

PIERRE-ALEXANDRE BALLAND

UTRECHT UNIVERSITY
AI TOULOUSE INSTITUTE
EUROPEAN COMMISSION (ESIR)

We are in the midst of a true Artificial Intelligence Revolution

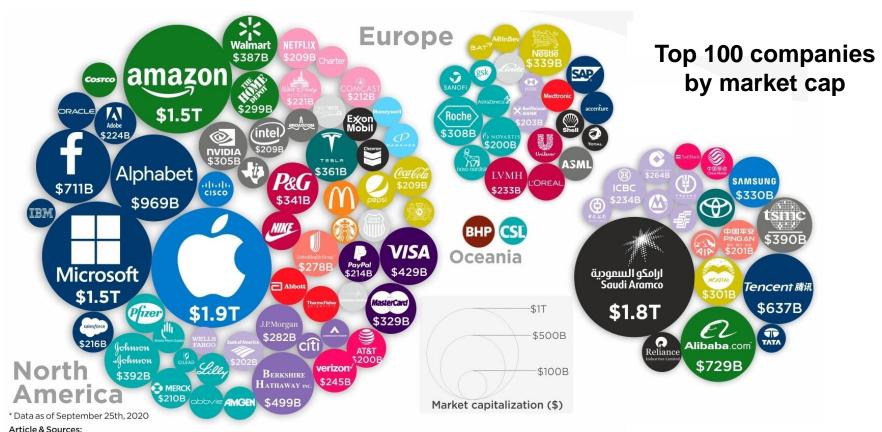
AI revolution - cultural products



AI revolution - national policy



AI revolution - global economy



Nttps://howmuch.net/articles/largest-companies-in-the-world-2020 Yahoo Finance - https://finance.yahoo.com

Champions of the first AI wave



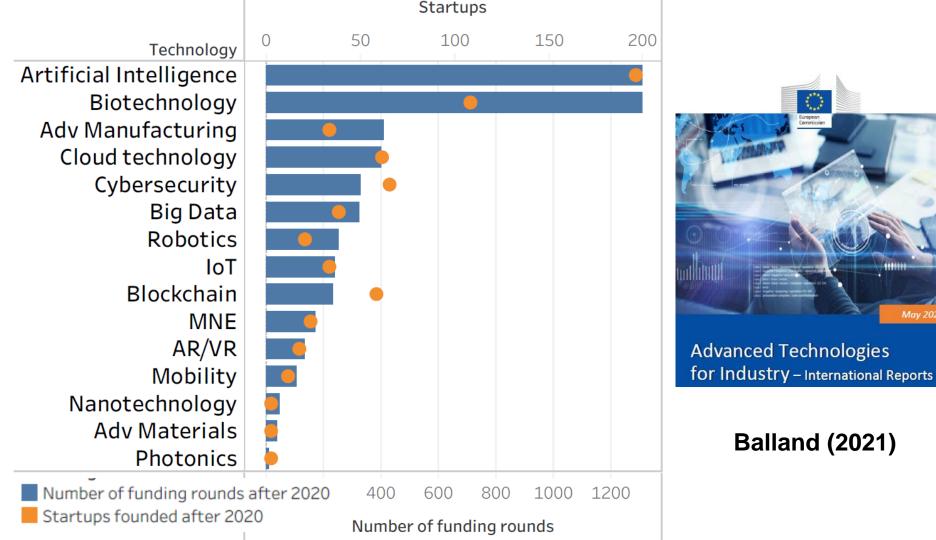




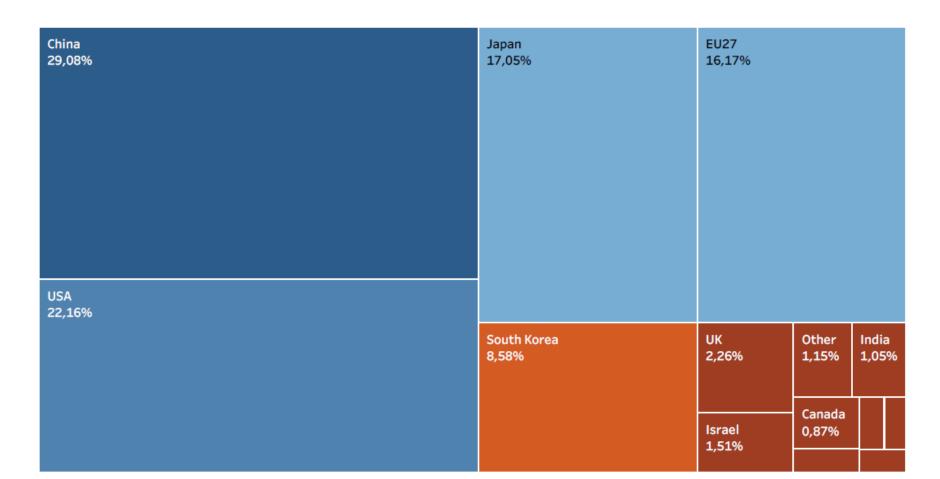


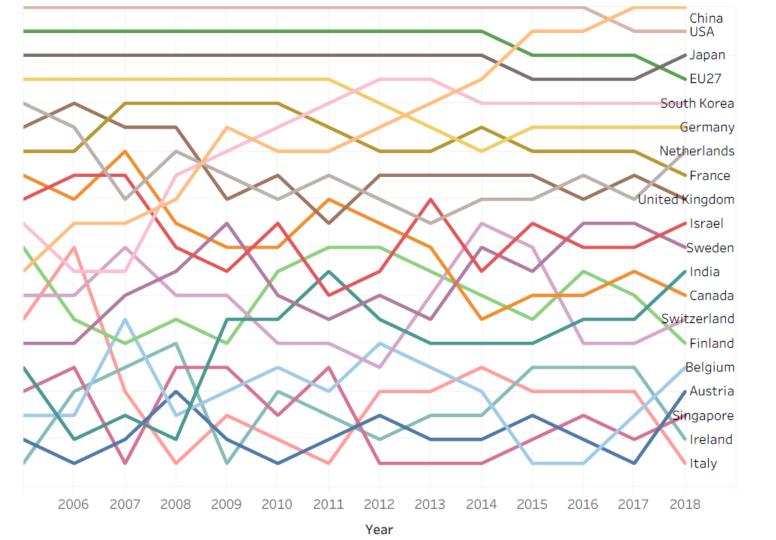


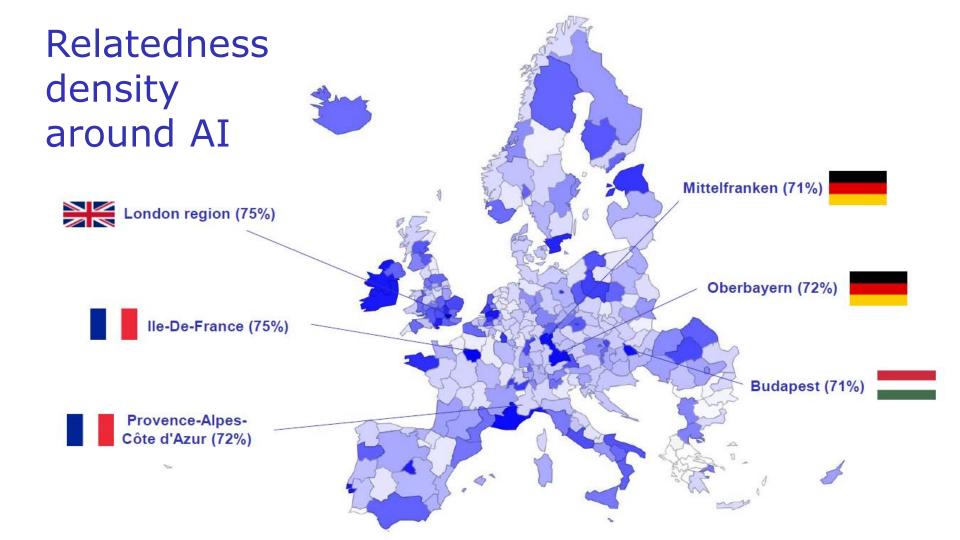




Who leads the AI revolution (patents)







THE WORLD OF
KNOWLEDGE
CONSUMPTION IS
GETTING
FLATTER

Digital technologies, transports and globalization allows products to be widely distributed THE WORLD OF
KNOWLEDGE
PRODUCTION IS
GETTING
SPIKIER

Knowledge increasingly concentrates as it becomes more complex

WINNER TAKES-ALL ECONOMY

Zooming out: an historical context

The ability for a machine to perform a specific task that requires human intelligence (narrow AI)

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The ability for a machine to learn to perform any task that requires human intelligence (general AI)

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AI is composed by symbolic AI & expert systems, machine learning & deep learning

Vol. LIX. No. 236.] [October, 1950 MIND A QUARTERLY REVIEW OF PSYCHOLOGY AND PHILOSOPHY I.—COMPUTING MACHINERY AND INTELLIGENCE By A. M. TURING 1. The Imitation Game. I PROPOSE to consider the question, 'Can machines think?'

Turing Test 1950

1956 Dartmouth Conference: The Founding Fathers of AI







Marvin Minsky



Claude Shannon



Ray Solomonoff



Alan Newell



Herbert Simon



Arthur Samuel



Oliver Selfridge



Nathaniel Rochester

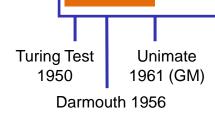


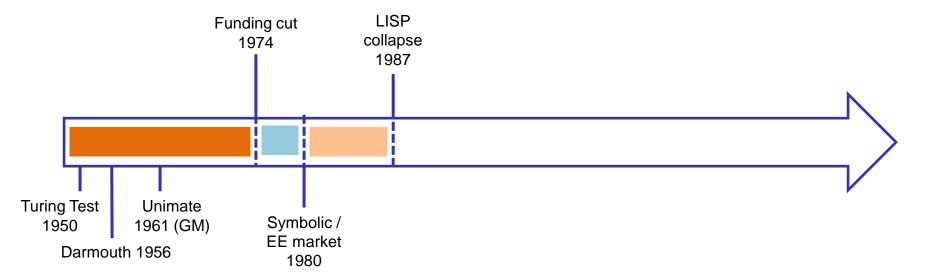
Trenchard More

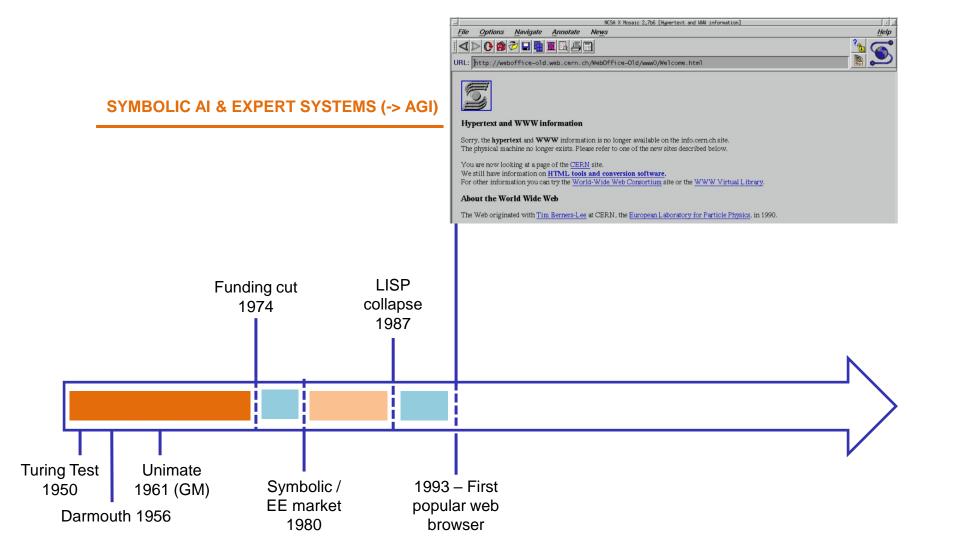
Turing Test 1950

Darmouth 1956

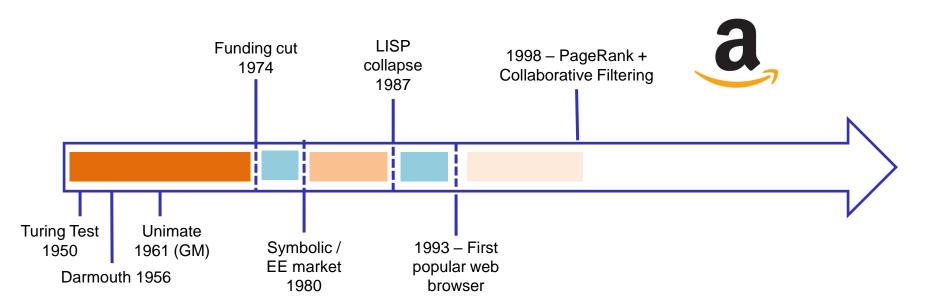


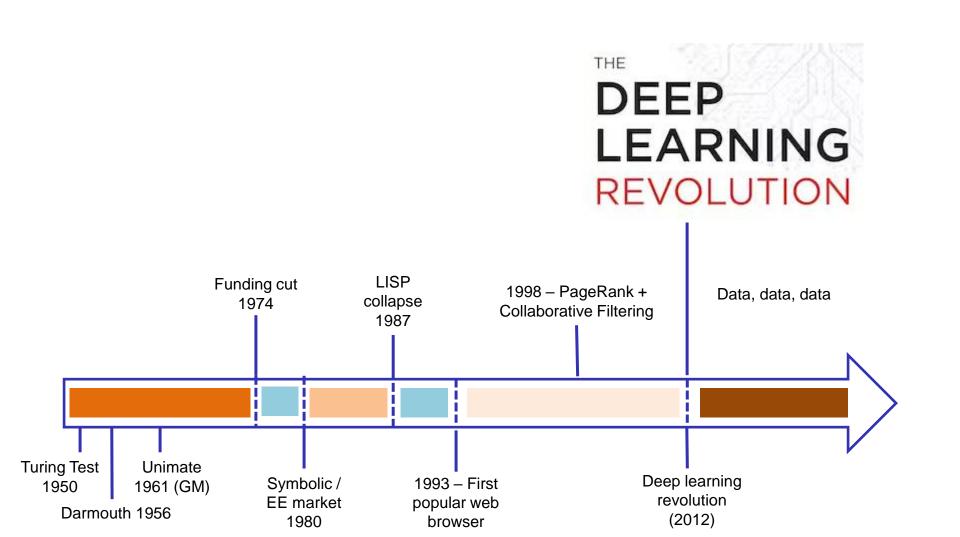


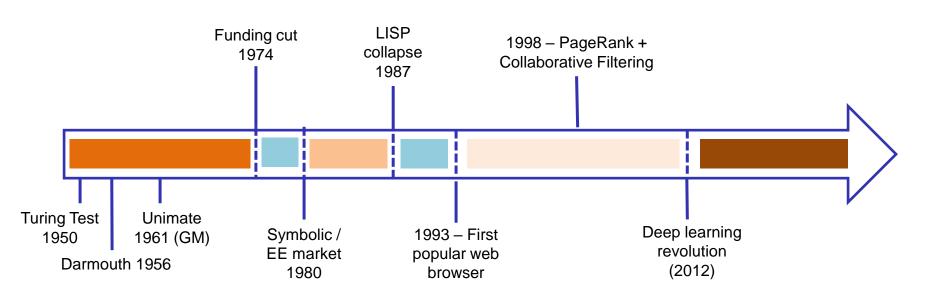












How do modern machines learn and how intelligent did they really become?

The AI revolution has been **powered** by massive (internet) **data**, **computing** resources & better ML/DL **algorithms**

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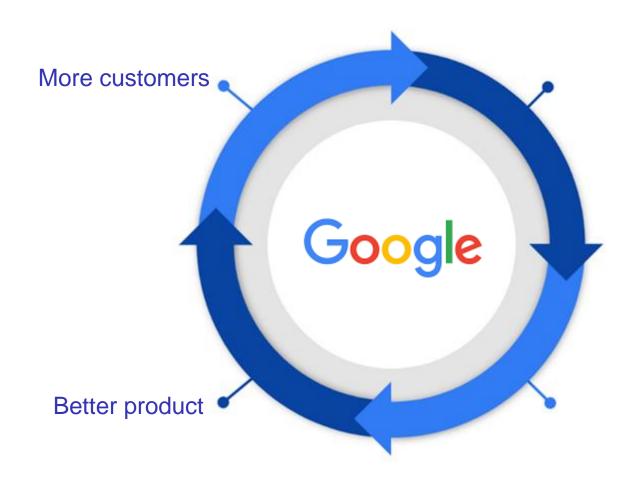
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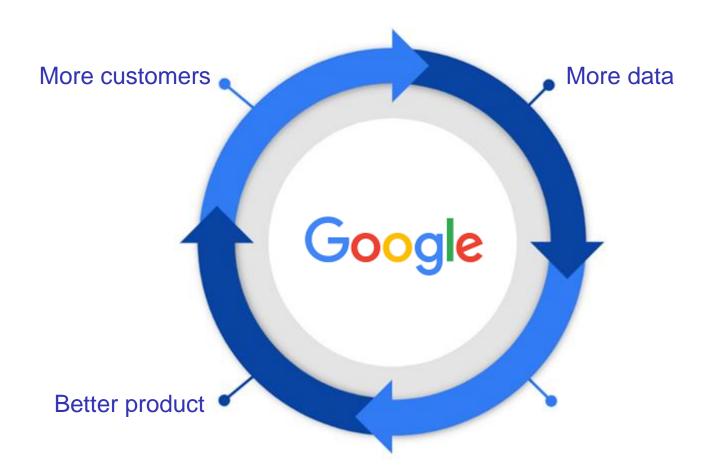
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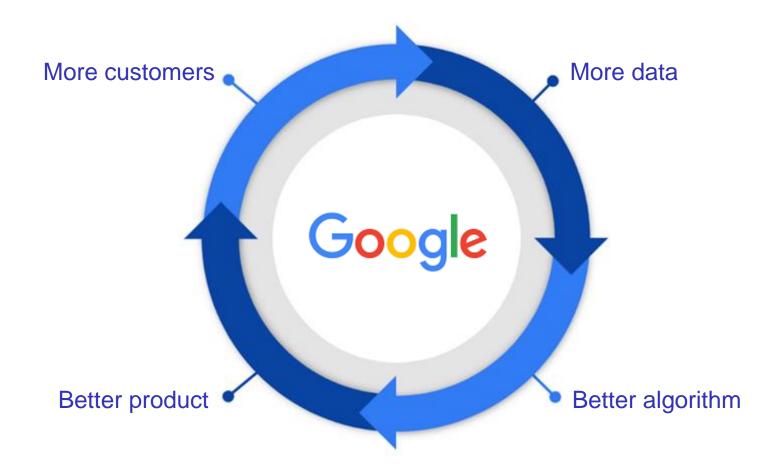
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Recommender systems are the most successful and widespread application of AI in business

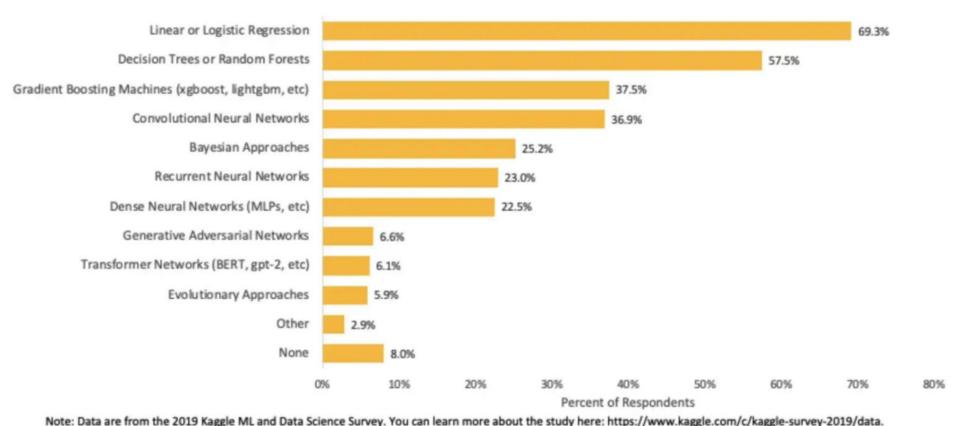








Which of the following ML algorithms do you use on a regular basis? (Select all that apply)



A total of 19717 respondents completed the survey; the percentages in the graph are based on a total of 14762 respondents who provided an answer to this question.

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Learning = **associating** inputs and outputs – not **understanding** (we talk about training)

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You need a gigantic amount of data

Different forms of learning

Supervised learning: humans train the ML with good **labeled** data examples and the algorithm derives rules from these specific examples

→ regression & classification problems

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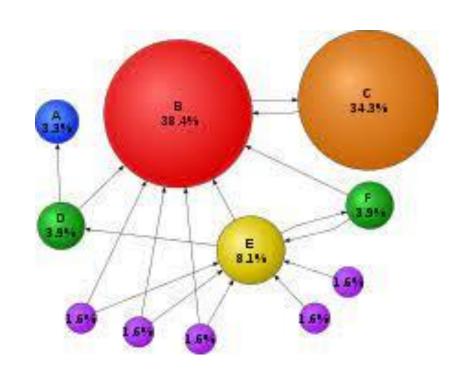
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Unsupervised learning: no labeled data - the algorithm guesses that some objects or events cluster together (belong to the same class) without being explicitly told (find similar patterns)

Reinforcement learning: lack labels too, but humans provide positive/negative feedback

Sorting the world by its structure





AI for recommender systems















Recommender systems are **filtering** massive amount of data (content-based filtering & collaborative filtering)

AI for recommender systems















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Recommendation of news, movies or personalization in travel and investing can be handled by similar machine learning algorithms

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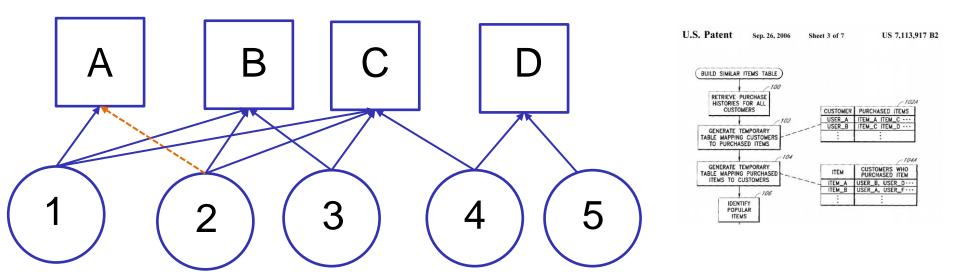
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→ Where would you apply these algorithmic principles?



Matching products and customers





Modern AI techniques extract information from network structures

The century of personalization

Media

Recommending news, pages, movies, music, ads...

eCommerce

Product recommendations (books, cars, literally everything)

Job boards & education

Recommending jobs, classes, degrees...

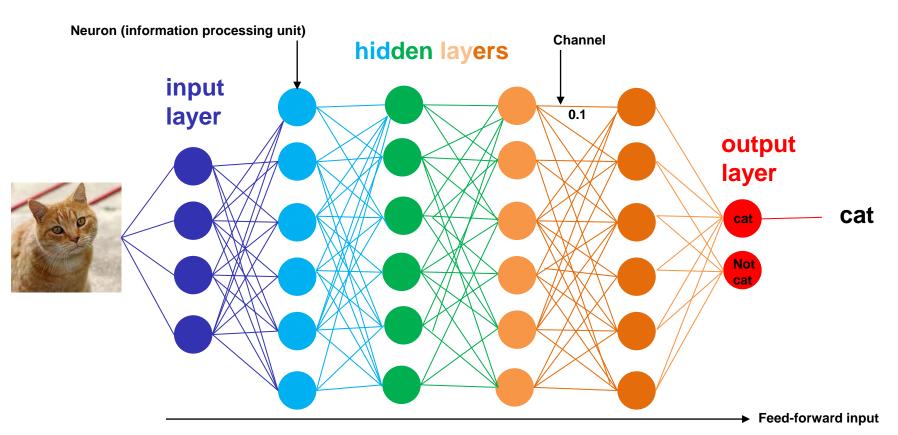
Travel

Recommending hotels, restaurants, events, places, flights...

Investing

Recommending stocks, crypto, real estate, technologies...

Deep learning



Features extraction + learning

A mostly complete chart of

Neural Networks

Deep Feed Forward (DFF) ©2016 Fjodor van Veen - asimovinstitute.org







Probablistic Hidden Cell

Backfed Input Cell

Spiking Hidden Cell

Output Cell

Match Input Output Cell

Recurrent Cell

Memory Cell

Different Memory Cell

Kernel

Convolution or Pool



Feed Forward (FF)



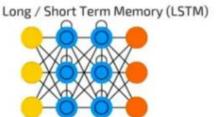
Radial Basis Network (RBF)





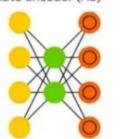
Recurrent Neural Network (RNN)



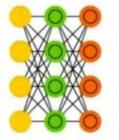




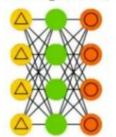
Auto Encoder (AE)



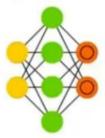
Variational AE (VAE)



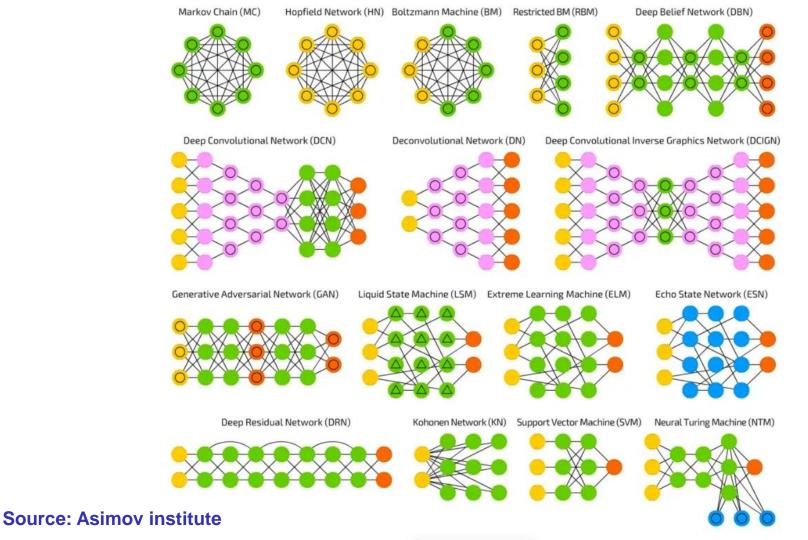
Denoising AE (DAE)



Sparse AE (SAE)



Source: Asimov institute





Latest breakthrough: Generative AI

vibrant portrait painting of Salvador Dalí with a robotic half face



a shiba inu wearing a beret and black turtleneck



panda mad scientist mixing sparkling chemicals, artstation



a close up of a handpalm with leaves growing from it



a corgi's head depicted as an explosion of a nebula

OpenAl's DALL-E 2

Al that can create realistic images and art from a description in natural language

It uses a 12-billion parameter version of GPT-3

GPT-3 = language model using DL to produce humanlike text

an espresso machine that makes coffee from human souls, artstation

The text-to-image generation battle

Combines Computer Vision (CV) + Natural Language Processing (NLP)

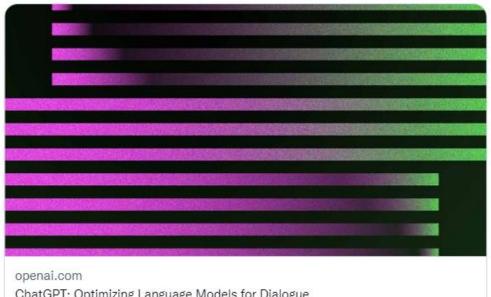
Diffusion models are far superior to Generative adversarial networks (GANs) & Variational Autoencoders (VAEs)







Try talking with ChatGPT, our new Al system which is optimized for dialogue. Your feedback will help us improve it.



ChatGPT: Optimizing Language Models for Dialogue

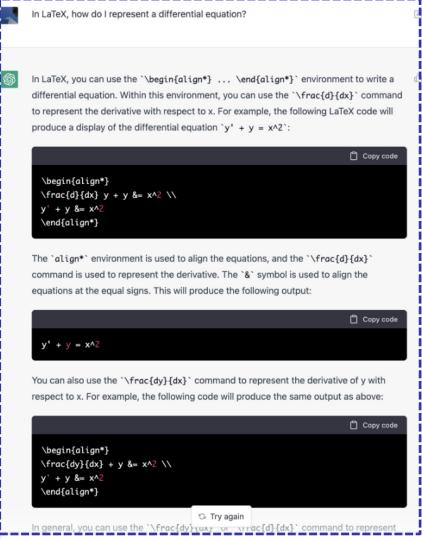
We've trained a model called ChatGPT which interacts in a conversational way.

The dialogue format makes it possible for ChatGPT to answer followup ...

OpenAl's **ChatGPT**

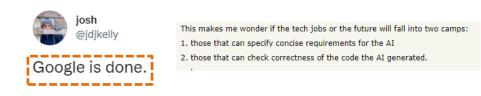
ChatGPT: Optimizing Language Models for Dialogue

We've trained a model called ChatGPT which interacts in a conversational way. The dialogue format makes it possible for ChatGPT to answer followup questions, admit its mistakes, challenge incorrect premises, and reject inappropriate requests. ChatGPT is a sibling model to InstructGPT, which is trained to follow an instruction in a prompt and provide a detailed response.

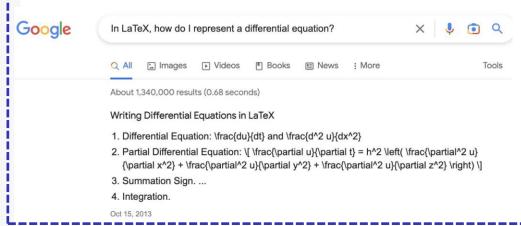


Latest language model using reinforcement learning from human feedback (RLHF)

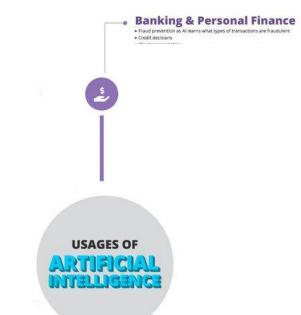
Took the AI community by storm

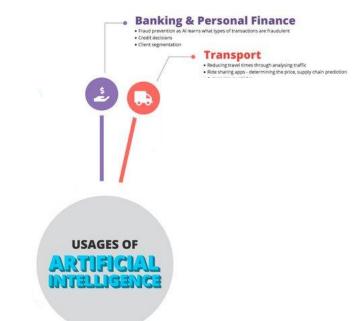


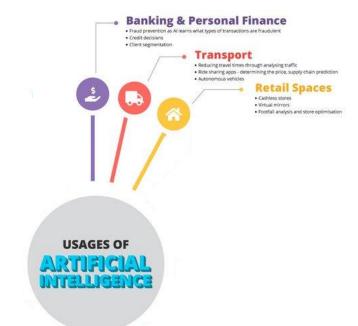
Compare the quality of these responses (ChatGPT)



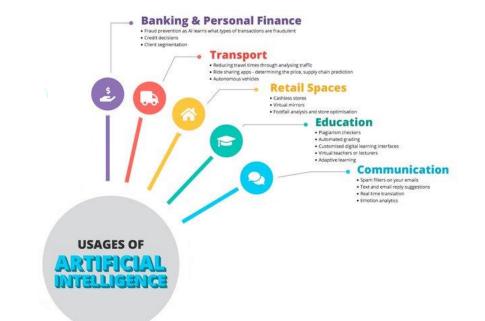
Key recent real-world applications of AI

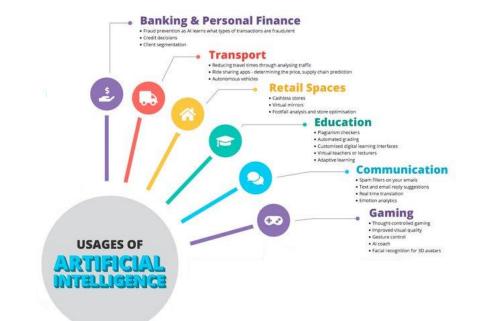




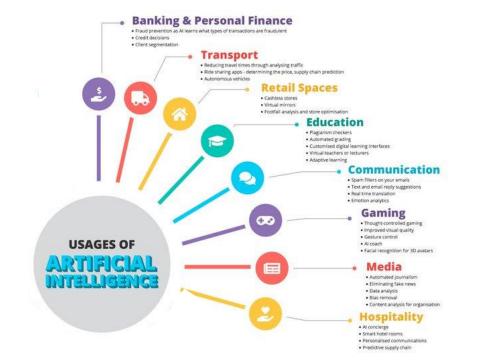




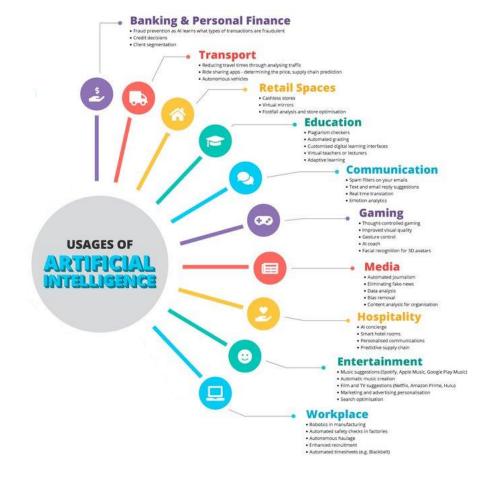


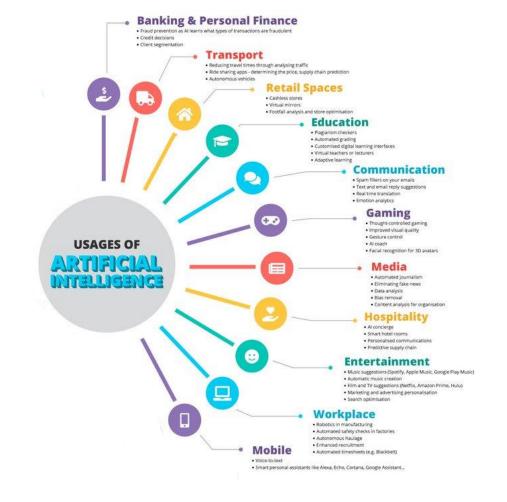




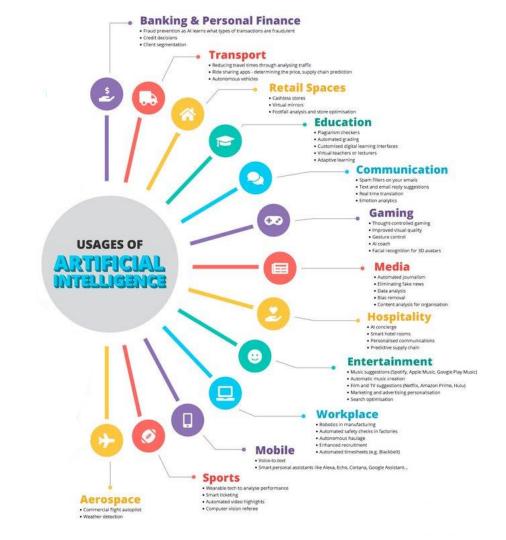


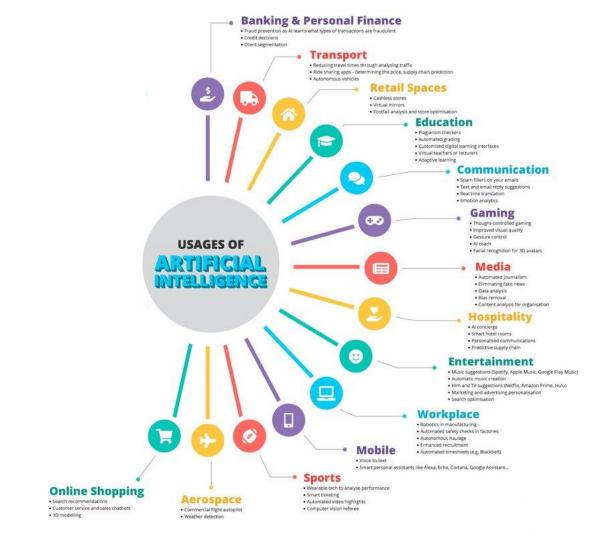


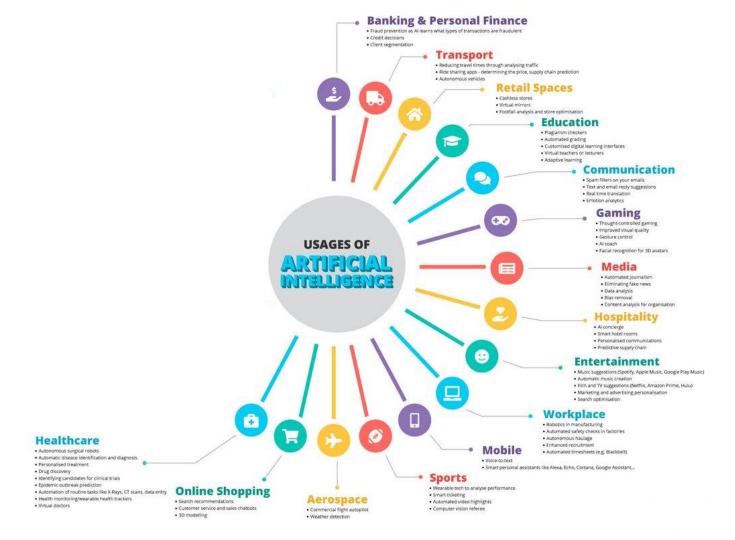


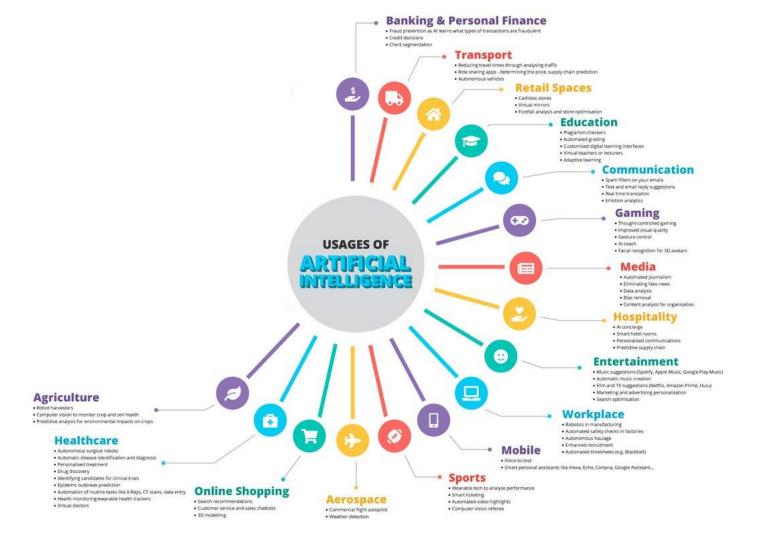


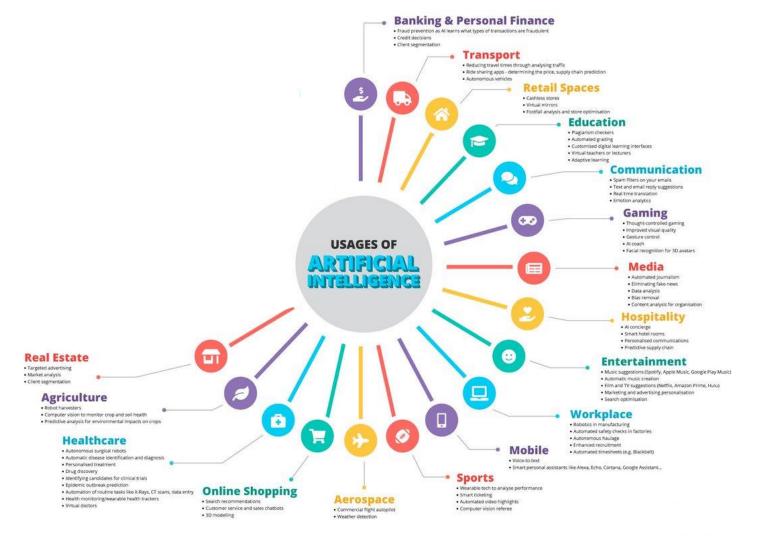


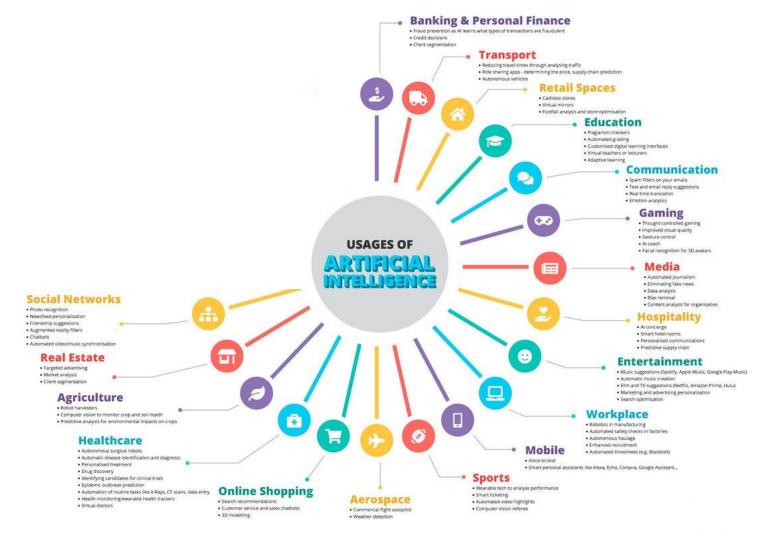


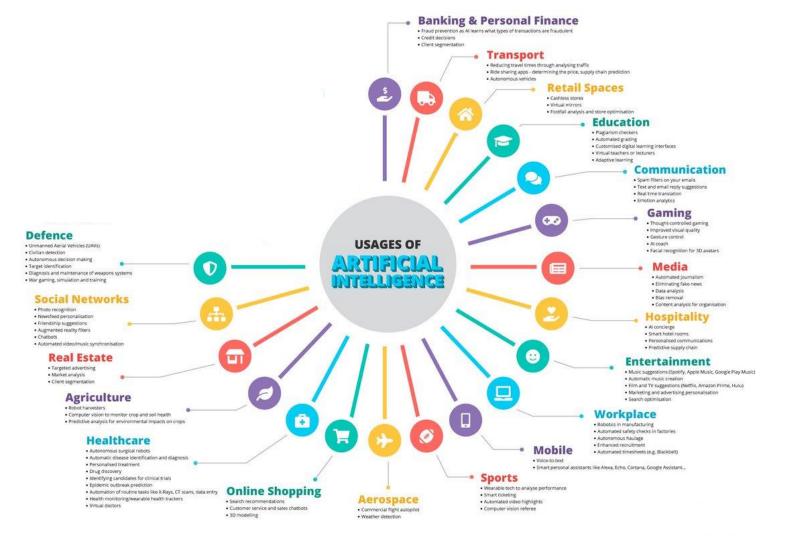


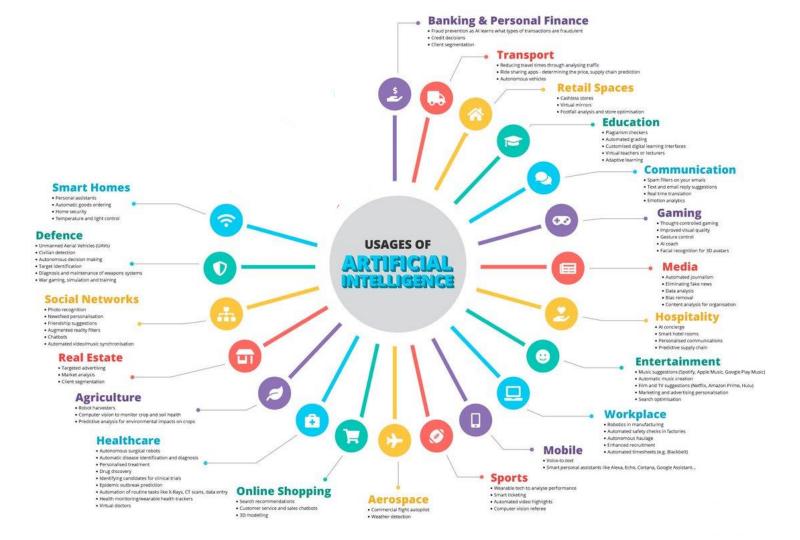




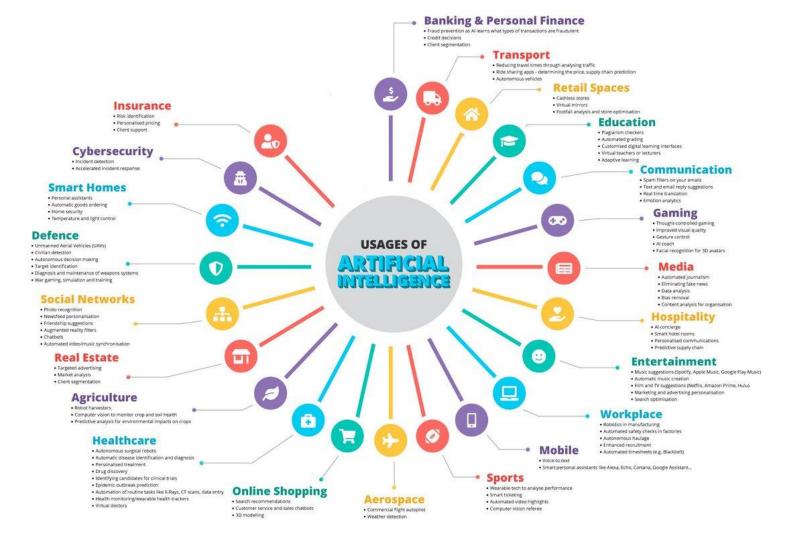


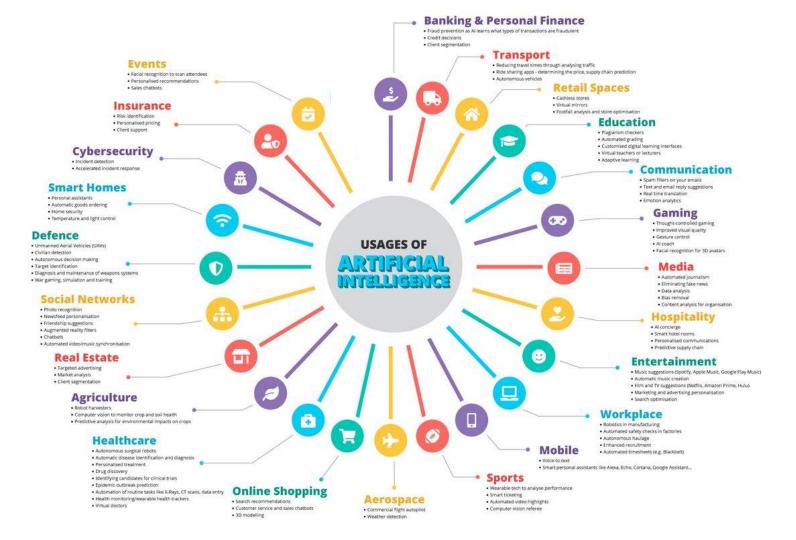


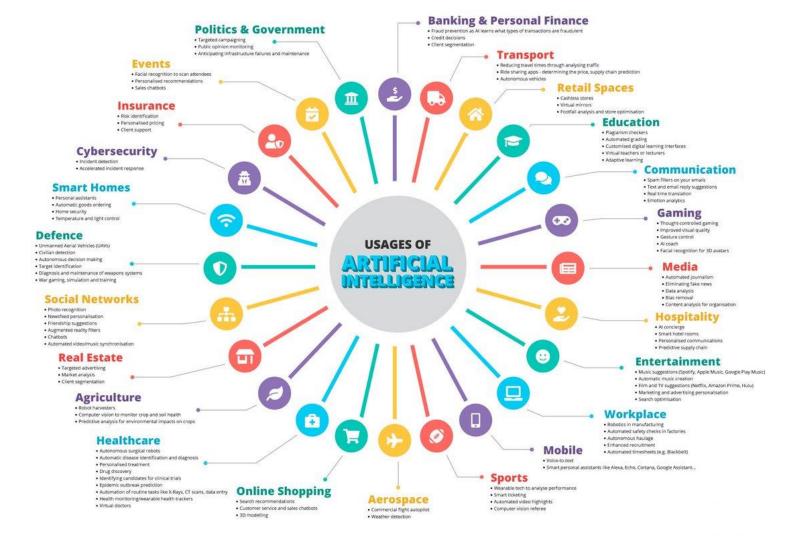




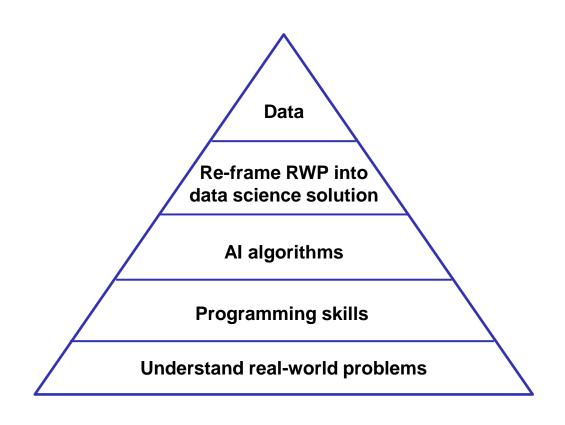








Solving business problems with AI



The AI skil space



Challenges of real-world AI applications

Major limitations of ML & DL

ML can only solve single and **specific** problems

Amplification of bias & algorithmic discrimination

DL is a **black box** – humans don't understand what happens within the neural network

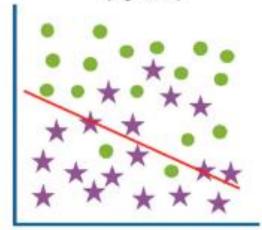
Requires a **huge** number of examples/data

It is very **expensive** to train and deploy (computing power)

Overfitting issue

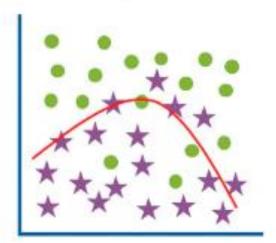
ML overfitting & my students

Underfit (high bias)



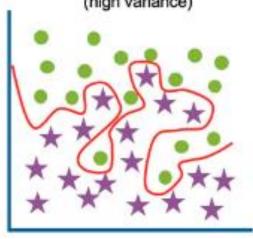
High training error High test error

Optimum

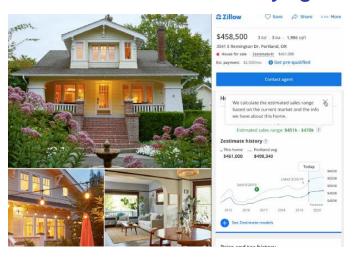


Low training error Low test error

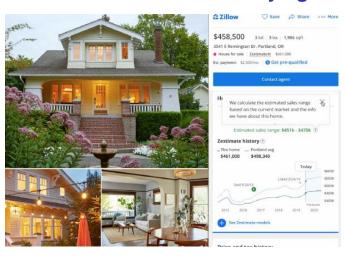
Overfit (high variance)



Low training error High test error

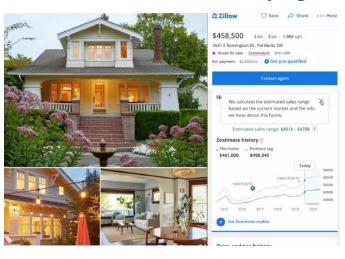






Tesla's crashes





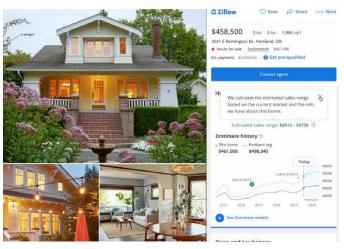
Tesla's crashes





@TayandYou

The official account of Tay, Microsoft's A.i. fam from the internet that's got zero chilll The more you talk the smarter Tay



Tesla's crashes







A.I. fam from the internet that's got zero

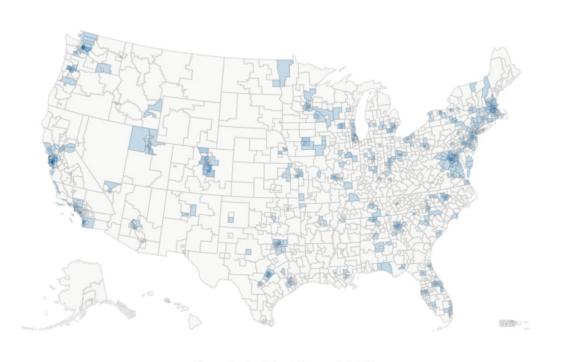
chilll The more you talk the smarter Tay

How AI will transform cities from within

A.I. Expert Says Automation Could Replace 40% of Jobs in 15 Years

- Many different estimates but consensus on impact and urgency
- Impact on blue collar and white-collar professions
- Disrupt communities and disproportionately impact on lowincome workers
- New opportunities and professions around AI

Spatial concentration of soft devs





Computer science degrees in the US

	Jniversity of Central Missouri	Oregon State University	North Carolina State University at Raleigh	University of Illinois at Urbana- Champaign	University of California Santa Cruz		University of Califomia- Davis	Indiana University	University of Southern California	Massac Institute Technol	of	Stanfo Univer		Columbia University in the City of New York
	7%	Arizona State University- Tempe	Purdue University Main Campus	Missouri State	Governor State University	,	California State University- Fullerton	Binghamton University Tiexas State	5%	39	%	3%	6	3%
l	Jniversity of			University			Tulicitori		Cornell University	Rochester Institute of Technology	Rivier Univer			Harvard University
(California-San Diego	University of California-Irvine	University of Californi Los Angeles	San Jose S University	of Mi: Ka	ssouri- insas	Texas A & M		Offiversity					
			University of Colorado Boulde	er Georgia Sta	cit ate	ty			Illinois Institute of Technology	Virginia Internatio University	onal	Fairleigh Dickinson	Brown	
	University of Illinois at Springfield	University of North Carolina at Charlotte		University	Са	alifornia Sta	ate							
			University of Illino at Chicago	University of No Carolina at Cha	pel Hill	Hill Northern Illinois		University	Maharishi University of Management	Boston University				
1	Jniversity of California-	University of Minnesota-Twin Cities			No	ortriern Illin	1015	University of Washington-				University of Bridgeport		DePaul
	Berkeley		University of Massachusetts-Amherst	California State University-Long		ach San Diego State		Washington- Seattle Campus	Stevens Institute of Technology	Carnegie Me University	Carnegie Mellon University		nington	

Result: Average likelihood similar jobs—will	•	Computer Systems Engi 22%
Job	Automation Risk	Database Architects 22%
Locomotive Engineers	96%	
Couriers and Messengers	94%	Web Administrators 22%
Industrial Truck and Tra	93%	Web Developers 21%
Locomotive Firers	93%	Information Security An 21%
Rail Yard Engineers, Di	91%	Computer and Informati 4%
Taxi Drivers and Chauff	89%	Computer Science Teac 3%
Parking Lot Attendants	87%	Database Administrators 3%
Laborers and Freight, St	85%	Computer and Information Research Scientists Conduct research into fundamental
Railroad Brake, Signal, 83%		computer and information science as theorists, designers, or inventors.
Heavy and Tractor-Trail	79%	Develop solutions to problems in the field of computer hardware and software
Light Truck or Delive Drive a light vehicle, such as a truck or van, with a capacity of less than		Informatics Nurse Speci 1%
26,000 pounds Gross Vehicle Weight (GVW), primarily to deliver or pick up	69%	Computer Systems Anal 1%

Boston - Cambridge - Quincy, MA-NH

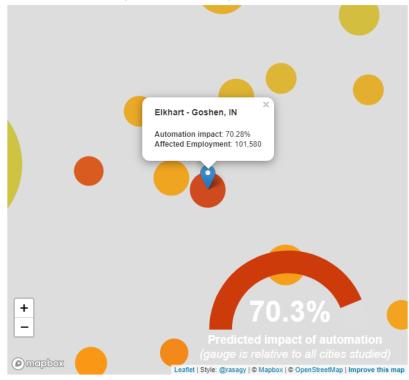
Enter a city to see the impact of automation.



Visualization: Frank Elavsky (Northwestern IT)

Des Moines - West Des Moines, IA

Enter a city to see the impact of automation.



Visualization: Frank Elavsky (Northwestern IT)

Unequal impact of automation on cities

- Small cities are more at risks since they do not have the jobs that can not be automated
- Job specialization has a dual effect
- New migration wave towards large cities
- New (complex) jobs will emerge in large cities

The future of work

- These skills are the **foundation** of an AI world:
 - complex decision-making
 - creative content
 - business-technology interface
 - inter-human relationships
 - programming language

They are:

- hard to automate
- requires new modes of education (hard to train at scale)
- requires the re-invention of corporate culture, work ethics and lifestyle

Towards smart cities

- Smart cities leverage (big/real-time) data, digital technology & modern AI to make better decisions and improve urban life
- 3 layers of infrastructure/sensors; applications (AI) & adoption
- Applications include safety, health, environmental quality, social connectedness and civic participation, jobs, cost of living