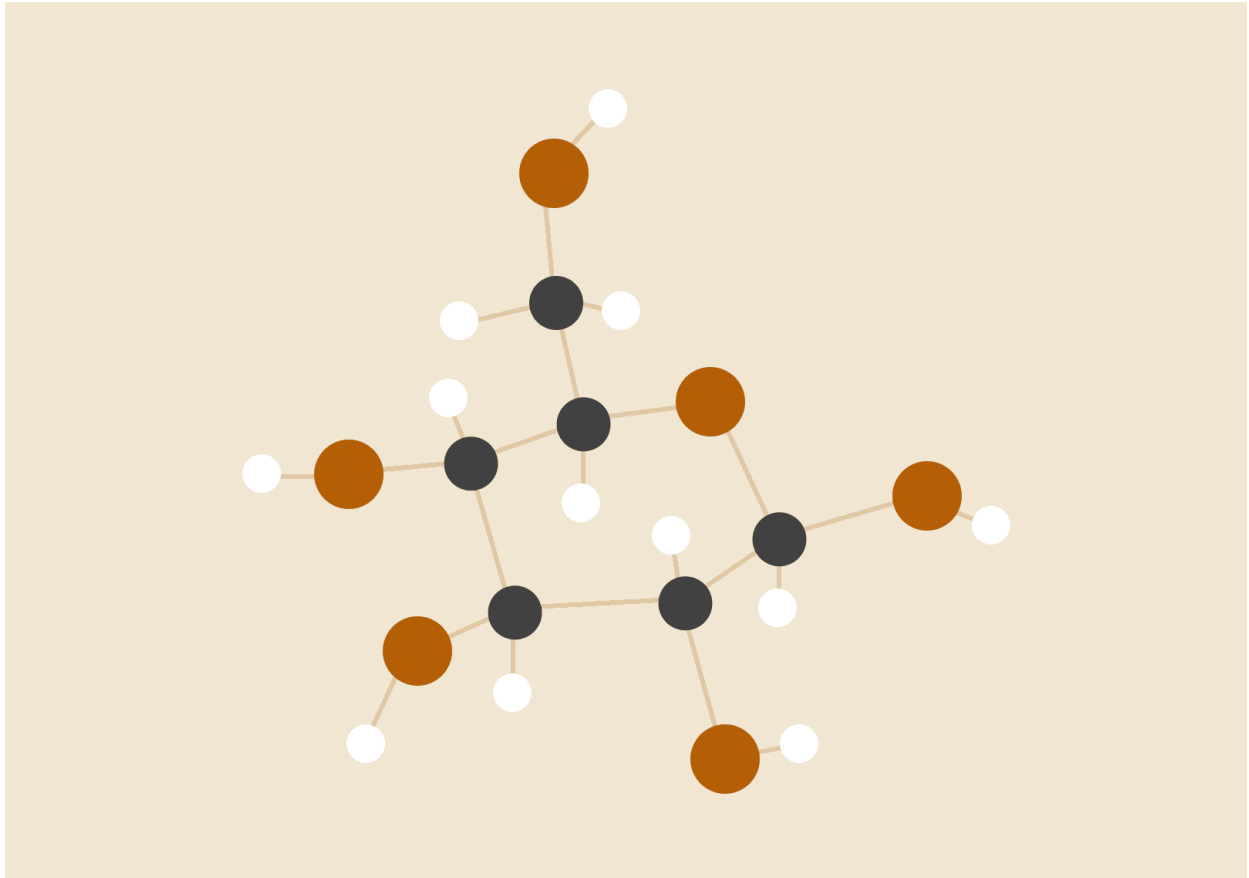


CNN



INTRODUCTION

Libraries for CNN model training were imported that included tensorflow.

```
import numpy as np
import pandas as pd
from sklearn.model_selection import train_test_split
from sklearn.preprocessing import StandardScaler
from tensorflow.keras.models import Sequential
from tensorflow.keras.layers import Input, Conv1D, Flatten, Dense, Dropout, BatchNormalization
from tensorflow.keras.optimizers import Adam
from tensorflow.keras.callbacks import EarlyStopping
from tensorflow.keras.metrics import Precision, Recall, AUC
import matplotlib.pyplot as plt
from sklearn.metrics import classification_report, confusion_matrix
```

MODEL IMPLEMENTATION

The data was split into test and train data as per usual custom. Model was fit with train data, and test data was tested on the algorithm built.

Scaling (fit transform) was done on data.

```
X_scaled = X_scaled.reshape(X_scaled.shape[0], X_scaled.shape[1], 1)
```

For implementation of CNN model an additional dimension was added.

```
X_train.shape
```

```
(199364, 29, 1)
```

Models

```

Epoch 1/20
6231/6231 — 133s 20ms/step - accuracy: 0.9959 - auc_1: 0.8347 - loss: 0.0035 - precision_1: 0.3038 - recall_1: 0.5482 - val_accuracy: 0.9992 - val_auc_1: 0.
Epoch 2/20
6231/6231 — 122s 17ms/step - accuracy: 0.9990 - auc_1: 0.9482 - loss: 0.0010 - precision_1: 0.7471 - recall_1: 0.5794 - val_accuracy: 0.9992 - val_auc_1: 0.
Epoch 3/20
6231/6231 — 141s 17ms/step - accuracy: 0.9989 - auc_1: 0.9348 - loss: 0.0012 - precision_1: 0.8151 - recall_1: 0.5105 - val_accuracy: 0.9992 - val_auc_1: 0.
Epoch 4/20
6231/6231 — 139s 16ms/step - accuracy: 0.9991 - auc_1: 0.9462 - loss: 0.0011 - precision_1: 0.8461 - recall_1: 0.5750 - val_accuracy: 0.9993 - val_auc_1: 0.
Epoch 5/20
6231/6231 — 144s 17ms/step - accuracy: 0.9991 - auc_1: 0.9410 - loss: 8.5257e-04 - precision_1: 0.7790 - recall_1: 0.5543 - val_accuracy: 0.9992 - val_auc_1
Epoch 6/20
6231/6231 — 142s 17ms/step - accuracy: 0.9990 - auc_1: 0.9107 - loss: 0.0010 - precision_1: 0.7672 - recall_1: 0.4892 - val_accuracy: 0.9993 - val_auc_1: 0.
Epoch 7/20
6231/6231 — 138s 16ms/step - accuracy: 0.9990 - auc_1: 0.9585 - loss: 6.6018e-04 - precision_1: 0.8415 - recall_1: 0.5667 - val_accuracy: 0.9992 - val_auc_1
Epoch 8/20
6231/6231 — 106s 17ms/step - accuracy: 0.9990 - auc_1: 0.9514 - loss: 7.1329e-04 - precision_1: 0.8482 - recall_1: 0.5504 - val_accuracy: 0.9993 - val_auc_1
Epoch 9/20
6231/6231 — 152s 19ms/step - accuracy: 0.9994 - auc_1: 0.9693 - loss: 4.4339e-04 - precision_1: 0.8910 - recall_1: 0.7120 - val_accuracy: 0.9993 - val_auc_1
Epoch 10/20
6231/6231 — 131s 17ms/step - accuracy: 0.9991 - auc_1: 0.9649 - loss: 6.0105e-04 - precision_1: 0.8284 - recall_1: 0.6251 - val_accuracy: 0.9993 - val_auc_1
Epoch 11/20
6231/6231 — 140s 16ms/step - accuracy: 0.9992 - auc_1: 0.9741 - loss: 4.8963e-04 - precision_1: 0.8502 - recall_1: 0.6568 - val_accuracy: 0.9992 - val_auc_1
Epoch 12/20
6231/6231 — 144s 17ms/step - accuracy: 0.9994 - auc_1: 0.9635 - loss: 4.9715e-04 - precision_1: 0.8766 - recall_1: 0.7465 - val_accuracy: 0.9993 - val_auc_1
Epoch 13/20
6231/6231 — 142s 17ms/step - accuracy: 0.9993 - auc_1: 0.9607 - loss: 5.3417e-04 - precision_1: 0.9049 - recall_1: 0.6847 - val_accuracy: 0.9993 - val_auc_1
2671/2671 — 12s 4ms/step

```

Model was trained for CNN

Key Points

```
class_weights = {0: 1.0, 1: 20.0}
```

```
gamma=2.0, alpha=0.25
```

```
kernel_size=2, activation='relu'
```

Batch Normalization: Normalizes activations of the previous layer to stabilize learning.

```
threshold = 0.25
```

RESULTS

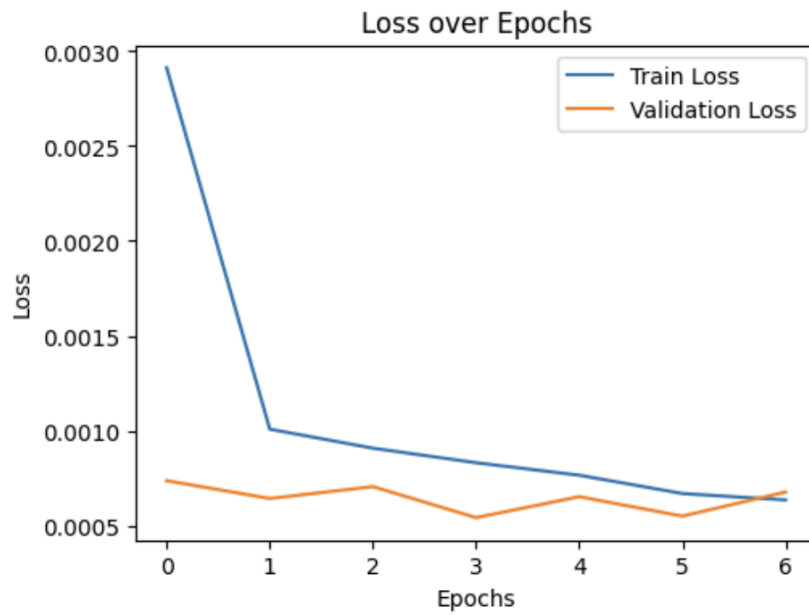
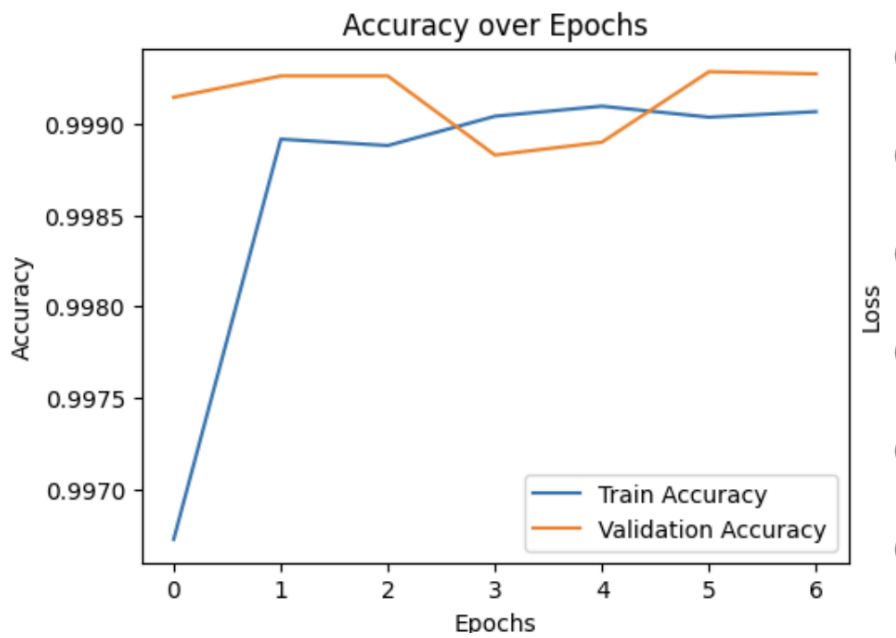
Confusion Matrix:

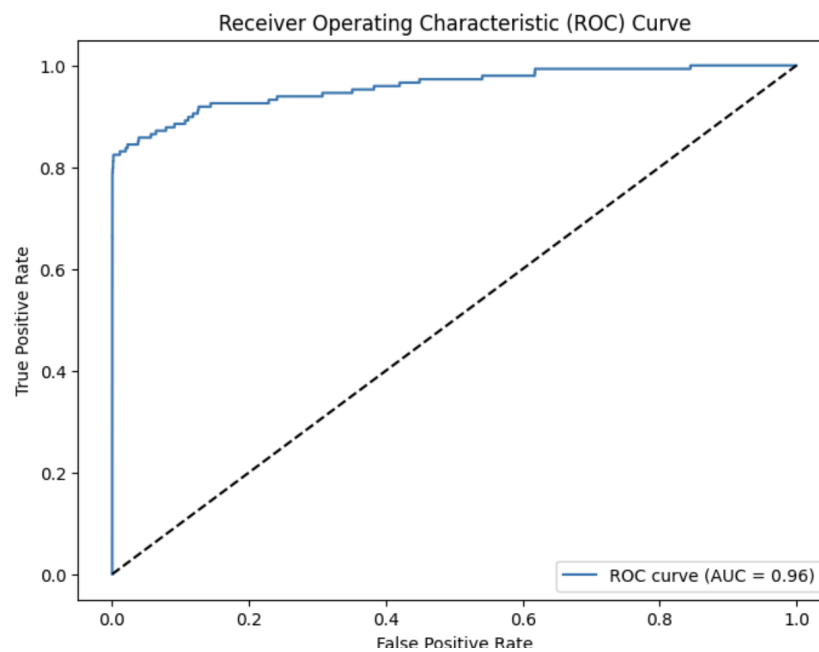
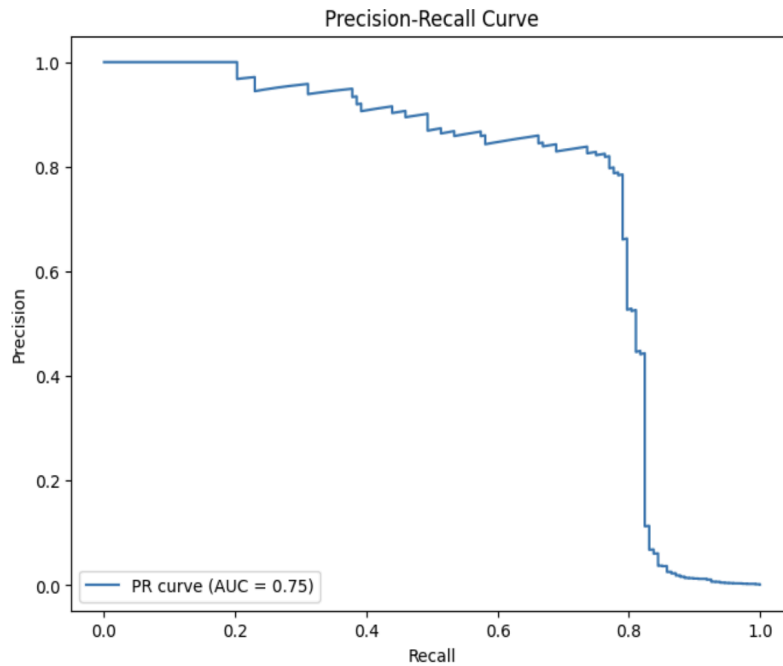
```

[[85259   36]
 [   46  102]]

```

	precision	recall	f1-score	support
0	1.00	1.00	1.00	85295
1	0.74	0.69	0.71	148
accuracy			1.00	85443
macro avg	0.87	0.84	0.86	85443
weighted avg	1.00	1.00	1.00	85443





Conclusion

The minimal difference between training and validation metrics suggests the model is well-fitted without severe overfitting.

Despite making efforts to lower down the FNs, there is no significant difference observed.