Artificial Intelligence - 2018
AI Intro, Uninformed, informed Search

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Introduction to Artificial Intelligence

Intelligent tasks

- Learning
- Problem solving
- Image recognition
- Voice recognition
- Navigation ability
- Ability to remember
- Working in unknown environment
- Ability to make a guess

Nowadays most of these intelligent features are also built into machines. Few AI programs;

- IBM watson
- IBM deep blue
- Siri
- Alpha Go
- Asimo
- DART

What is AI?

- A - Artificial
- I - Intelligence

There are so many definitions around the world, but basically, AI is concerned with the design of intelligence in an artificial device (an agent)
That means, having artificial or man made devices and intelligence built into them.

What is Intelligence?

We can take intelligence as something that characterizes human.
Artificial intelligence is having behaviour like a human.
There are 2 ways of how the intelligence is concerned by artificial intelligence.

1. Have a machine or a system that behaves intelligently like a human.
   But humans are not always completely intelligent, even there are some intelligent people among us, but they're also not all the time behave intelligently. So, the 2nd thought is;

2. Machine should behave in the best possible manner, which is the ideal or the most rational intelligence. So, it should be able to overtake the human intelligence.

So, we talked about something "behave". What sort of behaviour we're talking about? (two main types)

1. Thinking - reasoning properly to come up with a solution.
2. Acting - how the system actually acts or behave.

So, based on those, can see the different ways of defining AI.

Thought - (processing/reasoning) vs behaviour (act)
Human like performance vs ideal performance.

Four schools of thought

There is no unique definition for machine intelligence and there are four major schools of thought. Not having a single definition doesn't mean AI is weak but many opportunity for expansion.

For instance during Buddha's time there were 62 different viewpoints about the life after death. As another example Dolton and Einstein had two different views about the atom.

01) Acting humanly

According to this view AI wants to develop machines that can behave like human beings. This is exactly what turing test talked about.
But this prevent building animal intelligence (birds, monkeys, ants, bees, ...)

02) Thinking Humanly

According to this view AI wants to develop machines that can think like humans.
Ex : problem solving, playing games, planning, scheduling, proving theorems we need thinking.
We have already seen machines with those features. (IBM Deep Blue, Alpha Go)

03) Thinking Rationally

According to this view AI wants to develop machine can work based on logic.
Many programs like NLP systems, expert systems are based on logic.
We need logic in maths, law, …

In reality logic doesn't reveal the truth all the time. For example how can a murderer be outside and an innocent person goes to jail after debating in the court?

Chain rule :
p ---> q
q ---> r
Therefore, p → r

If baby is dead then baby does not cry.
If baby doesn't cry then mother is happy.
Therefore,
If baby is dead then mother is happy ?

04) Acting Rationally

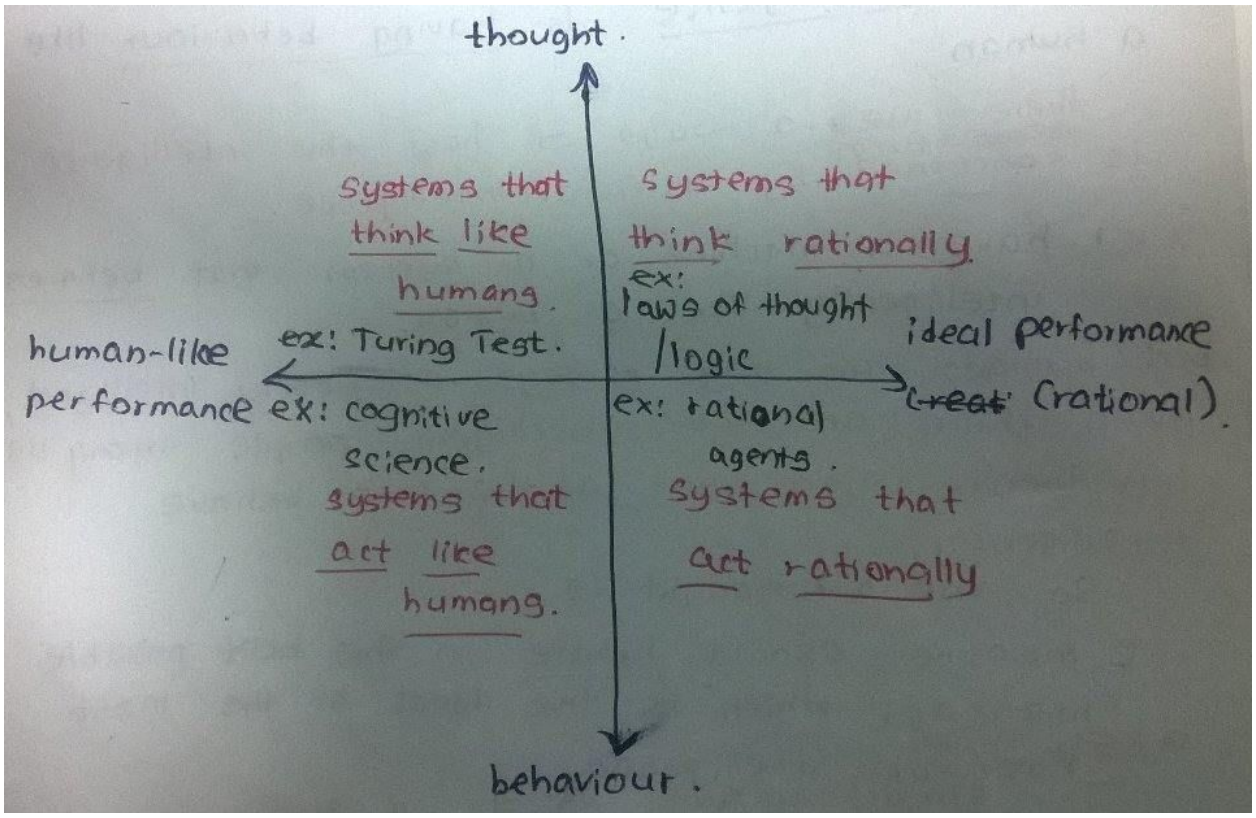
This view suggest that AI wants to build machines that do the right thing.
Here the term, "right" stands for most appropriate practical, cost effective, etc. but not necessarily logical or being like human.

For an example your home robot bring a cup of tea with a piece of chocolate when sugar is not there, you may say the robot is intelligent. If the robot went by logic or algorithm when sugar is not there he cannot proceed work all the time.

We also expect human being to be act rationally (doing right thing) rather than being logical or behaving like human all the time.

The modern approach to AI is considered as building rational agent program.

There are many definitions for AI by different people, but comes under this four schools of thought.



Example for thinking humanly

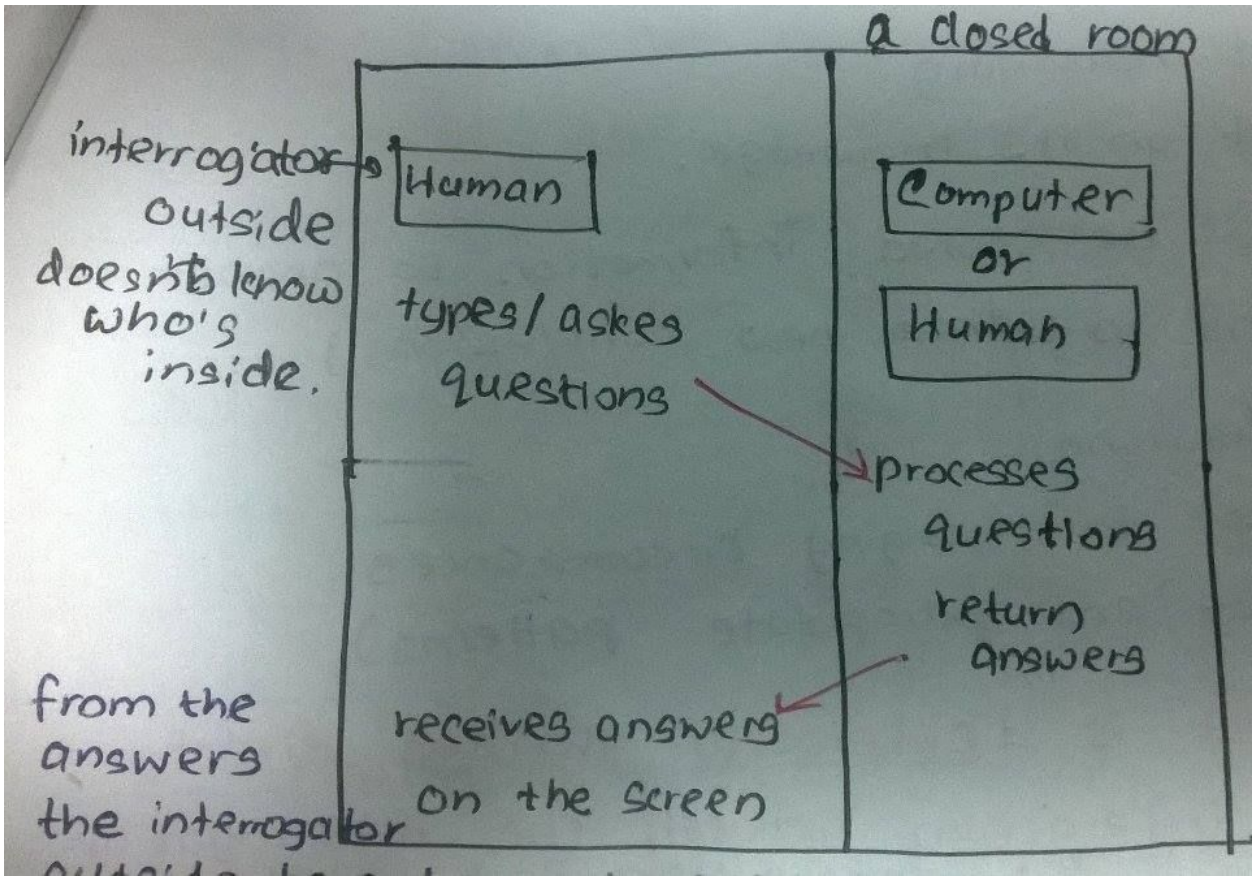
Turing Test - Proposed by father of AI : Alan Turing , 1950

How we can claim that a machine is intelligent or not?
Turing has proposed a simple test to talk about machine intelligence.

- There is a closed room, it can be a computer (or a human) inside.
- There is an interrogator outside, doesn't know who is inside. It asks/types questions, the thing inside will process questions and return answers to outside, interrogator receives answers on the screen.
- From the answers, the interrogator outside have to make-out who's inside the room, a computer or a human?
- If a computer is inside, it tries to claim that it's actually a human being, in the way it answers to the questions.

- It is the task to the interrogator to decide who's human, what is inside the room.

- If the interrogator cannot reliably distinguish the human from the computer, then the computer possesses intelligent which is artificial.
- By turing test, to see whether the machine can come up with the right amount of intelligence to match human intelligence by answering questions.



Another way;

- Assume that a woman and a man kept in two rooms and communicating with a third person through a keyboard without seeing each other.
- Now assume that man is replaced with a machine without knowing each other.
- Interrogator or the third person is continued asking questions from two rooms.
- If he noticed answers from the two rooms are the same, then he may say that machine and the woman are equally intelligent.

The following capabilities should be in the computer to pass the turing test.

1. Natural language processing - enable to communicate successfully in English (to understand the question)
2. Knowledge representation - to store what it knows or hears
3. Automated reasoning - to act on its knowledge (to use the stored information to answer questions and to draw new conclusions)
4. Machine learning - to adapt to changing circumstances (to detect and extrapolate patterns)

Turing test deliberately avoided direct physical interaction between the interrogate or and the computer. The questions were sent in written form. (because physical simulation of a person is unnecessary for intelligence)

Total Turing Test

Standard turing test is limited to textual input. But if you want to ask question about images, moving objects maybe in voice form, we need an extended input interface with image processing, computer vision, motion tracking, natural language processing, etc.

Some of the physical interaction is also included. Ex : interrogation sends a video signal. So then the interrogator can test the subject's perceptual abilities. Interrogator passes physical objects "through the hatch"
To pass the total turing test, the computer will need,

Computer vision - to perceive objects
Robotics - to manipulate objects and move about.

But the implication of this test is that intelligent is a comparative thing.

Question
Using Turing test explain that a calculator can be considered as an intelligent machine.

Selecting a 3 year old child to compare with a calculator and by asking to find the square root of a big number, we can say the calculator is more capable than the child.

Question
Using turing test explain that MS word cannot be considered as an intelligent program.

Compare with an English professor and ask to rephrase a paragraph to give the same meaning.

In summary, turing test can be used to prove that machine is intelligent or not intelligent depended on with whom the comparison is done and what kind of questions been asked.

Example for acting humanly

Cognitive Science

What are the cognitive features : thinking, remembering, creativity, etc.

Expert System is the champion of cognitive systems.

A model of problem solving by experts, where subject specific knowledge and problem solving knowledge can be maintained separately.

Example : A medical doctor can be taken as an example for an expert. Two doctors may have same subject knowledge but they are different because of the difference in problem solving knowledge.

Features of an expert system are similar to features of human experts:

1. Asking questions is dominated by the experts but not the client.
2. Even with an incomplete information from a client, an expert can proceed with some assumptions.
3. Experts can give more than one answer to a question.
4. Can give reasons to the answer.
5. Expert knows the amount of the validity of the answer.

https://www.youtube.com/watch?v=GLCares2LRA

Knowledge Engineering

The scenario when a person / human interacting with the environment

Sense the environment, take some data from the environment, process it and make some decisions / act on the environment.

Agent System

A computer has replaced the human is Artificial Intelligence.

- How to act on when it is working on the environment.
- Make decision

How to do this ?

01) Read the environment, in terms of data.

Kind of images, you see images, objects, read text, see emotions / expressions.

In Digital Image Processing - see / capture something and understand it
In Speech Processing - listen and understand
In NLP Natural Language Processing - read and understand

02) Knowledge

After reading it will understand this is the environment. Then it will make decisions. To make decisions, it needs knowledge, about the environment and what the environment need from it.
Knowledge gathered from sources like textbooks called as basic knowledge and other knowledge is acquired through the experience, called as practical knowledge.

Basic Knowledge

About the environment, initial knowledge of the environment.
Business environment, business knowledge, when working on a “e-commerce” platform, about the company : what kind of customers are handling by the company, customer profile,behaviours, understanding the external environment.

Practical Knowledge

Using these inputs, apply them into this knowledge , it will give some output. That input is coming from the environment. It can be talk ; speech processing, facial / emotional expressions, NLP.

Once you experienced, once you performed an action on the environment, by that experience, update to the basic knowledge. Can mine the experience and understand new knowledge called as updating your knowledge. When continuously interacting with the environment, can update the knowledge.
Can gather knowledge from books or from someone else’s experience , can execute, once you executed you can get your own experience, can derive your knowledge out of that.
The past data, that can be mined

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Complex vs Complicated Problems

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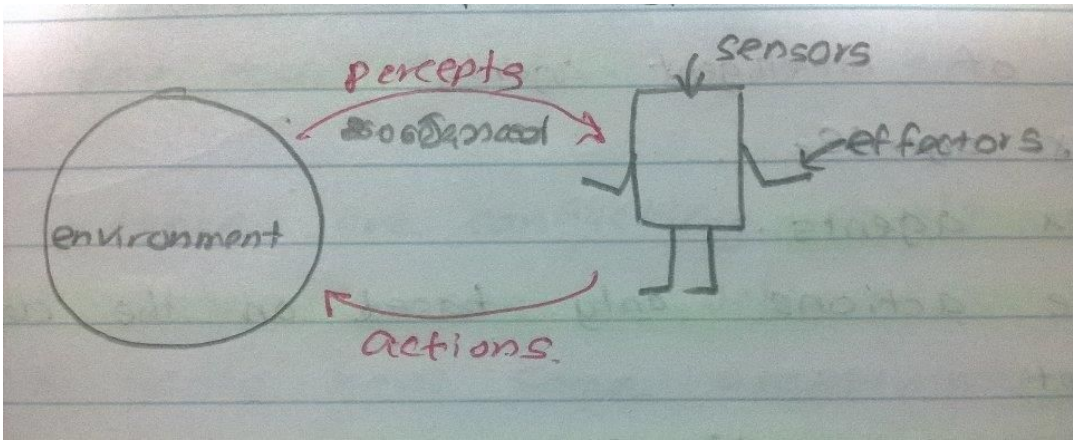
AI system is composed of an agent and its environment. An agent acts in their environment. That environment can contain other agents too,

What is agent and environment

1. Human agent - has sensory organs : eyes, ears, nose, tongue and skin parallel to the sensors. And other organs : hands, legs, mouth as effectors.
2. Robotic agents - sensors : camera, infrared range finders. Effectors : motors, actuators
3. Software agent - has encoded bit strings as programs and actions



Agent terminology

1. Performance measure - how successful the agent is
2. Behaviour - action that agent perform after any given sequence of percepts.
3. Percept - perceptual inputs at a given instance
4. Percept sequence - history of all it perceived till date.
5. Agent function - where percept sequence maps action

Rational agent

They are intelligent agents
Capable of doing actions to maximize its performance measure, based on:-
    Percept sequence
    Built in knowledge
Always performs right action

Structure of an intelligent agents

Agent = Architecture + Agent Program
(Intelligence in an artificial device)

Categories of intelligent agents

1. Simple reflex agents
    - Choose actions only based on the current percept
    - Rational only if a correct decision is made only on based on current percept
    - Environment is completely observable

2. Model based reflex agents
    - Use a model of the world to choose their actions
    - Maintain an internal state
    - Model - knowledge about how the things happen in the world
    - Internal state - representation of unobserved aspects of current state depending on percept history

3. Goal based agents (problem solving agent)
    - Choose their actions to achieve a goal
    - More flexible than reflex agent because the knowledge supporting a decision is explicitly modeled, thereby allowing for modifications
    - Goal - the description of desirable situations

4. Utility based agents
    - Choose actions based on a preference (utility) for each state.
    - Goals are inadequate when;
    - There are conflicting goals, out of which only few can be achieved

    - Goals have some uncertainty of being achieved and you need to weigh likelihood of success against the importance of a goal

Nature of environments

Some program operate in the entirely artificial environment. Confined to keyboard input, database, computer file systems and character output on a screen.
Most famous artificial environment is the Turing Test Environment, where one real and other artificial agents are tested on equal ground.

From this onwards, we are talking about goal based agents, which is problem solving agents.
Searching is the universal technique of problem solving in AI.

Going to define

- Problem and solution
- General purpose of search algorithms and compare them
- Analysis of algorithms, O() big O notation etc
- Uninformed search algorithms (brute force or blind)
    - Breadth-first
    - Depth-first
    - Iterative deepening (ID)
    - Repeated states
- Informed search algorithms (heuristic or intelligent)
    - best -first
        - A* search
        - Greedy best-first search

What are these search algorithms for?

To solve a problem, or plan, or play a game you often have to search. So, search algorithms are essential to AI.

Search :-

Algorithm
Performance

So, what is a problem? Or a search problem?

For an example, take “finding a path”, imagine you have to find the shortest path between two locations on a map. Here, you have to “search”.

How to look at a problem?

- To systematically explore the search problem we can use a graph or a search tree.
- Can represent the map using a graph.
- Nodes to represent locations and edges represent paths between nodes
- The estimated travelling time or the distance is often attached to edges
- (can be as a label of an edge)

“Solution is abstract”

That means finding a shortest path in a graph is not the same as the trip.

Inessential factors are stripped out of formulation by abstraction.

We can say that abstraction is valid, if we can expand any abstract solution into a more detailed world’s solution.

Problem Types

1. Single state problem

   Agent knows everything about the world, the exact stake.

   Can calculate optimal action sequence to reach goal state.

   Example ; playing chess, any action will result in an exact state.

2. Multiple state problem

   Agent does not know the exact state (could be in any of possible states)

   Assume states while working towards the goal.

   Example : walking in a dark room

3. Contingency problem
4. Exploration problem

Elements of a search problem

1. Initial state

   Description of starting configuration of an agent
2. Actions in each state

   Operations that take agent one state to another.

An action → successor (state)
Which returns → (action, state) pairs

3. Goal

Can be a one or a set of goals, description of a set of desirable states in the world.

4. Path cost

Label on edges

5. Plan

A sequence of actions

Search Problem representation or notations

S - set of states
S0 - initial state
A - operators actions
G - goal state
{S, S0, A, G} - search problem
P - plan, sequence of actions
P = {a0, a1, a2,..., an}

Search tree and map

Searching typically can be represented in a search tree. Start node on the root connected by branches : successfully visited nodes.
Tree grows by expanding node N, add as branches nodes reachable from N, with associated paths, no looping, ass children to visit later.

A node has a

state in the state space,
parent node which generated this node
Action apply to parents to generate children
Path cost g(n) cost to path to node from the initial state
Depth no of steps along path from initial state.