RPS CNN Training

March 28, 2021

[1]:
```python
from os import getcwd, listdir
import numpy as np
import tensorflow as tf
from tensorflow.keras.preprocessing.image import ImageDataGenerator
from tensorflow.keras import datasets, layers, models
from tensorflow.keras.models import load_model
from tensorflow.keras.utils import plot_model
from tensorflow.keras.preprocessing import image
import matplotlib.pyplot as plt
from sklearn.metrics import classification_report, confusion_matrix
```

[2]:
```python
DATASET = getcwd() + "/dataset/rps-cv-images/"
CLASSES = 3
IMG_WIDTH = 300
IMG_HEIGHT = 200
BATCH_SIZE = 16
NB_TRAIN_SAMPLES = 1751
NB_VALIDATION_SAMPLES = 437
EPOCHS = 50
```

[3]:
```python
DATASET
```

[3]:
```
'/home/amogh/Documents/Study/PiRockPaperScissors/notebooks/dataset/rps-cv-
images/'
```

[37]:
```python
train_datagen = ImageDataGenerator(
    rescale=1.0 / 255,
    shear_range=0.2,
    zoom_range=0.2,
    horizontal_flip=True,
    validation_split=0.2,
)

test_datagen = ImageDataGenerator(rescale=1.0 / 255, validation_split=0.2)

train_generator = train_datagen.flow_from_directory(
    DATASET,
    target_size=(IMG_WIDTH, IMG_HEIGHT),
```

```
    batch_size=BATCH_SIZE,
    class_mode="categorical",
    subset="training",
)

validation_generator = test_datagen.flow_from_directory(
    DATASET,
    target_size=(IMG_WIDTH, IMG_HEIGHT),
    batch_size=BATCH_SIZE,
    class_mode="categorical",
    subset="validation",
    shuffle=False
)
```

```
Found 1751 images belonging to 3 classes.
Found 437 images belonging to 3 classes.
```

[5]:

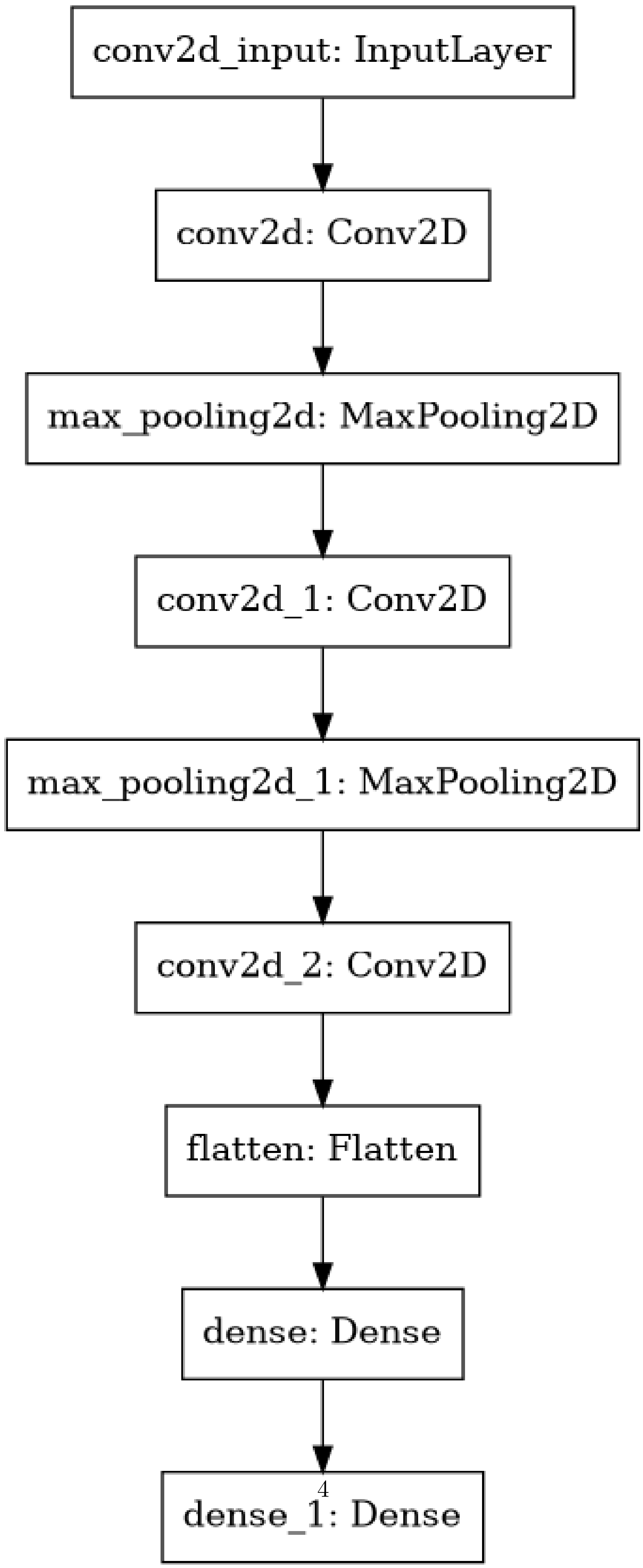
```
model = models.Sequential()
model.add(
    layers.Conv2D(32, (3, 3), activation="relu", input_shape=(IMG_WIDTH,␣
 ↪IMG_HEIGHT, 3))
)
model.add(layers.MaxPooling2D((2, 2)))
model.add(layers.Conv2D(64, (3, 3), activation="relu"))
model.add(layers.MaxPooling2D((2, 2)))
model.add(layers.Conv2D(64, (3, 3), activation="relu"))
model.add(layers.Flatten())
model.add(layers.Dense(512, activation="relu"))
model.add(layers.Dense(CLASSES, activation="softmax"))
model.summary()
```

```
Model: "sequential"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
conv2d (Conv2D)              (None, 298, 198, 32)      896
_________________________________________________________________
max_pooling2d (MaxPooling2D) (None, 149, 99, 32)       0
_________________________________________________________________
conv2d_1 (Conv2D)            (None, 147, 97, 64)       18496
_________________________________________________________________
max_pooling2d_1 (MaxPooling2 (None, 73, 48, 64)        0
_________________________________________________________________
conv2d_2 (Conv2D)            (None, 71, 46, 64)        36928
_________________________________________________________________
flatten (Flatten)            (None, 209024)            0
_________________________________________________________________
dense (Dense)                (None, 512)               107020800
```

```
_________________________________________________________________
dense_1 (Dense)              (None, 3)                 1539
=================================================================
Total params: 107,078,659
Trainable params: 107,078,659
Non-trainable params: 0
_________________________________________________________________
```

[6]:
```
plot_model(model)
```

[6]:


conv2d_input: InputLayer
conv2d: Conv2D
max_pooling2d: MaxPooling2D
conv2d_1: Conv2D
max_pooling2d_1: MaxPooling2D
conv2d_2: Conv2D
flatten: Flatten
dense: Dense
dense_1: Dense

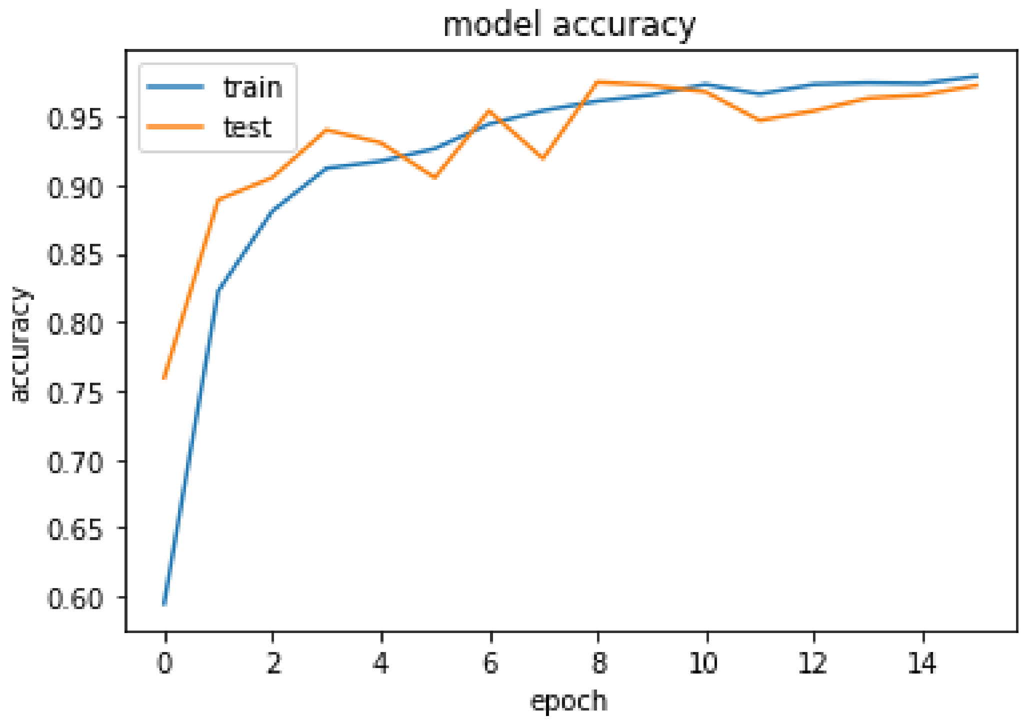
[7]:
```
earlystop = tf.keras.callbacks.EarlyStopping(
    monitor="val_loss", min_delta=0, patience=5, verbose=1,␣
 ↪restore_best_weights=True
)

callbacks = [earlystop]

model.compile(
    optimizer="adam",
    loss=tf.keras.losses.CategoricalCrossentropy(),
    metrics=["accuracy"],
)

history = model.fit(
    train_generator,
    steps_per_epoch=NB_TRAIN_SAMPLES // BATCH_SIZE,
    epochs=EPOCHS,
    callbacks=callbacks,
    validation_data=validation_generator,
    validation_steps=NB_VALIDATION_SAMPLES // BATCH_SIZE,
)
```

```
Epoch 1/50
109/109 [==============================] - 19s 173ms/step - loss: 1.0308 -
accuracy: 0.5948 - val_loss: 0.6890 - val_accuracy: 0.7593
Epoch 2/50
109/109 [==============================] - 17s 159ms/step - loss: 0.4613 -
accuracy: 0.8225 - val_loss: 0.3221 - val_accuracy: 0.8889
Epoch 3/50
109/109 [==============================] - 17s 157ms/step - loss: 0.3131 -
accuracy: 0.8807 - val_loss: 0.2772 - val_accuracy: 0.9051
Epoch 4/50
109/109 [==============================] - 17s 156ms/step - loss: 0.2557 -
accuracy: 0.9118 - val_loss: 0.2102 - val_accuracy: 0.9398
Epoch 5/50
109/109 [==============================] - 17s 155ms/step - loss: 0.2179 -
accuracy: 0.9170 - val_loss: 0.2233 - val_accuracy: 0.9306
Epoch 6/50
109/109 [==============================] - 17s 154ms/step - loss: 0.2050 -
accuracy: 0.9262 - val_loss: 0.2498 - val_accuracy: 0.9051
Epoch 7/50
109/109 [==============================] - 17s 154ms/step - loss: 0.1545 -
accuracy: 0.9441 - val_loss: 0.1428 - val_accuracy: 0.9537
Epoch 8/50
109/109 [==============================] - 17s 154ms/step - loss: 0.1335 -
```

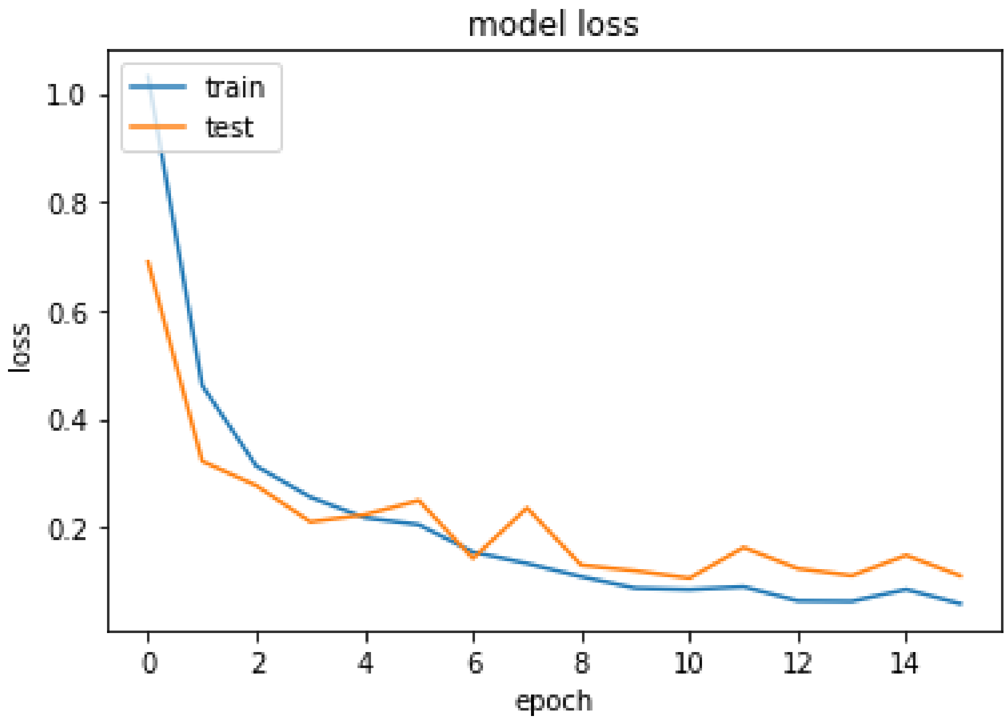
```
accuracy: 0.9539 - val_loss: 0.2359 - val_accuracy: 0.9190
Epoch 9/50
109/109 [==============================] - 17s 155ms/step - loss: 0.1091 -
accuracy: 0.9608 - val_loss: 0.1305 - val_accuracy: 0.9745
Epoch 10/50
109/109 [==============================] - 17s 155ms/step - loss: 0.0879 -
accuracy: 0.9654 - val_loss: 0.1198 - val_accuracy: 0.9722
Epoch 11/50
109/109 [==============================] - 17s 157ms/step - loss: 0.0853 -
accuracy: 0.9729 - val_loss: 0.1064 - val_accuracy: 0.9676
Epoch 12/50
109/109 [==============================] - 17s 153ms/step - loss: 0.0905 -
accuracy: 0.9660 - val_loss: 0.1630 - val_accuracy: 0.9468
Epoch 13/50
109/109 [==============================] - 17s 155ms/step - loss: 0.0646 -
accuracy: 0.9729 - val_loss: 0.1241 - val_accuracy: 0.9537
Epoch 14/50
109/109 [==============================] - 17s 153ms/step - loss: 0.0637 -
accuracy: 0.9741 - val_loss: 0.1110 - val_accuracy: 0.9630
Epoch 15/50
109/109 [==============================] - 17s 153ms/step - loss: 0.0856 -
accuracy: 0.9735 - val_loss: 0.1486 - val_accuracy: 0.9653
Epoch 16/50
109/109 [==============================] - ETA: 0s - loss: 0.0593 - accuracy:
0.9787Restoring model weights from the end of the best epoch.
109/109 [==============================] - 17s 156ms/step - loss: 0.0593 -
accuracy: 0.9787 - val_loss: 0.1108 - val_accuracy: 0.9722
Epoch 00016: early stopping
```

[8]:

```
plt.plot(history.history["accuracy"])
plt.plot(history.history["val_accuracy"])
plt.title("model accuracy")
plt.ylabel("accuracy")
plt.xlabel("epoch")
plt.legend(["train", "test"], loc="upper left")
plt.show()
```



[9]:
```
plt.plot(history.history["loss"])
plt.plot(history.history["val_loss"])
plt.title("model loss")
plt.ylabel("loss")
plt.xlabel("epoch")
plt.legend(["train", "test"], loc="upper left")
plt.show()
```



[10]:
```
model.save("rps-cnn.h5")
```

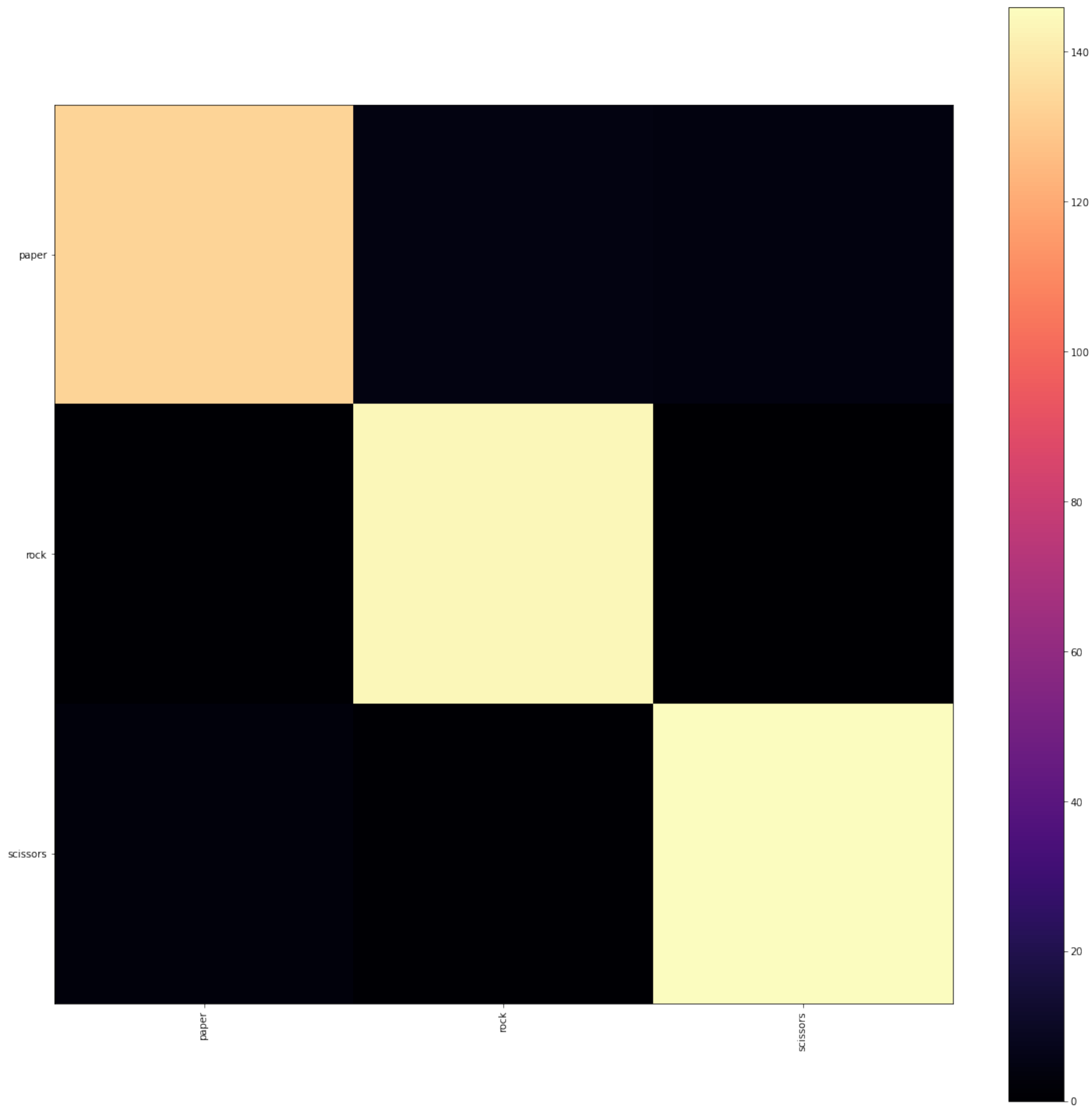
[11]:
```
model.save_weights("rps-cnn-weights.h5")
```

[13]:
```
loaded_model = load_model(getcwd() + "/rps-cnn.h5")
```

[38]:
```
Y_pred = loaded_model.predict_generator(
    validation_generator, NB_VALIDATION_SAMPLES // BATCH_SIZE + 1
)
y_pred = np.argmax(Y_pred, axis=1)

class_labels = {v: k for k, v in validation_generator.class_indices.items()}

print("Confusion Matrix")
print(confusion_matrix(validation_generator.classes, y_pred))

print("Classification Report")
target_names = list(class_labels.values())
print(
    classification_report(
        validation_generator.classes, y_pred, target_names=target_names
    )
)
```

```
Confusion Matrix
[[133   5   4]
 [  1 144   0]
 [  3   1 146]]
Classification Report
              precision    recall  f1-score   support

       paper       0.97      0.94      0.95       142
        rock       0.96      0.99      0.98       145
    scissors       0.97      0.97      0.97       150

    accuracy                           0.97       437
   macro avg       0.97      0.97      0.97       437
weighted avg       0.97      0.97      0.97       437
```

[39]:
```
plt.figure(figsize=(20,20))
cnf_matrix = confusion_matrix(validation_generator.classes, y_pred)
plt.imshow(cnf_matrix, interpolation='nearest', cmap = "magma")
plt.colorbar()

classes = list(class_labels.values())

tick_marks = np.arange(len(classes))
_ = plt.xticks(tick_marks, classes, rotation=90)
_ = plt.yticks(tick_marks, classes)
```



[36]:

```
path = DATASET

fig = plt.figure(figsize=(20, 8))


def predictedLabelColor(original, predicted):
    if original == predicted:
        return "green"
    else:
        return "red"
```

```python
for i in range(50):
    rps_names = listdir(path)
    rps_names_folders = listdir(path)
    random_rps_index = np.random.randint(0, len(rps_names))
    rps_name = rps_names_folders[random_rps_index]

    rps_images_path = path + "/" + rps_name
    rps_images = listdir(rps_images_path)
    random_rps_image_index = np.random.randint(0, len(rps_images))
    rps_image = rps_images[random_rps_image_index]
    rps_image_path = rps_images_path + "/" + rps_image

    result_image_array = image.img_to_array(
        image.load_img(rps_image_path, target_size=(IMG_WIDTH, IMG_HEIGHT))
    )
    normalized_result = result_image_array * 1.0 / 255
    expanded_result = np.expand_dims(normalized_result, axis=0)
    classes = loaded_model.predict_classes(expanded_result, batch_size=10)
    predicted_label = class_labels[classes[0]]

    ax = fig.add_subplot(5, 10, 1 + i, xticks=[], yticks=[])
    ax.set_title(
        "Predicted: {}".format(predicted_label),
        color=predictedLabelColor(rps_name, predicted_label),
    )
    plt.imshow(normalized_result)

plt.show()
```