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Artificial Intelligence (AI)

When was it called / named so? — 1956 Dartmouth Meeting. AI first coined. John McCathy

Views of AI

4 categories:

① → System that think like humans.
(thinking, mind-body dualism, think before action or action before think)

② → System that act like humans. (Turing Test)

③ → System that think rationally.

④ → System that act rationally.

· Cognitive Modelling
→ thought process
→ perspection

Alan Turing Test's counter → Chinese Room Argument.

Rational → right / correct.

(The first 50 Dates)

Intelligence → through characteristics

② Turing test passing characteristics
→ Natural Language Processing
→ Knowledge Representation (store & usage of knowledge)
→ Automated Reasoning
→ ML

Total turing test pass
→ Computer Vision
→ Robotics (Mobility)

Roots

parent disciplines of AI

Philosophy & cognitive science | Maths | Psychology | Computer Science

Artificial Intelligence

Reasoning, learning, planning, perception, knowledge aquisition
Intelligent search, uncertainty management, others

└ subjects covered under AI ┘

Game Playing | Theorem Proving | Language & Image Understanding | Robotics & Navigation

Application areas of AI

AI.

Intelligence:

→ Ability to interact with the real world
→ Reasoning and planning
→ Learning and adaptation.

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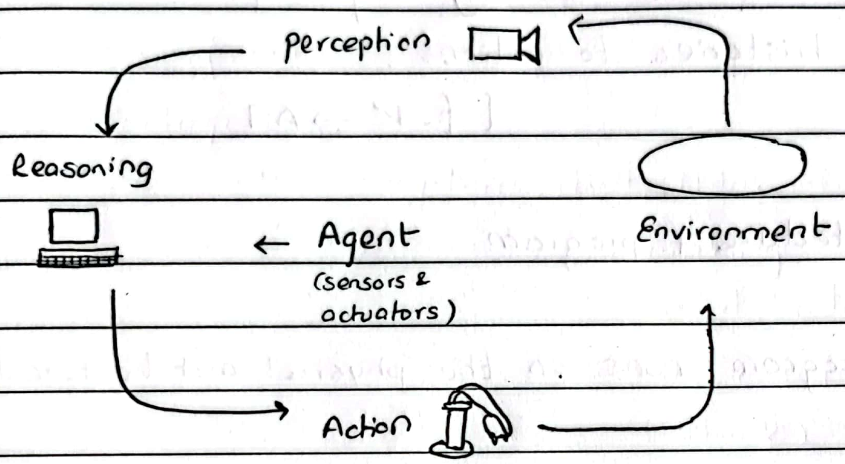
* Intelligent Agents

Components of an AI system:



An agent perceives its env. through sensors & acts on the env. through actuators.

1) Human: sensors are eyes, ears & actuators (effectors) are hands, legs, mouth.

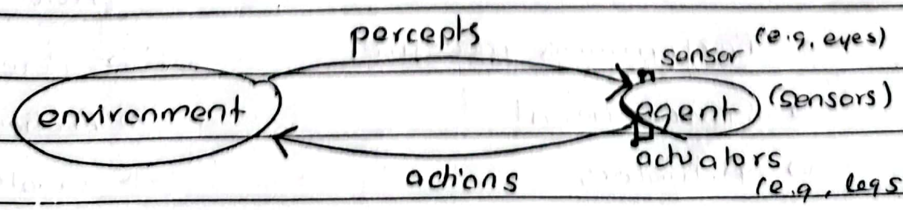
2) Robot (Hardbot): sensors are cameras, sonar, lasers, ladar, bump
effectors are grippers, manipulators, motors.

3) Softbot (chatbots.)

The agent's behavior is decribed by its function that maps percept to action.

State 1 : Rule → Action
State 2 : Rule → Action
- - - - - -

Agents



An agent choice of action at any given instance can depend on entire percept sequence observed to date.

Agent behavior described best by agent function that maps from percept histories to actions :

$$[f. P^* \rightarrow A]$$

Agent = architecture + program

The agent program runs on the physical architecture to produce f

* Rational Agents
  - "do the right thing"

omniscience → state of knowing everything.

- Rationality is different from omniscience.
- Rational agent learns
- Autonomous agent (still needs to maintain rationalism)

* Rationality at a given time depends upon.
  - The performance measure that define the success criteria.
  - The agent's prior knowledge of the environment.
  - The actions that the agent can perform
  - The agent's percept sequence.

* Factors Defining Agents

PEAS

↳ Performance measure.
→ Environment
↳ Actuators
↳ Sensors

OR

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→ Percepts
→ Actions
→ Goals
→ Environment

Environment Properties

- Fully observable / accessible vs. partially observable / partially accessible
- Deterministic vs. stochastic / strategic
- Episodic vs. sequential
- Static vs. dynamic
- Discrete vs. continuous
- ~~Sig~~ Single agent vs. multiagent.

Fully observable → chess, tictactoe moves prediction / action by computer.

Partially obsewable → e.g. you going to ktm.

Deterministic → if current state depends on previous state.

Stochastic → probabilistic strategies.

Static → if it doesn't change the state even after we give input.

Continuous → changes with time.

chess → multi-agent, discrete.

Agent Types:

- Simple reflex agents
- Model-based reflex agents
- Goal based agents
-

Simple reflex agent
- Use simple "if then" rules
- Can be short sighted
- will work only if environment is fully observable.

- Model based reflex agent
  → stores previously observed information.

- Goal
  ~~Utility~~- based agents
  needs a goal to know which situations are desirable.

- Utility-based agents
  → certain goals can be reached in different ways. Some are better and have higher utility.

Learning agent

fig..

critic gives continuous feedbacks to the learning element.

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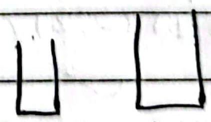
* Problem Types

- Deterministic, fully observable
  → Single state problem
  Agent knows exactly which state it will be in ; sol^n is a sequence.
- Non- observable
  → Sensor Loss problem (conformant problem)
  Agent may have no idea where it is ; sol^n is a sequence.
- Nondeterministic and/or partially observable
  → contigency problem
  percepts provide new info about current state.
  often interleave search, execution
- Unknown state space → exploration problem.

* Well- Defined Problems

- Initial State
- Actions
- Goal test
- Path cost
- A state space consists of :
  → A (possibly infinite) set of states. (start state + --- + end state)
  → A set of operators.
  ↳ transforms state from one to other.

State space : Water Jug Problem



3 Litres 4 lt.

How to get 2lt. in 4lt. jug?

- State (x, y)

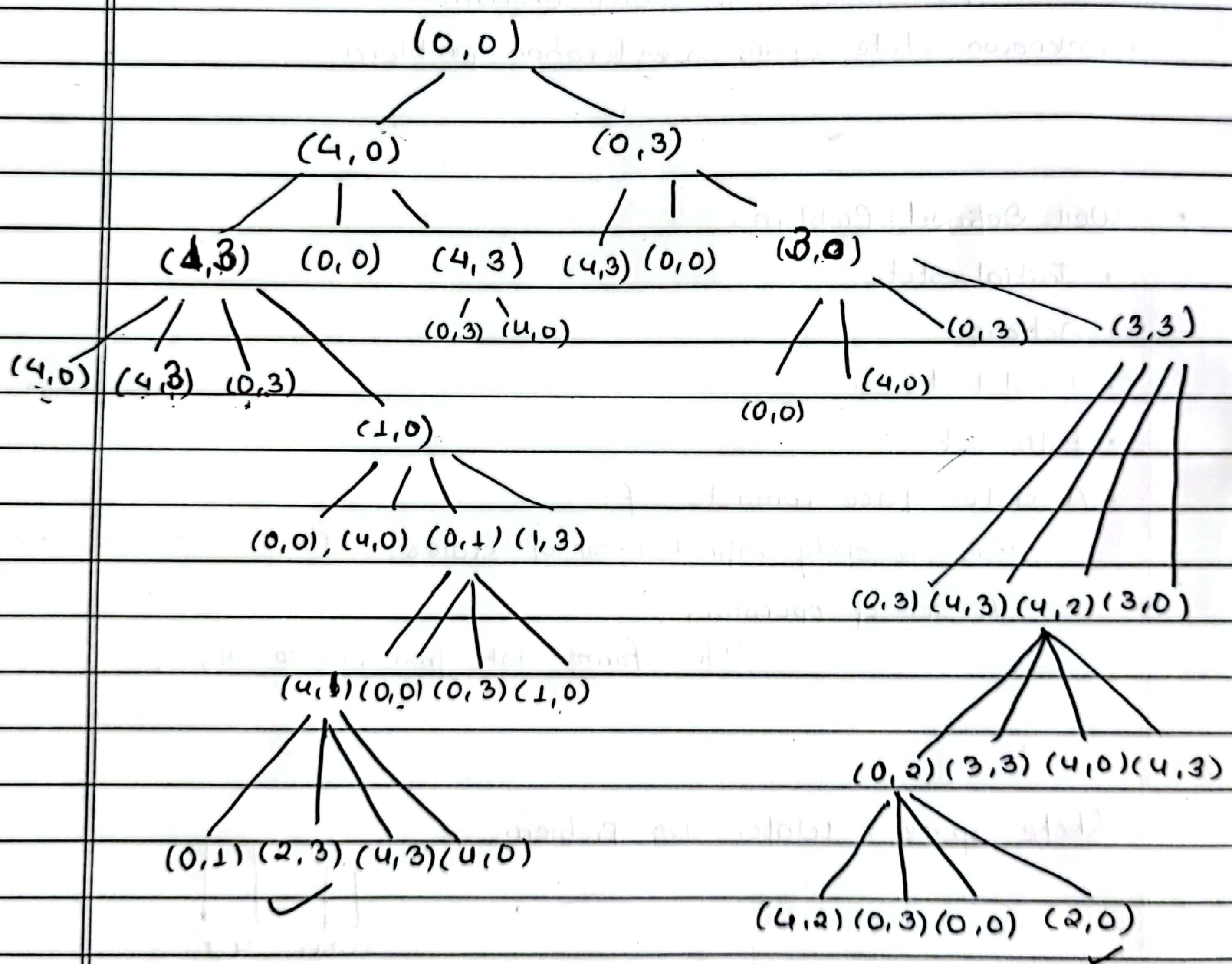
  $x = 0, 1, 2, 3$ or 4

  $y = 0, 1, 2, 3$
- Initial state $(0,0)$
- Goal state $(2, n)$ for any n
- Attempting to end up in a goal state.

- State Space Tree

Search Tree

4	3



alb. → $\boxed{3,3,0} \xrightarrow{1,1} \boxed{2,2,1}$ - - - -

Missionaries & cannibal problem

Solution state : (State space - solution path)

(3m, 3c
canoe)

↓ 1m1c

(2m, 2c)

↓ 1m

(3m, 2c, canoe)

↓ 2c

(3m, 0)

↓ 1c

(3m, 1c, canoe)

↓ 2m

(1m, 1c)

↓ 1m1c

(2m, 2c, canoe)

↓ 2m

(0m, 2c)

↓ 1c

(0m, 3c, canoe)

↓ 2c

(0m, 1c) $\xrightarrow{1c}$ (0m, 2c, canoe) $\xrightarrow{2c}$ (0m, 0c)

	mmmccc
	mc ←
c	mmmcc
	← cc
cc	mmmc
	mm ←
	c →
cm	mmcc

Uninformed → slides..

Informed Search Algorithms

A* search → A algorithm.

Best first search

Greedy best-first search algorithm not optimal → e.g. slids
Arad → Bukarest

Heuristic

→ guess, intuition, instinct

Optimality of A*

Theorem proof

$f(G_2) > f(G_1)$ Since G_2 is suboptimal with obvious greater cost than G_1.

$h(n) \leq h^*(n)$ since h is admissible (under-estimate)

$g(n) + h(n) \leq g(n) + h^*(n)$

$f(n) \leq f(G)$ since $g(n) + h(n) = f(n)$ & $g(n) + h^*(n) = f(G)$

$f(n) < f(G_2)$ from top.

Hence, n is preferred over G_2.

7	2	4			1	2
5		6		3	4	5
8	3	1		6	7	8

Total Manhattan distance = 3 + 1 + 2 + 2 + 2 + 3 + 3 + 2

$h_2(s)$

= 18

$h_1(s)$

no. of misplaced tiles = 8

Exercise.

Initial

2	8	3 ✓
1	6	4 ✓
7		5 ✓

Goal

1	2	3
8		4
7	6	5

Total Manhattan distance $= 1+1+0+0+0+1+0+2$

$h_1(s) = \cancel{4}\ 5$

no. of misplaced tiles = ~~5~~ ~~6~~ 5

2	8	3
1	6	4
7		5

LRDU

2	8	3
1	6	4
7	5	

2	8	3
1	6	4
	7	5

2	8	3
1		4
7	6	5

2	8	3
1	6	4
7		5

⇒

1	2	3
8		4
7	6	5

2	8	3
1	6	4
7		5

h = 5 , g = 0

h = 6
g = 1

2	8	3
1	6	4
7	5	

2	8	3
1		4
7	6	5

h = 4
g = 1

2	8	3
1	6	4
	7	5

h = 6
g = 1

h = 3
g = 2

2		3
1	8	4
7	6	5

h = 5

2	8	3
	1	4
7	6	5

h = 5

2	8	3
1	4	
7	6	5

h = 2
g = 3

	2	3
1	8	4
7	6	5

2	3	
1	8	4
7	6	5

h = ~~8~~ 4

h = 1
g = 4

1	2	3
	8	4
7	6	5

1	2	3
7	8	4
	6	5

h = 2
g = 5.

h = 0
g = 5

1	2	3
8		4
7	6	5