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Artificial Intelligence

Applications and Challenges for the Armed Forces

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Les notes σtratégiques

Intelligence in
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White papers

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Executive Summary

Artificial Intelligence or AI can be defined as "*a machine's ability to replicate functions generally attributed to animals or humans, [in particular] recognising images and understanding videos, sounds and texts."*[1]

In concrete terms, AI is based on algorithms capable of analysing huge quantities of information very quickly or even in quasi real time. Using the power of modern computing, they can process quantities of information that the human brain cannot. To achieve optimal performances, these algorithms must be trained beforehand, requiring an immense amount of data. They may then become able to recognise relevant elements in a vast array of information (such as an object, correlations, a general trend, etc.).

The widespread digitalisation of all sectors of society has led to a dramatic increase in the amount of data produced. It stands to reason that Artificial Intelligence – a concept born in the 1960s – should become the focus of renewed attention. Indeed, while the digital sphere in 2013 was equivalent to 4.4 zettabytes – i.e. 4.4 billion terabytes – it is expected to reach ten times that amount in 2020. To represent the size of the digital sphere in 2020 in concrete terms would require more than 6.5 towers of iPads, each measuring the equivalent of the distance between the Earth and the Moon.[2] The military sector has not escaped this general trend,[3] with the use of geolocation systems as well as air and sea traffic management systems, on-board sensors, messaging systems and networks that generate increasing amounts of data in various formats.[4]

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1 http://www.lefigaro.fr/secteur/high-tech/2016/06/17/32001-20160617ARTFIG00317-yann-lecun-l- intelligence-artificielle-a-connu-des-succes-et-des-echecs.php

2 https://www.emc.com/leadership/digital-universe/2014iview/executive-summary.htm

3 Strategy note "Internet des Objets (IoT) - Une nouvelle donne pour la Défense?", CEIS, https://ceis.eu/fr/ note-strategique-internet-des-objets-iot-une-nouvelle-donne-pour-la-defense

4 Strategy note "Enjeux stratégiques du Big Data pour la Défense", CEIS, https://ceis.eu/fr/note- strategique-enjeux-strategiques-du-big-data-pour-la-defense/

This permanent data stream has led to an abundance of data, commonly known as Big Data.

In order to process this amount of data and turn it into real operational value, effective tools have had to be developed. AI has proven to be particularly suitable, processing large amounts of information in quasi real time and as a result extracting trends or designing models. While business was quick to find profitable applications, operational military applications based on these technologies are being developed in fields as varied as training and education, planning and conduct, intelligence, logistics, operational readiness and cyber-security.

Furthermore, Big Data enables the creation of powerful algorithms that can function autonomously without needing external computing capacities and/or databases. This "offline" operating mode, which is extremely useful for operations, was, for example, the model selected for the Reco NG Pod used for Rafale fighter aircraft reconnaissance missions, which relies on a database stored inside the tool itself.[5]

While AI-based solutions may be interesting, these technologies are nevertheless not a panacea. To leverage their full potential, their operational added value must be confirmed against inevitable technical constraints, and certain inherent risks – such as "technological dependence" and the possible loss of expertise in certain fields.

5 http://www.air-cosmos.com/thales-propose-de-l-ia-pour-le-pod-reco-ng-111813

AI – Automating Data Processing

Far from a new concept

Artificial Intelligence has been in the news regularly in recent years – with Vladimir Putin, the President of the Russian Federation, going so far as to state that “whoever becomes the leader in this sphere will become the ruler of the world”[6] – yet the concept is by no means new.

Although the huge investments that GAFAM[7] and BATX[8] have made in commercial applications – in particular by developing voice assistants that society often believes to be AI – may give the impression that progress in AI is mainly linked to the civil sector, it was in fact **the military who were behind the first developments in this field.**

Indeed, the expression first appeared in an article called "Computing Machinery and Intelligence" written by the British mathematician and computer engineer Alan Turing in 1950.[9] Through his previous work, Turing had been instrumental in deciphering the "Enigma" code, an electromechanical device that the Germans used to encrypt their messages during World War II. He accomplished this by designing a machine that could sort through millions of possibilities in order to identify the code being used.[10] This was the beginning of AI, which leverages machine power to carry out tasks that a human or a group of humans could not accomplish in a reasonable timeframe.

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6 https://www.sciencesetavenir.fr/high-tech/intelligence-artificielle/poutine-pense-dominer-le-monde-en-maitrisant-l-intelligence-artificielle_116062

7 Google, Apple, Facebook, Amazon, Microsoft

8 Baidu, Alibaba, Tecent, Xiaomi

9 https://www.usine-digitale.fr/article/bios-de-robots-1950-la-naissance-de-l-intelligence-artificielle.N277018

10 https://paidpost.nytimes.com/the-weinstein-company/world-war-iis-greatest-hero-the-true-story-of-alan-turing.html#.WrPzXmZ7RTZ

Artificial Intelligence became a research field following a seminar at Dartmouth College (USA) in **1956**. One of its instigators, Marvin Minski, had built the first neurocomputer – known as SNARC (Stochastic Neural Analog Reinforcement Computer) – in 1951, by creating a network of 40 artificial neurons that modelled the behaviour of a rat looking for food in a maze.[11] His work was sponsored by the US army.[12]

The 1960s saw the invention of **Dendral, the first "expert" system** used to identify the chemical components of a substance using mass spectrometry and nuclear magnetic resonance. Since then, the achievements of "intelligent machines" have constantly been making headlines:

- **In 1997, Deep Blue** finally defeated the six-time world chess champion Garry Kasparov using to the 600,000 games it had stored in its memory and its 256 processors capable of evaluating 200 million positions per second;[13]
- **In 2005, Stanley, a driverless vehicle** developed in Stanford, autonomously followed a trail over more than 200 km without prior reconnaissance in the Nevada desert;[14]
- **In 2016, Alpha Go,** a programme developed by Google DeepMind, beat a human Go player for the first time after learning the game by analysing thousands of examples of games played by humans;[15]

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11 https://interstices.info/jcms/p_88809/marvin-minsky-un-pere-visionnaire-de-l-intelligence-artificielle

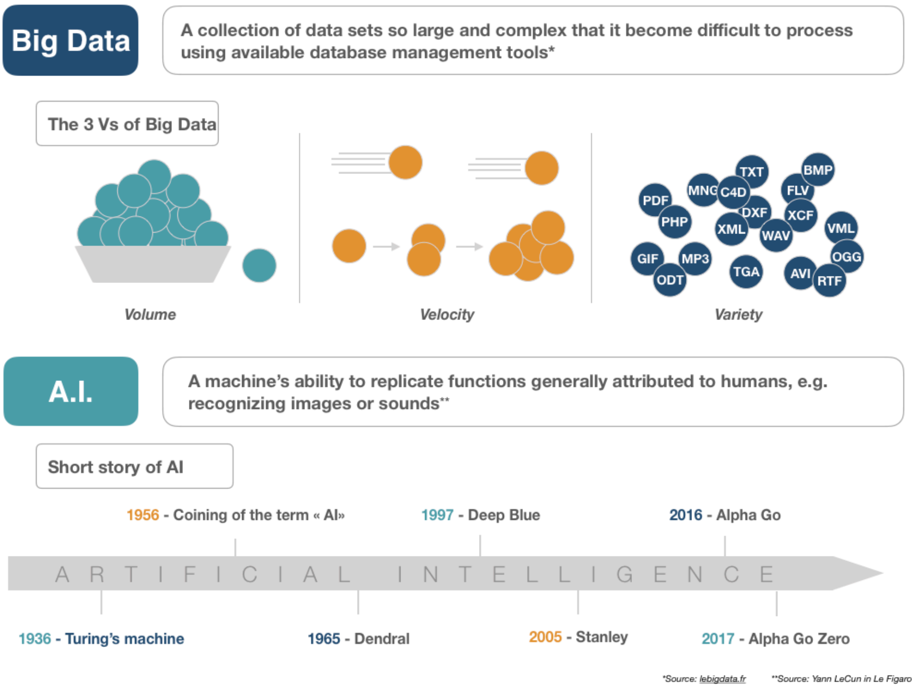
12 https://www.lesechos.fr/idees-debats/sciences-prospective/010174900737-1956-et-lintelligence- artificielle-devint-une-science-2108749.php#8FrHtcslTGcz8krb.99

13 https://www.lesechos.fr/idees-debats/sciences-prospective/030475334820-1997-2109945.php

14 https://lexpansion.lexpress.fr/actualite-economique/la-championne-du-rallye-sans-pilote_1406808.html

15 http://www.lemonde.fr/pixels/article/2016/01/27/premiere-defaite-d-un-professionnel-du-go-contre-une-intelligence-artificielle_4854886_4408996.html

- In 2017, Alpha Go Zero, an improved version of the programme, learned how to play on its own: the only information it received was the rules of the game and the position of the stones on the board – it built its database on its own based on these elements.[16]



16 http://www.lemonde.fr/pixels/article/2017/10/18/intelligence-artificielle-toujours-plus-puissant-alphago-apprend-desormais-sans-donnees-humaines_5202931_4408996.html

Big Data – new challenges

The amazing progress of the past two decades can be partly explained by the widescale creation of data which , to some extent, provides the raw material essential for training AI algorithms. This trend is likely to continue and increase in the years to come, with digital data created expected to represent 44,000 billion gigabytes worldwide by 2020, ten times more than in 2013.

This is commonly known as **Big Data.** In concrete terms, it can be defined as "*a collection of data sets so large and complex that it becomes difficult to process using existing database management tools*".[17] This definition mainly focuses on one key element, namely the amount of data generated, the efficient processing of which is a significant challenge.

Volume, however, is only one of the three Vs characteristic of Big Data, along with **velocity**– the frequency with which data is generated, collected and shared – and **variety** – the multiplication of data formats requiring processing.[18]

In the military world, as on-board sensors, messaging systems, networks and, more generally, connected objects and platforms become increasingly common, the amount of data produced has exploded. Robert Cardillo, head of the National Geospatial Intelligence Agency, stated in June 2017 that "**if we attempted to manually exploit the imagery** we will receive over the next twenty years, **we would need eight million imagery analysts**".[19]

17 https://www.businesswire.com/news/home/20140916006240/en/Research-Markets-Big-Data-Business-Intelligence-Market

18 http://www.journaldunet.com/solutions/expert/51696/les-3-v-du-big-data---volume--vitesse-et- variete.shtml

19 https://www.nga.mil/MediaRoom/SpeechesRemarks/Pages/Small-Satellites---Big-Data.aspx

This **volume** issue is compounded by the issue of **velocity**. As a result, the increase in data transfer speeds – among other due to improvements in materials – has led to a significant increase in the amount of data transferred. The generation of these massive data streams arriving in real time is largely responsible for network saturation. Finally, the **variety** of data produced – text, video, audio, technical data – is another challenge that should lead to an increased focus on the development of strategies to process unstructured information.

Solutions based on Artificial Intelligence may largely prove useful in dealing with these issues.

AI and Big Data processing

Artificial Intelligence is "*a machine's ability to replicate functions generally attributed to animals or humans, [...], with a current focus on computer perception, recognising images and understanding video, sound and text.*"[20]

In concrete terms, the AI process is based on algorithms for which the main added value is the processing, very quickly or in quasi real time, of huge quantities of information that humans cannot assimilate nor exploit.

[20] http://www.lefigaro.fr/secteur/high-tech/2016/06/17/32001-20160617ARTFIG00317-yann-lecun-l- intelligence-artificielle-a-connu-des-succes-et-des-echecs.php

Training these algorithms requires an immense amount of data, allowing them for example to recognise relevant elements in a vast array of information (such as an object, correlation, general trend, etc.).

The added value is provided through their capacity to summarise large amounts of information in quasi real time and as a result to extract trends or design models. In other words, Artificial Intelligence allows humans to process volumes of information that could not otherwise be exploited.

Armed Forces, who use increasingly digitalised software and generate an ever more data, could also benefit from the operational added value provided by these solutions. Without claiming to be exhaustive, here are a few representative examples, most of which have already been implemented.

A wide range of possible defence applications

Training and education

In order to vary engagement scenarios and maintain troops' operational readiness, numerous Artificial Intelligence applications could be used in simulation systems.

Applications based on AI could thus help generate new training scenarios or could be used to simulate an enemy, based on data collected during training, measured performance or information extracted from known opponent manoeuvres.

The US Air Force has tested an AI programme called ALPHA against a fighter pilot in air combat simulation. ALPHA, which can process radar data and predict fighter plane movements at extremely high speeds, selects the relevant information necessary to make decisions based on the behaviour of the opponent pilot and therefore adjusts its actions during combat.

Planning and conduct

Operations planning and vector automation

By modelling operation scenarios based on a significant number of variables (information on availability as well as the state of human and material resources, field conditions, etc), AI programmes could help with the forward-planning of operations, allowing various options to be tested and providing decision-makers with a range of possibilities. This type of programme can also bring added value when used in operation as it can provide continuous mission plan updates by collecting data on friendly or enemy presence in real time.

AI can also be used to automate weapons systems deployment. The Iron Dome system deployed by Israel in 2010 is the most advanced example. This mobile anti-missile defence system was designed to intercept short-range rockets and artillery shells by detecting suspicious objects when they are launched and identifying their trajectory to decide whether they should be shot down or not. This decision is made autonomously and in quasi real time.

Drones and autonomous platforms

AI is also at the heart of semi-autonomous – or even fully autonomous – platforms. It is for example used to deploy (aerial, ground or seafaring) drone swarms that are capable of cooperating with each other – sometimes through one core machine – to collaboratively carry out surveillance and intelligence missions or submerge enemy defence systems.

In early 2017, the Pentagon announced that it had successfully deployed a swarm of 103 *Perdix* micro-drones from three fighter planes. The swarm successfully worked together by adapting its behaviour as the mission progressed, under the control of a human operator, each micro-drone communicating with the rest of the swarm.

Robotisation

By integrating AI algorithms into robotic machines, a robot's tasks and functions can be – either partially or entirely – automated, such as detecting and identifying targets or mapping a theatre of operations.

In Syria, Russian forces relied on the use of semi-autonomous land robots for intelligence missions, mine clearance missions and combat operations through the implementation of *Platforma-M*s (land robots on a crawler, each armed with cannons and a machine gun) and *Argo*s (armed with machine guns and rocket launchers). In this context, however, a human operator always controls the discharging of weapons.

Intelligence

The advantages of AI are clear when it comes to processing the huge amounts of information required for enlightened decision-making based on an evaluation of the operational and strategic situation.

The principal efforts in AI software and programme development known to the broader public focus on automatic object recognition (object in its widest sense, including people, infrastructure and vehicles) from video and photo data streams. AI helps analysts by taking over time-consuming identification tasks and thereby freeing up time to focus on missions where detailed human analysis provides better added value than machine analysis.

This is the objective of the project pairing the Maven and Minotaur algorithms to work with US Special Operations Command intelligence analysts. Both applications identify objects from video feeds collected by drones over the battlefield and then classify, georegister and analyse these objects.

The potential of AI is not limited to this type of application used for intelligence activities. Indeed, as Dawn Meyerriecks, the Central Intelligence Agency's deputy director for technology development declared, in the long run, some tools could "predict significant future events [political or other] by finding correlations in data shifts and other evidence."[21] The American

[21] http://www.opex360.com/2018/02/06/face-a-linflation-donnees-direction-renseignement-militaire-mise-lintelligence-artificielle

intelligence agency is currently developing more than one hundred AI projects.

Logistics and maintenance

By powering Artificial Intelligence software with data from sensors installed on resources (vehicles, effectors, etc), the data can be managed more efficiency, thus freeing up resources and time.

One of the main advantages of using AI in this field is moving from traditional logistics and corrective maintenance to predictive logistics and maintenance. By taking into account the constraints of the various parties involved (users, manufacturers, subcontractors, military services) and the data provided from flow management systems or platforms, information systems allow logistical management to be optimised while also anticipating equipment maintenance operations so that the required replacement parts can be ordered and installed preventively.

Another approach being studied by some Armed Forces is the AI-based development of autonomous logistics vehicles.

Cyber-security

Due to their inherent characteristics – speed, automation, easy adjustment capabilities – AI-based solutions help respond to challenges in the field of cybersecurity. The idea is to use AI's capacity to process large quantities of data to automate the identification and analysis of issues or security breaches in real time. Most commercial solutions currently under development focus on this segment.

Developments in the field of AI also allow computer network data to be processed to anticipate vulnerabilities and automate incident handling.

For example, UBA[22] solutions leverage learning techniques that do not require operator assistance ("unsupervised"), allowing AI software to detect the signs that could announce a cyber-attack at an early stage.

DARPA[23] currently finances several initiatives in this area, including the CHESS programme,[24] which was launched in early April 2018 and aims to improve collaboration between cybersecurity experts and semi-autonomous or fully autonomous systems. The goal is to improve the resilience of computer systems against cyber threats by combining the added values of both humans and machines.

Other approaches

The potential applications of Artificial Intelligence also extend to neuroscience, with the development of solutions to improve human cognitive abilities.

DARPA, in particular, is conducting two projects with this aim:

- The RAM[25] (Restoring Active Memory) programme, introduced in 2013, seeks to create implants placed inside the human brain to help restore the memory of soldiers wounded in the field.
- Project N3 (Next-Generation Non-Surgical Neurotechnology) aims to develop a neural interface that does not require surgical procedures to help improve soldiers' capacity to multitask and also to communicate with semi-autonomous or fully autonomous systems.

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22 User Behaviour Analytics

23 Defense Advanced Research Projects Agency

24 Computers and Humans Exploring Software Security

25 RAM also refers to "Random Access Memory", i.e. the memory where computers store data while it is being processed.

The Russian Neurobotics company and the Foundation for Advanced Research Projects (FPI) – a government body that develops innovative military applications – are currently developing a neural interface to allow drones to be piloted by thought. It works as follows: the AI software processes the brain's electric signals, which are collected by sensors, and sends them to a computer that translates them into functionalities to pilot the drone.

Unlocking uses through technological advances

AI and learning

The rapid progress of AI has been made possible, among others, by the introduction of a learning functionality in machines. While it is possible to write programmes that can correctly execute simple tasks (such as calculating probabilities or comparing elements) with consistent performance, this is impossible for more complex tasks such as image recognition.

A young child, for example, will easily recognise two planes in the images below. However, this task is much more complex for a computer as, while both elements belong to the same category, they do not have the same characteristics.

Therefore, to bring machine capacities closer to human performances, a training functionality must be integrated.

To come back to our example, it is particularly difficult to identify a plane in an image as this object can have an infinity of different shapes, which, to a machine, corresponds to an infinity of pixel combinations. To make this possible, algorithms have had to evolve and become capable of "learning".

Machine learning and hardware improvements

Machine learning, also known as "automatic learning", is a subset of the field of Artificial Intelligence which, as the name implies, is related to learning capabilities. In essence, it is about "*developing computer programmes that can acquire new knowledge in order to improve and evolve on their own when they are exposed to new data.*"[26]

Machine learning algorithms fall into several broad categories that correspond to the various different types of learning. The most famous are supervised learning and unsupervised learning.

With supervised learning, the algorithm is provided with a certain number of relevant examples from which it can progressively "learn". This input data can be "labelled" images for example, that is to say images for which a description is provided. The machine will then "understand" the link between the image and the description and will be able to apply this label to other images that it has not yet encountered. This method is used in particular to teach machines how to recognise objects or how to analyse and recognise natural language, that is to say language used by humans. In this mode of operation, machines collect and analyse elements and then produce results that can be confirmed or not by humans.

In concrete terms, if a machine analyses an image of an airplane and decides that it is a helicopter, a human can point out the mistake and the system will adjust its parameters accordingly.

Through a series of trials and errors, the machine will progressively become more efficient as its suggestions are confirmed or contradicted. In this way, its knowledge base grows, its performance criteria are refined, and the results suggested become more and more reliable.

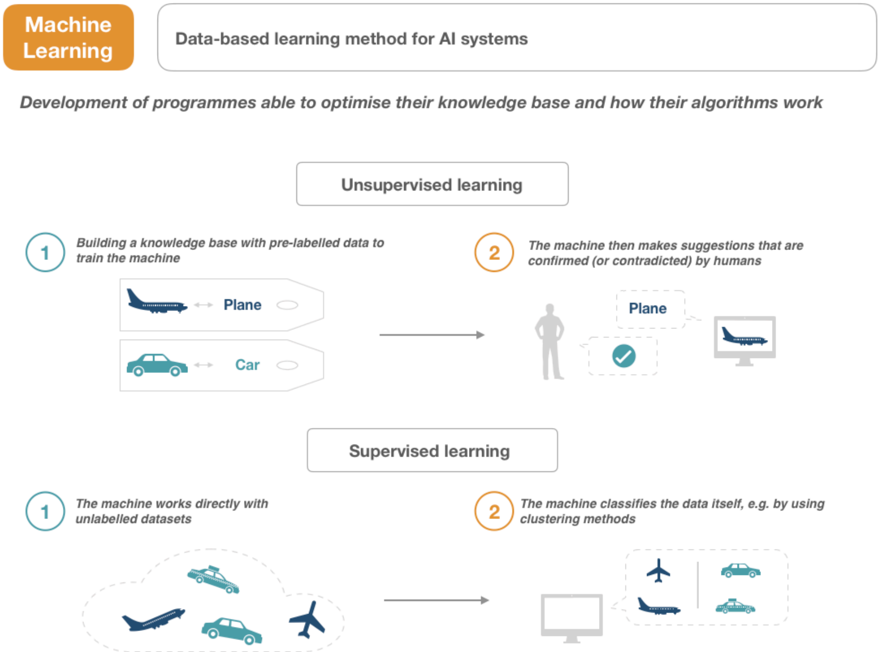
[26] https://www.ledigitalab.com/fr/intelligence-artificielle-machine-learning-deep-learning-kezako

With unsupervised learning, human beings do not need to intervene. In this situation, the algorithm works on a dataset and structures the data autonomously based on various criteria, for example by using clustering methods.[27] If images of planes and tanks are supplied as input data, the algorithm will divide them into two categories by finding links between elements in the same category based on shape analysis.

This learning method unfortunately produces results that humans do not always find easy to understand. However, the advantage is that human biases are not introduced into the algorithms from the start (by training them with manually labelled data), and therefore correlations that humans might not have seen can sometimes be discovered.

Although Artificial Intelligence helps address some of the issues raised by Big Data, the latter is itself a necessary condition to deploy AI, since AI relies on data to learn. Both concepts are therefore interrelated.

[27] Clustering is the process of organising objects into groups whose members are similar in some way" (Source: https://home.deib.polimi.it/matteucc/Clustering/tutorial_html/)



New horizons for deep learning

Deep learning refers to the system architecture and not the (supervised or unsupervised) learning method used. It is a multilayer network – hence the idea of depth – in which each layer is responsible for a specific operation and sends the result of its analysis to the next level.

Yann LeCun, head of Facebook Artificial Intelligence Research in Paris, explains how deep learning works for image recognition: *"How can one recognise an image of a cat? The key features are the eyes and the ears. How do you recognise a cat's ear? The angle is about 45°. To recognise the presence of a line, the first neural layer will compare the difference between* *the pixels above and below, which will give a level one characteristic. The second layer will work on these characteristics and combine them. If there are two lines that form a 45° angle, it will start to recognise the triangle of the cat's ear.* And so on and so forth."[28]

To summarise, each layer accomplishes a very simple task, and it is the sum of the individual actions of each different layer that allows the network to complete a complex task.

Although the idea is far from new, it has only recently been properly used through graphic processing units (GPUs).

These chips, originally designed for videogame applications, have proved very successful for deep learning applications, in particular when it comes to training neural networks to recognise objects from massive image banks.

Furthermore, the development of massively parallel architecture using GPUs – structures that can carry out certain types of calculations extremely efficiently, such as has those related to the processing of low-resolution images[29] – has paved the way for innovative applications. These structures are used by the American (GAFAM) and Chinese (BATX) giants to develop new solutions.

Some of the current research in the field of deep learning focuses on creating the best possible representation of reality and generating models that can function with these representations using the least amount of data possible. Potential applications, some of which could be particularly relevant for the Armed Forces, include recognising shapes and people, recognising speech, automatically processing natural language, and recognising audio.

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28 http://www.lemonde.fr/pixels/article/2015/07/24/comment-le-deep-learning-revolutionne-l-intelligence-artificielle_4695929_4408996.html

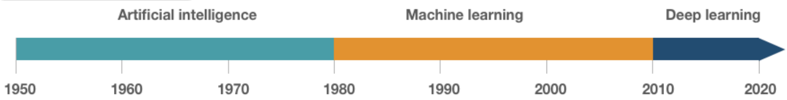
29 https://tel.archives-ouvertes.fr/tel-00820700/file/phdAP.pdf

Deep Learning

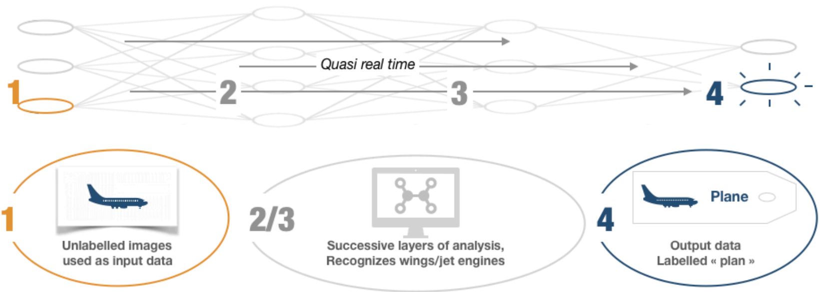
Learning method based on systems' physical architecture

Architecture comprising several layers, each one responsible for a specific operation and sending the result of its analysis to the next level

Progress of AI



Deep learning



Challenges of AI for the defence sector

Having useful data

Artificial Intelligence is based on algorithms whose main added value is the processing, very quickly or in quasi real time, of huge quantities of information that humans cannot assimilate.

In other words, leveraging AI requires access to large amounts of relevant data, at least during the algorithm training phase – the use phase can sometimes rely on a small dataset linked to a powerful algorithm. Therefore, without this initial data input, AI cannot produce results.

Furthermore, the data provided must – if this is not already the case – be structured in such a way that it can be processed. To train a machine to recognise specific images, input data must be *"classified and labelled in advance, work which is often done manually".*[30] This may require a great deal of effort: in the Maven project mentioned above, for example, more than 150,000 images were labelled one by one by humans to create the initial data sets needed to train the algorithms.[31]

30 https://geointblog.wordpress.com/2018/04/11/le-pentagone-dans-la-course-a-lintelligence-artificielle

31 http://www.intellisia.org/index.php/Index/news_page/id/121.html

Developing personnel skills

The human resources (HR) dimension must also be taken into account. In many cases, the implementation of process automation methods – such as installing passenger screening gates at airports – is seen as a way to reduce staff numbers by using machines to manage more cases within tight deadlines. In practice, machines focus on certain repetitive tasks that they can perform quickly and with consistent performance, giving humans more time to perform more complex tasks. As an example, machines compare the photos in a passenger's passport with his face, while humans continue to carry out behavioural analysis.

In other words, **AI will make personnel more productive by allowing them to focus on tasks where human intelligence currently has an undeniable added value.** At the same time, **the skills of these staff members, who will have to perform new tasks**, must be developed, among others by identifying ways to improve the performance of machines. The large-scale introduction of AI will also lead to a growing need for talent to create, configure and run the relevant software.

Adopting the civil sector's "short loop"

It is impossible to implement AI solutions with to the usual cycles of military programme development that can span years. Indeed, information and communication technologies and AI-related technologies are driven by **the civil market, where development cycles are very short** – sometimes only a few months – compared to the Armed Forces where cycles can last several decades.

To adapt to this environment, small teams with diverse skills, combining operational and technical specialists, must be put in place. **Solutions**

benefit from a quick turnaround and various iterations – always in partnership with end-users. Ideally, end-users should be able to share their feedback, which can then be used to improve solutions through successive iterations.

The creation of mechanisms focused on integrating the progressive innovation momentum in the defence sector shows that this challenge is being taken into account. For example, the US Department of Defense's Defense Innovation Unit eXperimental (DIUx), located in the heart of Silicon Valley, commits to getting projects off the ground in less than 60 days. To do so, the body relies on a mechanism known as "Other Transaction Agreements Commercial Solutions Openings", which does not follow the Pentagon's usual acquisition procedures.

Solutions in degraded mode

The very nature of military missions means Armed Forces must think about the deployment and **use of applications** relying on Artificial Intelligence in **a particular environment characterised by limited network capacity and poor operating conditions** in theatres of operation.

Some of the applications mentioned above allow a large amount of information to be processed in record time, which can facilitate decision-making. However, they have the disadvantage of taking up a lot of bandwidth as these large datastreams must be transferred to a central hub to be processed. Such a system is not always a viable option for the Armed Forces, particularly when conducting operations in remote, off-the-grid areas. In this specific context, one avenue to explore is how AI can work "locally" as opposed to what could be described as a "centralised" mode of operation.

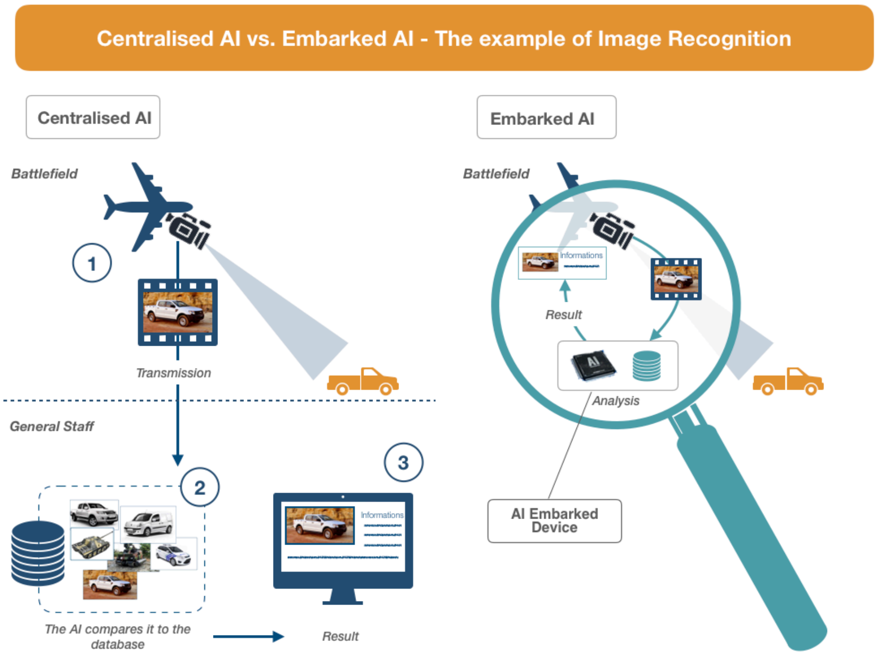
In summary, **the centralised mode involves sending all the information to a single point** so that it can be compared to massive databases stored on servers. Algorithms are therefore enriched and refined as they come into contact with ever-increasing volumes of information.

The local mode of operation, on the other hand, involves **an embarked "trained" algorithm with a smaller database on a terminal**. This type of solution is then able to interpret its environment from a few weak signals. This architecture opens the door to significantly smaller data streams – and therefore to solutions that are truly operational in degraded conditions.

Indeed, **embarked tools perform their analysis without relying on external resources**. However, there are disadvantages to this system, namely lower computing power and a smaller database. Furthermore, this technique creates unique systems since each system evolves based on the data it receives, making it increasingly different from the other systems in its category.

The respective merits of both approaches – from a strictly military point of view – are summarised in the table below:

	"Centralised" AI	*"Local" AI*
Database	Massive, centralised	Smaller, local
Methodology	Machine learning	Optimisation of algorithms
Access	Networked client	"Offline" possible
Use	General staff only	Also possible during operations



Risks related to the use of AI

While the implementation of AI-based solutions is of undeniable interest to the Armed Forces, the use of these technologies nevertheless entails a certain number of risks:

- By using algorithms that can theoretically be "read and understood" by opponents, **forces –** and their movements in particular – **could become predictable** and thereby vulnerable.
- Poorly configured or misused algorithms could lead to **a flood of information that could paralyse decisions**, or even lead to poor decision-making due to analysis carried out by software in which human bias has been introduced, voluntarily or not.
- Once the use of AI becomes a habit, it can be tempting to constantly question the algorithms and **remain stuck in the "analysis" phase without ever taking action**, which leads to paralysis.
- Once humans have become used to relying on AI as a "decision-making crutch", **they could gradually lose their skills (e.g. navigation).**

Taking these realities into account is a necessary prerequisite for the deployment of AI-based solutions.

To conclude, Artificial Intelligence – which allows the processing of huge volumes of information that humans could not otherwise use – could have real added value for the Armed Forces. If used properly, it would make it possible to do better or more in many areas, by relieving people of certain tasks.

However, AI is not a panacea. In this respect, the classification established by Jean-Claude Heudin, head of the *Institut de l'Internet et du Multimedia* (Internet and Multimedia Institute), which distinguishes six levels of Artificial Intelligence, is particularly enlightening:[32]

Level 1	Sub-human for specific tasks
Level 2	Equivalent to a human for specific tasks
Level 3	Superior to most human intelligence for specific tasks (Alpha Go)
Level 4	Superior to all human intelligence for specific tasks
Level 5	Superior to human intelligence for most tasks – Artificial General Intelligence
Level 6	Ultimate Artificial Intelligence (technological singularity)

As Heudin points out, while the development of Level 4 AI is within the realm of the possible, this is absolutely not the case at present for the higher levels. In summary, while AI can provide valuable assistance for specific tasks, it is not a miracle solution that can completely replace humans in decision-making.

32 http://www.mondedesgrandesecoles.fr/robots-intelligence-artificielle-futur-de-lindustrie/

In addition, the deployment of AI-based solutions – whether in the form of stand-alone platforms or image recognition software – only makes sense if they provide real operational added value. This is the criterion that should ultimately govern whether or not AI is used.

Finally, the increased use of AI for military purposes should lead to questioning how these technologies are used and their consequences on military doctrine, whether in peacetime or in wartime.

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