Title: Historical notes & Intelligent Agents

AIMA: Chapters 1 & 2

Introduction to Artificial Intelligence

CSCE 476-876, Spring 2002

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Terms for glossary: (20 terms) *Bonus*

Assigned: Wednesday, Jan 16, 2002

Due date: Wednesday, Jan 23, 2002 (instead of Monday).

Agent

Autonomy (autonomous agent)

Chinese room experiment

Cognitive science Condition-action rule

Decision theory

Deduction

Hidden Markov Models

Induction

Intractability

Occam's (or Ockham's) razor

Planning

Prolog

Rationality (restricted rationality)

Reduction (problem reduction)

Total Turing test

Turing machine

Turing test

Syllogism

Utility

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.

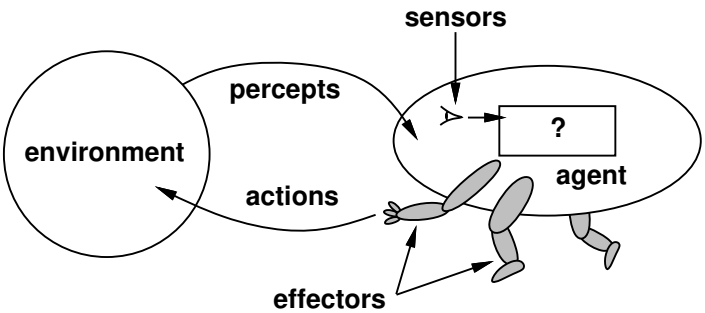
Claims more rigorously supported: empirically or theoretically

Intelligent Agents

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

Agent

Anything that { perceives its environment through sensors
acts upon its environment through effectors



Human: sensors? effectors?

Robot: sensors? effectors?

Software: sensors? effectors?

Goal of AI: build rational 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

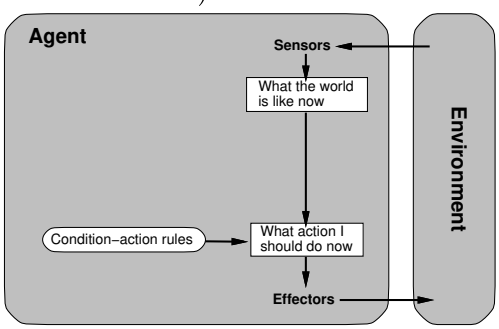
Four, in order of increasing generality:

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)



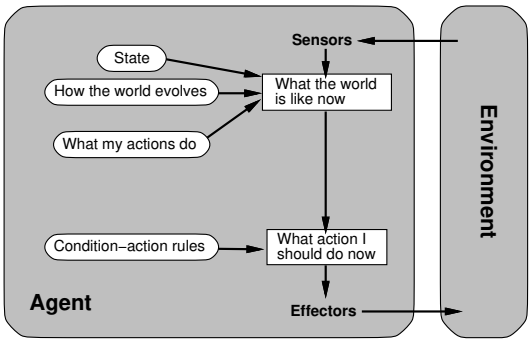
Rectangles: agent's internal state Ovals: background information

Implementation: easy; Applicability: narrow

Agents that keep track of the world

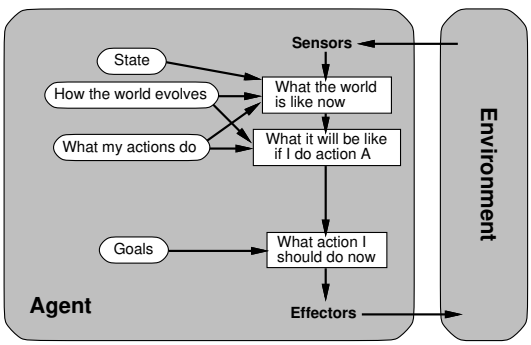
- Sensory information alone is not sufficient
- Need to keep track of how the world evolves

(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)

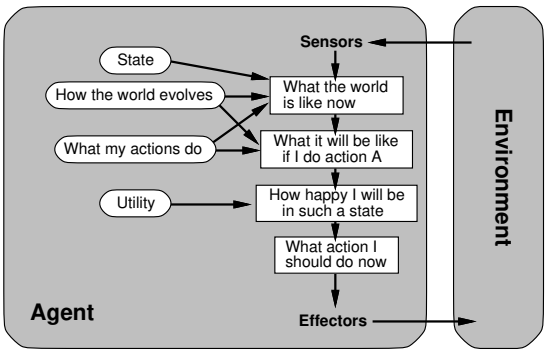


Goal-based: uses the same rules for different goals

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