Introduction to AI

Russell and Norvig: Chapter 1 & 2
CSE 240: Winter 2023
Lecture 1

Acknowledgements: Material in this course is based on material from Dan Klein's and Peter Abbeel's UC Berkeley Course, Norvig and Koller's Stanford course, Narges Nourouzi's course at UCSC, and more.

About Me

- Leilani H. Gilpin
  - Assistant Professor
- M.S. in Computational Mathematics from Stanford University (2013), Ph.D. in EECS from MIT (2020).
- Email: lgilpin@ucsc.edu
- Office hours: Over zoom Thursdays 5:00pm-6:00pm
- Research: The methodologies and underlying technologies for complex systems to explain themselves.

Lectures

- Tuesdays and Thursdays 9:50am - 11:25am
- Today on zoom (Thursday?)
- Zoom link is provided on Canvas.

Discussion Section

- Two options
  - Mondays at 8:00am
  - Friday at 10:40am
- Discussion sections are both **remote** on zoom.
- Attendance is not mandatory but it is recommended as your TA will discuss assignments and review lecture content.

Course Personnel

- Prof:
  - Leilani H. Gilpin
  - Office Hours: Thursday 5:00-6:00pm
- TAs:
  - Minghao Liu
  - Jeshwanth (Jesh) Bheemanpally
- Zoom Corps: Greg Ziegler
- Discussion sections starting **next** week.
- Both sections are on zoom

Prof. Leilani H. Gilpin

TA: Minghao Liu

TA: Jeshwanth (Jesh) Bheemanpally

Zoom Corps: Greg Ziegler

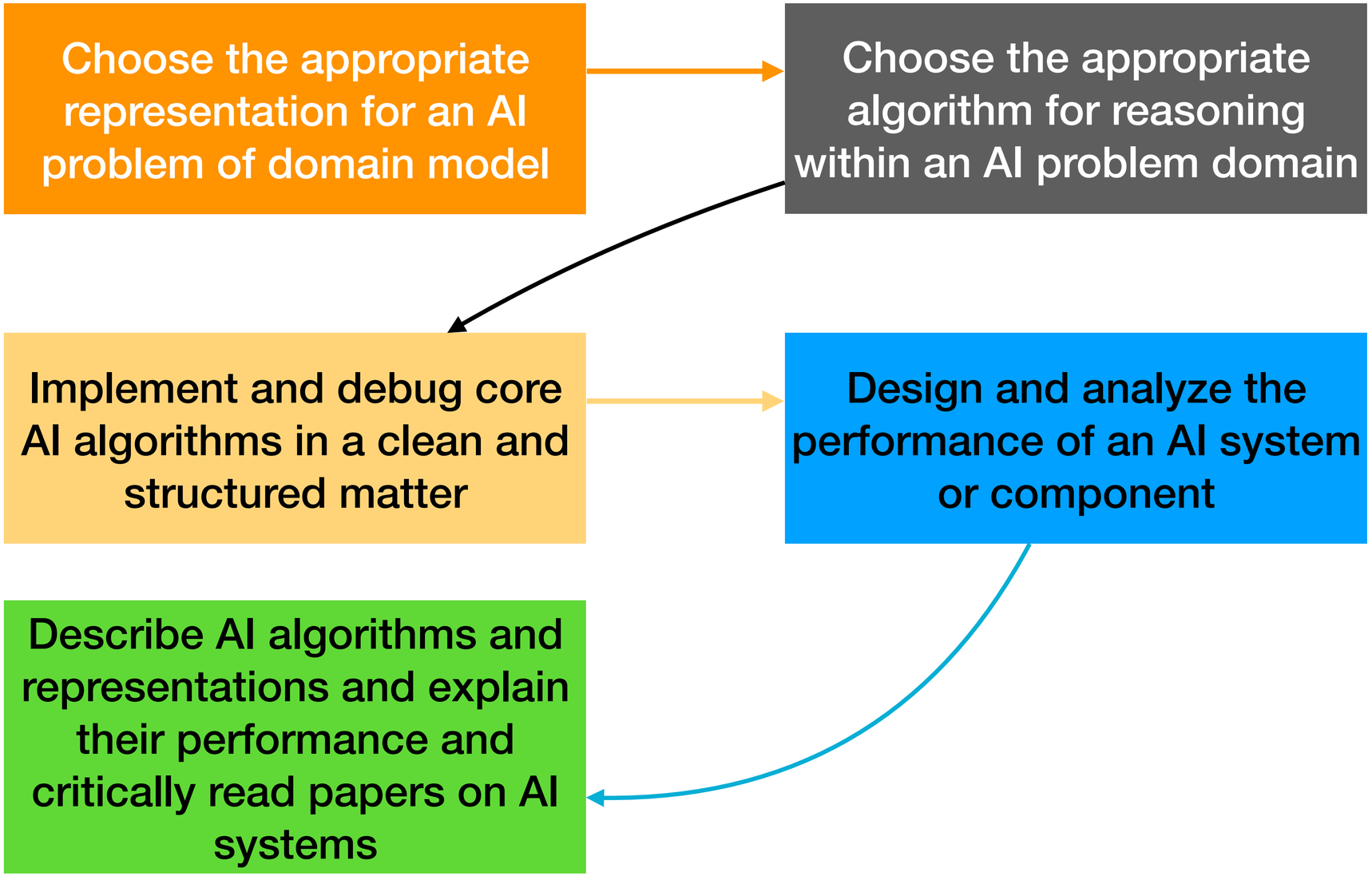
Slack

Sign up link: https://join.slack.com/t/w23cse240/shared_invite/zt-1mrpm5tpw-exC8iqDjxOcJ1E1DlHKcwA

What are the Prerequisites?

- Algorithms:
  - Basic algorithms, data structures, computational complexity
  - E.g., searching graphs, lists, trees, hash tables
  - Difference between $O(n)$ and $O(2^n)$
- Logic
- Probability
- Math

Course Objectives



Course Topics

Part 1: Planning agents and search algorithms

Part 2: Decision making (including reinforcement learning)

Part 3: Learning agents -> Machine learning

Syllabus on Canvas

https://canvas.ucsc.edu/courses/59609/assignments/syllabus

Weekly Schedule

Week 1

- Introduction to AI
- Structure of Agents
- Solving problems by searching
  - Uninformed search strategies
    - BFS, DFS, ID-DFS, UCS

Week 2

- Solving problems by searching (cont.)
  - Informed search strategies
  - Heuristics functions
- Search in complex environments
  - Hill climbing, simulated annealing, local beam search, evolutionary algorithm.

Weekly Schedule

Week 3

- Game theory
  - Adversarial games
    - Minimax algorithm and alpha-beta pruning
  - Stochastic games
    - Expectimax search algorithm

Week 4

- Constraint satisfaction problems
  - Examples of CSP
  - Inference in CSP
  - Backtracking search for CSP
  - Local search for CSP
  - Structure of problem in CSP
    - Cutset conditioning, Tree decomposition

Weekly Schedule

Week 5

- Quantifying uncertainty
  - Review of probabilities
- Naive Bayes model
- Introduction to Bayesian networks

Week 6

- Bayesian Networks (cont.)
- Markov Decision Processes (MDP)

Weekly Schedule

Week 7

- Making simple decisions
  - Decision trees
    - Value of information
- Learning from examples
  - Learning decision trees
  - Linear regression and classification

Week 8

- Perceptron learning
- Logistic regression
- Neural networks

Weekly Schedule

Week 9

- Deep neural networks - Introduction

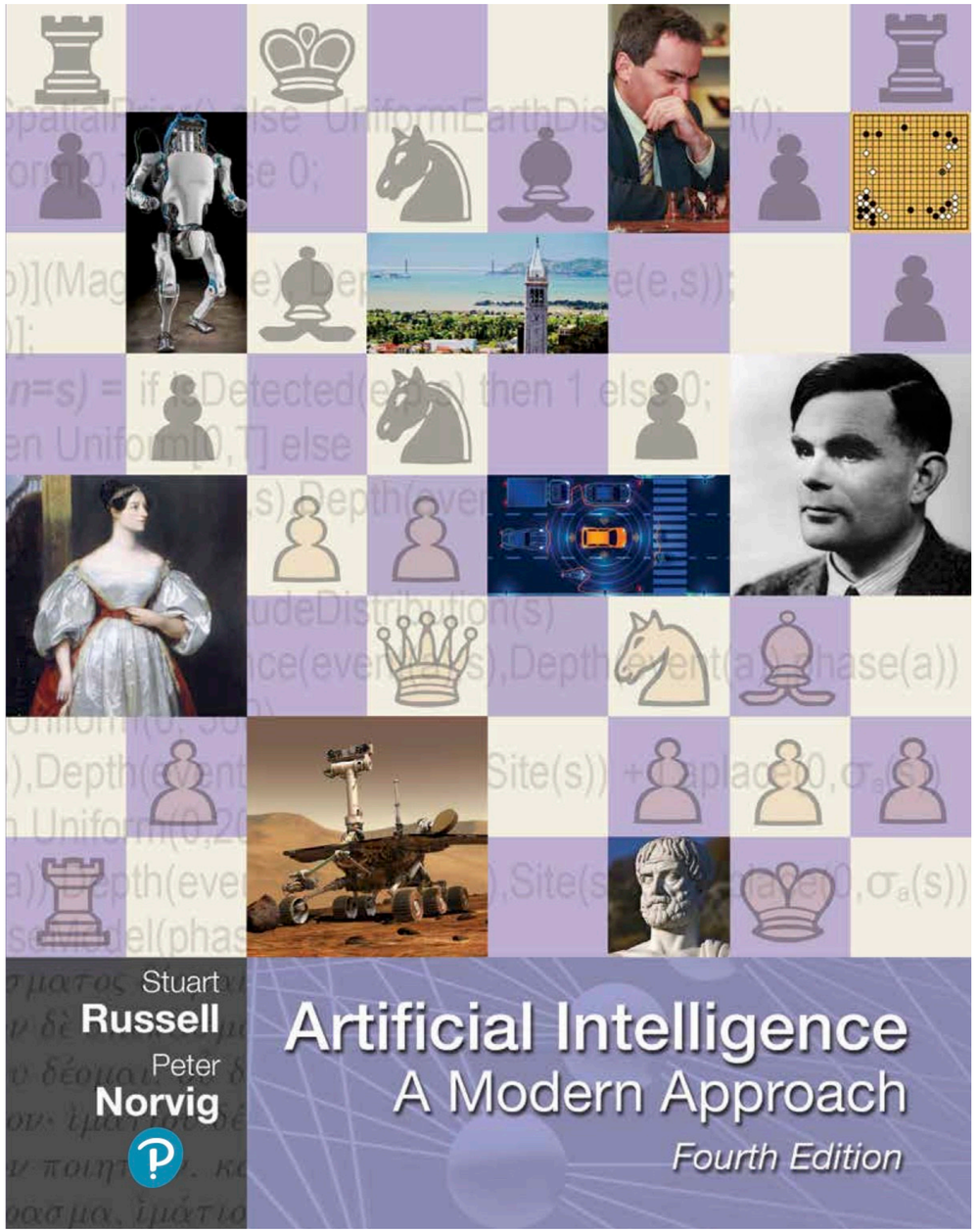
Week 10

- Reinforcement learning
- Deep reinforcement learning
- (If time, applications).

Textbook

Artificial Intelligence: A Modern Approach (AIAMA) by Stuart Russell and Peter Norvig, 4th edition

http://aima.cs.Berkeley.edu



Course Work

- 5 assignments - 50%
- 4 Quizzes - 45%
- Class participation - 5%

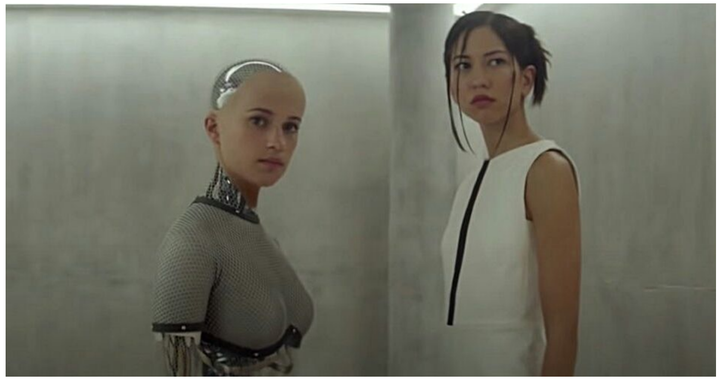
- Late submission policy: you can submit *one* of assignment up to 24 hours late to accommodate for unforeseen circumstances. No further accommodation will be granted (except for DRC accommodations).

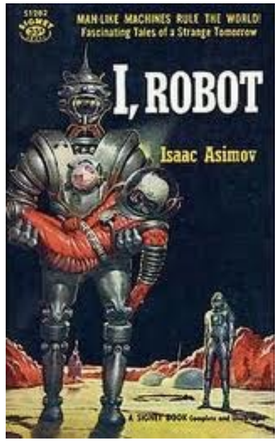
Canvas Overview

What is Artificial Intelligence?

What is AI?

- You've seen the movies, you've read the books
- What is **your** definition of AI?





Class Exercise #1

- Take out a piece of paper
- Write down **your** definition of AI
- (hint, don’t worry, there are no right or wrong answers!
- Submit on Canvas for CE 1 when you’re ready.

Take 5 minutes

Formal Definitions of AI

Discipline that systematizes and automates intellectual tasks to create machines that:

Think like humans	Think rationally
Act like humans	Act rationally

Rationality

- Rationality means doing the right thing.
- Philosophers -> mind is in some ways like a machine and it operates based on the encoded knowledge.
- Mathematicians -> provided tools to use logical statements for reasoning and decision making.
- Economics -> formalized the problem of decision making using maximization of expected outcome.

#1: Act Like Humans

- Behaviorist approach
- Not interested in how you get results, just the similarity to human results
- Exemplified by the **Turing Test** (Alan Turing, 1950)

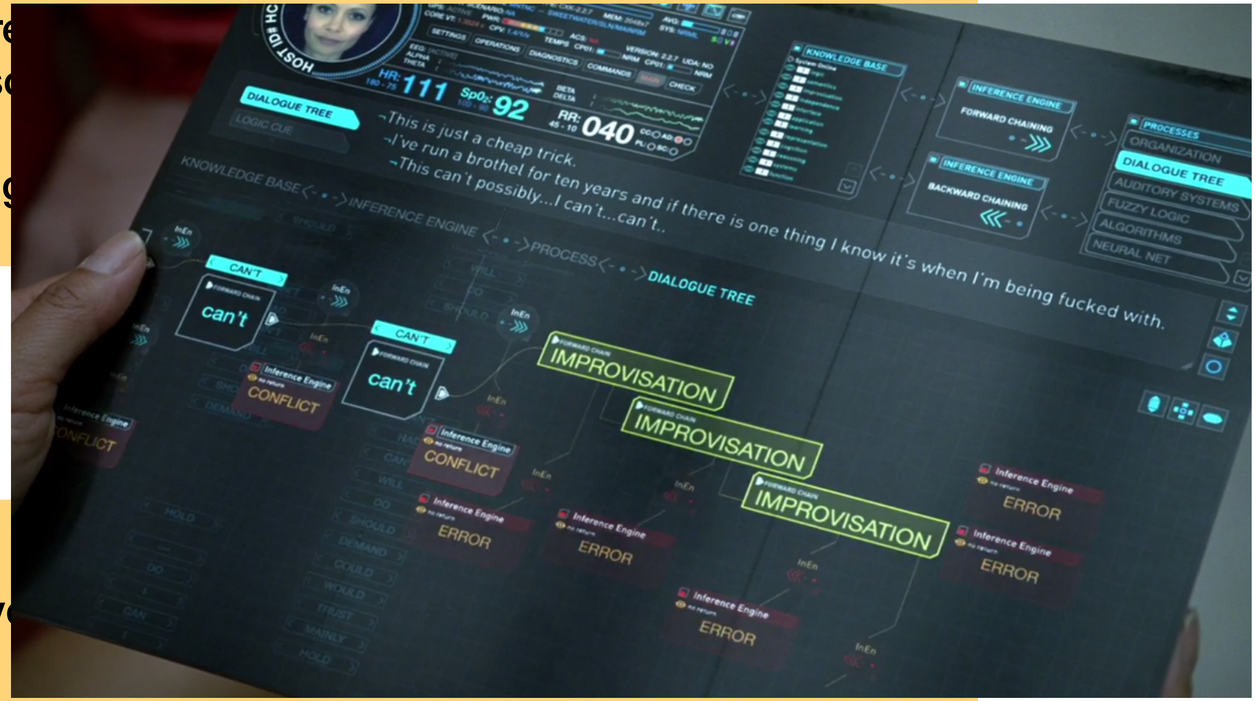
Turing test

- Interrogator interacts with a computer and a person via a teletype.
- Computer passes the Turing test if interrogator cannot determine which is which.
- Loebner contest: Modern version of Turing Test, held annually, with a $100,000 grand prize. http://www.loebner.net/Prizef/loebner-prize.html
  - 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 $4,000.
  - If better than a human, win $100,000. (Nobody yet…)

Acting Humanly (Cont).

Basic Turing Test

1. Natural Language Processing (Communication)
2. Knowledge Repre
3. Automated Reas
   conclusions).
4. Machine Learnin



Total Turing test

In addition the abov

1. Vision
2. Robotics

#2: Think Like Humans

- Needs some way of determining how humans think
  - **Brain imaging** (observing brain in action)
  - **Introspection** (catching our thoughts as we go)
  - **Psychological experiences** (observing a person in action)
- Cognitive science and AI are not distinct sciences (still work together)
- Precise theory of mind is not available and seems mysterious

- Exemplified by
  - General Problem Solver (Newell and Simon)

#3: Thinking rationally: Law of Thought

- Aristotle: what are correct arguments/thought processes?
  - “Socrates is a man, all men are mortal, therefore, Socrates is mortal.”
  - Several Greek schools developed various forms of logic: notation and rules of derivation for thoughts
- Direct line through mathematics and philosophy to modern AI

Problems:

1. Not easy to translate informal real world problem into formal terms (problem formulation is difficult)
2. While may be able to solve the problem in principal (i.e. decidable), in practice, may not get the answer in a reasonable amount of time (computationally intractable)

#4: Acting Rationally

- Rational behavior: do the right thing
- Always make the best decision given what is available (knowledge, time, resources)
- Perfect knowledge, unlimited resources ➔ logical reasoning (#3)
- Imperfect knowledge, limited resources ➔ (limited) rationality

- Connection to economics, operations research, and control theory
- But ignores role of consciousness, emotions, fear of dying on intelligence

Rational Agent

What is rational at any given time depends on four things:	1. The performance measure (agent function) that defines the criterion of success 2. The agent's prior knowledge of the environment 3. The actions that the agent can perform 4. The agent's percept sequence to date.

Definition	For each possible percept sequence, a rational agent should select an action that is expected to maximize its performance measure given the evidence provided by the percept sequence and whatever built-in knowledge the agent has,

Task Environment

- Elements of the task environment: PEAS
  - Performance
  - Environment
  - Actuators
  - Sensors

Types of Task Environments

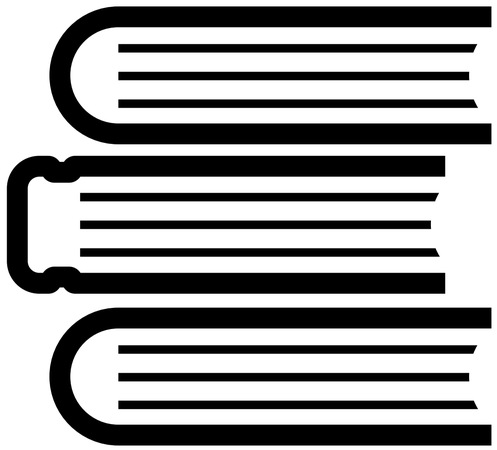
- Fully or partially observable
- Single agent or multi agent
- Deterministic or stochastic
- Episodic or sequential
- Static or dynamic
- Discrete or continuous
- Known or unknown

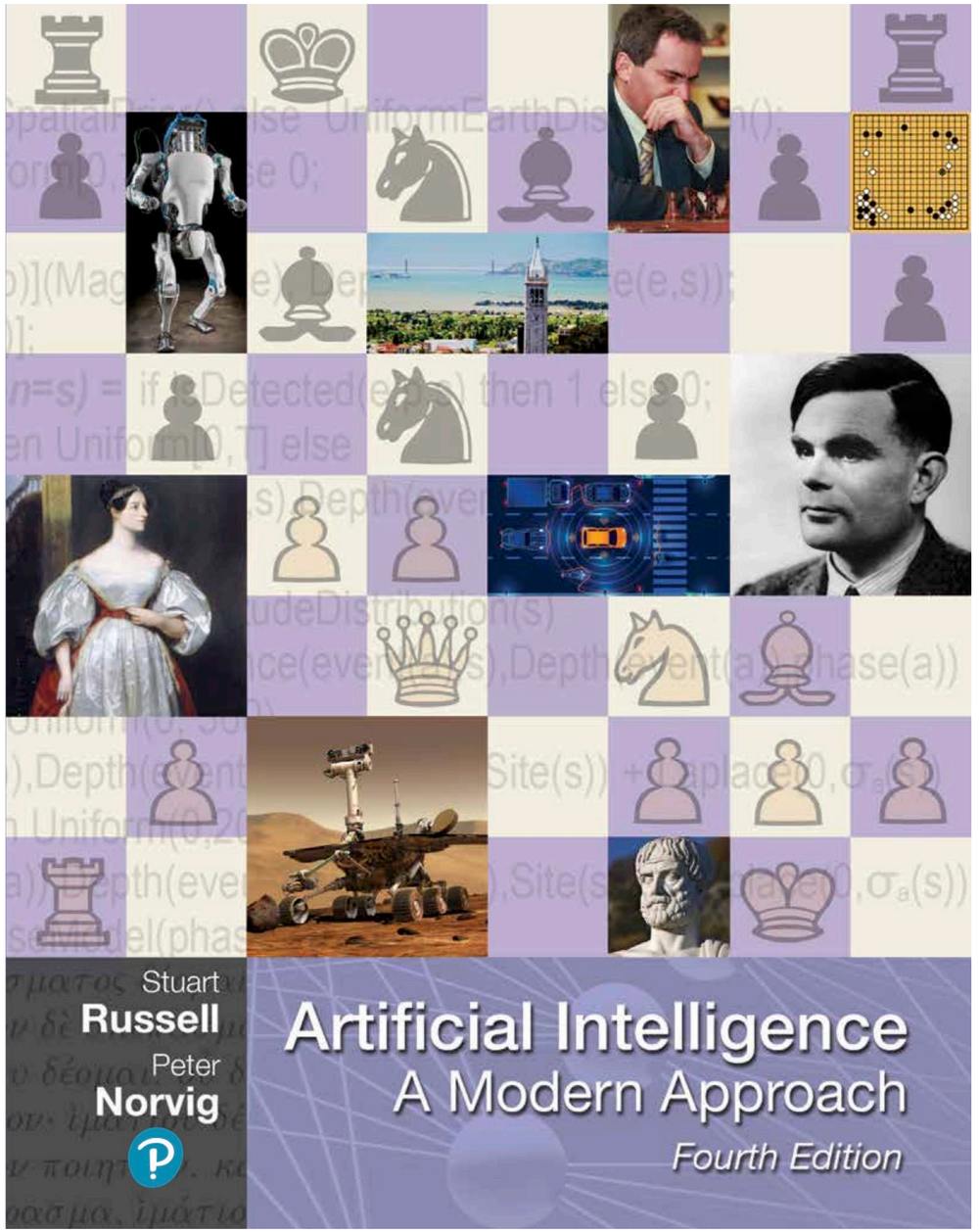
Types of Agents

- Simple reflex agents: responds directly to percepts
- Model-base reflex agents: maintains an internal state
- Goal-based reflex agents: act to achieve a goal or goals
- Utility-base reflex agents: considers to maximize an expected utility
- Learning agents: all of the above agents can improve their performance through learning

Chapter 1 & 2

Readings





Next time

Week 1

- Introduction to AI
- Structure of Agents
- **Solving problems by searching**
  - **Uninformed search strategies**
    - **BFS, DFS, ID-DFS, UCS**