CSC520 - Artificial Intelligence

Lecture 3

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In The News

'Worst in Show' CES Products Risk Data, Cause Waste

e-commerce site iFixit released its fourth annual 'Worst in Show' awards for products showcased at this year's Consumer Electronics Show. Ultrahuman's Rare Luxury Smart Ring was named "least repairable"; it costs $2,200 and has a battery that cannot be replaced without destroying the device. Bosch's Revol crib was panned for collecting "excessive" data about babies. "We're seeing more and more of these things that have basically surveillance technology built into them," said iFixit's Liz Chamberlain.
[» Read full article]

Associated Press; Sarah Parvini (January 9, 2025)

Agenda

- Agent Function vs Program vs Architecture
- Agent Types
  - Simple reflex
  - Model-based reflex
  - Goal-based
  - Utility-based

Agent Function vs. Program vs Architecture

- *Agent function* maps a percept sequence to an action; external characterization

$$f : p_0, p_1, \ldots p_n \rightarrow a_i$$

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- *Agent architecture* is the computing device with sensors and actuators
- *Agent* is the combination of architecture and program
  $agent = architecture + program$

Simple Reflex Agent

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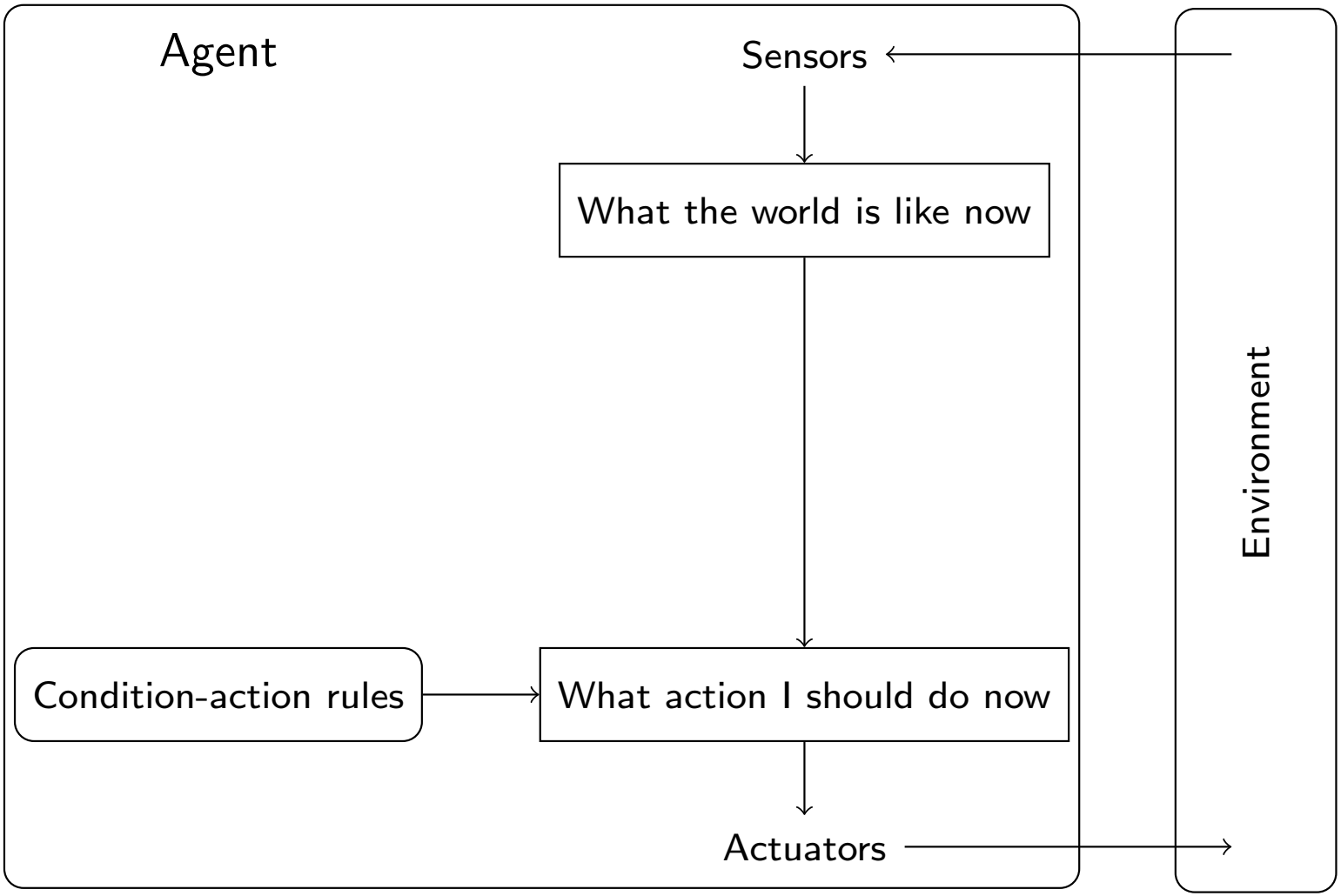
- Simple but can fail if the environment is not fully observable
  - Agent cannot figure out if a car infront is braking by observing only a single image frame

Simple Reflex Agent



Simple Reflex Agent

function SIMPLE-REFLEX-AGENT(*percept*) **return** an action

persistent: *rules*: a set of condition-action rules

state ← INTERPRET-INPUT(*percept*)

rule ← RULE-MATCH(*state*, *rules*)

action ← *rule*.ACTION

return action

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    - ★ How state changes based on the agent action?
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    - ★ How state changes independent of the agent action?
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    - ★ How state changes independent of the agent action?
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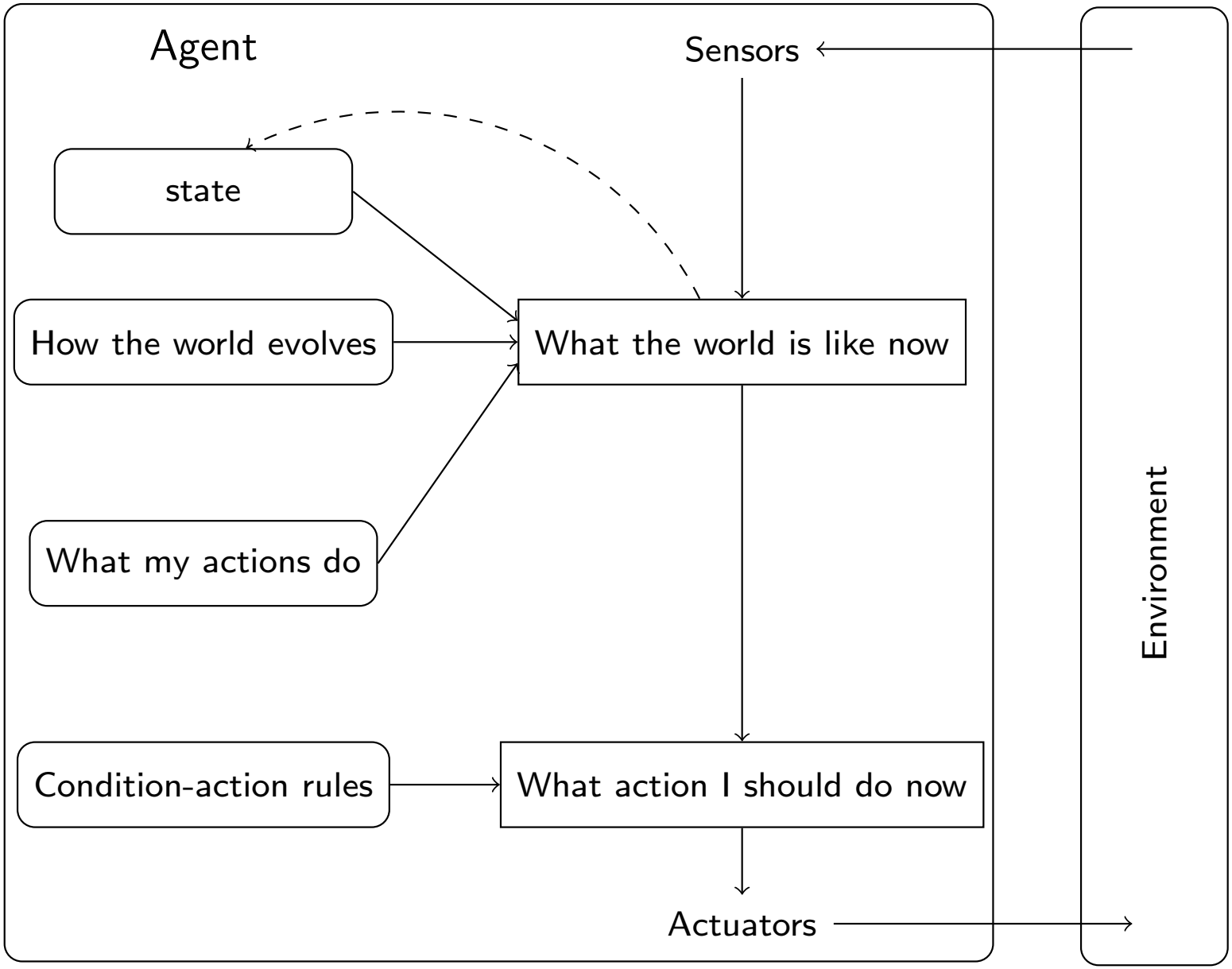
  - *Sensor model*
    - ★ What is the current state given the agent's percepts?
      e.g. red tail lights appearing in the camera image means the car is braking

Model-based Reflex Agent



Model-based Reflex Agent

function MODEL-BASED-REFLEX-AGENT(*percept*) **return** an action
  persistent:
    state: current world state
    transition_model: next state given the current state and action
    sensor_model: the state given the percepts
    rules: a set of condition-action rules
    action: the most recent action, initially none

  state ← UPDATE-STATE(*state*, *action*, *percept*, *transition_model*, *sensor_model*)
  rule ← RULE-MATCH(*state*, *rules*)
  action ← *rule*.ACTION
  return action

Goal-based Agent

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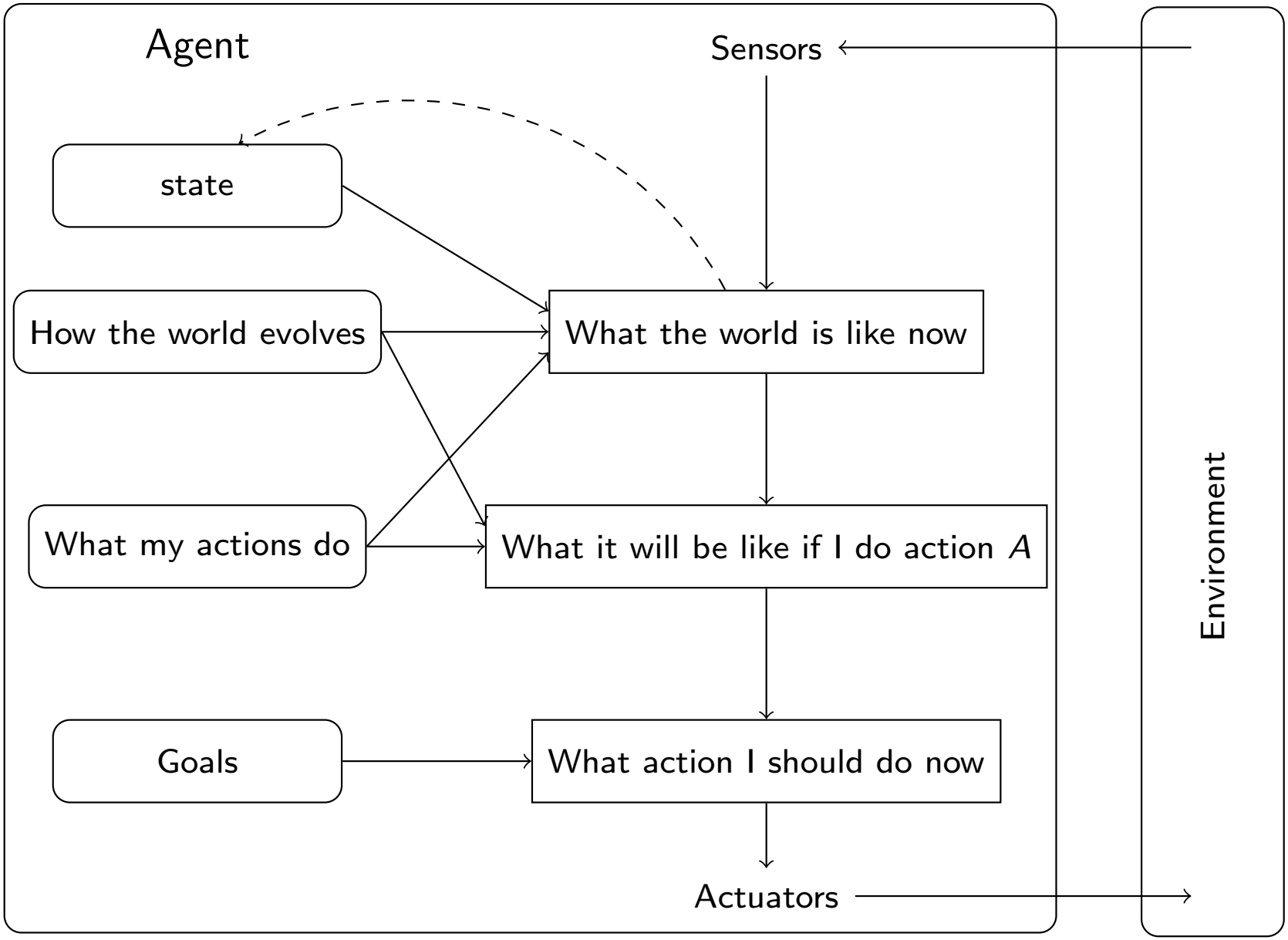
- Goal-based agent employs goals with world state, transition and sensor models
- Compute *sequence* of actions to achieve goals using search and planning techniques
- Goals offer more flexibility in building agents

Goal-based Agent



Goal-based Agent

function GOAL-BASED-AGENT(*percept*) **return** an action

persistent:

state: current world state

transition_model: next state given the current state and action

sensor_model: the state given the percepts

goal: description of the desired goal state

plan: a sequence of actions to take, initially none

action: the most recent action, initially none

state ← UPDATE-STATE(*state*, *action*, *percept*, *transition_model*, *sensor_model*)

if GOAL-ACHIEVED(*state*, *goal*) **then**

return *SUCCESS*

if *plan* is *none* **then**

plan ← PLAN(*state*, *goal*, *transition_model*, *sensor_model*)

action ← FIRST(*plan*)

plan ← REST(*plan*)

return action

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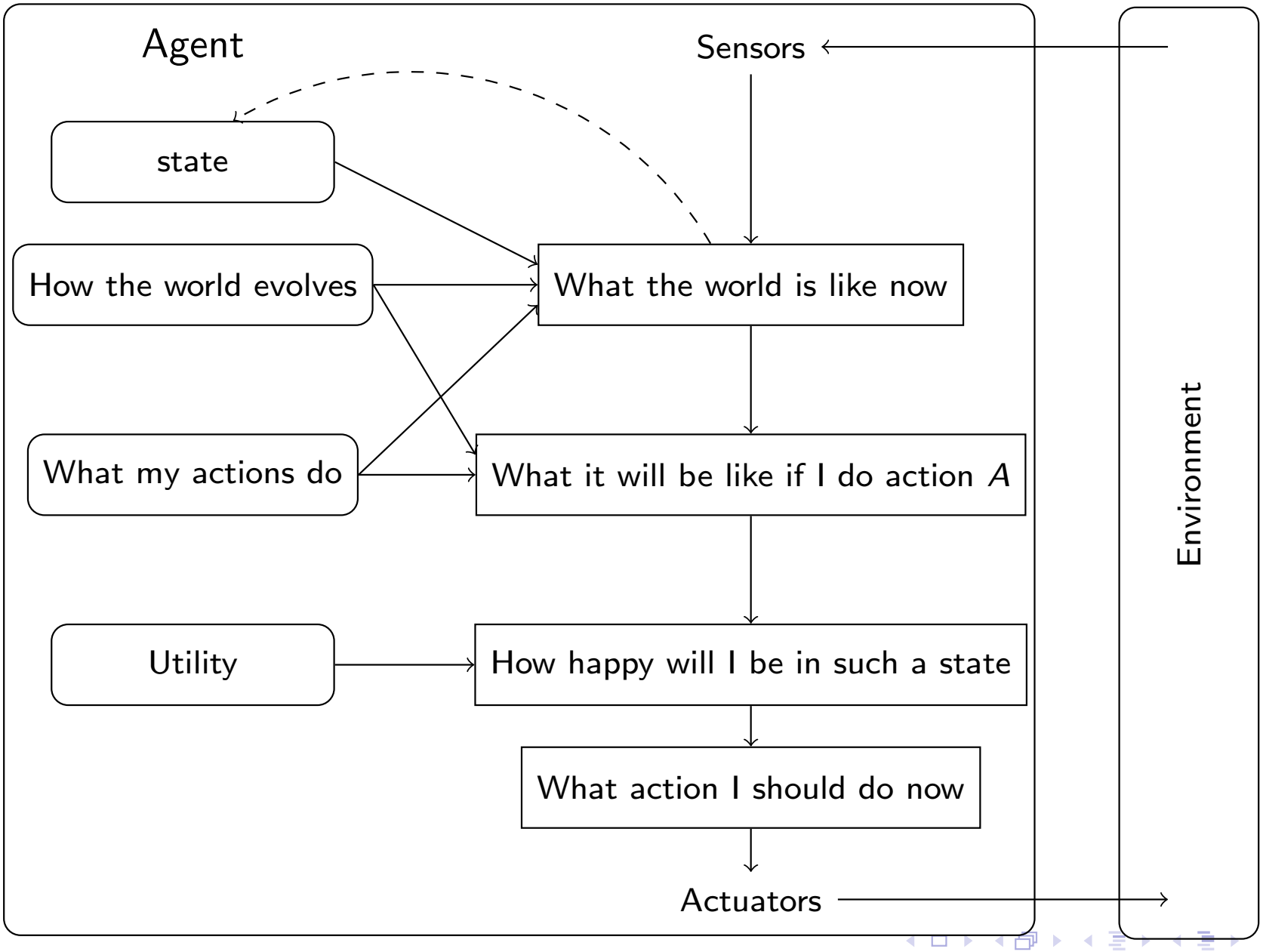
- Utility-based agent employs *utility function* while computing a plan
- Utility function is an internalization of performance measure
  - A *rational* agent maximizes its expected utility
- Can handle cases when the agent has multiple goals and when their success is not guaranteed

Utility-based Agent



Learning Agent

- Agents that learn from experience
  - What my actions do?
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  - What my actions do?
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- Any agent (model-based, goal-based, utility-based) can be built as a learning agent

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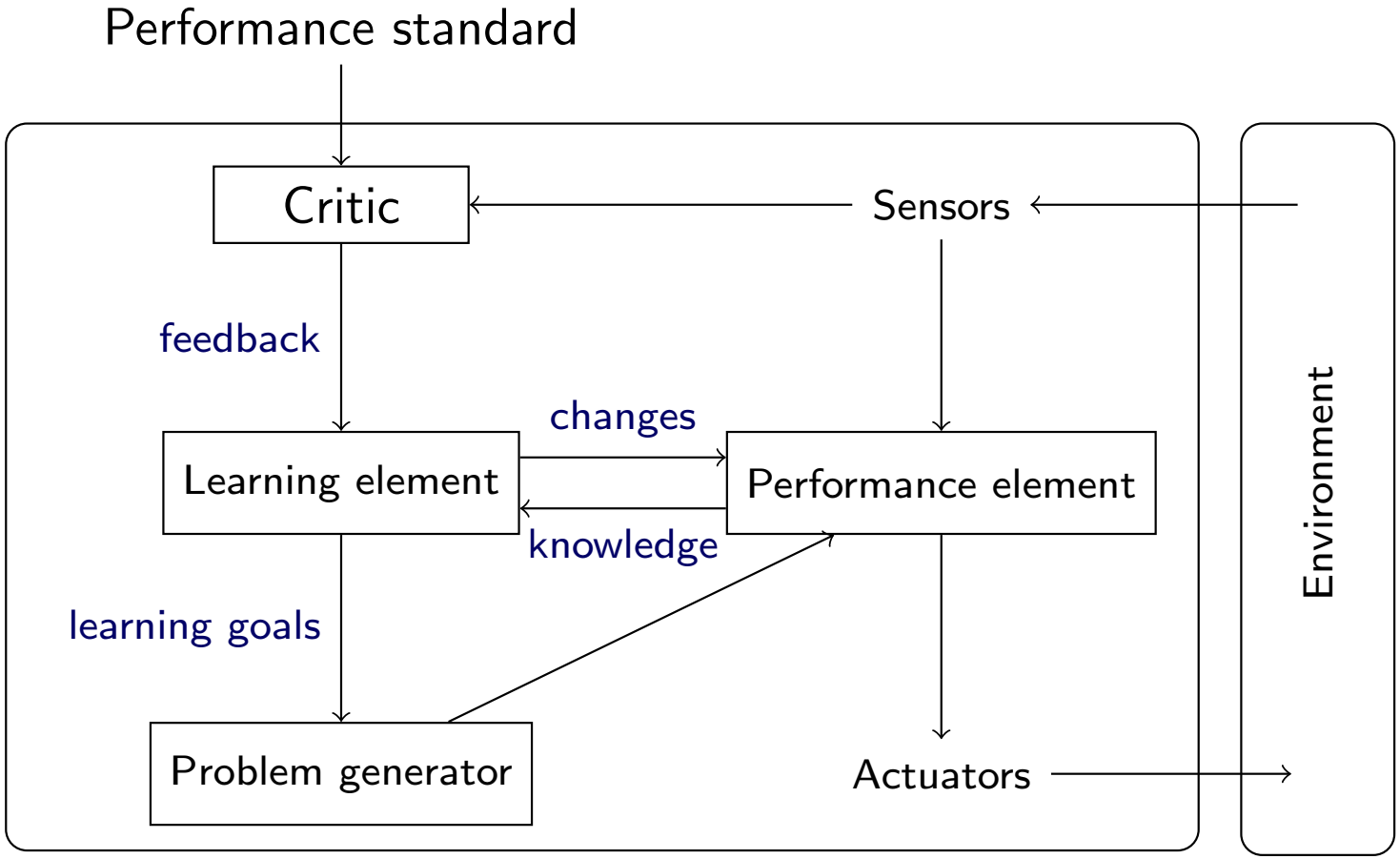

Learning Agent

- Learning element is responsible for making improvements
- Performance element is responsible for selecting actions
  - That is, any of the agents we have studied thus far
- Critic provides feedback on how well the agent is doing with respect to some performance standard
- Problem generator suggests exploratory actions to the agent

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  - Structured
    - ★ Objects related to other objects
      {(CarA[16.5gal, LIGHT_ON, 60mph], RoadA[paved, 4lane], CarA-on-RoadA),
      (CarA[10.5gal, LIGHT_ON, 30mph], RoadB[gravel, 1lane], CarA-on-RoadB),
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  - Search to find a plan
    - ★ Agent *simulates* sequences of actions
  - Execute the plan

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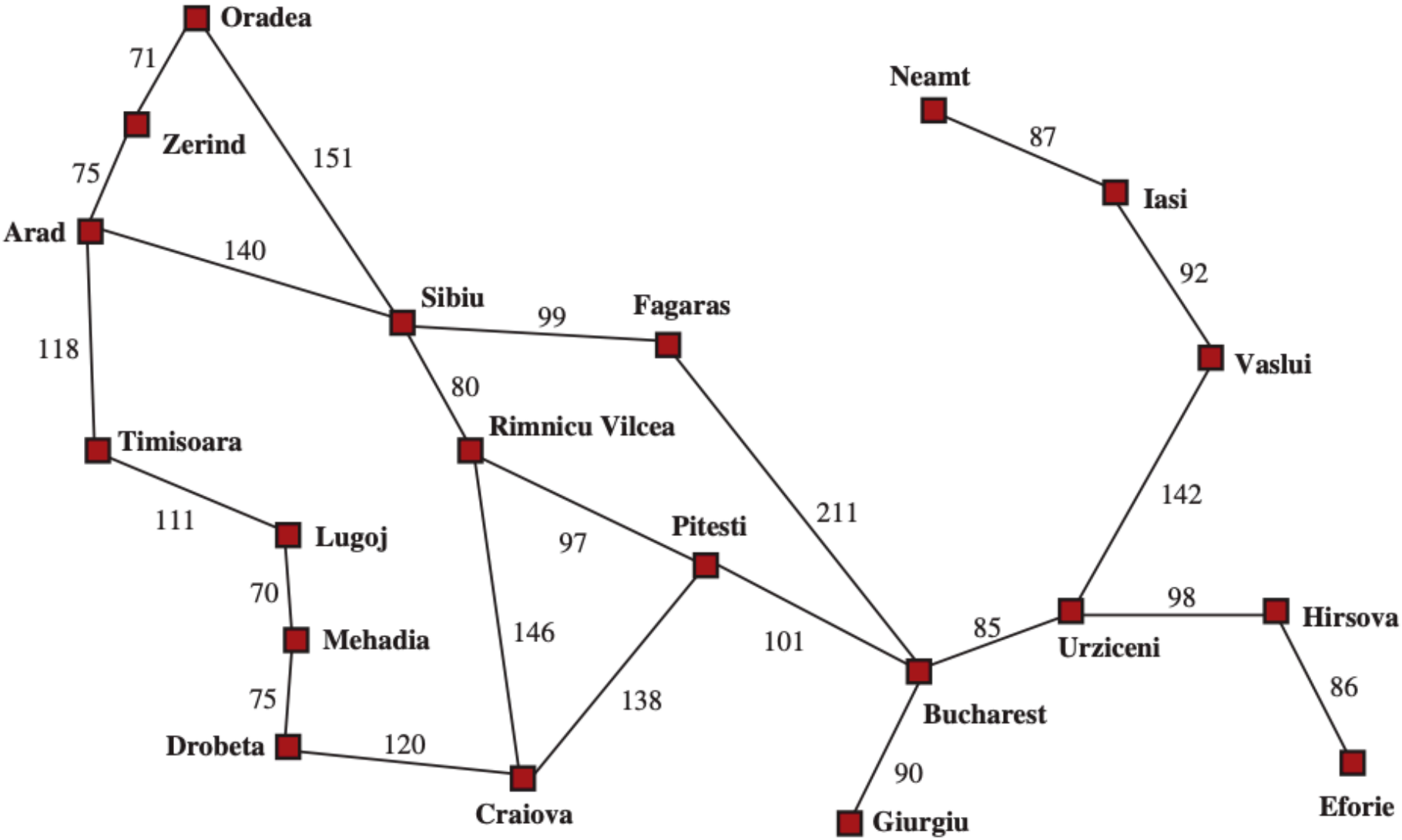
- *Optimal* solution is the lowest cost solution

Example Problems



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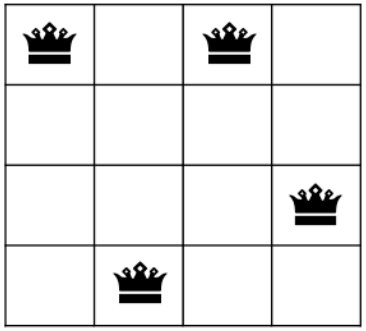
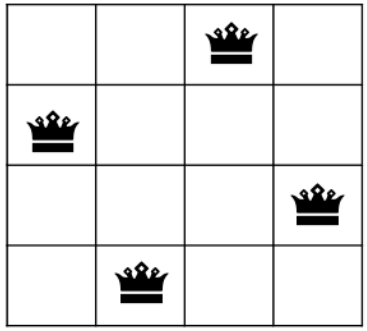
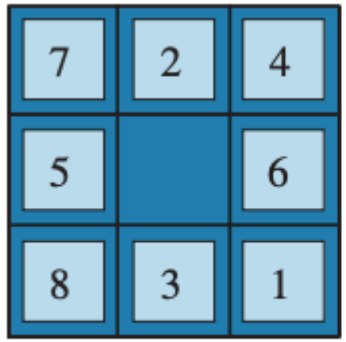


Start State



Goal State

4-Queen



Start State

Goal State

8-Puzzle

Task Environment

- Fully vs. Partially Observable
- Deterministic vs. Stochastic
- Episodic vs. Sequential
- Static vs. Dynamic
- Discrete vs. Continuous
- Known vs. Unknown
- Single vs. Multi-agent

Search Problem

- State Space
- Initial State
- Goal State
- Actions
- Transition Model
- Action Cost Function