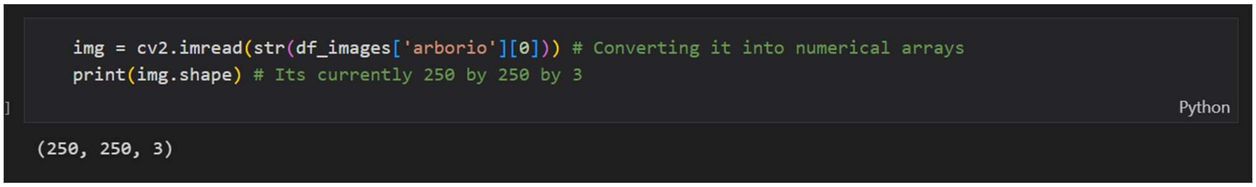
Model Development Phase Template

Date	8July 2024
Team ID	SWTID1720078167
Project Title	Rice type classification using CNN
Maximum Marks	10 Marks

Initial Model Training Code, Model Validation and Evaluation Report

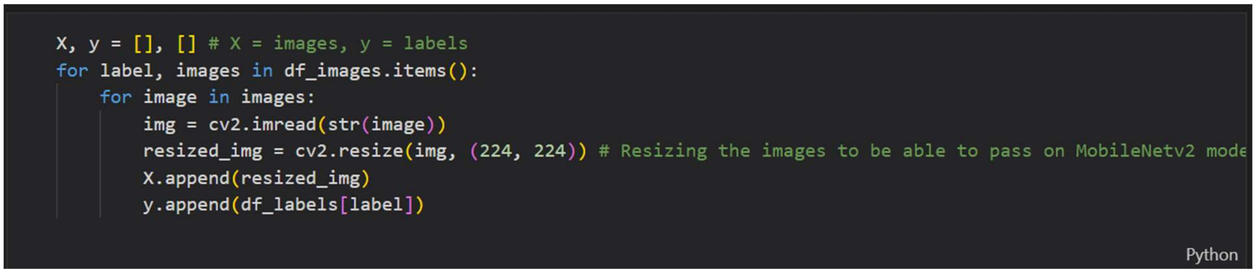
The initial model training code will be showcased in the future through a screenshot. The model validation and evaluation report will include a summary and training and validation performance metrics for multiple models, presented through respective screenshots.

Initial Model Training Code (5 marks):

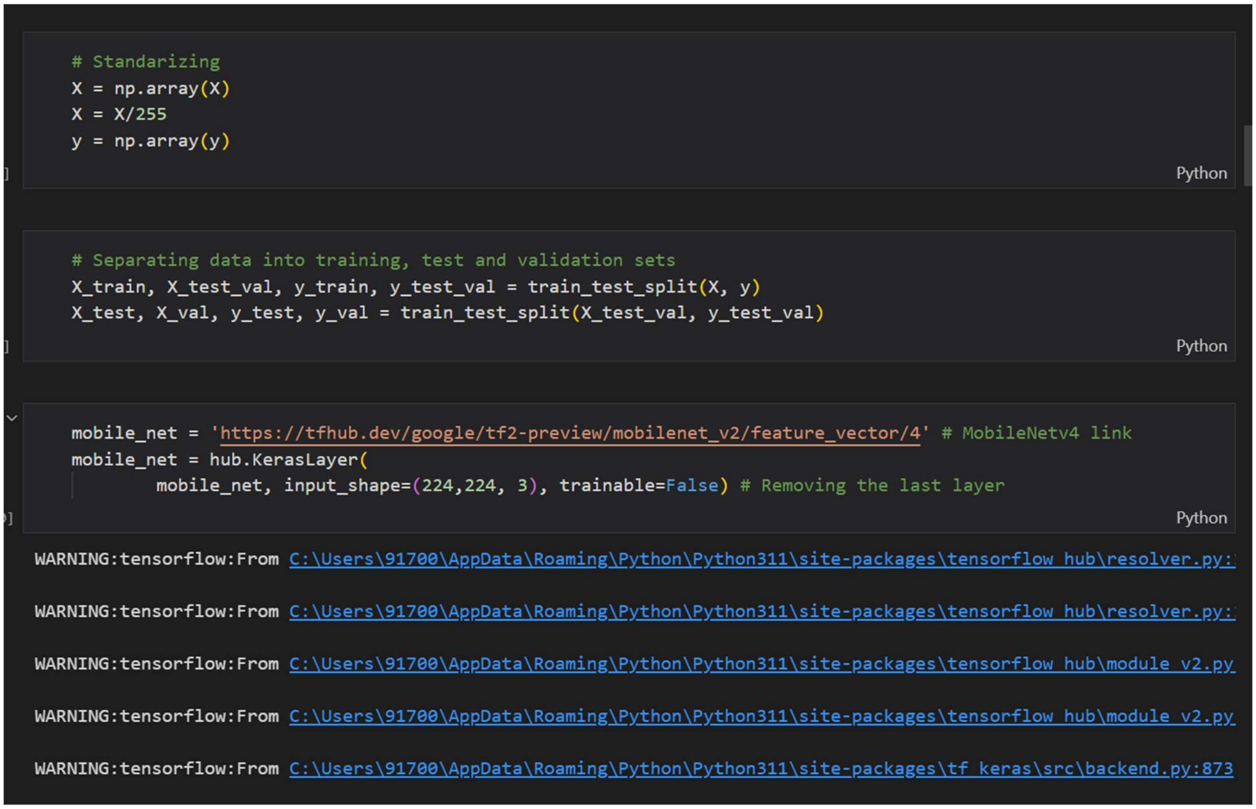


```python
img = cv2.imread(str(df_images['arborio'][0])) # Converting it into numerical arrays
print(img.shape) # Its currently 250 by 250 by 3
```

```
(250, 250, 3)
```



```python
X, y = [], [] # X = images, y = labels
for label, images in df_images.items():
    for image in images:
        img = cv2.imread(str(image))
        resized_img = cv2.resize(img, (224, 224)) # Resizing the images to be able to pass on MobileNetv2 mode
        X.append(resized_img)
        y.append(df_labels[label])
```



```
# Standarizing
X = np.array(X)
X = X/255
y = np.array(y)
```

Python

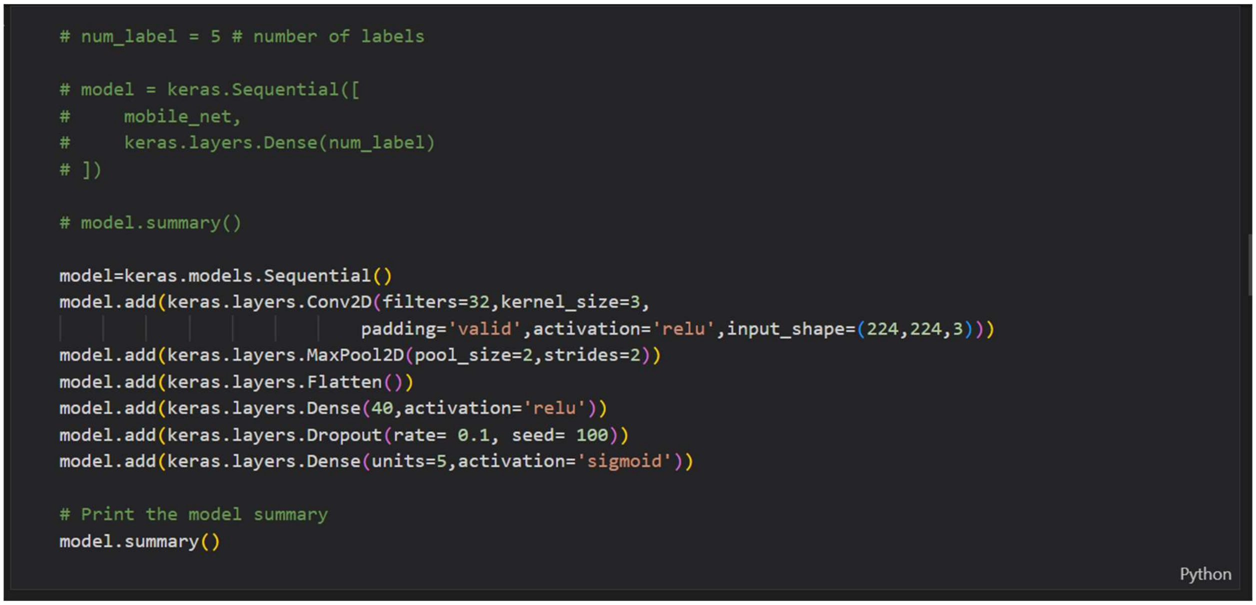
```
# Separating data into training, test and validation sets
X_train, X_test_val, y_train, y_test_val = train_test_split(X, y)
X_test, X_val, y_test, y_val = train_test_split(X_test_val, y_test_val)
```

Python

```
mobile_net = 'https://tfhub.dev/google/tf2-preview/mobilenet_v2/feature_vector/4' # MobileNetv4 link
mobile_net = hub.KerasLayer(
        mobile_net, input_shape=(224,224, 3), trainable=False) # Removing the last layer
```

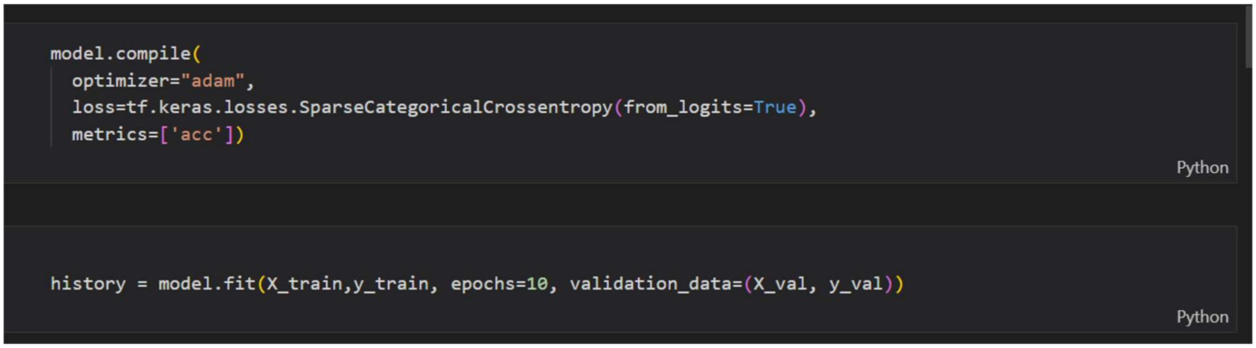
Python

```
WARNING:tensorflow:From C:\Users\91700\AppData\Roaming\Python\Python311\site-packages\tensorflow_hub\resolver.py:

WARNING:tensorflow:From C:\Users\91700\AppData\Roaming\Python\Python311\site-packages\tensorflow_hub\resolver.py:

WARNING:tensorflow:From C:\Users\91700\AppData\Roaming\Python\Python311\site-packages\tensorflow_hub\module_v2.py

WARNING:tensorflow:From C:\Users\91700\AppData\Roaming\Python\Python311\site-packages\tensorflow_hub\module_v2.py

WARNING:tensorflow:From C:\Users\91700\AppData\Roaming\Python\Python311\site-packages\tf_keras\src\backend.py:873
```



```
# num_label = 5 # number of labels

# model = keras.Sequential([
#     mobile_net,
#     keras.layers.Dense(num_label)
# ])

# model.summary()

model=keras.models.Sequential()
model.add(keras.layers.Conv2D(filters=32,kernel_size=3,
                            padding='valid',activation='relu',input_shape=(224,224,3)))
model.add(keras.layers.MaxPool2D(pool_size=2,strides=2))
model.add(keras.layers.Flatten())
model.add(keras.layers.Dense(40,activation='relu'))
model.add(keras.layers.Dropout(rate= 0.1, seed= 100))
model.add(keras.layers.Dense(units=5,activation='sigmoid'))

# Print the model summary
model.summary()
```

Python



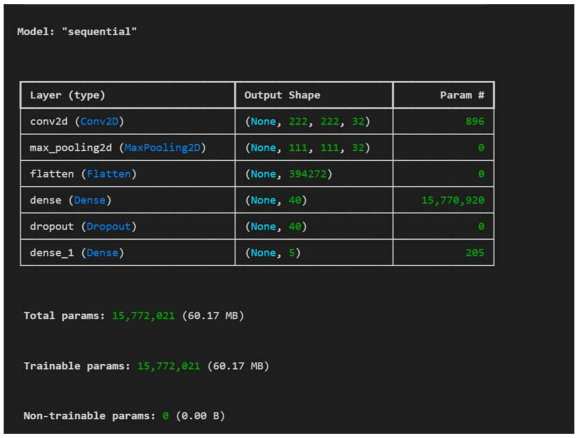
```
model.compile(
  optimizer="adam",
  loss=tf.keras.losses.SparseCategoricalCrossentropy(from_logits=True),
  metrics=['acc'])
```

Python

```
history = model.fit(X_train,y_train, epochs=10, validation_data=(X_val, y_val))
```

Python

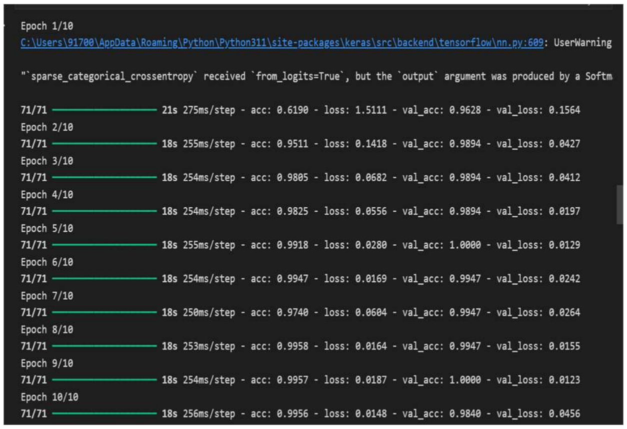
Model Validation and Evaluation Report (5 marks):

<table>
<tr><th>Model</th><th>Summary</th><th>Training and Validation Performance Metrics</th></tr>
<tr><td>CNN MODEL</td><td>
<pre>
Model: "sequential"

┌───────────────────────────────┬────────────────────────┬───────────┐
│ Layer (type)   │ Output Shape   │   Param # │
├───────────────────────────────┼────────────────────────┼───────────┤
│ conv2d (Conv2D)   │ (None, 222, 222, 32)   │   896 │
├───────────────────────────────┼────────────────────────┼───────────┤
│ max_pooling2d (MaxPooling2D) │ (None, 111, 111, 32)   │   0 │
├───────────────────────────────┼────────────────────────┼───────────┤
│ flatten (Flatten)   │ (None, 394272)   │   0 │
├───────────────────────────────┼────────────────────────┼───────────┤
│ dense (Dense)   │ (None, 40)   │15,770,920 │
├───────────────────────────────┼────────────────────────┼───────────┤
│ dropout (Dropout)   │ (None, 40)   │   0 │
├───────────────────────────────┼────────────────────────┼───────────┤
│ dense_1 (Dense)   │ (None, 5)   │   205 │
└───────────────────────────────┴────────────────────────┴───────────┘

 Total params: 15,772,021 (60.17 MB)

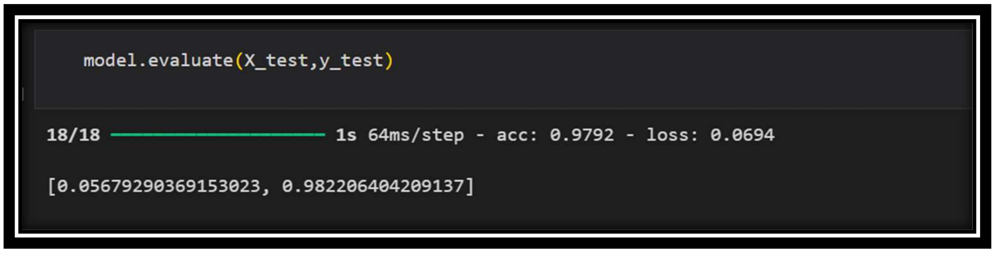
 Trainable params: 15,772,021 (60.17 MB)

 Non-trainable params: 0 (0.00 B)
</pre></td><td>
<pre>
Epoch 1/10
C:\Users\91700\AppData\Roaming\Python\Python311\site-packages\keras\src\backend\tensorflow\nn.py:609: UserWarning

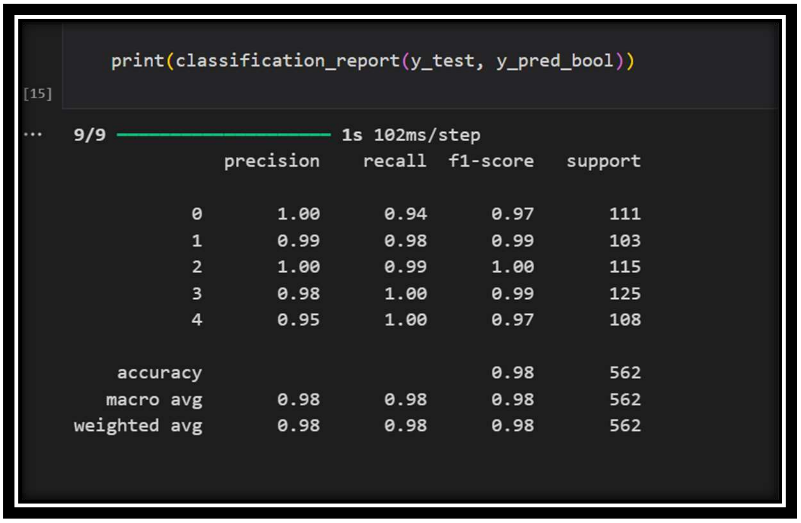
"`sparse_categorical_crossentropy` received `from_logits=True`, but the `output` argument was produced by a Softm

71/71 ━━━━━━━━━━━━━━━━━━━━ 21s 275ms/step - acc: 0.6190 - loss: 1.5111 - val_acc: 0.9628 - val_loss: 0.1564
Epoch 2/10
71/71 ━━━━━━━━━━━━━━━━━━━━ 18s 255ms/step - acc: 0.9511 - loss: 0.1418 - val_acc: 0.9894 - val_loss: 0.0427
Epoch 3/10
71/71 ━━━━━━━━━━━━━━━━━━━━ 18s 254ms/step - acc: 0.9805 - loss: 0.0682 - val_acc: 0.9894 - val_loss: 0.0412
Epoch 4/10
71/71 ━━━━━━━━━━━━━━━━━━━━ 18s 254ms/step - acc: 0.9825 - loss: 0.0556 - val_acc: 0.9894 - val_loss: 0.0197
Epoch 5/10
71/71 ━━━━━━━━━━━━━━━━━━━━ 18s 255ms/step - acc: 0.9918 - loss: 0.0280 - val_acc: 1.0000 - val_loss: 0.0129
Epoch 6/10
71/71 ━━━━━━━━━━━━━━━━━━━━ 18s 254ms/step - acc: 0.9947 - loss: 0.0169 - val_acc: 0.9947 - val_loss: 0.0242
Epoch 7/10
71/71 ━━━━━━━━━━━━━━━━━━━━ 18s 250ms/step - acc: 0.9740 - loss: 0.0604 - val_acc: 0.9947 - val_loss: 0.0264
Epoch 8/10
71/71 ━━━━━━━━━━━━━━━━━━━━ 18s 253ms/step - acc: 0.9958 - loss: 0.0164 - val_acc: 0.9947 - val_loss: 0.0155
Epoch 9/10
71/71 ━━━━━━━━━━━━━━━━━━━━ 18s 254ms/step - acc: 0.9957 - loss: 0.0187 - val_acc: 1.0000 - val_loss: 0.0123
Epoch 10/10
71/71 ━━━━━━━━━━━━━━━━━━━━ 18s 256ms/step - acc: 0.9956 - loss: 0.0148 - val_acc: 0.9840 - val_loss: 0.0456
</pre></td></tr>
</table>

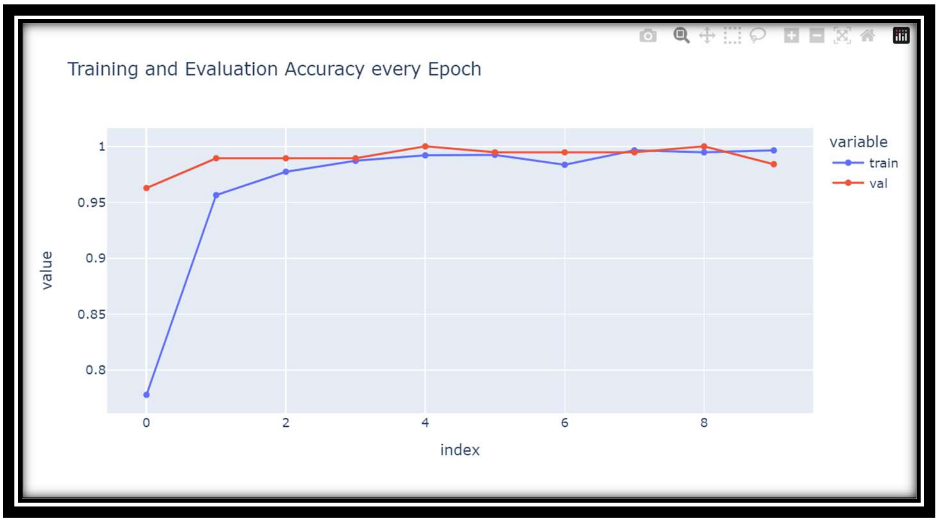
Training and Validation Performance Metrics



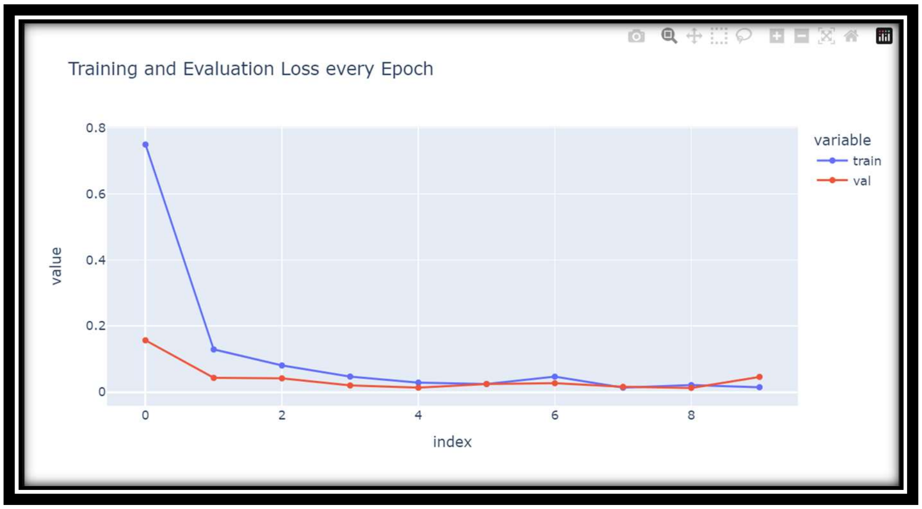
```
model.evaluate(X_test,y_test)

18/18 ━━━━━━━━━━━━━━━━━━━━ 1s 64ms/step - acc: 0.9792 - loss: 0.0694

[0.05679290369153023, 0.982206404209137]
```



```
print(classification_report(y_test, y_pred_bool))
[15]

... 9/9 ━━━━━━━━━━━━━━━━━━━━ 1s 102ms/step
              precision    recall  f1-score   support

           0       1.00      0.94      0.97       111
           1       0.99      0.98      0.99       103
           2       1.00      0.99      1.00       115
           3       0.98      1.00      0.99       125
           4       0.95      1.00      0.97       108

    accuracy                           0.98       562
   macro avg       0.98      0.98      0.98       562
weighted avg       0.98      0.98      0.98       562
```



Training and Evaluation Accuracy every Epoch


Training and Evaluation Loss every Epoch
0.8
0.6
0.4
0.2
0
value
0
2
4
6
8
index
variable
train
val