

Model Development Phase Template

Date	4 June 2024
Team ID	SWTID1720109344
Project Title	Rice Type Classification using CNN
Maximum Marks	10 Marks

Initial Model Training Code, Model Validation and Evaluation Report:

Initial Model Training Code (5 marks):

Libraries importing:

```
6]: import numpy as np
    np.random.seed(42)

    import matplotlib.pyplot as plt
    import matplotlib.image as mpimg
    import cv2
    from PIL import Image
    from skimage import io
    import scipy
    import os

    import pandas as pd
    from sklearn.model_selection import train_test_split
    from sklearn.metrics import precision_score, recall_score, f1_score, roc_curve
    import seaborn as sns
    from sklearn.metrics import confusion_matrix, classification_report, accuracy_score
    from sklearn.model_selection import GridSearchCV
    from imblearn.over_sampling import SMOTE
    from sklearn.model_selection import StratifiedKFold
    from sklearn.model_selection import KFold

    import tensorflow as tf
    from tensorflow.keras.preprocessing.image import load_img, img_to_array
    from tensorflow.keras.preprocessing.image import ImageDataGenerator
    import keras
    from keras import Model
    from keras.models import load_model
    from keras.utils import normalize
    from keras.models import Sequential
    from keras.layers import Conv2D, MaxPooling2D
    from keras.layers import Activation, Dropout, Flatten, Dense, BatchNormalization, GlobalAveragePooling2D
    from keras import layers
    from keras.utils import to_categorical
    from keras.callbacks import ModelCheckpoint, EarlyStopping, TensorBoard, CSVLogger, LearningRateScheduler
    from keras.applications import VGG16, VGG19
```

Data splitting:

** Training the Model**

```
try:
    history = model.fit(train,
                        epochs=50,
                        validation_data=valdata,
                        callbacks=[checkpoint, earlystopping, reduce_lr])
except KeyboardInterrupt:
    print("\nTraining Stopped")
```

CNN-Model3(using xception):

```
CNN = tf.keras.models.Sequential()
CNN.add(tf.keras.layers.Conv2D(filters = 32, kernel_size = 3, activation="relu", input_shape=[150,150,3]))
CNN.add(tf.keras.layers.MaxPool2D(pool_size = 2, strides=2))
CNN.add(tf.keras.layers.Flatten())
CNN.add(tf.keras.layers.Dense(units=512, activation="relu"))
CNN.add(tf.keras.layers.Dense(units=5, activation="softmax"))
CNN.summary()
```

Training the CNN

```
[14]: CNN.compile(optimizer="adam", loss="categorical_crossentropy", metrics=['accuracy'])
      history = CNN.fit(x=train_generator, validation_data=validation_generator, epochs=10)
```

Model Validation and Evaluation Report (5 marks):

Model	Summary	Training and Validation Performance Metrics																																							
Model 1(resnet)	<p>Model: "functional_1"</p> <table border="1"> <thead> <tr> <th>Layer (type)</th><th>Output Shape</th><th>Param #</th></tr> </thead> <tbody> <tr> <td>input_layer (InputLayer)</td><td>(None, 128, 128, 3)</td><td>0</td></tr> <tr> <td>conv2d (Conv2D)</td><td>(None, 118, 118, 32)</td><td>896</td></tr> <tr> <td>conv2d_1 (Conv2D)</td><td>(None, 118, 118, 32)</td><td>9,248</td></tr> <tr> <td>max_pooling2d (MaxPooling2D)</td><td>(None, 58, 58, 32)</td><td>0</td></tr> <tr> <td>conv2d_2 (Conv2D)</td><td>(None, 56, 56, 64)</td><td>18,496</td></tr> <tr> <td>conv2d_3 (Conv2D)</td><td>(None, 54, 54, 64)</td><td>36,928</td></tr> <tr> <td>conv2d_4 (Conv2D)</td><td>(None, 52, 52, 64)</td><td>36,928</td></tr> <tr> <td>max_pooling2d_1 (MaxPooling2D)</td><td>(None, 26, 26, 64)</td><td>0</td></tr> <tr> <td>conv2d_5 (Conv2D)</td><td>(None, 24, 24, 128)</td><td>73,856</td></tr> <tr> <td>conv2d_6 (Conv2D)</td><td>(None, 24, 24, 25)</td><td>3,225</td></tr> <tr> <td>flatten (Flatten)</td><td>(None, 14480)</td><td>0</td></tr> <tr> <td>dense (Dense)</td><td>(None, 5)</td><td>72,805</td></tr> </tbody> </table> <p>Total params: 251,582 (982.74 KB) Trainable params: 251,582 (982.74 KB) Non-trainable params: 0 (0.00 B)</p>	Layer (type)	Output Shape	Param #	input_layer (InputLayer)	(None, 128, 128, 3)	0	conv2d (Conv2D)	(None, 118, 118, 32)	896	conv2d_1 (Conv2D)	(None, 118, 118, 32)	9,248	max_pooling2d (MaxPooling2D)	(None, 58, 58, 32)	0	conv2d_2 (Conv2D)	(None, 56, 56, 64)	18,496	conv2d_3 (Conv2D)	(None, 54, 54, 64)	36,928	conv2d_4 (Conv2D)	(None, 52, 52, 64)	36,928	max_pooling2d_1 (MaxPooling2D)	(None, 26, 26, 64)	0	conv2d_5 (Conv2D)	(None, 24, 24, 128)	73,856	conv2d_6 (Conv2D)	(None, 24, 24, 25)	3,225	flatten (Flatten)	(None, 14480)	0	dense (Dense)	(None, 5)	72,805	<pre>Epoch 1/25 1/18 ----- 0.43 step - accuracy: 0.2049 - loss: 1.4008 WARNING: All log messages before absl::InitLoggings() is called are written to STDERR 2020-08-08:17:57:07.508.504035 70 device_compiler>:185 Compiled cluster using XLA! This line is logged at most once for the lifetime of the process. 15/18 ----- 0s 1s/step - accuracy: 0.4702 - loss: 0.2040 2020-08-08:17:57:07.508.523777 70 graph_launch.cc:471] fallback to up-by-row mode because memset node breaks graph update 15/18 ----- 0s 1s/step - accuracy: 0.4702 - loss: 0.2040 2020-08-08:17:57:07.524407 70 graph_launch.cc:471] fallback to up-by-row mode because memset node breaks graph update 2020-08-08:17:57:07.527555 70 graph_launch.cc:471] fallback to up-by-row mode because memset node breaks graph update 15/18 ----- 0s 1s/step - accuracy: 0.4805 - loss: 1.2068 - val_accuracy: 0.5168 - val_loss: 0.3027 Epoch 2/25 2020-08-08:17:57:07.537.190709 70 graph_launch.cc:471] fallback to up-by-row mode because memset node breaks graph update 15/18 ----- 2s 134ms/step - accuracy: 0.5049 - loss: 0.4325 - val_accuracy: 0.5940 - val_loss: 0.2085 Epoch 3/25 15/18 ----- 2s 135ms/step - accuracy: 0.5094 - loss: 0.3883 - val_accuracy: 0.5680 - val_loss: 0.1580 Epoch 4/25 15/18 ----- 2s 135ms/step - accuracy: 0.5045 - loss: 0.2223 - val_accuracy: 0.5680 - val_loss: 0.1304 Epoch 5/25 15/18 ----- 2s 135ms/step - accuracy: 0.5006 - loss: 0.1595 - val_accuracy: 0.5640 - val_loss: 0.1408 Epoch 6/25 15/18 ----- 2s 135ms/step - accuracy: 0.5004 - loss: 0.1418 - val_accuracy: 0.5930 - val_loss: 0.1647 Epoch 7/25 15/18 ----- 2s 134ms/step - accuracy: 0.5017 - loss: 0.1171 - val_accuracy: 0.5930 - val_loss: 0.1399 Epoch 8/25 15/18 ----- 2s 134ms/step - accuracy: 0.5718 - loss: 0.0948 - val_accuracy: 0.5930 - val_loss: 0.1048 Epoch 9/25 15/18 ----- 2s 134ms/step - accuracy: 0.5842 - loss: 0.0954 - val_accuracy: 0.5840 - val_loss: 0.1089 Epoch 10/25 15/18 ----- 2s 135ms/step - accuracy: 0.5680 - loss: 0.1057 - val_accuracy: 0.5930 - val_loss: 0.1540 Epoch 11/25 15/18 ----- 2s 136ms/step - accuracy: 0.5680 - loss: 0.1163 - val_accuracy: 0.5930 - val_loss: 0.1576 Epoch 12/25 15/18 ----- 2s 136ms/step - accuracy: 0.5657 - loss: 0.0754 - val_accuracy: 0.5640 - val_loss: 0.2150 Epoch 13/25 15/18 ----- 2s 136ms/step - accuracy: 0.5885 - loss: 0.0756 - val_accuracy: 0.5280 - val_loss: 0.2195 Epoch 14/25 15/18 ----- 2s 140ms/step - accuracy: 0.5724 - loss: 0.0887 - val_accuracy: 0.5640 - val_loss: 0.1668</pre>
Layer (type)	Output Shape	Param #																																							
input_layer (InputLayer)	(None, 128, 128, 3)	0																																							
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Model 2 (using vgg)

Model: "sequential"

Layer (type)	Output Shape	Param #
vgg16 (Functional)	(None, 7, 7, 512)	14714688
global_average_pooling2d (GlobalAveragePooling2D)	(None, 512)	0
dense (Dense)	(None, 512)	262656
dropout (Dropout)	(None, 512)	0
dense_1 (Dense)	(None, 5)	2565

Total params: 14979909 (57.14 MB)
Trainable params: 7344645 (28.02 MB)
Non-trainable params: 7635264 (29.13 MB)

```
Epoch 1/50
938/938 [=====] - ETA: 0s - loss: 0.1043 - accuracy: 0.9623
Epoch 1: val_loss improved from inf to 0.8287, saving model to model.h5
938/938 [=====] - 1265s 1s/step - loss: 0.1043 - accuracy: 0.9623 - val_loss: 0.8287 - val_accuracy: 0.9911 - lr: 1.0000e-04
Epoch 2/50
938/938 [=====] - ETA: 0s - loss: 0.0548 - accuracy: 0.9881
Epoch 2: val_loss improved from 0.8287 to 0.8138, saving model to model.h5
938/938 [=====] - 990s 1s/step - loss: 0.0548 - accuracy: 0.9881 - val_loss: 0.8134 - val_accuracy: 0.9923 - lr: 1.0000e-04
Epoch 3/50
938/938 [=====] - ETA: 0s - loss: 0.0291 - accuracy: 0.9984
Epoch 3: val_loss improved from 0.8138 to 0.8181, saving model to model.h5
938/938 [=====] - 991s 1s/step - loss: 0.0291 - accuracy: 0.9984 - val_loss: 0.8181 - val_accuracy: 0.9966 - lr: 1.0000e-04
Epoch 4/50
938/938 [=====] - ETA: 0s - loss: 0.0250 - accuracy: 0.9924
Epoch 4: val_loss did not improve from 0.8181
938/938 [=====] - 992s 1s/step - loss: 0.0250 - accuracy: 0.9924 - val_loss: 0.8146 - val_accuracy: 0.9955 - lr: 1.0000e-04
Epoch 5/50
```

Model 3 (xception)

Model: "sequential"

Layer (type)	Output Shape	Param #
conv2d (Conv2D)	(None, 148, 148, 32)	896
max_pooling2d (MaxPooling2D)	(None, 74, 74, 32)	0
flatten (Flatten)	(None, 175232)	0
dense (Dense)	(None, 512)	89,719,296
dense_1 (Dense)	(None, 5)	2,565

Total params: 89,722,757 (342.27 MB)
Trainable params: 89,722,757 (342.27 MB)
Non-trainable params: 0 (0.00 MB)

```
Epoch 1/50
WARNING: All log messages before absl::InitializeLog() is called are written to STDERR
200000 00:00:17.6249113.358925 110 service.cc:149] XLA service 0x7020000000000000 initialized for platform CUDA (this does not guarantee that XLA will be used). Devices:
200000 00:00:17.6249113.358977 110 service.cc:153] StreamExecutor device (0): Tesla T4, Compute Capability 7.5
200000 00:00:17.6249113.358983 110 service.cc:153] StreamExecutor device (1): Tesla T4, Compute Capability 7.5
7/3282 110 23ms/step - accuracy: 0.2704 - loss: 0.1827
200000 00:00:17.6249113.358742 110 device_compiler.cc:138] Compiled cluster using XLA! This line is logged at most once for the lifetime of the process.
938/938 [=====] - 91s 25ms/step - accuracy: 0.5291 - loss: 0.2792 - val_accuracy: 0.9609 - val_loss: 0.8982
Epoch 2/50
938/938 [=====] - 83s 25ms/step - accuracy: 0.5777 - loss: 0.8657 - val_accuracy: 0.9724 - val_loss: 0.8936
Epoch 3/50
938/938 [=====] - 83s 25ms/step - accuracy: 0.5875 - loss: 0.8359 - val_accuracy: 0.9756 - val_loss: 0.8888
Epoch 4/50
938/938 [=====] - 83s 25ms/step - accuracy: 0.5940 - loss: 0.8359 - val_accuracy: 0.9877 - val_loss: 0.1341
Epoch 5/50
938/938 [=====] - 83s 25ms/step - accuracy: 0.5975 - loss: 0.8085 - val_accuracy: 0.9711 - val_loss: 0.1300
Epoch 6/50
938/938 [=====] - 83s 25ms/step - accuracy: 0.5983 - loss: 0.8045 - val_accuracy: 0.9691 - val_loss: 0.1304
Epoch 7/50
938/938 [=====] - 83s 25ms/step - accuracy: 0.5988 - loss: 0.8036 - val_accuracy: 0.9740 - val_loss: 0.1300
Epoch 8/50
938/938 [=====] - 83s 25ms/step - accuracy: 0.5993 - loss: 0.8024 - val_accuracy: 0.9709 - val_loss: 0.1430
Epoch 9/50
938/938 [=====] - 142s 25ms/step - accuracy: 0.5995 - loss: 0.8027 - val_accuracy: 0.9738 - val_loss: 0.1322
Epoch 10/50
938/938 [=====] - 83s 25ms/step - accuracy: 0.5996 - loss: 0.8021 - val_accuracy: 0.9735 - val_loss: 0.1350
```