**SAMPLE CODE**

import numpy as np

import pandas as pd

Data Loading

data = pd.read\_csv("D:\skin cancer\hmnist\_28\_28\_RGB.csv")

data.head()

pixel0000 pixel0001 pixel0002 pixel0003 pixel0004 pixel0005 pixel0006 pixel0007 pixel0008 pixel0009 ... pixel2343 pixel2344 pixel2345 pixel2346 pixel2347 pixel2348 pixel2349 pixel2350 pixel2351 label

0 192 153 193 195 155 192 197 154 185 202 ... 173 124 138 183 147 166 185 154 177 2

1 25 14 30 68 48 75 123 93 126 158 ... 60 39 55 25 14 28 25 14 27 2

2 192 138 153 200 145 163 201 142 160 206 ... 167 129 143 159 124 142 136 104 117 2

3 38 19 30 95 59 72 143 103 119 171 ... 44 26 36 25 12 17 25 12 15 2

4 158 113 139 194 144 174 215 162 191 225 ... 209 166 185 172 135 149 109 78 92 2

5 rows × 2353 columns

meta\_df = pd.read\_csv("D:\skin cancer\HAM10000\_metadata.csv")

meta\_df.head()

lesion\_id image\_id dx dx\_type age sex localization

0 HAM\_0000118 ISIC\_0027419 bkl histo 80.0 male scalp

1 HAM\_0000118 ISIC\_0025030 bkl histo 80.0 male scalp

2 HAM\_0002730 ISIC\_0026769 bkl histo 80.0 male scalp

3 HAM\_0002730 ISIC\_0025661 bkl histo 80.0 male scalp

4 HAM\_0001466 ISIC\_0031633 bkl histo 75.0 male ear

meta\_df.shape

(10015, 7)

data.shape

(10015, 2353)

yData = data['label']

XData = data.drop(columns = ['label'])

EDA

distribution = meta\_df['dx'].value\_counts()

distribution

dx

nv 6705

mel 1113

bkl 1099

bcc 514

akiec 327

vasc 142

df 115

Name: count, dtype: int64

# classes = {4: ('nv', ' melanocytic nevi'),

# 6: ('mel', 'melanoma'),

# 2 :('bkl', 'benign keratosis-like lesions'),

# 1:('bcc' , ' basal cell carcinoma'),

# 5: ('vasc', ' pyogenic granulomas and hemorrhage'),

# 0: ('akiec', 'Actinic keratoses and intraepithelial carcinomae'),

# 3: ('df', 'dermatofibroma')}

dist = data['label'].value\_counts()

dist

label

4 6705

6 1113

2 1099

1 514

0 327

5 142

3 115

Name: count, dtype: int64

There's alot of data imbalance

distribution.plot()

<Axes: xlabel='dx'>

Fixing Data Imbalance

over sample the dateset using Random Over Sampler

from imblearn.over\_sampling import RandomOverSampler

sampler = RandomOverSampler()

XData,yData = sampler.fit\_resample(XData,yData)

XData.shape, yData.shape

((46935, 2352), (46935,))

XData = np.array(XData).reshape((-1, 28, 28, 3))

XData = XData / 255

XData.shape

(46935, 28, 28, 3)

Create the train and validation set

from sklearn.model\_selection import train\_test\_split

Xtrain, Xtest, Ytrain, Ytest = train\_test\_split(XData,yData, test\_size=0.2)

Xtrain.shape, Xtest.shape

((37548, 28, 28, 3), (9387, 28, 28, 3))

Train the model

from keras.models import Sequential

from keras.layers import Conv2D, MaxPooling2D

from keras.layers import Activation, Dropout, Flatten, Dense

import tensorflow as tf

img\_width, img\_height = 28,28

input\_shape = (img\_width, img\_height, 3)

model = Sequential()

model.add(Conv2D(32, (2, 2), input\_shape=input\_shape))

model.add(Activation('swish'))

model.add(MaxPooling2D(pool\_size=(2, 2)))

model.add(Conv2D(32, (2, 2)))

model.add(Activation('swish'))

model.add(MaxPooling2D(pool\_size=(2, 2)))

model.add(Conv2D(64, (2, 2)))

model.add(Activation('swish'))

model.add(MaxPooling2D(pool\_size=(2, 2)))

model.add(Flatten())

model.add(Dense(64))

model.add(Activation('swish'))

model.add(Dropout(0.5))

model.add(Dense(7))

model.add(Activation('softmax'))

model.compile(loss='sparse\_categorical\_crossentropy',

optimizer='nadam',

metrics=['accuracy'])

callback = tf.keras.callbacks.ModelCheckpoint(filepath='skin.h5',

monitor='val\_acc', mode='max',

verbose=1)

early\_stopping = tf.keras.callbacks.EarlyStopping(patience=10, restore\_best\_weights=True)

history = model.fit(Xtrain,

Ytrain,

epochs = 100,

validation\_data = (Xtest, Ytest),

callbacks=[callback, early\_stopping])

Epoch 1/100

1169/1174 [============================>.] - ETA: 0s - loss: 1.3977 - accuracy: 0.4422

Epoch 1: saving model to best\_model.h5

1174/1174 [==============================] - 12s 9ms/step - loss: 1.3966 - accuracy: 0.4427 - val\_loss: 1.0891 - val\_accuracy: 0.5787

Epoch 2/100

1174/1174 [==============================] - ETA: 0s - loss: 1.0505 - accuracy: 0.5962

Epoch 2: saving model to best\_model.h5

1174/1174 [==============================] - 12s 10ms/step - loss: 1.0505 - accuracy: 0.5962 - val\_loss: 0.9161 - val\_accuracy: 0.6580

Epoch 3/100

1172/1174 [============================>.] - ETA: 0s - loss: 0.8979 - accuracy: 0.6580

Epoch 3: saving model to best\_model.h5

1174/1174 [==============================] - 12s 10ms/step - loss: 0.8975 - accuracy: 0.6581 - val\_loss: 0.7588 - val\_accuracy: 0.7180

Epoch 4/100

1171/1174 [============================>.] - ETA: 0s - loss: 0.7806 - accuracy: 0.7031

Epoch 4: saving model to best\_model.h5

1174/1174 [==============================] - 12s 10ms/step - loss: 0.7807 - accuracy: 0.7030 - val\_loss: 0.6681 - val\_accuracy: 0.7474

Epoch 5/100

1171/1174 [============================>.] - ETA: 0s - loss: 0.7002 - accuracy: 0.7354

Epoch 5: saving model to best\_model.h5

1174/1174 [==============================] - 12s 10ms/step - loss: 0.7005 - accuracy: 0.7353 - val\_loss: 0.5869 - val\_accuracy: 0.7759

Epoch 6/100

1169/1174 [============================>.] - ETA: 0s - loss: 0.6371 - accuracy: 0.7584

Epoch 6: saving model to best\_model.h5

1174/1174 [==============================] - 12s 10ms/step - loss: 0.6369 - accuracy: 0.7584 - val\_loss: 0.5319 - val\_accuracy: 0.7971

Epoch 7/100

1171/1174 [============================>.] - ETA: 0s - loss: 0.5826 - accuracy: 0.7784

Epoch 7: saving model to best\_model.h5

1174/1174 [==============================] - 11s 10ms/step - loss: 0.5823 - accuracy: 0.7785 - val\_loss: 0.4946 - val\_accuracy: 0.8143

Epoch 8/100

1171/1174 [============================>.] - ETA: 0s - loss: 0.5356 - accuracy: 0.7992

Epoch 8: saving model to best\_model.h5

1174/1174 [==============================] - 12s 10ms/step - loss: 0.5356 - accuracy: 0.7992 - val\_loss: 0.4610 - val\_accuracy: 0.8327

Epoch 9/100

1169/1174 [============================>.] - ETA: 0s - loss: 0.4981 - accuracy: 0.8126

Epoch 9: saving model to best\_model.h5

1174/1174 [==============================] - 12s 10ms/step - loss: 0.4977 - accuracy: 0.8128 - val\_loss: 0.4077 - val\_accuracy: 0.8465

Epoch 10/100

1170/1174 [============================>.] - ETA: 0s - loss: 0.4611 - accuracy: 0.8278

Epoch 10: saving model to best\_model.h5

1174/1174 [==============================] - 12s 10ms/step - loss: 0.4611 - accuracy: 0.8277 - val\_loss: 0.3759 - val\_accuracy: 0.8634

Epoch 11/100

1170/1174 [============================>.] - ETA: 0s - loss: 0.4279 - accuracy: 0.8386

Epoch 11: saving model to best\_model.h5

1174/1174 [==============================] - 12s 10ms/step - loss: 0.4276 - accuracy: 0.8388 - val\_loss: 0.3541 - val\_accuracy: 0.8681

Epoch 12/100

1172/1174 [============================>.] - ETA: 0s - loss: 0.3985 - accuracy: 0.8512

Epoch 12: saving model to best\_model.h5

1174/1174 [==============================] - 12s 10ms/step - loss: 0.3985 - accuracy: 0.8512 - val\_loss: 0.3451 - val\_accuracy: 0.8684

Epoch 13/100

1173/1174 [============================>.] - ETA: 0s - loss: 0.3740 - accuracy: 0.8582

Epoch 13: saving model to best\_model.h5

1174/1174 [==============================] - 12s 10ms/step - loss: 0.3740 - accuracy: 0.8582 - val\_loss: 0.2944 - val\_accuracy: 0.8942

Epoch 14/100

1168/1174 [============================>.] - ETA: 0s - loss: 0.3478 - accuracy: 0.8713

Epoch 14: saving model to best\_model.h5

1174/1174 [==============================] - 12s 10ms/step - loss: 0.3476 - accuracy: 0.8714 - val\_loss: 0.2705 - val\_accuracy: 0.9020

Epoch 15/100

1169/1174 [============================>.] - ETA: 0s - loss: 0.3304 - accuracy: 0.8748

Epoch 15: saving model to best\_model.h5

1174/1174 [==============================] - 12s 10ms/step - loss: 0.3303 - accuracy: 0.8748 - val\_loss: 0.2720 - val\_accuracy: 0.9006

Epoch 16/100

1168/1174 [============================>.] - ETA: 0s - loss: 0.3114 - accuracy: 0.8819

Epoch 16: saving model to best\_model.h5

1174/1174 [==============================] - 12s 10ms/step - loss: 0.3116 - accuracy: 0.8819 - val\_loss: 0.2462 - val\_accuracy: 0.9084

Epoch 17/100

1169/1174 [============================>.] - ETA: 0s - loss: 0.2954 - accuracy: 0.8883

Epoch 17: saving model to best\_model.h5

1174/1174 [==============================] - 12s 10ms/step - loss: 0.2954 - accuracy: 0.8884 - val\_loss: 0.2342 - val\_accuracy: 0.9156

Epoch 18/100

1168/1174 [============================>.] - ETA: 0s - loss: 0.2819 - accuracy: 0.8939

Epoch 18: saving model to best\_model.h5

1174/1174 [==============================] - 12s 10ms/step - loss: 0.2822 - accuracy: 0.8938 - val\_loss: 0.2193 - val\_accuracy: 0.9237

Epoch 19/100

1173/1174 [============================>.] - ETA: 0s - loss: 0.2676 - accuracy: 0.8990

Epoch 19: saving model to best\_model.h5

1174/1174 [==============================] - 12s 10ms/step - loss: 0.2677 - accuracy: 0.8990 - val\_loss: 0.2010 - val\_accuracy: 0.9314

Epoch 20/100

1171/1174 [============================>.] - ETA: 0s - loss: 0.2526 - accuracy: 0.9059

Epoch 20: saving model to best\_model.h5

1174/1174 [==============================] - 12s 10ms/step - loss: 0.2527 - accuracy: 0.9059 - val\_loss: 0.2011 - val\_accuracy: 0.9327

Epoch 21/100

1171/1174 [============================>.] - ETA: 0s - loss: 0.2436 - accuracy: 0.9068

Epoch 21: saving model to best\_model.h5

1174/1174 [==============================] - 12s 10ms/step - loss: 0.2435 - accuracy: 0.9069 - val\_loss: 0.1862 - val\_accuracy: 0.9384

Epoch 22/100

1169/1174 [============================>.] - ETA: 0s - loss: 0.2362 - accuracy: 0.9098

Epoch 22: saving model to best\_model.h5

1174/1174 [==============================] - 12s 10ms/step - loss: 0.2363 - accuracy: 0.9098 - val\_loss: 0.1796 - val\_accuracy: 0.9378

Epoch 23/100

1172/1174 [============================>.] - ETA: 0s - loss: 0.2257 - accuracy: 0.9155

Epoch 23: saving model to best\_model.h5

1174/1174 [==============================] - 12s 10ms/step - loss: 0.2257 - accuracy: 0.9155 - val\_loss: 0.1698 - val\_accuracy: 0.9387

Epoch 24/100

1172/1174 [============================>.] - ETA: 0s - loss: 0.2180 - accuracy: 0.9189

Epoch 24: saving model to best\_model.h5

1174/1174 [==============================] - 12s 10ms/step - loss: 0.2182 - accuracy: 0.9188 - val\_loss: 0.1731 - val\_accuracy: 0.9396

Epoch 25/100

1169/1174 [============================>.] - ETA: 0s - loss: 0.2081 - accuracy: 0.9221

Epoch 25: saving model to best\_model.h5

1174/1174 [==============================] - 12s 10ms/step - loss: 0.2077 - accuracy: 0.9223 - val\_loss: 0.1849 - val\_accuracy: 0.9328

Epoch 26/100

1173/1174 [============================>.] - ETA: 0s - loss: 0.2062 - accuracy: 0.9223

Epoch 26: saving model to best\_model.h5

1174/1174 [==============================] - 12s 10ms/step - loss: 0.2062 - accuracy: 0.9223 - val\_loss: 0.1575 - val\_accuracy: 0.9482

Epoch 27/100

1173/1174 [============================>.] - ETA: 0s - loss: 0.1963 - accuracy: 0.9277

Epoch 27: saving model to best\_model.h5

1174/1174 [==============================] - 12s 10ms/step - loss: 0.1962 - accuracy: 0.9277 - val\_loss: 0.1459 - val\_accuracy: 0.9509

Epoch 28/100

1169/1174 [============================>.] - ETA: 0s - loss: 0.1900 - accuracy: 0.9295

Epoch 28: saving model to best\_model.h5

1174/1174 [==============================] - 12s 10ms/step - loss: 0.1900 - accuracy: 0.9295 - val\_loss: 0.1531 - val\_accuracy: 0.9476

Epoch 29/100

1171/1174 [============================>.] - ETA: 0s - loss: 0.1886 - accuracy: 0.9290

Epoch 29: saving model to best\_model.h5

1174/1174 [==============================] - 12s 10ms/step - loss: 0.1888 - accuracy: 0.9289 - val\_loss: 0.1404 - val\_accuracy: 0.9532

Epoch 30/100

1169/1174 [============================>.] - ETA: 0s - loss: 0.1762 - accuracy: 0.9348

Epoch 30: saving model to best\_model.h5

1174/1174 [==============================] - 12s 10ms/step - loss: 0.1761 - accuracy: 0.9349 - val\_loss: 0.1265 - val\_accuracy: 0.9597

Epoch 31/100

1170/1174 [============================>.] - ETA: 0s - loss: 0.1742 - accuracy: 0.9359

Epoch 31: saving model to best\_model.h5

1174/1174 [==============================] - 12s 10ms/step - loss: 0.1739 - accuracy: 0.9360 - val\_loss: 0.1419 - val\_accuracy: 0.9512

Epoch 32/100

1171/1174 [============================>.] - ETA: 0s - loss: 0.1720 - accuracy: 0.9360

Epoch 32: saving model to best\_model.h5

1174/1174 [==============================] - 12s 10ms/step - loss: 0.1720 - accuracy: 0.9360 - val\_loss: 0.1488 - val\_accuracy: 0.9524

Epoch 33/100

1172/1174 [============================>.] - ETA: 0s - loss: 0.1634 - accuracy: 0.9392

Epoch 33: saving model to best\_model.h5

1174/1174 [==============================] - 13s 11ms/step - loss: 0.1633 - accuracy: 0.9393 - val\_loss: 0.1419 - val\_accuracy: 0.9565

Epoch 34/100

1169/1174 [============================>.] - ETA: 0s - loss: 0.1611 - accuracy: 0.9404

Epoch 34: saving model to best\_model.h5

1174/1174 [==============================] - 13s 11ms/step - loss: 0.1613 - accuracy: 0.9403 - val\_loss: 0.1248 - val\_accuracy: 0.9591

Epoch 35/100

1171/1174 [============================>.] - ETA: 0s - loss: 0.1551 - accuracy: 0.9432

Epoch 35: saving model to best\_model.h5

1174/1174 [==============================] - 12s 10ms/step - loss: 0.1550 - accuracy: 0.9433 - val\_loss: 0.1189 - val\_accuracy: 0.9601

Epoch 36/100

1173/1174 [============================>.] - ETA: 0s - loss: 0.1507 - accuracy: 0.9440

Epoch 36: saving model to best\_model.h5

1174/1174 [==============================] - 12s 10ms/step - loss: 0.1507 - accuracy: 0.9440 - val\_loss: 0.1213 - val\_accuracy: 0.9627

Epoch 37/100

1171/1174 [============================>.] - ETA: 0s - loss: 0.1502 - accuracy: 0.9449

Epoch 37: saving model to best\_model.h5

1174/1174 [==============================] - 12s 10ms/step - loss: 0.1502 - accuracy: 0.9448 - val\_loss: 0.1344 - val\_accuracy: 0.9548

Epoch 38/100

1170/1174 [============================>.] - ETA: 0s - loss: 0.1446 - accuracy: 0.9478

Epoch 38: saving model to best\_model.h5

1174/1174 [==============================] - 12s 10ms/step - loss: 0.1443 - accuracy: 0.9479 - val\_loss: 0.1171 - val\_accuracy: 0.9610

Epoch 39/100

1173/1174 [============================>.] - ETA: 0s - loss: 0.1413 - accuracy: 0.9481

Epoch 39: saving model to best\_model.h5

1174/1174 [==============================] - 12s 10ms/step - loss: 0.1413 - accuracy: 0.9481 - val\_loss: 0.1163 - val\_accuracy: 0.9614

Epoch 40/100

1171/1174 [============================>.] - ETA: 0s - loss: 0.1440 - accuracy: 0.9481

Epoch 40: saving model to best\_model.h5

1174/1174 [==============================] - 12s 10ms/step - loss: 0.1439 - accuracy: 0.9481 - val\_loss: 0.1160 - val\_accuracy: 0.9646

Epoch 41/100

1170/1174 [============================>.] - ETA: 0s - loss: 0.1399 - accuracy: 0.9479

Epoch 41: saving model to best\_model.h5

1174/1174 [==============================] - 12s 10ms/step - loss: 0.1397 - accuracy: 0.9480 - val\_loss: 0.1220 - val\_accuracy: 0.9648

Epoch 42/100

1172/1174 [============================>.] - ETA: 0s - loss: 0.1352 - accuracy: 0.9508

Epoch 42: saving model to best\_model.h5

1174/1174 [==============================] - 12s 10ms/step - loss: 0.1352 - accuracy: 0.9508 - val\_loss: 0.1049 - val\_accuracy: 0.9667

Epoch 43/100

1170/1174 [============================>.] - ETA: 0s - loss: 0.1286 - accuracy: 0.9517

Epoch 43: saving model to best\_model.h5

1174/1174 [==============================] - 12s 10ms/step - loss: 0.1287 - accuracy: 0.9516 - val\_loss: 0.1271 - val\_accuracy: 0.9595

Epoch 44/100

1169/1174 [============================>.] - ETA: 0s - loss: 0.1271 - accuracy: 0.9533

Epoch 44: saving model to best\_model.h5

1174/1174 [==============================] - 12s 10ms/step - loss: 0.1270 - accuracy: 0.9534 - val\_loss: 0.1050 - val\_accuracy: 0.9681

Epoch 45/100

1169/1174 [============================>.] - ETA: 0s - loss: 0.1272 - accuracy: 0.9549

Epoch 45: saving model to best\_model.h5

1174/1174 [==============================] - 12s 10ms/step - loss: 0.1275 - accuracy: 0.9549 - val\_loss: 0.1069 - val\_accuracy: 0.9687

Epoch 46/100

1168/1174 [============================>.] - ETA: 0s - loss: 0.1242 - accuracy: 0.9538

Epoch 46: saving model to best\_model.h5

1174/1174 [==============================] - 12s 10ms/step - loss: 0.1242 - accuracy: 0.9538 - val\_loss: 0.1120 - val\_accuracy: 0.9664

Epoch 47/100

1170/1174 [============================>.] - ETA: 0s - loss: 0.1213 - accuracy: 0.9553

Epoch 47: saving model to best\_model.h5

1174/1174 [==============================] - 12s 10ms/step - loss: 0.1217 - accuracy: 0.9552 - val\_loss: 0.1103 - val\_accuracy: 0.9668

Epoch 48/100

1173/1174 [============================>.] - ETA: 0s - loss: 0.1227 - accuracy: 0.9556

Epoch 48: saving model to best\_model.h5

1174/1174 [==============================] - 12s 10ms/step - loss: 0.1228 - accuracy: 0.9556 - val\_loss: 0.1052 - val\_accuracy: 0.9673

Epoch 49/100

1170/1174 [============================>.] - ETA: 0s - loss: 0.1175 - accuracy: 0.9581

Epoch 49: saving model to best\_model.h5

1174/1174 [==============================] - 12s 10ms/step - loss: 0.1175 - accuracy: 0.9581 - val\_loss: 0.1071 - val\_accuracy: 0.9650

Epoch 50/100

1168/1174 [============================>.] - ETA: 0s - loss: 0.1190 - accuracy: 0.9581

Epoch 50: saving model to best\_model.h5

1174/1174 [==============================] - 12s 10ms/step - loss: 0.1191 - accuracy: 0.9580 - val\_loss: 0.0946 - val\_accuracy: 0.9712

Epoch 51/100

1170/1174 [============================>.] - ETA: 0s - loss: 0.1147 - accuracy: 0.9590

Epoch 51: saving model to best\_model.h5

1174/1174 [==============================] - 12s 10ms/step - loss: 0.1148 - accuracy: 0.9590 - val\_loss: 0.1019 - val\_accuracy: 0.9694

Epoch 52/100

1168/1174 [============================>.] - ETA: 0s - loss: 0.1080 - accuracy: 0.9608

Epoch 52: saving model to best\_model.h5

1174/1174 [==============================] - 12s 10ms/step - loss: 0.1085 - accuracy: 0.9605 - val\_loss: 0.0947 - val\_accuracy: 0.9727

Epoch 53/100

1174/1174 [==============================] - ETA: 0s - loss: 0.1117 - accuracy: 0.9599

Epoch 53: saving model to best\_model.h5

1174/1174 [==============================] - 12s 10ms/step - loss: 0.1117 - accuracy: 0.9599 - val\_loss: 0.1174 - val\_accuracy: 0.9657

Epoch 54/100

1170/1174 [============================>.] - ETA: 0s - loss: 0.1142 - accuracy: 0.9592

Epoch 54: saving model to best\_model.h5

1174/1174 [==============================] - 12s 10ms/step - loss: 0.1142 - accuracy: 0.9592 - val\_loss: 0.1004 - val\_accuracy: 0.9694

Epoch 55/100

1171/1174 [============================>.] - ETA: 0s - loss: 0.1069 - accuracy: 0.9614

Epoch 55: saving model to best\_model.h5

1174/1174 [==============================] - 12s 10ms/step - loss: 0.1070 - accuracy: 0.9614 - val\_loss: 0.1206 - val\_accuracy: 0.9629

Epoch 56/100

1168/1174 [============================>.] - ETA: 0s - loss: 0.1088 - accuracy: 0.9616

Epoch 56: saving model to best\_model.h5

1174/1174 [==============================] - 12s 10ms/step - loss: 0.1088 - accuracy: 0.9615 - val\_loss: 0.1018 - val\_accuracy: 0.9717

Epoch 57/100

1172/1174 [============================>.] - ETA: 0s - loss: 0.1016 - accuracy: 0.9636

Epoch 57: saving model to best\_model.h5

1174/1174 [==============================] - 12s 10ms/step - loss: 0.1017 - accuracy: 0.9636 - val\_loss: 0.0970 - val\_accuracy: 0.9700

Epoch 58/100

1171/1174 [============================>.] - ETA: 0s - loss: 0.1083 - accuracy: 0.9612

Epoch 58: saving model to best\_model.h5

1174/1174 [==============================] - 12s 10ms/step - loss: 0.1083 - accuracy: 0.9611 - val\_loss: 0.1072 - val\_accuracy: 0.9699

Epoch 59/100

1171/1174 [============================>.] - ETA: 0s - loss: 0.1013 - accuracy: 0.9632

Epoch 59: saving model to best\_model.h5

1174/1174 [==============================] - 12s 10ms/step - loss: 0.1014 - accuracy: 0.9631 - val\_loss: 0.1008 - val\_accuracy: 0.9718

Epoch 60/100

1169/1174 [============================>.] - ETA: 0s - loss: 0.1007 - accuracy: 0.9634

Epoch 60: saving model to best\_model.h5

1174/1174 [==============================] - 12s 10ms/step - loss: 0.1011 - accuracy: 0.9632 - val\_loss: 0.0884 - val\_accuracy: 0.9758

Epoch 61/100

1169/1174 [============================>.] - ETA: 0s - loss: 0.1005 - accuracy: 0.9641

Epoch 61: saving model to best\_model.h5

1174/1174 [==============================] - 12s 10ms/step - loss: 0.1004 - accuracy: 0.9642 - val\_loss: 0.0957 - val\_accuracy: 0.9727

Epoch 62/100

1171/1174 [============================>.] - ETA: 0s - loss: 0.0984 - accuracy: 0.9650

Epoch 62: saving model to best\_model.h5

1174/1174 [==============================] - 12s 10ms/step - loss: 0.0984 - accuracy: 0.9651 - val\_loss: 0.0904 - val\_accuracy: 0.9743

Epoch 63/100

1168/1174 [============================>.] - ETA: 0s - loss: 0.0929 - accuracy: 0.9669

Epoch 63: saving model to best\_model.h5

1174/1174 [==============================] - 12s 10ms/step - loss: 0.0930 - accuracy: 0.9669 - val\_loss: 0.0969 - val\_accuracy: 0.9722

Epoch 64/100

1171/1174 [============================>.] - ETA: 0s - loss: 0.0953 - accuracy: 0.9652

Epoch 64: saving model to best\_model.h5

1174/1174 [==============================] - 12s 10ms/step - loss: 0.0954 - accuracy: 0.9652 - val\_loss: 0.1018 - val\_accuracy: 0.9732

Epoch 65/100

1173/1174 [============================>.] - ETA: 0s - loss: 0.0964 - accuracy: 0.9655

Epoch 65: saving model to best\_model.h5

1174/1174 [==============================] - 12s 10ms/step - loss: 0.0964 - accuracy: 0.9655 - val\_loss: 0.0962 - val\_accuracy: 0.9753

Epoch 66/100

1169/1174 [============================>.] - ETA: 0s - loss: 0.0986 - accuracy: 0.9655

Epoch 66: saving model to best\_model.h5

1174/1174 [==============================] - 12s 10ms/step - loss: 0.0988 - accuracy: 0.9654 - val\_loss: 0.0836 - val\_accuracy: 0.9774

Epoch 67/100

1168/1174 [============================>.] - ETA: 0s - loss: 0.0870 - accuracy: 0.9687

Epoch 67: saving model to best\_model.h5

1174/1174 [==============================] - 12s 10ms/step - loss: 0.0869 - accuracy: 0.9687 - val\_loss: 0.1046 - val\_accuracy: 0.9722

Epoch 68/100

1173/1174 [============================>.] - ETA: 0s - loss: 0.1005 - accuracy: 0.9645

Epoch 68: saving model to best\_model.h5

1174/1174 [==============================] - 12s 10ms/step - loss: 0.1006 - accuracy: 0.9645 - val\_loss: 0.1023 - val\_accuracy: 0.9732

Epoch 69/100

1173/1174 [============================>.] - ETA: 0s - loss: 0.0881 - accuracy: 0.9691

Epoch 69: saving model to best\_model.h5

1174/1174 [==============================] - 12s 10ms/step - loss: 0.0882 - accuracy: 0.9691 - val\_loss: 0.1115 - val\_accuracy: 0.9685

Epoch 70/100

1168/1174 [============================>.] - ETA: 0s - loss: 0.0920 - accuracy: 0.9674

Epoch 70: saving model to best\_model.h5

1174/1174 [==============================] - 12s 10ms/step - loss: 0.0919 - accuracy: 0.9674 - val\_loss: 0.0880 - val\_accuracy: 0.9777

Epoch 71/100

1167/1174 [============================>.] - ETA: 0s - loss: 0.0893 - accuracy: 0.9685

Epoch 71: saving model to best\_model.h5

1174/1174 [==============================] - 12s 10ms/step - loss: 0.0891 - accuracy: 0.9685 - val\_loss: 0.0932 - val\_accuracy: 0.9777

Epoch 72/100

1173/1174 [============================>.] - ETA: 0s - loss: 0.0848 - accuracy: 0.9698

Epoch 72: saving model to best\_model.h5

1174/1174 [==============================] - 12s 10ms/step - loss: 0.0848 - accuracy: 0.9698 - val\_loss: 0.1018 - val\_accuracy: 0.9732

Epoch 73/100

1173/1174 [============================>.] - ETA: 0s - loss: 0.0937 - accuracy: 0.9663

Epoch 73: saving model to best\_model.h5

1174/1174 [==============================] - 12s 10ms/step - loss: 0.0938 - accuracy: 0.9663 - val\_loss: 0.0849 - val\_accuracy: 0.9765

Epoch 74/100

1168/1174 [============================>.] - ETA: 0s - loss: 0.0795 - accuracy: 0.9720

Epoch 74: saving model to best\_model.h5

1174/1174 [==============================] - 12s 10ms/step - loss: 0.0796 - accuracy: 0.9720 - val\_loss: 0.0879 - val\_accuracy: 0.9784

Epoch 75/100

1173/1174 [============================>.] - ETA: 0s - loss: 0.0858 - accuracy: 0.9695

Epoch 75: saving model to best\_model.h5

1174/1174 [==============================] - 12s 10ms/step - loss: 0.0857 - accuracy: 0.9695 - val\_loss: 0.0869 - val\_accuracy: 0.9778

Epoch 76/100

1172/1174 [============================>.] - ETA: 0s - loss: 0.0848 - accuracy: 0.9697

Epoch 76: saving model to best\_model.h5

1174/1174 [==============================] - 13s 11ms/step - loss: 0.0850 - accuracy: 0.9697 - val\_loss: 0.1063 - val\_accuracy: 0.9738

import matplotlib.pyplot as plt

model.evaluate(Xtrain, Ytrain)

1174/1174 [==============================] - 3s 3ms/step - loss: 0.0267 - accuracy: 0.9917

[0.026694364845752716, 0.9916639924049377]

model.evaluate(Xtest, Ytest)

294/294 [==============================] - 1s 3ms/step - loss: 0.0836 - accuracy: 0.9774

[0.08363594859838486, 0.9774155616760254]

PLEASE GIVE AN UPVOTE

history\_dict = history.history

loss\_values = history\_dict['loss']

val\_loss\_values = history\_dict['val\_loss']

epochs = range(1, len(loss\_values) + 1)

line1 = plt.plot(epochs, val\_loss\_values, label='Validation/Test Loss')

line2 = plt.plot(epochs, loss\_values, label='Training Loss')

plt.setp(line1, linewidth=2.0, marker = '+', markersize=10.0)

plt.setp(line2, linewidth=2.0, marker = '4', markersize=10.0)

plt.xlabel('Epochs')

plt.ylabel('Loss')

plt.grid(True)

plt.legend()

plt.show()

history\_dict = history.history

acc\_values = history\_dict['accuracy']

val\_acc\_values = history\_dict['val\_accuracy']

epochs = range(1, len(loss\_values) + 1)

line1 = plt.plot(epochs, val\_acc\_values, label='Validation/Test Accuracy')

line2 = plt.plot(epochs, acc\_values, label='Training Accuracy')

plt.setp(line1, linewidth=2.0, marker = '+', markersize=10.0)

plt.setp(line2, linewidth=2.0, marker = '4', markersize=10.0)

plt.xlabel('Epochs')

plt.ylabel('Accuracy')

plt.grid(True)

plt.legend()

plt.show()