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Abstract

This impact paper seeks to highlight and discuss the intrinsic relationship between the development of the artificial intelligence (AI) industry and geopolitics. We point to the disparities in AI technology advancement across nations and focus on four aspects of their competition: talent, data, chips, and energy consumption. The United States continues to lead in AI technology and talent acquisition. China comes second with its vast market advantage and massive quantity of available data. Europe unfortunately lags behind but is at the forefront of data and individual privacy protection. Many other nations are indispensable contributors to the global supply chain of AI chip manufacturing. Nonetheless, all governments should think about the overconsumption of energy caused by AI development and the need to devote collective effort to address this urgent issue.

Keywords: Artificial intelligence, geopolitics, AI talent, specialized AI chips, energy consumption

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AI as a new geopolitical battleground: What are we competing for?

Stuart Russell, a professor at the University of California, Berkeley and co-author of the textbook *Artificial Intelligence: A Modern Approach*, defined artificial Intelligence (AI) as “the study of methods for making computers behave intelligently”. AI technologies include machine learning, computer vision, intelligent robotics, biometrics, swarm intelligence, virtual agents, and natural language processing (Miall, 2018). Recent big data technologies and high-performance computing breakthroughs have significantly boosted the development of AI, which is becoming a key national strategy and security topic. As Elon Musk, the founder of SpaceX and Tesla, recently tweeted, “Competition for AI superiority at national level is the most likely cause of WW3.”

With regards to the development of artificial intelligence, the US and China are unquestionably in leading positions with significant competitive advantages. The US has cutting-edge hardware, research and talent, while China pertains a vast market and massive AI-ready data that are driving its technological development (Engagemedia, 2022). Being in a “catch and surpass” position, China has ambitiously integrated the digital and AI technologies into its geopolitical strategy (Engagemedia, 2022). The Digital Silk Road (DSR), a key aspect of the Belt and Road Initiative (BRI), had garnered approximately US\$79 billion in investments as of 2019 (Engagemedia, 2022).

Europe, another major player, is lagging behind the US and China in terms of technological advancement. European AI companies are valued at less than \$1 billion, while GAFA (the US tech giants: Google, Apple, Facebook, and Amazon) will soon be worth \$1 trillion each (Miall, 2018). Nonetheless, Europe has discovered its own AI model: an imperative quest for AI power with primary concern over personal privacy and data protection (e.g., the release of the General Data Protection Regulation (GDPR)). A heated debate is now underway about whether such regulations could hamper its own rise to power.

Africa is currently a “Blue Ocean” for AI. Several leading countries in AI technology (notably China) are making significant investment in Africa to develop a competitive edge, with multiple examples of Chinese industrial presence: Transsion Holdings became the first smartphone company in Africa in 2017; ZTE provides infrastructure for the Ethiopian government; CloudWalk Technology will work on facial recognition under an agreement with the Zimbabwean government (Miall, 2018).

AI talent war

Any country that strives to become a global AI leader must invest in talent. In fact, talent is the first and foremost resource that competing nations use to hold the AI front line. The US is by far the clear winner in this talent war. Its AI talent pool contains over 78,000 AI researchers, while China has approximately half that number at 39,000 (Miall, 2018). Assuming the US has 100% AI talent penetration, China ranks second with about 92%, followed by India, Israel, and Germany with 84%, 54%, and 45%¹.

The Global AI Talent Report by Jean-François Gagné (Gagné, 2020) categorizes nations into four classes based on their inflow and outflow of AI talent: i.e., producer countries, anchored

¹ <https://albertchristopherr.medium.com/ai-talent-pool-in-2019-past-present-future-30bcd8162744>

countries, platform countries, and inviting countries. Examples of *producer countries* are India, Singapore, and Israel, where we see less inflow and more outflow. Japan, Belgium, and Russia are what we call *anchored countries*. They have less talent inflow and less talent outflow, which signals the relative stability of their talent pools, but perhaps also a risky insularity. *Platform countries* are those with high inflow and outflow, which are best exemplified by the U.K., China, and Canada. Lastly, the US, France, and Portugal are called *inviting countries* with more inflow than outflow, indicating that they are relatively more successful at both retaining their existing talent and drawing in talent from other ecosystems (Gagné, 2020).

One major strategy to attract AI talent from other ecosystems is through attractive and motivating immigration policies. The United States' internationally recognized education institutions, innovative industries, top-tier research laboratories, and relatively liberal immigration policies, have attracted large numbers of AI talent from across the globe, and it now leads the world in AI technological innovation (Huang, 2020). Over the past five years, the UK, Canada, France, and Australia have adopted significant immigration reforms to attract talent in AI and other technical fields. Canada has devised new immigration policies to bring in skilled migrants and integrate graduates into its workforce. The UK proposed similar reforms to expedite the immigration process for technically-skilled migrants (Huang, 2020). There is no doubt that the talent war between countries seeking a competitive advantage in AI will continue.

Data as the fuel powering AI

In the era of AI, data are as crucial as (if not more important than) talent. As the new fuel powering AI, unlike the common functionality of fuel, data is not ready for direct use until they have been properly organized, processed, cleaned, and analyzed. And data are more valuable when they are linked to more relevant and heterogeneous sources. Like wind or solar energy, data can be used in multiple forms to serve more than one purpose. Data may find their atypical use and value when new analytical technologies become available. As an example, people barely knew how to make use of ubiquitous online pictures and photos until computer vision and deep-learning techniques reached the mainstream.

Historically, geopolitics were mainly governed by oil and natural gas, and most private sector organizations had little impact on the global economy. In modern society, tech giants are geopolitical players and have become de facto global stakeholders (Paganini, 2021). The biggest tech giants in the US, for example, include GAFAMI (Google, Apple, Facebook, Amazon, Microsoft, and IBM), while in China, the main tech companies are BHATX (Baidu, Huawei, Alibaba, Tencent, and Xiaomi). Owing to less stringent data regulations in the US and China, these companies can collect and analyze massive amounts of data to profile and better understand their users, and subsequently provide personalized products, services, and experiences at the right time (Miaillhe, 2018). European officials, on the other hand, place high hopes on data regulation, including the GDPR regime and data localization. However, putting its faith in data regulation may leave the EU lagging even further behind the US and China in the global geopolitical AI battle (Tabansky, 2021).

Specialized AI chips

Apart from talent and data, chips also play an indispensable role in developing AI competitiveness. Depending on the chip type, the market can be categorized into GPU, ASIC, FPGA, CPU, and others. Modern specialized "AI chips" are essential for deploying AI at

scale. Developing AI applications using general-purpose or older AI chips may be tens to thousands times more expensive in both processing time and financial cost (Khan, 2020).

In several semiconductor industry sectors, the United States and its allies have a competitive edge in the production of specialized AI chips as they dominate the design of such chips, which includes electronic design automation (EDA) software. Chinese AI chip design firms are still behind and reliant on US EDA software (Khan, 2020). However, it is believed that China will soon move forward with the help of significant government-backed investments, a large engineering pool, and dozens of semiconductor fabs under construction or on the books (Ernst, 2020).

The European Union is unfortunately falling behind in the competition for AI chips. During the 1990s, Europe held more than 40% of the chip market. By the early 2000s, however, this figure had fallen to 24% and is barely 10% today². It is still questionable whether the EU will be able to fund a multi-billion Chips Act, given that European member states' budgets are already overstretched. Meanwhile, private investors might not see Europe as an appealing place for investment.

In fact, it is exceedingly challenging for the two superpowers (the US and China) to maintain a full supply chain on their own. The United States is dominant in sectors like intellectual property, chip design, manufacturing, and non-wafer materials, while China is the largest supplier of raw materials like the silicon needed for manufacturing. But they are both strongly reliant on South Korea, Japan, and Taiwan in contract manufacturing and other fields³. Thus, geopolitics and AI chip manufacturing are likely to remain in an enduring relationship in the foreseeable future.

Energy consumption and decarbonization

Demand for computing power is rapidly increasing with the rise of artificial intelligence and machine learning. A feedback loop is observable between AI and computing power: additional computing power nurtures new AI and facilitates AI advances, while AI optimization necessitates more computing power⁴. To illustrate AI's shocking energy consumption, we take an example of AI model training. OpenAI (an advanced AI company) trains its GPT-3 model on 45 terabytes of data. To train the final version of MegatronLM (a language model similar to, but smaller than, GPT-3), Nvidia ran 512 V100 GPUs over nine days. Given that a single V100 GPU can consume at least 250 watts, 512 such GPUs consume a total of 128,000 watts, or 128 kilowatts (kW). Running for nine days means that training the MegatronLM costs 27,648 kilowatt hours (kWh). Given that the average household in the US uses 10,649 kWh a year, MegatronLM's training consumes almost three times the amount of a single household's annual energy use (Labbe, 2021).

Energy consumption results in CO₂ emissions, which aggravate the global issue of climate change. The Paris Agreement urges governments to drastically cut carbon and other greenhouse gas (GHG) emissions over the next few decades. However, the decarbonization process has an inevitable impact on a nation's economic growth, domestic, and foreign policy, and hence has significant geopolitical implications. It is imperative for nations and

² <https://www.euronews.com/2022/02/11/for-the-eu-microchips-and-geopolitics-are-two-sides-of-the-same-coin-view>

³ <https://www.csis.org/blogs/strategic-technologies-blog/chip-shortages-light-geopolitics-and-climate-change>

⁴ <https://redanalysis.org/2018/06/25/artificial-intelligence-computing-power-geopolitics-2/>

regions to work together to support decarbonization processes beyond their own borders (Dennis, 2020).

Conclusion

The artificial intelligence industry exhibits disparate development worldwide. This impact paper discusses the intrinsic relationship between AI and geopolitics from four main perspectives: talent, data, chips, and energy consumption. The United States continues to dominate in AI technology and has a clear advantage in AI talent. With its vast market and massive consumer data to power AI, China is catching up and is emerging as a strong rival. Europe has put more emphasis on data and individual privacy protection and, in the meantime, strives to advance its AI technology. Other nations and regions also play an indispensable role in the supply chain of AI chip manufacturing. Nonetheless, no government can overlook the potential energy overconsumption and greenhouse gas emission issues, and all need to work together to develop a healthy and sustainable AI ecosystem.

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