

ML Assignment – 2

Evaluation of Classification Models

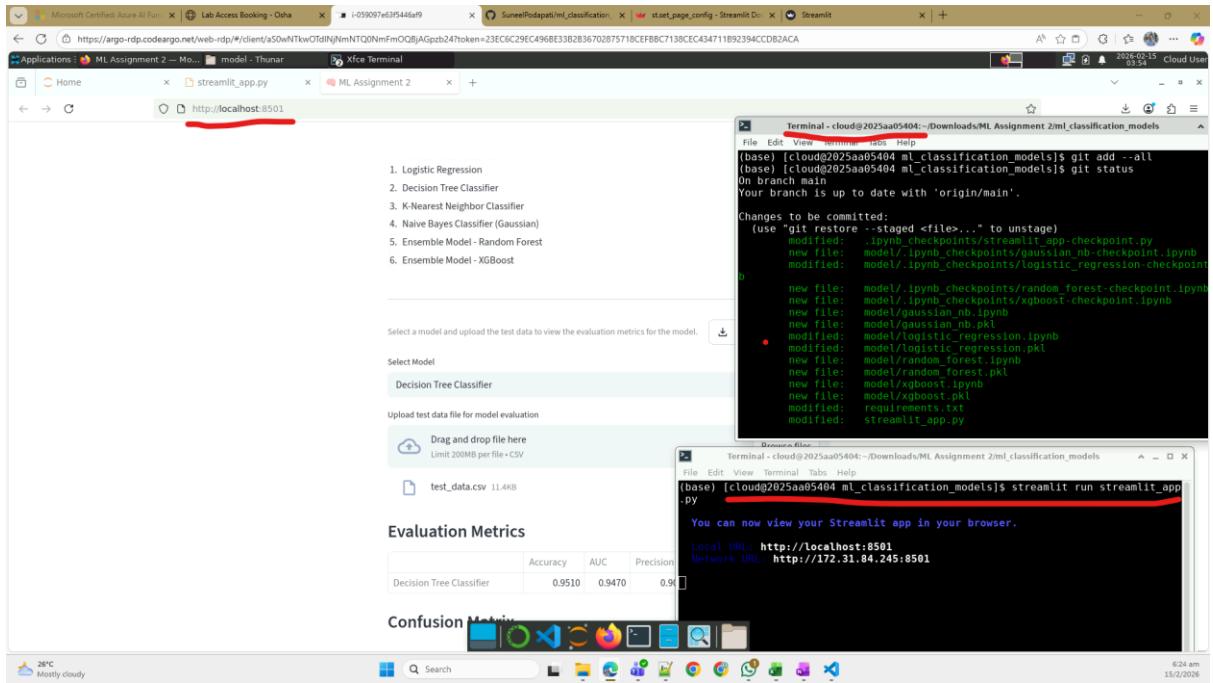
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1. GitHub Repo Link: https://github.com/SuneelPodapati/ml_classification_models

2. Live Streamlit App Link: <https://sp-ml-assignment2.streamlit.app/>

3. Screenshot of BITS Virtual Lab



4. GitHub README content

ML Assignment 2 – Heart Failure Prediction

Evaluate 6 classification models

a. Problem statement

The objective of this assignment is to train and evaluate multiple classification models. I have selected a data set to train and predict whether a patient with heart failure will survive or not based on their clinical records. The goal is to identify the high-risk patients, so required medical procedures can be suggested.

The target/outcome variable:

- **y = 0 => Not Dead → Survived**
- **y = 1 => Dead → Not Survived**

b. Dataset description

[Heart Failure Prediction](#) data from Kaggle.

The Heart Failure Clinical Records data contains clinical and demographic information of patients diagnosed with heart failure. It contains details about existing medical conditions and clinical measurements such as ejection fraction, serum creatinine, and serum sodium. These attributes are highly useful for predicting a patient's risk of mortality during the follow-up period.

Features: **12** - age creatinine_phosphokinase ejection_fraction platelets serum_creatinin e serum_sodium time anaemia diabetes high_blood_pressure sex smoking

Data set size: **5000** (before cleaning)

Instances/sample size: **1319** (after removing the contradictory and duplicate samples)

Train/Test split: **80:20 → 1055:264**

Attribute details

- age: age of the patient (years)
- anaemia: decrease of red blood cells or haemoglobin (boolean)
- creatinine phosphokinase (CPK): level of the CPK enzyme in the blood (mcg/L)
- diabetes: if the patient has diabetes (boolean)

- ejection fraction: percentage of blood leaving the heart at each contraction (percentage)
- high blood pressure: if the patient has hypertension (boolean)
- platelets: platelets in the blood (kiloplatelets/mL)
- sex: woman or man (binary)
- serum creatinine: level of serum creatinine in the blood (mg/dL)
- serum sodium: level of serum sodium in the blood (mEq/L)
- smoking: if the patient smokes or not (boolean)
- time: follow-up period (days)
- DEATH_EVENT: if the patient died during the follow-up period (boolean)

Feature Engineering

- Instances with same feature values but different (contradicting) target values has been cleaned to have single instance for each combination of features.
- All categorical features are One-hot encoded
- All numerical features are z-score normalized (standardization)

c. Models used

The following machine learning classification models were implemented and evaluated using the same dataset. The evaluation metrics used for comparison are Accuracy, AUC Score, Precision, Recall, F1 Score, and Matthews Correlation Coefficient (MCC).

1. Logistic Regression
2. Decision Tree Classifier
3. K-Nearest Neighbor Classifier
4. Naive Bayes Classifier (Gaussian)
5. Ensemble Model - Random Forest
6. Ensemble Model – XGBoost

Comparison Table

ML Model Name	Accuracy	AUC	Precision	Recall	F1	MCC
Logistic Regression	0.856	0.886	0.797	0.696	0.743	0.647
Decision Tree Classifier	0.951	0.947	0.902	0.937	0.919	0.884
K-Nearest Neighbor Classifier	0.852	0.936	0.917	0.557	0.693	0.636
Naive Bayes Classifier (Gaussian)	0.799	0.850	0.703	0.570	0.629	0.499
Random Forest (Ensemble)	0.962	0.985	0.960	0.911	0.935	0.909
XGBoost (Ensemble)	0.936	0.984	0.943	0.835	0.886	0.844

Observations on Model Performance

ML Model Name	Observation about model performance
Logistic Regression	<p>A solid baseline model with balanced performance. Accuracy (0.856) and AUC (0.886) indicate good overall discrimination. Precision (0.797) is stronger than recall (0.696), meaning it predicts positive cases conservatively and may miss some true death events. Could not improve the performance even after increasing the iterations by 10x</p>
Decision Tree Classifier	<p>Very strong performance with high accuracy (0.951) and excellent recall (0.937). It captures most positive cases and maintains high precision (0.902). However, single trees can overfit, so this performance may not generalize as consistently as ensemble methods.</p>
K-Nearest Neighbor Classifier	<p>Shows mixed behaviour: high precision (0.917) but low recall (0.557). This means it is very good at avoiding false positives but misses many true positives. Accuracy (0.852) and AUC (0.936) are strong, but the imbalance between precision and recall suggests sensitivity issues. Increasing the k value after 6 was also increasing the error</p>
Naive Bayes (Gaussian)	<p>The weakest performer in your set. Accuracy (0.799), recall (0.570), and F1 (0.629) are noticeably lower. The independence assumption likely limits its ability to model the clinical relationships in this dataset.</p>
Random Forest	<p>The best overall performer. Outstanding accuracy (0.962), AUC (0.985), and F1 (0.935). Precision (0.960) and recall (0.911) are both high, showing excellent balance. MCC (0.909) confirms strong reliability across both classes.</p>
XGBoost	<p>Another top-tier model with excellent accuracy (0.936) and AUC (0.984). Precision (0.943) and recall (0.835) are well-balanced, though slightly lower than Random Forest. Still a highly dependable model with strong generalization.</p>

Conclusion

Ensemble Model - Random Forest achieved the highest AUC and strongest overall metrics on this dataset. This model has a good trade-off between accuracy, F1, and MCC, making it the preferred choice for production use.

Streamlit 🚀

The trained models are saved into *pkl* files and are deployed to Streamlit with an interactive evaluation application at <https://sp-ml-assignment2.streamlit.app/>

The application can be used to

- download sample test data
- select a model for evaluation
- upload test data
- view the model evaluation metrics: Accuracy, AUC, Precision, Recall, F1, and MCC.
- view confusion matrix and classification report.

Sample Evaluation: Random Forest

Heart Failure Prediction 🩺

A Classification Models Evaluation Assignment

Interactively explore 6 trained classification models performance for [Heart Failure Prediction](#) data from Kaggle.

The trained models are:

1. Logistic Regression
2. Decision Tree Classifier
3. K-Nearest Neighbor Classifier
4. Naive Bayes Classifier (Gaussian)
5. Ensemble Model - Random Forest
6. Ensemble Model - XGBoost

The target/outcome variable:

- $y = 0 \Rightarrow \text{Not Dead} \rightarrow \text{Survived}$
- $y = 1 \Rightarrow \text{Dead} \rightarrow \text{Not Survived}$

Select a model and upload the test data to view the evaluation metrics for the model. [Download test data](#)

Select Model: Ensemble Model - Random Forest

Upload test data file for model evaluation

Drag and drop file here
Limit 200MB per file + CSV

Browse files

test_data (4).csv 11.1KB

Evaluation Metrics

	Accuracy	AUC	Precision	Recall	F1	MCC
Ensemble Model - Random Forest	0.9620	0.9850	0.9600	0.9110	0.9350	0.9090

Confusion Matrix (Ensemble Model - Random Forest)

		True label	
		Survived	Not Survived
Predicted label	Survived	182	3
	Not Survived	7	72

Classification Report (Ensemble Model - Random Forest)

	precision	recall	f1-score	support
Survived	0.9630	0.9838	0.9733	185.0000
Not Survived	0.9600	0.9114	0.9351	79.0000
accuracy	0.9621	0.9621	0.9621	0.9621
macro avg	0.9615	0.9476	0.9542	264.0000
weighted avg	0.9621	0.9621	0.9618	264.0000