1. XGboost:

Accuracy of XGBoost: 0.9599857410212993

Prediction time: 0.0199127197265625 seconds

Precision of XGBoost: 0.9602886389005038

Recall of XGBoost: 0.9599857410212993

F1-score of XGBoost: 0.9598138701378524

precision recall f1-score support

0 0.97 0.96 0.97 5559

1 0.98 0.99 0.99 5690

2 0.93 0.98 0.96 5543

3 0.96 0.91 0.93 5650

accuracy 0.96 22442

macro avg 0.96 0.96 0.96 22442

weighted avg 0.96 0.96 0.96 22442

Tuned:

Best score: 0.9615752540437024

Optimized parameters: {'max\_depth': 10, 'learning\_rate': 0.08801996430543457, 'n\_estimators': 200, 'gamma': 0.04265157891257164, 'min\_child\_weight': 5, 'subsample': 0.8778610685522019, 'colsample\_bytree': 0.5976519221785005}

Accuracy of XGBoost: 0.9621691471348365

Prediction time: 0.05974125862121582 seconds

Precision of XGBoost: 0.9624110293899752

Recall of XGBoost: 0.9621691471348365

F1-score of XGBoost: 0.9620227571916335

precision recall f1-score support

0 0.97 0.97 0.97 5559

1 0.99 0.99 0.99 5690

2 0.94 0.98 0.96 5543

3 0.96 0.91 0.93 5650

accuracy 0.96 22442

macro avg 0.96 0.96 0.96 22442

weighted avg 0.96 0.96 0.96 22442

1. RandomForest:

Accuracy of RandomForest: 0.956019962570181

Prediction time: 0.23851227760314941 seconds

Precision of RandomForest: 0.9561303146010326

Recall of RandomForest: 0.956019962570181

F1-score of RandomForest: 0.9558565998227

precision recall f1-score support

0 0.97 0.95 0.96 5559

1 0.98 0.99 0.98 5690

2 0.93 0.97 0.95 5543

3 0.95 0.91 0.93 5650

accuracy 0.96 22442

macro avg 0.96 0.96 0.96 22442

weighted avg 0.96 0.96 0.96 22442

Tuned:

Best score: 0.9554830249591568

Optimized parameters: {'n\_estimators': 400, 'max\_depth': None, 'min\_samples\_split': 3, 'min\_samples\_leaf': 1, 'max\_features': 'sqrt'}

Accuracy of RandomForest: 0.9564209963461368

Prediction time: 1.0477261543273926 seconds

Precision of RandomForest: 0.9565314706900193

Recall of RandomForest: 0.9564209963461368

F1-score of RandomForest: 0.9562974743345438

precision recall f1-score support

0 0.97 0.95 0.96 5559

1 0.98 0.99 0.98 5690

2 0.94 0.97 0.95 5543

3 0.94 0.91 0.93 5650

accuracy 0.96 22442

macro avg 0.96 0.96 0.96 22442

weighted avg 0.96 0.96 0.96 22442

1. Decision Tree

Accuracy of DecisionTree: 0.9387309508956421

Prediction time: 0.004979133605957031 seconds

Precision of DecisionTree: 0.9387210818302025

Recall of DecisionTree: 0.9387309508956421

F1-score of DecisionTree: 0.9387149521990094

precision recall f1-score support

0 0.94 0.95 0.95 5559

1 0.98 0.98 0.98 5690

2 0.93 0.93 0.93 5543

3 0.90 0.90 0.90 5650

accuracy 0.94 22442

macro avg 0.94 0.94 0.94 22442

weighted avg 0.94 0.94 0.94 22442

Tuned:

Best score: 0.9407395272371598

Optimized parameters: {'criterion': 'gini', 'splitter': 'best', 'max\_depth': 13, 'min\_samples\_split': 10, 'min\_samples\_leaf': 8}

Accuracy of DecisionTree: 0.9437215934408698

Prediction time: 0.004978656768798828 seconds

Precision of DecisionTree: 0.9442796857531569

Recall of DecisionTree: 0.9437215934408698

F1-score of DecisionTree: 0.9433509246649306

precision recall f1-score support

0 0.95 0.95 0.95 5559

1 0.98 0.98 0.98 5690

2 0.91 0.97 0.94 5543

3 0.94 0.87 0.91 5650

accuracy 0.94 22442

macro avg 0.94 0.94 0.94 22442

weighted avg 0.94 0.94 0.94 22442

4. Stacking

Accuracy of StackingClassifier: 0.9619463505926388

Prediction time: 0.48891234397888184 seconds

Precision of StackingClassifier: 0.9619771734719249

Recall of StackingClassifier: 0.9619463505926388

F1-score of StackingClassifier: 0.9618188646770158

precision recall f1-score support

0 0.97 0.97 0.97 5559

1 0.99 0.99 0.99 5690

2 0.94 0.97 0.96 5543

3 0.95 0.92 0.93 5650

accuracy 0.96 22442

macro avg 0.96 0.96 0.96 22442

weighted avg 0.96 0.96 0.96 22442

Tuned:

Best score: 0.9624919187226466

Optimized parameters: {'hidden\_layer\_sizes': '50\_50', 'alpha': 0.0007005756483303174, 'learning\_rate\_init': 0.00018803473842393673}

Accuracy of StackingClassifier: 0.9624365029854737

Prediction time: 1.8222887516021729 seconds

Precision of StackingClassifier: 0.9625829569642195

Recall of StackingClassifier: 0.9624365029854737

F1-score of StackingClassifier: 0.9623144759178868

precision recall f1-score support

0 0.97 0.97 0.97 5559

1 0.99 0.99 0.99 5690

2 0.94 0.98 0.96 5543

3 0.95 0.92 0.93 5650

accuracy 0.96 22442

macro avg 0.96 0.96 0.96 22442

weighted avg 0.96 0.96 0.96 22442