Concepts and Technologies of AI

5CS037

Student Name: Aaditya Acharya
Student ID: 2510333

Abstract

The goal is to find the target variable with the use classification techniques. 30691 patient data of Liver Patient Disease Dataset with 11 features that supports the UN sustainable development Goal 3 (Good Health and Well-Being) is used. The project analyzed the 19083 patients after the successful cleaning of the data. The methodology includes the EDA, Neural Network (MLP), Classical ML (Logistic Regression, Decision Tree Classifier), Hyperparameter Optimization (Randomized Search CV), Feature Selection and final model comparison. For the evaluation of the different metrices was calculated. The Decision Tree model achieved accuracy of 98% showing the strong predictive capability for the liver disease. Feature selection using RFE identified 6 features which is important for the final model.

Table of Contents

Table Of Figures

1 Introduction

1.1 Problem Statement

Liver disease shows the important health challenge so Early and effective diagnosis are crucial for the treatment of the patient. The goal is to make the model that predicts the patients liver disease. The challenge it to build a model that help to identify the risk of the disease

1.2 Dataset

Dataset Name: Liver Disease Patient Dataset 30K train data

Source : Kaggle

Total records: 30,691

Number of features: 10 features with 1 target variable.

Features	Description
Age of the patient	Patients age
Gender of the patient	Patients gender
Total Bilirubin	Yellow pigments produced
Direct Bilirubin	Processed from bilirubin
Alkphos	Enzyme found in liver
Sgpt Alamine Aminotransferase	enzyme
Sgot Aspartate Aminotransferase	enzyme
Total Proteins	Total proteins blood
ALB	Main protein
A/G Ratio	Ration of albumin to proteins
Result	Liver disease or not

The Dataset aligns with the **SDG3: Good Health and Well Being.** The project directly supports the Sustainable Development Goal 3 by early detection of liver disease of the patients. By developing the model accurately the model aims to improve the health outcomes as early detection of disease helps to promote the well-being across the populations.

1.3 Objective

The objectives of this model are:

- Make different models for the liver disease classification.
- To Perform the data preprocessing.
- Compare the model using the standard evaluation metrices.
- To Optimize the models with the help of hyperparameter tuning.
- Identification of important features for disease prediction.

1.4 Research Questions

- Can liver disease be predicted by machine learning?
- For model performance, what is the hyperparameter optimization?
- Do classification algorithms different from each other?

UNIVERSITY OF WOLVERHAMPTON HERALD COLLEGE KATHMANDU ing

2 Methodology

2.1 Data Pre Processing

For preprocessing of data different step was performed. Initially data contains 30,691 data with different missing values, duplicate values, etc. tor the cleaning the data columns names was standardized by removing the extra spaces with underscores. For the missing values Numerical features was filled with median values and categorical features (Gender) was filled with the mode. Duplicates patients was removed to prevent the bias in the data training. Outliers was detected using the IQR method which was clipped rather than removing it. After all this cleaning process final datasets contains 19.083 datasets without missing values, duplicate values, etc.

2.2 Exploratory Data Analysis (EDA)

Class Distribution

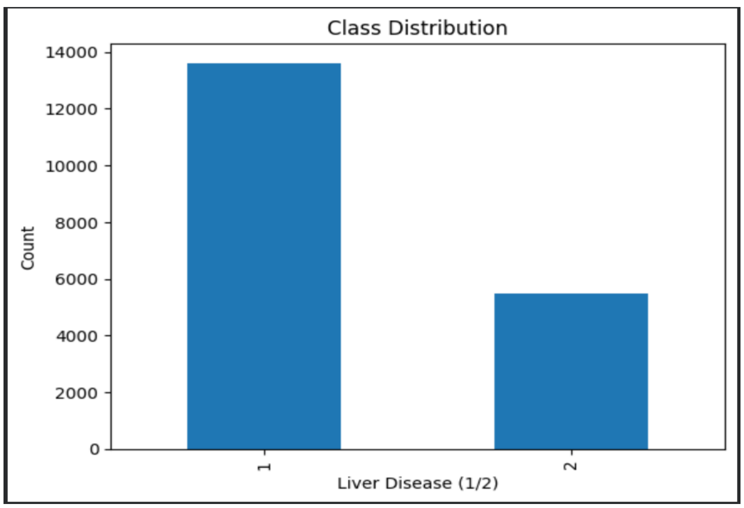


Figure 1 class distribution of target variable

Correlation Analysis

Correlation analysis shows the Relation with the target variable.

```
Age_of_the_patient                      -0.004597
Total_Bilirubin                         -0.313699
Direct_Bilirubin                        -0.320679
Alkphos_Alkaline_Phosphotase            -0.230792
Sgpt_Alamine_Aminotransferase           -0.286602
Sgot_Aspartate_Aminotransferase         -0.298538
Total_Protiens                           0.036707
ALB_Albumin                              0.165456
A/G_Ratio_Albumin_and_Globulin_Ratio     0.179971
Result                                   1.000000
Name: Result, dtype: float64
```

Figure 2 correlation with target variable

Direct Bilirubin shows the strongest negative correlation as age of the patient shows the minimal correlation which shows that age is not only the factor for the disease. Total proteins shows the positive correlation which shows that increase in proteins decreases the chance of disease.

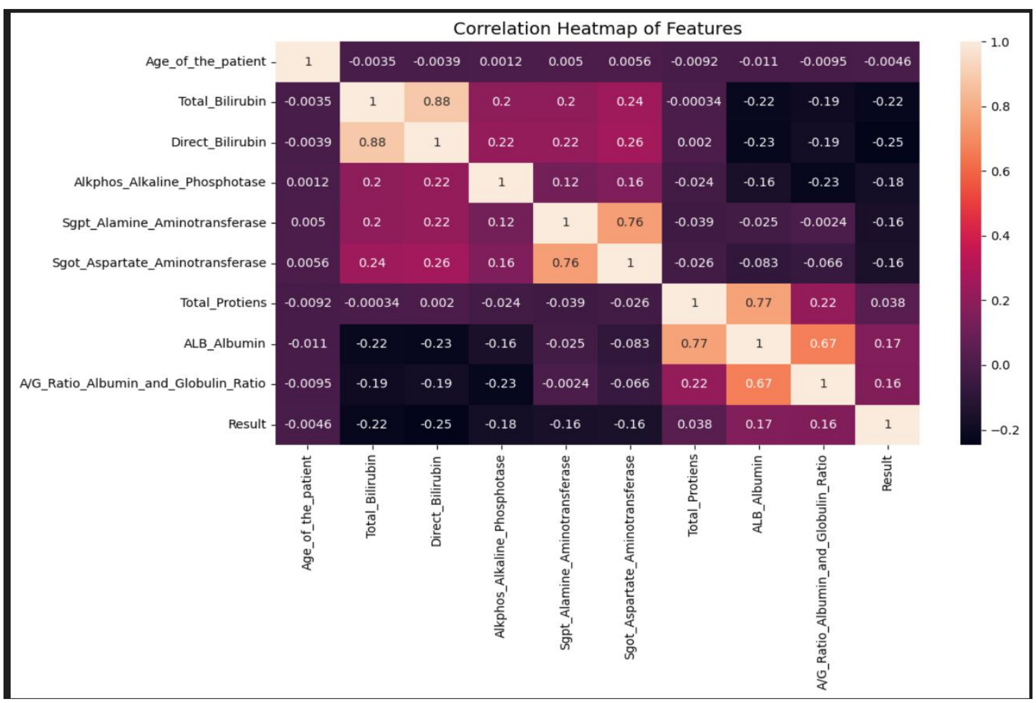


Figure 3 Heatmap

Outlier Detection

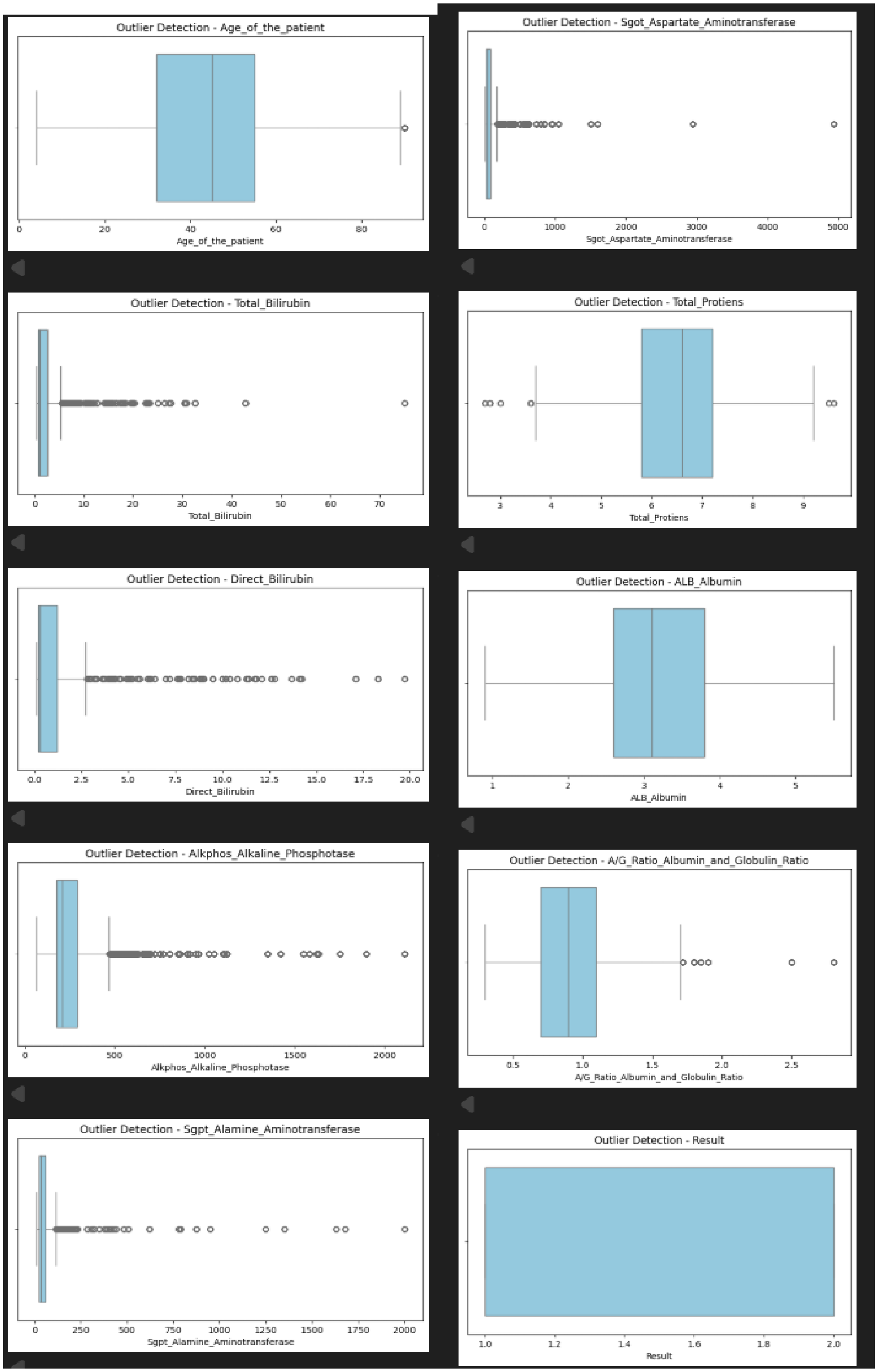


Figure 4 Outlier Detection

Gender Based Analysis

To know the rate of disease across male and female gender based analysis was performed which shows that more number of patients is male compared to the female. This also helps to know the demographic factors in liver disease.

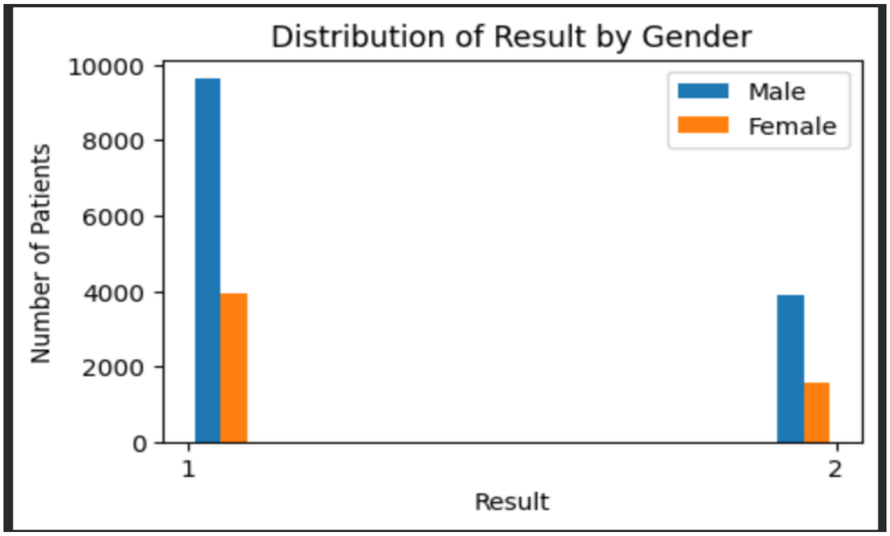


Figure 5 gender based analysis

2.3 Model Building

Feature Selection

- The gender was removed before training the model as it is categorical data.
- Data was split into training and testing.
- Standard scaler was applied as standardization is crucial for the algorithms like MLP and Logistic Regression.

Multi-Layer Perception (MLP)

With the different hidden layers, activation functions, etc. MIP is a neural network capable of learning complex non-linear patterns.

The model was configured using the following parameters:

- Hidden Layers: (50,25) neurons.
- Activation Function: ReLU
- Solver: Adam
- Regularization: alpha(0.001)
- Learning rate: adaptive
- Maximum iterations: 300
- Early stopping: True to prevent the overfitting

Loss Function: Log loss for the binary classification.

Optimizer: Adam optimizer with Adaptive Learning Rate.

Logistic Regression

To build the Logistic Regression model standard scaler data was used in LogisticRegression to train and predict the model in which 80% was used for training whereas 20% was used for the testing the data.

Decision Tree Classifier

. To built the Decision Tree model DecisionTreeClassifier was used to fit the training dataset and predictions for the training and testing was done in which 80% was used for training whereas 20% was used for the testing of the data.

2.4 Model Evaluation

Multi-Layer Perception (MLP)

Metrices	Training performance	Testing Performance
Accuracy	0.95	0.94
Precision	0.95	0.94
Recall	0.98	0.97
F1-Score	0.96	0.96

Logistic Regression

Metrices	Training performance	Testing Performance
Accuracy	0.72	0.73
Precision	0.75	0.76
Recall	0.90	0.90
F1-Score	0.82	0.83

Decision Tree

Metrices	Training performance	Testing Performance
Accuracy	1.0	0.98
Precision	1.0	0.99
Recall	1.0	0.98
F1-Score	1.0	0.99

These Classification metrices was chosen as this is the most commonly used metrices.

Initial Model Comparison

Decision Tree have 99 % test accuracy and logistic regression have 73%. However decision tree shows perfect 100% accuracy showing potential overfitting.

2.5 Hyperparameter Optimization

RandomizedSearchCV was used in both logistic and Random Forest models. This approach checks the parameters by randomly sampling the combinations.

Logistic Regression

For the improvement of the model, Parameters includes the regularization strength (C), penalty type (L1,L2), fit intercept, maximum iteration and solver. The search identified the best hyperparameters for the model.

- **solver**: liblinear
- **penalty**: l1
- **max_iter**: 500
- **fit_intercept**: True
- **C**: 100

Decision Tree

To improve, Parameters includes the splitter , maximum depth, minimum samples split and leaf , maximum features and criteration. The search identified the best hyperparameters for the model.

- splitter: 'best'
- max_depth: 50
- min_samples_split: 20
- min_samples_leaf: 2
- max_features: 'sqrt'
- criteration: log_loss

Cross-Validation Scores

5 CV was done during hyperparameter search. The best cv achieved is 0.98 for decision tree and 0.72 for logistic regression.

2.6 Feature Selection

Feature selection is done by the RFE which is wrapper method.

- Total_Bilirubin
- Alkphos_Alkaline_Phosphotase
- Sgpt_Alamine_Aminotransferase
- Sgot_Aspartate_Aminotransferase
- Total_Protiens
- ALB_Albumin

RFE was selected as it balances between the model performance and feature selection and it also works well with various classifiers.

3 Results And Conclusion

Model	Features	CV Score	Accuracy	Precision	Recall	F1-Score
Logistic Regression	Selected (6)	0.72	0.73	0.77	0.91	0.83
Decision Tree	Selected (6)	0.98	0.98	0.99	0.99	0.99

3.1 Key Findings

- Got 94% testing accuracy in neural Network (MLP) which is very good.
- Got 98% accuracy in Decision Tree.
- Got 73% accuracy in logistic regression, it is not good but it finds 92% recall.
- 6 features out of 9 was used in the final evaluation.

3.2 Final Model

The final model was evaluated using accuracy. Based on that the best model was decision Tree as it achieved 98% accuracy on the test data with excellent precision and recall of 99%. It also have high cv score 98%. Based on the accuracy decision tree achieved 98% accuracy whereas Logistic regression achieved 73%.

```
Final Model Comparison Table:
                            Model  Features Used CV Score  Accuracy  \
0                             MLP              9        -      0.95
1  Logistic Regression (Classical)             9        -      0.73
2        Decision Tree (Classical)             9        -      0.99
3      Logistic Regression (Final)             6     0.72      0.73
4            Decision Tree (Final)             6     0.98      0.98

   Precision  Recall  F1-Score
0       0.95    0.98      0.96
1       0.77    0.91      0.83
2       0.99    0.99      0.99
3       0.77    0.91      0.83
4       0.99    0.99      0.99
```

Figure 6 Final Model

3.3 Challenges

The challenges we faced are:

- out of 30691 only 19083 was used as data was duplicated, missing, etc.
- Testing all different things took a lot of computer time.
- The data is unbalanced as there is more sick patients rather than healthy which can cause model biased.

3.4 Future Work

To make the model better:

- More patients data can help model learn better patterns.
- More additional information can be added.
- More advanced ml algorithms can be used to make model more better.
- Testing on external dataset can be done.

4 Discussion

4.1 Model Performance

On Neural Network model shows the 95% accuracy on training and 94 % accuracy on testing which means model is performing very well. On the Logistic regression the model shows 73% accuracy on testing data which is not good but it shows 92% recall which is good. In the case of Decision Tree the model shows 98% accuracy.

4.2 Impact of Hyperparameter Tuning and Feature Selection

Hyperparameter was performed using RandomizedSearchCV, which finds the optimal parameter for both Methods. After applying the technique the model perform 73% accuracy on Logistic regression with C=100, penalty=l1, solver 'liblinear' as C allows model to be complex and l1 will better suit for the real world data. There in not so big changes after the hyperparameter tuning. Hyperparameter somehow prevents overfitting in Decision Tree.

Feature selection was performed using the Decision tree to find the most important features affecting the liver disease patients. After applying the technique The features was reduced from 9 to 6 which make model more faster. Different features like age, total_proteins, ALB_Albumin was removed.

4.3 Interpretation of results

chosen features model performed in a consistent manner with expectations. The Multi-Layer Perceptron (MLP) shows the strong performance, showing the testing accuracy of approximately 94%. The Logistic Regression model recorded slightly lower accuracy (72%) but high recall of 92% High recall implies that model successfully majority of patients who successfully have liver disease.

4.4 Limitations

- Initially the data contains 30,691 patients data which is good but later the size decreases to 19083 after the cleaning of the as data contains duplicated value.
- There are more patients with disease cases than healthy case.
- Missing many features like treatment history, etc.

4.5 Suggestions for Future Research

- On independent dataset perform the testing
- Other classification algorithms can be tested.
- Use of larger dataset and increase the quality of the dataset.
- Handle the class imbalance to improve the fairness.
- Apply more better feature selection techniques.

5 References

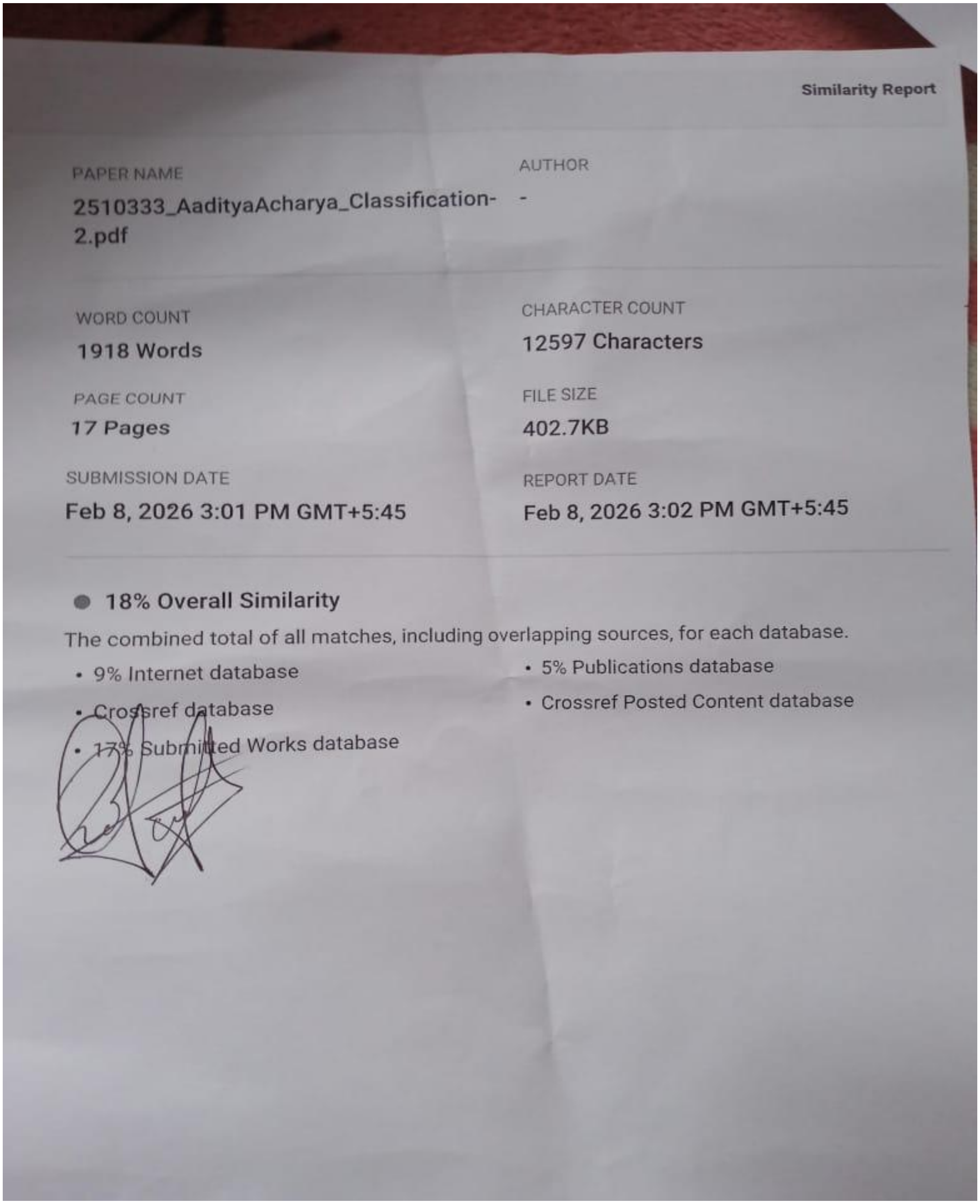
Shrivastava, A., 2021. *Liver Disease Patient Dataset 30K train data*. [Online]
Available at: https://www.kaggle.com/datasets/abhi8923shriv/liver-disease-patient-dataset
[Accessed 2026].

United Nations, n.d. *Good Health And Well Being*. [Online]
Available at: https://sdgs.un.org/goals/goal3
[Accessed 2026].

6 GitHub Link

https://github.com/aaditya6882/2510333_AadityaAcharya_Final

7 Appendix



Similarity Report

PAPER NAME
2510333_AadityaAcharya_Classification-2.pdf

AUTHOR
-

WORD COUNT
1918 Words

CHARACTER COUNT
12597 Characters

PAGE COUNT
17 Pages

FILE SIZE
402.7KB

SUBMISSION DATE
Feb 8, 2026 3:01 PM GMT+5:45

REPORT DATE
Feb 8, 2026 3:02 PM GMT+5:45

18% Overall Similarity

The combined total of all matches, including overlapping sources, for each database.

- 9% Internet database
- 5% Publications database
- Crossref database
- Crossref Posted Content database
- 17% Submitted Works database

Figure 7 Plagiarism Report