Winning with Artificial Intelligence

by Chief Warrant Officer 4 Timothy Zilliox

Introduction

The 2019 Army Modernization Strategy states that "future warfare will only expand in geographic scale, domains, and types of actors, while decision cycles and reaction times compress."[1] To address future warfare, our Army must continue to develop ways to leverage emerging technological advancements in computing to understand, visualize, decide, and direct faster than our competitors. China and Russia are already investing heavily in artificial intelligence. Rapid development and integration of this technology are critical to enabling commanders to counter adversaries in the information environment as effectively as in the physical domains and to win in the cognitive space.[2] We must outpace our adversaries if we are to win in a complex world.

Artificial Intelligence

The *Oxford English Dictionary* defines artificial intelligence as "the theory and development of computer systems able to perform tasks normally requiring human intelligence, such as visual perception, speech recognition, decision-making, and translation between languages."[3]

Playing Smarter Baseball

Baseball has always been a game of numbers. Since its inception, managers, coaches, and fans have paid close attention to a player's "stats" and debated which players their team should hire. However, in 2002, Oakland A's general manager Billy Beane and Harvard economics graduate Paul DePodesta turned the baseball world upside down when they discovered that using new approaches to advanced statistical analysis enabled them to staff their baseball team with undervalued players, allowing them to acquire quality players while staying within their team's budget. Their approach proved successful, and Major League Baseball now widely uses it. It became the subject of the movie *Moneyball*, starring Brad Pitt. This marked the beginning of a new era of advanced analytics in baseball.

The next significant milestone in the evolution of analytics in baseball came in 2014, when Major League Baseball turned to Amazon Web Services to incorporate artificial intelligence into baseball analytics. With the introduction of Amazon's Statcast, the game is now more precise than ever. For example, managers have access to spray charts, which depict in graphical format where a batter is most likely to hit the ball, allowing the defensive players to shift accordingly to increase their chances of getting the hitter out. In 2018, Amazon introduced an interface that uses a combination of statistical analysis; sensors, including radar and cameras, positioned at multiple points around the baseball stadium; and situational analysis of unique factors in a game to predict the likelihood that a baserunner will successfully steal a base. Amazon's Statcast does this by crunching a variety of data points. These include a baserunner's known sprint speed, the distance of his lead off from the base (as collected by the in-stadium cameras), his stolen base success rate, the time it takes the pitcher to release the ball, the time it takes the ball to travel to the catcher, and the catcher's success rate throwing out baserunners.[4]

All of this in-game data is analyzed against a database of more than 1.5 million plays collected over the past 2 years, incorporating machine learning into the process. The system processes the data in a matter of seconds and displays it for managers and fans in real time. Amazon's next goal is to enable its interface to predict which pitches a pitcher will throw. The system will do this by analyzing the pitcher, the batter, the catcher, the in-game situation, and a database of plays given a similar game situation.[5]

The use of computer-accelerated, real-time, in-game analysis reveals minute details of players' behavior during a game. It also allows coaches to determine the best matchups, decide which throws by a pitcher are most likely to result in a hit, know which hitters are more likely to get on

base in particular situations, and make informed decisions about which players to use in given situations.[6] Imagine the advantage an army would have if it had computer-accelerated, real-time, in-conflict analysis to reveal minute details of the adversary's force to enable commanders to determine the best courses of action faster than the adversary.

U.S. Army photo illustration by Peggy Frierson

It's time for robots to replace Soldiers for certain specialized tasks involving "dull, dirty or dangerous work and to reduce their cognitive load," said retired MG Cedric T. Wins, former Commander of Combat Capabilities Development Command.

The Department of Defense Needs to Play Smarter Too

Like Billy Beane's Oakland A's, the Department of Defense (DoD) is developing new ways to analyze data to gain a competitive advantage. In pursuit of its quest to incorporate artificial intelligence into military applications, the DoD initiated a joint venture with Google in April 2017 dubbed Project Maven. The goal of the program was to develop ways the military could use artificial intelligence to enhance its defense capabilities. The program's pilot venture was to develop algorithms to interpret aerial video images from conflict zones, reducing the time it takes analysts to review thousands of hours of video to find information of intelligence value. However, because of protests from many of Google's employees, who objected to their company using its technology for military applications, the company announced its withdrawal from the program in 2018.[7]

Google's decision did little to slow the development of artificial intelligence in the military. In June 2018, the DoD created the Joint Artificial Intelligence Center to accelerate the delivery of artificial intelligence-enabled capabilities, synchronize the DoD's artificial intelligence activities, and expand joint force advantages.[8] In 2018, the Army issued Army Directive 2018-18, *Army Artificial Intelligence Task Force in Support of the Department of Defense Joint Artificial Intelligence Center*.[9] Funding for Project Maven, officially called the Algorithmic Warfare Cross-Functional Team, was $131 million in 2018.[10] In 2019, the Army awarded an $800 million contract over 10 years to develop intelligence data analytics and prediction software for inclusion in the Distributed Common Ground System-Army.[11]

Artificial Intelligence in Intelligence Analysis

Information overload is a significant challenge that intelligence analysts face today. There simply are not enough trained analysts to review the mass of collected information, analyze it, synthesize it, and develop it to provide situational awareness to decision makers. The potential use of artificial intelligence to streamline this process is significant. Computers using advanced algorithms can sort through tremendous volumes of data rapidly, highlighting patterns and anomalies that trained intelligence analysts can further scrutinize. This allows analysts to focus more of their time synthesizing relevant data by applying their expertise and knowledge of the mission to build situational understanding.

Imagery analysis provides a good example of how artificial intelligence can streamline analysis. An imagery analyst would spend countless hours watching video footage or reviewing thousands of images looking for particular objects. A computer, programmed to identify the same object, could perform this task in seconds, freeing the human analyst to perform tasks that require more critical thought. In other words, leveraging artificial intelligence allows analysts to perform more in-depth analysis and save time on sorting the data itself. Suppose, for example, a commander wanted to know if an adversary intended to deploy his long-range fires assets and if he intended to conduct an attack. The analyst knows what the adversary's vehicles look like but does not know where they are located, where the adversary will deploy them, or when he will move them. To answer the

commander's requirement, the analyst would spend countless hours reviewing imagery looking for the adversary's vehicles. However, an artificial intelligence-enabled computer could monitor numerous video feeds in real time and alert the analyst when the vehicles are identified. The analyst could then apply critical thinking and experience to discern if the vehicles are moving to a position to conduct an attack or are withdrawing from the battlespace.

The U.S. Air Force is going a step further, developing machine learning to assist its analysts. It is incorporating a tool called Artificial Intelligence Discovery and Exploitation, also known as AIDE, into its version of the Distributed Common Ground System. The system sorts through "oceans of data" seeking information it deems most relevant to its user.[12] It determines what information is most relevant from factors such as the user's search history and requests for information. Daniel Goddard, Director of the Information Directorate at the Air Force Research Laboratory, stated, "We believe advances in computational intelligence will help shift the burden of search, annotation and aggregation and analysis from airmen to artificial intelligence. AIDE reduces the time to discover potentially relevant information in air, space and cyberspace for the analyst, freeing up time for them to do what they do best—analysis."[13] To illustrate his point, Goddard notes that every day about 3.6 exabytes of new information are created globally. In one minute on the internet, YouTube receives a few hundred hours of video and people post about 450,000 new tweets. In that same time, the Air Force exploits, processes, and analyzes thousands of gigabytes of data according to Goddard.[14]

Biases in Artificial Intelligence

It is important to note that although the potential of artificial intelligence is tremendous, it does have limitations. Just as the potential for biases exists with human analysts, so it exists in artificial intelligence. MAJ Lee Hayward, an Intelligence Corps officer in the Australian Army, notes that "[artificial intelligence] AI systems are only as good as the input data, and outcomes can be corrupted by 'bad data' that contains implicit…biases."[15]

Many people mistakenly believe that artificial intelligence is objective and rational because a machine makes the decisions. The reality is that a machine performs artificial intelligence using the algorithms in its programming. People program those algorithms. Therefore, the potential exists for the programmer to pass his biases on to the machine through the programming code, thereby influencing how the computer considers and evaluates the data.

Likewise, machine learning is a process that inherently can be flawed because of the biases of the original programmer or the user. In machine learning, the computer "learns" based on the behaviors of the user, considering such things as search history and what the user does with the data. The computer uses these things to "predict" what the user will desire in the future and to return results it thinks the user would require. Thus, it is easy to see how the computer's "prediction" could be skewed given that it is based on a human user's interaction with the system, rather than on objective or rational criteria.

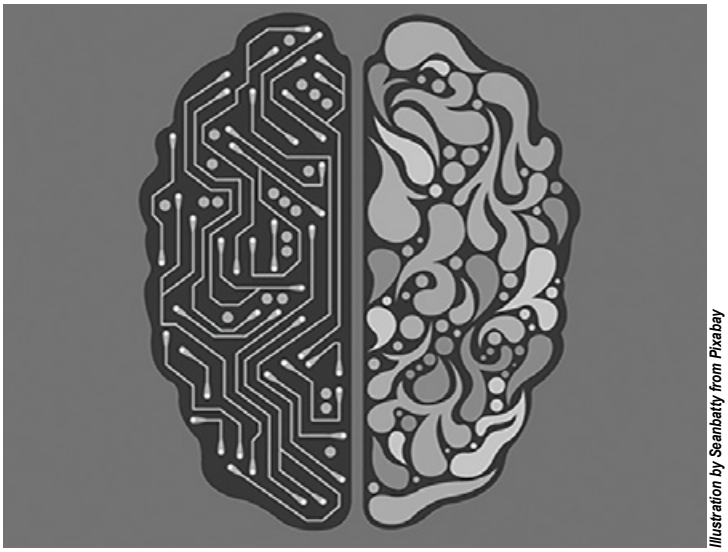

Illustration by Seanbatty from Pixabay

Algorithmic antibias training is harder than it seems. However, according to Olga Russakovsky, assistant professor at Princeton, "Debiasing humans is harder than debiasing [artificial intelligence] AI systems."[16]

It makes sense that biases in artificial intelligence could be mitigated through the careful application of critical thought and objective reasoning during the programming process. However, military end users of automation systems are not involved in the development process of their systems and often do not interact with those involved in programming the software. Therefore, end users are unaware of the original programmers' biases, making mitigation difficult. As MAJ Hayward states, "there is an opacity in machine learning, making it difficult to identify which features of the data-input the machine used to make a particular decision, and therefore where in the code the bias existed."[17]

Intuition versus Artificial Intelligence

As noted earlier, advanced analytics and artificial intelligence are widely used across Major League Baseball. However, many baseball managers still make decisions from a "gut feeling" in certain situations. For example, in the ninth inning of a playoff game in 2012, New York Yankees manager Joe Girardi decided to bench his star third baseman Alex Rodriguez, one of baseball's greatest hitters. He replaced him with aging pinch-hitter Raúl Ibañez. Ibañez hit a home run in that inning and another in the twelfth inning to win the game. When asked later about his decision,

Girardi said, "I just had a gut feeling."[18] David Bell, manager of the Cincinnati Reds, plans his lineups several days in advance, primarily relying on data analyzed by a computer that "predicts" the best matchups versus his opponents. However, occasionally he will alter the lineups because of his intuition, stating, "There's nothing wrong with that, taking a chance, and mixing things up. Over the course of a long period of time, it is great to have the numbers and that objective information as more of a guide."[19]

Carl von Clausewitz, in his seminal publication *On War*, acknowledged the importance of the commander's intuition, something he called *coup d'oeil* (this French term literally means "stroke of [the] eye"). He based his analysis of the importance of coup d'oeil on Napoleon's keen sense for identifying opportunities to win battles.[20] Professor William Duggan, Associate Professor of Management at Columbia Business School, notes that research on expert intuition supports the notion that in urgent situations people make decisions by combining analysis of past experience with a flash of insight.[21] In his book *Coup d'Oeil: Strategic Intuition in Army Planning*, Duggan asserts that Army doctrine reflects an outdated view of the human mind—the idea that analysis and intuition take place in separate parts of the brain and are appropriate for different situations.[22] He goes on to argue that new brain research shows analysis and intuition are closely intertwined in all situations.[23]

The Commander's Coup d'Oeil

When all is said and done, it really is the commander's *coup d'oeil,* his ability to see things simply, to identify the whole business of war completely with himself, that is the essence of good generalship. Only if the mind works in this comprehensive fashion can it achieve the freedom it needs to dominate events and not be dominated by them.

—Carl von Clausewitz
On War[24]

The examples from Major League Baseball show us that when managers fully embrace artificial intelligence in decision making, they understand it is only a tool. Successfully managing a baseball team involves art and science. Intelligence analysis is both an art and a science as well. The algorithms behind artificial intelligence, the machine-learning process, and even the critical-thinking tools that a human analyst uses are the science of intelligence analysis. They are rules-based and are applied to given situations. Conversely, making sense of the data, predicting the adversary's actions, and communicating the information to the commander is the art of intelligence analysis, because it requires an analyst to combine the collected data with experience and intuition. This process varies among different analysts and is situationally dependent. It is not based on definitive rules. Hence, this is the art of conducting intelligence analysis.

Conclusion

Artificial intelligence alone will not win wars. War will remain a human endeavor. And though the nature of war will not change—with nations using applied violence to achieve a political end—the character of war will continue to evolve. The speed at which commanders make decisions has been a determining factor in victory for centuries. Artificial intelligence has the potential to revolutionize the military decision-making process, enabling commanders to act faster than their adversaries. Baseball managers rely on advanced analytics and artificial intelligence to inform their decisions while still applying their experience and intuition in certain situations; military commanders must do the same.

Artificial intelligence has tremendous potential to improve decision making, but we should view it as a complementary tool, not a substitute for experience and intuition. Dr. Aaron Bazin, U.S. Army officer and author of the book *Think: Tools to Build Your Mind,* emphasizes this point, noting that combing artificial intelligence and the human brain, rather than using them as separate elements, could result in better decision making. A military force that quickly takes this approach and combines it with cognitive computing could gain a decisive advantage on the battlefield.[25]

Endnotes

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