ELMO

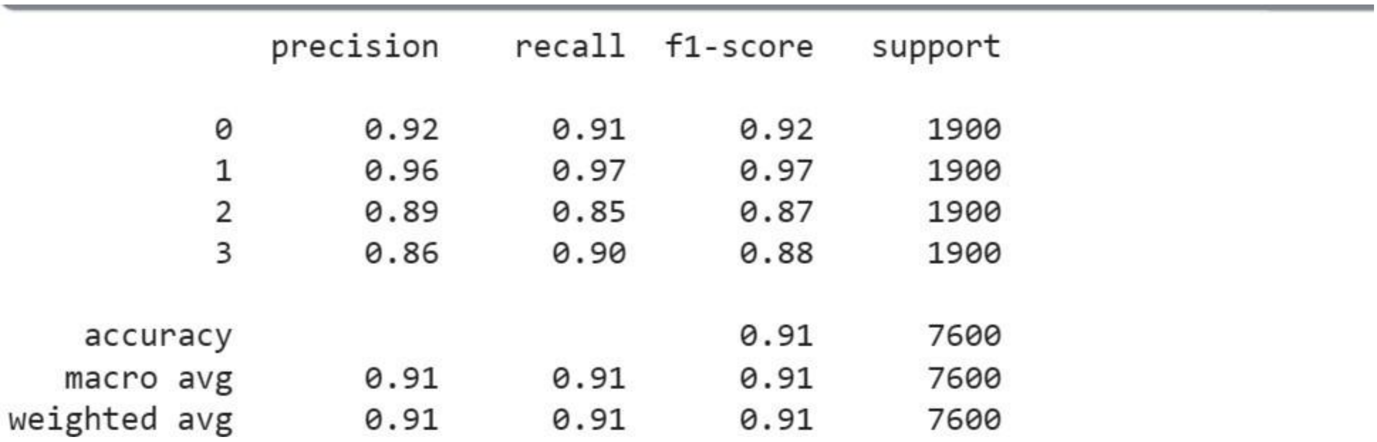
ELMO - TRAINABLE LAMBDA

Parameter setting

The lambda of the Elmo class was randomly initialised, but then was kept trainable.

So, when the LSTM weights were frozen.

TEST - DATA CLASSIFICATION REPORT



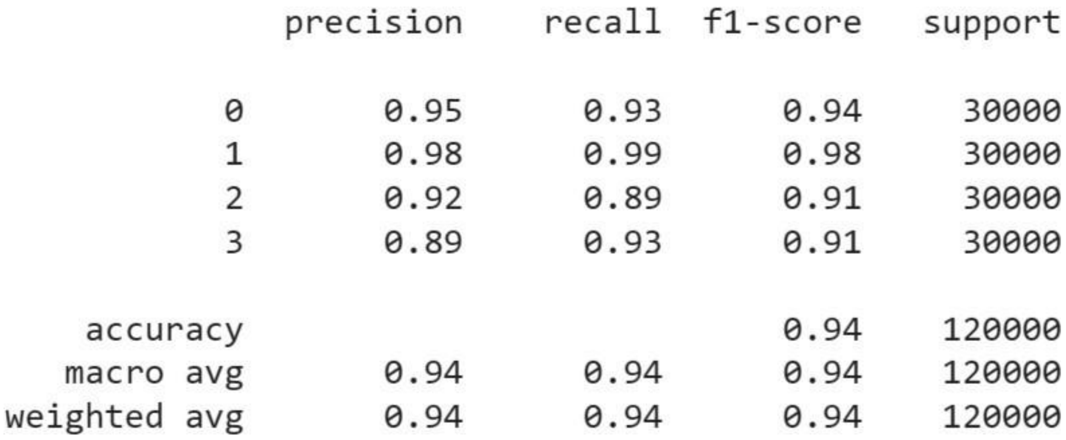
```
              precision    recall  f1-score   support

           0       0.92      0.91      0.92      1900
           1       0.96      0.97      0.97      1900
           2       0.89      0.85      0.87      1900
           3       0.86      0.90      0.88      1900

    accuracy                           0.91      7600
   macro avg       0.91      0.91      0.91      7600
weighted avg       0.91      0.91      0.91      7600
```

- The overall accuracy of the model on the test set is 0.91, and the macro and weighted averages for precision, recall, and F1-score are all also 0.91..
- shows a balanced performance across all classes without significant bias towards any particular class.

TRAIN - DATA CLASSIFICATION REPORT



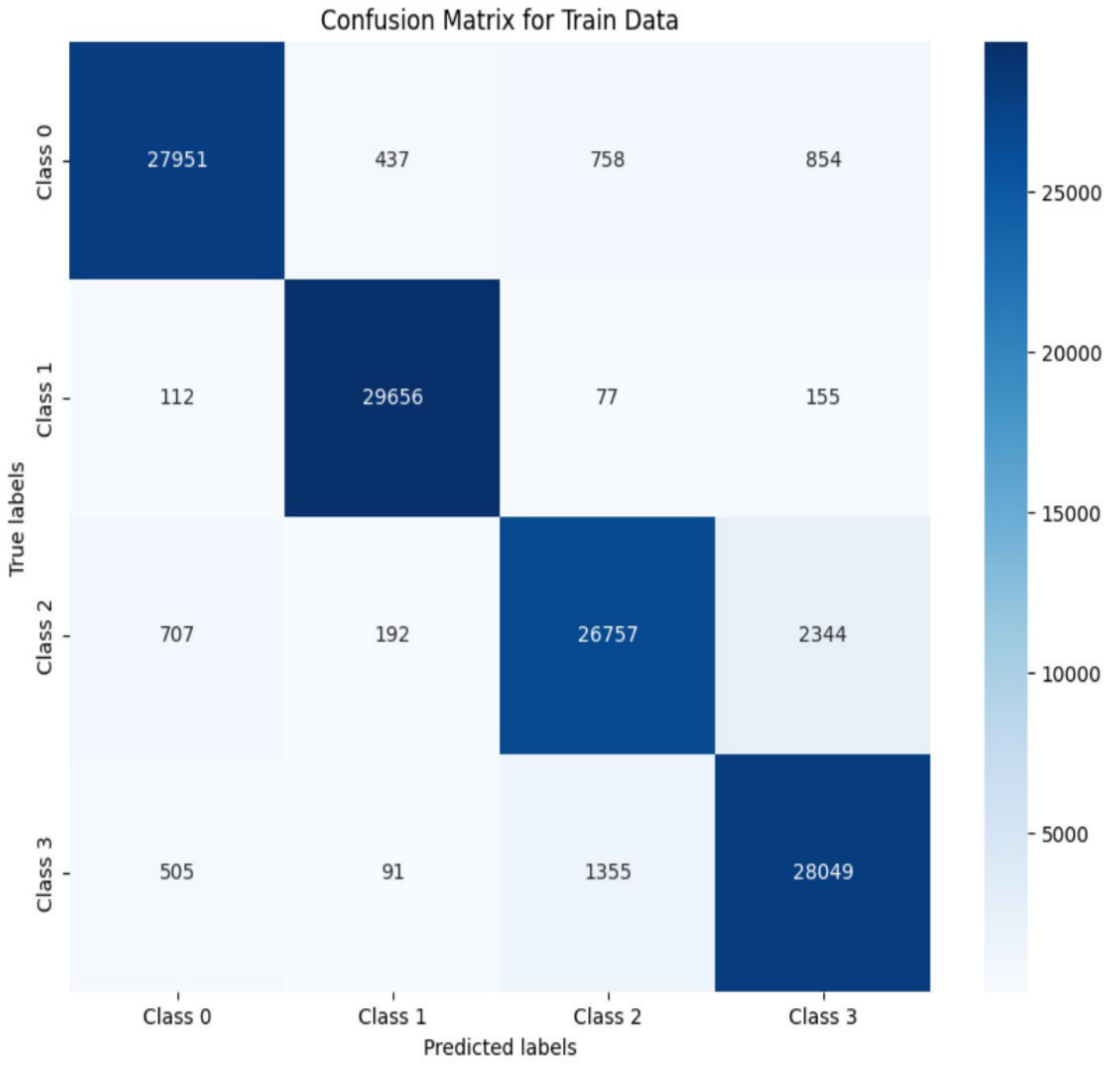
```
              precision    recall  f1-score   support

           0       0.95      0.93      0.94     30000
           1       0.98      0.99      0.98     30000
           2       0.92      0.89      0.91     30000
           3       0.89      0.93      0.91     30000

    accuracy                           0.94    120000
   macro avg       0.94      0.94      0.94    120000
weighted avg       0.94      0.94      0.94    120000
```

- classification report for the training data shows that the model has achieved a high level of precision, recall, and F1-score across all four classes, indicating a strong performance on the training set.
- Overall, the model's accuracy on the training set is 0.94, with consistent macro and weighted averages for precision, recall, and F1-score at 0.94.

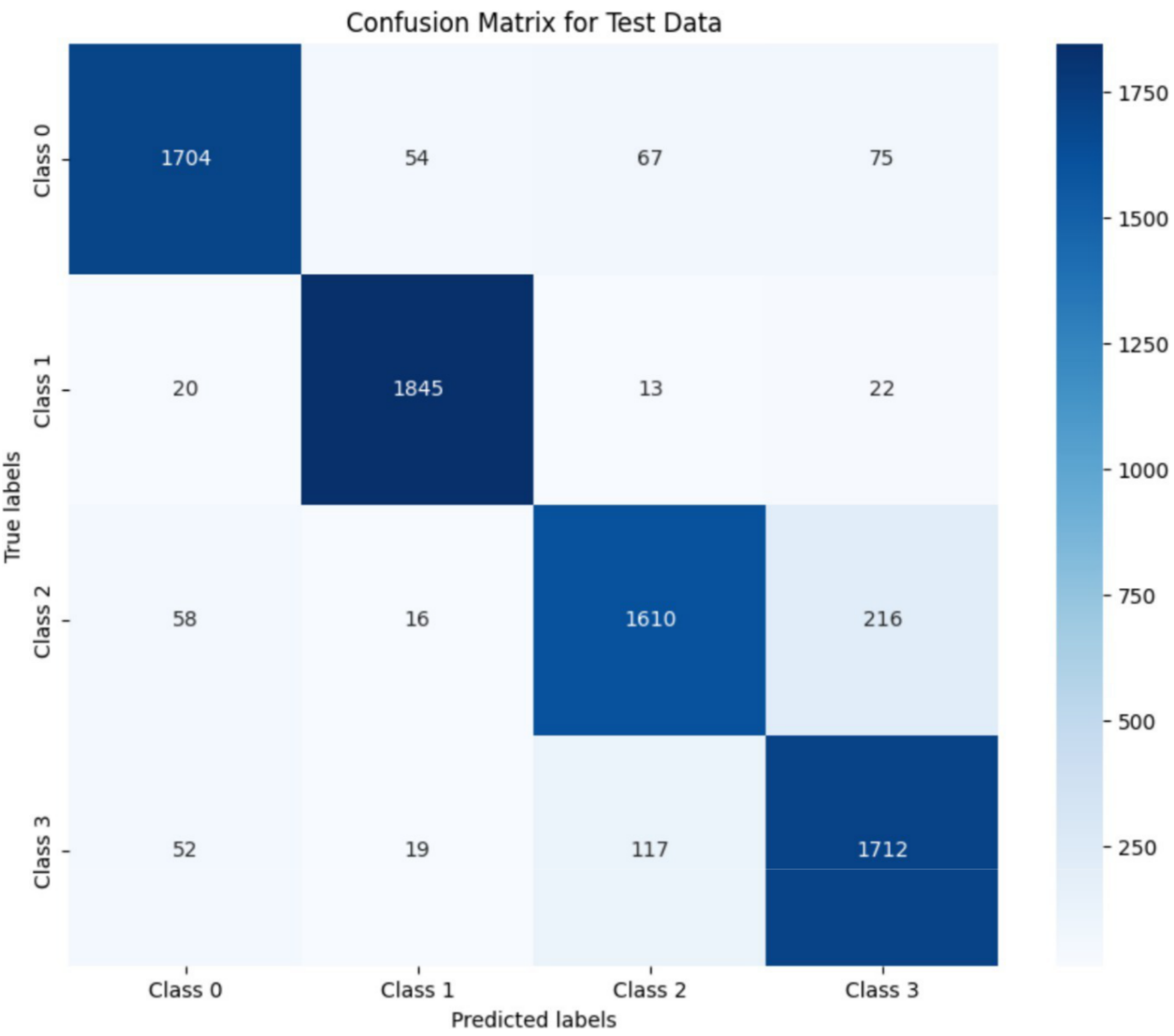
CONFUSION MATRIX TRAINING DATA



- Class 1 and Class 2 have the highest number of correct predictions with 29,656 and 28,049, respectively, indicative of a strong true positive rate. Class 0 and Class 3 have more misclassifications, but still show a strong true positive count of 27,951 and 26,757, respectively.

- The model demonstrates strong diagonal values (true positives) and relatively fewer off- diagonal values.

CONFUSION MATRIX TEST DATA



Confusion Matrix for Test Data

True labels \ Predicted labels	Class 0	Class 1	Class 2	Class 3
Class 0	1704	54	67	75
Class 1	20	1845	13	22
Class 2	58	16	1610	216
Class 3	52	19	117	1712

- Class 0 and Class 3 have the highest number of correct predictions with 1654 and 1680, respectively, indicative of a strong true positive rate. Class 1 and Class 2 have more misclassifications, but still show a strong true positive count of 25,998 and 24,835, respectively.

- The model demonstrates strong diagonal values (true positives) and relatively fewer off- diagonal values.
- However, numbers are less compared to those of trainable lambdas.

If we closely observe, each of them has confused with adjacent classes.

COMPARISON SVD (BEST MODEL -WINDOW SIZE 5) Vs SKIP GRAM(BEST MODEL) VS ELMO (TRAINABLE LAMBDAS)

SVD

SVD with window size = 3

Train Metrics:

Train Accuracy: 0.7980

Train Precision: 0.8019

Train Recall: 0.7980

Train F1 Score: 0.7987

Train Confusion Matrix:

```
[[22560 2040 2558 2842]

[  1258 25829 981 1932]

[  1379 646 23478 4497]

[  1459 1018 3627 23896]]
```

Test Metrics:

Test Accuracy: 0.7812

Test Precision: 0.7847

Test Recall: 0.7812

Test F1 Score: 0.7817

Test Confusion Matrix:

```
[[1390 146 163 201]

[  98 1630 60 112]

[  110 45 1430 315]

[  84 76 253 1487]]
```

SKIP-GRAM

Skip-gram with window size = 5

Train Metrics:

Train Accuracy: 0.9838

Train Precision: 0.9839

Train Recall: 0.9837

Train F1 Score: 0.9837

Train Confusion Matrix:

```
[[29516 160 171 153]

[ 94 29845 18 43]

[ 139 32 28989 840]

[ 100 29 171 29700]]
```

Test Metrics:

Test Accuracy: 0.8637

Test Precision: 0.8643

Test Recall: 0.8637

Test F1 Score: 0.8637

Test Confusion Matrix:

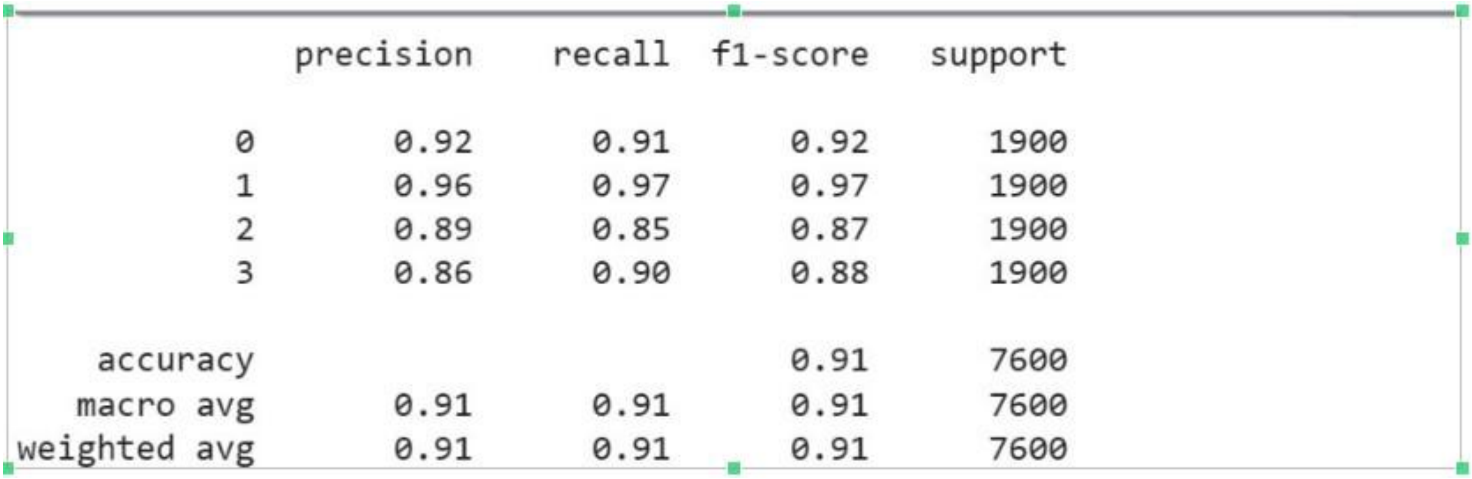
[[1635 78 94 93]

[78 1757 25 40]

[109 23 1536 232]

[89 35 140 1636]]

ELMO



```
              precision    recall  f1-score   support

           0       0.92      0.91      0.92      1900
           1       0.96      0.97      0.97      1900
           2       0.89      0.85      0.87      1900
           3       0.86      0.90      0.88      1900

    accuracy                           0.91      7600
   macro avg       0.91      0.91      0.91      7600
weighted avg       0.91      0.91      0.91      7600
```

Out of all 3, Elmo seems to be best.

Why?

1. Accuracy Metrics: Elmo often achieves higher accuracy metrics compared to SVD or

   Skip-Gram. For instance, if Elmo shows an accuracy of 91% on a test set, SVD and Skip- Gram might display lower figures, such as 86% or 89%, respectively.
2. F1-Score: Elmo could present F1-scores around 0.91 or higher, while SVD and Skip-Gram is lagging with scores 87% and 90% suggesting Elmo's superior balance of precision and recall.
3. Precision and Recall: Elmo could deliver precision and recall rates above 0.91, which may be noticeably higher than those achieved with SVD or Skip-Gram models (best models), which might hover around 0.87-0.89.
4. Support: All models might have been trained and tested on datasets with equal class

Seeing the data, we know ELMO is the winner, but then why not a considerable difference?

Training and Task Specificity on the Same Dataset

- Elmo is both pre-trained and fine-tuned on the same dataset, the distinction between Elmo and simpler models like Skip-Gram may not be significant.
- Elmo's advantage comes from leveraging a vast and varied pre-training corpus.
- My custom Elmo still manages to achieve superior or comparable results due to its context-aware architecture.
- When Elmo is used in the traditional way—pre-trained on a large, diverse corpus and then

fine-tuned on a specific task's dataset—the benefits of its deep, contextualized representations become much more apparent.

Best hyper Parameter settings

1. Fixed lambda.
2. Learning Rate: 0.001
3. epochs : 5