International Session | International Session | E-5 Human interface, education aid

[2O1-ES-5] Human interface, education aid: Bigdata and trend analysis

Chair: Arisaka Ryuta (Nagoya Institute of Technology)

Wed. Jun 10, 2020 9:00 AM - 10:20 AM Room O (jsai2020online-15)

[2O1-ES-5-01] “AI for Social Good” and the First AI Arms Race

○Colin Shunryu Garvey[1] (1. Stanford University, Institute for Human-Centered AI)

9:00 AM - 9:20 AM

[2O1-ES-5-02] Grasping Research Trends Based on Similar Cited Papers

○Shun Gendo[1], Koichi Hodooka[1], Mitsunori Matsushita[1] (1. Kansai University)

9:20 AM - 9:40 AM

[2O1-ES-5-03] Supporting Fundamental Analysis for Investment Beginners based on Investment Behavior Model

Yuki Iwasaki[1], ○Miku Takenaka[1], Mitsunori Matsushita[1] (1. Kansai University)

9:40 AM - 10:00 AM

[2O1-ES-5-04] A Study on Identifying Factors that Make Crises Turn into Opportunities on Social Media

QU XIANG[1], Takayuki Ito[1], Ahmed Moustafa[1], ○Shun Okuhara[1] (1. Nagoya Institute of Technology)

10:00 AM - 10:20 AM

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"AI for Social Good" and the First AI Arms Race: Lessons from Japan's Fifth Generation Computer Systems (FGCS) Project

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AI is now dominated by two superpowers, the USA and China. Both are engaged in an "arms race" that promises to shape the global balance of power. But this is not the first AI arms race between the USA and a rising Asian economic power. Japan's 1981 announcement of the Fifth Generation Computer Systems (FGCS) project—a bold plan to revolutionize computing hardware and software—sparked a global AI arms race that ran for over a decade. This paper draws on prior historical research analyzing Japan's FGCS project to ask: What can be learned from this historical episode? After briefly recapitulating the FGCS and global responses to it, the paper expounds a handful of policy lessons relevant to navigating the current AI arms race.

1. History Doesn't Repeat, But It Does Rhyme

One consequence of the renewal of "great power competition" in geopolitics has been discussion of an "arms race" between the United States and China over artificial intelligence (AI). Competitive rhetoric has grown considerably following China's 2017 announcement of a "New Generation AI Development Plan" to lead globally in AI by 2030 (Webster et al. 2017). Noting that "The development of AI will shape the future of power," the US National Security Commission on AI explicitly names China as an adversary and claims China's progress in AI R&D threatens the US national interest (NSCAI 2019).

This is not, however, the first time a rising Asian economic power's AI initiative has sparked trans-Pacific competition over AI, leading to arms race dynamics of mutual escalation around the globe. It was, rather, Japan's 1981 announcement of the Fifth Generation Computer Systems (FGCS) project—a bold plan to revolutionize computing hardware and software—that initiated the first global AI arms race.

Fearing the FGCS would give Japan the computing advantage it needed to dominate the global economy, Western nations used the "threat" of Japanese AI to justify large-scale AI projects of their own. These programs funded the second major boom of AI activity in the 1980s. However, the failure of these projects contributed to the "AI Winter" of the 1990s.

What can be learned from this historical episode? Building on prior historical research (Garvey 2019), this paper examines Japan's FGCS project to extract parallels and policy lessons relevant to navigating the current AI arms race.

2. What Was the Fifth Generation?

The Fifth Generation Computer Systems (FGCS) project was a national program to innovate novel computing hardware to run intelligent software. Envisioned as computers the "Japanese society of the 1990s would require," the FGCS endeavored to create "knowledge information processing systems" that would not only aid the Japanese people but stand as a symbol of Japan's new status as an economic world power (JIPDEC 1981). Accordingly, the project was from the start an open, international, basic R&D project—the first of Japan's post-WWII national computing projects that was *not* focused on "catching up" with the West through product commercialization. Indeed, there were no commercial objectives (Fuchi 1983).

With a budget of ¥ 100 billion (approximately $500 million) the FGCS was planned to run in three stages for a decade, beginning in 1982. Goals were refined at each stage. After achieving its technical objectives in 1993, a 2-year follow-on project was initiated to upload the results onto the young Internet (Uchida et al. 1993). The FGCS finally concluded in 1995 (Yokota 1999).

2.1 Origins of the Fifth Generation, 1978-1981

Japan rose from the devastation of WWII to become the world's second largest economy within a mere three decades. Credit for this "miracle economy" (Johnson 1982) was ascribed to the Ministry of International Trade and Industry (MITI), which used a variety of policy mechanisms to steer domestic industry toward market success in sectors such as automobiles, consumer electronics, and computer hardware. Notably, MITI worked with manufacturers to prevent IBM from dominating the nation's domestic computer market; Japan's share of its domestic market rose from 6.9% in 1958 to 74% by 1982, it the only industrialized country in the developed world where IBM was not the market leader (Anchordoguy 1989).

Beginning in the 1960s, MITI sponsored "catching up" efforts in computer hardware that brought the domestic industry up to date through four generations: 1) vacuum tubes 2) transistors 3) integrated circuits 4) very large-scale integrated circuits (VLSI). MITI's fourth generation hardware project put Japan at the cutting edge of VLSI by late-1970s. But these were all *serial*, von Neumann architectures, and posed a bottleneck to future progress.

In 1978, MITI bureaucrats proposed the development of a fifth generation of *parallel*, non-von Neumann hardware, suggesting it would be necessary for software (i.e. AI) capable of human-computer interaction in natural language and imagery. Because users could talk to the machine instead of programming it, these Fifth Generation machines would lower barriers to computer use for ordinary people and prepare Japan for the society of the 1990s.

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This was a bold and risky plan because the non-von Neuman hardware, however fast, would not be backwards compatible with the standard IBM architectures. Industry expressed reluctance to adopt a new, unique architecture. Bureaucrats and technologists MITI, however, seeking to capitalize on the nation's economic strength and new position in the global order, framed the nascent Fifth Generation project as Japan's opportunity to "break the yoke" of IBM's industry dominance (Uemae 1985). Seeing this an opportunity to silence criticisms of Japan as a "copycat" and set goals for technology leadership, MITI adopted the plan.

2.2 Announcing the First "AI for Social Good" Project

Following setbacks in the late-1960s, Western AI programs were enduring the first "Winter" of low activity, low funding, and low optimism throughout the 1970s. Consequently, Japan's 1981 announcement of the FGCS project came as a surprise to computer scientists abroad, dozens of whom attended the inaugural FGCS conference in Tokyo, October 19-22, 1981.

Here FGCS leaders presented the project's two major technical goals: to produce, by the end of a decade, 1) parallel, non-von Neumann computer hardware that would run 2) intelligent software written in the logic programming language PROLOG. In addition, the FGCS also included four broad social goals: 1) to increase productivity in service, manufacturing, and other sectors; 2) to augment the human capital of Japan's workforce; 3) to improve energy efficiency; and 4) to help cope with the changes wrought by an aging society. The intertwined social and technical goals of the FGCS project made Japan's Fifth Generation a forgotten pioneer in the area of "AI for Social Good."

3. Western Responses to the Fifth Generation

In addition to a formidable language barrier between Western attendees of the 1981 conference and their hosts, the FGCS project's hybrid socio-technical goals were unlike anything they had seen before. AI R&D in the West had to date been focused exclusively on technical progress; social issues were typically not a concern. The FGCS broke with this mold and set a new direction for AI R&D that was focused on Japanese society.

In 1983, Western powers initially responded in a variety of ways to the FGCS project before escalating a "threat" narrative:

- *IBM:* The world's largest computer manufacturer was unimpressed and did not believe the FGCS to be a threat to their global domination of the computer market.
- *UK:* Alarmed at the size and scope of the FGCS plan, the UK under Margaret Thatcher's government launched the Alvey Project at $500 million over 5 years.
- *US:* Portraying the FGCS as a threat to national interests, Reagan's administration launched the Microelectronics and Computer Technology Corporation (MCC), an industrial consortium, as well as the military-focused Strategic Computing Initiative (SCI) at $1 billion over a decade.
- *European Economic Community (EEC):* Seeing activity in the UK and US, the EEC launched European Strategic Programme on Research in Information Technology (ESPRIT) with an unprecedented $2 billion over five years.

The *New Scientist* described the competition as the "The race for the thinking machine" (Marsh 1982), while in a *Washington Post* article entitled "'5th Generation' Spurs A Global Computer Race," Alvey director Brian Oakley likened the race to "some sort of warfare" (Schrage 1984).

3.1 Manufacturing the "Threat" of Japan

If Japan was a close military ally, why did the US respond to the Fifth Generation as if it were a threat to the national interest? Japan's post-War rise to become the second largest economy in the world gave rise to worries of a new global order with "Japan as Number One" (Vogel 1979). The response of the American business community was ambivalent: on the one hand, Japan was accused of forced technology transfers, limiting foreign access, regulatory favoritism, and other unfair trade practices. On the other, American businesspeople rushed to adopt aspects of Japanese business practice: "lean production," "just in time manufacturing," globalized supply chains, and so on.

Into this volatile context came AI scientist Edward Feigenbaum's co-authored book, *The Fifth Generation: Artificial Intelligence and Japan's Computer Challenge to the World* (1983). It successfully reframed the FGCS as a threat to American economic and computing dominance through a 3-part argument:

- First, computers were ushering in a "New Wealth of Nations" in which control of *knowledge*, rather than material resources, determined national power.
- Second, Japan, lacking material resources, had no choice but to seek domination of the emerging "knowledge industry" with a new generation of AI systems.
- Therefore, the Fifth Generation could be nothing other than Japan's attempt to become the global leader in AI and thus the most powerful nation in the world.

Although the FGCS' lack of commercial product development objectives suggests this argument is exaggerated if not misleading, the book was extremely successful, becoming a bestseller even in Japan. Moreover, it was persuasive: policymakers in Washington DC quickly began using the "threat" of Japan's Fifth Generation project to justify launching national computing projects such as the MCC and SCI (Roland and Shiman 2002). In addition, computer scientists around the world used it to petition for their respective nations for more funding for AI research.

4. Outcomes of the First AI Arms Race

By 1993, the FGCS had achieved its two technical goals. Parallel Inference Machines (PIM) built of parallel computing hardware running logic programming language-based software were favorably evaluated by teams of international experts (van de Riet 1993). MITI deemed it a success and granted a 2-year extension to port results onto the young Internet, and later launched Real World Computing, a 10-year project with many of the same aims (Yonezawa 1992).

But global AI industry had already collapsed into the "AI Winter" of the 1990s. Not without irony, the West considered the FGCS a failure because it produced no commercial products. That this was never the goal did not matter, nor did the fact that none of the Western projects produced commercial products either. Alvey failed to revive the dying British computing industry. The SCI "did not quite end; it simply disappeared," having simply "vanished" from the DARPA budget by 1993 (Roland and Shiman 2002). The MCC dragged on until 2000, reoriented around chip packaging rather than AI. ESPRIT ran in at least four stages into

the late 1990s, but if there were successes, they do not appear in the literature; obviously, Europe never achieved leadership in AI. The first AI arms race ended not with a bang, but a whimper.

5. Discussion

What can be learned from this historical episode? How can the first global AI arms race inform understandings of present conflicts and competition? The next section considers some similarities while the following section examines some differences.

5.1 Similarities

Some similarities between the first AI arms race and the second are quite striking:

- In the digital economy, where "data is the new oil," China is said to be uniquely positioned to dominate through its unparalleled data resources (Lee 2018). This mirrors precisely the 1983 claim that Japan would dominate the "knowledge industry" in a "New Wealth of Nations."
- Sinophobia is on the rise in the USA, and the American business community's claims about the Chinese technology industry's offenses are virtually identical to those made against Japan in the early 1980s (Zakaria 2020), although, for example, "industrial espionage" is now called "IP theft."
- In July 2017, bureaucrats in China's Ministry of Science & Technology launched a "New Generation AI Development Plan," that aims to make their nation a "premier global AI innovation center" and global leader in AI by 2030. In addition to technical goals for commercial development, the plan includes social development efforts.
- Since China's New Generation plan was announced, multiple Western AI experts and technologists have raised the alarm about Chinese AI (Kahn 2019), drawing the attention of business executives and government officials who, following journalists, use the language of "arms race" to describe the conflict (Kania 2017; Barnes and Chin 2018).
- Fearful of falling behind in the "race," nations around the world launch national AI R&D plans of various sizes (Dutton, Barron, and Boskovic 2018). The UK and Europe are second-order players after the US and Asia, which lead.
- The US has framed the Chinese AI initiative as a threat to the national interest and plans to respond by increasing military spending on AI R&D as well as system implementation (Department of Defense 2018).

5.2 Differences

Despite these similarities, there are important differences between the AI arms races of the 1980s and late 2010s - early '20s:

- Japan is a democracy, and the military ally of the US and other Western nations. China is neither.
- Japan's FGCS focused on AI as a public good for lowing barriers to citizens' use of computers. China' domestic use of AI includes far more controversial applications.
- Japan's AI goals were non-military and non-commercial. This is not true of China's plan, which is both.
- Japan's Fifth Generation originated endogenously from internal MITI deliberations. China's New Generation was apparently sparked by the May, 2017 defeat of reigning Go world champion by Google DeepMind's AlphaGo.

5.3 Lessons

What are some lessons that can be drawn from this rhyming set of AI arms races?

First, non-Western nations face a Catch-22 in technoscientific R&D: If they pursue technology transfer, they are labeled "copycats" of the West; if they develop domestic capacities, they are labeled as threats to the global order. More sober threat assessments could temper this.

However, language barriers problematize technical and social evaluations of the credibility of foreign, high-tech threats. Far more Japanese and Chinese speak English than Americans speak either, creating a "filter bubble" around policymakers that partisans can fill with idiosyncratic interpretations. Moreover, as the first AI arms race demonstrates, technical experts are partisans too, willing to engage in threat escalation to gain funding for their own projects and aims.

Second, history suggests that large-scale, national plans for AI R&D, even when funded at unprecedented levels, do not translate directly into strategic advantage, either in markets or on the battlefield. New funding opportunities can attract high volumes of research proposals of dubious scientific and technological merit, forcing policymakers who often lack technical expertise to select projects for funding based on secondary criteria such as researcher reputation or the desirability of the promised results despite the implausibility of proposed methods.

Third and more broadly, investment in AI is no guarantee of returns. Neither scientific, technological, nor policy expertise confer the ability to predict the future; in complex endeavors, plans inevitably go awry and fail. The first AI arms race suggests that AI R&D carries a considerable risk of unintended consequences, as unprecedented funding levels incentivize overpromising by technical experts and attract dubious proposals. If and when such efforts fail to deliver, AI could be plunged into another Winter.

6. Conclusion

This paper examined the first global AI arms race of the 1980s, drew some parallels to the current AI arms race now underway, and extracted a handful of lessons to be learned from the historical precedent that could be used to inform policymaking. After Japan sparked the first AI arms race with its Fifth Generation Computer Systems (FGCS) project, countries around the world launched national AI projects in response. The US in particular portrayed Japan's FGCS as a threat to the national interest and launched military-focused endeavors such as the Strategic Computing Initiative (SCI) to protect American supremacy in computing and the economy more generally.

Nevertheless, by the early 1990s, despite spending billions of dollars and hundreds of billions of yen, no national developed any geopolitically decisive AI systems. Instead, the these programs failed to deliver the promised AI systems, precipitating an "AI Winter" that lasted more than a decade (Hendler 2008). By comparing the first arms race to the current conflict, this paper suggests that without acknowledging this historical context and avoiding a repeat, similar outcomes may await the field of AI in the next decade. However, if competitive arms race scenarios continue to guide decision making about AI R&D in the US and Asia, another AI Winter may be the least of humanity's problems.

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