

# **CS 380: Artificial Intelligence**

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## **Lecture 1: Introduction**

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# Welcome!

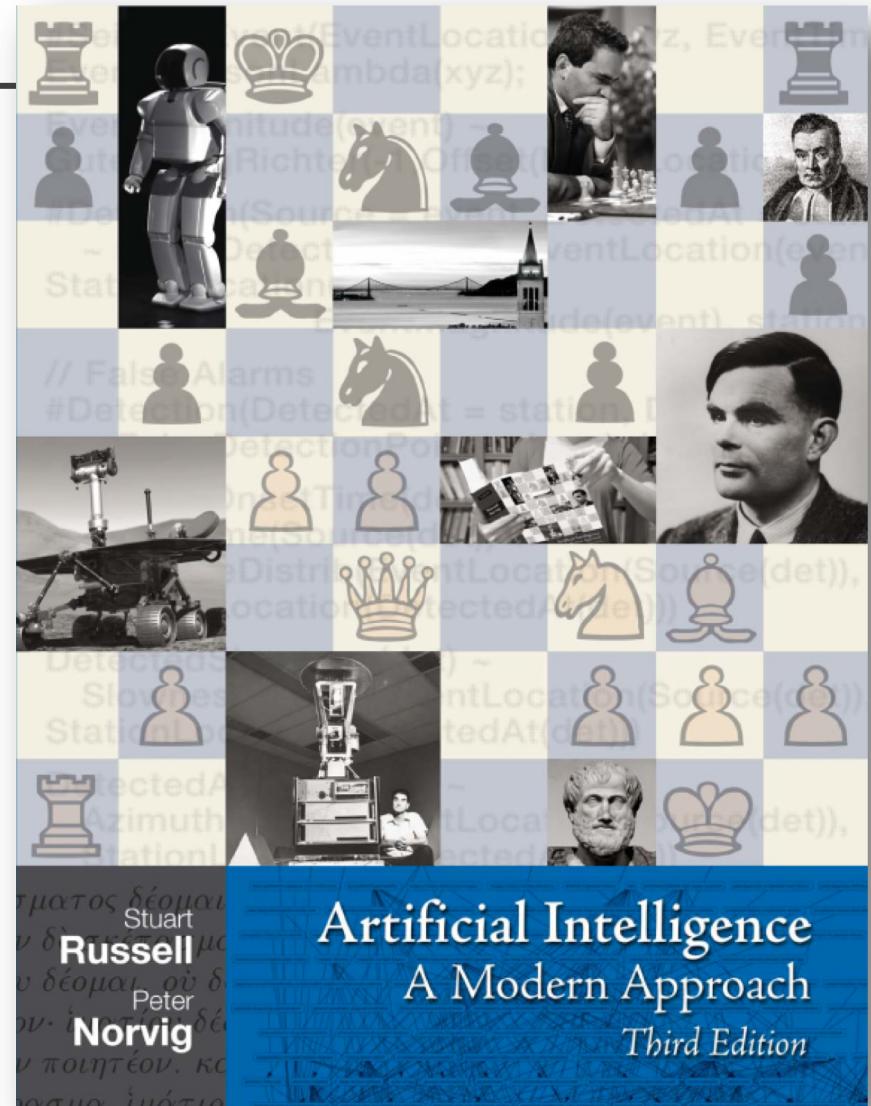
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- About me
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- Our course TA
  - Ehsan Khosroshahi, *eb452@drexel.edu*
- About this course
  - Syllabus, timeline, & resources on-line...

# Textbook

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- Russell & Norvig,  
3rd edition
- A great standard  
introduction to AI
- We'll plan to cover  
Chapters 1-9, 13, 14...  
but schedule might  
change



# Class Schedule (Tentative)

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Week	Notes
1	Introduction, Rational Agents
2	Problem Solving, Uninformed Search, LISP
3	Informed Search, Adversarial Search
4	A* Search, Local Search
5	Monte Carlo Search, Logical Agents
6	<b>Midterm Exam</b> Predicate Logic, First-Order Logical Inference
7	First-Order Logic (FOL), Natural Language Processing
8	Machine Learning, Reinforcement Learning
9	Uncertainty, Philosophy of AI
10	Topics in AI (TBD)
11	<b>Final Exam</b>

# Lectures

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- We will have lectures twice/week
- Attendance is considered mandatory for all students
- For lecture slides, many many many thanks to...
  - Santi Ontañón for lots of great material!
  - Stuart Russell and Hwee Tou Ng for more great material linked from <http://aima.cs.berkeley.edu/> !
  - The slides here are a conglomeration of all of the above plus lots of new material and revisions

# Homework Assignments

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- 4 assignments
  - To be done individually — standard CS rules apply
  - Generally due Mondays at midnight
- For each assignment, you should submit a ZIP file with all requested materials
  - ZIP... not RAR or any other format
  - For text answers on some assignments, PDF is required (not MS Word!)
  - Failure to follow these guidelines → no credit
  - Late submissions lose 33% per day late

# Homework Assignments

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- Acceptable languages: Python or Java
- Assignments MUST run on tux.cs.drexel.edu
- Comment your code!
  - We need to understand what you wrote and why,  
to properly give you credit for what you did

# Course Structure: Evaluation

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- Homework assignments: 40%
  - Midterm exam: 30%
  - Final exam: 30%
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- (+ in-class quizzes depending on attendance!)

# What is Artificial Intelligence?

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# What is Artificial Intelligence?

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- Origins (John McCarthy 1956):

We propose that a 2-month, 10-man study of artificial intelligence be carried out during the summer of 1956 at Dartmouth College in Hanover, New Hampshire. 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.

# 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  
phenomena of perception and motor control, experimental techniques, cognitive models
  - Computer engineering  
building fast computers, software vs. hardware
  - Control theory  
design systems that maximize an objective function over time
  - Linguistics  
knowledge representation, grammar

# What is Artificial Intelligence?

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- Basically:
  - Replicating (human) intelligence in a machine.

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# What is Artificial Intelligence?

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- Basically:
  - Replicating (human) intelligence in a machine.
- So, what is “intelligence”?
  - Hard to define “intelligence” rigorously.
  - Any definition would be arbitrary:
    - We could list features of intelligence, such as: learning, language, knowledge, reasoning, understanding, etc. But any such list leaves things out.
  - Many have been proposed:
    - If you are curious Google “definition intelligence”
  - Intelligence is simply a term that we use to describe certain behaviors that we observe in humans and not in other entities.

# What is Artificial Intelligence?

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- So, if we cannot define intelligence, then... what is AI? How would we recognize it when we achieve it?

# What is Artificial Intelligence?

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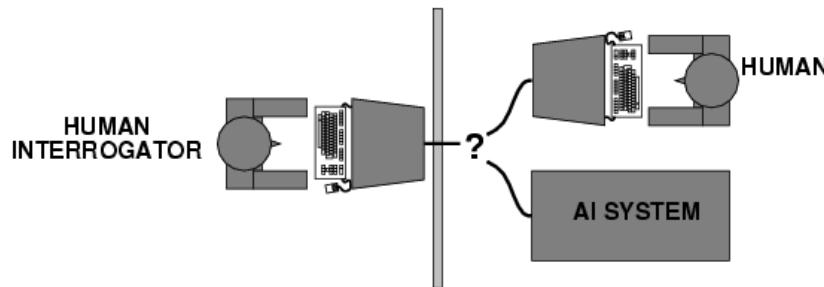
- So, if we cannot define intelligence, then... what is AI? How would we recognize it when we achieve it?

Thinking humanly	Thinking rationally
Acting humanly	Acting rationally

# Acting Humanly: The Turing Test

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- Turing (1950) "Computing machinery and intelligence":
- "Can machines think?" → "Can machines behave intelligently?"
- Operational test for intelligent behavior: the Imitation Game



- Predicted that by 2000, a machine might have a 30% chance of fooling a lay person for 5 minutes
- Anticipated all major arguments against AI in following 50 years
- Suggested major components of AI: knowledge, reasoning, language understanding, learning

# Acting Humanly: The Turing Test

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- Turing (1950) example:

Q: Please write me a sonnet on the subject of the Forth Bridge.

**A : Count me out on this one. I never could write poetry.**

Q: Add 34957 to 70764.

**A: (Pause about 30 seconds and then give as answer) 105621.**

Q: Do you play chess?

**A: Yes.**

Q: I have K at my K1, and no other pieces. You have only K at K6 and R at R1. It is your move. What do you play?

**A: (After a pause of 15 seconds) R-R8 mate.**

# Thinking Humanly: Cognitive Modeling

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- 1960s "cognitive revolution": information-processing psychology
- Requires scientific theories of internal activities of the brain
- Validation of these theories would require:
  - Predicting and testing behavior of human subjects (top-down)
  - Direct identification from neurological data (bottom-up)
- Both approaches (roughly, Cognitive Science and Cognitive Neuroscience) are now distinct from AI
  - ... but will they merge again??

# Thinking Rationally: Laws of Thought

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- Aristotle: What are correct arguments/thought processes?
- Several Greek schools developed various forms of logic: notation and rules of derivation for thoughts; may or may not have proceeded to the idea of mechanization
- Direct line through mathematics and philosophy to modern AI
- Problems:
  - Not all intelligent behavior is mediated by logical deliberation
  - What is the purpose of thinking? What thoughts should I have?

# Acting Rationally: A Rational Agent

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- Rational behavior: doing the “right thing”
- The “right thing” = that which is expected to maximize goal achievement, given the available information
- Doesn't necessarily involve thinking – e.g., a blinking reflex – but thinking should be in the service of rational action

# Acting Rationally: A Rational Agent

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- This course focuses on designing **rational agents**
- An agent is an entity that perceives and acts
- Abstractly, an agent is a function from percept histories to actions:
  - $[f: P^* \rightarrow A]$
- For any given class of environments and tasks, we seek the agent (or class of agents) with the best performance
- Caveat: computational limitations make perfect rationality unachievable
  - → design best program for given machine resources

# What is Artificial Intelligence?

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- So, if we cannot define intelligence, then... what is AI? How would we recognize it when we achieve it?

Thinking humanly	Thinking rationally
Acting humanly	<b>Acting Rationally</b>

# What is Artificial Intelligence?

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- In reality, AI is a research field that encompasses research concerning computational techniques to replicate any aspect of intelligence:
  - Automated reasoning
  - Knowledge representation
  - Learning
  - Natural language generation/understanding
  - Problem solving
  - Planning
  - Vision/Perception
  - Action
- AI draws on the fields of computer science, mathematics, philosophy, economics, psychology, neuroscience, linguistics, or control theory among others.

# Brief History of AI

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- 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
- 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
- 1980-- AI becomes an industry
- 1986-- Neural networks return to popularity
- 1990s Probability, Agents (neural networks are back)
- 1995-- The emergence of intelligent agents
- 2000s Human-level AI back on the agenda

# What can AI do nowadays?

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- (from Russell & Norvig)

# What can AI do nowadays?

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- Play ping-pong?
  - <https://www.youtube.com/embed/lXyKLDNzGGI>

# What can AI do nowadays?

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- Play ping-pong? YES
- Autonomously drive a car?
  - You all know about autonomous driving
  - Where is the future headed?
    - <https://www.youtube.com/embed/4pbAI40dKOA>
    - <https://www.youtube.com/embed/4SmJP8TdWTU>

# What can AI do nowadays?

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- Play ping-pong? YES
- Autonomously drive a car? YES
- Play Soccer?
  - <https://www.youtube.com/embed/aLy5pUsmpKE>
  - <https://www.youtube.com/embed/CJITj4vmDZE>

# What can AI do nowadays?

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- Play ping-pong? YES
- Autonomously drive a car? YES
- Play Soccer? KIND OF
- Play Chess/Go?
  - [https://www.youtube.com/embed/\\_HCWBS6k8j0](https://www.youtube.com/embed/_HCWBS6k8j0)

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- Play Chess/Go? YES
- Accurately translate a text?
  - <http://translate.google.com>

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- Have a conversation? NO
- Understand an image?

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- Understand an image? KIND OF
- Play Jeopardy better than humans?
  - <https://www.youtube.com/embed/P18EdAKuC1U>

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# Next Class

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- Rational Agents