The **Machine Learning (ML) Life Cycle** is the step-by-step process used to build, train, evaluate, and deploy machine learning models. Here's a detailed breakdown of each stage:

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## 🧠 1. Problem Definition

- Understand the business or research problem.
- Define the goal of the ML system.
- Example: Predict student dropout from an online course.

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## 📊 2. Data Collection

- Gather data from sources like databases, sensors, web, etc.
- The data should be relevant and sufficient.
- Example: Collect student attendance, grades, and activity logs.

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## 🧹 3. Data Preprocessing / Cleaning

- Handle missing values, noise, duplicates, etc.
- Convert raw data into a usable format (e.g., numerical encoding).
- Normalize or scale features.

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## 📈 4. Exploratory Data Analysis (EDA)

- Visualize data patterns.
- Identify relationships and trends.
- Example: Correlation heatmaps, boxplots for outlier detection.

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## 🛠️ 5. Feature Engineering

- Select, create, or transform features to improve model performance.
- Example: Convert a date into day, month, and weekday.

## 🧪 6. Model Selection

- Choose suitable algorithms (e.g., Linear Regression, Decision Trees, SVM, etc.).
- Split data into training and testing sets.

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## 🏋️ 7. Model Training

- Feed training data to the algorithm.
- Learn patterns and create a model.

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## 📊 8. Model Evaluation

- Use testing data to measure performance using metrics:
  - Classification: Accuracy, Precision, Recall, F1-score
  - Regression: MAE, RMSE, $R^2$
- Example: Confusion matrix for a spam email detector.

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## 🔧 9. Hyperparameter Tuning

- Adjust parameters like learning rate, tree depth, etc., for better results.
- Use techniques like Grid Search or Random Search.

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## 🚀 10. Model Deployment

- Deploy the trained model to a production environment (web app, mobile app, etc.).
- Example: Flask API that predicts student dropout risk.

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## 🔁 11. Model Monitoring & Maintenance

- Monitor real-world performance.

- Retrain with new data if the model degrades (called model drift).