PART-2
ARTIFICIAL INTELLIGENCE

Chapter 1: AI Project Lifecycle

Imagine a world where machines can hear, see, talk, and even take decisions. This may sound like a scene from a science fiction movie. It is not; it is Artificial Intelligence (AI).

AI is a type of technology that gives machines and computers the ability to perform work that normally requires human intelligence. These machines can perform complex tasks done by humans, like analysing data, finding patterns, predicting trends, solving problems, and making decisions by using data and learning from past experiences.

AI systems are designed to learn, adapt, and improve their performance over time. In simple words, AI is human-made intelligence that allows machines to behave intelligently. How is this possible?

Artificial Intelligence systems have been created to mimic human cognitive processes.

They can:

- **Analyse data:** Humans read and understand information to get knowledge. Similarly, AI studies large amounts of data to find meaning and make decisions. It can manage huge data quickly and efficiently.
- **Recognize patterns:** AI recognises patterns and relationships in data, such as trends, similarities, or repeated behaviours, by learning from various examples.
- **Learn from experience:** AI keeps improving over time by learning from new data. The more it learns, the better its performance becomes, much like humans improving with practice.
- **Make predictions or decisions:** Using what it has learned, AI can predict outcomes or make decisions, often based on probabilities and past data.

AI at Work: It's All Around Us!

AI is an important part of our everyday lives.

Here are a few examples:

In Healthcare: AI helps doctors diagnose diseases faster and more accurately by looking at medical scans and reports.
At Home: AI powers smart home devices like speakers that play your favourite music when you tell them to and thermostats that learn what temperature you like.
Getting Around: AI is the main technology behind self-driving cars and helps navigation apps find the quickest routes.
On Your Smartphone: AI is used when you use a voice assistant on your phone to set a reminder or when your photo app automatically puts pictures of the same person together.
Personalised Apps: It suggests new videos, items, and products you might like based on what you have done in the past.

How does AI learn?

The real magic behind Artificial Intelligence lies in **data**. Artificial intelligence and Machine Learning systems learn from data. These models learn by analysing huge datasets and recognising patterns. For example, Voice assistants, language translators and recommendation systems are so intelligent that they seem to know everything—that is only because they have access to massive data and keep training themselves. Every AI-driven program works correctly when supported by accurate and reliable data.

What is an AI Project?

Creating an AI application isn't magic, but it is a defined process. An AI project is the journey of developing a smart system to solve a real-world problem by learning from data.

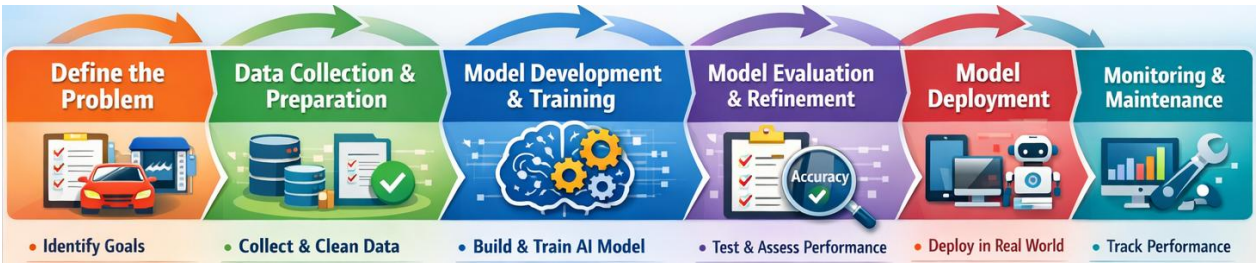
Think of it like a science fair project. You have a clear goal: *Will a plant grow better with sunlight?* For an AI project, the goal is just as specific, for example, to build a system that can recommend a new product to a user or create a filter that automatically detects spam emails.

An **AI project** is a step-by-step process of developing a system or model using artificial intelligence technology to solve a real-world problem by learning from past data. Similar to science projects, AI projects also have specific goals, such as recommending songs or detecting spam emails. The developed AI-based system is first trained on previous data, then identifies patterns, and makes predictions or decisions. The entire process of building, testing, and improving the system step by step is called the **AI project lifecycle.**

AI Project lifecycle:

The AI project lifecycle is an iterative, six-stage framework, for developing, deploying, and maintaining AI tools. It starts with defining the problem, data collection and preparation for modelling, development and training of AI models, model evaluation and its refinement, deployment of the model and continuous monitoring and maintenance.

Key Phases of AI Project lifecycle:



1. Define the problem:

The first and most crucial step in an AI project lifecycle is to define or identify the problem or goal clearly. At this stage, we must determine how the system should work and whether the AI system is really required for this project. It may be possible to complete the project without AI using simple automation.

Let us take an example of an Automatic car wash system

In this problem, the steps are:

- The car enters the bay
- Sensor detects Vehicle Position
- The car moves forward on the conveyor
- For a fixed duration, water is sprayed
- Soap is applied for a fixed time
- Brushes rotate at programmed speed
- Rinse cycle run
- Dryer activates
- The system stops when the car exits

In this example, there is no learning, adaptation, or decision-making beyond the programmed logic. No matter how big or small the car is, the machine always does the same things in the same way. It doesn't think, *this car is really dirty; maybe I should scrub it longer.* It simply does what it is told to do. So, you don't need AI to solve this problem. The system only needs rules that could be set up ahead of time and automated. These kinds of systems have fixed set rules and do not learn from data. This is an example of **automation**, not **AI**.

To develop an **AI-based car wash system**, learning, adaptation, and decision-making using AI replace fixed rules, where cameras with AI system scan the car to detect its size, dirt level, and type of dirt, and the system then decides water spray time, soap usage, and brush speed based on the dirt instead of fixed timing.

AI-based car wash uses **AI** to **detect** car size and dirt level and adapt washing actions. In contrast, in **automation** there is no learning, adaptation, or decision-making and the system follows fixed rules without thinking or improving.

Some other examples:

- **Traffic signal control:**
  - **Time**-based (automation): Traffic lights change every 30 seconds, no matter how many cars are waiting
  - **AI**-based: Traffic lights can also be controlled using AI. Where AI models are designed to adjust green light timing based on traffic density
- **Irrigation system:**
  - **Time**-based (automation): This irrigation system has a timer that waters the plants every day at 7 AM, no matter what the weather is like
  - **AI**-based: The irrigation system can also be developed using AI. Where AI models are designed to water plants based on soil moisture and weather using predictive analytics.

Identifying the problem or goal that an AI system really needs, is an essential task during the development of an AI project.

2. Data Collection and Preparation:

After defining the problem that requires AI, **Data collection** and preparation are the next important phase of an AI project lifecycle. AI systems/models mainly learn from past data, so the quality of that data is a **crucial factor** affecting their **performance**.

Let me give you a fun analogy:

Think about how you would teach a friend to bake a cake. The cake will be a disaster if you do not give the right ingredients or if the recipe is full of mistakes. AI is the same. The AI will be bad if the data is bad. In the world of AI, there is a well-known saying: **Garbage In, Garbage Out.**

Data collection:

Relevant data can be collected from the various sources based on the problem. Some of the sources of data collection are:

- **Sensors**: It is a device that measures physical changes in the environment and convert them into a measurable electrical signal. For example, temperature sensor measures the heat, or light sensor can detect the light intensity and convert it into an electrical signal.
- **Surveys:** Data is collected by asking questions and collecting responses from people
- **Websites:** Data can be collected from online sources such as articles, social media platforms, and websites.
- **Historical records:** These include past data stored in files, reports, or records.

Let us take an example:

To predict whether a student will score more than 75% marks in the exam or not. This is something every student secretly worries about, right?

For this problem, we can collect the following data from the previous students:

- **Attendance percentage** shows whether regular attendees usually score better
- **Hours studied per day** show if studying more helps improve performance
- **Previous test marks** show how they performed in earlier tests
- **Participation in class** Yes or No shows whether active students are more likely to succeed
- Final exams result Above 75% or Below 75% is the result we want to predict

Students	Attendance	Study Hours	Test Marks	Participation	Final Result
Student 1	90%	3 hours	78	Yes	Above 75%
Student 2	60%	1 hours	55	No	Below 75%
Student 3	80%	2 hours	70	Yes	Above 75%

This step is called data collection.

Data Preparation:

For developing an AI system, we need a large amount of data. However, during the data collection, the data we usually collect is raw or unorganised.

It may contain:

- **Missing values** are the data points that are not recorded, empty or unavailable in a dataset
- **Duplicate entries** are the data points that are repeated more than once in a dataset
- **Incorrect information** are data points that are incorrect and inaccurate
- **Irrelevant data** are data points that are not related or useful to the given problem

The data we collect is often raw and unorganised. It may contain errors, missing values, or unnecessary information. Therefore, we clean and organise the data before using it to train an AI model.

The following steps are commonly used during the data preparation:

Data Cleaning:

- Remove errors or irrelevant data
- Fill missing values
- Remove duplicate data

Data Formatting:

- Convert text into number (if required)
- Arrange data in a spreadsheet neatly

Data Labelling:

- Assign correct categories (e.g., Spam/Not Spam, Pass/Fail)

3. Model Development and Training:

After the data collection and preparation, the next step is AI model development and its training. Model development means creating an AI model that solves the problem defined in stage 1. An AI model works like the brain of the system. It learns from data and uses that learning to make predictions.

Think of it like this:

You are a teacher, and the AI model is your student. The data is your textbook. You teach the student (the model) by showing it examples from the textbook (the data). Over time, the student learns the patterns and can answer questions on its own.

Let us look at the previous example whether a student will score more than 75% or not. Create an AI model to address this issue by using the following data to learn from past students:

- Study hours
- Attendance
- Test marks
- Participation in class

This learning process of a model is known as **model training**.

The model will learn from the information of student 1, student 2, and student 3 and find the relationship between these students. It might notice that students with attendance above 75% usually score well. Or that students who study less than 2 hours rarely cross 75%. It's like the model is connecting the dots!

4. Model Evaluation and Refinement

After training, the model is tested using new data to check how well it works. Its performance is usually measured by accuracy, which shows how many predictions are correct.

Testing means checking the model using a test dataset. A test dataset is a set of data that was not used during training. It helps us understand how well the model performs on new, unseen data.

Think of it like this:

You taught your friend how to identify birds using a book with 10 pictures. Now you show them 5 new bird pictures they have never seen before. If they correctly identify 4 out of 5, their accuracy is 80%.

In the same previous example of predicting whether a student will score more than 75% marks in the exam or not, the accuracy of these predictions largely depends on the quality of the data used to train the model.

Let us consider from our training, the model learned that a student would get more than 75% if they have:

- More than 80% attendance
- Study more than two hours
- Get more than 75 on tests
- Participate in class

If not, the student will likely score below 75%. Now, this trained model will work for two new students, student 4 and student 5. Based on what it learned, the model predicts that student 4 will get more than 75%, but student 5 will get less than 75%.

Students	Attendance	Study Hours	Test Marks	Participation	Final Result
Student 4	82%	2.5 hours	77	Yes	**Above 75%**
Student 5	70%	1.5 hours	62	No	**Below 75%**

The model correctly predicts for 2 out of 2 students, so the accuracy of the developed model is 100%. Great job, model!

Suppose there are 10 students during the model evaluation, and the developed model correctly predicts for 7 of them. Then the model's accuracy is 70%.

There may be a condition: if our model correctly predicts only 2 out of 10 students, then its accuracy is only 20%. In this case, **model refinement** is required.

Model Refinement: Model refinement means improving the model when it does not give satisfactory results.

We can improve the model by making changes as given below:

- Adding more data
- Removing incorrect data
    - Changing model settings

- Training the model again

This process continues until the model performs well.

5. Model Deployment:

After the model has been trained, tested, and refined, the next stage is to deploy it in real-world use. It means the model is now ready for use :

- Take the input data (e.g., images, signals, or voice)
- Make prediction
- Help users in the real situation

It is like graduation day for your AI. It has learned, it has passed its tests, and now it's time for it to get a job!

In the previous example, a model is developed to predict whether a student will score more than 75%. This model can be **added or deployed** to a school software system after evaluation. The teacher enters the student information (like study hours, attendance, etc.) and then the system predicts the result of which students will score more than 75% and who will not.

Real-life examples of deployment:

- Spam detection in email apps
- Recommendation system in shopping apps
- Voice assistant
- Face unlock in smartphones

6. Monitoring and Maintenance

After the model is deployed and in use in the real world, the next key step is **Monitoring** and **Maintenance**. Monitoring is the continuous checking of the performance of the deployed AI model whereas Maintenance is to update the model to keep it accurate and efficient over time.

It regularly checks the following essential tasks:

- Is the system working correctly?
- Is the model giving the correct prediction?
- Has the accuracy remained the same or decreased?

In the previous example of score prediction, after some months or years, the model accuracy may have reduced because:

- Study pattern may change
- The exam pattern may change
- New types of questions may be introduced

If the deployed model is monitored regularly, it can help identify when it is not working properly or when its accuracy reduces. In such cases, the model needs to be updated or improved.

The model can be updated by:

- Adding new data
- Retraining the model
- Fixing the errors
- Improving performance

Points to remember:

- ✓ AI systems learn from data.
- ✓ A clear problem must be defined before building an AI system.
- ✓ AI models identify patterns in data.
- ✓ AI projects follow a step-by-step lifecycle.
- ✓ AI systems improve over time with more data.

Exercise

A. Multiple Choice Questions.

1. AI learns from:
   a) Magic b) Luck c) Data d) Guessing

   _____

2. In spam detection, the AI problem is to:
   a) Send emails b) Write emails c) Delete all emails d) Identify spam emails

   _____

3. The first stage of a project cycle is:
   a) Defining the problem b) Data collection c) Model development d) Model deployment

   _____

4. If an AI model predicts 8 out of 10 spam emails, the accuracy of the model is:
   a) 50% b) 20% c) 80% d) 100%

   _____

5. AI model improves because:
   a) It thinks like a human b) It has feelings c) New data is added d) It gets angry

   _____

B. Fill in the blanks.

1. AI learns by finding _____ in data.
2. An AI project follows a _____cycle.
3. Spam emails often contain suspicious _____.
4. After testing, we _____the system.
5. AI cannot work without _____.

C. Short answer questions.

1. How does AI learn?
2. Why is defining the problem important in an AI project?
3. What happens in the testing stage of an AI project?
4. What is meant by accuracy in AI?

5. Give one real-life example of an AI project.

D. Think and apply.

1. Imagine you are building an AI system to detect fake news.

Fill the table:

Stage	Your Answer
Define the problem	_____
Collect data	_____
Test AI tools	_____
Reflect and improve	_____

2. An online shopping company wants to build an AI system to predict whether a product will be delivered **on time or late**.

   To build this system, the company collects the following data from previous orders:

Order No.	Distance	Weather	Traffic	Delivery Partner	Final Status
01	5 km	Clear	Low	Experienced	On Time
02	20 km	Rainy	High	New	Late
03	10 km	Clear	Low	Experienced	On Time
04	15 km	Rainy	High	New	Late

After training, the model learned from the following pattern and delivery will be on time, if:

- Distance is less than 10 km.
- Weather is Clear
- Traffic is Low
- Delivery partner is experienced

Based on the learned pattern, complete the following table.

Order No.	Distance	Weather	Traffic	Delivery Partner	Final Status
05	8 km	Clear	Low	Experienced	_____
06	18 km	Rainy	High	New	_____