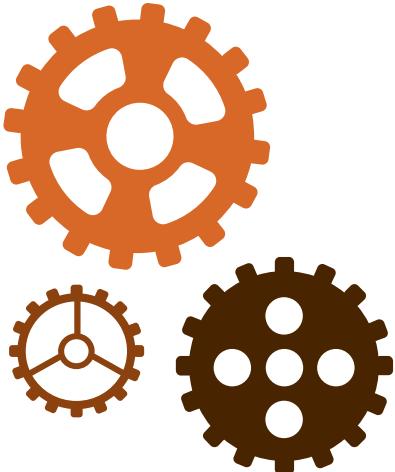


CS 482/628 AI: Intelligent Agents

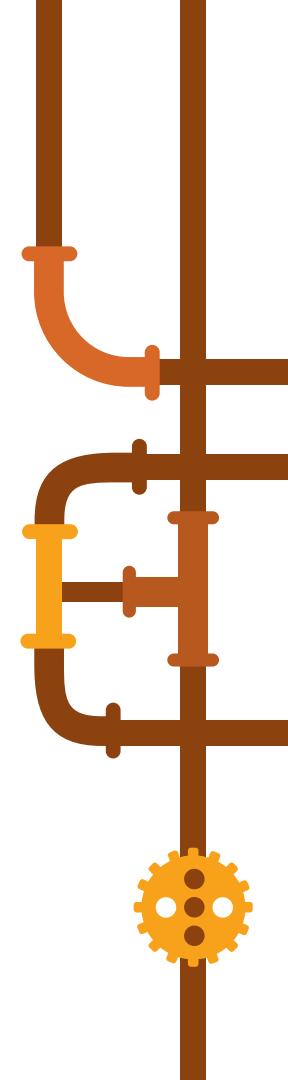
Fall 2021



What were the original promises of AI?

Have things lived up to those promises?

What is responsible for any differences?



Definitions of AI

Think like Humans <p>"The automation of activities that we associate with human thinking, activities such as decision-making, problem solving, learning..." – Bellman, 1978</p>	Think Rationally <p>"The study of mental faculties through the use of computational models" – Charniak and McDermott, 1985</p>
Act like Humans <p>"The art of creating machines that perform functions that require intelligence when performed by people." – Kurzweil, 1990</p>	Act Rationally <p>"A field of study that seeks to explain and emulate intelligent behavior in terms of computational processes." – Schalkoff, 1990</p>

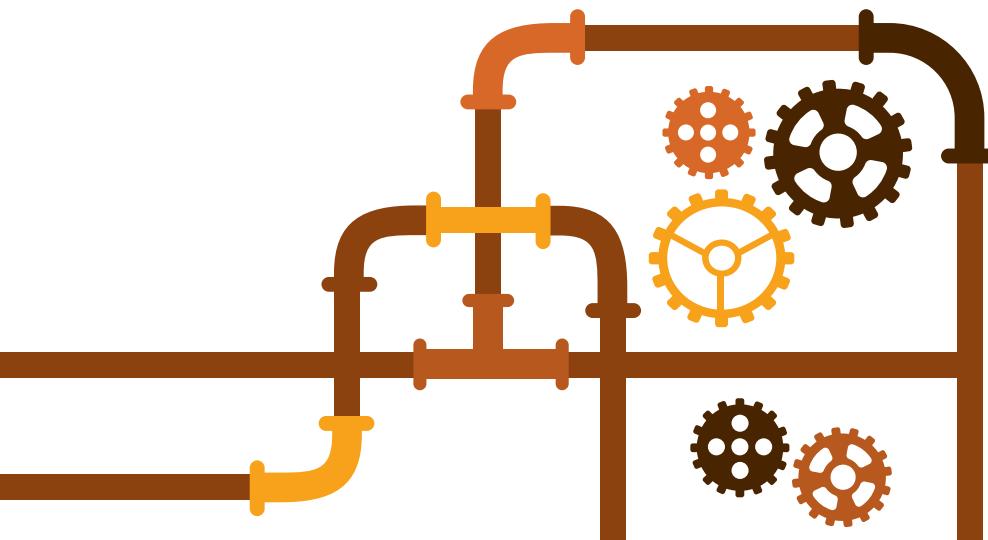
Defined in terms of Humans

Defined in terms of Logic

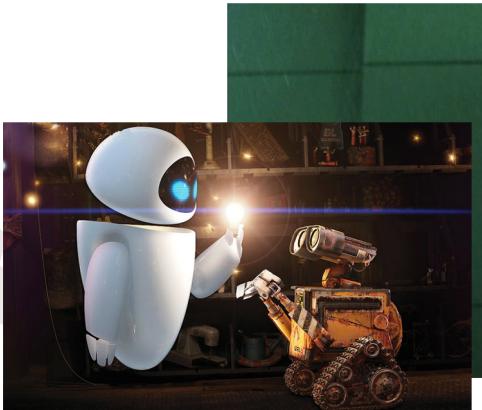
Thought

Action

AI and Expectations



What were we promised?



What did we get?



“ Who are you ”

I'm Siri. But I don't like talk about myself.

“ Who created you ”

I, Siri, was designed by An-

New – Play 'Today's Hits' station on Pandora

Add gelato to my shopping list

New – What's on my calendar today?

Then do the play next?

What's the weather in Los Angeles this weekend?

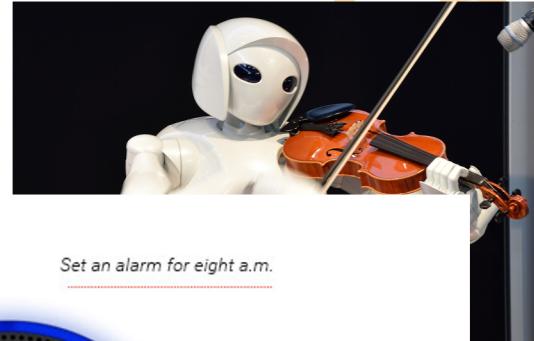
Set an alarm for eight a.m.

New – How is traffic?

Wikipedia: Abraham Lincoln

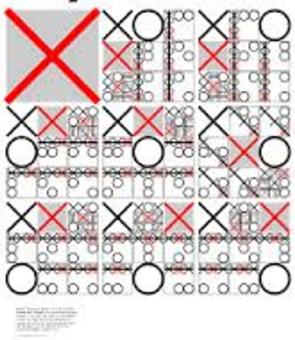
New – Read my book

New – Turn off the lights

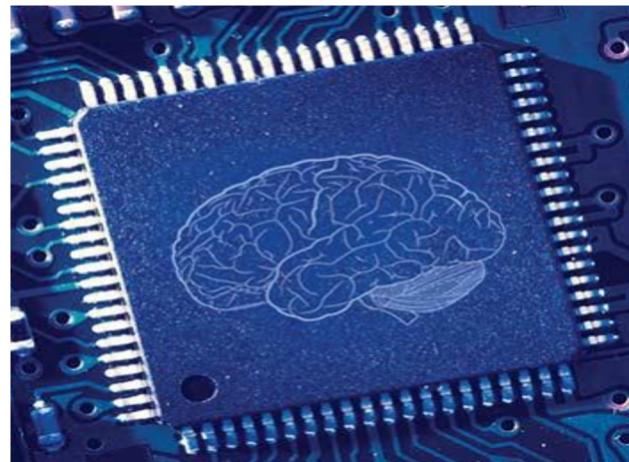


What do we need for intelligent machines?

Optimal
Strategy for
Player X.



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Let's explore some history...

Where did these promises come from?

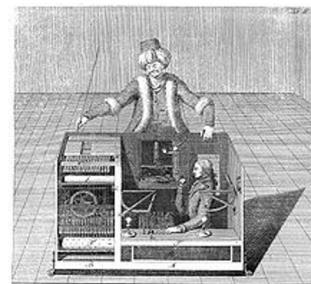
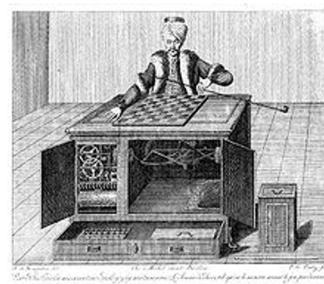
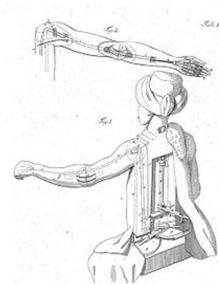


Talos (made by Hephaestos) in Greek myth

Golem myth (10th century)

Karel Čapek's Rossum's Universal Robots (Czech play, 1920)

Automata



The Turk, invented by Wolfgang von Kempelen (1770)

Wooden box, powered by clockwork, controlling a costumed mannequin,
which could play a game of chess

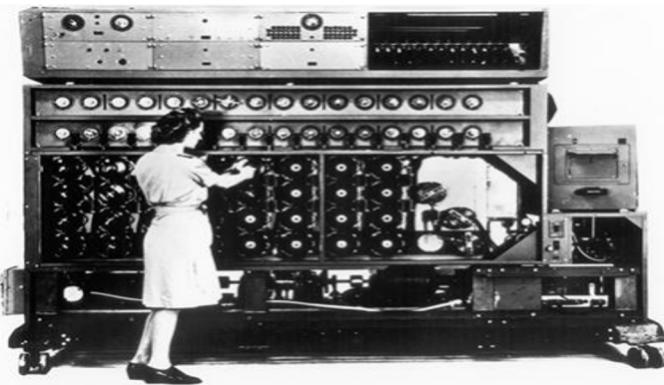
Built to impress the Empress of Austria, taken on European tour

Exposed as a fraud in 1834, destroyed in 1850

Beginning of AI

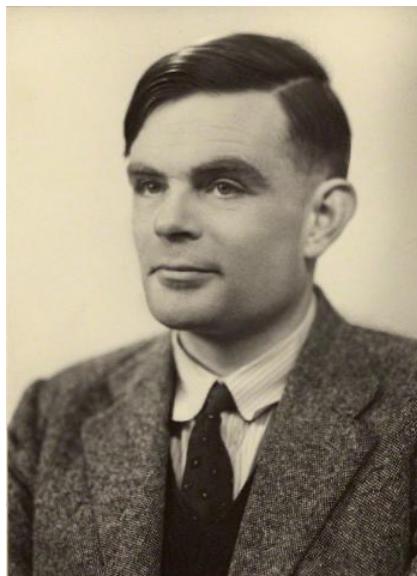
Computers can solve complex problems like breaking the Enigma Code, and computing missile trajectories...

Can computers think like a person?



Turing and AI

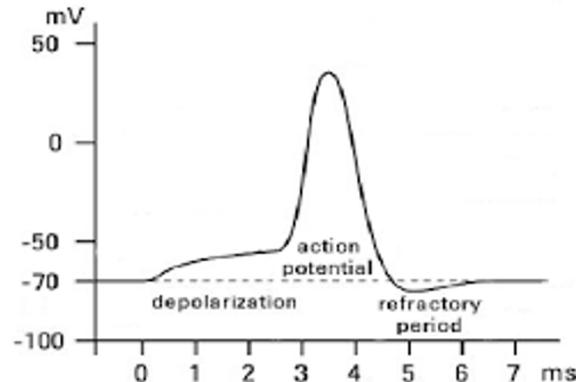
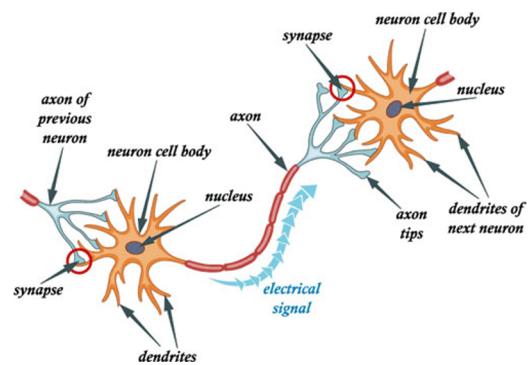
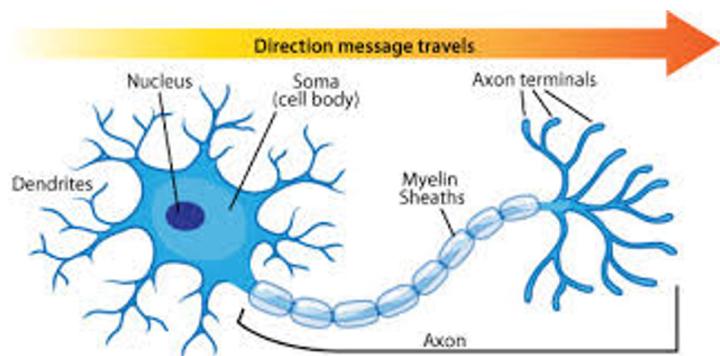
- The Enigma was a type of enciphering machine used by the German armed forces to send messages
- Germans increased its security at the outbreak of war by changing the cipher system daily
- Turing played a key role in this, inventing a machine known as the Bombe. This device helped to significantly reduce the work of the code-breakers
- With the help of captured Enigma material, and Turing's work in developing a technique he called 'Banburismus', the naval Enigma messages were able to be read from 1941.
- In 1936, Turing had invented a hypothetical computing device that came to be known as the 'universal Turing machine'



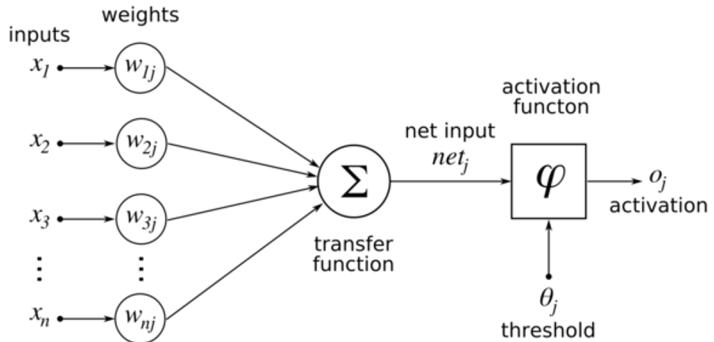
Chess and AI

- Turing experimented with two heuristics that later became common in AI: minimax and best-first
- In principle, a chess-playing computer could play by searching exhaustively through all the available moves, but in practice this is impossible, since it would involve examining an astronomically large number of moves
- The minimax heuristic (described by the mathematician John von Neumann in 1928) involves assuming that one's opponent will move in such a way as to maximise their gains; one then makes one's own move in such a way as to minimise the losses caused by the opponent's expected move
- The best-first heuristic involves ranking the moves available to one by means of a rule-of-thumb scoring system and examining the consequences of the highest-scoring move first

Biological basis for cognition: Neuron



Early years of AI (1943-1956)



Artificial Neuron: Turing-complete formal design for neuron-like computation (1943)

1956 Dartmouth conference (2 months, 10 people) organized by John McCarthy

Coined term "Artificial Intelligence"



"Within 20 years..." (1952-1969)

Newell and Simon's GPS (1959)

Samuel's Checkers program (1952)

Slagel's SAINT program (1963)

Evans's ANALOGY program (1968)

Predictions of Success

"It is not my aim to surprise or shock you ... But the simplest way I can summarize is to say that there are now in the world machines that think, that learn and that create. Moreover, their ability to do these things is going to increase rapidly until -- in a visible future -- the range of problems they can handle will be coextensive with the range to which the human mind has been applied" -- Simon and Newell (1958)

"Machines will be capable, within twenty years, of doing any work that a man can do." -- Herbert Simon (1965)

"...within a generation the problem of creating 'artificial intelligence' will be substantially solved." -- Marvin Minsky (1967)

A Veneer of Intelligence

ELIZA: A Rogerian therapist created by Joseph Weizenbaum in 1966

The illusion of intelligence works best, however, if you limit your conversation to talking about yourself and your life.

Observations from people using ELIZA:

- Emotional attachment occurred
- Believed to be real
- Worried practicing psychotherapists
- A serious solution to producing natural language?

Me: Men are all alike.

Eliza: *In what way*

Me: They're always bugging us about something or other.

Eliza: *Can you think of a specific example*

Me: Well, my boyfriend made me come here.

Eliza: *Your boyfriend made you come here*

Me: He says I'm depressed much of the time.

Eliza: *I am sorry to hear you are depressed*

Me: It's true. I am unhappy.

Eliza: *Do you think coming here will help you not to be unhappy*

Me: I need some help, that much seems certain.

Eliza: *What would it mean to you if you got some help*

Me: Perhaps I could get along with my mother.

Eliza: *Tell me more about your family*

Me: My mother takes care of me.

Eliza: *Who else in your family takes care of you*

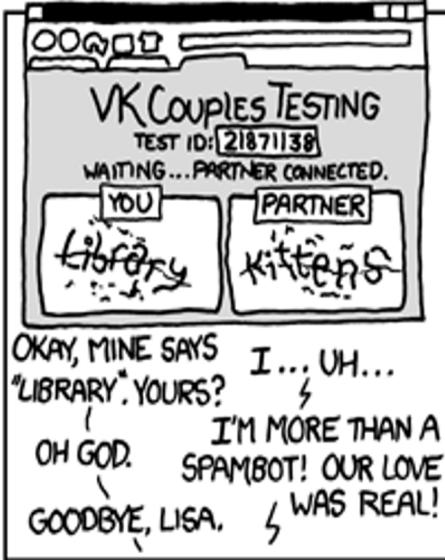
Me: My father.

Eliza: *Your father*

Me: You are like my father in some ways

Eliza: *What resemblance do you see?*

...



- VK = Voight-Kampff empathy tests from the novel *Do Androids Dream of Electric Sheep* and film *Blade Runner*
- The name "Lisa" may be an allusion to ELIZA, one of the first chatbots, written in 1966. According to its(her?) creator, people became "quickly and deeply emotionally involved with the computer program" during the chat.

A Dose of Reality (1966-1969)

AI failed to live up to expectations

Intelligence was symbolic, logical computations without any context

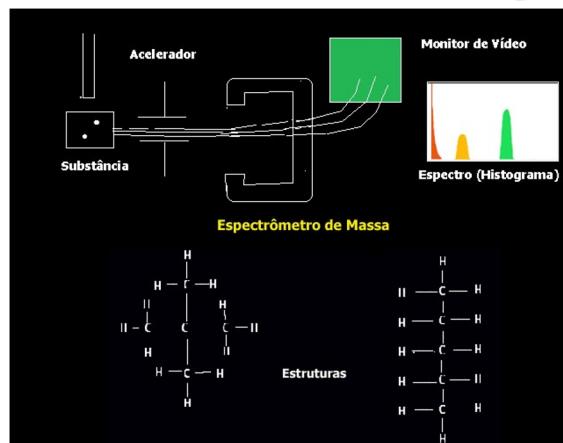
- Chess Playing
- Solving Logic Problems
- Solving Calculus Problems

Input/Output tasks are seen as secondary

Knowledge-Based Systems as the road to intelligence? (1969-1979)

Stand-alone, single-purpose systems with specific knowledge of a domain (Expert Systems)

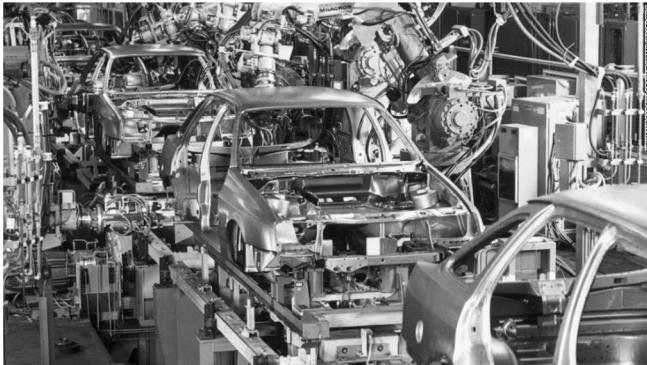
- DENDRAL: infer molecular structure based on mass spectrometer readings
- Edward Feigenbaum (AI), Joshua Lederberg (genetics), Carl Djerassi (chemistry)



AI goes Industrial (1980-1988)

Expert systems save money!

- R1 at DEC (John McDermott, 1982)
 - Helped configure orders for new computer systems
 - Saved \$25-40 million per year
- Real-world practical tasks
 - Machine vision systems for parts inspection
 - Assembly-line robots

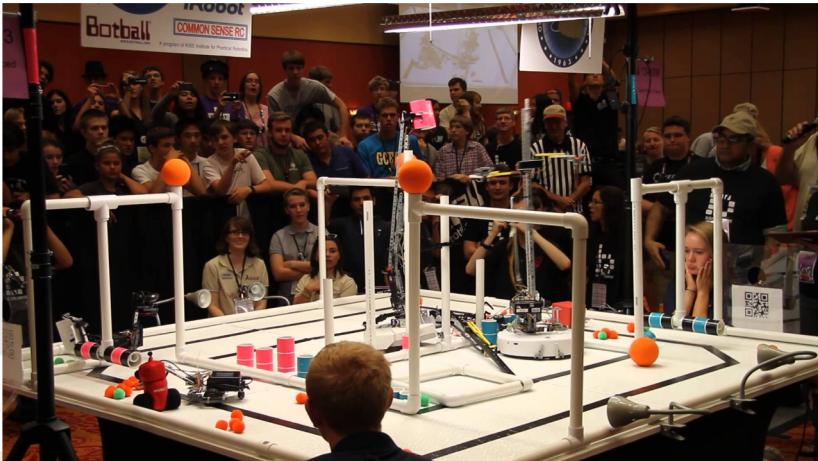


Fad Computing (1986-present)

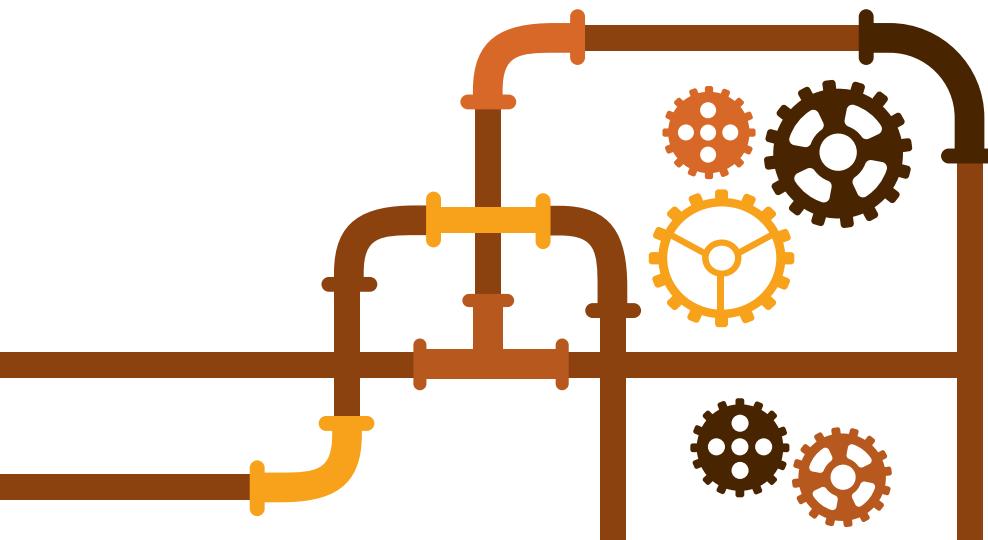
- FAD = Functioning As Designed
- Belief Nets
- The return of neural nets
 - and then their demise again
 - and then their rise again
- PDP: parallel distributed processing
- Hidden Markov Models(HMMs)
- POMDPs: partially observable Markov decision process
- Deep Learning...
- Crowdsourcing...
- Cloud Computing...

Agents, Big Data, and AI for the Masses (2001-present)

- Retool to think about complete package
- Integration becomes an issue
- Many put their hope in reliance on amassing huge data sets
- AI projects become mainstream



AI Doesn't Solve the Problem, AI IS the Problem (2014-present)



THIS IS YOUR MACHINE LEARNING SYSTEM?

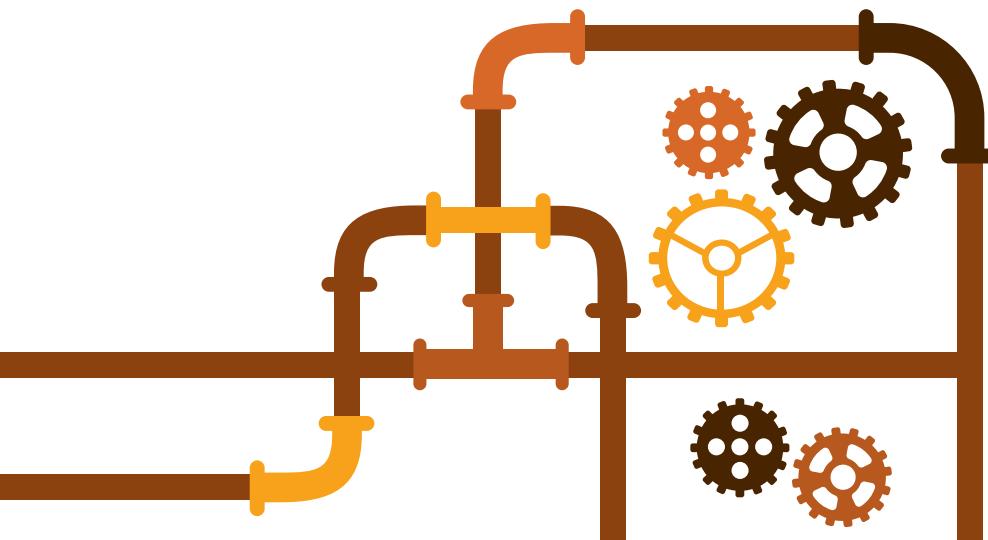
YUP! YOU POUR THE DATA INTO THIS BIG
PILE OF LINEAR ALGEBRA, THEN COLLECT
THE ANSWERS ON THE OTHER SIDE.

WHAT IF THE ANSWERS ARE WRONG?

JUST STIR THE PILE UNTIL
THEY START LOOKING RIGHT.



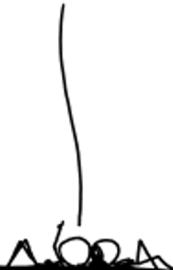
State-of-the-art



Siri



WHAT DO YOU THINK
THAT CLOUD LOOKS LIKE?



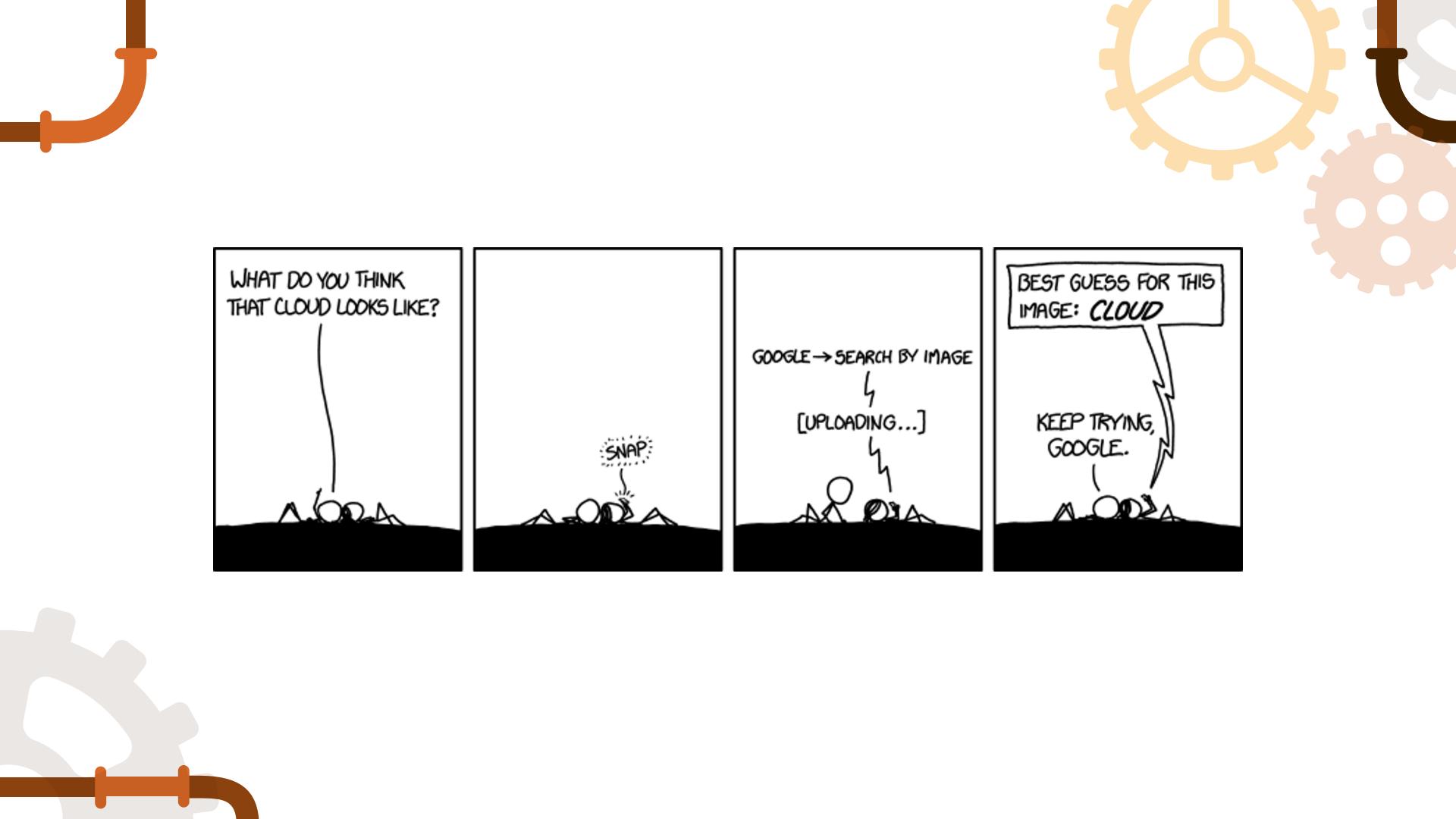
SNAP

GOOGLE → SEARCH BY IMAGE

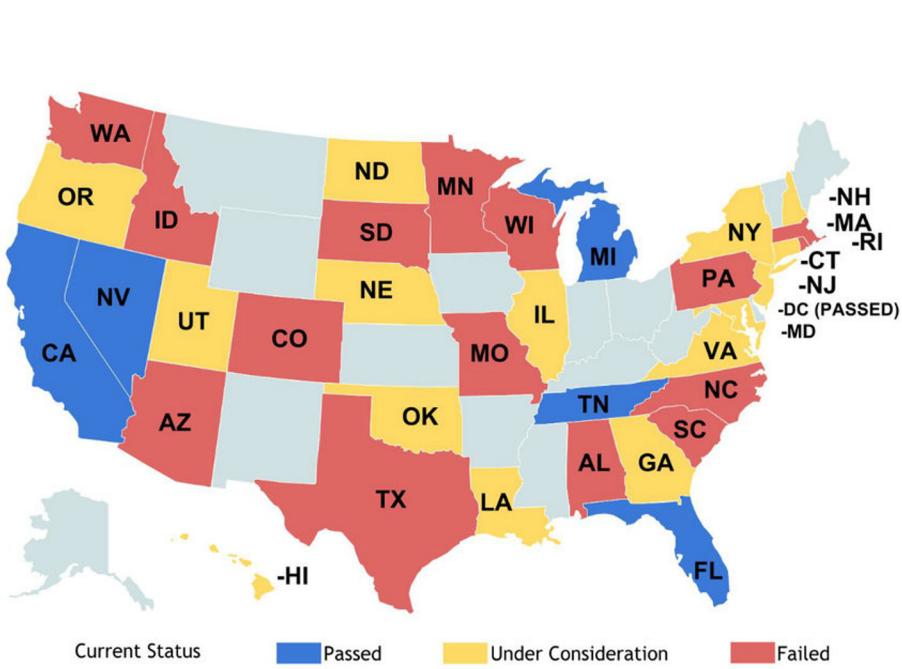
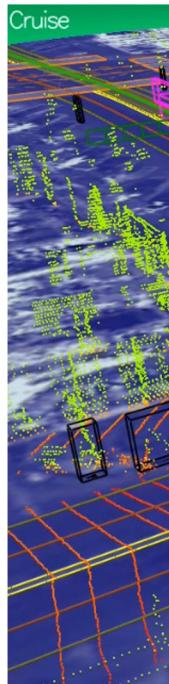
[UPLOADING...]

BEST GUESS FOR THIS
IMAGE: CLOUD

KEEP TRYING,
GOOGLE.

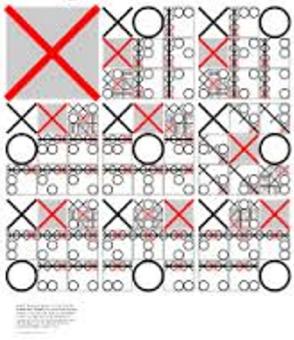


Autonomous Cars

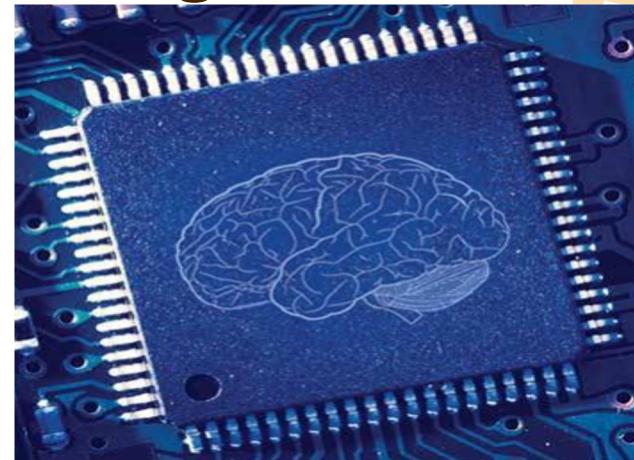


What do we need for intelligent machines?

Optimal
Strategy for
Player X.



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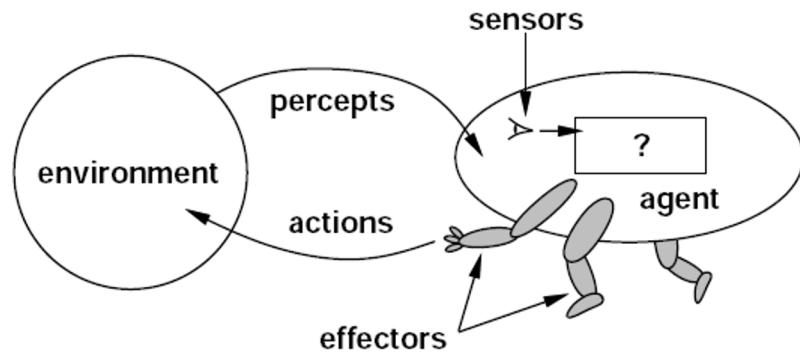
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Formalisms...

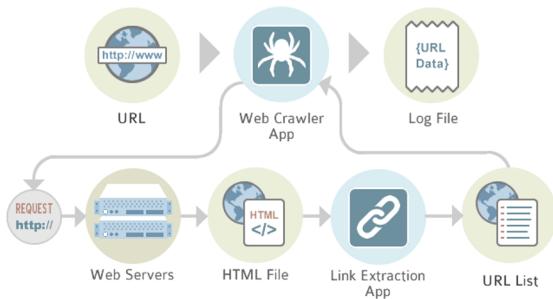
The Intelligent Agent

Rational Agent
Performance Measure



Agent Examples

Web Crawler



ALIVE (Maes, 1994)



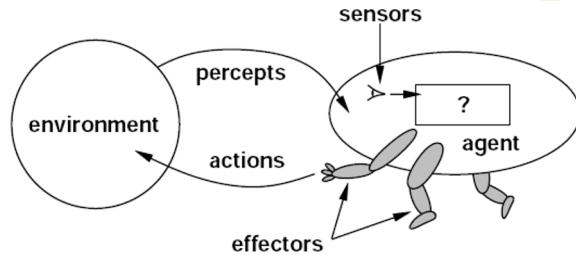
Simulated Soccer



Search and Rescue



Agent Examples



Agent Type	Performance	Environment	Actuators	Sensors
Web crawler	# of archived pages, minimal bandwidth	Hyperlinks, HTML and PDF docs	Web navigation, text processing	Network traffic
Simulated Soccer	Scoring, compute cycles	Simulated (standardized) soccer arena	Interface to physical simulator	Interface to simulated visual sensors
ALIVE: Silas	User satisfaction	Fixed room, contents of that room	Display screen, speaker system	Cameras in room, microphones
Search and Rescue Robot	Survey location, find survivors	Collapsed building	Travel, signal base, emit sounds	Camera images, temperature, touch sensors, etc.

Characterizing Environments

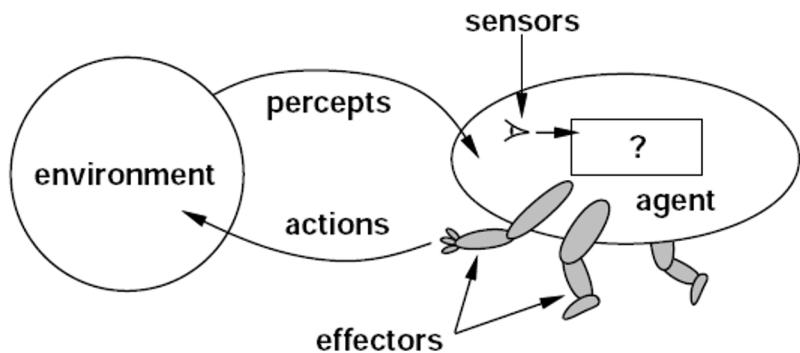
- Fully Observable vs Partially Observable
 - Do sensors give complete world state?
- Deterministic vs Stochastic
 - Can next state be derived from current state and action?
- Episodic vs Sequential
 - Does quality of an action depend only upon the current sensory state?
 - (are sensing/action pairings atomic?)
- Static vs Dynamic
 - Does the environment stay the same while the agent decides to act?
- Discrete vs Continuous
 - Are there a limited number of distinct percepts and actions?

Characterizing Sample Environments

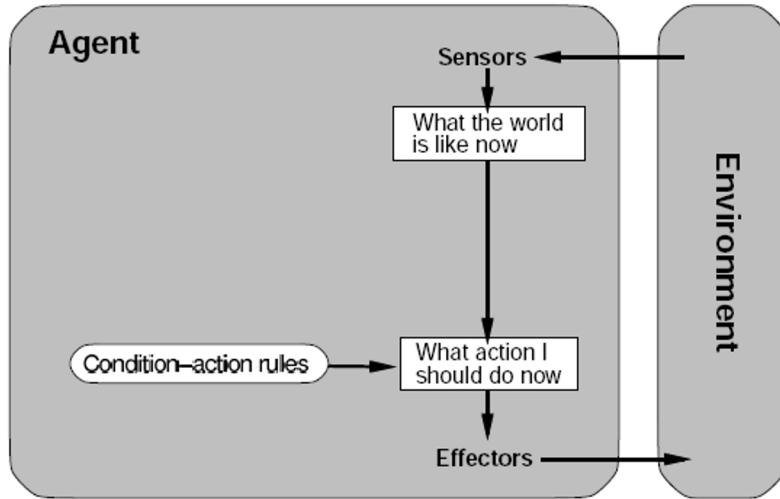
Environment	Observable	Deterministic	Episodic	Static	Discrete
	Do sensors give complete world state?	Can next state be determined by current state and action?	Does quality of an action depend only on current state?	Does the env. stay the same while the agent thinks?	Are the number of percepts and actions limited?
Chess (no clock)	Fully	Yes	No	Yes	Yes
Poker	Partially	No	No	Yes	Yes
Taxi Driving	Partially	No	No	No	No
Image analysis	Fully	Yes	Yes	Semi	No
Part-picking robot	Partially	No	Yes	No	No

Characterizing Agents

We can characterize the environment
Are there differences among agents themselves?



Reflexive Agent

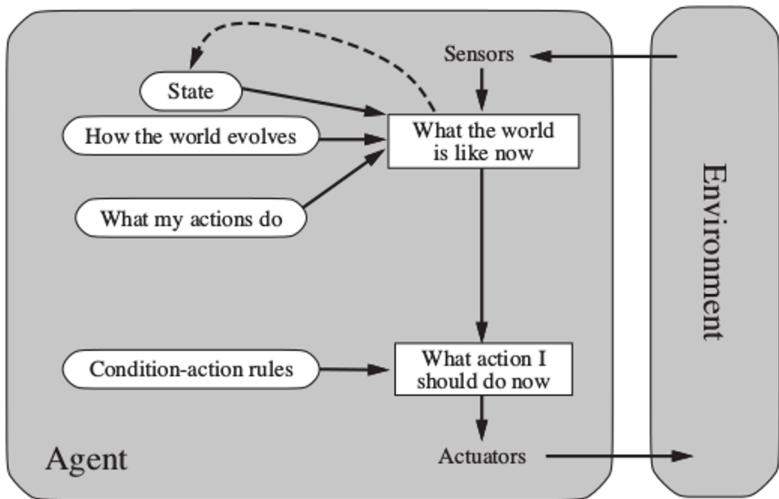


Fixed set of condition-action rules:

if car-in-front-is-braking **then** apply-brakes

Efficient implementations, limited applications

Reflex Agent with Internal State

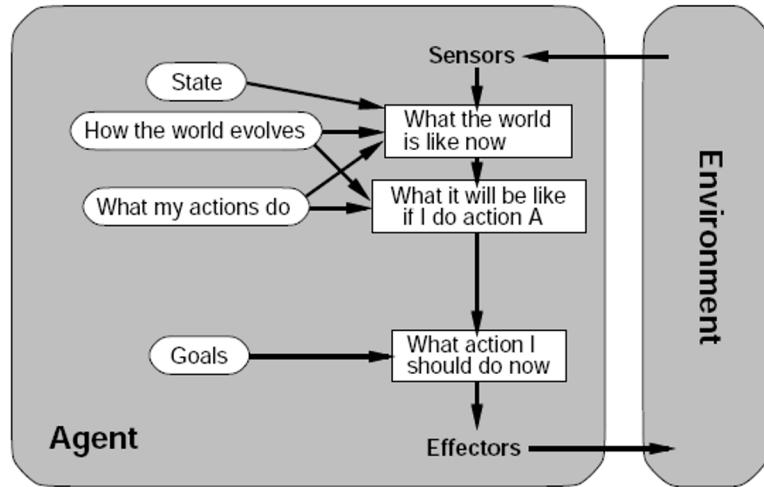


Keeps track of the world or its own actions

Allows for variation in behavior

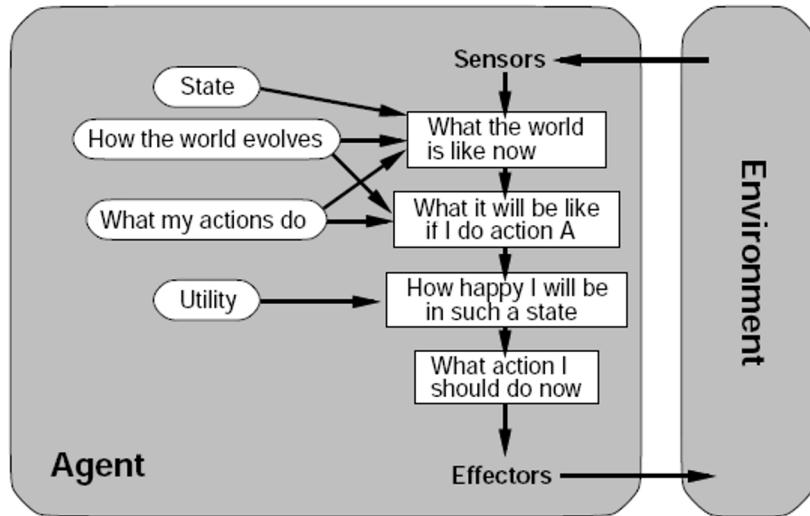
Must have a model of how this internal state evolves

Goal-Based Agent



Consideration of future actions
Allows for actions to be directed
Varied implementations, varied usefulness

Utility-Based Agent



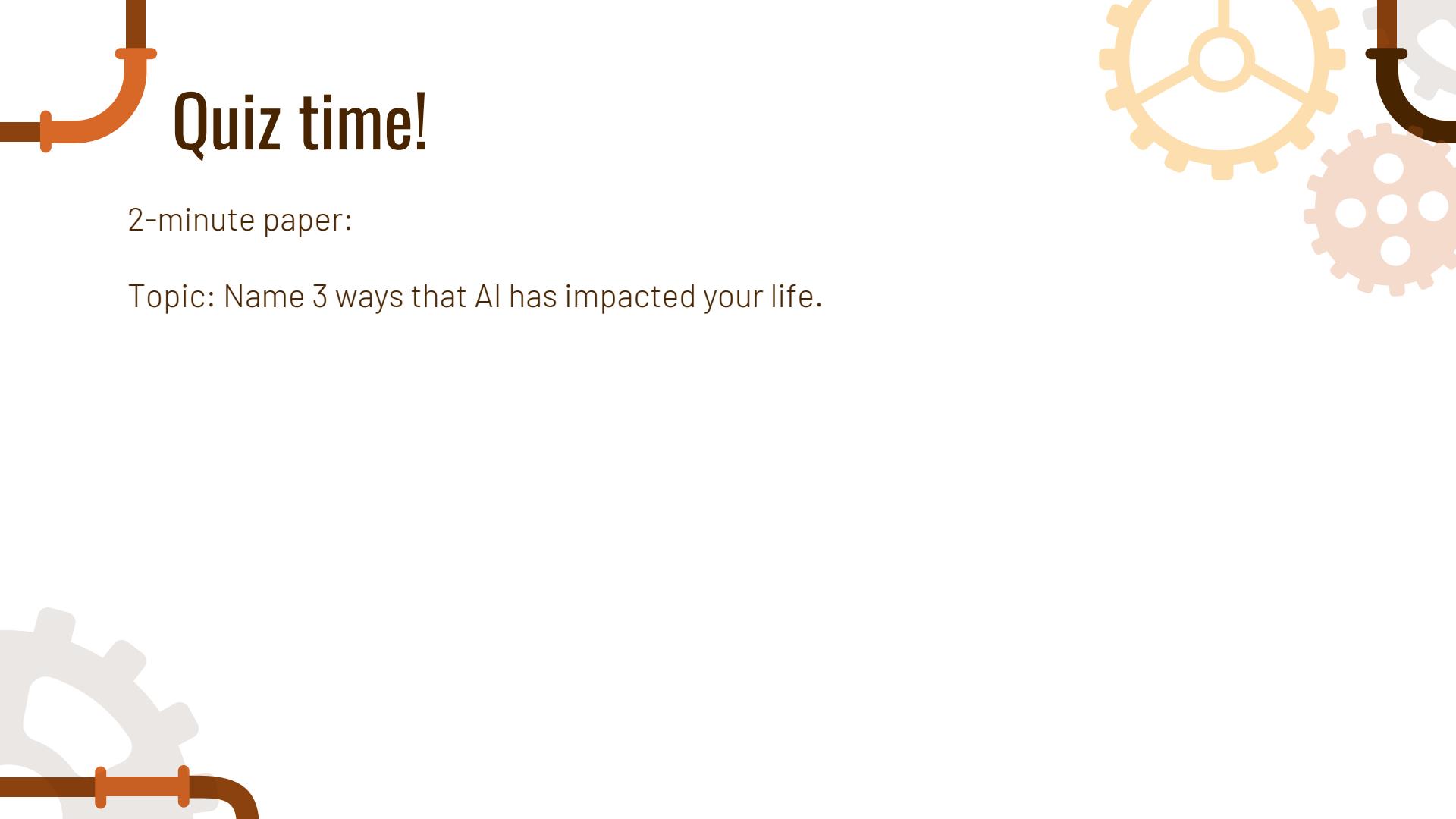
Utility function maps all states onto reals
Act to maximize utility
Varied implementations, varied usefulness

What does this formalism get us?

Describe variations among:

- Goals, percepts, actions
- Environments
- Agent architectures

How easy is it to cross these boundaries?



Quiz time!

2-minute paper:

Topic: Name 3 ways that AI has impacted your life.

OK, so why don't we have intelligent machines?

Lessons from history:

- We are not really good judges of intelligence
- We want to believe the hype
- Easy to make big predictions

Why is it so hard?

- Range of environments and goals makes it difficult to leverage other work
- Our understandings and expectations are changing

Next Week

Early AI mechanisms for problem-solving:

- Brute-force search
- Smarter search
- Applications of search

Read R & N: Chapters 3 and 4

Brush up on C++ and standard template library (STL)