Chapter 10:
The Talent Competition

Winning the AI Talent Competition

NDEA II With a Focus on Digital Skills

Attract and Retain the World's Brightest

The United States is in a global competition for scarce AI talent.[1] The Commission is very concerned with current talent trends. The number of domestic-born students participating in AI doctorate programs has not increased since 1990, and competition for international students has accelerated, endangering the United States' ability to retain international students.[2] For the first time in our lifetime, the United States risks losing the competition for talent on the scientific frontiers. Cultivating more potential talent at home and recruiting and retaining more existing talent from foreign countries are the only two options to sustain the U.S. lead.

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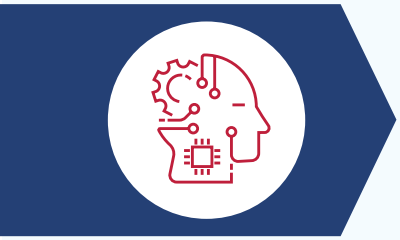
Competitors and allies recognize the importance of implementing AI talent strategies. Between 2000 and 2014, China's university system increased its number of science, technology, engineering, and mathematics (STEM) graduates by 360%, producing 1.7 million in 2014 alone.[3] The number of STEM graduates in the United States' university system rose by 54% during the same time period, and many were international students.[4] China's researchers now represent roughly 29% of top-tier deep learning talent in the world.[5] China and other states have also taken steps to attract international talent with flexible immigration policies and incentives for tech talent.[6]

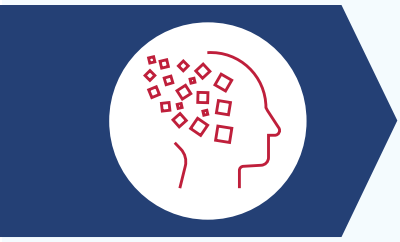
The United States needs to invest in all AI talent pipelines in order to remain at the forefront of AI now and into the future. A passive strategy will not work in the face of the AI talent competition.

To achieve dominance in AI, the U.S. needs to train four archetypes to propel AI in America: researchers, implementers, end users, and informed consumers.



Researchers

AI research engineers will focus on R&D of technologies that enable and advance semi- and fully-autonomous systems. They serve as algorithm experts with up-to-date knowledge of modern AI research and may be involved in the inception of ideas and drive the development cycles from research to testing of prototypes for a major project or component of a major project.

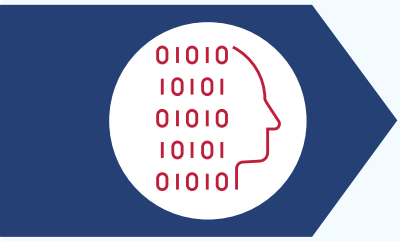


Implementers

They will be responsible for data cleaning, feature extraction and selection, and analysis; model training and tuning; partnerships with domain knowledge experts and end users; and the discovery of local opportunities for exploitation. Developers require less training and education than AI experts, and will have training, education, and/or experience that is roughly equivalent to an associate or bachelor's degree; and that includes relevant ethics and bias mitigation in data processing and model training.

End Users

They will have their daily business augmented/enabled by AI. Use of AI will strongly resemble the use of currently available software in that it will require some system-specific training, but, with the exception of some positions that manage data, little to no AI specific expertise.



Informed Consumers

This group of people needs the ability to make better consumer choices when purchasing technology and understand the importance of their actions in the market.

The Promise and Limits of Expanding STEM.

Investments in STEM education are a necessary part of increasing American national power and improving national security. The United States ranks well overall on international measures of talent because of our ability to attract international talent, in spite of our uneven kindergarten to 12th grade (K-12) education system.[7] It is critical that the United States invest significantly in STEM education as an engine to drive the growth of AI talent in America. Investments in STEM education alone, however, will not be enough for the United States to win the international competition for AI and STEM talent. China is producing large numbers of computer scientists, engineers, and other STEM graduates.[8] For the foreseeable future, the United States' STEM education system does not have the capacity nor the quality to produce sufficient STEM or AI talent to supply the United States' markets or national security enterprise.[9] To compete, the United States must reform its education system to produce both a higher quality and quantity of graduates.

Recommendation

Pass a National Defense Education Act II. Motivated by fear that America had fallen behind in education and innovation after the Soviets launched Sputnik in 1957, Congress passed the National Defense Education Act (NDEA) the following year. The NDEA promoted the importance of science, mathematics, and foreign languages for students, authorizing more than $1 billion toward decreasing student loans, funding for education at all levels, and funding for graduate fellowships. Many students were able to attend college because of this legislation. In 1960, 3.6 million students attended college; by 1970 it was 7.5 million.[10] This act helped America win the Space Race, helped power the microelectronics industry, accelerated the U.S. capacity to innovate, and, ultimately, played an important role in America's victory in the Cold War.

The Commission believes the time is right for a second NDEA, one that mirrors the first legislation, but with important distinctions. NDEA II would focus on funding students acquiring digital skills, like mathematics, computer science, information science, data science, and statistics. NDEA II should include K-12 education and reskilling programs that address deficiencies across the spectrum of the American educational system, purposefully targeting under-resourced school districts. The Commission also recommends investments in university-level STEM programs with 25,000 undergraduate, 5,000 graduate, and 500 PhD-level scholarships. Undergraduate scholarships should include credit hours at community colleges to ensure more Americans have access to affordable STEM education. Ultimately, the goal of NDEA II is to widen the digital talent pool by incentivizing programs for underrepresented Americans.

"The Commission believes the time is right for a second NDEA ..."

Recommendation

Strengthen AI talent through immigration. Immigration reform is a national security imperative. Nations that can successfully attract and retain highly skilled individuals gain strategic and economic advantages over competitors. Human capital advantages are particularly significant in the field of AI, where demand for talent far exceeds supply.[11] Highly skilled immigrants accelerate American innovation, improve entrepreneurship, and create jobs.[12] The United States benefits far more from the immigration of highly skilled foreign workers than other countries. In 2013, the United States had 15 times as many immigrant inventors as there were American inventors living abroad.[13] By contrast, Canada, Germany, and the U.K. all maintain a net negative inventor immigration rate.[14] Compared with other U.S. advantages in the AI competition—such as financial resources or hardware capacity—this immigration advantage is harder for other countries to replicate.

“Nations that can successfully attract and retain highly skilled individuals gain strategic and economic advantages over competitors.”

Unfortunately, international students in the United States are increasingly choosing to study in other countries or return home.[15] One reason is the growing backlog of green card petitions.[16] Indian immigrants face a particularly long wait. Many will spend decades on constrictive work visas waiting to receive their green cards, hindering both the technology sector’s ability to recruit talent and Indian immigrants’ quality of life. At the same time, other countries are increasing their efforts to attract and retain AI talent, including immigrants in Silicon Valley.[17]

“Restrictions harm U.S. innovation and economic growth and only help our competitors by enabling their human capital to grow. They also incentivize U.S. technology companies to move to where talent resides, whether right across our borders or overseas.”

While immigration benefits the United States, policymakers must also bear in mind the threat of unwanted technology transfer. However, restricting immigration is far too blunt a tool to solve this problem.[18] Restrictions harm U.S. innovation and economic growth and only help our competitors by enabling their human capital to grow. They also incentivize U.S. technology companies to move to where talent resides, whether right across our borders or overseas.[19] Technology transfer will only get worse if significant components of the U.S. technology sector move their research and development to China or other countries that are more vulnerable than the United States to technology transfer efforts.[20] A more effective strategic approach would pair actions to improve the United States' ability to attract top global talent with targeted efforts to combat technology transfer vectors. NSCAI addresses technology transfer in detail in Chapter 14 of this report. Changes to immigration policies should be paired with those recommendations.

Immigration policy can also slow China's progress. China's government takes the threat of brain drain seriously, noting that the United States' ability to attract and retain China's talent is an obstacle to the Chinese Communist Party's (CCP) ambitions.[21] Increasing China's brain drain will create a dilemma for the CCP—which will be forced to choose between losing even more human capital, further slowing their economic growth and threatening their advancement in AI, or denying Chinese nationals opportunities to study and work in the United States. At the same time, the United States should be cautious about potential adverse effects on talent pools in partner nations.

"Increasing China's brain drain will create a dilemma for the CCP ..."

Recommendation

Broaden the scope of "extraordinary" talent to make the O-1 visa more accessible and emphasize AI talent. The O-1 temporary worker visa is for people with extraordinary ability or achievement. Currently adjudicators determine an applicant's eligibility through a subjective assessment. For the sciences and technology, this aligns largely with academic criteria such as publications in major outlets and is not well suited for people who excel in industry.

Recommendation

Implement and advertise the international entrepreneur rule. The International Entrepreneur Rule (IER) allows U.S. Citizenship and Immigration Services (USCIS) to grant a period of authorized stay to international entrepreneurs who demonstrate that "their stay in the United States would provide a significant public benefit through their business venture."[22] An executive action could announce the administration's intention to use the IER to boost immigrant entrepreneurship, job creation for Americans, and economic growth. USCIS

could also be directed to announce that it will give priority to entrepreneurs active in high-priority STEM fields such as AI, or in fields that use AI for other applications, such as agriculture. Entrepreneurs' ability to attract investors should be used as a screening criterion for entrepreneurs.

Recommendation

Expand and clarify job portability for highly skilled workers. The criteria for workers with H-1B, O-1, and other temporary work visas to obtain open market work permits for a one-year renewable period are too limited and ambiguous. Changes should clarify when highly skilled, nonimmigrant workers are permitted to change jobs or employers, increase job flexibility when an employer either withdraws their petition or goes out of business, and increase flexibility for H-1B workers seeking other H-1B employment.

Recommendation

Recapture green cards lost to bureaucratic error. Federal agencies generally issue fewer green cards than they are allowed. As of 2009, the federal government had failed to issue more than 326,000 green cards based on cumulative bureaucratic error.[23] The Departments of State and Homeland Security (DHS) should publish an up-to-date report on the number of green cards lost due to bureaucratic error. Using available authorities, both should grant lost green cards to applicants waiting in line. Congress should support the Departments of State and Homeland Security by passing legislation to recapture lost green cards.[24]

Recommendation

Grant green cards to students graduating with STEM PhDs from accredited American universities. Congress should amend the Immigration and Nationality Act[25] to grant lawful permanent residence to any vetted (not posing a national security risk) foreign national who graduates from an accredited United States institution of higher education with a doctoral degree in a STEM-related field in a residential or mixed residential and distance program and has a job offer in a field related to science, technology, engineering, or mathematics. They should not be counted toward permanent residency caps.

Recommendation

Double the number of employment-based green cards. Under the current system, employment-based green cards are unduly scarce: 140,000 per year, fewer than half of which go to the principal worker.[26] This leaves many highly skilled workers unable to gain permanent residency and unable to transfer jobs or negotiate with employers as effectively as domestic workers. This decreases the appeal of joining the American workforce. To reduce the backlog of highly skilled workers, the United States should double the number of employment-based green cards, with an emphasis on permanent residency for STEM and AI-related fields.

Recommendation

Create an entrepreneur visa. International doctoral students are more likely than their native peers to want to found a company or become an employee at a startup, but they are less likely to pursue those paths.[27] One reason is the constraints of the H-1B visa system.[28] Similarly, immigrant entrepreneurs without the capital to use the EB-5 route to permanent residency are forced to use other visas that are designed for academics and workers in existing companies, not entrepreneurs.[29] All of these issues make the United States

less attractive for international talent, and, perhaps as important, reduce the ability of startups and other small companies—the main source of new jobs for Americans—to hire highly skilled immigrants, who have been shown to improve the odds that the business will succeed. Congress should create an entrepreneur visa for those who would provide a "significant public benefit" to the United States if allowed to stay in the country for a limited trial period to grow their companies.[30] This visa should serve as an alternative to employee-sponsored, investor, or student visas and should instead target promising potential founders.

Recommendation

Create an emerging and disruptive technology visa. The National Science Foundation (NSF) should identify critical emerging technologies every three years. DHS would then allow students, researchers, entrepreneurs, and technologists in applicable fields to apply for emerging and disruptive technology visas. This would provide much-needed talent R&D and strengthen our economy.[31]

Chapter 10 - Endnotes

[1] Estimates on the gap of talent necessary to fill AI slots vary greatly, but it is agreed upon that the gap in talent currently is and will continue to be significant as nations compete for scarce resources. See Remco Zwetsloot, et al., *Strengthening the U.S. AI Workforce: A Policy and Research Agenda*, Center for Security and Emerging Technology at 2 (Sept. 2019), https://cset.georgetown.edu/wp-content/uploads/CSET-Strengthening-the-U.S.-AI-Workforce.pdf ("The Research Institute at Tencent, a major Chinese technology company, asserts there are roughly 300,000 AI researchers and practitioners worldwide, with market demand for millions of roles. Element AI, a leading Canadian AI company, estimated in 2018 that there are roughly 22,000 PhD-educated researchers globally who are able to work on AI research, with only about 25 percent of those 'well-versed enough in the technology to work with teams to take it from research to application.' AI firm Diffbot estimates that there are over 700,000 people skilled in machine learning worldwide.").

[2] Remco Zwetsloot, et al., *Keeping Top AI Talent in the United States*, Center for Security and Emerging Technology at iii-vi (Dec. 2019), https://cset.georgetown.edu/wp-content/uploads/Keeping-Top-AI-Talent-in-the-United-States.pdf.

[3] *The Rise of China in Science and Engineering*, NSF National Science Board (2018), https://www.nsf.gov/nsb/sei/one-pagers/China-2018.pdf (China also passed the United States in the global share of peer-reviewed S&E articles).

[4] *Science & Engineering Indicators 2018*, NSF National Science Board (2018), https://www.nsf.gov/statistics/2018/nsb20181/assets/561/higher-education-in-science-and-engineering.pdf.

[5] For these purposes "top tier" talent was defined by accepted papers at the prestigious AI deep learning conference Neural Information Processing Systems in 2019. This reflected approximately the top 20% of researchers in the field. *The Global AI Talent Tracker*, MacroPolo (last accessed Dec. 28, 2020), https://macropolo.org/digital-projects/the-global-ai-talent-tracker/. China has placed a strong emphasis on deep learning, just one of the important components of AI.

[6] For example, China's Thousand Talents Plan is part of a state-organized blueprint to be a global leader in science and technology by 2050. Staff Report, *Threats to the U.S. Research Enterprise: China's Talent Recruitment Plans*, U.S. Senate Permanent Subcommittee on Investigations at 14 (Nov. 2019), https://www.hsgac.senate.gov/imo/media/doc/2019-11-18%20PSI%20Staff%20Report%20-%20China's%20Talent%20Recruitment%20Plans.pdf.

[7] *The Global AI Talent Tracker*, MacroPolo (last accessed Dec. 28, 2020), https://macropolo.org/digital-projects/the-global-ai-talent-tracker/. See also Gordon Hanson & Matthew Slaughter, *High-Skilled Immigration and the Rise of STEM Occupations in U.S. Employment*, National Bureau of Economic Research at 1 (Sept. 2016), https://www.nber.org/system/files/working_papers/w22623/w22623.pdf.

[8] *The Rise of China in Science and Engineering*, NSF National Science Board (2018), https://www.nsf.gov/nsb/sei/one-pagers/China-2018.pdf.

[9] As noted in Chapter 6 of this report, there were 433,116 open computer science jobs in the United States in 2019, while only 71,226 new computer scientists graduated from American universities in 2019. Code.org (last accessed Jan. 11, 2021), https://code.org/promote. See also Oren Etzioni, *What Trump's Executive Order on AI Is Missing: America Needs a Special Visa Program Aimed at Attracting More AI Experts and Specialists*, Wired (Feb. 13, 2019), https://www.wired.com/story/what-trumps-executive-order-on-ai-is-missing/.

[10] *Sputnik Spurs Passage of the National Defense Education Act*, U.S. Senate (last accessed Dec. 28, 2020), https://www.senate.gov/artandhistory/history/minute/Sputnik_Spurs_Passage_of_National_Defense_Education_Act.htm#:~:text=The%20National%20Defense%20Education%20Act%20of%201958%20became%20one%20of,and%20private%20colleges%20and%20universities.

[11] According to one report, job listings for AI on one popular job website "increased more than five-fold between 2015 and 2017 and demand for 'deep learning' skills increased by a factor of more than 30," while the number of people looking for jobs in the field grew much more slowly. This mismatch is slowing the adoption of AI. Most firms report that skills gaps are one of the top obstacles preventing them from adopting AI. Remco Zwetsloot, et al., *Strengthening the U.S. AI Workforce: A Policy and Research Agenda*, Center for Security and Emerging Technology at 1 (Sept. 2019), https://cset.georgetown.edu/wp-content/uploads/CSET-Strengthening-the-U.S.-AI-Workforce.pdf.

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[12] William S. Kerr, *High-Skilled Immigration, Innovation, and Entrepreneurship: Empirical Approaches and Evidence*, National Bureau of Economic Research at 7-8 (Aug. 2013), https://www.nber.org/papers/w19377; Gordon Hanson & Matthew Slaughter, *Strengthening the U.S. AI Workforce, High-Skilled Immigration and the Rise of STEM Occupations in U.S. Employment*, National Bureau of Economic Research at 23 (Sept. 2016), https://www.nber.org/system/files/working_papers/w22623/w22623.pdf; Remco Zwetsloot, et al., *Strengthening the U.S. AI Workforce: A Policy and Research Agenda*, Center for Security and Emerging Technology at 5 (Sept. 2019), https://cset.georgetown.edu/wp-content/uploads/CSET-Strengthening-the-U.S.-AI-Workforce.pdf.

[13] Carsten Fink, *What Leads Inventors to Migrate?*, World Economic Forum (July 17, 2013), https://www.weforum.org/agenda/2013/07/what-leads-inventors-to-migrate/.

[14] Ernest Miguelez & Carsten Fink, *Measuring the International Mobility of Inventors: A New Database*, World Intellectual Property Organization at 16 (May 2013), https://www.wipo.int/edocs/pubdocs/en/wipo_pub_econstat_wp_8.pdf.

[15] According to the Center for Security and Emerging Technology, in 2016, 14% of international students declined offers to study at U.S. universities to study at home, and 19% decided to study in another country. In 2018, these numbers rose, with 39% staying at home and 59% studying in another country. Remco Zwetsloot, et al., *Keeping Top AI Talent in the United States: Findings and Policy Options for International Graduate Student Retention*, Center for Security and Emerging Technology at 26 (Dec. 2019), https://cset.georgetown.edu/wp-content/uploads/Keeping-Top-AI-Talent-in-the-United-States.pdf.

[16] Shulamit Kahn & Megan MacGarvie, *The Impact of Permanent Residency Delays for STEM PhDs: Who Leaves and Why*, Research Policy (Nov. 2020), https://www.sciencedirect.com/science/article/abs/pii/S0048733319301982.

[17] Tina Huang & Zachary Arnold, *Immigration Policy and the Global Competition for AI Talent*, Center for Security and Emerging Technology at 8 (June 2020), https://cset.georgetown.edu/research/immigration-policy-and-the-global-competition-for-ai-talent/.

[18] Zachary Arnold, et al., *Immigration Policy and the U.S. AI Sector: A Preliminary Assessment*, Center for Security and Emerging Technology at 22 (Sept. 2019), https://cset.georgetown.edu/research/immigration-policy-and-the-u-s-ai-sector/.

[19] Remco Zwetsloot, et al., *Strengthening the U.S. AI Workforce: A Policy and Research Agenda*, Center for Security and Emerging Technology at 5 (Sept. 2019), https://cset.georgetown.edu/wp-content/uploads/CSET-Strengthening-the-U.S.-AI-Workforce.pdf.

[20] China is the world's largest single source of AI talent. Leading U.S. technology companies such as Google and Microsoft have established cutting-edge research centers in China, in part to access that talent. This increases China's AI R&D capacity and potential for technology transfer, and, if the companies remain American, it reduces the American Intelligence Community's (IC) legal authorization to collect information about Chinese technology development. See *The Global AI Talent Tracker*, MacroPolo (last accessed Jan 17, 2020), https://macropolo.org/digital-projects/the-global-ai-talent-tracker/; Roxanne Heston & Remco Zwetsloot, *Mapping U.S. Multinationals' Global AI R&D Activity*, Center for Security and Emerging Technology at 20 (Dec. 2020), https://cset.georgetown.edu/wp-content/uploads/CSET-Mapping-U.S.-Multinationals-Global-AI-RD-Activity-1.pdf.

[21] Remco Zwetsloot, *US-China STEM Talent "Decoupling": Background, Policy, and Impact*, Johns Hopkins Applied Physics Laboratory at 19 (2020), https://www.jhuapl.edu/assessing-us-china-technology-connections/dist/407b0211ec4929960855132604l488d4.pdf ("[T]he head of the [Chinese Communist Party's (CCP)] Central Talent Work Coordination Small Group … complained that 'the number of top talents lost in China ranks first in the world.'"); see also Joy Dantong Ma, *China's AI Talent Base Is Growing, and Then Leaving*, MacroPolo (July 30, 2019), https://macropolo.org/chinas-ai-talent-base-is-growing-and-then-leaving/?rp=m (noting that of the 2,800 Chinese NeurIPS participants between 2009 and 2018, about three-quarters of them were currently working outside of China).

[22] *International Entrepreneur Parole*, USCIS (May 25, 2018), https://www.uscis.gov/humanitarian/humanitarian-parole/international-entrepreneur-parole. There is currently no visa category well-suited to entrepreneurship in immigration statute. The IER, which relies on parole authority, was initiated after legislative avenues were exhausted. Legislative fixes would be preferable, but have so far they have proven politically infeasible.

[23] A 2010 report to Congress indicated that some 242,000 unused family-based green cards were ultimately applied to the employment-based backlog, while Congress recaptured some 180,000 green cards via special legislation, leaving more than 326,000 green card numbers wasted. *Citizenship and Immigration Services Ombudsman: Annual Report 2010*, U.S. Department of Homeland Security (June 30, 2010), https://www.dhs.gov/xlibrary/assets/cisomb_2010_annual_report_to_congress.pdf. The number today is likely higher, but DHS has not published updated statistics.

[24] Prior examples of Congressional action include provisions in the American Competitiveness in the 21st Century Act of 2000 and the REAL ID Act of 2005. See Pub. L. 106-313, 114 Stat. 1251, 1254 (2000) and Pub. L. No. 109-013, 119 Stat. 231, 322 (2005).

[25] Specifically, 8 U.S.C. § 1151(b)(1).

[26] William Kandel, *The Employment-Based Immigrant Backlog*, Congressional Research Service at 4-5 (March 26, 2020), https://fas.org/sgp/crs/homesec/R46291.pdf.

[27] Michael Roach, et al., *Are Foreign STEM PhDs More Entrepreneurial? Entrepreneurial Characteristics, Preferences and Employment Outcomes of Native and Foreign Science & Engineering PhD Students*, National Bureau of Economic Research at 1 (Sept. 2019), https://www.nber.org/system/files/working_papers/w26225/w26225.pdf.

[28] *Id.* at 12.

[29] EB-5 visas require a minimum $900,000 investment in a business in the United States. William R. Kerr, *Global Talent and U.S. Immigration Policy: Working Paper 20-107*, Harvard Business School at 14 (2020), https://www.hbs.edu/faculty/Publication%20Files/20-107_0967f1ab-1d23-4d54-b5a1-c884234d9b31.pdf.

[30] 83 Fed. Reg. 24415, *Removal of International Entrepreneur Parole Program*, U.S. Department of Homeland Security (May 29, 2018), https://www.federalregister.gov/documents/2018/05/29/2018-11348/removal-of-international-entrepreneur-parole-program.

[31] Oren Etzioni, *What Trump's Executive Order on AI Is Missing: America Needs a Special Visa Program Aimed at Attracting More AI Experts and Specialists*, Wired (Feb. 13, 2019), https://www.wired.com/story/what-trumps-executive-order-on-ai-is-missing/.