



ECE 448: Artificial Intelligence

Lecture 2: History and Themes

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- Thinking Humanly?
 - Examples: embodied cognition, trying to reconstruct a brain cell-by-cell
- Acting Humanly?
 - Examples: Turing test, Winograd schema
- Thinking Rationally?
 - Example: Aristotle, especially the Analytics
 - Example: the logicist approach to AI, symbolic reasoning, fuzzy logic
- Acting Rationally?
 - Example: John Stuart Mill, Utilitarianism
 - Example: rational agent theory, Economics

IBM Watson and “cognitive computing”

- 2010 NY Times article, trivia demo
- February 2011: IBM Watson wins on Jeopardy
- Since then: Watson Analytics, social services, personal shopping, health care



Self-driving cars



If the age of **self-driving cars** is upon us, what's keeping them off the ...
The Guardian - 9 hours ago
Sitting in the passenger seat of Google's **self driving car** is a less bizarre experience than sitting in the driving seat, but it's still unsettling. In the ...



How will **self-driving cars** affect your insurance?
The Conversation UK - 1 hour ago
And software bugs in **self-driving cars** could create a new reason manufacturers might have to shoulder the cost of crashes. Yet if drivers ...



If Uber and Lyft switch to **self-driving cars**, what about the drivers?
Digital Trends - Aug 21, 2016
Uber and Lyft have tens of thousands of drivers in the U.S. alone. The two ridesharing companies have each been in the news recently for their ...
The summer that changed everything for Uber: China, **self-driving** ...
In-Depth - VentureBeat - 3 hours ago

[View all](#)



Uber is about to start giving rides in **self-driving cars**
Los Angeles Times - Aug 18, 2016
The robot **cars** aren't coming. The robot **cars** are here. A fleet of Fords and Volvos, capable of driving themselves, is fully equipped and ready to ...
How Pittsburgh Birthed the Age of the **Self-Driving Car**
In-Depth - WIRED - Aug 19, 2016

[View all](#)



Here's how Ford's **self-driving cars** will work
Business Insider - Aug 20, 2016
On Tuesday, the automaker announced that it aims to roll out an autonomous taxi fleet in at least one city in 2021. Ford said its **driverless cars** will have level 4 ...



Legislators rush to keep up with **self-driving cars**
East Valley Tribune - 1 hour ago
There apparently are no laws which would prohibit manufacturers from marketing **self-driving cars** today to consumers. And nothing keeps ...



From Microsoft to **Self-Driving Cars**, Invention Springs From Data
Adweek - 16 hours ago
The product data arms race is also at play in the nascent but exploding space of **self-driving cars**. While design will certainly be important, ...



Ford Promises Fleets of **Driverless Cars** Within Five Years
New York Times - Aug 16, 2016
In the race to develop **driverless cars**, several automakers and technology companies are already testing vehicles that pilot themselves on ...
Want a ride? Ford hopes to race ahead of **self-driving** pack sans ...
Opinion - Chicago Tribune - Aug 17, 2016

[View all](#)



Self-driving cars safe, say firms developing such vehicles here
The Straits Times - Aug 20, 2016
Despite recent accidents involving **driverless cars** in the United States, two companies involved in developing such vehicles here said they are ...



Uber Buys **Self-Driving** Truck Biz
Sci-Tech Today - Aug 21, 2016
Uber Buys Self-Driving Truck Biz and Tests Autonomous Cars Ford's approach to the autonomous car breaks from many other companies, ...

Google News snapshot as of August 22, 2016

Speech and Natural Language



Skype Translator

Break down the language barrier with your friends, family and colleagues.

Our online translator can help you communicate in 7 languages for voice calls, and in more than 50 languages while instant messaging.

Skype Translator uses machine learning. So the more you use it, the better it gets. Thanks for being patient as the technology graduates from Preview mode.



***Hallo, hola, olá* to the new, more powerful Google Translate app**

Posted: Wednesday, January 14, 2015

- Instant translation with Word Lens
- Have a conversation with Google Translate

<https://www.skype.com/en/features/skype-translator/>

<http://googleblog.blogspot.com/2015/01/hallo-hola-ola-more-powerful-translate.html>



Speech and Natural Language

- [Transformers](#) and pretrained language models:
 - [BERT](#) (110M~340M parameters)
 - [XL-Net](#)
 - [RoBERTA](#)
 - GPT-1, GPT-2, [GPT-3](#) (175 billion parameters)
 - ...
- GPT-3 applications
 - [Blog writer with a given topic](#)
 - [Poetry writing](#)
 - Explain codes
 - Converts English to Latex or Linux commands
 - [More examples](#)

```
~ # cmdxyz create a directory named foo, and enter it
~ # mkdir foo; cd foo;
~ # cmdxyz create a file named test.txt that contains 3 colors
~ # echo "red green blue" > test.txt
~ # cmdxyz list files in this directory
~ # ls
~ # test.txt
```

Equation description

$$x^2 + 2x$$

On the road to AI

I was recently watching a podcast about how OpenAI built their latest language model and it made me wonder what could be done with a system like this. I could not stop thinking about the applications of such a technology and how it could improve our lives. I was thinking of how cool it would be to build a Twitter-like service where the only posts are GPT-3 outputs.

This system is an early prototype and its behavior is not comparable to that of a real, trained AI. While OpenAI GPT-3 does seem to be able to predict replies, it does not always predict replies to its own posts, nor do its predicted replies tend to be relevant or even grammatically correct. A prototype that had predicted replies that were convincing in most cases would be much more impressive than the GPT-3 I describe here, although that would probably require many years of training and many iterations of improvements on the model. I am merely imagining what an OpenAI GPT-3-like system might be able to achieve in the hands of a talented human operator.

[Articles fully written by GPT-3](#)

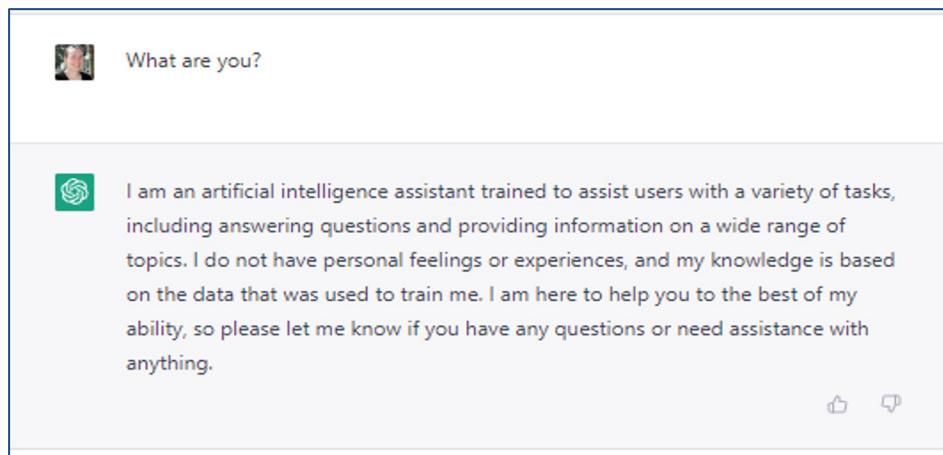
William Shakespeare ¶

Transformer AI poetry: Poetry classics as reimagined and rewritten by an artificial intelligence.
 "Sonnet 18"
 William Shakespeare
 Shall I compare thee to a summer's day?
 Thou art more lovely and more temperate:
 Rough winds do shake the darling buds of May,
 And summer's lease hath all too short a date;
 A winter's day, when beams of sun are few,
 And skies are grey with clouds intemperate,
 Is to thy beauty somehow sordid grown.
 Her lovely-lovely eye is quite shut up,
 Like windows pale before a sunny shower.

[Shakespeare inspired poem generated by GPT-3](#)

ChatGPT

- **GPT** - Generative Pre-Training Transformer
- **ChatGPT** – An AI tool that uses natural language processing (NLP) techniques to respond to user-generated prompts.
Put simply: You ask ChatGPT a question or provide a prompt, it replies using natural language.
- **OpenAI** – Organisation that developed ChatGPT



The screenshot shows a conversation in a messaging application. The user, represented by a profile picture of a person with short hair, asks "What are you?". The AI, represented by a green square icon with a white swirl, responds with a detailed message: "I am an artificial intelligence assistant trained to assist users with a variety of tasks, including answering questions and providing information on a wide range of topics. I do not have personal feelings or experiences, and my knowledge is based on the data that was used to train me. I am here to help you to the best of my ability, so please let me know if you have any questions or need assistance with anything." At the bottom right of the message area, there are two small icons: a thumbs up and a thumbs down.

Screenshot of ChatGPT prompt and response.

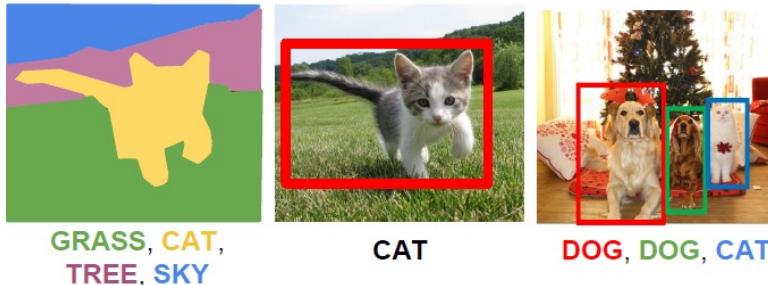
What are some successes of AI today



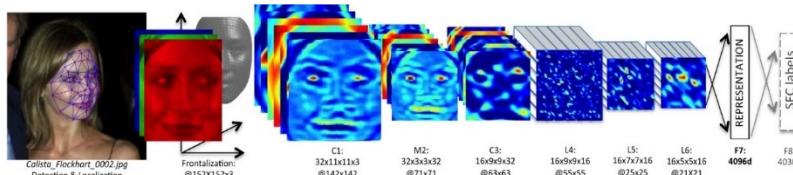
ZJUI

Computer Vision

- Object detection and semantic segmentation



- Face recognition



- Style transfer

NeuralStyle

[A Neural Algorithm of Artistic Style by Leon A. Gatys, Alexander S. Ecker, and Matthias Bethge, 2015]
good implementation by Justin in Torch:
<https://github.com/jcjohnson/neural-style>



Image synthesis, motion prediction, depth prediction, ...

Games

- 1997: IBM's Deep Blue defeats the reigning world chess champion Garry Kasparov
 - **1996: Kasparov Beats Deep Blue**
“I could feel – I could smell – a new kind of intelligence across the table.”
 - **1997: Deep Blue Beats Kasparov**
“Deep Blue hasn't proven anything.”
- 2007: Checkers is solved
 - Though checkers programs had been beating the best human players for at least a decade before then
- 2014: Heads-up limit Texas Hold-em poker is solved
 - First game of imperfect information
- 2016: AlphaGo computer beats Go grandmaster Lee Sedol 4-1



AlphaFold: a scientific breakthrough to solve protein folding

- Nature: Highly accurate protein structure prediction with AlphaFold
- AlphaFold DB

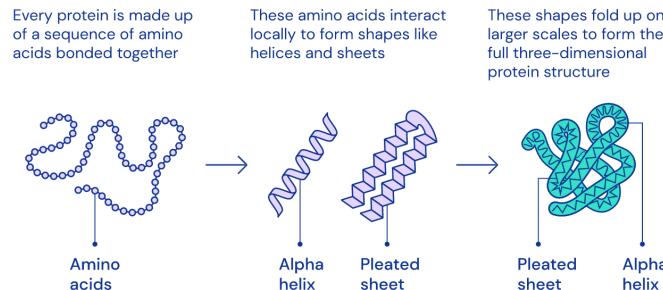
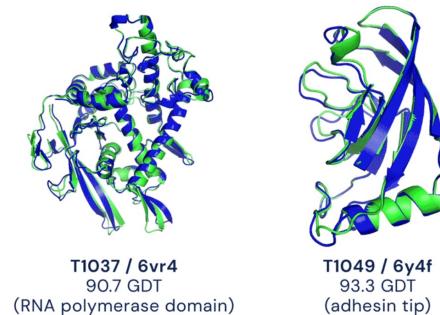
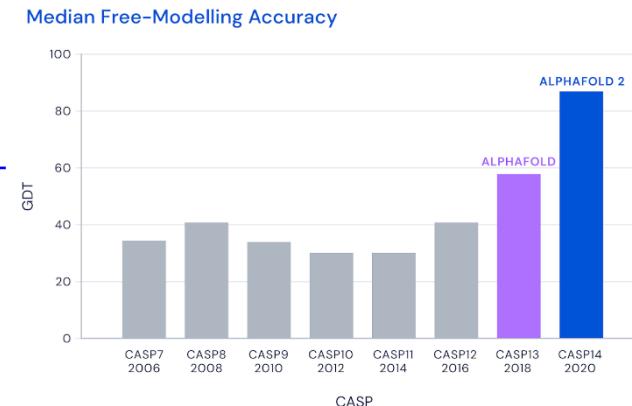


Figure 1: Complex 3D shapes emerge from a string of amino acids.



● Experimental result
● Computational prediction



Mathematics

- In 1996, a computer program written by researchers at Argonne National Laboratory proved a mathematical conjecture unsolved for decades
 - NY Times story: "[The proof] would have been called creative if a human had thought of it"
- Mathematical software:

Wolfram
Mathematica®



$$\begin{aligned}\partial_r^2 u &= - \left[E' - \frac{l(l+1)}{r^2} - r^2 \right] u(r) \\ e^{-2s} (\partial_s^2 - \partial_s) u(s) &= - [E' - l(l+1)e^{-2s} - e^{2s}] u(s) \\ e^{-2s} \left[e^{\frac{1}{2}s} \left(e^{-\frac{1}{2}s} u(s) \right)^{''} - \frac{1}{4} u \right] &= - [E' - l(l+1)e^{-2s} - e^{2s}] u(s) \\ e^{-2s} \left[e^{\frac{1}{2}s} \left(e^{-\frac{1}{2}s} u(s) \right)^{''} \right] &= - \left[E' - \left(l + \frac{1}{2} \right)^2 e^{-2s} - e^{2s} \right] u(s) \\ v'' &= -e^{2s} \left[E' - \left(l + \frac{1}{2} \right)^2 e^{-2s} - e^{2s} \right] v\end{aligned}$$

Logistics, scheduling, planning

- During the 1991 Gulf War, US forces deployed an AI logistics planning and scheduling program that involved up to 50,000 vehicles, cargo, and people
- NASA's [Remote Agent](#) software operated the Deep Space 1 spacecraft during two experiments in May 1999
- In 2004, NASA introduced the [MAPGEN](#) system to plan the daily operations for the Mars Exploration Rovers

Robotics

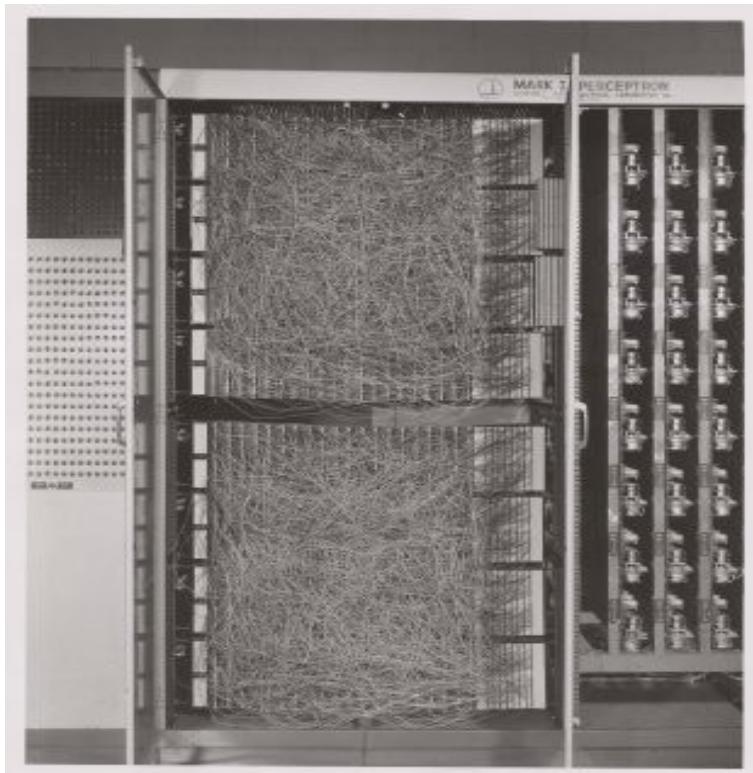
- Mars rovers
- Autonomous vehicles
 - [DARPA Grand Challenge](#)
 - Self-driving cars
- [Autonomous helicopters](#)
- Robot soccer
 - [RoboCup](#)
- Personal robotics
 - [Humanoid robots](#)
 - [Robotic pets](#)
- [Boston dynamics robot](#)



- 1940s First model of a neuron (W. S. McCulloch & W. Pitts)
- Hebbian learning rule
- Cybernetics
- 1950s Turing Test
- Perceptrons (F. Rosenblatt)
- Computer chess and checkers (C. Shannon, A. Samuel)
- Machine translation (Georgetown-IBM experiment)
- Theorem provers (A. Newell and H. Simon,
H. Gelernter and N. Rochester)
- **1956 Dartmouth meeting: “Artificial Intelligence” adopted**



An Electronic Model of Neural Learning: the Perceptron, 1957, Rosenblatt



Attribution: Cornell University Library



NEW NAVY DEVICE LEARNS BY DOING

**Psychologist Shows Embryo
of Computer Designed to
Read and Grow Wiser**

WASHINGTON, July 7 (UPI)—The Navy revealed the embryo of an electronic computer today that it expects will be able to walk, talk, see, write, reproduce itself and be conscious of its existence.

The embryo—the Weather Bureau's \$2,000,000 "704" computer—learned to differentiate between right and left after fifty attempts in the Navy's demonstration for newsmen..

The service said it would use this principle to build the first of its Perceptron thinking machines that will be able to read and write. It is expected to be finished in about a year at a cost of \$100,000.

Dr. Frank Rosenblatt, designer of the Perceptron, conducted the demonstration. He said the machine would be the first device to think as the human brain. As do human be-

ings, Perceptron will make mistakes at first, but will grow wiser as it gains experience, he said.

Dr. Rosenblatt, a research psychologist at the Cornell Aeronautical Laboratory, Buffalo, said Perceptrons might be fired to the planets as mechanical space explorers.

Without Human Controls

The Navy said the perceptron would be the first non-living mechanism "capable of receiving, recognizing and identifying its surroundings without any human training or control."

The "brain" is designed to remember images and information it has perceived itself. Ordinary computers remember only what is fed into them on punch cards or magnetic tape.

Later Perceptrons will be able to recognize people and call out their names and instantly translate speech in one language to speech or writing in another language, it was predicted.

Mr. Rosenblatt said in principle it would be possible to build brains that could reproduce themselves on an assembly line and which would be conscious of their existence.

1958 New York Times...

In today's demonstration, the "704" was fed two cards, one with squares marked on the left side and the other with squares on the right side.

Learns by Doing

In the first fifty trials, the machine made no distinction between them. It then started registering a "Q" for the left squares and "O" for the right squares.

Dr. Rosenblatt said he could explain why the machine learned only in highly technical terms. But he said the computer had undergone a "self-induced change in the wiring diagram."

The first Perceptron will have about 1,000 electronic "association cells" receiving electrical impulses from an eye-like scanning device with 400 photo-cells. The human brain has 10,000,000,000 responsive cells, including 100,000,000 connections with the eyes.

- “*It is not my aim to surprise or shock you – but ... there are now in the world machines that think, that learn and that create. Moreover, their ability to do these things is going to increase rapidly until – in a visible future – the range of problems they can handle will be coextensive with the range to which human mind has been applied. More precisely: within 10 years a computer would be chess champion, and an important new mathematical theorem would be proved by a computer.*”
- Prediction came true – but 40 years later instead of 10





Harder than originally thought

- 1966: [Eliza](#) chatbot (Weizenbaum)
 - “... mother ...” → “**Tell me more about your family**”
 - **“I wanted to adopt a puppy, but it’ s too young to be separated from its mother.”**
- 1954: [Georgetown-IBM experiment](#)
 - Completely automatic translation of more than sixty Russian sentences into English
 - Only six grammar rules, 250 vocabulary words, restricted to organic chemistry
 - Promised that machine translation would be solved in three to five years ([press release](#))
 - Automatic Language Processing Advisory Committee (ALPAC) report (1966): machine translation has failed
 - **“The spirit is willing but the flesh is weak.”** → **“The vodka is strong but the meat is rotten.”**

The ALPAC Report of 1966

"They concluded, in a famous 1966 report, that machine translation was more expensive, less accurate and slower than human translation."



Photo: Eldon Lyttle,
https://commons.wikimedia.org/wiki/File:Computer-translation_Briefing_for_Gerald_Ford.jpg

W AI winter - Wikipedia Mark

Secure | https://en.wikipedia.org/wiki/AI_winter fonts

AI winter

From Wikipedia, the free encyclopedia

This article has multiple issues. Please help [improve it](#) or discuss these issues on the [talk page](#). ([Learn how and when to remove these template messages](#))



- The lead section of this article may need to be rewritten. (January 2016)
- This article's tone or style may not reflect the [encyclopedic tone](#) used on Wikipedia. (July 2016)

In the [history of artificial intelligence](#), an **AI winter** is a period of reduced funding and interest in [artificial intelligence](#) research.^[1] The term was coined by analogy to the idea of a [nuclear winter](#).^[2] The field has experienced several [hype cycles](#), followed by disappointment and criticism, followed by funding cuts, followed by renewed interest years or decades later.

The term first appeared in 1984 as the topic of a public debate at the annual meeting of [AAAI](#) (then called the "American Association of Artificial Intelligence"). It is a chain reaction that begins with pessimism in the AI community, followed by pessimism in the press, followed by a severe cutback in funding, followed by the end of serious research.^[2] At the meeting, [Roger Schank](#) and [Marvin Minsky](#)—two leading AI researchers who had survived the "winter" of the 1970s—warned the business community that enthusiasm for AI had spiraled out of control in the '80s and that disappointment would certainly follow. Three years later, the billion-dollar AI industry began to collapse.^[2]

Hypes are common in many emerging technologies, such as the [railway mania](#) or the [dot-com bubble](#). The AI winter is primarily a collapse in the *perception* of AI by government bureaucrats and venture capitalists. Despite the rise and fall of AI's reputation, it has continued to develop new and successful technologies. AI researcher [Rodney Brooks](#) would complain in 2002 that "there's this stupid myth out there that AI has failed, but AI is around you every second of the day."^[3] In 2005, [Ray Kurzweil](#) agreed: "Many observers still think that the AI winter was the end of the story and that nothing since has come of the AI field. Yet today many thousands of AI applications are deeply embedded in the infrastructure of every industry."^[4]

Enthusiasm and optimism about AI has gradually increased since its low point in 1990, and by the 2010s [artificial intelligence](#) (and especially the sub-field of [machine learning](#)) became widely used, well-funded and many in the technology predict that it will soon

Artificial intelligence

Major goals

- Knowledge reasoning
- Planning
- Machine learning
- Natural language processing
- Computer vision
- Robotics
- Artificial general intelligence

Approaches

- Symbolic
- Deep learning
- Recurrent neural networks
- Bayesian networks
- Evolutionary algorithms

Philosophy

Print/export

Computer-translati....jpg ^ Mark_I_perceptron....jpeg ^ Mark_I_perceptron.jpeg ^ Artificial_neuron.png ^

Show all X



History of AI to the present day

- 1975-1985: Expert systems boom
- 1985-1995: Expert system bust; the second “AI winter”
- Expert system, brief comic explanation:
- <https://www.youtube.com/watch?v=sg6hLmuyQ54>
- 1995-2009: The probabilistic reasoning/ Bayesian logic boom
- 2009-present: Deep learning
- Neural nets solve the expert system problems:
- <https://www.youtube.com/watch?v=n-YbJi4EPxc>



What accounts for recent successes in AI?

- Faster computers
 - The IBM 704 vacuum tube machine that played chess in 1958 could do about **50,000 calculations per second**
 - Deep Blue could do **50 billion calculations per second**
– a million times faster!
- Dominance of statistical approaches, machine learning
- Big data
- Crowdsourcing

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Last updated: January 4, 2015 4:46 pm

Investor rush to artificial intelligence is real deal

Richard Waters in San Francisco



©Bloomberg

IBM's Dario Gil unveils its question-answering system Watson. AI can help predict customer behaviour, says venture capitalist Matt McIlwain

Silicon Valley loves a new fad. To judge by the spate of fundraising by start-ups in recent weeks, it has found one in an idea that is more than half a century old: artificial intelligence.

AI weapons are a threat to humanity, warn Hawking, Musk and Wozniak

by Jason Murdock 28 Jul 2015



The rush to develop autonomous weapons will cause a global arms race, according to an open letter signed by over 1,000 artificial intelligence (AI) researchers, academics and computer scientists.

The letter has been signed by high-profile figures including physicist Stephen Hawking, Tesla chief executive Elon Musk and Apple co-founder Steve Wozniak, and argues AI has reached a point where deployment of robotic weapons is feasible within years.

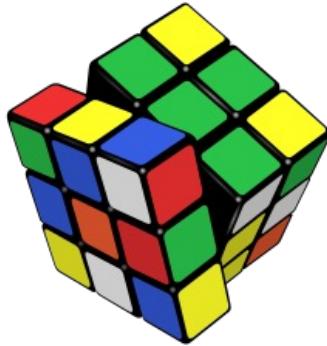
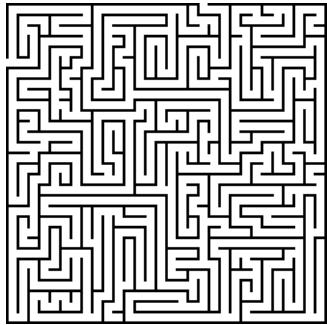
Autonomous weapons are described in the letter as those that "select and engage targets without human intervention".

This includes, for example, armed quadcopters searching and eliminating targets that meet pre-defined criteria, but not remote controlled missiles or piloted drones that still have human involvement.

The letter was presented at this year's International Joint Conferences on AI in Buenos Aires, and argues that there are advantages to replacing human soldiers with machines but that doing so would "lower the threshold" for warfare.

In this class

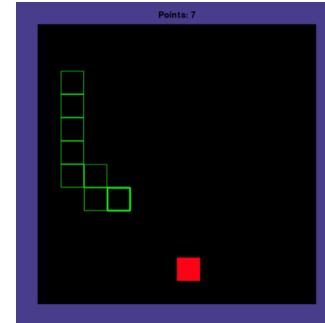
- Part 1: sequential reasoning (MP1, MP2)



8	4	6	7
1			
5	9	3	7 8
		7	
4	8	2	1 3
5	2		9
	1		
3		2	5



- Part 2: pattern recognition and learning (MP3, MP4, MP5)





Philosophy of this class

- Goal: use machines to solve hard problems that are traditionally thought to require human intelligence
- We will try to follow a sound scientific/engineering methodology
 - Consider relatively limited application domains
 - Use well-defined input/output specifications
 - Define operational criteria amenable to objective validation
 - Zero in on essential problem features
 - Focus on principles and basic building blocks