Artificial Intelligence 15-381
Introuduction to AI

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Today’s Angeda

- Are we in the right class?
- Introductions: Instructors and TAs
- What exactly is AI, anyway?
- AI = "search" + knowledge + learning
- AI application areas
- The outline of this course
- Administration and grading :-(

What is AI: Some Quick Answers

From the Media: AI is...

- ...what socially-inept superhackers do
- ...the opposite of natural stupidity
- ...building useful idiot-savant programs

From Academia: AI is...

- ...modeling aspects of human cognition by computer
- ...the study of solving ill-formed problems
- ...nothing more than advanced algorithms research
- ...cool stuff! machine learning, data mining, speech, language, vision, web agents, ... you can actually get paid a lot for having fun.
- ...what other CS folks don't yet know how to do

Operationally Speaking, AI is:

Applied Cognitive Science

- Model and understand human reasoning
- Eg: Language learning, memory organization
- => Cognitive Processes (Simon)

Knowledge Engineering

- Codify human knowledge for specific tasks
- Eg: Medical diagnosis, Machine Translation
- Central in 1970s & 80’s => just 1 lecture

Problem-Solving Methods

- How to encode and use knowledge to find answer
- E.g. HS, MEA, A*, Logic resolution
- Always at the very core of AI => many lectures

Machine Learning

- Learning as the hallmark of intelligence
  ...but for ***practical*** reasons beyond problem-solving
- Eg: D-trees, rule-induction, reinforcement, NNets
- Discredited fringe in 1960’s => Vibrant core in 1990’s
- Applications: data & text mining, speech, robotics, ...
- Most active research area in AI => many lectures

AI "Application" Areas

Rule-Based Expert Systems

- Medical Diagnosis: MYCIN, INTERNIST, PUFF
- CSP Scheduling: ISIS, Airline scheduling

Data Mining

- Financial: Fraud detection, credit scoring
- Sales: Customer preferences, inventory
- Science: NASA galaxy DB, genome analysis

Language Processing

- Speech: dictation, HCI
- Language: Machine Translation
- ML & NLP: Fact Extraction
- ML & words: Information Retrieval

Robotics

- Machine Vision
- Mobile Robots & "agents"
- Manipulation

AI-Based Problem Solving

State-Space $<S_0,\{S_{G_j}\},\{O_i\}>$

S_0: Initial State

S_G: Goal State (to achieve)

O_i: Operators O: {S} => {S}

State-Space Nagivation

- Forward Search: BFS, DFS, HS, ...
- Backward Search: BFS^{-1}, BC, ...
- Bi-Directional Search: BFS^2, ...
- Goal Reduction: Island-S, MEA, ...
- Transformation: {S} => {S'}
- Abstraction: {S} => $\{S^A\}$ + MEA($\{S^A\}$) ...
- Analogy: If Sim(P,P') then Sol(P) => Sol'(P')
- ...

More on the State Space

Useful functions:

$Succ(s_i) = \{s_k \mid o_j(s_i) = s_k D\}$

$Reachable(s_i) = \{U\{s_k\} \mid Succ^*(s_i)\}$

$Succ^{-1}(s_i) = \{s_k \mid o_j(s_k) = s_i)$

$Reachable^{-1}(s_i) = \{U\{s_k\} \mid (Succ^{-1})^*(s_i)\}$

$s\text{-}Path(s_{a_0}, s_{a_n}) = (s_{a_0}, s_{a_1}, ..., s_{a_n})$
...such that for all s_{a_i} exists $o_j(s_{a_i}) = s_{a_{i+1}}$

$o\text{-}Path(s_{a_0}, s_{a_n}) = (o_{j_0}, o_{j_1}, ..., o_{j_{n-1}})$
...such that for all s_{a_i} exists $o_j(s_{a_i}) = s_{a_{i+1}}$

Useful concepts:

- Solution = o-Path(s_0, s_G) [or s-Path]
- cost(Solution) = Σcost(o_j) ... (often cost(o_j) = 1)
- P is solvable if at least one o-Path(s_0, s_G) exists
- Solutions may be constructed forward, backward or any which way.
- State spaces may be finite, infinite, implicit or explicit