CSC 665: Artificial Intelligence

Intelligent Agents

Pooyan Fazli

San Francisco State University

Assignment 0: Feedback

- Due on Feb 4, 1pm
- To be done alone
- Submission via iLearn (Check the submission instructions on the website)

- Python 3.6. The autograder will give an error message about cgi.escape if you use Python 3.8+.

- Autograder: We have provided a local autograder and a set of test cases for you to evaluate your code. The local autograder is a file called autograder.py.

Assignment 0: Feedback

- **What to submit:**
  - **T**he files that are required in the assignment's description (addition.py, buyLotsOfFruit.py, and shopSmart.py). Please use comments appropriately across your code.
  - A short README.txt file that specifies:
    - Your name and SFSU ID.
    - A brief description (i.e. a short paragraph) that includes the main ideas of your implementation.

- **Place your files in a single folder inside the archive.**
  Submit your assignment on iLearn as a single archive file (.zip, tar.gz, etc), with the name csc665-0-lastname-sfsuid

MOSS (Measure Of Software Similarity)

MOSS is an automatic system for determining the similarity of programs.

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4-71		2-66	
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115-132		110-127	

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```
>>>> file: LongJump.py
#S[redacted]a

print("***** Long Jump Information System *****")
print("Please enter the names of competitors. (Press return when done.)")
print("Competitor no. 1:")
competitor = input()
b,c,g,h,d,k = 1,0,0,0,[],0
maxi,competitors = [],[competitor]
while True:
    b += 1
    print("Competitor no. "+str(b)+":")
    competitor = input()
    if competitor == "":break
    else:
        competitors.append(competitor)
print("Please enter the distances for each competitor.")
for each in competitors:
    print("Competitor ",each,":",sep="")
    at1 = input("Attempt 1:\n")
    at2 = input("Attempt 2:\n")
    at3 = input("Attempt 3:\n")
    x = (at1+at2+at3).lower()
    if (at1+at2+at3).find("oul") != -1:
        x = (at1+at2+at3).lower()
    d.append(at1)
    d.append(at2)
    d.append(at3)
    if x.find("foul") == -1:
        maxi.append(max(eval(at1),eval(at2),eval(at3)))
```

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```
>>>> file: LongJump.py

print("***** Long Jump Information System *****")
print("Please enter the names of competitors. (Press return when done.)")
print("Competitor no. 1:")
competitor = input()
b,c,g,h,d,k = 1,0,0,0,[],0
maximums,competitors = [],[competitor]
while True:
    b += 1
    print("Competitor no. "+str(b)+":")
    competitor = input()
    if competitor == "":break
    else:
        competitors.append(competitor)
print("Please enter the distances for each competitor.")
for each in competitors:
    print("Competitor ",each,":",sep="")
    attempt1 = input("Attempt 1:\n")
    attempt2 = input("Attempt 2:\n")
    attempt3 = input("Attempt 3:\n")
    g = (attempt1+attempt2+attempt3).lower()
    if (attempt1+attempt2+attempt3).find("oul") != -1:
        g = (attempt1+attempt2+attempt3).lower()
    d.append(attempt1)
    d.append(attempt2)
    d.append(attempt3)
    if g.find("foul") == -1:
        maximums.append(max(eval(attempt1),eval(attempt2),eval(attempt3)))
    else:
        d.remove("foul")
        if not "foul" in d:
```

What is Artificial Intelligence?

- We use the following definitions

Systems that think rationally

Systems that act like humans

Systems that act rationally

Systems that think like humans

Today

- Agents and Environments
- Rationality
- PEAS (Performance measure, Environment, Actuators, Sensors)
- Environment types
- Agent types

Agents

- A Goal of AI: Build robust, fully autonomous agents in the real world

Intelligent (Autonomous) Agents: Examples

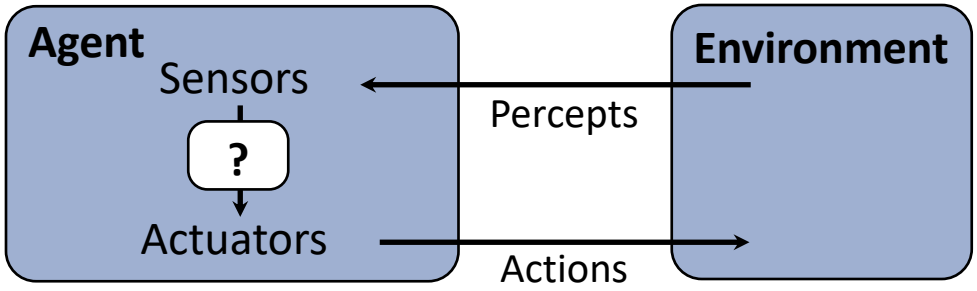
- Autonomous robot
- Information gathering agent
  - Find me the cheapest?
- E-commerce agents
  - Decides what to buy/sell and does it
- Air-traffic controller
- Meeting scheduler
- Computer-game-playing agent

Not Intelligent Agents

- Thermostat
- Telephone
- Answering machine
- Pencil
- Java object

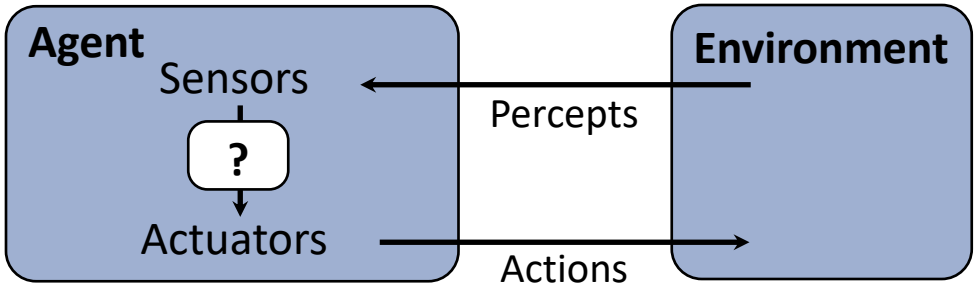
What is an Agent?

Agents and Environments



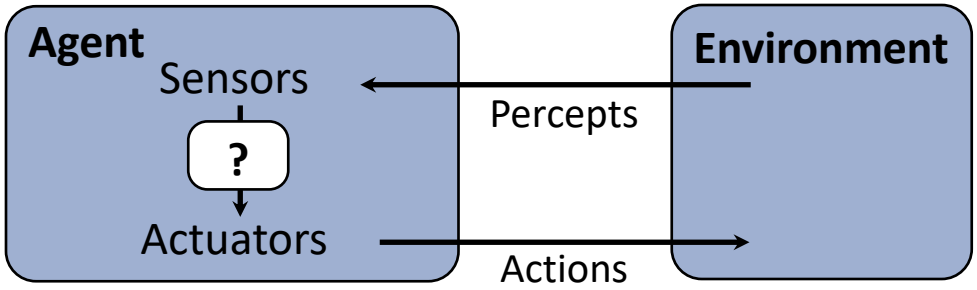
- An agent *perceives* its environment through *sensors* and *acts* upon it through *actuators*.

Agents and Environments



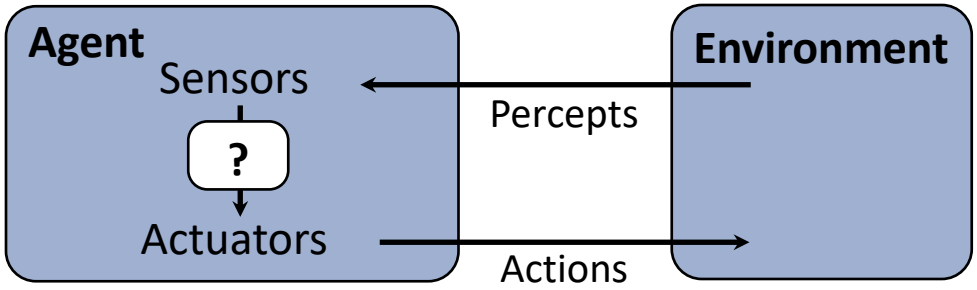
- Are humans agents?
- Yes!
  - Sensors = vision, audio, touch, smell, taste, …
  - Actuators = muscles, secretions, changing brain state

Agents and Environments



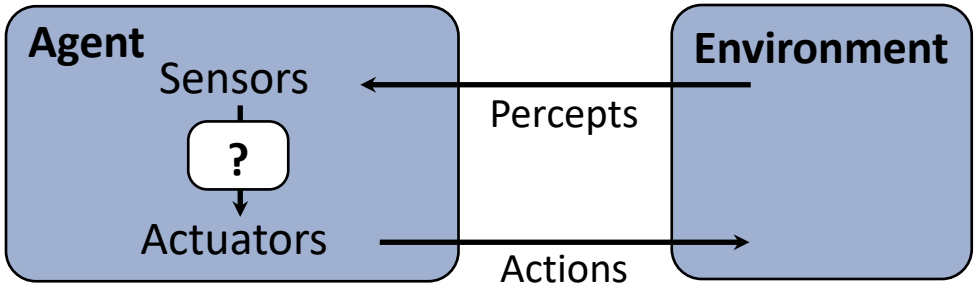
- Are Robots agents?
- Yes!
  - Sensors = cameras, laser range finders, GPS
  - Actuators = various motors

Agents and Environments



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

Agents and Environments

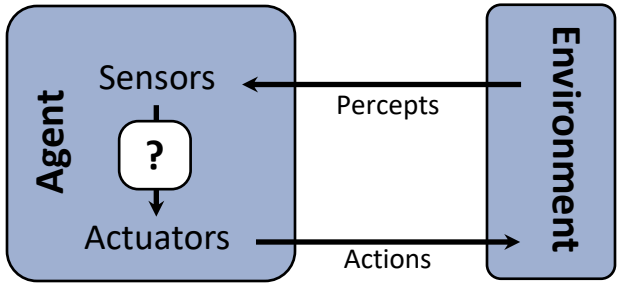


- AI is more interested in agents with substantial computation resources and environments requiring nontrivial decision making

Rational Agents

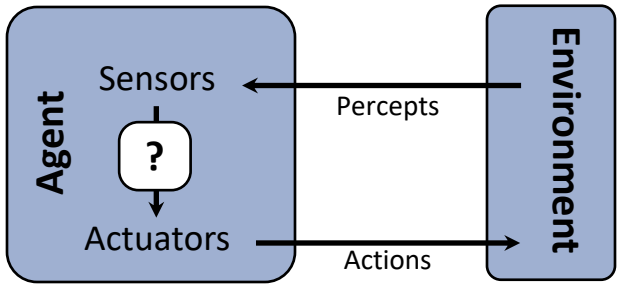
- A **rational agent** selects actions that maximize its (expected) **utility**.

- Utility or performance measure of a vacuum-cleaner agent:
  - amount of dirt cleaned up
  - amount of time taken
  - amount of electricity consumed
  - amount of noise generated
  - etc.



Rational Agents

- A **rational agent**
  - acts appropriately given goals and circumstances
  - is flexible to changing environments and goals
  - learns from experience
  - makes appropriate choices given perceptual and computational limitations
- Characteristics of the **percepts**, **environment**, and **action space** dictate techniques for selecting rational actions.



Rational Agents

- Are rational agents omniscient?
  - No – they are limited by the available percepts
- Are rational agents clairvoyant?
  - No – they may lack knowledge of the environment dynamics
- Do rational agents explore and learn?
  - Yes – in unknown environments these are essential
- So rational agents are not necessarily successful, but they are autonomous

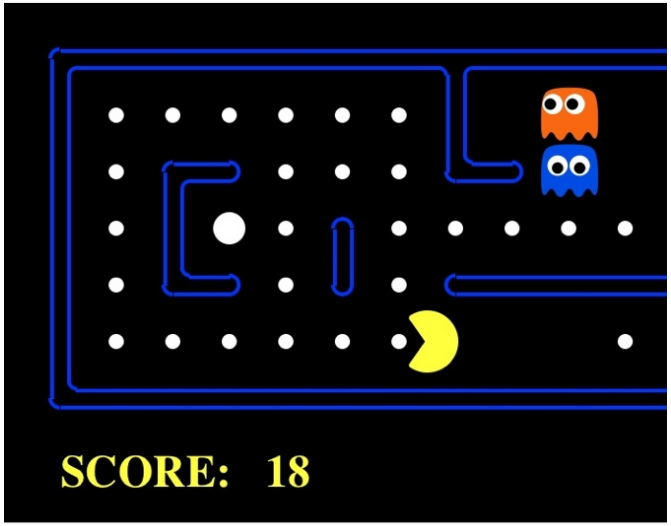
Discussion Item

- A realistic agent has finite amount of computation and memory available. Assume an agent is killed because it did not have enough computation resources to calculate some rare event that eventually ended up killing it. Can this agent still be rational?

PEAS: Performance measure, Environment, Actuators, Sensors

PEAS: Pacman

- Performance measure
  - -1 per step; + 10 food; +500 win; -500 die;
- Environment
  - Maze, food, ghosts, …
- Actuators
  - Pacman’s body and mouth
- Sensors
  - Some sort of Vision (Entire state is visible)



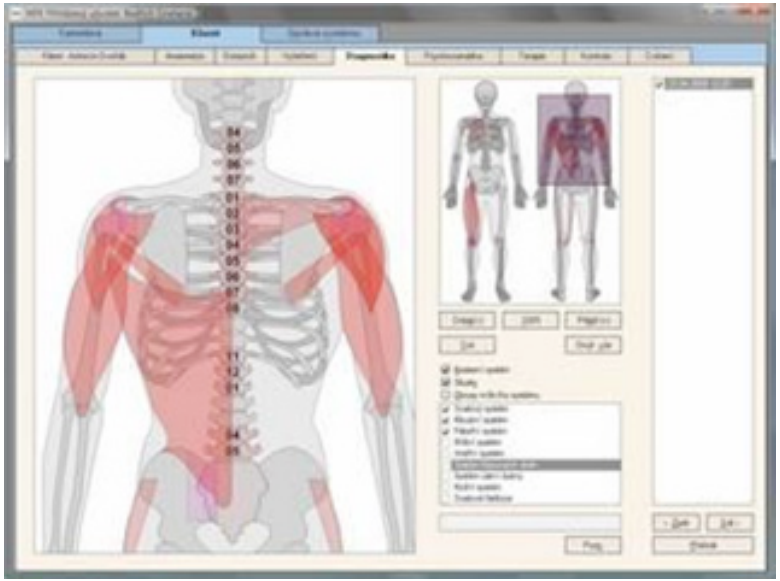
PEAS: Automated Taxi

- Performance measure
  - Time, income, happy customer, vehicle costs, fines, insurance premiums
- Environment
  - US streets, other drivers, customers
- Actuators
  - Steering, brake, display/speaker
- Sensors
  - Camera, radar, accelerometer, engine sensors

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, insurers, courts
- Actuators
  - Screen display, email
- Sensors
  - Keyboard/mouse, Scanner



Environment Types

Environment Types

- Fully Observable (vs. Partially Observable)
- Deterministic (vs. Stochastic)
- Episodic (vs. Sequential)
- Static (vs. Dynamic)
- Discrete (vs. Continuous)
- Single-Agent (vs. Multi-Agent):

Fully Observable vs. Partially-Observable Domains

- Fully-observable: The agent has access to all information in the environment relevant to its task.

- Partially-observable: Parts of the environment are inaccessible

Pacman	Crossword	Backgammon	Pick&Place Robot	Diagnosis	Taxi
Fully	Fully	Fully	Partially	Partially	Partially

Deterministic vs. Stochastic Domains

If an agent knew the initial state and its action, could it predict the resulting state? The dynamics can be:

- Deterministic: the resulting state is determined from the action and the state
- Stochastic: there is uncertainty about the resulting state

Pacman	Crossword	Backgammon	Pick&Place Robot	Diagnosis	Taxi
Deterministic	Deterministic	Stochastic	Stochastic	Stochastic	Stochastic

Episodic vs Sequential Domains

- Episodic: Current action is independent of previous actions.
- Sequential: Current choice of action will affect future actions

Pacman	Crossword	Backgammon	Pick&Place Robot	Diagnosis	Taxi
Sequential	Sequential	Sequential	Episodic	Sequential	Sequential

Static vs Dynamic Domains

- Static: Environment does not change while the agent is deliberating over what to do

- Dynamic: Environments does change

Pacman	Crossword	Backgammon	Pick&Place Robot	Diagnosis	Taxi
Static	Static	Static	Dynamic	Dynamic	Dynamic

Discrete vs Continuous Domains

- Discrete: A limited number of distinct, clearly defined states, percepts, actions, and time steps (otherwise continuous)

Pacman	Crossword	Backgammon	Pick&Place Robot	Diagnosis	Taxi
Discrete	Discrete	Discrete	Continuous	Continuous	Continuous

Single-agent vs. Multi-agent Domains

- Does the environment include other agents?
- If there are other agents whose actions affect us
  - It can be useful to explicitly model their goals and beliefs, and how they react to our actions
- Other agents can be: cooperative, competitive, or a bit of both

Pacman	Crossword	Backgammon	Pick&Place Robot	Diagnosis	Taxi
Multi	Single	Multi	Single	Single	Multi

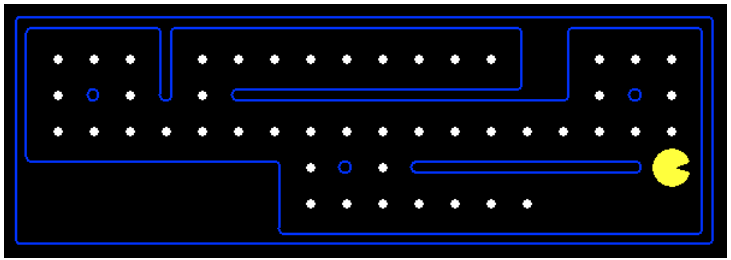
Environment Types: Summary

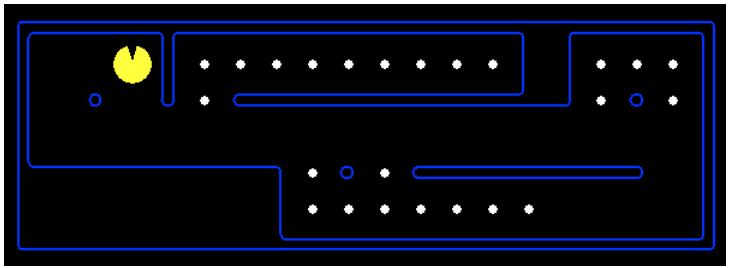
	Pacman	Crossword	Backgammon	Pick&Place Robot	Diagnosis	Taxi
Fully or Partially Observable	Fully	Fully	Fully	Partially	Partially	Partially
Deterministic or Stochastic	Deterministic	Deterministic	Stochastic	Stochastic	Stochastic	Stochastic
Episodic or Sequential	Sequential	Sequential	Sequential	Episodic	Sequential	Sequential
Static or Dynamic	Static	Static	Static	Dynamic	Dynamic	Dynamic
Discrete or Continuous	Discrete	Discrete	Discrete	Continuous	Continuous	Continuous
Single-agent or Multiagent	Multi	Single	Multi	Single	Single	Multi

Agent Types

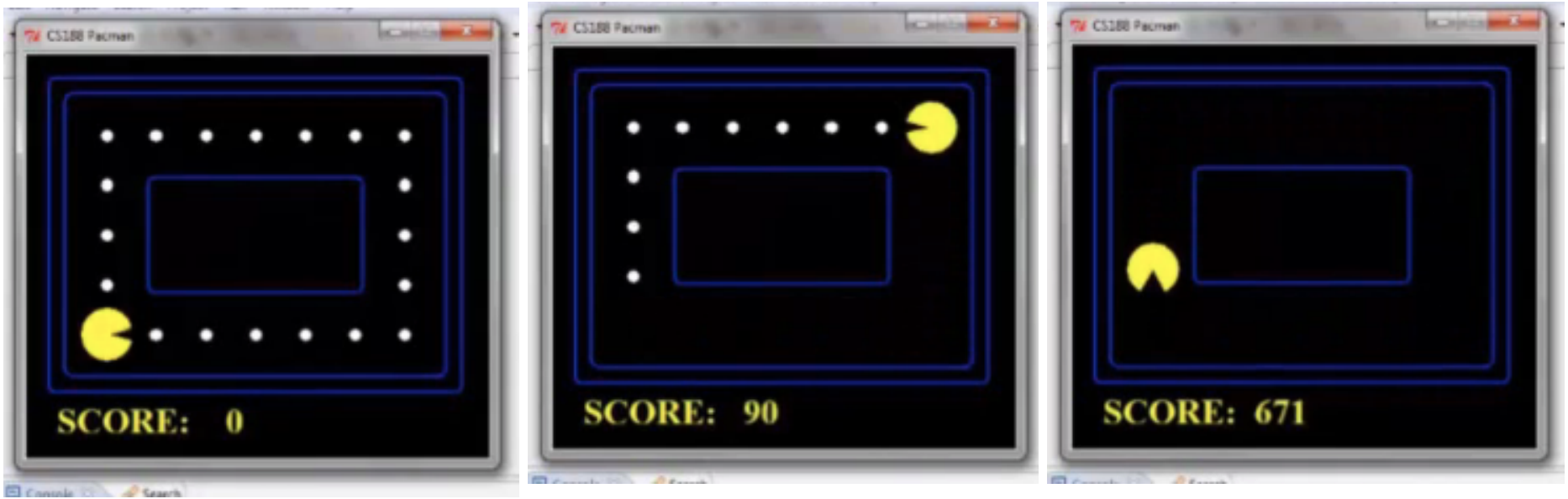
Reflex Agents

- 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
- Can a reflex agent be rational?

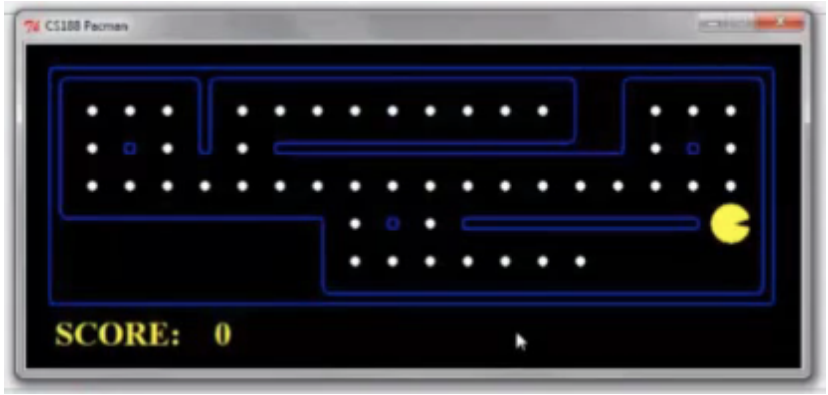


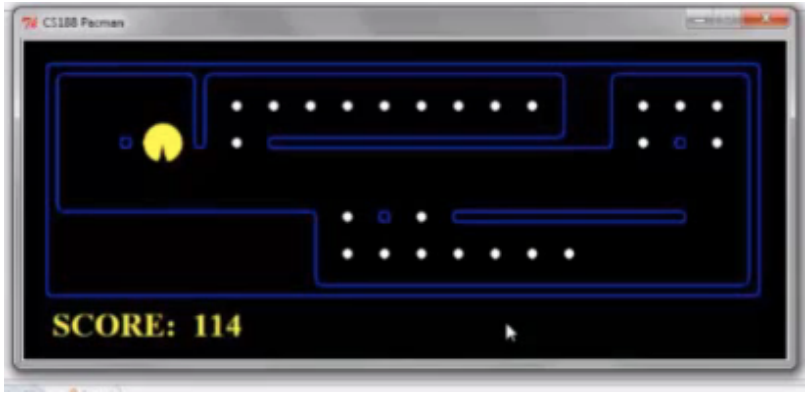


Video of Demo Reflex Optimal



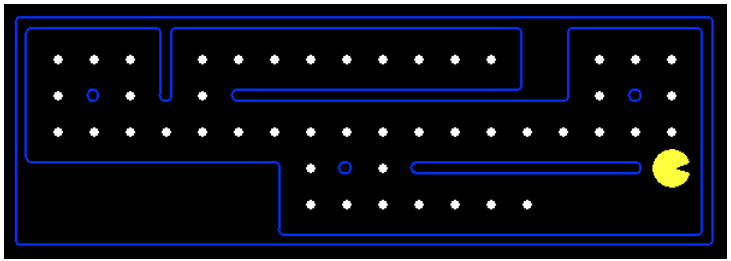
Video of Demo Reflex Odd

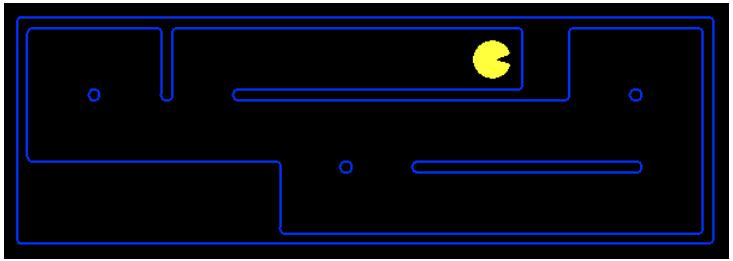




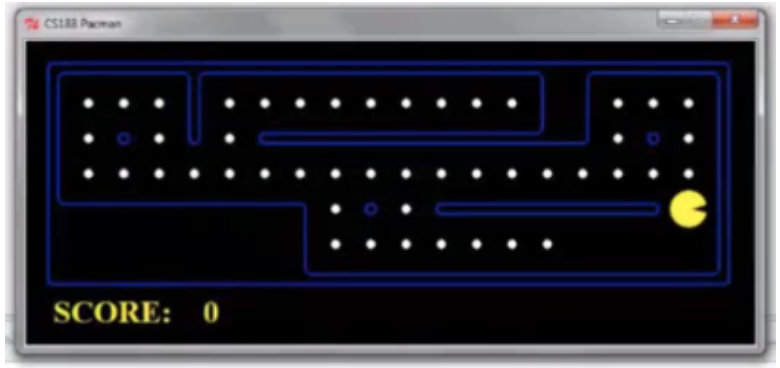
Planning Agents

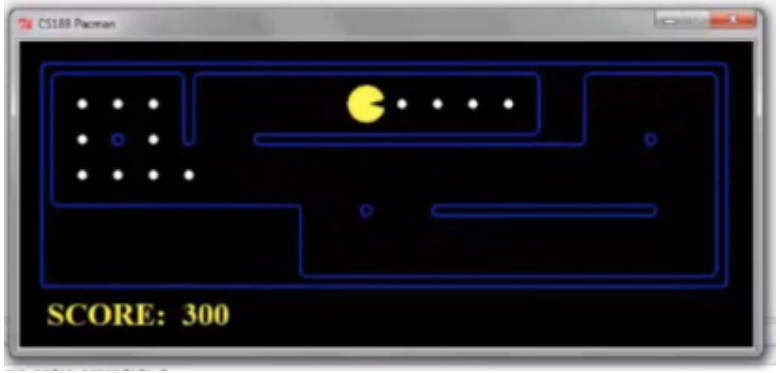
- Planning agents:
  - Ask “what if”
  - Decisions based on (hypothesized) consequences of actions
  - Must have a model of how the world evolves in response to actions
  - Must formulate a goal (test)
  - Consider how the world WOULD BE
- Optimal vs. complete planning
- Planning vs. replanning



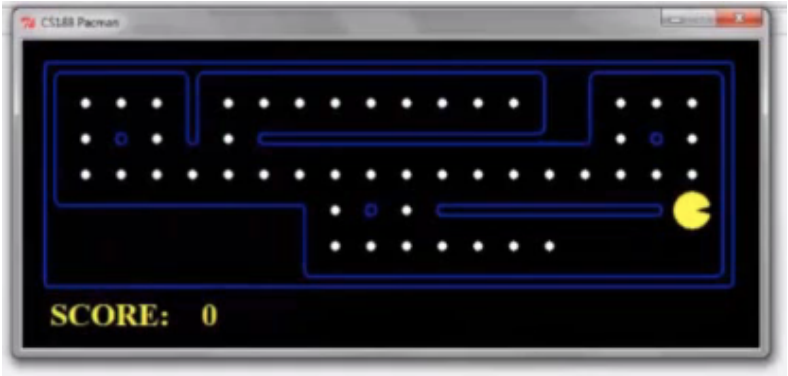


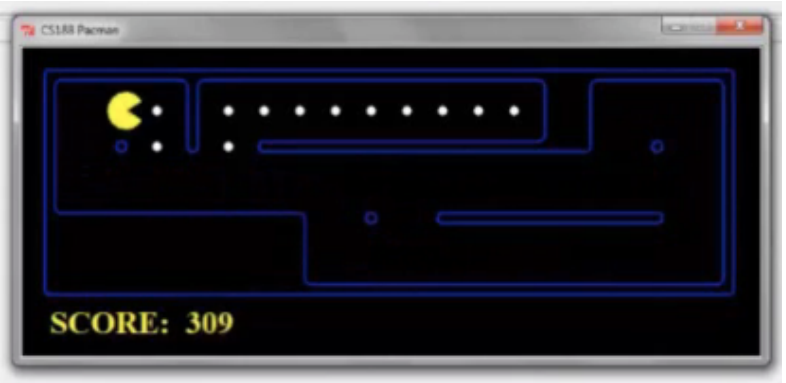
Video of Demo Replanning

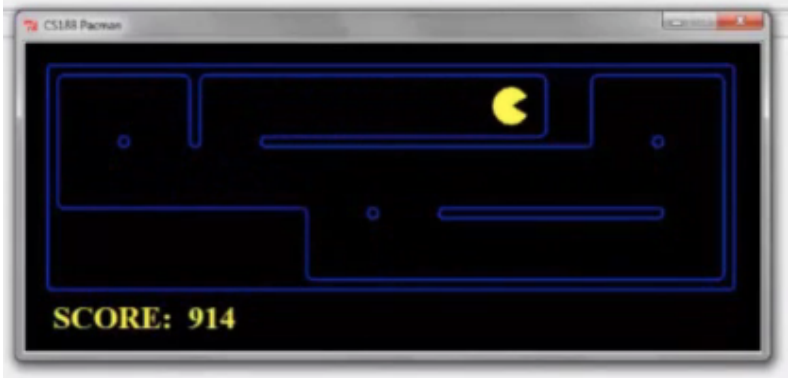




Video of Demo Mastermind



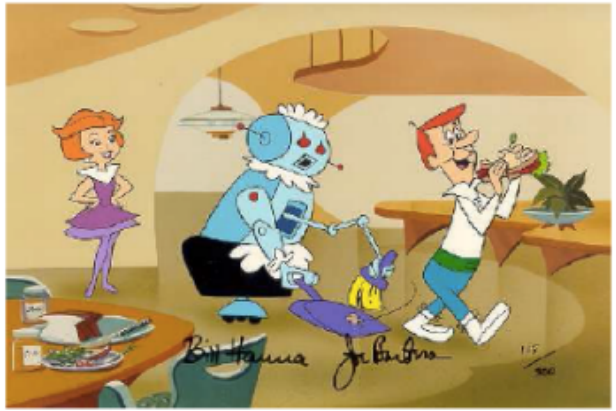


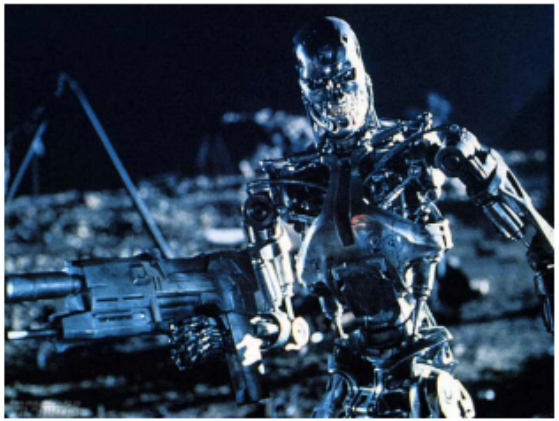


Ethics and Implications

- Robust, fully autonomous agents in the real world

- What happens when we achieve this goal?





Ethics and Implications

- Who is liable if a robot driver has an accident?
- What will we do with superintelligent machines?
- Would such machines have conscious existence? Rights?
- Can human minds exist indefinitely within machines (in principle)?

Reading

- Chapter 2 in the AIMA textbook