Introduction to Artificial Intelligence

Artificial Intelligence

Faculty of Computing
Universiti Teknologi Malaysia

Outline

1. Theory Definition
   - What is intelligence?
   - History
   - What is AI?
   - Logic and AI
   - Exercises
2. Taxonomy in AI
   - AI vs CI
   - Weak AI vs Strong AI
   - AI in 4 IR
     - IR stages differences
     - Application AI in IR

Theory Definition

- What is intelligence?
- History
- What is AI?
- Logic and AI

What is intelligence?

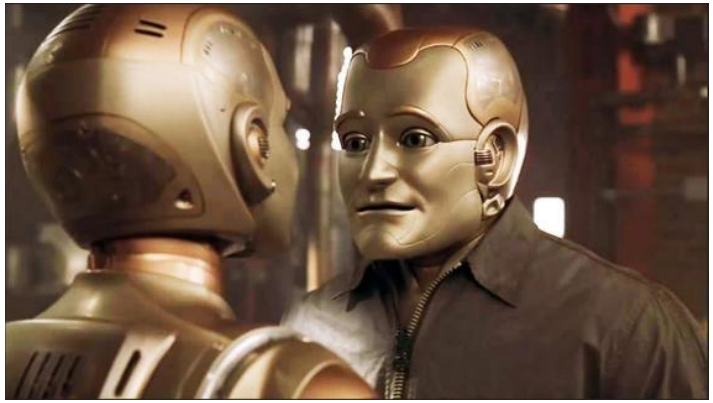
the ability to comprehend, to understand and profit from experience?

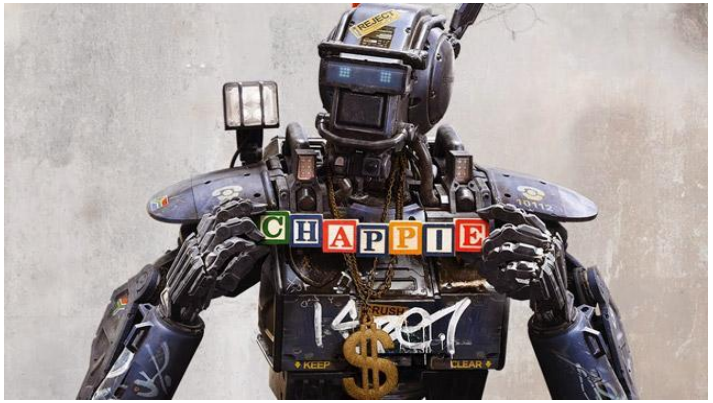
For thousands of years people tried to understand *how we think*

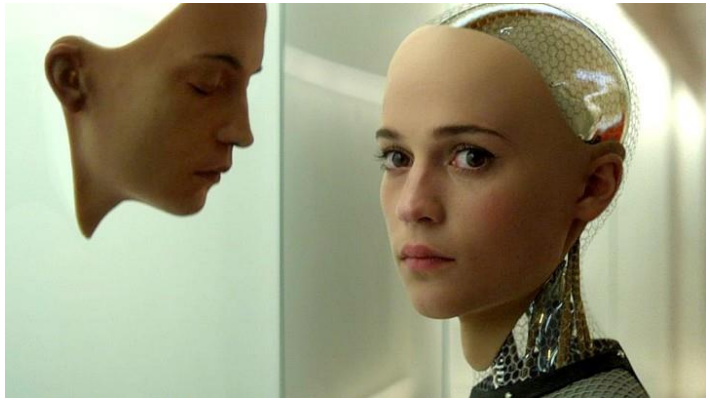
- Philosophy
- Mathematics
  - What is correct mathematical reasoning?
- Neuroscience
- Psychology
- Economics

Sci-Fi AI?

Have you watched those movies?
What best keyword to represent those movies?







What is AI? : Think Pair Share (TPS) Activity

Questions:

Describe what is Artificial Intelligence.

Activity 2.0:

1. Ask Chatgpt
2. Think individually for 2 minutes and complete the answer.
3. Discuss with your neighbor for 2 minutes.
4. Share with the class when asked

What is AI? : From the book…

Artificial Intelligence is composed of two words **Artificial** and **Intelligence**, where Artificial defines *"man-made,"* and intelligence defines *"thinking power"*, hence AI means *"a man-made thinking power."*

"It is a branch of computer science by which **we** can **create intelligent machines** which can **behave like a human, think like humans, and able to make decisions**."

Artificial Intelligence exists when a machine can have human based **skills** such as **learning**, **reasoning**, and **solving problems**.

History : A Bit of History

- ENIAC: first super-computer, created in 1946
- Summer 1956: “Dartmouth Summer Research Project on Artificial Intelligence”
- John McCarthy (also known for LISP, time-sharing) coined the term “artificial intelligence”
- Organizers: Marvin Minsky (co-founder with McCarthy of MIT AI lab, pioneer and detractor of neural nets), Nathaniel Rochester (IBM), and Claude Shannon (Bell Labs, inventor of information theory, also had a robot that did open-loop 5-ball juggling)
- Herbert Simon (Nobel prize in economics) and Allen Newell presented “Logic theorist” (an automated theorem prover), one of the first operating programs in AI

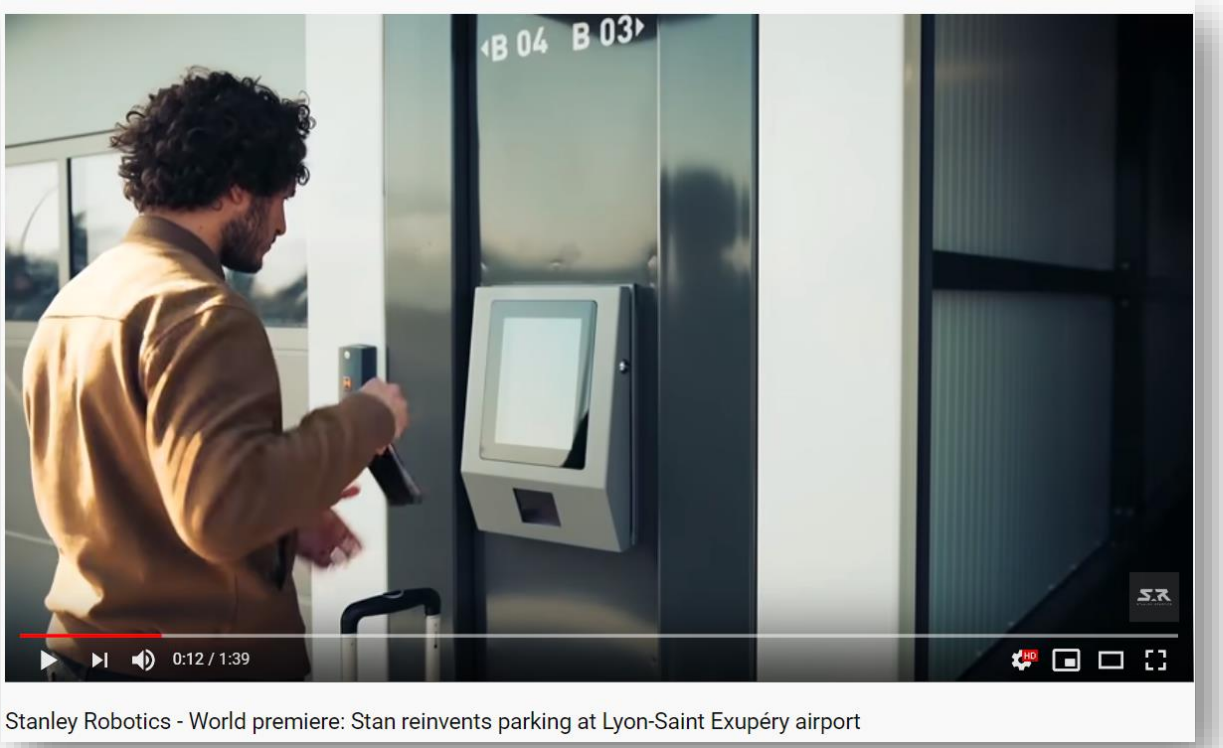
History : Early AI Hopes and Dreams

- Make programs that exhibit similar signs of intelligence as people: prove theorems, play chess, have a conversation
- Learning from experience was considered important
- Logical reasoning was key
- The research agenda was geared towards building “general problem solvers”
- There was a lot of hope that natural language could be easily understood and processed

History : 50 years later

Watch here: https://www.youtube.com/watch?v=ZYVXGYHw8Eg

Detail description can be found on the following slides.



History : 50 years later

Darpa Grand Challenge

- Darpa (US military research funding agency), offered a $2,000,000 prize for an automated driving competition
- Task: Drive through the Nevada desert 132 miles, start and finish specified the morning of the competition, with no input from any human
- In the 2004 competition, the best robot car crashed after 7.4 miles
- In the 2005 competition, five robots (out of 23) finished the race
- The winning robot, Stanley (from Stanford Univ.) finished in little under 7 hours

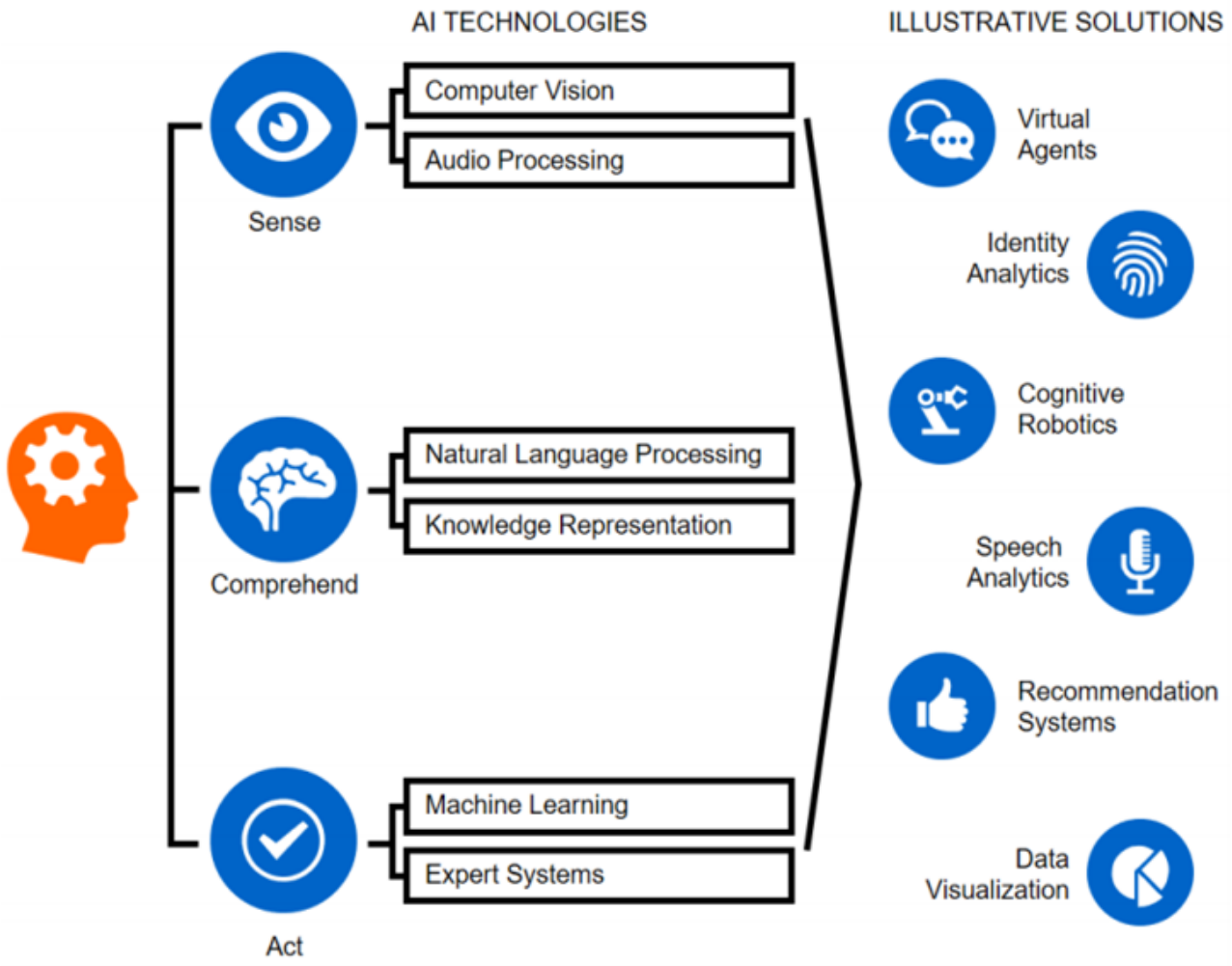
History : From NY Times

- The five robots that successfully navigated a 132-mile course in the Nevada desert last weekend demonstrated the re-emergence of artificial intelligence [...]
- The winning robot, named Stanley, covered the unpaved course in just 6 hours and 53 minutes without human intervention and guided only by global positioning satellite(GPS) waypoints.
- The feat, which won a $2 million prize from the Pentagon Defense Advanced Research Project Agency, was compared by exuberant Darpa officials to the Wright brothers' accomplishment at Kitty Hawk, because it was clear that it was not a fluke. [...]
- The ability of the vehicles to complete a complex everyday task - driving - underscores how artificial intelligence may at last be moving beyond the research laboratory.

History : Stanley

- Built based on a Volkswagen car
- An array of sensors: cameras, laser range finders, radar, GPS
- Probabilistic reasoning and machine learning algorithms are the heart of the software
- The robot is capable of assessing how good the data is, based on prior training

Area of AI?


AI TECHNOLOGIES
ILLUSTRATIVE SOLUTIONS
Computer Vision
Audio Processing
Sense
Natural Language Processing
Knowledge Representation
Comprehend
Machine Learning
Expert Systems
Act
Virtual Agents
Identity Analytics
Cognitive Robotics
Speech Analytics
Recommendation Systems
Data Visualization

What is AI? : Four Views of AI

Systems that think like humans	Systems that think rationally/optimally
Systems that act like humans	Systems that act rationally/optimally

- AI as acting _____ : as typified by the Turing test
- AI as thinking _____ : cognitive science
- AI as thinking _____ : as typified by logical approaches
- AI as acting _____ : the intelligent agent approaches

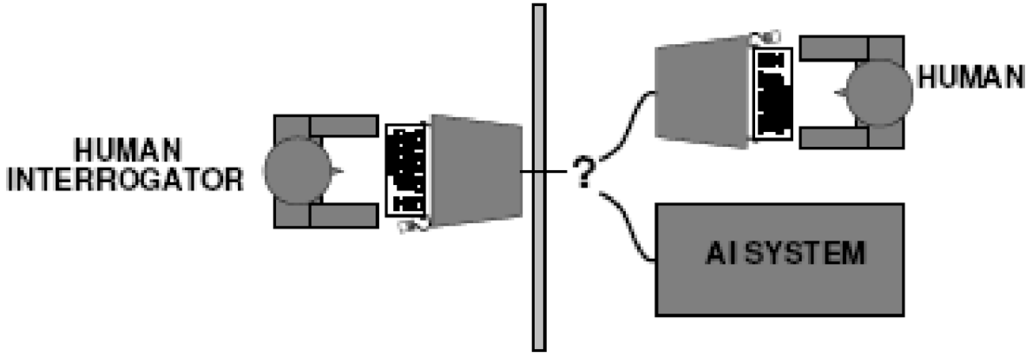
What is AI? : Four Views of AI

Acting Humanly

- Emphasis on how to *tell* that a machine is intelligent, not on how to *make it* intelligent *when can we count a machine as being intelligent*?

"Can machines think?" "Can machines behave intelligently?"

- Most famous response due to Alan Turing, British mathematician and computing pioneer:



What is AI? : Four Views of AI

Acting Humanly : Turing test

- No program has yet passed Turing test! *(Annual Loebner competition & prize.)*

- A program that succeeded would need to be capable of:
  - natural language understanding & generation;
  - knowledge representation;
  - learning;
  - automated reasoning.

- Note no *visual* or *aural* component to basic Turing test
  -- augmented test involves video & audio feed to entity.

Problem: Turing test is not *reproducible*, *constructive*, or amenable to *mathematical analysis*

What is AI? : Four Views of AI

Thinking Humanly

- Try to understand how the mind works . how do we think?
- Two possible routes to find answers:
  - by *introspection* -- we figure it out ourselves!
  - by *experiment* -- draw upon techniques of psychology to conduct controlled experiments. (“Rat in a box”!)
- The discipline of *cognitive science*: particularly influential in *vision*, *natural language processing*, and *learning*.

What is AI? : Four Views of AI

Thinking Rationally/Optimally

- Trying to understand how we *actually* think is one route to AI -- but how about how we *should* think
- Use *logic* to capture the *laws of rational thought* as *symbols*
- *Reasoning* involves shifting symbols according to well-defined rules (like algebra)
- Result is *idealised* reasoning.

What is AI? : Four Views of AI

Acting Rationally/Optimally (I)

- Acting rationally = acting to achieve one's goals, given one's beliefs.
- An *agent* is a system that perceives and acts; intelligent agent is one that acts rationally w.r.t. the goals we delegate to it.
- Emphasis shifts from designing *theoretically best* decision making procedure to best decision making procedure possible in *circumstances*.
- Logic may be used in the service of finding the best action -- not an end in itself.

What is AI? : Four Views of AI

Acting Rationally/Optimally (II)

- Achieving perfect rationality -- making the best decision theoretically possible -- is not usually possible, due to limited resources:
  - limited time;
  - limited computational power;
  - limited memory;
  - limited or uncertain information about environment

- The trick is to do the best with what you've got!

What is AI? : Four Views of AI

Human vs Machine Thinking (I)

Expert systems -- AI success story in early 80's.

- Human expert's knowledge and experience is passed to a computer program
- Rule-based representation of knowledge
- Typical domains are:
  - medicine (INTERNIST, MYCIN, . . .)
  - geology (PROSPECTOR)
  - chemical analysis (DENDRAL)
  - configuration of computers (R1)
- Thinking humanly works

What is AI? : Four Views of AI

Human vs Machine Thinking (II)

Computer program playing chess

- "Human way"
  - Tried by World champion M.Botvinnik (who also was a programmer)
  - Poor performance
- "Computer way"
  - Sophisticated search algorithms
  - Vast databases
  - Immense computing power
  - Human world champion beaten

What is AI? : Four Views of AI

Logic and AI

- Logicist approach theoretically attractive

- Lots of problems:
  - *transduction* -- how to map the environment to symbolic representation;
  - *representation* -- how to represent real world phenomena (time, space, . . .) symbolically;
  - *reasoning* -- how to do symbolic manipulation *tractably* -- so it can be done by real computers!

Taxonomy in AI

- Types of AI
- Computational Intelligence
- Application of AI

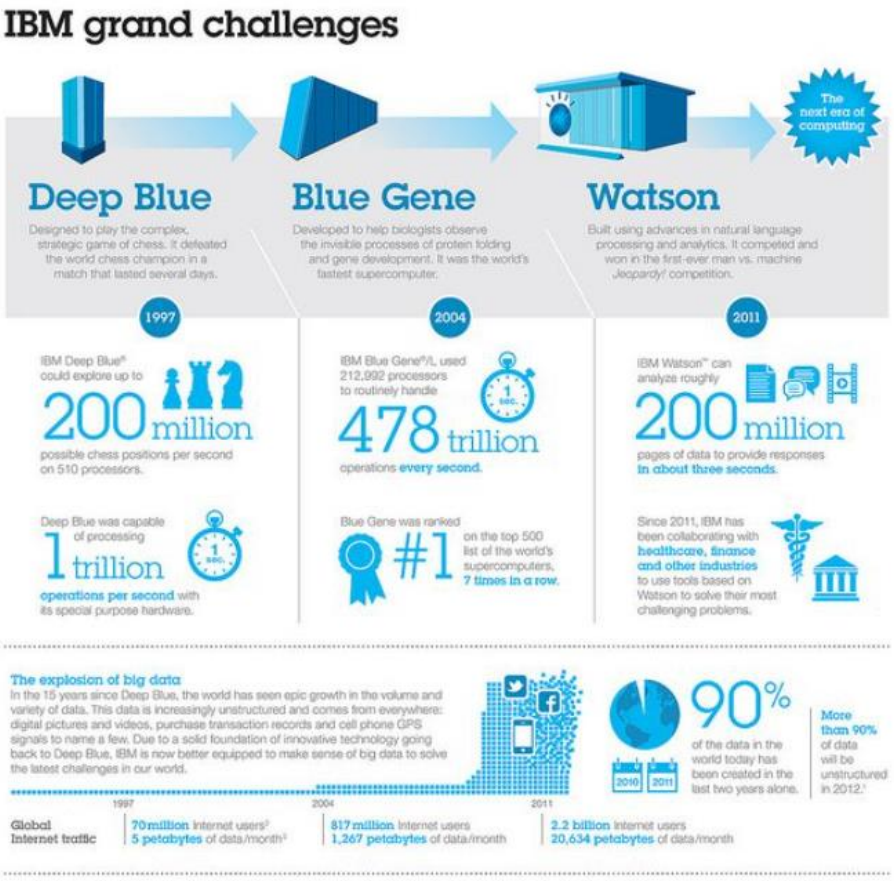
Type of AI

- Reactive Machines
- Limited memory
- Theory of mind
- Self awareness

Type of AI : Based on functionality

Reactive Machines

- Purely reactive machines are the most basic types of Artificial Intelligence
- Such AI systems do not store memories or past experiences for future actions
- These machines only focus on current scenarios and react on it as per possible best action
- IBM's Deep Blue system is an example of reactive machines



Type of AI : Based on functionality

Limited Memory

- Limited memory machines can store past experiences or some data for a short period of time
- These machines can use stored data for a limited time period only
- Dashboard cameras, often referred to as "dashcams," are devices that continuously record video footage of the road and the surroundings while a vehicle is in motion. Real-time data stream processing in the context of dashcams refers to the ability to process and analyze the video and sensor data in real-time as it is being recorded.
- The amount of memory available on the dashcam's storage device (usually a microSD card) varies. Dashcams typically have limited memory capacity compared to other recording devices, like security cameras. The storage size determines how much video data can be retained before loop recording overwrites it.

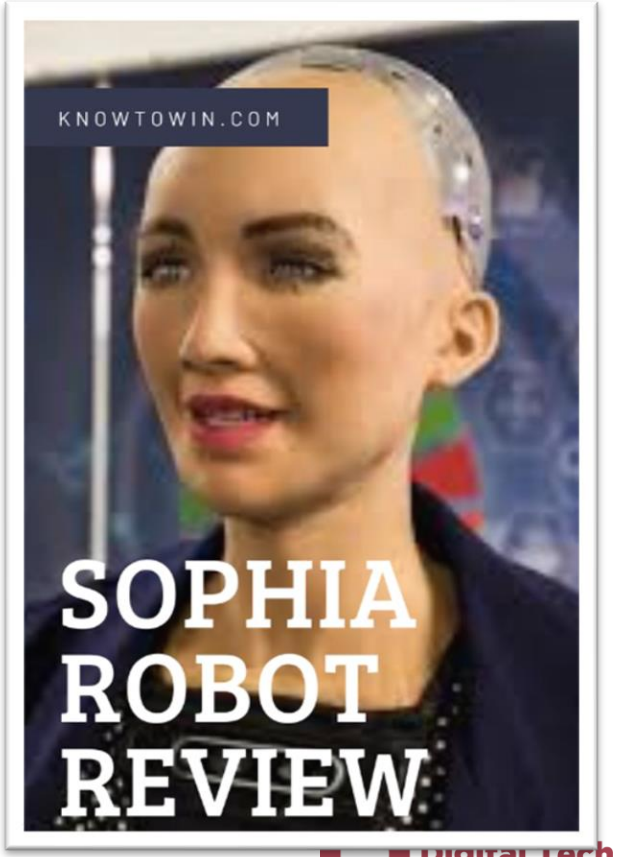
Type of AI : Based on functionality

Theory of Mind

- Theory of Mind AI should understand the human emotions, people, beliefs, and be able to interact socially like humans

- This type of AI machines are still not developed, but researchers are making lots of efforts and improvement for developing such AI machines.

- Social Robots: Some social robots, like Pepper and Sophia, are designed to interact with humans in a more human-like way. They can engage in conversations, recognize emotions, and make eye contact, creating a more socially interactive experience.



Type of AI : Based on functionality

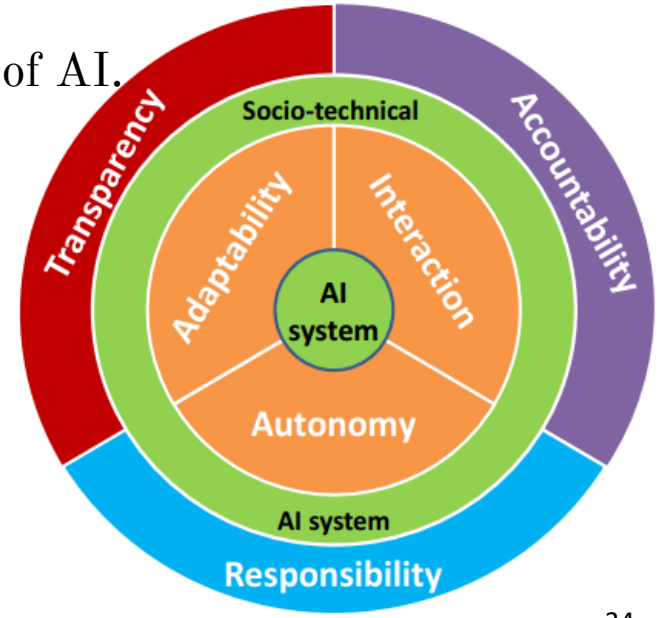
Self-Awareness

- Self-awareness AI is the future of Artificial Intelligence. These machines will be super intelligent, and will have their own consciousness, sentiments, and self-awareness
- These machines will be smarter than human mind
- Self-Awareness AI does not exist in reality still and it is a hypothetical concept

Responsible AI

Responsible AI means different things to different people. The concept of Responsible AI also serves as an overall container for many diverse opinions and topics. Depending on the speaker and on the context, it can mean one of the following things:

1. Policies concerning the governance of R&D activities and the deployment and use of AI in societal settings,
2. The role of developers, at individual and collective level,
3. Issues of inclusion, diversity and universal access,
4. Predictions and reflections on the benefits and risks of AI.

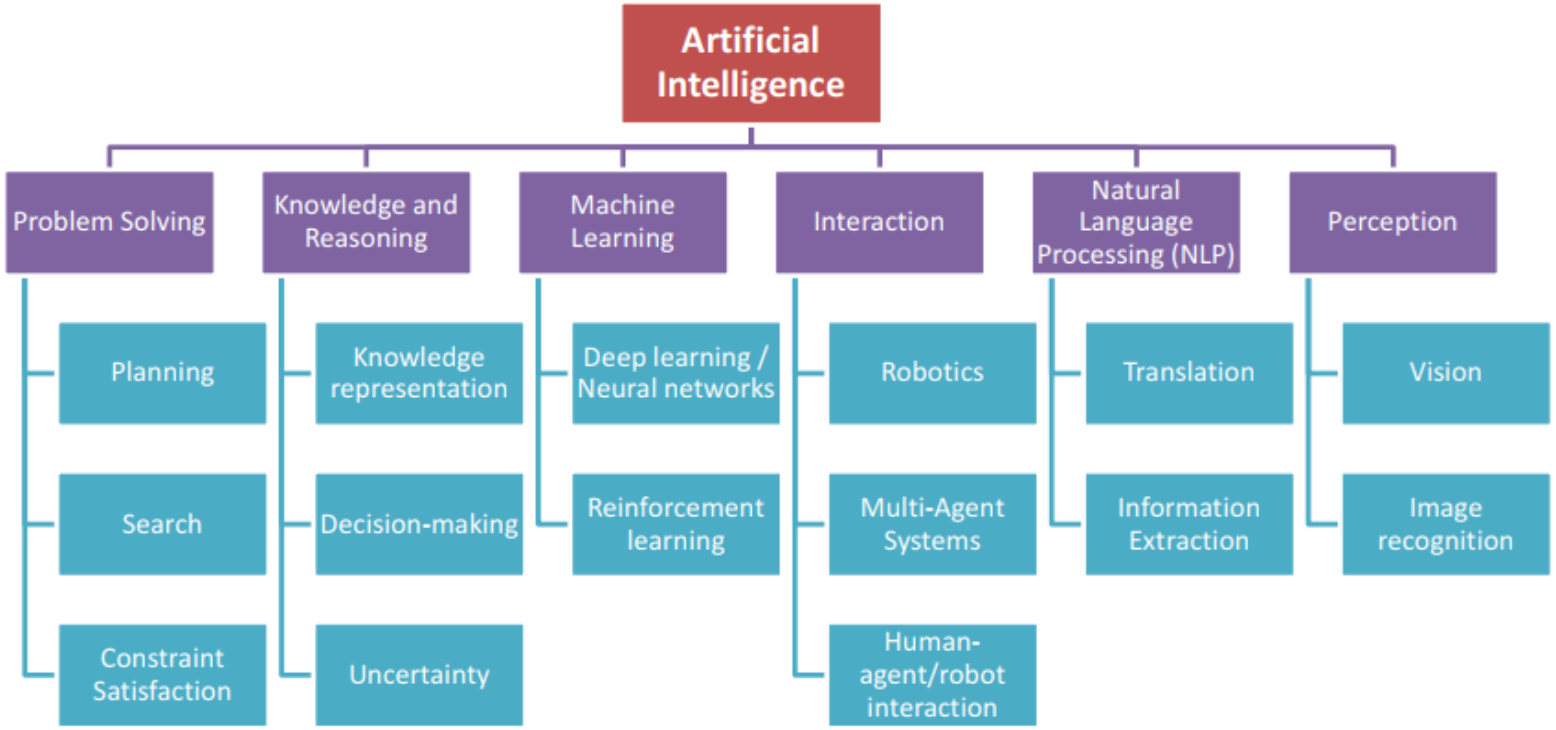


The ART principles of AI: Accountability, Responsibility, Autonomy

Principles of Responsible AI

	Challenge or Risk	Example
Fairness	Bias can affect results	A loan-approval model discriminates by gender due to bias in the data with which it was trained
Reliability & Safety	Errors may cause harm	An autonomous vehicle experiences a system failure and causes a collision
Privacy & Security	Data could be exposed	A medical diagnostic bot is trained using sensitive patient data, which is stored insecurely
Inclusiveness	Solutions may not work for everyone	A predictive app provides no audio output for visually impaired users
Transparency	Users must trust a complex system	An AI-based financial tool makes investment recommendations - what are they based on?
Accountability	Who's liable for AI-driven decisions?	An innocent person is convicted of a crime based on evidence from facial recognition – who's responsible?

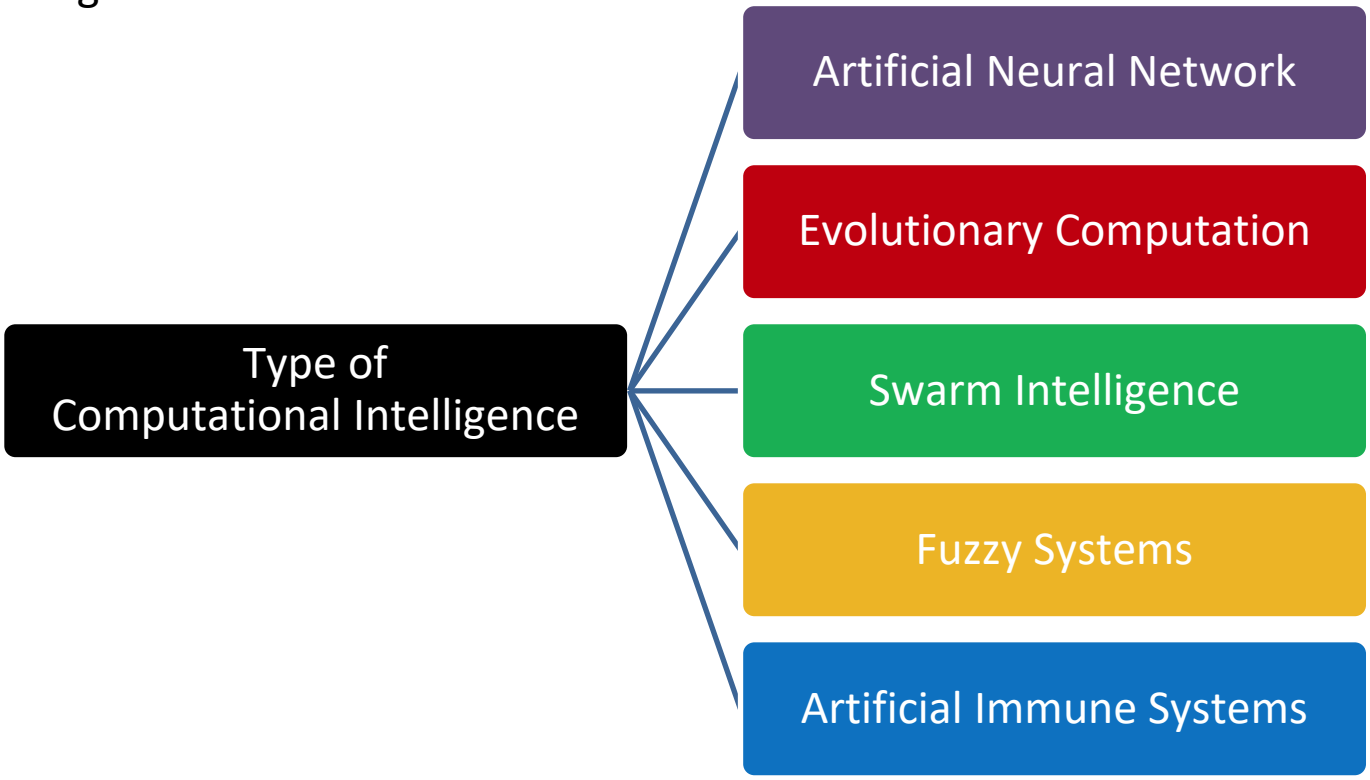
Main Current Stream in AI



Dignum, V. (2019)

Computational Intelligence (CI)

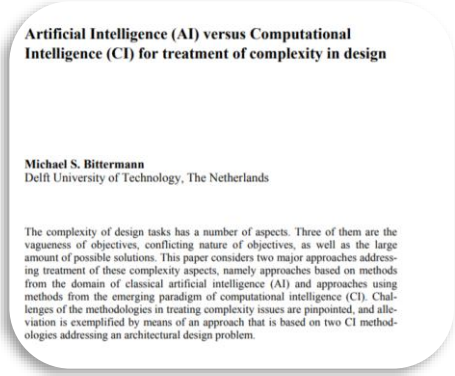
The ability of a computer to learn a specific task from data or experimental observation. Even though it is commonly considered a synonym of soft computing, there is still no commonly accepted definition of computational intelligence



AI vs CI

Artificial Intelligence	Computational Intelligence
• Hard computing technique	• Soft computing technique
• Follows binary logic. • Based on mathematical models	• Follows fuzzy logic. • Nature inspired models
• Not very effective	• Can work inexact and incomplete data
• Deterministic results	• Probabilistic results

Good readings:

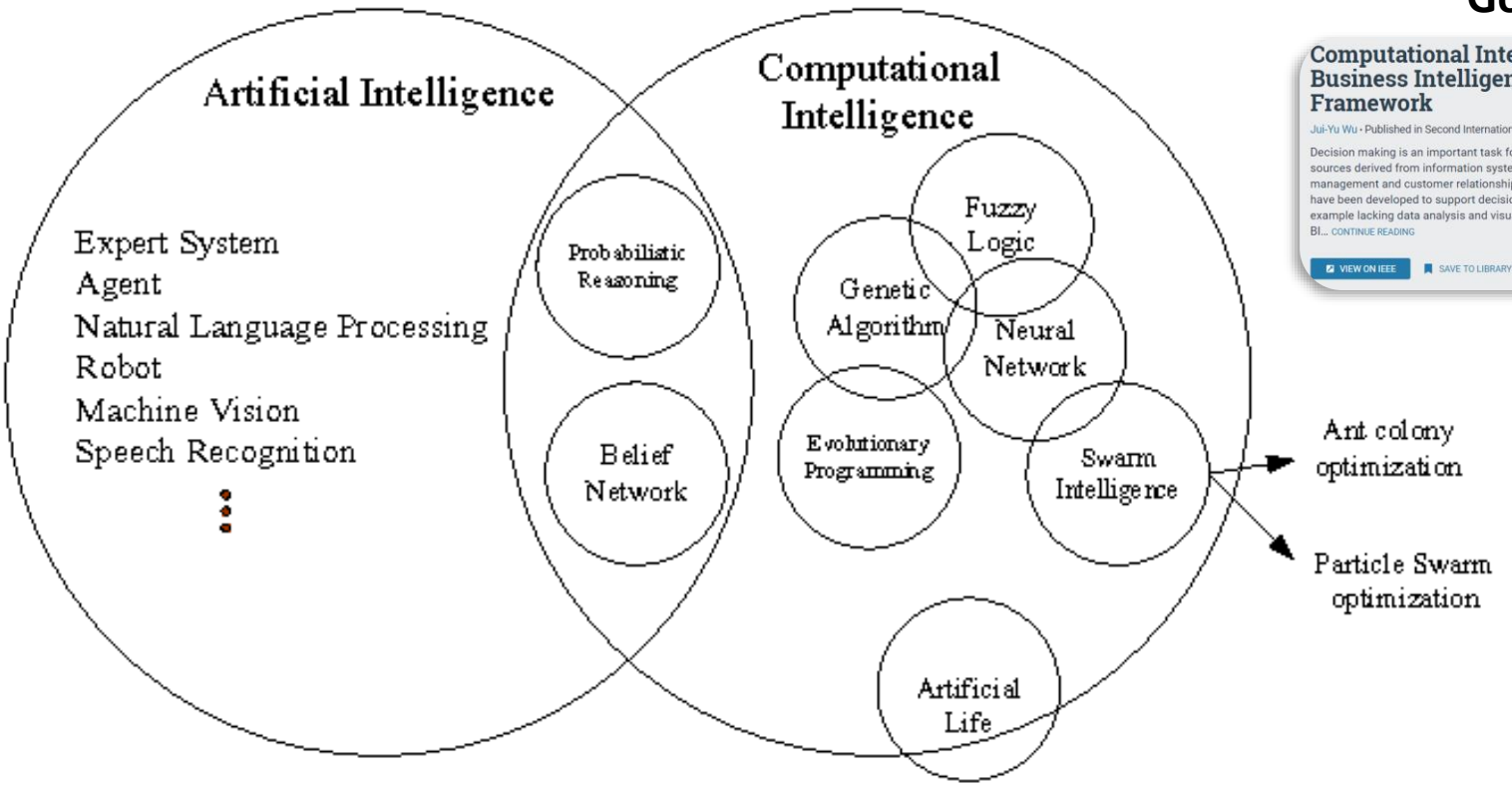


Artificial Intelligence (AI) versus Computational Intelligence (CI) for treatment of complexity in design

Michael S. Bittermann
Delft University of Technology, The Netherlands

The complexity of design tasks has a number of aspects. Three of them are the vagueness of objectives, conflicting nature of objectives, as well as the large amount of possible solutions. This paper considers two major approaches addressing treatment of these complexity aspects, namely approaches based on methods from the domain of classical artificial intelligence (AI) and approaches using methods from the emerging paradigm of computational intelligence (CI). Challenges of the methodologies in treating complexity issues are pinpointed, and alleviation is exemplified by means of an approach that is based on two CI methodologies addressing an architectural design problem.

AI vs CI



The relationship between AI and CI (Wu, 2010)

Good readings:

Computational Intelligence-Based Intelligent Business Intelligence System: Concept and Framework

Jui-Yu Wu - Published in Second International Conference on Computer and... 2010 - DOI: 10.1109/iccnt.2010.23

Decision making is an important task for enterprise managers, and is typically based on various data sources derived from information systems, such as enterprise resource planning, supply chain management and customer relationship management. Numerous business intelligence tools (BI) thus have been developed to support decision making. Some existing BI tools have several limitations, for example lacking data analysis and visualization capabilities. To increase the data analysis capability of BI... CONTINUE READING

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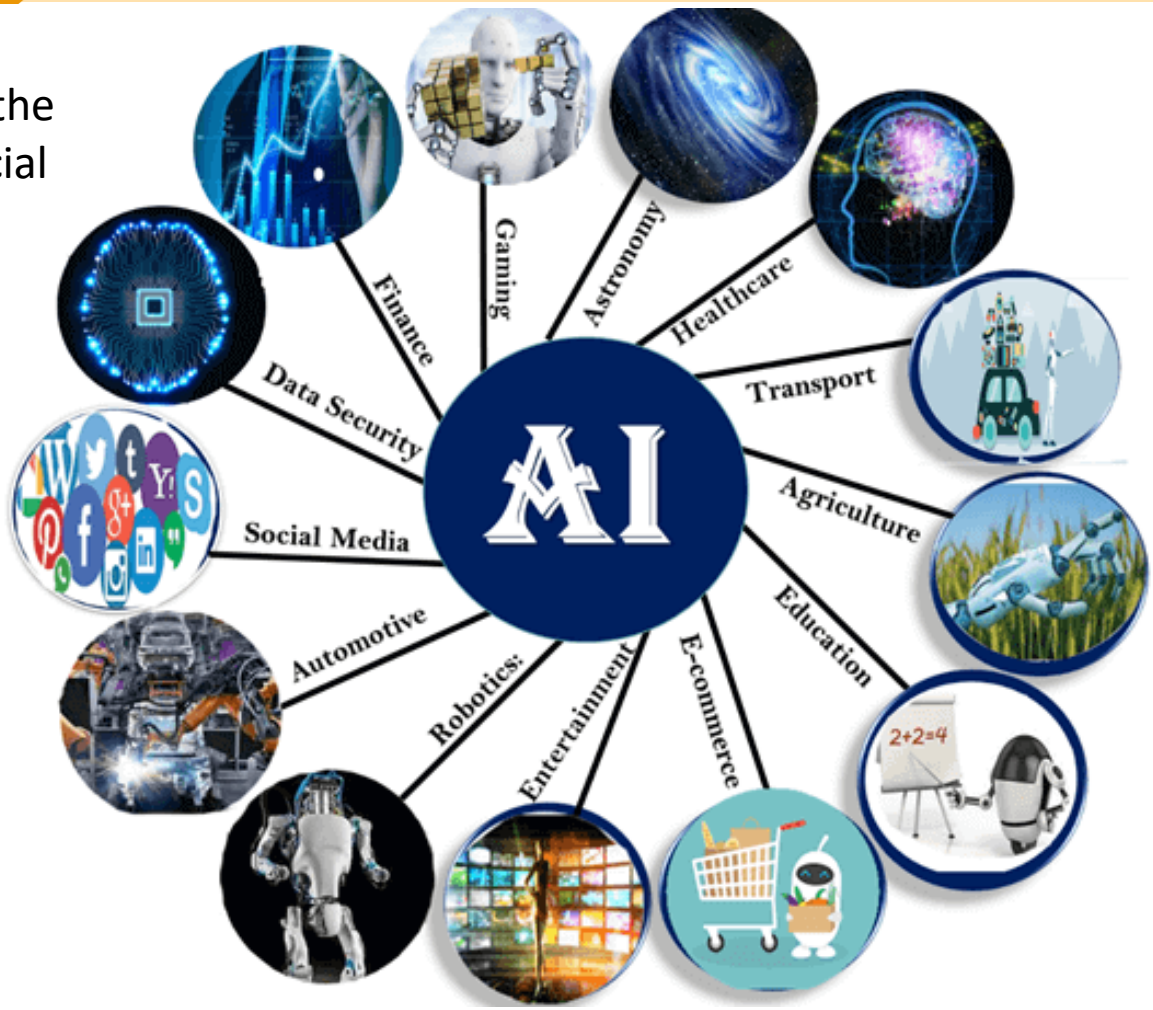
Applications

Following are some sectors which have the application of Artificial Intelligence:



Applications

1. AI in Astronomy

- Artificial Intelligence can be very useful to solve complex universe problems. AI technology can be helpful for understanding the universe such as how it works, origin, etc.

2. AI in Healthcare

- In the last, five to ten years, AI becoming more advantageous for the healthcare industry and going to have a significant impact on this industry.
- Healthcare Industries are applying AI to make a better and faster diagnosis than humans. AI can help doctors with diagnoses and can inform when patients are worsening so that medical help can reach to the patient before hospitalization

3. AI in Gaming

- AI can be used for gaming purpose. The AI machines can play strategic games like chess, where the machine needs to think of a large number of possible places.

Applications

4. AI in Finance

- AI and finance industries are the best matches for each other. The finance industry is implementing automation, chatbot, adaptive intelligence, algorithm trading, and machine learning into financial processes.

5. AI in Data Security

- The security of data is crucial for every company and cyber-attacks are growing very rapidly in the digital world. AI can be used to make your data more safe and secure. Some examples such as AEG bot, AI2 Platform, are used to determine software bug and cyber-attacks in a better way

6. AI in Social Media

- Social Media sites such as Facebook, Twitter, and Snapchat contain billions of user profiles, which need to be stored and managed in a very efficient way. AI can organize and manage massive amounts of data. AI can analyze lots of data to identify the latest trends, hashtag, and requirement of different users

Applications

7. AI in Travel &Transport

- AI is becoming highly demanding for travel industries. AI is capable of doing various travel related works such as from making travel arrangement to suggesting the hotels, flights, and best routes to the customers. Travel industries are using AI-powered chatbots which can make human-like interaction with customers for better and fast response

8. AI in Automotive Industry

- Some automotive industries are using AI to provide virtual assistant to their user for better performance. Such as Tesla has introduced TeslaBot, an intelligent virtual assistant.
- Various Industries are currently working for developing self-driven cars which can make your journey more safe and secure

Applications

9. AI in Robotics:

- Artificial intelligence has a remarkable role in robotics. Usually, general robots are programmed such that they can perform some repetitive task, but with the help of AI, we can create intelligent robots which can perform tasks with their own experiences without pre-programmed.
- Humanoid Robots are best examples for AI in robotics, recently the intelligent Humanoid robot named as Erica and Sophia has been developed which can talk and behave like humans

10. AI in Entertainment

- We are currently using some AI based applications in our daily life with some entertainment services such as Netflix or Amazon. With the help of ML/AI algorithms, these services show the recommendations for programs or shows.

Applications

11. AI in Agriculture

- Agriculture is an area which requires various resources, labor, money, and time for best result. Now a day's agriculture is becoming digital, and AI is emerging in this field. Agriculture is applying AI as agriculture robotics, solid and crop monitoring, predictive analysis. AI in agriculture can be very helpful for farmers

12. AI in E-commerce

- AI is providing a competitive edge to the e-commerce industry, and it is becoming more demanding in the e-commerce business. AI is helping shoppers to discover associated products with recommended size, color, or even brand

13. AI in education:

- AI can automate grading so that the tutor can have more time to teach. AI chatbot can communicate with students as a teaching assistant.
- AI in the future can be work as a personal virtual tutor for students, which will be accessible easily at any time and any place.

Applications : Chess Playing

E.g. Deep Blue (IBM)

- Perception: advanced features of the board
- Actions: choose a move
- Reasoning: heuristics to evaluate board positions, search

Applications : Medical Diagnosis

E.g. Pathfinder (D.Heckerman, Microsoft Research)

- Perception: symptoms, test results
- Actions: suggest tests, make diagnosis
- Reasoning: Bayesian inference, machine learning, Monte Carlo simulation

Applications : Automatic Driver

E.g. ALVINN (D.Pomerleau, CMU)

- Perception: digitized camera image of the road
- Actions: 64 different steering angles
- Reasoning: artificial neural network trained with backpropagation

Applications : Scheduling

- Perception: task description language
- Action: trivial
- Reasoning: constraint satisfaction, linear programming, genetic algorithms

Classical AI

- Reasoning was once seen as ***the*** AI problem
- Chess (and related games) were considered pivotal to understanding intelligence
- Golden goal: a *general problem solver*
- But general problem solving is hard! Memory and computational complexity issues hit in early 70s
- Instead, research moved to rule-based expert systems in the 80s, and discovered their limitations too...

How should we represent knowledge? Is logic enough?

Recent AI: Math to the Rescue!

- Heavy use of probability theory, decision theory, statistics
- Trying to solve *specific problems* rather than build a general reasoner
- AI today is a collection of sub-fields:
  - Perception (especially vision) is a separate community
  - Robotics is also largely separate
  - Deliberative reasoning is now the part named “AI”
  - Even within reasoning, different approaches evolved,with different styles and terminology
- A lot of progress was made in this way!

State of the Art

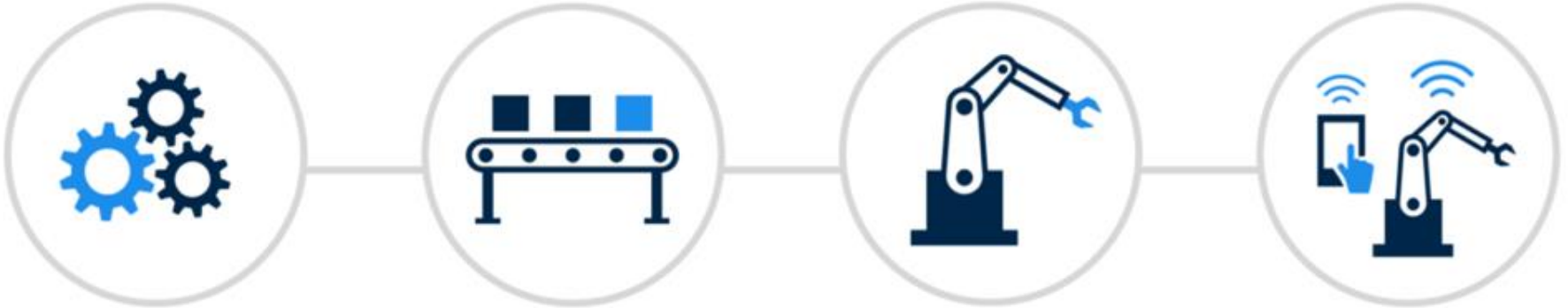
Which of the following can be done at present?

- Play a decent game of table tennis
- Play a decent game of bridge
- Discover and prove a new mathematical theorem
- Write an intentionally funny story
- Give competent legal advice in a specialized area of law
- Translate spoken English into spoken Swedish in real time

Applications : IR 4.0

- Automation and robotics provide the muscle for Industry 4.0, AR/VR, cameras and other sensors provide the senses, and data and connectivity are its central nervous system.
- The real brains behind this industrial revolution is AI.
- AI is used to enhance processes driven by the collaboration between human and machine.
- Industry 4.0 creates what has been called a "smart factory".

Applications : IR 4.0



Industry 1.0

Mechanization and the introduction of steam and water power

Industry 2.0

Mass production assembly lines using electrical power

Industry 3.0

Automated production, computers, IT-systems and robotics

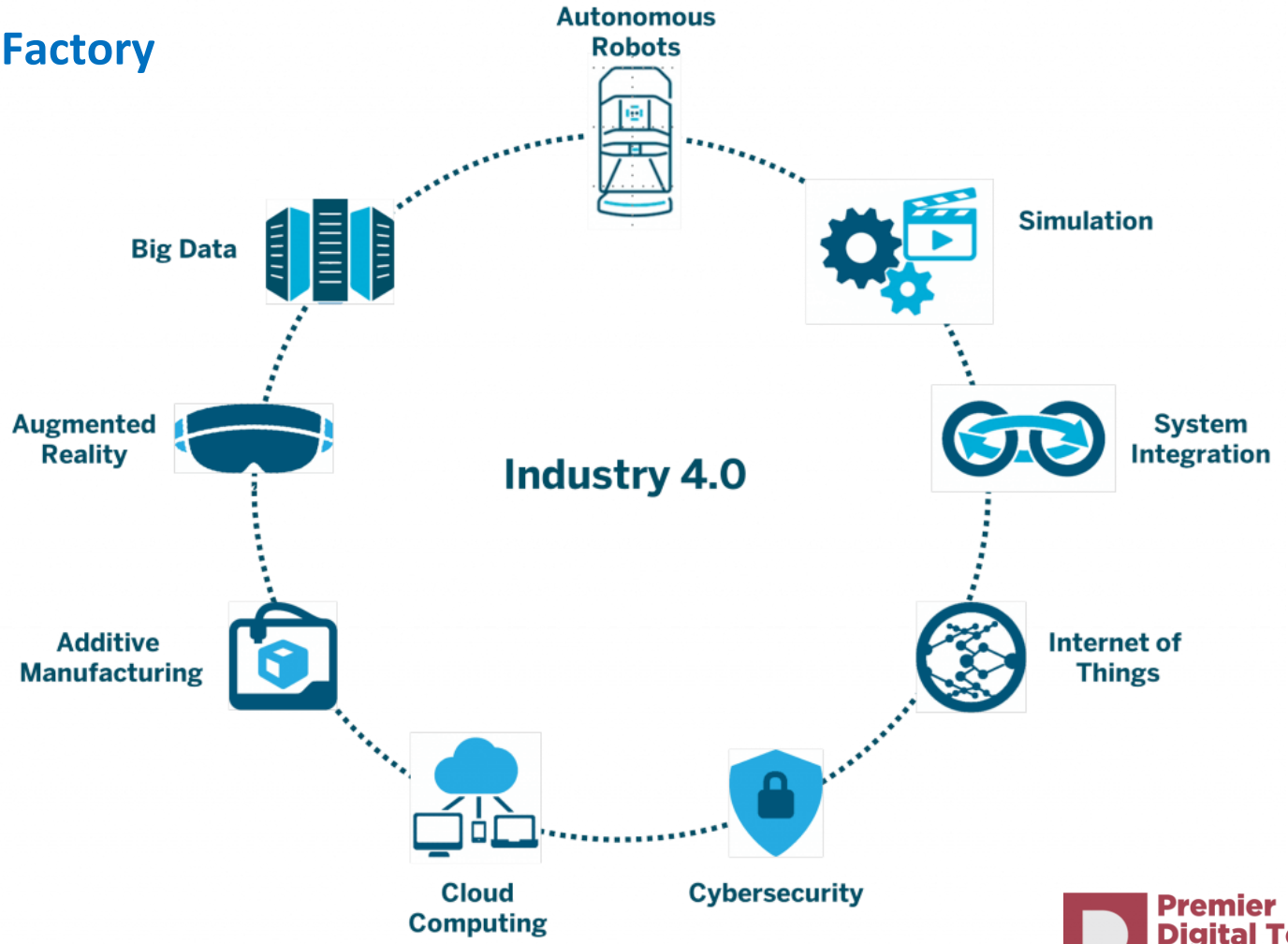
Industry 4.0

The Smart Factory. Autonomous systems, IoT, machine learning

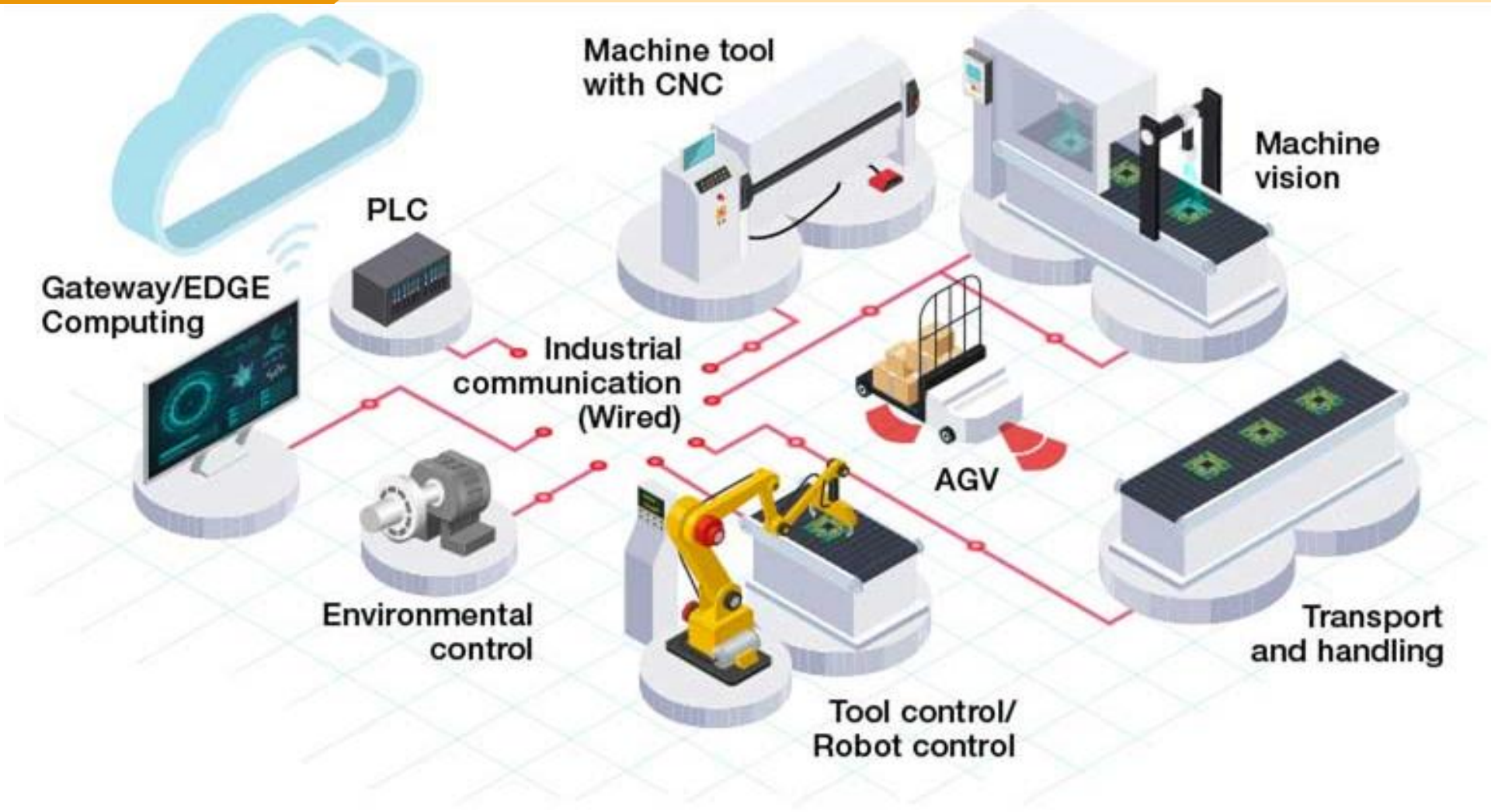
Artificial Intelligence
Biological Science
Engineering Tech
→ Intelligent System

Applications : IR 4.0

Elements in Smart Factory

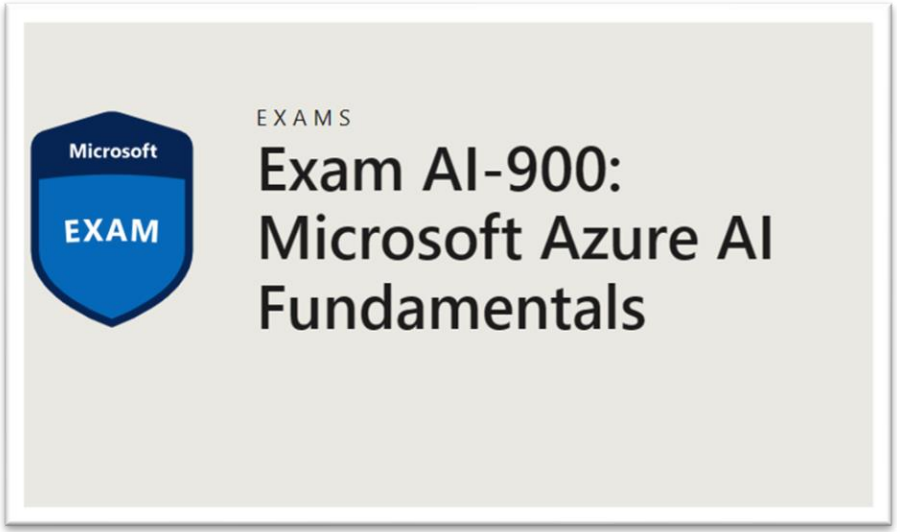


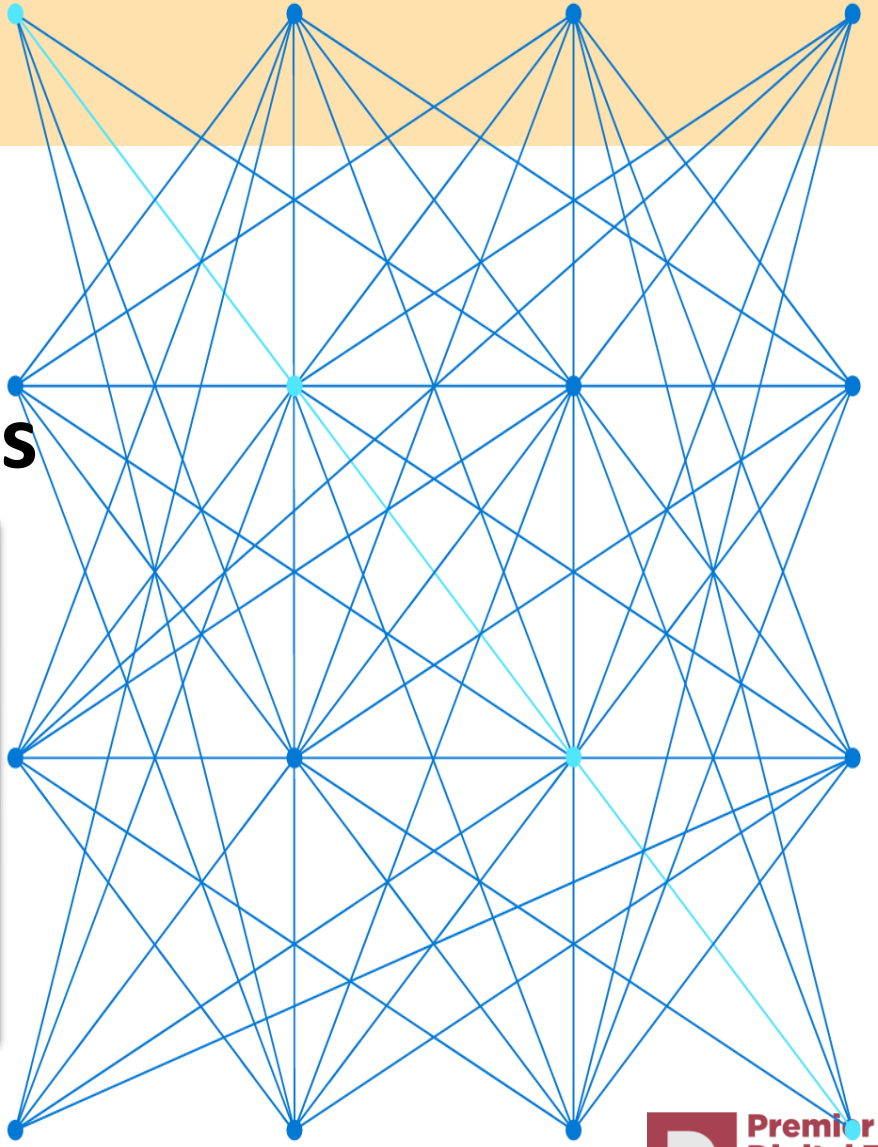
Applications : IR 4.0



Applications : IR 4.0

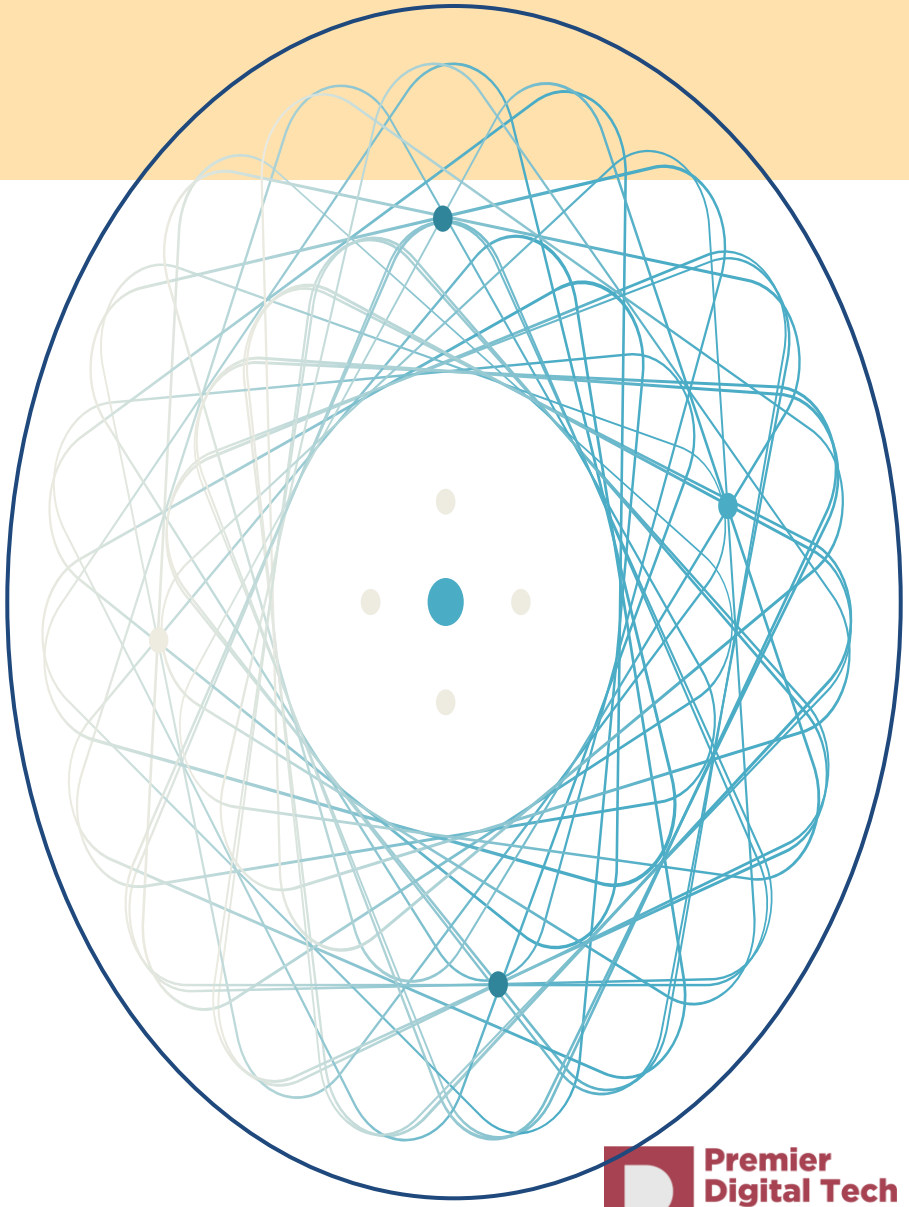
AI-900
Azure AI Fundamentals





Module 1:

Explore Fundamentals of Artificial Intelligence



Module Agenda

- Introduction to Artificial Intelligence
- Artificial Intelligence in Microsoft Azure

Premier Digital Tech University™

Lesson 1: Introduction to Artificial Intelligence

What is Artificial Intelligence?

Software that imitates human capabilities

- Predicting outcomes and recognizing patterns based on historic data
- Recognizing abnormal events and making decisions
- Interpreting visual input
- Understanding language, and engaging in conversations
- Extracting information from sources to gain knowledge

Common Artificial Intelligence Workloads

	Machine Learning	Predictive models based on data and statistics – the foundation for AI
	Anomaly Detection	Systems that detect unusual patterns or events, enabling pre-emptive action
	Computer Vision	Applications that interpret visual input from cameras, images, or videos
	Natural Language Processing	Applications that can interpret written or spoken language, and engage in dialogs with human users
	Knowledge Mining	Extract information from data sources to create a searchable knowledge store

Principles of Responsible AI

	Challenge or Risk	Example
Fairness	Bias can affect results	A loan-approval model discriminates by gender due to bias in the data with which it was trained
Reliability & Safety	Errors may cause harm	An autonomous vehicle experiences a system failure and causes a collision
Privacy & Security	Data could be exposed	A medical diagnostic bot is trained using sensitive patient data, which is stored insecurely
Inclusiveness	Solutions may not work for everyone	A predictive app provides no audio output for visually impaired users
Transparency	Users must trust a complex system	An AI-based financial tool makes investment recommendations - what are they based on?
Accountability	Who's liable for AI-driven decisions?	An innocent person is convicted of a crime based on evidence from facial recognition – who's responsible?

Lesson 2: Artificial Intelligence in Microsoft Azure

Azure Basics

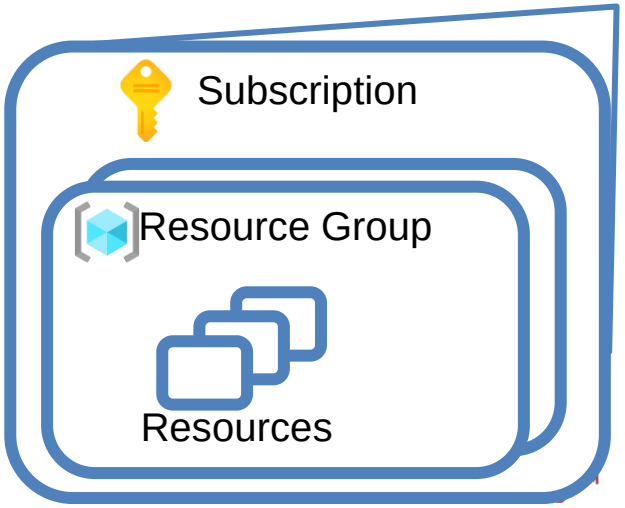
Microsoft Azure is a scalable and reliable cloud platform that offers a range of services, including data storage, compute, and various other cloud-based services.

1. **Data Storage**: Microsoft Azure provides a wide array of data storage solutions to cater to different needs:

- **Azure SQL Database**: A fully managed relational database service for structured data.
- **Azure Data Lake Storage**: Designed for big data analytics and large-scale data processing.
- **Azure Files**: Managed file shares in the cloud, suitable for file storage and sharing.

2. **Compute**: Azure provides various computing options to run applications and workloads:

   - **Virtual Machines (VMs)**: You can deploy and manage VMs running Windows or Linux.
   - **App Service**: A platform for building, deploying, and scaling web apps and APIs.



3. **Services**: Microsoft Azure offers a vast ecosystem of cloud services, including but not limited to:

   - **Artificial Intelligence (AI)**: Azure AI services, including machine learning, cognitive services, and bot services.

AI Services in Microsoft Azure

 Azure Machine Learning	A platform for training, deploying, and managing machine learning models
 Cognitive Services	A suite of services with four main pillars: Vision, Speech, Language, Decision
 Azure Bot Service	A cloud-based platform for developing and managing conversational bots
 Azure Cognitive Search	Data extraction, enrichment, and indexing for intelligent search and knowledge mining

Cognitive Services

- AI application resources in an Azure subscription:
  - Standalone resources for specific services
  - General *Cognitive Services* resource for multiple services
- Consumed by applications via:
  - A REST endpoint (https:// address)
  - An authentication key or authorization token