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The WILLIAM STATES LEE COLLEGE *of* ENGINEERING

Introduction to ML
Lecture 0: Course Introduction

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Prerequisites and Preparation

- Recommended preparation: basic probability, statistics, linear algebra, calculus, optimization.

  (Math alert!)

- Experience in Python programming languages

Additional reading

- Linear Algebra and its Applications, Gilbert Strang (1988).
- For those who want to simply keep a concise reference for linear algebra, my best recommendation is The Matrix Cookbook

What we will learn in this course

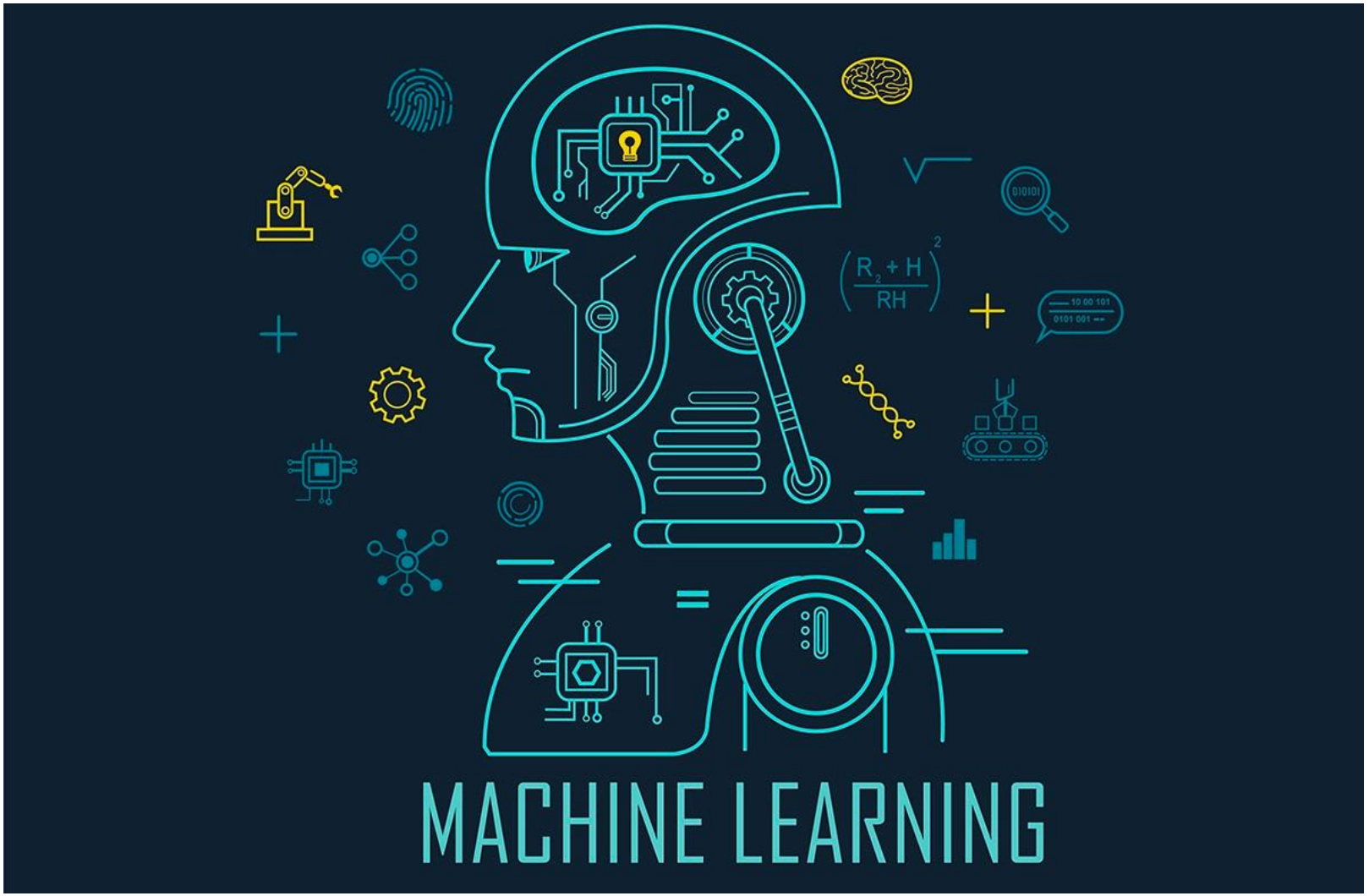
- Basic ML concepts and techniques
- A bit about ML in computer vision applications (computer vision is the best testbed for ML)
- Fundamentals about machine learning (not necessarily easy, math involved)
- We do NOT teach how to build AlphaGO, which I don't know either, but you can try ☺

Goals

By the end of the course,

- Be an expert in ML (understand the internals of ML algorithms)
- Be able to build ML applications (know which algorithms to use when)
- Be able to start ML research (read research papers)

Lecture 2: Introduction to ML



Source: https://www.smaartt.com/knowledge/wp-content/uploads/2020/05/CX2.jpeg

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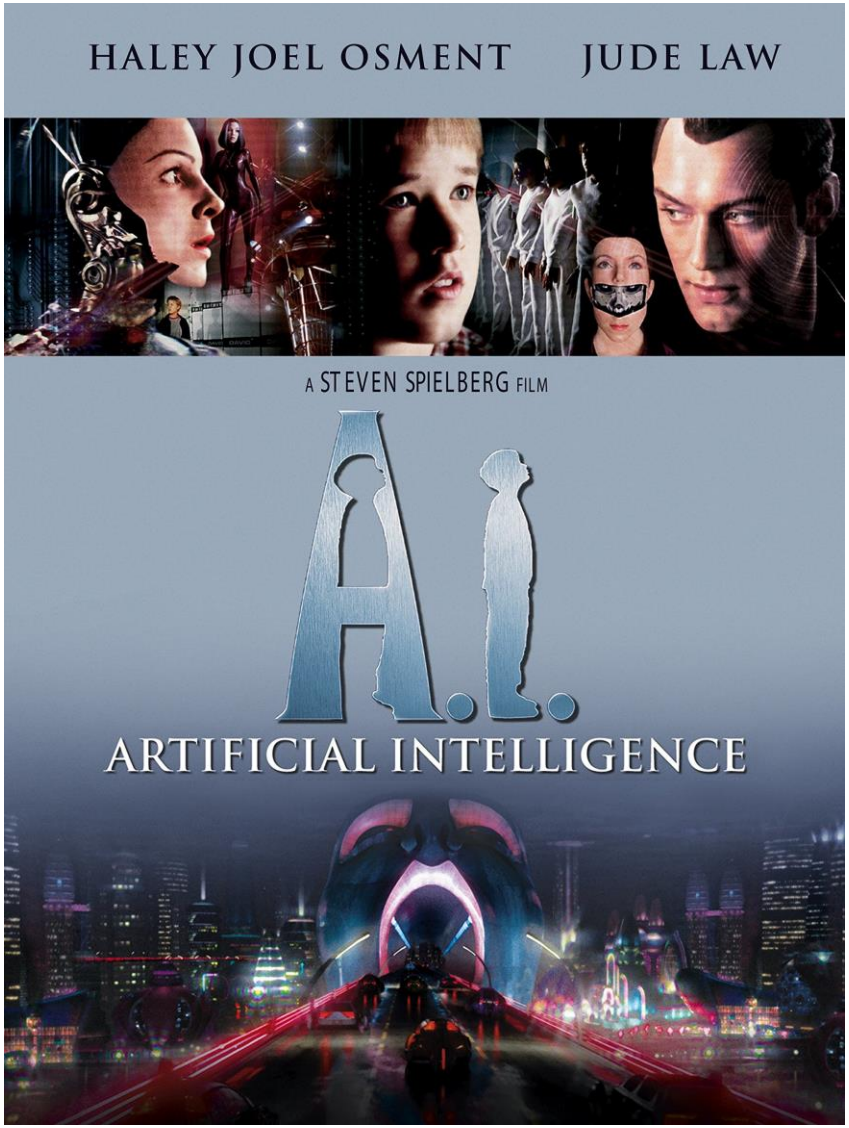
- Two Academy Awards nomination

Director: Steven Spielberg



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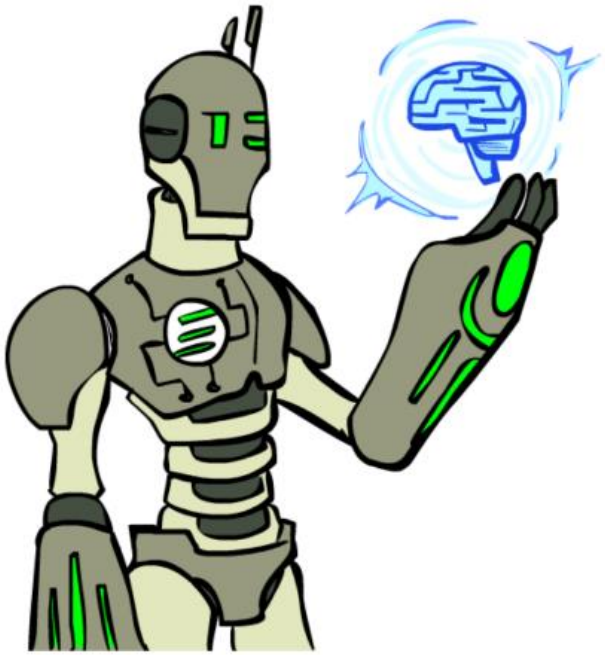
What is AI?

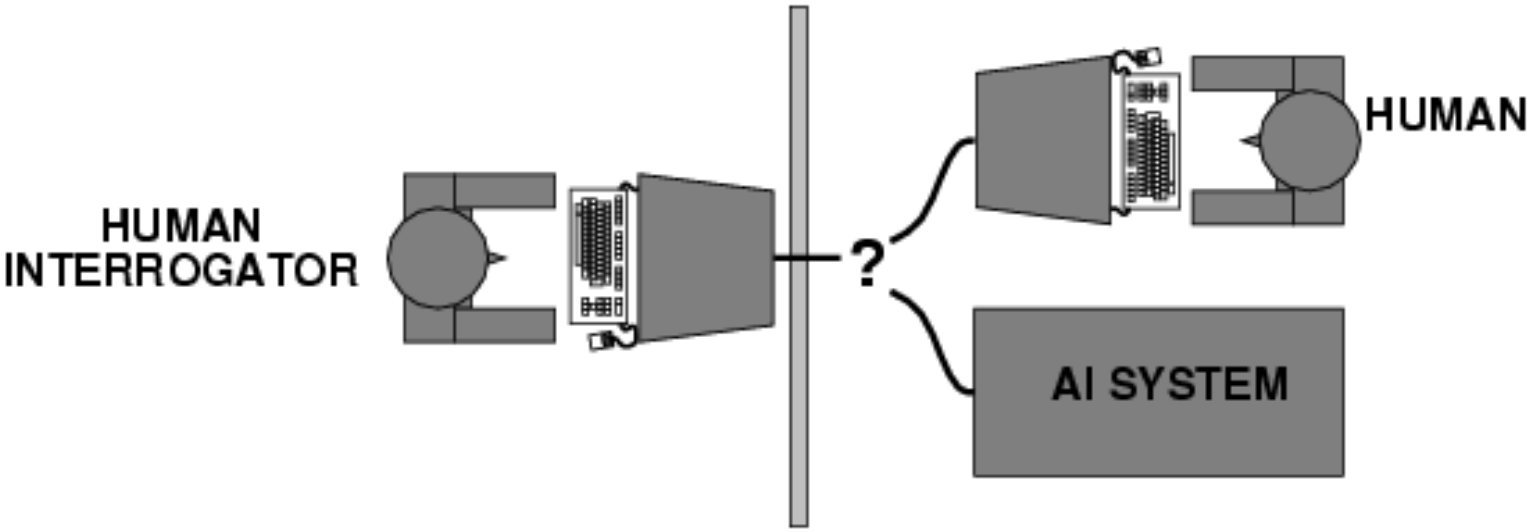
- What is your definition of AI?



Turing Test

- The Turing test, developed by Alan Turing in 1950

Alan Turing



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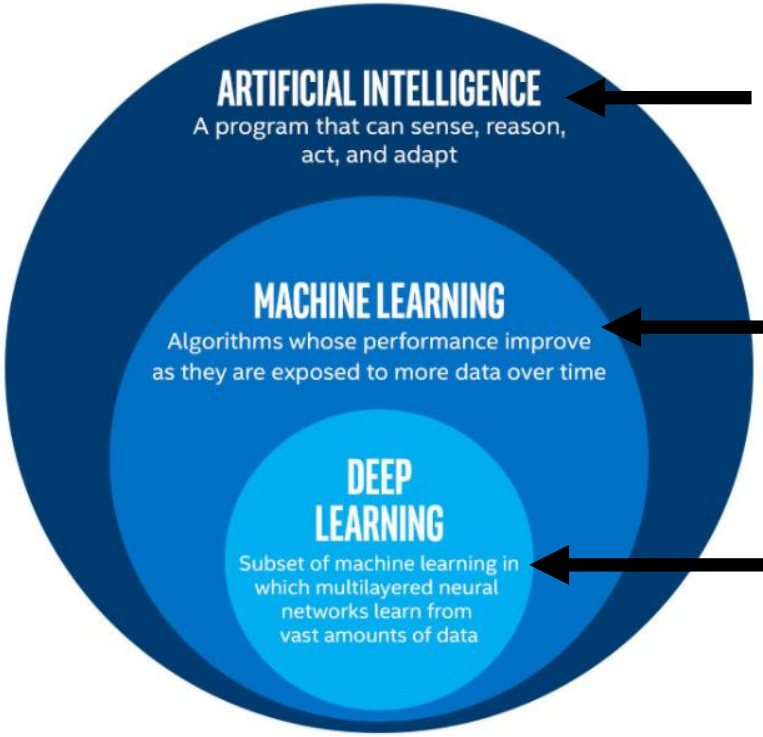
What is ML?

- Now we know the general concept of AI, so what is machine learning (ML) then?



A broader umbrella
A technique for incorporating human intelligence to machine

Machine Learning is a subset of Artificial Intelligence

Deep Learning is a subset of Machine Learning

Deep Learning uses neural networks to simulate human like decision making

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What is ML?

- Term “Machine Learning” coined by Arthur Samuel in 1959.
  - Samuel Checkers-playing Program

- Common definition (by Tom Mitchell):
  - ***Machine Learning is the study of computer algorithms that improve automatically through experience***

Credit: Dr. Avati

ML applications

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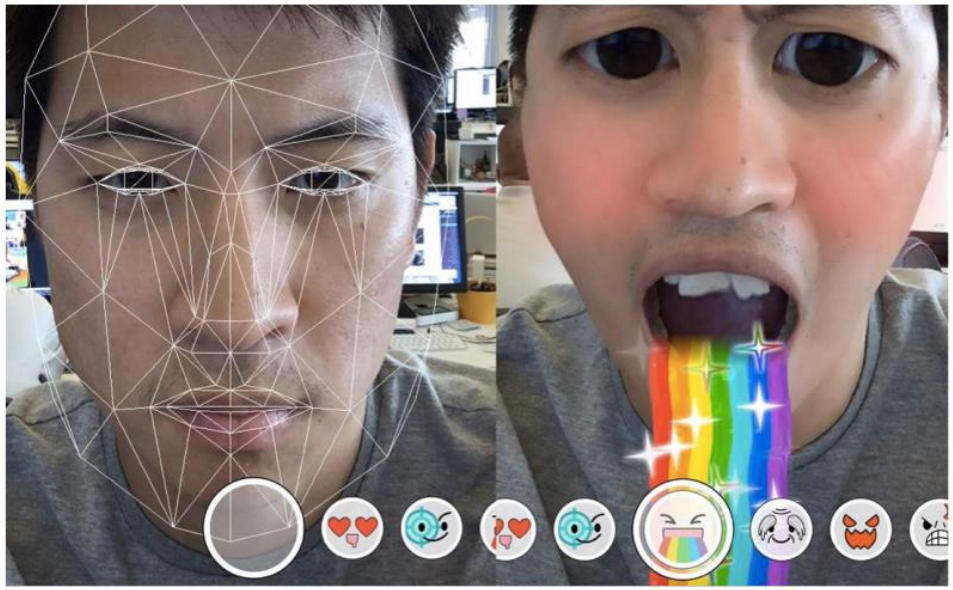
Computer vision

- Facebook accessibility tools for the visually impaired



Technology behind Snapchat lenses

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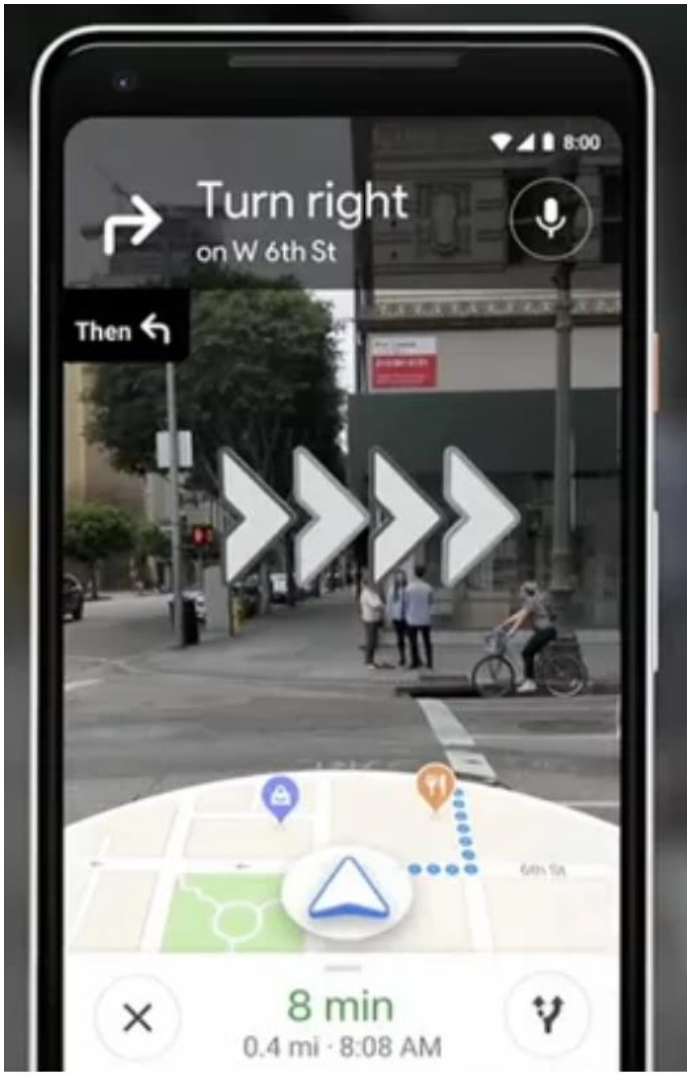
Computer vision



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Speech and natural language

Skype Translator

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

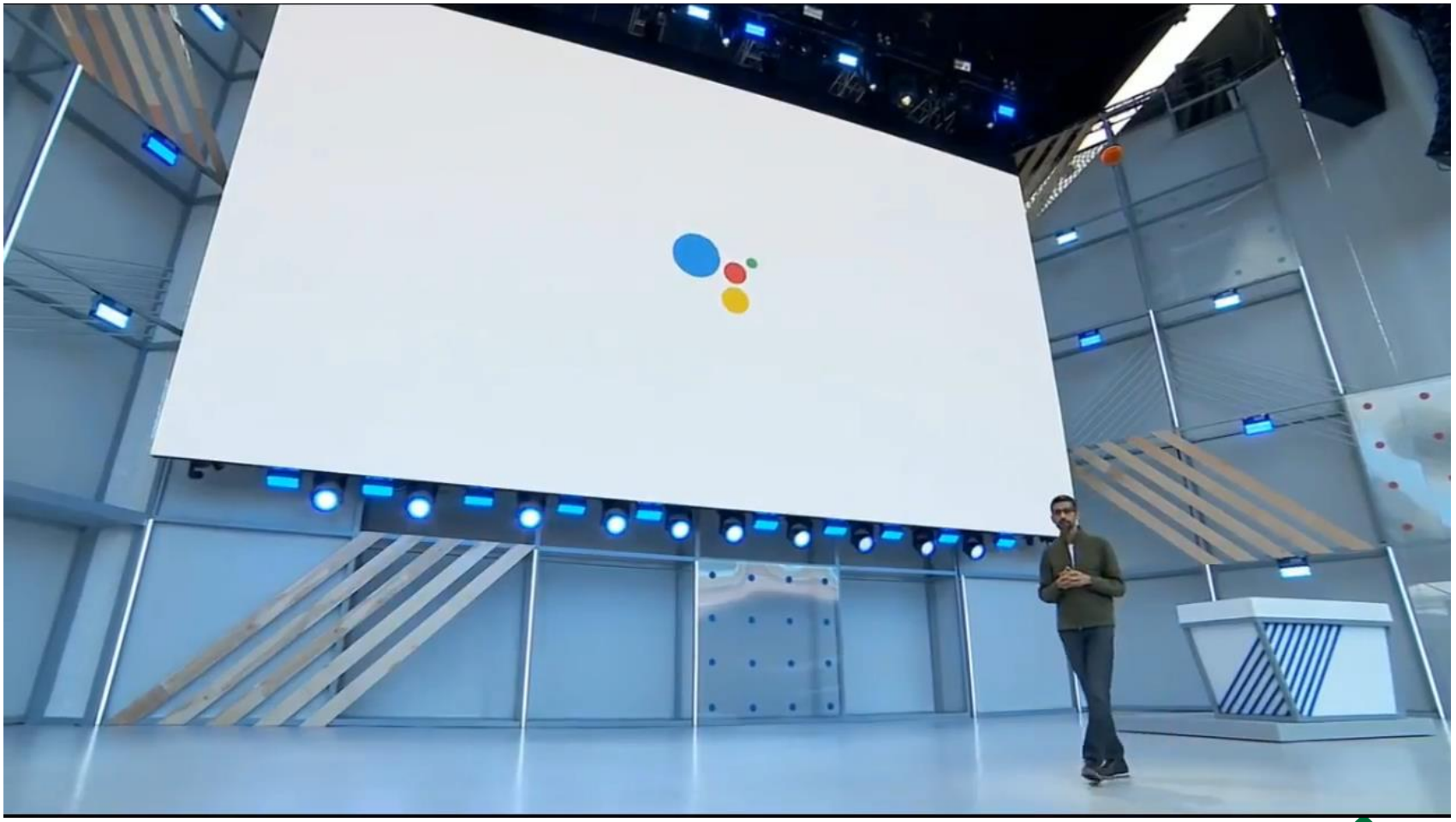
Our online translator can help you communicate in 7 languages for voice calls, and in more than 50 languages while instant messaging.

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.

Google Translate App

- Translate between 103 languages by typing
- Offline: Translate 52 languages when you have no Internet
- Instant camera translation: Use your camera to translate text instantly in 30 languages
- Camera Mode: Take pictures of text for higher-quality translations in 37 languages
- Conversation Mode: Two-way instant speech translation in 32 languages
- Handwriting: Draw characters instead of using the keyboard in 93 languages

Speech recognition and natural language processing (NLP)



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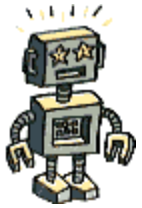
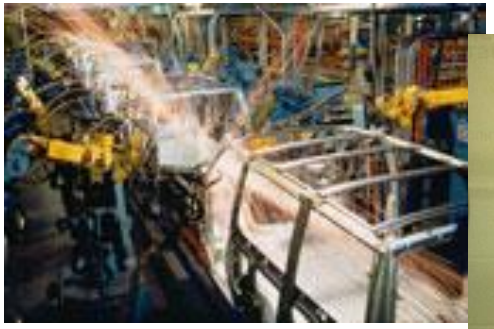
Robotics and ML

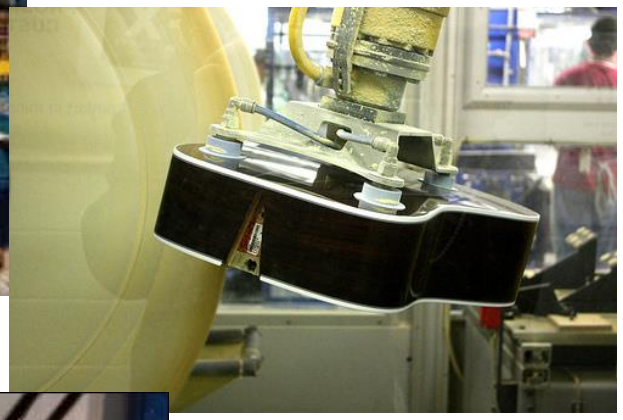


- Areas that robots are used:
  - Industrial robots
  - Military, government and space robots
  - Service robots for home, healthcare, laboratory
- Why are robots used?
  - Dangerous tasks or in hazardous environments
  - Repetitive tasks
  - High precision tasks or those requiring high quality
  - Labor savings
- Control technologies:
  - Autonomous (self-controlled), tele-operated (remote control)

Industrial Robots

- Uses for robots in manufacturing:
  - Welding
  - Painting
  - Cutting
  - Dispensing
  - Assembly
  - Polishing/Finishing
  - Material Handling
    - Packaging, Palletizing
    - Machine loading





Credit: Lee Giles

Military/Government Robots

- iRobot PackBot

- Remotec Andros

Credit: Lee Giles

Military/Government Robots

Soldiers in Afghanistan being trained how to defuse a landmine using a PackBot.

Credit: Lee Giles

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Military Robots

- Aerial drones (UAV)

- Military suit

Credit: Lee Giles

Space Robots

- Mars Rovers – Spirit and Opportunity
  - Autonomous navigation features with human remote control and oversight

Credit: Lee Giles

Service Robots

- Many uses…
  - Cleaning & Housekeeping
  - Humanitarian Demining
  - Rehabilitation
  - Inspection
  - Agriculture & Harvesting
  - Lawn Mowers
  - Surveillance
  - Mining Applications
  - Construction
  - Automatic Refilling
  - Fire Fighters
  - Search & Rescue

iRobot Roomba vacuum cleaner robot

Credit: Lee Giles

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Medical/Healthcare Applications

DaVinci surgical robot by Intuitive Surgical.

St. Elizabeth Hospital is one of the local hospitals using this robot. You can see this robot in person during an open house (website).

Credit: Lee Giles

Japanese health care assistant suit (HAL - Hybrid Assistive Limb)

Also… Mind-controlled wheelchair using NI LabVIEW

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Robotics - demo

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Autonomous vehicles

- First challenge in 2004
- 150 miles off-road course in the Mojave desert
- Given a set of GPS "breadcrumbs", vehicles were required to drive 100% autonomously
- $1M Prize, authorized by congress to the fastest team

CC 2.5 Wikipedia user Spaceape

The site of the DARPA Grand Challenge on race day, fronted by the Team Case vehicle, DEXTER

Credit: Stephen Welch

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Tesla is getting very impressive results from only camera + radar sensors, leveraging **large labeled datasets** and **deep learning**.

Credit: Stephen Welch

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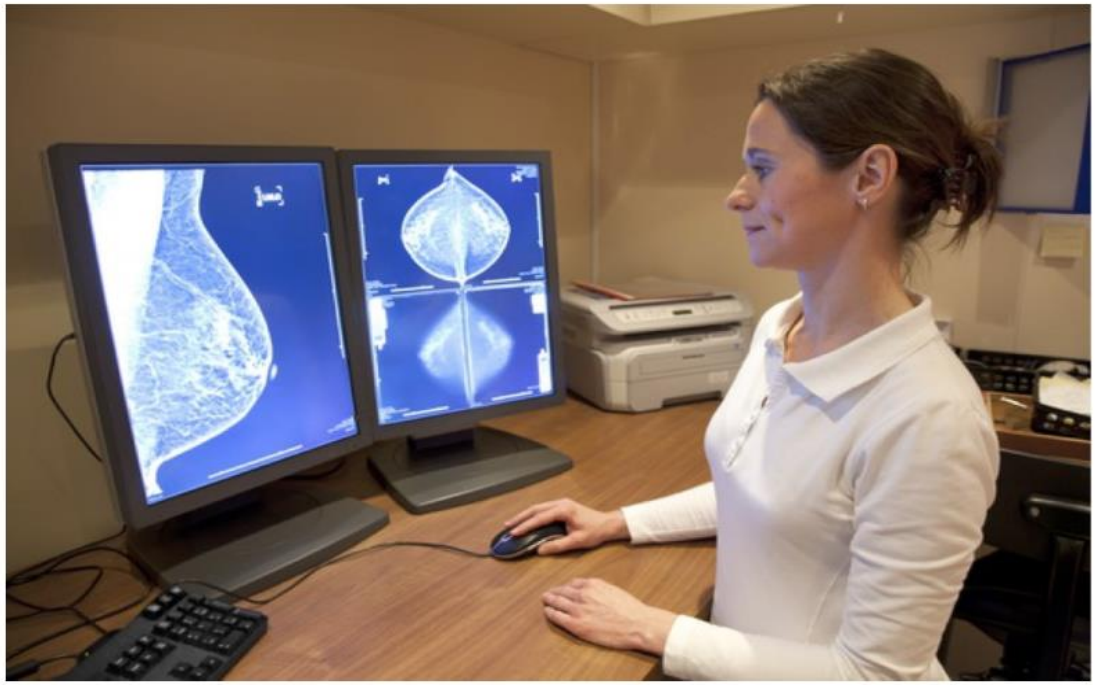
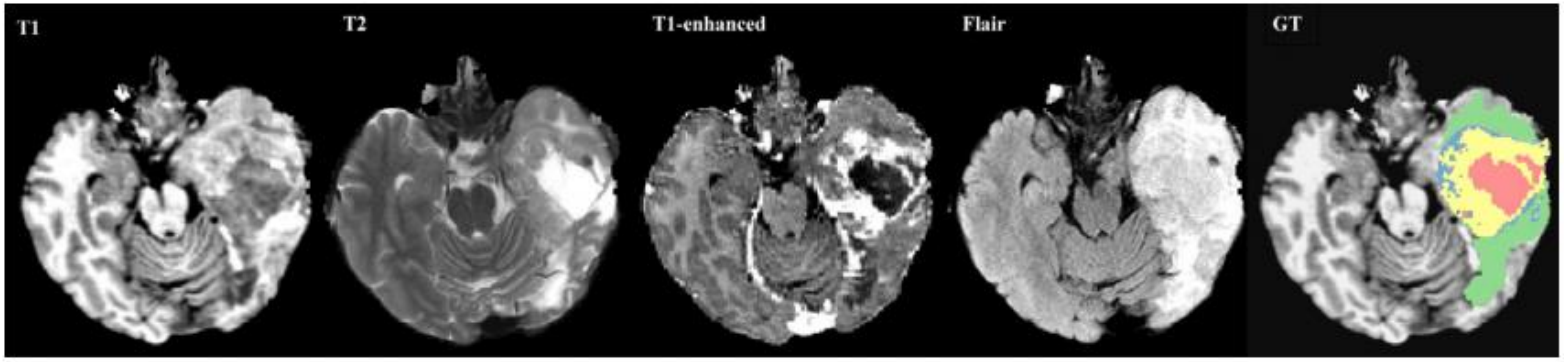
Medical/Healthcare



AI beats human pathologists at detecting cancer



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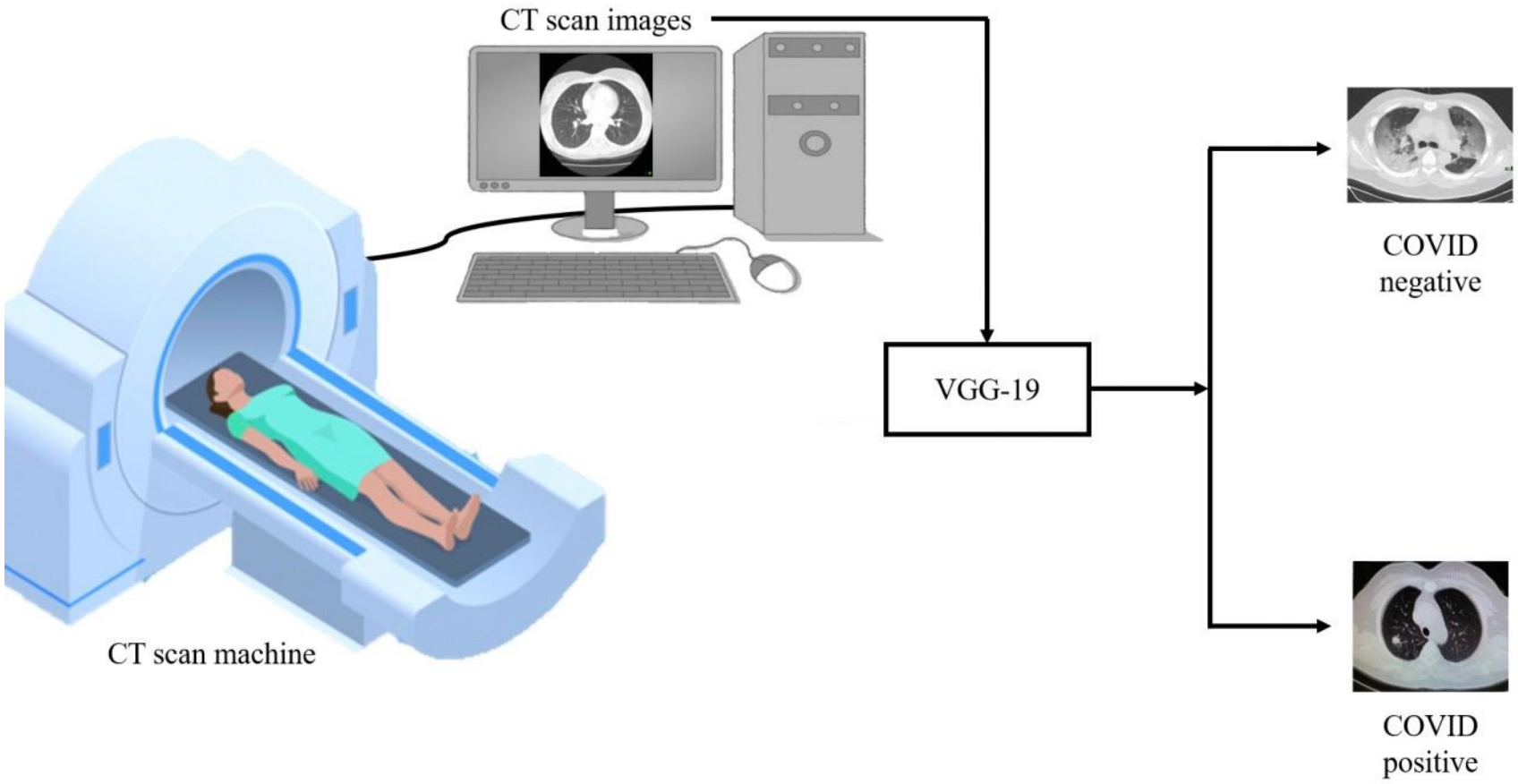
Medical/Healthcare

- **Diagnosis of COVID-19 using CT scan images and deep learning techniques**



Ozturk, Tulin, et al. "Automated detection of COVID-19 cases using deep neural networks with X-ray images." Computers in Biology and Medicine (2020): 103792.

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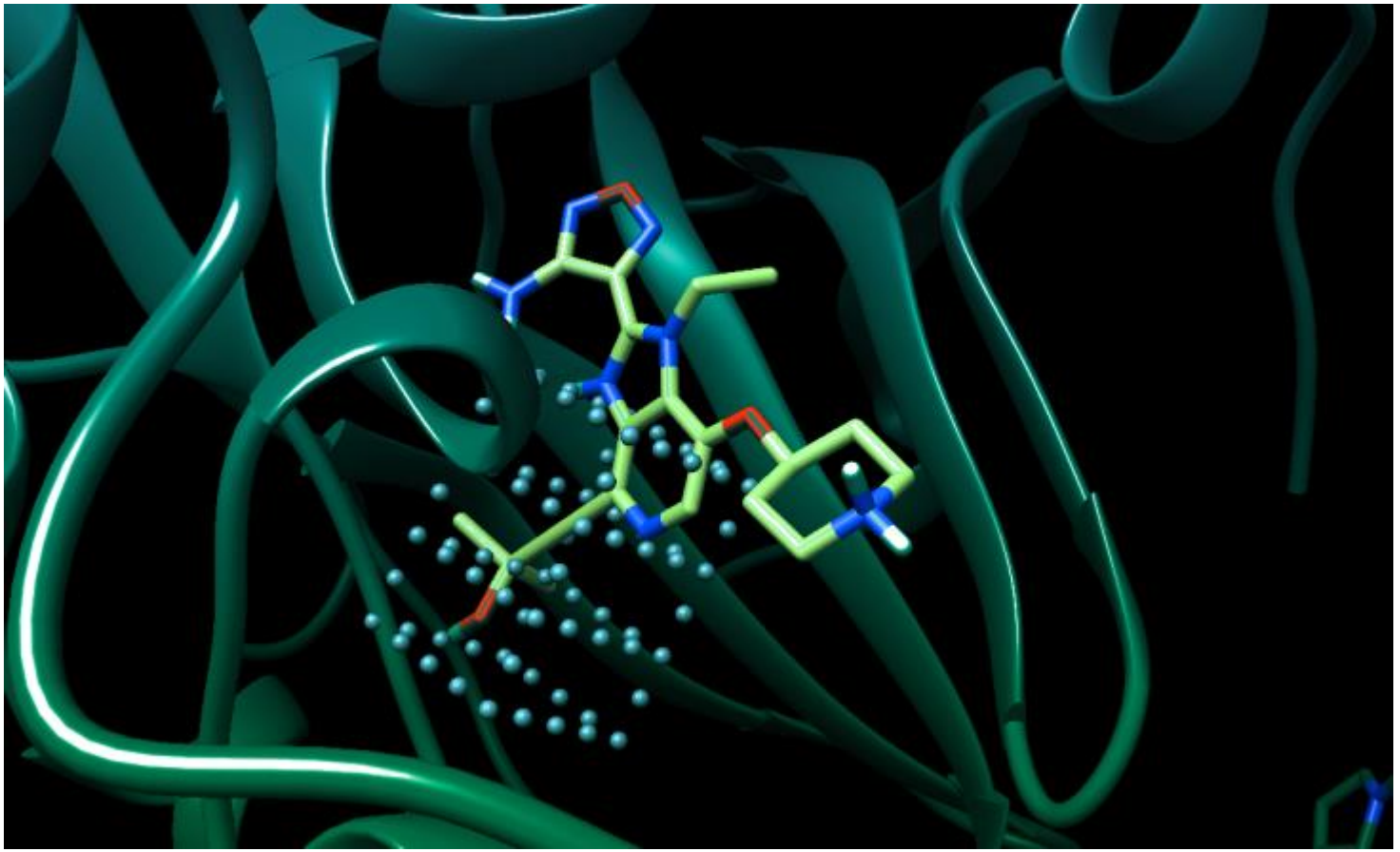
Medical/Healthcare

Drug discovery



Atomwise, which uses deep learning to shorten the process of discovering new drugs

Game

AlphaGo beat the 18-time world champion Lee Sedol in Go match in 2016.

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Game

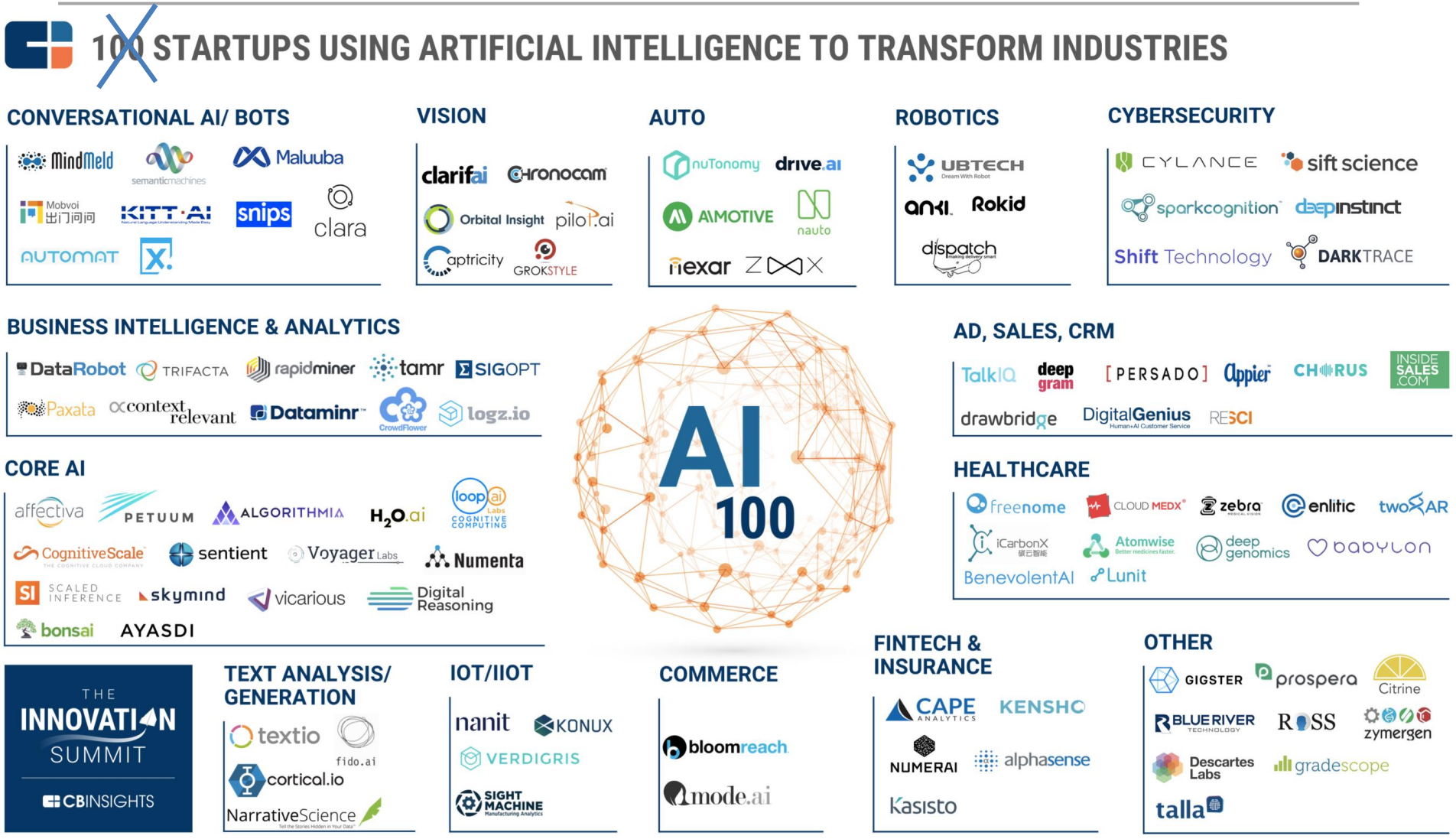
OpenAI defeating Humans at ‘Dota 2’

Other applications

- Security (e.g., cybersecurity)
- Education
- Music
- Virtual assistant
- Sales

⋮

Much more!



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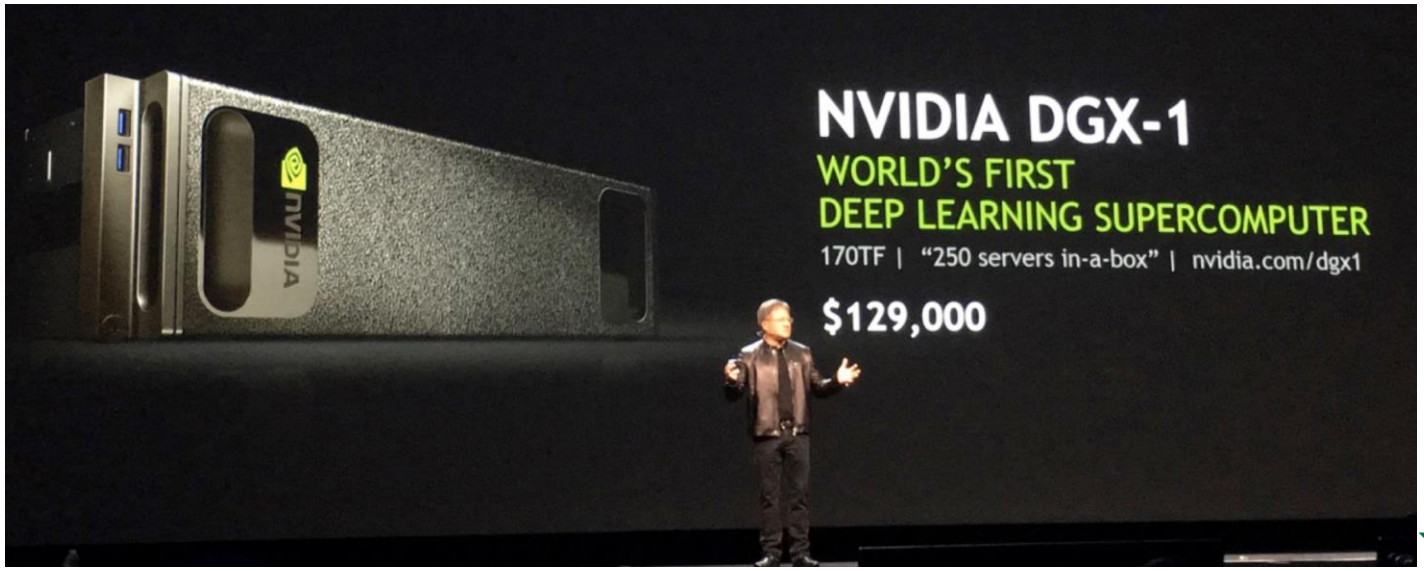
What accounts for recent successes in AI/ML?

- Faster computers
  - The IBM 704 vacuum tube machine that played chess in 1958 could do about **50,000 calculations per second**
- Powerful GPUs – highly parallelism



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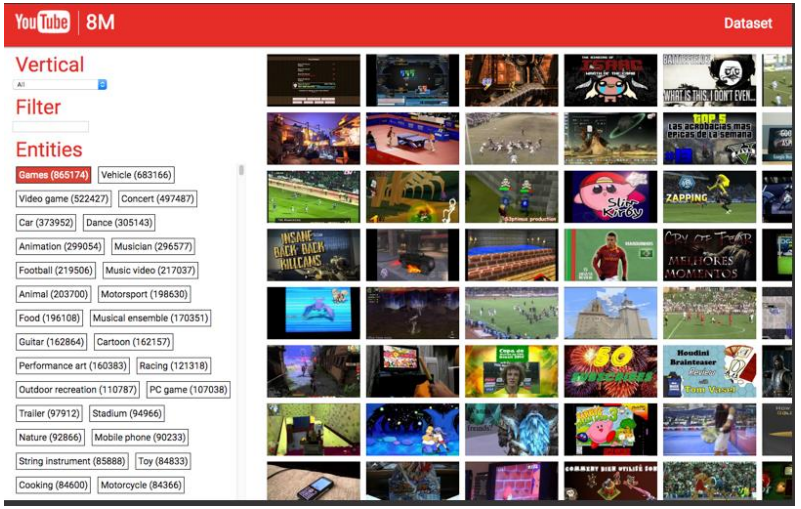
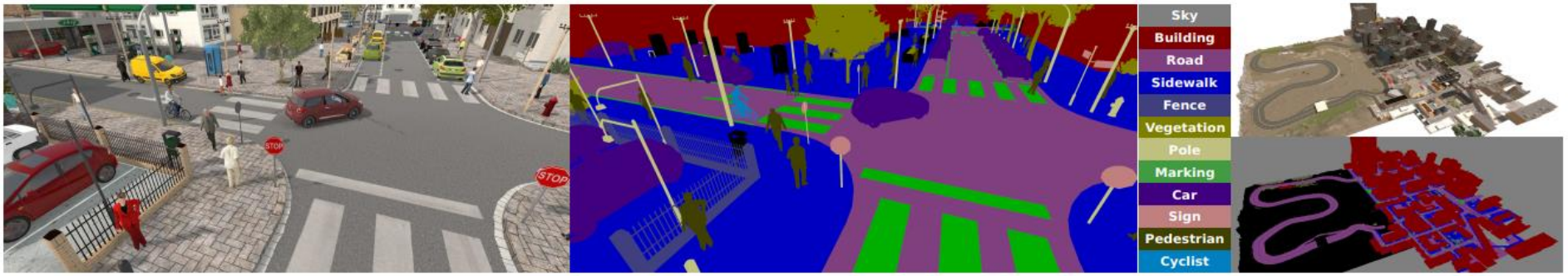
What accounts for recent successes in AI/ML?

- Big data and Crowdsourcing (labeled datasets)





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Questions?

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