Title: Historical notes & Intelligent Agents

AIMA: Chapters 1 & 2

Introduction to Artificial Intelligence

CSCE 476-876, Spring 2003

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**Terms for glossary:** *Bonus*

**Assigned:** Wednesday, Jan 15

**Due date:** Wednesday, Jan 22

- Agent
- Autonomy (autonomous agent)
- Chinese room experiment
- Cognitive science
- Occam's (or Ockham's) razor
- Rationality (restricted rationality)
- Total Turing test
- Turing machine
- Turing test

## Summary

- Goal of AI:
  - Understand intelligent entities
  - Build intelligent entities
- Multidisciplinary:
  - philosophy, psychology, cognitive science
  - mathematics, engineering, computer science
- Study:
  - general mechanisms
  - specific tasks
- Dimensions:
  - Concern: thought+mental processes vs. action+behavior
  - Performance: human-like vs. rational







## Quick historical note (I)

**1956:** McCarthy organizes a two-month workshop in Dartmouth
no breakthrough, united major players, term coined

**1952-1969:** Early enthusiasm and great expectations
General Problem Solver (Newell & Simon),
Chess program (learning disproved "computers do what they are told to do"),
LISP in 1958, time sharing, principles of knowledge representation and reasoning,
Split: logic (neat) vs. anti-logic (scruffy, clumsy),
Microworlds (*e.g.*, block world: → vision, constraint propagation, NL understanding, planner),
Neural Nets, *etc.*

## Quick historical note (II)

**1966-1974:** hard reality. Too big claims, wildly optimistic

1- Systems work on 1 or 2 examples, failed otherwise
NLP: Russian → English.
The spirit is willing but the flesh is weak
→ the vodka is good but the meat is rotten

2- Intractability: difficulty to scale up, handle combinatorial explosion
UK → report Lighthill in 1973, *etc.*

Neural Net almost disappears

**1969-1979:** Knowledge-based systems

Knowledge-based system (DENDRAL) expert knowledge
expert systems (MYCIN), certainty factors, frames (OO!)



## Quick historical note (III)

**1980-1988:** AI becomes an industry

R1 at DEC, Fifth Generation project.
S/W: Carnegie Group, Inference, Intellicorp, Teknowledge
H/W: Lisp Machines, TI, Symbolics, Xerox.

**1986:** Expert Systems failed; Neural Networks returned.

Late 80's-early 90's: AI winter

**1988-:** Resurgence of probabilistic & decision theory (UAI).

"Nouvelle AI:" ALife, GAs, soft computing

**Present:** Big changes.

Claims more rigorously supported: empirically or theoretically

# Intelligent Agents

- Definition and components (PAGE)
- Types of Intelligent Agents
- Types of environments

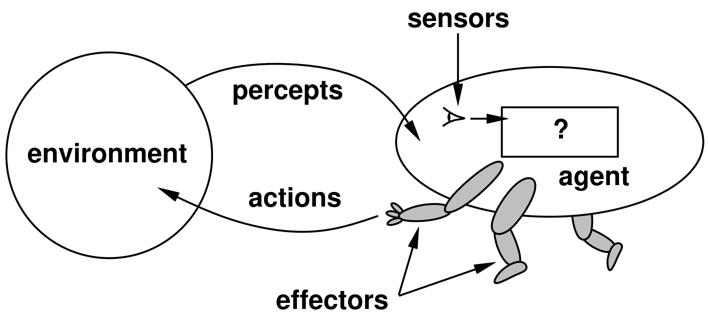






# Agent

Anything that $\begin{cases} \text{perceives its environment through sensors} \\ \text{acts upon its environment through effectors} \end{cases}$




**Human:** sensors? effectors?

**Robot:** sensors? effectors?

**Software:** sensors? effectors?

**Goal of AI:** build <u>rational</u> agents. Rational = ?

**What is "rational" depends on:**

1. Performance measures (how, when)
2. Perceptual history: everything agent has perceived so far
3. What the agent knows about the environment
4. Actions the agent can perform

**Ideal rational agent:** PAGE

- For each perceptual history, **P**ercepts
- chooses an action **A**ctions
- to maximize performance measures ($\rightarrow$ key!) **G**oals
- given perceptual history and built-in knowledge **E**nvironment



## Examples

| Agent Type | Percepts | Actions | Goals | Environment |
|---|---|---|---|---|
| Medical diagnosis system | Symptoms, findings, patient's answers | Questions, tests, treatments | Healthy patient, minimize costs | Patient, hospital |
| Satellite image analysis system | Pixels of varying intensity, color | Print a categorization of scene | Correct categorization | Images from orbiting satellite |
| Part-picking robot | Pixels of varying intensity | Pick up parts and sort into bins | Place parts in correct bins | Conveyor belt with parts |
| Refinery controller | Temperature, pressure readings | Open, close valves; adjust temperature | Maximize purity, yield, safety | Refinery |
| Interactive English tutor | Typed words | Print exercises, suggestions, corrections | Maximize student's score on test | Set of students |

# PAGE

The task of designing an automated taxi:

**Percepts:**

**Actions:**

**Goals:**

**Environment:**







# PAGE: automated taxi

**Percepts:** video, accelerometers, engine sensors, keyboard, microphone, GPS, ...

**Actions:** steer, accelerate, brake, horn, speak/display, ...

**Goals:** safety, reach destination, maximize profits (fuel, tire wear), obey laws, passenger comfort, ...

**Environment:** US urban streets, freeways, traffic, pedestrians, weather, customers, ...

$\longrightarrow$ Different aspects of driving, different types of agent programs

# Types of Agents

Four, in order of increasing generality:

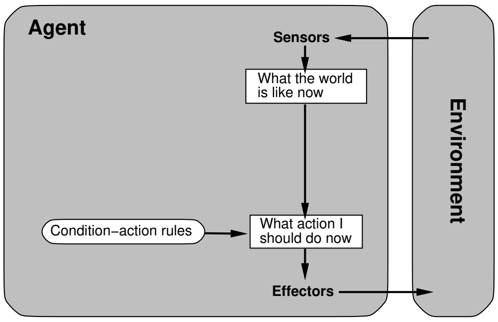
1. Simple reflex agent
2. Agents that keep track of the world
3. Goal-based agents
4. Utility-based agents



# Simple reflex agent

• Simple look-up table, mapping percepts to actions, is out of question (too large, too expensive to build)

• Many situations can be summarized by condition-action rules (humans: learned responses, innate reflexes)



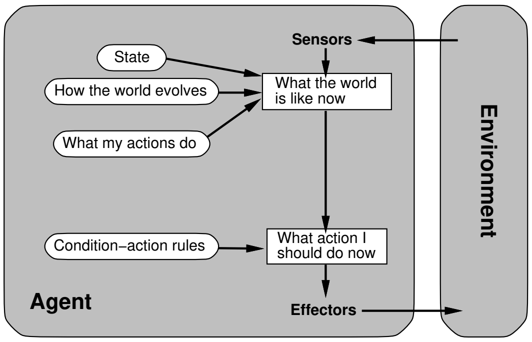

Rectangles: agent's internal state　　Ovals: background information

Implementation: easy; Applicability: narrow

## Agents that keep track of the world

- Sensory information alone is not sufficient
- Need to keep track of how the world evolves

(evolution: independently of agent, or caused by agent's actions)



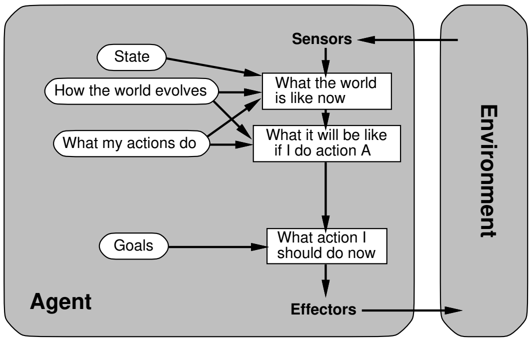







## Goal-based agents

- State & actions don't tell <u>where</u> to go
- Need goals to build sequences of actions (planning)

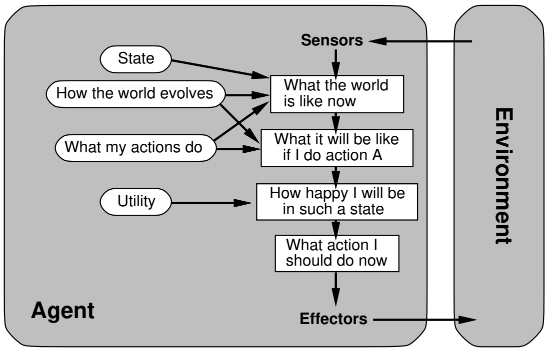



Goal-based: uses the same rules for different goals

Reflex: will need a complete set of rules for each goal

## Utility-based agents

- Several action sequences to achieve some goal (binary process)
- Need to select among actions & sequences. Preferences.
- Utility: State → real number (express degree of satisfaction, specify trade-offs between conflicting goal)






## Environment (I)

typical quizz question

**Accessible:** sensors can detect all aspects of the world
Effectively accessible: relevant aspects

**Deterministic:**
Next state determined by current state and agents' actions
Inaccessible + deterministic appears nondeterministic from the agent's view point

**Episodic:** Agent's experience divided into episodes; subsequent episodes do not depend on actions in previous episodes

**Static vs. dynamic:**
Dynamic: Environment changes while agent is deliberating
Semi-dynamic: environment static, performance scores dynamic

**Discrete vs. continuous:** Finite number of precepts, actions
Chess? Taxi driving? hardest case?

## **Environment** (II)

Hardest case: inaccessible, nondeterministic, nonepisodic, dynamic, continuous

| | Solitaire | Backgammon | Internet shopping | Taxi |
|---|---|---|---|---|
| Accessible | | | | |
| Deterministic | | | | |
| Episodic | | | | |
| Static | | | | |
| Discrete | | | | |

Answers depend on how you define/interpret the case

Episodic: chess tournament