**Machine leraning**

**Model Performane:**

**📊 Model Performance in Machine Learning**

Model performance refers to how well a machine learning (ML) model predicts or classifies new, unseen data. Evaluating model performance helps determinewhether your model is useful and reliable.

**🔍 1. Key Concepts in Model Performance**

Term Description

Training Set Data used to train the model.

Test Set Unseen data used to evaluate performance.

Overfitting Model performs well on training data but poorly on new data.

Underfitting Model is too simple and performs poorly on both training and test data.

Generalization Model’s ability to perform well on unseen data.

🧪 2**. Common Evaluation Metrics**

➤ **Classification Models**

**Metric Formula / Meaning Use When**

Accuracy (TP + TN) / (TP + FP + FN + TN) Balanced classes

Precision TP / (TP + FP) Minimize false positives

Recall (Sensitivity) TP / (TP + FN) Minimize false negatives

F1 Score 2 \* (Precision \* Recall) / (Precision + Recall) Imbalanced classes

Confusion Matrix Table of TP, FP, FN, TN Detailed class results

ROC-AUC Area under the ROC curve Binary classification

> ✅ **TP: True Positive, FP: False Positive, FN: False Negative, TN: True Negative**

**➤ Regression Models**

Metric Description Use

MSE (Mean Squared Error) Avg. of squared errors Penalizes large errors

RMSE (Root MSE) Square root of MSE Easy to interpret

MAE (Mean Absolute Error) Avg. of absolute errors Robust to outliers

R² (R-squared) Proportion of variance explained Good overall fit metric

🧠 3. **Model Validation Techniques**

Technique Purpose

Train/Test Split Simple holdout validation (e.g., 80% train, 20% test)

K-Fold Cross-Validation Train model on different subsets (folds) of data

Stratified Sampling Ensures equal class distribution in each folw.

🧰 4. **Tools for Evaluating Performance**

Scikit-learn (sklearn.metrics)

TensorFlow/Keras (model.evaluate, model.predict)

Confusion Matrix Plots (Seaborn, Matplotlib)

Classification/Regression Reports

**🔁 5. Improving Performance**

Feature Engineering

Hyperparameter Tuning (Grid Search, Random Search)

Model Selection (Try multiple models)

Ensemble Methods (Random Forest, Gradient Boosting)