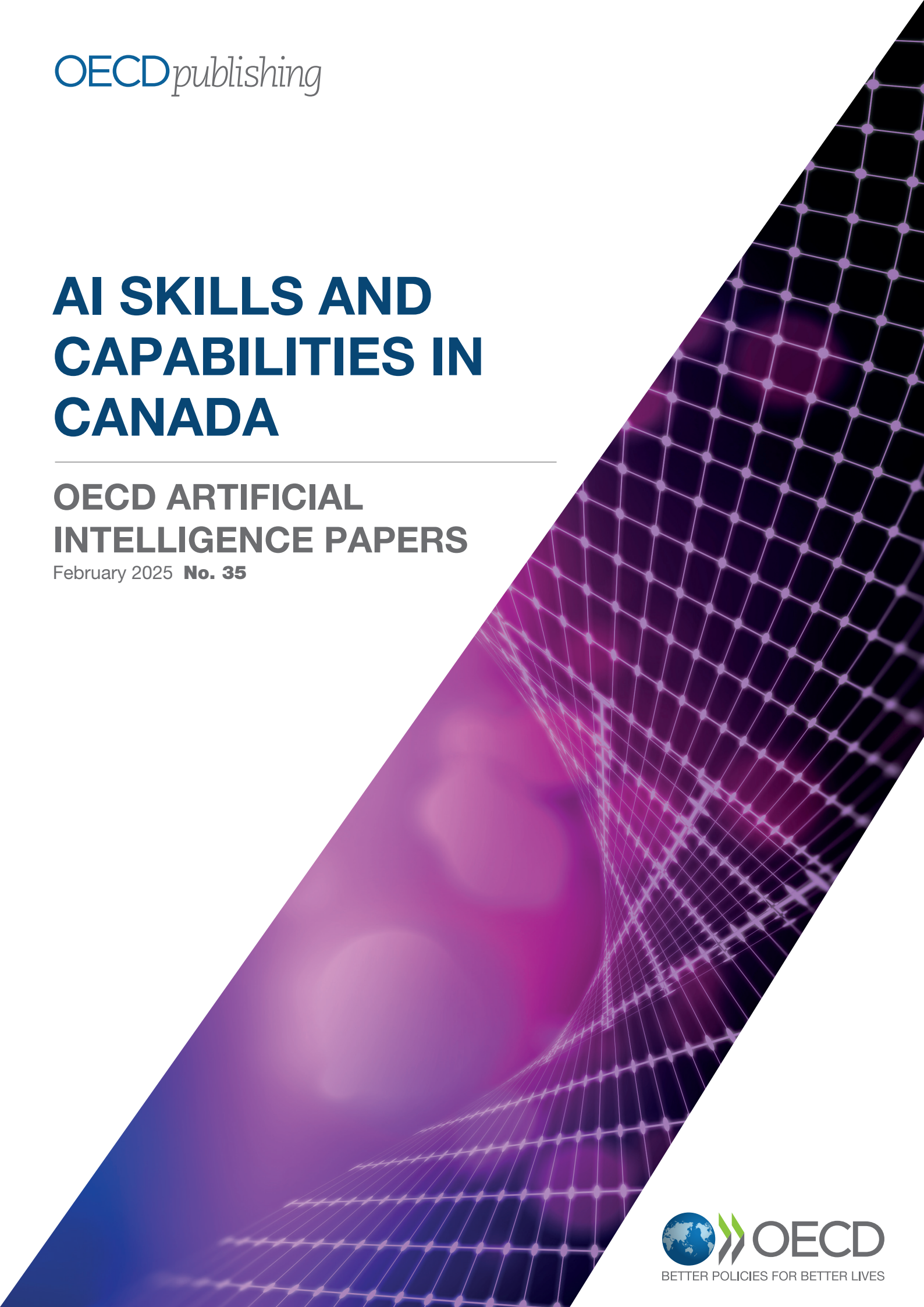
OECD publishing

AI SKILLS AND CAPABILITIES IN CANADA

OECD ARTIFICIAL INTELLIGENCE PAPERS

February 2025 **No. 35**



OECD
BETTER POLICIES FOR BETTER LIVES

OECD Artificial Intelligence Papers

AI skills and capabilities in Canada

OECD Working Papers should not be reported as representing the official views of the OECD or of its member countries. The opinions expressed and arguments employed are those of the authors.

Working Papers describe preliminary results or research in progress by the author(s) and are published to stimulate discussion on a broad range of issues on which the OECD works. Comments on Working Papers are welcomed and may be sent to els.contact@oecd.org.

This document and any map included herein are without prejudice to the status of or sovereignty over any territory, to the delimitation of international frontiers and boundaries and to the name of any territory, city or area.

Cover image: © Kjpargeter/Shutterstock.com.

AI skills and capabilities in Canada

Diego Eslava, Fabio Manca and Caroline Paunov

This paper analyses the demand for talent proficient in developing or working with Artificial Intelligence (AI) systems in Canada, utilising over 12 million online job postings (OJPs) from 2018 to 2023. The study reveals a steady increase in demand, which peaked in 2021 but has slowed in 2022 and 2023. Despite this, the demand for AI skills in specialised fields such as machine learning (ML), Natural Language Processing (NLP) and Neural Networks has expanded significantly. AI-related skills demand is concentrated in specific occupations, with data scientists, cloud engineers, and AI research roles leading the way and emphasising the focus on research and development in AI technologies. The paper concludes by stressing the importance of flexible academic pathways and strategies to encourage broader AI adoption and deployment in the Canadian economy.

Keywords: Artificial intelligence (AI), Skills, AI industry demand, Data scientists, AI adoption and usage policy, Canada.

JEL Codes: J24, J23, J63, O33, O38.

Acknowledgements

The authors would like to thank Canada's ISED for their support of this study, including active support with the organisation of a project workshop. The authors would also like to thank participants at the workshop of 29th May and comments from delegates received at the 64th TIP Meeting in June 2024. The authors would also like to thank Sandra Planes-Satorra for her support of the project and specifically the organisation of the workshop.

Table of contents

FIGURES

TABLES

BOXES

Abbreviations

AI	Artificial Intelligence
DS	Data Scientists
ETL	Extract, Transform, Load
ICT	Information and Communication Technology
ISED	Canadian Ministry for Innovation Science and Economic Development
IT	Information Technology
LDA	Latent Dirichlet Allocation
LST	Lightcast Skills Taxonomy
ML	Machine Learning
NAICS	North American Industry Classification System
NLP	Natural Language Processing
NOC	National Occupation Classification
OJPs	Online Job Postings
R&D	Research and Development
SMEs	Small and Medium-sized Enterprises
STI	Science, Technology and Innovation

Executive summary

This paper provides a comprehensive analysis of the demand for AI skills in Canada, drawing from a dataset of over 12 million Online Job Postings (OJPs) collected between 2018 and 2023. The study assesses the demand for skills required to work with or develop AI systems in Canada and the intensity of AI demand across various sectors and occupations.

AI skills demand in Canada from 2018-23: Steady growth, slowing pace

The data suggests that, while the demand for AI talent is gradually expanding, recent economic challenges have slowed down its pace. From 2018 to 2023, job postings for professionals with AI skills in Canada represented between 0.3% and 0.5% of all the new job postings published online. While still relatively small, this level of demand saw a steady increase until 2021, peaking at 0.5% of total job postings. Between 2022 and 2023 demand has slowed, likely due to economic uncertainties and layoffs in tech companies, a trend observed in other countries as well. Despite this deceleration, demand for AI talent is still expected to grow rapidly in the coming years as technological adoption and automation continue to advance.

Demand for AI talent is concentrated in specific occupations and industries

The paper shows that demand for AI talent is heavily concentrated in specific occupations and industries. Canadian employers hiring for these roles place a strong emphasis on skills necessary for AI systems training and development. Some 20% of the demand for AI talent in Canada, as measured using the job postings data, is for data scientists. A closer look at this occupation shows that data scientists typically perform four key roles: i) research data scientists, ii) cloud and big data engineers, iii) data managers and analysts, and iv) data engineering specialists. Other occupations requiring AI skills include software developers, database analysts, and computer engineers. Including data scientists, these occupations collectively make up 45% of AI-related job postings. The definition of these roles is the result of a data-driven approach that identifies underlying groups in job postings for data scientists through the analysis of common skill requirements. Annex C provides detailed information on this procedure.

Despite an overall growing trend in the share of AI-related job postings, demand for these skills remains relatively small within individual occupations. Among the occupations contributing most to the demand of AI talent, less than 10% of job postings require AI-related skills, except for data scientists, where 30-35% of job postings require these skills. In over 500 other occupations analysed, this share is below 5%.

A pattern of highly specialised demand for AI-related skills can also be seen across various industry sectors. Just 8 out of more than 100 sectors accounted for 50% of AI-related job postings between 2018 and 2023. These include industries like computer systems design, scientific consulting, and electronic product manufacturing in the Professional, Scientific, and Technical Services sector, along with the Credit Intermediation sector, where AI roles still represent only around 1% of all job postings. In Publishing Industries and Computer and Electronic Product Manufacturing the share was 2.5% on average over the period.

Machine Learning (ML) is at the core of AI-related skills demand, with other fields growing and soft skills also required

Among AI fields, ML skills are in high demand, reflecting its broad application across industries. Other specialised AI techniques and fields, such as Natural Language Processing (NLP), Neural Networks, Visual Image Recognition, and Robotics, remain less prevalent but are gaining traction, highlighting evolving occupational priorities. The increasing mentions of these specialised skills in OJPs suggest that employers are progressively recognising their importance.

OJPs for AI-talent often include a combination of technical competencies and professional/soft skills, such as communication, management, and problem-solving skills. An analysis of skills co-occurrence in AI job postings shows that 'communication' is strongly linked to core technical skills in such fields as ML, AI and Python. A closer look at the co-occurrence of skills in AI-talent demand within selected economic sectors reveals a consistent demand for professional skills, though the strength of their connections varies. The analysis highlights the importance of curricula that balance technical knowledge with interpersonal skills, to ensure that professionals are equipped to handle both the technical and human aspects of AI-driven projects.

Training and flexible academic pathways to foster the development of AI skills

The findings and exchanges with AI experts consulted during a workshop on Canada's AI demand suggest the following pathways to support development of Canada's AI skills:

- Providing tailored education and training programmes to address demand of AI skills.
- Strengthening co-ordination between employers, government and education and training providers to address AI skill mismatches.
- Promoting flexible academic pathways for acquisition of AI skills and complementary soft skills, including opportunities for on-the-job training.
- Integrating AI training into sectoral- and domain-specific programmes to prepare workers with the skills needed as AI becomes more widely adopted across professions.
- Collecting timely and detailed data to track AI skills demand in Canada to inform education, training, and policy design.

To fully harness the economic and societal potential of AI, policies must be designed to facilitate private and public sector uptake of AI. This includes helping small and medium-sized enterprises, in new and established industries, to identify and meet their AI skills needs. Among other measures, it will be essential to ensure the availability of a workforce with the requisite AI skills, even as skills needs quickly evolve.

1 Introduction

AI is profoundly reshaping the world and the future of work. It is expanding to different industries with tools designed for improving decision-making, increasing efficiency, facilitating customer service, among many other goals. AI technology is evolving at a rapid pace in line with improvements in processing power, the design of new algorithms with multiple applications, and access to data. National AI strategies have identified the widespread and responsible adoption of AI across industries as key for future competitiveness and as a means towards improving well-being at large. Substantial investments in support of research and development (R&D) in the field of AI have also led to increased investments in skills development across the globe.

Canada's AI strategy aims to strengthen the country's leadership in AI to drive economic growth and societal advancement, as set out in the Pan-Canadian AI and Sovereign Compute Strategies (ISED, 2024[1]). Canada is among the countries leading in AI research and in building a talent pool to support the development of AI systems. According to the OECD.AI Policy Observatory, it is among the top countries in AI research in the last two decades, with approximately 2%-3% of AI-related research publications in the world (OECD.AI, 2024[2]). LinkedIn data, accessible through the OECD.AI Policy Observatory, shows that between 2019 and 2022, Canada has attracted increasing numbers of AI-skilled workers from abroad. The inflow contributed to raising the share of AI talent as a percentage of total LinkedIn members (AI talent concentration indicator) in the country from less than 0.20% in 2017 to more than 0.45% in 2023 (OECD.AI, 2025[3]). However, in terms of gender participation in AI-related occupations, data shows that big disparities persist, as the share of female data scientists and ML experts remains below 30%, slightly above the average of more than 40 countries with information from LinkedIn (OECD.AI, 2024[4]).

This paper explores AI skills required by Canadian industry for working with and/or developing AI systems, using OJP as the main data source. The use of OJPs for such analysis has the advantage of providing both granular and timely data on AI skills demand, which is particularly important in this fast-evolving field. This paper uses data on OJPs collected by Lightcast for more than 12 million job postings in the period 2018-23. The analysis presented in this paper is complemented by insights from a joint Canadian Ministry for Innovation, Science and Economic Development (ISED)/OECD expert workshop Organised by the OECD and ISED on 29 May 2024. This workshop brought together Canadian AI industry stakeholders to discuss key sectoral trends and implications for science, technology and innovation (STI) policy. The conversation was based on preliminary findings from this paper and other relevant OECD publications.

The remainder of the paper is structured as follows. Section 2 describes the methodology, while sections 3 and 4 describe the results of the analysis of AI job postings. The final section concludes with remarks on policy.

2 Methodology

2.1. Online job postings data

This paper uses data from more than 12 million OJPs collected by the firm Lightcast between 2018 and 2023. OJPs data, as those by Lightcast, provide advantages over traditional labour market information relevant to this analysis, namely timeliness, comprehensiveness and granularity. Lightcast collects data from a comprehensive list of online sources through web scraping techniques that continuously monitor websites to identify those with new job postings and extract relevant information. A process of deduplication ensures that information related to the same position is not included multiple times. Data are enriched through different algorithms and match patterns for cleaning and extraction of key features, including company (advertiser) information, industry classification under the North American Industry Classification System (NAICS) 2017 for the case of Canada, occupation classification under the Canada's National Occupation Classification (NOC) 2021 and the Lightcast Occupation Taxonomy, and the list of skills required in the posting classified under the Lightcast Skill Taxonomy (LST).

However, some caveats apply when using OJPs in the context of labour market and skills analyses. First, not all job vacancies are posted online. In some cases, job seeking relies more on informal channels or word-of-mouth. Annex A shows that, on average, OJPs from Lightcast represent 70% of the total job vacancies reported annually by Statistics Canada during the period 2018-23. This limitation disproportionally affects certain industries and occupations and may lead to an overrepresentation of high-skilled OJPs – including those related to AI. For instance, OJPs data from Lightcast have been shown to overrepresent industries demanding high-skilled jobs (Carnevale, Jayasundera and Repnikov, 2014[5]; Cammeraat and Squicciarini, 2021[6]; Tsvetkova et al., 2024[7]). Tsvetkova (2024[7]) shows that occupational groups such as Business, Finance and Administration and Management are overrepresented in data for Canada when compared to official statistics on job vacancies. It is therefore likely that job postings classified as AI-related in this paper can be somewhat overrepresented, as they are high-skilled jobs that tend to be more posted online.

Second, the representativeness of OJPs across Canadian provinces is a challenge of the standard Lightcast data for Canada due to the underrepresentation of Québec (see Tsvetkova et al. (2024[7])). New versions of the Canadian database, as the one used in this paper, have incorporated historical information from OJPs advertised in French, which were extracted from web sources by Lightcast but not incorporated in the final database at that time due to limitations for feature extraction. The database used in this paper aligns significantly better with official data in the relative distribution of OJPs by provinces (see Annex A).

2.2. Identifying AI-related jobs

This paper aims at identifying and characterising the occupations and industries in Canada demanding professionals who develop and work with AI systems.[1] For this objective, data from OJPs provide some advantages over traditional labour force statistics and official occupational taxonomies. For example, official taxonomies often lack the detailed information required to distinguish AI-related positions, leading to these roles being grouped into broad categories alongside other occupations that share similar skills but

are not directly involved in developing or using AI systems (Borgonovi et al., 2023[8]; Green and Lamby, 2023[9]).

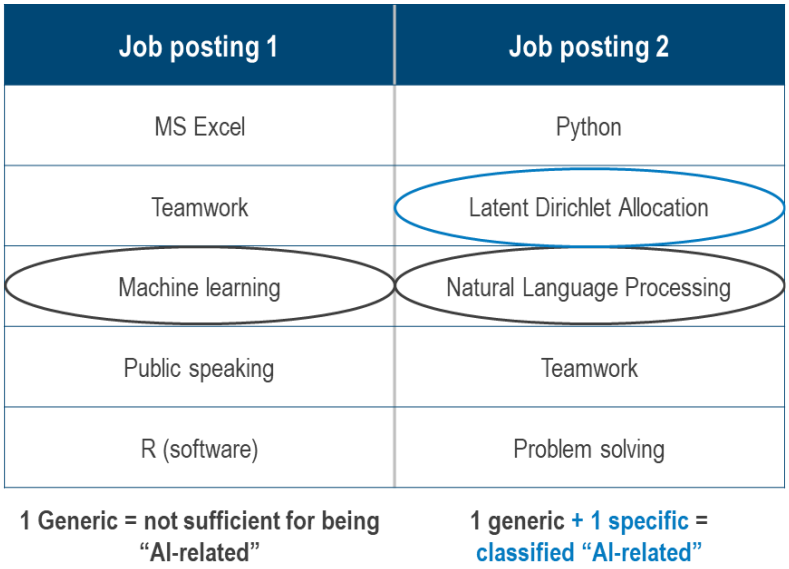
On the contrary, OJPs data collect up-to-date detailed information on employers' demands and the set of skills mentioned in job descriptions, allowing identification of the precise job postings that are related to AI systems and disentangling them from other more generic roles. In addition, while official taxonomies are somewhat static and receive updates once a year or less, the skillset extracted from job postings provides a nearly real-time update at the occupation level (or the aggrupation required).

Previous analyses of AI skills mostly rely on data from job postings and have used different methodologies to classify OJPs into AI-related jobs. Data-driven approaches leverage NLP and ML techniques to create semantic indicators or ML classifiers to identify job postings requiring AI skills (see, for example, Manca (2023[10]) and Green and Lamby (2023[9])). Semantic indicators can help provide insights about occupations broadly linked to AI skills but do not provide a detailed identification of individual job postings, reducing the advantages of data granularity. Supervised ML classifiers learn from underlying data and do not depend on static lists, which make them more flexible to be applied with information in different languages, representing a great advantage in cross-country analyses. However, these models require pre-labelled data for training that are not available in the dataset.

Skill-list approaches, such as the one used in this paper, rely on predefined lists of keywords –extracted from taxonomies or academic publications – and rules to classify job postings. This method is intuitive, tagging job postings as AI-related if they contain a certain number of AI-related keywords above a defined threshold. By classifying at the job posting level, this approach enables tracking changes in AI skills demand within specific occupations over time. Acemoglu et al. (2022[11]), Alekseeva (2021[12]) and Green and Lamby (2023[9]), for instance, use a list of skills extracted from the LST including keywords directly associated with AI systems such as *deep learning, machine vision, AI*, among others. Samek, Squicciarini and Cammeraat (2021[13]), Squicciarini and Nachtigall (2021[14]) and Borgonovi et al. (2023[8]) have based their AI skills lists on the keywords selected by Baruffaldi et al. (2020[15]),[2] which form the core of their operational definition of AI, aimed at recognising developments in AI in science, algorithms and technologies.

This document follows the recent work from Borgonovi et al. (2023[8]), which maps Baruffaldi et al. (2020[15]) skills to the LST and includes additional keywords extracted from OJPs of English-speaking countries. As the LST is constantly updated, this document also includes additional keywords (See Annex B for more detail). Borgonovi et al. (2023[8]) original list classifies each keyword into one of seven AI fields (AI Systems, Autonomous Driving, ML, NLP, Neural Networks, Robotics and Visual Image Recognition). Additionally, each skill is classified as generic or specific. Generic skills refer to those AI skills that can be common in roles using AI systems but not necessarily developing them. In contrast, specific skills include AI skills related to more specific applications or methods. AI-related jobs are those OJPs including at least one specific or two generic AI skills (see example in Figure 1). This paper pools all these keywords together under the term *skills* and will use this term throughout the remainder of the document when referring to them.

Figure 1. Example of AI-related classification



Note: This figure provides a straightforward example of the process used to classify a job posting as AI-related. AI-related job postings are those that include at least one specific AI skill or two generic AI skills. Generic skills refer to those commonly associated with roles that utilise AI systems, though not necessarily in the development of them (circled in black in the figure). In contrast, specific skills refer to AI applications or methods that are more specialised (circled in blue).
Source: Authors' elaboration based on Borgonovi et al. (2023[8]), "Emerging trends in AI skill demand across 14 OECD countries", *OECD Artificial Intelligence Papers*, No. 2, https://doi.org/10.1787/7c691b9a-en.

3 Trends in the demand for AI skills in Canada

This section examines the evolution of AI-related job postings from 2018 to 2023, with a focus on the characteristics and skill demands of occupations with the highest proportion of AI job postings, as well as the industries that advertise the most AI vacancies.

3.1. Trends in the demand for AI professionals from 2018-23

The demand for professionals with AI skills represented between 0.3% and 0.5% of new OJPs advertised in Canada between 2018 and 2023. Figure 2 shows the quarterly evolution of AI-related job postings as a percentage of both total job postings and those classified into occupations more likely to be linked with the development and use of AI skills (i.e. data scientists, mathematicians and statisticians, software engineers/developers, etc.).[3] This period is characterised by an initial expansion in the demand for AI-related professionals from Q1 2018 until Q4 2021, reaching 0.5% of total job postings (2.7% of job postings in the Natural and Applied Sciences occupational category). However, between Q1 2022 and Q2 2023, data show a slowdown in the number of new job postings seeking AI talent.

This finding is consistent with cross-country evidence provided by Borgonovi et al. (2023[8]) and Lightcast (2024[16]). In particular, Borgonovi et al. (2023[8]) indicate that, despite the overall increasing demand for AI professionals in recent years, AI-related online vacancies still account for less than 1% of all postings across 14 English-speaking and European countries. Focusing on Canada, the study reveals that although job postings in Canada indeed declined after 2021, the number of new vacancies in 2022 remained above the average for the 14 countries.

The slowdown in new vacancies for professionals with AI skills may be attributed to broad economic uncertainty in 2022 and 2023, which impacted hiring plans across various industries. In early 2023 the Canadian economy experienced a cooling in employment, with professional services – including tech fields –among the sectors showing declines in employment during the first half of the year (Statistics Canada, 2023[17]). Data from Indeed also show a generalised decline in job vacancies posted in the country between June 2022 and June 2023, with white-collar occupations (including tech occupations such as software developers) dropping faster than others (Indeed Hiring Lab, 2023[18]).

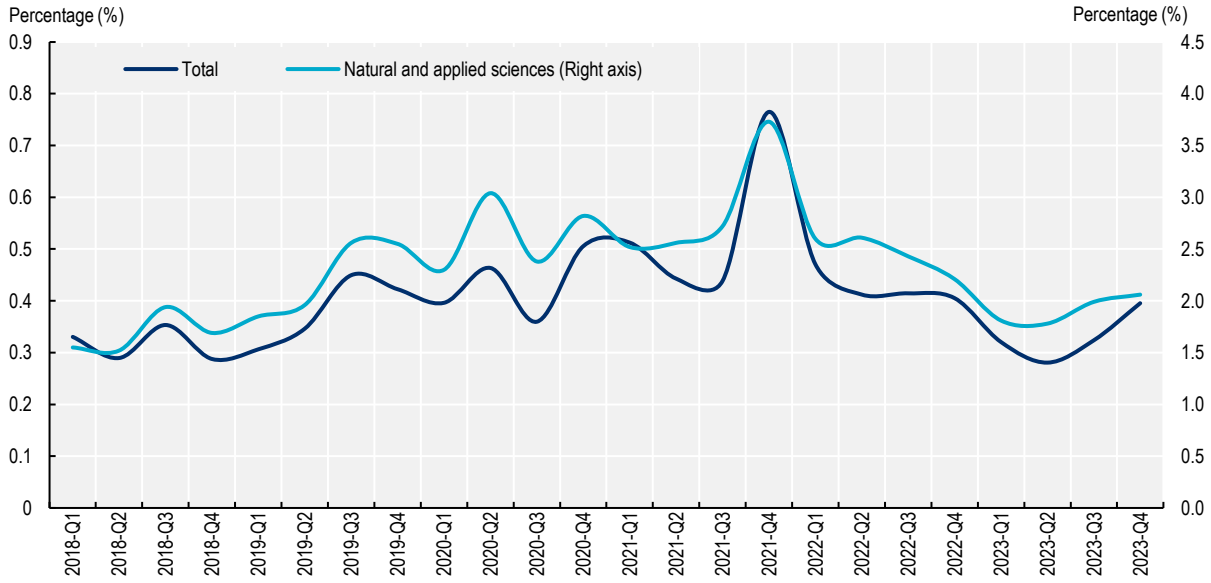
It is important to notice that fluctuations in OJPs do not reflect the actual number of workers with AI skills currently employed in the Canadian economy but, instead, the strength of the 'new' demand for professionals with AI expertise. In other words, these figures broadly measure the need for additional AI-skilled workers or the replacement of existing ones, rather than the current workforce's capabilities in AI. This distinction is important because it highlights the ongoing demand for AI talent rather than providing a snapshot of the current AI-skilled labour force.

During the OECD-ISED workshop organised as part of the project leading to this paper, Canadian AI industry experts highlighted several factors that could explain the slowdown in new AI skills demand in 2023:

1. **Companies leverage internal talent more**: following layoffs in the tech sector experienced in Canada in 2023, companies tend to invest in building skills of existing professionals and promoting internal mobility and promotion more, instead of searching for external talent.
2. **Accelerated productivity growth**: companies may require fewer staff to perform certain tasks compared to what was needed in the past (e.g. number of developers needed may have decreased due to the productivity gains driven by the use of generative AI).
3. **A slowdown in hiring of new graduates** in AI-related fields is observed, but there is demand for more experienced professionals, particularly among small and medium-sized enterprises (SMEs). Many graduates leave the country after graduation and come back after gaining some years of experience abroad (particularly in the United States) to take on more senior positions.

Figure 2. Share of AI-related job postings in Canada

AI-related job postings as a percentage of total job postings and those classified under the Natural and Applied Sciences broad occupational category in NOC



Note: The figure shows the share of job postings with at least one specific or two generic AI skills.
Source: OECD based on Lightcast data.

While many factors can influence future developments, most expert accounts expect AI occupations to experience sustained growth globally in the coming years. The World Economic Forum (World Economic Forum, 2023[19]), for instance, indicates a structural reconfiguration of labour markets based on technological adoption and automation, in which emerging roles such as AI/ML specialists and data analysts/scientists will grow faster than other occupations.

3.2. AI adoption across occupations and among data scientists

This section explores what type of AI skill profiles are in high demand among Canadian employers. The analysis leverages the detailed information from OJPs, categorised by occupation according to Canada's NOC 2021, as provided by Lightcast.

3.2.1. Data scientists and AI-related skills demand

Panel A of Figure 3 shows that the demand for AI talent is heavily concentrated on data scientists. On average, nearly 400 new job postings each quarter seek data scientists with AI skills, accounting for 20% of the total demand for AI professionals. The term “data scientist” is often used by employers to cover a range of roles involving data analytics, big data analysis, and data engineering. The rise and solidification of this profession in recent years are closely tied to the widespread adoption of ML and AI tools across various industries. Consequently, it is unsurprising that over 30% of job postings for data scientists are categorised as AI-related positions (Figure 3, Panel B).

As the demand for data scientists with AI skills is high, it is helpful to explore the specific roles and skills employers seek in data scientist job postings. Using the list of skills extracted from data science OJPs and the Latent Dirichlet Allocation (LDA), a widely used method for topic modelling (Annex C provides technical details), four underlying roles are identified: research data scientists, cloud/big data engineers, data managers and analysts, and data engineering specialists. The first three roles account for similar shares, with each ranging from 300-400 new job postings per quarter (which correspond to 25%-30% of data science job postings). Data engineering specialists accounted for an average of 130 new postings, representing 11% of all data science job postings.

Differing from data scientist positions in general, AI-related postings dominate among research data scientists, but less so among cloud based big-data engineers. In the former, AI-related postings account for 70%-80% of the job postings classified in this role (Panel B of Figure 4). In consequence, Panel A of Figure 4, shows that two of every three AI-related data science job postings are for research data scientists. This role requires mathematics, statistics, algorithms, and research skills, which points to a strong emphasis on AI systems development and training. The results support previous findings on the emphasis in Canada for developing an AI talent based on research and development of AI systems (Scale AI, 2023[20]; Deloitte, 2023[21]).

Cloud/big data engineers saw a rapid increase in the number of job postings between 2020 and 2022 (Figure 4, Panel A). While only approximately 30% of postings in this category seeking professionals with AI skills, employers likely increasingly look for applicants with expertise deploying AI systems. For instance, some key skills defining this role include data engineering, extract, transform, load (ETL) processes, data pipelines, and big data.

3.2.2. Other roles and occupations requiring AI skills in Canada

Beyond data scientists, other occupations requiring AI skills are those with a greater focus on the deployment of AI solutions. These are software developers and programmers, database analysts and data administrators, software engineers and designers, and computer engineers. These four occupations collectively account for an average of 500 new job postings per quarter (Figure 3, Panel A), representing 26% of the demand for professionals with AI skills between 2018 and 2023. These roles are crucial for integrating trained and tested models into existing systems to solve real-world problems. As Canada transitions from AI adoption to broader diffusion, attracting talent in deployment-focused roles is key to achieving global competitiveness in the AI sector.

The “Other occupations” group, comprising nearly 500 distinct roles, accounted for an average of 40% of AI-related job postings between 2018 and 2022. By 2023, this figure had risen to 46%. The size of this group, combined with its increasing share of AI-related job postings, suggests a growing trend toward integrating AI skills across a wider range of occupations beyond traditional tech roles. However, AI skills are not yet a common requirement across most professions.

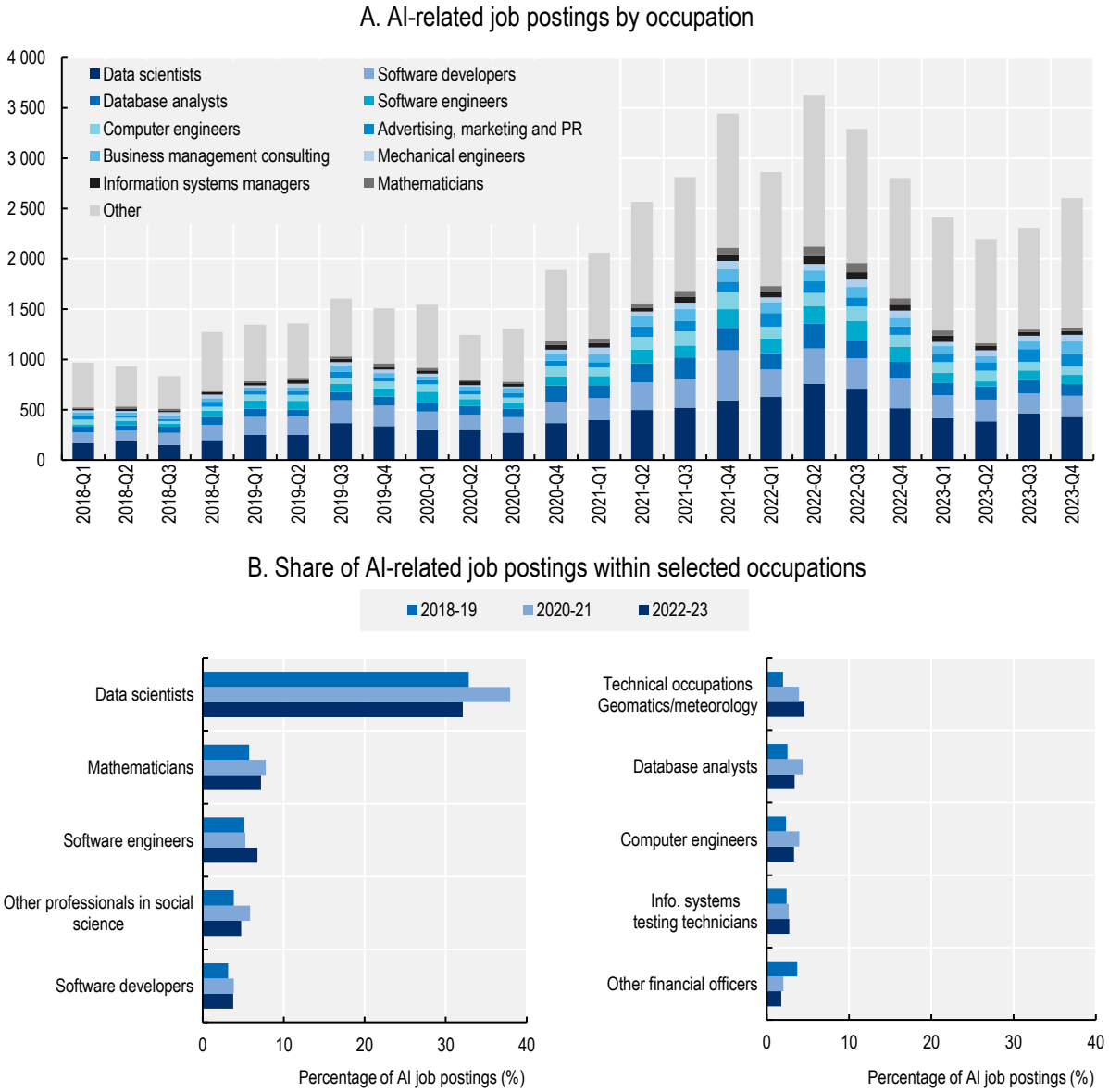
As illustrated in Panel B in Figure 3, the demand for AI skills is concentrated in specific areas. For all occupations, except for data scientists, the percentage of job postings requiring AI skills remains below 10%. This shows that the broader labour market is still in the early stages of adopting AI skills. The

relatively low demand for AI expertise across most digital occupations – excluding data scientist – could be due to a limited number of roles focused on AI deployment in Canada or employers' hesitancy to require AI skills, as they are still exploring the integration of AI in their businesses.

In other words, while the growing share of AI-related postings in the "Other occupations" group suggests a trend toward a broader range of roles requiring AI skills, the overall demand for these skills remains limited across the labour market, highlighting the ongoing process of AI integration across various professions, with significant room for growth.

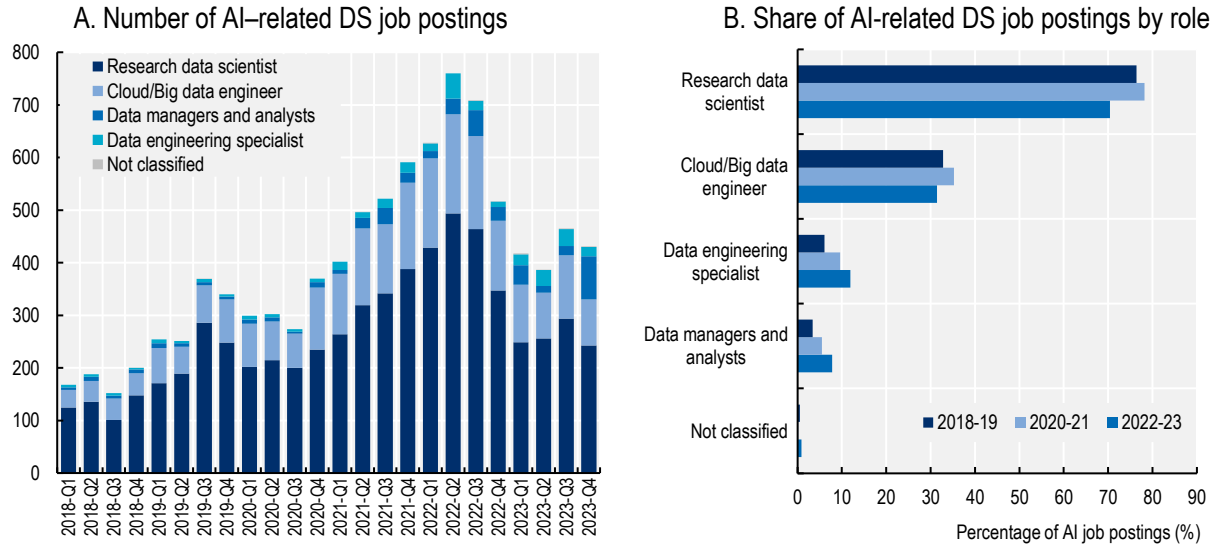
Figure 3. Occupation with the highest share of AI-related job postings

Top 10 NOC 5-digit occupations



Note: According to the NOC 2021 classification, there are more than 500 occupations at the 5-digit level (NOC). Panel A shows the 10 occupations with the largest number of AI-related OJPs and groups the remaining occupations in the group "other". In Panel B, occupations that fall within the first quartile in terms of the total number of job postings have been excluded from the analysis.
Source: OECD based on Lightcast data.

Figure 4. AI-related Data Scientists (DS) by roles



Note: Four roles were identified using NLP techniques for topic modelling in which each job posting represents a document with a list of specialised skills. A generative AI tool defined the names of the job roles based on the list of skills describing each role (see Annex C). The category "Not classified" accounts for job postings with less than three skills since the model would struggle to assign a role to them.
Source: OECD based on Lightcast data.

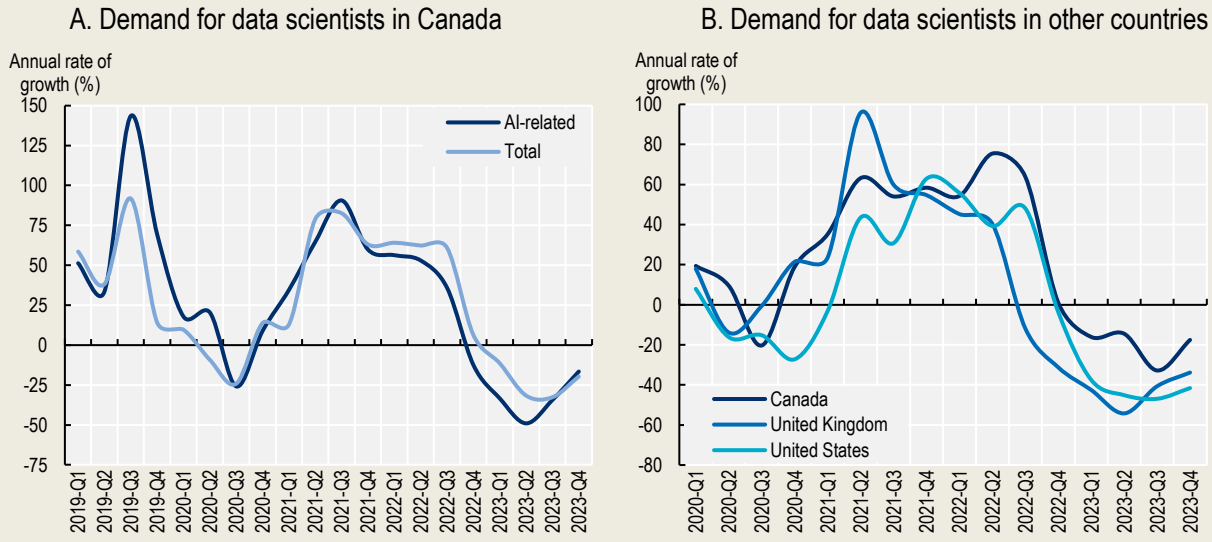
Box 1. The evolution of the demand for data scientists in Canada in the global context

The decrease in the demand for new AI talent in Canada may be surprising at first glance, given the headlines applications of AI systems such as ChatGPT. It is important to note that this is not to say that there is less AI talent operating in Canada, since the nature of the data – job postings – do not reflect the current stock of AI talent in Canadian industry. However, the question emerges as to whether this decrease is a trend and, in particular, whether it is specific to Canada.

Figure 5 shows that the slowdown in demand for AI-related data scientists is driven by the evolution of the overall demand for professionals in this occupation (Panel A) and that it is shared with other countries (Panel B). The United Kingdom and the United States similarly see a decrease in new demand starting in Q4 2022, and persisting in 2023, with early signals of a pick-up in Q4 2023. The reasons relate to uncertain political and economic conditions globally more than to a deceleration in demand due to technology or industry factors.

These findings are in line with opinions from Canadian AI industry experts who participated in the aforementioned workshop carried out in developing this paper. They suggested that the slowdown in demand can be associated with signs of AI projects being scaled down or postponed and changes in skill needs due to productivity gains derived from introducing AI tools in the workplace.

Figure 5. Data scientist market adjusts after a period of expansion



Note: The classification of data scientist in Panel A is based in the NOC 2021 taxonomy (code 21 211). Panel B uses the Lightcast Occupational Taxonomy (code 231 114) for a clearer comparison across countries.
Source: OECD based on Lightcast data; Lightcast (2024[16]), *The Lightcast Global AI Skills Outlook*, https://lightcast.io/resources/research/the-lightcast-global-ai-skills-outlook.

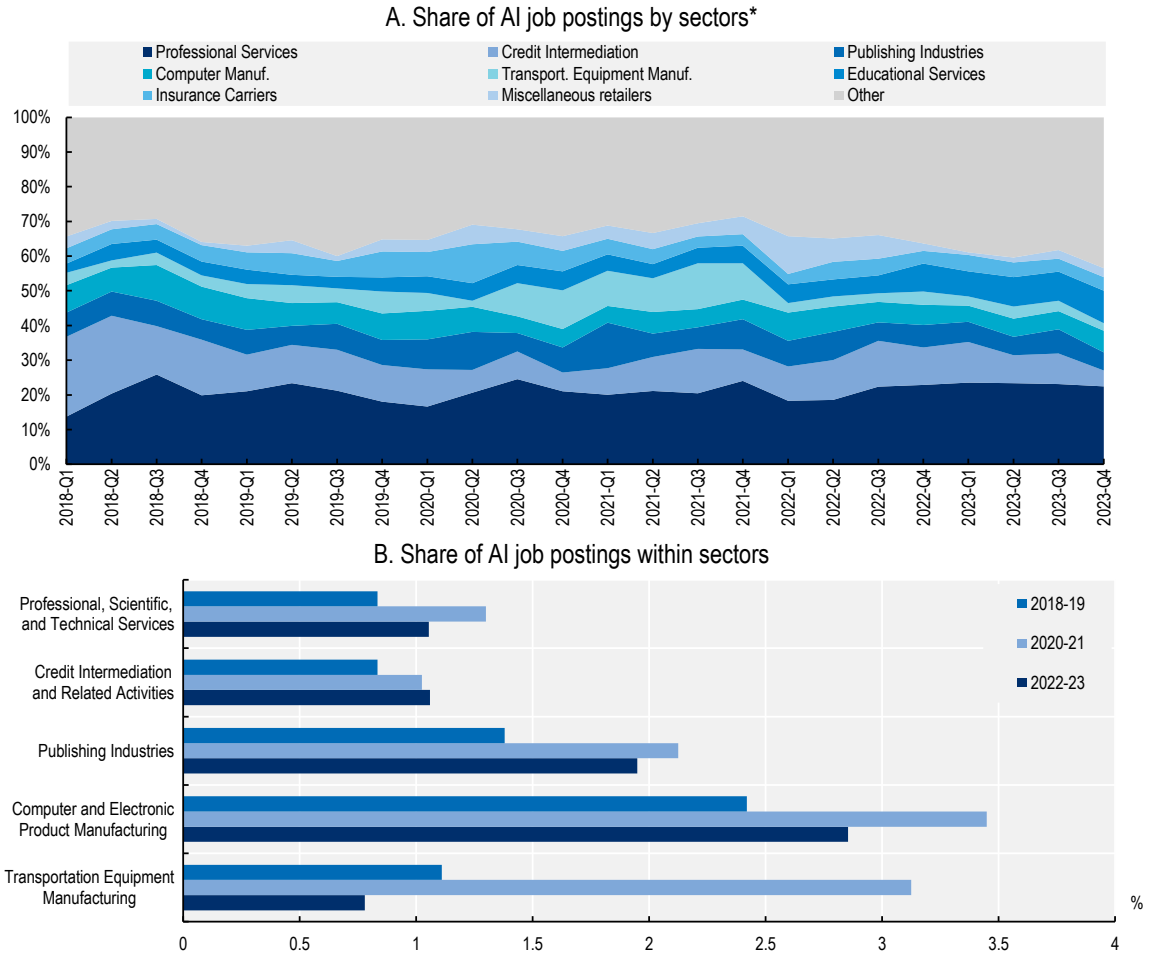
3.3. AI skills demand across economic activities

Data from OJPs show that the demand for professionals with AI skills is concentrated in a few NAICS 2-digit sectors, predominantly within Professional Services (54), Information (51) and Manufacturing (31-33) – a trend consistent with those observed in other OECD countries (Borgonovi et al., 2023[8]) and

explored in other recent OECD work on Canada (Green, 2024[22]; Calvino et al., 2024[23]). In Canada, 8 out of 102 NAICS 3-digit sectors accounted for nearly 70% of the total demand for AI-related professionals between 2018 and 2023 (Figure 6, Panel A).

The Professional, Scientific, and Technical Services and Credit Intermediation sectors stand out for their strong demand for AI skills, despite these skills accounting for only a small fraction of their overall OJPs. The former includes industries that heavily rely on human capital, with some of them likely at the forefront of AI systems research and design, such as Computer Systems Design. The latter gathers establishments in the banking sector, which can benefit from AI automation to streamline data intensive tasks such as fraud detection. Together, these sectors represented 30% of the total AI job postings during the period of analysis. At the same time, the demand for AI talent represents only a small part of total demand of these sectors (Panel B, Figure 6). Both in Professional Services and Credit Intermediation, AI positions represent 1% of the total sector demand in these sectors.

Figure 6. Demand for AI-related professionals in selected economic activities



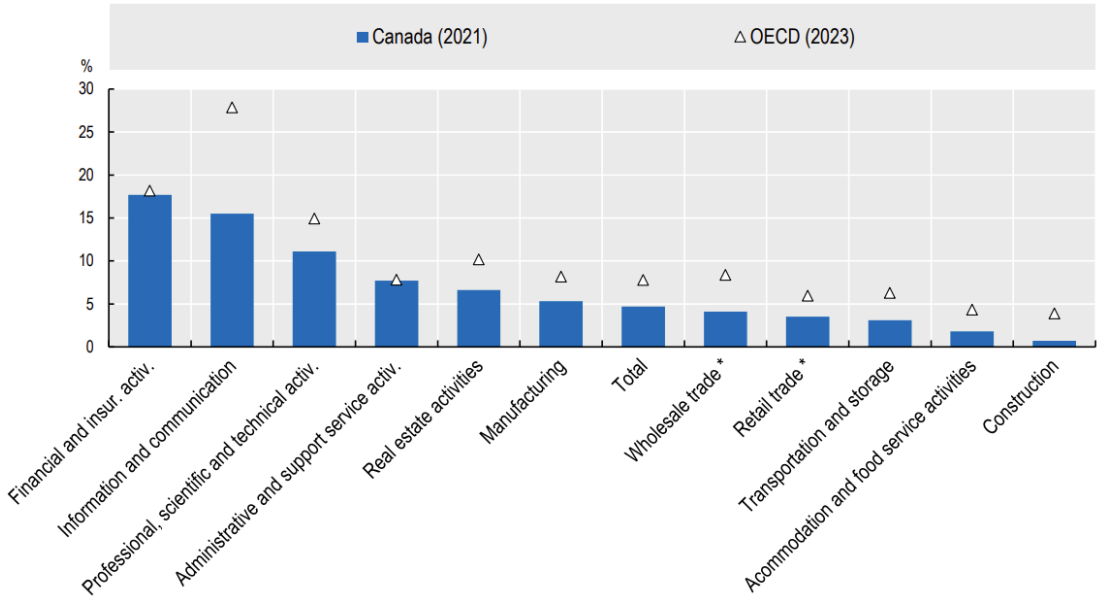
Note: Original NAICS 3-digit sector labels in Panel A are: Professional, Scientific, and Technical Services, Credit Intermediation and Related Activities, Publishing Industries, Computer and Electronic Product Manufacturing, Transportation Equipment Manufacturing, Educational Services, Insurance Carriers and Related Activities, and Sporting Goods, Hobby, Musical Instrument, Book, and Miscellaneous Retailers. * Shares in Panel A exclude the job postings not classified under the NAICS taxonomy by Lightcast (grouped as "unclassified'), which represents approximately 23% of AI job postings, as well as those advertised by staffing companies, approximately 10% of AI job postings.
Source: OECD based on Lightcast data.

In contrast, AI job postings in *Publishing Industries* and *Computer and Electronic Product Manufacturing* accounted for nearly 2% and 3% of the total demand in these sectors for the 2020-21 period, the largest share among the top sectors demanding AI talent (Figure 6, Panel B). Publishing Industries includes, among others, all the establishments engaged in producing and distributing computer software, these industries represent most of the demand for AI talent in this field, as shown in Figure 8. Computer and Electronic Product Manufacturing gathers establishments producing hardware and other electronic products, which may use AI for their production process or integrated with their products.

The relatively low share of AI-related job postings in main sectors, such as Professional Services, may signal the still emerging diffusion of AI-technology across Canadian industries. For instance, insights from information and communication technology (ICT) usage surveys data show that the share of enterprises using AI in Canada is relatively low in comparative perspective (Montagnier and Ek, 2021[24]). In addition, Figure 7 shows that AI usage by industry in Canada is slightly below the OECD average for most of the sectors, except for the information and communication industry, where it is much lower than the average. In line with this evidence, Borgonovi et al. (2023[8]) indicates that Canadian demand for AI skills in the Professional Services and Information sectors are below the average for the English-speaking and European countries.

Figure 7. Enterprises using AI in selected sectors in Canada, 2021

As percentage of enterprises with 10 or more employees



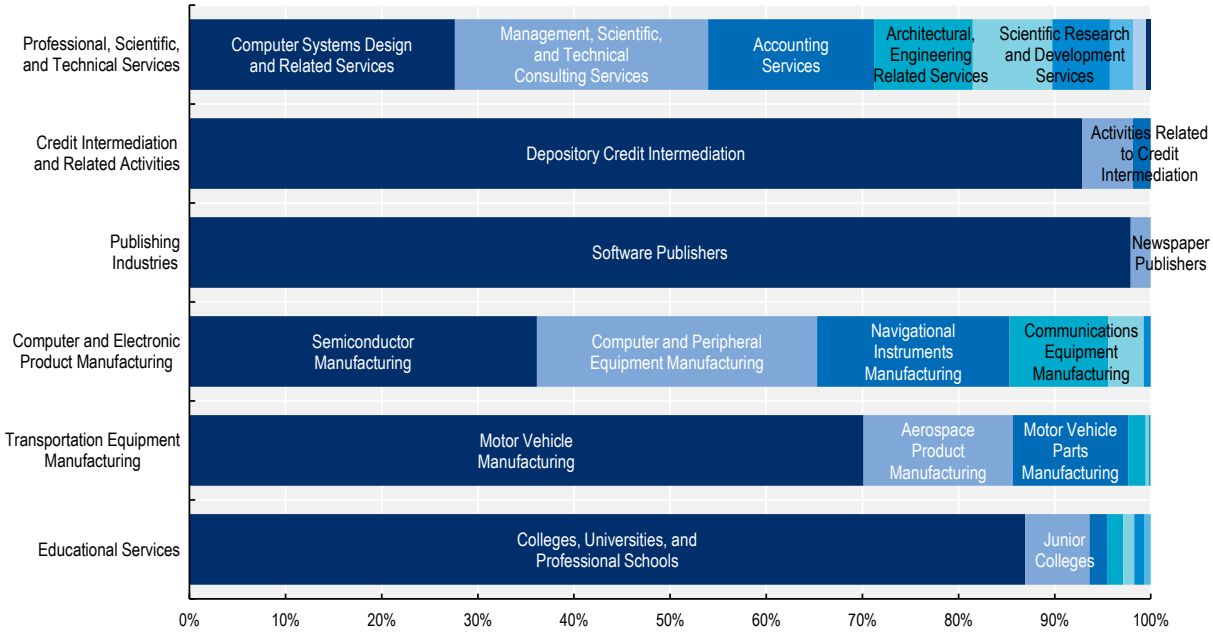
Source: Based on OECD (2024[25]), *OECD Digital Economy Outlook 2024 (Volume 1): Embracing the Technology Frontier*, https://doi.org/10.1787/a1689dc5-en; and on OECD ICT access and usage (databases), https://oe.cd/dx/ict-access-usage.

Figure 8 explores in depth the sectors that have been leading in advertising AI job postings by describing the industry groups (NAICS 4-digit) demanding most of the AI professionals. An important share of industries demanding AI skills produce IT services and products, such as those included in the groups Software Publishers, Computer Systems Design and Related Services, and all included in the Computer and Electronic Product Manufacturing sector. Interestingly, data also show a growing demand for AI skills in industry groups that are not traditionally associated with IT, such as Depository Credit Intermediation, Motor Vehicle Manufacturing, Accounting Services, and Architectural, Engineering, and Related Services, among others. This trend suggests that AI skills are increasingly permeating a wide range of sectors

beyond the traditional IT industry, highlighting the expanding significance of AI across diverse fields (see, for instance, the case of the Pharmaceutical and Medicine industry group in Box 2).

Figure 8. Main industry groups advertising AI job postings in selected sectors (2018-23)

Industry groups (NAICS 4-digit) with the highest share of AI jobs postings within selected sectors (NAICS 3-digit)



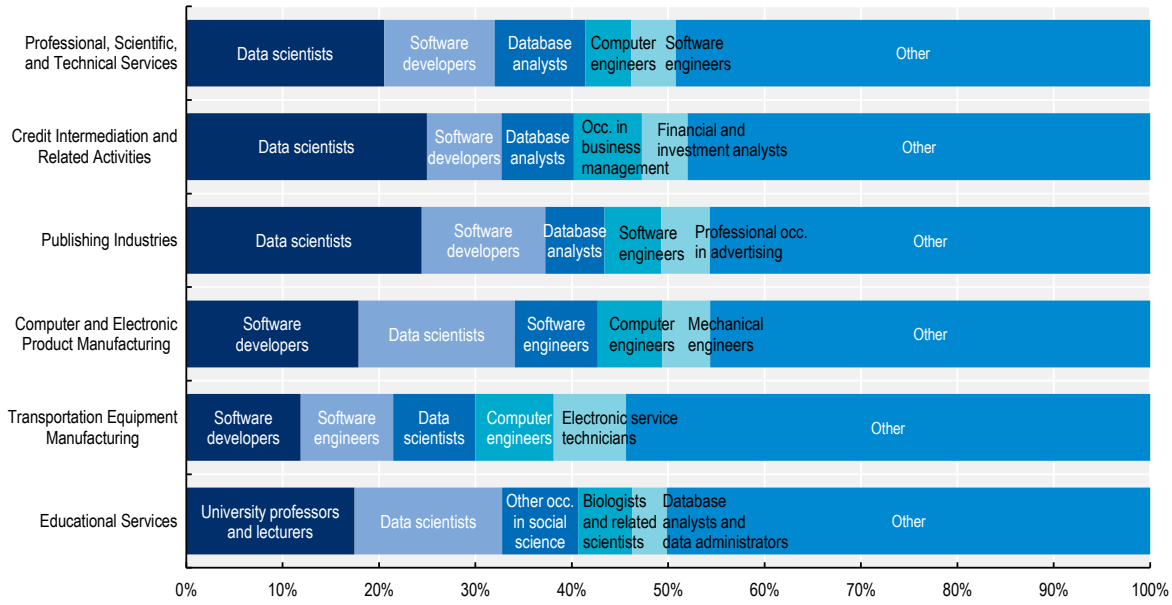
Note: The figure illustrates the industry groups demanding AI talent based on the average annual number of AI job postings in 2018-23. Shares in this figure excludes job postings advertised by staffing companies, approximately 10% of AI job postings.
Source: OECD based on Lightcast data.

A closer look at each sector shows that particularly two of them, Professional Services and Computer and Electronics Manufacturing, exhibit a demand distributed across different industry groups. In the former, for instance, Computer Systems Design and Related Services and Management, Scientific and Technical Consulting Services represents more than half of the demand. These groups comprise companies developing and implementing AI. Accounting Services and Architectural, Engineering and Related Services account for an additional 30% of the AI talent demand in this sector, industries that are likely to be consumers of AI systems more than developers. In the rest of the sectors, one or two industry groups dominate the demand.

Occupations with technical expertise in AI-related fields are the primary drivers of AI-related job demand within sectors (Figure 9). Data Scientists lead the demand for across most sectors, emphasising its central role in AI talent. Nevertheless, the demand for Software Developers and Engineers is higher in manufacturing industries, where the implementation of AI systems may contribute to optimising production processes, automating tasks, and enhancing product design. Database Analysts and Data Administrators are relevant in most of the sectors in Figure 9, excluding those in manufacturing, which may reflect the importance of data management solutions in some services. Additionally, the presence of roles outside traditional IT functions, such as Professional Occupations in Business Management and Financial and Investment Analysts, suggests that the demand for AI skills is permeating broader business operations.

Figure 9. Main occupations within the AI-jobs demand in selected sectors (2018-23)

NOC 5-digit occupations with the highest share of AI-related jobs postings within selected sectors (NAICS 3-digit)



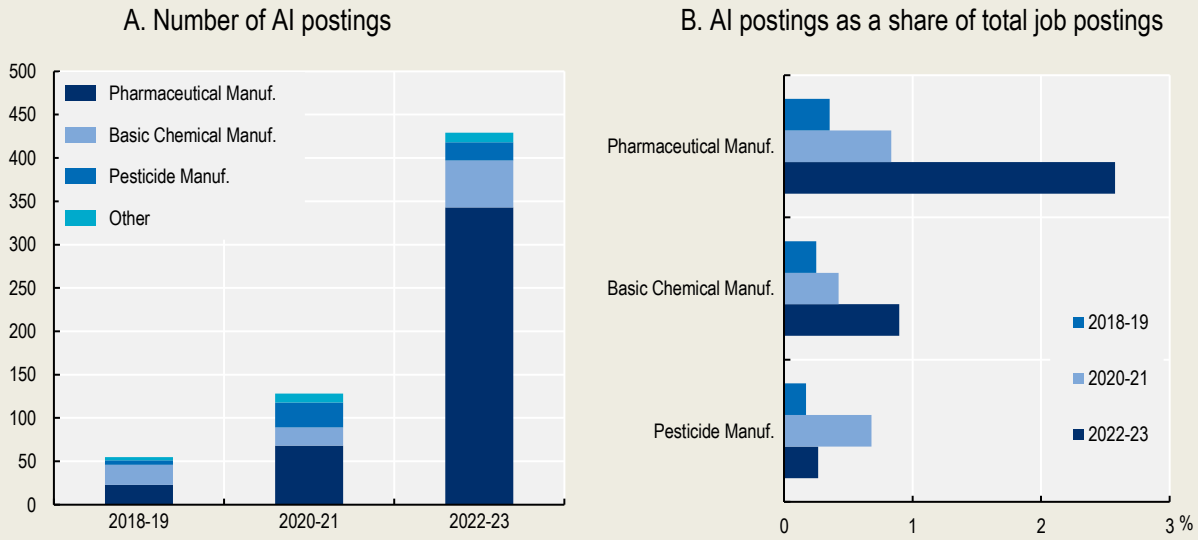
Note: Occupation shares based on the average annual number of AI job postings in the 2018-23 period. The Other group contains more than 500 occupations classified at the 5-digit level under the NOC 2021 taxonomy. Shares in this figure excludes job postings advertised by staffing companies, approximately 10% of AI job postings.
Source: OECD based on Lightcast data.

Box 2. The rising demand for AI talent in the chemical industry

As AI tools become increasingly versatile, there is a growing demand for AI talent in sectors that previously had little to no need for such expertise. One notable example is the chemical industry (NAICS 325), which includes industries such as pharmaceuticals, resins and artificial fibres, and pesticides.

In 2018-19, job postings seeking AI professionals in the Chemical Manufacturing sector were minimal, accounting for less than 0.4% of total demand in the main industries (see Figure 10, Panel B). However, by 2022-23, the demand surged, with AI job postings tripling compared to 2020-21, as shown in Panel A of Figure 10. This increase was largely driven by a rise in AI job postings within the Pharmaceutical and Medicine Manufacturing industry. Consequently, the share of AI-related job postings in this industry grew from 0.8% in 2020-21 to 2.6% in 2022-23.

Figure 10. AI job postings in chemical by main industry groups



Note: Industry groups' names were shortened to improve readability. The original names from NOC are: Pharmaceutical and medicine manufacturing, Basic chemical manufacturing, and Pesticide, fertilizer, and other agricultural chemical manufacturing. The category other in Panel A includes four additional industry groups.
Source: OECD based on Lightcast data.

The demand for AI talent in the pharmaceutical industry

In 2022-23, the pharmaceutical industry demanded AI talent primarily in three occupations: Data scientists (25% of total AI demand), Database analysts and data administrators (17%), and Computer and information systems managers (6%). This demand underscores the need in the industry for professionals who can not only develop applications and algorithms but also ensure effective data management.

A significant driver of the surge in demand is the establishment of new AI-powered digital hubs in the sector in Canada. For instance, the opening of Sanofi's AI Centre of Excellence in Toronto in 2022, along with their plans to hire over 100 tech employees (Sanofi-Aventis Canada, 2022[26]), likely played a crucial role in spurring the demand. This example highlights how non-tech companies are adapting strategically to an evolving landscape by investing in AI and placing a growing importance on building an AI-proficient workforce.

4 Specific AI skill requirements and the demands for soft skills

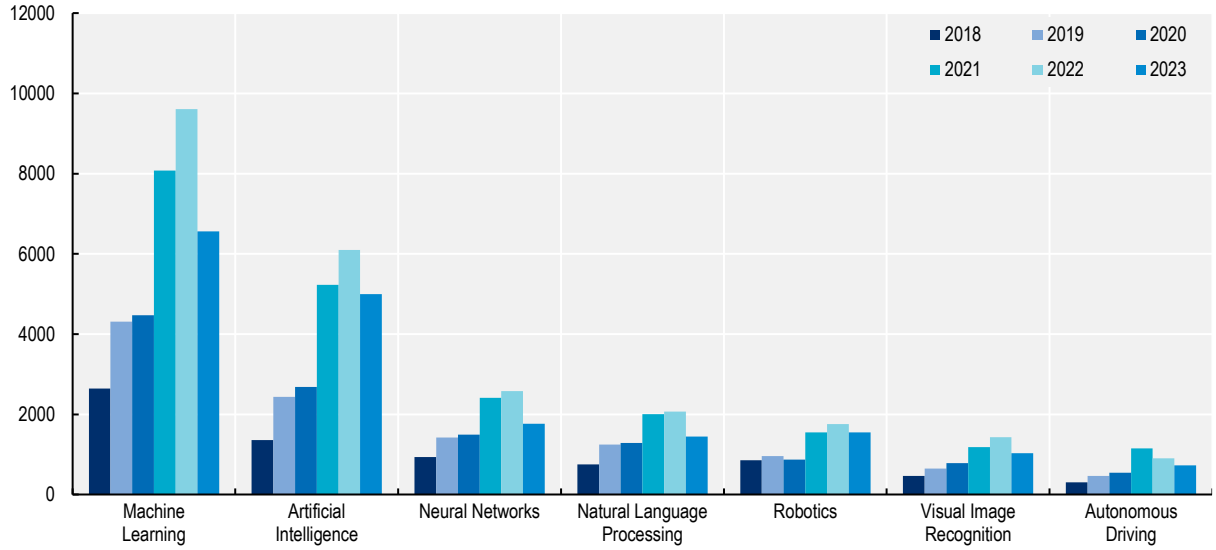
This section of the paper explores the composition of the demand for AI skills, shedding in this way light on technological adoption and identifying both current and emerging industry priorities and the relationship between AI and other skills, including soft skills.

4.1. AI skills demand by fields of specialisation

The analysis in Figure 11 reveals a significant growth in demand for AI skills across the key AI fields of specialisation (Annex B provides relevant definitions). Notably, AI fields like ML and AI systems (the latter includes different types of AI-powered systems such as *Chat GPT*® or *chatbots*) have experienced rapid adoption in recent years. The results show that, in 2022, the number of job postings mentioning at least one skill from these fields was 3.6 times higher for ML and 4.5 times higher for AI compared to 2018. This surge in demand for specific AI skills outpaces the broader increase in AI-related job postings, which were three times higher in 2022 than in 2018.

Figure 11. AI skills demand by field of specialisation

Job postings mentioning at least one skill from each field



Note: Since one job posting may require skills from multiple fields, the sum of the bars does not equal the total number of AI job postings for any particular year.
Source: OECD based on Lightcast data.

These trends indicate ML's critical role in data-driven innovation with a growing emphasis on developing predictive models, automating processes, and enhancing decision-making across industries, as well as the broad application of AI technologies, including data analysis, automation, and intelligent systems, which are becoming essential in many fields.

The demand for other, more specialised, fields is lower as compared to ML, but there has been an increase in job postings mentioning them. For instance, in 2022, job postings mentioning NLP, Neural Networks and Visual Image Recognition skills were nearly three times higher than in 2018, in line with the overall increase in AI-related job postings. These fields involve the capacity to process and analyse large volumes of text, images, and audio data, where understanding and generating human language can greatly enhance performance across industries like customer service, healthcare, finance, medical diagnostics, and surveillance.

The demand for skills related to Autonomous Driving and Robotics followed a slightly different trend compared to the other AI skills. The demand for skills in this field decreased, however, during 2022 and 2023. Job postings requiring Robotics[4] skills increased modestly, reflecting the specialised nature of robotics or the slower adoption rate in industries compared to fast-growing fields like data science or AI.

4.2. AI skill demand by field of specialisation across occupations

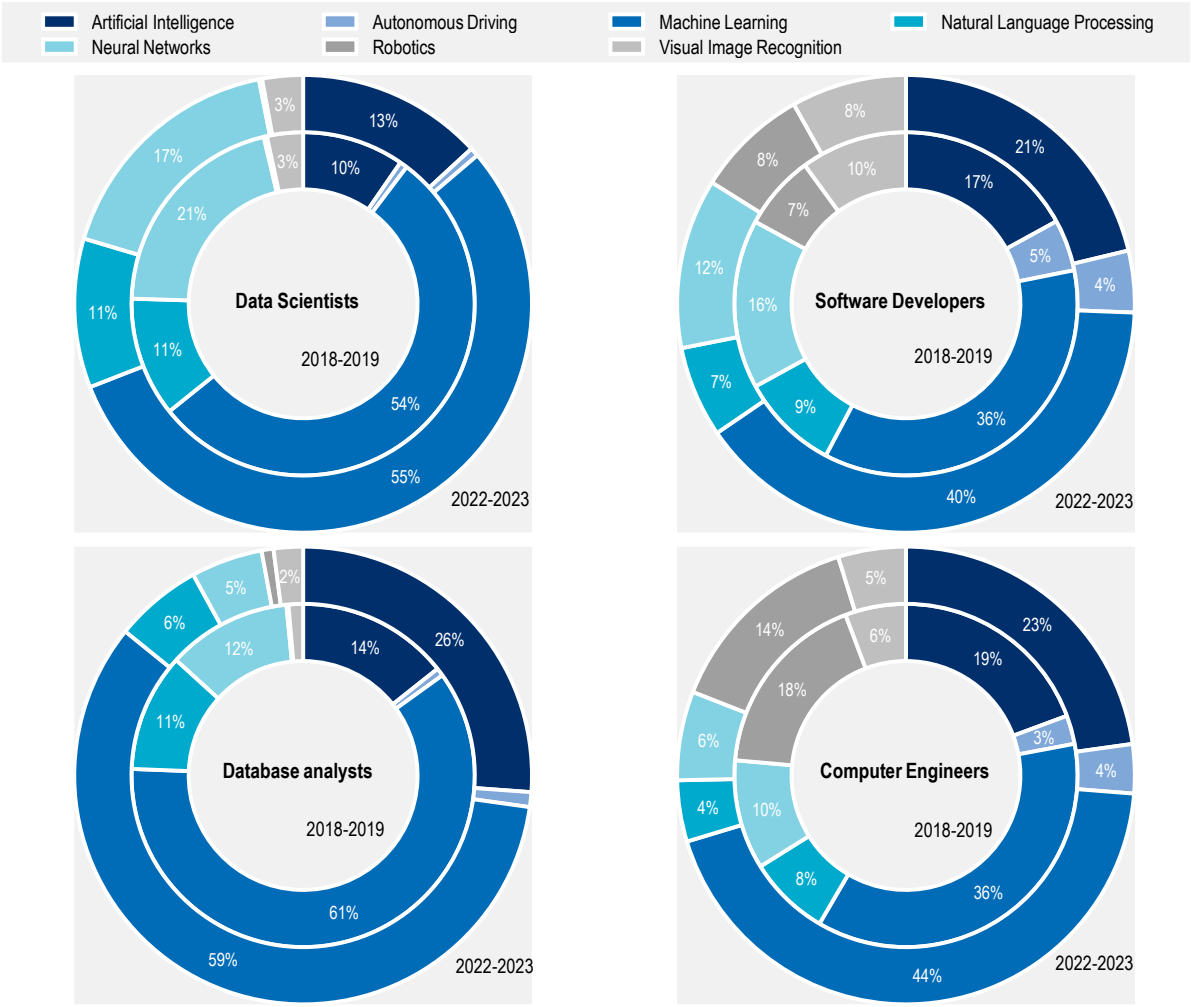
The composition of the demand for AI skills in the Canadian job market varies significantly across different occupations. To highlight these differences, this section examines the demand for AI in OJPs by fields of specialisation, focusing on the top four occupations that most demand AI skills in Canada:[5] data scientists, software developers and programmers, database analysts and data administrators, and computer engineers (excluding software engineers and designers).

Overall, data show that the specific share of AI skills varies by occupation, with a more diverse set of skills demand for software developers and computer engineers. Overall, ML and AI remain the top skills across all periods and occupations, reflecting their foundational role in AI-related jobs. The demand for other AI technologies varies significantly. For instance, data scientists and software developers both heavily rely on ML and AI. Software developers job postings also require significant expertise in Robotics and Visual Image Recognition for developing diverse applications.

Moreover, despite recent developments in the field of AI, the relative share of AI skill demand within each occupation has remained largely consistent over time, with only minor shifts observed (Figure 12). This suggests that, while the overall demand for AI skills is growing, the distribution of the skill demands across different occupations has remained relatively stable.

In conclusion, these differences in AI skills demand across occupations highlight the specialised nature of AI skill demands within each occupation, driven by the unique requirements and applications of their respective fields. Understanding these nuances is crucial for tailoring education and training programmes to meet the evolving needs of the job market. By aligning education and training with the specific AI skill demands of each occupation, professionals can be better equipped to support the digital transformation in their respective industries.

Figure 12. AI skills by field of specialisation in the four most AI-reliant occupations in Canada



Note: The figure illustrates the distribution of AI skills within selected occupations across two periods. The progression of skill requirements over time is depicted with the inner circle reflecting the earliest period (2018-19) and the outer circle representing the most recent data (2022-23). Due to space constraints, the names of some occupations were shortened. Original names are Data Scientists, Software Developers and Programmers, Database Analysts and Data Administrators, and Computer Engineers (except Software Engineers and Designers).
Source: OECD based on Lightcast data.

4.2.1. Data scientists

Data scientist OJPs show a high demand for ML skills, with over 50% of the skill mentions across all periods (see Figure 12, Panel A). The strong emphasis on ML reflects its central role in data science for developing predictive models, performing advanced analytics, and deriving actionable insights from complex datasets. Neural Networks also have a significant presence, though slightly decreasing from 20.8% in 2018-19 to 17.3% in 2022-23. This trend indicates the continued but slightly moderated use of deep learning techniques. NLP skills are essential for text analysis and understanding, though their share has slightly declined to 10.5% in 2022-23. The demand for other AI skills is rare, suggesting that these technologies are less critical for this occupation.

4.2.2. Software developers and programmers

The results presented in Figure 12, Panel B, show that the demand for ML skills is also significant for software developers and programmers, representing around 35-40% of total AI demand in the occupation. General AI skills are also important, reflecting broader AI integration in software development. The mentions of Robotics and Visual Image Recognition skills are higher compared to other top AI occupations, indicating the involvement of software developers in creating applications that require these technologies. For instance, software developers are often tasked with creating the algorithms and control systems allowing robots to perform tasks autonomously (see Box 3).

Box 3. The role of Robotics and Visual Image Recognition in software development

Software developers are often tasked with creating the algorithms and control systems that enable robots to perform tasks autonomously. Real-life applications include industrial automation where robots assemble products on a manufacturing line, perform quality inspections, or manage logistics within a warehouse. An example is the development of software for robotic arms used in automotive manufacturing, where precision and reliability are crucial. These robotic systems rely on sophisticated software to ensure they operate seamlessly, efficiently, and safely alongside human workers.

Another notable application is in the healthcare industry, where robots assist in surgeries, among other uses. Developers create the software that controls surgical robots, allowing surgeons to perform minimally invasive procedures with greater precision and reduced recovery times for patients. The da Vinci Surgical System, for example, uses software developed by engineers to enable complex and minimally invasive surgery (UC Health, 2024[27]). This technology is pivotal in procedures that require high precision, such as cardiac surgery, and it exemplifies the advanced integration of robotics and software development.

Similarly, Visual Image Recognition is increasingly being integrated into various applications, requiring specialised skills from software developers. This technology involves the use of algorithms to interpret and analyse visual data from the physical world. Visual Image Recognition is crucial in the development of autonomous vehicles, which rely on this technology to detect and respond to traffic signs, pedestrians, and other vehicles. Increasingly, software developers create the systems that allow these vehicles to process visual data in real-time, ensuring they can navigate complex driving environments.

In the retail sector, Visual Image Recognition is used to improve inventory management and enhance customer experiences. For example, some retail stores have piloted this technology to allow customers to shop without traditional checkout processes. The software tracks items as they are taken from shelves and adds them to the customer's virtual cart, streamlining the shopping experience. This innovative approach requires robust software development to manage transactions seamlessly.

4.2.3. Database Analysts and Data Administrators

For database analysts and data administrators, ML also dominates the AI skill mentions, with shares consistently around 58-60%. Interestingly, the share of AI systems skills has increased from 14.3% in 2018-19 to 26.2% in 2022-23, reflecting the use of AI technologies in database management. For instance, ML algorithms can automate data cleaning by identifying and correcting inconsistencies, thereby improving data quality and reliability. With that increase, the role of NLP and Neural Networks in the skillset of Database Analysts has decreased. It possibly suggests a shift towards integrating more generalised AI applications that enhance core database functionalities rather than niche, advanced techniques. Also, the

minimal mentions of Robotics and Autonomous Driving skills suggest that these technologies are currently not integral to the database management field.

4.2.4. Computer engineers

Computer engineer OJPs show a distinct pattern with a high demand for ML skills, increasing to 44% of total AI skill mentions in 2022-23. This emphasis reflects their role in developing hardware-software integration and optimising computing systems. AI systems skills are also on the rise (22.8% in 2022-23), indicating Computer Engineers' role in designing AI-driven systems. The request for Robotics skills (14.3% in 2022-23) reflects the involvement of computer engineers in developing and integrating robotic systems (see Box 4).

Box 4. Robotics skill demands for computer engineers

The high demand for Robotics skills among computer engineers underscores their pivotal role in creating the sophisticated software and hardware that enable modern robotic systems. Robotics involves a blend of mechanical engineering, electrical engineering, and computer science. Computer engineers design and develop the control systems and algorithms that allow robots to perform complex tasks autonomously.

In the logistics industry, computer engineers develop software that powers robotic systems used in warehouses for sorting, packing, and transporting goods. Large retailers use autonomous robots to streamline their operations, reducing manual labour and increasing efficiency. These robots navigate warehouse floors, avoid obstacles, and work alongside employees to ensure timely order fulfilment.

In the medical field, computer engineers contribute to the development of robotic prosthetics and rehabilitation devices. These advanced prosthetics incorporate sensors and actuators controlled by algorithms that allow for natural movement and better functionality. For example, robotic exoskeletons, used to aid individuals with mobility impairments, require intricate software systems to provide real-time assistance and adjust to the user's movements.

In agriculture, robotic systems developed by computer engineers are also transforming traditional farming practices. Automated harvesters, for instance, use advanced sensors and AI to identify and pick ripe fruits and vegetables. These robots must navigate through fields, avoid damaging crops, and work efficiently to maximise yield. The integration of robotics into agriculture not only increases productivity but also addresses labour shortages in the sector.

All in all, while the prevalence of ML and AI skills among computer engineers indicates a broad engagement with cutting-edge technologies, the significant presence of Robotics skills highlights a specialised area where their expertise is indispensable.

4.3. Mapping the relationships between AI and other skills in the demands of Canadian employers

This section focuses on the interaction between AI and soft skills like communication and teamwork. This interplay is increasingly critical, as the true potential of AI is realised through the ability to collaborate, communicate, and apply these technologies in ways that are innovative, ethical, and aligned with human needs. To investigate this issue, this section conducts a skill network analysis (Box 5) to map the connections across skills in AI-related OJPs, revealing how soft skills, technical non-AI skills, and AI skills are integrated in occupational demands (see, for instance, Samek, Squicciarini and Cammeraat (2021[13])).

Box 5. Methodological note on the skill network analysis

This study employs a network analysis to provide a comprehensive understanding of how various skills, including AI and non-AI skills, interrelate in the context of AI-related job postings. This analysis leverages data on skill mentions from job postings collected in between 2018 and 2023 and classified as AI-related to construct a graphical representation of the skill bundles defining them.

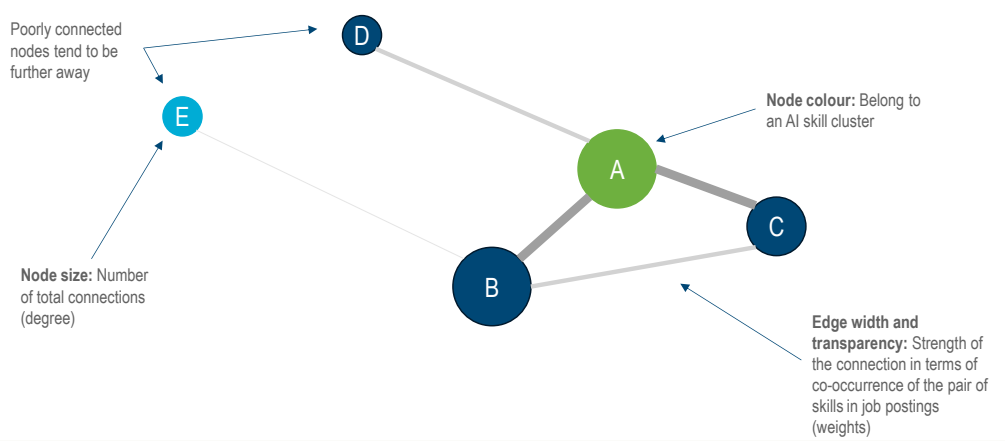
Data preprocessing

To facilitate the presentation and ensure the network relevance, a pre-processing step was applied. First, it involved dropping skills with less than 50 mentions to reduce sparsity. Once created the network, it also involved dropping the least relevant nodes (skills) and edges (connections) based on their degree (number of connections) and weight (strength of connections), respectively (more details in Annex D).

Network construction and graphical representation

The skill network is visualised as a graph (see Figure 13), where nodes represent individual skills and edges represent the connections between them. The characteristics of the nodes and edges provide insights into the structure and dynamics of the skill network:

Figure 13. Example of a network analysis



Source: Authors' elaboration.

- Node size: Represents the number of total connections (weighted degree). Larger nodes indicate skills that are frequently mentioned alongside a diverse range of other skills.
- Node colour: Nodes are coloured based on their AI classification. For instance, skills that belong to an AI skill field are distinguished from other skills.
- Edge width and transparency: The width and transparency of the edges represent the strength of the connection in terms of co-occurrence of the skill pairs in job postings. Thicker and more opaque edges indicate stronger connections.

The resulting network graph provides a visual map of how different skills are interconnected. Poorly connected nodes tend to be positioned further away from the rest, while highly interconnected nodes tend to form clusters. This visualisation helps in identifying central skills that play a pivotal role in the network, as well as peripheral skills that are less frequently connected.

4.3.1. Analysis of the Skills Network in AI-Related Job Postings

The network for AI-related job postings, depicted in Figure 14, provides a picture of how various skills co-occur in the context of AI-related employment in Canada. Most of the technical skills are located to the right of the central node (ML), whilst soft and management skills are located to the left, as indicated by the dashed line in Figure 14. Several interesting observations emerge from this analysis:

- First, the pivotal skills at the centre of the network are ML, AI, computer science, communications, and Python. These nodes are strongly linked with each other, highlighting their central role in the AI job market. ML and AI are foundational connected technologies, due to their joint relevance in developing predictive models, automating decision-making processes, and creating intelligent systems. For instance, AI-driven applications often rely on ML algorithms to improve performance over time, as seen in recommendation systems used by numerous online sales platforms.
- Second, the technical cluster of skills points to the importance of AI roles for systems deployment and software development. This explains the central role of programming language Python, and key connections to ML, data science and programming language, C, also surrounded by software engineering, Java and Amazon Web Services.
- Third, surrounding ML is a second cluster of technical skills associated with data science and data analysis roles. This includes skills such as SQL (a language for managing and querying databases, R (a programming language), data analysis, data science, mathematics and statistics. Other technical skills, such as big data, Apache Spark and Microsoft Azure point to emerging big data and cloud computing roles.
- Fourth, diverse soft skills are also prominent. Communication is part of the core skills in the network. Its strong links with several technical and non-technical skills indicate the importance employers give to abilities to effectively interact and collaborate with other and convey information to different audiences. Problem solving is also prominent, as AI professionals must often troubleshoot issues with algorithms, optimise performance, and adapt solutions to new problems. Finally, management skills figure in the requested AI OJPs, indicating the importance of capabilities to co-ordinate software developers, data scientists, and business analysts.

The findings here echo those of the cross-country analysis of Borgonovi et al. (2023[8]) in showing higher demand for AI professionals that combine technical, and soft skills.

This analysis underscores the multifaceted nature of AI job postings, revealing that AI roles demand a blend of technical and professional skills. This has several important implications:

- For policy makers, employers and AI professionals, the relevance of technical and soft skills in AI-related OJPs suggests that learning curricula should focus on both the technical aspects of AI, such as ML and programming languages, and also train for problem-solving, communication tasks, and project management. By doing so, a data scientist would be better equipped to tackle complex projects that require both technical proficiency and strategic thinking. Moreover, enhancing management skills can prepare AI professionals for leadership roles, enabling them to oversee projects and teams effectively.
- Employers could also consider providing ongoing training opportunities to help employees develop a well-rounded skill set, thereby enhancing their ability to contribute to the organisation's AI initiatives. Employers can support collaborative environment where diverse skills are valued and utilised to help their staff to further improve their soft skills. Collaboration with external partners that bring in technical or organisational capacities can also be contemplated where there are constraints on gathering diverse technical and soft skills within the same company.

4.3.2. Insights from Occupational Skills Networks

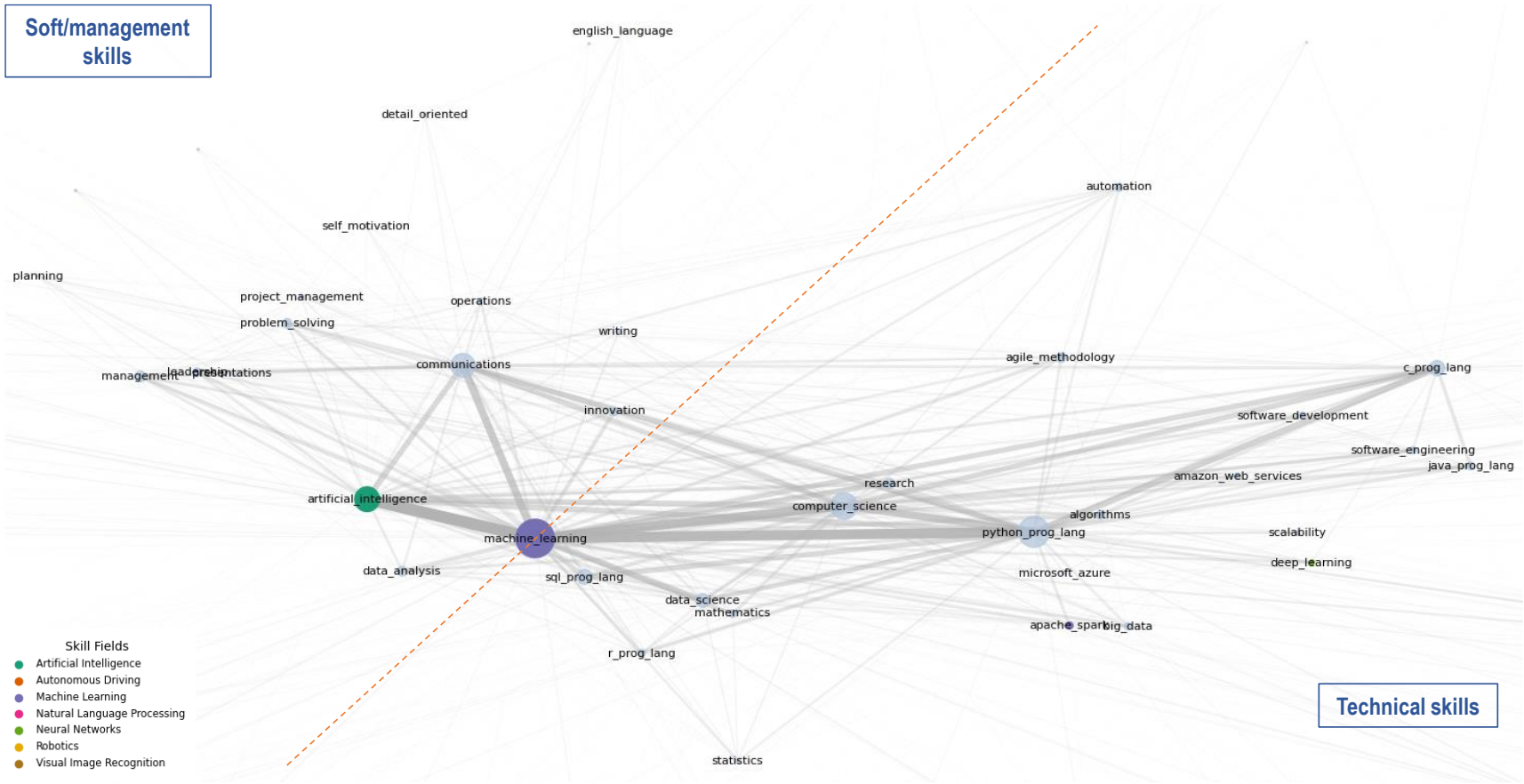
Distinct occupational AI-related OJPs show interesting specificities as compared to the average network, as briefly discussed here. This analysis explores skill networks within specific economic sectors with the highest proportion of AI-related job postings, offering a more granular view of how skill demands vary across different industries.

In the Finance and Insurance sector, the AI-related job postings network is characterised by more diversified and stronger links compared to the network for all AI-related OJPs (see Figure 15). Finance-specific skills, such as risk management, financial services, and finance, are linked to the core AI technical skills, underscoring the wider penetration of AI in the sector and notably in financial analysis, risk assessment, and decision support systems. Professional skills like problem-solving, management, and leadership also show strong connections, indicating their relevance in navigating the intricate financial services landscape and to successful AI project implementation. This sector's emphasis on a diverse skill set reflects the critical role AI plays in enhancing financial operations, from fraud detection and customer service automation to sophisticated investment strategies.

The Manufacturing sector's AI skills network shows a distinct pattern. The strong presence of skills related to automation and computer engineering reflects the sector's focus on enhancing productivity and efficiency through advanced AI technologies (Figure 16). In particular, the programming language C plays a core role in this network, showing strong connection with technical and soft skills. Robust connections with other technical skills such as computer vision, deep learning, TensorFlow, and computer engineering also indicate the integration of advanced AI technologies in manufacturing operations. Soft skills such as communication, management, leadership and problem-solving are prominently linked to the core technical skills, illustrating the sector's need for effective communication and management to co-ordinate complex manufacturing processes and ensure smooth operation of AI-driven systems.

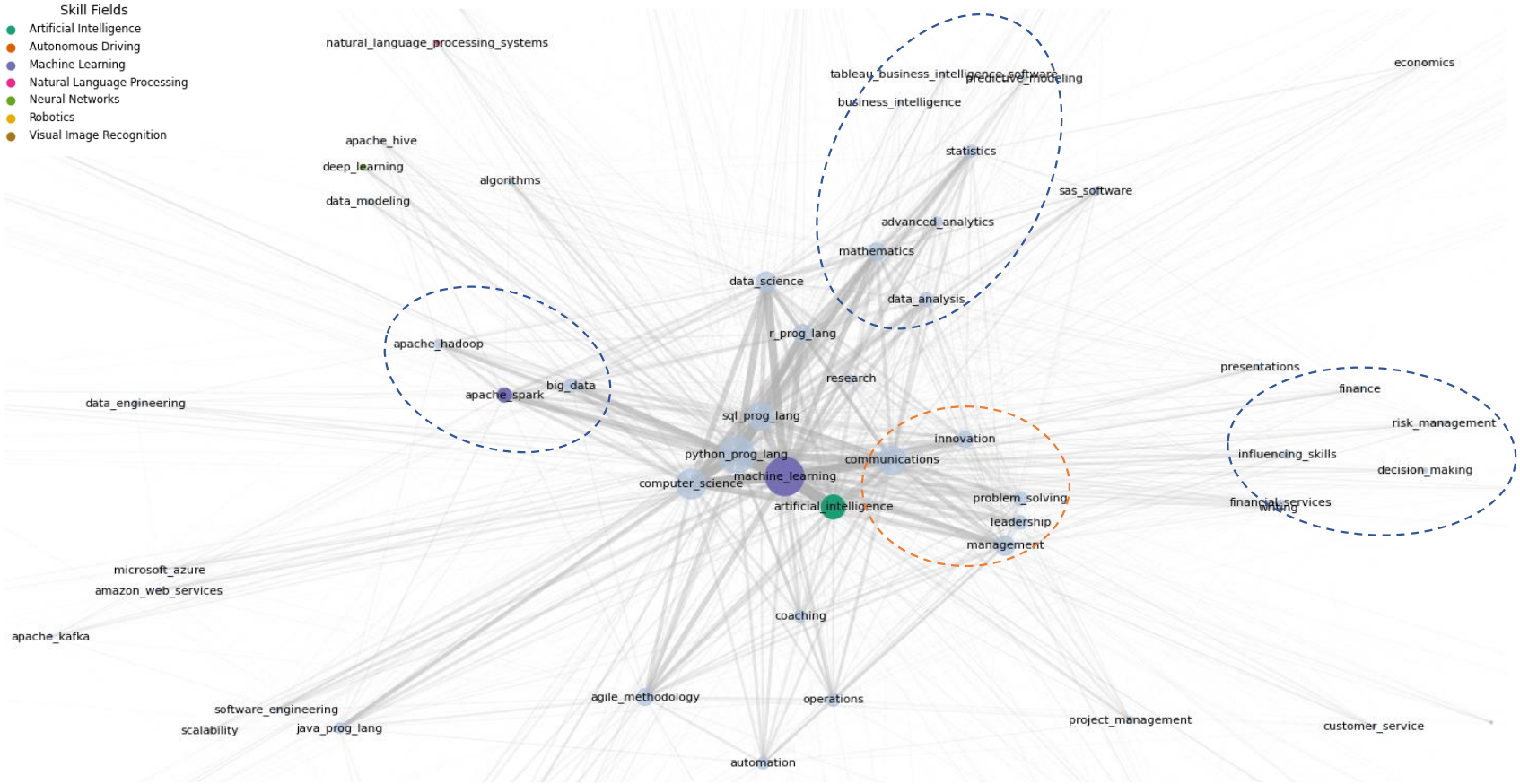
Finally, the skills network for AI-related job postings in the Professional, Scientific, and Technical Services sector (see Figure 17) is the closest to the general AI-related OJP network, with ML playing a central role. The core of the network features strong connections among ML, AI, Python, computer science, communications, and data science. Additionally, the network reveals a prominent cluster of business and management skills, such as leadership, innovation, and project management that is linked to the technical core. Other technical skills, including big data, SQL, C (programming language) and data engineering techniques, point to their role in managing and processing large datasets essential for AI applications.

Figure 14. AI skills network in Canada (2018-23)



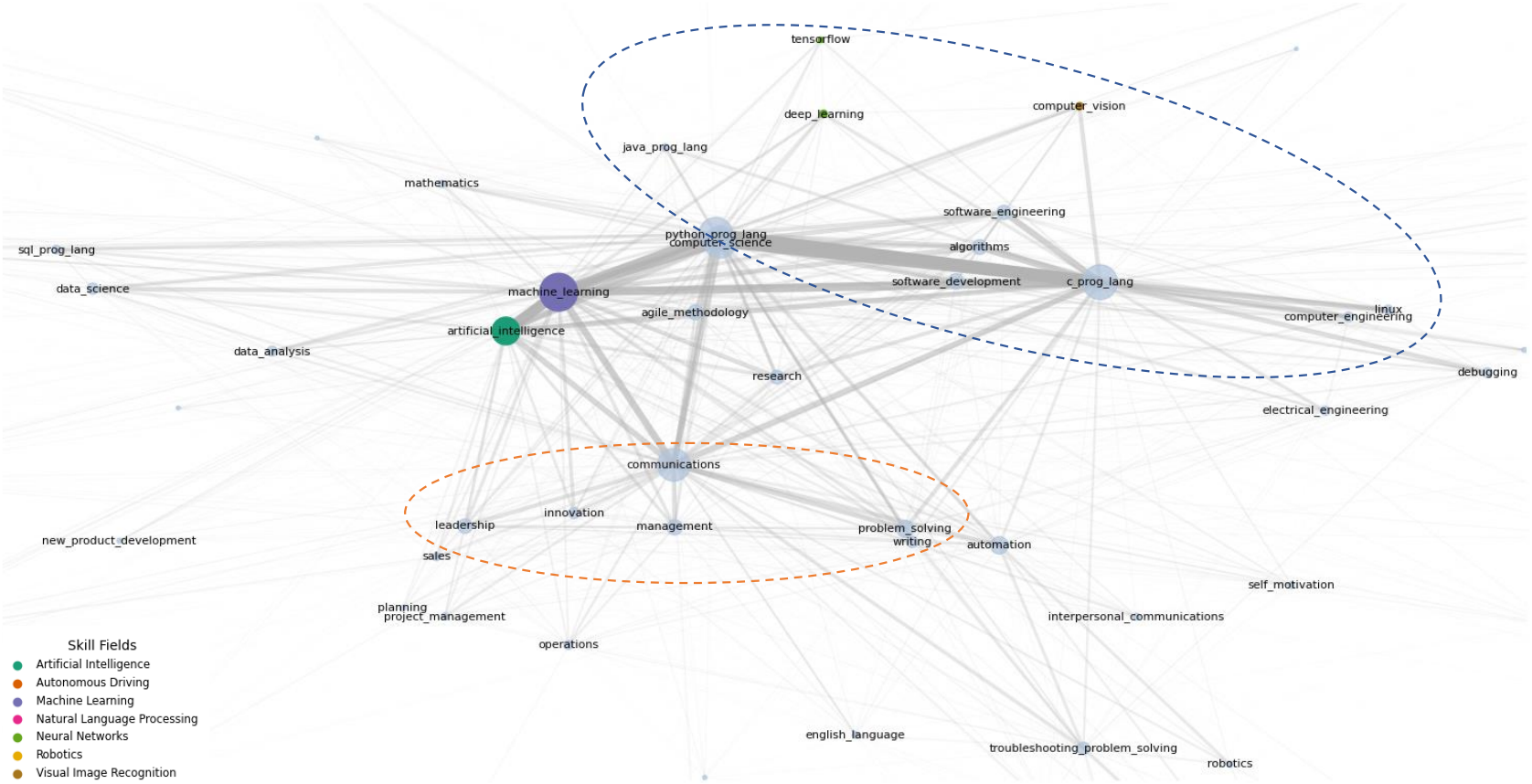
Note: The network depicted consists of 170 skills (nodes) and 1 800 connections (edges). This is the result of filtering out, in this order, edges with fewer than 600 co-occurrences and nodes within the 20th percentile according to their total number of connections (degree). Therefore, this visual representation focuses on the most relevant connections defining AI roles in Canada. The figure zooms in on the centre of the network to facilitate the presentation of the results.
Source: OECD based on Lightcast data.

Figure 15. Skills network – AI-related job postings in Finance and insurance



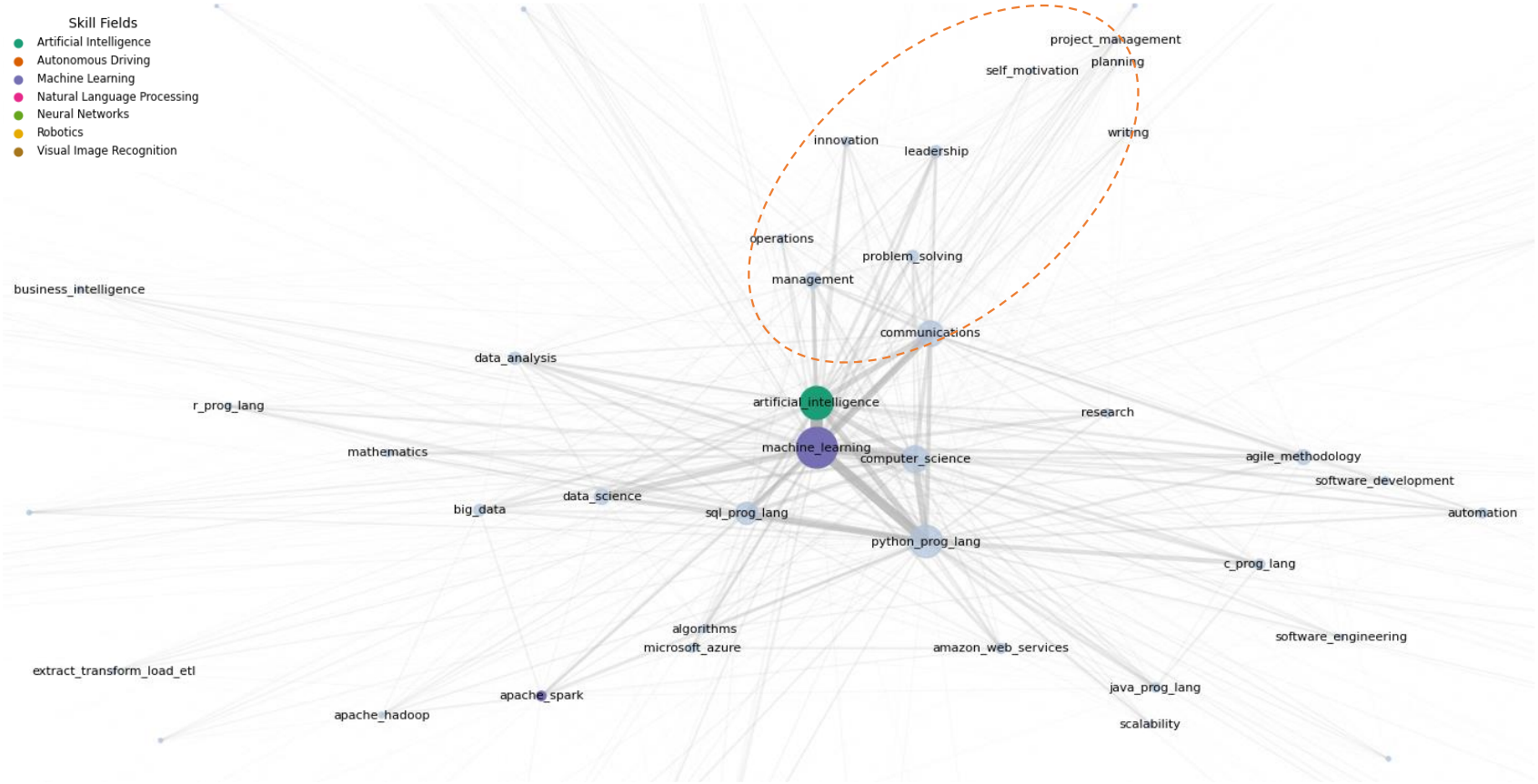
Note: The network depicted consists of 119 skills (nodes) and 2 105 connections (edges). This is the result of filtering out, in this order, edges with fewer than 100 co-occurrences and nodes within the 20th percentile according to their total number of connections (degree). Therefore, this visual representation focuses on the most relevant connections defining AI roles in the sector. The figure zooms in on the centre of the network to facilitate the presentation of the results.
Source: OECD based on Lightcast data.

Figure 16. Skills network – AI-related job postings in Manufacturing



Note: The network depicted consists of 116 skills (nodes) and 1 643 connections (edges). This is the result of filtering out, in this order, edges with fewer than 100 co-occurrences and nodes within the 20th percentile according to their total number of connections (degree). Therefore, this visual representation focuses on the most relevant connections defining AI roles in the sector. The figure zooms in on the centre of the network to facilitate the presentation of the results.
Source: OECD based on Lightcast data.

Figure 17. Skills network – AI-related job postings in Professional, Scientific, and Technical Services



Note: The network depicted consists of 116 skills (nodes) and 1 573 connections (edges). This is the result of filtering out, in this order, edges with fewer than 100 co-occurrences and nodes within the 20th percentile according to their total number of connections (degree). Therefore, this visual representation focuses on the most relevant connections defining AI roles in the sector. The figure zooms in on the centre of the network to facilitate the presentation of the results.
Source: OECD based on Lightcast data.

5 Conclusions and policy remarks

The analysis of AI-related job postings in Canada offers insights into the evolving landscape of AI talent demand and its penetration across the economy, resulting in the following core findings:

- While still relatively small, demand saw a steady increase until 2021. A slowdown in demand growth occurred in 2022-23, likely due to economic uncertainties and layoffs in tech companies, a trend observed in other countries as well. As AI continues to integrate into various technologies and new AI-powered systems enter the market, a future increase in demand for AI skills is likely.
- Moreover, the concentration of demand for AI talent in specific occupations, particularly for data scientists, underscores the specialised nature of these roles. Alongside data scientists, other occupations such as software developers, data administrators and computer engineers are among those where AI-related skills are in highest demand in Canada.
- At the same time, as AI technologies spread across the economy, talent in deployment roles – aimed at integrating AI models and tools into existing systems – is likely to grow in importance in the country's AI labour market. Certain AI fields, such as machine learning (ML), as well as areas like natural language processing (NLP) and visual image recognition, have made significant progress, leading to broader traction and wider industry adoption.
- The analysis of the co-occurrence among different types of skills emphasises the importance of complementary professional skills like communication, problem-solving, and management. It highlights the need for curricula and training approaches that support the acquisition of multiple technical and soft skills. Professionals possessing a broader set of skills, beyond just the technical, will be of greatest value to firms.

While the analysis primarily focused on producing data-driven evidence, the following policy perspectives are nonetheless worth noting.

- Providing tailored education and training programmes to address AI skill demand. While skills in ML are foundational to using AI, some occupations show a still more diverse set of required skills, including the Robotics and Visual Image Recognition fields. Identifying these nuances is essential for designing education and training programmes that align with the evolving demands of the job market.
- Promoting flexible pathways for AI skills acquisition and addressing skill gaps is key. Short, targeted non-formal programmes, developed in partnership with industry leaders, can help address specific skill gaps, while apprenticeships and on-the-job training can provide valuable practical experience and equip students with essential soft skills. This approach is particularly beneficial for those firms that face difficulties in sourcing AI talent, due to high costs and scarcity of skilled professionals, before AI solutions become commercially viable. Supporting internships can be one way to support these firms with AI needs while, at the same time, giving young people with AI skills the work experience that they may need to build their careers.
- Integrating AI training across sectoral- and domain-specific training as AI becomes more widely deployed across professions is becoming a priority. The evidence provided in this study on the Finance and Insurance sector, where AI has penetrated widely, shows that employers seek technical expertise, soft skills and domain expertise relevant to specific sectors. As AI penetrates

a wider range of sectors, the need for integrated programmes that address AI as part of domain-specific training will become essential for future success (Paunov and Planes-Satorra, 2019[28]).

- Helping firms better assess their AI needs is also very important. An international firm-level survey on the use of AI in firms, including Canadian enterprises, suggests that an important share of small and medium-sized enterprises do not fully understand their AI skills needs, and consequently cannot easily assess which AI skills would best support their enterprise (OECD/BCG/INSEAD, forthcoming[29]). Consequently, assisting such enterprises in developing AI strategies that best support their business is an important fist step. Relevant public support in this area involve strengthening information flows and co-ordination among employers, industry skills councils, and education and training providers to address potential AI skill mismatches. It also involves support for the provision of such education and training programmes.
- Producing timely and detailed data to track AI skills demand in Canada to inform the type and scale of education and training needs will help face future challenges. This paper shows how big data can be used to achieve this goal, creating granular and timely indicators that could be used to track the evolving AI landscape in Canada. Digital systems that monitor AI skills demand in real time can serve to provide critical evidence for designing targeted training programmes, enabling a timely response to the rapidly evolving needs of this dynamic field.

Notes

[1] The OECD defines an AI system as "*… a machine-based system that, for explicit or implicit objectives, infers, from the input it receives, how to generate outputs such as predictions, content, recommendations, or decisions than can influence physical or virtual environments*" (OECD, 2024[31]).

[2] The authors extract relevant keywords listed in scientific publications classified as AI in bibliographic databases. Text mining techniques allow for identifying additional keywords available in publications' titles and abstracts.

[3] These occupations are in the NOC 2021 as the Natural and Applied Sciences broad occupational category (code 2).

[4] Robotics is an interdisciplinary field that combines mechanical engineering, electrical engineering, and computer science to design, build, and operate automated systems.

[5] See Section 3 of this study.

References

Acemoglu, D. et al. (2022), "Artificial Intelligence and Jobs: Evidence from Online Vacancies", *Journal of Labor Economics*, pp. 293-340, https://doi.org/10.1086/718327. [11]

Alekseeva, L. et al. (2021), "The demand for AI skills in the labor market", *Labour Economics*, Vol. 71, p. 102002, https://doi.org/10.1016/j.labeco.2021.102002. [12]

Baruffaldi, S. et al. (2020), "Identifying and measuring developments in artificial intelligence: Making the impossible possible", *OECD Science, Technology and Industry Working Papers*, No. 2020/05, OECD Publishing, Paris, https://doi.org/10.1787/5f65ff7e-en. [15]

Borgonovi, F. et al. (2023), "Emerging trends in AI skill demand across 14 OECD countries", *OECD Artificial Intelligence Papers*, No. 2, OECD Publishing, Paris, https://doi.org/10.1787/7c691b9a-en. [8]

Calvino, F. et al. (2024), "A sectoral taxonomy of AI intensity", *OECD Artificial Intelligence Papers*, No. 30, OECD Publishing, Paris, https://doi.org/10.1787/1f6377b5-en. [23]

Cammeraat, E. and M. Squicciarini (2021), "Burning Glass Technologies' data use in policy-relevant analysis: An occupation-level assessment", *OECD Science, Technology and Industry Working Papers*, No. 2021/05, OECD Publishing, Paris, https://doi.org/10.1787/cd75c3e7-en. [6]

Carnevale, A., T. Jayasundera and D. Repnikov (2014), "Understanding Online Job Ads Data: A Technical Report", *Georgetown University, Center on Education and the Workforce*, https://cew.georgetown.edu/wp-content/uploads/2014/11/OCLM.Tech_.Web_.pdf. [5]

Deloitte (2023), *Impact and opportunities: Canada's AI ecosystem*, https://www2.deloitte.com/ca/en/pages/deloitte-analytics/articles/impact-and-opportunities-canadas-ai-ecosystem-2023.html (accessed on 26 June 2024). [21]

Green, A. (2024), "Artificial intelligence and the changing demand for skills in Canada: The increasing importance of social skills", *OECD Artificial Intelligence Papers*, No. 17, OECD Publishing, Paris, https://doi.org/10.1787/1b20cdb6-en. [22]

Green, A. and L. Lamby (2023), "The supply, demand and characteristics of the AI workforce across OECD countries", *OECD Social, Employment and Migration Working Papers*, No. 287, OECD Publishing, Paris, https://doi.org/10.1787/bb17314a-en. [9]

Indeed Hiring Lab (2023), *Canadian Labour Market Update: Second Quarter 2023*, https://www.hiringlab.org/en-ca/2023/07/25/canadian-labour-market-update-second-quarter-2023/ (accessed on 20 June 2024). [18]

ISED (2024), *Consultation on Artificial Intelligence (AI) Compute*, https://ised-isde.canada.ca/site/ised/en/public-consultations/consultation-artificial-intelligence-ai-compute (accessed on 19 September 2024). [1]

Lightcast (2024), *The Lightcast Global AI Skills Outlook*, https://lightcast.io/resources/research/the-lightcast-global-ai-skills-outlook (accessed on 19 August 2024). [16]

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. [10]

Montagnier, P. and I. Ek (2021), "AI measurement in ICT usage surveys: A review", *OECD Digital Economy Papers*, No. 308, OECD Publishing, Paris, https://doi.org/10.1787/72cce754-en. [24]

OECD (2024), "Explanatory memorandum on the updated OECD definition of an AI system", *OECD Artificial Intelligence Papers*, No. 8, OECD Publishing, Paris, https://doi.org/10.1787/623da898-en. [31]

OECD (2024), *OECD Digital Economy Outlook 2024 (Volume 1): Embracing the Technology Frontier*, OECD Publishing, Paris, https://doi.org/10.1787/a1689dc5-en. [25]

OECD.AI (2025), *AI talent concentration by country. Visualization powered by JSI, using data from LinkedIn*, https://oecd.ai/en/ (accessed on 17 January 2025). [3]

OECD.AI (2024), *AI research publications time series by country. visualization powered by JSI, using data from OpenAlex https://openalex.org/*, http://www.oecd.ai (accessed on 21 June 2024). [2]

OECD.AI (2024), *Demographics of AI professionals by gender. Visualisation powered by Tableau using data from Stack Overflow Survey. Supported by the Patrick J. McGovern foundation*, https://oecd.ai/en/ (accessed on 27 August 2024). [4]

OECD/BCG/INSEAD (forthcoming), *The adoption of artificial intelligence in firms: New evidence for policymaking*. [29]

Paunov, C. and S. Planes-Satorra (2019), "How are digital technologies changing innovation?: Evidence from agriculture, the automotive industry and retail", *OECD Science, Technology and Industry Policy Papers*, No. 74, OECD Publishing, Paris, https://doi.org/10.1787/67bbcafe-en. [28]

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. [13]

Sanofi-Aventis Canada (2022), *Sanofi to Launch Artificial Intelligence Centre of Excellence in Toronto*, https://sanoficanada.mediaroom.com/2022-06-22-Sanofi-to-Launch-Artificial-Intelligence-Centre-of-Excellence-in-Toronto (accessed on 4 November 2024). [26]

Scale AI (2023), *AI at Scale: How Canada Can Build an AI-Powered Economy*, https://www.scaleai.ca/aiatscale-2023/ (accessed on 26 June 2024). [20]

Squicciarini, M. and H. Nachtigall (2021), "Demand for AI skills in jobs: Evidence from online job postings", *OECD Science, Technology and Industry Working Papers*, No. 2021/03, OECD Publishing, Paris, https://doi.org/10.1787/3ed32d94-en. [14]

Statistics Canada (2024), *Table 14-10-0325-01 Job vacancies, payroll employees, job vacancy rate, and average offered hourly wage by provinces and territories, quarterly, unadjusted for seasonality*, https://doi.org/10.25318/1410032501-eng (accessed on 1 March 2024). [30]

Statistics Canada (2023), *The daily: Labour Force Survey, May 2023*, https://www150.statcan.gc.ca/n1/daily-quotidien/230609/dq230609a-eng.htm (accessed on 20 June 2024). [17]

Tsvetkova, A. et al. (2024), "How well do online job postings match national sources in large English speaking countries?: Benchmarking Lightcast data against statistical sources across regions, sectors and occupations", *OECD Local Economic and Employment Development (LEED) Papers*, No. 2024/01, OECD Publishing, Paris, https://doi.org/10.1787/c17cae09-en. [7]

UC Health (2024), *About the daVinci Surgical System*, https://www.uchealth.com/services/robotic-surgery/patient-information/davinci-surgical-system/ (accessed on 19 August 2024). [27]

World Economic Forum (2023), *Future of Jobs Report 2023*, https://www.weforum.org/publications/the-future-of-jobs-report-2023/ (accessed on 20 June 2024). [19]

Annex A. Representativeness of Lightcast job posting data for Canada

OJPs provide high-frequency, real-time and detailed information useful to track labour market demand and identify changes in skill demands. However, job postings are web-scraped unstructured data that do not follow any specific collection methodology that guarantees they represent the universe of job vacancies available in a country. Assessing the representativeness of OJPs is essential to support the conclusions derived from the analysis of the information extracted.

Canada is one of the few countries publishing official data on job vacancies with different levels of detail (by province, region, occupational category, year, quarter, etc.). Statistics Canada collects information on job vacancies under the following definition:

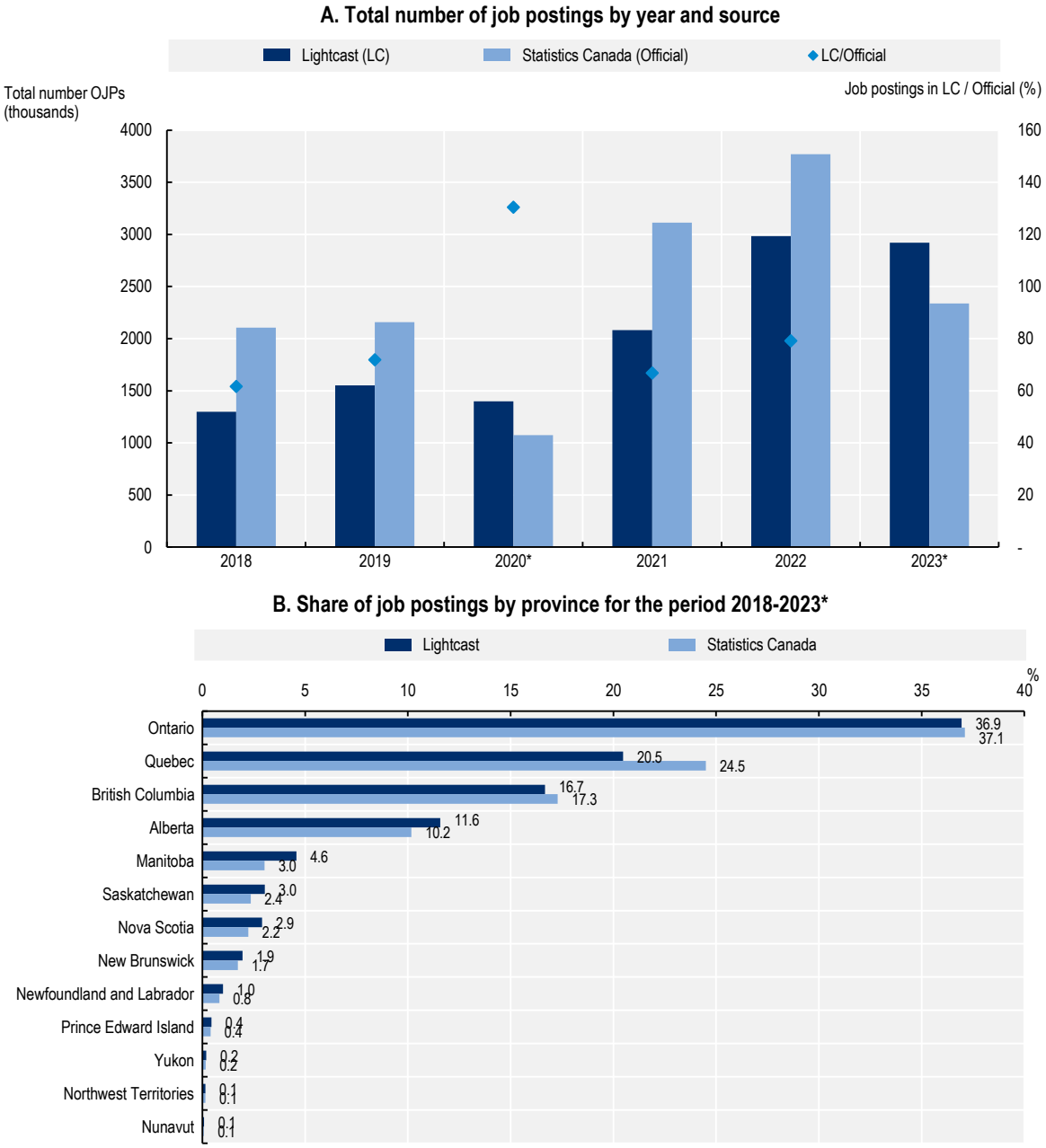
> *''A job is vacant if it meets the following conditions: it is vacant on the reference date (first day of the month) or will become vacant during the month; there are tasks to be carried out during the month for the job in question; and the employer is actively seeking a worker outside the organisation to fill the job. The jobs could be full-time, part-time, permanent, temporary, casual, or seasonal. Jobs reserved for subcontractors, external consultants, or other workers who are not considered employees, are excluded.'' (Statistics Canada, 2024[30])*

In consequence, OJPs are likely to represent a fraction of the official job vacancies, as some of the job opportunities depend on more traditional or word-of-mouth channels to be shared. Figure A A.1 shows that job postings collected by Lightcast represent, on average, 70% of the total job vacancies reported annually by Statistics Canada during the period 2018-2023. In 2022 this share was 80%, the highest for the period of analysis after excluding 2020 and 2023 as information for some quarters in these years was not available at the moment of retrieving the data.

Previous analyses have explored the representativeness of Lightcast data for Canada across different levels of aggregation. For instance, Tsvetkova et al. (2024[7]) show that occupational groups such as Business, Finance and Administration and Management are overrepresented in job postings data for Canada, exceeding the shares in official data by 2-6 percentage points. The report also assesses the regional representativeness of Lightcast data, emphasising the underrepresentation of the province of Québec in this data, with a share 13 percentage points below that extracted from official statistics.

Recently, Lightcast have incorporated historical information of OJPs advertised in French to the Canadian database. The database used in this document includes these job postings in French. Lightcast algorithms for analysing texts in French ensures that these new observations follow a similar process of deduplication, cleaning, and feature extraction. Panel B in Figure A A.1 shows that, overall, Lightcast data across regions are well aligned in relative terms with official job vacancy data. Although Québec's share is still 4 percentage points below official data, it represents a significant improvement compared to the previous gap reported by Tsvetkova et al. (2024[7]).

Figure A A.1. Job postings in Canada



Note: Official data is available online in Statistics Canada. *Statistics Canada did not report data for 2020-Q2 and 2023-Q3. Last update of official data (March 2024) includes information up to 2023-Q3.
Source: OECD based on Lightcast data and Statistics Canada. Table 14-10-0325-01 Job vacancies, payroll employees, job vacancy rate, and average offered hourly wage by provinces and territories, quarterly, unadjusted for seasonality (March 2024) https://doi.org/10.25318/1410032501-eng.

Annex B. List of AI skills

The list used for classifying job postings as AI-related is based on Borgonovi et al. (2023[8]). 76 additional keywords classified in the LST as part of the AI and ML, Image NLP or Robotics subcategories, but not available in the original list, were added to the final version.

This list classifies each AI skill into one of seven AI fields of specialisation. The broader field called *Artificial Intelligence Systems* includes different types of AI-powered systems such as *Chat GPT*, *chatbots* or *Microsoft Cortana*. A slight difference of the list used in this document, compared to the original, is that the keyword *chatbot* was included in this group instead of being in the *NLP* field. The rest of AI fields gather AI skills in relevant topics necessary to develop AI systems. Below is the definition provided by Borgonovi et al. (2023[8]) for each field:

- *Autonomous Driving* focuses on the development of vehicles operating and navigating without human intervention and involves, e.g. sensors and control systems.
- *Machine Learning* enables learning from experience without explicit programming to make predictions based on identified patterns, e.g. recommendations provided by online platforms.
- *Natural Language Processing* deals with the interaction between computers and human language, allowing for e.g. language translation or chatbots.
- *Neural Networks* are a type of ML model inspired by the structure of the human brain, these models are used, e.g. to detect fraudulent activities or diseases.
- *Robotics* focuses on the design and construction of devices that can (semi-)autonomously perform physical tasks, e.g. autonomous drones and humanoid robots.
- *Visual Image Recognition* refers to the use of algorithms to analyse and interpret visual data, such as images or videos.

In the original list, each AI skill was classified as generic or specific. Generic skills refer to those AI skills that can be common in roles using AI systems but not necessarily developing them. For instance*, ML*, *applications of AI* or *sentiment analysis*. In contrast, specific skills include AI skills related with more specific applications or methods, such as *gaussian process*, *transformers* or *Apache Spark*. This classification is essential in the classification of OJPs as AI-related.

Table A B.1. List of AI skills grouped by AI field and category

Skill	AI Skill Field	Category	Original/Added
AIOps (Artificial Intelligence for IT Operations)	Artificial Intelligence Systems	specific	Original
Applications of Artificial Intelligence	Artificial Intelligence Systems	generic	Original
Artificial General Intelligence	Artificial Intelligence Systems	generic	Original
Artificial Intelligence	Artificial Intelligence Systems	generic	Original
Artificial Intelligence Development	Artificial Intelligence Systems	generic	Original
Artificial Intelligence Markup Language (AIML)	Artificial Intelligence Systems	specific	Original
Artificial Intelligence Systems	Artificial Intelligence Systems	generic	Original
Azure Cognitive Services	Artificial Intelligence Systems	specific	Original
Baidu	Artificial Intelligence Systems	generic	Original
Cognitive Automation	Artificial Intelligence Systems	specific	Original
Cognitive Computing	Artificial Intelligence Systems	specific	Original
Computational Intelligence	Artificial Intelligence Systems	specific	Original

Skill	AI Skill Field	Category	Original/Added
Cortana	Artificial Intelligence Systems	generic	Original
Expert Systems	Artificial Intelligence Systems	generic	Original
Intelligent Control	Artificial Intelligence Systems	generic	Original
Intelligent Systems	Artificial Intelligence Systems	generic	Original
Interactive Kiosk	Artificial Intelligence Systems	generic	Original
IPSoft Amelia	Artificial Intelligence Systems	specific	Original
Knowledge-Based Configuration	Artificial Intelligence Systems	generic	Original
Knowledge-Based Systems	Artificial Intelligence Systems	generic	Original
Multi-Agent Systems	Artificial Intelligence Systems	generic	Original
Open Neural Network Exchange (ONNX)	Artificial Intelligence Systems	specific	Original
OpenAI Gym	Artificial Intelligence Systems	specific	Original
Reasoning Systems	Artificial Intelligence Systems	specific	Original
Soft Computing	Artificial Intelligence Systems	generic	Original
Watson Conversation	Artificial Intelligence Systems	generic	Original
Watson Studio	Artificial Intelligence Systems	specific	Original
Weka	Artificial Intelligence Systems	generic	Original
Chatbot	Artificial Intelligence Systems	generic	Original
Swarm Intelligence	Artificial Intelligence Systems	specific	Added
Generative Artificial Intelligence	Artificial Intelligence Systems	generic	Added
Ethical AI	Artificial Intelligence Systems	generic	Added
ModelOps	Artificial Intelligence Systems	generic	Added
Explainable AI (XAI)	Artificial Intelligence Systems	generic	Added
Embedded Intelligence	Artificial Intelligence Systems	generic	Added
Voice Assistant Technology	Artificial Intelligence Systems	generic	Added
AI Copywriting	Artificial Intelligence Systems	generic	Added
Speech Synthesis	Artificial Intelligence Systems	generic	Added
ChatGPT	Artificial Intelligence Systems	generic	Added
Knowledge Engineering	Artificial Intelligence Systems	generic	Added
Bot Framework	Artificial Intelligence Systems	specific	Added
Nuance Mix	Artificial Intelligence Systems	specific	Added
Conversational AI	Artificial Intelligence Systems	generic	Added
Advanced Driver Assistance Systems	Autonomous Driving	generic	Original
Autonomous Cruise Control Systems	Autonomous Driving	specific	Original
Autonomous System	Autonomous Driving	specific	Original
Autonomous Vehicles	Autonomous Driving	specific	Original
Guidance Navigation and Control Systems	Autonomous Driving	generic	Original
Light Detection and Ranging (LiDAR)	Autonomous Driving	generic	Original
OpenCV	Autonomous Driving	specific	Original
Path Analysis	Autonomous Driving	generic	Original
Path Finding	Autonomous Driving	generic	Original
Remote Sensing	Autonomous Driving	generic	Original
Unmanned Aerial Systems (UAS)	Autonomous Driving	generic	Original
Unmanned Underwater Vehicles	Autonomous Driving	generic	Added
Automated Guided Vehicle (Unmanned Ground Vehicles)	Autonomous Driving	generic	Added
Collision Detection	Autonomous Driving	generic	Added
ArduPilot (Autopilot System)	Autonomous Driving	specific	Added
PX4 Autopilot	Autonomous Driving	specific	Added
AdaBoost (Adaptive Boosting)	Machine Learning	generic	Original
Apache MADlib	Machine Learning	specific	Original
Apache Mahout	Machine Learning	specific	Original
Apache SINGA	Machine Learning	generic	Original
Apache Spark	Machine Learning	generic	Original

Skill	AI Skill Field	Category	Original/Added
Association Rule Learning	Machine Learning	specific	Original
Automated Machine Learning	Machine Learning	specific	Original
Autonomic Computing	Machine Learning	generic	Original
AWS SageMaker	Machine Learning	specific	Original
Azure Machine Learning	Machine Learning	specific	Original
Boosting	Machine Learning	generic	Original
CHi-Squared Automatic Interaction Detection (CHAID)	Machine Learning	specific	Original
Cluster Analysis	Machine Learning	specific	Original
Collaborative Filtering	Machine Learning	specific	Original
Confusion Matrix	Machine Learning	generic	Original
Cyber-Physical Systems	Machine Learning	generic	Original
Dask (Software)	Machine Learning	generic	Original
Data Classification	Machine Learning	generic	Original
Dbscan	Machine Learning	specific	Original
Decision Models	Machine Learning	specific	Original
Decision Tree Learning	Machine Learning	specific	Original
Dimensionality Reduction	Machine Learning	specific	Original
Dlib (C++ Library)	Machine Learning	specific	Original
Ensemble Methods	Machine Learning	specific	Original
Evolutionary Programming	Machine Learning	generic	Original
Expectation Maximization Algorithm	Machine Learning	specific	Original
Feature Engineering	Machine Learning	specific	Original
Feature Extraction	Machine Learning	specific	Original
Feature Learning	Machine Learning	specific	Original
Feature Selection	Machine Learning	generic	Original
Gaussian Process	Machine Learning	generic	Original
Genetic Algorithm	Machine Learning	specific	Original
Google AutoML	Machine Learning	specific	Original
Google Cloud ML Engine	Machine Learning	specific	Original
Gradient Boosting	Machine Learning	specific	Original
H2O.ai	Machine Learning	specific	Original
Hidden Markov Model	Machine Learning	generic	Original
Hyperparameter Optimization	Machine Learning	specific	Original
Inference Engine	Machine Learning	specific	Original
K-Means Clustering	Machine Learning	specific	Original
Kernel Methods	Machine Learning	generic	Original
Kubeflow	Machine Learning	specific	Original
LIBSVM	Machine Learning	specific	Original
Machine Learning	Machine Learning	generic	Original
Machine Learning Algorithms	Machine Learning	generic	Original
Markov Chain	Machine Learning	generic	Original
Matrix Factorization	Machine Learning	generic	Original
Meta Learning	Machine Learning	generic	Original
Microsoft Cognitive Toolkit (CNTK)	Machine Learning	specific	Original
MLflow	Machine Learning	specific	Original
MLOps (Machine Learning Operations)	Machine Learning	specific	Original
mlpack (C++ Library)	Machine Learning	specific	Original
Naive Bayes Classifier	Machine Learning	generic	Original
Perceptron	Machine Learning	generic	Original
Predictionio	Machine Learning	specific	Original
PyTorch (Machine Learning Library)	Machine Learning	specific	Original
Random Forest Algorithm	Machine Learning	specific	Original

Skill	AI Skill Field	Category	Original/Added
Recommender Systems	Machine Learning	specific	Original
Reinforcement Learning	Machine Learning	specific	Original
Scikit-Learn (Python Package)	Machine Learning	specific	Original
Semi-Supervised Learning	Machine Learning	specific	Original
Soft Computing	Machine Learning	generic	Original
Sorting Algorithm	Machine Learning	specific	Original
Supervised Learning	Machine Learning	specific	Original
Support Vector Machine	Machine Learning	specific	Original
Test Datasets	Machine Learning	generic	Original
Torch (Machine Learning)	Machine Learning	generic	Original
Training Datasets	Machine Learning	generic	Original
Transfer Learning	Machine Learning	specific	Original
Unsupervised Learning	Machine Learning	specific	Original
Vowpal Wabbit	Machine Learning	specific	Original
Xgboost	Machine Learning	specific	Original
Fuzzy Set	Machine Learning	generic	Added
Q Learning	Machine Learning	specific	Added
Bayesian Networks	Machine Learning	generic	Added
DeviceNet	Machine Learning	specific	Added
Hierarchical Clustering	Machine Learning	specific	Added
Evolutionary Algorithm	Machine Learning	specific	Added
Particle Swarm Optimization	Machine Learning	specific	Added
Genetic Programming	Machine Learning	specific	Added
Differential Evolution	Machine Learning	specific	Added
Adversarial Machine Learning	Machine Learning	specific	Added
CatBoost (Machine Learning Library)	Machine Learning	specific	Added
Machine Learning Methods	Machine Learning	generic	Added
Machine Learning Model Monitoring and Evaluation	Machine Learning	generic	Added
Machine Learning Model Training	Machine Learning	generic	Added
AWS Certified Machine Learning Specialty	Machine Learning	specific	Added
AI/ML Inference	Machine Learning	generic	Added
Shogun	Machine Learning	specific	Added
Loss Functions	Machine Learning	generic	Added
Objective Function	Machine Learning	generic	Added
Theano (Software)	Machine Learning	specific	Added
Mnist	Machine Learning	generic	Added
PyTorch Lightning	Machine Learning	specific	Added
Amazon Textract	Natural Language Processing	specific	Original
ANTLR	Natural Language Processing	generic	Original
BERT (NLP Model)	Natural Language Processing	specific	Original
Computational Linguistics	Natural Language Processing	generic	Original
DeepSpeech	Natural Language Processing	specific	Original
Dialog Systems	Natural Language Processing	generic	Original
fastText	Natural Language Processing	specific	Original
Fuzzy Logic	Natural Language Processing	generic	Original
Handwriting Recognition	Natural Language Processing	generic	Original
Hugging Face (NLP Framework)	Natural Language Processing	specific	Original
Hugging Face Transformers	Natural Language Processing	specific	Original
Intelligent Agent	Natural Language Processing	generic	Original
Intelligent Virtual Assistant	Natural Language Processing	generic	Original
Kaldi	Natural Language Processing	specific	Original
Latent Dirichlet Allocation	Natural Language Processing	specific	Original

Skill	AI Skill Field	Category	Original/Added
Lexalytics	Natural Language Processing	generic	Original
Machine Translation	Natural Language Processing	generic	Original
Microsoft LUIS	Natural Language Processing	specific	Original
Natural Language Generation	Natural Language Processing	specific	Original
Natural Language Processing	Natural Language Processing	specific	Original
Natural Language Processing Systems	Natural Language Processing	specific	Original
Natural Language Programming	Natural Language Processing	specific	Original
Natural Language Toolkits	Natural Language Processing	specific	Original
Natural Language Understanding	Natural Language Processing	specific	Original
Natural Language User Interface	Natural Language Processing	generic	Original
Nearest Neighbour Algorithm	Natural Language Processing	specific	Original
Apache OpenNLP	Natural Language Processing	specific	Original
Optical Character Recognition (OCR)	Natural Language Processing	generic	Original
Screen Reader	Natural Language Processing	generic	Original
Semantic Analysis	Natural Language Processing	generic	Original
Semantic Interpretation for Speech Recognition	Natural Language Processing	generic	Original
Semantic Parsing	Natural Language Processing	generic	Original
Semantic Search	Natural Language Processing	generic	Original
Sentiment Analysis	Natural Language Processing	generic	Original
Seq2Seq	Natural Language Processing	specific	Original
Speech Recognition	Natural Language Processing	generic	Original
Speech Recognition Software	Natural Language Processing	generic	Original
Statistical Language Acquisition	Natural Language Processing	generic	Original
Text Mining	Natural Language Processing	specific	Original
Tokenization	Natural Language Processing	specific	Original
Voice Interaction	Natural Language Processing	generic	Original
Voice User Interface	Natural Language Processing	generic	Original
Word Embedding	Natural Language Processing	specific	Original
Word2Vec Models	Natural Language Processing	specific	Original
Topic Modelling	Natural Language Processing	generic	Original
Latent Semantic Indexing	Natural Language Processing	specific	Original
Semantic Web	Natural Language Processing	generic	Original
Text-To-Speech	Natural Language Processing	generic	Original
Speech Recognition Grammar Specification	Natural Language Processing	specific	Original
Large Language Modelling	Natural Language Processing	generic	Original
Prompt Engineering	Natural Language Processing	generic	Original
GPT-3 (NLP Model)	Natural Language Processing	specific	Original
Relationship Extraction	Natural Language Processing	generic	Original
Sphinx Speech Recognition	Natural Language Processing	specific	Original
Part-of-Speech Tagging	Natural Language Processing	generic	Original
Voice Technology	Natural Language Processing	generic	Original
Lemmatization	Natural Language Processing	generic	Original
Text Classification	Natural Language Processing	generic	Original
Apache OpenNLP	Natural Language Processing	specific	Original
Speech Processing	Natural Language Processing	generic	Original
N Gram	Natural Language Processing	generic	Original
Word-Sense Disambiguation	Natural Language Processing	specific	Original
Speech Technology	Natural Language Processing	generic	Original
NLTK (NLP Analysis)	Natural Language Processing	specific	Original
Disambiguation	Natural Language Processing	generic	Original
Named Entity Recognition	Natural Language Processing	generic	Original
Question Answering	Natural Language Processing	generic	Original

Skill	AI Skill Field	Category	Original/Added
Language Identification	Natural Language Processing	generic	Original
Information Extraction	Natural Language Processing	generic	Original
Amazon Comprehend	Natural Language Processing	specific	Original
Speech Enhancement	Natural Language Processing	generic	Original
Language Model	Natural Language Processing	generic	Original
Apache MXNet	Neural Networks	specific	Original
Artificial Neural Networks	Neural Networks	specific	Original
Autoencoders	Neural Networks	specific	Original
Caffe	Neural Networks	specific	Original
Caffe2	Neural Networks	specific	Original
Chainer (Deep Learning Framework)	Neural Networks	specific	Original
Convolutional Neural Networks	Neural Networks	specific	Original
Cudnn	Neural Networks	specific	Original
Deep Learning	Neural Networks	specific	Original
Deeplearning4j	Neural Networks	specific	Original
Keras (Neural Network Library)	Neural Networks	specific	Original
Long Short-Term Memory (LSTM)	Neural Networks	specific	Original
OpenVINO	Neural Networks	specific	Original
PaddlePaddle	Neural Networks	specific	Original
Pybrain	Neural Networks	specific	Original
Recurrent Neural Network (RNN)	Neural Networks	specific	Original
TensorFlow	Neural Networks	specific	Original
Generative Adversarial Networks	Neural Networks	specific	Added
Attention Mechanisms	Neural Networks	specific	Added
General-Purpose Computing on Graphics Processing Units	Neural Networks	specific	Added
Transformer (Machine Learning Model)	Neural Networks	specific	Added
Boltzmann Machine	Neural Networks	specific	Added
Deep Learning Methods	Neural Networks	specific	Added
Evolutionary Acquisition of Neural Topologies	Neural Networks	specific	Added
Advanced Robotics	Robotics	specific	Original
Cognitive Robotics	Robotics	specific	Original
Motion Planning	Robotics	generic	Original
Nvidia Jetson	Robotics	specific	Original
Robot Framework	Robotics	specific	Original
Robot Operating Systems	Robotics	specific	Original
Robotic Automation Software	Robotics	specific	Original
Robotic Liquid Handling Systems	Robotics	specific	Original
Robotic Programming	Robotics	specific	Original
Robotic Systems	Robotics	specific	Original
Servomotor	Robotics	generic	Original
SLAM Algorithms (Simultaneous Localization and Mapping)	Robotics	generic	Original
Sensor Fusion	Robotics	specific	Added
Inverse Kinematics	Robotics	specific	Added
Odometry	Robotics	generic	Added
Microsoft Robotics Developer Studio	Robotics	specific	Added
Robotics	Robotics	generic	Added
Industrial Robotics	Robotics	generic	Added
Mobile Robot Navigation	Robotics	specific	Added
Robot End Effector	Robotics	generic	Added
Robotic Machines	Robotics	generic	Added
3D Reconstruction	Visual Image Recognition	generic	Original
Activity Recognition	Visual Image Recognition	generic	Original

Skill	AI Skill Field	Category	Original/Added
Computer Vision	Visual Image Recognition	generic	Original
Contextual Image Classification	Visual Image Recognition	generic	Original
Digital Image Processing	Visual Image Recognition	generic	Original
Eye Tracking	Visual Image Recognition	generic	Original
Face Detection	Visual Image Recognition	generic	Original
Facial Recognition	Visual Image Recognition	generic	Original
Image Analysis	Visual Image Recognition	generic	Original
Image Matching	Visual Image Recognition	generic	Original
Image Recognition	Visual Image Recognition	generic	Original
Image Segmentation	Visual Image Recognition	generic	Original
Image Sensor	Visual Image Recognition	generic	Original
Imagenet	Visual Image Recognition	specific	Original
Machine Vision	Visual Image Recognition	generic	Original
Motion Analysis	Visual Image Recognition	generic	Original
Object Recognition	Visual Image Recognition	generic	Original
OmniPage	Visual Image Recognition	generic	Original
Pose Estimation	Visual Image Recognition	generic	Original
Realsense	Visual Image Recognition	specific	Original
Variational Autoencoders	Visual Image Recognition	specific	Added
Object Detection	Visual Image Recognition	generic	Added
Obstacle Avoidance	Visual Image Recognition	generic	Added
Gesture Recognition	Visual Image Recognition	generic	Added
Pattern Recognition	Visual Image Recognition	generic	Added
Trajectory Planning	Visual Image Recognition	specific	Added
Image Retrieval	Visual Image Recognition	generic	Added
Visual Odometry	Visual Image Recognition	generic	Added
Automatic Identification and Data Capture	Visual Image Recognition	generic	Added
Thermal Infrared (TIR)	Visual Image Recognition	generic	Added
Document Layout Analysis	Visual Image Recognition	generic	Added
Space Surveillance	Visual Image Recognition	generic	Added
Photogrammetry	Visual Image Recognition	generic	Added
Feature Detection	Visual Image Recognition	generic	Added
Amazon Rekognition	Visual Image Recognition	specific	Added
Visual Recognition	Visual Image Recognition	generic	Added
Deconvolution	Visual Image Recognition	specific	Added
Laser Scanning	Visual Image Recognition	generic	Added
Motion Estimation	Visual Image Recognition	generic	Added

Note: The original AI skill list is available in Borgonovi et al. (2023[8]). 76 additional keywords (tagged as "Added" in the table) were extracted from the Lightcast Skill Taxonomy (LST) version 9.4.1, which includes more than 33 000 skills classified under 32 broad categories and 443 specific subcategories. In particular, those skills that are not in the original list but classified in the LST under the subcategories Artificial Intelligence and Machine Learning (AI/ML), Image Analysis, Natural Language Processing (NLP) and Robotics were included in the table.
Source: Authors, based on Borgonovi et al. (2023[8]), "Emerging trends in AI skill demand across 14 OECD countries", *OECD Artificial Intelligence Papers*, No. 2, https://doi.org/10.1787/7c691b9a-en; and Lightcast® Skill Taxonomy.

Annex C. Data-driven approach for extracting job roles from the data science occupation

Section 3.2 describes the results of a data-driven analysis aimed at identifying underlying roles present in data science job postings through the analysis of the skills required by employers. The statistical technique used for this purpose is the LDA algorithm. The LDA is a powerful statistical technique for uncovering the underlying topics (job roles) within a collection of documents, which in this context are lists of keywords (specialised skills and certifications[1]) extracted from job postings.

The model assumes that each job posting is a combination of a (pre)defined number of topics, and that each skill mentioned in the job posting can be associated with multiple topics, each with a certain probability. By detecting patterns of words that frequently appear together, LDA estimates the topics likely to exist across the entire collection of job postings and assigns a probability distribution over topics for each individual job posting. Therefore, the results obtained from the LDA model are two: 1) a list of skills more likely to be associated with each job role, and 2) a probability distribution over topics (job roles) for each job posting, with each job posting assigned to the role that has the highest probability.

The results obtained from the analysis of data science job postings show four roles: research data scientists, cloud/big data engineers, data managers and analysts, and data engineering specialists. Table A C.1 provides a description of these roles based on the results obtained from the LDA model, along with an exploration of the most frequent single keywords (unigrams) and pairs of consecutive keywords (bigrams) extracted from the titles of the job postings classified under each role. The role names and descriptions were generated with a Large Language Model, using as input the LDA model results.

Table A C.1. Description of job roles identified in data science job postings

	Attribute	Description
Data Engineering Specialist	**Role description**	"This role emphasises the foundational aspects of data management necessary for effective data science, including expertise in data governance, engineering, ETL processes, and warehousing. Professionals in this area ensure the data quality and structure necessary for analysis and decision-making processes, serving as the backbone for data scientists by preparing and managing the data infrastructure."
	Skills	0.013*"data_governance" + 0.013*"data_engineering" + 0.013*"extract_transform_load_etl" + 0.013*"data_warehousing" + 0.013*"data_quality" + 0.012*"data_modelling" + 0.011*"business_intelligence" + 0.010*"data_integration" + 0.010*"management" + 0.009*"problem_solving"
	Job title unigrams	[('data', 2 266), ('specialist', 903), ('engineer', 778), ('senior', 423), ('developer', 283), ('consultant', 259), ('scientist', 215), ('engineering', 188), ('governance', 182), ('integration', 175)]
	Job title bigrams	[(('data', 'engineer'), 542), (('data', 'specialist'), 268), (('specialist', 'data'), 246), (('senior', 'data'), 231), (('engineer', 'data'), 218), (('data', 'scientist'), 195), (('data', 'governance'), 166), (('data', 'engineering'), 164), (('pharmacy', 'data'), 127), (('consultant', 'data'), 104)]
Cloud / Big Data Engineer	**Role description**	"Specializing in the use and management of cloud-based platforms for handling large datasets, this role focuses on developing scalable data pipelines, leveraging cloud services (such as AWS, Azure), and employing advanced data engineering technologies. These engineers support data science teams by providing the tools and environments necessary for handling big data efficiently."

	Attribute	Description
	Skills	0.027*"data_engineering" + 0.017*"extract_transform_load_etl" + 0.017*"data_pipelines" + 0.015*"apache_spark" + 0.015*"microsoft_azure" + 0.015*"big_data" + 0.013*"agile_methodology" + 0.013*"data_modelling" + 0.013*"amazon_web_services" + 0.013*"java_programming_language"
	Job title unigrams	[('data', 5 879), ('engineer', 4 722), ('senior', 1 403), ('learning', 778), ('machine', 776), ('developer', 741), ('engineering', 526), ('specialist', 473), ('scientist', 445), ('lead', 403)]
	Job title bigrams	[(('data', 'engineer'), 3 837), (('engineer', 'data'), 1 279), (('senior', 'data'), 922), (('machine', 'learning'), 767), (('engineer', 'senior'), 602), (('data', 'engineering'), 436), (('data', 'scientist'), 424), (('big', 'data'), 384), (('developer', 'data'), 252), (('learning', 'engineer'), 227)]
Data Manager / Analyst	**Role description**	"This role combines leadership and analytical skills, focusing on managing data science projects and teams while also possessing the technical expertise to conduct in-depth data analyses. Professionals in this area are adept at translating business problems into data-driven solutions, requiring strong problem-solving skills, proficiency in data analysis tools, and the ability to communicate insights effectively to stakeholders."
	Skills	0.022*"management" + 0.014*"data_analysis" + 0.014*"problem_solving" + 0.014*"leadership" + 0.014*"research" + 0.013*"microsoft_excel" + 0.013*"detail_oriented" + 0.012*"customer_service" + 0.011*"interpersonal_communications" + 0.011*"writing"
	Job title unigrams	[('data', 3 396), ('specialist', 2 584), ('scientist', 789), ('management', 496), ('mobile', 419), ('mortgage', 416), ('senior', 403), ('science', 388), ('consultant', 305), ('engineer', 287)]
	Job title bigrams	[(('data', 'specialist'), 657), (('data', 'scientist'), 656), (('specialist', 'data'), 461), (('mobile', 'mortgage'), 415), (('mortgage', 'specialist'), 415), (('data', 'science'), 300), (('master', 'data'), 252), (('data', 'management'), 204), (('management', 'specialist'), 179), (('data', 'steward'), 166)]
Research Data Scientist	**Role description**	"Focused on the cutting-edge of artificial intelligence and machine learning, this role is deeply involved in theoretical research and the development of new algorithms and models. These scientists apply advanced mathematics, statistics, and programming skills (i.e. Python, R, TensorFlow) to drive innovation in AI, deep learning, and related fields. They contribute to the foundational knowledge that enables practical AI solutions in various applications."
	Skills	0.020*"mathematics" + 0.020*"statistics" + 0.019*"artificial_intelligence" + 0.019*"algorithms" + 0.018*"r_programming_language" + 0.017*"research" + 0.013*"data_analysis" + 0.013*"deep_learning" + 0.013*"tensorflow" + 0.010*"innovation"
	Job title unigrams	[('data', 6 250), ('scientist', 5 252), ('learning', 1922), ('machine', 1 794), ('senior', 1 447), ('engineer', 1 056), ('science', 879), ('analytics', 437), ('intern', 428), ('lead', 415)]
	Job title bigrams	[(('data', 'scientist'), 4 843), (('machine', 'learning'), 1 756), (('scientist', 'data'), 1 251), (('senior', 'data'), 1 035), (('data', 'science'), 734), (('learning', 'engineer'), 516), (('scientist', 'senior'), 463), (('scientist', 'machine'), 376), (('lead', 'data'), 269), (('engineer', 'data'), 259)]

Note: The "Skills" attribute is derived from the LDA model, which identifies the skills with the highest probability of being associated with each respective role. The probabilities are displayed to the left of each skill. The "Job title unigrams and bigrams" attributes list the most frequent tokens extracted from job titles, with each token's frequency indicated. The role names and descriptions were generated using a Large Language Model, based on the skills identified by the LDA model and the unigrams and bigrams extracted from the job titles.
Source: OECD based on Lightcast data.

Note

[1] LST classifies skills into three categories: Specialised, Common and Certifications. Common skills were not considered for the analysis since, by definition, they do not represent a differentiating factor between different roles and occupations.

Annex D. Methodological note of the skills network analysis

This study employs a network analysis to provide a comprehensive understanding of how AI and non-AI skills interrelate in the context of AI-related job postings. This analysis leverages data on skill mentions from the AI-related OJPs analysed by this study to construct a graphical representation of the skill bundles defining them.

The creation of the skill networks begins with a preprocessing step and creation of an adjacency matrix. The preprocessing step consists in extracting a list of skills from each AI-related job posting. Skills mentioned fewer than 50 times are excluded to reduce sparsity, since their co-occurrence with other skills would be limited. The resulting information allows for the construction of an adjacency matrix that indicates if a pair of skills appear together in the sample and records the number of times that this co-occurrence happens.

Then, a network is created on the basis of information from the adjacency, with skills and pairwise connections represented by nodes and edges, respectively. After the network is created, it undergoes a pruning process, where the least relevant edges and nodes are removed based on their weight (strength of connections) and degree (number of connections). This step facilitates the presentation of the network and ensures its relevance by retaining only meaningful connections and important skills.

The final network containing all the AI-related job postings (see section 4.3) was constructed by retaining only edges with a co-occurrence of at least 600 times, which corresponds to 100 job postings including both skills on average per year). Subsequently, nodes within the 20th percentile were dropped, ensuring that only the most central skills were retained in the network.

For the networks created for specific economic sectors, the threshold for dropping edges was a co-occurrence of at least 100 times, as the number of job postings was lower than in the network for all AI-related job postings.

The characteristics of the nodes and edges provide insights into the structure and dynamics of the skill network:

- Node size: Represents the number of connections of a node, reflecting the frequency with which a pair of skills co-occurs (weighted degree). Larger nodes indicate skills that are frequently mentioned alongside other skills in job postings.
- Node colour: Nodes are coloured based on the AI skill field they belong to.
- Edge width and transparency: The width and transparency of the edges represent the strength of the connection in terms of co-occurrence of the skill pairs in job postings. Thicker and more opaque edges indicate stronger connections.