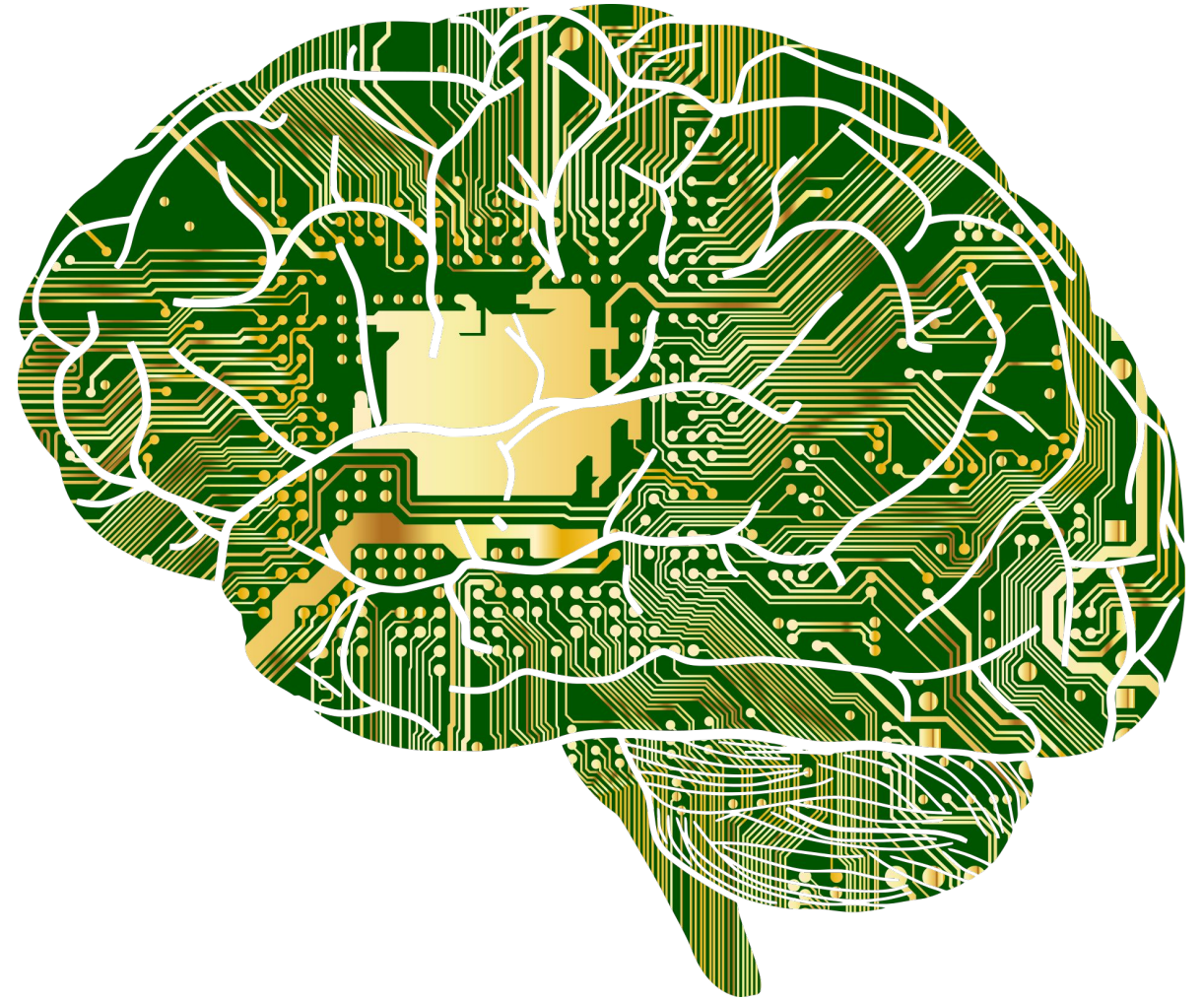


Artificial Intelligence

Opportunities and Challenges for Military Modeling and Simulation

Andy Fawkes



Overview

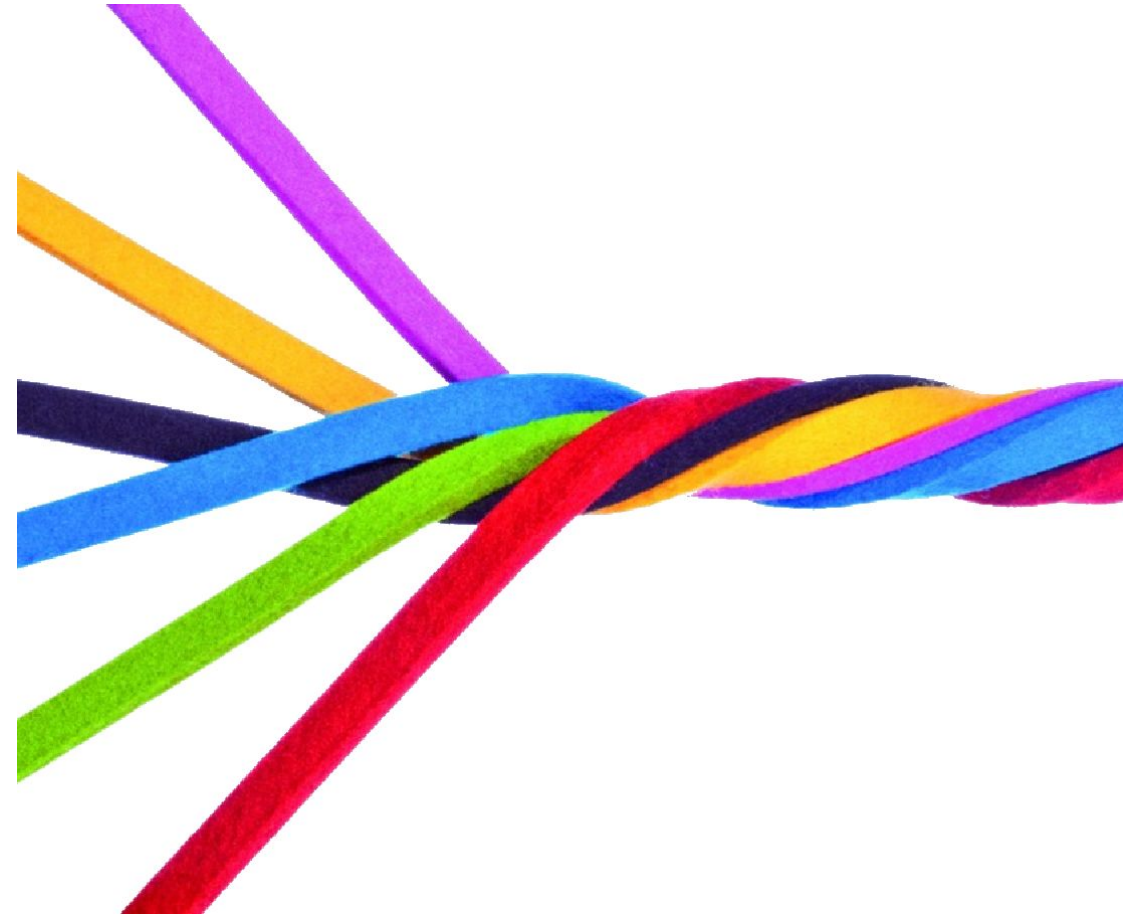
- **Context**
- **What is Artificial Intelligence?**
- **Historical Context**
- **Current Developments**
- **Conclusions**

High Level View



Principal Message

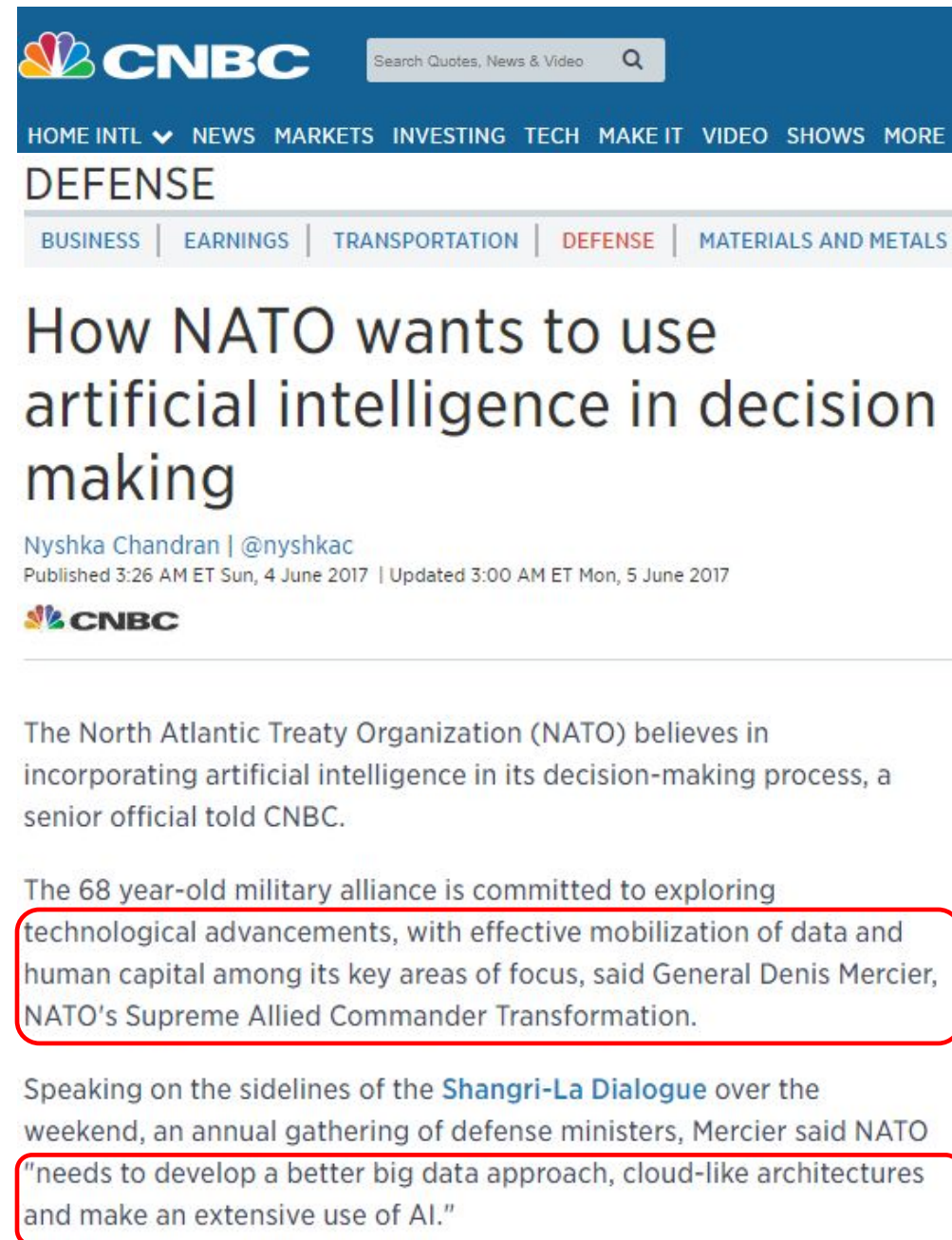
Developments in
Artificial Intelligence
are entwined with
those in M&S and
Gaming



Context

Relevance to NATO

- NATO Science and Technology Organization's (STO) Principal Themes in 2017 include:
- "Military Decision Making using the tools of Big Data and Artificial Intelligence (AI)"



The screenshot shows the top portion of a CNBC news article. The header includes the CNBC logo, a search bar, and navigation links for HOME, INTL, NEWS, MARKETS, INVESTING, TECH, MAKE IT, VIDEO, SHOWS, and MORE. Below this is a 'DEFENSE' category bar with sub-links for BUSINESS, EARNINGS, TRANSPORTATION, DEFENSE (highlighted), and MATERIALS AND METALS. The article title is 'How NATO wants to use artificial intelligence in decision making' by Nyshka Chandran (@nyshkac), published on June 4, 2017. The article text states that NATO believes in incorporating artificial intelligence in its decision-making process. A quote from General Denis Mercier is highlighted in a red box: 'The 68 year-old military alliance is committed to exploring technological advancements, with effective mobilization of data and human capital among its key areas of focus, said General Denis Mercier, NATO's Supreme Allied Commander Transformation.' Another quote is also highlighted in a red box: 'needs to develop a better big data approach, cloud-like architectures and make an extensive use of AI.'

CNBC Search Quotes, News & Video

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DEFENSE

BUSINESS | EARNINGS | TRANSPORTATION | **DEFENSE** | MATERIALS AND METALS

How NATO wants to use artificial intelligence in decision making

Nyshka Chandran | @nyshkac
Published 3:26 AM ET Sun, 4 June 2017 | Updated 3:00 AM ET Mon, 5 June 2017

CNBC

The North Atlantic Treaty Organization (NATO) believes in incorporating artificial intelligence in its decision-making process, a senior official told CNBC.

The 68 year-old military alliance is committed to exploring technological advancements, with effective mobilization of data and human capital among its key areas of focus, said General Denis Mercier, NATO's Supreme Allied Commander Transformation.

Speaking on the sidelines of the [Shangri-La Dialogue](#) over the weekend, an annual gathering of defense ministers, Mercier said NATO "needs to develop a better big data approach, cloud-like architectures and make an extensive use of AI."

WIRED

TOM SIMONITE BUSINESS 09.08.17 07:00 AM

FOR SUPERPOWERS, ARTIFICIAL INTELLIGENCE FUELS NEW GLOBAL ARMS RACE



MIKHAIL KLIMENTYEV/AP

9 Aug 17

AI in the News

6 Sep 17



Elon Musk / Getty Images

Tesla and SpaceX CEO says Russia's superiority in robotics field a major cause for concern

LEONID BERSHIDSKY
Wednesday 6 September 2017 10:23 BST

90 SHARES Like CLICK TO FOLLOW THE INDEPENDENT TECH



Forbes / Tech / #BigData
SEP 18, 2017 @ 12:28 AM 42,197

The Amazing Ways Coca Cola Uses Artificial Intelligence And Big Data To Drive Success



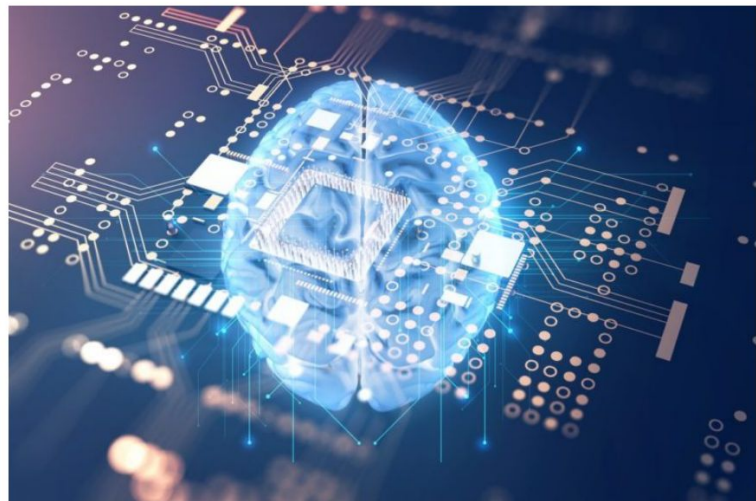
Shutterstock

18 Sep 17

Business Matters

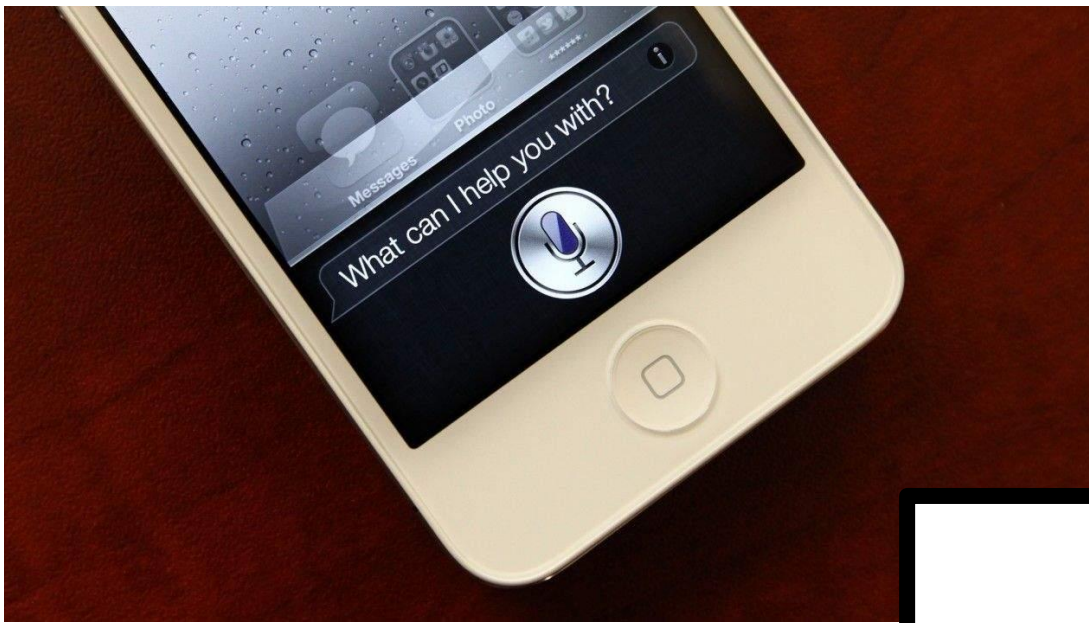
The UK's leading SME business magazine

Over half of employees believe artificial intelligence will affect their job in the future

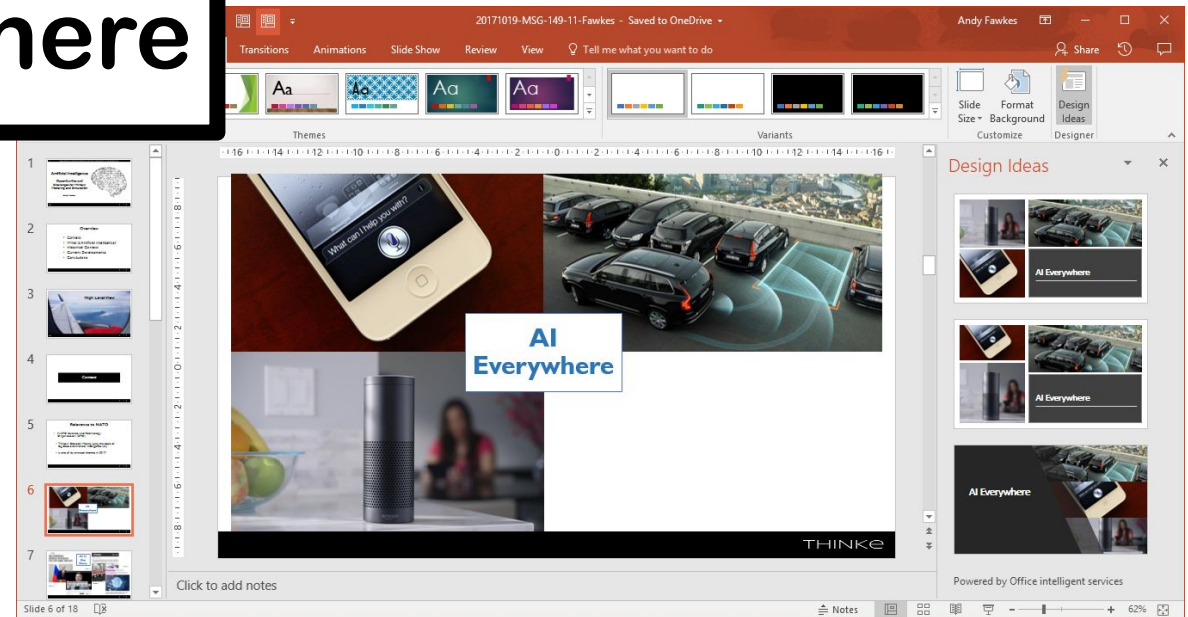


Research revealed that more than half of employees expect artificial intelligence to affect their working lives within three years.

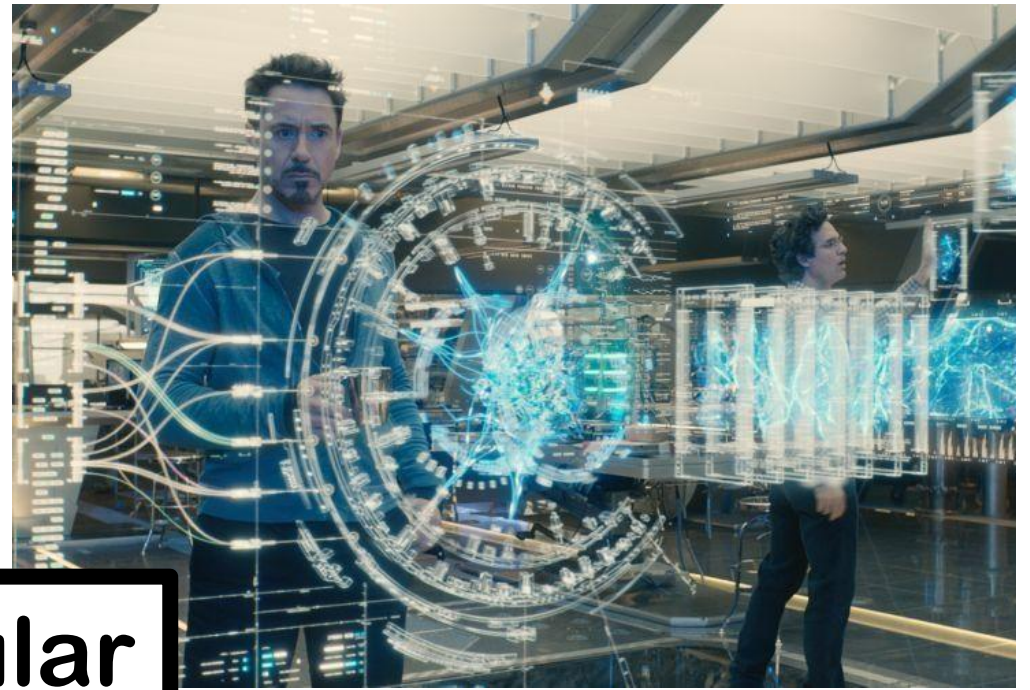
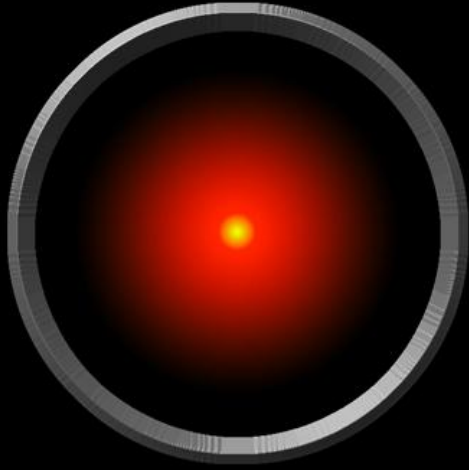
THINKE



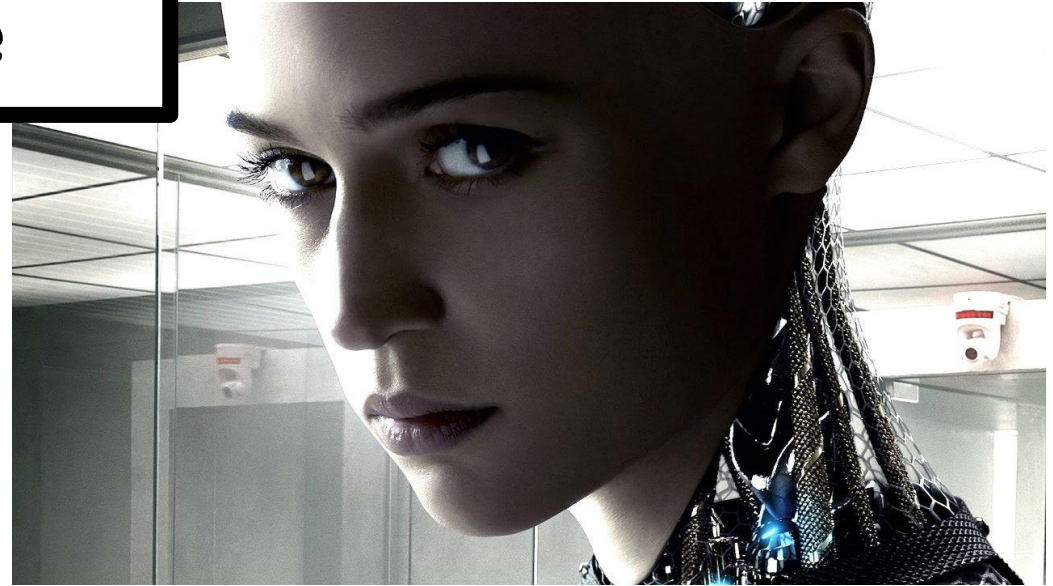
AI Everywhere



I'm sorry Dave,
I'm afraid I can't do that.



AI in Popular Culture



THINKE

Cost

MailOnline

Science & Tech

[Home](#) | [News](#) | [U.S.](#) | [Sport](#) | [TV&Showbiz](#) | [Australia](#) | [Femail](#) | [Health](#) | **[Science](#)** | [Money](#) | [Video](#) | [Travel](#) | [Fashion Finder](#)

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Google has spent at least \$1.1 BILLION on developing self-driving cars, document reveals

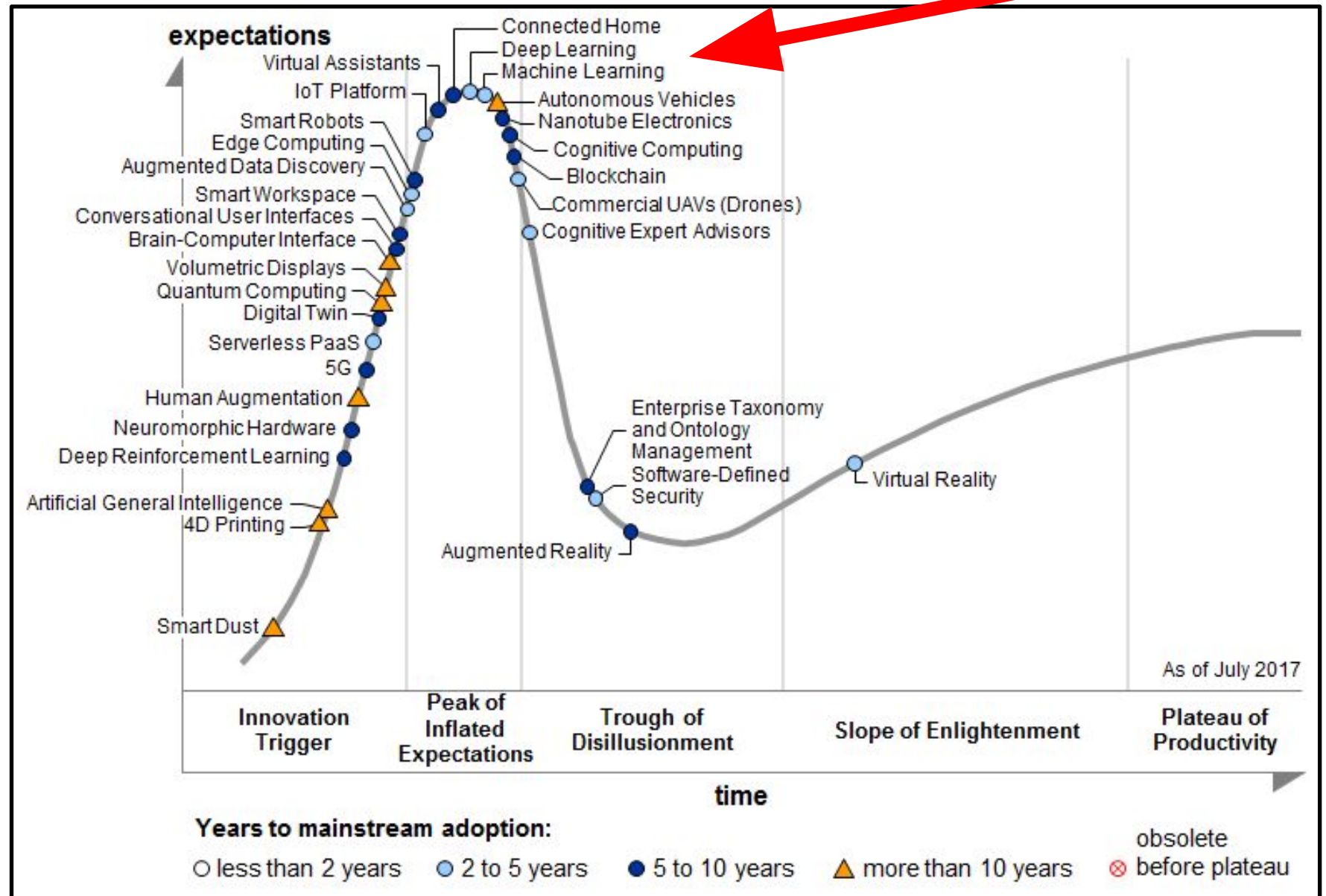
- Google accidentally revealed its spent \$1.1 billion developing self-driving cars
- The firm forgot to redact the total from deposition given in the case against Uber
- It's less than Intel but in line with the \$1 billion GE has put into Cruise Automation

By [SAGE LAZZARO FOR DAILYMAL.COM](#)

PUBLISHED: 23:54, 15 September 2017 | **UPDATED:** 00:40, 16 September 2017

Hype?

Gartner
(July
2017)



What is Artificial Intelligence?

AI Definition

Oxford Dictionary

- “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.”

AI Scope

- The nature of the intelligence can be:
 - “narrow” intelligence which is highly tailored or specialised through to
 - artificial “general” intelligence which is flexible, adaptive and inventive, much like the human brain

Is it Really Intelligence?

- AI in many games/simulations appears to represent human behaviour but this is pre-programmed and there is little or no learning over time.
- Professor Isbell (Georgia Tech) proposes that AI systems should have two features :
 - They must learn over time as their environment changes
 - Their challenge must be demanding too for humans to learn



AI Techniques

- **Many approaches to AI, eg:**
 - **decision trees**
 - **fuzzy logic**
 - **neural nets**
 - **machine learning**
 - **deep or reinforcement learning**

Historical Context

Early Days



1950
Alan Turing (1912-1954)



1955
John McCarthy (1927-2011)

Feasts and Famines

- Early successes in areas such as mathematical problem solving with some of the ideas being central to modern AI, such as those behind neural networks
- Funding for AI research ebbed and flowed with hype cycles in the 1970s, 80s and 90s
- In 1984 the term “AI Winter” was coined describing a period of reduced funding and interest in AI research



SIMNET and SAFs – 80s/90s



- BBN SAF
- BDS-D CGF
- IFOR/WISSARD
- ModSAF 1.0
- CCTT SAF
- Janus
- OneSAF

SAF - Semi-Autonomous Forces

Meanwhile...



**Radio Shack - 1988
Model 60-2204 - \$249.95**



**IBM Deep Blue - Feb 96 - first
machine to beat a reigning
world Chess champion
(Garry Kasparov)**

BML & C-BML (now C2-Sim)

- **Battle Management Language (BML) (2001) and Coalition Battle Management Language (C-BML) (2004)**
- **Link between C2 and Simulation Systems**
- **Standard digitized representation of a commander's intent to be used for real troops, for simulated troops, and for robotic and automated forces**

Current Developments

Driving Factors in Artificial Intelligence

1. Hardware

- Faster Processors hosted locally or in the cloud
- Synergies of AI programming (eg. solving matrices) and graphics cards

2. Data

- Explosion of data, online and real time, to train AI programs

3. Algorithms

- Algorithms such as deep learning are a major force driving AI

AI Learning in Games (2015)

Google DeepMind's Deep Q-learning

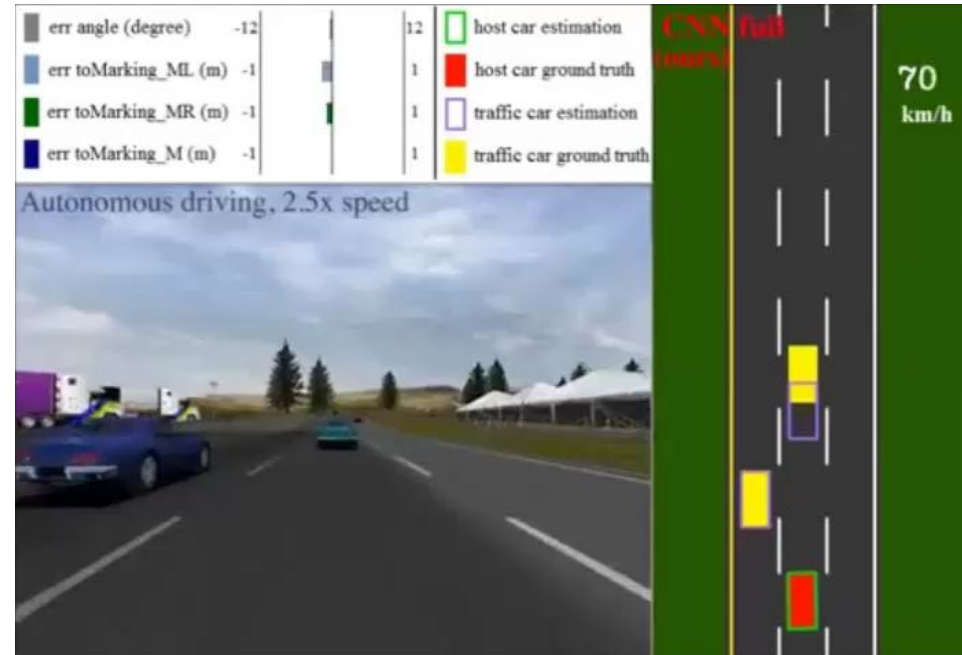
The algorithm will play Atari breakout.

The most important thing to know is that all the agent is given is sensory input (what you see on the screen) and it was ordered to maximize the score on the screen.

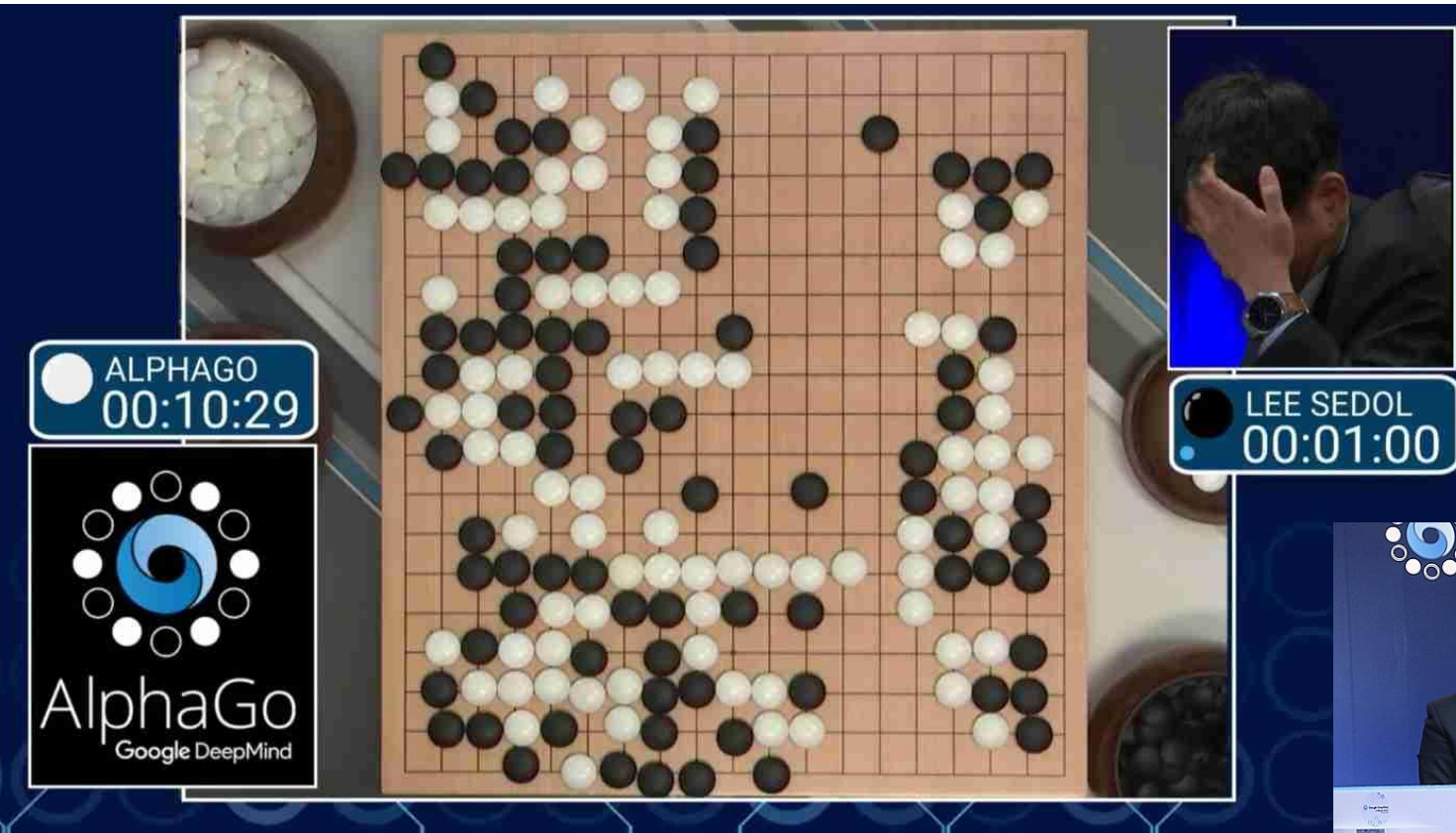
No domain knowledge is involved! This means that the algorithm doesn't know the concept of a ball or what the controls exactly do.

Google DeepMind (Atari Breakout)

Princeton University (TORCS Racing Simulator)



Board Games and AI



AlphaGo (2016)



Latest News... (Oct 2017)

- Latest DeepMind incarnation is “AlphaGo Zero”, with new neural net design
- Trained in 3 days, no human intervention except Go rules
- Result:
 - “AlphaGo Zero” beats “AlphaGo” – 100 to 0



DeepMind and Blizzard release new tools to train AI using Starcraft

What can computers learn from playing video games? Quite a lot actually

by James Vincent | @jvincent | Aug 9, 2017, 1:00pm EDT

f SHARE t TWEET in LINKEDIN



A screenshot of Starcraft II, a real-time strategy game where players control human or alien armies. | Image: Blizzard

AI and Strategy Games (2017)

Starcraft

1. A multi-agent problem
2. Imperfect information
3. Large & diverse action space
4. Early decisions influence the game later

So What?

**Computers are being
programmed to learn
how to play games, not
how to play games**

Nvidia's Isaac Robot Training (May 2017)

ROBOTS



Credit: Nguyen Chetrit, Kevin Hsu, Marvin Zhang, Sergey Levine

Berkeley University



Machine Learning Agents



Introducing: Unity Machine Learning Agents

Arthur Juliani, September 19, 2017

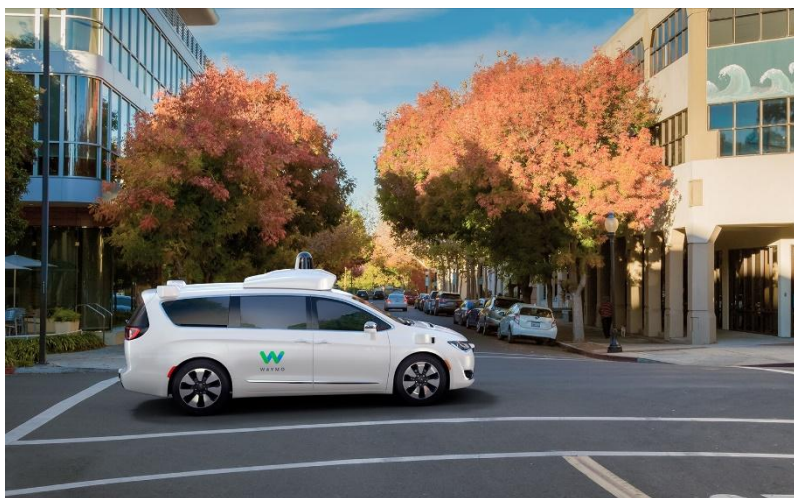
Unity Games Engine Machine Learning Agents (Sep 2017)



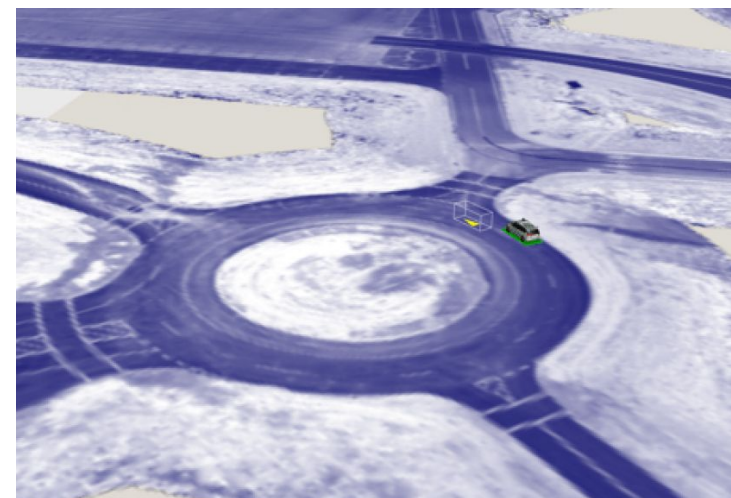
Machine Learning Agents

Simultaneous Training Demo

Alphabet (Google) Waymo



3 Million Real Miles (2016)



**2.5 Billion Simulated Miles
(2016)**

Military Autonomous Systems

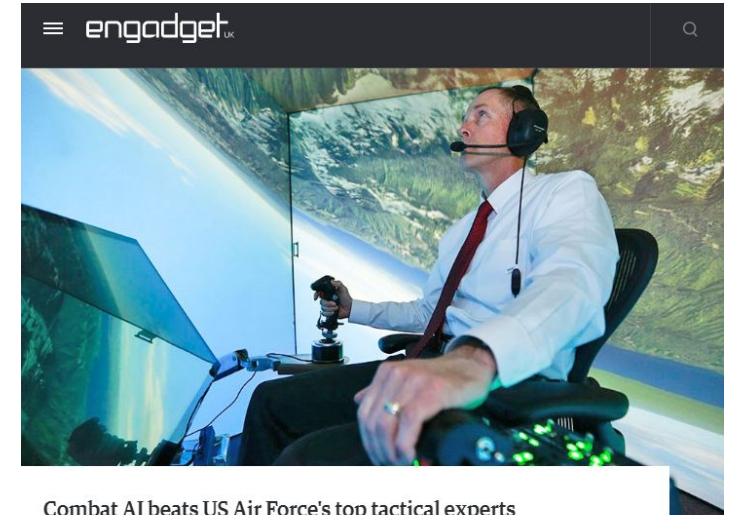


**US Navy
X-47B**



**US Army
Manned-Un
manned
Teaming
(MUM-T)**

**US AFRL
“ALPHA”**



Combat AI beats US Air Force's top tactical experts

And it only requires the processing power of a Raspberry Pi.

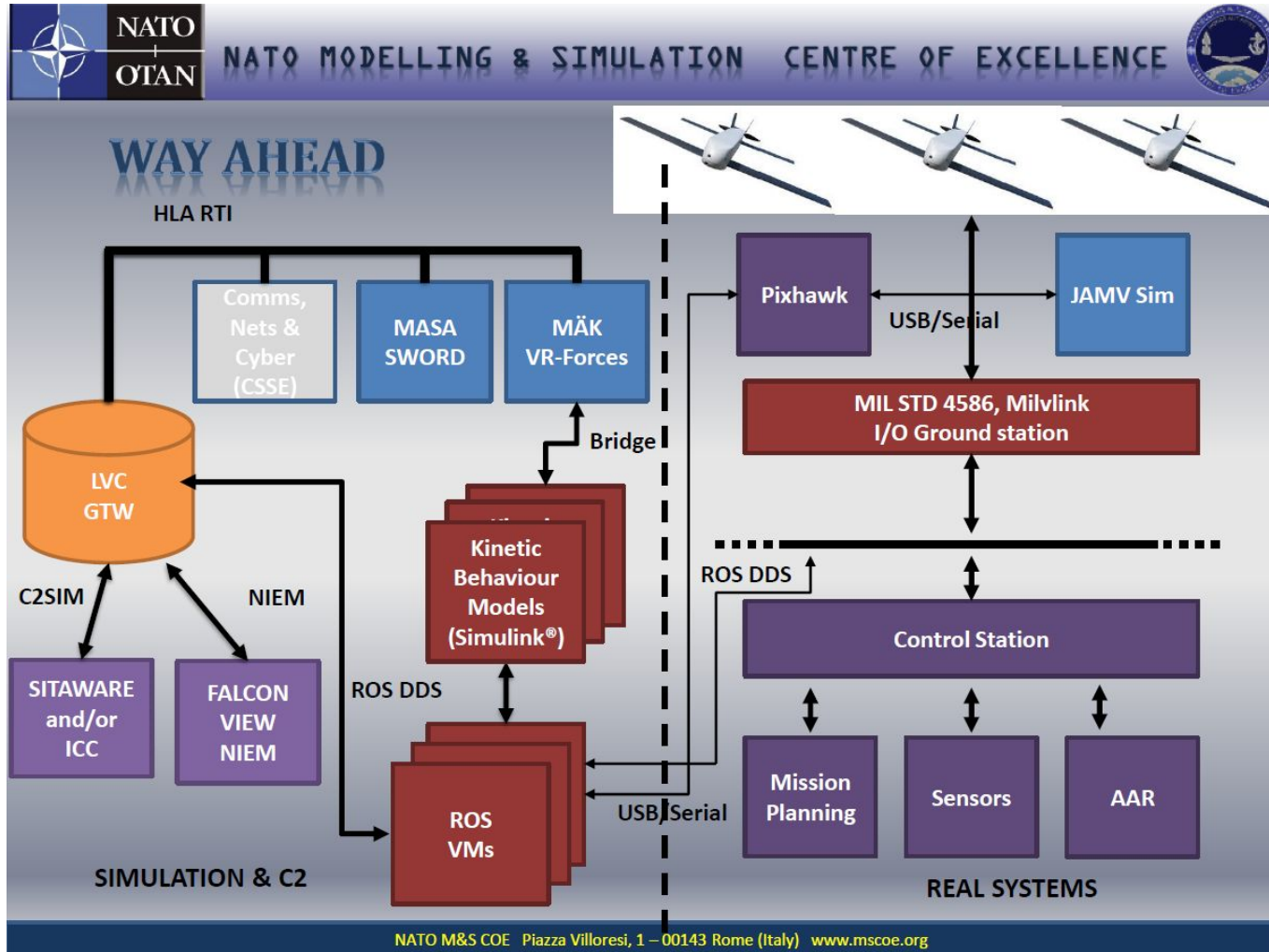


Andrew Dalton , @dolftown
06.28.16 in Robots



**US Navy
Autonomous
Craft**

M&S and Autonomous Systems



HLA/Robot Operating System (ROS)

Do We Need to Concern Ourselves with Autonomous System Interoperability?



The Ethical Dimension of Artificial Intelligence

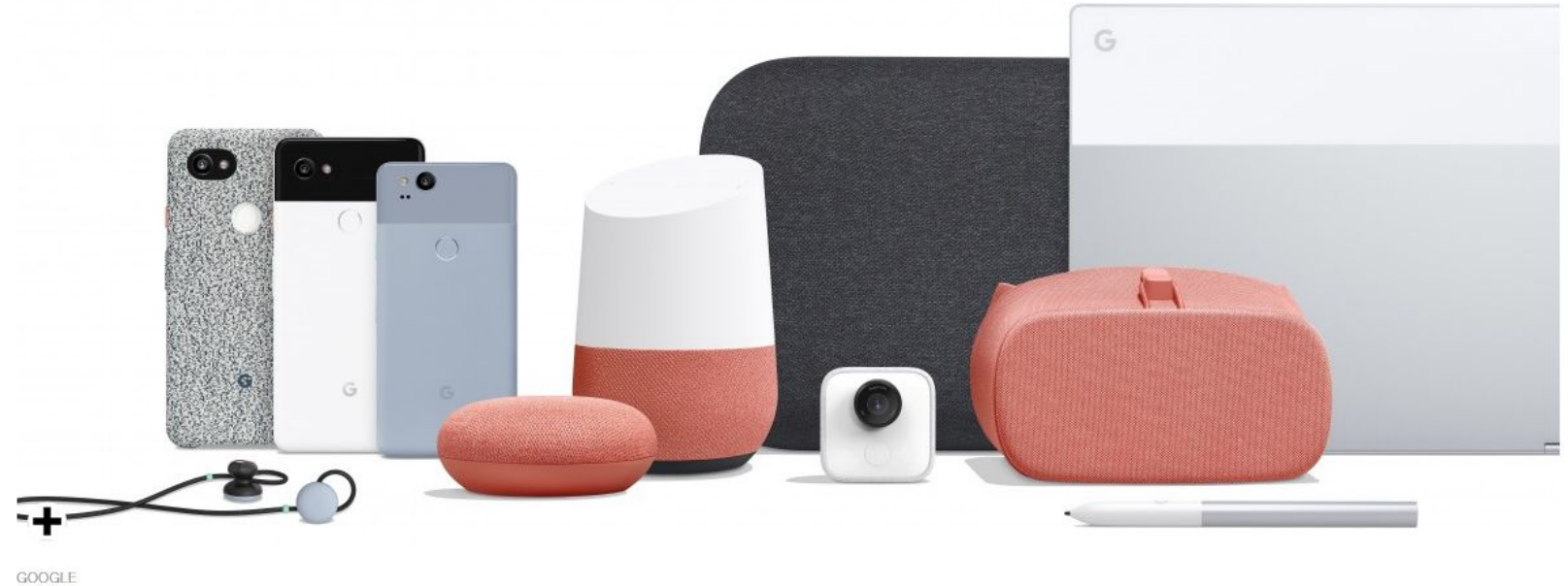
German Government Autonomous Car Design Principles (2017)

1. Automated/networked driving is ethically necessary if the systems cause fewer accidents than human drivers
2. In the event of danger, the protection of human life always has top priority
3. For unavoidable accidents, any qualification of people according to personal characteristics (eg. age) is not permitted
4. At all times the system must state who is responsible: the human or the computer
5. Anyone who drives must be documented
6. The driver must be able to decide themselves about the use of their vehicle data

UK Ministry of Defence (2017):

“It’s absolutely right that our weapons are operated by real people capable of making incredibly important decisions, and we are guaranteeing that vital oversight”

Privacy...



Connectivity

OK Google, Get Out of My Face

Ubiquitous computing is starting to get (really) real and I'm kind of afraid of it.

by Rachel Metz October 4, 2017

Artificial Intelligence Technology Challenges

- Large volumes of data are required, especially for modern neural net AI approaches
 - *Favours the large Tech companies?*
- AI programs typically can only do one task
 - *"there is no neural network in the world, and no method right now that can be trained to identify objects and images, play Space Invaders, and listen to music" (DeepMind)*
- AI programs can be difficult to understand and verify after programming
 - *DARPA's Explainable Artificial Intelligence (XAI)*
- Cyber Security?

Still Some Way to Go



Tom Clancy's Rainbow Six: Vegas
2

Google Street View



Conclusions

Some Key General Points

- Artificial intelligence as a concept is 60 or so years old with a number of cycles of growth and stagnation
- Currently in high growth period driven by processing power, availability of data, and algorithm improvements, with predominantly non-military funding
- Games and simulations are being used to test and train AI prior to deployment in the real world
- Significant challenges remain:
 - AI programs tend to be single function, require very large datasets to train from, and may have verification issues
 - Ethical and social issues can be very challenging now and into the future

Some Key Points for NATO

- AI and autonomous systems cut across many communities both inside and outside of the military
- The military M&S community itself has much to contribute given its development of AI in simulation systems and interoperability standards such as C2SIM and HLA
- Can the M&S community learn from non-defence sphere in the use of simulations and games to train and test AI, both for its own uses and wider exploitation?
- The human is always likely to be part of the military decision cycle, and working towards the optimum human and AI teaming should be a clear objective
- Simulation should have a key role in testing and training both humans and AI to achieve this optimum blend
- Do we need to concern ourselves with Autonomous System Interoperability?
- Assessing the risks of potential adversary's use of AI and commercial autonomous systems is necessary

Questions?

