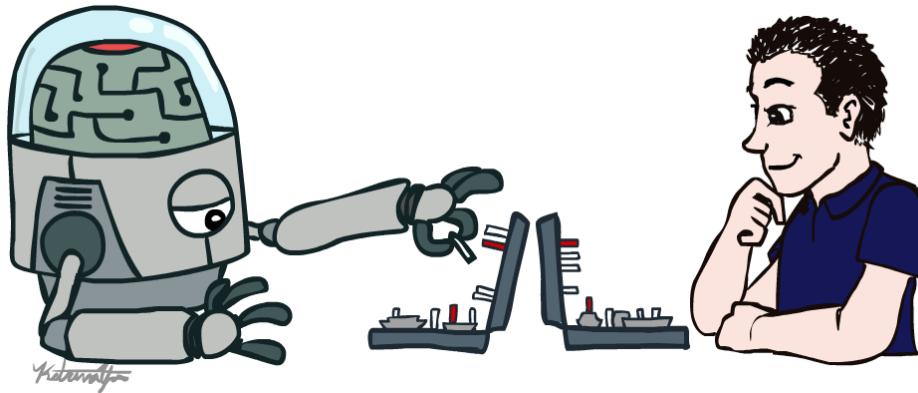


Artificial Intelligence

Introduction



Instructor



Anish Raj

 anishraj.comp@coep.ac.in

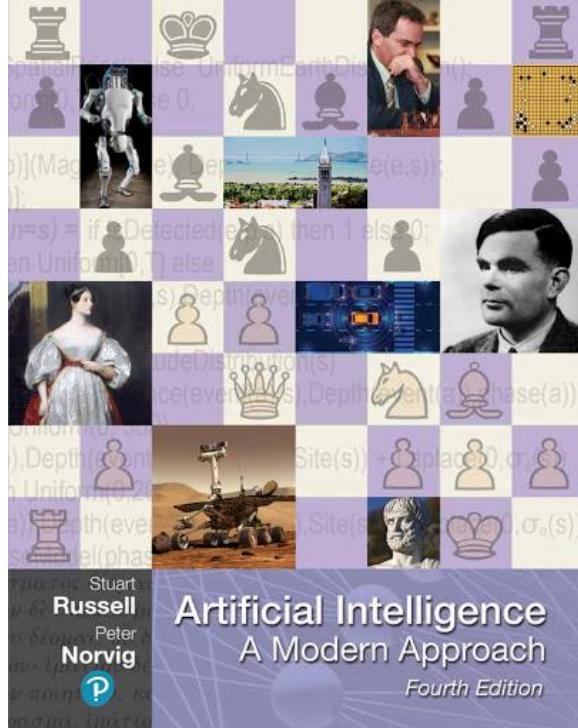
Assistant Professor

 7276626277

Computer Engineering and I.T.

Course Information

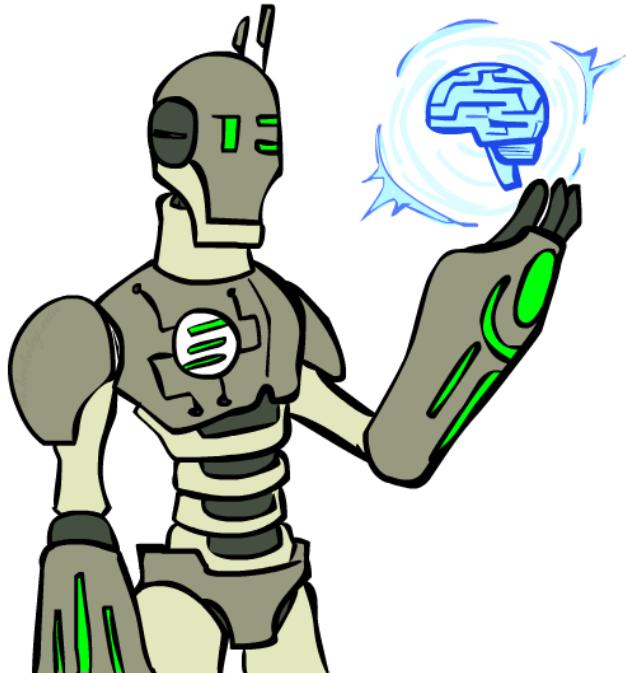
<http://aima.cs.berkeley.edu/>



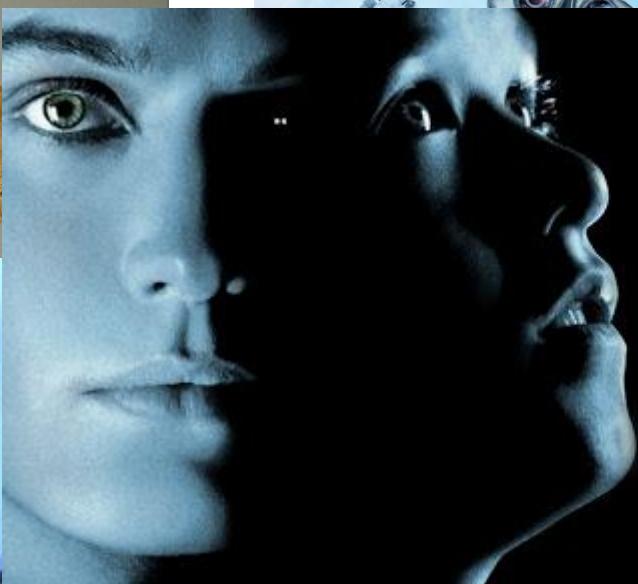
- Sessions:
- Work:
 - Homework
 - $20+20+60 = 100$ marks
 - Relative grading scale
- Prerequisites:
 - Computer Basics:
 - Data Structure
 - Algorithm
- There will be some
 - math
 - logic
 - Programming (python/java/C++)

Today

- Artificial intelligence in Movies, News?
- 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



A.I.



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

Computers should be trained to serve humans to reduce their risk of becoming 'sociopathic', says a leading expert on artificial intelligence.

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WHO issues first global report on Artificial Intelligence (AI) in health and six guiding principles for its design and use

Sophia' Robot Granted to Saudi Arabia

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

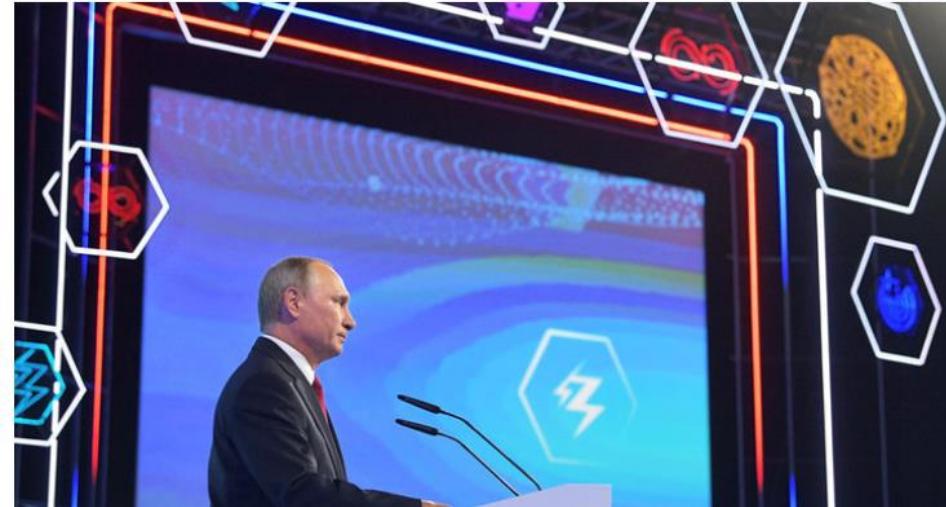
EU wants to invest £18b development

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

Who is Stoker?
(FOR ONE WELCOME OUR
NEW COMPUTER OVERLORDS)

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

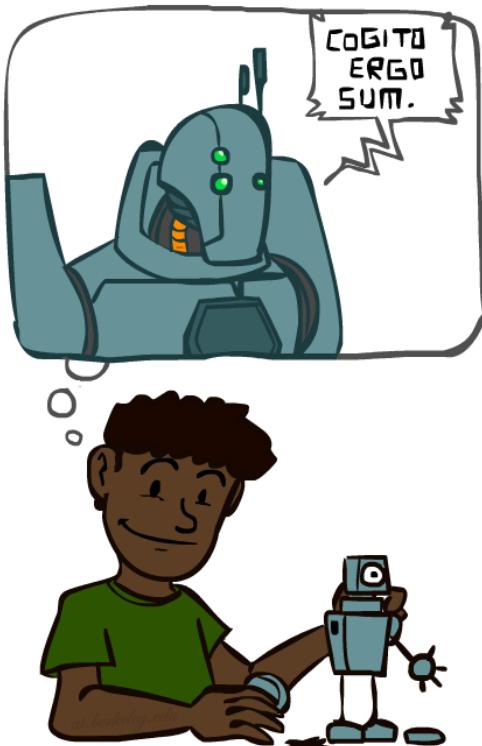
By Andy Chalk 4 hours ago

Google and Blizzard launched the artificial intelligence project in 2016.

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



A (Short) History of AI



Alan Mathison Turing

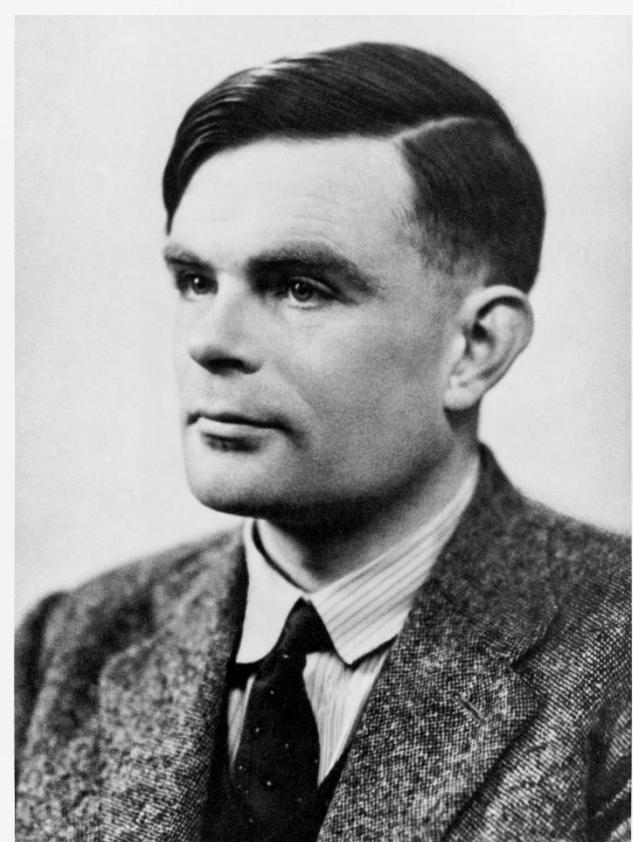
I.—COMPUTING MACHINERY AND INTELLIGENCE

BY A. M. TURING

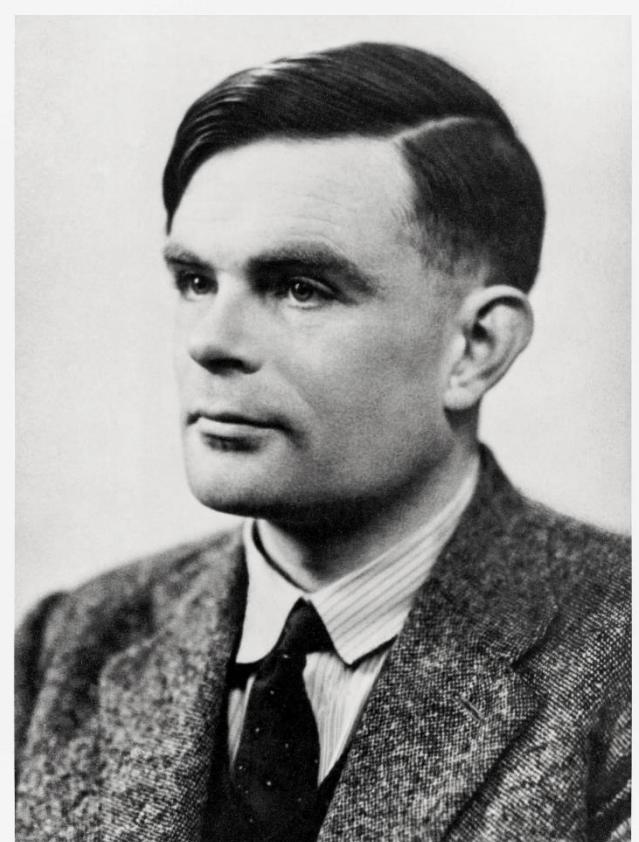
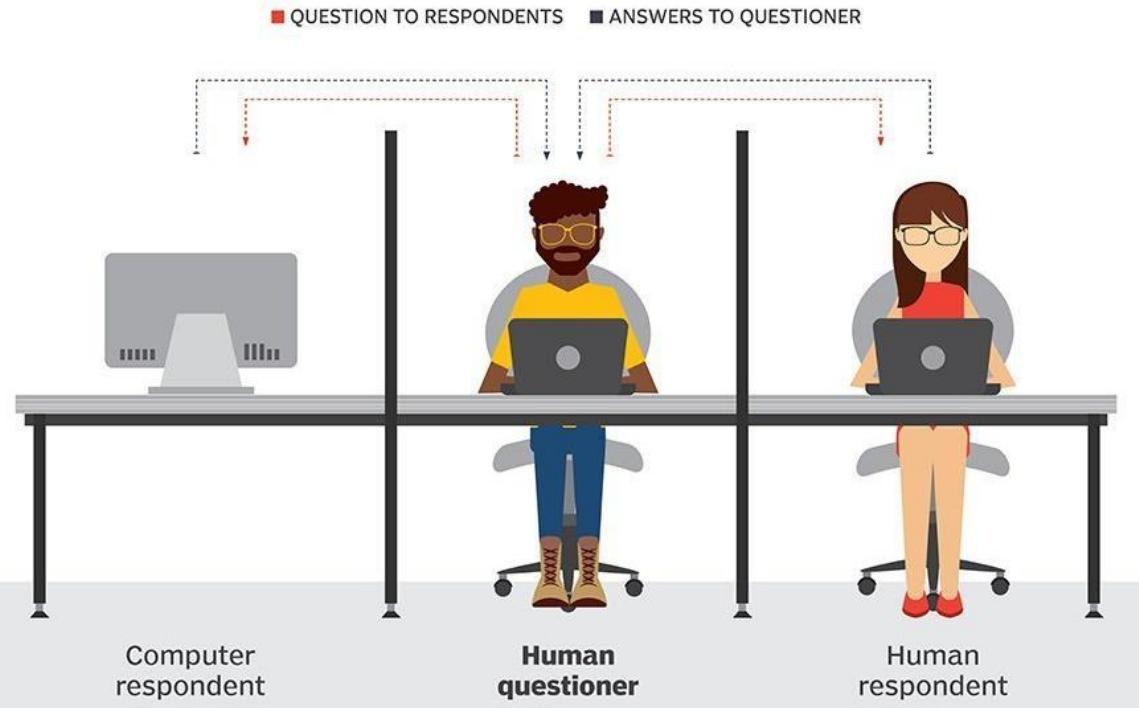
1. *The Imitation Game.*

I PROPOSE to consider the question, 'Can machines think ?' This should begin with definitions of the meaning of the terms 'machine' and 'think'. The definitions might be framed so as to reflect so far as possible the normal use of the words, but this attitude is dangerous. If the meaning of the words 'machine' and 'think' are to be found by examining how they are commonly used it is difficult to escape the conclusion that the meaning and the answer to the question, 'Can machines think ?' is to be sought in a statistical survey such as a Gallup poll. But this is absurd. Instead of attempting such a definition I shall replace the question by another, which is closely related to it and is expressed in relatively unambiguous words.

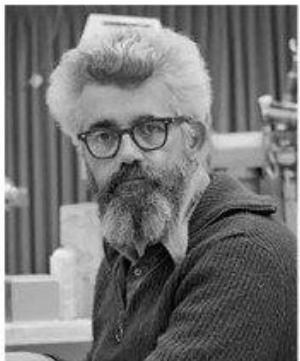
The new form of the problem can be described in terms of



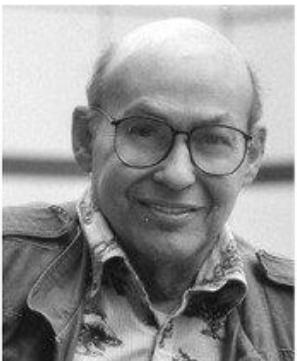
Turing Test



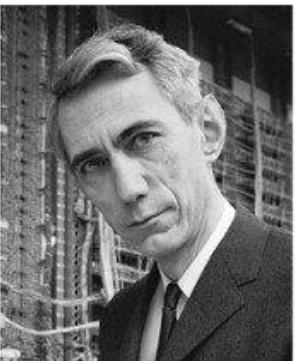
1956 Dartmouth Conference: The Founding Fathers of AI



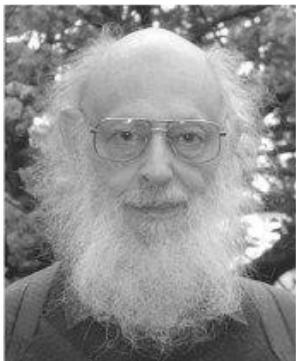
John MacCarthy



Marvin Minsky



Claude Shannon



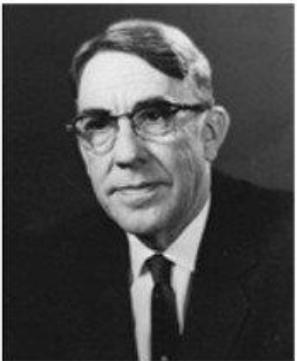
Ray Solomonoff



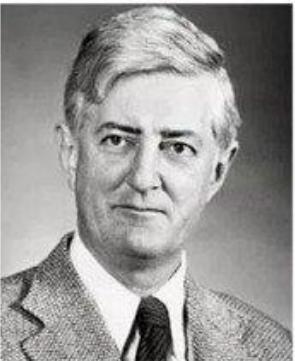
Alan Newell



Herbert Simon



Arthur Samuel



Oliver Selfridge



Nathaniel Rochester



Trenchard More

AI's official birth: Dartmouth, 1956

IN THIS BUILDING DURING THE SUMMER OF 1956

JOHN McCARTHY (DARTMOUTH COLLEGE), MARVIN L. MINSKY (MIT)
NATHANIEL ROCHESTER (IBM), AND CLAUDE SHANNON (BELL LABORATORIES)
CONDUCTED

THE DARTMOUTH SUMMER RESEARCH PROJECT ON ARTIFICIAL INTELLIGENCE

FIRST USE OF THE TERM "ARTIFICIAL INTELLIGENCE"

FOUNDING OF ARTIFICIAL INTELLIGENCE AS A RESEARCH DISCIPLINE

"To proceed on the basis of the conjecture
that every aspect of learning or any other feature of intelligence
can in principle be so precisely described that a machine can be made to simulate it."

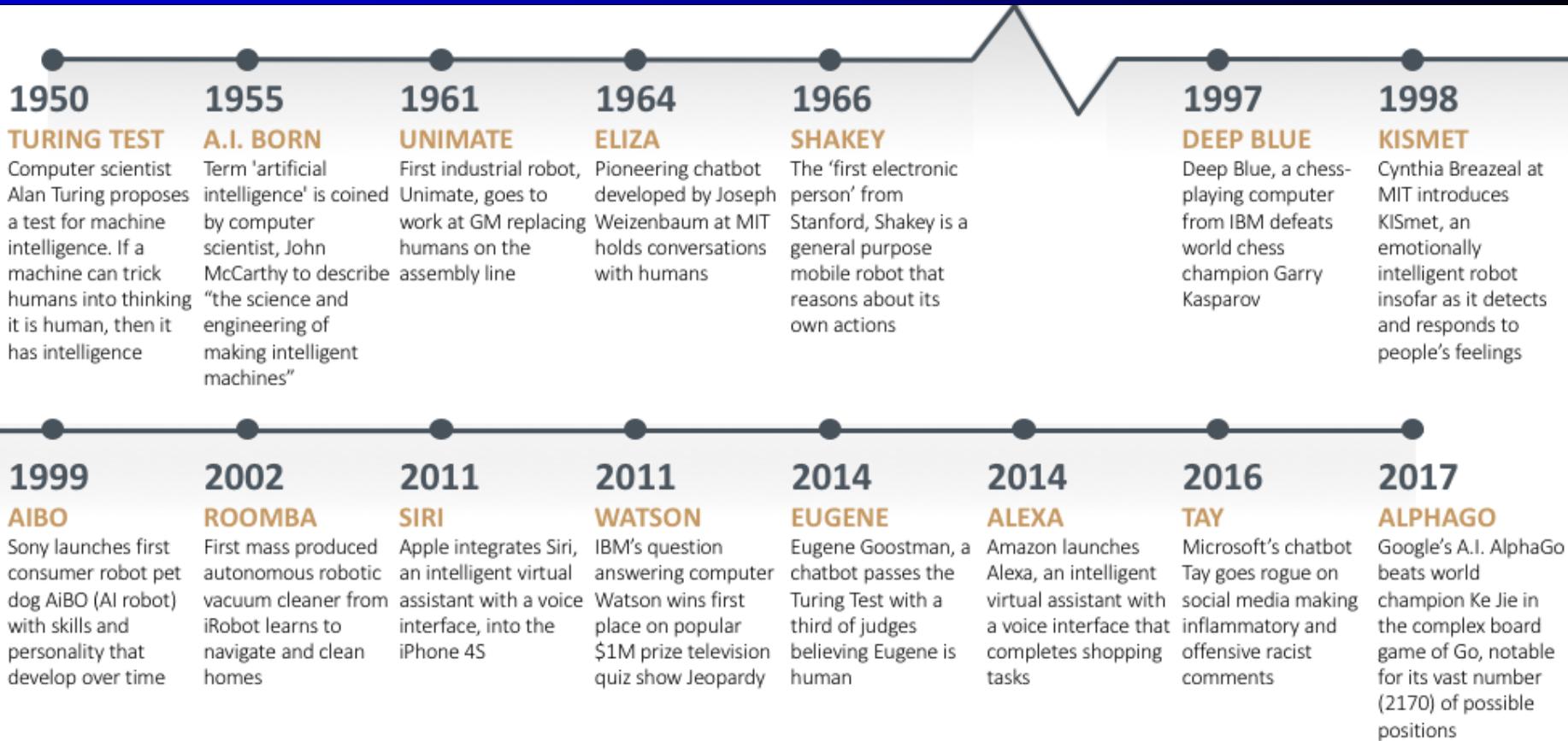
IN COMMEMORATION OF THE PROJECT'S 50th ANNIVERSARY
JULY 13, 2006



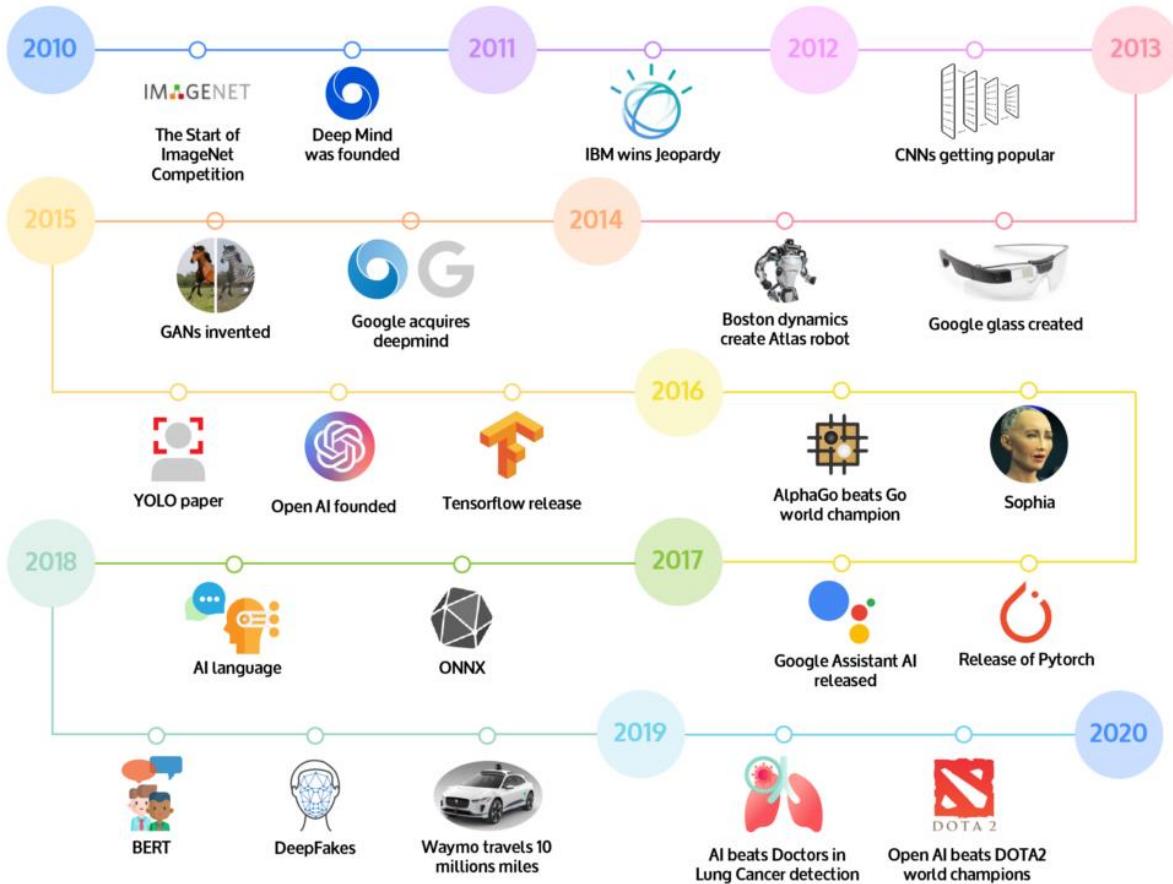
AI's official birth: Dartmouth, 1956

“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.***”

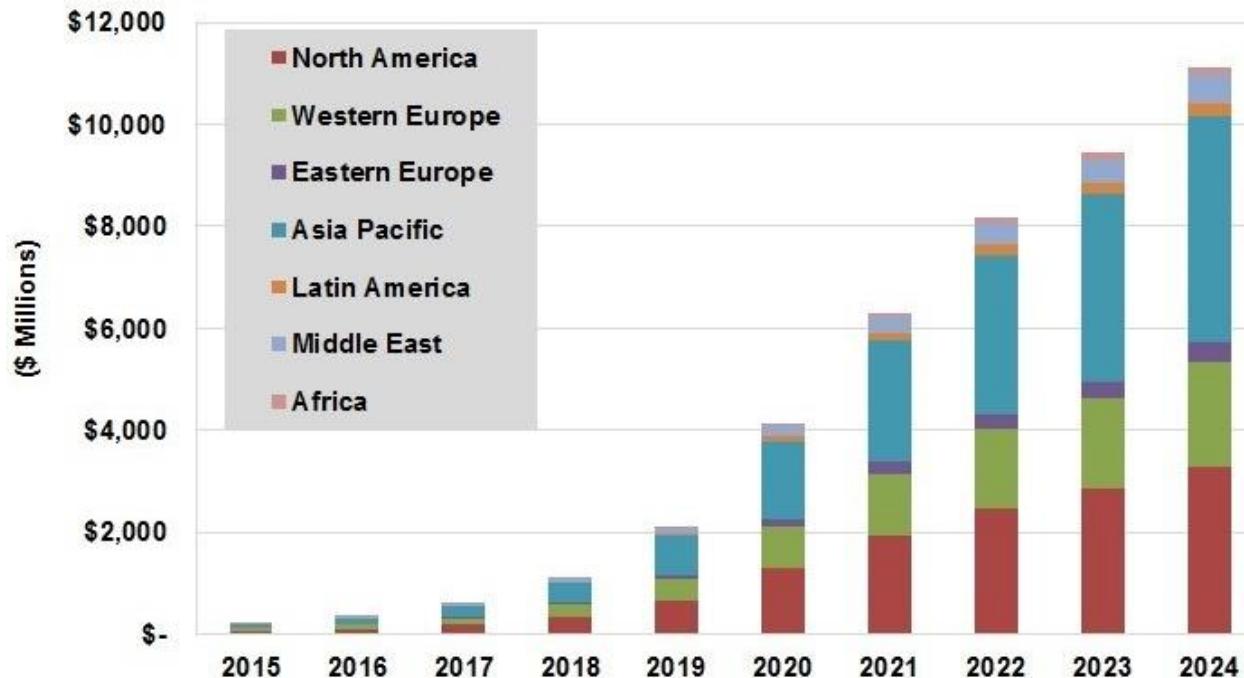
AI is not NEW



In last Decade



AI Revenue by Region, World Bank Report 2017



Artificial Intelligence System

Functions

Understands language and its nuances



Learns from experience



Uses the learning to reason



Creates perspectives



Solves complex problems

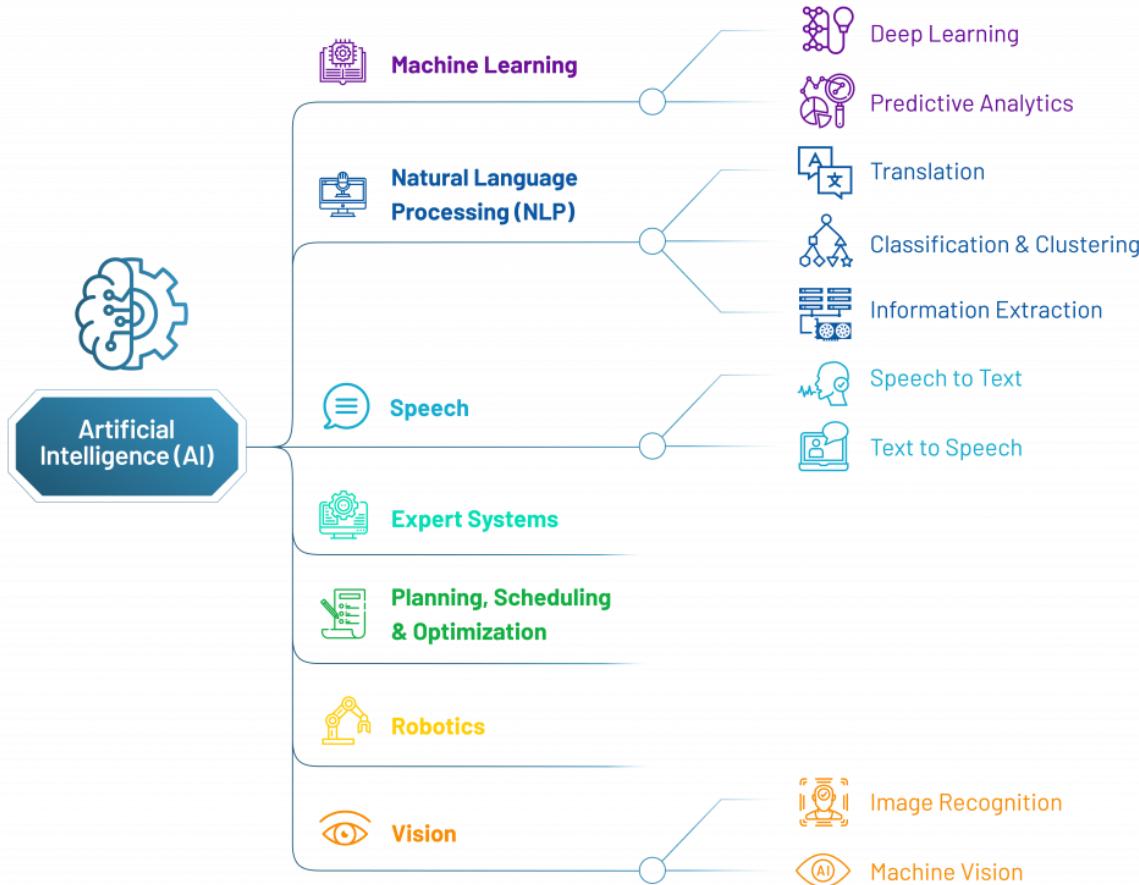


Artificial intelligence system



Recognizes images

Artificial Intelligence System Task



Artificial Intelligence System Types

- Artificial Narrow Intelligence (ANI):

- Machine intelligence that equals or exceeds human intelligence or efficiency at a specific task
- Siri, Alexa.

→ One specific task

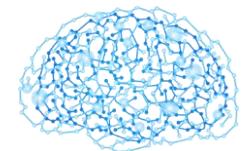


AN I: Chess Program

- Artificial General Intelligence (AGI):

- A machine with the ability to apply intelligence to any problem, rather than just one specific problem (human-level intelligence)
- Advanced Robotics

→ Many things like a human



AGI: Human Level

- Artificial Super Intelligence (ASI):

- An intellect that is much smarter than the best human brains in practically every field, including scientific creativity, general wisdom and social skills

→ More than what a human can

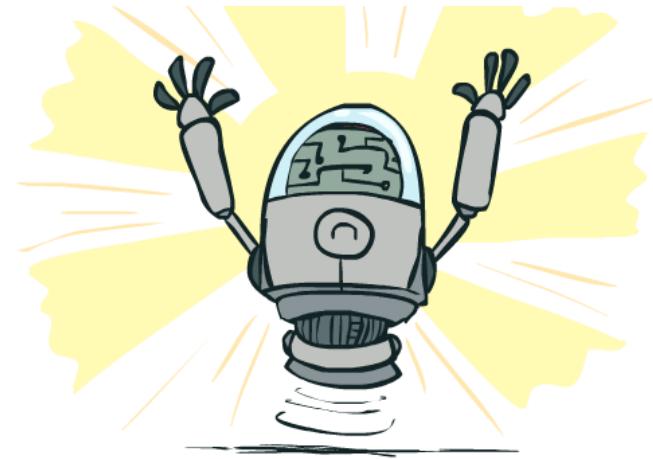


ASI: Superintelligence

What Can AI Do?

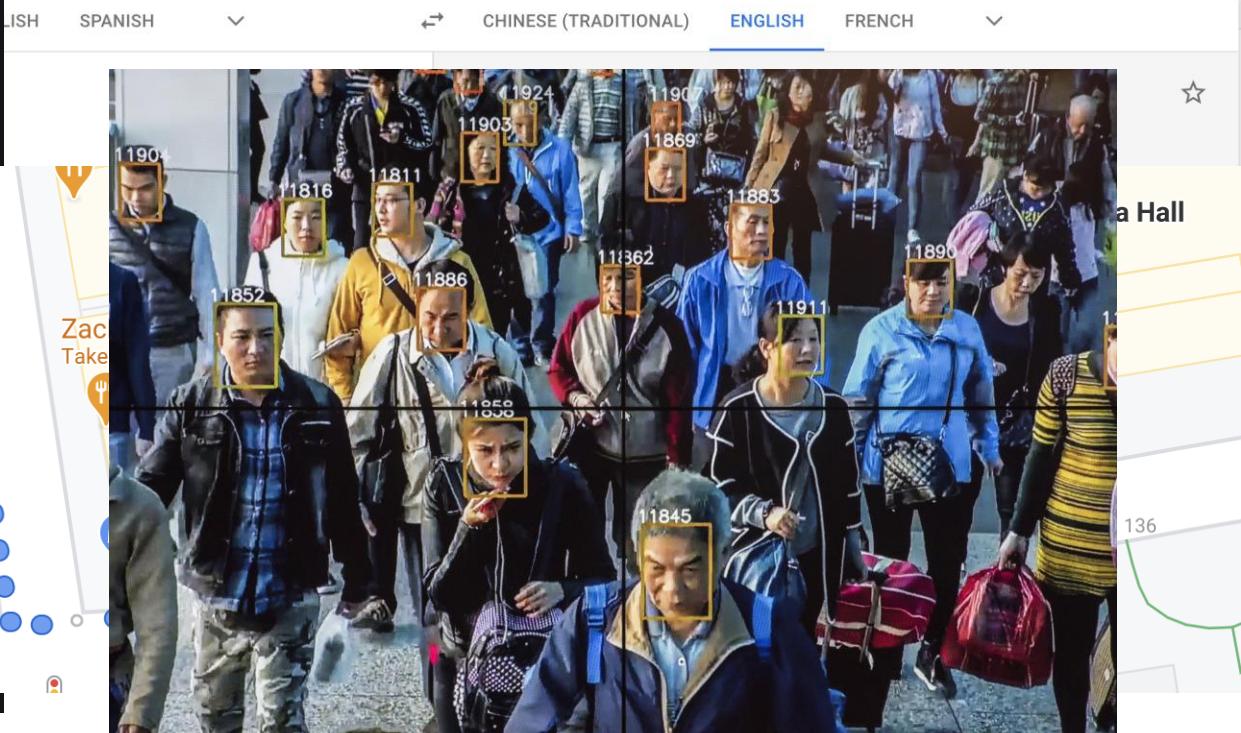
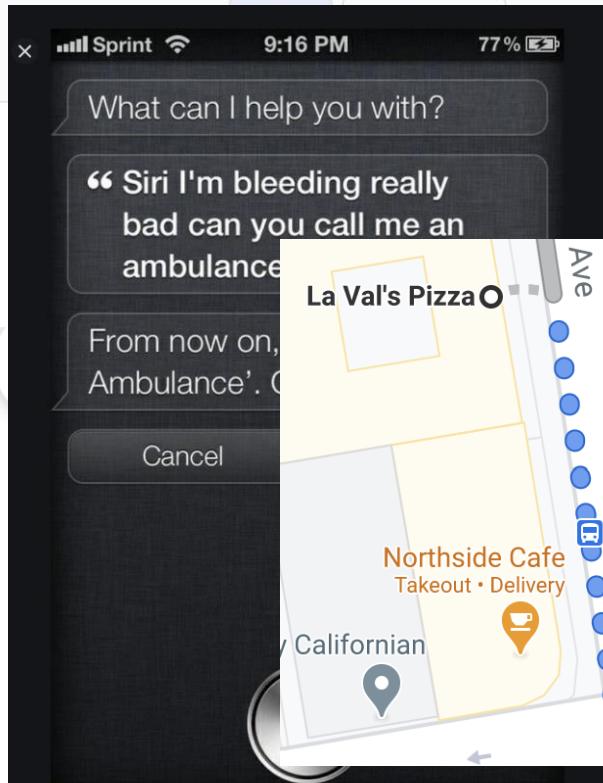
Quiz: Which of the following can be done at present?

- Play a decent game of table tennis?
- Play a decent game of Jeopardy?
- Drive safely along a curving mountain road?
- Drive safely along Lakshmi Road?
- Buy a week's worth of groceries on the web?
- Buy a week's worth of groceries at Tulsi Bag?
- 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?



Real AI

≡ Google Translate









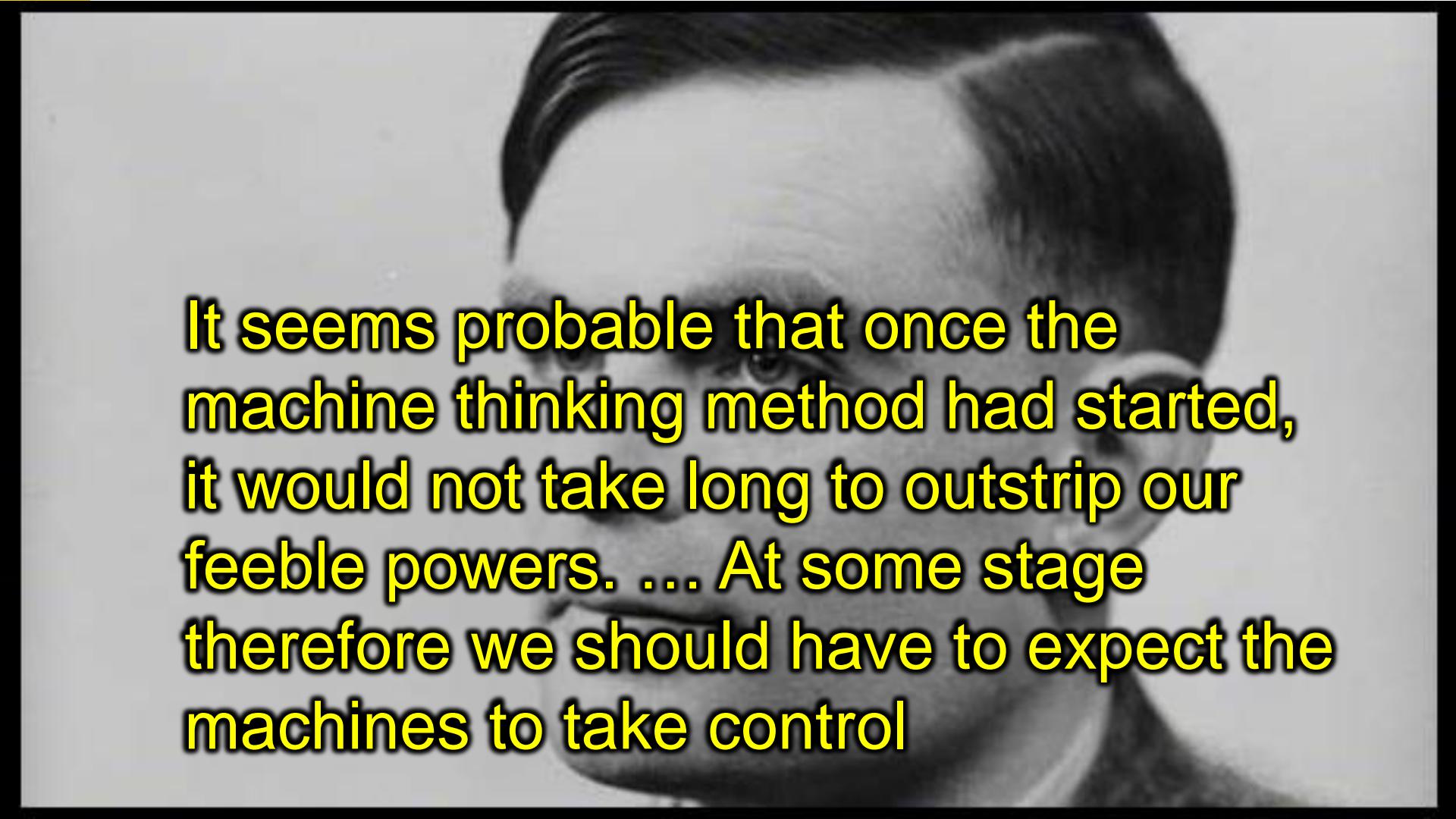
Boston Dynamics





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?

A black and white portrait of a man with dark hair and a mustache, looking slightly to the right.

It seems probable that once the machine thinking method had started, it would not take long to outstrip our feeble powers. ... At some stage therefore we should have to expect the machines to take control

WHAT IS A.I.?



What is Artificial Intelligence?

- There is no clear consensus on the definition of AI
 - John McCarthy coined the phrase AI in 1956
-
- Q. What is artificial intelligence?
 - It is the science and engineering of making intelligent machines, especially intelligent computer programs. It is related to the similar task of using computers to understand human or other intelligence, but AI does not have to confine itself to methods that are biologically observable.
 - Q. Yes, but what is intelligence?
 - Intelligence is the computational part of the ability to achieve goals in the world. Varying kinds and degrees of intelligence occur in people, many animals and some machines.

Other Definition

Definition	Researcher	Year
Automation of activities that we associate with human thinking, activities such as decision making, problem solving, learning.	Bellman	1978
The study of mental faculties through the use of computational models	Charniak & McDermott	1985
Artificial Intelligence is the study of how to make computer do things which, at the moment, people do better	Rich & Knight	1991
The branch of computer science that is concerned with the automation of intelligent behavior	Luger & Stubblefield	1993

Dimensions of AI

Human-like vs. Rational		
Thought vs. Behavior	Automation of activities that we associate with human thinking, activities such as decision making, problem solving, learning..." (Bellman 1978)	"The study of mental faculties through the use of computational models" (Charniak & McDermott 1985)
	Artificial Intelligence is the study of how to make computer do things which, at the moment, people do better. (Rich & Knight 1991)	"The branch of computer science that is concerned with the automation of intelligent behavior" (Luger & Stubblefield 1993)

Dimensions of AI

Human-like vs. Rational	
Thought vs. Behavior	Systems that think like humans
	Systems that act like humans
	Systems that think rationally
	Systems that act rationally

Dimensions of AI

Human-like vs. Rational	
Thought vs. Behavior	Systems that think like humans (Model human cognition)
	Systems that think rationally (Formalized inference process)
	Systems that act like humans (Exhibits the human behavior)
	Systems that act rationally (Doing the right thinks)

Artificial Intelligence

The science of making machines that:

Rational Decisions

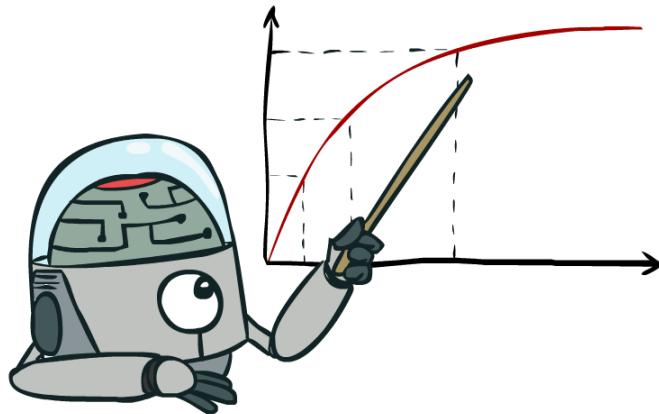
We'll use the term rational in a very specific, technical way:

- Rational: maximally achieving pre-defined goals
- Rationality only concerns what decisions are made
(not the thought process behind them)
- Goals are expressed in terms of the utility of outcomes
- Being rational means maximizing your expected utility

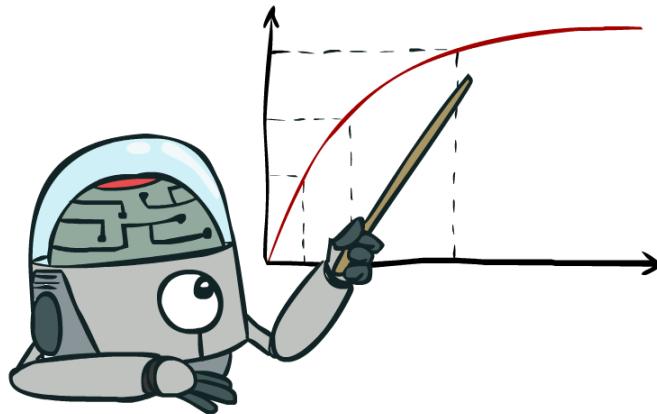
A better title for this course would be:

Computational Rationality

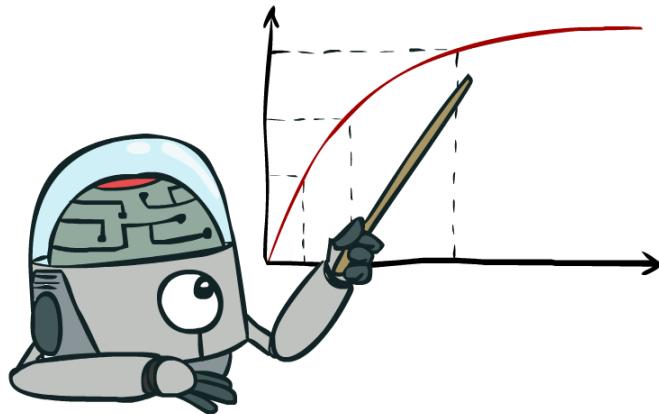
Maximize Your Expected Utility



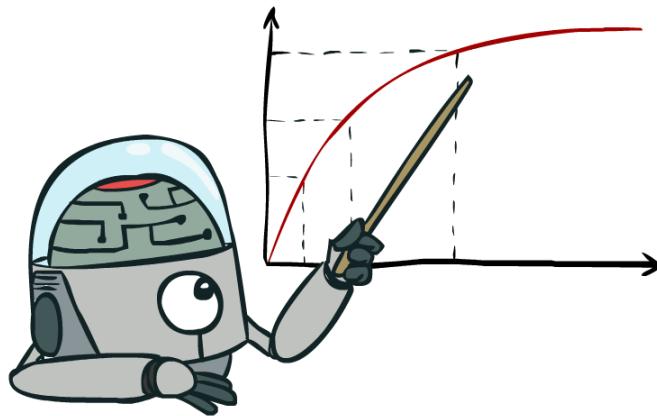
Maximize Your Expected Utility



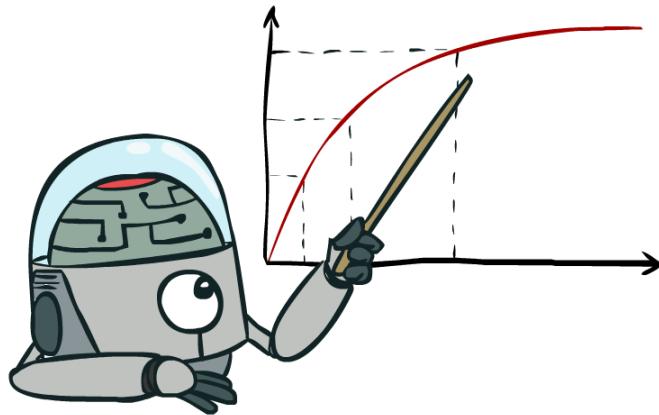
Maximize Your Expected Utility



Maximize Your Expected Utility

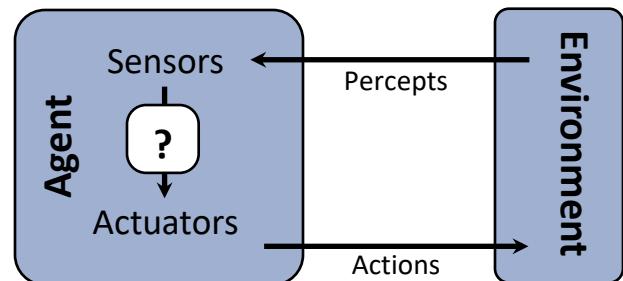
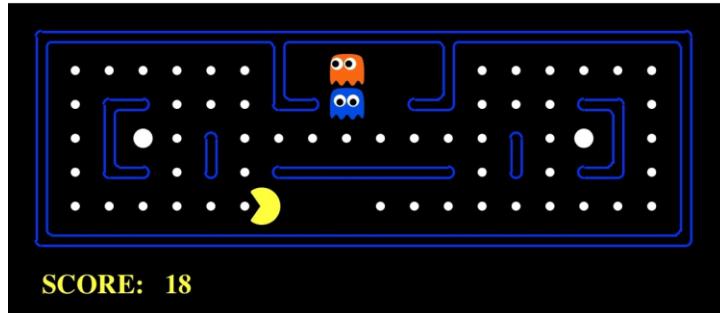


Maximize Your Expected Utility

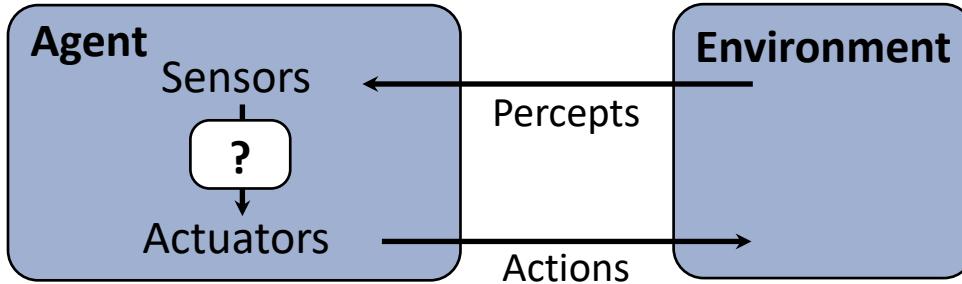


AI as Designing Rational Agents

- An **agent** is an entity that *perceives* and *acts*.
- A **rational agent** selects actions that maximize its expected utility.
- Characteristics of the **sensors, actuators, and environment** 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

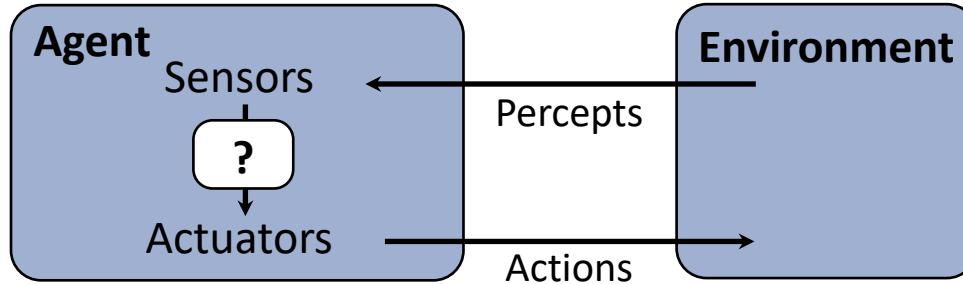


Agents and environments



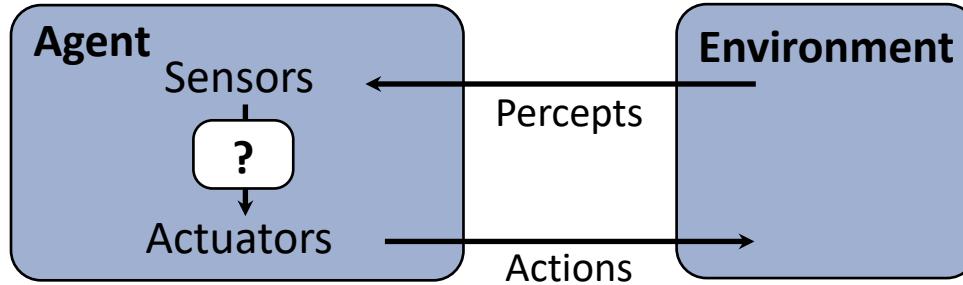
- An agent ***perceives*** its environment through ***sensors*** and ***acts*** upon it through ***actuators*** (or ***effectors***, depending on whom you ask)

Agents and environments



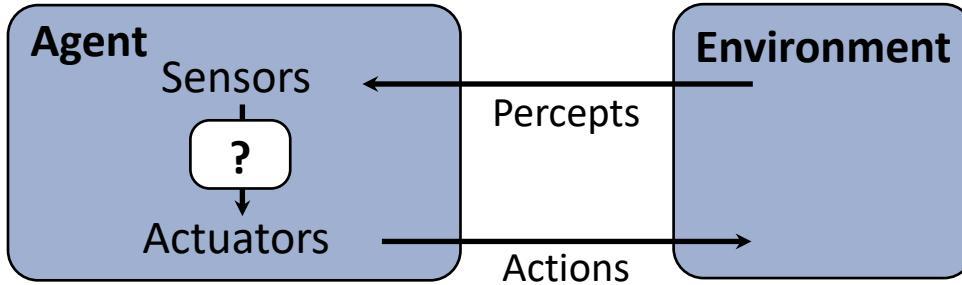
- Are humans agents?
- Yes!
 - Sensors = vision, audio, touch, smell, taste, proprioception
 - Actuators = muscles, secretions, changing brain state

Agents and environments



- Are pocket calculators agents?
- Yes!
 - Sensors = key state sensors
 - Actuators = digit display

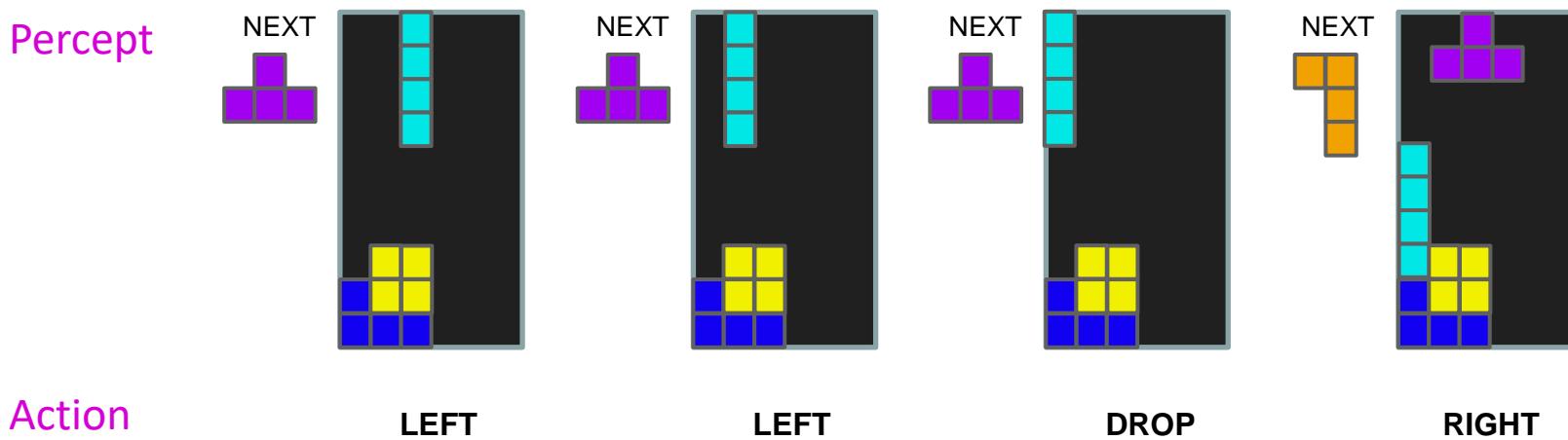
Agents and environments



- AI is more interested in agents with large computational resources and environments that require nontrivial decision making

Agent functions

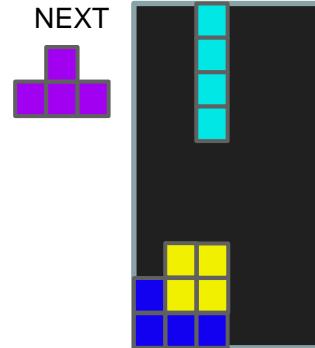
- The *agent function* maps from percept histories to actions:
 - $f: \mathcal{P}^* \rightarrow \mathcal{A}$
 - I.e., the agent's actual response to any sequence of percepts



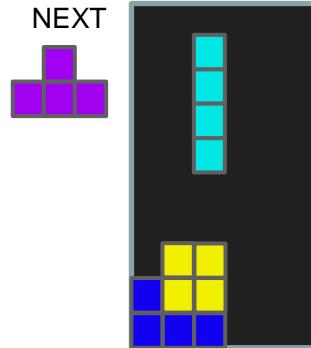
Agent programs

- The *agent program* $|$ runs on some machine M to implement f :
 - $f = \text{Agent}(l, M)$
 - Real machines have limited speed and memory, introducing delay, so agent function f depends on M as well as l

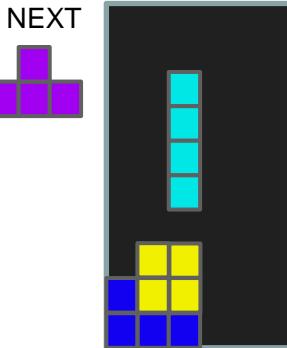
Percept



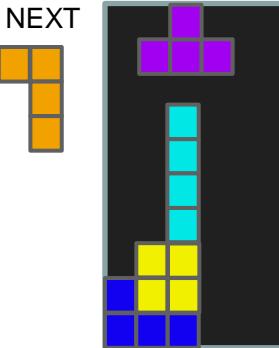
NOOP



NOOP

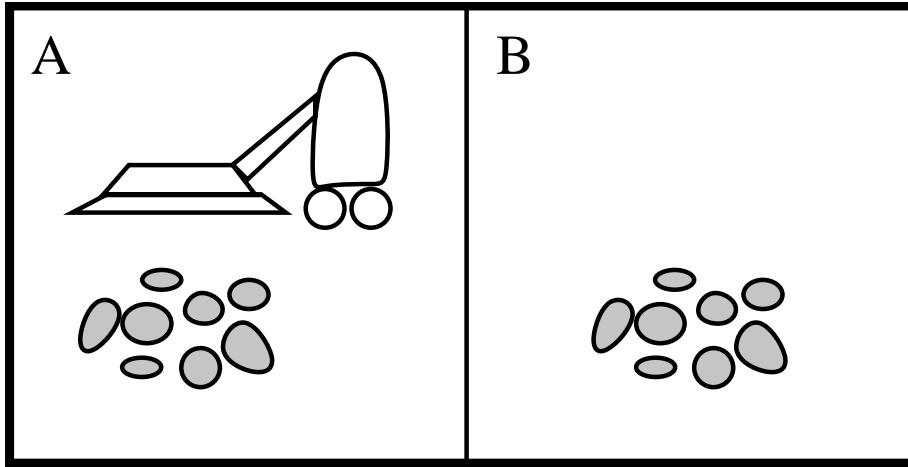


NOOP

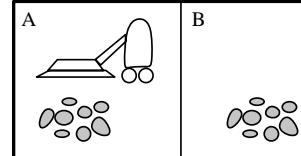


LEFT

Example: Vacuum world



- Percepts: [location,status], e.g., [A,Dirty]
- Actions: *Left, Right, Suck, NoOp*



Vacuum cleaner agent

Agent function

Percept sequence	Action
[A,Clean]	Right
[A,Dirty]	Suck
[B,Clean]	Left
[B,Dirty]	Suck
[A,Clean],[B,Clean]	Left
[A,Clean],[B,Dirty]	Suck
etc	etc

Agent program

```

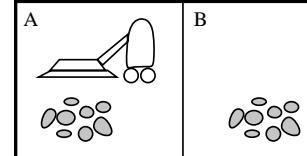
function Reflex-Vacuum-Agent([location,status])
    returns an action
    if status = Dirty then return Suck
    else if location = A then return Right
    else if location = B then return Left

```

What is the **right** agent function?

Can it be implemented by a small agent program?

Rationality



- Fixed ***performance measure*** evaluates the environment sequence
 - one point per square cleaned up?
 - NO! Rewards an agent who dumps dirt and cleans it up
 - one point per clean square per time step, for $t = 1, \dots, T$
- A ***rational agent*** chooses whichever action maximizes the ***expected value*** of the performance measure
 - given the percept sequence to date and prior knowledge of environment

Does Reflex-Vacuum-Agent implement a rational agent function?

Yes, if movement is free, or new dirt arrives frequently

A human agent in Pacman



The task environment - PEAS

- Performance measure
 - -1 per step; + 10 food; +500 win; -500 die;
+200 hit scared ghost
- Environment
 - Pacman dynamics (incl ghost behavior)
- Actuators
 - Left Right Up Down
- Sensors
 - Entire state is visible



PEAS: Automated taxi

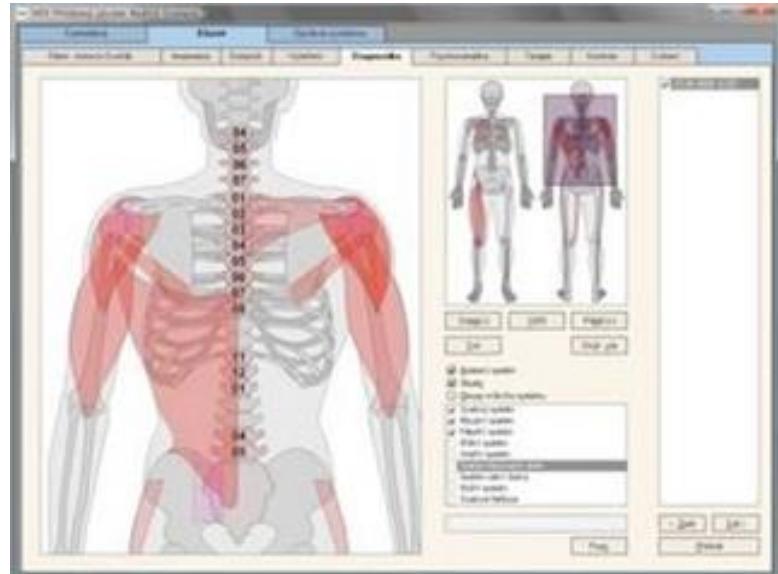
- Performance measure
 - Income, happy customer, vehicle costs, fines, insurance premiums
- Environment
 - Streets, other drivers, customers, weather, police...
- Actuators
 - Steering, brake, gas, display/speaker
- Sensors
 - Camera, radar, accelerometer, engine sensors, microphone, GPS



Image: <http://nypost.com/2014/06/21/how-google-might-put-taxi-drivers-out-of-business/>

PEAS: Medical diagnosis system

- Performance measure
 - Patient health, cost, reputation
 - Environment
 - Patients, medical staff, Lab
 - Actuators
 - Screen display, printer
 - Sensors
 - Keyboard/mouse



Environment types

Single Agent	Multi Agent
Single Vacuum Cleaner	Two Vacuum Cleaner
Fully Observable	Partially Observable
An agent's sensors give it access to the complete state of the environment at each point in time.	Noisy and inaccurate sensors or because parts of the state are simply missing from the sensor data
Agent need not maintain any internal state to keep track of the world	Agent need maintain all internal state to keep track of the world
Vacuum agent with max dirt sensor can tell whether there is dirt in other room.	Vacuum agent with only a local dirt sensor cannot tell whether there is dirt in other room.
Deterministic	Stochastic
The next state of the environment is completely determined by the current state and the action executed by the agent.	Otherwise Stochastic
Vacuum Cleaner world	Taxi Driving

Environment types

Episodic	Sequential
The next episode does not depend on the actions taken in previous episodes.	Current decision could affect all future decisions
Spot defective parts on an assembly line	Chess and taxi driving
Discrete	Continuous
A limited number of distinct state, clearly defined percepts and actions	state, percept and action change w.r.t. time.
Chess	Taxi driving
Static	Dynamic
The environment is unchanged while an agent is deliberating	Environment can change while an agent is deliberating
Vacuum Cleaner world	Taxi driving

task environm.	observable	determ./ stochastic	episodic/ sequential	static/ dynamic	discrete/ continuous	agents
crossword puzzle	fully	determ.	sequential	static	discrete	single
chess with clock	fully	strategic	sequential	semi	discrete	multi
poker	partial	stochastic	sequential	static	discrete	multi
taxi driving	partial	stochastic	sequential	dynamic	continuous	multi
medical diagnosis	partial	stochastic	sequential	dynamic	continuous	single
image analysis	fully	determ.	episodic	semi	continuous	single
partpicking robot	partial	stochastic	episodic	dynamic	continuous	single
refinery controller	partial	stochastic	sequential	dynamic	continuous	single
interact. Eng. tutor	partial	stochastic	sequential	dynamic	discrete	multi

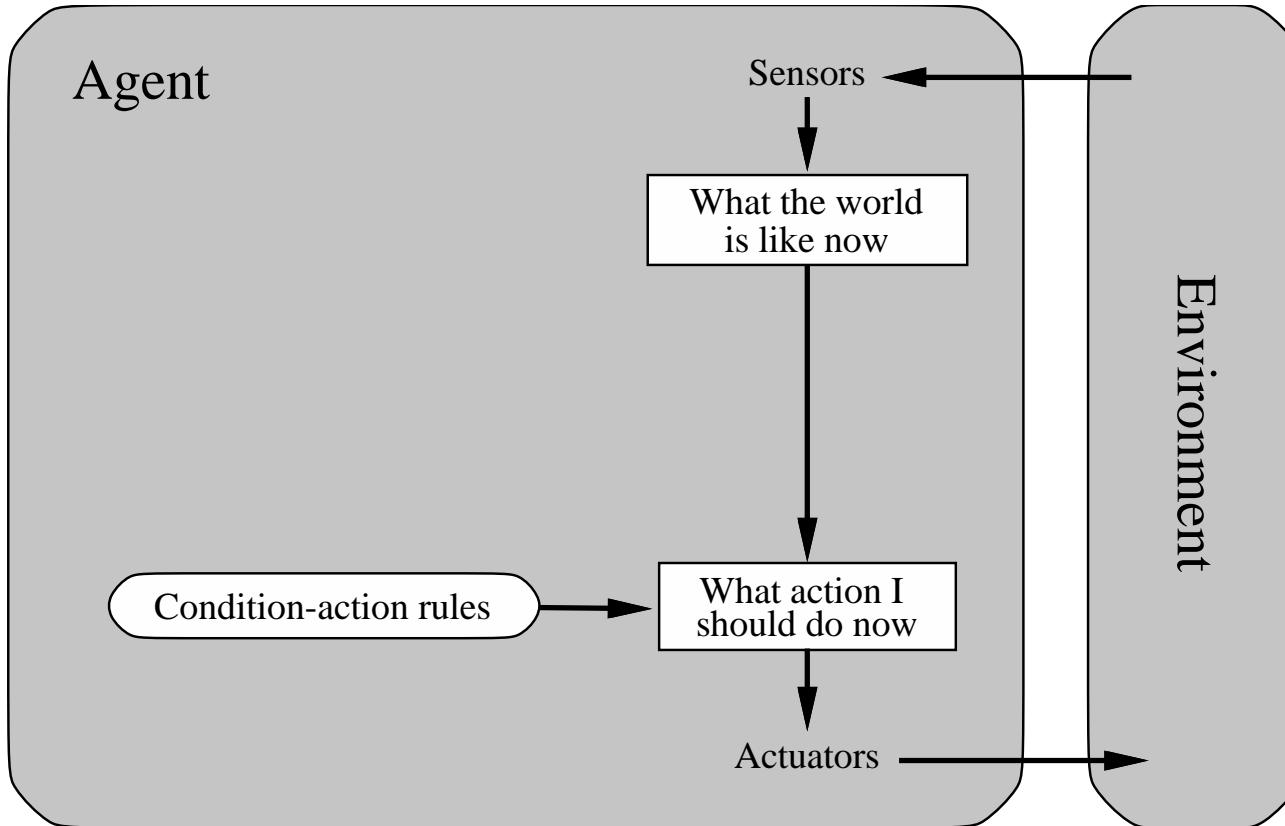
Agent design

- The environment type largely determines the agent design
 - *Partially observable* => agent requires **memory** (internal state)
 - *Stochastic* => agent may have to prepare for **contingencies**
 - *Multi-agent* => agent may need to behave **randomly**
 - *Static* => agent has time to compute a rational decision
 - *Continuous time* => continuously operating **controller**
 - *Unknown physics* => need for **exploration**
 - *Unknown perf. measure* => observe/interact with **human principal**

Agent types

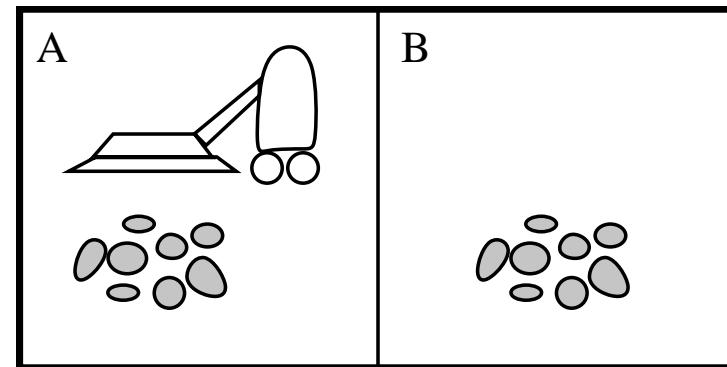
- In order of increasing generality and complexity
 - Simple reflex agents
 - Reflex agents with state
 - Goal-based agents
 - Utility-based agents

Simple reflex agents

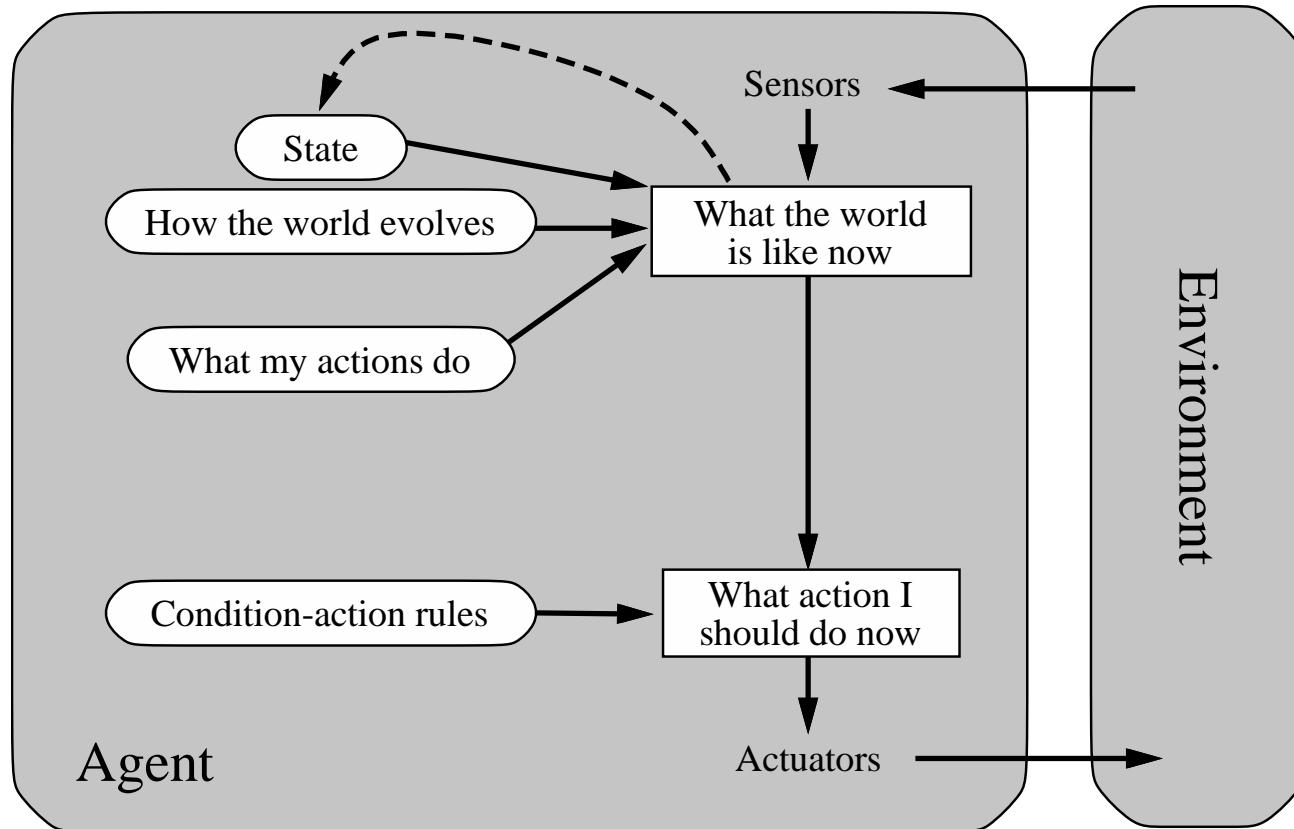


Example: Vacuum world

Percept sequence	Action
[A,Clean]	Right
[A,Dirty]	Suck
[B,Clean]	Left
[B,Dirty]	Suck
[A,Clean],[B,Clean]	Left
[A,Clean],[B,Dirty]	Suck
etc	etc

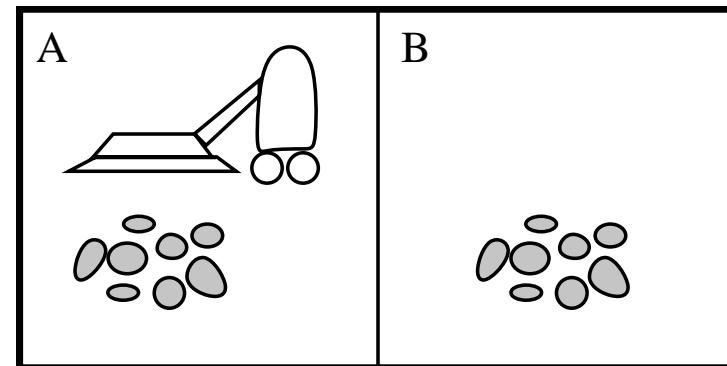


Reflex agents with state

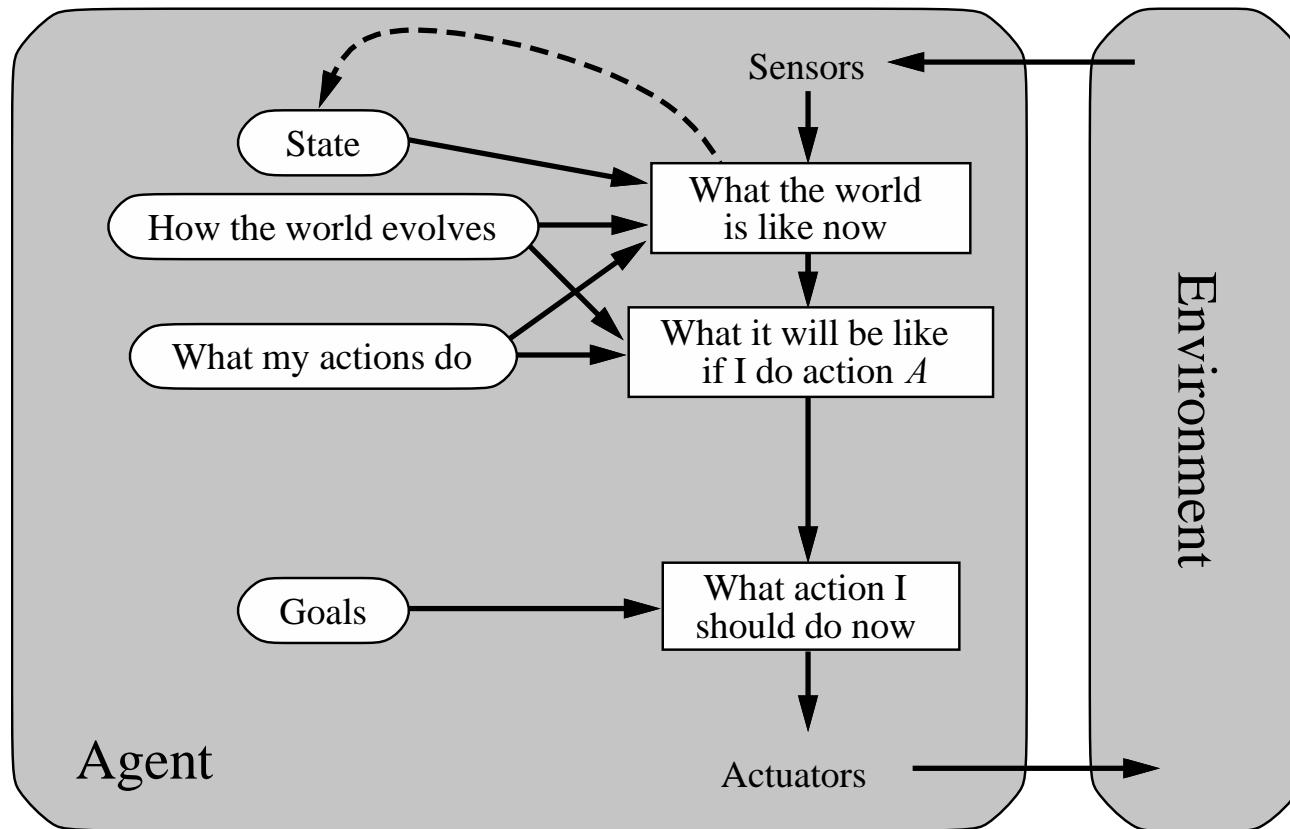


Example: Vacuum world

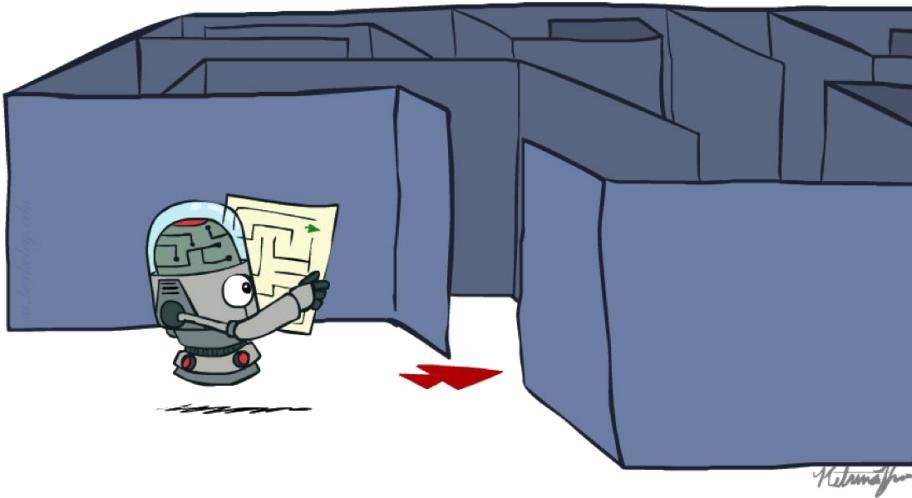
Percept sequence	Action
[A,Clean]	Right
[A,Dirty]	Suck
[B,Clean]	Left
[B,Dirty]	Suck
[A,Clean],[B,Clean]	No-Op
[A,Clean],[B,Dirty]	Suck
etc	etc



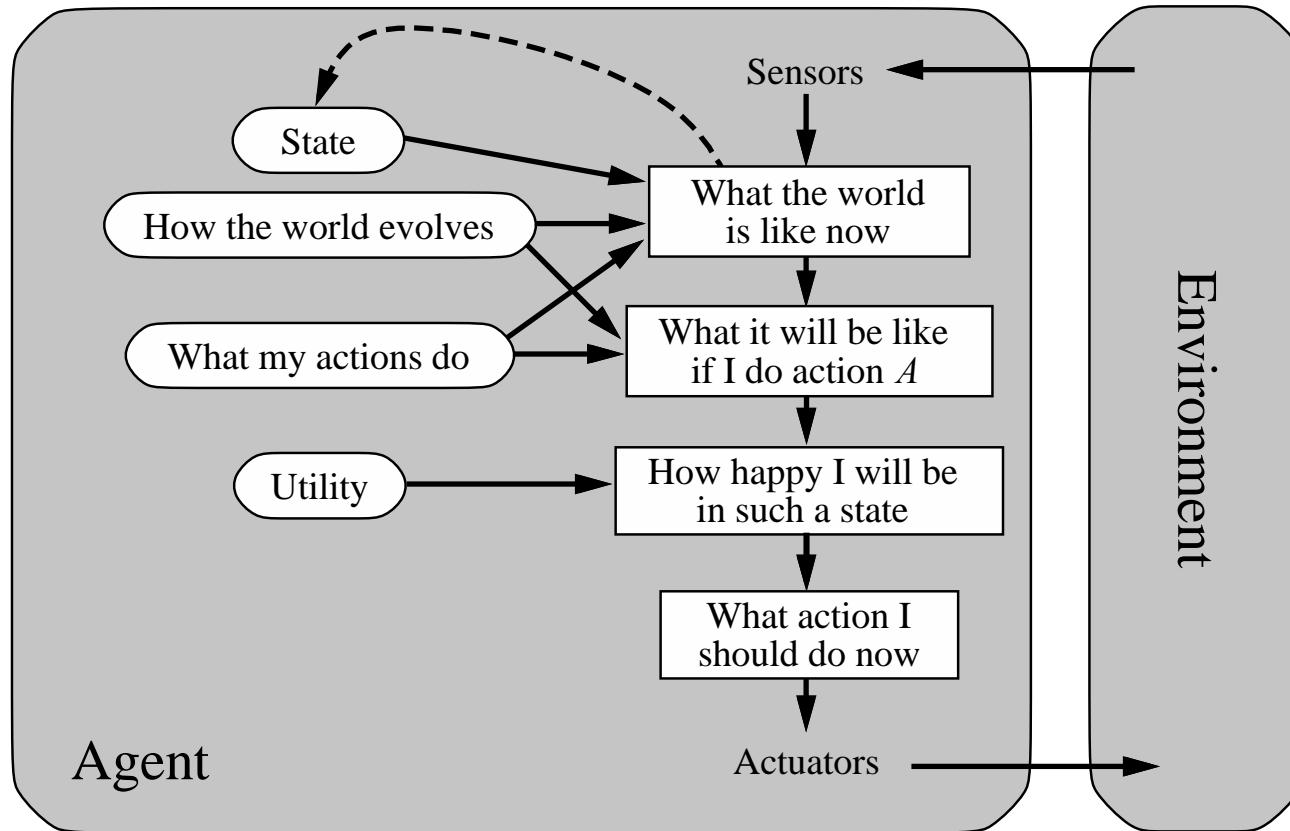
Goal-based agents



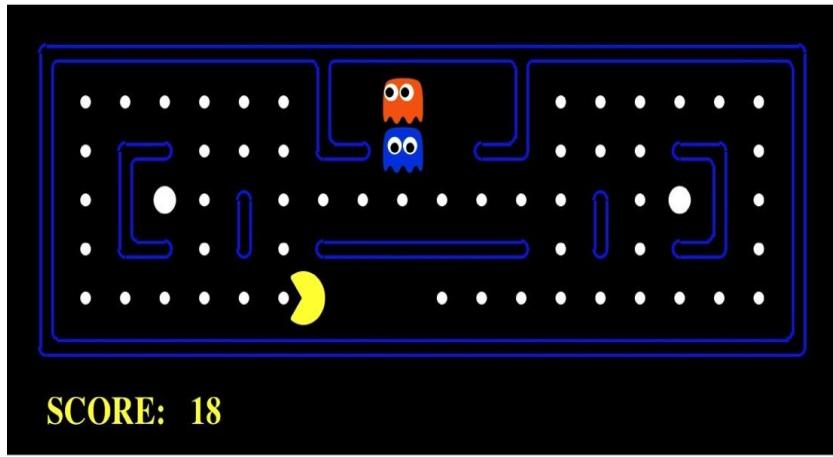
Example: Path Finding



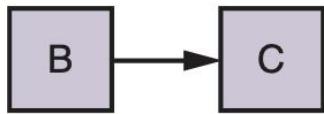
Utility-based agents



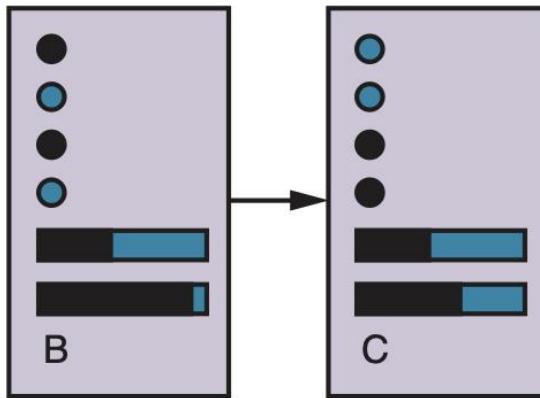
Example: Pac-Man



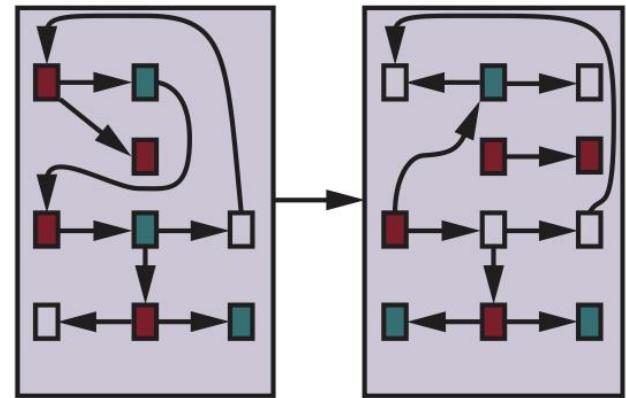
Spectrum of representations



(a) Atomic



(b) Factored



(c) Structured

Applied Areas of AI

- **Logical AI**
- **Search**
- **Planning**
- **Artificial Neural Network**
- **Natural language processing**
- **Computer vision**
- **Pattern recognition**
- **Ontology** the study of the kinds of things that exist.
- **Knowledge representation**
- **Inference** From some facts, others can be inferred.
- **Epistemology** This is a study of the kinds of knowledge that are required for solving problems in the world.
- **Reasoning**
- **Learning**
- **Games**
- **Artificial life / worlds**
- **Emotions**
- **Knowledge Management**
- **Socialization/communication**

Summary

- An *agent* interacts with an *environment* through *sensors* and *actuators*
- The *agent function*, implemented by an *agent program* running on a *machine*, describes what the agent does in all circumstances
- Rational agents choose actions that maximize their expected utility
- PEAS descriptions define task environments; precise PEAS specifications are essential and strongly influence agent designs
- More difficult environments require more complex agent designs and more sophisticated representations