6-17-2020

Literature Review: How U.S. Government Documents Are Addressing the Increasing National Security Implications of Artificial Intelligence

Bert Chapman
Purdue University, chapmanb@purdue.edu

How U.S. Government Policy Documents Are Addressing the Increasing National Security Implications of Artificial Intelligence

Bert Chapman[1]

> *Artificial intelligence is the future. . . . Whoever becomes the leader in this sphere will become the ruler of the world.*
>
> ~Vladimir Putin[2]

Introduction

This article emphasizes the increasing importance of artificial intelligence (AI) in military and national security policy making. It seeks to inform interested individuals about the proliferation of publicly accessible U.S. government and military literature on this multifaceted topic. An additional objective of this endeavor is encouraging greater public awareness of and participation in emerging public policy debate on AI's moral and national security implications.

Artificial intelligence has played a historically significant role in U.S. military policy for multiple decades. An early demonstration of artificial intelligence's interest in the academic community was a 1956 meeting on this subject at Dartmouth College in Hanover, New Hampshire, organized by a mathematics professor named John McCarthy. He maintained that this meeting was intended "to proceed on the basis of the conjecture that every aspect of learning or any other feature of intelligence can in principle be so precisely described that a machine can be made to stimulate it." A 1972 Naval Weapons Laboratory report discussed the role of automatic theorem proving on computers and the role algorithms can play in problem solving, while acknowledging that the time when intelligent machines will do most of the work being done by humans is far away. Subsequent decades have seen the growing sophistication of technology in civilian and military applications, increasing the ability of machines to

perform human tasks. This period also resulted in artificial intelligence obtaining increasing importance in U.S. national security policy making in publicly accessible literature produced by civilian and military agencies.[3]

Statutory Definition of Artificial Intelligence

The John S. McCain National Defense Authorization Act for Fiscal Year 2019 defines artificial intelligence as:

1. Any artificial system that performs tasks under varying and unpredictable circumstances without significant human oversight, or that can learn from experience and improve performance when exposed to data sets.
2. An artificial system developed in computer software, physical hardware, or other context that solves tasks requiring human-like perception, cognition, planning, learning, communication, or physical action.
3. An artificial system designed to think or act like a human, including cognitive architectures or neural networks.
4. A set of techniques, including machine learning, that is designed to approximate a cognitive task.
5. An artificial system designed to act rationally, including an intelligent software agent or embodied robot that achieves goals using perception, planning, reasoning, learning, communicating, decision making, and acting.[4]

Artificial intelligence has experienced ebbs and flows in public attention with a recently released U.S. government commission report acknowledging it is receiving renewed popularity for multiple reasons:

- The unprecedented availability of big data;
- More powerful computing, particularly use of specialized graphics processing units, which are suitable for parallel computations by neural networks;
- Ubiquitous mobile connectivity, enabling AI technologies to be easily embedded and portable while managing data within the cloud; and
- Dramatic improvements in machine learning algorithms, especially those involving deep learning.[5]

This resurgence in governmental interest in AI is reflected in multiple recent publications from civilian governmental and military agencies.

Presidential and Executive Office of the President Documents

This section examines the variety of U.S. civilian and military agencies producing AI national security policy making documentation. It begins with documents from the president and White House offices, such as the National Security Council (NSC) and National Science and Technology Council, which can be regarded as representing presidential administration policy aspirations. These materials reflect the complexity of this public policy arena in areas such as executive orders, laws, regulations, and budgetary allocations. They also examine potential competition between agencies and relevant congressional oversight committees. The competition typically involves determining which of these entities will have control of various segments of U.S. AI national security policy making and the monetary and staffing assets needed for effective implement of these programs.

June 2019 saw the White House's National Science and Technology Council release *The National Artificial Intelligence Research and Development Strategic Plan: 2019 Update*, updating a 2016 version of an *Artificial Intelligence Research & Development Strategic Plan* produced by this office. Strategic objectives stressed in this document include making long-term investments in AI research, including developing scalable AI systems and fostering research on human-like AI; understanding and addressing AI's ethical legal and societal implications; ensuring the safety and security of AI systems, including enhancing verification and validation and securing against attacks; and better understanding national AI research and development workforce needs.[6]

Increasing the lethality of U.S. military forces and responding to resurgent conventional and nuclear threats from revisionist powers such as China and Russia has been a hallmark characteristic of the Donald J. Trump administration's national security policy documents. The 2017 *National Security Strategy of the United States* stressed:

> To maintain our competitive advantage, the United States will prioritize emerging technologies critical to economic growth and security, such as data science, encryption, autonomous technologies, gene editing, new materials, nanotechnology, advanced computing technologies, and artificial intelligence. From self-driving cars to autonomous weapons, the field of artificial intelligence in particular is progressing rapidly.[7]

Executive Order (EO) 13859, issued by President Trump on 11 February 2019, stressed that the United States must maintain leadership in AI. It emphasized the necessity of a concerted effort to promote technological and innovation ad-

vancements. Additional EO emphases included protecting American technology, economic and national security, civil liberties, and privacy while enhancing national and industry collaboration with allied foreign partners.[8]

In response to EO 13859 multiagency reporting requirements, the Department of Commerce's National Institute of Standards and Technology issued *U.S. Leadership in AI: A Plan for Federal Engagement in Developing Technical Standards and Related Tools* on 10 August 2019. This treatise called for developing technical standards for advancing effective, reliable, robust, and trustworthy standards. These include data sets in standardized formats, including metadata for training, validation, and testing of AI systems; tools for capturing and representing knowledge and reason in AI systems; fully documented cases providing a range of data and information about specific AI technologies, standards, and best practice guides used in decision making and deploying these applications; documented cases proving a range or data and information about specific AI technologies, standards, and best practice guides used in decision making and deploying these applications; and metrics to quantifiably measure and characterize AI technologies.[9]

On 30 August 2019, the Office of Management and Budget issued the Trump administration's memorandum "Fiscal Year 2021 Administration Research and Development Budget Priorities" (1 October 2020–30 September 2021), which outlined research and development budget priorities. The American security section of this document stressed the importance of investing in research and development to deliver advanced military capabilities to meet emerging threats and protect American security. These capabilities include offensive and defensive hypersonic weapons, resilient national security space systems, and modernized and flexible strategic and nonstrategic nuclear deterrent capabilities. The American leadership in the industries of the future section highlights departmental and agency prioritizing basic and applied research spending consistent with EO 13859—emphasizing AI, quantum information science, and computing and strengthening workforce capability in these areas.[10]

Artificial intelligence research and development spending requests among civilian government agencies for fiscal year (FY) 2020 was $654.4 million, according to a 10 September 2019 document from the White House's National Science and Technology Council. The National Institutes of Health and the National Science Foundation accounts for $448.1 million of this amount.[11]

Another emerging sculptor of the national security implications of artificial intelligence for the U.S. is the National Security Commission on Artificial Intelligence (NSCAI). Established in 2018 by the FY 2019 National Defense Authorization Act, Congress directed NSCAI to examine U.S. competitiveness in artificial intelligence, machine learning, and other associated technologies related to national security. It was tasked with developing means and methods for

the United States to maintain technological leadership in national defense and security technologies, and monitor international cooperation and trends and developments and competitiveness, including foreign artificial intelligence and machine learning investments related to national security. The NSCAI found ways of fostering greater emphasis and investment, stimulating academic, private, public, and collaborative investments related to national security, including workforce and education incentives for attracting and recruiting leading talent in artificial intelligence and machine learning disciplines, such as science, technology, engineering, and math programs. It evaluated risks involving U.S. and foreign country advances in military employment of artificial intelligence and machine learning, including international law of armed conflict, international humanitarian law, and escalation dynamics. The NSCAI implemented means for establishing data standards and incentivizing sharing of open training data within national security and defense data industries and studied the evolution of artificial intelligence and appropriate mechanisms for managing national security and defense technology.

NSCAI released an initial report in July 2019, an interim report in November 2019, and is scheduled to release its final report in November 2020.[12] Interim report findings express concern that AI developments are linked to emerging strategic competition with China and broader global geopolitical developments. These concerns include that the United States' role as the world's preeminent innovator is threatened, and that strategic competitors and nonstate actors will use AI to threaten Americans, our allies, and national values. Another concern is that AI-enabled capabilities may be used to threaten critical infrastructure, amplify disinformation campaigns, and wage war.[13]

Consensus judgments on AI's national security relevance presented in NSCAI's interim report include the inherent endurance in AI-enabled autonomous systems, which can provide round-the-clock overhead reconnaissance and vast data quantities to give decision makers options about prioritizing maintenance needs or selecting which forces or equipment to send into battle. The U.S. government is not leveraging basic commercial AI to improve business practices and save tax dollars. Departments and agencies must modernize and become more effective and cost-efficient, and national security agencies need to rethink AI-ready workforce requirements, including extending knowledge of AI-relevant technologies through organizations, instilling training on ethical and responsible AI development at every level, and increasingly using modern software tools. Military and national security agencies need to improve their recruiting and incentives for top AI talent and American research universities and other research institutes need to be aware they are vulnerable to foreign exploitation and influence from strategic competitors like China; AI presents significant military interoperability challenges.

The United States and its allies must coordinate early and often on AI-enabled capabilities or military coalition effectiveness will suffer; U.S. diplomacy should explore possible AI cooperation with China and Russia on promoting AI safety and its impact on strategic stability. Federal law enforcement agencies should only use AI in ways constitutionally consistent with individual privacy, equal protection, nondiscrimination, and due process. There is widespread concern over Chinese use of AI surveillance to persecute Uighurs and religious groups, along with concern that U.S. institutions with Chinese ties are building these systems. The United States should take steps to prevent U.S. entities from unknowingly abetting such abuses through strong export controls, disclosure requirements, and economic sanctions.[14]

Defense Department Documents: Autonomous Policy

Assessing the national security implications of AI is becoming increasingly present in multiple Department of Defense (DOD) policy documents. A June 2016 Defense Science Board study on autonomy made multiple recommendations to DOD for enhancing autonomous policy capabilities. Representative samples include military chiefs integrating technology insertion, doctrine, and concepts of operations by ensuring early experimentation uses alternative sources and informs employment doctrine. DOD components should also develop an autonomy-literate workforce, and immediate action must be taken to counter adversary use of autonomy. The Defense Advanced Research Projects Agency (DARPA) and other organizations should adapt existing intelligence, surveillance, and reconnaissance screening and data tools. The Air Force's Dynamic Time Critical Warfighting Capability and the Marine Corps and DARPA should develop and experiment with a prototype heterogeneous, autonomous unmanned aircraft systems support team including 10 or more unmanned aircraft. Finally, DARPA should develop autonomous systems detecting large-scale intrusions on the internet of things by passively and remotely monitoring bulk network traffic and identifying aggregate indicators of compromise hidden within the flood of ordinary traffic.[15]

Adopted in 2012 and amended in 2017, *DOD Directive 3000.09, Autonomy in Weapons Systems*, reflects official DOD policy on weapons systems autonomy, such as autonomous and semiautonomous weapons systems designed to allow commanders and operators to exercise appropriate levels of human judgment over the use of force. They must also complete engagements in a timeframe consistent with commander and operator intentions and, if unable to do so, terminate engagements or seek additional human operator input before continuing the engagement. Policies should be sufficiently robust to minimize failures that could lead to unintended engagements or to loss of control of the system to unauthorized parties and provide clear procedures for trained opera-

tors to deactivate system functions. Persons authorizing the use of, or operating autonomous and semiautonomous weapons systems, must use appropriate care in accordance with the law of war, applicable treaties, weapon system safety rules, and applicable rules of engagement.[16]

DOD has established a Joint Artificial Intelligence Center (JAIC) as the focal center of its AI strategy. Institutional objectives include accelerating AI-enabled capabilities, scaling departmental-wide AI impact, and synchronizing DOD AI activities to expand joint force advantages. Specific examples of this include rapidly delivering AI-enabled capabilities to address key missions, strengthening current advantages, and enhancing emerging AI research and development efforts with mission needs, operational outcomes, user feedback, and data. Other objectives include establishing a common foundation for scaling AI's overall DOD impact, leading strategic data acquisition, and introducing unified data stores and other attributes. Furthermore, JAIC will facilitate AI planning, policy, governance, ethics, safety, cybersecurity, and multilateral coordination, attracting and cultivating world-class team expertise on AI capability delivery and creating new accelerated AI learning experiences throughout DOD professional education and training levels.[17]

The unclassified summary of the 2018 *National Defense Strategy* emphasizes that the emerging international security environment is impacted by rapid technological advances, including a relentless drive to develop new technologies such as advanced computing, "big data" analytics, AI, autonomy, robotics, directed energy, hypersonics, and biotechnology. This work stressed that DOD "will invest broadly in military application of autonomy, artificial intelligence, and machine learning, including rapid application of commercial breakthroughs, to gain competitive military advantages."[18]

On 6 February 2019, DARPA announced the creation of the Guaranteeing AI Robustness Against Deception (GARD) program. This endeavor develops new generation defenses against adversarial deception attacks on machine learning models. Current defense efforts are structured to protect against specific predefined hostile attacks while remaining vulnerable to attacks outside design perimeters when tested. GARD seeks to expand machine learning defense by developing broad-based defenses addressing numerous possible attacks in a given scenario. Three foci of GARD include:

- Developing theoretical foundations for defensible machine learning with a lexicon of new defense mechanisms based on them;
- Creating and testing defensible systems in divergent setting ranges; and
- Constructing a new testbed capable of characterizing machine learning defensibility relative to threat scenarios.[19]

U.S. Military and Intelligence Artificial Intelligence Spending

There are various estimates of U.S. military spending on artificial intelligence. On 7 September 2018, DARPA said it will spend up to $2 billion advancing AI during the next five years as part of a "Third Wave" campaign intended to develop machines capable of learning and adapting to changing environments.[20] A commercial database claimed DOD spent $7.4 billion on AI, big data, and cloud computing in FY 2017, with this total expected to reach $18.82 billion by 2025. Target areas of this increased AI spending include warfare platforms, cybersecurity, logistics and transportation, target recognition, battlefield health care, combat simulation and training, threat monitoring and situational awareness, and AI and data-information processing. The website Breaking Defense reported on 18 September 2019 that JAIC would see its budget double to more than $208 million with probable significant increases after 2021.[21]

A recent *Naval War College Review* assessment on emerging military spending on AI maintained that the Air Force allocated $87 million in 2019 for experimenting with war games and field training. The Army allocated $6.5 million for training, including simulations and virtual reality in 2019, and will begin fielding new unmanned combat systems by late 2019 with these being assigned to operational units by 2021. The eventual goal is for the Army to replace the M1 Abrams main battle tank and M2 Bradley infantry fighting vehicle. It also noted that the Marine Corps allocated $7.1 million for an unmanned warning system providing commanders with increased situational awareness. The Navy also allocated $6.5 million for AI training purposes, including submarine combat assets.[22]

Determining intelligence spending on AI is extremely difficult due to limited public disclosure of operationally specific items. A November 2019 Congressional Research Service report calculated FY 2020 National Intelligence Program spending at $62.8 billion and Military Intelligence Program spending for 2019 at $22.95 billion for a cumulative total of approximately $85.8 billion, representing 11.3 percent of overall defense spending. Debate about what degree the U.S. intelligence budget should be publicly disclosed remains ongoing.[23]

U.S. Armed Service Analyses of Machine Learning

Analysis of how AI and machine learning may affect operations of individual Armed Service branches in various threat scenarios is reflected in literature produced by the Air Force, Army, Marine Corps, and Navy. *Autonomous Horizons: The Way Forward* is a 2019 work from the Air Force's Air University Press focusing on emerging steps in autonomous systems development fielding and training. It presents recommendations for enhancing autonomous systems

capabilities in six areas: behavioral objectives, architectures and technologies, challenge problems, development processes, organizational structures, and knowledge platform.

These recommendations for enhancing autonomous systems capability include design ensuring proficiency in the given environment, tasks, and teammates envisioned during operations. Desired properties of *proficiency* include situated agency, capacity for adaptive cognition, allowance for multiagent emergence, and ability to learn from experience. Autonomous systems should be designed to ensure trust when operated by or teamed with human counterparts. Desired *tenets of trust* include cognitive congruence and/or transparency of decision making, situational awareness, design enabling natural human-system interaction, and a capability for effective human-system teaming and training. They also include developing one or more common autonomous system architecture capable of consuming multiple frameworks across disparate communities.

The architecture should be functionally structured to enable extensibility and reuse, make no commitment on symbolic versus subsymbolic processing for component functions, incorporate memory and learning, and support human teammate interaction as needed. Mission-oriented challenge problems with the two objectives should be selected for testing: a) addressing current or future operational gaps that may be well-suited for autonomous system application; and b) challenging the science and technology community to make significant advances in the science and engineering of autonomous system functionality. Through the U.S. Air Force chief data officer, acquire space to store the Services air, space, and cyber data so that AI professionals can use it to create autonomy solutions to challenge problems. Create data curator roles in relevant organizations to manage the data and establish the Autonomy Capabilities Team within the Air Force Research Laboratory, incorporating a "flatarchy" business model to bring experts into a single product-focused organization to develop the science of autonomous systems while delivering capabilities to the warfighter. Develop a knowledge platform centered on combining an information technology platform approach, with a platform business model. A knowledge platform designed for the multidomain operating Air Force should monopolize the connection of observation agents with knowledge creation agents and with warfighting effects agents, which can be either human or machine-based agents (autonomous systems).[24]

Another 2019 publication, *Artificial Intelligence: China, Russia, and the Global Order: Technological, Political Global, and Creative Perspectives*, examines how AI is affecting the global strategic environment with particular emphasis on its use by China and Russia. It notes that AI technology advances benefit all-encompassing surveillance used by dictatorial regimes, such as China and

Russia. Globally, countries are looking at democratic and dictatorial uses of AI to affect domestic developments in authoritarian, hybrid, and democratic countries.

U.S. policy makers should use a three-pronged strategy to understand this challenge and develop global policy, including ensuring the protection and robustness of U.S. democracy as it adapts to these new technologies. It must respond to domestic threats (e.g., capture by a tech oligopoly or drift to a surveillance state) and external threats without becoming governed by a military-industrial complex. U.S. digital democracy, if successful at home, will exert gravitational influence globally; the United States must exert influence effectively and manage potential escalation in the swing states (e.g., Asia or Europe) and global systems (e.g., norms and institutions) that form the key terrain for competition among the digital regime types. U.S. pushback on the diplomatic, economic, informational, and commercial dimensions will be crucial with allies and other states but must do so in ways that manage the significant risks of spiraling fear and animosity.[25]

One section of *Artificial Intelligence, China, Russia, and Global Order* examines AI and military dimensions in international competition. It focuses on hacking making AI more important by searching for vulnerabilities in opposing systems whose exploitation enhances national leverage, changing the nature of warfare and the risks of conflict escalation from AI-enabled military systems. Additionally, China's People's Liberation Army is exploring AI technological use in future command decision making by overcoming admitted deficiencies in commanders' capabilities and leveraging AI technologies to achieve decision superiority in emerging "intelligentized" warfare. This section of the book also examines Chinese efforts to integrate neural networks into its hypersonic platforms, potentially heralding a shift from active defense to a more offensive posture. Russia's military is also investing heavily in creating an AI intellectual and physical infrastructure across its armed services while expanding cooperation between a growing high-tech infrastructure and expansive military-academic infrastructure.[26]

The potential of AI to change war is also reflected in Army professional military literature. A 2018 Army Command and General Staff College study noted AI can enhance an Army commander's ability to exercise mission campaigns. This involves the Mission Command Battle Lab in the Army's Capability Development Integration Directorate taking a leading role in developing tools the Army can use with AI for enhancing human capacity and capability. This treatise also noted that it is a matter of when, not if, militaries focus on using AI in future wars. It stresses that the Army will focus efforts on human-AI teaming and that the machine's advantage over humans consists of unlimited bandwidth

and a narrowly defined focus within a clearly defined structure, which can easily outperform the best human counterparts.[27]

Conclusions of this work stress that AI places large volumes of information at commanders' fingertips, provides access to other's experiences, and usefully enhances cognition by organizing large volumes of information and presenting only situationally pertinent information. If employed correctly, AI gives the military an asymmetrical advantage by providing greater access to the information environment, allowing commanders to shape the operational environment. This shaping effort does not require employing forces, enabling operations to begin long before troop movements. Such deployment allows military commanders to conduct operations deep behind enemy lines with minimal or zero political risk.[28]

Army AI activities can also involve collaboration with business and academic entities. *Army Directive 2018–18*, issued on 2 October 2018, involves collaboration between DOD's JAIC and projects based at Carnegie Mellon University, which has established an Army-Artificial Intelligence (AI) Task Force (AATF) to enhance existing AI capabilities by leveraging existing technological applications to enhance warfighters, preserve, peace, and win wars. AATF's ultimate objective is rapidly integrating and synchronizing AI activities across the Army and DOD. AATF program objectives include:

- Revising the Army cloud strategy to establish an accessible, secure cloud environment that is an AI and machine learning-ready hybrid to share system data more easily to support decision-making speed and lethality;
- Developing and recommending policy and procedures for an identity, credential, and access management system that will efficiently issue and verify credentials to nonperson entities, such as AI agents and machines authorized to operate on Army networks;
- Reviewing all information technology, network, and cybersecurity policies to account for developing and employing emerging AI capabilities and tools on Army networks;
- Reviewing all information technology network, and cybersecurity policies to account for developing and employing emerging AI capabilities and tools on Army networks; and
- Developing and recommending standards-based technical architecture establishing a common foundation underpinning all AI and machine learning capabilities, including network connectivity, data access and availability, hybrid cloud hosting capabilities, and data protection mechanisms.[29]

U.S. Marine Corps AI discussion and analysis is also growing exponentially. The 2016 *Marine Corps Operating Concept* stresses that "even in a world of ever-increasing technology, we must continue to provide combat formations capable of closing with and destroying the enemy."[30] The *Marine Corps Operating Concept* goes on to stress that the Corps must be a lethal force combining arms with information warfare and destroying and defeating enemies across air, land, sea, space, and cyberspace. It also notes that information used as a weapon complicates the United States' ability to gain and maintain accurate, up-to-date, and intelligence-driven understanding of conflicts. Additionally, the Marine Corps is not presently organized, trained, and equipped to meet future operating environment demands featuring complex terrain, technology proliferation, information warfare, the need to shield and exploit signatures, and an increasingly nonpermissive maritime domain.[31]

To successfully adapt to this environment, the Corps must learn to use unmanned systems and automation at all echelons and in every domain. Mastering the human-machine interface represents a military operational revolution. The Marine Corps must understand and manage heat and radar signatures by combining mission control and use decoys, cover, concealment, camouflage, and deception. It should also exploit data strategies and information-sharing architectures to gain benefits from machine-aided tipping and relational visualization, along with displaying battlefield threats, expediting commanders' ability to quickly and intuitively understand complex situations. The Marine Corps must engage in information warfare by enhancing our ability to identify and oppose adversary narratives by using counternarrative methods, such as competing narratives, as well as reducing voices contributing to hostile narratives. The United States could exploit human-machine and artificial intelligence interfaces to enhance performance.[32]

Three recent Marine Corps University School of Advanced Warfighting (SAW) master's theses describe how emerging Marine Corps leaders view AI and its possible integration into military operations. Joshua E. Cavan's thesis, "Artificial Intelligence and the First to Fight: The Implications of Artificial Intelligence for Forward-Deployed and Early-Deploying Forces in Contingency Operations" notes AI can quickly process large data volumes, convert the data to information, and point to courses of action based on an algorithm in ways and speeds beyond human cognitive processing. He notes that AI is limited by its foundational machine learning, requiring vast amounts of data, and collecting sufficient machine learning of military AI systems may become important for forward-deployed and early-deploying forces, including country teams, special operations, expeditionary, naval, air, and forward-deployed ground forces.[33] Cavan's work argues that the United States should avoid being surprised by hostile deception processes by using data collected by advance- and forward-

deployed forces to quickly spot significant deviations from preconflict patterns. This information could drive decision-making tempo by analyzing hostile use of AI to exploit opportunities to protect friendly operations through surprise. It stresses using ambiguity to achieve surprise by referencing Russian forces' use of ambiguity during the 2014 Crimean annexation. The conclusion warns the American government to guard against surprise by avoiding being formulaic and predictable in decision making when there is excessive dependence on AI at the cost of human creativity. It is possible the United States and its allies may effectively use this creativity and national tradition of individual initiative against authoritarian societies if their mutual AI capabilities are of equal quality.[34]

A second SAW master's thesis, Jason C. Copeland's "Swarms of Flying iPhones: Using Limited Artificial Intelligence to Root Out an Adversary," stresses that evolving technology will increase the lethality of future wars. Noting the increasing urbanization of global demographics and the probability that more military conflict will occur in such areas, the author stresses the increasing importance of small unmanned aerial systems and their AI capabilities in changing the character of future war. They could provide critical targeting information to separate and target adversaries from friendly or neutral populations as they seek shelter from bullets and bombs.[35]

Copeland goes on to express concern that a Marine Corps squad could experience cognitive overload with the amount of information provided, such as integrating and making sense of an unmanned aerial system feed while winning a firefight. He notes that an individual squad leader could effectively receive redirecting intelligence for a patrol based on later intelligence updates produced by small unmanned aerial systems swarms compiling, sorting, and supporting real-time information into actionable intelligence. Additional determinations of this work are that weapons release is highly unlikely to defer to an automated system for killing human combatants, but that the data collected before deciding to target a human can be exploited by machines to shorten the decision to strike. This technology is not currently available since a flying iPhone would need a multimegapixel camera, require long air loiter times, extended range from the base station recharging the small unmanned aerial systems, and a high bandwidth data downlink.[36]

How machine learning transforms the joint targeting process is analyzed by a third SAW thesis, Joseph F. Sgro Jr.'s "A Blueprint to Exploiting Artificial Intelligence: How Machine Learning Is Transforming the Joint Targeting Process." This work notes that Project Maven, a former collaborative venture between Google and the Department of Defense, aspired to accelerate military integration of big data and machine learning by using machine learning algorithms to efficiently process large volumes of video footage collected by aerial drones and identifying objects that analysts had previously evaluated. Oppo-

sition to this program by some Google employees led to it being sourced to competitors, such as Booz Allen Hamilton.[37]

Recommendations made by Sgro include DOD increasing its AI budget and focusing heavily on machine learning to support military intelligence, surveillance, and reconnaissance and data collection for joint force commanders. The DOD could leverage AI within the traditional collections and analysis process, expanding the reach of available information in developing shared understanding while accelerating the collection process. AI would need to monitor, collect, and exploit adversary media outlets to facilitate development of joint intelligence preparation of the environment to increase intelligence collections. Machine learning has the ability to offer systems-oriented collections in military, information, economic, and infrastructure systems and will play a critical role with its ability to find, fix, and track military targets while also providing combat assessment and battle damage assessment.[38]

Scrutiny of AI's potential for naval operations is ongoing in this Service's literature. A 2015 U.S. Naval War College thesis asserts that AI may "potentially revolutionize national security affairs by decreasing the human cost of war while increasing the speed and efficiency of America's tools of national power at the tactical, operational, and strategic levels of conflict."[39] This could produce a future AI race or the emergence of very intelligent or hostile AI requiring combatant commanders to develop ways to confront hostile AI with faster and more linear thinking processes.

A late 2019 *Naval War College Review* assessment on AI's potential role in naval operations maintained that autonomous AI war-fighting machines are years away, along with operational applications of swarm techniques, autonomous copilots for pilots, and *general AI*, which attempts to mimic the human brain in completely autonomous thought. However, it stressed widespread AI adaptation that produces three benefits. By collecting and compiling data now, the Navy and Marine Corps will have larger databases from which AI can learn, and these larger databases frequently produce more effective AI systems. In addition, fewer naval personnel

> will be restricted to the noncombat sector if support functions are transferred to AI. This development frees up manpower for use in new specialties, additional combat units, and forward deployments around the world. Finally, the sooner the [Department of the Navy] DoN can expose average Marines and sailors to AI, the more familiar and comfortable they will become with the technologies. In the future, when the full capabilities of AI are harnessed and implemented throughout the services, the fighting force will be ready to embrace them.[40]

Intelligence Community Research

AI's potential is also being thoroughly analyzed and deployed within the intelligence community. In 2019, the Office of the Director of National Intelligence (ODNI) released its unclassified Augmenting Intelligence using Machines (AIM) initiative. ODNI noted that data generation pace, whether through collection or publicly available information, is increasing exponentially and exceeds our ability to understand or find the most relevant data for making analytic judgments.

The AIM initiative's executive summary stresses that the intelligence community is carefully considering methods for fully automating well-defined processes and augmenting human expertise with analytics or planning capabilities for their potential benefit. They are monitoring the vulnerability of these technologies in development and adoption. AIM seeks to determine how the intelligence community can best manage uncertainty by achieving operational risk suited to the demonstrable analytic and operational advantages in AIM-enabled solutions and tradecraft. This strategic imperative of leveraging private investment, focusing on areas of unique mission need, and rethinking how to attract and retain human expertise exists because our adversaries, notably Russia and China, also recognize AI's potential to transform military and intelligence operations and are investing aggressively to make that advantage a reality.[41]

Primary AIM investment objectives are the immediate and ongoing strengthening of a digital foundation, data science, and technical intelligence to enhance understanding of the commercial supply chain, determining ongoing federal government programs that can be leveraged for wider audiences, and identifying adversarial AI uses. A second short-term objective is adopting commercial and open source AI solutions by rapidly transitioning the best commercial and open source narrow AI capabilities where technology outperforms humans in a very narrow specifically defined task, such as playing chess. A third and medium-term objective is developing the capability and capacity to exploit available data across all human, imagery, measurement, open source, and signals intelligence, while developing AI solutions processing and relating information from multiple modalities, breaking down traditional intelligence stovepipes such as using data from multiple intelligence agencies and open sources. A fourth and long-term AIM investment objective is investing in basic research focused on sense-making, aspiring to increase trust between human and machine teams, while also achieving research advances in knowledge representation of AI, goals and intent, entity extraction from incomplete multimodal data, and discourse generation.[42]

The Intelligence Advanced Research Projects Agency (IARPA) is a critical incubator of intelligence community research and development as the following programs demonstrate. The Aladdin Video Program recognizes that prodi-

gious amounts of video clips are generated daily on many consumer electronics and uploaded to the internet. Such videos are produced for broadcast or from planned surveillance, presenting significant challenges for manual and automated analysis. Aladdin aspires to combine state-of-the-art video and audio extraction, knowledge representation, and searchable technologies to create fast, accurate, robust, and extensible technology supporting future multimedia analytic needs.[43]

Intelligence Advanced Research Projects Agency Programs

The Better Extraction from Text Towards Enhanced Retrieval (BETTER) program seeks to develop methods for extracting fine-grained semantic information focusing on *whom-did-what-to-whom-when-where* across multiple languages and problem domains. Such extracted information is applied to an information retrieval task. Focusing on human-in-the-loop computation requiring human interaction in modeling and simulation is an additional BETTER focus area. BETTER also focuses on performer systems requiring the ability to incorporate human judgments for metrics, including relevancy and the accuracy of extracted and retrieved information.[44] Another program that seeks to extract information and intelligence from multiple sources is Crowdsourcing Evidence, Argumentation, Thinking and Evaluation, which seeks to develop and experimentally test systems using crowdsourcing and structured analytic techniques to improve analytic reasoning. Such systems aspire to help humans better understand the evidence and assumptions supporting or conflicting with human conclusions. They also help users better communicate their reasoning and conclusions. This U.S.-Australian collaboration is projected to last 4.5 years.[45]

Cyber-attack Automated Unconventional Sensor Environment (CAUSE) acknowledges cyberattacks evolve in a phased approach. Detection typically occurs in an attack's later phase and analysis is often postmortem to investigate and discover early phase indicators. Observing earlier attack phases, including target reconnaissance, planning, and delivery may facilitate warning of significant cyber events before their most damaging phases. CAUSE seeks to develop and test new automated methods forecasting and detecting cyberattacks significantly earlier than existing methods. Prime contractors include BAE Systems and Electronic Systems Integration, Charles River Analytics, Leidos, and the University of Southern California.[46]

The Deep Intermodal Video Analytics (DIVA) program develops robust automatic activity detection for a multicamera streaming video environment. Such activities will be enriched by person and object detection with DIVA addressing activity detection for forensic applications and real-time alerting. DIVA-derived research areas include machine learning, deep learning or hierarchical modeling, person detection and reidentification, tracking across multiple

nonoverlapping camera viewpoints, 3D video reconstruction, and super-resolution.[47]

Forecasting Counterfactuals in Uncontrolled Settings (FOCUS) seeks to develop and study the systematic approaches to counterfactual forecasting and lessons learned processes. Counterfactual forecasts represent statements about what would have happened if different circumstances had resulted. A postmortem review of an analysis failure could produce a conclusion that analysts would have to avoid such failure in the future by employing better analytic tradecraft; double-checking assumptions; or considering a broader range of hypotheses. Counterfactual forecasts working in past circumstances often represent the basis for lessons learned on how to respond in the future and can be incorporated into best practices and tradecraft.

FOCUS notes that there is limited research measuring which different approaches to counterfactual forecasting yield accurate or inaccurate counterfactual forecasts. FOCUS also maintains that research is scarce on the accuracy of lessons drawn from divergent lessons learned approaches. Consequently, there is insufficient evidence-based guidance for approaching lessons learned activities or for developing counterfactual forecasts representing the core of such activities. FOCUS aspires to develop and empirically test alternative approaches to structuring counterfactual forecasting and lessons learned processes to be readily incorporated into lessons learned activities.[48]

The Hybrid Forecasting Competition (HFC) program develops and tests hybrid geopolitical forecasting systems to integrate human and machine forecasting components to create maximally accurate, flexible, and scalable forecasting capabilities of events as varied as disease outbreaks, elections, financial market fluctuations, and interstate conflict. Since human-generated forecasts may be subject to cognitive biases or scalability limits, machine-generated statistical and computational forecasting approaches might prove more data driven and scalable, but they are often unable to provide forecasts of idiosyncratic or newly emerging geopolitical subjects.

Hybrid approaches may combine the strengths of these two approaches while reducing their individual weaknesses. HFC participants compete in a multiyear competition to identify approaches enabling the intelligence community to radically enhance the accuracy and timeliness of its geopolitical forecasts.[49]

Department of State

The Department of State is exploring ways of integrating AI into U.S. foreign policy and geopolitical forecasting. A 24 October 2018 speech by Christopher A. Ford, the assistant secretary of state in the Bureau of International Security and Nonproliferation, quoted Chinese president Xi Jinping that the revolution

in military affairs will be intertwined with a scientific and technical revolution, with AI being incorporated into military systems and doctrine. Xi's 19th National Congress of the Communist Party of China speech on 18 October 2017 stressed that AI military applications are part of intelligent warfare. Ford also noted that China sees military-civil fusion as involving AI and related disciplines including aerospace, aviation, big data processing, cloud computing, and nuclear technology.[50]

The Department of State's Office of the Science and Technology advisor lists AI as an emerging and transformational technology, which the department is using to develop its foreign policy priorities, including analyzing and advising how this strategic foresight can inform real time decision processes.[51] The Department of State's Office of Emerging Security Challenges (ESC) within the Bureau of Arms Control, Verification, and Compliance develops department positions for enhancing space security and missile defense cooperation among allies and partners. The ESC leads departmental efforts to ensure polar region security and plays a leading role through encouraging cooperation, enhancing cyber strategic stability, and developing confidence-building measures such as including AI's national security implications.[52]

Congressional Reports: Civilian and Military Aspects of Artificial Intelligence

Numerous congressional committees are involved in addressing civilian and military aspects of AI under its Article I U.S. Constitution powers. A 9 January 2018 hearing by a House Armed Services Committee subcommittee examined China's pursuit of emerging and exponential technologies, such as AI. Witness Paul Scharre of the Center for a New American Security maintained that China is second only to the United States in AI and that Alibaba, Baidu, and Tencent are top-tier AI companies. He also claimed that since 2014 China has surpassed the United States in the number of deep-learning publications, while stressing that publication quantity does not necessarily represent quality. Scharre also noted that the 2017 meeting of the Association for the Advancement of Artificial Intelligence saw nearly as many accepted papers from China as from the United States and noted the U.S. world leadership in AI patents. Nevertheless, China's AI patent rate is growing faster than the United States. China published a July 2017 national strategy for AI. Beijing's goal is to be an AI global leader by 2030, and China is striving to educate and recruit leading AI talent, including top-tier AI researchers.[53]

William A. Carter of the Center for Strategic and International Studies stressed that China sees AI and quantum technology as foundational to long-term economic and military competitiveness and has become an AI innovator. He also emphasized that Chinese companies have made significant AI break-

throughs in natural language processing, real-time translation, imagery analysis, facial recognition, and autonomous driving. Carter stressed that the United States must counter Chinese efforts to exploit U.S. military dependence on information and communications technology by investing in resiliency of critical conventional and nuclear military infrastructure and ensuring that China never has confidence in their abilities to compromise U.S. systems with a first strike.[54]

General congressional interest in AI is reflected by the Congressional Artificial Intelligence Caucus. Its membership of 27 representatives during the 116th Congress seeks to inform policy makers of AI's economic, social, and technological impacts and promote rapid innovation in AI and related fields by bringing together academic, government, and private sector experts to discuss emerging technologies and opportunities.[55]

Conclusion

Artificial intelligence has both positive and negative implications in civilian and military policy making and strategy. In January 2015, the Future of Life Institute, a collaborative of senior business and science leaders, including Tesla/Space X founder Elon Musk and the late theoretical physicist Stephen Hawking, released an open letter warning of an existential risk presented by the next phase of AI research on humanity's future. This document maintained that AI systems must do what we want them to do and adhere to human intentions.[56]

In its November 2019 interim report, the U.S. National Security Commission on Artificial Intelligence was blunt in its judgment that the United States is not using its AI strengths and strategies for national security advantages, meaning that many agencies have not adopted AI into their missions.[57] The NSCAI military implications include "changes to how we fight," such as military use of AI-enabled machines and weapons, enabling faster decision making in the battlefield. Furthermore,

> AI will foster a new generation of semi-autonomous and autonomous combat systems and operations. Autonomous capabilities can be useful for a wide array of applications, including for predictive analysis, decision support systems, unmanned platforms, robotics, and weapons (both cyber and physical).[58]

An additional November 2019 NSCAI contention is that AI is necessary to enable the United States to remain competitive. The advantages of embracing AI are clear:

> The Commission believes AI is key to the next technological leap forward which, if leveraged appropriately, will equip the United States to extend its advantages and preserve a credible deterrent in East Asia and Eastern Europe. AI-enabled

> systems could allow U.S. forces to understand the battlespace more clearly and rapidly; use autonomous systems to mount operations even when communication links are under attack; and develop capabilities to better defend against adversary AI systems. Intelligence agencies will be able to integrate massive amounts of data and better identify threats and discern patterns, which will provide military commanders and policy makers with more timely and sophisticated analysis.[59]

For Marine Corps personnel and policy makers, the 2016 *Marine Corps Operating Concept* argues that the full potential inherent in automation must be captured. It subsequently contends that putting people and machines together in the most effective pairing for the mission at hand is essential as machines become more capable and autonomous. Fully exploiting automation's power must take into account several things. The Marine Corps must refine the concept of manned-unmanned teaming to integrate robotic autonomous systems with manned platforms and Marines. The Corps should develop concepts of operations acting to accomplish mission objectives supporting and embracing robotic autonomous systems as a critical enabler. Finally, the Marine Corps needs to develop unmanned reconnaissance and surveillance systems to investigate littoral environments and complex terrain features, including sewers, tunnels, subways, buildings, and caves.[60]

Key findings of this literature and subsequent research opportunities for scholars and policy makers include the United States and its military allies not making the mistake of assuming that potential battlefield opponents will adhere to international law of war standards when using AI in military operations. *Unrestricted Warfare*, authored by two Chinese military officers in 1999 and published by the People's Liberation Army (PLA), essentially envisions no geographic restrictions on waging war as a result of emerging technological developments and the breakdown of long-standing boundaries between soldiers and civilians. This creates a borderless battlefield with globalization increasing interconnectivity and makes it imperative that the United States and its allies adopt sufficient operational, tactical, and strategic flexibility to defend its interests and defeat its foes in such a Hobbesian military environment.[61]

AI offers the potential for more accurate forecasting of hostile actor intentions. It remains to be seen whether this can be translated into more effective policy responses by the United States and its allies. Hostile countries and transnational organizations will seek various ways to respond to U.S. and allied use of AI against them. How will the United States and its allies respond to our adversaries' use of AI? AI in national security policy making also must address the ethical question of human/machine agency in geopolitical decision making,

and all democratic countries must address the manifold dangers of letting hostile actors have control of AI technology.

Civilian and military policy makers must recognize that even with advanced information processing capabilities, it may not be possible to sort out timely, accurate, and policy relevant and actionable information by AI to national leaders, military commanders, intelligence analysts, and military personnel on air, land, sea, and space. The advent of AI is likely to have significant impacts on U.S. civilian law, military operational planning, international law, international laws of war, and personal privacy. How these results will impact the entire spectrum of civilian and military policy making in a constitutional republic is a question with major moral and policy making implications.

The United States must determine which agencies will coordinate, fund, and prioritize U.S. AI geopolitical and military programs. How much AI funding will agencies such as DOD, DARPA, and the intelligence communities receive, and will they use it effectively? Which congressional committees will take the lead in conducting oversight of federal national security AI funding? Will the current parochial and stove-piped approach to congressional national security oversight remain in place and keep AI national security policy making programs mired in a bureaucratic morass as with other federal programs?

U.S. civilian and military leaders must also recognize that there are limits on how accurately AI can forecast human thinking and actions. This is particularly true if these policy makers assume that hostile foreign national and transnational leaders are rational or adhere to anything resembling Western norms.

The emergence of AI poses acute challenges and opportunities for the U.S. intelligence and military communities, civilian national security policy makers, their congressional overseers and appropriators, and foreign civilian and military leaders. Official U.S. AI literature gives interested citizens the opportunity to participate in influencing U.S. AI national security policy making. This can be done through interaction with relevant government agencies, providing feedback to congressional representatives, and commenting on proposed federal agency AI regulations under the 1946 Administrative Procedures Act. How these subjects and their profound moral implications are addressed in subsequent decades will influence the conduct of wars, military strategy, and numerous national and international security matters that will be paid for with taxpayer dollars and civilian and military sacrifice when wars occur.

Endnotes

1. Bert Chapman is the Government Information, History, and Political Science Librarian and professor of library science in the Purdue University Libraries and School for Information Studies, West Lafayette, IN. His research interests include government and military information resources dealing with national security. He has written six

books, including *Global Defense Procurement and the F-35 Joint Strike Fighter* (2019), and his articles have appeared in journals such as *Astropolitics*; *Geopolitics, History, and International Relations*; the *Korean Journal of Defense Analysis*; *Security Challenges*; and *Security and Defence Quarterly*.

2. Capt Dan Deluce, RCAF, "AI and the Kill Chain," *Royal Canadian Air Force Journal* 8, no. 3 (Summer 2019): 7.
3. John McCarthy et al., *A Proposal for the Dartmouth Summer Research Project on Artificial Intelligence* (Hanover, NH: Dartmouth College, 1955), 9; Susan Knapp, "Artificial Intelligence: Past, Present, and Future," *Vox of Dartmouth*, 24 July 2006, 1; and Hartmut G. M. Huber, *The Role of Theorem Proving In Artificial Intelligence* (Dahlgren, VA: Naval Weapons Laboratory, 1972).
4. John S. McCain National Defense Authorization Act for Fiscal Year 2019, S. 238, H.R. 5515, 115th Cong. (2018).
5. *Interim Report: November 2019* (Washington, DC: National Commission on Artificial Intelligence, 2019), 54.
6. *The National Artificial Intelligence Research and Development Strategic Plan: 2019 Update* (Washington, DC: White House, 2019), ii–iii.
7. *National Security Strategy of the United States of America, December 2017* (Washington, DC: White House, 2017), 20.
8. *Exec. Order No. 13859*: Maintaining American Leadership in Artificial Intelligence (2019).
9. *U.S. Leadership in AI: A Plan for Federal Engagement in Developing Technical Standards and Related Tools* (Washington, DC: Department of Commerce, 2019), 4, 40.
10. Memorandum for the Heads of Executive Department and Agencies, memo M-19-25, "Fiscal Year 2021 Administration Research and Development Budget Priorities," 30 August 2019.
11. *The Networking and Information Technology Research and Development Program: Supplement to the President's FY 2020 Budget* (Washington, DC: National Science and Technology Council, 2019), 10.
12. *Initial Report, July 2019* (Washington, DC: National Security Commission on Artificial Intelligence, 2019), 1.
13. *Interim Report*, 1.
14. *Interim Report*, 30, 34, 36, 38, 40, 45–46, 49.
15. *Defense Science Board Summer Study on Autonomy* (Washington, DC: Department of Defense, 2016), 38–41, 46–51, 55–57, 70–76, 94–95.
16. *Department of Defense Directive Number 3000.09, Autonomy in Weapon Systems* (Washington, DC: Department of Defense, 2017), 2–3.
17. *Summary of the 2018 Department of Defense Artificial Intelligence Strategy: Harnessing AI to Advance our Security and Prosperity* (Washington, DC: Department of Defense, 2018), 9.
18. *Summary of the 2018 National Defense Strategy of the United States*, 3, 7.
19. "Defending Against Adversarial Artificial Intelligence," Defense Advanced Research Projects Agency, 6 February 2019.
20. Drew Harwell, "Defense Department Pledges Billions Toward Artificial Intelligence Research," *Washington Post*, 7 September 2018.
21. Tejaswi Singh and Amit Gulhane, "8 Key Military Applications for Artificial Intelligence in 2018," *Market Research* (blog), 3 October 2018; and "DOD Growth in Artificial Intelligence: The Frontline of a New Age in Defense," Breaking Defense, 18 September 2019.
22. Christian H. Heller, "The Future Navy—Near-Term Applications of Artificial Intelligence," *Naval War College Review* 72, no. 4 (Autumn 2019): 78.
23. Michael E. Devine, *Intelligence Community Spending: Trends and Issues* (Washington, DC: Congressional Research Service, 2019), 8, 10–11.
24. Greg L. Zacharias, *Autonomous Horizons: The Way Forward* (Maxwell Air Force Base, AL: Air University Press, 2019), xxii–xxvii.
25. *Artificial Intelligence, China, Russia, and Global Order: Technological, Political, Global,*

and Creative Perspectives, ed. Nicholas D. Wright (Maxwell Air Force Base, AL: Air University Press, 2019), xvii–xviii.

26. *Artificial Intelligence*, xxiv–xxv.
27. Maj Lazaro Oliva Jr., USA, *Artificial Intelligence and the Future of Operational Art: A Monograph* (Fort Leavenworth, KS: School of Advanced Military Studies, Army Command and General Staff College, 2018), 5–6.
28. Oliva, *Artificial Intelligence and the Future of Operational Art*, 28–31.
29. *Army Directive 2018-18, Army Artificial Intelligence Task Force in Support of the Department of Defense Joint Artificial Intelligence Center* (Washington, DC: Department of Defense, 2 October 2018), 1, 5.
30. *Marine Corps Operating Concept: How an Expeditionary Force Operates in the 21st Century* (Washington, DC: Headquarters Marine Corps, 2016), i.
31. *Marine Corps Operating Concept*, 4, 6, 8.
32. *Marine Corps Operating Concept,* 9, 17, 19, 21–22.
33. Joshua E. Cavan, "Artificial Intelligence and the First to Fight: The Implications of Artificial Intelligence for Forward-Deployed and Early-Deploying Forces in Contingency Operation" (master's thesis, School of Advanced Warfighting, Marine Corps University, 2018), 2–3.
34. Cavan, "Artificial Intelligence and the First to Fight," 4, 6, 10–11; and Susan F. Bryant and Andrew Harrison, *Finding Ender: Exploring the Intersections of Creativity, Innovation, and Talent Management in the U.S. Armed Forces*, Strategic Perspectives no. 31 (Washington, DC: Institute for National Strategic Studies, National Defense University, 2019).
35. Jason C. Copeland, "Swarms of Flying iPhones: Using Limited Artificial Intelligence to Route Out an Adversary" (master's thesis, Marine Corps University, 2019), 3–4; and *Complex Terrain: Megacities and the Changing Character of Urban Operations*, ed. Benjamin M. Jensen, Henrik Breitenbauch, and Brandon Valeriano (Quantico, VA: Marine Corps University Press, 2019).
36. Copeland, "Swarms of Flying iPhones," 12–13, 15–16; and Joseph F. Sgro Jr., "A Blueprint to Exploiting Artificial Intelligence: How Machine Learning Is Transforming the Joint Targeting Process" (master's thesis, School of Advanced Warfighting, Marine Corps University, 2019), 5.
37. Sgro, "A Blueprint to Exploiting Artificial Intelligence," 5.
38. Sgro, "A Blueprint to Exploiting Artificial Intelligence," 9, 11–12, 15.
39. Jonas Stewart, "Strong Artificial Intelligence and National Security: Operational and National" (master's thesis, U.S. Naval War College, 2015), iii.
40. Heller, "The Future Navy," 95.
41. *The AIM Initiative: A Strategy for Augmenting Intelligence Using Machines* (Washington, DC: Office of the Director of National Intelligence, 2019), iv.
42. *The AIM Initiative*, v.
43. "Aladdin Video," Intelligence Advanced Research Projects Agency, accessed 3 December 2019.
44. "Better Extraction from Text Towards Enhanced Retrieval (BETTER)," Intelligence Advanced Research Projects Agency, accessed 3 December 2019.
45. "Crowdsourcing Evidence, Argumentation, Thinking and Evaluation (CREATE)," Intelligence Advanced Research Projects Agency, accessed 3 December 2019.
46. "Cyber-Attack Automated Unconventional Censor Environment (CAUSE)," Intelligence Advanced Research Projects Agency, accessed 3 September 2019,
47. "Deep Intermodal Video Analytics (DIVA)," Intelligence Advanced Research Projects Agency, accessed 3 December 2019.
48. "Forecasting Counterfactuals in Uncontrolled Settings (FOCUS)," Intelligence Advanced Research Products Agency, accessed 3 December 2019.
49. "Hybrid Forecasting Competition (HFC)," Intelligence Advanced Research Projects Agency, accessed 3 December 2019; and Caitlin Dawson, "USC ISI Leads IARPA Contract for Developing Hybrid Forecasting Systems," Viterbi School of Engineering, University of Southern California, 11 October 2017.

50. Christopher Ashley Ford, "Why China Technology-Transfer Threats Matter" (remarks, U.S. Naval Academy, Annapolis, MD, 24 October 2018).
51. "Key Topics-Office of the Science and Technology Advisor," U.S. Department of State, accessed 4 December 2019.
52. "Office of Emerging Security Challenges-Our Mission," U.S. Department of State, accessed 4 December 2019.
53. *Hearing before the Subcommittee on Emerging Threat and Capabilities of the Committee on Armed Services House of Representatives, China's Pursuit of Emerging and Exponential Technologies*, 115th Cong. (9 January 2018), 6, hereafter *China's Pursuit of Emerging and Exponential Technologies.*
54. *China's Pursuit of Emerging and Exponential Technologies*, 8–9.
55. "About," Congressional Artificial Intelligence Caucus, accessed 5 December 2019.
56. "An Open Letter Research Priorities for Robust and Beneficial Artificial Intelligence," Future of Life Institute, accessed 4 December 2019.
57. *Interim Report*, 22.
58. *Interim Report*, 10.
59. *Interim Report*, 29.
60. *Marine Corps Operating Concept*, 16.
61. Qiao Liang and Wang Xiangsui, *Unrestricted Warfare* (Beijing: PLA Literature and Arts Publishing House, 1999). Thomas Hobbes was an British political philosopher known for his "science of politics," which he believed demonstrated political truths with the certainty of a geometric proof.