EECS 391
Intro to AI

Intelligent Agents

L2: Tue, Sep 5, 2017

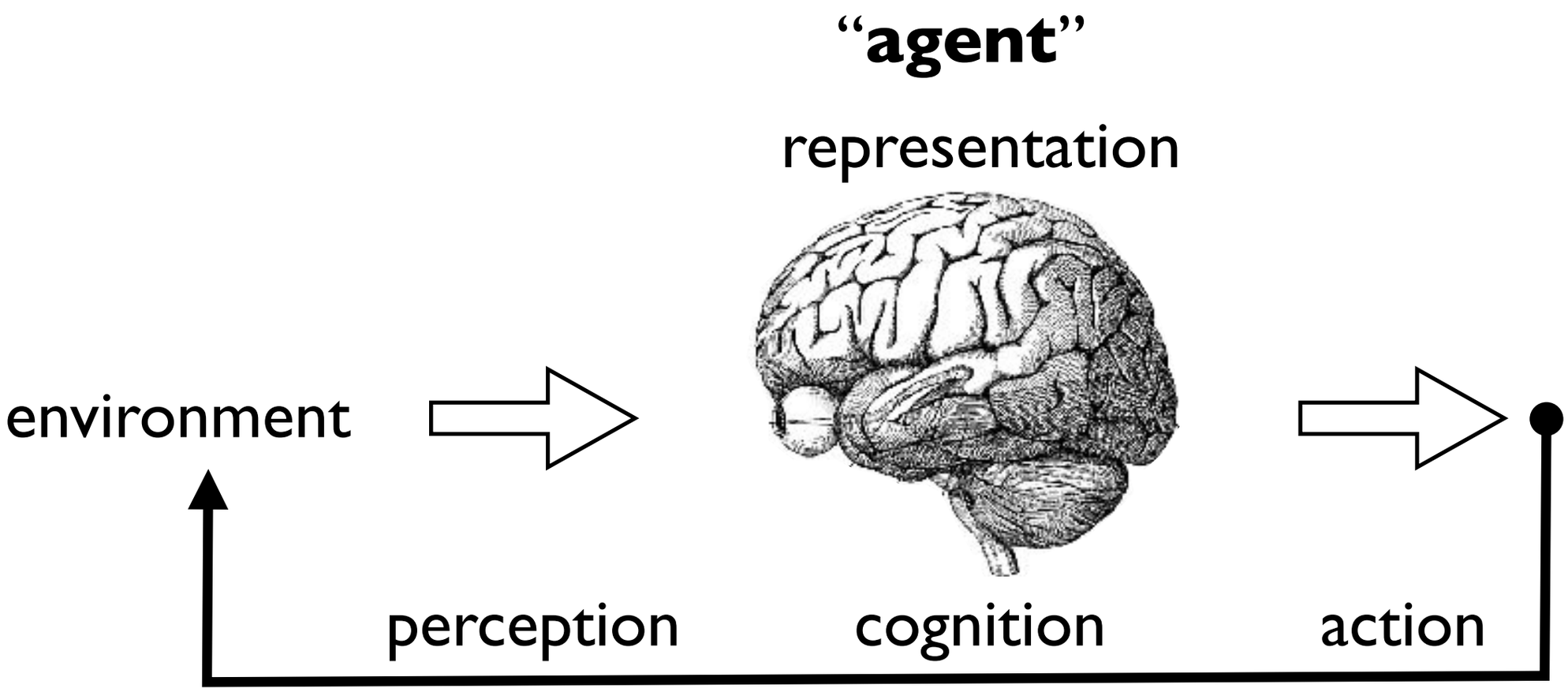
Lecture Overview

- Questions of the day:
  - How do we define an intelligent system?
  - What are some real-world examples?
- Intelligent agents environments
- Rationality and performance measures

What are intelligent systems?

Three key steps of a ***knowledge-based agent*** (Craik, 1943):

1. the stimulus (or world or problem space) must be translated into an *internal representation*
2. the representation is manipulated by *cognitive processes* to derive new internal representations
3. these in turn are translated into *action*



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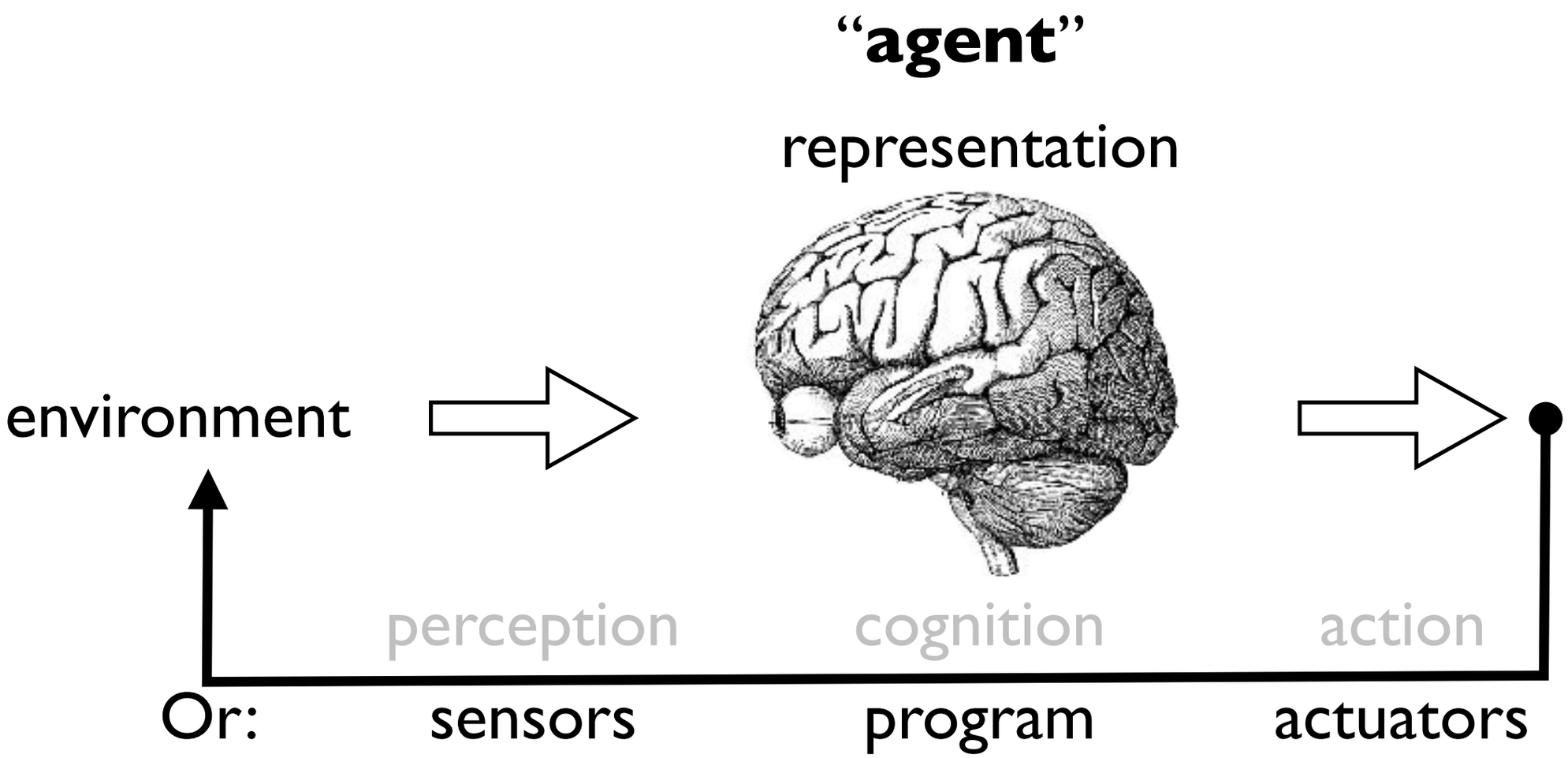
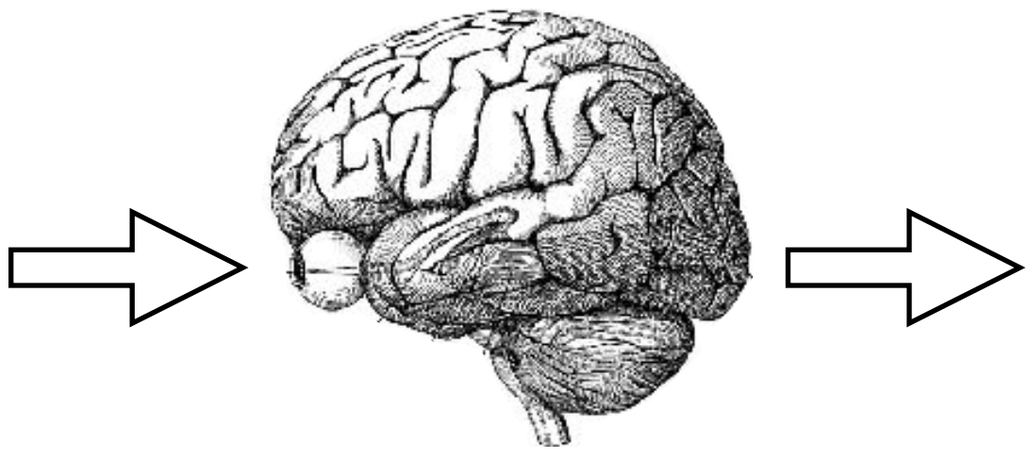


Representation and action

All AI problems require some form of representation.
The output can also be complex

- puzzle
- maze
- chess board
- text
- audio
- visual scene



perception cognition action

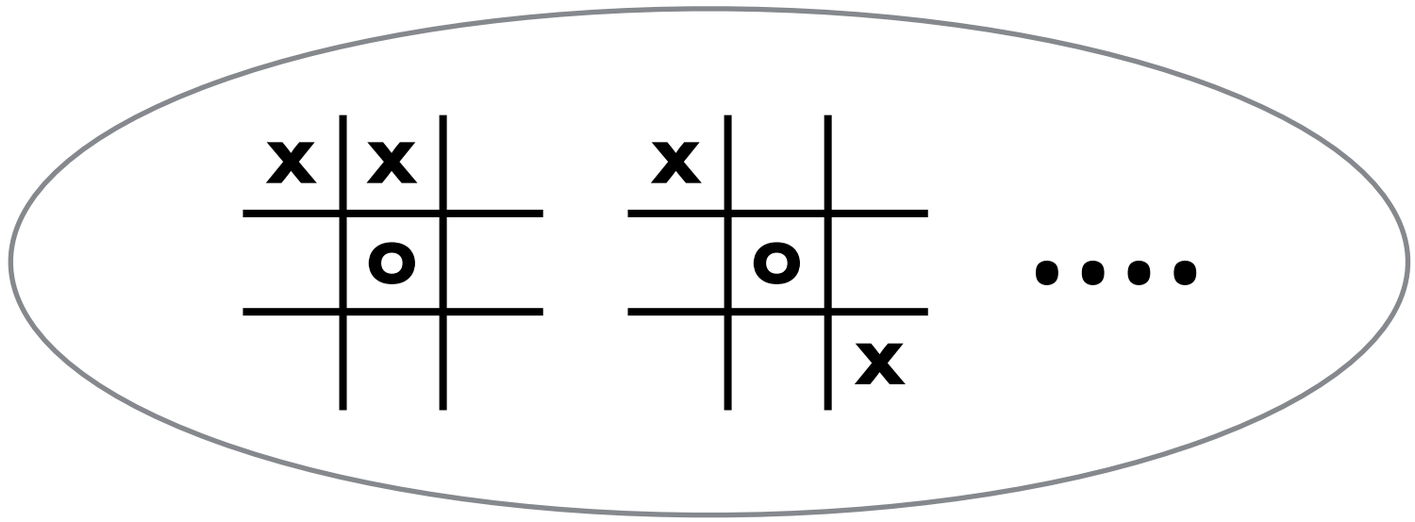
- next action / move
- text
- label
- actuator command

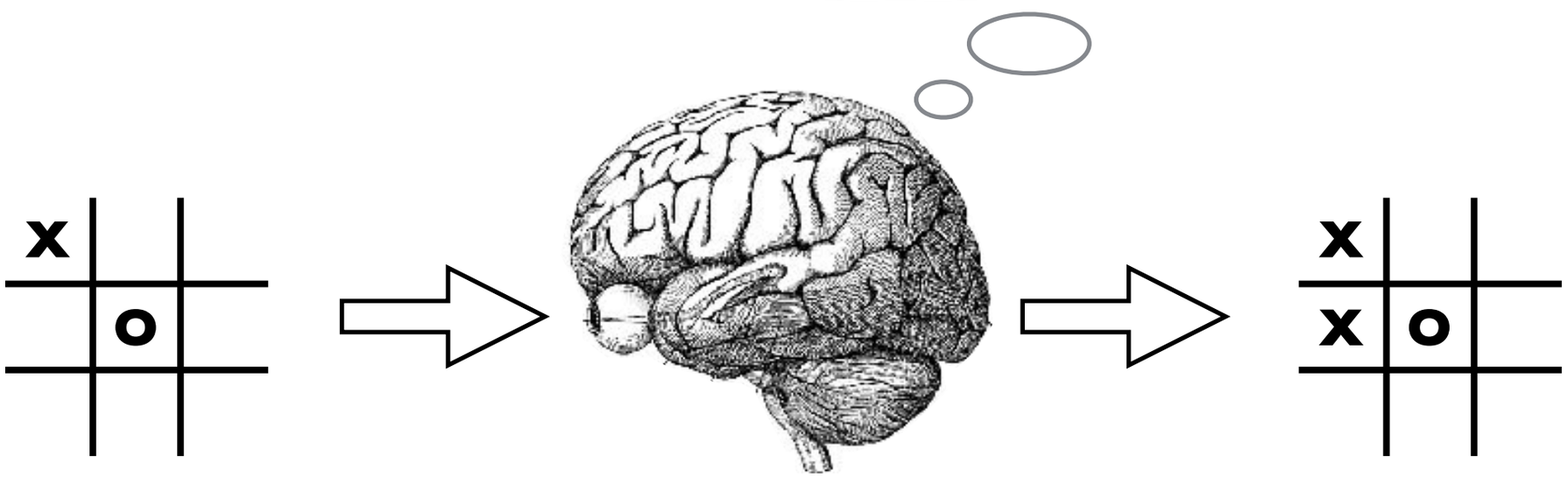
A challenge in AI is how to represent the environment to allow intelligent actions.

Sometimes the representation *is* the result, e.g. discovering structure in data.

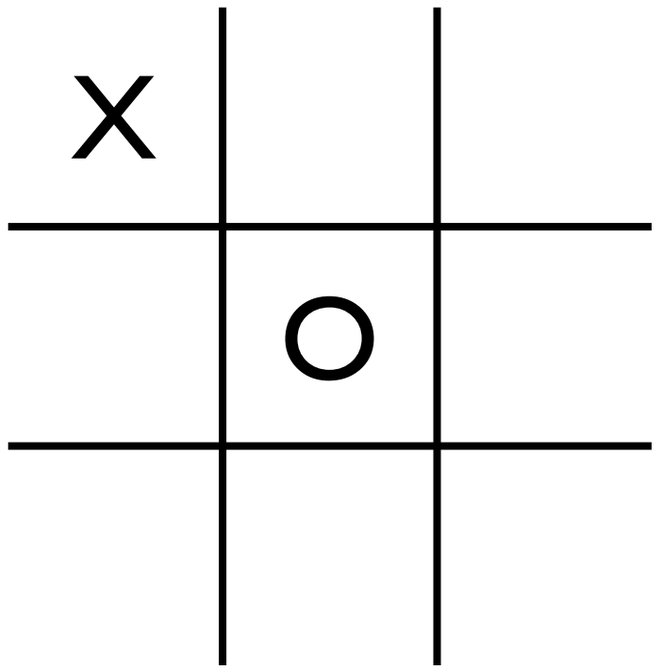
Representation and action in tic-tac-toe game

- no perception, just representation
- "thinking" starts from the current game state and explores future states
- action is the choice of next move





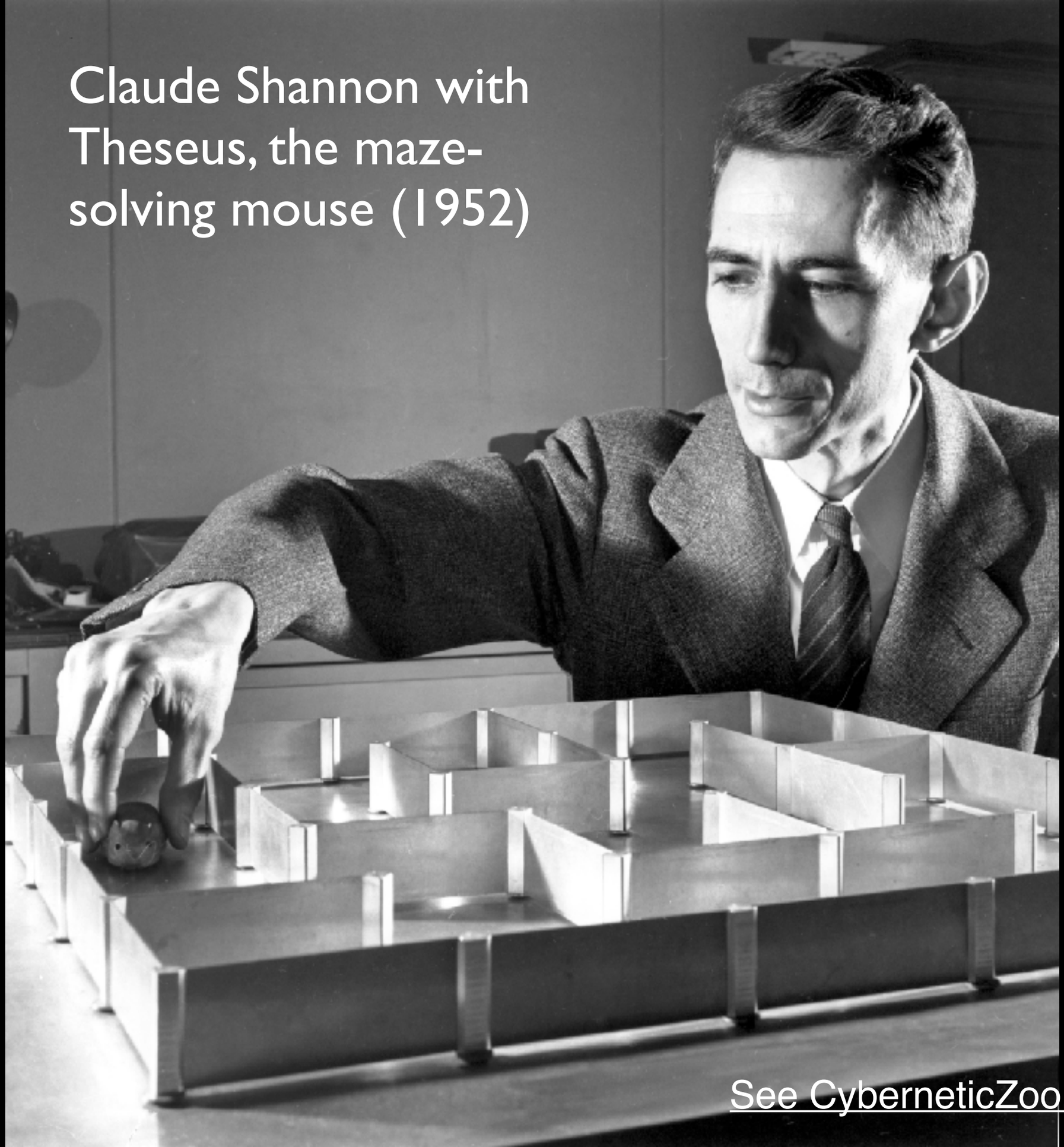
Representing a tic-tac-toe game



- many valid implementation choices
- positions need only blank, X or O
- Integer matrix:

2	0	0
0	1	0
0	0	0

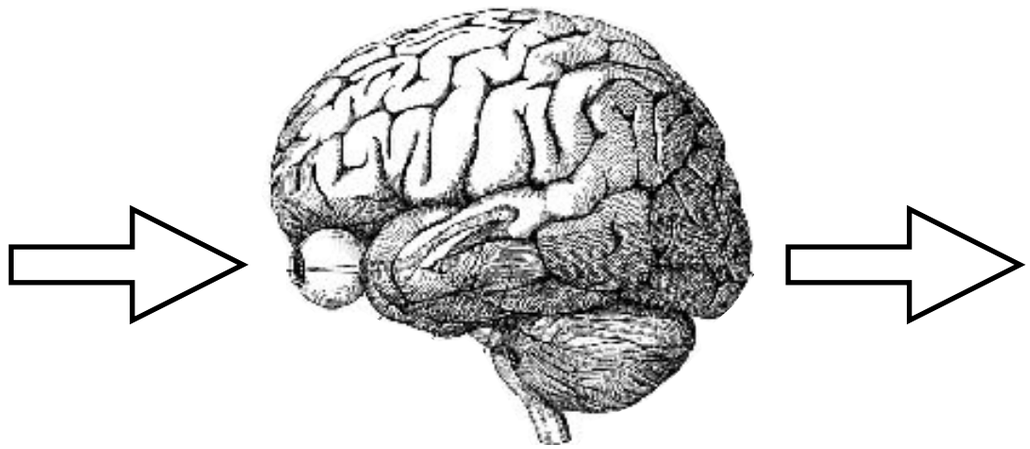
- 9-character ASCII string:
  "X___O____"
- minimal space, 18-bit vector:
  `10 00 00 00 01 00 00 00 00`
- advice: choose *simplest* (for both programming & state space search)
- memory savings is only a constant factor



See CyberneticZoo.com article

Thinking

What do you do once you have a representation? This requires a goal.



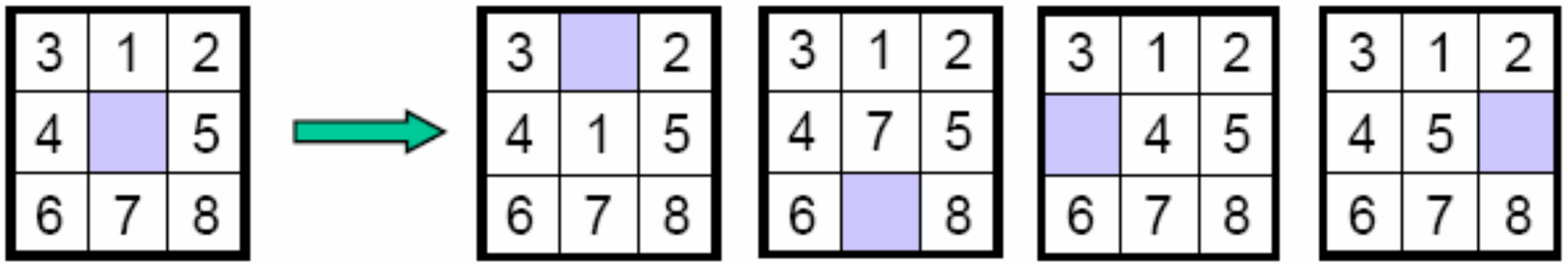
perception cognition action

- chess board
- maze
- text
- object
- room
- sound
- visual scene

- find best move
- shortest path
- semantic parsing
- recognition
- object localization
- speech recognition
- path navigation

Rational behavior:
choose actions that maximize goal achievement given available information

The 8-puzzle (a sliding block puzzle)



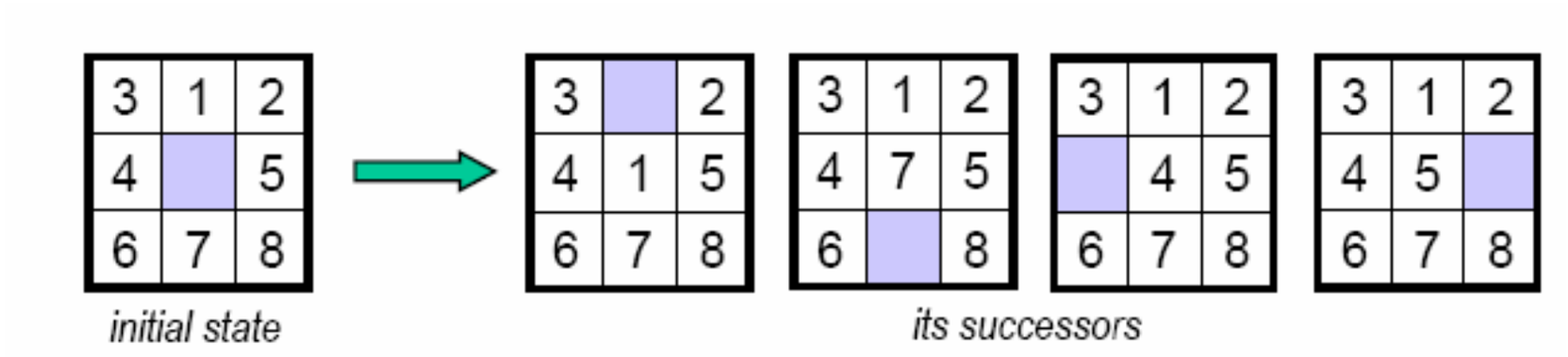
current state

states reachable by available actions

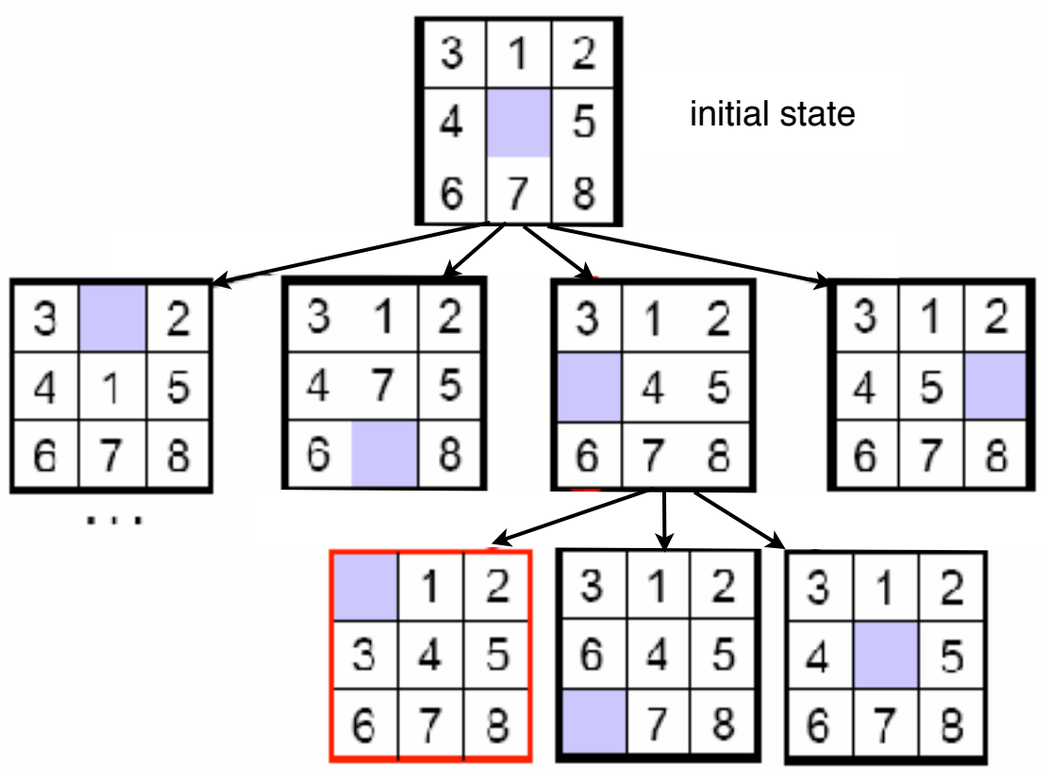
- environment could again be represented by a simple 3x3 matrix
- actions by the agent change the state of the environment

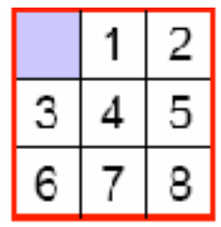
State-space search

- Each successor defines different moves possible from the current puzzle state

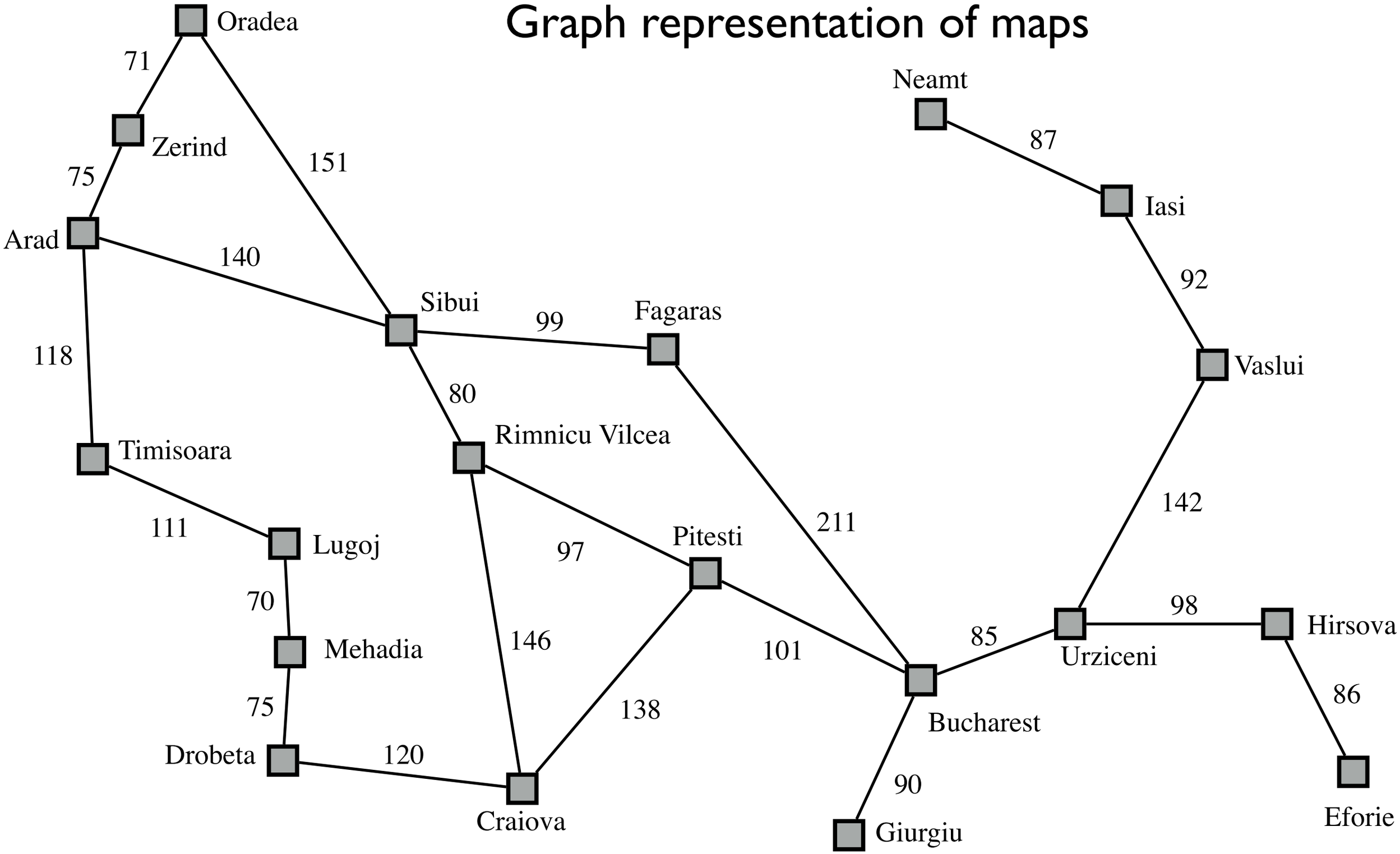


- We can employ different *search strategies* to find the goal state



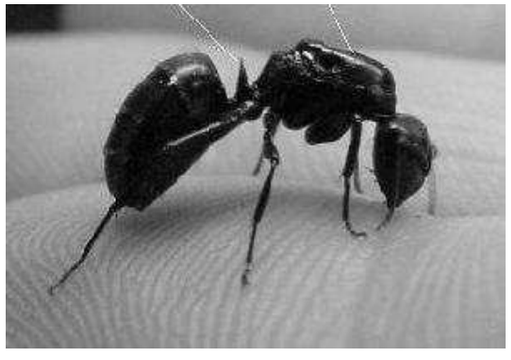


Graph representation of maps



- What information is needed in the representation?
- Nodes, edges and weights: cities, roads, distance/time. Other info?
- Rational behavior?

What about object recognition?



from (Mutch and Lowe, 2008)

Form of most object recognition models

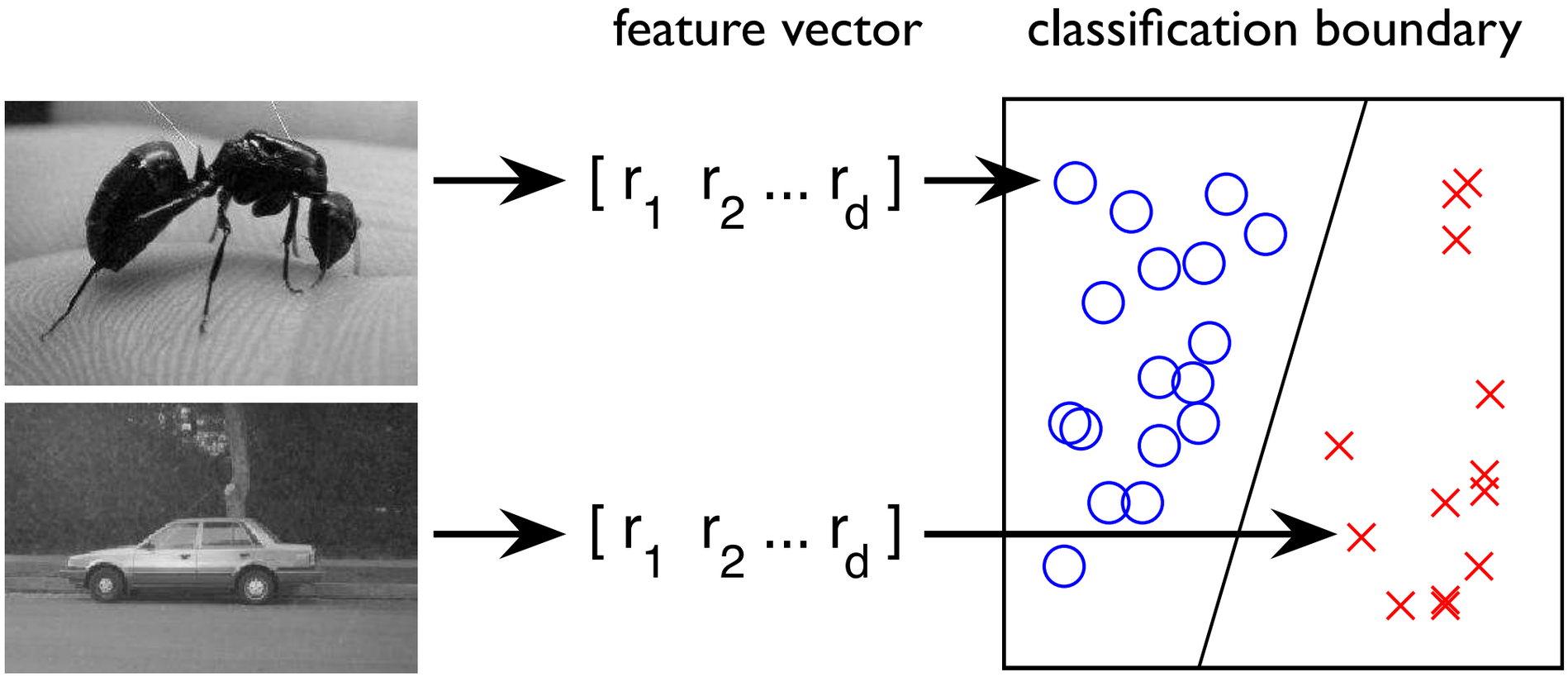
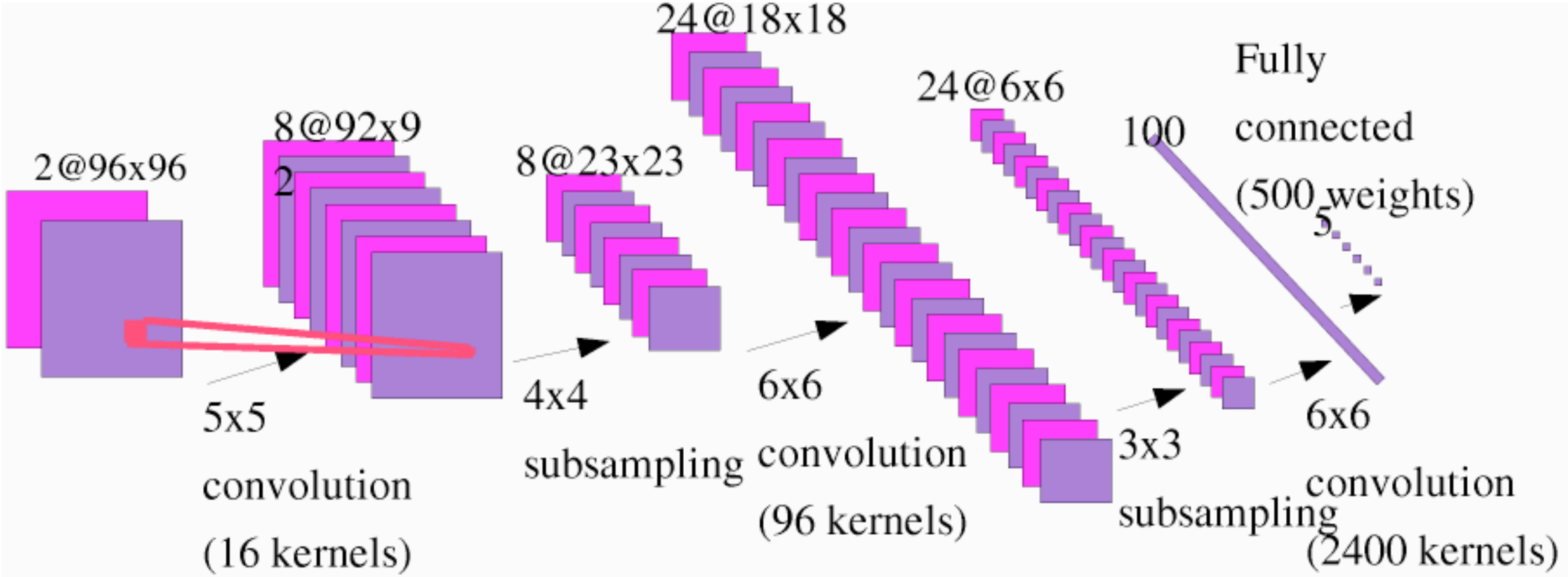


Figure 1. Overall form of our model. Images are reduced to feature vectors which are then classified by an SVM.

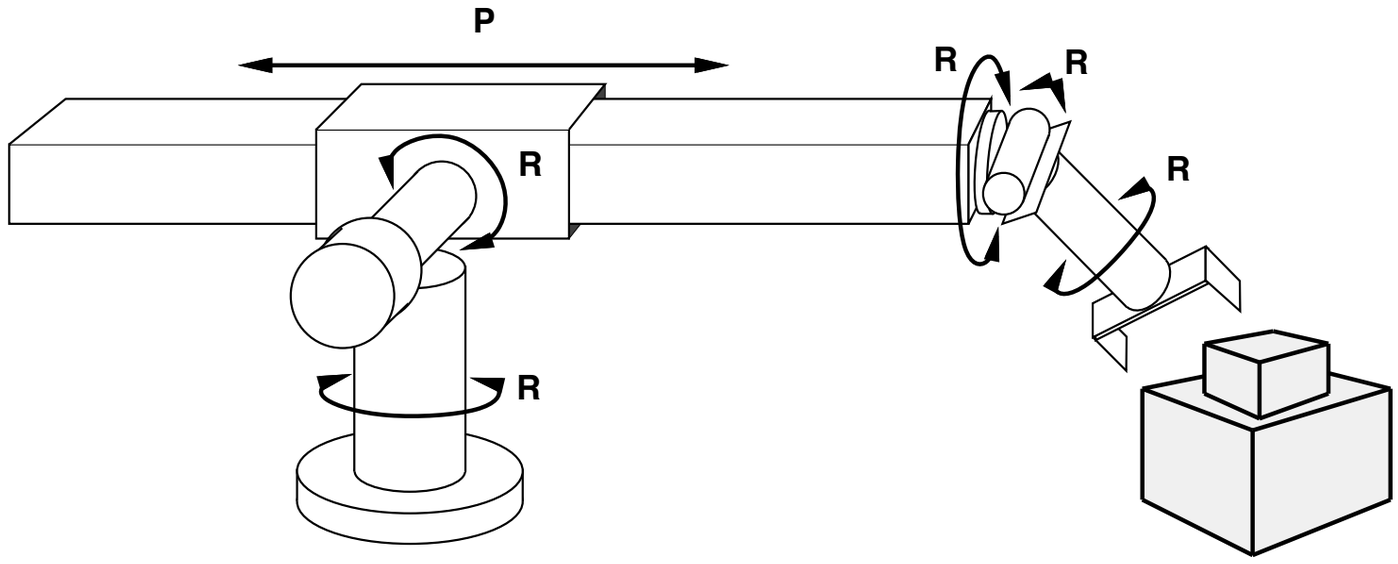
from (Mutch and Lowe, 2008)

Deep neural network



The transformation from image to feature vector can be arbitrarily complex.

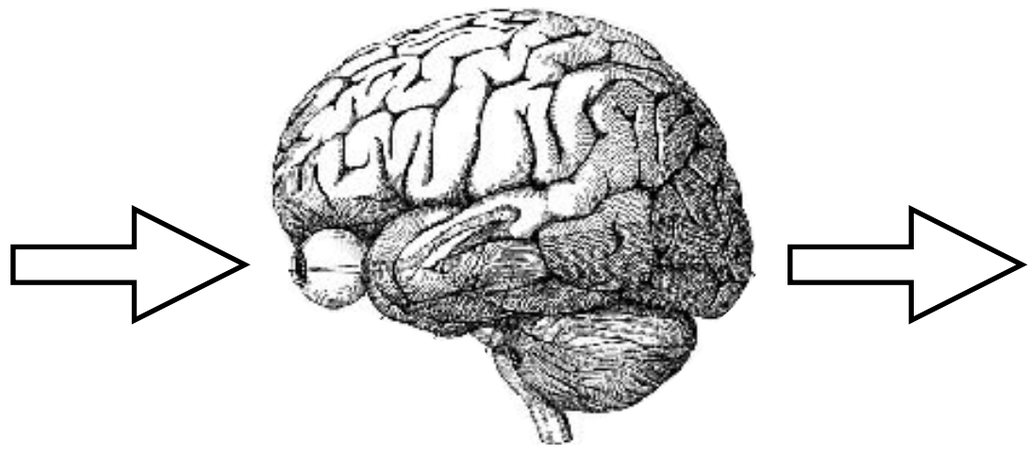
Robotic arm



Representation?	Angles and coordinations of joints. Also need object shapes and positions.
Cognition?	How to grasp object or avoid other obstacles.
Actions?	motion actions of robot arms and manipulators
Goal?	grasp/place/sort objects
Rational behavior?	speed / accuracy / robustness

Reasoning

Reasoning can be thought of as constructing an accurate world model.



perception cognition action

- facts
- observations
- "wet ground"

- logical consequences
- inferences
- "it rained" or "sprinkler" ?

Rational inference:
What can be logically inferred give available information?

What kinds of AI-type goals might Google have?

Go to classic Google.

Advanced Search
Language Tools

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Google

Language Tools

Translated search

Type a search phrase in your language. Google will find results in other languages and translate them for you to read.

Search for: Translate and Search

Search pages written in:
- **Automatically selected languages**
- Specific languages

My language: English ▼

Example: 1. Search for Bern tourist information.
2. We translate your query into French and German, and find French and German results.
3. Finally, we translate the French and German results back into your language.

Translate text

Spanish ❯ English Translate

Translate a we

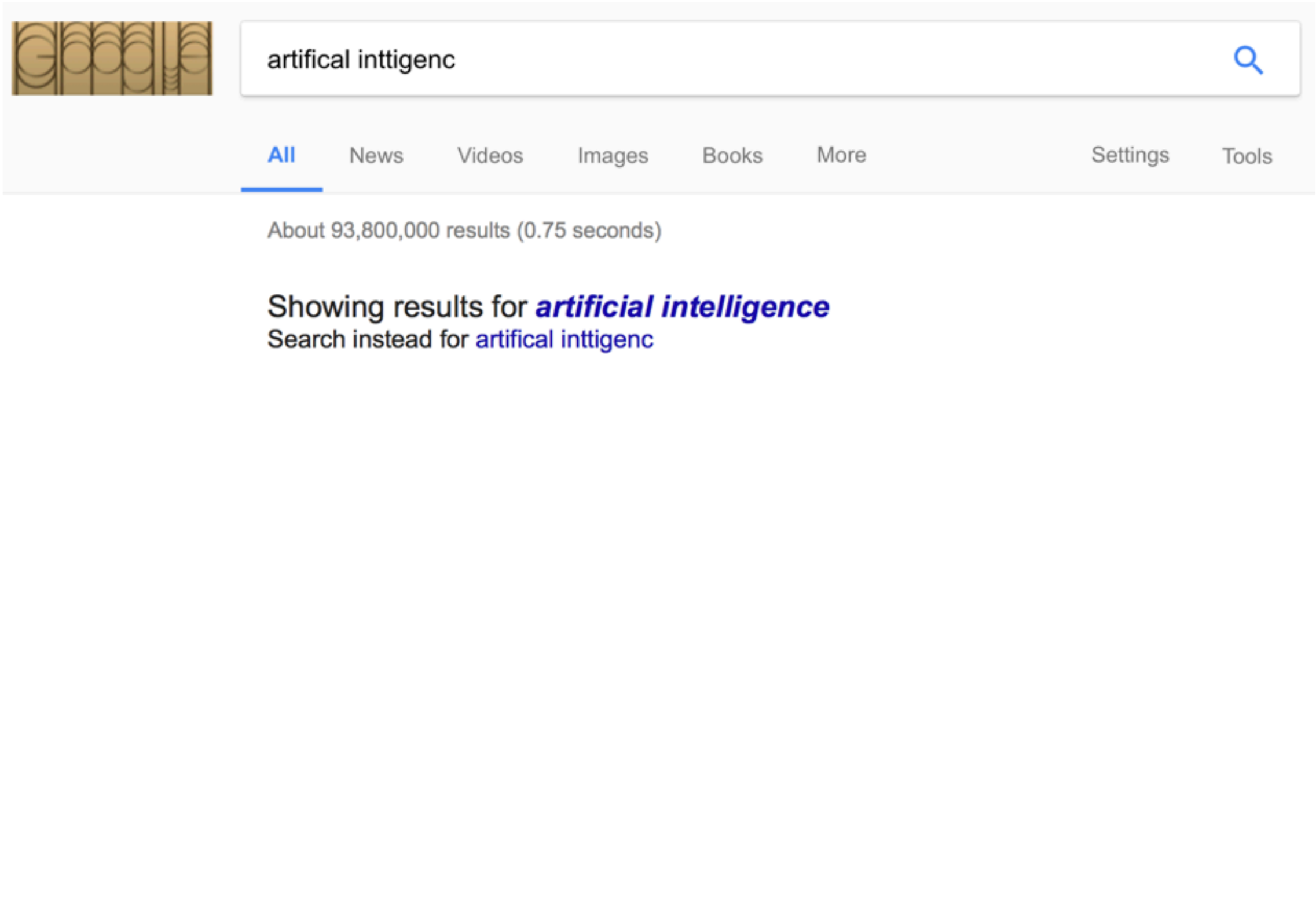
http://

Spanish ❯ Translate

Use the Googl Language

Afrikaans
Albanian
Arabic
Belarusian
Bulgarian
Catalan
Chinese (Simplified)
Chinese (Traditional)
Croatian
Czech
Danish
Dutch
✓ English
Estonian
Filipino
Finnish
French
Galician
German
Greek
Haitian Creole
Hebrew
Hindi
Hungarian
Icelandic

Spell-check is an AI problem



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Artificial intelligence is intelligence exhibited by machines, rather than humans or other animals (natural intelligence, NI). In computer science, the field of **AI** ...
Intelligent agent · Artificial general intelligence · Ai · Disambiguation

Artificial intelligence

Field of study

Artificial intelligence is intelligence exhibited by machines, rather than humans or other animals. In computer science, the field of AI research defines itself as the study of "intelligent agents": ...
Wikipedia

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Google's real goal

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Artificial intelligence is intelligence exhibited by machines, rather than humans or other animals (natural intelligence, NI). In computer science, the field of **AI** ...
Intelligent agent · Artificial general intelligence · AI · Disambiguation

Artificial intelligence

Field of study

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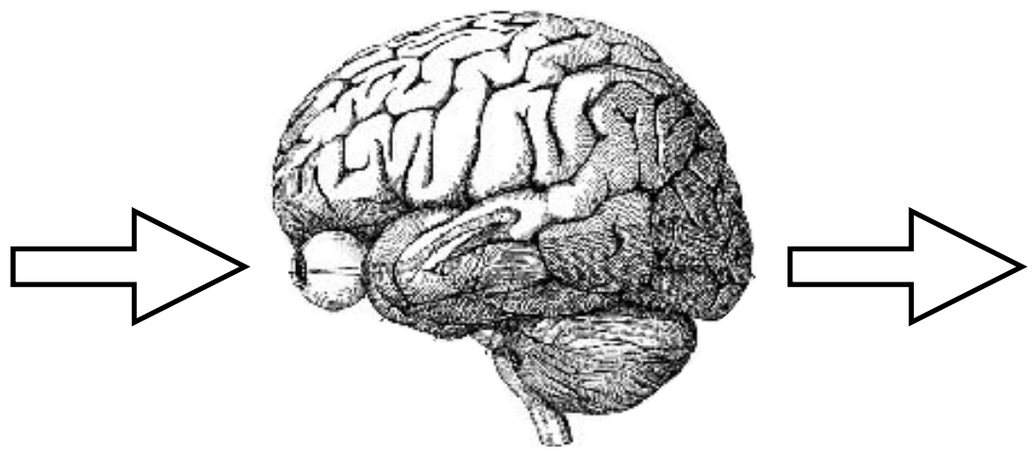
Feedback

Reasoning with uncertain information

Most facts are not concrete and are not known with certainty.



perception cognition action

- facts
- observations
- “fever”
- “aches”
- platelet count=N

- inferences
- What disease?
- What causes?

Probabilistic inference:
How do we give the proper weight to each observation?

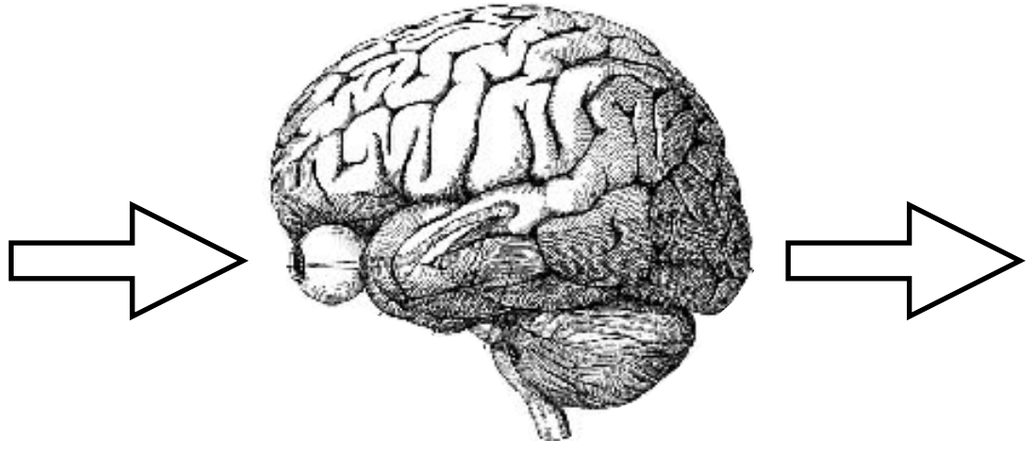
What is ideal?

IBM's Watson


THINK
DENKE
PENSER
$3,400
$4,400
$1,200
KEN
WATSON
BRAD
Purple 98%
Barnaby 20%
Where the Wild Things Are 12%

Learning

What if your world is changing? How do we maintain an accurate model?



perception cognition action

- chess board
- maze
- text
- object
- room
- sound
- visual scene

Learning:
adapt internal representation so that it is as accurate as possible.

Can also adapt our models of other agents.

Where can this go?

- problem solving
- game playing
- computer aided design
- robotics
- internet search
- planning & scheduling logistics
- human-computer interaction
- economics, auction design
- medical/problem diagnosis
- computer aided reasoning

In class, we will focus on general methods for problem representation, inference, and learning.

Agents with artificial intelligence

- In AI, an agent is anything that ***perceives*** and ***acts*** in an ***environment***
  - "*perceives*": input information, e.g. through sensors
  - "*acts*": the response to the percept
  - "*environment*": external environment, problem space

- **Performance measures** define the behavior of a ***rational agent***:
  - a *rational agent* acts to maximize the ***expected performance***

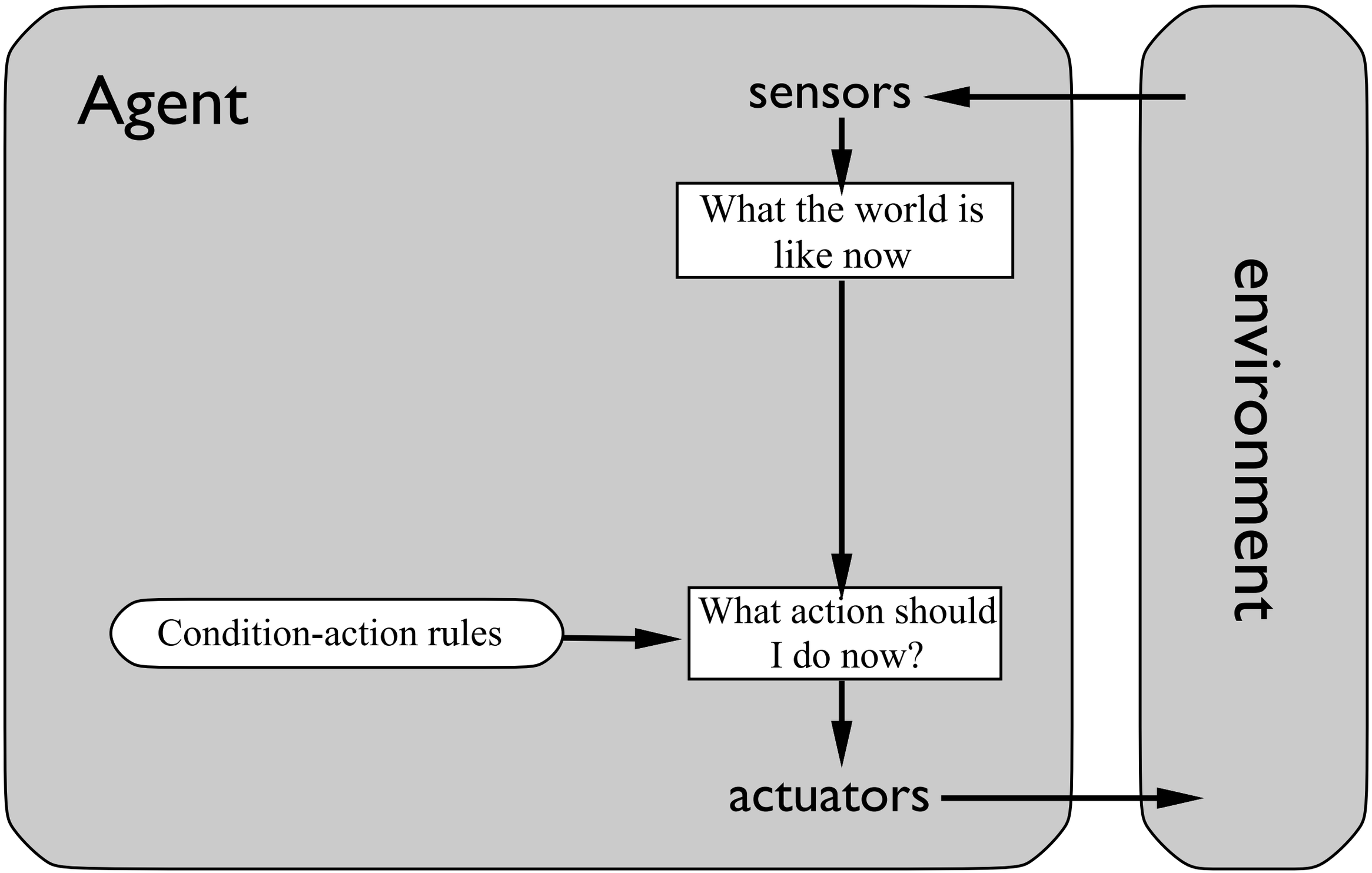
- To specify an agent, we have to define:
  1. Performance measure
  2. Environment of the agent
  3. Actions the agent can perform
  4. Sensors the agent has

- *How do we know if an agent is rational?*

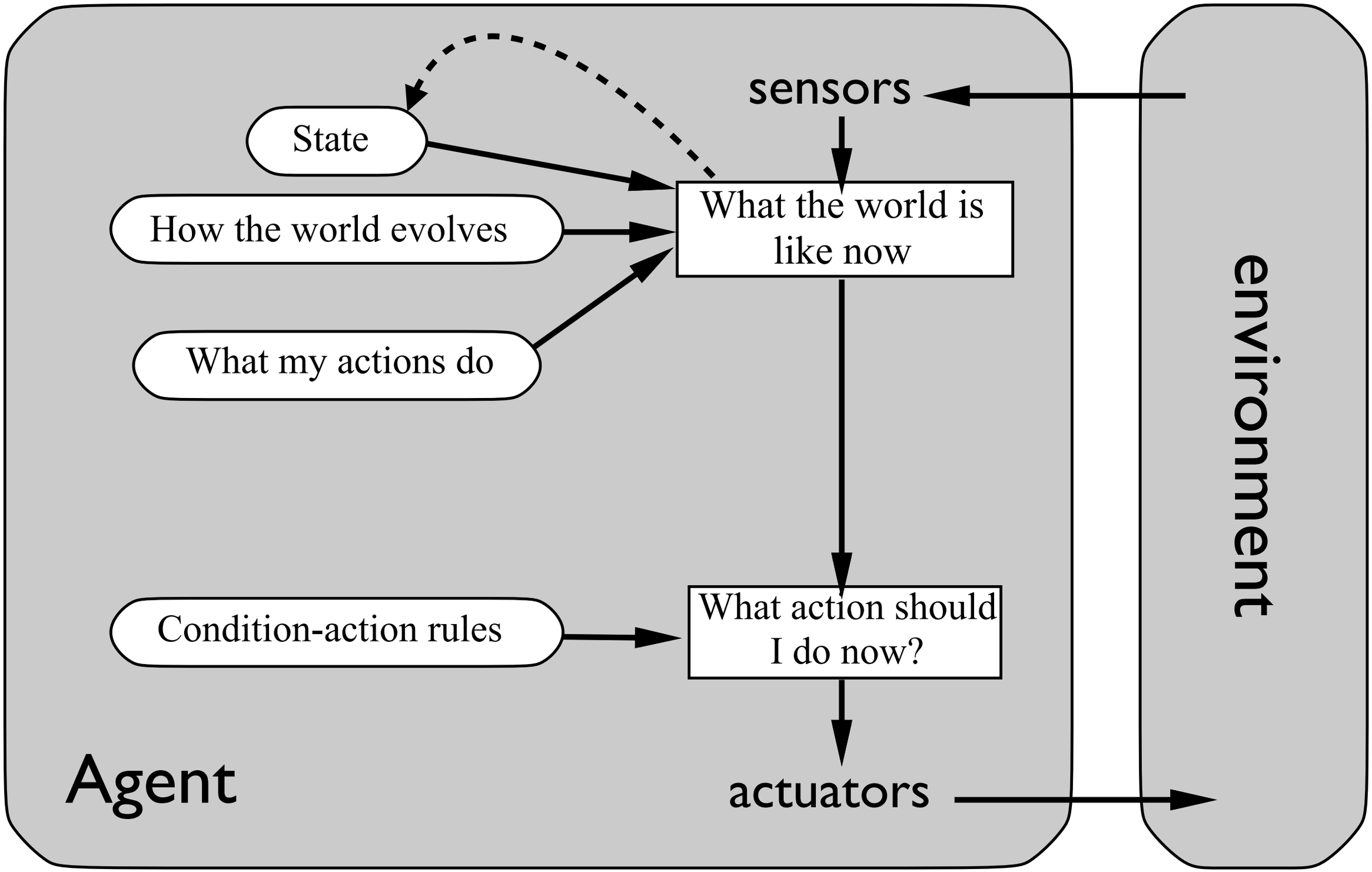
Agent "PEAS" descriptions

Agent type	Performance measure	Environment	Actuators	Sensors
medical diagnosis	health, risk, cost, time	patient, hospital, staff	questions, test, diagnosis, treatment	symptoms, vitals, test results
image analysis	categorization accuracy	image acquisition system	categorization results	image sensor data, rgb pixel values
part sorting robot	sorting accuracy, speed	factory, conveyor belt	arm, actuators	camera, joint angle sensors
refinery controller	product purity, yield	refinery, operators	values, pumps, heaters, etc	flow, temperature, pressure, etc
English tutor	test score, retention	students, testing agency	exercises, suggestions, corrections	keyboard entry, speech

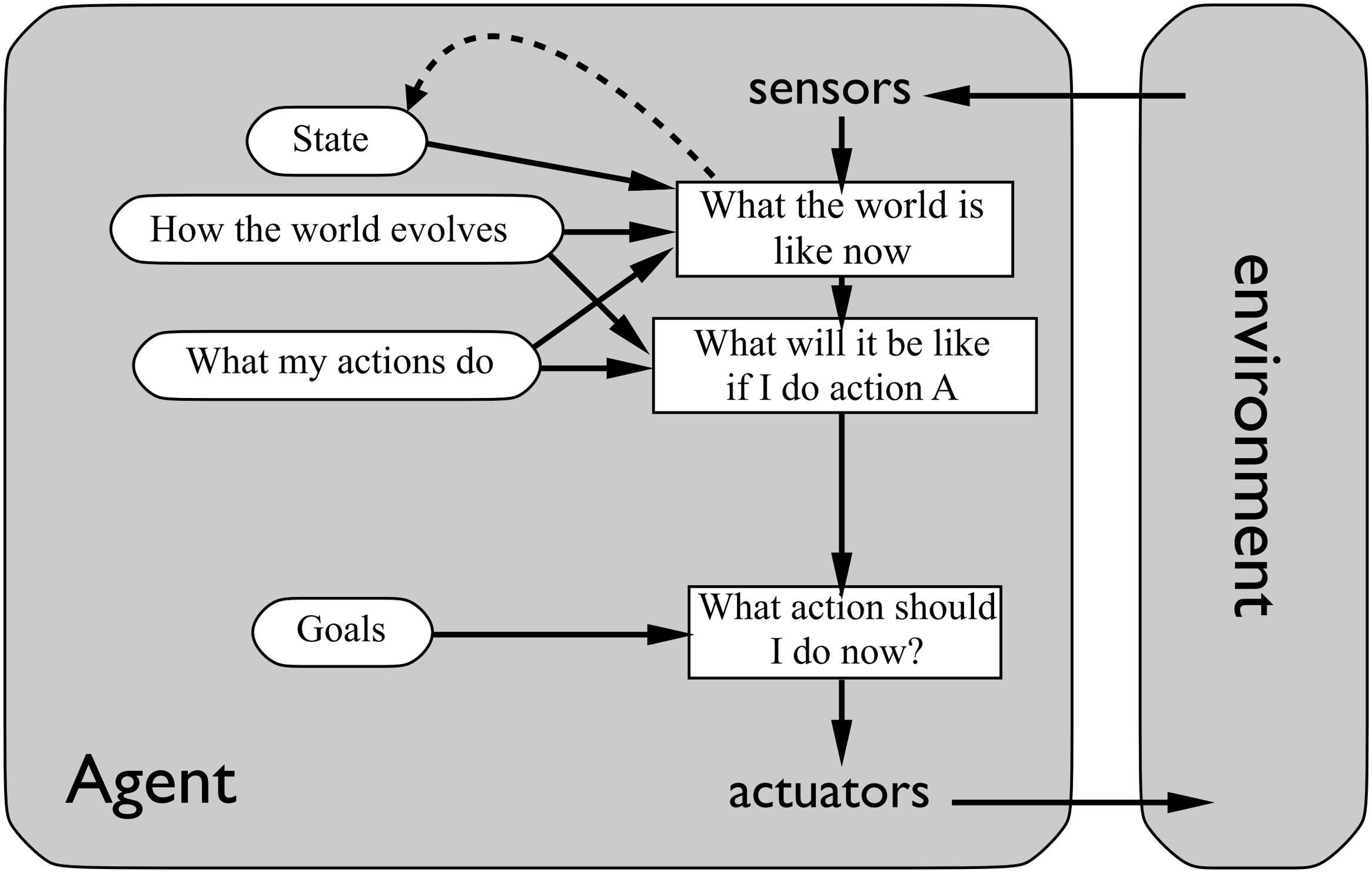
Simple reflex agent



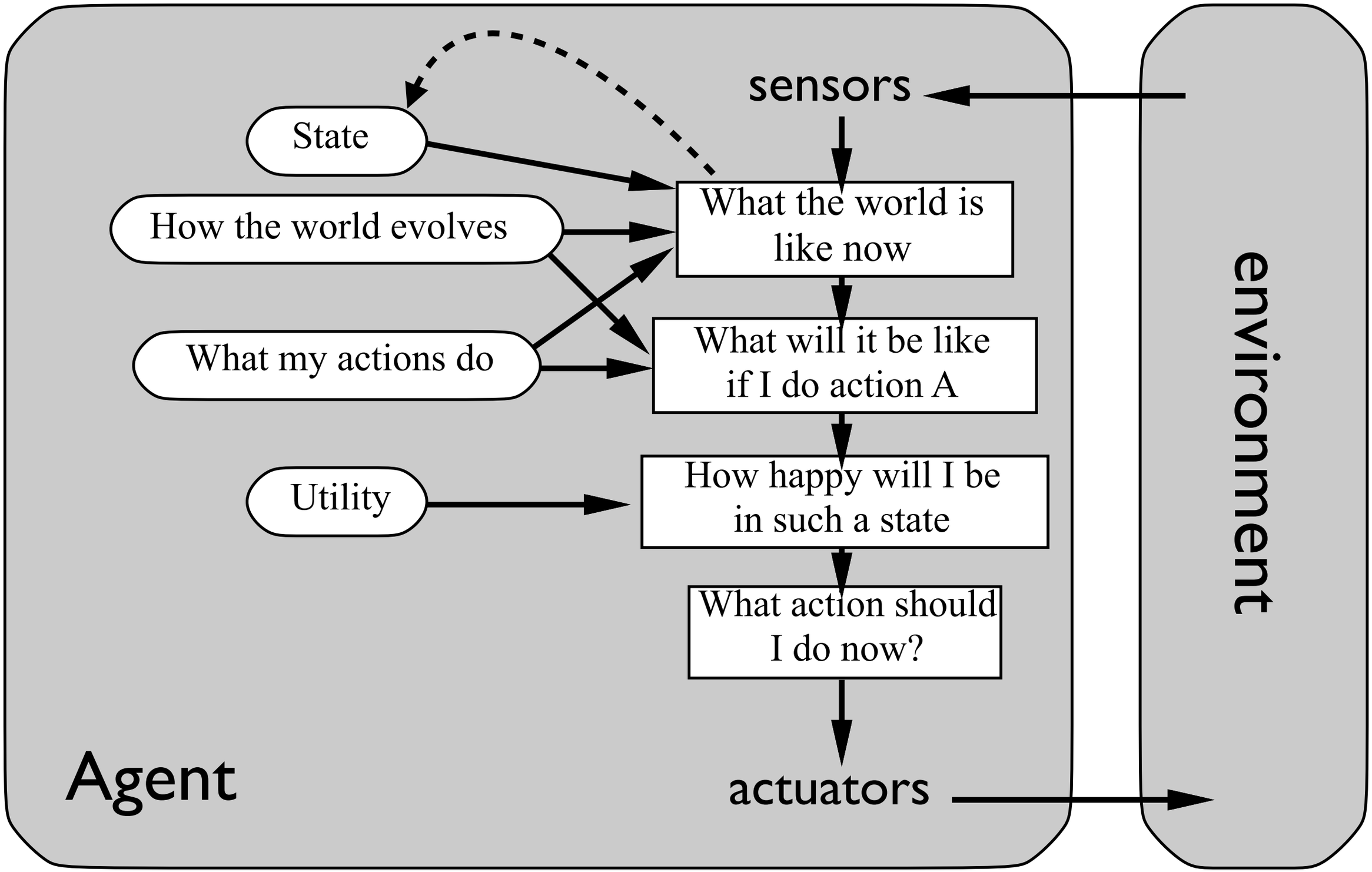
Model-based reflex agent



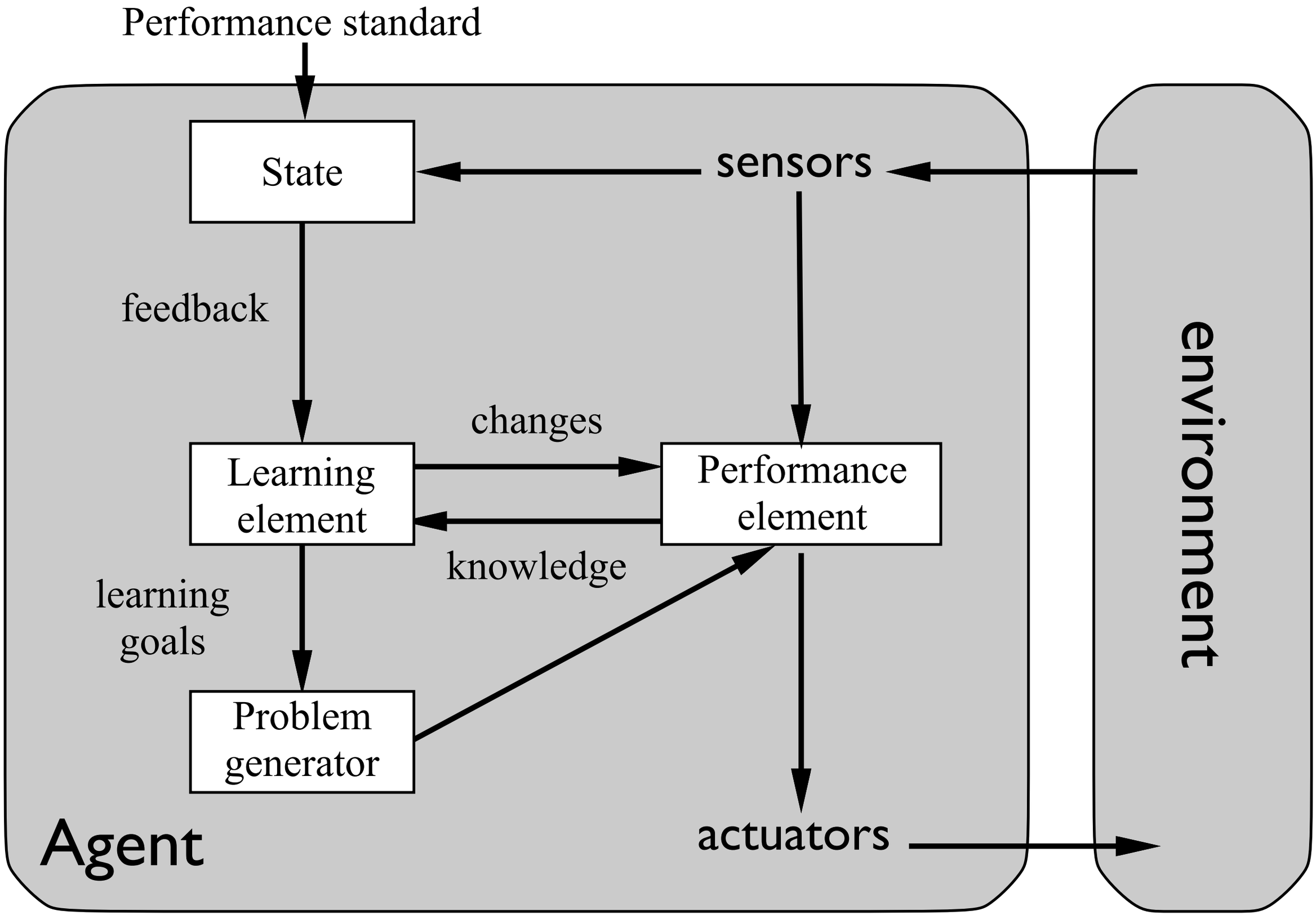
Model-based, goal-based agent



Model-based, utility-based agent



General model of learning agents



Types of environments

- **fully observable** vs **partially observable**
  Can the agent sense the whole environment at once?
  Are the sensors accurate or noisy?
  Does it need to keep an internal representation of the environment?
- **deterministic** vs **stochastic**
  Is the next state completely determined by the current state?
  Is the environment completely predictable?
- **strategic environments** (games)
  Environment is deterministic except for the action of other agents
- **episodic** vs **sequential**
  In episodic environments, the next actions do not depend on previous ones.
  Sequential environments require thinking ahead.
- **static** vs **dynamic**
- **discrete** vs **continuous**
- **single agent** vs **multiagent** (competitive or cooperative?)

Watson today: AI platform for enterprise

- machine learning, reasoning, decision making
- language, speech, and vision processing
- turn business data into "actionable insights that enhance decision making"
- eg: H&R Block: provide best-possible tax outcome for clients
- Ed Harbour, IBM: head of Watson project:

"The biggest misperception about Watson is that it's meant to replace humans."

source: *IBM Watson: Everything You Ever Wanted to Know, The Motley Fool, Aug 30, 2017*