WEEK 3: CORE MATHEMATICS FOR MACHINE LEARNING

DAY 11 (10/07/2025)

Loss Functions in Machine Learning:

When a machine learning model makes predictions, it often makes mistakes — the **difference between predicted and actual values** is called **error**.
A **loss function** measures *how wrong the model's predictions are* and helps the model learn to reduce those errors over time.

Loss functions act like a **report card** for the model — showing how well or poorly it is performing during training.

1. What is a Loss Function?

A **loss function** gives a numerical value that represents how far off the model's predictions are from the actual values.

- **High loss** = Model is performing poorly.
- **Low loss** = Model is performing well.

The goal of training is to **minimize the loss**, meaning to make predictions as close to correct as possible.

Example:

If the actual house price is ₹50 lakhs and the model predicts ₹55 lakhs, the loss will measure the difference (error = 5 lakhs).
The model then adjusts its parameters to reduce this gap.

2. Why Do We Need Loss Functions?

Without a loss function, the model wouldn't know:

- How good or bad its predictions are.
- Which direction to move in to improve.
- When to stop training.

Loss functions give the feedback signal that drives learning — they tell the model whether it's getting closer to the goal or going the wrong way.

3. Types of Loss Functions

Different tasks use different loss functions depending on the problem type.

a. Regression Loss (for predicting numbers)

Used when output is continuous (like house prices, temperature, etc.)

- **Mean Squared Error (MSE):** Measures the average of squared differences between predicted and actual values.
    - Punishes large errors more strongly.
    - Example: Used in predicting house prices.
- **Mean Absolute Error (MAE):** Measures the average of absolute differences.
    - Less sensitive to outliers.
    - Example: Used in forecasting sales or weather.

b. Classification Loss (for predicting categories)

Used when output is a class label (like “Cat” or “Dog”).

- **Cross-Entropy Loss:** Measures how well the predicted probabilities match the actual labels.
    - Example: Used in image classification models.
    - If the model predicts 0.9 for “Cat” when the true label is “Cat,” the loss will be small.

4. How Loss and Optimization Work Together

Once the model calculates the loss, **optimization algorithms** (like Gradient Descent) :

- Look at the loss value.
- Adjust the model’s parameters (weights).
- Try to make the next prediction more accurate.

So, the **loss function tells the model *how wrong* it is**, and the **optimizer tells it *how to improve***.

Reflection

Today I learned that **loss functions are the heart of the learning process**.
They give direction to the model by showing how far off the predictions are from reality.
Without loss functions, machine learning would be like shooting arrows in the dark — the model wouldn’t know whether it’s hitting or missing the target.