arisa

AI Skills Needs Analysis

AN INSIGHT INTO THE AI ROLES AND SKILLS NEEDED FOR EUROPE

31 May 2023

Co-funded by the European Union

Document details

AI Skills Needs Analysis, 2023.

Deliverable D2.2 "Needs Analysis Report" / Status: Draft version

This document version is subject to change after review coordinated by the European Education and Culture Executive Agency (EACEA).

Authors: Paul Aertsen (Global Knowledge France), Carmel Somers (Digital Technology Skills Limited), Xander Lub (University of Applied Sciences Utrecht), Pascal Ravesteijn (University of Applied Sciences Utrecht), Ran Zhang (University of Applied Sciences Utrecht)

Editors/Reviewers: Mateja Baebler (CCIS), Bálint Gyires-Tóth (Budapest University of Technology), Jose Martinez-Usero (DIGITALEUROPE), Kerli Saarelaid (BCS Koolitus), Ants Sild (BCS Koolitus), Katarzyna Udala (DIGITALEUROPE), Willemijn van Haeften (University of Applied Sciences Utrecht), Blaz Zupan (University of Ljubljana)

Published date: 31 May 2023

Disclaimer

Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or the European Education and Culture Executive Agency (EACEA). Neither the European Union nor EACEA can be held responsible for them.

Co-funded by the European Union

Revision history

Version	Date	Modified by	Comments
V0.1	16/02/2023	DTSL	First draft version presented for feedback of the consortium
V0.2	16/03/2023	DTSL	Second version of the report based on feedback.
V0.3	11/05/2023	GK/HU/BME/UL/CCIS/DE	Revised version of the report based on feedback.
V1.0	31/05/2023	GK/HU/BME/UL/CCIS/DE	Final draft version to be submitted.

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

The ARISA consortium is led by DIGITALEUROPE. ARISA regroups leading ICT representative bodies, education and training providers, qualification regulatory bodies, and a broad selection of stakeholders and social partners across the industry.

View all project partners.

Table of contents

List of figures

1. Executive Summary

1.1. Introduction

In the context of the ARISA project, the Need Analysis Report aims at gaining a comprehensive understanding of the skills required in AI on the European market. The report is meant to set the basis for the AI Skills Strategy for Europe that will be developed in the next phase of the ARISA project and that will provide a response to the identified skills needs.

1.2. Objectives

The objective of this needs analysis is to feed the development of the AI Skills Strategy for Europe with skills intelligence on the current and future skills demand in the field of AI. It will also feed the development of the AI Skills Strategy with information on the current and future demand for AI roles and with information on the current supply of AI learning offers. This needs analysis also fulfils the first purpose of a Blueprint project being gathering skills intelligence, with the results to be fed into the ESCO classification of occupations and skills & competences.

1.3. Methodological approach

This study has a multi-method approach in which primary and secondary data collection is used as input for the analysis. Desk research was conducted to gain insight on potentially relevant AI roles and skills. This included the analysis of papers and AI (policy) initiatives on EU and national levels. A questionnaire was used to collect data from industry on the needs for AI roles and skills now and in the future. The current need was investigated further by performing a job vacancy analysis using an AI-driven tool. To validate the results of the quantitative data collection, expert group meetings were held. Finally, desk research was also used to gain an overview of the current AI learning offerings ranging from academic AI master programmes to short upskill AI training programmes.

1.4. Results

The data collected by this multi-method approach are summarised the table.

Research method	Data collected
Industry questionnaire	409 Responses
Job Vacancy analysis	2563 Job advertisements
Expert focus groups	145 Participants
Desk research on AI roles and skills	243 articles and other documents
Desk research on supply of AI learning programmes	772 learning programmes

The main findings of the desk research on AI roles and skills are:

- The desk research focused on two elements: identifying relevant AI occupational roles and analysing AI initiatives to underpin the need for certain professionals.
- Stanford University's classification of AI skills clusters was taken as a starting point which led to a focus on the clusters: natural language processing, visual image recognition (computer vision), robotics, machine learning, neural networks (deep learning), and data.

- Of the roles related to these skills clusters, machine learning engineers, data scientists, and data engineers were identified as the fastest-growing AI professional roles.
- The analysis of AI projects and initiatives revealed the most prevalent skills clusters being utilized, including machine learning, data analytics, natural language processing, robotics, computer vision, and deep learning. Examples of initiatives in each cluster were provided to illustrate their application.

The main findings of the industry questionnaire are:

- The majority of the 409 organizations that responded were large organisations, with the technology sector being the most prevalent.
- Data scientists, machine learning engineers, and data engineers are highly sought-after AI professionals roles, while the demand for data analysts showed a potential decrease.
- Project managers, product managers, and business unit managers were identified as the most important managerial roles requiring AI skills.
- Workshop-style training sessions were preferred, and while full academic qualification programs were less preferred overall, they were considered important for AI practitioners.

The main findings of the job vacancy analysis are:

- A total of 756,076 job advertisements from the EU area in 2023 were scanned, resulting in 2,563 AI job advertisements for analysis.
- The demanded skills from the job advertisements were categorized into five clusters: AI general skills, big data & data analytics, machine learning & deep learning, cyber and data security, and (large) language models.
- AI general skills encompass programming languages (Python, Java, JavaScript, C++), traditional ICT skills (SQL, big data), and soft skills like teamwork.
- Big data and data Analytics are closely related to skills on data science, machine learning, data management, and data security. They also need skills like business intelligence, systems and architecture, process automation, technology & business topics, and renewable technology.
- Machine Learning and Deep Learning form the biggest and most connected sub-cluster of AI skills and are essential for data literacy and understanding AI.
- Cyber Security and Data Security are important in the AI field, emphasizing the need for a broad understanding of security within AI systems.
- (Large) Language models is an emerging skills cluster with a fast-growing demand and rapidly evolving application areas.

The main findings of the expert focus groups are:

- There were two kinds of expert focus groups held: 12 expert groups with policymakers and 12 expert groups with experts from organisations with a total 145 experts involved.
- Policymakers at national and European levels, along with their advisors, require AI knowledge and skills to make informed decisions. They need to understand various aspects of AI, such as ethical considerations, legal consequences, and the impact on employment. Basic AI knowledge is essential, and there is a need to relate AI knowledge to real-world contexts.
- Organizational decision-makers, or to be more precise their AI advisors, should focus on skills to implement AI in a business environment, understand the relevance of data, manage risks and compliance, and formulate digital strategies.
- Technical AI skills that have been identified as important for AI professionals include skills on data science, data analysis, data engineering, and machine learning. Soft skills and

business-related skills, such as effective communication, presentation, and conflict management, were also considered crucial. Also, skills on transversal topics like ethics, security, and accessibility, are fundamental to function as an AI professional.
- Focus groups proposed several ways to bridge the skills gap, including increasing collaboration between academia and the labour market, promoting diversity and inclusion, implementing rapid reskilling programs, and sector-specific initiatives.

The main findings of the supply of AI learning programmes:

- AI in general is the most covered topic in learning programmes, followed by machine learning, data sciences, robotics, and deep learning.
- Commonly targeted roles in learning programmes include data scientist, AI engineer, and machine learning engineer. Other mentioned roles are AI trainer, AI Research Scientist, AI Technical writer, Deep Learning Engineer, and AI UX Designer.
- Higher educational institutes are the dominant providers of AI learning programmes that were studied. Classroom-based training is the most prevalent mode, although online forms like distance learning and blended teaching are also mentioned.
- The learning programme duration varies depending on the role category, with AI practitioners preferring longer programs for skills training and decision-makers opting for shorter programs to enhance their understanding.
- Focussing on the most targeted roles, the data scientist is most often found in higher education and VET programmes. AI engineer is commonly offered as classroom-based learning, with longer programs of 2-4 semesters or more than 4 semesters. No significant relations were found for the role of machine learning engineer in terms of learning provider, mode of study, or duration.

1.5. Conclusions

The main takeaways of this needs analysis provide the starting point for the discussion on the AI skills strategy. Conclusions are formulated on the main topics of this skills needs analysis

Th main conclusions on roles with need for AI skills are:

- The AI practitioners' roles that are needed most are data scientists, data engineers and especially machine learning engineers including NLP engineers and computer vision engineers.
- An emerging role that requires urgent attention is prompt engineer.
- AI management & support roles are also emerging with the most foreseen need for AI strategists, AI ethics officers and AI quality controller.
- Organisational decision-makers like business leaders and middle management, and policymakers all need basic AI knowledge and skills.
- Policy- and decision-makers rely on AI advisors that combine deeper AI knowledge and skills with expertise on policy or business.
- These findings can feed the ESCO occupational roles by suggesting to add (or amend) roles.

The main conclusions on the skills needs of AI professionals and the need for AI skills of policy- and decision-makers are:

- Each AI professional role (e.g., data scientist, machine learning engineer) has its own specific set of technical skills that can also be different based on the specific context of the AI professional.

- Each AI professional role also needs a set of skills on transversal topics (e.g., ethics, security), soft skills (e.g., problem solving), and skills on functioning in organisations.
- Policy- and decision-makers need basic AI knowledge and skills including basis terminology & practice, AI ethics, and law & regulations.
- AI advisors need AI advisory skills covering e.g., AI risk management, AI compliance, AI strategy, and implementing AI.
- Both Basic AI knowledge & skills and AI advisory skills need urgent attention for Europe to move forward in the field of AI.
- These findings can feed the ESCO Skills & competences by suggesting to add (or amend) skills.

The main conclusions on the supply of AI learning programmes and how to close the skills gaps are:

- There are learning programmes for common AI professional roles although not enough people are getting educated or trained in these programmes at the moment.
- There is hardly any supply related to emerging demand like prompt engineering, although those skills are needed urgently. Programmes on these skills need to be agile and modular so they can be updated fast, meeting the quickly changing needs.
- Full educational profiles will need to be developed for AI professional roles that include soft skills, transversal skills and skills related to functioning in organisations.
- Educational profiles for policy- and decision-makers will need to focus on AI related knowledge and skills in line with the skills needs mentioned above.
- There is an urgent need for AI upskilling programmes. These programmes are: a short programme on basic AI knowledge for policy- & decision-makers, a programme on AI advisory skills, and a longer AI practitioner programme on prompt engineering.
- These urgent upskilling programmes will be designed, developed and implemented before the end of the year.

1.6. Use of this document

The main use of this document is that it informs the development of the AI skills strategy for Europe in the next Work Package of this project. Also, urgent skill gaps are identified that need immediate attention and learning programmes for that will be designed and developed as quickly as possible.

Another important use is to feed ESCO with skills intelligence from this needs analysis on new and changing AI roles and on new and changing skills in the field of AI.

2. Introduction

2.1. The field of AI

The field of Artificial Intelligence (AI) has experienced remarkable growth and transformation in recent years, revolutionizing various industries and shaping the future of technology. The growth of AI has been nothing short of exponential, driven by advancements in computing power, availability of big data, and breakthroughs in machine learning algorithms. AI has the potential to significantly impact a large range of different roles and functions across industries as AI systems are now capable of performing complex tasks that were once exclusively in the domain of human intelligence. From natural language processing and computer vision to autonomous vehicles and medical diagnosis, AI is transforming industries across the globe. The widespread adoption of AI technologies by businesses is driving economic growth and productivity improvements. Organizations are leveraging AI to gain insights from data, automate processes, enhance customer experiences, and develop innovative products and services. While it is expected to automate certain repetitive and routine tasks, it can also create new opportunities and change the nature of work thereby creating new roles. According to the Future of Jobs report 2023 by the World Economic Forum "*AI and Machine Learning Specialists top the list of fast-growing jobs*" and AI skills training is also one of the highest priorities after training for analytical thinking and creative thinking.

The AI market is expanding rapidly, with predictions suggesting that it will reach unprecedented levels in the coming years. The growth of AI presents numerous opportunities for organizations to innovate, improve efficiency, and deliver new services. However, it also raises important considerations regarding ethics, transparency, and responsible AI development. Recognizing the transformative potential of AI, the European Union has taken significant steps to shape the development, deployment, and regulation of AI technologies. The EU's policy initiatives aim to ensure ethical and trustworthy AI while fostering innovation and competitiveness. Artificial intelligence should identify biases and educate people about equality, regardless of race, color, origin, gender, age, language, religion, political opinion, economic or social status of birth or disability, or any other basis protected by human rights.

This document serves as a comprehensive analysis[1] of the current state of the art in AI, with a particular focus on the growing need of AI roles and skills including the latest technology developments such as advancements in the use of instruction-led large language models (e.g., ChatGPT) and prompt engineering. By staying informed about the latest advancements, policy developments, and best practices, ARISA aims to navigate the AI landscape effectively and leverage its potential for societal benefit by developing courses for upskilling and reskilling of (future) employees.

2.2. Purpose and scope of the needs analysis

The premise of the ARISA project is that the growing demand for skilled professionals within the field of Artificial Intelligence (AI) cannot be met by current education and training programmes or such programmes in their current form will not address the needs of the target audience. One of the main objectives of the ARISA project is to define an innovative AI skills strategy that fast-tracks the skilling,

[1] The research was partly assisted by AI-based medium and large language models in data and knowledge mining, text generation, and language correction. In cases where an AI-tool was used, the results were manually verified, for which the author, who used the tool, bears responsibility.

upskilling and reskilling of the EU's workforce to address this skills gap within the field of AI. The purpose of the Need Analysis is to gain a comprehensive understanding of the skills gap in the AI sector so that this intelligence can feed the development of this AI skills strategy. The skills gap can be identified by investigating the needed AI roles and skills needed for those roles in relation to the current professionals and skills that are available in the AI sector. To feed the development of the AI skills strategy with information on how to close the skills gap, another purpose of this needs analysis is to establish the supply of AI learning programmes. A second purpose of this skills needs analysis is to fulfil the first purpose of a Blueprint project being gathering skills intelligence, with the results to be fed into the ESCO classification of occupations and skills & competences. The scope of this skills needs analysis is therefore roles with AI skills needs, the skills needed by them, the supply of AI learning programmes, conclusions on how to address the skills gap.

2.2.1. Roles with AI skills needs

AI skills are in high demand across various industries as organizations recognize the potential of artificial intelligence to transform their operations and create value. This requires specific expertise and therefore the main focus of the project is on AI professionals that design, develop, implement and maintain AI solutions. These AI professional roles can be divided in AI practitioner roles and AI management and support roles.

AI also can and will have a fundamental impact on organisations and on society in general. It is important that good, solidly underpinned decisions are made to make the best, just use of the possibilities of AI and limit the risks associated with it. To achieve these well-informed decisions, decision-makers within organisations and policymakers within (governmental) institutions, need to possess AI knowledge and skills.

AI affects, and will affect even more, all aspects of society. This means that, besides the already mentioned target groups, every worker, every citizen, needs to know about how AI works and how it affects work and everyday life. This is not the focus of ARISA though, since the alliance focusses on specialised skills needed for the development and maintenance of AI initiatives and applications. The AI skills that workers and citizens in general need are on the level of digital skills that everyone should have and should be part of initiatives related to e.g., DigComp.

2.2.2. Skills needs for AI related roles

The skills-needs for AI related roles can be divided in skills for AI professionals and skills for policy- and decision-makers.

The skills needed for each identified AI professional role, will include all the skills needed for this role in the field of AI, which means both technical and non-technical skills. To be successful in a role in the field of AI, professionals need transversal skills, such as soft skills and skills on functioning in organisations, besides technical skills.

The approach for decision-makers and policymakers is different. They have their own fields of expertise and only have to take onboard AI knowledge and skills they need to decide on AI initiatives. Therefore, the focus there is only on the AI related knowledge and skills they need.

2.2.3. Supply of AI learning programmes

To be able to conduct a gap analysis it is necessary to identify existing AI learning programmes, the roles they target, and the skills that are trained. Subsequently, an assessment of the suitability of current programmes for meeting the identified skills needs across AI professional roles and policy- & decision-makers. This will help to identify potential gaps between the skills needed and the available learning opportunities.

2.2.4. Addressing the skills gap

The conclusions will be focused on input on how to address the skills gap by the development of learning programmes that meet the identified skills needs of the sector. This also includes skills gaps that need to be addressed urgently, for which the design, development, and implementation of learning programmes, will start as soon as possible. These conclusions will be the starting point for drafting of that aspect the AI Skills Strategy for Europe. Other important topics to be covered in the AI skills strategy like diversity are not covered in this needs analysis since they are not directly related to skills needs. It is noteworthy though that even not being the focus of this needs analysis, the opportunity has been taken to collect data on this topic parallel with the needs analysis, so that can be used an analysed in the process of the strategy development.

2.3. Structure of the document

This document continues with in the next chapter with an overview of the methodology of this needs analysis which consists of a multi-method approach. The chapter after that describes the results of the needs analysis by addressing the results of each method. This is the input for the conclusions of this report that are presented in the last chapter of this report. These conclusions are a vital input for the development of the AI skills strategy.

3. Methodology

This chapter describes in short, the methods that are used in this needs analysis. It starts with a description of the multi-method approach followed by a brief description of each method[2].

3.1. Overview of methods

The needs analysis follows a multi-method approach that is used to collect and analyse both quantitative and qualitative data from multiple sources to provide a comprehensive understanding of the AI related roles and skills and the gaps between demand and supply in Europe.

The first step in this study was to identify the potentially relevant AI related roles, which was done using desk research. Once the AI related roles were identified, a gap analysis was conducted by analysing both the demand and supply of AI related roles and skills. Primary data collection for skills demand was conducted using an industry questionnaire and a job vacancies analysis, while qualitative data was collected through semi-structured focus groups with experts from different stakeholder groups. The secondary data collection for skills demand was conducted through desk research on national publications on initiatives related to skills demand for AI related roles. For the supply of AI related roles and skills, secondary data was collected through desk research on AI learning programmes. This was done to determine to what extent the current range of AI learning programmes available are suitable to meet the skills needs of these roles.

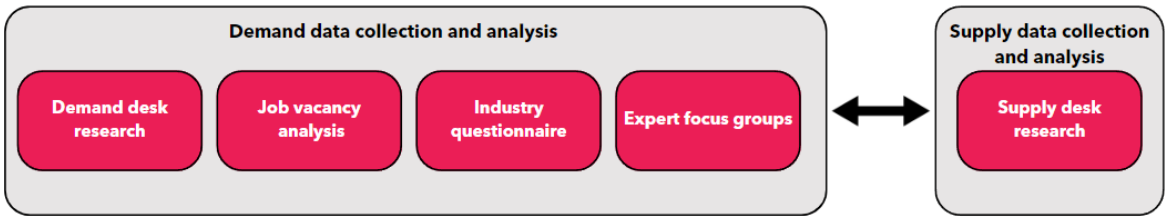

Figure 1: Demand and supply data collection and analysis

3.2. Demand desk research

The demand desk research includes a study of the AI occupational profiles that could be relevant for ARISA and a study on national initiatives.
The first element of the demand desk research is a study on what could be relevant AI occupational roles that should be considered for further study in this needs analysis. This consists of a literature review of scientific and professional articles on AI roles within organisations.
The second element of the demand desk research focusses on AI projects and initiatives and investigates a broad range of topics as a backdrop to AI skills demand. This desk research covers a range of topics related to AI skills and employment targeting the need for AI professionals, including the skills needed. This part of the desk research was conducted by collecting initiatives on national level to gain a broad insight in the AI initiatives across Europe.

[2] More detailed information on the methodology including e.g. templates for data collection can be found in ARISA (2022), "D2.1 Research plan and needs analysis methodology".

3.3. Industry questionnaire

The purpose of the industry questionnaire was to gather information from industry actors about the need for AI professionals and the skills they have now and those they should have in the near future. This focused not only on technical skills but included transversal skills (e.g. soft skills) as well. Furthermore, the types of roles that exist within organisations working with AI. Finally, the questionnaire looked at the forms and formats of education and training best suited for different kinds of professionals and asked about micro-credentials in the field. The geographical coverage of the questionnaire is based on the ARISA Partner Countries (Spain, Germany, Ireland, Italy, Slovenia, Estonia, Greece, Belgium, France, Netherlands, Hungary and Poland), with the option for partners to distribute it in other relevant countries. The EU Survey tool was used to collect responses with each ARISA Partner issuing the questionnaire to a targeted list of respondents based on guidelines provided on the types of participants to enrol.

3.4. Job vacancies analysis

Job advertisement analysis is a valuable tool for determining the demand for specific roles, as it provides current information on the number of open positions, types of skills required, and industries with the most demand for AI professionals. Headai (https://headai.com/), a specialised organisation in AI-driven analysis, was commissioned to capture and analyse job vacancy advertisements across a number of job platforms. This included national public employment services like e.g., Jobtech and Tyomarkkinatori and private job portals like e.g., Indeed and Hellowork. Only original English written job advertisements are included within the analysis.

NLP techniques are used to extract the specific job roles. For the purposes of ARISA, text analytics has been used to analyse job advertisement data using NLP techniques to process the unstructured text data contained within job adverts to identify the market demand for the AI occupational profiles, and the skills that these job vacancies request. The dataset ranks skills based on their level of demand and is based on term frequency - inverse document frequency (TF-IDF). TF-IDF is used to determine how common or rare a term is in a given set of documents and is calculated as the logarithm of the total number of documents in the collection divided by the number of documents that contain the term.

The results are visualised in a PowerBI tool in which a honeycomb network structure is used to show the connections between skills, roles and other related aspects in the field of AI and in specific subcategories within this field. This interactive tool allows to focus on different roles and skills to visualise the relation with other roles and skills.

3.5. Expert focus groups

The expert focus groups were divided into two main kinds of groups: groups with experts from the policy domain and groups with experts from the organisational domain. The word “policymaker” in this study is referring to the limited definition of policymakers in the governmental policy domain, like national and EU policymakers. In relation to the organisational domain, in this study the word “decisionmaker” is used to distinguish between these two target groups, which will have different needs for AI related skills.

The policy focus groups served two purposes: (1) to validate the information collected by partners as part of their earlier research in the area of national AI initiatives and (2) collect information specific to policy makers, like their skills need and the challenges they must address. The policy focus groups

are comprised of experts that can provide specialist insights on policy development and formulation. The geographical coverage of the policy maker focus group is based on the ARISA Partner Countries (Spain, Germany, Ireland, Italy, Slovenia, Estonia, Greece, Belgium, France, Netherlands, Hungary and Poland).

The purpose of the industry focus group was to validate information collected during the industry questionnaire and to explore other areas of interest including options to address skills shortages. The types of technical, soft and business skills that are required within an organisation to effectively utilise AI were discussed as well as the challenges posed by skills gaps in the workforce. Selected participants are mainly experts in the field of AI design, development, delivery or consultation and contributed to business strategy, technology planning and development within their respective organisations. The geographical coverage of the industry focus group is again based on the ARISA Partner Countries.

Expert focus groups are a qualitative method given that its discussions are focused on the content and not with the goal of providing numbers. The fact that experts agree (or disagree) on points of discussion provides information on how for example information from the questionnaire could be interpreted. Also, it is possible to get more in-depth information than when (only) using quantitative methods. The analysis will therefore mainly contain of the identification of patterns between the expert groups. These will be presented using the co-called sandwich method starting with explaining what will be shown, then show the evidence in most cases in the form of quotes, and finally summarising what has been shown.

3.6. Supply desk research

The supply desk research focused on finding existing learning programmes on AI offered by educational institutions, both public and private, across EU countries. The objective is to determine whether these learning programmes match the needs as found by the analyses of the demand desk research, job vacancies and questionnaire and to identify any gaps that require attention. Educational and training programmes were found to be delivered by a variety of learning providers; academic, VET, private providers, and providers of learning in organisations internally. Learning programmes were identified relevant to each of the target groups. Data were gathered on the roles covered, the topics and content of the programmes, the type and level of the programme, delivery method, and duration of the programmes.

4. Results

The multi-method approach led to extensive data collection of which the results are presented in this chapter. For each of the methods the main results will be summarised. These results will be synthesized in the next chapter which contains conclusions on each of the main topics of this needs analysis: the AI roles, AI skills, and AI learning programmes.

4.1. Results of the demand desk research

The demand desk research included a study of the AI occupational profiles that could be relevant for ARISA and a study on national initiatives.

The first element is a study on relevant AI occupational roles and related skills to focus on the rest of the methods used in this study. The results of this are described in the paragraphs on classification, roles, and skills. The starting point for that is a classification of Standford University that was verified by using reports from e.g., OECD and the WEF and by lists provided online about the most important AI roles from e.g., Coursera, Leeds University, McKinsey, Springboard.

The second element focusses on AI initiatives and perspectives by verifying the most relevant clusters of AI skills. 243 relevant sources were selected and analysed, resulting in an overview of projects and initiatives. A summary of this can be found in the paragraph AI projects and initiatives.

4.1.1. Classification of the field of AI

To structure the search for skills and roles, a classification of the field of AI was used.

Stanford University (2023) uses seven categories to define their AI skills clusters in their AI 2023 Index report. Five of these clusters correspond to the elements in the test Turing designed to define AI with. These five clusters are also used in this research. The categories related to 'Artificial intelligence' and 'Autonomous driving' are left out in this research, as the focus is not on AI in general, but on specific AI skills and also not on specific industry applications. An important application of AI, though, is in the area of 'data'. The terms are often mentioned together in the same sentence, not only in research and literature, but also elsewhere in practice. Data processing and analysis using AI are the basis of many other applications in a variety of industries. Therefore, 'data' is added to the list, resulting in the following categorisation with six clusters of AI skills:

- Natural language processing
- Visual image recognition (computer vision)
- Robotics
- Machine learning
- Neural networks (deep learning)
- Data

4.1.2. Roles

AI skills are closely related to AI roles. In many cases, when a certain skill becomes so prevalent and important on its own, businesses will create distinct roles and functions dedicated to that skill. This is clearly the case with skills such as machine learning, natural language processing, computer vision and data (science, analysis and engineering), and their corresponding roles: machine learning engineers, natural language processing engineers, computer vision engineers and data scientists, analysts and engineers.

Machine learning engineers are the fastest growing AI-related role worldwide according to the WEF (2023), followed by data analysts and data scientists. Lightcast (2022) comes up with similar results, adding that besides a machine learning engineer, also a data engineer is a fast-growing job title. Machine learning engineers and computer vision engineers are also mentioned in the AI Index by the researchers from Stanford University (2023). According to OECD (2023) data scientists are very relevant in this respect.

This is underpinned by the 2023 top job lists in AI that many organisations provide: almost unanimously they are mentioning machine learning engineers (San Diego University (2023), Leeds University (2023), McKinsey (2023), Springboard (2023), Coursera (2023), as well as data engineers (San Diego University, McKinsey, Springboard, Coursera), data scientists (San Diego University, McKinsey, Springboard, Coursera) and data analysts (San Diego University, Leeds University, Forbes, Springboard). Also, albeit to a somewhat lesser extent, natural language processing engineers (San Diego University, Springboard) and computer vision engineers (San Diego University) are mentioned.

4.1.3. Skills

Each one of the skills clusters contains more detailed skills that relate to the specific cluster. So, for example computational linguistics and speech recognition are more detailed skills within the natural language processing cluster. Annex 3 shows Stanford University's list derived from Lightcast with the more detailed skills within each cluster. As there are many AI-related skills, for reasons of clarity, the focus is on skills clusters, not on detailed skills in this desk research.

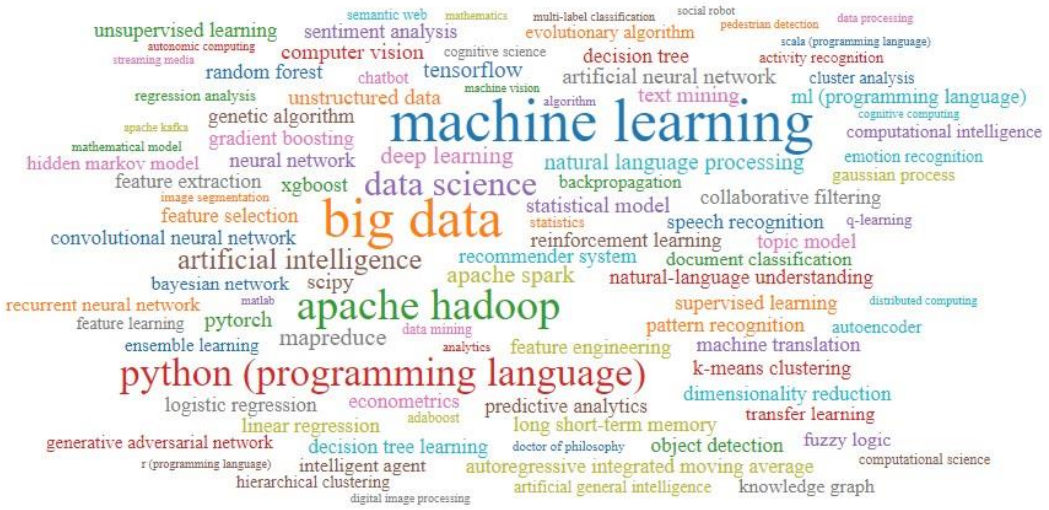

Figure 2: OECD (2023) Word Cloud - AI skills

Stanford University (2023) and OECD (2023) consider machine learning a very important, if not the most important skill, representing a must-have for working with AI. OECD sees other relevant skills as those related to data (analysis, engineering) and data visualisation. Besides these, Stanford also explicitly mentions skills related to robotics and natural language processing.

4.1.4. AI projects and initiatives

The desk research targeted around 1400 projects and initiatives of which 243 turned out to be relevant to the project. The six skills clusters described in the first part of the desk research were also mentioned the most when looking at the projects and initiatives deployed across Europe. This triangulation of results underpins the relevance of focusing on the six skills clusters. To illustrate the

initiatives in each of the skills clusters, for each one some examples are mentioned. The topics covered by the most initiatives including those examples are:

1. **Machine Learning**

The analysis of the initiatives showed that a lot of project and initiatives used machine learning for a wide variety of applications. For example:

- EdgeTier (Ireland): Integrates domain knowledge and technical skills to deliver statistical insights and predictive models for enhanced customer service.
- Kayrros (France): Provides real-time, scalable data analytics solutions to assist global energy market participants in making better investment decisions.
- Owlin (Netherlands): Aids finance professionals by monitoring large portfolios to detect early warning signals of potential risk and generate investment opportunities.

2. **Data Analytics**

Although the field of data analytics is of course much broader, the analysis showed that there are a lot of initiatives focused on predictive analytics. Some examples of this are:

- Santander (Spain): Utilizes predictive analytics for credit risk analysis, fraud detection, and enhancing the user experience in finance.
- Philips (Netherlands): Applies predictive analytics in healthcare to forecast patient outcomes and optimize treatment plans.
- Nokia (Finland): Uses predictive analytics for network optimization, customer churn reduction, and targeted marketing campaigns in the telecommunications sector.
- Heuritech (France): Employs AI-driven predictive analytics on fashion trends and social media data to provide meaningful insights for brands.

3. **Natural Language Processing (NLP)**

Some examples of the use of NLP are:

- Soffos (Greece): Utilizes NLP to summarize legal, financial, and educational data or meeting notes, highlighting key insights.
- Promethist (Czechia): Creates Digital Personas using NLP to engage with humans and provide assistance with mental health.

4. **Robotics**

Although robotics not only involves AI but also other fields, the AI component is vital for the success of complex robotics initiatives like for example:

- Airbus: Fully automates solar array production using robotics in the aerospace industry.
- VESA (Latvia): Uses robotics for automated assembly of electronics components, such as soldering and testing.
- AIrobotics (Hungary): Applies robotics for automated assembly tasks in electronics production.

5. **Computer Vision**

Examples of the use of computer vision are:

- CNH Industrial (Netherlands): Embeds multi-spectral vision systems into combine harvesters for agricultural and construction equipment.
- IVISYS (Sweden): Develops advanced machine vision inspection systems for quality inspection, verification, and machine guidance.

- Prophesee (France): Pioneers bio-inspired computer vision solutions for the automotive and connected objects industries, replicating the way biological eyes acquire and process visual information.

6. **Deep learning**

Deep learning as specific application of machine learning, is utilised for example in the following examples of initiatives:

- Xnor.ai (Sweden): Specializes in developing efficient AI solutions for edge devices, such as mobile phones, cameras, and drones. For this they also utilise deep learning.
- Blue River Technology (Spain): Utilizes AI, including a large role for deep learning, and robotics to improve the efficiency of agriculture.
- Medtronic (Ireland): Applies deep learning to improve the performance and accuracy of medical devices, particularly insulin pumps for diabetes management.

Please remember that these are examples and not an exhaustive list in each skill cluster. These groups of initiatives were the six most undertaken projects and initiatives, which confirms these are the most relevant skills clusters to focus on in the rest of this needs analysis.

4.2. Results of the industry questionnaire

4.2.1. Introduction

The completion of the Industry Questionnaire yielded a dataset consisting of responses from 409 organizations. Among the sampled organizations, the majority (53%) were characterized as large-scale entities with a workforce exceeding 250 employees; approximately one-fourth of the organizations represented in the sample employed fewer than 50 individuals. The distribution of organization sizes is visually presented in Figure 3.

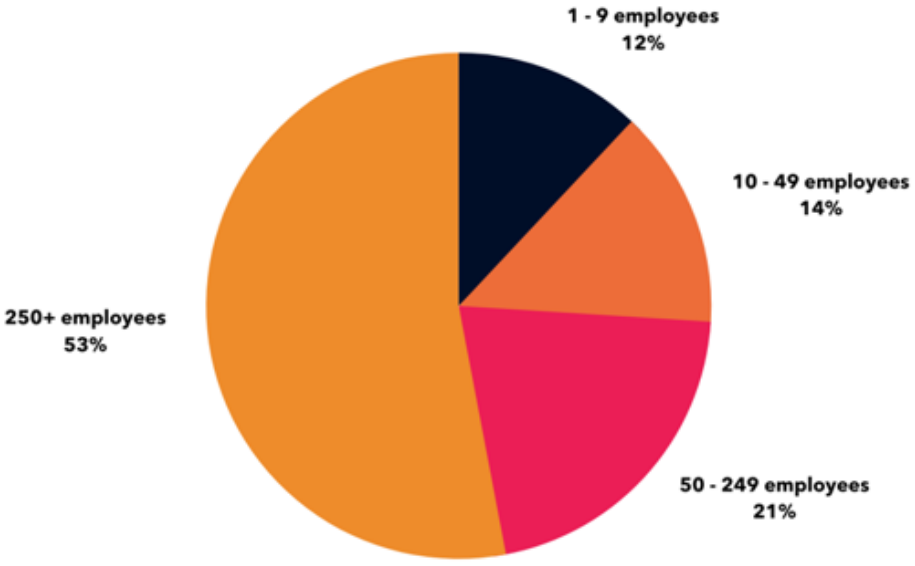

Figure 3: Organization sizes

In terms of geographical locations, all participating organizations were based in European Union countries, with Ireland (50 organizations), Hungary (45 organizations), and Italy (40 organizations) being the most prominently represented, as illustrated in Figure 4.

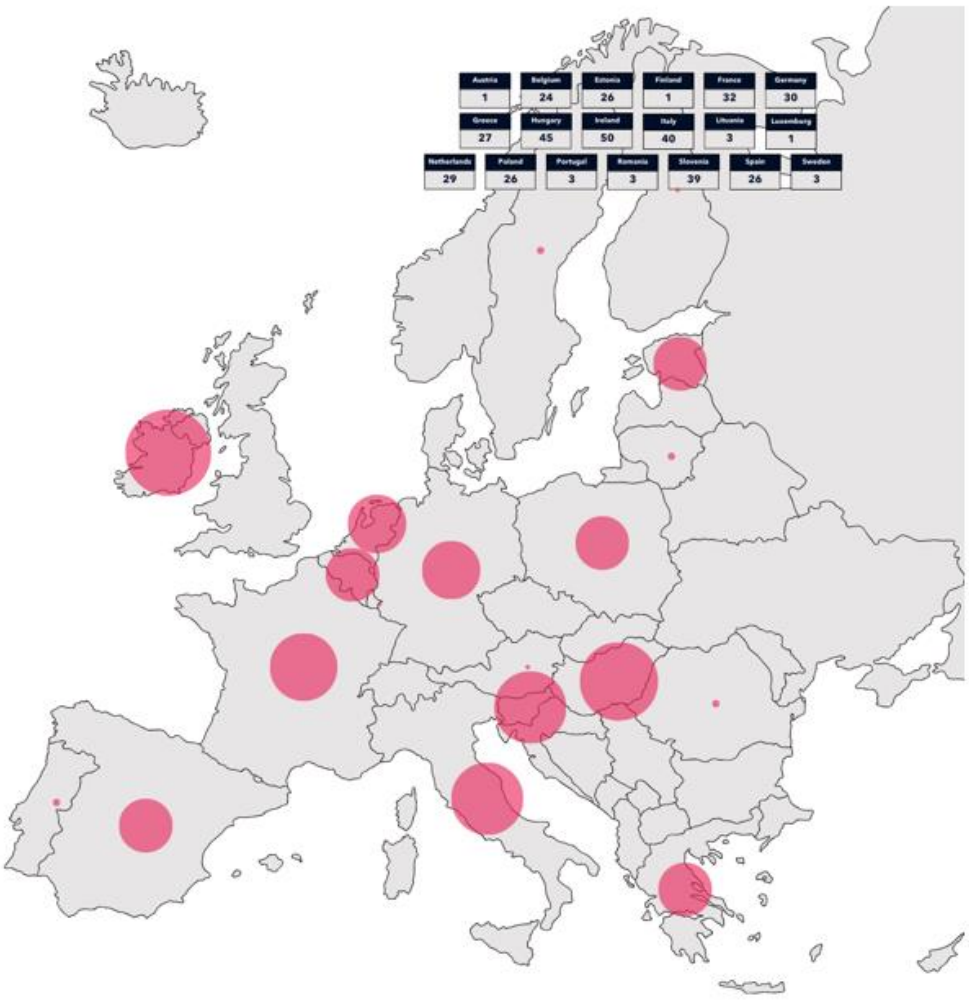

Figure 4: Country of operation

Regarding the sectors of operation, the technology sector emerged as the most prevalent, with 155 organizations indicating their involvement in this domain. This was followed by the education sector, with 79 organizations, and the financial services sector, with 68 organizations. Among the 409 participating organizations, 292 organizations reported they operated in single sectors while 117 organizations reported they operated in multiple sectors. A comprehensive overview of the sectors is depicted in Figure 5.

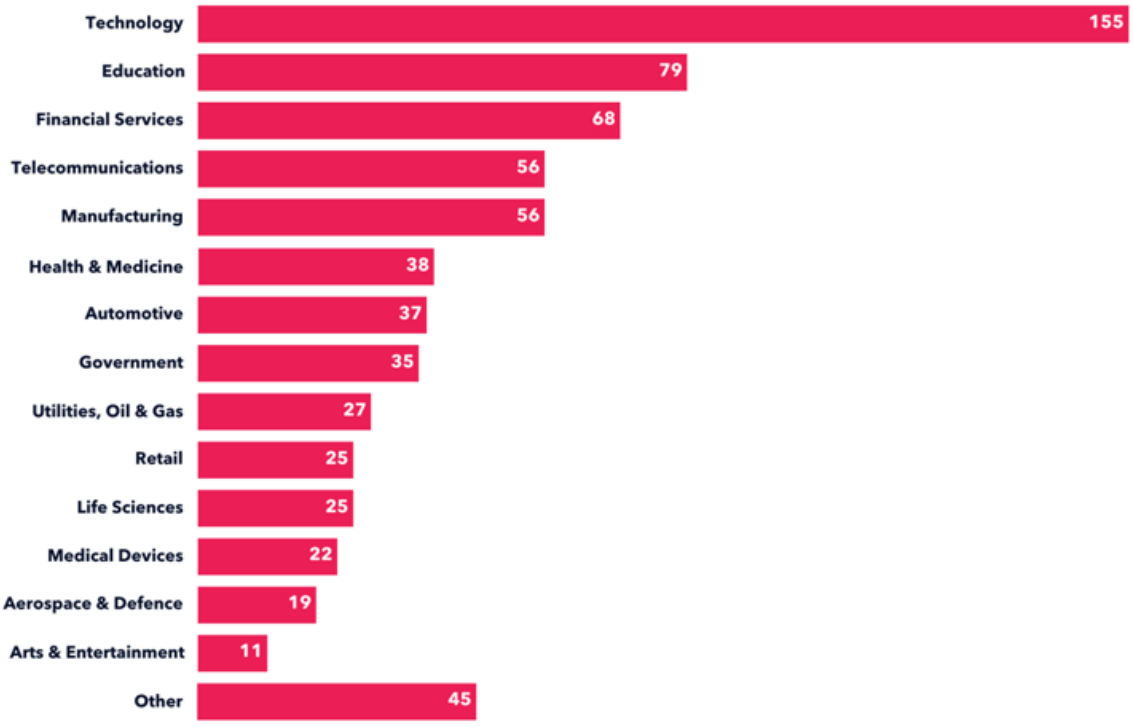

Figure 5: Sector of operation

Lastly, when examining the fields of application for artificial intelligence (AI), research and development ranked as the most frequent area (225 organizations indicating AI usage and application for this purpose), closely followed by new product development (213 organizations) and operations management (153 organizations). Among the 409 sample organizations, 135 organizations reported they used AI for single purposes while 274 reported their AI applications were focused on multiple usage areas. A visual representation of the AI fields of application is presented in Figure 6.

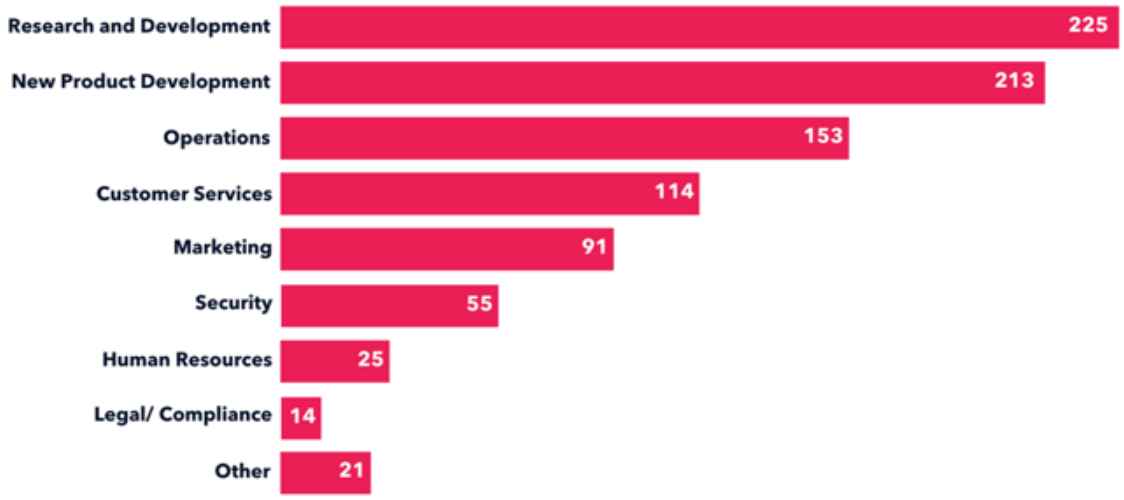

Figure 6: AI application fields

4.2.2. AI roles

The findings derived from the analysis of the Industry Questionnaire provide valuable insights into the landscape of current and future AI roles within organizations. These roles encompass both technical AI practitioner positions, decision-making roles that require AI proficiency, as well as AI management and support roles. By examining the results presented in Figure 7, a comprehensive understanding of the prominence of specific technical roles emerges.

Data Scientists, Machine Learning Engineers, and Data Engineers stand out as the most highly sought-after technical roles across diverse organizational contexts. The prevalence of these roles underscores their criticality in harnessing AI capabilities effectively. A closer examination of the disparities in demand between the present and the near future uncovers variations among specific technical roles. Specifically, the importance and demand for NLP Engineers and Computer (Machine) Vision Engineers exhibit a significant increase, signalling the growing recognition of the value these roles bring to AI-related initiatives. This surge in demand highlights the increasing emphasis placed on natural language processing and computer vision expertise within organizations. Conversely, the reported importance for Data Analysts demonstrates a decline, suggesting a potential decrease in demand for this particular role as time progresses.

A detailed breakdown of all technical roles and their respective rated importance is provided in Figure 7, enabling stakeholders and researchers to gain a comprehensive understanding of the distribution of demand and importance across different technical roles.

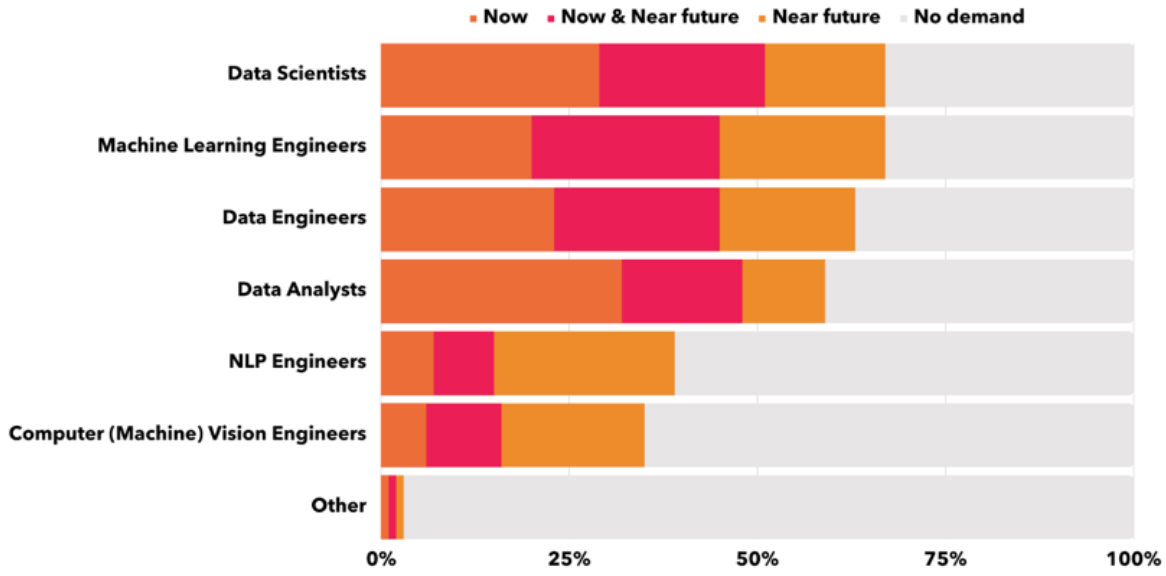

Figure 7: Technical AI practitioner roles now and in the near future

The Industry Questionnaire also included an inquiry into the significance of non-technical managerial decision-making roles that necessitate proficiency in AI skills. Among the managerial positions examined, Project Managers, Product Managers, and Business Unit Managers emerged as the roles exhibiting the highest levels of reported demand and importance within organizations. These findings indicate the pivotal role played by these managerial positions in effectively harnessing AI technologies for organizational decision-making processes.

Moreover, when scrutinizing the reported demand and importance of these managerial roles between the present and the near future, notable variations come to the forefront. Notably, Financial Managers, Auditors, and CxOs show a substantial increase in reported demand and importance. This observation indicates a growing recognition of the critical role played by these decision-making positions in integrating AI strategies into financial operations, audit processes, and executive-level

decision-making. Figure 8 visually presents the proportions depicting the reported demand and importance associated with different managerial decision-making roles requiring AI skills.

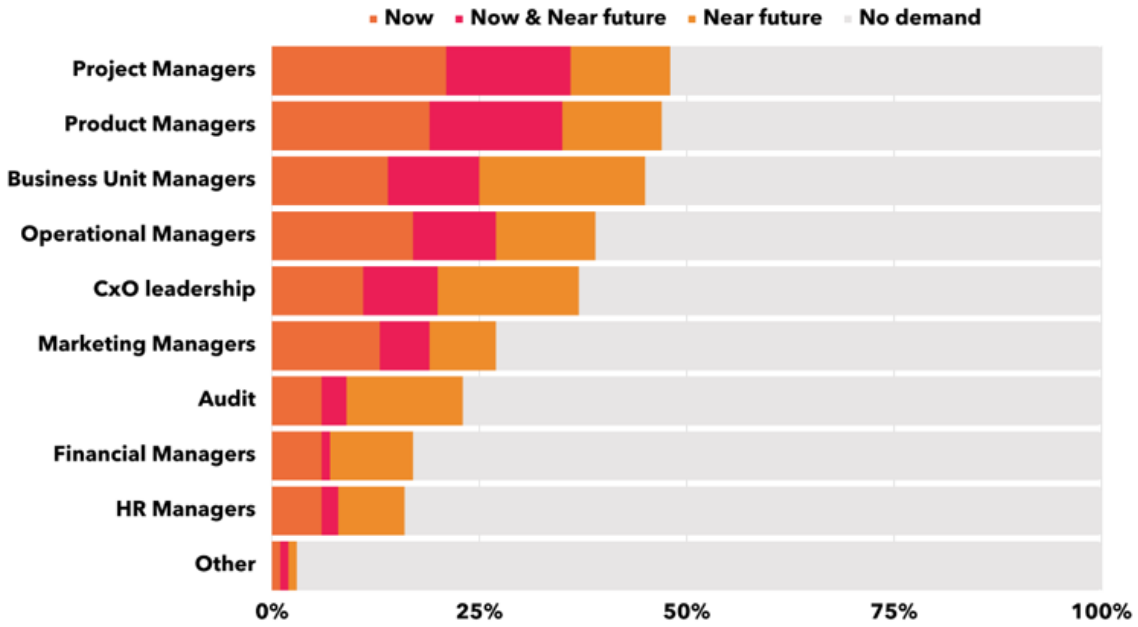

Figure 8: Managerial decision-making roles requiring AI skills now and in the near future

Finally, the outcomes derived from the Industry Questionnaire have elucidated the domain of AI management and support roles. The preeminent quartet of roles within this classification encompasses data product manager, AI strategist, AI quality control**,** and AI ethics officer. A comprehensive graphical representation of these AI management and support roles is visually presented in Figure 9, thereby facilitating a more detailed comprehension.

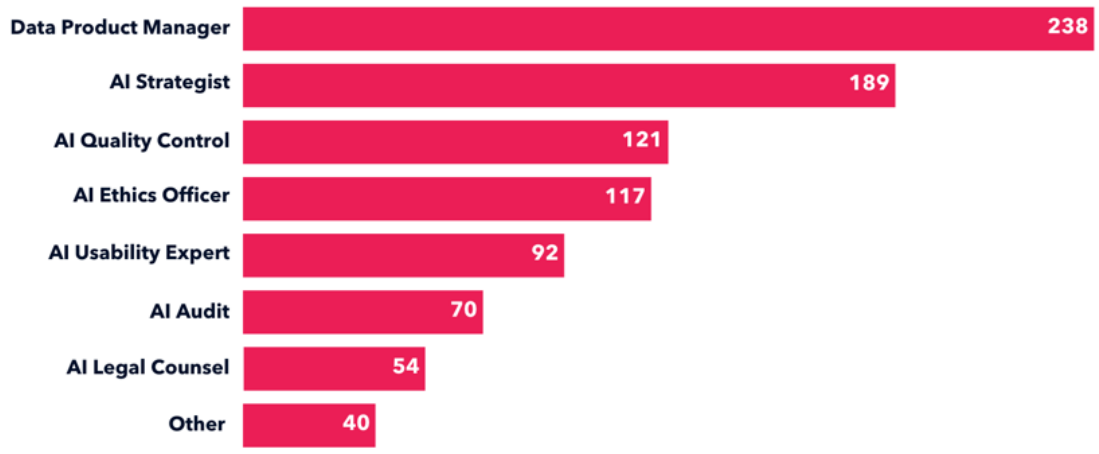

Figure 9: AI management and support roles

4.2.3. AI skills

The Industry Questionnaire incorporated two distinct sets of questions and items, aiming to capture the range of AI skills required by organizations. The findings reveal a set of competences and skills that are deemed crucial for organizations to effectively embrace and integrate AI into their operational frameworks. Notably, three categories of skills emerge as particularly high in demand.

Firstly, individuals possessing the acumen to understand business opportunities arising from AI implementation are highly sought-after. The ability to discern and leverage the potential benefits of AI technologies within the organizational context is considered paramount for driving strategic decision-making and enhancing competitive advantage. Secondly, organizations place great importance on individuals capable of procuring high-quality data. The ability to gather, manage, and curate datasets that serve as the foundation for AI-driven applications and models is essential for deriving accurate and actionable insights. Lastly, organizations express a critical need for the ability to secure and AI expertise and talent. Securing individuals possessing comprehensive knowledge and proficiency in AI technologies is crucial for effectively navigating the complexities of AI development, implementation, and maintenance.

For a comprehensive overview of the skill requirements as reported by the participating organizations, please refer to Figure 10. This visual representation provides a detailed breakdown of the specific competences and skills that organizations prioritize when seeking to successfully adopt AI in their operational frameworks.

Figure 10: AI skill requirements

The Industry Questionnaire incorporated another set of variables elucidating the organizational requirements for successful AI adoption and these variables pertain to the realm of soft skills. The findings derived from the analysis of the Industry Questionnaire shed light on the particular soft skills that organizations deem essential for navigating the complexities of AI implementation. Notably, problem solving, critical thinking, effective communication**,** and innovative mindset emerged as the four key soft skills identified by the participating organizations.

Among these soft skills, problem solving garnered the highest overall importance rating, signifying its central role in addressing complex challenges and devising effective solutions within the AI-driven landscape. Moreover, critical thinking received the highest ranking in terms of top importance, underscoring its significance in promoting analytical reasoning and discernment in the context of AI-related decision-making processes.

A comprehensive breakdown of all the rated soft skills, as reported by the participating organizations, is presented in Figure 11.

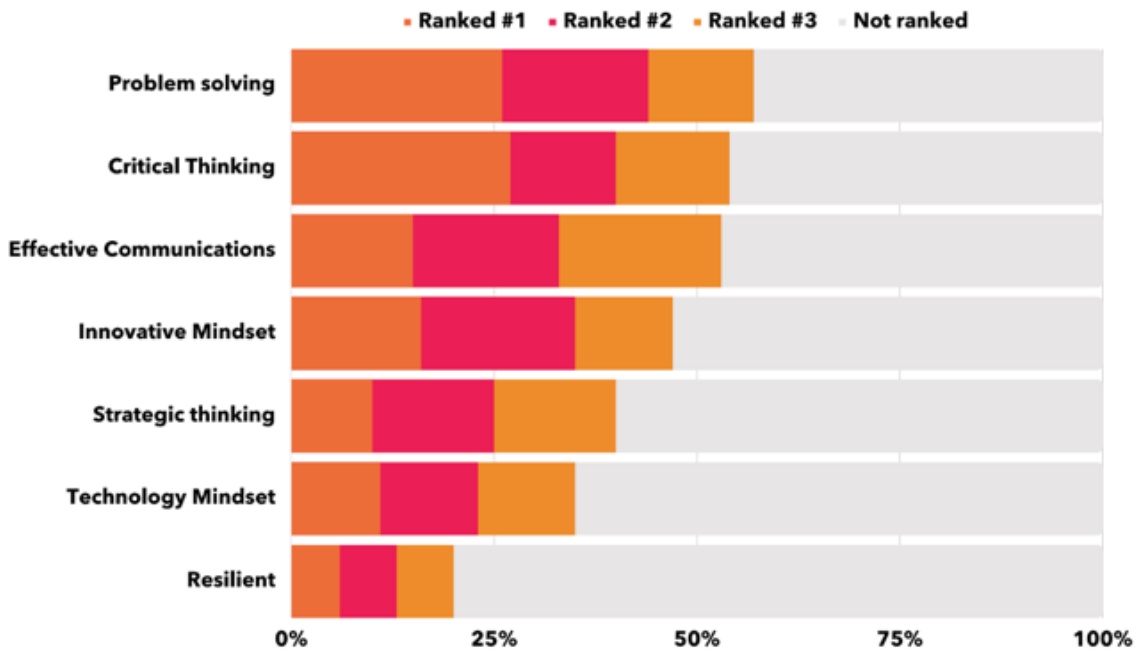

Figure 11: Soft skills for AI success

4.2.4. AI education and training

The Industry Questionnaire incorporated assessment of organizations' education and training requirements pertaining to AI. Specifically, participating organizations expressed their preferences and needs regarding various formats of training and education on different AI-related roles.

Among the various formats of training and education, workshop-style training sessions emerged as the most highly preferred option, garnering the highest overall rating. This format was deemed desirable not only for AI practitioners but also for managerial decision-makers, indicating the widespread recognition of the value of interactive and experiential learning approaches.

Conversely, full academic qualification programs received the lowest overall rating of preference. However, intriguingly, this form of training was deemed most desirable specifically for AI practitioners. This finding highlights the continued relevance and necessity of long-term, in-depth academic programs for individuals seeking to acquire a high level of technical expertise in the field of AI. Despite its lower preference among organizations as a whole, the recognition of the value of full academic qualification programs among AI practitioners underscores the importance of comprehensive theoretical foundations and advanced technical skills in their roles.

Figure 12 visualizes organizations' preferences for different types of training and education programs for different AI roles.

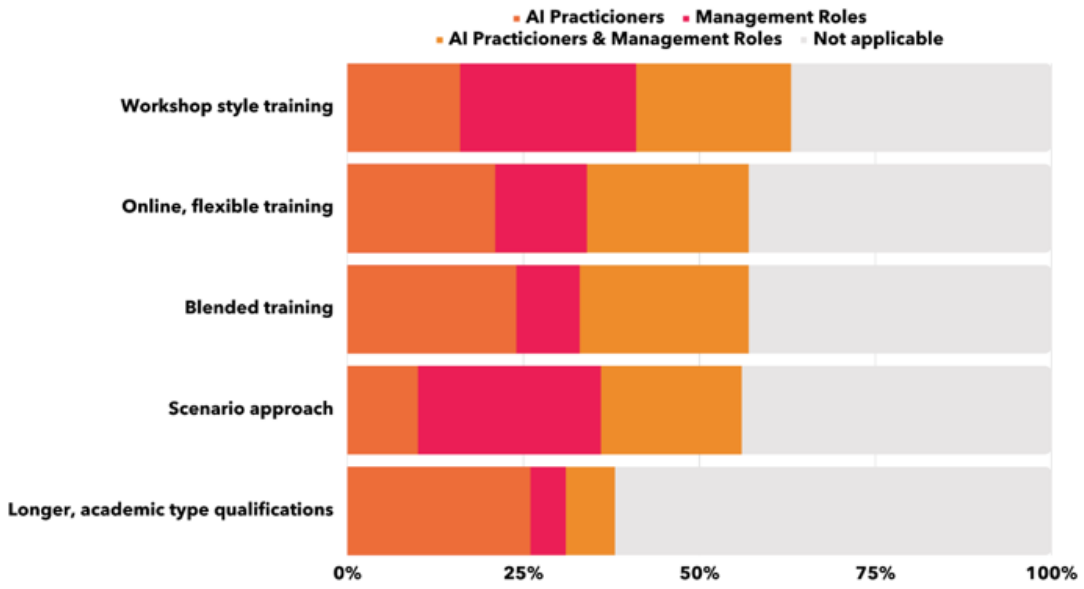

Figure 12: AI training and education

Furthermore, it is noteworthy that 21% of the surveyed organizations reported their current utilization of micro-credential programmes as part of their training initiatives. This finding underscores the increasing recognition and adoption of micro-credentials as a valuable means of enhancing employees' AI competencies within organizational contexts.

Moreover, the industry questionnaire results reveal that organizations are exploring diverse strategies beyond training programmes to meet their AI needs. In addition to upskilling their existing workforce through the aforementioned training and education programmes, organizations indicated the use of alternative approaches. These include the possibility of recruiting employees who already possess AI capabilities, engaging in collaborative endeavours with external organizations that possess qualified AI personnel, and even outsourcing certain AI tasks to third-party entities. Such findings highlight the multifaceted approaches organizations employ to fulfil their AI requirements in business and organizational operations in addition to upskilling through training and educational programmes.

4.3. Results of the job vacancies analysis

In total 756076 job advertisements from the EU area posted in 2023 (until 19 May 2023) were scanned using the Headai Dynamic Ontology. This resulted in 2563 AI job advertisements which were analysed for the demanded skills. These skills can be categorised in 5 clusters: AI general skills, big data & data analytics, machine learning & deep learning, cyber and data security, and (large) language models. The results are available using an interactive tool that shows the connections between topics like skills, roles and other relevant elements in a honeycomb structure. In this tool it is possible for example to visualise strings of connected skills and to show which skills are most closely related to a specific skill or role. In this report, some screenshots are added to illustrate the descriptions of the skills clusters.

4.3.1. AI general skills

The core skillset of AI jobs is more around broad or generic topics than single hard skills.

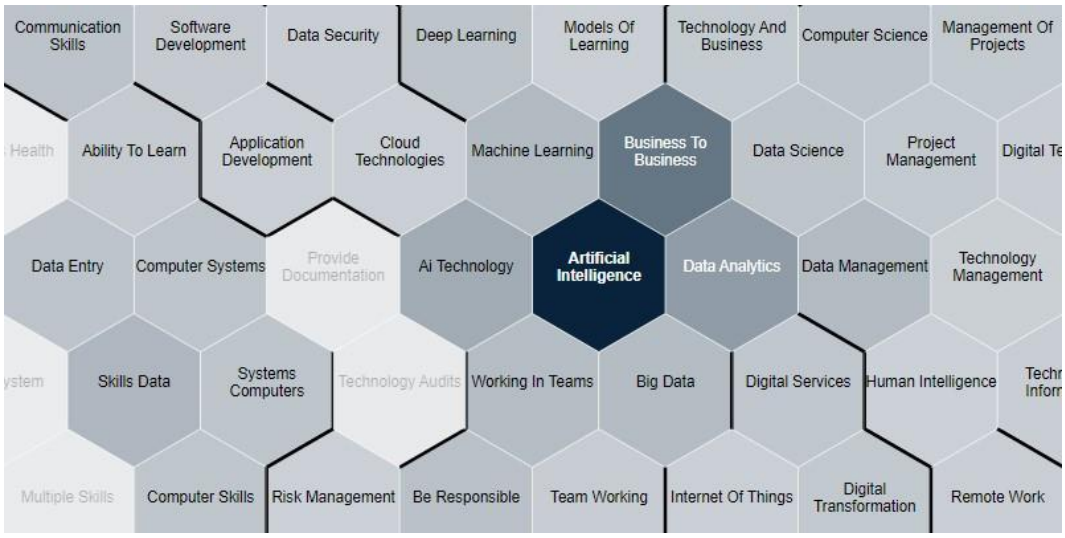

Figure 13: AI general skills overview

Programming languages, such as Python, Java, JavaScript and C++ are all in high demand, which indicates that AI is also multi-programming-lingual topic. Other interesting findings are related to traditional ICT skills, such as SQL and Big Data, that are still going strong in the labour market. From a training point of view, the key finding is that we should not focus only few buzzwords, but train versatile topics including traditional ICT topics, broad topics and soft skills like teamwork skills.

4.3.2. Big Data and Data Analytics

Big Data and Data Analytics is a big skills-cluster in the core of AI. The figure shows it is directly related to important topics as data science, machine learning, data management, and data security.

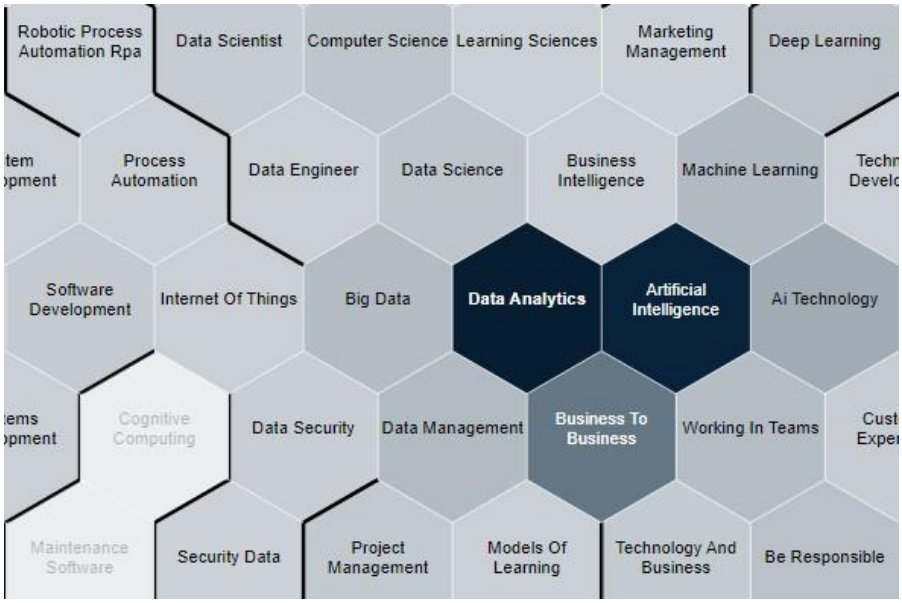

Figure 14: Big data and data analytics skills overview

Other strings of honeycombs show that data analytics is mainly about business: business intelligence, systems and architecture, process automation and technology & business topics. Traditional ICT topics like databases and SQL are also well represented looking at yet another string. Renewable technology is also detected as a relatively big topic, especially the cluster connected to

renewables. Also, the importance of security issues is, not surprising, even more visible in the interactive presentation of relevant skills.

4.3.3. Machine Learning and Deep Learning

Machine Learning and Deep Learning represents the biggest and most connected sub cluster of the AI skills. They are connected to everything related to AI, which is not a surprise at all.

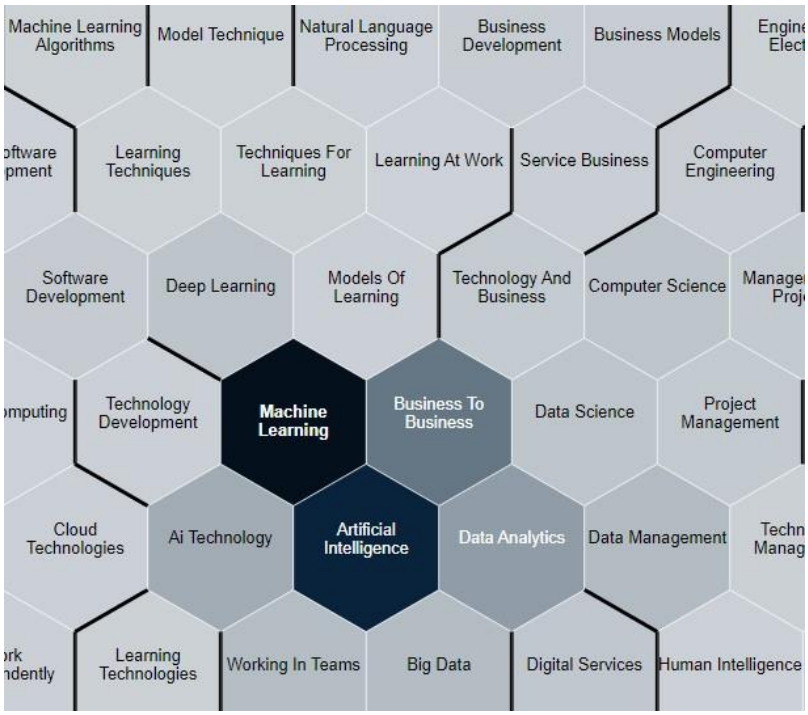

Figure 15: Machine learning and deep learning skills overview

From AI training and education point of view, it is evident that these topics must be in the core, no matter of what job role or what industry. Based on data, it can be claimed that machine learning and deep learning are crucial part of data literacy. One can't understand AI without understanding machine Learning.

4.3.4. Cyber Security and Data Security

Cyber Security and Data Security is important in all the ICT-sector and especially in the field of AI. Furthermore, when talking about cyber security and data security in context of AI, it is not only about protocols or security certificates. It is about broad understanding on how security is built inside AI systems.

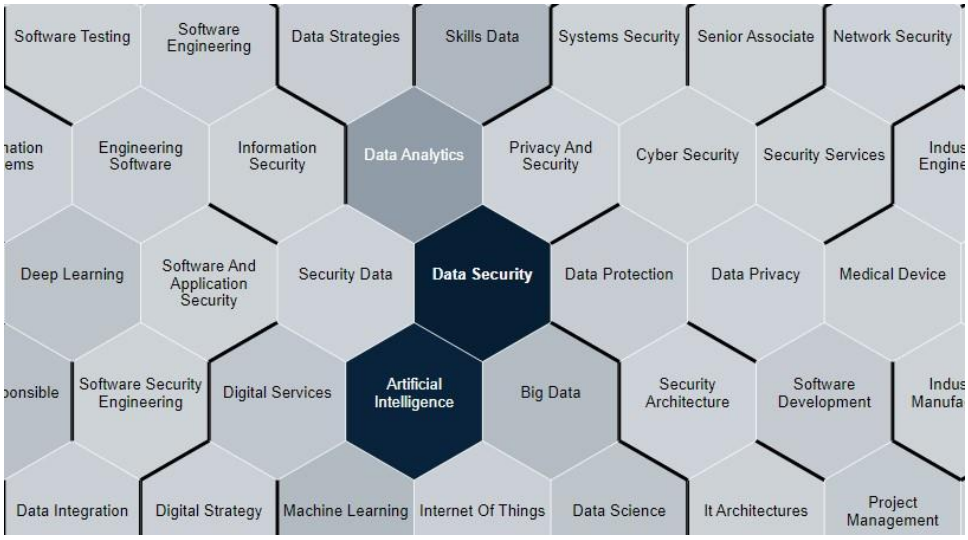

Figure 16: Cyber- and data security skills overview

4.3.5. (Large) Language Models

Language models appeared into job ads in 2021 and Large Language Models (LLMs) in 2022. However, the fundamentals of these topics are old: Natural Language Processing (NLP), deep learning, neural networks etc. It is important to recognise that the skills demand around LLMs is exponentially growing and the application areas of LLMs are evolving all the time. From education and training development point of view it is important to pay a lot of attention to this domain together with generative AI as a broader topic. This is now the area where change is happening, and it's a fast change.

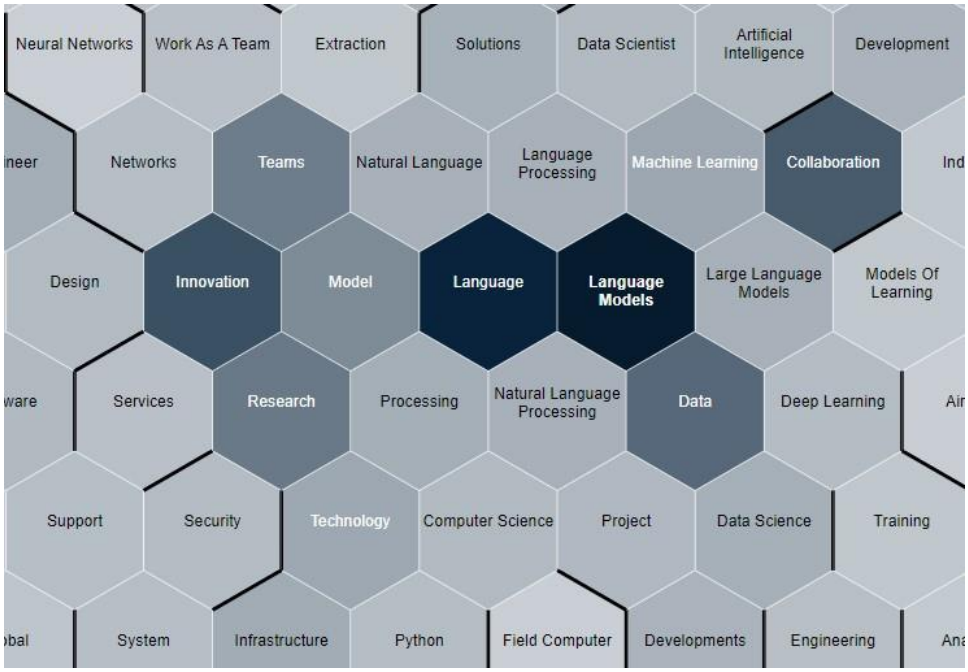

Figure 17: (Large) Language Models skills overview

4.3.6. Roles example: Data scientist and data engineer

The visualisations can also be used to illustrate the different focus of jobs that are closely related, but still are different. The data scientist and data engineer are for example closely related, but shifting the focus from the one to the other, the skills most relevant, and therefore closest to the central honeycomb of the role, change.

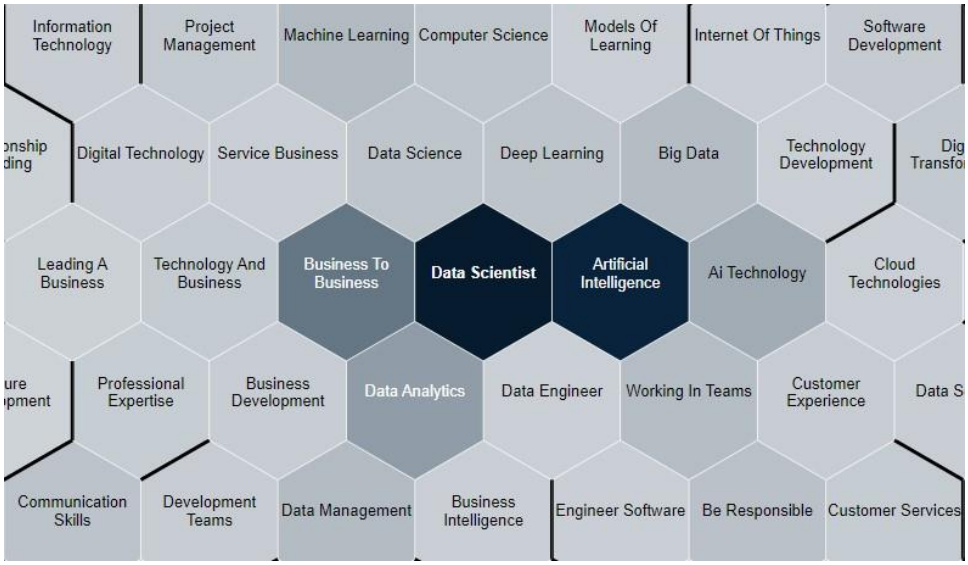

Figure 18: Focus on the data scientist role

The focus on data scientist shows that most important skills for that role include skills besides the technical skills like working in teams, business development, and project management. Shifting the focus to data engineer it becomes clear that in this role the focus is on more specific technical skills like mathematics & statistics and machine learning algorithms.

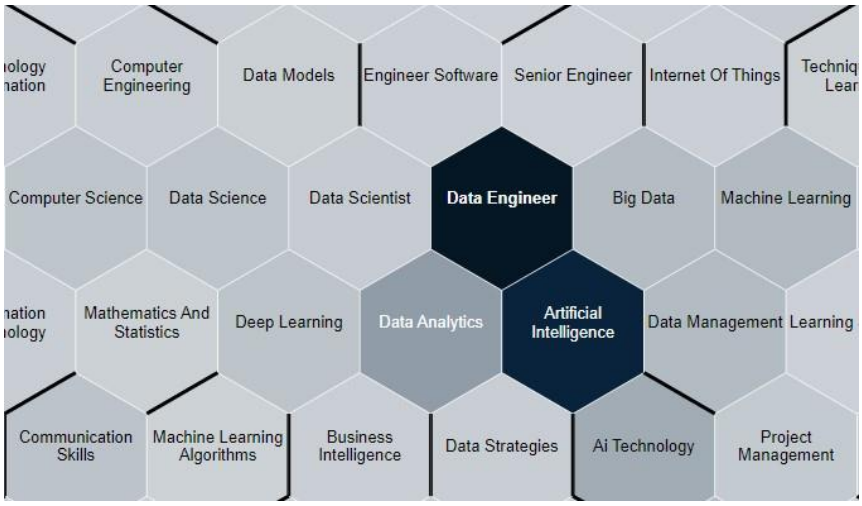

Figure 19: Focus on data engineer role

This tool enables ARISA to finetune educational profiles, curricula and the learning programmes based on those not only initially as part of this needs analysis, but also during the rest of the project and hopefully even after that. This is because it is dynamic, includes the latest market needs and can be used to identify trends over time.

4.4. Results of the expert focus groups

The expert groups were divided in two kinds of groups: policymakers' groups and groups with experts from organisations.

In total, 41 policymakers participated across 12 policymakers focus groups in the ARISA partner countries (Spain, Germany, Ireland, Italy, Slovenia, Estonia, Greece, Belgium, France, Netherlands, Hungary and Poland). In three cases the focus group was replaced by individual interviews of which the aggregated results within a country were taken aboard.

In total, 104 experts from organisations participated across 12 industry focus groups in the ARISA partner countries (Spain, Germany, Ireland, Italy, Slovenia, Estonia, Greece, Belgium, France, Netherlands, Hungary and Poland). In two cases, the focus group was replaced by individual interviews of which the aggregated results within a country were taken aboard.

4.4.1. Policymakers focus groups

The policymakers focus groups focused on the categories of policymakers with AI skills needs and on the actual AI knowledge and skills that these policymakers need.

4.4.1.1 Categories of policymakers with AI skills needs

The first topic is to identify the categories of policy makers which will require an understanding of artificial intelligence to effectively formulate national and EU policies. In the discussion during the meetings, a distinction was made between policymakers on national level and European level.

On the national level it is important to know which roles will need upskilling with AI related skills the most, so they can make well informed decisions in relation to the use of AI not only in government, but in the society in general. It became clear that this is not only important for the policymakers making the final decisions, but especially also for their advisors. It was for example stated that:

> *"Not only policymakers but those who advise them, and influence decision making should be equipped with the relevant AI knowledge."*
>
> *"Ministers should have advisors, who have an understanding of AI and the AI-related opportunities and constraints."*

And it should not only be focused on the more technical fields, but also on policymakers in other fields:

> *"Not only for technology/digital - more knowledge on AI for decision-makers in the areas of education, environment, health, economy is also needed"*

But, although it is true that these target groups need AI skills, in most focus groups it was indicated that one of the most important groups of policymakers are the national chief information officers:

> *"National CIOs are almost obvious … and is the top priority"*
>
> *"National Chief IT Officers are the roles most connected to AI"*

The discussions showed that the majority of the policymakers focus groups indicated that especially government ministers, their ministries and their advisors are an important target group for upskilling. This not only for ministries dealing with technology/ digital, but for a broad range of policy fields. The national CIOs are also an important target group, but they will need a different, more extensive AI related skill set. Besides these target roles, also lobbyists and leaders of government agencies are considered to be important target groups for upskilling on AI related skills.

It is also important to know which are the main target groups for upskilling on AI related skills looking at the international level. The policymakers on EU-level like members of the European parliament, but also directorate generals, all need a basic AI skill set:

> *"On a higher-level raising awareness and education would be the first important step"*
>
> *"All policymakers at the EU level should have at least a basic understanding of the potential and risks of AI to support their legislative efforts"*

But it is also clear that especially their advisors and specialised committee members should have a broader AI skill set:

> *"Advisors are expected to have a higher understanding."*
>
> *"On lower levels (e.g., director, unit) a deeper understanding and more perspectives on AI would be required."*
>
> *"Specialist committee members (in most committees, not only technical ones) should have at least some members with deep understanding of AI."*

The results of the focus groups indicate that members of the EU parliament, director generals and other high-level policymakers are not an important direct target group. They should acquire basic AI knowledge, but the real need for AI related skills is at the level of advisors and specialists in committees. Lobbyists are also mentioned on the international level as a target group that is in need of an AI skills set.

An important aspect that came up in focus groups was the urgency of the need for AI related knowledge and skills for policymakers on both national and European level. Remarks were made like:

> *"We cannot wait. The future is now and affects everybody."*
>
> *"One of the problems we face in the near future is that policymakers know too little about how it really works."*

The results of the focus groups indicate that the upskilling of policymakers on national and international level is urgent.

There was also asked about AI related policymaker roles that might occur in the future and which would be the most relevant ones. Reactions to presented options were for example:

> *"Legal Experts and Ethical Advisors have a crucial role."*
>
> *"Ethical experts and law practitioners are strategically important"*

Also, it was mentioned that not specialist roles, but AI skills and making use of specialists are more important:

> *"Strong suggestion to focus on skill sets rather than specific roles - we should combine the puzzle based on relevant skills, not fixed roles, and include multidisciplinary teams in policy making"*
>
> *"All levels of the administration require specialized advisors (strategic or technical) capable of dealing with AI issues."*

The focus groups showed that there are some doubts on the relevance of specialised AI policymaker roles at the highest level, but that specialists are very much needed to inform decisions on policy. This especially includes AI ethical advisors, AI legal experts, AI strategic and AI technology advisors. Other options that were prompted like AI citizen champions, AI ambassadors, AI auditors at country level and dedicated ministers for AI, were not considered relevant, feasible or needed now.

4.4.1.2 AI knowledge and skills needed by policymakers

The second main topic is the AI knowledge and skills that policymakers need, starting with the question what policymakers need to know about AI to formulate policies. Input for the discussions were the preliminary findings from the other data collection methods. There were areas prompted that could be relevant and, in most cases, it was indicated that they were all important areas:

"Almost all topics are considered highly relevant and very pressing concerns."

"The list is relevant"

Some of these areas got more attention during the focus groups, since they more considered most important:

"Legal consequences (accountability) have to be taken in high consideration."

"They need to understand ethical aspects of AI."

"… such as the ethics, law/regulation and security of data and its use."

Looking at what areas are considered the highest priority and which somewhat lower across the focus groups, topics like employment growth opportunities, research investment priorities, Impact of AI on employment, AI skills required in the labour market, ethics and trust in relation to AI, AI legal consequences, international frameworks of best practice and EU AI ecosystem mappings. Less important are considered methods to grow skills capacity rapidly, public services opportunities and risks and EU legislation briefings.

Unfortunately, prompting topics resulted in the fact that there was hardly any mentioning in focus groups of other relevant AI knowledge that policymakers need. It is mentioned though in a couple of focus groups that the level of even basic knowledge is low:

"The level of knowledge is on general minimum or not existing. Large need for basic training."

"Knowing the difference between AI and automation – these are often confused."

"Policymakers need some technical knowledge on AI– even as a user."

Besides areas mentioned above, it shows that also providing basic knowledge on AI is very relevant. Other topics that came up in individual focus groups were for example translating EU legislation (e.g., AI act) in national laws and emergent skills for AI in combination with other fields. Also, the importance of relating AI knowledge to a real context, is considered important.

The last topic discussed during the focus groups was about what types of AI skills will be required by civil and public service employees. Again, skills were prompted, but also some other remarks were made about AI skills that indicate that the prompted more technical skills are not very relevant:

"Management, Processing and Analysis of Data are directly connected with the public functions. The technical aspects for the implementation of the AI are usually contracted."

"Strong technical knowledge is not that important– more important is general knowledge and the understanding of usability of AI with some technical experience (even as a user)."

"… not on specific skills but rather on having a general knowledge of how AI works and how it can be applied."

"The first phase and key for them would be to understand capabilities of AI."

Looking at the prompted, more technical, skills, the most important skills across the focus groups are data management, data processing, data analysis, and somewhat less important, modelling and prediction. Not important are considered image recognition, speech recognition and robotics. The remarks made across the focus groups indicate that technical AI skills are not important for these target groups. Only skills regarding working with (big) data are considered relevant. It is far more important are knowledge and skills with regards to how AI works and can be implemented.

4.4.2. Organisation focus groups

The industry focus groups consisted of two main topics: the AI related skills needed for organisational decision-makers and AI professionals and the ways that the AI skills gap could be addressed.

4.4.2.1 AI related skills for decision-makers

The focus groups were prompted with a group of skills that might be important for organisational decision-makers in relation to AI decisions. Besides these skills, the most important topic across focus groups was organisational culture and the skills to make changes happen:

> *"… fostering a culture of experimentation. Culture is important for change."*
>
> *"Leadership roles should have a culture … that is at the moment lacking."*
>
> *"It is important to develop a culture of support"*
>
> *"Change management skills will be required from managers as AI will continue to change the processes."*

The focus groups indicate that decision-makers should focus on change management skills to align the organisational culture with AI developments. Another topic that was mentioned are skills to implement AI in a business environment. The prompted skills showed that the most important skills from that list across focus groups are understanding the relevance of data and data science, manage risks and compliance of AI, formulate and deliver a digital strategy (of which AI can be a part), and position AI for competitive gain. Skills that were considered less important are quality management and build a winning go to market strategy.

4.4.2.2 Skills needs for AI professionals

The focus groups were also asked to provide input on the technical AI skills that are needed. A valid remark that was made in focus groups is that not every professional needs all those skills, but a specialised subset. The intention in these focus groups was to find out which skills were most needed, independent whether these skills were united in one person or spread among multiple persons. Looking at the more technical skills some the typical remarks are:

> *"Most important technical skills identified are by far: data science, data analysis, machine learning, and deep learning."*
>
> *"Data science is deemed the most valuable skill."*
>
> *"In turn, data engineering is identified as not needing that many people, but being the hardest one to find in the market."*

The technical AI skills that were discussed and mentioned as important across focus groups were data science skills, data analysis skills, data engineering skills and machine learning skills. Skills that have lower importance for AI professionals are skills regarding data visualisation, robotics, natural language processing, machine learning operations and intelligent automation.

The focus groups also showed that soft skills and business-related skills are important for AI professionals besides technical skills. Some comments about these kinds of skills are:

> *"There is a strong need for soft skills."*
>
> *"There is also a need for good communication within the organization."*
>
> *"Soft skills are also very important in technical roles"*

"-AI practitioners need skills- such as understanding business processes, ability to present and sell a product, customer relations, conflict management."

"People in AI technical roles should be more social than other IT technical roles."

These quotes highlight the importance of soft skills in AI and analytics roles, like for example effective communication, present products, and conflict management. Business related skills include understanding of business processes, and customer relations. These skills complement technical knowledge and are crucial for successful functioning within organizations in the field of AI.

4.4.2.3 Ways to reduce the AI skills gap

It is important for the AI sector skills strategy to establish what ways organisations see as potential options to reduce the skills gap between existing and needed skills in AI. Some typical remarks on this topic are:

"Reducing the gap of competences is fundamental, in particular increasing the collaboration between academia/education and the labour market."

"Increase sector/industry-specific initiatives."

"Include people with a different background (training/education in other fields) in ICT roles."

"Rapid reskilling and in-house mentoring are identified as key measures, as well as increasing diversity and generating more welcoming work environments."

These quotes highlight the importance of collaboration between academia and the labour market, sector-specific initiatives, and promoting diversity and inclusion. They emphasize the need to bridge the gap between industry training and academic training, and involve individuals from diverse backgrounds. Additionally, the focus groups recognize the significance of creating welcoming work environments and promoting women's inclusion in the AI sector.

The prompted options to reduce the skills gap resulted in a couple of ways that are considered promising across focus groups: increase industry-education collaboration, encourage women to enter the market, rapid reskilling programmes, and increase sector specific initiatives. Other proposed options were considered less or even almost not relevant. These less relevant options include using remote work to attract talent, increase mentor programmes, establish skills accelerators, embrace established AI community schemes, increase collaboration between organisations, and rapidly extend the use of micro-credentials.

Finally, the industry focus groups discussed the importance of certification in relation to closing the skills gap.

"The creation of a European certification on the subject would be a real plus to attract future employees to our professions."

"Certification would have a real meaning especially for the populations of Data Analyst and Data Scientists."

"It is fundamental that the certifications reflect real abilities and skills developed."

"Proven experience, previous results, and positive references from previous partners/clients are more important."

The focus groups highlight the importance of European certification, the value of certification for specific, technical roles, the significance of certifications reflecting real abilities and skills, and the

emphasis on proven experience and references as important tools to assess somebody besides certifications.

4.5. Results of the supply desk research

The data collected on the current supply of AI related courses and programmes resulted in 772 courses and programmes in the 12 countries part of the ARISA alliance. It provides an indication of the most important topics that are currently covered in all sorts of learning programmes varying from master programmes to short courses and seminars.

4.5.1. Skills covered as topics in learning programmes

The general topic of AI is the most covered topic in the descriptions of the programmes, which suggests there is already supply on the introduction level on the basics of AI, but many offerings does not seem to focus on specific target groups with specific needs like for example policymakers and decision-makers. Other often mentioned skills being topics in learning programmes are machine learning, data sciences, robotics and deep learning. This is followed by a wide range of topics which are relatively often mentioned like natural language processing and computer vision.

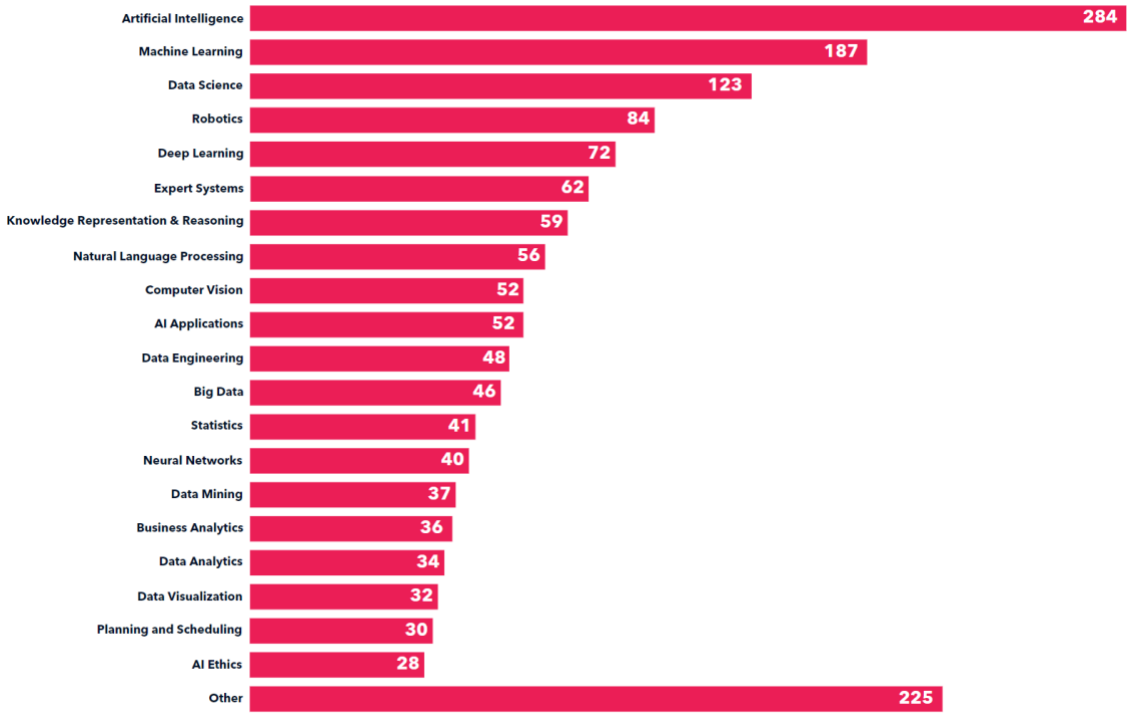

Figure 20: Skills covered as topics in learning programmes

It appears that current programmes on AI teach a mixture of classic machine learning and AI skills including expert systems and knowledge representation, and newer skills like deep learning. Besides these more frequently covered skills, there is a large list of less frequently addressed skills like reinforcement learning (21) and pattern recognition (18) all the way to sentiment analysis (4) and evolutionary computing (3) that are rarely mentioned as being covered in courses.

4.5.2. Roles targeted by learning programmes

As expected, the roles that are most targeted in learning programmes are roles such as data scientist, AI engineer and machine learning engineer. Surprisingly, some less conventional roles that are often mentioned are that of AI trainer, AI Research Scientist, and AI Technical writer. Training for new important roles which are emerging include Deep Learning Engineer and AI UX Designer. A lot of

learning programmes don't focus on one role but aim to cover skills & competences that are relevant for a range of roles. This explains why the total numbers of the roles are much higher than the amount of learning programmes in this study. Besides this top list of roles shown in the figure, there is a long list of other roles for which the learning programmes prepare including Natural Language Processing (NLP) Engineer (82), AI Support Engineer (81), AI Sales Engineer (72), AI Model Validation Engineer (70), AI Business Strategist (64), AI Project Manager (59), AI Operations (AIOps) Engineer (58), AI Consultant (57), AI Compliance Officer (55), AI Ethicist (52), AI Quality Assurance Engineer (51), AI Startup Founder (49), and AI Product Manager (35).

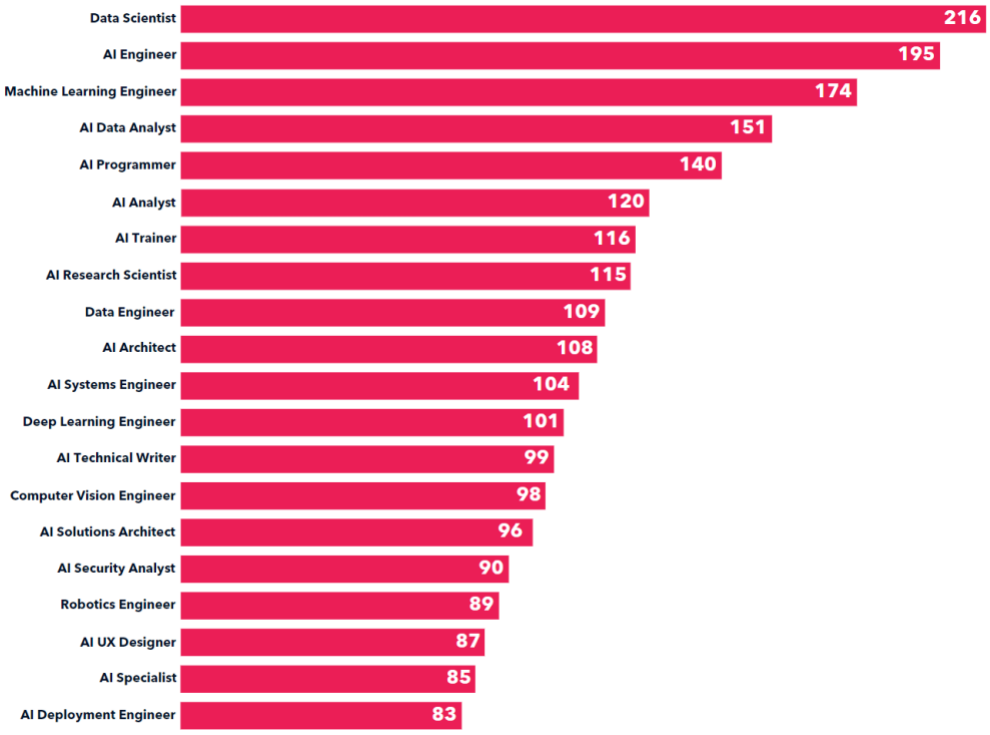

Figure 21: Roles targeted by learning programmes

4.5.3. Delivery of learning programmes

We distinguish three aspects regarding the delivery of learning programmes. First, the **type of provider** that is delivering the training, this can be public institutions for higher education (academia), a VET provider or an organization that organizes seminars. Based on the collected data higher educational institutes are found to be the dominant provider of AI learning programmes.

	Higher Education	VET	Seminar
# providers	429	126	37

Second, the **mode of study** refers to the method of delivery such as classroom, blended (classroom and online), apprenticeship etc. The most prevailing form of delivery mode is traditional classroom-based training although online forms (distance learning and blended teaching) are also often mentioned.

	Classroom based	Blended	Apprenticeship	Distance learning	Workshop	Other
# mentioned	450	115	5	75	64	35

Third, the course **duration** indicates the "time to complete" a given course and consequently achieve the accreditation or certification (if any) offered by the service provider. The table below shows the

duration in relation to the different role categories (policy makers are not mentioned and therefore not included). Based on this it is clear that roles related to AI practitioners prefer longer training programmes that can provide more detail and emphasis on skills training, while decision-makers want short training programmes that focus on enhancing their understanding (knowledge) on AI and its implications for practice.

	Few hours - days	1 – few months	2 – 4 semesters	>4 semesters – few years
Decision-makers	31	20	23	5
AI management & Support	11	9	80	25
AI Practitioners	93	63	182	131
Total	135	92	285	161

4.5.4. Top three AI roles

For the top three roles that are mentioned most (data scientist, AI engineer and machine learning engineer) as being present in current learning programmes, it is determined if there are any significant correlations (using chi-squared statistics and applying Bonferroni correction due to the larger number of roles) as to whether these roles are present in different types of providers of learning programmes. The results show that the role of Data Scientist is most often found in higher education (176 out of 483 respondents mentioned this) and VET (72 out of 126). However, this also means that there are respectively 307 and 54 respondents from higher education and VET that stated the role of data scientist was not present in their learning programmes. Moreover, no significant relation to the applied mode of study or duration for the role of data scientist was found. For the role of AI engineer there was no dominant provider found in the data, but the results do show that the mode of study offered the most is that of classroom-based learning (150 out of 492). Furthermore, for the AI engineer typically longer learning programmes are offered in the range of 2-4 semesters (95 out of 321) or even more than 4 semesters (70 out of 178). Finally, for machine learning engineer no significant relations were found with the type of learning programmes provider, mode of study and duration. This means that there is no specific dominant form.

5. Conclusions

The multi method approach allows for triangulation of results. The nature and focus of the methods do not allow for triangulation of all the main topics between all methods, but for each of the main topics multiple methods could be used to validate results. The synthesis of the results between methods leads to conclusions on the roles, skills, learning programmes and the skills gaps to be addressed in the field of AI. These conclusions are important input for the AI sector skills strategy. Also, this needs analysis fulfils the first purpose of a Blueprint project being gathering skills intelligence. The results will be used to feed the ESCO classification of occupations and skills & competences.

5.1. AI related roles

AI-related roles can be divided into two sets of subgroups: AI practitioners, AI management & Support on the one hand; and non-AI professionals such as decision-makers, and policymakers on the other hand. The first two groups are the AI professional roles and the other two groups that need some AI knowledge and skills to make better informed decisions on AI related initiatives and other AI related decisions.

5.1.1. AI professionals

The conclusion is that there is a growing need for professionals in the field of AI and data analytics. These professionals need to be skilled, reskilled or upskilled to be able to close the gap between supply and demand of AI professionals. Roles with growing need focused on data are data scientists and data engineers, and with focus on AI these are roles like machine learning engineers including NLP engineers and computer vision engineers. An emerging role in relation to the very recent upsurge in LLM that needs urgent attention is prompt engineer.

The AI management & support roles are mostly still emergent and it is not clear whether they will all develop into complete, independent roles. The ones that are most likely to evolve into roles are AI strategist, AI ethics officer and AI quality controller.

5.1.2. Policy- & decision-makers

Decision-makers within organisations need basic AI knowledge and skills for example to understand proposals for AI initiatives made by AI professionals and to understand the impact of AI on business processes. There are two levels of decision-makers: business leaders (e.g., CEO, CFO) and middle management (e.g., project managers, business unit managers), but they have similar basic AI knowledge & skills needs. It is important to realise that these groups need to be advised on specific considerations, and for that purpose they need AI advisors that are experts in both the technical aspects and the business aspects with regards to AI. Also, these persons should have a good idea not only of the technology itself, but also of moral, ethical, accessibility and legal aspects of the (ramifications of the) technology, as well as an understanding of what it takes to successfully implement these technologies.

Policymakers can be divided in a group that need basic AI knowledge & skills like parliament members, DGs and lobbyists. More advanced AI knowledge and skills is needed for AI advisors, national CIOs and specialised committee members.

5.1.3. Feeding ESCO occupations

The roles identified as AI professional roles, are checked against the most recent version of ESCO occupational roles. Some roles are already in there somewhat longer like data analyst and some were added more recently like computer vision engineer. Both these groups of roles could use an update in the descriptions and related skills and knowledge. Other roles like for example machine learning engineer, NLP engineer or prompt engineer are not yet in ESCO. Therefore, the ESCO team will be contacted to discuss the possible additions.

5.2. Skill needs for AI related roles

Starting from the differentiation between AI professionals and policy- & decision-makers, there are two different approaches to define the relevant skills. AI professionals are of core importance for the field of AI and therefore complete role profiles are considered including soft skills, transversal skills and skills related to functioning in organisations. Policymakers and decision-makers need another level of AI knowledge and skills. Also, it is not the aim of ARISA to go beyond the boundaries of the field of AI, so only skills that relate directly to the field of AI and are relevant for specifically decisions on AI are taken into consideration.

5.2.1. Skills for AI professionals

Each AI professional role has its own specific set of technical skills. A data scientist needs data science skills, a machine learning engineer needs machine learning skills, and a prompt engineer needs prompt engineering skills. Each of these technical skills sets consists of course of multiple more specific skills. Starting points to establish the specific skills that are needed are the Stanford University/ Lightcast taxonomy described in the desk research and the Headai ontology described and used in the job vacancy analysis. The actual, specific skills that are needed in a certain situation depends on the specific context of each professional.

Besides technical skills, each AI professional needs soft skills (e.g., problem solving, critical thinking, communication), skills on transversal topics (accessibility, ethics, privacy, security) and on functioning in organisations (project skills, DevOps, understanding business processes). These skills are essential for functioning as an AI professional.

5.2.2. AI skills for policy- & decision-makers

The skills for policymakers and decision-makers can be divided in basic AI knowledge & skills and AI advisory skills. The basic AI knowledge & skills include basic technical terminology & practice, ethics, and law & regulations. The AI advisory skills include managing risks of AI, AI compliance, formulating a digital strategy (incl. AI) or a specific AI strategy, change management & implementing AI. Both Basic AI knowledge & Skills and AI advisory skills need urgent attention, since decisions on policy and organisational level are necessary to move forward in the field of AI and as Europe keep up with the rapid developments in the rest of the world.

5.2.3. Feeding ESCO Skills & competences

The identified AI skills, are checked against the most recent version of ESCO Skills & competences. In the earlier versions these specific AI skills were mostly lacking, but some are added in the latest updates. Skills like “prompting LLMs”, “Utilise NLP” and “Utilise deep learning” are not in there yet or only mentioned as knowledge and could use an update. Therefore, the ESCO team will also be contacted to discuss the possible additions to the skills & competences.

5.3. Supply of AI learning programmes

For the most common roles that are identified such as data scientist, AI engineer and machine learning engineer there is a large offering of training and education by both higher education and VET providers. The level ranges from introductions to the basics of AI to in-depth full academic programmes containing courses on amongst others machine learning and deep learning. Training on skills that are in more recent demand such as prompt engineering related to Large Language Models were not found although courses in underlying fundamentals such as Natural Language Processing and neural networks are somewhat available,

The majority of the programmes analysed fall in this category which is deemed applicable specifically to AI practitioners but less so for managerial decision-makers and policy makers who tend to prefer short duration workshop-style training. But many offerings do not seem to focus on specific target groups with specific needs like for example policymakers and decision-makers. Although the needs analysis shows that specialised AI policymaker and decisionmaker roles are not needed at the highest level of an organization there is a clear need for roles such as AI ethical advisors, AI legal experts, AI strategic and AI technology advisors. However, currently programmes for these roles and related skills are in limited supply.

5.4. Addressing the skills gap

To sum up some of the conclusions in the paragraph, our different data sources all point in the same general direction:

1. Two general target groups being AI professionals with a need for further education in areas such as Natural language processing/LLM, Visual image recognition (computer vision), Robotics, Machine learning, Neural networks (deep learning) and data engineering; and policy- and decision-makers with a more basic understanding of these skills but deeper skills on implementation AI in organizations or policy.
2. AI professionals also require soft skills, transversal skills and skills related to functioning in organisations. Given the central role of AI professionals in the field, educational profiles for AI professionals will have to include those skills.
3. Policy- and decision-makers have their own fields in which they work, so in this project context educational profiles for these target groups need to focus solely on AI knowledge and skills.
4. To understand the specific challenges a specific sector tries to resolve, it is important to have AI professionals that also have expertise in this other field (e.g., finance, marketing, supply chain). This is commonly referred to as a π -shaped professional: someone who has a technical AI expertise and expertise of the specific context (the two legs of the π), combined with an ability to reach out and communicate with people from different disciplines. By upskilling people from other disciplines with AI skills, they will become much needed π -shaped professionals.
5. Although there is a growing offer of education, it does not match the demand at this time, both in quantitative and qualitative terms. Moreover, as technologies progress rapidly, VET and higher education will need to be designed in an agile, modular manner that adjusts quickly to new and upcoming requirements. As the survey and the focus groups indicate, there is a need from a breadth of course offerings spanning from 2-hour seminars, through MOOCs to full-blown Master and or PHD/Professional Doctorate programs. Project-/challenge-/problem-based learning maybe a great solution in connecting the industry innovation with the innovations in how courses are developed. Many new roles will be at

EQF level 6-8, given the complexity of the role and its connectedness to different parts of the organization/ecosystem/society.

6. The quick adoption of Large Language Models and their impact on many professions shows that the AI skills strategy needs an approach that is more iterative to adjust for new technologies, with room for quick testing and prototyping. In a similar fashion, sustainability of developed systems beyond the project will require more attention too, and more collaboration.

These identified skills gaps and conclusions on how these can be addressed will inform the AI Skills Strategy that will formulate an approach to close these skill gaps.

5.4.1. Gaps to address urgently

To address the urgent need for upskilling in AI, a plan is outlined to commence as soon as possible, aiming to start delivering this upskilling by the end of 2023 at the latest. The plan includes three targeted training programmes.

1. Basic AI knowledge for policy- & decision-makers
   Firstly, a short course on basic AI knowledge will be implemented, designed to provide policymakers and decision-makers with essential insights into AI. The course will be structured in a workgroup style, lasting a couple of hours at the most to ensure efficiency.
2. AI Advisory skills
   Additionally, an AI advisory skills course will be designed, developed and implemented. The initial idea is that it will be spanning a week and have a workload of 1 to 2 ECTS. This course is specifically tailored for advisors of policymakers, lobbyists, and CIOs to equip them with the necessary skills to navigate AI-related issues effectively.
3. Prompt engineering
   Lastly, a comprehensive course on prompt engineering will be designed, spanning probably 5 to 10 ECTS. This course primarily targets practitioners such as software developers and machine learning engineers, aiming to enhance their expertise in prompt engineering techniques.

The coming months the programmes will be designed and developed using existing and new materials. In parallel, potential pilot opportunities will be explored and learners participating in these pilots recruited. This makes it possible to start delivering these programmes by the end of the year at the latest. Given the urgency of this upskilling, this process will run in parallel with the originally planned processes in the project like the development of the AI Skills Strategy.

6. References

Bologna Working Group on Qualifications Frameworks (2005). A Framework for Qualifications of the European Higher Education Area. Ministry of Science, Technology and Innovation, Copenhagen. https://www.ehea.info/media.ehea.info/file/Qualifications_framework_Copenhagen_2005/27/8/050113-14_General_report_578278.pdf

Borghans, L., Duckworth, A. L., Heckman, J. J., & Ter Weel, B. (2008). The economics and psychology of personality traits. Journal of Human Resources, 43(4), 972-1059. https://muse.jhu.edu/article/466652

Cedefop (2014). Terminology of European education and training policy - A selection of 130 key terms. 2nd ed. Luxembourg: Publications Office of the European Union. https://www.cedefop.europa.eu/en/publications/4117

Cedefop (2019). The changing nature and role of vocational education and training in Europe - Vol. 6: Vocationally oriented education and training at higher education level; Expansion and diversification in European countries. Luxembourg: Publications Office of the European Union. https://www.cedefop.europa.eu/en/publications/5570

Cedefop (2021). Microcredentials are here to stay. Accessed 27-05-2023. https://www.cedefop.europa.eu/en/news/microcredentials-are-they-here-stay)

Cedefop 2021, Terminology of European education and training policy, https://www.cedefop.europa.eu/nl/tools/vet-glossary

Cedefop. Terminology of European education and training policy. https://www.cedefop.europa.eu/nl/tools/vet-glossary

CEN - CEN/TS 17699 Guidelines for developing ICT Professional Curricula as scoped by EN16234-1 (e-CF). Brussels: CEN-CENELEC. https://standards.cencenelec.eu/dyn/www/f?p=CEN:110:0::::FSP_PROJECT,FSP_ORG_ID:72363,1218399&cs=169E9940F2911D404FAE0D4872E5D2630

CEN - European Committee for Standardization/ TC 428 (2019). e-Competence Framework (e-CF) – A common European Framework for ICT Professionals in all sectors - Part 1: Framework. Brussels: CEN-CENELEC. European norm EN 16234-1:2019. General information, available at ITPE: https://itprofessionalism.org/about-it-professionalism/competences/the-e-competence-framework/. Formal information, available at CEN & CENELEC: https://standards.cencenelec.eu/dyn/www/f?p=205:110:0::::FSP_PROJECT:67073&cs=15E62ED24D608A5F10D6BEE8E6D50FA10

CEN - prEN 17748-1 Foundational Body of Knowledge for the ICT Profession (ICT BoK) - Part 1: Body of Knowledge. Brussels: CEN-CENELEC. https://standards.cencenelec.eu/dyn/www/f?p=CEN:110:0::::FSP_PROJECT,FSP_ORG_ID:71369,1218399&cs=1037FF415D2B146EA5B76090895FB7FDD

Council of the European Union (2017). Council recommendation of 22 May 2017 on the European Qualifications Framework for lifelong learning and repealing the recommendation of the European Parliament and of the Council of 23 April 2008 on the establishment of the European Qualifications Framework for lifelong learning (2017/C 189/03). Official Journal of the European Union (2017/C 189/03). https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32017H0615%2801%29

Coursera (2023). 6 Artificial Intelligence (AI) Jobs to Consider in 2023. Accessed 29-05-23. https://www.coursera.org/articles/artificial-intelligence-jobs

Dall'Amico, E. & Verona, S. (2015). Cross-country survey on soft skills required by companies to medium/ high skilled migrants - Methodological approach for a common framework of Soft Skills at work. Project -1-IT02-KA204-003515. Torino: Ceipiemonte Scpa. https://ec.europa.eu/programmes/erasmus-plus/project-result-content/dce32717-6cfc-4b23-b7af-e4effad68f21/Framework_soft_skill_Report.pdf

ESCO (2022). European Skills, Competences, Qualifications and Occupations Taxonomy. https://esco.ec.europa.eu/en/home

European Micro-Credential Terminology (2022). https://microcredentials.eu/terminology

Forbes (2023). What Jobs Are Available In Artificial Intelligence? How To Make A Career In This AI Boom. Accessed 29-05-23. https://www.forbes.com/sites/qai/2023/01/15/what-jobs-are-available-in-artificial-intelligence-how-to-make-a-career-in-this-ai-boom/
Leeds University (2023). What are the top 5 jobs in AI? Accessed 29-05-23. https://pg-online.leeds.ac.uk/blogs/top-5-jobs-in-ai/
Lightcast (2022). Artificial Intelligence in the UK: The relevance of AI in the digital transformation of the UK labour market. https://aiskills.lightcast.io/
McKinsey (2022). The state of AI in 2022—and a half decade in review. https://www.mckinsey.com/capabilities/quantumblack/our-insights/the-state-of-ai-in-2022-and-a-half-decade-in-review
OECD - Manca, F. (2023). Six questions about the demand for artificial intelligence skills in labour markets. OECD Social, Employment and Migration Working Papers. No. 286. OECD Publishing: Paris. https://doi.org/10.1787/ac1bebf0-en
OECD - Samek, L., M. Squicciarini and E. Cammeraat (2021). The human capital behind AI: Jobs and skills demand from online job postings. OECD Science, Technology and Industry Policy Papers. No. 120. OECD Publishing: Paris. https://doi.org/10.1787/2e278150-en
OECD (2019). Recommendation of the Council on Artificial Intelligence, OECD/LEGAL/0449 - Adopted on: 22/05/2019. https://legalinstruments.oecd.org/en/instruments/oecd-legal-0449
Springboard (2023). 10 Awesome & High-Paying AI Careers to Pursue in 2023. Accessed 29-05-23. https://www.springboard.com/blog/data-science/careers-in-ai/
Stanford University (2023). Artificial Intelligence Index Report 2023. https://aiindex.stanford.edu/report/
UNESCO (2009). Guide to measuring Information and Communication Technologies (ICT). Education – technical paper no.2. Montreal, Quebec: UNESCO Institute for Statistics. http://uis.unesco.org/en/glossary-term/information-and-communication-technologies-ict
University of San Diego (2023). Want to Work in Artificial Intelligence? 14 AI Careers & Job Outlook [2023]. Accessed 29-05-23. https://onlinedegrees.sandiego.edu/artificial-intelligence-jobs/
WEF (2023). Future of Jobs Report 2023. Cologny/Geneva: Switzerland. https://www.weforum.org/reports/the-future-ofjobs-report-2023/

7. Annexes

7.1. Annex 1: Glossary

Term	Definition
Artificial Intelligence (AI) knowledge	AI knowledge refers to the skills and resources, such as data, code, algorithms, models, research, know-how, training programmes, governance, processes and best practices, required to understand and participate in the AI system lifecycle. (OECD, 2019)
Certification (of learning outcomes)	Process of issuing a certificate, diploma or title formally of learning outcomes attesting that a set of learning outcomes (knowledge, knowhow, skills and/or competences) acquired by an individual have been assessed by a competent body against a predefined standard. (Cedefop, 2014)
Competence	Demonstrated ability to apply knowledge, skills, and attitudes for achieving observable results. (CEN/TC 428, EN 16234-1 (2019)
e-Competence Framework (e-CF)	Standard established as a tool to support mutual understanding and provide transparency of language through the articulation of competences required and deployed by Information and Communication Technology (ICT) professionals. (CEN/TC 428, EN 16234, 2019)
European Credit Transfer System (ECTS)	Systematic way of describing a higher education programme by attaching credits to its components (modules, courses, placements, dissertation work, etc.), to: - make study programmes easy to read and compare for all students, local and foreign; - encourage mobility of students and validation of learning outcomes; - help universities organise and revise their study programmes. (Cedefop, 2014)
European Qualification Framework (EQF)	Overarching framework that makes transparent the relationship between European national (higher) education frameworks of qualifications and the qualifications they contain. It is an articulation mechanism between national frameworks. (Bologna Working Group on Qualifications Frameworks, 2005)
European Skills, Competences, Qualifications and Occupations (ESCO)	The multilingual ESCO classification identifies and categorises skills, competences, qualifications, and occupations relevant for the EU labour market and education and training. It systematically shows the relationships between the different concepts. (ESCO, 2022)
Higher or upper VET	Composed of: a) post-secondary level VET, offered outside higher education; b) higher-level continuing VET (CVET) offered within or outside the formal education system (usually after entry into working life); qualification here often gives access to nationally recognised qualifications but the target is adult learners; qualifications are often based on professional experience and examinations (competence tests); c) higher-level CVET provided outside the formal education system (by adult education centres, public employment services or private companies), which do not fall into the above categories. Higher VET relates to EQF levels 5 to 8. (Cedefop, 2019)

Information and Communication Technology (ICT)	Diverse set of technological tools and resources used to transmit, store, create, share or exchange information. (UNESCO, 2009)
Knowledge	Theoretical or practical understanding and awareness of phenomena such as facts, terminology, concepts, models, or theories that are related to a field of work or study. Knowledge is the outcome of the assimilation of information through learning and is theoretical and/or factual. (CEN/TC 428 EN 17748-1, 2022; Council of the European Union, 2017)
Learning	Process by which an individual assimilates information, ideas and values and thus acquires knowledge, knowhow, skills and/or competences. Learning occurs through personal reflection, reconstruction and social interaction. It may take place in formal, non-formal or informal settings. (Cedefop, 2014)
Learning programmes	Coherent set of learning activities with the aim of providing learners with certain knowledge, skills or behaviour over a certain period of time. (CEN/TC 428, TS 17699, 2022)
Masters degree	Qualification awarded after successful completion of the second cycle in the Qualifications Framework of the European Higher Education Area (EQF). The degree usually requires a minimum of 90 ECTS, of which at least 60 ECTS at master's level. (European Consortium for Accreditation, 2021)
Micro-credentials	Sub-unit of a credential that could accumulate into a larger credential or degree or be part of a portfolio. Microcredentials are frequently portrayed and promoted as a new way for individuals to build their own skills profile (portfolio) by collecting and "stacking" learning in flexible ways, at their own pace and according to their own priorities. Micro-credentials certify the learning outcomes of short-term learning experiences, for example a short course or training. They offer a flexible, targeted way to help people develop the knowledge, skills and competences they need for their personal and professional development. (European Micro Credential Terminology, 2022; Cedefop, 2021 & European Approach to Micro-Credentials, 2022)
(Formal) Qualification	The formal outcome (certificate, diploma or title) of an assessment process which is obtained when a competent body determines that an individual has achieved learning outcomes to given standards and/or possesses the necessary competence to do a job in a specific area of work. A qualification confers official recognition of the value of learning outcomes in the labour market and in education and training. A qualification can be a legal entitlement to practise a trade (OECD). (Cedefop, 2014)
Reskilling	Training enabling individuals to acquire new skills and knowledge giving access either to a new occupation or to new professional activities. (Cedefop, 2014)
π-shaped professionals	Professionals who have a depth of knowledge and skills in two specific domains or fields (the two vertical bars of the π-shape) and have broad knowledge and skills across multiple fields or disciplines (the horizontal bar of the π-shape), which enables them to bridge the gap between the two domains or fields and also to collaborate with experts in other areas.
Skilling	Training enabling individuals to acquire new skills and knowledge giving access either to an occupation or to professional activities. (Cedefop, 2014).

Skills	Ability to apply knowledge and use know-how to complete tasks and solve problems. Skills can be cognitive (involving the use of logical, intuitive, and creative thinking) or practical (involving manual dexterity and the use of methods, materials, tools and instruments). (Council of the European Union, 2017)
Skills gaps	Situation where an individual does not have the kind and/or level of skills required to perform their job adequately. (Cedefop, 2014).
Skills intelligence	Process of identifying, collecting, analysing, synthesising and presenting quantitative or qualitative information on skills and labour market to: - identify key trends and demands in the labour market; - assess, anticipate and forecast skill needs; - address skill gaps and mismatches; - adapt provision of education and training accordingly; - provide relevant educational and career guidance and counselling. (Cedefop, Terminology of European education and training policy, https://www.cedefop.europa.eu/nl/tools/vet-glossary)
Soft skills	Patterns of thought, feelings and behaviours that are socially determined and can be developed throughout the lifetime to produce value. These are cross-cutting skills across jobs roles and sectors that relate to personal competences (confidence, discipline, selfmanagement) and social competences (teamwork, communication, emotional intelligence). (Borghans, 2008; Dall'Amico, E. & Verona, S., 2015).
Transferable skills and competences	Skills learned in one context that are useful for another. They can serve as a bridge from study to work and from one career to another, as they enable subject and research-related skills to be applied and developed effectively in different work environments. (European Science Foundation, 2009). Knowledge, know-how, abilities, and attitudes that an individual can use across jobs and across his/her career and education or training path. (Cedefop 2021, Terminology of European education and training policy, https://www.cedefop.europa.eu/nl/tools/vet-glossary)
Transversal skills and competences	Learned and proven abilities which are commonly seen as necessary or valuable for effective action in virtually any kind of work, learning or life activity. (Cedefop 2021, Terminology of European education and training policy, https://www.cedefop.europa.eu/nl/tools/vet-glossary)
Upskilling	Short-term targeted training typically provided following initial education or training, and aimed at supplementing, improving or updating knowledge, skills and/or competences acquired during previous training. (Cedefop, 2014).
Vocational Education and Training (VET)	Education and training which aims to equip people with knowledge, know-hows, skills and/or competences required in particular occupations or more broadly on the labour market. Vocational Education and Training covers upper-secondary, postsecondary, non-tertiary, and tertiary levels of education. (Cedefop, 2008; Erasmus+ Programme Guide, 2019).

7.2. Annex 2: Sources analysed

AI Organisations and technologies

Artificial Intelligence Capitalising on the Value of Data. Airbus.com. (n.d.). Retrieved February 27, 2023, from https://www.airbus.com/en/innovation/industry-4-0/artificial-intelligence

About 2021.ai – The Enterprise AI Company. 2021.AI. (2022). Retrieved February 27, 2023, from https://2021.ai/company/about-us/

About Comino. Comino. (n.d.). Retrieved February 27, 2023, from https://www.comino.com/en/about

About Ontotext. Ontotext. (2023, January 16). Retrieved February 27, 2023, from https://www.ontotext.com/

About Us - Alexandr Instituttet. Alexandra Instituttet. (2022). Retrieved February 27, 2023, from https://alexandra.dk/about-the-alexandra-institute/

About. Augmenta. (n.d.). Retrieved February 27, 2023, from https://www.augmenta.ag/company

Adatnindzsákkal hódít a világpiacon a Magyar Cég - Hiflylabs Zrt. Bet site. (n.d.). Retrieved February 27, 2023, from https://www.bet.hu/Kibocsatok/bet50/2020/bet50-vallalatok/hiflylabs-zrt

AG, D. T. (2020, November 17). *Schneller zur Glasfaser dank künstlicher Intelligenz*. Deutsche Telekom. Retrieved February 27, 2023, from https://www.telekom.com/de/blog/netz/artikel/kuenstliche-intelligenz-fuer-glasfaserausbau-612882

Ai Hungary. AI Hungary. (2019, August 23). Retrieved February 27, 2023, from https://ai-hungary.com/hu/siker-tortenetek/piaci-trendelemzes-szocialis-media-szoveges-tartalmak-alapjan

Ai Image Upscaler Boosts Printful Orders | news - printful. (2020, May). Retrieved February 27, 2023, from https://www.printful.com/news/printfuls-customer-orders-increase-with-the-new-ai-image-upscaler

AI solutions on SAP Business Technology Platform . SAP. (n.d.). Retrieved February 27, 2023, from https://www.sap.com/products/artificial-intelligence/business-technology-platform.html

AI Topics. Aitopics. (n.d.). Retrieved February 27, 2023, from https://aitopics.org/search?filters=taxnodes%3A%22Country%7CEurope%7CSlovakia%22

Aksyonova, D. (2022, February 6). *🎧 revolutionizing the pig farming industry - with Kristóf Nagy, serket*. Tech.eu. Retrieved February 27, 2023, from https://tech.eu/2021/11/23/revolutionizing-the-pig-farming-industry-with-kristof-nagy-serket/

Anzivino, N., Anfos, P., & Saracino, D. (2021). *Artificial Intelligence Market - PWC*. PWC. Retrieved February 27, 2023, from https://www.pwc.com/it/it/publications/assets/docs/pwc-ai-evolution-financial-services.pdf

Artificial Intelligence and Machine Learning. Hyperlink Infosystem. (n.d.). Retrieved February 27, 2023, from https://www.hyperlinkinfosystem.com/artificial-intelligence-and-machine-learning

Artificial Intelligence in Industry. Siemens. (n.d.). Retrieved February 27, 2023, from https://new.siemens.com/global/en/products/automation/topic-areas/artificial-intelligence-in-industry.html

Artificial Intelligence Solutions. Dell Technologies. (n.d.). Retrieved February 27, 2023, from https://dell.to/3ez1bac

Artificial Intelligence Startups in Luxembourg. Tracxn. (2020, April). Retrieved February 27, 2023, from https://tracxn.com/explore/Artificial-Intelligence-Startups-in-Luxembourg

Artificial Intelligence – A key technology for drive development. Volkswagenag.com. (2AD, March 11). Retrieved February 27, 2023, from https://www.volkswagenag.com/en/news/2021/11/artificial-intelligence---a-key-technology-for-drive-development.html

Ascanio Entertainment. (n.d.). *Ascanio Entertainment*. Software Development full of creative imagination. Retrieved February 27, 2023, from https://ascanioentertainment.com/

Attila, G. (2017, January 23). *A Fél Szilícium-Völgynek Egy Magyar Cég Bányász adatokat*. Index. Retrieved February 27, 2023, from https://index.hu/tech/2017/01/23/starschema_big_data_szilicium_volgy/

Avaleht. Tehnopol. (n.d.). Retrieved February 27, 2023, from https://ai.tehnopol.ee/

Bringing mixed reality to training. ascanio.io. (n.d.). Retrieved February 27, 2023, from https://ascanio.io/

Budapesti Műszaki és Gazdaságtudományi Egyetem. AI-DO 2020 - BME VIK. (2020, December 21). Retrieved February 27, 2023, from https://www.vik.bme.hu/hir/2711-ai-do-2020

Business Insider. (n.d.). *Dax Market Capitalization | Markets insider*. Business Insider. Retrieved February 27, 2023, from https://markets.businessinsider.com/index/market-capitalization/dax

BusinessNews.gr. (2022, September 9). *Deep seatechnologies: ποια είναι η ελληνική εταιρεία που εφαρμόζει τεχνητή νοημοσύνη στη ναυτιλία*. Business News. Retrieved February 27, 2023, from https://www.businessnews.gr/epixeiriseis/item/246087-deep-seatechnologies-poia-einai-i-elliniki-etaireia-pou-efarmozei-texniti-noimosyni-sti-naftilia

Cantab Pi Life Science Solutions for Pharma Sales and Marketing. CantabPI. (n.d.). Retrieved February 27, 2023, from https://cantabpi.com/life-sciences2/

CB Insights. (2022, August 12). *AI 100: The most promising artificial intelligence startups of 2022*. CB Insights Research. Retrieved February 27, 2023, from https://www.cbinsights.com/research/report/artificial-intelligence-top-startups-2022/

Computerworld. (2022, October 20). *Kifü - Megérkezett Komondor, Hazánk Legerősebb Szuperszámítógépe*. Computerworld. Retrieved February 27, 2023, from https://computerworld.hu/technologia/kifu-megerkezett-komondor-hazank-legerosebb-szuperszamitogepe-317955.html

Conversational AI . Telekom Geschäftskunden. (n.d.). Retrieved February 27, 2023, from https://contact-solutions.telekom.de/loesungen/kuenstliche-intelligenz-und-chatbots

De-risk the development of novel therapies. fueled by AI. intelligencia.ai. (n.d.). Retrieved February 27, 2023, from https://www.intelligencia.ai/

Deepsea. DeepSea. (n.d.). Retrieved February 27, 2023, from https://www.deepsea.ai/

Der Datenlehrling. Siemens Deutschland. (n.d.). Retrieved February 27, 2023, from https://new.siemens.com/de/de/unternehmen/stories/forschung-technologien/kuenstliche-intelligenz/salt-artificial-intelligence-siemensai.html

Deus. (2022, July 4). *Deus Ex Machina*. DEUS EX MACHINA. Retrieved February 27, 2023, from https://ekmechanes.com/

DigitalPoland.org. (2021). *State of Polish AI 2021*. Digital Poland. Retrieved February 27, 2023, from https://digitalpoland.org/en/publications/download?id=df54480f-f689-4d5d-8629-31277b864611

Dossier : L'intelligence artificielle, Entre Espoirs et dangers pour l'homme. Hello Future. (2022, June 20). Retrieved February 27, 2023, from https://hellofuture.orange.com/fr/grand-format/intelligence-artificielle-entre-espoirs-et-dangers-pour-homme/

Drone and UTM Flight Safety - LMT Innovations. Drone and UTM flight safety - LMT Innovations. (2021). Retrieved February 27, 2023, from https://innovations.lmt.lv/areas/drones_utm/

Dynasoft, G. (2023). *Hacemos Tu Dynamics*. Grupo Dynasoft. Retrieved February 27, 2023, from https://www.dynasoftsolutions.es/es/blog/entry/6-empresas-lideres-espanolas-que-acumulan-exitos-con-la-inteligencia-artificial/203

Eng.LSM.lv. (2019, August 6). *Tilde beats internet giants in machine translation battle*. LSM. Retrieved February 27, 2023, from https://eng.lsm.lv/article/society/education/latvias-tilde-beats-internet-giants-in-machine-translation-battle.a327904/

Eng.LSM.lv. (2021, May 24). *Printful claims Latvia's first "Unicorn" status*. LSM. Retrieved February 27, 2023, from https://eng.lsm.lv/article/economy/business/printful-claims-latvias-first-unicorn-status.a405996/

Estonia AI Topics. Aitopics. (2023). Retrieved February 27, 2023, from https://aitopics.org/search?filters=taxnodes%3A%22Country%7CEurope%7CEstonia%22

Fyma and LMT to offer AI-based traffic analytics in the Baltics. Labs of Latvia. (2021, August 3). Retrieved February 27, 2023, from https://investinlatvia.org/en/news/fyma-and-lmt-to-offer-ai-based-traffic-analytics-in-the-baltics

Glarvig, M. K. (2021). *Geomatic i NYT Digitalt Partnerskab Med førende Dansk Ai-Virksomhed*. Geomatic. Retrieved February 27, 2023, from https://geomatic.dk/dk/nyheder/2018/august/geomatic-i-nyt-digitalt-partnerskab-med-foerende-dansk-ai-virksomhed/

Government of the Republic of Slovenia. (2020, December 18). *Domača Stran: Ai4si*. GoDigital. Retrieved February 27, 2023, from https://ai4si.gzs.si/

Havel, Z. (n.d.). *AI & Digital*. CzechInvest. Retrieved February 27, 2023, from https://www.czechinvest.org/en/Key-sectors/AI-Digital

Home, Top 9 Artificial Intelligence (AI) Companies in Belgium. The Manifest: Lists of Top B2B Companies & Business News. (2023, February). Retrieved February 27, 2023, from https://themanifest.com/be/artificial-intelligence/companies

Horváth-Varga, J. (2021, May 14). *A Vanda-Sztori - AZ ötlettől a megvalósításig*. LinkedIn. Retrieved February 27, 2023, from https://www.linkedin.com/pulse/vanda-sztori-az-%C3%B6tlett%C5%91l-megval%C3%B3s%C3%ADt%C3%A1sig-j%C3%A1nos-horv%C3%A1th-varga/?trk=public_profile_article_view

How Teva is making innovative use of AI and advanced analytics in the pharma and Health Sector. Healthy Returns. (2022, April 28). Retrieved February 27, 2023, from https://www.tevapharm.com/news-and-media/feature-stories/artificial-intelligence-advanced-analytics

Hyper-Personalized AI-Powered Workplace Training via Conversational Micro-Learning. Soffos. (n.d.). Retrieved February 27, 2023, from https://www.soffos.cy/

Identity verification. Microblink. (2023, January 26). Retrieved February 27, 2023, from https://microblink.com/identity/identity-verification/

Intelligent traffic rule violation detection system. HData Systems. (n.d.). Retrieved February 27, 2023, from https://www.hdatasystems.com/case-study/intelligent-traffic-rules-violation-detection-system

Introducing Human Security Radar®. APSTEC SYSTEMS. (n.d.). Retrieved February 27, 2023, from https://apstecsystems.com/#section-01

Jayatissa, H. (2021, November 3). *KMD: Kunstig intelligens Kan Styrke Kvaliteten af Offentlig Sagsbehandling*. Altinget. Retrieved February 27, 2023, from https://www.altinget.dk/digital/artikel/kmd-kunstig-intelligens-kan-styrke-kvaliteten-af-offentlig-sagsbehandling

Karayan, R. (2022, March 29). *Atos Voit dans la 5g et l'edge ia son Prochain Relais de Croissance après Le Cloud*. digitale.fr. Retrieved February 27, 2023, from https://www.usine-

digitale.fr/article/atos-voit-dans-la-5g-et-l-edge-ia-son-prochain-relais-de-croissance-apres-le-cloud.N1791017

Kendall, M. (2021, June 27). *98 top artificial intelligence startups and companies in Finland (2021)*. BestStartup.eu. Retrieved February 27, 2023, from https://beststartup.eu/98-top-artificial-intelligence-startups-and-companies-in-finland-2021/

Ki & Maschinelles Lernen: Airbus Baut Eine Ki Optimierte Trennwand. Hannovermesse. (2019, December 12). Retrieved February 27, 2023, from https://www.hannovermesse.de/de/news/news-fachartikel/airbus-baut-eine-ki-optimierten-trennwand

KMD. (2022). *Data & Ai - end-to-end services in data, Information Management & Analytics*. Data & AI - End-to-end services in data, information management & analytics. Retrieved February 27, 2023, from https://www.kmd.net/en/solutions-and-services/data-and-ai

Kuthi, Á. (2019, April 26). *Magyar Kutatók Dolgoznak a balesetmentes Közlekedés ELÉRÉSÉÉRT*. Autopro HU. Retrieved February 27, 2023, from https://autopro.hu/trend/magyar-kutatok-dolgoznak-a-balesetmentes-kozlekedes-elereseert/214692/

Künstliche Intelligenz aus der Open Telekom Cloud. T-Systems. (n.d.). Retrieved February 27, 2023, from https://www.t-systems.com/de/de/cloud-services/managed-platform-services/open-telekom-cloud/ki-cloud

Labor Market in Sofia. Investsofia. (2019). Retrieved February 27, 2023, from https://investsofia.com/wp-content/uploads/2019/11/Labor-market-in-Sofia-Report-2019-ENG.pdf

Lindberg, B., Riis Andersen, J., Adsetts Edberg Hansen, M., Frandsen, S., Alstrup, S., Krause, S., & Duvold, T. (2019). *An ai nation - innovationsfonden.dk*. Retrieved February 27, 2023, from https://innovationsfonden.dk/sites/default/files/2019-09/an-ai-nation-harnessing-the-opportunity-of-ai-in-denmark.pdf

Makris, K. (n.d.). *Services*. GIZELIS ROBOTICS . Retrieved February 27, 2023, from https://www.grobotics.eu/services

Medtronic. (n.d.). *Home*. Medtronic. Retrieved February 27, 2023, from https://www.medtronic.com/ie-en/index.html

Mesterséges Intelligencia a Gyártásban. Techmonitor.hu. (2019, June 19). Retrieved February 27, 2023, from http://www.techmonitor.hu/piacmonitor/elemezes-velemeny/mesterseges-intelligencia-a-gyartasban-20180619

Mesterséges Intelligencia Az Onkológiában. Medical Online. (2018, June 1). Retrieved February 27, 2023, from http://medicalonline.hu/gyogyitas/cikk/mesterseges_intelligencia_az_onkologiaban

A mesterséges Intelligencia Fogja Segíteni a Magyar mentőket, Előre Tudhatják, Hova Kell majd menni. hvg.hu. (2021, July 15). Retrieved February 27, 2023, from https://hvg.hu/tudomany/20210715_mesterseges_intelligencia_dyntell_omsz_mentok_mentoszolgalat

Nanalyze. (2019, June 6). *Top-10 artificial intelligence startups in Portugal*. Nanalyze. Retrieved February 27, 2023, from https://www.nanalyze.com/2019/06/artificial-intelligence-portugal/#:~:text=Top-10%20Artificial%20Intelligence%20Startups%20in%20Portugal%201%20Unbabel,7%20PLUX%20...%208%20Liquid%20...%20M%C3%A1s%20elementos

Nanalyze. (2021, June 18). *Top-11 artificial intelligence startups in Finland*. Nanalyze. Retrieved February 27, 2023, from https://www.nanalyze.com/2018/11/artificial-intelligence-startups-finland/

Payo, A. (2019, July 21). *5 startups españolas que Han marcado un antes y un después en el uso de la inteligencia artificial*. Business Insider España. Retrieved February 27, 2023, from

https://www.businessinsider.es/mejores-startups-espanolas-uso-inteligencia-artificial-448369

Poročilo Surs: Težave pri Digitalni Preobrazbi Poslovanja in UPORABA Tehnologij Umetne inteligence V podjetjih. GoDigital. (2021, October 13). Retrieved February 27, 2023, from https://ai4si.gzs.si/b/porocilo-surs-tezave-pri-digitalni-preobrazbi-poslovanja-in-uporaba-tehnologij-umetne-inteligence-v-podjetjih

Porsche Digital Develops Artificial Intelligence for Noise Detection. Volkswagenag.com. (2020, December 11). Retrieved February 27, 2023, from https://www.volkswagenag.com/en/news/2020/12/Porsche-Digital-develops-artificial-intelligence-for-noise-detection.html

Portfolio.hu. (2019, October 21). *Magyar kutatók hoznak forradalmat az egészségügyi innováció területén*. Portfolio.hu. Retrieved February 27, 2023, from https://www.portfolio.hu/uzlet/20191021/magyar-kutatok-hoznak-forradalmat-az-egeszsegugyi-innovacio-teruleten-404455

Printaction Staff. (2021, May 7). *Spotlight: Janis Akmentins, head of engineering at printful*. PrintAction. Retrieved February 27, 2023, from https://www.printaction.com/spotlight-janis-akmentins-head-of-engineering-at-printful/

Professzionális Intelligencia Az Autóiparban. Continental AG. (2021, October 31). Retrieved February 27, 2023, from https://www.continental.com/hu-hu/vallalat/continental-kiallitasok-es-rendezvenyek/continental-pia-project/

Protagonisti dell'Ai in Italia . Technologyreview.it. (n.d.). Retrieved February 27, 2023, from https://www.technologyreview.it/wp-content/uploads/2022/05/Protagonisti-dell-AI-in-Italia.pdf

Smejkál, P. (2019, January 15). *Az Adat AZ új Olaj, De Hiába, ha képnézegető állatokká Válunk*. Forbes.hu. Retrieved February 27, 2023, from https://forbes.hu/uzlet/big-data-mesterseges-intelligencia-hub-design-house-ai-neural-network/

Smith, W. by M., & Richards, M. (2021, October 6). *28 most innovative czech republic based machine learning companies*. Futurology. Retrieved February 27, 2023, from https://futurology.life/28-most-innovative-czech-republic-based-machine-learning-companies/

Startups - everyone is here. Startup Lithuania. (2022, December 15). Retrieved February 27, 2023, from https://www.startuplithuania.com/startup/

Strautniece, L. (2021, October 11). *News*. Tilde. Retrieved February 27, 2023, from https://www.tilde.com/news/tilde-wins-major-contract-provide-machine-translation-services-finnish-government

Szuperszámítógép érdekében fogott össze AZ ITM és Az Otp Csoport Tagja, a MONICOMP Zrt. OTP Bank. (n.d.). Retrieved February 27, 2023, from https://www.otpbank.hu/portal/hu/NKFIA/szuperszamitogep

Thales et Atos créent le champion Européen du Big Data et de l'intelligence artificielle pour la défense et la sécurité. Atos. (2021, July 8). Retrieved February 27, 2023, from https://atos.net/fr/2021/communiques-de-presse_2021_05_27/thales-et-atos-creent-champion-europeen-big-data-ia

Top 10+ AI development companies in Portugal: AI developers Portugal February 2023. Top Software Companies. (2023). Retrieved February 27, 2023, from https://topsoftwarecompanies.co/ai-development/agencies/portugal

Top 10+ artificial intelligence companies in Slovakia (2023). TechBehemoths. (n.d.). Retrieved February 27, 2023, from https://techbehemoths.com/companies/artificial-intelligence/slovakia

Top 20 Artificial Intelligence (AI) Companies in Portugal. The Manifest. (n.d.). Retrieved February 27, 2023, from https://themanifest.com/pt/artificial-intelligence/companies

Top 20 Artificial Intelligence (AI) Companies in the Netherlands. The Manifest. (n.d.). Retrieved February 27, 2023, from https://themanifest.com/nl/artificial-intelligence/companies

Top 40 Artificial Intelligence (AI) Companies in Romania. The Manifest: Lists of Top B2B Companies & Business News. (n.d.). Retrieved February 27, 2023, from https://themanifest.com/ro/artificial-intelligence/companies

Top artificial intelligence (AI) companies - 2023 reviews - clutch.co. (n.d.). Retrieved February 27, 2023, from https://clutch.co/developers/artificial-intelligence

Top artificial intelligence (AI) companies - 2023 reviews - Luxembourg. Clutch. (2023). Retrieved February 27, 2023, from https://clutch.co/developers/artificial-intelligence

Top artificial intelligence (AI) companies - Bulgaria- 2023 reviews - clutch.co. Clutch. (2023). Retrieved February 27, 2023, from https://clutch.co/developers/artificial-intelligence

Top artificial intelligence (AI) companies -Itay . Clutch. (2023). Retrieved February 27, 2023, from https://clutch.co/developers/artificial-intelligence

Top artificial intelligence companies - reviews 2023. GoodFirms. (2023, February 27). Retrieved February 27, 2023, from https://www.goodfirms.co/artificial-intelligence?location%5B83%5D=lu

Top artificial intelligence companies in Romania - 2023 reviews | Clutch.co. (n.d.). Retrieved February 27, 2023, from https://clutch.co/ro/developers/artificial-intelligence

Top rated AI companies in Luxembourg: Client reviews. Lisnic. (n.d.). Retrieved February 27, 2023, from https://www.lisnic.com/services/lu/kanton-reiden/artificial-intelligence

Using AI to decode speech from brain activity. Meta AI. (2022, August). Retrieved February 27, 2023, from https://ai.facebook.com/blog/ai-speech-brain-activity/

Velliv og 2021.ai bag nyt projekt I ft lab. (2021, May 4). Retrieved February 27, 2023, from https://www.finanstilsynet.dk/Nyheder-og-Presse/Pressemeddelelser/2021/Velliv_AI_projekt

Világszerte Vezetnek - Aimotive Kft. Bét. (n.d.). Retrieved February 27, 2023, from https://www.bet.hu/Kibocsatok/bet50/2018/vallalatok/vilagszerte-vezetnek-aimotive-kft

Academia sector and technology collaboration within EU countries

About AIJU Institute. AIJU. (2022, June 6). Retrieved February 28, 2023, from https://www.aiju.es/en/about-us/

Adapt: SFI Research Centre for AI-driven Digital Content Technology. Science Foundation Ireland. (n.d.). Retrieved February 28, 2023, from https://www.sfi.ie/sfi-research-centres/adapt/

Adaptive deep sensing methods for autonomous vessels. Adaptivne Globoke metode zaznavanja za avtonomna Plovila. (n.d.). Retrieved February 27, 2023, from https://www.fri.uni-lj.si/sl/projekti/1685

Admin. (2017, January 21). *Standardization and regulation of technical scope*. Catim. Retrieved February 28, 2023, from https://www.catim.pt/en/node/210

AI and Machine Learning. IBM training. (n.d.). Retrieved February 28, 2023, from https://www.ibm.com/training/ailearning

AI for Healthcare. Croatian EDIH candidate AI4HEALTH.Cro. (n.d.). Retrieved February 28, 2023, from https://ai4healthcro.eu/

AI x Theatre: Τεχνητή νοημοσύνη και νέες προσεγγίσεις στη θεατρική θεωρία και πράξη . Ανοικτό Πανεπιστήμιο Κύπρου. (2023, February 24). Retrieved February 28, 2023, from https://www.ouc.ac.cy/index.php/el/news-events-menu-2/ekdiloseis-2021/2293-aitheatre

Aicia. Advanced Technologies for Industry. (n.d.). Retrieved February 28, 2023, from https://ati.ec.europa.eu/technology-centre/aicia

Aiju - Asociación de Investigación de la Industria del juguete, conexas y afines. Advanced Technologies for Industry. (n.d.). Retrieved February 28, 2023, from https://ati.ec.europa.eu/technology-centre/aiju-asociacion-de-investigacion-de-la-industria-del-juguete-conexas-y-afines

Aimen Centro Tecnológico. AIMEN. (n.d.). Retrieved February 28, 2023, from http://www.aimen.es/en/servicios-tecnologicos

Aixia News. Aixia. (n.d.). Retrieved February 28, 2023, from https://aixia.it/news/

Al via il primo Partenariato Esteso per lo sviluppo dell'intelligenza artificiale. Intervento della Presidente. (2022, October 10). Retrieved February 28, 2023, from https://www.cnr.it/it/intervento-presidente/11425/al-via-il-primo-partenariato-esteso-per-lo-sviluppo-dell-intelligenza-artificiale

Algorithms for genome sequence analysis. AGESA. (n.d.). Retrieved February 28, 2023, from http://bioinfo.zesoi.fer.hr/en/projects/agesa

Anagnostopoulos, K. (n.d.). *Mako Rio: Robotic Technology in orthopedic surgery*. Metropolitan Hospital. Retrieved February 28, 2023, from https://www.metropolitan-hospital.gr/en/photo-gallery/435-mako-rio-robotic-technology-in-orthopedic-surgery

Asociación de Investigación y Cooperación Industrial de Andalucía. Asociacin de Investigacin y Cooperacin Industrial de Andaluca. (n.d.). Retrieved February 28, 2023, from http://www.aicia.es/

BIOCC OÜ. Advanced Technologies for Industry. (n.d.). Retrieved February 28, 2023, from https://ati.ec.europa.eu/technology-centre/biocc-ou

Bioprocess development in Industrial Biotechnology. Biotrend. (n.d.). Retrieved February 28, 2023, from http://www.biotrend.pt

Carklin, N. (2021, August 17). *Parallels and University of Malta Collaborate to Further Research and Deploy AI Solutions* . Parallels Remote Application Server Blog - Application virtualization, mobility and VDI. Retrieved February 27, 2023, from https://tinyurl.com/mw7unmzt

Centre for Nanotechnology and smart materials. CeNTI. (n.d.). Retrieved February 28, 2023, from http://www.centi.pt/

CMYK Ingredients Bulgaria. Advanced Technologies for Industry. (n.d.). Retrieved February 28, 2023, from https://ati.ec.europa.eu/technology-centre/cmyk-ingredients

Connect, create, grow! pt. (n.d.). Retrieved February 28, 2023, from http://www.ccg.pt/

The CRT programme. SFI Centre for Research Training in Foundations of Data Science. (n.d.). Retrieved February 28, 2023, from https://www.data-science.ie/the-crt-programme/

Ctcv. (n.d.). *Bem Vindos AO CTCV*. CTCV. Retrieved February 28, 2023, from http://www.ctcv.pt/

Cybels Academy. Thales Group. (n.d.). Retrieved February 27, 2023, from https://www.thalesgroup.com/en/cybels-academy

De-identification for privacy protection in Surveillance Systems - DePPSS. Laboratory for Pattern Recognition and Biometric Security Systems. (n.d.). Retrieved February 28, 2023, from http://rubioss.zemris.fer.hr/DePPSS.html

Development and integration of new data algorithms and visual analytics into an investigative platform. V2-2117 - razvoj in integracija novih Algoritmov podatkovne in Vizualne Analitike v Preiskovalno Platformo. (2021). Retrieved February 27, 2023, from https://gemma.feri.um.si/V2-2117/

Digital Innovation Hub. Institute of Information Technology. (n.d.). Retrieved February 28, 2023, from https://iti.rtu.lv/en/dih

Digital Innovation Hubs. Smart Specialisation Platform. (n.d.). Retrieved February 27, 2023, from https://s3platform.jrc.ec.europa.eu/digital-innovation-hubs-tool/-/dih/22073/edih_view?_eu_europa_ec_jrc_dih_web_DihWebPortlet_backUrl=%2Fdigital-

innovation-hubs-tool%3Fp_p_id%3Deu_europa_ec_jrc_dih_web_DihWebPortlet%26p_p_lifecycle%3D0%26p_p_state%3Dnormal%26p_p_mode%3Dview_eu_europa_ec_jrc_dih_web_DihWebPortlet_edihTabParam%3DCandidate%2520European%2520DIHs#digitTechFocus

Digital Innovation Hubs. Smart Specialisation Platform. (n.d.). Retrieved February 28, 2023, from https://s3platform.jrc.ec.europa.eu/digital-innovation-hubs-tool/-/dih/1436/view?_eu_europa_ec_jrc_dih_web_DihWebPortlet_backUrl=%2Fdigital-innovation-hubs-tool%3Fp_p_id%3Deu_europa_ec_jrc_dih_web_DihWebPortlet%26p_p_lifecycle%3D0%26p_p_state%3Dnormal%26p_p_mode%3Dview

DIH for digital twins of logistics systems and manufacturing processes and systems. DIHDiTMaPS. (n.d.). Retrieved February 27, 2023, from https://dih-ditmaps.si/projects

Données et intelligence artificielle : Nouvelles perspectives pour les clients et pour la société. Orange. (2020, July 1). Retrieved February 27, 2023, from https://www.orange.com/fr/linnovation-utile-et-source-de-progres-pour-tous/donnees-et-intelligence-artificielle-nouvelles

Driver fatigue and distraction monitoring system. Image Processing Group - Image Processing Group. (n.d.). Retrieved February 28, 2023, from https://ipg.fer.hr/ipg/research/driver_assistance

EcoSmart - Eco System of the Smart City. Gem²a. (n.d.). Retrieved February 27, 2023, from https://gemma.feri.um.si/projects/slovene-national-research-projects/ecosmart-eco-system-of-the-smart-city/

Finnish Geospatial Research Institute FGI . National Land Survey of Finland. (2023, February 10). Retrieved February 28, 2023, from https://www.maanmittauslaitos.fi/en/research

Fokus Forschung: Lässt Sich künstliche Intelligenz zur Vorhersage von Pharmazeutischen Wirkstoffeigenschaften Nutzen? – kiwi soll antwort finden. HS Mittweida. (2021, December 1). Retrieved February 28, 2023, from https://www.forschung.hs-mittweida.de/news/aktuell/7199/

Furtenbacher, T. (n.d.). *PHYMOL: A Marie Skłodowska–Curie Actions Doctoral Network (MSCA DN) on Intermolecular Interactions*. PHYMOL. Retrieved February 28, 2023, from http://phymol.eu/

Gizelis Robotics:"Alliance for Health and Safety: Gizelis Robotics and Athens Medical Group join forces in the battle against covid-19 virus". SEV. (2021, June 22). Retrieved February 28, 2023, from https://en.sev.org.gr/members_news/gizelis-roboticsalliance-for-health-and-safety-gizelis-robotics-and-athens-medical-group-join-forces-in-the-battle-against-covid-19-virus/

Home Page. CITEVE. (n.d.). Retrieved February 28, 2023, from http://www.citeve.pt/

Home. Smart Specialisation Platform. (n.d.). Retrieved February 28, 2023, from https://s3platform.jrc.ec.europa.eu/

IDEAL - Implementing Digital Twins of Ecosystems of Agricultural Lands. Gem²a. (2020). Retrieved February 27, 2023, from https://gemma.feri.um.si/projects/slovene-national-research-projects/ideal-implementing-digital-twins-of-ecosystems-of-agricultural-lands/

IMECC OÜ. Advanced Technologies for Industry. (n.d.). Retrieved February 28, 2023, from https://ati.ec.europa.eu/technology-centre/imecc-ou

Information and Communication Technology. ICE. (2020). Retrieved February 28, 2023, from https://www.ice.it/en/sites/default/files/2021-01/ict-booklet-jan-2021.pdf

Instituto de Ciência E Inovação em Engenharia Mecânica e Engenharia industrial. INEGI. (n.d.). Retrieved February 28, 2023, from http://www.inegi.up.pt/partners.asp?LN=EN

Intelligent home of a new generation based on smart devices and wood. Gem²a. (n.d.). Retrieved February 27, 2023, from https://gemma.feri.um.si/projects/slovene-national-research-projects/intelligent-home-of-a-new-generation-based-on-smart-devices-and-wood/

Križanović, K. (n.d.). *Single-genome and metagenome de novo assembly*. SIGMA. Retrieved February 28, 2023, from https://bioinfo.zesoi.fer.hr/en/projects/sigma-en

Künstliche Intelligenz für eine bessere arbeitswelt. Schlie&en. (n.d.). Retrieved February 28, 2023, from https://www.fh-bielefeld.de/presse/pressemitteilungen/kuenstliche-intelligenz-fuer-eine-bessere-arbeitswelt

L-Università ta' Malta. (n.d.). *Artificial Intelligence Research Group at the Institute of Digital Games*. L-Università ta' Malta. Retrieved February 27, 2023, from https://www.um.edu.mt/digitalgames/airesearchgroup

L2-3170 - Computational tools for the discovery of prognostic markers in survival analysis. L2-3170 - računska orodja za odkrivanje prognostičnih markerjev V Analizi Preživetja. (n.d.). Retrieved February 27, 2023, from https://www.fri.uni-lj.si/sl/projekti/1726

LIST - Materials Research and Technologies (MRT). Advanced Technologies for Industry. (n.d.). Retrieved February 27, 2023, from https://ati.ec.europa.eu/technology-centre/list-materials-research-and-technologies-mrt

Lt- bridge · ADAPT: The Global Centre of Excellence for Digital Content and Media Innovation. ADAPT. (2021, April 29). Retrieved February 27, 2023, from https://www.adaptcentre.ie/projects/bridging-the-technology-gap-integrating-malta-into-european-research-and-innovation-efforts-for-ai-based-language-technologies/

Lægeduo booster udvikling af intelligent testmetode. Få hjælp og vejledning til at drive virksomhed | Virksomhedsguiden.dk. (n.d.). Retrieved February 28, 2023, from https://ehfyn.dk/content/ydelser/laegeduo-booster-udvikling-af-intelligent-testmetode/12ebdbc5-6590-4077-872e-fb5e064337a3/

Mesterséges Intelligencia Alapú Fejlesztés indul a GE Healthcare és a Debreceni Egyetem Együttműködésében. DEBRECENI EGYETEM. (2021, November 22). Retrieved February 28, 2023, from https://hirek.unideb.hu/mesterseges-intelligencia-alapu-fejlesztes-indul-ge-healthcare-es-debreceni-egyetem

MESTERSÉGES INTELLIGENCIA TUDÁSKÖZPONT PROGRAM: STRATÉGIAI SZÖVETSÉG A JÖVŐBEMUTATÓ FEJLESZTÉSEKÉRT. Microsoft Magyarország. (2019, November 12). Retrieved February 28, 2023, from https://news.microsoft.com/hu-hu/2019/11/12/mesterseges-intelligencia-tudaskozpont-program-strategiai-szovetseg-a-jovobemutato-fejlesztesekert/

Mesterséges Intelligencia Tudástárat Jelentetett Meg a Műegyetem és a jegybank. MNB. (2022, January 28). Retrieved February 28, 2023, from https://mnbprogram.bme.hu/2022/01/28/mesterseges-intelligencia-tudastarat-jelentetett-meg-a-muegyetem-es-a-jegybank/

Moltzau, A. (2020, February 27). *Malta's AI Strategy: Exploring the AI Launchpad*. Medium. Retrieved February 27, 2023, from https://alexmoltzau.medium.com/maltas-ai-strategy-2b8ce5bc9b3f

NL AI Coalition. (n.d.). Retrieved February 28, 2023, from https://nlaic.com/en/

PAKT Architecture – IoT based machine learning model for predicting electricity consumption. Gem²a. (n.d.). Retrieved February 27, 2023, from https://gemma.feri.um.si/projects/slovene-national-research-projects/pakt-architecture-iot-based-machine-learning-model-for-predicting-electricity-consumption/

Pametni razvoj bolnišnice na osnovi umetne inteligence. FERI. (n.d.). Retrieved February 27, 2023, from https://feri.um.si/raziskovanje/mednarodni-projekti-in-projekti-strukturnih-skladov/pametni-razvoj-bolnisnice-na-osnovi-umetne-inteligence/

PARENT - PremAtuRe nEwborn motor and cogNitive impairmenTs: Early diagnosis. Parent - premature newborn motor and cognitive impairments: Early diagnosis. (n.d.). Retrieved February 27, 2023, from https://www.fri.uni-lj.si/sl/projekti/1666

Partners- Academic & Industry. SMART 40. (n.d.). Retrieved February 28, 2023, from https://smart.confirm.ie/partners-academic-industry/

Personalised Intelligent Platform Enabling Interaction with Digital Services. Insension. (n.d.). Retrieved February 28, 2023, from https://www.insension.eu/

Professzionális Intelligencia Az Autóiparban. Continental AG. (2021, October 31). Retrieved February 28, 2023, from https://www.continental.com/hu-hu/vallalat/continental-kiallitasok-es-rendezvenyek/continental-pia-project

Projects & Results | Cordis | European Commission. CORDIS is the primary source of results from EU-funded projects since 1990. (n.d.). Retrieved February 28, 2023, from https://cordis.europa.eu/projects

R&D and Innovation. CENTIMFE. (n.d.). Retrieved February 28, 2023, from https://www.centimfe.com/rdi.html

Research and Development Center Bulgaria. Advanced Technologies for Industry. (n.d.). Retrieved February 28, 2023, from https://ati.ec.europa.eu/technology-centre/research-and-development-center

Retinal Image Analysis for Diabetic Retinopathy. Image Processing Group - Image Processing Group. (n.d.). Retrieved February 28, 2023, from https://ipg.fer.hr/ipg/research/retinal

RIVR – high performance computing. HPC. (n.d.). Retrieved February 27, 2023, from https://www.hpc-rivr.si/

Robotica, Automazione Industriale, Intelligenza Artificiale. ROBOSIRI, ASSOCIAZIONE ITALIANA DI ROBOTICA E AUTOMAZIONE. (n.d.). Retrieved February 28, 2023, from https://www.robosiri.it/

Roinsider. (2020, July 2). *Romanian universities partner with companies for research, training programs*. Romania Insider. Retrieved February 28, 2023, from https://www.romania-insider.com/ro-universities-continental-cnair-bluespace-partnerships-jul-2020

Schwartz, E. H. (2019, September 26). *Meet the only voice assistant that speaks Greek, Serbian, Albanian, and Bulgarian*. Voicebot.ai. Retrieved February 28, 2023, from https://voicebot.ai/2019/09/26/meet-the-only-voice-assistant-that-speaks-greek-serbian-albanian-and-bulgarian/

STACC OÜ. Advanced Technologies for Industry. (n.d.). Retrieved February 28, 2023, from https://ati.ec.europa.eu/technology-centre/stacc-ou

Technology Centre Mapping. Advanced Technologies for Industry. (n.d.). Retrieved February 27, 2023, from https://ati.ec.europa.eu/technology-centre/mapping?search=&countries%5B%5D=BE

Telecomunicações, I. T.- I. de. (n.d.). *Creating and sharing knowledge for telecommunications*. IT. Retrieved February 28, 2023, from https://www.it.pt/

Tencent signed a strategic cooperation agreement with Shenzhen University to help AI talents "undergraduate, master, and doctoral" one-stop training. 腾讯与深圳大学签署战略合作协议助力AI人才"本硕博"一站式培养. (2022, June 29). Retrieved February 28, 2023, from https://baijiahao.baidu.com/s?id=1736972061700708695&wfr=spider&for=pc

Tet: Facebook pauze ļauj saskatīt vairākas Svarīgas Lietas it Darbības Nepārtrauktībā. Par drošību! (2021, October 6). Retrieved February 28, 2023, from https://www.pardrosibu.lv/2021/06/15/tet-un-rtu-izstrada-maksliga-intelekta-risinajumu-it-sistemu-vienoto-monitoringu/TET

Themayor. (2021, December 6). *Romanian universities join forces to Open International AI Research Centre*. TheMayor.EU. Retrieved February 28, 2023, from https://www.themayor.eu/en/a/view/romanian-universities-join-forces-to-open-international-ai-research-centre-9514

ThemeFuse. (n.d.). *Projects: Ongoing Projects*. CTT. Retrieved February 27, 2023, from http://tehnologije.ijs.si/en/?page_id=81

Tracking of soccer players. Image Processing Group - Image Processing Group. (n.d.). Retrieved February 28, 2023, from https://ipg.fer.hr/ipg/research/playertracking

Udvalg for Kunstig intelligens (S-855). Dansk Standard. (n.d.). Retrieved February 28, 2023, from https://www.ds.dk/da/udvalg/kategorier/it/kunstig-intelligens

Universidade de Aveiro. (n.d.). *I&D*. Universidade de Aveiro. Retrieved February 28, 2023, from https://www.ua.pt/pt/tema/projetos_mobilizadores

Universität Kooperiert mit dem Bosch Center for Artificial Intelligence. News TF. (n.d.). Retrieved February 28, 2023, from http://news.vm.uni-freiburg.de/de/newsarchiv/universitaet-kooperiert-mit-dem-bosch-center-for-artificial-intelligence

Welcome to VTT. VTT. (n.d.). Retrieved February 28, 2023, from https://www.vttresearch.com/en

Working in Collaborative Factory of the Flight Simulators Branch of RISE (WrightBroS). Wrightbros. (n.d.). Retrieved February 28, 2023, from http://wrightbros.lgnexera.at/

xAIM - Interpretable Artificial Intelligence in Healthcare. Xaim - Razložljiva Umetna inteligenca V zdravstvu. (n.d.). Retrieved February 27, 2023, from https://www.fri.uni-lj.si/sl/projekti/1706

Your point of reference on Digital Innovation. Digital Innovation Observatories. (n.d.). Retrieved February 28, 2023, from https://www.osservatori.net/en/home

¿Qué es IndesIA? IndesIA. (2023, February 16). Retrieved February 28, 2023, from https://www.indesia.org/

Átadták Magyarország első mesterséges intelligencia ipari tanszékét a Bosch és az ELTE együttműködésében. Átadták Magyarország Első mesterséges intelligencia Ipari tanszékét a Bosch és AZ Elte Együttműködésében. (n.d.). Retrieved February 28, 2023, from https://www.inf.elte.hu/content/atadtak-magyarorszag-elso-mesterseges-intelligencia-ipari-tanszeket-a-bosch-es-az-elte-egyuttmukodeseben.t.3687

Ψηφιακά Δίδυμα και Τεχνητή Νοημοσύνη στη μάχη κατά της covid-19 από Κύπρια επιστήμονα. Cyprus Times. (2021, February 19). Retrieved February 28, 2023, from https://cyprustimes.com/koinonia/psifiaka-didyma-kai-techniti-noimosyni-sti-machi-kata-tis-covid-19-apo-kypria-epistimona/

AI national priorities within EU countries

AI Strategies and Policies in Slovak Republic. OECD.AI. (n.d.). Retrieved March 1, 2023, from https://oecd.ai/en/dashboards/countries/Slovakia

Misheva, G. V. (2022, July 19). *Croatia - National Development Strategy 2030*. Digital Skills and Jobs Platform. Retrieved March 1, 2023, from https://digital-skills-jobs.europa.eu/en/actions/national-initiatives/national-strategies/croatia-national-development-strategy-2030#:~:text=The%20National%20Strategy%20outlines%204,transition%2C%20and%20Balanced%20regional%20development.

AI - Here for Good A National Artificial Intelligence Strategy for Ireland. enterprise.gov.ie. (n.d.). Retrieved March 1, 2023, from https://enterprise.gov.ie/en/publications/publication-files/national-ai-strategy.pdf

AI Strategies and Policies in Estonia . OECD.AI. (n.d.). Retrieved March 1, 2023, from https://oecd.ai/en/dashboards/countries/Estonia

AI Strategies and Policies in Finland. OECD.AI. (n.d.). Retrieved March 1, 2023, from https://oecd.ai/en/dashboards/countries/Finland

AI Strategies and Policies in Romania . OECD.AI. (n.d.). Retrieved March 1, 2023, from https://oecd.ai/en/dashboards/countries/Romania

Ai Watch index 2021. AI Watch. (2022, March 31). Retrieved March 1, 2023, from https://ai-watch.ec.europa.eu/publications/ai-watch-index-2021_en

Artificial Intelligence will strengthen Sweden's welfare and competitiveness. Regeringskansliet. (n.d.). Retrieved March 1, 2023, from https://www.government.se/articles/2018/03/artificial-intelligence-will-strengthen-swedens-welfare-and-competitiveness/

Belgium AI Strategy Report. AI Watch. (n.d.). Retrieved March 1, 2023, from https://ai-watch.ec.europa.eu/countries/belgium/belgium-ai-strategy-report_en

The Danish National Strategy for Artificial Intelligence. digst.dk. (n.d.). Retrieved March 1, 2023, from https://en.digst.dk/strategy/the-danish-national-strategy-for-artificial-intelligence/

Digitalna tranzicija društva. Hrvatska 2030. (2020, November 12). Retrieved March 1, 2023, from https://hrvatska2030.hr/rs3/sc11/

Economy Today. (2022, May 17). *Τι θα κάνει η Amazon Web Services στην Κύπρο*. Economy Today. Retrieved March 1, 2023, from https://economytoday.sigmalive.com/oikonomia/kypros/47825_ti-tha-kanei-i-amazon-web-services-stin-kypro

Estonia: Public sector dimension of AI strategy. AI Watch. (n.d.). Retrieved March 1, 2023, from https://ai-watch.ec.europa.eu/topics/public-sector/public-sector-dimension-ai-national-strategies/estonia-public-sector-dimension-ai-strategy_en

Estrategia Espanola DE I+D+I en Inteligencia Artificial. lamoncloa.gob.es. (2019). Retrieved March 1, 2023, from https://www.lamoncloa.gob.es/presidente/actividades/Documents/2019/040319-estrategia-inteligencia.pdf

Estrategia nacional de Inteligencia Artificial. lamoncloa.gob.es. (2021, June 16). Retrieved March 1, 2023, from https://www.lamoncloa.gob.es/temas/fondos-recuperacion/Documents/16062021-Componente30.pdf

EY: Διάσταση προτεραιοτήτων για την τεχνητή νοημοσύνη - ποια τα διλήμματα. Business Daily. (2021, March 9). Retrieved March 1, 2023, from https://www.businessdaily.gr/epiheiriseis/38127_ey-diastasi-proteraiotiton-gia-tin-tehniti-noimosyni-poia-ta-dilimmata

Finland AI Strategy Report. AI Watch. (n.d.). Retrieved March 1, 2023, from https://ai-watch.ec.europa.eu/countries/finland/finland-ai-strategy-report_en#ecl-inpage-260

"Fourteenth Five -Year" National Informatization Plan ": Establish a sound and standardized and orderly digital development governance system. baijiahao.baidu.com. (n.d.). Retrieved March 1, 2023, from https://baijiahao.baidu.com/s?id=1720295022817929723&wfr=spider&for=pc

Harnessing Digital - the Digital Ireland framework. Search for services or information. (n.d.). Retrieved March 1, 2023, from https://www.gov.ie/en/publication/adf42-harnessing-digital-the-digital-ireland-framework/

Homola, J., Gemela, J., & Toskova, M. (2021, June). *Cyprus ICT 2020 Analysis and 2021-2023 Forecast*. ccs.org. Retrieved March 1, 2023, from https://ccs.org.cy/assets/uploads/IDC%20Report/ICT%20CYPRUS%20REPORT%202021.pdf

Informatīvais ziņojums "Par mākslīgā intelekta risinājumu attīstību". tap.mk.gov.lv. (2017, July 11). Retrieved March 1, 2023, from https://tap.mk.gov.lv/lv/mk/tap/?pid=40475479

Intelligenza Artificiale: l'Italia lancia la strategia nazionale. Assets.innovazione.gov.it. (n.d.). Retrieved March 1, 2023, from https://assets.innovazione.gov.it/1637779156-csprogrammastrategico-ia.pdf

Italy: Public sector dimension of AI strategy. AI Watch. (n.d.). Retrieved March 1, 2023, from https://ai-watch.ec.europa.eu/topics/public-sector/public-sector-dimension-ai-national-strategies/italy-public-sector-dimension-ai-strategy_en

Ki Als markenzeichen für Deutschland. Die Bundesregierung informiert . (n.d.). Retrieved March 1, 2023, from https://www.bundesregierung.de/breg-de/suche/ki-als-markenzeichen-fuer-deutschland-1549732

Luxembourg AI Strategy Report. AI Watch. (n.d.). Retrieved March 1, 2023, from https://ai-watch.ec.europa.eu/countries/luxembourg/luxembourg-ai-strategy-report_en

Magyarország Mesterséges Intelligencia Stratégiája 2020-2030. ai-hungary. (2020, May). Retrieved March 1, 2023, from https://ai-hungary.com/api/v1/companies/15/files/137203/view

Malta the Ultimate AI Launchpad. Malta AI. (2019, October). Retrieved March 1, 2023, from https://malta.ai/wp-content/uploads/2019/11/Malta_The_Ultimate_AI_Launchpad_vFinal.pdf

Nacionalni program spodbujanja razvoja in uporabe umetne inteligence v Republiki Sloveniji do leta 2025. ai4si.gzs.si. (n.d.). Retrieved March 1, 2023, from https://ai4si.gzs.si/uploads/hYNt3uhO/NpUI-SI-2025.pdf

National Artificial Intelligence Strategy of the Czech Republic. MPO. (2019). Retrieved March 1, 2023, from https://www.mpo.cz/assets/en/guidepost/for-the-media/press-releases/2019/5/NAIS_eng_web.pdf

National strategic programme on artificial intelligence: The strategic programme on artificial intelligence: Anchoring, principles and goals. Docs Italia. (n.d.). Retrieved March 1, 2023, from https://docs.italia.it/italia/mid/programma-strategico-nazionale-per-intelligenza-artificiale-en-docs/en/bozza/the-strategic-programme-on-artificial-intelligence-anchoring-principles-and-goals.html#objectives-and-priority-sectors

Polityki dla rozwoju sztucznej inteligencji w Polsce od roku 2020. monitorpolski.gov.p. (2020, December 28). Retrieved March 1, 2023, from https://monitorpolski.gov.pl/M2021000002301.pdf

Portugal AI Strategy Report. AI Watch. (n.d.). Retrieved March 1, 2023, from https://ai-watch.ec.europa.eu/countries/portugal/portugal-ai-strategy-report_en

Portugal launches the National Strategy for Artificial Intelligence. Portugal INCoDe. (2019, June 11). Retrieved March 1, 2023, from https://www.incode2030.pt/en/featured/portugal-launches-national-strategy-artificial-intelligence

Prime minister Kyriakos Mitsotakis attends the event for the presentation of Google's investment plans in Greece. Ο Πρωθυπουργός της Ελληνικής Δημοκρατίας. (2022, October 1). Retrieved March 1, 2023, from https://primeminister.gr/en/2022/09/29/30303

Romania AI Strategy Report. AI Watch. (n.d.). Retrieved March 1, 2023, from https://ai-watch.ec.europa.eu/countries/romania/romania-ai-strategy-report_en

Strategie der bundesregierung für Künstliche Intelligenz; Artificial Intelligence Mission Austria 2030. Innovation. (n.d.). Retrieved March 1, 2023, from https://www.bmk.gv.at/themen/innovation/publikationen/ikt/ai/strategie-bundesregierung.html

Strategisch Actieplan voor Artificiële Intelligentie. open.overheid.nl. (n.d.). Retrieved March 1, 2023, from https://open.overheid.nl/documenten/ronl-e14cdcee-690c-4995-9870-fa4141319d6f/pdf

Strategy and Vision for AI in Malta 2030. Malta AI |. (2019, October 4). Retrieved March 1, 2023, from https://malta.ai/

Stratégie Nationale pour l'intelligence artificielle. La Stratégie Nationale pour l'IA | Stratégie nationale pour l'intelligence artificielle. (n.d.). Retrieved March 1, 2023, from https://www.intelligence-artificielle.gouv.fr/fr/strategie-nationale/la-strategie-nationale-pour-l-ia

Stratégie Nationale pour l'intelligence artificielle. Éduquer à l'Intelligence artificielle | Stratégie nationale pour l'intelligence artificielle. (n.d.). Retrieved March 1, 2023, from https://www.intelligence-artificielle.gouv.fr/fr/thematiques/talents-et-competences/eduquer-l-intelligence-artificielle

Sánchez, P. (n.d.). *España Digital*. España Digital 2026. Retrieved March 1, 2023, from https://espanadigital.gob.es/en

Technology and Start-Ups; an Era of Disruption. Cyprus Profile. (2022, November). Retrieved March 1, 2023, from https://www.cyprusprofile.com/sectors/technology-start-ups

Εφαρμογές Τεχνητής Νοημοσύνης για Έξυπνη Φιλοξενία. dialogos. (2022, August). Retrieved March 1, 2023, from https://dialogos.com.cy/efarmoges-technitis-noimosynis-exypni-filoxenia/

Τεχνητή Νοημοσύνη: Τα δεδομένα σήμερα και οι προτάσεις του ΣΕΒ. Capital.gr. (2020). Retrieved March 1, 2023, from https://www.capital.gr/epixeiriseis/3499627/texniti-noimosuni-ta-dedomena-simera-kai-oi-protaseis-tou-seb

Концепция за развитието на ИЗКУСТВЕН ИНТЕЛЕКТ В България до 2030 г. mtc.government.bg. (2020, October). Retrieved March 1, 2023, from https://www.mtc.government.bg/sites/default/files/conceptforthedevelopmentofaiinbulgariauntil2030.pdf

Attracting investment

Antonova, A. (2022, May 2). *Bulgaria to become an AI research powerhouse as it launches the Institute for Computer Science, Artificial Intelligence and Technology (INSAIT)*. Digital Skills and Jobs Platform. Retrieved March 2, 2023, from https://digital-skills-jobs.europa.eu/en/latest/news/bulgaria-become-ai-research-powerhouse-it-launches-institute-computer-science

AI scientific publications by subject area, from Scopus . from OECD.AI partners - OECD.AI. (n.d.). Retrieved March 2, 2023, from https://oecd.ai/en/data?selectedArea=ai-research&selectedVisualization=ai-scientific-publications-by-subject-area-from-scopus

AI Strategies and Policies in Romania. OECD.AI. (n.d.). Retrieved March 2, 2023, from https://oecd.ai/en/dashboards/countries/Romania

AI strategies in Romania. CMS Expert Guides. (n.d.). Retrieved March 2, 2023, from https://cms.law/en/int/expert-guides/cms-expert-guide-to-ai-strategies-in-cee/romania

AI WATCH LANDSCAPE Czech Republic. web.jrc.ec.europa.eu. (n.d.). Retrieved March 2, 2023, from https://web.jrc.ec.europa.eu/dashboard/AI_WATCH_LANDSCAPE/index.html?bookmark=overview&sel-Country=Czechia

Aquabiotech Group. Advanced Technologies for Industry. (n.d.). Retrieved March 2, 2023, from https://ati.ec.europa.eu/technology-centre/aquabiotech-group

ARTIFICIAL INTELLIGENCE at the service of citizens. ia.italia.it. (2018, March). Retrieved March 2, 2023, from http://libro-bianco-ia.readthedocs.io/en/latest/

Artificial Intelligence Research Agenda for The Netherlands. NWO. (2019). Retrieved March 2, 2023, from https://www.nwo.nl/sites/nwo/files/documents/AIREA-NL%20AI%20Research%20Agenda%20for%20the%20Netherlands.pdf

Az Mi Jelenti a jövőt. Mesterséges Intelligencia Nemzeti Laboratórium. (n.d.). Retrieved March 2, 2023, from https://mi.nemzetilabor.hu/hu

Belgium AI Strategy Report. AI Watch. (n.d.). Retrieved March 2, 2023, from https://ai-watch.ec.europa.eu/countries/belgium/belgium-ai-strategy-report_en#from-the-lab-to-the-market

Chatignoux, C. (2018, December 19). *Investissements dans la recherche : L'Europe s'Essouffle*. Les Echos. Retrieved March 2, 2023, from https://www.lesechos.fr/monde/europe/investissements-dans-la-recherche-leurope-sessouffle-240093#:~:text=La%20high-tech%20et%20la%20sant%C3%A9%20sont%20les%20domaines,de%20sp%C3%A9cialisation%20de%20part%20et%20d%27autre%20de%20l%27Atlantique.

CONCEPT FOR THE DEVELOPMENT OF AI IN BULGARIA UNTIL 2030 . OECD.AI. (n.d.). Retrieved March 2, 2023, from https://oecd.ai/en/dashboards/policy-initiatives

CONCEPT FOR THE DEVELOPMENT OF ARTIFICIAL INTELLIGENCE IN BULGARIA UNTIL 2030. mtc.government.bg. (2020, October). Retrieved March 2, 2023, from https://www.mtc.government.bg/sites/default/files/conceptforthedevelopmentofaiinbulgariauntil2030.pdf

Cordis | European Commission, Ireland. Cordis. (n.d.). Retrieved March 2, 2023, from https://cordis.europa.eu/

Digitális Munkaerő program - IVSZ. ivsz.hu. (2016, September). Retrieved March 2, 2023, from https://ivsz.hu/wp-content/uploads/2016/09/ivsz-digitalis-munkaero-program.pdf

Eesti riiklik tehisintellekti alane tegevuskava ehk kratikava 2022-2023. Kratid. (2021). Retrieved March 2, 2023, from https://www.kratid.ee/andmeteadus

Find the right funding. Vinnova. (n.d.). Retrieved March 2, 2023, from https://www.vinnova.se/en/apply-for-funding/find-the-right-funding/

Foundation for Research and technology-Hellas (forth). Advanced Technologies for Industry. (n.d.). Retrieved March 2, 2023, from https://ati.ec.europa.eu/technology-centre/foundation-research-and-technology-hellas-forth

High-Precision Detection Technologies for Water Quality in Aquaculture. aquabt.com. (n.d.). Retrieved March 2, 2023, from https://aquabt.com/wp-content/uploads/2022/04/ABT_Aquadetector_22.pdf

Intelligent Fish feeding through Integration of ENabling technologies and Circular principle. aquabt.com. (n.d.). Retrieved March 2, 2023, from https://aquabt.com/wp-content/uploads/2022/04/iFishIENCi-AUG-19.pdf

IRELAND'S NATIONAL SKILLS STRATEGY 2025. assets.gov.ie. (n.d.). Retrieved March 2, 2023, from https://assets.gov.ie/24412/0f5f058feec641bbb92d34a0a8e3daff.pdf

Končar - Electrical Engineering Institute Inc.. Advanced Technologies for Industry. (n.d.). Retrieved March 2, 2023, from https://ati.ec.europa.eu/technology-centre/koncar-electrical-engineering-institute-inc

Koražija, N. (2021, November 11). *Kako bomo Nadoknadili Zamudo pri Razvoju in Uporabi Umetne inteligence*. Finance Manager. Retrieved March 2, 2023, from https://manager.finance.si/8982010/Kako-bomo-nadoknadili-zamudo-pri-razvoju-in-uporabi-umetne-inteligence

Latvia AI Strategy Report. AI Watch. (n.d.). Retrieved March 2, 2023, from https://ai-watch.ec.europa.eu/countries/latvia-0/latvia-ai-strategy-report_en

Lero, the Irish Software Research Centre. Advanced Technologies for Industry. (n.d.). Retrieved March 2, 2023, from https://ati.ec.europa.eu/technology-centre/mapping?search=&countries%5B%5D=IE&activities%5B%5D=5710

Live data . OECD.AI. (n.d.). Retrieved March 2, 2023, from https://oecd.ai/en/data?selectedArea=investments-in-ai&selectedVisualization=top-ai-start-ups-per-country-and-industry

Luxembourg AI Strategy Report. AI Watch. (n.d.). Retrieved March 2, 2023, from https://ai-watch.ec.europa.eu/countries/luxembourg/luxembourg-ai-strategy-report_en

Machine Learning for Sciences and humanities. cordis.europa.eu. (n.d.). Retrieved March 2, 2023, from https://cordis.europa.eu/project/id/101081355

MAGYARORSZÁG DIGITÁLIS EXPORTFEJLESZTÉSI STRATÉGIÁJA. Digitális Jólét Nonprofit Kft. (2016, June). Retrieved March 2, 2023, from https://digitalisjoletprogram.hu/

Magyarország Mesterséges Intelligencia Stratégiája. AI Hungary. (2020, May). Retrieved March 2, 2023, from https://ai-hungary.com/

Major research initiative will put Sweden on the map in Artificial Intelligence and Quantum Technology Fields. Knut and Alice Wallenberg Foundation. (n.d.). Retrieved March 2, 2023, from https://kaw.wallenberg.org/en/research/major-research-initiative-will-put-sweden-map-artificial-intelligence-and-quantum

National Artificial Intelligence Strategy of the Czech Republic. MPO. (n.d.). Retrieved March 2, 2023, from https://www.mpo.cz/assets/en/guidepost/for-the-media/press-releases/2019/5/NAIS_eng_web.pdf

National strategic programme on artificial intelligence: Context: Italy's competitive position and challenges ahead. Docs Italia. (n.d.). Retrieved March 2, 2023, from https://docs.italia.it/italia/mid/programma-strategico-nazionale-per-intelligenza-artificiale-en-docs/en/bozza/context-italy-competitive-position-and-challenges-ahead.html#the-italian-ecosystem

National Strategies on Artificial Intelligence a European perspective - Country Report Romania. knowledge4policy.ec.europa.eu. (n.d.). Retrieved March 2, 2023, from https://knowledge4policy.ec.europa.eu/sites/default/files/romania-ai-strategy-report.pdf

National-funded projects - Department of Artificial Intelligence Malta. um.edu.mt. (n.d.). Retrieved March 2, 2023, from https://www.um.edu.mt/ict/ai/ourresearch/nationalfundedprojects

Newsroom. (2020, September 29). *"Ανοδική" η πορεία της τεχνητής νοημοσύνης στην Ελλάδα - Η εικόνα του επιχειρηματικού τοπίου*. startupper.gr. Retrieved March 2, 2023, from https://startupper.gr/news/64418/anodiki-i-poreia-tis-technitis-noimosynis-stin-ellada-i-eikona-tou-epicheirimatikou-topiou/

Plan de Recuperación, Transformación y Resiliencia. www.lamoncloa.gob.es. (2021, June 16). Retrieved March 2, 2023, from https://www.lamoncloa.gob.es/temas/fondos-recuperacion/Documents/16062021-Componente26.pdf

Portal Sztucznej Inteligencji . portal gov.pl. (n.d.). Retrieved March 2, 2023, from https://www.gov.pl/web/ai

Portugal launches the National Strategy for Artificial Intelligence. Portugal INCoDe.2030. (2019, June 11). Retrieved March 2, 2023, from https://www.incode2030.pt/en/featured/portugal-launches-national-strategy-artificial-intelligence

Research priority areas 2018 to 2023. knowledgetransferireland.com. (n.d.). Retrieved March 2, 2023, from https://www.knowledgetransferireland.com/Reports-Publications/Ireland-s-Research-Priority-Areas-2018-2023.pdf

Romania AI Strategy Report. AI Watch. (n.d.). Retrieved March 2, 2023, from https://ai-watch.ec.europa.eu/countries/romania/romania-ai-strategy-report_en#ecl-inpage-396

Self-reconfiguration of a robotic workcell for the recycling of electronic waste. cordis.europa.eu. (n.d.). Retrieved March 2, 2023, from https://cordis.europa.eu/project/id/871352

Smart specialisation strategy (RIS3). Izglītības un zinātnes ministrija. (n.d.). Retrieved March 2, 2023, from https://www.izm.gov.lv/en/smart-specialisation-strategy-ris3

Soutien à l'investissement et la modernisation de l'industrie. economie.gouv.fr. (2021, August 18). Retrieved March 2, 2023, from https://www.economie.gouv.fr/plan-de-relance/mesures/soutien-investissement-modernisation-industrie

Strategia per l'innovazione tecnologica e la digitalizzazione del Paese. assets.innovazione.gov.it. (n.d.). Retrieved March 2, 2023, from https://assets.innovazione.gov.it/1610546390-midbook2025.pdf

Strategie der bundesregierung für Künstliche Intelligenz. bmk.gv.at. (n.d.). Retrieved March 2, 2023, from https://www.bmk.gv.at/themen/innovation/publikationen/ikt/ai/strategie-bundesregierung.html

Suomesta Voittaja kaksoisiirtymässä – Tavoitteista Käytäntöön. julkaisut.valtioneuvosto.fi. (2021). Retrieved March 2, 2023, from https://julkaisut.valtioneuvosto.fi/bitstream/handle/10024/163693/TEM_2021_64.pdf?sequence=1

Swedish AI society: SAIS - Swedish Artificial Intelligence Research. SAIS. (n.d.). Retrieved March 2, 2023, from http://www.sais.se/blog/

Toepassingsgebieden. Nederlandse AI Coalitie. (n.d.). Retrieved March 2, 2023, from https://nlaic.com/toepassingsgebied/

Towards a Romanian AI strategy - clujit.ro. www.clujit.ro. (2021, December 1). Retrieved March 2, 2023, from https://www.clujit.ro/wp-content/uploads/2021/12/Towards-a-Romanian-AI-Strategy.pdf

Trends in AI subtopics over time . OECD.AI. (n.d.). Retrieved March 2, 2023, from https://oecd.ai/en/data?selectedArea=ai-research&selectedVisualization=trends-in-ai-subtopics-over-time

VAN ROY , V., ROSSETTI, F., PERSET, K., & GALINDO-ROMERO, L. (2021, June 22). *Ai watch - national strategies on artificial intelligence: A European perspective, 2021 edition*. JRC Publications Repository. Retrieved March 2, 2023, from https://publications.jrc.ec.europa.eu/repository/handle/JRC122684

Yovchev, E. (2020, November 23). *The mapping of the Bulgarian Artificial Intelligence Ecosystem is starting: Call for local AI companies*. Trending Topics. Retrieved March 2, 2023, from https://www.trendingtopics.eu/ai/

Έρχονται Κύπρο για να επενδύσουν εκατ. ευρώ για το διάστημα. Brief. (2021, June 14). Retrieved March 2, 2023, from https://www.brief.com.cy/kainotomia/erhontai-kypro-gia-na-ependysoyn-ekat-eyro-gia-diastima

Αρχική - Γενική Γραμματεία Ψηφιακής Διακυβέρνησης & απλούστευσης ... secdigital.gov.gr. (2017, May). Retrieved March 2, 2023, from https://www.secdigital.gov.gr/wp-content/uploads/2020/07/secdigital-digital-Greece-060517.pdf

Αρχική - Γενική Γραμματεία Ψηφιακής Διακυβέρνησης & απλούστευσης ... secdigital.gov.gr. (n.d.). Retrieved March 2, 2023, from https://www.secdigital.gov.gr/wp-content/uploads/2020/07/secdigital-digital-Greece-060517.pdf

Βίβλος Ψηφιακού Μετασχηματισμού 2020-2025. digitalstrategy.gov.gr. (2021, June). Retrieved March 2, 2023, from https://digitalstrategy.gov.gr/website/static/website/assets/uploads/digital_strategy.pdf

Επενδύσεις ύψους 20 δις ευρώ στην Τεχνητή Νοημοσύνη επιδιώκει η Ε.Ε. Κατασκευές Κτιρίων. (2020, December 5). Retrieved March 2, 2023, from https://kataskevesktirion.gr/%CE%B5%CF%80%CE%B5%CE%BD%CE%B4%CF%8D%CF%83%CE%B5%CE%B9%CF%82-%CF%8D%CF%88%CE%BF%CF%85%CF%82-20-%CE%B4%CE%B9%CF%82-%CE%B5%CF%85%CF%81%CF%8E-%CF%83%CF%84%CE%B7%CE%BD-%CF%84%CE%B5%CF%87%CE%BD%CE%B7%CF%84/

Μαλλάς, Δ. (2020, June 24). *Την ενίσχυση των ψηφιακών δεξιοτήτων επιδιώκει η κυβέρνηση*. Moved.gr. Retrieved March 2, 2023, from https://www.moved.gr/tin-enischysi-ton-psifiakon-deksiotiton-epidiokei-i-kyvernisi/

Σχέδιο δράσης για την ψηφιακή εκπαίδευση (2021-2027). European Education Area. (n.d.). Retrieved March 2, 2023, from https://education.ec.europa.eu/el/focus-topics/digital-education/action-plan

7.3. Annex 3: Lightcast taxonomy of AI skills (as used by Stanford University)[3]

Natural Language Processing (NLP)	• Amazon Textract • ANTLR • BERT (NLP Model) • Chatbot • Computational Linguistics • DeepSpeech, Dialog Systems • fastText • Fuzzy Logic • Handwriting Recognition • Hugging Face (NLP Framework) • HuggingFace Transformers • Intelligent Agent • Intelligent Software Assistant • Intelligent Virtual Assistant • Kaldi • Latent Dirichlet Allocation • Lexalytics • Machine Translation • Microsoft LUIS • Natural Language Generation • Natural Language Processing • Natural Language Processing Systems • Natural Language Programming • Natural Language Toolkits • Natural Language Understanding • Natural Language User Interface • Nearest Neighbour Algorithm • OpenNLP • Optical Character Recognition (OCR) • Screen Reader • Semantic Analysis • Semantic Interpretation for Speech Recognition • Semantic Parsing • Semantic Search • Sentiment Analysis • Seq2Seq • Speech Recognition • Speech Recognition Software • Statistical Language Acquisition • Text Mining, Tokenization • Voice Interaction • Voice User Interface • Word Embedding • Word2Vec Models
Visual Image Recognition (computer vision)	• 3D Reconstruction • Activity Recognition • Computer Vision

[3] Stanford University (2023). https://aiindex.stanford.edu/report/ p.366-368

	• Contextual Image Classification • Digital Image Processing • Eye Tracking, Face Detection • Facial Recognition • Image Analysis • Image Matching • Image Processing • Image Recognition • Image Segmentation • Image Sensor • Imagenet • Machine Vision • Motion Analysis • Object Recognition • OmniPage • Pose Estimation • RealSense
Robotics	• Advanced Robotics • Cognitive Robotics • Motion Planning • Nvidia Jetson • Robot Framework • Robot Operating Systems • Robotic Automation Software • Robotic Liquid Handling Systems • Robotic Programming • Robotic Systems • Servomotor • SLAM Algorithms (Simultaneous Localization and Mapping)
Machine Learning	• AdaBoost • Apache MADlib • Apache Mahout • Apache SINGA • Apache Spark • Association Rule Learning • Automated Machine Learning • Autonomic Computing • AWS SageMaker • Azure Machine Learning • Boosting • CHi-Squared Automatic Interaction Detection (CHAID) • Classification And Regression Tree (CART) • Cluster Analysis • Collaborative Filtering • Confusion Matrix • Cyber-Physical Systems • Dask (Software) • Data Classification • DBSCAN • Decision Models • Decision Tree Learning • Dimensionality Reduction • Dlib (C++ Library)

	• Ensemble Methods • Evolutionary Programming • Expectation Maximization Algorithm • Feature Engineering • Feature Extraction • Feature Learning • Feature Selection • Gaussian Process • Genetic Algorithm • Google AutoML • Google Cloud ML Engine • Gradient Boosting • H2O.ai • Hidden Markov Model • Hyperparameter Optimization • Inference Engine • K-Means Clustering • Kernel Methods • Kubeflow • LIBSVM • Machine Learning • Machine Learning Algorithms • Markov Chain • Matrix Factorization • Meta Learning • Microsoft Cognitive Toolkit (CNTK) • MLflow • MLOps (Machine Learning Operations) • mlpack (C++ Library) • Naive Bayes • Perceptron • Predictionio • PyTorch (Machine Learning Library) • Random Forest Algorithm • Recommendation Engine • Recommender Systems, Reinforcement Learning • Scikit-learn (Machine Learning Library) • Semi-Supervised Learning, Soft Computing • Sorting Algorithm • Supervised Learning • Support Vector Machine • Test Datasets • Torch (Machine Learning) • Training Datasets • Transfer Learning • Unsupervised Learning • Vowpal Wabbit • Xgboost
Neural networks (deep learning)	• Apache MXNet • Artificial Neural Networks • Autoencoders • Caffe • Caffe2

	• Chainer • Convolutional Neural Networks • Cudnn • Deep Learning • Deeplearning4j • Keras (Neural Network Library) • Long Short-Term Memory (LSTM) • OpenVINO • PaddlePaddle • Pybrain • Recurrent Neural Network (RNN) • TensorFlow

Artificial Intelligence Skills Alliance
www.aiskills.eu
info@aiskills.eu

Co-funded by the European Union

Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or the European Education and Culture Executive Agency (EACEA). Neither the European Union nor EACEA can be held responsible for them.