Neural Networks & Deep Learning

Assignment – 4

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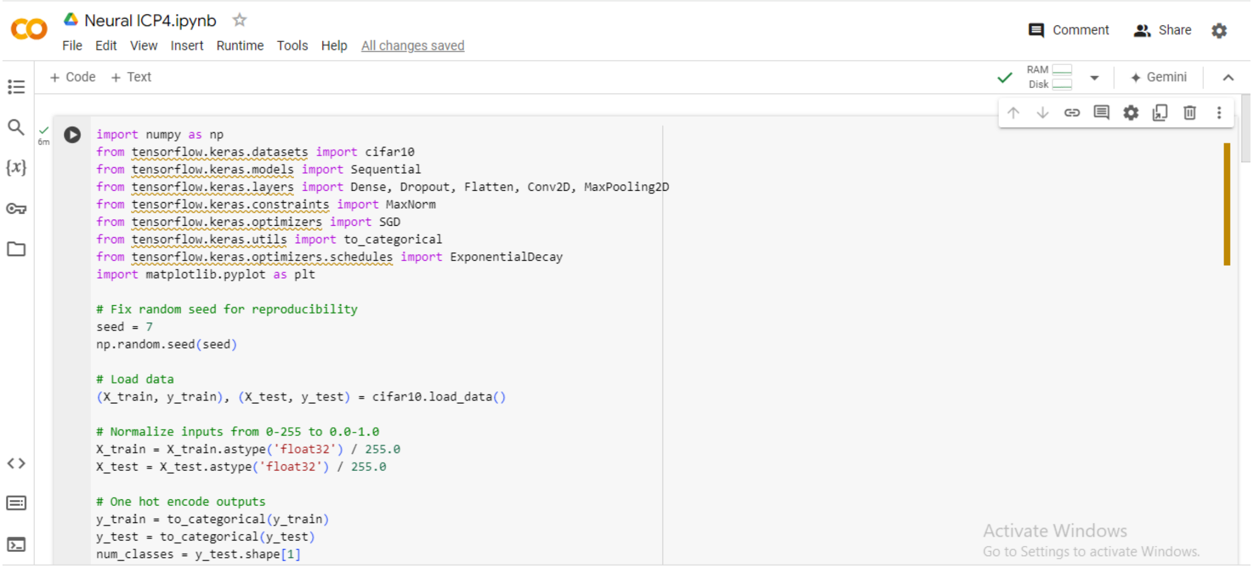
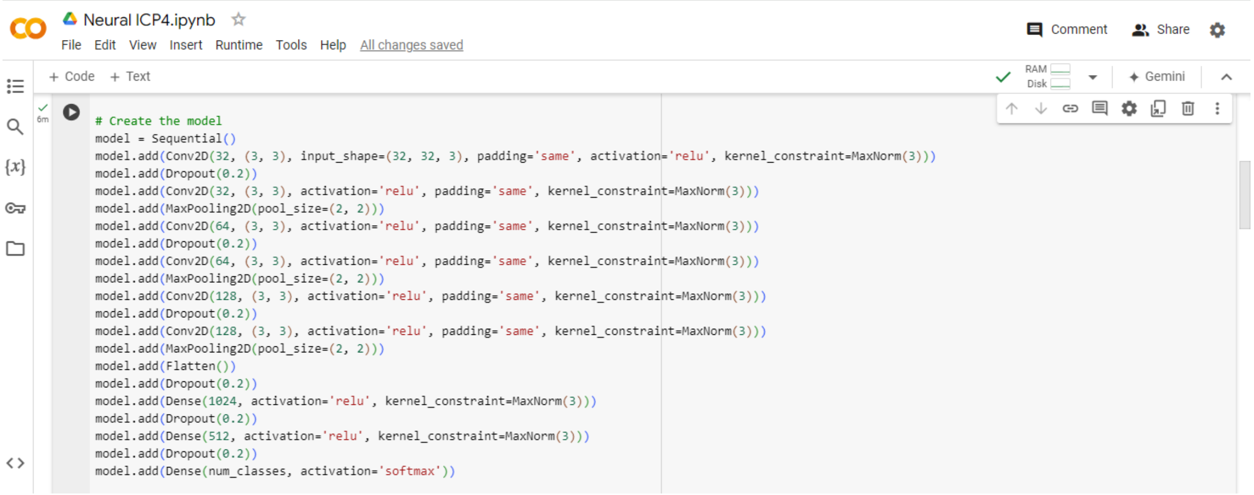
Github Link: https://github.com/sravs2031/Neural-Networks-ICP4.git

Video Link: https://drive.google.com/file/d/1uDU3FUwF4NytDRDyofeXcREhflvN-tF1/view?usp=drive_link

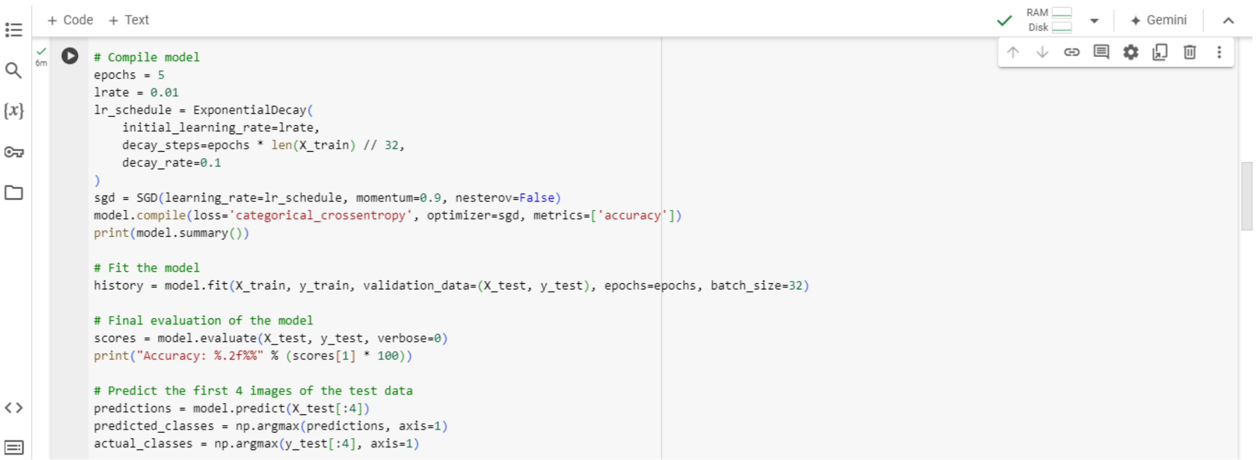
Screenshots:



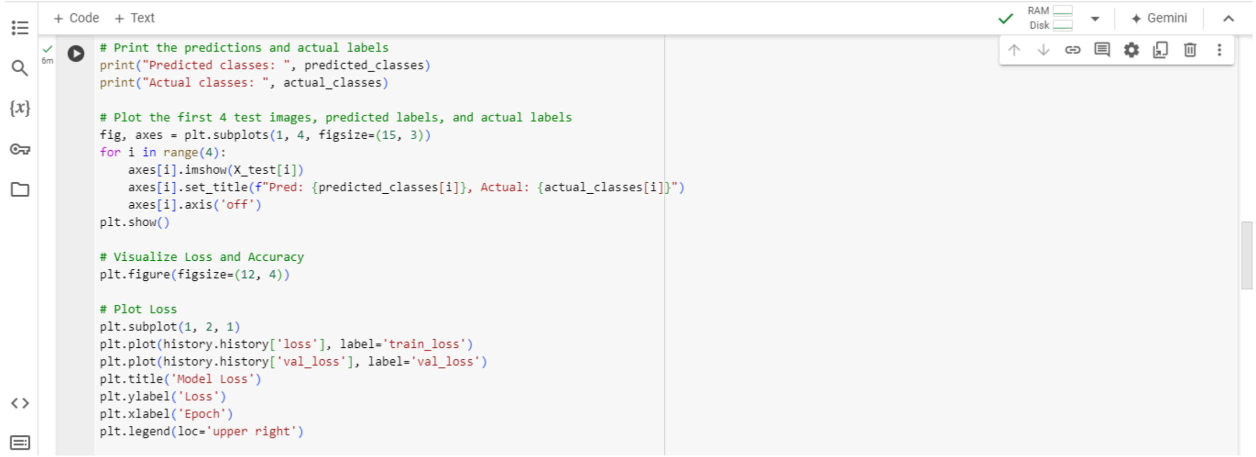
```python
import numpy as np
from tensorflow.keras.datasets import cifar10
from tensorflow.keras.models import Sequential
from tensorflow.keras.layers import Dense, Dropout, Flatten, Conv2D, MaxPooling2D
from tensorflow.keras.constraints import MaxNorm
from tensorflow.keras.optimizers import SGD
from tensorflow.keras.utils import to_categorical
from tensorflow.keras.optimizers.schedules import ExponentialDecay
import matplotlib.pyplot as plt

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

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



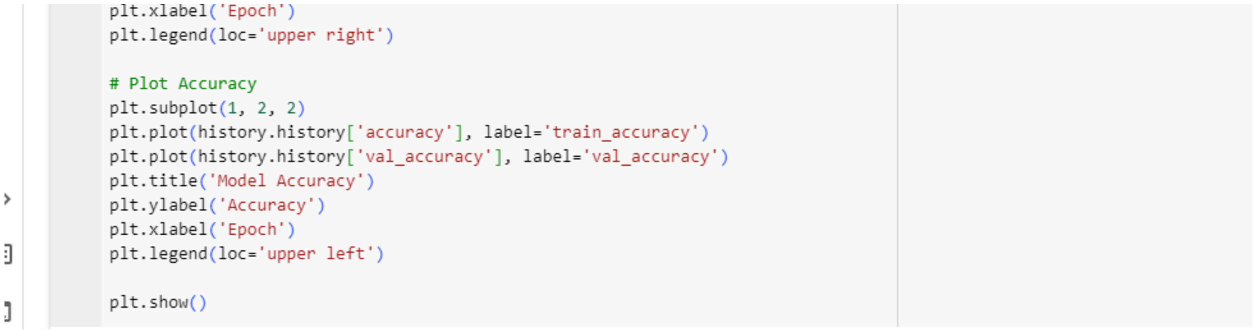
```python
# Create the model
model = Sequential()
model.add(Conv2D(32, (3, 3), input_shape=(32, 32, 3), padding='same', activation='relu', kernel_constraint=MaxNorm(3)))
model.add(Dropout(0.2))
model.add(Conv2D(32, (3, 3), activation='relu', padding='same', kernel_constraint=MaxNorm(3)))
model.add(MaxPooling2D(pool_size=(2,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



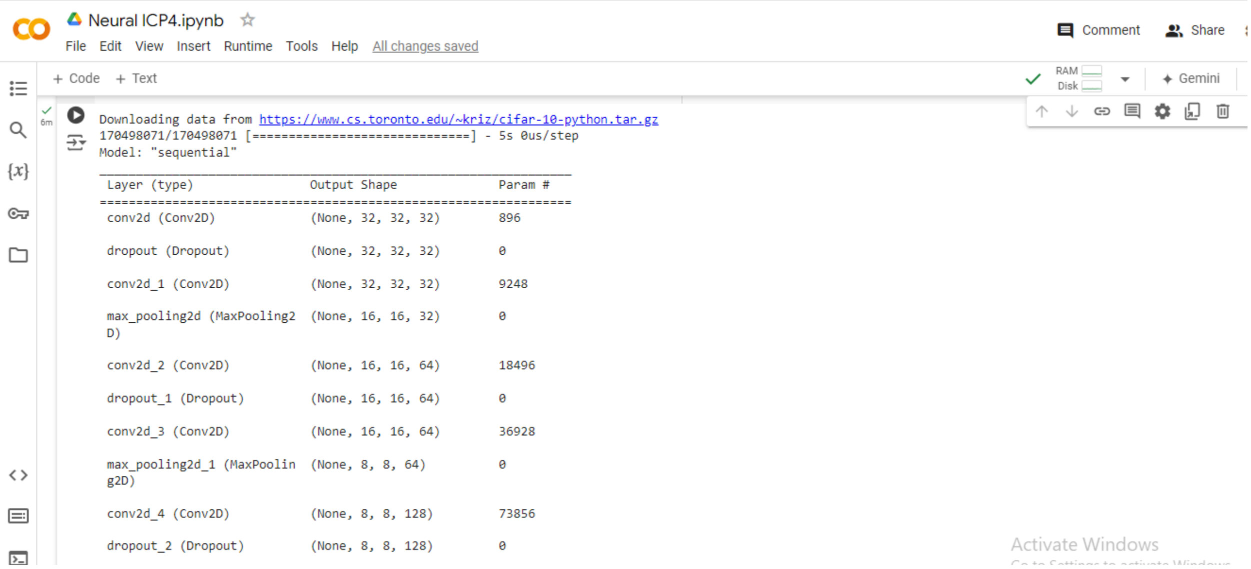
```python
# Compile model
epochs = 5
lrate = 0.01
lr_schedule = ExponentialDecay(
    initial_learning_rate=lrate,
    decay_steps=epochs * len(X_train) // 32,
    decay_rate=0.1
)
sgd = SGD(learning_rate=lr_schedule, momentum=0.9, nesterov=False)
model.compile(loss='categorical_crossentropy', optimizer=sgd, 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)

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

# Predict the first 4 images of the test data
predictions = model.predict(X_test[:4])
predicted_classes = np.argmax(predictions, axis=1)
actual_classes = np.argmax(y_test[:4], axis=1)
```



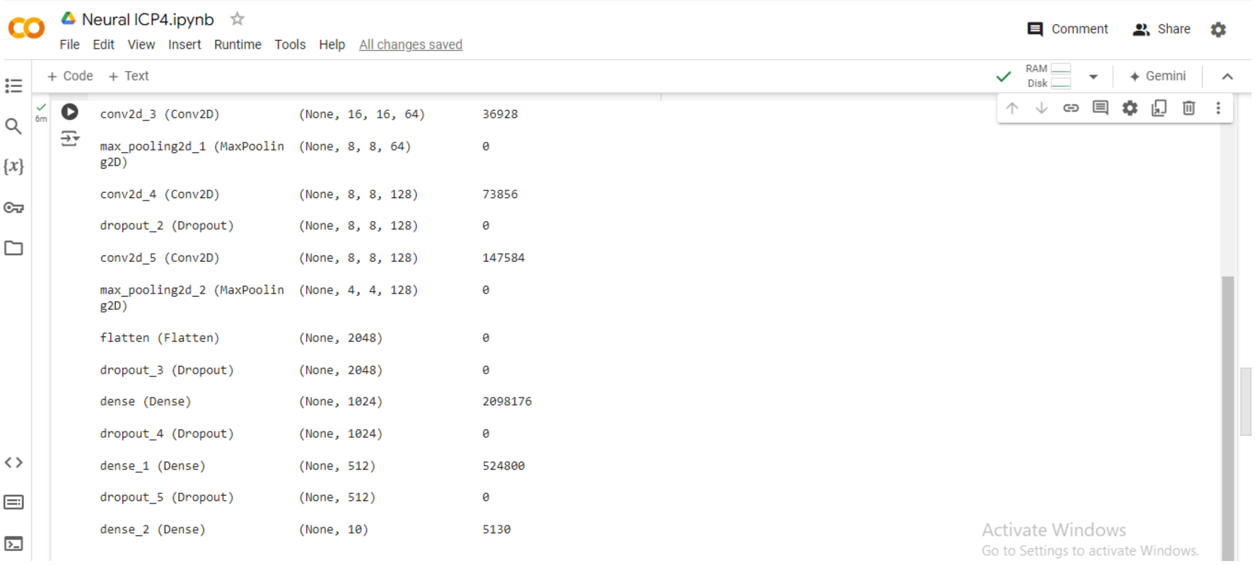
```python
# Print the predictions and actual labels
print("Predicted classes: ", predicted_classes)
print("Actual classes: ", actual_classes)

# Plot the first 4 test images, predicted labels, and actual labels
fig, axes = plt.subplots(1, 4, figsize=(15, 3))
for i in range(4):
    axes[i].imshow(X_test[i])
    axes[i].set_title(f"Pred: {predicted_classes[i]}, Actual: {actual_classes[i]}")
    axes[i].axis('off')
plt.show()

# Visualize Loss and Accuracy
plt.figure(figsize=(12, 4))

# Plot Loss
plt.subplot(1, 2, 1)
plt.plot(history.history['loss'], label='train_loss')
plt.plot(history.history['val_loss'], label='val_loss')
plt.title('Model Loss')
plt.ylabel('Loss')
plt.xlabel('Epoch')
plt.legend(loc='upper right')
```



```python
plt.xlabel('Epoch')
plt.legend(loc='upper right')

# Plot Accuracy
plt.subplot(1, 2, 2)
plt.plot(history.history['accuracy'], label='train_accuracy')
plt.plot(history.history['val_accuracy'], label='val_accuracy')
plt.title('Model Accuracy')
plt.ylabel('Accuracy')
plt.xlabel('Epoch')
plt.legend(loc='upper left')

plt.show()
```



```
Downloading data from https://www.cs.toronto.edu/~kriz/cifar-10-python.tar.gz
170498071/170498071 [==============================] - 5s 0us/step
Model: "sequential"
_________________________________________________________________
 Layer (type)                Output Shape              Param #
=================================================================
 conv2d (Conv2D)             (None, 32, 32, 32)        896

 dropout (Dropout)           (None, 32, 32, 32)        0

 conv2d_1 (Conv2D)           (None, 32, 32, 32)        9248

 max_pooling2d (MaxPooling2  (None, 16, 16, 32)        0
 D)

 conv2d_2 (Conv2D)           (None, 16, 16, 64)        18496

 dropout_1 (Dropout)         (None, 16, 16, 64)        0

 conv2d_3 (Conv2D)           (None, 16, 16, 64)        36928

 max_pooling2d_1 (MaxPoolin  (None, 8, 8, 64)          0
 g2D)

 conv2d_4 (Conv2D)           (None, 8, 8, 128)         73856

 dropout_2 (Dropout)         (None, 8, 8, 128)         0
```


Neural ICP4.ipynb
File Edit View Insert Runtime Tools Help All changes saved
Comment
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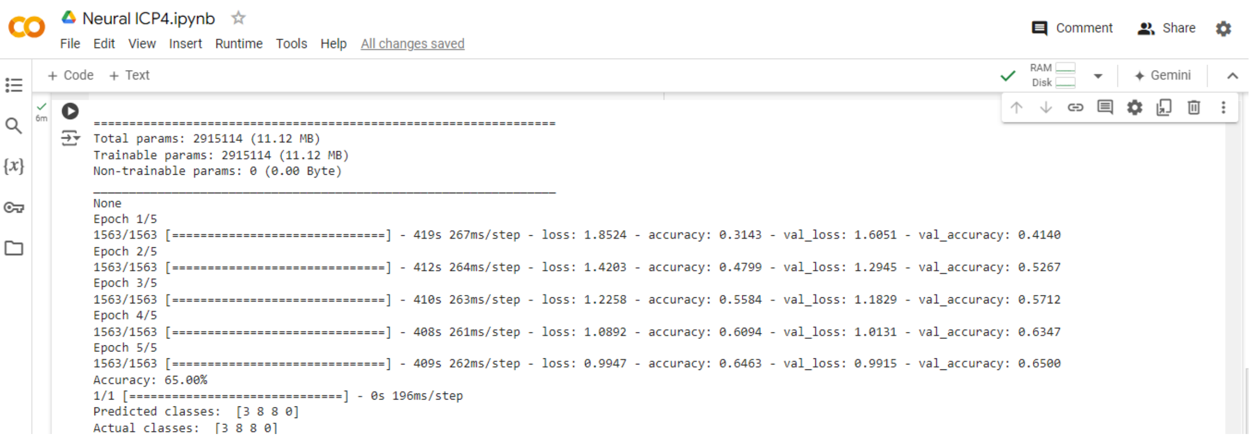
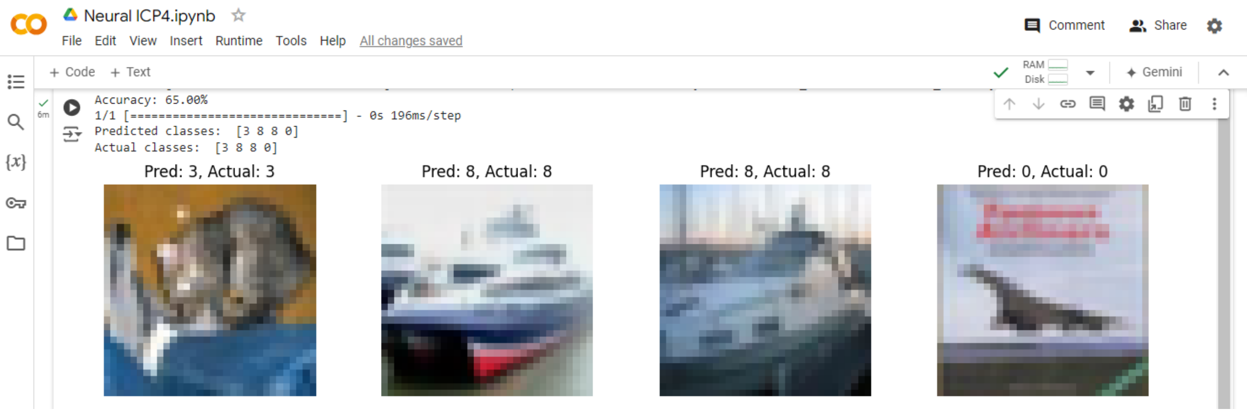
RAM
Disk
Gemini
Activate Windows
Go to Settings to activate Windows.

```
 conv2d_3 (Conv2D)           (None, 16, 16, 64)        36928

 max_pooling2d_1 (MaxPoolin  (None, 8, 8, 64)          0
 g2D)

 conv2d_4 (Conv2D)           (None, 8, 8, 128)         73856

 dropout_2 (Dropout)         (None, 8, 8, 128)         0

 conv2d_5 (Conv2D)           (None, 8, 8, 128)         147584

 max_pooling2d_2 (MaxPoolin  (None, 4, 4, 128)         0
 g2D)

 flatten (Flatten)           (None, 2048)              0

 dropout_3 (Dropout)         (None, 2048)              0

 dense (Dense)               (None, 1024)              2098176

 dropout_4 (Dropout)         (None, 1024)              0

 dense_1 (Dense)             (None, 512)               524800

 dropout_5 (Dropout)         (None, 512)               0

 dense_2 (Dense)             (None, 10)                5130
```

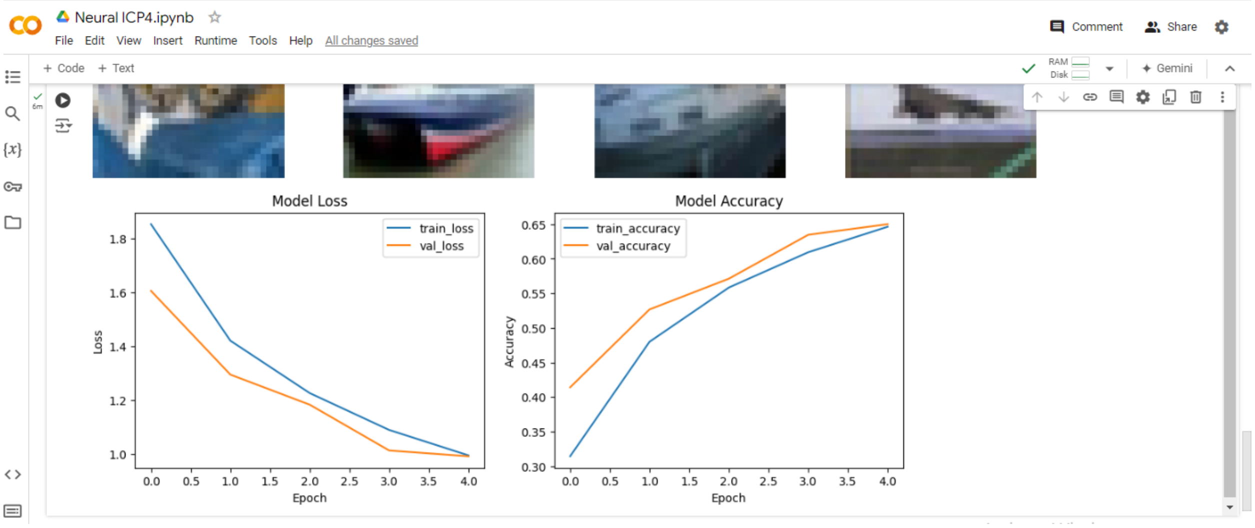
OUTPUT:



```
=================================================================
Total params: 2915114 (11.12 MB)
Trainable params: 2915114 (11.12 MB)
Non-trainable params: 0 (0.00 Byte)
_________________________________________________________________
None
Epoch 1/5
1563/1563 [==============================] - 419s 267ms/step - loss: 1.8524 - accuracy: 0.3143 - val_loss: 1.6051 - val_accuracy: 0.4140
Epoch 2/5
1563/1563 [==============================] - 412s 264ms/step - loss: 1.4203 - accuracy: 0.4799 - val_loss: 1.2945 - val_accuracy: 0.5267
Epoch 3/5
1563/1563 [==============================] - 410s 263ms/step - loss: 1.2258 - accuracy: 0.5584 - val_loss: 1.1829 - val_accuracy: 0.5712
Epoch 4/5
1563/1563 [==============================] - 408s 261ms/step - loss: 1.0892 - accuracy: 0.6094 - val_loss: 1.0131 - val_accuracy: 0.6347
Epoch 5/5
1563/1563 [==============================] - 409s 262ms/step - loss: 0.9947 - accuracy: 0.6463 - val_loss: 0.9915 - val_accuracy: 0.6500
Accuracy: 65.00%
1/1 [==============================] - 0s 196ms/step
Predicted classes:  [3 8 8 0]
Actual classes:  [3 8 8 0]
```



```
Accuracy: 65.00%
1/1 [==============================] - 0s 196ms/step
Predicted classes:  [3 8 8 0]
Actual classes:  [3 8 8 0]
```



Neural ICP4.ipynb
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RAM Disk
Gemini
Model Loss
train_loss
val_loss
Loss
1.8
1.6
1.4
1.2
1.0
0.0 0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0
Epoch
Model Accuracy
train_accuracy
val_accuracy
Accuracy
0.65
0.60
0.55
0.50
0.45
0.40
0.35
0.30
0.0 0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0
Epoch