Good Afternoon, Colleagues
Good Afternoon, Colleagues

Are there any questions?
Logistics

● Questions about the syllabus?
Logistics

• Questions about the syllabus?

• Class registration
Logistics

- Questions about the syllabus?
- Class registration
- Problems with the assignment?
Logistics

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- Class registration
- Problems with the assignment?
- Mailing list — announcements yesterday
Logistics

- Questions about the syllabus?
- Class registration
- Problems with the assignment?
- Mailing list — announcements yesterday
  - CC Daniel (urieli@cs), and me on everything
Logistics

- Questions about the syllabus?
- Class registration
- Problems with the assignment?
- Mailing list — announcements yesterday
  - CC Daniel (urieli@cs), and me on everything
- Assignments up through week 3
Logistics

• Questions about the syllabus?

• Class registration

• Problems with the assignment?

• Mailing list — announcements yesterday
  – CC Daniel (urieli@cs), and me on everything

• Assignments up through week 3
Example Intelligent (autonomous) Agents

- Autonomous robot
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- Autonomous robot

- Information gathering agent
  - Find me the cheapest?
Example Intelligent (autonomous) Agents

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  - Find me the cheapest?
- E-commerce agents
  - Decides what to buy/sell and does it
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- Air-traffic controller
Example Intelligent (autonomous) Agents

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- Information gathering agent
  - Find me the cheapest?

- E-commerce agents
  - Decides what to buy/sell and does it

- Air-traffic controller

- Meeting scheduler
Example Intelligent (autonomous) Agents

- 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
Your Examples

- Cooking agent (*6!),
Your Examples

- Cooking agent (*6!), grocery shopper, jellybean sorter
Your Examples

- Cooking agent (*6!), grocery shopper, jellybean sorter
- piano tuner, music analyzer
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- Mario Bros. player, Mario Kart driver
Your Examples

• Cooking agent (*6!), grocery shopper, jellybean sorter
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- Cooking agent (*6!), grocery shopper, jellybean sorter
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- Mario Bros. player, Mario Kart driver
- Autonomous toothbrush
- Survivor search helicopter, autonomous lawn mower, Roomba, parallel parking car, GPS navigation device, automated car wash, Saluter robot

Peter Stone
Your Examples

- Cooking agent (*6!), grocery shopper, jellybean sorter
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- Survivor search helicopter, autonomous lawn mower, Roomba, parallel parking car, GPS navigation device, automated car wash, Saluter robot
- Interplanetary gold explorer robot, missile interceptor
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- Price setter for online merchant
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- Interplanetary gold explorer robot, missile interceptor
- Movie suggestion agent, automated author
- price setter for online merchant
- house alarm system, gentle alarm clock, treadmill, dog trainer,
Your Examples

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- price setter for online merchant
- house alarm system, gentle alarm clock, treadmill, dog trainer, cat tail grabber
- RFID door lock, vaccine nanobot,
Your Examples

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- Interplanetary gold explorer robot, missile interceptor
- Movie suggestion agent, automated author
- price setter for online merchant
- house alarm system, gentle alarm clock, treadmill, dog trainer, cat tail grabber
- RFID door lock, vaccine nanobot, human exam taker, super hero
Environments

Environment $\rightarrow$ sensations, actions
Environments

- Environment $\leftrightarrow$ sensations, actions

- fully observable vs. partially observable (accessible)
Environments

Environment $\iff$ sensations, actions

- fully observable vs. partially observable (accessible)
- single-agent vs. multiagent
Environments

Environment $\mapsto$ sensations, actions

- fully observable vs. partially observable (accessible)
- single-agent vs. multiagent
- deterministic vs. non-deterministic
Environments

Environment $\rightarrow$ sensations, actions

- fully observable vs. partially observable (accessible)
- single-agent vs. multiagent
- deterministic vs. non-deterministic
- episodic vs. sequential
Environments

Environment \implies \text{sensations, actions}

- fully observable vs. partially observable (accessible)
- single-agent vs. multiagent
- deterministic vs. non-deterministic
- episodic vs. sequential
- static vs. dynamic
Environments

Environment $\rightarrow$ sensations, actions

- fully observable vs. partially observable (accessible)
- single-agent vs. multiagent
- deterministic vs. non-deterministic
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- static vs. dynamic
- discrete vs. continuous
Environments

- Environment $\rightarrow$ sensations, actions

- fully observable vs. partially observable (accessible)
- single-agent vs. multiagent
- deterministic vs. non-deterministic
- episodic vs. sequential
- static vs. dynamic
- discrete vs. continuous
- known vs. unknown
An Example
An Example

- You, as a class, act as a learning agent
An Example

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- **Actions**: Wave, Stand, Clap
An Example

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- **Actions**: Wave, Stand, Clap
- **Observations**: colors, reward
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- **Actions**: Wave, Stand, Clap
- **Observations**: colors, reward
- **Goal**: Find an optimal *policy*
An Example

- You, as a class, act as a learning agent

- **Actions**: Wave, Stand, Clap

- **Observations**: colors, reward

- **Goal**: Find an optimal *policy*
  - Way of selecting actions that gets you the most reward
How did you do it?
How did you do it?

- What is your policy?
- What does the world look like?
Formalizing the Activity

Knowns:
Formalizing the Activity

Knowns:

- $\mathcal{O} = \{\text{Blue, Red, Green, Black, } \ldots\}$
- Rewards in $\mathbb{R}$
- $\mathcal{A} = \{\text{Wave, Clap, Stand}\}$

$o_0, a_0, r_0, o_1, a_1, r_1, o_2, \ldots$
Formalizing the Activity

Knowns:

- $\mathcal{O} = \{\text{Blue, Red, Green, Black, . . .}\}$
- Rewards in $\mathbb{R}$
- $\mathcal{A} = \{\text{Wave, Clap, Stand}\}$

Unknowns:

- $o_0, a_0, r_0, o_1, a_1, r_1, o_2, \ldots$
Formalizing the Activity

Knowns:

• \( \mathcal{O} = \{ \text{Blue, Red, Green, Black, } \ldots \} \)
• Rewards in \( \mathbb{R} \)
• \( \mathcal{A} = \{ \text{Wave, Clap, Stand} \} \)

Unknowns:

• \( S = 4 \times 3 \) grid
• \( \mathcal{R} : S \times \mathcal{A} \mapsto \mathbb{R} \)
• \( \mathcal{P} = S \mapsto \mathcal{O} \)
• \( \mathcal{T} : S \times \mathcal{A} \mapsto S \)

\[ o_0, a_0, r_0, o_1, a_1, r_1, o_2, \ldots \]
Formalizing the Activity

Knowns:

- \( \mathcal{O} = \{\text{Blue, Red, Green, Black, ...}\} \)
- Rewards in \( \mathbb{R} \)
- \( \mathcal{A} = \{\text{Wave, Clap, Stand}\} \)

\[
\begin{align*}
o_0, a_0, r_0, o_1, a_1, r_1, o_2, & \ldots
\end{align*}
\]

Unknowns:

- \( \mathcal{S} = 4 \times 3 \) grid
- \( \mathcal{R} : \mathcal{S} \times \mathcal{A} \rightarrow \mathbb{R} \)
- \( \mathcal{P} = \mathcal{S} \rightarrow \mathcal{O} \)
- \( \mathcal{T} : \mathcal{S} \times \mathcal{A} \rightarrow \mathcal{S} \)

\[
o_i = \mathcal{P}(s_i)
\]
Formalizing the Activity

Knocks:

- \( \mathcal{O} = \{ \text{Blue, Red, Green, Black, \ldots} \} \)
- Rewards in \( \mathbb{R} \)
- \( \mathcal{A} = \{ \text{Wave, Clap, Stand} \} \)

\[
\begin{align*}
o_0, a_0, r_0, o_1, a_1, r_1, o_2, \ldots
\end{align*}
\]

Unknowns:

- \( \mathcal{S} = 4\times3 \) grid
- \( \mathcal{R} : \mathcal{S} \times \mathcal{A} \rightarrow \mathbb{R} \)
- \( \mathcal{P} = \mathcal{S} \rightarrow \mathcal{O} \)
- \( \mathcal{T} : \mathcal{S} \times \mathcal{A} \rightarrow \mathcal{S} \)

\[
o_i = \mathcal{P}(s_i) \quad \quad r_i = \mathcal{R}(s_i, a_i)
\]
Formalizing the Activity

**Knowns:**

- \( \mathcal{O} = \{ \text{Blue, Red, Green, Black, \ldots} \} \)
- Rewards in \( \mathbb{R} \)
- \( \mathcal{A} = \{ \text{Wave, Clap, Stand} \} \)

**Unknowns:**

- \( \mathcal{S} = 4 \times 3 \) grid
- \( \mathcal{R} : \mathcal{S} \times \mathcal{A} \rightarrow \mathbb{R} \)
- \( \mathcal{P} : \mathcal{S} \rightarrow \mathcal{O} \)
- \( \mathcal{T} : \mathcal{S} \times \mathcal{A} \rightarrow \mathcal{S} \)

\[
\begin{align*}
o_i &= \mathcal{P}(s_i) & r_i &= \mathcal{R}(s_i, a_i) & s_{i+1} &= \mathcal{T}(s_i, a_i)
\end{align*}
\]
Formalizing the Activity

Knowns:

- $O = \{\text{Blue, Red, Green, Black, \ldots}\}$
- Rewards in $\mathbb{R}$
- $A = \{\text{Wave, Clap, Stand}\}$

Unknows:

- $S = 4 \times 3$ grid
- $R : S \times A \mapsto \mathbb{R}$
- $P = S \mapsto O$
- $T : S \times A \mapsto S$

$o_i = P(s_i) \quad r_i = R(s_i, a_i) \quad s_{i+1} = T(s_i, a_i)$
Self-Introductions

• Speak loudly
Self-Introductions

- Speak loudly
- Name, year, major
Self-Introductions

- Speak loudly
- Name, year, major
- At least one other thing about yourself
Next week: Search

- Textbook readings
- Responses both Monday and Wednesday
- Python tutorial due