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AI and Industry

Postings and Media Portrayals

CSET Data Brief

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Introduction

Over the past 10 years, "artificial intelligence" has become a seemingly ubiquitous buzzword, found in everything from academic papers and news articles to movies and government proceedings. It is said to be transforming the global economy and society in what some dub as the "fourth industrial revolution," and the COVID-19 pandemic has only accelerated the adoption of AI-powered automation.[1] This paper takes an initial look at media representations of AI and any alignments or misalignments with the requisite AI skills needed by industries to make AI a practical reality. This type of distortion is important as the U.S. Congress begins to place an increasing emphasis on AI as an emerging technology that is transitioning to create economic value and new jobs across the country.[2] If government funds are shifted away from other areas of science and technology, based partly on the representations that leaders and the public believe, it is important to understand the truth underpinning those beliefs.

In order to tackle this question, we take a look into how industries are seeking out talent to turn the promise of AI into real world products and services. While we do not address the pervasive and complex challenge of whether or not there is an AI talent shortage in the United States, we recommend, "The U.S. AI Workforce: Labor Market Dynamics," by CSET's Diana Gehlhaus and Ilya Rahkovsky.[3] In this data brief, we leverage the framework laid out by Gehlhaus and Rahkovsky to specifically consider the patterns of AI-related job postings across a sampling of industrial sectors chosen to represent areas often perceived as being transformed and automated due to AI. We consider sectors that capture the imagination with news of things like real estate apps and self-driving cars,[4] alongside sectors that represent the tech giants, commonly touted as some of the most active in hiring for AI talent. In this study, we examine news articles to analyze media portrayals of AI and industry, and then in order to begin to truly understand the reality of the demand for AI talent across sectors, we delve into data on AI job postings and associated in demand academic majors. With this study, we hope to initiate a conversation around the reality of AI progress beyond what is reported in the news.

Our key findings are:

- While the information sector (which includes the tech giants) dominates media stories related to AI, the majority of AI-related job posts come from the Professional, Scientific, and Technical Services sector and the Manufacturing sector.
    - Focusing too much attention on the tech giants may mean major areas are neglected where AI is actually being commercialized.
- AI-related job postings show that integrating AI into real-world industrial products involves more than just researchers developing the next cutting-edge algorithm in a lab at a big tech company.
    - It is clear that a range of AI skills are essential across industrial sectors, and that in particular the data shows an undeniable market signal for product development skills (such as project or product managers and legal compliance officers).
    - Even within the most technical job postings, we see that recruitment from a diverse range of majors beyond those that are strictly considered STEM.

Analysis

To frame our analysis on media and job posting trends, we focused on five industrial sectors in the United States where meaningful applications of AI technology might be expected: 1) Information, 2) Manufacturing, 3) Professional, Scientific, and Technical Services, 4) Real Estate, Rental, and Leasing, and 5) Transportation and Warehousing. These were chosen from the 20 industrial sectors laid out in the North American Industry Classification System 2-Digit Sector Codes[5] and represent a wide range of job posting activity. While we recognize NAICS codes to be an imperfect binning for industry, and that large companies often have multiple NAICS codes, our analysis showed that virtually all of the job postings by each company were concentrated in one sector.[6]

Our analysis of news coverage provides insight into the frequency and associated sentiment of media portrayals for a specific industry's involvement in AI. To accomplish this, we selected the top companies from the five sectors above, where "top companies" were defined as having 0.5 percent or more of the share of job postings in their respective sector,[*] and calculated how many times their names were mentioned by media outlets along with the keywords "artificial intelligence" or "machine learning" and what the associated sentiment was for each mention.[7] The sentiment scores are generated by Lexalytics, where topics, entities, and themes in each article are assigned a sentiment score on a scale of -1 (negative) to 1 (positive) and combined to produce an article-level sentiment score. Data was taken from English-language sources in the LexisNexis Metabase[8] from 2011 to 2019. Furthermore, we used LexisNexis quantitative measures of sentiment at the article level and at the specific entity level.[9] To correct for yearly fluctuations in the total number of articles published, we normalize yearly counts by multiplying the maximum yearly count over all years and dividing by the current year's count.[†]

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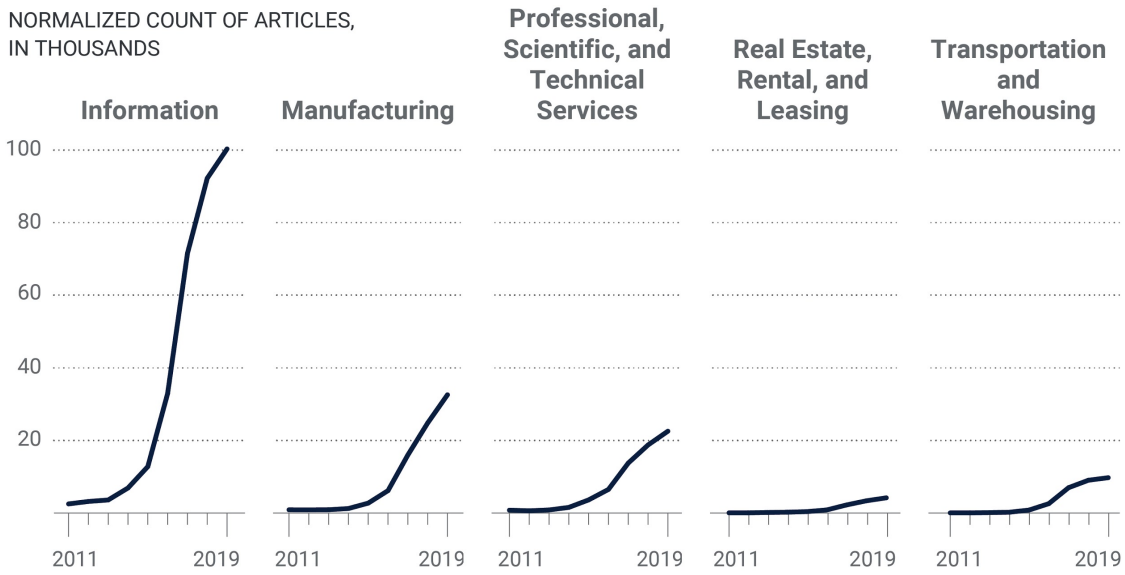
[*] The 0.5 percent threshold selects companies in the 90th percentile for number of job postings.

[†] We normalize the counts in order to address variance in the volume of data sources collected by LexisNexis in any given year.

Please note, this data brief does not look at the possibility that the media is following investor activity rather than a translation of that funding into hiring of AI skills. However, this would be a worthwhile research question for future analyses.

Data showed that from 2011 to 2019, all of our selected sectors experienced increased media representation (Figure 1). But the Information sector—which includes tech giants like Apple, Facebook, Google, and Microsoft—overshadows other sectors as the most prominently represented sector in the media. It is also interesting that a sector associated with a widely discussed form of AI application, like the Transportation sector which has a direct stake in autonomous vehicles, signals the fewest job opportunities and is represented the least in the media.

Figure 1. AI Articles Mentioning Artificial Intelligence / Machine Learning and Company Name by Sector, 2011–2019.

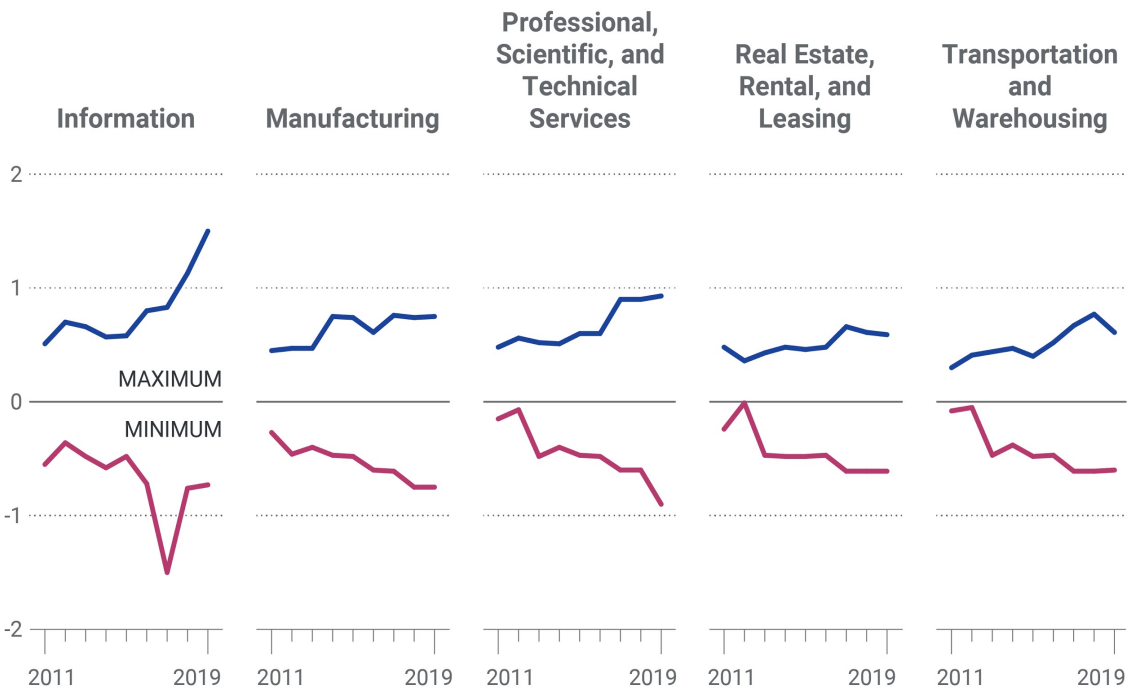


Source: LexisNexis.

Furthermore, data shows that the maximum and minimum sentiment scores have been shifting towards more extreme values in all sectors (Figure 2). When examining the top companies from each sector, the trend is the same: Media mentions have grown along with a slight increase in polarity of the sentiment. Although

they are not extreme in comparison to the overall distribution of sentiment across LexisNexis data* (see Appendix), the maximum and minimum entity scores have also become less neutral. Meaning—we see a public representation unfolding that is perhaps less simply descriptive and instead articulates both positive and negative views of AI.

Figure 2. Maximum and Minimum Sentiment Scores by Sector, 2011–2019.



Source: LexisNexis.

These findings from the media analysis solidify that the tech giants and the Information sector dominate the media representation of industrial AI. Popular perception may be skewed by uneven coverage of AI focusing on the information industry.

To assess how companies are actually concentrating efforts into AI talent acquisition, and to see if this media coverage aligns to the

* Details on how sentiment scores are assigned found here: https://www.lexalytics.com/technology/sentiment-analysis.

real-world hiring within these industrial sectors, we looked at job postings for AI-related occupations from 2010 to 2019 in the five sectors.[10] To identify market signals for AI talent demand, we used the Burning Glass dataset which drew data from more than 45,000 online job sites.[11] To characterize AI-related occupations, we adopted the framework for AI workforce categories developed by CSET, where job postings are assigned an AI workforce category based on their standard occupation classification code:[12]

1. Technical Team 1 (Tech 1): occupations that are or could be actively working in AI, needed to provide technical inputs into AI applications, or could laterally move into an AI development role.

2. Technical Team 2 (Tech 2): occupations that have the related knowledge, skills, and abilities to perform technical roles on an AI team, either as is or with some minimal additional training.

3. Product Team (PT): occupations that complement AI technical occupations in product development (such as project or product managers and legal compliance officers).

4. Commercial Team (CT): occupations that provide support for the scaling, marketing, or acquisition of AI at the organizational level.

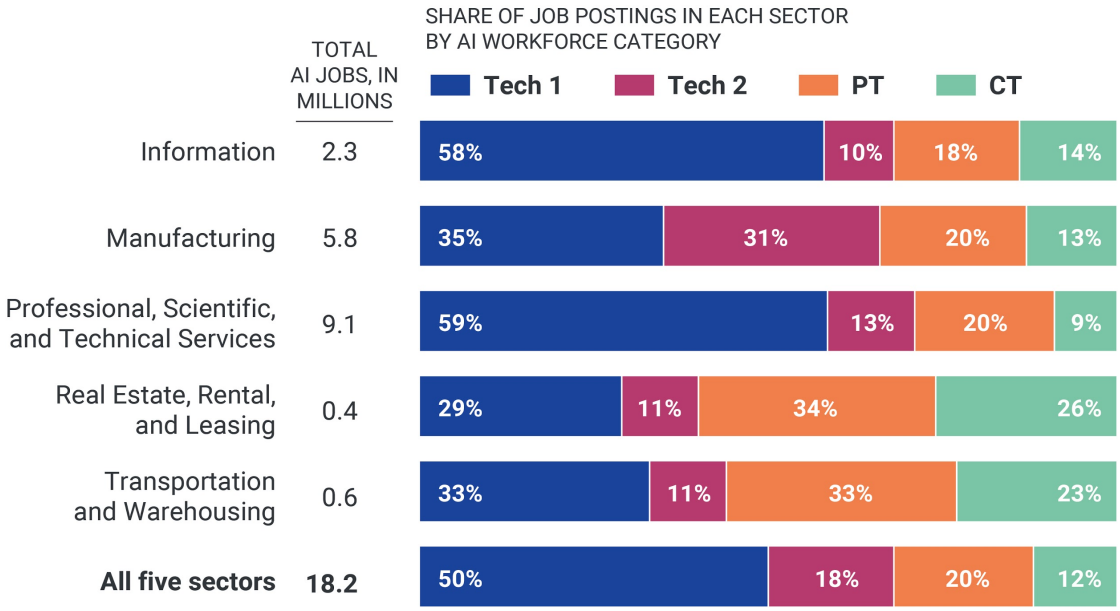
A complex and wide-ranging field of practice is often reduced to the buzzword "AI", but in fact AI-related work can take on many forms and serve a variety of industries. Therefore, we first identified the degree majors required on AI-related job postings in each sector (e.g., Manufacturing) and for each AI workforce category (e.g., Technical Team 1).

When we examine the AI-related job postings across the industry sectors, the first thing that jumps out is that the Information sector accounts for a modest portion of the job postings—Manufacturing has 150 percent more job postings than Information and Professional, Scientific, and Technical Services has 296 percent more job postings than Information. The Manufacturing sector and

Professional, Scientific, and Technical Services sector dominate the AI-related job market with 5.8 million and 9.1 million job postings respectively (Figure 3). Their command of the AI-related job postings stands in stark contrast to the Information sector's command of the media space.

When AI-related job postings in 2019 are analyzed by sector, the in demand majors are clear—business, computer science, and general engineering dominate across all five sectors.[13] However, computer science is most popular for Tech 1 jobs, engineering for Tech 2 jobs, and business for PT and CT jobs. Therefore, we further analyzed job postings by AI workforce categories in order to understand which category (and its associated major) is most relevant in each sector (Figure 3). In both the Information sector and the Professional, Scientific, and Technical Services sector, the demand for Tech 1 jobs dwarfs other categories (PT, Tech 2, CT). Their job postings signal that highly technical skills are in demand, and correspondingly, computer science majors. It is worth noting, however, that PT jobs are the second in demand both overall and within each sector with the exception of Manufacturing. In the Manufacturing sector, the most popular AI workforce categories, in descending order, are Tech 1, Tech 2, PT, and CT. Job postings signal that collectively, and in the top three analyzed sectors for job postings—Professional, Scientific, and Technical Services, Manufacturing, and Information Services—Tech 1 and Tech 2 jobs are the most needed and correspondingly degrees in computer science and engineering. However, In the Real Estate, Rental, and Leasing sector, and the Transportation and Warehousing sector, Tech 1, PT, and CT jobs all enjoy relatively high demand. Tech 1 and PT jobs are almost equally valued in the Transportation and Warehousing sector. It is also worth noting that these last two sectors are the most balanced in terms of their hiring for AI talent, looking to recruit people across the AI workforce categories. Additionally, a quick analysis of aggregate job posting data across sectors shows that Tech 1 is dominantly popular, followed by PT, Tech 2, and CT.

Figure 3. Trend in AI Labor Demand by AI Workforce Category, 2010–2019.

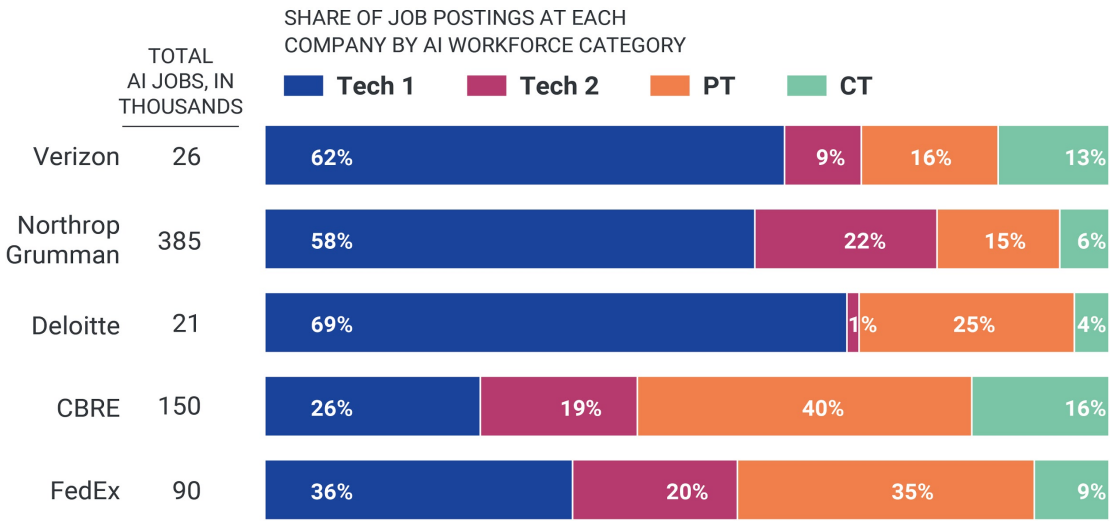


Source: Burning Glass.

While computer science, business, and engineering degrees are important across industries, the level of demand varies by a sector's AI needs. Generally, job postings across sectors signal prioritization of foundational AI (Tech 1) and are favorable towards the more technical skills like computer science. However, there is a concurrent, clearly signaled need for people with majors in business who can turn AI research into applicable, working products (PT). This suggests that AI is indeed turning a corner from being purely science and transitioning to broad industrial applications.

These sector-level trends also appear to be true at the individual company level when we examine the company with the largest number of job postings in each sector (Figure 4). While Northrop Grumman (Manufacturing) seeks to mainly fill Tech 1 and Tech 2 jobs, PT jobs instead come in as the second most popular AI jobs at both Deloitte (Professional, Scientific, and Technical Services) and Verizon (Information). At Coldwell Banker Richard Ellis, or CBRE (Real Estate, Rental, and Leasing), and FedEx (Transportation and Warehousing), PT jobs enjoy extremely high demand.

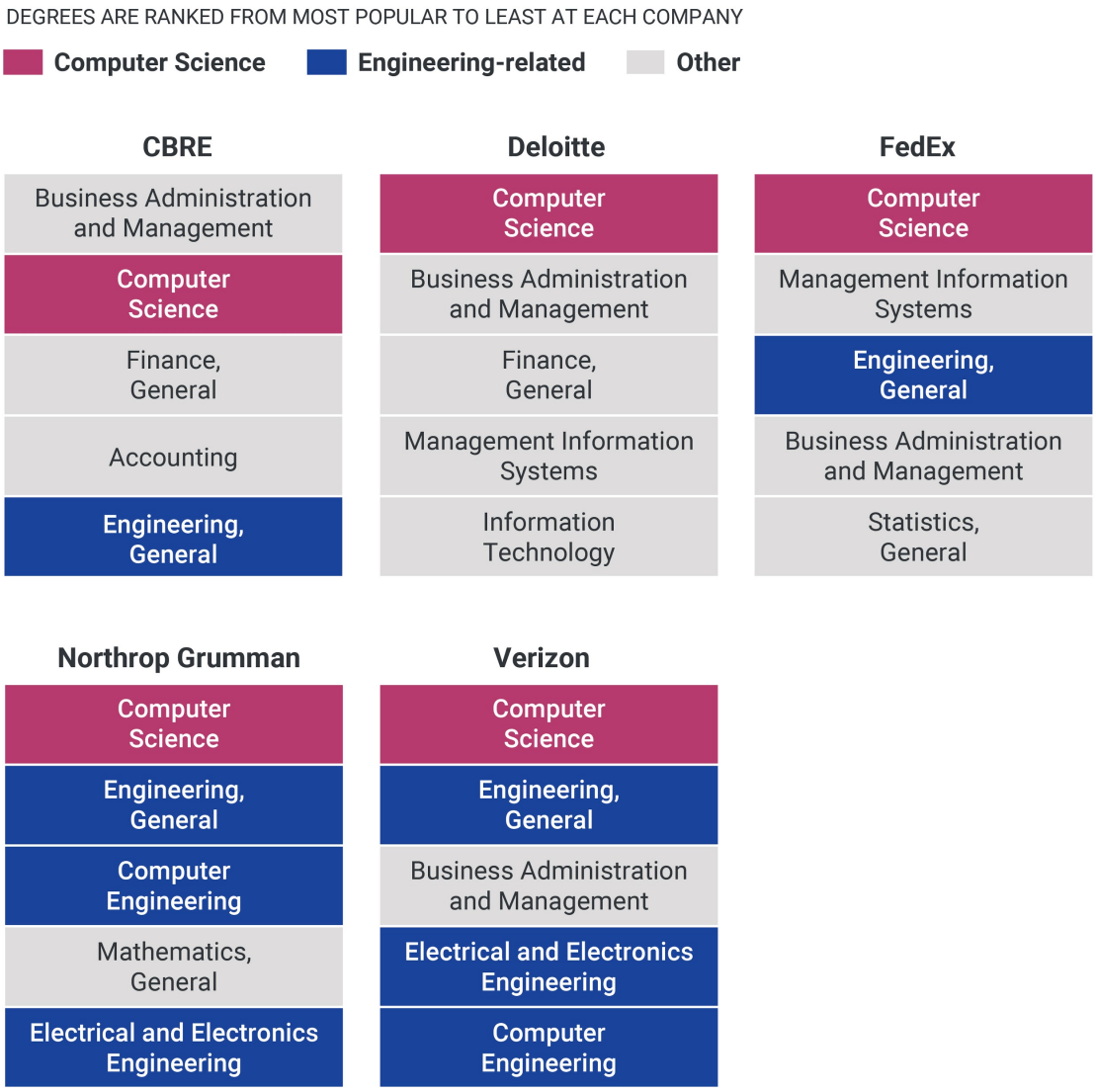
Figure 4. Trend in AI Labor Demand by Top Companies, 2010-2019



Source: Burning Glass.

Since Tech 1 jobs are popular across sectors, we additionally compared the top majors for Tech 1 job postings at each company (Figure 5). CBRE, Deloitte, and FedEx look for a mix of majors with different levels of technical skills, such as computer science, business, finance, and management information systems. On the other hand, Verizon and Northrop Grumman are focused primarily on computer science and degrees related to engineering.

Figure 5. Top Five Majors in Demand for Tech 1 Jobs, 2019.



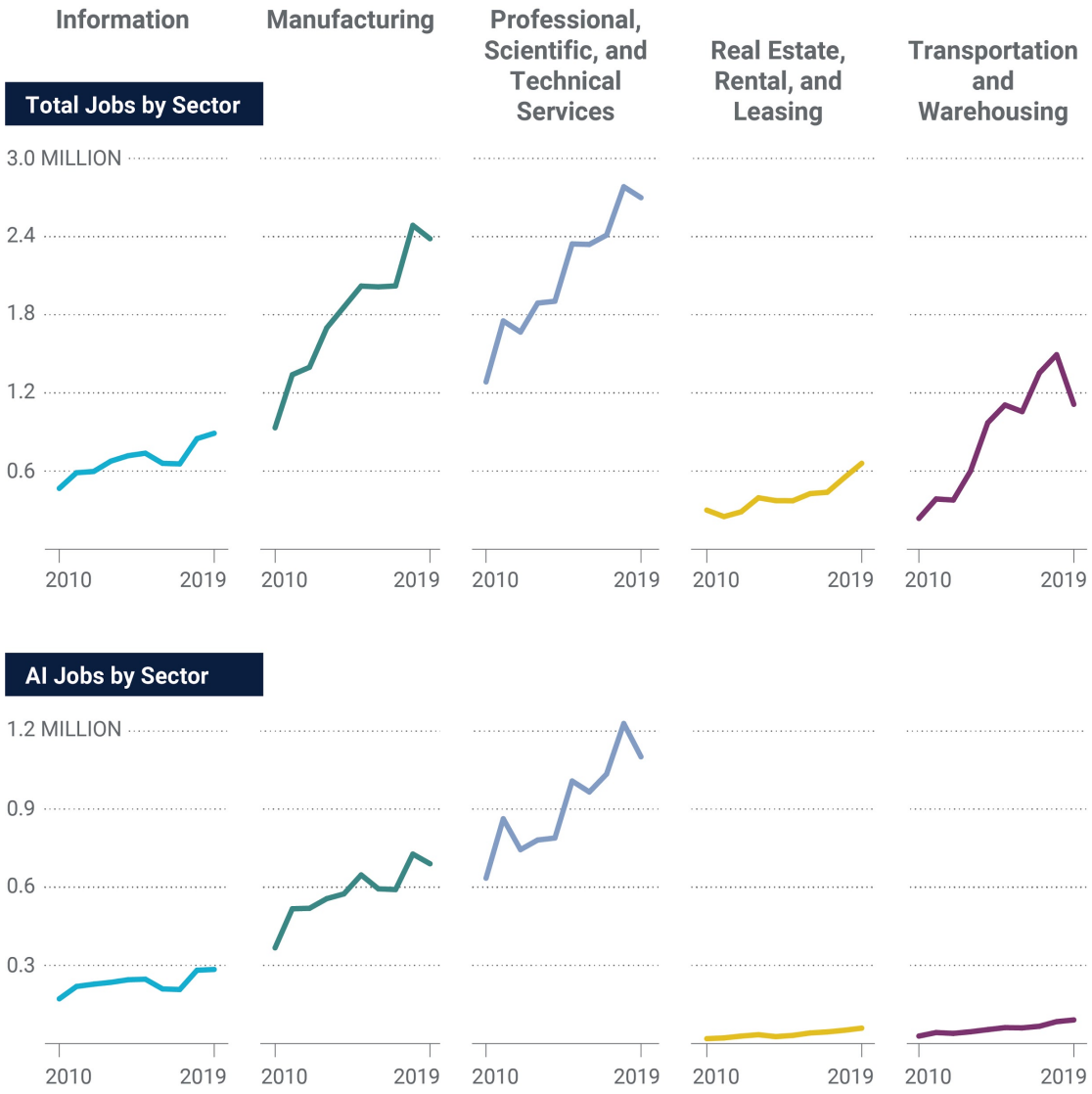
Source: Burning Glass.

Overall, the top employer from each sector reflects the sector-level trend for AI workforce categories, but a closer examination of popular majors for Tech 1 job postings suggests that individual sectors approach core AI research differently: Northrop Grumman and Verizon are primarily focused on computer scientists and engineers, while CBRE, Deloitte, and FedEx look for people with a variety of technical backgrounds for Tech 1 job postings. These case studies reemphasize the idea that even for jobs categorized

as the most purely technical, AI talent needs in industry extend far beyond this. The analysis also raises some questions about overall hiring strategies for large, diverse organizations that may seek talent with AI skills, but also people who can be more widely leveraged across the organization.

Interestingly, a broader analysis of AI job postings provides an important context—contrary to our initial expectation, the data shows that AI hiring is not following a unique trend line. While job postings for AI-related work increase from 2010 to 2019 in each sector we analyzed—which seems consistent with increased media mentions over the years— they do so in conjunction with the total job postings in each respective sector (Fig. 6). Specifically, by analyzing their trends in growth over time, we find that AI job postings never outpace total job posting by sector. Similarly, during the same period of time, the top company from each sector signaled a demand for AI talent in a pattern that was consistent with its overall job postings. Moreover, it is, in fact, not the Information sector and their traditional tech companies that have been posting the most jobs over the years, but instead recruitment for AI talent has been most aggressive in the Professional, Technical, and Scientific Services sector, followed by the Manufacturing sector. In other words, the prominence of the tech giants in the media is actually outsized compared to its level of job postings.

Figure 6. Trend for Total vs AI-related Job Postings by Sector.



Source: Burning Glass.

Takeaways

By analyzing data on media representation of industries and AI, we gain insight into the patterns of media focus and see a clear trend that the media is a bit out of sync with the reality of industries that are actually signaling an investment in technical talent relevant to AI. The tech giants (i.e., Information sector) monopolize AI in the news, but job postings show that, in fact, the largest demand signal for technical talent relevant to AI exists in the Professional, Scientific, and Technical Services and Manufacturing sectors. Furthermore, sentiment data shows that the media has increasingly broadened its coverage around AI and industry, becoming less neutral over time, but with a heavy focus on companies in the Information sector. Policymakers need to understand that the media representation of AI is not representative of the industries that are hiring the technical talent relevant to AI. While this analysis does not directly measure AI jobs, but uses AI skills and related job categories as a proxy, this is still an interesting challenge for policymakers and lawmakers that want to convert emerging technologies into national job creation across the United States. Focusing so much energy on the tech giants may obscure a deeper understanding of the sectors where AI skills are being sought.

AI trends at the larger scale also show that the reality is not exactly congruent with the media representation. While job postings that included skills relevant to AI have indeed increased over the years, demand for this talent pool with AI skills within specific industries and companies appears to follow fluctuations in the overall labor demand. Job postings that include skills relevant to AI appear to tightly mirror trends in overall hiring in all five sectors analyzed. Job postings data do not show companies signaling a demand to specifically grow talent with AI skills at higher rates than the general workforce. This really underscores the need for more nuanced analysis of the idea and reality of a talent shortage in AI and the education pipeline needed to supply this market demand.

As government continues to increase investment in the development and integration of AI into the U.S. economy, it is

essential to understand the true needs and priorities of U.S. industry, and to be critical of drawing conclusions influenced heavily by media portrayals. While AI is on track to be a key enabling technology in the twenty-first century, policymakers should monitor overall job postings and hiring across the economy to avoid producing a glut of talent that outstrips the true depth of commitment to this technology in industry. There are clearly opportunities for people with backgrounds far beyond computer science to move into the AI workforce as industry works to move AI out of the lab and into products.

Authors

Eri Phinisee is a former semester research assistant at CSET, where Autumn Toney is a data research analyst, and Melissa Flagg is a senior research fellow.

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Appendix

Distribution of Sentiment Scores

According to LexisNexis, the score range for "neutral" sentiment is (-0.05, 0.22). The distribution of sentiment scores in the database, according to the provided definition, is summarized below.

Sentiment	Number of Articles	Percentage
Positive	7,479,687	56.2%
Neutral	4,963,597	37.3%
Negative	857,800	6.4%

Top Five Majors in Each Sector (2019)

The top five most popular majors from each sector in 2019 are presented, in order, in the table below. Combined, the five majors in each sector make up more than 50 percent of the job postings.

Sector	Top Five Majors
Information	1. Computer Science 2. Business Administration and Management, General 3. Engineering, General 4. Marketing/Marketing Management, General 5. Electrical and Electronics Engineering
Manufacturing	1. Engineering, General 2. Computer Science 3. Business Administration and Management, General 4. Electrical and Electronics Engineering 5. Mechanical Engineering

Professional, Scientific, and Technical Services	1. Computer Science 2. Business Administration and Management, General 3. Engineering, General 4. Information Technology 5. Management Information Systems, General
Real Estate, Rental, and Leasing	1. Business Administration and Management, General 2. Computer Science 3. Engineering, General 4. Marketing/Marketing Management, General 5. Finance, General
Transportation and Warehousing	1. Business Administration and Management, General 2. Computer Science 3. Engineering, General 4. Logistics, Materials, and Supply Chain Management 5. Management Information Systems, General

Endnotes

[1] Sandy Ong, "Covid-19's AI Revolution," New Scientist 248, no. 3303 (October 2020): 44-48, https://doi.org/10.1016/S0262-4079(20)31808-X.

[2] Daniel Hague, "Legislative Roundup: End-of-Year Sprint Includes Major AI Proposals" (Center for Security and Emerging Technology, December 15, 2020), https://cset.georgetown.edu/article/legislative-roundup-end-of-year-sprint-includes-major-ai-proposals/.

[3] Diana Gehlhaus and Ilya Rahkovsky, "The U.S. AI Workforce: Labor Market Dynamics" (Center for Security and Emerging Technology, April 2021), https://cset.georgetown.edu/research/u-s-ai-workforce/.

[4] See Axeleo, "5 Ways AI is Changing the Real Estate Sector," *Medium*, December 10, 2019, https://medium.com/axeleo/5-ways-ai-is-changing-the-real-estate-sector-a726bf600a83; VB Staff, "How AI is impacting the automotive world," *VentureBeat*, October 28, 2019, https://venturebeat.com/2019/10/28/how-ai-is-impacting-the-automotive-world/; and Rilind Elezaj, "How AI is Paving the Way for Autonomous Cars," *MachineDesign*, October 17, 2019, https://www.machinedesign.com/mechanical-motion-systems/article/21838234/how-ai-is-paving-the-way-for-autonomous-cars.

[5] "NAICS & SIC Identification Tools," NAICS Association, https://www.naics.com/search/.

[6] While a company can be associated with multiple NAICS codes, analysis showed that virtually all of the job postings by each company were concentrated in one sector. Further details can be found on CSET GitHub.

[7] To best capture different variations of a company name, each company went through entity resolution. Further details can be found on CSET GitHub.

[8] Nexis Metabase, https://www.lexisnexis.com/en-us/professional/academic/nexis-uni.page

[9] "Sentiment," Lexalytics, https://semantria-docs.lexalytics.com/docs/sentiment#how-is-it-calculated. See Appendix for distribution of sentiment scores.

[10] Further details can be found on CSET GitHub.

[11] Burning Glass database, https://www.burning-glass.com.

[12] Diana Gehlhaus and Santiago Mutis, "The U.S. AI Workforce: Understanding the Supply of AI Talent" (Center for Security and Emerging Technology, January 2021), https://cset.georgetown.edu/research/the-u-s-ai-workforce/. We note that two additional occupations were added to the definition of "AI Workforce" since the analysis featured here was completed. These are Web Developers (added to Technical Team 2) and Web and Digital Interface Designers (added to Product Team). We also note that because Burning Glass uses an older version of the federal occupational classification system, both occupations are actually classified as Web Developers. Therefore, only Technical Team 2 figures are affected. However, these occupations are relatively small and we do not expect our results would be significantly different.

[13] See Appendix for the list of top five majors in each sector.