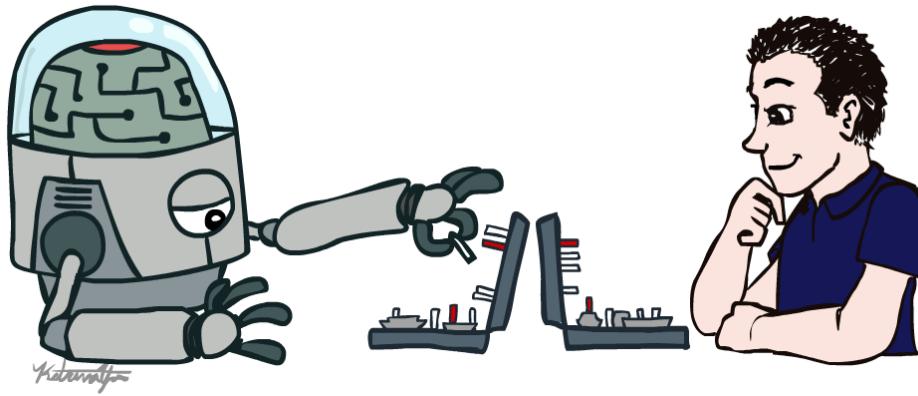


CS 188: Artificial Intelligence

Introduction



Instructors: Aditya Baradwaj and Brijen Thananjeyan

Course Staff

Instructors



Aditya Baradwaj

TAs



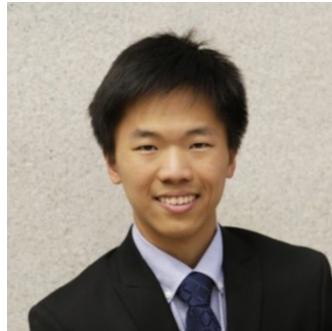
Caryn Tran (Head TA)



Arin Nair



Bobby Yan



Mesut Yang (Head TA)



Benson Yuan



Mike Danielczuk

Brijen Thananjeyan

Course Information

<http://inst.cs.berkeley.edu/~cs188>

CS 188 | Summer 2019

Syllabus Policies Projects Schedule Staff Piazza 

 Warning: Summer 2019 website is under construction. There may be misleading information from past semesters on this website, which may be different from the Summer 2019 offering of the course. We will remove this warning when the information on this website is accurate.

CS 188 | Introduction to Artificial Intelligence

Summer 2019

Lectures: M/Tu/W/Th 12:30 - 2:00 pm, Evans 10



Description

This course will introduce the basic ideas and techniques underlying the design of intelligent computer systems. A specific emphasis will be on the statistical and decision-theoretic modeling paradigm.

By the end of this course, you will have built autonomous agents that efficiently make decisions in fully informed, partially observable and adversarial settings. Your agents will draw inferences in uncertain environments and optimize actions for arbitrary reward structures. Your machine learning algorithms will classify handwritten digits and photographs. The techniques you learn in this course apply to a wide variety of artificial intelligence problems and will serve as the foundation for further study in any application area you choose to pursue.

See the syllabus for slides, deadlines, and the lecture schedule. Readings refer to [AIMA](#) unless otherwise specified.

Syllabus

Week	Date	Lecture Topic	Readings	Section	Homework	Project
1	Mon 6/24	Introduction		Section 1	HW1 Search [Electronic] (Due 6/28 11:59 pm)	P0 Tutorial (Optional) (Due 6/28 4 pm)
	Tue 6/25	Uninformed Search	Ch. 3.1-3.4			
	Wed 6/26	A* Search and Heuristics	Ch. 3.5-3.6			
	Thu	Game trees				

Communication:

- Announcements, questions on Piazza
- Staff email: cs188@berkeley.edu
- Check Calendar for TA OHs, Mega OHs, Section timings
- Instructor Office Hours in 212 Cory
 - Monday 2-3, after lectures, priority: lecture content, logistical issues

Course technology:

- Website
- Piazza
- Gradescope
- This course is not webcast**

Course Information

- Prerequisites:
 - (CS 61A or CS 61B) and (CS 70 or Math 55)
 - Recommended: CS 61A and CS 61B and CS 70
 - There will be some math and some programming
- Work and Grading:
 - 6 programming projects (25%): Python, groups of 1 or 2
 - 7 homework assignments (15%):
 - Electronic component: Online, interactive, solve alone/together, submit alone
 - Written component: On paper, solve alone/together, submit alone, self-assess
 - Two midterms (15% each), one final (30%)
 - Fixed grading scale (85% A, 80% A-, etc.)
 - Participation (class, section, Piazza, contests) can help on margins
 - Academic integrity policy
 - Late Policy: -20% for each day late, up to 5 days

Exam Dates

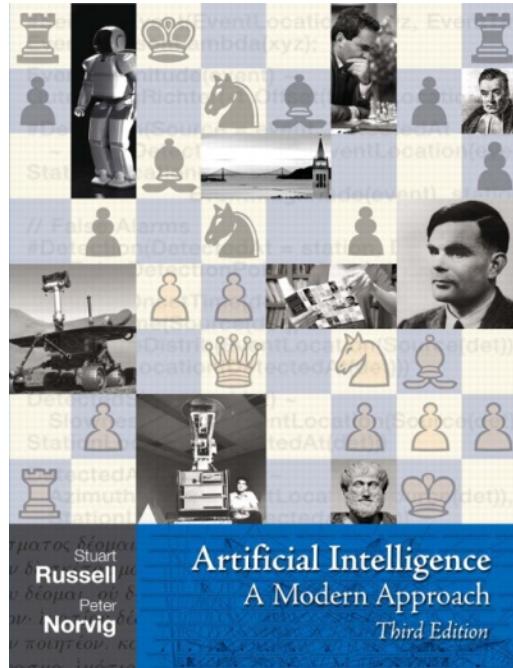
- Midterm 1: July 15, 12:30pm – 2pm
- Midterm 2: July 31, 12:30pm – 2pm
- Final: August 14th, TBD
- There will be no alternate exams
 - Conflict with other class final exam: see web site form

Discussion Section

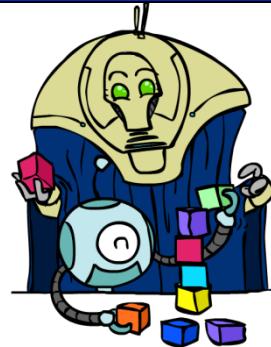
- Topic: review / warm-up exercises / questions not handled in class
- You are welcome to attend any section of your preference
- Piazza survey (@10) to help keep sections balanced
- From past semesters' experience we know sections will be (over)crowded the first two weeks of section, but then onwards section attendance will be lower and things will sort themselves out

Textbook (optional)

Russell & Norvig, AI: A Modern Approach, 3rd Ed.

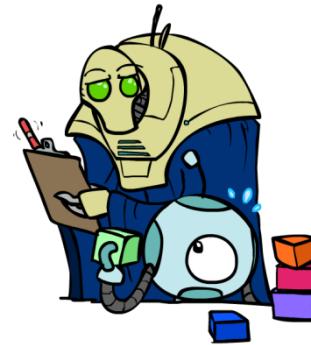


Instruction vs. Assessment



Instruction

Grow knowledge, collaborate,
work until success



Assessment

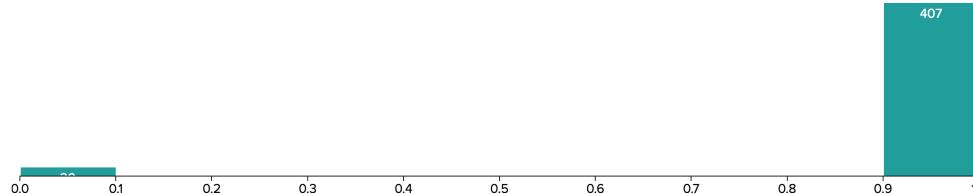
Measure knowledge, each student
on their own, stopped before success

Our experience: these two goals don't mix

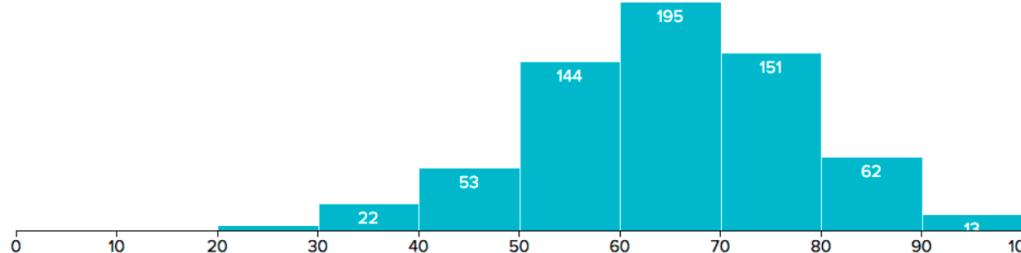
- Lecture / Section / OH / Piazza / Homework / Projects are instruction
 - collaborative, work until success (but please no spoilers, no cheating)
- Exams are assessment
 - on your own

Some Historical Statistics

- Homework and projects: work alone/together, iterate/learn till you nailed it



- Exams: assessment



Announcements This Week

- Important this week:
 - **Check out website:** <https://inst.eecs.berkeley.edu/~cs188> (has links to homework, projects)
 - **Register on Gradescope and Piazza** (check your email for links)
 - **HW1: Search** is online now (due on Friday 6/28 at 11:59pm)
 - **P1: Search** is online now (due on Tuesday 7/2 at 11:59pm)
 - **Instructional accounts:** if you want one, go to <https://inst.eecs.berkeley.edu/webacct>

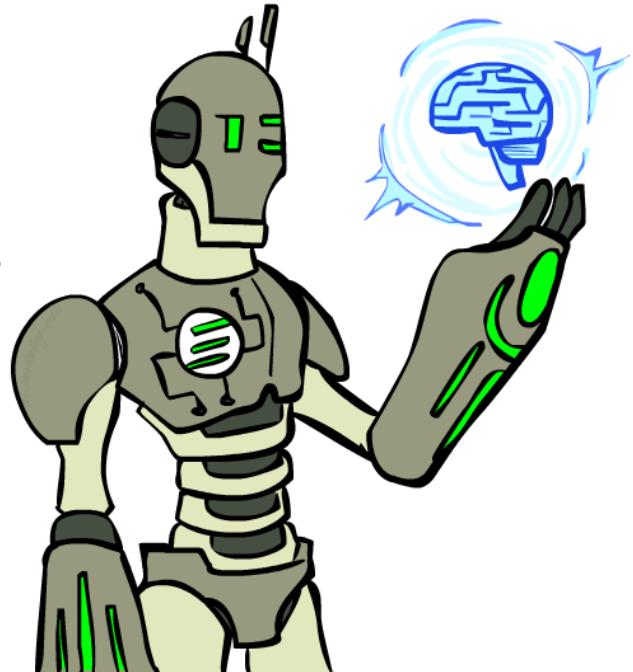
Laptops in Lecture

- Laptops can easily distract students behind you

Please consider sitting towards the back if using your laptop in lecture

Today

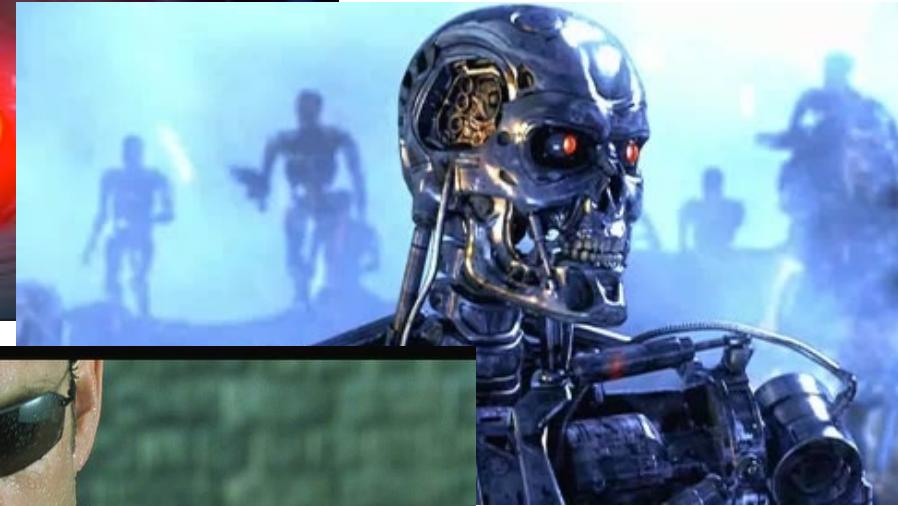
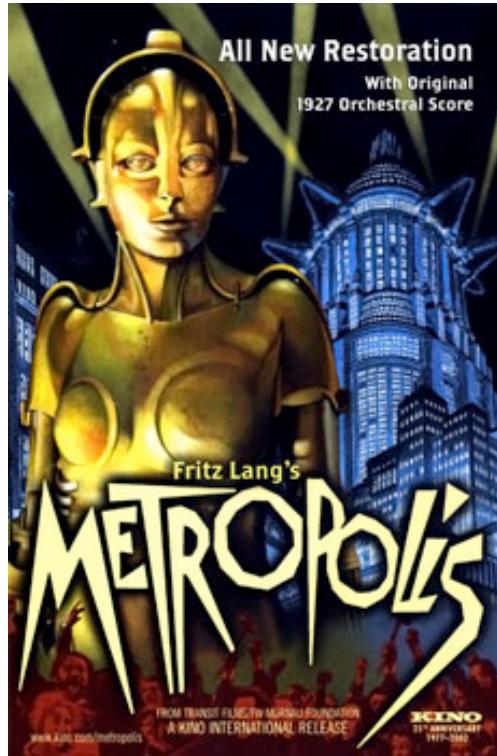
- What is artificial intelligence?
- Past: how did the ideas in AI come about?
- Present: what is the state of the art?
- Future: will robots take over the world?



Movie AI



Movie AI



News AI

AI is the biggest risk we face as a civilisation, Elon Musk says

Billionaire burn: Musk says Zuckerberg's understanding of AI threat 'is limited'

[HOME](#) » [FINANCE](#) » [FINANCE TOPICS](#) » [DAVOS](#)

understanding of AI threat 'is limited'

BY PE
Published
Updated

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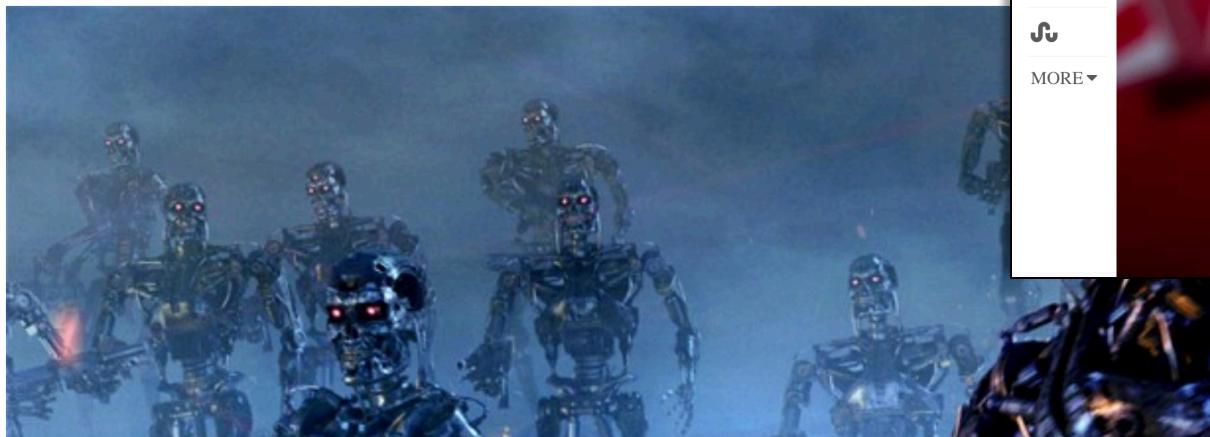
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'Sociopathic' robots could overrun the human race in a generation

Computers should be trained to serve humans to reduce their threat to the human race, says a leading expert on artificial intelligence



LIVE SCIENCE

NEWS TECH HEALTH PLANET EARTH

Live Science > Tech

Lifelike 'Sophia' Robot Granted Citizenship to Saudi Arabia

By Mindy Weisberger, Senior Writer | October 30, 2017 03:39pm ET

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News AI

TECH • ARTIFICIAL INTELLIGENCE

United Kingdom Plans \$1.3 Billion Intelligence Push

France to spend \$1.8 billion on compete with U.S., China

EU wants to invest £18b development

China's Got a Huge Artificial Intelligence Plan

'Whoever leads in AI will rule the world': Putin to Russian children on Knowledge Day

Published time: 1 Sep, 2017 14:08

Edited time: 1 Sep, 2017 14:40



News AI

NATURAL 'PROZAC': DOES IT REALLY WORK?

IBM's Watson Jeopardy Computer Shuts Down Humans in Final Game

DAILY NEWS 9 March 2016

Sili

'I'm in shock!' How world's best human



8 - 15 March 2016



Blizzard will show off Google's Deepmind AI in StarCraft 2 later this week

By Andy Chalk 4 hours ago

Google and Blizzard launched the artificial intelligence project in 2016.

[f](#) [t](#) [r](#) [m](#) | [c](#) COMMENTS

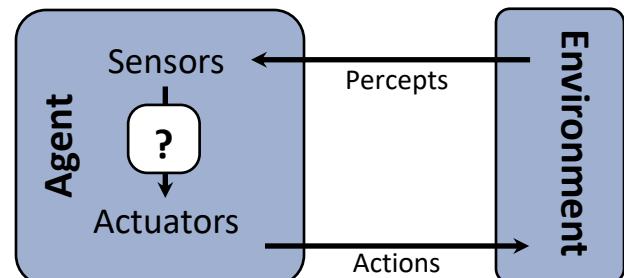
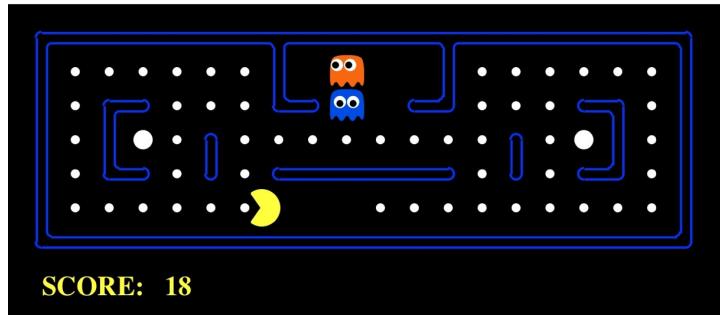


AI as computational rationality

- Humans are intelligent to the extent that our actions can be expected to achieve our objectives
- Machines are intelligent to the extent that their actions can be expected to achieve their objectives
 - Control theory: minimize cost function
 - Economics: maximize expected utility
 - Operations research: maximize sum of rewards
 - Statistics: minimize loss function
 - AI: all of the above, plus logically defined goals
- AI ≈ computational rational agents

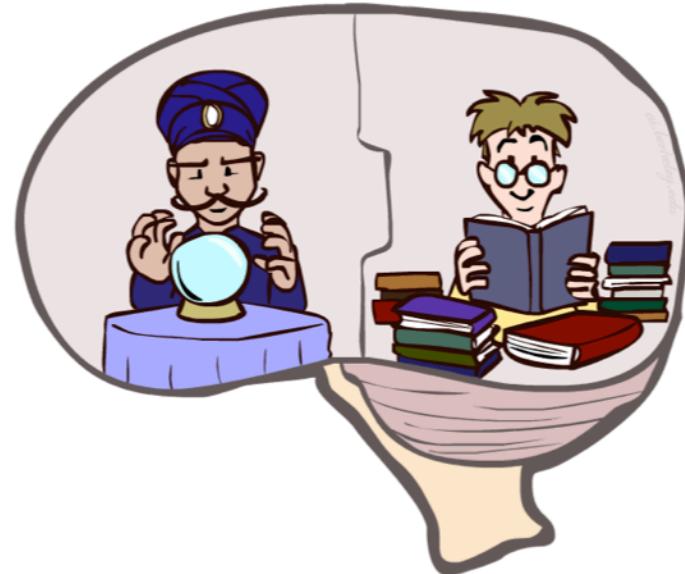
Designing Rational Agents

- An **agent** is an entity that *perceives* and *acts*.
- A **rational agent** selects actions that maximize its (expected) **utility**.
- Characteristics of the **percepts**, **environment**, and **action space** dictate techniques for selecting rational actions
- **This course** is about:
 - General AI techniques for many problem types
 - Learning to choose and apply the technique appropriate for each problem

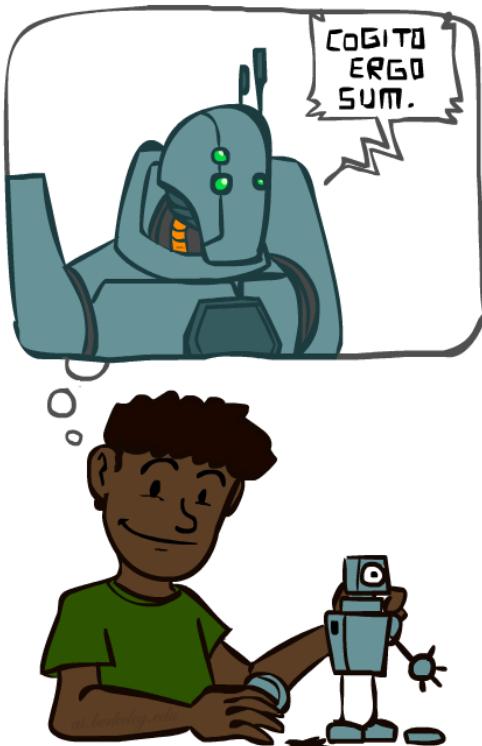


What About the Brain?

- Brains (human minds) are very good at making rational decisions, but far from perfect; they result from accretion over evolutionary timescales
- We don't know how they work
- Lessons learned from human minds: memory, knowledge, feature learning, procedure formation, and simulation are key to decision making



A (Short) History of AI



A short prehistory of AI

- Prehistory:
 - **Philosophy** from Aristotle onwards
 - **Mathematics** (logic, probability, optimization)
 - **Neuroscience** (neurons, adaptation)
 - **Economics** (rationality, game theory)
 - **Control theory** (feedback)
 - **Psychology** (learning, cognitive models)
 - **Linguistics** (grammars, formal representation of meaning)
- Near miss (1842):
 - Babbage design for universal machine
 - Lovelace: “a thinking machine” for “all subjects in the universe.”

AI's official birth: Dartmouth, 1956



“An attempt will be made to find how to make machines use language, form abstractions and concepts, solve kinds of problems now reserved for humans, and improve themselves. ***We think that a significant advance can be made if we work on it together for a summer.***”



**John McCarthy and Claude Shannon
Dartmouth Workshop Proposal**

MIT Summer Vision Project, 1965

MASSACHUSETTS INSTITUTE OF TECHNOLOGY
PROJECT MAC

Artificial Intelligence Group
Vision Memo. No. 100.

July 7, 1966

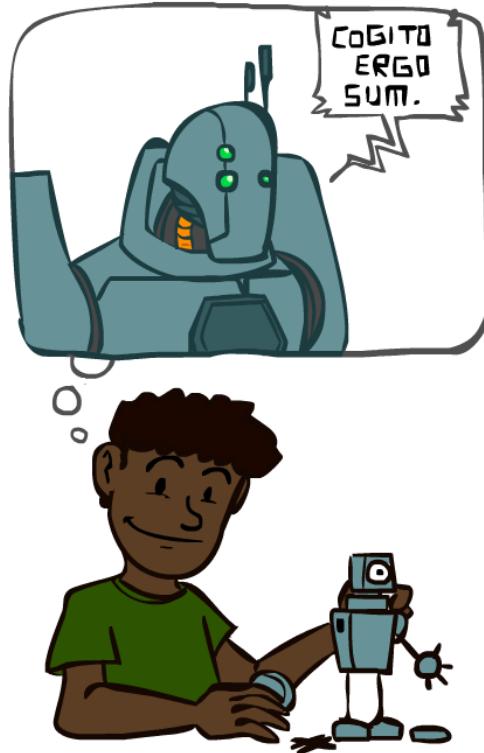
THE SUMMER VISION PROJECT

Seymour Papert

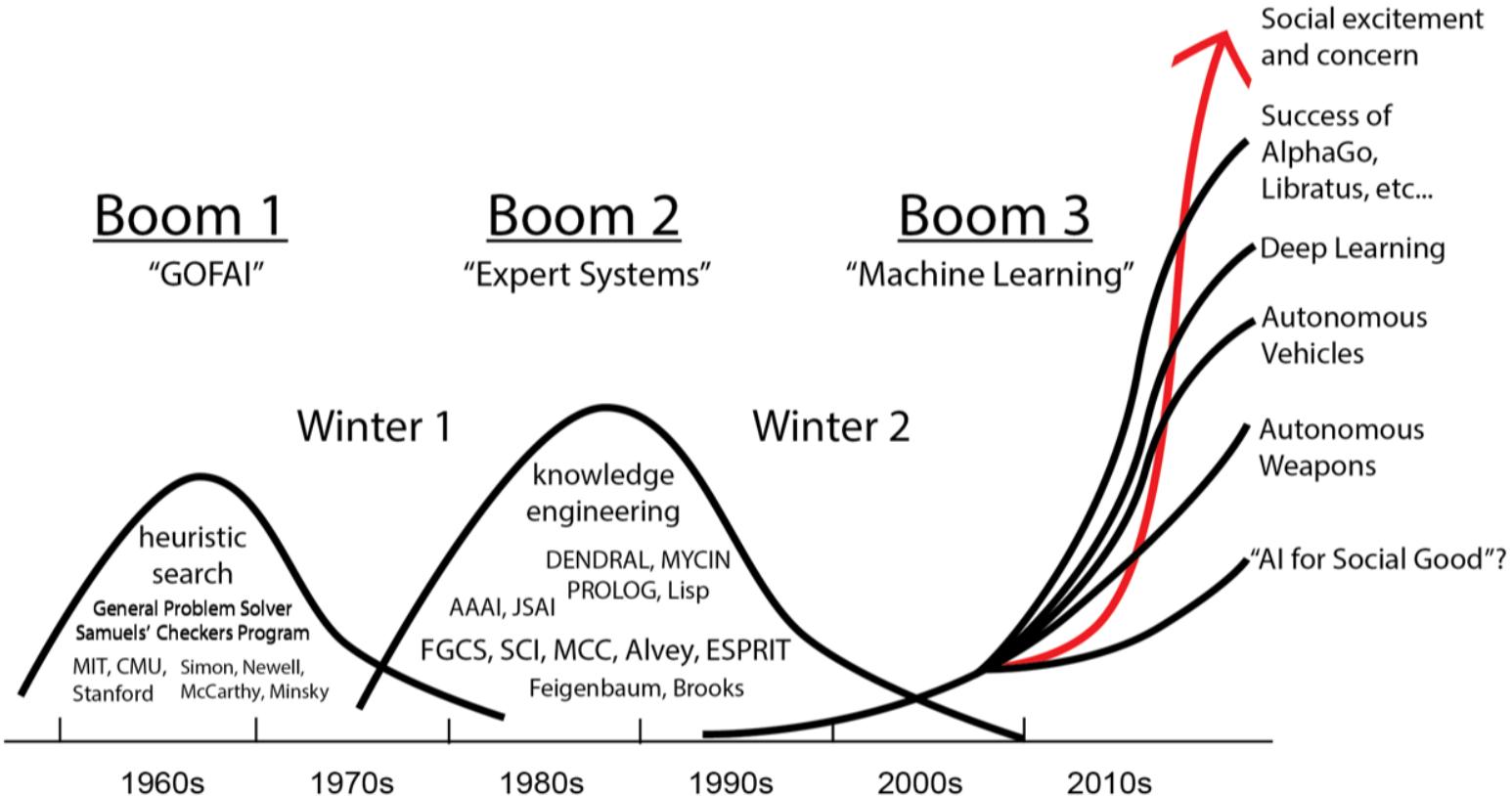
The summer vision project is an attempt to use our summer workers effectively in the construction of a significant part of a visual system. The particular task was chosen partly because it can be segmented into sub-problems which will allow individuals to work independently and yet participate in the construction of a system complex enough to be a real landmark in the development of "pattern recognition".

A (Short) History of AI

- 1940-1950: Early days
 - 1943: McCulloch & Pitts: Boolean circuit model of brain
 - 1950: Turing's "Computing Machinery and Intelligence"
- 1950—70: Excitement: Look, Ma, no hands!
 - 1950s: Early AI programs: chess, checkers program, theorem proving
 - 1956: Dartmouth meeting: "Artificial Intelligence" adopted
 - 1965: Robinson's complete algorithm for logical reasoning
- 1970—90: Knowledge-based approaches
 - 1969—79: Early development of knowledge-based systems
 - 1980—88: Expert systems industry booms
 - 1988—93: Expert systems industry busts: "AI Winter"
- 1990— 2012: Statistical approaches + subfield expertise
 - Resurgence of probability, focus on uncertainty
 - General increase in technical depth
 - Agents and learning systems... "AI Spring"?
- 2012— ____ : Excitement: Look, Ma, no hands again?
 - Big data, big compute, neural networks
 - Some re-unification of sub-fields
 - AI used in many industries



AI Boom and Bust Cycles



Alex Castro, quoted in *The Economist*, 7 June 2007: "[Investors] were put off by the term 'voice recognition' which, like 'artificial intelligence', is associated with systems that have all too often failed to live up to their promises."

Patty Tascarella in *Pittsburgh Business Times*, 2006: "Some believe the word 'robotics' actually carries a stigma that hurts a company's chances at funding."

Many researchers in AI in the mid 2000s **deliberately called their work by other names**, such as informatics, machine learning, knowledge-based systems, business rules management, intelligent systems

Misinformation in the Media

From the Magazine

| April 2017

ELON MUSK'S BILLION-DOLLAR CRUSADE TO STOP THE A.I. APOCALYPSE

Elon Musk is famous for his futuristic gambles, but Silicon Valley's latest rush to embrace artificial intelligence scares him. And he thinks you should be frightened too. Inside his efforts to influence the rapidly advancing field and its proponents, and to save humanity from machine-learning overlords.

BY MAUREEN DOWD

MARCH 26, 2017



IT IS TOO DANGEROUS TO
MAKE PUBLIC

In the
robots

Recent breakthroughs



OpenAI's Dota 2 AI steamrolls world champion e-sports team with back-to-back victories

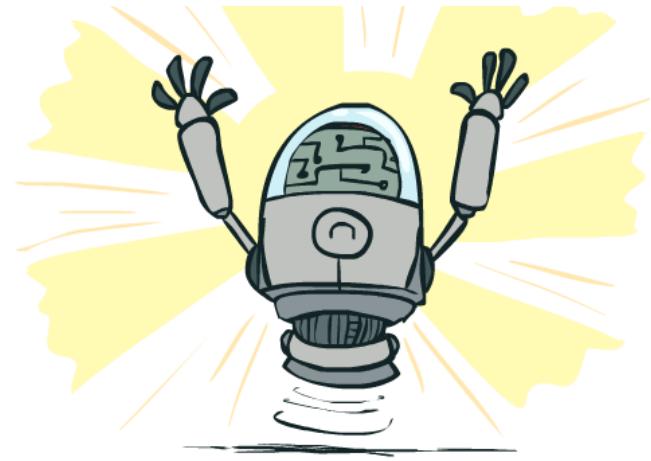
The International 2018 champion OG loses to OpenAI's bots in a stunning defeat

By [Nick Statt](#) | [@nickstatt](#) | Apr 13, 2019, 5:05pm EDT

What Can AI Do?

Quiz: Which of the following can be done at present?

- ✓ Play a decent game of table tennis?
- ✓ Play a decent game of Jeopardy?
- ✓ Drive safely along a curving mountain road?
- ? Drive safely along Telegraph Avenue?
- ✓ Buy a week's worth of groceries on the web?
- ✗ Buy a week's worth of groceries at Berkeley Bowl?
- ? Discover and prove a new mathematical theorem?
- ✗ Converse successfully with another person for an hour?
- ? Perform a surgical operation?
- ✓ Translate spoken Chinese into spoken English in real time?
- ? Fold the laundry and put away the dishes?
- ✗ Write an intentionally funny story?



Unintentionally Funny Stories



Janelle Shane
@JanelleCShane

Follow

Tried retraining the neural net on just "what do you get when you cross a X with a X?" jokes. Results did not improve. And for some reason, bungees are its favorite thing.

What do you get when you cross a dog and a vampire? A bungee

What do you get when you cross a gorilla and a bull? A spider.

What do you get when you cross a cow with a rhino? A bungee with a dog.

What do you get when you cross a mountain and a bungee and a cow? A cow with a rhinocero.

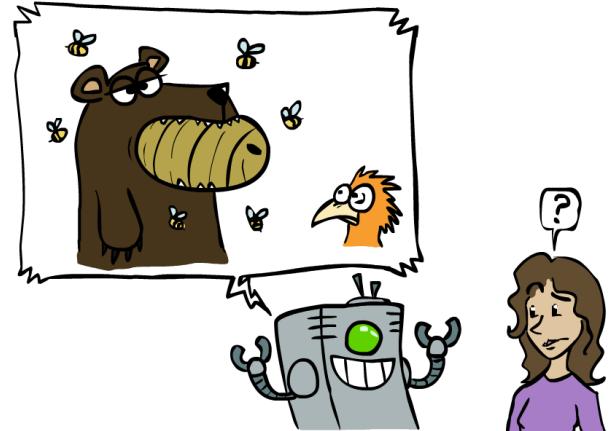
What do you get when you cross a street and a bungee with a cow? A bungee and a pig with a cow.

What do you get when you cross a street and a cow? A bungee with a bungee and a rhino.

What do you get when you cross a pig with a cow with a party? Because the engineers with a dog.

friend
I him
ed to

the
sitting.
owned.



nd a vain crow. One day the cheese in his mouth. He noticed he became hungry, and swallowed The End.

[Shank, Tale-Spin System, 1984]

Natural Language

- Speech technologies (e.g. Siri)
 - Automatic speech recognition (ASR)
 - Text-to-speech synthesis (TTS)
 - Dialog systems
- Language processing technologies
 - Question answering
 - 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'ilégalité".

Les faits Le dalaï-lama dénonce l'"enfer" imposé au Tibet depuis sa fuite, en 1959
Vidéo Anniversaire de la rébellion tibétaine à Lhasa



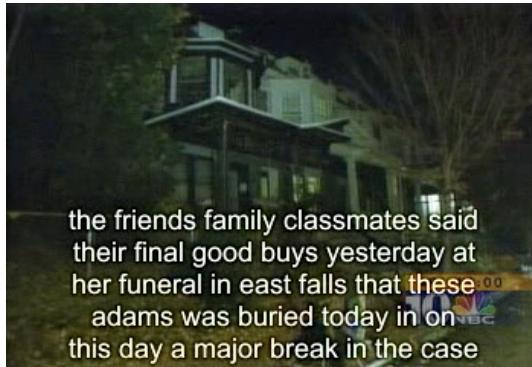
"It is impossible for journalists to enter Tibetan areas"

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."

Facts The Dalai Lama denounces the "hell" imposed since he fled Tibet in 1959
Video Anniversary of the Tibetan rebellion: China on guard



- Web search
- Text classification, spam filtering, etc...

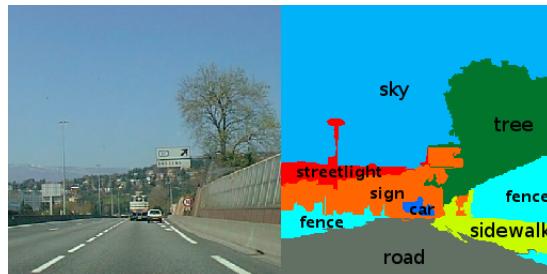


Vision (Perception)

Face detection and recognition

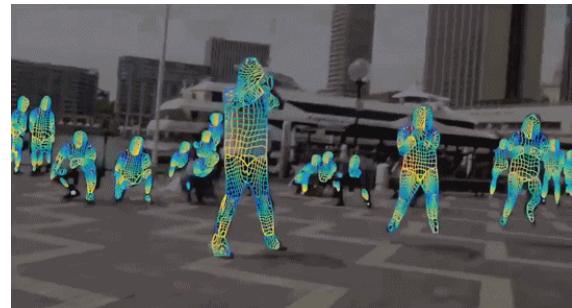


Semantic Scene Segmentation

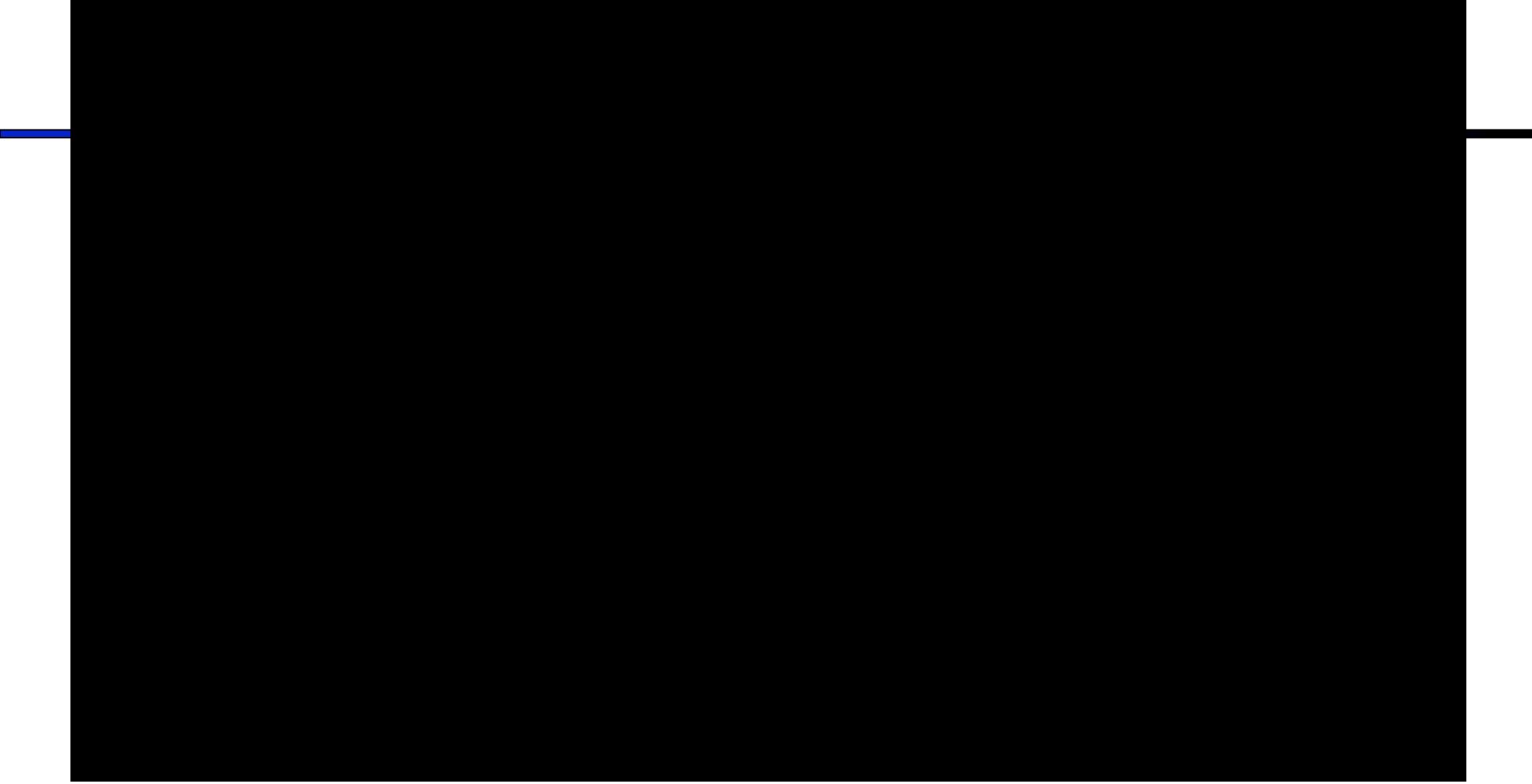


[Caesar et al, ECCV 2017]

3-D Understanding



[DensePose]



Robotics

- Robotics
 - Part mech. eng.
 - Part AI
 - Reality much harder than simulations!
- In this class:
 - We ignore mechanics
 - Methods for planning
 - Methods for control



Images from UC Berkeley, Boston Dynamics, RoboCup, Google





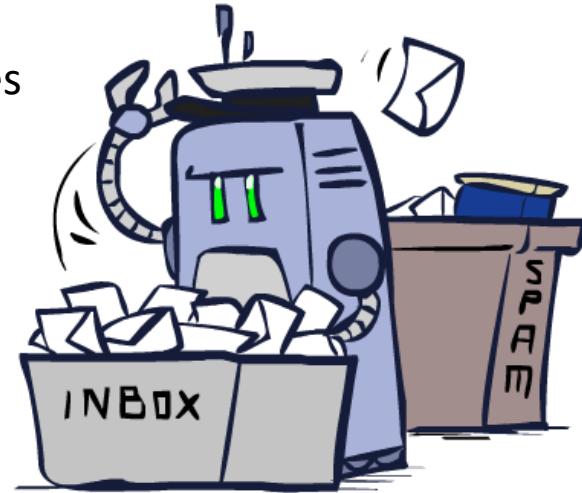


Boston Dynamics



AI everywhere...

- Search engines
 - Route planning, e.g. maps, traffic
 - Logistics, e.g. packages, inventory, airlines
 - Medical diagnosis, machine diagnosis
 - Automated help desks
 - Spam / fraud detection
 - Smarter devices, e.g. cameras
 - Product recommendations
 - Assistants, smart homes
- ... Lots more!



Future

- We are doing AI...
 - To create intelligent systems
 - The more intelligent, the better
 - To gain a better understanding of human intelligence
 - To magnify those benefits that flow from it
 - E.g., net present value of human-level AI $\geq \$13,500T$
 - Might help us avoid war and ecological catastrophes, achieve immortality and expand throughout the universe
- What if we succeed?

What's bad about better AI?

- AI that is incredibly good at achieving something other than what we really want
- AI, economics, statistics, operations research, control theory all assume utility to be *exogenously specified*

Value misalignment

- E.g., “Calculate pi”, “Make paper clips”, “Cure cancer”
- King Midas, genie’s three wishes

We had better be quite sure that the purpose put into the machine is the purpose which we really desire

Norbert Wiener, 1960



I'm sorry, Dave, I'm afraid I can't do that

This Course

- This course is about:
 - General AI techniques for a variety of problem types
 - Learning to recognize when and how a new problem can be solved with an existing technique

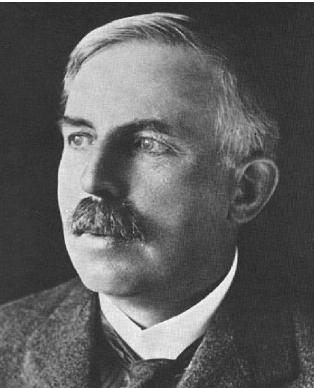
This Course

- Module 1
 - Search
 - Game Trees
 - MDPs and RL
- Module 2
 - Probabilistic Graphical Models
- Module 3
 - Machine Learning

Towards human-level AI

- Still missing:
 - Real understanding of language
 - Integration of learning with knowledge
 - Long-range thinking at multiple levels of abstraction
 - Cumulative discovery of concepts and theories
- Date unpredictable

Unpredictability



Sept 11, 1933: Lord Rutherford addressed BAAS:
“Anyone who looks for a source of power in the transformation of the atoms is talking moonshine.”



Sept 12, 1933: Leo Szilard invented neutron-induced nuclear chain reaction
“We switched everything off and went home. That night, there was very little doubt in my mind that the world was headed for grief.”

So, if all this matters....

- Can we affect the future of AI?
 - Can we reap the benefits of superintelligent machines and avoid the risks?
- ***The essential task of our age.***

Nick Bostrom, Professor of Philosophy, Oxford University.