CSE 473
Artificial Intelligence

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www.cs.washington.edu/education/courses/cse473/04sp
Outline

- Objectives
- What is AI?
- State of the Art
- Challenges
- Logistics
Goals of this Course

• To introduce you to a set of key:
   Paradigms &
   Techniques

• Teach you to identify when & how to use
  Heuristic search
  Constraint satisfaction
  Machine learning
  Logical inference
  Bayesian inference
  Policy construction
AI as Science

Where did the *physical universe* come from? And what laws guide its dynamics?

How did *biological life* evolve? And how do living organisms function?

What is the nature of *intelligent thought*?
AI as Engineering

• How can we make software systems more powerful and easier to use?

  Speech & intelligent user interfaces
  Autonomic computing
  Mobile robots, softbots & immobots
  Data mining
  Medical expert systems...
What is Intelligence?
Hardware

- $10^{11}$ neurons
- $10^{14}$ synapses
- Cycle time: $10^{-3}$ sec

- $10^7$ transistors
- $10^{10}$ bits of RAM
- Cycle time: $10^{-9}$ sec
Computer vs. Brain

All Things, Great and Small

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Evolution of Computers
Projection

• In near future computers will have
  As many processing elements as our brain,
  But far fewer interconnections
  Much faster updates.

• Fundamentally different hardware
  Requires fundamentally different algorithms!
  Very much an open question.
**Dimensions of the AI Definition**

<table>
<thead>
<tr>
<th>thought vs. behavior</th>
<th>human-like vs. rational</th>
</tr>
</thead>
<tbody>
<tr>
<td>Systems that think like humans</td>
<td>Systems that think rationally</td>
</tr>
<tr>
<td>Systems that act like humans</td>
<td>Systems that act rationally</td>
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</tbody>
</table>
Mathematical Calculation

\[ \partial_r^2 u = - \left[ E' - \frac{l(l + 1)}{r^2} - r^2 \right] u(r) \]

\[ e^{-2s} \left( \partial_s^2 - \partial_s \right) u(s) = - \left[ E' - l(l + 1)e^{-2s} - e^{2s} \right] u(s) \]

\[ e^{-2s} \left[ e^{\frac{1}{2}s} \left( e^{-\frac{1}{2}s} u(s) \right)'' - \frac{1}{4} u \right] = - \left[ E' - l(l + 1)e^{-2s} - e^{2s} \right] u(s) \]

\[ e^{-2s} \left[ e^{\frac{1}{2}s} \left( e^{-\frac{1}{2}s} u(s) \right)'' \right] = - \left[ E' - \left( l + \frac{1}{2} \right)^2 e^{-2s} - e^{2s} \right] u(s) \]

\[ v'' = -e^{2s} \left[ E' - \left( l + \frac{1}{2} \right)^2 e^{-2s} - e^{2s} \right] v \]
State of the Art

“I could feel – I could smell – a new kind of intelligence across the table”
-Gary Kasparov

Saying Deep Blue doesn’t really think about chess is like saying an airplane doesn’t really fly because it doesn’t flap its wings.

– Drew McDermott
Speech Recognition
Shuttle Repair Scheduling
Compiled into 2,000 variable SAT problem

Real-time planning and diagnosis
2004 & 2009
Europa Mission ~ 2018
Limits of AI Today

• Today’s successful AI systems
  operate in well-defined domains
  employ narrow, specialize knowledge

• Commonsense Knowledge
  needed in complex, open-ended worlds
  • Your kitchen vs. GM factory floor
  understand unconstrained Natural Language
Role of Knowledge in Natural Language Understanding

• WWW Information Extraction
• Speech Recognition
  "word spotting" feasible today
  continuous speech – rapid progress
• Translation / Understanding
  limited progress
  The spirit is willing but the flesh is weak.
  (English)
  The vodka is good but the meat is rotten.
  (Russian)
How the heck do we understand?

• John gave Pete a book.
• John gave Pete a hard time.
• John gave Pete a black eye.
• John gave in.
• John gave up.
• John’s legs gave out beneath him.
• It is 300 miles, give or take 10.
How to Get Commonsense?

• CYC Project (Doug Lenat, Cycorp)
  Encoding 1,000,000 commonsense facts about the world by hand
  Coverage still too spotty for use!
  (But see Digital Aristotle project)

• Machine Learning
• Alternatives?
Recurrent Themes

• **Representation vs. Implicit**
  
  Neural Nets - McCulloch & Pitts 1943
  
  • Died out in 1960’s, revived in 1980’s
  • Simplified model of real neurons, but still useful; parallelism
  
  Brooks “Intelligence without Representation”

  • **Logic vs. Probability**
  
  In 1950’s, logic dominates (McCarthy, ...)
  
  • attempts to extend logic “just a little” (e.g. nomon)
  
  1988 – Bayesian networks (Pearl)
  
  • efficient computational framework
  
  Today’s hot topic: combining probability & FOL
Recurrent Themes II

• **Weak vs. Strong Methods**
  - Weak – general search methods (e.g. A* search)
  - Knowledge intensive (e.g. expert systems)
    - more knowledge ⇒ less computation
  - Today: resurgence of weak methods
    - desktop supercomputers
  - How to combine weak & strong?

• **Importance of Representation**
  - Features in ML
  - Reformulation
473 Topics

- Agents & Environments
- Problem Spaces
- Search & Constraint Satisfaction
- Knowledge Repr’n & Logical Reasoning
- Machine Learning
- Uncertainty: Repr’n & Reasoning
- Dynamic Bayesian Networks
- Markov Decision Processes
Logistics:

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• Required Reading
  Russell & Norvig “AIMA2”
  Papers from WWW

• Grading:
  Problem Sets  45%
  Final  30%
  Midterm 15%
For You To Do

• Get on class mailing list
• Read Ch 2 in text
  \textit{Ch 1 is good, but optional}
• PS1 forthcoming