CS 440 / ECE 448
Introduction to Artificial Intelligence
Fall 2010

Gerald DeJong dejong@cs.uiuc.edu
3320 SC
3-0491

Dae Hoon Park cs440ta@cs.illinois.edu
207 SC

See web site for office hours
• Text:

• Web Site:
  www.cs.illinois.edu/class/fa10/cs440/

• Newsgroup:
  class.fa10.cs440 on news.cs.illinois.edu

• All official announcements will be either in class or on the web site (or both)
Grading

• Graduate and Undergraduate graded separately

• Homework (written & MPs): ~ 25%

• In-class exercises: ~ 5%

• Midterm: ~35%
  – In class
  – October 7

• Final: ~35%
  – December 15
  – 1.25 hrs.
  – Focus primarily on material after midterm

• 4th Unit/Hour credit:
  – Significant programming project
  – Accompanying paper
  – Due last class
  – 25% of your grade

Check for conflicts now!

Let me know no later than two weeks from today of problems
Cheating

Unless specifically announced, you are expected to do each homework on your own. You may discuss concepts with your classmates, but there must be no interactions about solutions. You may consult the web but the work handed in must be done on your own.

The penalty for cheating on any assignment is straightforward. On the first occurrence, you will receive a zero for the assignment and your course grade will be reduced by one full letter grade. A second occurrence will result in course failure.
Homework

Unless announced in advance, solutions will be posted no sooner than two days after the due date. Homework will be accepted until that point with a penalty of 10% for any fraction of a day that it is late. No assignments will be accepted after the solutions have been posted. Late homework will only be accepted in class, during office hours, or electronically by email to the TA.

Homework regrades requests must be made within one week after the graded homework is returned (exam regrade requests must be made immediately).
About our Text

• Best available text, good but not perfect
• Assigned reading / HWs
• Also an excellent reference work
  – Overly complete; Very accurate; Usually std treatment
  – Feel free to consult other sources
  – You are responsible for integration
    Exams & homework assume accuracy of
    1) lectures 2) text 3) other sources

• Not as readable as some...
  SO ASK QUESTIONS in class!
  Expose & clear up confusions early
  Your classmates will appreciate it!!
We will assume that you

1) Attend & understand all lectures
2) Understand all assigned readings
3) Finish & understand all assignments satisfactorily

“Understand” means “can use knowledge productively”

Importance of concepts can be inferred from the above...
## Tentative Syllabus

<table>
<thead>
<tr>
<th>TOPIC</th>
<th>TEXT CHAPTERS</th>
<th>APPROX. BEGIN DATE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Introduction</td>
<td>1, 2, Appx.A</td>
<td>8/24</td>
</tr>
<tr>
<td>Models &amp; Search</td>
<td>3, 4</td>
<td>8/26</td>
</tr>
<tr>
<td>Logic &amp; Knowledge Rep.</td>
<td>7, 8, 9</td>
<td>9/7</td>
</tr>
<tr>
<td>Planning &amp; Action</td>
<td>10</td>
<td>9/14</td>
</tr>
<tr>
<td>Reinforcement Learning</td>
<td>17, 21</td>
<td>9/21</td>
</tr>
<tr>
<td>Uncertainty &amp; Statistics</td>
<td>13, 14</td>
<td>10/12</td>
</tr>
<tr>
<td>Machine Learning</td>
<td>18, 20</td>
<td>10/28</td>
</tr>
<tr>
<td>Applications</td>
<td>22, 24</td>
<td>11/18</td>
</tr>
<tr>
<td>Social/Phil. Implications</td>
<td>26</td>
<td>12/7</td>
</tr>
</tbody>
</table>
What you can expect from us

• What is AI?
• Why is it difficult?
• What can it do now?
• Where is it going?

Assignment:

Read Ch 3 & 4 on Search
Read Ch 1 & 2 at your leisure
Review & understand Appendix A
What is AI?

• An attempt to program computers to do things that would be said to require intelligence if done by people.

• A way to study the human mind.

• A formalization of “common sense.”

• A collection of methods and approaches.

• The next step in computer user friendliness and adaptivity.
What is Intelligence?

Fast thinking?
Knowing a lot?
Pass as a smart human?
Effective reasoning?

Being able to learn?
Perceiving and acting on one’s environment?
Writing poetry?
Passing an AI class?
Operational Definitions of AI

Thinking Humanly
“The automation of activities that we associate with human thinking, activities such as decision-making, problem solving, learning...”
[Bellman, 1978]

Thinking Rationally
“The study of mental faculties through the use of computational models.”
[Charniak & McDermott, 1985]

Acting Humanly
“The study of how to make computers do things at which, at the moment, people are better.”
[Rich & Knight, 1991]

Acting Rationally
“The branch of computer science that is concerned with the automation of intelligent behavior.”
[Luger & Stubblefield, 1993]
AI History

1943  McCulloch & Pitts: Boolean circuit model of brain
1950  Turing's ``Computing Machinery and Intelligence'‘ the imitation game
1950s  Early AI programs, including Samuel's checkers program, Newell & Simon's Logic Theorist, Gelernter's Geometry Engine
1956  McCarthy organizes Dartmouth meeting and includes Minsky, Shannon, Newell, Samuel, Simon
      Name “Artificial Intelligence'' adopted
1957  General Problem Solver [Newell, Simon, Shaw @ CMU]
1958  Creation of the MIT AI Lab by Minsky and McCarthy
1958  LISP, [McCarthy], second high level language (MIT AI Memo 1)
1963  Creation of the Stanford AI Lab by McCarthy
1965  Robinson's complete algorithm for logical reasoning
1966-74  AI discovers computational complexity ...
1966-72  Shakey, SRI’s Mobile Robot [Fikes, Nilson]
AI History (Cont.)

1969  Publication of “Perceptrons” [Minsky & Papert], Neural network research almost disappears
1969-79  Early development of knowledge-based systems
1970  SHRDLU, Winograd’s natural language system
1971  MACSYMA, an symbolic algebraic manipulation system
1980-88  Expert systems industry booms
1981  Japan: Fifth generation project
       US: Microelectronics and Computer Technology Corp.
       UK: Alvey
1988-93  Expert systems industry counters the feared “AI Winter"
1985-95  Rise of probabilistic / statistical approaches
1997  Deep Blue defeats reigning chess champion Gary Kasparov 3.5-2.5
2005  Stanley the car wins $2,000,000 DARPA Grand Challenge, autonomously driving 132 miles of desert roads
2009  BellKor’s Pragmatic Chaos wins Netflix collaborative filtering prize using ensemble ML methods.
Game Playing
Which are still interesting?

Tic Tac Toe   Never was interesting
Connect Four  Solved
Go-Moku       Solved
Qubic         Solved
Checkers      Probably solved
Othello       Much better than any human
Backgammon    Better than all but a few humans
Chess         Better than any / all but a few humans
Scrabble      Close to the best humans
Bridge        Worse than best players at local clubs
Go            Worse than the best 9 year old humans
Is Game-Playing Interesting?

Initially - “Yes”

Now - “No” *

Easy/Difficult for humans $\neq$ Easy/Difficult for computers
(often inverted!)

* Computational Game Theory is an important advanced topic in AI
What is Hard?

Making a bed
Walking / Running / Playing basketball
Feeding one’s self
Explaining / answering questions about a picture or natural language utterance
Mixed initiative / cooperative behavior
Reasoning under uncertainty / inferring missing structure

We’re so good it’s often hard to see why computers are bad
Embellishment is Essential

Unbiased Interpretation is Impossible
Understanding = Bias

These people were wrong (what / why?)

John Locke:
Empiricism (esp. *Tabula Rasa*)

Gene Roddenberry:
Star Trek’s Mr. Spock (too logical)

Robert Heinlein:
Fair Witness in *Stranger in a Strange Land*
(too literal)
These Sentences are Difficult (for computers, why?)

Newspaper headline during H1N1 flu scare:
Sick Teachers Pose a Problem

Twelve South Korean government officials were killed Friday when a bomb exploded at a wreath-laying ceremony in Rangoon, Burma.

John wanted to be chairman of his department.
He bought some arsenic.

Hard for people:
Did you hear about the taxi driver who ran over himself?
Metaphor / Hyperbole

“The shocking truth is that while record deficits are unanimously condemned, the politicians in power have not lifted one finger to balance the books.”
Literal Impossibilities

Is the kettle boiling yet?

Are the cans of tuna we bought last year still palatable?

Please turn on the fish!
Similar or Different?

John drove his car to buy groceries.

John drove his sister to buy groceries.

John drove his car to commit suicide.

John drove his sister to commit suicide.

Common sense can resolve the relationship among the nouns
More common sense...

Frank hit the girl with long hair.

Did you see that woman with a glass eye?

Is it legal in Arkansas to hang a man with a moustache?

Is it good to write on an empty stomach?
Center Embedding

The mouse died.
The mouse the cat chased died.
The mouse the cat the dog bit chased died.

Garden Path Sentences

The grocery store always orders a hundred pound bags of sugar.
The horse raced past the barn fell.
Question:

Did you ever shake hands with Abraham Lincoln?

Did you ever shake hands with Barack Obama?
More Memory

Whose face is on the penny?
Vision
Vision
The lines are parallel
These are circles not spirals
See black dots? Count them.
What is this?
Stroop effect (1935)

YELLOW  BLUE  ORANGE
BLACK   RED   GREEN
PURPLE  YELLOW RED
ORANGE  GREEN  BLACK
BLUE    RED   PURPLE
GREEN   BLUE  ORANGE
AI Areas

- Machine Learning
- Knowledge Representation & Reasoning
- Planning
- Natural language processing
- Collaborative Filtering
- Bioinformatics
- Data Mining
- Diagnosis
- Vision
- Robotics
- Semantic Web

- [many more]