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Potential for Increased Use of Artificial Intellegence in Danish Research and Innovation

Artificial intelligence (AI) will enhance the quality and relevance of Danish research and innovation (R&I) and create prosperity and welfare if utilized appropriately and critically. However, there is potential to increase the use of AI by Danish companies and university researchers for R&I. In light of global competition, it is crucial that Denmark invests in its own AI strengths and supports the Danish research and innovation system to seize opportunities while avoiding ethical and security pitfalls.

It is estimated that by 2030, Denmark can increase the annual GDP growth by 1.6 percentage points and achieve several welfare improvements through the use of existing AI solutions for automation and efficiency across sectors.[1] AI is particularly well-suited for collecting, categorizing, analyzing, and interpreting large volumes of data and is expected to especially accelerate R&I, thereby increasing the prosperity and welfare returns from R&I.[2] In the winter of 2024, the Danish Council for Research and Innovation Policy (DFiR) hosted a series of debates on the potentials, risks, and barriers associated with the development and use of Danish AI. This was done in collaboration with the Ministry of Digitalization, the Pioneer Center for AI, and the Knowledge Center for Foundations.[3]

Potential for Better Utilization of AI in Danish R&I

Denmark has been among the top five countries in international rankings for digitalization for several years,[4] but is now outside the top 10 in rankings for investments in AI talent, Deep Data quality and availability, digital networks and computing capacity, AI research, as well as the state's commitment and engagement in these areas.[5] Finland holds the leading position in the Nordic region and is internationally in the top five.

It's not because Denmark has been idle. Since 2012, Denmark has invested over 1 billion DKK in foundational and health data programs, a data guide, and a language technology platform to improve Danish public data and language resources, providing access for companies and public institutions. During the same period, the Danish e-infrastructure Consortium has invested over 1 billion DKK in high-speed networks and computer systems for Danish researchers, including 3% of the capacity in LUMI in Finland, one of the three supercomputers in the EuroHPC project.

Denmark has also invested in AI research, development, and application. Since 2020, more than 500 million DKK has been allocated to AI research, enabling the establishment of the Pioneer Center for AI, co-financed with private foundation funds. In the same period, more than 500 million DKK has been invested in advising and financing the development and dissemination of AI in the private and public sectors through Innovation Fund Denmark, AI Denmark, public signature projects, and grant pools. Denmark also participates in major European programs such as CitCom.ai and AI-Matters.

With the digitalization agreement, 230 million DKK is allocated to improve data quality and availability, in addition to 100 million DKK to strengthen Denmark's engagement in the EU and internationally. With the 700 million DKK agreement between the Novo Nordisk Foundation, EIFO, and NVIDIA, one of the world's fastest computers will be established in Denmark by 2025. This will bring Denmark closer to the international AI elite.

AI is being utilized, but there is potential for better exploitation of AI in Danish R&I. In 2023, a larger proportion of companies in Denmark used AI (15%) than in any other EU country. The proportion of companies using Cloud (70%) and Big Data (27%) was also higher in Denmark than in most other countries.[6] DFiR estimates, based on data from Statistics Denmark, that approximately 25% of research and development-active companies use AI for research and development.[7] Similarly, AI appears to be used hesitantly in academic research and primarily for editing language and content in, for example, research proposals, rather than for design, methodology, theory, data collection, and analysis.[8]

During DFiR's series of debates, several barriers to the development and dissemination of AI in R&I were highlighted, including uncertainty and lack of guidance on guidelines for ethical AI and data security, which is otherwise one of Denmark's strengths, and the shortage of profiles with IT skills who can develop and support the use of AI, as well as ensure the quality and security of Deep Data.

Ethically Responsible AI and Data Security

Common ethical principles and guidelines for AI have been developed for Danish public authorities and private companies as part of Denmark's AI strategy from 2019

and under the auspices of the Data Ethics Council. Additionally, 6.6 million DKK has been allocated for capacity building, as well as networking and dissemination activities on cyber and information security, and the Data Ethics Council was strengthened with 22.5 million DKK in 2022. Nevertheless, companies that use AI tools express uncertainty about guidelines for data usage (24%) and data security (26%)[9] while several university researchers call for clearer AI guidelines.[10]

The uncertainty about data ethics, data security, and EU regulations has been addressed with the new digitalization agreement. The business-oriented data ethics effort is continued with 6.9 million DKK, and practical guidance for companies and authorities on the rules stemming from the EU's AI regulation and GDPR is established with 17 million DKK. These initiatives should be closely monitored to ensure there are sufficient legal competencies available to provide guidance on EU regulations and guidelines, as highlighted during DFiR's series of debates. Additionally, a new code of integrity in research should address these issues. Leaders at institutions and companies must also take responsibility for formulating and communicating principles for AI.

During DFiR's series of debates, it was highlighted that Denmark's strong tradition for inclusion and equality could become a unique competitive advantage in the development of ethically responsible and human-centered AI, which is expected to be in demand internationally. Denmark could strengthen Nordic cooperation to support the Nordic position in ethical and responsible AI, for example, through joint Nordic Horizon Europe applications. This could also enhance the common language resource as a foundation for generative AI and attract investments and talents from abroad, which also represent significant barriers to the development and dissemination of Danish AI.

IT Skills Enhancement and International Recruitment

In 2022, one in four companies in Denmark attempted to recruit IT specialists, more than in any other EU country. However, 61% had difficulty finding qualified candidates. Companies that use AI tools report that the lack of IT skills (49%) and practical knowledge of AI (29%) are significant barriers. University researchers also express a need for practical AI knowledge.[13] The proportion of IT specialists among the employed is lower in Denmark compared to countries like the Netherlands, Sweden, and Finland,[14] where IT specialists either constituted a larger share of graduates[15] or more than twice as many AI specialists are recruited from abroad. [16] Meanwhile, a little over 300 qualified applicants were rejected from IT bachelor's or diploma engineering programs during the 2023 admissions, while around 600 IT study places in other similar programs remained unfilled.[17] This indicates a discrepancy between educational supply and demand.

The shortage of AI skills in the workforce and among educators has been addressed to some extent. In 2019, 45 million DKK was allocated for multi-year competency development programs for educators in higher education. The new digitalization agreement allocates 35 million DKK for IT skill development of educators and educational development, and 30 million DKK for continuing education and retention of international IT students in the Danish labor market through professional master's programs. More can be done to ensure a greater number of AI specialists and broad IT skills in companies and research environments. According to Dansk Industri, an annual grant of 15 million DKK could secure 250-300 IT study places at Danish universities.[18] However, it is also important that the guidance provided to prospective students is strengthened and adapted so that IT programs in demand by businesses and research environments do not have vacant study places. Similarly, the allocation of funds for continuing education and further training activities should focus on collaboration between higher education institutions offering IT skill enhancement programs and private and public employers, ensuring that existing offerings are fully utilized.

Additionally, Denmark can take inspiration from Finland in the international recruitment of AI specialists and researchers. While Denmark is marketed as a digital pioneer through advisory and networking initiatives such as Digital Hub Denmark and Invest in Denmark, Finland has sought to ease the recruitment of IT and AI specialists by offering assistance with administrative permits and similar processes, temporary free housing, job search support in tech hubs, assistance with job searches for accompanying partners, and offers of school and daycare placements.[19]

Further Information:

Frede Blaabjerg,
Chairmain for DFiR
Phone: 21292454
E-mail: fbl@et.aau.dk

Steffen Bohni,
Leader of DFiR's AI Debate Series
Phone: 61155366
Mail: sbn@nfa.dk

Notes

[1] McKinsey & Company og Innovationsfonden. 2019. *An AI Nation? Harnessing the opportunity of artificial intelligence in Denmark.*

[2] OECD. 2023. *Artificial Intelligence in Science: Challenges, Opportunities and the Future of Research.*

[3] DFiRbrief 41. 2023. *Kunstig intelligens i forskning og innovation.*

[4] EU's Digital Economy and Society Index Score, FN's E-government survey og IMD's World Digital Competitiveness Ranking.

[5] Danmark var i 2023 nr. 11 på Oxford Insights Government AI Readiness Index og

på Tortoises Global AI Index, når der tages højde for befolkningens og økonomiens størrelse.

[6,11,14,15] Eurostat. 2024

[7] Danmarks Statistik. 2023. *It-anvendelse i virksomheder 2023*, og Danmarks Statistik særkørsel over antal FoU-aktive virksomheder i 2022. Opgørelserne er ikke fuldt sammenlignelige og der er derfor tale om et skøn.

[8,10,13] Survey of Danish University Researchers Conducted by the Danish Centre for Research Analysis in February 2024 and Presented at the Last of DFiR's AI Debate Meetings.

[9,12] Danske Erhverv. 2023. *Mangel på kompetencer og viden hindrer virksomheders brug af kunstig intelligens*.

[16] OECD.AI. Policy Observatory. 2024

[17] Den Koordinerede Tilmelding. 2023

[18,19] Dansk Industri. 2023. *AI for alle*.