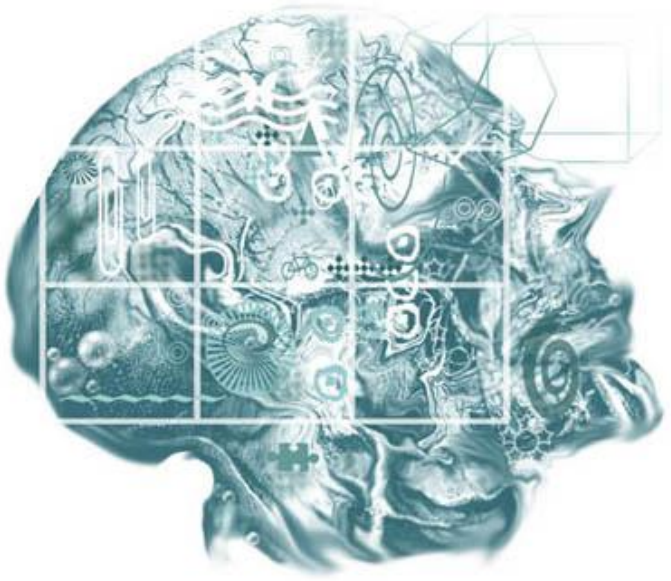

CSE 411
Artificial Intelligence (Elective Course #6)

400 level, Mechatronics Engineering
2nd Term 2016/2017 – Lecture #1

Dr. Hazem Ibrahim Shehata
Computer & Systems Engineering Department

Teaching Staff

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Course Info

- Webpage

  http://hshehata.github.io/courses/zu/cse411/

- Textbook

  Artificial Intelligence: A Modern Approach

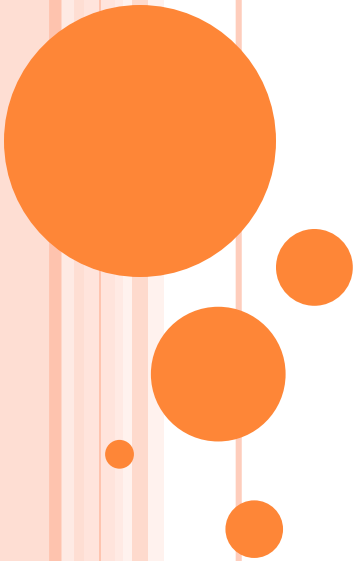
  Stuart Russell and Peter Norvig, **3rd edition**, 2010

- Grading

Course Work	Grade Distribution
Assignments	25pt
Midterm	25pt
Final	50pt

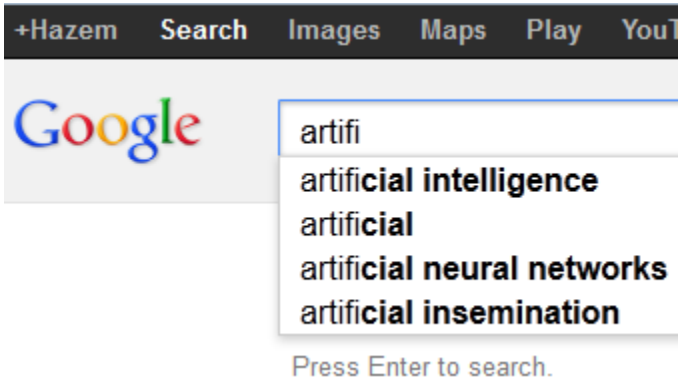
Course Outline (Subject to Change!)

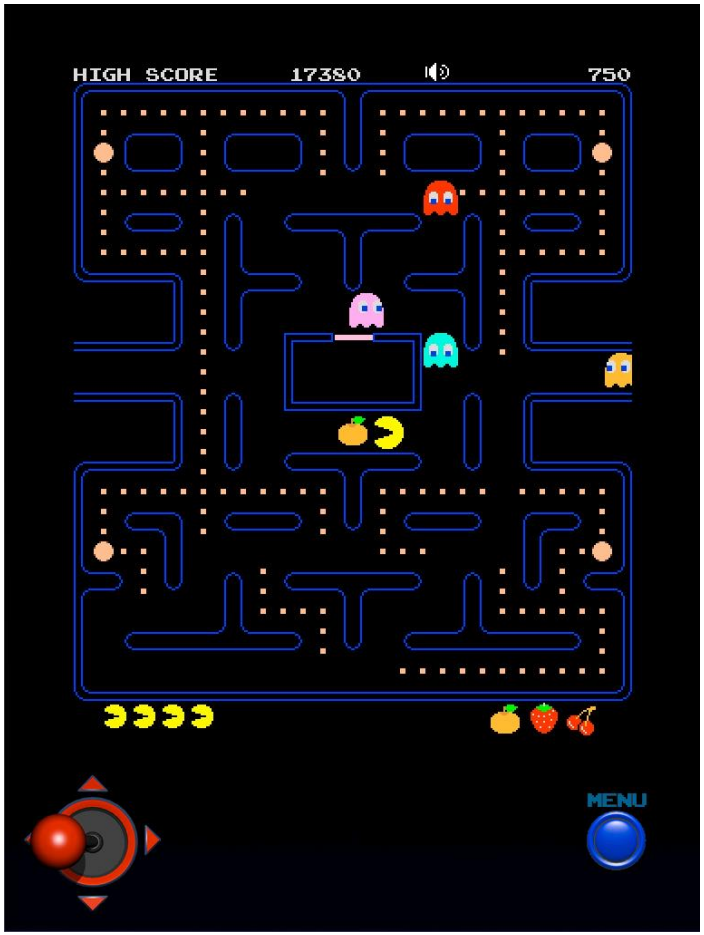
- Ch. 1: Introduction
- Ch. 2: Intelligent Agents
- Ch. 3: Solving Problems by Searching
- Ch. 4: Beyond Classical Search
- Ch. 5: Adversarial Search
- Ch. 6: Constraint Satisfaction Problems
- Ch. 7: Logical Agents
- …



Chapter 1: Introduction

Where Do We See AI?





Where Do We See AI?

- AI has been applied in many fields:
  - Entertainment (e.g., game playing).
  - Internet (e.g., semantic search engines, spam fighting).
  - Robotics (e.g., driverless vehicles, vacuum cleaners).
  - Military (e.g., logistics planning).
  - Space (e.g., rovers, autonomous planning/scheduling).
  - Medical (e.g., expert systems for medical diagnosis).
  - Aviation (e.g., auto-pilot).
  - Finance (e.g., stock market prediction, fraud detection).
  - Weather forecasting.
  - …

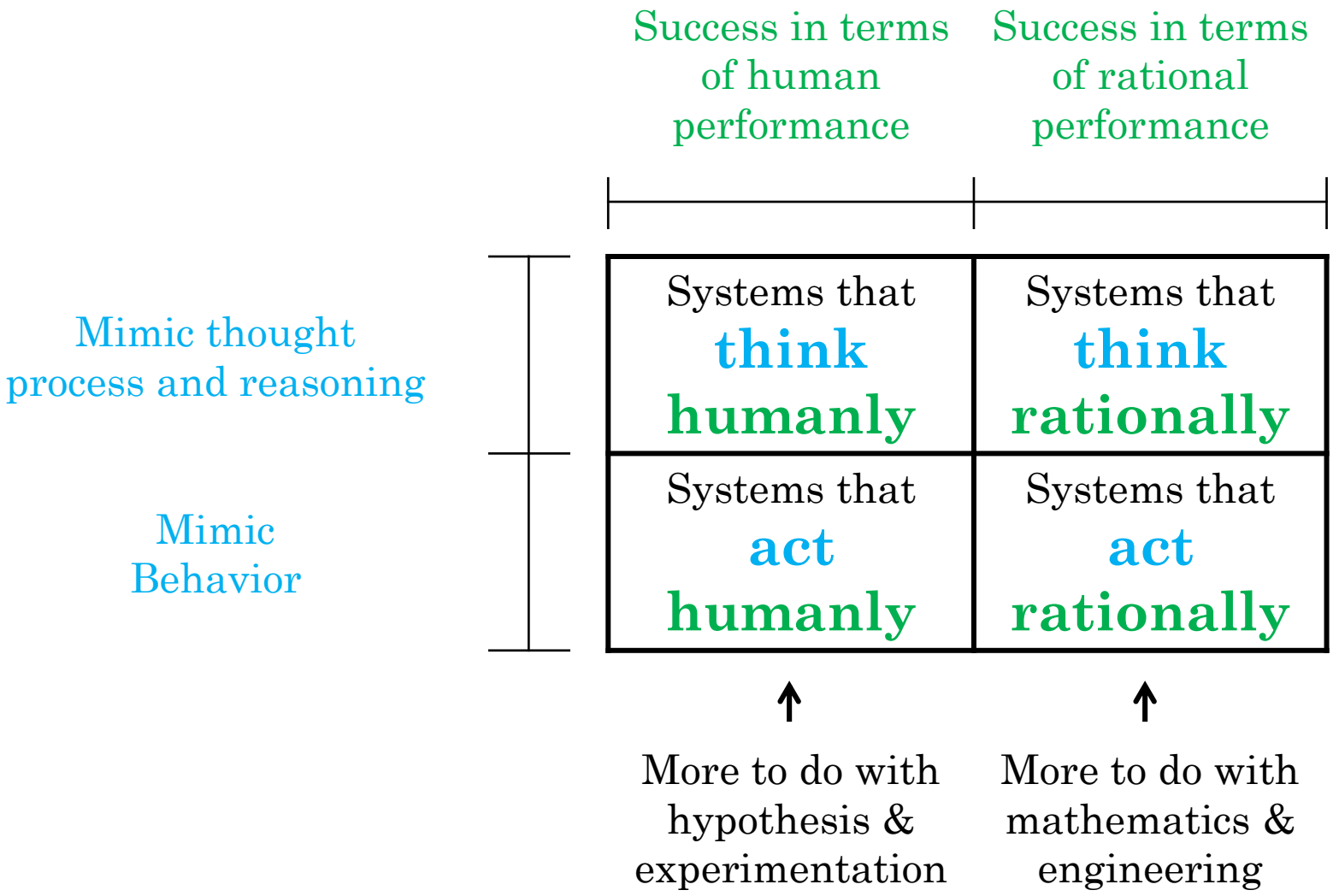
What Is AI?

- What do you think AI means?
- Some definitions from literature:
  1. The exciting new effort to make computers **think** … machines with **minds**, in the full and literal sense.
  2. The art of creating machines that **perform** functions that require intelligence when performed by **people**.
  3. The study of **mental faculties** through the use of **computational models**.
  4. AI … is concerned with **intelligent behavior** in artifacts.

What Is AI?

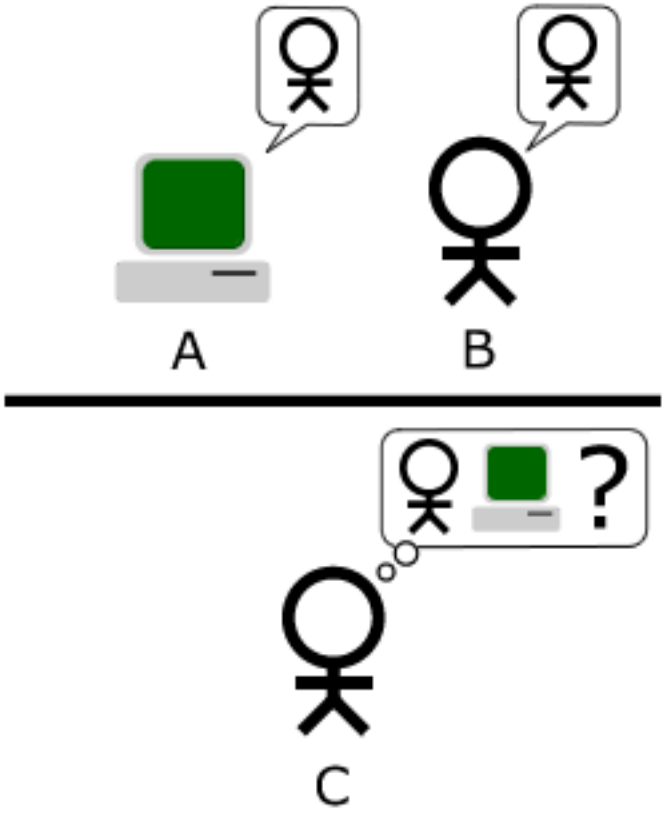
- AI Definitions vary along two dimensions:
  1. The **thinking** (reasoning) vs. **acting** (behaving),
  2. Measuring the success against **human** performance or against an ideal concept of intelligence (**rationality**).

What Is AI?


Success in terms of human performance
Success in terms of rational performance
Mimic thought process and reasoning
Mimic Behavior
Systems that think humanly
Systems that think rationally
Systems that act humanly
Systems that act rationally
More to do with hypothesis & experimentation
More to do with mathematics & engineering

Act Humanly: Turing Test Approach

- Turing Test: the computer passes the test if after given a series of written questions by a human interrogator, the interrogator can't tell if the written responses are coming from a person or a machine.
- Examples:
  - ELIZA (1966) & PARRY (1972)
  - Contemporary chat bots!



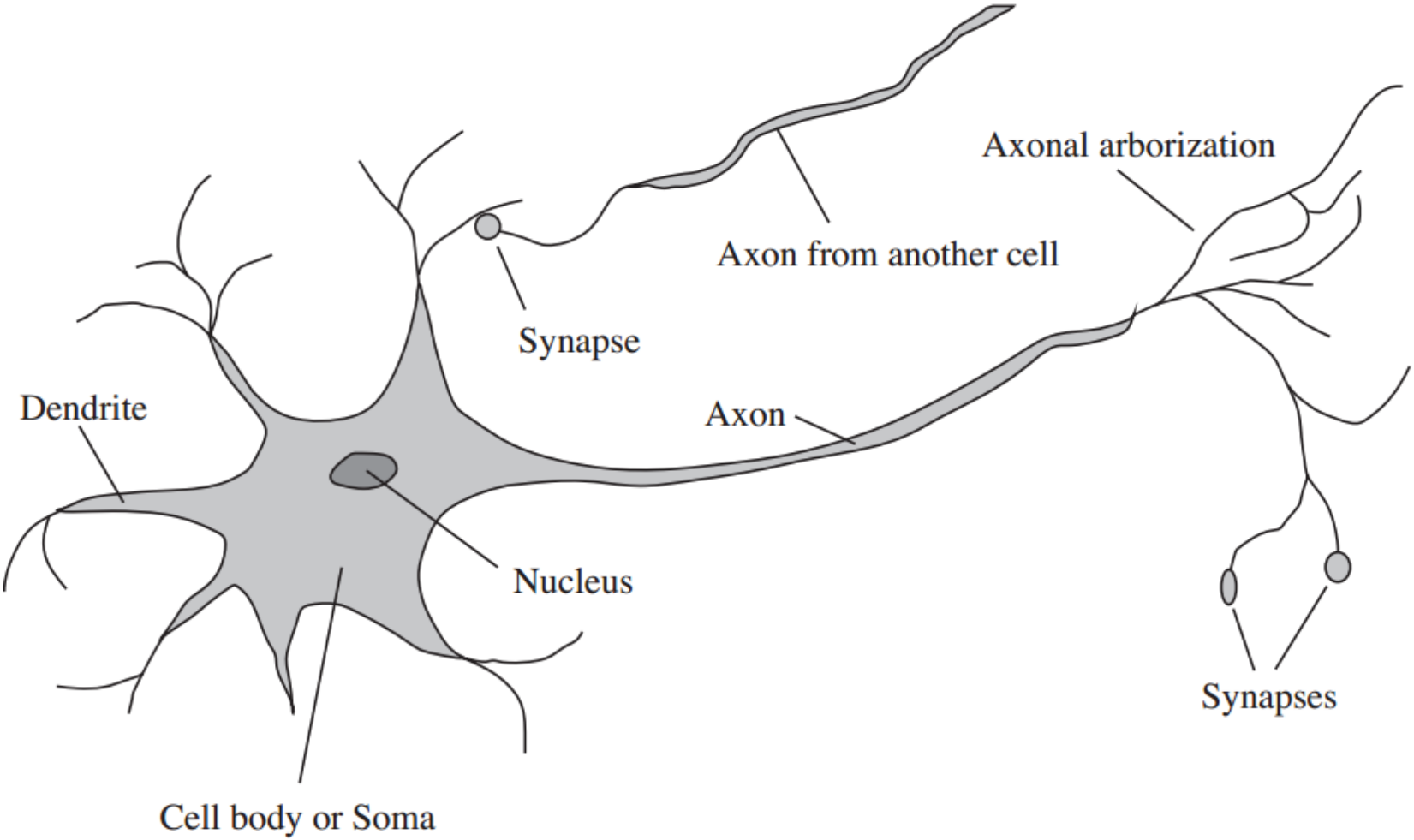
Act Humanly: Turing Test Approach

- To pass Turing test, computer needs:
  - Natural language processing
  - Knowledge representation
  - Automated reasoning
  - Machine learning
- Total Turing Test: interrogator can pass physical objects to the computer (through a hatch).
- To pass Total Turing test, computer needs:
  - Computer vision
  - Robotics

Think Humanly: Cognitive Modeling Approach

- If we want the computer to think as humans, we must first determine how humans think.
- An interdisciplinary field of **cognitive science**.
- It brings together models from AI and experimental techniques from psychology.
- It tries to come up with precise and testable theories of how the human mind works.
- Example: Neural Networks.

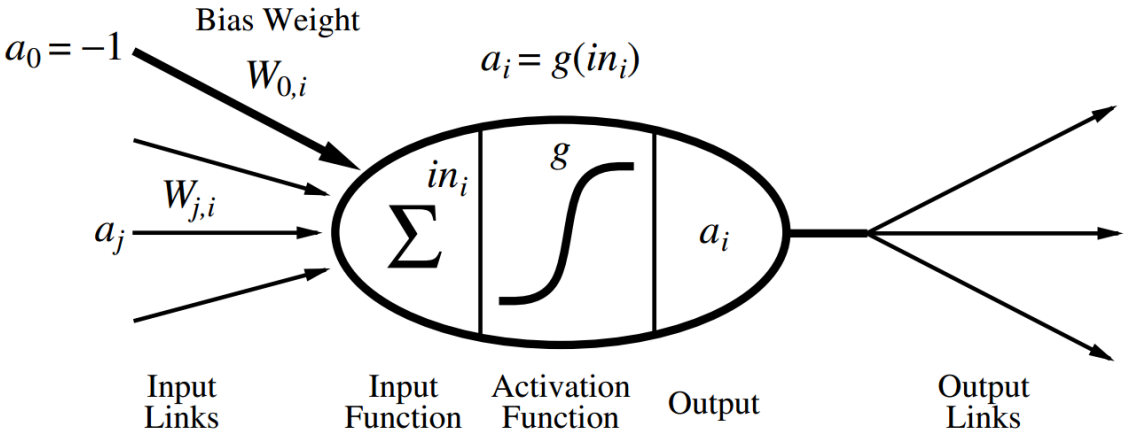
THINK HUMANLY: COGNITIVE MODELING APPROACH



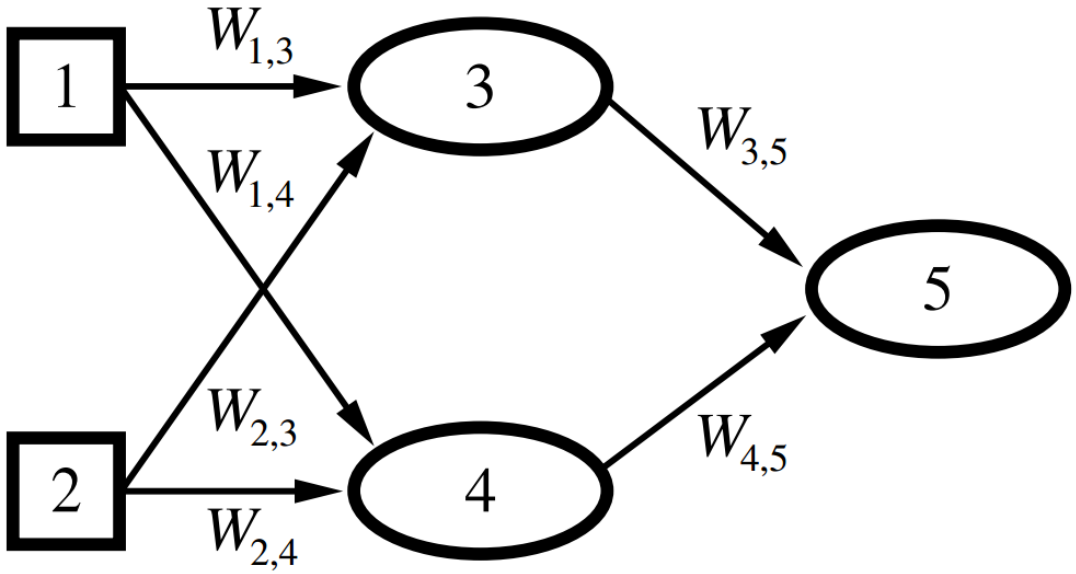
Neuron Cell

Think Humanly: Cognitive Modeling Approach

Neuron Unit



Artificial Neural Network (ANN)

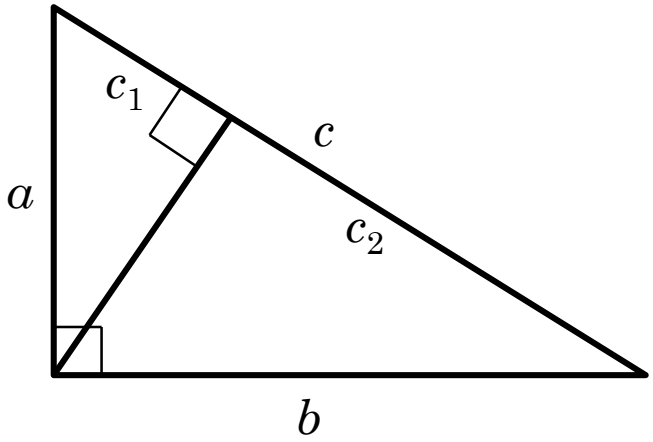


Think Rationally: "Laws of Though" Approach

- Uses logic to reach a decision given some facts via logical inferences.
- Greek philosopher Aristotle was the first to try to codify the way of thinking.
- His deductive reasoning always gave correct conclusions when given correct premises.
- Example: "All Cats are Pets; Bob is a Cat; therefore, Bob is a Pet",
- Example: Theorem proving in first-order logic.

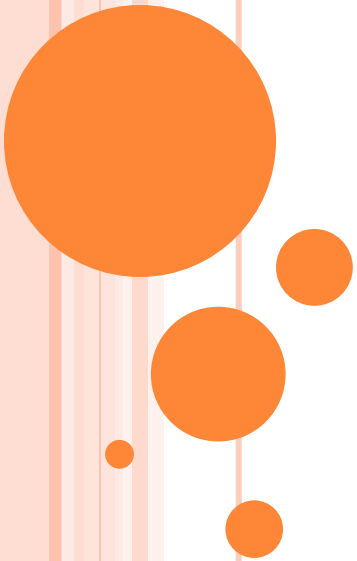
Think Rationally: "Laws of Though" Approach

- Theorem proving:
  - Set of rules:
    - R1: $X = Y / Z \Leftrightarrow X.Z = Y$
    - R2: $X = Y \Leftrightarrow X + Z = Y + Z$
    - R3: $X * Y + X * Z \Leftrightarrow X * (Y + Z)$
  - Set of facts (premises):
    - F1: $b / c \Leftrightarrow c_2 / b$
    - F2: $a / c \Leftrightarrow c_1 / a$
    - F3: $c = c_1 + c_2$
  - Goal:
    - Show that: $c^2 = a^2 + b^2$



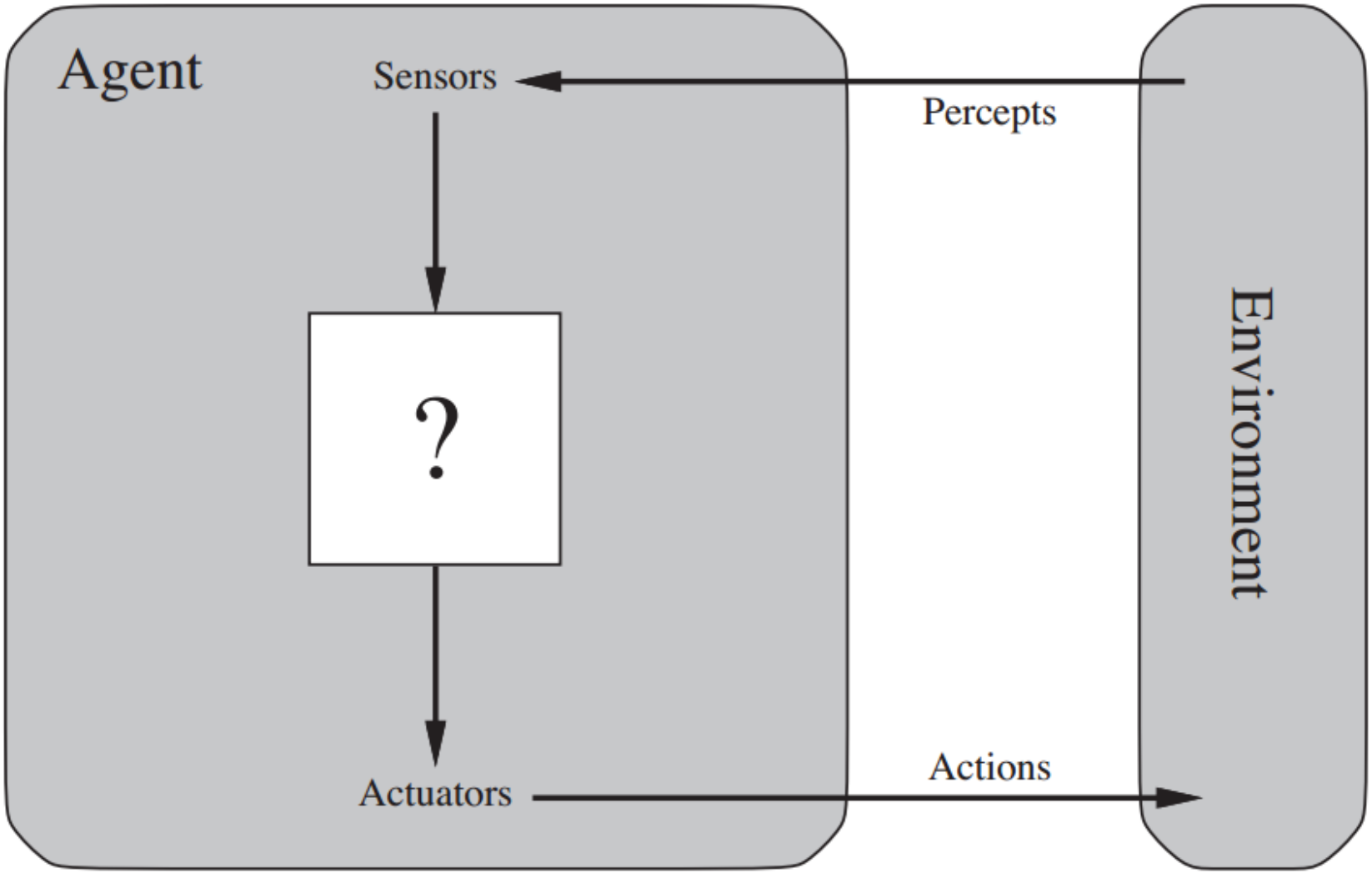
Act Rationally: Rational Agent Approach

- Perceive the environment, and act so as to achieve one's goal.
- Not necessary to do the best action:
  - There is not always an absolutely best action.
  - There is not always time to find the best action.
  - An action that's good enough can be acceptable.
- Example: Game playing.
- Sample approach: Tree-searching strategies.
- Problem: Choosing what to do given the constraints.



Chapter 2: Intelligent Agents

RATIONAL AGENTS



What is an Agent?

- A **rational agent** is one that does the right thing.
- In order to know the right thing, we need a performance measure.
- The **performance measure** is usually chosen by the agent designer.
- For each possible percept sequence, a rational agent should select an **action** that is expected to maximize the performance measure given the evidence provided by the percept sequence and whatever built-in **knowledge** the agent has.

Specifying the Task Environment

- Task Environments are "problems" to which rational agents are the solutions!
- To specify a task environment, four items need to be defined:
  - **P**erformance measure
  - **E**nvironment
  - **A**ctuators
  - **S**ensors

→ The **PEAS** description

Specifying the Task Environment

- Example: PEAS description of the task environment for an automated taxi.

Agent Type	Performance Measure	Environment	Actuators	Sensors
Taxi Driver	Safe, fast, legal, maximize profits, …	Roads, other traffic, pedestrians, customers, …	Steering, accelerator, signal, horn, …	Cameras, sonar, speedometer, GPS, …

Properties of the Environment

- Fully observable vs. partially observable:
  - See everything vs. hidden information.
- Deterministic vs. stochastic:
  - Controlled by agent vs. randomness.
- Episodic vs. sequential:
  - Independent atomic episodes vs. series of events.

Properties of the Environment

- Static vs. dynamic vs. semi-dynamic:
  - World waits for agent vs. world goes on without agent vs. world waits but agent timed.
- Discrete vs. continuous:
  - Finite distinct states vs. uninterrupted sequence.
- Single agent vs. cooperative vs. competitive:
  - Alone vs. team-mates vs. opponents.

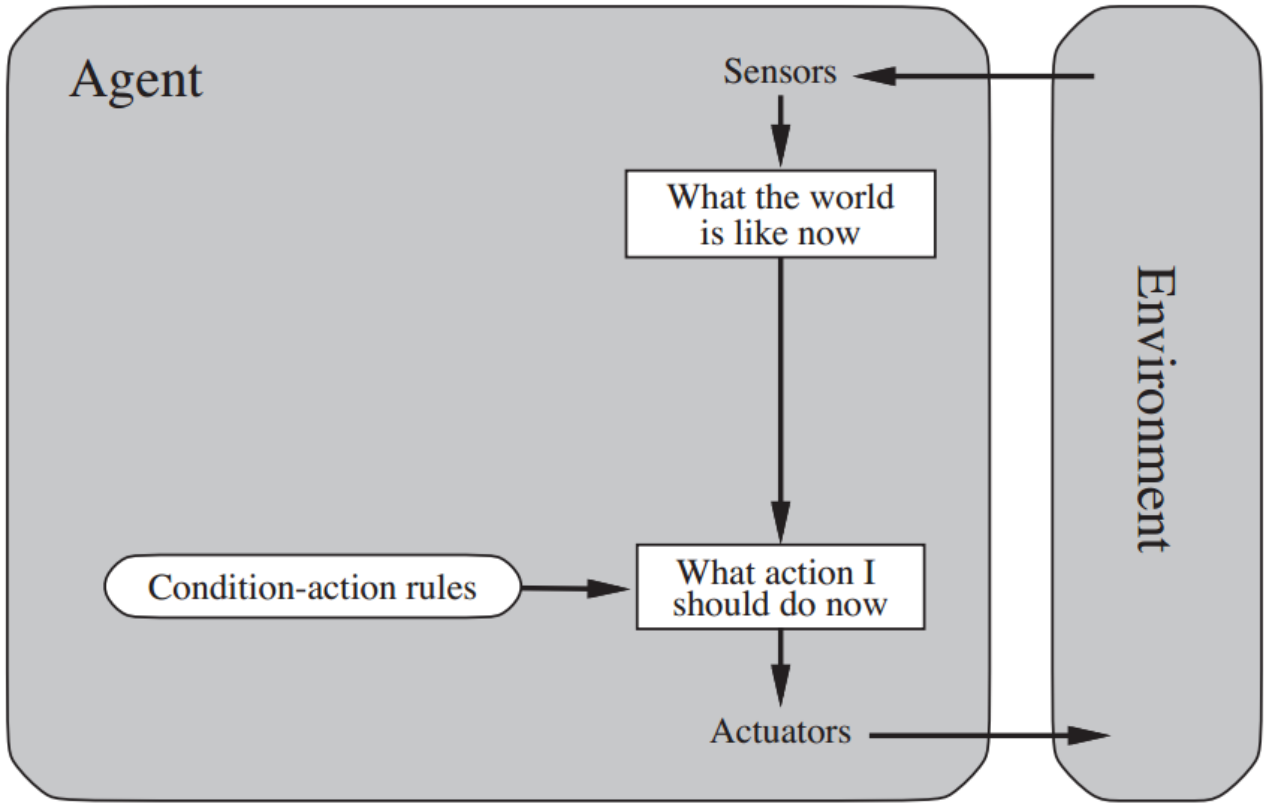
The Environment

- Examples of environments and their properties:

Environment	Obs.	Det.	Eps.	St.	Disc.	Agent
Sudoku	Fully	Det.	Seq.	St.	Disc.	Single
Chess (With a Clock)	Fully	Det.	Seq.	Semi	Disc.	Comp.
Robot Soccer Players	Part.	Stoc.	Seq.	Dyn.	Cont.	Comp./ Coop.
Part-Picking Robot	Part.	Stoc.	Eps.	Dyn.	Cont.	Single

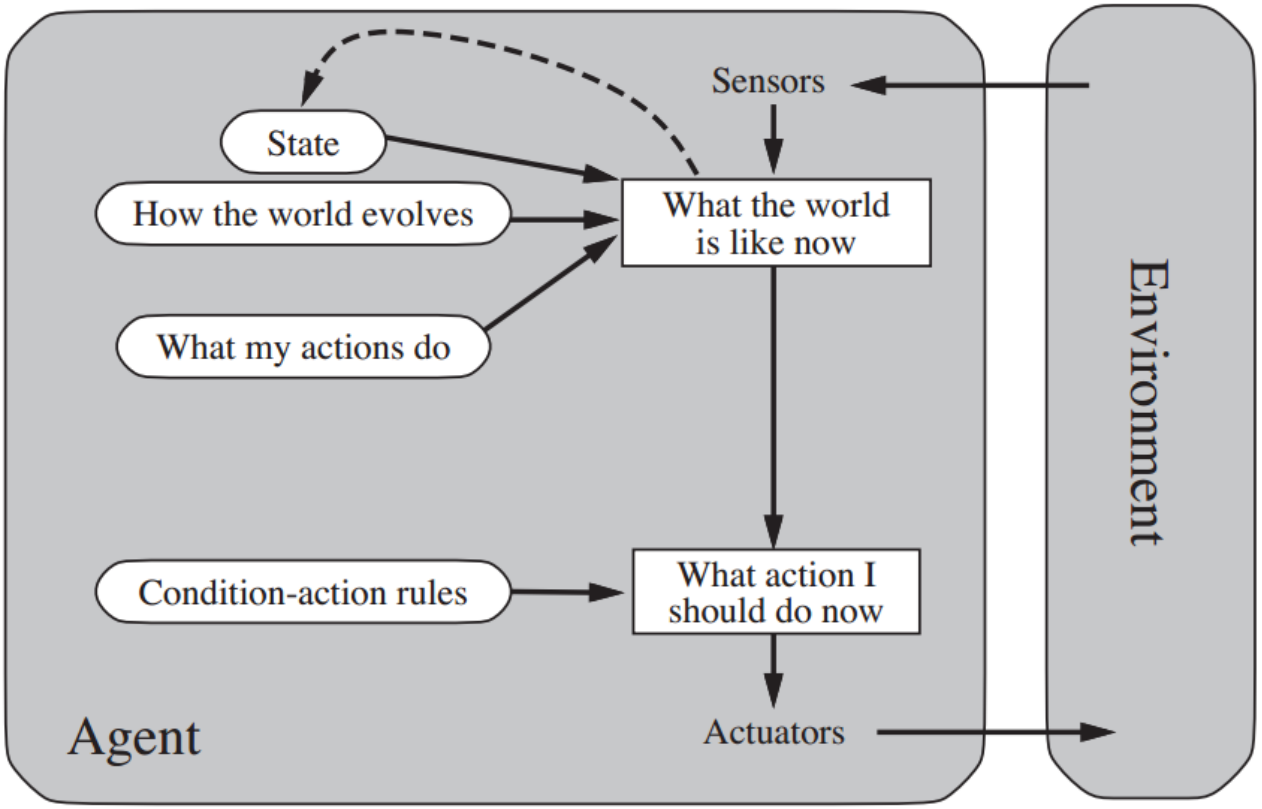
Simple Reflex Agents

- Selects action based only on current perception of the environment.
- Simple but has a limited intelligence!



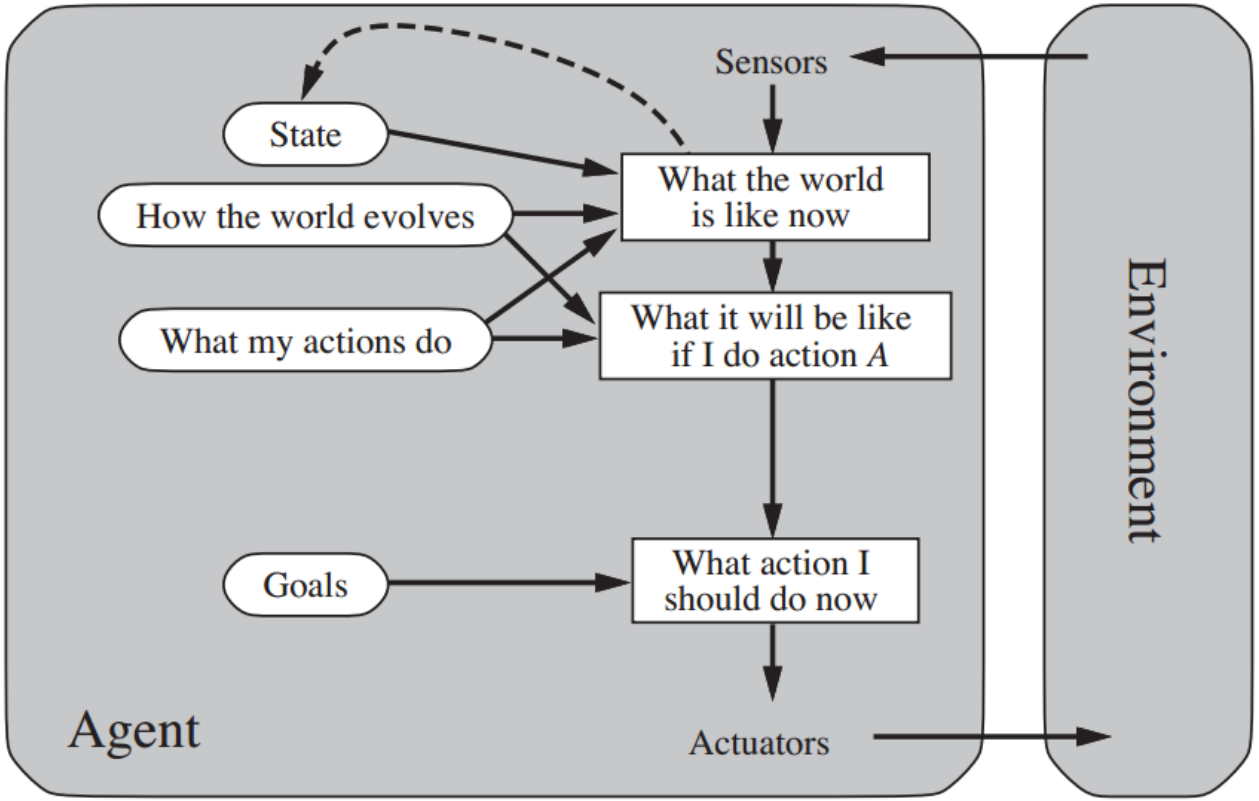
Model-Based Reflex Agent

- Keeps track of perception history in the form of internal state (reflecting unobserved aspects of the current state of the World).



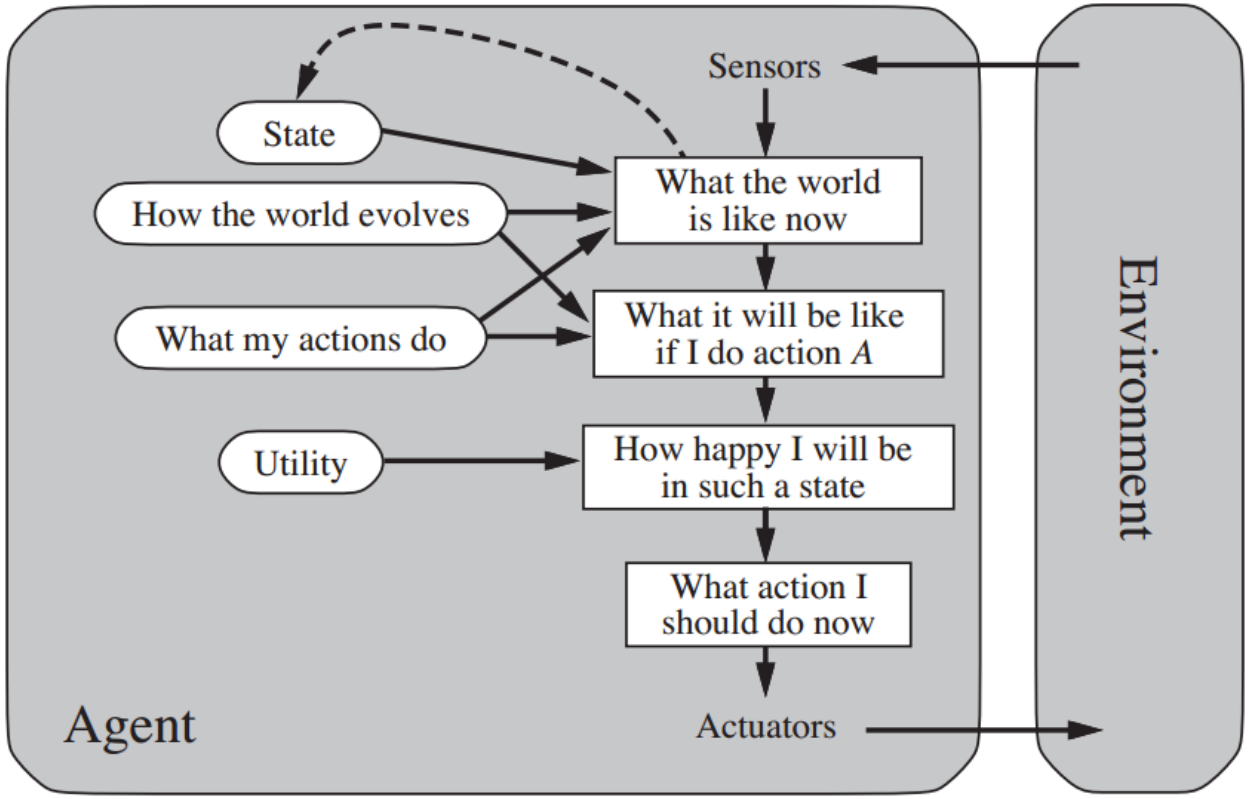
Goal-Based Agent

- Keeps track of world state and goals to be achieved.
- Chooses action that will lead to achieving its goals.
- Flexible (knowledge & goal can be easily modified).



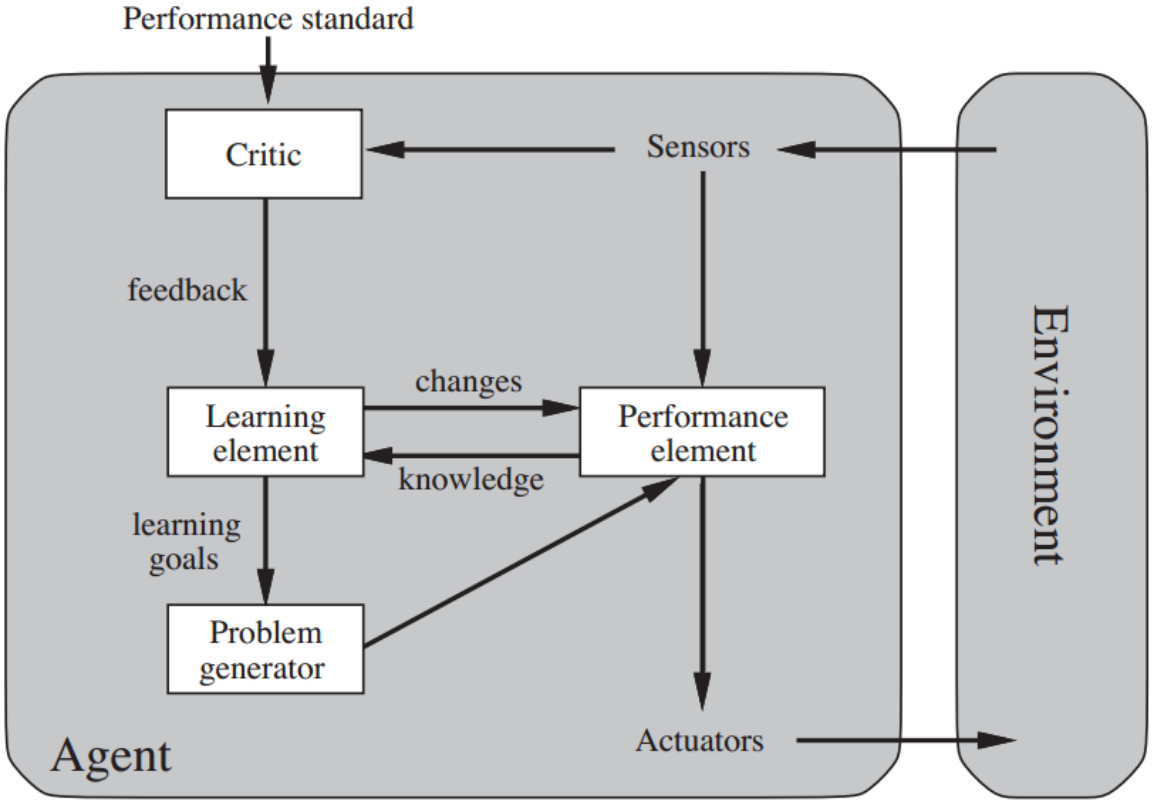
Utility-Based Agent

- Keeps track of world state and uses utility function to measure performance among world states.
- Agent chooses the actions that maximize its utility.



Learning Agent

- Adds the ability to learn from its experiences.
  - Learning element: makes improvements; Performance element: selects external actions; Critic: determines how agent is doing; Problem generator: suggests exploratory actions.



Requirements

- What do I need from you?
  - When given a certain problem you should be able to:
    - Specify the task environment (PEAS).
    - Identify the environment properties.
    - Determine the type of the most suitable agent.
  - Answer descriptive questions.

Reading Material

- Russell-Norvig, Chapters 1 & 2:
  - Pages 1 – 5.
  - Pages 28, 29.
  - Pages 34 – 36.
  - Pages 40 – 57.