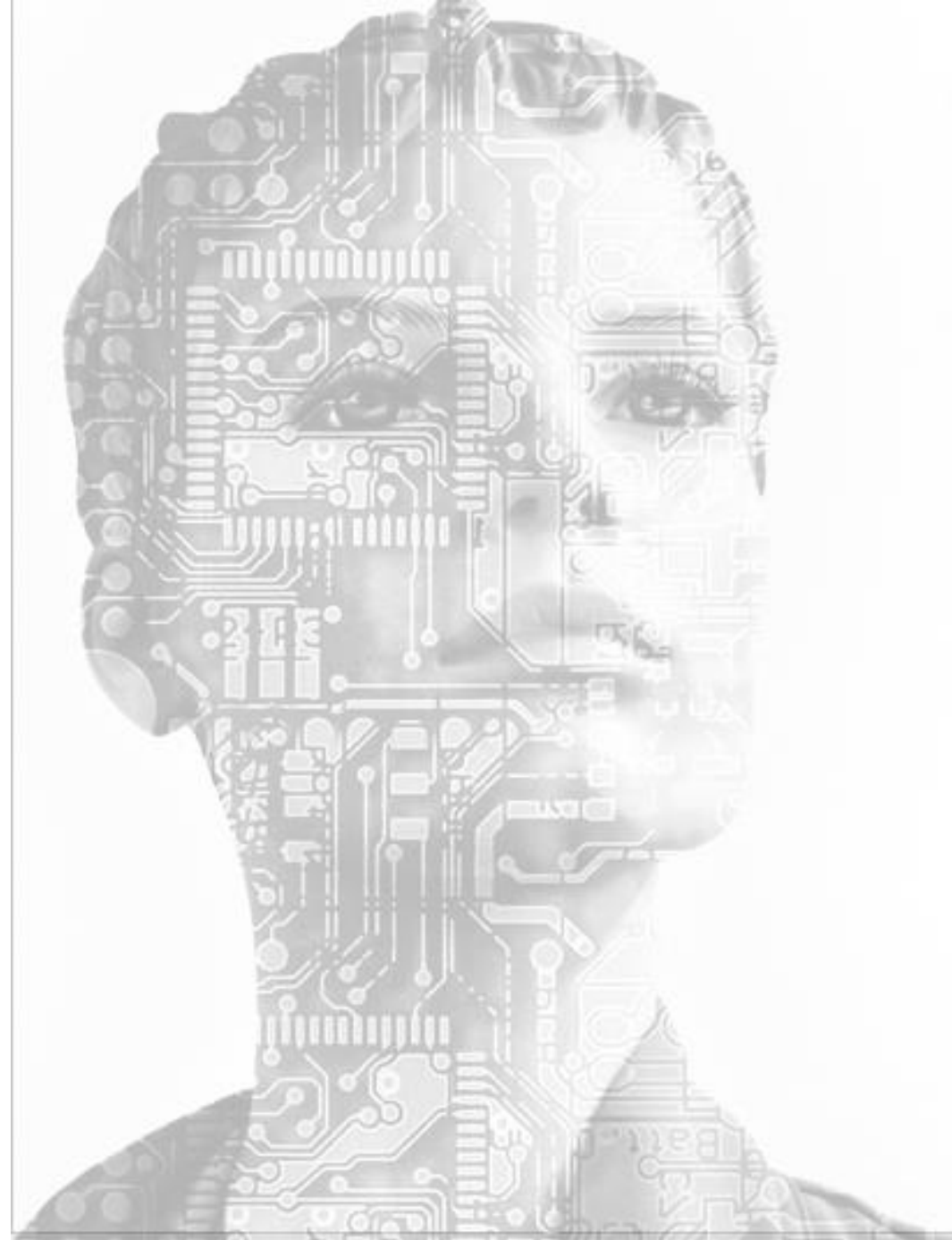# Artificial Intelligence Fundamentals

- **Real Time Vehicle Counting using AI**

- **Defining AI**

- **AI Landscape and Applications**

- **Types of AI**

- **Elements Underpinning AI Development**

- **Workflow to build an AI system**

- **AI – ML – DL Relationship**

MIT Introduction to Deep Learning | 6.S191, 2022

https://youtu.be/7sB052Pz0sQ

# Real Time Vehicle Counting using AI

Real-time vehicle **detection, tracking, and counting** from surveillance cameras.

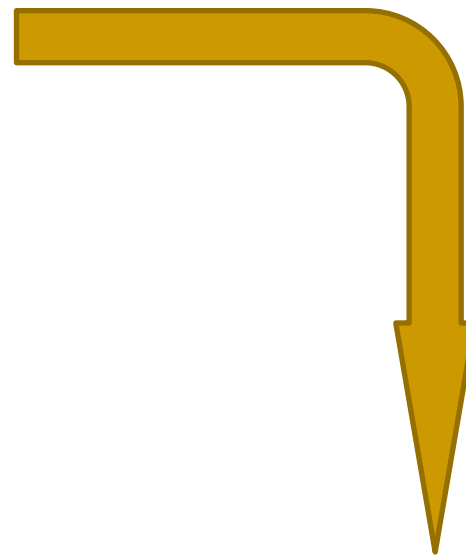Tiny YOLO for detection

Fast motion estimation for tracking.

The application is running in Ubuntu with GPU processing.

Experimental results show that the approach achieves high accuracy at real-time speed (33 FPS) on real traffic videos (real-time operation).
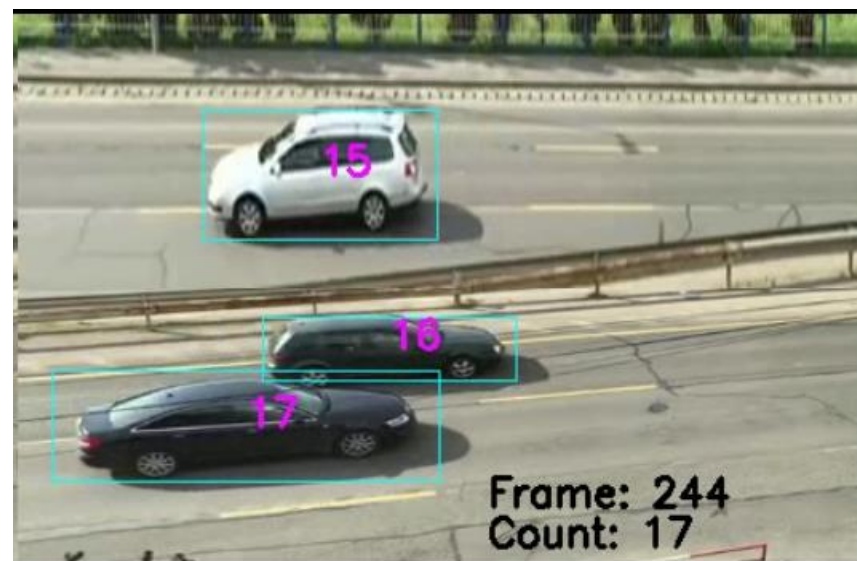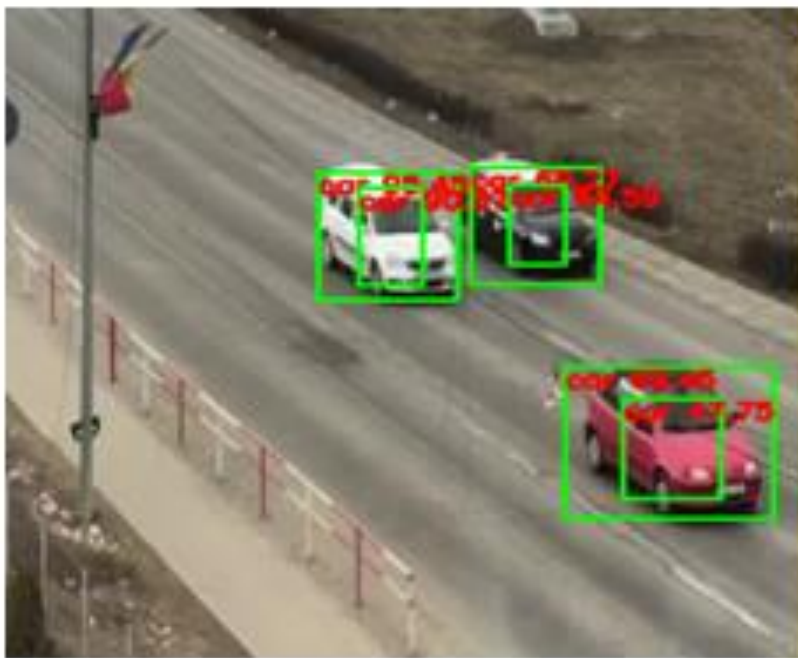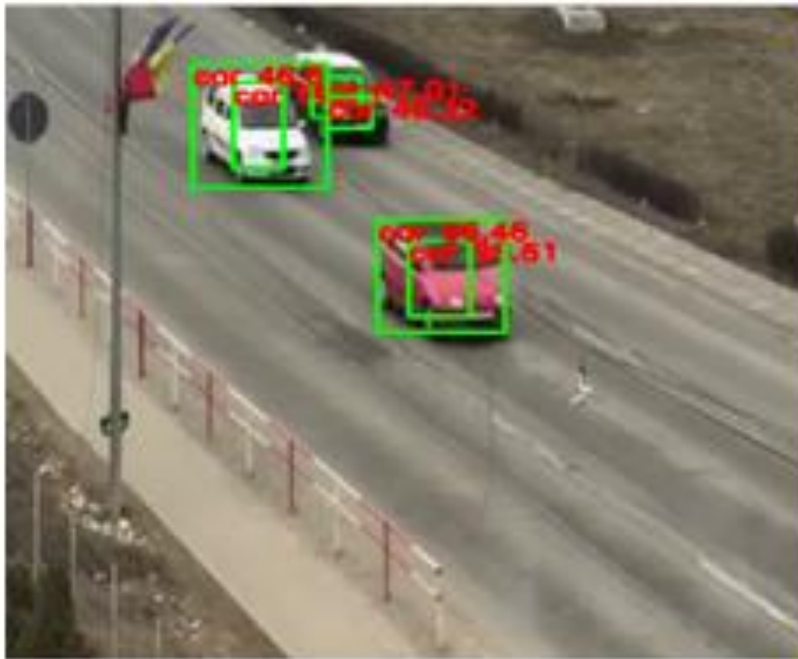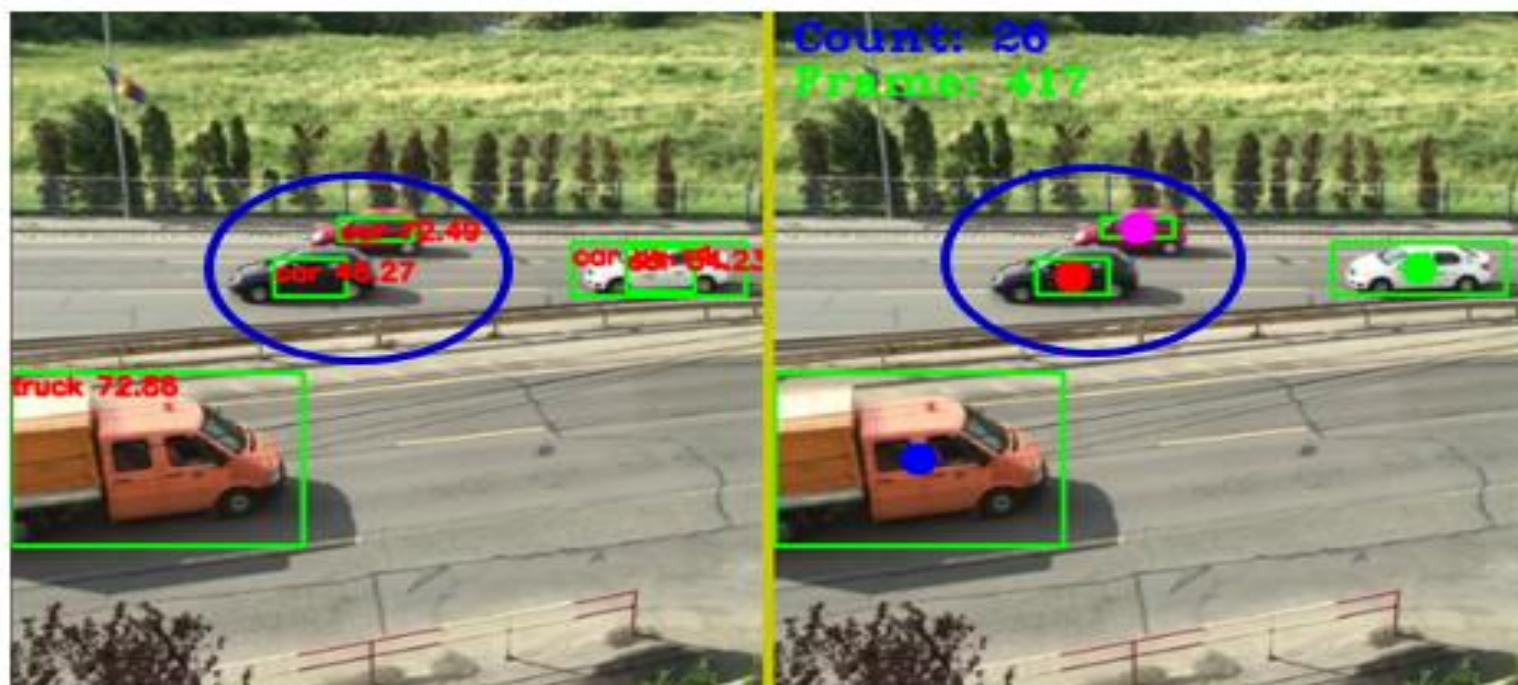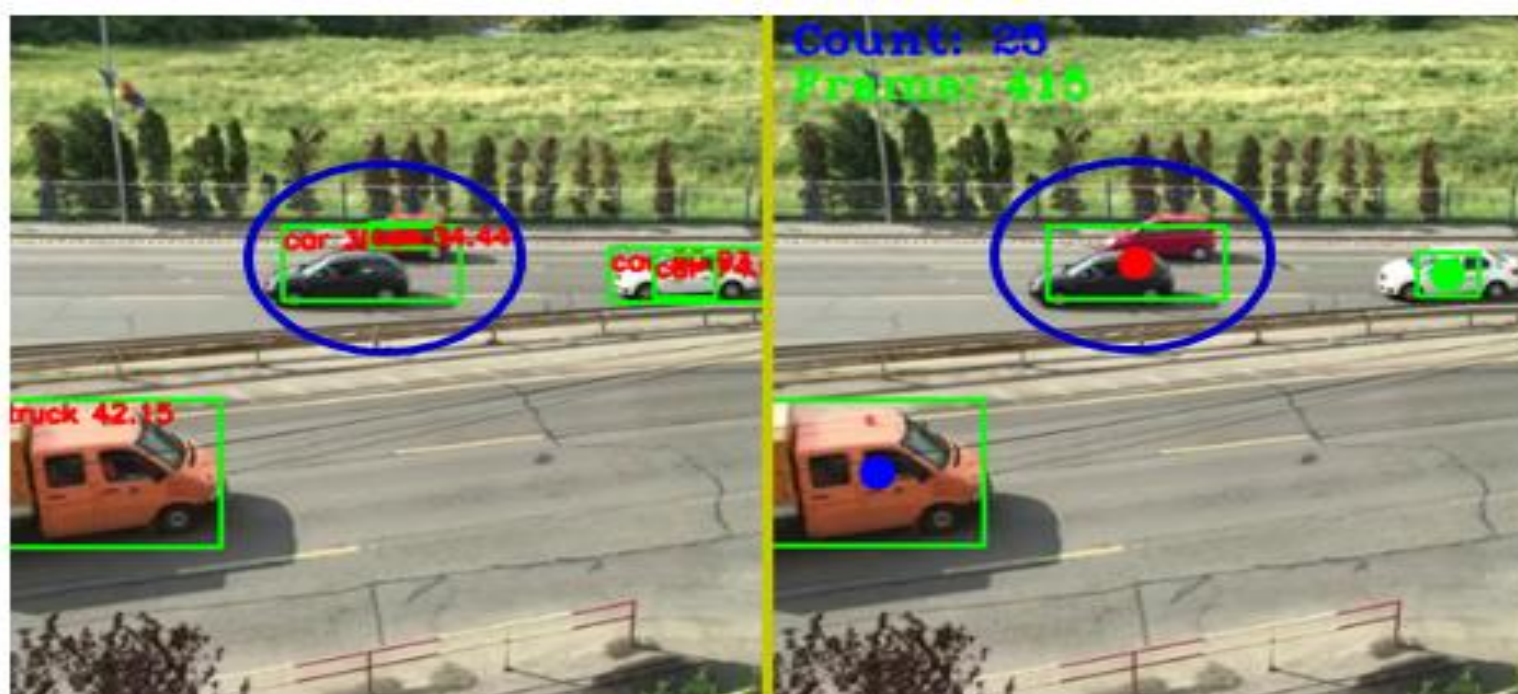
Original video frame

Processed  video frame

- Convolutional Neural Network (CNN) for detection, localization and classification

- Python application for frame preprocessing, tracking and counting

- Computer / Jetson Nano implementation

# Demonstration

[Movie](Movie)

[JSON file](JSON file)

# Defining AI

# Artificial Intelligence (AI)

❑ Revolutionary technology that develops **systems capable of performing tasks that require human intelligence** such as analyzing, interpreting and extracting meaningful information from data series, images or video sequences, speech recognition, language understanding, decision making.

❑ Technologies programmed to analyze the world around them and take actions to achieve specific goals.

➢ Developing AI involves **creating systems that can learn, reason and interact in ways like human intelligence**.

➢ Even if we don't realize it**, AI already plays a key role in our daily lives**, from filtering spam messages, suggesting a song /movie, to finding the optimal route to a destination

Exemplifying other areas of application

# AI – Artificial Intelligence

**Artificial Intelligence** is the broader concept of machines being able to carry out tasks in a way that we would consider "smart".

https://www.forbes.com/sites/bernardmarr/2016/12/06/what-is-the-difference-between-artificial-intelligence-and-machine-learning/#4c8bb2fc2742

**Artificial intelligence** is the field of study by which a computer (and its systems) develop the ability for successfully accomplishing complex tasks that usually require human intelligence such as visual perception, speech recognition, decision-making, and translation between languages.

**AI is usually defined as the "science of making computers do things that require intelligence when done by humans".**

https://www.stoodnt.com/blog/ann-neural-networks-deep-learning-machine-learning-artificial-intelligence-differences/

# AI – Artificial Intelligence

Artificial Intelligence is an approach to make a computer, a robot, or a product to think how smart human think.

The aim of AI is to improve computer functions which are related to human knowledge, for example, **reasoning, learning, and problem-solving.**

https://becominghuman.ai/introduction-to-artificial-intelligence-5fba0148ec99

**Video**:   Deep Learning and Traditional Machine Learning: Choosing the Right Approach

ARTIFICIAL INTELLIGENCE
Early artificial intelligence stirs excitement.

MACHINE LEARNING
Machine learning begins to flourish.

DEEP LEARNING
Deep learning breakthroughs drive AI boom.

1950's  1960's  1970's  1980's  1990's  2000's  2010's

Since an early flush of optimism in the 1950's, smaller subsets of artificial intelligence - first machine learning, then deep learning, a subset of machine learning - have created ever larger disruptions.

Demystifying Neural Networks, Deep Learning, Machine Learning, and Artificial Intelligence, Posted on March 29, 2018 By Tanmoy Ray
https://www.stoodnt.com/blog/ann-neural-networks-deep-learning-machine-learning-artificial-intelligence-differences/

# What Makes a Machine Intelligent?

While AI is the headliner, there are actually subsets of the technology which can be applied to solving human problems in different ways.

## Artificial Intelligence (AI)

A process where a computer solves a task in a way that mimics human behavior. Today, narrow AI—when a machine is trained to do one particular task—is becoming more widely used, from virtual assistants to self-driving cars to automatic tagging your friends in your photos on Facebook.

**Artificial Intelligence**

**Machine Learning**
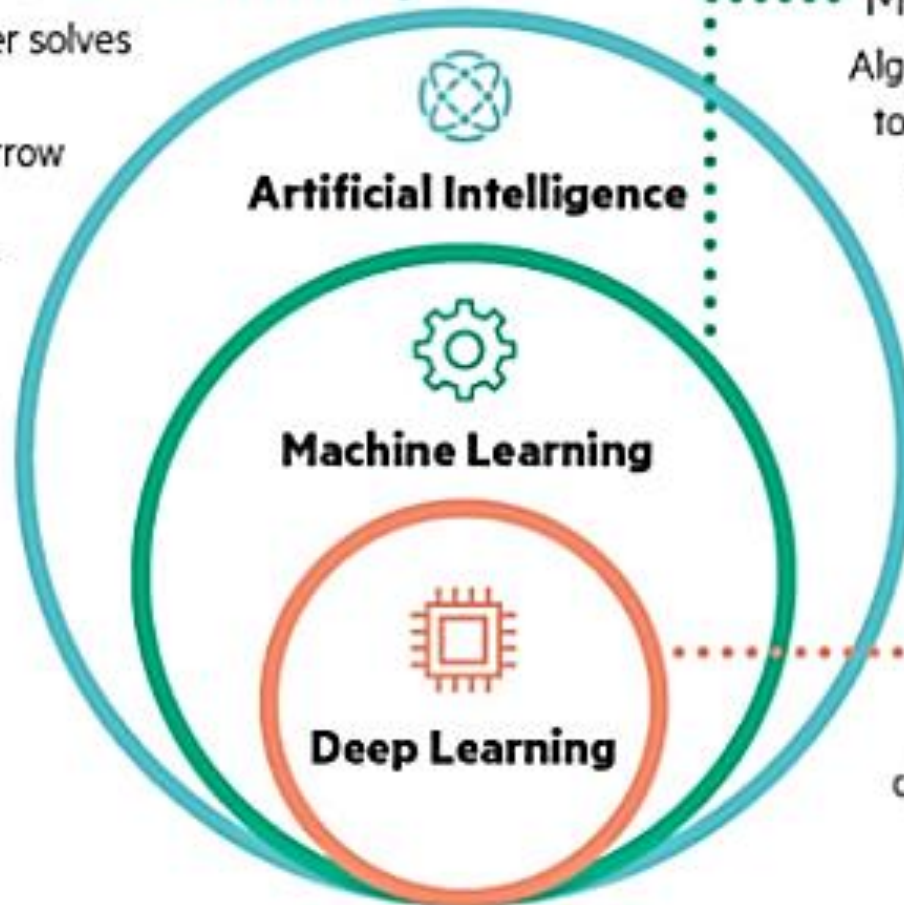
**Deep Learning**

## Machine Learning (ML)

Algorithms that allow computers to learn from examples without being explicitly programmed.

## Deep Learning (DL)

A subset of ML which uses deep artificial neural networks as models and does not require feature engineering.

https://deeplylearning.fr/cours-theoriques-deep-learning/fonctionnement-du-neurone-artificiel/

# Artificial Intelligence

The European Commission adopted in 2018, the European strategy for AI called "Artificial Intelligence for Europe".

"AI refers to intelligent systems by analyzing the behavior of the environment and take action - with a certain degree of autonomy - in order to carry out specific tasks.

AI-based systems can be
- only virtual world software (voice assistants, image analysis software, search engines, voice and facial recognition systems)
- embedded in hardware devices (advanced robots, autonomous vehicles, drones or Internet of Things applications).

"Simplified" definition: "**AI is a collection of technologies that combine data, algorithms and computing capabilities**."

❖ EC publishes the **AI package**, proposing new rules and actions to make Europe the global leader of trusted AI (**April 21, 2021**)

❖ The EU approach for AI focuses on **excellence and trust**, with the aim of increasing research and industry capacity and ensuring fundamental rights.

• Communication on Fostering a European Approach to AI

• Coordinated Plan with Member States: 2021 update (review)

• Proposal for a Regulation laying down harmonised rules on artificial intelligence (Artificial Intelligence Act)

A European approach to Artificial intelligence, https://digital-strategy.ec.europa.eu/en/policies/european-approach-artificial-intelligence

AI is the unprecedented divorce between the ability to solve problems successfully in view of a goal and any need to be intelligent in doing so.

This successful divorce has become possible only in recent years, thanks to skyrocketing
- **quantities of data,**
- **very sophisticated statistical tools,**
- **gigantic computational power,**
- **the transformation of our habitats into increasingly AI-friendly places.**

The more we live in the infosphere and onlife, the more we share our everyday realities with engineered forms of agency, and the more AI can deal with an increasing number of problems and tasks. The limit of AI is not the sky, but human ingenuity.

[ Luciano Floridi, Anna Christina (Kia) Nobre, The Green and the Blue: How AI may be a force for good, Nov 30, 2020, https://www.oecd-forum.org/posts/the-green-and-the-blue-how-ai-may-be-a-force-for-good ]

**Key proposals**
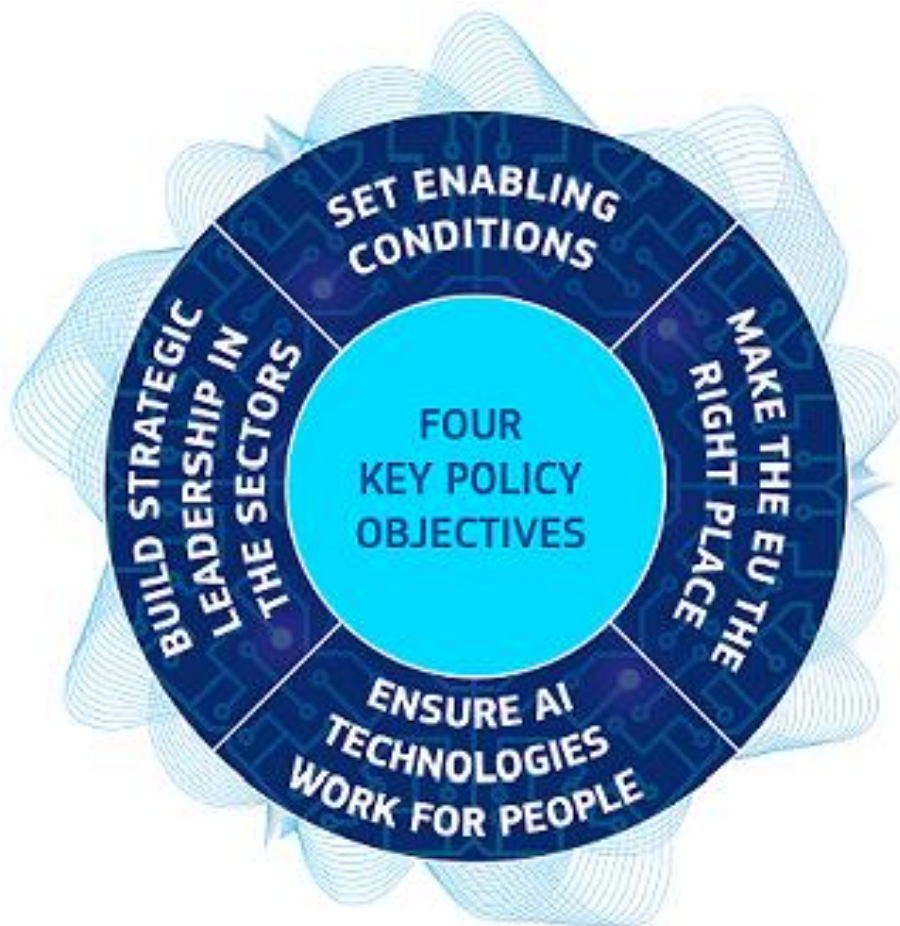


✓Set enabling conditions for AI development and uptake in the EU

✓Make the EU the place where excellence thrives from the lab to the market

✓Ensure that AI works for people and is a force for good in society

✓Build strategic leadership in high-impact sectors

# AI Landscape and Applications

# AI landscape

➢ After years of intense activity in technological development, in both hardware and software, **artificial intelligence has consolidated significantly**.

➢ Its influence is now evident throughout the **economy and society**.

➢ More and more **AI-supported tools and applications are being integrated into diverse work environments**, from automated factories and smart offices to financial services and healthcare.

➢ In addition, these technologies are making their way **into our personal lives**, through virtual assistants, smart home devices, personalized entertainment, fitness apps, automated driving, content generation, **transforming the way we live and interact with the world** around us in a big way.

# AI landscape
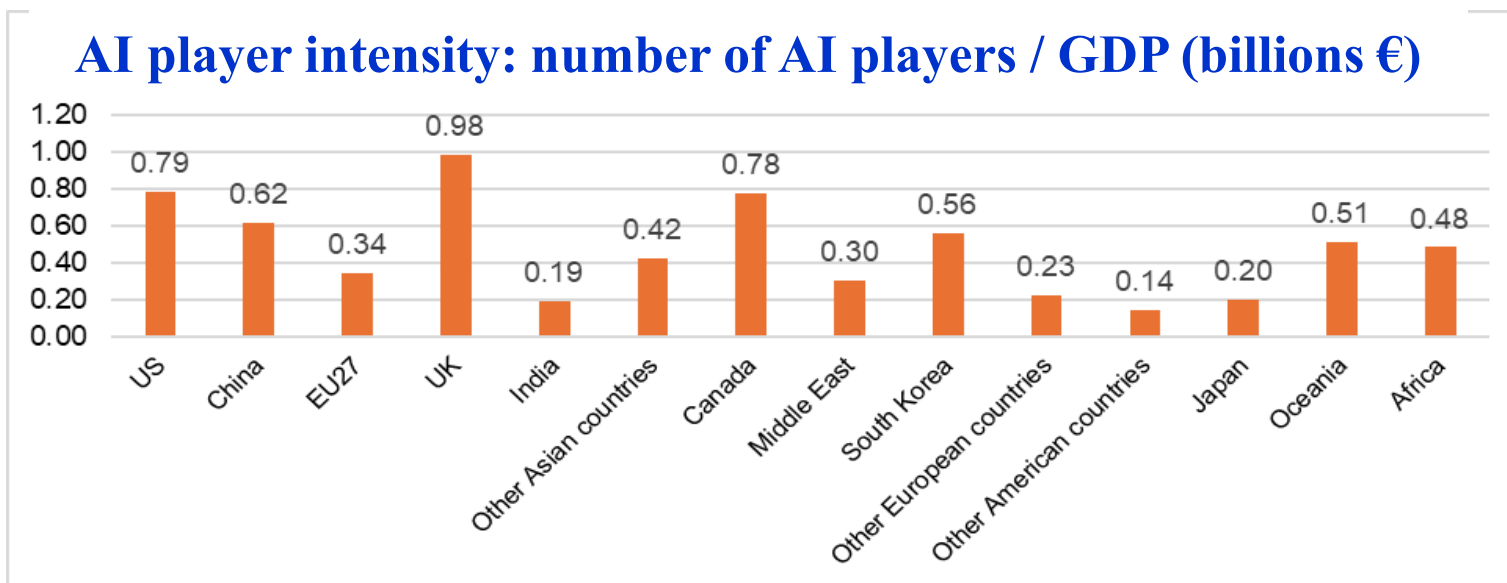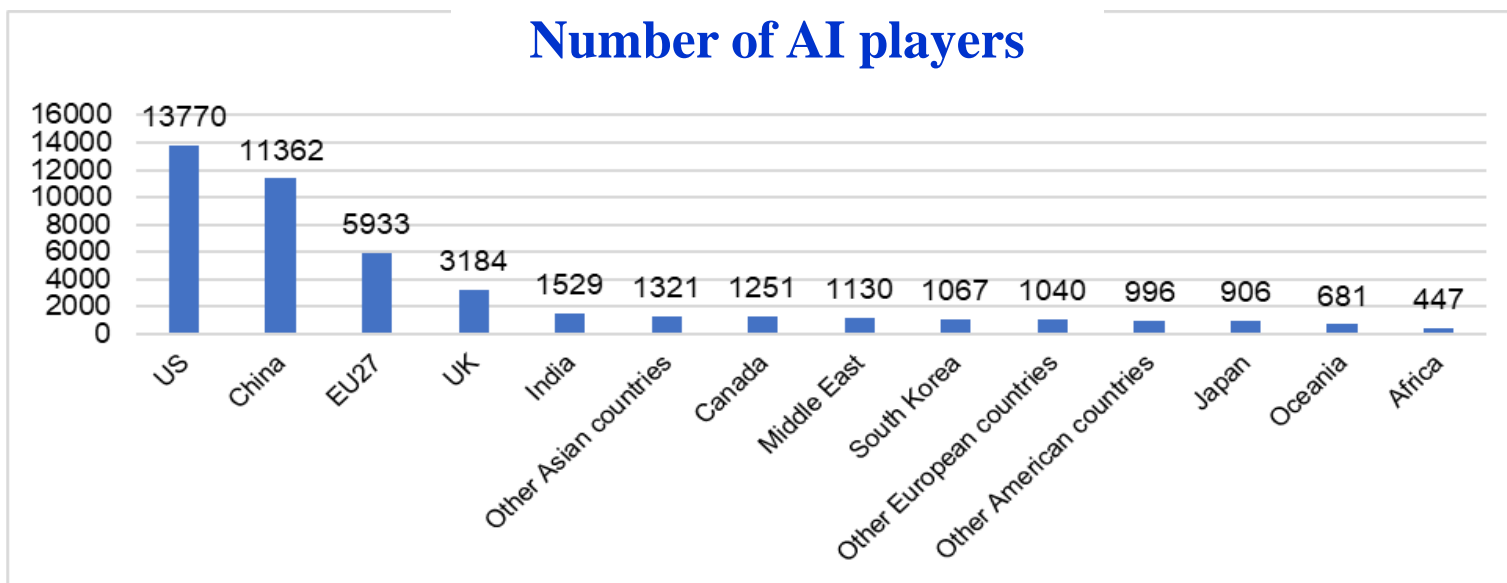
**Worldwide**



**Number of AI players**



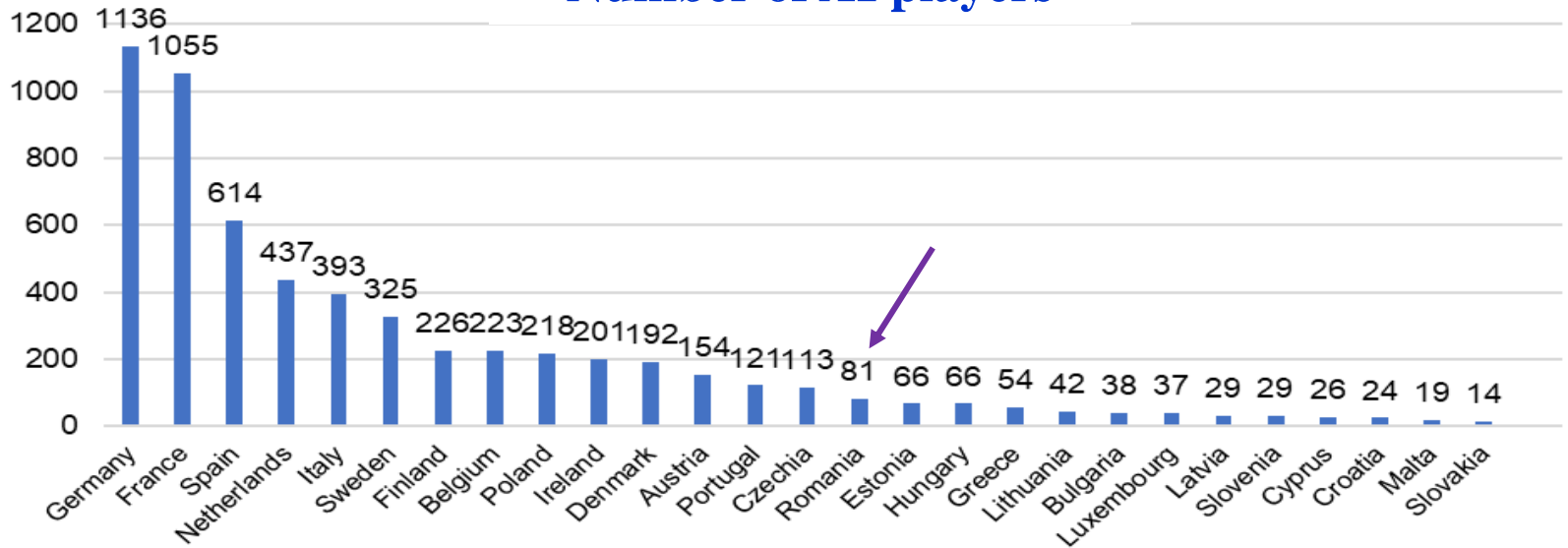**AI player intensity: number of AI players / GDP (billions €)**

**EU27**



# Number of AI players

Germany 1136, France 1055, Spain 614, Netherlands 437, Italy 393, Sweden 325, Finland 226, Belgium 223, Poland 218, Ireland 201, Denmark 192, Austria 154, Portugal 121, Czechia 113, Romania 81, Estonia 66, Hungary 66, Greece 54, Lithuania 42, Bulgaria 38, Luxembourg 37, Latvia 29, Slovenia 29, Cyprus 26, Croatia 24, Malta 19, Slovakia 14

# AI player intensity: number of AI players / GDP (billions €)

Germany 0.29, France 0.39, Spain 0.37, Netherlands 0.50, Italy 0.17, Sweden 0.68, Finland 0.94, Belgium 0.42, Poland 0.21, Ireland 0.56, Denmark 0.66, Austria 0.35, Portugal 0.39, Czechia 0.30, Romania 0.16, Estonia 1.57, Hungary 0.24, Greece 0.19, Lithuania 0.47, Bulgaria 0.27, Luxembourg 0.60, Latvia 0.56, Slovenia 0.41, Cyprus 0.85, Croatia 0.24, Malta 1.02, Slovakia 0.09

# Distribution of AI activities by thematic areas     Worldwide
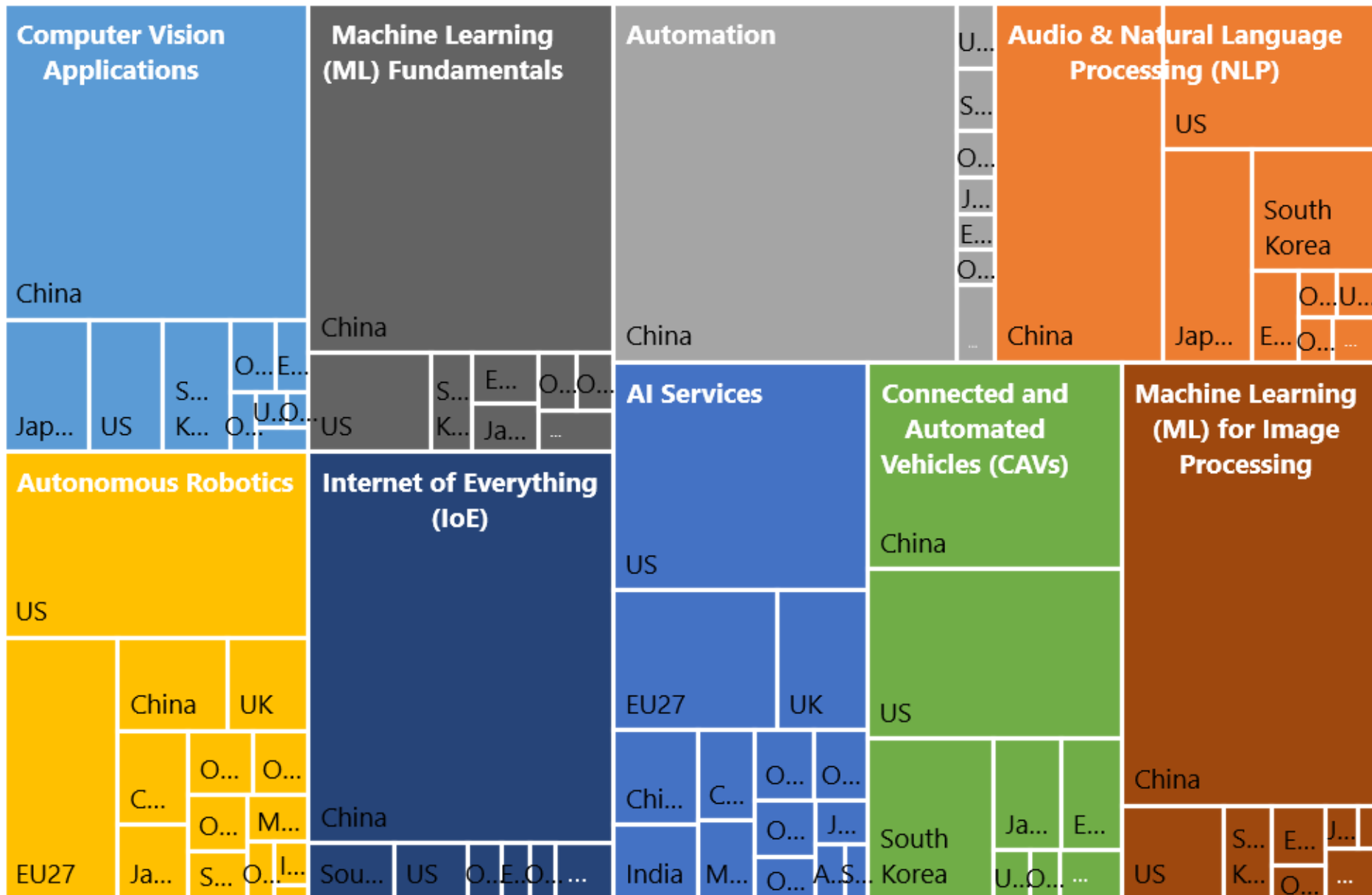
Put the following image in ChatGPT and ask her / him / it ??
to describe the content
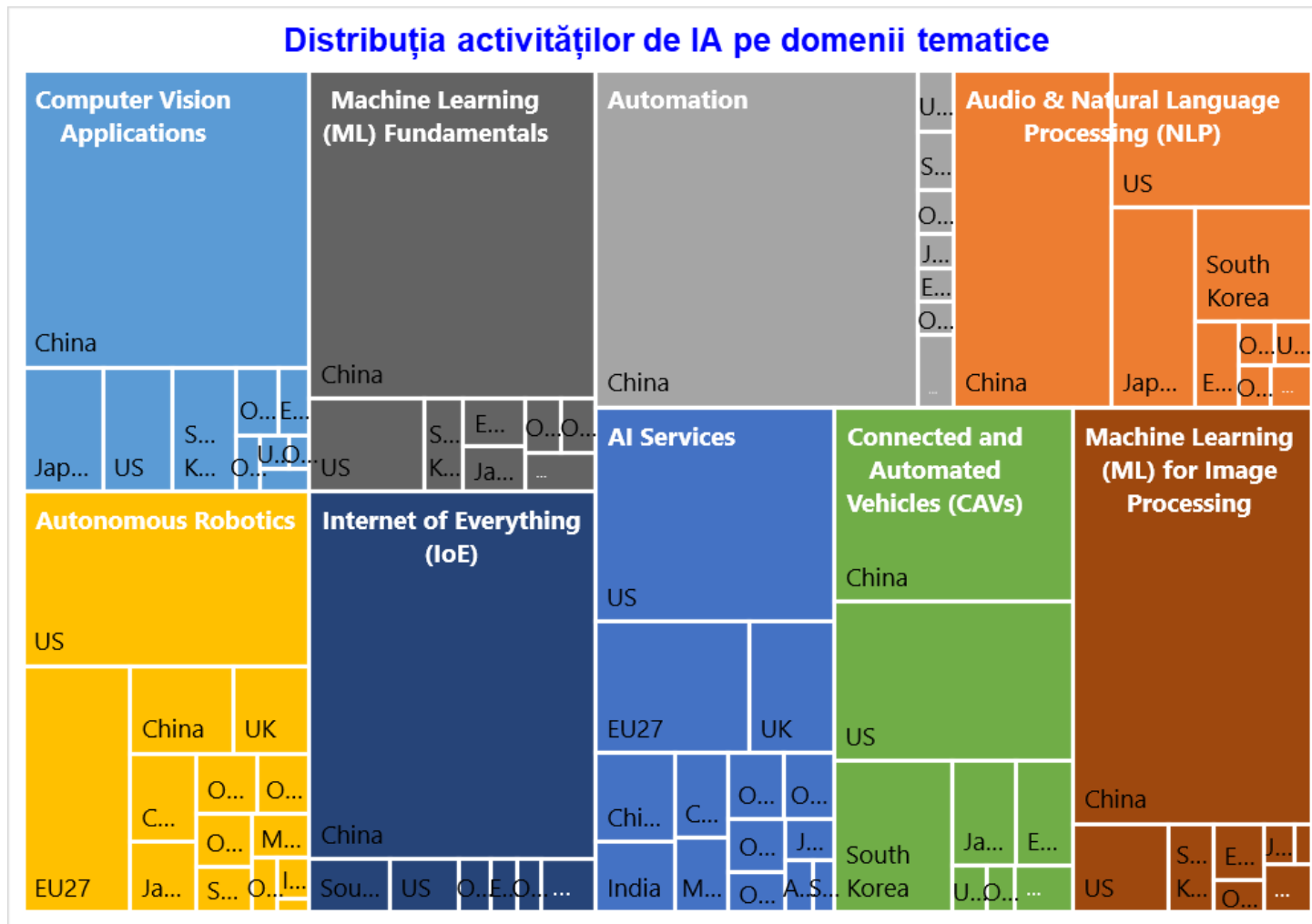
# ChatGPT opinion

ChatGPT should generally be referred to as **"it"** because it is an AI system, and the neutral pronoun "it" is commonly used for non-human entities.

AI systems do not have gender, so using **"it"** is the most accurate and widely accepted choice.

However, if someone prefers to personify ChatGPT, they could use **"he"** or **"she"**, but this would be more informal and based on personal preference, not standard usage.

The most neutral and correct way is to use **"it"** when referring to ChatGPT.

# Distribution of AI activities by thematic areas    EU27
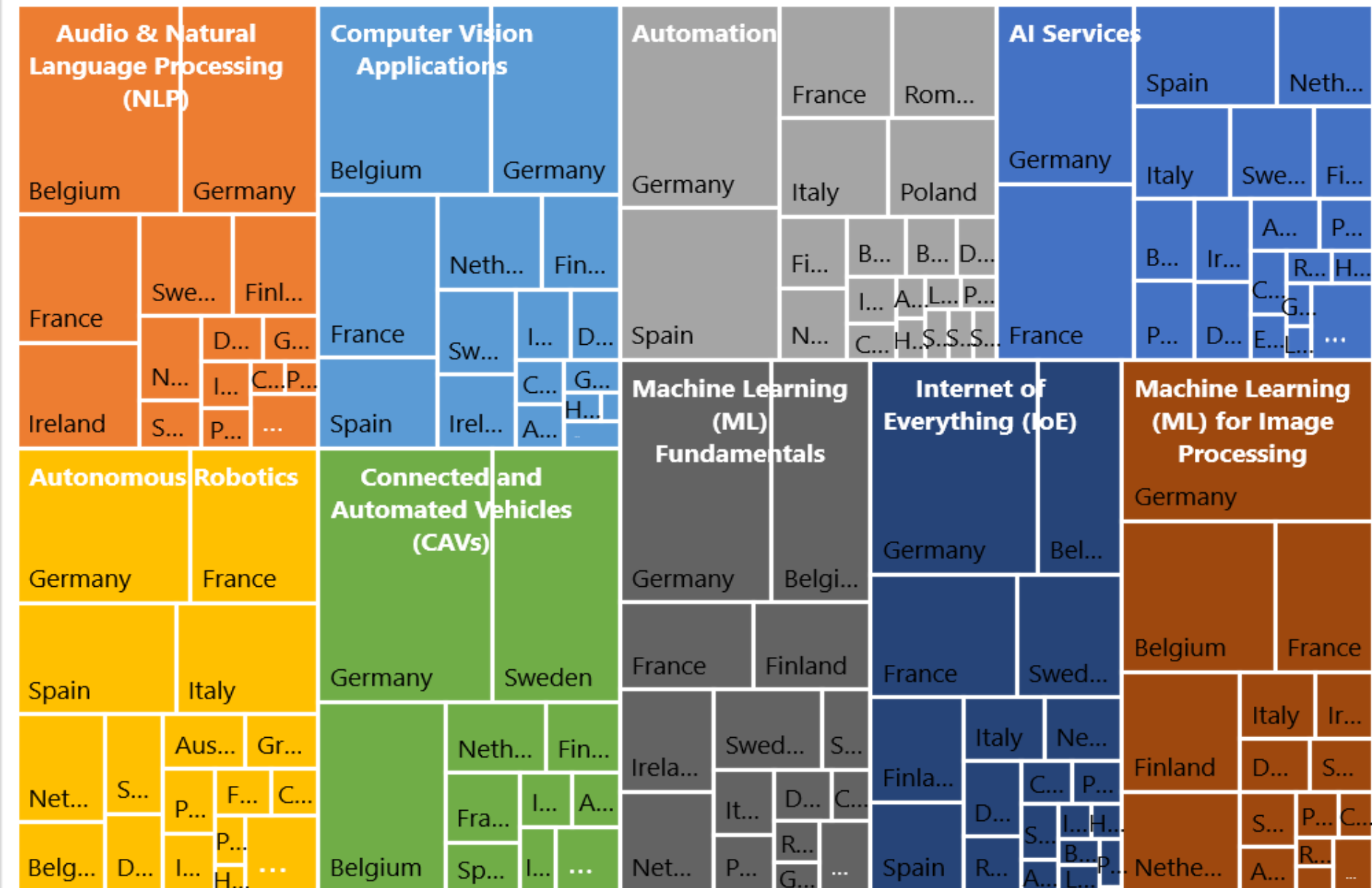
# AI applications

➢ **Healthcare:** AI has a significant impact in healthcare, improving the diagnosis, treatment and monitoring of patients (disease diagnosis, medical imaging, patient monitoring, drug discovery).

➢ **Finance and economics:** AI is used to improve the efficiency of operations, reduce risks and provide personalized services (algorithmic trading, fraud detection, credit risk assessment, financial robots, etc).

➢ **Retail and e-commerce:** AI optimizes the shopping experience and improves inventory and supply chain management processes (recommendation systems, price optimization, inventory management, personalized marketing).

➢ **Transport and logistics:** AI transforms transport and logistics through route optimization, fleet management and vehicle automation (autonomous vehicles, delivery robots, delivery drones, transport route optimization).

# AI applications

➢ **Education:** AI personalizes the learning experience and automates administrative tasks (adaptive learning platforms, automated test grading, virtual student assistants)

➢ **Cybersecurity:** AI is essential in detecting and preventing cyber threats, protecting digital infrastructures: (detecting and preventing cyber-attacks, network traffic monitoring, automated incident response).

➢ **Agriculture:** AI helps optimize agricultural production by monitoring crops and automating agricultural processes (irrigation optimization, farm machinery automation, autonomous tractors).

➢ **Production and industry:** AI improves production process efficiency and ensures product quality (supply chain optimization, predictive equipment maintenance, quality control, inventory management systems).
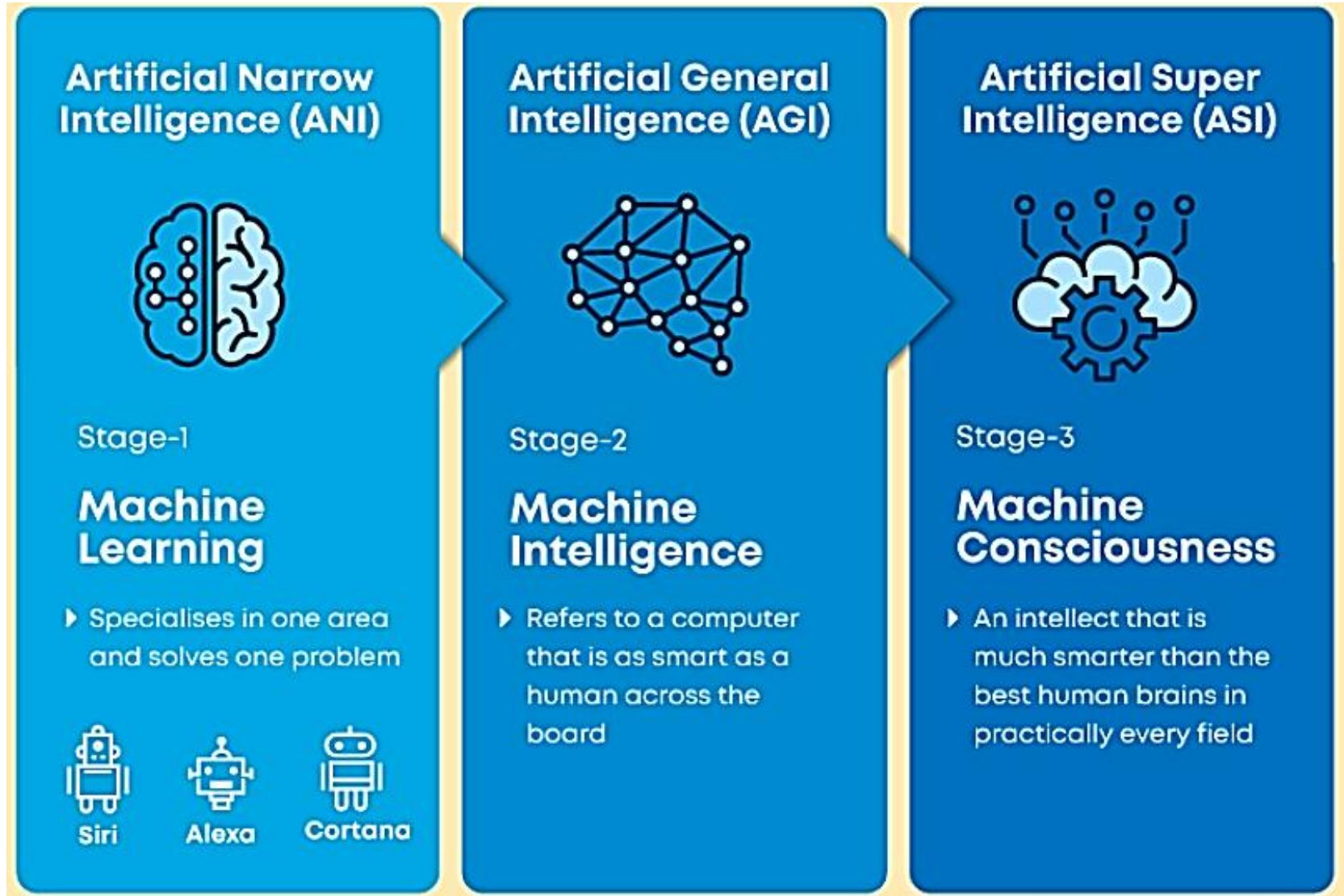
# AI applications

➢ **Media and entertainment:** AI personalizes media content and optimizes production and distribution processes (content recommendation systems, automatic content generation, sentiment analysis, search by voice or images).

➢ **Document management and content generation:** document classification, text analytics, automatic email response, document generation, speech-to-text and text-to-speech conversion, contextual machine translation.

➢ **Environment and energy:** AI contributes to monitoring the environment and optimizing the use of energy resources (air and water quality monitoring, smart management of energy networks, optimization of energy consumption).

➢ **Military:** AI is used in to improve strategy, security and operational efficiency (autonomous military vehicles, drones for surveillance and attack, data analysis for military intelligence, virtual simulation and training)

# Types of AI

# Types of AI



Artificial Narrow Intelligence (ANI)

Stage-1

**Machine Learning**

▶ Specialises in one area and solves one problem

Siri    Alexa    Cortana

Artificial General Intelligence (AGI)

Stage-2

**Machine Intelligence**

▶ Refers to a computer that is as smart as a human across the board

Artificial Super Intelligence (ASI)

Stage-3

**Machine Consciousness**

▶ An intellect that is much smarter than the best human brains in practically every field

Great Learning Editorial Team, What is Artificial Intelligence in 2024?, Updated on Sep 10, 2024, https://www.mygreatlearning.com/blog/what-is-artificial-intelligence/

# Types of AI

**Artificial Narrow Intelligence (ANI),** also known as **Weak AI**, refers to AI systems designed and trained to perform a **specific or narrow range of tasks**.

**Artificial General Intelligence (AGI),** or **Strong AI** or **Human-Level AI**, refers to AI systems that can understand, learn, and apply knowledge across a **broad range of tasks at a level comparable to human intelligence**.

**Artificial Super Intelligence (ASI)** refers to AI systems that **surpass human intelligence and capabilities in all aspects**, including creativity, general wisdom, and problem-solving.

- ASI represents a level of intelligence significantly more advanced than even the most brilliant human minds.

- The concept of ASI is highly speculative and remains a topic of debate and theoretical exploration

Great Learning Editorial Team, What is Artificial Intelligence in 2024?, Updated on Sep 10, 2024, https://www.mygreatlearning.com/blog/what-is-artificial-intelligence/

# Weak AI

These terms are somewhat misleading - on the one hand, weak AI is by no means lacking in strength, in performance, and on the other hand, strong AI is not an all-encompassing, all-encompassing tool.

**Most artificial intelligence applications today fall under weak AI:**

- ✓ Virtual assistants such as Apple's Siri and Amazon's Alexa,
- ✓ Language translation tools such as Google Translate, DeepL,
- ✓ Image recognition and recommendation systems used by platforms such as Netflix and Spotify,
- ✓ Automated/autonomous vehicles

Designed and trained for a specific task or narrow set of tasks, narrow AI excels in those specific domains.

# Weak AI

**Narow AI** is considered to be the **most successful** realization of artificial intelligence to date.

- Smart assistants can set reminders, search for information online, and control lights in homes thanks to weak AI and its ability to collect the right kind of data.

- By learning user preferences, narrow AI can improve interactions through past experiences and feedback.

- The future of autonomous vehicles also relies on lean AI.

  - By using deep neural networks to detect objects, measure distances, and recognize road signs, autonomous cars are being developed with a special focus on the accurate and efficient perception provided by narrow AI [3].

Abrahams, C. (April, 2024), Weak IA vs strong AI, https://ioco.tech/weak-ai-vs-strong-ai/#:~:text=AI%20can%20therefore%20be%20divided,or%20problem%20in%20any%20domain

# Strong AI

➢ Strong AI is designed to mimic or even surpass human intelligence.

➢ The idea behind strong AI is that it should be able to perform any intellectual task that a human being can do, learn from experience, adapt to new situations and apply knowledge from different domains.

➢ With the ability to understand, learn and apply knowledge across a wide range of tasks similar to human intelligence, strong AI seeks to understand context, make decisions and solve problems in a way that is **indistinguishable from human reasoning**.

➢ Closest to this are **large language models (LLMs)** and image generation models. The most well known LLM, **Chat GPT-4**, seems to be a strong artificial intelligence, as it is quite difficult to distinguish between a text generated by it and a text generated by a human expert, but it still falls under weak AI being dependent on predefined datasets (such as the internet)

Abrahams, C. (April, 2024), Weak IA vs strong AI, https://ioco.tech/weak-ai-vs-strong-ai/#:~:text=AI%20can%20therefore%20be%20divided,or%20problem%20in%20any%20domain

# Strong AI

Strong AI includes **artificial general intelligence** (a sophisticated form of AI that can learn and perform any intellectual task that a human being can perform)

A common example of general AI is the concept of an <span style="color:red">autonomous healthcare robot, able to diagnose and treat patients on its own</span>, seamlessly incorporating the latest medical findings without the need for human intervention.

Another example involves advanced environmental systems that could manage entire ecosystems, predicting changes and reacting automatically to maintain balance.

Aiming to achieve human-equivalent understanding, adaptability and independent thinking, **general AI** is the kind of artificial intelligence that has led to the spread of fear and predictions that AI could control the world. **Fortunately, a powerful AI that can be used in the real world has not (yet) been developed.**

# Generative AI

Generative artificial intelligence refers to artificial intelligence systems capable of **generating outputs such as text, images, pogramming code and other data**.

This type of artificial intelligence works mainly by taking large amounts of existing data, analyzing it and based on these findings, **producing new content.**

What this means is that generative AI relies on machine learning to **recognize, predict and create content** using the datasets it can access.

Generative AI also relies on providing **direct input from the human user** - a command or a set of specifications and parameters, most often referred to as a **prompt**.

**Prompts** do not necessarily have to be in the form of text, they can also be other types of content such as video, graphics or audio.

# Elements Underpinning AI Development

# Elements underpinning AI development

❑ **Access to big (massive) data**

❑ **Computing power**

❑ **Advanced algorithms and models**

❑ **Talent and education**

❑ **Technological advances and innovation**

❑ **Collaboration and research**

❑ **Ethics and regulation**

# Elements underpinning AI development

❑ **Access to big (massive) data**

➤ **Data collection and storage**: progress in AI is greatly supported by the availability of large datasets, essential for training and testing algorithms.

This data comes from diverse sources such as social networks, commercial transactions, IoT sensors and public databases.

➤ **Data processing**: advanced data processing techniques allow cleaning, labeling, and organizing raw data so that it is usable for AI models.

# Elements underpinning AI development

## ❑ Computing power

➢ Graphics Processing Units (**GPUs**) and Tensor Processing Units (**TPUs**): GPUs and TPUs are essential for training deep learning models due to their ability to perform parallel computations extremely fast.

They allow training models of high complexity using very large datasets in a reasonable amount of time.

➢ **Cloud computing**: cloud computing platforms such as AWS, Google Cloud and Microsoft Azure provide scalable resources that can be accessed on-demand, facilitating the training and deployment of AI models.

# Elements underpinning AI development

❑ **Advanced algorithms and models**

➢ **Machine learning**: significant advances have been made in machine learning algorithms such as decision trees, support vector machines and artificial neural networks, which enable models to efficiently learn from data and make accurate predictions.

➢ **Deep learning**: Convolutional Neural Networks (CNNs) and Recurrent Neural Networks (RNNs) are widely used in image recognition, natural language processing and many other applications.

▪ These models have revolutionized the field of AI through their ability to learn complex features directly from data, without the distinct prerequisite step of explicit feature extraction.

# Elements underpinning AI development

## ❑ Talent and education

➢ **Passionate people,** well-educated and trained who are willing to develop and continuously learn and experiment

➢ **Academic programs**: Top educational institutions offer advanced degree programs in AI, preparing the next generation of experts

➢ **Online courses**: Online learning platforms such as Coursera, edX and Udacity offer courses accessible to anyone interested in AI, tailored to different levels of prior knowledge

# Elements underpinning AI development

❑ **Technological advances and innovation**

➢ **Sensors and Internet of Things (IoT)**: Advanced sensors and IoT devices collect data from the environment, which is used to train and refine AI algorithms.

➢ **Robots and autonomous/automated vehicles**: advances in robotics and autonomous vehicles demonstrate the real-world applicability of AI, enabling the development of solutions that improve efficiency and safety in various domains [7].

# Elements underpinning AI development

❑ **Collaboration and research**

➢ **Consortia and initiatives**: Collaborations between universities, companies and governments, such as the Partnership on AI, facilitate the sharing of knowledge and resources.

➢ **Publications and scientific conferences**: Renowned conferences such as NeurIPS and ICML and scientific journals such as the Journal of Artificial Intelligence Research play a crucial role in disseminating new discoveries and technologies in AI.
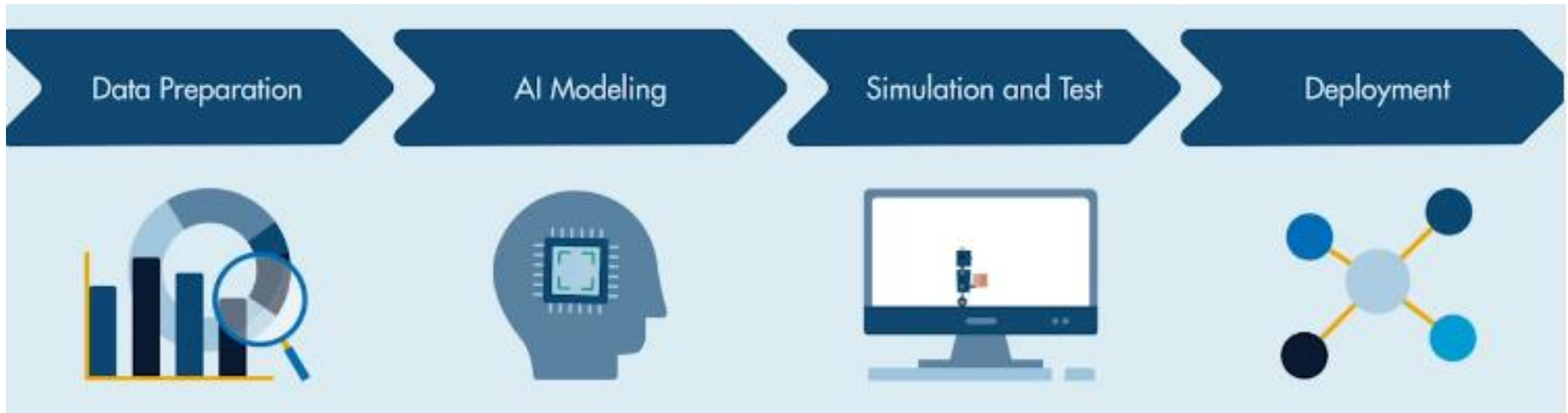
❑ **Ethics and regulation**

➢ **Regulations and policies**: The development of appropriate ethical frameworks and regulations for the use of AI is essential to ensure the **responsible and beneficial use of AI technology for the benefit of humanity**

# Workflow to build an AI system
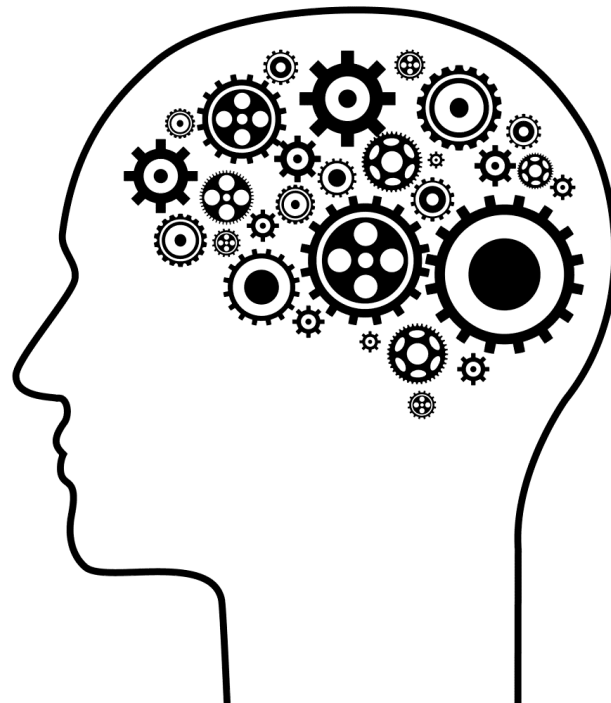
# Workflow to build an AI system



[https://www.mathworks.com/videos/ai-for-engineers-building-an-ai-system-1603356830725.html]
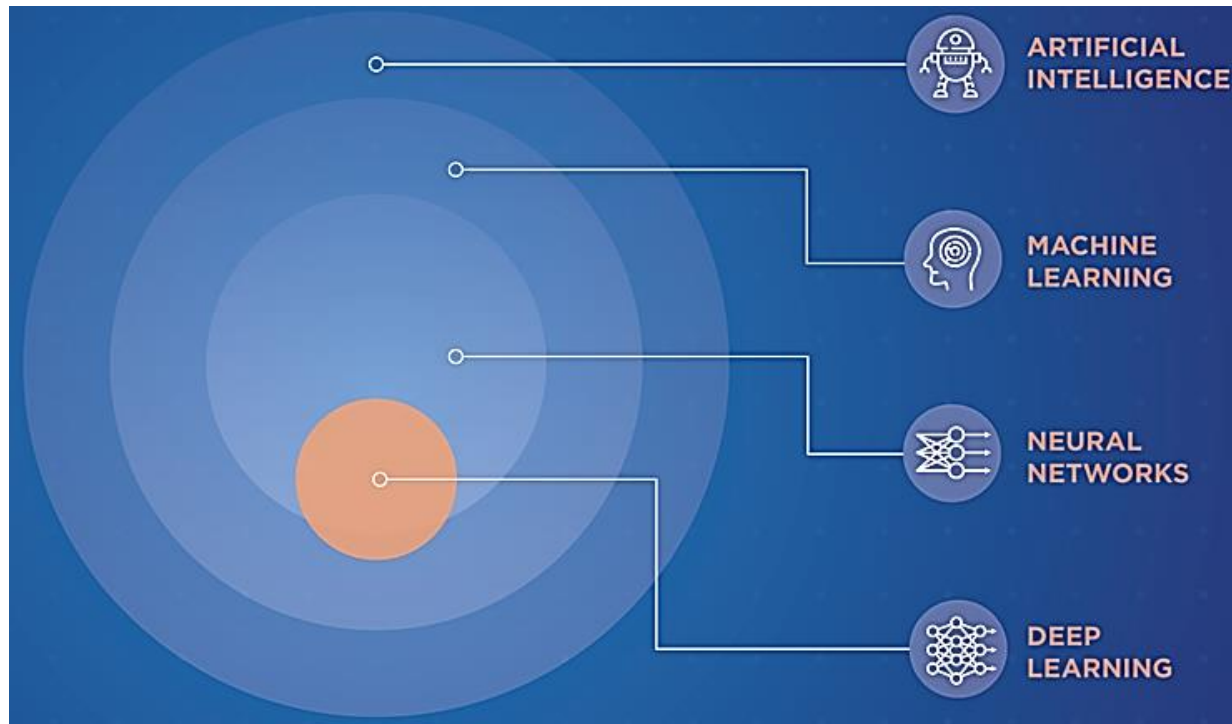
# AI - ML - DL Relationship

# AI – ML – ANN - DL



**ANN is a form of deep learning, which is a type of machine learning, and machine learning is a subfield of artificial intelligence.**
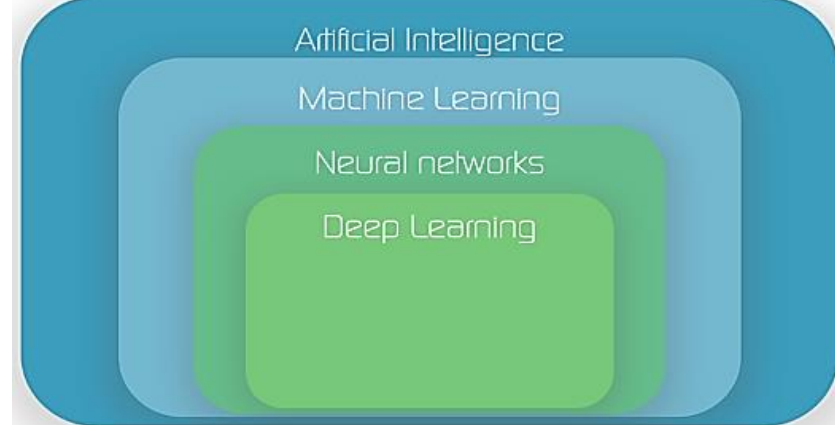
https://www.stoodnt.com/blog/ann-neural-networks-deep-learning-machine-learning-artificial-intelligence-differences/

**ML is a subset of AI.**

**In turn, DL is a subset of ML.**

**Essentially, all DL is ML, and all ML is AI,       but not all AI is ML.**

# AI – ML – ANN - DL



Image Source: aiso-lab.com

https://www.forbes.com/sites/bernardmarr/2016/12/08/what-is-the-difference-between-deep-learning-machine-learning-and-ai/#f62893a26cfa

While **ML** is often described as a sub-discipline of AI, it's better to think of it as the current state-of-the-art – it's the field of AI which today is showing the most promise at providing tools that industry and society can use to drive change.

It's helpful to think of Deep Learning as the cutting-edge of the cutting-edge. ML takes some of the core ideas of AI and focuses them on solving real-world problems with neural networks designed to mimic our own decision-making.
Deep Learning focuses even more narrowly on a subset of ML tools and techniques and applies them to solving just about any problem which requires "thought" – human or artificial.

# DL vs ML

➢ **ML** means computers learning from data using **algorithms to perform a task** without being explicitly programmed.

➢ **DL** uses a complex structure of **algorithms modeled on the human brain**.

   o  This enables the processing of unstructured data such as documents, images, and text.

## Artificial Intelligence

The theory and development of computer systems able to perform tasks normally requiring human intelligence

## Machine Learning

Gives computers "the ability to learn without being explicitly programmed"
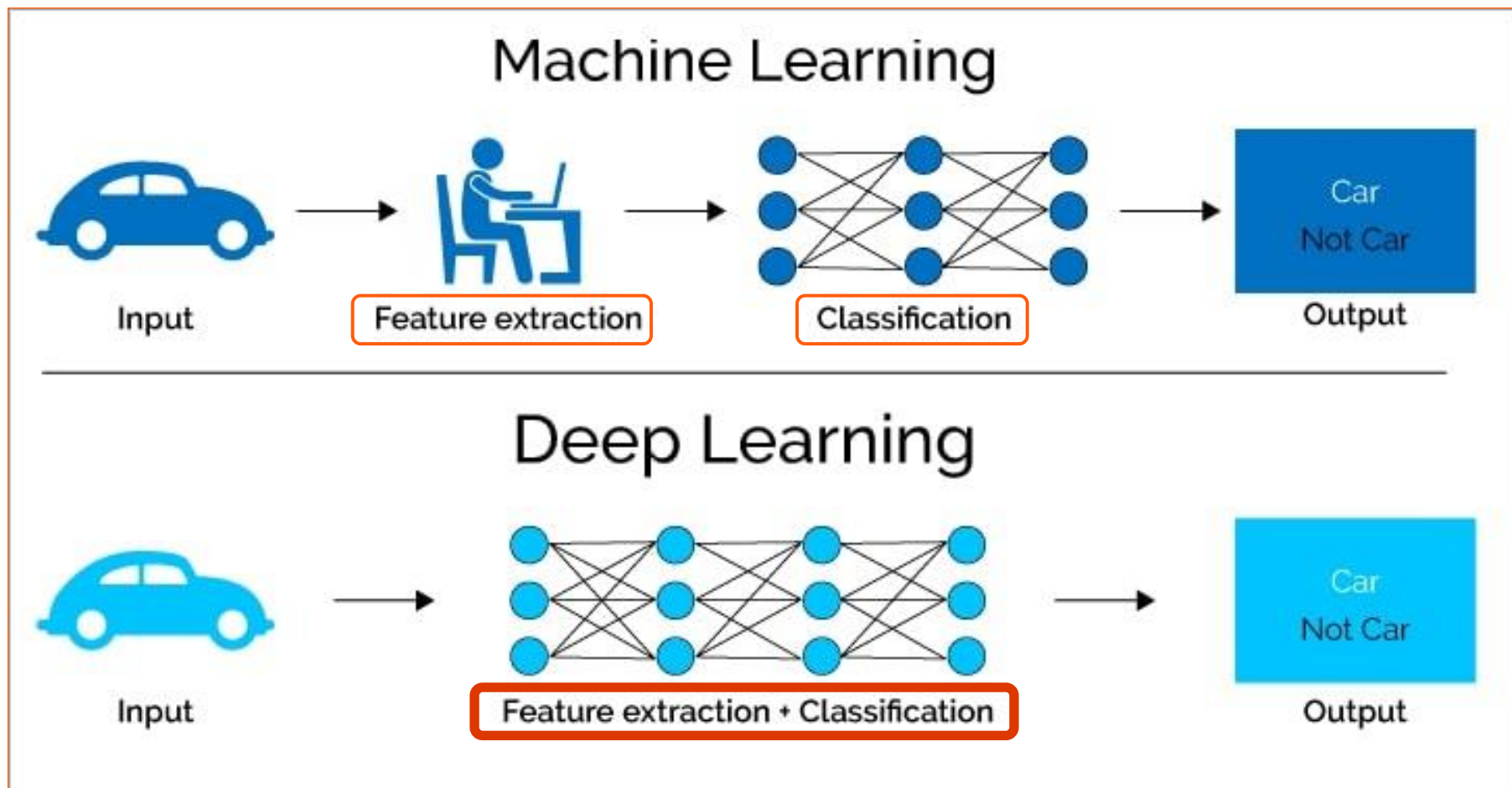
## Deep Learning

Machine learning algorithms with brain-like logical structure of algorithms called artificial neural networks

*LEVITY*

Arne Wolfewicz, Deep Learning vs. Machine Learning – What's The Difference?, February 15, 2023, https://levity.ai/blog/difference-machine-learning-deep-learning

# DL vs ML



The DL algorithm doesn't need a software engineer to identify features but is capable of automatic feature engineering through its neural network.

Arne Wolfewicz, Deep Learning vs. Machine Learning – What's The Difference?, February 15, 2023, https://levity.ai/blog/difference-machine-learning-deep-learning

# DL vs ML

❑ What makes DL special within the field of ML.

- ✓ ANN algorithm structure
  - ▪ like a human brain, complex and intertwined

- ✓ Lower need for human intervention
  - ▪ the algorithm learns from its own errors

- ✓ (Much) larger data requirements
  - ▪ ML works with a thousand data points, DL oftentimes only with millions.
  - ▪ Due to the complex multi-layer structure, a DL system needs a large dataset to eliminate fluctuations and make high-quality interpretations.

Arne Wolfewicz, Deep Learning vs. Machine Learning – What's The Difference?, February 15, 2023, https://levity.ai/blog/difference-machine-learning-deep-learning

# ML – Machine Learning

**Machine Learning** is a current application of AI based around the idea that we should just be able to give machines access to data and let them learn for themselves.

Machine learning is basically the use of an algorithm to formulate a system's desired output response to input data **without** the developer **defining the processing in between**.

Instead of telling the system what to do with the input data by writing a procedural program, machine learning has the system determine its own process based on **the input and some success criteria**.

**Currently, the key approach to ML is the artificial neural network (ANN).**

There are many implementations, called **frameworks**, for creating an ML design, such as TensorFlow, Microsoft CNTK, Theano, Caffe, Keras, Torch, Accord.NET, Spark Mllib, Sci-kit Learn, MLPack, Android NN, Cloud Machine Learning Engine, Matlab: Deep Learning Toolbox (former Neural Network Toolbox), etc.

# ML – Machine Learning

**Machine learning** is a field of study that applies the principles of computer science and statistics to create statistical models, which are used for future predictions (based on past data or *Big Data*) and identifying (discovering) patterns in data.

Machine learning is itself a type of artificial intelligence that allows software applications to become more accurate in predicting outcomes without being explicitly programmed.

Machine learning is the ability for a computer to output or does something that **it wasn't programmed to do**.

While machine learning emphasizes making predictions about the future, artificial intelligence typically concentrates on programming computers to make decisions. If you use an intelligent program that involves human-like behavior, it can be artificial intelligence. However, if the parameters are not automatically **learned (or derived) from data**, it's not machine learning.

https://www.stoodnt.com/blog/ann-neural-networks-deep-learning-machine-learning-artificial-intelligence-differences/

# ML – Machine Learning

**ML** is he process by which a computer learns from experience (e.g. using programs that can learn from historical cases) [Turban, Sharda, Delen, Decision Support and Business Intelligence, 9th edition, Pearson Education Limited, 2014]

Machine learning – a machine that is going to learn something.

❖ A beginner's introduction to the Top 10 Machine Learning (ML) algorithms. [https://www.kdnuggets.com/2017/10/top-10-machine-learning-algorithms-beginners.html]

❖ Top 10 Machine Learning Algorithms for Beginners [https://www.kdnuggets.com/2017/10/top-10-machine-learning-algorithms-beginners.html]

❖ Understanding Machine Learning Algorithms [https://www.kdnuggets.com/2017/10/understanding-machine-learning-algorithms.html]

# DL – Deep Learning

Essentially Deep Learning involves feeding a computer system **a lot of data**, which it can use to make decisions about other data.

This data is fed through neural networks, as is the case in machine learning.

Because Deep Learning work is focused on developing these neural networks, they become what are known as Deep Neural Networks – logic networks of the complexity needed to deal with classifying datasets as large as, say, Google's image library, or Twitter's firehose of tweets.

https://www.forbes.com/sites/bernardmarr/2016/12/08/what-is-the-difference-between-deep-learning-machine-learning-and-ai/#f62893a26cfa

# DL – Deep Learning

**Deep learning** is a special type of machine learning. It involves the study of ANN and ML related algorithms that contain more than one hidden layer.

Deep learning involves mathematical modeling, which can be thought of as a composition of simple blocks of a certain type, and where some of these blocks can be adjusted to better predict the final outcome.

The word "**deep**" means that the composition has **many of these blocks stacked on top of each other** – in a hierarchy of increasing complexity. The output gets generated via something called Back-propagation inside of a larger process called Gradient descent which lets you **change the parameters in a way that improves your model – learning from data**

Traditional machine learning algorithms are linear. Deep learning algorithms are stacked in a hierarchy of increasing complexity.

https://www.stoodnt.com/blog/ann-neural-networks-deep-learning-machine-learning-artificial-intelligence-differences/

❖ **Deep learning**, also known as the deep neural network, is one of the approaches to machine learning. Other major approaches include decision tree learning, inductive logic programming, clustering, reinforcement learning, and Bayesian networks.

❖ **Deep learning** is a special type of machine learning. It involves the study of ANN and ML related algorithms that contain more than one hidden layer.

❖ **Deep learning** involves mathematical modeling, which can be thought of as a composition of simple blocks of a certain type, and where some of these blocks can be adjusted to better predict the final outcome.

Demystifying Neural Networks, Deep Learning, Machine Learning, and Artificial Intelligence, Posted on March 29, 2018 By Tanmoy Ray
https://www.stoodnt.com/blog/ann-neural-networks-deep-learning-machine-learning-artificial-intelligence-differences/

❑ **Deep learning** involves mathematical modeling, which can be thought of as a composition of simple blocks of a certain type, and where some of these blocks can be adjusted to better predict the final outcome.

    ✓ The word "**deep**" means that the composition has many of these blocks stacked on top of each other – in a hierarchy of increasing complexity.

    ✓ The output gets generated via something called **Back-propagation** inside of a larger process called **Gradient descent** which lets you change the parameters in a way that **improves your model**.

❑ Traditional machine learning algorithms are linear. Deep learning algorithms are stacked in a hierarchy of increasing complexity.

Demystifying Neural Networks, Deep Learning, Machine Learning, and Artificial Intelligence, Posted on March 29, 2018 By Tanmoy Ray
https://www.stoodnt.com/blog/ann-neural-networks-deep-learning-machine-learning-artificial-intelligence-differences/

# ANN – Artificial neural network

A neural network is a **computer system** modeled after **the human brain**. A neural network is a computer simulation of the way biological neurons work within a human brain.

https://www.stoodnt.com/blog/ann-neural-networks-deep-learning-machine-learning-artificial-intelligence-differences/

A neural network is a computer system designed to work by classifying information in the same way a human brain does. It can be taught to recognize patterns (for example images) and classify them according to elements (features) they contain.
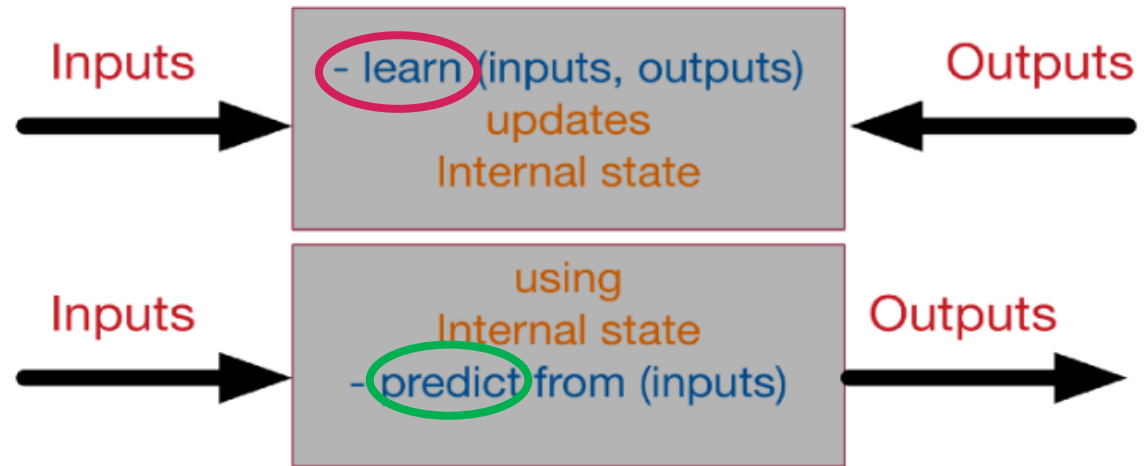
https://www.forbes.com/sites/bernardmarr/2016/12/06/what-is-the-difference-between-artificial-intelligence-and-machine-learning/#4c8bb2fc2742

# ANN – Artificial neural network

A neural network, at the highest and simplest representation, can be presented as a black box with 2 methods (processes)

- **Learn** (train ANN)
- **Predict** (use ANN)



Neural network as a black box

The **learning process** takes the inputs and the desired outputs and updates its internal state accordingly, so the calculated output get as close as possible to the desired output.

The **predict process** takes an input and generate, using the internal state, the most likely output according to its past "*training experience*".

Assaad MOAWAD, Neural networks and back-propagation explained in a simple way, https://medium.com/datathings/neural-networks-and-backpropagation-explained-in-a-simple-way-f540a3611f5e, Feb 2018