CS 510: Into to Artificial Intelligence

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www.cs.drexel.edu/~greenie/cs510/index.html
Overview

- What is Artificial Intelligence?
- History of AI
- What is CS 510?
- Syllabus, Schedule, Grading
- Final Project
- Overview of AI Topics
Introductions

• Introduce yourself:
  • Your name
  • Undergrad/Masters/Ph.D/How many years at Drexel?
  • What is your research area?
  • Which faculty member(s) do you work with?
  • What brings you to CS 510?
  • What else should we know about you? :)
What is AI?
Class Exercise

• Answer the following questions on three index cards:
  • What is Intelligence?
  • What is Artificial Intelligence?
  • What is an agent? What attributes does an agent have?

• When you’re done, swap your answers with a neighbor
Each card has a number or letter on one side and a square or circle on the other side.

Which cards must you turn over to determine if the following statement is true:

Every card with a letter on one side has a square on the other side.
Thinking like humans

• 90% of humans get it wrong
• Answer is cards 2 and 3
• Most people pick 1 and 3
Each card has an age on one side and a drink on the other side.

Which cards must you turn over to determine if the following statement is true:

Everyone in the bar is following the law.
What is AI?

<table>
<thead>
<tr>
<th>Thinking like a human</th>
<th>Thinking rationally</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acting like a human</td>
<td>Acting rationally</td>
</tr>
</tbody>
</table>
Why Study AI?

• Fundamental scientific questions
  • What does it mean to be smart?
  • What makes us smart?
  • Can our intelligence be replicated or exceeded? And how?
Why Study AI?

- Fundamentally useful engineering question
- AI in computers increases humanity's collective intelligence and abilities
- Areas where computers lack the ability to act rationally limit us
But is it even possible?

- Billions of human computers must be doing something....
- Strong vs. Weak AI
  - Human-level intelligent machines, conscious?
  - “thinking-like” features to make computers more useful
agent

1. One that acts or has the power or authority to acts
2. One empowered to act for or represent another
Agents
Simple reflex agent
Modern AI Agents

- Not just AI, but AI situated in some environment
- Not just inference, but inference used in some context
- Not just a control loop, but complex autonomous decision-making
- Not just an algorithm, but an intelligent system
- Holistic approach to AI
- Multiple AI tools can be integrated to build an Agent
Intelligent Software Agents

• Responsive
• Goal-Directed
• Autonomous
• Social
PEAS

- Performance Measure
- Environment
- Actuators
- Sensors
- Examples?
Autonomous Cars

- Consider an automated taxi driver:
  - **Performance measure:** Safe, fast, comfortable trip, maximize profits
  - **Environment:** Roads, other traffic, pedestrians, customers
  - **Actuators:** Steering wheel, accelerator, brake, signal, horn
  - **Sensors:** Cameras, sonar, speedometer, GPS, odometer, engine sensors, keyboard, lidar
Agent or Program?
The easy stuff is hard

• Computers still can’t speak, see, or reason like a 5 year old child

• And the hard stuff is easy....
  • Playing chess
  • Proving theorems
  • Diagnosing medical conditions
AI Historical Highlights

- 5th century
  - Aristotle invents syllogistic logic
- 13th century
  - Zairja device used by Arab astrologers to calculate ideas mechanically
  - Ramon Llull creates Ars Magna theological argumentation device
- 17th century
  - Material arguments for thinking: Hobbes, Descartes
  - Pascal invents mechanical calculating device
- 19th century
  - Babbage and Lovelace work on programmable mechanical machine
  - Boolean algebra representing some “laws of thought”
AI Historical Highlights

• 1928 von Neuman’s minimax algorithm, used for game-playing

• 1950 Turing test devised

• 1950 Asimov publishes the 3 laws of robotics

• 1956 McCarthy coins “Artificial Intelligence” / Dartmouth conference

• Early years (1956-1970)
  • Micro-worlds
  • Reasoning by search
  • Many successes, lots of optimism/hype - Samuel’s checkers, Gelemter’s Geometry theorem prover, Shakey, Dendral
AI Historical Highlights

• Al Winter (1970s)
  • Perceptrons - limits of neural networks
  • Language difficulties - “The spirit is willing but the flesh is weak”  ==>  “The vodka is good but the meat is rotten”
  • Development of computational complexity
  • Loss of funding

• Al becomes an industry (1980s)
  • Expert, intelligent systems all the rage
  • Bubble happens and expectations raised again
AI Historical Highlights

- 2nd AI Winter (late 1980s - 1990s)
  - More disappointment as AI fails to make people rich
  - Expert systems are “brittle”
  - Funding cut again
- AI Becomes a Science/Intelligent Agents (1987-present)
  - Victory of the “neats” (vs “scruffies”)
  - Statistical machine learning/HMMs has many successes
  - AI starts to make people rich
  - Moore’s law makes a lot more possible
  - Emergence of Intelligent Agents
The AI Landscape

See the AI timeline and more at www.aaai.org/ALLandscape
AI Applications
AI in Space

Autonomous satellite separation and docking

Exploring Mars

Monitoring the sky with telescope arrays
AI Art
What is CS 510?
Course Information

• Textbook
  • Stuart Russell and Peter Norvig
  • Artificial Intelligence: A Modern Approach
    • Prentice-Hall (Second Edition)

• Supplementary Readings
  • Available on course website
    • http://www.cs.drexel.edu/~greenie/cs510.html
Course Objectives

• Learn about AI techniques
• Learn how to do AI research (grad class)
Schedule

• Intro to AI
• Search and Problem Solving
• Planning
• Knowledge Representation
• Learning
Evaluation

- 30% Exams
- Midterm 15%
- Final 15%
- 5% Machine Learning exercise
- 25% Class Participation
- 40% Final Project
Class Participation

• In class exercises
• Class discussions
• bbvista Online discussions
• More instructions on website
Final Project

• Free form research project
• Groups of 1-3 people

Milestones
• Groups and topic (Oct 3)
• Proposal (Oct 14)
• Presentation
• Project write up
The Final Project Proposal

• 2 pages long
• Problem Statement and Motivation
• Brief Description of Approach
• Related Work and novelty
• Evaluation approach
• Milestones
AI Topics
Search

• The “Heuristic Search Hypothesis”
  - (Newell and Simon)

• Subroutine of intelligent systems
  • problem solving
  • planning
  • knowledge
  • games
Some search issues we’ll discuss

- Intractability of exhaustive search
- Use of heuristics (A*)
- Local search “satisficing”
Open Problems

- Distributed search
- Dynamic search
- Check out STAIRS workshop
Constraint Reasoning

• Way of representing knowledge and structure on a problem so that standard heuristics can be applied

• Problems expressed as:
  • Set of variables that need values
  • Set of domains from which the values are drawn
  • Set of constraints that represent relationships between the variables (must be satisfied or optimized)
Applications

- Supply chain management
- Scheduling
- Resource and task allocation
- Multiagent coordination
Open problems in Constraint Reasoning

• How to easily express problems as constraint problems
• What if the domain is dynamic or uncertain?
• How do you measure performance in distributed systems?
• See the Constraint Programming (CP) conference or the Distributed Constraint Reasoning (DCR) workshop
Games / Adversarial Search

- Inherently multiagent and competitive
- Classic work in turn based games
  - Chess
  - Checkers
  - Now poker, general game playing
Mechanism Design

- Construct incentives for agents that are:
  - self-interested
  - utility-maximizing

- Applications
  - Auctions
  - Reputation systems
  - Traffic systems
Knowledge Representation

• What is common sense?
• How a problem is represented greatly affects its efficiency
• How can we encode the things we know so computers understand them?
Model-based Reflex Agent
Planning

- Given
  - a set of actions
  - a goal state
  - a present state
- Choose actions to get to the goal state
- And what if you have a team of agents...
Goal-based Agent
Utility-based Agent
Planning problems

- Planning in the real world
- Highly dynamic environments
- Uncertain information
Learning

• What does it mean for computers to learn?
  • Supervised

• Unsupervised
Learning

• What does it mean for computers to learn?
  • Supervised
    “circle” “square” “circle” “square” ...  
     ○    □    ○    □
  • Unsupervised
Learning

• What does it mean for computers to learn?

• Supervised
  “circle” “square” “circle” “square” ...
  ●  ■  ●  ■

• Unsupervised
  ●
Learning

• What does it mean for computers to learn?

• Supervised
  “circle” “square” “circle” “square” ...
  🔘 ⬜️ 🔘 🔘

• Unsupervised
  🔘 🔘 🔘 🔘
  🔘 🔘 🔘 😡
  “group these into two categories”
Learning Agent
Project starting points

• Robocup soccer
  • http://www.robocup.org

• Search and rescue
  • http://www.robocuprescue.org
  • http://maple.cs.umbc.edu/~ericeaton/searchandrescue/

• Animated lifelike agents
  • http://hmi.ewi.utwente.nl/gala
Project starting points

- The JavaFF planner
  - http://personal.cis.strath.ac.uk/~ac/JavaFF/
- Sports prediction markets
- Games
  - http://www.cs.ualberta.ca/~games/
- Electronic markets
  - http://www.sics.se/tac/page.php?id=1
Resources

• http://www.aaai.org/AlTopics
• http://aima.cs.berkeley.edu
• AI Challenge problems
  • http://research.microsoft.com/users/horvitz/seltext.htm
• http://library.drexel.edu
• http://aispace.org
Readings this week: