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.

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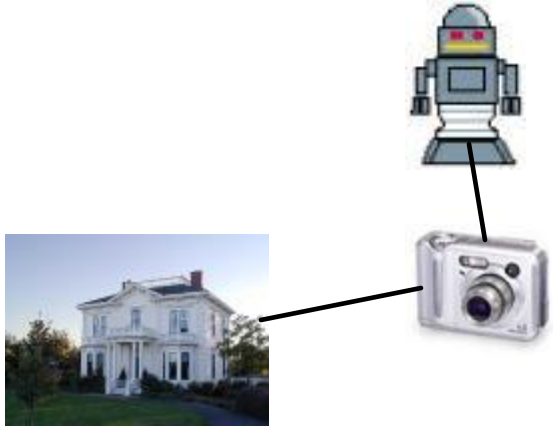
AI: A Vision

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

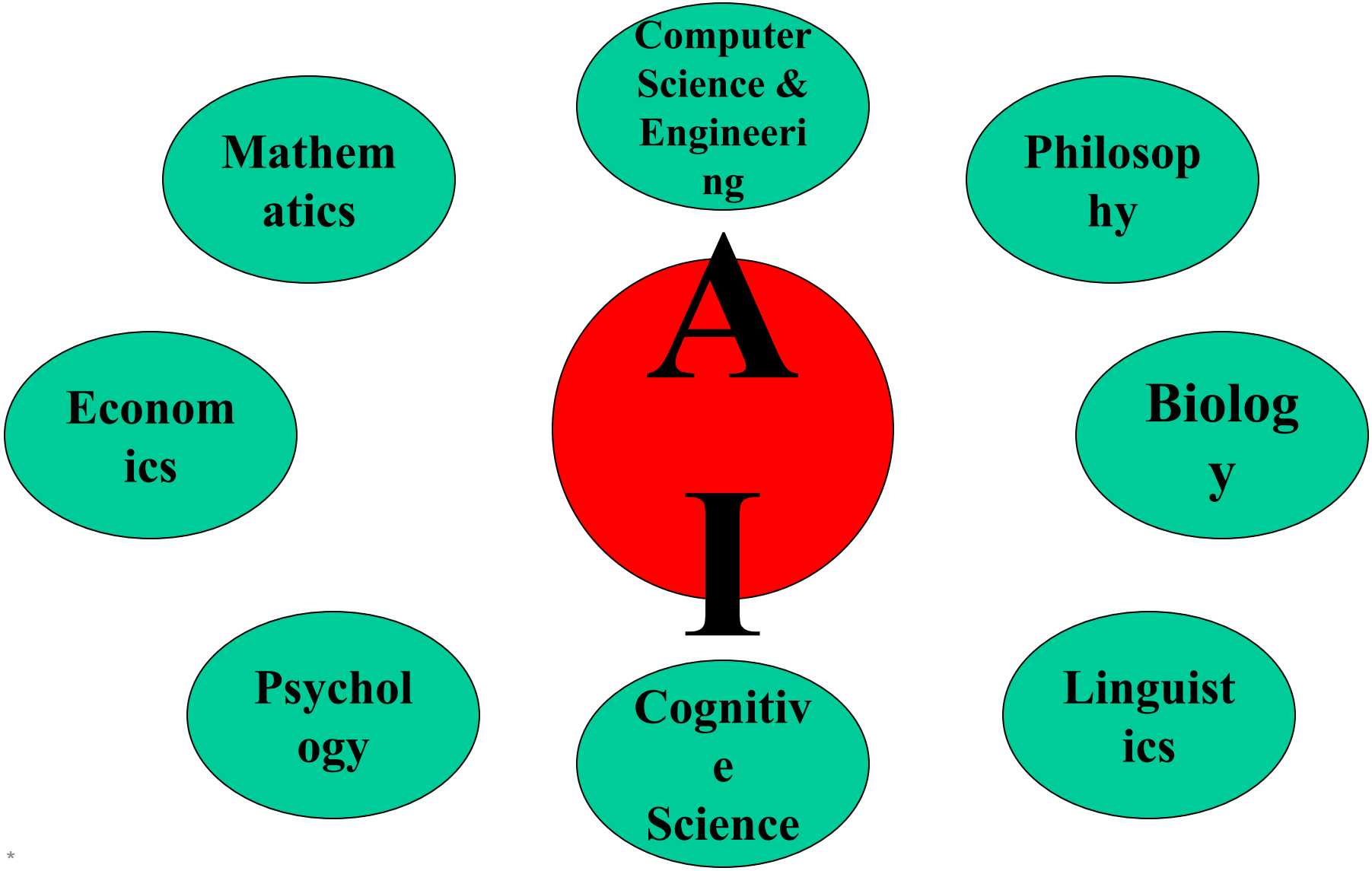
Develop interesting and useful **applications**

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



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A (Short) History of AI

1940-1950: Early days
- 1943: McCulloch & Pitts: Boolean circuit model of brain
- 1950: Turing's “Computing Machinery and Intelligence”

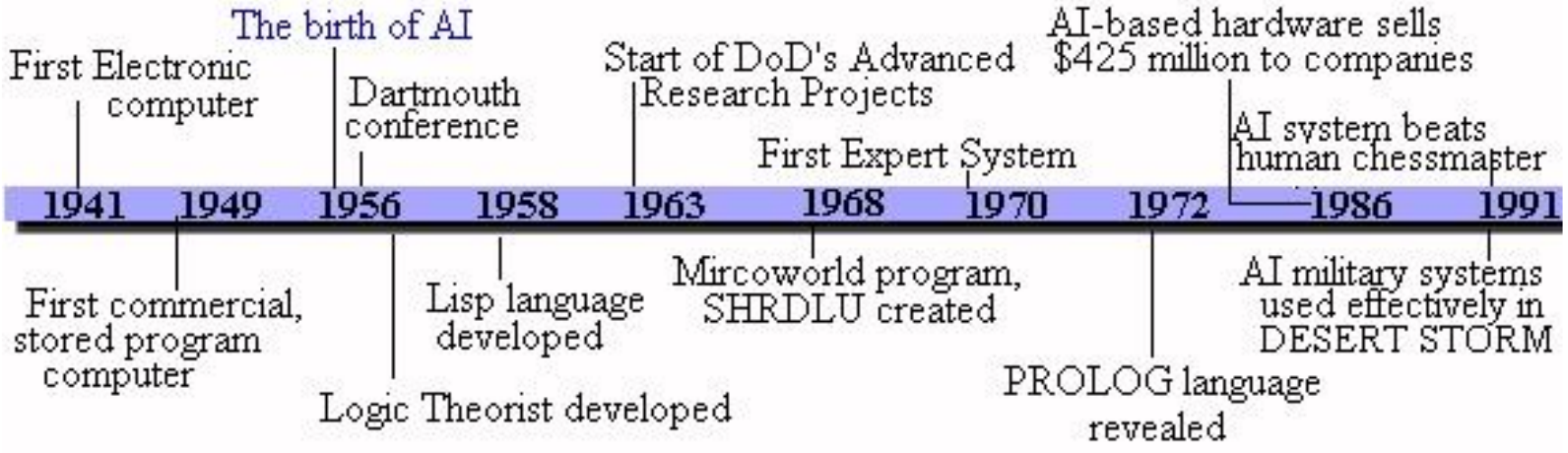
1950—70: Excitement: Look, Ma, no hands!
- 1950s: Early AI programs, including Samuel's checkers program, Newell & Simon's Logic Theorist, Gelernter's Geometry Engine
- 1956: Dartmouth meeting: “Artificial Intelligence” adopted
- 1965: Robinson's complete algorithm for logical reasoning

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

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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 though 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

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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/Prizef/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
- Construct plans in dynamic real-time domains
- Refocus attention in complex environments
- Perform life-long learning

Exhibit true autonomy and intelligence!

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Who Does AI?

- 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, ...

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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

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Behavior

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

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Interaction

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

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Robotics

- SRI: Shakey / planning ..\movies\sri-Shakey.ram
- SRI: Flakey / planning & control ..\..\movies\sri-Flakey.ram
- UMass: Thing / learning & control
  ..\movies\..\movies\umass_thing_irreg.mpeg
  ..\movies\..\movies\umass_thing_quest.mpeg
  ..\..\movies\umass-can-roll.mpeg
- MIT: Cog / reactive behavior
  ..\movies\mit-cog-saw-30.mov
  ..\movies\mit-cog-drum-close-15.mov
- MIT: Kismet / affect & interaction
  ..\..\movies\mit-kismet.mov
  ..\..\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

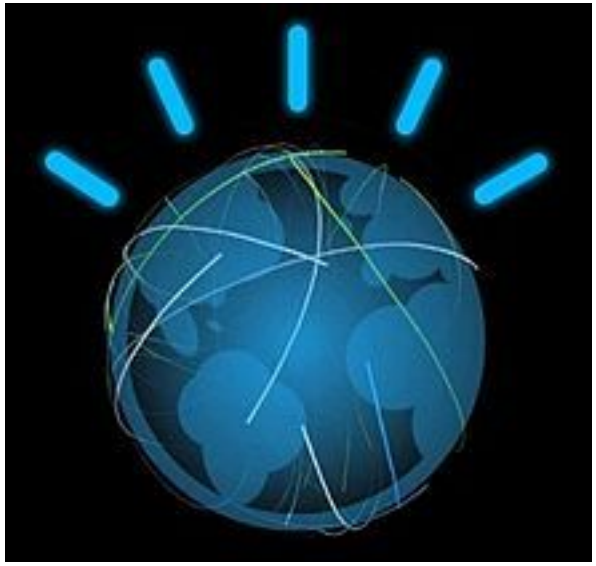
User Modeling/Recommender Systems

mission to make language education free and accessible to everyone.

Robotics

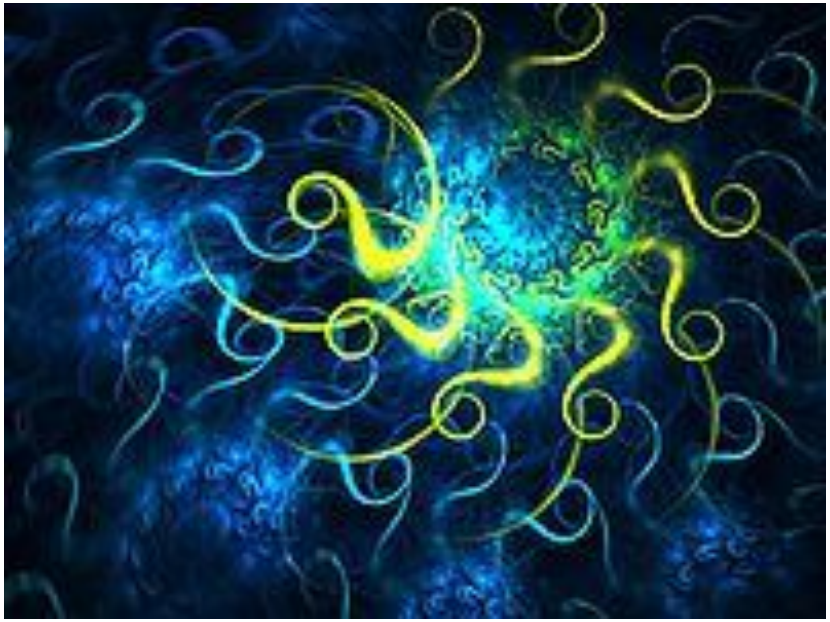
Knowledge Representation

Watson



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

Evolutionary Art

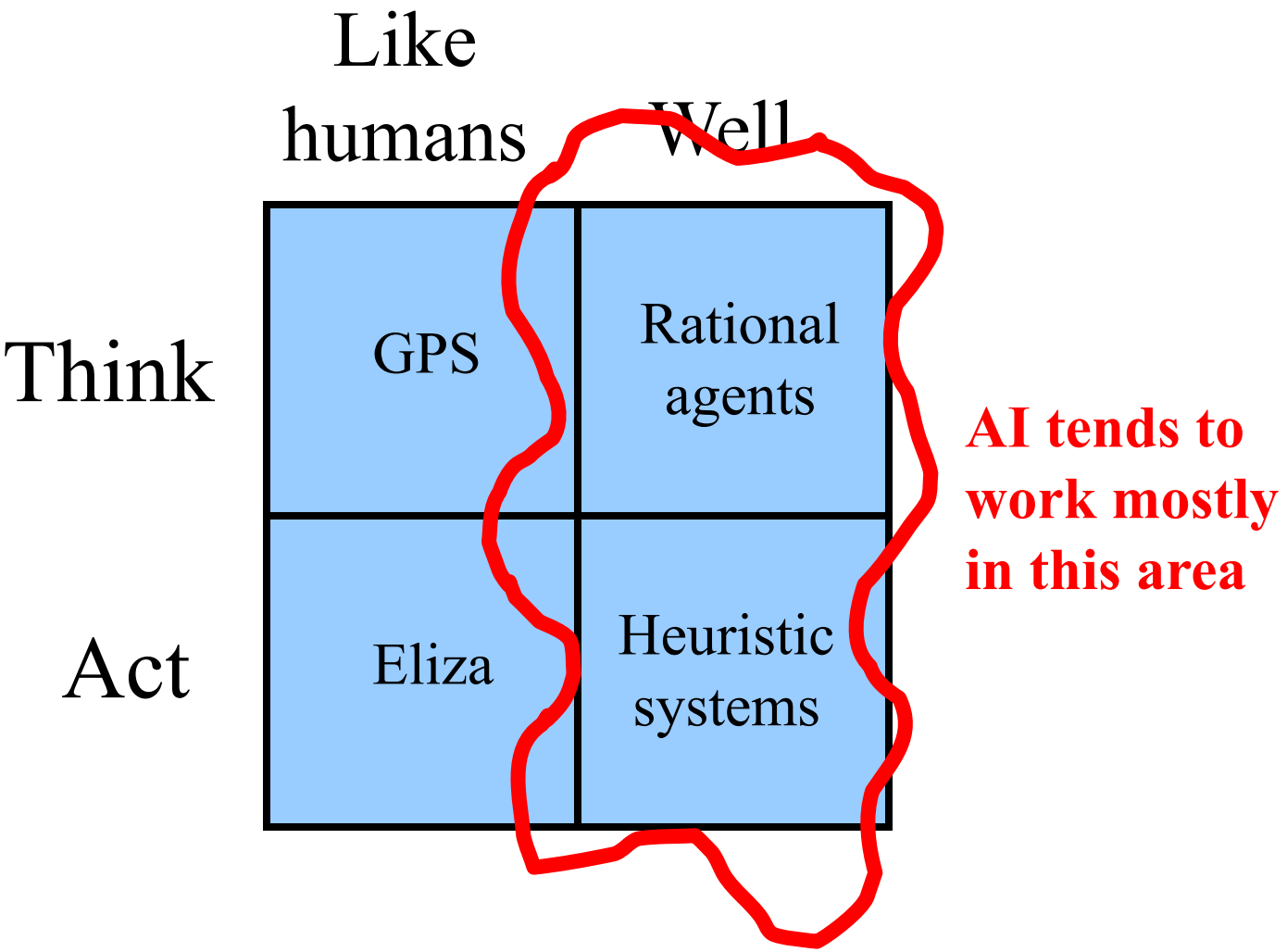


Evolutionary art is a branch of generative art, in which the artist does not do the work of constructing the art work, but rather lets a system do the construction

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

Computer Vision

Possible Approaches



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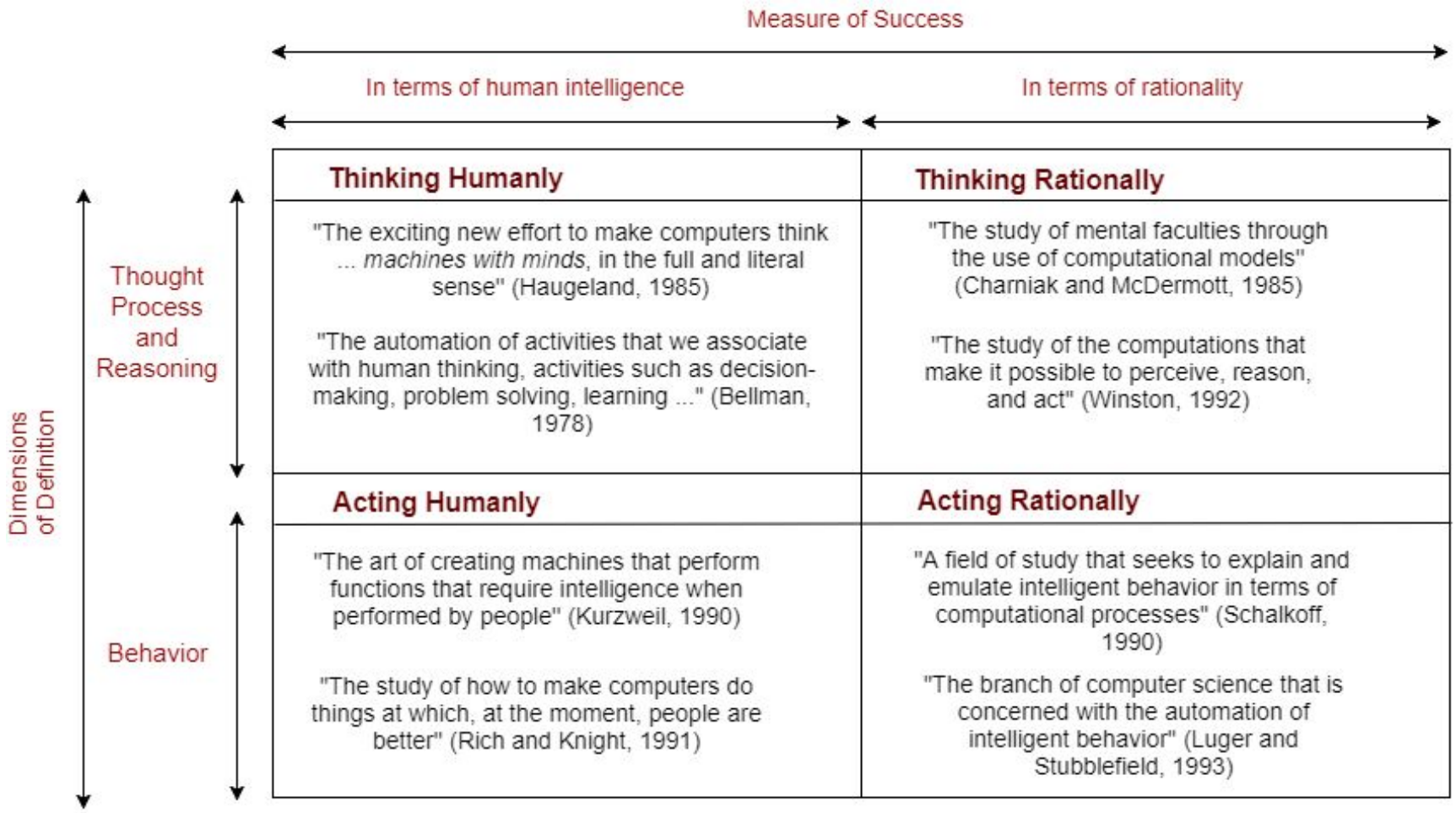
Four goals of AI

Systems that think like humans	*Systems that think rationally*
"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)	"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	***Systems that act rationally***
"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)	"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
"The exciting new effort to make computers think ... machines with minds, in the full and literal sense" (Haugeland, 1985)
"The automation of activities that we associate with human thinking, activities such as decision-making, problem solving, learning ..." (Bellman, 1978)
Thinking 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)
Acting Humanly
"The art of creating machines that perform functions that require intelligence when performed by people" (Kurzweil, 1990)
"The study of how to make computers do things at which, at the moment, people are better" (Rich and Knight, 1991)
Acting Rationally
"A field of study that seeks to explain and emulate intelligent behavior in terms of computational processes" (Schalkoff, 1990)
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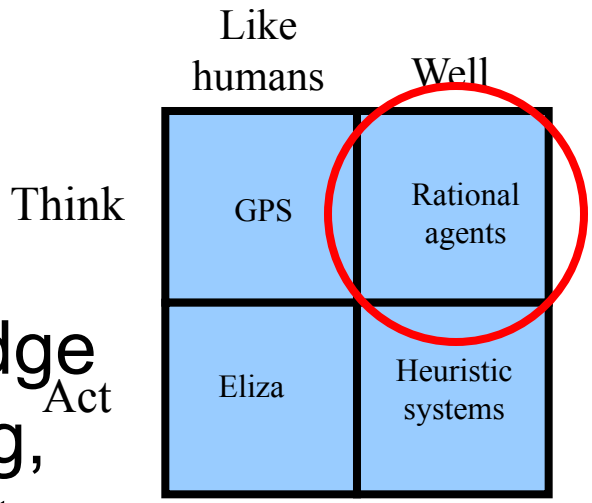
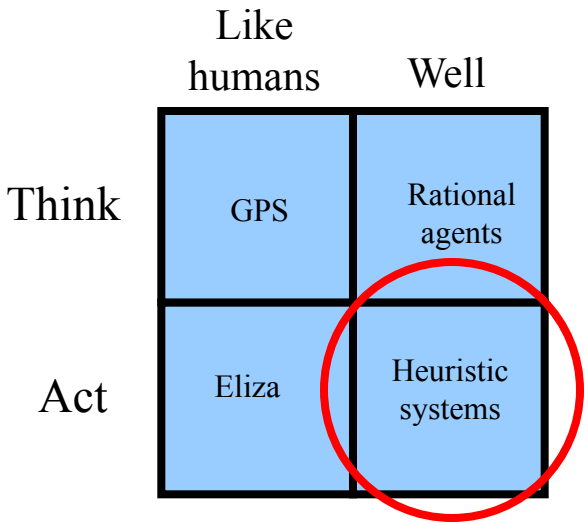
Think Well



- 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

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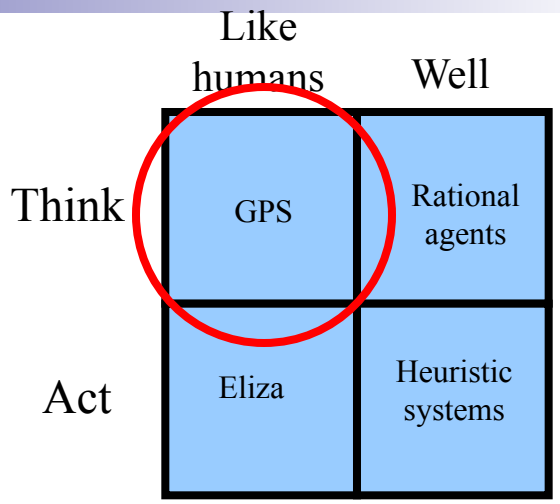
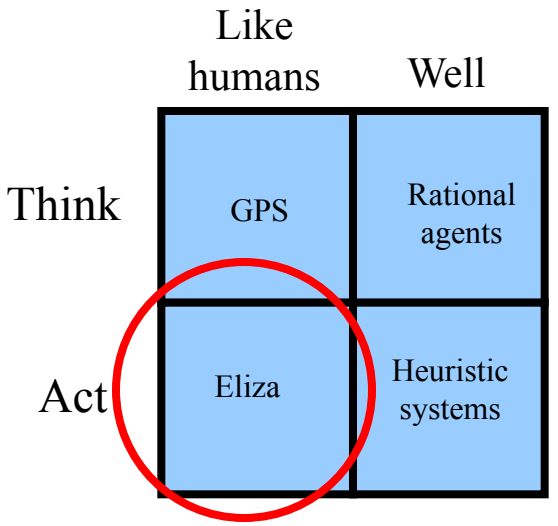
Think Like Humans



- 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.

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).



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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 ….

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Thanks!