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D4.2 Specific Curriculum

NLP ENGINEER EQF 7

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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

Name	NLP Engineer
EQF level	EQF 7
Goals	The NLP Engineer curriculum at EQF 7 equips participants with advanced expertise in Natural Language Processing and Artificial Intelligence. It emphasizes the mastery of cutting-edge machine learning techniques, deep neural networks, and generative AI models, integrating these with cloud services and ML Ops for scalable AI solutions. The program fosters the ability to design explainable AI systems, apply human-centred AI principles, and address complex ethical, legal, and societal challenges.
Scope	This program is aimed at individuals with a background in computer science or related fields who seek to advance their expertise in NLP, deep learning, and AI-driven language technologies.

Entry requirements	• Advanced Mathematics Proficiency:
	  ○ Linear Algebra
	  ○ Probability and Statistics
	  ○ Calculus
	• Programming Skills:
	  ○ Python
	  ○ Java or C++
	• Computer Science Fundamentals:
	  ○ Data Structures and Algorithms
	  ○ Software Engineering Principles
	  ○ Database Management

Programme learning outcomes (PLOs)	1 - Deep Learning (EQF 7) 2 - AI Technologies (EQF 7) 3 - ML Ops (EQF 7) 4 - HPC and Cloud services (EQF 7) 5 - Machine Learning (EQF 7) 6 - Explainable AI (EQF 7) 7 - Human-Centered AI (EQF 7) 8 - AI Ethics (EQF 7) 9 - AI Futures and Innovation (EQF 7) 10 - AI Awareness (EQF 6) 12 - NLP (EQF 7)

	13 - Generative AI (EQF 7) 14 - Change Management (EQF 5) 15 - Soft Skills (EQF 7)

2. Description of the structure

The course is structured into 17 modules for a total of 110 hours. It begins with foundational concepts in machine learning and deep learning, advancing to state-of-the-art ML techniques and deep neural networks. Students then explore practical applications of neural networks in Python, advanced ML Ops, and cloud services for AI.

The curriculum includes specialized modules in generative AI and NLP using frameworks like NLTK and SpaCy, and it covers large language models. The program also addresses the implications and drawbacks of generative AI, as well as ethical and legal issues in AI. The course concludes with strategies for responsible AI practices and managing organizational change in AI deployment.

3. Overview of Learning Units

Learning unit title	Hours/ECTS	EQF level	Assessment(s)
Introduction to Machine Learning and Deep Learning	8	EQF 6-7	Exam
State-of-the-Art Machine Learning Techniques and Architectures	8	EQF 7	Exam
Theoretical and Advanced Deep Neural Networks	10	EQF 7	Exam
Neural Network in Python (TensorFlow, Keras, PyTorch, CNNs, RNNs)	10	EQF 7	Exam and Practical Assignment
Advanced ML Ops and Lifecycle Management	8	EQF 7	Exam
Introduction to cloud services and infrastructure for AI	6	EQF 7	Exam
Generative AI	6	EQF 7	Exam
Generative AI applications in our society	6	EQF 7	Exam
NLP in Python (NLTK, SpaCy, Gensim, Transformers)	8	EQF 7	Practical Assignment
Large Language Models	8	EQF 7	Exam

Implications and potential drawbacks of Generative AI	6	EQF 6-7	Exam
Ethical and legal issues of AI technologies in our society	6	EQF 6-7	Exam
Responsible AI practices for Human-Computer Interaction	6	EQF 7	Exam
Overview of best practices to Explainability in ML	6	EQF 7	Exam
Strategies to manage change in organizations implementing AI	8	EQF 5	Exam
Project and thesis work	25	EQF 5/6/7	Practical Assignment

4. Details of Learning Units

4.1. Introduction to Machine Learning and Deep Learning

Description
Introduces fundamental concepts of machine learning and deep learning, providing a basis for understanding advanced AI techniques.
Related Programme Learning Outcome(s)
1 - Deep Learning (EQF 7) 2 - AI Technologies (EQF 7) 9 - AI Futures and Innovation (EQF 7) 10 - AI Awareness (EQF 6)
Unit learning outcomes
• Critically evaluates the theoretical underpinnings of deep learning • Reflects on the ethical, legal, and social implications of deploying deep learning models • Assesses the capabilities and limitations of different AI technologies • Understands the basic concepts and technologies underlying artificial intelligence • Lead multidisciplinary teams in experimental AI projects
Delivery method(s)
• Workshop • Lectures
Materials
Lecturer Materials: Tutorial Materials (Slide and Presentations) **Student readings suggested:** Burkov, A. (2019). The hundred-page machine learning book (Vol. 1, p. 32). Quebec City, QC, Canada: Andriy Burkov.

4.2. State-of-the-Art Machine Learning Techniques and Architectures

Description
Explores cutting-edge machine learning techniques and architectural designs used in modern AI systems.
Related Programme Learning Outcome(s)
1 - Deep Learning (EQF 7) 2 - AI Technologies (EQF 7) 5 - Machine Learning (EQF 7) 9 - AI Futures and Innovation (EQF 7)
Unit learning outcomes
• Manages the lifecycle of deep learning projects • Assesses the capabilities and limitations of different AI technologies • Integrates AI technologies to create comprehensive systems that improve decision-making • Innovates with AI technologies to solve novel or unstructured problems • Disseminates findings and developments in AI technologies • Independently develops robust machine learning models using advanced algorithms • Critically evaluates the performance of machine learning models • Integrates machine learning models into existing business processes and systems • Lead multidisciplinary teams in experimental AI projects
Delivery method(s)
• Lectures • Case studies
Materials
Lecturer Materials: Tutorial Materials (Slide and Presentations)

4.3. Theoretical and Advanced Deep Neural Networks

Description
Covers advanced topics in deep neural networks, including complex architectures and theoretical underpinnings.
Related Programme Learning Outcome(s)
1 - Deep Learning (EQF 7) 2 - AI Technologies (EQF 7) 5 - Machine Learning (EQF 7) 15 - Soft Skills (EQF 7)
Unit learning outcomes
• Critically evaluates the theoretical underpinnings of deep learning • Designs innovative deep learning models • Integrates AI technologies to create comprehensive systems that improve decision-making • Innovates with AI technologies to solve novel or unstructured problems • Independently develops robust machine learning models using advanced algorithms • Critically evaluates the performance of machine learning models • Optimizes machine learning algorithms and systems for improved performance • Integrates machine learning models into existing business processes and systems • Applies innovative approaches to extend the capabilities of machine learning • Cultivates an innovative mindset • Applies critical thinking to evaluate information
Delivery method(s)
• Workshop • Lectures
Materials
Lecturer Materials: Tutorial Materials (Slide and Presentations) **Student readings suggested:** Stevens, E., Antiga, L., & Viehmann, T. (2020). Deep learning with PyTorch. Manning Publications.

4.4. Neural Network in Python (TensorFlow, Keras, PyTorch, CNNs, RNNs)

Description
Provides hands-on experience with Python libraries and frameworks for developing and deploying neural networks.
Related Programme Learning Outcome(s)
1 - Deep Learning (EQF 7) 2 - AI Technologies (EQF 7) 3 - ML Ops (EQF 7) 5 - Machine Learning (EQF 7) 9 - AI Futures and Innovation (EQF 7) 15 - Soft Skills (EQF 7)
Unit learning outcomes
• Designs innovative deep learning models • Develops advanced deep learning models using current frameworks and tools • Analyses complex datasets using deep learning models • Manages the lifecycle of deep learning projects • Implements AI solutions using best practices in software engineering and data management • Optimizes machine learning pipelines for performance and efficiency • Independently develops robust machine learning models using advanced algorithms • Optimizes machine learning algorithms and systems for improved performance • Integrates machine learning models into existing business processes and systems • Applies innovative approaches to extend the capabilities of machine learning • Develops and implements creative problem-solving strategies • Applies critical thinking to evaluate information • Develop innovative AI applications, utilizing cutting-edge AI technologies
Delivery method(s)
• Workshop • Lectures • Project Work
Materials
Lecturer Materials: Tutorial Materials (Slide and Presentations)

Student readings suggested:

De Marchi, L., & Mitchell, L. (2019). Hands-On Neural Networks: Learn how to build and train your first neural network model using Python. Packt Publishing Ltd.

4.5. Advanced ML Ops and Lifecycle Management

Description
Focuses on best practices for managing machine learning operations and the full lifecycle of ML models.
Related Programme Learning Outcome(s)
1 - Deep Learning (EQF 7) 2 - AI Technologies (EQF 7) 3 – ML Ops (EQF 7) 9 - AI Futures and Innovation (EQF 7)
Unit learning outcomes
• Manages the lifecycle of deep learning projects • Implements AI solutions using best practices in software engineering and data management • Designs robust ML Ops architectures • Implements continuous integration and continuous delivery (CI/CD) pipelines • Optimizes machine learning pipelines for performance and efficiency • Evaluates the effectiveness and efficiency of ML Ops systems • Communicates the strategic value and operational impact of ML Ops to stakeholders • Develop innovative AI applications, utilizing cutting-edge AI technologies • Evaluate the impact of new AI technologies on existing business models and strategies
Delivery method(s)
• Workshop • Lectures • Project Work
Materials
Lecturer Materials: Tutorial Materials (Slide and Presentations) **Student readings suggested:** Gift, N., & Deza, A. (2021). Practical MLOps. " O'Reilly Media, Inc.".

4.6. Introduction to cloud services and infrastructure for AI

Description
Introduces cloud services and infrastructure setups that support scalable AI deployments.
Related Programme Learning Outcome(s)
4 - HPC and Cloud services (EQF 7) 9 - AI Futures and Innovation (EQF 7)
Unit learning outcomes
• Architects scalable and secure HPC and cloud infrastructures • Conduct detailed performance monitoring and tuning • Deploys complex applications on HPC and cloud platforms • Manages HPC and cloud environments • Analyses the performance of HPC and cloud systems • Evaluates new HPC and cloud technologies and services for potential adoption • Communicates technical and strategic aspects of HPC and cloud services • Evaluate the impact of new AI technologies on existing business models and strategies
Delivery method(s)
• Workshop • Lectures
Materials
Lecturer Materials: Tutorial Materials (Slide and Presentations) **Student readings suggested:** Velte, A. T., Velte, T. J., & Elsenpeter, R. C. (2010). Cloud computing: a practical approach. McGraw-Hill.

4.7. Generative AI

Description
Provides an overview of generative AI models, including their design, implementation, and applications.
Related Programme Learning Outcome(s)
9 - AI Futures and Innovation (EQF 7) 13 - Generative AI (EQF 7)
Unit learning outcomes
• Design and implement advanced generative AI models • Evaluate the effectiveness and safety of generative AI models • Advocate for a proactive approach to AI innovation
Delivery method(s)
• Lectures
Materials
Lecturer Materials: Tutorial Materials (Slide and Presentations) **Student readings suggested:** Foster, D. (2022). Generative deep learning. " O'Reilly Media, Inc.".

4.8. Generative AI applications in our society

Description
Examines the societal impact and applications of generative AI, including real-world case studies.
Related Programme Learning Outcome(s)
1 - Deep Learning (EQF 7) 7 - Human-Centered AI (EQF 7) 10 - AI Awareness (EQF 6) 13 - Generative AI (EQF 7) 15 - Soft Skills (EQF 7)
Unit learning outcomes
• Reflects on the ethical, legal, and social implications of deploying deep learning models • Critically assesses societal impacts of AI • 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 • Apply generative AI in novel applications • Stay abreast of technological advancements in the field of generative AI • Cultivates an innovative mindset
Delivery method(s)
• Lectures • Case studies
Materials
Lecturer Materials: Tutorial Materials (Slide and Presentations)

4.9. NLP in Python (NLTK, SpaCy, Gensim, Transformers)

Description
Teaches practical NLP techniques using Python libraries to handle and analyse textual data.
Related Programme Learning Outcome(s)
1 - Deep Learning (EQF 7) 12 - NLP (EQF 7) 15 - Soft Skills (EQF 7)
Unit learning outcomes
• Analyses complex datasets using deep learning models • Develops and implements creative problem-solving strategies • Applies critical thinking to evaluate information • Design and implement advanced NLP models • Evaluate NLP systems, using rigorous testing and validation methods • Optimize NLP algorithms for various computational environments • Apply NLP techniques to extract insights and information from textual data across different languages
Delivery method(s)
• Lectures • Workshop
Materials
Lecturer Materials: Tutorial Materials (Slide and Presentations) **Student readings suggested:** Bird, S., Klein, E., & Loper, E. (2009). Natural language processing with Python: analyzing text with the natural language toolkit. " O'Reilly Media, Inc.".

4.10. Large Language Models

Description
Focuses on the development, fine-tuning, and application of large language models (LLMs) for NLP tasks.
Related Programme Learning Outcome(s)
1 - Deep Learning (EQF 7) 2 - AI Technologies (EQF 7) 9 - AI Futures and Innovation (EQF 7) 12 - NLP (EQF 7) 13 - Generative AI (EQF 7) 15 - Soft Skills (EQF 7)
Unit learning outcomes
• Develops advanced deep learning models using current frameworks and tools • Analyses complex datasets using deep learning models • Implements AI solutions using best practices in software engineering and data management • Design and implement advanced generative AI models • Evaluate the effectiveness and safety of generative AI models • Optimize generative models for efficiency and scalability • Knowledge in fine tuning and customizing generative models and use of transfer learning • Applies critical thinking to evaluate information • Develop innovative AI applications, utilizing cutting-edge AI technologies • Pioneer research and development in AI • Design and implement advanced NLP models
Delivery method(s)
• Lectures • Workshop
Materials
Lecturer Materials: Tutorial Materials (Slide and Presentations) **Student readings suggested:** Ozdemir, S. (2023). Quick Start Guide to Large Language Models: Strategies and Best Practices for Using ChatGPT and Other LLMs. Addison-Wesley Professional.

4.11. Implications and potential drawbacks of Generative AI

Description
Explores ethical, legal, and societal challenges associated with generative AI technologies and their applications.
Related Programme Learning Outcome(s)
1 - Deep Learning (EQF 7) 7 - Human-Centered AI (EQF 7) 9 - AI Futures and Innovation (EQF 7) 10 - AI Awareness (EQF 6) 13 - Generative AI (EQF 7)
Unit learning outcomes
• Reflects on the ethical, legal, and social implications of deploying deep learning models • Critically assesses societal impacts of AI • 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 to keep pace with rapid advancements in AI • Stay abreast of technological advancements in the field of generative AI • Advocate for responsible use of generative AI technologies • Evaluate the impact of new AI technologies on existing business models and strategies
Delivery method(s)
• Lectures • Case studies • Group Discussions
Materials
Lecturer Materials: Tutorial Materials (Slide and Presentations)

4.12. Ethical and legal issues of AI technologies in our society

Description
Discusses the ethical and legal aspects of AI technologies, emphasizing responsible usage and compliance.
Related Programme Learning Outcome(s)
1 - Deep Learning (EQF 7) 7 - Human-Centered AI (EQF 7) 8 - AI Ethics (EQF 7) 10 – AI Awareness (EQF 6) 12 - NLP (EQF 7)
Unit learning outcomes
• Reflects on the ethical, legal, and social implications of deploying deep learning models • Critically assesses societal impacts of AI • Analyse the ethical implications of AI systems • Develop ethical guidelines for AI projects • Evaluate AI systems for ethical compliance • Lead discussions and workshops on AI ethics • Innovate in the creation of tools and methods for ethical AI • Research and apply interdisciplinary knowledge from philosophy, law, social science, and technology • Analyses the implications of AI on business processes • Assesses the strategic considerations for integrating AI into business operations • Recognizes the ethical, legal, and societal challenges associated with AI deployment • Advocate for ethical AI practices in NLP
Delivery method(s)
• Lectures • Case studies • Group Discussions
Materials
Lecturer Materials: Tutorial Materials (Slide and Presentations) **Student readings suggested:** Coeckelbergh, M. (2020). AI ethics. Mit Press.

4.13. Responsible AI practices for Human-Computer Interaction

Description
Focuses on developing AI systems that prioritize user experience and ethical interaction with humans.
Related Programme Learning Outcome(s)
7 - Human-Centered AI (EQF 7) 8 - AI Ethics (EQF 7) 13 – Generative AI (EQF 7)
Unit learning outcomes
• Designs AI solutions that incorporate human-centered design principles • Implements interactive AI systems that facilitate effective human-AI collaboration • Evaluates AI systems from a human-centered perspective • Critically assesses societal impacts of AI • Analyse the ethical implications of AI systems • Advocate for responsible use of generative AI technologies
Delivery method(s)
• Lectures • Workshop
Materials
Lecturer Materials: Tutorial Materials (Slide and Presentations) **Student readings suggested:** Preece, J., Rogers, Y., Sharp, H., Benyon, D., Holland, S., & Carey, T. (1994). Human-computer interaction. Addison-Wesley Longman Ltd.

4.14. Introduction and best practices to Explainability in ML

Description
Teaches methods and practices for creating explainable machine learning models and interpreting their outputs.
Related Programme Learning Outcome(s)
2 - AI Technologies (EQF 7) 6 - Explainable AI (EQF 7) 7 - Human-Centered AI (EQF 7) 9 - AI Futures and Innovation (EQF 7)
Unit learning outcomes
• Innovates with AI technologies to solve novel or unstructured problems • Designs AI systems with a focus on explainability • Implements techniques such as feature importance scores, model-agnostic methods, and visualization of AI decision paths • Evaluates the effectiveness of explainable AI models • Researches and applies the latest advancements in explainable AI • Critically assesses AI models for biases and ethical implications • Advocates for ethical AI practices • Designs AI solutions that incorporate human-centred design principles • Pioneer research and development in AI
Delivery method(s)
• Lectures • Workshop
Materials
Lecturer Materials: Tutorial Materials (Slide and Presentations)

4.15. Strategies to manage change in organizations implementing AI

Description
Provides strategies for managing organizational changes necessitated by the integration of AI technologies.
Related Programme Learning Outcome(s)
14 - Change Management (EQF 5)
Unit learning outcomes
• Analyses the need for change within organizations • Plans and designs change management strategies that are clear • Implements change initiatives effectively • Communicates change effectively to all stakeholders • Evaluates the impact of change initiatives • Adapts change strategies in response to evolving circumstances and feedback • Leads and inspires others during times of change
Delivery method(s)
• Lectures • Case Studies
Materials
Lecturer Materials: Tutorial Materials (Slide and Presentations)

4.16. Project and thesis work

Description
Involves practical project work and thesis development, applying the concepts learned to solve real-world problems.
Related Programme Learning Outcome(s)
1 - Deep Learning (EQF 7) 2 - AI Technologies (EQF 7) 5 - Machine Learning (EQF 7) 10 - AI Awareness (EQF 6) 12 - NLP (EQF 7) 15 - Soft Skills (EQF 7)
Unit learning outcomes
• Critically evaluates the theoretical underpinnings of deep learning • Designs innovative deep learning models • Assesses the capabilities and limitations of different AI technologies • Integrates AI technologies to create comprehensive systems that improve decision-making • Implements AI solutions using best practices in software engineering and data management • Disseminates findings and developments in AI technologies • Independently develops robust machine learning models using advanced algorithms • Critically evaluates the performance of machine learning models • Optimizes machine learning algorithms and systems for improved performance • Integrates machine learning models into existing business processes and systems • 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 • Design and implement advanced NLP models • Evaluate NLP systems, using rigorous testing and validation methods • Leads and enhances team performance through effective collaboration • Develops and implements creative problem-solving strategies • Delivers compelling presentations, utilizing state-of-the-art presentation tools • Cultivates an innovative mindset • Applies critical thinking to evaluate information

Delivery method(s)
• Project Work
Materials
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