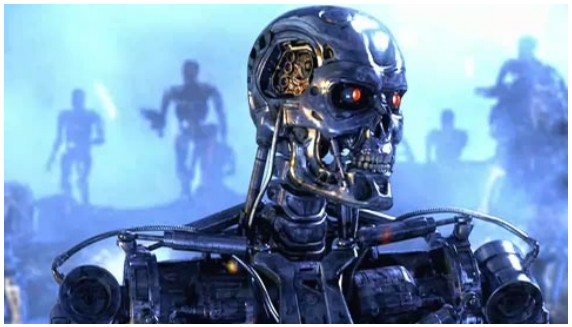
Introduction

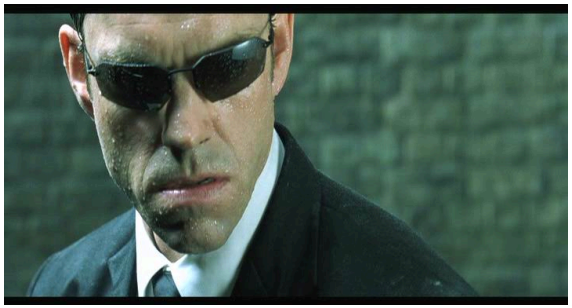
CS5491: Artificial Intelligence
ZHICHAO LU

Content Credits: **Prof. Wei**'s CS4486 Course and **Prof. Boddeti**'s AI Course

WHAT CAN AI DO?

HOLLYWOOD AI?

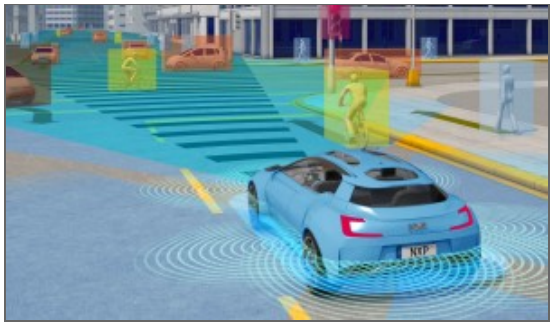




NEWS AI?


ALPHAGO
02:00:00
LEE SEDOL
01:59:31
AlphaGo
Lee Sedol


WAYMO




STEPHEN HAWKING
AI Can Outperform
HUMANS


THINK
$24,000
Who is Stoker?
$ 1,000
$77,147
Who is Bram Stoker?
$ 17,973
$21,600
WHO IS BRAM STOKER?
$5600

WHAT CAN AI DO?

Play a (decent) game of table tennis?

Play a (decent) game of Jeopardy?

Drive safely along a curving mountain road?

Drive safely along Grand River Avenue?

Buy a week's worth of groceries on the web?

Buy a week's worth of groceries from Meijer?

Discover and prove a mathematical theorem?

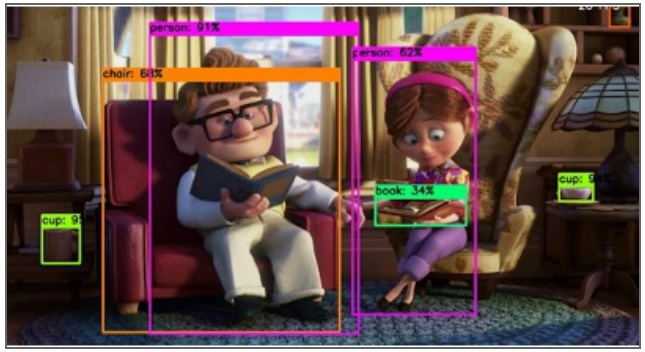
Converse successfully with a human for an hour?

Fold the laundry and put away the dishes?

Write an intentionally funny story?

PERCEPTION

Object and face recognition



Scene Segmentation

Image Classification

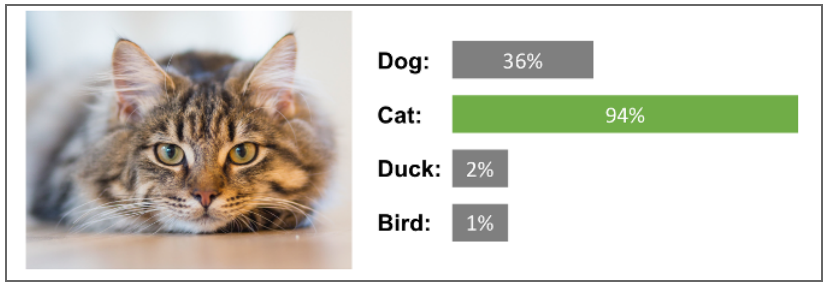


Image captioning

PERCEPTION

NATURE LANGUAGE PROCESSING

Question Answering

Context: California is a major economic center for US...

Question: What is a major importance of California?

Anaswer: major economic center

Sentiment analysis

Resturant review: The dessert is excellent.

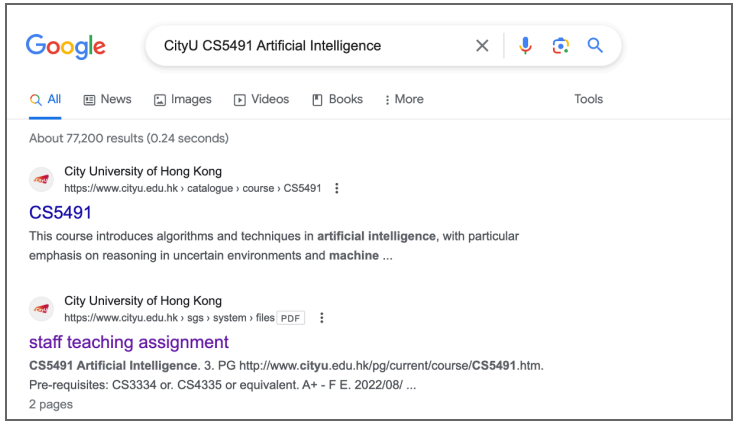
Sentiment: Positive

Machine translation

French: Cette rubrique comprend plusieurs tâches connexes.

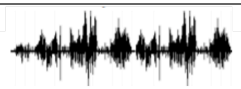
English: This rubric includes several related tasks.

Web Search



SPEECH

Automatic speech recognition

Speech: 

Text: This rubric includes several related tasks.

Chatbot

User: Are you mad at me?

Siri: I can't answer that.

User: Do you love me?

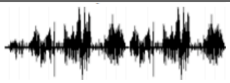
Siri: Would you like me to search the web for "love"?

Text-to-speech synthesis

Text: This rubric includes several related tasks.

Speech: 

Speaker verification

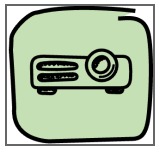
Speech: 

Question: Is this Bob's voice?

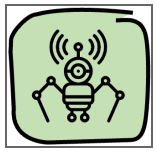
Answer: Yes

ROBOTICS

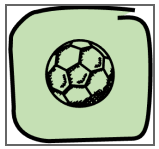
SELF-DRIVING CAR



WAREHOUSE ROBOT



RESCUE ROBOT

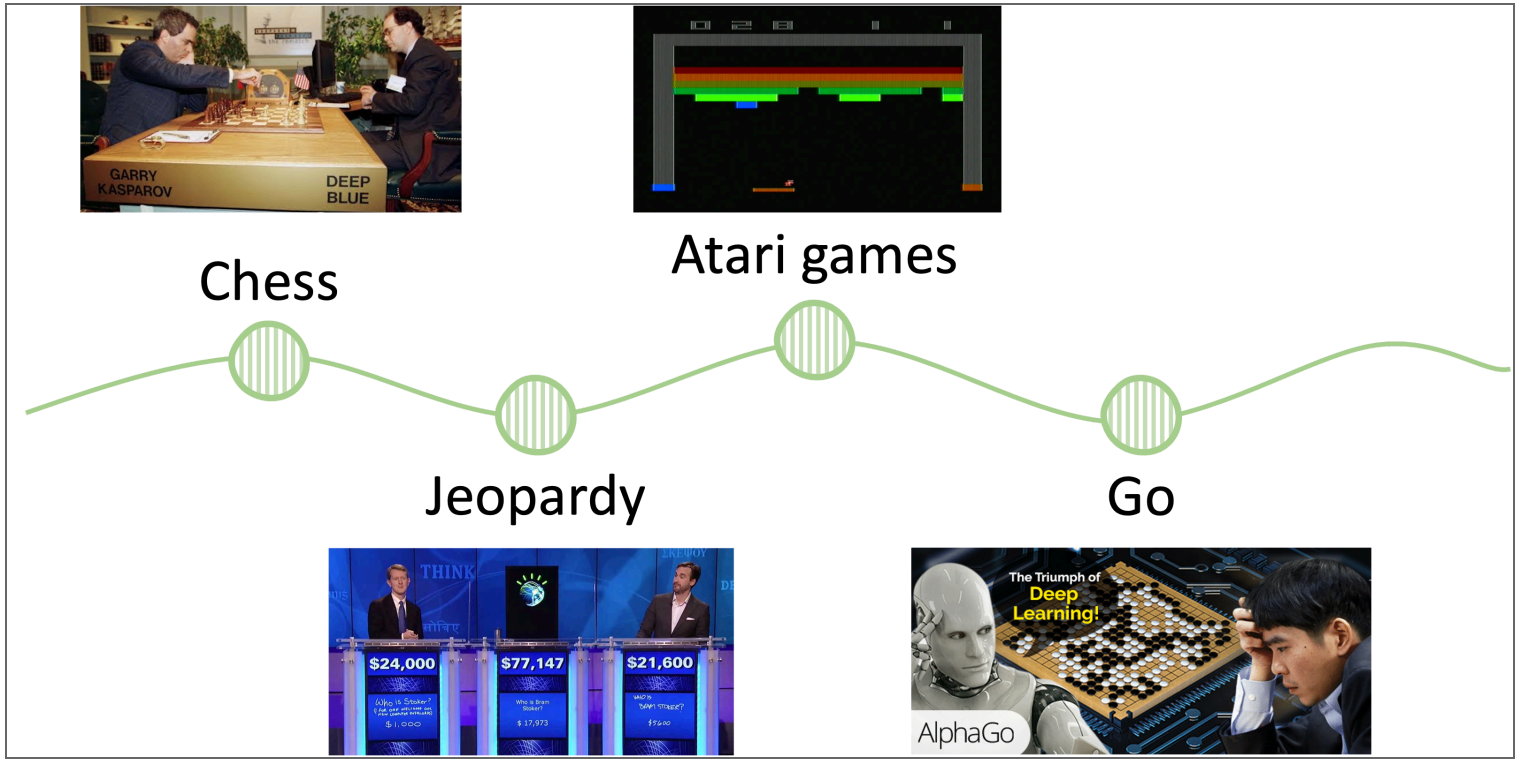


SOCCER ROBOT

SELF-DRIVING CAR

WAREHOUSE ROBOT

GAMING PLAYING



GAMING PLAYING

WHAT IS AI?

WHAT IS AI?

Some classical definitions: The science of making machines that:

	like humans	rationally
think	cognitive science / neuroscience	logic and automated reasoning
act	Turing test	intelligent agents

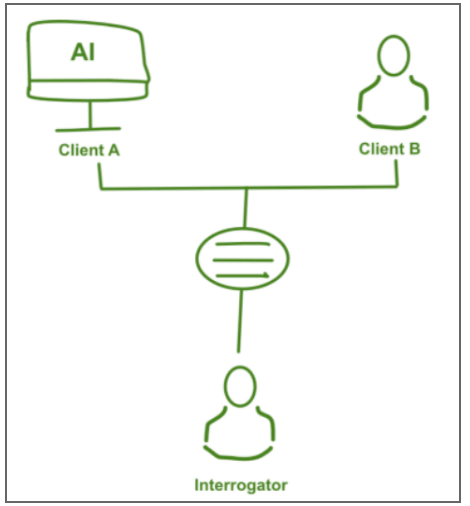
ACTING HUMANLY

TURING TEST:

Proposed by Alan Turing in 1950

- "Can machines think?" --> "Can machines behave intelligently?"
- Operational definition of intelligence

Can a human interrogator tell whether (written) responses to her (written) questions come from a human or an AI machine?



ACTING HUMANLY

Attempts on passing the Turing test

- 1960s: ELIZA (by Joseph Weizenbaum)
- 1990s: ALICE
- Yearly: **Loebner prize**

No machines has fully passed the test yet.

Applications of the Turing test

- CAPTCHA: Completely Automatic Public Turing tests to tell Computers and Humans Apart

Why do we want to replicate human behavior, including the imperfections?

ACTING RATIONALLY

Rationality:

- do the **right** thing rather than "whatever humans think or act".
- Definitions of "**right**":
- Logic: Conclusions are provable from inputs.
- Economics: The utility of outcomes is maximized.

ACTING RATIONALLY

Rationality only concerns what decisions are made (not the thought process behind them)

Irrationally ≠ insane

- an irrationally solution could be sub-optimal.

Rationally ≠ successful

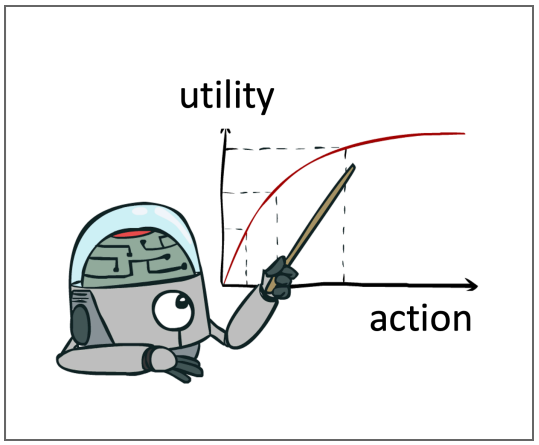
- the most rational action may fail due to out-of-control circumstances or due to incomplete knowledge.

WHAT IS THIS COURSE?

ACTING RATIONALLY

AI as Rational Machines:

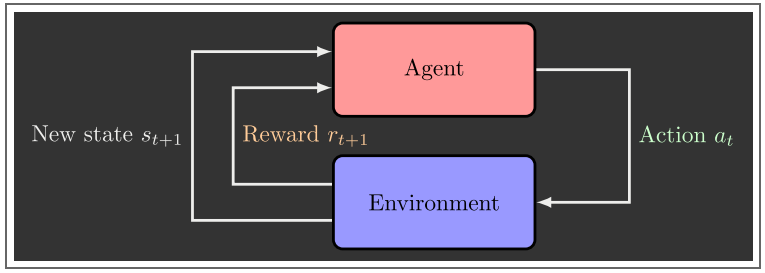
- Rational: maximally achieving pre-defined goals
- Goals are expressed in terms of the utility of outcomes
- Being rational means maximizing your expected utility



ESSENCE OF COURSE

> MAXIMIZE YOUR EXPECTED UTILITY

DESIGNING RATIONAL AGENTS



An **agent** is an entity that perceives and acts.

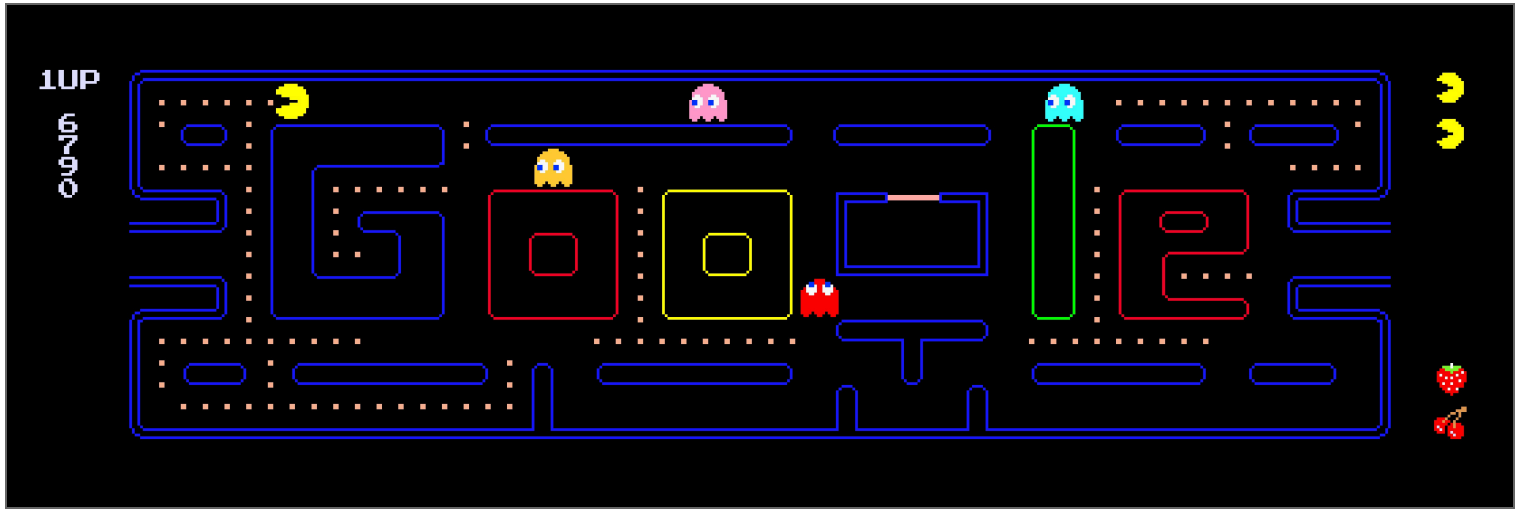
A **rational agent** selects actions that maximize its (expected) **utility**.

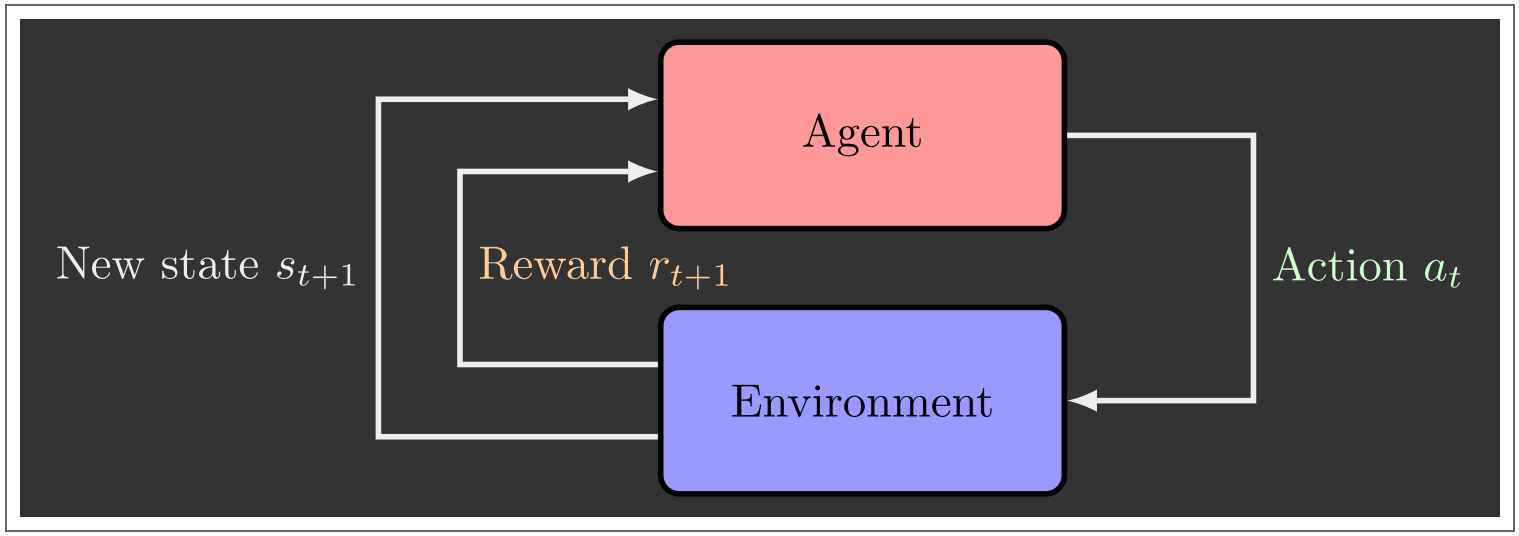
Characteristics of the **percepts**, **environment**, and **action space** dictate techniques for selecting rational actions.

This course is about:

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

PACMAN AS AN AGENT





PACMAN AS AN AGENT

GOALS OF THIS COURSE

✓ To have fun.

✓ To give you some ideas of AI.

✓ To be grounded despite the hype.

✓ To introduce you a set of key techniques and algorithms from AI.

✓ To get you thinking about how AI can be applied to a variety of real problems.

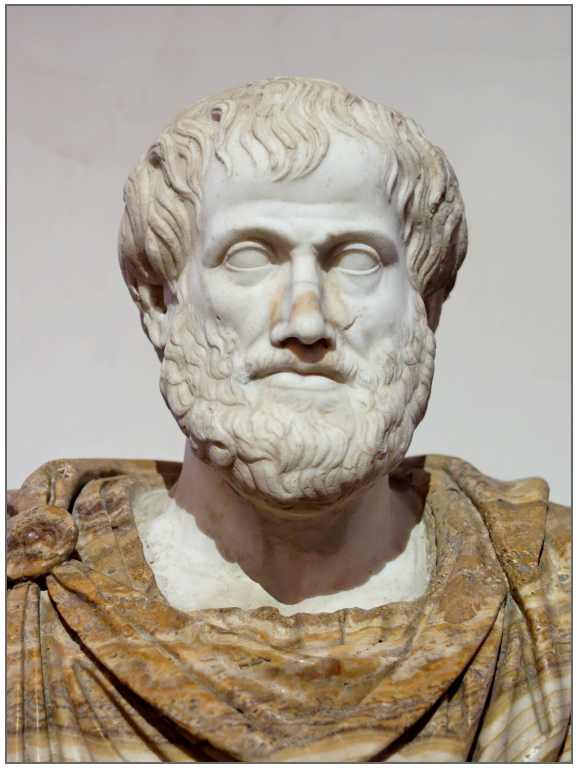
✓ To inspire your research.

✓ It is not about vision, natural language processing, or machine learning.

A (SHORT) HISTORY OF AI

PRE-HISTORY (400 B.C. -)

Philosophy: mind/body, dualism, materialism
Mathematics: logic, probability, decision theory, game theory
Cognitive psychology
Computer engineering

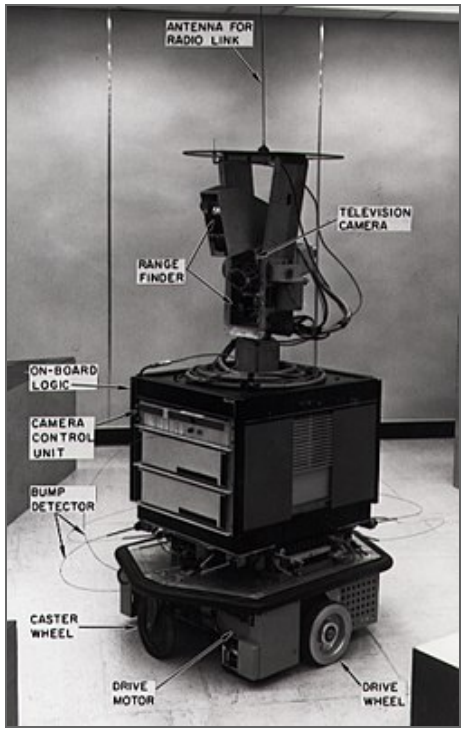


BIRTH OF AI (1943 - 1956)

1943 - McCulloch and Pitts: a simple neural network
1950 - Turing test
1955-1956 - Newell and Simon (Logic Theorist)
1956 - Dartmouth conference, organized by John McCarthy, Marvin Minsky, Nathaniel Rochester, Claude Shannon. ("Artificial Intelligence" adopted)

EARLY SUCCESS (1950 - 1960)

1952 - Arthur Samuel develops checkers program, learns via self-play
1958 - McCarthy LISP, advice taker, time sharing
1958 - Rosenblatt's Perceptron algorithm learns to recognize letters
1968-1972 - Shakey the robot (A^* algorithm)
1971 - 1974 - Blocksworld planning and reasoning

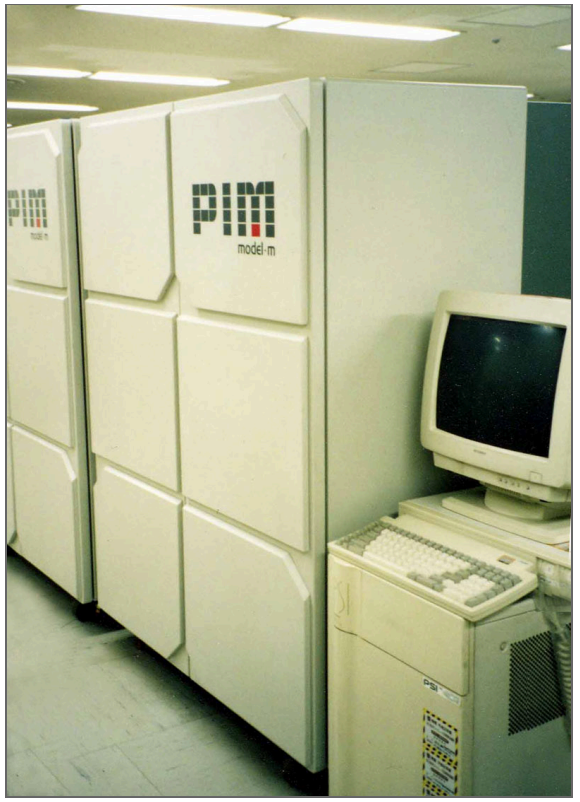


FIRST AI WINTER (LATER 1970)

Many early promises of AI fall short
1969 - Minsky and Pappert's "Perceptrons" book shows that single layer neural network cannot represent XOR function
1973 - Lighthill report effectively ends AI funding in U.K.
1970 - DARPA cuts funding for several AI projects

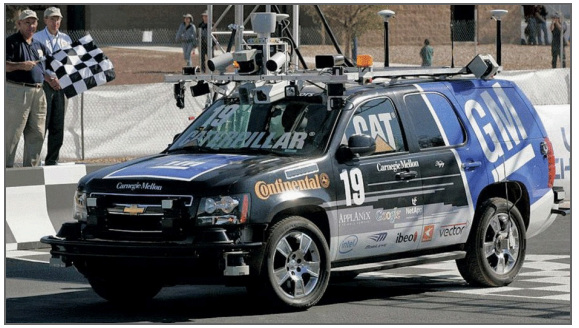
Expert Systems and Businesses (1970-1980)

- Move towards encoding domain expert knowledge in the form of logical rules
- 1971-1974 - Feigenbaum's DENDRAL (molecular structure prediction) and MYCIN (medical diagnoses)
- 1981 - Japan's "fifth generation" computer project, intelligent computers running Prolog
- 1982 - R1, expert system for configuring computer orders, deployed at DEC



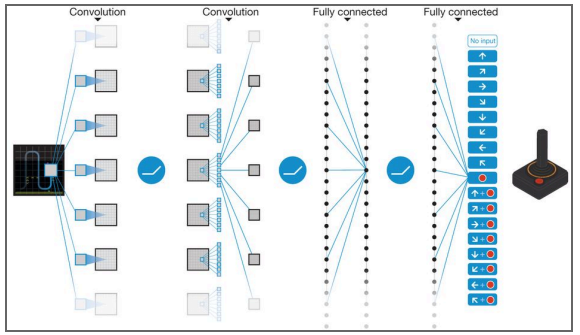
Focus on Applications (1990 - 2010)

- AI (under the guise of a sub-field), achieved some notable milestones
- 1997 - Deep Blue beats Gary Kasparov
- 2001 - 2010 - $60 Billion involved in combinatorial sourcing auctions
- 2005, 2007 - Stanford and CMU respectively win DARPA grand challenge in autonomous driving
- 2011 - IBM's Watson defeats human opponents on Jeopardy

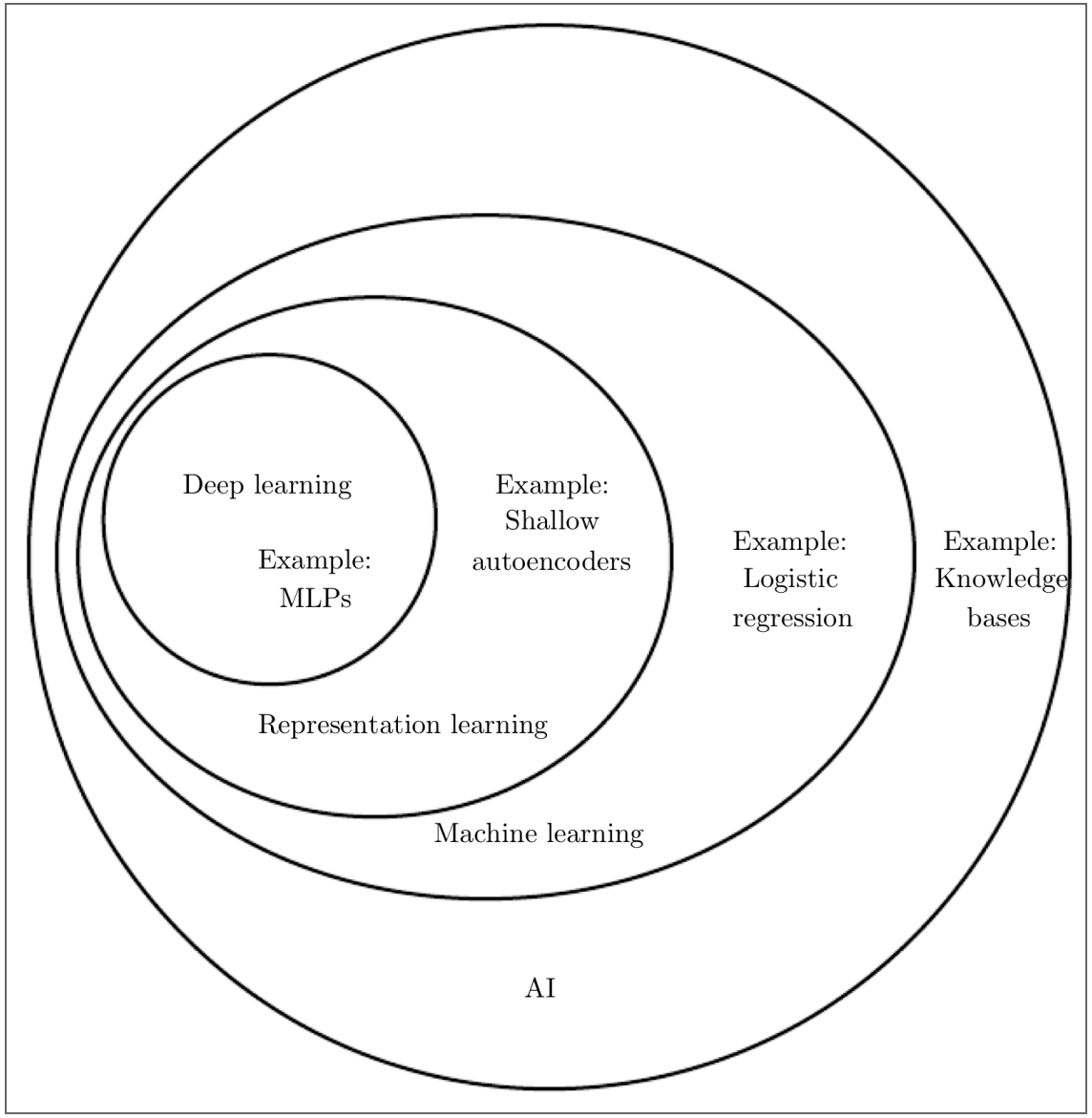


Reemergence of AI (2010 - ?)

- "AI" seems to be a buzzword again
- Google, Facebook, Microsoft, Amazon etc. all have large AI labs, named as such
- 2012 - AlexNet wins image classification contest
- 2013 - DeepMind shows computer learning to play Atari games
- 2015-2017 - superhuman speech recognition
- 2015-present - generating realistic fake images and video



WHERE DOES AI FIT?


Deep learning
Example: MLPs
Example: Shallow autoencoders
Representation learning
Example: Logistic regression
Machine learning
Example: Knowledge bases
AI

SUMMARY

Course Logistics

AI Overview

History of AI

To Do List:

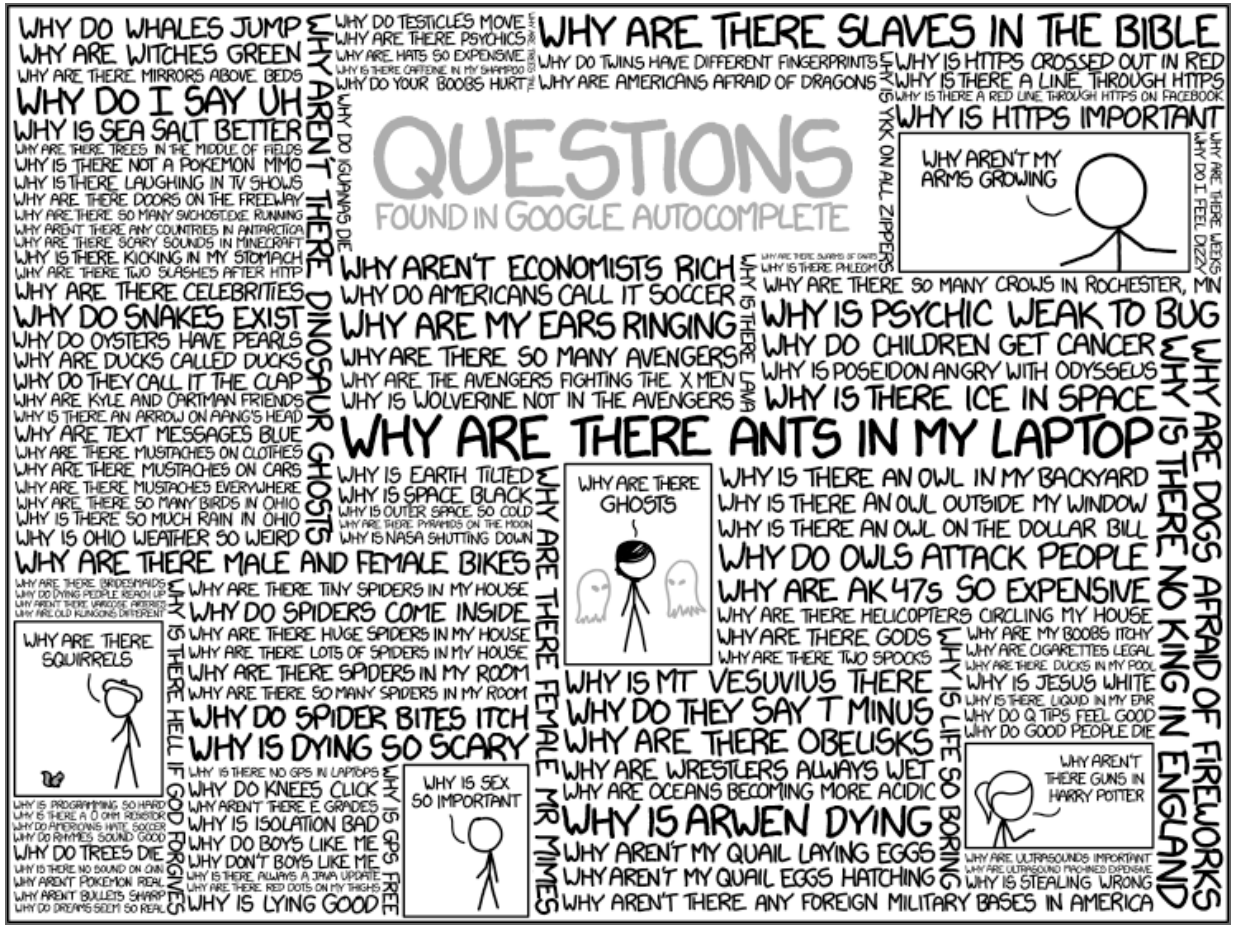
- Check Canvas course page and Piazza
- Reading for the lectures

READING

Today's Lecture: RN Chapter 1 and 2

Next Lecture: RN Chapter 3.1-3.4

Q & A


QUESTIONS
FOUND IN GOOGLE AUTOCOMPLETE
WHY DO WHALES JUMP
WHY ARE WITCHES GREEN
WHY ARE THERE MIRRORS ABOVE BEDS
WHY DO I SAY UH
WHY IS SEA SALT BETTER
WHY ARE THERE TREES IN THE MIDDLE OF FIELDS
WHY IS THERE NOT A POKEMON MMO
WHY IS THERE LAUGHING IN TV SHOWS
WHY ARE THERE DOORS ON THE FREEWAY
WHY ARE THERE SO MANY SVCHOST.EXE RUNNING
WHY AREN'T THERE ANY COUNTRIES IN ANTARCTICA
WHY ARE THERE SCARY SOUNDS IN MINECRAFT
WHY IS THERE KICKING IN MY STOMACH
WHY ARE THERE TWO SLASHES AFTER HTTP
WHY ARE THERE CELEBRITIES
WHY DO SNAKES EXIST
WHY DO OYSTERS HAVE PEARLS
WHY ARE DUCKS CALLED DUCKS
WHY DO THEY CALL IT THE CLAP
WHY ARE KYLE AND CARTMAN FRIENDS
WHY IS THERE AN ARROW ON AANG'S HEAD
WHY ARE TEXT MESSAGES BLUE
WHY ARE THERE MUSTACHES ON CLOTHES
WHY ARE THERE MUSTACHES ON CARS
WHY ARE THERE MUSTACHES EVERYWHERE
WHY ARE THERE SO MANY BIRDS IN OHIO
WHY IS THERE SO MUCH RAIN IN OHIO
WHY IS OHIO WEATHER SO WEIRD
WHY ARE THERE MALE AND FEMALE BIKES
WHY ARE THERE BRIDESMAIDS
WHY DO DYING PEOPLE REACH UP
WHY AREN'T THERE VARICOSE AFFERETS
WHY ARE OLD KUNGONS DIFFERENT
WHY ARE THERE SQUIRRELS
WHY IS PROGRAMMING SO HARD
WHY IS THERE A OHM RESISTOR
WHY DO APERONOMS HATE SOCCER
WHY DO RHYMES SOUND GOOD
WHY DO TREES DIE
WHY IS THERE NO BOUND ON OHM
WHY AREN'T POKEMON REAL
WHY AREN'T BULLETS SHARP
WHY DO DREAMS SEEM SO REAL
WHY AREN'T DINOSAUR GHOSTS
WHY IS THERE HELL IF GOD FORGIVES
WHY DO TESTICLES MOVE
WHY ARE THERE PSYCHICS
WHY ARE HATS SO EXPENSIVE
WHY IS THERE CAFFEINE IN MY SHAMPOO
WHY DO YOUR BOOBS HURT
WHY DO IGUANAS DIE
WHY ARE THERE SLAVES IN THE BIBLE
WHY DO TWINS HAVE DIFFERENT FINGERPRINTS
WHY ARE AMERICANS AFRAID OF DRAGONS
WHY AREN'T ECONOMISTS RICH
WHY DO AMERICANS CALL IT SOCCER
WHY ARE MY EARS RINGING
WHY ARE THERE SO MANY AVENGERS
WHY ARE THE AVENGERS FIGHTING THE X MEN
WHY IS WOLVERINE NOT IN THE AVENGERS
WHY ARE THERE ANTS IN MY LAPTOP
WHY IS EARTH TILTED
WHY IS SPACE BLACK
WHY IS OUTER SPACE SO COLD
WHY ARE THERE PYRAMIDS ON THE MOON
WHY IS NASA SHUTTING DOWN
WHY ARE THERE TINY SPIDERS IN MY HOUSE
WHY DO SPIDERS COME INSIDE
WHY ARE THERE HUGE SPIDERS IN MY HOUSE
WHY ARE THERE LOTS OF SPIDERS IN MY HOUSE
WHY ARE THERE SPIDERS IN MY ROOM
WHY ARE THERE SO MANY SPIDERS IN MY ROOM
WHY DO SPIDER BITES ITCH
WHY IS DYING SO SCARY
WHY IS THERE NO GPS IN LAPTOPS
WHY DO KNEES CLICK
WHY AREN'T THERE E GRADES
WHY IS ISOLATION BAD
WHY DO BOYS LIKE ME
WHY DON'T BOYS LIKE ME
WHY IS THERE ALWAYS A JAVA UPDATE
WHY ARE THERE RED DOTS ON MY THIGHS
WHY IS LYING GOOD
WHY IS SEX SO IMPORTANT
WHY IS GPS FREE
WHY ARE THERE FEMALE MR MINES
WHY IS THERE LAVA
WHY IS TKK ON ALL ZIPPERS
WHY IS HTTPS CROSSED OUT IN RED
WHY IS THERE A LINE THROUGH HTTPS
WHY IS THERE A RED LINE THROUGH HTTPS ON FACEBOOK
WHY IS HTTPS IMPORTANT
WHY AREN'T MY ARMS GROWING
WHY ARE THERE WEEKS
WHY DO I FEEL DIZZY
WHY ARE THERE SWARMS OF GNATS
WHY IS THERE PHLEGM
WHY ARE THERE SO MANY CROWS IN ROCHESTER, MN
WHY IS PSYCHIC WEAK TO BUG
WHY DO CHILDREN GET CANCER
WHY IS POSEIDON ANGRY WITH ODYSSEUS
WHY IS THERE ICE IN SPACE
WHY ARE DOGS AFRAID OF FIREWORKS
WHY IS THERE NO KING IN ENGLAND
WHY ARE THERE GHOSTS
WHY IS THERE AN OWL IN MY BACKYARD
WHY IS THERE AN OWL OUTSIDE MY WINDOW
WHY IS THERE AN OWL ON THE DOLLAR BILL
WHY DO OWLS ATTACK PEOPLE
WHY ARE AK 47s SO EXPENSIVE
WHY ARE THERE HELICOPTERS CIRCLING MY HOUSE
WHY ARE THERE GODS
WHY ARE THERE TWO SPOOKS
WHY IS MT VESUVIUS THERE
WHY DO THEY SAY T MINUS
WHY ARE THERE OBELISKS
WHY ARE WRESTLERS ALWAYS WET
WHY ARE OCEANS BECOMING MORE ACIDIC
WHY IS ARWEN DYING
WHY AREN'T MY QUAIL LAYING EGGS
WHY AREN'T MY QUAIL EGGS HATCHING
WHY AREN'T THERE ANY FOREIGN MILITARY BASES IN AMERICA
WHY IS LIFE SO BORING
WHY ARE MY BOOBS ITCHY
WHY ARE CIGARETTES LEGAL
WHY ARE THERE DUCKS IN MY POOL
WHY IS JESUS WHITE
WHY IS THERE LIQUID IN MY EAR
WHY DO Q TIPS FEEL GOOD
WHY DO GOOD PEOPLE DIE
WHY AREN'T THERE GUNS IN HARRY POTTER
WHY ARE ULTRASOUNDS IMPORTANT
WHY ARE ULTRASOUND IMAGINED EXPENSE
WHY IS STEALING WRONG

XKCD

Speaker notes