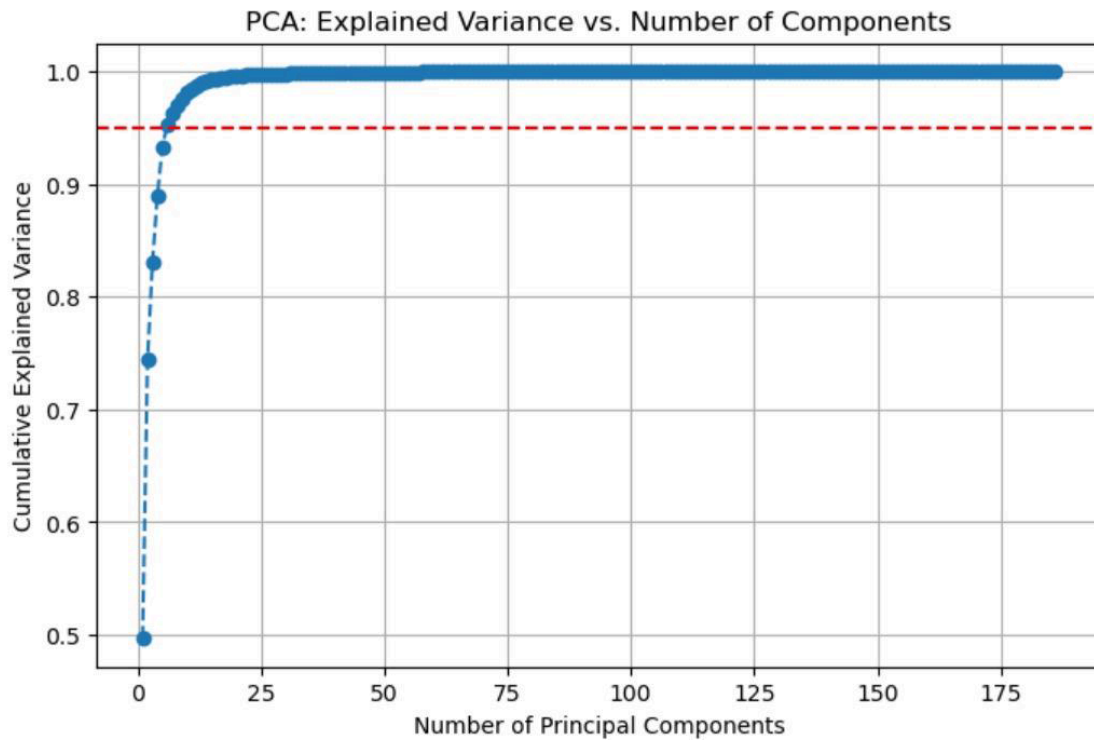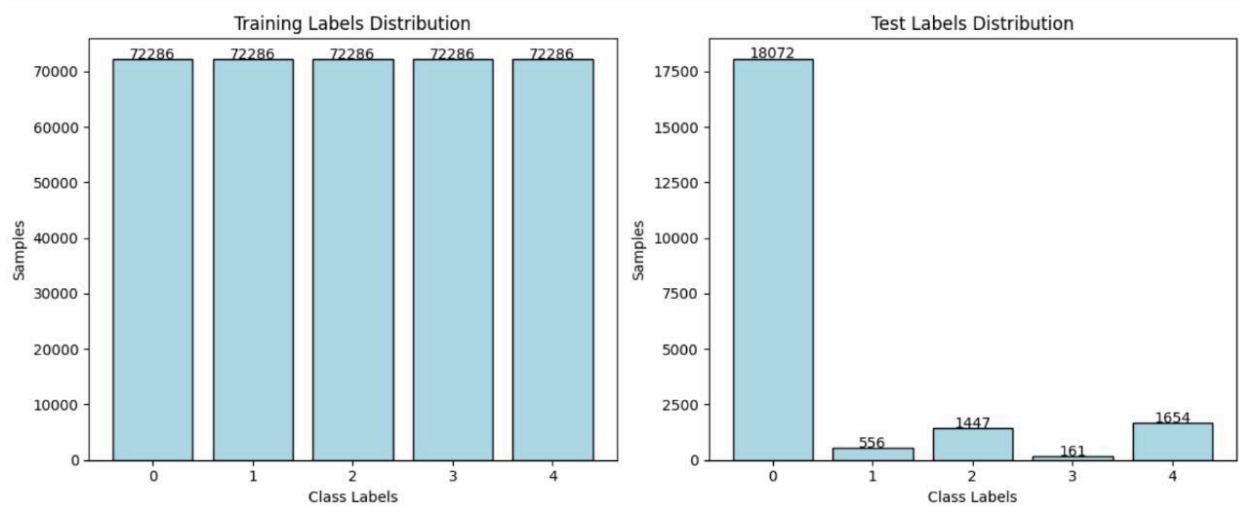# OUTPUT SNAPSHOTS

5.1 PCA:

5.2 GAN & SMOTE balanced histogram:

GAN outputs:

5.3 Classification report for GAN-XGBoost:

```
Classification Report on Test Set:

              precision    recall  f1-score   support

          0       0.98      1.00      0.99     18072
          1       0.93      0.71      0.80       556
          2       0.96      0.94      0.95      1447
          3       0.90      0.68      0.78       161
          4       0.99      0.96      0.98      1654

   accuracy                           0.98     21890
  macro avg       0.95      0.86      0.90     21890
weighted avg       0.98      0.98      0.98     21890
```

5.4 Classification report for GAN-Random Forest:

```
Macro F1-score on Training Data: 0.9312
Macro F1-score on Test Data: 0.8816

Classification Report on Test Set:

              precision    recall  f1-score   support

          0       0.98      1.00      0.99     18072
          1       0.98      0.62      0.76       556
          2       0.97      0.94      0.95      1447
          3       0.97      0.59      0.73       161
          4       1.00      0.95      0.97      1654

   accuracy                           0.98     21890
  macro avg       0.98      0.82      0.88     21890
ghted avg       0.98      0.98      0.98     21890
```

5.5 Classification report for GAN-LinearSVC:

```
Weighted F1-score: 0.9745789488796465
Macro F1-score: 0.8694139625225311
Micro F1-score: 0.9763819095477387
```

📝 Classification Report:

	precision	recall	f1-score	support
0	0.9754	0.9981	0.9866	18072
1	0.9849	0.5863	0.7351	556
2	0.9652	0.9385	0.9516	1447
3	0.9674	0.5528	0.7036	161
4	0.9968	0.9450	0.9702	1654
accuracy			0.9764	21890
macro avg	0.9779	0.8041	0.8694	21890
weighted avg	0.9765	0.9764	0.9746	21890

5.6 Classification report for GAN- SVC:
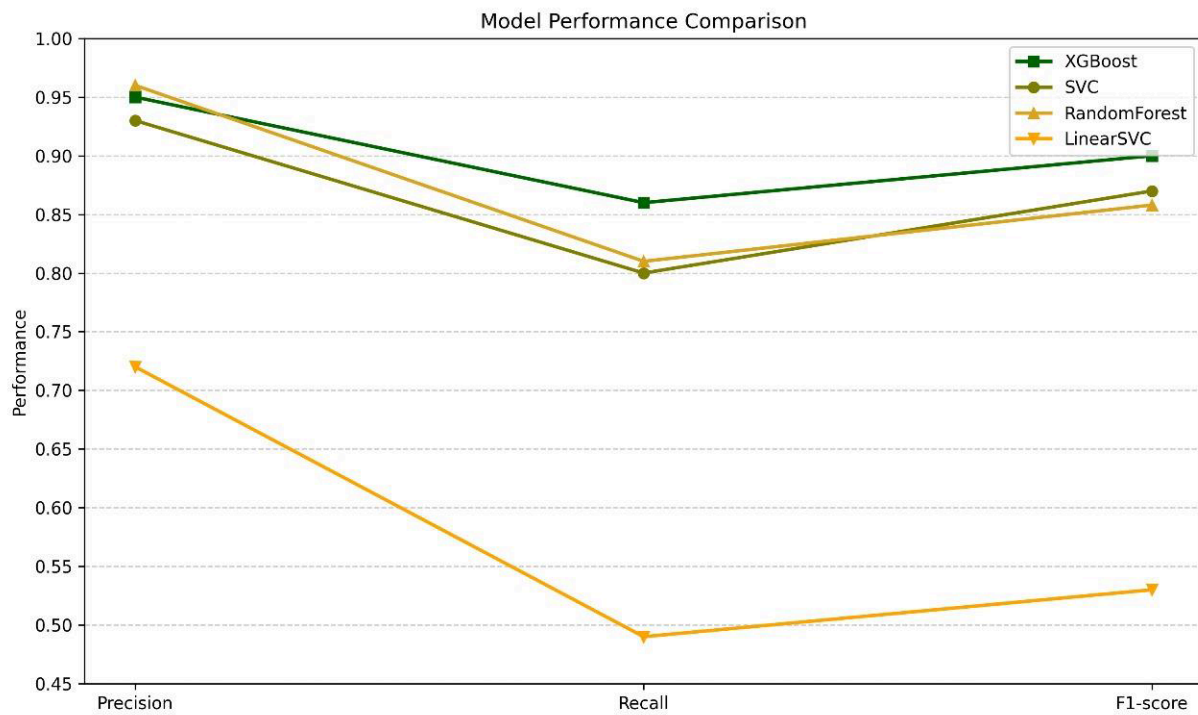
📊 Macro F1-score on Training Data: 0.8508
📊 Macro F1-score on Test Data: 0.8591

📋 Classification Report on Test Data:

	precision	recall	f1-score	support
0	0.97	0.99	0.98	18072
1	0.76	0.53	0.62	556
2	0.97	0.92	0.95	1447
3	0.97	0.66	0.79	161
4	1.00	0.92	0.96	1654
accuracy			0.97	21890
macro avg	0.93	0.80	0.86	21890
weighted avg	0.97	0.97	0.97	21890

5.7 Model performance comparison-GAN:

Model Performance Comparison

Class Weight outputs:

5.8 Classification report for Class Weight-XGBoost:

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

           0       0.99       0.99       0.99       18072
           1       0.91       0.87       0.89         556
           2       0.97       0.98       0.97        1447
           3       0.90       0.86       0.88         161
           4       0.99       0.99       0.99        1654

    accuracy                             0.99       21890
   macro avg       0.95       0.94       0.95       21890
weighted avg       0.99       0.99       0.99       21890


Test Macro F1 Score: 0.9452
```

5.9 Classification report for Class Weight-Random Forest:

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

           0       0.99      0.99      0.99     18072
           1       0.93      0.78      0.84       556
           2       0.94      0.97      0.96      1447
           3       0.92      0.78      0.85       161
           4       1.00      0.98      0.99      1654

    accuracy                           0.98     21890
   macro avg       0.96      0.90      0.93     21890
weighted avg       0.98      0.98      0.98     21890


Weighted F1-score: 0.9837080718108328
Macro F1-score: 0.9252242809783408
Micro F1-score: 0.9840566468707173
```

5.10 Classification report for Class Weight-LinearSVC:

```
Best Params for LinearSVC: {'linearsvc__C': 0.01200765032851924}
Classification Report:
              precision    recall  f1-score   support

           0       0.95      0.94      0.94     18072
           1       0.31      0.32      0.32       556
           2       0.54      0.65      0.59      1447
           3       0.42      0.50      0.46       161
           4       0.92      0.88      0.90      1654

    accuracy                           0.89     21890
   macro avg       0.63      0.66      0.64     21890
weighted avg       0.90      0.89      0.90     21890
```

5.11 Classification report for Class Weight-SVC:

```
Classification Report on Test Data:

             precision      recall  f1-score      support

         0        0.97        0.99      0.98        18072
         1        0.76        0.55      0.64          556
         2        0.98        0.94      0.96         1447
         3        0.97        0.70      0.82          161
         4        1.00        0.93      0.96         1654

  accuracy                             0.97        21890
 macro avg        0.94        0.82      0.87        21890
weighted avg      0.97        0.97      0.97        21890

Macro F1-score on Training Data: 0.8656
Macro F1-score on Test Data: 0.8718
```
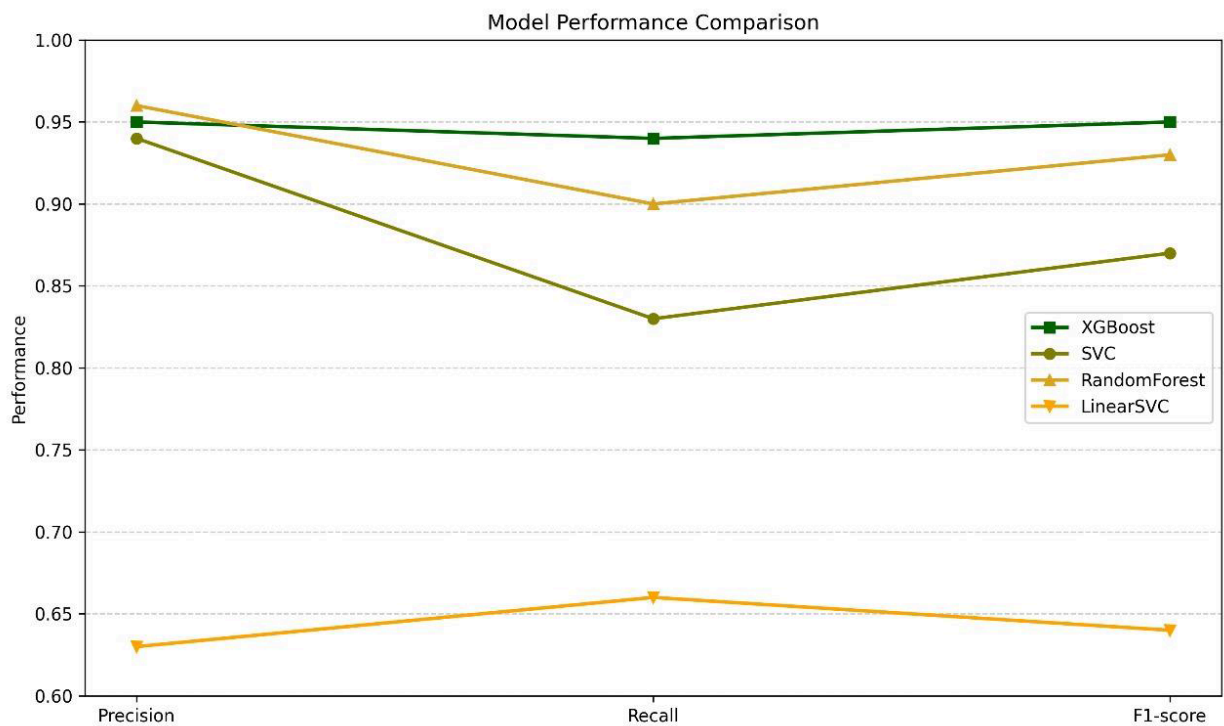
5.12 Model performance comparison – Class weight:

SMOTE outputs:

5.13 Classification report for SMOTE-XGBoost:

```
📊 Classification Report - Test:
              precision    recall  f1-score   support

           0       0.99      0.97      0.98     18072
           1       0.64      0.90      0.75       556
           2       0.93      0.98      0.95      1447
           3       0.68      0.89      0.77       161
           4       0.98      0.99      0.98      1654

    accuracy                           0.97     21890
   macro avg       0.85      0.95      0.89     21890
weighted avg       0.98      0.97      0.97     21890
```

```
✅ Train Macro F1 Score: 0.9918
✅ Test Macro F1 Score: 0.8888
```

5.14 Classification report for SMOTE-Random Forest :

```
✅ Best Parameters: {'n_estimators': 100, 'max_depth': 30, 'min_samples_split': 12, 'min_samples_leaf': 3]
Weighted F1-score: 0.9865156647541405
Macro F1-score: 0.937625757637309
Micro F1-score: 0.9865235267245317
Classification Report:
              precision    recall  f1-score   support

           0       0.99      0.99      0.99     18072
           1       0.89      0.87      0.88       556
           2       0.94      0.98      0.96      1447
           3       0.87      0.86      0.87       161
           4       0.99      0.99      0.99      1654

    accuracy                           0.99     21890
   macro avg       0.94      0.94      0.94     21890
weighted avg       0.99      0.99      0.99     21890
```
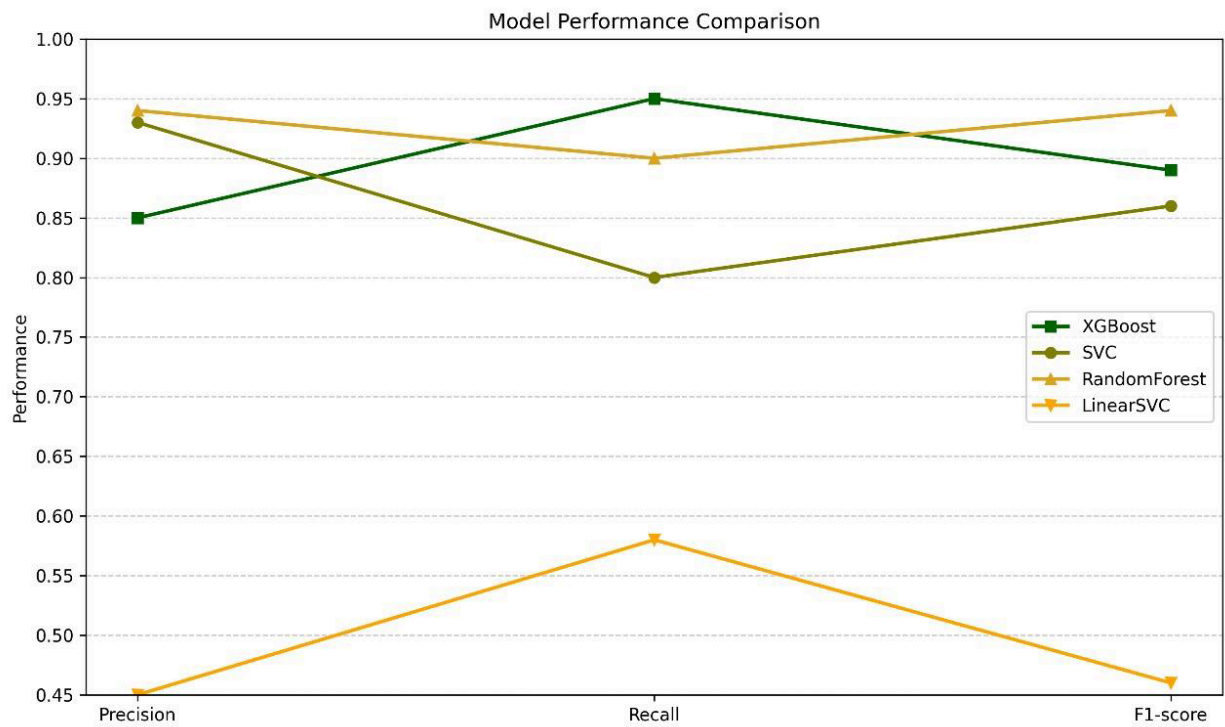
5.15 Classification report for SMOTE-LinearSVC:

```
Best Params for LinearSVC: {'linearsvc__C': 9.983275721601764}
LinearSVC Macro F1 Score: 0.4621
Classification Report:
              precision    recall  f1-score   support

           0       0.98      0.57      0.72     18072
           1       0.11      0.78      0.19       556
           2       0.33      0.75      0.46      1447
           3       0.07      0.89      0.13       161
           4       0.73      0.92      0.81      1654

    accuracy                           0.61     21890
   macro avg       0.44      0.78      0.46     21890
weighted avg       0.89      0.61      0.69     21890
```

5.16 Classification report for SMOTE-SVC:

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

           0       0.99      0.99      0.99     18072
           1       0.85      0.84      0.85       556
           2       0.98      0.96      0.97      1447
           3       0.81      0.79      0.80       161
           4       0.99      0.98      0.98      1654

    accuracy                           0.98     21890
   macro avg       0.92      0.91      0.92     21890
weighted avg       0.98      0.98      0.98     21890


Test Macro F1 Score: 0.9184
```
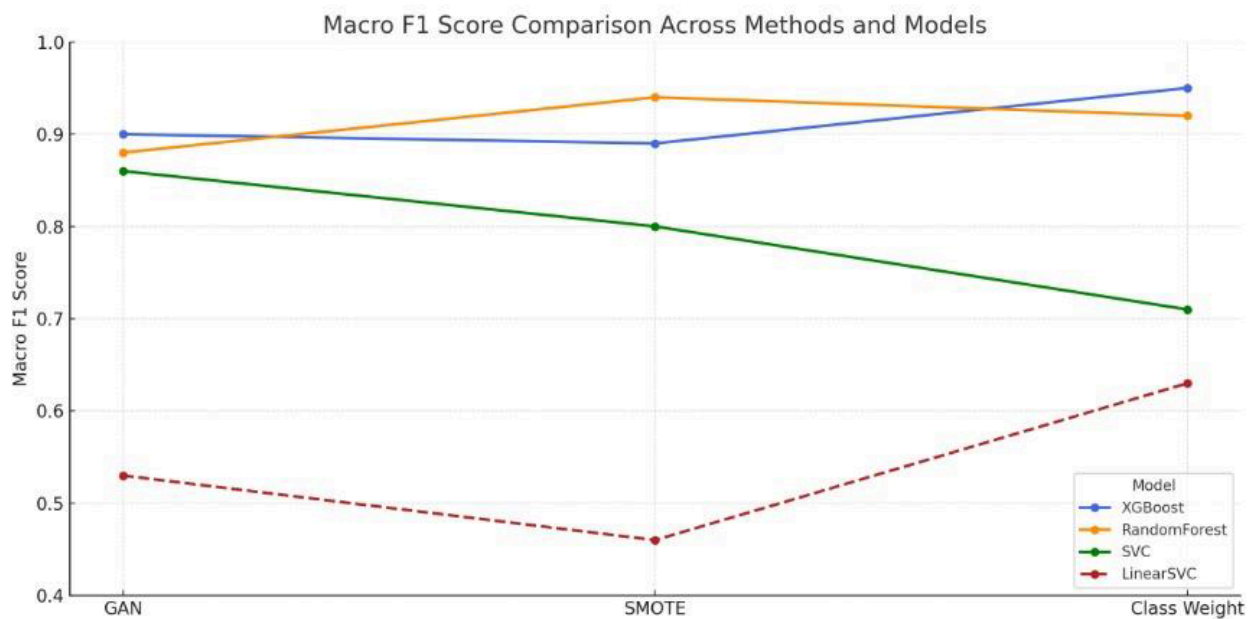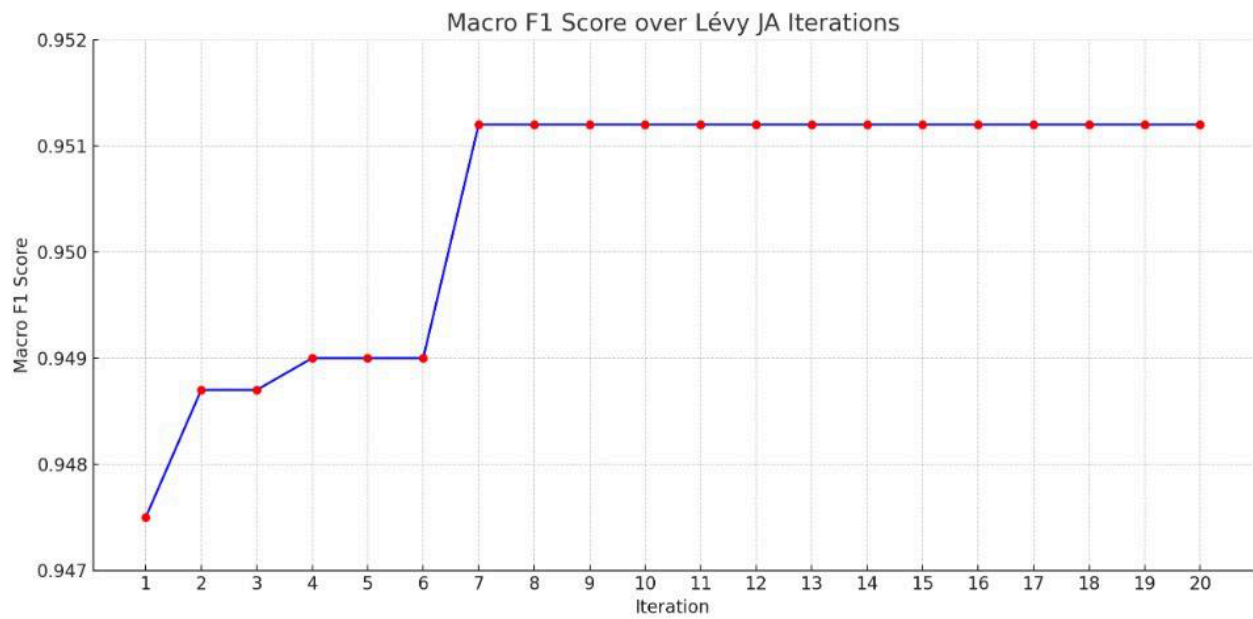
5.17 Model performance comparison – SMOTE:

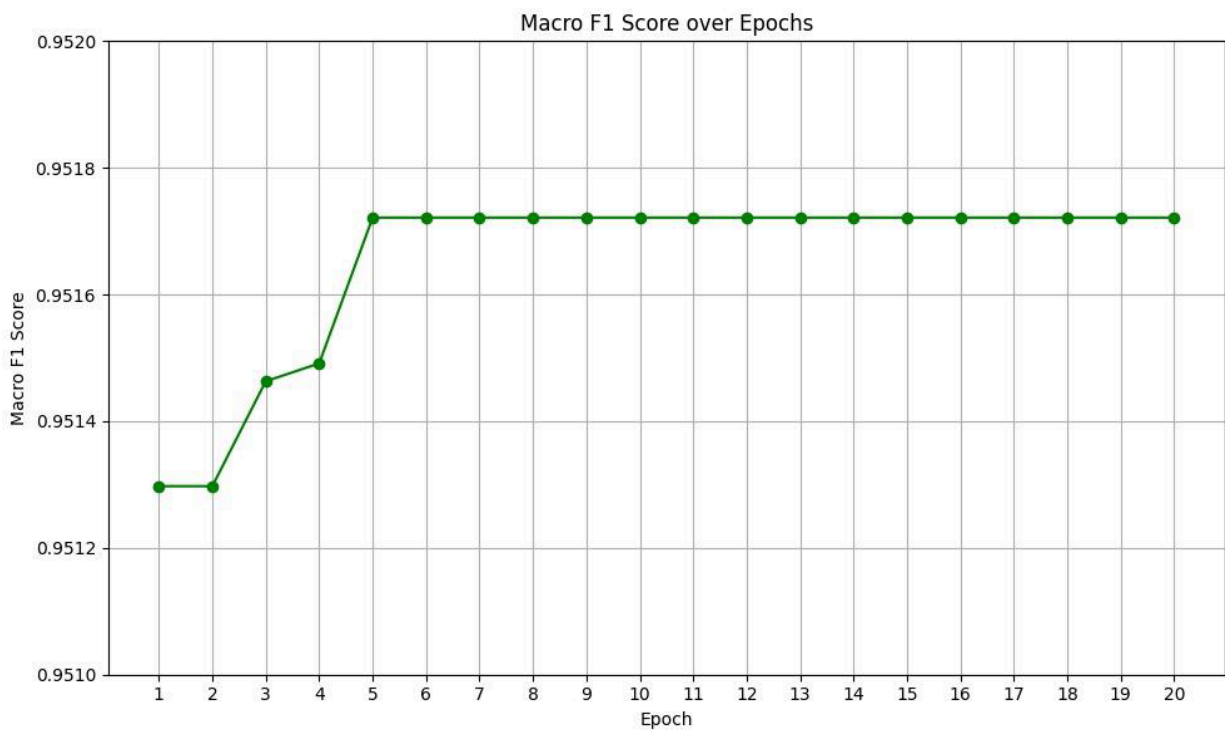## 5.18 Macro F1 Score comparison across methods and models:
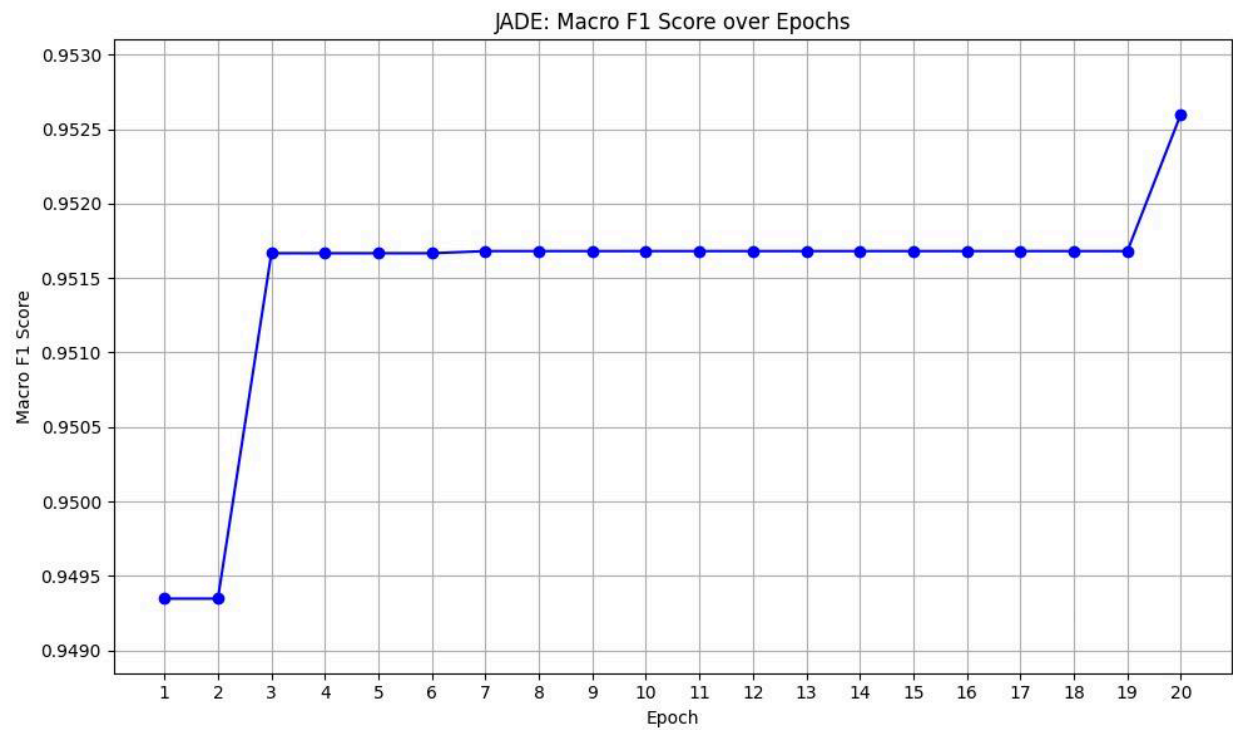
Macro F1 Score:

5.19 Iteration graph of LevyJA:

Macro F1 Score over Lévy JA Iterations

5.20 Iteration graph of EnhancedAEO:

Macro F1 Score over Epochs

5.21 Iteration graph of JADE:

JADE: Macro F1 Score over Epochs

5.22 Iteration graph of OriginalJA:

Original JA Optimization - Macro F1 Score per Iteration