Model Optimization and Tuning Report

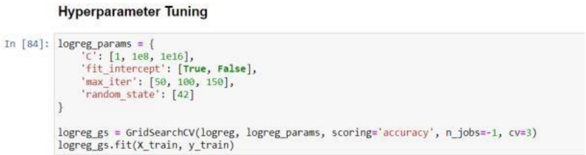
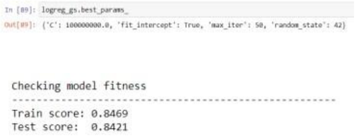
Date	15 April 2024
Team ID	Team-738164
Project Title	Rainfall Prediction Using Machine Learning
Maximum Marks	10 Marks

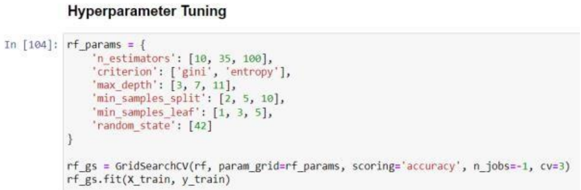
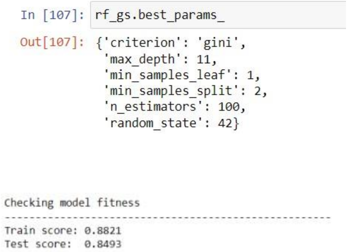
Model Optimization and Tuning Report:

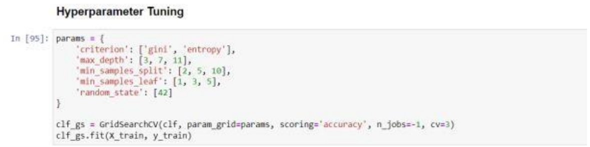
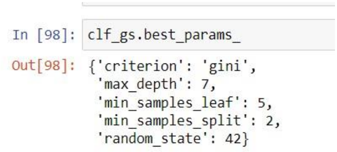
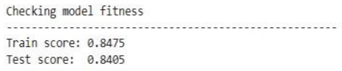
The Model Optimization and Tuning Report involves refining machine learning models for peak performance. It includes optimized model code, fine-tuning hyperparameters, comparing performance metrics, and justifying the final model selection for enhanced predictive accuracy and efficiency.

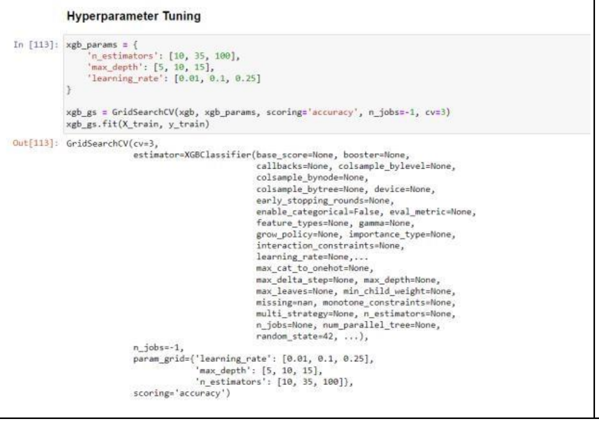
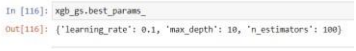
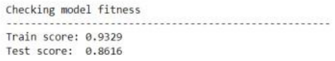
Hyperparameter Tuning Documentation (6 Marks):

Model	Tuned Hyperparameters	Optimal Values

Logistic Regression	
	Hyperparameter Tuning
	In [84]: logreg_params = {
	'C': [1, 1e8, 1e16],
	'fit_intercept': [True, False],
	'max_iter': [50, 100, 150],
	'random_state': [42]
	}
	logreg_gs = GridSearchCV(logreg, logreg_params, scoring='accuracy', n_jobs=-1, cv=3)
	logreg_gs.fit(X_train, y_train)
		
		In [89]: logreg_gs.best_params_
		Out[89]: {'C': 100000000.0, 'fit_intercept': True, 'max_iter': 50, 'random_state': 42}
		Checking model fitness
		--- 	
		Train score: 0.8469
		Test score: 0.8421

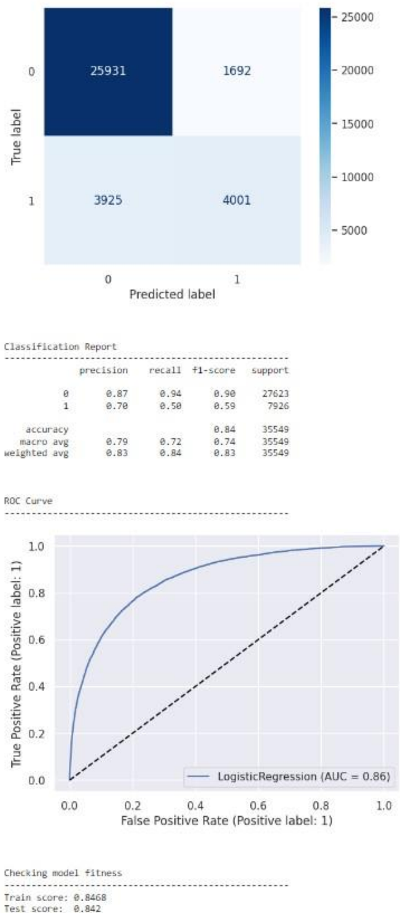
Random Forest	
	Hyperparameter Tuning
	In [104]: rf_params = {
	'n_estimators': [10, 35, 100],
	'criterion': ['gini', 'entropy'],
	'max_depth': [3, 7, 11],
	'min_samples_split': [2, 5, 10],
	'min_samples_leaf': [1, 3, 5],
	'random_state': [42]
	}
	rf_gs = GridSearchCV(rf, param_grid=rf_params, scoring='accuracy', n_jobs=-1, cv=3)
	rf_gs.fit(X_train, y_train)
		
		In [107]: rf_gs.best_params_
		Out[107]: {'criterion': 'gini',
		'max_depth': 11,
		'min_samples_leaf': 1,
		'min_samples_split': 2,
		'n_estimators': 100,
		'random_state': 42}
		Checking model fitness
		--- 	
		Train score: 0.8821
		Test score: 0.8493

Decision Tree	
	Hyperparameter Tuning
	In [95]: params = {
	    'criterion': ['gini', 'entropy'],
	    'max_depth': [3, 7, 11],
	    'min_samples_split': [2, 5, 10],
	    'min_samples_leaf': [1, 3, 5],
	    'random_state': [42]
	}
	
	clf_gs = GridSearchCV(clf, param_grid=params, scoring='accuracy', n_jobs=-1, cv=3)
	clf_gs.fit(X_train, y_train)
		
		In [98]: clf_gs.best_params_
		Out[98]: {'criterion': 'gini',
		 'max_depth': 7,
		 'min_samples_leaf': 5,
		 'min_samples_split': 2,
		 'random_state': 42}
		
		Checking model fitness
		--- 	
		Train score: 0.8475
		Test score: 0.8405

XG-Boost	
	Hyperparameter Tuning
	In [113]: xgb_params = {
	    'n_estimators': [10, 35, 100],
	    'max_depth': [5, 10, 15],
	    'learning_rate': [0.01, 0.1, 0.25]
	}
	
	xgb_gs = GridSearchCV(xgb, xgb_params, scoring='accuracy', n_jobs=-1, cv=3)
	xgb_gs.fit(X_train, y_train)
	Out[113]: GridSearchCV(cv=3,
	             estimator=XGBClassifier(base_score=None, booster=None,
	                                     callbacks=None, colsample_bylevel=None,
	                                     colsample_bynode=None,
	                                     colsample_bytree=None, device=None,
	                                     early_stopping_rounds=None,
	                                     enable_categorical=False, eval_metric=None,
	                                     feature_types=None, gamma=None,
	                                     grow_policy=None, importance_type=None,
	                                     interaction_constraints=None,
	                                     learning_rate=None,...
	                                     max_cat_to_onehot=None,
	                                     max_delta_step=None, max_depth=None,
	                                     max_leaves=None, min_child_weight=None,
	                                     missing=nan, monotone_constraints=None,
	                                     multi_strategy=None, n_estimators=None,
	                                     n_jobs=None, num_parallel_tree=None,
	                                     random_state=42, ...),
	             n_jobs=-1,
	             param_grid={'learning_rate': [0.01, 0.1, 0.25],
	                         'max_depth': [5, 10, 15],
	                         'n_estimators': [10, 35, 100]},
	             scoring='accuracy')
		
		In [116]: xgb_gs.best_params_
		Out[116]: {'learning_rate': 0.1, 'max_depth': 10, 'n_estimators': 100}
		
		Checking model fitness
		--- 	
		Train score: 0.9329
		Test score: 0.8616

Performance Metrics Comparison Report (2 Marks):

<table>
<tr><th>Model</th><th>Baseline Metric</th><th>Optimized Metric</th></tr>
<tr>
<td>Logistic
Regression</td>
<td>


0
1
True label
25931
1692
3925
4001
0
1
Predicted label
25000
20000
15000
10000
5000
True Positive Rate (Positive label: 1)
1.0
0.8
0.6
0.4
0.2
0.0
LogisticRegression (AUC = 0.86)
0.0
0.2
0.4
0.6
0.8
1.0
False Positive Rate (Positive label: 1)

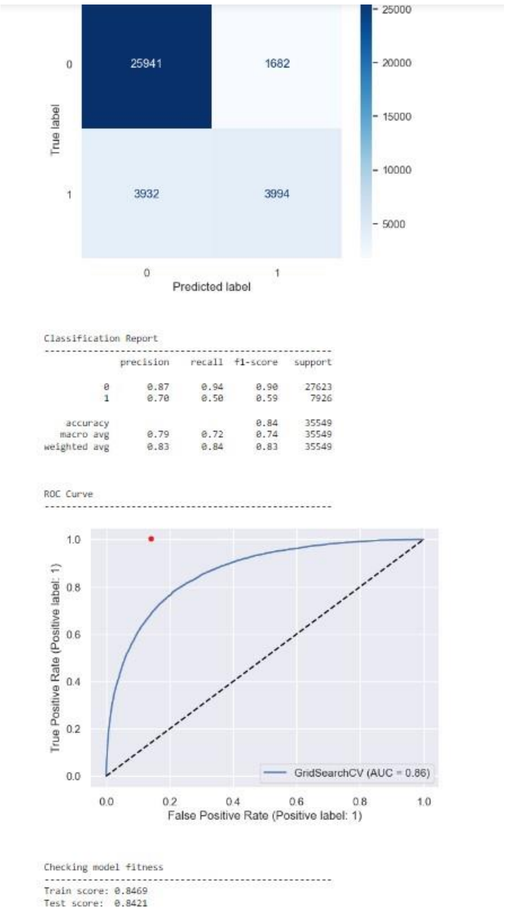
```
Classification Report
-------------------------------------------------------
              precision    recall  f1-score   support

           0       0.87      0.94      0.90     27623
           1       0.70      0.50      0.59      7926

    accuracy                           0.84     35549
   macro avg       0.79      0.72      0.74     35549
weighted avg       0.83      0.84      0.83     35549
```

```
ROC Curve
-------------------------------------------------------
```

```
Checking model fitness
-------------------------------------------------------
Train score: 0.8468
Test score:  0.842
```

Accuracy: 84%   AUC: 0.86

</td>
<td>



```
Classification Report
-------------------------------------------------------
              precision    recall  f1-score   support

           0       0.87      0.94      0.90     27623
           1       0.70      0.50      0.59      7926

    accuracy                           0.84     35549
   macro avg       0.79      0.72      0.74     35549
weighted avg       0.83      0.84      0.83     35549
```

```
ROC Curve
-------------------------------------------------------
```

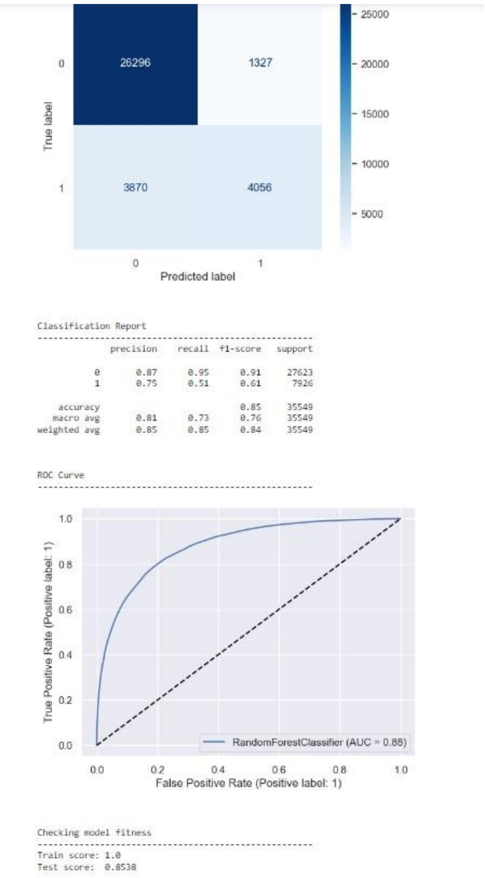
```
Checking model fitness
-------------------------------------------------------
Train score: 0.8469
Test score:  0.8421
```

Accuracy: 84%   AUC: 0.86

</td>
</tr>
</table>

Random

Forest

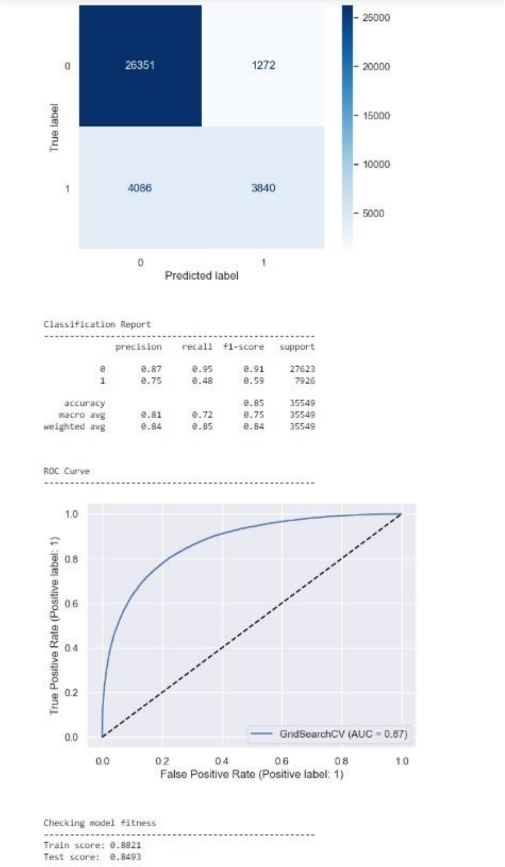

0
26296
1327
1
3870
4056
True label
0
1
Predicted label
25000
20000
15000
10000
5000
1.0
0.8
0.6
0.4
0.2
0.0
True Positive Rate (Positive label: 1)
RandomForestClassifier (AUC = 0.88)
0.0
0.2
0.4
0.6
0.8
1.0
False Positive Rate (Positive label: 1)

```
Classification Report
-----------------------------------------------------
              precision    recall  f1-score   support

           0       0.87      0.95      0.91     27623
           1       0.75      0.51      0.61      7926

    accuracy                           0.85     35549
   macro avg       0.81      0.73      0.76     35549
weighted avg       0.85      0.85      0.84     35549
```

```
ROC Curve
-----------------------------------------------------
```

```
Checking model fitness
-----------------------------------------------------
Train score: 1.0
Test score:  0.8538
```

Accuracy: 85%   AUC: 0.88



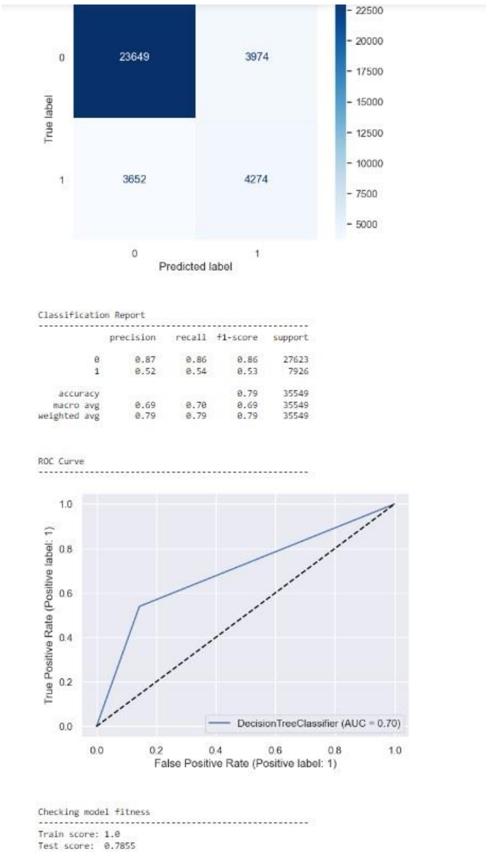
```
Classification Report
-----------------------------------------------------
              precision    recall  f1-score   support

           0       0.87      0.95      0.91     27623
           1       0.75      0.48      0.59      7926

    accuracy                           0.85     35549
   macro avg       0.81      0.72      0.75     35549
weighted avg       0.84      0.85      0.84     35549
```

```
ROC Curve
-----------------------------------------------------
```

```
Checking model fitness
-----------------------------------------------------
Train score: 0.8821
Test score:  0.8493
```

Accuracy: 85%   AUC: 0.88

<table>
<tr>
<td>Decision Tree</td>
<td>



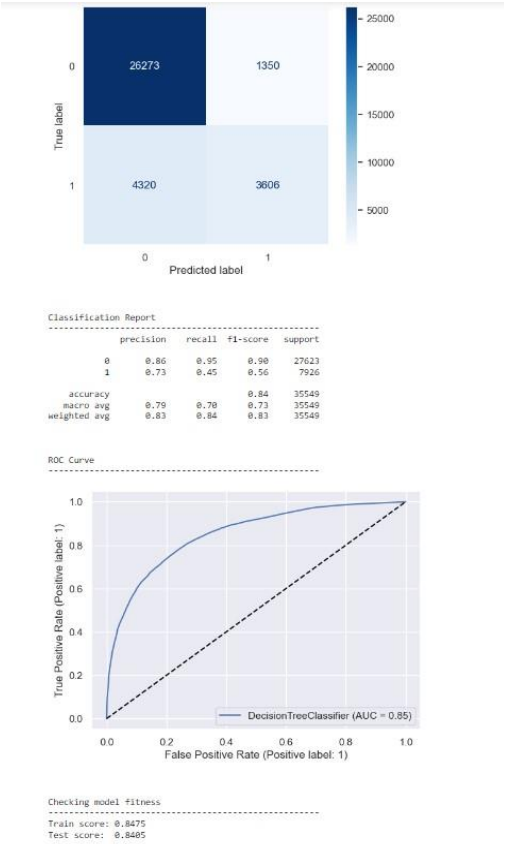
23649
3974
3652
4274
True label
Predicted label
0
1
22500
20000
17500
15000
12500
10000
7500
5000
True Positive Rate (Positive label: 1)
False Positive Rate (Positive label: 1)
DecisionTreeClassifier (AUC = 0.70)
0.0
0.2
0.4
0.6
0.8
1.0

```
Classification Report
--------------------------------------------------------------
              precision    recall  f1-score   support

           0       0.87      0.86      0.86     27623
           1       0.52      0.54      0.53      7926

    accuracy                           0.79     35549
   macro avg       0.69      0.70      0.69     35549
weighted avg       0.79      0.79      0.79     35549

ROC Curve
--------------------------------------------------------------
```

```
Checking model fitness
--------------------------------------------------------------
Train score: 1.0
Test score:  0.7855
```

Accuracy: 79%   AUC: 0.70

</td>
<td>



26273
1350
4320
3606
True label
Predicted label
0
1
25000
20000
15000
10000
5000
True Positive Rate (Positive label: 1)
False Positive Rate (Positive label: 1)
DecisionTreeClassifier (AUC = 0.85)
0.0
0.2
0.4
0.6
0.8
1.0

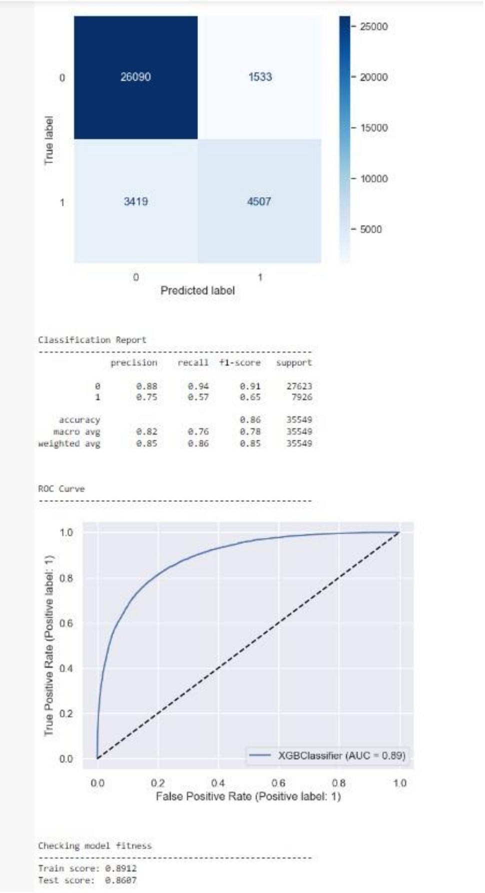
```
Classification Report
--------------------------------------------------------------
              precision    recall  f1-score   support

           0       0.86      0.95      0.90     27623
           1       0.73      0.45      0.56      7926

    accuracy                           0.84     35549
   macro avg       0.79      0.70      0.73     35549
weighted avg       0.83      0.84      0.83     35549

ROC Curve
--------------------------------------------------------------
```

```
Checking model fitness
--------------------------------------------------------------
Train score: 0.8475
Test score:  0.8405
```

Accuracy: 84%   AUC: 0.85

</td>
</tr>
</table>

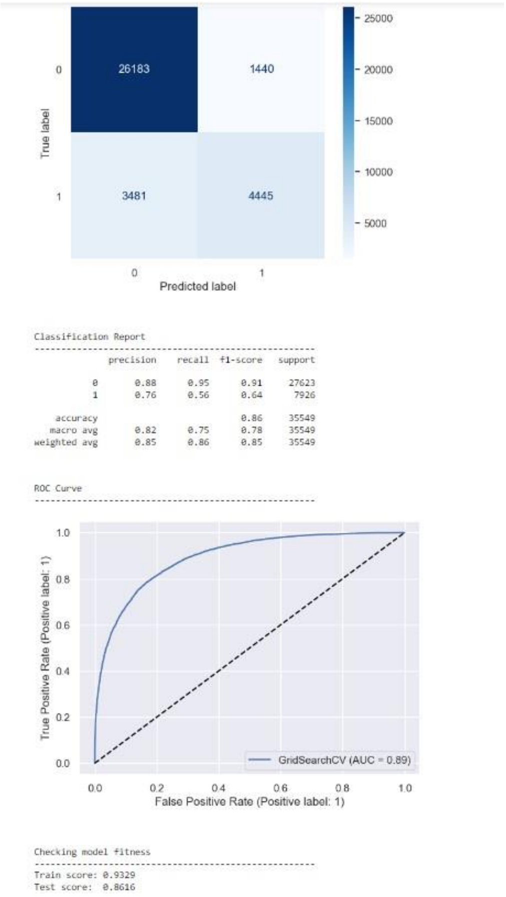
<table>
<tr>
<td>XG-Boost</td>
<td>



```
Classification Report
----------------------------------------------------------
              precision    recall  f1-score   support

           0       0.88      0.94      0.91     27623
           1       0.75      0.57      0.65      7926

    accuracy                           0.86     35549
   macro avg       0.82      0.76      0.78     35549
weighted avg       0.85      0.86      0.85     35549

ROC Curve
----------------------------------------------------------
```

```
Checking model fitness
----------------------------------------------------------
Train score: 0.8912
Test score:  0.8607
```

Accuracy: 86%   AUC: 0.89
</td>
<td>



```
Classification Report
----------------------------------------------------------
              precision    recall  f1-score   support

           0       0.88      0.95      0.91     27623
           1       0.76      0.56      0.64      7926

    accuracy                           0.86     35549
   macro avg       0.82      0.75      0.78     35549
weighted avg       0.85      0.86      0.85     35549

ROC Curve
----------------------------------------------------------
```

```
Checking model fitness
----------------------------------------------------------
Train score: 0.9329
Test score:  0.8616
```

Accuracy: 86%   AUC: 0.89
</td>
</tr>
</table>

Final Model Selection Justification (2 Marks):

Final Model	Reasoning
XG-Boost	The best performing model is the hyperparameter-tuned XG-Boost model with an accuracy of approximately 86%. The scores for both the training and testing data were similar, reducing concerns of the model being overfit.