



CSE422: Artificial Intelligence

Lecture 1

Fundamentals of AI

What is AI??

Artificial intelligence (AI) is the simulation of human intelligence processes by machines, especially computer systems.

These processes include learning (the acquisition of information and rules for using the information), reasoning (using rules to reach approximate or definite conclusions) and self-correction.



AI: A Vision



Could an intelligent agent living on your home computer **manage your email**, coordinate your **work and social activities**, help **plan your vacations**..... even **watch your house** while you take those well planned vacations?





Main Goals of AI

Represent and **store** knowledge

Retrieve and **reason** about knowledge

Behave intelligently in complex environments

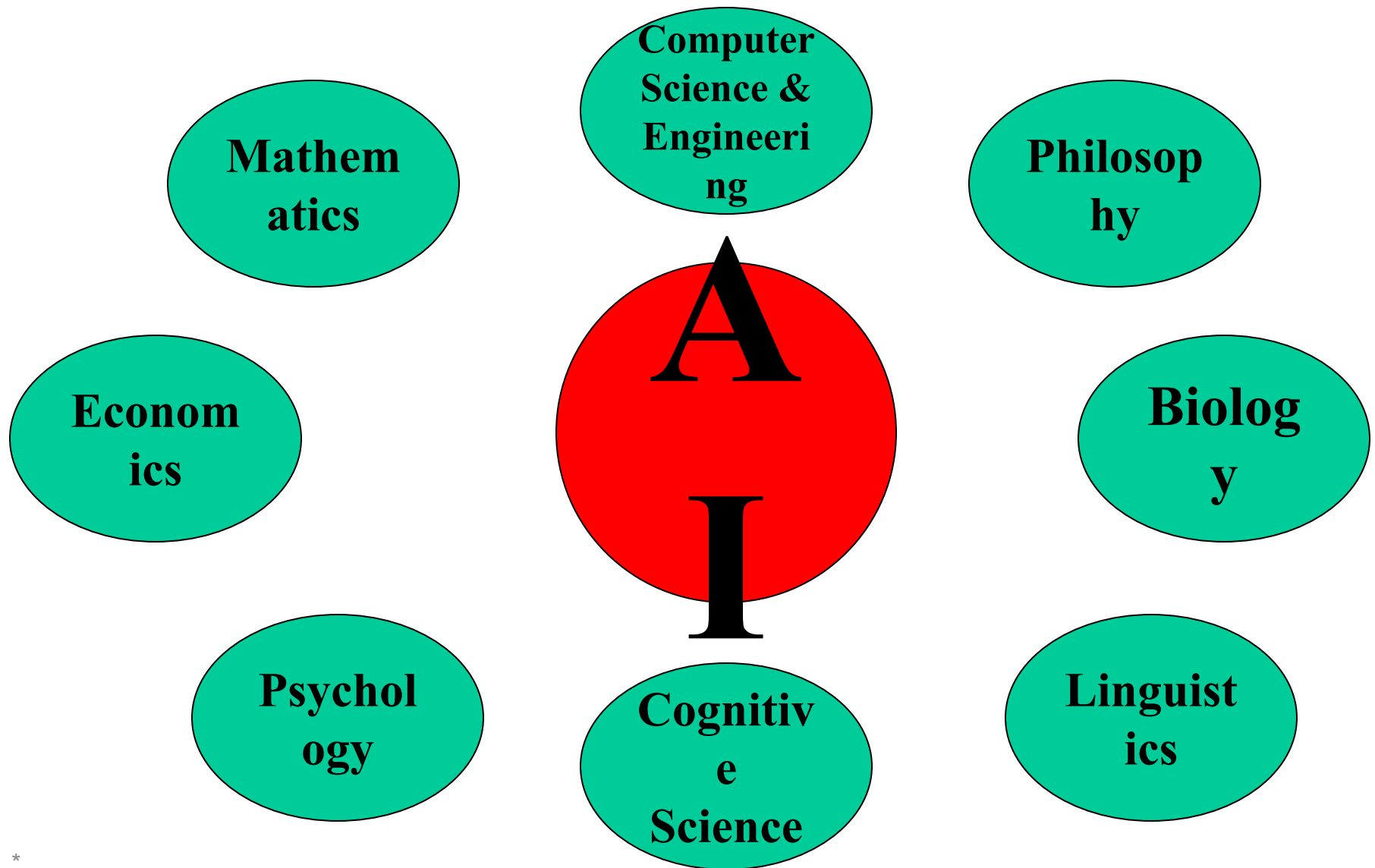
Develop interesting and useful **applications**

Interact with people, agents, and the environment

Why AI?

- **Engineering:** To get machines to do a wider variety of useful things
 - e.g., understand spoken **natural language**, recognize individual people in **visual scenes**, find the best travel plan for your vacation, etc.
- **Cognitive Science:** As a way to understand how **natural minds** and mental phenomena work
 - e.g., visual perception, memory, learning, language, etc.
- **Philosophy:** As a way to explore some basic and interesting (and important) philosophical questions
 - e.g., the mind body problem, what is **consciousness**, etc.

Foundations of AI



A (Short) History of AI

1940-1950: Early days

1943: McCulloch & Pitts: Boolean circuit model of brain

1950: Turing's "Computing Machinery and Intelligence"

1950—70: Excitement: Look, Ma, no hands!

1950s: Early AI programs, including Samuel's checkers program, Newell & Simon's Logic Theorist, Gelernter's Geometry Engine

1956: Dartmouth meeting: "Artificial Intelligence" adopted

1965: Robinson's complete algorithm for logical reasoning

1970—90: Knowledge-based approaches

1969—79: Early development of knowledge-based systems

1980—88: Expert systems industry booms

1988—93: Expert systems industry busts: "AI Winter"

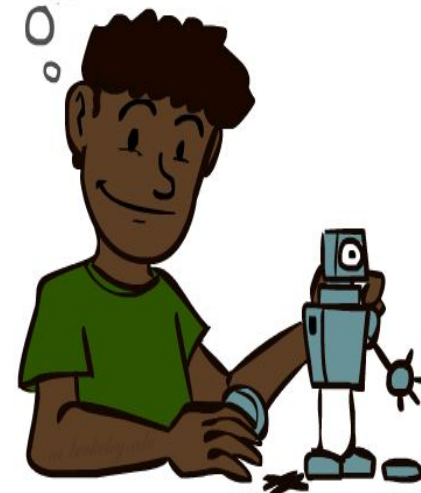
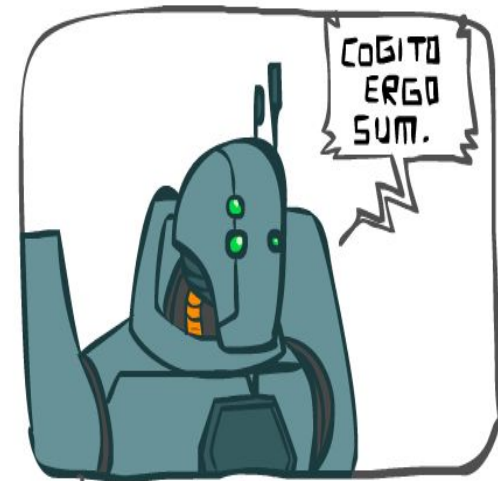
1990—: Statistical approaches

Resurgence of probability, focus on uncertainty

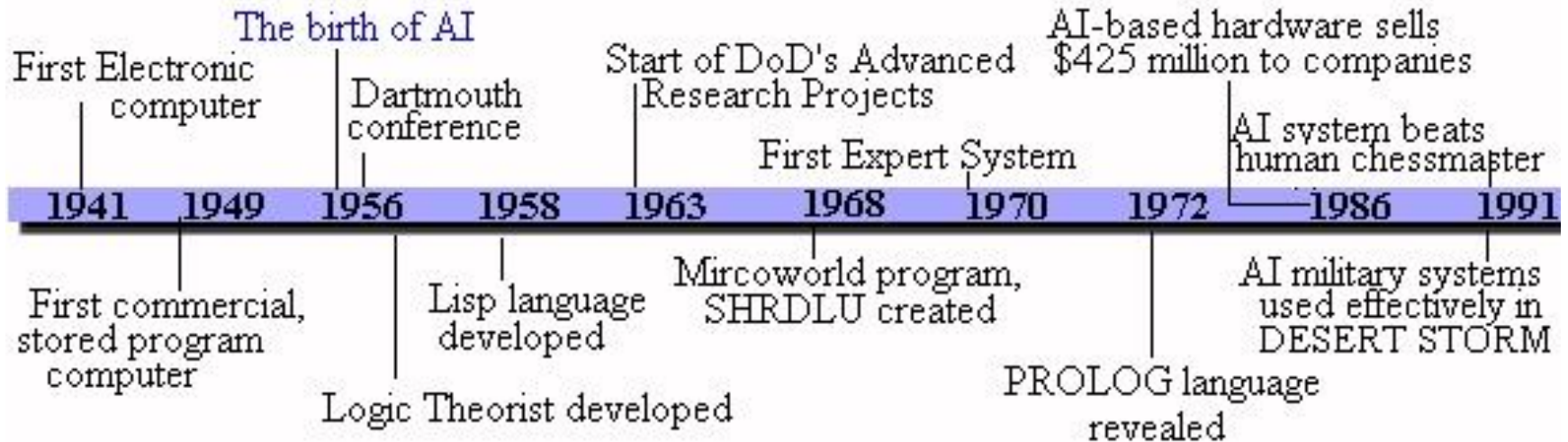
General increase in technical depth

Agents and learning systems... "AI Spring"?

2000—: Where are we now?



History



- 1997: Deep Blue beats Garry Kasparov (world champion)
- 1998: Founding of Google
- 2000: Interactive robot pets
- 2004: First DARPA Grand Challenge robot race
- 2004: Commercial recommender systems (TIVO, amazon.com)
- 2007: Checkers is solved!
- 2011: An AI named Watson beats the top Jeopardy! champions
- 2010: Google self-driving cars reach their 1000th mile

What Can AI Do?

Quiz: Which of the following can be done at present?



Play a decent game of table tennis?



Play a decent game of Jeopardy?



Drive safely along a curving mountain road?



Drive safely along Telegraph Avenue? ?



Buy a week's worth of groceries on the web?



Buy a week's worth of groceries at Berkeley Bowl? ?



Discover and prove a new mathematical theorem?



Converse successfully with another person for an hour? ?



Perform a surgical operation? ?



Put away the dishes and fold the laundry?



Translate spoken Chinese into spoken English in real time?



Write an intentionally funny story? ?



Eliza

- ELIZA: A program that simulated a psychotherapist interacting with a patient and successfully passed the Turing Test.
- Coded at MIT during 1964-1966 by Joel Weizenbaum.
- First script was DOCTOR.
 - The script was a simple collection of syntactic patterns not unlike regular expressions
 - Each pattern had an associated reply which might include bits of the input (after simple transformations (my → your))
- Weizenbaum was shocked at reactions:
 - Psychiatrists thought it had potential.
 - People unequivocally anthropomorphized.
 - Many thought it solved the NL problem.

Eliza

- This is a transcript of a conversation with an Eliza-like program found in Emacs

- Try typing

Meta-x doctor

in your favorite Emacs.

- I am the psychotherapist. Please, describe your problems. Each time you are finished talking, type RET twice.
- i'm having a hard time with my students
- Why do you say that?
- well, they keep asking me for money
- Maybe your plans have something to do with this.
- what plans?
- Is it because of your life that you say what plans?
- No, it's because I didn't know what you were talking about
- Is it because you didn't know what I was talking about that you came to me?
- no, it's because i wanted to see if you could pass the turing test
- Does it bother you that you wanted to see if I could really pass the turing test?
-
- How do you reconcile problems at school?
- This is a waste of time. Good bye
- My secretary will send you a bill.

Colby's PARRY

- Kenneth Colby modeled a paranoid using the same techniques circa 1968.
- PARRY has basic emotions. If it gets angry, its replies become more hostile.
- In a Turing test, expert psychiatrists were unable to distinguish PARRY's ramblings from those of real paranoids.

H: Good afternoon. My name is Doctor Jones.

P: Pleased to meet you.

H: How are you?

P: All right I guess.

H: Could you tell me your name?

P: Pat Smith.

H: I thought you might have some problems.

P: I've been upset lately.

H: By what?

P: People get on my nerves sometimes.

H: Tell me more.

P: Do you know anything about bookies?

...

Parry Meets Eliza

Please tell me **this** isn't AI!

P: I don't understand your motives.

E: Why don't you understand my motives?

P: Shouldn't I be?

E: Why do you say that just now?

P: That's just the way it is.

E: Suppose that's the way it were not.

P: So?

E: I am not sure I understand you fully.

P: You harp on the same questions too much.

E: What does that similarity suggest to you?

P: I don't get you.

E: Do you wish that you did get I?

We've Come a Long Way (or have we?...)

Two AI chatBots attempt to have a conversation with each other

Posted by Mark Frauenfelder on Monday, Aug 29th at 2:22pm





Big Questions

- Can machines think?
- If so, how?
- If not, why not?
- What does this say about human beings?
- What does this say about the mind?

What's Easy and What's Hard?

- It's been easier to mechanize many of the high-level tasks we usually associate with “intelligence” in people
 - e.g., symbolic integration, **proving theorems, playing chess, medical diagnosis**
- It's been **very hard to mechanize tasks** that lots of animals can do
 - **walking around without running into things**
 - **catching prey and avoiding predators**
 - **interpreting complex sensory information (e.g., visual, aural, ...)**
 - **modeling the internal states of other animals from their behavior**
 - **working as a team (e.g., with pack animals)**
- Is there a fundamental difference between the two categories?

Turing Test

- Three rooms contain a person, a computer, and an interrogator.
- The interrogator can communicate with the other two by teleprinter.
- The interrogator tries to determine which is the person and which is the machine.
- The machine tries to fool the interrogator into believing that it is the person.
- If the machine succeeds, then we conclude that the machine can think.

The Loebner Contest

- A modern version of the Turing Test, held annually, with a \$100,000 cash prize.
- Hugh Loebner was once director of UMBC's Academic Computing Services (née UCS)
- <http://www.loebner.net/Prizetf/loebner-prize.html>
- Restricted topic (removed in 1995) and limited time.
- Participants include a **set of humans** and a **set of computers** and a set of judges.
- Scoring
 - **Rank from least human to most human.**
 - Highest median rank wins \$2000.
 - If better than a human, win \$100,000. (Nobody yet...)

What Can AI Systems Do?

Here are some example applications

- **Computer vision:** face recognition from a large set
- **Robotics:** autonomous (mostly) automobile
- **Natural language processing:** simple machine translation
- **Expert systems:** medical diagnosis in a narrow domain
- **Spoken language systems:** ~1000 word continuous speech
- **Planning and scheduling:** Hubble Telescope experiments
- **Learning:** text categorization into ~1000 topics
- **User modeling:** Bayesian reasoning in Windows help (the infamous paper clip...)
- **Games:** Grand Master level in chess (world champion), perfect play in checkers, professional-level Go players

What Can't AI Systems Do Yet?

- Understand natural language robustly (e.g., read and understand articles in a newspaper)
- Surf the web
- Interpret an arbitrary visual scene
- Learn a natural language
- Play Go as well as the best human players
- Construct plans in dynamic real-time domains
- Refocus attention in complex environments
- Perform life-long learning

Exhibit true autonomy and intelligence!

Who Does AI?

Carnegie Mellon

- Academic researchers (perhaps the most Ph.D.-generating area of computer science in recent years)
 - Some of the top AI schools: CMU, Stanford, Berkeley, MIT, UIUC, UMd, U Alberta, UT Austin, ... (and, of course, UMBC!)
- Government and private research labs
 - NASA, NRL, NIST, IBM, AT&T, SRI, ISI, MERL, ...
- Lots of companies!
 - Google, Microsoft, Honeywell, Teknowledge, SAIC, MITRE, Fujitsu, Global InfoTek, BodyMedia, ...

The Google logo, featuring the word "Google" in its characteristic multi-colored font.The Honeywell logo, featuring the word "Honeywell" in a red, sans-serif font.The BodyMedia logo, featuring a blue circular icon with a stylized figure and the text "BODYMEDIA" in a blue, sans-serif font.The Microsoft logo, featuring the word "Microsoft" in a white, sans-serif font on a blue rectangular background.The MITRE logo, featuring the word "MITRE" in a white, sans-serif font on a blue rectangular background.The Fujitsu logo, featuring the word "FUJITSU" in a red, sans-serif font.



Representation

- Causality
- Constraints
- Description Logics
- Knowledge Representation
- Ontologies and Foundations

Reasoning

- Automated Reasoning
 - Belief Revision and Update
- Diagnosis
 - Nonmonotonic Reasoning
- Probabilistic Inference
 - Qualitative Reasoning
- Reasoning about Actions and Change
 - Resource-Bounded Reasoning
- Satisfiability
 - Spatial Reasoning
 - Temporal Reasoning

Behavior

- Case-Based Reasoning
- Cognitive Modeling
- Decision Theory
- Learning
- Planning
- Probabilistic Planning
- Scheduling
- Search

Interaction

- Cognitive Robotics
- Multi-agent Systems
- Natural Language
- Perception
- Robotics
- User Modeling
- Vision

Robotics

- SRI: Shakey / planning [..\movies\sri-Shakey.ram](#)
- SRI: Flakey / planning & control [..\..\movies\sri-Flakey.ram](#)
- UMass: Thing / learning & control
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- MIT: Cog / reactive behavior
[..\movies\mit-cog-saw-30.mov](#)
[..\movies\mit-cog-drum-close-15.mov](#)
- MIT: Kismet / affect & interaction
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[..\..\movies\mit-kismet-expressions-dl.mov](#)
- CMU: RoboCup Soccer / teamwork & coordination
[..\movies\cmu_vs_gatech.mpeg](#)

Applications

- AI and Data Integration
- AI and the Internet
- Art and Creativity
- Information Extraction

- A sample from IAAI-03:
 - Scheduling train crews
 - Automated student essay evaluation
 - Packet scheduling in network routers
 - Broadcast news understanding
 - Vehicle diagnosis
 - Robot photography
 - Relational pattern matching

Other Topics/Paradigms

- Intelligent tutoring systems
- Agent architectures
- Mixed-initiative systems
- Embedded systems / mobile autonomous agents
- Machine translation
- Statistical natural language processing
- Object-oriented software engineering / software reuse



Applications

Game Playing



Text/Sketch Recognition

steamboat train, from New
this **morning** ran off the track
New-London. Four cars plunged



morning upon

Type the two words:

reCAPTCHA™
stop spam.
read books.

User Modeling/Recommender Systems



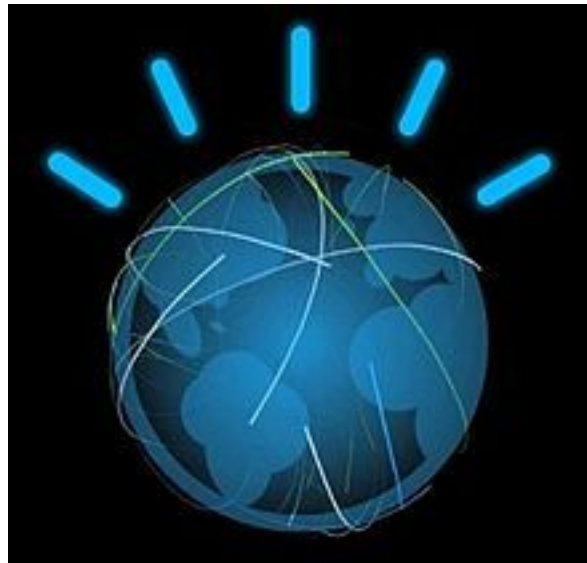
mission to
make language
education free
and accessible
to everyone.

Robotics



Knowledge Representation

Watson



Watson is a highly intelligent question answering computer system capable of processing questions posed in natural language.

Evolutionary Art



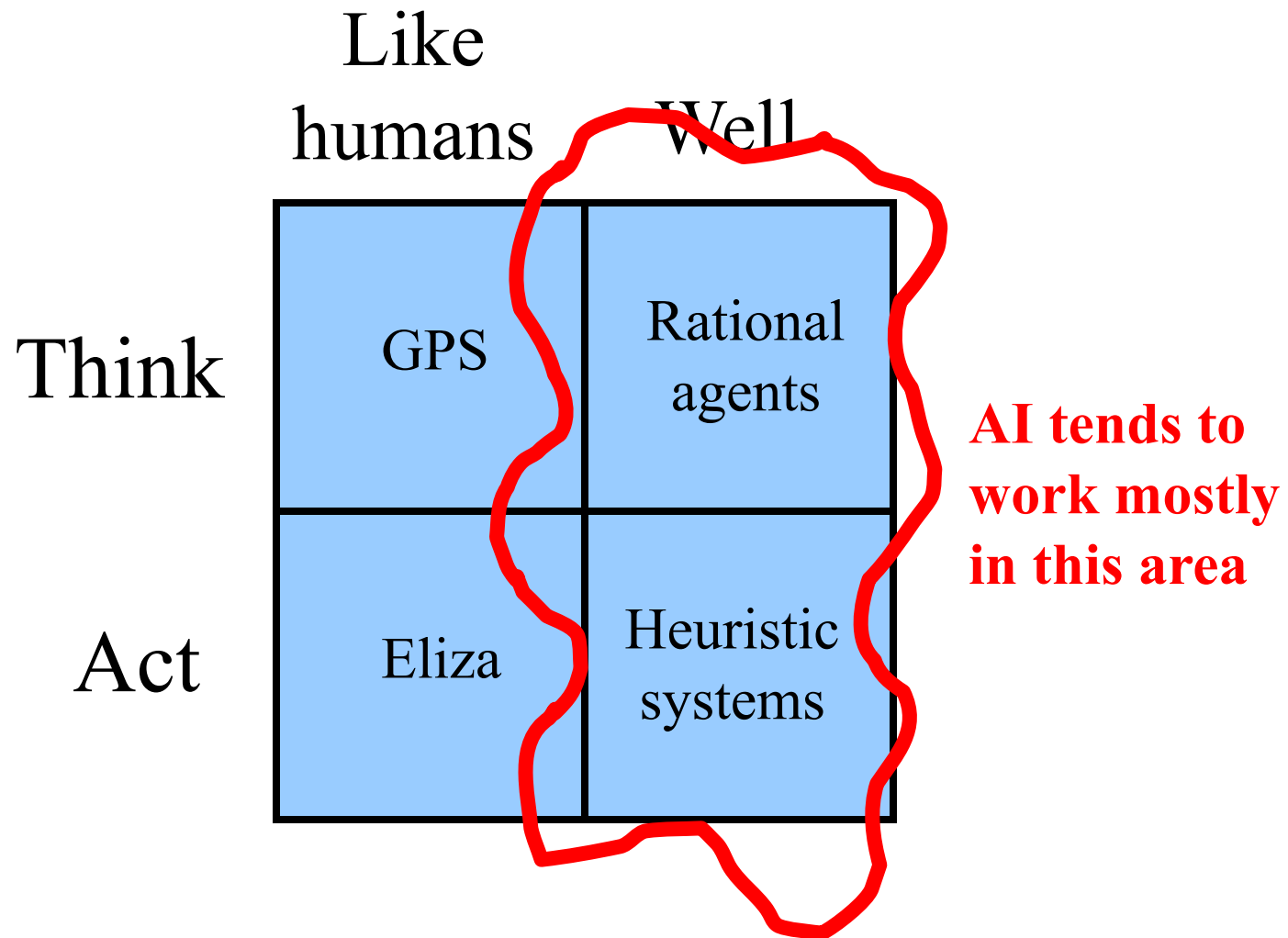
Evolutionary art is a branch of generative art, in which the artist does not do the work of constructing the art work, but rather lets a system do the construction

Electric Sheep is a distributed computing project for animating and evolving fractal flames

Computer Vision



Possible Approaches



Four goals of AI

Systems that think like humans

“The exciting new effort to make computers think ... machine in minds, in the full and literal senses” (Haugeland, 1985)

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

Systems that think rationally

“The study of mental faculties through the use of computational models” (Charniak and McDermott, 1985)

“The study of the computations that make it possible to perceive, reason, and act” (Winston, 1992)

Systems that act like humans

“The art of creating machines that perform functions that require intelligence when performed by people” (Kurzweil)

“The study of how to make computers do things at which, at the moment, people are better” (Rich and Knight, 1991)

Systems that act rationally

“A field of study that seeks to explain and emulate intelligent behavior in terms of computational processes” (Schalkoff, 1990)

“The branch of computer science that is concerned with the automation of intelligent behavior” (Luger and Stubblefield)

Measure of Success

In terms of human intelligence

In terms of rationality

Dimensions
of Definition

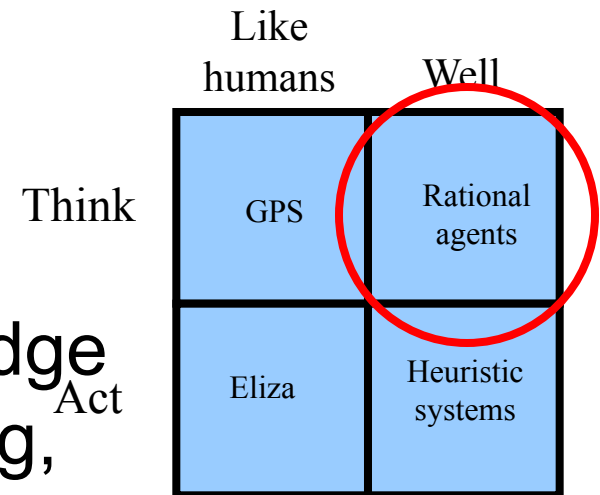
Thought
Process
and
Reasoning

Behavior

Thinking Humanly	Thinking Rationally
<p>"The exciting new effort to make computers think ... <i>machines with minds</i>, in the full and literal sense" (Haugeland, 1985)</p> <p>"The automation of activities that we associate with human thinking, activities such as decision-making, problem solving, learning ..." (Bellman, 1978)</p>	<p>"The study of mental faculties through the use of computational models" (Charniak and McDermott, 1985)</p> <p>"The study of the computations that make it possible to perceive, reason, and act" (Winston, 1992)</p>
Acting Humanly	Acting Rationally
<p>"The art of creating machines that perform functions that require intelligence when performed by people" (Kurzweil, 1990)</p> <p>"The study of how to make computers do things at which, at the moment, people are better" (Rich and Knight, 1991)</p>	<p>"A field of study that seeks to explain and emulate intelligent behavior in terms of computational processes" (Schalkoff, 1990)</p> <p>"The branch of computer science that is concerned with the automation of intelligent behavior" (Luger and Stubblefield, 1993)</p>

Think Well

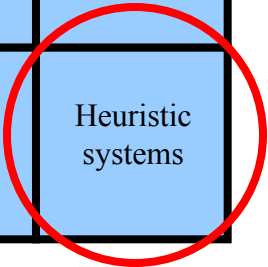
- Develop formal models of knowledge representation, reasoning, learning, memory, and problem solving, that can be **rendered in algorithms**.
- There is often an emphasis on systems that are provably correct, and guarantee finding an optimal solution.



Act Well

- For a given set of inputs, generate an appropriate output that is **not necessarily correct but gets the job done**.
- A **heuristic (heuristic rule, heuristic method)** is a rule of thumb, strategy, trick, simplification, or any other kind of device which drastically limits search for solutions in large problem spaces.
- Heuristics do not guarantee optimal solutions; in fact, they do not guarantee any solution at all: **all that can be said for a useful heuristic is that it offers solutions which are good enough most of the time.**
 - Feigenbaum and Feldman, 1963, p. 6

	Like humans	Well
Think	GPS	Rational agents
Act	Eliza	Heuristic systems



Think Like Humans

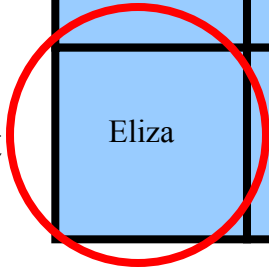
- Cognitive science approach
- Focus not just on behavior and I/O also look at reasoning process.
- Computational model should reflect “how” results were obtained.
- Provide a new language for expressing cognitive theories and new mechanisms for evaluating them
- **GPS (General Problem Solver)**: Goal not just to produce humanlike behavior (like ELIZA), but to produce a sequence of steps of the reasoning process that was similar to the **steps followed by a person** in solving the same task.

	Like humans	Well
Think	GPS	Rational agents
Act	Eliza	Heuristic systems

Act Like Humans

- Behaviorist approach.
- Not interested in how you get results, just the **similarity to what human results are**.
- Exemplified by the Turing Test (Alan Turing, 1950).

	Like humans	Well
Think	GPS	Rational agents
Act	Eliza	Heuristic systems



Strong vs. Weak AI

- Strong AI: “Artificial intelligence that matches or surpasses human intelligence.”
 - Must be able to:
 - Reason
 - Plan
 - Learn
 - Communicate
 - Integrate this skills towards common goals
- Weak AI: “Use of software to study and accomplish specific problem solving or reasoning tasks not encompassing full range of human cognitive abilities.”
- How it's being done: the Blue Brain Project. Tries to simulate the human brain using supercomputers.



Possible Questions

1. Purpose of Turing Test, Lubner test
2. Heuristic System
3. Act well
4. What AI can do/cant do yet
5. What are reasoning areas in which AI are used?
6. Strong vs Weak AI
7. So on



Thanks!