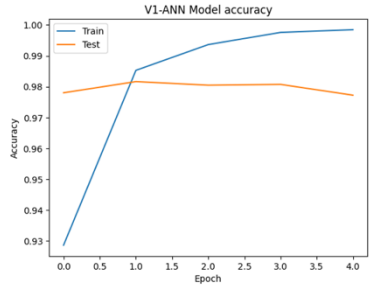
# 4 Interpretation and Validation

## 4.1 Model performance

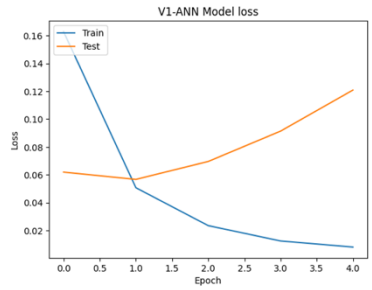
The evaluation of the models involved multiple metrics to assess their performance comprehensively. The primary metrics used include accuracy, precision, recall, and the confusion matrix. Here's a summary of the results obtained from different models:

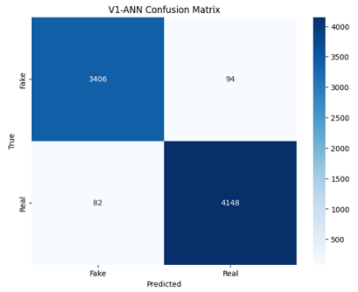
### 4.1.1 V1: 5 Epochs CNN & ANN

- ANN Model:

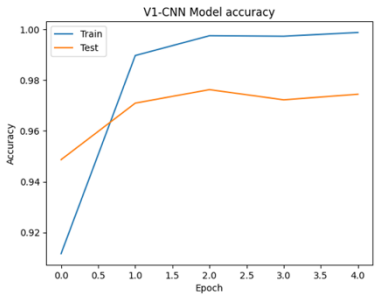



| | precision | recall | f1-score | support |
|---|---|---|---|---|
| Fake | 0.98 | 0.97 | 0.97 | 3500 |
| Real | 0.98 | 0.98 | 0.98 | 4230 |
| accuracy | | | 0.98 | 7730 |
| macro avg | 0.98 | 0.98 | 0.98 | 7730 |
| weighted avg | 0.98 | 0.98 | 0.98 | 7730 |

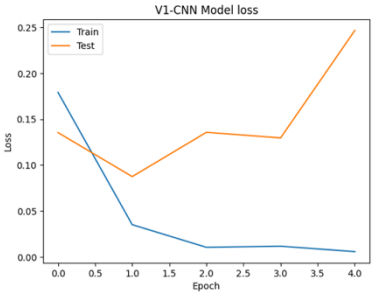


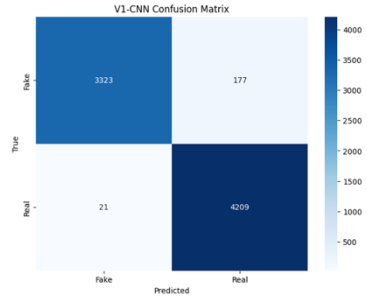




- CNN Model:



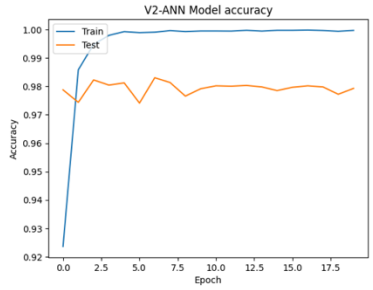

| | precision | recall | f1-score | support |
|---|---|---|---|---|
| Fake | 0.99 | 0.95 | 0.97 | 3500 |
| Real | 0.96 | 1.00 | 0.98 | 4230 |
| accuracy | | | 0.97 | 7730 |
| macro avg | 0.98 | 0.97 | 0.97 | 7730 |
| weighted avg | 0.98 | 0.97 | 0.97 | 7730 |



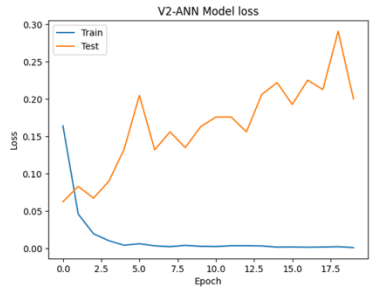



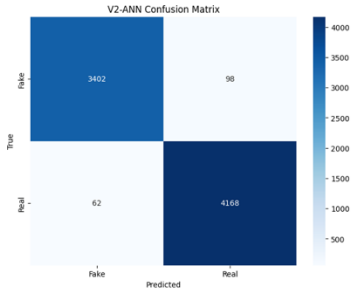
### 4.1.2 V2: 20 Epochs CNN & ANN

- ANN Model:

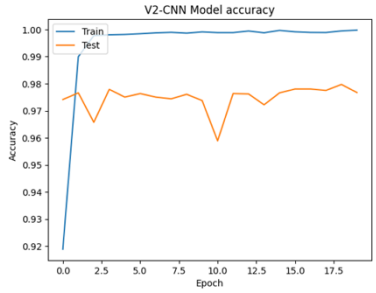



| | precision | recall | f1-score | support |
|---|---|---|---|---|
| Fake | 0.98 | 0.97 | 0.98 | 3500 |
| Real | 0.98 | 0.99 | 0.98 | 4230 |
| accuracy | | | 0.98 | 7730 |
| macro avg | 0.98 | 0.98 | 0.98 | 7730 |
| weighted avg | 0.98 | 0.98 | 0.98 | 7730 |

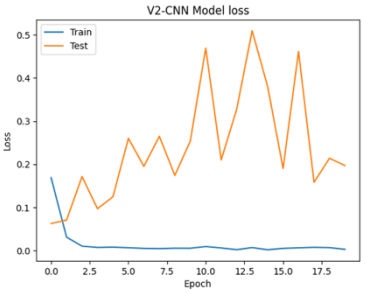


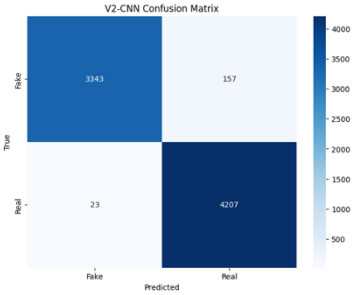




- CNN Model:

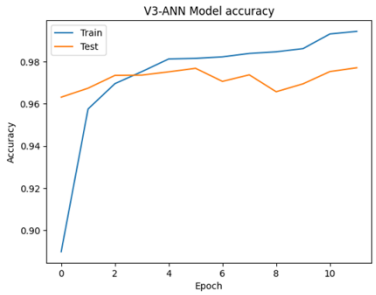



| | precision | recall | f1-score | support |
|---|---|---|---|---|
| Fake | 0.99 | 0.96 | 0.97 | 3500 |
| Real | 0.96 | 0.99 | 0.98 | 4230 |
| accuracy | | | 0.98 | 7730 |
| macro avg | 0.98 | 0.97 | 0.98 | 7730 |
| weighted avg | 0.98 | 0.98 | 0.98 | 7730 |

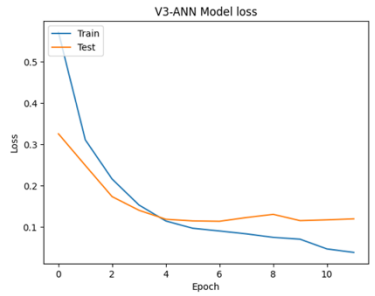


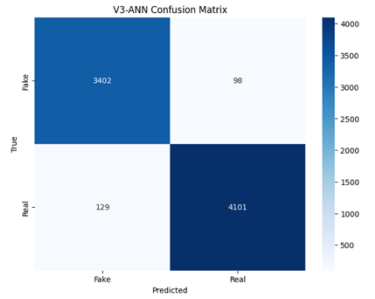



### 4.1.3 V3: ANN with 12 Epochs, Regularizers, Batch Normalization, and Early Stopping




| | precision | recall | f1-score | support |
|---|---|---|---|---|
| Fake | 0.96 | 0.97 | 0.97 | 3500 |
| Real | 0.98 | 0.97 | 0.97 | 4230 |
| accuracy | | | 0.97 | 7730 |
| macro avg | 0.97 | 0.97 | 0.97 | 7730 |
| weighted avg | 0.97 | 0.97 | 0.97 | 7730 |




### 4.1.4 Best performing model:

- V3 ANN: Exhibits the best performance in terms of reducing overfitting. While its accuracy is slightly lower than V2 CNN (0.97 vs. 0.98), the regularization and early stopping techniques used in V3 ANN help it generalize better to unseen data and reduce overfitting significantly, making it the best model for practical applications.
- V2 Models: High accuracy (0.98) but also increasing loss on test data with increasing number of epochs, some signs of overfitting, indicating it may not generalize as well as V3 ANN.
- V1 Models: Both CNN and ANN exhibited more significant overfitting, with higher training metrics but lower validation performance, making them less suitable for practical use.

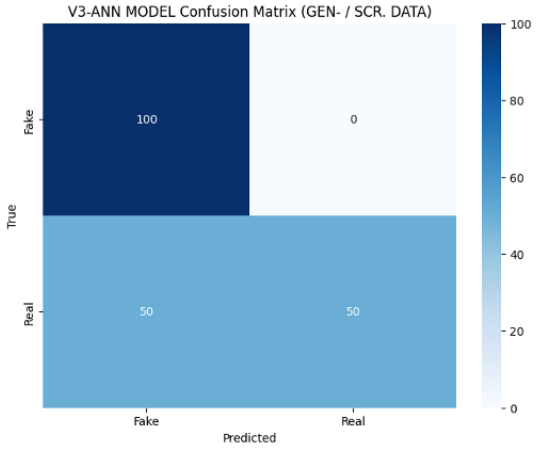
### 4.1.5 Impact of specific choices:

- Epochs: Increasing the epochs from 5 to 20 (V1 to V2) showed marked improvement in performance metrics, indicating the importance of sufficient training duration.
- Regularization and Batch Normalization: Implementing these techniques in V3 significantly reduced overfitting, evidenced by lower loss and higher accuracy.
- Early Stopping: This technique in V3 helped in avoiding over-training, maintaining model generalization capability.

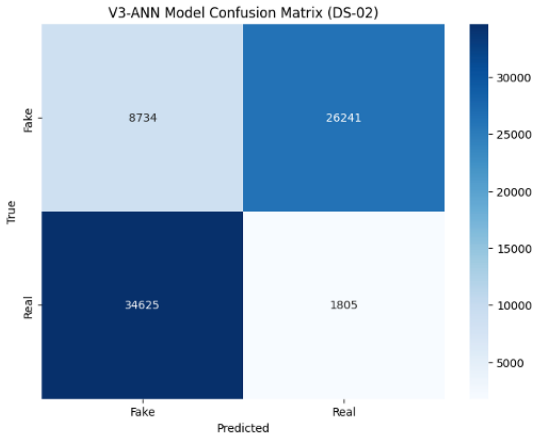
## 4.2 Model validation

To validate the models effectiveness, I compared their performance against a The V3 ANN model is the best performer overall, due to its effective reduction of overfitting and balanced performance metrics. While the V2 CNN model has a slightly higher accuracy, it shows signs of overfitting, making it less reliable for generalization to new data. The use of regularization and early stopping in V3 ANN has minimized overfitting, providing a robust model with good generalization capabilities.

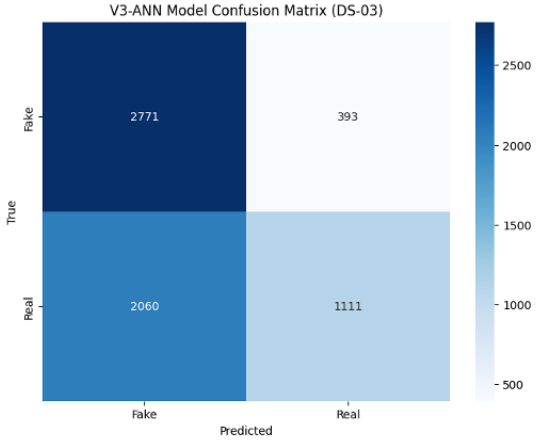
To further validate the V3 model, I tested the model prediction on three new datasets that have not benn used for training.




| | precision | recall | f1-score | support |
|---|---|---|---|---|
| Fake | 0.67 | 1.00 | 0.80 | 100 |
| Real | 1.00 | 0.50 | 0.67 | 100 |
| accuracy | | | 0.75 | 200 |
| macro avg | 0.83 | 0.75 | 0.73 | 200 |
| weighted avg | 0.83 | 0.75 | 0.73 | 200 |




| | precision | recall | f1-score | support |
|---|---|---|---|---|
| Fake | 0.20 | 0.25 | 0.22 | 34975 |
| Real | 0.06 | 0.05 | 0.06 | 36430 |
| accuracy | | | 0.15 | 71405 |
| macro avg | 0.13 | 0.15 | 0.14 | 71405 |
| weighted avg | 0.13 | 0.15 | 0.14 | 71405 |




| | precision | recall | f1-score | support |
|---|---|---|---|---|
| Fake | 0.57 | 0.88 | 0.69 | 3164 |
| Real | 0.74 | 0.35 | 0.48 | 3171 |
| accuracy | | | 0.61 | 6335 |
| macro avg | 0.66 | 0.61 | 0.58 | 6335 |
| weighted avg | 0.66 | 0.61 | 0.58 | 6335 |

### 4.3 Conclusion

The V3 ANN model is the best performer overall, due to its effective reduction of overfitting and balanced performance metrics. While the V2 CNN model has a slightly higher accuracy (0.98), it shows signs of overfitting, making it less reliable for generalization to new data. The use of regularization and early stopping in V3 ANN has minimized overfitting, providing a robust model with good generalization capabilities.

The validation on different datasets using confusion matrices and comprehensive performance metrics confirms the robustness and accuracy of the V3 ANN model. This model ensures not only a good fit to the training data but also good generalization to unseen data, making it the best choice for practical applications.