ROMANIAN MILITARY THINKING

IMPLICATIONS OF ARTIFICIAL INTELLIGENCE IN THE WAR OF THE FUTURE

Colonel (ret.) Professor Gheorghe BOARU, PhD

Full Member of the Academy of Romanian Scientists,
Full Member of the Academy of National Security Sciences

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Artificial intelligence (AI) is not a myth; it is a reality… and it is already influencing numerous aspects of modern life. While AI has the potential to transform many fields, it is not a fully autonomous intelligence and cannot replicate all human cognitive functions. As AI continues to advance, exaggerated myths about its capabilities must be separated from the reality of its current developments to understand its true potential and its impact on people's lives.

AI holds significant strategic importance, both in every day life – by streamlining and automating processes, and in the military domain – by enhancing defensive and offensive capabilities.

In defence, AI aids decision-making, threat prevention and counteraction, protects soldiers, and ensures a tactical advantage over adversaries.

Overall, AI is a technology that continues to redefine the boundaries of innovation, bringing profound benefits across various sectors and contributing to societal progress.

Keywords: drones; cybernetics; artificial intelligence; machine learning; human-machine interaction;

INTRODUCTION

Artificial Intelligence (AI) has a significant impact across numerous fields, from economics and healthcare to national security and defence. It brings a transformative shift in how complex problems are addressed, leveraging its ability to process vast amounts of data, learn from experience, and automate complex tasks.

In the present paper I will highlight several key aspects of AI's importance and utility in general, and specifically in the military sector.

❖ *The importance and utility of artificial intelligence* in general concerns several aspects of which I highlight a few more important.

A. Automation of repetitive tasks and efficiency improvement

AI can automate repetitive and time-consuming tasks, such as document processing, complex data analysis, and routine operations management. It frees human resources for more strategic and creative activities, enabling organizations to become more efficient and competitive.

B. Big Data processing and analysis

AI's capability to process and analyse large datasets rapidly helps identify patterns and trends that might otherwise go unnoticed by human analysts. It is crucial in fields like healthcare (for quick diagnoses), finance (to detect fraud), and scientific research (to discover new technologies or treatments).

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C. Learning and adaptability

Machine learning algorithms allow AI to improve over time as it processes more data and learns from experience. This adaptability enables AI to respond effectively to new contexts and challenges, becoming increasingly accurate and efficient with continued use.

D. Innovations in Human-Machine interaction

AI technologies such as voice recognition and natural language processing make human-machine interactions more intuitive and accessible. These advancements improve user experiences and reduce

technological barriers across sectors like consumer services, education, and public administration.

❖ *The importance and utility of artificial intelligence in the military domain*

AI represents a strategic advance in defence and security technologies, fundamentally transforming how military operations are conceived and executed. The main areas cover decision-making, equipment, information, logistics and training issues as follows:

A. Decision support and strategic analysis

AI can rapidly analyse data from diverse sources, such as satellites, drones, and communication networks, to identify threats or strategic opportunities. This type of analysis is vital for making fast, well-informed decisions, especially in critical national security situations.

B. Autonomy in military vehicles and equipment

Autonomous vehicles, such as drones and robots, allow the military to conduct reconnaissance, surveillance, and attacks in hazardous zones without endangering human lives. AI also enhances defensive systems by providing extremely short reaction times to potential threats.

C. Cyber warfare and information security

AI plays a crucial role in detecting and countering cyberattacks. Advanced algorithms can analyse traffic patterns and suspicious behaviours within military networks, identifying and preventing cyber threats in real time. Machine learning capabilities allow these systems to adapt to new attack strategies.

D. Logistical and operational support

AI can optimize supply chains and logistics, ensuring troops have swift access to equipment and supplies. It is critical for maintaining the operational efficiency and the mobility of military forces during conflicts.

E. Simulations and training

AI-based simulation systems provide soldiers with realistic environments for training, allowing them to practice various combat scenarios. These simulations are interactive and adaptive, reflecting the dynamics of real-world situations and enhancing training effectiveness.

Artificial Intelligence plays a crucial role in detecting and countering cyberattacks. Advanced algorithms can analyse traffic patterns and suspicious behaviours within military networks, identifying and preventing cyber threats in real time.

F. Support in combat medicine and soldier recovery

AI also contributes to battlefield medical assistance through rapid diagnostics and health monitoring of soldiers. In post-trauma recovery, AI supports personalized treatment plans tailored to individual soldiers' needs and improves real-time monitoring of their health status.

ARTIFICIAL INTELLIGENCE – CONCEPTS AND OPINIONS

Artificial intelligence (AI) is a branch of computer science focused on creating systems and algorithms capable of performing tasks that usually require human intelligence. These tasks may include reasoning, learning, image recognition, natural language processing, planning, and decision-making. The goal of AI is to enable computers and machines to solve complex problems and understand their environment to react autonomously and efficiently.

AI is found in a variety of fields and practical applications, such as virtual assistants, autonomous vehicles, voice recognition applications, industrial robots, and the recommendation algorithms. Generally, AI can be used to enhance efficiency, automate processes, and add value across many sectors, including medicine, education, transportation, entertainment, and military applications.

The emergence and development of new technologies have enabled spectacular advancements in beneficial applications for society as well as destructive ones. It can be said that *Information technology is "a double-edged sword"* (Boaru, David, 2022, pp. 312-315).

As AI advances, it increasingly influences fields such as philosophy, psychology, and biology, offering new perspectives on understanding the mind, human behaviour, and brain function. AI also raises ethical and philosophical questions, including those concerning its impact on jobs, safety, and the future of humanity as machines become increasingly intelligent.

The primary aim of artificial intelligence is to enable computers to perform tasks typically associated with human minds. Some of these tasks (e.g. reasoning) are commonly described as *"intelligent",* while others (e.g. visual perception) may not be. Nevertheless, they all involve psychological abilities – such as perception, association, prediction, planning, and motion control –, which allow humans and animals to achieve their goals.

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Intelligence is not a single dimension but a complex space structured by diverse capacities for processing information. Consequently, AI employs many different techniques to address a variety of tasks and is present everywhere.

The practical applications of AI (Boden, 2016, pp. 1-3) are found in the home, in the car (self-driving car included), in the office, at the bank, in the hospital, in the sky... and on the Internet, including in the *Internet of Things – IoT* (Boaru, 2021, pp. 59-79), which connects the numerous physical sensors in our gadgets, equipment and surrounding environments (it is actually the network of physical objects connected to the Internet, which can collect and exchange data).

Hollywood animation, video and computer games, navigation systems and the Google search engine are all based on AI techniques. So are the systems used by financiers to predict stock market movements and by national governments to support health and transportation decisions.

Some applications go beyond the limits of our planet: robots sent to the Moon and Mars or satellites orbiting in space. Hollywood animation, video and computer games, navigation systems and the Google search engine are all based on AI techniques. So are the systems used by financiers to predict stock market movements and by national governments to support health and transportation decisions. So are apps on mobile phones. Added to them are virtual reality avatars and early emotion models developed for *"companion"* robots.

Even art galleries are using AI – on their websites and in computer art exhibitions. Less pleasantly, military drones patrol today's battlefields, some of them causing human and/or material damage – but fortunately, so do ground-based demining robots.

AI has **two main goals** (Boden, 2016, p. 2). One is **technological**: using computers to achieve useful things (sometimes using methods very different from those used by the human mind). The other is **scientific**: using AI concepts and models to answer questions about humans and other living things. Most AI specialists focus on only one of these goals, but some consider both important.

In addition to providing an endless number of technological devices, AI has profoundly influenced the life sciences. A computer model of a scientific theory is proof of its clarity and coherence and a convincing demonstration of its often-unknown implications. Whether the theory is true or not depends on the evidence from that science. But even discovering that the theory is false can be revealing.

In particular, AI has allowed psychologists and neuroscientists to develop powerful theories about the mind and brain. They include models of how the physical brain works and – a different but equally important question – what exactly the brain does: what computational (psychological) questions it addresses and what kinds of information processing enable it to do so. Many questions remain unanswered, as AI itself has taught us that our minds are much more complex than psychologists previously imagined.

Biologists have also used AI – in the form of *"artificial life" (A-Life),* which develops computer models of various aspects of living organisms. It helps them explain different types of animal behaviour, the development of bodily form, biological evolution, and the nature of life itself.

In addition to influencing the life sciences, AI has influenced philosophy. Many philosophers today base their explanations of mind on concepts of AI. They use them to address, for example, the famous mind-body problem, the dilemma of free will, and the many conundrums of consciousness. However, these philosophical ideas are highly controversial. And there are deep debates whether any AI system can possess real intelligence, creativity, or life.

Ultimately, AI has challenged the way we think about humanity and its future. In fact, some people worry about the possibility of a future because they predict that AI will surpass human intelligence in all aspects. Although a few thinkers embrace this prospect, most view it with trepidation: *What room, they ask, will be left for human dignity and responsibility?*

ROMANIAN MILITARY THINKING

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TYPES AND FIELDS OF ARTIFICIAL INTELLIGENCE

Introducing the typology and domains of AI is an essential step for a better understanding of the potential and limitations of artificial intelligence. It contributes to informed decision-making, ethical use of technology, educating the public and encouraging responsible innovation, helping us better understand how AI works, what it can do and how it can be effectively applied in various sectors. Understanding these aspects helps both to maximize the benefits of AI and to manage the risks and challenges responsibly.

A synthetic presentation of AI typology and domains can be as follows:

❖ **Types of Artificial Intelligence:**

AI can also be classified by its capabilities:

- **Narrow AI (NAI)***:* It is oriented towards a specific task (e.g. a recommendation algorithm on a streaming site);
- **Artificial General AI (AGI)***:* It is a theoretical concept of AI that could understand, learn and apply knowledge as well as a human being;
- **Superintelligence:** A hypothetical concept in which an AI surpasses human intellectual capabilities.

Today, most AIs are *"narrow",* specialized in solving a specific type of problem.

Some important areas in AI include Machine Learning and Neural Networks, which are two fundamental concepts in the field of Artificial Intelligence used to develop systems capable of learning and making decisions based on data.

❖ **Fields of Artificial Intelligence**

Some important areas in AI include *Machine Learning* and *Neural Networks*, which are two fundamental concepts in the field of Artificial Intelligence used to develop systems capable of learning and making decisions based on data. Here is a detailed description of each of them:

- ***Machine learning (ML)***. This is a branch of AI where systems learn from data and improve performance based on experience. For example, a machine learning algorithm can be trained to recognize images of cats based on a set of images of cats and non-cats.

Machine learning is an area of AI that focuses on developing algorithms and models that can learn from data and make predictions or decisions without being explicitly programmed for each task. In other words, machine learning allows a system to *"learn"* from data experience, continuously improving itself.

Depending on the type of data and learning method, machine learning can be classified into several types:

- *Supervised learning*: The algorithm is trained on a labelled data set (e.g. images with cats labelled as *"cats"* and images without cats labelled as *"non-cats"*). The algorithm learns to recognize patterns to make predictions on new, unknown data.
- *Unsupervised learning*: The algorithm learns from unlabelled data, i.e. without being guided about what that data represents. The goal is to discover hidden structures

in the data, such as groups (clusters) or patterns. For example, in online user behaviour analysis, clustering can reveal similar types of buyers.

- *Reinforced learning*: The algorithm learns through trial and error, receiving rewards or penalties for its actions. It is mainly used in fields such as robotics or in the development of autonomous agents (e.g. game agents).

Let us take a moment to explore the relationship between the terms *AI, machine learning* and *deep learning*. On the one hand, all three have become synonymous with what we call modern AI. It is a bug, but a convenient one. *Figure 1* shows the correct relationship between these terms.

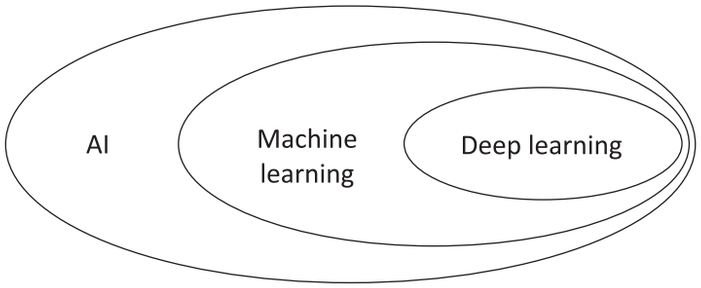

Figure 1: The relationship between artificial intelligence, machine learning and deep learning (Ronald, 2024, p. 18).

Artificial Neural Networks are models inspired by the structure of the human brain that can identify complex patterns in data. Deep Neural Networks (DNN) are the basis of many modern AI applications, such as speech recognition and image analysis.

Deep learning is a subfield of machine learning, which in turn is a subfield of artificial intelligence. This relationship implies that AI includes concepts that are neither machine learning nor deep learning.

We will call these concepts *"classical"* AI, which encompasses the algorithms and approaches developed since the 1950s. Classical AI is not what people have in mind when they discuss AI today.

- ***Artificial Neural Networks (ANN)****:* These are models inspired by the structure of the human brain that can identify complex patterns in data. *Deep Neural Networks (DNN)* are the basis of many modern AI applications, such as speech recognition and image analysis.

Neural networks are a type of machine learning algorithm inspired by how the human brain works. They consist of artificial *"neurons"* organized in layers: an *input layer*, *hidden layers*, and an *output layer.*

Neural networks are used to identify complex patterns in data and have been instrumental in the development of technologies such as image recognition, voice analysis and text generation.

How Neural Networks Work:

- *The input layer* receives the raw data (e.g. an image or a sequence of text);
- *The hidden layers* are where the complex calculations take place. Neurons in these layers are connected by weights that adjust during model training to optimize the output;
- *The output layer* produces the final output, such as identifying an object in an image or generating a text response.

Neural networks are complex machine learning models that rely on large data sets and continuous adjustment of connections to achieve high accuracy.

Deep neural networks or *"deep learning"* are neural networks with many hidden layers, being thus extremely effective in recognizing complex patterns. They have led to major achievements in AI, such as:

- image recognition in medical applications for disease detection;
- natural language processing in chatbots or virtual assistants;
- recommendation systems for streaming platforms that learn user preferences.

Neural networks and machine learning are often used together: neural networks are complex machine learning models that rely on large data sets and continuous adjustment of connections to achieve high accuracy.

Δ ***Natural Language Processing (NLP)***: This is an area of AI that deals with the interaction between computers and human language. NLP allows computers to understand and generate natural language, as is the case with voice assistants (e.g. Alexa, Siri).

NLP is a field of artificial intelligence that deals with the understanding and generation of human language by computers.

Natural language processing is used in many applications, such as:

- *Virtual assistants* (e.g. Siri, Alexa, Google Assistant), which interpret and respond to voice commands;
- *Automatic translation* (e.g. Google Translate), which translates the text from one language to another;
- *Sentiment analysis* in social media posts or reviews to determine if the text is positive, negative or neutral;

- *Chatbots* and other forms of *online assistance*, which interact with users via text to provide support and information (Boaru, David, 2022, pp. 328-342).

NLP combines linguistics, computer science and machine learning techniques to enable computers to *"understand"* and *"communicate"* in natural human language.

Δ ***Robots and autonomous systems***: These systems are capable of making decisions and acting in an autonomous way in various environments, such as industrial robots or autonomous cars.

Δ ***Computer Vision***: This is an area of AI that allows computers to interpret and understand the visual world around them using static images and videos.

GENERAL AND MILITARY APPLICATIONS OF ARTIFICIAL INTELLIGENCE

Artificial intelligence is playing an increasingly important role in society and in militaries around the world, helping to improve strategies, safety and operational efficiency. Here are some of the ways AI is being used in social and military fields.

❖ ***Drones and autonomous vehicles***

AI is used to develop drones and vehicles that can operate without the help of humans. They can perform surveillance or even attack missions, reducing the risks to soldiers. For example, drones can identify and destroy targets on the battlefield without direct human intervention.

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Drones and autonomous vehicles represent an innovative category of autonomous technology with diverse and ever-expanding applications in many industries. They use artificial intelligence, sensors, cameras and GPS to navigate and perform tasks without direct human intervention.

- **Drones** *(Unmanned Aerial Vehicles – UAVs)*

Drones are unmanned, remotely controlled or fully autonomous aerial vehicles. They can range in size from small models used for recreation to large drones used in industrial and military applications such as:

a) Agriculture: Used for crop monitoring, pesticide application and irrigation, streamlining the process and reducing the use of resources;

b) Logistics and delivery: Companies like Amazon are testing the use of drones to deliver packages in a fast and efficient way;

c) Film and media industry: Drones provide spectacular aerial images for films, television and journalism;

d) Military and security applications: Drones are used for surveillance, patrolling and even in military operations;

e) Disaster management: Drones can help identify areas affected by natural disasters and assist rescue teams.

- **Autonomous vehicles**

Autonomous vehicles are machines capable of navigating and operating without human intervention. Their development includes advanced technologies such as *LIDAR*[1] *(Light Detection and Ranging)* sensors, radars, cameras and machine learning algorithms.

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Autonomous vehicles are rated on a scale of 0 to 5, where:

- Level 0: Full human control, no automation;
- Level 5: Fully autonomous automobile, capable of operating without a steering wheel or pedals.

- **Applications of autonomous vehicles:**

a) Public transport: Autonomous vehicles can make public transport more efficient, reducing travel time and fuel consumption;

b) Ride-sharing services: Companies like Waymo and Uber are investing in autonomous vehicles for ride-sharing, which could reduce the need to own a personal car;

c) Industry and logistics: Autonomous vehicles are used in industrial spaces and warehouses for the transport of goods without drivers, optimizing production flows;

d) Freight transport: Autonomous trucks, developed by companies such as Tesla and TuSimple, can make long-distance freight transport more efficient and secure;

e) Passenger transport: Companies such as Tesla are working on developing fully autonomous vehicles for personal transport to increase safety and reduce accidents.

[1] *LIDAR sensors* are devices that use a laser to measure distances to objects and create a three-dimensional map of the environment. LIDAR works by emitting pulses of laser light, which are reflected off the surfaces of surrounding objects and return to the sensor. By measuring the time it takes for the light to return, the sensor can calculate the distance to each point. (A.N.)

- **Challenges and perspectives**

While drones and autonomous vehicles have huge potential, there are also major challenges such as safety, legal regulations, data protection and social acceptance. The ethical issue is also important: Who is liable in the event of an accident? In addition, the issue of cyber security is crucial, as drones and autonomous vehicles can be vulnerable to cyber attacks.

As technology continues to evolve, it is anticipated that we will see an increasing integration of drones and autonomous vehicles into everyday life. It will lead to major transformations in many industries, from transportation to agriculture and security.

❖ ***Data analysis for quick insights***

AI helps to quickly analyse a large volume of information, such as satellite images or intercepted messages. It allows the military to make quick and appropriate decisions in real time based on accurate data.

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❖ ***Planning battle strategies***

AI algorithms can simulate various battle scenarios, helping military leaders better understand how situations will play out and choose the best strategies to win.

❖ ***Cyber protection***

AI is used to protect the military's IT systems. Algorithms can quickly detect and respond to cyberattacks, preventing the loss of important information and ensuring the safety of military networks.

❖ ***Optimizing logistics***

AI helps manage military resources such as equipment, supplies, and personnel. For example, AI can predict what resource needs are and help plan troop movements or coordinate equipment deliveries.

❖ ***Facial recognition and monitoring***

Artificial intelligence is used to recognize people's faces and monitor activities in conflict zones. It helps identify suspicious people and behaviour.

❖ ***Robots for hazardous tasks***

Robots using AI can perform risky tasks, such as defuse mines or interventions in a dangerous environment. They can save lives and reduce risks for soldiers.

❖ ***Quick and informed decisions***

AI helps make quick decisions by providing clear and precise information that allows military leaders to choose the best course of action in a given situation.

❖ ***Virtual trainings***

Artificial intelligence is used to create realistic combat simulations that help soldiers prepare for various scenarios. These simulations can be extremely useful for learning how to react in different situations.

❖ ***Health systems for soldiers***

AI can also help in the medical field, monitoring the health of soldiers and quickly diagnosing injuries or illnesses. It can also optimize the management of equipment and medical resources in the field.

In conclusion, AI helps militaries become more efficient, better protect resources and respond quickly to threats. Although these technologies offer many advantages, it is important that they are used responsibly and with careful control.

The integration of AI into military operations is seen by many as a sign of a new Revolution in Military Affairs.

*"Despite fears that AI could overtake and dominate humanity, these concerns are often based on misconceptions. Among engineers, AI is less feared due to a deeper understanding of the technology's limits. Although AI, like any technology, has the potential to be misused, doomsday scenarios are largely based on fear of the unknown and remain speculative" (*Kaushik, 2024, p. 219).

ARTIFICIAL INTELLIGENCE IN MILITARY OPERATIONS

The integration of AI into military operations is seen by many as a sign of a new *Revolution in Military Affairs (RMA).* Robotic systems are increasingly common on the modern battlefield, showing higher levels of autonomy in various functions such as search, detection, assessment, tracking, engagement, and strike effectiveness evaluation. Examples include *"fire-and-forget"* munitions, patrol torpedoes, and smart anti-submarine or anti-tank mines. Mines feature modern technologies that allow them to be more effective and reduce the risk of collateral damage. They can include features such as automatic target type detection or activation based on precise criteria.

Because of these advances, AI and robotic technologies are seen as having the potential to trigger a new *RMA*, especially as *Lethal Autonomous Weapon Systems (LAWS)* become more sophisticated.

Defining LAWS is difficult because of the ambiguity of the term *"autonomous".*

A 2012 directive from the US *Department of Defense (DoD)* provides some clarification, defining an autonomous weapon as one that, *"once activated, can select and engage targets without the intervention of a human operator. In contrast, a semi-autonomous weapon is intended to engage individual targets or specific groups of targets once activated. As these technologies evolve, the definition of <fully autonomous> continues to be a matter of debate"* (Ib.).

❖ ***AI in Military Operations from an International Perspective***

AI technologies could impact future warfare and international security in three interconnected ways: *"amplifying the uncertainties and risks posed by existing threats (both physical and virtual); transforming the nature and characteristics of these threats; and introducing new risks to the security landscape. Artificial intelligence could bring about fundamental changes in military power, in turn reordering the military balance of power and triggering a new military-technological arms race"* (James, 2021, p. 2).

Some experts speculate that AI could push the pace of combat to a point where machine actions outpace human decision-making and change the cognitive underpinnings of international conflict and war, challenging the Clausewitzian notion that war is a fundamentally human endeavour, heralding a genuine revolution (with unprecedented potential) in military affairs. For example, China's military leadership recently stated that artificial intelligence will lead to a profound military revolution (Kanya, 2017, p. 8).

This speculation *"explores the tension between those who see the introduction of AI into warfare as inherently destabilizing, revolutionary and juxtaposed, and those who see AI as more evolutionary and a* ***double-edged sword*** *for strategic stability"* (James, p. 3).

Former US Secretary of Defense James Mattis has warned that AI is *"fundamentally different"* in ways that call into question the very nature of war (Mattis, 2018).

To date, several countries have deployed near-autonomous defensive systems to intercept enemy attacks. In contrast, offensive weapon systems would be those that can be deployed anywhere and actively seek targets. However, the distinction between offensive

ROMANIAN MILITARY THINKING

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and defensive weapons is not strict. The best-known autonomous defensive weapons are missile defence systems such as Israel's *Iron Dome* and the *Phalanx* Proximity Weapon System used by the US Navy. *"Launch-and-forget"* systems such as the UK's *Brimstone* missile system and Israel's *Harpy* Air Defence Suppression System are also nearly autonomous.

South Korea uses the *SGR-A1* sentry robot, equipped with an automatic mode, in the Demilitarized Zone with North Korea.

An example of an autonomous offensive system that is likely to be deployed in the near future is Norway's Joint Strike Missile, which can hunt, recognize and detect a target, either on a ship or a ground object, without human intervention.

The United States of America has placed AI at the centre of its efforts to maintain military dominance. In November 2014, former US Secretary of Defense, Chuck Hagel, announced a new Defense Innovation Initiative, also referred to as the *"Third Offset"* (Kaushik, 2024).

❖ ***Opinions on the exploitation of AI***

There is a view that instead of focusing exclusively on autonomous systems, the power of AI should be harnessed to increase the combat power of the current force. This approach is known as *Narrow AI* or *Weak AI*. Narrow AI could bring many benefits, such as using image recognition from video streams to identify imminent threats, anticipating supply bottlenecks, automating administrative functions etc. Such applications would allow the force to be restructured, with a smaller staff of data specialists replacing large organizations. Therefore, *Narrow AI* has the potential to help defence forces improve the ratio of combat to support components (Ib., p. 219).

Another area of interest in the evolution of autonomous weapons is what can be called *human-machine collaboration*, where machines and humans work together in a symbiotic relationship. Like the mythological centaur, this approach aims to combine inhuman speed and strength with human judgement, uniting machine precision and reliability with human robustness and flexibility, and allowing computers and humans to help each other think, a concept called *cognitive collaboration. "Some functions will need to be fully automated, such as laser missile defence or cyber security, in cases*

where there is no time for human intervention. But, at least in the medium term, most military AI applications will involve teamwork: computers will pilot the missiles, aim the lasers, jam the signals, read the sensors, and centralize all the data into an intuitive interface that humans, drawing on their experience, will use to make well-informed decisions" (Freedberg, 2015).

ROMANIAN MILITARY THINKING

Their impact on military effectiveness and comparative advantage can be significant and difficult to predict in their early stages. Moreover, such technologies and the resulting capabilities rarely spread evenly along geopolitical lines (Raska, Bitzinger, 2023, p. 8).

However, critical questions remain: How much can we trust AI systems, especially safety-critical ones? A growing area of research focuses on how to trick AI systems into making wrong predictions by generating fake data. State and non-state actors can use the so-called *"adversarial machine learning"* to deceive adversaries, using incorrect data to generate wrong conclusions and thus alter decision-making processes. The overall strategic impact of *"adversarial machine learning"* on international security could be even more disruptive than the technology itself (Danks, 2020).

"Some functions will need to be fully automated, such as laser missile defence or cyber security, in cases where there is no time for human intervention. But, at least in the medium term, most military AI applications will involve teamwork: computers will pilot the missiles, aim the lasers, jam the signals, read the sensors, and centralize all the data into an intuitive interface that humans, drawing on their experience, will use to make well-informed decisions".

Indeed, complex AI systems and data flows must also be technologically, organizationally and operationally integrated. For many militaries, it is an ongoing challenge: they must be able to efficiently integrate (in real time) AI-sensor-shooter loops and data flows between various services and platforms. It includes connecting various operational battle management and data systems; command and control, communications and networks; electronic warfare; positioning, navigation and synchronization; with precision ammunition. Although certain AI systems can mitigate some of the challenges, the same systems create new problems related to ensuring reliable AI (Cummings, 2017).

Consequently, it can be argued that the direction and character of the *"AI wave"* will depend on the appropriate strategic, organizational and operational agility, particularly how AI technologies interact with current and future operational structures and force structures (Raska, Bitzinger, ib.).

The convergence of three major factors – *strategic competition, emerging dual-use technological innovation, and the changing*

nature of human-machine interactions in warfare – is propelling a new environment that defines and leads the wave of AI-based *RMA*. In other words, a veritable military-technological *"tsunami"* is looming, one that can defy previous military revolutions. While this view risks exaggerating the impact of new technologies, it also demonstrates that current methods of warfare – weapons, tactics, trainings, procurement, and operational approaches – could quickly become obsolete, especially in a world where strategic vulnerabilities and dependencies coexist in a wide range of factors, sectors and countries (Ib.).

The fundamentals for machine learning were established in 1956 by researchers at Dartmouth College, USA. John McCarthy, then a Professor of Mathematics at Dartmouth College, proposed that the research group "proceed on the assumption that any aspect of learning or any other characteristic of intelligence can be described precisely enough that a machine can be made to simulate".

CONCLUSIONS

Although artificial intelligence is treated as a new technology, it is not actually new; rather, it is the diverse applications of AI technology that are new and ever-growing. The fundamentals for machine learning were established in 1956 by researchers at Dartmouth College, USA. John McCarthy, then a Professor of Mathematics at Dartmouth College, proposed that the research group *"proceed on the assumption that any aspect of learning or any other characteristic of intelligence can be described precisely enough that a machine can be made to simulate"* (Dartmouth College).

Why did it take from 1956 to 2023 for AI technology to gain global prominence and capture the imagination of tech firms, researchers and governments? There are concerns that the technology may not fully deliver on its promises, and memories of the Internet revolution, which turned from a boom period into a bust for many tech companies, are one of the *"elephants in the room"* (Jahankhani et al., 2024, p. 144).

In the ever-evolving digital landscape, the fusion of artificial intelligence and cybersecurity has introduced a formidable ally. AI's unique capabilities in processing massive volumes of data, recognizing complex patterns, and rapidly adapting to emerging threats mark the beginning of a new era in cyber defence. As AI continues to integrate seamlessly into our cybersecurity strategies, it plays a crucial role in our ongoing battle against the ever-changing cyber threat landscape (Mahajan et al., 2024, p. 40).

Projections of future warfare and operational concepts – such as multi-domain operations – increasingly depend on the direction

and character of the new wave of AI-based technological and defence innovations, including the development of advanced combat aircraft paired with unmanned air vehicle teams, lethal autonomous weapons systems, hypersonic missiles, directed energy or laser weapons, and technologies relevant to competition in cyberspace and the electromagnetic spectrum (Lingel et al. 2020).

At the same time, the diffusion trajectory of the AI wave raises new challenges and questions related to strategic stability, alliance relations, arms control, ethics and governance, but also the conduct of combat operations (Stanley-Lockman 2021).

As authors such as Michael Raska and Richard Bitzinger point out, (Raska, Bitzinger, p. 3), armed forces around the world are aggressively seeking to integrate certain AI systems and technologies into their arsenals to create a competitive advantage over adversaries. These developments raise questions about the challenges to current systems of decision-making, trust and military ethics. From existing applications of narrow artificial intelligence to the future prospect of superintelligence, human-machine dependency and collaboration are increasingly marked by issues of ethics and norms.

As authors such as Michael Raska and Richard Bitzinger point out, armed forces around the world are aggressively seeking to integrate certain AI systems and technologies into their arsenals to create a competitive advantage over adversaries.

Given the current borders, with friendly or unfriendly neighbours, it is well understood that sufficient presence of own troops is absolutely necessary. At the same time, it is imperative that the Romanian Armed Forces keep pace with the changing nature of warfare in the 21st century, fuelled by rapid advances in technology on multiple fronts. AI and robotics technologies, after decades of failed attempts, today appear to be at an inflection point, being rapidly incorporated into a wide range of products and services in the commercial environment. It is only a matter of time before they manifest themselves in defence systems, in ways significant enough to usher in a new revolution in military affairs.

Despite worldwide concerns regarding the development of Lethal Autonomous Weapon Systems from a legal and ethical point of view, it is increasingly clear that, regardless of the conventions adopted by the UN, research and development by the major players in this field is likely to continue unfettered (Kaushik, p. 225).

Considering Romania's own security landscape, in the current European context, the adoption of AI-based systems with increasing

degrees of autonomy in various operational scenarios is expected to bring considerable benefits in the coming years.

Perhaps a radically different approach is needed to facilitate the development of autonomous AI-based systems, using the best available expertise from within and outside the country.

Like any transformation, this is no easy task. I believe that the lack of personnel can somehow be compensated with super-qualified personnel, with well-regarded and motivated reservists. Only a determined effort, with Romanian specialists in the field, with motivated soldiers but also with highly trained reservists, to be consulted, as well as with a corresponding impulse from the higher level, is possible to lead to the desired results.

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