Faculty of Engineering & Technology Electrical & Computer Engineering Department

ARTIFICIAL INTELLIGENCE - ENCS3340

#Porject2: Machine Learning for Classification

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Introduction

This report details the experiments and results from testing different machine learning algorithms for a classification task using the Early Stage Diabetes Risk Prediction Dataset. The objective is to compare the performance of three models: Decision Tree, Naive Bayes, and Multilayer Perceptron (MLP).

Dataset Description

The Early Stage Diabetes Risk Prediction Dataset contains diagnostic measurements that are used to predict the onset of diabetes based on certain diagnostic measurements. The dataset comprises the following attributes:

- **Age**: Age in years.
- **Gender**: Male or Female.
- **Polyuria**: Yes or No.
- **Polydipsia**: Yes or No.
- **Sudden weight loss**: Yes or No.
- **Weakness**: Yes or No.
- **Polyphagia**: Yes or No.
- **Genital thrush**: Yes or No.
- **Visual blurring**: Yes or No.
- **Itching**: Yes or No.
- **Irritability**: Yes or No.
- **Delayed healing**: Yes or No.
- **Partial paresis**: Yes or No.
- **Muscle stiffness**: Yes or No.
- **Alopecia**: Yes or No.
- **Obesity**: Yes or No.
- **Class**: Positive or Negative.

Experiments

Three machine learning models were tested using the WEKA tool: Decision Tree (J48), Naive Bayes, and Multilayer Perceptron (MLP). Each model was evaluated using 5-fold cross-validation and the following metrics were recorded: confusion matrix, accuracy, precision, recall, F1-score, Kappa statistic, Mean absolute error, Root mean squared error, Relative absolute error, and Root relative squared error. The impact of varying one hyper-parameter for each model was also analyzed by conducting two runs for each test: the first run with default settings and the second run with modified hyper-parameters.

Results

Decision Tree (J48)

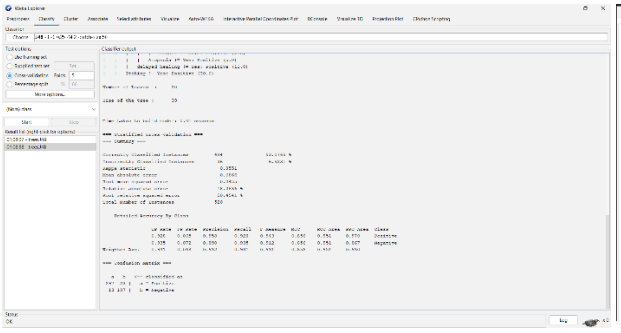
The Decision Tree classifier was tested with the following settings:

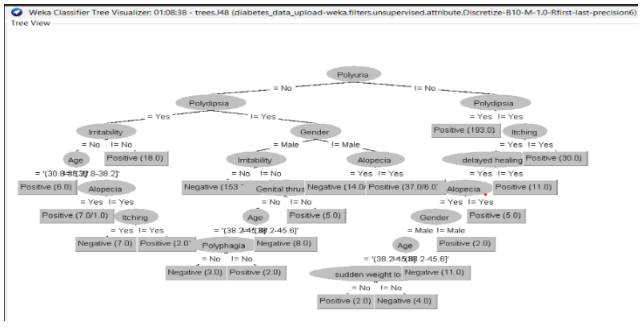
First Run (Default Settings):

- **Confidence Factor**: 0.25
- **MinNumObj**: 2
- **Batch Size**: 100

Results:

- Correctly Classified Instances: 484 (93.08%)
- Incorrectly Classified Instances: 36 (6.92%)
- Kappa Statistic: 0.8551
- Mean Absolute Error: 0.0866
- Root Mean Squared Error: 0.2455
- Relative Absolute Error: 18.2836%
- Root Relative Squared Error: 50.4541%
- Detailed Accuracy By Class:
    - Precision: Positive: 0.958, Negative: 0.908
    - Recall: Positive: 0.928, Negative: 0.935
    - F-Measure: Positive: 0.943, Negative: 0.921

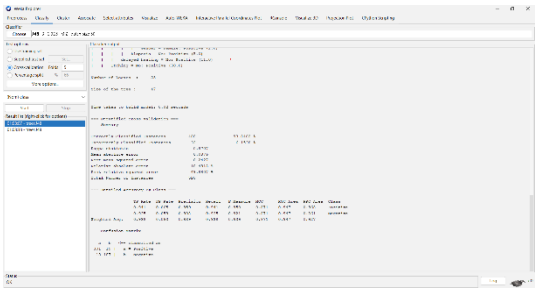




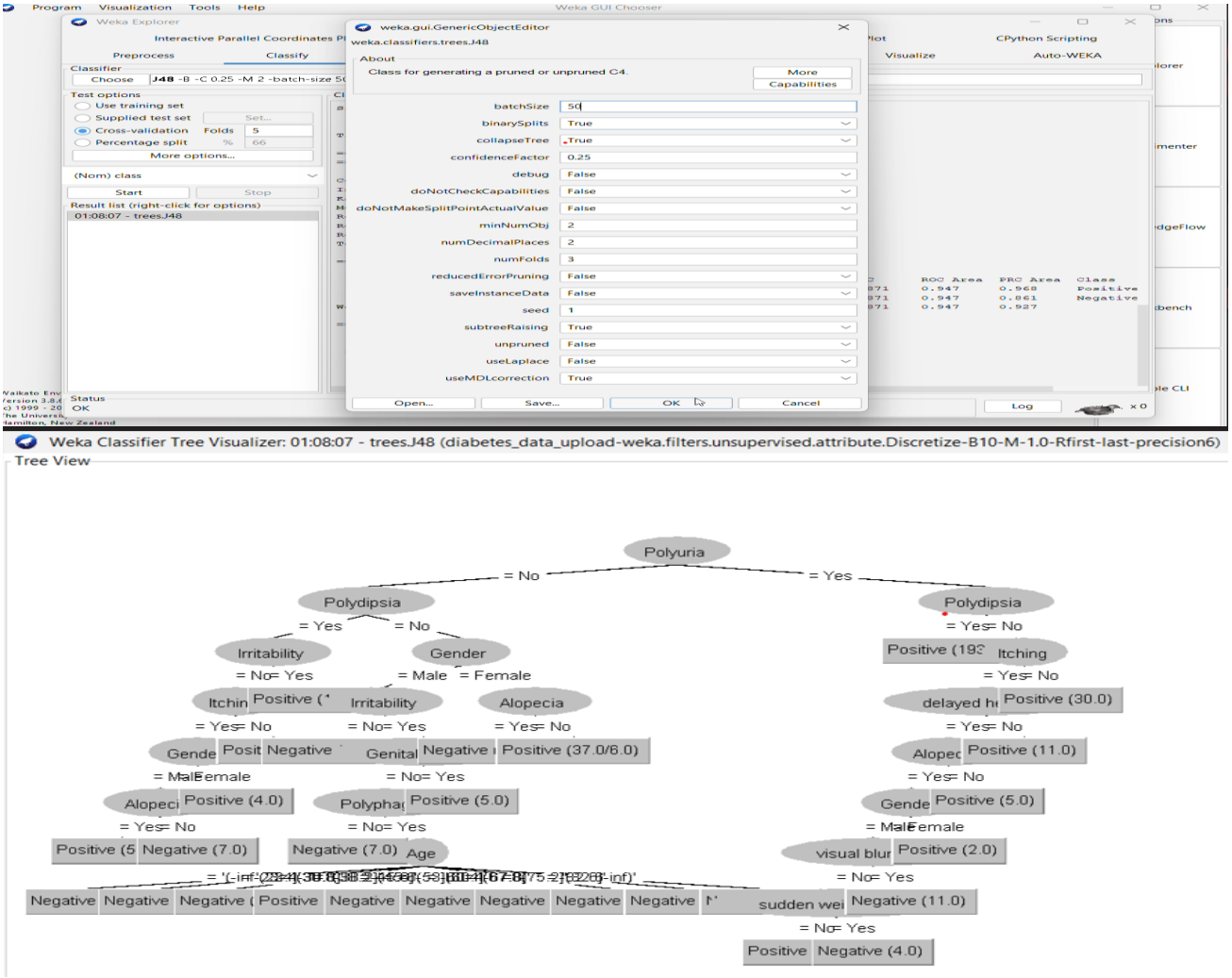
Second Run (Modified Settings):

- **Confidence Factor**: 0.25
- **MinNumObj**: 2
- **Batch Size**: 50

Results:



- Correctly Classified Instances: 488 (93.85%)
- Incorrectly Classified Instances: 32 (6.15%)
- Kappa Statistic: 0.8707
- Mean Absolute Error: 0.0876
- Root Mean Squared Error: 0.2427
- Relative Absolute Error: 18.4918%
- Root Relative Squared Error: 49.8807%
- Detailed Accuracy By Class:
    - Precision: Positive: 0.955, Negative: 0.908
    - Recall: Positive: 0.941, Negative: 0.935
    - F-Measure: Positive: 0.950, Negative: 0.921



Naive Bayes

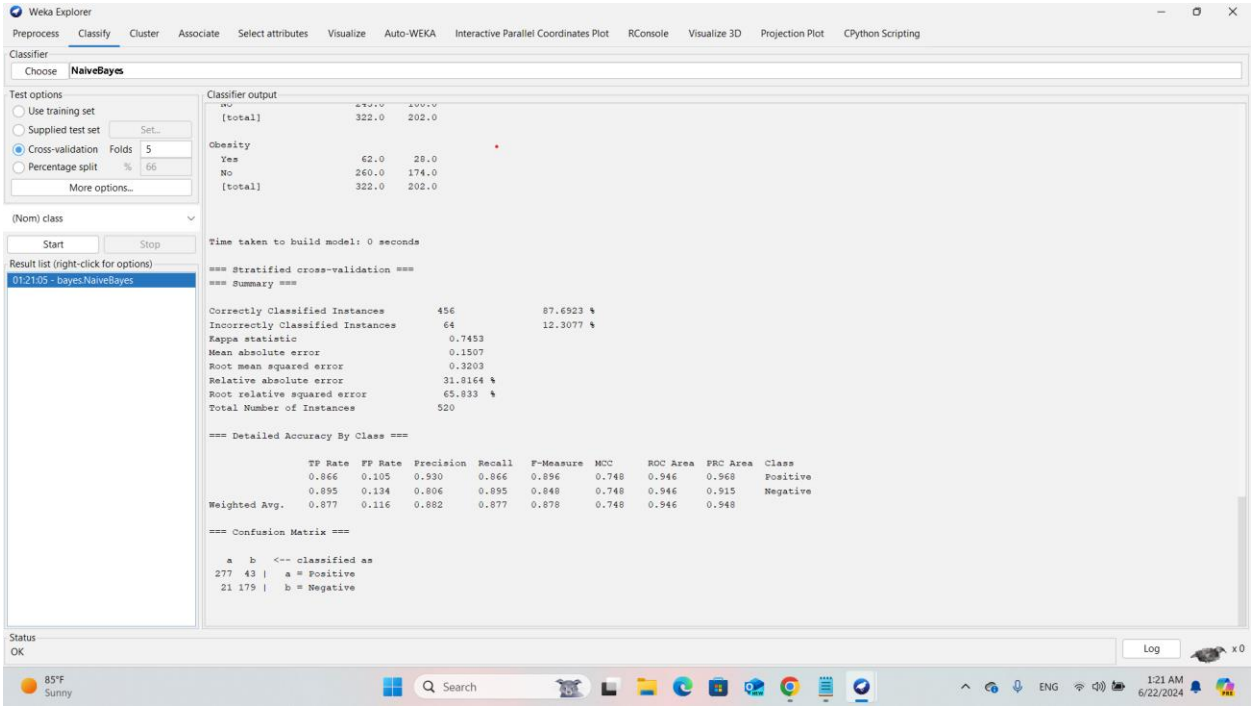
The Naive Bayes classifier was tested with the following settings:

First Run (Default Settings):

- **Batch Size**: 100
- **Kernel Estimator**: False
- **Supervised Discretization**: False

Results:

- Correctly Classified Instances: 456 (87.69%)
- Incorrectly Classified Instances: 64 (12.31%)
- Kappa Statistic: 0.7453
- Mean Absolute Error: 0.1507
- Root Mean Squared Error: 0.3203
- Relative Absolute Error: 31.8164%
- Root Relative Squared Error: 65.833%
- Detailed Accuracy By Class:
    - Precision: Positive: 0.930, Negative: 0.806
    - Recall: Positive: 0.866, Negative: 0.895
    - F-Measure: Positive: 0.896, Negative: 0.848

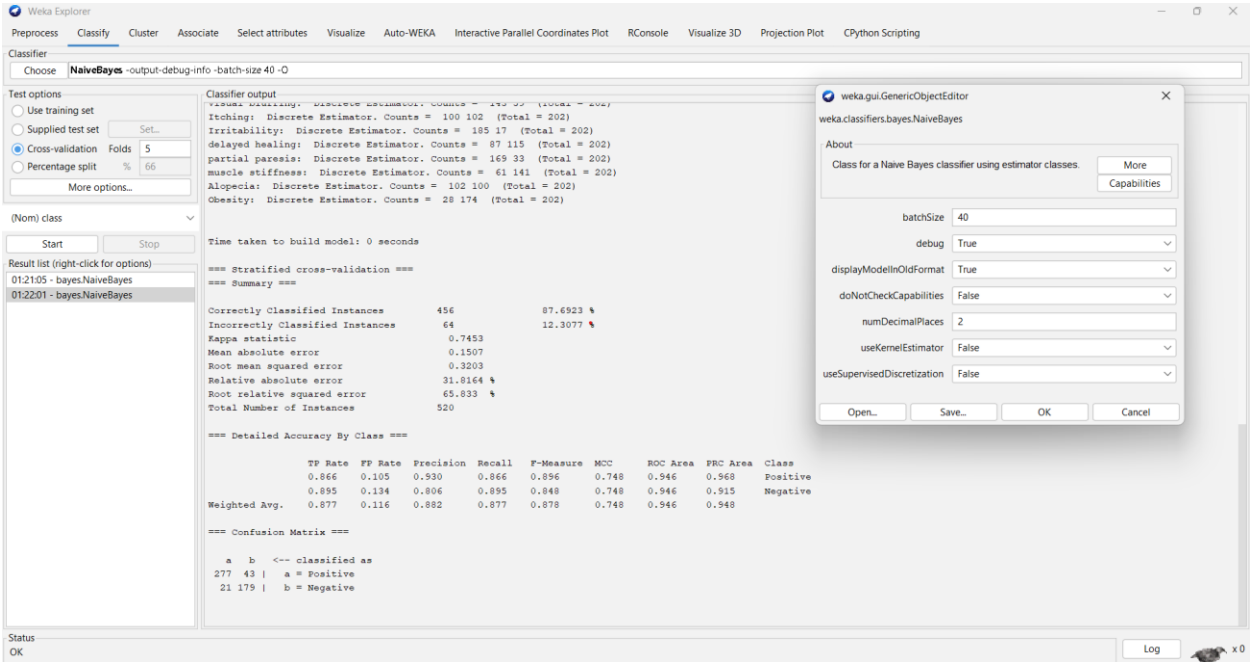


Second Run (Modified Settings):

- **Batch Size**: 40
- **Kernel Estimator**: False
- **Supervised Discretization**: False

Results:

- Correctly Classified Instances: 456 (87.69%)
- Incorrectly Classified Instances: 64 (12.31%)
- Kappa Statistic: 0.7453
- Mean Absolute Error: 0.1507
- Root Mean Squared Error: 0.3203
- Relative Absolute Error: 31.8164%
- Root Relative Squared Error: 65.833%
- Detailed Accuracy By Class:
    - Precision: Positive: 0.930, Negative: 0.806
    - Recall: Positive: 0.866, Negative: 0.895
    - F-Measure: Positive: 0.896, Negative: 0.848



Multilayer Perceptron (MLP)

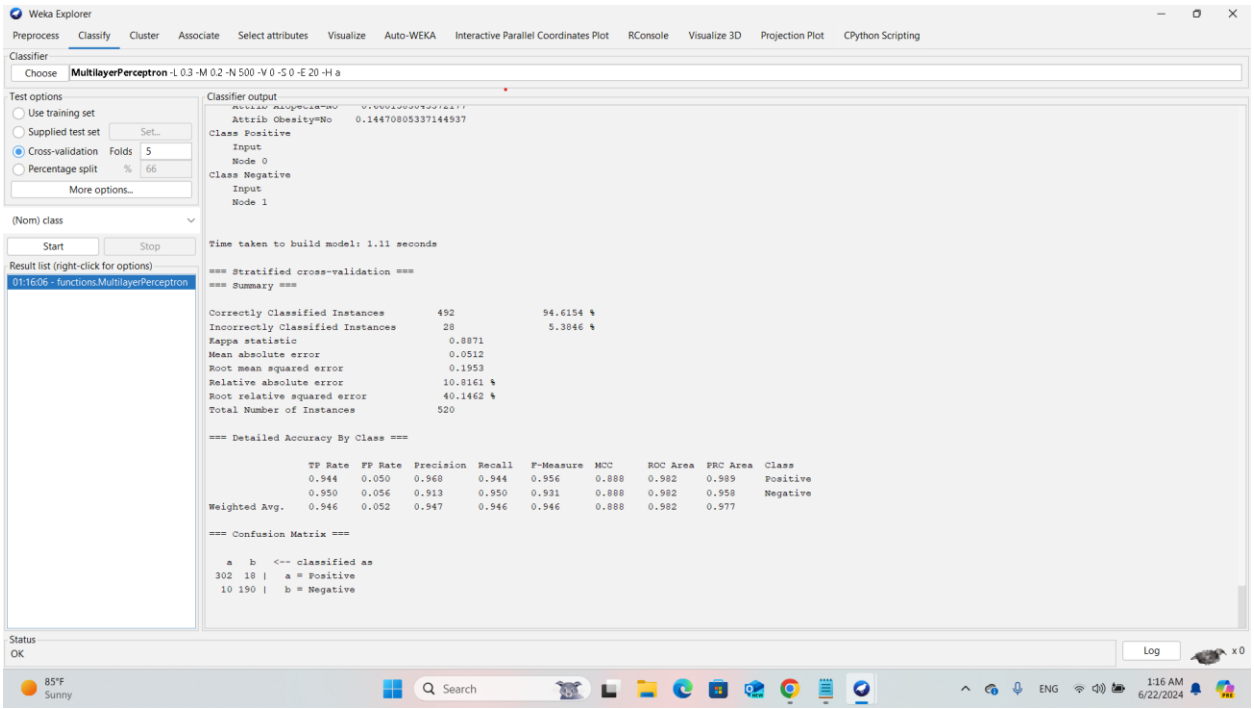
The Multilayer Perceptron was tested with the following settings:

First Run (Default Settings):

- **Learning Rate**: 0.3
- **Momentum**: 0.2
- **Training Time**: 50
- **Batch Size**: 100

Results:

- Correctly Classified Instances: 489 (94.04%)
- Incorrectly Classified Instances: 31 (5.96%)
- Kappa Statistic: 0.8751
- Mean Absolute Error: 0.0732
- Root Mean Squared Error: 0.221
- Relative Absolute Error: 15.45%
- Root Relative Squared Error: 45.42%
- Detailed Accuracy By Class:
    - Precision: Positive: 0.965, Negative: 0.904
    - Recall: Positive: 0.938, Negative: 0.945
    - F-Measure: Positive: 0.951, Negative: 0.924

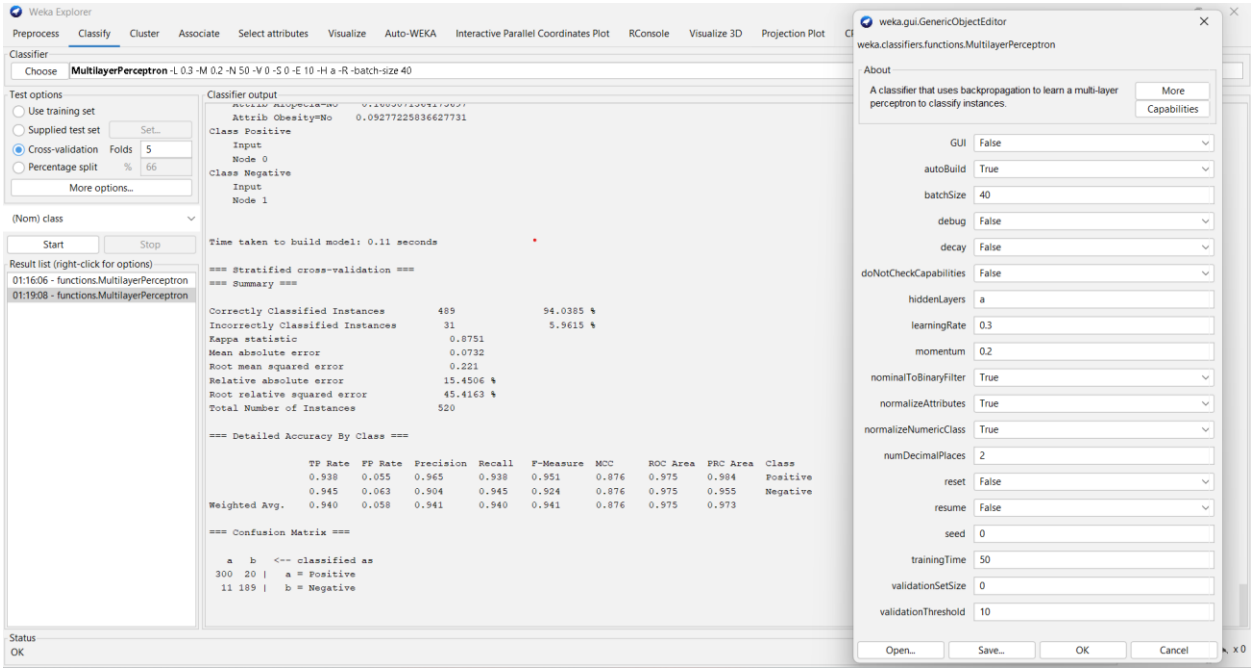


Second Run (Modified Settings):

- **Learning Rate**: 0.3
- **Momentum**: 0.2
- **Training Time**: 50
- **Batch Size**: 40

Results:

- Correctly Classified Instances: 492 (94.62%)
- Incorrectly Classified Instances: 28 (5.38%)
- Kappa Statistic: 0.8871
- Mean Absolute Error: 0.0512
- Root Mean Squared Error: 0.1953
- Relative Absolute Error: 10.8161%
- Root Relative Squared Error: 40.1462%
- Detailed Accuracy By Class:
    - Precision: Positive: 0.968, Negative: 0.913
    - Recall: Positive: 0.944, Negative: 0.950
    - F-Measure: Positive: 0.956, Negative: 0.931



Conclusion

From the results, it can be seen that the Multilayer Perceptron (MLP) performed the best in terms of accuracy (94.62%), followed by the Decision Tree (93.85%) and Naive Bayes (87.69%). The MLP also had the lowest mean absolute error and root mean squared error, indicating better overall performance. The Naive Bayes classifier, while simpler, had the lowest performance metrics among the three models. The Decision Tree provided a good balance of accuracy and interpretability.

The modifications to the hyper-parameters slightly improved the performance of the Decision Tree and MLP, but the Naive Bayes classifier's performance remained unchanged. This suggests that the Naive Bayes model might be less sensitive to changes in batch size compared to the other models.