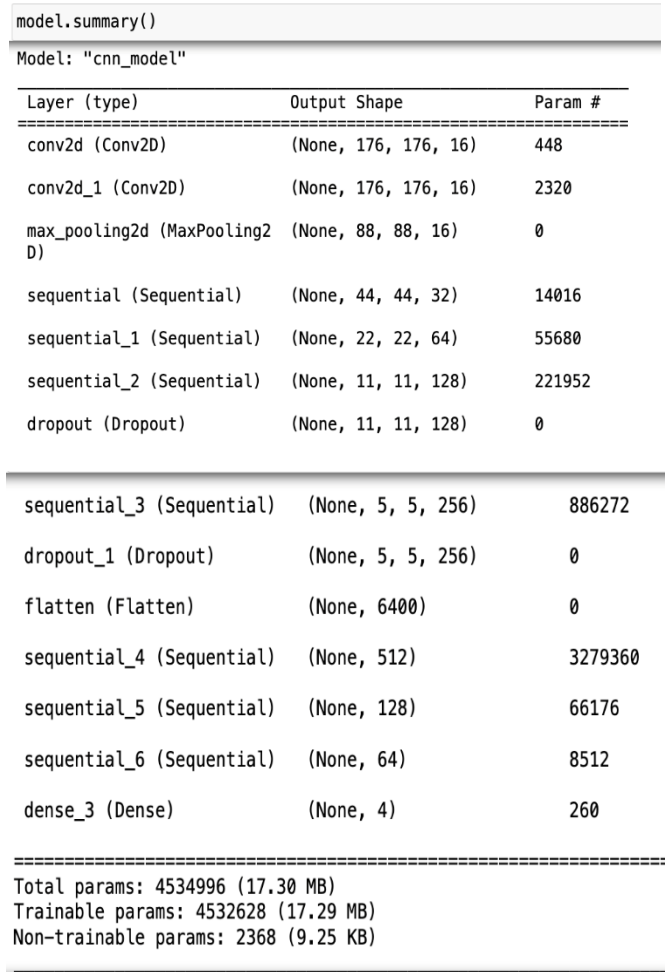


## Project Development Phase Model Performance Test

Date	14 November 2023
Team ID	Team - 592796
Project Name	Alzheimer Disease Prediction
Maximum Marks	10 Marks

### Model Performance Testing:

S.No.	Parameter	Values	Screenshot
1.	Model Summary	Total params: 4534996 Trainable params: 4532628 Non-trainable params: 2368	 <pre> model.summary() Model: "cnn_model" Layer (type)                Output Shape                Param # ===== conv2d (Conv2D)              (None, 176, 176, 16)       448 conv2d_1 (Conv2D)            (None, 176, 176, 16)       2320 max_pooling2d (MaxPooling2D) (None, 88, 88, 16)         0 sequential (Sequential)      (None, 44, 44, 32)         14016 sequential_1 (Sequential)    (None, 22, 22, 64)         55680 sequential_2 (Sequential)    (None, 11, 11, 128)        221952 dropout (Dropout)            (None, 11, 11, 128)        0 sequential_3 (Sequential)    (None, 5, 5, 256)          886272 dropout_1 (Dropout)          (None, 5, 5, 256)          0 flatten (Flatten)            (None, 6400)               0 sequential_4 (Sequential)    (None, 512)                 3279360 sequential_5 (Sequential)    (None, 128)                 66176 sequential_6 (Sequential)    (None, 64)                  8512 dense_3 (Dense)              (None, 4)                  260 ===== Total params: 4534996 (17.30 MB) Trainable params: 4532628 (17.29 MB) Non-trainable params: 2368 (9.25 KB) </pre>

2.	Accuracy	Training Accuracy: 99.93% Validation Accuracy: 95.51% Testing Accuracy: 94.84%	<pre> # Evaluating the model on the data train_scores = model.evaluate(train_data, train_labels) val_scores = model.evaluate(val_data, val_labels) test_scores = model.evaluate(test_data, test_labels)  print("Training Accuracy: %.2f%%"%(train_scores[1] * 100)) print("Validation Accuracy: %.2f%%"%(val_scores[1] * 100)) print("Testing Accuracy: %.2f%%"%(test_scores[1] * 100))  256/256 [=====] - 52s 203ms/step - loss: 0.0019 - acc: 0.9993 - auc: 1.0000 - f1_score: 0.9993 64/64 [=====] - 13s 200ms/step - loss: 0.2315 - acc: 0.9551 - auc: 0.9872 - f1_score: 0.9548 80/80 [=====] - 16s 200ms/step - loss: 0.2358 - acc: 0.9484 - auc: 0.9868 - f1_score: 0.9482 Training Accuracy: 99.93% Validation Accuracy: 95.51% Testing Accuracy: 94.84% </pre>
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## Screenshots

```
model.summary()
```

Model: "cnn\_model"

Layer (type)	Output Shape	Param #
conv2d (Conv2D)	(None, 176, 176, 16)	448
conv2d_1 (Conv2D)	(None, 176, 176, 16)	2320
max_pooling2d (MaxPooling2D)	(None, 88, 88, 16)	0
sequential (Sequential)	(None, 44, 44, 32)	14016
sequential_1 (Sequential)	(None, 22, 22, 64)	55680
sequential_2 (Sequential)	(None, 11, 11, 128)	221952
dropout (Dropout)	(None, 11, 11, 128)	0
sequential_3 (Sequential)	(None, 5, 5, 256)	886272
dropout_1 (Dropout)	(None, 5, 5, 256)	0
flatten (Flatten)	(None, 6400)	0
sequential_4 (Sequential)	(None, 512)	3279360
sequential_5 (Sequential)	(None, 128)	66176
sequential_6 (Sequential)	(None, 64)	8512
dense_3 (Dense)	(None, 4)	260

```

=====
Total params: 4534996 (17.30 MB)
Trainable params: 4532628 (17.29 MB)
Non-trainable params: 2368 (9.25 KB)

```

## Accuracy

```
Epoch 1/100
256/256 [=====] - 145s 562ms/step - loss: 1.6891 - acc: 0.2765 - auc: 0.5282 - f1_score:
0.2753 - val_loss: 1.9973 - val_acc: 0.2422 - val_auc: 0.5185 - val_f1_score: 0.0975
Epoch 2/100
256/256 [=====] - 145s 567ms/step - loss: 1.4286 - acc: 0.3192 - auc: 0.5847 - f1_score:
0.3145 - val_loss: 1.5013 - val_acc: 0.2393 - val_auc: 0.5012 - val_f1_score: 0.0987
Epoch 3/100
256/256 [=====] - 816s 3s/step - loss: 0.9941 - acc: 0.5436 - auc: 0.8183 - f1_score: 0.52
02 - val_loss: 1.8700 - val_acc: 0.4146 - val_auc: 0.6506 - val_f1_score: 0.3658
Epoch 4/100
256/256 [=====] - 153s 595ms/step - loss: 0.7979 - acc: 0.6385 - auc: 0.8830 - f1_score:
0.6302 - val_loss: 2.1478 - val_acc: 0.4775 - val_auc: 0.7073 - val_f1_score: 0.3594
Epoch 5/100
256/256 [=====] - 155s 605ms/step - loss: 0.6883 - acc: 0.6904 - auc: 0.9125 - f1_score:
0.6841 - val_loss: 1.1839 - val_acc: 0.4956 - val_auc: 0.8323 - val_f1_score: 0.3769
Epoch 6/100
256/256 [=====] - 233s 912ms/step - loss: 0.6539 - acc: 0.7031 - auc: 0.9213 - f1_score:
0.6997 - val_loss: 1.0413 - val_acc: 0.6060 - val_auc: 0.8701 - val_f1_score: 0.5719

Epoch 7/100
256/256 [=====] - 216s 845ms/step - loss: 0.6184 - acc: 0.7233 - auc: 0.9297 - f1_score:
0.7227 - val_loss: 0.6159 - val_acc: 0.6958 - val_auc: 0.9264 - val_f1_score: 0.6964
Epoch 8/100
256/256 [=====] - 226s 884ms/step - loss: 0.5485 - acc: 0.7570 - auc: 0.9445 - f1_score:
0.7564 - val_loss: 0.6865 - val_acc: 0.6328 - val_auc: 0.9048 - val_f1_score: 0.6020
Epoch 9/100
256/256 [=====] - 251s 981ms/step - loss: 0.5481 - acc: 0.7615 - auc: 0.9447 - f1_score:
0.7612 - val_loss: 0.8633 - val_acc: 0.6333 - val_auc: 0.8720 - val_f1_score: 0.6429
Epoch 10/100
256/256 [=====] - 223s 871ms/step - loss: 0.4852 - acc: 0.7883 - auc: 0.9562 - f1_score:
0.7888 - val_loss: 0.6715 - val_acc: 0.6777 - val_auc: 0.9150 - val_f1_score: 0.6657
Epoch 11/100
256/256 [=====] - 213s 834ms/step - loss: 0.4496 - acc: 0.8059 - auc: 0.9627 - f1_score:
0.8060 - val_loss: 0.4677 - val_acc: 0.7920 - val_auc: 0.9592 - val_f1_score: 0.7865
Epoch 12/100
256/256 [=====] - 219s 854ms/step - loss: 0.4074 - acc: 0.8285 - auc: 0.9689 - f1_score:
0.8288 - val_loss: 0.8827 - val_acc: 0.6479 - val_auc: 0.8891 - val_f1_score: 0.5976

Epoch 13/100
256/256 [=====] - 218s 850ms/step - loss: 0.4339 - acc: 0.8164 - auc: 0.9654 - f1_score:
0.8166 - val_loss: 0.5375 - val_acc: 0.7305 - val_auc: 0.9532 - val_f1_score: 0.6629
Epoch 14/100
256/256 [=====] - 219s 855ms/step - loss: 0.3637 - acc: 0.8467 - auc: 0.9752 - f1_score:
0.8462 - val_loss: 1.6647 - val_acc: 0.5508 - val_auc: 0.8326 - val_f1_score: 0.4944
Epoch 15/100
256/256 [=====] - 213s 832ms/step - loss: 0.3477 - acc: 0.8601 - auc: 0.9774 - f1_score:
0.8601 - val_loss: 1.2978 - val_acc: 0.5728 - val_auc: 0.8516 - val_f1_score: 0.5450
Epoch 16/100
256/256 [=====] - 214s 836ms/step - loss: 0.3018 - acc: 0.8799 - auc: 0.9827 - f1_score:
0.8797 - val_loss: 0.4002 - val_acc: 0.8330 - val_auc: 0.9729 - val_f1_score: 0.8344
Epoch 17/100
256/256 [=====] - 233s 910ms/step - loss: 0.2894 - acc: 0.8827 - auc: 0.9841 - f1_score:
0.8825 - val_loss: 0.6789 - val_acc: 0.7505 - val_auc: 0.9537 - val_f1_score: 0.7156
Epoch 18/100
256/256 [=====] - 246s 962ms/step - loss: 0.2828 - acc: 0.8903 - auc: 0.9848 - f1_score:
0.8901 - val_loss: 0.3758 - val_acc: 0.8521 - val_auc: 0.9766 - val_f1_score: 0.8523
```

Epoch 19/100  
256/256 [=====] - 252s 986ms/step - loss: 0.2316 - acc: 0.9147 - auc: 0.9893 - f1\_score: 0.9145 - val\_loss: 0.5368 - val\_acc: 0.7900 - val\_auc: 0.9605 - val\_f1\_score: 0.7639  
Epoch 20/100  
256/256 [=====] - 241s 941ms/step - loss: 0.1983 - acc: 0.9264 - auc: 0.9922 - f1\_score: 0.9264 - val\_loss: 0.8691 - val\_acc: 0.7163 - val\_auc: 0.9227 - val\_f1\_score: 0.7108  
Epoch 21/100  
256/256 [=====] - 240s 939ms/step - loss: 0.1885 - acc: 0.9327 - auc: 0.9928 - f1\_score: 0.9326 - val\_loss: 0.6804 - val\_acc: 0.7798 - val\_auc: 0.9473 - val\_f1\_score: 0.7735  
Epoch 22/100  
256/256 [=====] - 239s 934ms/step - loss: 0.1591 - acc: 0.9409 - auc: 0.9947 - f1\_score: 0.9407 - val\_loss: 0.2856 - val\_acc: 0.8896 - val\_auc: 0.9861 - val\_f1\_score: 0.8877  
Epoch 23/100  
256/256 [=====] - 248s 967ms/step - loss: 0.1460 - acc: 0.9482 - auc: 0.9951 - f1\_score: 0.9482 - val\_loss: 1.2427 - val\_acc: 0.6699 - val\_auc: 0.8628 - val\_f1\_score: 0.6741  
Epoch 24/100  
256/256 [=====] - 243s 948ms/step - loss: 0.1459 - acc: 0.9476 - auc: 0.9951 - f1\_score: 0.9476 - val\_loss: 0.4146 - val\_acc: 0.8491 - val\_auc: 0.9790 - val\_f1\_score: 0.8425

Epoch 25/100  
256/256 [=====] - 292s 1s/step - loss: 0.1275 - acc: 0.9585 - auc: 0.9959 - f1\_score: 0.9584 - val\_loss: 0.1938 - val\_acc: 0.9277 - val\_auc: 0.9928 - val\_f1\_score: 0.9274  
Epoch 26/100  
256/256 [=====] - 273s 1s/step - loss: 0.1140 - acc: 0.9590 - auc: 0.9972 - f1\_score: 0.9589 - val\_loss: 0.3242 - val\_acc: 0.8940 - val\_auc: 0.9834 - val\_f1\_score: 0.8938  
Epoch 27/100  
256/256 [=====] - 251s 980ms/step - loss: 0.1071 - acc: 0.9626 - auc: 0.9971 - f1\_score: 0.9626 - val\_loss: 0.2522 - val\_acc: 0.9077 - val\_auc: 0.9902 - val\_f1\_score: 0.9056  
Epoch 28/100  
256/256 [=====] - 233s 909ms/step - loss: 0.0856 - acc: 0.9739 - auc: 0.9978 - f1\_score: 0.9739 - val\_loss: 0.3217 - val\_acc: 0.8882 - val\_auc: 0.9831 - val\_f1\_score: 0.8898  
Epoch 29/100  
256/256 [=====] - 235s 918ms/step - loss: 0.0934 - acc: 0.9691 - auc: 0.9975 - f1\_score: 0.9691 - val\_loss: 0.3955 - val\_acc: 0.8828 - val\_auc: 0.9802 - val\_f1\_score: 0.8757  
Epoch 30/100  
256/256 [=====] - 247s 965ms/step - loss: 0.0907 - acc: 0.9697 - auc: 0.9975 - f1\_score: 0.9697 - val\_loss: 0.3866 - val\_acc: 0.8745 - val\_auc: 0.9816 - val\_f1\_score: 0.8702

Epoch 31/100  
256/256 [=====] - 237s 926ms/step - loss: 0.0759 - acc: 0.9764 - auc: 0.9983 - f1\_score: 0.9764 - val\_loss: 0.2729 - val\_acc: 0.9116 - val\_auc: 0.9872 - val\_f1\_score: 0.9101  
Epoch 32/100  
256/256 [=====] - 211s 825ms/step - loss: 0.0983 - acc: 0.9657 - auc: 0.9976 - f1\_score: 0.9657 - val\_loss: 0.2741 - val\_acc: 0.9043 - val\_auc: 0.9880 - val\_f1\_score: 0.9059  
Epoch 33/100  
256/256 [=====] - 219s 855ms/step - loss: 0.0694 - acc: 0.9766 - auc: 0.9988 - f1\_score: 0.9766 - val\_loss: 0.2249 - val\_acc: 0.9268 - val\_auc: 0.9907 - val\_f1\_score: 0.9258  
Epoch 34/100  
256/256 [=====] - 213s 833ms/step - loss: 0.0746 - acc: 0.9761 - auc: 0.9979 - f1\_score: 0.9761 - val\_loss: 0.5122 - val\_acc: 0.8633 - val\_auc: 0.9691 - val\_f1\_score: 0.8593  
Epoch 35/100  
256/256 [=====] - 213s 832ms/step - loss: 0.0665 - acc: 0.9795 - auc: 0.9982 - f1\_score: 0.9795 - val\_loss: 0.2069 - val\_acc: 0.9331 - val\_auc: 0.9917 - val\_f1\_score: 0.9327  
Epoch 36/100  
256/256 [=====] - 212s 826ms/step - loss: 0.0673 - acc: 0.9797 - auc: 0.9982 - f1\_score: 0.9797 - val\_loss: 0.3220 - val\_acc: 0.9004 - val\_auc: 0.9843 - val\_f1\_score: 0.8989  
\_ \_ \_ \_ \_

Epoch 37/100  
256/256 [=====] - 213s 832ms/step - loss: 0.0702 - acc: 0.9773 - auc: 0.9985 - f1\_score: 0.9773 - val\_loss: 0.2536 - val\_acc: 0.9238 - val\_auc: 0.9869 - val\_f1\_score: 0.9242  
Epoch 38/100  
256/256 [=====] - 218s 853ms/step - loss: 0.0454 - acc: 0.9861 - auc: 0.9993 - f1\_score: 0.9861 - val\_loss: 0.2527 - val\_acc: 0.9331 - val\_auc: 0.9845 - val\_f1\_score: 0.9324  
Epoch 39/100  
256/256 [=====] - 214s 836ms/step - loss: 0.0564 - acc: 0.9816 - auc: 0.9986 - f1\_score: 0.9816 - val\_loss: 0.3924 - val\_acc: 0.8921 - val\_auc: 0.9762 - val\_f1\_score: 0.8933

Epoch 40/100  
256/256 [=====] - 207s 810ms/step - loss: 0.0514 - acc: 0.9829 - auc: 0.9990 - f1\_score: 0.9829 - val\_loss: 1.1440 - val\_acc: 0.7554 - val\_auc: 0.9148 - val\_f1\_score: 0.7481  
Epoch 41/100  
256/256 [=====] - 203s 792ms/step - loss: 0.0538 - acc: 0.9832 - auc: 0.9990 - f1\_score: 0.9832 - val\_loss: 0.2511 - val\_acc: 0.9253 - val\_auc: 0.9899 - val\_f1\_score: 0.9243  
Epoch 42/100  
256/256 [=====] - 215s 840ms/step - loss: 0.0508 - acc: 0.9839 - auc: 0.9991 - f1\_score: 0.9839 - val\_loss: 0.5120 - val\_acc: 0.8608 - val\_auc: 0.9717 - val\_f1\_score: 0.8501

Epoch 43/100  
256/256 [=====] - 201s 784ms/step - loss: 0.0578 - acc: 0.9822 - auc: 0.9986 - f1\_score: 0.9822 - val\_loss: 0.2956 - val\_acc: 0.9048 - val\_auc: 0.9865 - val\_f1\_score: 0.9033  
Epoch 44/100  
256/256 [=====] - 200s 781ms/step - loss: 0.0605 - acc: 0.9799 - auc: 0.9983 - f1\_score: 0.9798 - val\_loss: 0.1963 - val\_acc: 0.9390 - val\_auc: 0.9920 - val\_f1\_score: 0.9388  
Epoch 45/100  
256/256 [=====] - 203s 793ms/step - loss: 0.0465 - acc: 0.9854 - auc: 0.9992 - f1\_score: 0.9853 - val\_loss: 0.1754 - val\_acc: 0.9512 - val\_auc: 0.9921 - val\_f1\_score: 0.9507  
Epoch 46/100  
256/256 [=====] - 204s 797ms/step - loss: 0.0302 - acc: 0.9910 - auc: 0.9996 - f1\_score: 0.9910 - val\_loss: 0.6197 - val\_acc: 0.8555 - val\_auc: 0.9593 - val\_f1\_score: 0.8549  
Epoch 47/100  
256/256 [=====] - 197s 769ms/step - loss: 0.0794 - acc: 0.9725 - auc: 0.9979 - f1\_score: 0.9725 - val\_loss: 0.2373 - val\_acc: 0.9297 - val\_auc: 0.9894 - val\_f1\_score: 0.9285  
Epoch 48/100  
256/256 [=====] - 195s 761ms/step - loss: 0.0374 - acc: 0.9879 - auc: 0.9995 - f1\_score: 0.9879 - val\_loss: 0.2649 - val\_acc: 0.9292 - val\_auc: 0.9846 - val\_f1\_score: 0.9293

Epoch 49/100  
256/256 [=====] - 196s 766ms/step - loss: 0.0338 - acc: 0.9890 - auc: 0.9993 - f1\_score: 0.9890 - val\_loss: 0.1791 - val\_acc: 0.9473 - val\_auc: 0.9923 - val\_f1\_score: 0.9468  
Epoch 50/100  
256/256 [=====] - 209s 815ms/step - loss: 0.0491 - acc: 0.9847 - auc: 0.9989 - f1\_score: 0.9847 - val\_loss: 0.1678 - val\_acc: 0.9521 - val\_auc: 0.9918 - val\_f1\_score: 0.9522  
Epoch 51/100  
256/256 [=====] - 179s 700ms/step - loss: 0.0329 - acc: 0.9907 - auc: 0.9995 - f1\_score: 0.9907 - val\_loss: 0.2764 - val\_acc: 0.9258 - val\_auc: 0.9859 - val\_f1\_score: 0.9241  
Epoch 52/100  
256/256 [=====] - 179s 700ms/step - loss: 0.0335 - acc: 0.9894 - auc: 0.9995 - f1\_score: 0.9894 - val\_loss: 0.2164 - val\_acc: 0.9414 - val\_auc: 0.9895 - val\_f1\_score: 0.9406  
Epoch 53/100  
256/256 [=====] - 187s 729ms/step - loss: 0.0410 - acc: 0.9869 - auc: 0.9993 - f1\_score: 0.9869 - val\_loss: 0.5101 - val\_acc: 0.8667 - val\_auc: 0.9631 - val\_f1\_score: 0.8676  
Epoch 54/100  
256/256 [=====] - 193s 755ms/step - loss: 0.0475 - acc: 0.9856 - auc: 0.9988 - f1\_score: 0.9856 - val\_loss: 0.3262 - val\_acc: 0.9165 - val\_auc: 0.9787 - val\_f1\_score: 0.9156

Epoch 55/100  
256/256 [=====] - 195s 761ms/step - loss: 0.0360 - acc: 0.9882 - auc: 0.9995 - f1\_score: 0.9882 - val\_loss: 0.2790 - val\_acc: 0.9263 - val\_auc: 0.9854 - val\_f1\_score: 0.9256  
Epoch 56/100  
256/256 [=====] - 191s 747ms/step - loss: 0.0228 - acc: 0.9938 - auc: 0.9997 - f1\_score: 0.9938 - val\_loss: 0.3429 - val\_acc: 0.9233 - val\_auc: 0.9771 - val\_f1\_score: 0.9233  
Epoch 57/100  
256/256 [=====] - 190s 742ms/step - loss: 0.0303 - acc: 0.9899 - auc: 0.9994 - f1\_score: 0.9899 - val\_loss: 0.2657 - val\_acc: 0.9307 - val\_auc: 0.9845 - val\_f1\_score: 0.9297  
Epoch 58/100  
256/256 [=====] - 182s 710ms/step - loss: 0.0430 - acc: 0.9862 - auc: 0.9990 - f1\_score: 0.9862 - val\_loss: 0.1925 - val\_acc: 0.9458 - val\_auc: 0.9917 - val\_f1\_score: 0.9459  
Epoch 59/100  
256/256 [=====] - 183s 715ms/step - loss: 0.0351 - acc: 0.9888 - auc: 0.9994 - f1\_score: 0.9888 - val\_loss: 0.8623 - val\_acc: 0.7896 - val\_auc: 0.9312 - val\_f1\_score: 0.7827  
Epoch 60/100  
256/256 [=====] - 183s 715ms/step - loss: 0.0373 - acc: 0.9880 - auc: 0.9994 - f1\_score: 0.9880 - val\_loss: 0.2484 - val\_acc: 0.9331 - val\_auc: 0.9877 - val\_f1\_score: 0.9322

Epoch 61/100  
256/256 [=====] - 184s 719ms/step - loss: 0.0360 - acc: 0.9901 - auc: 0.9991 - f1\_score: 0.9901 - val\_loss: 0.1849 - val\_acc: 0.9507 - val\_auc: 0.9916 - val\_f1\_score: 0.9501  
Epoch 62/100  
256/256 [=====] - 197s 770ms/step - loss: 0.0193 - acc: 0.9941 - auc: 0.9997 - f1\_score: 0.9941 - val\_loss: 0.4036 - val\_acc: 0.9077 - val\_auc: 0.9757 - val\_f1\_score: 0.9070  
Epoch 63/100  
256/256 [=====] - 201s 785ms/step - loss: 0.0340 - acc: 0.9901 - auc: 0.9992 - f1\_score: 0.9901 - val\_loss: 0.2027 - val\_acc: 0.9448 - val\_auc: 0.9896 - val\_f1\_score: 0.9450  
Epoch 64/100  
256/256 [=====] - 200s 783ms/step - loss: 0.0439 - acc: 0.9861 - auc: 0.9990 - f1\_score: 0.9861 - val\_loss: 0.1760 - val\_acc: 0.9521 - val\_auc: 0.9913 - val\_f1\_score: 0.9522  
Epoch 65/100  
256/256 [=====] - 201s 784ms/step - loss: 0.0369 - acc: 0.9897 - auc: 0.9994 - f1\_score: 0.9897 - val\_loss: 0.1864 - val\_acc: 0.9473 - val\_auc: 0.9909 - val\_f1\_score: 0.9472  
Epoch 66/100  
256/256 [=====] - 203s 792ms/step - loss: 0.0375 - acc: 0.9877 - auc: 0.9990 - f1\_score: 0.9877 - val\_loss: 0.1647 - val\_acc: 0.9541 - val\_auc: 0.9925 - val\_f1\_score: 0.9539

Epoch 67/100  
256/256 [=====] - 202s 789ms/step - loss: 0.0201 - acc: 0.9940 - auc: 0.9997 - f1\_score: 0.9940 - val\_loss: 0.2174 - val\_acc: 0.9453 - val\_auc: 0.9893 - val\_f1\_score: 0.9452  
Epoch 68/100  
256/256 [=====] - 204s 797ms/step - loss: 0.0295 - acc: 0.9911 - auc: 0.9994 - f1\_score: 0.9911 - val\_loss: 0.1949 - val\_acc: 0.9492 - val\_auc: 0.9909 - val\_f1\_score: 0.9489  
Epoch 69/100  
256/256 [=====] - 204s 797ms/step - loss: 0.0307 - acc: 0.9908 - auc: 0.9994 - f1\_score: 0.9908 - val\_loss: 0.1685 - val\_acc: 0.9507 - val\_auc: 0.9924 - val\_f1\_score: 0.9504  
Epoch 70/100  
256/256 [=====] - 204s 798ms/step - loss: 0.0330 - acc: 0.9891 - auc: 0.9991 - f1\_score: 0.9891 - val\_loss: 0.1688 - val\_acc: 0.9536 - val\_auc: 0.9922 - val\_f1\_score: 0.9538  
Epoch 71/100  
256/256 [=====] - 205s 802ms/step - loss: 0.0260 - acc: 0.9927 - auc: 0.9995 - f1\_score: 0.9927 - val\_loss: 0.1847 - val\_acc: 0.9507 - val\_auc: 0.9917 - val\_f1\_score: 0.9502  
Epoch 72/100  
256/256 [=====] - 204s 799ms/step - loss: 0.0182 - acc: 0.9946 - auc: 0.9996 - f1\_score: 0.9946 - val\_loss: 0.2271 - val\_acc: 0.9443 - val\_auc: 0.9869 - val\_f1\_score: 0.9447  
  
Epoch 73/100  
256/256 [=====] - 205s 800ms/step - loss: 0.0256 - acc: 0.9932 - auc: 0.9993 - f1\_score: 0.9932 - val\_loss: 0.1973 - val\_acc: 0.9463 - val\_auc: 0.9900 - val\_f1\_score: 0.9459  
Epoch 74/100  
256/256 [=====] - 206s 803ms/step - loss: 0.0250 - acc: 0.9919 - auc: 0.9996 - f1\_score: 0.9919 - val\_loss: 0.1898 - val\_acc: 0.9497 - val\_auc: 0.9896 - val\_f1\_score: 0.9499  
Epoch 75/100  
256/256 [=====] - 206s 805ms/step - loss: 0.0200 - acc: 0.9930 - auc: 0.9998 - f1\_score: 0.9930 - val\_loss: 0.2569 - val\_acc: 0.9419 - val\_auc: 0.9854 - val\_f1\_score: 0.9422  
Epoch 76/100  
256/256 [=====] - 207s 808ms/step - loss: 0.0175 - acc: 0.9950 - auc: 0.9996 - f1\_score: 0.9950 - val\_loss: 0.3128 - val\_acc: 0.9287 - val\_auc: 0.9804 - val\_f1\_score: 0.9287  
Epoch 77/100  
256/256 [=====] - 207s 810ms/step - loss: 0.0396 - acc: 0.9886 - auc: 0.9987 - f1\_score: 0.9886 - val\_loss: 0.1571 - val\_acc: 0.9541 - val\_auc: 0.9944 - val\_f1\_score: 0.9538  
Epoch 78/100  
256/256 [=====] - 208s 813ms/step - loss: 0.0163 - acc: 0.9957 - auc: 0.9997 - f1\_score: 0.9957 - val\_loss: 0.2138 - val\_acc: 0.9482 - val\_auc: 0.9885 - val\_f1\_score: 0.9479  
  
Epoch 79/100  
256/256 [=====] - 206s 806ms/step - loss: 0.0170 - acc: 0.9946 - auc: 0.9997 - f1\_score: 0.9946 - val\_loss: 0.2035 - val\_acc: 0.9507 - val\_auc: 0.9880 - val\_f1\_score: 0.9506  
Epoch 80/100  
256/256 [=====] - 205s 802ms/step - loss: 0.0230 - acc: 0.9937 - auc: 0.9996 - f1\_score: 0.9937 - val\_loss: 0.2214 - val\_acc: 0.9414 - val\_auc: 0.9883 - val\_f1\_score: 0.9405  
Epoch 81/100  
256/256 [=====] - 208s 811ms/step - loss: 0.0277 - acc: 0.9922 - auc: 0.9994 - f1\_score: 0.9922 - val\_loss: 0.2643 - val\_acc: 0.9287 - val\_auc: 0.9857 - val\_f1\_score: 0.9292  
Epoch 82/100  
256/256 [=====] - 205s 802ms/step - loss: 0.0252 - acc: 0.9918 - auc: 0.9994 - f1\_score: 0.9918 - val\_loss: 0.2049 - val\_acc: 0.9507 - val\_auc: 0.9875 - val\_f1\_score: 0.9509  
Epoch 83/100  
256/256 [=====] - 205s 800ms/step - loss: 0.0206 - acc: 0.9938 - auc: 0.9998 - f1\_score: 0.9938 - val\_loss: 0.2573 - val\_acc: 0.9370 - val\_auc: 0.9828 - val\_f1\_score: 0.9374  
Epoch 84/100  
256/256 [=====] - 205s 801ms/step - loss: 0.0151 - acc: 0.9956 - auc: 0.9998 - f1\_score: 0.9956 - val\_loss: 0.1761 - val\_acc: 0.9526 - val\_auc: 0.9912 - val\_f1\_score: 0.9525  
  
Epoch 85/100  
256/256 [=====] - 206s 804ms/step - loss: 0.0232 - acc: 0.9933 - auc: 0.9995 - f1\_score: 0.9933 - val\_loss: 0.1840 - val\_acc: 0.9502 - val\_auc: 0.9918 - val\_f1\_score: 0.9501  
Epoch 86/100  
256/256 [=====] - 211s 826ms/step - loss: 0.0170 - acc: 0.9944 - auc: 0.9997 - f1\_score: 0.9944 - val\_loss: 0.2619 - val\_acc: 0.9443 - val\_auc: 0.9863 - val\_f1\_score: 0.9441  
Epoch 87/100  
256/256 [=====] - 207s 808ms/step - loss: 0.0157 - acc: 0.9958 - auc: 0.9996 - f1\_score: 0.9958 - val\_loss: 0.2902 - val\_acc: 0.9365 - val\_auc: 0.9817 - val\_f1\_score: 0.9361  
Epoch 88/100  
256/256 [=====] - 206s 806ms/step - loss: 0.0236 - acc: 0.9927 - auc: 0.9996 - f1\_score: 0.9927 - val\_loss: 0.1584 - val\_acc: 0.9590 - val\_auc: 0.9924 - val\_f1\_score: 0.9589  
Epoch 89/100  
256/256 [=====] - 205s 801ms/step - loss: 0.0222 - acc: 0.9932 - auc: 0.9996 - f1\_score: 0.9932 - val\_loss: 1.0883 - val\_acc: 0.7988 - val\_auc: 0.9231 - val\_f1\_score: 0.7939  
Epoch 90/100  
256/256 [=====] - 204s 798ms/step - loss: 0.0312 - acc: 0.9904 - auc: 0.9994 - f1\_score: 0.9904 - val\_loss: 0.1729 - val\_acc: 0.9561 - val\_auc: 0.9897 - val\_f1\_score: 0.9562



```

Epoch 91/100
256/256 [=====] - 205s 801ms/step - loss: 0.0188 - acc: 0.9943 - auc: 0.9996 - f1_score:
0.9943 - val_loss: 0.1855 - val_acc: 0.9541 - val_auc: 0.9916 - val_f1_score: 0.9540
Epoch 92/100
256/256 [=====] - 209s 816ms/step - loss: 0.0124 - acc: 0.9963 - auc: 0.9999 - f1_score:
0.9963 - val_loss: 0.2140 - val_acc: 0.9521 - val_auc: 0.9888 - val_f1_score: 0.9523
Epoch 93/100
256/256 [=====] - 206s 807ms/step - loss: 0.0123 - acc: 0.9973 - auc: 0.9997 - f1_score:
0.9973 - val_loss: 0.3036 - val_acc: 0.9375 - val_auc: 0.9874 - val_f1_score: 0.9367
Epoch 94/100
256/256 [=====] - 208s 812ms/step - loss: 0.0185 - acc: 0.9944 - auc: 0.9996 - f1_score:
0.9944 - val_loss: 0.3299 - val_acc: 0.9375 - val_auc: 0.9854 - val_f1_score: 0.9366
Epoch 95/100
256/256 [=====] - 210s 820ms/step - loss: 0.0392 - acc: 0.9884 - auc: 0.9988 - f1_score:
0.9884 - val_loss: 0.1867 - val_acc: 0.9497 - val_auc: 0.9911 - val_f1_score: 0.9492
Epoch 96/100
256/256 [=====] - 215s 839ms/step - loss: 0.0120 - acc: 0.9965 - auc: 0.9999 - f1_score:
0.9965 - val_loss: 0.2038 - val_acc: 0.9521 - val_auc: 0.9881 - val_f1_score: 0.9522

Epoch 97/100
256/256 [=====] - 212s 830ms/step - loss: 0.0150 - acc: 0.9957 - auc: 0.9997 - f1_score:
0.9957 - val_loss: 0.2031 - val_acc: 0.9521 - val_auc: 0.9885 - val_f1_score: 0.9518
Epoch 98/100
256/256 [=====] - 205s 802ms/step - loss: 0.0188 - acc: 0.9945 - auc: 0.9996 - f1_score:
0.9945 - val_loss: 0.1918 - val_acc: 0.9546 - val_auc: 0.9887 - val_f1_score: 0.9546
Epoch 99/100
256/256 [=====] - 204s 795ms/step - loss: 0.0188 - acc: 0.9943 - auc: 0.9998 - f1_score:
0.9943 - val_loss: 0.2093 - val_acc: 0.9521 - val_auc: 0.9873 - val_f1_score: 0.9516
Epoch 100/100
256/256 [=====] - 204s 796ms/step - loss: 0.0089 - acc: 0.9972 - auc: 1.0000 - f1_score:
0.9972 - val_loss: 0.2315 - val_acc: 0.9551 - val_auc: 0.9872 - val_f1_score: 0.9548

<keras.src.callbacks.History at 0x28a0286d0>

```

```
# Evaluating the model on the data
```

```

train_scores = model.evaluate(train_data, train_labels)
val_scores = model.evaluate(val_data, val_labels)
test_scores = model.evaluate(test_data, test_labels)

print("Training Accuracy: %.2f%%"%(train_scores[1] * 100))
print("Validation Accuracy: %.2f%%"%(val_scores[1] * 100))
print("Testing Accuracy: %.2f%%"%(test_scores[1] * 100))

```

```

256/256 [=====] - 52s 203ms/step - loss: 0.0019 - acc: 0.9993 - auc: 1.0000 - f1_score: 0.
9993
64/64 [=====] - 13s 200ms/step - loss: 0.2315 - acc: 0.9551 - auc: 0.9872 - f1_score: 0.95
48
80/80 [=====] - 16s 200ms/step - loss: 0.2358 - acc: 0.9484 - auc: 0.9868 - f1_score: 0.94
82
Training Accuracy: 99.93%
Validation Accuracy: 95.51%
Testing Accuracy: 94.84%

```