

Project Report: Performance Evaluation of Neural Network and Logistic Regression Models for Binary Classification

1. Introduction

- **Objective:** To evaluate the performance of a Neural Network (NN) and Logistic Regression for classifying two activities: "**OPEN_DOOR**" and "**RUB_HANDS**".
 - **Data:** Time-series sensor data from accelerometer and gyroscope sensors.
 - **Task:** Binary classification (Open Door = 0, Rub Hands = 1).
 - **Evaluation Metrics:** Accuracy, F1-score (weighted, macro), precision, recall.
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2. Data Overview

- **Features:** Extracted statistical features from accelerometer and gyroscope signals.
 - Mean, max, min, standard deviation, percentiles (20%, 50%, 80%).
 - **Label Conversion:** Labels for **OPEN_DOOR** (0) and **RUB_HANDS** (1).
 - **Preprocessing:** Combined features from both sensors (accelerometer and gyroscope).
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3. Neural Network Model

- **Architecture:**
 - 4 fully connected layers with ReLU activation (hidden layers).
 - Sigmoid output layer for binary classification.
- **Hyperparameter Tuning:**

The performance of the **Neural Network** was optimized by experimenting with different hyperparameters, specifically the **learning rate** and **batch size**. Here's how the model's performance evolved:

1. **Initial Setup:**
 - The model was first trained with a learning rate of **0.1** and a batch size of **50**. With this configuration, the accuracy was relatively low at **53.33%**.
2. **Adjusting the Learning Rate:**
 - Next, the learning rate was reduced to **0.01**. This adjustment resulted in a significant improvement in accuracy, jumping to **73%**.
3. **Increasing the Batch Size:**
 - The batch size was then increased to **100**, which led to further improvement in the model's accuracy, reaching **76%**. Increasing the batch size allowed the model to process more data in each update, helping it converge more effectively.

4. Optimal Combination:

- Finally, the optimal combination of a **learning rate of 0.01** and a **batch size of 150** was found to maximize the performance, yielding the highest accuracy of **80%**.
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4. Logistic Regression Model

- **Model:** Simple linear classifier.
- **Evaluation Metrics:**
 - **Accuracy:** 81.11% (slightly better than NN).
 - **Weighted F1-score:** 0.75.
 - **Macro F1-score:** 0.75.
 - **Precision:** 0.75.
 - **Recall:** 0.76.