

The New Arms Race in AI



Illustration: Sean McCabe Photos: Stephen Shaver/ZUMA Press (soldier); Lintao Zhang/Getty Images (Xi)

China is making big investments in artificial intelligence, looking for military advantage—while the Pentagon is determined to maintain its edge.

By Julian E. Barnes and Josh Chin

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Four years ago, planners at the Pentagon reviewed estimates of China’s growing military investments with what one called a “palpable sense of alarm.” China, the planners determined, was making advances that would erode America’s military

might—its ability to project power far from its shores. The search began for technologies that could give the U.S. a new warfighting edge against its rival.

The officials were particularly impressed by one artificial-intelligence project. The program could scan video from drones and find details that a human analyst would miss—identifying, for instance, a particular individual moving between previously undetected terrorist safe houses.

“That was the ‘Aha!’ moment I had been looking for,” said William Roper, then the head of the Pentagon’s Strategic Capabilities Office. His superiors quickly latched onto the potential of America’s world-leading efforts in artificial intelligence. The U.S. could maintain its advantage, they hoped, by exploiting the growing ability of computer systems to adapt rapidly to novel conditions, respond autonomously and even make certain decisions within rules set by programmers.

The problem, according to U.S. officials, is that China’s People’s Liberation Army was closely watching the Pentagon’s technology search, and some of its officers soon had an “Aha!” moment of their own. The turning point was March 2016, said Elsa Kania, a specialist on Chinese military innovation at the Washington-based Center for a New American Security. That was when Google’s DeepMind used AI to defeat a world champion in the ancient Chinese game of Go. The outcome, she said, persuaded the Chinese military that AI could surpass the human mind and provide an advantage in warfare. Last July, China unveiled plans to become the world’s dominant power in all aspects of artificial intelligence, military and otherwise, by 2030.

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The U.S. now finds itself in an escalating AI arms race. Over the past two years, China has announced AI achievements that some U.S. officials fear could eclipse their own progress, at least in some military applications. “This is our Sputnik moment,” said Robert Work, the former deputy secretary of defense who oversaw the Pentagon’s move into the new field.

There should be no doubt that the Chinese military is chasing transformative AI technologies, said retired PLA Maj. Gen. Xu Guangyu, now a senior researcher at the

China Arms Control and Disarmament Association, a government-supported think tank. “China will not ignore or let slip by any dual-use technology, or any technology at all, that might improve the ability of our military to fight, our awareness, or our ability to attack,” he said.



American F-35 fighter jets use AI to evaluate and share radar and other data among pilots, expanding their battlefield awareness. *Photo: Christine Groening/Planet Pix/ZUMA Press*

U.S. universities and corporations remain the world’s leaders in AI and related technologies, and American researchers continue to patent the most important technologies. Chinese experts say that their country is playing catch-up, citing the expertise in the U.S. and the Pentagon’s long history of driving innovation through its Defense Advanced Research Projects Agency, or Darpa.

But the Chinese military has moved to copy the Pentagon’s model. Two years ago, the PLA elevated and reorganized its science and technology branch, aiming to turn it into a “Darpa with Chinese characteristics,” according to Tai Ming Cheung, an expert on the Chinese military at the University of California, San Diego. The Chinese

government is also building national laboratories in the mold of America's famed Los Alamos, and because of its deep involvement in industry at every level, Beijing can achieve more integration between military and civilian AI investments.

“The Chinese have done a good job of adopting the American strategy and using it against us,” said Chris Taylor, chief executive of Govini, a big-data and analytics firm that has studied government investments in AI. “Not too many years ago we would say China steals information and that is how they innovate. That is not where they are anymore.”

Fueling the AI race is processing power, an emerging area of strategic competition between China and the U.S. Chinese state media reported in January that researchers with the National University of Defense Technology and National Supercomputer Center in Tianjin had made a breakthrough in building a conventional supercomputer at exascale—10 times faster than today's supercomputers—scheduled for completion by 2020. “That's a revolutionary, generational leap up,” said Dr. Cheung.

China is also advancing in quantum information sciences, a field that could give a big boost to AI and provide other military advantages. The complex research capitalizes on the ability of subatomic particles like photons to exist in multiple states simultaneously and to mirror each other across vast distances. Breakthroughs in the field could enable vast improvements in computing power and secure communication. Strategists see numerous military applications, including the supercharging of artificial intelligence.



Researchers at China's National Supercomputer Center in Tianjin (shown here) and National University of Defense Technology have made a breakthrough in building a supercomputer 10 times faster than those being used today, state media reported in January. *Photo: Associated Press*

In the city of Hefei in eastern China, work began last year on a \$1 billion national quantum-information-sciences laboratory. Slated to open in 2020, it will build on research already under way nearby in the lab of physicist Pan Jianwei, who led the team that launched the world's first quantum communications satellite. The project propelled China far ahead of others in transmitting information with essentially unbreakable quantum encryption.

“It’s so fundamentally different, it changes the building blocks of force and power,” cybersecurity expert John Costello said in an interview he gave last month before becoming a senior adviser at the Department of Homeland Security.

For its part, the U.S. military has struggled to establish a partnership with the private sector in developing AI—a serious problem since high-tech firms in the U.S. are conducting the world’s most advanced research and development in the field. Last

November, Eric Schmidt, the former executive chairman of Google and Alphabet and the chairman of the Pentagon's Defense Innovation Board, told an audience of Washington officials at a think-tank event that the obstacles to cooperation include cumbersome government bureaucracy and fear within the tech industry of "the military-industrial complex using their stuff to kill people incorrectly."

Aware of the problem, the Pentagon set up a tech-industry outreach office in 2015, which has awarded military contracts to AI-focused startups to help nurture technology in which the Defense Department is interested. An Air Force AI team also has been working to strengthen ties with companies and research universities.

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The Air Force has embedded a member of its team, for instance, with IBM researchers working on chips for a neuromorphic computer. The new technology, pioneered by IBM and Darpa, is intended to process information much as the human brain does, performing massive calculations with a fraction of the energy needed by normal computer chips. IBM is due to deliver it to the Air Force this summer—and China has built a new national laboratory working on the same technology.

The Air Force effort is focused on creating something called flexible AI, machines that have multiple ways of learning and evolving, and demonstrate "phenomenally intelligent behavior," said Doug Riecken, a team member. "I am talking about something far more than playing the game Go."

Some AI is already on the battlefield. The F-35, one of America's most advanced jet fighters, uses AI to evaluate and share radar and other sensor data among pilots, expanding their battlefield awareness. AI stitches together information and highlights what is likely most important to the pilot.

The more that AI advances, the more nimble these battlefield networks will become at combining machine and human intelligence, according to current and former defense officials. "The F-35 takes in infrared intelligence, radar intelligence, all sorts of stuff, and it fuses it right in front of the pilot's eyes," said Mr. Work. "The machine is doing all of that, and the pilot doesn't have to ask the machine to do it."

The Pentagon wants to equip soldiers on the ground with this technology. The U.S. Army is working on tactical augmented reality systems—sort of a Google Glass for war—using goggles or a visor that could display video from drones flying above, current position and enhanced night vision. AI-powered computing could add information about incoming threats, targets and areas that have to be protected.



At Marine Corps Base Quantico, the U.S. is testing conventional “Huey” helicopters outfitted with AI systems meant to enable pilotless flight for supply runs.

Photo: U.S. Navy photo by John F. Williams/DVIDS

AI used by the U.S. military in its Project Maven system—the initiative that gave the Pentagon its “Aha” moment—can already find potential enemies in a crowd faster than trained intelligence analysts. At Marine Corps Base Quantico, the U.S. is testing conventional “Huey” helicopters outfitted with AI systems meant to enable pilotless flight for supply runs. AI-controlled aircraft might someday jam enemy air defenses. “This is going to change the way we fight wars,” Mr. Work said.

AI also could vastly improve the effectiveness of airstrikes, current and former U.S. officials said. A commander, Mr. Work said, could order an airstrike on an air defense

installation and launch a cluster of missiles at the target. Artificial intelligence could give each missile a distinct role: One flying at the ideal altitude to get the best radar picture of the target, another climbing higher to force the installation's radar to point skyward, and other missiles staying low and approaching from different directions, some serving as decoys others attempting a direct hit.

China is developing similar technology. In January, the country's military TV network broadcast footage of researchers testing such "swarm intelligence," which could eventually link dozens of armed drones into an automated attack force.

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In its unclassified budget for 2017, the Pentagon spent roughly \$7.4 billion on AI and the fields that support it, such as big data and cloud computing, up from \$5.6 billion in 2012, according to a report by Govini. This reflects only the known piece of AI defense spending; the Pentagon has additional spending that is classified. Defense officials say that the Pentagon is at work on a new AI strategy aimed at marshaling more resources.

Chinese spending on AI is even more difficult to track. Estimates for overall investment vary widely, though analysts agree that the number is rising quickly.

Some officials and analysts see excessive exuberance over AI in both China and the U.S. A daunting task still lies ahead for any military hoping to deploy AI: Winning a complex board game like Go is far different from winning on the constantly shifting terrain of a modern battlefield. "What will be difficult about conflict and warfare is that the rules are not well defined," said Dr. Roper, who in late February became the Air Force's new head of acquisition and technology. "As soon as the fight starts, everything changes."

Though U.S. officials say that China, thanks to its strong economy and AI investments, presents the greatest competitive threat, Russia is investing in AI as well. Moscow has focused on creating autonomous weapons powered by AI and hopes in the coming decade to have 30% of its military robotized, which could transform how it fights.

Russia's sophisticated drone development lags behind the U.S., but it has exceptional expertise in electronic warfare, and AI technologies could boost it further.

AI could speed up warfare to a point where unassisted humans can't keep up — a scenario that retired U.S. Marine Gen. John Allen calls “hyperwar.” In a report released last year, he urged the North Atlantic Treaty Organization to step up its investments in AI, including creating a center to study hyperwar and a European Darpa, particularly to counter the Russian effort.



Much of China's advanced work is in quantum science applications, building on the launch of the world's first quantum communications satellite in 2016 from the Jiuquan Satellite Launch Center. A second satellite could form the beginning of a quantum communications network impervious to code breaking. *Photo: Xinhua News Agency/Getty Images*

Mr. Work advocates competing with China and Russia by creating a new civilian agency akin to NASA for AI, as well as an AI reserve comparable to the military reserves, which would pay for young people to get degrees in computer science and related fields. In return, young scientists would regularly serve in military AI labs.

Once AI is sophisticated enough for either side to let it run military systems, the next problem could be deciding how much human authority to surrender. People still have an edge in handling changing conditions, assessing risks and making choices. Yet AI's biggest impact could ultimately be on decision-making. Winning at war requires a military to make better decisions than its enemy and to execute them quickly.

In a futuristic example, a military AI program would identify weak points in enemy infrastructure that humans couldn't detect and then devise attacks—conventional or cyber—against the targets. If a nation were willing to turn over all decision-making to machines, the strikes could be launched within nanoseconds of identifying the target. “In hyperwar, the side that will prevail will be the side that is able to respond more quickly,” Gen. Allen said. “Artificial intelligence will collapse the decision-action loop in a very big and very real way.”

A Pentagon directive from 2012 restricts autonomous weapons. AI may assist with targeting, but a human military commander must decide what a warhead strikes. Some current and former U.S. military officials believe that China will have fewer compunctions about autonomous AI. “We are not going to find the Chinese are going to feel particularly constrained,” Gen. Allen said.

Gen. Xu, the retired PLA officer, said that questions such as whether to respond to a missile attack require political decisions, so China's military would never completely relinquish control to machines. Still, he said, the PLA can't ignore AI's potential agility. “The speed of perception, of attack, of action, whether you're talking technology or strategy, this will be the key issue in the battles of the future,” he said.

Pentagon officials acknowledge that they may eventually need to hand machines greater responsibility. “We should fight to have people maximally involved,” Dr. Roper said, “but the necessities of conflict will make us face hard choices.”

— *Gordon Lubold contributed to this article.*

