20760-D02 Analysis of the educational activities available in the area of AI (CrossKIC)

20760 Artificial Intelligence

EIT Health

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Contents

Executive Summary

AI is considered one of the biggest technology trends in the 21st century. The scope of the given report is structurally analysing the current situation of AI education in Europe in terms of AI talent distribution and demand from industry. The analysis serves as the basis to assess EIT's positioning in Europe's Ai education landscape and the educational offerings in AI. The first chapter describes the scope and methodology used in the present report. The second highlights current developments and trends in AI; for example, interpretability, ethics, governance, systematic biases, security in AI or most recent trends like Auto- and Quantum machine learning.

Chapter 2 gives an overview of the present academic landscape, the rise of online education, poor accessibility for postgraduate students, and a theoretical teaching approach. Exemplary, the German AI strategy is highlighted. The chapter concludes that Europe provides cutting edge academic education. Chapter 3 provides an overview of the key market players of online education: Coursera, edX, and Udacity as well as on the content provided. Universities, as well as big-tech companies like Google and Microsoft, recently started creating their own platforms. The US is currently the largest producer of online education, while the EU is lagging. This results in a lack of coverage of specific European topics, like human-centric approaches and multilingualism.

The subsequent Chapter 4 focuses on EIT's previous course offerings and the unique EIT Digital Data Science Master curriculum. We were segmenting target groups, subjects and the location within the AI project process steps. EIT's courses via the KICs resemble the distribution of AI education when it comes to core topics of AI (e.g., Machine Learning) and also fundamentals (e.g., statistics). However, a white spot containing specialisation and in-depth topics, but also new educational offerings in ethics, governance, privacy, or security could be identified. Here, EIT can make use of its central role in Europe, its widely gained trust, its expertise, and its outstanding network in both academia and industry. Considering EIT's previous efforts in AI education, the present report recommends ten actionable suggestions to become a leader in the European AI education landscape:

1. Focus on European applied topics like language and culture in the courses.
2. Complement the hard skill education in AI with AI-related soft skills.
3. Market AI programs specifically to a female audience to foster diversity.
4. Strengthen collaboration with universities and facilitate offering accredited courses.
5. Create the first European open platform for online courses.
6. Offer students AI courses free of charge and early in education.
7. Help professionals in specific industries solve current problems with applied AI workshops.
8. Educate and enable managers to create pragmatic AI governance.
9. Facilitate courses for decision-makers to understand the potential of AI.

10. Strengthen courses for policymakers to understand the ethics of AI.

1 Introduction

Over the last decade, the discussion about the impact of AI on industries and the labour market has accelerated, and many debates within the EU are ongoing (European Commission, 2019). Most arguments are emotion-led and rarely grounded on data-based empirical evidence. Many questions among business leaders, policymakers, academics remain unanswered, and two perspectives dominate the debate today. One prevalent view sees AI as an emerging technology, providing opportunities to increase productivity, drive innovation, and conduct repetitive tasks freeing up human capital for further tasks. The other one is more concerned with the disruptive potential of AI, making hosts of jobs redundant, creating job losses, and increasing unemployment (McKinsey & Company, 2019). In any event, training the available workforce in the EU in AI on the highest possible quality level Is imperative if the EU member states aim at remaining competitive on a global scale.

To this end, the purpose of this report is to analyse the educational portfolio of the EIT KICs in terms of content in around AI and data analysis in general. The basis of the research was material compiled from over 500 courses that the various EIT KICs offer to their clients. As the KICs address different industry sectors, such as energy or healthcare, the base data is rich and diverse. From all courses, a subset of classes was selected according to pre-defined, unbiased criteria to include those courses that are relevant for AI education. This subset of AI-related courses was at the core of the analysis.

To guide the analysis, a systematic framework was developed to assess the current state of EIT KICs curricula efficiently. The overall goal of this analysis was to understand how complementary the contents of those courses are and whether synergistic effects are possible. Besides, this analysis aimed at revealing the diversity that the EIT KIC courses provide, not only in terms of the educational content but also in the name of its methodology (e.g., online versus onsite programs), the user level addressed, and its target audience.

To complement these results, key figures are compared with external AI curricula from various sources. A critical objective of the report is to reveal which trends in AI are covered more and which less. This is important to highlight where the educational offer provided by the EIT KICs can be extended to cover skills that will be of high relevance for future job openings. To be able to make these recommendations, this report summarises the current demand for AI talent from the European job market and outlines how this demand is changing. Based on this joint examination, recommendations for the introduction of new courses, educational paths, and the promotion of new job roles in AI are given.

2 Academic Landscape in AI

The growing number of activating users of MOOCs courses shows that electronic and distance learning methodologies are appreciated by society.

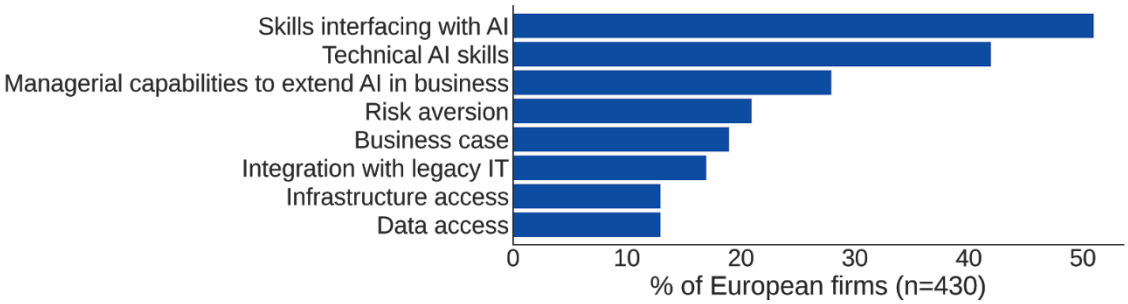

Figure 1 AI Skills required by companies in Europe in per cent

In practice, the change needed in skills cannot wait for a full redesign of the education system. In the short term, hiring new talent for firms on the required scale is impractical. Therefore, companies will need to be proactive about training and retraining their current employees. Although Europe today devotes more resources, in per cent of its GDP, to training than do the United States and China, many employees of European firms—tiny and medium-sized enterprises—have limited access to training. Concerning new skills such as digital ICT, 30 per cent of large enterprises still do not provide training. That percentage rises to 80 per cent in the case of small enterprises, defined as having between 10 and 49 employees. Some companies are turning to online training solutions, whereas others are providing their employees with subsidies to go back to school. In terms of high-end tech talent, some large companies are acquiring smaller tech and AI firms to gain an immediate infusion of expertise. AI itself provides valuable tools to aid in recruiting—including, for instance, neuroscience-based games that help to identify promising candidates who may have the right traits and innate talent, although they lack credentials.

AI itself could be a valuable tool to enable new forms of personalised learning. Digital technologies can support educational capacity, control costs, and boost quality. Virtual classrooms can increase the accessibility and scalability of lectures and allow for more personalised and flexible education models. Kennisnet, in the Netherlands, has provided virtual education since 2005, and the Koulu 360 initiative in Finland aims to develop the country's first virtual school.

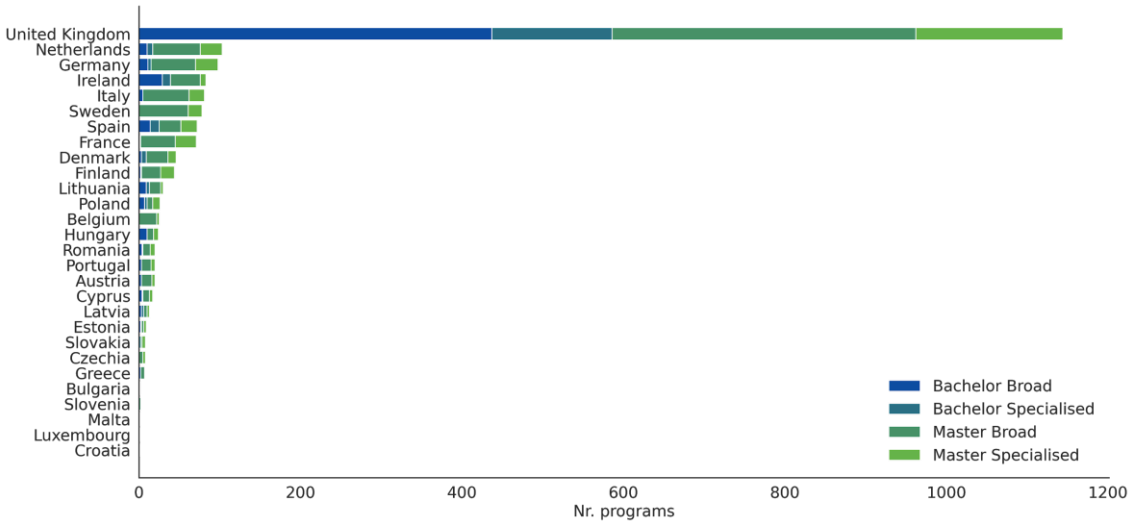

Figure 2 Number of AI programs within the EU27 and UK in 2018

When it comes to AI-related curricula, a study conducted by the European Commission found 765 bachelors, as well as 1 289 master programs offered in the EU, in the English language in 2018. They made up 3.9% of all programs in the EU. The study further revealed that 19% of all available AI programs from all countries correspond to the EU27.

In the study, programs have been classified in specialised and broad, according to the degree and depth with which they focus on the specific technological domain. Among the broader scope, general Computer science programs can be included, but also plans on other disciplines, e.g. Biomedical engineering, or modules on AI techniques. Still, about two-thirds of the EU Member States have less than ten master's programs with a focus on AI. Only 11 EU Member States have more than 20 Master's programs, including at least one AI module. (European Commission, 2020)

In 2019, with 1,275 courses, the UK offered more AI-related programs than all EU27 states combined (1,032), while the US accounts for 2,345. The EU27, however, concentrate the offer of AI skills at the most advanced level, i.e. the master's degrees. AI ethics (e.g., security, safety, accountability, explainability) makeup 15% of the curriculum on average but is not available in all countries. Germany, Netherlands, and Sweden lead the offer of AI master's degrees. Each of them individually accounts for more than 10% of the entire EU27 bid of AI master's degree programs. Both France and Finland provide a large amount of specialised AI master programs. France is offering the highest amount of specialised AI masters in the EU27.

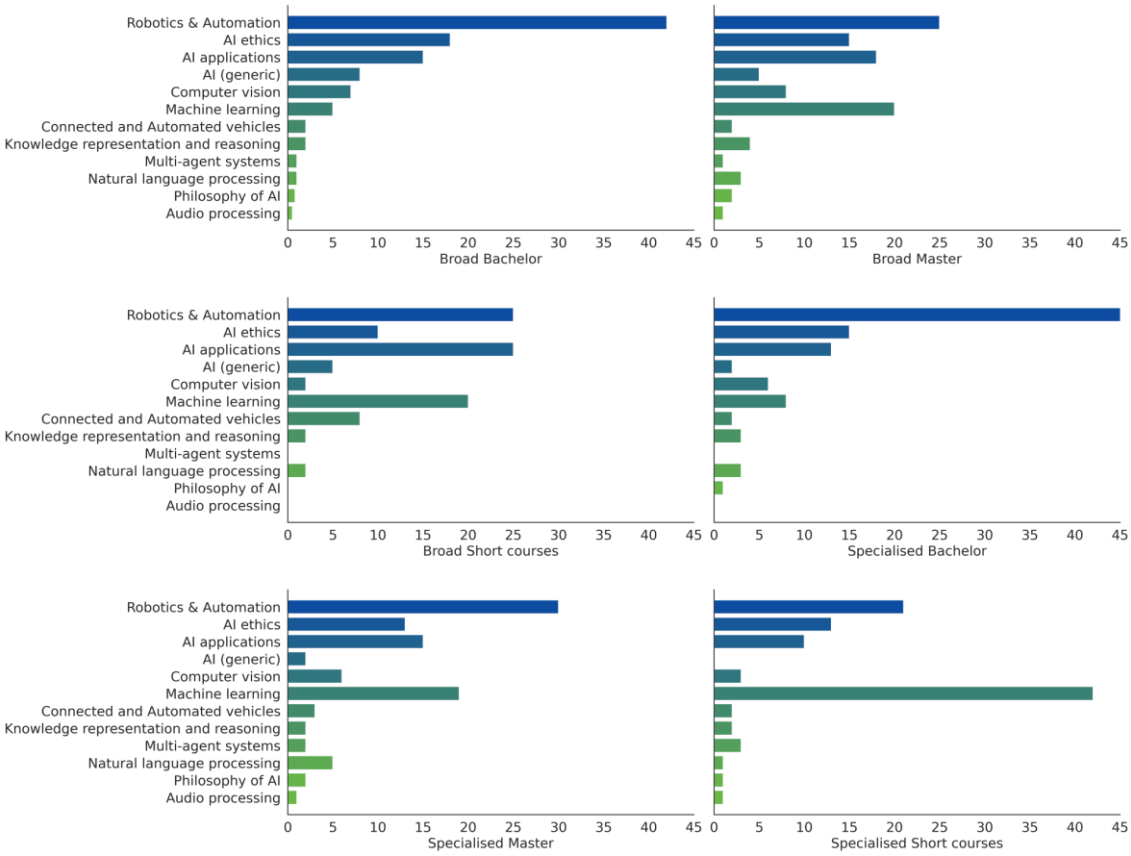

Figure 3 Content areas of academic programs within the EU27

Outline for a German artificial intelligence strategy

The government of Germany set up a strategy for artificial intelligence. The goal of this strategy is leadership in AI applications, business cases and talents. The approach is rooted in two pillars:

1. AI research: Compared to other countries, Germany is lagging in research expenditures and must drastically increase them. Research support needs to be open to different technological approaches within AI. It also needs to be more agile to better react to emerging trends and new opportunities in AI research. Better work conditions overall are required to compete for the best AI talent worldwide as well as clear benchmarks to measure progress in AI research.

2. Development of AI competencies across society: We do not only need to research. We also need broadly distributed AI competencies in society. Thus, AI should not only be taught in computer sciences, but core AI modules should also be integrated into engineering and natural science programs and be taught at schools of applied sciences.

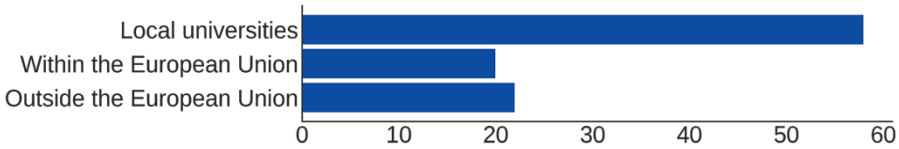

Figure 4 Universities attended by AI professionals in the EU (LinkedIn, 2019)

AI workers in Europe have, on average, a higher level of education than those in the U.S. The majority of AI workers in Europe (56%) hold either master's degree or a doctorate, compared to just over a third of AI workers in the U.S. (34%) having the same. The majority of AI workers in the U.S. (62%) hold a bachelor's degree. Although there is a wide variance among EU countries, only four have higher percentages of AI workers bachelors' degrees than the U.S.: Malta, Romania, Lithuania, and Ireland. The large variance is likely due to factors such as heterogeneity of education and training systems that result in different skill sets; differential opportunity costs of acquiring additional education; and the flexibility of labour markets and their ability to match workers with jobs. Cross-country variation may also originate from cultural expectations about the desired level of post-secondary education. In France, the master's level is standard practice for many post-secondary students, whereas, in Ireland, a bachelor's degree is seen as a sufficient level of education. Another possible factor could be the financial cost of formal education and the high demand for AI talent in the labour market. Considering the financial investment required in some countries to for masters or PhD degree, students may find it more worthwhile to enter the workforce and gain on-the-job training immediately, or to use free or part-time online training to advance their skill sets. Formal academic education is not the only way to acquire AI skills. It is now possible – and even desirable, given the rapid pace of technological change – to develop or continue to hone such skills after entering the labour market. Due to the wide variation between countries, it is unclear whether there is an optimal educational pathway to develop AI talent, and indeed this seems unlikely. Country-level analyses of the available education and training option would be needed to optimise the school-to-work transition for AI talent.

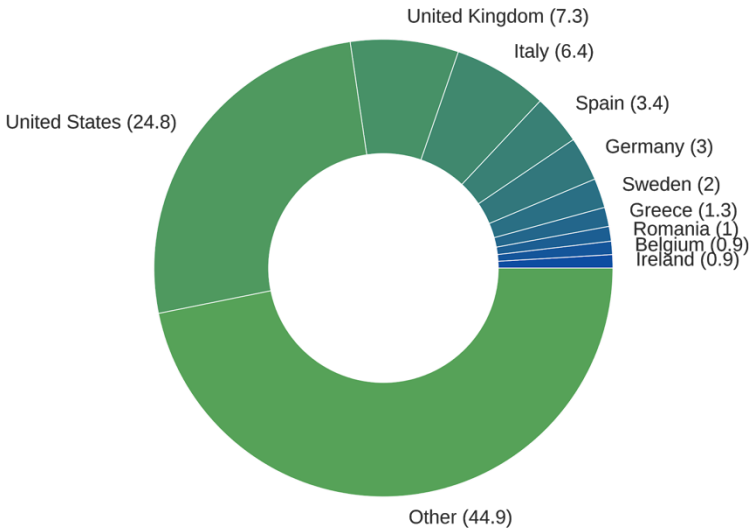

Figure 5 Origin of international students seeking AI education in the EU

The distribution of AI talent within and between countries is uneven. Most AI talent is found in Western Europe and urban areas. There is also a strong gender and age disparity.

The skills needed to develop or implement AI systems remain scarce and limited to a well-educated segment of the labour force.

The European Commission has touted the possibility of using digital learning and massive online courses (MOOCs) to supplement gaps in knowledge and help workers engage in lifelong learning. Country-specific strategy documents should assess these offerings and expand their availability as part of an AI talent development strategy. Lifelong learning and digital platforms such as Coursera and LinkedIn Learning can also offer flexible alternatives to formal education.

Policymakers and employers must also create pathways for non-near AI talent to eventually upskill to AI talent, for instance creating a learning pathway from business operations analyst into a data scientist, and then finally into an AI worker. This will widen the pipeline of future near-AI talent, avoid draining the pool of existing near-AI talent and create a path for talented individuals from underrepresented groups currently less likely to be at near-AI talent, but with the potential to get there.

3 Online Education in AI

While classical education held at universities remains a staple for skill acquisition, online AI education becomes more and more prevalent. The field of AI technology and education develops rapidly, so for classical education providers with traditional teaching approaches, it is hard to stay atop and keep up with online learning platforms. For example, to meet the needs of a wide range of artificial intelligence education professionals, edX offers a variety of courses in the AI education segment.

Nevertheless, postgrad and pragmatic courses in the field of AI education are provided by the world's leading universities, including MIT, Harvard, MIT Media Lab, Stanford and MIT. These courses fit best for professionals working with corporate data. Here, the goal is to add the applied and critical skills required, for example, in machine learning applications and systems. These post gradual classes are great for professionals who feel the need to develop AI-specific but applied knowledge and are excited about the potential of AI and its applications in businesses. The completion of respective online courses and the time spent depends on the specific class. Among most providers, online students will be rewarded with valuable and widely recognised certificates that will help to demonstrate their newly acquired knowledge to potential peers and their employers. If your goal is to understand and build AI, basically, then these courses will be beneficial and of great value. But if your goal is to understand AI deeply or even create and deploy AI systems, probably these are not appropriate.

Market overview of online education

The global market for online learning platforms can get classified and segmented by type of online education, learning type, technology and geography.

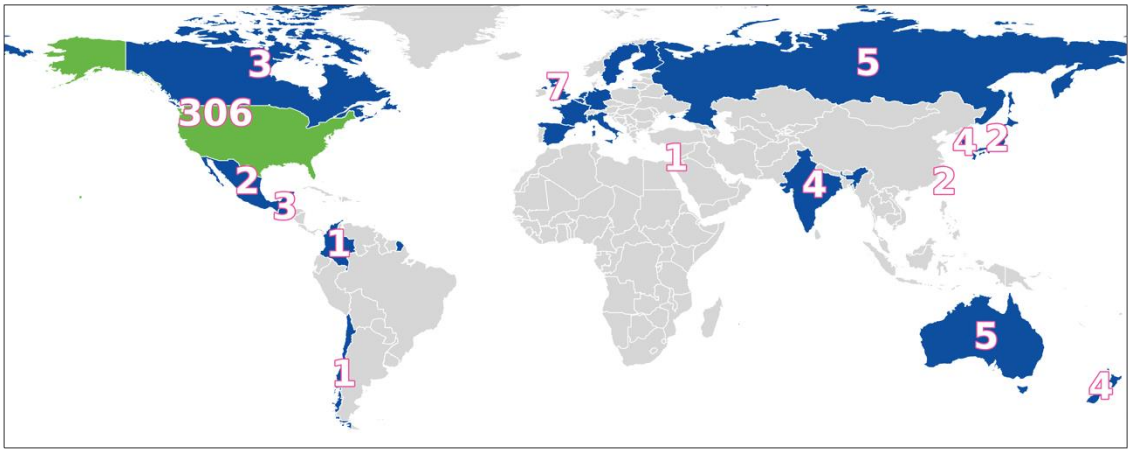

Figure 6 Distribution of MOOC courses by origin

Based on the learning type, the asynchronous learning segment dominates the global online education market. In contrast, synchronous learning types are expected to grow at the fastest CAGR rate of 31.01% over the forecast period.

Online learning offers students the freedom to learn from anywhere and anytime, as most online learning tools are consumable by portable devices. Online learning content can be provided through various channels, but the most effective being online learning platforms. There are more than 1,000 online education platforms that provide learning online content to millions of people. Those online courses are called “massive open online courses” (MOOCs) and are available to anyone with a computer and connection to the internet. MOOCs offer students a way to learn in an environment comparable to an online class but are usually more loosely structured and are offered for free.

For the report, the key market players of online education courses were identified. In the AI online education field, leaders are Coursera, edX, and Udacity. Besides dedicated learning platforms like the latter, universities started creating their own platforms recently on which they host their own produced educational content. Further, big tech organisations like Google and Microsoft offer their own learning platforms. Thereby, they follow a twofold goal: first, to promote tech education and make It available around the globe; second, to promote their products and facilitate the usage of their systems.

Figure 7 Distribution of European MOOC creators

AI-related data set for online courses

To get an overview of AI online course providers, data for 382 external courses from various platforms was collected. The data was obtained by filtering for AI relevant keywords and included data from a variety of sources, including Google, Wikipedia, and dedicated databases. The result does not include all available courses on specific AI topics but was intended to analyse what is communicated and considered as AI-related. The data aggregation was conducted with our own research and self-developed crawling tools. The following section refers to this data set from the data crawling. The dataset contains mostly courses from the US (306) and only 5% are from Europe.

The data suggests that a large proportion of AI online content is produced by private institutions (Figure 8). Institutions like Google Cloud, Coursera Project Network and IBM are providing various courses related to Ai technology. But apart from these private institutions, the most extensive content

producers are companies. Considering geography, the US is the largest producer of online courses; but the amount of data available for European courses is minimal. Most classes are run by universities in industry, except for a small number of universities in the UK, Germany and France.

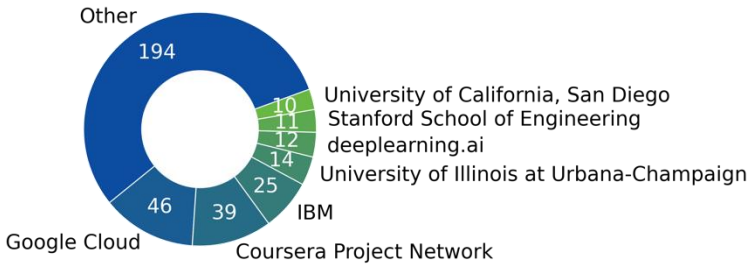

Figure 8 Top MOOC producing institutions

Coursera is the primary distributor of AI courses and the market leader in the distribution of AI online education with edX as its market successor. These platforms offer their educational content, originated either from companies or universities. Considering academic degrees, for instance, Udacity focuses on AI courses with more complex curricula, offering so-called Nanodegrees. Worth mentioning here, large companies promote besides general AI education also their technology in education as well (Figure 9). Here, the goal is to promote their own technology in course content as the medium.

Taking a look at different AI education distribution platforms, the data suggests, there is a subtle focus on profit-oriented institutions (Figure 9). Coursera, edX, Udacity and Google have besides providing education, the goal to facilitate their business model. Stanford, as a leading university in the top of the dataset, is a private university with an excellent reputation. Thereby it can rely on big budgets in comparison to public universities. Nevertheless, independent platforms for universities are becoming increasingly popular as universities look for ways to supplement their class lessons with virtual course offerings.

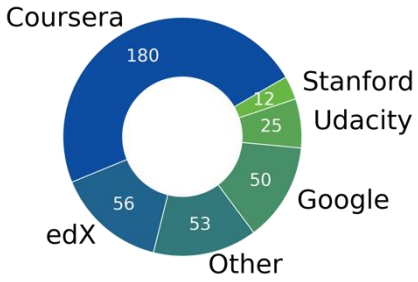

Figure 9 Top MOOC distributing platforms

Ratings of online courses

For the report and for further analysis, 30 courses were selected, which were highly rated by users as an indicator for representative best practices in AI education content. The remaining data set of online courses included not only courses by universities but also high-quality courses by educational platforms.

All courses in the data set, have good ratings, with some mediocre outliers in NLP and big data (Figure 10). NLP and big data have relatively low ratings, though they are long-established. Nevertheless, the low rating of those courses don't mean necessarily inferior course content, but a lack of interest in a more mature AI topic. Excellent ratings can be found in Deep Learning courses, which could reflect the high interest in the topic in combination with great educational content.
Moreover, the data suggests, courses like data mining, business-related courses, visualisation and machine learning display a great variance among their user ratings.

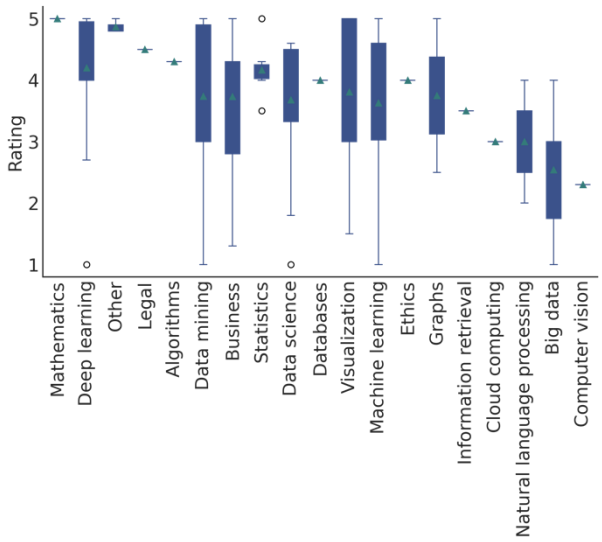

Figure 10 Average user ratings for MOOCs in different fields of study

Comparing EIT's AI with external course offerings

Regarding covering courses along the Machine Learning value chain, EIT covers the model making and project design well. But it has no infrastructure for data preparation and data collection. The external providers are vital in ML and DL, except for EIT, which is the only one to have received a good rating in NLP, deep learning and big data. Large differences in user ratings show a strong correlation between the quality of external courses and their user ratings, as well as the number of users.

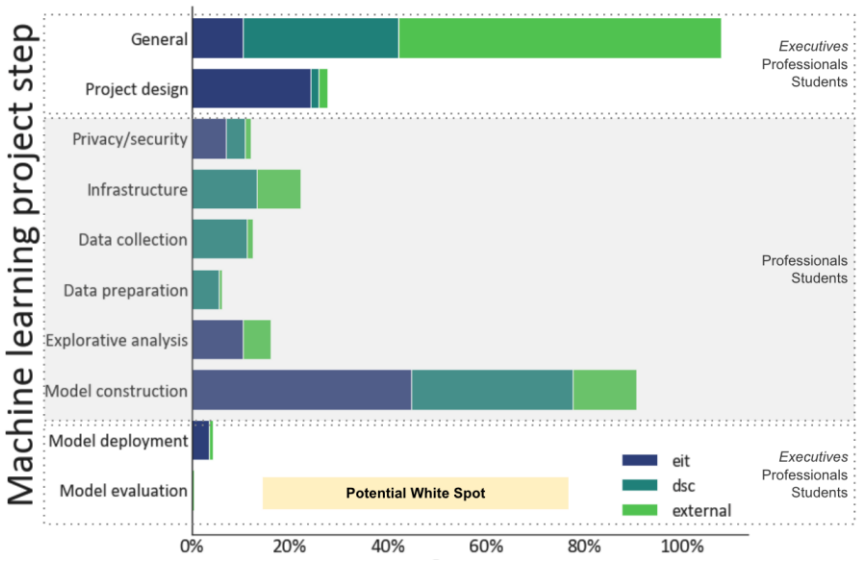

Figure 11 Gap analysis of AI education topics

Considering course length, EIT offers relatively short courses to complete, but there are some great introductory courses, in which Python and PyTorch are embedded as standard tools.

The most established courses come from universities, but classical universities are also pushing for an online investigation of the concept. Most institutions offer tracks ranging from very general to very specialised, and the ideas and explanations also make it easier for non-technicians to understand AI.

Data, ethics and social implications are part of many of these courses, but they are not the only topics of interest to students.

The gamification trend has only just begun in online education, and it looks like it will become more widespread in the next five years. In the coming days, we will improve the teaching because the focus is now on online learning. Digital technologies and online learning are becoming more advanced, leading to higher-quality online learning sessions, which ironically means that we can, ironically, spend more time face to face again. If the quality of online education in the planned study is to improve, universities must also consider educational issues in the field of online learning.

4 EIT internal offerings in AI education

The EIT KICs are offering a plethora of educational courses to a diverse audience whereas at least 29 of those courses either educate directly on AI or highly AI-related topics. These courses cover a broad scope of issues and are offered in different formats, including onsite education with renowned lecturers from both academic institutes and industry partners. Further EIT offers an accredited Digital Data Science Masters which includes various AI-related courses.

Structure of EIT internal courses

The set of AI-related courses clearly shows that the target group is well balanced in terms of its target group (Figure 12). To date, 50% of the AI-related courses address students, while the other 50% is evenly split between courses tailored to professionals with a technical background and executives and managers. The content of those courses varies accordingly. Student courses are characterised by more diverse scopes and often address a specific educational goal (e.g., the role of AI in healthcare by EIT Health). Courses for professionals mostly address a technical element (e.g., data science essential for the energy sector by EIT InnoEnergy). Classes for executives are geared towards enabling to conduct decisions regarding new AI concepts in a company (e.g., shaping the data-driven company by EIT Digital).

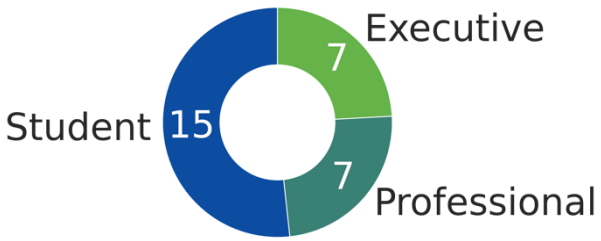

Figure 12 Distribution of the target students in EIT's AI-related courses address

EIT is also maintaining a balanced entry-level across all AI-related courses. Approximately 50% of the courses can be taken without or with only little prior background knowledge, while the other 50% of the studies address participants who aim at extending their practical background (Figure 13). This shows EIT's commitment to offering all individuals' suitable education programs. In general, this combination of beginner and advanced courses will help to strengthen the profiles of the emerging workforce in AI flexibly.

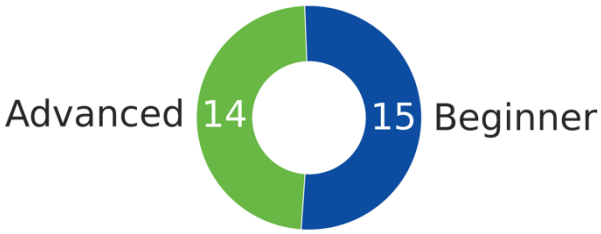

Figure 13 Distribution of background level required to participate in EIT's AI courses

However, the EIT offering lacks advanced courses. These are important for students who want to use EIT as a full-service provider for AI education. The current offering can likely be grouped in tracks with logical hierarchies for courses. This will simplify looking for gaps in the course offering.

Contents of EIT internal courses

Through all AI-related courses, EIT offers a broad and diverse range of educational topics (Figure 14). These topics range from general data science subjects (e.g., analytics and visualisation), over more technical elements (e.g., automation and infrastructure), to business concepts (e.g., decision making and change management). Generally, the distribution over these topics reflects the educational demands well, as most participants will require a general introduction to AI (both technical and non-technical) and only a selected minority will require additional training in specialised subjects. There is also a notable correlation between the introductory beginner level of courses to general topics and more advanced courses to specialised topics. The specialised issues tend to be technical, requiring basic knowledge in computer science or mathematics.

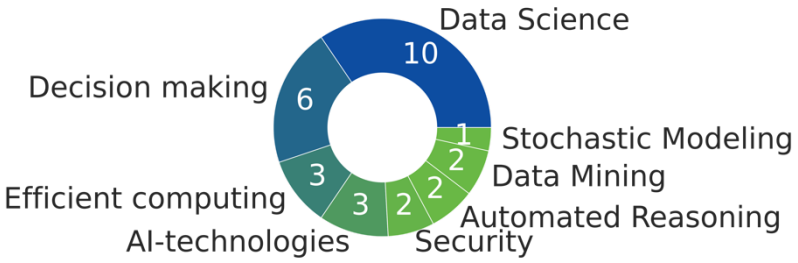

Figure 14 Distribution of topics offered through EIT's AI courses

EIT is well-positioned to offer AI courses that are industry-specific. Through the various KICs, several AI courses have branched out that address not only different levels of users across general professional stages (i.e., student, professional, or executive). Also, we must address particular topics that are particularly relevant for one industry but not for another. For demonstration purses, three courses across the three largest EIT KICs (in alphabetical order) can be mentioned:

1. **Digital**: Business Implications of Artificial Intelligence
2. **Health**: Artificial Intelligence for Reinventing European Healthcare
3. **InnoEnergy**: Artificial intelligence in energy

These courses train the target audience with practical examples that originate from their respective sectors. For example, Digital's study on Business Implications of AI aims at conveying the business opportunities provided by AI and to enable participants to perform better decisions throughout the digital transformation. Similar to EIT Health's course on AI for Reinventing European Healthcare is a Summer School addressing the complex challenges of recreating the European healthcare sector with AI. Along those EIT Energy's course on AI for Energy Professionals educates about how AI, Big Data, and advanced analytics will reshape (and potentially disrupt) the energy sector to a data-driven economy.

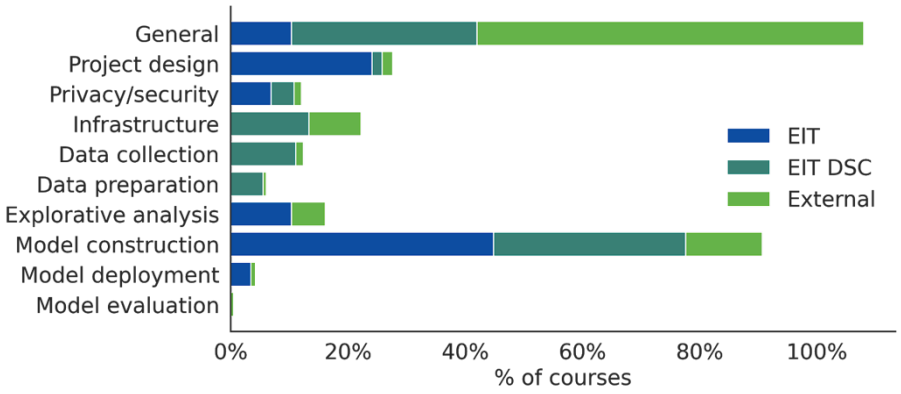

Figure 15 Distribution of courses by topic area

EIT Digital Data Science Masters (DSC) program

A unique educational highlight in the EIT ecosystem is the Data Science Master's (DSC) by EIT Digital Master School. DSC is a two-year full-time Master program for EU and non-EU citizens who acquire in-depth technical skills in scalable data collection techniques and data analysis methods. As with all European accredited courses, students will earn 120 ECTS to complete the course. The exciting part about this program is that students can choose two out of twelve European universities across eight countries. These universities are in Europe's technology hot spots, such as Eindhoven, Stockholm, or Berlin. The two universities that a student selects will be an entry and exit university, and every student will receive two joint degrees from both universities upon successful completion of the program.

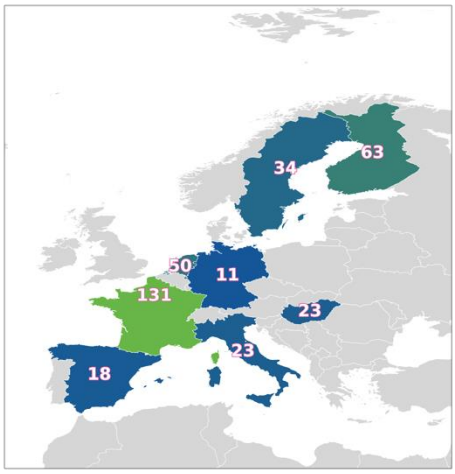

Figure 16 Origin of EIT DSC lectures

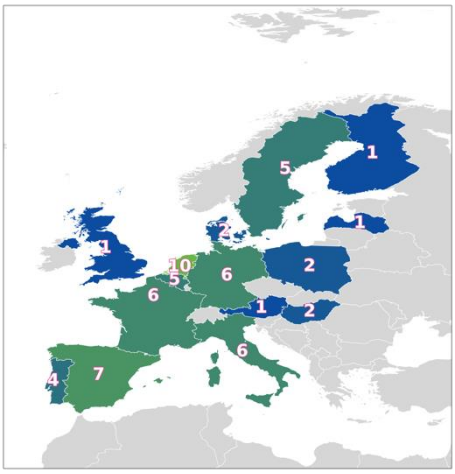

Figure 17 Origin of EIT internal courses

For quantitative analysis, 353 courses from 12 universities were scraped from their respective websites and labelled with topics and process steps within the AI project value chain. By far most courses are provided by universities located in France, followed by Finland and the Netherlands. The most extensive offering is provided by the University of Côte d'Azur and Aalto University.

The offered courses are rich in their scope (Figure 18). Aside from compulsory entrepreneurial education, students can choose from different paths to realise their own personal, educational goals. The topics allow specialisation within the realms of AI, like NLP and Computer Vision, but also on fundamentals like Big Data, Cloud Computing, or graph technologies. While some universities cover a wide variety of topics, others are more focused on their offerings. There is, however, little coverage on subjects becoming increasingly more necessary for the realisation of AI projects within the EU; for example, topics about ethics, privacy, legal, governance, and security.

There is also substantial diversity provided concerning the level of depth covered by the courses, ranging from introductory to advanced. This holds especially true for Machine Learning. Data Science gets dominantly taught in higher semesters after the foundation has been laid (Figure 19):

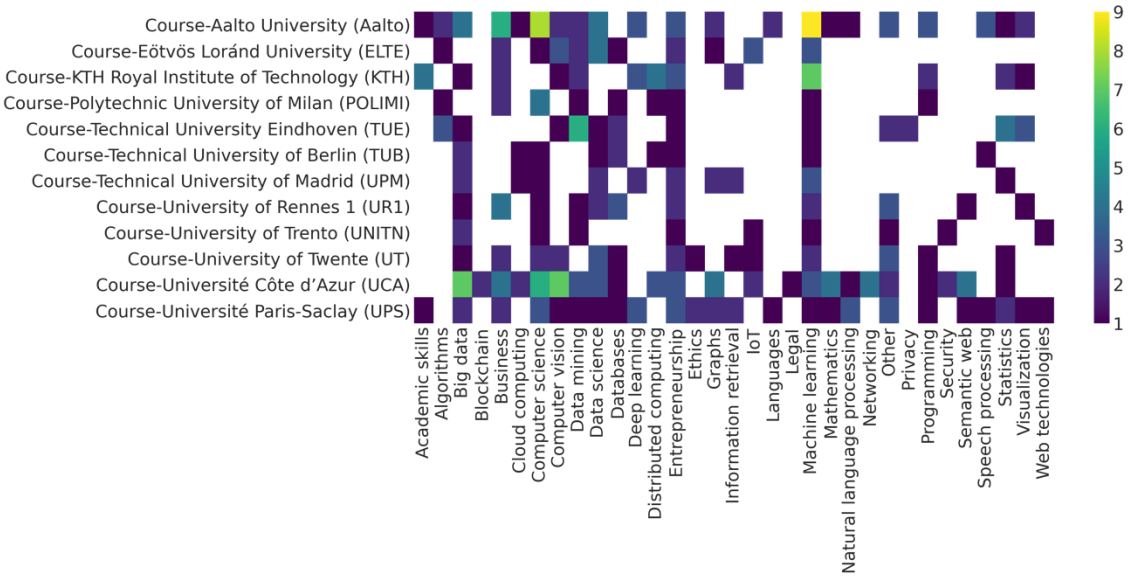

Figure 18 Universities and topics contributing to the EIT DSC

The course stands out among its peers through:

- An accredited master program.
- Very international: at least 12 participating European universities (internal note: perhaps we should verify).
- 353 lectures
- Very diverse scope: at least 33 topics in different areas covered, ranging from data science and deep learning to IoT and entrepreneurship.
- Students can specialise on demand
- Thus, the EIT Digital DSC can serve as a blueprint for other EIT charters to create a master's programs.

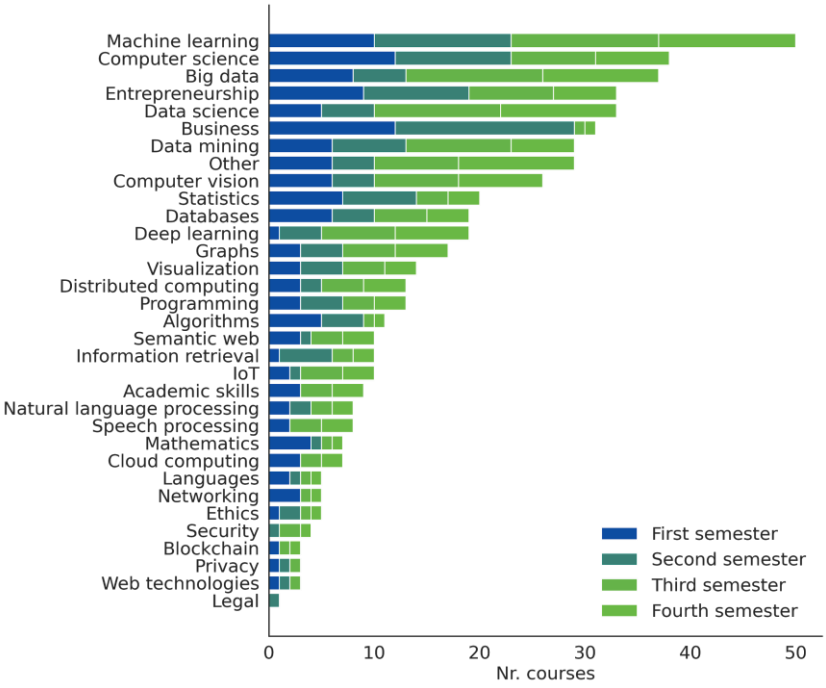

Figure 19 Course offering by semester and subject within the DSC master

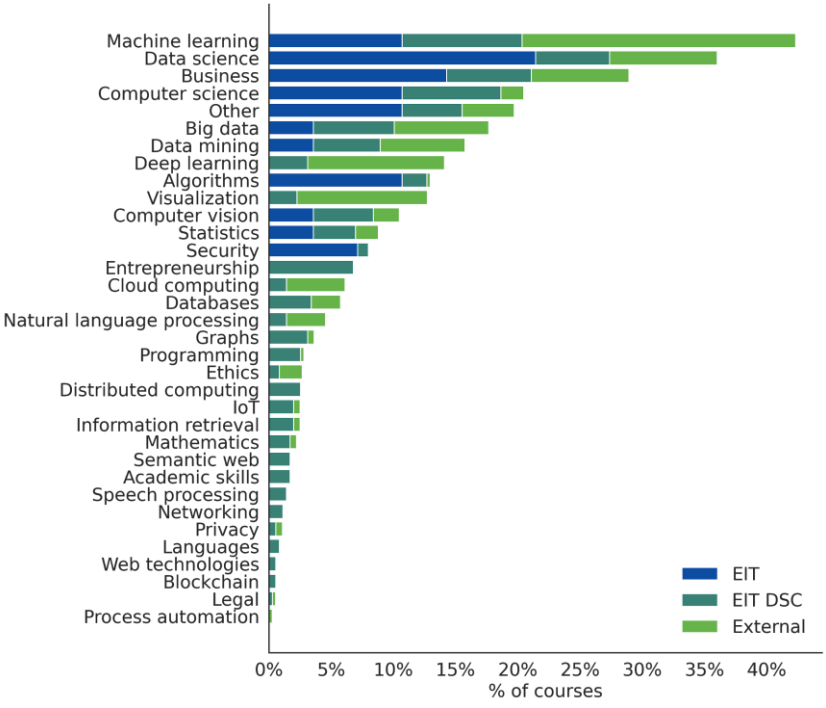

Figure 20 Coverage of subjects within EIT's courses, the DSC master, as well as general online education

Comparison

After providing several overviews on EIT's current educational offerings, a comparison with general online education concerning the focus on content as well as coverage of process steps within AI projects can be made (Figure 20). It is important to mention that there is a bias towards Machine Learning in the selection of external courses, so we are looking at the assumption of which topics should be covered in AI education.

On the one side, EIT's courses via the KICs resemble the distribution of AI education when it comes to core topics of AI, with a slight trend towards Data Science. They also cover fundamentals like statistics and algorithms very well. However, when it comes to specialisation or in-depth topics, there is room to increase the coverage. It is also recommended to create educational offerings for ethics in AI, privacy, or research data management, as these are in-demand skills. Considering the scarcity of these courses overall, this could be a white spot and opportunity for EIT to make use of its European context, trust, and expertise. On the other side, the EIT DSC master, a curriculum assembled by AI education experts from top European universities, can be used as a blueprint for academic education, it might, however, be necessary to adapt it to different target groups, like professionals, experts, or career changers, to be able to close the skill gap through upskilling quickly.

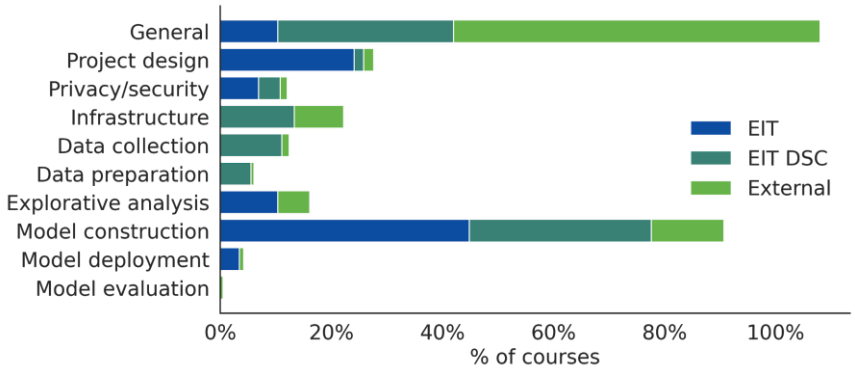

Figure 21 Topic coverage by offering

Many AI projects fail due to insufficient data governance. And it is not only data quality but also privacy and security concerns. This results in high demand for emerging roles like data governors, research data managers, and GDPR experts. It will be required to upskill existing employees for this role in established companies as well as start-ups in the near future. Providing accredited education could be well received by EITs partners and start-ups. Currently, EIT does not offer sufficient courses in the relevant fields of data collection, data infrastructure, data preparation, and model evaluation (Figure 21). As these roles are not perceived as attractive as building models or explorative analysis, these deficiencies are also reflected in online education in general. EIT should evaluate the possibilities to create online courses in collaboration with the universities that already provide relevant content for the DSC master program.

Conclusion and outlook

EIT, as a central organisation in the EU that successfully integrates stakeholders in both academia and industry, is in a unique position to play a major role in shaping the future of AI education in Europe. By expanding on the already existing and rich portfolio of courses in the EIT ecosystem, EIT will be able to offer educational content of high quality to contribute to catching up at the global race on AI talent. It Is important to align future content on the current and future trends in AI that were identified in this report, such as AI governance and the substantial gender gap. With a compelling mix of online and onsite courses offered via the international network of EIT, unprecedented offerings can be made to the growing user base of AI novices that will have a positive and lasting effect on AI in Europe.

References

2021.ai. (2020, July 7). *2021.ai*. Retrieved from AI Governance - What are the KPIs? And who is accountable?: https://2021.ai/ai-governance-kpi/

AllWomen. (2020, November 22). *AllWomen.com*. Retrieved from 'Women in Data' Post COVID-19 Scholarships: https://www.allwomen.tech/academy/scholarships/women-in-data-post-covid-19-scholarship/

Blue Pencil. (2020, April 9). *blue-pencil.ca*. Retrieved from What Is Data Management And Why It Is Vital?: https://www.blue-pencil.ca/what-is-data-management-and-why-it-is-important/

Capgemini. (2018). *The Digital Talent Gap.* San Francisco: https://www.capgemini.com/de-de/wp-content/uploads/sites/5/2018/09/dti_the-digital-talent-gap_20171025_final.pdf.

Carlos J. Costa, M. A. (2014). Do we need a shared European MOOC platform? *HOME - Higher education Online.* Porto.

CB Insights. (2020). *Artificial Intelligence Trends to Watch in 2020.* New York: https://drive.google.com/file/d/1HfUJOgnFnLAoGTE-brr1z3E6ckh8vL9X/view.

CEDEFOP. (2020, December 1). *europa.eu*. Retrieved from Skills Forecast: https://www.cedefop.europa.eu/en/publications-and-resources/data-visualisations/skills-forecast

CRA Taulbee. (2020). *2019 Taulbee Survey.* Pittsburgh: https://cra.org/wp-content/uploads/2020/05/2019-Taulbee-Survey.pdf.

Ed Michaels, H. H.-J. (2001). *The War for Talent.* Boston: Harvard Business School Publishing.

EIT Digital. (2010, December 1). *eitdigital.eu*. Retrieved from EIT Digital Master School: https://masterschool.eitdigital.eu/programmes/dsc/

Ernst & Young. (2020). *AI's trust gaps.* London: https://drive.google.com/file/d/1aOcZendAuarXaOxqrtPK6Vgcst_iEtxG/view.

Eur-lex.europa.eu. (2018, April 25). *European Commission*. Retrieved from European Commission: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM%3A2018%3A237%3AFIN

European Commission. (2018). *EC Artificial Intelligence.* Brussels: https://publications.jrc.ec.europa.eu/repository/bitstream/JRC113826/ai-flagship-report-online.pdf.

European Commission. (2018). *The European AI Landscape.* Brussels: https://ec.europa.eu/jrc/communities/sites/jrccties/files/reportontheeuropeanailandscapeworkshop.pdf.

European Commission. (2019). *Background note on the skills objective.* Brussels: https://drive.google.com/file/d/191AgjYIWWNxFH63AsTRookzgZa4aDGe9/view.

European Commission. (2019, November 19). *europa.eu*. Retrieved from Shaping Europe's Digital Future - Policy Artificial Intelligence: https://ec.europa.eu/digital-single-market/en/artificial-intelligence

European Commission. (2020). *Academic Offer of Advanced Digital Skills in 2019.* Sevilla: https://publications.jrc.ec.europa.eu/repository/bitstream/JRC121680/jrc121680_jrc121680_academic_offer_of_advanced_digital_skills.pdf.

European Commission. (2020, December 1). *europa.eu*. Retrieved from Member states and commission work together boost AI: http://ec.europa.eu/digital-single-market/en/news/member-states-and-commission-work-together-boost-artificial-intelligence-made-europe

European Digital SME Alliance. (2020, November 1). *digitalsme.eu*. Retrieved from A new Focus Group on AI for Europe: https://www.digitalsme.eu/european-focus-group-on-artificial-intelligence/

European Parliament. (2020). *Opportunities for Artificial Intelligence.* Brussels: https://www.europarl.europa.eu/RegData/etudes/STUD/2020/652713/IPOL_STU(2020)652713_EN.pdf. Retrieved from Opportunities of Artificial Intelligence.

European Parliament. (2020). *Opportunities of Artificial Intelligence.* Brussels: https://www.europarl.europa.eu/RegData/etudes/STUD/2020/652713/IPOL_STU(2020)652713_EN.pdf. Retrieved from Opportunities of Artificial Intelligence.

Forbes. (2018, November 27). *Forbes.com*. Retrieved from Is Ireland really a startup nation?: https://www.forbes.com/sites/shourjyasanyal/2018/11/27/is-ireland-really-a-startup-nation/?sh=6b22dfc84556

GoIreland. (2019, November 19). *GoIreland.com*. Retrieved from Companies in Ireland: https://www.goireland.in/companies-in-ireland

H. James Wilson, P. R.-B. (2017). *The Jobs That Artificial Intelligence Will Create.* Boston: https://www.maximo.ae/media/1306/the-jobs-that-artificial-intelligence-will-create-2-1.pdf.

IT Chronicles. (2019, October 11). *ITChronicles.com*. Retrieved from The AI Skills Shortage: https://itchronicles.com/artificial-intelligence/the-ai-skills-shortage/

IT Chronicles. (2020, December 15). *ITChronicles.com*. Retrieved from The AI Skills Shortage: https://itchronicles.com/artificial-intelligence/the-ai-skills-shortage/

Kalokairinou, L. (2018, June 19). *KOWI.de*. Retrieved from Data protection in EU projects: https://www.kowi.de/Portaldata/2/Resources/vortraege/buta31/2018-06-19-Data-Protection-in-EU-Projects.pdf

KPMG. (2019). *AI trends transforming the enterprise.* Houston: https://drive.google.com/file/d/1u2zTpCLeGx_1VVQyell7kd40aR71rcNW/view.

LinkedIn. (2019). *AI Talent in the European Labour Market.* London: https://business.linkedin.com/content/dam/me/economicgraph/en-us/PDF/AI-TAlent-in-the-European-Labour-Market.pdf.

LinkedIn. (2019, November 19). *linkedin.com*. Retrieved from Economic Graph: https://economicgraph.linkedin.com/content/dam/me/economicgraph/en-us/PDF/AI-TAlent-in-the-European-Labour-Market.pdf

LinkedIn. (2020). *Emerging Jobs Report.* San Francisco: https://business.linkedin.com/content/dam/me/business/en-us/talent-solutions/emerging-jobs-report/Emerging_Jobs_Report_U.S._FINAL.pdf.

Madiega, T. (2019). *EU guidelines on ethics in artificial intelligence: Context and implementation.* Brussels: https://www.europarl.europa.eu/RegData/etudes/BRIE/2019/640163/EPRS_BRI(2019)640163_EN.pdf.

Markets & Markets. (2019, September 1). *MarketsandMarkets.com*. Retrieved from AI Governance Market: https://www.marketsandmarkets.com/Market-Reports/ai-governance-market-176187291.html

Marr, B. (2020, September 28). *Frobes.com*. Retrieved from 9 Soft Skills Every Employee Will Need In The Age Of Artificial Intelligence (AI): https://www.forbes.com/sites/bernardmarr/2020/09/28/9-soft-skills-every-employee-will-need-in-the-age-of-artificial-intelligence-ai/?sh=20a3acbd54b8

McKinsey & Company. (2017). *VivaTech Survey 2017.* Berlin.

McKinsey & Company. (2019). *Notes from the AI Frontier.* Brussels: https://drive.google.com/file/d/15LuRHIeYPKyHxRdIKrO56GOxCE3B0t8C/view.

McKinsey & Company. (2020, November 1). *McKinsey.com*. Retrieved from 10 Imperatives for Europe in the age of AI and automation: https://www.mckinsey.com/featured-insights/europe/ten-imperatives-for-europe-in-the-age-of-ai-and-automation

McKinsey & Company. (2020). *The future is now: Closing the skills gap in Europe's public sector.* London: https://www.mckinsey.com/~/media/McKinsey/Industries/Public%20and%20Social%20Sector/Our%20Insights/The%20future%20is%20now%20Closing%20the%20skills%20gap%20in%20Europes%20public%20sector/The-future-is-now-Closing-the-skills-gap-in-Europes-public-sector-vF.

MIT Media Lab. (2020, April 7). *media.MIT.edu*. Retrieved from Learning about artificial intelligence: A hub of MIT resources for K-12 students: https://www.media.mit.edu/articles/learning-about-artificial-intelligence-a-hub-of-mit-resources-for-k-12-students/

Pieter Gijsbers, E. L. (2019). *An Open Source AutoML Benchmark.* AutoML Workshop at ICML 2019.

PricewaterhouseCoopers. (2018). *Forth Industrial Revolution for the Earth.* London: https://drive.google.com/file/d/1ALEtumqawyn-DJhrlKwek53_iWh0EJkR/view.

PricewaterhouseCoopers. (2018). *Fourth Industrial Revolution for the Earth.* London: https://drive.google.com/file/d/1ALEtumqawyn-DJhrlKwek53_iWh0EJkR/view.

Re-Work. (2020). *What is AI Assurance?* https://drive.google.com/file/d/12vhu0A5bux96QtaBkCPRM_wpmY_78_so/view.

Schaible, M. (2019, December 10). *reaktor.com*. Retrieved from Democratizing AI – Finland offers free AI education to every EU citizen: https://www.reaktor.com/blog/democratizing-ai-finland-offers-free-ai-education-to-every-eu-citizen/

Shao, C. (2018, July 18). *Medium.com*. Retrieved from A Data Scientist's Guide to Communicating Results: https://medium.com/comet-ml/a-data-scientists-guide-to-communicating-results-c79a5ef3e9f1

Stanford Human-Centered Artificial Intelligence. (2019). *Artificial Intellifence Index Report 2019.* Stanford: https://drive.google.com/file/d/1uqS4FD6s4EBzZQGV6psZ_WNtYlEzDCca/view.

Stanford Human-Centered Artificial Intelligence. (2019). *Artificial Intelligence Index Report 2019.* Stanford: https://drive.google.com/file/d/1uqS4FD6s4EBzZQGV6psZ_WNtYlEzDCca/view.

Stix, C. (2019). *A survey of the European Union's artificial intelligence ecosystem.* Cambridge: http://lcfi.ac.uk/media/uploads/files/Stix_Europe_AI_Final.pdf.

Sureka, A. (2020, November 1). *Clariontech.com*. Retrieved from Practical Benefits of AI for SMEs You Need to Know: https://www.clariontech.com/platform-blog/7-practical-benefits-of-ai-for-smes-you-need-to-know

Talentseer. (2020, November 12). *TalentSeer.com*. Retrieved from 2020 AI Talent Report: https://www.talentseer.com/2020-ai-talent-report

Taulli, T. (2020, October 10). *Frobes.com*. Retrieved from AI (Artificial Intelligence) Governance: How To Get It Right: https://www.forbes.com/sites/tomtaulli/2020/10/10/ai-artificial-intelligence-governance-how-to-get-it-right/?sh=3b5614b0745f

Tooploox. (2019). *AI Trend Report.* Warsaw: https://drive.google.com/file/d/1enLWM5L7DuaODVnaykNXGw2RDruIeF6t/view?usp=sharing.

Waters, R. C. (1986). *Where's The AI?* Boston: American Association for Artificial Intelligence.

Waters, R. C. (1986). *Where's The AI?* Boston: American Association for Artificial Intellgence.

World Economic Forum. (2018). *Future of Jobs Survey 2018.* Geneva: http://www3.weforum.org/docs/WEF_Future_of_Jobs_2018.pdf.

World Economic Forum. (2018, January 1). *WEForum.com*. Retrieved from Global Gender Gap Report 2018. Assessing Gender Gaps in Artificial Intelligence: https://reports.weforum.org/global-gender-gap-report-2018/assessing-gender-gaps-in-artificial-intelligence/#view/fn-23

World Economic Forum. (2018, September 16). *WEForum.org*. Retrieved from Global Gender Gap Report 2018: https://reports.weforum.org/global-gender-gap-report-2018/assessing-gender-gaps-in-artificial-intelligence/#view/fn-23

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