INT404 ARTIFICIAL INTELLIGENCE

Lecture 4

Defining Intelligence using Turing Test

- Alan M. Turing, in 1950, proposed the Turing Test to provide a definition of Intelligence.
- Turing Test is a test to see if a computer can learn to mimic human behavior.
- He defined intelligent behavior as the ability to achieve human-level intelligence during conversation.

Defining Intelligence using Turing Test

Founder of computer science, mathematician, philosopher

1912 (23 June): Birth, Paddington, London

1932-35: Quantum mechanics, probability, logic

1936: The Turing machine, computability, universal machine

1936-38: Princeton University. Ph.D. Logic, algebra, number theory

1938-39: Return to Cambridge. German Enigma cipher machine

1939-40: The Bombe, machine for Enigma decryption

1939-42: Breaking of U-boat Enigma, saving battle of the Atlantic

1943-45: Chief Anglo-American crypto consultant. Electronic work.

1945: National Physical Laboratory, London

1946: Computer and software design leading the world.

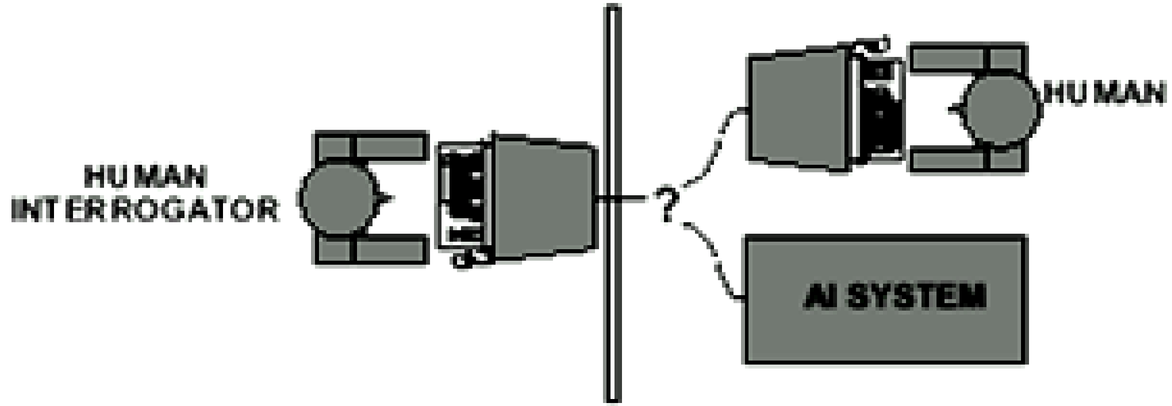
1947-48: Programming, neural nets, and artificial intelligence

1949: First serious mathematical use of a computer

1950: The Turing Test for machine intelligence

1952: Arrested

Defining Intelligence using Turing Test



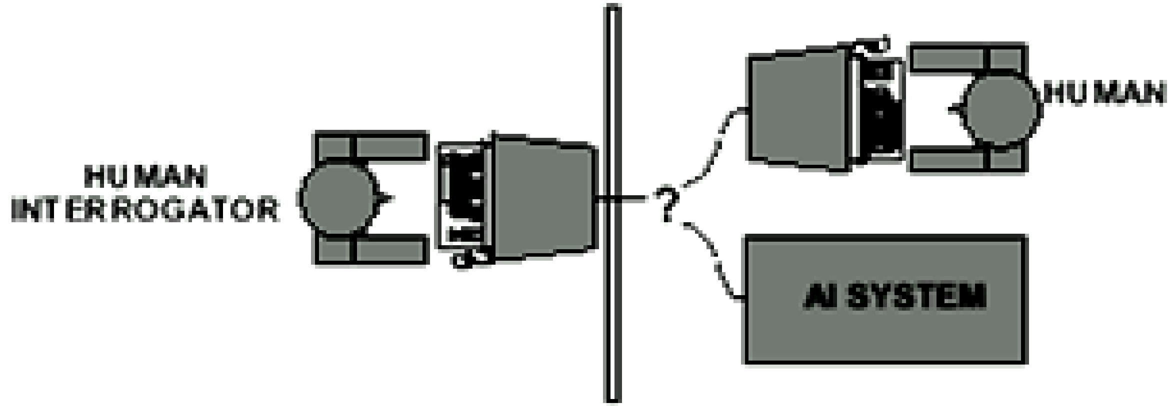
Turing Test

•Human interrogator can ask questions and can receive answers through typing terminal

•Interrogator does not know which answer is coming from machine and which is coming from human

•The Goal is, if at last, interrogate will be unable to Identify which one is machine and which one is human, we can declare that machine has achieved **INTELLIGENCE.**

Defining Intelligence using Turing Test



The Problems with Turing Test

1) Turing test is not reproducible, constructive, and amenable to mathematic analysis.
2) What about physical interaction with interrogator and environment?

Acting Humanly: The Full Turing Test

Total Turing Test: Requires physical interaction and needs perception and actuation.

Defining Intelligence using Turing Test

What would a computer need to pass the Turing test?

Natural language processing: to communicate with examiner.

Knowledge representation: to store and retrieve information provided before or during interrogation.

Automated reasoning: to use the stored information to answer questions and to draw new conclusions.

Machine learning: to adapt to new circumstances and to detect and extrapolate(generalized) patterns.

Vision (for Total Turing test): to recognize the examiner's actions and various objects presented by the examiner.

Motor control (total test): to act upon objects as requested.

Other senses (total test): such as audition, smell, touch, etc.

Defining Intelligence using Turing Test

"I believe that in about fifty years' time it will be possible to program computers, with a storage capacity of about **10^9,** to make them play the imitation game so well that an average interrogator will not have more than 70 per cent chance of making the right identification after 5 minutes of questioning"

Alan Turing (1950)

Defining Intelligence using Turing Test

ELIZA

1. ELIZA is an early **natural language processing** computer program created from 1964 to 1966 at the MIT Artificial Intelligence Laboratory by Joseph Weizenbaum.
2. Eliza simulated conversation by using a **"pattern matching"** and **substitution** methodology that gave users an illusion of understanding.
3. Had no built in framework for **contextualizing** events.
4. Directives on how to interact were provided by **"scripts",** written originally in MAD-Slip.
5. ELIZA was one of the first **chatter bots** and one of the **first** programs capable of attempting the Turing test.

Defining Intelligence using Turing Test

```
  Welcome to
                    EEEEEE  LL      IIII  ZZZZZZZ   AAAAA
                    EE      LL       II        ZZ  AA   AA
                    EEEEE   LL       II      ZZZ   AAAAAAA
                    EE      LL       II    ZZ      AA   AA
                    EEEEEE  LLLLLL  IIII  ZZZZZZZ  AA   AA

  Eliza is a mock Rogerian psychotherapist.
  The original program was described by Joseph Weizenbaum in 1966.
  This implementation by Norbert Landsteiner 2005.


ELIZA: Is something troubling you ?
YOU:   Men are all alike.
ELIZA: What is the connection, do you suppose ?
YOU:   They're always bugging us about something or other.
ELIZA: Can you think of a specific example ?
YOU:   Well, my boyfriend made me come here.
ELIZA: Is it important to you that your boyfriend made you come here ?
YOU:   He says I'm depressed much of the time.
ELIZA: I am sorry to hear that you are depressed.
YOU:   It's true. I am unhappy.
ELIZA: Can you explain what made you unhappy ?
YOU:
```

Making Machine Think like Human

- For decades, we have been trying to make machine think like a human.
- In order to make this happen, we have to understand the human thinking process.

Two ways

1. Note down how we respond to things, but it is intractable
2. Conduct an experiment based on predefined format
    - Develop certain questions to encompass a wide variety of human topics, and record people’s response
    - Create a model on the basis of gathered data
    - Create software's on the basis of model, not easy

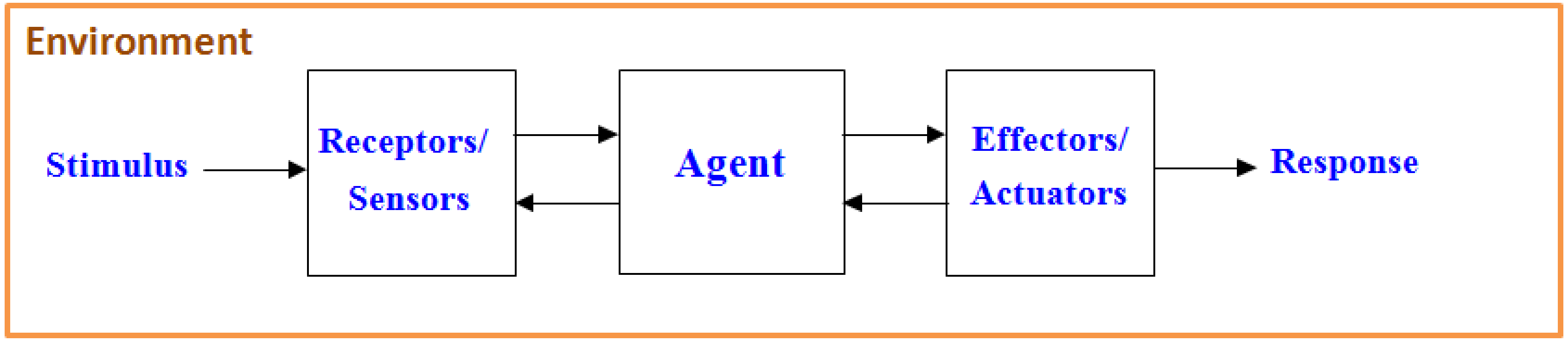
- In computer science the field of **COGNITIVE MODELLING** deals with simulating the human thinking process.

Intelligent Agents

1. Rational Agents
2. Agent's Environment
3. Ideal Rational Agents
4. Intelligent Agents
5. Simple Reflex Agents
6. Model – Based Agents
7. Goal Based Agents
8. Utility Based Agents
9. Learning Agents

Rational Agents

"An *agent* is anything that can be viewed as *perceiving* its environment through *sensors* and *acting* upon that environment through *actuators*." (Russell & Norvig, page 32)



- ❑ Same as interaction of the human nervous system with its environment.

- ❑ A ***rational agent*** is one that acts in a manner that causes it to be as **successful** as it can.

- ❑ What counts as **successful** obviously depends on what we **require the agent to do.** We need to determine an appropriate ***performance measure*** in each case.

The Agent Environments

There are **five** types :

Accessible vs. Inaccessible –

- An environment is ***accessible*** to an agent if the agent's sensory apparatus gives it access to the complete state of the environment.
- The agent will not then need to maintain an internal state to keep track of the world.

Example: In the **Checker Game,** the agent observes the environment completely while in **Poker Game**, the agent partially observes the environment because it cannot see the cards of the other agent.

Deterministic vs. Non-deterministic –

- The environment is ***deterministic*** if its next state is determined completely by **its current state and the actions of its agents.**
- A deterministic but inaccessible environment may *appear* non-deterministic to the agent.

Example: Image analysis – Deterministic

Taxi driving – Stochastic (cannot determine the traffic behavior)

The Agent Environments

Discrete vs. Continuous – A ***discrete*** environment has a limited/finite number of distinct, clearly defined percepts and actions.

Example: In Checkers game, there is a finite number of moves – Discrete
A truck can have infinite moves while reaching its destination – Continuous.

Episodic vs. Non-episodic –

❑ In an ***episodic*** environment the agent's experience can be divided into "episodes" consisting of the agent perceiving and then producing actions that depend only on that episode.

❑ Subsequent episodes do not depend on previous episodes, and so the agent can limit how far it needs to think ahead.

Example: Part-picking robot – Episodic
Chess playing – Sequential

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Static vs. Dynamic – A ***static*** environment does not change while an agent is deliberating. The agent will then have no need to keep checking the world while it is deciding on an action, nor worry about the passage of time.

Example: Crosswords Puzzles have a static environment while the Physical world has a dynamic environment.

- It is clear that different types of environment will require different types of agents to deal with them effectively.

- The **hardest environments** to cope with will be inaccessible, non-deterministic, continuous, non-episodic, and dynamic.

- An ***environment program*** for our agents to interact with. This gives each agent its percepts, receives an action from each agent, and then updates the environment. It may also keep track of the performance measures for each agent.

Ideal Rational Agents

- An ***ideal rational agent*** is one that takes whatever action is expected **to maximise** its **performance** measure on the basis of the evidence provided by its **perceptual history** and whatever **built-in knowledge** it has.

- If an agent's actions are based only on its built-in knowledge, and not on its own experience with its environment, then we say that the **agent lacks autonomy.**

- An ***autonomous agent*** will supplement its built-in knowledge with its own acquired (or learned) knowledge in order to act appropriately.

- It is often a good AI strategy to build systems/agents that have enough knowledge **to get them started**, and then leave them to learn the rest.

Intelligent Agents

Agents are comprised of an ***architecture*** (e.g. a computer) plus a ***program*** that runs on that architecture.

In designing intelligent systems there are four main factors to consider:

P **Percepts** – the inputs to our system

A **Actions** – the outputs of our system

G **Goals** – what the agent is expected to achieve

E **Environment** – what the agent is interacting with

We shall consider four types of agent system of increasing sophistication:

1. Simple Reflex Agents
2. Reflex Agents with an Internal State
3. Goal based agents
4. Utility based agents

Simple Reflex Agents

Simple reflex agents: It is the simplest agent which acts according to the current percept only, pays no attention to the rest of the percept history. The agent function of this type relies on the **condition-action rule** – "If condition, then action." It makes correct decisions only if the environment is fully observable.

Example: iDraw, a drawing robot which converts the typed characters into writing without storing the past data.

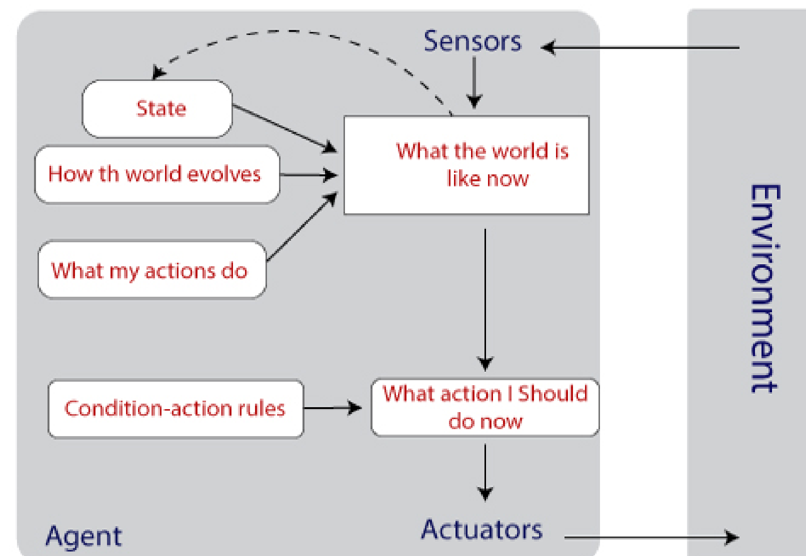
Model-Based Agent

❑These type of agents can **handle partially observable environments** by maintaining some internal states.

❑The internal state depends on the percept history, which reflects at least some of the unobserved aspects of the current state.

❑Therefore, as time passes, the internal state needs to be updated which requires two types of knowledge or information to be encoded in an agent program i.e., **the evolution of the world on its own** and **the effects of the agent's actions.**

Example: When a person walks in a lane, he maps the pathway in his mind.



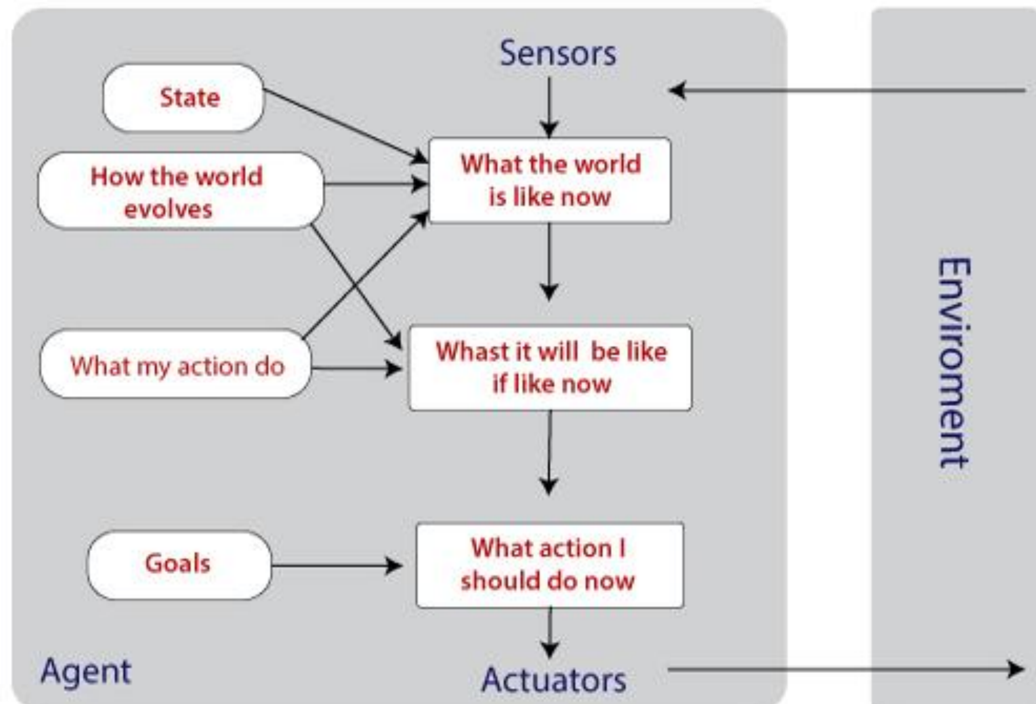
A model-based reflex agent

Goal Based Agents

❑It is not sufficient to have the current state information unless the goal is not decided.

❑Therefore, a goal-based agent selects a way **among multiple possibilities** that helps it to reach its goal.

Note: With the help of searching and planning (subfields of AI), it becomes easy for the Goal-based agent to reach its destination.



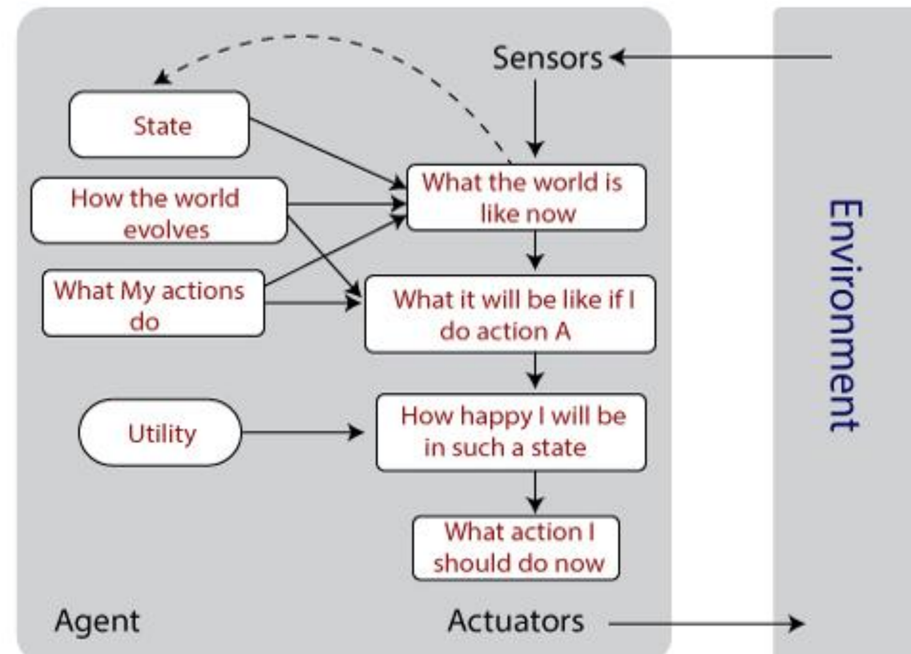
Goal-based agent

Utility Based Agents

Utility-based agents: These types of agents are concerned about the performance measure. The agent selects those actions which maximize the performance measure and devote towards the goal.

Example: The main goal of chess playing is to 'check-and-mate' the king, but the player completes several small goals previously.

Note: Utility-based agents keep track of its environment, and before reaching its main goal, it completes several tiny goals that may come in between the path.



Utility-Based

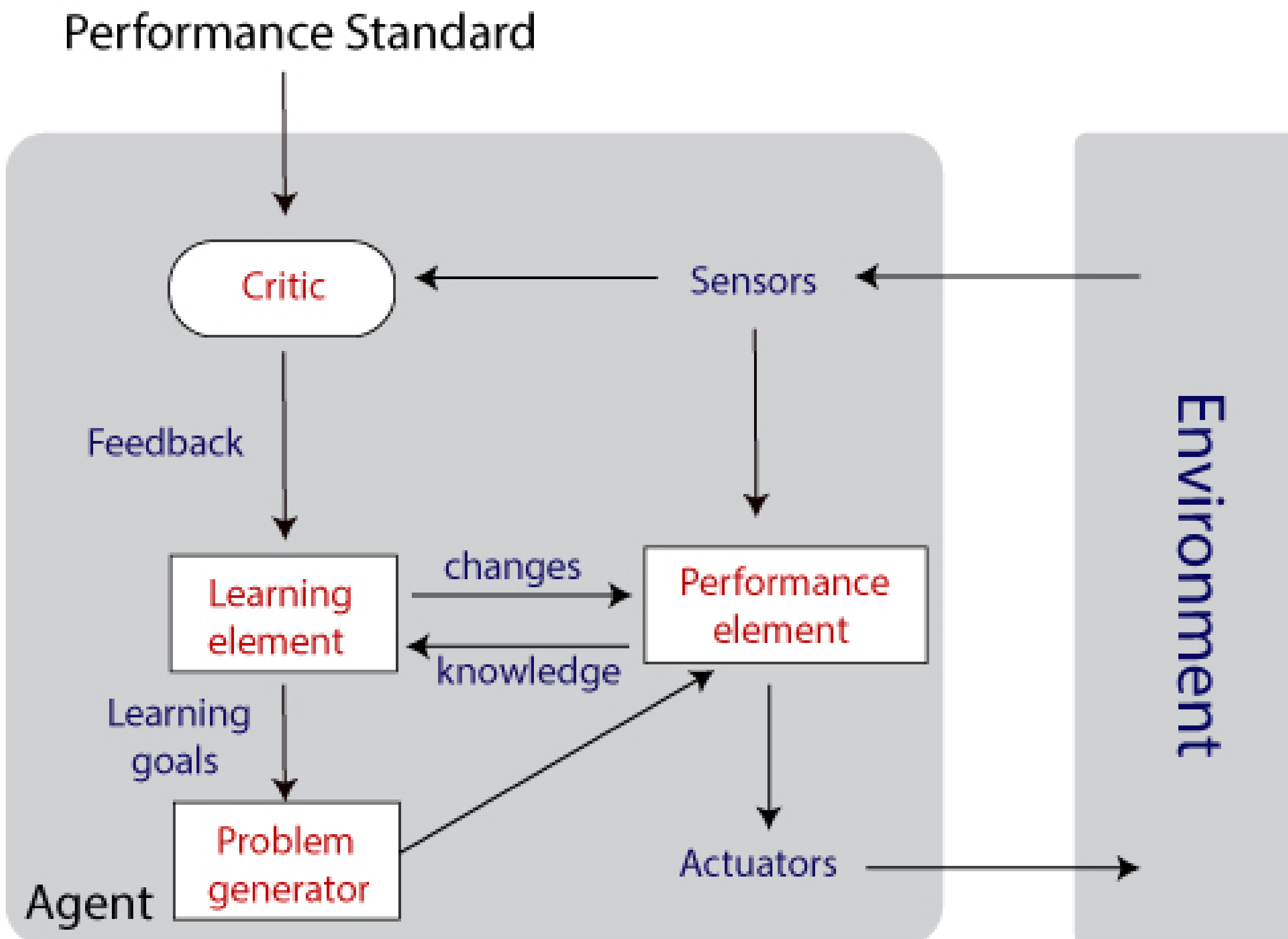
Learning Agents

The main task of these agents is to teach the agent machines to operate in an unknown environment and gain as much knowledge as they can. A learning agent is divided into four conceptual components:

- **Learning element:** This element is responsible for making improvements.
- **Performance element:** It is responsible for selecting external actions according to the percepts it takes.
- **Critic:** It provides feedback to the learning agent about how well the agent is doing, which could maximize the performance measure in the future.
- **Problem Generator:** It suggests actions which could lead to new and informative experiences.

Example: Humans learn to speak only after taking birth.

Note: The objective of a Learning agent is to improve the overall performance of the agent.



A general learning agent