CMPSCI 383
Introduction to Artificial Intelligence

Fall 2011

Tues-Thu 9:30-10:45

Computer Science Bldg. 142

Instructor: Andy Barto

Teaching Assistant: Phil Thomas

http://www-anw.cs.umass.edu/~barto/383-Fall2011

Today's lecture

- Introduce the basic idea of AI
  - The nature of intelligence
  - Characteristics of the field of study
  - Examples of AI systems
- Explain the structure of the course
  - Instructor & TA
  - Themes
  - Policies
  - Tips for doing well

"Over the Christmas holiday,
Al Newell and I invented a thinking machine."

— Herbert Simon (1956)

What is AI?

Historical definition:

"The study 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."

– Dartmouth Workshop, Summer of 1956

From the proposal for the Dartmouth Workshop

"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."

An Early Success in Machine Learning

~1970 at Stanford AI Laboratory

Arthur Samuel 1901-1990

IBM Poughkeepsie Laboratory

Worked on machine learning
for the game of checkers
from 1949 through the 1960s

Which is more intelligent?

or

Rule #1 — You tell intelligence by what it does, not what it is

Which is more intelligent?

or

Rule #2 — Intelligence depends on the task

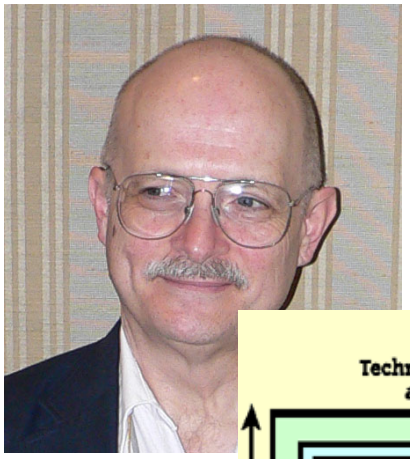
Which is more intelligent?

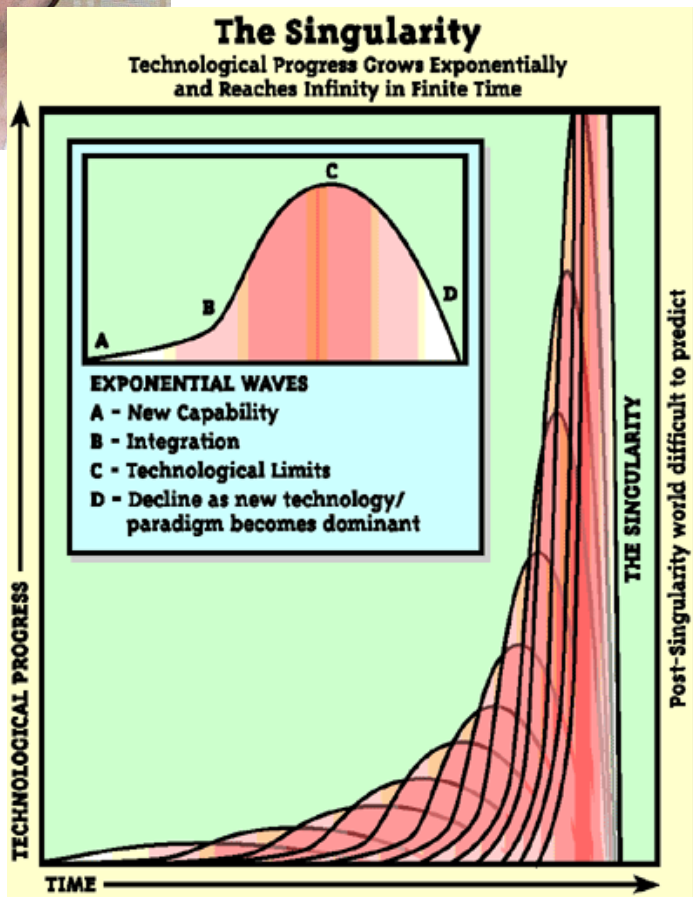
or

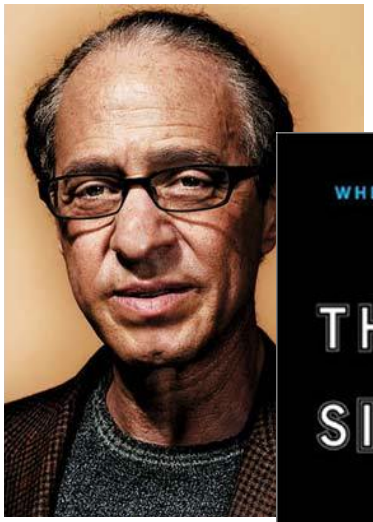
7,168 NVIDIA® Tesla™ M2050 GPUs and 14,336 CPUs

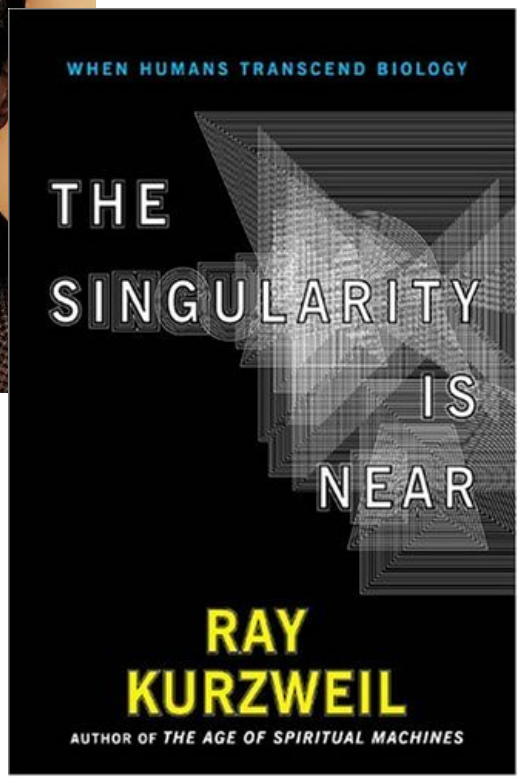
Rule #3 — Intelligence depends on software and knowledge

"Within thirty years, we will have the technological means to create superhuman intelligence. Shortly thereafter, the human era will be ended."
— Vernor Vinge (1993)

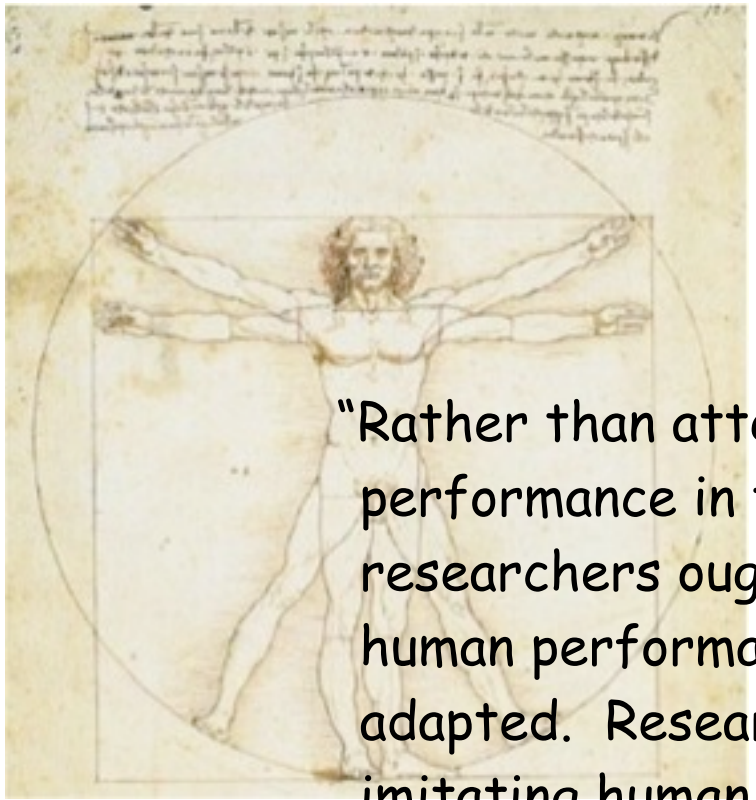








AI & human intelligence



"Rather than attempting to match human performance in tasks at which we excel, AI researchers ought to concentrate on surpassing human performance in tasks to which we are ill-adapted. Research should focus, not on imitating human cognition, but on exploring alternative styles of intelligence."

- Cullen Schaffer (1988).
"Statistical intelligence: A manifesto"

The "magic" of AI

"Any sufficiently advanced technology is indistinguishable from magic."

- Arthur C. Clarke

- AI research has enabled systems that can...
  - Identify patterns in data no human can find
  - Make better medical diagnoses than medical interns
  - Solve puzzles far faster than any human player
- ...and you will learn this semester how these systems can do these things.

Some AI Milestones

- **Watson** defeats Brad Rutter and Ken Jennings in a 2011 Jeopardy match
- **Stanley** sped over rough desert terrain for 22 miles to win the 2005 DARPA Grand Challenge
- **Deep Blue** defeated the reigning world chess champion Garry Kasparov in 1997
- **Proved a mathematical conjecture** (Robbins conjecture) unsolved for decades
- **No hands across America** (driving autonomously 98% of the time from Pittsburgh to San Diego)
- During the 1991 Gulf War, US forces deployed an **AI logistics planning and scheduling program** that involved up to 50,000 vehicles, cargo, and people
- **NASA's on-board autonomous planning program** controlled the scheduling of operations for a spacecraft
- **Proverb** solves crossword puzzles better than most humans, by using

"Some people refer to us as the Wright brothers...
But I prefer to think of us as Charles Lindbergh,
because he was better-looking."

— Sebastian Thrun (2006)

"A year ago, people said this couldn't be done...
Now everything is possible."

"AI is here. In fact it is all around us....

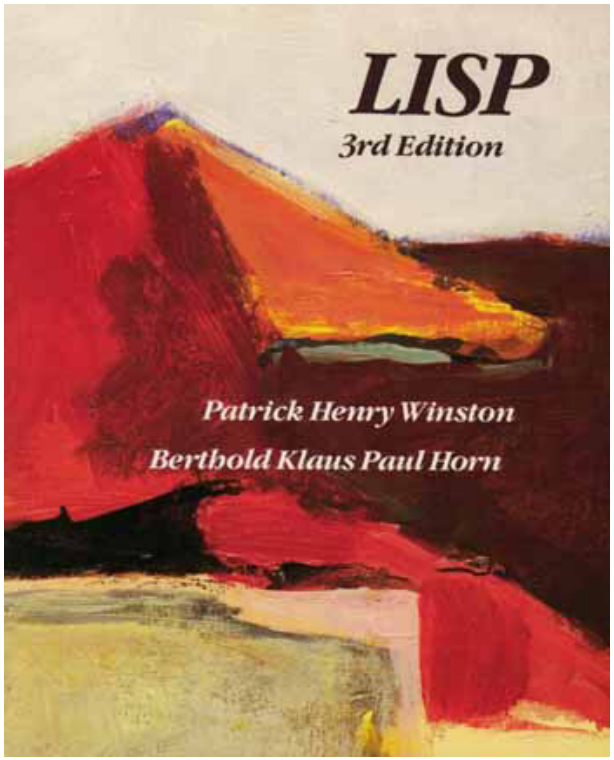
But it's nothing like we expected."

Wired, Jan 2011

- Kiva Systems warehouse bots
- Internet search
- Spam fighting
- Machine translation
- Fraud detection
- Advanced cruise control
- Vehicle dispatching
- Medical image analysis

What isn't considered AI any longer?

- Search engines
- Programming languages
- Theorem proving
- Optical character recognition
- Expert systems



AI draws together ideas many fields

- **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
- **Statistics** — Uncertainty, inference, learning
- **Economics** — Utility and decision theory
- **Psychology** — How do humans and animals act and think?
- **Neuroscience** — How do brains do it?
- **Computer engineering** — Building fast/efficient computers
- **Control theory** — Design systems that operate under their own control
- **Linguistics** — How does language relate to thought?

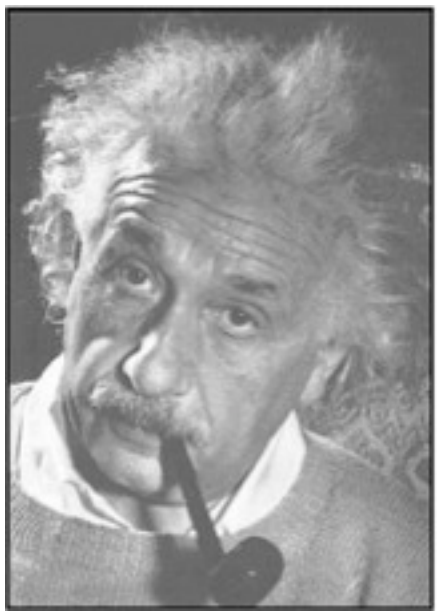
AI seeks answers to fundamental questions

- What are the necessary and sufficient conditions for intelligent action?
- What are the minimal components such that an agent can learn to act intelligently by interacting with the world?
- How deeply intertwined are knowledge and perception?
- Can intelligence be separated from a specific physical substrate that implements it?

Why study AI?

"A student in physics might reasonably feel that all the good ideas have already been taken by Galileo, Newton, Einstein, and the rest. AI, on the other hand, still has opening for several full-time Einsteins."

— Russell & Norvig (p. 1)



Autonomous Robot Skill Acquisition

Scott Kuindersma and George Konidaris

University of Massachusetts Amherst

ALL
AUTONOMOUS
LEARNING
LABORATORY

Introducing CMSCI 383

Course objectives

- Teach you key facts and skills
  - Understand some of the core algorithms and data structures used in AI
  - Abstract real problems into prototypical tasks that have been studied in AI
  - Map between abstract tasks and basic AI techniques that address them
- Prepare you for the future
  - Learning about new developments in AI
  - Practical application of AI ideas
  - Additional courses in AI

Who am I?

- Professor of Computer Science
- Former Department Chair
- Co-director of the Autonomous Learning Laboratory

Sridhar Mahadevan

AUTONOMOUS
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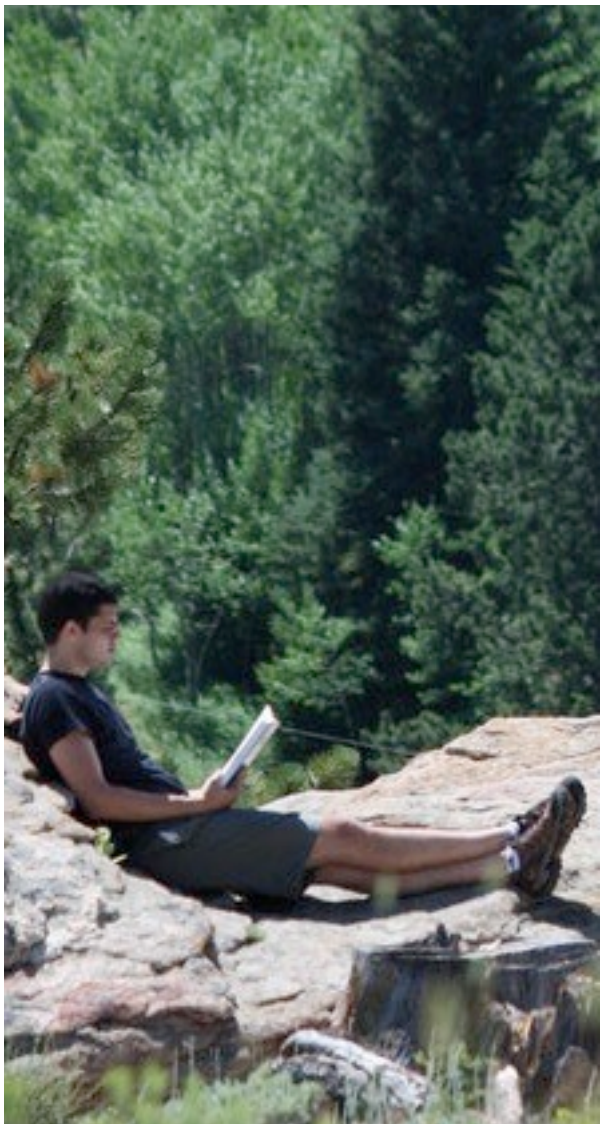
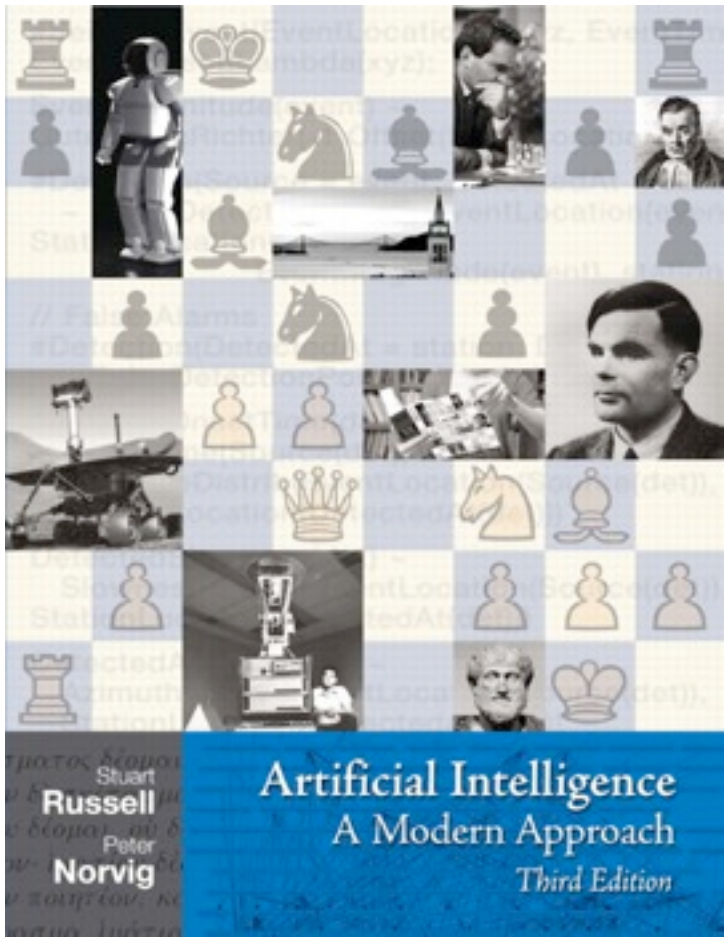
Who is Phil?



- Phil Thomas
- Graduate Student in Computer Science
- BS Cum Laude and MS in CS from Case Western Reserve University 2008, '09
- Research in Reinforcement Learning
- TA for the course

What is the text for this course?



Main Themes

- **Philosophy** — Can a machine **really** think? weak and strong AI, transhumanism, the singularity, friendly AI
- **Search** — Uninformed, heuristic, local, and adversarial
- **Planning** — Devising plans to achieve a goal
- **Uncertainty** — Basic probability, Bayes' rule, Bayesian networks
- **Learning** — Learning from examples, neural, networks, reinforcement learning

Pre-requisites

(CMPSCI 287 or CMPSCI 220 or CMPSCI 291SP) and
(CMPSCI 240 or CMPSCI 311)

- CMPSCI 287 — Programming with Data Structures
  - … including linked structures, recursive structures and algorithms, binary trees, balanced trees, and hash tables.
- CMPSCI 220 — Programming Methodology
  - …designing, implementing, testing and modifying larger programs
- CMPSCI 291SP — Computer Systems Principles
  - …large-scale software systems
- CMPSCI 240 — Reasoning about Uncertainty
  - …probabilistic reasoning, Markov chains, …
- CMPSCI 311 — Introduction to Algorithms
  - …search and graph algorithms…relating the empirical performance of an algorithm to theoretical predictions

Grading

- 45% Homework assignments (5 or 6)
- 10% Class participation
- 20% Midterm Exam (closed notes & book; in class)
- 25% Final (during exam period; cumulative; closed notes and book)

Homework policies

- Submitting homework — handed in in class or in main office by 4:00 pm on due date
- Extension days — A total of five extension days which can be applied to any combination of homework assignments during the semester without penalty.
- Other extension requests — Additional extensions will be granted only due to serious and documented medical or family emergencies.
- Regrade policy — Must talk to TA or instructor within a week of when it was handed out.

Exams

- Basics — Exams will be closed book and closed note.
- Focus — Exams will focus on conceptual understanding of key ideas from the course, including algorithms, data structures, and ability to match algorithms and data structures to actual problems.
- Review sessions — Exams will be preceded by a review session.

Academic honesty

- If you are unable to keep up, see us!
- You are encouraged to discuss and obtain help with basic concepts, approaches and techniques.
- But not at a level of detail where specific implementation issues are discussed with anyone else.
- All solutions on homework and programming assignments must be your own. Using other people's solutions is unacceptable.
- You are expected to take reasonable precautions to prevent others from using your work.
- Instances of dishonesty will result in zero on the assignment and initiation of formal process as described on the Academic Honesty website.

Tips for doing well

- Do some AI every day
  - Read text before class
  - Begin assignments early
- Take notes
  - Slides will be online, but they are only reminders of real content which is given verbally and on the board
  - Taking notes helps you learn
- Be active
  - Participate in discussion during class
  - Ask questions
  - Take notes
  - Visit during office hours

Office Hours

- Prof. Barto (CMPS 272)
  - Tues/Thurs 11:00-12:00pm
  - Other times by appointment
- Thomas (LGRT 220)
  - Mon/Wed 10:00-11:00