Lecture 1:
Introduction to the Course

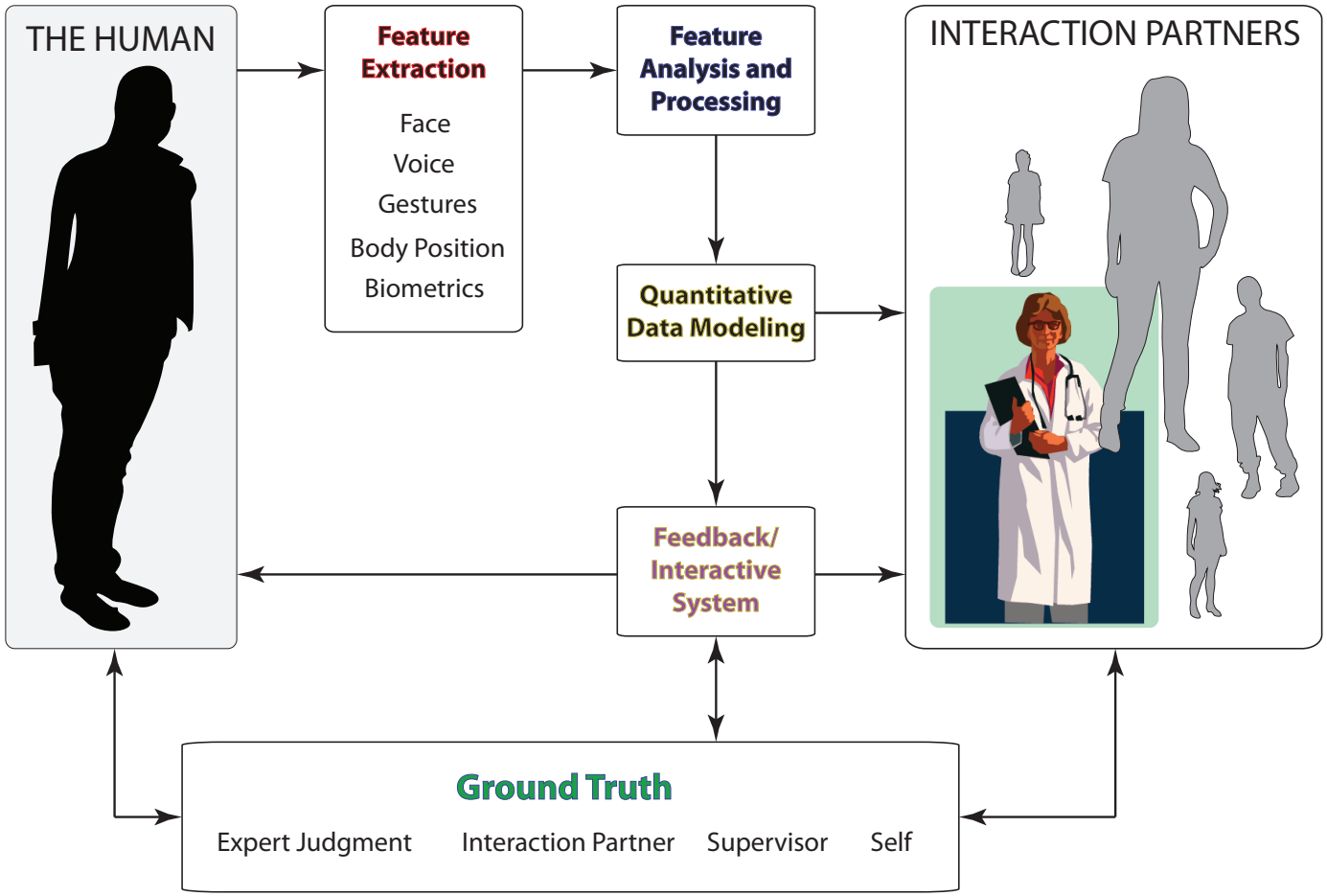
EECS 492

Introduction to Artificial Intelligence

Instructor

- Emily Mower Provost
  - Assistant Professor, CSE
  - Office: 3620 BBB
- Education:
  - Ph.D., University of Southern California, 2010, “Emotions in Engineering: Methods for the Interpretation of Ambiguous Emotional Content."
  - Post-doc studying affective interfaces for children with autism
- Current role
  - Research interest: estimating behavior from speech
  - Project Support: NSF and NIH

Behavior Recognition



EECS 492: Details

- Professor Emily Mower Provost
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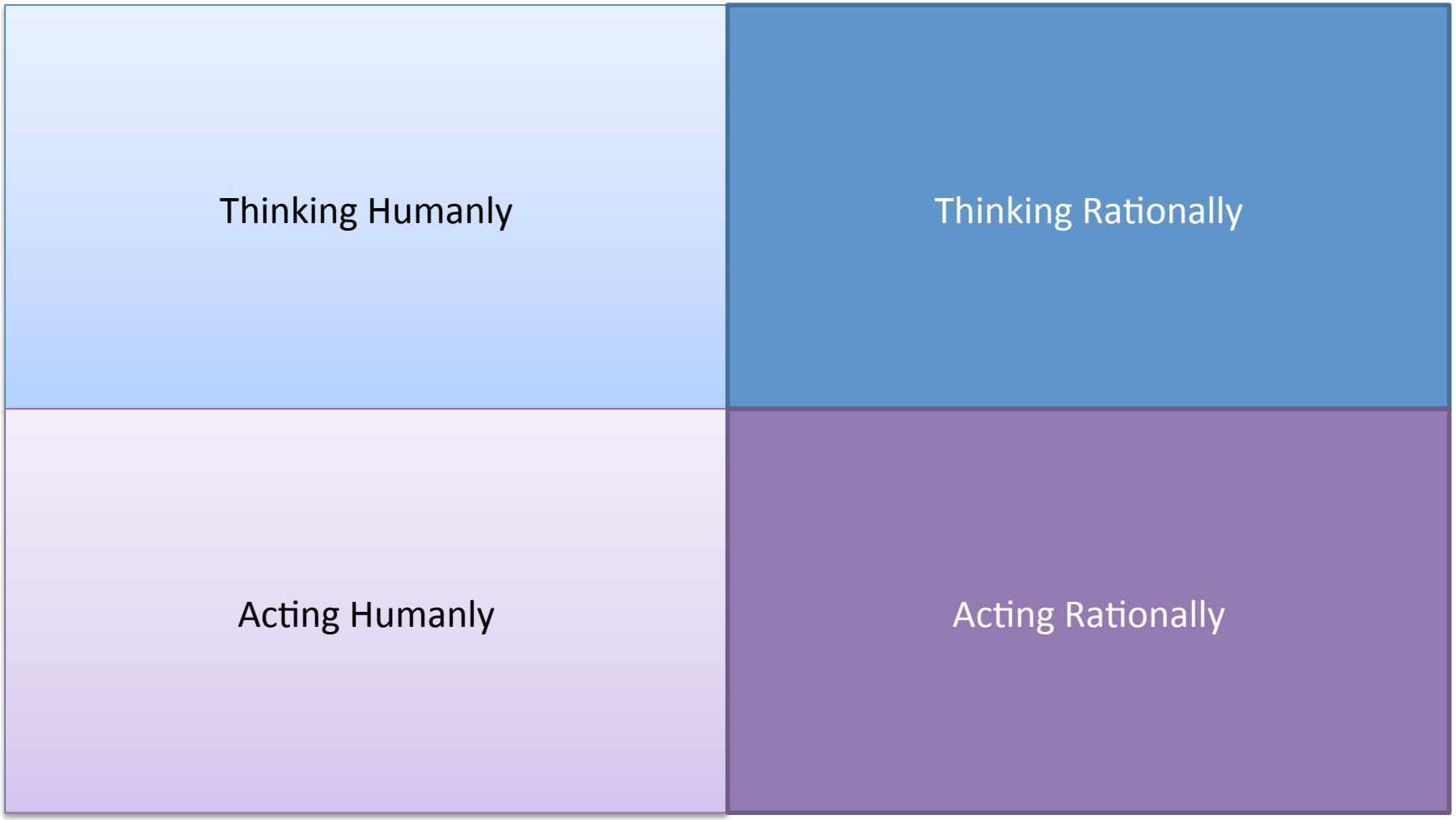
Class Overview

- Discussion of AI
- Overview of syllabus and evaluation
- Overview of topics to come
- Time for questions

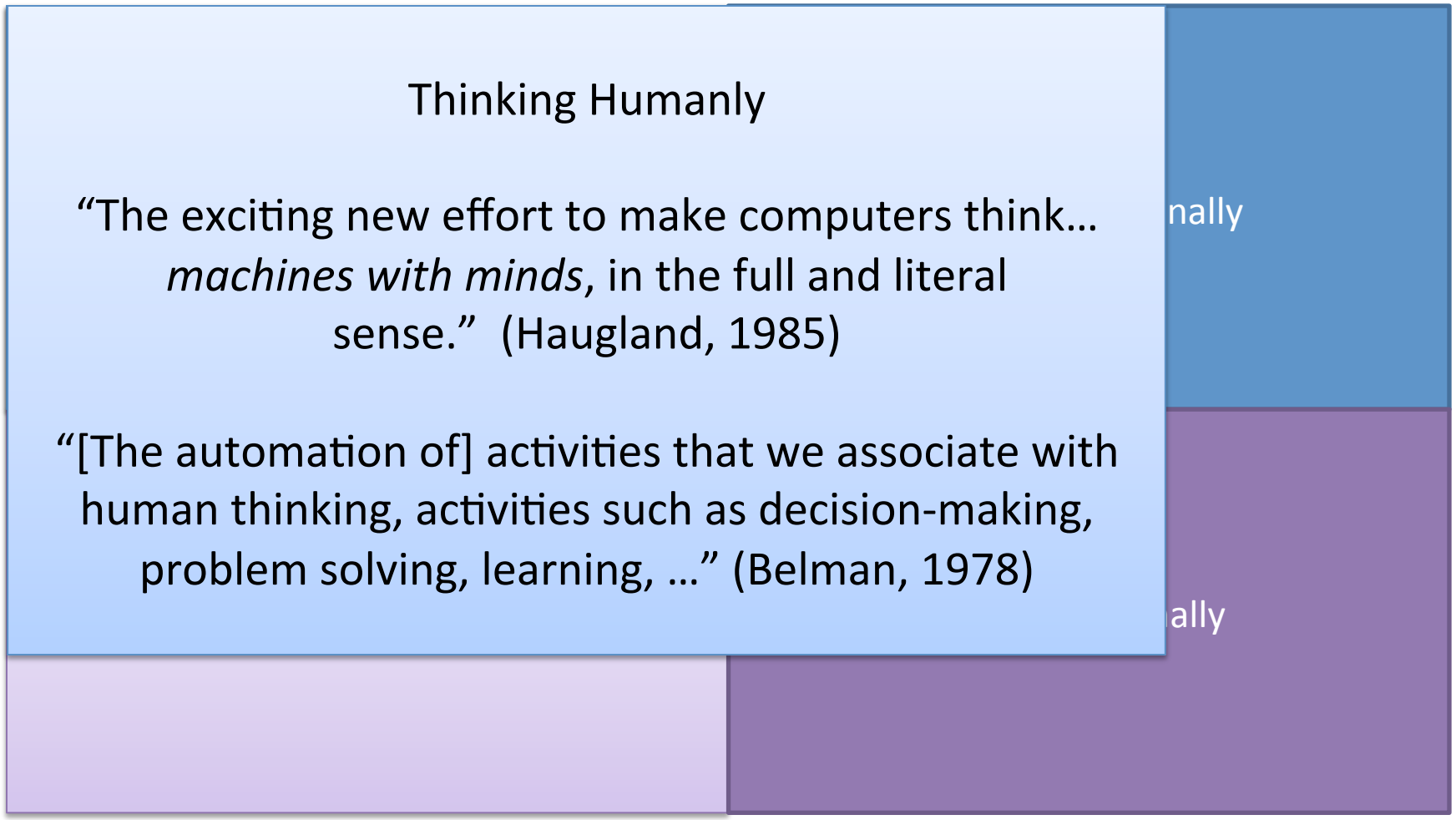
Multiple views on Artificial Intelligence

WHAT IS AI?

What is Artificial Intelligence?



What is Artificial Intelligence?



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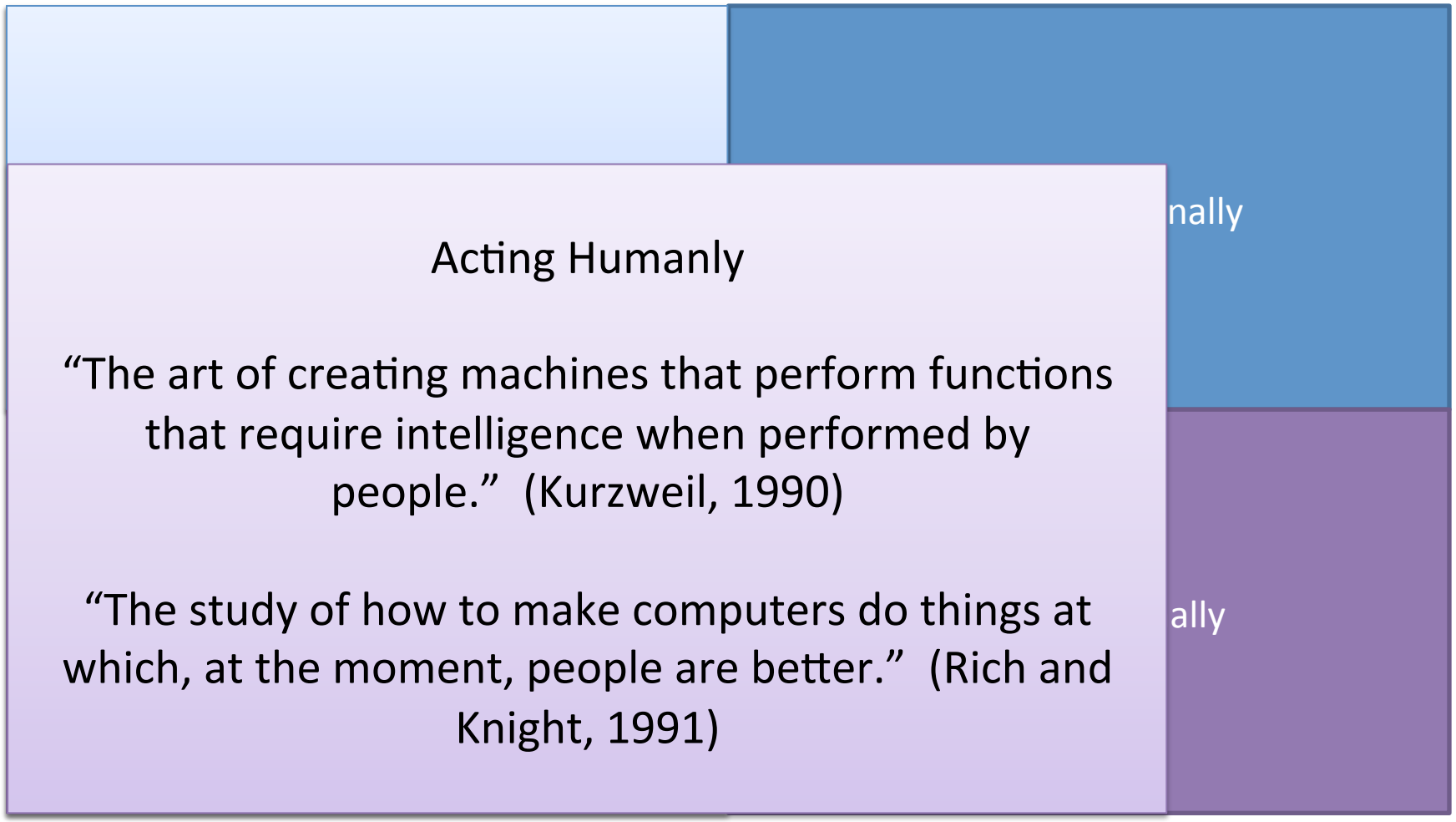

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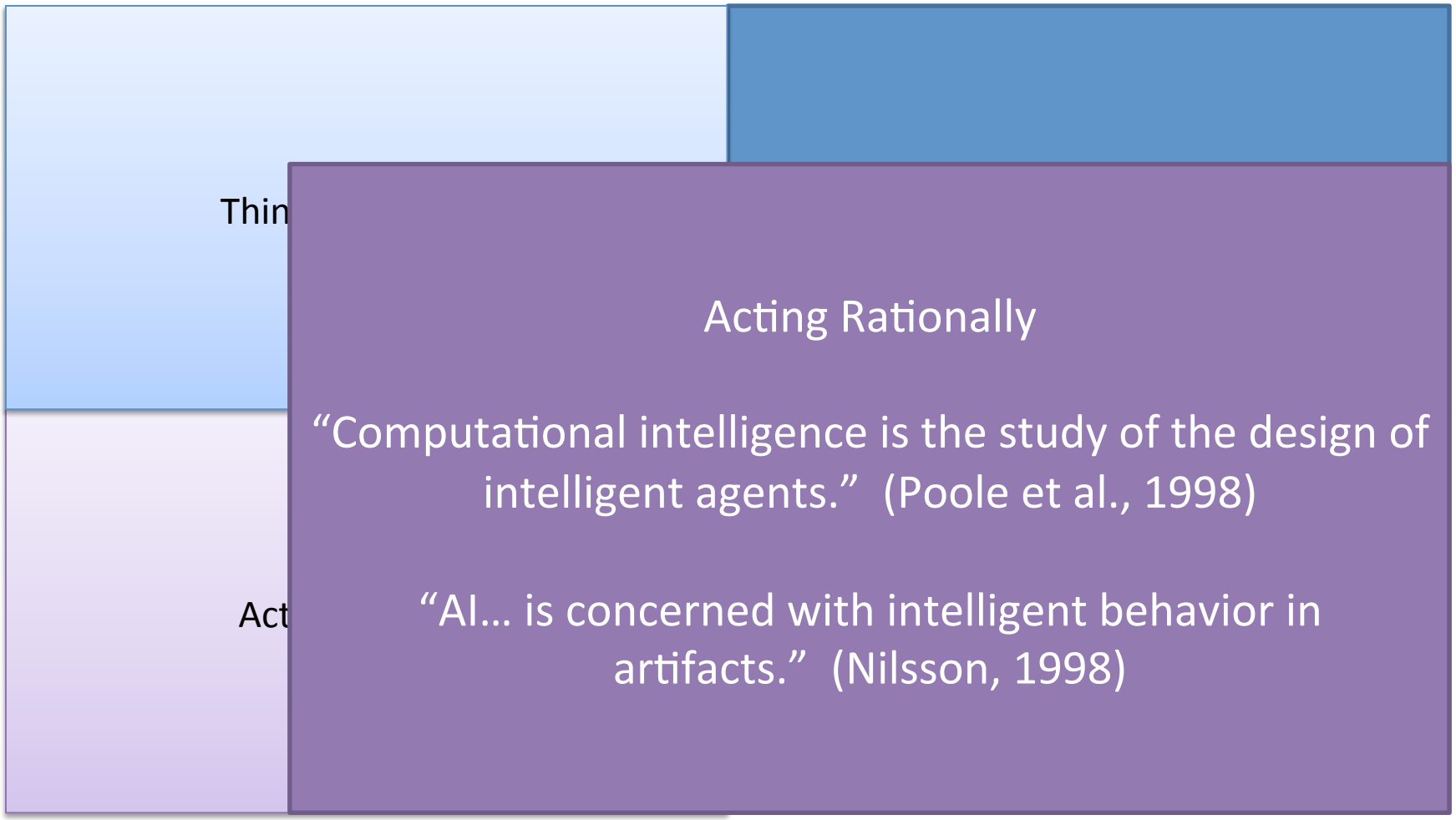

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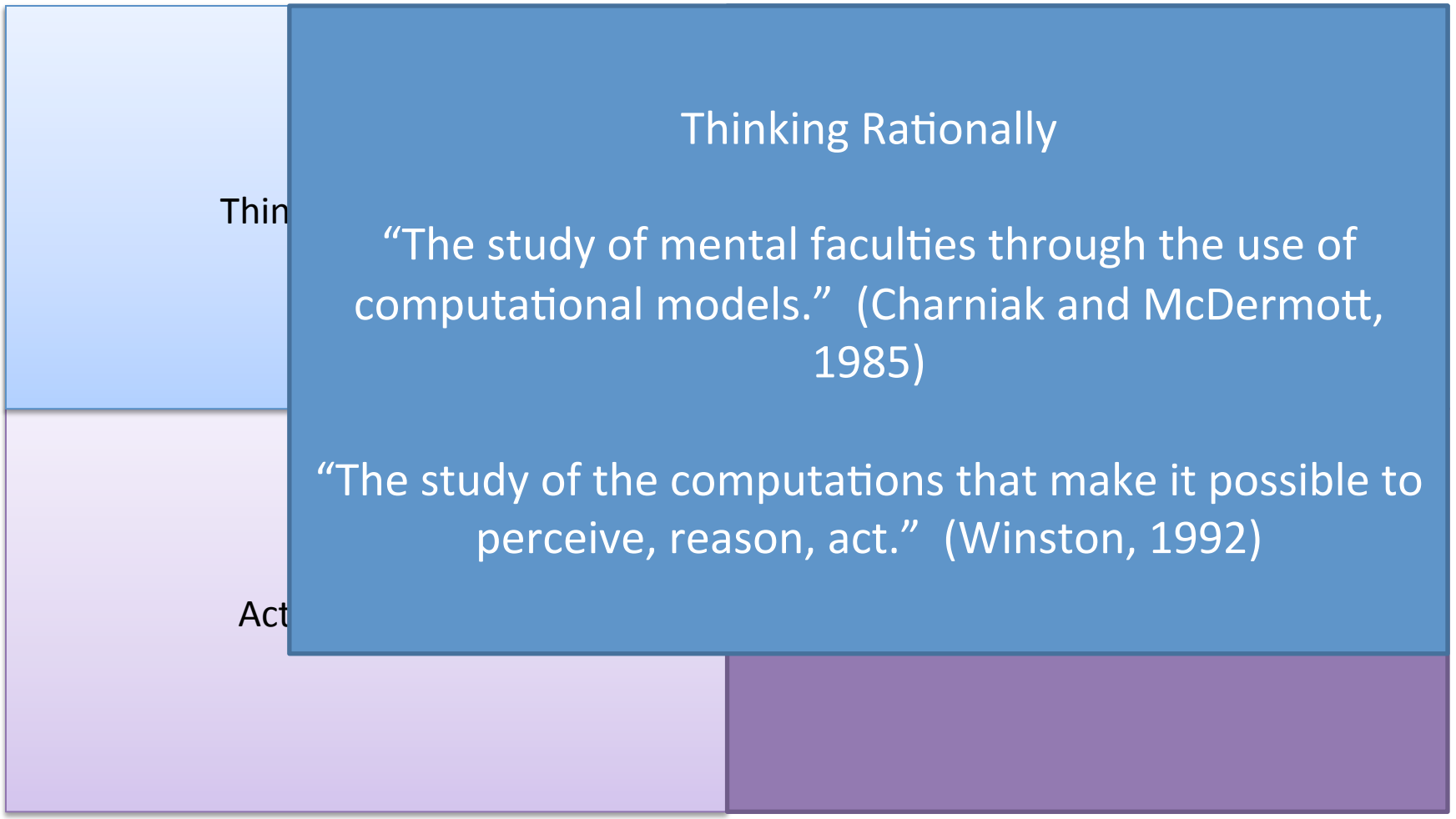


Acting Humanly

- How can we define intelligence?
  - What must a machine be able to do?
  - Assess via the Turing Test

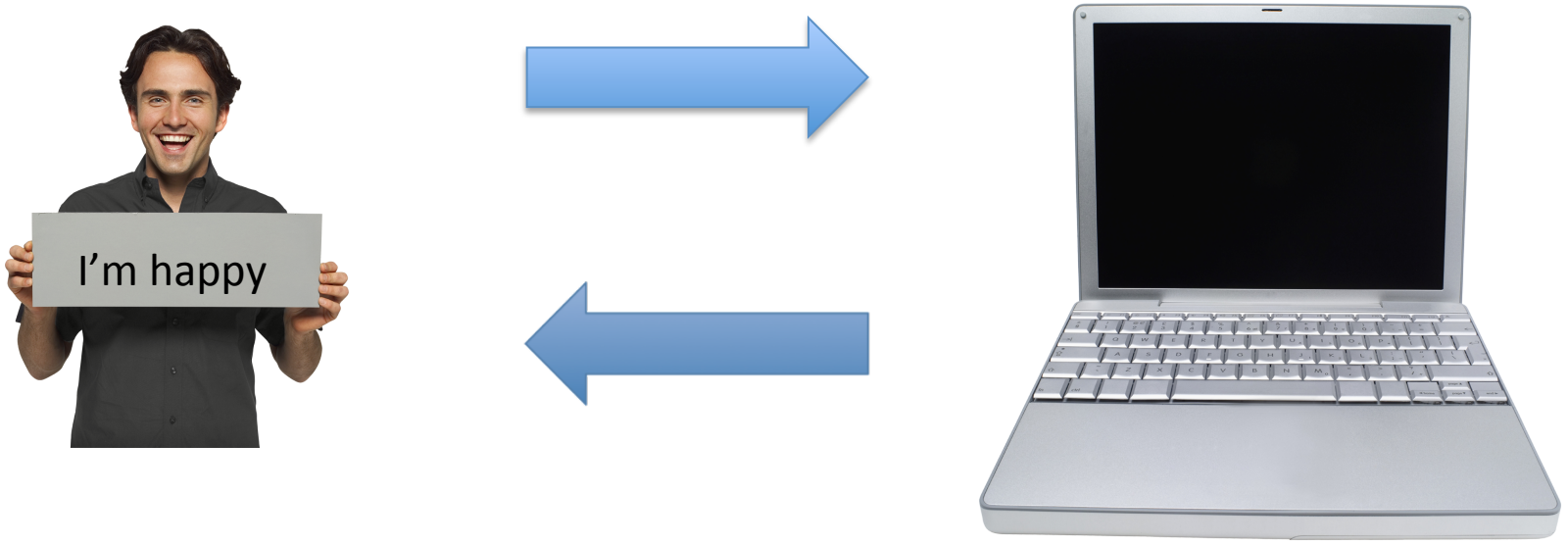
- Skills:
  - Natural language processing
  - Knowledge representation
  - Automated reasoning
  - Machine learning

What are some issues with this test?

Thinking Humanly

Thinking Humanly

- Why is this useful?
- How can we assess if it does this?
- What can we learn about humans?



Thinking Rationally

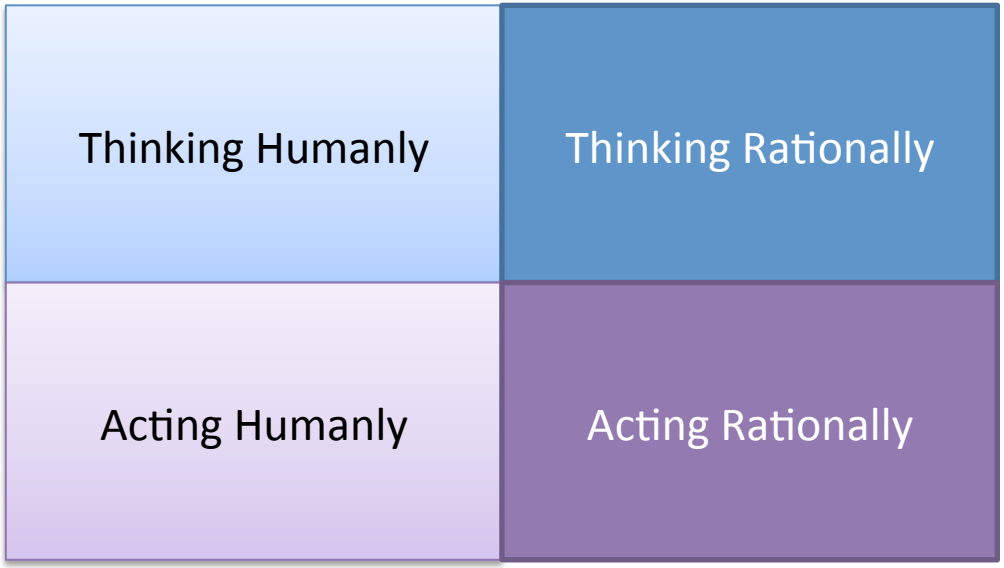
- Logic – provides precise notation for statements
- What are some limitations?

- Example:
  - The grass is green and a boy is playing.
  - The sky is blue and a girl is running.
  - These images:




Acting Rationally

- Agent – something that acts
  - What is a rational agent?
  - What is the goal of a rational agent?
- "Laws of Thought" approach – make decisions based on correct inferences
  - What is a limitation of this approach?
  - What do people do?
- Rational agent approach – make the best decision given uncertainty



Why do we care about the four quadrants?

An overview of the evolution of the artificial intelligence field

AI: A HISTORY

Inspiration

- Philosophy
  - Can formal rules be used to draw valid conclusions?
  - How does the mind arise from a physical brain?
  - Where does knowledge come from?
  - How does knowledge lead to action?

Inspiration

"We deliberate not about ends, but about means... They assume the end and consider how and by what means it is attained, and if it seems easily and best produced thereby; while if it is achieved by one means only they consider how it will be achieved by this and by what means this will be achieved, till they come to the first cause, ... and what is last in the order of analysis seems to be first in the order of becoming. And if we come on an impossibility, we give up the search.

- Aristotle, Nicomachean Ethics (Book III. 3, 1112b)

Inspiration

"We deliberate not about ends, but about means… They assume the end and consider how and by what means it is attained, and if it seems easily and best produced thereby; while if it is achieved by one means or [illegible] achieved by this [illegible] achieved, till th[illegible] what is last in t[illegible] first in the orde[illegible]n an impossibility[illegible]

This is the notion behind regression planning (we will see this later)!

- Aristotle, Nicomachean Ethics (Book III. 3, 1112b)

Inspiration

- Mathematics
  - What are the formal rules to draw valid conclusions?
  - What can be computed?
  - How do we reason with uncertain information?

Inspiration – Continued

- Economics
  - How can we make decisions to maximize profit?
  - How can we do this with an unwilling partner?
  - What if the payoff will occur sometime in the future?
- Neuroscience
  - How does the brain process information?
- Psychology
  - How do humans and animals think, act, and interact?

Inspiration

- Cognitive Psychology

- Three steps of a “knowledge-based” agent:
  - Stimulus translated into internal representation
  - Representation manipulated by internal processes to develop new representations
  - Representations are translated back into action

Inspiration

- Cognitive Psychology

- Three steps of a "knowledge-based" agent:
  - Stimulus tra
  - Representat
    to develop r
  - Representat

es

We will see how this feeds into our definitions of agents.

First work in AI

- Warren McCulloch and Walter Pitts (1943)

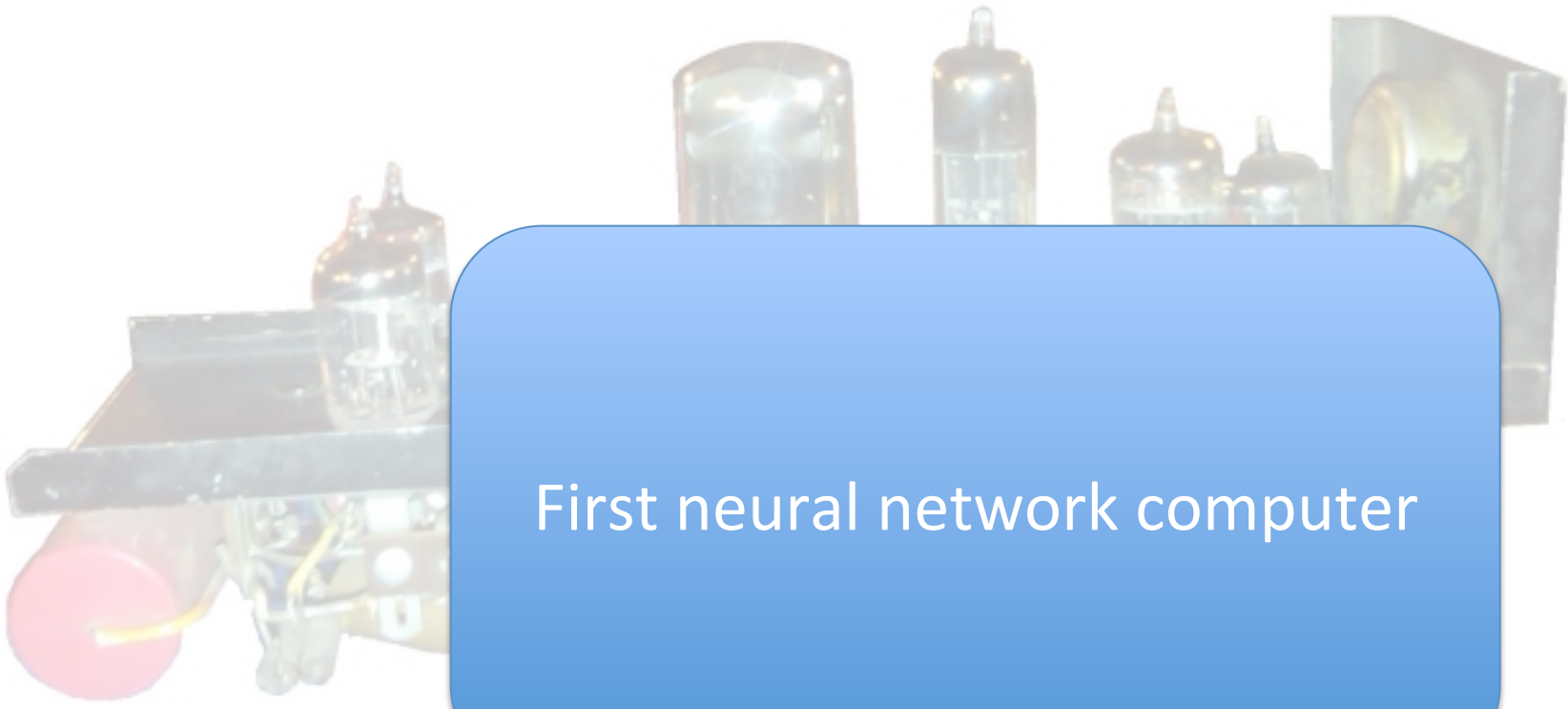
- Inspiration:
  - Basic physiology and function of neurons in the brain
  - Formal analysis of propositional logic
  - Turing's theory of computation

- Their notion: artificial neurons
  - Property: could turn on and off
  - Combination: logical connectives

First work in AI

- McCulloch and Pitts contributions:
  - Any computable function could be computed by some network of connected neurons
  - All logical connectives could be implemented in net structures
  - Suggested that suitably defined networks could learn!

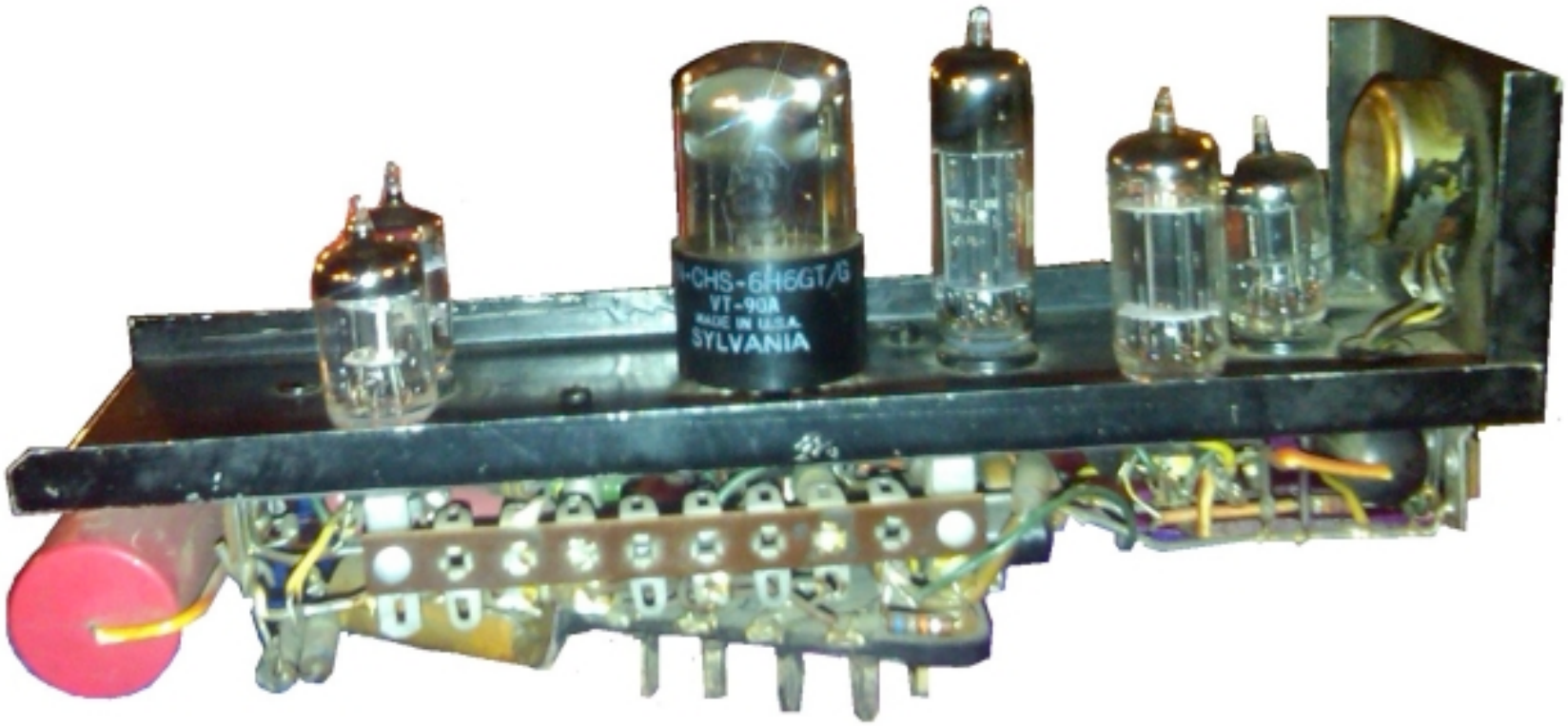
SNARC: Minsky and Edmonds (1950)



First neural network computer

http://cyberneticzoo.com/?m=200911&paged=3

SNARC: Minsky and Edmonds (1950)



http://cyberneticzoo.com/?m=200911&paged=3

AI Begins (1956)!

From the original proposal:

"... The study is to proceed on the basis of the conjecture that every aspect of learning or any other feature of intelligence can in principle be so precisely described that a machine can be made to simulate it. An attempt will be made to find how to make machines use language, form abstractions and concepts, solve kinds of problems now reserved for humans, and improve themselves. **We think that a 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.**"

They didn't quite finish...

AI Continues

- Newell and Simon – General Problem Solver
  - Designed to imitate human protocols
  - Subgoal ordering similar to human approaches
  - Embodiment of "thinking humanly"

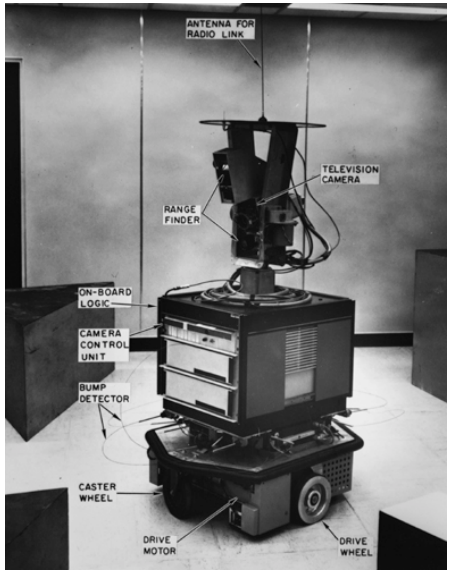
- Arthur Samuel (1952)
  - Checkers program
  - Learned to play at strong amateur level
  - Learned strategies that weren't taught

AI Continues

- John McCarthy (1958)
  - Language development: Lisp
  - Hypothetical AI System: Advice Taker
  - Interest in knowledge representation and reasoning in formal logic
- Marvin Minsky moves to MIT (1958)
  - Takes an “anti-logic” approach
  - Goal: get programs to work
  - Interest: Microworlds

AI Continues

- Stanford Research Institute – Shakey
  - Planning
  - Route-finding
  - Rearranging of simple objects
  - First to demonstrate integration of logical reasoning and physical activity



http://www.ai.sri.com/shakey/

- Video link: http://www.youtube.com/watch?v=qXdn6ynwpiI

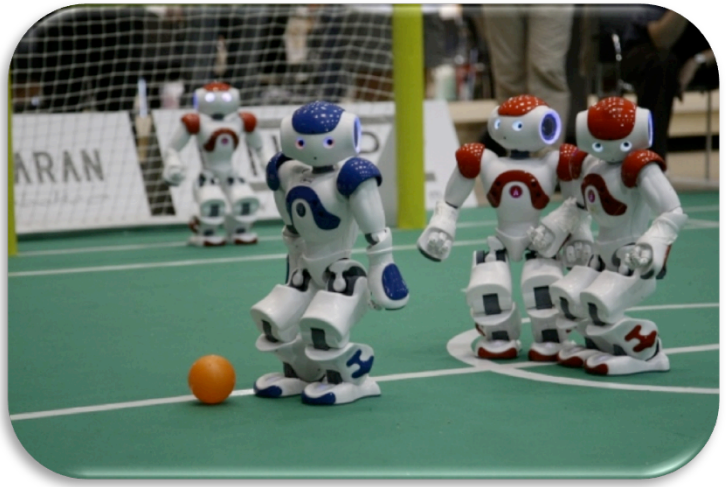
Overly Enthusiastic…

"It is not my aim to surprise or shock you – but the simplest way I can summarize is to say that there are now in the world machines that think, that learn, and that create. Moreover, their ability to do these things is going to increase rapidly until – **in a visible future** – the range of problems they can handle will be coextensive with the range to which the human mind has been applied."

-- Herbert Simon, 1957

Challenges

- Early programs had no subject knowledge
  - Success via simple syntactic manipulations
  - "The vodka is good but the meat is rotten."
- Intractability
  - In theory vs. practical demonstration
- Others?

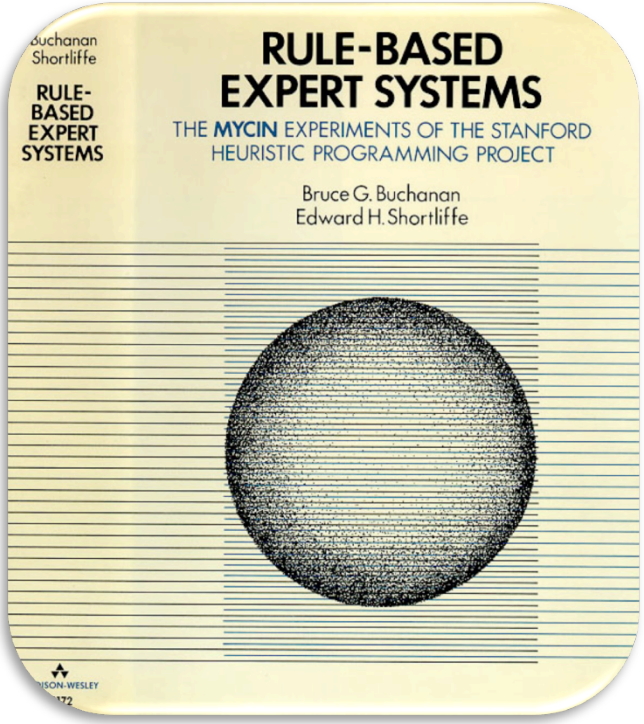


http://www.itechpost.com/articles/10846/20130701/robocup-2013-robot-soccer-players-ala-messi-ronaldo-van-persie.htm

Moving Beyond with Knowledge

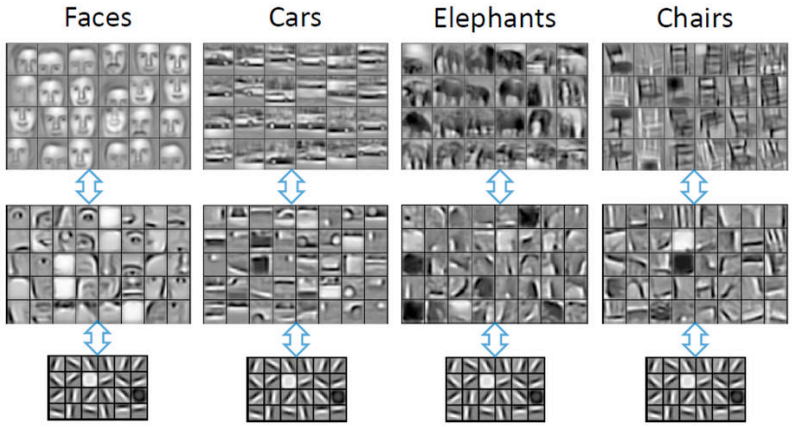
- Heuristic Programming Project
  - Create expert systems and apply to human knowledge
  - Moving towards more larger and real problem domains

- Example: Mycin
  - 450 rules to diagnose blood infections
  - Issue – no general framework
  - Required expert knowledge from humans
  - Must capture uncertainty: introduced certainty factors



Neural Networks and AI (1986 – now)

- Huge advance: reinvention of back-propagation
  - Original: 1969 Bryson and Ho
  - Enabled training of complex neural networks!



http://youqianhaozhe.com/research.htm

Current Applications in AI

- Robotics:
  - DARPA Grand and Urban challenges
  - Autonomous flight
  - Big Dog
  - iRobot Roomba
- Speech recognition
  - Computerized answering services
  - Search via Siri and Google Voice
  - **Not** based on human approaches to processing speech
- Game playing: IBM's Watson
- Factory robotics

We may have some work to do…

Computational Intelligence

- Computers are a special kind of machine
  - General, flexible
  - Most complex artifacts yet devised
- Still, lots of things that people seem capable of doing that computers can't (yet)
  - What makes these things hard?
- Whether or not those capabilities require "intelligence" per se, can be debated, but..
  - We will look at engineering principles for enlarging computer capabilities to encompass (more of) them.

Policies, syllabus, etc.

COURSE DESCRIPTION

EECS 492

- A first course in Artificial Intelligence
- Objectives
  - Introduce AI ideas and techniques
  - Discuss design of intelligent computational agents
- Prepare for:
  - Further study of AI
  - Any work involving the design of computer programs for substantial application domains

Course Objectives

- Goal: provide background in the field of artificial intelligence

- Specific objectives – finish the course with:
  - Specific modeling and analytical skills (e.g., search, logic, probability)
  - Knowledge of many of the most important knowledge representation, reasoning, and machine learning schemes
  - General understanding of AI principles and practice

Evaluation

- Homework 45%
- Midterm 25%
- Final 30%
- Course Evaluations +1%

Subject to slight modifications

Exam Dates

- **Midterm** – October 27 (in class)
- **Final** – December 20 (10:30 – 12:30)

- Note – midterm date/time is subject to slight change with notice

Homework

- Six problem sets (HW1-6)
  - Will be released at least a week in advance
  - Individual work (discuss with classmates but write down your own answers!)
  - One survey (HW0)

- Goal of assignments:
  - Assess your theoretical understanding of the topic
  - Assignments will have varying degrees of programming (**Python**)

Course Outline

- Introduction/agents
- Problem solving and search
- Logic and inference
- Planning
- Uncertainty and decision making
- Learning
- Applications

Topics in artificial intelligence

COURSE COVERAGE

Search

- A situation can often be modeled as a system with a space of possible states.
  - A problem is represented as a goal state
  - Problem-solving means finding a path from a start state to a goal state

- How do we define the state space?
- How do we search for a path?
- How can we prune away parts of the space?

Knowledge Representation

- States may be sets of sentences in a logic
  - Propositional logic
  - First-order logic
  - Inference can derive new sentences

- How should we represent knowledge?
- What knowledge should we represent?
- How do we make inference tractable?

Planning

- Planning is an important problem-solving task
  - Find a sequence of actions to achieve a desired state
- How do we describe actions and their effects?
- How do we handle interactions among actions?
- How do we handle uncertainty and failures?

Uncertainty

- Probability theory is a rigorous way to deal with certain kinds of uncertain knowledge
- Bayes Nets make it possible to:
  - Represent complex probabilistic models
  - Perform useful inferences with them
- Decision analysis formalizes:
  - Probabilities and utilities of results of actions
  - Helps an agent decide what is best to do

Machine Learning

- How can a robot or computer agent learn?
  - By being told what to do
  - Logical inference
  - Supervised learning (classification)
  - Unsupervised learning (clustering)

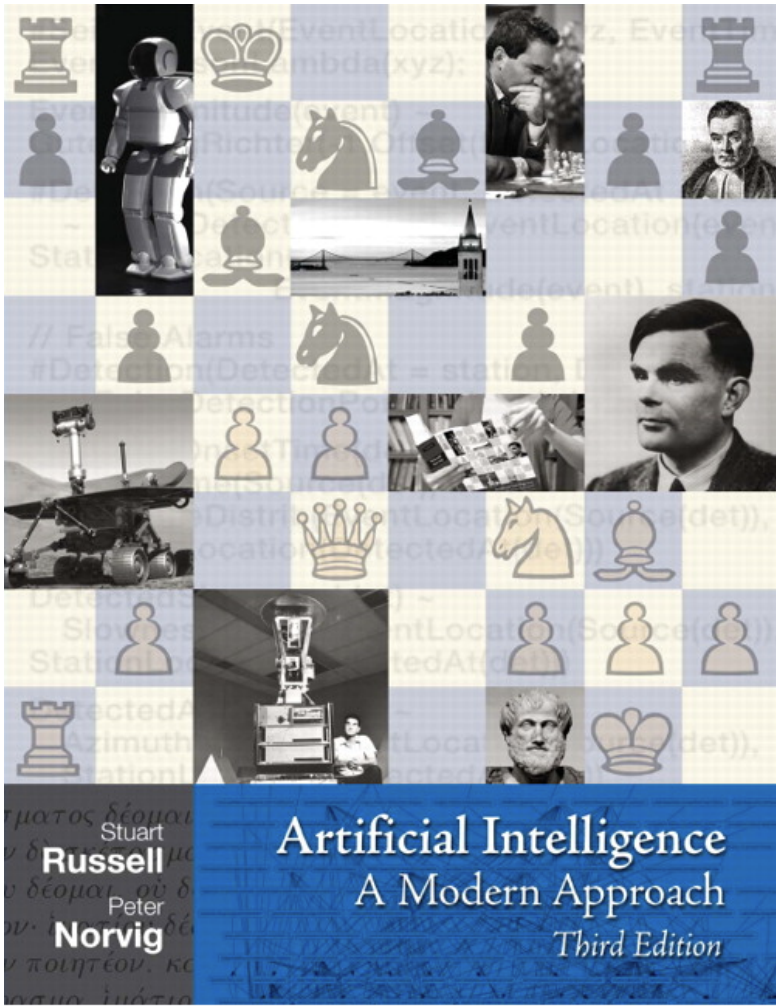
- Can a computer only do what it has been programmed to do?

Also consider EECS 445/545

The Textbook

- Russell and Norvig: Artificial Intelligence: A Modern Approach

- Readings posted with course schedule



Fill in the survey by Thursday (also posted on CTools)

SURVEYS AND QUESTIONS

Survey Link

- Complete the short survey on Canvas (assignment 0)

Next Time…

- Intelligent agents and task environments
- Guest Lecturer: Prof. Kuipers