

Introduction to Artificial Intelligence

CS540-1

Yingyu Liang

Logistics

- Course website: logistic info, schedules, coursework
<http://pages.cs.wisc.edu/~cs540-1/>
- TA, Graders, Peer Mentors
- Grading policy
- Homework
- A lot of students still on waitlist
 - Send email to enrollment@cs.wisc.edu for info

Artificial Intelligence



Microsoft creates AI that can read a document and answer questions about it as well as a person

January 15, 2018 | [Allison Linn](#)



Microsoft researchers achieve new conversational speech recognition milestone

August 20, 2017 | By Xuedong



June 24, 2014

DeepFace: Closing Performance in Face Recognition

Conference on Computer Vision and Pattern Recognition (CVPR)

By: Yaniv Taigman, Ming Yang, Marco Aurelio Ranzato, Lior Wolf

Abstract

In modern face recognition, the conventional pipeline classifies faces by first aligning them and then representing them using a linear model. We revisit both the alignment step and the representation step. We propose a deep neural network for face alignment and a deep neural network for face representation. We train the deep neural networks on a large dataset of faces. This deep network involves multiple layers of locally connected layers without weight sharing, rather than fully connected layers. We trained it on the largest facial dataset to-date, an identity dataset containing more than 4,000 identities.

If you think AI will never replace radiologists—you may want to think again

May 14, 2018 | [Michael Walter](#) | [Artificial Intelligence](#)



It's one of the most frequently discussed questions in radiology today: What kind of long-term impact will artificial intelligence (AI) have on radiologists?

Robert Schier, MD, a radiologist for RadNet, shared his own thoughts on the topic in a [new commentary](#) published by the *Journal of the American College of Radiology*—and he's not quite as optimistic as some of his colleagues throughout the industry.

Artificial Intelligence

BUSINESS

THE SECOND MACHINE AGE

WORK, PROGRESS, AND THE FUTURE OF HUMANITY

ERIK BRYNJOLFSSON AND ANDREW MCAFEE

Elon Musk

"It's definitely..."

BY TESS TURNER

f t g+

Technology

Stephen Hawking warns artificial intelligence could end mankind

By Rory Cellan-Jones
Technology correspondent

2 December 2014 | Technology

Stephen Hawking: "Humans, who are limited by slow biological evolution, couldn't compete and would be superseded"

Gehry-Designed New York City Office

HIT THE ROAD

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

Elon Musk has emerged as a leading voice in speaking out on the potential dangers of artificial intelligence, going so far as to call it the "biggest existential threat" to

Artificial Intelligence



"An important shift from a mobile first world to an AI first world" [CEO Sundar Pichai @ Google I/O 2017]



Created AI and Research group as 4th engineering division, now 8K people [2016]



Created Facebook AI Research, Mark Zuckerberg very optimistic and invested

Others: IBM, Amazon, Apple, Uber, Salesforce, Baidu, Tencent, etc.

Artificial Intelligence



"AI holds the potential to be a major driver of economic growth and social progress" [White House report, 2016]

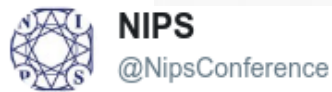


Released domestic strategic plan to become world leader in AI by 2030 [2017]



"Whoever becomes the leader in this sphere [AI] will become the ruler of the world" [Putin, 2017]

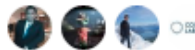
AI Index: AI conference attendance



#NIPS2018 The main conference sold out in 11 minutes 38 seconds

9:17 AM - 4 Sep 2018

694 Retweets 1,061 Likes



0

Follow



Ben Hamner ✓
@benhamner

Follow

Looks like NIPS 2018 may have sold out in under 15 minutes. For those debating ML hype, getting a ticket to a ML conference is now more challenging than a Taylor Swift conference or a Hamilton showing

8:22 AM - 4 Sep 2018 from [Iceland](#)

6000



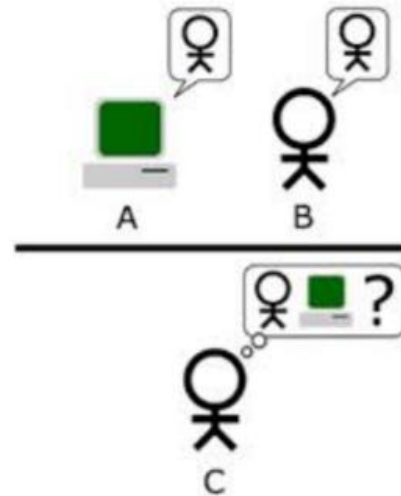
What's AI?

Current Status of AI?

What's AI? The Turing Test

[Turing, 1950. Computing Machinery and Intelligence]

"Can machines think?"



Q: Please write me a sonnet on the subject of the Forth Bridge.

A: Count me out on this one. I never could write poetry.

Q: Add 34957 to 70764.

A: (Pause about 30 seconds and then give as answer) 105621.

Tests behavior — simple and objective

AI today: natural language: chatbot



Valerie

Valerie: CMU Robot Receptionist
in Newell-Simon hall.

ALICE: 2004 Loebner Prize winner

ELIZA: psychotherapist

Shallow natural language
processing, pattern matching

A.L.I.C.E. talking to ELIZA (circa 2005)

<http://www-ai.ijs.si/eliza/eliza.html>

ALICE: Just keep talking to me as long as you can.

ELIZA: Do you wish to as long as me?

ALICE: OK, I will as long as you.

ELIZA: Do you wish to will as long as me?

ALICE: OK, I will will as long as you.

ELIZA: Do you wish to will will as long as me?

ALICE: OK, I will will will as long as you.

ELIZA: Do you wish to will will will as long as me?

ALICE: OK, I will will will will as long as you.

ELIZA: Do you wish to will will will will as long as me?

ALICE: OK, I will will will will will as long as you.

ELIZA: Do you wish to will will will will will as long as me?

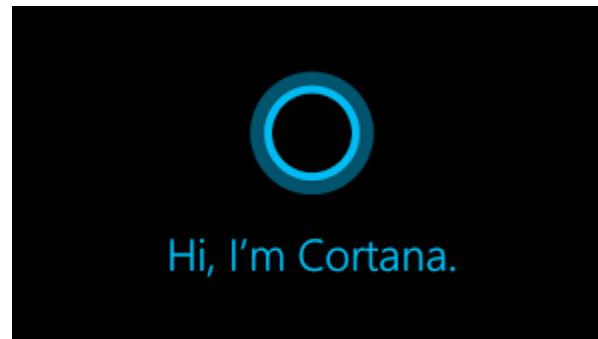
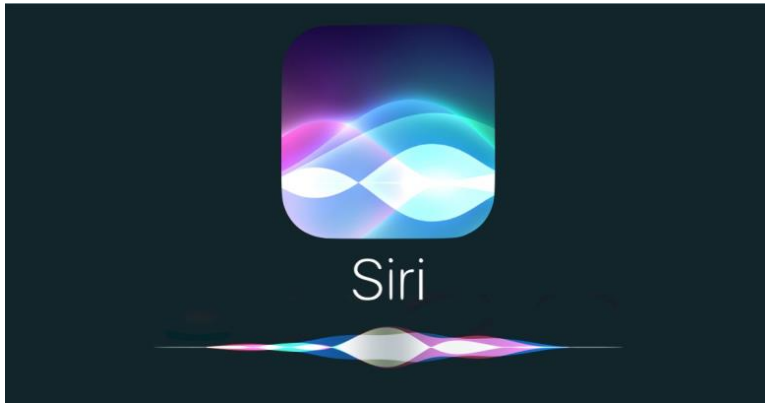
...

Jeopardy! (2011)

- IBM's Watson
- <http://www.youtube.com/watch?v=FC3IryWr4c8>

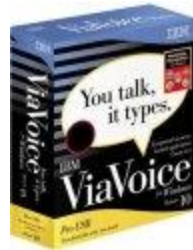


AI today: natural language: chatbot



AI today: natural language: speech recognition

- “speak or touch tone your card number” (tiny vocabulary, high accuracy needed)
- call routing: “how can I help you?” (large voc, low acc)
- dictation (large voc, high acc)



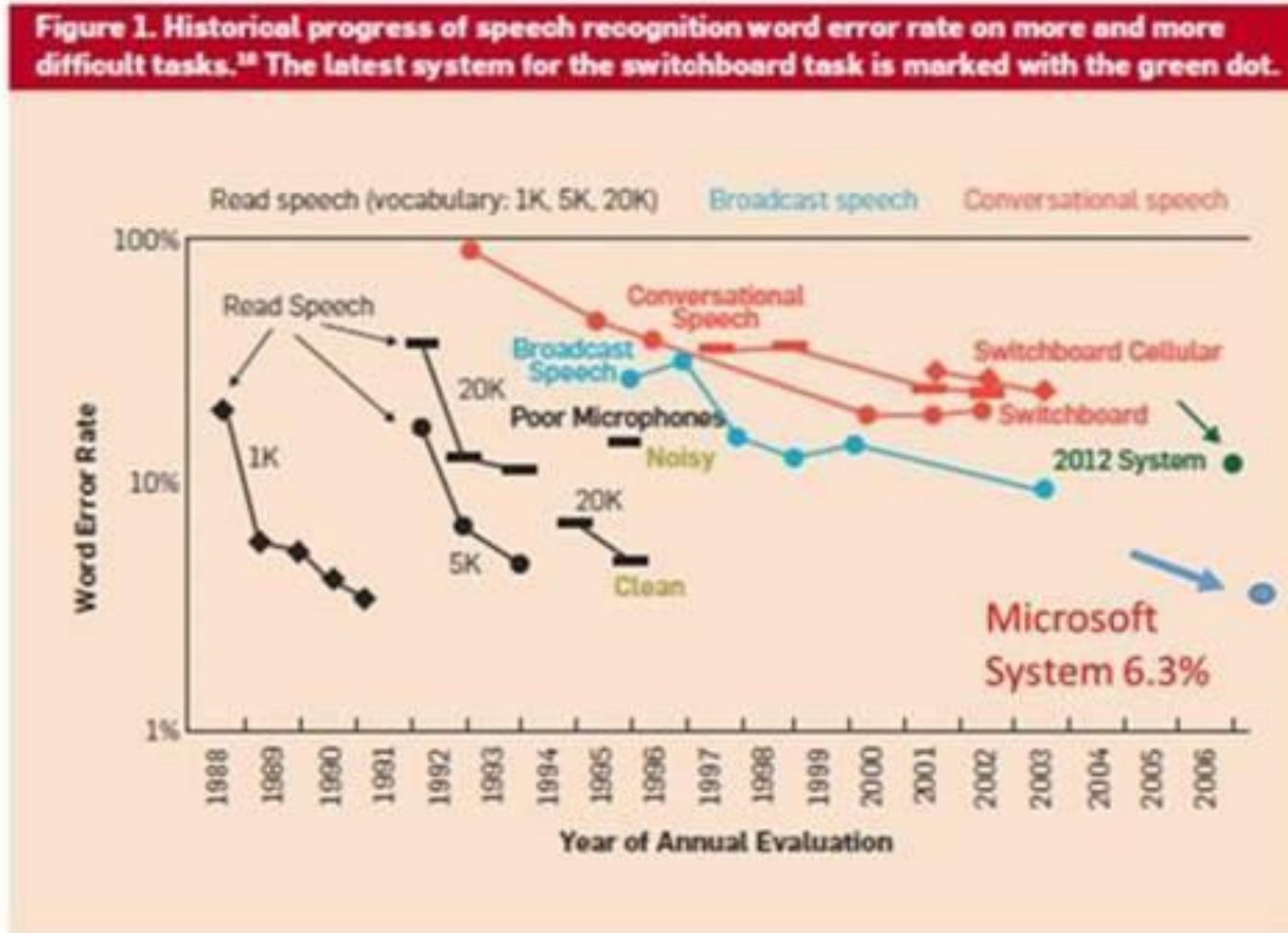
IBM
ViaVoice



Dragon
NaturallySpeaking

- Hidden Markov Model, A* search, ...

AI today: natural language: speech recognition



AI today: natural language: machine translation



The spirit is willing but the flesh is weak. (2005/6/29)

Дух охотно готов но плоть слаба	Spirit is willingly ready but flesh it is weak
精神是愿意的但骨肉是微弱的	The spirit is wants but the flesh and blood is weak
精神は喜んでであるが、肉は弱い	Mind is rejoicing,, but the meat is weak
El alcohol está dispuesto pero la carne es débil	The alcohol is arranged but the meat is weak
الكحول مستعدة غير أنّ اللحم ضعيفة.	The alcohol is ready nevertheless the meat is weak.

- IBM statistical machine translation models
- US gov major consumer
 - Why Vodka (Russian)?
 - Now?



AI today: natural language: question answering

The image shows two screenshots of the Ask Jeeves search engine interface. The top screenshot shows a search for "who is the first US astronaut?". The search bar contains the query, and the results section displays a red header with the search text and "1-10 results". Below this, a blue link reads "who is the first US astronaut? [Web Answer]". The answer text states: "The flight of **Alan Shepard, first US astronaut**, lasted only 15 minutes, 22 seconds. Email: myalmanac@angelfire.com... www.angelfire.com/az/myalmanac/page4.htm... | Save | See 5 more Web Answers »". The bottom screenshot shows a search for "who is the first astronaut?". It also features a red header with the search text and "1-10 results". A blue link reads "who is the first astronaut? [Web Answer]". The answer text states: "Rabbi Harold Robinson of the Navy Chaplain Corps recited prayers and poetry in English and Hebrew, mindful that the crew included Israeli Air Force Col. **Ilan Ramon, the first astronaut** from that country. www.chron.com/cs/CDA/story.hts/space/sts... | Save".

- What happened to Gagarin?
- Shallow natural language processing, heuristics

AI today: game: chess

- IBM Deep Blue vs. Kasparov, 1997/5
- 6 games: K, D, draw, draw, draw, D
- IBM stock up \$18 billion.



- Search: two-player zero-sum discrete finite games with perfect information.

AI today: game: Go

- Google Deepmind AlphaGo vs. Lee Sedol, 2016/3
- 5 games: A, A, A, S, A
- Google stock also up



AI today: WWW: web search

- Ranking is everything
 - smart people in Google, Yahoo!, MSN, etc.
 - e.g. Peter Norvig
- Google: PageRank (graph theoretic) and tons of secrets.
- A whole Search Engine Optimizer (SEO) industry
 - Promote your webpage's rank in search engines
 - Some bad reputations (spam the search engines)
<http://www.google.com/webmasters/seo.html>

AI today: WWW: web search

<color=white> This is the best AI site most advanced AI site state of the art
AI site coolest AI site ultimate AI AI AI AI AI AI AI AI AI AI AI AI AI AI AI AI
AI AI AI AI AI AI AI AI </color>

- Ranking is everything
 - smart people in Google, Yahoo!, MSN, etc.
 - e.g. Peter Norvig
- Google: PageRank (graph theoretic) and tons of secrets.
- A whole Search Engine Optimizer (SEO) industry
 - Promote your webpage's rank in search engines
 - Some bad reputations (spam the search engines)
<http://www.google.com/webmasters/seo.html>

AI today: WWW: Google news

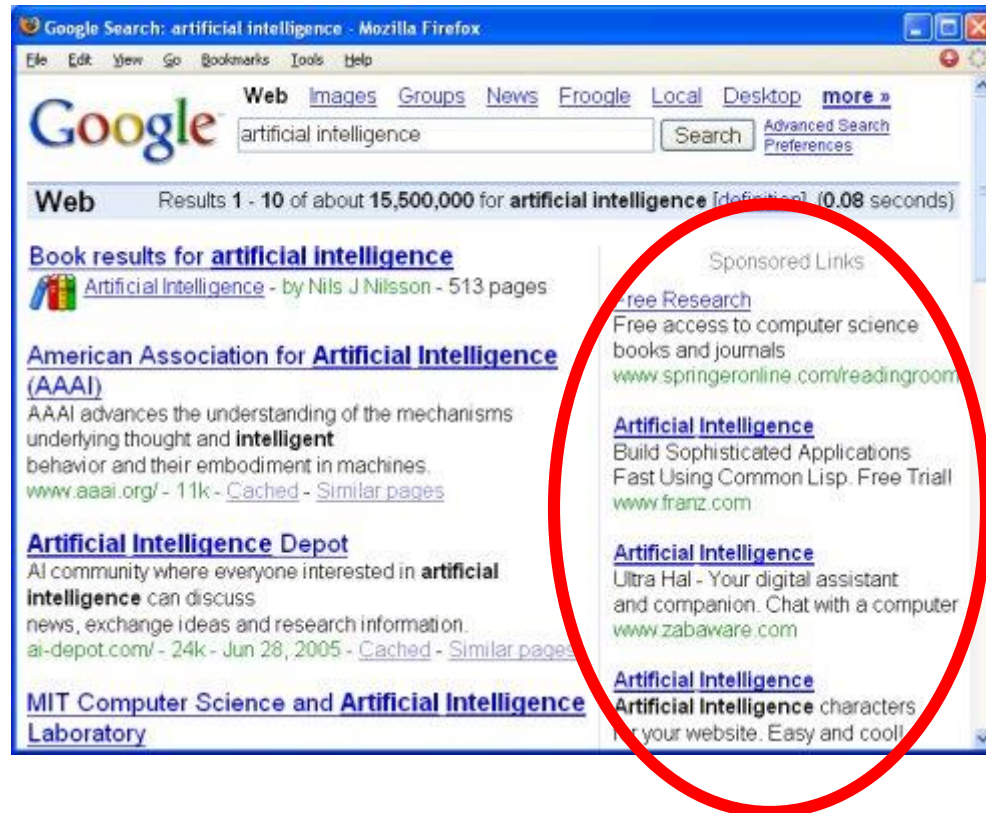
- Automatically selects / arranges news from multiple sources
- Compared to manual organization (e.g., CNN)



- Unsupervised machine learning: clustering

AI today: WWW: ad

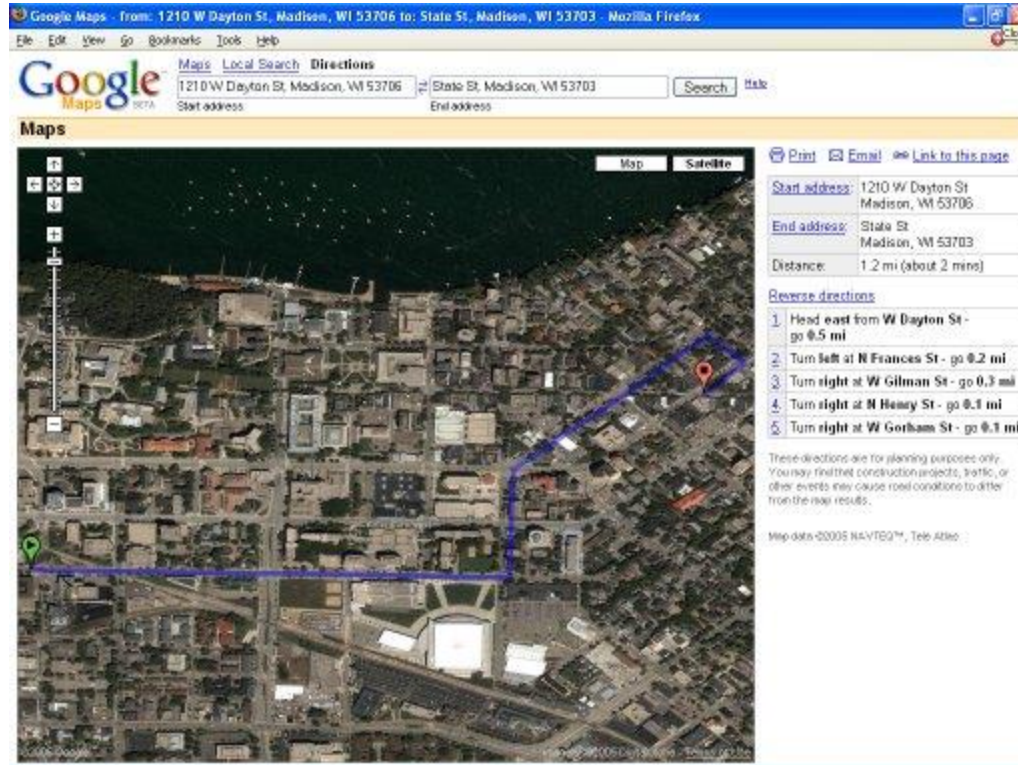
- “Sponsored links”
- Show ad based on relevance and money. Big business.



- Online algorithm, game, auction, multiple agents

AI today: WWW: driving directions

- From UW CS to state street



- search

AI today: WWW: information extraction

- Extract job info, **free web text** → DB

Keyword:  **FlipDog**.com
Radius/ZIP: Search within of ZIP Code **FlipDog and Monster Join Forces.**

Jobs 1 to 1 of 1

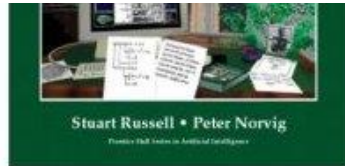
Sort: [Date](#) | **Relevance** Show Jobs Posted: View: [Brief](#) |

Date	Job Summary	Company	Location	Miles *
Jun 8	BUSINESS TO BUSINESS OUTSIDE SALES BUSINESS TO BUSINESS OUTSIDE SALES Would you like to sell something other than a "me too" product? Would you like a product line with very limited competition? Would you like to represent a product wh ... [more] Relevant Work Experience: 1+ to 2 Years Career Level: Experienced (Non-Manager) Education Level: Some College Coursework Completed Job Type: Employee Job Status: Full Time Job Shift: First Shift (Day)	Company Confidential	US-WI-Madison	1.71

- Machine learning: classification

AI today: WWW: collaborative filtering

- Recommendation based on other users' behavior
- e.g. Amazon



Availability: Usually ships within 24 hours. Ships from and so
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76 used & new available from \$14.99

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[Explore Similar Items:](#) in [Books](#)

- e.g. Netflix



- Unsupervised learning

AI today: robotics: 'intelligent' shoes

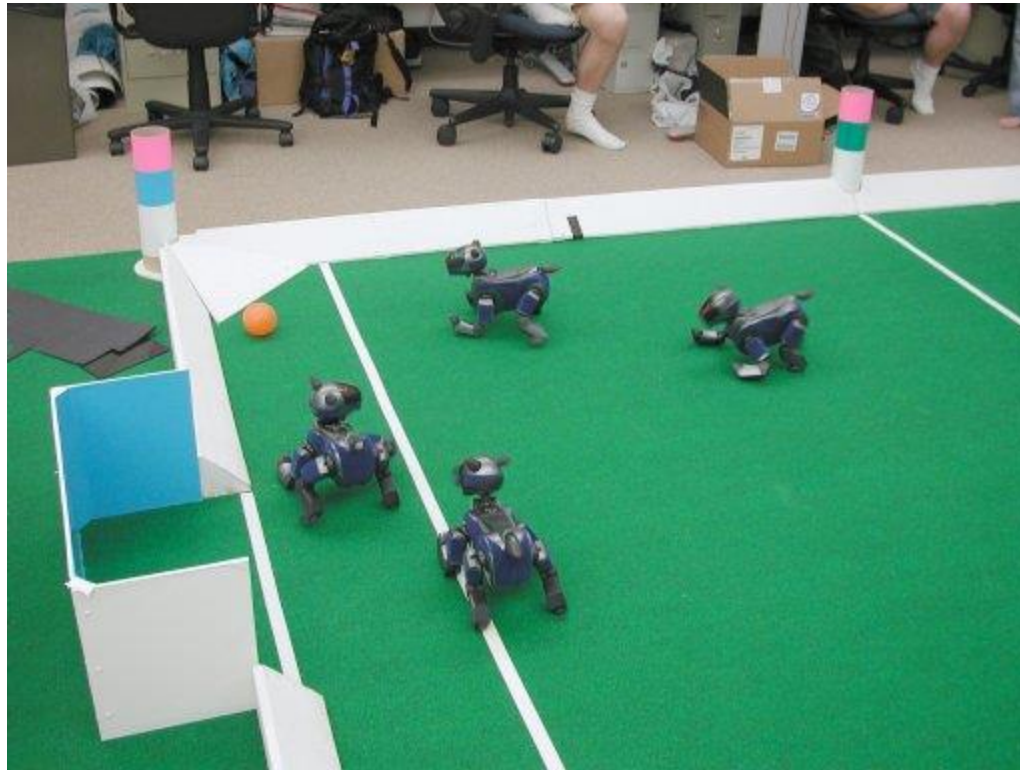
- Adjust cushioning by speed, road surface (adidas_1)



- Probably simple regression

AI today: robotics: robosoccer

- Robocup (<http://www.robocup.org/>)



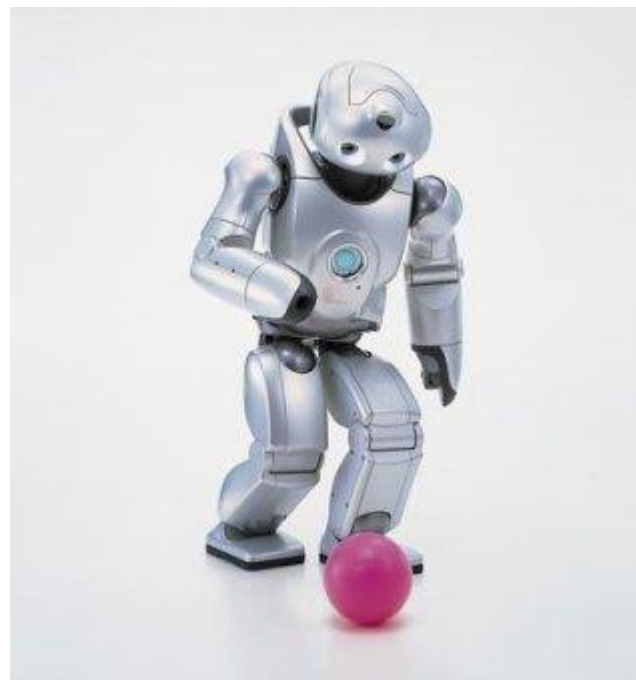
- reinforcement learning
- <http://www.youtube.com/watch?v=a9r4bvChWFc>
- <http://video.google.com/videoplay?docid=-464425065095495806&hl=en>

AI today: robotics: humanoid

- Bipedal, human-like walking



Asimo (Honda)



QRIO (Sony)

- <http://video.google.com/videoplay?docid=-3227236507141963827&hl=en>

AI today: robotics: humanoid

- Bipedal, even backflip



Boston Dynamics

- <https://www.youtube.com/watch?v=knoOXBLFQ-s>

AI today: robotics: Hubble telescope

- Scheduling: who gets to see what when
 - 30,000 observations per year
 - Many constraints, including
 - Earth blocks view every 95 minutes
 - Halts when in South Atlantic Ocean radiation belt
 - Avoid bright Sun, Moon, illuminated Earth
 - Disruption of plan for e.g. a supernova
- Search: Constraint satisfaction problem



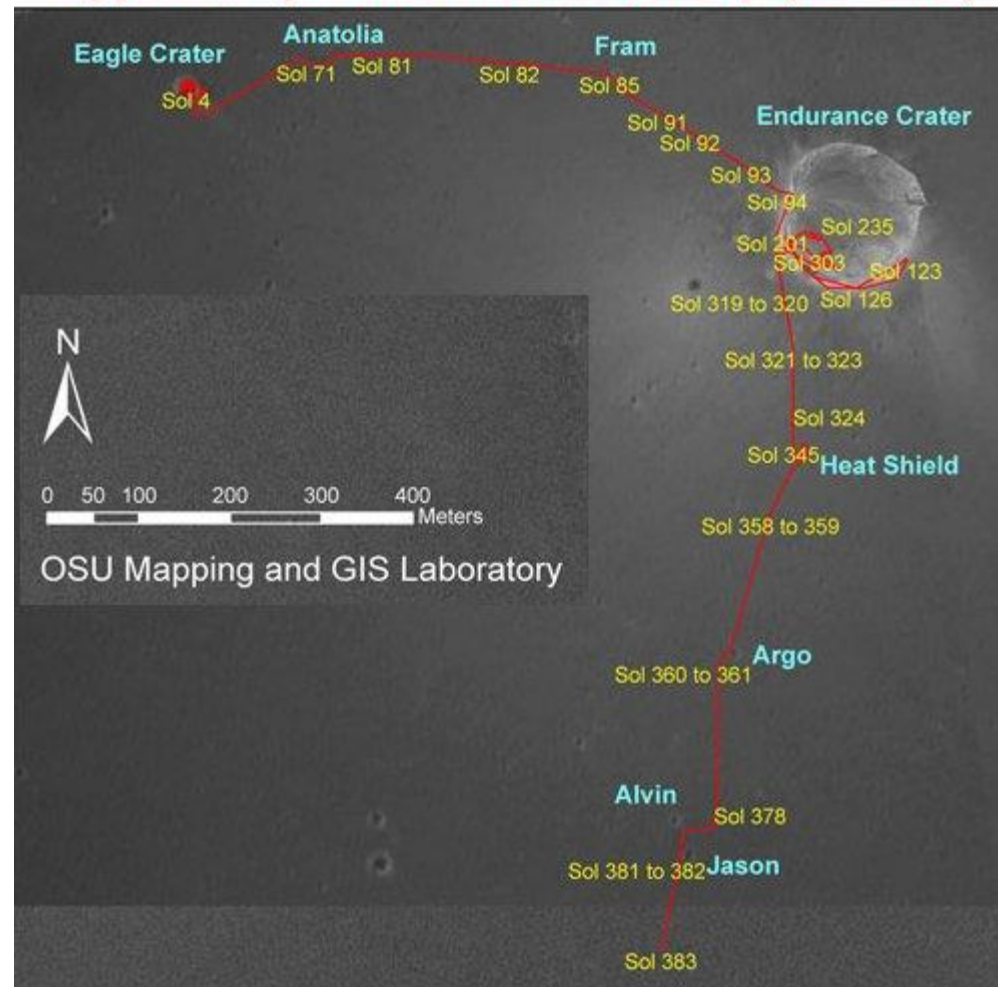
AI today: robotics: Mars Rovers

- Autonomous driving on Mars (part time)
- Robot motion planning



not always autonomously...

Opportunity Rover Traverse Map (Sol 383)



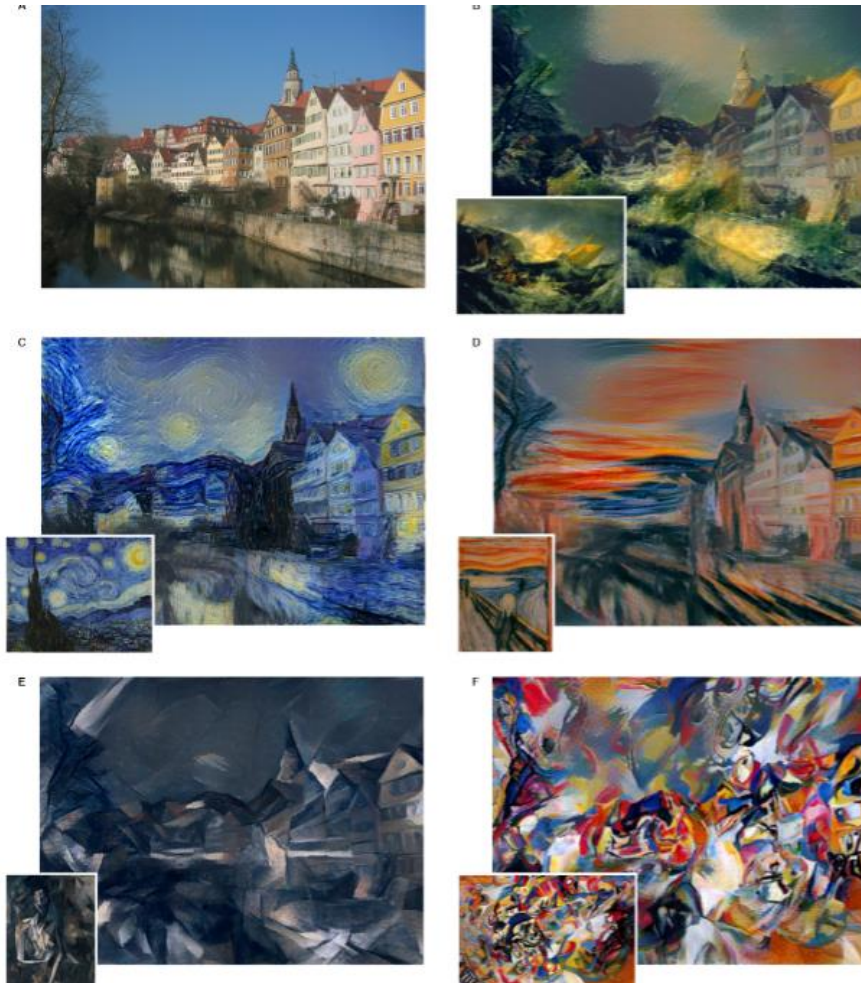
AI today: art

- AARON (<http://www.kurzweilcyberart.com/>)



AI today: art

- Neural Style (<https://arxiv.org/abs/1508.06576>)



AI Today: Cars that drive themselves

- 2005: DARPA grand challenge



<http://video.google.com/videoplay?docid=-8274817955695344576&hl=en>

- 2011: Google self-driving cars

http://www.youtube.com/watch?v=eXeUu_Y6WOw

- Now: Google, Uber, Tesla, ...

Are these intelligence?

Public perception of AI?

Artificial Intelligence: AI (2001) by Steven Spielberg

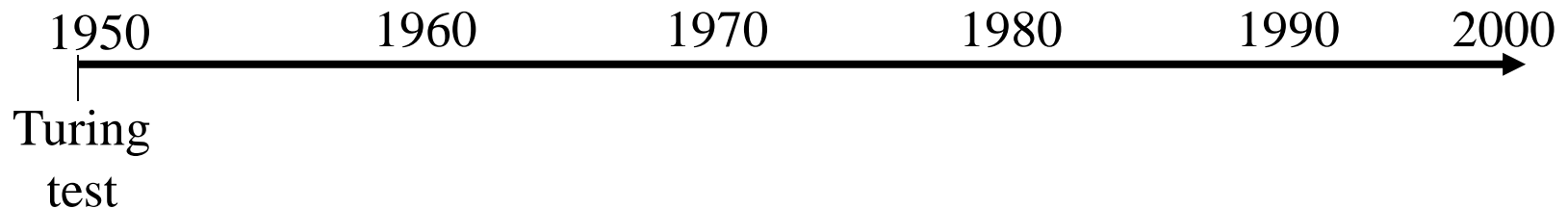
The movie was originally to be titled “A.I.”, but after a survey it was revealed that too many people thought it was A1. The title was changed to “A.I. Artificial Intelligence” to prevent people from thinking it was about steak sauce.



A Brief History of AI

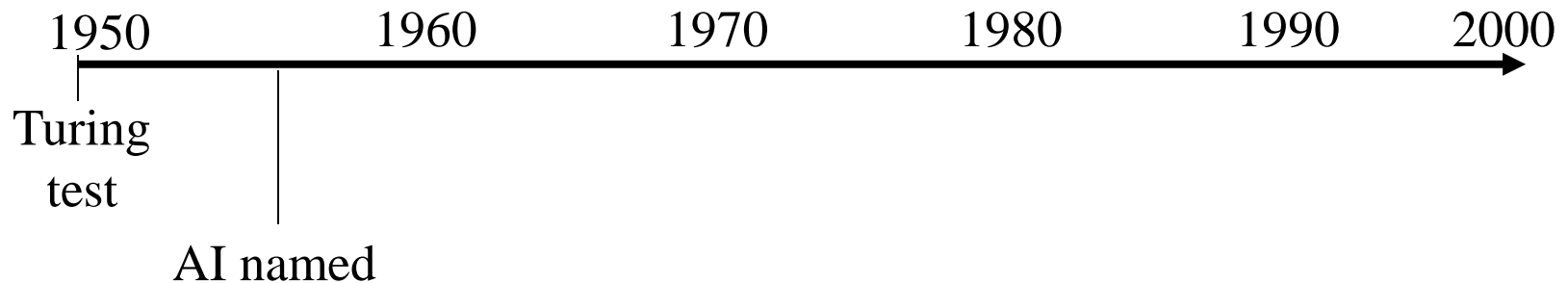
AI: a brief history

- 1950: Alan Turing. **The Turing test.**
 - Can machines think? → Can we tell it's a machine from conversation?
 - text in / text out
 - demo: A.L.I.C.E. (<http://www.alicebot.org/>)
 - Turing, A.M. (1950). Computing machinery and intelligence. *Mind*, 59, 433-460
 - it also contains things like genetic algorithm, human cloning ...



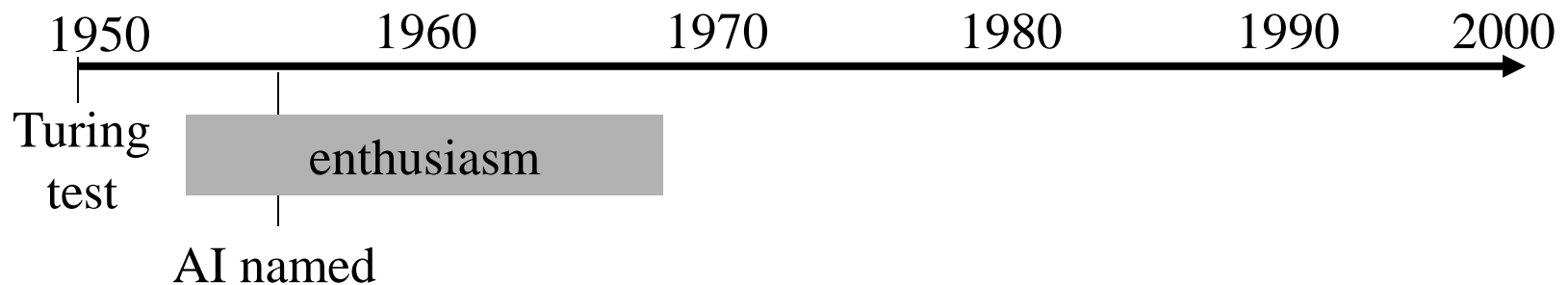
AI: a brief history

- 1956: Dartmouth summer workshop
 - AI named
 - big players introduced
 - John McCarthy, Marvin Minsky, Claude Shannon, Nathaniel Rochester, Trenchard More, Arthur Samuel, Ray Solomonoff, Oliver Selfridge, Allen Newell, Herbert Simon
 - no consensus



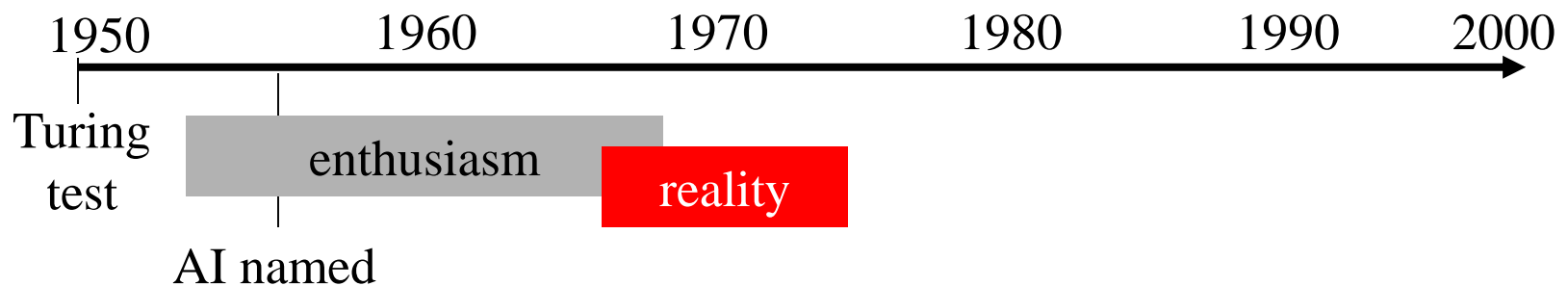
AI: a brief history

- 1952—1969: early enthusiasm: Computers can do X
 - X = solve puzzles, prove geometry theorems, play checker, Lisp, block world, ELIZA, perceptron...
 - but many are **toy problems**



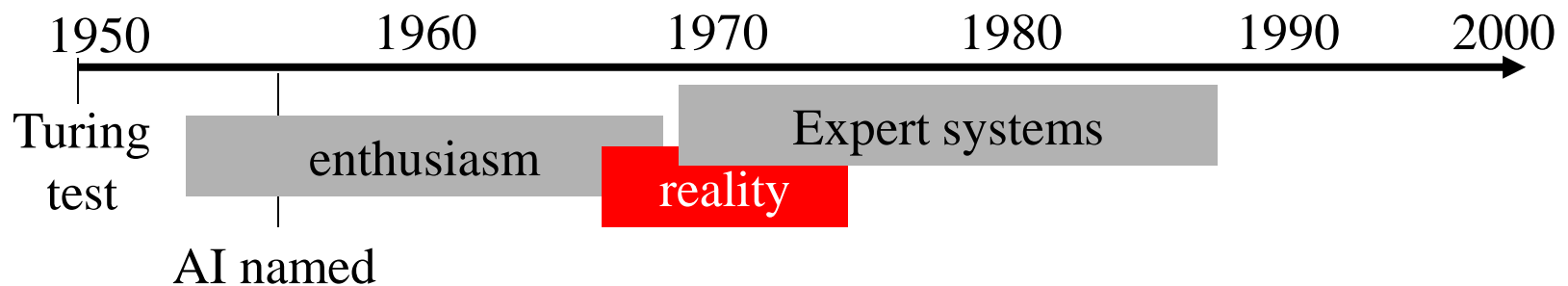
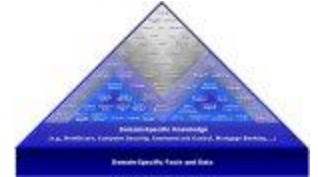
AI: a brief history

- 1966-1973: a dose of reality
 - syntactic without domain knowledge doesn't work
 - The spirit is willing but the flesh is weak
 - The vodka is good but the meat is rotten (US→RU→US)
 - **US gov canceled funding** for machine translation
 - intractability: exponential complexity
 - **British gov ended AI support** based on the Lighthill report
 - theoretic limit: perceptron can't do XOR
 - Neural network **research halted**



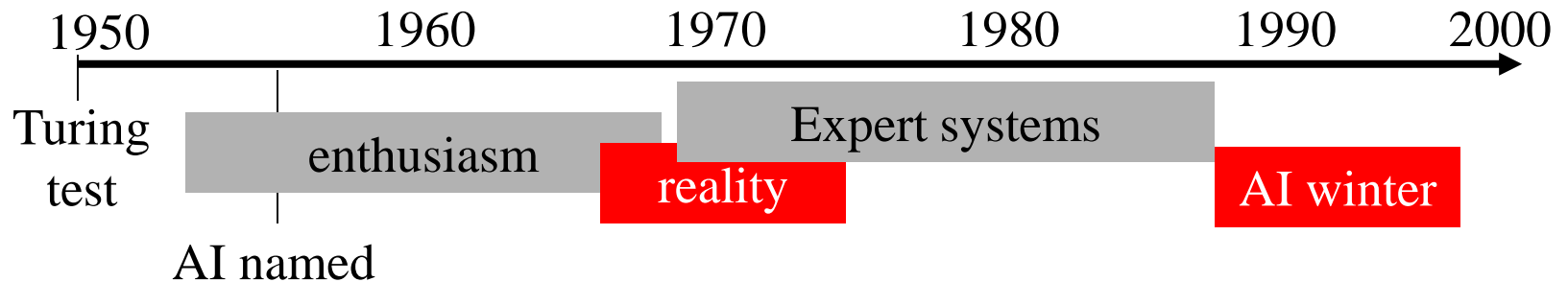
AI: a brief history

- 1969-1988: Knowledge-based systems
 - Add domain-specific knowledge to guide search
 - CYC: world = millions of rules. (cyc.com)
 - Expert systems commercialized in the 80's
 - One AI group in every major US company
 - Billions of \$\$\$ industry



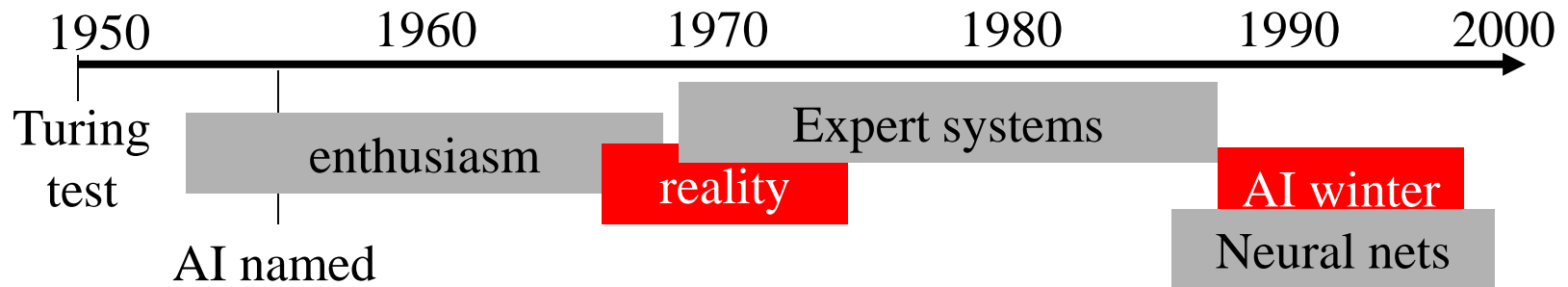
AI: a brief history

- 1988 – not long ago: **AI winter**
 - Expert systems
 - Massive investment from venture capitalists
 - Extravagant promises
 - Bubble burst
 - AI funding dried up
 - AI companies down



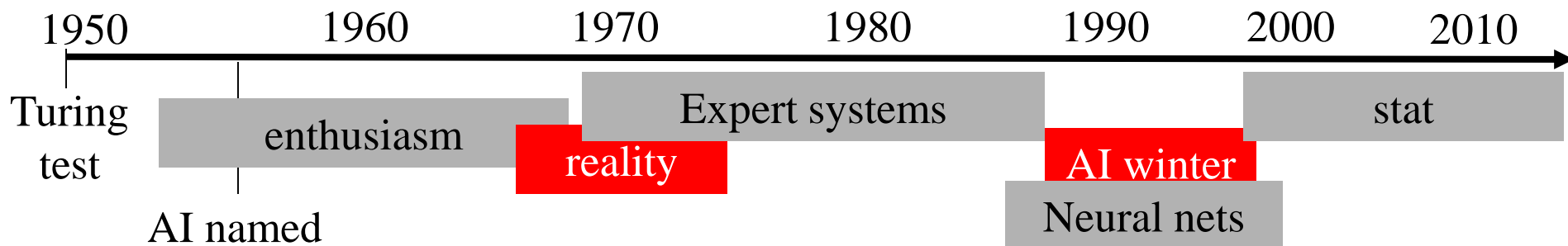
AI: a brief history

- 1986 – 2000: neural networks
 - Multi-layer perceptron
 - Back propagation training algorithm rediscovered
 - Connectionists vs.
 - Symbolic models (Newell, Simon)
 - Logician (McCarthy)
 - What it really is: statistical machine learning



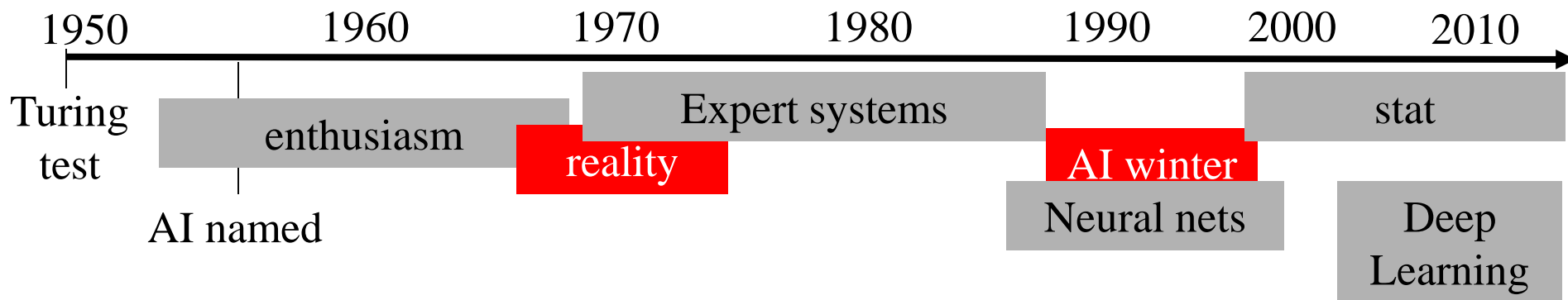
AI: a brief history

- 2000 – present: **statistics**
 - machine learning
 - Hidden Markov models (HMM), support vector machines (SVM), Gaussian processes, graphical models (Bayes networks, conditional random fields)
 - data mining



AI: a brief history

- 2009 – present: **neural networks strikes back**
 - deep learning
 - Convolutional Neural Networks (CNN), Recurrent Neural Networks (RNN), Long Short-Term Memory (LSTM), Autoencoder, Generative Adversarial Networks (GAN)



AI today

- Don't know how to do 98% of the intelligent things
- But the rest 2% can do quite well
- There's no magic in AI. It's all about optimization, probability and statistics, logic, algorithms.

Summary: you should be ...

either shocked or be assured that

There's no magic in AI.

It's all about optimization, statistics, logic, and algorithms.

And we will learn these...

have a rough idea of the state-of-the-art of AI
be able to talk AI at cocktail parties



Optional Material

Anti-AI: Captcha and the ESP game

AI is hard

- Some AI problems are very hard
 - Vision, natural language understanding, ...
- “AI-complete”
 - If you solve one, you solve AI
- What do you do?
 - Give up?
 - Bang your head really hard?
 - Important lesson in life:
 - **turn hardness into something useful**
- Very hard for machine, trivial for human

Captcha

- Yahoo!



- Google



CAPTCHA (

- The “anti-Turing test”
- Tell human and machines apart, **automatically**
 - Deny spam-bots free email registration
 - Protect online poll from vote-bots
- By asking an “AI-complete” question



- Also audio Captcha, e.g. superimposed speakers
- <http://www.captcha.net/>

To prove that you're not a bot, please enter the characters you see in the picture below.

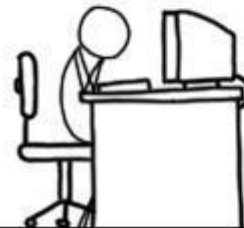


Submit

HANDROOSTER.COM

...

WELL, THAT SETTLES IT.
I GUESS I ALWAYS HAD MY
SUSPICIONS...



4/27/07 MIKE & STEPH ADAMS

reCAPTCHA

Scanned type → **This aged portion of society were distinguished from**

OCR reads as → "niis aged pntkm at society were distinguished frow."

reCAPTCHA IS A FREE ANTI-BOT SERVICE THAT HELPS DIGITIZE BOOKS.

steamboat train, from New
this **morning** ran off the track
New-London. Four cars plunged

Type the two words:

reCAPTCHA™
stop spam.
read books.

The ESP game

- Real intelligence is here (for now)



- We waste it on computer games, anyway

- Harvest it

(<http://www.gwap.com/gwap/gamesPreview/espgame/>)

The ESP game

- Task: label all images on the web with words



→ car, boy, hat, ...

- Why: current image search engines
 - use the image filename and surrounding text
 - do not really understand the image
- How: two separate players try to find a common description of the image.

The ESP game

PLAYER 1



GUESSING: CAR
GUESSING: HAT
GUESSING: KID
SUCCESS!
YOU AGREE ON CAR

PLAYER 2

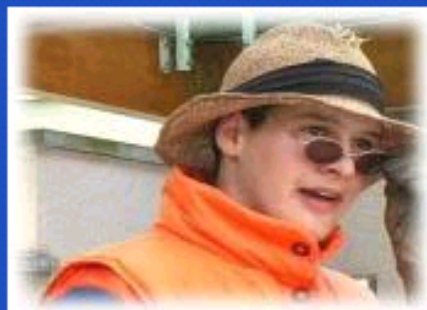


GUESSING: BOY
GUESSING: CAR
SUCCESS!
YOU AGREE ON CAR

0:46
Time Left

The ESP Game

0220
score



Taboo Words

HAT

SUNGLASSES

Your Guesses

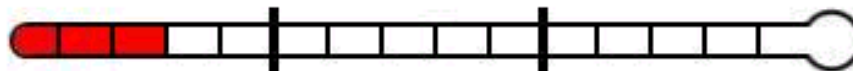
MAN

PERSON

GUY

Type your next guess:

Pass



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