

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

1. Introduction

- **Objective:** Classifying two activities: "**OPEN_DOOR**" and "**RUB_HANDS**".
 - **Data:** Time-series sensor data from Accelerometer and Gravity sensors.
 - **Task:** Binary classification (Open Door = 0, Rub Hands = 1).
 - **Evaluation Metrics:** Accuracy, F1-score (weighted, macro), confusion matrix, 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 **0.5** and a batch size of **50**. With this configuration, the accuracy was relatively low at **53.33%**.

```
Epoch [100/100], Loss: 46.6757
Test Accuracy: 53.33%
Classification Report:
              precision    recall  f1-score   support

     0.0         0.53      1.00      0.70         48
     1.0         0.00      0.00      0.00         42

 accuracy          0.53         90
  macro avg         0.27      0.50      0.35         90
 weighted avg         0.28      0.53      0.37         90

Confusion Matrix:
[[48  0]
 [42  0]]
```

2. Adjusting the Learning Rate:

- Next, the learning rate was reduced to **0.1**. This adjustment resulted in a significant improvement in accuracy, jumping to **81.11%**.

```
Epoch [100/100], Loss: 0.1218
Test Accuracy: 81.11%
Classification Report:
              precision    recall  f1-score   support

     0.0         0.74      1.00      0.85         48
     1.0         1.00      0.60      0.75         42

 accuracy          0.81         90
  macro avg         0.87      0.80      0.80         90
 weighted avg         0.86      0.81      0.80         90

Confusion Matrix:
[[48  0]
 [17 25]]
```

3. Optimal Combination:

- Finally, the optimal combination of a **learning rate of 0.01** was found to maximize the performance, yielding the highest accuracy of **94.44%**.

```
Epoch [100/100], Loss: 0.0311
Test Accuracy: 94.44%
Classification Report:
              precision    recall  f1-score   support

     0.0         0.91      1.00      0.95         48
     1.0         1.00      0.88      0.94         42

 accuracy          0.94         90
  macro avg         0.95      0.94      0.94         90
 weighted avg         0.95      0.94      0.94         90

Confusion Matrix:
[[48  0]
 [ 5 37]]
```

4. Logistic Regression Model:

- **Model:** Simple linear classifier.
- **Evaluation Metrics:**

Classification Report:				
	precision	recall	f1-score	support
0.0	0.92	1.00	0.96	48
1.0	1.00	0.90	0.95	42
accuracy			0.96	90
macro avg	0.96	0.95	0.95	90
weighted avg	0.96	0.96	0.96	90
Confusion Matrix:				
[[48 0]				
[4 38]]				

5. Conclusion:

Logistic Regression slightly outperforms the Neural Network in terms of accuracy (96% vs. 94.44%) and F1-scores, particularly for class 1.
