ECE 4524 Artificial Intelligence and Engineering Applications

Spring 2015 – CRNs 12472 (undergraduate), 20236 (graduate), and 20239 (CGEP/webex)
TR 4:00-5:15 in SURGE 118B and via WebEx
https://filebox.ece.vt.edu/~ECE4524

Today’s Schedule:
- What is AI?
- Introduce the Bounded Rational Agent
- Course objectives and content
- Course administration
What is AI?

ar-ti-fi-cial adjective
humanly contrived often on a natural model : MAN-MADE

in-tel-li-gence noun
the ability to learn or understand or to deal with new or trying situations : REASON; also : the skilled use of reason (2) : the ability to apply knowledge to manipulate one’s environment or to think abstractly as measured by objective criteria (as tests)
Human intelligence resides in the mind, the product of electro-chemical activity in our brain.

Some statistics:

- 3 lbs
- 100 billion neurons
- 100 trillion connections (synapses)

Further reading:

- Pinker, "How the Mind Works"
- Marcus, The Birth of the Mind: How a Tiny Number of Genes Creates the Complexities of Human Thought.

\(^1\)Image by Patrick Lynch, CC BY 2.5
What kind of intelligence are we talking about

Howard Gardner, 1983 "Frames of Mind: The Theory of Multiple Intelligences"

- musical
- visual
- verbal
- logical
- bodily
- interpersonal
- intrapersonal
- naturalistic
- moral?
How did we acquire it?

30,000 to 50,000 years ago humans became *behaviorally modern*. There are many theories about what drove this change. Two examples are:

- Social brain hypothesis
- Sexual selection

Ridley, 2003
Example milestones in human development

- 2 yo - recognize a wide variety of objects
- 4 yo - astounding language comprehension and production
- 6 yo - enough dexterity to tie shoes
- 8 yo - social skills develop, emotional intelligence
Some definitions of AI

Rich and Knight - An attempt to program computers to do things that people can do better

Winston - A study of the computations that make it possible to perceive, reason, and act

Our working definition will be: an attempt to program computers to do things that would be said to require intelligence if people did them.
Often the simplest tasks for humans are incredibly difficult in AI.
Often the simplest tasks for humans are incredibly difficult in AI.

Bill and Mary went out to a restaurant. After being seated they ordered from the menu. Later, they paid the check and went home.
But, often the simplest tasks for computers are difficult for humans.

After I read the following, try to recall it:
But, often the simplest tasks for computers are difficult for humans.

After I read the following, try to recall it:

- 1 5 7 4 0 2 4 8 5 1
But, often the simplest tasks for computers are difficult for humans.

After I read the following, try to recall it:

- 5 4 0 2 3 1 6 6 5 8
But, often the simplest tasks for computers are difficult for humans.

After I read the following, try to recall it:

1 2 3 3 2 1 1 2 3 3
And, humans often make mistakes

Partial list of human biases and cognitive errors

- Confirmation bias
- Framing
- Hindsight bias
- Availability Heuristic
- Anchoring
- IKEA effect
- on and on and on

The rotating snake illusion (Akiyoshi Kitaoka)

http://www.ritsumei.ac.jp/~akitaoka/rotsnake.gif
This is one of my favorites.

Margaret Thatcher (Peter Thompson, 1980)
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Margaret Thatcher (Peter Thompson, 1980)
Course Topics

- State-space search, solve complex problems by defining a state, transitions between states, and search for a solution
- Knowledge representation and reasoning, represent facts and use automated reasoning to arrive at conclusions
- Dealing with uncertainty and inference, uncertainty as probability and statistical inference
- How to make systems learn, create models with parameters that can be found given examples
The course is centered on the concept of a **rational agent**.

- Agents perceive their **environment** through **sensors** and act on the environment using **actuators**.
- A rational agent is one that makes decisions to optimize its **performance** given the percept sequence and any prior knowledge.

This tuple of descriptions, Performance, Environment, Actuators, Sensors, denoted PEAS characterizes a system.
PEAS == EASP

- **Environment**: the aspects of the environment the agent interacts with
  - observable? deterministic/stochastic
  - episodic/sequential static/dynamic
  - discrete/continuous single/multiple agent
- **Actuators**: what actions can the agent take, affects the environment
- **Sensors**: what percepts can the agent acquire
- **Performance**: embodies the criterion for success of an agent's behavior as seen by its effect on the environment
There are a variety of basic agent architectures.

- Simple Reflex
- Model-based
- Goal-based
- Utility-based
- Learning

Real systems usually end up as a hybrid among these.
Rational does not mean omniscient. Agents are bounded by:

- prior knowledge - what information has been provided by the designer
- time/energy - how much time (or energy) is available for exploration, learning, and decisions (actions to be taken).

A rational agent takes the action that maximizes performance given resource constraints, e.g. the information and time available (Herbert Simon).
A Problem is:

- An Environment
- An Agent with Sensors and Actuators
- A Performance measure

Consider a general programming interface that takes a problem description and simulates the agent.
Demos

- 8-Puzzle
- First-Order Logic
Course Schedule

- State-space search (1/27 - 2/12)
- Problem Set 1, Quiz 1
- Knowledge representation and reasoning (2/19 - 3/17)
- Problem Set 2, Quiz 2
- Dealing with uncertainty and inference (3/24 - 4/7)
- Problem Set 3, Quiz 3
- How to make systems learn (4/14 - 4/30)
- Problem Set 4, Quiz 4
Prerequisites

- ECE 2574 for knowledge of data structures and basic algorithms, complexity theory, and programming ability. I expect you to be able to read, understand, and write programs of a substantial nature independently.

- Probability (STAT 4714) is needed for the uncertainty and learning portions of the course.
We will be using Python (2.7) for program implementations.

- Python is a dynamic, strongly typed language with clear, readable syntax
- High level dynamic data types
- Extensive standard libraries and third party modules for virtually every task
- Has a REPL for fast experimentation

See [http://www.python.org/](http://www.python.org/) for pointers to documentation. Other resource links are available on the course website.
Texts and Resources


The books website is also very helpful with code, demo links, etc. http://aima.cs.berkeley.edu/
Course Activities

- Readings - Each meeting has a section of the text, see the reading guides to help you
- Warmups - due before (usually) every lecture, test basic understanding of assigned reading
- Lectures - I try to make these as interactive and interesting as possible
- Problem Sets - core of your learning, consists mostly of both exercises and engineering design problems (programming)
- Quizes

Note the undergraduate version of the course is four credit hours.
Grading

For CRN 12472 (4524) the grades will be computed as follows:

- **Warmups**: 5% (Extra Credit)
- **Problem Sets**: 68% (15% each + PS0)
- **Quizes**: 32% (8% each)

For CRNs 20236 and 20239 (5984) the same grading scheme is used as for 4524 with the addition of an independent course project.
Collaboration and Late Policy

- All assignments must be turned in via scholar by due date and time
- Record the Scholar Submission ID as proof of submission
- No late assignments will be accepted, with the following exception: you get three free late days (24 hour periods) during the semester to accommodate emergencies. To use one or more of these, just submit the assignment via scholar as normal.
- All graded work is expected to be the original work of the individual student unless otherwise directed.
Communication

Course Website: https://filebox.ece.vt.edu/~ECE4524
  ▶ syllabus, schedule, notes, etc.
  ▶ primary way materials are distributed.

Piazza: https://piazza.com/
  ▶ forum/wiki like software for QA, polls, announcements
  ▶ replaces email listserv, but has a configurable email digest
  ▶ much better than Scholar’s forum tool
  ▶ good mobile apps
  ▶ use it to ask (and answer) questions

Scholar: https://learn.vt.edu
  ▶ take warmups
  ▶ submit problem set solutions
  ▶ grades posted
Course Goals

At the end of the course you will be able to ...

- formulate a problem as state space search and write a program to solve it
- capture knowledge using logic-based grammar and write programs that can automatically reason
- write programs that can handle uncertainty
- write programs that can learn from experience
Questions ?
Next Actions

- Start PS0 - this is largely to get started with python
- Read through the Python Tutorial
- Take warmup before noon on Thursday 1/22.