

Artificial Intelligence

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Lecture 2

Introduction of AI

Agenda

Agents and Environments

Rationality

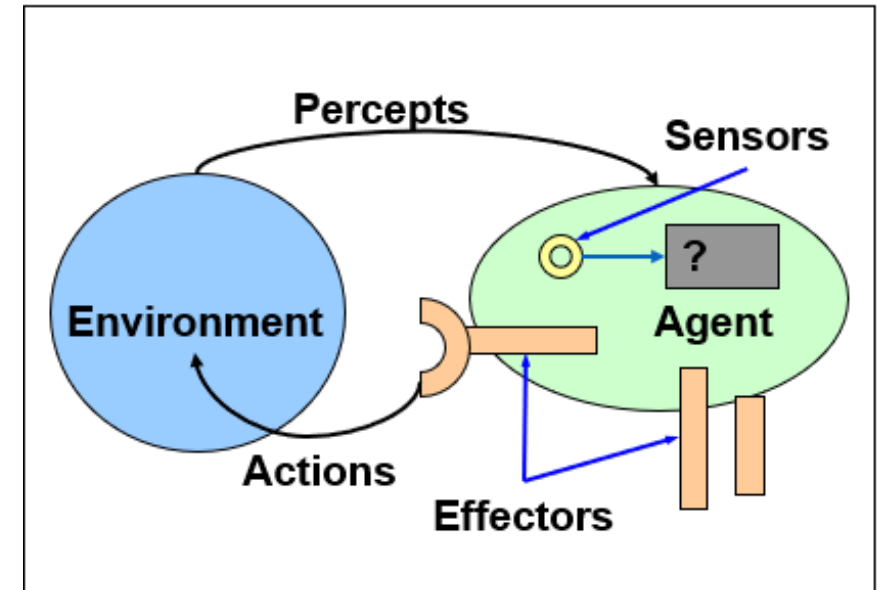
PEAS (Performance, Environment, Actuators, Sensors)

Environment types

Agent types

Agents

- An AI program = an intelligent Agent
- Agent is an entity that perceives and acts
- An agent is anything that can be viewed as perceiving its environment through sensors and acting upon that environment through actuators.
- **Perception**
 - Signal from the environment
- **Sensors**
 - Acquires percepts
- **Action**
 - Attempts to affect the environment
- **Effectors (actuators)**
 - Transmits actions



Example of agents

Human agent:

- eyes, ears, and other organs for sensors;
- hands, legs, mouth, and other body parts for actuators

Robotic agent:

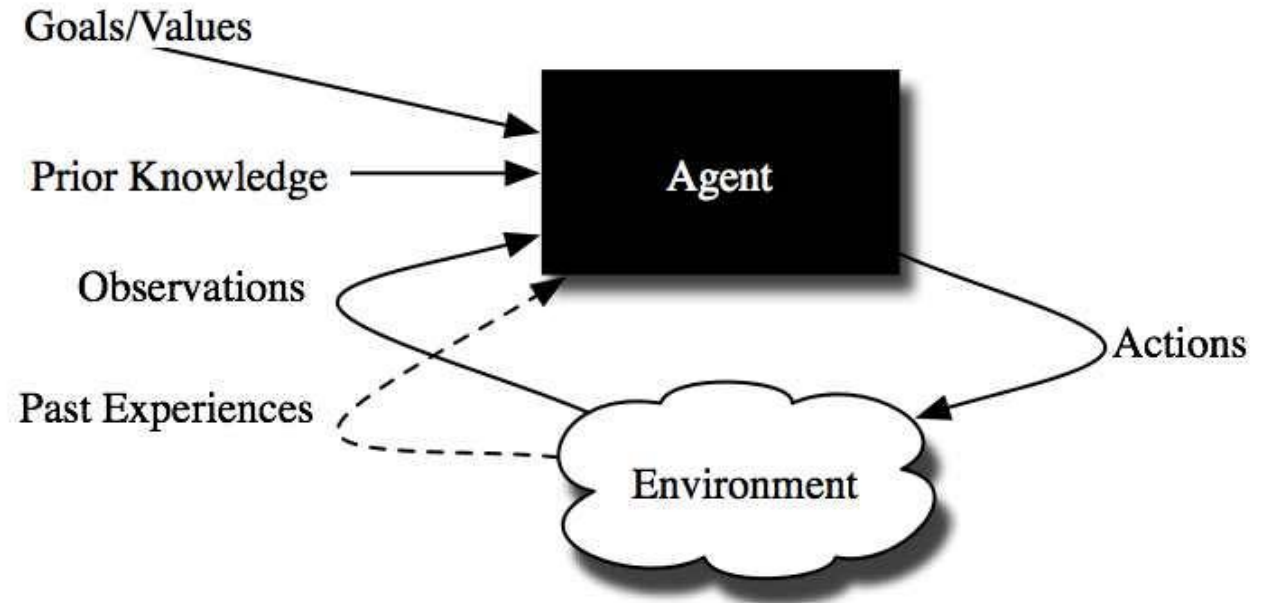
- cameras and infrared range finders for sensors
- various motors for actuators

software agents

- Keyboard, file content, and network packet as input
- Display on screen, write file and send net packets as output

Agents and Environments

- **Prior knowledge**: about the agent and the environment.
- **History** of interaction with the environment, which is composed of:
 - **observations** of the current environment
 - **past experiences** of previous actions and observations, or other data, from which it can learn.
- **Goals** that it must try to achieve.



Example of intelligent Agent: *Robot*

- *Actions:*
 - movement, speech, facial expressions, . . .
- *Observations:*
 - vision, sonar, sound, speech recognition, gesture recognition, . . .
- *Goals:*
 - deliver food, rescue people, score goals, explore, . . .
- *Past experiences:*
 - effect of steering, slipperiness, how people move, . . .
- *Prior knowledge:*
 - what is an important feature, categories of objects, what a sensor tell us, . . .

Example of intelligent Agent: *Medical Agent*

- *Actions:*
 - operate, test, prescribe drugs, explain instructions, . . .
- *Observations:*
 - verbal symptoms, test results, visual appearance. . .
- *Goals:*
 - remove disease, relieve pain, increase life expectancy, reduce costs, . . .
- *Past experiences:*
 - treatment outcomes, effects of drugs, test results given symptoms. . .
- *Prior knowledge:*
 - possible diseases, symptoms, possible causal relationships. . .

Example of intelligent Agent: *Teacher*

- *Actions:*
 - present new concept, drill, give test, explain concept, . . .
- *Observations:*
 - test results, facial expressions, errors, focus, . . .
- *Goals:*
 - particular knowledge, skills, social skills, . . .
- *Past experiences:*
 - prior test results, effects of teaching strategies, . . .
- *Prior knowledge:*
 - subject material, teaching strategies, . . .

PEAS(task environment)

- **PEAS**: Performance measure, Environment, Actuators, Sensors
- To design a rational agent, we must specify the task environment
- Performance measure: how agent be assessed?
- Environment: what elements exist around agents?
- Actuators: how do agents change the environment?
- Sensors: how agents sense the environment?

Agent Type	Performance Measure	Environment	Actuators	Sensors
Medical diagnosis system	Healthy patient, reduced costs	Patient, hospital, staff	Display of questions, tests, diagnoses, treatments, referrals	Keyboard entry of symptoms, findings, patient's answers
Satellite image analysis system	Correct image categorization	Downlink from orbiting satellite	Display of scene categorization	Color pixel arrays
Part-picking robot	Percentage of parts in correct bins	Conveyor belt with parts; bins	Jointed arm and hand	Camera, joint angle sensors
Refinery controller	Purity, yield, safety	Refinery, operators	Valves, pumps, heaters, displays	Temperature, pressure, chemical sensors
Interactive English tutor	Student's score on test	Set of students, testing agency	Display of exercises, suggestions, corrections	Keyboard entry

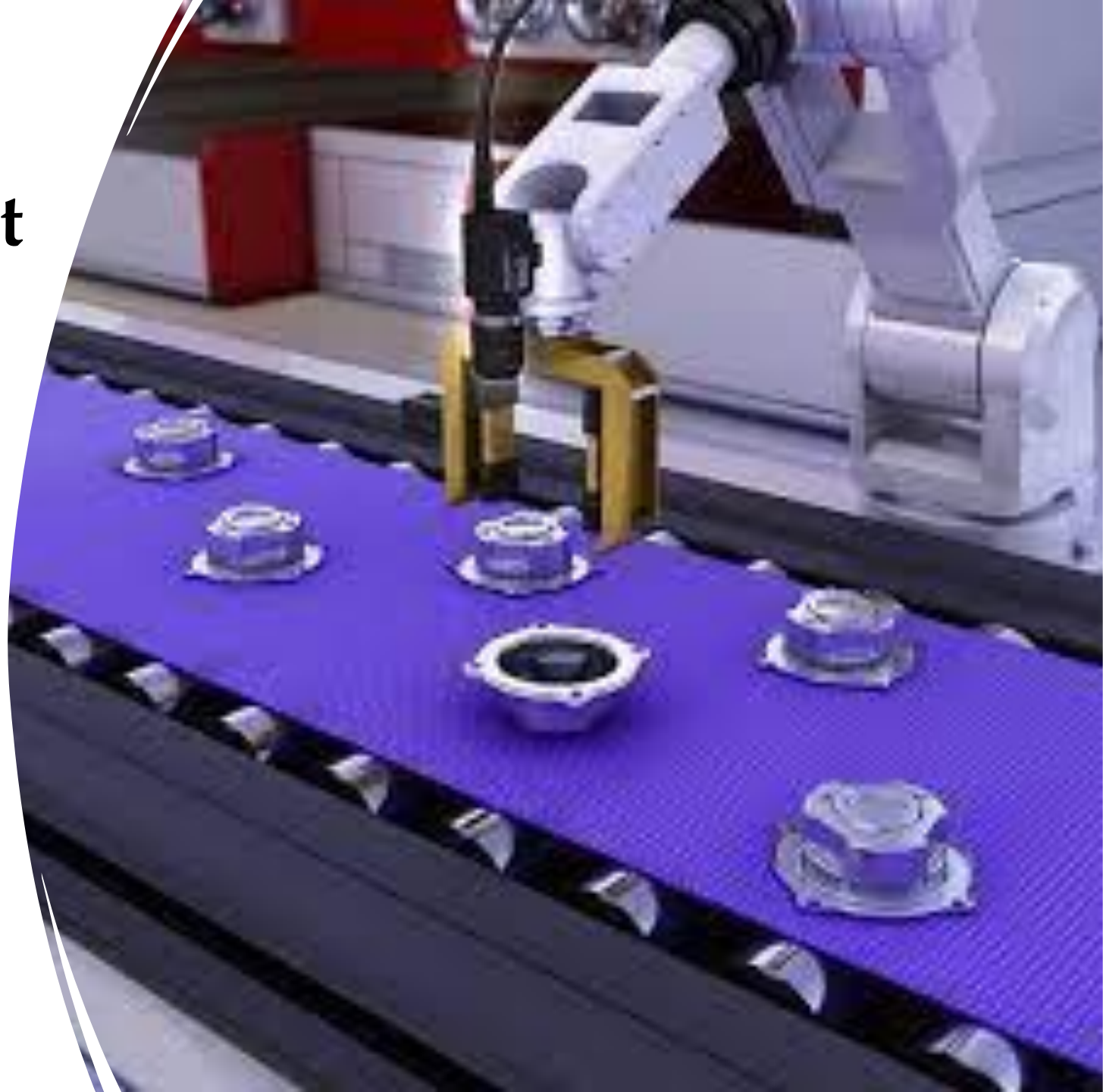
Agent: an automated taxi

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- **Performance measure:** Safe, fast, legal, comfortable trip, maximize profits
 - **Environment:** Roads, other traffic, pedestrians, customers
 - **Actuators:** Steering wheel, accelerator, brake, signal
 - **Sensors:** Cameras, sonar, speedometer, GPS, odometer, engine sensors, keyboard



Agent: Part-picking robot

- **Performance measure:** Percentage of parts in correct bins
- **Environment:** Conveyor belt with parts, bins
- **Actuators:** Jointed arm and hand
- **Sensors:** Camera, joint angle sensors



Agent: Interactive English tutor

- **Performance measure:** Maximize student's score on test
- **Environment:** Set of students
- **Actuators:** Screen display (exercises, suggestions, corrections)
- **Sensors:** Keyboard



Agent: Medical diagnosis system

- **Performance measure:** Healthy patient, reduced costs
- **Environment:** Patient, hospital, staff
- **Actuators:** Display of questions, tests, diagnoses, treatments
- **Sensors:** Keyboard entry of symptoms, findings, patient's answers



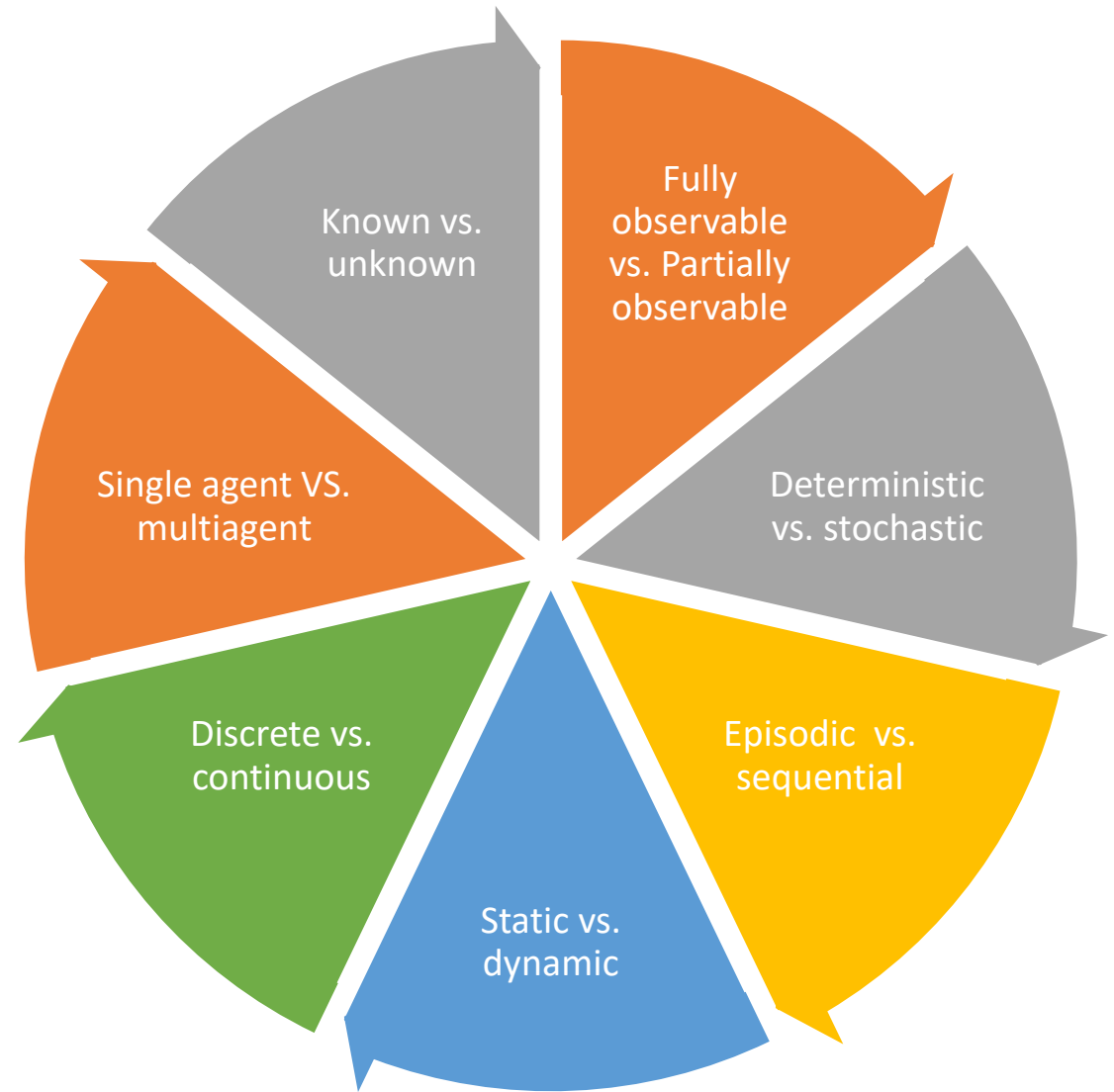
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Agent : Playing soccer:

- **Performance Measure:** Winning the match, scoring goals, maintaining possession, teamwork effectiveness.
- **Environment:** Soccer field, players, ball, referees, spectators, weather conditions.
- **Actuators:** Players' legs for running and kicking the ball, arms for throwing, and goalkeeper's hands for blocking shots.
- **Sensors:** Visual perception to track the ball and opponents, auditory perception for communication with teammates and referees.

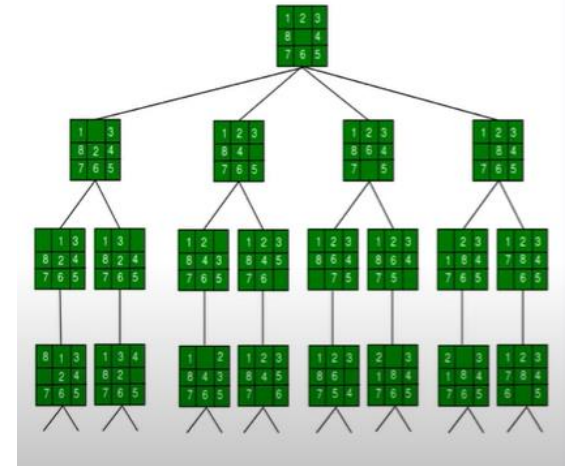


Environments types



Fully observable vs. Partially observable

- Is everything an agent requires to choose its actions available to it via its sensors? Perfect or Full information.
 - If so, the environment is fully accessible
- If not, parts of the environment are inaccessible
- If an agent's sensors give it access to the complete state of the environment at each point in time then the environment is effectively and fully observable
- The agent can either observe the entire state of the environment or only a portion of it.



Cross Word

Fully

Poker

Partially

Backgammon

Partially

Taxi driver

Partially

Part picking robot

Fully

Image analysis

Fully

Deterministic vs. stochastic

- Next state of the environment Completely determined by the current state and the actions executed by the agent, then the environment is deterministic, otherwise, it is Stochastic.
- The outcome of an action is either certain or uncertain due to randomness.

Cross Word	Poker	Backgammon	Taxi driver	Part picking robot	Image analysis
Deterministic	Stochastic	Stochastic	Stochastic	Stochastic	Deterministic

Episode vs Sequential

- The quality of the agent's action does not depend on other episodes
- Every episode is independent of each other
- The agent's interaction with the environment can either be divided into distinct episodes or a continuous sequence of actions.
- Sequential
 - Current action may affect all future decisions

Cross Word	Poker	Backgammon	Taxi driver	Part picking robot	Image analysis
Sequential	Sequential	Sequential	Sequential	Episodic	Episodic

Static vs. dynamic

- The environment can either remain constant or change over time
- Static environments don't change
- Dynamic environments do change
- A dynamic environment is always changing over time
- Semidynamic
 - The environment is not changed over time
 - but the agent's performance score does

Cross Word

Static

Poker

Static

Backgammon

Static

Taxi driver

Dynamic

Part picking robot

Dynamic

Image analysis

Semi

Discrete vs. continuous

- If there are a limited number of distinct states, clearly defined percepts and actions, the environment is discrete
- The state and action spaces can either be finite and well-defined or infinite and continuous.

Cross Word	Poker	Backgammon	Taxi driver	Part picking robot	Image analysis
Discrete	Discrete	Discrete	Conti	Conti	Conti

Single agent VS. multiagent

- An agent operating by itself in an environment or many agents working together
- The agent interacts with either a single entity or multiple entities.

Cross Word	Poker	Backgammon	Taxi driver	Part picking robot	Image analysis
Single	Multi	Multi	Multi	Single	Single

Examples of task environments

Task Environment	Observable	Agents	Deterministic	Episodic	Static	Discrete
Crossword puzzle	Fully	Single	Deterministic	Sequential	Static	Discrete
Chess with a clock	Fully	Multi	Deterministic	Sequential	Semi	Discrete
Poker	Partially	Multi	Stochastic	Sequential	Static	Discrete
Backgammon	Fully	Multi	Stochastic	Sequential	Static	Discrete
Taxi driving	Partially	Multi	Stochastic	Sequential	Dynamic	Continuous
Medical diagnosis	Partially	Single	Stochastic	Sequential	Dynamic	Continuous
Image analysis	Fully	Single	Deterministic	Episodic	Semi	Continuous
Part-picking robot	Partially	Single	Stochastic	Episodic	Dynamic	Continuous
Refinery controller	Partially	Single	Stochastic	Sequential	Dynamic	Continuous
Interactive English tutor	Partially	Multi	Stochastic	Sequential	Dynamic	Discrete

Figure 2.6 Examples of task environments and their characteristics.

Agent types



Simple
reflex
agents

Model-
based
reflex
agents

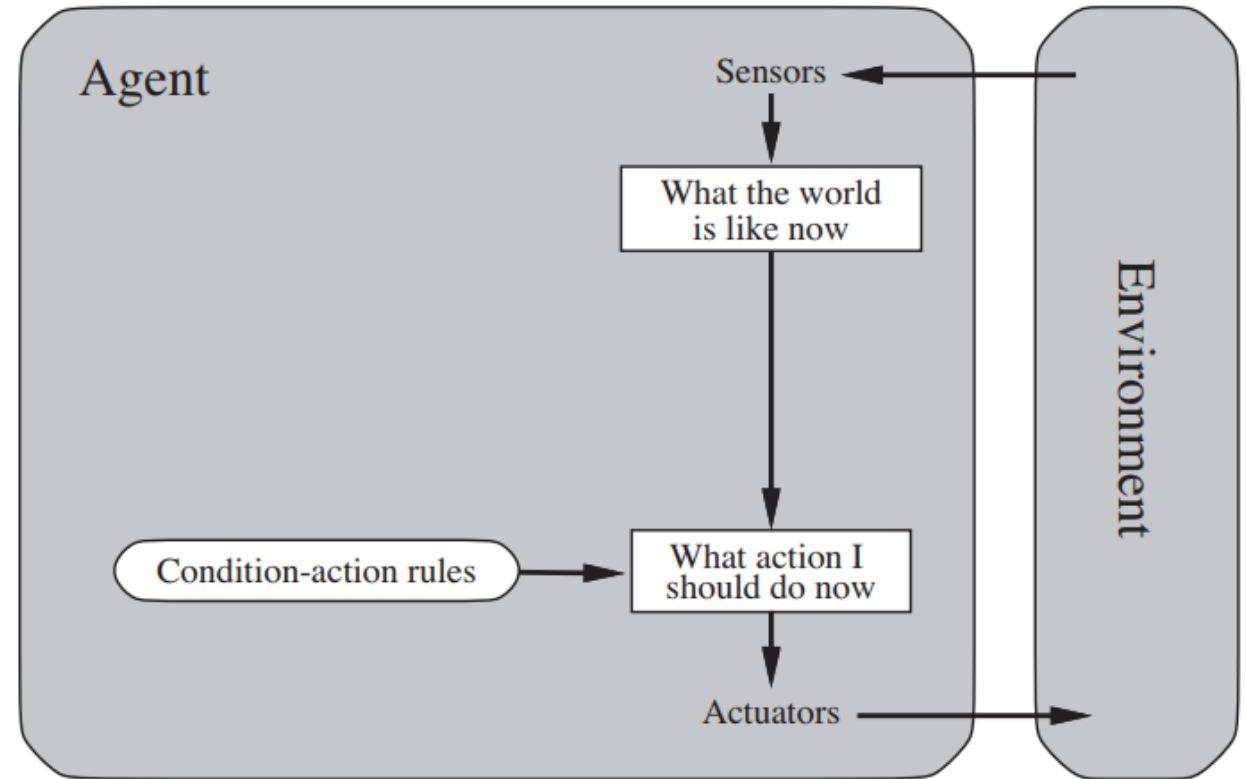
Goal-
based
agents

Utility-
based
agents

Learning
agents

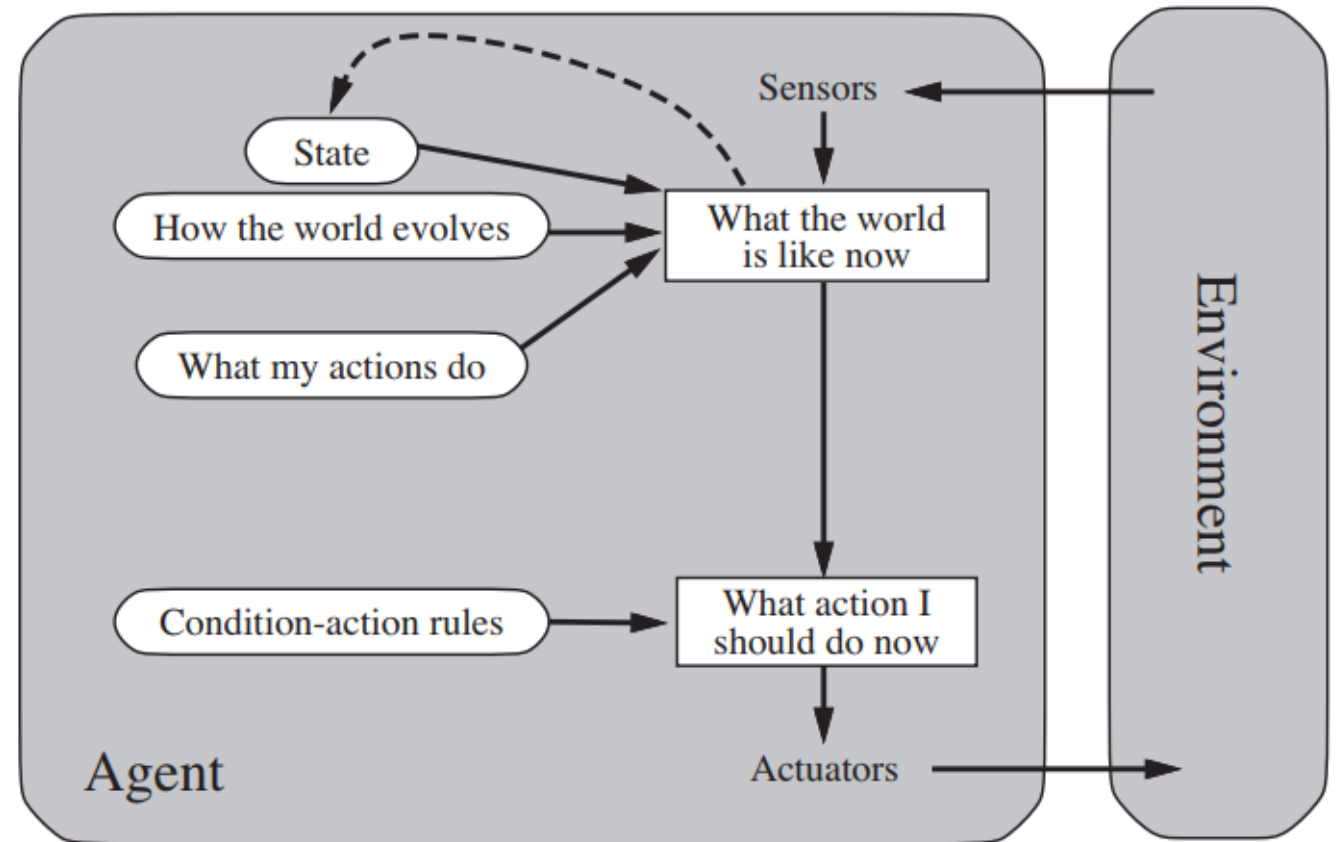
Simple reflex agents

- Action does not depend on percept history, only on current percept.
- It uses just *condition-action rules*
- The rules are like the form “if ... then
- Efficient but have narrow range of applicability
- Simple but very limited intelligence
- Therefore no memory requirements.
- These agents only succeed in the fully observable environment.



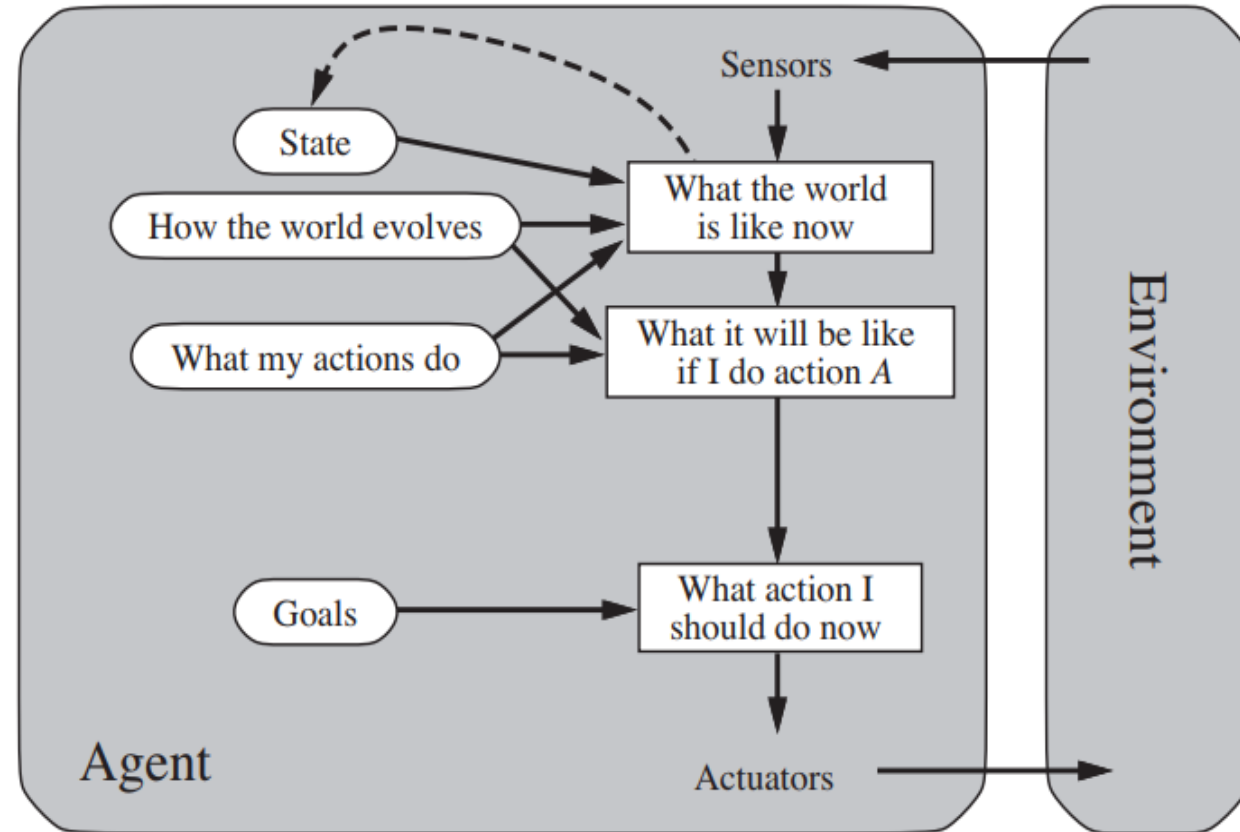
Model-based reflex agents

- Depends on the percept history
- The Model-based agent can work in a partially observable environment
- Example: A vacuum cleaner that uses sensors to detect dirt and obstacles and moves and cleans based on a model.



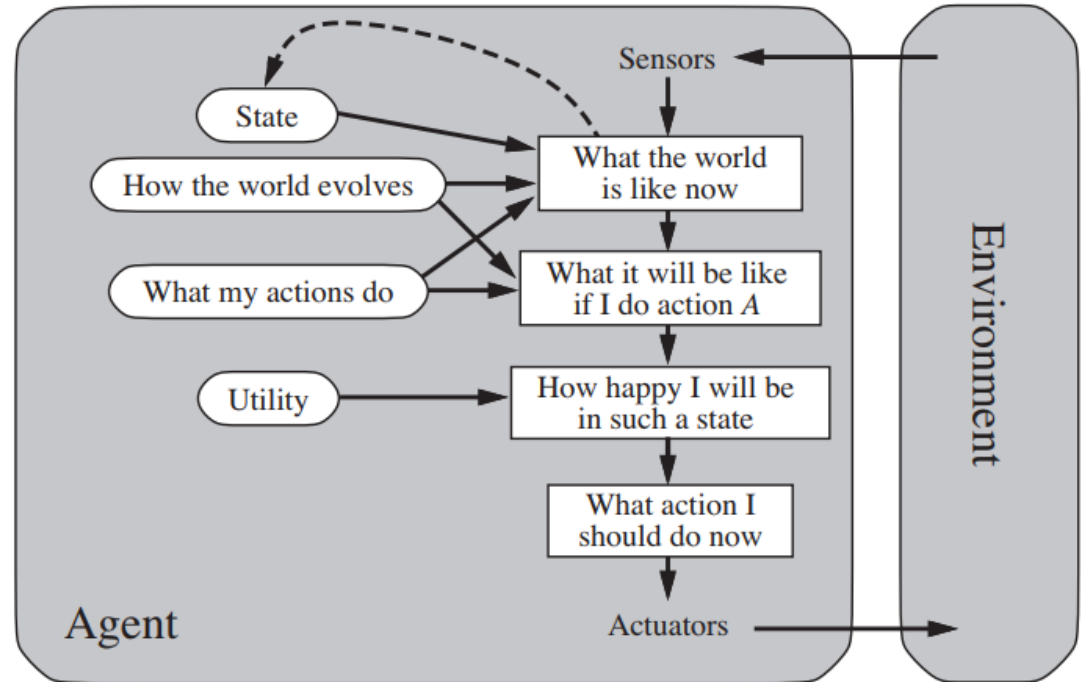
Goal-based agents

- Have a goal
- The current state of the environment is always not enough
- The goal is another issue to achieve
- Uses knowledge about a goal to guide its actions
- It is an improvement over model-based agent
- Goal-based agents are less Efficient but more flexible



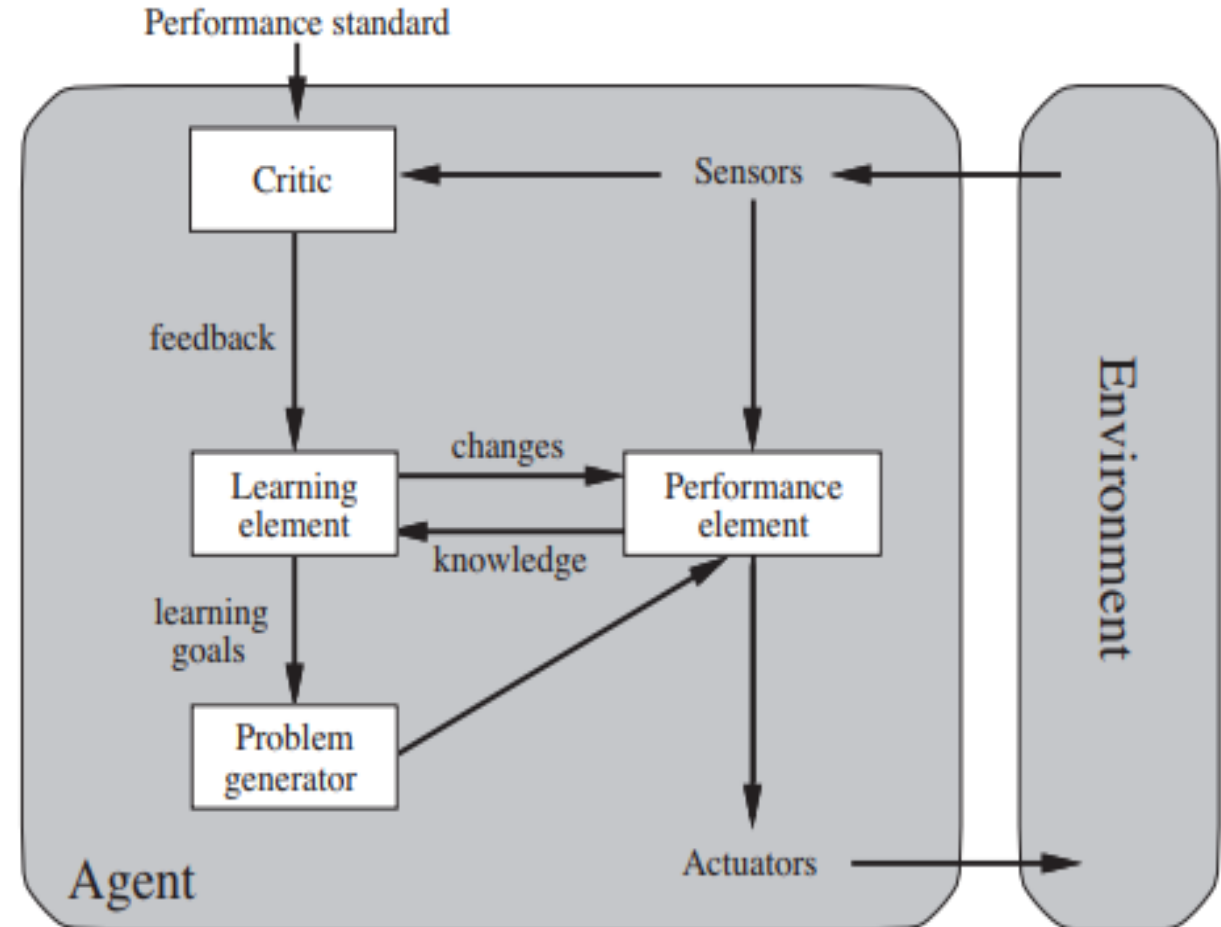
Utility-based agents

- It is an improvement over goal-based agent
- Goals are not always enough
- Providing a measure of success at a given state.



Learning agents

- **Performance element** is what was previously the whole agent
 - Input sensor
 - Output action
- **Learning element**
 - Modifies performance element.
- **Critic**: how the agent is doing
 - Learning element takes feedback from critic
- **Problem generator**
 - Tries to solve the problem differently instead of optimizing.
 - Suggests **exploring** new actions -> new problems.



Assignment

- **Write the PEAS analysis (*Performance Measure, Environment, Actuators and Sensors*) for the following intelligent agents:**
 - a) Chess Game Player
 - b) Artificial Goalkeeper.
 - c) Vacuum-cleaner
 - d) Playing a tennis match



THANKYOU