4BCS605: ARTIFICIAL INTELLIGENCE

DR.K.BABU RAO

PROFESSOR IN CSE,

SCHOOL OF ENGINEERING AND TECHNOLOGY

CMR UNIVERSITY

ARTIFICIAL INTELLIGENCE

Dr.K.Babu Rao
baburao.k@cmr.edu.in

- Module–I: Introduction to Artificial Intelligence
- Module–II: Problem Solving
- Module–III: Knowledge Representation and Planning
- Module–IV: Uncertain knowledge and Reasoning
- Module–V: Learning

Dr.K.Babu Rao
baburao.k@cmr.edu.in

Module–I:
Introduction to Artificial Intelligence

What is AI?

Dr.K.Babu Rao
baburao.k@gmr.edu.in

- **AI** (Artificial Intelligence) is the ability of a machine to perform cognitive functions as humans do, such as perceiving, learning, reasoning and solving problems. The benchmark for AI is the human level concerning in teams of reasoning, speech, and vision.
- **AI Levels**
  1. **Narrow AI**: A artificial intelligence is said to be narrow when the machine can perform a specific task better than a human. The current research of AI is here now
  2. **General AI**: An artificial intelligence reaches the general state when it can perform any intellectual task with the same accuracy level as a human would
  3. **Strong AI**: An AI is strong when it can beat humans in many tasks
- Nowadays, AI is used in almost all industries, giving a technological edge to all companies integrating AI at scale.

Real Life A.I. Examples

Dr.K.Babu Rao
baburao.k@cmr.edu.in

- ❑ Self Driving Cars
- ❑ Boston Dynamics
- ❑ Navigation Systems
- ❑ ASIMO
- ❑ Chatbots
- ❑ Human vs Computer Games
- ❑ Many More

Foundations of AI

- Deferent fields have contributed to AI in the form of ideas, viewpoints and techniques.
  - **Philosophy :** Logic, Reasoning, Mind as a physical system, foundations of learning, language and rationality.
  - **Mathematics:** Formal representation and proof algorithms, computation, (un)decidability, (in)tractability, probability.
  - **Psychology :** adaptation, phenomena of perception and motor control.
  - **Economics :** formal theory of rational decisions, game theory.
  - **Linguistics:** knowledge representation, grammar.
  - **Neuroscience :** physical substrate for mental activities.
  - **Control theory and Cybernetics :** homeostatic system, stability, optimal agent design
  - **Computer engineering** : efficient computer

Dr.K.Babu Rao
baburao.k@cmr.edu.in

Foundation of AI: Philosophy

Dr.K.Babu Rao
baburao.k@cmr.edu.in

- Can formal rules be used to draw valid conclusions?
- How does the mind arise from a physical brain?
- Where does knowledge come from?
- How does knowledge lead to action?

Foundation of AI: Mathematics

Dr.K.Babu Rao
baburao.k@cmr.edu.in

- What are the formal rules to draw valid conclusions?
- What can be computed?
- How do we reason with uncertain information?

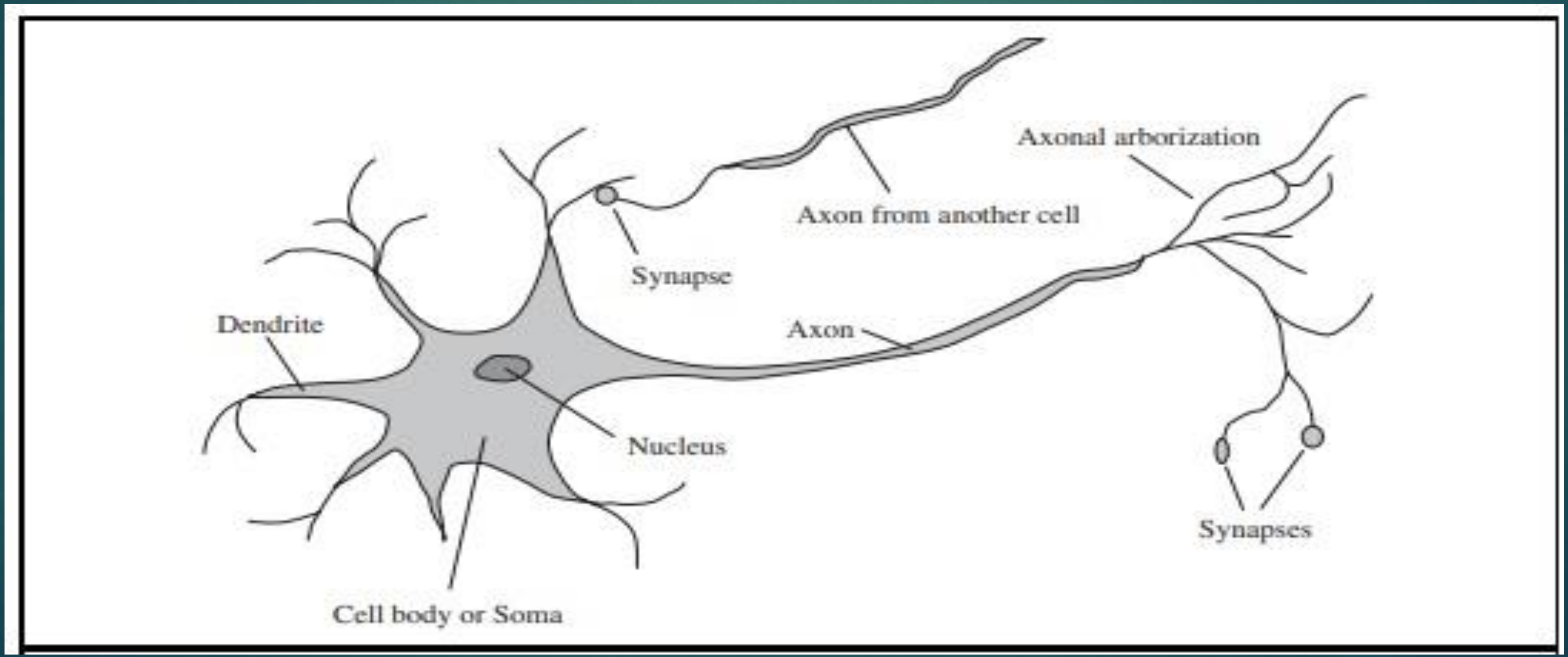
Foundation of AI: Economics

Dr.K.Babu Rao
baburao.k@cmr.edu.in

- How should we make decisions so as to maximize payoff?
- How should we do this when others may not go along?
- How should we do this when the payoff may be far in the future?

Foundation of AI : Neuroscience

- Neuroscience is the study of the nervous system, particularly the brain.
- How do brains process information?



Dr.K.Babu Rao
baburao.k@cmr.edu.in

Foundation of AI: Psychology

Dr.K.Babu Rao
baburao.k@cmr.edu.in

- How do humans and animals think and act?
  - Behaviorism
  - Cognitive psychology

Foundation of AI: Computer Engineering

Dr.K.Babu Rao
baburao.k@cmr.edu.in

- How can we build an efficient computer?
- For artificial intelligence to succeed, we need two things:
  - Intelligence
  - Artifact(i.e. object).
- The computer is the artifact of choice.

Foundation of AI: Control Theory and Cybernetics

- How can artifacts operate under their own control?

Dr.K.Babu Rao
baburao.k@cmr.edu.in

Foundation of AI: Linguistics

Dr.K.Babu Rao
baburao.k@cmr.edu.in

- How does language relate to thought?
- Modern linguistics and AI:
  - computational linguistics or natural language processing
  - knowledge representation

A brief history

Dr.K.Babu Rao
baburao.k@cmr.edu.in

- What happened after WWII?
  - 1943 : Warren Mc Culloch and Walter Pitts : a model of artificial Boolean neurons to perform computations.
    - First steps toward connectionist computation and learning(Hebbian learning).
    - Marvin Minsky and Dann Edmonds(1951) constructioted the first neural network computer.
  - 1950 : Alan Turing`s "Computing Machinery and Intelligence"
    - First complete vision of AI.

- The birth of AI(1956)
  - Darmouth Workshop bring together top minds on automata theory, neural nets and the study of intelligence.
    - Allen Newell and Herbert Simon : The logic theorist(first nonnumerical thinking program used for theorem proving)
    - For the next 20 years the field was dominated by these participants.
- Great expectation(1952-1969)
  - Newell and Simon introduced the General Problem Solver.
    - Imitation of human problem-solving.
  - Arthur Samuel (1952-) investigated game playing(checkers) with great success.
  - John McCarthy(1958-)
    - Inventor of Lisp(second-oldest high-level language)
    - Logic oriented, Advice Taker(separation between knowledge a reasoning)

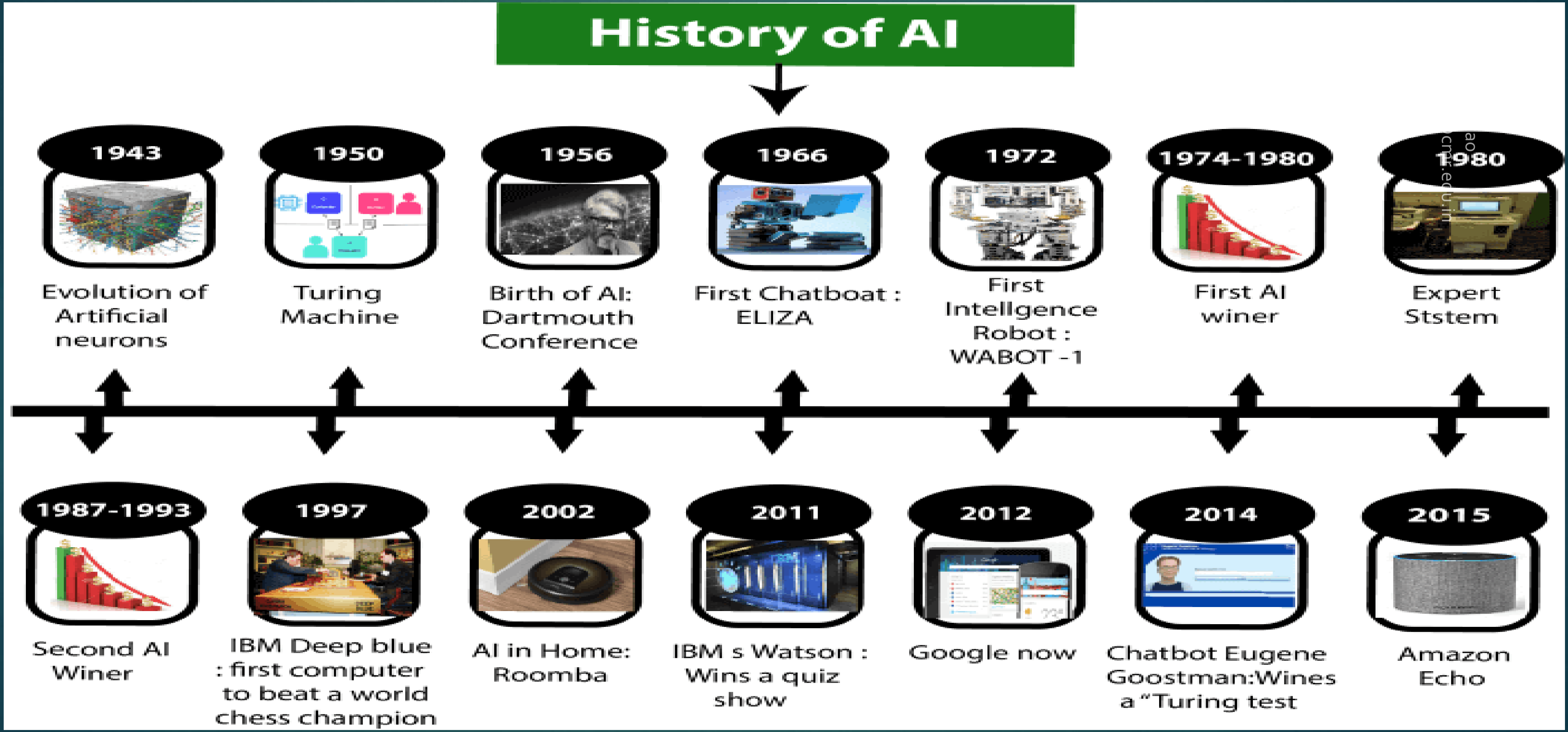
Dr.K.Babu Rao
baburao.k@cmr.edu.in

- The birth of AI(1956)
  - Great expectations continued….
    - Marvin Minsky(1959 -)
      - Introduction of microworlds that appear to require intelligence to solve: e.g. blocks-world
      - Anti-logic orientation, society of the mind.
- Collapse in AI research(1966 – 1973)
  - Progress was slower than expected.
    - Unrealistic predictions.
  - Some systems lacked scalability.
    - Combinatorial explosion in search
  - Fundamental limitations on techniques and representations.
    - Minsky and Papert (1969) Perceptorns.

Dr.K.Babu Rao
baburao.k@cmr.edu.in

Dr.K.Babu Rao
baburao.k@cmr.edu.in

A brief History of Artificial Intelligence



Applications of AI
What can AI do today?

- Robotic Vehicles
- Speech Recognition
- Autonomous planning and scheduling
- Game playing
- Spam fighting
- Logistics planning
- Robotics
- Machine Translation

Dr.K.Babu Rao
baburao.k@cmr.edu.in

Demand for AI

Dr.K.Babu Rao
baburao.k@cmr.edu.in

- More Computational Power.
- More Data.
- Better algorithms.
- Broad Investment.

TESLA

Dr.K.Babu Rao
baburao.k@cmr.edu.in

- Artificial intelligence implements computer vision, image detection, deep learning in order to build cars that can automatically detect any objects or any obstacles and drive around without human intervention. So, these are fully automated self-driving cars

Dr.K.Babu Rao
baburao.k@cmr.edu.in

Intelligent agents : Agents and Environment

Intelligent Agent : Agents

Dr.K.Babu Rao
baburao.k@cmr.edu.in

- An **agent** is anything that can be viewed as perceiving its **environment** through **sensors** and acting upon that environment through **actuators**.
- Intelligence is concerned mainly with **rational action**. Ideally, an **intelligent agent** takes the best possible action in a situation.
- We study the problem of building agents that are intelligent in this sense.
- simple definition: an agent is any device that can sense and act upon its environment

Dr.K.Babu Rao
baburao.k@cmr.edu.in

- The term **percept** to refer to the agent's perceptual inputs at any given instant. An agent's **percept sequence** is the complete history of everything the agent has ever perceived.
- The agent's choice of action for every possible percept sequence, we have said more or less everything there is to say about the agent.
- Mathematically speaking, we say that an agent's behavior is described by the **agent function** that maps any given percept sequence to an action.
- Internally, the agent function for an artificial agent will be implemented by an **agent program**.
- The agent function is an abstract mathematical description; the agent program is a concrete implementation, running within some physical system.

- A human agent has eyes, ears, and other organs for sensors and hands, legs, vocal tract, and so on for actuators.
- A robotic agent might have cameras and infrared range finders for sensors and various motors for actuators.
- A software agent receives keystrokes, file contents, and network packets as sensory inputs and acts on the environment by displaying on the screen, writing files, and sending network packets

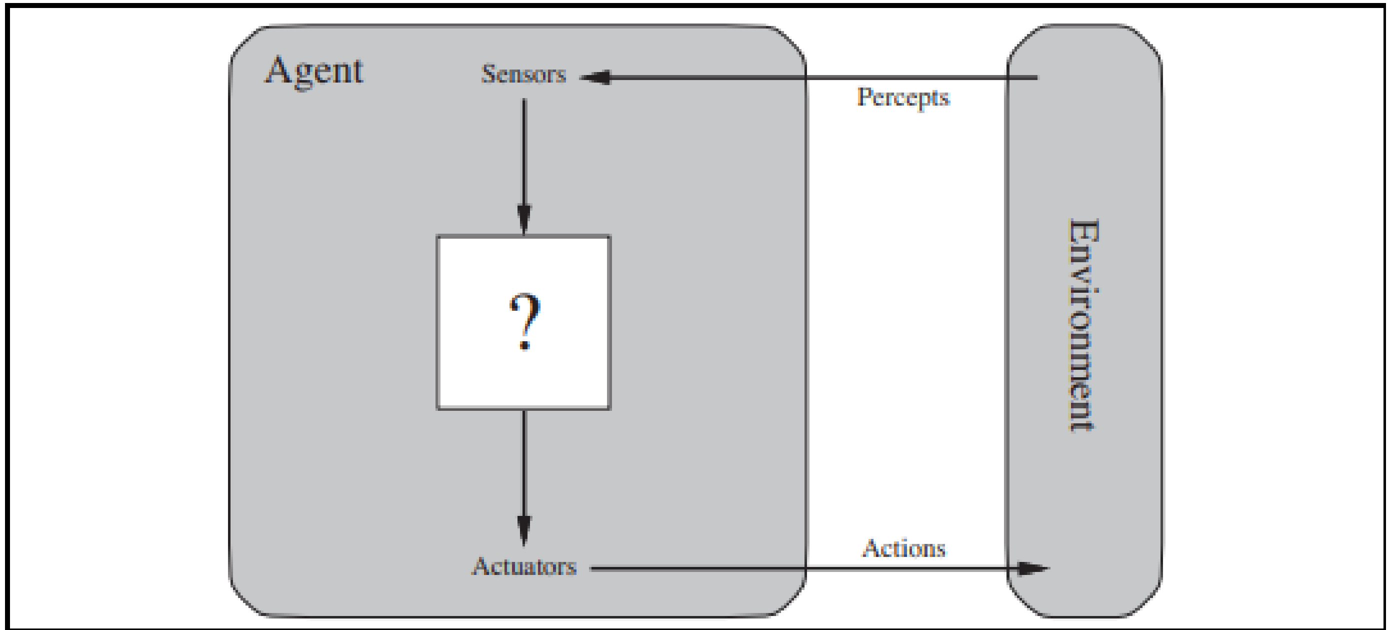


Figure 2.1 Agents interact with environments through sensors and actuators.

Dr.K.Babu Rao
baburao.k@cmr.edu.in

Rational Agent

Dr.K.Babu Rao
baburao.k@cmr.edu.in

- A **rational agent** is one that does the right thing—conceptually speaking, every entry in the table for the agent function is filled out correctly.
- Obviously, doing the right thing is better than doing the wrong thing, but what does it mean to do the right thing?
- When an agent is plunked down in an environment, it generates a sequence of actions according to the percepts it receives.
- This sequence of actions causes the environment to go through a sequence of states.
- If the sequence is desirable, then the agent has performed well. This notion of desirability is captured by a **performance measure** that evaluates any given sequence of environment states.

- Rationality What is rational at any given time depends on four things:
  - The performance measure that defines the criterion of success.
  - The agent's prior knowledge of the environment.
  - The actions that the agent can perform.
  - The agent's percept sequence to date
- **Rational agent: -**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.
- Ex: - vacuum-cleaner agent that cleans a square if it is dirty and moves to the other square if not; this is the agent function.

Dr.K.Babu Rao
baburao.k@cmr.edu.in

Environment

Dr.K.Babu Rao
baburao.k@cmr.edu.in

- This definition can be very widely applied: to humans, robots, pieces of software, and so on. It is only one of many.
- Questions:
  - How can we judge an agent’s performance?
  - How can we begin successfully to design an agent?
  - How can an agent’s environment affect its design?
- Recall that we are interested in devices that act rationally, where ‘rational’ means doing the correct thing under given circumstances.

- task environment - **PEAS** (**P**erformance, **E**nvironment, **A**ctuators, **S**ensors) description.
- **performance measure -** Desirable qualities include getting to the correct destination; minimizing fuel consumption and wear and tear; minimizing the trip time or cost; minimizing violations of traffic laws and disturbances to other drivers; maximizing safety and passenger comfort; maximizing profits.

Dr.K.Babu Rao
baburao.k@cmr.edu.in

Agent Type	Performance Measure	Environment	Actuators	Sensors
Taxi driver	Safe, fast, legal, comfortable trip, maximize profits	Roads, other traffic, pedestrians, customers	Steering, accelerator, brake, signal, horn, display	Cameras, sonar, speedometer, GPS, odometer, accelerometer, engine sensors, keyboard

Figure 2.4 PEAS description of the task environment for an automated taxi.

Properties of task environments

Dr.K.Babu Rao
baburao.k@cmr.edu.in

- Some common attributes of an environment have a considerable influence on agent design.
  - **Accessible/inaccessible:** do percepts tell you everything you need to know about the world?
  - **Deterministic/non-deterministic:** does the future depend predictably on the present and your actions?
  - **Episodic/non-episodic** is the agent run in independent episodes.
  - **Static/dynamic:** can the world change while the agent is deciding what to do?
  - **Discrete/continuous:** an environment is discrete if the sets of allowable percepts and actions are finite.
  - **Single-agent/multi-agent:** is the agent acting individually or in the presence of other agents. In the latter case is the situation competitive or cooperative, and is communication required?

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

Figure 2.5 Examples of agent types and their PEAS descriptions.

Basic structures for intelligent agents

Dr.K.Babu Rao
baburao.k@cmr.edu.in

- **Example:** email spam filter.

- **Percepts:** the textual content of individual email messages. (A more sophisticated program might also take images or other attachments as percepts.)
- **Actions:** send to the inbox, delete, or ask for advice.
- **Goals:** remove spam while allowing valid email to be read.
- **Environment:** an email program.

Basic structures for intelligent agents

Dr.K.Babu Rao
baburao.k@cmr.edu.in

- Example: aircraft pilot.

- **Percepts:** sensor information regarding height, speed, engines etc, audio and video inputs, and so on.
- **Actions:** manipulation of the aircraft's controls. Also, perhaps talking to the passengers etc.
- **Goals:** get to the current destination as quickly as possible with minimal use of fuel, without crashing etc.
- **Environment**: aircraft cabin

The Structure of Agents

Dr.K.Babu Rao
baburao.k@cmr.edu.in

- The job of AI is to design an **agent program** that implements the agent function— the mapping from percepts to actions.
- We assume this program will run on some sort of computing device with physical sensors and actuators—we call this the **architecture**:
  agent = architecture + program .
- The program we choose has to be one that is appropriate for the architecture.
- If the program is going to recommend actions like **Walk**, the architecture had better have **legs**.
- The architecture might be just an ordinary PC, or it might be a robotic car with several onboard computers, cameras, and other sensors.
- In general, the architecture makes the percepts from the sensors available to the program, runs the program, and feeds the program's action choices to the actuators as they are generated.

Agent programs

Dr.K.Babu Rao
baburao.k@cmr.edu.in

- The agent programs that they take the current percept as input from the sensors and return an action to the actuators.
- Agent program takes the current percept as input, and the agent function takes the entire percept history.
- four basic kinds of agent programs that embody the principles underlying almost all intelligent systems:
  - Simple reflex agents;
  - Model-based reflex agents;
  - Goal-based agents; and
  - Utility-based agents.

- **Simple reflex agents :**
  - Simple reflex agents select actions on the basis of the current percept, ignoring the rest of the percept history.
- **Model-based reflex agents:**
  - The agent should maintain some sort of the internal state that depends on the percept history and thereby reflects at least some of the unobserved aspects of the current state.
- **Goal-based agents:**
  - Goal-based agents a current state description+ the agent needs some sort of goal information that describes situations that are desirable.
- **Utility-based agents:**
  - An agent's utility function is essentially an internalization of the performance measure. If the internal utility function and the external performance measure are in agreement, then an agent that chooses actions to maximize its utility will be rational according to the external performance measure.

Dr.K.Babu Rao
baburao.k@gmr.edu.in

Simple reflex agents :

Simple reflex agents select actions on the basis of the current percept, ignoring the rest of the percept history.

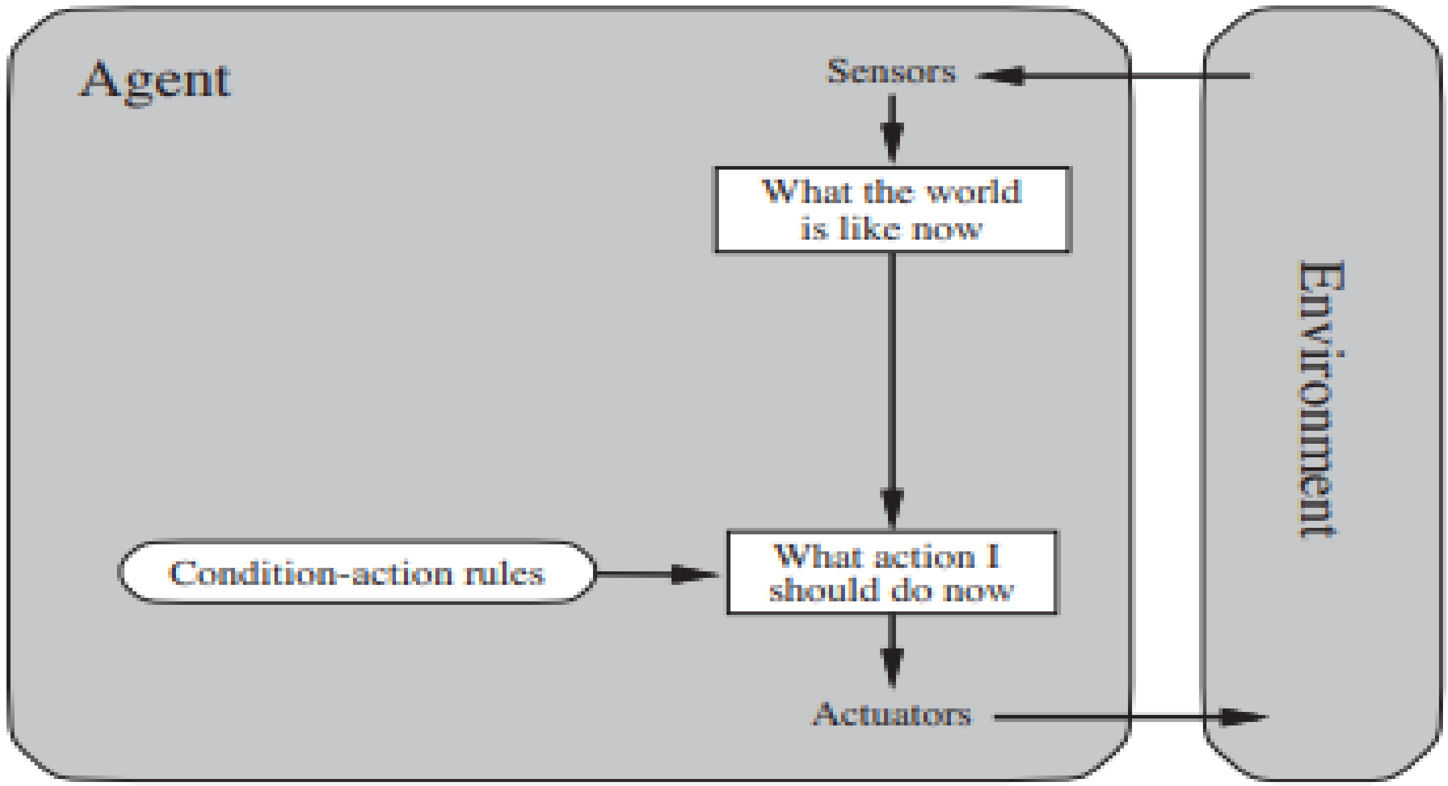


Figure 2.9 Schematic diagram of a simple reflex agent.

Model-based reflex agents:

The agent should maintain some sort of the internal state that depends on the percept history and thereby reflects at least some of the unobserved aspects of the current state.

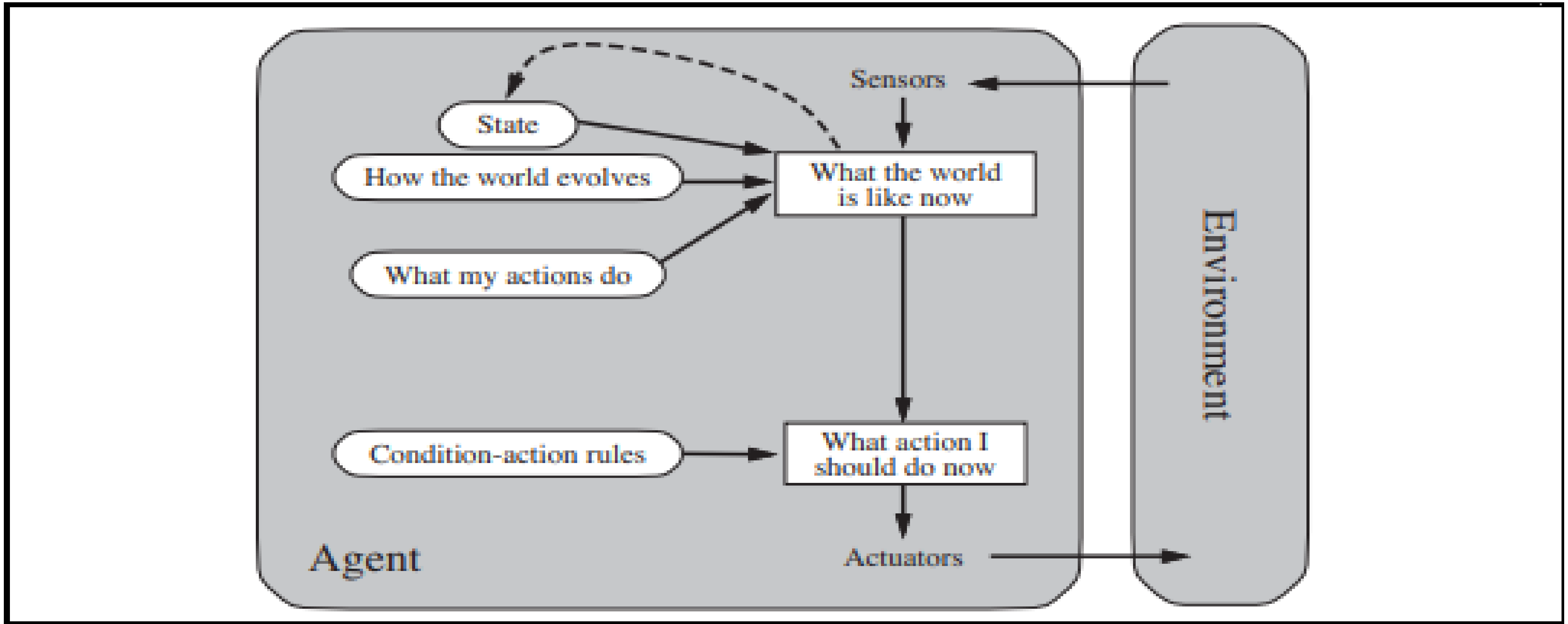


Figure 2.11 A model-based reflex agent.

Goal-based agents:

Goal-based agents a current state description+ the agent needs some sort of goal information that describes situations that are desirable.

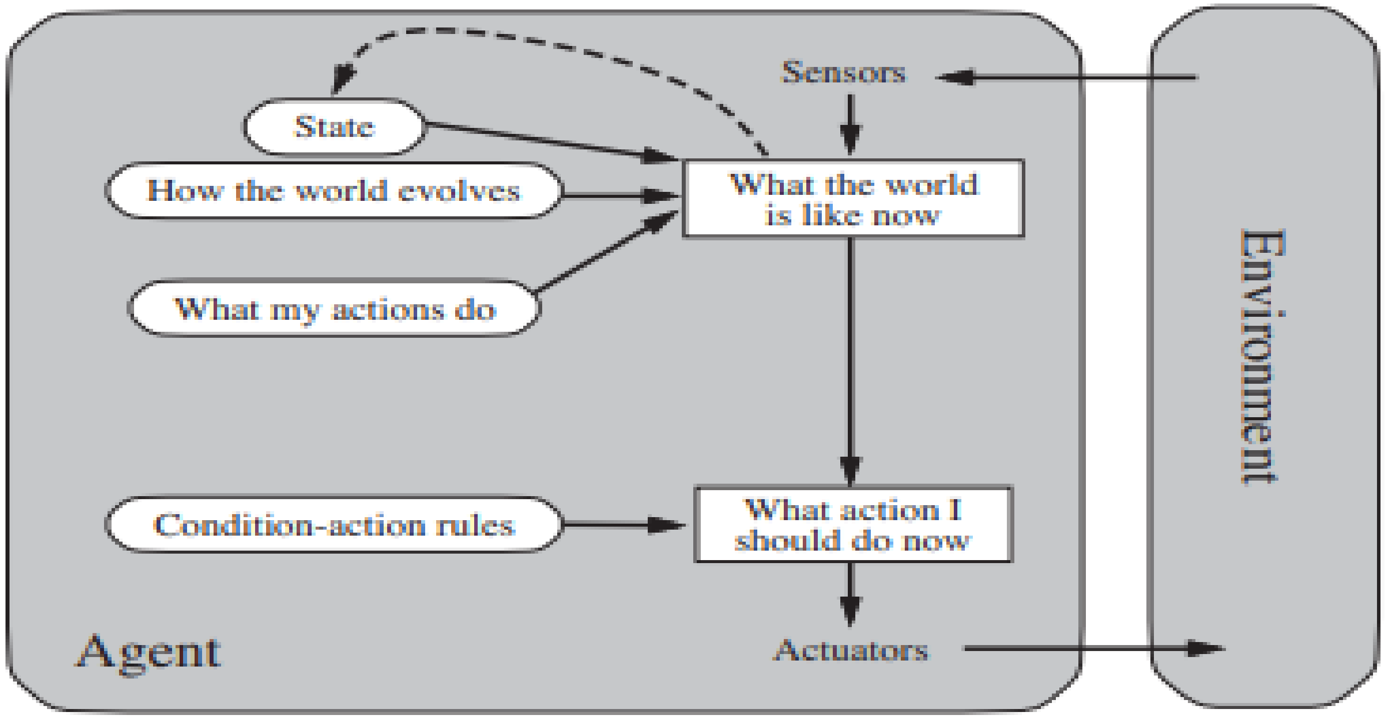
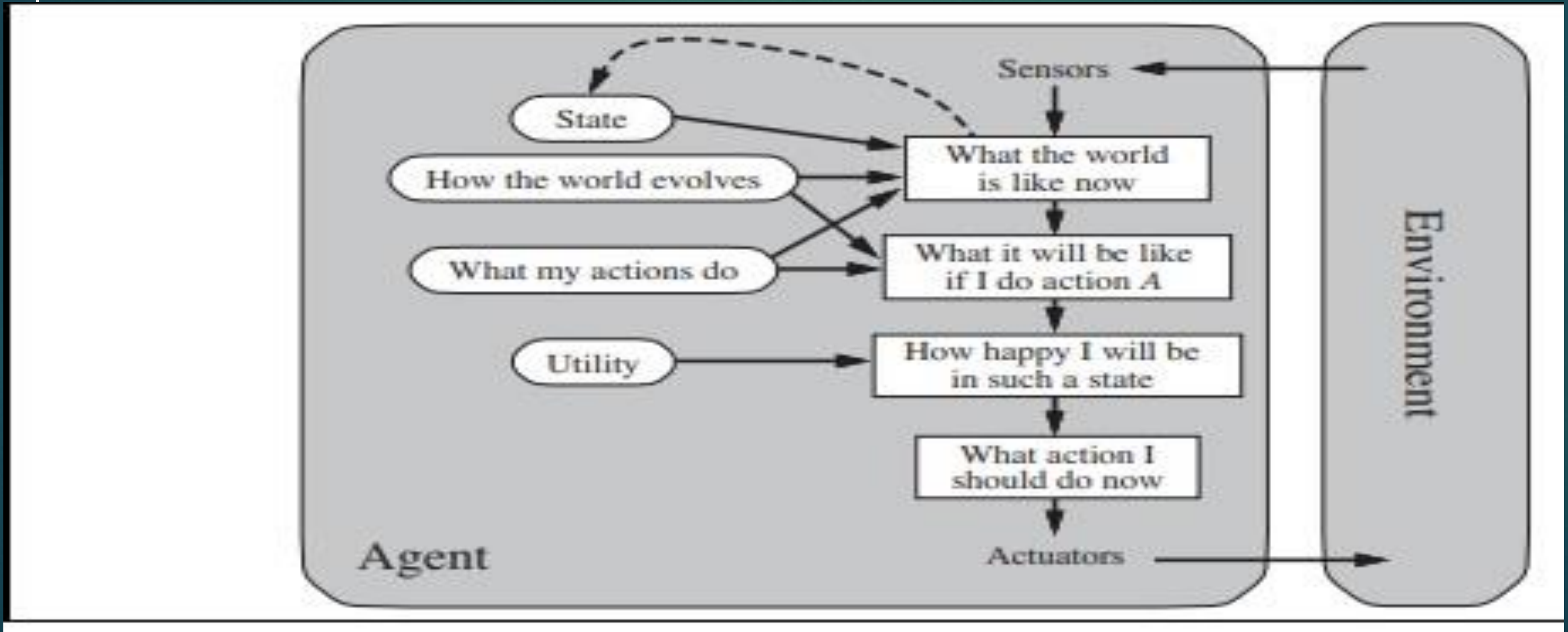


Figure 2.11 A model-based reflex agent.

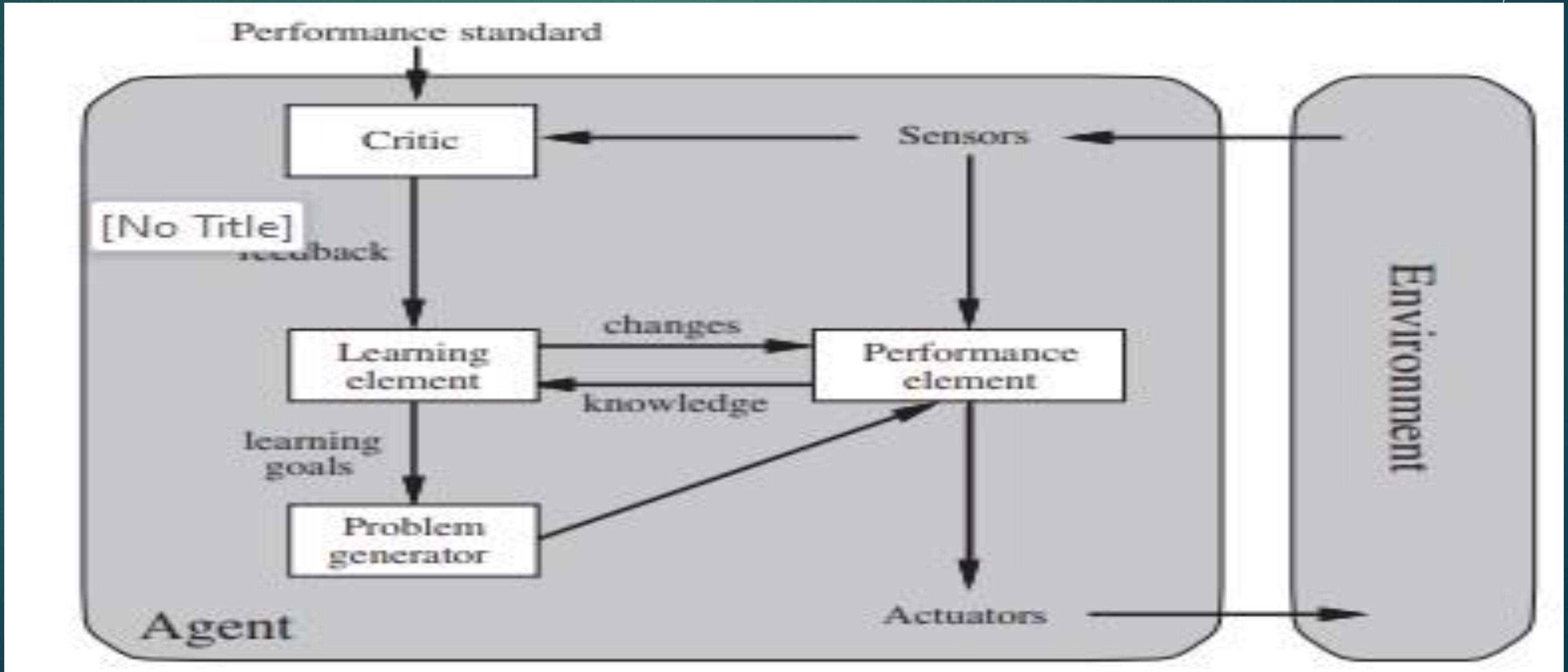
Utility-based agents:

An agent's utility function is essentially an internalization of the performance measure. If the internal utility function and the external performance measure are in agreement, then an agent that chooses actions to maximize its utility will be rational according to the external performance measure.



Dr.K.Babu Rao
baburao.k@cmr.edu.in

- **Simple reflex agents** respond directly to percepts, whereas **model-based reflex agents** maintain internal state to track aspects of the world that are not evident in the current percept. **Goal-based agents** act to achieve their goals, and **utility-based agents** try to maximize their own expected "happiness."
- All agents can improve their performance through **learning**.



Dr.K.Babu Rao
baburao.k@cmr.edu