Data Brief

The State of AI-Related Apprenticeships

Authors
Luke Koslosky
Jacob Feldgoise

CSET CENTER for SECURITY and EMERGING TECHNOLOGY

February 2025

Executive Summary

Over the past decade, the creation and adoption of increasingly sophisticated artificial intelligence systems have sparked a new demand for middle-skill AI talent; that is, workers who neither hold a bachelor's nor an advanced degree. During that same time period, policymakers have committed increased attention and resources to revitalizing the nation's Registered Apprenticeship system. The rising demand for middle-skill AI talent, combined with increased interest in a workforce development approach that has historically targeted middle-skill occupations, is the impetus for this brief examining the topic of AI apprenticeships.

The apprenticeships we describe in this brief are in occupations that share some of the knowledge, skills, and abilities (KSAs) with the range of competencies needed to create AI systems. As such, the apprentices highlighted are not necessarily currently working in AI-specific roles. However, they do possess KSAs that would allow them to participate in the design, development, or deployment of an AI product. This approach allows us to measure the amount of potential talent that could work in the AI ecosystem. We refer to apprenticeships in such occupations as AI-related apprenticeships.

In our analysis, we assessed trends in the number, completion rates, demographics, geographic distributions, and program sponsors of AI-related apprenticeships between 2013 and 2023, using a novel dataset that draws on the Department of Labor's publicly available Registered Apprenticeship Partners Information Database System (RAPIDS). We identified a total of over 19,000 new apprentices in AI-related occupations.

As a whole, our findings show that over the past decade, AI-related apprenticeships have become a more common training pathway for the technology workforce. These programs have high completion rates, can reach underserved populations, are geographically dispersed, and are used by small- to medium-sized firms to recruit smaller numbers of workers.

- **AI-related apprenticeships were practically nonexistent in 2013 but have since expanded rapidly.** The first three years of our data, 2013 through 2015, had very few apprentices in AI-related occupations. Since 2015, programs have registered 18,980 new apprentices. During the highest period of growth, 2020 to 2022, the number of new apprentices in AI-related occupations increased by 191%, much higher than the rate of growth for all apprenticeships.

- **AI-related apprenticeships have extremely high completion rates.** On average, 68% of apprentices in AI-related occupations completed their program, which is 25 percentage points higher than the completion rate of all (non-military) apprenticeships.

- **The number of organizations sponsoring AI-related apprenticeship programs also increased over time alongside the number of new apprentices.** A small number of sponsors account for a large proportion of registered apprentices in AI-related occupations, but there are also hundreds of sponsors that have registered fewer than ten apprentices.

- **AI-related apprenticeships have effectively recruited Black apprentices.** The percentage of Black apprentices present in AI-related occupations far exceeds the percentage of Black workers in AI and STEM fields. In 2022, the number of new Black apprentices in these fields nearly equaled the number of new White apprentices.

- **AI-related apprenticeships are less effective at reaching women and Hispanic apprentices.** Gender disparities present in other STEM fields and in the broader AI workforce are also reflected in AI-related apprenticeships. Meanwhile, Hispanic and Latino representation in AI-related apprenticeships is lower (12%) across all years compared to their overall participation in apprenticeships (20%) from 2015 to 2024.

- **AI-related apprenticeship programs are located in nearly every state, but the top ten states by new apprentices registered account for a huge share of AI-related apprenticeships.** From 2013 through 2023, the top ten performing states registered 62% of new apprentices in AI-related occupations. Five of those states are not among the most populous states. Missouri, Texas, and California were the top three states in terms of new AI-related apprentices registered.

To sustain progress, federal and state governments should continue to support apprenticeship initiatives, thereby solidifying apprenticeships as a valuable pathway for workers in AI-related and other technical fields, and broadening access to quality jobs for a diverse workforce.

Table of Contents

Introduction

As AI permeates different sectors and industries across the economy, demand for AI talent with all levels of educational attainment will expand in kind.[1] Previous CSET research has shown that the potential AI workforce—namely, those workers with the knowledge, skills, and abilities to work on the design, development, or deployment of an AI system—is made up of four-year and advanced degree holders as well as workers with less than a bachelor's degree.[*] As such, it is important to better understand not only the education and training pathways for college graduates into highly technical AI jobs, but also the pipeline into middle-skill AI jobs that do not necessarily require a four-year degree. This brief focuses on the latter, seeking to trace and analyze trends and developments in one such route into the AI workforce: Registered Apprenticeships.

The Registered Apprenticeship system is a national workforce and training program overseen by the Office of Apprenticeship (OA) within the Department of Labor (DOL).[†] Registered Apprenticeship Programs pair employers with workers in designated occupations, and combine classroom instruction for apprentices with paid, on-the-job training and mentorship.

Apprentices earn wages, learn in-demand skills, and receive a nationally recognized credential upon completion of their program. Employers, meanwhile, gain immediate access to a worker who learns skills specific to their role and industry. Although firms have direct costs in the form of wages and startup costs, in the longer term they reduce costs in recruitment, develop a talent pipeline that produces workers likely to stay with the firm, and see positive returns on investment that increase over time.[2]

Despite their positive labor market impact, apprenticeship in the U.S. has long been underutilized compared to systems in many European countries. Prior research has shown that apprentices made up only about 0.2% of the U.S. labor force, compared

---

[*] In 2018, according to CSET's definition of the AI workforce and data from the U.S. Census Bureau, the share of workers with less than a bachelor's degree was 28% for Technical Team 1 occupations, 24% for Technical Team 2 occupations, 44% for Product Team occupations, and 34% for Commercial Team occupations.

[†] While the Office of Apprenticeship operates the National Registered Apprenticeship System and oversees and registers the programs of 25 states and territories, as of 2023, 32 states and territories have their own State Apprenticeship Agency (SAA) that acts on the behalf of the DOL for their recognized state. The DOL employs regional staff who oversee their region's states. See https://www.apprenticeship.gov/about-us/apprenticeship-system for a breakdown by state.

with 2.2% in Canada, 2.7% in Great Britain, and 3.7% in Australia and Germany.[3] Furthermore, apprenticeships in the U.S. have historically been dominated by the construction industry and skilled trades. As of 2021, about two-thirds of apprentices were in construction-related occupations.[4]

However, since 2015 there has been a growing, bipartisan interest in apprenticeships. The American Apprenticeship Initiative of 2015 invested $175 million in grants to 46 awardees, the largest apprenticeship investment of its kind to date.[5] The Biden administration pursued expansion of the apprenticeship system. Under the Biden administration, the DOL announced a notice of proposed rulemaking to enhance and modernize the National Apprenticeship System, a sweeping set of proposals that spans 180 pages.[6] In an executive order from March 2024, the administration created the Registered Apprenticeship Interagency Working Group to expand the use of apprenticeships in the federal government.[7] In February 2024, the DOL announced the availability of $200 million for apprenticeship programs through the Apprenticeship Building America Grant Program and State Apprenticeship Expansion Formula Grants.[8] This allotment builds on previous authorized outlays for apprenticeships, which included $90 million in 2016, $160 million in 2019, and $185 million in 2021.[9]

The growing interest in apprenticeships writ large, and especially in skilled, non-construction fields like healthcare and manufacturing, indicates a potential avenue for building pathways for middle-skill AI workers. This brief uses a novel analysis of the DOL's Registered Apprenticeship Partners Information Database System (RAPIDS) to measure the number of apprentices registered in AI-related occupations, calculate their completion rates, provide an overview of apprentice demographics, describe the geographic distribution of programs, and outline the top program sponsors for AI-related apprenticeships.

Methodology

The Office of Apprenticeship (OA) maintains the Registered Apprenticeship Partners Information Management Data System (RAPIDS), which captures individual-level data on apprentices from all 50 states, the District of Columbia, and eight additional jurisdictions.* OA publishes an anonymized, publicly accessible data archive that provides a record for each new, active, and completed apprentice by fiscal year (FY), starting in FY13. The public data are updated quarterly on the OA website, and the most recently available data at time of analysis were Q1 2024. It is worth noting that this data only covers apprenticeships officially registered with state apprenticeship agencies or the OA, and that some estimations place the number of unregistered apprenticeships on par with those that are registered.[10]

In this analysis, we analyzed RAPIDS "new apprentice" records from the beginning of FY13 through FY23 (i.e., 2013 through 2023). We chose to look at new apprentices because they clearly indicate whether apprenticeship programs are expanding or contracting, which is the principle aim of this analysis.

This brief focuses on apprenticeships in technical AI-related occupations, which we call "AI-related apprenticeships." Workers in technical AI-related occupations have knowledge, skills, and abilities (KSAs) that could enable them to provide technical input

---

* The eight additional jurisdictions with an apprenticeship office include four territories (listed below), one commonwealth, and three foreign nations that have Compacts of Free Association with the United States.

- Territories: Guam, Puerto Rico, the Virgin Islands, and American Samoa
- Commonwealth of the Northern Mariana Islands (CNMI)
- Foreign Nations: Federated States of Micronesia, the Republic of Palau, and the Marshall Islands.

Over the past few years, OA has improved the coverage of the RAPIDS system and corresponding public data files. In FY18, RAPIDS only captured individual level data for 39 states and additional jurisdictions (https://www.dol.gov/agencies/eta/apprenticeship/about/statistics/2018). As of FY24, RAPIDS contains individual-level data for all 50 states, the District of Columbia, and five of the eight additional jurisdictions (CNMI and all four territories). Of the additional jurisdictions, only Guam and Puerto Rico have registered apprentices in technical AI-related occupations. RAPIDS appears to include retroactive data back to FY13 for all states and jurisdictions, except for Delaware, which did not provide data prior to 2021 (https://www.apprenticeship.gov/data-and-statistics/apprentices-by-state-dashboard).

to the development of an AI system.* As such, the apprentices highlighted are not necessarily currently working in AI-specific roles. However, they do possess KSAs that would allow them to participate in the design, development, or deployment of an AI product. This approach allows us to measure the amount of potential talent that could work in the AI ecosystem, and subsequently identify apprenticeship programs that are training such talent.

When available, we used the occupation codes provided by RAPIDS. In a small number of cases, however, RAPIDS provides an occupation title but no occupation code. For these apprentices, we used other datasets maintained by the OA to assign each record to an occupation code using the provided occupation title. Our system cleans the occupation title field and maps it to a corresponding occupation code, if one exists. For the small number of occupation titles that we could not programmatically map to an occupation code, we manually assigned occupation codes based on the apprenticeship program's details.

Following this process, for each apprentice record with a valid occupation code, we determined whether that occupation code matches an occupation in our AI workforce taxonomy. We excluded apprentice records missing both occupation title and occupation code from this analysis.[11]

Approximately 28% of apprentice records in the complete RAPIDS dataset do not have an occupation code, because they do not have a listed job title. See Appendix A for an evaluation of missing occupation information.

Overall, there were 65 different occupation titles reported in the RAPIDS database that fit into a technical AI occupation—either based on their RAPIDS-assigned occupation code or our title-to-code matching system. Between 2013 and 2023, the top occupations in AI-related apprenticeships were Application Developer, Computer Programmer, and Cyber Security Support Technician. See Appendix B for a list of top occupations.

In this initial pass, the vast majority of apprentices in AI-related occupations participated in the United Services Military Apprenticeship Program (USMAP).[12]

---

* The original methodology separates AI occupations into four categories — two technical and two nontechnical. For the purpose of this brief, we examine the two technical teams in one combined group. For a full description of the methodology used to arrive at this definition, see: 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/publication/the-u-s-ai-workforce/.

USMAP is an apprenticeship training program similar to those used by civilian employers, but is only available to active-duty military personnel. Therefore, any high-level evaluation of the updated dataset would skew results to reflect features of military apprenticeships while obscuring trends in civilian apprenticeships.

Additionally, of the AI-related USMAP apprentices' occupations, 99% of them were classified under the occupation code "Computer Occupations, All Other" (ONET 15-1299.00). This code serves as a catchall for occupation titles under the umbrella of "Computer and Mathematical Occupations" that do not fit into a more granular occupational category. Although this occupational code was included in CSET's previous definition of the AI workforce, the large number of USMAP apprentices classified with this occupation code warranted a close inspection of the specific occupation titles assigned to these apprentices.

Upon review, we found that a very large percentage of USMAP apprentices in the "Computer Occupations, All Other" code had the occupation title "Computer Operator," or an alias. We reviewed the competencies of the USMAP Computer Operator apprenticeship program and determined that they did not meet the threshold of an AI-related apprenticeship as defined above.[13]

Based on this review, we ultimately determined to exclude apprentices from our definition of AI-related apprentices and from the subsequent analysis if they had *either* of the following characteristics:

- Apprentice participates in USMAP, or

- Apprentice has the occupation code "Computer Occupations, All Other" (ONET 15-1299.00).
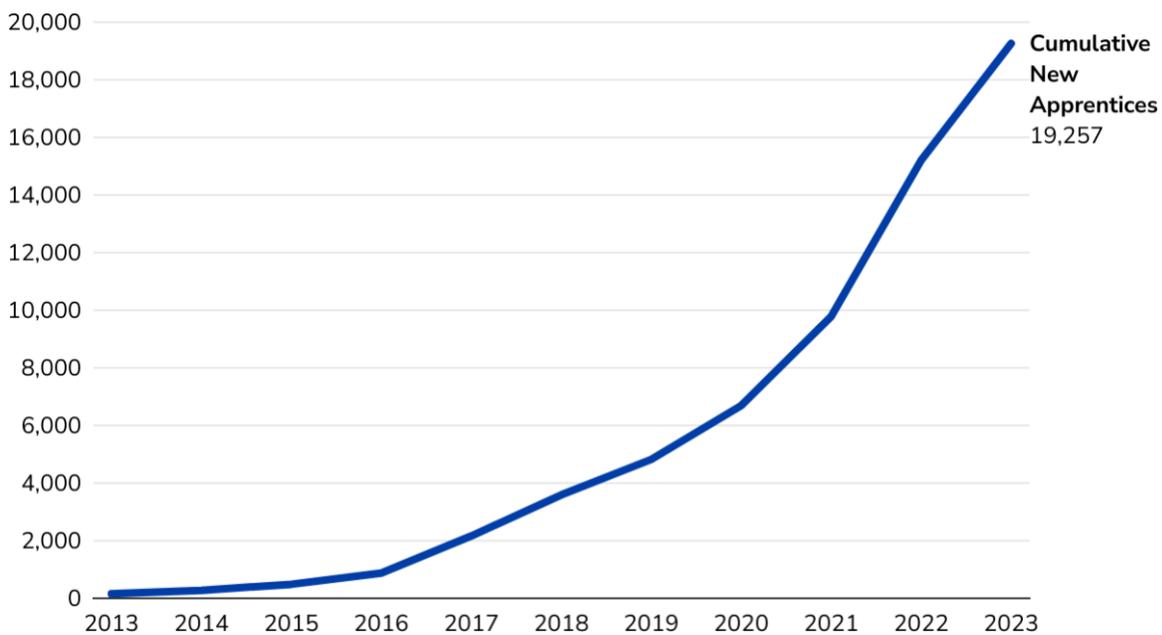
Findings

In our analysis of the RAPIDS database, for AI-related occupations we provide overviews of:

- Total new apprentices
- Completion rates for apprentices
- The gender, race, and ethnicity of apprentices
- State distribution of apprentices
- Sponsors of apprenticeship programs

Total AI-Related Apprentices

Figure 1 below shows the cumulative number of new apprentices from 2013 to 2023 for AI-related occupations. During that period, a total of 19,257 new workers joined apprenticeship programs in AI-related occupations across the country. While in 2013 there were only 155 new apprentices in AI-related occupations, a decade later there were 4,047 new apprentices joining these fields.
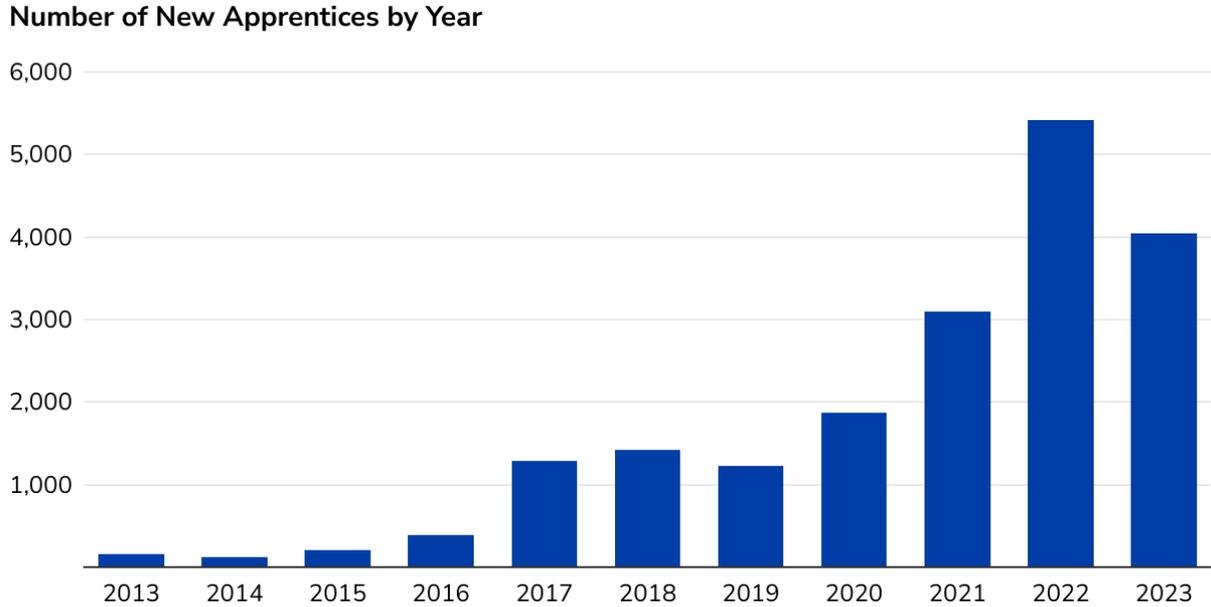
Figure 1. The Cumulative Number of New Apprentices in Technical AI-Related Occupations Has Risen Substantially Over the Last Decade

Source: CSET analysis of RAPIDS data.

The rapid growth in technical AI apprenticeships is even more impressive when compared to national totals for new apprentices in all occupations. From 2013 through 2023, the number of new apprentices in all non-military occupations grew an average of 15% per year. In the same period of time, new apprentices in technical AI occupations grew by 250% per year.

Figure 2. The Number of New Apprentices Per Year in Technical AI-Related Occupations Has Risen Substantially Over the Last Decade

Number of New Apprentices by Year

Source: CSET analysis of RAPIDS data.

The most notable period of growth occurred between 2020 to 2022, when technical AI occupations experienced the most rapid, sustained growth of new apprentices. During this three-year period, technical AI apprenticeship programs added 10,389 apprentices—54% of the total new apprentices added since 2013. Notably, unlike many employment trends, these technical apprenticeships exhibited continued growth throughout the COVID-19 pandemic beginning in 2020.

Although new apprenticeships in AI-related occupations showed tremendous growth until 2022, there was a marked decline in 2023. A large portion of the decline was concentrated in a few states with high numbers of apprentices. It was further concentrated among a few apprenticeship program sponsors in those states. This decline will be covered in more depth in the state-level analysis.
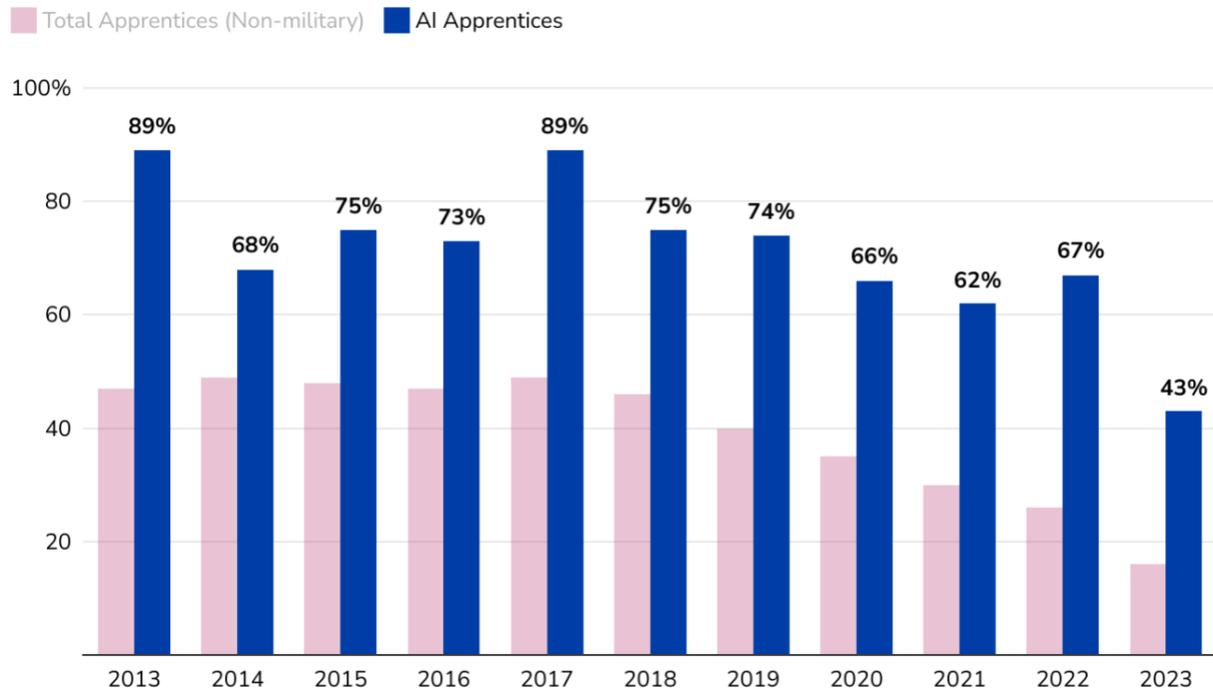
There are a few possible explanations for these declines. One likely driver was the Cybersecurity Apprenticeship Sprint that ran from July to November of 2022.[14] The sprint involved hundreds of programs and thousands of apprentices in cybersecurity occupations, resulting in a sharp increase in 2022 and a decrease once the sprint participants completed their programs. Another potential explanation is a result of the fact that the data represented here shows the number of new apprentices each year. While most tech apprenticeship programs are one-year, competency-based programs, some apprentices that joined from 2020 to 2022 may still be in their programs. Said programs and their associated employers may be at capacity or may have succeeded in meeting labor demand. Alternatively, programs in those states may have closed or faced reduced funding as previous federal and state grant programs time out. The exact reasoning is unclear and most likely can be attributed to multiple factors.

Completion Rates

Another positive feature of AI apprenticeships is that the completion rate of apprentices in technical AI occupations (i.e., the percentage of apprentices who finish their program after registration) is much higher than that found for other occupational categories. In total, from 2013 through 2023, 68% of apprentices who began and departed an apprenticeship in an AI-related occupation successfully completed their program. This is 25 percentage points higher than the completion rate of all (non-military) apprenticeships, which was 41% over the same time period. Figure 3 shows that even in the year with the worst completion rate, 43% of apprentices finished their program.

Figure 3. The Percentage of Apprentices in Technical AI Occupations Who Complete Their Programs is Much Higher Than for All (Non-USMAP) Apprentices

Completion Rate (Percentage of Exited New Apprentices)

Legend: Total Apprentices (Non-military) | AI Apprentices

Source: CSET analysis of RAPIDS data.

Note: For each year's cohort, this chart measures the number of apprentices who (successfully) completed their program, divided by the number of apprentices who exited their program (completed or cancelled). We exclude from the denominator all apprentices who are still enrolled in their program. The chart above shows the completion rate of apprentices who began their program in the indicated year.[*]
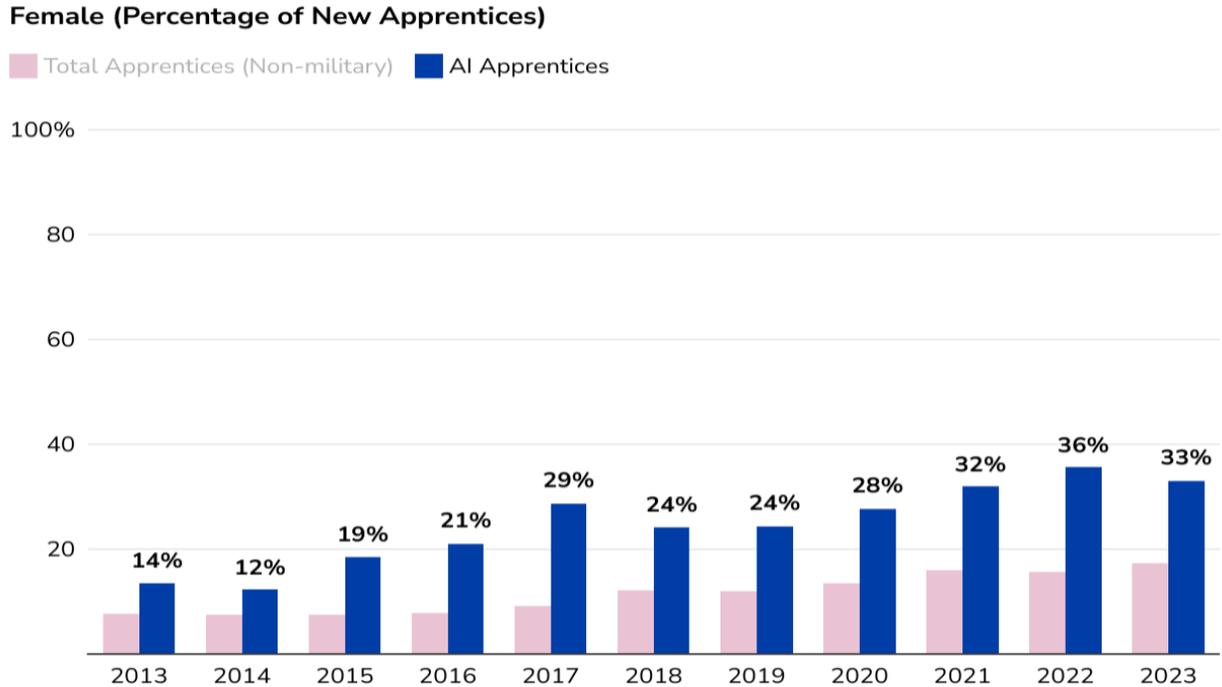
Gender, Race, and Ethnicity

This section analyzes the demographic attributes of AI-related apprentices registered across the country between 2013 and 2023, focusing specifically on attributes such as gender, race, and ethnicity.

---

[*] We exclude active (non-exited) apprentices from the completion rate's denominator to help control for each cohort's start year; more recent cohorts will inherently have a higher share of apprentices still enrolled in their programs compared to older cohorts, reducing the completion rate. Each apprentice has a unique identification number in our dataset, a registration date, and a current status. Using these fields, for each year we identified how many apprentices entered a program and whether they were still active, left the program but did not complete it, or completed it successfully.

Similar to other STEM occupations, there is significant gender inequity across AI-related apprenticeships. From 2013 through 2023, women accounted for about 31% of new AI-related apprentices, with some variation from year to year. For example, in 2022 they accounted for 36% but only 12% in 2014. This is similar to the gender composition of technical occupations in the total AI workforce, where women accounted for about 25% of workers in 2018, for example.[15] However, women accounted for a higher share of AI apprenticeships than of all (non-military) occupations: 31% relative to just 12%. Figure 4 shows on average, women held about twice the share of apprenticeships in AI-related occupations than in all occupations. However, the share of women in AI-related apprenticeships still reinforces the gender disparity seen in many tech-related fields. Efforts by the federal government, such as the Women in Apprenticeship and Nontraditional Occupations (WANTO) grant, indicate this is a known gap and steps are being taken to address it.[16]

Figure 4. A Low Percentage of New AI-Related Apprentices Are Women, but That Share is Higher Than for All Apprentices

Female (Percentage of New Apprentices)

Source: CSET analysis of RAPIDS data.

When looking at race and ethnicity variables, as Figure 5 shows, there are some positive indicators of progress toward greater diversity and inclusion in AI-related apprenticeships. The share of new AI-related apprentices who identify as Black or
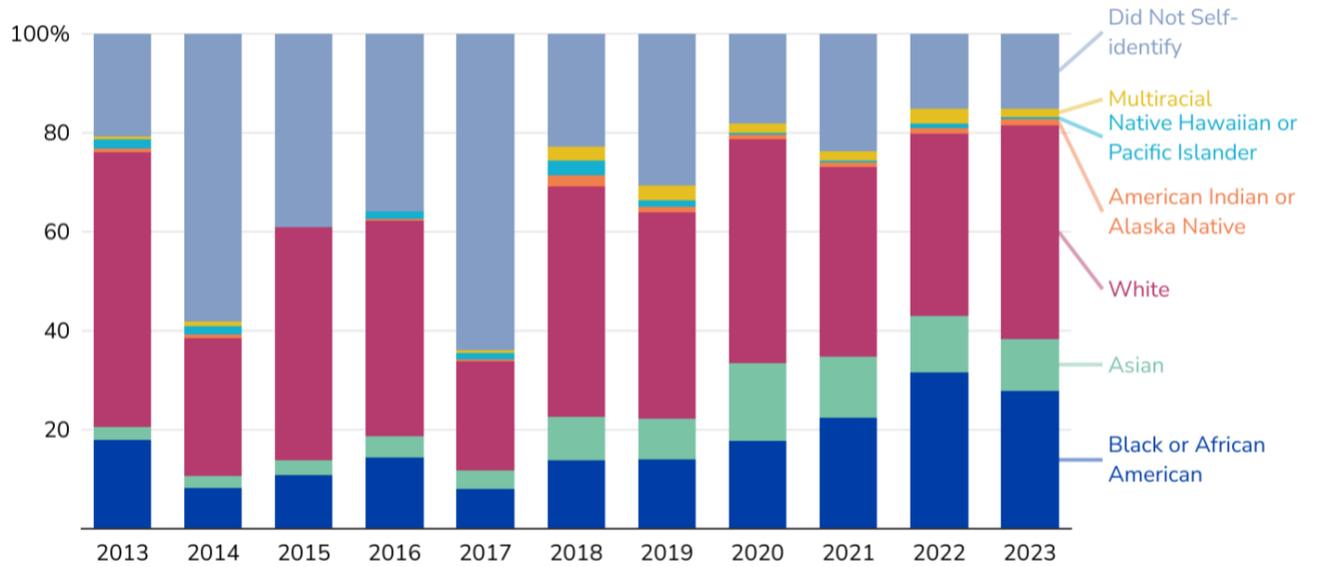
African American averaged 12% from 2013 through 2019, but then began to climb as enrollment in AI-related apprenticeship programs grew. From 2020 through 2023, 27% of new AI-related apprentices identified as Black or African American. Similarly, Asian-identifying apprentices averaged only 6% of AI-related apprenticeships from 2013 through 2019, but that share grew to 12% over the 2020–2023 period.

While previous research shows that Registered Apprenticeship Programs are often diverse, AI apprenticeships are more diverse than average. From 2013 through 2023, 23% of AI apprentices identified as Black or African American, compared to only 12% of all (non-military) apprentices. Over the same period, 10% of AI apprentices identified as Asian, compared to only 2% of all (non-military) apprentices.
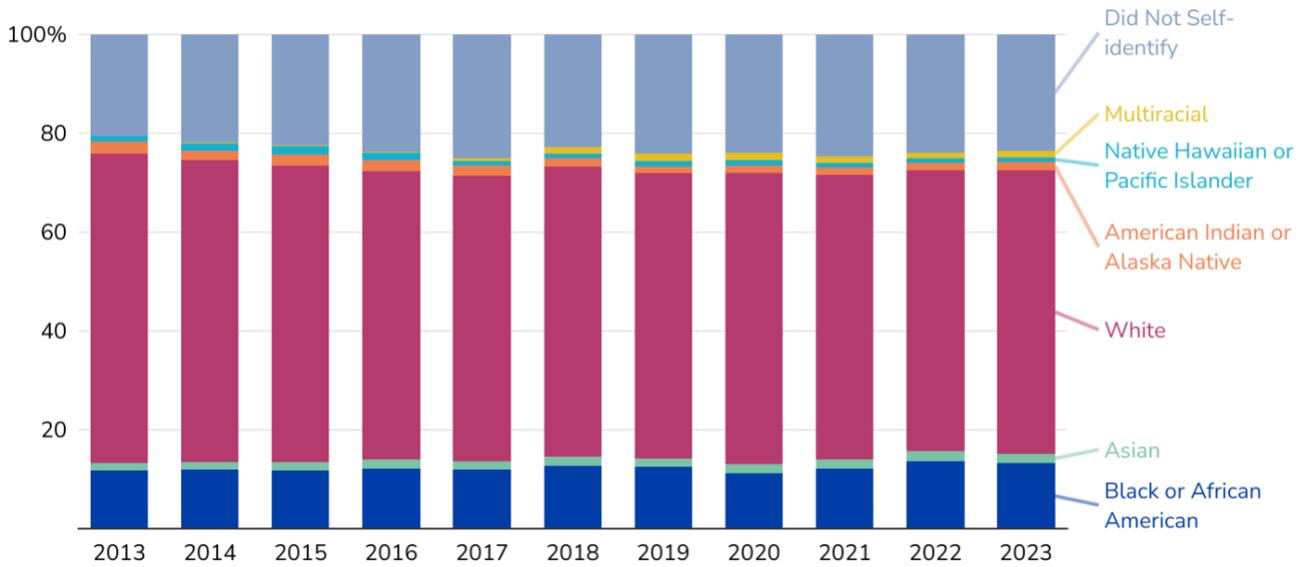
The diversity of AI apprenticeships is also notable considering that science and engineering occupations, including AI-related occupations, tend to be dominated by White and Asian workers. For comparison against all STEM occupations, in 2022 Black workers made up only 7% of the STEM workforce despite accounting for 12% of the population.[17]

Figure 5. The Share of New Apprentices Who Identify as Black or African American is Higher for Technical AI-Related Apprentices Than for All (Non-Military) Apprentices
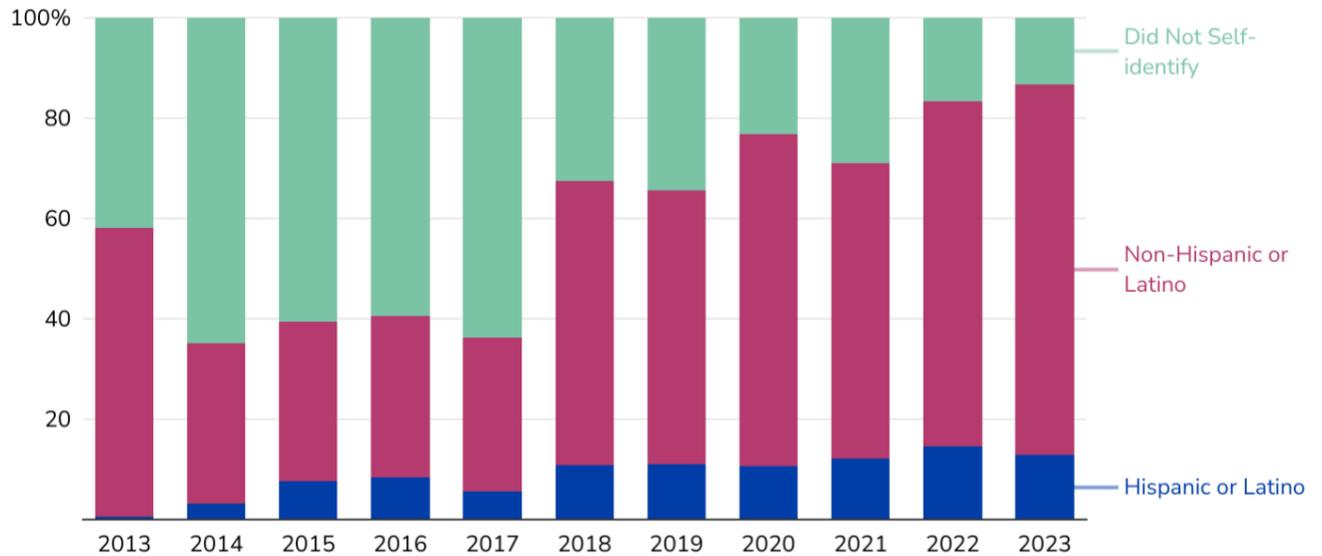

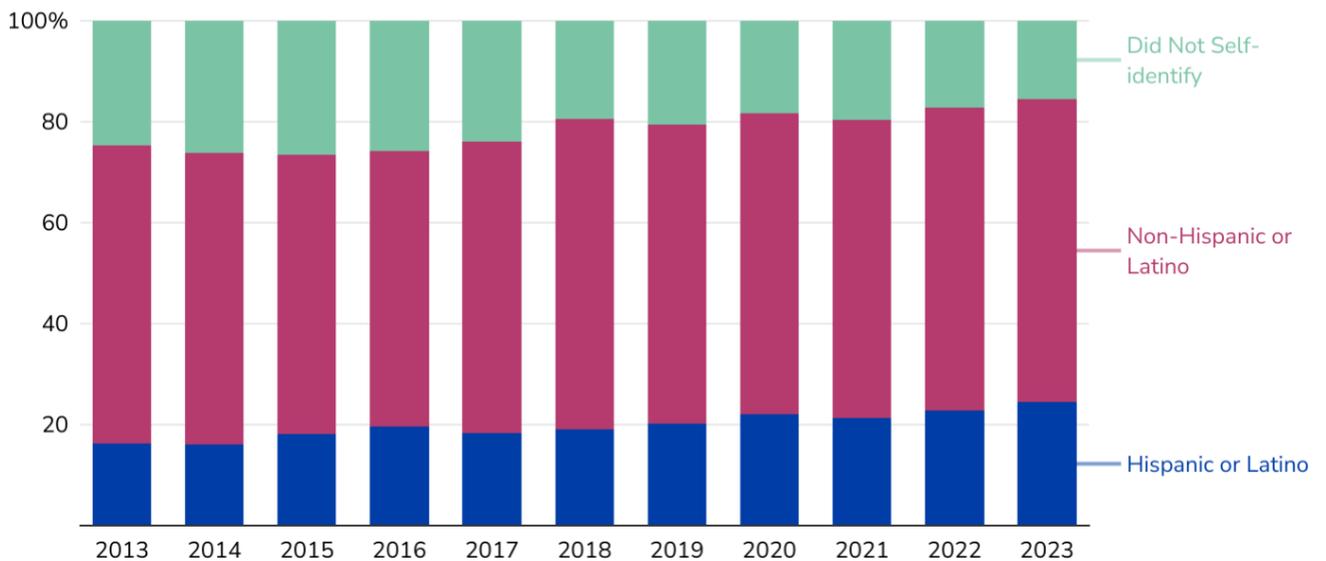Source: CSET analysis of RAPIDS data.

The ability of AI apprenticeships to reach workers from non-White backgrounds was less effective concerning apprentices who identified as Hispanic or Latino. From 2013 through 2023, about 12% of new apprentices in technical AI occupations identified as such. This is lower than the 20% of all new (non-military) apprentices who identified as Hispanic or Latino over the same period.

Figure 6: The share of Hispanic or Latino apprentices in technical AI-related occupations is lower than in all new (non-military) occupations.

Technical AI-Related Apprentices

All Apprentices (Non-Military)

Source: CSET analysis of RAPIDS data.
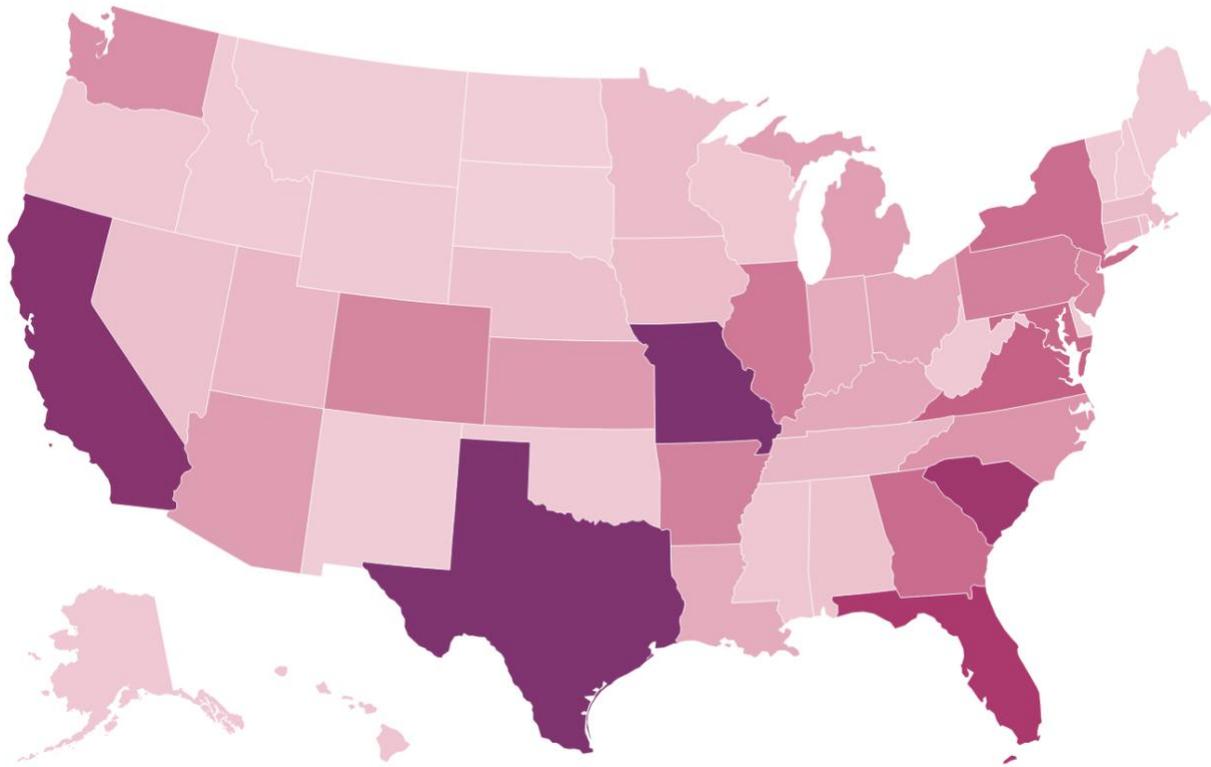
Distribution by State

We were also able to analyze apprenticeships in AI-related occupations by state. We used three time periods to frame our analysis: the entire time period from 2013 through 2023, the period of rapid growth from 2020 to 2022, and the decline in new apprentices from 2022 to 2023.

Figure 7 shows which states registered the most apprentices in technical AI occupations. This metric lends itself to high-population states and states with national tech hubs, making it no surprise to see Texas, California, New York, and Florida in the top ten. However, we also see states with lower populations and without established national tech hubs in the top ten, such as Missouri and South Carolina. Missouri had the highest number of new apprentices, with just over 2,000 registered. Overall, the top ten states account for 11,909, or 62%, of the 19,257 new apprentices in AI-related occupations across the country between 2013 and 2023.[*] Throughout this section, we show that apprenticeships in AI-related occupations are concentrated in a few states but are present in every state and territory. Variations in new apprentice totals in these states are the main driver for the trends we see in national totals.

---

[*] The top ten states from 2013 through 2023 from most to least new apprentices registered were Missouri, Texas, California, South Carolina, Florida, Virginia, Maryland, Georgia, New York, and Illinois.

Figure 7. The Greatest Number of New Apprentices in Technical AI-Related Occupations Were Registered in Missouri, Texas, and California From 2013 Through 2023

Number of New Apprentices

5   2,036

Source: CSET analysis of RAPIDS data.

As previously noted, the number of new apprentices in AI-related occupations increased most significantly from 2020 through 2022. When examining how this upsurge in AI apprenticeships unfolded across the country, our analysis shows that while 45 states increased the number of new apprentices registered in 2022 compared to 2020, the rapid growth was largely due to the ten top-performing states over those three years. Those top ten states added more than 6,100 new apprentices, or 59% of all new apprentices during that period. These ten states are the same as the ten

highest-performing states from 2013 through 2023, with the exception of Arkansas, which entered the top ten in 2020 to 2022 with 405 apprentices registered.[*]

While AI apprenticeships grew significantly between 2020 and 2022, driven largely by top-performing states, data from 2022 to 2023 reveals a decline in new registrations. Once again, the change is largely due to decreases in states with high apprentice totals. The ten states with the largest net decline accounted for 64% of the national net decline.[†] The state with the largest decline, Washington, was not present in the top ten during the growth period and dropped from 200 new apprentices in 2022 to only 39 in 2023.

We also found that 38 states had fewer new apprentices in 2023 than in 2022. The net change in new AI-related apprentices for each state from 2022 to 2023 is shown in Figure 8.
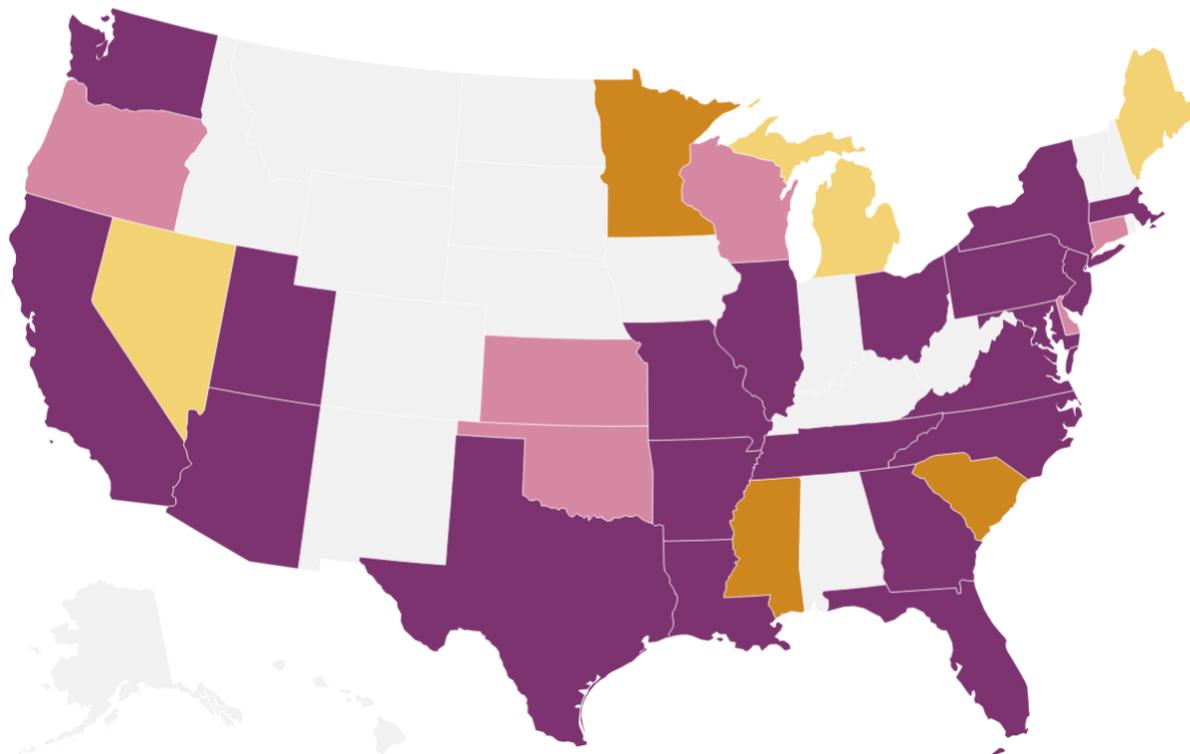
---

[*] Arkansas replaced South Carolina in the top ten from 2020 to 2022.

[†] Those were: Washington, Georgia, Virginia, Texas, California, Illinois, North Carolina, New York, Ohio, and Arkansas.

Figure 8. Most States Saw the Number of New Apprentices in Technical AI-Related Occupations Decline From 2022 to 2023

Source: CSET analysis of RAPIDS data.

Furthermore, within each of the states that experienced the greatest net declines in new apprenticeships, a few program sponsors accounted for the majority of *total* declines in registration. For example, in Washington, one program administered by Apprenti registered 111 fewer apprentices in 2023 than in 2022. This alone accounts for 66% of the total decrease by programs in Washington state for 2023. Similarly, in the other four states with the biggest decreases in new apprentices, three or fewer program sponsors accounted for the majority of the drop in new apprentice registrations.

When viewing each of the three time periods at the state level, we see that the same top states are driving new apprenticeship totals each year. We also see that states with fewer new apprenticeships per year followed the same general trends as states with more apprentices, but they were less consistent in their growth and had less impact on

nationwide totals. It is worth noting that states that had more new apprentices were not necessarily states with the highest populations. Four of the top ten states for new apprentices registered from 2013 through 2023 were not among the top ten most populous states.[*]
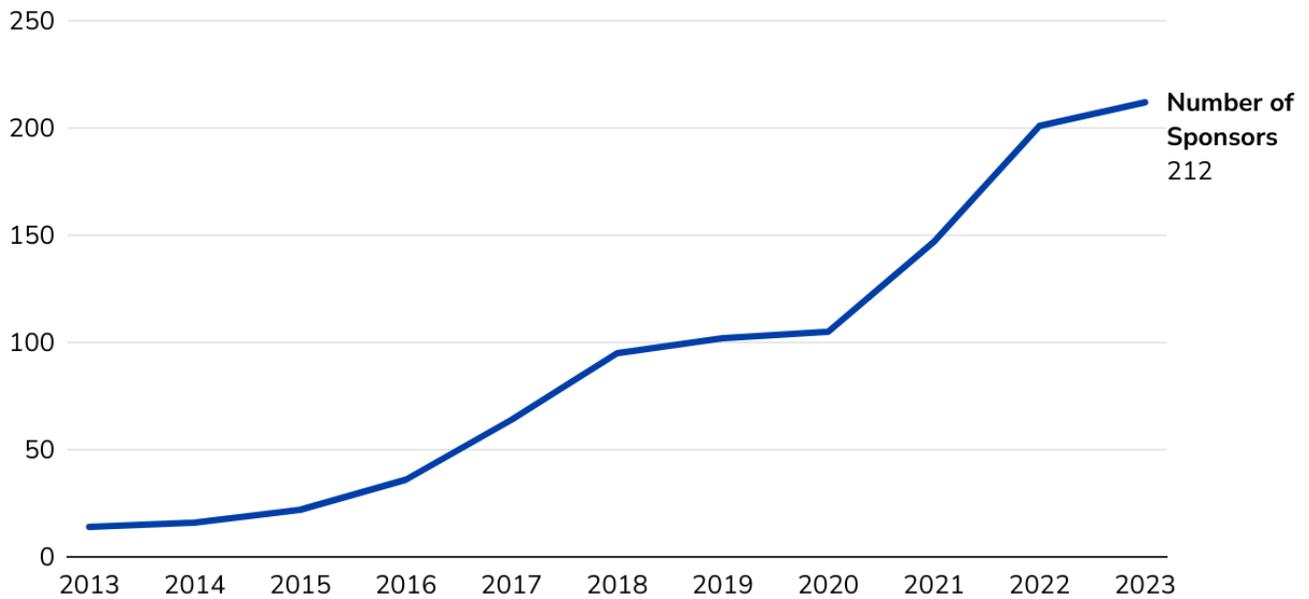
Sponsors

Each Registered Apprenticeship Program is initiated and overseen by a program sponsor that develops or approves the standards for the apprenticeship. Sponsors also handle the administrative requirements associated with operating a federally recognized apprenticeship program. Historically, employers or labor organizations functioned as program sponsors, but more and more this role is being fulfilled by organizations like nonprofits, community colleges, and industry associations.[18] Since 2020, the DOL has also funded 19 Industry Intermediaries to enhance apprenticeship opportunities in high-growth industries.[19] These intermediaries are organizations that serve as liaisons between the DOL and employers, facilitating the development and implementation of apprenticeship programs. Their roles include promoting the benefits of RA, providing technical assistance, and helping employers establish and sustain apprenticeship initiatives.

We can see in Figure 9 that in the case of AI-related apprenticeships, there has been a steady increase in the number of sponsors as the number of apprentices in AI-related occupations has risen. From 2013 through 2023, a total of 478 different sponsors administered 540 programs.

---

[*] Pennsylvania, Ohio, North Carolina, and Michigan are among the ten most populated states, but not the ten states with the most new apprentices. Conversely, Virginia, South Carolina, Missouri, Arkansas (from 2020 to 2022), and Maryland are not on the list of the top ten most populated states but are present in the states with the most new apprentices.

Figure 9. The Number of Active Sponsors for New Apprentices in Technical AI Occupations Has Increased Alongside the Annual Number of New Apprentices

Source: CSET analysis of RAPIDS data.

Note: The data within this figure shows the number of active sponsors in each year. Each year does not include the summed total of sponsors that had been active in previous years.

The increase in the total number of sponsors, along with the histogram of apprentices per sponsor seen in Figure 10, shows that the increase in AI-related apprentices is not only fueled by companies and nonprofits that sponsor dozens of new apprentices, but also by over 300 organizations that sponsor few apprentices (total of ten or fewer apprentices from 2013 through 2023).

Figure 10. Histogram of Number of Apprentices Per Program Sponsor

Number of Sponsors

Source: CSET analysis of RAPIDS data.

A common concern regarding apprenticeships in new industries is that the startup costs, or difficulty navigating the regulatory and administrative landscape of the Registered Apprenticeship system, may make the model inaccessible for small- to medium-sized firms. To determine whether this is the case for AI-related occupations, we pulled a random sample of 43 program sponsors who registered fewer than six apprentices from 2013 through 2023. We manually searched Crunchbase to determine the number of employees at each organization as an indicator of their size. In that sample, five sponsors employed between 1–10 employees and five sponsors employed between 11–50. While not conclusive, this does indicate that the model is amenable to smaller cohorts of apprentices within smaller organizations.

While there are hundreds of sponsors with relatively small numbers of apprentices in their programs, the top sponsors do account for a large share of total apprentices registered in AI-related occupations. Table 1 shows the top ten sponsors by total registered apprentices from 2013 through 2023. Over that time period, those ten sponsors accounted for half of all apprentices registered. Apprenti, a nonprofit that specifically works with organizations to facilitate tech apprenticeships, far outpaces other sponsors and accounted for 11% of new apprentices by itself. LaunchCode,

another nonprofit based in Missouri, has accounted for 39% of all new apprentices in its home state and is the main reason we saw a high number of apprentices in Missouri. Oracle, IBM, and Lockheed Martin, all well-known corporations, round out the top five. Interestingly, the South Carolina National Guard is also in the top ten list, and it makes up 50% of new AI-related apprentices in South Carolina.

Table 1. Top 10 Sponsors of Registered Apprentices in Technical AI Occupations, 2013 Through 2023

Sponsor Name	Total Registered Apprentices
Apprenti	2,108
Oracle	1,317
LaunchCode	1,184
Lockheed Martin	1,051
International Business Machines (IBM)	880
South Carolina National Guard	700
Avid Solutions Peoria	673
Cognizant Technology Solutions	649
Apprenticely (Arkansas Center for Data Sciences)	501
Step IT Up America	484

Source: CSET analysis of RAPIDS data.

Note: The Arkansas Center for Data Sciences was recently rebranded as "Apprenticely"; https://talkbusiness.net/2024/04/arkansas-center-for-data-sciences-rebrands-as-apprenticely/.

Policy Considerations

The growth of AI-related apprenticeships shown in the preceding sections is a promising sign for building a new, effective pathway into AI-related occupations. However, continued growth is not a foregone conclusion. Apprenticeships in the U.S., even in the construction and trades industries, are underdeveloped and underutilized compared to countries with thriving apprenticeship systems.

Although there is no direct evidence of causation between federal investment in the National Apprenticeship System and an increase in AI-related apprenticeship growth, the timeline of investment does align with the upward trend in new apprentice registrations. The first year of noteworthy growth in apprenticeships, 2015, was the year the Obama administration launched the American Apprenticeship Initiative, the single largest U.S. investment in apprenticeships to date. That program, as well as subsequent initiatives, were continued through the Trump and Biden administrations, and often highlighted emerging technology and high-growth industries as targets for investment.

Because of the lack of historical focus on apprenticeships in the U.S., they are less prevalent than in European countries where they are deeply integrated into the workforce development framework. To effectively scale apprenticeships, for AI-related occupations as well as other STEM occupations, and make them a cornerstone of American workforce training, it is essential to ensure consistent federal support and foster a culture that values and recognizes the importance of apprenticeships.[*] A sustained effort will help lift public awareness of apprenticeships and establish them as a viable and respected pathway to skilled employment.

---

[*] For apprenticeships to be a truly viable pathway to skilled employment, attention must be given not only to training and completion rates but also to whether apprentices transition into stable, quality jobs. Measuring these outcomes is key to assessing the broader success of apprenticeship programs.

Conclusion

The concurrent proliferation of AI and the elevated focus on the national apprenticeship system is a potentially promising combination for training and upskilling middle-skill AI workers. While apprenticeships have historically focused on the construction and trades industries, we found that over the last decade apprenticeships in AI-related occupations have grown rapidly. Since 2015, apprenticeship programs in AI-related fields have registered nearly 19,000 new apprentices.

There are also other positive features besides sheer volume. These apprenticeships are present in nearly every state, and at 68%, the average completion rate of AI-related apprenticeships is much higher than the national average for apprenticeships in other occupations. While a relatively small number of large program sponsors registered the majority of new apprentices, there are also hundreds of sponsors that registered fewer than ten. This indicates that the apprenticeship model for AI-related occupations is amenable to smaller firms with smaller cohorts of apprentices. AI-related apprenticeships have also been successful at recruiting Black apprentices at far higher rates than other AI and STEM jobs, potentially demonstrating that Apprenticeship Programs are a promising career development pathway into AI-related occupations for Black workers.

However, there are also shortfalls that require attention. Despite growth, even in its peak year of 2022, new AI-related apprenticeships made up only 2.4% of all new non-military apprenticeships. Also, the gender disparities present in other STEM fields are similarly reflected in the low number of women enrolled in AI-related apprenticeship programs. Furthermore, the success of programs in enrolling Black apprentices does not extend to Hispanic and Latino populations. And finally, while AI-related apprenticeships grew steadily from 2015 to 2022, there was a notable drop in new registrations in 2023 compared to 2022.

Our findings show that over the past decade, AI-related apprenticeships have become a more common training pathway for the technology workforce. Federal and state governments should continue to support apprenticeship initiatives to sustain momentum, normalize apprenticeships as a valuable pathway for workers in AI-related and other technical fields, and expand pathways into quality jobs for a wide range of workers.

Authors

Luke Koslosky is a research analyst at CSET.

Jacob Feldgoise is a data research analyst at CSET.

Acknowledgments

Appendix A: Evaluation of Missing Occupational Data

Approximately 28% of apprentice records in the RAPIDS dataset have no occupation code, because their job titles are missing. The share of records missing occupational information is consistent between the time period assessed in this analysis (2013 through 2023) and the time periods excluded from analysis (pre-2013 and 2024Q1). See Table A1.

Table A1: Number of New Apprentices by Time Period and Whether Occupation Code is Missing

Population	Pre-2013 and 2024 Q1 (out of scope)	2013 through 2023 (in scope)	Total (all years)
Apprentices with Occ. Code	1,633,694	1,773,327	3,407,021
Apprentice missing Occ. Code	635,464 (28.0%)	682,048 (27.8%)	1,317,512 (27.9%)
Total	2,269,158	2,455,375	4,724,533

Source: CSET analysis of RAPIDS data. Note: The percentages in the "Missing Occ. Code" row are the share of records that are missing an occupation code in each time period (i.e., cell value divided by column total).

We tested the population of apprentice records missing occupation information to predict whether it is comparable to the population of apprentice records that has occupation information. To accomplish this, we compared the gender and racial demographics of the two populations. The share of female apprentices was nearly the same between the two populations (see Table A2). The racial breakdown was not exactly the same—22% of apprentices missing occupation did not self-identify compared to 31% of apprentices who had occupation data. However, despite this difference, the racial demographics are generally similar between the two populations (see Table A3). These tests increase our confidence that results of the analysis of apprentices with occupation information may also hold for apprentices missing that information.

Table A2: Balance Check for Missing Occupation Codes—Share of Each Population by Gender

Gender	Apprentices with Occ. Code	Apprentices Missing Occ. Code
Female	11.9%	13.5%
Male	88.1%	86.5%

Source: CSET analysis of RAPIDS data.

Note: In order to properly test the dataset analyzed throughout this paper, this table only considers non-USMAP apprentices who started their program from 2013 through 2023.

Table A3: Balance Check for Missing Occupation Codes—Share of Each Population by Race

Race	Apprentices with Occ. Code	Apprentices Missing Occ. Code
American Indian or Alaska Native	1.8%	1.4%
Asian	1.8%	1.9%
Black or African American	13.3%	8.9%
Multiracial	0.8%	1.7%
Native Hawaiian or Pacific Islander	1.1%	1.0%
White	59.5%	54.0%
Did Not Self-Identify	21.7%	31.1%

Source: CSET analysis of RAPIDS data.

Note: In order to properly test the dataset analyzed throughout this paper, this table only considers non-USMAP apprentices who started their program from 2013 through 2023.

Appendix B: Additional Data

Top-Performing States

Table B1. Top 10 States by Number of New AI-Related Apprentices from 2013 to 2023

Rank	State	New AI-Related Apprentices
1	Missouri	2,036
2	Texas	1,983
3	California	1,823
4	South Carolina	1,393
5	Florida	1,181
6	Virginia	768
7	Maryland	713
8	Georgia	705
9	New York	694
10	Illinois	613

Source: CSET analysis of RAPIDS data.

Occupations

Table B2. Top 10 Occupation Titles for New Apprentices Within Ai-Related Occupations from 2013 Through 2023

Occupation Title	New AI-Related Apprentices
Application Developer	3,705
Computer Programmer	3,425
Cyber Security Support Technician	1,712
IT Generalist	1,438
Computer Support Specialist/Desktop Support Tech	1,390
IT Specialist	1,202
IT Project Manager	826
Computer Support Specialist	487
Network Support Technician	450
Computer Systems Analyst	409

Source: CSET analysis of RAPIDS data.

Endnotes

[1] 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/publication/the-u-s-ai-workforce/.

[2] Estimates on the average return on investment for firms utilizing a Registered Apprenticeship Program vary and depend on a few variables. However, evidence suggests that the return is positive, especially over longer periods of time, and surveys of program sponsors indicate high levels of satisfaction. For more information, see: Annelies Goger, Chenoah Sinclair, and Aaliyah Dick, "An Apprenticeship FAQ: What Employers Need to Know About Talent Development," Brookings, March 1, 2021, https://www.brookings.edu/articles/an-apprenticeship-faq-what-employers-need-to-know-about-talent-development/; Robert Lerman, "Do Firms Benefit from Apprenticeship Investments?," IZA World of Labor, October 2019, https://wol.iza.org/articles/do-firms-benefit-from-apprenticeship-investments/long; Susan Helper, Ryan Noonan, Jessica R. Nicholson, and David Langdon, "The Benefits and Costs of Apprenticeships: A Business Perspective," U.S. Department of Commerce, November 2016, https://files.eric.ed.gov/fulltext/ED572260.pdf; and ApprenticeshipNC and North Carolina Department of Commerce, "North Carolina Apprenticeship Program Survey Report," October 2020, https://www.apprenticeshipnc.com/sites/default/files/news-files/nc_apprenticeship_program_survey_report_2020_final.pdf.

[3] Robert I. Lerman, "Expanding Apprenticeship Opportunities in the United States," The Hamilton Project, November 2013, https://www.hamiltonproject.org/assets/legacy/files/downloads_and_links/expand_apprenticeship_opportunities_united_states_lerman.pdf.

[4] Robert I. Lerman, "The State of Apprenticeship in the US: A Plan for Scale," Apprenticeships for America, July 2022, https://static1.squarespace.com/static/61f1c7ff7041697cc1eff1bd/t/62d5b4981261b74803071036/1658172568403/planforscale.pdf.

[5] Jeffrey Zients, "Expanding Apprenticeships to Invest in American Workers," The White House, September 10, 2015, https://obamawhitehouse.archives.gov/blog/2015/09/10/expanding-apprenticeships-invest-american-workers.

[6] Employment and Training Administration, "National Apprenticeship System Enhancements," Federal Register, January 17, 2024, https://www.federalregister.gov/documents/2024/01/17/2023-27851/national-apprenticeship-system-enhancements.

[7] The White House, "FACT SHEET: President Biden Signs Executive Order: Scaling and Expanding the Use of Registered Apprenticeships in Industries and the Federal Government and Promoting Labor-Management Forums," March 6, 2024, https://bidenwhitehouse.archives.gov/briefing-room/presidential-

actions/2024/03/06/executive-order-on-scaling-and-expanding-the-use-of-registered-apprenticeships-in-industries-and-the-federal-government-and-promoting-labor-management-forums/.

[8] U.S. Department of Labor, "Biden-Harris Administration Announces Nearly $200M Available in Grants to Expand Registered Apprenticeships," February 21, 2024, https://www.dol.gov/newsroom/releases/eta/eta20240221.

[9] This is not an exhaustive list of apprenticeship-related programs over this time period, but rather a few examples to illustrate the renewed and continued emphasis on Registered Apprenticeships over the time period. For more details see, Robert I. Lerman, "The State of Apprenticeship in the US: A Plan for Scale."

[10] Robert I. Lerman, "The State of Apprenticeship in the US: A Plan for Scale."

[11] In some cases, an occupation title maps to multiple occupation codes, where one is a technical AI-related occupation and one is not; records with these occupation titles are not included in our analysis. For a full description of the four categories, see: 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/publication/the-u-s-ai-workforce/.

[12] 88.8% of apprentices initially identified as AI-related participated in USMAP (153,285 of 172,542).

[13] The U.S. Department of Defense has made details about the USMAP Computer Operator apprenticeship program publicly available on its website: https://usmap.osd.mil/trades/time/0817N.pdf.

[14] The White House, "FACT SHEET: Biden-Harris Administration Accomplishes Cybersecurity Apprenticeship Sprint," November 15, 2022, https://bidenwhitehouse.archives.gov/briefing-room/statements-releases/2022/11/15/fact-sheet-biden-%e2%81%a0harris-administration-accomplishes-cybersecurity-apprenticeship-sprint/.

[15] Gehlhaus and Mutis, "The U.S. AI Workforce."

[16] U.S. Department of Labor, "Women in Apprenticeship & Nontraditional Occupations (WANTO) Grant Program," https://www.dol.gov/agencies/wb/grants/wanto.

[17] U.S. Equal Employment Opportunity Commission, "High Tech, Low Inclusion: Diversity in the High Tech Workforce and Sector 2014–2022," September 10, 2024, https://www.eeoc.gov/sites/default/files/2024-09/20240910_Diversity%20in%20the%20High%20Tech%20Workforce%20and%20Sector%202014-2022.pdf.

[18] U.S. Department of Labor, "U.S. Department of Labor Awards Over $22 Million to Industry Intermediaries to Support Continued Apprenticeship Expansion and Opportunity," September 25, 2020, https://www.dol.gov/newsroom/releases/eta/eta20200925-3; and Alexandria M. Wright, "Best Practices:

Workforce Systems," Economic Development Collaborative, October 2019, https://edcollaborative.com/wp-content/uploads/2020/03/EDC-Workforce-Systems-Best-Practices-Apprenticeships-2019.pdf.

[19] U.S. Department of Labor, "Department of Labor Awards Nearly $17M to Expand Use of Registered Apprenticeships in Education, Clean Energy, Other Critical Industries," July 19, 2023, https://www.dol.gov/newsroom/releases/eta/eta20230719-0; and U.S. Department of Labor, "U.S. Department of Labor Awards Over $22 Million to Industry Intermediaries to Support Continued Apprenticeship Expansion and Opportunity," September 25, 2020, https://www.dol.gov/newsroom/releases/eta/eta20200925-3.