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As the Future Operating Environment (FOE) remains uncertain, the MOC seeks to prepare for sustained operations in the contact layer within indirect conflicts. An avenue to achieve a theory of victory in the FOE is to concentrate resources on forms of AI and machine learning. Machine learning within the Joint Force will accelerate intelligence collections and provide a competitive advantage within the contact layer by analyzing information faster, enhancing intelligence collections, and optimizing information operation by linking in-depth learning analysis to the lethal and non-lethal targeting process. The human decision will remain, yet informed machine predictions can enable faster and more efficient decision-making.

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A Blueprint to Exploiting Artificial Intelligence:
How Machine Learning is Transforming the Joint Targeting Process

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Table of Contents

TITLE PAGE .... **I**
DISCLAIMER .... **II**
TABLE OF CONTENTS .... **III**
INTRODUCTION **1**
CURRENT MILITARY APPLICATIONS FOR MACHINE LEARNING **4**
RECOMMENDATION FOR MACHINE LEARNING WITHIN THE JOINT FORCE **9**
VIGNETTE: MACHINE LEARNING ISO MAGTF OPERATIONS **16**
CONCLUSION **18**
ENDNOTES **20**
BIBLIOGRAPHY **22**

Introduction

General Wesley Clark, the Supreme Allied Commander for NATO from 1997-2000, suggests a Cold War 2.0 theory on the premise that the old struggle never ended and that the United States remains in competition for world structure in a global conflict that remains ongoing today.[1] General Clark explains an uncertain security environment existing in recent conflicts witnessed in Syria, Libya, Yemen, Ukraine, and through competition short of conflict with China and Russia. This global Cold War 2.0 theory of future great power competition establishes a framework to describe the future operating environment.

The Cold War 2.0 framework, or underlying assumption, will highlight future conflicts residing within the contact layer - focusing on proxy wars, small wars, gray zone conflicts, and competition short of conflict. If General Clark's theory proves accurate, the United States military will most likely maintain a status quo of current force ratios and be required to innovate and adapt with the force structure it currently maintains. The National Defense Strategy (NDS) characterizes the leading strategic challenge facing the United States to be "the reemergence of great power competition and the erosion of the United States military exploitation of technological advantage."[2] Similar challenges are echoed within the Marine Corps Operating Concept (MOC), seeking a more lethal force within a twenty-first-century approach that integrates new technologies.[3] These new technologies, within the field of artificial intelligence (AI), are shaping evolving military capabilities under development today.

The Cold War 2.0 theory further indicates rationale behind the international relations theory of a stability-instability paradox which claims two nuclear states are less likely to engage in direct war, yet are more likely to engage in indirect conflicts or limited war. However, the paradox relies on a critical assumption that neither nation will assume mutually assured destruction as a consequence. As the Future Operating Environment (FOE) remains uncertain, the MOC seeks to prepare for sustained operations within the contact layer within indirect conflicts. An avenue to achieve a theory of victory in the FOE is to concentrate resources on forms of AI and machine learning. Machine learning within the Joint Force will accelerate intelligence collections and provide a competitive advantage within the contact layer by analyzing information faster, enhancing intelligence collections, and optimizing information operation by linking in-depth learning analysis to the lethal and non-lethal targeting process. The human decision will remain, yet informed machine predictions can enable faster and more efficient decision-making.

The United States military must explore new methods of maintaining advantages over pacing threats who are presently exploiting artificial intelligence as the modern battlefield continues to grow in complexity with the emergence of new technologies and capabilities.[4] Likewise, machine learning, as a form of artificial intelligence, can rapidly exploit and analyze enormous amounts of information faster than current methods. Increasing access to information has saturated the security environment by enabling people to see more, share more, and organize faster than ever before. The nuance of vast information sharing has allowed state and non-state actors to advance their objectives and effect global audiences which have lessened Americas' supremacy across the globe.[5]

To maintain a competitive advantage and make timely decisions, Commanders must have the tools available to monitor and respond, in any situation, to threats within all domains. Information, as a new warfighting function, strives to harness information as an instrument of national power[6]; furthermore, ongoing advancements of information technology, such as artificial intelligence, has, and will, significantly affect the future battlefield. As research and development evolve, the weaponization of artificial intelligence must be considered from all aspects. Consider, within the next two decades, people will have developed computers much more capable than today's computers; capable of analyzing massive amounts of information, developing predictive recommendations, and continue to evolve and learn from observing outcomes relative to their tasks. This will be possible through the further development of machine learning.

Current Military Applications for Machine Learning

Artificial intelligence is not a new phenomenon. For years, research institutes like Stanford University and MIT Lincoln Laboratories have been pioneering fundamental research for the use and application of machine learning. In modern terms, machine learning is not synonymous with artificial intelligence, yet machine learning is a form of artificial intelligence capable of automatically learning and improving from experience not specifically programmed. Machine learning has evolved from the 1965 creation of expert systems. Expert systems originated from supervised programs created to solve specific problems in a particular domain.[7] Today, basic machine learning is commonly a monitored process using statistics-based analysis of previous datasets, where unsupervised or semi-supervised machine learning draws inferences from data and can evolve in three conceptual ways: deep learning, neural networks, and through singularity.[8]

To better understand machine learning, it is essential to define its conceptual applications. Deep learning is a subset of machine learning which uses algorithms, a set of rules or formulas, to analyze involved amounts of information. Facebook, Google search engines, and self-driving cars are good examples of deep learning. A neural network can enhance deep learning and act as a framework of multiple neural nodes to compute layers of information. Lastly, singularity remains a theoretical concept today, but predicts that machine learning can eventually overtake human intelligence levels.[9]

As early as 1955, Nils Nilsson, "one of the founding researchers in the discipline of artificial intelligence, began narrow artificial intelligence applications of machine learning and rudimentary pattern recognition."[10] Limited by the technology of his time, it was not until the 1980s when computer technology catapulted artificial intelligence theories into practical applications.[11] Since then, companies like the Defense Advanced Research Project Agency (DARPA) and Google have produced artificial intelligence technologies for the Department of Defense (DoD) including biometric scanners, autonomous vehicles, manned-unmanned team platforms, swarming technologies, and most recently Project Maven.

Project Maven, a co-venture between Google and the Pentagon (also known as the Algorithmic Warfare Cross-Functional Team) strives to accelerate DoD's integration of big data and machine learning and will serve as the primary case study to support follow-on recommendations.

> "Project Maven uses machine learning algorithms to efficiently process massive amounts of video footage collected by aerial drones and identify objects which analyst had previously been evaluating."[12]

The algorithms developed by Google have incorporated machine learning into mass object recognition that on the surface provides a significant competitive advantage to military intelligence, surveillance, and reconnaissance (ISR) platforms.

Unfortunately, in 2018, Google has announced they will not be continuing the project due to the controversy surrounding the program and the employee's realization of Project Maven's potential ability to determine lethal drone strikes. However, the contract will most likely be sourced to other competitors.[13] Booz Allen Hamilton, for instance, recently received an $885 million Pentagon contract for development of artificial intelligence over the next five years. It is foreseeable that Booz Allen Hamilton will, in part, work with Project Maven in the future.[14] Additionally, in a 2018 press release, Booz Allen Hamilton stated that "its work will allow the Defense Department to rapidly employ artificial intelligence and deep neural networks for ISR operations."[15] With growing DoD interest in Project Maven, it is likely that other larger DoD companies like DARPA will soon play a key role as well.

DARPA alone has focused on eight primary military applications for artificial intelligence within their 'Third Wave' artificial intelligence campaigns: warfare platforms, cybersecurity, logistics and transportation, target recognition, battlefield healthcare, combat simulations, threat monitoring, and artificial intelligence/data information processing. Over the past several years, the DoD continues to fund research, test, and implement different artificial intelligence applications. On the forefront of the modern battlefield autonomous vehicles and swarming technologies have left the drawing boards and entered the operational forces, but what is DARPA's focus on machine learning?

Within the 'Third Wave' DARPA portfolio, two mainstay artificial intelligence efforts seek to develop contextual reasoning in artificial intelligence systems to improve human teaming and machine learning.[16] DARPA continues to incorporate artificial intelligence into target recognition programs like target recognition and adaptation in contested environments (TRACE), developed to enhance the accuracy of target recognition in complex combat environments.[17] TRACE "seeks to develop an accurate, real-time, low-power target recognition system that can be co-located with the radar to provide responsive long-range targeting for tactical airborne surveillance and strike applications."[18] Another DARPA machine learning portfolio includes the Radio Frequency Machine Learning Systems (RFMLS). The RFMLS operates within radio frequency spectrums and has established goals on a foundation of applying machine learning to modern data-driven technology.[19] These developments, in conjunction with programs like Project Maven, are ideal projects to accelerate how the United States military can operate within the future operating environment if machine learning continues to evolve at projected rates.

While most media reports and open source information point out the positive future of artificial intelligence and machine learning, some professionals are more pessimistic about the growing technology. Akshay Krishnamurthy, a leading Microsoft researcher, stated in his dissertation on unsupervised machine learning explains that although machine learning promises active learning and adaptive sensing, the theoretical ideas are slower to market than on an empirical front.[20] Akshay brings to light the variety of supervised machine learning and signals processing problems that currently exist without the aid of human corrections.[21] Other studies of the behavioral methods of balancing machine learning assert that "several aspects might influence the performance achieved by existing learning systems" and that common imbalances within data sets continue to segregate certain classes of information, thus alluding to bias within current technologies.[22]

The evolution of artificial intelligence is progressing at a rapid rate, and in the computer age, digital technology has progressively advanced the world as we know it. Investments in machine learning have the potential to open the door to cognitively exploiting the future operating environment. Since the 2007 DARPA Urban Challenge, autonomous vehicles became a focus for the DoD to begin investing in the future of artificial intelligence.[23] Since then, the *Washington Post* reported the 2017 DoD budget surpassed $7.4 billion on artificial intelligence-related projects and market analysts speculate that the market size of artificial intelligence within the military is expected to reach $18.82 billion by 2025.[24] For perspective, in 2018, President Trump signed the $717 billion annual National Defense Authorization Act (NDAA) which included $7.6 billion for F-35 acquisitions and $21.9 billion in the nuclear weapons program. Additionally, this year alone, the Washington Post reported a $2 billion budget for DARPA as part of the 'Third Wave' campaign aimed at developing machine learning[25] – both, the DoD and civilian sector, "are stepping up the technological arms race with China and an ideological clash with Silicon Valley."[26]

With a common understanding of current machine learning capabilities within the realm of artificial intelligence, one can begin to project the future of implementing artificial intelligence into current military concepts. Within the Joint Force, the targeting cycle remains a complex process stemming from collections requirements. These collection methods come in all forms: visual surveillance for multiple aerial platforms, spectrum and radio signatures, and information-based systems (big data) from computer-based networks. The big question is: how fast will artificial intelligence develop over the next two decades, and what military application will serve the DoD best for such costly investments?

Recommendation for Machine Learning within the Joint Force

Major combat operations will always remain a concern to the Joint Force and America's national security objectives, yet it is more likely that future conflicts will predominantly result in proxy wars, small wars, gray zone conflicts, and competition short of conflict. If a majority of conflicts are to remain in the contact layer, then smaller scaled units will be required to compete with regional threats on a smaller scale in modern, conventional, and irregular warfare will rely heavily on the targeting process. The 2018 Joint Concept of Integrated Campaigning (JCIC) identifies implications of recent, ongoing, and emerging strategic challenges such as China, Russia, Iran, and North Korea who employ coercive methods in the competitive space between peace and War. The JCIC seeks to eliminate the binary institutional conception of ‘peace or war’ in the future operating environment by enabling policy aims as integral elements of armed conflict to integrate military power to achieve sustainable political objectives.[27] The linkage lies within the Joint Forces lethal and non-lethal targeting process within the contact layer.

Using Project Maven, TRACE, and RFMLS as a starting point for continued research and development, the DoD should increase the budget for artificial intelligence and consider focusing heavily on machine learning applications to support military ISR and data collection for the Joint Force Commanders (JFC). To establish a way ahead and theory of victory for concentrating on machine learning, it is essential to understand the current targeting process found in Joint Doctrine to better understand the argument of weaponizing machine learning to support current concepts to reduce analysis timelines, increase available data feeds, and provide a more efficient method enabled by machine predictions.

Joint Publication 2-0 (Intelligence) and *Joint Publication 3-60* (Targeting) explains the joint targeting lifecycle as a six-phase interrelated process of intelligence planning and target development of lethal and nonlethal targets.[28] While target adjudication remains a human decision, the target nomination process can be accelerated by machine learning. The use of AI enabled targeting will help the United States achieve superiority in the contact layer by observing, analyzing, and predicting target nominations significantly faster than humans currently can.

Before exploring the application of artificial intelligence, it is important to review targeting in a joint construct. Fundamentally, the principles of targeting support the JFC's objectives through kinetic or non-kinetic and lethal or non-lethal fires. Throughout the targeting process, focus, effect-based, interdisciplinary, and systematic principles ground a common understanding of achieving deliberate and dynamic targets.

The six-phase targeting process begins with Phase 1: identifying objectives effects and the commander's guidance. Signals intelligence, or other intelligence collections, receive indications and warnings of enemy movement, posturing, or by observing other military activities. The information is analyzed by intelligence analysts who produce the joint information preparation of the operating environment (JIPOE) which provides the JFC and subordinate component commanders updated situational awareness. Phase 2 includes target development and prioritization. This is when analysts produce nodal analysis and begin developing an enemy target system analysis for targeteers to start target nomination for the joint integrated prioritized target list (JIPTL). Phase 3 consists of capability analysis, weaponeering, and allocation. In this step, forces recommend weapon systems to match the desired effects of JIPTL targets and allocate assets via the master air attack plan (MAAP). In Phase 4, the JFCs decision and force assignment enable the production of the air tasking order (ATO) and dissemination. Phase 5 includes mission planning for assigned tactical forces - intelligence collections continue, and

JIPOE updates continue to inform the ATO. Additionally, intelligence feeds continue to monitor and validate targets. Phase 6 concludes the process by conducting strikes and performing battle damage assessments (BDA).[29] With an understanding of the joint targeting process and machine learning capabilities, the following recommendations serve as an approach to incorporate machine learning. While machine learning can be integrated through all six phases, the majority of machine learning innovation predominately enhances Phase 5 and 6, and the dynamic targeting process most.

Joint Publication 3-60 provides a graphic depiction of the six-phases of targeting and their relationship between deliberate targeting and dynamic targeting. Dynamic targeting includes six additional steps to find, fix, track, target, engage, and assess (F2T2EA). These steps provide the most advantageous use of machine learning and will be explored in subsequent targeting recommendations.[30] In addition to the targeting process, intelligence collections must become a primary driver of target selection within the contact layer. Lieutenant Colonel Drew Cukor (USMC), the author of *Operate to Know*, argues to "fight and win decisively against a complex adaptive adversaries of the twenty-first century, knowing must become a primary operational activity."[31] He emphasizes the "development of a joint operating concept that establishes the foundation for an aggressive knowing capability consisting of active observation with pulsing and continuous diagnostic feedback to create a continuous receive-respond, collect-pulse connection between intelligence and operations to pry, test, understand the environment, and then take decisive action."[32] His conceptual introduction helps aid the implementation for furthering the necessity of machine learning within emerging technologies.

Recommendation for Phase 1-4: Leveraging artificial intelligence within the traditional collections and analysis process will not only expand the reach of information available in developing a shared understanding but, will also accelerate the collections process in a fraction of the time. These efforts would include collaboration with newly established Cyberspace Commands who possess the ability to exploit social networks which can be mapped through machine learning neural networks, and layer data fields to develop information on population centers. For example: IA algorithms on Facebook continuously monitor social media feeds to identify likes/dislikes or trending information to automatically market certain consumer products. Likewise, Offensive Cyberspace Operations (OCO) can use learning neural networks to identify trending data on persons of interests and insert links to gain access to certain networks as part of the targeting process.

In addition to cyber support, interorganizational coordination between the DoD and three-letter agencies (CIA, FBI, NSA, etc.) continue to strengthen Americas ability to assess a threat, but the United States military currently alone lacks the organic capability, capacity, and authorities to truly weaponize machine learning. However, technology in the future will be able to monitor, collect, and exploit adversary media outlets to enable the development of the JIPOE to increase intelligence collections. Machine learning will be able to offer systems-oriented collections considered in several layers: military systems, information systems, economic systems, and infrastructure systems. These capabilities will enable the future force the ability to develop non-lethal fire capabilities through information operations significantly faster and with less overhead personnel.

Target development requires prioritization concerning the taxonomy between targets and target systems. Currently, targeteers and intelligence analysts work in unison to recommend priority targets and establish intelligence needs to develop the integration of fires further. Machine learning will have the ability to automate the collections data analyzed in Phase 1 and be able to learn from human approval of specific targets and be able to evolve itself and enhance the prioritization, synchronization, and actions of the targeting process in phase 5.

Recommendation: After developing the JIPOE, JIPTL, and ATO – mission planning and force execution takes over. During execution, the establishment of a battle rhythm is established. The battle rhythm is designed to support the commander's decision-making cycle and routinely has a generic methodology to the order of boards, bureaus, cells, centers, and working groups (B2C2WGs). For example: after planning, collections requirements are established from the commander's critical information requirements and determine the baseline for collections assets. Within the battle rhythm, a series of B2C2WGs convene in a sequential order: a collection working group, followed by a targeting working group and boards, and an aviation working group followed by ATO production. These battle rhythm events typically are resource intensive and driven by human decisions or observations and analysis of collections material.

Within the collections working group, analysts have already assessed multiple collection reports and provide a summary of actions within the area of operations. These actions are often limited by the personnel and access available to synthesize massive amounts of collections reports, data feeds, or visual imagery. Project Maven is one of the first steps towards introducing supervised machine learning into drone ISR feeds to filter and monitor raw video and thus becomes the premier platform to increase the proficiency of intelligence summaries. Using neural networks, Project Maven-like programs will be able to filter and discern an array of information collected from ISR feeds, web-based reports, and other intelligence collections platforms or sensors to summarize data in fractions of the time. Simultaneously, mission dependent, it will have the ability to make predictive recommendations as to enemy dispositions, troop movement, and population responses on media outlets. These recommendations feed the targeting working groups who develop target nominations for decision by the commander within a targeting board. Machine learning will have the ability to calculate collateral damage assessments, inform target and target system selections, and provide weaponeering recommendations to the targeteers.

Lastly, the aviation working group plans for the allocation and apportionment of air assets to support targeting objectives. Once developed, the ATO is approved by the commander and completes the targeting process until the actual strike on a target commences or information operation begins. Machine learning can play a pivotal role in recommending allocation and apportionment once systems are aware of assets available. Again, improving the weaponeering timeline and developing of the ATO more efficiently. Once the ATO is executed, aircraft can perform assigned missions and can perform dynamic targeting. Within the find, fix, and track steps of dynamic targeting, machine learning for visual object recognition will accelerate the United States military's ability to identify and observe targets.

Within the first step of F2T2EA, evolving technologies can find targets, collect intelligence, and detect objects through multiple sensors. The machine learning algorithms will be able to focus those sensors in Step 2 and expedite locating and identifying new or known targets. Once detected, machine learning algorithms can provide prioritized intelligence, surveillance, and reconnaissance information to maintain and track objects in real time. Step 4 and 5 of dynamic targeting are assumed to become controversial topics as technology evolves. Currently, the human decision to engage a target remains the standard, but over time, machine learning can inform, predict, and calculate those decisions. However, to what end will humans allow technology to act independently or potentially engage a target without human approval?

Lastly, Step 6 of dynamic targeting and Phase 6 of deliberate targeting conclude with a combat assessment or battle damage assessment. To further understand how the implementation of machine learning will provide a position of advantage within the contact layer, the following vignette will serve as a conceptual scenario to demonstrate future utility on the battlefield.

Vignette - Machine Learning ISO MAGTF Operations

Consider a Marine Expeditionary Brigade (MEB) or Special Purpose MAGTF is deployed in a crisis response scenario by a Joint Force Commander to conduct a large-scale non-combatant evacuation (NEO) within an ongoing uprising or insurrection in a foreign country. During the NEO, the uprising transitions into an armed rebellion and the United States approves lethal force to quell the rebellion by targeting known rebel camps, key leaders, and defending host nation infrastructure with the area of operation. Within a cooperative framework, elements from the Cyber Command and JFC's Joint Information Operation Center (JIOC) continue to analyze raw closed-circuit television (CCTV) and ISR feeds through machine leaning processors to rapidly develop an intelligence summary of creditable threats within the MAGTF area of operation.

The intelligence section leverages joint enablers who begin populating automated personnel profiles directly from open source social media and news outlets to create a high-value target list and known assailant databases. Simultaneously, machine learning enhanced signals intelligence begins filtering keywords and phrases of possible enemy military activities and relays triangulated locations to ISR platforms which transmit data feeds to machine learning processors at the command element to quickly identify viable targets based off optical recognition of individuals and weapons systems. Linking the multi-domain machine learning feeds together will enable the predictive recommendation to the targeting board to begin target nomination. If immediately selected, the commander can approve lethal targeting or continue to collect information to begin counterinsurgency coordination with host nation forces.

The Doctrine, Organization, Training, Materiel, Leadership and Education, Personnel, Facilities, and Policy (DOTMLPF-P) process will need to keep pace with the evolution of these aforementioned technologies. The process must be flexible enough to promote the changing character of war to the Cognitive Age of warfare and be less constrained by current bureaucratic processes.

Conclusion

As the NDAA and Cold War 2.0 theory portrays, doing more with less remains a reality for DoD funding and predictions regarding the future operating environments. It remains more likely that future conflicts will predominantly result in proxy wars, small wars, gray zone conflicts, and competitions short of conflict within the contact layer, and that artificial intelligence is, and will, play a key role in keeping pace with other regional actors. Furthermore, United States research and development programs like Project Maven, TRACES, RFMLS, and others will provide a competitive advantage in the contact layer and within the realm of intelligence collections.

Following the trends of budgetary increases in technological evolution, it is expected that within 15-years, artificial intelligence will become an integral part of modern warfare through intelligence collections, ISR, and data-mining. The reality of machine learning technology will not change the way the United States collects information and intelligence – but it will enable faster and more efficient methods. Furthermore, the primary benefactor of these evolving technologies is likely to be the analysts and targeteers within the targeting process. Deliberate and dynamic targeting can both be significantly enhanced by the capabilities Project Maven may be capable of in the next two decades. Efficiencies in analysis and the ability to compute substantially more information at an accelerated rate will provide the JFC the ability to rapidly project power, assess, and target adversaries within the future operating environment.

As Project Maven continues over the next several years, it is reasonably foreseeable that machine learning algorithms will become a mainstay in ISR analyzation. Additionally, considering the incorporation of sensor platforms like TRACE, and spectrum sensors, like RFLMS, into aerial platforms, machine learning will propel the United States military capabilities to surpass peer adversaries. As technology continues to evolve, America's national security requires the continued investment in machine learning and endeavors to innovate and adapt to the future of artificial intelligence.

Endnotes:

[1] Clark, Wesley, Russia and Cold War 2.0, A Conversation with General Wesley Clark. Michael V. Haden Center for Intelligence, Policy, and International Security, March 13, 2018. https://www.youtube.com/watch?v=bXEsu9eGwFo

[2] National Security Strategy Section, 1041 Report on Highest-Priority Roles and Missions of the DoD and the Armed Forces Subtitle E, SEC. 1041.A.1.478.

[3] Headquarters US Marine Corps, *Marine Corps Operating Concept (MOC), How an Expeditionary Force Operates in the 21st Century*, Washington, DC: Headquarters US Marine Corps, September, 2016. 4.

[4] Ibid, 4.

[5] US Department of Defense, Joint Concept for Operating in the Information Environment (JCOIE), Washington DC: Office of the Chairman of the Joint Chiefs of Staff, 25 July 2018. vii.

[6] Ibid, vii.

[7] Expert Systems, COGITO: Expert System's Professional Services https://www.expertsystem.com/products/cogito-cognitive-technology/cogito-expert-system-professional-services/

[8] Expert Systems, Cognito: Human Intelligence for Cognitive Computing. https://www.expertsystem.com/products/cogito-cognitive-technology/.

[9] Ibid, 1.

[10] Nils J. Nilsson, *The Quest for Artificial Intelligence: A History of Ideas and Achievements*, Cambridge University Press, Stanford University, 2010 http://www.cambridge.org/us/0521122937, 73.

[11] Ibid, 433.

[12] Kate Conger, Google is Helping the Pentagon Build artificial intelligence for Drones, https://gizmodo.com/google-is-helping-the-pentagon-build-ai-for-drones-1823464533

[13] Ibid, 1.

[14] Fast Company, Pentagon's artificial intelligence programs get a huge boost in defense budget Aug 2018. https://www.fastcompany.com/90219751/pentagons-artificial-intelligence-programs-get-huge-boost-in-defense-budget.

[15] Press Release, Booz | Allen | Hamilton, U.S. Government and GSA FEDSIM Select Booz Allen to Help Apply AI, https://www.boozallen.com/e/media/press-release/booz-allen-selected-to-help-apply-artificial-intelligence.html.

[16] DARPA, "Our Research," https://www.darpa.mil/our-research.

[17] Martin Buehler, Karl Iagnemma, Sanjiv Sigh, *The DARPA Urban Challenge: Autonomous Vehicles in City Traffic* - Springer Tracts in Advanced Robotics, Volume 56 Library of Congress 2009, 3.

[18] Dr. John Gorman, Target Recognition and Adaptation in Contested Environments (TRACE). https://www.darpa.mil/program/trace.

[19] Paul Tilghman, Radio Frequency Machine Learning Systems (RFMLS), https://www.darpa.mil/program/radio-frequency-machine-learning-systems.

[20] Krishnamurthy, Akshay. *Interactive Algorithms for Unsupervised Machine Learning*. School of Computer Science, Carnegie Mellon University Pittsburgh, PA, June 2015. http://www.dtic.mil/dtic/tr/fulltext/u2/a624286.pdf.

[21] Ibid, 28.

[22] Gustavo E. A. P. A. Batista, A study of the behavior of several methods for balancing machine learning training data https://dl.acm.org/citation.cfm?id=1007735

[23] Martin Buehler, Karl Iagnemma, Sanjiv Sigh, *The DARPA Urban Challenge: Autonomous Vehicles in City Traffic* - Springer Tracts in Advanced Robotics, Volume 56 Library of Congress 2009, 3.

[24] Tejaswi Singh and Amit Gulhane, *8 Key Military Applications for Artificial Intelligence in 2018,* October 3, 2018 https://blog.marketresearch.com/8-key-military-applications-for-artificial-intelligence-in-2018.

[25] The Washington Post, Defense Depart Pledges Billions Towards artificial intelligence Research, Sept 2018. https://www.washingtonpost.com/technology/2018/09/07/defense-department-pledges-billions-toward-artificial-intelligence-research/?noredirect=on&utm_term=.80cf3faeccf9

[26] Ibid, 1.

[27] US Department of Defense, Joint Concept for Integrated Campaigning, Washington DC: Office of the Chairman of the Joint Chiefs of Staff, 16 March 2018, 2.

[28] US Department of Defense, Joint Publication 2-0, Joint Intelligence, Washington DC: Office of the Chairman of the Joint Chiefs of Staff, 22 Oct 2013, I-12.

[29] US Department of Defense, *Joint Publication 3-60*, *Joint Targeting*. Washington DC: Office of the Chairman of the Joint Chiefs of Staff, Oct 2018, x-xi.

[30] Ibid, I-7.

[31] Drew Komer, *Operate to Know: An Operational and Intelligence Design for the Operational Level of War*, National Defense University, Joint Staff College, 2014, i. https://apps.dtic.mil/dtic/tr/fulltext/u2/a600189.pdf

[32] Ibid, i.

Bibliography

Batista, Gustavo E. A. P. A. *A study of the behavior of several methods for balancing machine learning training data. 2004.* https://dl.acm.org/citation.cfm?id=1007735.

Berkowitz, Bruce D. "WARFARE IN THE INFORMATION AGE." *In Athena's Camp: Preparing for Conflict in the Information Age*, edited by Arquilla John and Ronfeldt David, by Toffler Alvin and Toffler Heidi. RAND Corporation, 1997. http://www.jstor.org.lomc.idm.oclc.org/stable/10.7249/mr880osd-rc.12.

Biały, Beata. "Social Media - From Social Exchange to Battlefield." *The Cyber Defense Review* 2, no. 2. 2017. http://www.jstor.org.lomc.idm.oclc.org/stable/26267344.

Brauer and Van Tuyll. *Castles, Battles, and Bombs: How Economics Explains Military History*. Chicago, University of Chicago Press.

Buehler, Martin, Iagnemma, and Sigh. *The DARPA Urban Challenge: Autonomous Vehicles in City Traffic* Springer Tracts in Advanced Robotics, Volume 56. Library of Congress, 2009.

Camm, Frank, Stuart E. Johnson, Martin C. Libicki, Gregory F. Treverton, Bruce W. Bennett, Nurith Berstein, David S.C. Chu, Paul K. Davis, Daniel B. Fox, James R. Hosek, David Mussington, Stuart H. Starr, and Harry J. Thie. "Adapting Best Commercial Practices to Defense." In *New Challenges, New Tools for Defense Decision-making*, 211-46. RAND Corporation, 2003. http://www.jstor.org.lomc.idm.oclc.org/stable/10.7249/mr1576rc.18.

Castells, Manuel. *Communication Power.* NY: Oxford University Press, 2013.

Civil Officer. *What is Machine learning, Deep learning, Neural Network, Expert system, and Singularity*. https://www.youtube.com/watch?v=7vJTYR8GTQU.

Cleveland, Jensen, Bryant, and David. *Military Strategy in the 21st Century: People, Connectivity, and Competition.* Cambria, 2018.

Conger, Kate. Google is Helping the Pentagon Build artificial intelligence for Drones. https://gizmodo.com/google-is-helping-the-pentagon-build-ai-for-drones-1823464533

Cross, Tyler. General Michael Hayden Discusses ‘Russia: Cold War 2.0’ with Former NATO SACEUR General Wesley Clark at Hayden Center Event, 5 Mar 2018. https://haydencenter.gmu.edu/news/general-michael-hayden-discusses-russia-cold-war-2.0-with-former-nato-saceur-general-wesley-clark-at-hayden-center-event-5-mar-2018

DARPA. “Our Research.” https://www.darpa.mil/our-research.

Expert Systems. COGITO: Expert System's Professional Services/ https://www.expertsystem.com/products/cogito-cognitive-technology/cogito-expert-system-professional-services/.

Expert Systems. Cognito: Human Intelligence for Cognitive Computing. https://www.expertsystem.com/products/cogito-cognitive-technology/.

Fast Company. Pentagon's artificial intelligence programs get a huge boost in defense budget, Aug 2018. https://www.fastcompany.com/90219751/pentagons-artificial-intelligence-programs-get-huge-boost-in-defense-budget.

Gorman, John, Ph.d. *Target Recognition and Adaptation in Contested Environments (TRACE).* https://www.darpa.mil/program/trace.

Hayden, Patrick M., David K. Woolrich, and Katherine D. Sobolewski. "Providing Cyber Situational Awareness on Defense Platform Networks." *The Cyber Defense Review* 2, no. 2. 2017. http://www.jstor.org.lomc.idm.oclc.org/stable/26267347.

Headquarters US Marine Corps. *Marine Corps Operating Concept (MOC). How an Expeditionary Force Operates in the 21st Century*. Washington, DC: Headquarters US Marine Corps, September, 2016.

Healy, John, Leland McInnes, and Colin Weir. "Bridging the Cyber-Analysis Gap: The Democratization of Data Science." *The Cyber Defense Review* 2, no. 1. 2017. http://www.jstor.org.lomc.idm.oclc.org/stable/26267404.

Komer, Drew. *Operate to Know: An Operational and Intelligence Design for the Operational Level of War.* National Defense University, Joint Staff College, 2014. https://apps.dtic.mil/dtic/tr/fulltext/u2/a600189.pdf

Krishnamurthy, Akshay. "Interactive Algorithms for Unsupervised Machine Learning." School of Computer Science, Carnegie Mellon University Pittsburgh, PA, June 2015. http://www.dtic.mil/dtic/tr/fulltext/u2/a624286.pdf.

Lee, Valisetty, Breuer, Kirk, Panneton, and Brown. "Current and Future Applications of Machine Learning for the US Army." US Army Research Laboratory, April 2018. https://www.arl.army.mil/arlreports/2018/ARL-TR-8345.pdf

Libicki, Martin C. "Cyber defense." In *Cyber deterrence and Cyberwar*. RAND Corporation, 2009. https://archive.org/stream/CyconBookCombineallpapers/CyCon_book_djvu.txt

Massie, Andrew. "Autonomy and the Future Force." *Strategic Studies Quarterly* 10, no. 2. 2016. http://www.jstor.org.lomc.idm.oclc.org/stable/26271508.

National Security Strategy Section. 1041 Report on Highest-Priority Roles and Missions of the DoD and the Armed Forces Subtitle E, SEC. 1041.A.1.478.

Nilsson, Nils J. *The Quest for Artificial Intelligence: A History of Ideas and Achievements*, Cambridge University Press, Stanford University, 2010 http://www.cambridge.org/us/0521122937.

Press Release, Booz | Allen | Hamilton, U.S. GOVERNMENT & GSA FEDSIM SELECT BOOZ ALLEN TO HELP APPLY ARTIFICIAL INTELLIGENCE. https://www.boozallen.com/e/media/press-release/booz-allen-selected-to-help-apply-artificial-intelligence.html.

Sgro, Jason. *There is Nothing Artificial About Intelligence*. October 2017. https://www.jasonsgro.com/blog/2017/10/26/there-is-nothing-artificial-about-intelligence

Singh, Tejaswi and Gulhane, Amit. *8 Key Military Applications for Artificial Intelligence in 2018.* October 3, 2018. https://blog.marketresearch.com/8-key-military-applications-for-artificial-intelligence-in-2018.

Tilghman, Paul. Radio Frequency Machine Learning Systems (RFMLS). https://www.darpa.mil/program/radio-frequency-machine-learning-systems.

The Washington Post, Defense Depart Pledges Billions Towards artificial intelligence Research, Sept 2018. https://www.washingtonpost.com/technology/2018/09/07/defense-department-pledges-billions-toward-artificial-intelligence-research/?noredirect=on&utm_term=.80cf3faeccf9

US Department of Defense. *Joint Concept for Operating in the Information Environment (JCOIE)*. Washington DC: Office of the Chairman of the Joint Chiefs of Staff, 25 July 2018.

US Department of Defense. *Joint Publication 2-0, Joint Intelligence*. Washington DC: Office of the Chairman of the Joint Chiefs of Staff, 22 Oct 2013.

US Department of Defense. *Joint Publication 3-60, Joint Targeting*. Washington DC: Office of the Chairman of the Joint Chiefs of Staff, Oct 2018.

Wu, Jionglin, Roy, and Stewart. "Prediction Modeling Using EHR Data: Challenges, Strategies, and a Comparison of Machine Learning Approaches." *Medical Care* 48, no. 6. 2010. http://www.jstor.org.lomc.idm.oclc.org/stable/20720782.