

# Course Overview and Introduction

*CE417: Introduction to Artificial Intelligence*  
*Sharif University of Technology*  
*Spring 2016*

*Soleymani*

# Course Info

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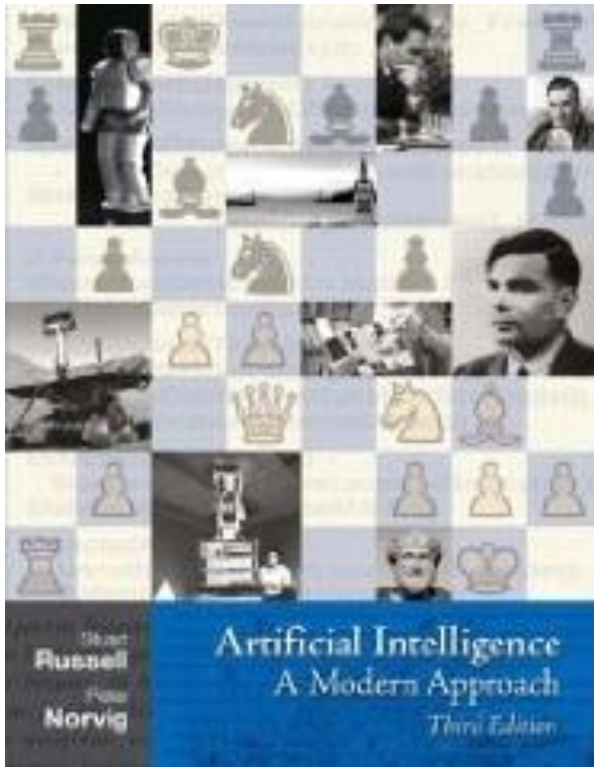
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- ▶ Teacher Assistants:
  - ▶ Seyed Mohammad Chavoshian
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- ▶ Lectures: Sun-Tue (15:00-16:30), Room 202
- ▶ Website: <http://ce.sharif.edu/courses/94-95/2/ce417-1>

# Text Book

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## *Artificial Intelligence: A Modern Approach*

by Stuart Russell and Peter Norvig 3<sup>rd</sup> Edition, 2009



<http://aima.cs.berkeley.edu/>

# Marking Scheme

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▶ Mid Term Exam:	25%
▶ Final Exam:	35%
▶ Homeworks (written & programming):	20%
▶ Miniexams:	15%
▶ Quizzes:	5%

# Class Target

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- ▶ Getting a feeling of Artificial Intelligence (AI), its aims, fields, abilities, some applications and open problems
- ▶ Learning fundamentals of AI
- ▶ Learning some basic tools for AI and a little experience with AI

# Why AI?

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- ▶ One of the newest fields in science (coined in 1956)
  - ▶ However, the quest for AI begins with dreams thousands of years ago
- ▶ One of the most preferred fields
- ▶ Still has openings for several full time Einsteins
- ▶ Huge variety of subfields
- ▶ Can be useful to any intellectual task (universal field)

# What is Artificial Intelligence?

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- ▶ What is **AI**?
- ▶ What is **intelligence**?
- ▶ What are features that make humans (animals, animate objects) intelligent?

# Intelligence: Definitions

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- ▶ The ability to carry out **abstract thinking** (Terman, 1921)
- ▶ The capacity for **knowledge**, and knowledge possessed (Henmon, 1921)
- ▶ The capacity to **learn** or to profit by experience (Dearborn, 1921)
- ▶ Intelligence is what is measured by **intelligence tests** (Boring, 1923)
- ▶ A global concept that involves an individual's ability to act purposefully, think rationally, and deal effectively with the environment (Wechsler, 1958)



# Intelligence: Definitions

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- ▶ A general factor that runs through all types of performance (Jensen)
- ▶ Intelligent activity consists of grasping the essentials in a given situation and responding appropriately to them (Heim 1970)
- ▶ A person possesses intelligence insofar as he had learned, or can learn, to adjust himself to his environment (Colvin 1982)
- ▶ Intelligence is adaptation to the environment (unknown)
- ▶ Intelligence is that faculty of mind by which order is perceived in a situation previously considered disordered (R.W.Young, 1999)
- ▶ Intelligence is the ability to use optimally limited resources - including time - to achieve goals. (Kurzweil, 1999)

# Formal Definitions of Artificial Intelligence

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“[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+McDermott, 1985)
“The study of how to make computers do things at which, at the moment, people are better” (Rich+Knight, 1991)	“The branch of computer science that is concerned with the automation of intelligent behavior” (Luger+Stubblefield, 1993)

	Human intelligence	Rational
Thinking	Thinking humanly	Thinking rationally
Behavior	Acting humanly	Acting rationally

# Rationality

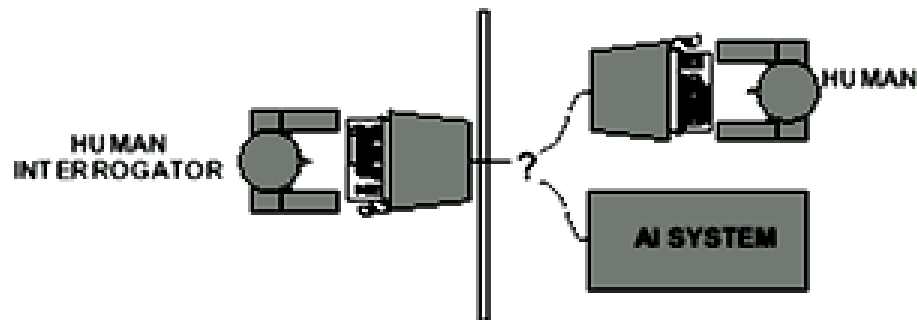
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- ▶ Rationality: *doing the right thing*
- ▶ Mathematical characterizations of rationality have come from diverse areas like:
  - ▶ Logic
  - ▶ Economics
    - ▶ Utility theory: how best to act under uncertainty
    - ▶ Game theory: how self-interested agents interact

# Acting Humanly

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- ▶ Turing Test (*Turing, 1950*): Operational test for intelligent behavior:
  - ▶ A human interrogator communicates (through a teletype) with a hidden subject that is either a computer system or a human. If the human interrogator cannot reliably decide whether or not the subject is a computer, the computer is said to have passed the Turing test.
  - ▶ 5 minutes test, it passes by fooling the interrogator 30% of time



- ▶ Turing predicted that by 2000 a computer could pass the test.
  - ▶ He was wrong.

# Acting Humanly (Cont.)

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- ▶ To pass the basic Turing test:
  - ▶ Natural Language Processing (communication)
  - ▶ Knowledge Representation (storing what it knows or hears)
  - ▶ Automated Reasoning (using the stored info to draw new conclusions or answer questions)
  - ▶ Learning (adapting to new circumstances)
- ▶ To pass the total Turing test (in addition to above):
  - ▶ Vision
  - ▶ Robotics
  - ▶ ...

Anticipated most of AI major fields (60 years ago)

Problem: Turing test is not reproducible, constructive, or amenable to mathematical analysis

# Thinking humanly: cognitive modeling

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- ▶ Needs some way of determining how humans thinks
  - ▶ Brain imaging (observing brain in action)
  - ▶ Introspection (catching our thoughts as they go)
  - ▶ Psychological experiments (observing a person in action)
- ▶ Scientific theories of internal activities of the brain
  - ▶ Experimental investigation of actual human or animal behavior (top-down)
  - ▶ Direct identification from neurological data (bottom-up)
- ▶ Cognitive Science and AI are now distinct sciences (while continuing to fertilize each other)
- ▶ Precise theory of mind is not available and seems mysterious.

# Thinking rationally: "laws of thought"

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- ▶ Aristotle codified the right thinking and correct arguments/inference processes
  - ▶ “Socrates is a man, all men are mortal, therefore Socrates is mortal”
- ▶ Direct line through mathematics and philosophy to modern AI
  - ▶ However, intelligent behaviors are not necessarily mediated by logical deliberation
- ▶ Main obstacles:
  - ▶ Not easy to convert informal knowledge to formal ones
  - ▶ Reasoning usually needs high computational resource

# Acting rationally: rational agent

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- ▶ **Rational agent** does the right thing achieving the best outcome or expected outcome (given what it knows)
- ▶ Thinking rationality is sometimes part of being a rational agent (it is not all of rationality)
  - ▶ Rational behavior doesn't necessarily involve thinking (e.g., blinking reflex)
  - ▶ There may be no provable correct thing to do but something must be done
  - ▶ Acting rationally is more general than thinking rationally
- ▶ Compared to approaches based on human (behavior or thinking), it can be more scientific
  - ▶ Well-defined mathematically and completely general



# Acting rationally: rational agent (cont.)

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- ▶ Bounded rationality – design best agent for given resources when not enough time available to do all computations
  - ▶ Perfect rationality as a good starting point
- ▶ We'll focus on acting rationally in this course.

# Rational agents

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- ▶ An **agent** is an entity that perceives and acts
- ▶ Abstractly, an agent is a function from percept histories to actions:

$$[f: \mathcal{P}^* \rightarrow \mathcal{A}]$$

- ▶ For any given class of environments and tasks, we seek the agent (or agents) with the best performance

# AI definition evolution

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- ▶ Agents acting rationally have been gradually more popular than systems based on human intelligence (thinking or acting humanly)
- ▶ Definition of AI has also been changed during the time.
- ▶ Despite successes, founders of AI including McCarthy & Minsky have expressed discontent with the progress of AI
  - ▶ AI should put less emphasis on creating ever-improved version of applications that are good at a specific task
  - ▶ AI should return to its roots “machines that **think**, that **learn**, and **create**” (Human-level AI)

# Human Level Intelligence: Samples

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- ▶ Game playing: Chess, Backgammon, Othello, Poker, ...
- ▶ Proving a mathematical theorem using a set of known axioms
- ▶ Planning to reach a set of goals
- ▶ Learning from previous experience to do a task better

# Subareas of AI

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- ▶ Problem solving
  - ▶ Search (focus of our course)
  - ▶ Planning (we talk also about it)
- ▶ Knowledge representation & reasoning (focus of our course)
  - ▶ Knowledge representation & Reasoning: logical, probabilistic
- ▶ Learning
- ▶ Perception (Vision, Speech, ...)
- ▶ Robotics (ability to move and manipulate objects)
- ▶ Natural Language Processing (communication)

# Course Outline

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- ▶ Intelligent agents (chapters 1-2)
- ▶ Search
  - ▶ Heuristic Search (Chapter 3,4)
    - ▶ Search spaces & heuristic guidance
  - ▶ Game tree search (Chapter 5)
    - ▶ Working against an opponent
  - ▶ Backtracking Search (Chapter 6)
    - ▶ Constraint Satisfaction Problems
- ▶ Reasoning and knowledge Representation (Chapter 7-9)
  - ▶ Logical agents and First Order Logic for more general knowledge
- ▶ Planning (Chapter 10)
  - ▶ Predicate representation of states, planning graphs, reachability heuristics
- ▶ Uncertainty (Chapter 13-14)
  - ▶ Probabilistic reasoning, Bayesian networks
- ▶ Reinforcement learning