

Artificial Intelligence



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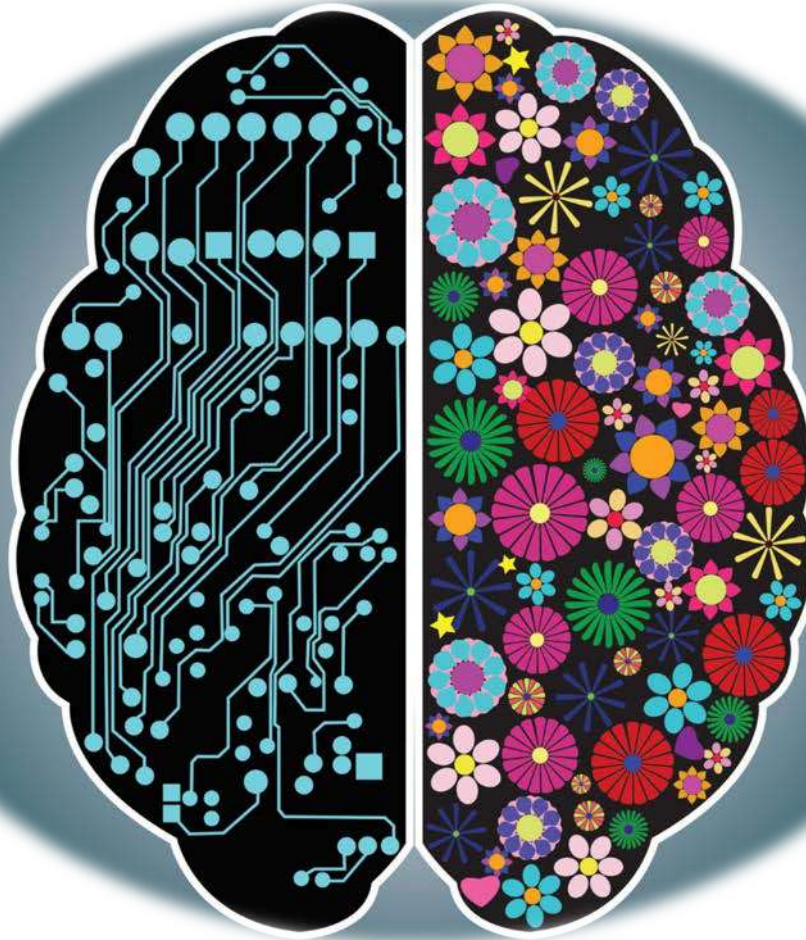
Prerequisites

- Comfortable **programming** in language such as C (or C++) or Python
- Some knowledge of **algorithmic concepts** such as running times of algorithms; having some rough idea of what NP-hard means
- Some familiarity with **probability**
- Not scared of **mathematics**, some background in discrete mathematics, able to do simple mathematical proofs

Human Cognition Abilities

LEFT BRAIN FUNCTIONS

- Logic
- Analysis
- Sequencing
- Mathematics
- Language
- Facts
- Words of songs
- Computation



RIGHT BRAIN FUNCTIONS

- Creativity
- Imagination
- Holistic Thinking
- Intuition
- Arts (Motor Skill)
- Rhythm (beats)
- Visualization
- Tune of songs
- Daydreaming

Symbolic methods: Classical AI

Modern AI is the
convergence of these two

Statistical methods: ML

Real AI

- A serious science.
- **General-purpose AI** like the robots of science fiction is incredibly hard
 - Human brain appears to have lots of special and general functions, integrated in some amazing way that we really do not understand at all (yet)
- **Special-purpose AI** is more doable (nontrivial)
 - E.g., chess/poker playing programs, logistics planning, automated translation, voice recognition, web search, data mining, medical diagnosis, keeping a car on the road,

Definitions of AI

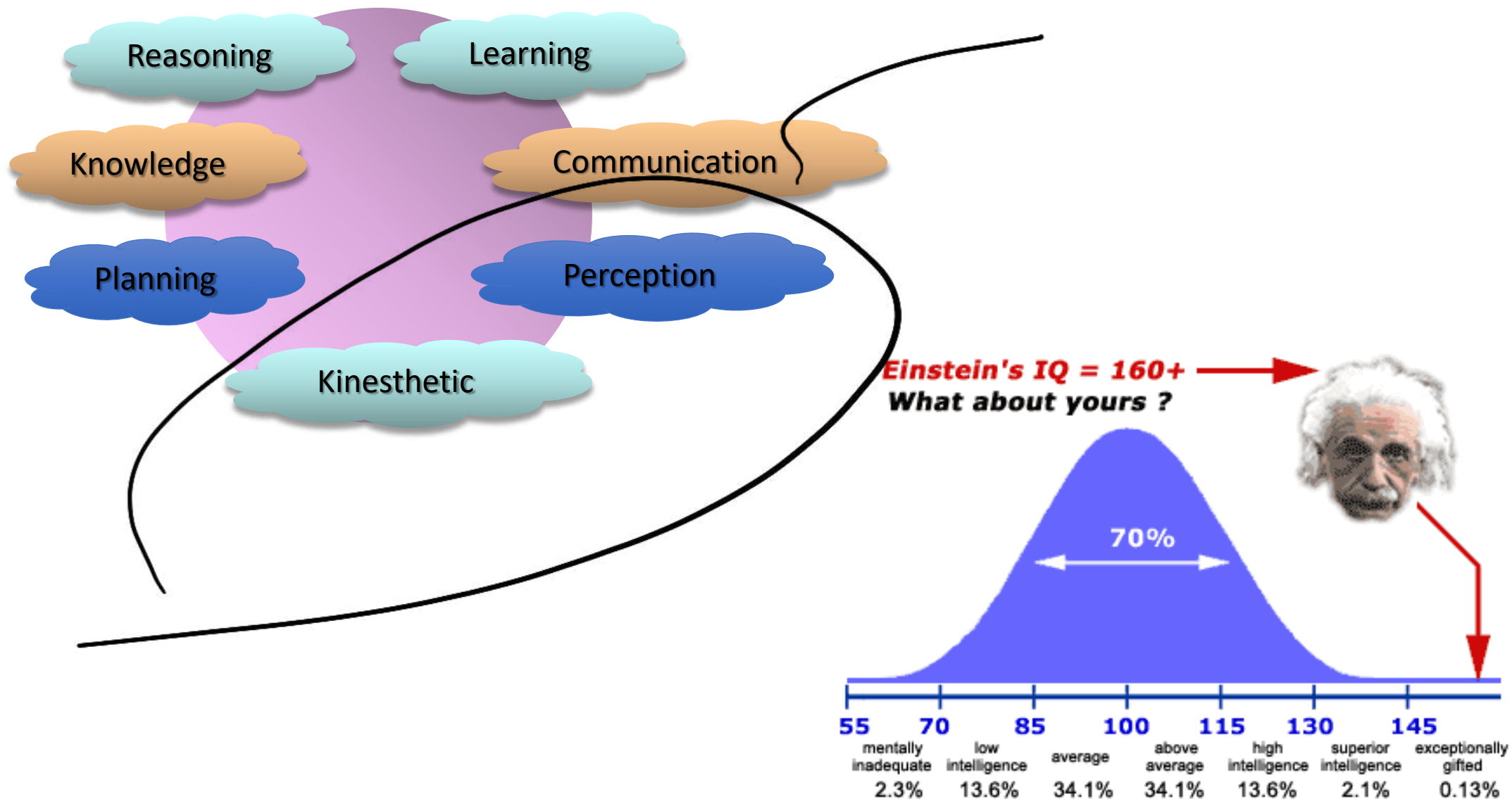
if our system can be
more rational than
humans in some
cases, why not?

focus on **action** avoids
philosophical issues
such as “is the system
conscious” etc.

Systems that think like humans	Systems that think rationally
Systems that act like humans	Systems that act rationally

- We will follow “**act rationally**” approach
 - Distinction may not be that important
 - acting rationally/like a human presumably requires (some sort of) thinking rationally/like a human,
 - humans much more rational anyway in complex domains

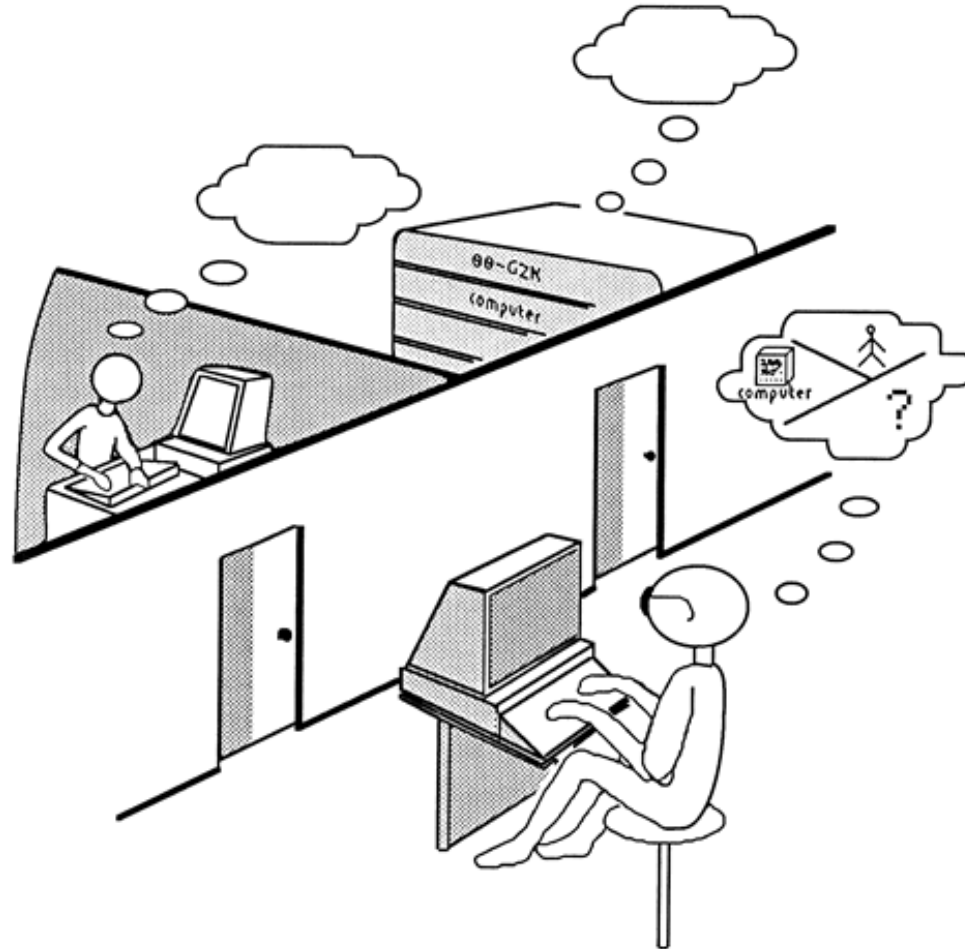
What is Intelligence?



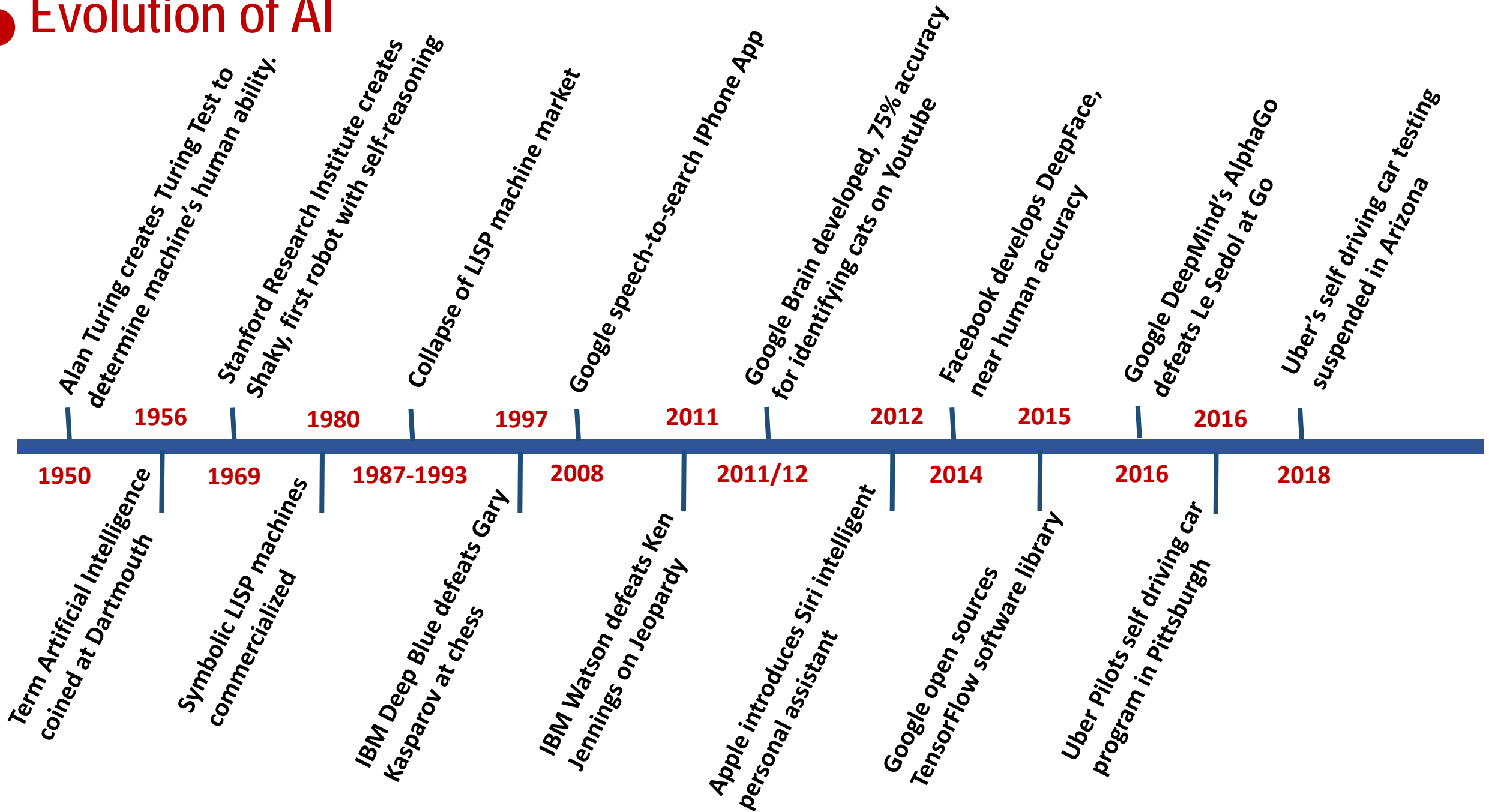
What is “Artificial Intelligence”?

Turing Test (1950)

- The computer is interrogated by a human via a teletype.
- It passes if the human cannot tell if there is a computer or human at the other end



Evolution of AI



Kasparov versus Deep Blue



On May 11, 1997, it won a 6-game match by 2 wins to 1 with 3 draws

**Today, we have power to evaluate
200 million moves per second !!**





What are the green fields for AI in India?

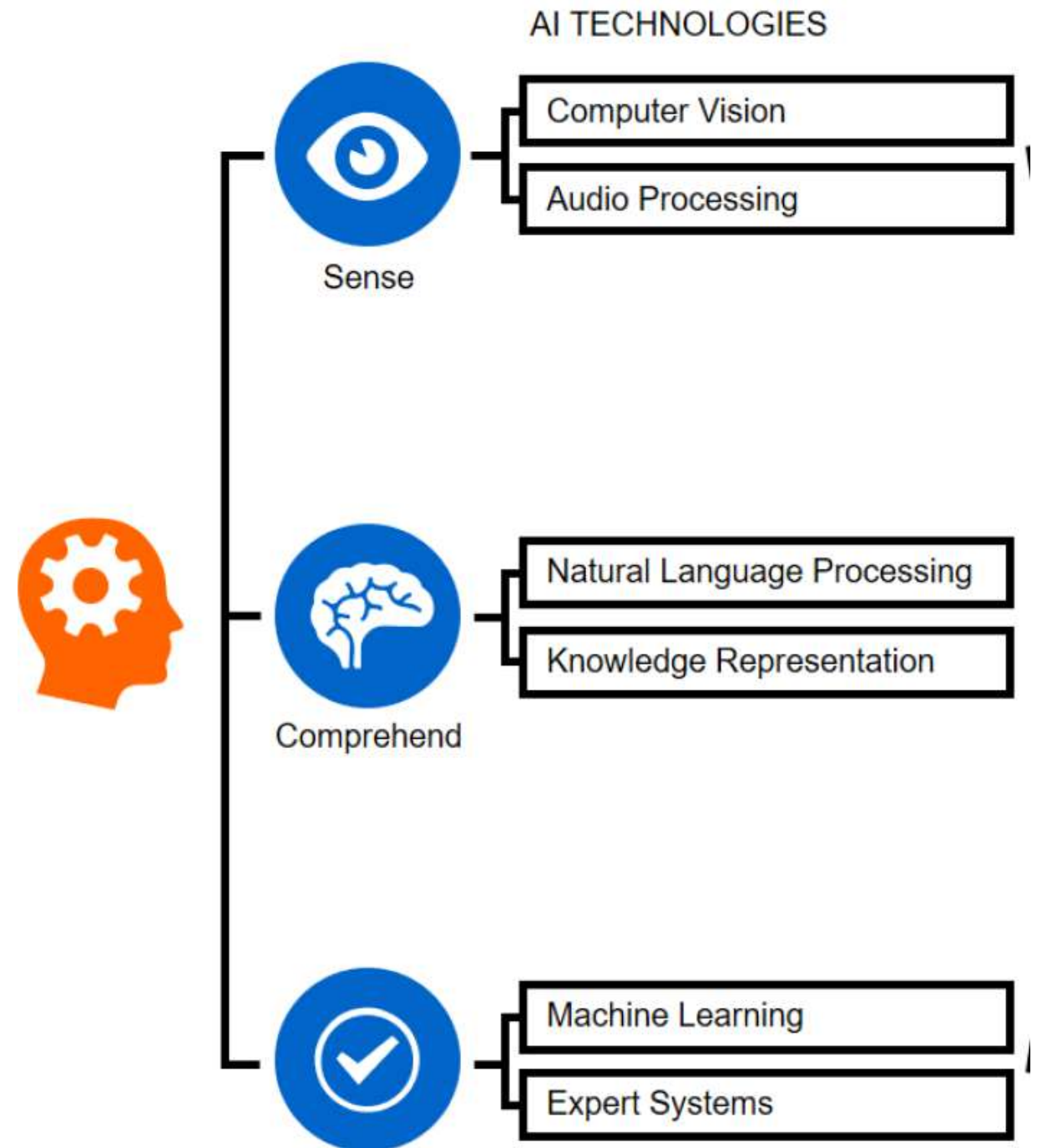
- Preventive and affordable Healthcare
- Agriculture and Rural Development
- Smart Mobility and Intelligent Transportation Systems
- Retail
- Manufacturing
- Energy management
- Smart Cities
- Education and Skilling

Source: Niti Aayog Discussion Paper on AI, June 2018

Artificial Intelligence

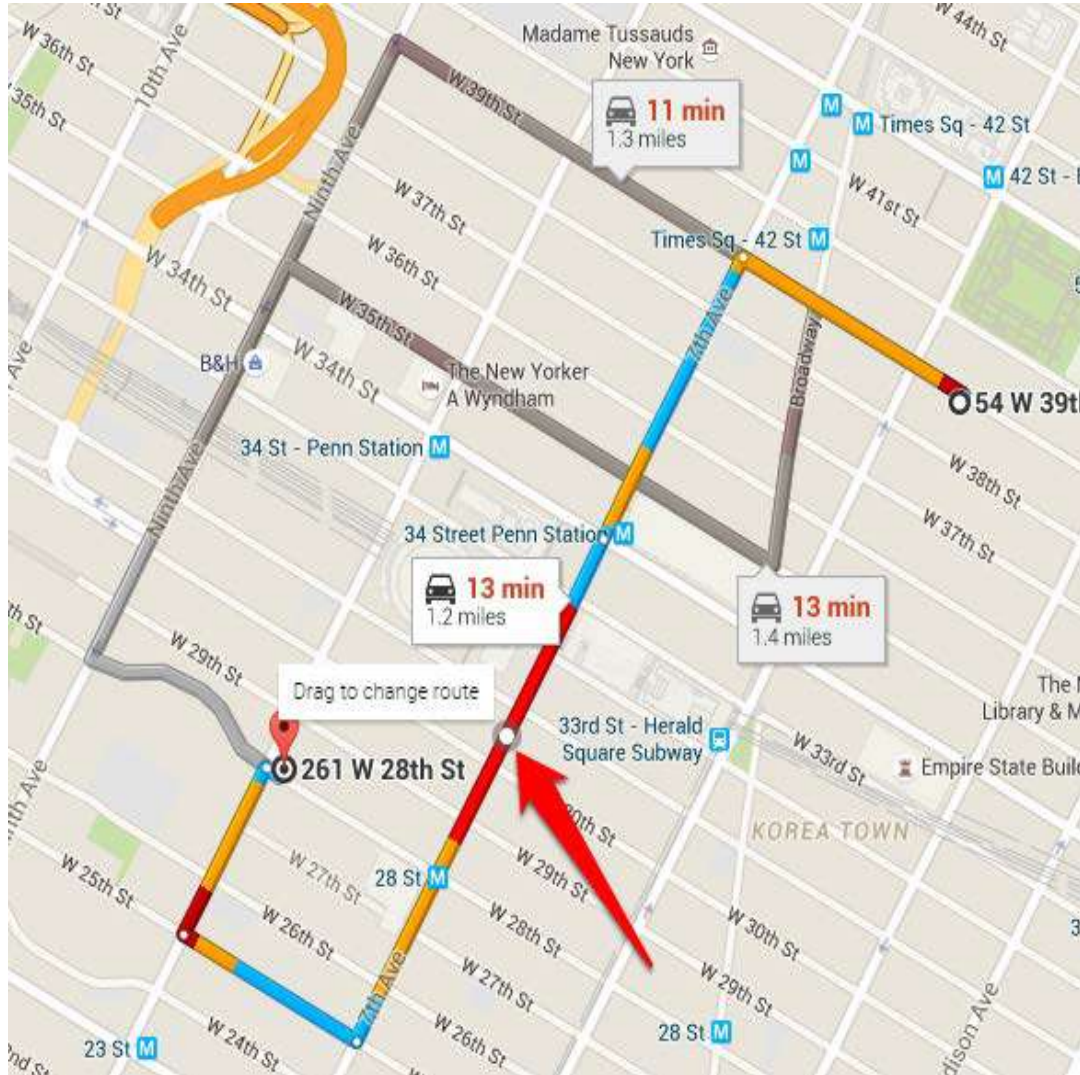
CORE CAPABILITIES

- The ability to solve problems
 - Constraint satisfaction, Optimization, Search
- The ability to plan
 - Abstraction
- The ability to deduce
 - Logic, Reasoning algorithms
- The ability to learn
 - Models, Data, Learning algorithms
- The ability to handle uncertainty
- The ability to interface with the real world



Source: Accenture

Constraints and Optimization



Path Finding

- I wish to find a shortest path
- I wish to find a path with minimum congestion
- I wish to find a path with combination of transportation options (metro, bus, taxi)
- I wish to find a path which goes past a medicine shop
- I wish to find a path which minimizes energy consumption from my battery in a e-vehicle

When the size and complexity becomes too big we use "heuristic functions" to cut out unnecessary parts.

In the lack of domain knowledge, we can statistically learn the best way (reinforcement learning) by exploration.

Modern AI aims to combine learning from data with structured use of domain knowledge.

AI Planning

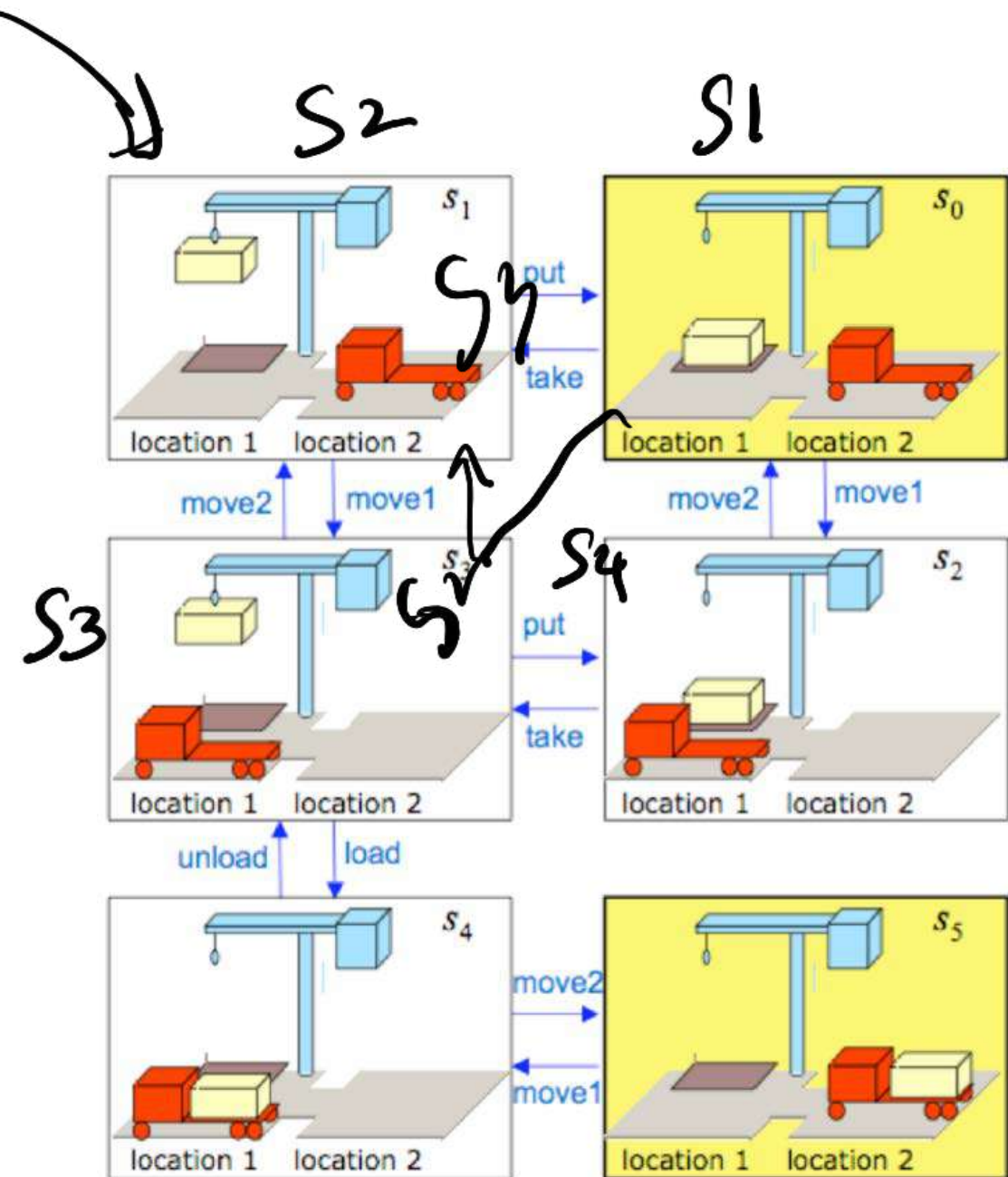
Elements of a Planning Problem

- A set of states (worlds) described in terms of predicates
- A set of actions which transforms some parts of one world to take us to another world
- An initial world
- A goal in terms of the predicates that must hold in the final world

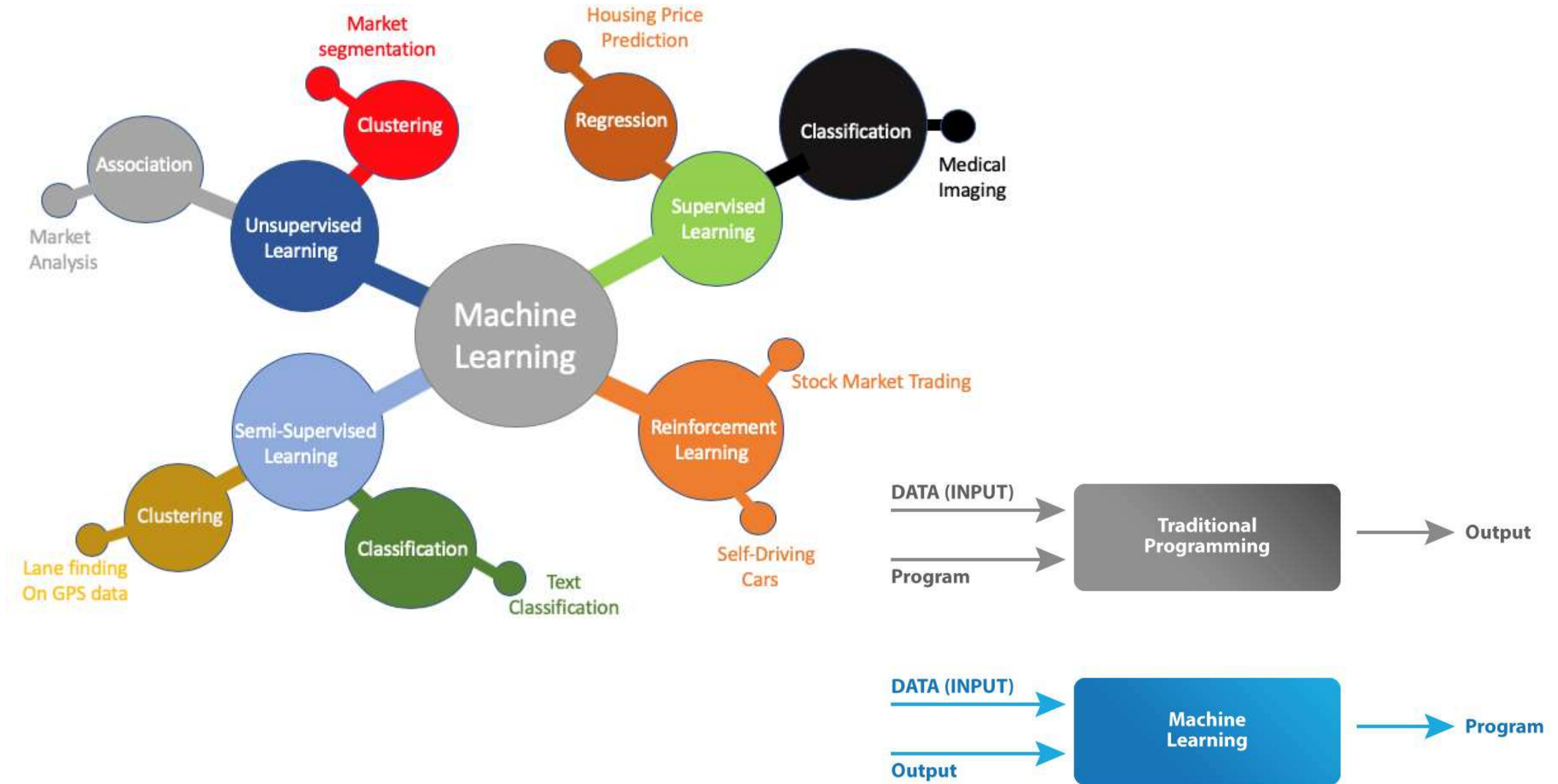
Planning is widely used in robotics and automated control

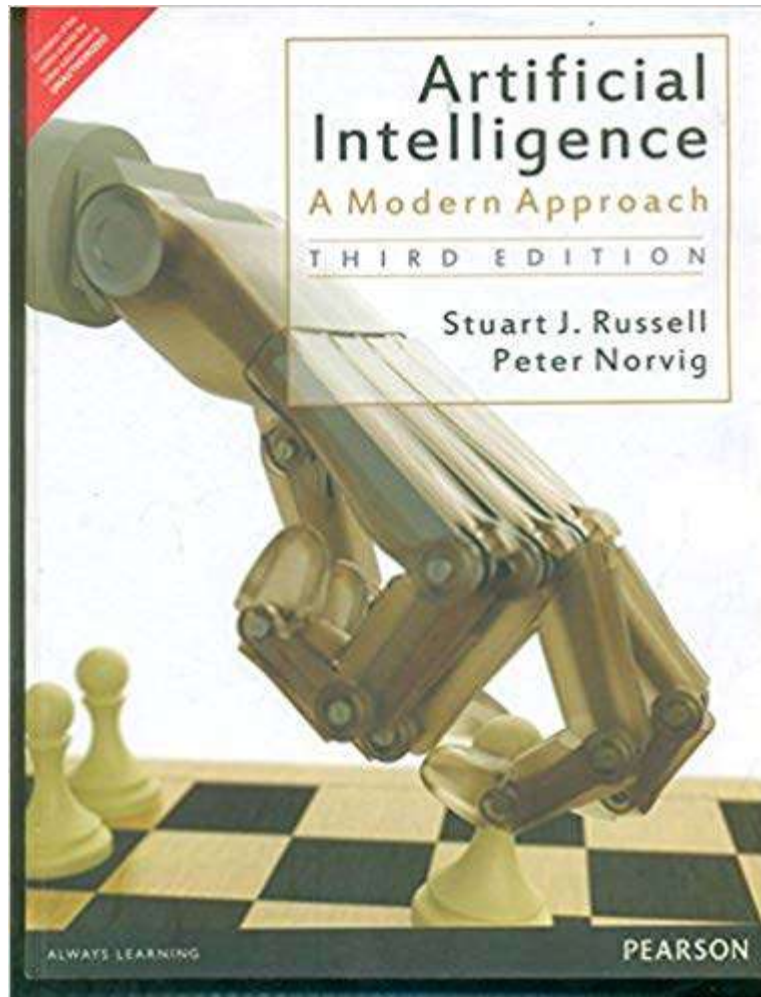
Modern AI explores techniques that combine planning with machine learning

- Autonomous driving is one of many areas where such combinations are highly relevant



Machine Learning





The book that we will follow mostly for this and many other topics:

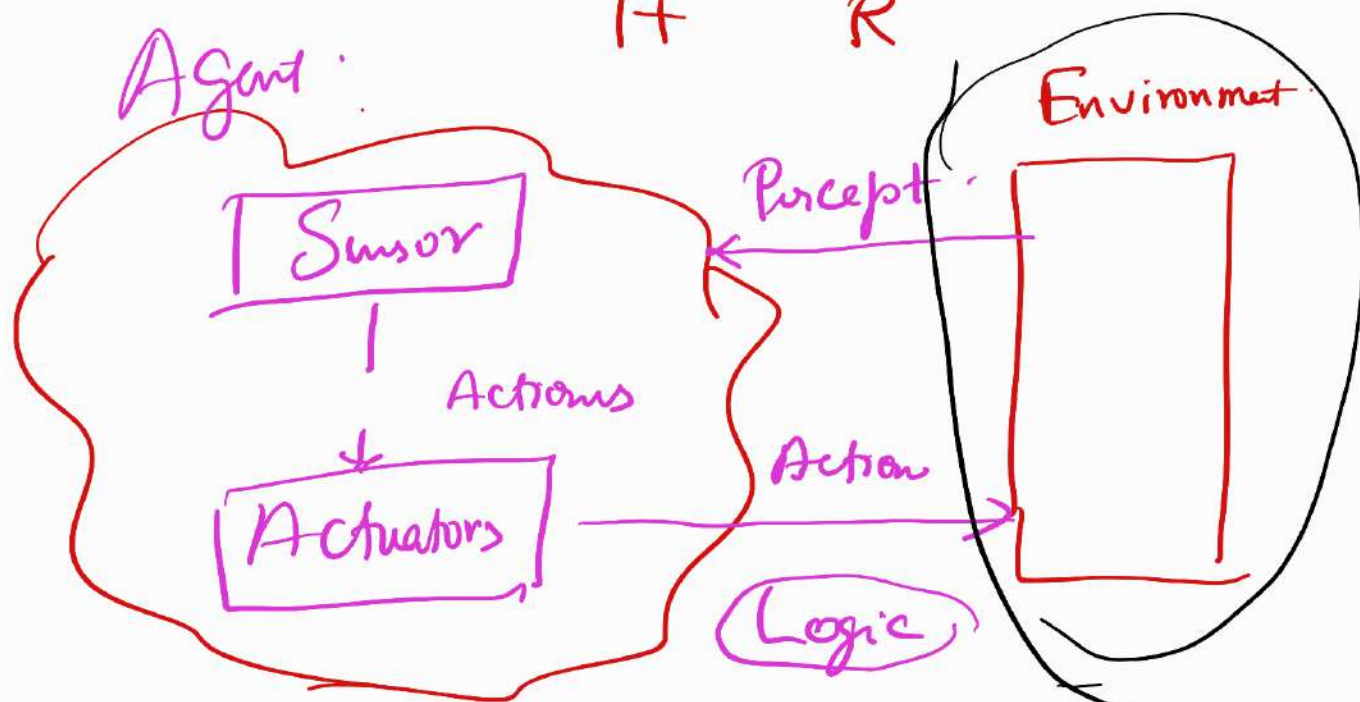
Artificial Intelligence – A Modern Approach
Stuart J Russell, Peter Norvig

Pearson Education India

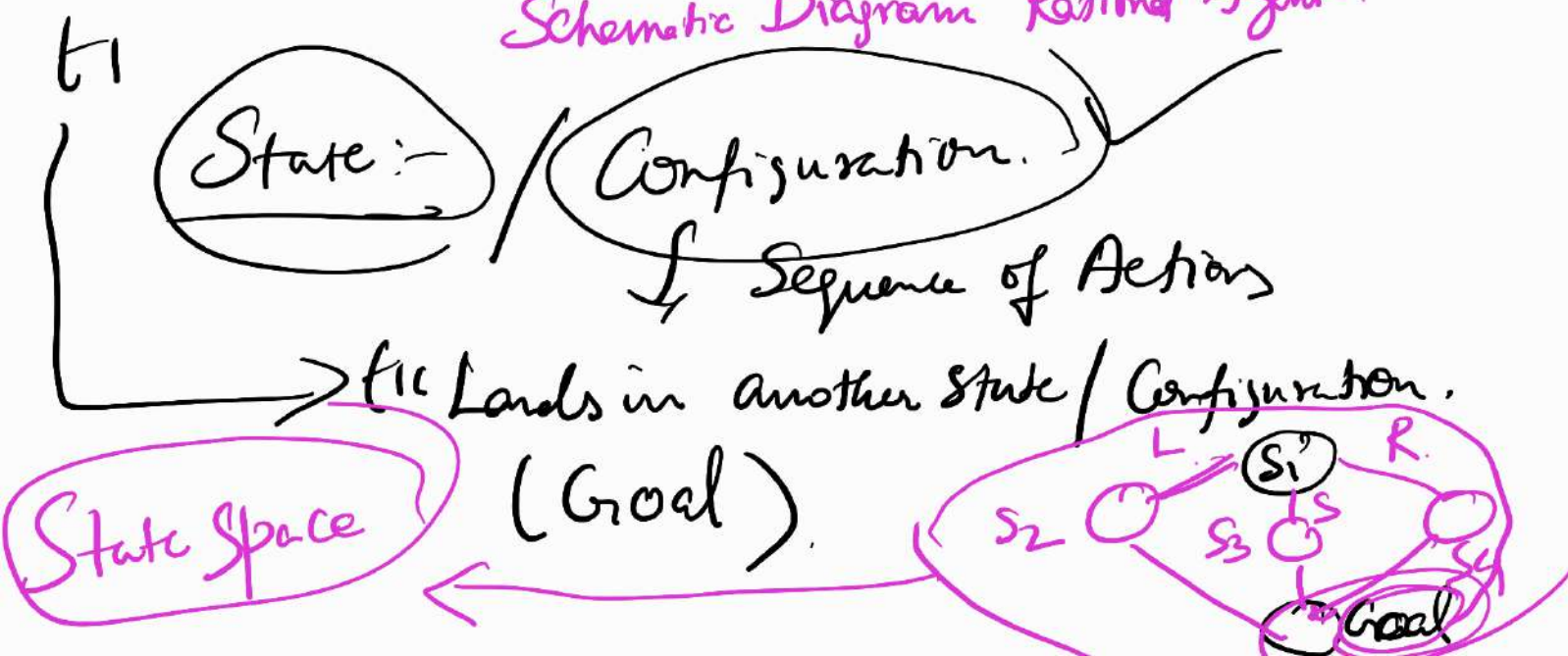
Agent:-

- that acts; operates autonomously
- Rational agents, that acts to achieve the best outcome especially when there is uncertainty.
- Not about correct inferences. But it is one of several mechanism.
- In general, Anything that perceiving its environment through sensors and acting upon through actuators.

I + R



Schematic Diagram Rational Agent.



Agent Behaviour:-

* Agent behaviour is described by the agent function that maps any given percept sequence to action.

Agent Program:-

* Concrete implementation running within some physical system.

Rationality:-

* Sequence of actions causes the environment to go through sequence of states.

* Performance measure - Evaluated by sequence of environment states.

In nutshell, Rationality depends on.

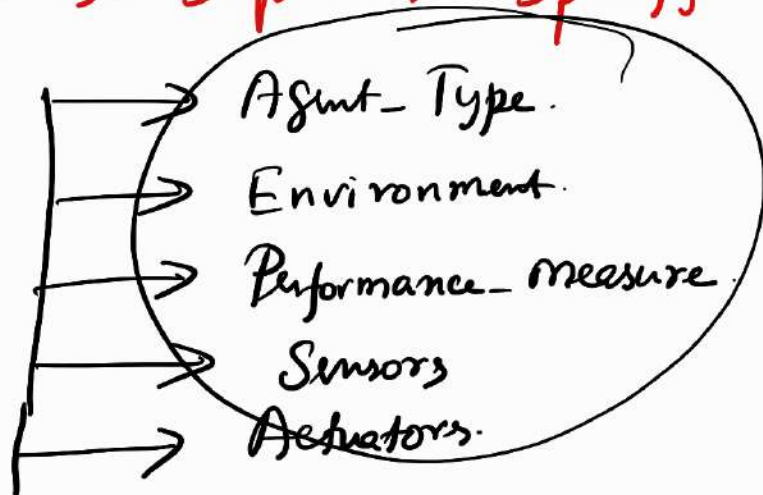
- ① Performance measure
- ② Agent's prior knowledge.
- ③ Actions
- ④ Agent's percept sequence to date.

Task Environment:-

① To design agent, First step is to specify the task.

Environment

②.



Agent-Type	Environment	Performance-measure	Sensors	Actuators
Autonomous Car.	Road, Path.	Speed, No. of accidents, Sudden-brakes	Camera, GPS, IR sensors, Accelerator	Steering, Brake, Green Indicator

PEAS

- ① Simple-reflex.
- ② Model-based reflex.
- ③ Goal-based
- ④ Utility-based

Complex Problems & Solutions:-

- ① How to solve a problem?
- ② Unified technique for all problems.
- ③ Identify the Constraints.

Environment
Rules
Constraints
Optimization

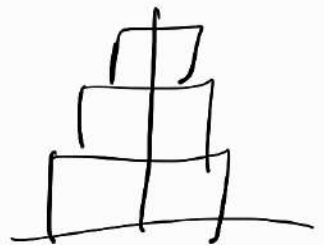
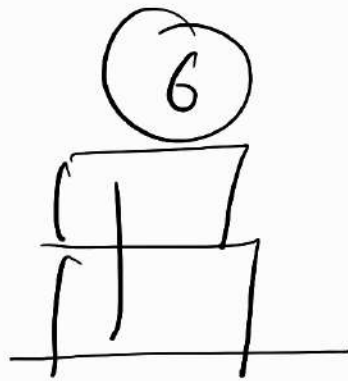
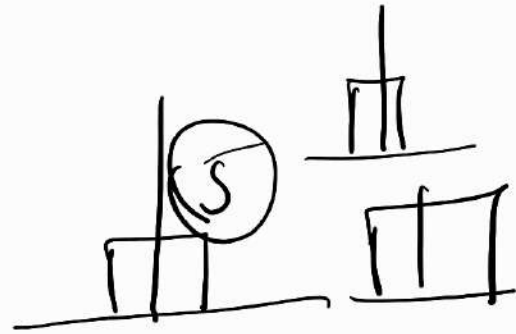
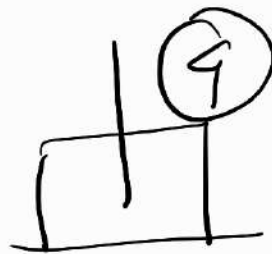
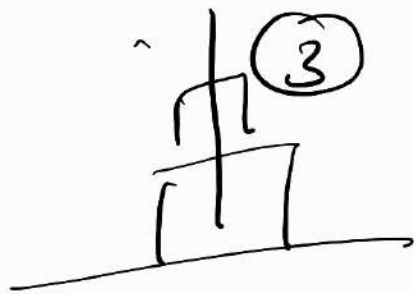
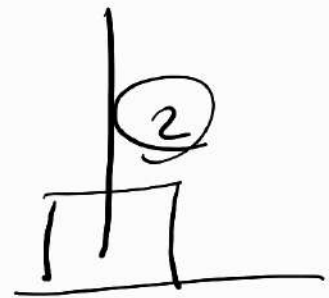
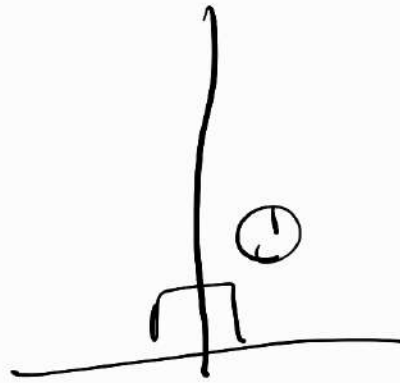
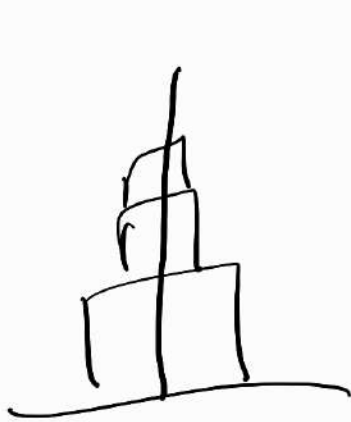
Constraints:-

- * Placement
- * Optimization
- * Routing.

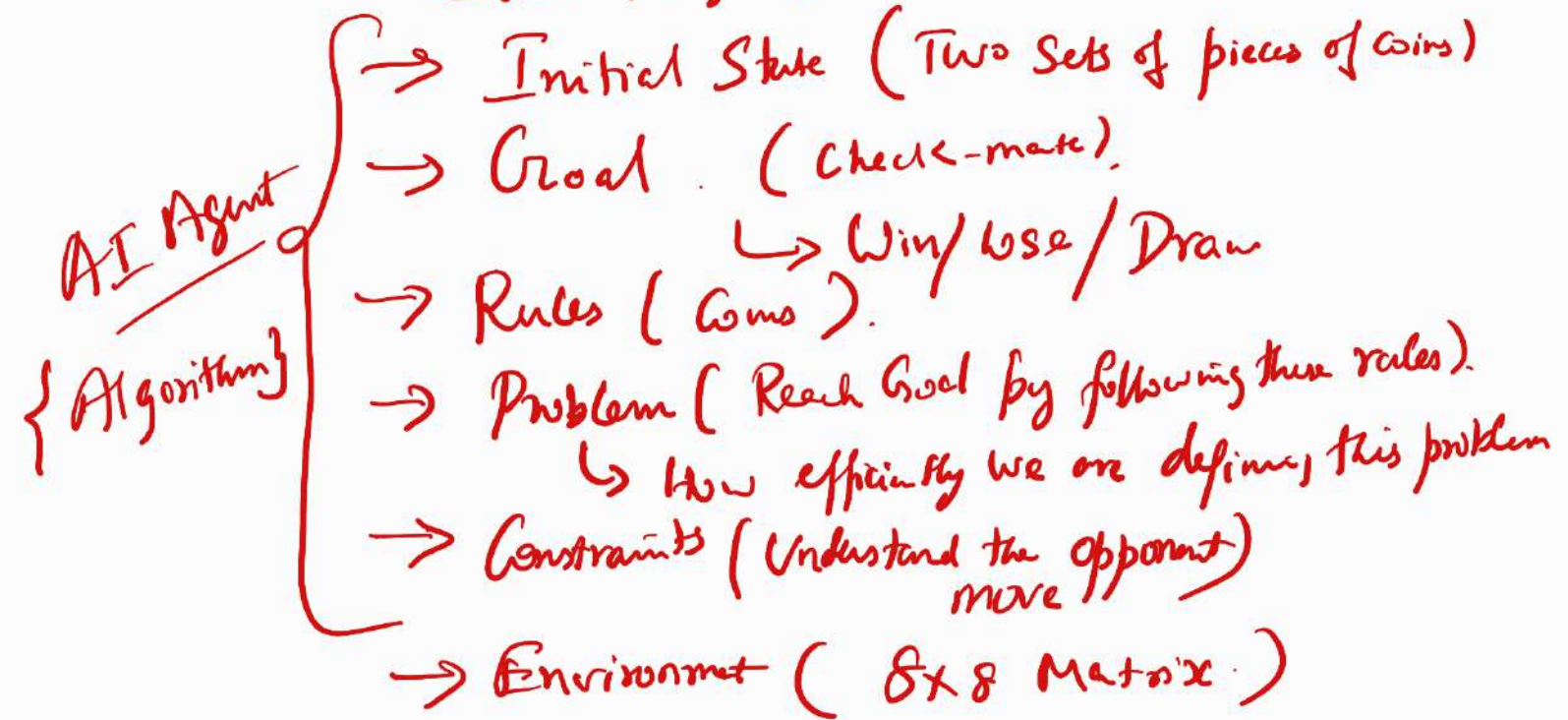
Commonality:- Configuration/State.

- ① Set of rules/moves.
- ② Constraints to be satisfied
- ③ Optimization
- ④ How to change from one state to another state to reach destination.

Implicit State change (or) State Space.



Chess-Playing



State-Space

6 Coins - State

