What is AI?
Possible Answers?
AI: How did it all begin?
AI prehistory

Philosophy: Logic, methods of reasoning, mind as physical system foundations of learning, language, rationality

Mathematics: Formal representation and proof algorithms, computation, (un)decidability, (in)tractability, probability

Economics: utility, decision theory

Neuroscience: physical substrate for mental activity

Psychology: cognitive science, affective science

Computer engineering: efficient algorithms

Control theory: design systems that maximize an objective function over time

Linguistics: knowledge representation, grammar
...solve kinds of problems now reserved for humans...

...significant advance can be made in one or more of these problems if a carefully selected group of scientists work on it together for a summer...
Abridged history of AI

- **1943** McCulloch & Pitts: Boolean circuit model of brain
- **1950** Turing's "Computing Machinery and Intelligence"
- **1956** Dartmouth meeting: "Artificial Intelligence" adopted
- **1952—69** Look, Ma, no hands!
- **1950s** Early AI programs, including Samuel's checkers program, Newell & Simon's Logic Theorist, Gelernter's Geometry Engine
1960s: Initial Optimism

- Playing checkers (Arthur Samuel)
- General Problem Solver (Allen Newell & Herbert Simon)
Abridged history of AI

1965  
Robinson's complete algorithm for logical reasoning

1966—73  
AI discovers computational complexity
Neural network research almost disappears

1969—79  
Early development of knowledge-based systems

Blocks world SHRDLU (Winograd 1972)
Expert System Shells - Examples

- **EMYCIN**: Shell taken from MYCIN, backward chaining, uncertainty factors, explanation facility
- **CLIPS**: Public domain ESS from NASA, combines three paradigms: rule-base, object-oriented, procedural
- **JESS**: Successor to CLIPS, entirely in Java, can execute Java code
Abridged history of AI
What do you think the road block to these types of systems were?
Abridged history of AI

- 1980-- AI becomes an industry
- 1986-- Neural networks return to popularity
- 1987-- AI becomes a science
- 1995-- The emergence of intelligent agents
1990s: Resurgence

- Probabilistic approaches
- Adoption of scientific rigor
- Return to dreams of human-level AI
2000s: Big Data

- Focus on data
- Solution to KA bottleneck?
What is AI?
Views of AI fall into four categories:

<table>
<thead>
<tr>
<th>Thinking humanly</th>
<th>Thinking rationally</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acting humanly</td>
<td>Acting rationally</td>
</tr>
</tbody>
</table>

The textbook advocates "acting rationally"
Thinking humanly: cognitive modeling

- Cognitive Modeling Approach
  - 1960s "cognitive revolution": information-processing psychology
  - Requires scientific theories of internal activities of the brain
  - Validation Requires
    1) Predicting and testing behavior of human subjects (top-down)
    or 2) Direct identification from neurological data (bottom-up)

Systems modeled based on the way humans think.

Systems are based on:
- Productions
- Rule-based
- Experimental results of human behavior
Thinking humanly: examples

Cognitive Modeling Approach - SOAR

Credit for images from Laird’s article on Introduction to Soar
Figure 6: Memory structures in Soar.

Credit for images from Laird’s article on Introduction to Soar
Thinking humanly: examples

- Cognitive Modeling Approach – ACT-R

Image from: http://act-r.psy.cmu.edu/about/
Turing (1950) "Computing machinery and intelligence": "Can machines think?" → "Can machines behave intelligently?"
Acting humanly: Turing Test

- Stimulated the development of:
  - Natural Language Processing
  - Knowledge Representation
  - Automated Reasoning
  - Machine Learning
  - Computer Vision
  - Robotics
Eliza

HI USER, CAN YOU PLEASE TELL ME YOUR NAME?
>my name is Gonzales.
GLAD TO MEET YOU GONZALES.
>ok Eliza!
PLEASE BE MORE SPECIFIC.
>what do you mean by that?
SORRY I CAN'T PROVIDE MORE EXPLANATION ON THIS.
>why not?
WHY ARE YOU ASKING ME THIS?
>i dont know.
HOW COME YOU DONT KNOW?
>i'm just kidding.
WHAT MAKES YOU THINK THAT YOU ARE JUST KIDDING?
>well, because it is true.
SO YOU ARE TELLING ME THE REASON.
>yes, exactly.
YOU SOUND VERY OPTIMISTIC.
>thank you for the compliment!
DONT MENTION IT.
>ok.
PLEASE BE MORE SPECIFIC.
>i will try to be more specific next time.
DO YOU LIKE TALKING ABOUT YOURSELF?
>so, you think that i was talking about myself.
YOU ARE NOT REALLY TALKING ABOUT ME, ARE YOU?
>well, not really.
WHY ARE YOU SO UNCERTAIN?
>i dont know why.
HOW COME YOU DONT KNOW?
>i have no idea.
IS THAT TRUE?
>no, not exactly.
ARE YOU REALLY SURE?
>yes i'm.
HAVE YOU TAKE SOME TIMES TO THINK ABOUT IT?
>ofcourse
YOU'VE TOLD ME JUST BEFORE THAT YOU HAVE NO IDEA, IS THAT TRUE?
>yes it is true.
MAYBE IT'S NOT TRUE.
Person: Men are all alike.
ELIZA: In what way?
Person: They're always bugging us about something or other.
ELIZA: Can you think of a specific example?
Person: Well, my boyfriend made me come here.
ELIZA: Your boyfriend made you come here?
Person: He says I'm depressed much of the time.
ELIZA: I am sorry to hear that you are depressed.
Person: It's true. I am unhappy.
ELIZA: Do you think coming here will help you not to be unhappy?
Person: I need some help, that much seems certain.
ELIZA: What would it mean to you if you got some help?
Person: Perhaps I could learn to get along with my mother.
ELIZA: Tell me more about your family
Examples

Views of AI fall into four categories:

<table>
<thead>
<tr>
<th>Thinking humanly</th>
<th>Thinking rationally</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acting humanly</td>
<td>Acting rationally</td>
</tr>
</tbody>
</table>
Example Applications

http://www.youtube.com/watch?v=iragGqvoHLQ
Example Applications

http://www.youtube.com/watch?v=oG-2qr78GbE&playnext=1&list=PLSVPS6u0z0xfa7Xml9TKLv6IWCcHF5cNBc&feature=results_main
Example Applications

http://www.youtube.com/watch?v=fkZKxsG0AVw
Thinking rationally: "laws of thought"

- Aristotle: what are correct arguments/thought processes?
- Purely logical thought and reasoning
- Mathematically well-defined

Problems:
1. Not all intelligent behavior is mediated by logical deliberation
2. What is the purpose of thinking? What thoughts should I have?
Agent: entity that perceives and acts

Rational behavior:

choose behavior that maximize goal achievement, given the available information
Agent-Based AI

Diagram:
- Agent
- Sensors
  - What the world is like now
- Environment
- Condition-action rules
  - What action I should do now
- Actuators
What can the agent do?
- Range of actions

What is the environment? (Input: percepts)
- How is it interpreted?

What does the agent know?
- History of previous inputs and actions (how far back?)
- Properties of environment: world knowledge
- Knowledge of its own goals and preferences
- Strategies for behavior

How does the agent choose to act?
- Mapping from percept sequence -> action called an agent function
Example: Vacuum Cleaner World

What are the actions? What are the percepts?
Kinds of Agents: Simple Reflex Agent
Kinds of Agents: Model-Based Agent
Kinds of Agents: Goal-Based Agent

Diagram:
- Agent
  - Goals
  - State
  - What my actions do
  - How the world evolves
- Sensors
  - What the world is like now
  - What it will be like if I do action A
- Environment
  - What action I should do now
  - Actuators
Kinds of Agents: Utility-Based Agent
Kinds of Agents: Learning Agent
More Applications
http://www.cs.northwestern.edu/~ian/videos/pit.mov
Computer Vision

https://www.youtube.com/watch?v=LdQw8PSV2P8
Hello, World!

Hola, Mundo!
One final example

In early 2011, an IBM computing system named Watson competed against the world's best Jeopardy! champions.

https://www.youtube.com/watch?v=lI-M7O_bRNg