Artificial Intelligence

”Artificial Intelligence (AI) is not the solution to everything, but its disruptive innovation gives us the opportunity to make the world better for everyone”

Andrew NG

Co-founder of Coursera,

Adjunct Professor of Stanford

(regarded as one of the world’s foremost experts on AI)

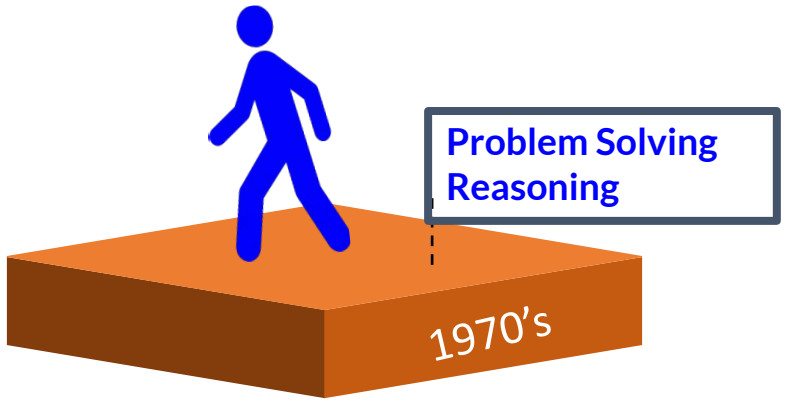
What is AI?

Intelligence: “ The ability to learn and solve problems”
Artificial Intelligence: AI is the simulation of human intelligence by machines

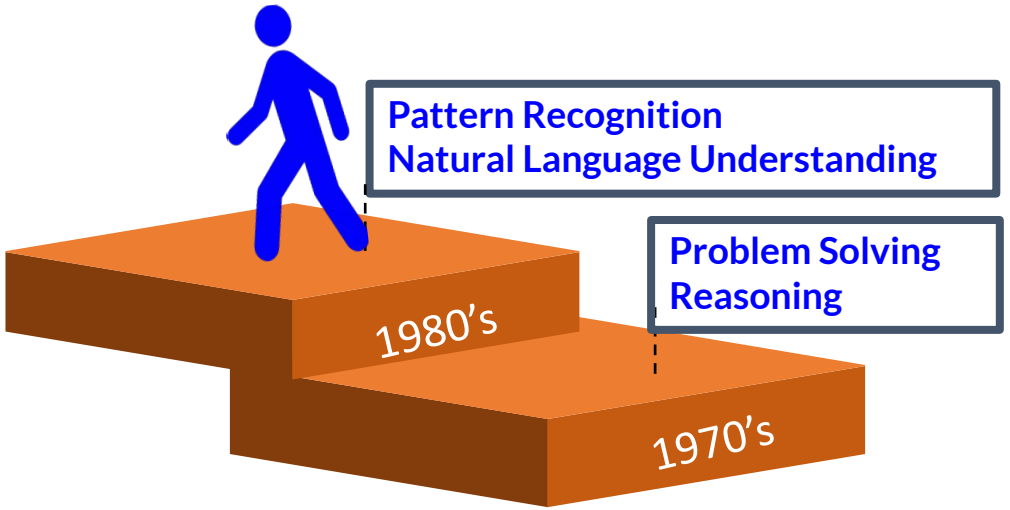
- The science and engineering of building "intelligent" software agents.
- AI - is the reproduction of human reasoning and intelligent behavior by computational methods

Think like humans	Think rationally
Act like humans	Act rationally

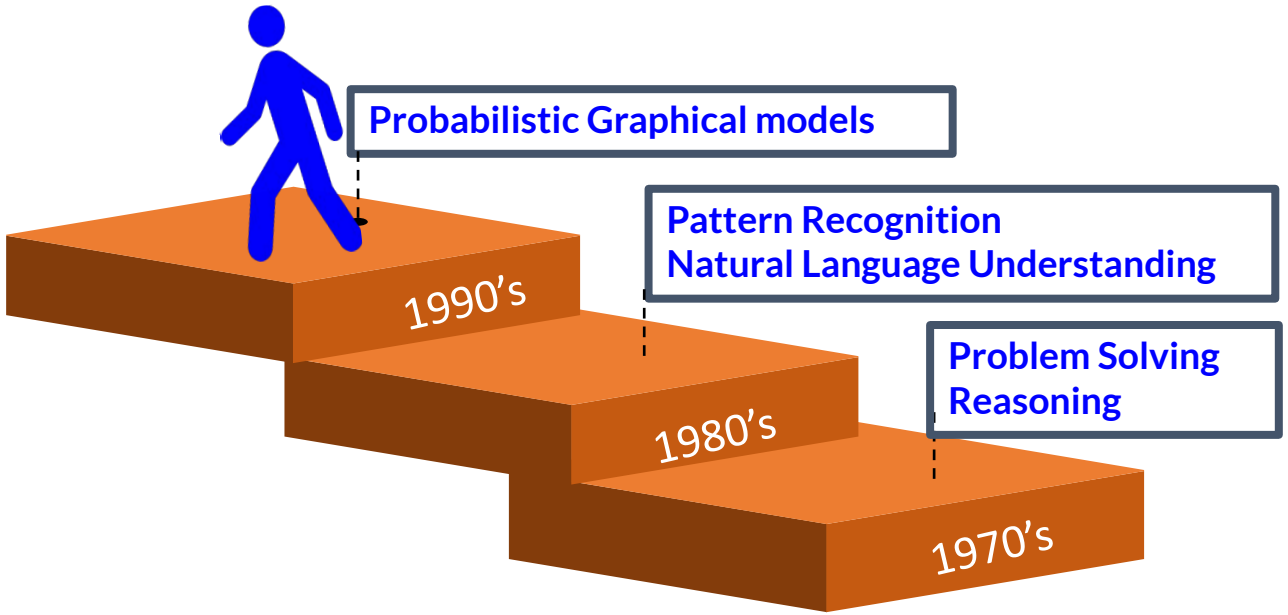
Evolution of AI



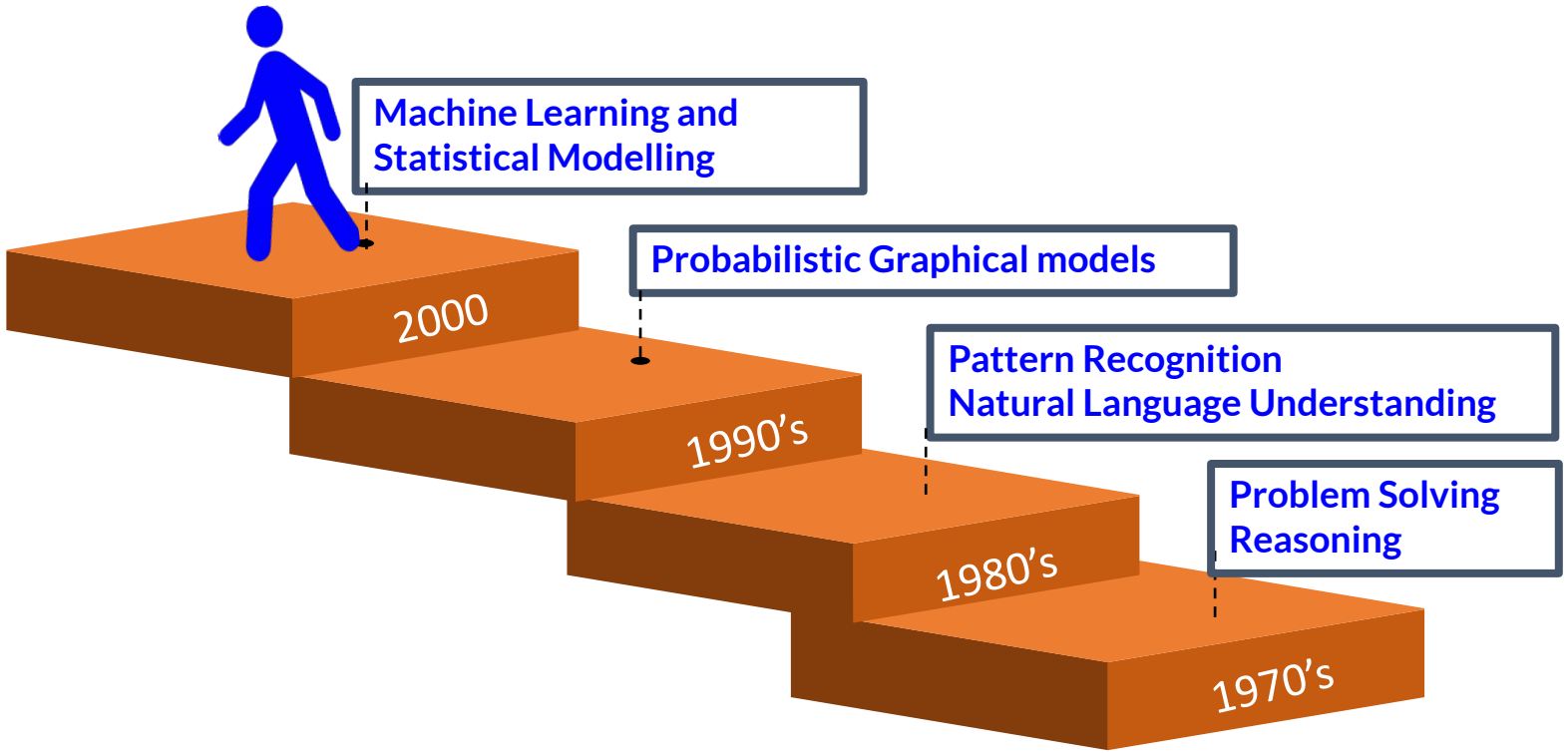
Evolution of AI



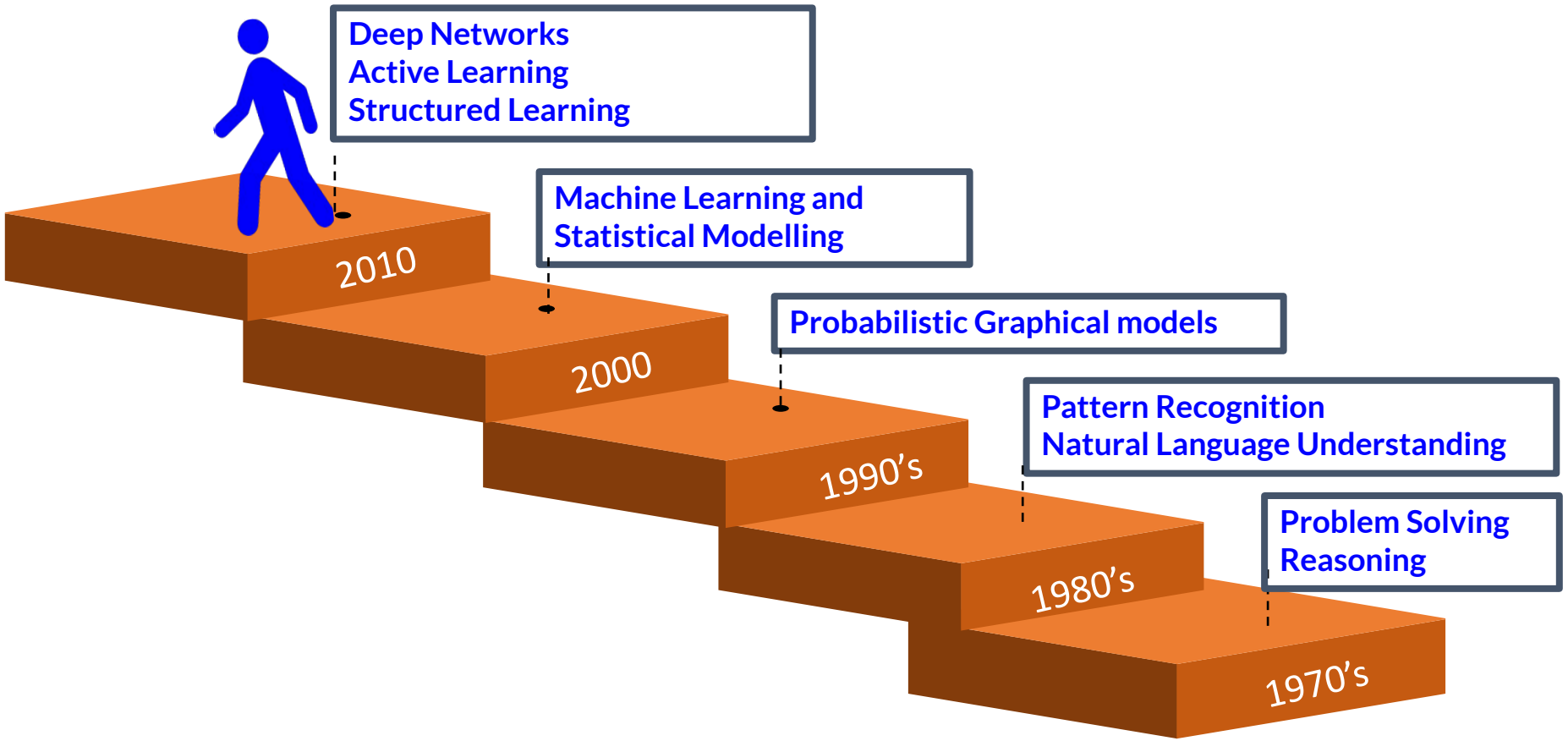
Evolution of AI



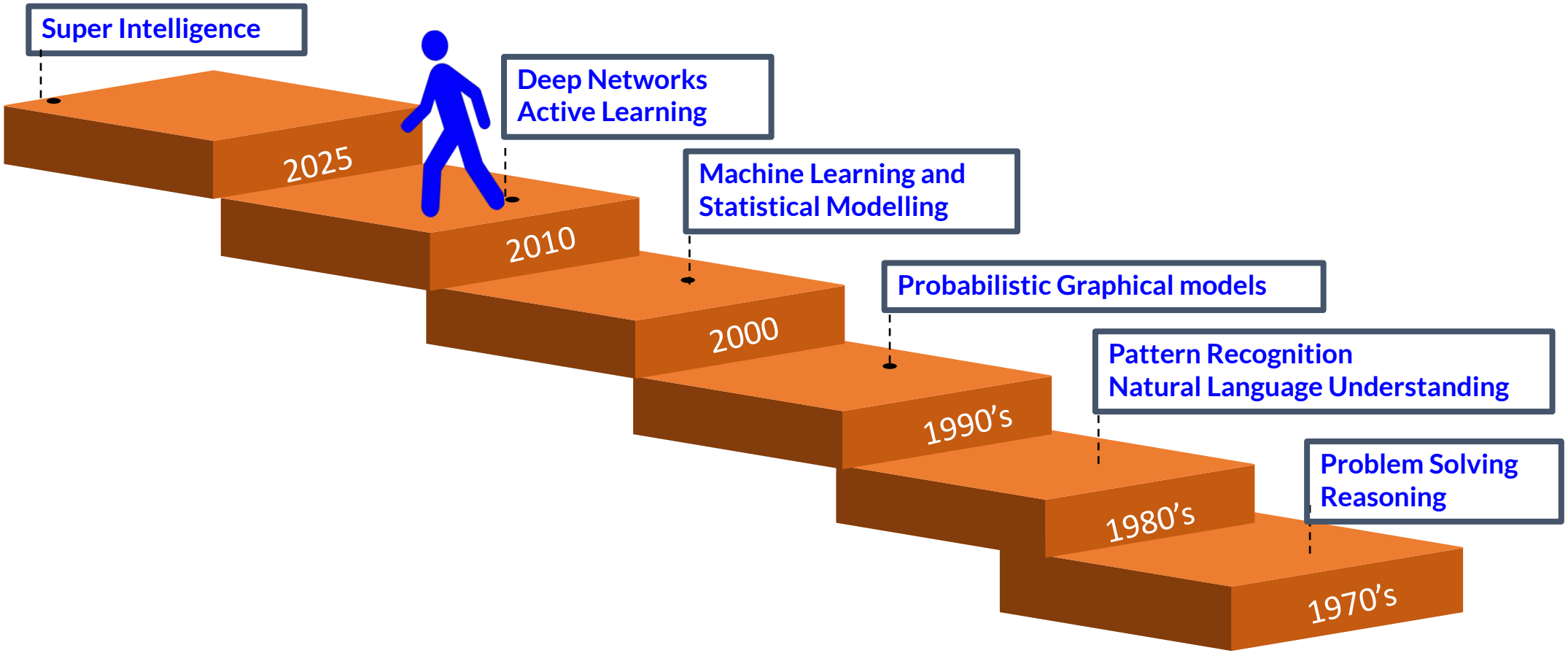
Evolution of AI



Evolution of AI



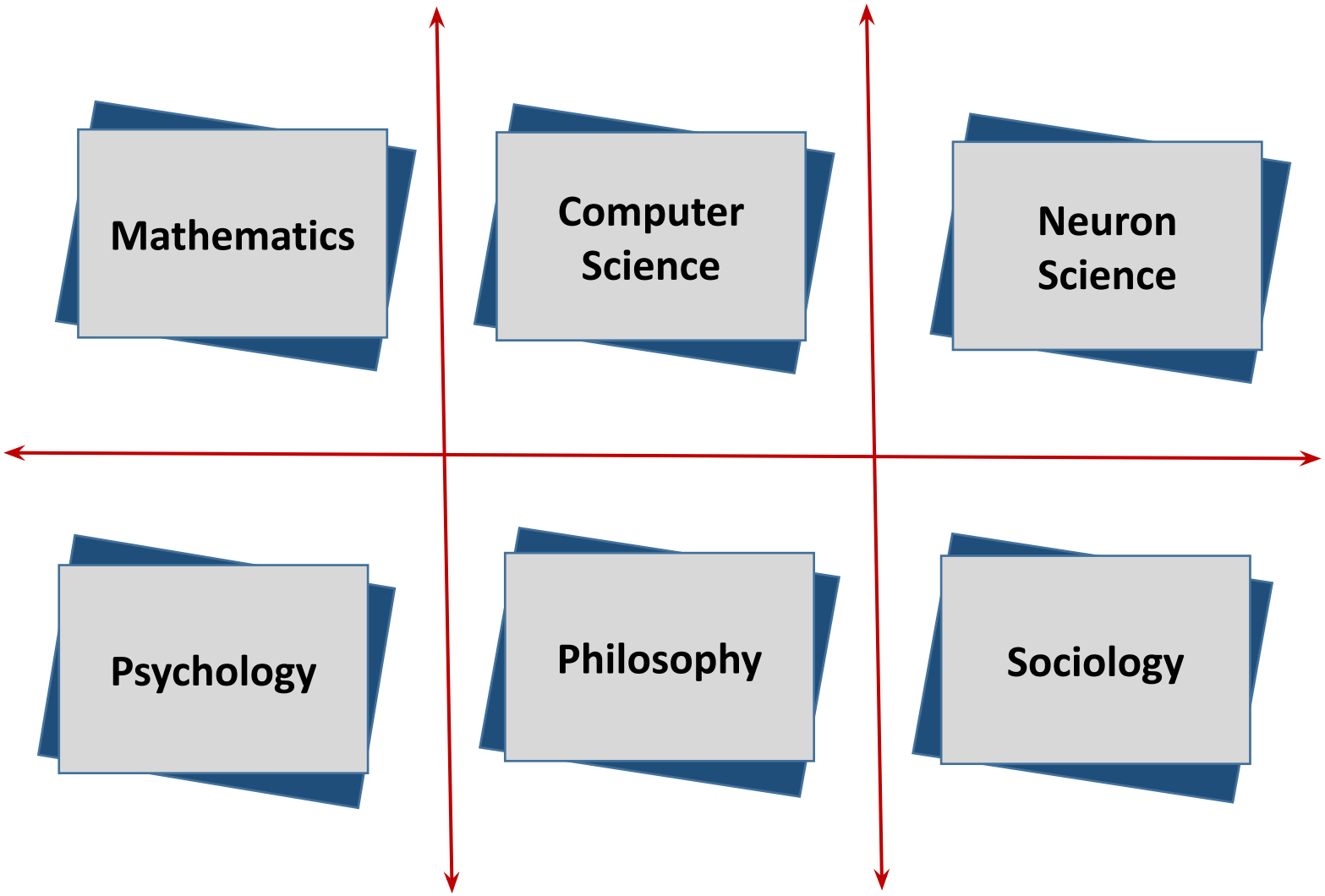
Evolution of AI



Major Players

- Google - DeepMind, Google AI
- OpenAI
- IBM
- Facebook
- Apple Inc.
- Amazon
- Microsoft

Multi-disciplinary task



AI task

Perform actions in it (robotics)

Robotics

Perceive the world (computer vision)

Perception

Communicate with other agents and human beings

Language

Learning

Learn from data and adapt over time

Knowledge

Have knowledge about the world

Reasoning

Draw inferences and make decisions.

Machine learning has become the primary driver of many of the AI applications

Solving AI tasks?

Modelling -- Inference – Learning Paradigm

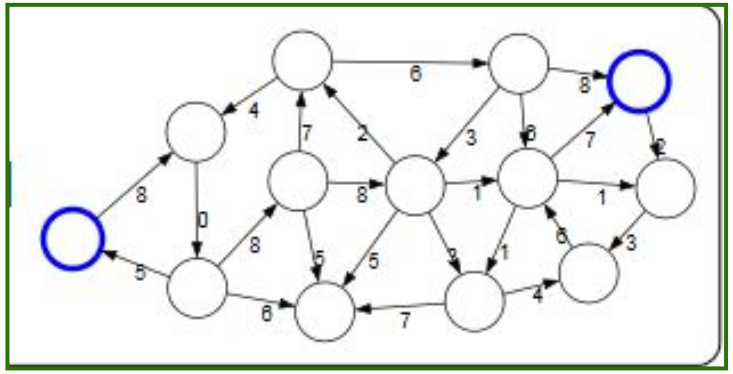
Task : Find the shortest path for navigation

Model is a representation of a system from a particular perspective

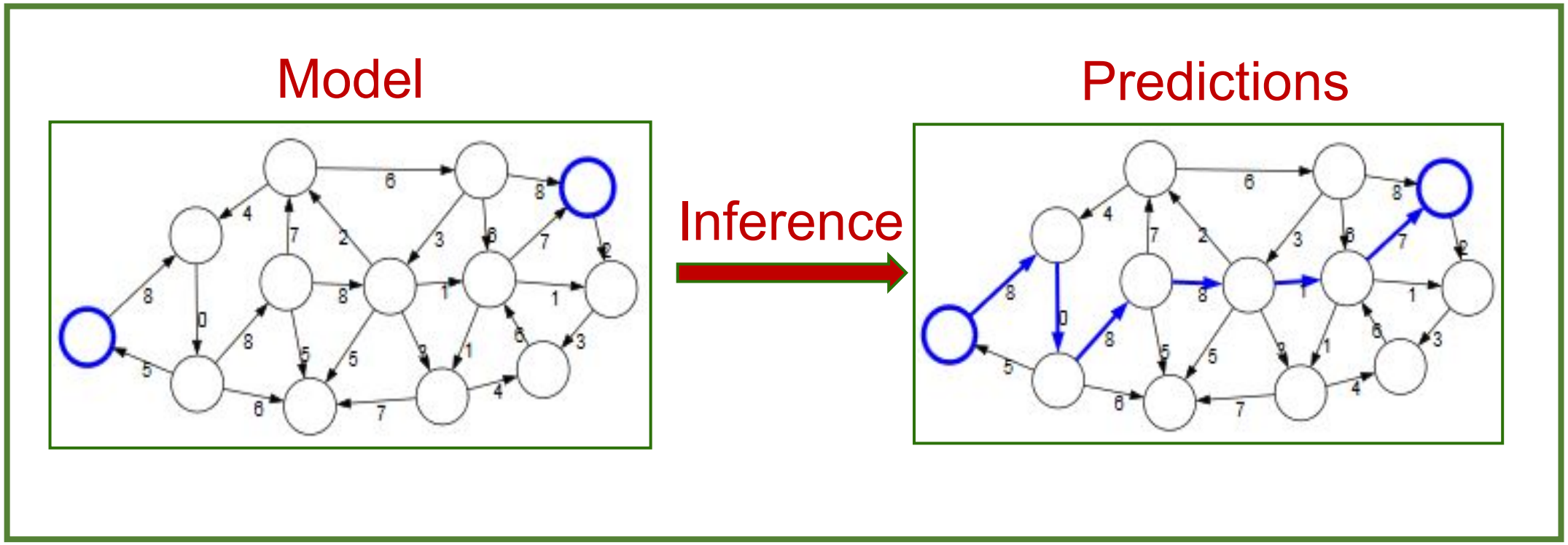
Real World

Modeling

Model

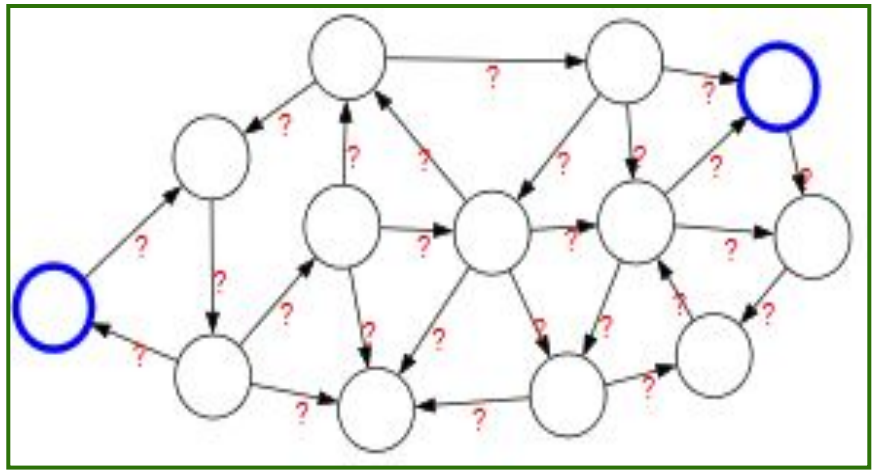


Modeling takes real world problems and convert them into formal mathematical objects called models



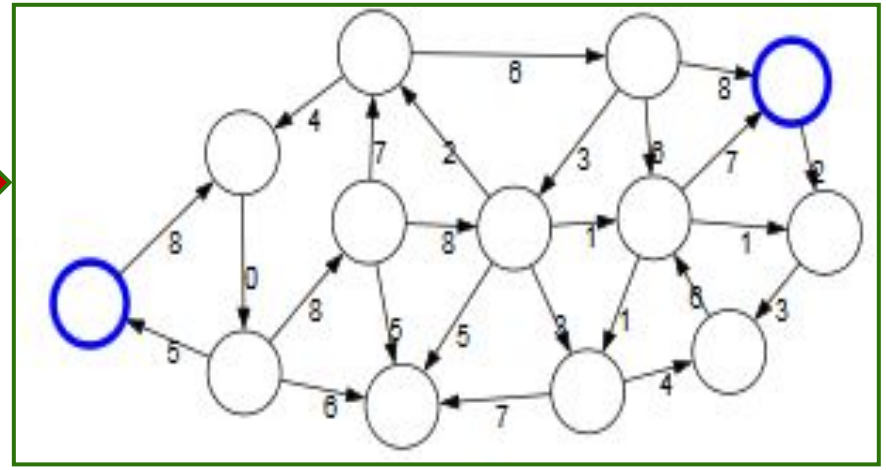
Given a model, the task of **inference** is to answer questions with respect to the model.

Model without parameters



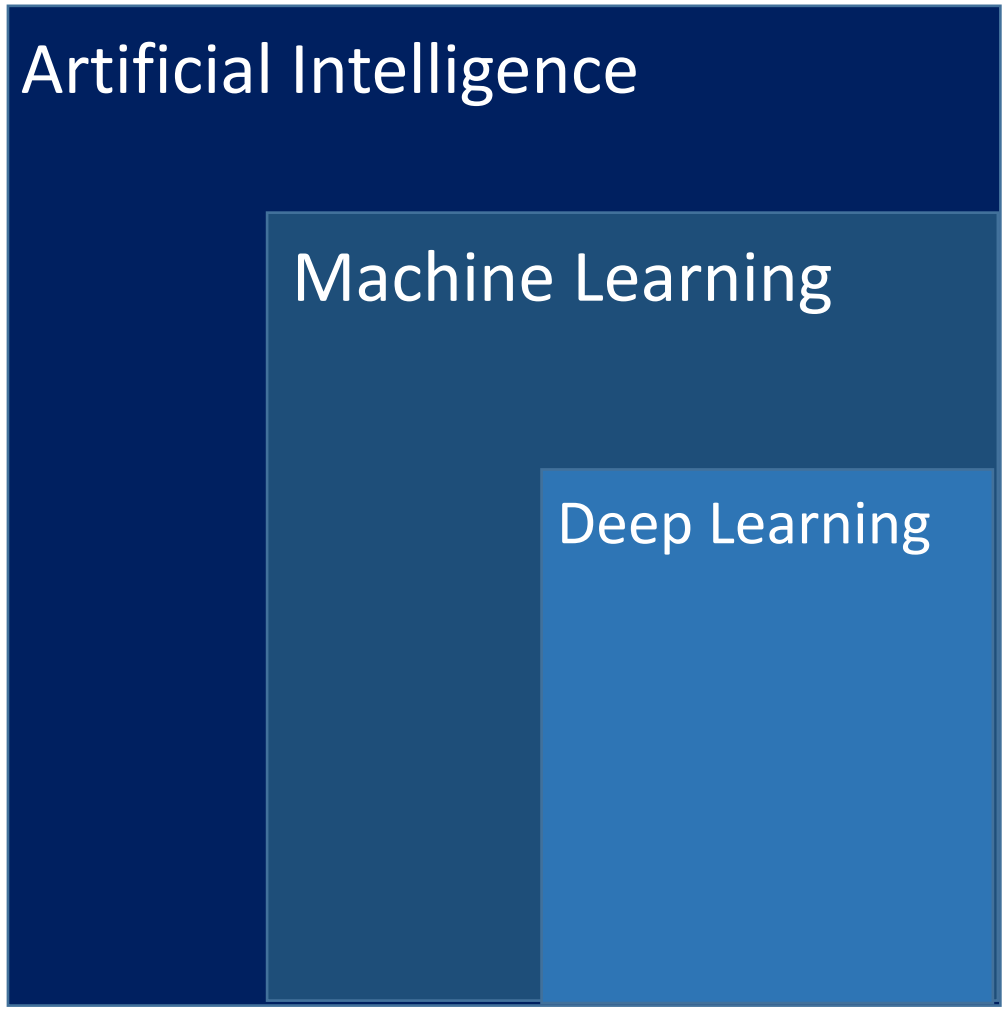
Data & Learning

Model with parameters



Idea behind (machine) **learning** is to get the model from data and tune the parameters.

Ability to automatically learn and improve from experience without being explicitly programmed



AI - Intelligence demonstrated by machines

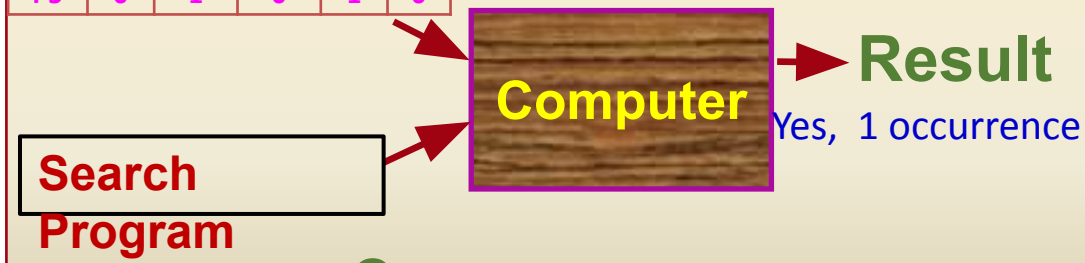
ML- Giving computers the skill to learn without explicit programming

DL – Subset of ML, examining algorithms that learn and improve on their own

Traditional Program

Input Data

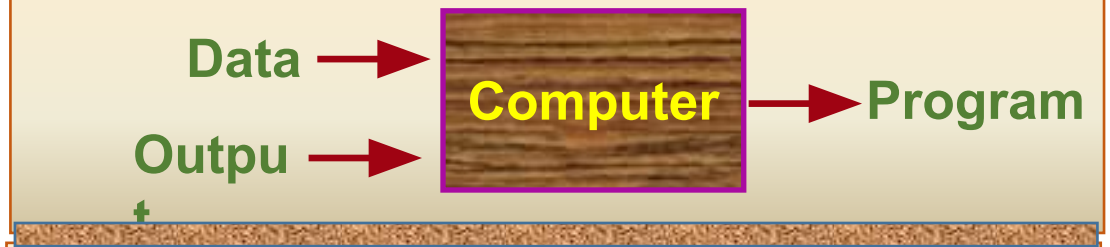
	A1	A2	A3	A4	A5
P1	1	0	1	1	1
P2	0	1	0	0	1
P3	1	0	1	0	1
P4	1	0	1	1	0
P5	0	1	0	1	0



Query

Does an instance (1, 0, 1, 1, 0) exist?

ML Program



Input Data

	A1	A2	A3	A4	A5
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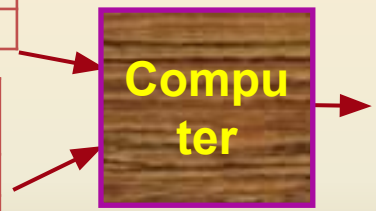
P4	1	0	1	1	0
P5	0	1	0	1	0



	Has glaucoma?
P1	Y
P2	N
P3	Y
P4	Y
P5	N

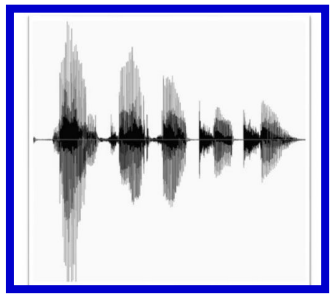
Output

$Y = f(A1,A2,A3,A4,A5)$

Search Engine

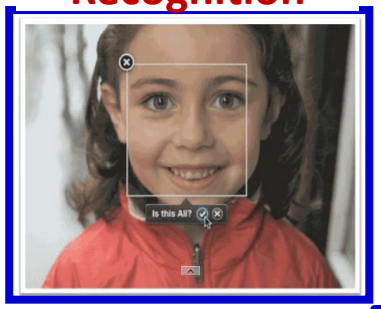
Recommendations

Speech Recognition

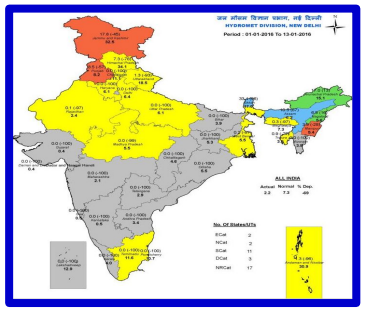


Medical Traits

Face Recognition



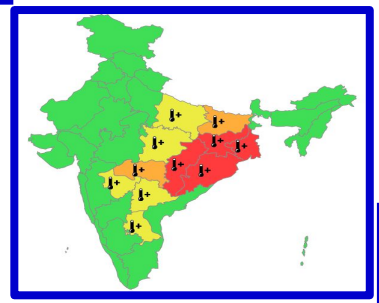
Rain fall Prediction



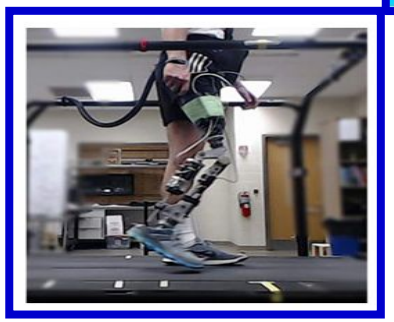
Game Playing

Medical Imaging

Heat Wave Prediction

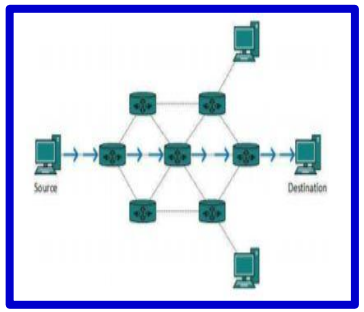


Prosthetics



Hand Writing Recognition

Network Routing



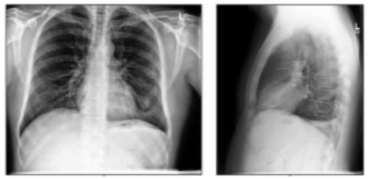
Machine translation

Input sentence:	Translation (PBMT):	Translation (GNMT):	Translation (human):
李克強此行將啟動中加總理年度對話機制，與加拿大總理杜魯多舉行兩國總理首次年度對話。	Li Keqiang premier added this line to start the annual dialogue mechanism with the Canadian Prime Minister Trudeau two prime ministers held its first annual session.	Li Keqiang will start the annual dialogue mechanism with Prime Minister Trudeau of Canada and hold the first annual dialogue between the two premiers.	Li Keqiang will initiate the annual dialogue mechanism between premiers of China and Canada during this visit, and hold the first annual dialogue with Premier Trudeau of Canada.

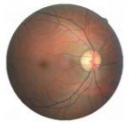
Virtual assistants

Health care

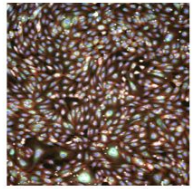
Chest radiology



Diabetic retinopathy



Drug screening for COVID-19

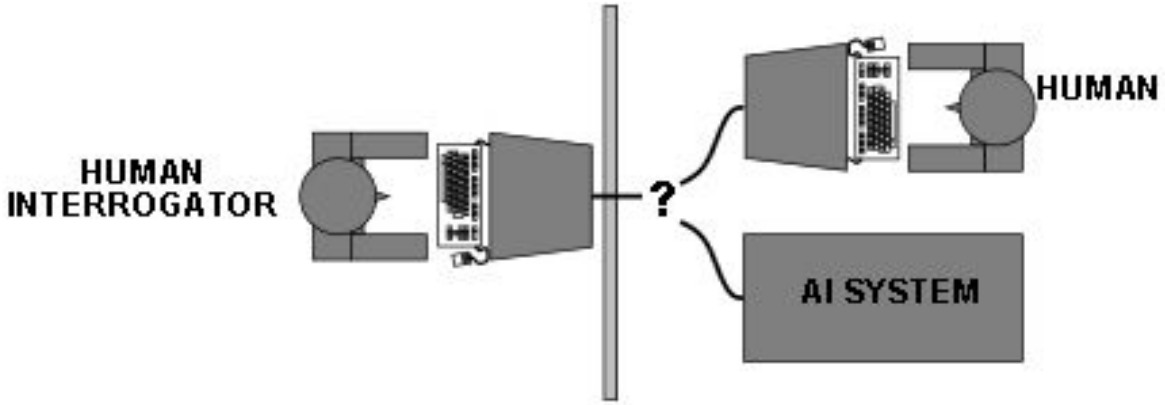


Autonomous driving

Agent

Turing(1950) “Computing machinery and intelligence“:

Can machines think? An imitation game



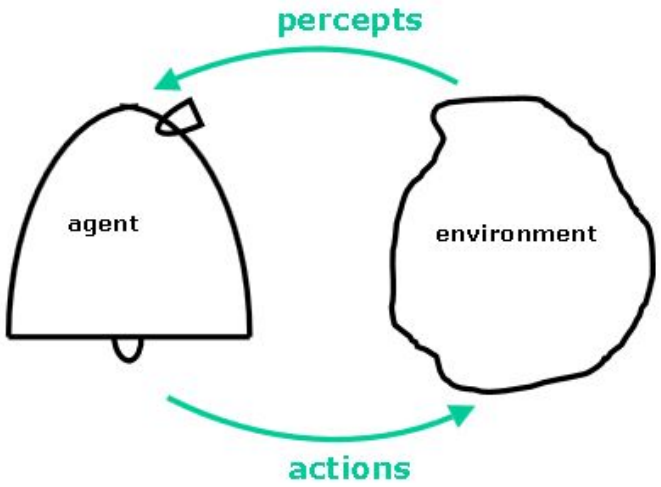
Software Agent

Software that gathers information about an environment and takes actions based on that

- a robot
- a web shopping program
- a traffic control system...

Computational agents behave autonomously

Agent and Environment

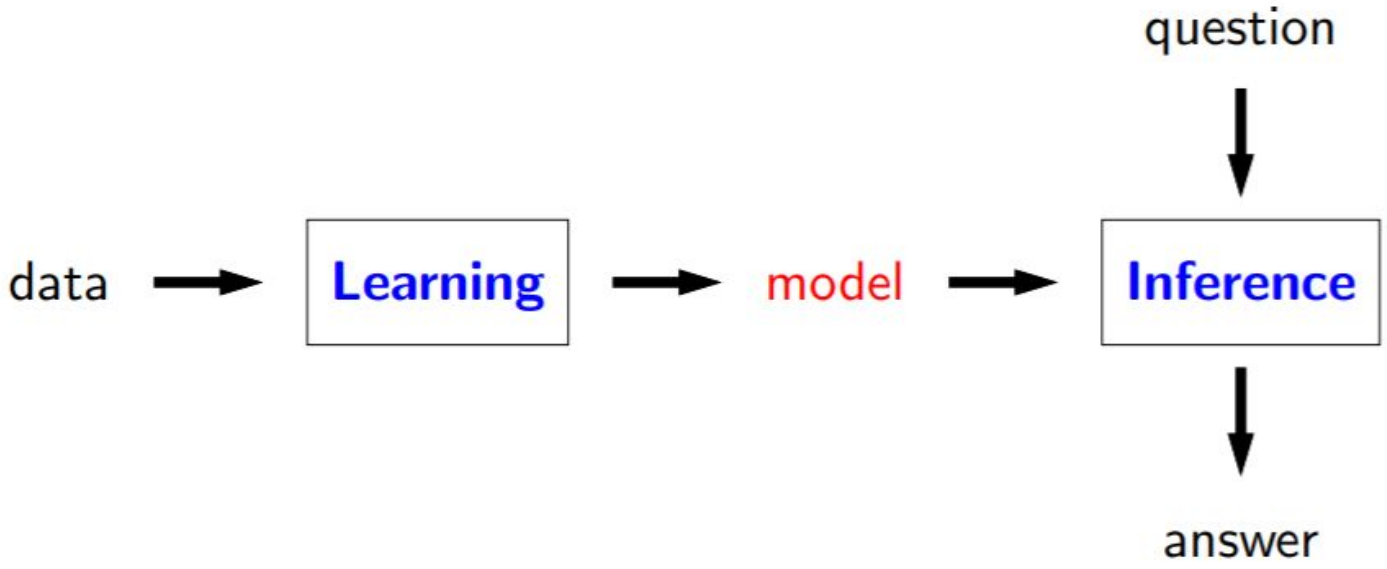


- An agent is anything that can be viewed as perceiving its environment through sensors and acting upon that environment through effectors.
- A robotic agent substitutes cameras and infrared range finders for the sensors and various motors for the effectors.
- A software agent has encoded bit strings as its percepts and actions.

Components of an AI problem?

- Initial State
- Actions
- Result
- Goal State
- Path cost function

Modelling



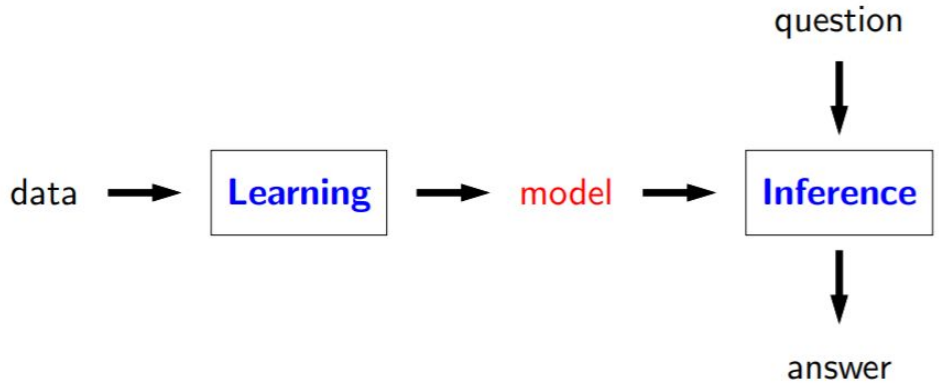
Examples: search problems, MDPs, games, CSPs, Bayesian networks

Search Problems

What is the minimum cost path?

Inference as finding minimum cost paths in a graph

Inference algorithms such as DFS, UCS or A* produced the minimum cost path.



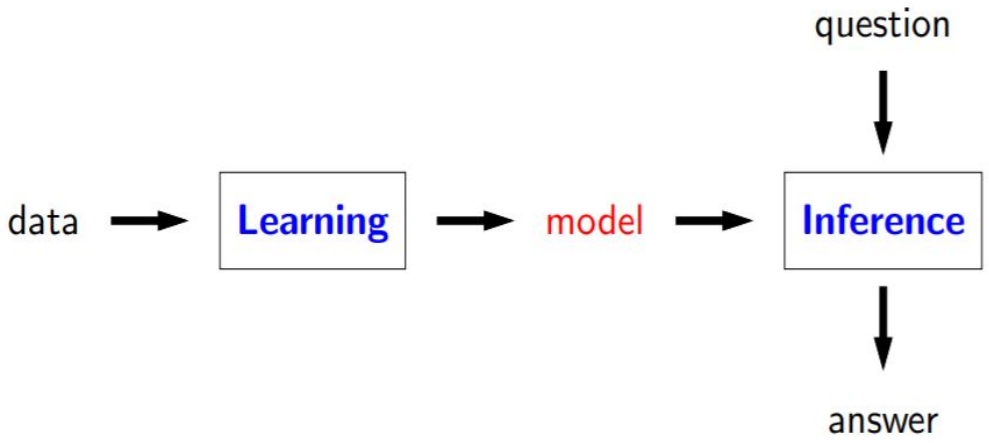
Examples: search problems, MDPs, games, CSPs, Bayesian networks

MDP and Games

what is the maximum value policy?

Inference algorithms such as value iteration or minimax produced this.

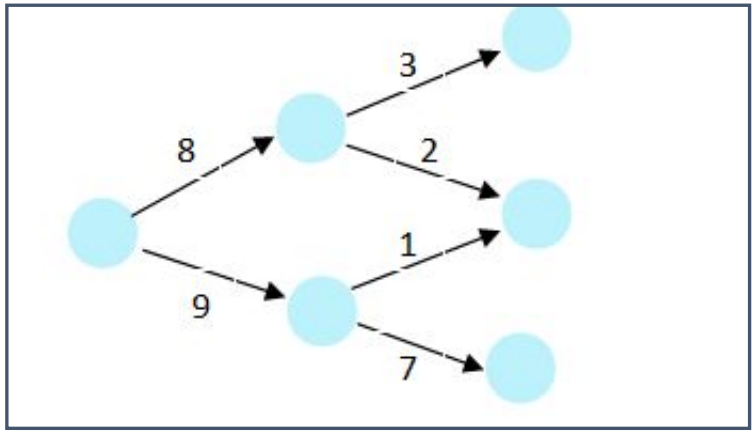
Learning algorithms such as Q-learning or TD learning.



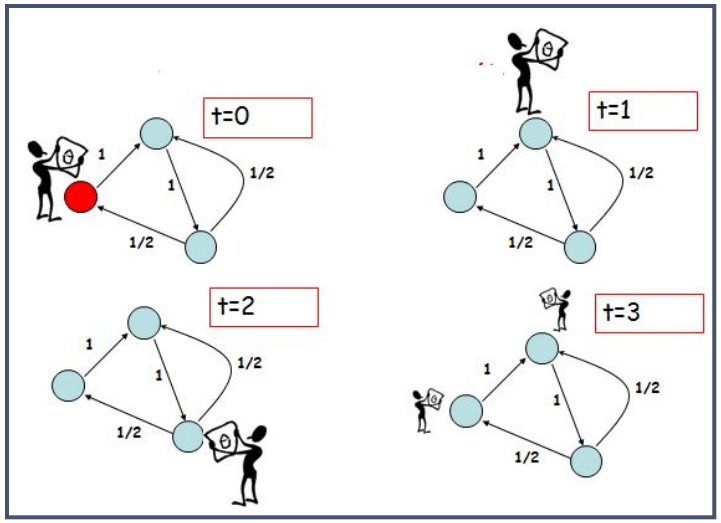
Examples: search problems, MDPs, games, CSPs, Bayesian networks

State based models

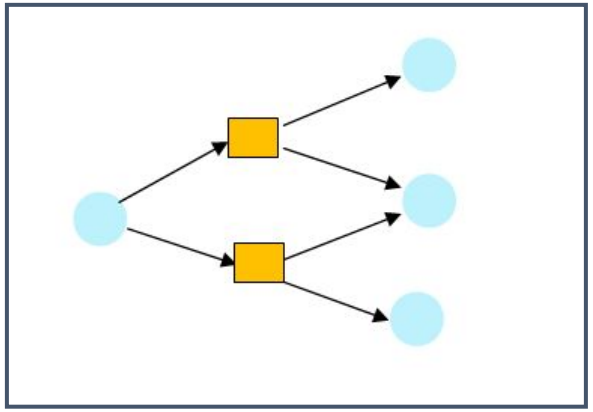
Search Problems : You control everything



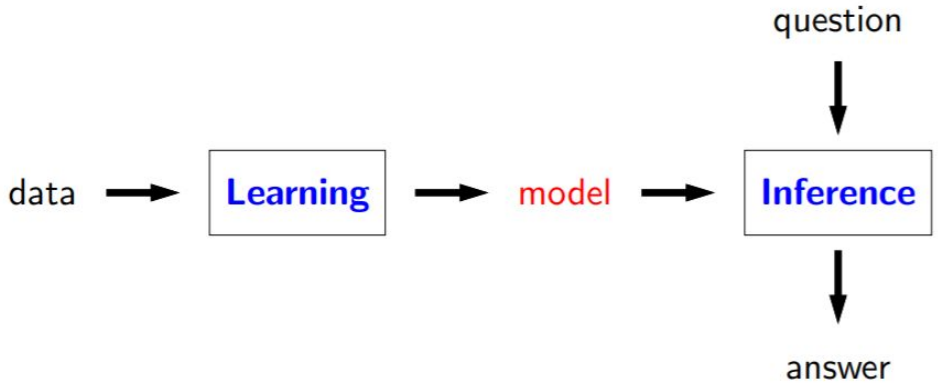
Markov Decision Process: Blackjack



Adversarial Games : Adversary Controls



Constraint Satisfaction

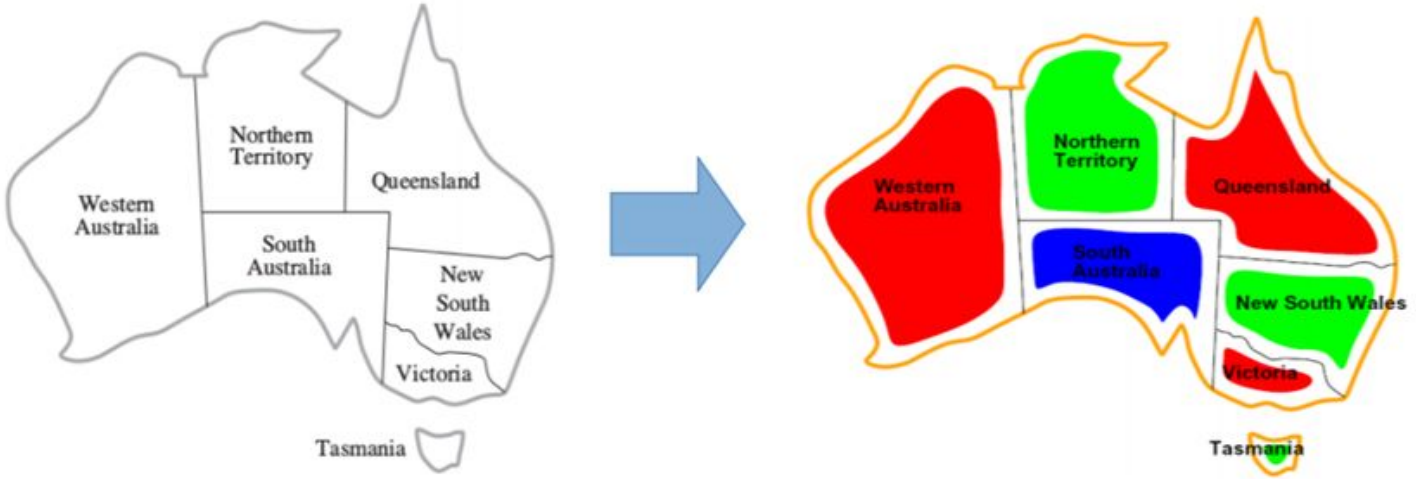


”what is the maximum weight assignment?”

inference as finding maximum weight assignments or computing conditional probabilities.

Inference algorithms such as backtracking search, beam search, or variable elimination to find such an assignment

Examples: search problems, MDPs, games, CSPs, Bayesian networks

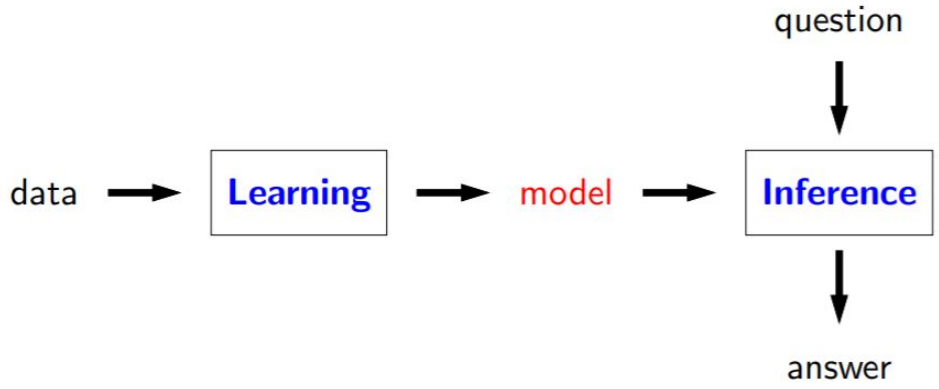


Bayesian Network

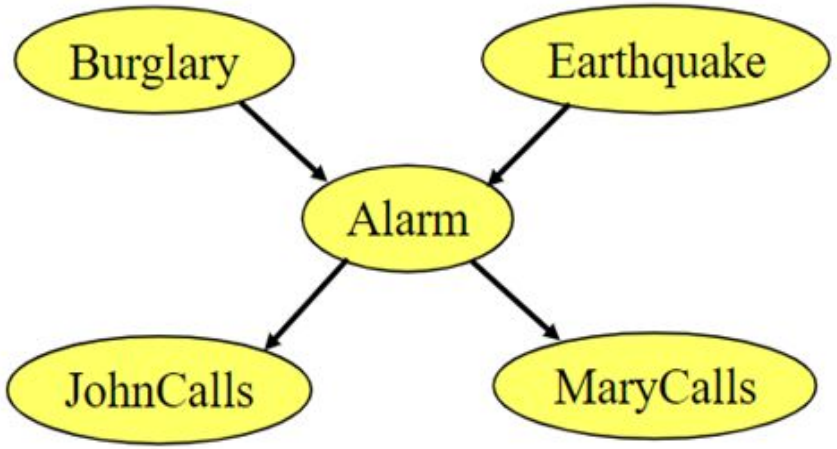
What is the probability of a query given evidence?”

Inference algorithms such as Gibbs sampling and particle filtering

we can learn them using maximum likelihood estimators

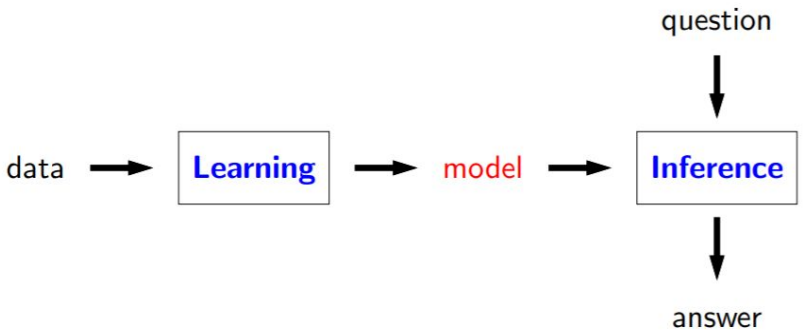


Examples: search problems, MDPs, games, CSPs, Bayesian networks



Logic based Models

inference is applying a set of rules



Examples: search problems, MDPs, games, CSPs, Bayesian networks

1. Lucy* is a professor
2. All professors are people.
3. John is the dean.
4. Deans are professors.
5. All professors consider the dean a friend or don't know him.
6. Everyone is a friend of someone.
7. People only criticize people that are not their friends.
8. Lucy criticized John .

Is Lucy a friend of John?

Modelling Paradigms

State-based models: search problems, MDPs, games

Applications: route finding, game playing, etc.

Think in terms of **states, actions, and costs**

Variable-based models: CSPs, Bayesian networks

Applications: scheduling, tracking, medical diagnosis, etc.

Think in terms of **variables and factors**

Logic-based models: propositional logic, first-order logic

Applications: theorem proving, verification, reasoning

Think in terms of **logical formulas and inference rules**


Search problems
Markov decision processes
Adversarial games
Constraint satisfaction problems
Markov networks
Bayesian networks
Reflex
States
Variables
Logic
"Low-level intelligence"
"High-level intelligence"