Neural Network and Deep Learning – ICP4

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Github link: https://github.com/Avinash-hub1/Assignment-4.git

Video link: https://drive.google.com/file/d/1c3CaxBTwY-9SddgzuyuPV44KWqmVd8Dd/view?usp=drive_link

In class programming:

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

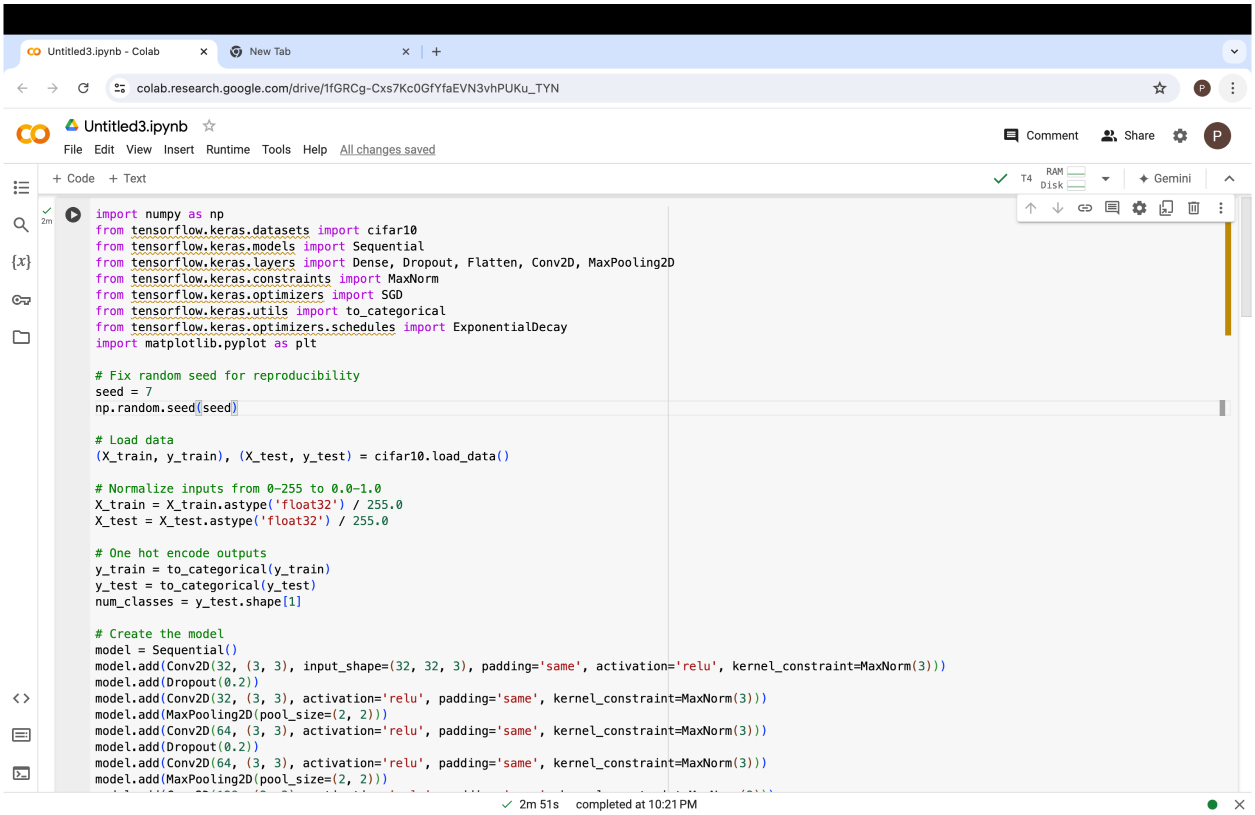
Did the performance change?

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.

3. Visualize Loss and Accuracy using the history object

Output: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```
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]

# 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)))
```

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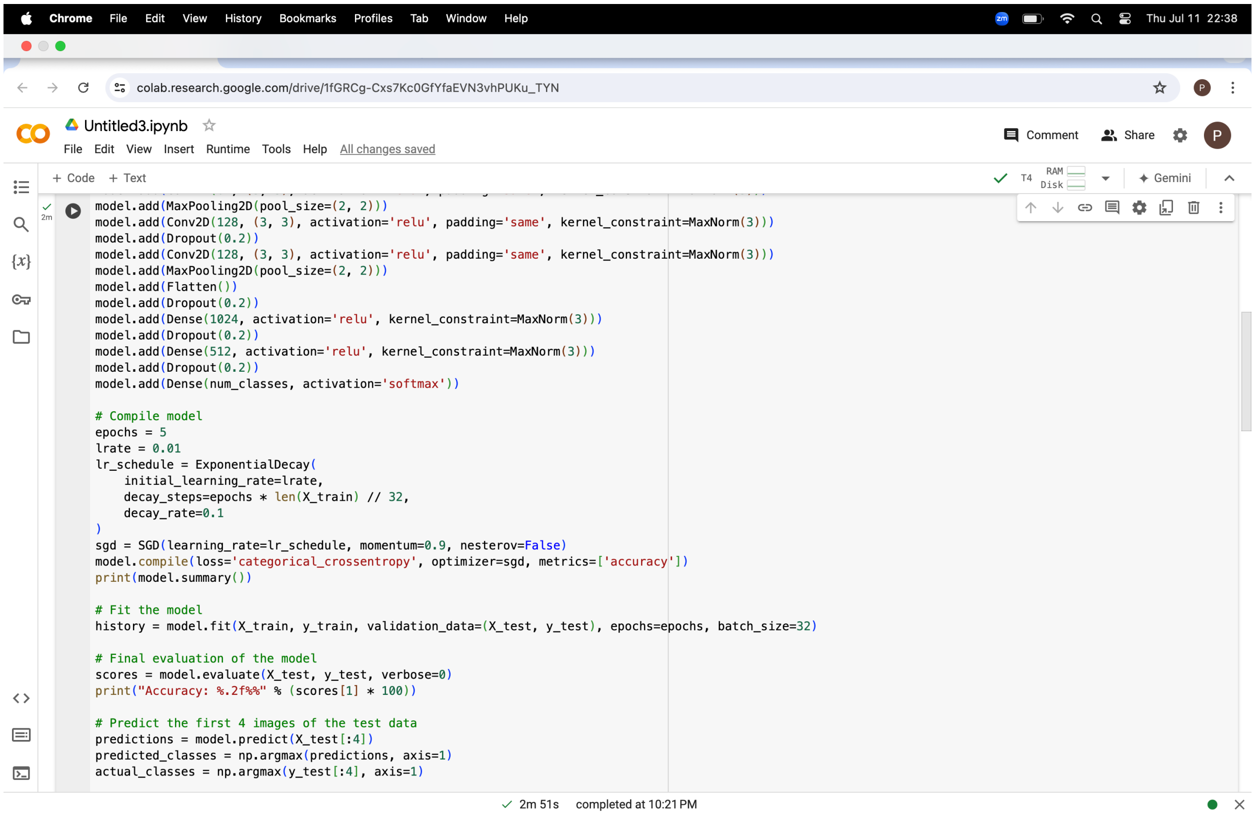
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```
model.add(MaxPooling2D(pool_size=(2, 2)))
model.add(Conv2D(128, (3, 3), activation='relu', padding='same', kernel_constraint=MaxNorm(3)))
model.add(Dropout(0.2))
model.add(Conv2D(128, (3, 3), activation='relu', padding='same', kernel_constraint=MaxNorm(3)))
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
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)
```

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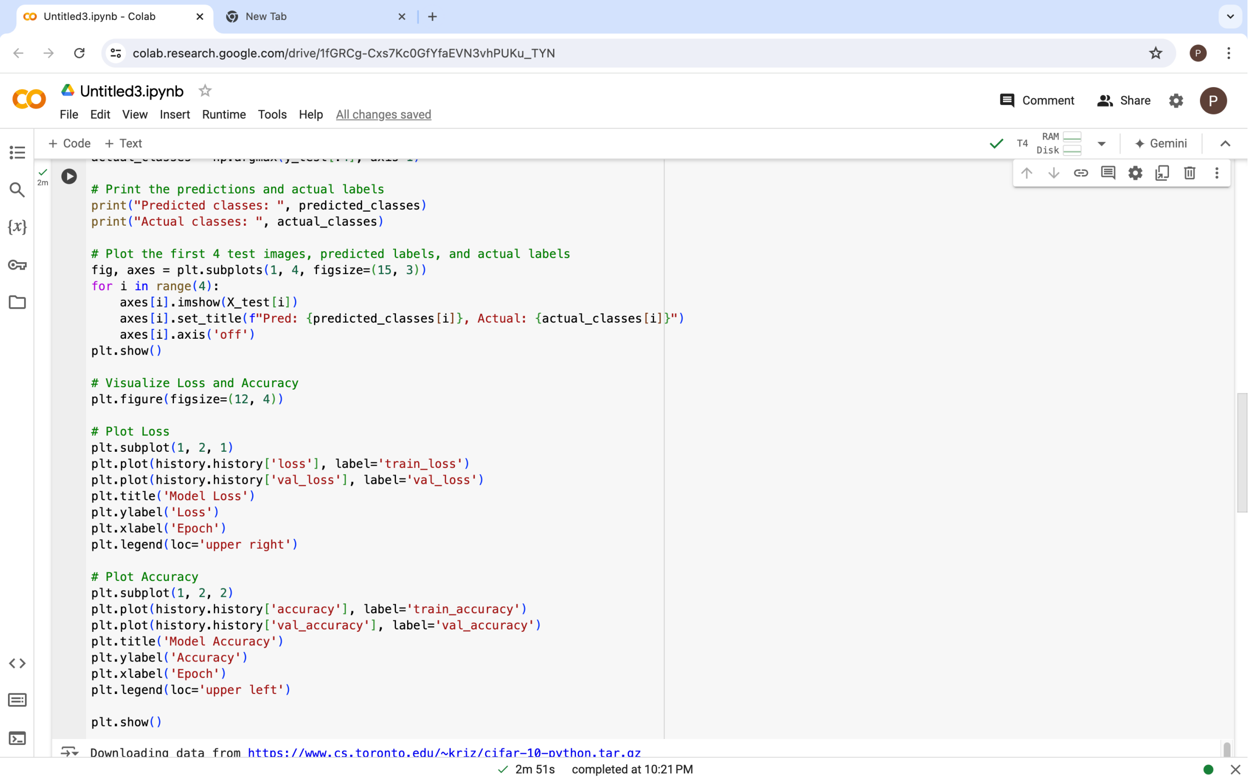
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# Print the predictions and actual labels
print("Predicted classes: ", predicted_classes)
print("Actual classes: ", actual_classes)

# 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')

# 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
```

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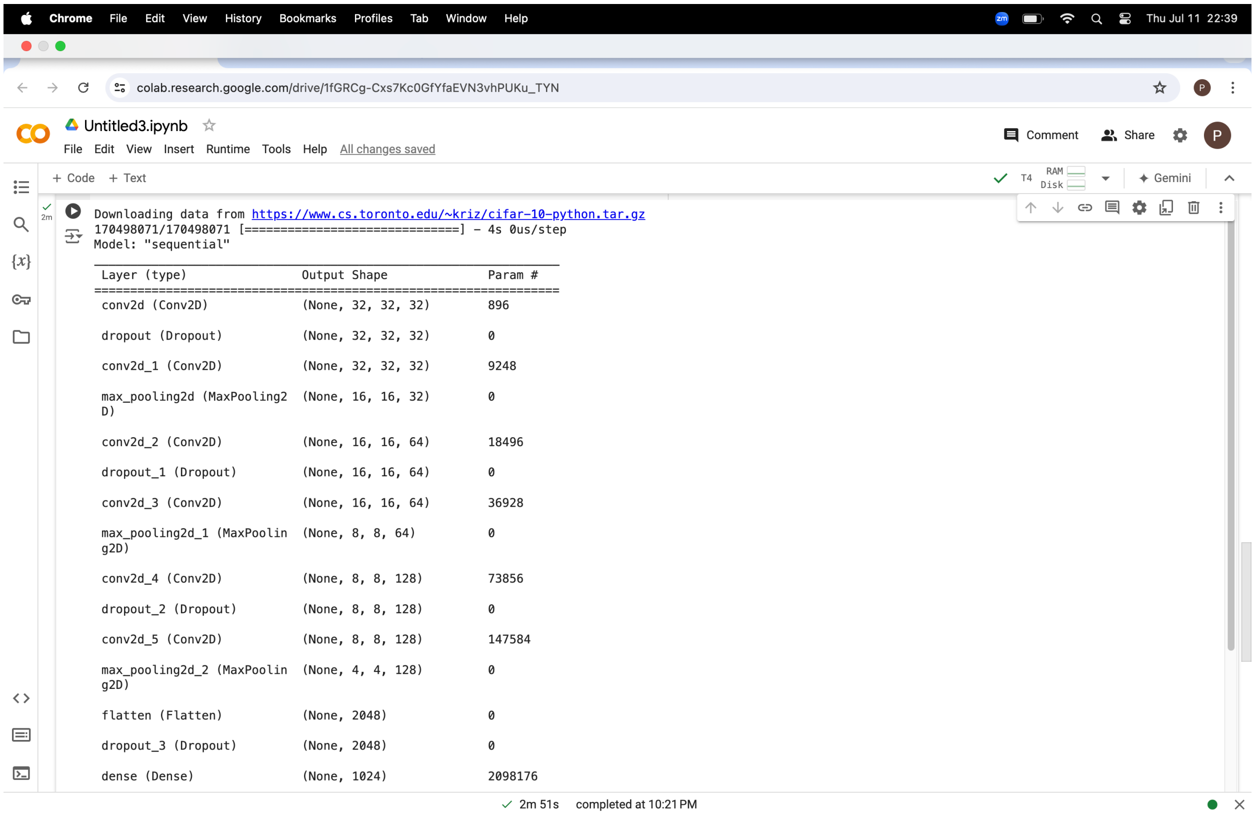
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```
Downloading data from https://www.cs.toronto.edu/~kriz/cifar-10-python.tar.gz
170498071/170498071 [==============================] - 4s 0us/step
Model: "sequential"
_________________________________________________________________
 Layer (type)                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

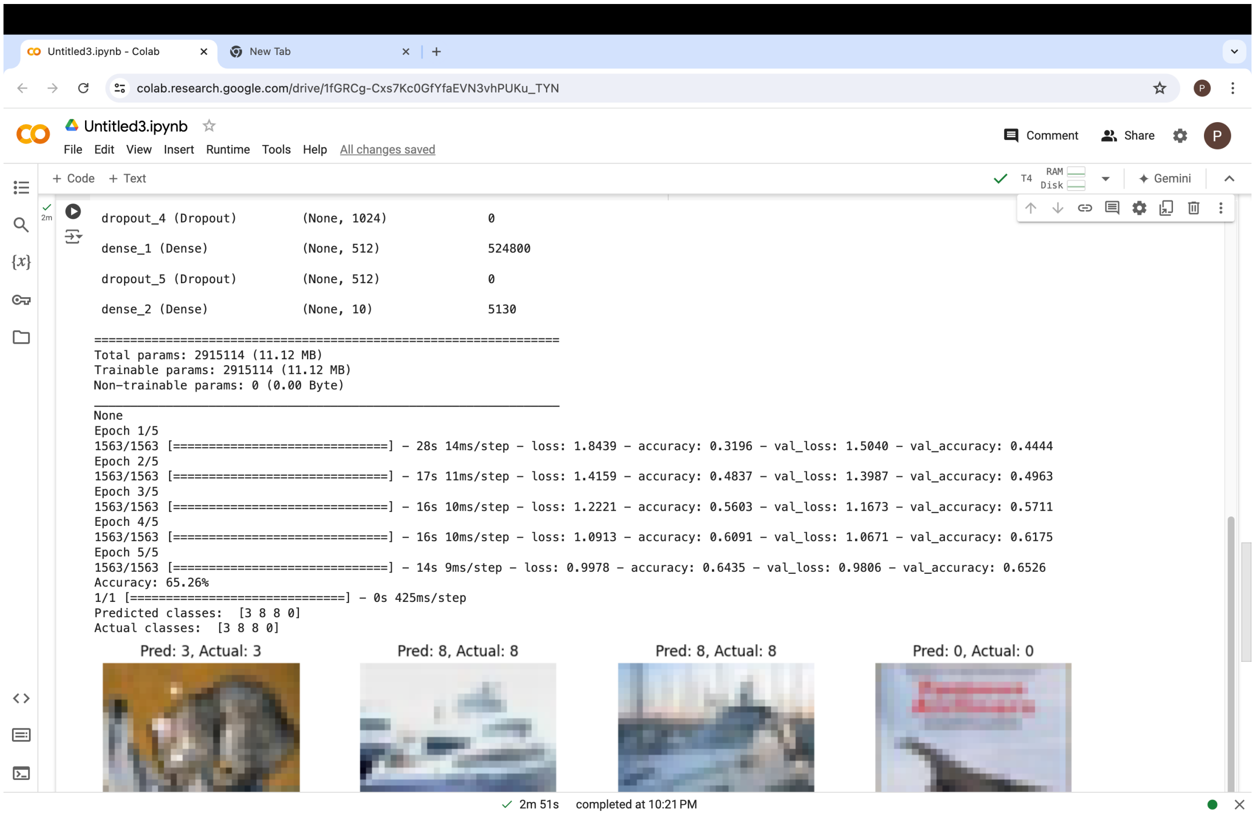
 conv2d_5 (Conv2D)           (None, 8, 8, 128)         147584

 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
```



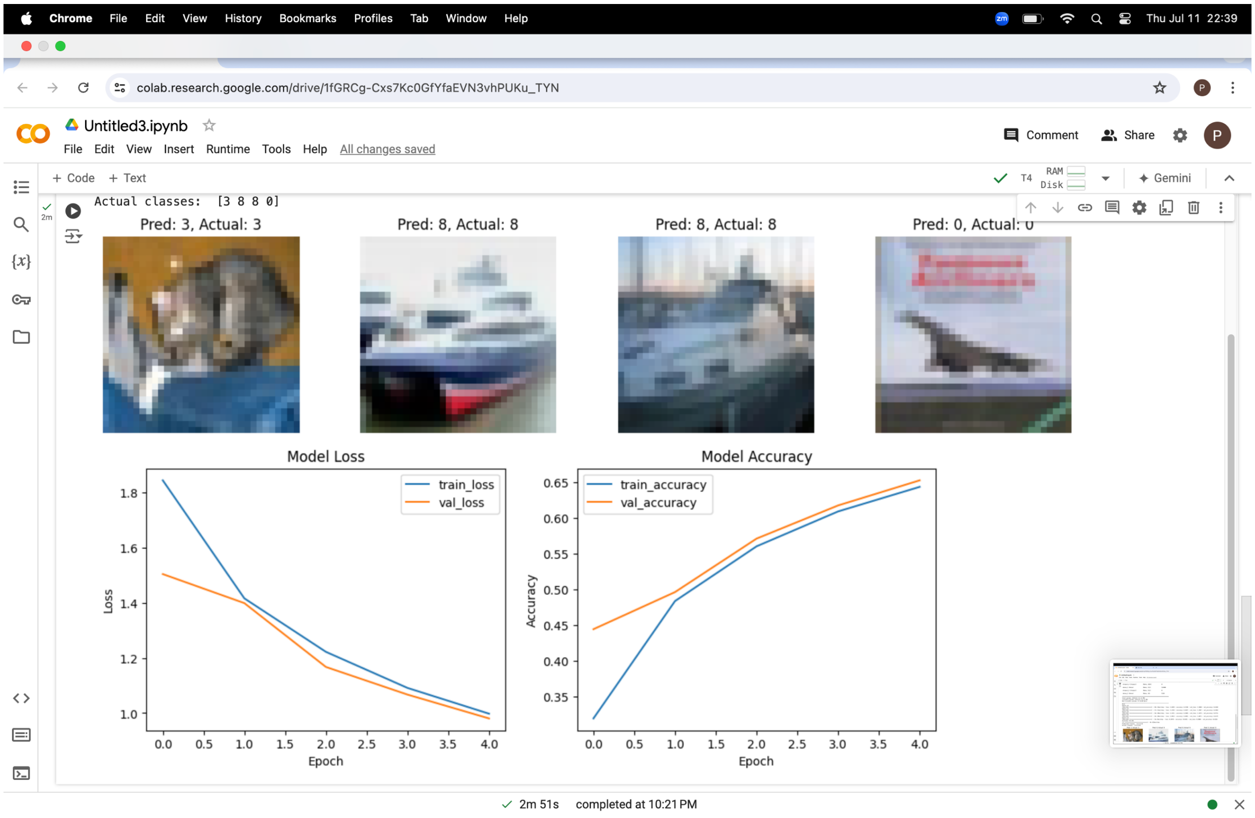
```
 dropout_4 (Dropout)         (None, 1024)              0

 dense_1 (Dense)             (None, 512)               524800

 dropout_5 (Dropout)         (None, 512)               0

 dense_2 (Dense)             (None, 10)                5130

=================================================================
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 [==============================] - 28s 14ms/step - loss: 1.8439 - accuracy: 0.3196 - val_loss: 1.5040 - val_accuracy: 0.4444
Epoch 2/5
1563/1563 [==============================] - 17s 11ms/step - loss: 1.4159 - accuracy: 0.4837 - val_loss: 1.3987 - val_accuracy: 0.4963
Epoch 3/5
1563/1563 [==============================] - 16s 10ms/step - loss: 1.2221 - accuracy: 0.5603 - val_loss: 1.1673 - val_accuracy: 0.5711
Epoch 4/5
1563/1563 [==============================] - 16s 10ms/step - loss: 1.0913 - accuracy: 0.6091 - val_loss: 1.0671 - val_accuracy: 0.6175
Epoch 5/5
1563/1563 [==============================] - 14s 9ms/step - loss: 0.9978 - accuracy: 0.6435 - val_loss: 0.9806 - val_accuracy: 0.6526
Accuracy: 65.26%
1/1 [==============================] - 0s 425ms/step
Predicted classes:  [3 8 8 0]
Actual classes:  [3 8 8 0]
```



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Actual classes:  [3 8 8 0]
```