



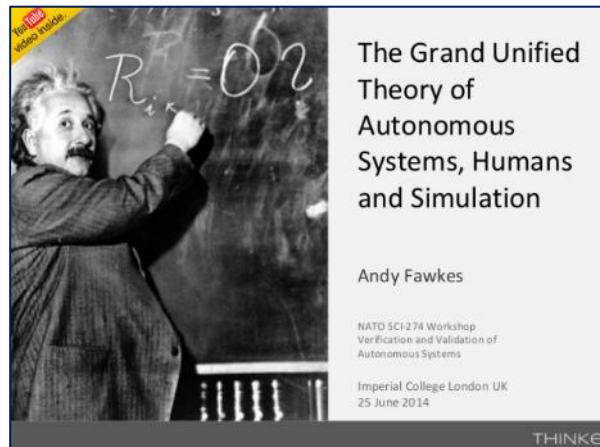
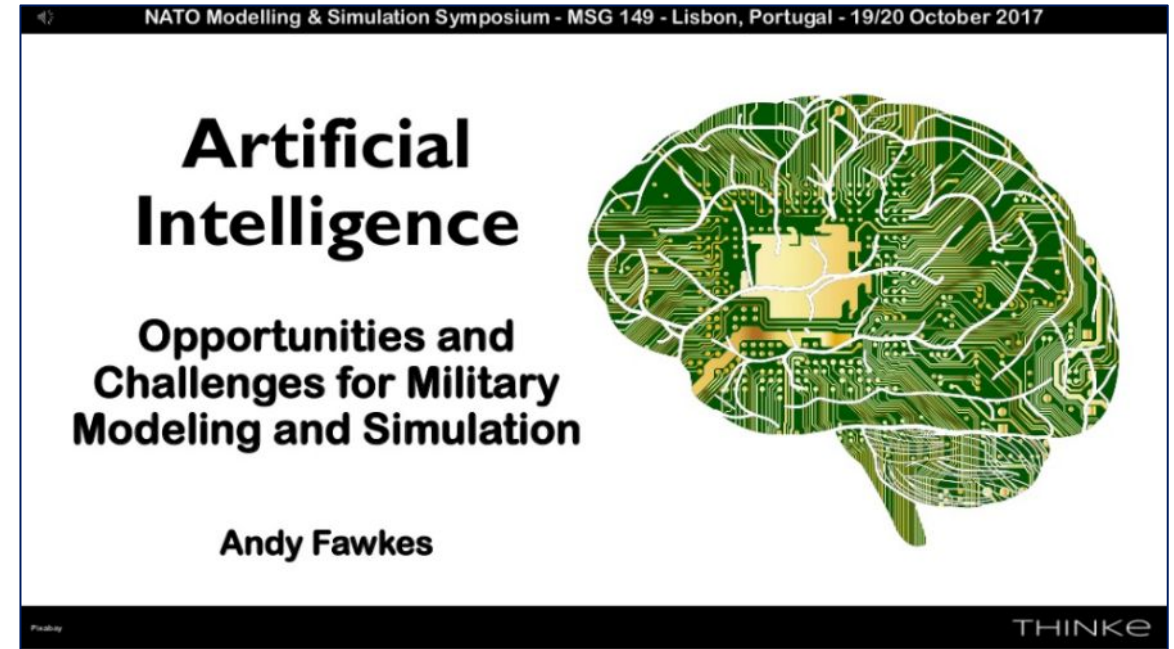
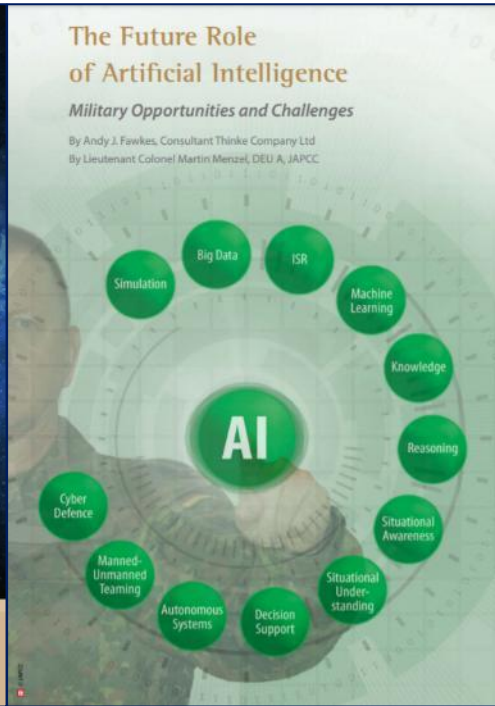
US Navy

**3rd Annual SMi
Unmanned Maritime Systems
Technology Conference
London - 9 May 2019**

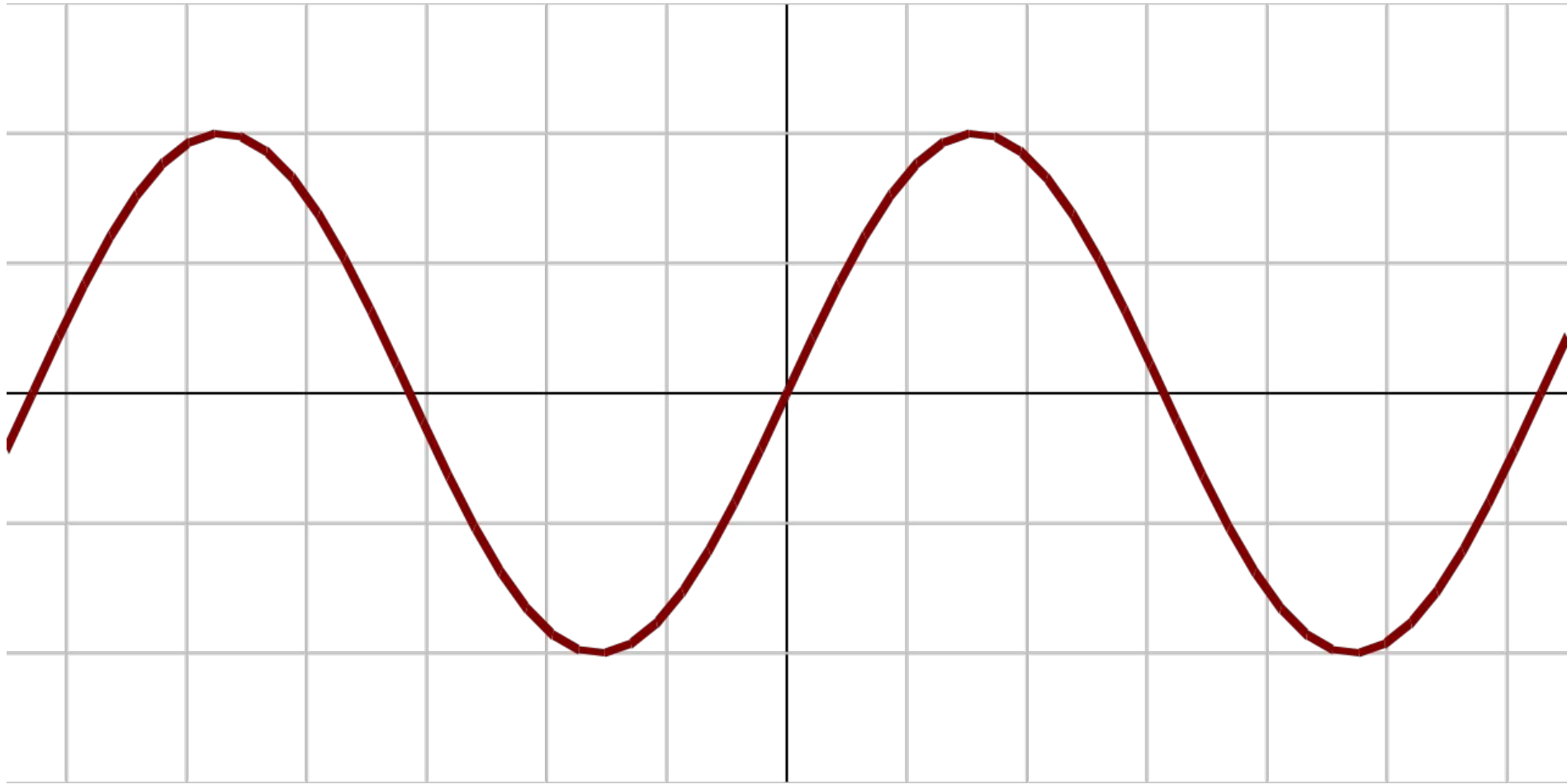
A Training & Simulation Perspective

Andy Fawkes

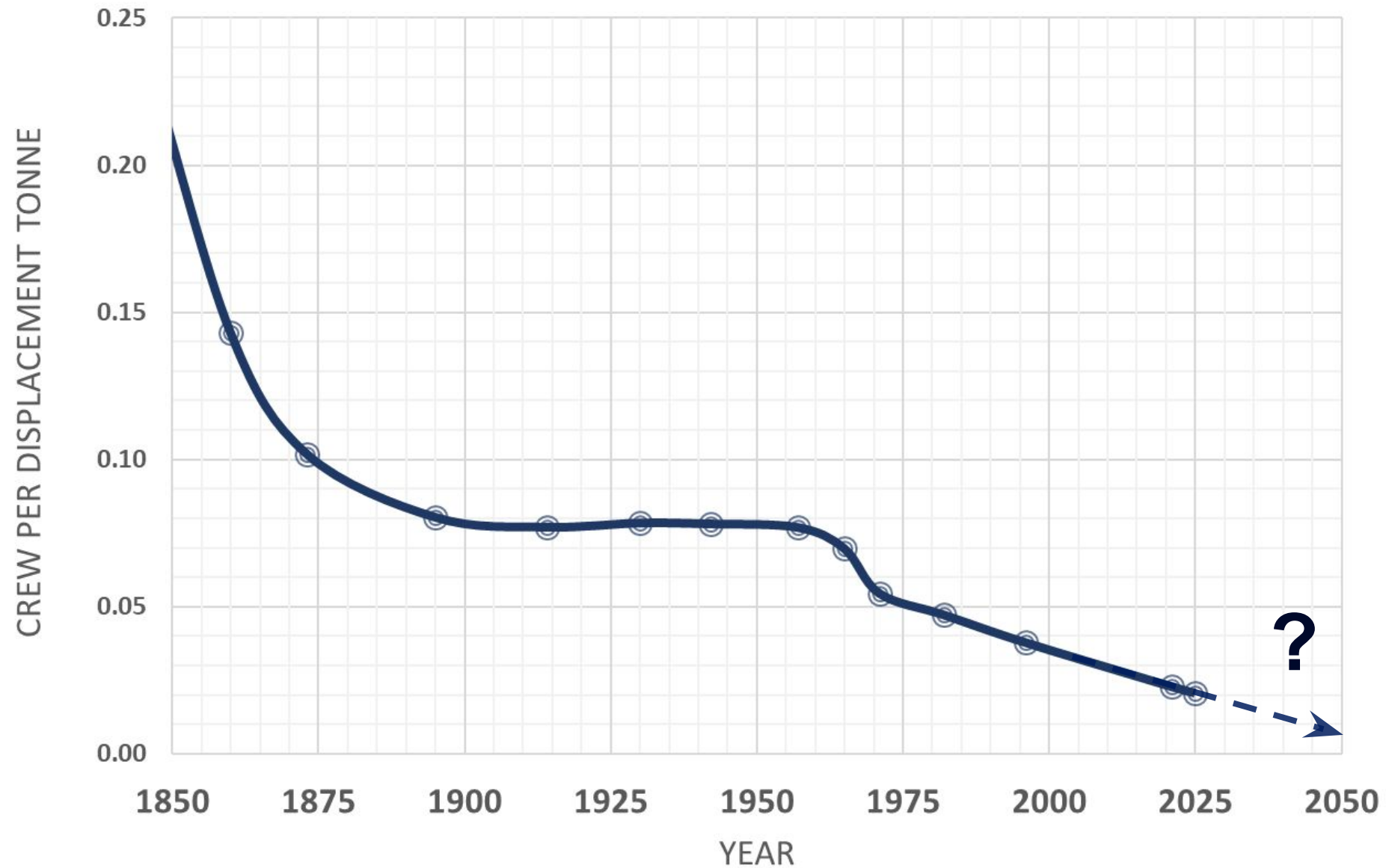
Earlier Presentations/Publications



My Feelings on Unmanned/Automation



RN Frigates – Crew per Displacement Tonne



- **The Unmanned Challenge**
- **Unmanned Trends**
- **Training & Simulation Trends**
- **AI & Gaming**
- **Sailor(s) of the Future?**

Presentation Overview

The Unmanned Challenge

unmanned
“not having
or needing a
crew or
staff”

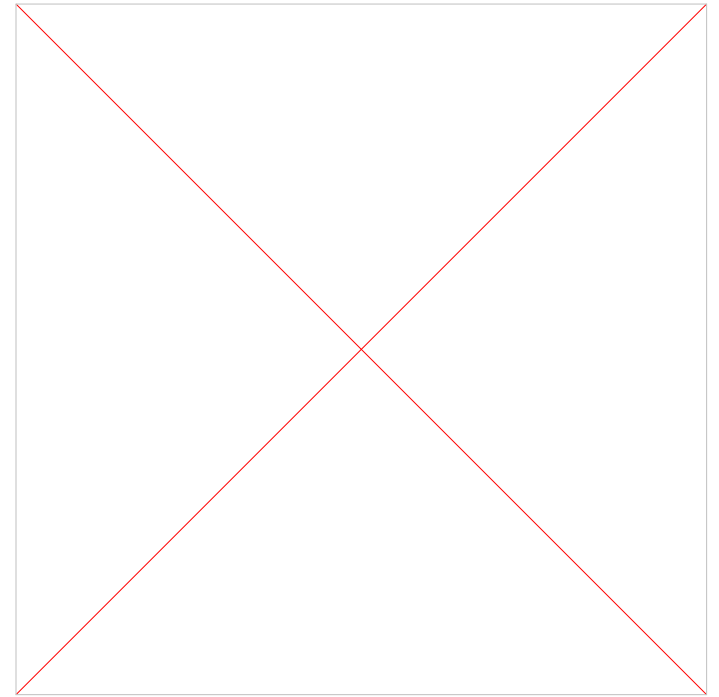
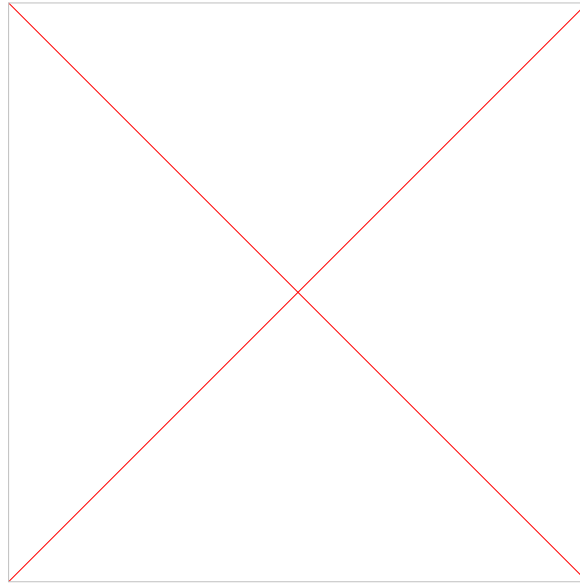
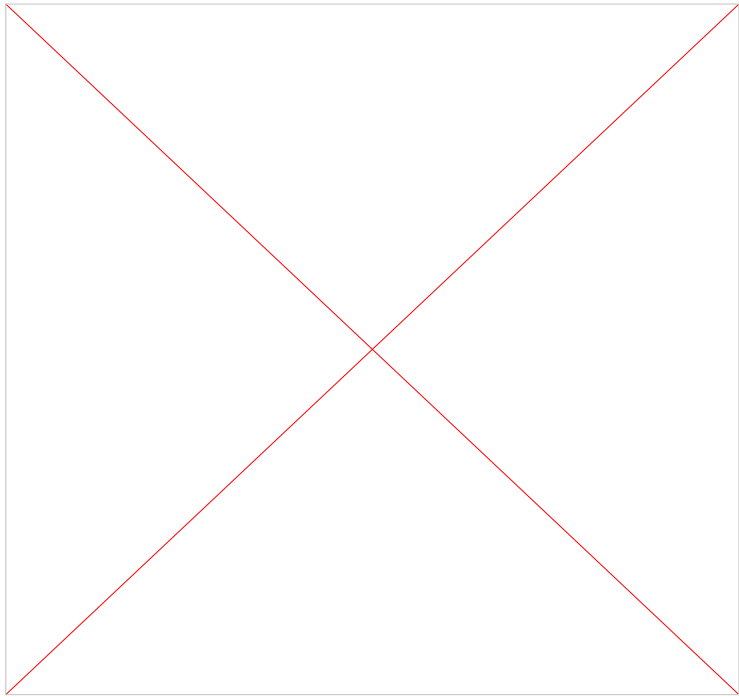
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Autonomy and Communications



Autonomy and Communications

High Communications



Low Communications



Single Role

Multi Role

Communication and Trust



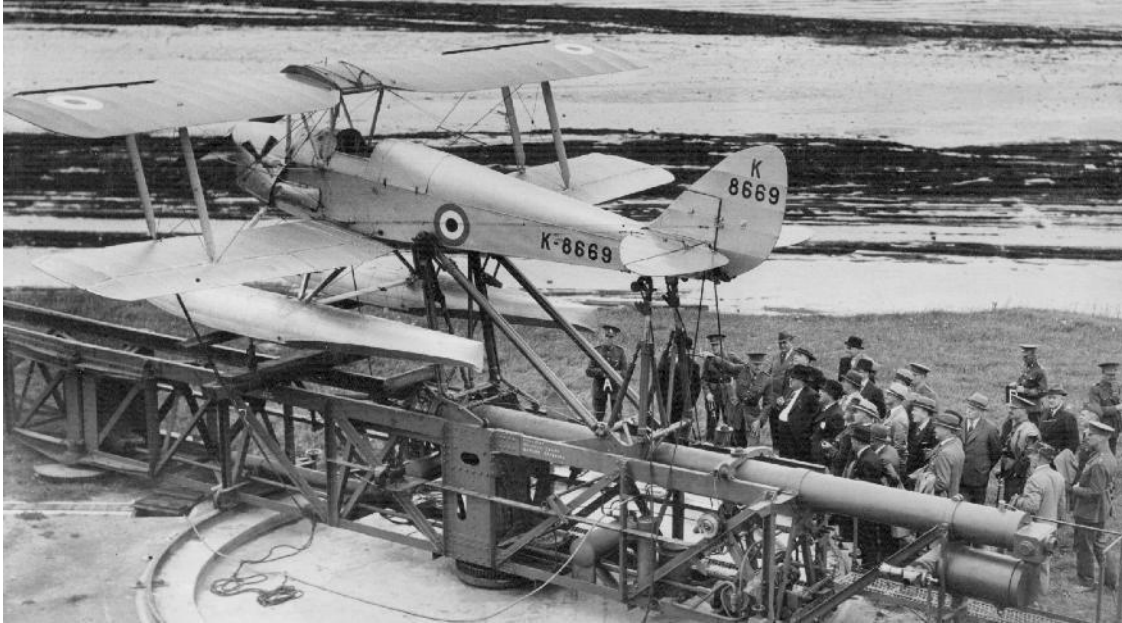
Some Driving Factors for Unmanned Systems

- **Communications**
- **Reliability**
- **Programming**
- **Computing**
- **Data Availability**
- **Sensors**
- **Power**
- **Culture**

Unmanned Trends



Remote Pilots



**Radio Controlled “Queen Bee”
(1936)**

Sailor of the Future?



Sailors of the Future?



Autonomous Ferry – Dec 18



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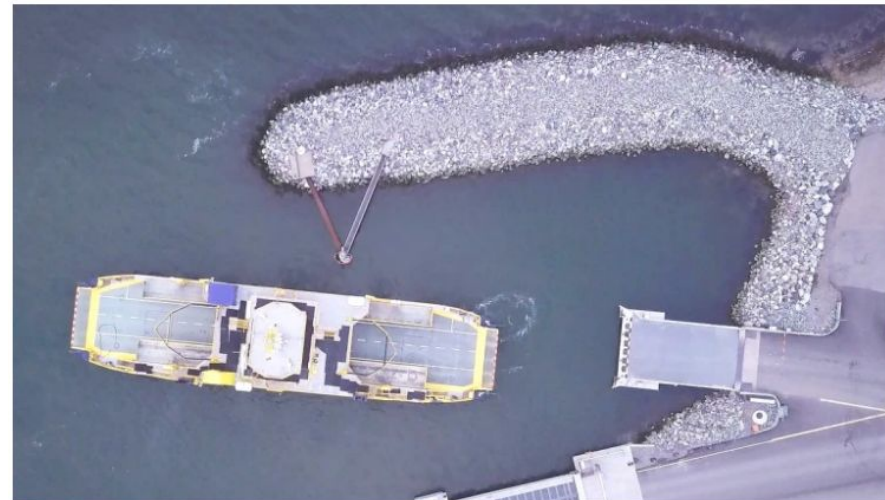
Search



TRANSPORTATION

Rolls-Royce demonstrates fully autonomous passenger ferry in Finland

PAUL SAWERS @PSAWERS DECEMBER 3, 2018 3:29 AM



Above: Rolls-Royce and Finferries: Autodocking in action

Image Credit: Rolls-Royce

Rolls-Royce has publicly demonstrated what it calls the “world’s first fully autonomous ferry” on a trip between Parainen and Nauvo in Finland.

Autonomous Ferry – Dec 18



Rolls-Royce's Intelligent Awareness system

Military Autonomous Systems



**US Navy
X-47B**

**US F-18 &
103 Drone
Swarm**



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

**US Navy
Autonomous
Craft**



Automation & Humans



2009
Air France 447



2019
Boeing 737 MAX

Automation & Humans

Security

Brit Watchkeeper drone fell in the sea because blocked sensor made algorithms flip out

Report scolds maker Thales for poorly understood software

By [Gareth Corfield](#) 15 Apr 2019 at 13:58

120 SHARE ▼



A Thales Watchkeeper drone. File pic, Crown copyright

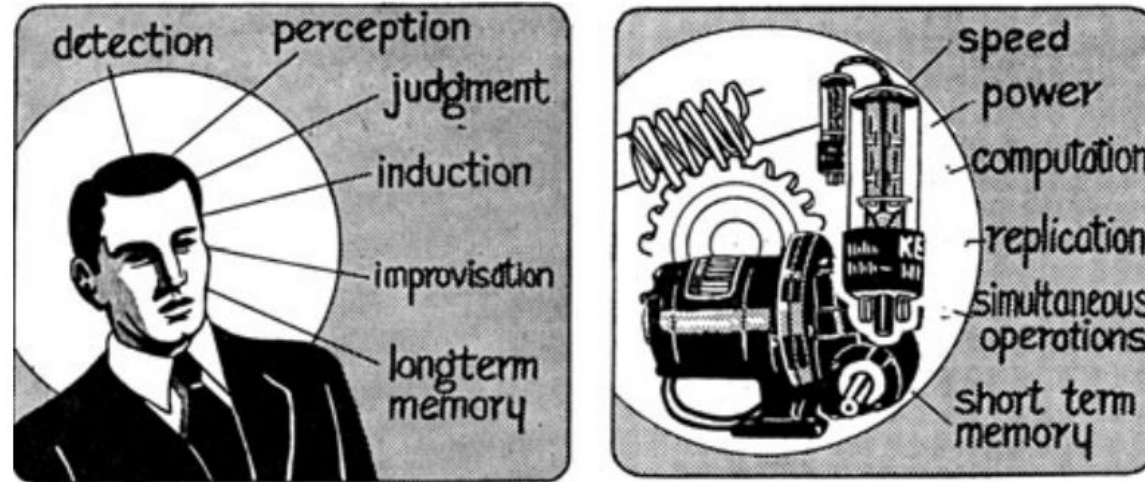
Investigators concluded that one of its pitot probes used for reading the aircraft's speed and angle of attack (AOA) became blocked, causing the Watchkeeper's onboard flight control logic to enter an erratic series of climbs and dives until it stalled itself and flopped into the sea. They criticised the craft's maker, Thales, for not fully understanding how its algorithms responded to loss of accurate sensor data.

Air Marshal Susan Gray, director-general of the Defence Safety Authority, criticised the Ministry of Defence and Thales for their "incomplete level of detailed technical understanding" regarding the drone and its systems.

A British Army Watchkeeper drone stalled itself and crashed into the sea on a bad weather flight test, military investigators have said – though most of the wreckage was never found.

Paul M Fitts (ed) (1951)

Human Engineering for an Effective Air Navigation and Traffic Control System



- **We suggest that great caution be exercised in assuming that men can successfully monitor complex automatic machines and take over if the machines break down.**
- **Engineers should seriously consider systems in which machines would monitor men and prevent them from making dangerous mistakes.**

Black Swan

Pre-1697



Post-1697

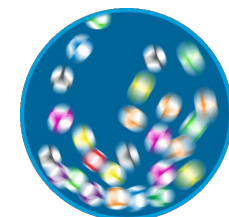
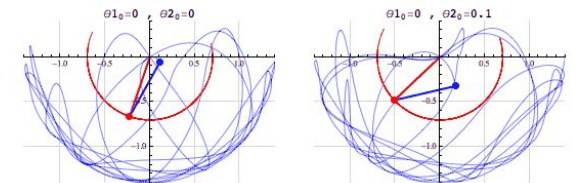
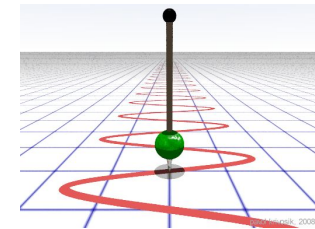
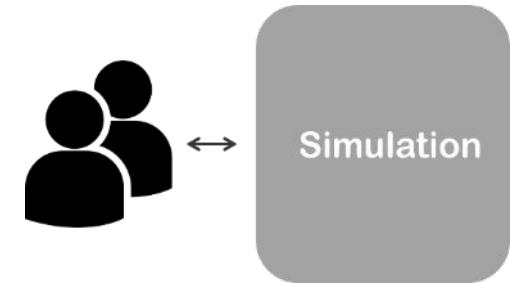


The challenge of modelling and simulating a world with unknown unknowns

Training & Simulation Trends

What is Simulation?

- Humans Inside or Outside
- Runs in Real or Non-Real Time
- Some Systems have Order
- Some Systems are Chaotic
- Some are Random



Why Use Simulation in Training?



Simulation Now - Land, Sea, Air, Anywhere



US Army STE (Synthetic Training Environment)

One World Simulation, AI-Driven Entities



Additional Realities

Reality

The real world



Augmented Reality

Information layered over vision



Mixed Reality

Blend of real & digital information to enhance reality



Virtual Reality

Fully virtual world



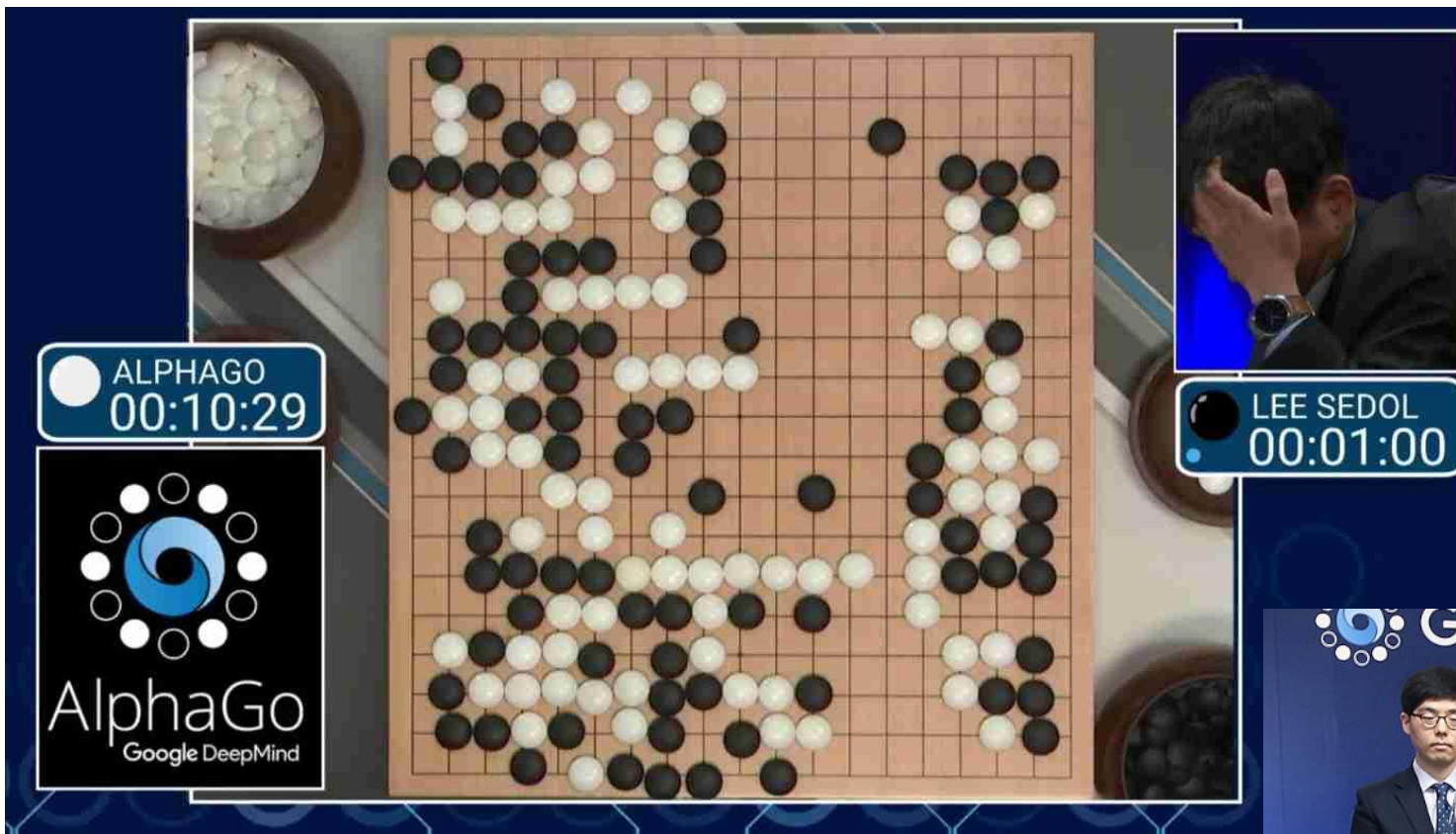
VR in Training (or Remote Ops?)

Pacific 24 RHIB VR Simulator



AI & Gaming

Board Games and AI



AlphaGo (2016)



“AlphaGo Zero” (Oct 2017)

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



DeepMind and Chess – Dec 18



AI Learning in Games/Simulation

Google DeepMind's Deep Q-learning

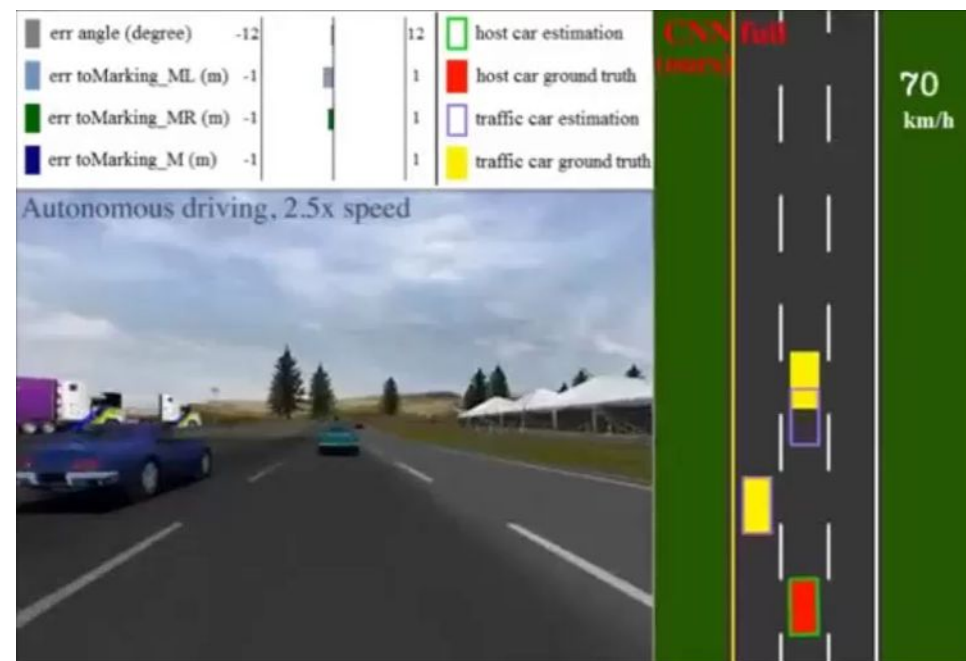
The algorithm will play Atari breakout.

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 (2015)
(Atari Breakout)

Princeton University
(TORCS Racing Simulator)



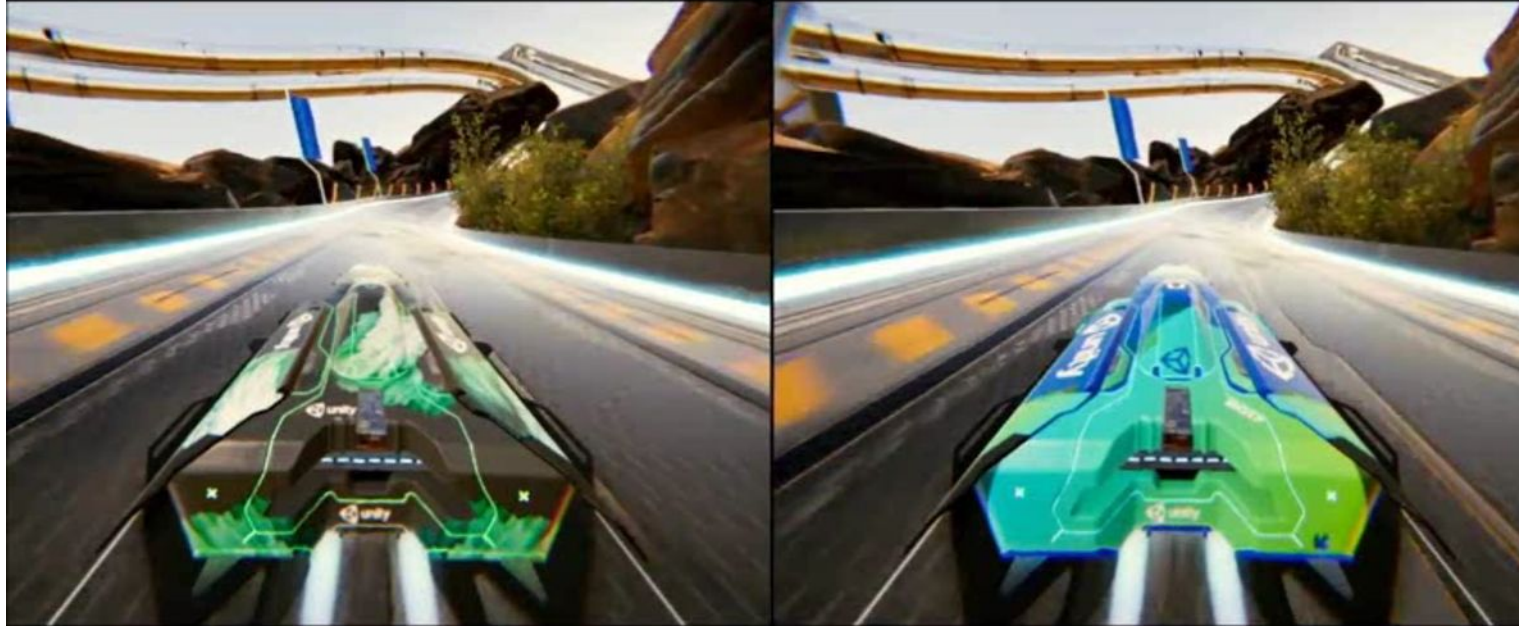


Machine Learning Agents



Unity Games Engine Machine Learning Agents *AI Training*

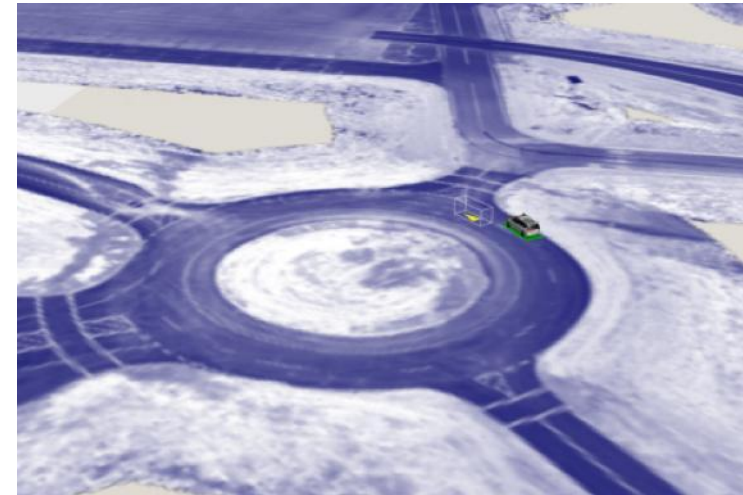
Imitation learning



Alphabet (Google) Waymo



3 Million Real Miles (2016)



2.5 Billion Simulated Miles
(2016)

AI-Created Simulation

This is the first interactive AI rendered virtual world

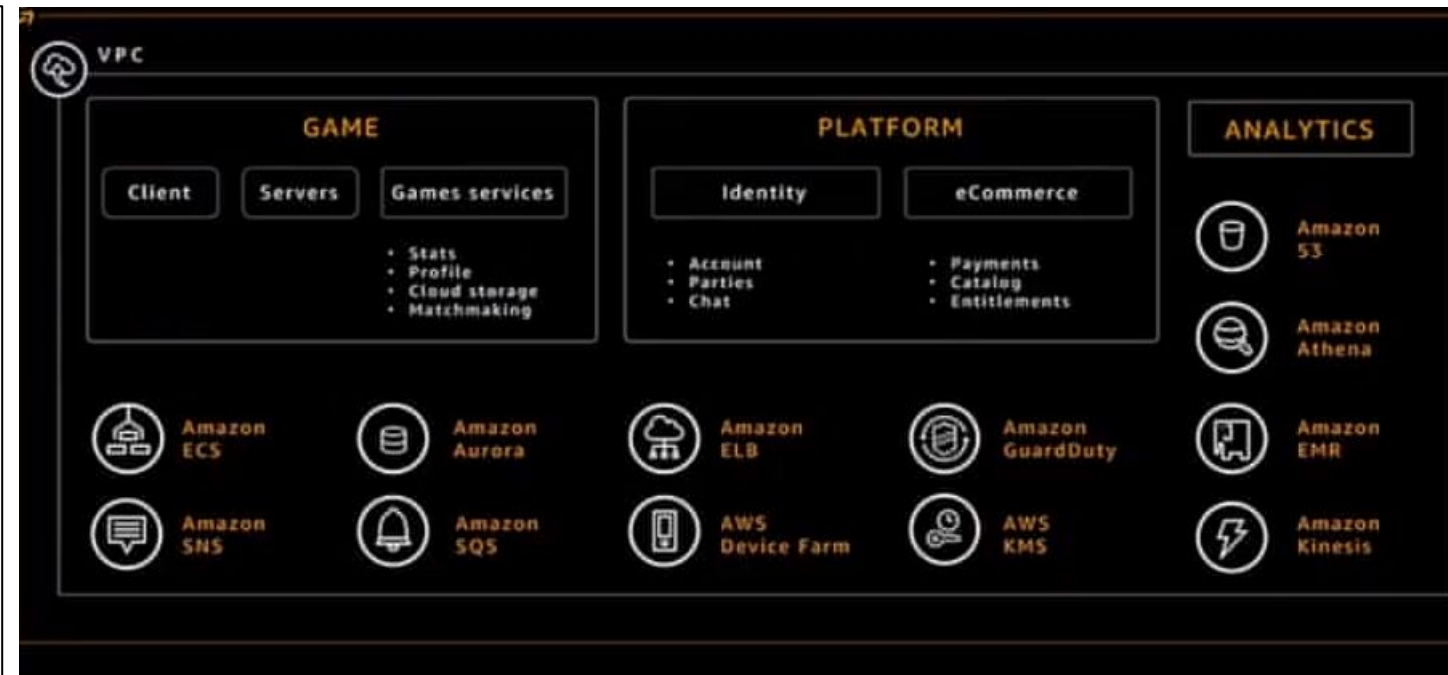
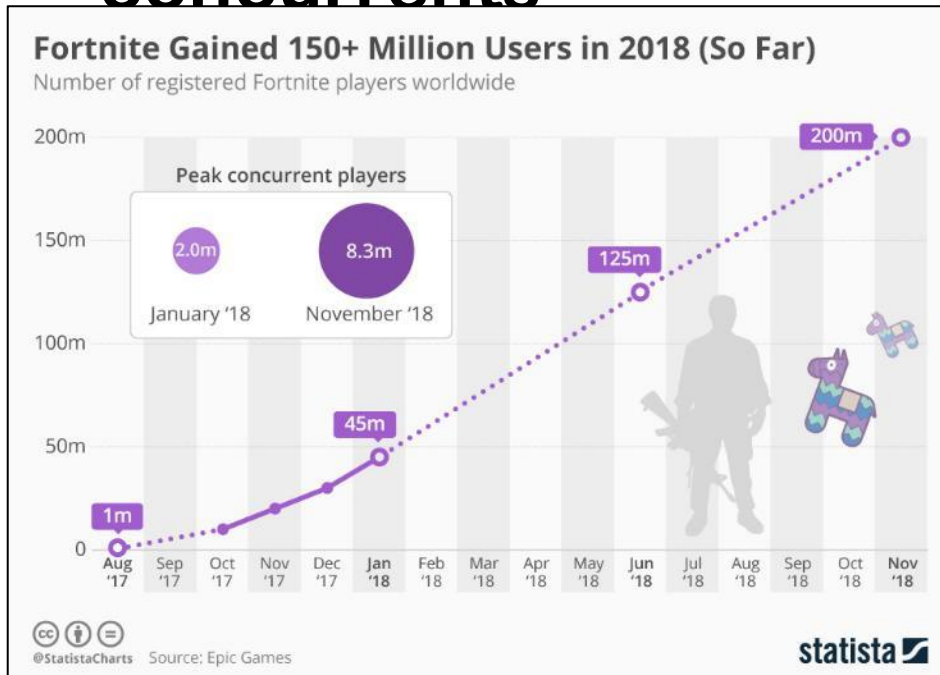
Apex Legends (Team-Based Battle Royale)

- Released 4 February 2019
- 50 Million Players Joined in One Month
- A novel ping system allows teammates to mark supplies, locations, and enemies



Fortnite Hosting

- Epic Games exploits Amazon Web Services (AWS)
- Each month Epic collects two petabytes of data
- From Zero to 250 Million Players in 24 Months; ≤ 10.8 million concurrents



Dota 2 and OpenAI – August 18

- Popular complex battle strategy game with a large array of variables playing out onscreen
- OpenAI bots play Dota 2 at an accelerated rate, 180 years of training time each day
- Two teams of pro gamers overcame a squad of AI bots
- New tactics and moves created by bots, e.g. instead of having a fixed division of labour like human teams, the AI rapidly and repeatedly switched the allocation of roles among players



StarCraft II and DeepMind's AlphaStar – Jan 19

- Real-time multi-agent strategy game with early decisions influencing the game later
- Bots trained the equivalent of 200 years of gameplay over 14 days
- Next, several versions of the bot played against each other in a league to build up experience as quickly as possible
- The reinforcement learning process required the equivalent of 50 GPUs

The Register
Biting the hand that feeds IT

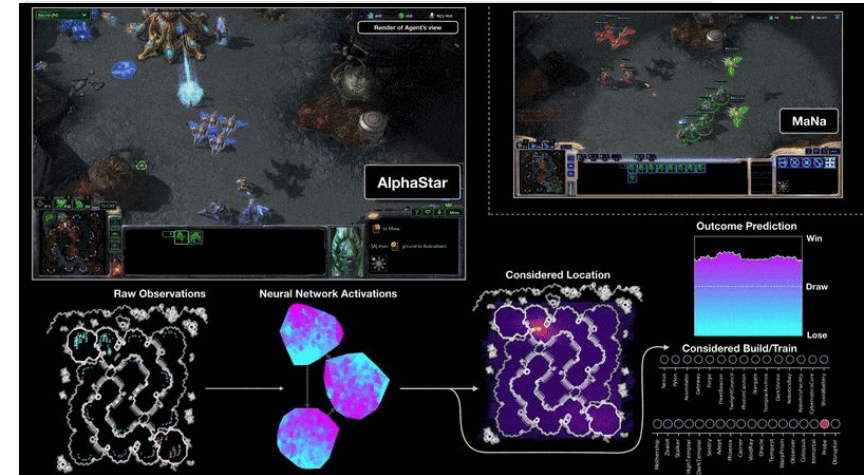
DATA CENTRE SOFTWARE SECURITY DEVOPS BUSINESS PERSONAL TECH SCIENCE EMERGENT TECH BOOTNOTES LECTURES

Emergent Tech ► Artificial Intelligence

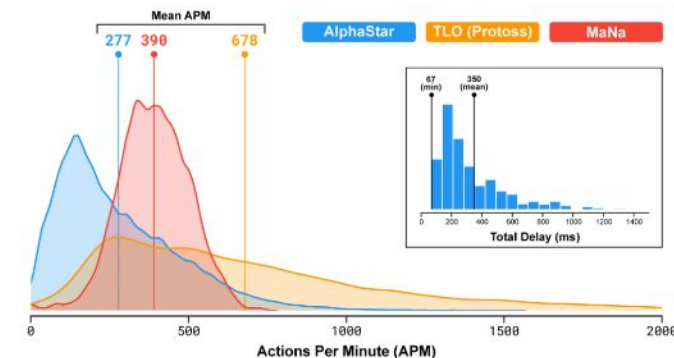
Human StarCraft II e-athletes crushed by neural net ace – DeepMind's AlphaStar

Computers 10 - 1 Humanity

By Katyanna Quach 25 Jan 2019 at 06:06 25 SHARE



Analysis AlphaStar, DeepMind's latest AI bot, crushed professional gamers playing popular strategy video game StarCraft II during a demonstration broadcast online Thursday.



Dota 2 and OpenAI – April 19

OpenAI co-founder and
chairman Greg
Brockman:

“OpenAI Five is powered by deep reinforce learning, which means we didn’t code it how to play. We coded it how to learn. In its 10 months of existence, it’s already played 45,000 years of Dota 2 gameplay. It hasn’t grown bored yet.”

OpenAI's Dota 2 AI steamrolls world champion e-sports team with back-to-back victories

15

The International 2018 champion OG loses to OpenAI's bots in a stunning defeat

By Nick Statt | @nickstatt | Apr 13, 2019, 5:05pm EDT



Photo by Nick Statt / The Verge

OpenAI, the AI research organization, can claim a world first: its artificial intelligence system trained to play the complex strategy game *Dota 2* has bested a world champion e-sports team. The competition was held in San Francisco today and dubbed the OpenAI Five Finals, ending the organization's public demonstrations of its *Dota*-playing technology on a high note.

The Simplest Problems?

 **TECH TIMES**

TECH SCIENCE HEALTH CULTURE FEATURES  BUZZ

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Google's DeepMind Failed A High School Level Math Test: What Does This Mean?



Google's premiere [artificial intelligence](#) program DeepMind nearly flunked a math exam designed to measure the knowledge of 16-year-old British students.

In a study titled "Analyzing Mathematical Reasoning Abilities of Neural Models", researchers put DeepMind's analytical skills to the test by exposing it to various mathematical subjects. They fed the AI with question typically found in schools in the UK, such as algebra, arithmetic, measurement, and calculus.

Despite its [cutting-edge approach to learning](#), DeepMind had a hard time making calculations that a regular human teenager would normally breeze through. Google's AI, as it turns out, could only muster an E in the British grading system.

At one point, the program was asked to give the sum of "1+1+1+1+1+1." Instead of giving the correct answer of "7", the machine surprisingly said it was "6".

In the end, DeepMind scored only 14 out of the 40 questions it was given.

Data Misjudgements



Google Street View

Still Some Way to Go



Tom Clancy's Rainbow Six: Vegas

Artificial Intelligence Technology Challenges

- Large volumes of data are required, especially for modern neural net AI approaches
 - *Favours the large Tech companies and some Nations?*
- 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 and Privacy
- Ethical Considerations

Sailor(s) of the Future?

Sailors of the Future?



- Who will they be?
- What will they do?
- Where will they be?
- How will they train?
- Will we need them?

RN Age Distribution - 2019



46% of the RN is ≤ 29
and 79% ≤ 39

UK REGULAR FORCES BY AGE

Full-time trained and untrained personnel, at 1 April 2018

	Army Service	Naval Service	RAF Service	All services
Under 18-24	21,720	7,440	5,530	34,710
Under 18	1,630	230	160	2,030
18-24	20,090	7,210	5,370	32,680
25-34	34,770	13,550	13,220	61,530
25-29	19,250	7,540	6,830	33,610
30-34	15,520	6,010	6,390	27,920
35-44	19,640	7,490	9,330	36,470
35-39	12,760	4,650	5,790	23,210
40-44	6,880	2,840	3,540	13,260
45 and over	4,970	4,010	4,860	13,850
45-49	3,270	2,360	2,790	8,420
50-54	1,510	1,390	1,740	4,640
55-59	190	250	330	770
60 and over	~	10	~	20



“Digital Native”

generally considered a person born in the 1980s and after growing up in the digital age with day to day access to computers, games, Internet, etc.

Broadly, 2/3rds of the RN now are Digital Natives and 90% by 2030

What's Next?



Digital Native



AI Native?

**UK Children aged 12 to 15
spend 12.2 hours a week
gaming in 2017**

**and 11 to 64 year-olds
8.9 hours**



FIND WHERE YOU BELONG

SEARCH **ARMY JOBS**



Air Chief Marshal Sir Stephen Hillier Jan 18

“teenagers playing on
their Xbox at home
should take their gaming
to the next level and join
the RAF to operate real
drones”

MailOnline

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Join the RAF for the real thing, Xbox teenagers are told: Head of the air force says young gamers should take it to the next level by operating drones

- Air Chief Marshal Sir Stephen Hillier wants more young people to join the RAF
- The service will be celebrating their 100th anniversary with events this year
- Among the major events planned is a flypast along the Mall before the Queen
- RAF chiefs hope a display of military might could provide a boost to recruitment

By LARISA BROWN FOR THE DAILY MAIL

PUBLISHED: 00:32, 12 January 2018 | UPDATED: 00:53, 12 January 2018



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Teenagers playing on their Xbox at home should take their gaming to the next level and join the RAF to operate real drones, the head of the air force said yesterday.

Air Chief Marshal Sir Stephen Hillier said the RAF's next 100 years will see a huge shift towards unmanned flying machines as he outlined plans for centenary celebrations.



Ender's Game - 1985



HDWallpapersImages.com

Ender's Game Film - 2013



Ender's Game



Leadership



Remotely-Operated/Autonomous Agents

Intuitive Interfaces

Where Does Automation Fit In?

NATO code	OF-10	OF-9	OF-8	OF-7	OF-6	OF-5	OF-4	OF-3	OF-2	OF-1	OF(D)
 United Kingdom											 
	Admiral of the Fleet	Admiral	Vice admiral	Rear admiral	Commodore	Captain	Commander	Lieutenant commander	Lieutenant	Sub lieutenant	Midshipman Officer Cadet

NATO Code	OR-9	OR-8	OR-7	OR-6	OR-5	OR-4	OR-3	OR-2	OR-1
 United Kingdom					No equivalent		No equivalent		No equivalent
	Warrant officer class 1 WO1	Warrant officer class 2 (phased out 2014) WO2	Chief petty officer CPO	Petty officer PO	-	Leading rate LR	-	Able rate AB	-

and finally...

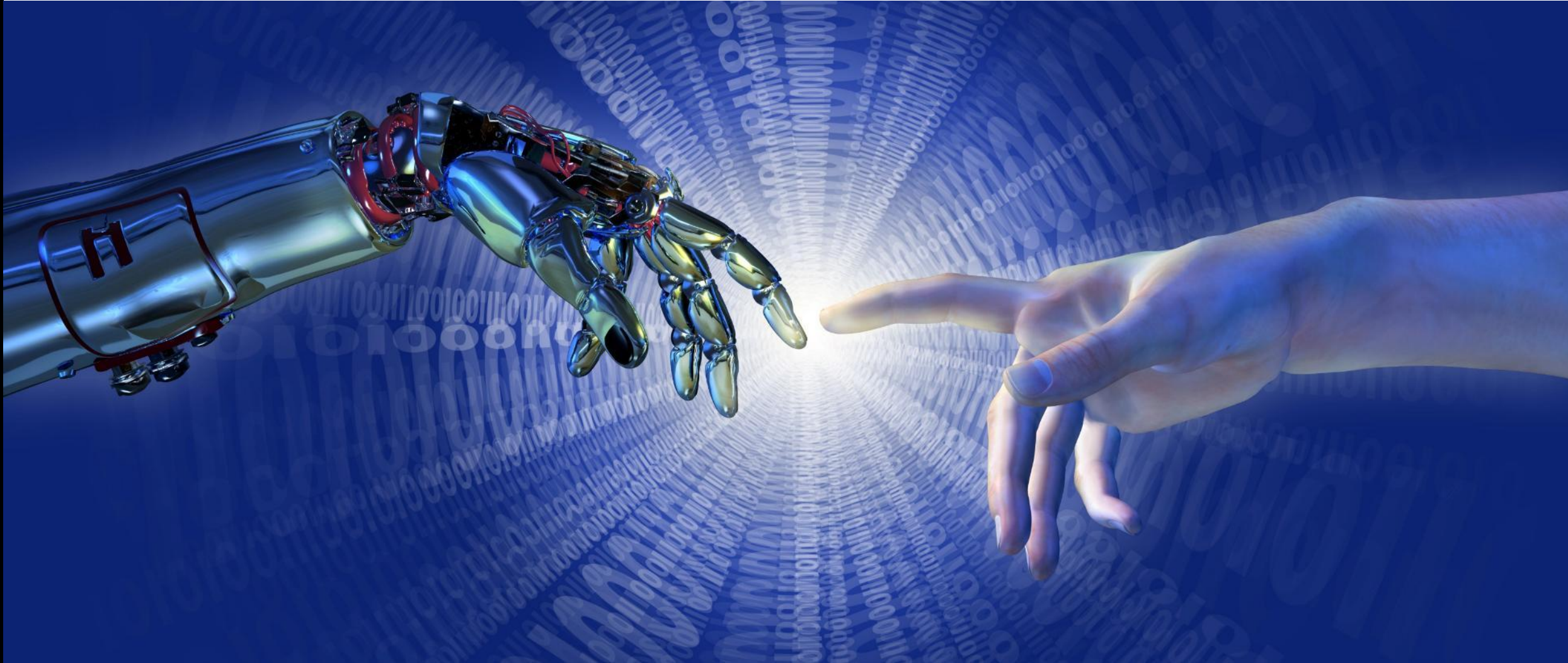


War is chaotic

**No battle plan
withstands
contact with
the enemy**

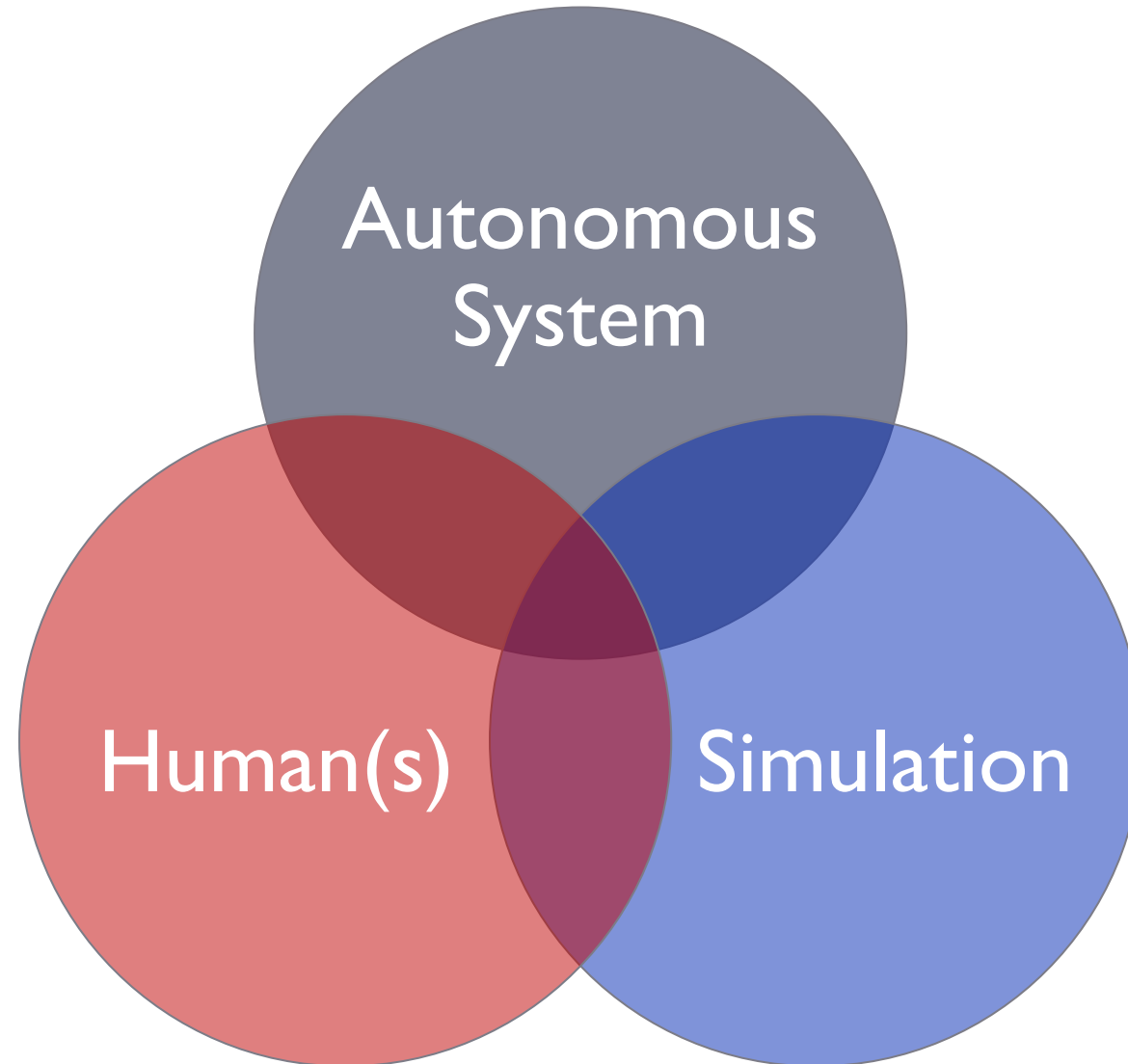
**Humans are
Very
Adaptable**

Seek the Optimum Human/Machine Blend



**Humans & Machines working in Harmony
Maximising the Strengths of Both**

Test, Test and Test Again...





Questions?