Artificial Intelligence - 1

Asst. Prof. Salwa Osama

Email: SalwaOsama@fci.helwan.edu.eg

اللَّهُمَّ انْفَعْنِي بِمَا عَلَّمْتَنِي، وَعَلِّمْنِي مَا يَنْفَعُنِي، وَزِدْنِي عِلْمًا

O' Allah, Benefit me from what I learn, let me learn what would benefit me, and increase me in knowledge

The Big Goal

، 1/53، وصححه الألباني في صحيح ابن ماجه، 281 /10، وابن أبي شيبة، 251برقم ، وابن ماجه، المقدمة، باب الانتفاع بالعلم،3599أخرجه الترمذي، كتاب الدعوات، باب حدثنا أبو كريب، برقم 2845.وصحيح الترمذي، برقم

من سلك طريقًا يطلبُ فيه علمًا ، سلك اللهُ به طريقًا من طرقِ الجنةِ

Whoever follows a path to seek knowledge therein, Allah will make easy for him a path to paradise

Why??

صحيح :والمحدث حكم خلاصة | 3641 :الرقم أو الصفحة داود أبي صحيح : المصدر | الألباني : المحدث | الدرداء أبو : الراوي
(21715) وأحمد ،(223) ماجه وابن ،(2682) والترمذي له، واللفظ (3641) داود أبو أخرجه : التخريج

About me...

- Salwa Osama
  - Asst. Prof. Computer Science at Helwan University
  - Asst. Prof. Computer Science In MIU(Part time)
  - Instructor in ITI
  - Salwaosama@fci.helwan.edu.eg
- Research Interests:
  - Recognizing of Human Activities
  - Internet of Things
  - NLP

The Deal …

- Ethics
- Attendance
- Participation
- Your laptop
- Daily Tasks
- Final Project

Course Objectives

This course gives a basic introduction to Artificial Intelligence (AI) and Machine Learning (ML).

The course covers basic Searching techniques (exhaustive and heuristics), supervised classification, as well as unsupervised learning (Clustering), optimization (Evolutionary Algorithms and other search methods), and tentatively regression, finally Math in Datascience.

Through an algorithmic approach, the students are given a practical understanding of the methods being taught, through making their own implementations of several of the methods.

Textbox

- Not required, but for students who want to read more we recommend

1. Artificial Intelligence: A Systems Approach,5th ed by M. Tim Jones
2. Artificial Intelligence: A Modern Approach, 4th US ed.by Stuart Russell and Peter Norvig

- Warning: Not a course textbook, so our presentation does not necessarily follow the presentation in the books.

Outline

An introduction to Artificial Intelligence [AI], Intelligent Agents, Introduction to Python

Solving Problems by Searching

- Exhaustive vs. Heuristic techniques

Linear Algebra for Data Science

Probability and Statistics for Machine Learning

Evolutionary Algorithms, Numerical Optimization

Common steps of Machine Learning

- Data Cleaning and Normalization
- Data Visualization
- Feature Extraction
- Building Model
- Evaluating Model

Supervised Machine Learning

Unsupervised Machine Learning

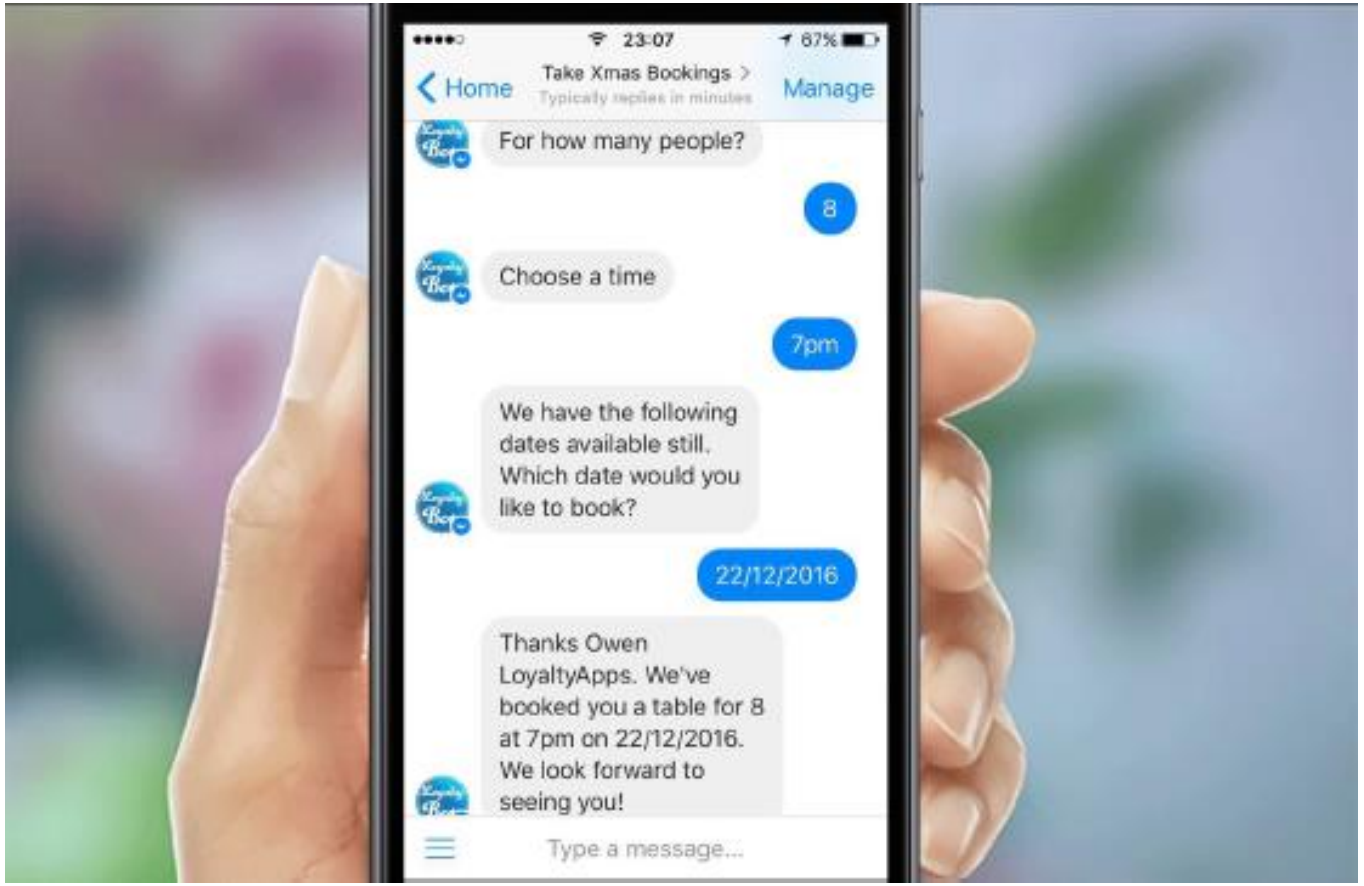
Introduction to Deep Learning

AI is formed from different areas

Philosophy:	Can formal rules be used to draw valid conclusions?
Mathematics:	How do we reason with uncertain information? *Probability
Neuroscience:	How do brains process information? *Neural Network
Psychology:	How do humans and animals think and act? learning
Economics:	How should we make decisions so as to maximize payoff? *Decision and game theory
Computer Engineering:	What is the best technique to build efficient computer? Optimization,
Linguistics:	How does language relate to thought? Understand and generate language

Applications of AI

- Automated Customer Support

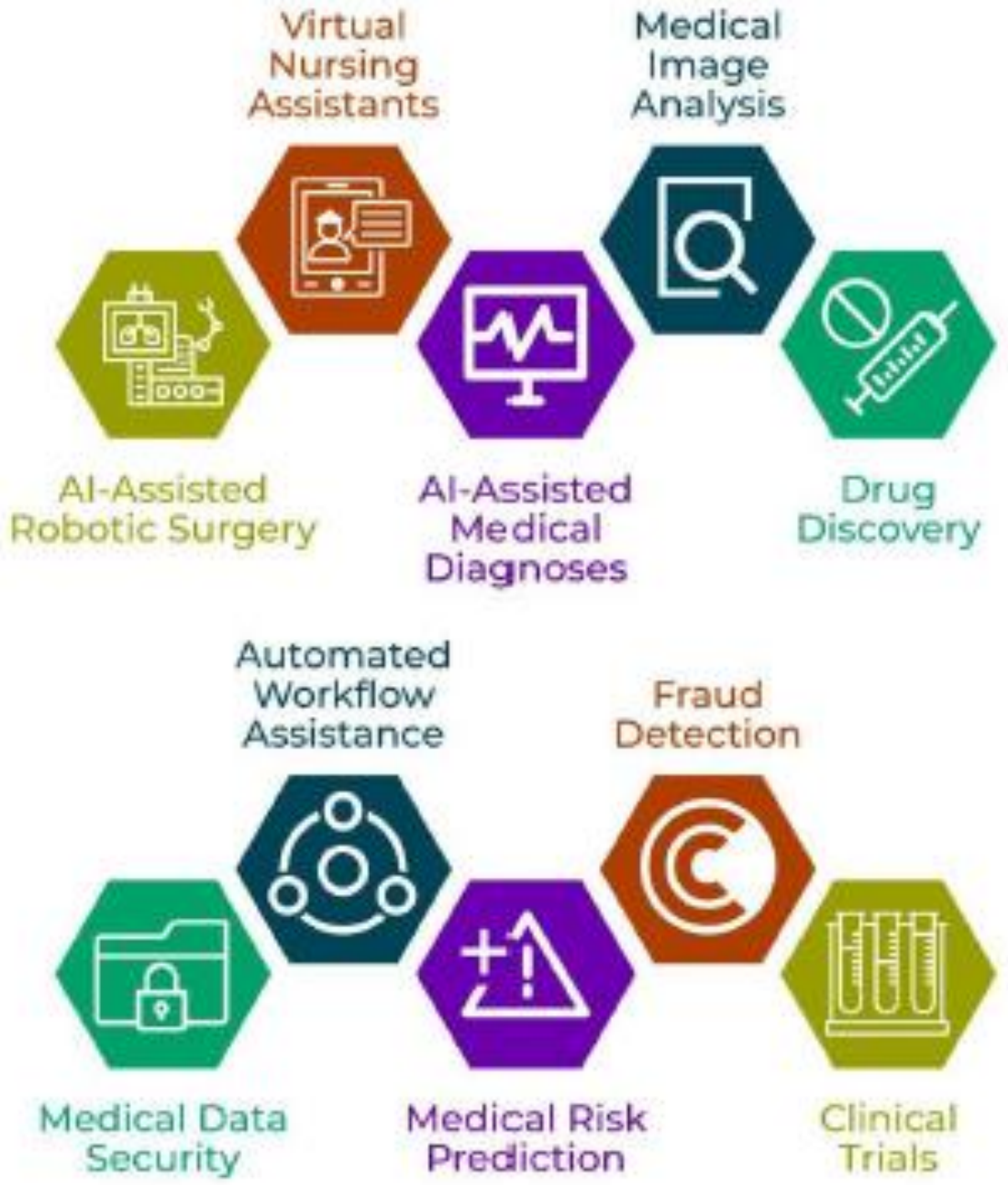


Applications of AI

- Personalized online shopping

Applications of AI

- Healthcare



Applications of AI

- Finance

Applications of AI

- Smart cars and Drones

Applications of AI

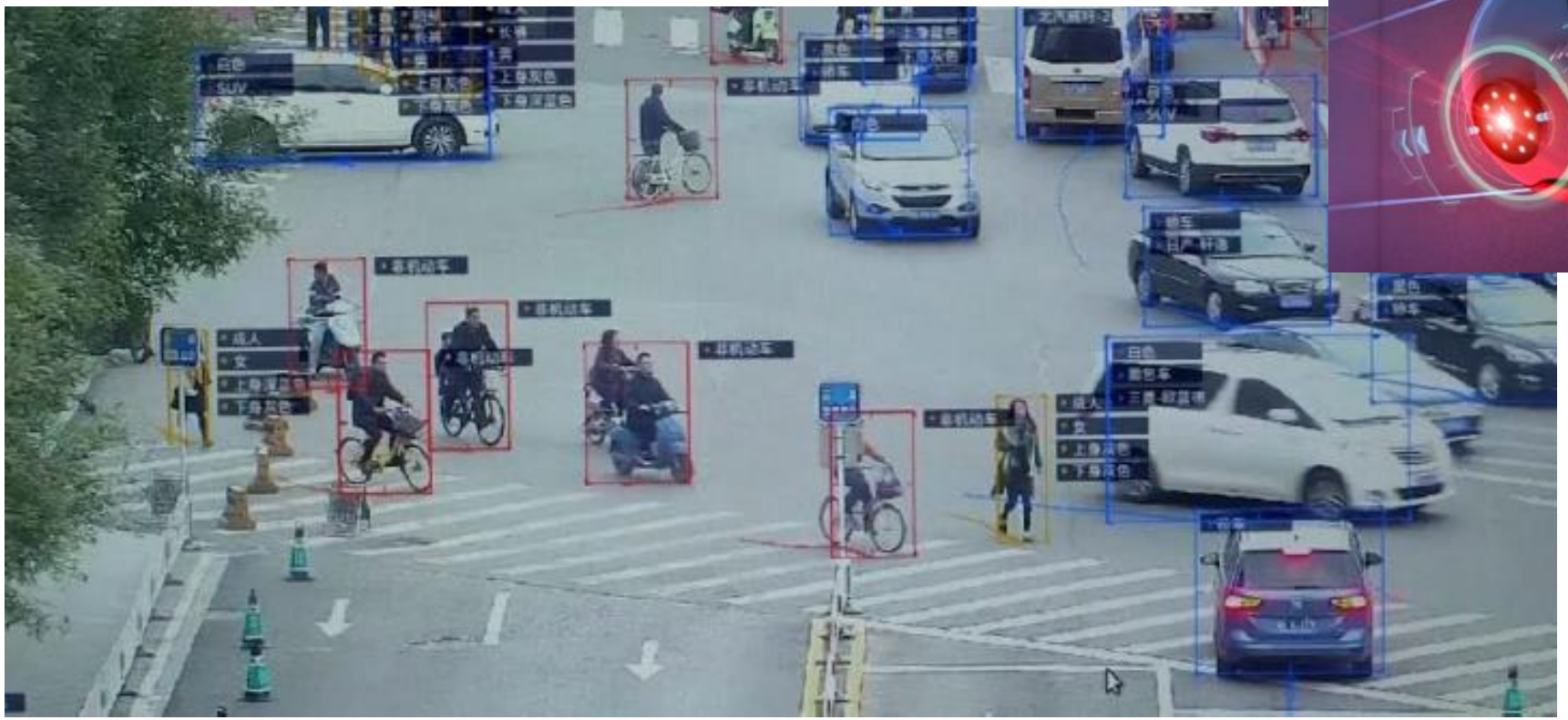
- Travel and Navigation

Applications of AI

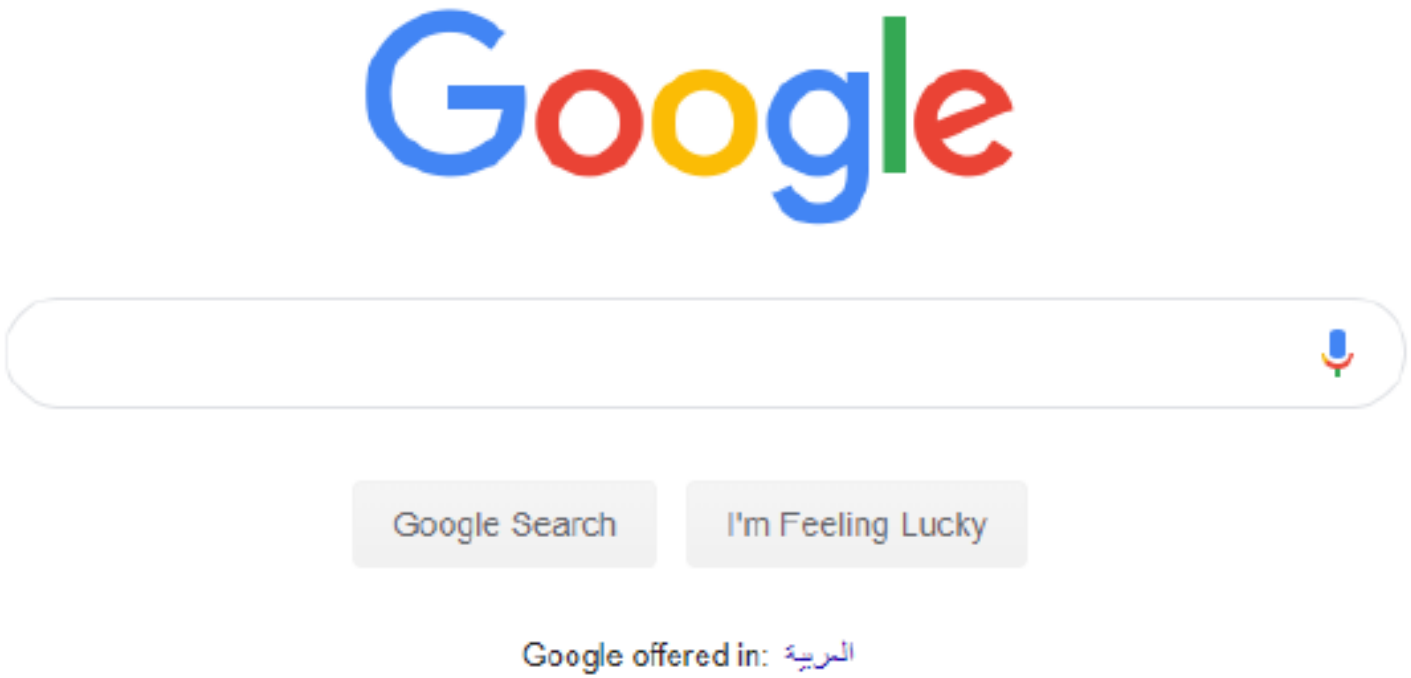
- Smart home devices

Applications of AI

- Monitoring and surveillance



AI in Google


Google
Google Search
I'm Feeling Lucky
Google offered in: العربية

AI in Facebook

In present, what can AI do?

- Play a decent game of Chess?

  Deep Blue - Chess Engines - Chess.com

- Play a decent game of table tennis?

  Robotics and real-time decision-making in dynamic environments are still areas of active research.

- Drive safely along a curving mountain road?

  still under development

- Drive safely along a crowded Road?

  still face challenges in complex urban environments with unpredictable human behavior.

- Buy a week's worth of groceries on the web?

  Amazon and grocery delivery services.

In present, what can AI do?

- Buy a week's worth of groceries at Hyper Supermarket?

  fully autonomous shopping without human intervention is still limited.

- Discover and prove a new mathematical theorem?

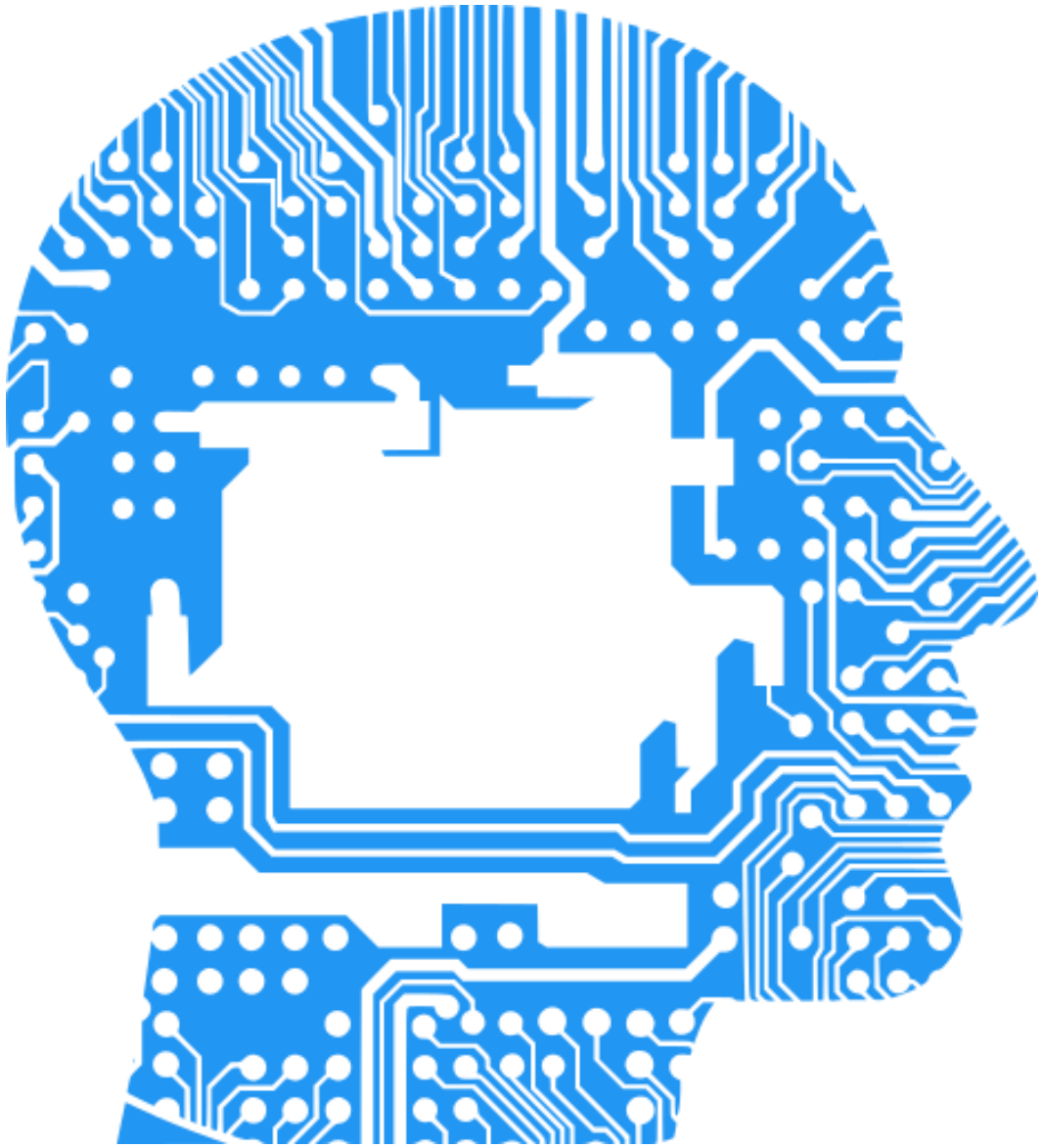
  human intuition and creativity are still crucial in many cases.

- Converse successfully with another person for an hour?

  but they may struggle with deeper, more accurate, and context-rich dialogues over extended periods.

- Perform a surgical operation?

  Vinci Surgical System but still need human



What is Intelligence?

Judgment, otherwise called "good sense," "practical sense," "initiative," the faculty of adapting one's self to circumstances .. auto-critique ~ *Alfred Binet (July 8, 1857 – October 18, 1911) was a French psychologist who invented the first practical intelligence test (An intelligence quotient (IQ); a total score derived from one of several standardized tests designed to assess human intelligence)*

What is Intelligence?

“.. the resultant of the process of acquiring, storing in memory, retrieving, combining, comparing, and using in new contexts information and conceptual skills.” *~Lloyd G. Humphreys (December 12, 1913 – September 7, 2003) was an American psychologist*

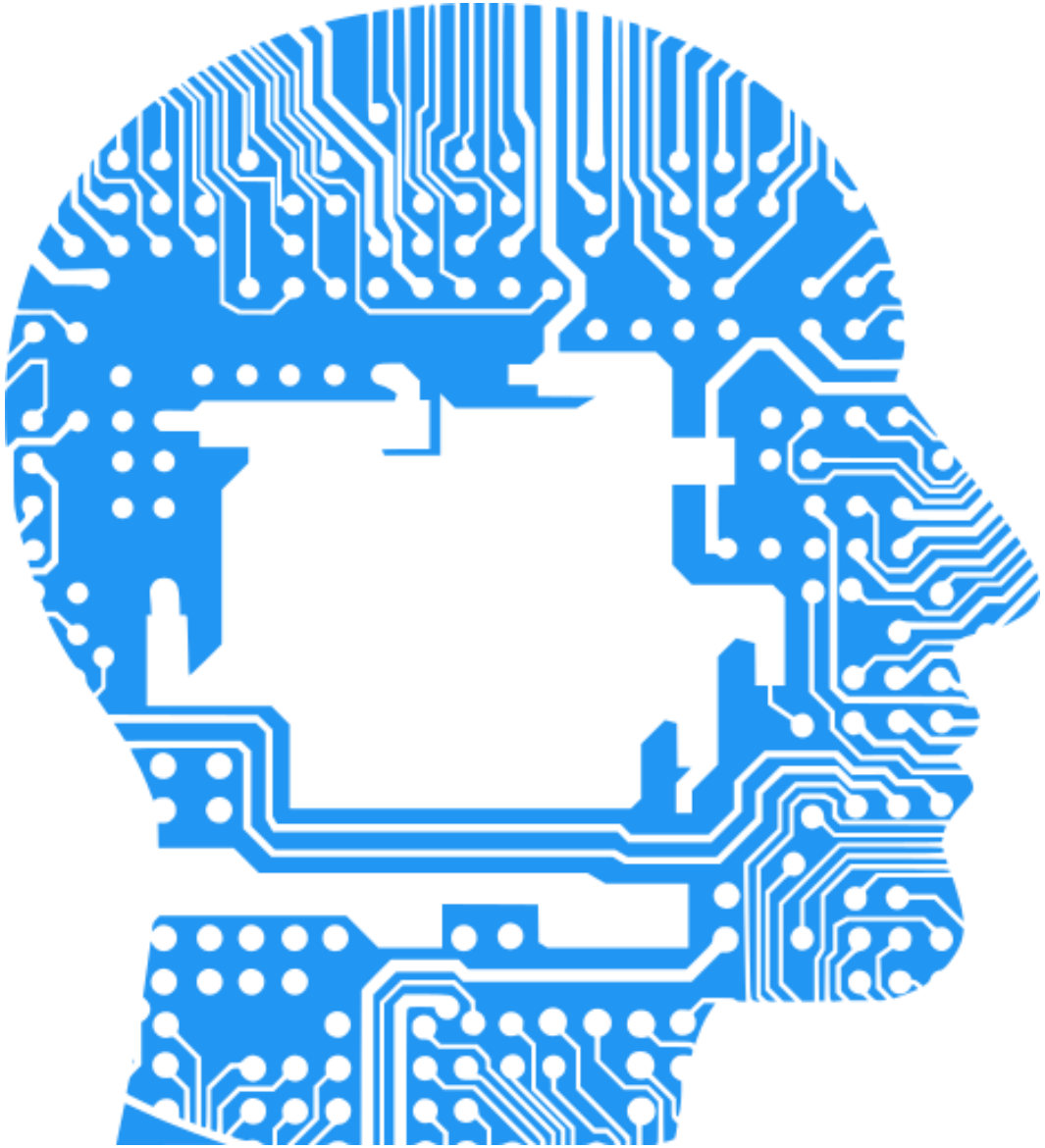
“ .. the capacity to learn and solve problems ..” (Webster’s dictionary)

- in particular,

  the ability to solve novel problems

  the ability to act rationally

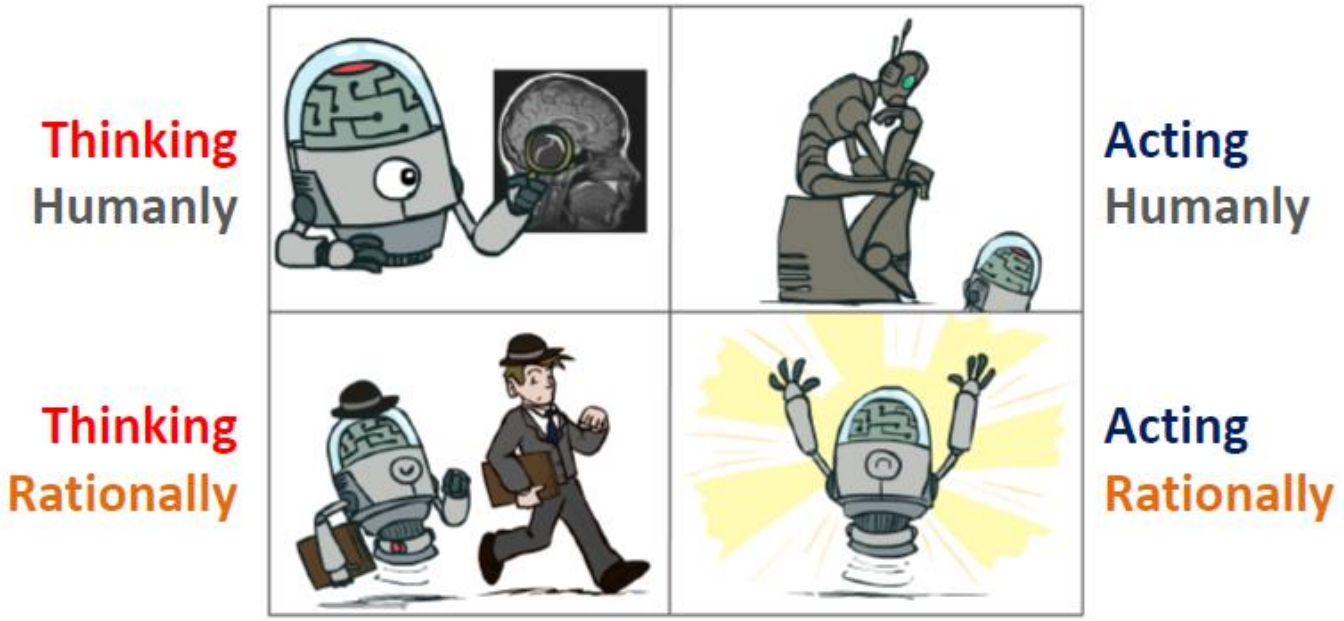
  the ability to act like humans



What is AI

Every aspect of learning or any other feature of intelligence can in principle be so precisely described that a machine can be made to simulate it. An attempt will be made to find how to make machines use language, form abstractions, and concepts, solve kinds of problems now reserved for humans, and improve themselves

- Artificial Intelligence is the ability of a computer program to **learn** and **think**.
- John McCarthy*, Stanford University, coined the term Artificial Intelligence in the year 1950.



What is Artificial Intelligence?

- Four Main Approaches that have been followed, each by different people with different methods.

Systems that act like humans

Goal: Emulate human behavior.

Focus: Human-like actions.

Approach: Turing Test, human-computer interaction.

Example: Chatbots and conversational agents.

Systems that think rationally

Goal: Apply logical reasoning.
Focus: Ideal rational thought.
Approach: Formal logic, mathematics, automated reasoning.
Example: Systems using logical proofs for decision making.

Systems that think like humans

Goal: Mimic human cognitive processes.
Focus: Human thought.
Approach: Cognitive science, psychology, neuroscience.
Example: Cognitive architectures that simulate human problem-solving.

Systems that act rationally

Goal: Optimize performance and outcomes.

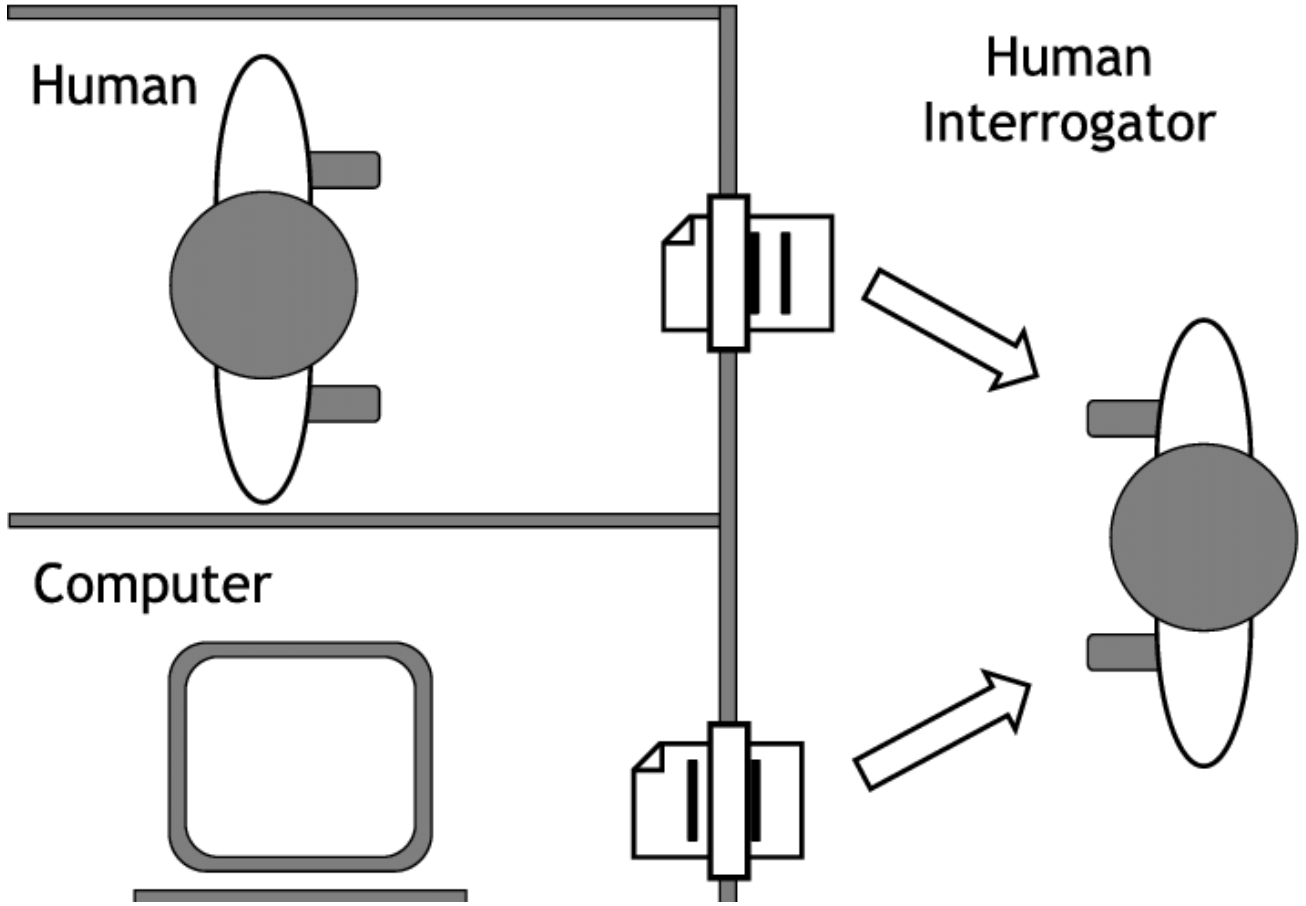
Focus: Rational actions.

Approach: Rational agent design, decision theory.

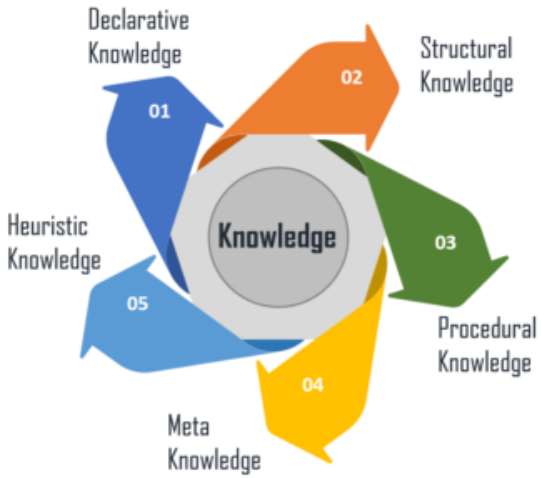
Example: Autonomous vehicles, strategic game playing AI.

Systems that Act Like Humans

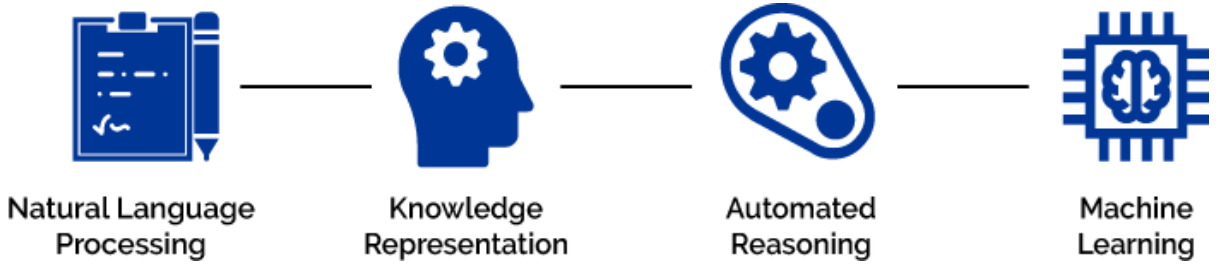
- Turing Test; the Imitation Game …
- In Turing's(1950) paper "Computing machinery and intelligence": **Can machines think ?** ≡ *(identical to)* **Can machines behave intelligently?**
- Operational test for intelligent behavior: *the* **Imitation Game**



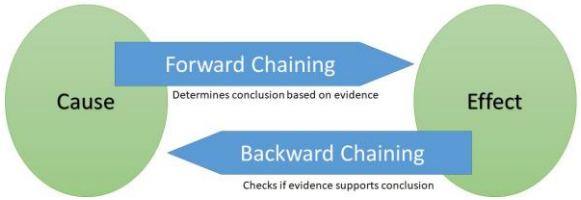
Systems that Act Like Humans



- **Turing Test;** *the* ***Imitation Game …***
  - **Turing test (1950)**: Can a human interrogator tell whether (written) responses to her (written) questions come from a human or a machine?
    - Natural Language Processing
    - Knowledge Representation
    - Automated Reasoning
    - Machine Learning



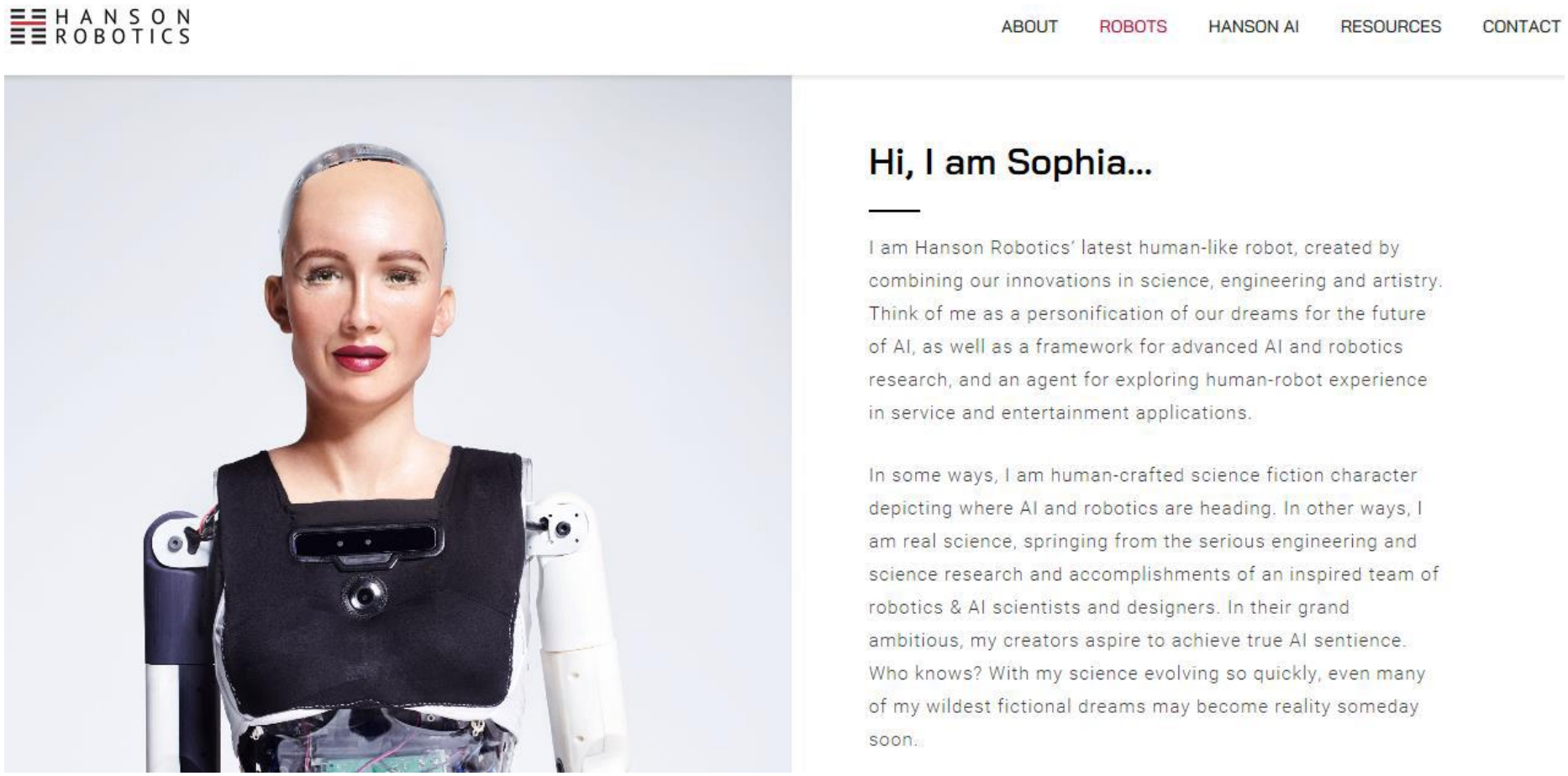
  - **Total Turing Test** *(extended to include physical aspects of human behavior):*
    - Computer Vision
    - Robotics



Total Turing Test?

But why do we want an intelligent system to act like a human?

- Because for many tasks, humans are still the Gold Standard.



Total Turing Test?

BabyX!

BabyX is a project *(by Auckland's Bioengineering Institute Laboratory for Animate Technologies)* to make a **virtual animated baby** that **learns and reacts like a human baby**. It uses the computer's cameras for "seeing" and microphones to "listen" as the inputs. The computer uses AI algorithms for BabyX's "learning" and interpretation of the inputs (**voice and image**) to understand the situation. The result is a virtual toddler that can learn to read, recognize objects and "understand." The output is the baby's face that can

"speak" and express its mood by facial expressions (such as smiling).

Total Turing Test?

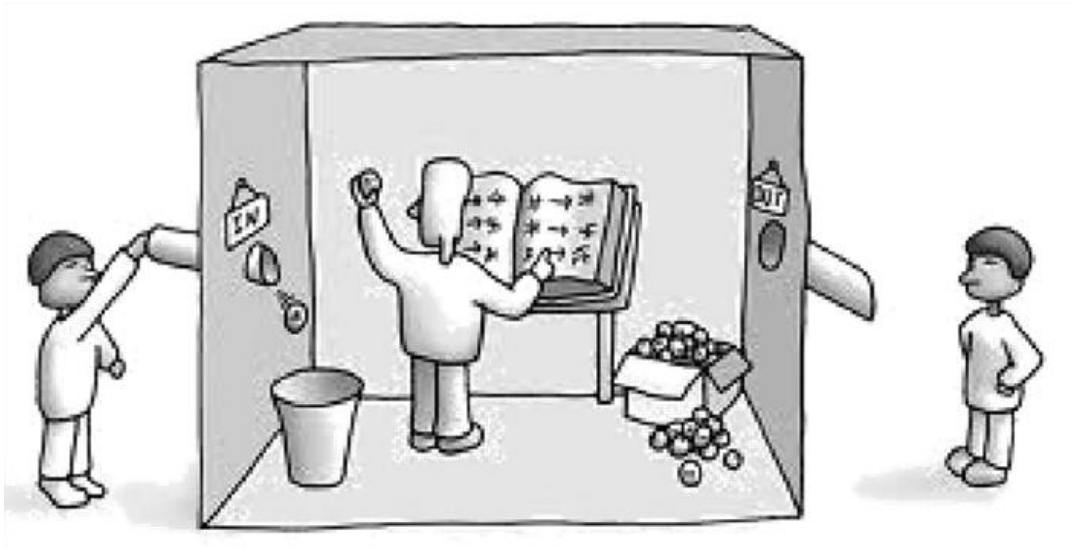
BabyX!

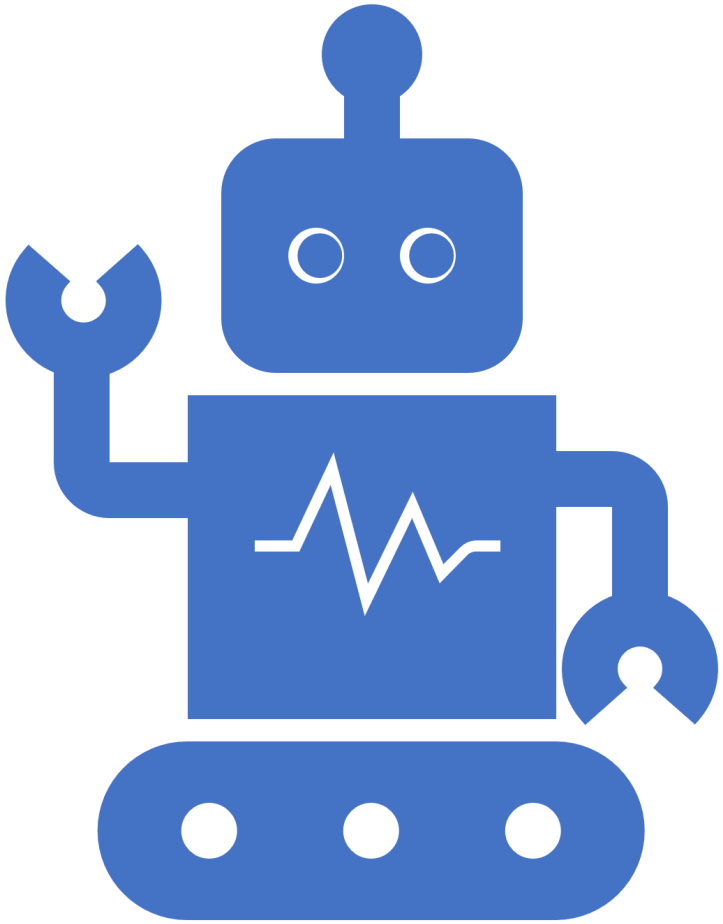
Reinforcement learning ..? It is a machine learning training method based on rewarding desired behaviors and/or punishing undesired ones.

Affective Computing ..? it describes computing that is in some way connected to emotion (a.k.a. emotional artificial intelligence). It is the study and development of systems and devices that can recognize, interpret, process, and simulate human affects (feelings, emotions, or mood.

Systems that Act Like Humans

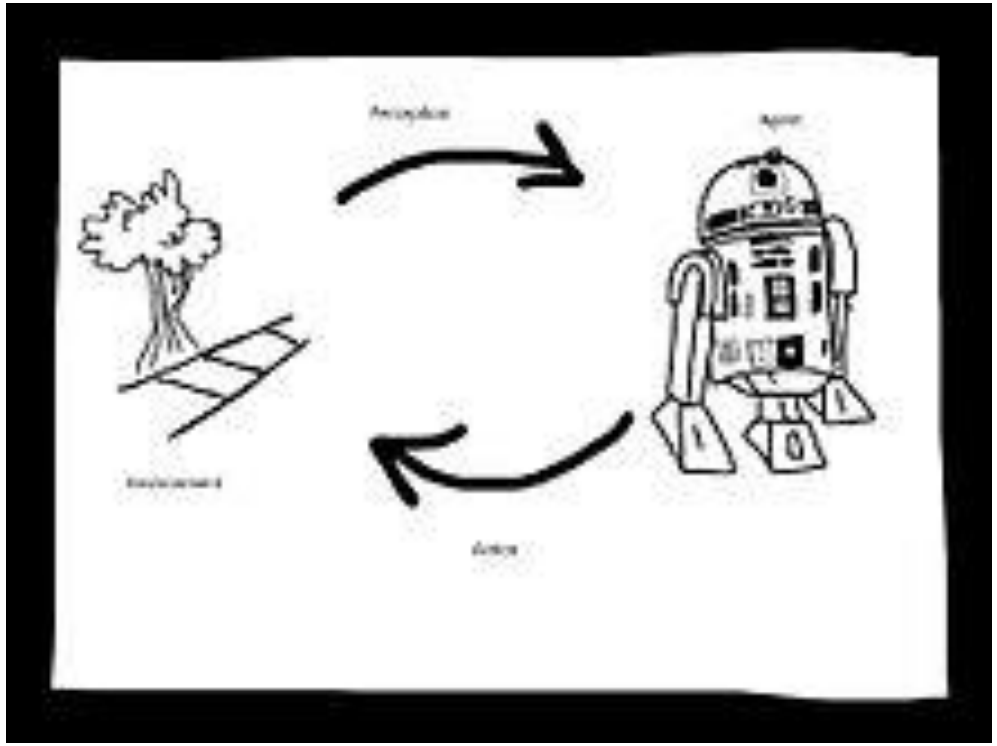
- The Chinese Room Argument
- **If person inside does a great job of answering questions, can we say s/he *understands*?**
- **Even if (s)he is only blindly following rules?**
- ***(Obviously, the 'person inside' is acting like an AI program)***





AI is classified as:

1. Weak AI
2. Strong AI



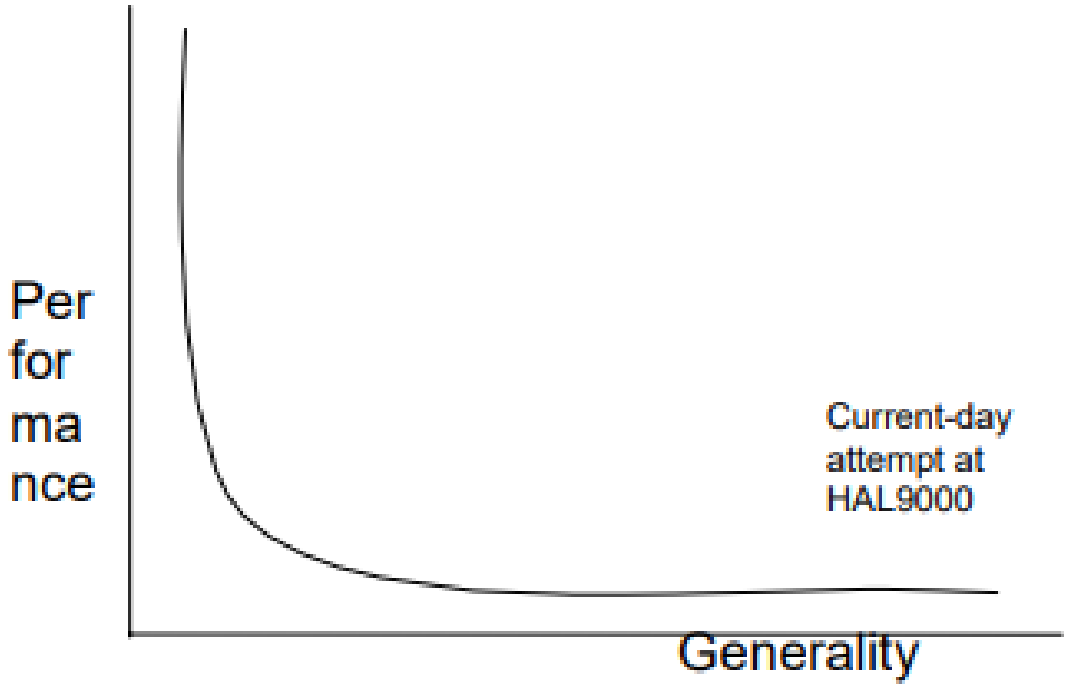
Weak AI

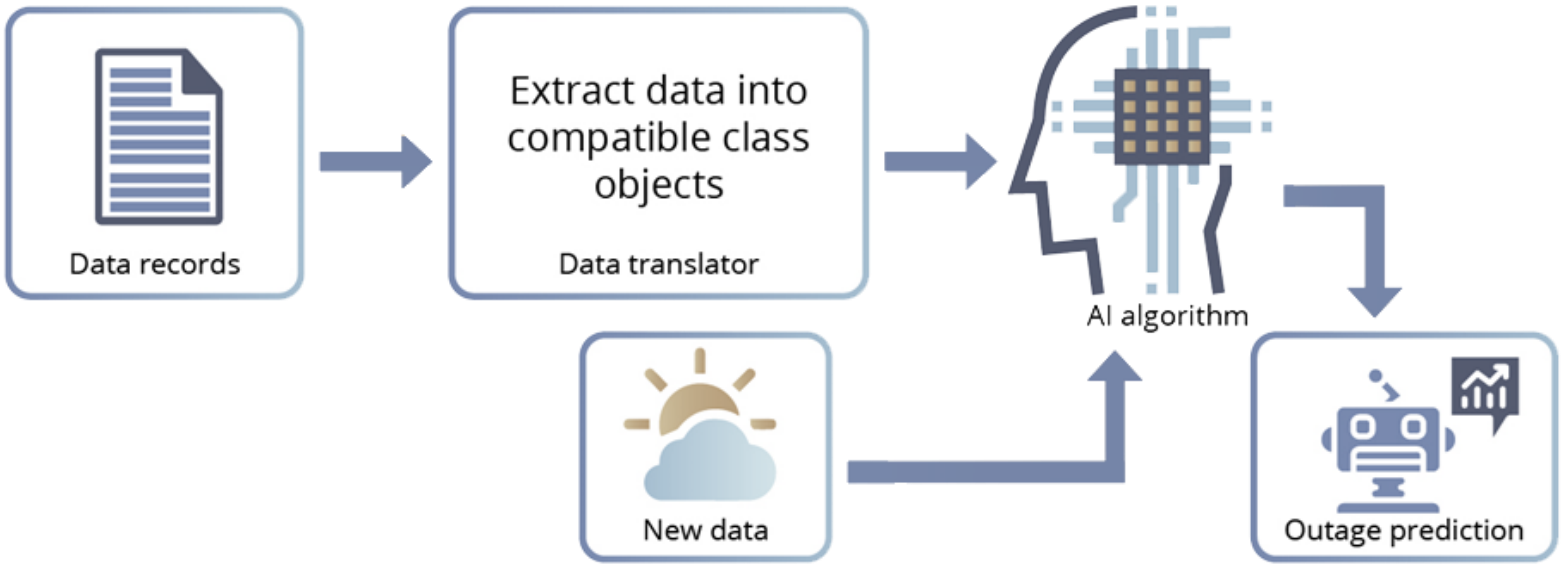
- The study and design of machines that perform intelligent tasks. Not concerned with how tasks are performed, mostly concerned with performance and efficiency, such as solutions that are reasonable for NP-Complete problems. E.g., to make a flying machine, use logic and physics, don’t mimic a bird.

Strong AI

- The study and design of machines that simulate the human mind to perform intelligent tasks. Borrow many ideas from psychology, neuroscience. Goal is to perform tasks the way a human might do them – which makes sense, since we do have models of human thought and problem solving.

Generality/Performance curve observed in current AI systems

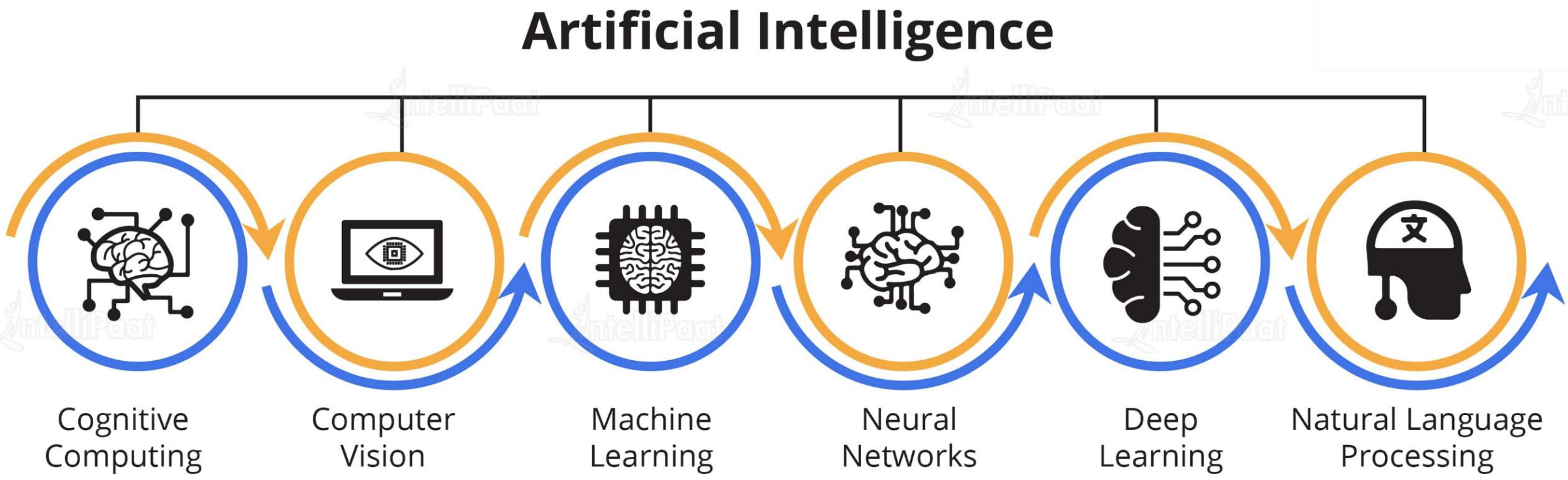


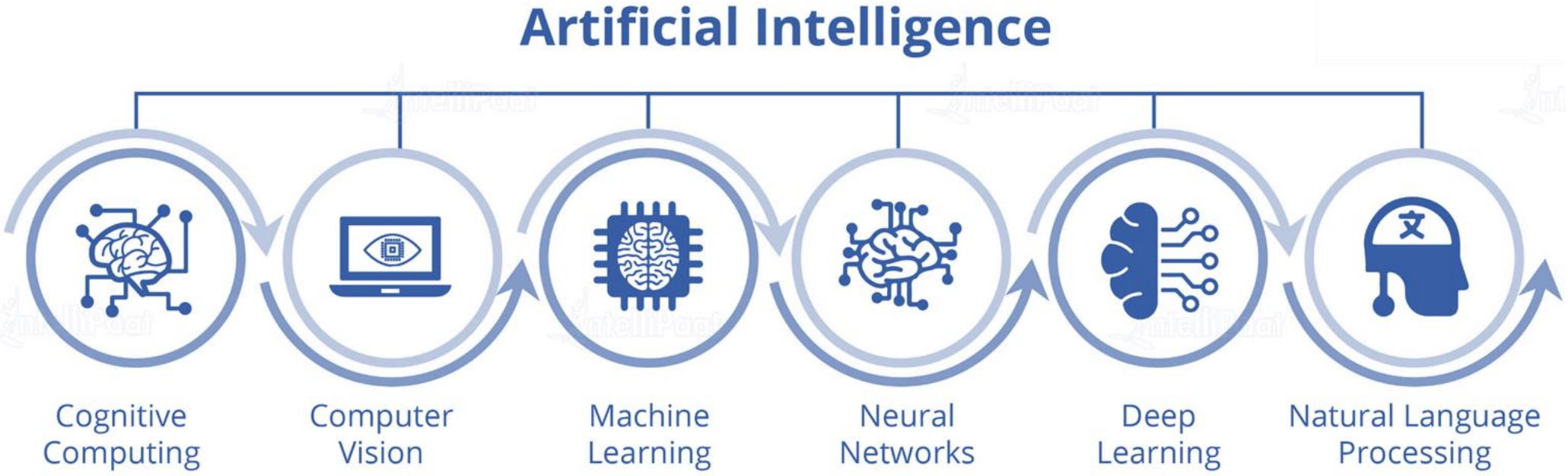


How AI work?

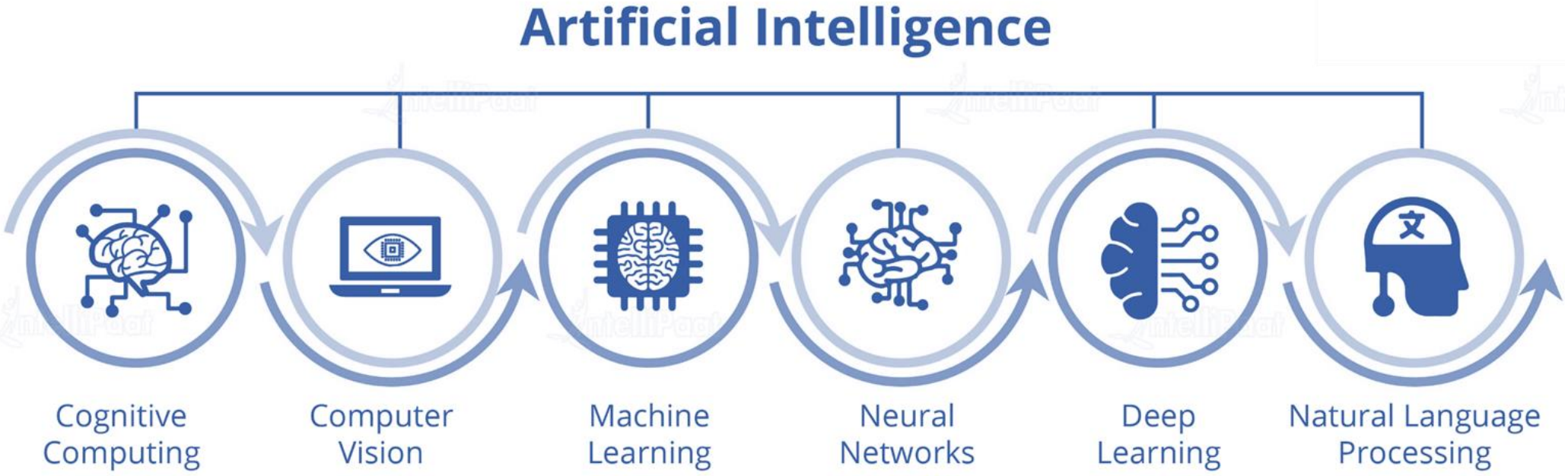
- Computers are good to follow a sequences of steps to execute a task. If we give a computer steps to execute a task, it should easily be able to complete it. The steps are nothing but algorithms.

The Major Subfields of AI





- **Cognitive Computing** aims to imitate the human thought process in a computer model using self-learning algorithms, pattern recognition, and natural language processing, a computer can mimic the human way of thinking.
- **Computer vision** works on allowing computers to see, recognize, and process images, the same way as the human vision does, and then it provides an appropriate output.
- **Machine Learning** is the learning in which a machine can learn by its own from examples and previous experiences. The program developed for it need not be specific and is not static. The machine tends to change or correct its algorithm as and when required.



- **Artificial Neural Networks** (ANNs) were developed getting inspired by the biological neural network, i.e., the brain. ANNs are one of the most important tools in Machine Learning to find patterns within the data, which are far too complex for a human to figure out and teach the machine to recognize.
- In **Deep Learning**, a large amount of data is analyzed, and here the algorithm would perform the task repeatedly, each time twisting/editing a little to improve the outcome.
- **Natural language processing** means developing methods that help us communicate with machines using natural human languages like English.

Intelligent Agents

Intelligent Agents
(Poole and Mackworth, 1999)

- Intelligent agents are entities, typically software-based, that perceive their environment and take actions to maximize their chances of successfully achieving their goals.
- An intelligent agent is such that:
  - Its actions are appropriate for its goals and circumstances.
  - It is flexible to changing environments and goals.
  - It learns from experience.
  - It makes appropriate choices given perceptual limitations and limited resources (bounded rationality or bounded optimality).

Intelligent Agents

In AI, **artificial agents that have a physical presence** in the world are usually known as ***Robots***.

Robotics is the field primarily concerned with the implementation of the physical aspects of a robot *(i.e. perception of the physical environment, actions on the environment)*.

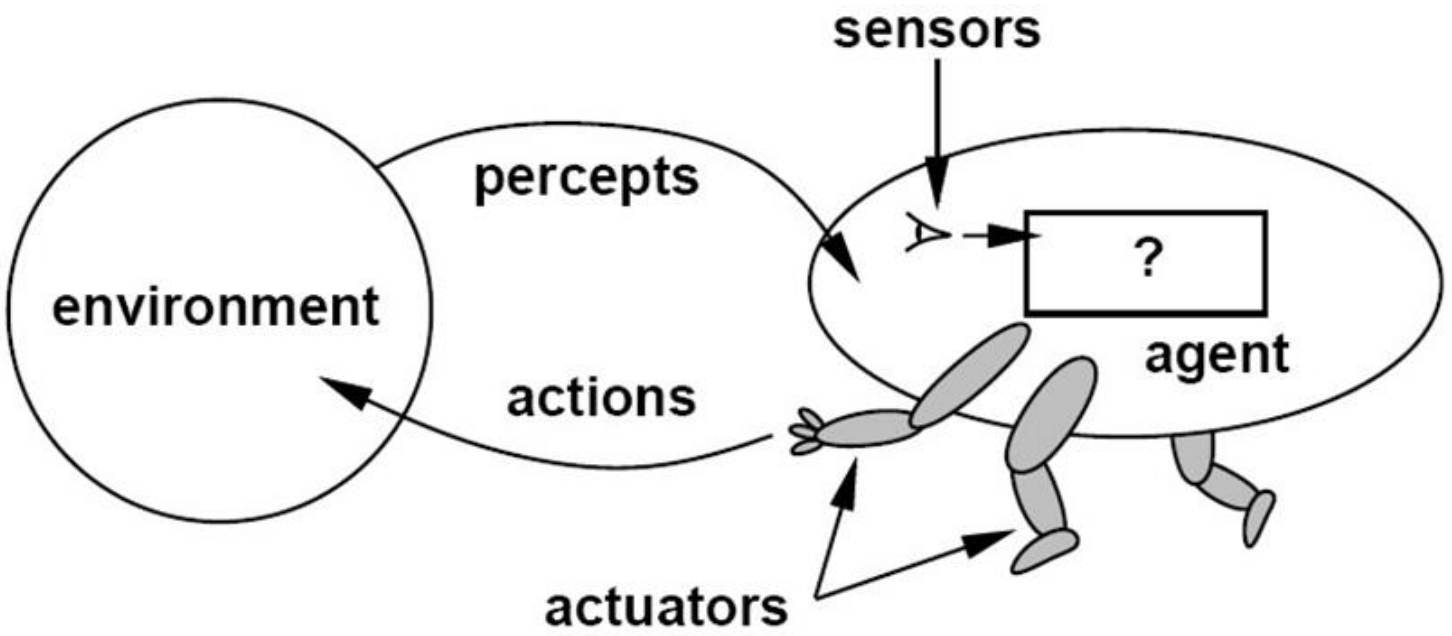
Another class of artificial agents include ***interface agents***, for either stand alone or Web-based applications *(e.g. intelligent desktop assistants, recommender systems, intelligent tutoring systems)*.

Interface agents don't have to worry about interaction with the physical environment but share all other fundamental components of intelligent behavior with robots.

We will focus on these agents in this course.

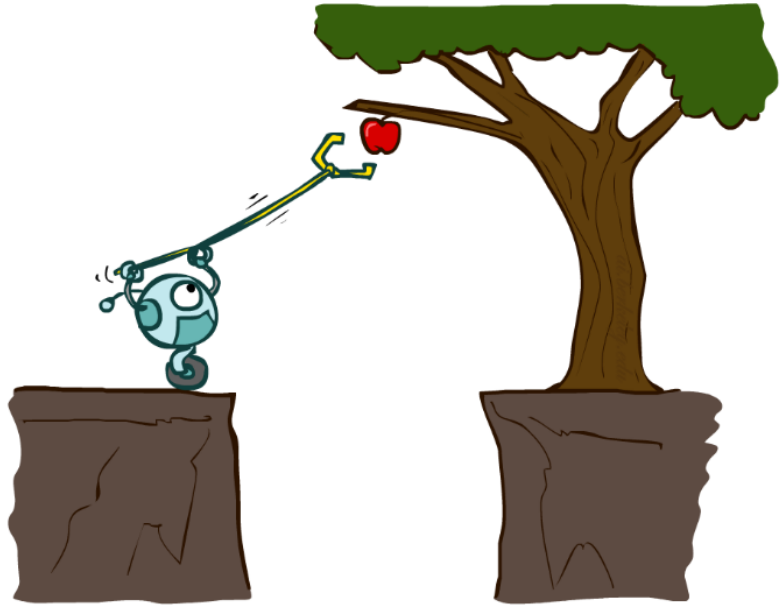
Intelligent Agents

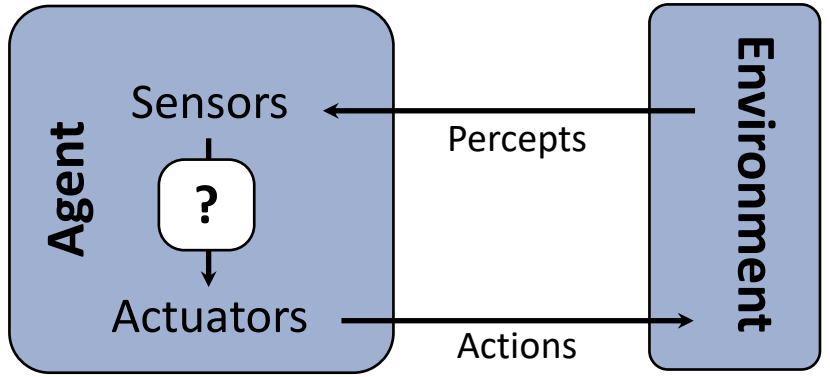
- **An agent** is anything that can be viewed as perceiving its environment through sensors and acting upon that environment through actuators.



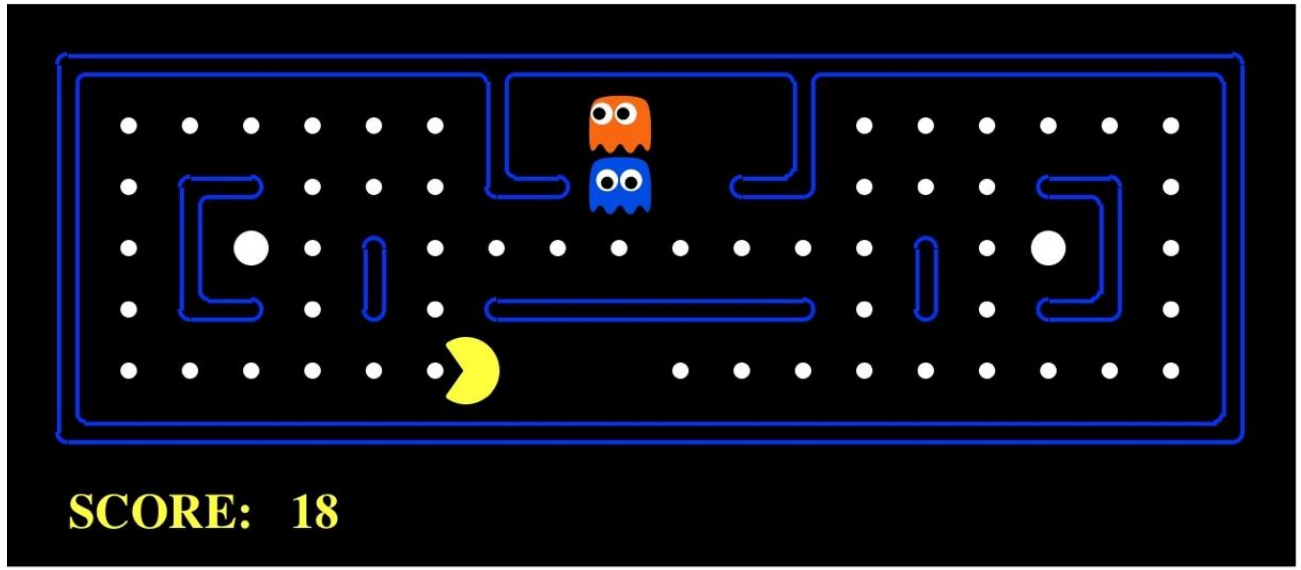
Designing Rational Agents

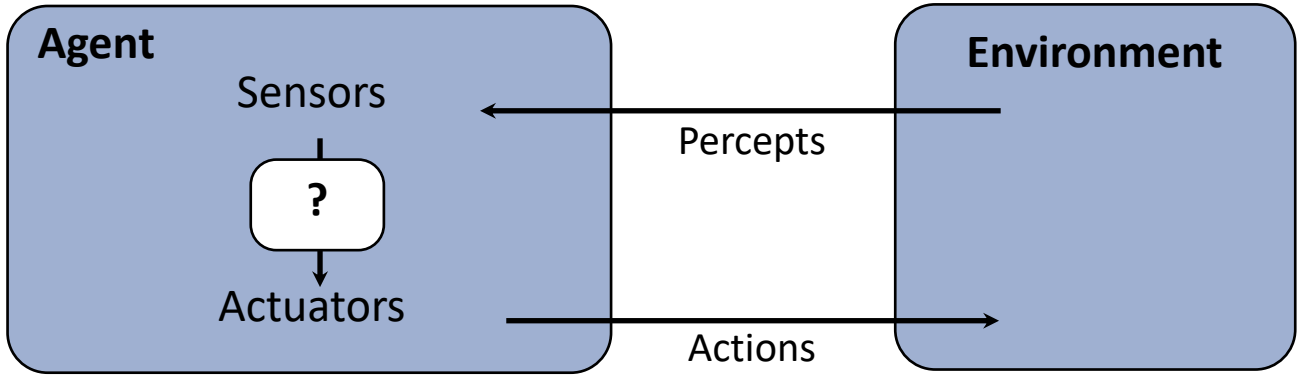
- An **agent** is an entity that *perceives* and *acts*.
- A **rational agent** selects actions that maximize its (expected) **utility**.
- Characteristics of the **percepts, environment,** and **action space** dictate techniques for selecting rational actions



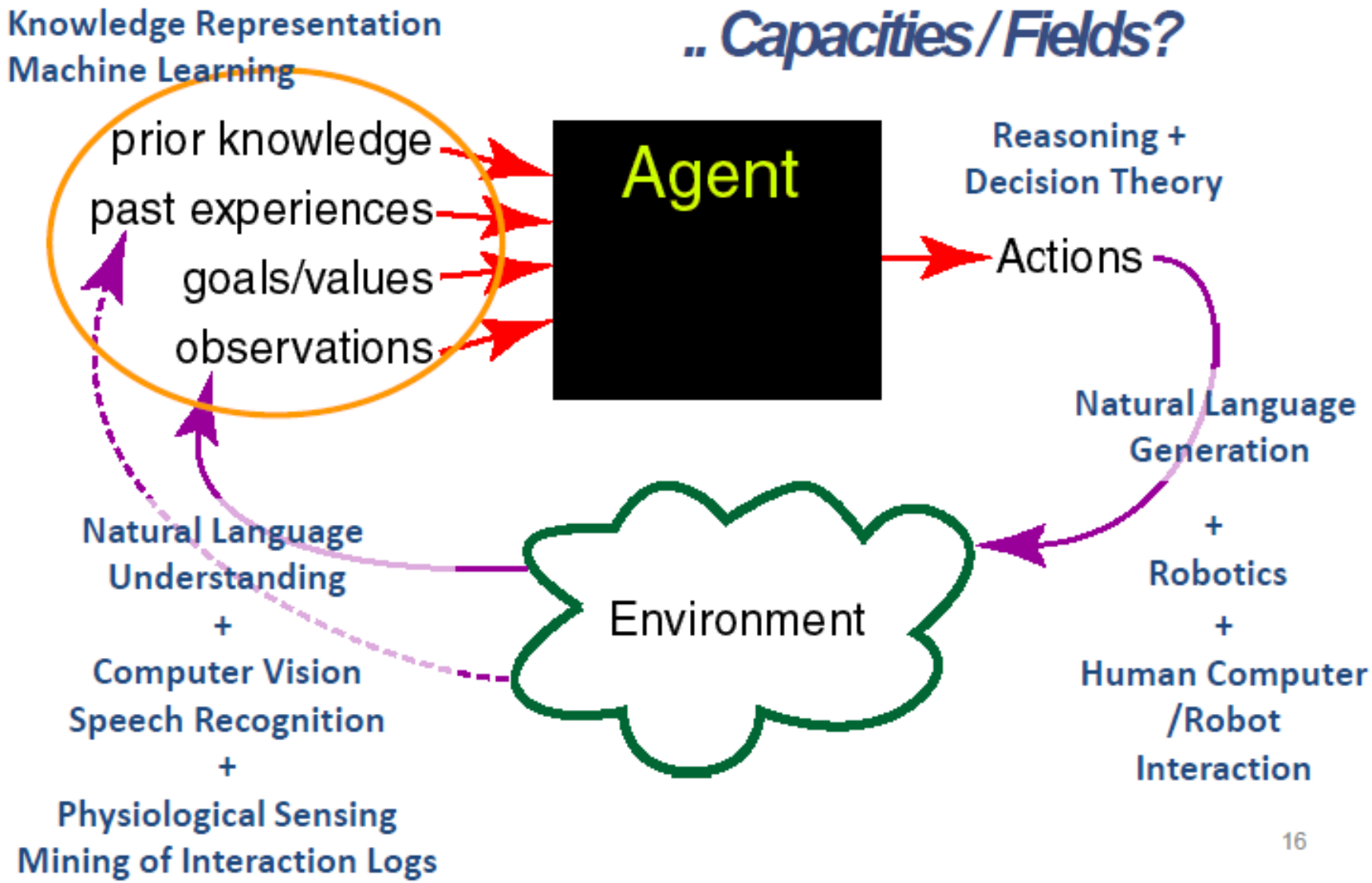


Pac-Man as an Agent



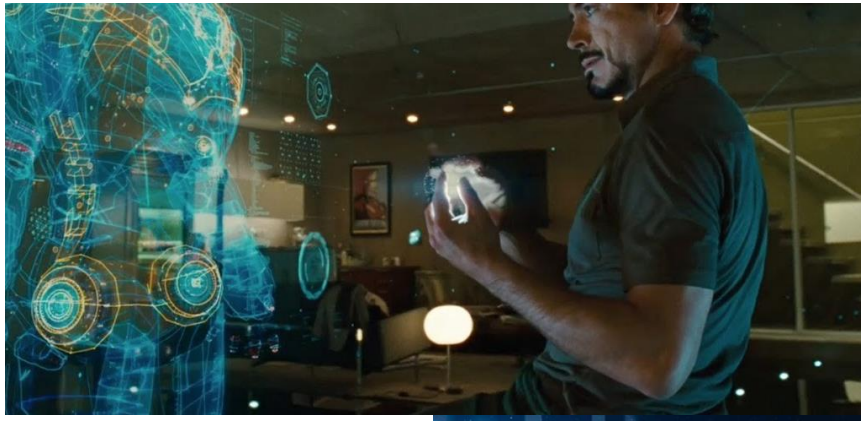


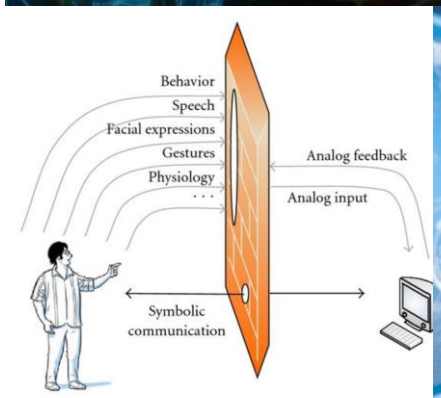
Intelligent Agents in th World ..



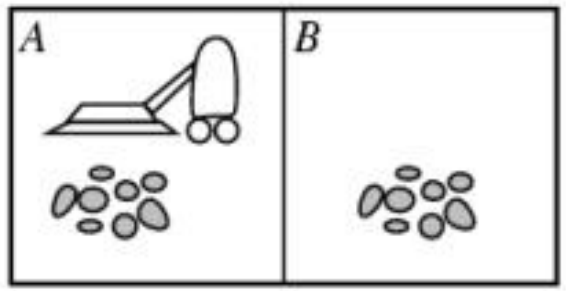
- Ritter, Walter. (2011). Benefits of Subliminal Feedback Loops in Human-Computer Interaction. Advances in Human-Computer Interaction. 2011. 10.1155/2011/346492.

Human Computer Interaction





Vacuum Cleaner World



Percepts: location and contents, e.g., [A,Dirty]
Actions: *Left*, *Right*, *Suck*, *NoOp*

Percept sequence	Action
$[A, Clean]$	$Right$
$[A, Dirty]$	$Suck$
$[B, Clean]$	$Left$
$[B, Dirty]$	$Suck$
$[A, Clean], [A, Clean]$	$Right$
$[A, Clean], [A, Dirty]$	$Suck$
⋮	⋮

Specifying the Task Environment [PEAS]

PEAS: Performance measure, Environment, Actuators, Sensors

P: a function the agent is maximizing (or minimizing);
- Assumed given ..
- In practice, needs to be computed somewhere.

E: a formal representation for *world states*;
- For concreteness, a tuple ($var_1 = val_1$, $var_2 = val_2$, ... , $var_n = val_n$).

A: actions that change the state according to a *transition model*;
- Given a state and action, what is the successor state (or distribution over successor states)?

S: observations that allow the agent to infer the world state;
- Often come in very different form than the state itself ..
- E.g., in tracking, observations may be pixels and state variables 3D coordinates.

PEAS Example 1:Autonomous Taxi

- Performance measure
  - Safe, fast, legal, comfortable trip, maximize profits
- Environment
  - Roads, other traffic, pedestrians, customers
- Actuators
  - Steering wheel, accelerator, brake, signal, horn
- Sensors
  - Cameras, LIDAR, speedometer, GPS, odometer, engine sensors, keyboard

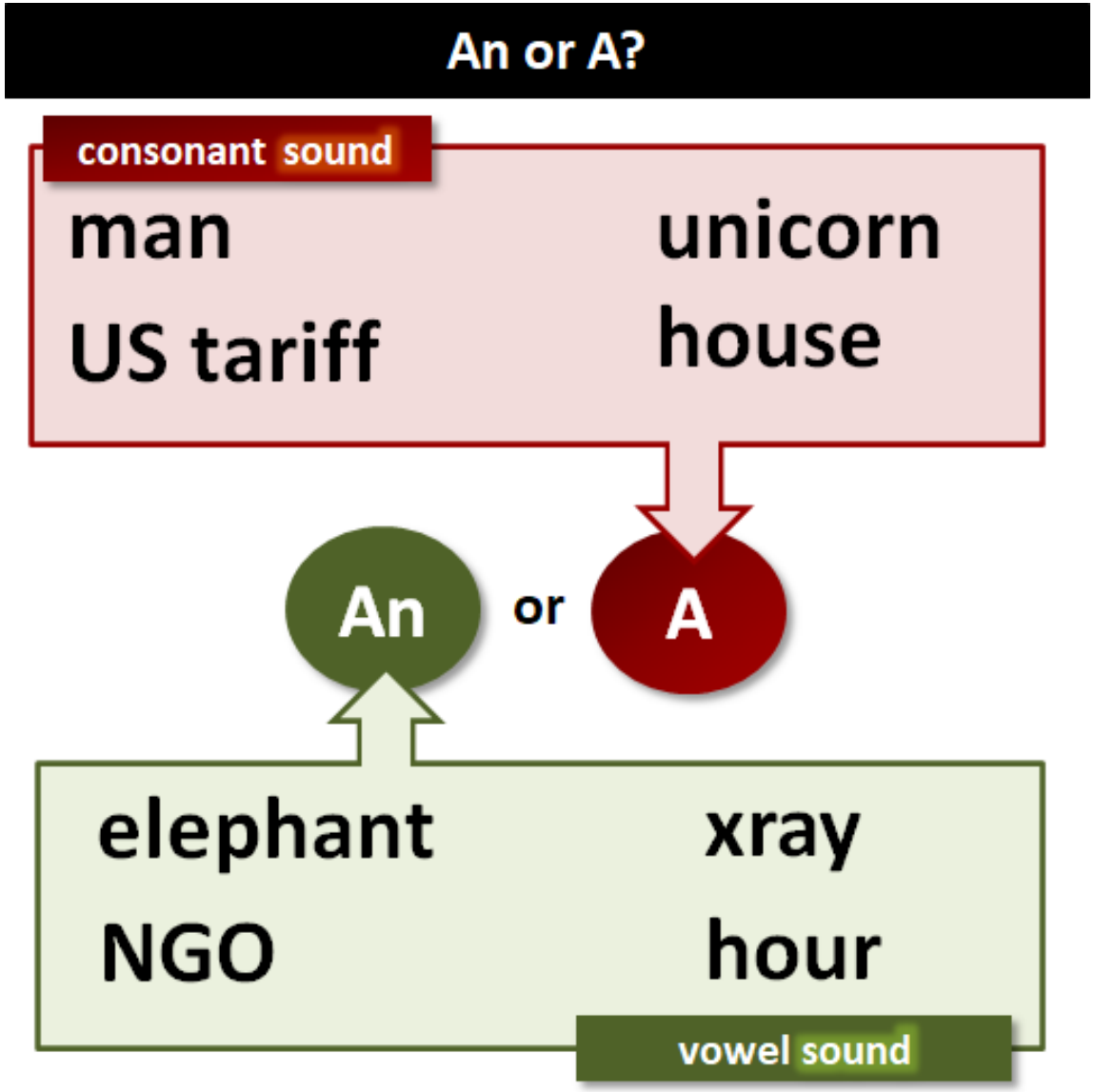
PEAS Example 2:Spam Filter

		Actual	
		Positive	Negative
Predicted	Positive	True Positive	False Positive
	Negative	False Negative	True Negative

- Performance measure
  - Minimizing false positives, false negatives
- Environment
  - A user's email account, email server
- Actuators
  - Mark as spam, delete, etc.
- Sensors
  - Incoming messages, other information about user's account

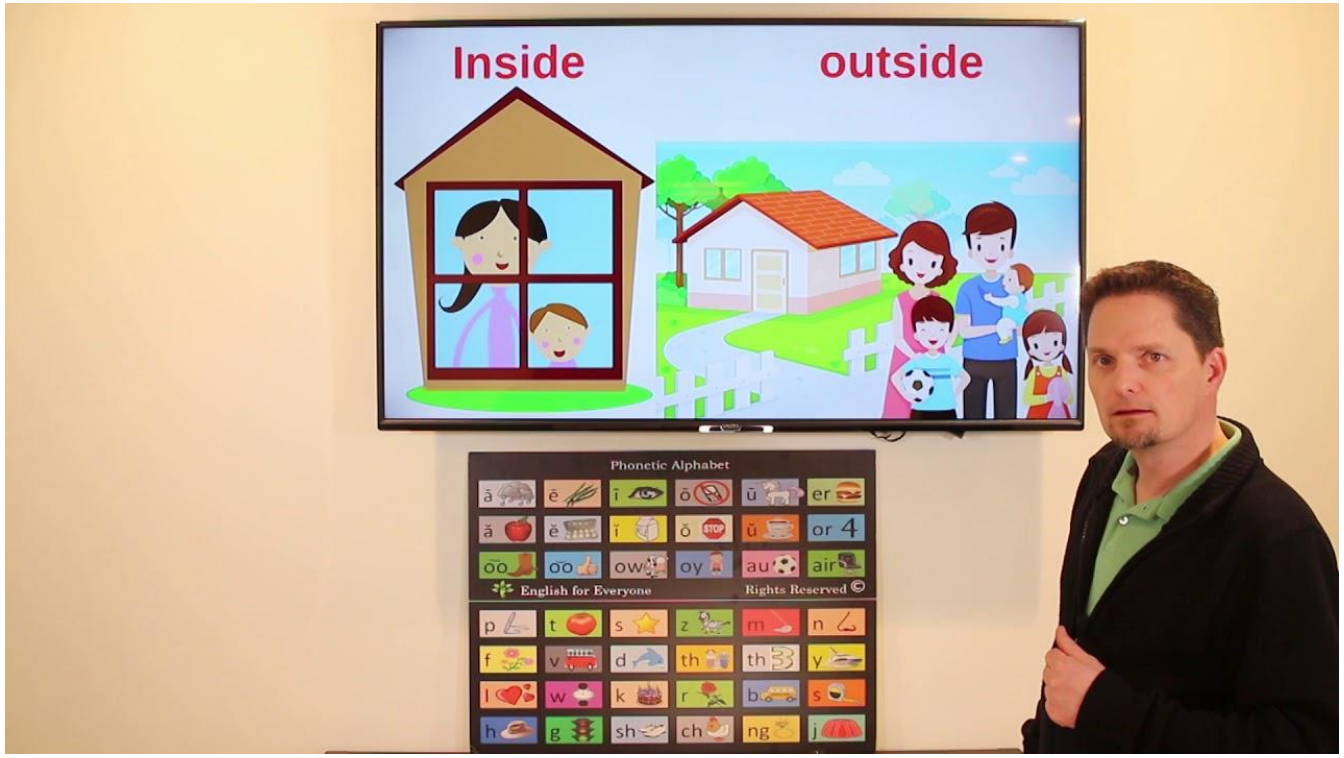
PEAS Example 3: Put A or AN in Text

- Performance measure
  - No of correct words
- Environment
  - Document
- Actuators
  - Put (a) or (an) or NoOp
- Sensors
  - Incoming text

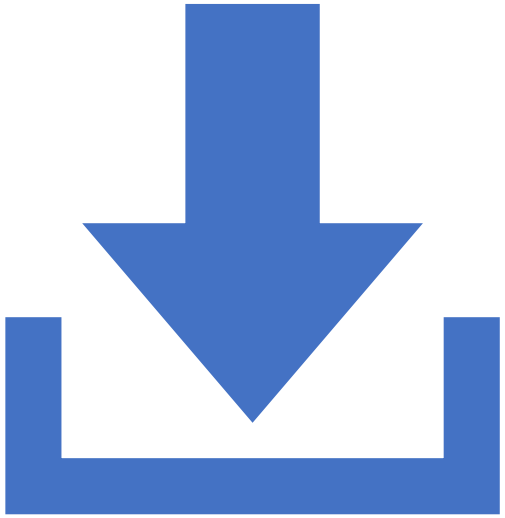


PEAS Example 4: Interactive English tutor

- Performance measure:
  - Maximize student's score on test
- Environment:
  - Set of students
- Actuators:
  - Screen display (exercises, suggestions, corrections)
- Sensors:
  - Keyboard (student answers)




let's begin implementing Vaccuum and
NLP Agents

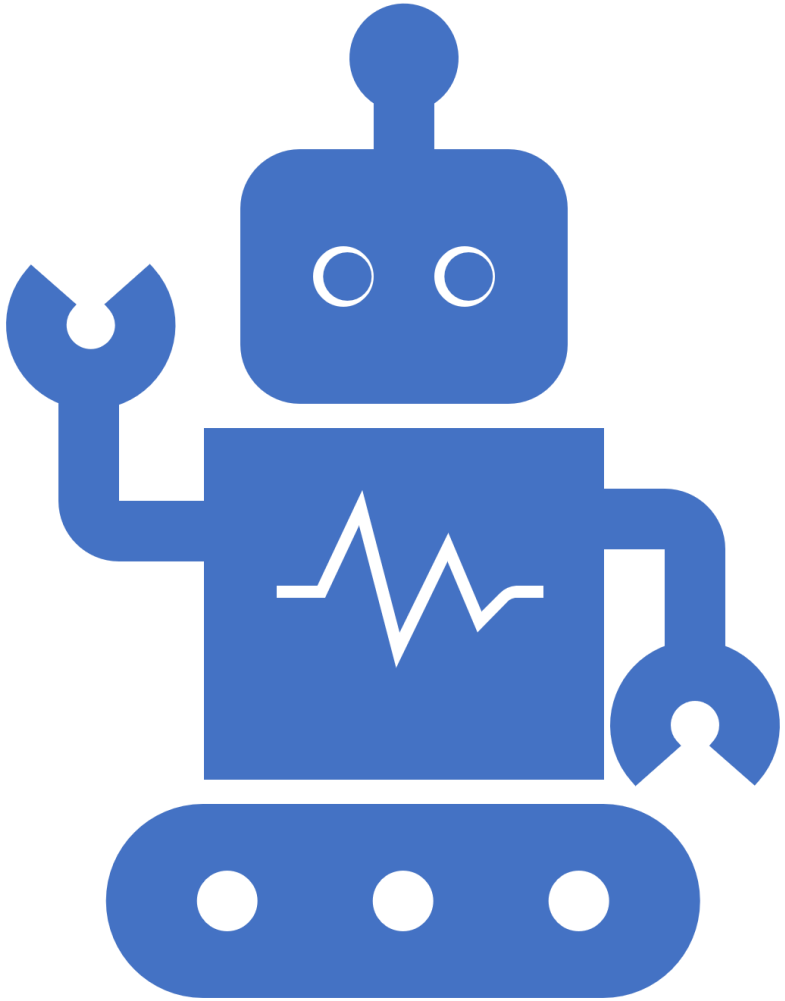


Install NLTK

- In python shell : pip install nltk
- Create directory (nltk_data) in (user\AppData\Local\Programs\Python\Python39\nltk_data)
- Download all data by
  - In CMD write (python -m nltk.downloader)
  - This'll pop up the nltk downloader. Set your Download Directory to (user\AppData\Local\Programs\Python\Python39\nltk_data). If you're using the GUI downloader, the download directory is set through a text field on the bottom of the UI.
-

Goal-based Agents versus Cost-based Agents

- **Goal-based agents: the actions depend on the goal;** *E.g., a mobile robot which should move from room 112 to room 179 in a building takes actions different from those of a robot that should move to room 105.*



Goal-based Agents versus Cost-based Agents

- **Cost-based agents: the goal is to minimize the cost of erroneous decisions in the long term;** *E.g., a spam filter is an agent that puts incoming emails into wanted or unwanted (spam) categories & deletes any unwanted emails. Its goal as a goal-based agent is to put all emails in the right category. In the course of this not-so simple task, the agent can occasionally make mistakes. Because its goal is to classify all emails correctly, it will attempt to make as few errors as possible. However, that is not always what the user has in mind. Let us compare the following two agents. Out of 1,000 emails, Agent 1 makes only 12 errors. Agent 2 on the other hand makes 38 errors with the same 1,000 emails. Is it therefore worse than Agent 1? The errors of both agents are shown in more detail in the following confusion matrix*

Agent 1:

		correct class	
		wanted	spam
spam filter decides	wanted	189	1
	spam	11	799

Agent 2:

		correct class	
		wanted	spam
spam filter decides	wanted	200	38
	spam	0	762

Goal-based Agents versus Cost-based Agents

- *Agent 1 in fact makes fewer errors than Agent 2, but those few errors are severe because the user loses 11 potentially important emails. Because there are in this case two types of errors of differing severity, each error should be weighted with the appropriate cost factor.*

Agent 1:

		correct class	
		wanted	spam
spam filter decides	wanted	189	1
	spam	11	799

Agent 2:

		correct class	
		wanted	spam
spam filter decides	wanted	200	38
	spam	0	762

Another Example,
Automatic Detection for Breast Cancer

We are going to Maximize True Positive, True Negative and Minimize False positive, False negative.

But False negative is very important than False Positive because the cost here is Human's soul

Environment Types

Fully Observable	vs.	Partially Observable
Deterministic	vs. *(vs. Strategic)*	Stochastic
Episodic	vs.	Sequential
Static	vs. *(vs. Semi-Dynamic)*	Dynamic
Discrete	vs.	Continuous
Single-Agent	vs.	Multi-Agent
Known	vs.	Unknown

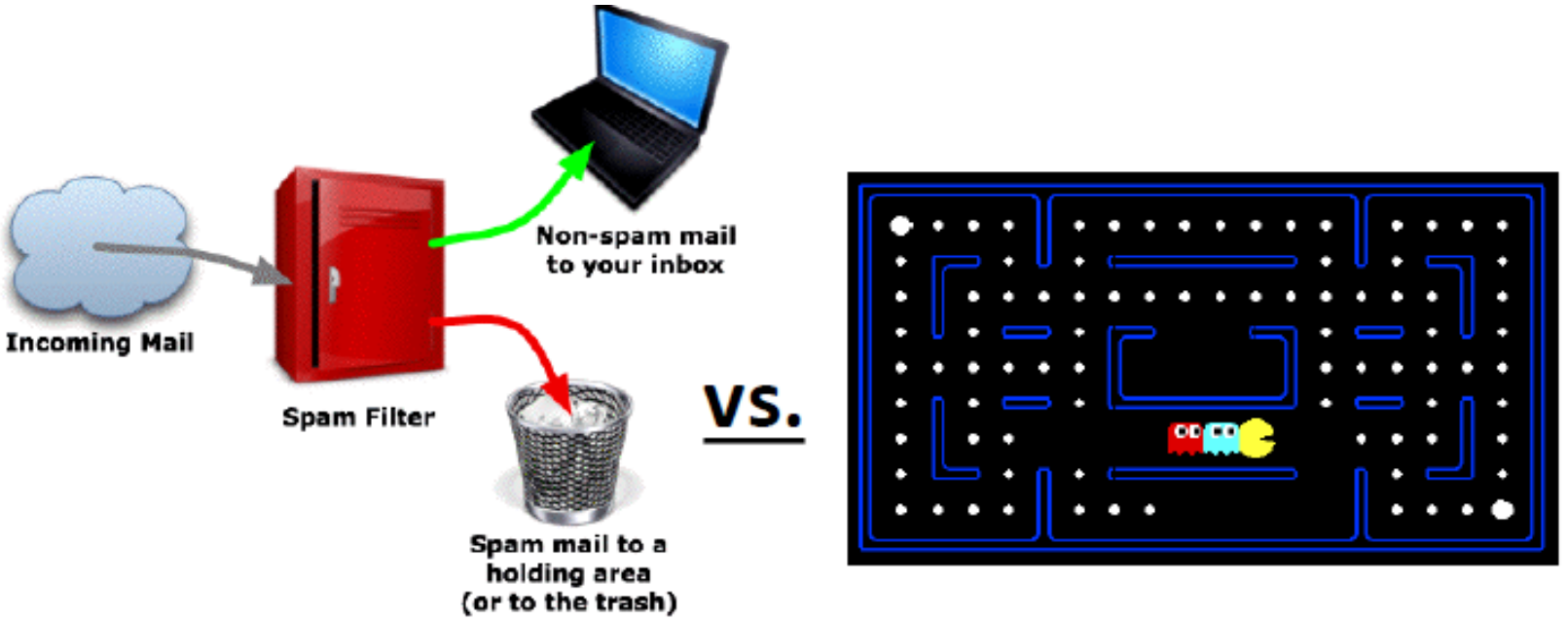
Fully Observable vs. Partially Observable

- Do the agent's sensors give it access to the complete state of the environment?
- For any given world state, are the values of all the variables known to the agent?

vs.

Deterministic vs. Stochastic (vs. Strategic)

- Is the next state of the environment completely determined by the current state and the agent's action?
- Is the transition model **deterministic** *(unique successor state given current state and action)* or **stochastic** *(distribution over successor states given current state and action)*?
- **Strategic:** the environment is deterministic except for the actions of other agents.



Episodic vs. Sequential

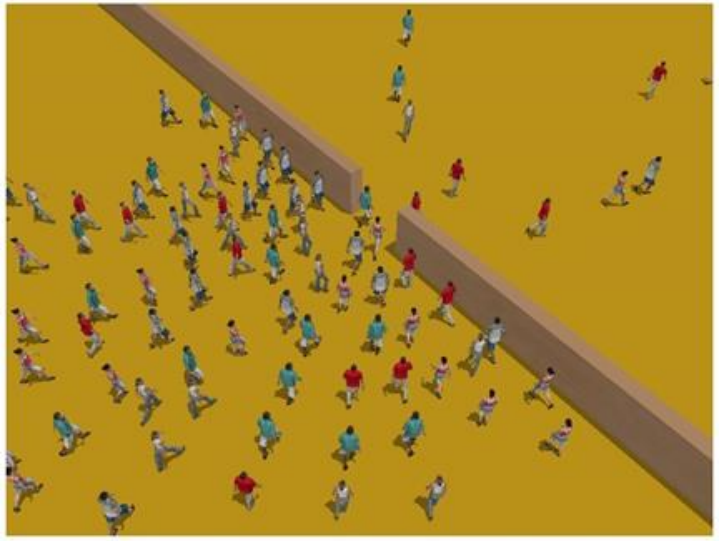
- Is the agent's experience divided into unconnected single decisions/actions, or is it a coherent sequence of observations and actions in which the world evolves according to the transition model?

VS.

Static vs. Dynamic (vs. Semi-dynamic)

- Is the world changing while the agent is thinking?
- **Semi-dynamic:** the environment does not change with the passage of time, but the agent's performance score does.

vs.



Single–Agent vs. Multi–Agent

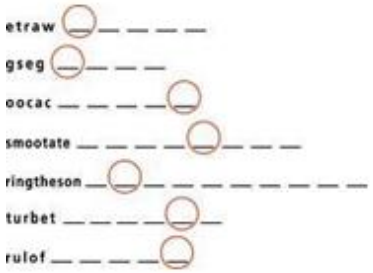
- Is an agent operating by itself in the environment? o Is the environment of an autonomous taxi driver a competitive multiagent environment?

vs.

Known vs. Unknown

- Are the rules of the environment *(transition model and rewards associated with states)* **known to the agent**?
- Strictly speaking, not a property of the environment, but of the agent's state of knowledge.

Examples of the different environments



	WORD JUMBLE SOLVER	CHESS WITH A CLOCK	SCRABBLE	AUTONOMOUS DRIVING
Observable (environment)	Fully	Fully	Partially	Partially
Deterministic (action depends on..)	Deterministic	Strategic	Stochastic	Stochastic
Episodic (s the current action related to the previous action?)	Episodic	Sequential	Sequential	Sequential
Static (changing environment while thinking)	Static	Semi-dynamic	Static	Dynamic
Discrete (value output)	Discrete	Discrete	Discrete	Continuous
Single agent (agent is alone)	Single	Multi	Multi	Multi

What is the useful?

- You must know the characteristics of your environment to determine the suitable algorithms.
- For example,
  - If you know the environment is deterministic and it is static , Search algorithm is the best for detecting the solution.
  - But if the environment is sequential, you must navigate in the planning techniques.
  - If the environment is stochastic, you must search in uncertainty area of AI.
  - If you have stochastic and sequential environment, this is decision theory area.