

# CS440/ECE 448 Lecture 1: Introduction to AI

Mark Hasegawa-Johnson, 1/2023

Lecture slides: CC0



# Outline

- What is Artificial Intelligence?
  - Human-like? Rational? Autonomous? Conscious?
  - Seven things an AI should be able to do
  - Environments in which an AI can operate
- Syllabus
  - Text
  - Web Page, Office Hours, and CampusWire
  - Grades: Quizzes, MPs, Exams, and Project
  - Lectures

# What Is Artificial Intelligence?

- Human-like: Is it able to communicate with human beings, and explain or demonstrate its reasoning to them?
- Rational: Does it always act in a manner that maximizes its expected performance metric?
- Autonomous: Is it capable of revising its sensor→action mapping in response to changes in the environment?
- Conscious: Does it sense, feel, and know the history and present of all of its relationships to other people and to the universe as a whole?

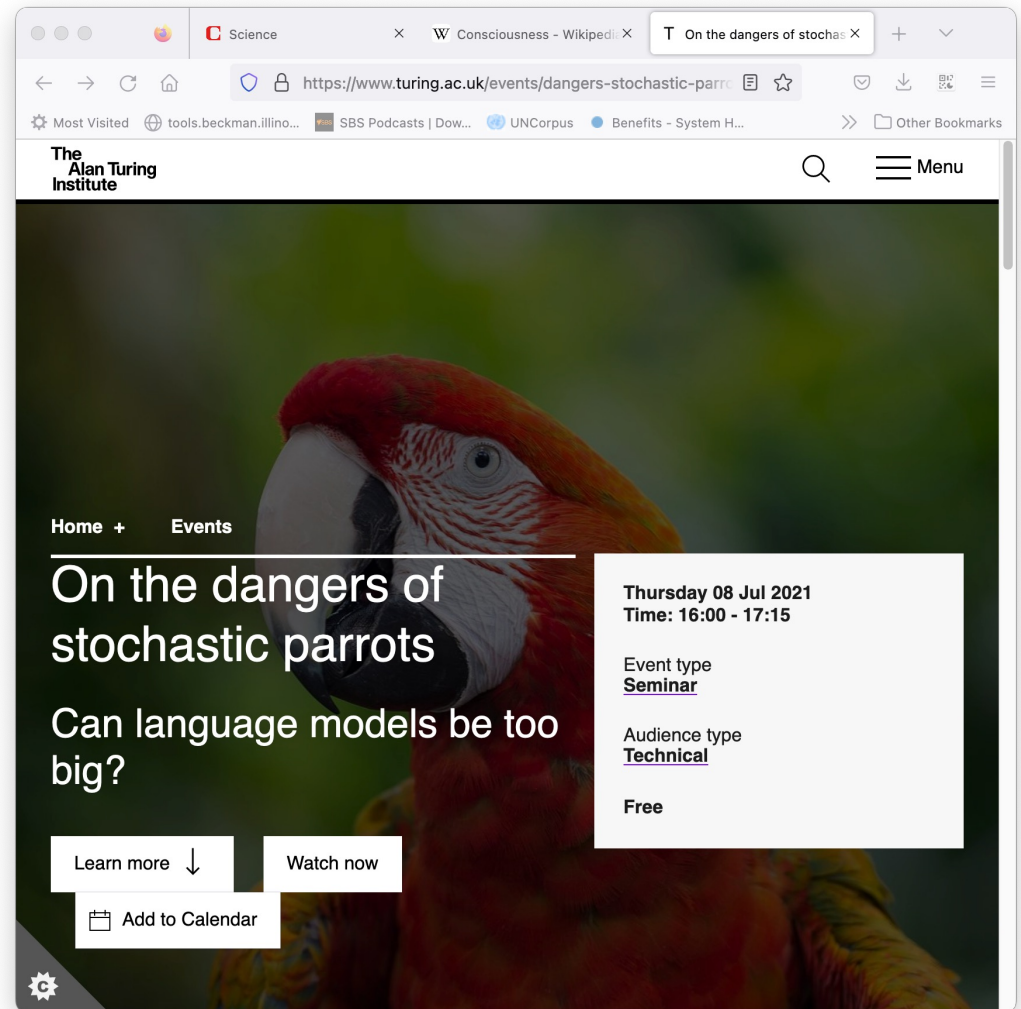
# Human-likeness

The Turing test proposes that an AI is intelligent if a human interviewer can't tell whether it is human.

Modern AI routinely fools humans.

It does so by performing as a "Stochastic Parrot:" given a prompt, the AI repeats what a well-read human would have said in response to that prompt.

Is that intelligence?

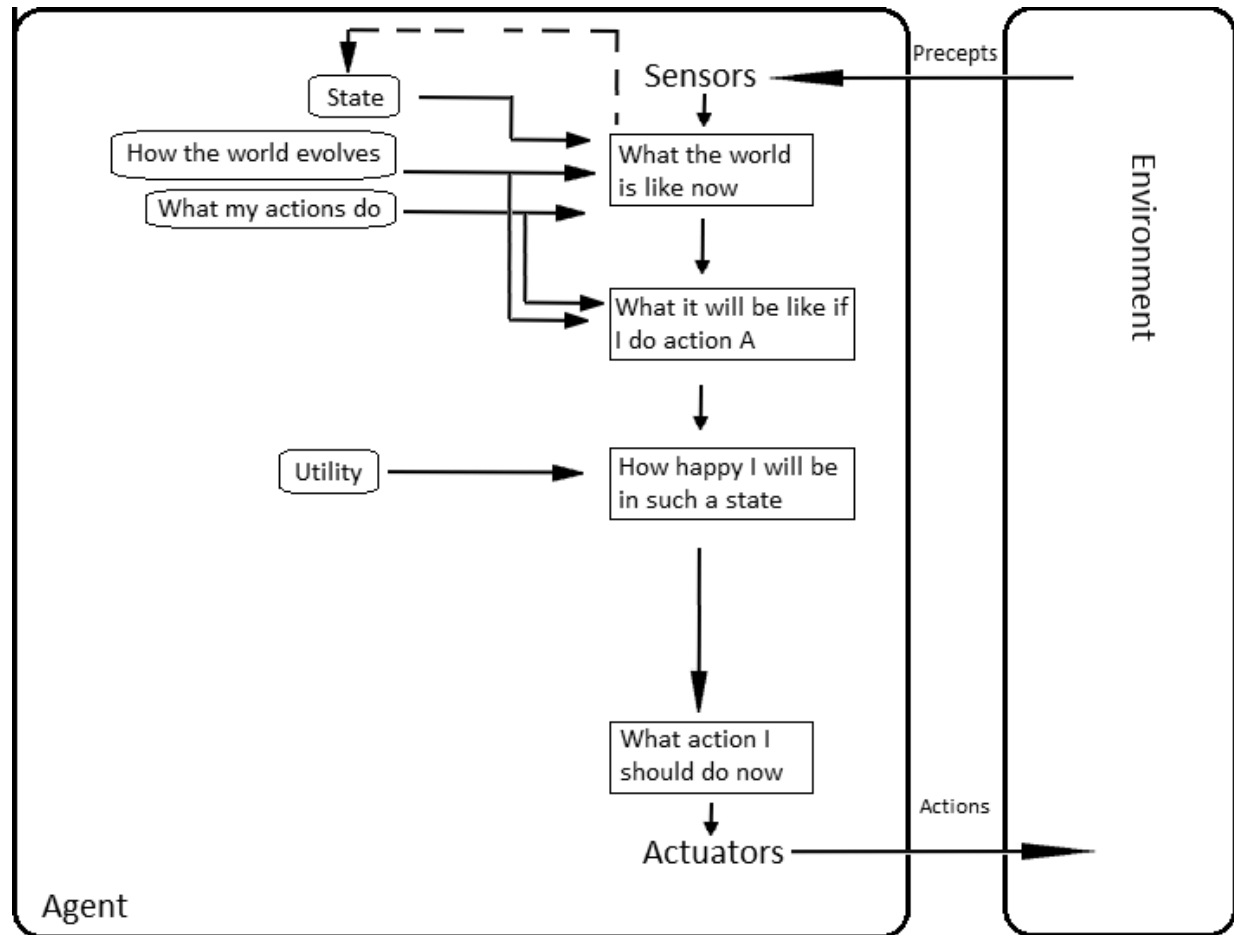


The screenshot shows a web browser window with the URL <https://www.turing.ac.uk/events/dangers-stochastic-parrots>. The page is for an event titled "On the dangers of stochastic parrots" at The Alan Turing Institute. The event is scheduled for Thursday 08 Jul 2021, from 16:00 to 17:15. It is a free seminar with a technical audience type. The main text on the page asks "Can language models be too big?". There are buttons for "Learn more", "Watch now", and "Add to Calendar". The background of the page features a close-up image of a red and yellow macaw parrot.

Ad from the Turing Institute for a lecture by Emily Menon Bender about the article she co-wrote with Gebru, McMillan-Major, and Gebru.

# Rationality

- It has been argued that the Turing test is too human-centric. How would we know if an Elephant is intelligent? An Extraterrestrial? A Robot?
- The most commonly proposed alternative is **rationality**: the quality of being guided by reasons.



# Autonomy

An agent is “autonomous” if it is capable of revising its own behavior in response to changes in the environment.



The [quadrupedal military robot Cheetah](#), an evolution of [BigDog](#) (pictured), was clocked as the world's fastest legged robot in 2012. Open-source image, DARPA strategic plan 2007.

# But do those things make it “intelligent”?

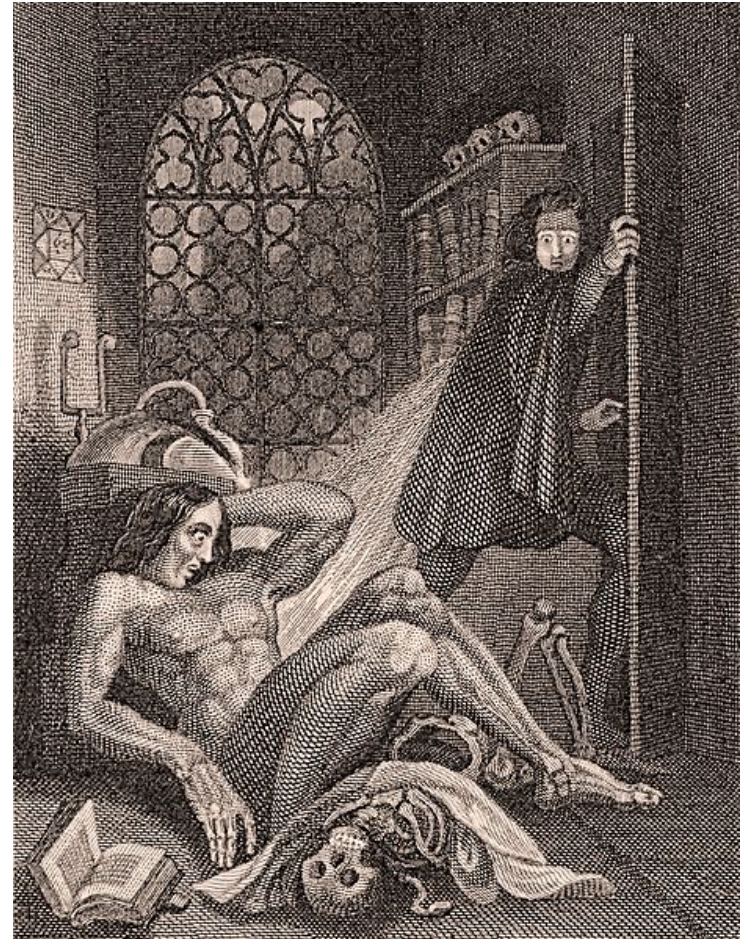
If an agent is:

- Human-like,
- Rational, and
- Autonomous...

Does that make it intelligent?

By “intelligent,” do we mean “conscious”?

- Science fiction leads us to think that an “intelligent” agent should be one that is self-aware in the way we are: conscious.
- ... but we currently have no way to test whether a given agent is conscious.



Frankenstein, 1831 edition. Public domain image.



# Outline

- What is Artificial Intelligence?
  - Human-like? Rational? Autonomous? Conscious?
  - Seven things an AI should be able to do
  - Environments in which an AI can operate
- Syllabus
  - Text
  - Web Page, Office Hours, and CampusWire
  - Grades: Quizzes, MPs, Exams, and Project
  - Lectures

# Seven things an AI should be able to do

Without any need for consciousness...

- Make rational (reason-guided) decisions
- Learn
- Plan (solve problems)
- Understand what it has learned (make inferences)
- Communicate using natural language
- Perceive its environment
- Act on its environment

# Outline of this Course

Topics for this semester will roughly follow the “seven things an AI should be able to do.”

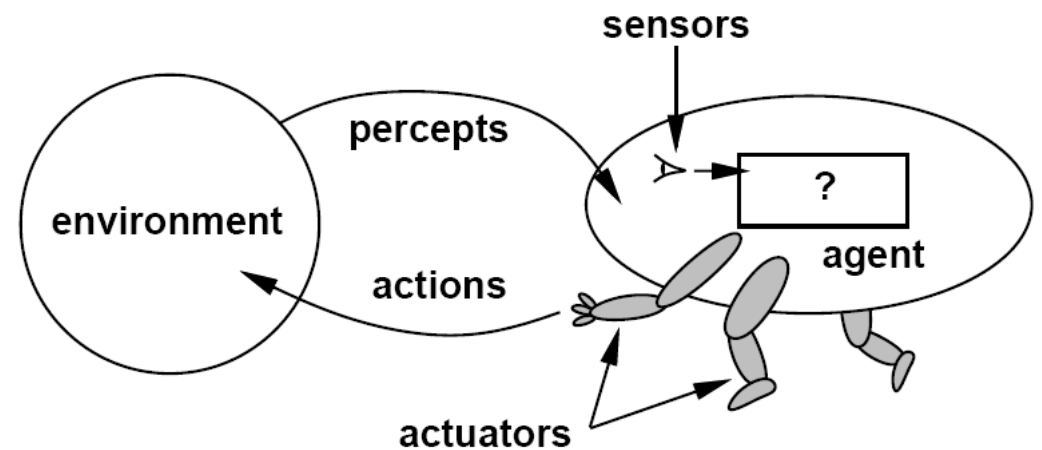
| Topic         | Week | Day | Quiz   | Slides                 | MP          | Reading          |
|---------------|------|-----|--------|------------------------|-------------|------------------|
| Intro         | 1    | W   | 18-Jan | Welcome & Intro        |             | 2.1-5            |
| Deciding      |      | F   | 20-Jan | Random Variables       |             | 12.1-7           |
|               | 2    | M   | 23-Jan | Decision Theory        |             | 16.1-4           |
|               |      | W   | 25-Jan | Naïve Bayes            | Probability | 20.2.1-2;23.1.1  |
|               |      | F   | 27-Jan | Game Theory            |             | 18.2             |
| Learning      | 3    | M   | 30-Jan | Fairness               |             | 27.3.3           |
|               |      | W   | 1-Feb  | Learning               | Naïve Bayes | 19.1-5;7         |
|               |      | F   | 3-Feb  | Linear Regression      |             | 19.6             |
|               | 4    | M   | 6-Feb  | Linear Classifiers     |             | 19.6             |
|               |      | W   | 8-Feb  | Multilayer Networks    | KNN         | 21.1-2           |
|               |      | F   | 10-Feb | PyTorch                |             | Pytorch tutorial |
|               | 5    | M   | 13-Feb | Optimization           |             | 4.1-5            |
|               |      | W   | 15-Feb | Privacy                | Neural Nets | 27.3.2           |
|               |      | F   | 17-Feb | Exam 1 Review          |             |                  |
| Planning      | 6    | M   | 20-Feb | Exam 1                 |             |                  |
|               |      | W   | 22-Feb | Search                 |             | 3.1-4            |
|               |      | F   | 24-Feb | A* Search              |             | 3.5-6            |
|               | 7    | M   | 27-Feb | Minimax                |             | 5.1-3            |
|               |      | W   | 1-Mar  | AI Safety              | Search      | 27.3.7           |
|               |      | F   | 3-Mar  | Logic                  |             | 7.1-7            |
| Understanding | 8    | M   | 6-Mar  | Ontology               |             | 10.1-6           |
|               |      | W   | 8-Mar  | Bayesian Networks      | Logic       | 13.1-3           |
|               |      | F   | 10-Mar | Transparency           |             | 27.3.4           |
| Communicating | 9    | M   | 20-Mar | HMM                    |             | 14.1-3           |
|               |      | W   | 22-Mar | Parsing                | Bayes Nets  | 23.1-4           |
|               |      | F   | 24-Mar | DL for NLP             |             | 24.1-6           |
|               | 10   | M   | 27-Mar | Convolutional Networks |             | 21.3             |
|               |      | W   | 29-Mar | Consciousness          | HMM         | 27.2;27.3.6      |
|               |      | F   | 31-Mar | Exam 2 Review          |             |                  |
| Perceiving    | 11   | M   | 3-Apr  | Exam 2                 |             |                  |
|               |      | W   | 5-Apr  | Computer Vision        |             | 25.1-5           |
|               |      | F   | 7-Apr  | Robot Perception       |             | 26.1-4           |
|               | 12   | M   | 10-Apr | Kalman Filter          |             | 14.4             |
|               |      | W   | 12-Apr | Autonomous Weapons     | Perception  | 27.3.1           |
|               |      | F   | 14-Apr | MDP                    |             | 17.1-3           |
| Acting        | 13   | M   | 17-Apr | Model-Based RL         |             | 22.1-2           |
|               |      | W   | 19-Apr | Model-Free RL          | MDP         | 22.3             |

# Outline

- What is Artificial Intelligence?
  - Human-like? Rational? Autonomous? Conscious?
  - Seven things an AI should be able to do
  - Environments in which an AI can operate
- Syllabus
  - Text
  - Web Page, Office Hours, and CampusWire
  - Grades: Quizzes, MPs, Exams, and Project
  - Lectures

# The abilities of an AI need to be matched to the properties of its environment

- Fully observable vs. partially observable
- Deterministic vs. stochastic
- Episodic vs. sequential
- Static vs. dynamic
- Discrete vs. continuous
- Single agent vs. multi-agent
- Known vs. unknown

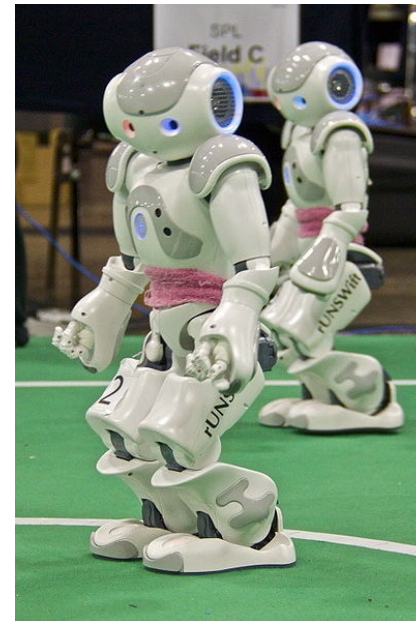


# Fully observable vs. Partially observable

- Do the agent's sensors give it access to the complete state of the environment?
  - For any given world state, are the values of all the variables known to the agent?



VS.



Source: L. Zettlemoyer

## Deterministic vs. Stochastic

- Is the next state of the environment completely determined by the **current state** and the **agent's action**?
  - Is the transition model **deterministic** (unique successor state given current state and action) or **stochastic** (distribution over successor states given current state and action)?
  - **strategic**: the environment is deterministic except for the actions of other agents



VS.

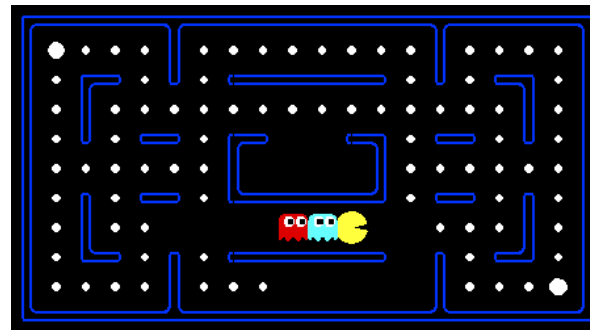


# Episodic vs. Sequential

- Is the agent's experience divided into unconnected episodes, or is it a coherent sequence of observations and actions?
  - Does each problem instance involve just one action or a series of actions that change the world state according to the transition model?



VS.





## Static vs. Dynamic

- Is the world changing while the agent is thinking?

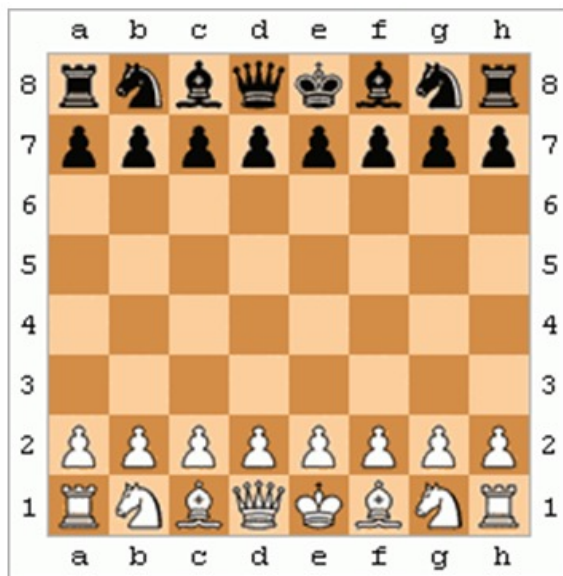


vs.

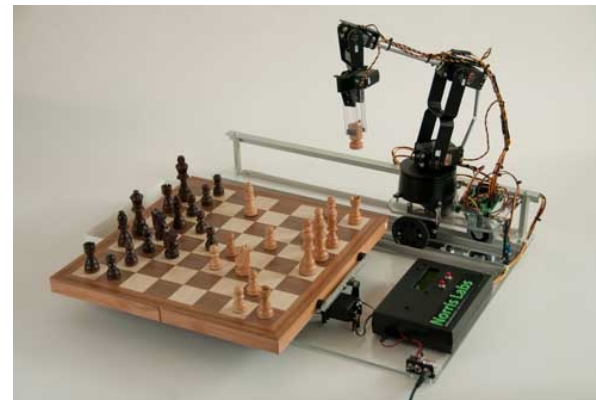


## Discrete vs. Continuous

- Does the environment provide a countable (discrete) or uncountably infinite (continuous) number of distinct percepts, actions, and environment states?
  - Are the values of the state variables discrete or continuous?
  - Time can also evolve in a discrete or continuous fashion
  - “Distinct” = different values of utility



VS.

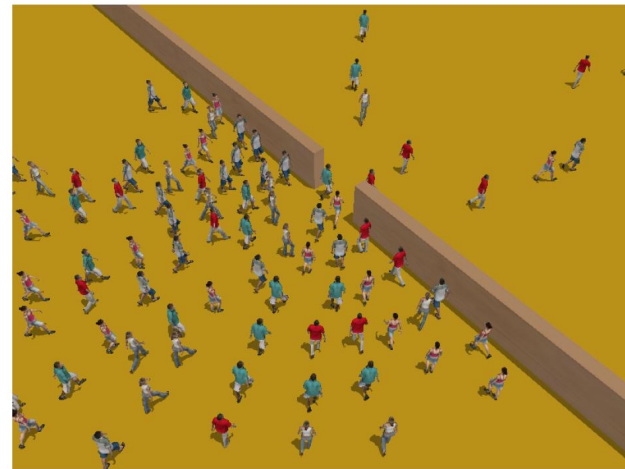


# Single-agent vs. Multi-agent

- Is an agent operating by itself in the environment?



vs.



# Known vs. Unknown

- Are the rules of the environment (transition model and rewards associated with states) known to the agent?
  - Strictly speaking, not a property of the environment, but of the agent's state of knowledge



vs.



# Quiz question

Go to [https://us.prairielearn.com/pl/course\\_instance/129874/](https://us.prairielearn.com/pl/course_instance/129874/)

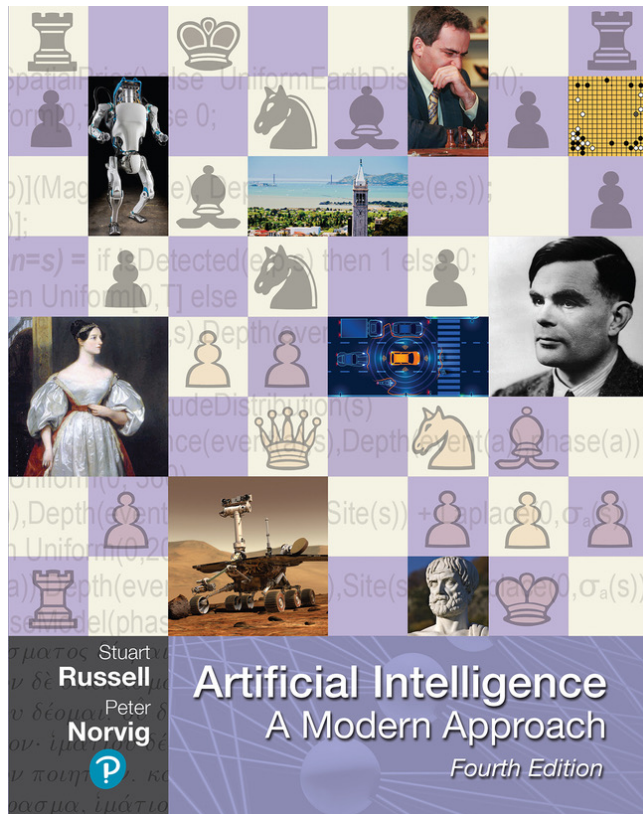
Join the course

Take the quiz called “18-Jan”

# Outline

- What is Artificial Intelligence?
  - Human-like? Rational? Autonomous? Conscious?
  - Seven things an AI should be able to do
  - Environments in which an AI can operate
- Syllabus
  - Text
  - Web Page, Office Hours, and CampusWire
  - Grades: Quizzes, MPs, Exams, and Project
  - Lectures

# Textbook



## Artificial Intelligence, A Modern Approach: Fourth Edition by Russell & Norvig

- Readings will be specified for each lecture.
- Material will only show up on exams if it has first appeared in the lecture slides, and usually, on a quiz or MP. Textbook is a backup, if you want deeper understanding.

Webpage: <https://courses.grainger.illinois.edu/ece448>

The screenshot shows a web browser window with the URL <https://courses.grainger.illinois.edu/ece448/sp2023/>. The page title is "CS440/ECE448 Artificial Intelligence, Spring 2023". The main content area features a 3x3 grid logo with a blue 'I' in the top right, a red swirl in the bottom right, and a blue robot in the bottom left. Below the logo is a "Table of Contents" section with links for "On-line Tools" and "Textbook". To the right, the "Contents:" section lists "Grades", "Quizzes, Machine Problems, and Lectures", "Exams", "Project", "Office Hours", and "Links". The "On-line Tools" section lists "CampusWire", "PrairieLearn", "Gradescope", and "Mediaspace". The "Textbook" section mentions "Russell and Norvig, Artificial Intelligence: A Modern Approach, fourth edition" and a "Python Tutorial". A sidebar on the left contains "Next topic: Grades", "This Page: Show Source", and a "Quick search" box with a "Go" button.

CS440/ECE448 Artificial Intelligence, Spring 2023

## CS440/ECE448 Artificial Intelligence, Spring 2023

This course provides an introductory survey of concepts and techniques in artificial intelligence. Intelligence is the ability to decide, learn, plan, understand, communicate, perceive, and act; AI is the creation of machines that do these things. This course gives a one- or two-week introduction to each of the seven aspects of intelligence, with pointers to key mathematical concepts, articles and books.

This course assumes that you have taken data structures (CS225) and random variables (e.g., CS 360, ECE 313).

Contents:

- Grades
- Quizzes, Machine Problems, and Lectures
- Exams
- Project
- Office Hours
- Links

### On-line Tools

- [CampusWire](#) will be used for on-line question answering. The enrollment code is available in the slides for lecture 1.
- [PrairieLearn](#) will be used for quizzes.
- [Gradescope](#) will be used for machine problems. The code to join Gradescope is on CampusWire.
- You can watch the lectures remotely on [Mediaspace](#). Videos are usually available two hours after the end of lecture.

### Textbook

The textbook is Russell and Norvig, [Artificial Intelligence: A Modern Approach](#), fourth edition.

You will also need a reference for Python, which we will use to write the MPs. A good place to start is the [Python Tutorial](#).



# LEVEL 02

## Office Hours

Office hours will be:

Every M,T,W,R

5:00-7:00 pm

Starting this Thursday,  
1/19

In-person only

ECEB 2036



# CampusWire

Add yourself to  
CampusWire if  
you're not already  
added:

<https://campuswire.com/c/G2DB4EC0D>,

Code 9176.

The screenshot shows a web browser window displaying a CampusWire class feed. The browser's address bar shows the URL <https://campuswire.com/c/G2DB4EC0D/feed/1>. The page is titled "Class feed" for "CS440/ECE448: Artificial Intelligence". A navigation sidebar on the left includes options for Notifications, DMs, Search, Class feed (selected), Rooms, Calendar, Files, Grades, and Settings. The main content area features a "New post" button and a recent post by Mark Hasegawa-Johnson. The post is titled "Welcome to CS440/ECE448! #1" and is categorized as "General". The post text includes a welcome message, a link to the course website (<https://courses.grainger.illinois.edu/ece448/sp2023/>), information about quizzes and machine problems submitted at [https://us.prairielearn.com/pl/course\\_instance/129874](https://us.prairielearn.com/pl/course_instance/129874), and other machine problems submitted at <https://www.gradescope.com/courses/486387>. It also mentions a final project submission link at <https://uofi.app.box.com/folder/189637771360>. The post has 0 likes, 0 comments, 1 mention, and 1 reaction. A comment input field is visible at the bottom of the page.

# Grading: Quizzes, MPs, Exams, Project

- Quizzes: 15% of 3-credit grade
  - Every lecture will have a quiz. Do it in class if you can.
  - Due: 23 hours after the end of lecture.
- Machine Problems: 45% of 3-credit grade
  - Every week will have an MP (11 in total)
  - Due: Every Wednesday, at 1:00pm, starting NEXT WEDNESDAY
- Exams: 40% of 3-credit grade
  - Will be held in person
- Project: 100% of the 4<sup>th</sup> credit
  - Seven project component deadlines throughout the semester

# Late Policy

- Quizzes, MPs, and Project components may be turned in late for partial credit:

$$\max\left(1 - \frac{t}{20}, 0.5\right)$$

where  $t$  is the lateness, in days. This policy is intentionally lenient: if you get sick, you can still turn in your homework late for most of the credit.

- Further exemptions from this late policy are not granted for illness, travel, or any other reason.

# Lectures

- Lectures are MWF, 1pm, Lincoln Hall Theater
- Lecture recordings are automatically posted, about 6 hours later, on MediaSpace

The screenshot shows a web browser window with the URL [https://mediaspace.illinois.edu/channel/CS%2B440\\_%2BECE%2B448](https://mediaspace.illinois.edu/channel/CS%2B440_%2BECE%2B448). The page features the MediaSpace Illinois logo and navigation menu. The main content area displays the channel name "CS 440/ ECE 448 2023 Spring" and a list of video thumbnails. The thumbnails include a blue diamond icon, a red flame icon, and a blue robot icon. Below the thumbnails, there are three buttons with the following text: "CS 440 Q3 2023 Spring CRN31423", "CS 440 Q4 2023 Spring CRN31424", "ECE 448 Q3 2023 Spring CRN31425", and "ECE 448 Q4 2023 Spring CRN31426".

# Welcome to Artificial Intelligence!

- Come to office hours tomorrow (1/19), 5pm in ECEB 2036, to meet some of your teaching assistants
- Get started on MP01
- See you on Friday!



iCub Production Lab,  
[https://commons.wikimedia.org/wiki/File:P058324-119830\\_\(cropped\).jpg](https://commons.wikimedia.org/wiki/File:P058324-119830_(cropped).jpg)