D4.1 Collection of Learning Outcomes (LO)

●●●●

30 April 2024

Disclaimer

How to cite

ARISA. (2024). D4.1 Collection of Learning Outcomes (LO). [URL]

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 and acronyms

AI	Artificial Intelligence
ARISA	Artificial Intelligence Skills Alliance
BERT	Bidirectional Encoder Representations from Transformers
D	Deliverable
EC	European Commission
e-CF	European e-Competence Framework
EQF	European Qualifications Framework
ESCO	European Skills, Competences, and Occupations
EU	European Union
LOs	Learning Outcomes
NER	Named Entity Recognition
NLP	Natural Language Processing
PLO	Programme Learning Outcome

Table of contents

List of Tables

1. Executive Summary

1.1. Introduction

The present report (D4.1) explains how the project moved from the Needs Analysis Report (D2.2) to the definition of the Learning Outcomes (LOs). The methodology described herein has been implemented in tasks 4.1 and 4.2, as described in section 2. The application of the methodology gave the results presented in section 3.

1.2. Objectives

The objective of the deliverable D4.1 presented in this report is to identify and write the LOs for the ARISA curricula, with the aim of constructing educational plans that address the needs identified through the Needs Analysis Report (D2.2) and align with the overarching goals of the ARISA project. The project consortium aimed at maintaining the proper methodological approach considering the different roles the project is focusing on: AI practitioners, policy- and decisionmakers, and AI advisors/ consultants.

1.3. Methodological approach

To achieve the results presented in this report we adopted a mixed-method approach that includes data-driven methods and qualitative methods. Specifically, in T4.1 and T4.2 a mix of Natural Language Processing (NLP) techniques and interaction with partners through structured brainstorming, interviews, questionnaires, and one-to-one meetings sessions has been implemented. Given the complexity of the field, it was needed in this phase to consider different sources to properly deliver LOs. Using mixed methods made it possible to efficiently integrate the information coming from different sources, internal and external to the project and to properly focus on the different relevant roles of the project.

1.4. Results

The main result of this Deliverable are the LOs for the ARISA Curricula, as shown in Annex 1. An intermediate result (the output of T4.1) is the set of skills related to the LOs, shown in section 3.1.

Task 4.1 delivered a mapping of AI roles and skills, informed by the Needs Analysis Report (D2.2), extensive consultation with experts, and a review of scientific literature. The outcome is a detailed table of 46 specific skills. Notably, this task not only reconfirmed 30 skills from previous analyses but also introduced 4 new skills derived from recent scientific findings, thereby ensuring the curriculum remains cutting-edge.

Following the skill identification, Task 4.2 focused on formulating Program and Unit Learning Outcomes aligned with the European Qualifications Framework (EQF). Each learning outcome was written to match the complexity of the skills at various EQF levels, ensuring they are suitable for professional application in diverse AI fields. The outcomes were extensively validated through partner consultations, incorporating a structured and iterative review process to guarantee precision and relevance.

1.5. Conclusions

In this deliverable has been identified and catalogued a set of skills essential for AI roles, grounded in current industry requirements and forward-looking analyses. This activity not only reaffirmed existing needs but also adapted to emerging trends by integrating new skills identified through scientific literature.

The learning outcomes formulated are aligned with the EQF, ensuring that they meet the standards required for educational programs across Europe. This alignment guarantees that the learning outcomes are not only relevant but also adaptable to the needs of AI roles across varying levels of expertise.

The results serve as a critical resource also for external stakeholders of the project across governmental, industrial, and educational sectors, informing ongoing strategies and initiatives within the European AI Skills Strategy framework.

1.6. Use of this document

The main use of this document is to provide insights for the further progress of the Development of innovative curricula and training programmes. It can further be used by government, industry, and education and training representatives to get insights into the key factors and enablers of effective skilling and reskilling programs, and to understand how to promote and build trust in AI. It also offers valuable insights into how to become or keep up to date with AI developments.

2.   Methodology

There are two processes used to translate the findings from the market skills Needs Analysis Report (D2.2) in programme and unit learning outcomes.

In this section both processes are presented: the first, "Identification of relevant roles and skills", describes the approach used to formalise the relevant roles and skills in the scope of the project and has been the main object of T4.1. The second, "Definition of learning outcomes", shows the method implemented to formulate learning outcomes that cover the identified skills, as done in T4.2.

2.1.   Identification of relevant roles and skills

The selection of relevant roles and skills, on which the LOs will be based, is structured in a series of sub-activities articulated as follows:

1.   Listing of roles and skills (section 2.1.1.)

   1.1.   Overview of roles and skills from the Needs Analysis Report (D2.2), and output documents from WP8.5 (curricula and educational profiles) (section 2.1.1.1.)

   1.2.   Extraction of skills from scientific literature (section 2.1.1.2.)

   1.3.   Finetuning the list of skills (section 2.1.1.3.)

2.   Linking of skills and roles to existing European Frameworks (section 2.1.2)

3.   Validation of roles and skills (section 2.1.3.)

During these tasks, we relied on the Needs Analysis Report (D2.2) that identified skills and roles to react to the AI transition, which triggers skill gaps and shortages. In the tasks described in the next sections, these skills and roles have been formalised in such a way that they can practically inform the curricula design. We also reconfirmed the results gathered from the Need Analysis report (D2.2) with an automated analysis (with the use of text mining tools) of scientific literature. The output of the process "Listing of roles and skills" is a table with the list of skills associated with each role.

2.1.1. Listing of roles and skills

The aim of this phase was to:

- List the roles in scope for the project, as described in the Needs Analysis Report (D2.2)

- List the skills described in the Needs Analysis Report (D2.2) and confirm the relevance of those skills. The primary sources for this phase were the Needs Analysis Report (D2.2) produced in WP2, as well as task WP8.5 results in which roles and skills were defined for AI supporting roles (like AI advisor) and skills for policy- and decision makers were refined.

These documents gave us information about the relevant roles in the context of the ARISA project and the skills the market currently requires for these roles.

Since AI-related technology moves fast, the skills gathered from the documents previously listed were confirmed by mapping them against the results from an automatic extraction of skills from scientific literature related to the AI field. (Please find more content on this topic under section 2.1.1.2).

Under the first step, 2.1.1.1 "Provide an overview of roles and skills from the Needs Analysis Report (D2.2), and output documents from WP8.5 (curricula and educational profiles)", we focused on collecting the skills already identified in previous stages. In contrast, the integration of new AI-related skills is addressed under the second step, 2.1.2.2. "Extraction of skills from scientific literature".

The output of this phase is a table with a list of roles and skills relevant for this project, as shown in section 3.1, where the reader can also see the sources from which the skills were collected.

2.1.1.1 Overview of roles and skills from the Needs Analysis Report (D2.2), and output documents from WP8.5 (curricula and educational profiles)

Roles

In the Needs Analysis Report (D2.2) two main groups of relevant roles are identified: AI professionals and policy- & decision makers.

The first main group of AI professionals is divided in two subgroups: AI practitioners and AI management and supporting roles. The group of AI practitioners include the roles: data scientists, data engineers, and machine learning engineers including the specific roles NLP engineers and computer vision engineers. The second subgroup of AI professionals covers AI management and support roles. The Needs Analysis Report (D2.2) already showed that it is not yet clear yet in this quickly developing and changing field which of those potential roles will develop into actual roles. The choice is therefore made that no specific roles will be defined for the AI management and support roles at the moment only the role of AI advisor is identified, which is an already existing role and includes skills that potentially will be the core of specific roles in the future.

The second main group is the policy- & decision makers. This group needs some AI skills, but since that will always be a (small) part of their role, no specific roles are defined for this group.

The result is that the following (groups of) roles are distinguished in this analysis and are matched to skills:
- Data scientists
- Data engineers
- (General) machine learning engineers
- NLP engineers
- Computer vision engineers
- AI advisor
- (Governmental) Policymakers
- (Organisational) Decisionmakers

Skills

The Needs Analysis Report (D2.2) also indicates the most relevant skills. This is divided in skills for complete AI practitioners' roles and AI skills related to supporting roles and policy- and decision makers.

Complete roles do not only require specific AI technical skills, but also other skills to be able to apply these technical skills in a professional setting. These other groups of skills are soft (transversal) skills, skills in transversal general areas, and skills related to functioning in organisation skills. Each role has its own specific set of technical skills that is named accordingly, so for example machine learning engineers need machine learning skills. These skills are detailed further when they are translated into programme and unit learning outcomes.

For the people in the other group, the focus will only be on the specific AI skills they need, since they will not become AI professionals and the focus of the project remains AI. The premise is that people in these other roles will possess or acquire other relevant skills to fulfil their roles will obtain in another way.

This results in the following groups of skills that are included this analysis:

- Technical skills for AI professionals
  (including data engineering, machine learning, deep learning, NLP, visual image recognition)
- Soft skills for AI professionals
  (including problem solving, critical thinking, communication)
- Skills on AI related transversal topics
  (including topics like ethics, privacy, accessibility, and security)
- Skills on functioning in organisations
  (including project skills, DevOps, understanding business processes)
- Foundational skills for policy- and decision makers
  (including basic terminology and practise, AI ethics, law & regulations)
- AI advisory skills
  (including AI risk management, AI compliance, formulating AI strategy, change management & implementing of AI solutions)

For the AI professional, we reframed the list of skills to be more specific with the aim of feeding into the curricula design. This process was carried out using the table shown in section 3.1 as a basis for discussion, to achieve consensus in the partnership about the number, names, and definitions of the skills as it will be described in further detail below.

2.1.1.2 Extraction of skills from scientific literature

In this phase, the list of skills collected from the Needs Analysis Report (D2.2) was integrated with skills extracted from the scientific literature. The use of Natural Language Processing (NLP) techniques supported the extraction.

The process followed can be divided into four steps:

1. Query design

2. Paper retrieval

3. Skills extraction

4. Data Cleaning

The use of automated tools in this task is appropriate, given the large number of documents to be processed. As will be shown in the Paper retrieval step, more than 170.000 scientific papers were processed. Also, this step focused on AI practioners, since we expect most of the literature to be relevant for these profiles, and just few papers focusing on the policy- and decisionmakers, and AI advisors/ consultants.

Query design

In the query design step, the query to retrieve scientific papers on the AI domains from Scopus was designed. The choice of Scopus is confirmed as the best one for this kind of analysis, as supported by a large scientific literature on the topic (Belingheri et al., 2021; Shah et al., 2021; Petroșanu et al., 2019).

The query used was the following:

TITLE (("Artificial Intelligence" OR "Machine Learning" OR "Deep Learning" OR "Neural Networks" OR "Natural Language Processing" OR "Computer Vision" OR "Expert Systems" OR "Reinforcement Learning" OR "Supervised Learning" OR "Unsupervised Learning" OR "Speech Recognition" OR "Image Processing" OR "Pattern Recognition" OR "Predictive Analytics" OR "Data Mining")) AND PUBYEAR > 2021 AND PUBYEAR < 2024 AND (LIMIT-TO (SUBJAREA , "COMP") OR LIMIT-TO (SUBJAREA , "ENGI") OR LIMIT-TO (SUBJAREA , "DECI") OR LIMIT-TO (SUBJAREA , "BUSI"))

First, the query lists a series of keywords that the papers need to have in their titles, then a selection of specific fields where to search (computer science, engineering, decision sciences and business). These keywords and fields have been used in similar contexts in the scientific literature (Vlačić et al., 2021; Cioffi et al., 2020). The presence of these keywords in the papers' titles guarantees that the papers are significant for the research. The papers are then limited to only those that were published in 2022 and 2023, which is the period we are interested in analysing for the purpose of confirming the need analysis described in D2.2.

Paper retrieval

In the Paper retrieval step, the scientific papers as output from the query were downloaded, which numbered more than 170,000 articles. This high number (since we are looking at the last two years) confirms that the field of AI is also growing fast from the scientific point of view and motivates the usage of text mining in the next steps.

Skills extraction

In the Skills extraction step, the AI skills were extracted from the downloaded articles using Named Entity Recognition (NER) techniques. Specifically, we used two kinds of NER methods: gazetteer-based and rule-based methods (Chiarello et al., 2024). The gazetteer-based method maps mention of entities within texts to terminological resources. In our case, the gazette is composed of AI-related terms gathered from: ESCO, the Lightcast taxonomy of AI skills (as used by Stanford University) and skills from the Needs Analysis Report (D2.2)C. The rule-based method, instead, uses regular expressions, and linguistic information to express knowledge-based systems that can extract a specific type of entity (in our case, skills). Using a series of clues that indicate the presence of a skill in the text (i.e. ability to, development of), it is possible to extract the skills present in the text even if they are not present in the previously described gazette.

Data Cleaning

After the extraction, the results were cleaned by automatically removing noisy entities, ensuring that only relevant information was retained for further analysis and enhancing the quality and reliability of the extracted results. The threshold for filtering was set to 5% of the papers (i.e. a skill to be considered in further steps should appear in at least the 5% of the documents). This threshold is the most used in scientific literature (Belingheri et al., 2021). Then, the skills were manually reviewed to validate their accuracy (the entities should be skills in scope of the roles of the ARISA project) and relevance for the selected roles. The goal was to eliminate any potential errors or inconsistencies in the data.

2.1.1.3 Finetuning the list of skills

In this phase, the results from the two previous stages ("Provide an overview of roles and skills from the Needs Analysis Report (D2.2), and output documents from WP8.5" and "Extraction of skills from scientific literature") were integrated.

As expected, the analysis of the scientific literature has provided a large number of potentially relevant skills (280). These skills, anyway, are sometimes polysemic (same concepts are expressed in different forms) and more specific than the ones listed in the Need Analysis Report (D2.2). To harmonise and fine tune the skills, similar skills were grouped based on the Semantic Similarity algorithm. In particular, the semantic similarity is measured as follows: each skill was mapped to a vector in a 1024-dimensional semantic space using the BERT model (Devlin et al., 2018). We then measured the cosine similarity as the cosine of the angle between the two semantic vectors. The method just described made it possible to effectively cluster related skills based on their semantic similarities, thereby bringing the data to a consistent level of abstraction, i.e. to a uniform degree of detail.

Grouping together similar skills made it possible to reconfirm the skills extracted in the Needs Analysis Report (D2.2), clearly identifying which of them were also present in the most recent scientific discourse on AI, and to eventually identify new emerging skills. Also, it was possible to organise the list of skills in such a way that is useful for next steps of curricula development. This process also led to the creation of column "Specific skills" in table 1 (section 3.1.), where the reader can see examples of skills grouped together under the same label. The label was picked during partners meeting discussing about the most representative and useful ones from the specific skills.

After the grouping, to reach a consensus about the meaning of the different skills, it was necessary to give definitions of the skills. The definitions were again discussed in the consortium, to reach a shared definition using as a starting point the Needs Analysis Report (D2.2) and the definitions coming from ESCO and the CEN e-CF.

2.1.2. Linking of skills and roles to existing European Frameworks

In this stage, a process was conducted to map the skills and selected roles to existing European frameworks, i.e. ESCO and the CEN ICT roles.

As for ESCO and CEN ICT professional role profiles, the steps were as follows:

1. Associate each role collected from the Needs Analysis Report (D2.2) with roles from the ESCO and the CEN e-CF, considering the similarities between the two. To do this we searched the ESCO database using the search engine provided on the website https://esco.ec.europa.eu/en.

2. Since the skills as output from <u>section 2.1.1.</u> may be expressed differently from ESCO and the CEN e-CF, we have again evaluated semantic similarity between the skills of the relevant roles as written in ESCO and CEN e-CF and the ones previously collected. Since each role has several skills that vary from 40 (computer vision engineer) to 83 (ICT intelligent systems designer), and that as output from the previous stage we had 46 specific skills, this step was supported by automated techniques to identify potential matches of similarity. The semantic similarity is measured as follows: each skill was mapped to a vector in a 1024-dimensional semantic space using the BERT model (Devlin et al., 2018). We then measured the cosine similarity as the cosine of the angle between the two semantic vectors. The skills were clustered with a low threshold of cosine similarity to maximise the recall.

All the links identified were then integrated in table 3 in <u>section 3.2</u>. This will serve the next phases of curricula design, facilitating connections both in terms of skills and roles with existing European frameworks.

2.1.3. Validation of roles and skills

The output of the previous analysis, namely the list of skills and roles shown in table 1 in <u>section 3.1</u>, was shared with experts within the consortium as a final step of validation feedback. Two rounds of consultations (during the weekly meeting) was done, with a mean of 15 participants per meeting. The partners were asked for feedback using a structured document. The aim was to get information about Skills the partners expected but missing in the table, and Irrelevant skills present in the table.

Following the initial round of review and collection of feedback, the modifications discussed and approved were implemented. We then conducted necessary evaluations to identify remaining points for discussion. This collaborative approach enriched the analysis by incorporating different viewpoints, enhancing the comprehensiveness and accuracy of the conclusions. The feedback collected was used to revise the previous output and define the final one, which is the input to the subsequent validation.

To address these remaining open points, the partners in the consortium who have experience on the previously identified skills (in terms of teaching and/or research) were identified (5 partners in total). We aimed to get information about the specificity of the skills and necessity to delete/cluster the current skills. Once the feedback was received, we grouped them in a single table to come back to the whole partnership. In the meeting with the partners final decision has been taken reaching an agreement whatever to delete, cluster or leave the skills.

These steps generated the final roles-skills table, as shown in table 1 in <u>section 3.1</u>.

The process described above focussed as stated on the AI practitioners roles. The validation process of the other relevant roles and related skills grouped in the categories AI advisor, (governmental) policymakers, and (organisational) decisionmakers, was designed somewhat differently. The relevant skill groups were defined based on the needs analysis results, and this was discussed in project internal expert meetings and in qualitative feedback rounds in which project internal experts could provide feedback on drafts. Also, a short questionnaire was sent out to policy- and decisionmakers to confirm whether the skills that were identified, were indeed the topics they need to learn more about.

2.2. Definition of learning outcomes

The goal of this second process is to identify the LOs and their EQF level in relation to each skill output from the previous phase. The sub-activities to reach this goal were:

1. Learning Outcome Formulation (section 2.2.1.)

2. EQF Level Identification (section 2.2.2.)

3. Learning Outcome Finalisation (section 2.2.3.)

4. Learning Outcome Validation (section 2.2.4.)

2.2.1. Learning Outcomes Formulation

In this phase, a set of Programme Learning Outcomes (PLOs) and Unit Learning Outcomes (ULOs) was created for each skill. PLOs are a clear statement of what a person, after successful completion of a course, knows, understands, and can do. ULOs describe a measurable result of a learning experience. A set of ULOs together covers a PLO.

This first set of LOs (both program and unit) served as a starting base, all formulated at the same EQF level. The final LOs were then written for the different EQF levels in the next phase. Before finalising the creation of the learning outcomes, we identified the proper EQF levels for each skill related to each role, which will be described in the next section. This preliminary formulation of the LOs at the same EQF level, made it possible to receive fast feedback from the partners on the form and content of the LOs.

The formulation of the PLOs was based on the Tuning formula (TUNING Association, 2010) and Bloom's Taxonomy (Anderson & Krathwohl, 2001). The Tuning Formula refers to a structured approach for formulating degree program profiles that include clear definitions of program competences and learning outcomes within the higher education context. It is a tool designed to assist educators in aligning degree programs with the broader objectives of the Bologna Process, thereby enhancing transparency, comparability, and compatibility of qualifications across Europe. Referring to the LOs, the Formula advocates for the integration of both generic competences (transferable across various fields and professions) and subject-specific competences (unique to a particular discipline) into LOs. It also describes the five key components of each LO:

1. An active verb form

2. An indication of the type of LO: knowledge, cognitive processes, skills, or other competences

3. The topic area of the LO: this can be specific or general and refers to the subject matter, field of knowledge or a particular skill

4. An indication of the standard or the level that is intended / achieved by the LO

5. The scope and/or context of the LO

Specifically, to better identify the active verb form of the LO, Bloom's Taxonomy was used. Bloom's Taxonomy is a hierarchical framework for categorising educational objectives (Krathwohl, 2002). It serves as a tool for educators to classify learning outcomes and objectives that reflect different levels

of cognitive skills and learning complexity. Originally developed by Benjamin Bloom and colleagues in 1956, the taxonomy has since been updated to include six cognitive processes, ranging from simpler to more complex: Remember, Understand, Apply, Analyse, Evaluate, and Create.

Finally, to move from the PLOs to the Unit LOs, the concept expressed in the PLO was first associated to a set of verbs coming from the Bloom's Taxonomy that could give a complete description of the PLO. The association was made based on the specific skills previously identified for each skill collected and the description of the EQF level of the skill. The verbs where then used as seed to create new LOs, still following the Tuning Formula.

2.2.2. EQF level Identification

Before finalising the creation of the learning outcomes, EQF levels for each of skill related to each role were identified. To do so, we prepared a questionnaire. Partners were requested to indicate the most suitable EQF levels of LO for each skill-role pair. It was possible to pick multiple EQF levels for the same skill-role pair, or no EQF at all. To consider the questionnaire valid, at least the partners identified as experts in section 2.1.3 should answer to the questionnaire. To consider the EQF level as relevant for a specific skill in the context of a job profile, it should be indicated by at least the majority of the responding partners.

2.2.3.   Learning Outcomes Finalisation

The LOs were then rewritten for the different identified EQF levels. This was done taking on to consideration the description of the four EQF levels relevant for the project (from 4 to 8). Each of the levels of the EQF is defined by a set of descriptors indicating the learning outcomes relevant to qualifications at that level in any qualifications system (European Union, 2018). The learning outcomes are defined in terms of:

- Knowledge: in the context of EQF, knowledge is described as theoretical and/or factual
- Skills: In the context of EQF, skills are described as cognitive (involving the use of logical, intuitive, and creative thinking) and practical (involving manual dexterity and the use of methods, materials, tools, and instruments)
- Responsibility and autonomy: In the context of the EQF responsibility and autonomy is described as the ability of the learner to apply knowledge and skills autonomously and with responsibility

Particular attention was put on the formulation of the LOs to ensure their alignment to the Tuning Formula, while Bloom's taxonomy verbs were adapted to fit the EQF levels.

2.2.4. Learning Outcomes Validation

A second questionnaire was prepared to assess the LOs Formulation. Partners were asked to evaluate the formulation of all the LOs based on these specific criteria:

1. Specificity: LOs should provide sufficient detail and be written in clear language. A sufficient detail in this case, is such that the LOs are detailed enough to be achievable (see point number 3) but abstract enough to be adaptable to the different contexts in which partners of ARISA operate
2. Objectivity: Formulation should be neutral, avoiding subjective opinions and ambiguities
3. Standard-setting: LOs should clearly indicate the standard to be achieved

If any LO formulation was considered unsatisfactory, partners were encouraged to suggest modifications for improvement on the different criteria.

The validation process for the Programme and corresponding unit learning outcomes related to the AI advisory skills and the skills for policy- and decisionmakers, was organised differently. Every PLO was defined at one complexity level, and the defined PLOs were discussed during project internal expert panels and qualitative feedback rounds in which project internal experts could provide feedback. These rounds were held until there was consensus on the LOs.

3. Results

In this section we present the results output from task 4.1 and 4.2 that are the relevant roles and skills (section 2.1) and learning outcomes (section 2.2).

3.1. Relevant roles and skills

AI Practitioners

Here we present the output of T4.1, created as described in section 2. This output, shown in table 1, is a set of skills connected to the AI professionals (Data Analyst, Data Scientist, Machine Learning Engineer, NLP engineer and Computer Vision Engineer). Table 1 has the following structure:

1. The first column shows the *skills* collected
2. The second column shows related *specific skills*
3. The third column shows the *sources* from which each specific skill was collected

Of all the 46 specific skills collected, 30 came from the Needs Analysis Report (D2.2), 12 from the discussion with experts and 4 from the scientific literature. Therefore, even if the extraction of skills from scientific literature (section 2.1.1.2) only resulted in 4 new skills, it reconfirmed all the skills presented and collected from the Needs Analysis Report (D2.2).

Skills	Specific skills	Source
Deep Learning Skills	Deep Learning Skills	Needs Analysis Report
AI Technologies	AI Frameworks and AI Libraries	ARISA partners
	Use of AI model and technologies	Scientific Papers
MLOps	Implementation of AI	Needs Analysis Report
	ML OPS	ARISA partners
	Project Management	Needs Analysis Report
	AI Quality Control Skills	Needs Analysis Report
HPC and Cloud services	High-Performance Computing	ARISA partners
	Use of Cloud Services	Scientific Papers
Machine Learning	Machine Learning	Needs Analysis Report

Explainable AI	Explainable AI	ARISA partners
Big Data & Data Analytics	Big Data & Data Analytics Skills	Needs Analysis Report
	Data Visualization	ARISA partners
	Data Science Skills	Needs Analysis Report
Human-Centred AI	AI Sustainability	ARISA partners
	AI Governance and Policy Formulation	Needs Analysis Report
	AI Risk Management	Needs Analysis Report
	AI Strategy Skills	Needs Analysis Report
	Human Computer Interaction	Scientific Papers
AI Ethics	AI Ethics Skills	Needs Analysis Report
AI Futures and Innovation	Future Literacy	ARISA partners
	AI Developments and Trends Understanding	Needs Analysis Report
	Research Skills	ARISA partners
Business Intelligence	Business Intelligence	Needs Analysis Report
AI Awareness	AI Awareness	Needs Analysis Report
	Knowledge of programming application market	Scientific Papers
	AI Implications on Business Processes	Needs Analysis Report
AI for Robotics	Robotics Skills	Needs Analysis Report

	Computer Vision Skills	Needs Analysis Report
	Reinforcement Learning	ARISA partners
	Speech Technologies	ARISA partners
Cyber and Data Security	Cyber and Data Security Skills	Needs Analysis Report
NLP	Natural Language Processing (NLP)	Needs Analysis Report
Image Processing	Image Processing	ARISA partners
Generative AI	Identification of AI-Generated Content	Needs Analysis Report
	Generative AI	Needs Analysis Report
	LLMs	ARISA partners
	Prompt Engineering Skills	Needs Analysis Report
Change Management	Change Management	Needs Analysis Report
Soft Skills	Communication	Needs Analysis Report
	Teamwork	Needs Analysis Report
	Problem Solving	Needs Analysis Report
	Presentation Skills	Needs Analysis Report
	Innovative Mindset	Needs Analysis Report
	Critical Thinking	Needs Analysis Report
	Conflict Management	Needs Analysis Report

Table 1. Table of skills related to the AI practitioners, main output from task 4.1.

AI advisory, policy- and decisionmakers

The other groups of relevant roles AI advisory, policy- and decisionmakers of course also need to possess some of the skills described above. These skills were derived from the needs analysis and in the case of these groups only focused on specific AI skills. The output is shown in Table 2 and has a similar structure to Table 1.

The skills include:

- For all groups: Skills on AI fundamentals (e.g. on AI ethics, law/regulations, basic technical terminology, and practice.
- For policy makers: Skills to include AI in policy (e.g. on laws/ regulations, the balance between regulation and innovation, best practises of national AI strategies)
- For decisionmakers: Skills on the role of AI in organisations (e.g. on laws/ regulations, relation between AI and business strategies, creating value with AI, the impact of AI on the organisation)
- For AI advisors/ consultants: AI advisory skills (e.g. formulating AI strategy, AI risk management, change management & implementing AI)

These results were the starting point for a discussion on the relevant skills that should be part of the upskilling of the policy- and decisionmakers and those that should be part of the AI advisory role that encompasses the skills related to the possible future AI management and supporting roles.

There were 14 project internal expert meetings in a weekly basis in which in the first weeks the relevant skills were discussed which agile and iterative switched to be development of the related programme and unit learning outcomes that were the topic of the rest of these meetings.

A short questionnaire aimed at policy- and decisionmakers was used to reconfirm the relevant AI skills they need upskilling in. There were 90 respondents, and they reconfirmed the most important skills they need upskilling in.

Skills	Specific skills	Source
AI Fundamentals	AI ethics	Needs Analysis Report
	AI laws and regulations	Needs Analysis Report
	Basic AI technical terminology	Needs Analysis Report
	Basic AI practice	Needs Analysis Report
AI in Policy	AI laws and regulations	Needs Analysis Report
	Balance between regulation and innovation	Needs Analysis Report
	Best practices of national AI strategies	Needs Analysis Report
AI in organisations	AI laws and regulations	Needs Analysis Report
	Relation between AI and business strategies	Needs Analysis Report

	Creating value with AI	Needs Analysis Report
	Impact of AI on the organisation	Needs Analysis Report
AI advisory skills	Formulating AI strategy	Needs Analysis Report
	AI risk management	Needs Analysis Report
	Change management & implementing AI	Needs Analysis Report

Table 2. Table of skills related to the AI advisory, policy- and decisionmakers.

3.2. Learning outcomes

In this section we present the identified LOs and their EQF level in relation to each skill output from the previous phase, from the five roles in the group 'AI professionals', i.e. Data Analyst, Data Scientist, Machine Learning Engineer, NLP engineer and Computer Vision Engineer. The output of this process is a list of PLOs, each with its Unit LOs associated.

Each LO is represented by a table, divided in two sections: the first one declares the PLO of the skill for the specific EQF, the second one a list of between six and nine Unit LOs related to the PLO. Every PLO and Unit LO is characterised by a verb from Bloom's taxonomy and follows the structure of the Tuning Formula. The whole set of LOs relevant for the project is shown in Annex 1. This set includes LOs for each skill at each EQF level(s) identified as relevant.

In table 3 we give an example for the skill Deep Learning – EQF 6.

Programme Learning Outcomes
Deep Learning – EQF 6 The learner has demonstrated the ability to design and implement deep learning models and architectures, encompassing their development, implementation, and application across various domains, while integrating computational and organizational considerations and evaluating their societal and technological impacts.

Unit Learning Outcomes
1. Analyses the fundamental principles of neural networks, focusing on their structure and function, to understand the underlying mechanics of deep learning technologies in a professional context. 2. Identifies suitable applications for deep and shallow neural architectures by evaluating their types and functionalities, ensuring the selection aligns with specific project requirements and industry standards. 3. Designs deep learning models by selecting appropriate architectures and frameworks, demonstrating innovation in model architecture to meet the unique needs of diverse applications. 4. Implements deep learning models using relevant frameworks and libraries, showcasing proficiency in parameter tuning, performance optimization, and addressing computational challenges to enhance model efficiency and effectiveness. 5. Evaluates the performance of deep learning models using standard metrics, interpreting results to make informed decisions about model improvements, adjustments, and the selection of models for specific tasks in real-world applications. 6. Applies deep learning techniques to solve problems in various domains such as image recognition, natural language processing, and predictive analytics, demonstrating the ability to adapt models to new challenges and datasets within a given context. 7. Discusses the ethical implications of deploying deep learning models, including issues related to fairness, privacy, transparency, and accountability, proposing strategies to mitigate risks and promote ethical AI development in diverse societal applications. 8. Critiques the current trends and advancements in deep learning, assessing their potential impact on future technologies, industry practices, and societal norms, with a focus on sustainable and responsible innovation. 9. Collaborates effectively in teams to design, implement, and evaluate deep learning projects, demonstrating the ability to communicate complex concepts to stakeholders with varying levels of technical expertise, facilitating informed decision-making and promoting interdisciplinary understanding.

10. Engages with the AI community by participating in discussions, debates, and collaborative projects, contributing to the advancement of ethical practices and innovative technologies in deep learning.

Table 3. Table of LOs for the skill Deep Learning at EQF level 6, example of output from task 4.2.

Finally, to give an overview of the results achieved in this deliverable, table 4 shows, for each skill:
- the EQF level(s) identified as relevant for the roles (numbers in the cells)
- if the skill is present in ESCO or CEN e-CF for the role (under the numbers in the cell between parentheses)
- and the related ESCO or CEN e-CF role (second row of the table).

PLOs	Data Analyst Data analyst (ESCO)	Data Scientist Data scientist (ESCO) Data scientist (CEN e-CF)	Machine learning engineers ICT intelligent systems designer (ESCO)	NLP engineers Language Engineer (ESCO)	Computer vision engineers Computer vision engineer (ESCO)
Deep Learning	EQF 6	EQF 6; 7	EQF 6; 7 (ESCO)	EQF 6; 7; 8	EQF 6; 7; 8 (ESCO)
AI Technologies	EQF 5; 6	EQF 5; 6; 7	EQF 6; 7	EQF 5; 6; 7; 8	EQF 5; 6; 7; 8
MLOps	EQF 6	EQF 7 (ESCO)	EQF 6; 7 (ESCO)	EQF 7 (ESCO)	EQF 7; 8
HPC and Cloud services	(ESCO)	(ESCO)	EQF 7	EQF 7	EQF 7
Machine Learning	EQF 5; 6	EQF 6; 7	EQF 6; 7 (ESCO)	EQF 5; 6; 7	EQF 5; 6; 7; 8 (ESCO)
Explainable AI	EQF 5; 6; 7	EQF 6; 7	EQF 6; 7	EQF 7	EQF 5; 6; 7
Big Data & Data Analytics	EQF 5; 6; 7 (ESCO)	EQF 4; 5; 6; 7 (ESCO, CEN e-CF)	EQF 7 (ESCO)	(ESCO)	(ESCO)
Human-Centered AI	EQF 6	EQF 5; 6; 7 (CEN e-CF)	EQF 7	EQF 5; 6; 7	EQF 5; 6; 7 (ESCO)
AI Ethics Skills	EQF 4; 5; 6	EQF 5; 6; 7 (ESCO)	EQF 5; 6	EQF 5; 6; 7	EQF 5; 6; 7
AI Futures and Innovation	EQF 6	EQF 6; 7 (ESCO, CEN e-CF)		EQF 6; 7 (ESCO)	EQF 6; 7 (ESCO)

Business Intelligence	EQF 5; 6 (ESCO)	EQF 5; 6; 7 (ESCO)	(ESCO)		
AI Awareness	EQF 4; 5; 6	EQF 5; 6; 7	EQF 6 (ESCO)	EQF 5; 6	EQF 6; 7
AI for Robotics			(ESCO)	(ESCO)	EQF 6 (ESCO)
Cyber and Data Security	EQF 6	EQF 6; 7 (CEN e-CF)	EQF 5	EQF 4; 5; 6; 7	EQF 6; 7
Natural Language Processing (NLP)	(ESCO)	(ESCO)	(ESCO)	EQF 5; 6; 7; 8 (ESCO)	
Image Processing					EQF 5; 6; 7; 8
Generative AI	EQF 6	EQF 6; 7	EQF 6; 7	EQF 5; 6; 7; 8	EQF 6; 7
Change Management		EQF 5; 6 (CEN e-CF)	EQF 6	EQF 5	EQF 5
Soft Skills	EQF 4; 5; 6	EQF 5; 6; 7	EQF 5; 6	EQF 5; 6; 7	EQF 5; 6; 7

Table 4. Table of EQF levels for each skill related to the AI practitioners, main output from task 4.2.

On the first row in red are included the roles as defined in the Need Analysis (D2.2) and in the second row in red the relative roles identified in ESCO and CEN e-CF.

The complexity levels for the skills for the other roles were predefined and that was translated in PLOs with matching EQF levels. For all the soft skills (Communication, Teamwork, Problem Solving, Presentation Skills, Innovative Mindset, Critical Thinking and Conflict Management), we create one PLOs at each relevant EQF level (5-6-7). The results are shown in Table 5. This will facilitate the integration of the soft skills in the curricula and make it possible to maintain the same aggregation level as the other skills groups.

PLO	(governmental) Policymakers	(organisational) Decision-makers	AI advisor/ consultant
AI fundamentals	*EQF 6*	*EQF 6*	*EQF 6*
AI and policy	EQF 7		
Organisational decision-making on AI		EQF 7	
AI Strategy			EQF 7

AI implementation			EQF 7
AI Ethics advanced			EQF 7
Impact of AI			EQF 7

Table 5. Table of EQF levels for each skill related to the policy- and decisionmakers, and AI advisors/ consultants.

Based on this level the draft LOs were formulated using the described approach. These drafts were a starting point for a discussion on the relevant LOs that should be part of the upskilling of the policy- and decisionmakers and those that should be part of the AI advisory role that encompasses the LOs related to the possible future AI management and supporting roles.

There were 14 project internal expert meetings in a weekly basis in total. The first weeks focused on the relevant skills which agile and iterative switched to be development of the related programme and unit learning outcomes that were the topic of the rest of these meetings. Also, the drafts were shared with project internal experts that provided feedback on the drafts in a couple of rounds.

This resulted in a set of PLOs and the related LOs that can also be found in Annex 1.

4. Conclusions

This report marks a significant step in the ARISA project, detailing the methodologies used in the Definition of Learning Outcomes (LOs) for AI-related curricula and the outcomes obtained. Throughout tasks T4.1 and T4.2, we transitioned from a foundational Needs Analysis (D2.2) to the formalisation of skills and finally the formulation of specific PLOs and Unit LOs that serve as the main input for innovative curricula in the rapidly evolving AI sector.

The methodological approach adopted in this deliverable was multifaceted, combining stakeholder consultations, targeted questionnaires, and Natural Language Processing (NLP) techniques to gather and analyse data. This methodological approach ensured a mapping of necessary skills across various AI professional roles. The primary outcome of these efforts is the articulation of Program Learning Outcomes (PLOs) and Unit Learning Outcomes (ULOs), detailed in Section 5.4 of this report, and collected in Annex 1. These outcomes not only align with European frameworks and standards but also respond adeptly to the fast-paced changes in AI technology.

This document serves as a relevant resource for stakeholders across government, industry, and education sectors, providing insights into effective strategies for AI education and training. It supports the ongoing development of the European AI Skills Strategy by offering a clear framework for addressing skill gaps and fostering a workforce capable of advancing AI technologies responsibly and innovatively. Additionally, the outcomes of this project contribute to the broader discussion on trust, ethics, and inclusivity in AI, promoting an educated and ethically aware AI workforce. By laying down a solid foundation of learning outcomes, the ARISA project is poised to influence the design of future-oriented AI curricula that are robust, dynamic, and aligned with both market needs and European educational standards.

References

Anderson, L. W. and Krathwohl, D. R., et al (Eds..) (2001). "A Taxonomy for Learning, Teaching, and Assessing: A Revision of Bloom's Taxonomy of Educational Objectives." *Allyn & Bacon. Boston, MA (Pearson Education Group)*

ARISA (2023). AI Skills Needs Analysis, https://aiskills.eu/wp-content/uploads/2023/06/ARISA_AI-Skills-Needs-Analysis_V1.pdf

Belingheri, P., Chiarello, F., Fronzetti Colladon, A., & Rovelli, P. (2021). "Twenty years of gender equality research: A scoping review based on a new semantic indicator." *Plos one*, 16(9), e0256474.

Benvenuti, M., Cangelosi, A., Weinberger, A., Mazzoni, E., Benassi, M., Barbaresi, M., & Orsoni, M. (2023). "Artificial intelligence and human behavioral development: A perspective on new skills and competences acquisition for the educational context." *Computers in Human Behavior*, 148, 107903.

Bloom, B. S.; Engelhart, M. D.; Furst, E. J.; Hill, W. H.; Krathwohl, D. R. (1956). "Taxonomy of educational objectives: The classification of educational goals. Vol. Handbook I: Cognitive domain." *New York: David McKay Company*.

Chiarello, F., Fantoni, G., Hogarth, T., Giordano, V., Baltina, L., & Spada, I. (2021). "Towards ESCO 4.0–Is the European classification of skills in line with Industry 4.0? A text mining approach." *Technological Forecasting and Social Change*, 173, 121177.

Chiarello, F., Giordano, V., Spada, I., Barandoni, S., & Fantoni, G. (2024). "Future applications of generative large language models: A data-driven case study on ChatGPT." *Technovation*, 133, 103002.

Cioffi, R., Travaglioni, M., Piscitelli, G., Petrillo, A., & De Felice, F. (2020). "Artificial intelligence and machine learning applications in smart production: Progress, trends, and directions." *Sustainability*, 12(2), 492.

Devlin, J., Chang, M. W., Lee, K., & Toutanova, K. (2018). Bert: Pre-training of deep bidirectional transformers for language understanding. arXiv preprint arXiv:1810.04805.

European Union (2018), "The European Qualifications Framework: supporting learning, work and cross-border mobility", *Luxembourg: Publications Office of the European Union,* 2018

Guz, A. N., & Rushchitsky, J. J. (2009). "Scopus: A system for the evaluation of scientific journals." *International Applied Mechanics*, 45, 351-362

Krathwohl, D. R. (2002). "A revision of Bloom's taxonomy: An overview. Theory into practice", 41(4), 212-218.

Matteson, M. L., Anderson, L., & Boyden, C. (2016). ""Soft skills": A phrase in search of meaning." *portal: Libraries and the Academy*, 16(1), 71-88.

Petroșanu, D. M., Căruțașu, G., Căruțașu, N. L., & Pîrjan, A. (2019). "A review of the recent developments in integrating machine learning models with sensor devices in the smart buildings sector with a view to attaining enhanced sensing, energy efficiency, and optimal building management." *Energies*, 12(24), 4745.

Shah, K., Saxena, D., & Mavalankar, D. (2020). "Secondary attack rate of COVID-19 in household contacts: a systematic review." *QJM: An International Journal of Medicine*, 113(12), 841-850.

Spector, J. M., & Ma, S. (2019). "Inquiry and critical thinking skills for the next generation: from artificial intelligence back to human intelligence." *Smart Learning Environments*, 6(1), 1-11.

TUNING Association (2010), "A Tuning Guide to Formulating Degree Programme Profiles", https://tuningacademy.org/wp-content/uploads/2014/02/A-Guide-to-Formulating-DPP_EN.pdf

Vlačić, B., Corbo, L., e Silva, S. C., & Dabić, M. (2021). "The evolving role of artificial intelligence in marketing: A review and research agenda." *Journal of Business Research*, 128, 187-203.

Annex 1: Learning Outcomes

PLOs for AI Practitioners

Programme Learning Outcome
Deep Learning - EQF 6 The learner has demonstrated the ability to design and implement deep learning models and architectures, encompassing their development, implementation, and application across various domains, while integrating computational and organizational considerations and evaluating their societal and technological impacts.

Unit learning outcomes
1. Analyses the fundamental principles of neural networks, focusing on their structure and function, to understand the underlying mechanics of deep learning technologies in a professional context. 2. Identifies suitable applications for deep and shallow neural architectures by evaluating their types and functionalities, ensuring the selection aligns with specific project requirements and industry standards. 3. Designs deep learning models by selecting appropriate architectures and frameworks, demonstrating innovation in model architecture to meet the unique needs of diverse applications. 4. Implements deep learning models using relevant frameworks and libraries, showcasing proficiency in parameter tuning, performance optimization, and addressing computational challenges to enhance model efficiency and effectiveness. Evaluates the performance of deep learning models using standard metrics, interpreting results to make informed decisions about model improvements, adjustments, and the selection of models for specific tasks in real-world applications. 5. Applies deep learning techniques to solve problems in various domains such as image recognition, natural language processing, and predictive analytics, demonstrating the ability to adapt models to new challenges and datasets within a given context. 6. Discusses the ethical implications of deploying deep learning models, including issues related to fairness, privacy, transparency, and accountability, proposing strategies to mitigate risks and promote ethical AI development in diverse societal applications. 7. Critiques the current trends and advancements in deep learning, assessing their potential impact on future technologies, industry practices, and societal norms, with a focus on sustainable and responsible innovation. 8. Collaborates effectively in teams to design, implement, and evaluate deep learning projects, demonstrating the ability to communicate complex concepts to stakeholders with varying levels of technical expertise, facilitating informed decision-making and promoting interdisciplinary understanding. 9. Engages with the AI community by participating in discussions, debates, and collaborative projects, contributing to the advancement of ethical practices and innovative technologies in deep learning.

Programme Learning Outcome
Deep Learning - EQF 7 The learner has demonstrated the ability to critically analyse and synthesize deep learning concepts and methodologies, as well as to develop and implement advanced deep learning models in complex, interdisciplinary contexts. This includes taking responsibility for managing the

development process of these models and contributing to the advancement of knowledge and practice within the field of deep learning.

Unit learning outcomes

1. Critically evaluates the theoretical underpinnings of deep learning, including neural network architectures, optimization algorithms, and loss functions, to understand their applicability and limitations in various domains.
2. Designs innovative deep learning models by integrating knowledge from computational theory, data science, and domain-specific requirements to address complex problems, ensuring the models are efficient, scalable, and ethical.
3. Develops advanced deep learning models using current frameworks and tools, demonstrating the ability to manage datasets, pre-process data, and optimize model performance in unpredictable and multifaceted environments.
4. Analyses complex datasets using deep learning models to extract meaningful patterns and insights, applying critical thinking to assess the validity and reliability of the findings in a specific context.
5. Reflects on the ethical, legal, and social implications of deploying deep learning models, including considerations of bias, fairness, transparency, and accountability, leading discussions on ethical AI development practices.
6. Collaborates effectively in interdisciplinary teams to design, develop, and deploy deep learning solutions, demonstrating leadership in guiding strategic approaches to problem-solving and innovation.
7. Communicates complex deep learning concepts, methodologies, and outcomes clearly and effectively to both technical and non-technical stakeholders, adapting the communication style as necessary to ensure understanding and ethical use of AI technology.
8. Applies innovative problem-solving skills to extend the frontiers of knowledge in deep learning, contributing to the development of new methodologies, applications, or approaches that integrate knowledge from different fields.
9. Manages the lifecycle of deep learning projects, from conceptualization through development and evaluation, demonstrating the ability to adapt to new challenges and requirements in complex and unpredictable environments.

Programme Learning Outcome

Deep Learning - EQF 8
The learner has demonstrated the ability to synthesize and evaluate advanced deep learning theories and practices to solve critical problems in research and/or innovation, significantly contributing to the extension and redefinition of existing knowledge in the field.

Unit learning outcomes

1. Critically analyses the theoretical foundations of deep learning, including neural networks, optimization techniques, and loss functions, at an advanced level, within a research-oriented context.
2. Designs and implements complex deep learning models, employing state-of-the-art architecture, to address specific research challenges, demonstrating a high level of skill and innovation.
3. Evaluates the efficacy and reliability of deep learning models using rigorous statistical methods and data validation, ensuring professional integrity and accuracy in high-stakes environments.
4. Leads interdisciplinary teams in the development of novel applications of deep learning technologies, showing substantial authority and autonomy in managing innovative projects.

5. Proposes improvements on existing deep learning techniques, showcasing ability to think creatively and critically to extend the current limits of the technology.
6. Communicates complex deep learning concepts and results effectively to both technical and non-technical audiences, ensuring clarity, transparency, and understanding of cutting-edge technology.
7. Adheres to ethical standards in the deployment of deep learning, including considerations of bias, fairness, and transparency, demonstrating scholarly integrity and responsibility.
8. Anticipates and assesses the impact of deep learning advancements on societal, economic, and ethical dimensions, integrating these insights into responsible practice and policy-making.
9. Engages with the latest research in deep learning to continuously update and refine personal knowledge and practice, demonstrating a sustained commitment to professional development.
10. Applies advanced problem-solving skills to integrate deep learning solutions across different domains such as healthcare, finance, and autonomous systems, highlighting the interdisciplinary nature of the field.

Programme Learning Outcome

AI Technologies - EQF 5
The learner has demonstrated the ability to integrate and innovate using various AI technologies to address real-world challenges, managing multidisciplinary teams in contexts that require adaptability and continuous learning.

Unit learning outcomes

1. Applies a range of AI technologies such as machine learning, natural language processing, and computer vision, understanding their specific applications and limitations in the field of AI.
2. Designs and optimizes AI models to solve specific problems, demonstrating a comprehensive understanding of the underlying algorithms and data requirements.
3. Leads projects and teams in the development and deployment of AI solutions, fostering an environment of innovation and ethical responsibility.
4. Evaluates the effectiveness and impact of AI technologies in various sectors such as healthcare, finance, and transportation, using advanced analytical skills.
5. Synthesizes knowledge from different AI subfields to develop integrated solutions that are robust, scalable, and sustainable in changing environments.
6. Communicates technical and non-technical aspects of AI technologies effectively to a variety of stakeholders, ensuring clarity and inclusivity in decision-making processes.
7. Assesses and addresses ethical, legal, and social implications of AI technologies, promoting responsible and sustainable use.

Programme Learning Outcome

AI Technologies - EQF 6
The learner has demonstrated the ability to know and effectively utilize AI frameworks and libraries for the development and deployment of AI models and technologies, applying these tools across various domains to solve complex problems while considering ethical implications and industry standards.

Unit learning outcomes

1. Selects appropriate AI frameworks and libraries for specific project needs, demonstrating an understanding of their strengths, limitations, and optimal use cases in the development of AI models.
2. Develops AI models using chosen frameworks and libraries, showcasing the ability to integrate various AI technologies to create efficient, scalable, and effective solutions for real-world applications.
3. Analyses the performance and efficiency of AI models and technologies, employing appropriate metrics and tests to ensure they meet project specifications and performance goals.
4. Adapts existing AI models to new contexts and problems, demonstrating innovation and flexibility in applying AI technologies to a diverse range of challenges and domains.
5. Communicates technical details and project outcomes related to AI technologies effectively to both technical and non-technical audiences, ensuring clarity and facilitating informed decision-making.
6. Discusses the ethical implications of deploying AI technologies, including issues related to fairness, privacy, transparency, and accountability, proposing strategies to mitigate risks and promote ethical AI development in diverse societal applications.
7. Critiques the current trends and advancements in AI, assessing their potential impact on future technologies, industry practices, and societal norms, with a focus on sustainable and responsible innovation.
8. Collaborates with multidisciplinary teams on AI projects, leveraging collective expertise to enhance the development, implementation, and evaluation of AI technologies, fostering an environment of knowledge sharing and innovation.
9. Demonstrates an ongoing commitment to advancing skills and knowledge in the field of AI by staying updated on emerging AI frameworks, libraries, and technologies.

Programme Learning Outcome

AI Technologies - EQF 7
The learner has demonstrated the ability to critically evaluate and apply various AI technologies across different domains, managing complex projects that innovate and integrate AI solutions, thereby enhancing professional practice and contributing to the field.

Unit learning outcomes
1. Assesses the capabilities and limitations of different AI technologies, including machine learning, neural networks, and natural language processing, within diverse operational environments.
2. Integrates AI technologies to create comprehensive systems that improve decision-making and operational efficiency in business, healthcare, or other domains.
3. Implements AI solutions using best practices in software engineering and data management, ensuring scalability, security, and compliance with regulatory standards.
4. Critiques the impact of AI technologies on society, addressing ethical considerations like privacy, bias, and job displacement, and proposes mitigation strategies.
5. Fosters multidisciplinary collaboration in developing AI technologies, demonstrating leadership and effective communication in team settings.
6. Innovates with AI technologies to solve novel or unstructured problems, contributing to new knowledge and methods in the field.
7. Leads strategic planning and execution of AI projects, ensuring alignment with organizational goals and adapting to new technological advancements and market trends.
8. Disseminates findings and developments in AI technologies through scholarly articles, conferences, or workshops, enhancing the knowledge base and application of AI in various fields.

Programme Learning Outcome

AI Technologies - EQF 8
The learner has demonstrated the ability to master, integrate, and apply a wide range of advanced AI technologies to foster innovation and address complex challenges in multidisciplinary research and professional practice environments.

Unit learning outcomes

1. Develops comprehensive AI solutions by integrating advanced machine learning, neural networks, and computational algorithms, reflecting high-level technical expertise and innovation.
2. Synthesizes and applies new AI methodologies to real-world problems, demonstrating creativity and advanced problem-solving skills.
3. Leads cross-functional teams in the deployment and scaling of AI technologies, ensuring ethical standards and professional integrity.
4. Evaluates the performance and impact of AI technologies on various industries such as healthcare, automotive, and finance, using advanced analytical techniques.
5. Communicates the capabilities and limitations of various AI technologies to non-specialist stakeholders, promoting informed decision-making.
6. Advocates for responsible AI by understanding and addressing potential societal, ethical, and legal implications.
7. Stays abreast of emerging trends in AI technology, continually enhancing personal expertise and contributing to community knowledge.
8. Implements and adapts AI technologies in response to evolving market and technological developments, showing a high degree of flexibility and foresight.
9. Critiques and debates the strategic implications of AI technologies in a global context, enhancing industry understanding and advancing public discourse.
10. Designs and conducts research that pushes the boundaries of existing AI technologies, aimed at generating new knowledge and practical applications.

Programme Learning Outcome

ML Ops - EQF 6
The learner has demonstrated the ability to proficiently implement AI and machine learning projects, utilizing ML Ops principles to streamline development, ensure high-quality outputs, and manage projects efficiently. This includes deploying scalable AI solutions, managing the lifecycle of machine learning models, and applying quality control measures to maintain accuracy and reliability in AI applications.

Unit learning outcomes

1. Implements AI projects by applying foundational ML Ops principles, ensuring efficient transition from development to production while maintaining high standards of scalability, performance, and reliability.
2. Utilizes project management techniques specific to ML Ops to plan, execute, and monitor AI projects, ensuring alignment with objectives, timelines, and stakeholder expectations.
3. Integrates continuous integration and continuous delivery (CI/CD) pipelines for machine learning projects, automating the testing, deployment, and monitoring of AI models to enhance productivity and reduce time to market.
4. Applies AI quality control measures throughout the machine learning project lifecycle, employing techniques for data validation, model testing, and performance monitoring to ensure the accuracy and reliability of AI applications.

5. Adapts machine learning models to evolving data and requirements, leveraging ML Ops tools and practices for model versioning, updating, and retraining to maintain high performance in dynamic environments.
6. Communicates effectively with stakeholders involved in AI projects, including technical teams, management, and external partners, ensuring clear understanding of project goals, progress, and outcomes.
7. Evaluates the ethical and social implications of deploying AI solutions, implementing strategies to address potential biases, privacy concerns, and ethical issues in machine learning applications.
8. Stays informed about emerging technologies, practices, and standards to lead and innovate in the implementation and management of AI projects.

Programme Learning Outcome

ML Ops - EQF 7
The learner has demonstrated the ability to design, implement, and manage ML Ops systems that efficiently operationalize machine learning models within production environments, ensuring scalable, reproducible, and ethical AI solutions.

Unit learning outcomes
1. Designs robust ML Ops architectures that integrate machine learning models with production systems to streamline deployment, monitoring, and maintenance processes.
2. Implements continuous integration, continuous delivery (CI/CD) pipelines for machine learning applications, demonstrating proficiency in automating model training, testing, and deployment.
3. Optimizes machine learning pipelines for performance and efficiency, applying best practices in data handling, model versioning, and experiment tracking.
4. Evaluates the effectiveness and efficiency of ML Ops systems, using metrics to monitor model performance and resource utilization in real-world scenarios.
5. Collaborates with data scientists, developers, and IT professionals to ensure ML Ops strategies align with organizational goals and technical requirements.
6. Adapts ML Ops practices to emerging technologies and methodologies, maintaining agility in dynamic and complex environments.
7. leads cross-functional teams in the development and implementation of ML Ops initiatives, taking responsibility for project outcomes and strategic alignment.
8. Communicates the strategic value and operational impact of ML Ops to stakeholders, including technical teams, management, and external partners, ensuring transparency and alignment with business objectives.

Programme Learning Outcome

ML Ops - EQF 8
The learner has demonstrated the ability to integrate, manage, and optimize machine learning operations (ML Ops) to enhance the scalability, reliability, and efficiency of AI systems in complex and demanding environments, ensuring alignment with advanced technological standards and ethical considerations.

Unit learning outcomes
1. Designs and implements robust ML Ops architectures that support the scalable deployment of machine learning models, ensuring they meet the advanced criteria of performance, maintainability, and compliance.

2. Automates the machine learning lifecycle from data collection, model training, testing, deployment, to monitoring, ensuring high levels of efficiency and reproducibility.
3. Leads cross-functional teams to foster a culture of collaboration and innovation in the development and operation of machine learning projects.
4. Evaluates and optimizes the performance of machine learning systems through advanced monitoring tools and techniques to ensure they operate effectively under dynamic conditions.
5. Innovates in the field of ML Ops by developing new tools and methods that advance the practice of machine learning in business or research environments.
6. Communicates complex ML Ops concepts to stakeholders, including potential risks and the strategic value of machine learning implementations, promoting transparency and informed decision-making.
7. Adheres to and champions ethical standards in machine learning operations, including data privacy, security, and bias mitigation, reflecting professional integrity and responsibility.
8. Foresees technological and market trends in machine learning and ML Ops, integrating foresight into strategic planning and operational adjustments.
9. Engages with academic and professional communities to share knowledge, discuss challenges, and disseminate best practices in ML Ops.
10. Researches and implements solutions to critical problems in ML Ops, contributing to scholarly articles, papers, or industry reports that push forward the boundaries of knowledge and practice.

Programme Learning Outcome

HPC and Cloud services - EQF 7
The learner has demonstrated the ability to architect, deploy, and manage high-performance computing and cloud services solutions that meet advanced computing needs across various industries, ensuring scalability, reliability, and security.

Unit learning outcomes

1. Architects scalable and secure HPC and cloud infrastructures that meet the specific computational and data requirements of diverse applications.
2. Conduct detailed performance monitoring and tuning to enhance the efficiency of HPC and cloud applications.
3. Deploys complex applications on HPC and cloud platforms, utilizing automation tools to ensure efficiency and accuracy in resource allocation and service provisioning.
4. Manages HPC and cloud environments, overseeing operational aspects such as performance tuning, cost optimization, and compliance with security standards.
5. Analyses the performance of HPC and cloud systems, employing advanced monitoring tools and techniques to optimize resource utilization and service delivery.
6. Innovates with emerging technologies in HPC and cloud computing, integrating them into existing systems to enhance capabilities and address new market challenges.
7. Collaborates effectively with IT specialists, software developers, and business managers to ensure that HPC and cloud solutions align with organizational goals and user needs.
8. Evaluates new HPC and cloud technologies and services for potential adoption, assessing their strategic impact on business and technology operations.
9. Communicates technical and strategic aspects of HPC and cloud services to a diverse range of stakeholders, ensuring clarity and supporting strategic decision-making processes.

Programme Learning Outcome

Machine Learning - EQF 5
The learner has demonstrated the ability to effectively design, implement, and refine machine learning algorithms, managing complex projects within interdisciplinary teams in dynamic and diverse settings.

Unit learning outcomes

1. Applies comprehensive and specialized knowledge in machine learning techniques such as supervised, unsupervised, and reinforcement learning, identifying the appropriate methods for specific real-world applications.
2. Designs and evaluates machine learning models to optimize performance, utilizing a deep understanding of mathematical and statistical foundations to address abstract problems creatively.
3. Manages and leads machine learning projects, ensuring effective team collaboration, project alignment with strategic objectives, and adaptation to unforeseen changes in technology or project scope.
4. Implements advanced data pre-processing, feature engineering, and algorithm tuning techniques to enhance model accuracy and efficiency in various operational contexts.
5. Assesses the ethical implications of machine learning projects, developing guidelines and practices that ensure fairness, transparency, and accountability in algorithmic decision-making.
6. Communicates complex machine learning concepts and results to stakeholders with varying levels of technical expertise, facilitating informed decision-making and fostering a culture of data-driven innovation.
7. Stays abreast of emerging trends and technologies in machine learning, continuously integrating new knowledge and techniques into professional practice to maintain technical proficiency and competitive advantage.

Programme Learning Outcome

Machine Learning - EQF 6
The learner has demonstrated the ability to design, implement, and evaluate machine learning models and algorithms to address (complex) problems across various domains.

Unit learning outcomes

1. Applies fundamental machine learning concepts and algorithms to address predictive analytics, classification, and clustering tasks, employing appropriate tools and techniques for model development within diverse real-world contexts. Knowledge of the techniques for hyperparameter tuning and optimization to enhance model accuracy and efficiency.
2. Evaluates machine learning models using established metrics and validation techniques, critically interpreting results to ensure the models' reliability, accuracy, and applicability to specific problem domains.
3. Designs data pre-processing and feature engineering strategies to enhance machine learning model performance, demonstrating an understanding of the influence of data quality and feature selection on model outcomes.
4. Assesses the ethical implications of machine learning projects, identifying potential biases, fairness issues, and privacy concerns, and developing strategies to address these challenges in the design and deployment of models.

5. Communicates machine learning findings effectively to both technical and non-technical stakeholders, ensuring clarity and facilitating informed decision-making.
6. Collaborates with interdisciplinary teams on machine learning projects, leveraging collective expertise to overcome complex challenges and innovate while upholding ethical standards and achieving practical solutions.
7. Engages in professional development and community activities related to machine learning, including attending workshops, contributing to forums, and participating in collaborative research, to stay informed about industry trends and ethical discussions.

Programme Learning Outcome

Machine Learning - EQF 7
The learner has demonstrated the ability to independently develop, evaluate, and refine machine learning models, using advanced techniques to address and solve complex, real-world problems across various sectors. This includes leading projects that integrate machine learning into existing systems, enhancing their efficiency and effectiveness.

Unit learning outcomes

1. Independently develops robust machine learning models using advanced algorithms and techniques, tailored to solve specific problems in areas such as finance, healthcare, or technology.
2. Critically evaluates the performance of machine learning models using sophisticated validation techniques to ensure accuracy, reliability, and generalizability of the results.
3. Optimizes machine learning algorithms and systems for improved performance, focusing on aspects such as computational efficiency, model accuracy, and data handling.
4. Integrates machine learning models into existing business processes and systems, demonstrating the ability to enhance operational capabilities and address strategic business goals.
5. Leads multidisciplinary teams in the design and implementation of machine learning projects, taking responsibility for decision-making, strategic direction, and project outcomes.
6. Applies innovative approaches to extend the capabilities of machine learning, exploring new algorithms, data sources, and modelling techniques to advance the field.
7. Effectively communicates complex machine learning concepts and results to stakeholders, including technical and non-technical audiences, ensuring transparency, and facilitating informed decision-making.
8. Assesses the ethical implications of machine learning applications, ensuring that models adhere to ethical standards and contribute positively to societal goals.

Programme Learning Outcome

Machine Learning - EQF 8
The learner has demonstrated the ability to develop, implement, and critically evaluate advanced machine learning algorithms and systems, significantly contributing to the extension and redefinition of existing knowledge and practices in diverse applied contexts.

Unit learning outcomes

1. Develops advanced machine learning models that incorporate complex algorithms and data structures, demonstrating high-level proficiency and technical expertise.
2. Analyses and interprets large datasets to derive meaningful patterns and insights, applying sophisticated statistical methods and machine learning techniques.
3. Optimizes machine learning algorithms for performance and efficiency, using state-of-the-art computational techniques to solve significant challenges in real-world applications.
4. Leads and coordinates interdisciplinary project teams, providing expertise in machine learning while fostering innovation and ethical practices in project design and execution.
5. Evaluates the ethical implications of machine learning deployments, including issues related to bias, privacy, and security, ensuring adherence to ethical standards and regulations.
6. Communicates complex machine learning concepts and the results of analyses clearly and effectively to both specialist and non-specialist audiences.
7. Innovates by developing new machine learning methodologies or enhancing existing ones to push forward the boundaries of what is technically and practically feasible.
8. Implements rigorous testing and validation procedures to ensure the robustness and reliability of machine learning models under diverse operating conditions.
9. Stays abreast of emerging trends and technologies in machine learning, continuously integrating the latest research findings and techniques into practice.
10. Contributes to the scholarly and professional communities in machine learning through research, publications, and presentations, establishing a profile as a thought leader in the field.

Programme Learning Outcome

Explainable AI - EQF 5
The learner has demonstrated the ability to develop and implement AI systems that are not only effective but also transparent and understandable, ensuring that these systems are accessible and interpretable to diverse stakeholders in various sectors.

Unit learning outcomes

1. Understands and explains the theoretical foundations of explainable AI, including methods for model transparency and interpretability, to ensure stakeholders can comprehend AI decision-making processes.
2. Implements techniques for developing explainable AI models, such as LIME, SHAP, or decision trees, to enhance transparency in machine learning algorithms across different applications.
3. Assesses the impact of AI systems on stakeholders, particularly focusing on how explainability affects trust and reliance in sectors like healthcare, finance, and public services.
4. Evaluates the trade-offs between model complexity and interpretability, optimizing algorithms to balance performance with clarity and ease of understanding.
5. Develops guidelines and best practices for creating explainable AI solutions, promoting ethical standards and regulatory compliance in AI deployments.
6. Communicates effectively the principles and benefits of explainable AI to non-technical audiences, ensuring clarity and reducing barriers to acceptance and utilization of AI technologies.

7. Leads interdisciplinary teams in projects that integrate explainable AI, fostering an environment where ethical considerations are prioritized in the development and deployment of AI technologies.

Programme Learning Outcome

Explainable AI - EQF 6

The learner has demonstrated the ability to design, implement and evaluate AI models that are both transparent and interpretable, ensuring that stakeholders can understand, trust, and effectively manage AI solutions. Also, the learner has demonstrated the ability to assess the explainability level of an AI system. This includes applying principles and techniques of explainable AI to enhance the accountability, fairness, and ethical use of AI technologies across various domains.

Unit learning outcomes

1. Develops AI models using explainable AI techniques to ensure transparency and interpretability, enhancing the ability of users to understand how AI decisions are made.
2. Analyses existing AI models to assess and measure their explainability, employing methods and metrics to evaluate the transparency and interpretability of model decisions and outputs.
3. Implements strategies to improve the explainability of existing AI models, incorporating techniques such as feature importance scoring, model simplification, and visualization tools to make AI decision-making processes more accessible to non-expert users.
4. Evaluates the impact of explainable AI on model performance, balancing the trade-offs between transparency, accuracy, and complexity to meet both technical and ethical standards.
5. Conveys the principles and benefits of explainable AI to stakeholders, including developers, end-users, and decision-makers, ensuring that the rationale behind AI decisions is clear and comprehensible.
6. Collaborates with interdisciplinary teams to integrate explainable AI practices into the development lifecycle, fostering a culture of transparency and accountability in AI applications.
7. Navigates ethical and legal considerations associated with AI explainability, addressing concerns such as bias, fairness, and privacy to ensure responsible AI deployment.
8. Stays up to date with emerging techniques, tools, and best practices to lead advancements in creating transparent and understandable AI systems.

Programme Learning Outcome

Explainable AI - EQF 7

The learner has demonstrated the ability to design, implement, and evaluate artificial intelligence (AI) systems that are not only effective but also transparent and understandable by humans, ensuring these systems can be audited and trusted by users and stakeholders. This capability includes leading the integration of explainable AI components into broader AI projects to enhance accountability and foster trust in AI applications.

Unit learning outcomes

1. Designs AI systems with a focus on explainability, ensuring that all outputs of AI models can be interpreted by end-users and stakeholders.

2. Implements techniques such as feature importance scores, model-agnostic methods, and visualization of AI decision paths to make complex AI models more understandable.
3. Evaluates the effectiveness of explainable AI models by comparing their performance and transparency with traditional AI models, ensuring that explainability does not compromise system performance.
4. Researches and applies the latest advancements in explainable AI to remain at the forefront of the field, incorporating innovative methods that enhance transparency without sacrificing functionality.
5. Communicates the importance and benefits of explainable AI to a variety of audiences, including technical teams, business stakeholders, and regulatory bodies, highlighting how transparency leads to better trust and adoption.
6. Critically assesses AI models for biases and ethical implications, ensuring that explanations accurately reflect the decision-making process and do not mislead users.
7. Leads cross-functional teams in projects that require the integration of explainable AI, coordinating efforts between data scientists, developers, and business analysts to meet project goals and compliance requirements.
8. Advocates for ethical AI practices, using explainability as a cornerstone for ethical discussions and decision-making in AI development and deployment.

Programme Learning Outcome

Big Data & Data Analytics - EQF 4
The learner has demonstrated the ability to interpret and manipulate large datasets to uncover valuable insights and trends, manage data-driven projects, and guide a team within established frameworks effectively.

Unit learning outcomes

1. Explains the fundamental principles and technologies behind Big Data, including data storage, processing architectures, and analytics platforms, to provide a solid foundation in the field.
2. Utilizes statistical methods and machine learning algorithms to conduct thorough data analysis and predictive modelling, delivering actionable insights for decision-making.
3. Designs and implements robust data processing pipelines to handle large volumes of data efficiently, using both batch and real-time processing techniques.
4. Assesses the quality and integrity of data sources and analytical outputs, ensuring accuracy and reliability in data-driven conclusions and recommendations.
5. Leads data analytics projects, coordinating the efforts of team members and stakeholders to meet project goals while adapting to changing conditions and requirements.

Programme Learning Outcome

Big Data & Data Analytics - EQF 5
The learner has demonstrated the ability to masterfully manage, analyse, and interpret large datasets using advanced data analytics techniques, driving decision-making processes and strategic initiatives in various industries.

Unit learning outcomes

1. Utilizes comprehensive, specialized knowledge of big data technologies and data analytics processes to extract, transform, and load large datasets efficiently.
2. Analyses complex data using statistical models and machine learning techniques to uncover trends, predict outcomes, and provide actionable insights.
3. Develops scalable data pipelines and architectures that ensure data integrity and accessibility, adapting to changing technological landscapes and business requirements.
4. Evaluates the effectiveness of data analytics strategies and tools in real-world applications, continuously seeking improvements and innovations in data handling and analysis.
5. Implements data governance and compliance measures, ensuring that data handling practices meet ethical standards and legal requirements.
6. Communicates findings from data analytics clearly to stakeholders across various levels of an organization, ensuring that insights are accessible and actionable for decision-making.
7. Leads and manages teams in data-driven projects, promoting a culture of data literacy and fostering collaboration and innovation across functional areas.

Programme Learning Outcome

Big Data & Data Analytics - EQF 6
The learner has demonstrated the ability to effectively harness big data technologies and data analytics methodologies to extract insights and inform decision-making. This includes the application of data science principles to analyse datasets that express large velocity, volume, value, variety, and veracity. Also, the learner has shown the ability to implement data visualization techniques to communicate findings clearly.

Unit learning outcomes

1. Utilizes big data technologies to efficiently process and analyse large volumes of data, applying scalable solutions to handle data-intensive applications across various domains.
2. Implements data analytics methodologies to derive actionable insights from complex and unstructured datasets, employing statistical analysis, machine learning techniques, and predictive modelling to support evidence-based decision-making.
3. Develops data science solutions to tackle specific analytical challenges, integrating data pre-processing, analysis, and model evaluation to ensure the accuracy and relevance of analytical outcomes.
4. Creates effective data visualizations that clearly communicate analytical findings to both technical and non-technical audiences, using visualization tools and principles to represent complex data in an accessible and impactful manner.
5. Describes the results and implications of data analysis projects to stakeholders, providing insights and recommendations that inform strategic decision-making and operational improvements.
6. Collaborates with multidisciplinary teams on big data and data analytics projects, leveraging collective expertise to address complex data challenges and achieve comprehensive analytical solutions.
7. Engages in continuous learning and professional development related to big data, data analytics, and data science, staying abreast of emerging technologies, methodologies, and industry best practices to maintain and enhance analytical capabilities.

Programme Learning Outcome

Big Data & Data Analytics - EQF 7
The learner has demonstrated the ability to effectively design, implement, and lead advanced data analytics projects that leverage big data technologies to extract meaningful insights from large, diverse datasets. This includes managing projects that integrate big data solutions into business or research environments, enhancing decision-making processes and strategic development.

Unit learning outcomes

1. Designs and implements robust big data infrastructures that can efficiently process and store massive volumes of data, using advanced technologies like Hadoop, Spark, and NoSQL databases.
2. Develops and applies sophisticated data analytics algorithms and models to big data sets to uncover patterns, trends, and insights that support strategic decision-making.
3. Manages the entire lifecycle of data analytics projects, from data collection and cleaning to analysis and reporting, ensuring alignment with organizational goals and compliance with data privacy laws.
4. Evaluates the performance of big data systems and analytics approaches, using metrics to ensure scalability, efficiency, and accuracy in real-world applications.
5. Innovates with machine learning and artificial intelligence techniques to enhance the capabilities of data analytics, pushing the boundaries of what can be achieved with big data.
6. Leads multidisciplinary teams in data-driven projects, fostering collaboration among data scientists, IT specialists, and business stakeholders to ensure project success.
7. Communicates complex data insights to non-technical audiences, translating analytical findings into actionable business strategies and clear, understandable presentations.
8. Advocates for responsible data usage, ensuring that big data projects adhere to ethical standards and contribute positively to societal challenges.

Programme Learning Outcome

Human-Centered AI - EQF 5
The learner has demonstrated the ability to design and implement artificial intelligence systems that prioritize human values, needs, and ethics, ensuring that AI technologies enhance human capabilities and well-being in diverse contexts.

Unit learning outcomes

1. Understands and articulates the principles of human-centered design in the context of AI, emphasizing the importance of user-centric approaches in the development of AI systems.
2. Applies methodologies for involving stakeholders in the AI design process, ensuring that AI solutions are tailored to enhance user experience and meet specific human needs.
3. Assesses the impact of AI technologies on individuals and communities, considering factors such as accessibility, usability, and potential biases, to foster inclusive and equitable AI solutions.

4. Designs AI systems that incorporate ethical considerations, such as privacy, transparency, and accountability, aligning technology development with human rights and ethical standards.
5. Evaluates and iterates on AI systems using feedback from user interactions and empirical studies to refine and improve the alignment of AI solutions with human values and behaviours.
6. Communicates effectively the concepts and advantages of human-centered AI to diverse audiences, including technical teams, stakeholders, and end-users, ensuring clarity, and promoting ethical awareness.
7. Leads multidisciplinary teams in projects that integrate human-centered principles into AI development, championing a culture that values ethical responsibility and user engagement.

Programme Learning Outcome

Human-Centered AI - EQF 6

The learner has demonstrated the ability to integrate human-centered design principles in AI development, ensuring sustainable, ethical, and effective AI solutions. This includes formulating and implementing AI governance policies, managing AI-related risks, devising strategic AI plans, and enhancing human-computer interaction to create AI systems that are aligned with human values and societal goals.

Unit learning outcomes

1. Incorporates human-centered design principles in the development of AI systems, focusing on user needs and ethical considerations to create solutions that enhance human well-being and productivity.
2. Manages AI risks by identifying potential ethical, legal, and operational issues associated with AI technologies and implementing strategies to mitigate these risks, ensuring the sustainability and reliability of AI systems.
3. Enhances human-computer interaction through the design of intuitive and accessible AI interfaces, improving user experience and engagement with AI systems across diverse application areas.
4. Evaluates the sustainability of AI solutions, considering their environmental, social, and economic impacts to promote responsible and sustainable AI development and use.
5. Communicates effectively with stakeholders about the benefits, challenges, and ethical implications of AI technologies, ensuring informed decision-making and fostering a culture of transparency and trust in AI.
6. Stays informed about emerging trends and best practices in human-centered AI, governance policies, risk management, and sustainability, contributing to the advancement of ethical and effective AI solutions.

Programme Learning Outcome

Human-Centered AI - EQF 7
The learner has demonstrated the ability to design and lead the development of AI systems that are user-friendly, ethical, and transparent, integrating human-centered design principles into AI development to enhance user trust and engagement.

Unit learning outcomes

1. Designs AI solutions that incorporate human-centered design principles, ensuring that the end user's needs and experiences are at the forefront of AI development.
2. Implements interactive AI systems that facilitate effective human-AI collaboration, enhancing user satisfaction and system usability.
3. Evaluates AI systems from a human-centered perspective, assessing usability, accessibility, and the ethical implications of AI technologies to ensure they align with human values.
4. Innovates by applying the latest research in psychology, cognitive science, and user experience design to AI development, creating more intuitive and empathetic AI systems.
5. Leads interdisciplinary teams that include UX designers, psychologists, and AI developers, fostering a collaborative environment where diverse perspectives enhance the human-centered approach to AI.
6. Communicates the benefits and limitations of human-centered AI systems to stakeholders, including technical teams, business leaders, and end-users, ensuring clear understanding and appropriate expectations.
7. Advocates for ethical standards in AI development, emphasizing the importance of transparency, fairness, and accountability in systems that impact human users.
8. Critically assesses societal impacts of AI, considering how AI systems can be designed to contribute positively to societal needs and mitigate potential harms.

Programme Learning Outcome

AI Ethics - EQF 4
The learner has demonstrated the ability to critically analyse and apply ethical principles in the design, implementation, and deployment of artificial intelligence systems, while effectively managing ethical reviews and facilitating discussions within their professional environment.

Unit learning outcomes

1. Identifies and explains key ethical issues associated with AI technologies, including privacy, bias, transparency, and accountability, ensuring a comprehensive understanding of the ethical landscape.
2. Applies ethical frameworks and guidelines to AI projects to promote fairness, accuracy, and respect for user privacy during the development and deployment phases.
3. Conducts impact assessments for AI projects to evaluate potential ethical risks and societal implications, preparing thorough reports and recommendations for stakeholders.
4. Facilitates discussions on AI ethics within teams and broader organizational contexts, promoting a culture of ethical awareness and responsible AI use.
5. Implements and monitors compliance with ethical standards in AI applications, taking responsibility for ongoing ethical management and improvement initiatives.

Programme Learning Outcome

AI Ethics - EQF 5

The learner has demonstrated the ability to critically assess, develop, and implement AI technologies in accordance with ethical principles, ensuring that AI systems are developed and used responsibly across various sectors.

Unit learning outcomes

1. Analyses and understands the foundational ethical theories and principles that guide the responsible development and deployment of AI technologies, such as fairness, accountability, transparency, and privacy.
2. Evaluates AI systems for potential ethical issues and biases, applying ethical frameworks and tools to ensure these systems do not perpetuate inequality or harm.
3. Develops guidelines and best practices for ethical AI, leading the creation of policies and procedures that safeguard user rights and promote ethical standards within organizations.
4. Implements strategies for ethical auditing and compliance in AI projects, ensuring that all stages of AI development adhere to established ethical norms and regulations.
5. Communicates effectively the importance of ethics in AI to diverse audiences, including developers, policymakers, and end-users, fostering an organizational culture that prioritizes ethical considerations in technology.
6. Leads multidisciplinary teams in ethical decision-making processes, promoting critical thinking and ethical reasoning in the design and deployment of AI systems.
7. Stays abreast of emerging ethical issues and debates in AI, continuously updating knowledge and practices to address new challenges as technology evolves.

Programme Learning Outcome

AI Ethics - EQF 6
The learner has demonstrated the ability to critically assess the ethical implications of AI technologies, develop and implement strategies to address ethical challenges, and effectively advocate for responsible AI practices, ensuring AI innovations align with societal values and human rights across various contexts.

Unit learning outcomes

1. Identifies ethical considerations and challenges in AI development and deployment, such as bias, fairness, transparency, and accountability, emphasizing their importance for respecting human rights and societal norms.
2. Develops ethical guidelines and frameworks for AI projects, integrating ethical considerations into the AI lifecycle from design through deployment, to promote ethical AI practices within organizations and society.
3. Implements strategies to mitigate ethical risks in AI applications, employing methods for detecting and correcting biases, ensuring privacy, and maintaining transparency and accountability in AI systems.
4. Advocates for responsible AI by communicating the significance of ethical considerations in AI to diverse audiences, including technologists, policymakers, and the public, to foster an ethical AI culture.
5. Assesses AI projects for ethical implications, utilizing ethical frameworks and principles to evaluate AI's impact on individuals and communities and to ensure alignment with ethical standards and societal values.
6. Collaborates with interdisciplinary teams to address ethical challenges in AI, facilitating discussions and actions that balance technical possibilities with ethical considerations to achieve consensus on responsible AI development and use.

7. Engages in professional and community forums on AI ethics, contributing to the discourse on responsible AI practices and staying informed about emerging ethical issues and solutions in the field.
8. Knowledge of industry-specific laws (national and international) and any kind of regulations that affect AI development to ensure its compliance.
9. Reflects on personal ethical beliefs and practices in relation to AI technologies, committing to ethical professional conduct and continuous learning about ethical challenges and best practices in AI.

Programme Learning Outcome

AI Ethics - EQF 7
The learner has demonstrated the ability to critically analyse and navigate the ethical challenges associated with AI technologies, developing, and implementing strategies to ensure AI systems are designed and used in a responsible and ethical manner.

Unit learning outcomes

1. Analyse the ethical implications of AI systems, identifying potential risks and benefits to individuals and society, and proposing balanced solutions to mitigate ethical concerns.
2. Develop ethical guidelines for AI projects, ensuring that all phases of AI development, from design to deployment, adhere to these principles to protect user privacy and promote fairness.
3. Evaluate AI systems for ethical compliance, using established frameworks and tools to assess the transparency, accountability, and fairness of AI technologies.
4. Lead discussions and workshops on AI ethics, educating and engaging stakeholders from various backgrounds to foster a broader understanding and commitment to ethical AI practices.
5. Innovate in the creation of tools and methods for ethical AI, contributing to the development of new ways to address ethical issues in AI research and practical applications.
6. Advocate for policies and regulations that encourage ethical AI practices, influencing public and private sector approaches to AI development and governance.
7. Collaborate with ethicists, technologists, and business leaders to integrate ethical considerations into the corporate and public-sector use of AI.
8. Research and apply interdisciplinary knowledge from philosophy, law, social science, and technology to enrich the understanding and application of AI ethics.

Programme Learning Outcome

AI Futures and Innovation - EQF 6
The learner has demonstrated the ability to critically analyse future AI developments, leveraging research skills to innovate and contribute to the advancement of AI technologies. This encompasses a deep understanding of current trends, the capability to forecast technological evolutions, and the application of this knowledge to drive forward-thinking AI solutions that address emerging challenges and opportunities for companies.

Unit learning outcomes

1. Analyses current AI developments and trends, applying critical thinking to evaluate the potential impact, benefits, and challenges of emerging AI technologies in various industrial sectors.
2. Forecasts future trends in AI technology, using research methodologies and future literacy skills to anticipate changes, identify opportunities for innovation, and prepare for potential societal and ethical implications.
3. Conducts research to explore new possibilities in AI, demonstrating proficiency in designing and implementing studies that contribute to the knowledge base and development of AI technologies.
4. Innovates in the field of AI by applying insights from research and trend analysis to develop novel AI solutions or improve existing technologies, focusing on addressing unmet needs and capitalizing on future opportunities.
5. Communicates insights and predictions about future AI developments to a variety of audiences, including academic, industry, and public stakeholders, effectively bridging the gap between current research and practical applications.
6. Collaborates with experts from various fields to explore interdisciplinary approaches to AI innovation, fostering a culture of creativity and shared knowledge that supports the advancement of AI technologies.
7. Evaluates the ethical, social, and economic implications of future AI innovations, incorporating ethical considerations into the forecasting and development process to ensure responsible and beneficial outcomes.
8. Knowledge of the regulations and ethical use of data and data practices to ensure data privacy and compliance.
9. Engages in continuous learning and professional development to stay at the forefront of AI research and innovation, actively participating in forums, conferences, and professional networks to exchange ideas and keep abreast of cutting-edge developments.

Programme Learning Outcome

AI Futures and Innovation - EQF 7
The learner has demonstrated the ability to critically assess and creatively engage with emerging AI technologies, predicting future trends and spearheading innovative projects that explore new possibilities and applications of AI in various fields.

Unit learning outcomes

1. Assess the emerging trends in AI technology, evaluating potential future developments and their implications for various industries and societal norms.
2. Develop innovative AI applications, utilizing cutting-edge AI technologies and methodologies to create novel solutions that address unmet needs or open new markets.
3. Lead multidisciplinary teams in experimental AI projects, fostering a collaborative environment that encourages creative problem-solving and rapid prototyping of new ideas.
4. Evaluate the impact of new AI technologies on existing business models and strategies, providing insights that help organizations adapt to technological changes.
5. Advocate for a proactive approach to AI innovation, emphasizing the importance of ethical considerations, sustainability, and long-term societal impacts in the development of new AI technologies.
6. Communicate the potential and risks of future AI innovations to a range of stakeholders, including investors, policymakers, and the public, to foster informed decision-making.

7. Integrate diverse knowledge from fields such as cognitive science, engineering, and digital ethics to enrich AI innovation processes, ensuring that new developments are well-rounded and grounded in interdisciplinary insights.
8. Pioneer research and development in AI, pushing the boundaries of what is technically possible while also considering the practical and ethical challenges associated with advanced AI technologies.

Programme Learning Outcome

Business Intelligence - EQF 5
The learner has demonstrated the ability to effectively harness business intelligence tools and techniques to analyse data, inform strategic decision-making, and improve organizational performance across various business contexts.

Unit learning outcomes

1. Utilizes specialized knowledge in business intelligence systems, including data warehousing, data mining, and visualization tools, to extract and analyse business data efficiently.
2. Develops and implements analytical models and reports that transform raw data into actionable insights, driving business strategy and operational improvements.
3. Evaluates the effectiveness of business intelligence strategies and tools in achieving organizational goals, identifying areas for enhancement and innovation.
4. Manages business intelligence projects, coordinating between technical teams and business stakeholders to ensure that business needs are met through effective data analysis.
5. Communicates complex data insights in a clear and understandable manner to stakeholders at all levels of the organization, enhancing data-driven decision-making processes.
6. Leads the adoption of new business intelligence technologies and practices within the organization, fostering a culture of continuous learning and adaptation to technological advancements.
7. Assesses ethical considerations in data handling and analytics, ensuring that business intelligence practices comply with legal standards and respect privacy and data protection laws.

Programme Learning Outcome

Business Intelligence - EQF 6
The learner has demonstrated the ability to effectively utilize business intelligence tools and methodologies to analyse data, extract actionable insights, and support strategic business decisions.

Unit learning outcomes

1. Utilizes business intelligence tools and software to collect, process, and analyse large datasets, ensuring data accuracy and relevance for business analysis.
2. Interprets complex data sets to identify trends, patterns, and insights that inform business strategies and operations, applying analytical techniques and critical thinking.

3. Designs and implements data visualization techniques to effectively communicate business insights to stakeholders, using dashboards, reports, and presentations to facilitate data-driven decision-making.
4. Evaluates the effectiveness of business intelligence strategies and tools in meeting business objectives, identifying areas for improvement and optimization to enhance business performance.
5. Integrates data warehousing and data management practices to ensure the integrity, security, and accessibility of business data, supporting effective and efficient business intelligence processes.
6. Explains findings and strategic recommendations based on business intelligence analysis to stakeholders, including management and cross-functional teams, ensuring clarity and actionable insights.
7. Collaborates with team members and departments to gather data requirements, share insights, and implement business intelligence solutions that support organizational goals and initiatives.

Programme Learning Outcome

Business Intelligence - EQF 7
The learner has demonstrated the ability to critically analyse large datasets, develop and implement strategic business intelligence (BI) systems, and lead projects that transform data into actionable insights, thereby driving business optimization and innovation.

Unit learning outcomes

1. Develop comprehensive BI strategies that align with organizational goals, utilizing advanced analytics to inform strategic decisions and improve business processes.
2. Implement BI tools and technologies effectively to collect, store, and analyse data, ensuring the delivery of reliable and timely insights.
3. Lead BI projects, managing cross-functional teams to ensure that BI implementations meet time and budget constraints while achieving intended outcomes.
4. Evaluate the effectiveness of BI systems, using performance metrics to assess and optimize the impact of BI on organizational efficiency and competitiveness.
5. Innovate with emerging BI technologies and methodologies, identifying and integrating new tools that enhance the analytical capabilities of the organization.
6. Communicate complex data insights to stakeholders at all levels of the organization, translating data findings into clear, strategic actions that can be easily understood and implemented.
7. Advocate for data-driven culture within the organization, encouraging the use of BI tools across departments to foster informed decision-making.
8. Ensure ethical considerations in data handling and analysis, maintaining compliance with data protection regulations and ensuring integrity in reporting and analytics.

Programme Learning Outcome

AI Awareness - EQF 4
The learner has demonstrated the ability to understand the fundamental concepts and implications of artificial intelligence, effectively communicating these ideas and their potential impacts to a non-technical audience within various organizational contexts.

Unit learning outcomes

1. Explains the basic principles, technologies, and applications of artificial intelligence, ensuring a clear understanding of AI's role and capabilities in modern settings.
2. Identifies real-world examples where AI is currently being used effectively across different industries, illustrating the diverse applications and benefits of AI technologies.
3. Discusses the social, economic, and ethical implications of AI, raising awareness of the challenges and opportunities AI presents in society.
4. Communicates the potential risks and limitations of AI, including data privacy concerns and the risk of bias, to foster a balanced understanding among stakeholders.
5. Encourages ongoing learning and curiosity about AI among peers and colleagues, promoting an environment of continuous professional growth and adaptation to new technologies.

Programme Learning Outcome

AI Awareness - EQF 5
The learner has demonstrated the ability to understand and articulate the fundamental concepts of artificial intelligence, its potential impacts, and the challenges it presents in various societal and business contexts.

Unit learning outcomes

1. Identifies and explains the key technologies and methodologies that underpin AI, such as machine learning, neural networks, and natural language processing, and their applications across different industries.
2. Analyses the potential impacts of AI on society, including economic, ethical, and social implications, promoting an informed perspective on how AI can be used responsibly.
3. Discusses the challenges and risks associated with AI deployment, such as privacy concerns, job displacement, and decision-making biases, fostering a critical understanding of AI limitations.
4. Evaluates real-world case studies where AI has been successfully implemented, understanding both the benefits and the complexities involved in integrating AI into existing systems.
5. Communicates effectively about AI technologies and their implications to diverse audiences, ensuring clarity and addressing common misconceptions and fears.
6. Participates in debates and discussions about the future of AI, contributing informed viewpoints that consider both technological advancements and societal needs.
7. Advocates for ethical AI practices, emphasizing the importance of transparency, fairness, and accountability in AI development and deployment.

Programme Learning Outcome

AI Awareness - EQF 6
The learner has demonstrated the ability to understand the fundamentals of artificial intelligence, its applications across various markets, and its transformative impact on business processes. This encompasses an appreciation of AI technologies, their potential for innovation, and the strategic considerations necessary for integrating AI into business operations.

Unit learning outcomes

1. Understands the basic concepts and technologies underlying artificial intelligence, including machine learning, natural language processing, and robotics, recognizing their roles in driving innovation.
2. Identifies key AI applications in the programming application market, assessing the competitive landscape and potential for disruptive innovation across industries.
3. Analyses the implications of AI on business processes, evaluating how AI technologies can optimize operations, enhance customer experiences, and create new business models.
4. Assesses the strategic considerations for integrating AI into business operations, including technical feasibility, cost-benefit analysis, and alignment with business goals.
5. Recognizes the ethical, legal, and societal challenges associated with AI deployment, advocating for responsible AI use that respects privacy, fairness, and transparency.
6. Communicates effectively about AI technologies and their business applications to a range of audiences, fostering AI literacy and supporting informed decision-making within organizations.
7. Collaborates with technical and non-technical teams to explore AI opportunities, facilitating cross-functional understanding and strategic alignment on AI initiatives.
8. Knowledge of current trends in AI technology to evaluate how these might influence industry innovation and competitive strategies.
9. Engages in continuous learning to keep pace with rapid advancements in AI technology and its evolving impact on the business landscape, maintaining an informed perspective on future opportunities and challenges

Programme Learning Outcome

AI Awareness - EQF 7
The learner has demonstrated the ability to comprehensively understand and communicate the foundational principles of AI, its current and potential applications, and the ethical, legal, and societal challenges associated with its deployment.

Unit learning outcomes

1. Understand the fundamental concepts of AI, including machine learning, deep learning, neural networks, and their underlying algorithms, to build a solid foundation of AI knowledge.
2. Assess the impact of AI technologies on various sectors such as healthcare, finance, manufacturing, and education, analysing both the opportunities and challenges they present.
3. Communicate effectively about AI to diverse audiences, explaining complex AI concepts in accessible language and contextualizing its benefits and risks.
4. Analyse ethical implications of AI deployments, considering issues such as bias, privacy, and accountability, and proposing strategies to address these concerns.
5. Explore AI's potential for innovation, identifying areas where AI can drive advancements and improve outcomes, while also considering the disruption it may cause.
6. Lead discussions and training sessions on AI literacy within the organization to foster an informed and engaged workforce prepared to adapt to AI-driven changes.
7. Advocate for responsible AI use, promoting policies and practices that ensure AI technologies are implemented in a fair, ethical, and transparent manner.

8. Stay informed about the latest developments in AI, maintaining an ongoing awareness of emerging technologies, research findings, and regulatory changes to remain current in the field.

Programme Learning Outcome

AI for Robotics - EQF 6

The learner has demonstrated the ability to integrate AI technologies with robotics, applying computer vision, speech recognition, and reinforcement learning to develop intelligent robotic systems. This includes designing, programming, and implementing AI-driven robots that can interact with their environment and humans in sophisticated ways, leveraging AI to enhance robotic perception, decision-making, and learning capabilities.

Unit learning outcomes

1. Designs and develops robotic systems that incorporate AI technologies, demonstrating proficiency in programming robots to perform tasks autonomously and interact with their surroundings effectively.
2. Implements computer vision algorithms in robotic systems, enabling robots to understand and interpret visual information from their environment, facilitating navigation, object recognition, and task execution.
3. Integrates speech recognition and natural language processing technologies into robotic systems, allowing for effective human-robot interaction through voice commands and auditory feedback.
4. Applies reinforcement learning techniques to enable robots to learn from their environment and experiences, optimizing their actions to achieve specific goals and adapt to new challenges over time.
5. Evaluates the performance of AI-driven robotic systems, using metrics and tests to assess their efficiency, reliability, and effectiveness in real-world applications.
6. Describes technical details and project outcomes related to AI for robotics to stakeholders, including the capabilities, limitations, and potential applications of robotic systems in various industries.
7. Collaborates with interdisciplinary teams on AI robotics projects, leveraging collective expertise to address complex challenges and innovate in the design and implementation of intelligent robotic solutions.
8. Knowledge of robotics simulation environments to test algorithms before its deployment.

Programme Learning Outcome

Cyber and Data Security - EQF 4

The learner has demonstrated the ability to implement and manage cyber and data security measures effectively, ensuring the protection of information assets while overseeing security protocols within an organizational context.

Unit learning outcomes

1. Identifies and explains the core concepts and principles of cyber and data security, including the types of threats, vulnerabilities, and the importance of data integrity and confidentiality.

2. Implements security measures and protocols to safeguard data across different platforms and environments, using best practices in cybersecurity to prevent unauthorized access and data breaches.
3. Evaluates and improves existing security frameworks within an organization, assessing risks and applying enhancements to strengthen overall security posture.
4. Educates and trains team members on security best practices and emerging threats, fostering a culture of security awareness and proactive defence.
5. Manages incident response strategies and procedures, leading efforts to mitigate damages in the event of a security breach and ensuring quick recovery and continuity of operations.

Programme Learning Outcome

Cyber and Data Security - EQF 5
The learner has demonstrated the ability to design, implement, and evaluate security measures and protocols to protect data integrity and confidentiality across various digital platforms and systems, effectively managing risks in diverse and unpredictable cybersecurity environments.

Unit learning outcomes

1. Analyses the landscape of cyber threats and vulnerabilities, employing comprehensive and specialized knowledge to identify and assess risks in different technological environments.
2. Implements advanced security measures, such as encryption, firewalls, and intrusion detection systems, to safeguard information assets against unauthorized access and breaches.
3. Develops and tests robust cybersecurity policies and procedures that comply with legal and ethical standards, ensuring data protection and network security across organizational platforms.
4. Manages incident response and recovery operations, demonstrating the ability to effectively handle security breaches and minimize their impact on business operations and data privacy.
5. Evaluates the effectiveness of security protocols through regular audits and updates, adapting strategies to combat evolving cyber threats and ensure continuous protection.
6. Communicates complex cybersecurity concepts and practices to non-specialists, fostering a culture of security awareness and compliance throughout the organization.
7. Leads cybersecurity teams and projects, coordinating efforts to enhance data security, and fostering innovation in response to emerging security challenges and technological advancements.

Programme Learning Outcome

Cyber and Data Security - EQF 6
The learner has demonstrated the ability to identify cybersecurity threats and vulnerabilities, implement and manage robust security measures, and develop comprehensive strategies to protect digital assets and ensure data privacy across various operational environments, while understanding the ethical, legal, and societal implications.

Unit learning outcomes

1. Identifies a variety of cybersecurity threats and vulnerabilities, understanding their mechanisms and the potential impact they pose on information systems, to enhance awareness and preparedness in a dynamic digital landscape.
2. Implements key cybersecurity measures such as firewalls, encryption, and intrusion detection systems, showcasing the ability to safeguard information assets against unauthorized access and cyber threats in compliance with relevant regulations.
3. Designs security architectures for information systems that incorporate risk management principles and security-by-design approaches, aiming to minimize vulnerabilities and ensure the integrity, confidentiality, and availability of data across diverse applications.
4. Manages cybersecurity incidents by effectively deploying incident response strategies and techniques to promptly address and mitigate the impact of security breaches, ensuring a rapid return to normal operations and compliance with legal and reporting obligations.
5. Evaluates the ethical, legal, and societal implications of cybersecurity practices, considering issues such as data protection laws, privacy rights, and ethical hacking, to promote responsible and lawful security measures that respect individual and societal values.
6. Conveys complex cyber and data security concepts, policies, and protocols clearly to a broad audience, including technical and non-technical stakeholders, enhancing the organizational culture of security, and fostering best practices in cybersecurity awareness and training.
7. Collaborates within teams to develop and implement comprehensive cybersecurity solutions, leveraging interdisciplinary knowledge and perspectives to address complex security challenges with innovative, ethical, and effective strategies.
8. Reflects on personal and professional growth in the field of cyber and data security, engaging in continuous learning to stay abreast of evolving threats, technologies, and regulatory landscapes, contributing to the advancement of cybersecurity knowledge and practices.

Programme Learning Outcome

Cyber and Data Security - EQF 7
The learner has demonstrated the ability to design, implement, and lead comprehensive cybersecurity strategies that protect information assets against emerging threats and vulnerabilities, while ensuring compliance with international data protection regulations.

Unit learning outcomes

1. Analyse and mitigate security risks associated with organizational data assets, utilizing advanced risk assessment tools and techniques to identify vulnerabilities and threats.
2. Design and implement robust security frameworks that incorporate best practices in cybersecurity, including the use of encryption, intrusion detection systems, and secure software development life cycles.
3. Develop policies and procedures that enforce data security standards and regulatory compliance, including GDPR and other international data protection laws.
4. Lead cybersecurity incident response teams, coordinating efforts to quickly address and mitigate the impact of security breaches.
5. Evaluate the effectiveness of security measures by regularly conducting security audits and penetration testing to ensure systems are resilient against attacks.

6. Train and mentor staff on cybersecurity best practices, raising awareness and fostering a security-minded culture within the organization.
7. Stay abreast of the latest developments in cybersecurity technology and threat landscapes, continuously updating and adapting security strategies to address new challenges.
8. Advocate for ethical considerations in data handling and security practices, ensuring that the privacy and rights of individuals are protected in the face of increasing digital surveillance and data collection.

Programme Learning Outcome

Natural Language Processing (NLP) - EQF 5
The learner has demonstrated the ability to design, implement, and optimize NLP systems that effectively process and analyse human language, contributing to advancements in AI-driven communication technologies across various sectors.

Unit learning outcomes

1. Understands and applies fundamental and advanced concepts of NLP, including syntax, semantics, and pragmatics, to develop algorithms capable of interpreting and generating human language.
2. Designs and tests NLP applications such as chatbots, translation systems, and sentiment analysis tools, ensuring they meet user needs and perform effectively in real-world scenarios.
3. Evaluates the performance of NLP systems using state-of-the-art metrics and methodologies, continuously seeking improvements in accuracy, efficiency, and usability.
4. Implements machine learning techniques in NLP, including supervised and unsupervised learning methods, to enhance the learning and adaptability of language models.
5. Addresses ethical and privacy concerns in NLP projects, developing guidelines to protect user data and prevent biases in language processing models.
6. Communicates the capabilities and limitations of NLP technologies to stakeholders, explaining complex technical details in a clear and accessible manner.
7. Leads interdisciplinary teams in NLP projects, fostering collaboration between linguists, computer scientists, and industry experts to innovate and push the boundaries of what AI can achieve with human language.

Programme Learning Outcome

Natural Language Processing (NLP) - EQF 6
The learner has demonstrated the ability to apply natural language processing techniques to analyse, understand, and generate human language, leveraging computational methods to solve complex problems in linguistics and communication. This includes proficiency in utilizing NLP tools and algorithms to extract insights from text data, enhance human-computer interaction, and create applications that can process and produce language effectively.

Unit learning outcomes

1. Applies NLP techniques to analyse text data, extracting relevant information and insights to support decision-making and knowledge discovery across various domains.
2. Develops applications that utilize NLP for tasks such as sentiment analysis, language translation, and chatbot development, demonstrating the ability to design and implement systems that improve human-computer interaction through natural language understanding.
3. Implements machine learning models for NLP, including supervised and unsupervised learning approaches, to automate the processing and interpretation of large text datasets, enhancing the scalability and efficiency of language-based applications.
4. Knowledge of advance NLP techniques based on deep learning and attention methods and architectures and pipelines for LLM.
5. Evaluates the performance of NLP systems, using appropriate metrics and validation techniques to ensure their accuracy, reliability, and fairness in real-world applications.
6. Integrates NLP with other AI technologies, such as speech recognition and computer vision, to create multidimensional applications that can process and understand multimodal inputs.
7. Communicates the capabilities and limitations of NLP technologies to technical and non-technical audiences, facilitating understanding and ethical use of NLP in various applications.
8. Addresses ethical and societal considerations in NLP applications, including issues of bias, privacy, and the ethical use of language data, advocating for responsible development and deployment of NLP technologies.
9. Engages in continuous learning and professional development in the field of NLP, staying informed about emerging trends, technologies, and research findings to lead innovation and advance the state of the art in natural language processing.

Programme Learning Outcome

Natural Language Processing (NLP) - EQF 7
The learner has demonstrated the ability to critically design, develop, and optimize NLP systems, using advanced algorithms and machine learning techniques to efficiently process and analyse large volumes of natural language data, leading projects that innovate and enhance communication technologies.

Unit learning outcomes

1. Design and implement advanced NLP models, utilizing state-of-the-art techniques such as deep learning and transformer architectures to solve complex language processing challenges.
2. Evaluate NLP systems, using rigorous testing and validation methods to ensure their accuracy, efficiency, and applicability to real-world scenarios.
3. Optimize NLP algorithms for various computational environments, enhancing performance without sacrificing accuracy or increasing computational costs.
4. Apply NLP techniques to extract insights and information from textual data across different languages and dialects, supporting diverse applications such as sentiment analysis, chatbots, and automated translation.
5. Lead interdisciplinary teams in NLP projects, coordinating efforts between linguists, software developers, and data scientists to achieve project goals and push the boundaries of current technology.

6. Communicate NLP concepts and results effectively to both technical and non-technical stakeholders, ensuring that the benefits and limitations of NLP technologies are understood.
7. Stay informed on the latest developments in NLP research and industry applications, integrating cutting-edge research findings into practical applications.
8. Advocate for ethical AI practices in NLP, addressing issues such as bias, privacy, and the potential for misuse of language technologies.
9. Engages in continuous learning and professional development in the field of NLP, staying informed about emerging trends, technologies, and research findings to lead innovation and advance the state of the art in natural language processing.

Programme Learning Outcome

Natural Language Processing (NLP) - EQF 8
The learner has demonstrated the ability to master, innovate, and critically evaluate advanced techniques in Natural Language Processing, significantly enhancing the development and implementation of NLP solutions in complex real-world applications.

Unit learning outcomes

1. Develops sophisticated NLP models that can understand, interpret, and generate human language, employing cutting-edge machine learning algorithms and linguistic theory.
2. Evaluates and enhances the performance of NLP systems using advanced metrics and testing methodologies to ensure accuracy, efficiency, and scalability in diverse applications.
3. Leads research and development projects in NLP, demonstrating substantial autonomy and responsibility in high-stakes or innovative applications.
4. Implements state-of-the-art techniques for semantic analysis, sentiment analysis, and machine translation, pushing the boundaries of current technology and opening new avenues for application.
5. Communicates technical details and strategic implications of NLP systems to a broad audience, including stakeholders, policymakers, and non-technical team members, to facilitate informed decision-making.
6. Addresses ethical considerations in NLP applications, such as bias, fairness, and privacy concerns, upholding high standards of professional integrity and responsibility.
7. Stays abreast of emerging trends and technologies in NLP and related fields, continually integrating new findings to maintain cutting-edge knowledge and practices.
8. Fosters interdisciplinary collaboration by integrating insights from linguistics, psychology, and data science to enrich NLP projects and innovations.
9. Publishes and presents research findings in prestigious journals and conferences, contributing to the scholarly community and establishing a professional reputation as an expert in NLP.
10. Adapts NLP techniques to novel problems and industries, demonstrating creativity and the ability to redefine existing practices and assumptions in the field.

Programme Learning Outcome

Image Processing - EQF 5

The learner has demonstrated the ability to design, implement, and evaluate advanced image processing systems that enhance, analyse, and interpret visual data, driving innovation and problem-solving in fields ranging from healthcare to digital media.

Unit learning outcomes

1. Understands and applies comprehensive theoretical and practical knowledge of image processing techniques, including digital filtering, image enhancement, segmentation, and feature extraction.
2. Develops algorithms and systems for applications such as medical imaging, satellite photo analysis, and automated quality control, ensuring they are effective and suitable for specific tasks.
3. Evaluates the performance of image processing systems using advanced metrics and tests, optimizing algorithms to improve accuracy and efficiency in real-world applications.
4. Implements machine learning and deep learning methods in image processing tasks, enhancing the capability of systems to perform tasks like object detection, recognition, and classification autonomously.
5. Addresses ethical and privacy issues related to the use of image data, formulating guidelines and practices that protect individuals' rights and ensure responsible use of imaging technology.
6. Communicates complex image processing concepts and results to both technical and non-technical audiences, ensuring understanding and appropriate use of imaging technologies.
7. Leads and manages multidisciplinary project teams in the development and deployment of image processing technologies, fostering innovation and adherence to best practices in diverse settings.

Programme Learning Outcome

Image Processing - EQF 6
The learner has demonstrated the ability to apply image processing techniques and algorithms to analyse, enhance, and interpret images. This includes leveraging computational methods to solve problems related to visual data, utilizing a range of tools and techniques for image analysis, enhancement, restoration, and feature extraction to support applications in various fields such as healthcare, security, and multimedia.

Unit learning outcomes

1. Applies fundamental and advanced image processing techniques to enhance the visual quality of images, addressing issues such as noise reduction, contrast enhancement, and colour correction to improve image clarity and detail.
2. Develops algorithms for the segmentation of images, enabling the isolation and analysis of specific regions or objects within an image, facilitating applications such as medical imaging analysis, object recognition, and content-based image retrieval.
3. Implements feature extraction methods to identify and quantify distinctive attributes in images, supporting tasks like pattern recognition, texture analysis, and shape detection for automated decision-making processes.
4. Utilizes machine learning and deep learning models in conjunction with image processing to automate the classification, detection, and interpretation of visual information, enhancing the capabilities of computer vision applications.

5. Evaluates the performance of image processing algorithms and systems, employing appropriate metrics and validation strategies to ensure accuracy, efficiency, and suitability for specific application requirements.
6. Integrates image processing techniques into applications and systems, demonstrating the ability to design and develop software solutions that leverage visual data for information extraction, user interaction, and problem-solving.
7. Communicates the principles, methodologies, and outcomes of image processing projects to both technical and non-technical audiences, ensuring clear understanding of the technology's potential and limitations.
8. Engages in continuous learning and professional development within the field of image processing, staying abreast of emerging technologies, algorithms, and application areas to maintain expertise and contribute to innovation in processing and analysing visual data.

Programme Learning Outcome

Image Processing - EQF 7
The learner has demonstrated the ability to design, optimize, and lead projects that utilize advanced image processing techniques to analyse and interpret visual data from various sources, thereby enhancing decision-making and innovation in fields such as medicine, remote sensing, and multimedia.

Unit learning outcomes

1. Develop and implement advanced image processing algorithms, using techniques such as convolutional neural networks, edge detection, and image segmentation to improve the accuracy and efficiency of image analysis.
2. Evaluate the performance of image processing systems, conducting comprehensive tests to ensure that they meet specific requirements and are robust against various challenges in real-world scenarios.
3. Optimize image processing pipelines for speed and efficiency, ensuring that large volumes of images can be processed in real-time or near-real-time environments.
4. Apply machine learning and artificial intelligence in image processing, enhancing the capability to automatically interpret and classify image data across different domains.
5. Lead multidisciplinary project teams involved in the development and deployment of image processing technologies, managing resources and timelines to meet project goals.
6. Communicate technical details and project impacts effectively to stakeholders, including project managers, clients, and team members, ensuring clarity and alignment with broader organizational goals.
7. Stay current with technological advancements in the field of image processing, incorporating emerging tools and methods into existing systems to maintain cutting-edge capabilities.
8. Advocate for ethical considerations in image processing, particularly in the handling and analysis of images involving personal or sensitive information, to ensure privacy and data protection compliance.

Programme Learning Outcome

Image Processing - EQF 8
The learner has demonstrated the ability to develop, implement, and critically evaluate advanced image processing techniques, leading to significant advancements in the field and its applications in various high-impact domains such as medical imaging, remote sensing, and multimedia.

Unit learning outcomes

1. Develops and optimizes sophisticated algorithms for image enhancement, restoration, and reconstruction, pushing forward the capabilities of current imaging technologies.
2. Analyses complex imaging data to extract meaningful information, applying advanced mathematical models and machine learning techniques.
3. Leads multidisciplinary teams in the design and execution of large-scale image processing projects, demonstrating high levels of responsibility and innovative thinking.
4. Evaluates the effectiveness and limitations of different image processing methods in real-world scenarios, using rigorous testing and validation frameworks.
5. Innovates in the application of image processing techniques to new areas such as augmented reality, autonomous vehicles, and robotic vision, contributing to the expansion of the field.
6. Communicates complex image processing concepts and the implications of research findings to a diverse audience, including technical experts, industry stakeholders, and laypersons.
7. Ensures ethical considerations are integrated into image processing practices, particularly in sensitive applications like surveillance and personal data handling.
8. Stays informed about the latest technological advancements and research in image processing, continually updating and refining professional practice.
9. Contributes to academic and professional communities by publishing research, delivering presentations at conferences, and serving on editorial boards or review panels.
10. Implements and customizes image processing solutions to meet specific industry needs, demonstrating adaptability and expertise in applying theory to practical challenges.

Programme Learning Outcome

Generative AI - EQF 5
The learner has demonstrated the ability to design, develop, and deploy generative AI models that creatively synthesize new content, such as images, text, and music, advancing the capabilities of AI in creative and commercial industries.

Unit learning outcomes

1. Understands and applies foundational and advanced concepts in generative AI, including generative adversarial networks (GANs), variational autoencoders (VAEs), and transformer models, to create novel AI-generated content.
2. Develops and refines generative models to ensure high-quality outputs, addressing challenges like mode collapse in GANs and ensuring diversity and realism in generated content.
3. Evaluates the effectiveness and authenticity of AI-generated content using quantitative and qualitative metrics, continually improving the models based on feedback and performance data.

4. Implements ethical considerations in the development and use of generative AI, particularly regarding copyright, authenticity, and the potential for misuse, establishing guidelines for ethical AI creativity.
5. Communicates the principles, capabilities, and limitations of generative AI technologies to stakeholders, clarifying how these tools can be used responsibly in creative and commercial contexts.
6. Leads projects that integrate generative AI into existing digital media, entertainment, and design workflows, managing interdisciplinary teams to innovate and push the boundaries of traditional content creation.
7. Stays abreast of emerging trends and technologies in generative AI, incorporating new ideas and techniques to maintain cutting-edge capabilities in AI-driven content creation.

Programme Learning Outcome

Generative AI - EQF 6

The learner has demonstrated the ability to design, implement, and evaluate generative AI systems, utilizing advanced techniques including prompt engineering for Large Language Models. This includes the capacity to identify AI-generated content, create innovative applications using generative AI models, and apply best practices in prompt engineering to achieve desired outcomes in various industrial domains.

Unit learning outcomes

1. Designs generative AI models to create novel content, including text, images, and audio, demonstrating an understanding of the underlying technologies and their application in generating high-quality, creative outputs.
2. Identifies AI-generated content, employing analytical methods and tools to distinguish between human and machine-generated outputs, addressing concerns related to authenticity, copyright, and ethics.
3. Develops prompt engineering skills, crafting effective prompts to guide generative AI models in producing specific and relevant outputs, optimizing the interaction between users and AI systems for enhanced creativity and efficiency.
4. Implements Large Language Models (LLMs) in generative AI projects, leveraging their capabilities for text generation, language understanding, and complex problem-solving, tailoring model parameters and prompts to specific use cases.
5. Evaluates the performance of generative AI systems, using criteria such as originality and relevance to assess system outputs and guide improvements.
6. Assesses the ethical implications of generative AI systems, considering the impact on stakeholders and societal norms to ensure responsible use and development of AI technologies.
7. Integrates generative AI into diverse applications, from content creation and augmentation to problem-solving and innovation, demonstrating the ability to apply generative AI technologies across various fields and industries.
8. Conveys the principles and potential of generative AI to a broad audience, including technical and non-technical stakeholders, facilitating understanding and ethical use of generative technologies.
9. Engages in continuous learning and professional development in the field of generative AI, staying informed about advancements in AI models, prompt engineering techniques, and emerging ethical standards, to lead in the development of responsible and innovative AI-driven solutions.

Programme Learning Outcome

Generative AI - EQF 7
The learner has demonstrated the ability to design, implement, and evaluate generative AI models, leveraging their capabilities to innovate and drive forward creative solutions in various sectors such as media, healthcare, and technology.

Unit learning outcomes

1. Design and implement advanced generative AI models, such as Generative Adversarial Networks (GANs), Variational Autoencoders (VAEs), and Transformer models, to generate novel images, texts, and data structures.
2. Evaluate the effectiveness and safety of generative AI models, ensuring they produce high-quality, innovative outputs while addressing potential risks like misinformation or unethical use.
3. Optimize generative models for efficiency and scalability, ensuring they can be deployed effectively in diverse environments, including cloud platforms and edge devices.
4. Knowledge in fine tuning and customizing generative models and use of transfer learning while implementing strategies to identify and mitigate biases in generative AI outputs.
5. Apply generative AI in novel applications, exploring uses in fields such as synthetic data generation for training other AI models, creative arts, and product design.
6. Lead projects and teams in the development of generative AI applications, managing cross-disciplinary groups to foster innovation and ensure project alignment with strategic goals.
7. Communicate the capabilities and limitations of generative AI, educating stakeholders on both the potential and the challenges of generative models, ensuring informed decision-making.
8. Stay abreast of technological advancements in the field of generative AI, incorporating the latest research and tools into ongoing projects to maintain cutting-edge knowledge and application.
9. Advocate for responsible use of generative AI technologies, ensuring that ethical considerations are integrated into the development and deployment processes to mitigate harm and bias.

Programme Learning Outcome

Generative AI - EQF 8
The learner has demonstrated the ability to conceptualize, develop, and evaluate advanced generative AI models, leading innovations that redefine existing practices and create new opportunities in various fields such as art, design, entertainment, and technology.

Unit learning outcomes

1. Develops cutting-edge generative models that can create high-quality, novel content such as images, text, and music, demonstrating advanced skills in neural networks and deep learning.

2. Analyses and optimizes the performance of generative AI systems using state-of-the-art techniques to ensure they are efficient, scalable, and capable of producing desired outputs.
3. Leads projects that apply generative AI to solve complex, real-world problems, demonstrating substantial autonomy and responsibility in managing innovative applications.
4. Evaluates the societal and ethical implications of generative AI, particularly in terms of copyright, originality, and privacy, ensuring that developments adhere to high ethical standards.
5. Communicates the capabilities and limitations of generative AI technologies to various stakeholders, effectively bridging the gap between technical possibilities and practical applications.
6. Innovates by integrating new algorithms and creative approaches into generative AI projects, pushing the boundaries of what is technologically feasible and artistically expressive.
7. Stays abreast of emerging trends and advancements in AI and related fields, continually enhancing personal expertise and the performance of generative models.
8. Fosters interdisciplinary collaboration by working with artists, designers, engineers, and scientists to explore new applications and perspectives in generative AI.
9. Publishes research findings and technical innovations in prestigious journals and conferences, contributing to the academic and professional discourse on generative AI.
10. Customizes and adapts generative AI tools to specific industry needs, demonstrating a deep understanding of both the technology and the context of its application.

Programme Learning Outcome

Change Management - EQF 5
The learner has demonstrated the ability to effectively lead and manage organizational change, applying systematic approaches to plan, implement, and sustain changes that align with strategic objectives and enhance organizational performance.

Unit learning outcomes

1. Analyses the need for change within organizations, identifying key drivers such as technological advancement, market dynamics, and internal challenges that necessitate adaptation.
2. Plans and designs change management strategies that are clear, structured, and aligned with the organization's long-term goals and values.
3. Implements change initiatives effectively, using project management tools and techniques to monitor progress, manage resources, and mitigate risks.
4. Communicates change effectively to all stakeholders, using appropriate methods to ensure buy-in, address concerns, and minimize resistance.
5. Evaluates the impact of change initiatives, using metrics and feedback to assess outcomes and determine the effectiveness of the strategies employed.
6. Adapts change strategies in response to evolving circumstances and feedback, demonstrating flexibility and resilience to ensure the sustainability of change.
7. Leads and inspires others during times of change, exhibiting strong leadership qualities that foster a culture of continuous improvement and readiness for change.

Programme Learning Outcome

Change Management - EQF 6
The learner has demonstrated the ability to effectively lead and manage change processes within organizations, employing strategies to facilitate smooth transitions, overcome resistance, and ensure stakeholder engagement. This includes understanding the dynamics of organizational change, communicating effectively to align team and organizational goals, and applying change management models to support and sustain organizational transformation.

Unit learning outcomes

1. Understands the principles and theories of change management, including the factors driving change, the stages of change processes, and the impact of change on organizations and individuals.
2. Assesses organizational readiness for change, evaluating factors such as culture, resources, and stakeholder attitudes to plan effective change initiatives.
3. Designs change management strategies, developing plans that outline objectives, actions, timelines, and resources needed to achieve successful change.
4. Communicates change effectively, using clear, persuasive messaging to convey the reasons for change, the benefits of the change process, and the expected outcomes to various stakeholders.
5. Engages stakeholders throughout the change process, employing techniques to build support, address concerns, and foster participation in change initiatives.
6. Implements change management plans, coordinating actions, monitoring progress, and adjusting as necessary to ensure the success of change initiatives.
7. Manages resistance to change, identifying sources of opposition and employing strategies to address resistance constructively and supportively.
8. Evaluates the effectiveness of change management efforts, analysing outcomes to determine the impact of change initiatives and identifying lessons learned for future change efforts.
9. Cultivates resilience and adaptability in teams, fostering an organizational culture that embraces change as an opportunity for growth and development.

Programme Learning Outcome

Soft Skills - EQF 4

The learner has demonstrated the ability to effectively utilize a comprehensive range of soft skills, including communication, teamwork, problem-solving, and more, to enhance personal and organizational performance, while adeptly managing change and conflicts within diverse and dynamic environments.

Unit learning outcomes

1. Demonstrates the ability to articulate complex ideas clearly and persuasively in various formats and to different audiences, ensuring mutual understanding and collaboration.
2. Engages constructively with team members, leveraging diverse perspectives and skills to achieve shared goals and enhance team productivity.

3. Employs critical thinking and a structured approach to identify, analyse, and resolve problems, optimizing outcomes and learning from each experience.
4. Designs and executes presentations that effectively communicate key messages, engage audiences, and drive action.
5. Cultivates creativity and innovation, encouraging new ideas and approaches to improve processes, products, and services.
6. Analyses information and situations critically, questioning assumptions and making informed decisions based on sound reasoning and evidence.
7. Resolves interpersonal and team conflicts through effective negotiation and mediation strategies, maintaining workplace harmony and cooperation.

Programme Learning Outcome

Soft Skills - EQF 5

The learner has demonstrated the ability to master a suite of essential soft skills, including communication, teamwork, problem-solving, presentation, innovation, critical thinking, conflict management, and change management, effectively applying these skills to enhance personal effectiveness and organizational performance in various professional settings.

Unit learning outcomes

1. Communicates effectively across a variety of platforms, ensuring clear, persuasive, and impactful exchanges with diverse audiences to facilitate organizational and personal objectives.
2. Collaborates within teams, fostering a cooperative environment that leverages diverse strengths and perspectives to achieve common goals and optimize team performance.
3. Solves problems creatively and efficiently, applying structured and innovative approaches to overcome challenges and implement practical solutions in dynamic environments.
4. Designs and delivers compelling presentations, utilizing advanced tools and techniques to convey information clearly and engage audiences effectively.
5. Cultivates an innovative mindset, encouraging creative thinking and continuous improvement both individually and within teams.
6. Applies critical thinking to analyse and synthesize information, making informed decisions based on comprehensive evaluation and logical reasoning.
7. Manages conflicts by implementing effective resolution strategies, promoting a harmonious work environment, and enhancing interpersonal relationships.

Programme Learning Outcome

Soft Skills - EQF 6

The learner has demonstrated the ability to effectively apply a wide range of soft skills in diverse professional and personal contexts. This includes mastering communication, collaboration,

problem-solving, and adaptability, as well as the ability to manage change and conflict, think critically, and innovate.

1. Collaborates within teams, contributing positively to group efforts, sharing responsibility, and supporting colleagues to achieve collective goals.
2. Solves problems creatively and efficiently, applying logical and innovative thinking to overcome challenges and optimize outcomes.
3. Delivers impactful presentations, effectively using verbal and visual communication to engage audiences and clearly convey information.
4. Cultivates an innovative mindset, embracing and fostering creativity, questioning conventional approaches, and generating novel solutions.
5. Communicates effectively across a variety of platforms and media, adapting messages for different audiences and purposes to enhance understanding and engagement.
6. Thinks critically, analysing situations, evaluating diverse perspectives, and synthesizing information to make informed decisions.
7. Manages conflicts constructively, employing negotiation and mediation skills to resolve disputes and maintain harmonious relationships.

Programme Learning Outcome

Soft Skills - EQF 7

The learner has demonstrated the ability to integrate and apply a broad range of advanced soft skills to lead teams, manage change, solve complex problems, and communicate effectively, enhancing organizational performance and driving innovation.

Unit learning outcomes

1. Masters advanced communication techniques, tailoring messaging and employing diverse media to effectively reach and engage varied audiences in different contexts.
2. Leads and enhances team performance through effective collaboration, motivational strategies, and conflict resolution, fostering a cooperative and productive workplace environment.
3. Develops and implements creative problem-solving strategies, using innovative and critical thinking to address complex challenges and achieve strategic goals.
4. Delivers compelling presentations, utilizing state-of-the-art presentation tools and persuasive communication techniques to influence and drive decisions.
5. Cultivates an innovative mindset, encouraging creativity and continuous improvement in personal and organizational practices.
6. Applies critical thinking to evaluate information, make informed decisions, and develop well-reasoned arguments to support organizational objectives.
7. Resolves conflicts effectively, using advanced negotiation and mediation skills to handle disputes and maintain positive relationships among stakeholders.

PLOs for policy- and decisionmakers, and AI advisors/ consultants

Programme Learning Outcome
AI fundamentals - EQF 6 The learner has demonstrated capability to explain the concept of AI, as well as related methods, tools and techniques and its potential risks and impact to generate information using a common AI tool.
Unit learning outcomes
1. Explains the history of AI, its benefits and common terms and concepts related to AI, such as algorithms, machine learning and deep learning, neural networks, supervised and unsupervised learning, narrow and broad AI. 2. Explains common AI methods, tools, and techniques, such as generative AI, algorithmic decision-making, autonomous systems, computer vision, natural language processing. 3. Indicates the differences and the relationship between AI and fields such as data analytics, data science, robotics, RPA, etc. 4. Explains business and other AI applications and tools, such as predictive analytics. 5. Discusses the economic and social impact of AI. 6. Describes general concerns, fears, risks, and pitfalls commonly associated with AI. 7. Explains ethical issues such as fairness, bias, transparency, and accountability raised by AI. 8. Shows awareness of emerging and recent innovations in AI (or: Explores emerging developments in the field of AI and their potential implications for business and society)

Programme Learning Outcome
AI and policy - EQF 7 The learner has demonstrated capability to understand the impact and consequences of AI on policy and public affairs**.**
Unit learning outcomes
1. Lists the main authoritative EU and global publications and sources on AI, such as those of the European Council and the European Commission, the OECD and UNESCO 2. Distinguishes current and emerging laws and regulations related to AI, such as the EU AI Act, data protection laws, sectoral regulatory frameworks, intellectual property (IP) laws, anti-trust/competition laws, consumer protection laws, cyber and information security laws. 3. Recognises the balance and interaction between regulation and innovation. 4. Indicates the impact of AI on human rights, economic well-being, and its implications on economic, social, medical, security, and environmental developments. 5. Discusses main building blocks and best practices (case studies) of national AI and data strategies. 6. Recognises the importance of a well-governed, transparent, and structured AI policy development and assessment process.

Programme Learning Outcome
Organisational decision-making on AI - EQF 7
The learner has demonstrated capability to understand the impact and consequences of AI on organisational decision-making.
Unit learning outcomes

1. Lists the main authoritative EU and global publications and sources on AI, such as those of the European Council and the European Commission, the OECD and UNESCO
2. Distinguishes current and emerging laws and regulations related to AI, such as the EU AI Act, data protection laws, sectoral regulatory frameworks, intellectual property (IP) laws, anti-trust/competition laws, consumer protection laws, cyber and information security laws.
3. Describes the relation between AI and business strategy and the way AI can support corporate objectives (AI vision), e.g., by explaining how AI can be used to create value and be a source of competitive advantage to a business.
4. Discusses main building blocks and best practices (case studies) of AI and data strategies in a range of businesses and industries.
5. Indicates the potential impact of implementing an AI solution in terms of organisation (e.g., structure, processes, governance), technology (e.g., infrastructure, data), and people (e.g., know-how, roles, functions)
6. Interprets a risk analysis of implementing an AI solution.
7. Critically discusses and evaluates proposals (plans, recommendations, etc.) on the application of AI in a specific business.
8. Recognises the importance of a well-governed, transparent, and structured AI adoption and implementation process.

Programme Learning Outcome
AI strategy - EQF 7
The learner has demonstrated capability to advise on and formulate an AI strategy, aligned with the organisation strategy, compliant with relevant laws and regulations and considering opportunities, risks, and ethical considerations.
Unit learning outcomes

1. Distinguishes current and emerging laws and regulations related to AI, such as the EU AI Act, data protection laws, sectoral regulatory frameworks, intellectual property (IP) laws, anti-trust/competition laws, consumer protection laws, cyber and information security laws.
2. Explains related concepts such as digital transformation and digital strategy and
3. Guides the process of identifying customer needs.
4. Proposes and evaluates creative ideas on the application of AI technologies, by applying idea generation and evaluation techniques.
5. Describes the relation between AI and the business strategy and the way AI supports corporate objectives (AI vision), e.g. by setting high-level goals of for AI applications in line with business objectives.
6. Explains how AI can be used to create value and be a source of competitive advantage to a business by using structured methods and analysis techniques.

7. Identifies and prioritizes AI use cases/ scenarios to determine when and what AI solutions are best applicable in a specific situation.
8. Provides advice about the possibilities, advantages, and limitations of existing and emerging AI applications in general.
9. Formulates an AI strategy (or a digital strategy that incorporates AI) in a in a coherent, clear, convincing, well-argued manner, aligned with the organisation strategy, compliant with relevant laws and regulations and while considering opportunities, risks, and ethical considerations.

Programme Learning Outcome
AI implementation - EQF 7   The learner has demonstrated capability to advise on the implementation of an AI solution considering risks, benefits, costs and enabling factors.
Unit learning outcomes
1. Explains practices, principles, methods, tools, and techniques related to risk management.   2. Performs a risk analysis with identification and assessment of risks of possible AI solutions, considering corporate and societal values and interests.   3. Proposes appropriate actions to handle risks and formulates an AI risk management plan, including governance mechanisms.   4. Explains methods and techniques to manage change and reach consensus and commitment.   5. Determines enabling factors for implementing an AI solution in terms of organisation (e.g., structure, processes, governance), technology (e.g., infrastructure, data), and people (e.g., know-how, roles, functions)   6. Explains the dependence upon data and how to acquire, prepare, manage, and provide and scale data for AI applications.   7. Performs a costs and benefits analysis of possible AI solutions.   8. Provides advice on appropriate AI solutions based upon benefits, risks, and overall impact for a specific situation.   9. Formulates an AI implementation plan.   10. Formulates an AI project plan by applying relevant project management methods and tools, e.g., CRISP-DM and agile methodologies.   11. Explains the evaluation of AI solutions.   12. Communicates and presents advice on an AI implementation in a coherent, clear, convincing, well-argued, and inspiring way

Programme Learning Outcome
AI Ethics advanced – EQF 7   The learner has demonstrated ability to realise and critically evaluate ethical ways of working around AI and develop an ethical AI policy, considering prevailing laws and relevant frameworks and criteria.
Unit learning outcomes

1. Describes the essence and key concepts of fundamental human rights and human values.
2. Explains the nature and the field of ethics, its importance and main theories, concepts, and principles.
3. Recognises ethical dilemmas.
4. Describes the regulatory and policy landscape for AI, including in the EU, e.g. AI Act, and in supra-national bodies like the IEEE and OECD.
5. Identifies and describes the concepts of bias, trust, fairness, transparency, equality, accountability, and empowerment in the context of artificial intelligence.
6. Explains criteria for trustworthy AI, such as lawful, ethical, and robust.
7. Explains main recommendations, codes and frameworks related to the ethics of AI, such as the framework for achieving Trustworthy AI of the High-Level Expert Group on Artificial Intelligence and the values-based principles of the OECD.
8. Explains methods to implement ethical work practices regarding AI, such as the AI Ethics maturity model.
9. Indicates how to support a culture that preserves AI ethical behaviour and work practices.
10. Analyses and assesses algorithmic rules against ethical criteria and policy.
11. Applies technical and non-technical methods to monitor and evaluate the development, deployment and use of the AI system and its learning processes.
12. Defines an AI ethical policy.
13. Names initiatives, organisations and communities of interest related to AI ethics, such as the OECD AI Policy Observatory.

Programme Learning Outcome

Impact of AI – EQF 7
The learner has demonstrated ability to explain the abilities of AI-based technology and its implications in different areas and perform an AI impact assessment of an AI-based technology in a specific context.

Unit learning outcomes

1. Describes the terms "impact" and "impact assessment" and explains the importance of impact assessments related to AI.
2. Explains the abilities of AI-based technology and its possible applications to be misused in general, such as privacy violations, algorithmic bias, socio-economic inequalities, misinformation and deep fake technologies, lack of transparency and explainability and social surveillance.
3. Explains the abilities of AI-based technology and its possible applications to be used for good in general, such as solving complex problems in fields like climate science, drug discovery and engineering, the amplification of people's abilities e.g. by improving accessibility and self-expression.
4. Describes the political implications of AI by distinguishing the main issues, concerns, advantages, and disadvantages, such as the potential to affect the democratic process and elections in a negative way, but also improve the policy-making process and the alignment between citizens and politicians.
5. Describes the societal implications of AI by distinguishing the main issues, concerns, advantages, and disadvantages, such as facilitating individual services and improving customer satisfaction, but also its ability to undermine as well as to support human autonomy, well-being, and safety.
6. Describes the economic implications of AI by distinguishing the main issues, concerns, advantages, and disadvantages, such as automation-spurred job loss, but also the

creation of new jobs, the automation of routine and time-consuming tasks and optimisation of workflows.
7. Describes the implications of AI in specific areas, such as the automatization of weapons in defence, algorithmic trading in financial markets, AI-powered recruiting in HR and use of AI-driven robotic devices in healthcare.
8. Performs an overall AI impact assessment for an AI project or a specific AI application in a certain context by applying an impact assessment model or tool, such as the AI Impact Assessment of the Dutch government, the Microsoft Responsible AI Impact Assessment Guide or OECD's Algorithmic Impact Assessment (AIA)
9. Explains how to perform impact assessments of AI projects or applications from different perspectives, such as a Data Protection Impact Assessment, an Environmental Impact Assessment, a Health Impact Assessment, a Human rights impact assessment, a Racial equity impact assessment and a Gender impact assessment.

arisa

Artificial Intelligence Skills Alliance