

Chapter 2

Intelligent Agents

sensory organ এর range পাবে।

Agents

human → eye, skin, ear

organ মাত্রা perceive
এর মাত্রা sensor

হিমালয়ে
বর্ষা,

- An agent is anything that can be viewed as **perceiving its environment** through sensors and acting upon that environment through actuators

1. information perceive through diff. sensory organ.
2. information process করে action generate করা
3. action implement

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

Intelligent agent → ওটা component দ্বারা লাগায়।

Learning করবলয় একটি iterative method. (and incremental)

improves gradually avoiding mistakes

objective function

- Move as straight as possible
- Keep safe distance from obstacle
- Cover max distance

$$f = (1-s)(1-v)D \rightarrow \text{simple but efficient}$$

s = Normalized sensory value

v = Difference between wheels

D = total distance travelled

obstacle থেকে দূরে থাকলে s এর value বেশ হবে।

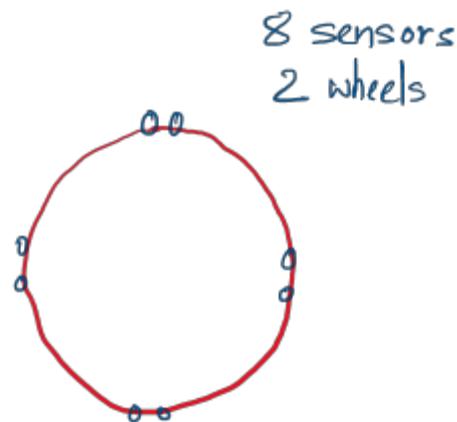
বাতু থাকলে $s \rightarrow$ value বেশি হবে।

$\rightarrow 1-s$ এর value কম হবে

$v \rightarrow$ ২টি wheel এর speed diff. বেশি হলে বেশি দুরুত্ব হলে

বেশি straight হবে।

আমরা চাই as straight as possible ভাব যে



Khepera mobile Robot
→ lab 6

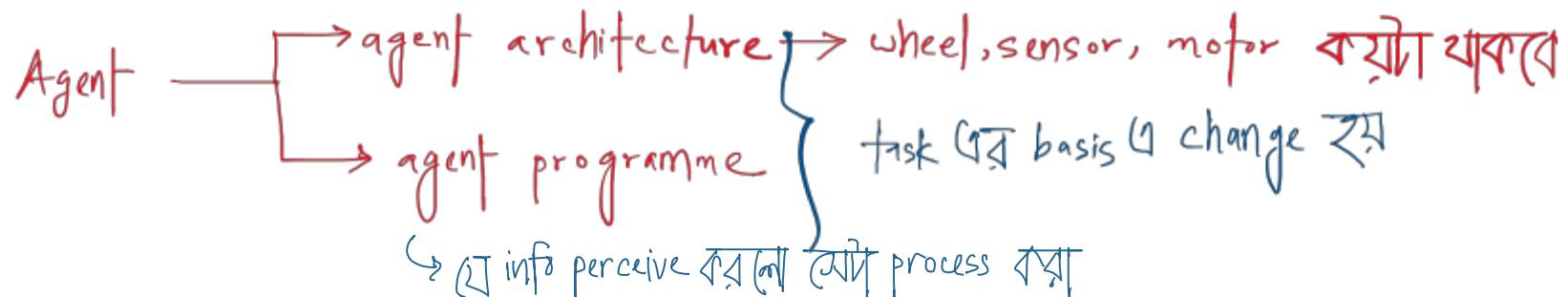
(1-v) component বাদ দিলে \rightarrow মেঘখন free space এবে তখন মেঘনেই ঘূরত
ঘূরবে।

$\left. \begin{array}{l} D \text{ ন্তর থাকলে} \rightarrow \text{এক জ্যাগায় দাঁড়িয়ে থাকবে।} \\ V \rightarrow 0 \text{ (চাঁচা wheel)ই ছির } \\ 1-v \text{ ঘূরবে।} \end{array} \right\}$

Move Forward
" backward
" Right
" Left

temperature related বোনো বাজ করতে পারবেনা because related বোনো sensor
পৰি নাই। process

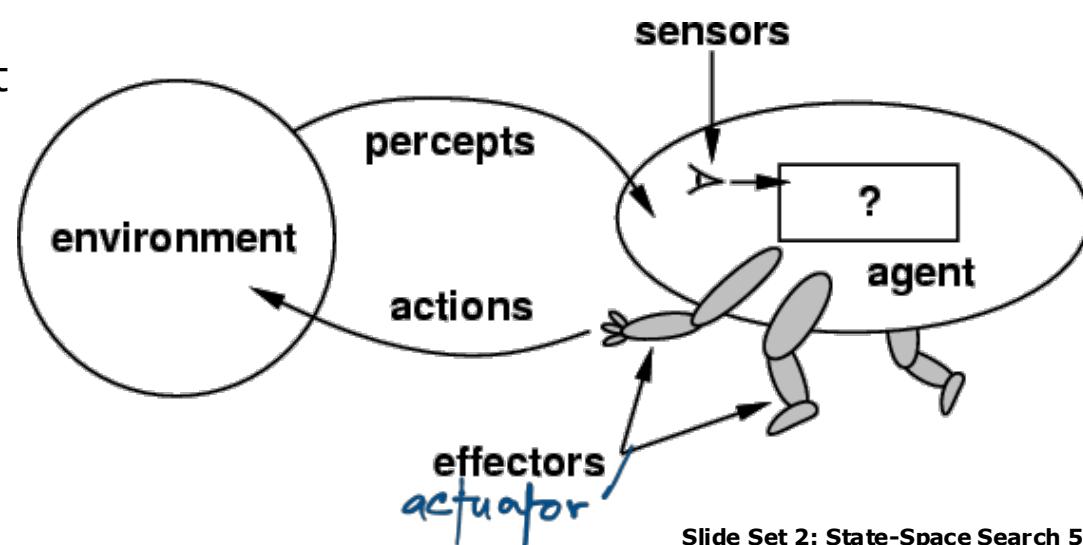
related action, এর জন্য sensor and motor/ actuator or আৰা লাগব।



How to design an intelligent agent?

- An **intelligent agent** perceives its environment via **sensors** and acts rationally upon that environment with its **effectors**.
- A discrete agent receives **percepts** one at a time, and maps this percept sequence to a sequence of discrete **actions**.
- Properties

- Autonomous
- Reactive to the environment
- Pro-active (goal-directed)
- Interacts with other agents via the environment

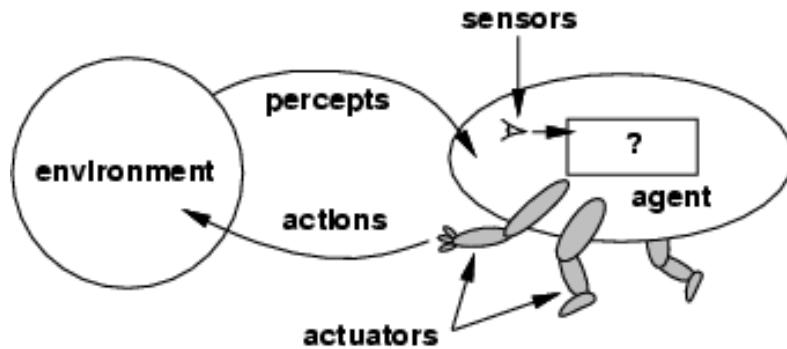


Sensors/percepts and effectors/actions?

- Humans

- Sensors: Eyes (vision), ears (hearing), skin (touch), tongue (gustation), nose (olfaction), neuromuscular system (proprioception)
- Percepts:
 - At the lowest level – electrical signals from these sensors
 - After preprocessing – objects in the visual field (location, textures, colors, ...), auditory streams (pitch, loudness, direction), ...
- Effectors: limbs, digits, eyes, tongue, ...
- Actions: lift a finger, turn left, walk, run, carry an object, ...

Agents and environments



- The agent function maps from percept histories to actions:

$$[f: P^* \rightarrow \mathcal{A}] \rightarrow$$

agent program এর বাজ প্রু
implement করা | execute করা হল এটা
performance দখতে দারু

- The agent program runs on the physical architecture to produce f

↪ lookup table দ্বারা মাত্র

based on current sensor info action choose করবে।

- agent = architecture + program

যেন্তে row বাধানে table size বড়, searching ও যোগ্য time
লাগবে।

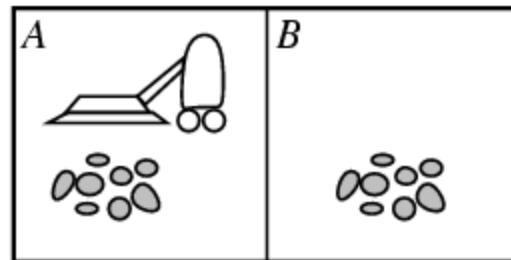
অস্থিরিক্ত \rightarrow sensor value 10, 15, 20

এর জন্যে দেয়া, sensor value

মাত্র 12.5, 110 এর জন্যে নাবি

15 এর জন্যে ব্যবহার? Missing range
value পাইতে দারুনা interpolation facility
নাই।

Vacuum-cleaner world



- Percepts: location and state of the environment, e.g., [A,Dirty], [A,Clean], [B,Dirty]
- Actions: *Left*, *Right*, *Suck*, *NoOp*

Rational agents

প্রতি moment এ তার expected performance বা improve করতে চাহে।

এবাবে metric কাজ করে, task defn অনুযায়ী metric সৈরি করবে।

অবশ্যেই performance improve করতে হবে।

- **Performance measure:** An objective criterion for success of an agent's behavior, e.g.,
 - Robot driver?
 - Chess-playing program?
 - Spam email classifier?
- **Rational Agent:** selects actions that is *expected* to maximize its performance measure,
 - given percept sequence
 - given agent's built-in knowledge
 - sidepoint: how to maximize expected future performance, given only historical data

Rational agents

- Rational Agent → Always try to maximize performance.
 - No Agent is **Omniscience**. Rationality is distinct from omniscience (all-knowing with infinite knowledge)
→ infinite knowledge base যাই। impractical.
 - Agents can perform actions in order to modify future percepts so as to obtain useful information (information gathering, exploration)
→ ultimate target কোন task এর জন্য এজেন্ট
 - An agent is **autonomous** if its behavior is determined by its own percepts & experience (with ability to learn and adapt) without depending solely on built-in knowledge
→ environment থেকে info. নিয়ে রাবে। Over the time, experience improve রাবে।
চাবি নিয়ে রাবে।
 - To survive, agents must have:
 - Enough built-in knowledge to survive.
 - The ability to learn
- traffic light
controller doesn't take any input from the environment.
2 min এর পর light on-off ...

agent এর imp. জিনিয় → agent যে environment এ কাজ করে
Task Environment and যেই environment-এ তার performance বেজন করে,

- Before we design an intelligent agent, we must specify its "task environment":

PEAS: Performance Environment Actuator Sensor

Performance measure → over the time performance improve করতে বিনা দরজে
Environment একটি metric/indicator যাবা লাগব।

Actuators

Sensors

} Agent এর যাথে
related

DARPA Robotics Challenge

- A prize competition funded by the US Defense Advanced Research Projects Agency, held from 2012 to 2015
- Aimed to develop semi-autonomous ground robots that could do complex tasks in dangerous, degraded, human-engineered environments

DARPA Robotics Challenge

The initial task requirements for robot entries are

- Drive a utility vehicle at the site
- Travel dismounted across rubble
- Remove debris blocking an entryway
- Open a door and enter a building
- Climb an industrial ladder and traverse an industrial walkway
- Use a tool to break through a concrete panel
- Locate and close a valve near a leaking pipe
- Connect a fire hose to a standpipe and turn on a valve

PEAS

- Example: Agent = robot driver in DARPA Challenge
 - Performance measure:
 - Time to complete course
 - Environment:
 - Roads, other traffic, obstacles
 - Actuators:
 - Steering wheel, accelerator, brake, signal, horn
 - Sensors:
 - Optical cameras, lasers, sonar, accelerometer, speedometer, GPS, odometer, engine sensors,

→ Autonomous driving

starting থেকে destination-এ যেতে বাত ঘৰিব
ମୁଣ୍ଡାବେ ।

PEAS

- Example: Agent = Medical diagnosis system

Performance measure:

Healthy patient, minimize costs, lawsuits

Environment:

Patient, hospital, staff, doctor

Actuators:

Screen display (questions, tests, diagnoses, treatments, referrals)

Sensors:

Keyboard (entry of symptoms, findings, patient's answers)

Real system প্রতি limit/range থাবে,

environment = 10cm

sensor range = 1m

∴ sensor fully observable.

Environment types

- **Fully observable** (vs. **partially observable**): *in reality*
 - An agent's sensors give it access to the complete state of the environment at each point in time.
 - **Deterministic** (vs. **stochastic**):
 - The next state of the environment is completely determined by the current state and the action executed by the agent.
 - If the environment is deterministic except for the actions of other agents, then the environment is **strategic**
 - Deterministic environments can appear stochastic to an agent (e.g., when only partially observable) *room প্রতি temperature 24°C রাখাতে চাহে।*
at least এই দুটি লক্ষণ: } 1. বাইরের temperature বিটা } 2. বিটা রান্নাঘর আছে room /
 - **Episodic** (vs. **sequential**):
 - An agent's action is divided into atomic episodes. Decisions do not depend on previous decisions/actions.
- agent action কে তোট তোট part এ ভাগ করা যাব।*
- room → controlled environment না, stochastic.*

Environment types

- **Static** (vs. **dynamic**):
 - The environment is unchanged while an agent is deliberating.
 - The environment is **semidynamic** if the environment itself does not change with the passage of time but the agent's performance score does
- **Discrete** (vs. **continuous**):
 - A discrete set of distinct, clearly defined percepts and actions.
 - How we **represent** or **abstract** or **model** the world
 - *Let's say football game* → *co-operation* (স্থিতি দলের মাধ্যমে)
 - *competition* (বিপক্ষ দলের মাধ্যমে)
- **Single agent** (vs. **multi-agent**):
 - An agent operating by itself in an environment. Does the other agent interfere with my performance measure?
 - *মৈ task accomplish করতে চাই তবে তার জন্য প্রয়োজীব্য agent আছে।*

Characteristics of environments

	Fully observable?	Deterministic	Episodic	Static	Discrete?	Single agent?
Solitaire						
Driving						
Internet shopping						
Medical diagnosis						

Characteristics of environments

	Fully observable?	Deterministic?	Episodic?	Static?	Discrete?	Single agent?
Solitaire	No	Yes	Yes	Yes	Yes	Yes
Driving	No	No	No	No	No	No
Internet shopping						
Medical diagnosis						

Characteristics of environments

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Solitaire	No	Yes	Yes	Yes	Yes	Yes
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Medical diagnosis						

Characteristics of environments

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Solitaire	No	Yes	Yes	Yes	Yes	Yes
Driving	No	No	No	No	No	No
Internet shopping	No	No	No	No	Yes	No
Medical diagnosis	No	No	No	No	No	Yes

→ Lots of real-world domains fall into the hardest case!

task environm.	observabl e	deterministic / stochastic	episodic/ sequential	static/ dynamic	discrete/ continuous	agents
crossword puzzle	fully	determ.	sequential	static	discrete	single
chess with clock	fully	strategic	sequential	semi	discrete	multi
poker						
taxi driving	partial	stochastic	sequential	dynamic	continuous	multi
medical diagnosis						
image analysis	fully	determ.	episodic	semi	continuous	single
partpicking robot	partial	stochastic	episodic	dynamic	continuous	single
refinery controller	partial	stochastic	sequential	dynamic	continuous	single
interact. tutor	partial	stochastic	sequential	dynamic	discrete	multi

What is the environment for the DARPA Challenge?

- Agent = robotic vehicle
- Environment = 130-mile route through desert
 - Observable?
 - Deterministic?
 - Episodic?
 - Static?
 - Discrete?
 - Agents?

Agent types

- Five basic types in order of increasing generality:

- Table Driven agent
 - ↳ table থেকে sensor value দিয়ে action select

sensor	action

- Simple reflex agents
- Model-based reflex agents
- Goal-based agents
 - Problem-solving agents

- Utility-based agents
 - Can distinguish between different goals
- Learning agents

→ uncontrolled বিটুনার
→ system প্রেরণা perfect

Lookup table ।
Most of the case এ multiple
agent কাজ করবে।

- যদিও agent প্রয়োজন লাগে
- agent এর energy scarcity আছে
↳ refuel করা লাগবে।

পটু-table driven practically-use বলিনা।

Some agent types

- **Table-driven agents**
 - use a percept sequence/action table in memory to find the next action. They are implemented by a (large) **lookup table**. It is not autonomous.
- **Simple reflex agents**
 - are based on **condition-action rules**, implemented with an appropriate production system. They are stateless devices which do not have memory of past world states. It can not save history.
- **Agents with memory**
 - have **internal state**, which is used to keep track of past states of the world.
- **Agents with goals**
 - are agents that, in addition to state information, have **goal information** that describes desirable situations. Agents of this kind take future events into consideration. **Never thinks about cost.**
- **Utility-based agents**
 - base their decisions on **classic axiomatic utility theory** in order to act rationally. **Always thinks about cost.**

Table-driven/reflex agent Architecture

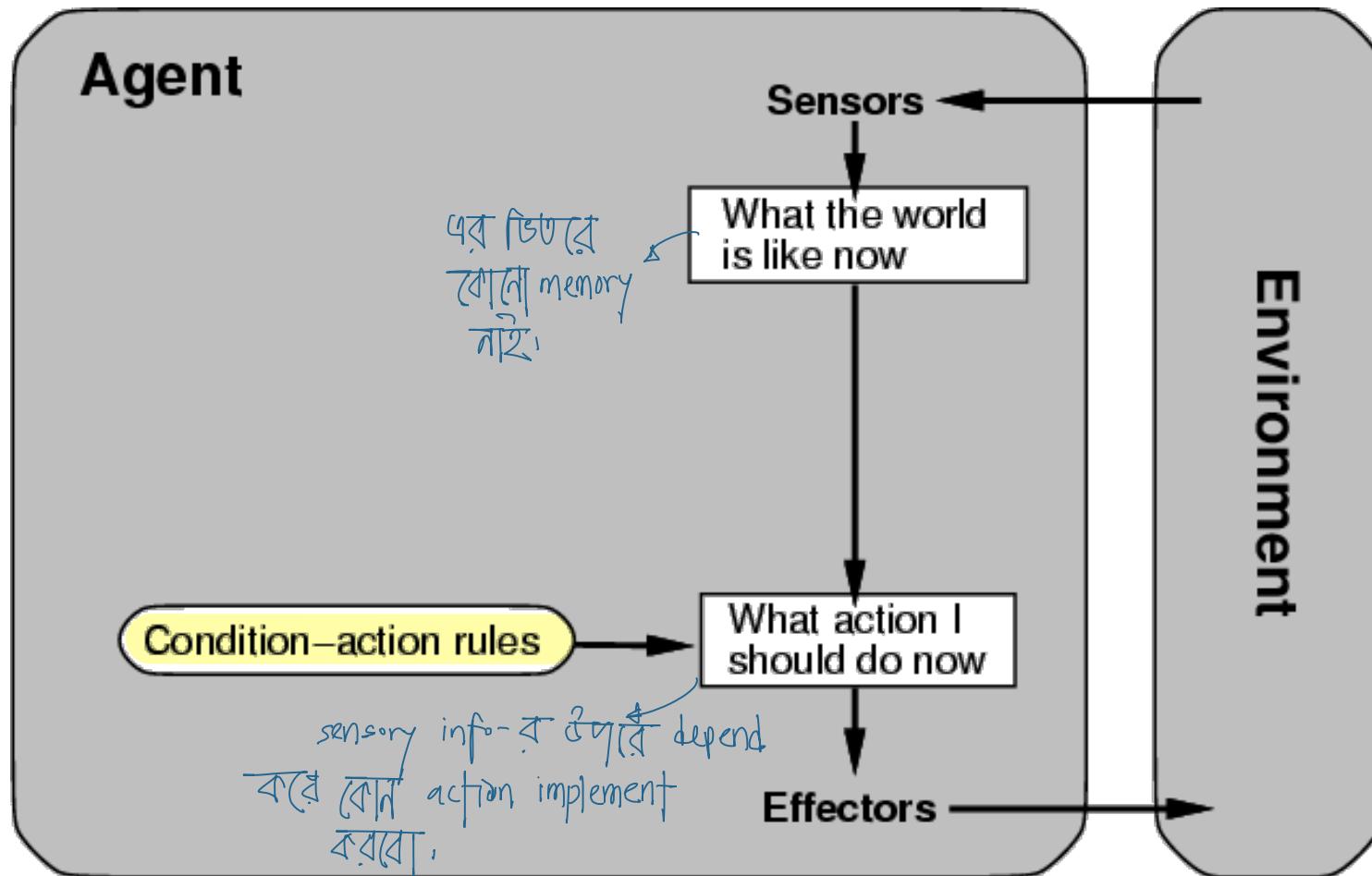


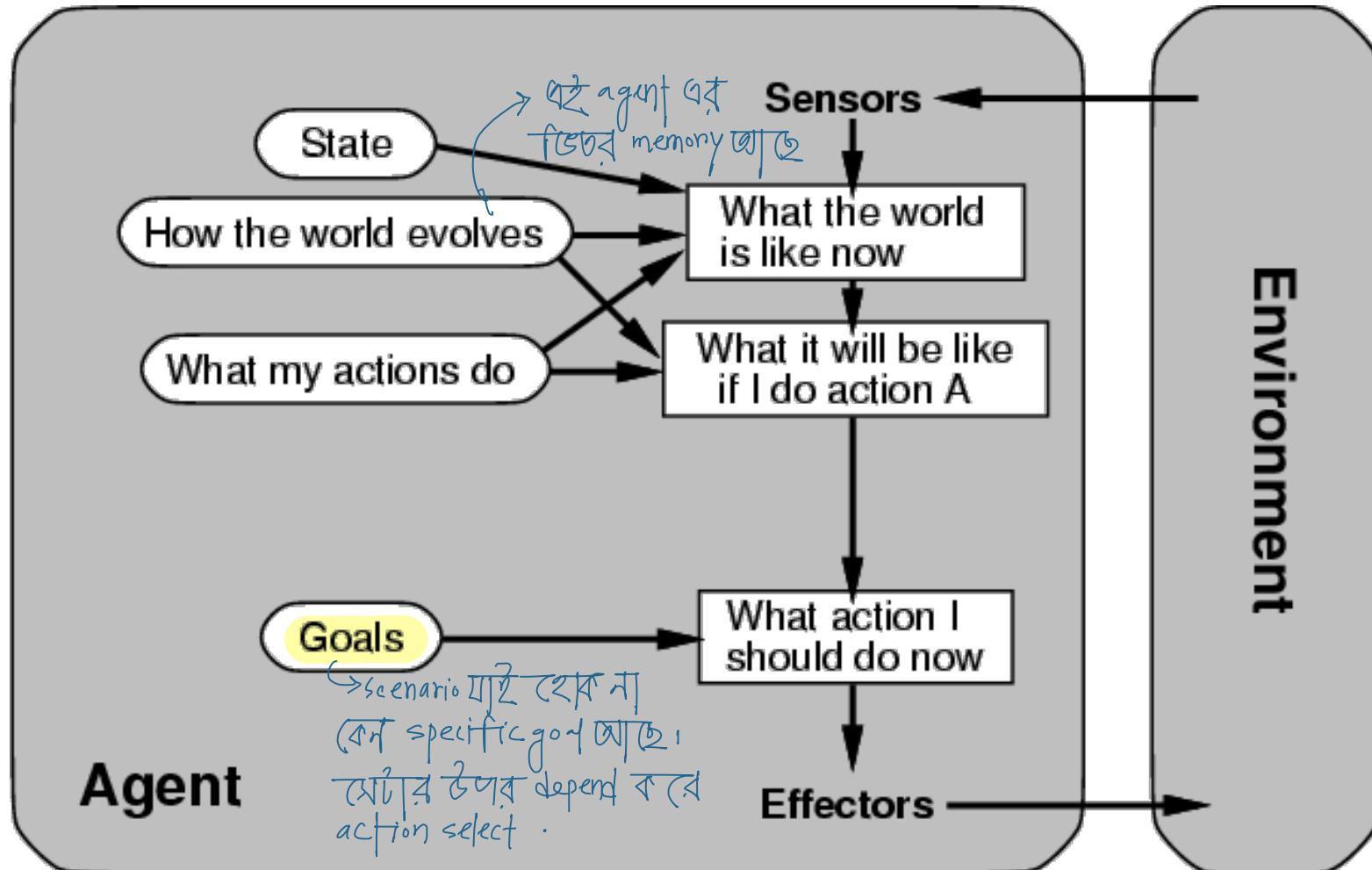
Table-driven agents

- **Table lookup** of percept-action pairs mapping from every possible perceived state to the optimal action for that state
- **Problems**
 - Too big to generate and to store (Chess has about 10^{120} states, for example)
 - No knowledge of non-perceptual parts of the current state
 - Not adaptive to changes in the environment; requires entire table to be updated if changes occur
 - Looping: Can't make actions conditional on previous actions/states

Simple reflex agents

- **Rule-based reasoning** to map from percepts to optimal action; each rule handles a collection of perceived states
- **Problems**
 - Still usually too big to generate and to store
 - Still not adaptive to changes in the environment; requires collection of rules to be updated if changes occur
 - Still can't make actions conditional on previous state

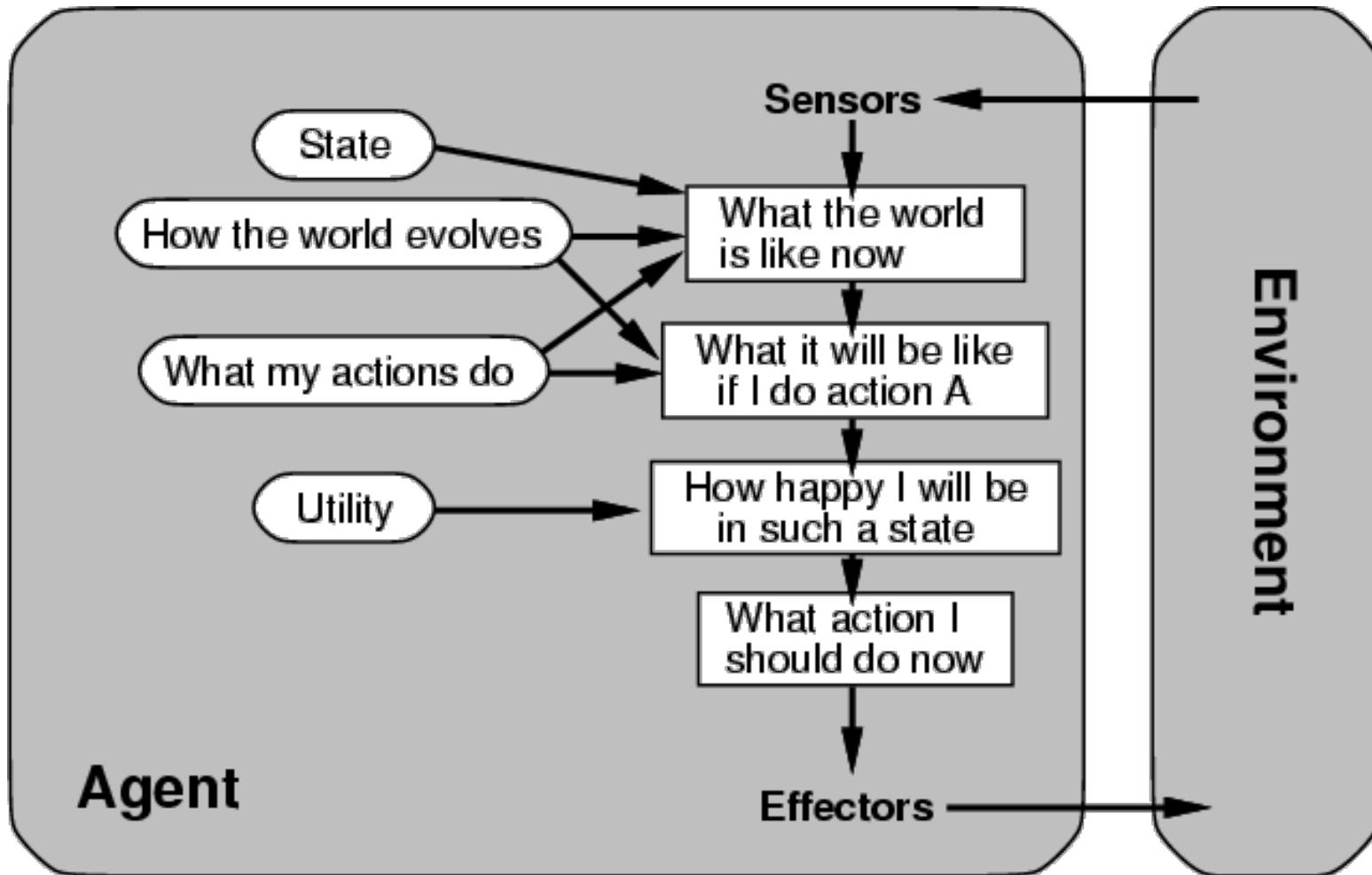
Goal-based agent: Architecture



Goal-based agents

- Choose actions so as to achieve a (given or computed) goal.
- A goal is a description of a desirable situation.
- Keeping track of the current state is often not enough – need to add goals to decide which situations are good
- **Deliberative** instead of **reactive**.
- May have to consider long sequences of possible actions before deciding if goal is achieved – involves consideration of the future, “*what will happen if I do...?*”

Complete utility-based agent



Utility-based agents

- When there are multiple possible alternatives, how to decide which one is best?
- A goal specifies a crude distinction between a happy and unhappy state, but often need a more general performance measure that describes “degree of happiness.”
- Utility function **U: State → Reals** indicating a measure of success or happiness when at a given state.

Summary

- An **agent** perceives and acts in an environment, has an architecture, and is implemented by an agent program.
- An **ideal agent** always chooses the action which maximizes its expected performance, given its percept sequence so far.
- An **autonomous agent** uses its own experience rather than built-in knowledge of the environment by the designer.

Summary (Contd.)

- An **agent program** maps from percept to action and updates its internal state.
 - **Reflex agents** respond immediately to percepts.
 - **Goal-based agents** act in order to achieve their goal(s).
 - **Utility-based agents** maximize their own utility function.
- **Representing knowledge** is important for successful agent design.
- The most challenging environments are
 - partially observable
 - stochastic
 - sequential
 - Dynamic
 - continuous
 - contain multiple intelligent agents