National Defence Défense nationale

Canadian Forces College

Collège des Forces Canadiennes

MILITARY APPLICATION OF ARTIFICIAL INTELLIGENCE (AI) BEFORE 2023

Major Andrew Bassingthwaighte

JCSP 45

Service Paper

Disclaimer

Opinions expressed remain those of the author and do not represent Department of National Defence or Canadian Forces policy. This paper may not be used without written permission.

PCEMI 45

Étude militaire

Avertissement

Les opinons exprimées n'engagent que leurs auteurs et ne reflètent aucunement des politiques du Ministère de la Défense nationale ou des Forces canadiennes. Ce papier ne peut être reproduit sans autorisation écrite

Canada

CANADIAN FORCES COLLEGE/COLLÈGE DES FORCES CANADIENNES
JCSP 45/PCEMI 45
15 OCT 2018

DS545 COMPONENT CAPABILITIES

MILITARY APPLICATION OF ARTIFICIAL INTELLIGENCE (AI) BEFORE 2023

By / Par le Major Andrew Bassingthwaighte

Word Count: 2,602 / 2,400 (+/-10%)

Nombre de mots : 2,760 (+/- 10%)

MILITARY APPLICATION OF ARTIFICIAL INTELLIGENCE (AI) BEFORE 2023

AIM

1. The aim of this paper is to suggest possible military uses of current civilian Artificial Intelligence (AI) technology to support the Australian Army in its current operating environment and prepare it for the future operating environment.

INTRODUCTION

2. The 2014 Future Land Warfare Report outlined fundamental changes to the operating environment which included a crowded, connected and collective battlespace.[1] It highlighted that although the nature of war is enduring the character of war is changing. A fundamental change is the unparalleled advances in technology and its use across multiple domains by states, sub states and non-state actors. The Chief of Army recently noted in *Accelerated Warfare* that "rapidly evolving, easily accessed technology increasingly offers asymmetric capabilities to both established powers as well as non-state actors and even individuals".[2]

3. Current research within the field of AI focus on unmanned autonomous systems guided by Internet of Things (IoT) and Machine Learning AI conducting swarm attacks en masse to overwhelm an enemy physically and intellectually. Whilst China has recently demonstrated the largest coordinated drone display, the application of this technology on the battlefield for the Australian Army is conceivably years away. Commander of the Australian Defence College, Major General Ryan, has suggested that the Australian Army is not ready for AI and there needs to be a concerted effort to transition to AI awareness before the full capability can be a reality.[3] This paper will investigate AI and its current use within the civilian sector. It will then identify its possible use in a military context now and the associated risks and limitations.

DISCUSSION

AI and Machine Learning

4. 'AI refers to any device that can perceive its environment and take action to maximise its chance of successfully achieving its goal'.[4] In basic terms, a system that is capable of human like cognitive reasoning is considered to have artificial intelligence. Whilst AI has been around since the 1950s, its development has been relatively slow with a recent surge in the 21st century. The main misconception with AI is that it will become self-aware and destroy the human race. AI covers a scalable range of different ideas of which the peak is Artificial General Intelligence (AGI). AGI refers to the agile and adaptive thinking across all functions that remains distinctly

---

[1] Modernisation and Strategic Planning Division - Australian Army Headquarters, "Future Land Warfare Report 2014," 2014, www.army.gov.au/Our-future.

[2] Rick (LTGEN) Burr, "Accelerated Warfare - Futures Statement for an Army in Motion," *The Australian Army*, 2018.

[3] Mick (Aust Army) Ryan, "Building a Brilliant ADF," Australian Strategic Policy Institute - The Strategist, 2018, https://www.aspistrategist.org.au/author/mick-ryan/.

[4] David Poole; Alan Mackworth; Randy Goebel, *Computational Intelligence: A Logical Approach*. New York: Oxford University Press, 1998.

human. Tractable or narrow AI systems work on restricted lines with a singular purpose. An example of this level of AI which is being prolifically used in the civilian sector is Machine Learning.

5. Machine Learning uses algorithms to analyse selected data to learn and make predictions. It speaks to the core idea of AI; to handover repetitive and mundane tasks. Machine Learning has made enormous progress in the 21st century due to a leap in computing power and the presence of vast amounts of data. Once the algorithm is designed, Machine Learning processes the data with a focus and speed beyond human capabilities. Machine Learning learns in many ways, including:[5]

a. Supervised learning. The computer is given example inputs and desired outputs and learns the rule between the inputs and outputs to achieve its goal;

b. Semi-supervise learning. The computer is given an incomplete set of rules and must devise a structure with which to achieve its goal; and

c. Unsupervised learning. The computer is given no labels and therefore must design its own methods to learn and achieve its goal.

6. Machine Learning is commonly used to make predictions from numerous data categories, such as:

a. Image Analysis. AI is able to analyse huge numbers of different images in detail and establish commonalities which enable it to identify key factors and identify those in other images. This extends to text in documents;

b. Signal Analysis. AI is able to identify the presence of signals across the electromagnetic spectrum and their effect on the environment. This enables it to not only categorise signals but also potentially map the environment;

c. Sound Analysis. AI is able to analyse voice and other sounds to identify commonalities in language and other sounds; and

d. System Analysis. AI is able to process select informational data to identify inefficiencies, anomalies and points of failure.

Employment in the Civilian sector

7. AI continues to be developed in most universities and IT companies around the world. It is not just the IT giants like Google and Apple that are using it. Companies across the energy, financial, mining, agricultural, automotive, health and even retail sectors are actively incorporating AI to analyse and design internal systems, and to alleviate their employees of time consuming mundane and repetitive tasks. Notable examples relevant to the Army are:

[5] David Poole; Alan Mackworth; Randy Goebel, *Computational Intelligence: A Logical Approach*. New York: Oxford University Press, 1998

a. ‘Inversion’ is a Chinese system that assists radiographers in analysing 1.4 billion CT scans each year, thereby reducing human fatigue and errors;[6]

b. Google’s Global Fishery Watch is a system that analyses satellite imagery and through Machine Learning ascertain a fishing vessel’s intent and therefore identifies likely illegal fishing operations;[7]

c. Dina Katabi from MIT has developed a system that aims to monitor seriously ill patients at home.[8] Through analysing wireless signals in a room in their home, the system identifies and monitors a patient’s vital signs for advanced warning of deterioration of their health. This system works by monitoring the patient’s effect on existing signals in the room, without any worn hardware or devices;

d. The Google Translate application allows a user to translate up to 32 different languages instantly during a live conversation;

e. McPAD is a networked based cyber defence system that uses Machine Learning to detect anomalies and intrusions;[9] and

f. Volvo is using AI to monitor a vehicles performance across hundreds of sensors and predict the failure of parts and when the car should be serviced.[10]

Military Application

8. Major General Ryan outlined in a paper that militaries in the future would “contain thousands or even tens of thousands of unmanned and robotic systems”[11]. He also identified it was imperative that Defence move beyond limited experimentation to broader use of AI. In order to introduce AI in a more workable timeline a humble approach may be required. This would focus on retrofitting existing technology to perform the same role but for the military. The civilian sector has spent decades and millions of dollars in developing AI for their own use, while the defence sector lags behind. At the same time, they have established the foundation of structures and learning paradigms which can be the ground work for military application with minimal transitional costs from the civilian sector to the military sector.

9. Instead of highlighting uses in line with Defence’s strategic objectives or the Army’s operational priorities, this paper will use some combat functions to provide a broad and simple framework with which AI can be operationalised.

---

[6] Bernard Marr, “27 Incredible Examples Of AI And Machine Learning In Practice,” Forbes, 2018, https://www.forbes.com/sites/bernardmarr/2018/04/30/27-incredible-examples-of-ai-and-machine-learning-in-practice/2/#4348a6424a36.
[7] Marr.
[8] Diana Katabi. Speech, A new way to monitor vital signs, TED, Vancouver, April 2018.
[9] Marr.
[10] Marr.
[11] Ryan, “Building a Brilliant ADF.”

a. **Know**. The focus of the 'Know' function is to understand the battlespace. This would support rapidly understanding situations and building operating pictures on expeditionary operations as well as defending Australia's sovereignty at home.

(1) Through the application of Machine Learning, large amounts of imagery and signal data can be analysed and categorised to support the intelligence preparation of the battlespace. A key issue in the Australian Intelligence community and the FVEY community, for several years has been the challenge of 'big data.' The creation of vast amounts of inputs, data and information still needs to be analyzed by an individual. This creates a bottleneck of sorts; which humans cannot overcome due to the sheer amount of information that needs to be analyzed.

(2) In June 2017 the US Department of Defence announced they would have AI in the field to process vast amounts of still and moving imagery. This was headed by an Algorithmic Warfare Cross-Functional Team as part of Project Maven.[12]

(3) Through the use of the same technology used in driverless cars, surveillance can be done through autonomous networks of low-cost motion sensors and cameras, all supported by minimal military presence. This would allow for quick identification of Persons or Vehicles of Interest within an area of surveillance normally limited by the reach and availability of ISR assets. It would benefit expeditionary operations and domestic security of the northern coast line of Australia.

b. **Strike.** The focus of this function is to apply precise kinetic or non-kinetic effects.

(1) With human oversight, Machine Learning can be utilised in the targeting process to dynamically identify and prioritise targeting of high pay off or high value targets.

c. **Shield.** Shielding refers to the protection of personnel, national infrastructure and territory. It extends from operations overseas to insider negligence and threats domestically across the multiple domains.

(1) Cyber defence systems like McPAD can be utilised on domestic and deployed information, communication and technology ICT to identify anomalies in the cyberspace and detect intrusions of hostiles, whether they be state supported or non-state actors.

(2) Google's Global Fishery Watch is an example of a system that can support the sovereignty of the Australia's border region in the identification of illegal fishing and movement from the Indonesian archipelago. This can be done with a

[12] Cheryl Pellerin, "Project Maven to Deploy Computer Algorithms to War Zone by Year's End," *DoD News*, no. August 2016 (2017), https://www.defense.gov/News/Article/Article/1254719/project-maven-to-deploy-computer-algorithms-to-war-zone-by-years-end/.

minimal footprint from a centralised location to support a response from either the Navy, Army or local law enforcement.

(3) AI systems utilised in the financial sector would identify patterns of resource usage, improve efficiency and detect fraud by Defence members and contractors.

d. **Sustain.** The Sustain function refers to support provided to military personnel, infrastructure and processes by Army personnel and civilian contractors. Whilst this function is the most similar to the civilian sector as any, it is vital to military operations.

(1) The mining sector utilises systems that would be equally as applicable to Defence for the efficient management of logistic supply chains and improve the use of resources and workplace health and safety.

(2) Volvo's example provides great promise in predicting and monitoring vehicle serviceability in new vehicle fleets. It also is useful in mapping key issues in older fleets to reach the limit of the life of the type of vehicle.

(3) Contract management in Defence is an area that AI can be used to maintain accuracy and organise, manage and update. It is estimated large firms can lose between 5% and 40% of value on a deal through poor contract management of large numbers of contracts across branches.[13] The same large legal firms turn to AI to increase the efficiency and accuracy of their contracts to create savings in the budget.

e. **Adapt.** Adaptation is central to operating within the enduring nature of war. It is fundamental for a medium sized military to be agile and respond quickly to a change in any situation.

(1) Google's Translate would reduce the burden on language training and translators in operating with civilian populations and host nations on operations. It would alleviate pressure on the system to develop a large number of trained personnel.

Limitations and risks of AI

10. As AI is at the cutting edge of development in the civilian sector, there are limitations which will affect it achieving full operational capability in the Australian Army. The use of existing technology reduces risk by building on capabilities already developed and shares the burden with the civilian sector. However, there are specific limitations and risks for military application.

[13] Beverly Rich, "How AI Is Changing Sales," *Harvard Business Review*, 2018, https://hbr.org/2018/07/how-ai-is-changing-sales.

a. There is a limitation with some analytical methods in the Army being based on qualitative interpretive data. The output and analysis of Machine Learning are only as good as the data that is inputted. There is a requirement to ensure performance metrics are clear and mathematically based as possible to ensure that the analytical output is accurate and applicable to the situation.[14]

b. The military is concerned with both the output and the means of achieving it. There are limits in our understanding of how a prediction or design was built from the data. If how the output was achieved is not understood, or the source of information is unknown, there is the potential for an ethical dilemma with how to use that information. For example, if the AI's analysis of surveillance product is not understood, how can the Army determine hostile intent and use the intelligence in the targeting process with the agreed ROE? Whilst this isn't the same as an autonomous AI system deciding on the use of lethal force, it can create issues with how the human decision maker uses that information to guide their actions.[15]

c. There are issues with integration of AI military into military equipment and systems. As Colonel Cukor of Project Maven stated, "there is no black box that delivers AI to the government needs… key elements have to be put together".[16] It requires analysts to 'clean up the data' to train the AI system, data-labeling companies and, as with Project Maven, a selection process for multiple coding contracts. The US government authorised rapid acquisition with a view to complete the initial work in 36 months.[17] It is an enormous undertaking to build the system and then integrate it into existing systems and equipment.

d. The system requirements for AI are a limitation for military use. The requirement for high computing performance, large network capacity and power requirements. If the system is to be utilised on operations and remote locations of Australia, investment in higher performance ICT would be fundamental to successfully incorporating AI in direct support of forward echelons.

e. There is a long-term risk that the impact of current developing existing and limited systems for military application will divert resources which are destined for other projects, namely higher-level autonomous AI. The risk is balanced against the advantage that a graduated approach to AI creates awareness in the Army.

f. Finally, arguably AI is more susceptible to deception or outside influence from hostile actors. Whilst this is something to consider in design, the limited use of AI and a compartmentalised approach would limit an ever-present risk whilst producing results. The risk of interference is ever present in the modern day. It would be a greater risk to yield and have limited to no capability.

---

[14] Michael Lee et al., "Current and Future Applications of Machine Learning for the US Army," 2018, http://www.dtic.mil/dtic/tr/fulltext/u2/1050263.pdf.
[15] Lee et al.
[16] Pellerin, "Project Maven to Deploy Computer Algorithms to War Zone by Year's End."
[17] Pellerin.

CONCLUSION

11. AI is used in everyday life by every person. Whilst this paper has examined the use of AI in the military in the near term by adopting existing civilian technology, there are other factors which were not considered. The vast scale of the project to prepare the Army for AI undoubtedly has numerous facets; the equipment required to achieve the effects outlined above, the funding to see the project through and civilian partners who are willing to work with the military.

12. The CDF, General Campbell highlighted, it is important that we maintain Australia's advantage as a relatively small military through engagement, maintenance of a technological edge and development an intellectual edge.[18] Commander Forces Command, Major General McLachlan expressed a view similar to Major General Ryan when he spoke of increased focus on AI in the professional military education program.[19] As the desired state of autonomous AI is beyond the immediate grasp of the Australian Army, there is a capability gap and an intellectual leap required to use AI in a world where it will undoubtedly provide the edge for any military in the future operating environment.

13. Whilst the risks and limitations are there, they are present for all users of AI, including other militaries. The use of existing technology reduces the likelihood and the impact of force modernising the ADF. The Australian Army is looking to a future where the use of AI will make it a multi-domain leader in an increasingly complex future. The use of AI systems tried and tested by the civilian sector provides the Army with a near immediate capability and builds the foundations for the future. As the Chief of Army stated in *Accelerated Warfare*, "we must pull the future towards us rather than wait for it".[20]

---

[18] Angus Campbell. Speech, Preparing for the Indo-Pacific Century: Challenges for the Australian Army, RUSI, Canberra, 8 December 2017.
[19] Fergus (MGEN) Mclachlan, "Webinar – Major General McLachlan AM 2018 Address," 2018, https://www.cove.org.au.
[20] Burr, "Accelerated Warfare - Futures Statement for an Army in Motion."

BIBLIOGRAPHY

Barno, David, and Nora Bensahel. “Governance in the Fourth Industrial Revolution.” War on the Rocks, 2018. https://warontherocks.com/2018/06/war-in-the-fourth-industrial-revolution/.

Bienvenue, Emily, Zac Rogers, and Sian Troath. “Cognitive Warfare : The Fight We’ve Got.” The Cove, 2018. https://www.cove.org.au.

Birch, Solomon. “What Does Open AI Mean for the Military.” The Cove, 2018. https://www.cove.org.au.

Burr, Rick (LTGEN). “Accelerated Warfare - Futures Statement for an Army in Motion.” *The Australian Army*, 2018.

Butler-jones, Evan. “AI and Machine Learning : A New Kind of Military Intelligence.” *Line of Defence*. Auckland, 2017.

Button, Robert. “Artificial Intelligence and the Military.” The RAND Blog, 2017. https://www.rand.org/blog/2017/09/artificial-intelligence-and-the-military.html.

Combined Arms Training and Development Centre. “Land Warfare Doctrine 1: The Fundamentals of Land Power,” 2014, 1–60.

Follow, Carlos E Perez. “**The US Military Needs to Urgently Rethink Its Deep Learning Strategy,” no. April (2017).

Campbell, Angus. Speech, Preparing for the Indo-Pacific Century: Challenges for the Australian Army, RUSI, Canberra, 8 December 2017.

Gilbert, Brendan (Aust. Army). “Soldier as a System Part 3 : Systems Integration.” The Cove, 2018. https://www.cove.org.au.

Gilchrist, Mark. “Emergent Technology, Military Advantage, and the Character of Future War.” The Strategy Bridge, 2018. https://thestrategybridge.org/the-bridge/2018/7/26/emergent-technology-military-advantage-and-the-character-of-future-war.

Gupta, Deepak Kumar. “Military Applications of Artificial Intelligence.” Indian Defence Review, 2018. http://www.indiandefencereview.com/military-applications-of-artificial-intelligence/.

Horowitz, Michael C. “Artificial Intelligence, International Competition, and the Balance of Power.” *Texas National Security Review* 1, no. 3 (2018). https://doi.org/10.1093/qje/qjr035.

Katabi, Diana. Speech, A new way to monitor vital signs, TED, Vancouver, April 2018.

Lee, Michael, Ramakrishna Valisetty, Alexander Breuer, Kelly Kirk, Brian Panneton, and Scott Brown. “Current and Future Applications of Machine Learning for the US Army,” 2018. http://www.dtic.mil/dtic/tr/fulltext/u2/1050263.pdf.

Marr, Bernard. “27 Incredible Examples of AI and Machine Learning In Practice.” Forbes, 2018. https://www.forbes.com/sites/bernardmarr/2018/04/30/27-incredible-examples-of-ai-and-machine-learning-in-practice/2/#4348a6424a36.

McLachlan, Fergus (MGEN). “Webinar – Major General McLachlan AM 2018 Address,” 2018. https://www.cove.org.au.

Modernisation and Strategic Planning Division - Australian Army Headquarters. “Future Land Warfare Report 2014,” 2014. www.army.gov.au/Our-future.

Pellerin, Cheryl. “Project Maven to Deploy Computer Algorithms to War Zone by Year’s End.” *DoD News*, no. August 2016 (2017). https://www.defense.gov/News/Article/Article/1254719/project-maven-to-deploy-computer-algorithms-to-war-zone-by-years-end/.

Poole, David; Mackworth, Alan; Goebel, Randy. *Computational Intelligence: A Logical Approach*. New York: Oxford University Press, 1998.

Rich, Beverly. “How AI Is Changing Sales.” *Harvard Business Review*, 2018. https://hbr.org/2018/07/how-ai-is-changing-sales.

Rowlands, Greg (Aust Army). “The Internet of Military Things & Machine Intelligence : A Winning Edge or Security Nightmare?”, 1944. https://www.army.gov.au/our-future/blog/emerging-threats-and-opportunities/the-internet-of-military-things-machine.

Ryan, Mick (Aust Army). “Building a Brilliant ADF.” Australian Strategic Policy Institute - The Strategist, 2018. https://www.aspistrategist.org.au/author/mick-ryan/.

Skinner, Dan (Aust Army). “Physiological Data Collection.” The Cove, 2018. https://www.cove.org.au.