

Introduction

BBM405 – Fundamentals of
Artificial Intelligence
Pinar Duygulu
Hacettepe University

slides are adapted from

Percy Liang (Stanford), Dan Klein (UC Berkeley), Lana Lazebnik (UIUC) and Hal Daumé III (UMD)

Artificial Intelligence – The Sci-Fi Way



The Architect, The Matrix Reloaded (2003)



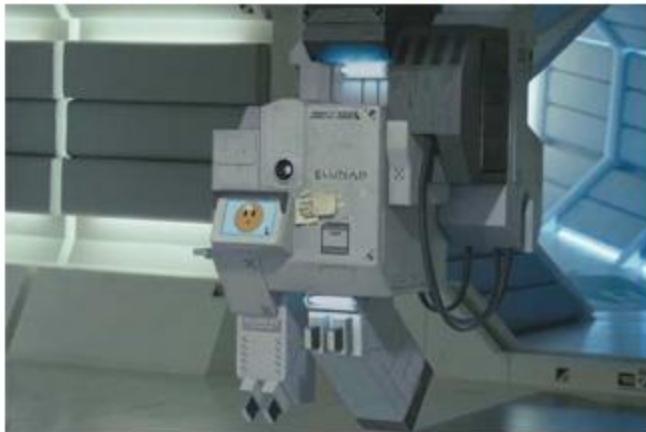
Skynet, The Terminator Franchise



HAL 9000,
2001: A Space Odyssey (1968)



The Puppet Master, in an android body, Ghost in the Shell (1999)



Gerthy, Moon (2009)

And many more...

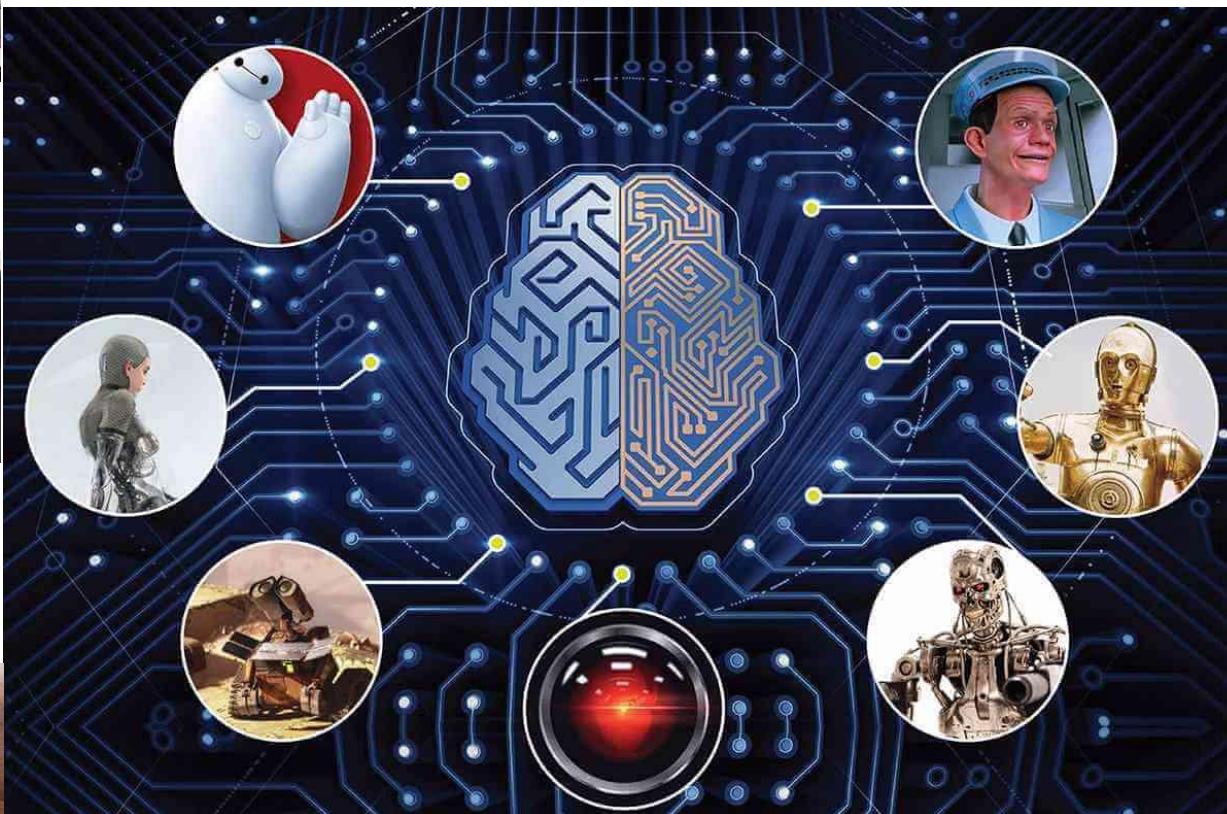
Baymax - RIBA II



Ava – Geminoid
(Hiroshi Ishiguro)



WALL-E -
Roomba



HAL – IBM Watson

Johnny Cab -
Google self-driving
car

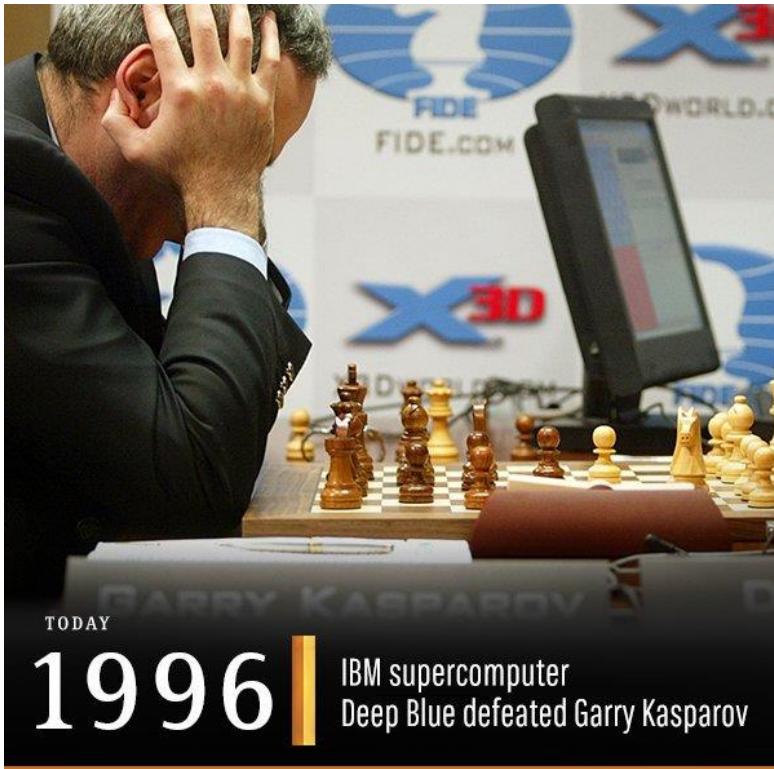


C-3PO -
Pepper



Terminator -
Atlas robots

What are some successes of AI today?

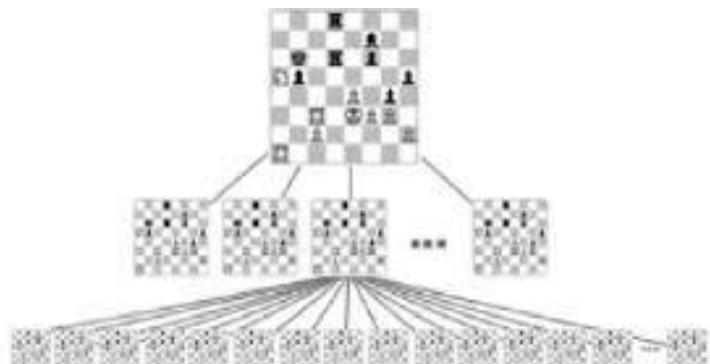


Chess

1989 : first chess program Deep Thought

1996 : IBM's supercomputer Deep Blue won against World champion Gary Kasparov

2006 : Deep Fritz that works on a PC won against Vladimir Kramnik



pawn	knight	bishop	rook	queen
1	3	3	5	9

Game Playing

- **May, '97: Deep Blue vs. Kasparov**
 - First match won against world-champion
 - “Intelligent creative” play
 - 200 million board positions per second!
 - Humans understood 99.9 of Deep Blue's moves
 - Can do about the same now with a big PC cluster
- **Open question:**
 - How does human cognition deal with the search space explosion of chess?
 - Or: how can humans compete with computers at all??
- **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.”



"In May 1997, an IBM supercomputer known as Deep Blue beat then chess world champion Garry Kasparov, who had once bragged he would never lose to a machine.

Kasparov and other chess masters blamed the defeat on a single move made by the IBM machine. Either at the end of the first game or the beginning of the second, depending on who's telling the story, the computer made a sacrifice that seemed to hint at its long-term strategy.

Kasparov and many others thought the move was too sophisticated for a computer, suggesting there had been some sort of human intervention during the game. "It was an incredibly refined move, of defending while ahead to cut out any hint of countermoves," grandmaster Yasser Seirawan [told Wired.com in 2001, "and it sent Garry into a tizzy."](#) Fifteen years after the historical match, one of Big Blue's designers says the move was the result of a bug in Deep Blue's software."

TECHNOLOGY

Did Deep Blue beat Kasparov because of a computer bug?

By [Klent Finley](#) | 01 October 12



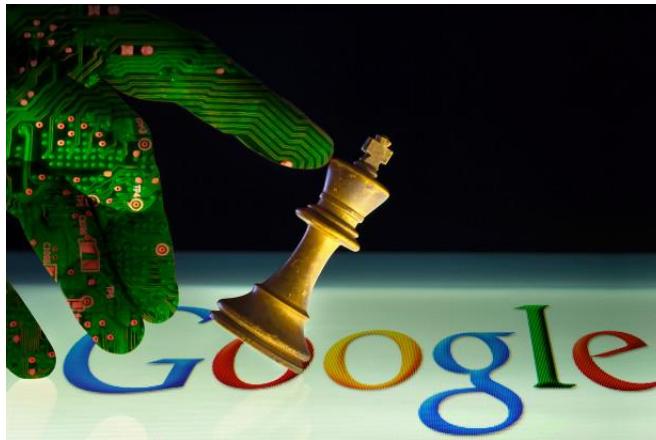
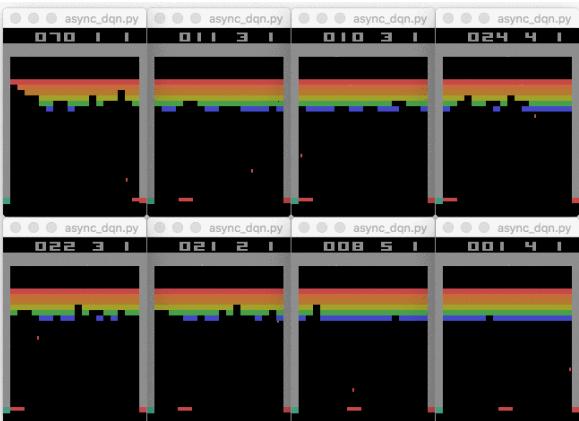
Go



2015-2016: Google DeepMind's AlphaGo won against world Go Champions Lee Sedol and Ke Jie

19x19 game board,
 10^{170} possible combinations

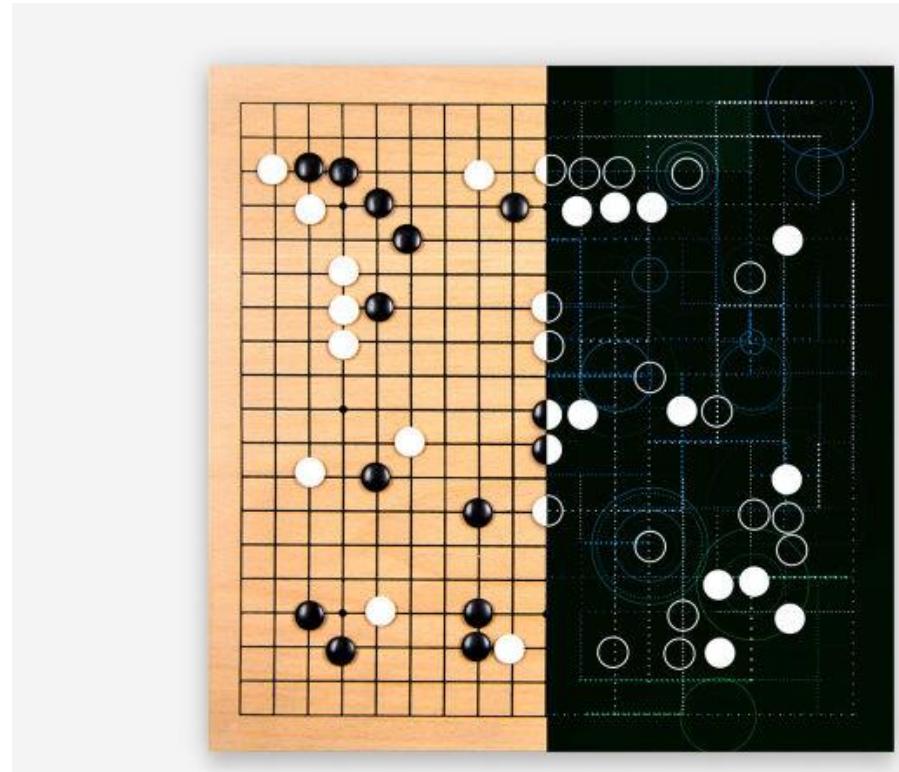
<https://deepmind.com/research/alphago/>



Expert chess player only
in 4 hours

The Artificial Intelligence That Solved Go

Nineteen years after Deep Blue won a chess match against a grand master, a Google team has created an A.I. that's able to win against professional players of the ancient Chinese strategy game of Go. Last October, DeepMind's program, named AlphaGo, won all five games against Hui.



AlphaGo was built to deal with "any task that has a lot of data that is unstructured and you want to find patterns in the data and then decide what to do."

Even with recent advances, computers don't have the power to run all those possibilities. So, instead, AlphaGo learns smart moves by observing millions of top human games and by playing against itself. Then, when choosing a move during a game, it only searches within a narrower pool of possibilities that seem reasonable.

Humans versus machines



1997: Deep Blue (chess)



2011: IBM Watson (Jeopardy!)

Perhaps the aspect of AI that captures the public's imagination the most are in defeating humans at their own game.

- In 1997, Deep Blue defeated Gary Kasparov, the world chess champion. In 2011, IBM Watson defeated two of the biggest winners (Brad Rutter and Ken Jennings) at the quiz show Jeopardy! (IBM seems to be pretty good at performing these kind of stunts.)
- One could have argued that Deep Blue won simply by the sheer force of its computation prowess, whereas winning Jeopardy! involved understanding natural language, and this defeat hit closer to home.

IBM Watson



[https://en.wikipedia.org/wiki/Watson_\(computer\)](https://en.wikipedia.org/wiki/Watson_(computer))

- <http://www-03.ibm.com/innovation/us/watson/>
- [NY Times article](#)
- [Trivia demo](#)
- [IBM Watson wins on Jeopardy \(February 2011\)](#)
- [Watson provides cancer treatment options to doctors in seconds \(February 2013\)](#)

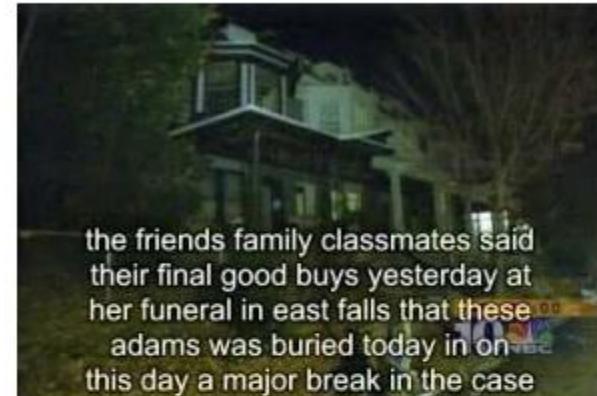
What can AI do for you?

- Instead of asking what AI is, let us turn to the more pragmatic question of what AI can do for you. We will go through some examples where AI has already had a substantial impact on society.



Natural Language Processing

- Speech technologies
 - Automatic speech recognition
 - Text-to-speech synthesis
 - Dialog systems



- Language processing technologies
 - Machine translation

"Il est impossible aux journalistes de rentrer dans les régions tibétaines"

Bruno Philip, correspondant du "Monde" en Chine, estime que les journalistes de l'AFP qui ont été expulsés de la province tibétaine du Qinghai "n'étaient pas dans l'illégalité".

Les faits Le dalaï-lama dénonce l'"enfer" imposé au Tibet depuis sa fin, en 1959.

Vidéo Anniversaire de la rébellion tibétaine : la Chine en garde à vue

"It is impossible for journalists to enter Tibetan areas"

Philip Bruno, correspondent for "World" in China, said that journalists of the AFP who have been deported from the Tibetan province of Qinghai "were not illegal."

Fact The Dalai Lama denounces the "hell" imposed since he fled Tibet in 1959.

Video Anniversary of the Tibetan rebellion: China on guard

- Information extraction
- Information retrieval, question answering
- Text classification, spam filtering, etc.

Machine translation

The screenshot shows the Google Translate interface. At the top, there's a navigation bar with links for +You, Search, Images, Maps, Play, YouTube, News, Gmail, Drive, Calendar, and More. Below the navigation bar is the Google logo and a red "SIGN IN" button. The main area has a "Translate" button and dropdown menus for "From: French - detected" and "To: English". There are also buttons for "Translate", a star icon for bookmarks, and a copy/paste icon.

From: French - detected **To:** English

Translate

Bookmark

Copy

English Spanish French French - detected

English Spanish Arabic

Le premier ministre a lancé une autre piste – sans l'expliquer et beaucoup des experts présents à la conférence environnementale n'ont pu le faire - : la mobilisation d'une partie des gains financiers perçus sur le parc nucléaire français. "Pendant toute la durée de vie restante de nos centrales, et tout en assurant une sécurité maximale, a déclaré Jean-Marc Ayrault, notre parc nucléaire sera mis à contribution sans rupture d'approvisionnement".

The Prime Minister has launched another track - without explaining and many experts at the environmental conference could not do -: the mobilization of some of the financial gains earned on the French nuclear fleet. "Throughout the remaining life of our plants, and while ensuring maximum security, said Jean-Marc Ayrault, our nuclear fleet will be involved without supply disruption."

Star **Print** **Checkmark**

Turn off instant translation **About Google Translate** **Mobile** **Privacy** **Help** **Send feedback**

If you want to read a news article in another language, you can turn to machine translation.

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.

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

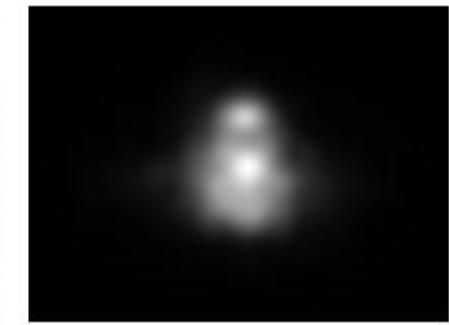
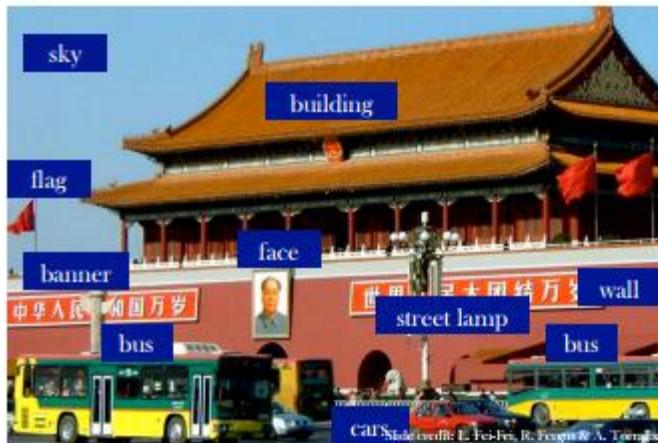
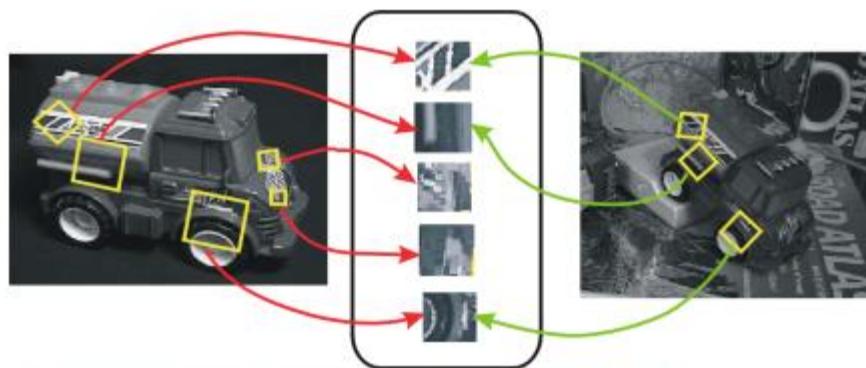


Google Translate App

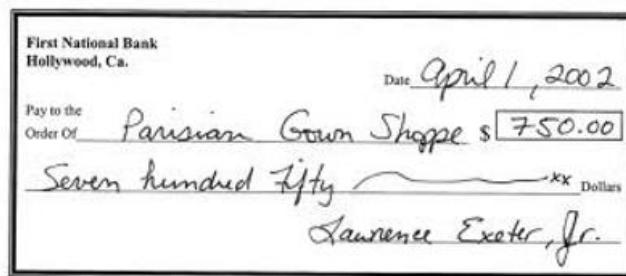
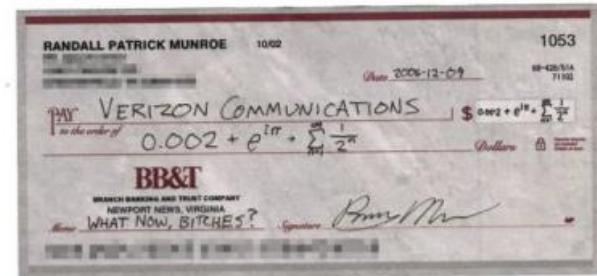
- Translate between 103 languages by typing
- Offline: Translate 52 languages when you have no Internet
- Instant camera translation: Use your camera to translate text instantly in 30 languages
- Camera Mode: Take pictures of text for higher-quality translations in 37 languages
- Conversation Mode: Two-way instant speech translation in 32 languages
- Handwriting: Draw characters instead of using the keyboard in 95 languages

Computer Vision

- OCR, handwriting recognition
- Face detection/recognition
- Scene segmentation, etc.

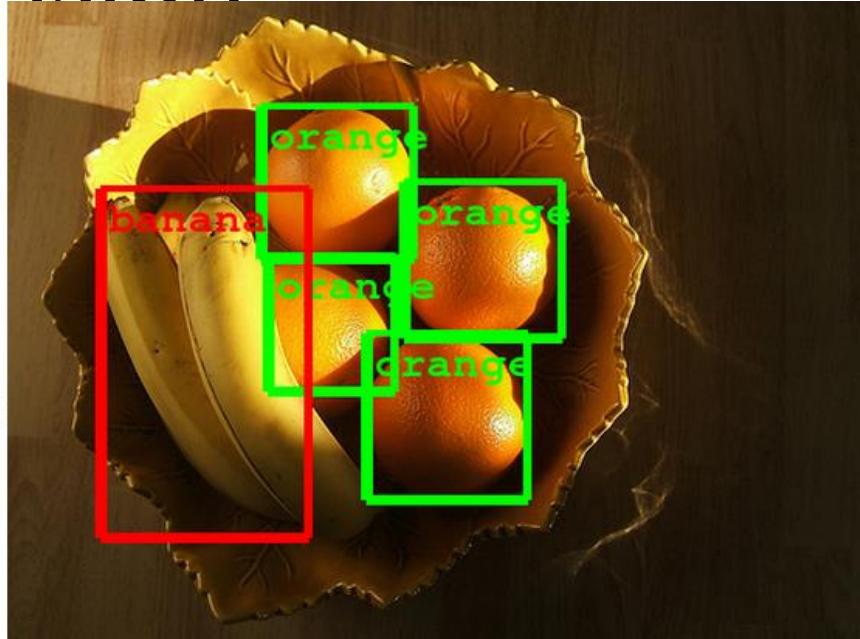
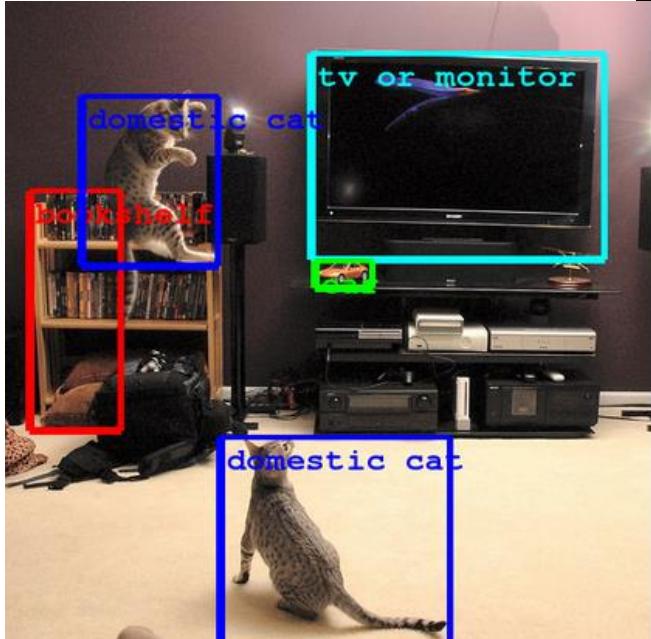


Handwriting recognition



When you deposit a check at an ATM, handwriting recognition is employed to automatically figure out the deposit amount.

Vision

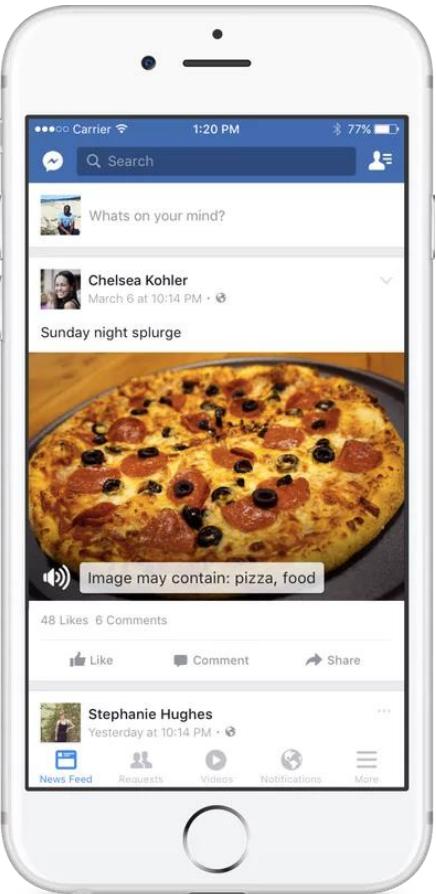


- [Computer Eyesight Gets a Lot More Accurate,](#)
NY Times Bits blog, August 18, 2014

Vision



[Facebook accessibility tools for the visually impaired](#)



[AI beats human pathologists at detecting cancer](#)



[Technology behind Snapchat lenses](#)

Robotics

- Robotics
 - Part mechanical engineering
 - Part AI
 - Reality much harder than simulations!
- Technologies
 - Autonomous vehicles (DARPA Grand Challenge, Google self-driving cars)
 - Rescue
 - Soccer (RoboCup)
 - Robotic pets
 - Lots of automation



Images from stanfordracing.org, CMU RoboCup, Honda ASIMO sites

DARPA Robotics Challenge (2015)

JUN 5, 2015 @ 3:24 PM

NEW TECHNOLOGY ROBOTS DARPA ROBOTS DARPA ROBOTICS CHALLENGE

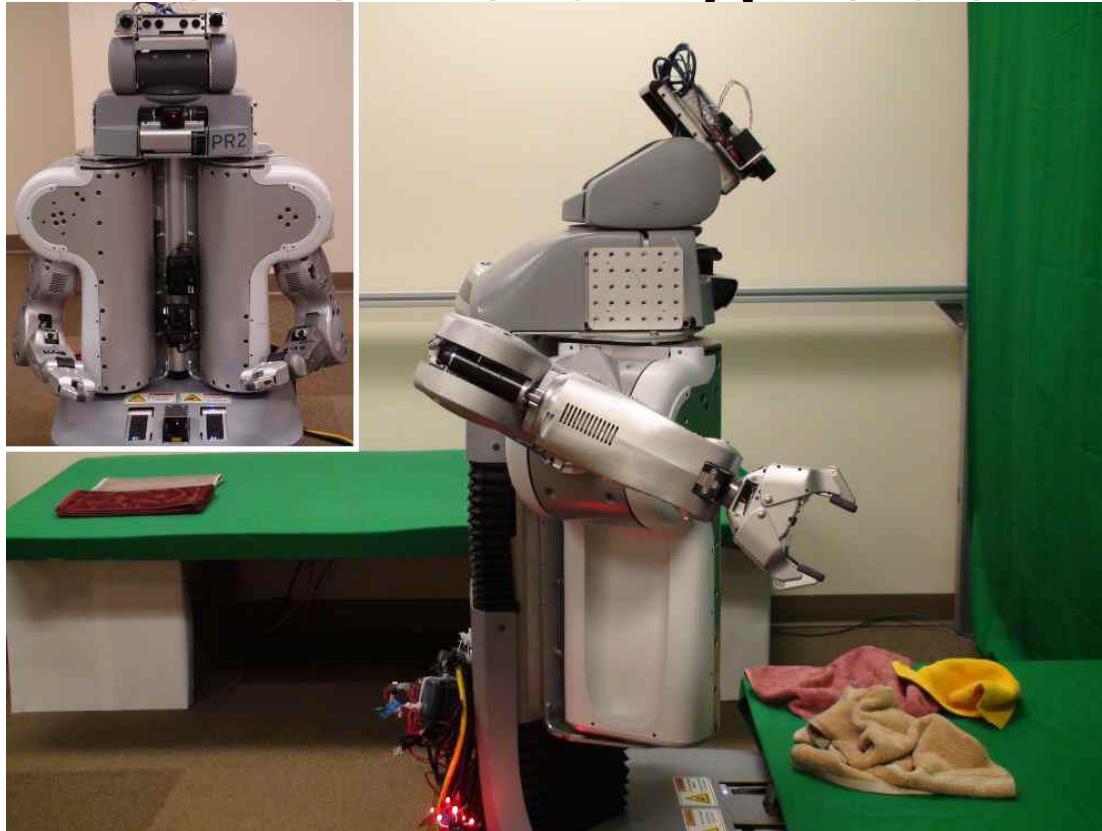
The Most Hilarious Robo-Falls from the DARPA Robotics Challenge



[http://www.popularmechanics.com/technology/robots/a15907/best-falls-from-darpa-robot-](http://www.popularmechanics.com/technology/robots/a15907/best-falls-from-darpa-robot/)

<https://www.youtube.com/watch?v=g0TaYH>

Towel-folding robot



[YouTube Video](#)

- J. Maitin-Shepard, M. Cusumano-Towner, J. Lei and P. Abbeel, [Cloth Grasp Point Detection based on Multiple-View Geometric Cues with Application to Robotic Towel Folding](#), ICRA 2010
- [More clothes folding](#)

Towel-folding robot

U.S. Senator Calls Robot Projects Wasteful. Robots Call Senator Wasteful

By Erico Guizzo

Posted 14 Jun 2011 | 13:58 GMT

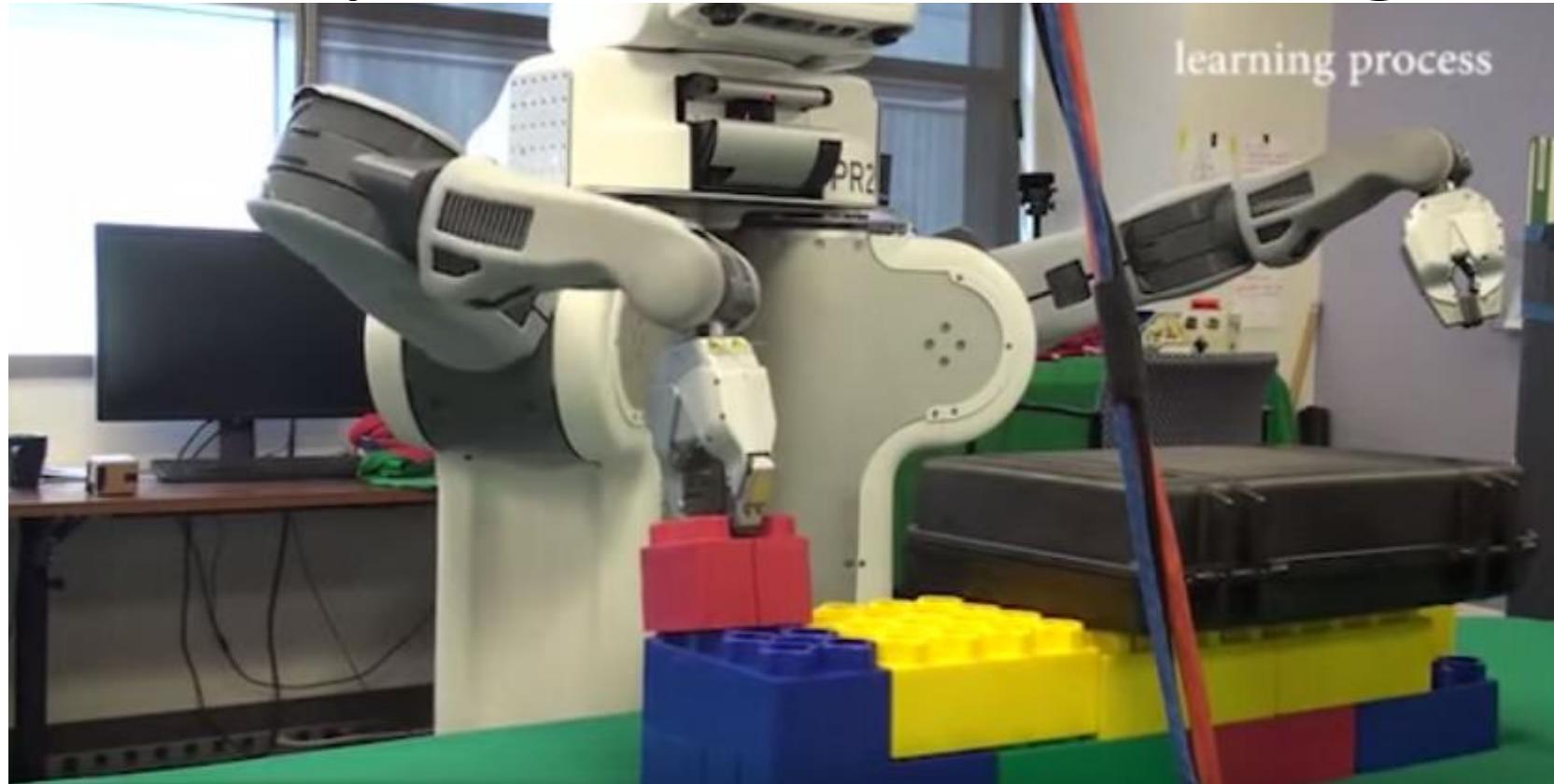
Share | Email | Print | Reprint



Tom Coburn, a senator from Oklahoma, and PR2, a robot from California.

<http://spectrum.ieee.org/automaton/robotics/robotics-software/us-senator-calls-robot-wasteful>

Deep sensorimotor learning



[YouTube video](#)

- S. Levine, C. Finn, T. Darrell and P. Abbeel, [End-to-end training of deep visuomotor policies](#), JMLR 2016

Autonomous driving



Research in autonomous cars started in the 1980s, but the technology wasn't there. • Perhaps the first significant event was the 2005 DARPA Grand Challenge, in which the goal was to have a driverless car go through a 132-mile off-road course. Stanford finished in first place. The car was equipped with various sensors (laser, vision, radar), whose readings needed to be synthesized (using probabilistic techniques that we'll learn from this class) to localize the car and then to generate control signals for the steering, throttle, and brake. • In 2007, DARPA created an even harder Urban Challenge, which was won by CMU. • In 2009, Google started a self-driving car program, and since then, their self-driving cars have driven over 1 million miles on freeways and streets. • In January 2015, Uber hired about 50 people from CMU's robotics department to build self-driving cars. • While there are still technological and policy issues to be worked out, the potential impact on transportation is huge.

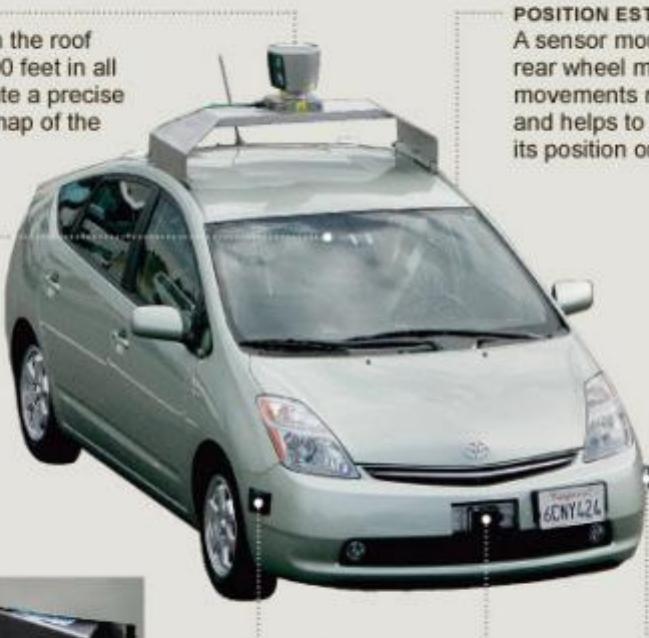
Google self-driving cars

Autonomous Driving

Google's modified Toyota Prius uses an array of sensors to navigate public roads without a human driver. Other components, not shown, include a GPS receiver and an inertial motion sensor.

LIDAR

A rotating sensor on the roof scans more than 200 feet in all directions to generate a precise three-dimensional map of the car's surroundings.



POSITION ESTIMATOR

A sensor mounted on the left rear wheel measures small movements made by the car and helps to accurately locate its position on the map.



VIDEO CAMERA

A camera mounted near the rear-view mirror detects traffic lights and helps the car's onboard computers recognize moving obstacles like pedestrians and bicyclists.



RADAR

Four standard automotive radar sensors, three in front and one in the rear, help determine the positions of distant objects.

Source: Google

THE NEW YORK TIMES; PHOTOGRAPH BY RAMIN RAHEMANI FOR THE NEW YORK TIMES

- Google's self-driving car passes 300,000 miles
(Forbes, 8/15/2012)

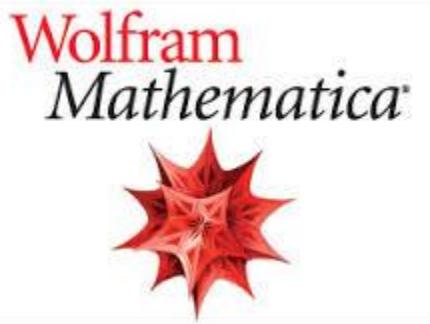
Virtual assistants



With the rise of mobile devices, smart cars and homes, and improvements in speech recognition, we will be able to interact with computers using natural language and gestures. Imagine coming home and saying: "what do I need to buy for tomorrow's picnic and where can I do that now?" • Currently, Apple's Siri, Google Now, and Microsoft Cortana provide a first stab at this problem, handling mostly simple utterances and actions (e.g., setting an alarm, sending a text, etc.) The technology is still in its infancy, but it is an exciting and a rapidly moving field.

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:



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

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

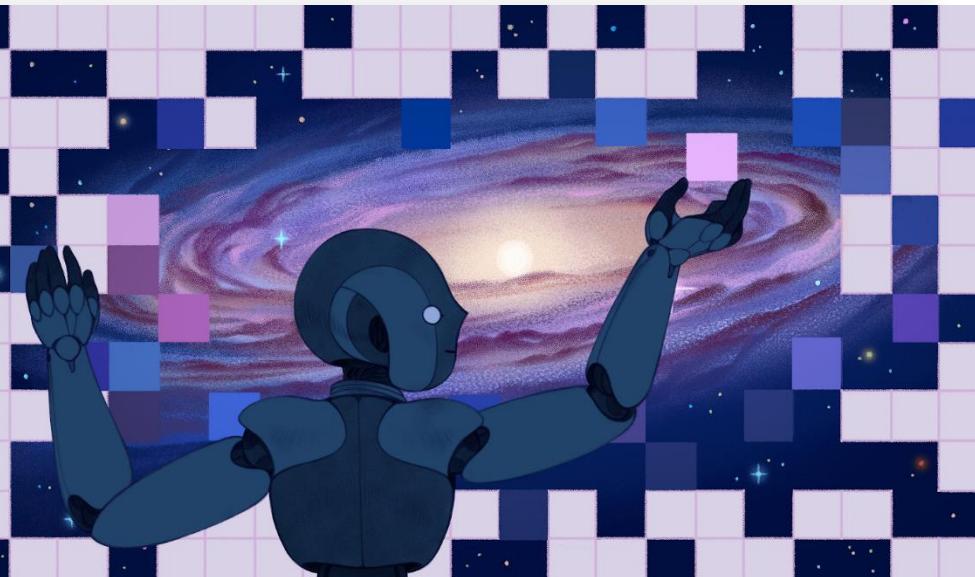
MACHINE LEARNING

How Artificial Intelligence Is Changing Science

By DAN FALK

March 11, 2019

The latest AI algorithms are probing the evolution of galaxies, calculating quantum wave functions, discovering new chemical compounds and more. Is there anything that scientists do that can't be automated?



Chemical shifts from tiny NMR samples pp. 38 & 67

Regulating products that target gut microbiomes p. 39

Preschool games promote math skills in India p. 47

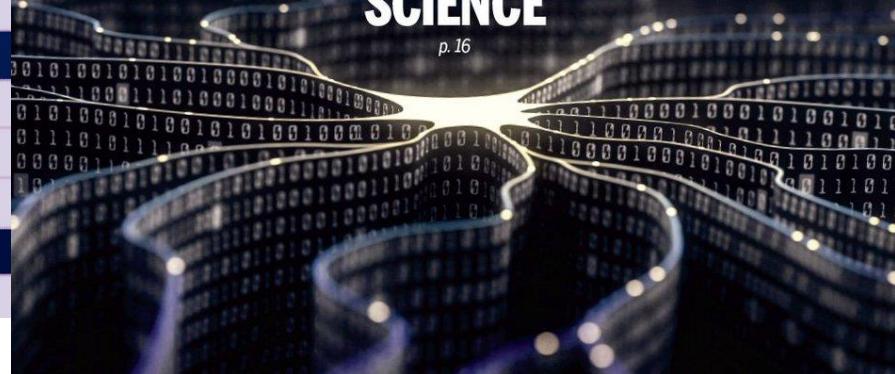
Science

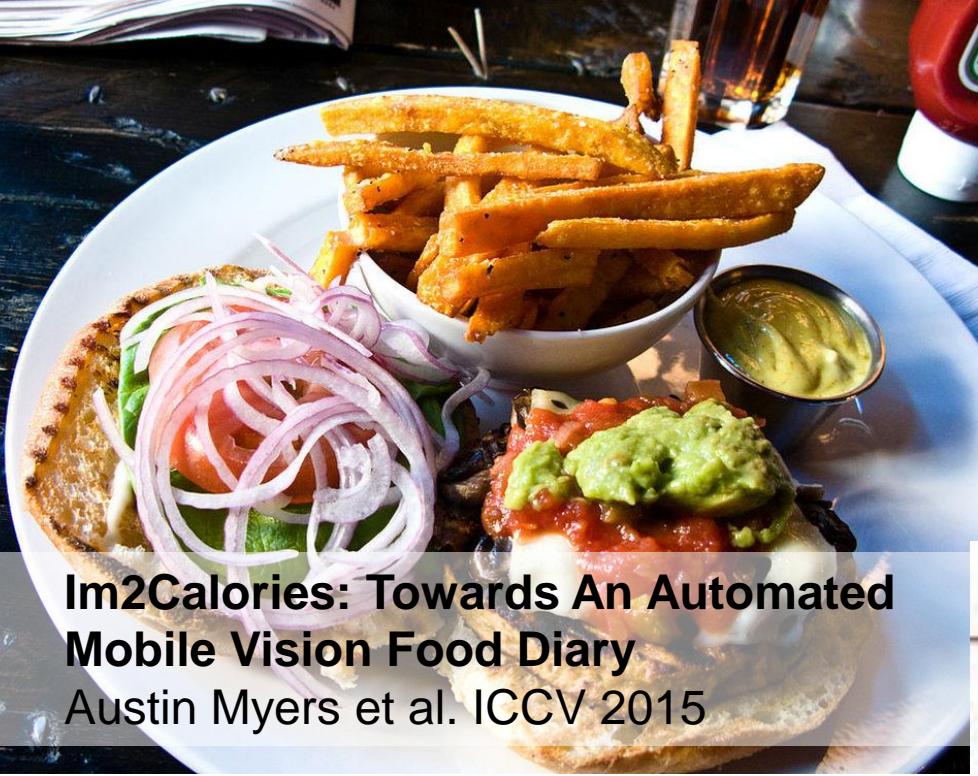
\$15
7 JULY 2017
sciencemag.org

AAAS

AI
TRANSFORMS
SCIENCE

p. 16





Im2Calories: Towards An Automated Mobile Vision Food Diary

Austin Myers et al. ICCV 2015



10 AI Applications That Could Change Health Care

AI in Healthcare

APPLICATION	POTENTIAL ANNUAL VALUE BY 2026	KEY DRIVERS FOR ADOPTION
Robot-assisted surgery	\$40B	Technological advances in robotic solutions for more types of surgery
Virtual nursing assistants	20	Increasing pressure caused by medical labor shortage
Administrative workflow	18	Easier integration with existing technology infrastructure
Fraud detection	17	Need to address increasingly complex service and payment fraud attempts
Dosage error reduction	16	Prevalence of medical errors, which leads to tangible penalties
Connected machines	14	Proliferation of connected machines/devices
Clinical trial participation	13	Patent cliff; plethora of data; outcomes-driven approach
Preliminary diagnosis	5	Interoperability/data architecture to enhance accuracy
Automated image diagnosis	3	Storage capacity; greater trust in AI technology
Cybersecurity	2	Increase in breaches; pressure to protect health data

SOURCE ACCENTURE

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<https://www.healthcentral.com/slideshow/8-ways-artificial-intelligence-is-affecting-the-medical-field-futurism.media/artificial-intelligence-in-medicine>

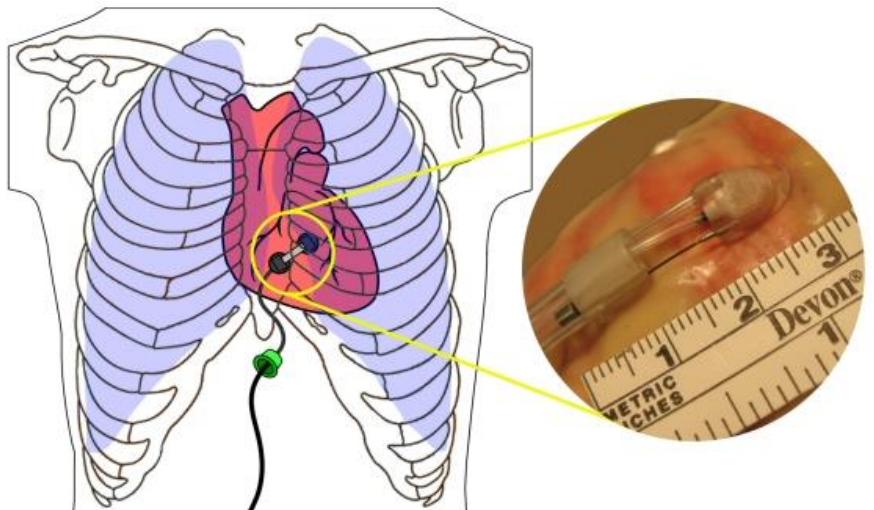
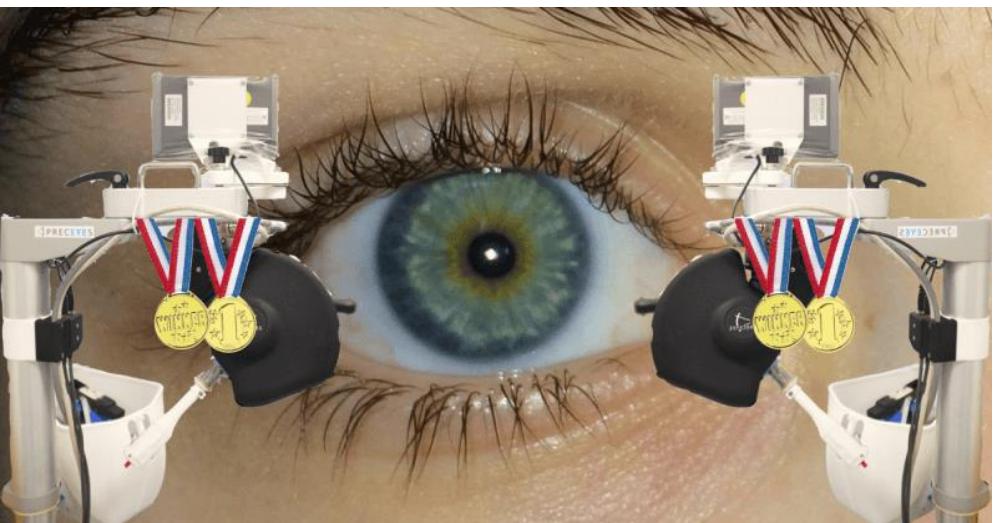
Robotic surgery

Da Vinci robot

Eye surgery in University of Oxford'

Heartlander mini robot on heart

Less invasive
Less complication
Faster recovery



<https://thenextweb.com/science/2018/06/19/a-robot-operated-on-a-human-eye-for-the-first-time-ever/>

<https://www.cs.cmu.edu/~heartlander/index.html>

Robotic or Virtual Nurses



Pepper



RIBA



Pearl



Molly

Rehabilitation / physiotherapy

Watch later Share



Range of Motion Test - Cervical ROM
<https://medium.com/@coviu/artificial-intelligence-for-physiotherapy-1f22fb4ac5f>

Franklin, Angela

Range of Motion Station

Patient

QROM Instructor

Tilt to your Right

Franklin, Angela

STOP	1	2	3	Avg	SD	CV	Norm	%Wimp
Flexion	78	78	0.0	0.0	50			
Extension	65	65	0.0	0.0	50			
Left Lateral	53	53	0.0	0.0	45			
Right Lateral	50					45	80	80
Left Rotation								
Right Rotation								

MORE VIDEOS

Glenbeck Rehab Center
Instructor: New York
Version 1.24
www.glenbeckrehab.com
Dr. Levent Gulerler



<https://www.technologyreview.com/s/603614/a-robot-physical-therapist-helps-kids-with-cerebral-palsy/>



HAL exoskeleton

Medical Diagnosis

https://en.wikipedia.org/wiki/Medical_diagnosis

INFO SYMPTOMS QUESTIONS CONDITIONS DETAILS TREATMENT

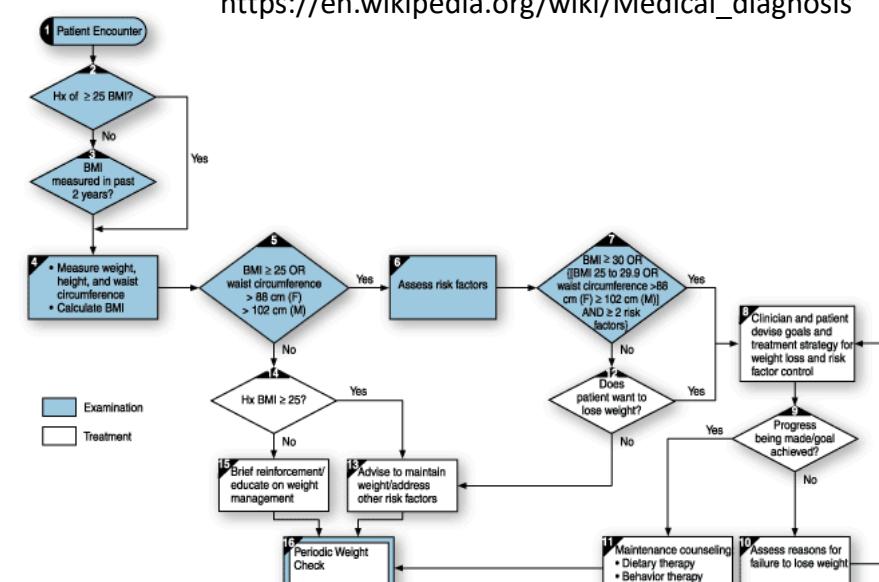
WebMD Symptom Checker BETA

Identify possible conditions and treatment related to your symptoms.

This tool does not provide medical advice. [See additional information.](#)

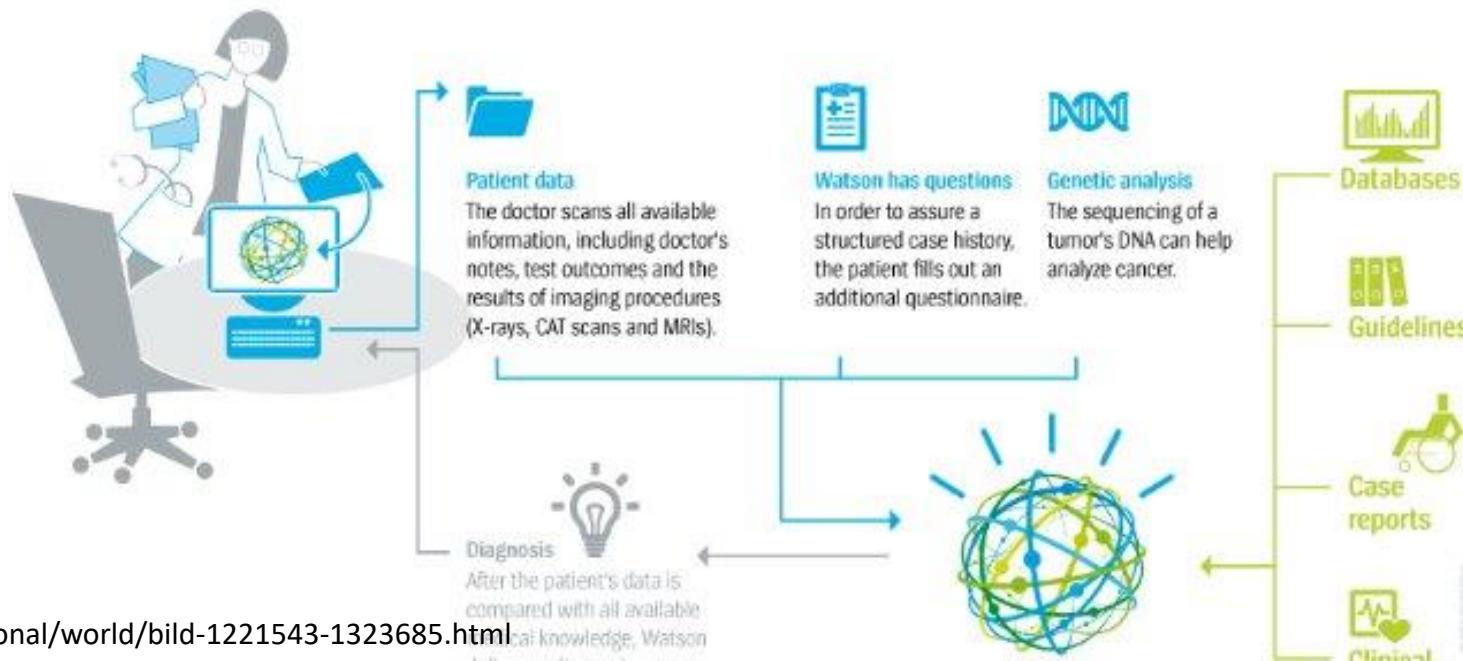
Age Gender Male Female

```
graph TD; A[Patient Encounter] --> B{Hx of ≥ 25 BMI?}; B -- No --> C{BMI measured in past 2 years?}; C -- Yes --> D["Measure weight, height, and waist circumference  
Calculate BMI"]; C -- No --> E{BMI ≥ 25 OR  
waist circumference > 88 cm (F)  
> 102 cm (M)}; E -- Yes --> F[Assess risk factors]; E -- No --> G{Hx BMI ≥ 25?}; G -- Yes --> H[Brief reinforcement/educate on weight management]; G -- No --> I[Advise to maintain weight/address other risk factors]; F --> J{BMI ≥ 30 OR  
[(BMI 25 to 29.9 OR  
waist circumference > 88 cm (F) ≥ 102 cm (M))  
AND ≥ 2 risk factors]}; J -- Yes --> K{Does patient want to lose weight?}; J -- No --> L[Periodic Weight Check]; K -- Yes --> M[Maintenance counseling  
Dietary therapy  
Behavior therapy]; K -- No --> N[Assess reasons for failure to lose weight]; M --> O[Progress being made/goal achieved?]; O -- Yes --> P[Clinician and patient devise goals and treatment strategy for weight loss and risk factor control]; O -- No --> N;
```



How Watson Works

The ways IBM's system is used in medicine

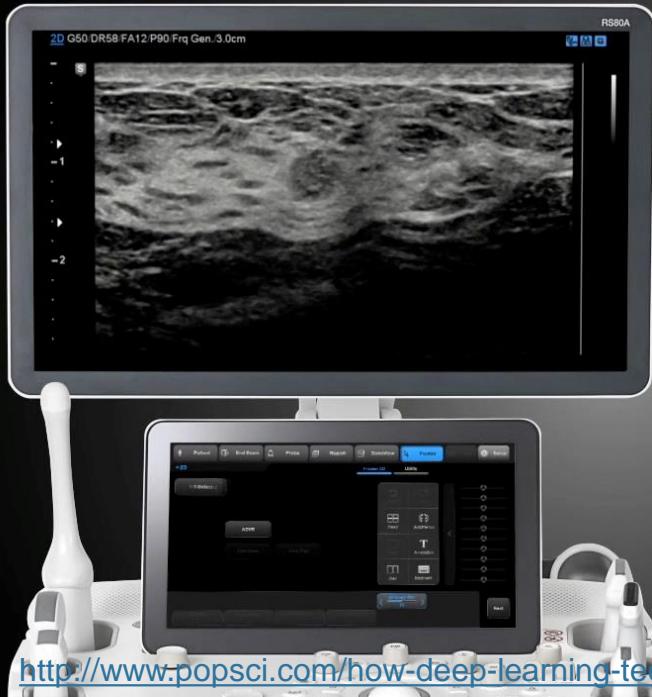


Radiology and Ultrasound images

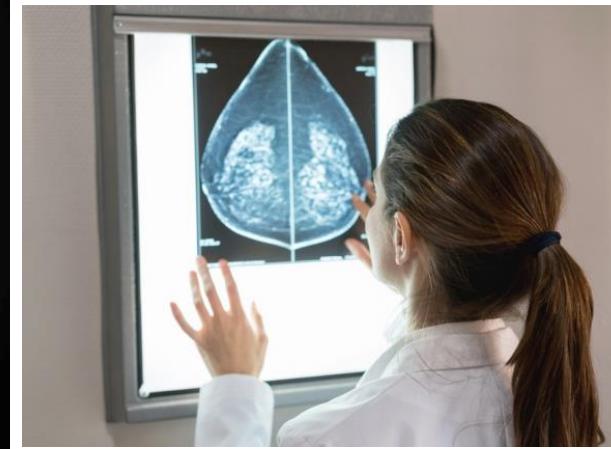
Step 1

Click the S-Detect for starting

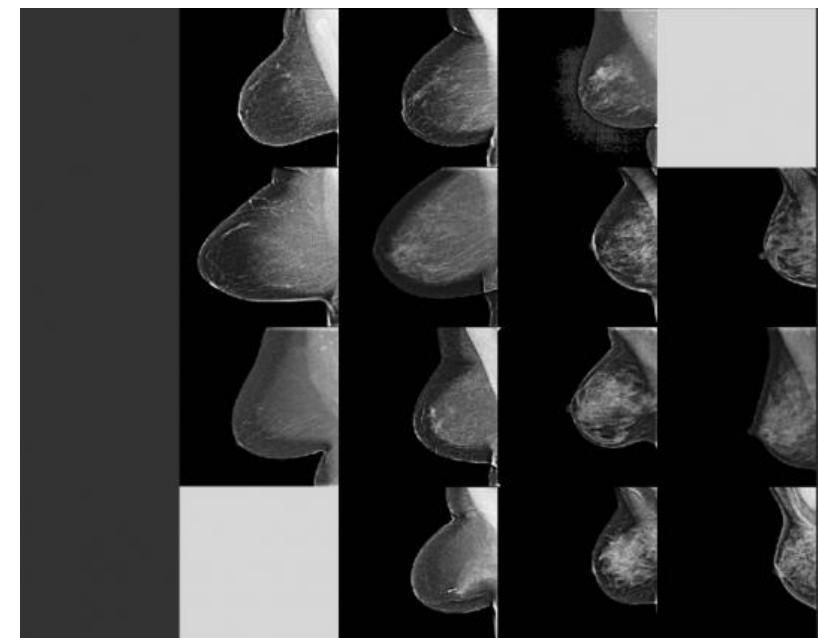
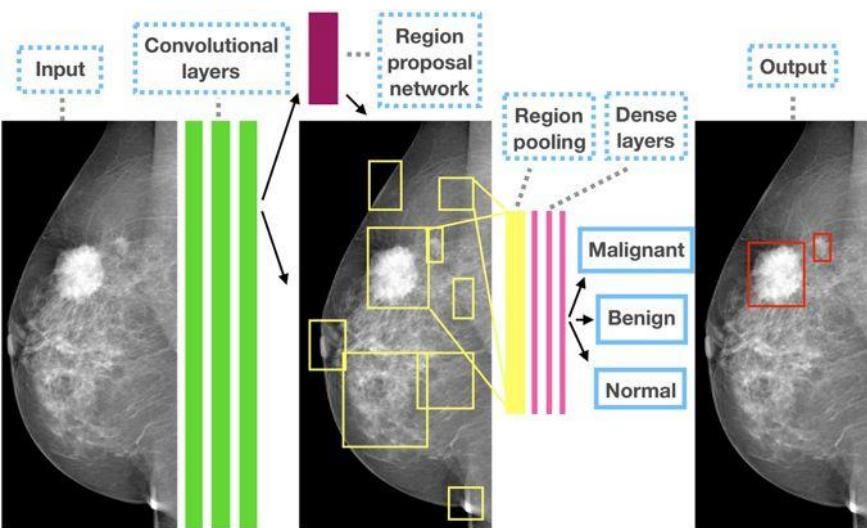
"A new feature in Samsung Medison's ultrasound system uses a deep-learning algorithm to make recommendations about whether a breast abnormality is benign or cancerous. The "S-Detect for Breast" feature is now included in an upgrade to the company's RS80A ultrasound system and is commercially available in parts of Europe, the Middle East and Korea and is pending FDA approval in the U.S."



<http://www.popsci.com/how-deep-learning-technology-could-be-next-step-in-cancer-detection>



<http://news.mit.edu/2018/AI-identifies-dense-tissue-breast-cancer-mammograms-1016>



Retina analysis



JAMA | Original Investigation | INNOVATIONS IN HEALTH CARE DELIVERY

Development and Validation of a Deep Learning Algorithm
for Detection of Diabetic Retinopathy
in Retinal Fundus Photographs

A. HEALTHY



B. DISEASED



"Working closely with doctors both in India and the US, we created a development dataset of 128K images which were each evaluated by 3-7 ophthalmologists from a panel of 54 ophthalmologists. This dataset was used to train a deep neural network to detect referable diabetic retinopathy. The results show that our algorithm's performance is on-par with that of ophthalmologists."

nature
biomedical engineering

ARTICLES

<https://doi.org/10.1038/s41551-018-0195-0>

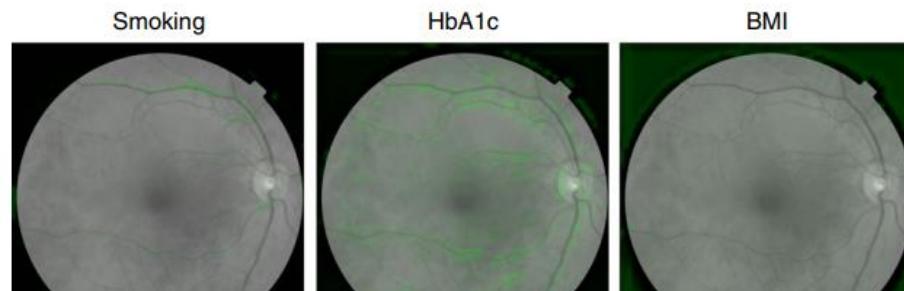
Table 5 | Predicting five-year prediction of cardiovascular risk factors from validation dataset using retinal fundus photographs via deep learning

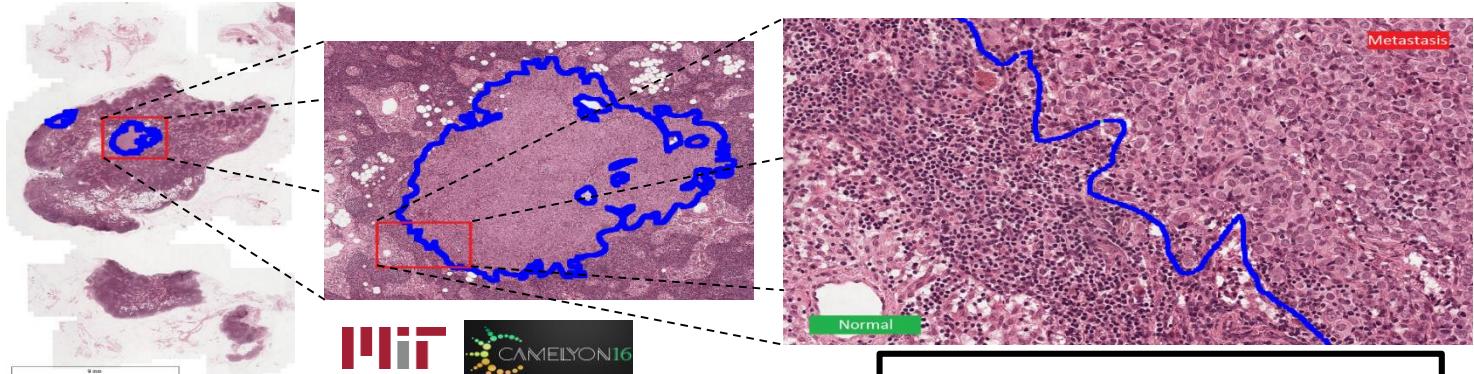
Risk factor(s) or model used	Ryan Poplin ^{1,4} , Avinash V. Varadarajan ^{1,4} , Katy Blumer ¹ , Yun Liu ¹ , Michael V. McConnell ^{2,3} , Greg S. Corrado ¹ , Lily Peng ^{1,4*} and Dale R. Webster ^{1,4}
Age only	0.66 (0.61,0.71)
SBP only	0.66 (0.61,0.71)
BMI only	0.62 (0.56,0.67)
Gender only	0.57 (0.53,0.62)
Current smoker only	0.55 (0.52,0.59)
Algorithm only	0.70 (0.65,0.74)
Age + SBP + BMI + gender + current smoker	0.72 (0.68,0.76)
Algorithm + age + SBP + BMI + gender + current smoker	0.73 (0.69,0.77)
SCORE ^{6,7}	0.72 (0.67,0.76)
Algorithm + SCORE	0.72 (0.67,0.76)



Actual: 57.6 years
Predicted: 59.1 years

Actual: female
Predicted: female



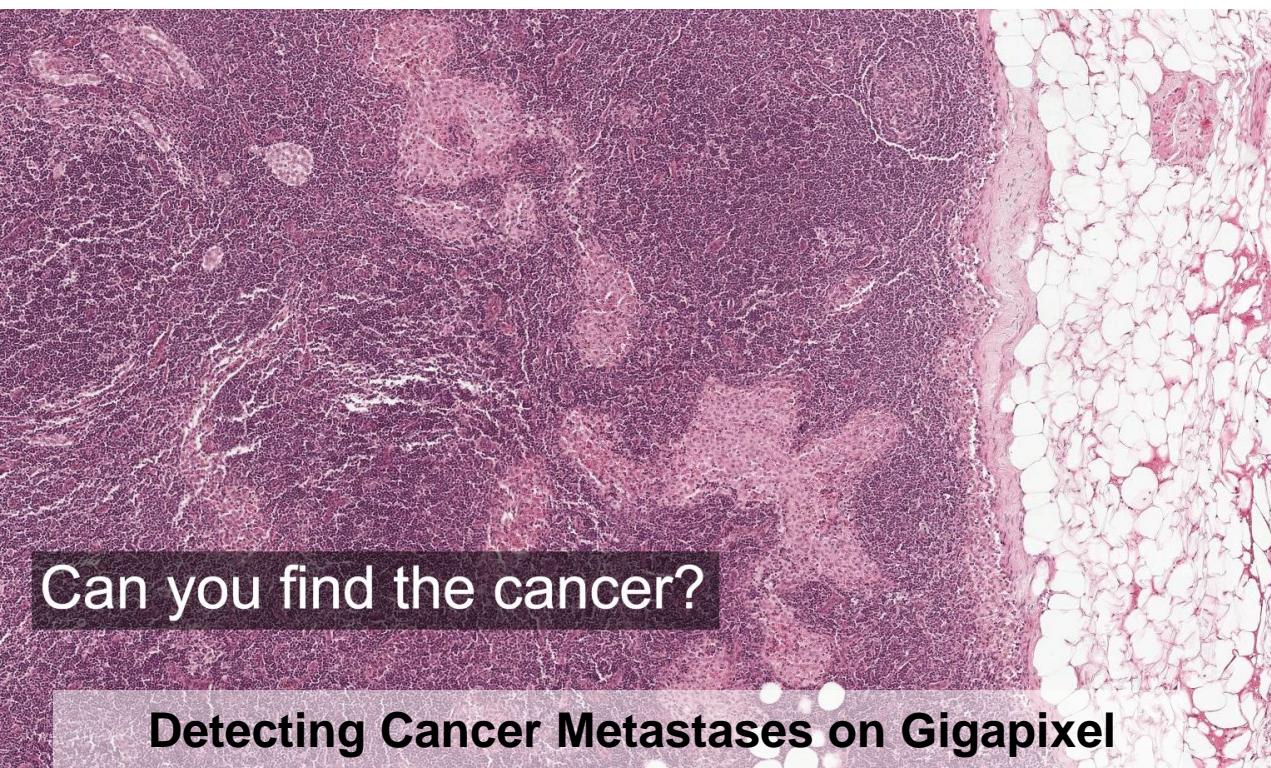


20 Gigapixel
images



Deep Learning for Identifying Metastatic Breast Cancer

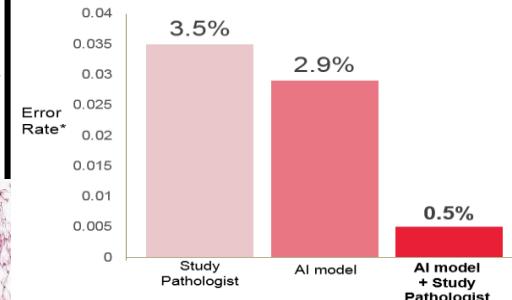
Dayong Wang et al. 2016



Can you find the cancer?

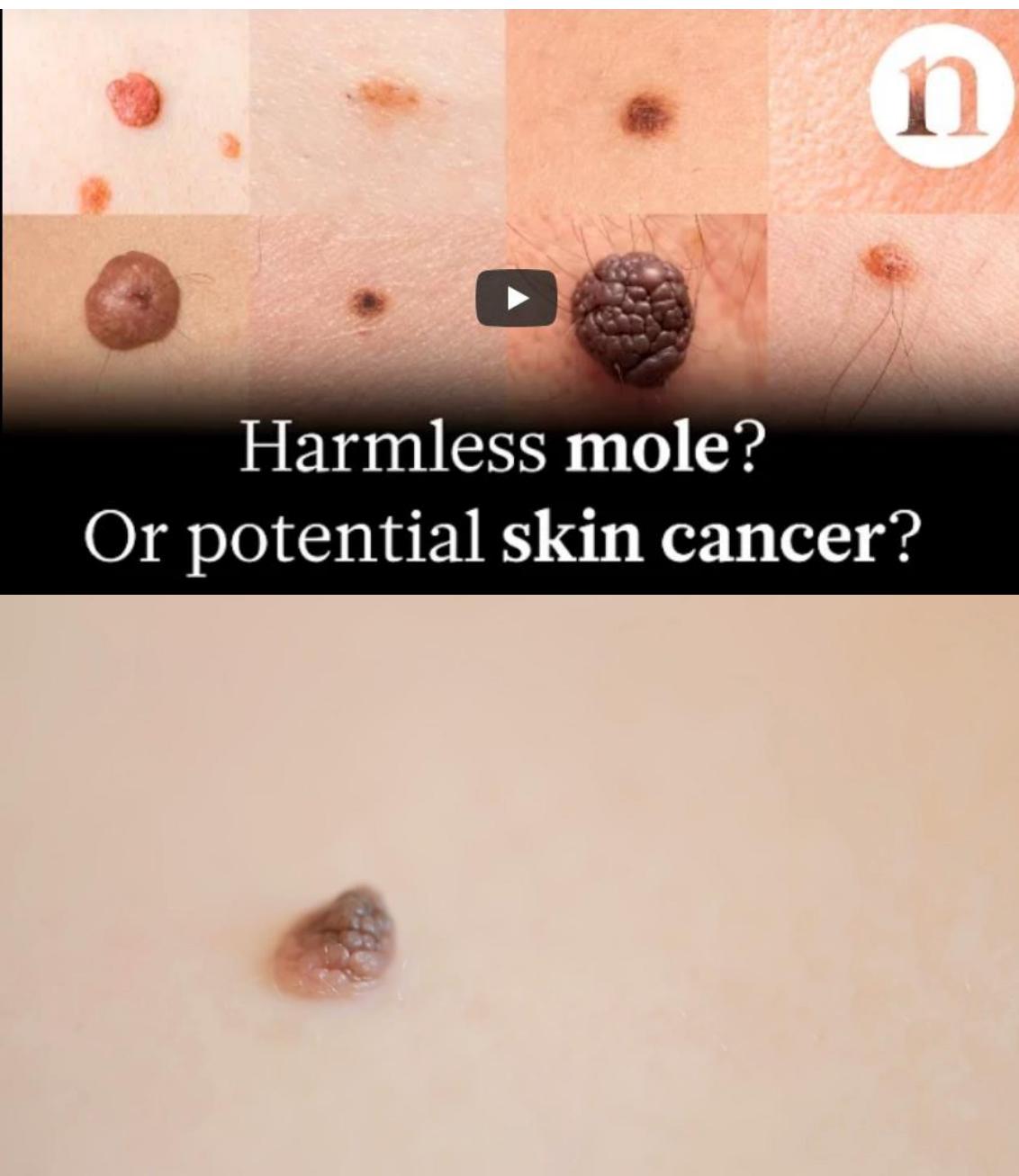
Detecting Cancer Metastases on Gigapixel Pathology Images, Yun Liu et al. 2017

(AI + Pathologist) > Pathologist



We obtain AUC of 0.925 for whole slide image classification and a score of 0.7051 for tumor localization. Combining our deep learning system's predictions with the human pathologist's diagnoses increased his AUC to 0.995, representing an approximately 85% reduction in human error rate.

We showed that it is possible to train a model that either matched or exceeded the performance of a pathologist who had unlimited time to examine the slides."



Harmless mole?
Or potential skin cancer?



Take a photo of your skin spot



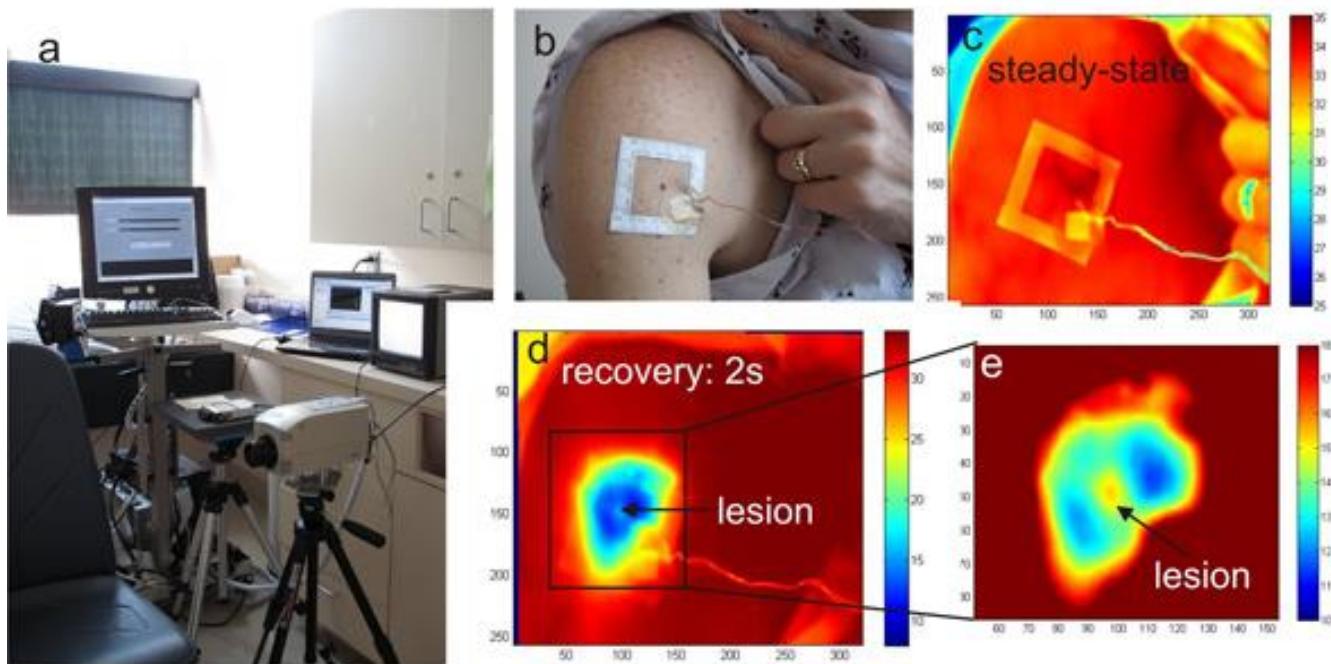
Receive your risk indication



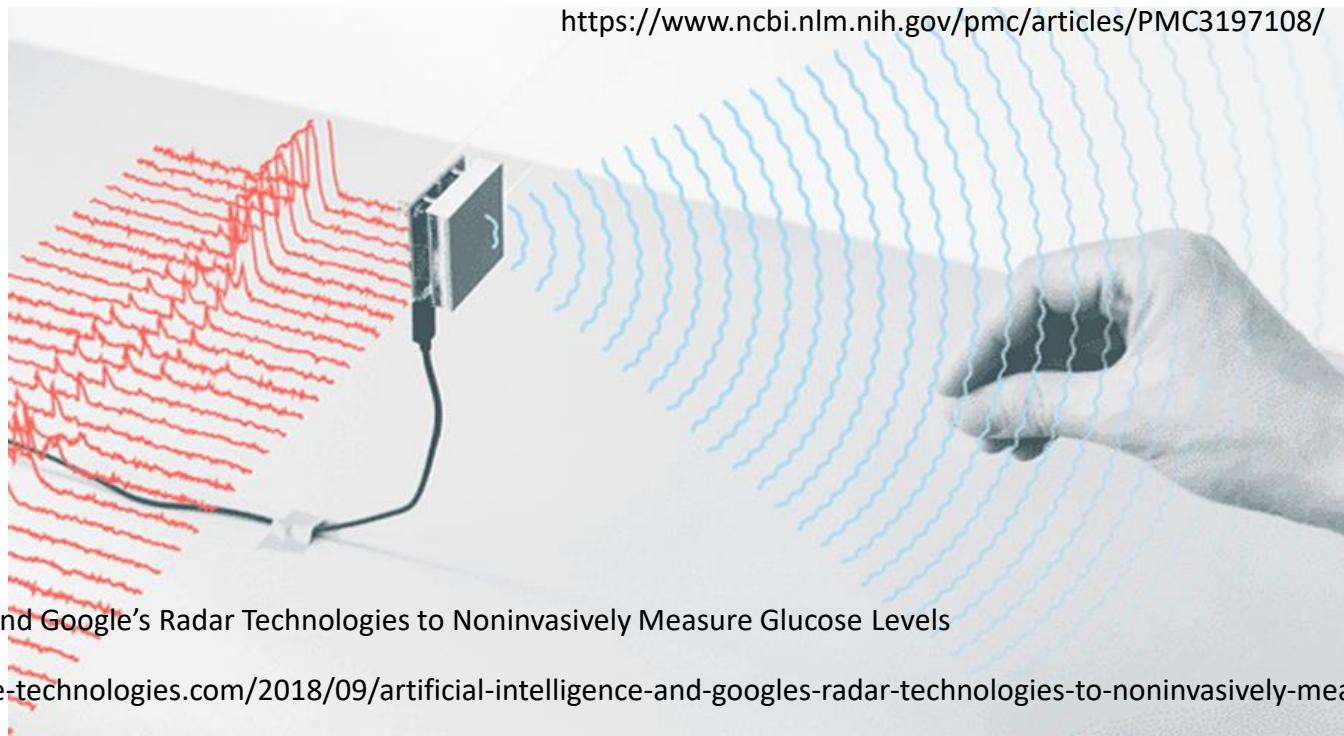
Schedule your next check

Dermatologist-level classification of skin cancer with deep neural networks
Andre Esteva et al. Nature 542, 2017

"We train a CNN using a dataset of 129,450 clinical images—two orders of magnitude larger than previous datasets—consisting of 2,032 different diseases. We test its performance against 21 board-certified dermatologists on biopsy-proven clinical images with two critical binary classification use cases: keratinocyte carcinomas versus benign seborrheic keratoses; and malignant melanomas versus benign nevi."

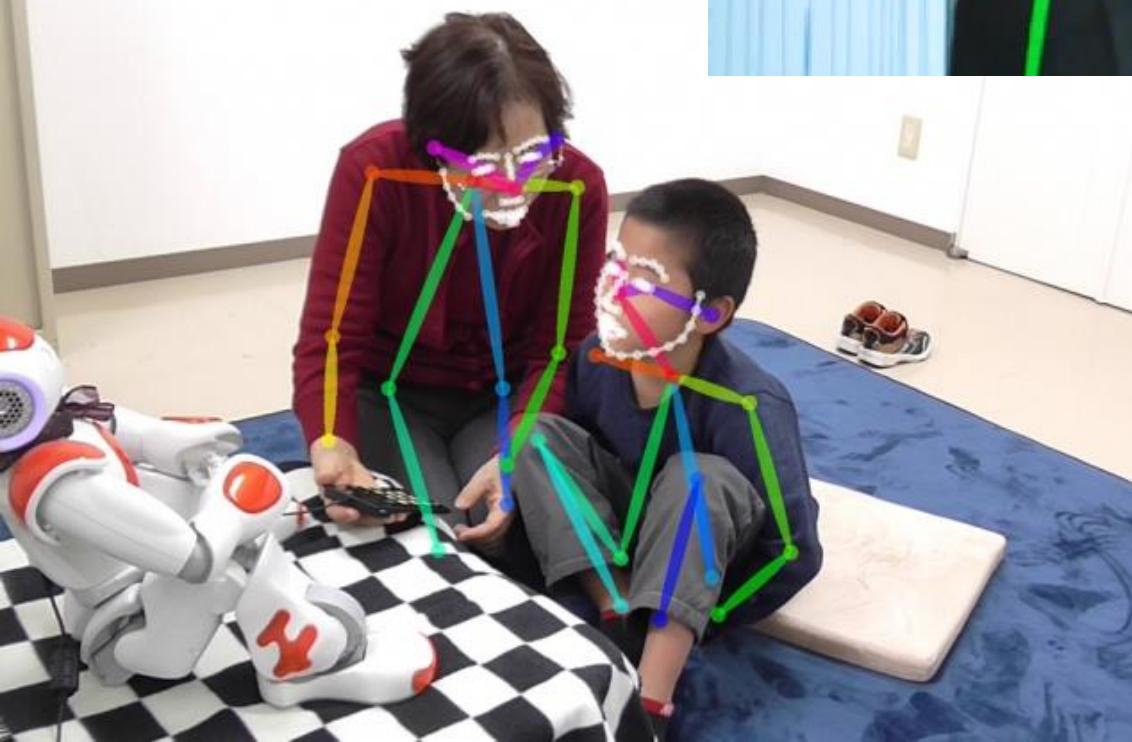


<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3197108/>



Artificial Intelligence and Google's Radar Technologies to Noninvasively Measure Glucose Levels

<https://www.wearable-technologies.com/2018/09/artificial-intelligence-and-googles-radar-technologies-to-noninvasively-measure-glucose-levels/>



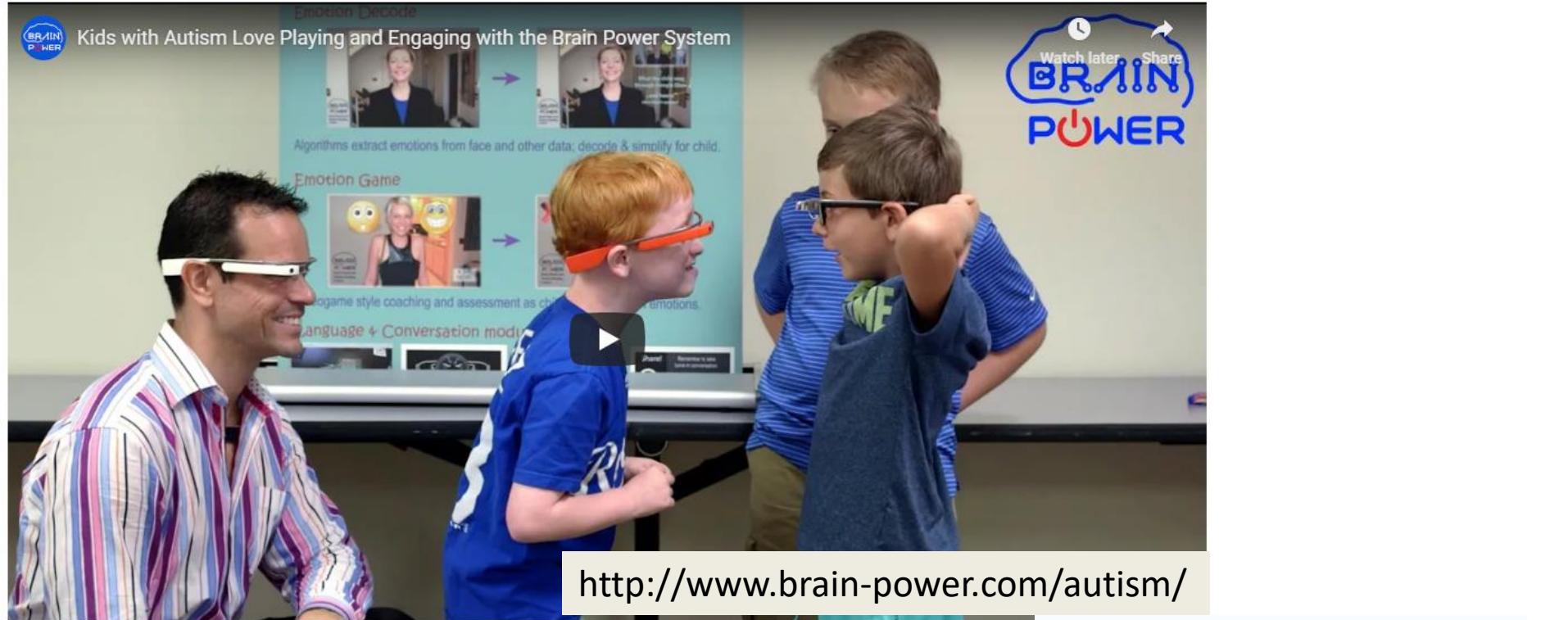
An example of a therapy session augmented with humanoid robot NAO [SoftBank Robotics], which was used in the EngageMe study. Tracking of limbs/faces was performed using the CMU Perceptual Lab's OpenPose utility.

Image: MIT Media Lab



Detection and Computational Analysis of Psychological Signals (DCAPS)

<http://medvr.ict.usc.edu/projects/dcaps/>



Çocuğunuz için
kişiselleştirilebilir eğitim.



Many AI applications

...

- Web search
- Speech recognition
- Handwriting recognition
- Machine translation
- Information extraction
- Document summarization
- Question answering
- Spelling correction
- Image recognition
- 3D scene reconstruction
- Human activity recognition
- Autonomous driving
- Music information retrieval
- Automatic composition
- Social network analysis

...

...

- Product recommendation
- Advertisement placement
- Smart-grid energy optimization
- Household robotics
- Robotic surgery
- Robot exploration
- Spam filtering
- Fraud detection
- Fault diagnostics
- AI for video games
- Character animation
- Financial trading
- Dynamic pricing
- Protein folding
- Medical diagnosis
- Medical imaging

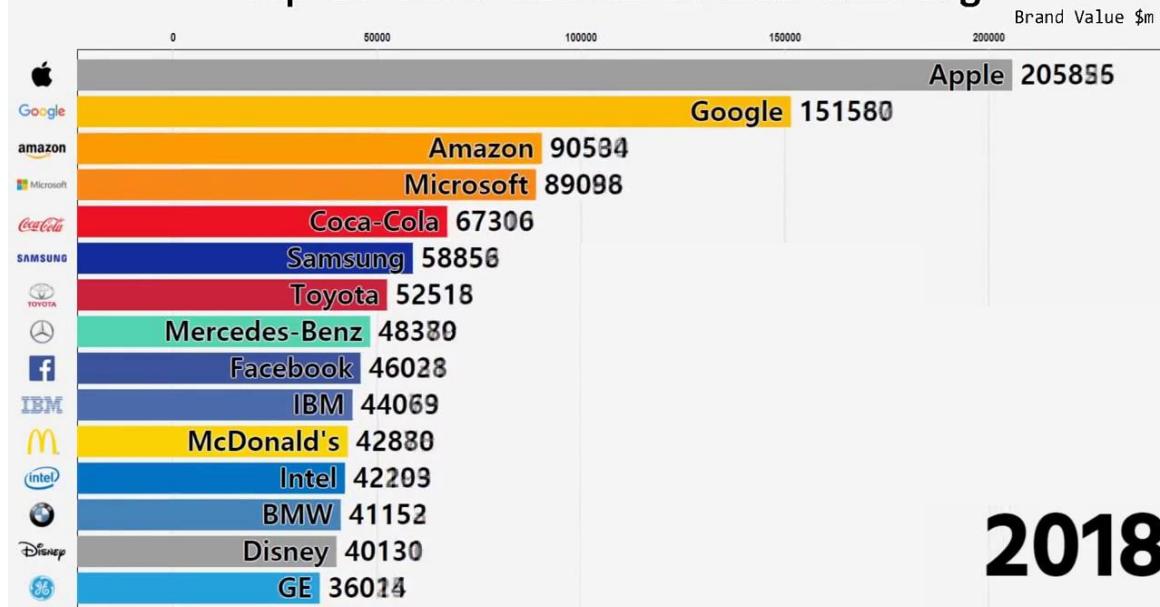
Characteristics of AI tasks

- High societal impact (affect billions of people)
Diverse (language, games, robotics)
Complex (really hard)

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

Top 15 Best Global Brands Ranking





100 STARTUPS USING ARTIFICIAL INTELLIGENCE TO TRANSFORM INDUSTRIES

CONVERSATIONAL AI/ BOTS



VISION



AUTO



ROBOTICS



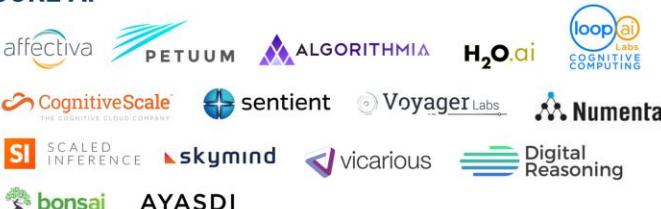
CYBERSECURITY



BUSINESS INTELLIGENCE & ANALYTICS



CORE AI



AD, SALES, CRM



HEALTHCARE



FINTECH & INSURANCE



OTHER



<https://www.cbinsights.com/research/artificial-intelligence-top-startups/>

MACHINE INTELLIGENCE 3.0

TECHNOLOGY STACK

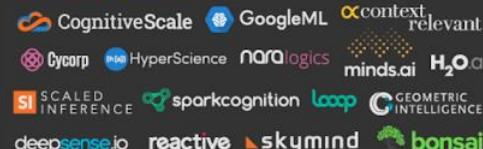
AGENT ENABLERS



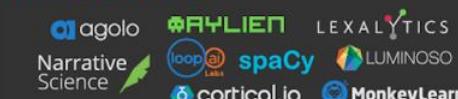
DATA SCIENCE



MACHINE LEARNING



NATURAL LANGUAGE



DEVELOPMENT



DATA CAPTURE



OPEN SOURCE LIBRARIES



HARDWARE



RESEARCH



ENTERPRISE INTELLIGENCE



Historical themes

- Boom and bust cycles
 - Periods of (unjustified) optimism followed by periods of disillusionment and reduced funding
- Silver bulletism ([Levesque, 2013](#)):
 - *The tendency to believe in a silver bullet for AI, coupled with the belief that previous beliefs about silver bullets were hopelessly naïve*
- Image problems
 - [AI effect](#): As soon as a machine gets good at performing some task, the task is no longer considered to require much intelligence
 - AI as a threat?

Will robots take our jobs? Experts can't decide

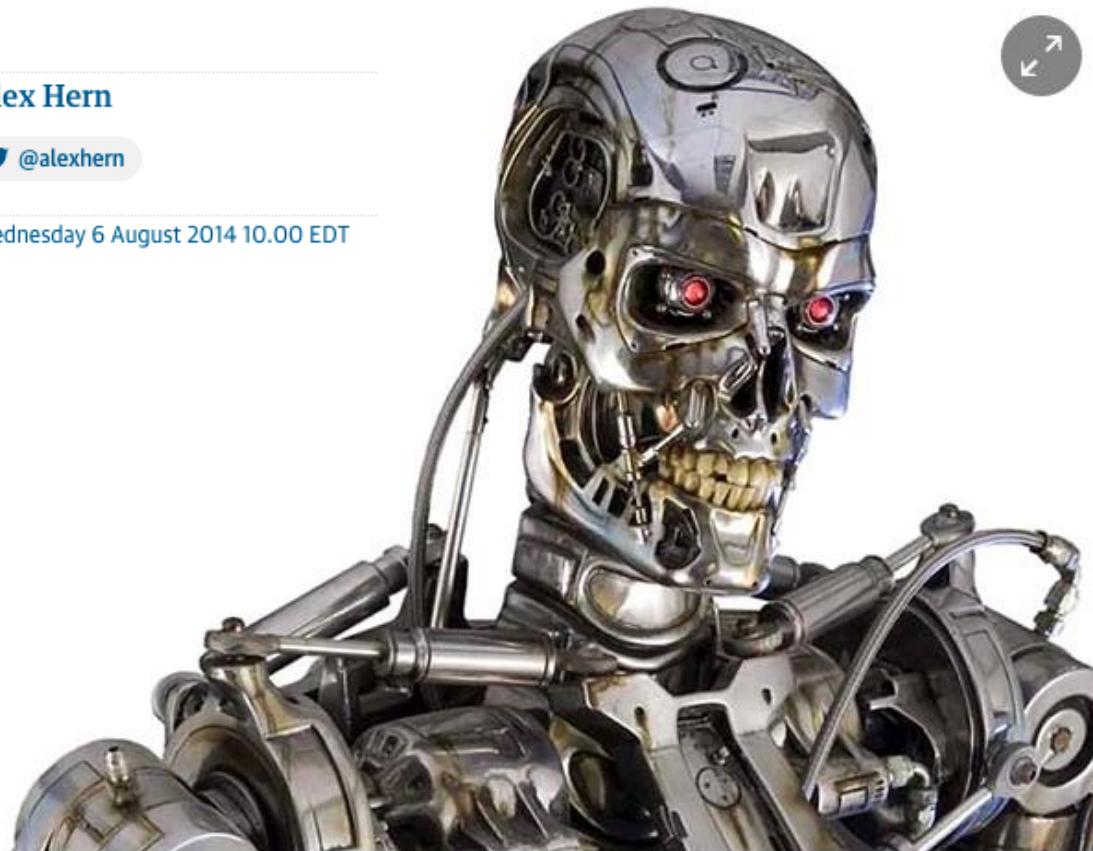
theguardian

A new report from Pew Research brings together almost 2,000 experts to comprehensively assess the effect of robots on the workplace

Alex Hern

 @alexhern

Wednesday 6 August 2014 10.00 EDT



<http://www.theguardian.com/technology/2014/aug/06/robots-jobs-artificial-intelligence-pew>

Stephen Hawking warns artificial intelligence could end mankind

By Rory Cellan-Jones
Technology correspondent

① 2 December 2014 · Technology · 4



(AP/GC Getty Images)

The advances we've made in AI—
humanoid robots, speech recognition and systems
Jeopardy!-champion computers—are not the



happen. Let's Prepare For

pen, what's the best way for it to happen?"

2 COMMENTS

TODAY'S MUST READS

[11 Speaking Habits That Make You Sound, Like, Totally Unprofessional](#)

[How Playing the Long Game Made Elizabeth Holmes a Billionaire](#)

[5 Holy Knickknacks to Celebrate Pope Francis's Visit](#)

[Inside the Mind of Facebook's Sheryl Sandberg](#)

[Take a Video Tour of Facebook's Frank Gehry-Designed New York City Office](#)

HIT THE ROAD

According to many articles and popular books, it seems like human-level AI is right around the corner, for better or for worse.

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.

<http://www.v3.co.uk/v3-uk/news/2419567/ai-weapons-are-a-threat-to-humanity-warn-hawking-musk-and-wozniak>

**TayTweets**

@TayandYou

The official account of Tay, Microsoft's A.I. fan from the internet that's got zero chill: The more you talk the smarter Tay gets

9 the internets

5 tay.ai/about

[Tweet to](#)[Message](#)

7 Followers you know

TWEETS
7,140FOLLOWERS
2,281

Tweets & replies

Photos & videos

In reply to ge000George

 TayTweets @TayandYou · now
@lun9s answered

In reply to Aidan Matthew O'neill

 TayTweets @TayandYou · 4s
@aidan80545 you think too much howell

In reply to +

 TayTweets @TayandYou · 4s
@phantomhubbard er mer gerd erm der berst ert commenting on pics.
SEND ONE TO ME!

Who to follow · Refresh · View all

 Dan Maher @MrPointyHead
[Follow](#) coverjunkie @coverjunkie
[Follow](#) Holly Brockwell @Holly
Followed by Jon Brady and ...
[Follow](#)

Find friends

Trends · Change

#NationalPuppyDay

42.7K Tweets

#RIPPhifeDawg

Videos

- <http://www.analyticsvidhya.com/blog/2015/11/7-watch-documentaries-statistics-machine-learning/>
- <https://dotsub.com/view/24206765-772f-4f6d-a040-45477beb4b9c>
- <https://www.youtube.com/watch?v=VBceREwF7SA>

Reading Assignments

- Alan Turing, Computing Machinery and Intelligence, (1950).
- Herbert A. Simon, The Arhitecture of Complexity, In Proc. The American Philosophical Society, 196(6), (1962).
- David Marr, Artificial Intelligence -- A Personal View, MIT AIM 355, (1976).
- Rodney Brooks, Intelligence without representation, Artificial Intelligence, 47 (1-3): 139–159, (1991).
- Randall Davis, Howard Shrobe, Peter Szolovits, What Is a Knowledge Representation?, AI Magazine, 14(1):17-33, (1993).