Weekly Report: Imtiaz AI Alpha

Week 1 (April 22 – April 25)

Machine Learning Specialization

Course: **Supervised Machine Learning: Regression & Classification**

Week 1

The first week provided an introduction to supervised learning, emphasizing its goal of mapping input variables to corresponding outputs. Real-world applications were outlined, and foundational machine learning concepts were systematically introduced.

Key Points to Note:

- **Supervised Learning:** Mapping inputs (x) to outputs (y).
- **Regression**: Prediction of continuous numerical values; linear relationship modeled as y=mx+cy = mx + cy=mx+c.
- **Classification:** Categorization into classes (Binary or Multi-Class).
- **Unsupervised Learning:**
    - Clustering: Grouping similar data points.
    - Anomaly Detection: Identifying outliers.
    - Dimensionality Reduction: Simplifying datasets.
- **Linear Regression Notation:** Defining features, weights, bias, and predictions.
- **Cost Function:** Squared error to measure model performance.
- **Gradient Descent:**
    - Goal: Minimize cost function.
    - Types: Batch, Stochastic, Mini-Batch.
- **Learning Rate (α):** Critical parameter for optimization convergence.

Week 2

The second week expanded into advanced regression techniques and essential preprocessing steps, emphasizing computational efficiency and the importance of preparing data for optimal model training.

Key Points to Note:

- **Multiple Linear Regression**:
  - Handling multiple input features.
  - Vectorization for computational efficiency.
- **Gradient Descent with Vectors**: Speeding up training via matrix operations.
- **Normal Equation**: Alternative method for solving linear regression without iterations (limited by dataset size).
- **Feature Scaling**:
  - Mean Normalization and Z-Score Normalization.
  - Essential for convergence and balanced model training.
- **Learning Curves**: Visual tool for assessing gradient descent convergence.
- **Automatic Convergence Test**: Measuring small improvements in cost function.
- **Feature Engineering**:
  - Creating or selecting significant features.
- **Polynomial Regression**:
  - Capturing non-linear relationships through higher-order terms.

Week 3 Summary

The third week transitioned from regression to classification, addressing the limitations of linear regression for classification tasks and introducing logistic regression as a robust alternative.

Key Points to Note:

- **Issues with Linear Regression for Classification**:
  - Unbounded and continuous outputs.
- **Logistic Regression**:
  - Introduction of **Sigmoid Function** to bound outputs between 0 and 1.
  - Probabilistic interpretation of predictions.
- **Decision Boundaries**:
  - Linear and non-linear boundaries based on feature interaction.
- **Cost Function for Logistic Regression**:
  - Development of a convex function for effective optimization.

- **Gradient Descent for Logistic Regression**: Adjustment of parameters using updated equations.
- **Overfitting and Underfitting**:
  - Definitions and visual interpretations.
- **Solutions to Overfitting**:
  - Data augmentation, feature selection, and regularization techniques.
- **Regularization**:
  - Addition of penalty terms to cost functions in both linear and logistic regression.
  - Importance of choosing appropriate regularization parameter (λ).