Assignment - 7

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Video link : https://drive.google.com/drive/my-drive

GitHub link : https://github.com/NavyaBonthu/ICP7

1. Follow the instruction below and then report how the performance changed.(apply all at once)

• Convolutional input layer, 32 feature maps with a size of 3×3 and a rectifier activation function.

• Dropout layer at 20%.

• Convolutional layer, 32 feature maps with a size of 3×3 and a rectifier activation function.

• Max Pool layer with size 2×2.

• Convolutional layer, 64 feature maps with a size of 3×3 and a rectifier activation function.

• Dropout layer at 20%.

• Convolutional layer, 64 feature maps with a size of 3×3 and a rectifier activation function.

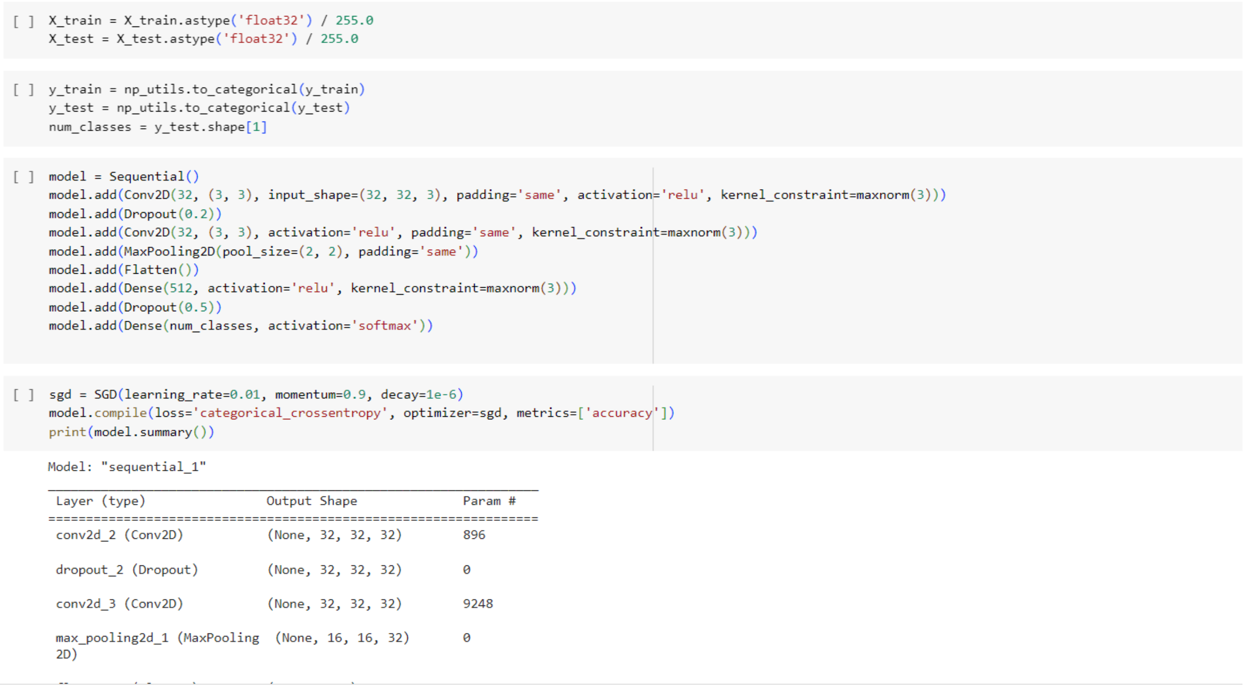
• Max Pool layer with size 2×2.

• Convolutional layer, 128 feature maps with a size of 3×3 and a rectifier activation function.

• Dropout layer at 20%.

- Convolutional layer,128 feature maps with a size of 3×3 and a rectifier activation function.
- Max Pool layer with size 2×2.
- Flatten layer.
- Dropout layer at 20%.
- Fully connected layer with 1024 units and a rectifier activation function.
- Dropout layer at 20%.
- Fully connected layer with 512 units and a rectifier activation function.
- Dropout layer at 20%.
- Fully connected output layer with 10 units and a Softmax activation function

Did the performance change?



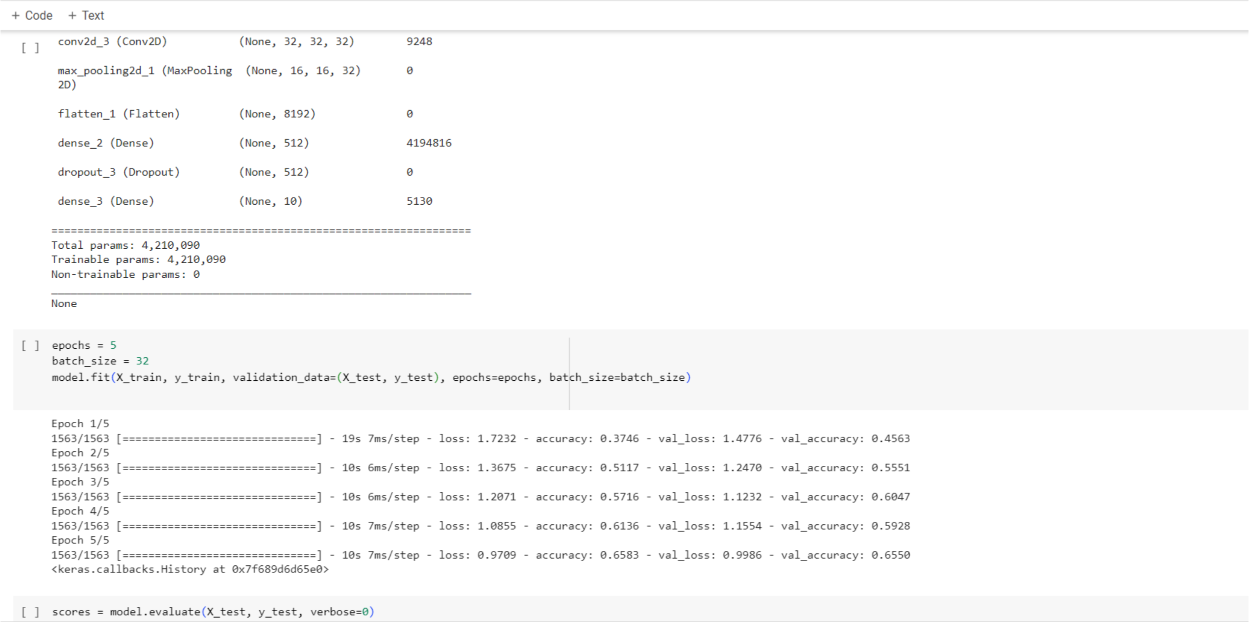
```
[ ] X_train = X_train.astype('float32') / 255.0
    X_test = X_test.astype('float32') / 255.0
```

```
[ ] y_train = np_utils.to_categorical(y_train)
    y_test = np_utils.to_categorical(y_test)
    num_classes = y_test.shape[1]
```

```
[ ] model = Sequential()
    model.add(Conv2D(32, (3, 3), input_shape=(32, 32, 3), padding='same', activation='relu', kernel_constraint=maxnorm(3)))
    model.add(Dropout(0.2))
    model.add(Conv2D(32, (3, 3), activation='relu', padding='same', kernel_constraint=maxnorm(3)))
    model.add(MaxPooling2D(pool_size=(2, 2), padding='same'))
    model.add(Flatten())
    model.add(Dense(512, activation='relu', kernel_constraint=maxnorm(3)))
    model.add(Dropout(0.5))
    model.add(Dense(num_classes, activation='softmax'))
```

```
[ ] sgd = SGD(learning_rate=0.01, momentum=0.9, decay=1e-6)
    model.compile(loss='categorical_crossentropy', optimizer=sgd, metrics=['accuracy'])
    print(model.summary())
```

```
Model: "sequential_1"
_________________________________________________________________
 Layer (type)                Output Shape              Param #
=================================================================
 conv2d_2 (Conv2D)           (None, 32, 32, 32)        896

 dropout_2 (Dropout)         (None, 32, 32, 32)        0

 conv2d_3 (Conv2D)           (None, 32, 32, 32)        9248

 max_pooling2d_1 (MaxPooling  (None, 16, 16, 32)       0
 2D)
```

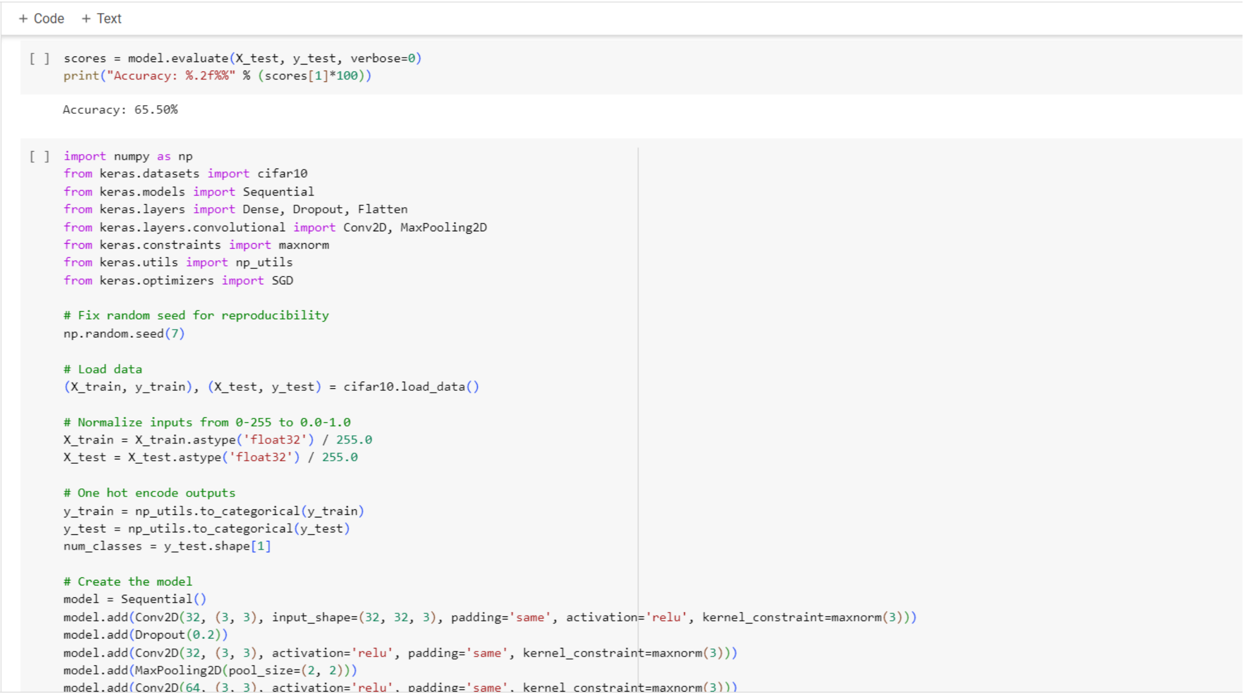


```
[ ]  conv2d_3 (Conv2D)           (None, 32, 32, 32)        9248

     max_pooling2d_1 (MaxPooling  (None, 16, 16, 32)       0
     2D)

     flatten_1 (Flatten)         (None, 8192)              0

     dense_2 (Dense)             (None, 512)               4194816

     dropout_3 (Dropout)         (None, 512)               0

     dense_3 (Dense)             (None, 10)                5130

    =================================================================
    Total params: 4,210,090
    Trainable params: 4,210,090
    Non-trainable params: 0
    _________________________________________________________________
    None
```

```
[ ] epochs = 5
    batch_size = 32
    model.fit(X_train, y_train, validation_data=(X_test, y_test), epochs=epochs, batch_size=batch_size)
```

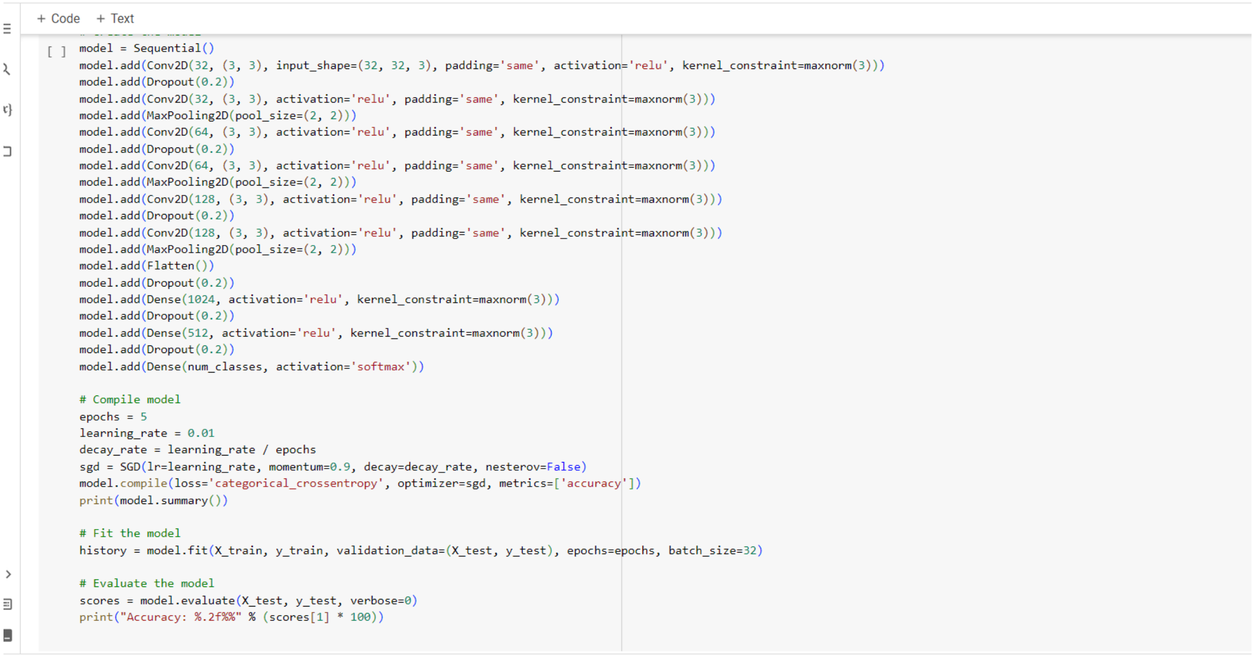
```
    Epoch 1/5
    1563/1563 [==============================] - 19s 7ms/step - loss: 1.7232 - accuracy: 0.3746 - val_loss: 1.4776 - val_accuracy: 0.4563
    Epoch 2/5
    1563/1563 [==============================] - 10s 6ms/step - loss: 1.3675 - accuracy: 0.5117 - val_loss: 1.2470 - val_accuracy: 0.5551
    Epoch 3/5
    1563/1563 [==============================] - 10s 6ms/step - loss: 1.2071 - accuracy: 0.5716 - val_loss: 1.1232 - val_accuracy: 0.6047
    Epoch 4/5
    1563/1563 [==============================] - 10s 7ms/step - loss: 1.0855 - accuracy: 0.6136 - val_loss: 1.1554 - val_accuracy: 0.5928
    Epoch 5/5
    1563/1563 [==============================] - 10s 7ms/step - loss: 0.9709 - accuracy: 0.6583 - val_loss: 0.9986 - val_accuracy: 0.6550
    <keras.callbacks.History at 0x7f689d6d65e0>
```

```
[ ] scores = model.evaluate(X_test, y_test, verbose=0)
```



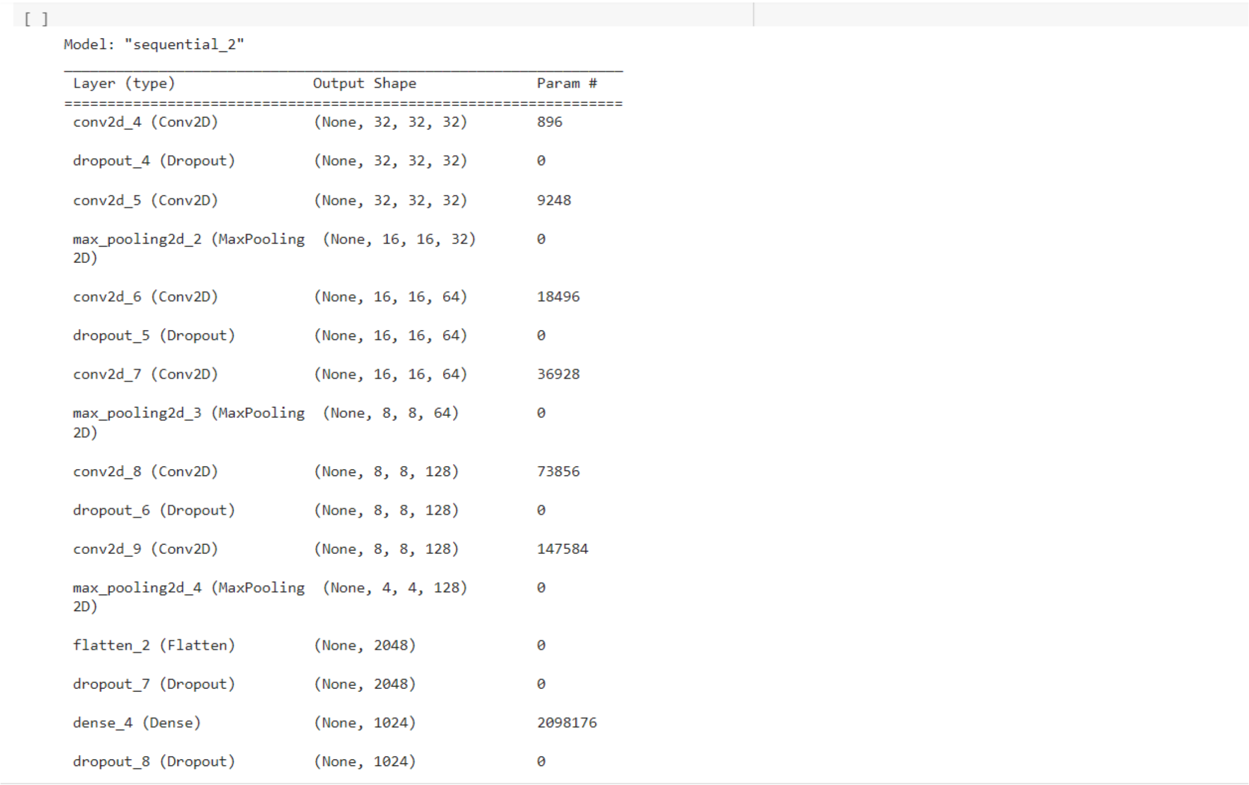
```
[ ] scores = model.evaluate(X_test, y_test, verbose=0)
    print("Accuracy: %.2f%%" % (scores[1]*100))

    Accuracy: 65.50%
```

```
[ ] import numpy as np
    from keras.datasets import cifar10
    from keras.models import Sequential
    from keras.layers import Dense, Dropout, Flatten
    from keras.layers.convolutional import Conv2D, MaxPooling2D
    from keras.constraints import maxnorm
    from keras.utils import np_utils
    from keras.optimizers import SGD

    # Fix random seed for reproducibility
    np.random.seed(7)

    # Load data
    (X_train, y_train), (X_test, y_test) = cifar10.load_data()

    # Normalize inputs from 0-255 to 0.0-1.0
    X_train = X_train.astype('float32') / 255.0
    X_test = X_test.astype('float32') / 255.0

    # One hot encode outputs
    y_train = np_utils.to_categorical(y_train)
    y_test = np_utils.to_categorical(y_test)
    num_classes = y_test.shape[1]

    # Create the model
    model = Sequential()
    model.add(Conv2D(32, (3, 3), input_shape=(32, 32, 3), padding='same', activation='relu', kernel_constraint=maxnorm(3)))
    model.add(Dropout(0.2))
    model.add(Conv2D(32, (3, 3), activation='relu', padding='same', kernel_constraint=maxnorm(3)))
    model.add(MaxPooling2D(pool_size=(2, 2)))
    model.add(Conv2D(64, (3, 3), activation='relu', padding='same', kernel_constraint=maxnorm(3)))
```

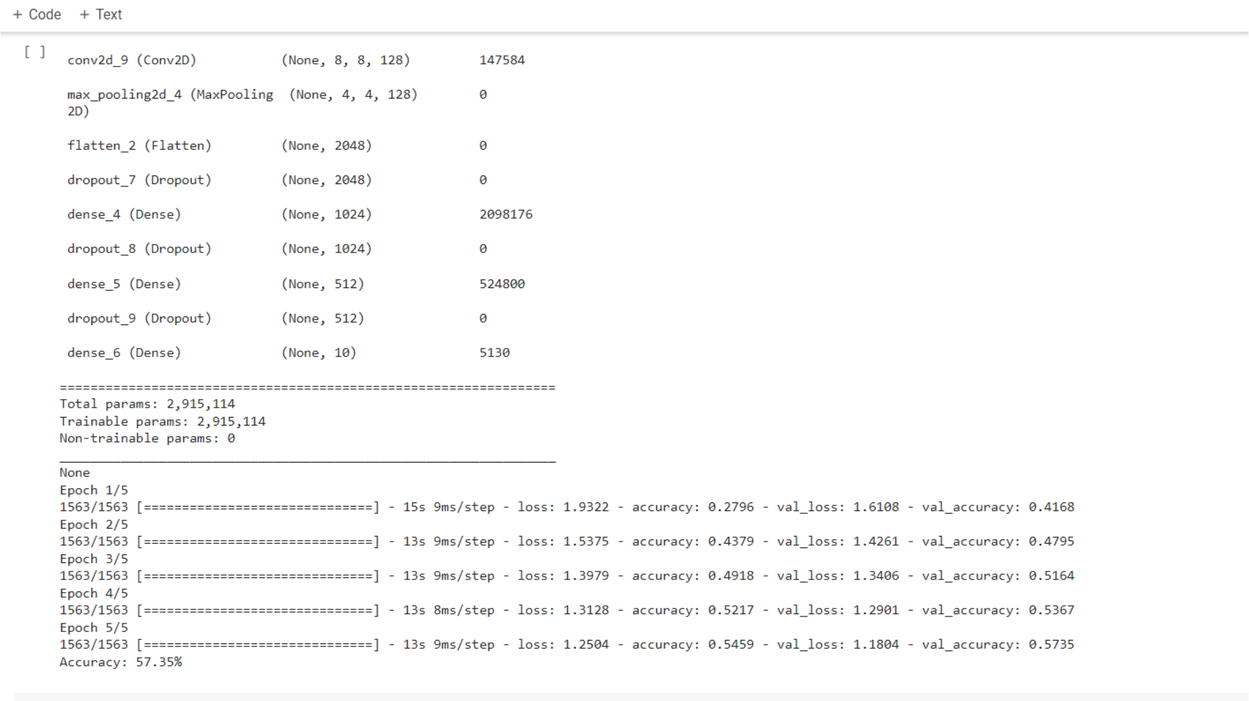


```
[ ] model = Sequential()
    model.add(Conv2D(32, (3, 3), input_shape=(32, 32, 3), padding='same', activation='relu', kernel_constraint=maxnorm(3)))
    model.add(Dropout(0.2))
    model.add(Conv2D(32, (3, 3), activation='relu', padding='same', kernel_constraint=maxnorm(3)))
    model.add(MaxPooling2D(pool_size=(2, 2)))
    model.add(Conv2D(64, (3, 3), activation='relu', padding='same', kernel_constraint=maxnorm(3)))
    model.add(Dropout(0.2))
    model.add(Conv2D(64, (3, 3), activation='relu', padding='same', kernel_constraint=maxnorm(3)))
    model.add(MaxPooling2D(pool_size=(2, 2)))
    model.add(Conv2D(128, (3, 3), activation='relu', padding='same', kernel_constraint=maxnorm(3)))
    model.add(Dropout(0.2))
    model.add(Conv2D(128, (3, 3), activation='relu', padding='same', kernel_constraint=maxnorm(3)))
    model.add(MaxPooling2D(pool_size=(2, 2)))
    model.add(Flatten())
    model.add(Dropout(0.2))
    model.add(Dense(1024, activation='relu', kernel_constraint=maxnorm(3)))
    model.add(Dropout(0.2))
    model.add(Dense(512, activation='relu', kernel_constraint=maxnorm(3)))
    model.add(Dropout(0.2))
    model.add(Dense(num_classes, activation='softmax'))

    # Compile model
    epochs = 5
    learning_rate = 0.01
    decay_rate = learning_rate / epochs
    sgd = SGD(lr=learning_rate, momentum=0.9, decay=decay_rate, nesterov=False)
    model.compile(loss='categorical_crossentropy', optimizer=sgd, metrics=['accuracy'])
    print(model.summary())

    # Fit the model
    history = model.fit(X_train, y_train, validation_data=(X_test, y_test), epochs=epochs, batch_size=32)

    # Evaluate the model
    scores = model.evaluate(X_test, y_test, verbose=0)
    print("Accuracy: %.2f%%" % (scores[1] * 100))
```

Output:



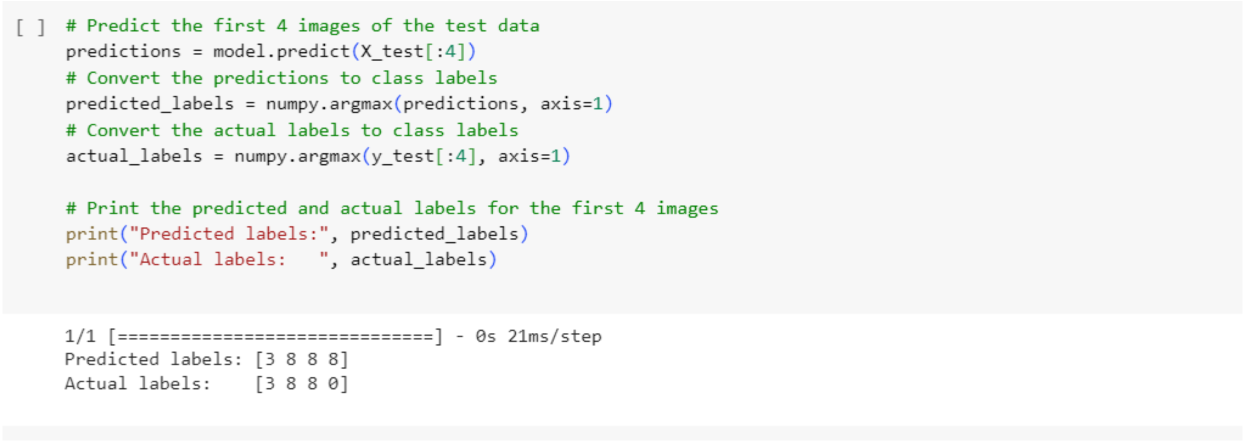
```
[ ]
  Model: "sequential_2"
  _________________________________________________________________
   Layer (type)                Output Shape              Param #
  =================================================================
   conv2d_4 (Conv2D)           (None, 32, 32, 32)        896

   dropout_4 (Dropout)         (None, 32, 32, 32)        0

   conv2d_5 (Conv2D)           (None, 32, 32, 32)        9248

   max_pooling2d_2 (MaxPooling  (None, 16, 16, 32)       0
   2D)

   conv2d_6 (Conv2D)           (None, 16, 16, 64)        18496

   dropout_5 (Dropout)         (None, 16, 16, 64)        0

   conv2d_7 (Conv2D)           (None, 16, 16, 64)        36928

   max_pooling2d_3 (MaxPooling  (None, 8, 8, 64)         0
   2D)

   conv2d_8 (Conv2D)           (None, 8, 8, 128)         73856

   dropout_6 (Dropout)         (None, 8, 8, 128)         0

   conv2d_9 (Conv2D)           (None, 8, 8, 128)         147584

   max_pooling2d_4 (MaxPooling  (None, 4, 4, 128)        0
   2D)

   flatten_2 (Flatten)         (None, 2048)              0

   dropout_7 (Dropout)         (None, 2048)              0

   dense_4 (Dense)             (None, 1024)              2098176

   dropout_8 (Dropout)         (None, 1024)              0
```



```
[ ]  conv2d_9 (Conv2D)           (None, 8, 8, 128)         147584

     max_pooling2d_4 (MaxPooling  (None, 4, 4, 128)        0
     2D)

     flatten_2 (Flatten)         (None, 2048)              0

     dropout_7 (Dropout)         (None, 2048)              0

     dense_4 (Dense)             (None, 1024)              2098176

     dropout_8 (Dropout)         (None, 1024)              0

     dense_5 (Dense)             (None, 512)               524800

     dropout_9 (Dropout)         (None, 512)               0

     dense_6 (Dense)             (None, 10)                5130

    =================================================================
    Total params: 2,915,114
    Trainable params: 2,915,114
    Non-trainable params: 0
    _________________________________________________________________
    None
    Epoch 1/5
    1563/1563 [==============================] - 15s 9ms/step - loss: 1.9322 - accuracy: 0.2796 - val_loss: 1.6108 - val_accuracy: 0.4168
    Epoch 2/5
    1563/1563 [==============================] - 13s 9ms/step - loss: 1.5375 - accuracy: 0.4379 - val_loss: 1.4261 - val_accuracy: 0.4795
    Epoch 3/5
    1563/1563 [==============================] - 13s 9ms/step - loss: 1.3979 - accuracy: 0.4918 - val_loss: 1.3406 - val_accuracy: 0.5164
    Epoch 4/5
    1563/1563 [==============================] - 13s 8ms/step - loss: 1.3128 - accuracy: 0.5217 - val_loss: 1.2901 - val_accuracy: 0.5367
    Epoch 5/5
    1563/1563 [==============================] - 13s 9ms/step - loss: 1.2504 - accuracy: 0.5459 - val_loss: 1.1804 - val_accuracy: 0.5735
    Accuracy: 57.35%
```

2. Predict the first 4 images of the test data using the above model. Then, compare with the actual label for those 4

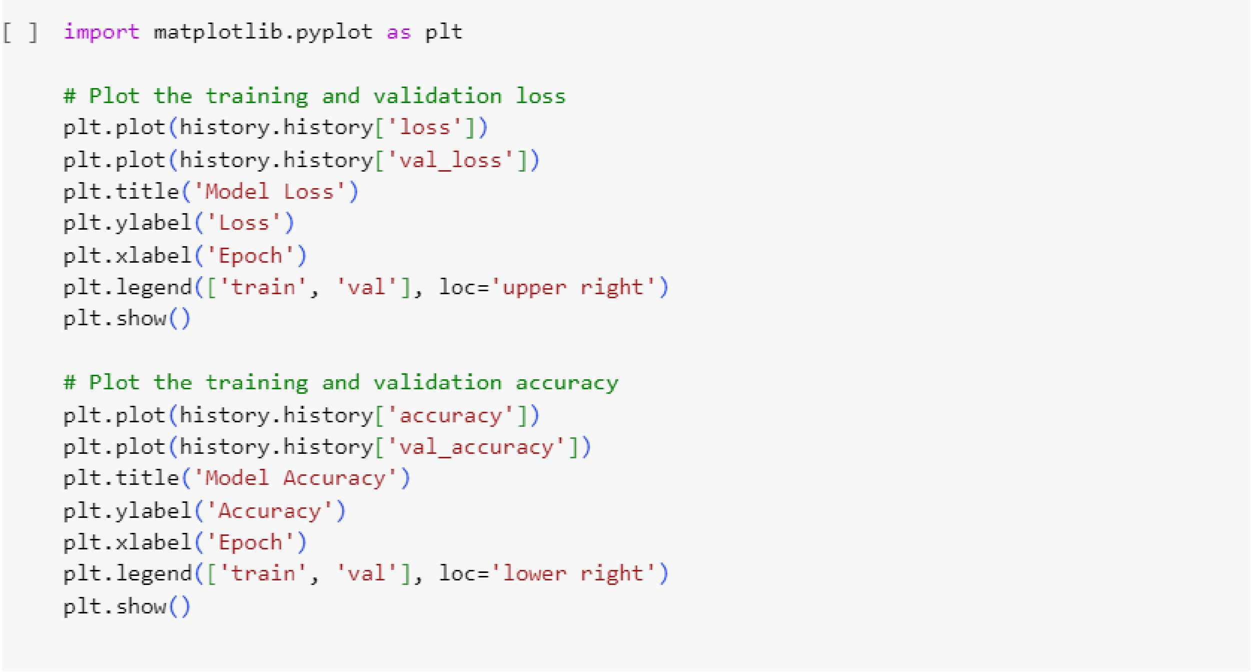
images to check whether or not the model has predicted correctly.



```
[ ]  # Predict the first 4 images of the test data
     predictions = model.predict(X_test[:4])
     # Convert the predictions to class labels
     predicted_labels = numpy.argmax(predictions, axis=1)
     # Convert the actual labels to class labels
     actual_labels = numpy.argmax(y_test[:4], axis=1)

     # Print the predicted and actual labels for the first 4 images
     print("Predicted labels:", predicted_labels)
     print("Actual labels:    ", actual_labels)
```

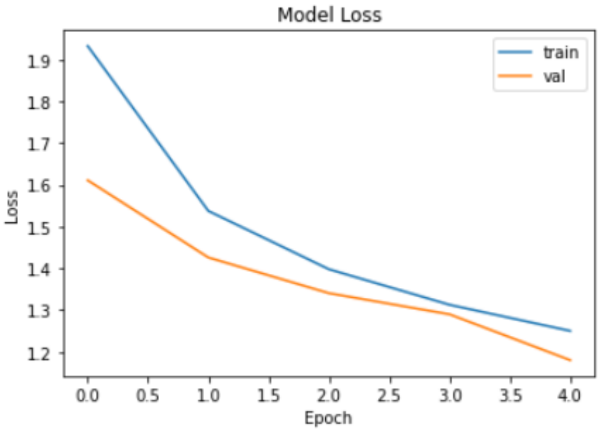
```
     1/1 [==============================] - 0s 21ms/step
     Predicted labels: [3 8 8 8]
     Actual labels:    [3 8 8 0]
```

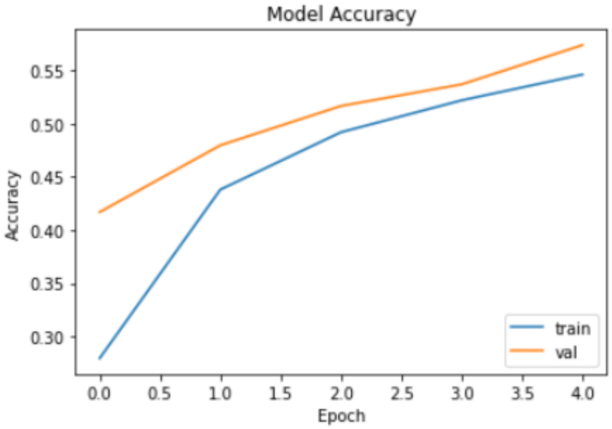
3. Visualize Loss and Accuracy using the history object



```
import matplotlib.pyplot as plt

# Plot the training and validation loss
plt.plot(history.history['loss'])
plt.plot(history.history['val_loss'])
plt.title('Model Loss')
plt.ylabel('Loss')
plt.xlabel('Epoch')
plt.legend(['train', 'val'], loc='upper right')
plt.show()

# Plot the training and validation accuracy
plt.plot(history.history['accuracy'])
plt.plot(history.history['val_accuracy'])
plt.title('Model Accuracy')
plt.ylabel('Accuracy')
plt.xlabel('Epoch')
plt.legend(['train', 'val'], loc='lower right')
plt.show()
```

Output:


Model Loss
train
val
Loss
1.9
1.8
1.7
1.6
1.5
1.4
1.3
1.2
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
Epoch


Model Accuracy
Accuracy
0.55
0.50
0.45
0.40
0.35
0.30
train
val
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
Epoch