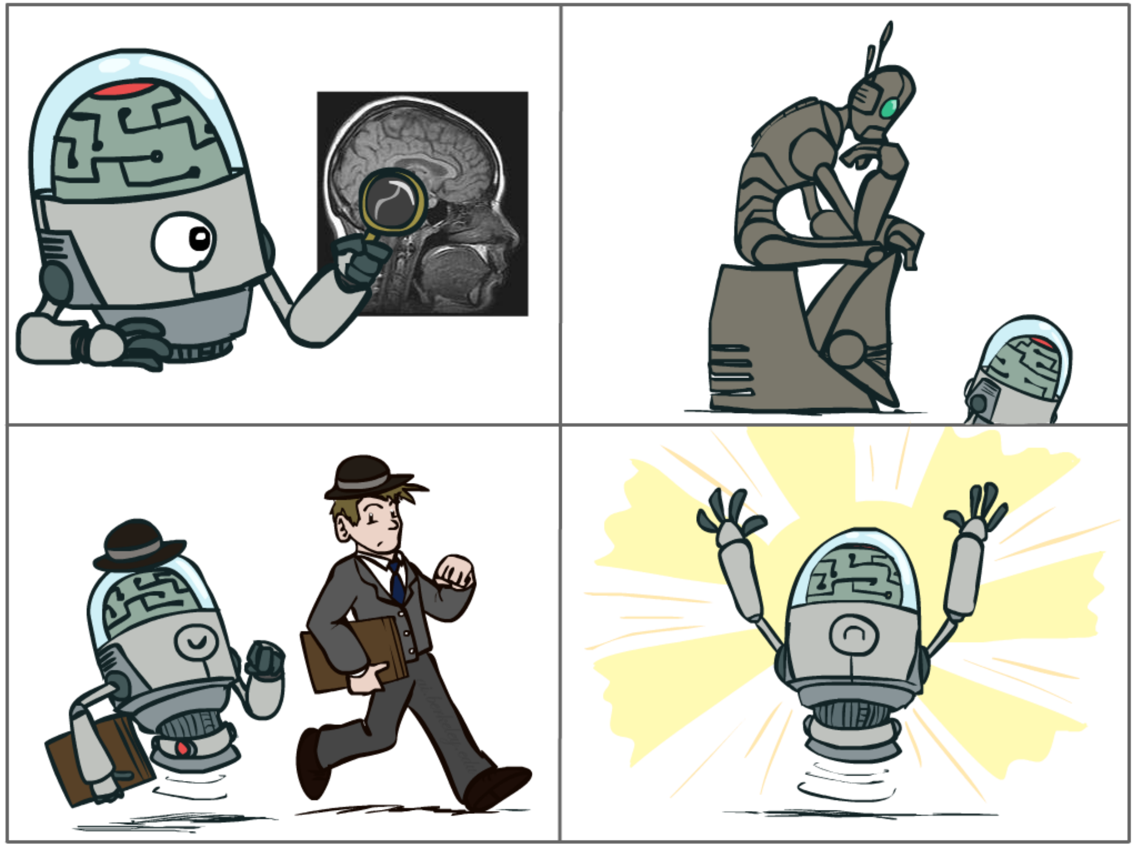
# What is AI?

## The science of making machines that:

Think like people

Think rationally



Act like people

Act rationally

Fundamental question for this lecture
(and really this whole AI field!):

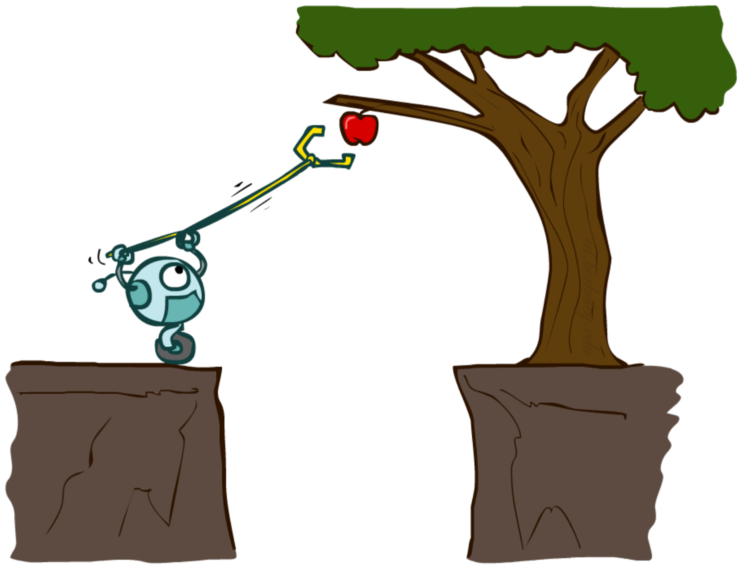
**How do you turn a real-world problem into an AI solution?**

# AI – Agents and Environments

Much (though not all!) of AI is concerned with **agents** operating in **environments.**

**Agent –** an entity that *perceives* and *acts*

**Environment –** the problem setting



# Fleshing it out

**P**erformance – measuring desired outcomes

**E**nvironment – what populates the task's world?

**A**ctuators – what can the agent act with?

**S**ensors – how can the agent perceive the world?

# PEAS in a taxi

## Automated taxi driver

**Performance** – Safe, fast, legal, comfortable trip, maximize profits

**Environment** – Roads, other traffic, pedestrians, customers

**Actuators** – Steering, accelerator, brake, signals, horn, display

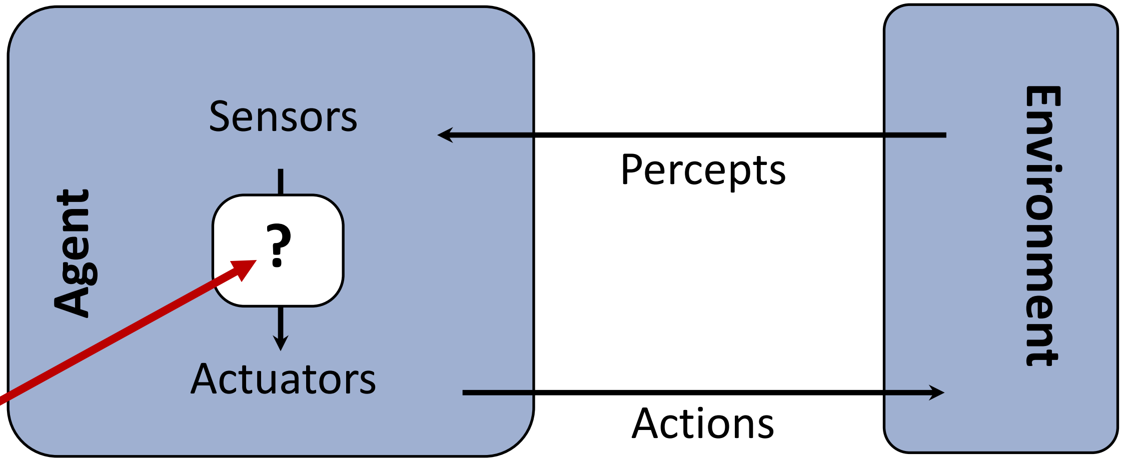
**Sensors -** Cameras, sonar, speedometer, GPS, odometer, accelerometer, engine sensors, microphone/keyboard

# What makes an Agent?

**Agent** – an entity that perceives its environment through sensors, and acts on it with actuators.

Percepts are constrained by
Sensors + Environment

Actions are constrained by
Actuators + Environment




**Agent Function** – how does it choose the action?

# What makes one rational?

Actually pretty simple:

A **rational agent** always acts to **maximize its expected performance measure**, given current state/percept

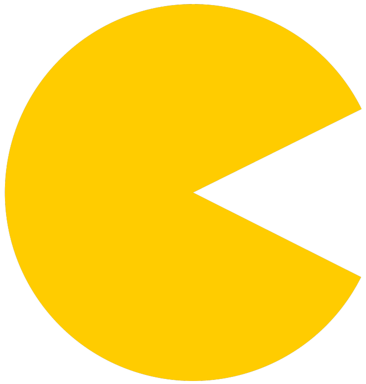
# Our sample agents

## Pacman

Percepts – squares around Pacman

Actions – move U/D/L/R

Environment – map with walls, dots, and ghosts



## Spam detector

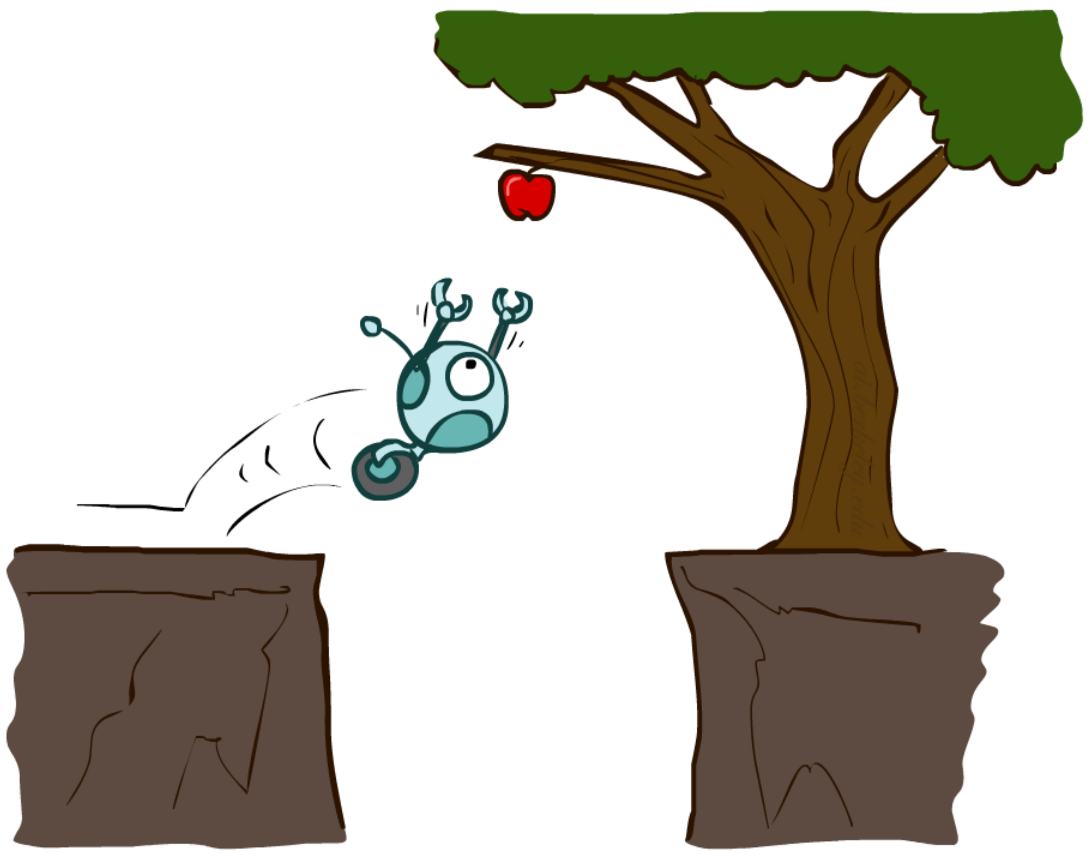
Percepts – sender, subject line, body of current email

Actions – mark Spam/Not Spam

Environment – your email inbox

# Reflex Agents

- Reflex agents:
  - Choose action based on current percept (and maybe memory)
  - May have memory or a model of the world's current state
  - Do not consider the future consequences of their actions
  - Consider how the world IS



# Reflex Agents

- Reflex agents:
  - Choose action based on current percept (and maybe memory)
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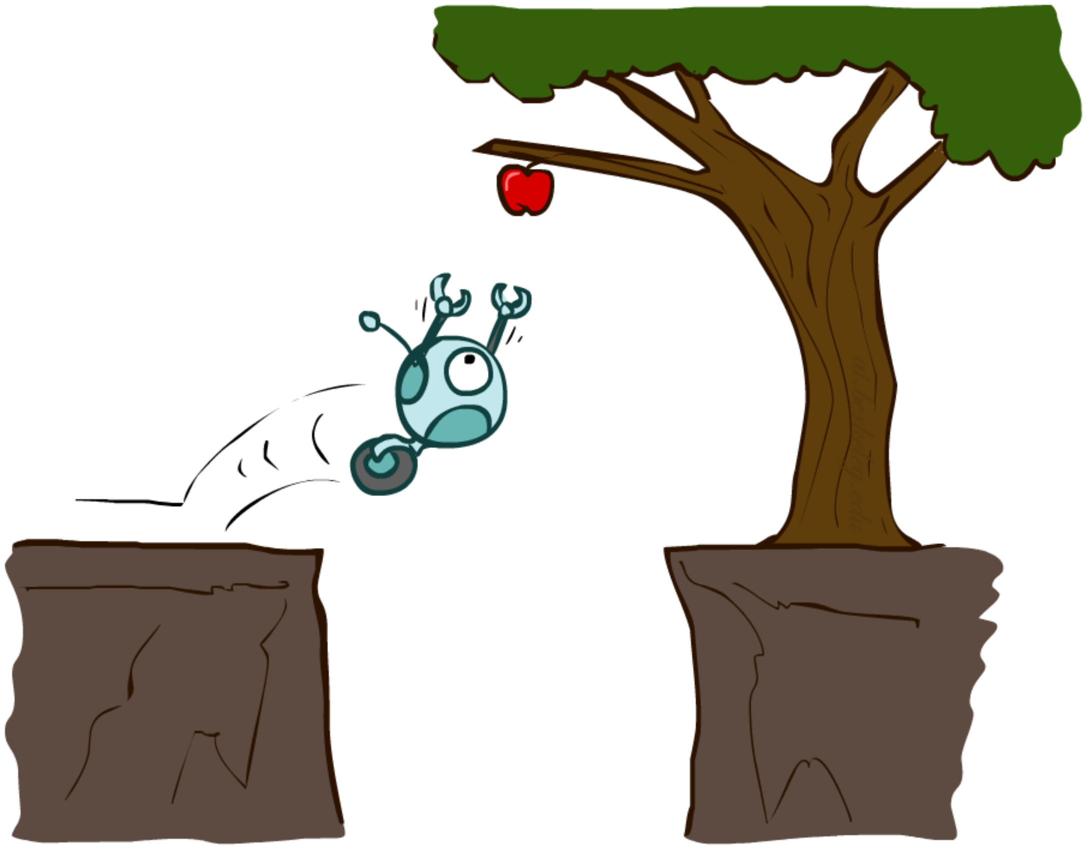
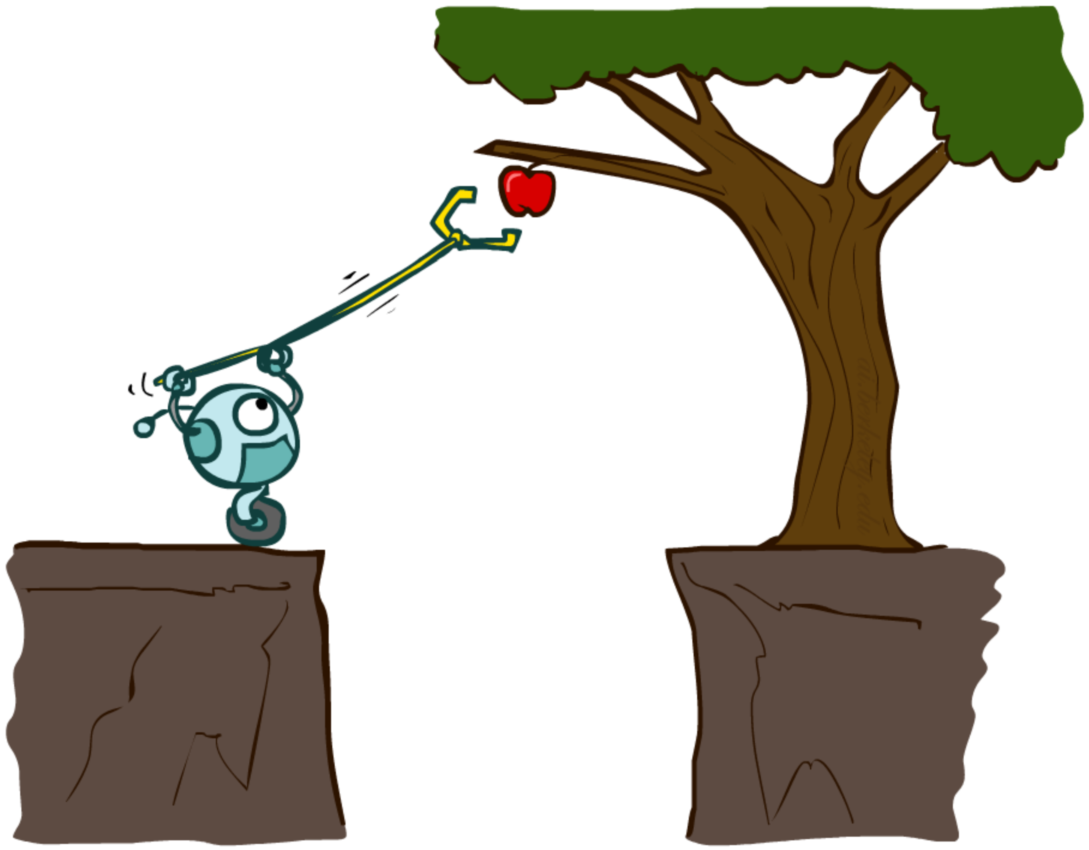
  - Consider how the world IS

- Can a reflex agent be rational?



# Planning Agents

- Planning agents:
  - Ask “what if”
  - Decisions based on (hypothesized) consequences of actions
  - Must have a model of how the world evolves in response to actions
  - Must formulate a goal (test)
  - Consider how the world WOULD BE



# Goal-based Agents

Chooses action (sequence) to get from current state to some goal

**Pacman**

Percepts – squares around Pacman

Actions – move U/D/L/R

Environment – map with walls, dots, and ghosts

Goal:


**Spam detector**

Percepts – sender, subject line, body of current email

Actions – mark Spam/Not Spam

Environment – your email inbox

Goal:

*???*

# Utility-based Agents

Chooses action (sequence) to get from current state to some goal
with maximum utility along the way

**Pacman**

Percepts – squares around Pacman

Actions – move U/D/L/R

Environment – map with walls, dots, and ghosts

Goal:


*…in as short a path as possible!*

**Spam detector**

Percepts – sender, subject line, body of current email

Actions – mark Spam/Not Spam

Environment – your email inbox

Goal:

# Summary

## Reflex agents

Act on current state (and maybe past)

Simple – current p

Model – current p

of rest of


## Goal-based agents

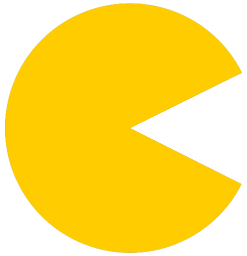
From current state to desired future

Goal only – find *any* action(s) to

ch the goal

*st* action(s) to

the goal



Can also have a **Learning Agent** – we'll talk about these later in the course!

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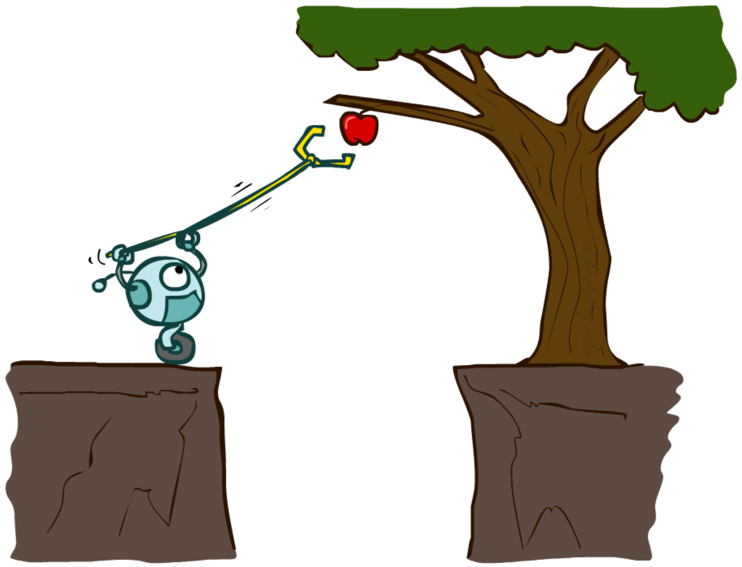


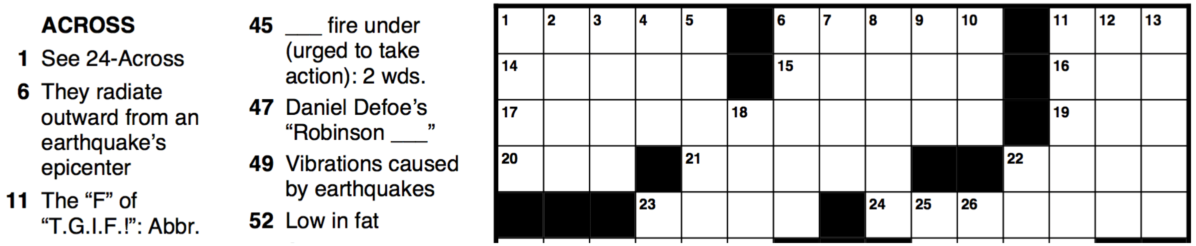
# Kinds of task environments

6 common properties to distinguish tasks (not exhaustive)

- **Fully observable** vs **Partially observable**
- **Single agent** vs **Multiagent**
- **Deterministic** vs **Stochastic**
- **Episodic** vs **Sequential**
- **Static** vs **Dynamic**
- **Discrete** vs **Continuous**

# Fully observable vs partially observable

**Fully observable** – agent is able to sense everything in the environment




**Partially observable** – noisy, inaccurate, or incomplete sensors

# Single agent vs Multiagent

**Single agent** – self-explanatory


**Multiagent** – task involves more than one agent, each with its own performance measure

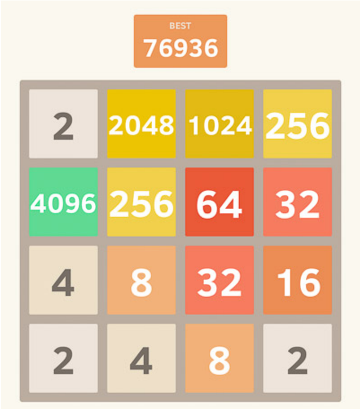
May be **competitive** (measures are opposed)

or **cooperative** (measures align)

# Deterministic vs Stochastic

**Deterministic** – next state of the world is fully determined by current state + agent action

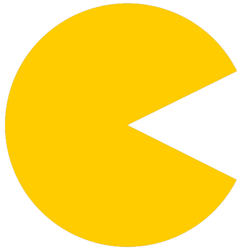
**Stochastic** – it's not deterministic



# Episodic vs Sequential

**Episodic** – Each step/decision is independent of the previous ones


**Sequential** – Each step/decision affects later ones



# Static vs Dynamic

**Static** – world doesn’t change while agent is choosing an action

**Dynamic** – decision time matters!

# Discrete vs Continuous

**Discrete** – possible states/actions are distinct; world changes discretely

**Continuous** – states/actions take on continuous values

# These help determine how to approach problems

**Static** -> can focus on getting really high accuracy/utility

**Dynamic** -> trade some utility for higher efficiency (speed!)

**Episodic** -> reflex agent with a great model

**Sequential** -> need a goal-oriented agent

**Stochastic** -> need robustness to uncertainty/failure (robots!)

**Deterministic** -> can focus on efficiency and exactness (Internet crawler)

# Next up

**Defining search problems** – how to choose the right action sequence?

**Uninformed search approaches** – simple reflex agents for searching