CSC421 Intro to Artificial Intelligence

Chapter 1
Overview & Introduction

Overview

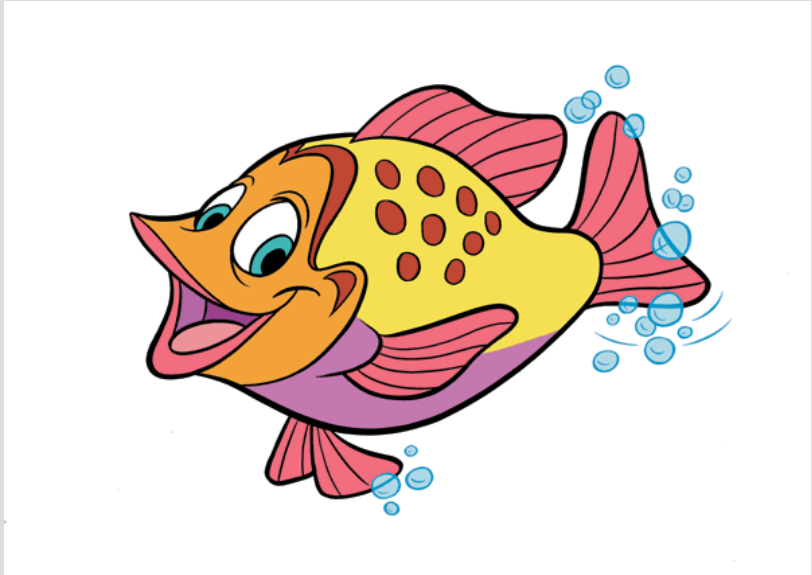
- Emphasis :
  - Agents as a way of thinking about AI and software in general
- Workload :
  - Balanced over the term
  - IMPORTANT: prepare for lectures
  - Suggested work-plans
- Exams (midterm & final)
  - Open book
- Thoughts on cheating, copying, attendance

Grades

Grades	Description
A+, A, A-	**Exceptional**, **outstanding** or **excellent** performance. Normally achieved by a minority of students. These grades indicate a student who is *self-initiating*, *exceeds expectation* and has an *insightful* grasp of the subject matter.
B+, B, B-	**Very good**, **good** or **solid** performance. Normally achieved by the largest number of students. These grades indicate a *good* grasp of the subject matter or *excellent grasp in one area balanced with satisfactory grasp in the other areas*.
C+, C	**Satisfactory**, or **minimally satisfactory**. These grades indicate a *satisfactory performance and knowledge* of the subject matter.
D	**Marginal Performance**. A student receiving this grade demonstrated a *superficial grasp* of the subject matter.
F	**Unsatisfactory performance**. Wrote final examination and completed course requirements; no supplemental.

Grades (the reality)

Salamander



Sunfish

Cheating

- You are adults – I am not going to treat like children
- Cheating is stupid and you only hurt yourself doing it
- We live in a transparent world where what matters is what you can do not what your grades are
- If your goal for next year is to get 60% or higher in all my courses with the least amount of effort then please drop this class

Rosie Ruiz

Attendance

- I am not responsible for the 8:30am class time
- There are excellent resources online for learning AI including courses based on the same textbook
- As long as you can do the assignments, midterm and final I don't care if you attend
- However I hope you find the lectures interesting and stimulating and we can all work together on exploring this very fascinating topic that for many is the coolest part of Computer Science

What is AI ?

Do you know of any examples of applications of AI ?

Major challenges ahead ?

Why study AI ?

What do you expect to learn in this course ?

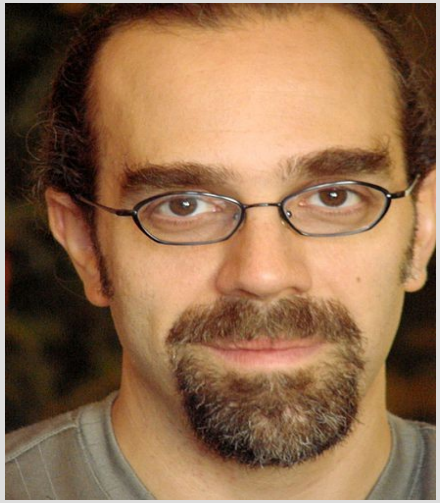
Along with molecular biology, AI is regularly cited at the “field I would most like to be in” by scientists in other disciplines. Do you agree ? Why ?

My favorite definition

"Artificial Intelligence (AI) is the science of how to get machines to do the things they do in movies" - Dr. Astro Teller

http://en.wikipedia.org/wiki/Astro_Teller

Currently heading Google X



4 approaches

Systems that:

Think like humans

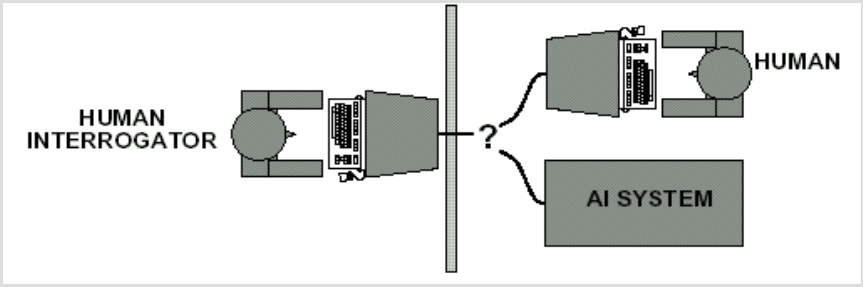
Think rationally

Act like humans

Act rationally

Acting Humanly: Turing Test

Operational test for intelligent behavior:



By 2000, a machine might have a 30% chance of fooling a human for 5 minutes

Knowledge, reasoning, language understanding, learning

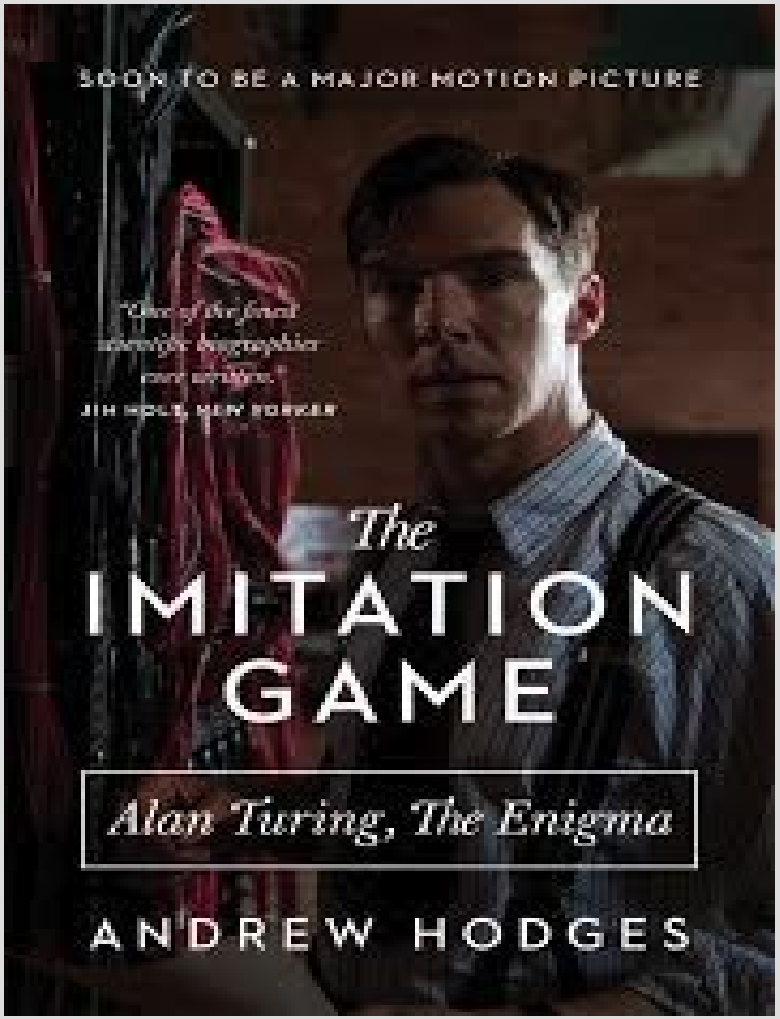
Extended version: computer vision, robotics

Problems: Not reproducible, constructive, amendable to mathematical analysis

Test that remains relevant 60 years later

Turing also was crucial for winning World War II

Turing


SOON TO BE A MAJOR MOTION PICTURE
The
IMITATION
GAME
Alan Turing, The Enigma
ANDREW HODGES

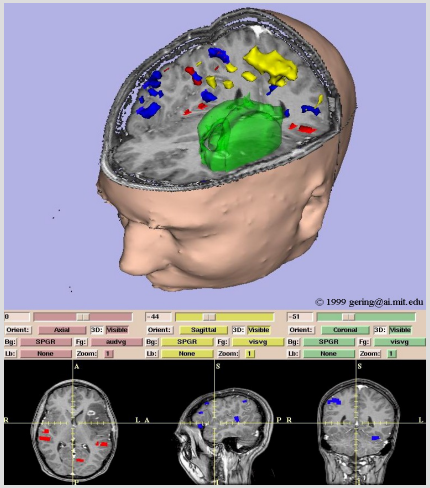
Thinking humanly: Cognitive modeling

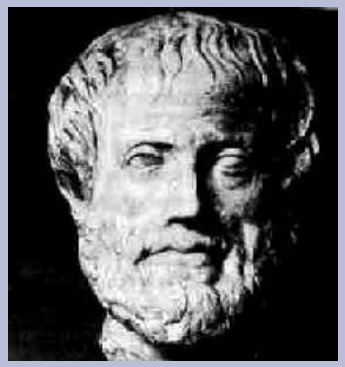
1960s "cognitive revolution": information processing psychology replaced prevailing orthodoxy of behaviorism

Theories of how the brain works

- Predicting and testing user subjects (top-down)
- Direct analysis of neurological data (bottom-up)

Cognitive science and cognitive neuroscience – today distinct from AI





Thinking rationally: Laws of thought

Greek schools developed various forms of logic

Socrates is a man; all men are mortal; therefore Socrates is mortal

Notation and rules of derivation for thoughts

- Mechanization of computation/proof

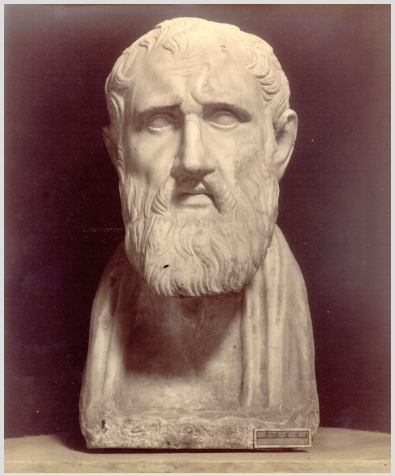
Direct line through mathematics and philosophy to AI

Problems:

Not all intelligent behavior is mediated by logic deliberation

What is the purpose of thinking ?

What thoughts should I have ?



Acting rationally: The rational agent approach

Rational behavior: doing the right thing

That which is expected to maximize goal achievement given the available information

Not necessarily just thinking: blinking reflex – thinking should be in the service of rational action

Advantages:

- More general than laws of thought
- More amendable to scientific development

Rational agents

An agent is an entity that perceives and acts
This course is about designing rational agents
Abstractly, an agent is a function from precept histories to actions: f: *P** -> *A*
For any given class of environments, we seek the agent (or class of agents) with the best performance
Caveat: computational resources

AI Prehistory

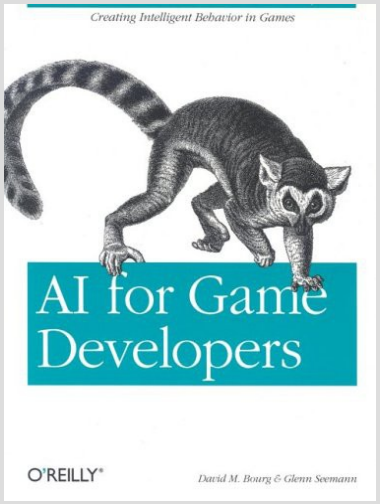
Philosophy : logic, methods of reasoning
mind as a physical system
foundations of learning, language, rationality
Mathematics: formal representation and proof
algorithms, computation, (un)decidability,
(in)tractability, probability
Psychology : adaptation
phenomena of perception and motor control
experimental techniques (psychophysics etc)
Economics : formal theory of rational decisions
Linguistis : knowledge representation and grammar
Neuroscience: Plastic physical substrate for mental activity
Control theory: homeostatic systems, stability, simple optimal
agent designs

Brief history of AI

1943: McCulloch & Pitts: Boolean circuit model of the brain
1950: Turing's “Computing Machinery and Intelligence”
1952-69: Look, Ma, no hands !
1950s: Early AI programs, including Samuel's checkers program, Newell & Simon's Logic Theorist, Gelernter's Geometry Engine
1956 : Dartmouth meeting: “Artificial Intelligence” adopted
1965 : Robinson's complete algorithm for logical reasoning
1966-74: AI discovers computational complexity – Neural Network research almost disappears
1969-79: Early development of knowledge-based systems
1980-88: Expert systems industry booms
1988-93: Expert systems industry busts: “AI Winter”

Brief History of AI

1985-95: Neural networks return to popularity
1988- : Resurgance of probability; general increase in technical depth, “Nouvelle AI”: ALife, GAs, soft computing
1995- : Agents, agents, everywhere, ...
2003- : Human-level AI back on the agenda, games



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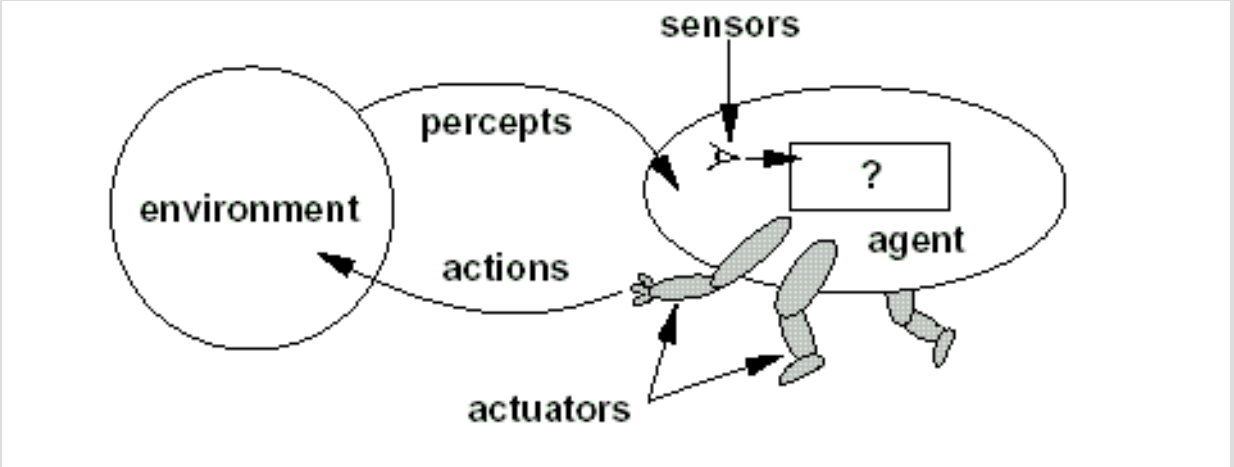
Chapter 2
Intelligent Agents

Agents & environments

Examples of agents ?

Agents & environments



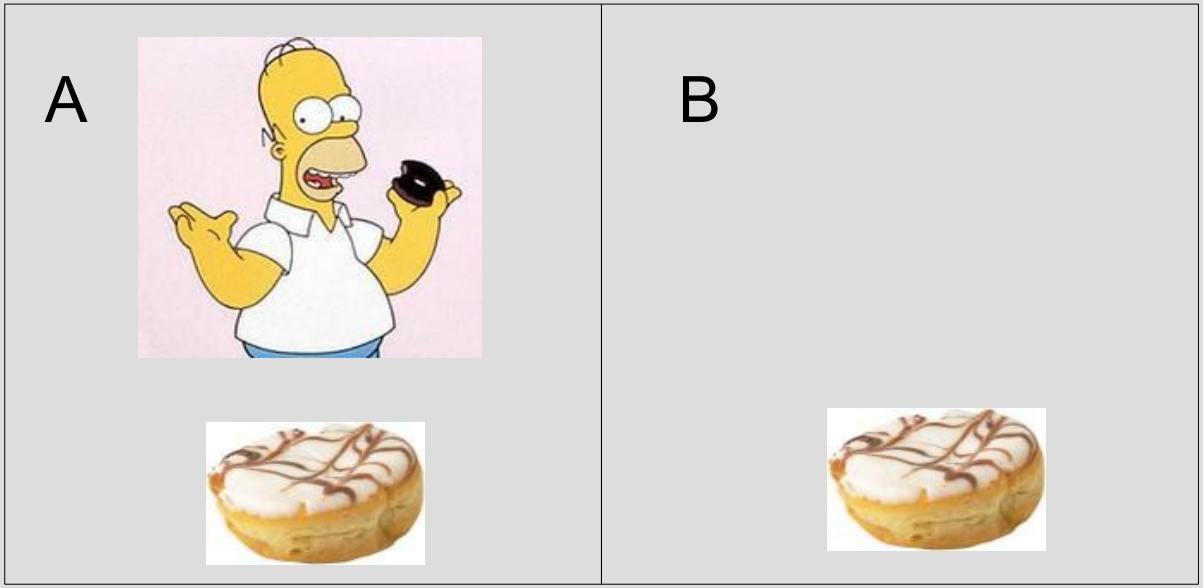
Agents include humans, robots, softbots, thermostats etc

The agent function maps from precept history to actions:

f: P* -> A

The agent program run on the physical architecture to produce f

The doughnut world



Precepts: location and contents e.g [A, Doughnut]
Actions : left, right, eat, NoOp

Doughnut Eating Agent (DEA)

Precept Sequence	Action
[A, empty]	Right
[A, doughnut]	Eat
[B, empty]	Left
[B, doughnut]	Eat
[A, empty], [A, empty]	Right
[A, empty], [B, doughnut]	Eat
.....	....

What is the "right" function ?
Can it be implemented by a small agent program?

function RELFEX_DEA([location, status]) **returns** an action
if status = *Doughnut* **then return** *Eat*
else if location = *A* **then return** *Right*
else if location = *B* **then return** *Left*

Rationality

Fixed performance measure evaluates the environment sequence

- One point per square cleaned in time T ?
- One point per clean square per time step, minus one per move ?

A rational agent chooses whichever action maximizes the expected value of the performance measure given the percept sequence to date

Rational is not omniscient - percepts may not supply all relevant information

PEAS description

Performance measure
Environment
Actuators
Sensors

PEAS for

Doughnut eating agent ?
Automated taxi ?
Internet shopping agent ?
Non-player character in computer game ?
Chess-playing program ?

Environments

	Solitaire	Backgammon	Internet shopping	Taxi
Observable?? Deterministic?? Episodic?? Static?? Discrete?? Single-agent??				

The environment type largely determines the agent design
The real world is (of course) partially observable, stochastic, sequential, dynamic, continuous, multi-agent.

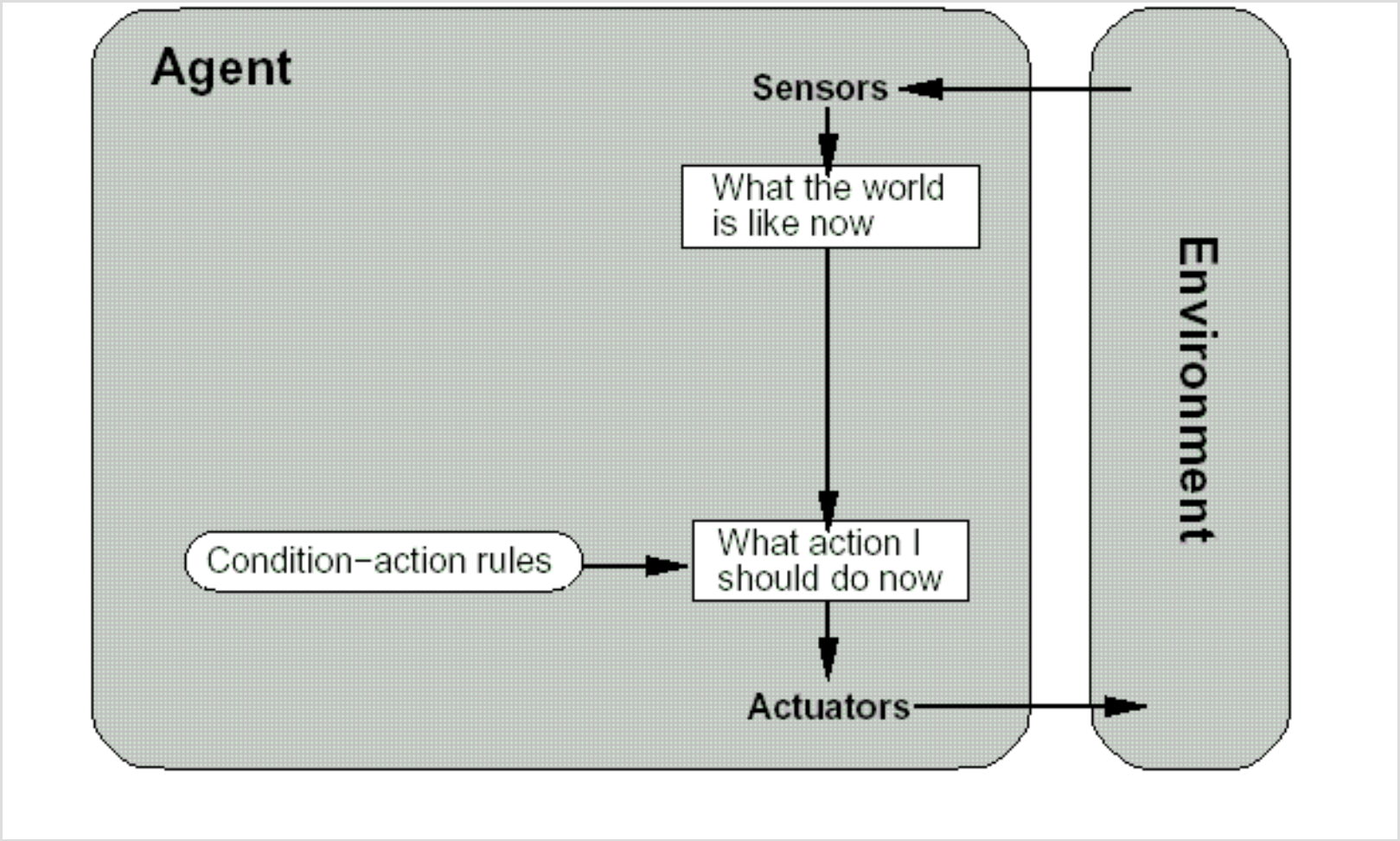
Agent types

Four basic types in order of increasing complexity

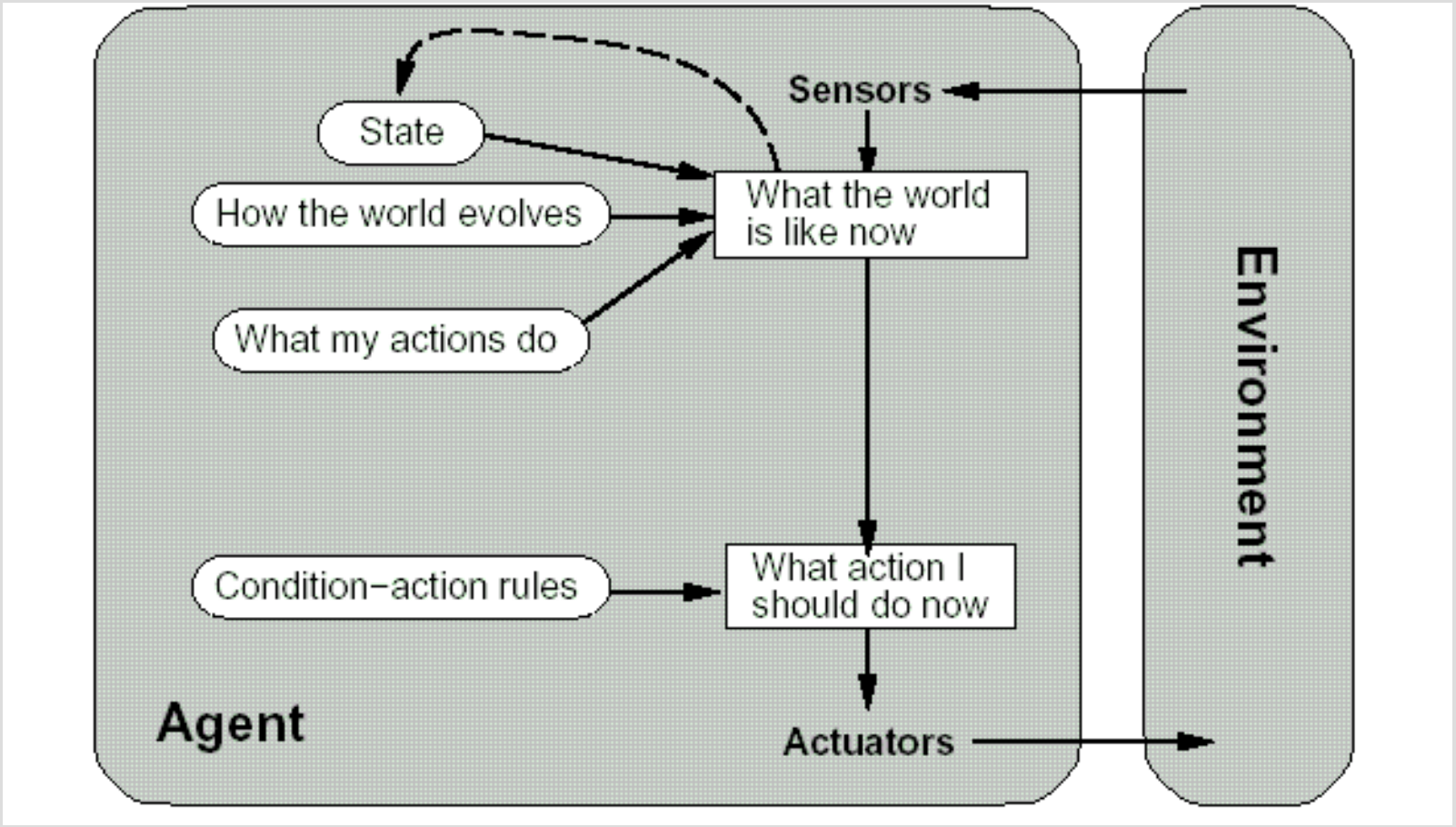
- Simple reflex agents
- Reflex agents with state
- Goal-based agents
- Utility-based agents

All these can be turned into learning agents

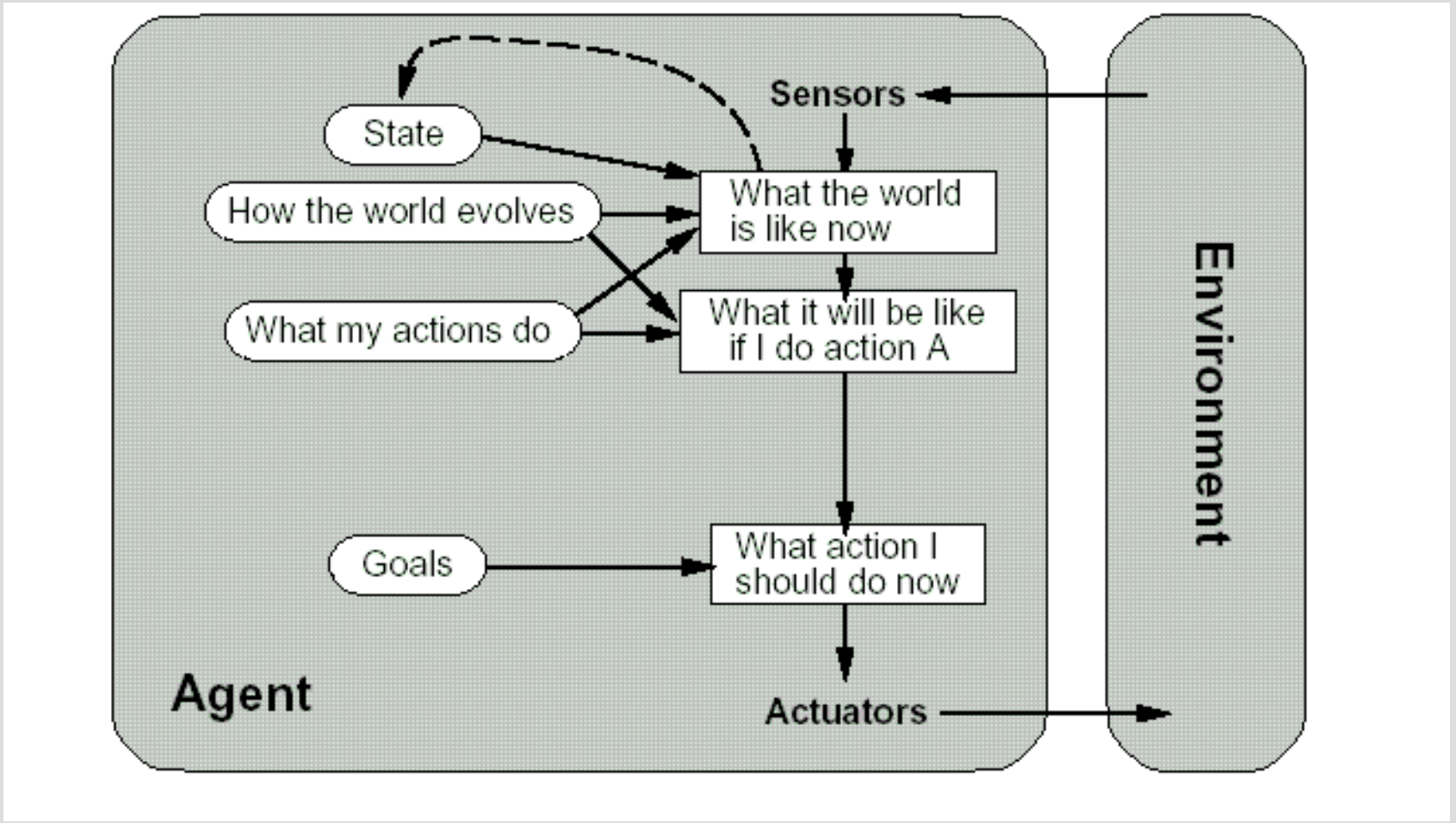
Simple reflex agents



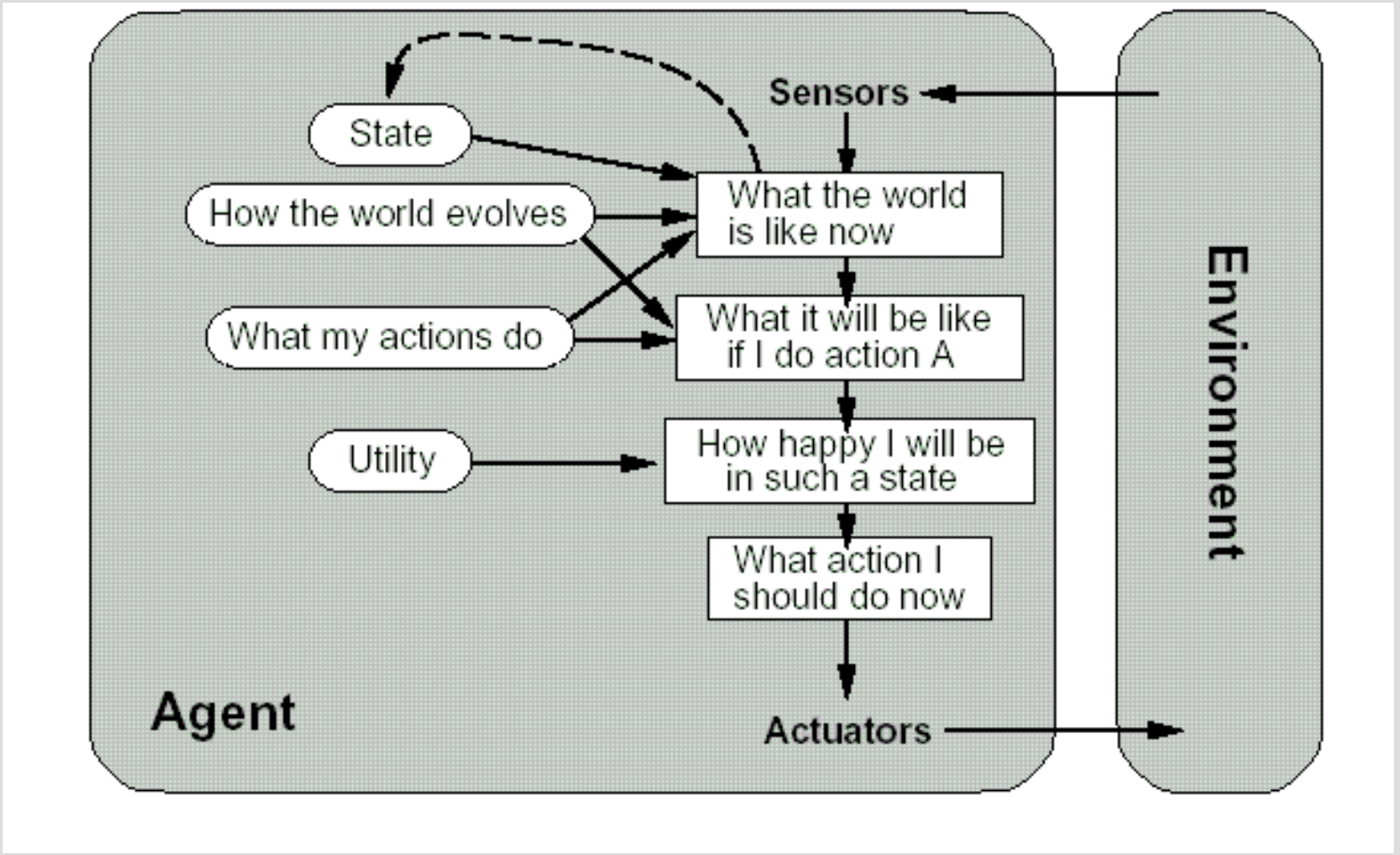
Reflex agents with state



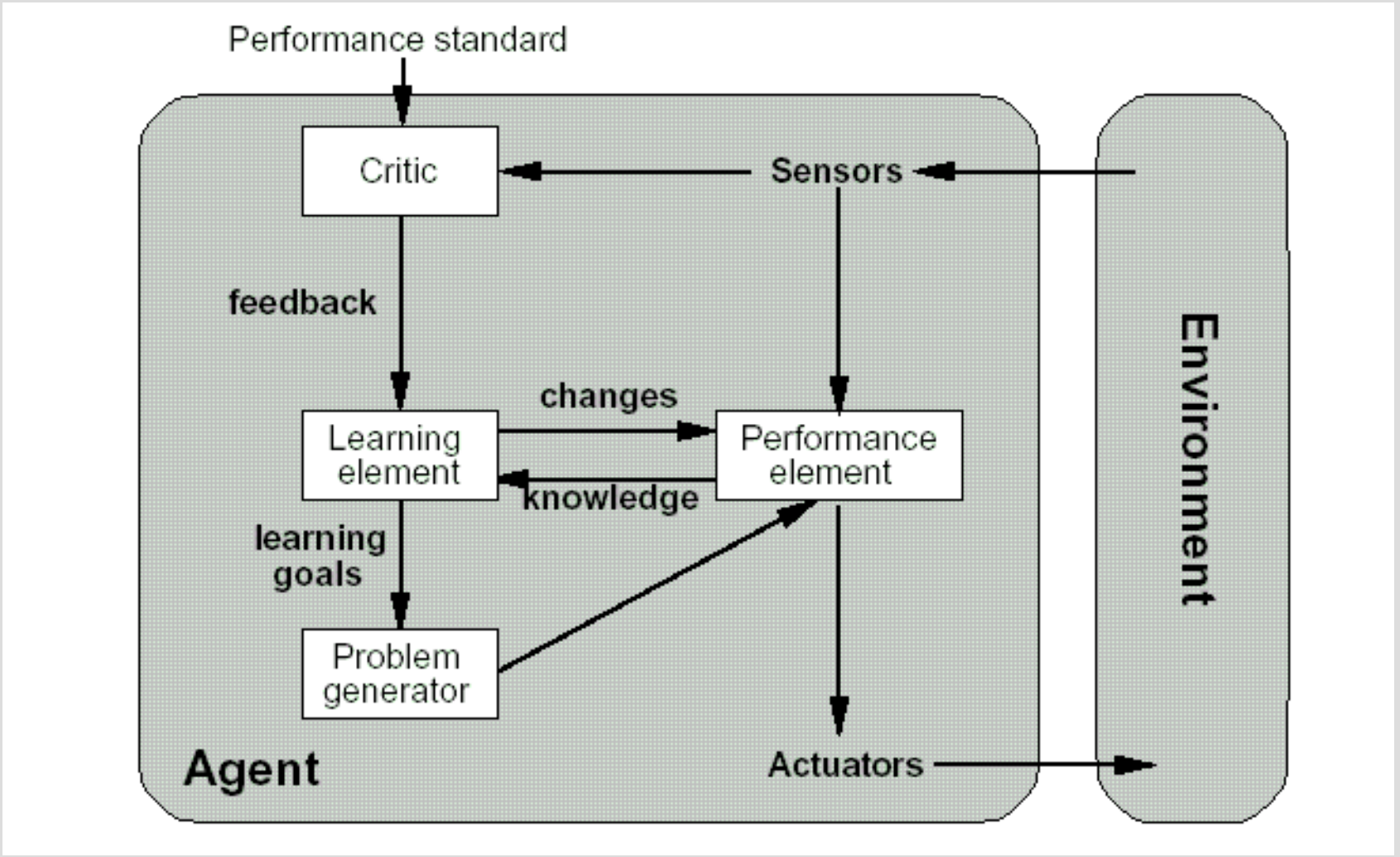
Goal-based agents



Utility-based agents



Learning Agents



Summary I

Agents interact with environments through actuators and sensors

The agent function describes what the agent does in all circumstances

The performance measure evaluates the environment sequence

A rational agent tries to maximize performance

PEAS descriptions define task environments

Summary II

- Environments
  - Observable ? deterministic ? episodic ? static ? discrete ? single agent ?
- Agent architectures
  - Reflex
  - Reflex with state
  - Goal-based
  - Utility-based