Applies deep learning techniques to solve problems
- Selects appropriate AI frameworks and libraries for specific project needs
- Develops AI models using chosen frameworks and libraries
- Analyses the performance and efficiency of AI models and technologies
- Adapts existing AI models to new contexts and problems
- Demonstrates an ongoing commitment to advancing skills and knowledge
- Adapts machine learning models to evolving data and requirements
- Applies fundamental machine learning concepts and algorithms
- Evaluates machine learning models using established metrics and validation techniques
- Designs data pre-processing and feature engineering strategies
- Assesses the ethical implications of machine learning projects
- Understands the basic concepts and technologies underlying artificial intelligence
- Identifies key AI applications in the programming application market

- Analyses the implications of AI on business processes
- Assesses the strategic considerations for integrating AI into business operations
- Knowledge of current trends in AI technology
- Engages in continuous learning to keep pace with rapid advancements in AI technology
- Designs generative AI models to create novel content
- Identifies AI-generated content, employing analytical methods and tools
- Develops prompt engineering skills
- Implements Large Language Models (LLMs) in generative AI projects
- Evaluates the performance of generative AI systems
- Assesses the ethical implications of generative AI systems
- Integrates generative AI into diverse applications
- Conveys the principles and potential of generative AI to a broad audience
- Engages in continuous learning and professional development
- Collaborates within teams, contributing positively to group efforts
- Solves problems creatively and efficiently
- Delivers impactful presentations
- Cultivates an innovative mindset, embracing and fostering creativity
- Communicates effectively across a variety of platforms and media
- Thinks critically, analysing situations, evaluating diverse perspectives

Delivery method(s)

In-class / Blended learning

Materials

Learning materials: presentation slides and Jupyter notebooks

Suggested materials:

- David Foster: Generative Deep Learning: Teaching Machines to Paint, Write, Compose, and Play, O'Reilly, 2019
- Chris Fregly, Antje Barth, Shelbee Eigenbrode (2023). Generative AI on AWS: Building Context-Aware Multimodal Reasoning Applications 1st Edition, O'Reilly Media, Inc.

4.6. Explainable AI

Description

The "Explainable AI" learning unit is designed to provide students with a comprehensive understanding of the principles and methods for making AI systems explainable, interpretable and transparent. This unit emphasizes the importance of explainability in AI for trust, accountability, and regulatory compliance. Students will explore various techniques and tools used to create explainable AI models, along with their practical applications.

Topics:

1. Fundamentals of Explainable AI (definitions, key concepts),
2. Interpretable machine learning models (linear and logistic regression, decision trees, etc.),
3. Post-hoc explainability techniques (feature importance, sensitivity analysis, partial dependence plot, individual conditional expectation),
4. Visualization techniques for explainability, dimension reduction,
5. Model-agnostic methods (Local Interpretable Model/agnostic Explanations, SHapley Additive exPlanations),
6. Explainability in Deep Learning, model specific techniques,
7. Tools and Frameworks (e.g. Alibi, ELI5, interpretML).

Related Programme Learning Outcome(s)

- 1 - Deep Learning (EQF 6)
- 2 - AI Technologies (EQF 6)
- 3 - ML Ops (EQF 6)
- 4 - Machine Learning (EQF 6)
- 5 - Explainable AI (EQF 6)
- 7 - AI Awareness (EQF 6)
- 11 - Soft Skills (EQF 6)

Unit learning outcomes

- Analyzes the fundamental principles of neural networks
- Selects appropriate AI frameworks and libraries for specific project needs
- Develops AI models using chosen frameworks and libraries
- Analyses the performance and efficiency of AI models and technologies
- Adapts existing AI models to new contexts and problems
- Demonstrates an ongoing commitment to advancing skills and knowledge
- Adapts machine learning models to evolving data and requirements
- Applies fundamental machine learning concepts and algorithms
- Evaluates machine learning models using established metrics and validation techniques
- Designs data pre-processing and feature engineering strategies
- Assesses the ethical implications of machine learning projects

- Develops AI models using explainable AI techniques to ensure transparency and interpretability
- Analyses existing AI models to assess and measure their explainability
- Implements strategies to improve the explainability of existing AI models
- Evaluates the impact of explainable AI on model performance
- Conveys the principles and benefits of explainable AI to stakeholders
- Understands the basic concepts and technologies underlying artificial intelligence
- Identifies key AI applications in the programming application market
- Analyses the implications of AI on business processes
- Assesses the strategic considerations for integrating AI into business operations
- Knowledge of current trends in AI technology
- Engages in continuous learning to keep pace with rapid advancements in AI technology
- Collaborates within teams, contributing positively to group efforts
- Solves problems creatively and efficiently
- Delivers impactful presentations
- Cultivates an innovative mindset, embracing and fostering creativity
- Communicates effectively across a variety of platforms and media
- Thinks critically, analysing situations, evaluating diverse perspectives

Delivery method(s)

In-class / Blended learning

Materials

Learning materials: presentation slides and Jupyter notebooks

Suggested materials:

- Christoph Molnar, Interpretable Machine Learning: A Guide for Making Black Box Models Explainable, 2024, online: <https://christophm.github.io/interpretable-ml-book/>
- Samek, W., Montavon, G., Vedaldi, A., Hansen, L. K., & Müller, K. R. (Eds.). (2019). Explainable AI: interpreting, explaining and visualizing deep learning (Vol. 11700). Springer Nature.

4.7. AI for Business

Description

ML Engineers need to be able to articulate their technological expertise into the language and needs of business to be truly effective.

This learning unit looks in detail as to possibilities for ML exploitation in business. It will offer case studies for analysis so that learners are able to identify and communicate them clearly to clients.

Topics include: (1) overview of ML successes and failures in business and what the critical factors are (2) common ML use cases (3) analysis of business processes for automation possibilities (4) making a business case for ML and communicating with business clients.

Related Programme Learning Outcome(s)

- 1 - Deep Learning (EQF 6)
- 2 - AI Technologies (EQF 6)
- 4 - Machine Learning (EQF 6)
- 5 - Explainable AI (EQF 6)
- 7 - AI Awareness (EQF 6)
- 11 - Soft Skills (EQF 6)

Unit learning outcomes

- Identifies suitable applications for deep and shallow neural architectures
- Adapts existing AI models to new contexts and problems
- Demonstrates an ongoing commitment to advancing skills and knowledge
- Assesses the ethical implications of machine learning projects
- Evaluates the impact of explainable AI on model performance
- Conveys the principles and benefits of explainable AI to stakeholders
- Understands the basic concepts and technologies underlying artificial intelligence
- Identifies key AI applications in the programming application market
- Analyses the implications of AI on business processes
- Assesses the strategic considerations for integrating AI into business operations
- Knowledge of current trends in AI technology
- Engages in continuous learning to keep pace with rapid advancements in AI technology
- Collaborates within teams, contributing positively to group efforts
- Solves problems creatively and efficiently
- Delivers impactful presentations
- Cultivates an innovative mindset, embracing and fostering creativity
- Communicates effectively across a variety of platforms and media
- Thinks critically, analysing situations, evaluating diverse perspectives

Delivery method(s)

Lectures either online or in-person, and/or case-study based seminars

Materials

Lecture Slides, example case-studies, resources document.

Selected readings from business literature, for example HBR.

4.8. AI Ethics

Description

ML Engineers need to be aware of their professional responsibilities and this unit aims to deliver this in a manner accessible to technologists.

Topics include: (1) The dark side of AI: what can go wrong (1) The legal framework in the EU (AI Act, GDPR, Digital Services Act), (2) Ethical Considerations: Fairness, Explainability and Robustness, (3) AI Governance and Regulation, (4) AI Ethics in Generative AI and Machine Learning (5) Compliance in practice and the responsibilities of an ML practitioner.

Though this is a short learning unit, in the context of a larger first-cycle program it may be extended by additional related material as required by professional bodies.

Related Programme Learning Outcome(s)

2 - AI Technologies (EQF 6)

4 - Machine Learning (EQF 6)

6 - AI Ethics (EQF 6)

7 - AI Awareness (EQF 6)

9 - Generative AI (EQF 6)

11 - Soft Skills (EQF 6)

Unit learning outcomes

- Demonstrates an ongoing commitment to advancing skills and knowledge
- Assesses the ethical implications of machine learning projects
- Identifies ethical considerations and challenges in AI development and deployment
- Develops ethical guidelines and frameworks for AI projects
- Implements strategies to mitigate ethical risks in AI applications
- Assesses AI projects for ethical implications
- Knowledge of industry-specific laws (national and international)
- Knowledge of current trends in AI technology
- Engages in continuous learning to keep pace with rapid advancements in AI technology
- Assesses the ethical implications of generative AI systems
- Conveys the principles and potential of generative AI to a broad audience
- Engages in continuous learning and professional development
- Collaborates within teams, contributing positively to group efforts
- Solves problems creatively and efficiently
- Delivers impactful presentations
- Cultivates an innovative mindset, embracing and fostering creativity
- Communicates effectively across a variety of platforms and media
- Thinks critically, analysing situations, evaluating diverse perspectives

Delivery method(s)

Lectures either online or in-person, and/or case-study based seminars

Materials

Lecture Slides, example case-studies, resources document.

Suggested Readings:

- AI Ethics, Michael Coeckelbergh; The Cambridge Handbook of Artificial Intelligence, chapter 15 (Nick Bostrom, Oxford University, Eliezer Yudkowsky);
- EU Artificial Intelligence Act: The Essential Reference, Lex Press

4.9. Project and Thesis Work

Description

Aspiring ML Engineers benefit from an opportunity to exercise their acquired knowledge and skills in an extended piece of work. To this end, a synoptic capstone Project and Thesis Work learning unit may be offered.

This unit supports both a traditional academic project typical of first-cycle studies, as well as a work-based or industrial project. It could also be used as a concluding unit in a microcredential-based scheme that leads to a larger award.

The scheme should give clear guidance as to what constitutes a suitable project in the context of the final award as well as providing support in appropriate methodological issues (eg. referencing).

The focus and the regulations of the awarding institutions and overall purpose of the study programme will determine the type and shape of the project. That said, a minimum of 5 ECTS is suggested to allow for an extended piece of work to be produced.

Related Programme Learning Outcome(s)

- 1 - Deep Learning (EQF 6)
- 2 - AI Technologies (EQF 6)
- 4 - Machine Learning (EQF 6)
- 6 - AI Ethics (EQF 6)
- 7 - AI Awareness (EQF 6)
- 11 - Soft Skills (EQF 6)

Unit learning outcomes

- Analyzes the fundamental principles of neural networks
- Identifies suitable applications for deep and shallow neural architectures
- Designs deep learning models by selecting appropriate architectures
- Implements deep learning models using relevant frameworks and libraries
- Applies deep learning techniques to solve problems
- Selects appropriate AI frameworks and libraries for specific project needs
- Develops AI models using chosen frameworks and libraries
- Analyses the performance and efficiency of AI models and technologies
- Adapts existing AI models to new contexts and problems
- Demonstrates an ongoing commitment to advancing skills and knowledge
- Applies fundamental machine learning concepts and algorithms
- Evaluates machine learning models using established metrics and validation techniques
- Designs data pre-processing and feature engineering strategies
- Assesses the ethical implications of machine learning projects
- Assesses AI projects for ethical implications

- Understands the basic concepts and technologies underlying artificial intelligence
- Identifies key AI applications in the programming application market
- Analyses the implications of AI on business processes
- Assesses the strategic considerations for integrating AI into business operations
- Knowledge of current trends in AI technology
- Engages in continuous learning to keep pace with rapid advancements in AI technology
- Solves problems creatively and efficiently
- Cultivates an innovative mindset, embracing and fostering creativity
- Communicates effectively across a variety of platforms and media
- Thinks critically, analysing situations, evaluating diverse perspectives

Delivery method(s)

As this is self-directed, it could be supported in a number of ways: lectures, seminars and well as consultations with a project supervisor. These could be conducted either online or face-to-face.

Materials

Generic project guideline document, presentation of scheme/guidance, resources document.

Suggested Reading: Thesis Projects: A Guide for Students in Computer Science and Information Systems, Mikael Berndtsson, Jörgen Hansson, Björn Olsson, Björn Lundell



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