CS249
Artificial Intelligence

Week 1

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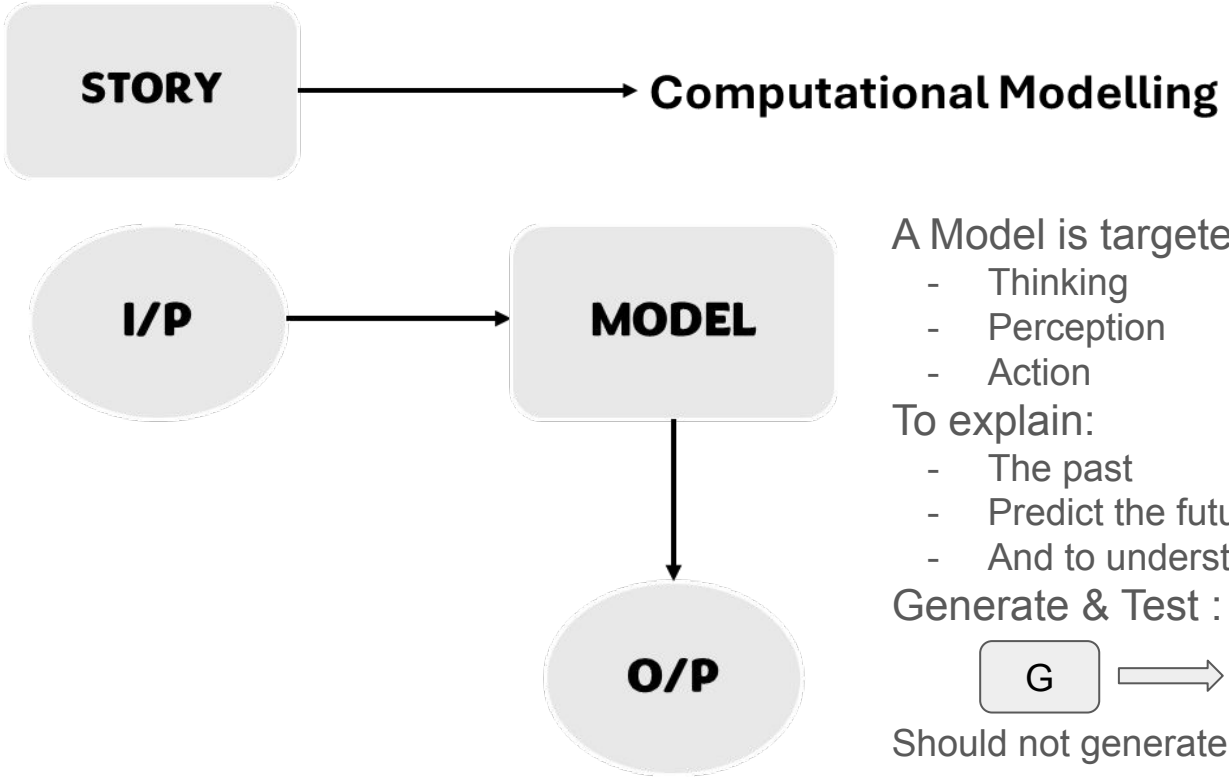
Intro to Artificial Intelligence

- “The art of creating machines that perform functions that require intelligence when performed by people” (Kurzweil, 1990).
- “The branch of computer science that is concerned with the automation of intelligent behavior.” (Luger and Stubblefield, 1993)
- “The study of how to make computer do things at which, at the moment, people are Better." (Rich+Knight,1991)

Views of AI fall into four categories:

Thinking Humanely	**Thinking Rationally**
Acting Humanely	**Acting Rationally**

Intro to Artificial Intelligence



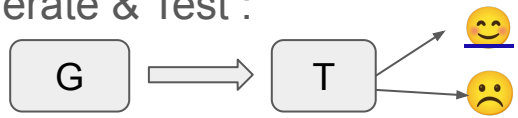
A Model is targeted at :

- Thinking
- Perception
- Action

To explain:

- The past
- Predict the future
- And to understand the subject

Generate & Test :

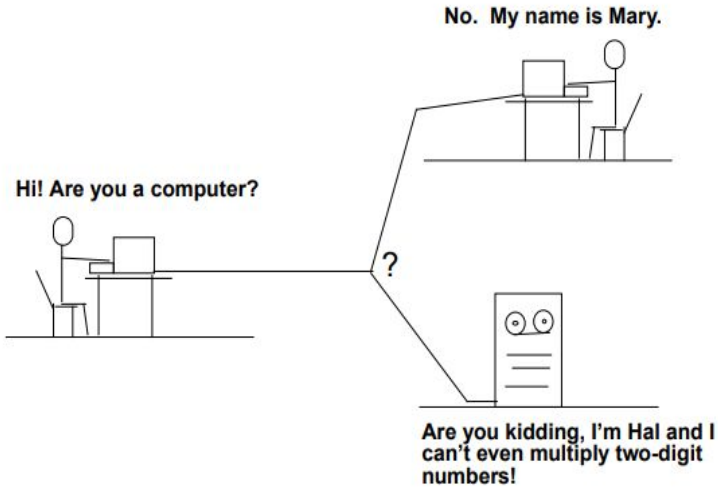


Should not generate redundant information

Turing Test (1950)

If the response of a computer to an unrestricted textual natural-language conversation cannot be distinguished from that of a human being then it can be said to be intelligent.

The Turing Test, proposed by Alan Turing (1950), was designed to provide a satisfactory operational definition of intelligence. A computer passes the test if a human interrogator, after posing some written questions, cannot tell whether the written responses come from a person or from a computer.

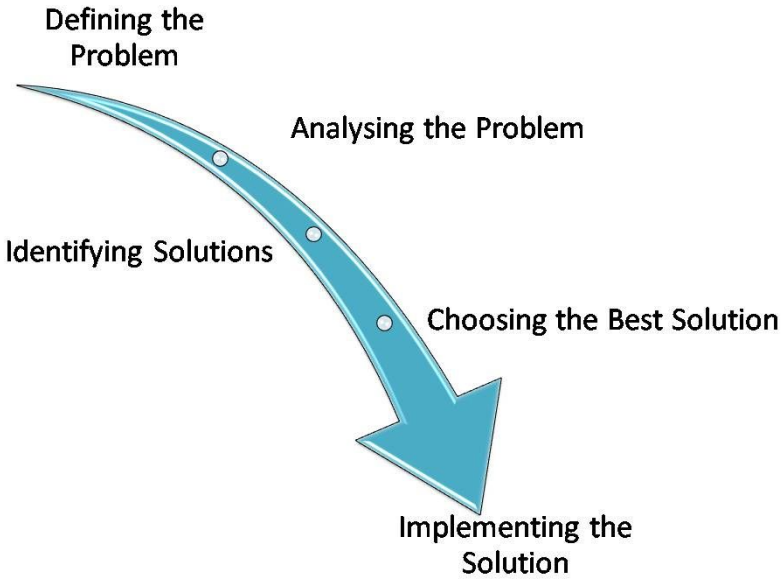


The Ability To Solve Problem

Search: Efficient Trial & Error

- SPACE/TIME Complexity trade off
- Use of domain knowledge(Heuristic)

- **Linear Programming**
- **Integer Programming**
- **Dynamic Programming**
- **Heuristic Search**
- **Evolutionary Algorithms**



Knowledge and Deduction

- How to store and retrieve knowledge
- How to interpret facts as well as rules and able to deduce
- The gap between knowledge and realization
- Logics of Knowledge

    a)Knowledge Based System(KBS)

    b)Expert System(ES)

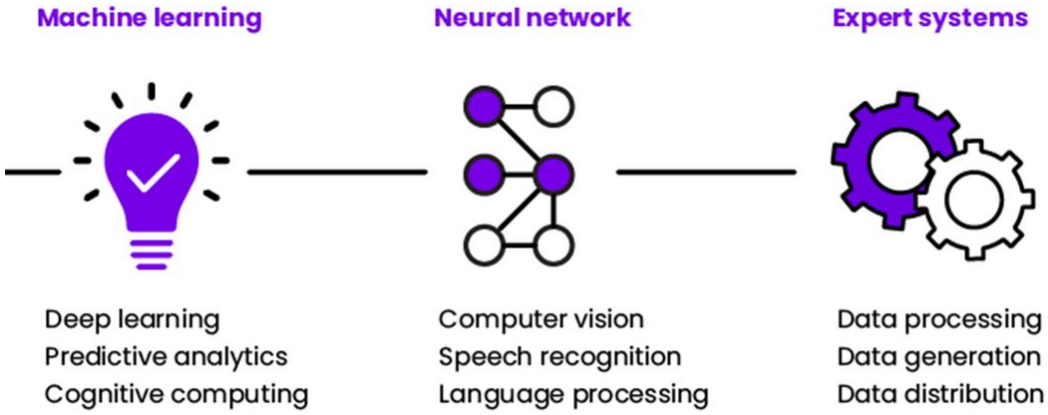
    c)Automated Theorem Processing

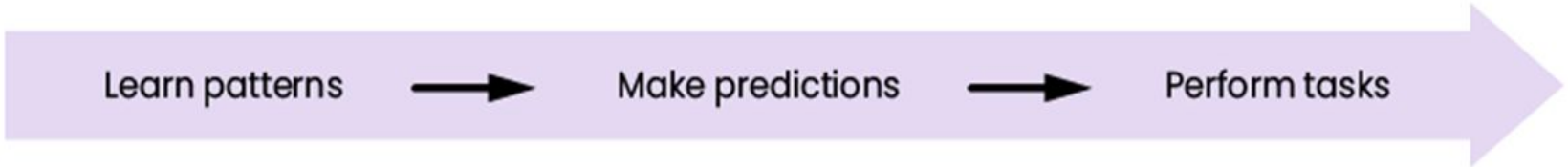
The Ability To Learn

Can we learn to solve a problem better?

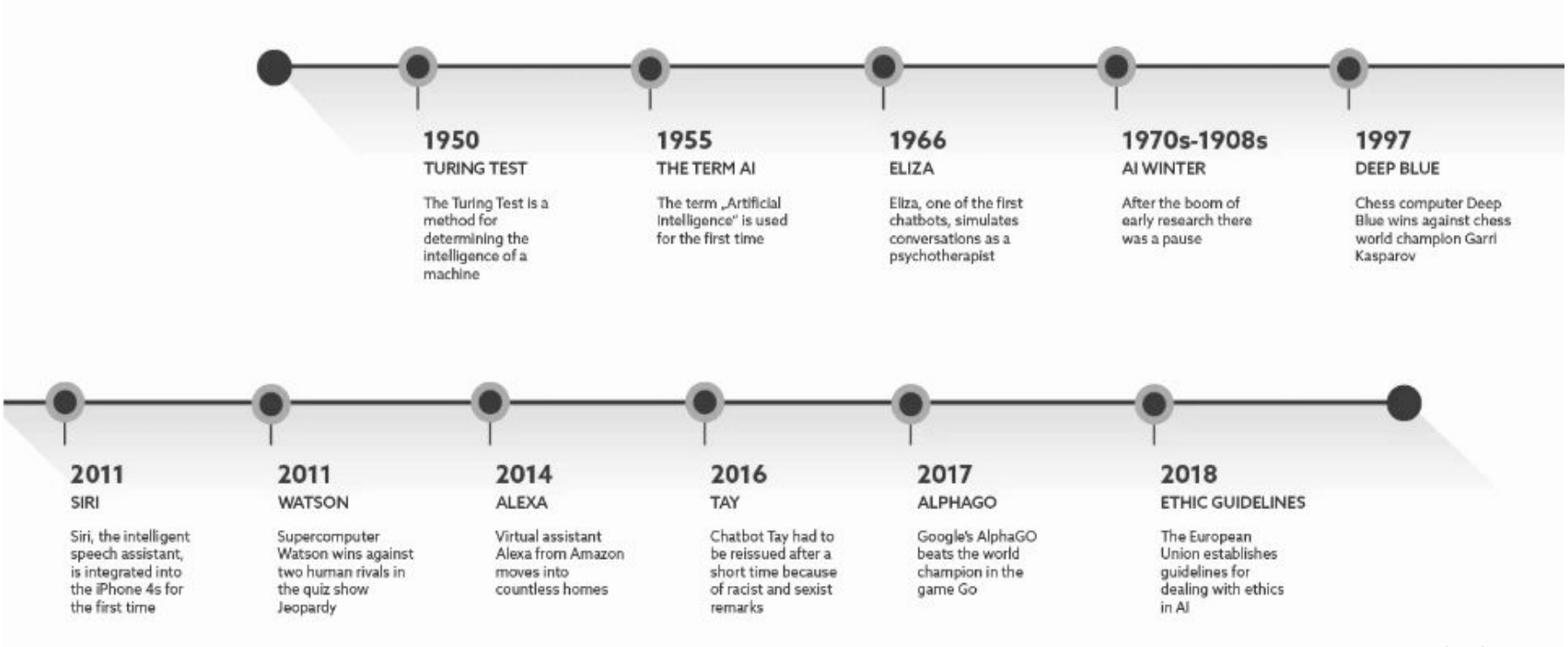
Approaches:

- **Learning the answer.**
- **Learning the rule of the game.**
- **Learning to plan.**
  - **Belief Networks**
  - **Perceptrons and Neural Networks**





History of Artificial Intelligence



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Fundamentals

- The notion of expressing computation as an algorithm
- **Godel's incompleteness theorem**
- **Church Turing Hypothesis:** Turing machine is capable of any computable function
- 2 notions of interact-ability
  - NP Completeness
  - Reduction

Problem Solution by Search

- State Space Search
- Probability reduction
- Name playing

Logic & Deduction

- 1st order logic,temporal logic
- Planning
- Reasoning under uncertainty
- Learning

An Agent

An agent is just something that acts. all computer programs do something, but computer agents are expected to do more: operate autonomously, perceive their environment, persist over a prolonged time period, adapt to change, and create and pursue goals.

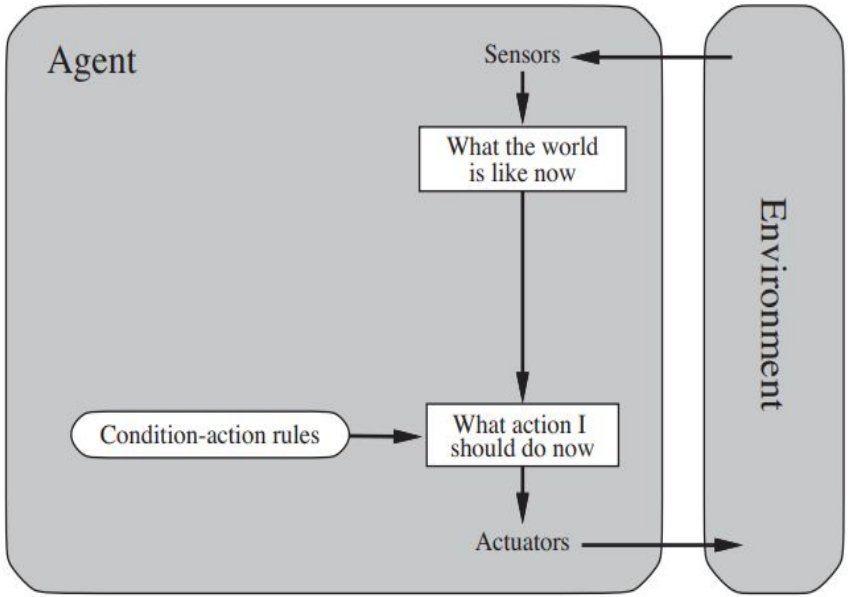
Definition: An intelligent agent perceives its environment via sensors and acts rationally upon that environment with its effectors. A discrete agent receives percepts one at a time, and maps this percept sequence to a sequence of discrete actions.

Properties:

- Autonomous
- Reactive to the environment
- Proactive (goal-directed)
- Interacts with other agents via the environment

The rational agent approach

A rational agent is one that acts so as to achieve the best outcome or, when there is uncertainty, the **best expected outcome**.



A simple reflex based rational agent

Examples of Agents Types and their Descriptions

Agent Type	Performance Measure	Environment	Actuators	Sensors
Medical diagnosis system	Healthy patient, reduced costs	Patient, hospital, staff	Display of questions, tests, diagnoses, treatments, referrals	Keyboard entry of symptoms, findings, patient's answers
Satellite image analysis system	Correct image categorization	Downlink from orbiting satellite	Display of scene categorization	Color pixel arrays
Part-picking robot	Percentage of parts in correct bins	Conveyor belt with parts; bins	Jointed arm and hand	Camera, joint angle sensors
Refinery controller	Purity, yield, safety	Refinery, operators	Valves, pumps, heaters, displays	Temperature, pressure, chemical sensors
Interactive English tutor	Student's score on test	Set of students, testing agency	Display of exercises, suggestions, corrections	Keyboard entry
Taxi driver	Safe, fast, legal, comfortable trip, maximize profits	Roads, other traffic, pedestrians, customers	Steering, accelerator, brake, signal, horn, display	Cameras, sonar, speedometer, GPS, odometer, accelerometer, engine sensors, keyboard

Properties of task environments

Fully observable/Partially observable

If an agent's sensors give it access to the complete state of the environment needed to choose an action, the environment is fully observable.

Such environments are convenient, since the agent is freed from the task of keeping track of the changes in the environment.

Deterministic/Stochastic

An environment is deterministic if the next state of the environment is completely determined by the current state of the environment and the action of the agent.

In a stochastic environment, there are multiple, unpredictable outcomes.
In a fully observable, deterministic environment, the agent need not deal with uncertainty.

Episodic/Sequential

An episodic environment means that subsequent episodes do not depend on what actions occurred in previous episodes.

In a sequential environment, the agent engages in a series of connected episodes.Such environments do not require the agent to plan ahead.

Static/Dynamic

A static environment does not change while the agent is thinking.The passage of time as an agent deliberates is irrelevant.The agent doesn't need to observe the world during deliberation.

Discrete/Continuous

If the number of distinct perceptions and actions is limited, the environment is discrete.Otherwise, it is continuous.

Single agent / Multi-agent

If the environment contains other intelligent agents, the agent needs to be concerned about strategic, game-theoretic aspects of the environment (for either cooperative or competitive agents).
Most engineering environments don't have multi-agent properties, whereas most social and economic systems get their complexity from the interactions of (more or less) rational agents.

Examples of tasks Environments and their characteristics

Task Environment	Observable	Agents	Deterministic	Episodic	Static	Discrete
Crossword puzzle	Fully	Single	Deterministic	Sequential	Static	Discrete
Chess with a clock	Fully	Multi	Deterministic	Sequential	Semi	Discrete
Poker	Partially	Multi	Stochastic	Sequential	Static	Discrete
Backgammon	Fully	Multi	Stochastic	Sequential	Static	Discrete
Taxi driving	Partially	Multi	Stochastic	Sequential	Dynamic	Continuous
Medical diagnosis	Partially	Single	Stochastic	Sequential	Dynamic	Continuous
Image analysis	Fully	Single	Deterministic	Episodic	Semi	Continuous
Part-picking robot	Partially	Single	Stochastic	Episodic	Dynamic	Continuous
Refinery controller	Partially	Single	Stochastic	Sequential	Dynamic	Continuous
Interactive English tutor	Partially	Multi	Stochastic	Sequential	Dynamic	Discrete

Structure of Agents

Table-driven agents

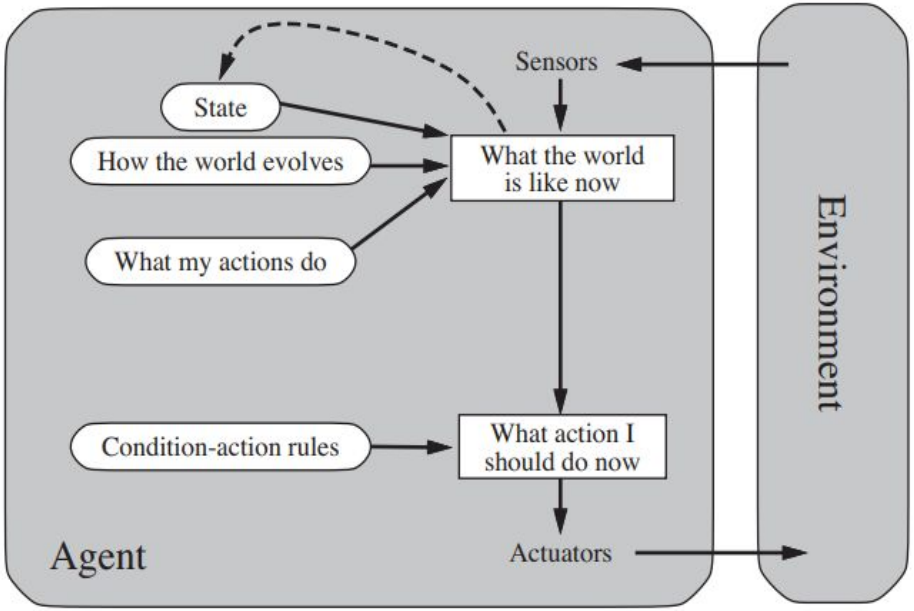
Use a percept sequence/action table in memory to find the next action.
They are implemented by a (large) lookup table.

Simple reflex agents

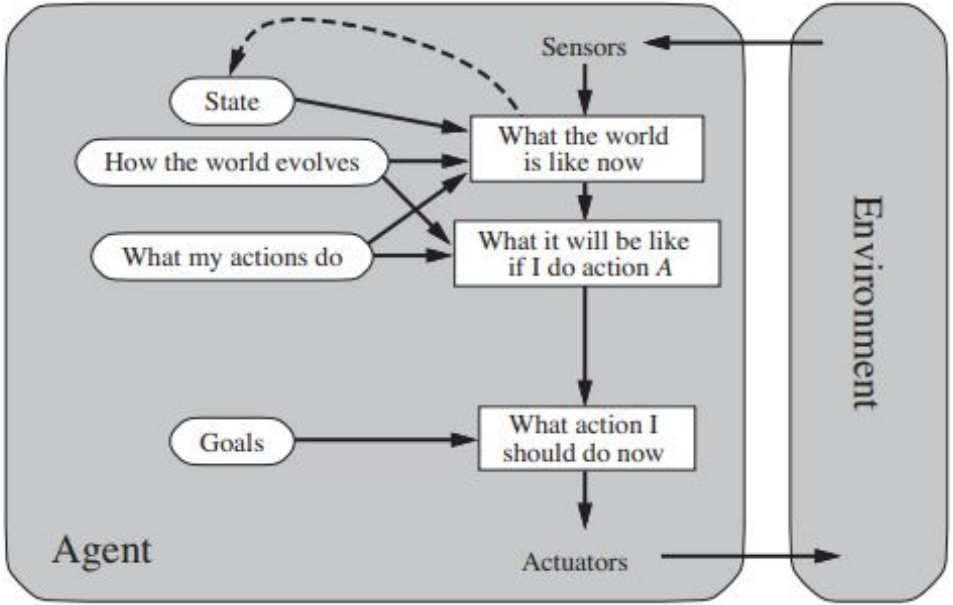
Are based on condition-action rules, implemented with an appropriate production system.
They are stateless devices which do not have memory of past world states.

Agents with memory

Have internal state, which is used to keep track of past states of the world.



Model based reflex based agent



Model based Goal based Reflex agent

CITATIONS

- https://people.eecs.berkeley.edu/~russell/slides/
- https://www.cs.utexas.edu/~mooney/cs343/slide-handouts
- Artificial Intelligence : A Modern Approach by Stuart Russell and Peter Norvig