FUTURE STEM HUB

Educational Materials for AI Essentials

FUTURE-STEM-HUB

Empowering Secondary School STEM Education with AI Training and Resources for Students and Educators

Project No.
2024-1-DE03-KA220-SCH-000247346

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EDUCATIONAL MATERIALS FOR AI ESSENTIALS

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The FUTURE-STEM-HUB Educational Materials for AI Essentials are developed by the project team members representing all partner organisations. They aim to introduce the fundamental concepts of AI to secondary students, fostering awareness and discussion regarding their societal and ethical implications.

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List of Abbreviations:

AI: Artificial Intelligence

ML: Machine Learning

DL: Deep Learning

NN: Neural Networks

NLP: Natural Language Processing

CV: Computer Vision

RGB: Red, Green, Blue (Colour Model)

CNN: Convolutional Neural Networks

OECD: Organization for Economic Co-operation and Development

MIT: Massachusetts Institute of Technology

IBM: International Business Machines

AAAI: Association for the Advancement of Artificial Intelligence

GPU: Graphics Processing Units

LSVRC: Large Scale Visual Recognition Challenge

SLAM: Simultaneous Localization and Mapping

STEM: Science, Technology, Engineering, and Mathematics

ENISA: European Union Agency for Cybersecurity

INTI: National Institute of Industrial Technology

IPN: National Polytechnic Institute

IoT: Internet of Things

CMOS: Complementary Metal-Oxide-Semiconductor (Image Sensor)

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FUTURE-STEM-HUB

Project Overview

FUTURE-STEM-HUB project aims to advance and facilitate the integration of Artificial Intelligence (AI) topics into STEM education at secondary schools by: 1) Providing educational materials introducing AI concepts and their societal implications; 2) Offering practical learning resources for students to explore AI using Python programming and 3) Equipping teachers with support for integrating AI into secondary school STEM training.

Project Outputs

1. **Course 1: A Digital Primer: Artificial Intelligence Essentials** (Introduction to AI through Interactive Educational Materials for Secondary Students)

2. **Course 2: Delving Deeper in AI with Python and Scratch** (Advanced AI: Hands-On Learning Materials for Secondary Students)

3. **E-Toolkit for School Educators: Enhancing Artificial Intelligence Skills** (AI Methodological Guiding for Secondary Teachers)

Introduction

Welcome to the Educational Materials for AI Essentials - an engaging and interactive learning journey designed to introduce secondary school students to the fascinating world of AI. These educational materials aim to make AI accessible and relatable while striking a balance between theoretical knowledge and practical activities. Tailored for students aged 15–18 with diverse STEM proficiency levels, the materials are perfect for self-paced asynchronous learning and can also be seamlessly integrated into classroom teaching with teacher facilitation.

The content is divided into five comprehensive modules, each building foundational knowledge and hands-on skills on the history of AI, machine learning, deep learning, neural networks, cognitive computing and AI technologies, applications of AI across industries, as well as AI ethical considerations and its future implications.

Each module combines theory, infographics, interactive videos, quizzes, external resources for further exploration, and practical exercises to ensure a comprehensive understanding of AI concepts. The estimated learning duration for all five modules is approximately 10 hours.

After completing the course, students will be able to understand and define key AI concepts, such as machine learning, neutral networks, deep learning. They will gain deeper knowledge about the history and evolution of Artificial Intelligence and its applications across various industries, learning how new AI technologies shape today's trends and world. Students will also dive deeper into fundamental technologies, including computer vision and natural language processing. Lastly, they will explore and gain more profound understanding about AI ethical considerations, AI's responsibility and its societal impact.

On the other hand, teachers will gain access to innovative, interactive resources that they can easily use and apply in the STEM classroom supporting their curricula and teaching. These materials will help them create more interesting and engaging classroom environments as they offer different approaches to actively involve secondary students in the learning process.

These materials will be further transformed into an online course that will be hosted on the FUTURE STEM-HUB platform and accessible via the project website: www.future-stem-hub.

Upon successful completion of the course on AI Essentials, students will receive a digital certificate, recognizing their achievement.

Module 1: Introduction to Artificial Intelligence

The aim of the current module is to define Artificial Intelligence, understand its basic history and evolution, and explore various AI applications in daily life.

By the end of the module, you will be able to acquire different skills, such as:

- **Basic AI Literacy:** developing an understanding of what AI is and how it has evolved over time.
- **Awareness of AI in Everyday Life:** recognizing common AI applications (e.g., virtual assistants, recommendation systems) and how they impact day-to-day activities.
- **Historical Context:** understanding the historical milestones in AI's development.

Module Duration	1 hour (guided and self-paced)

Artificial Intelligence is a concept that can be traced back to ancient times and has been evolving and improving over time. In order to better understand its complexity, in this module you will learn more about AI's history and development.

You will be also introduced to the main definitions and elements of AI, exploring different concepts and AI tools, such as chatbots, virtual assistants, and how the first intelligent robot was created.

DEFINITION OF ARTIFICAL INTELLIGENCE

Computers and computer systems have become an indispensable part of our life in the contemporary world. Many devices, from our mobile phones to the refrigerators in our kitchens, work with computer systems. It has become commonplace to use computers in almost every field, from business to public affairs, from environmental and health organizations to military systems.

Every corner of the modern world is blessed with technology. At first the computers were developed only to transfer electronic data and perform complex calculations. Later, they have gained the ability to filter and summarize large amounts of data over time and to make comments about situations using existing information. Nowadays, computers can both make decisions in certain situations and learn the relationships between them. Problems that cannot be formulated and solved mathematically can be solved by computers using intuitive methods. The studies that equip computers with this feature and enable them to develop their abilities are called “Artificial Intelligence”.

What is Artificial Intelligence?

The OECD (Organization for Economic Co-operation and Development) defines an Artificial Intelligence system as follows: “An AI system, being a machine-based system, produces an output such as predictions, recommendations or decisions for a given set of objectives and, as a result, can affect the environment.

This system perceives real and/or virtual environments using machine and/or human-based data and inputs, abstracts these perceptions into models through manual or automatic (such as machine learning) analysis, and formulates options using model inference for the results it obtains.” (OECD, 2019).

At this point, it is also necessary to put forward the definition of **"intelligent behaviour"**. Many types of behaviour can be considered signs of intelligence and all of these behaviours can be clearly seen by AI. Some typical examples of AI and intelligent behaviour are:

- Learning and understanding from experiences
- Making sense of mixed and contradictory messages
- Responding successfully and quickly to a new situation
- Using reasoning ability in solving problems
- Understanding and using information
- Ability to overcome unfamiliar and surprising situations
- Thinking and reasoning etc.

More specifically, Artificial Intelligence is a kind of intelligence that allows certain machines to perceive the environment around them and respond to it in a similar way to the human brain. This includes the ability to perform functions such as reasoning, perceiving, learning, and problem solving.

In general, the purposes of Artificial Intelligence can be grouped under three main headings:

- Making machines smarter,
- Understanding what intelligence is, and
- Making machines more useful

HISTORY OF ARTIFICIAL INTELLIGENCE (AI)

Do You Know How AI Was Created?

The idea of “Artificial Intelligence” dates back thousands of years, when ancient philosophers thought about questions of life and death. In ancient times, inventors built things called “automatons” that were mechanical and moved independently of human intervention. The word “automato” comes from ancient Greek and means “to act of one's own will”. One of the earliest records of an automaton dates back to 400 BC (before the birth of Jesus Christ) and refers to a mechanical pigeon created by a friend of the philosopher Plato. Years later, one of the most famous automatons was created by Leonardo da Vinci around 1495.

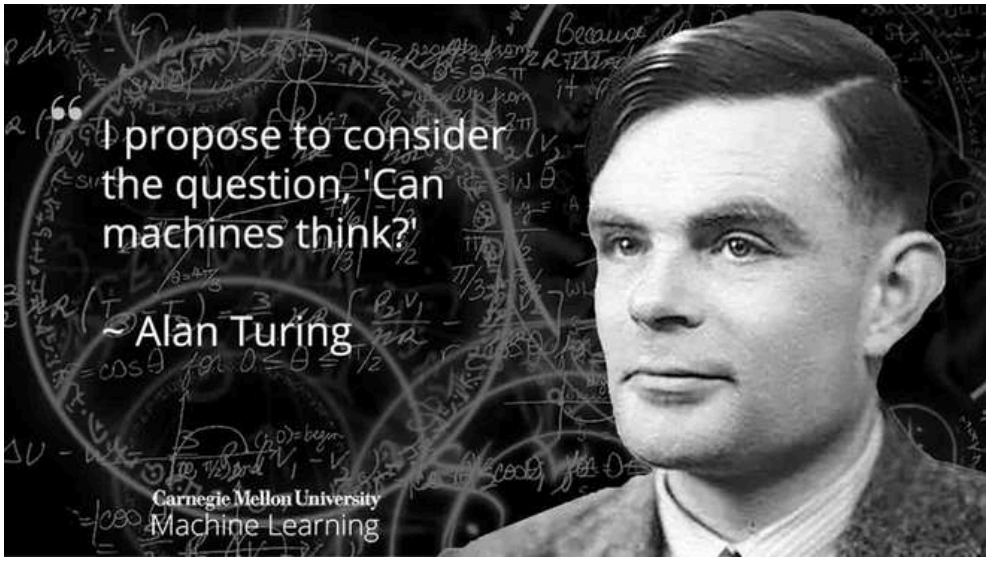
In the 17th century, the race to create automatons that imitated human and animal behaviour began across all segments of the society, especially among the ruling and aristocratic classes. This race was also reflected in the philosophical perspective of the period. Descartes (1596-1650), one of the famous philosophers of the period, compared humans to machines working with a clock-like mechanism.

After this period, when many human behaviours began to be imitated, British mathematician Charles Babbage (1792-1871) aimed to imitate human mental characteristics instead of physical characteristics and developed the first calculator, which he called the “Difference Engine”. In addition to being able to perform simple mathematical operations, the calculator developed by Babbage had a memory in which it could store the results of intermediate operations. In addition, he had the ability to play chess and checkers. The calculator, in which Babbage aimed to imitate the features of the human mind, was a big step forward for Artificial Intelligence studies in his time.

Modern Artificial Intelligence

Although the beginning of Artificial Intelligence studies can be traced back to Cezeri's (1136-1206) robot drawings, modern Artificial Intelligence studies gained importance during and after the Second World War. Alan Mathison Turing changed the fate of the war by inventing the first fully automatic code-breaking machine, which he called “Bombe” during the Second World War, which is quite important and unique for this period.

After World War II, many researchers, especially Alan Turing, began to work independently on Artificial Intelligence. Alan Turing gave a conference on Artificial Intelligence for the first time in 1947 and explained that intelligent machines could be invented by combining Artificial Intelligence and computer programs. In his article "Computing Machinery and Intelligence" published in 1950, Alan Turing asked "Can machines think?" and discussed the question. And now you know that Turing, who made statements based on the combination of the words "machine" and "thinking", created the intellectual foundations of Artificial Intelligence (Turing, 1950).



"I propose to consider the question, 'Can machines think?'" - Alan Turing (New, 2020)

Although Alan Turing is considered the father of Artificial Intelligence, the term "Artificial Intelligence" was first used in a workshop on Artificial Intelligence organized by John McCarthy at Dartmouth College in 1956. In addition to John McCarthy, other important figures in the AI field are Marvin L. Minsky (Massachusetts Institute of Technology - MIT), Nathaniel Rochester (International Business Machines - IBM) and Claude Shannon (Bell Laboratories) who also participated in this event.

What About the AI Robots and Programmes?

In 1957, the Perceptron, the basic unit of a single-layer artificial neural network, was discovered by American psychologist Frank Rosenblatt at the Cornell Aeronautical Laboratory. Rosenblatt's goal was to create a physical machine that behaved like a neuron because it was influenced by the biological neuron and its ability to learn.

In the 1960s Artificial Intelligence studies gained momentum and important Artificial Intelligence programmes, such as Aziz (1961), Benzesim (1963), Eliza (1965), Bilgin (1970) and Stajyer (1979) were developed. The first **human-like intelligent robot** was made in Japan in 1972 under the name **WABOT-I**.

An early single-layer artificial neural network, **ADALINE** (Adaptive Linear Neuron or later Adaptive Linear Element), was developed in 1960 by Professor Bernard Widrow and his doctoral student Ted Hoff at Stanford University.

"Unimate" which is an industrial robot invented by George Devol in 1961, became the first robot to work on a General Motors assembly line in New Jersey. It was tasked with transporting mold casings and welding parts (considered hazardous to humans) on carts.

Chatbots: How They Were Created?

By 1966, Joseph Weizenbaum created the first chatterbot (later shortened to chatbot), **"ELIZA"**, a fake psychotherapist that used natural language processing (NLP) to talk to people. In 1968, Arthur C. Clarke presented the intelligent machine named **"HAL 9000"** as the main enemy character in his science fiction novel "2001: A Space Odyssey". The period from the emergence of the term "Artificial Intelligence" to the 1980s was a period in which Artificial Intelligence research developed rapidly. From programming languages that continue to be used today to books and movies that explore the idea of robots, AI has quickly become a mainstream idea.

Challenges: Who Was Against AI Development?

Since many publications negatively criticized Artificial Intelligence, some governments were influenced by them and stopped funding AI studies between 1974 and 1980. The late 1980s and early 1990s marked a period of disappointment often referred to as the **"AI winter"**. Interestingly, the Association for the Advancement of Artificial Intelligence (AAAI) had predicted this beforehand. This period had led to funding cuts and general stagnation in AI research and development. Private investors and governments lost interest in AI and stopped their funding due to the high cost and seemingly low returns.

Despite the lack of funding during the "AI winter", some impressive advances were made in AI research in the early 1990s, including the introduction of the first AI system capable of beating a world champion chess player. The increased interest in Artificial Intelligence has also led to increased research funding, allowing further progress to be made.

In 1997, the program called **"Deep Blue"** produced by IBM made a big impact when it defeated the world chess champion Garry Kasparov in a chess match. In this match, Garry Kasparov competed against a program that could process 200 million chess moves per second and lost. This event showed the world that computers can perform better than humans in some areas.

Source: "Worry about human (not machine) intelligence" (Kasparov, n.d.)

AI Rapid Development in Modern Times

In 1998 Dave Hampton and Caleb Chung invented **Furby**, the first "pet toy robot" for children. In 1999, Sony introduced **"AIBO"** (Artificial Intelligence RoBOt), a $2,000 robotic pet dog designed to "learn" by interacting with its environment, owners, and other AIBOs, in line with Furby. Its features included the ability to understand and respond to more than 100 voice commands and communicate with its human owner.

By 2000, Professor Cynthia Breazeal developed **"Kismet"**, a robot that could recognize and simulate emotions with its face. It was structured like a human face, with eyes, lips, eyelids and eyebrows.

The 2000s was a period when new Artificial Intelligence developments were shared every day. The most notable works that you should remember are the first **ROOMBA** (robot vacuum cleaner) in 2002, the navigation of vehicles landed on the planet Mars without human intervention in 2003, and the **Xbox360 Kinect** which was released in 2010.

The introduction of Siri, the first virtual assistant, introduced by Apple in 2011, was an explicit indication of how rapidly Artificial Intelligence was developing. Again in 2011, an NLP computer called Watson (created by IBM) programmed to answer questions was used in "Jeopardy!". It defeated the champions Rutter and Jennings in a television competition.

The Beginning of the GPU Era

The work that enabled Artificial Intelligence to reach its most popular form was carried out in 2012 by Alex Krizhevsky, Ilya Sutskever and Geoff Hinton during an image processing-focused competition called Large Scale Visual Recognition Challenge (LSVRC). The team managed to take the first place by halving its best error rate. The **GPU (Graphics Processing Units)** era began with the graphics processors used to train models for Artificial Intelligence reaching high calculation speeds.

Nowadays almost every company has created and uses its own Artificial Intelligence. For example, **Cortana** (2014) was launched by Microsoft, and **Amazon Alexa** (2014) was implemented by Amazon.

Hanson Robotics has created a humanoid robot named **Sophia**, known as the first **"robot citizen"** and the first robot with a realistic human appearance and the ability to copy emotions and to communicate.

"Sophia: The latest and most advanced humanoid robot - World's first robot citizen" (Century College, 2018)

In 2018, Alibaba language processing AI surpassed human intelligence in the Stanford reading and comprehension test. Alibaba language processing scored "82.30 versus 82.44 in a set of 100,000 questions."

By 2020 **Open AI**, which already has a big place in our lives, has started beta testing **GPT-3**, a model that uses deep learning to create code, poetry and other similar language and writing tasks. A year later, Open AI took Artificial Intelligence one step further to understanding the visual world by developing **DALL-E**, which can process and understand images sufficiently to create accurate captions.

DIFFERENT AI APPLICATIONS IN DAILY LIFE

As you may already know, there has been much faster progress over the last 10 years. Artificial Intelligence is increasingly found in sectors where it has not been used before, and even in daily life. AI is important because it can improve society by making things easier and better in many parts of life. Artificial Intelligence-supported tools that can be updated and personalized have the potential to impact both your personal development and the development of the society as a whole. To give you some examples of Artificial Intelligence used on a daily basis, we can mention facial recognition systems, personal shopping agents on e-commerce sites, music recognition, online chat and assistants, and autonomous vehicles.

One of the most popular AI technologies used in our everyday life is **ChatGPT**. If you ask ChatGPT how AI is used in daily life, the answer that you will likely get, is the list below:

- **Smartphones and Virtual Assistants:** AI powers voice assistants like Siri and Google Assistant, offering personalized suggestions, setting reminders, and controlling smart devices.
- **Smart Homes:** AI is used in devices like smart thermostats, lighting systems, and security cameras to adjust settings based on your preferences and improve home safety.
- **Transportation:** AI helps in navigation apps (Google Maps, Waze), autonomous vehicle features, and ride-hailing services (Uber, Lyft) by optimizing routes and matching drivers and riders.
- **Entertainment:** Streaming services (Netflix, Spotify) use AI to recommend content based on your preferences. AI also enhances gaming with responsive, dynamic environments.
- **Shopping and E-Commerce:** AI personalised shopping experiences with product recommendations, virtual try-ons, and customer service chatbots on platforms like Amazon.

- **Healthcare and Wellness:** AI is used in fitness apps, telemedicine, and personalized treatments to monitor health and diagnose conditions.
- **Finance and Banking:** AI detects fraud, offers customer service through chatbots, and assists in investment decisions with data analysis.
- **Social Media:** AI curates content, moderates posts, and recognizes images to enhance user experience on platforms like Facebook and Instagram.
- **Food Delivery and Grocery Shopping:** AI optimizes delivery times, recommends food, and helps with grocery shopping by predicting needs based on past behaviours.
- **Education and Learning:** AI personalises learning through apps like Duolingo and Khan Academy and automates grading and plagiarism detection.

At the end of this module, we can conclude that AI has been an integral part of human innovation for centuries. By providing a thorough introduction to the history, evolution, and key applications of Artificial Intelligence, you have gained valuable insights into how AI shapes our daily lives and continues to advance.

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VIDEO: History of AI, from the Turing test to today's AI milestones

INFOGRAPHIC: Timeline of key AI advancements

ADDITIONAL READING (links to external information resources)

What is Artificial Intelligence (AI)? (by Google Cloud) In this article you can find more information about AI, its capabilities, and its various applications. The article also introduces key concepts such as machine learning (ML), deep learning, and neural networks, highlighting how AI is used in areas like speech recognition, image analysis, and natural language processing. https://cloud.google.com/learn/what-is-artificial-intelligence

What is Artificial Intelligence (AI)? (by IBM) This article provides an overview of AI and discusses key concepts such as machine learning and deep learning, explaining how these technologies allow AI systems to process complex data, recognize patterns, and perform tasks like natural language processing and computer vision. https://www.ibm.com/topics/artificial-intelligence

PRACTICAL EXERCISE (for classroom activities with a teacher)

Case Study: Exploring AI Creativity - Storytelling, Image Generation, and Music Composition

Objective: The aim of this practical task is for the students to get familiar with and to explore the functionalities and capabilities of AI models.

Instructions:

The teacher asks the students to choose one topic and write an introduction for a story. After that, the students have to use an AI model, such as ChatGPT and ask it to continue and develop their stories. Then, again with the help of the AI model, students have to generate and select images suitable for their stories. They need to develop a comic book-like structure. Additionally (at the teacher`s discretion), students can also work with the AI model to develop a background music suitable for their stories, which will help them to explore the composition abilities of Artificial Intelligence. After completing the task, the students have to share their stories in front of the class.

Reflective Questions:

1. How did it feel to collaborate with an AI in continuing your story? Did the AI's continuation match your expectations, or did it surprise you?
2. What challenges did you face when incorporating AI-generated images or music into your story? How did you overcome them?
3. In what ways does the use of AI enhance your creative process in writing and presenting your story?
4. How did the AI-generated visuals or music help you to communicate the mood or theme of your story?
5. After sharing your work with others, what feedback did you receive, and how would you improve your story if you had more time?

"Be creative and let your imagination lead the way! Use AI as your storytelling partner - explore, experiment, and don't be afraid to be bold!"

QUIZ WITH MULTIPLE-CHOICE QUESTIONS (one correct answer per question)

1. What is the primary goal of Artificial Intelligence?
a) To replace human workers
b) To make machines smarter, understand intelligence, and make machines more useful
c) To improve human brain function
d) To create robots that can think like humans

2. Which of the following is NOT listed as an example of intelligent behaviour in AI?
a) Learning from experiences
b) Understanding and using information
c) Emotional intelligence
d) Responding quickly to new situations

3. Who is considered the father of Artificial Intelligence?
a) John McCarthy
b) Alan Turing
c) Marvin Minsky
d) Claude Shannon

4. Which event first introduced the term "Artificial Intelligence"?
a) The development of the first computer
b) A workshop at Dartmouth College in 1956
c) The invention of the Turing Test
d) The creation of the Perceptron in 1957

5. What was Alan Turing's main contribution to AI during World War II?
a) He developed the first AI program
b) He invented the Bombe machine to break codes
c) He created the first computer
d) He invented the first neural network

QUIZ WITH MULTIPLE-CHOICE QUESTIONS (one correct answer per question)

6. Which robot was created in Japan in 1972 as the first human-like intelligent robot?
a) Kismet
b) WABOT-I
c) Furby
d) AIBO

7. Which AI system developed by OpenAI is known for creating code, poetry, and other language tasks?
a) GPT-3
b) DALL-E
c) Watson
d) AIBO

8. What is the significance of the term "AI Winter"?
a) A period of rapid growth in AI research
b) A period of stagnation and reduced funding in AI research
c) The invention of AI in the winter season
d) A time when AI machines were banned

9. Which AI system, developed in the early 2000s, was responsible for guiding vehicles on Mars without human intervention?
a) Deep Blue
b) Roomba
c) HAL 9000
d) AI navigation systems

10. What was the main focus of Frank Rosenblatt's work on the Perceptron in 1957?
a) To create a machine that could think
b) To design a chess-playing AI
c) To simulate the behaviour of biological neurons in machines
d) To invent the first robot

In this module, you will uncover the foundational principles of AI, diving into ML, DL and NN to understand how they work and what makes them distinct. You will also explore how neural networks mimic human learning, enabling machines to make intelligent decisions. Along the way, you will gain hands-on experience with simple AI tools to see these concepts in action.

Let's embark on this journey to explore the core building blocks of AI and how they shape the technology-driven world around us.

UNRAVELLING ARTIFICIAL INTELLIGENCE: FUNDAMENTALS OF MACHINE LEARNING (ML) AND DEEP LEARNING (DL)

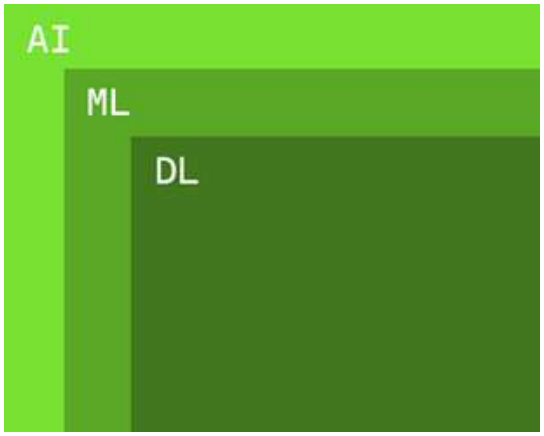
Artificial Intelligence, or AI, is like **giving computers a "brain" to perform tasks that typically require human intelligence**. These tasks could include learning from experience, recognizing patterns, making decisions, or even understanding and generating human language. AI does not just try to copy how human brains work; it can go beyond that, quickly analysing large amounts of data and finding patterns that might be missed.

How Does AI Learn and Process Information?

Imagine this: the first time a child sees a dog, they might not know what it is. An adult point to the animal and says, "That is a dog!" The next time the child sees a dog, they start to recognize it a little faster because they remember what they were taught. But one day, the child sees a pig and excitedly shouts, "Dog!" Why? Because they haven't learned about pigs yet and assume that anything with four legs is a dog.

AI works in a similar way. For it to learn, many examples need to be shown, such as pictures of dogs, cats, and pigs, with explanations of what each one is. If only pictures of dogs are shown, AI might mistakenly classify a pig as a dog. The more varied examples provided, the better AI becomes at correctly recognizing and distinguishing between different things.

To better understand AI, it is important to understand some of the fundamental concepts that support it: Machine Learning (ML), Deep Learning (DL) and Artificial Neural Networks (NN).



AI -> Teaching machines to think and solve problems, like humans do.

ML -> Helping machines to learn from past examples so they can predict what might happen next.

DL -> Using networks inspired by the brain to let machines make smart decisions on their own.

Source: Illustration developed by ETAP

But Where Do You Use Machine Learning or Deep Learning?

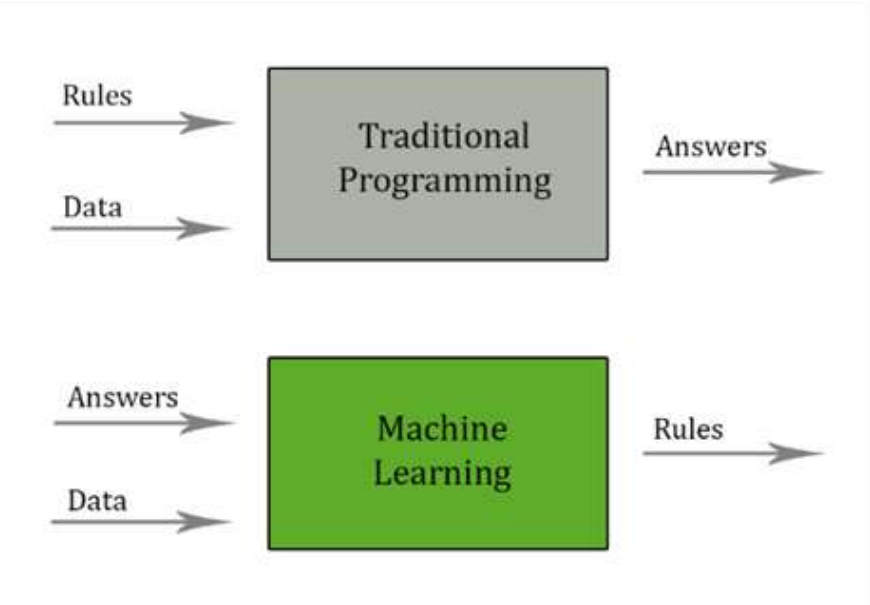
Imagine you are running a music app like Spotify. Some users love relaxing playlists, while others are into upbeat workout tracks. You can use **Machine Learning** to group people based on their listening habits and suggest playlists they will enjoy. This is an example of **clustering algorithms**, which automatically find patterns in data.

Suppose you are selling sneakers online and want to charge the best price. You could analyse what competitors are charging and use that information to adjust your prices to attract more buyers. This is done with **price prediction models in Machine Learning**, helping you make smart pricing decisions based on market trends.

Let's say you are using an app that can identify things in a picture - like telling you that an animal in your photo is a cat or a dog. This is where **Deep Learning**, specifically **Convolutional Neural Networks (CNNs)**, comes in. They process and analyse images to recognize objects and details automatically.

Machines that Learn: the Machine Learning Revolution?

"It is a branch of Artificial Intelligence based on the idea that systems **can learn from data, identify patterns and make decisions** with minimal human intervention."



Source: Illustration developed by ETAP

In **Traditional Programming**, specific rules (step-by-step instructions) are written and fed into the computer along with data. The computer then follows these rules to provide the answers. For example, to calculate taxes a program follows specific formulas provided.

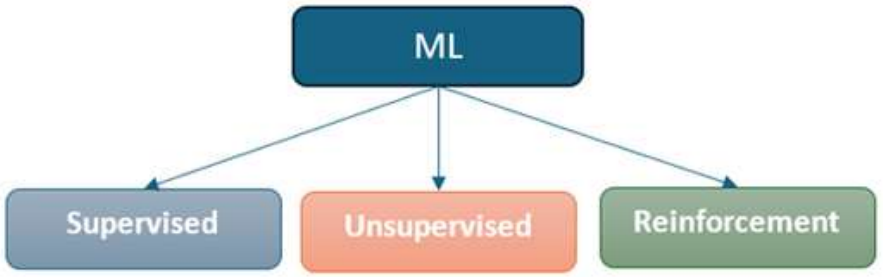
In **Machine Learning**, the process is different. Instead of writing all the rules manually, examples of data (such as pictures of cats and dogs) and their corresponding answers (labels like "cat" or "dog") are given to the computer. The machine then **learns the rules** by finding patterns in the data. This is why Machine Learning is so powerful – it can handle tasks that are too complex for humans to write all the rules for recognizing faces or translating languages!

Think of it like this:

- **Traditional Programming** – You explain everything in detail.
- **Machine Learning** – You teach through examples and it learns by itself.

Understanding the Types of Machine Learning

Machine Learning (ML) can be divided into different categories based on how the model learns from the data. These categories help define how to use ML in different scenarios.



Source: Illustration developed by ETAP

SUPERVISED LEARNING

What Is It?

Supervised Learning occurs when a model is trained using labelled data. For example, to teach models to recognize different animals, many images of dogs, cats and birds are shown with each image labelled with its correct name. Over time, the model learns to identify these animals based on the patterns in the labelled data.

Objective: To predict or classify new data based on patterns learned from the labelled examples.

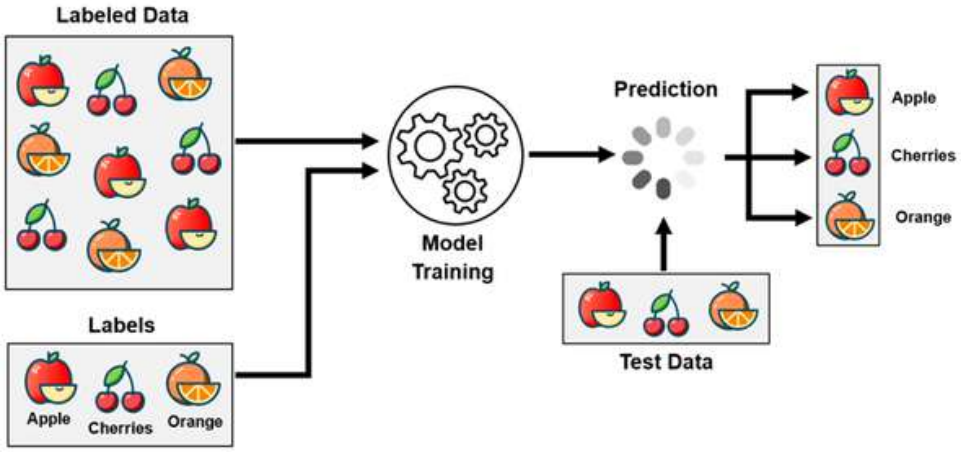
How Does It Work?

Imagine you want to teach a machine to recognize a car:

1. **Collect data**: Gather pictures of cars, motorbikes, bicycles, etc., and label each one with what it is (e.g., "car," "motorbike," "bicycle").

2. **Train the model**: The machine analyses the patterns in the images and their labels, like the shape of the wheels or size of the vehicle.

3. **Make predictions**: Once trained, the model can identify whether a new image shows a car, motorbike, or bicycle



Source: Illustration developed by ETAP

Examples For You:

- **Spam Filters** – Detect if an email is "spam" or "not spam" based on previously labelled emails.
- **Facial Recognition on Phones** – Your phone knows it's you because it learned using labelled images of your face.
- **Voice Assistants** – Siri or Alexa can understand your speech thanks to labelled examples of spoken commands.

UNSUPERVISED LEARNING

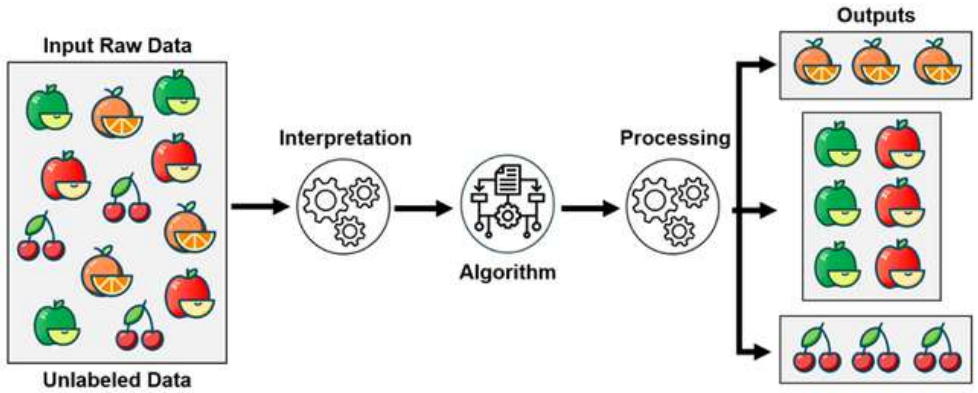
What Is It?

Unsupervised Learning works without labels. The model does not know what the data represents — it just looks for patterns, groups, or hidden structures on its own.

Objective: To explore data and find relationships or clusters without guidance.

How Does It Work?

Think of how your friend group is naturally divided into "gamers," "movie buffs", and "athletes". An unsupervised learning model works similarly — it analyses what is common in the data and groups it automatically.



Source: Illustration developed by ETAP

Examples For You:

- **Finding Similar Music Preferences** – Grouping people with similar habits, like Spotify suggesting "Chill Vibes" playlists for relaxing music.
- **Personalized Show Recommendations** – Netflix recommends shows based on what people with similar tastes enjoy watching.

REINFORCEMENT LEARNING

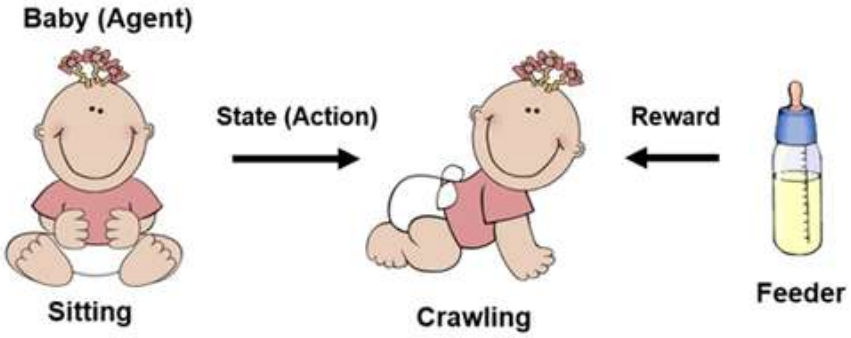
What Is It?

Reinforcement Learning teaches a model to make decisions by giving it rewards for good choices and penalties for bad ones. Think of it as training a pet: the model learns by trial and error until it gets better over time.

Objective: To develop strategies that maximize rewards by learning from experience.

How Does It Work?

Imagine you are training a robot to play a video game. At first, the robot makes a lot of mistakes, like falling into traps. But every time it wins points, it gets rewarded. Over time, it figures out the best strategies to win.



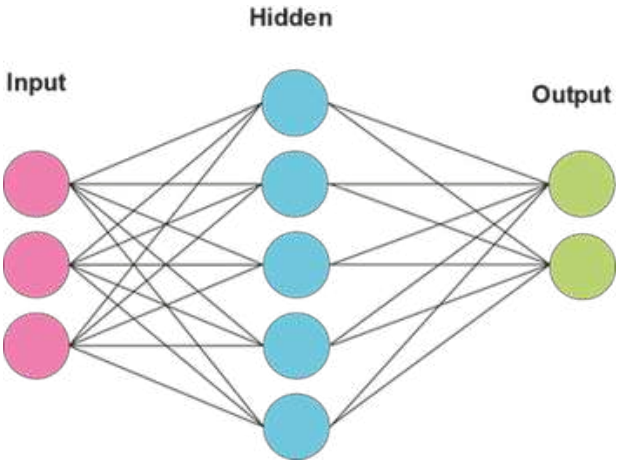
Source: Illustration developed by ETAP

Examples For You:

- **Gaming AI** – Bots in games like Minecraft or Fortnite learn how to defeat opponents by playing repeatedly.
- **Self-Driving Cars** – Learn to drive safely by being rewarded for following traffic rules and penalized for risky moves.
- **Robotic Pets** – AIBO, the robotic dog, learns new tricks based on how you interact with it.

...BUT WHERE DOES DEEP LEARNING COME IN?

Deep Learning is like a super-powered form of Machine Learning. It uses a special system called **Artificial Neural Networks (ANNs)**, which are inspired by how the human brain works. These networks are great at handling large amounts of complex data, like images, videos, or audio.



Source: Illustrations developed by ETAP

To better understand Deep Learning, it is essential to first understand how a **Neural Network** works.

- **Input Layer** – This is the starting point where the data enters the network. The input can be an image, sound or a set of numbers. Example: To teach a network to recognize a banana, you might input an image of the banana or details such as its colour, size and shape.

- **Hidden Layers** – These are the layers in the middle that do the heavy lifting. Think of them as the "thinking" part of the network. They perform complex mathematical calculations to identify patterns in the input data. Example: In the case of a banana, the hidden layers might identify features like yellow colour, curved shape and smooth texture.

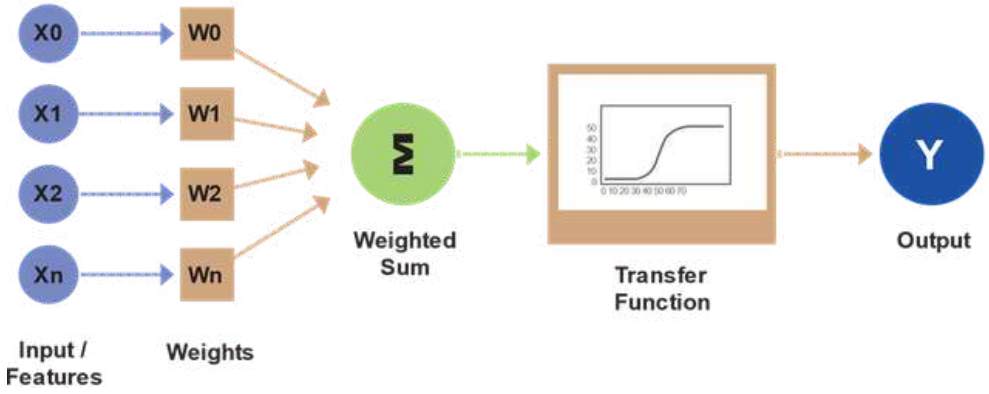
- **Output Layer** – This is the last layer of the network, where the final decision or result is made. Example: After analysing the patterns, the output layer concludes: "This is a banana!"

When understanding how a neural network operates, there are three key elements in each "neuron" that play an important role:

- **Weight** – This decides how important each input is. For example, if you are teaching the network about bananas, the yellow colour might have more weight than the size.

- **Bias** – This is like an adjustment that helps the network make better predictions. It shifts the calculations slightly to help the model learn better.

- **Activation Function** – This gives the network the ability to learn complex patterns by deciding whether the neuron should "activate" or not. It is what helps the network make smarter connections, like identifying that something curved and yellow is likely a banana.



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Each neuron receives inputs (like colour, shape or size) and the **weights** determine how much importance each input has. For example, in identifying a banana, the colour might be given more importance (weight) than the size. The **bias** helps adjust these calculations, fine-tuning the process to improve predictions. Finally, the **activation** function decides whether the neuron should pass its information forward. It is like flipping a switch that helps the network focus on relevant patterns, such as recognizing that something yellow and curved is most likely a banana.

This process of testing and adjusting happens repeatedly, like practicing a sport - each mistake helps it learn and do better. Over time, the network gets really good at making accurate predictions.

MAIN USES OF DEEP LEARNING

Examples from everyday life:

Facial recognition: In security systems, the identification of individuals through their face.

Object identification: autonomous cars can identify pedestrians, road signs and other vehicles.

Machine translation: Systems that translate texts from one language to another, such as Google Translate.

Sentiment analysis: analysing feelings and emotions in texts, such as social media comments or product reviews.

Virtual Assistants such as Siri, Alexa or Google Assistant, which understand and respond to voice commands.

Medical diagnostics: the detection of tumours or diseases through the analysis of medical images.

Streaming platforms such as Netflix and Spotify use Deep Learning to suggest films, music and series based on user preferences.

Intelligent robots that use Deep Learning to learn new tasks, navigate unknown environments and interact with objects in an adaptive way.

Create game characters with AI or even create games that they play themselves.

In this module, you learned about the key concepts behind Artificial Intelligence: Machine Learning (ML), Deep Learning (DL), and Neural Networks (NN), and how they work together to enable AI systems to analyse data, make predictions, and adapt over time. You also explored the various ways AI models learn, including supervised, unsupervised, and reinforcement learning, and how Neural Networks process information similar to the human brain. With a solid understanding of these foundational principles, you are now prepared to explore more advanced AI applications.

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VIDEO: History of AI, from the Turing test to today's AI milestones

INFOGRAPHIC: Timeline of key AI advancements

ADDITIONAL READING (links to external information resources)

Machine Learning for Kids is a platform designed to introduce students to machine learning through fun, hands-on projects. It allows learners to train simple AI models and experiment with real-world data. Additionally, the platform provides tools and resources for educators, enabling them to effectively guide students in exploring AI concepts and applications. https://machinelearningforkids.co.uk/

Google Experiments provides a collection of interactive online projects designed to make exploring machine learning fun and accessible. Through creative tools involving pictures, drawings, language and music, users can engage with AI concepts in a hands-on and visually engaging way, offering an approachable introduction to the world of machine learning.about:blank

PRACTICAL EXERCISE (for classroom activities with a teacher)

Case Study: Building Your Own AI Hand Gesture Recognition Model (Teachable Machine)

Objective: Students will learn how to train an AI model that can recognize and classify three different hand gestures, going through the process of collecting data, training the model, and testing it to ensure it correctly identifies each gesture. By the end of this exercise, they will have to upload a screenshot or video of your model correctly classifying gestures in action.

Instructions for students:

Step 1: Set Up Your AI Project

1.Visit **Teachable Machine**.
2.Select **Get Started** and choose the **Image Project** option.
3.Create three classes:

- **Thumbs Up**
- **Peace Sign**
- **Fist**
- (Feel free to add more gestures if time allows!)

Step 2: Collect Training Data

1. Use your webcam or upload pictures to teach your model.
2. For each class, capture at least **30 images** of your hand performing the gesture:
   - Try different angles and lighting conditions to improve accuracy.
   - Make sure the background is not too distracting.

Step 3: Train Your Model

1. Click the **Train Model** button.
2. Wait for the training to be completed. This may take a few minutes depending on your images.

Step 4: Test Your Model

1. Switch to the **Preview** tab.
2. Use your webcam to test the gestures. Does the model recognize them correctly?
3. If the model is inaccurate:
    - o Add more training data.
    - o Adjust your environment (lighting, background).

Step 5: Export and Share

1. Save your model:
    - o Export it to use later (optional).
    - o No need to deploy it online for this exercise.
2. Take a screenshot or record a short video of your model in action. Include:
    - o The live preview with the correct gesture being recognized.
    - o The labels showing the prediction.

Submission requirements:

Deliverable: Upload either a screenshot or a 30-second video of your model correctly identifying at least three gestures.

Bonus Challenge: Modify your model to include an extra gesture and showcase it to your classmates!

Reflective Questions:

1. What challenges did you face while training your model? How did you overcome them?
2. What factors (lighting, background, angles) seemed to affect the accuracy of your model the most?
3. How might AI like this be used in real-world applications?

QUIZ WITH MULTIPLE-CHOICE QUESTIONS (one correct answer per question)

1. What are the main types of Machine Learning?
a) Supervised Learning, Unsupervised Learning and Reinforcement Learning.
b) Deep Learning, Neural Networks and Traditional Programming.
c) Labelled Learning, Pattern Matching and Trial-Based Learning.
d) Image Processing, Data Clustering and Rule-Based.

2. How does Machine Learning differ from traditional programming?
a) ML uses predefined rules to make decisions, while traditional programming learns from data.
b) ML learns patterns from data and makes decisions, while traditional programming follows step-by-step rules written by humans.
c) ML uses only numerical data, while traditional programming uses images and text.
d) There is no difference between ML and traditional programming.

3. Which of the following is an example of Supervised Learning?
a) Grouping music listeners into categories based on their preferences.
b) Teaching a robot to navigate a maze through trial and error.
c) Training a spam filter using labelled examples of "spam" and "not spam" emails.
d) Finding clusters of similar customer behaviours without using labels.

4. What is the main difference between Supervised and Unsupervised Learning?
a) Supervised learning uses labelled data, while unsupervised learning does not.
b) Supervised learning finds hidden patterns, while unsupervised learning predicts outcomes.
c) Supervised learning uses numerical data, while unsupervised learning uses text data.
d) There is no difference; they are the same.

QUIZ WITH MULTIPLE-CHOICE QUESTIONS (one correct answer per question)

5. Which scenario best represents Reinforcement Learning?

a) A system clustering similar songs into playlists based on listening habits.
b) A model learning to identify cats and dogs from labelled images.
c) A robot learning to win at chess by being rewarded for good moves and penalized for bad ones.
d) A virtual assistant understanding voice commands using labelled examples of speech.

6. What is the role of the hidden layers in a neural network?

a) They are the entry point for data to the network.
b) They perform complex calculations to identify patterns in the data.
c) They produce the final output of the network.
d) They store the weights and biases permanently.

7. What is the purpose of the activation function in a neuron?

a) To assign labels to the output data.
b) To activate or deactivate the neuron based on the input data, enabling the network to learn complex patterns.
c)To adjust the weights and biases during training.
d) To calculate the loss or error of the network.

8. What is Deep Learning?

a) A method of teaching machines using only labelled data.
b) A type of AI that uses Artificial Neural Networks (ANNs) to process large amounts of complex data.
c) A tool for analysing simple datasets with limited variables.
d) A form of reinforcement learning for solving reward-based problems.

Module 3: AI Applications Across Industries

The aim of the current module is to explore various Artificial intelligence (AI) applications in different industries such as education, healthcare, finance, social media, entertainment, and automotive, and help you understand how AI impacts each of these industries.

By the end of the module, you will be able to acquire different skills, such as:

- **Industry-Specific AI Knowledge**: understanding how AI is applied in various industries, including automative, education, healthcare, finance, social media, and entertainment.
- **Real-World Impact Awareness**: learning how AI transforms industries by making processes more efficient, enhancing decision-making, and creating new opportunities.
- **Critical Thinking on AI Use**: reflecting on how AI could be applied to improve or disrupt specific sectors, particularly education.

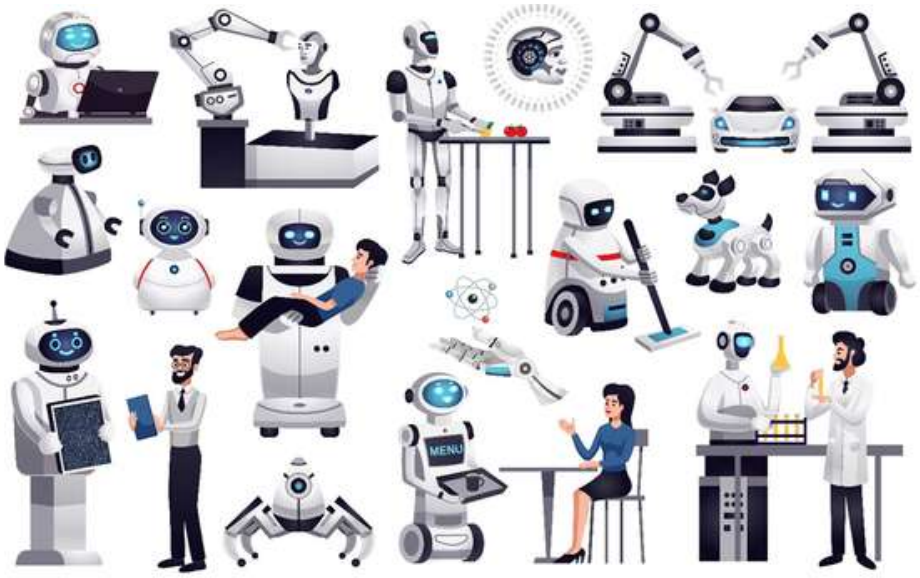
Module Duration	2 hours (guided and self-paced)

AI rapidly transforms the world around us, finding its way into countless industries and everyday tasks. Whether it helps businesses automate repetitive processes, analyse complex data, or improve the performance of software programs, AI reshapes how we work and live.

In this module, you will explore the positive impact of AI: how it supports industries, improves operations, and makes everyday life easier, faster, and more efficient, discovering practical applications that highlight AI's potential to enhance people's lives across various sectors.

You have likely interacted with at least one AI in your life. Think about when you use ChatGPT to help with homework or when your email filters spam automatically (as you learned in Module 2) — that is AI at work! Your smartphone might use facial recognition to unlock your device or secure a transaction. Even domestic robots and devices like smart vacuums, smart TVs or air conditioners you may have at home, rely on AI to navigate obstacles or to decide the best time to operate. And let's not forget about everyday helpers like Siri, Amazon Alexa, and Google Assistant, or advanced home security systems and monitoring devices that use AI to keep you safe.

Now, let's explore together how AI advances technology across some key industries and the impact it has on our lives.



Source: Freepik.com

ARTIFICAL INTELLIGENCE IN EDUCATION

Have you ever wondered how AI could make your school life easier? AI already helps teachers, students, and schools around the world remarkably!

When a teacher spends hours grading homework or preparing lessons, it takes away time they could use to help students like you. This is where AI steps in, speeding up tasks and leaving teachers more time to focus on teaching and helping you succeed.

For example, AI tools like **Quizlet** can help teachers to quickly find activities, videos, or even create quizzes that make learning in class more effective, engaging and fun. But there are also many ways AI changes education.

How does AI help you learn?

- **Personalized learning for you**: Imagine having a learning app (i.e., **Khan Academy**) that adjusts to your unique way of learning. Whether you're quick at math but need extra help with history, AI tools can create lessons just for you, making learning fun and effective.

- **Your private AI tutor**: Struggling with a tough subject? AI-powered tutors (i.e., **Khanmigo**, built by Khan Academy) can guide you step-by-step, answering questions and explaining concepts in a way that fits your pace.

- **Faster grading for teachers, quicker feedback for you**: Tools like **Gradescope** use AI to assess assignments, quizzes, and even essays. This means teachers can evaluate and grade your homework, projects and tests easier and provide feedback faster. These tools not only support teachers in organizing their administrative tasks better but also allow them to focus on and spend more time with their students and work on improving their knowledge.

- **Smart suggestions for teachers, enriched learning experience for you**: With AI, teachers can get help planning lessons, finding resources, or even creating study guides for you (i.e., **Quizlet**). This means more engaging and interactive content in your classes which will make your learning at school more interesting, compelling and fun.

- **Fun language learning**: Learning a new language? AI tools like **Duolingo** give instant feedback on your pronunciation, grammar, and vocabulary. It's like having a language coach in your pocket!

- **Secure online exams**: Have you ever wondered how schools prevent cheating in online exams? AI monitors test sessions and ensures fairness, making exams stress-free and secure for everyone (i.e., **Examity**).

- **Automation in virtual classrooms:** Tools such as **Google Classroom** and **Canvas** integrate AI to make online learning more accessible. They automatically assess homework, grade tests, and manage reports, letting you stay on track even if you can't physically attend school.

- **Efficient school management:** AI also makes school operations smoother. It handles scheduling, student enrolments, and even routine inquiries using chatbots (**FreshSchools, HubSpot Chatbot**). This allows school staff to spend more time on what matters most — helping you!

Why should you care?

Whether it helps your teacher plan lessons, making your homework less stressful, or giving you quick feedback, AI creates a better learning experience for the students.

ARTIFICAL INTELLIGENCE IN HEALTHCARE

As artificial intelligence has grown more precise, nowadays it saves numerous people's lives. It helps doctors, nurses, and patients in ways you might not have imagined. AI diagnoses illnesses faster, creates better treatment plans, and definitely changes the way we take care of our health.

Source: Freepik.com

How is AI being used to keep us healthier?

- **Seeing what doctors might miss:** AI is like a super helper for doctors. Tools like **Google Health AI** analyse X-rays, CT scans (computed tomography scans), or MRIs (magnetic resonance imaging) to detect diseases like pneumonia, tuberculosis, or even cancer with incredible accuracy. They can spot tiny issues, like lung nodules, that might be hard to notice otherwise.

- **Robotic surgeries**: Nowadays there are robots relying on AI to automate surgeries. AI allows doctors to perform many types of complex procedures with more precision, flexibility and control than it is possible with traditional procedures. Machine-led surgeries are considered to be more accurate and less invasive, have a smaller margin for error and can run 24/7.

- **Treatments made just for you**: AI analyses your genetic information, health history, and lifestyle to create personalized treatment plans. For example, platforms like IBM Watson Health help doctors find the best therapies, adjust doses, and anticipate potential side effects.

- **Helping doctors stay organized**: Doctors deal with tons of paperwork! AI tools like **Suki AI** help them by transcribing medical notes, organizing files, and even updating patient records automatically. This means doctors spend less time on administrative tasks and more time caring for patients.

- **Keeping an eye on your health from anywhere**: AI is a big part of wearable devices like **Dexcom** for diabetic patients. These gadgets track your health in real time — like monitoring blood sugar levels — and send alerts to both you and your doctor if something's off.

- **Faster drug discoveries**: Finding new medicines can take years, but AI speeds up the process! Tools like **Atomwise** analyse huge amounts of data to predict which drug combinations might work, helping pharmaceutical companies develop new treatments faster.

- **Fraud detection**: AI doesn't just help patients — it also protects healthcare systems. It scans for unusual patterns in billing or medical claims, preventing fraud and ensuring resources go to the people who need them.

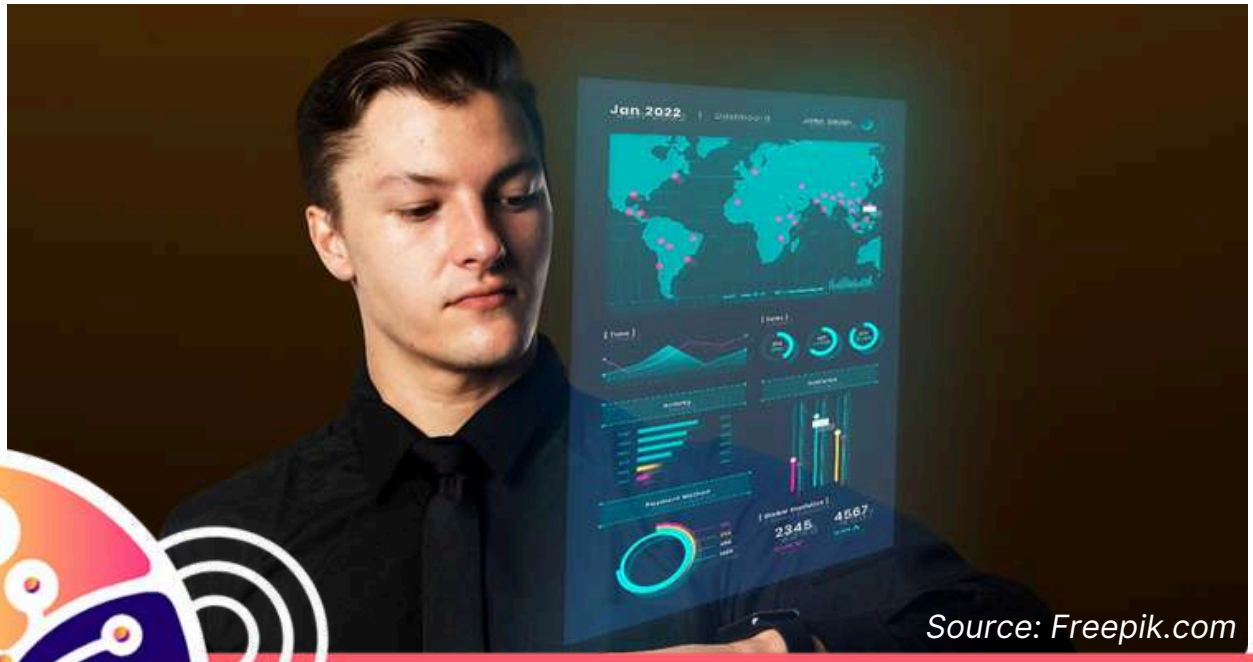
- **Smarter medical records:** AI tools like **Epic AI** organize, analyse, and securely store medical records, helping healthcare providers find the information they need quickly while keeping it safe.
- **Decision-making support for doctors:** AI systems like **Zebra Medical Vision** help doctors make difficult decisions by analysing a patient's medical history, lab results, and scans. They guide doctors toward the best possible diagnosis and treatment options.
- **Better care for patients:** AI-powered platforms like **HealthTap** let you chat with virtual health assistants, get prescriptions, and even receive personalized treatment recommendations. These tools ensure faster and more efficient healthcare for everyone.

Why does AI revolutions in healthcare matter to you?

From spotting illnesses earlier to helping doctors provide better care, AI does not only improve medicine, but also contributes to a healthier future for all of us.

ARTIFICAL INTELLIGENCE IN FINANCE

Artificial Intelligence changes the way we manage money, making finance smarter, faster, and more efficient. It helps people protect their bank accounts, making the complex world of finance easier to navigate.



Source: Freepik.com

How does AI support financial services?

- **Fraud detection, keeping your money safe:** AI analyses your transaction patterns and flags anything suspicious in real time. This means banks can stop fraud before it happens, ensuring your money stays secure.
- **Better loan decisions:** AI help lenders decide faster and more accurately by analysing client's credit history and other data. This eases the fair and timely access to financial support.
- **Personal investment advisor:** Have you ever heard of robo-advisors? These AI-powered tools help people invest smarter by analysing the market and suggesting strategies based on their goals. AI also executes trades faster than any human investor, ensuring people don't miss an opportunity.
- **Making customer service smarter:** AI chatbots can answer questions about bank accounts, loans, or investments instantly. They're like having a personal banker available 24/7.
- **Teaching money skills:** AI tools simplify complex financial concepts for beginners, offering personalized advice and easy-to-follow explanations to help them manage their finances effectively.
- **Fighting money laundering:** AI scans millions of transactions to detect unusual patterns that could indicate illegal activities, helping banks comply with regulations and keep the financial system clean.
- **Debt management for a brighter financial future**: AI identifies the best strategies to help borrowers pay off debts, prioritizes repayment plans, and offers solutions to make the process easier for everyone.

How does AI in finance impact you?

With AI in finance, everything from securing accounts to planning financial future becomes simpler, safer, and more accessible. It supports customers, banks, and businesses alike!

ARTIFICAL INTELLIGENCE IN SOCIAL MEDIA AND ENTERTAINMENT

Artificial intelligence totally renovates how we experience social media and entertainment. Companies like Meta and X use artificial intelligence to analyse massive data and create super-personalized experiences.

AI that can suggest you the perfect playlist, recommend shows you'll actually love, or even create filters and effects for your posts. It all happens because AI learns what you like and shows you content specifically tailored to you.

Source: Freepik.com

How AI influences these two industries?

- **Spotting what's trending:** You have probably wondered how platforms know which videos or hashtags are going viral. AI analyses millions of posts to figure out trends in real time.
- **Personalized feeds just for you**: AI tracks your behaviour on social media — what you like, comment on, or share — and suggests posts, reels, and accounts you might enjoy.

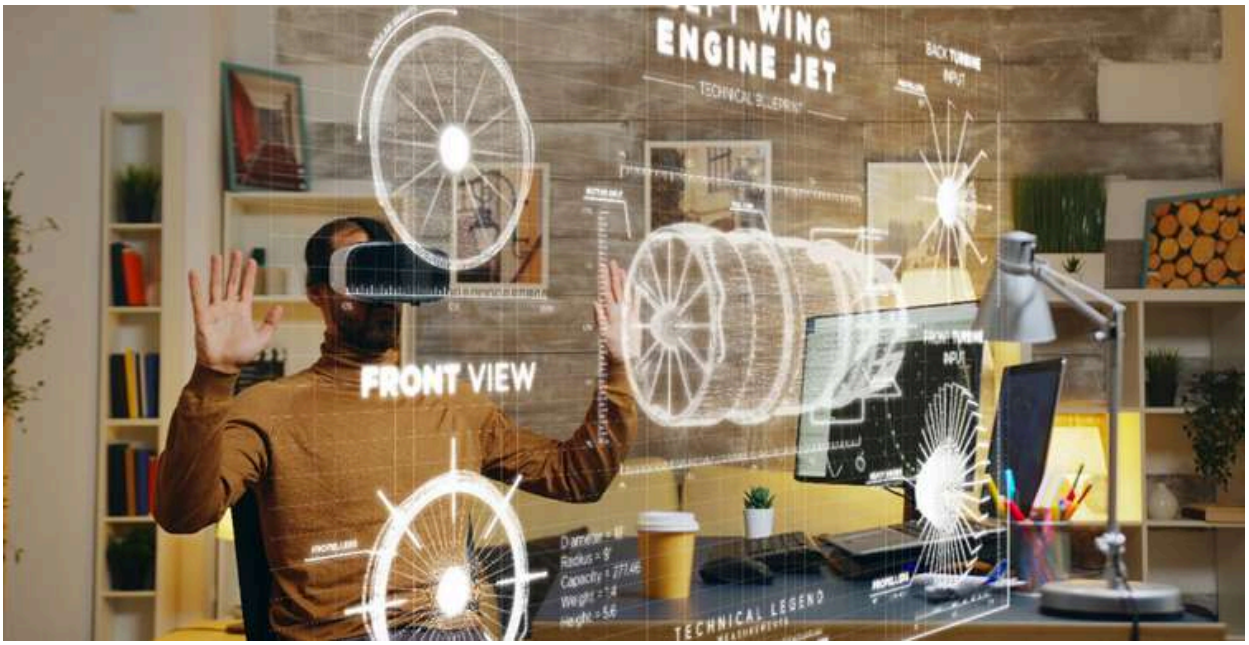
- **Safer online spaces:** To combat cyberbullying or inappropriate content, AI tools monitor and remove harmful posts, creating a healthier digital environment.
- **Better ads and recommendations:** Companies use AI to understand your interests and show ads or content that match what you love. That's why your ads seem to "know" what you've been thinking about!
- **Video games with smarter NPCs:** AI helps developers create NPCs (non-player characters) with realistic reactions and adaptive gameplay, making games more fun and immersive.
- **Content recommendations:** Platforms like **Netflix** and **Spotify** use AI to recommend shows, movies, or songs based on your tastes. It's why you always find something new to binge-watch or listen to.
- **Movie trailers and editing:** AI picks the most exciting scenes and even edits full movies, saving time for editors.
- **Music creation:** AI tools like **Soundraw** help musicians compose songs or write lyrics based on mood, genre, or topic. It's like having a virtual songwriting assistant.
- **Smarter book publishing:** AI makes life easier for publishers by summarizing books, designing layouts, and even suggesting marketing strategies to reach readers like you.
- **Interactive podcasts:** AI helps in editing audio, adding subtitles, and personalizing podcast recommendations. It ensures every listener gets the perfect audio experience.
- **Highlights for sports and events:** AI can create highlight reels instantly and allow fans to create their own custom highlights. For example, you could generate highlights of a particular play or a tournament series.

Why does this matter to you?

AI in social media and entertainment enhances your experience by making it more enjoyable, personalized, and secure. Whether it suggests your next favourite show or crafts realistic, immersive gaming experiences, AI ensures that everything you interact with is exciting and tailored to your preferences.

ARTIFICAL INTELLIGENCE IN AUTOMOTIVE INDUSTRY

AI has completely transformed the automotive industry. You've definitely heard about the self-driving technologies in cars from Tesla, Audi, and Volvo. The car can see everything around it, predict what might happen in a second, and react faster than any human driver could. These technologies use super-advanced AI that works like a brain, processing tons of information from cameras and sensors in real-time.



Source: Freepik.com

But what other significant contributions AI makes to this industry?

- **Intelligent traffic management:** AI analyses live traffic data from cameras and GPS to manage traffic flow in real time. It adjusts traffic lights dynamically to reduce congestion and helps drivers avoid jams through smarter route suggestions.
- **Smarter navigation systems:** AI-powered navigation systems consider real-time traffic, weather, and road conditions, suggesting alternate routes to save time and ensure a smooth driving experience.

- **Predictive vehicle maintenance:** Imagine your car telling you it needs a repair before something breaks! AI monitors your vehicle's performance in real time, identifying potential problems and reducing breakdowns and repair costs.
- **Personalized driving experiences:** AI can learn your preferences — like favourite seat positions or music settings — and even suggest tailored maintenance plans based on your driving habits. AI-powered chatbots also help with troubleshooting and booking services.
- **AI in manufacturing and design:** AI makes vehicle manufacturing faster and more efficient by optimizing production lines, reducing waste, and ensuring higher quality. Designers use AI to spot errors in prototypes and enhance designs before building vehicles.
- **Autonomous vehicles:** Self-driving cars use AI to "see" and understand the environment around them. They rely on cameras, radar, and advanced machine learning to navigate roads safely, avoid obstacles, and follow traffic rules.
- **Demand forecasting for vehicles:** AI predicts which car models will be in demand, helping manufacturers produce the right amount and reducing waste. This means better options for buyers and lower costs.

Why does this matter to you?

AI does not just improve the cars we drive, but the entire experience of how we interact with transportation, making it safer, smarter, and more personalized.

As you learned in this module, AI changes the industries by making complicated tasks super simple, creating experiences that feel like they are made just for you, and keeping things safer in ways we never thought possible. So, the next time when someone talks about Artificial Intelligence, do not think "boring tech stuff" - remember that AI helps us all live better and thrive in our ever-changing world!

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VIDEO: AI in Education – How AI is revolutionizing education and student learning

INFOGRAPHIC: AI applications in multiple industries

ADDITIONAL READING (links to external information resources)

World Economic Forum Article: The article highlights four ways AI can enhance education, including personalized learning, automating administrative tasks, and improving teaching tools. https://www.weforum.org/stories/2023/04/can-ai-improve-education-here-are-4-potential-use-cases/

BBC Article: The article discusses how AI changes workplaces by boosting productivity and creating new ways for people and machines to work together. It also highlights challenges and opportunities AI brings to jobs. https://www.weforum.org/stories/2023/04/can-ai-improve-education-here-are-4-potential-use-cases/

PRACTICAL EXERCISE (for classroom activities with a teacher)

Case Study: The Future of Learning – Alex's Journey with AdaptLearn

Objective and instructions:

The students need to read the following case study and, based on the information from the story, they need to answer 2 reflective questions. The answers should be with approx. 200-300 words length each.

The story is about a student, Alex, who faces challenges in studying, particularly in math. However, after starting to use an AI-powered platform at school (AdaptLearn), he overcomes these challenges, making learning at school interesting and fun. The case study aims to demonstrate to the students how AI can influence their learning process.

The case study for the students:

Alex is a high school student who, despite all his efforts, has always struggled with math. It is a puzzle to him and often very frustrating, especially in algebra, where complex equations seemed like an impossible task to solve. However, his school decided to start using an AI-powered platform that understands how students learn differently. Thus, the AdaptLearn platform was introduced at the beginning of the new school year.

To start using the platform, Alex had to take a test. Interestingly, the questions adapted based on his responses. When he struggled, the platform immediately adjusted the difficulty of the questions, and when he excelled, the challenges increased. This way, the AI quickly understood Alex's learning style – he was a visual learner who loves diagrams, struggling with abstract mathematical concepts and learning best through interactive, bite-sized lessons.

Based on this data, the platform suggested learning materials tailored specifically for Alex. Each lesson was crafted to break down intimidating concepts into manageable, engaging segments. Suddenly, mathematics transformed and became thrilling for him.

Moreover, the AI also noticed when Alex lost attention during his study sessions. In these moments, the platform automatically changed the way the learning content was presented, using short video explanations, interactive problem-solving games, and visual mind-mapping tools instead of long explanatory texts.

By the end of the school year, Alex demonstrated not only a significant improvement in his math grades but also in all subjects overall. Additionally, he became much more excited and eager to study. The AdaptLearn platform wasn't just about presenting information — it was about understanding Alex's unique learning journey. The AI tracked his progress, identified knowledge gaps, and continuously adapted to provide the best learning content for Alex.

Reflection questions (200-300 words):

1. How can AI platforms like AdaptLearn help students in their learning process?
2. Do you think that such AI tools can replace entirely teachers in school? If not, please explain why?

QUIZ WITH MULTIPLE-CHOICE QUESTIONS (one correct answer per question)

1. How does AI personalize the learning experience for students?
a) By providing the same lesson to all students regardless of learning needs
b) By adjusting lessons based on each student's pace and learning style
c) By replacing teachers with automated robots
d) By eliminating assignments and homework

2. In what way does AI assist teachers in education?
a) By grading assignments faster and offering quick feedback to students
b) By conducting all parent-teacher meetings
c) By creating lesson plans without teacher input
d) By replacing teachers in the classroom

3. How does AI assist in diagnosing diseases?
a) By replacing doctors entirely
b) By analysing medical images, like X-rays and MRIs, to detect issues like cancer
c) By automating all patient appointments
d) By providing prescriptions without doctor consultation

4. How does AI improve personalized treatment plans for patients?
a) By replacing traditional medicines
b) By analysing a patient's genetic data and health history to customize treatments
c) By automating patient care in hospitals
d) By recommending one-size-fits-all treatments for all patients

5. How does AI help banks prevent fraud?
a) By monitoring all social media accounts
b) By analysing transaction patterns to flag unusual or suspicious activity
c) By restricting all customer transactions
d) By removing all human involvement in banking

QUIZ WITH MULTIPLE-CHOICE QUESTIONS (one correct answer per question)

6. In which way does AI benefit personal finance management?
a) By automatically investing all savings
b) By offering robo-advisors that analyse financial data and recommend investment strategies
c) By preventing any financial mistakes
d) By stopping all bank charges from occurring

7. How does AI contribute to the personalization of social media content?
a) By controlling user activity completely
b) By tracking user interactions and suggesting posts or ads that align with interests
c) By automatically generating posts for users
d) By removing all ads from social media platforms

8. How does AI improve video game experiences?
a) By creating real-world actors for every character
b) By enabling non-player characters (NPCs) to react realistically and adapt to player actions
c) By limiting the player's options in the game
d) By automating the game design process without input from creators

9. How does AI contribute to traffic management in cities?
a) By taking control of all vehicles on the road
b) By analysing live traffic data to optimize signal timings and reduce congestion
c) By requiring all cars to follow specific routes
d) By controlling pedestrian traffic

10. What role does AI play in autonomous vehicles?
a) It allows self-driving cars to "see" and navigate the environment, avoiding obstacles
b) It directly controls how drivers should operate their vehicles
c) It only controls the car's speed without considering road conditions
d) It removes the need for traffic signs and signals

Module 4: Cognitive Computing and AI Technologies

The aim of the current module is to explain key concepts that include how to define and differentiate cognitive computing, Artificial Intelligence, and related technologies like natural language processing (NLP), computer vision (CV), and robotics.

By the end of the module, you will be able to acquire different skills:

- **Cognitive Computing Understanding:** knowing how cognitive computing mimics human thought processes to make AI smarter.
- **Familiarity with AI Subfields:** gaining basic knowledge about key AI technologies such as natural language processing (NLP), computer vision, and robotics.
- **Evaluating AI Systems:** interacting with chatbots and similar tools to understand how AI systems process information and communicate with users.

Module Duration	2 hours (guided and self-paced)

In this module, you will learn about complex AI technologies and delve into the foundational principles of computer vision (e.g., RGB values, feature extraction, object detection) and how robots use machine learning techniques like reinforcement learning, CNNs, and transfer learning.

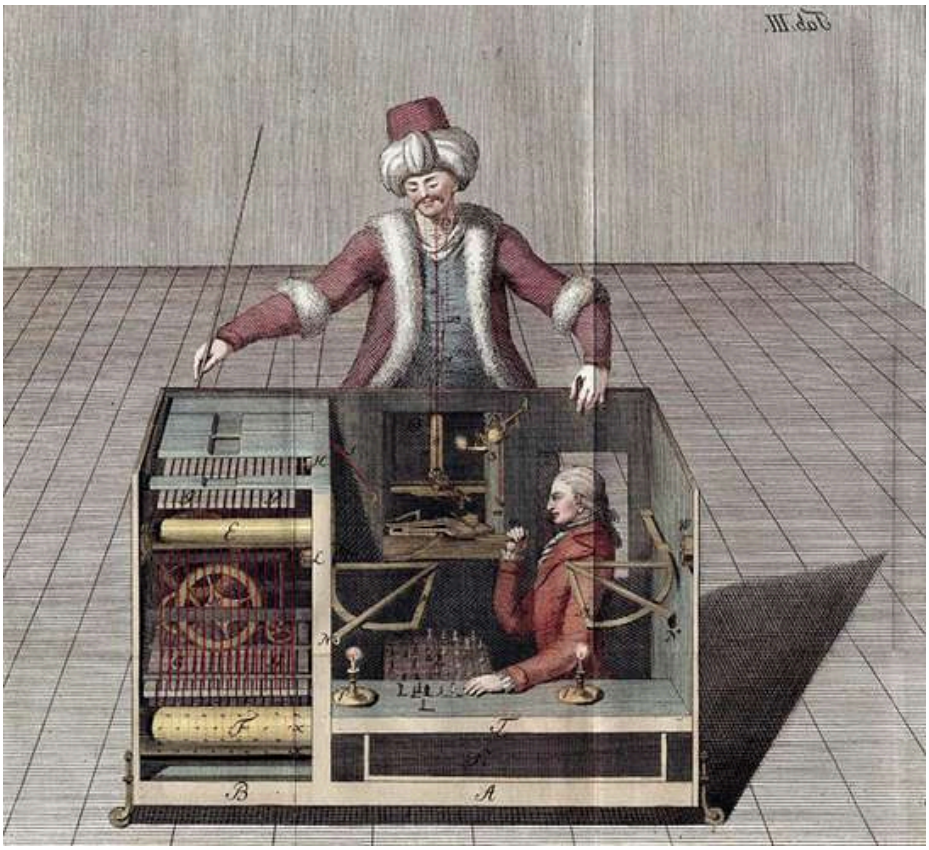
Do you remember ELIZA that we told you about in Module 1? Let's find out more about its capabilities and complexity!

DEFINITION OF COGNITIVE COMPUTING AND HOW IT RELATES TO AI

You can separate the two determinants of the concept “cognitive computing” into “cognitive”, which is described as “connected with thinking or conscious mental processes” (Cambridge Dictionary 2024a) and compute”, which is described as “to calculate an answer or amount by using a machine:” (Cambridge Dictionary 2024b). At this point, we can give you an interesting fact: “[...] until the middle of the 20th century, computers were, in fact, humans who performed calculations. This is shown in older specialized books and numerous printed reference works. For complex calculations, the assistance of reckoning centres was required. In calculation halls, human computers worked with mechanical desk calculating machines. This was often the work of women". (Bruderer 2021).

Cognitive computing represents the ability of computing machines to adapt their functionality to human behaviour, and thus to human thought and action. The question of a being created by humans and the associated creative ability to shape and reshape the environment is a central driver of human behaviour. The desire to create something that acts like a human being (Artificial Intelligence) and the creative ability to actively shape and change the environment are among the fundamental drives of human creativity. There are many determinants that describe the concept above, which can also be found in the concepts of IBM (Watson) among others. They describe cognitive computing indirectly as the ability of systems to analyse large, unstructured amounts of data, to highlight and understand content or aspects with special characteristics, and to learn from the experience gained.

A step back in time also shows the ambitions of creating Artificial Intelligence. Many ambitions were perhaps not documented and have not survived to this day. The “Turk”, for example, should be highlighted as a historical technical artefact. It was supposed to possess a kind of Artificial Intelligence and beat its opponents at chess. It was invented by the Austrian inventor Wolfgang von Kempelen as a chess machine. The Turk was supposed to play chess independently. What do you believe, was the Turk, Artificial Intelligence? In reality, however, this was a trick, as a human was hidden inside the “Turk” and moved the chess pieces.



Mechanical Turk (Copperplate engraving by Racknitz 1789)

Nevertheless, this example shows that people were interested in building machines that could simulate human-like intelligence or behaviour. This creative fervour was perhaps partly shaped by a religious perspective and the idea that humans were also formed and created. Genesis 2:7: "Then the LORD God formed the man of dust from the ground and breathed into his nostrils the breath of life […]“ or in Surah Al-Mu’minun 23:12-14: "And indeed, We created humankind from an extract of clay." and another example Bereshit Rabbah 8:1: "The Holy One, blessed be He, said: 'I created man in My image, and I created him as a single being […]“.

In summary, cognitive computing can be described as a technology that enables human-like learning and understanding of information. They adapt to new information and contexts. They can analyse and interpret complex data patterns and can also process the respective input (machine-machine interface).

NATURAL LANGUAGE PROCESSING (NLP)

Imagine you are a psychotherapist and find out about ELIZA (one of the first chatbots), an apparently intelligent being. How would you react? ELIZA simulated a conversation partner for a therapeutic conversation (client-centred psychotherapy) and is considered one of the first programmes to use natural language processing via input from an electric typewriter. ELIZA used a series of pattern recognition and substitution rules to respond to client input.

Through rephrasing statements (mirroring), repeating them or returning questions, she was able to create the impression that she actually understood the conversation. In this way, ELIZA was capable of involving her clients in what appeared to be a psychotherapeutic conversation. How do you suppose Weizenbaum – her creator, reacted?

Weizenbaum was surprised to discover that some therapists and clients regarded ELIZA as a serious dialogue partner or saw it as a potentially helpful tool in therapy. This unsettled Weizenbaum and led to his scepticism towards Artificial Intelligence in a therapeutic context (from ethical perspective). He himself criticized the idea that machines could replace complex human relationships and therapeutic processes. He warned that relying on such algorithms could undermine human empathy and professional psychotherapeutic work. Weizenbaum's work was revolutionary because ELIZA demonstrated the potential - and, as the development highlighted, the ethical challenges - of using an ostensible 'AI' to interact with people.

Technically speaking, however, ELIZA is not Artificial Intelligence in the modern sense. It had neither the understanding, nor the learning capabilities or adaptive logic that characterize modern AI systems. ELIZA worked exclusively according to fixed rules that followed predefined patterns, without recognizing the meaning of the input. It was, therefore, more of a sophisticated algorithm using pattern matching techniques than a true AI based on more complex methods of learning or decision-making.

Pattern Matching

Here, the programme recognizes certain words or phrases in a processed text statement and assigns them to predefined response patterns. Instead of really understanding the meaning of sentences, the programme works with patterns. The user input (INPUT) is compared with a list of keywords or phrases that trigger certain responses. To illustrate, ELIZA could respond to an input such as 'I am sad' by identifying the word 'sad' and giving a predefined response, such as 'Why are you [sad]?' or 'Can you describe this in more detail?'. This response gives the impression that ELIZA can understand your emotions, although the programme only calls up a predefined mechanism. For example, ELIZA recognises the word 'mother' in a sentence and could respond with 'Tell me more about your [mother / family]'. With the pattern 'mother', sequences or speech patterns are recognised and frequently used formulation chunks 'Tell me more about ...' are triggered, for example, on a topic of family relationships, and thus operate according to strictly defined rules.

Adaptive Logic

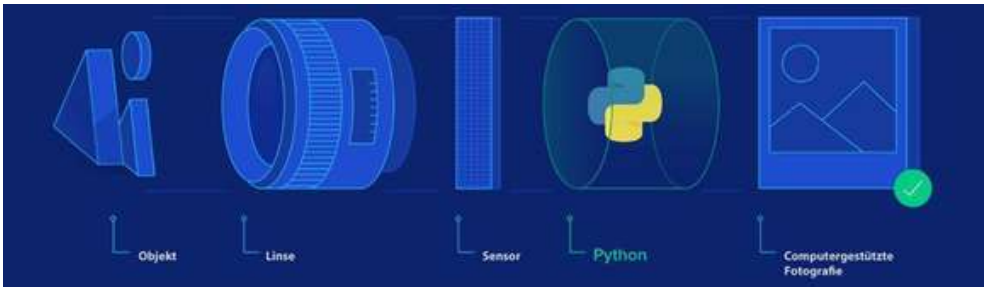
Instead of a strictly defined method, adaptive logic enables dynamic adjustment to new data or findings by flexibly switching between different solution approaches or learning new patterns. This approach can, therefore, react to complex and unpredictable situations. Take autonomous driving, for example. Oh, I'm not sure, would you trust a car to an AI? Here, the system can react to different situations (manhole cover missing on the road). Depending on changing environmental conditions (for example, darkness) or new obstacles (round hole in the road), the system can adapt and make decisions (for example, swerve, brake, drive over).

FUNDAMENTALS OF IMAGE PROCESSING AND COMPUTER VISION

You're aware that you're seeing something right now and in this very moment, you're actively reading and processing this text. But have you ever wondered how machines "see"? Can machines really "see"? Computer vision (CV), "also known as machine vision, comprises various methods [of interoperability for] capturing, processing, analysing and interpreting images" (Priese, 2015, p. V). In addition to individual images, video sequences and real-time video transmissions can also be processed sequentially in form of frame rates (frames per second).

This means that you can use CV to transform image information (pixel information) from a real environment into a digital environment. Accordingly, CV is an interdisciplinary and scientific field that deals with the use and further development of techniques to help computers analyse or understand the content of a single image or video.

The figure below visualises the interaction between technical components such as lenses, image sensors (CMOS) in smartphones and digital processes. These interactions include, for example, real-time image processing, the use of higher programming languages (such as Python, including various programme libraries). This means that the transfer of an object's information into the digital environment is determined by the interaction of nearly all components.



Computer vision (Balaban, 2018)

Software-based image pre-processing already takes place within the camera, which, for example, automatically adjusts the brightness and contrast as well as making other colour changes. “This adjusts the result, which is more attractive to the human viewer [...]” (ibid.).

Now let’s break down the image processing. It involves the following 5 steps:

- **Data or image input:** Think of this as taking a photo. You start with a digital image. It is just like snapping a picture with your smartphone. It is the raw data you are working with.

- **Pre-processing of the images for optimization:** Imagine adjusting the photo. Maybe it is blurry, too dark, or full of unnecessary image noise. You adjust, for example, the brightness or crop it so that only the important parts are clear and ready to use.

- **Segmentation of the images:** Now, let's pretend you are cutting the photo into pieces, like a puzzle. For example, if it is a picture of a cat in a garden, you separate the cat from the background so you can focus only on the cat.

- **Classification and / or analysis:** Here you play a detective. You look at the cat and decide, "This is a Siamese cat", or analyse its characteristics, like size or fur colour.

- **Output:** Finally, you share the processed photo. Maybe it is a processed image ready for social media or it is labelled as "Cat" and stored in your organized gallery.

But How Computer Vision Works?

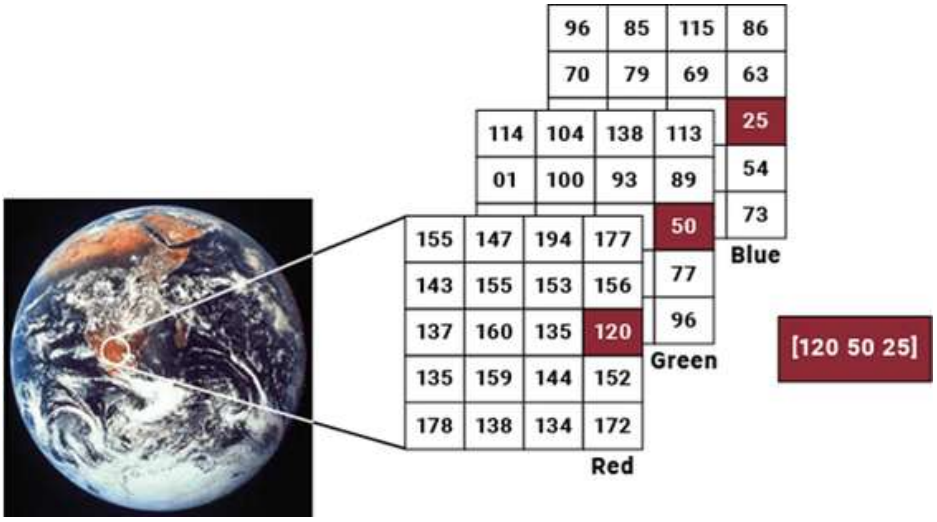
Imagine you are a robot trying to recognize objects in your surroundings by using a camera. Just like you (as a human) use your eyes to see, a computer "sees" through its camera. When you look at something, your brain automatically processes the information. Did you know that the image on your retina is actually upside-down and reversed? Did you know that infants have the inability to recognize upside-down faces and inability to recognize upright faces ("inversion effect") at 5 months of age? Luckily, your brain fixes this for you. Computers also process information, but they do it differently. Let's explore that more closely. Think about mosaic images made of small shapes, like squares of colourful stone, arranged in patterns. These mosaics have been around since ancient times. Now imagine how this idea is similar to digital pixel graphics. At a low resolution, images look "blocky" or pixelated, but at a higher resolution, the transitions between pixel colours become smooth. Digital images, just like mosaics, are made up of tiny pieces called pixels.

When you look at a digital image, the colour information it contains is stored in something called the RGB colour space. This is based on the three primary colours of light (red, green, and blue). By changing the intensity of these three colours, you can create a huge range of new colours. Think about how you mix colours in art using pigments, where mixing more colours generally darkens the result. In contrast, with light, combining more colours (like red, green, and blue) creates brighter, even white light. The RGB system works so well because it mirrors how your eyes work.

Your retina has special receptors (called cones) that are sensitive to red, green, and blue light. In an RGB image, each pixel has three values, one for red, one for green, and one for blue. These values are stored in a three-dimensional grid, making it easy to adjust and control the colour of each pixel individually. This setup is what makes digital images so flexible for editing and processing.

In each colour channel, the array contains a grey value between 0 and 255 (8-bit) for each pixel, with 0 representing black and 255 the maximum brightness for this channel. When an RGB image is output, the values of the three-colour channels are combined, which makes it possible to access each colour value of a pixel via the pixel coordinates (i, j). For example, a pixel in RGB format can assume the value [155, 15, 20], which represents a specific colour nuance.

In a greyscale image, there is only one intensity level, which is also specified as a value between 0 and 255, for example [115].



RGB true colour image. Retrieved from: www.mathworks.com/help/matlab/creating_plots/image-types.html

Examples of RGB colour values are:

- Red: [255, 0, 0]
- Orange: [255, 100, 0]
- Turquoise: [0, 255, 255]

You can try to extract pixel values from one of your images (www.boxentriq.com/code-breaking/pixel-values-extractor). “Extract pixel values from images of most file formats (include .jpg, .tif, .png, GIF, etc). Your images will be converted to numerical values. Either 0 or 1 for the black/white modes, or 0-255 for the other modes. You can also customize the delta (step size) in both x and y directions. Leave the values at default to include all pixels of the image.” (Boxentriq 2024).

Processing Images

We now know that the computer needs information from the images to process them. Let's have a closer look at this processing procedure. In computer vision, image processing usually involves several steps to extract and analyse relevant information:

- **Image acquisition:** We have already gone through this process before. We have image information in RGB values.
- **Pre-processing:** To improve the processability of the image and its image information, pre-processing, for example resizing, black and white conversion, etc., is often carried out. This makes it easier for the algorithms to interpret the data (through the reduction of data).
- **Feature extraction:** Relevant details in the image are extracted. Characteristics can be edges, shapes, colours or specific objects. Various methods, such as edge detection (e.g., the Sobel or Canny method) or colour analysis, can help to simplify and highlight key parts of the image.
- **Object detection and recognition:** Once the most important features have been identified, the algorithms attempt to recognize and identify objects in the scene. Techniques such as convolutional neural networks (CNNs) allow the computer to recognize patterns and shapes and identify objects in the image.
- **Evaluation and decision-making:** Finally, the computer interprets the data and analyses the relationships between the recognized objects or parts of the scene. Depending on the task, it can provide insights, make decisions or perform an action, for example, draw a user's attention to a recognized object.

The limits of perception or interpretation for humans are sometimes very difficult, and the machine and its underlying algorithms also reach their limits.

AI IN ROBOTICS

When you think about Artificial Intelligence in robotics, it's built on methods like machine learning, computer vision, natural language processing, and more. To make it easier for you to understand, here are some examples of how these AI concepts can be used in robotics.

Imagine you are teaching a robot to navigate its surroundings. With reinforcement learning, the robot learns through trial and error and exploring, making decisions, or earning rewards when it avoids obstacles or finds the fastest route. Now think about how you use your senses to understand the world. Robots do something similar with sensor fusion. They combine inputs from lidar, cameras, and infrared sensors to create a detailed 3D map and figure out where they are in it. Algorithms like SLAM (Simultaneous Localization and Mapping) help robots use this data to move through places they have never been before. When it comes to recognizing objects, robots rely on Convolutional Neural Networks (CNNs). These networks are great at processing images and allow robots to identify objects, understand their shape and size, and even spot production defects or sort items correctly.

In dynamic environments, robots use deep reinforcement learning to handle objects. Picture a robot figuring out how to pick up or move things by trying different strategies and learning what works best from its successes. With supervised learning, robots can be trained for specific tasks using example data. For instance, they might learn how to use a tool to solve a problem or recognize patterns that signal potential failures. Robots can also use transfer learning to apply skills they have learned before in new situations, making them faster and more adaptable. If a robot interacts with you, it uses natural language processing to understand what you say or write. Advanced models like the Transformer help it grasps the context and meaning of your words so it can respond appropriately. Robots can even recognize emotions by analysing facial expressions and tone of voice. This helps them react to your feelings and create a more natural, empathetic interaction.

Think about how you might notice when something feels off in your daily routine. Robots do the same with anomaly detection algorithms. These algorithms look for unusual patterns in the robot's operational data, that do not match to normal behaviour. This helps catch errors early, so they can be fixed before turning into bigger problems. Now imagine you are trying to make your work more efficient. Robots use optimization algorithms to do just that in production processes. They analyse how things are being made, identify bottlenecks, and suggest changes to improve efficiency and reduce resource use. This is known as mathematical optimization, and it helps streamline processes for better results.

In this module, you explored the core ideas behind cognitive computing and its connection to AI technologies such as NLP, computer vision, and robotics. From understanding how machines process language and images to how robots learn and adapt, you have gained valuable insights into the systems that make AI behave more like humans. With this foundation, you are now prepared to think critically about both the capabilities and the implications of AI as we move into more complex discussions in the next module.

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15. ELIZA (NLP): https://www.youtube.com/watch?v=8jGpkdPO-1Y

16. TURK (AI not AI): https://www.youtube.com/watch?v=1tvla70hy9o

VIDEO: How NLP works in voice assistants (e.g., Alexa, Siri)

INFOGRAPHIC: Cognitive computing vs. traditional AI

ADDITIONAL READING (links to external information resources)

The NASA Space Place page explores the role of robots in space exploration, highlighting their ability to endure harsh environments, operate autonomously, and perform tasks that are too dangerous for humans. Examples of robots include the Mars rovers (Curiosity and Perseverance), A-PUFFER (a foldable explorer), and BRUIE (a buoyant rover for under-ice exploration). NASA is also developing humanoid robots like Valkyrie, designed to assist in future human space missions. Robots provide cost-effective, long-term solutions for space missions without the risks and costs associated with human travel. http://www.spaceplace.nasa.gov/space-robots/en/

The European Space Agency (ESA) is exploring the use of Artificial Intelligence (AI) in space, particularly for enhancing satellite autonomy, Earth observation, and space exploration. AI is helping satellites become more agile, manage large data sets, and support sustainable missions like lunar exploration. ESA's projects are focused on AI-driven advancements, such as autonomous navigation, AI-based data analysis, and collision avoidance for satellites. These innovations aim to improve space operations, optimize resource use, and expand the scope of space exploration. http://www.esa.int/Enabling_Support/Preparing_for_the_Future/Discovery_and_Preparation/Artificial_intelligence_in_space

PRACTICAL EXERCISE (for classroom activities with a teacher)

Case Study: Evaluating a Natural Language Processing Chatbot ELIZA

Objective and instructions: Students will interact with a chatbot that uses natural language processing (NLP) to understand and respond to students' questions. The students will be tasked to evaluate how well it performs and then write a short review sharing their thoughts.

At the end of the task, the students will have to answer the reflective questions. The answers should be with approx. 150-200-words length each, depending on the question.

Introduction: First, let's talk about natural language processing (NLP) - a technology that allows chatbots to understand and generate human language. It helps them "read" your questions and respond in a way that feels natural. The purpose of the ELIZA chatbot is to simulate conversation. It is a simple NLP program that rephrases your inputs to create the illusion of a conversation, like a mirror reflecting what you say.

For completing the task use of one of the following ELIZA chatbot tools:

- NJIT's ELIZA: https://web.njit.edu/~ronkowit/eliza.html
- Masswerk's ELIZA: https://www.masswerk.at/eliza/

Instructions for students:

Step 1: Activity

1. Open one of the **provided links** to start using the ELIZA chatbot.
2. Ask the chatbot a**t least 10 different questions** or make statements about various topics.
3. Pay attention to **how ELIZA responds** and keep track of its replies.

Instructions for students:

Step 2: Evaluate how well the chatbot performs using the following criteria:

1. **Clarity**: Are the chatbot's responses well-structured, easy to understand, and free from ambiguous or overly complex language?
2. **Relevance**: Do the chatbot's answers directly address the question, and do they provide useful, meaningful information?
3. **Understanding**: Does the chatbot correctly interpret your intent or context, even if the question is phrased in a less straightforward way?

Step 3: Document your observations:

1. **Create a table summarizing the evaluation** for each criterion. Use the table below as an example:

Criterion	Example Response	Evaluation	Notes
Clarity	Answer: "The capital of Germany is Berlin." (Question: "What is the capital of Germany?")	Clear	Simple and correct answer.
Relevance	Asnwer: "I think you're asking about sports". (Question: "I have recently started running. What do you think about sports?")	Partially relevant	Missed the question focus.
Understanding	Answer: "Yes, I can help with that topic". (Question: "Can you tell me about philosophy?")	Good understanding	Understood vague intent.

2. Use the table and provide a **descriptive analysis (150-200 words).** Write a brief explanation for each criterion:
   - o What worked well?
   - o What did not work well?
   - o Include specific examples to support their observations.

QUIZ WITH MULTIPLE-CHOICE QUESTIONS (one correct answer per question)

1. What is the primary difference between 'cognitive' and 'compute' in the context of cognitive computing?

a) 'Cognitive' relates to machines performing calculations, while 'compute' is about understanding human thoughts.
b) 'Cognitive' refers to conscious mental processes, and 'compute' refers to using machines to calculate answers.
c) 'Cognitive' means machines can think like humans, and 'compute' is about physical computing hardware.
d) 'Cognitive' is about analysing data, and 'compute' is about managing complex algorithms.

2. Which of the following best describes cognitive computing?

a) A technology that enables machines to think and act like humans.
b) A system that adapts to human behaviour and interprets complex data to learn from experience.
c) A method for simulating human-like thought through physical computation devices.
d) A technology that mimics human emotions in machine interactions.

3. Who first proposed the Turing Test to assess machine intelligence?

a) John McCarthy
b) Arnold Schwarzenegger
c) Alan Turing
d) Ada Lovelace

4. What was ELIZA, developed by Josef Weizenbaum in 1966, primarily designed to do?

a) Perform intelligent calculations for scientists.
b) Simulate a conversation for client-centred psychotherapy using pattern recognition.
c) Operate as a chatbot to perform basic language translations.
d) Analyse large datasets to provide fast solutions

QUIZ WITH MULTIPLE-CHOICE QUESTIONS (one correct answer per question)

5. What is the key difference between ELIZA and modern AI systems like those used today?

a) ELIZA uses advanced learning algorithms, whereas modern AI does not.
b) ELIZA relies on fixed patterns and rules without understanding or adapting, while modern AI can learn and adapt.
c) ELIZA can understand context, but modern AI cannot.
d) ELIZA uses machine vision to process images, while modern AI uses text-based input only.

6. Which of the following is a typical step in the image processing pipeline of computer vision?

a) Predicting emotions from facial expressions
b) Image acquisition, pre-processing, segmentation, classification, and output
c) Transforming an image into audio format
d) Detecting specific colours in a digital environment.

7. In which of the following scenarios would reinforcement learning most likely be used in robotics?

a) A robot uses labelled data to categorize objects in its environment.
b) A robot learns to navigate a new environment by trial and error, receiving rewards for successful actions.
c) A robot applies pre-defined rules to detect and correct production errors.
d) A robot communicates with humans through natural language processing.

8. Which of the following AI technologies is most commonly used in robots to recognize objects in their environment?

a) Natural Language Processing (NLP)
b) Computer Vision by using Convolutional Neural Networks (CNNs)
c) Pattern Matching (PM)
d) Reinforcement Learning (RL).

QUIZ WITH MULTIPLE-CHOICE QUESTIONS (one correct answer per question)

9. What is the purpose of transfer learning in robotics?

a) To allow robots to learn new tasks from scratch.
b) To help robots adapt previously learned skills to new situations or environments.
c) To improve robots' ability to process images in real time.
d) To enable robots to communicate more effectively with humans.

10.What role do RGB values play in image processing within computer vision?

a) RGB values define the size and resolution of an image.
b) RGB values help to distinguish objects from the background.
c) RGB values store colour information for each pixel, enabling detailed image processing.
d) RGB values are used to convert images to grayscale.

Module 5: Ethical Considerations and the Future of AI

The aim of the current module is to help you comprehend the ethical considerations surrounding Artificial Intelligence (bias, privacy, job displacement) and the future developments in AI and their potential societal impact.

By the end of the module, you will be able to acquire different skills:

- **Ethical Reasoning:** gaining the ability to critically evaluate the ethical challenges AI poses, including bias, privacy, and job displacement.
- **Awareness of AI's Societal Impact:** understanding the potential future developments of AI and how they could shape society, the workforce, and technology.
- **Reflection on AI Responsibility:** developing opinions on how to responsibly use and implement AI to minimize harm and maximize benefits.

Module Duration	2 hours (guided and self-paced)

You already know how strongly AI is embedded in our everyday lives. Without knowing the rightful use of AI, we might violate other people's rights. It is, therefore, essential to learn and understand the ethical implication of AI systems and models. This will also help you to better understand what future roles and developments are predicted for AI in the years to come.

In this module, you will explore how to use AI-generated content appropriately in different forms, what constitutes dishonest use of AI, what AI ethics guidelines are, and what biased AI is. Moreover, you will learn interesting facts about the relation of AI development to job displacement, privacy issues and surveillance misuse.

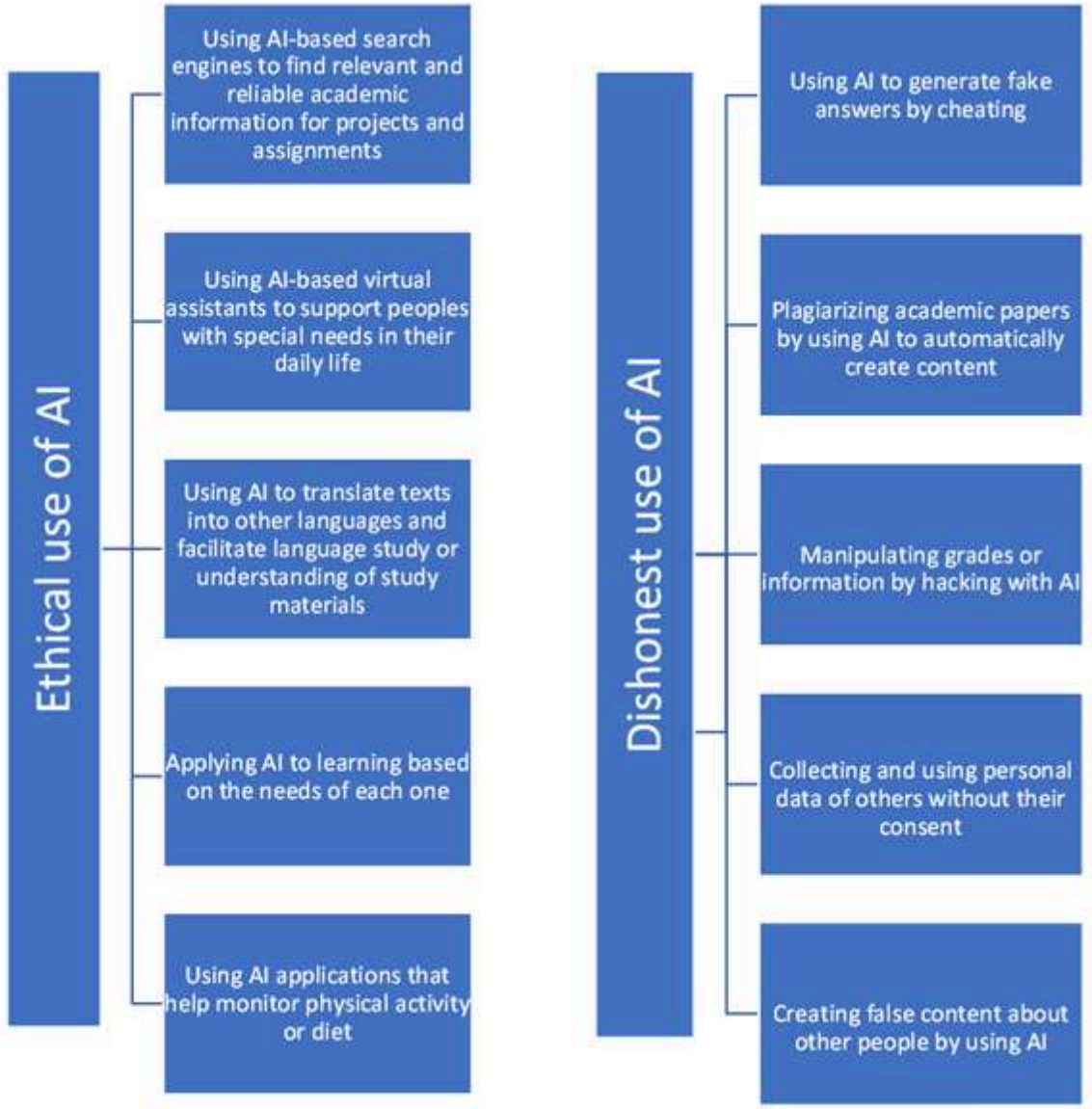
OVERVIEW OF AI ETHICS

Today, perhaps more than ever, it is vital to insist that technology, in itself, is ethically neutral. Everything depends on how we use it. Artificial Intelligence can serve the human community, but it could also be the other way around: we might be serving this new tool. That is why it is worth complementing purely technological training with some reflection on the meaning of it all. Think not only about the means, but also about the ends.

As a student, life can get busy. Between your daily tasks, classes, and family obligations, you may not feel you have enough time to complete all what you have to do. Generative Artificial Intelligence can help you create new content based on patterns it has learned from vast, existing datasets. But this capability could lead to misinformation if the AI generates and disseminates plausible but entirely fabricated information or stories. Along the same lines, AI-generated art, music, and text might violate existing copyrights. Artificial Intelligence systems could be used for harmful reasons, such as terrorism, manipulation, and disinformation, or entrenching a totalitarian state. Would it be such a bad thing to let an Artificial Intelligence tool, such as ChatGPT, do your assignment? Or what could happen if you use AI to fabricate information or unreal situations? These are ethical questions – ones that Artificial Intelligence ethics tries to answer.

> ***"Simulating the behaviour of 100 billion neurons in the human brain is not feasible by classical computing, but quantum machine learning promises to meet that requirement".*** - Amit Ray, born on 12th of August, 1960, is an Indian author and "spiritual master", known for his teachings on meditation, yoga, peace and compassion.

Think About These Examples:



Source: Graphic created by M&M Profuture Training

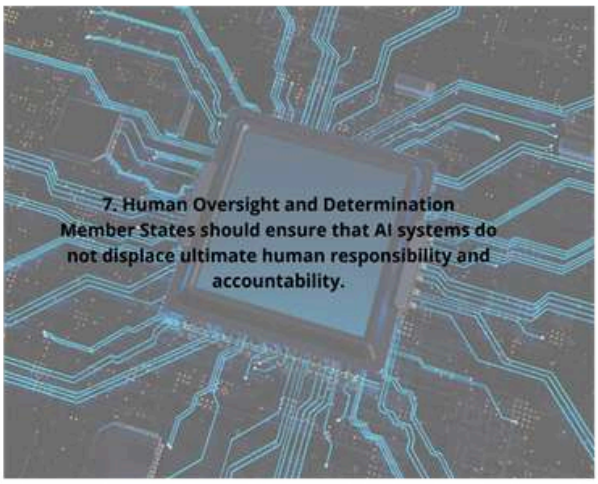
This is the Reality of AI, but What are the Ethics in AI?

As with any powerful technology, AI comes the responsibility to use it ethically. AI must involve the responsible conception, creation, and implementation of systems that uphold fundamental rights and human values. Ethics in AI refers to the set of moral principles that govern the design, development, integration, and use of Artificial Intelligence systems. AI ethics guidelines are meant to ensure that AI is used responsibly, ensuring the privacy of both data and users, eliminating bias, and not causing harm to society.

In November 2021, UNESCO produced the first-ever global standard on AI ethics named “Recommendation on the Ethics of Artificial Intelligence”. It developed 10 core principles that outline the human-rights-centred approach to the ethics of AI.

The 10 core principles are:

Source: Illustration created by M&M Profuture Training



Source: Illustration created by M&M Profuture Training

But How These Aspects Can Affect Your Daily Life, Not Only as a Student but also as a Citizen?

Read these examples of AI uses:

AI in Automotive - Autonomous car

An autonomous car is a vehicle capable of sensing its surroundings and moving with little or no human involvement. Imagine a self-driving car with broken brakes speeding towards a grandmother and a child. By swerving slightly, only one of them can be saved. This time, it is not a human driver who will make the decision, but the car's algorithm.

Source: AI creation

Who would you choose, the grandmother or the child? Do you think there is only one correct answer?

AI in Court of Justice

The use of AI in judicial systems around the world is increasing, creating more ethical questions to explore. Presumably, AI could evaluate cases and apply justice in a better, faster and more efficient way than a judge.

Would you like to be judged by a robot in a court of law, even if we are not sure how it would arrive at its conclusions?

> ***"What we all need to do is make sure that we are using AI in a way that is for the benefit of humanity, not to the detriment of humanity".*** - Tim Cook, CEO and soul of Apple after the loss of Steve Jobs in 2011.

AI in Education

Do you know that using AI or ChatGPT to do your homework and assignments can be an ethically controversial issue? On one hand, these resources can be useful because they help you to find information and better understand a topic. However, if you simply copy and paste information generated by AI or ChatGPT without doing your own research and reflection, this can be considered plagiarism and you will violate academic standards.

What do you think – is it ethical for students to use AI or ChatGPT for their homework?

AI Creates Art

The use of AI in the field of culture raises interesting ethical reflections. In 2016, a painting by Rembrandt, was designed by a computer and created by a 3D printer, 351 years after the painter's death.

But who can be designated as the author? The company that ran the project, the engineers, the algorithm, or... Rembrandt himself?

Source: ING, Microsoft, TU Delft, & Mauritshuis. (2016). The Next Rembrandt [Image generated by Artificial Intelligence].

All these examples show different concerns surrounding AI ethics. Which ones are they?

THE MAIN CONCERNS SURROUNDING AI ETHICS

Ethics surrounding AI attempt to address three of the biggest concerns: privacy and security, bias, and human rights.

Bias and Discrimination

A bias is an inclination or prejudice for or against a person or group, especially in a way considered to be unfair. AI systems can inherit biases from their training data, leading to unfair outcomes. This becomes an ethical problem if societal inequalities and discrimination are perpetuated among AI's output across the healthcare, employment, and criminal justice sectors, among others. In a digital world where AI is increasingly capable of generating fake news and serious deepfakes, it's crucial to develop critical thinking and to stay alert. Every individual has responsibility and plays an essential role in detecting and combating misinformation online.

There are:

- **Selection bias:** This happens when the data used to train an AI system is not representative of the reality it's meant to model.
- **Confirmation bias:** This type of bias happens when an AI system is tuned to rely too much on pre-existing beliefs or trends in the data. This can reinforce existing biases and fail to identify new patterns or trends.
- **Measurement bias:** This bias occurs when the data collected differs systematically from the actual variables of interest.
- **Stereotyping bias:** This bias happens when an AI system reinforces harmful stereotypes.
- **Out-group homogeneity bias:** When this happens, an AI system is less capable of distinguishing between individuals who are not part of the majority group in the training data; it's a form of out-group homogeneity bias.

An image search for "schoolgirl" will likely bring up a page full of women and girls in all sorts of sexualized costumes. Surprisingly, if you type in "schoolboy," the results will mostly show regular young students. No or very few boys will appear sexualized.

Job Displacement

The workplace is one of the main fields of application for AI. Thanks to this technology, companies can optimize their production processes. In addition, they manage to improve productivity and increase the security and efficiency of workflows. Automation also makes it possible to obtain customer data during the sales process in order to analyse their movements and develop personalized strategies. But, is AI capable of taking away jobs from some people?

Yes, it is a fact that AI has the potential to automate certain jobs and make them redundant. This could result in some job losses for people in those industries. Besides leading to widespread unemployment, AI can disproportionately replace the jobs of lower-skilled workers, increasing income inequality. This would create a societal challenge, raising concerns about the fair distribution of the benefits and burdens of technological advancements. On the other hand, AI also has a potential to create new jobs and increase productivity, leading to economic growth and the creation of new opportunities.

Actually, there are tasks that Artificial Intelligence cannot perform autonomously and efficiently, such as creativity and critical thinking. These skills are essential for resolving potentially complex situations and making strategic decisions, which are essential for the proper functioning of companies. The arrival of AI has meant an improvement in jobs, but it has also become an opportunity for the creation of new profiles specialized in technologies, such as experts in AI, Cloud and Data.

Some of the digital profiles with great job prospects include:

- Data analyst
- Blockchain specialist
- Cloud engineer
- AI specialist

> ***"Every machine has artificial intelligence. And the more advanced a machine gets, the more advanced the artificial intelligence will be. But a machine cannot feel what it is doing. It only follows instructions – our instructions – from human beings."*** **–** Abhijit Naskar, one of the world's most renowned neuroscientists.

Privacy and Surveillance

The collection and processing of data can raise concerns about how it is used and who has access to it. Key privacy concerns around AI are the potential for data breaches and unauthorized access to personal information.

Do you know? The reality shows that the EU cybersecurity landscape continues to be strongly impacted by geopolitical events, with cyberattacks on the rise: ENISA recorded more than 2 500 cyber incidents from July 2022 to June 2023, with 220 incidents specifically targeting two or more EU countries.

Consider this example:
In 2010, Facebook founder and CEO Mark Zuckerberg said in an interview that "the era of privacy is dead". Ironically, in July 2019, the US Federal Trade Commission (FTC) imposed a fine of 5 billion dollars on Facebook for its management of user privacy following the Cambridge Analytica scandal.

The use of personal data by the British consultancy Cambridge Analytica of 87 million users, obtained through Facebook, to psychologically manipulate voters – apparently decisively – in the US election campaign in favour of Trump, or in the campaign of the last British referendum in favour of Brexit, is the most sinister example of the power of Big Data and Machine Learning.

This company obtained psychometric profiles of citizens across the United States. Through their digital trail, it could identify if users were male or female, their age, what car they drove and even what type of cereal they ate for breakfast. It could also find out their political preferences and main social concerns. Cambridge Analytica used Big Data and Machine Learning to perform predictive analysis which helped them develop commercial and political communication strategies. Did they break the AI ethics using personal data without permission?

How Can You Avoid Such Situation?

Source: Illustration created by M&M Profuture Training

THE FUTURE OF AI

When the company OpenAI released an Artificial Intelligence program called ChatGPT in 2022, it marked a radical change in how we use technology. People could unexpectedly have a conversation with their computer that felt a lot like talking to another person, but that was just the beginning. AI assured to upend everything from how we write programming code and compose music to how we diagnose sick people and design new pharmaceutical remedies.

Artificial Intelligence has a bright future, but it also faces some difficulties. It is expected to become more widespread as technology keeps advancing, transforming sectors such as healthcare, banking, and transportation. Furthermore, as we have said the labour market will change as a result of AI-driven automation, creating a need for new jobs and skills.

AI is already impacting our lives in ways we don't always see. AI technology is being deployed in many domains, from autonomous vehicles to the Internet of Things (IoT), to a wide range of AI enabled algorithms and robots. Organizations are rushing to embrace the potential and possibilities of an AI-driven future. AI is estimated to become a $13T global market by 2030.

The Future of Humanity Institute, an interdisciplinary research centre at the University of Oxford, has conducted a study with 352 scientists and researchers who are experts in AI and has drawn up some predictions that seem likely to come true:

- It is believed that by 2026 machines will be able to write text comments better than high school students.
- Driving a truck, from 2027, will be safer if done by a machine than by a person. The accident rate will be significantly reduced.
- AI in commerce will surpass human salespeople by 2031.
- In 2049, machines with AI will be able to write best sellers. Can you imagine buying a book written by a robot?
- Entering the operating room will be very safe in 2053, when robots will be able to perform surgery.
- And it is even predicted that in 2057 robots will be able to carry out their own scientific research.

> ***"The world hasn't had that many technologies that are both promising, and dangerous"*** - Bill Gates (Seattle, Washington, 1955), is an American computer scientist and businessman, founder of Microsoft.

As we move further into an AI-driven era, understanding the ethical dimensions and future implications of Artificial Intelligence is no longer optional – it is essential. In this module you have understood how AI works, recognizing its applications, and critically evaluating its impact on society. Being informed now enables you to engage in discussions about AI ethics and contribute to the responsible development of future technologies. As a student, citizen, and future professional, your perspective can help ensure that AI serves humanity, respects individual rights, and promotes a fairer, more equitable future for all.

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VIDEO: The future of AI – Ethical dilemmas and emerging challenges

INFOGRAPHIC: AI ethics issues (e.g., bias in algorithms, impact on employment)

ADDITIONAL READING (links to external information resources)

The Guardian Article: The article presents students' evidence about the Twitter algorithm's "bias" toward lighter, slimmer, younger faces. https://www.theguardian.com/technology/2021/aug/10/twitters-image-cropping-algorithm-prefers-younger-slimmer-faces-with-lighter-skin-analysis

The electronic frontier foundation: The article explains the concerns about the widespread use of AI-powered monitoring software in schools, such as Gaggle and GoGuardian. https://www.eff.org/deeplinks/2024/09/school-monitoring-software-sacrifices-student-privacy-unproven-promises-safety

PRACTICAL EXERCISE (for classroom activities with a teacher)

Case Study: Scandal at a School in Córdoba (Spain): A Student Used AI to Create Pornographic Images of His Classmates

Objective and instructions:

The students need to read the following case study and, based on the information from the story, they need to answer the reflective questions. The answers should be with approx. 100-150 or 150-200-words length each, depending on the question.

The case study:

In July 2024, a student at the Manuel Belgrano School in Córdoba, Argentina, was accused of using Artificial Intelligence to create and distribute fake pornographic images of his female classmates. The student used AI tools to superimpose the faces of the young women onto the bodies of nude adult women, subsequently sharing the material on a pornographic website with objectifying descriptions. The father of one of the affected girls filed a complaint with prosecutor Juan Ávila Echenique, who specializes in crimes against sexual integrity. However, because the victims were of legal age, the prosecutor faced legal limitations under the current Penal Code, which only penalizes such acts when minors are involved. As a result, the case was referred to a judicial gender contravention unit. This incident reignited the debate on the need to regulate AI use to prevent similar abuses. In response, Córdoba legislator Juan Brügge introduced a bill in the National Congress to establish a legal framework promoting responsible use of AI, protecting citizens' rights, and ensuring ethical and transparent applications. The proposal includes identifying potential risks of AI concerning human rights and suggests that the National Institute of Industrial Technology (INTI) serves as the oversight and sanctioning authority.

This case in Córdoba is not isolated. In November 2024, students at the National Polytechnic Institute (IPN) in Mexico reported a classmate for altering photos of his classmates using AI to sell sexualized content. This legal process could set a precedent in Latin America regarding the use of AI in sexual offenses.

The proliferation of AI tools has facilitated the creation of "deepfakes" and other fake content, increasing cases of digital gender-based violence. Experts and international organizations have highlighted the urgency of legislating and educating on ethical AI use to protect individuals' rights and prevent abuse.

In summary, the incident in Córdoba underscores the need to update legal and educational frameworks to address the challenges posed by new technologies, ensuring the protection of individual rights and promoting the ethical use of Artificial Intelligence.

Source: https://www.infobae.com/sociedad/2024/07/03/escandalo-en-una-escuela-de-cordoba-un-alumno-utilizo-ia-para-crear-imagenes-pornograficas-de-sus-companeras/

Reflective Questions:

1. Think about how such incidents can be prevented. Summarize the event in your own words (150-200 words).
2. Highlight the key ethical concerns involved (e.g., privacy violation, misuse of AI, psychological harm).
3. Write a short reflection with your personal opinion: "If I were a classmate of the victims, how would I feel? What actions would I want to be taken?" (100-150 words).
4. Think about whether AI tools that generate images should have restrictions or regulations. What role do users, companies, and governments play in preventing misuse? (100-150 words).

QUIZ WITH MULTIPLE-CHOICE QUESTIONS (one correct answer per question)

1. What does "Ethics in AI" primarily focus on?
a) Increasing AI efficiency
b) Ensuring the ethical design, development, and deployment of AI systems
c) Enhancing AI's decision-making speed
d) Replacing human decision-makers.

2.Which organization produced the first global standard on AI ethics?
a) UNESCO
b) WHO
c) NASA
d) European Union.

3. What are the three primary concerns addressed by AI ethics?
a) Privacy, speed, and cost
b) Privacy and security, bias, and human rights
c) Design, implementation, and execution
d) Creativity, logic, and responsibility.

4. What potential danger of AI is highlighted regarding misinformation?
a) It can speed up decision-making processes.
b) It can generate and spread fabricated yet plausible information.
c) It cannot provide accurate search results.
d) It reduces bias in digital content.

5. What societal role does critical thinking play in AI ethics?
a) To automate decision-making
b) To improve AI programming
c) To combat misinformation and detect bias in AI
d) To eliminate the need for human intervention in AI.

QUIZ WITH MULTIPLE-CHOICE QUESTIONS (one correct answer per question)

6. What ethical challenge is associated with AI surveillance?
a) Reducing the cost of data collection
b) Using personal data without consent
c) Eliminating bias in security systems
d) Increasing accessibility of public resources

7. Why is bias in AI considered a significant ethical problem?
a) It increases the complexity of AI algorithms.
b) It can perpetuate societal inequalities and discrimination.
c) It reduces the speed of AI development.
d) It ensures AI systems are entirely neutral.

8. What is an example of stereotyping bias in AI?
a) AI creating art based on historical patterns
b) AI systems reinforcing harmful gender stereotypes
c) AI recommending diverse hiring practices
d) AI failing to provide accurate translations.

TEST

Final Assessment: AI Essentials Test

This is a multiple-choice quiz with a mix of conceptual questions and scenario-based questions that reflect the material covered in each of the five modules.

Grading:

- Total questions: **10**
- Passing score: **70% or above**

Take your time to read each question carefully and respond thoughtfully!

Question 1: What is the primary goal of Artificial Intelligence?

A) To replace human creativity entirely
B) To make machines capable of understanding intelligence and performing useful tasks
C) To develop robots exclusively for industrial applications
D) To replicate emotional intelligence in machines

Question 2: Imagine you are using a virtual assistant powered by AI, like Siri or Google Assistant. You ask it to remind you of an appointment tomorrow at 3 PM. Which key AI capability is being demonstrated in this scenario?

A) Emotional intelligence
B) Machine learning
C) Natural language processing (NLP)
D) Decision-making algorithms

Question 3: You are designing a new mobile app that helps users identify objects in their photos. Which AI technology would be most appropriate to implement this feature?

Certification

Upon completion of the course, including all 5 modules with quizzes, and the final assessment test, students will receive a digital certificate recognizing their understanding of AI fundamentals.

A) A deep learning model using convolutional neural networks (CNNs) to analyse images.
B) A machine learning model for detecting patterns in user behaviour.
C) A reinforcement learning model that adjusts suggestions based on user interaction.
D) A supervised learning model to recommend items based on user preferences.

Question 4: Why are deep learning models often better than traditional machine learning models for tasks like image and speech recognition?

A) Deep learning models use simple algorithms to process data, making them faster.
B) Deep learning models can handle large volumes of complex data and automatically extract features from raw data.
C) Traditional machine learning models are better for handling complex, unstructured data.
D) Deep learning models require less data to perform well on tasks like speech recognition.

Question 5: Imagine you are the principal of a school, and you want to use AI to improve learning outcomes for students. Which AI application would be the most effective choice?

A) An AI system that automates grading for teachers to save their time.
B) A personalized learning platform that adapts to each student's strengths and weaknesses.
C) A virtual assistant that schedules meetings and manages teacher calendars.
D) An app that generates random quiz questions for students.

Question 6: What is the main reason industries like healthcare, education, entertainment, automotive industry and finance to use AI?

A) To completely replace human workers.
B) To make decisions without the need of information.
C) To quickly analyse data and support making better decisions.
D) To make websites and apps look better.

Certification

Upon completion of the course, including all 5 modules with quizzes, and the final assessment test, students will receive a digital certificate recognizing their understanding of AI fundamentals.

Question 7: A delivery robot is tasked with navigating a busy warehouse to deliver packages to specific locations. The robot uses reinforcement learning and computer vision to avoid obstacles, locate the delivery zone, and optimize its route. Which of the following best describes the role of reinforcement learning in this scenario?

A) Detecting objects like packages and shelves
B) Learning optimal actions through trial and error based on rewards
C) Translating spoken instructions into commands
D) Processing colour information from RGB images

Question 8: In a technology education class, a robot is tasked with helping students identify tools on a table and sort them by size. The robot uses computer vision to recognize the tools and reinforcement learning to learn the most efficient sorting method. Which of the following technologies allows the robot to recognize the tools?

A) Natural Language Processing
B) Convolutional Neural Networks (CNNs)
C) Decision Trees
D) Reinforcement Learning

Question 9: What is the primary focus of ethics in Artificial Intelligence?

A) Improving the efficiency of AI systems.
B) Ensuring the ethical design, development, and implementation of AI systems.
C) Replacing human decision-making with faster systems.
D) Maximizing AI computational power and processing speed

Question 10: An AI system used for hiring discriminates against certain groups due to biases in its training data. What should be done to address this situation?

A) Review the data and adjust the algorithm to eliminate biases.
B) Suspend the use of AI systems in hiring processes.
C) Allow the system to operate while seeking a long-term solution.
D) Ensure diversity in the team developing the AI system to help identify and address biases.

Certification

Upon completion of the course, including all 5 modules with quizzes, and the final assessment test, students will receive a digital certificate recognizing their understanding of AI fundamentals.

Summary and Next Steps

These learning materials are made to help secondary school students understand the basics of AI. They cover important topics like the history of AI, how it's used in the real world, what the future might look like, and technologies like machine learning and neural networks. Everything is explained in a simple and easy-to-follow way, so students can easily learn the key ideas without getting into complicated details.

As a result of engaging with these educational materials, students will become familiar with the basic logic and fundamental concepts of AI, sparking their curiosity and motivating them to explore the subject further. They will gain sufficient background knowledge to take part in meaningful discussions and debates on AI ethics and its future implications.

These materials will also inspire students to think creatively about how AI can be used to address societal challenges in innovative ways. Furthermore, secondary school teachers will benefit from valuable resources to design engaging activities, assignments, and projects that build on students' foundational understanding of AI.

What Next?

Expanding on the work from Course 1 "Artificial Intelligence Essentials", there will be created a second digital course "Delving Deeper in AI with Python and Scratch" to explore advanced Python programming for AI and the associated mathematical principles. It will introduce hands-on exercises, especially in gaming contexts using Pygame/Arcade libraries. By integrating practical learning into gaming scenarios, Course 2 will boost student engagement and cultivate a stronger interest in STEM subjects.

Project Partners

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