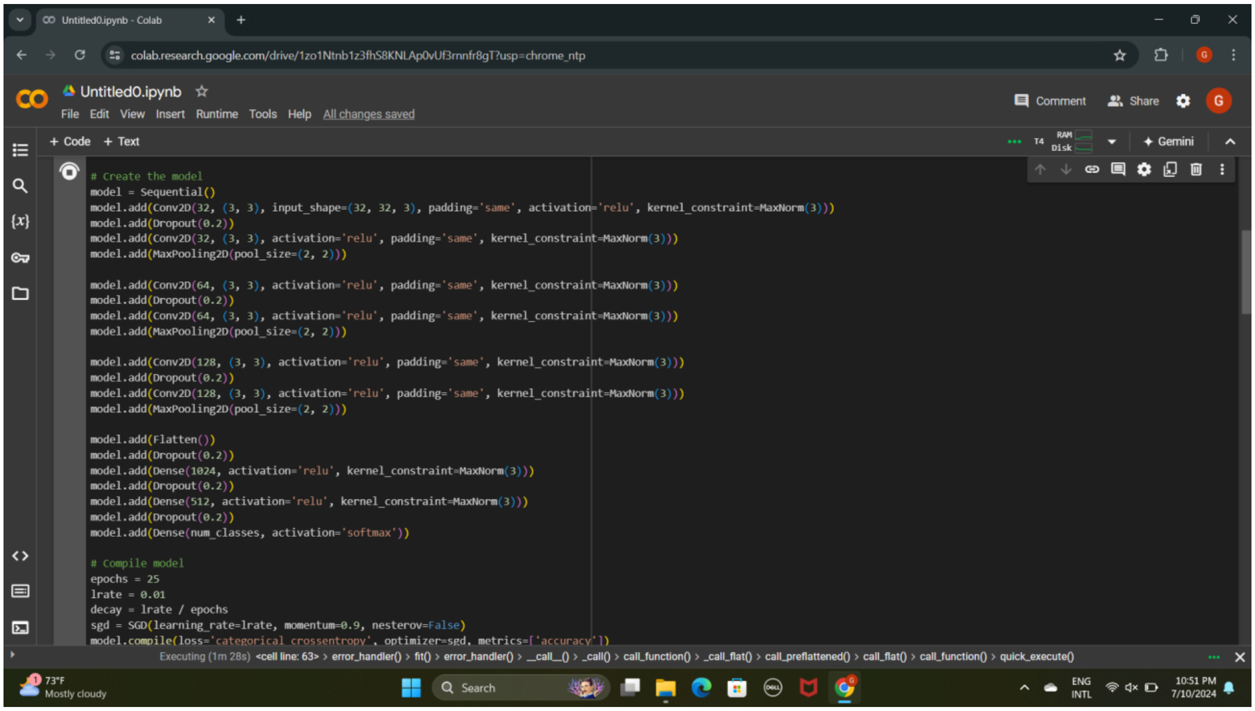
NAME:GANESH KUMAR KORRA

STUDENT ID:700761716

Github Link: [GaneshKumarKorra/ICP4 (github.com)](https://github.com/GaneshKumarKorra/ICP4)



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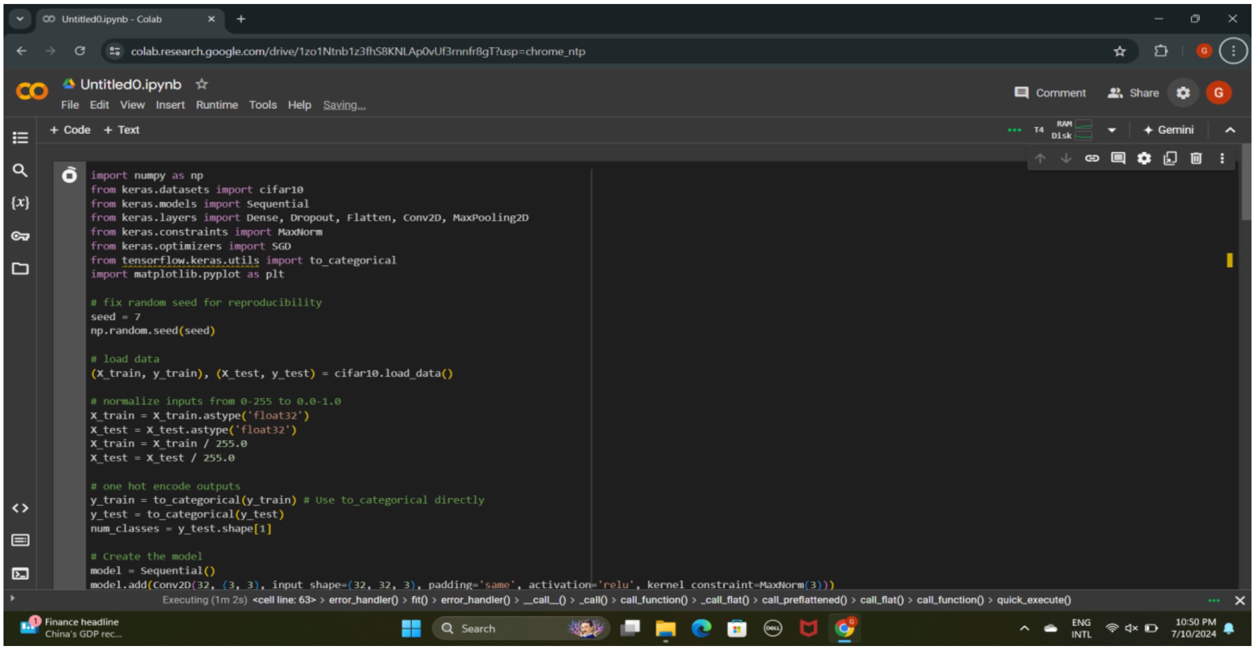
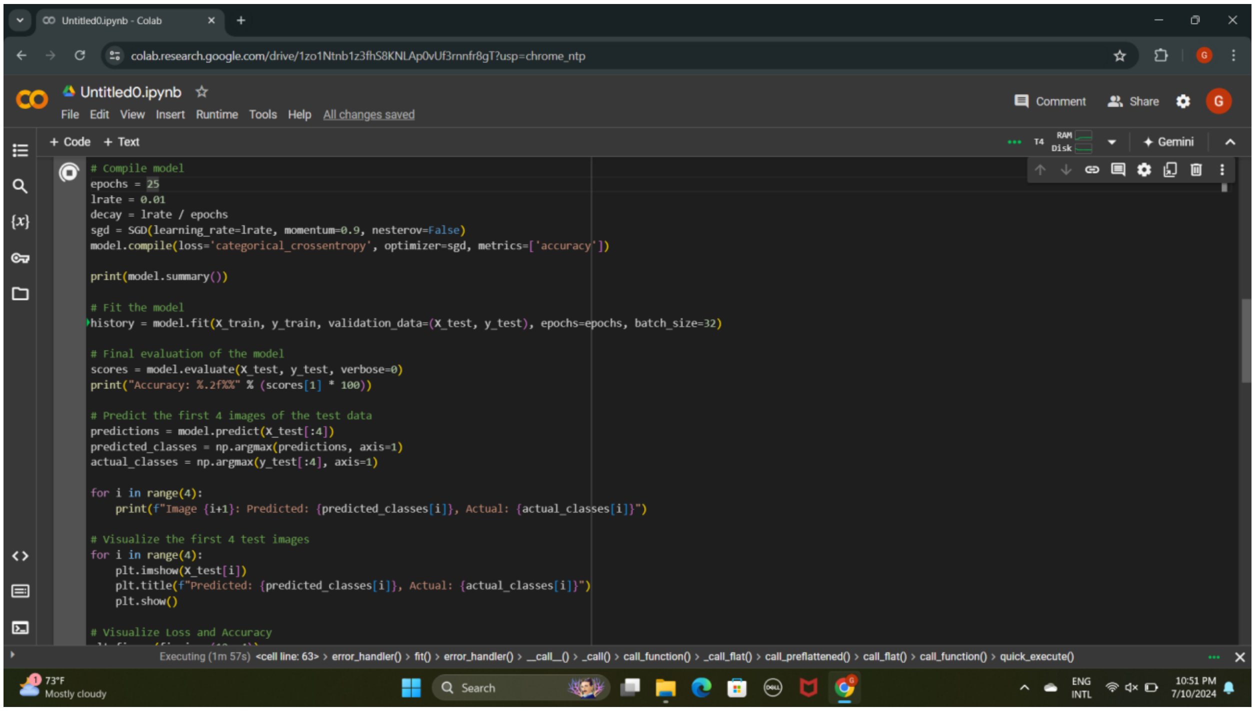
```python
# Create the model
model = Sequential()
model.add(Conv2D(32, (3, 3), input_shape=(32, 32, 3), padding='same', activation='relu', kernel_constraint=MaxNorm(3)))
model.add(Dropout(0.2))
model.add(Conv2D(32, (3, 3), activation='relu', padding='same', kernel_constraint=MaxNorm(3)))
model.add(MaxPooling2D(pool_size=(2,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

# Compile model
epochs = 25
lrate = 0.01
decay = lrate / epochs
sgd = SGD(learning_rate=lrate, momentum=0.9, nesterov=False)
model.compile(loss='categorical_crossentropy', optimizer=sgd, metrics=['accuracy'])
```

Executing (1m 28s) <cell line: 63> > error_handler() > fit() > error_handler() > __call__() > _call() > call_function() > _call_flat() > call_preflattened() > call_flat() > call_function() > quick_execute()



```python
import numpy as np
from keras.datasets import cifar10
from keras.models import Sequential
from keras.layers import Dense, Dropout, Flatten, Conv2D, MaxPooling2D
from keras.constraints import MaxNorm
from keras.optimizers import SGD
from tensorflow.keras.utils import to_categorical
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')
X_test = X_test.astype('float32')
X_train = X_train / 255.0
X_test = X_test / 255.0

# one hot encode outputs
y_train = to_categorical(y_train) # Use to_categorical directly
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)))
```

Executing (1m 2s) <cell line: 63> > error_handler() > fit() > error_handler() > __call__() > _call() > call_function() > _call_flat() > call_preflattened() > call_flat() > call_function() > quick_execute()



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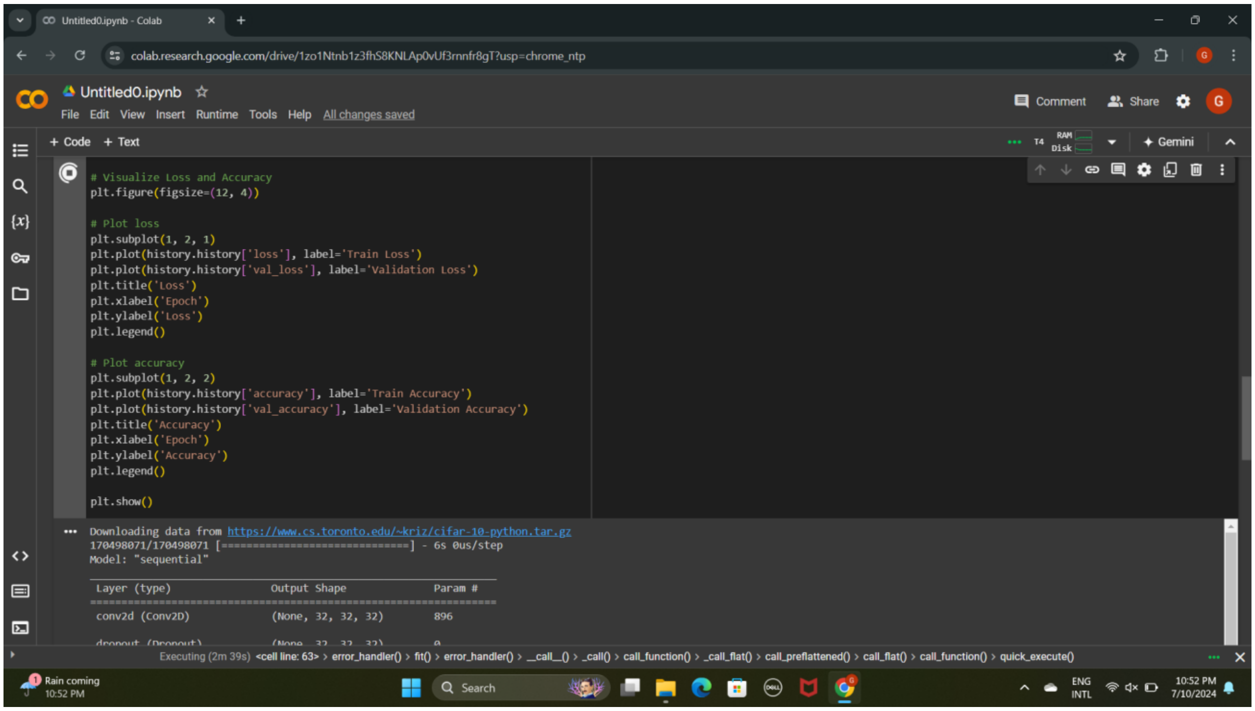
```python
# Compile model
epochs = 25
lrate = 0.01
decay = lrate / epochs
sgd = SGD(learning_rate=lrate, momentum=0.9, nesterov=False)
model.compile(loss='categorical_crossentropy', optimizer=sgd, metrics=['accuracy'])

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)

for i in range(4):
    print(f"Image {i+1}: Predicted: {predicted_classes[i]}, Actual: {actual_classes[i]}")

# Visualize the first 4 test images
for i in range(4):
    plt.imshow(X_test[i])
    plt.title(f"Predicted: {predicted_classes[i]}, Actual: {actual_classes[i]}")
    plt.show()

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

```
Executing (1m 57s) <cell line: 63> > error_handler() > fit() > error_handler() > __call__() > _call() > call_function() > _call_flat() > call_preflattened() > call_flat() > call_function() > quick_execute()
```



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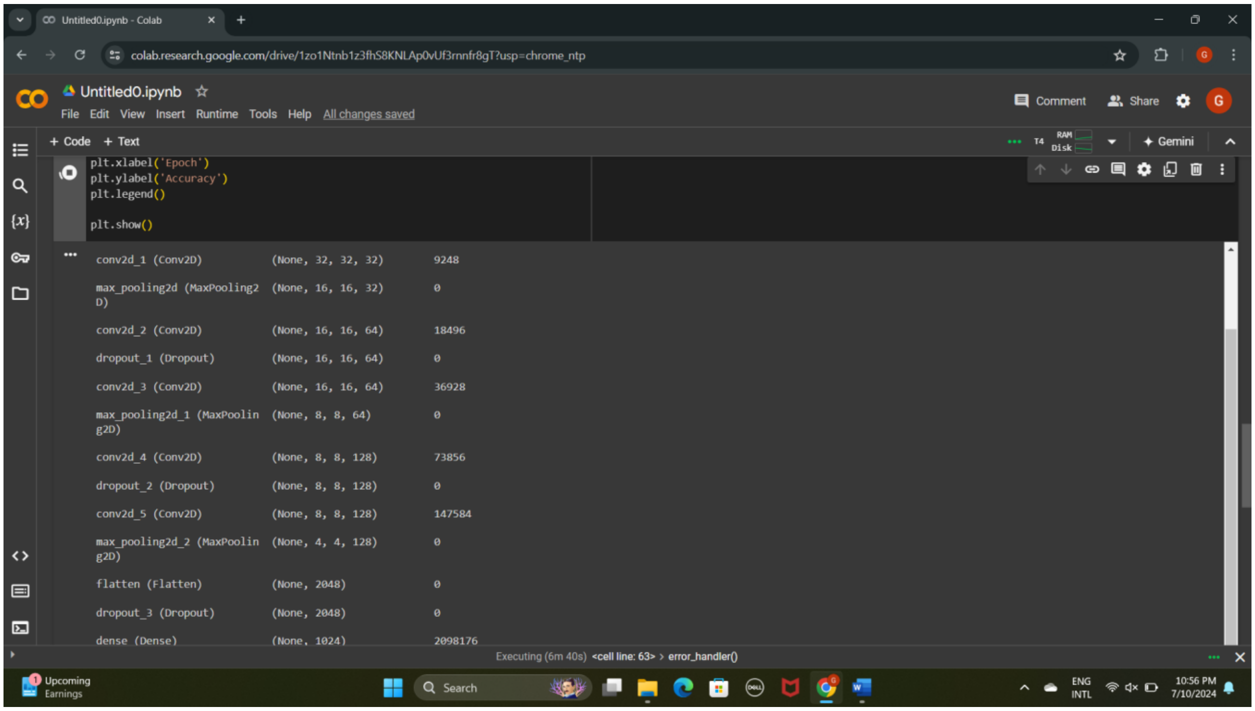
```python
# Visualize Loss and Accuracy
plt.figure(figsize=(12, 4))

# Plot loss
plt.subplot(1, 2, 1)
plt.plot(history.history['loss'], label='Train Loss')
plt.plot(history.history['val_loss'], label='Validation Loss')
plt.title('Loss')
plt.xlabel('Epoch')
plt.ylabel('Loss')
plt.legend()

# Plot accuracy
plt.subplot(1, 2, 2)
plt.plot(history.history['accuracy'], label='Train Accuracy')
plt.plot(history.history['val_accuracy'], label='Validation Accuracy')
plt.title('Accuracy')
plt.xlabel('Epoch')
plt.ylabel('Accuracy')
plt.legend()

plt.show()
```

```
Downloading data from https://www.cs.toronto.edu/~kriz/cifar-10-python.tar.gz
170498071/170498071 [==============================] - 6s 0us/step
Model: "sequential"
_________________________________________________________________
 Layer (type)                Output Shape              Param #
=================================================================
 conv2d (Conv2D)             (None, 32, 32, 32)        896

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

```
Executing (2m 39s) <cell line: 63> > error_handler() > fit() > error_handler() > __call__() > _call() > call_function() > _call_flat() > call_preflattened() > call_flat() > call_function() > quick_execute()
```

output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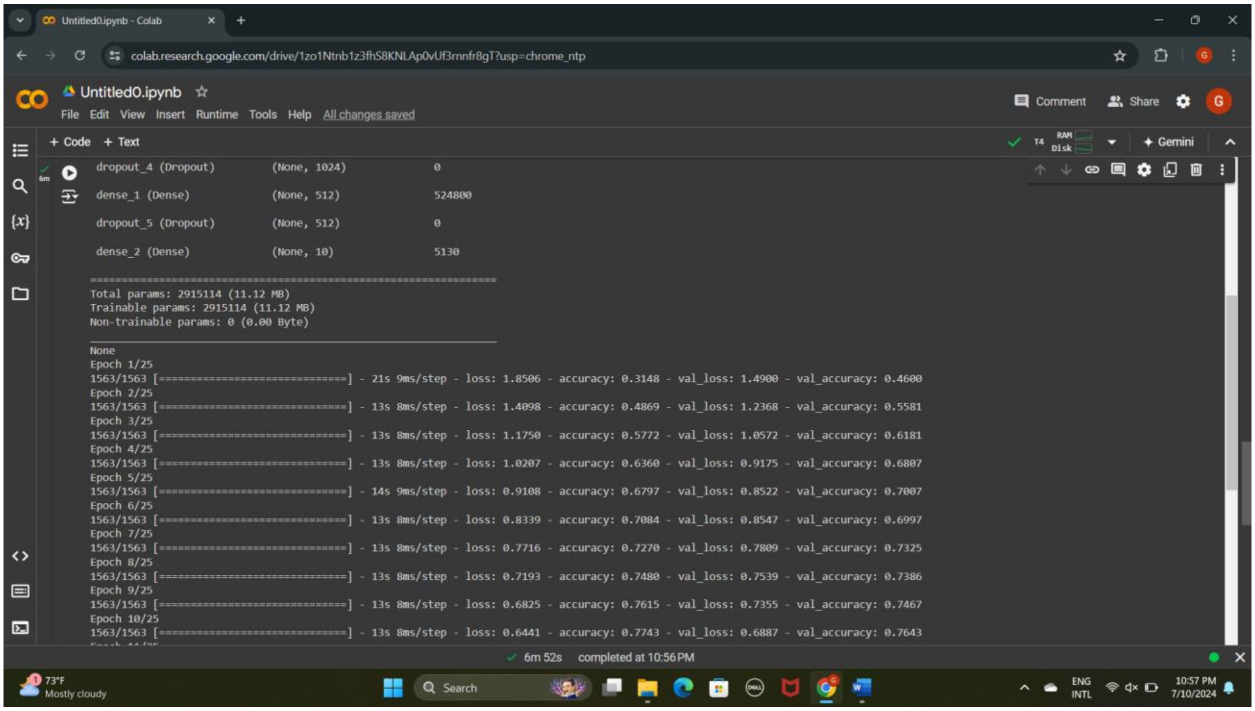
```
plt.xlabel('Epoch')
plt.ylabel('Accuracy')
plt.legend()

plt.show()
```

```
 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
```

Executing (6m 40s) <cell line: 63> > error_handler()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```
 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 1/25
1563/1563 [==============================] - 21s 9ms/step - loss: 1.8506 - accuracy: 0.3148 - val_loss: 1.4900 - val_accuracy: 0.4600
Epoch 2/25
1563/1563 [==============================] - 13s 8ms/step - loss: 1.4098 - accuracy: 0.4869 - val_loss: 1.2368 - val_accuracy: 0.5581
Epoch 3/25
1563/1563 [==============================] - 13s 8ms/step - loss: 1.1750 - accuracy: 0.5772 - val_loss: 1.0572 - val_accuracy: 0.6181
Epoch 4/25
1563/1563 [==============================] - 13s 8ms/step - loss: 1.0207 - accuracy: 0.6360 - val_loss: 0.9175 - val_accuracy: 0.6807
Epoch 5/25
1563/1563 [==============================] - 14s 9ms/step - loss: 0.9108 - accuracy: 0.6797 - val_loss: 0.8522 - val_accuracy: 0.7007
Epoch 6/25
1563/1563 [==============================] - 13s 8ms/step - loss: 0.8339 - accuracy: 0.7084 - val_loss: 0.8547 - val_accuracy: 0.6997
Epoch 7/25
1563/1563 [==============================] - 13s 8ms/step - loss: 0.7716 - accuracy: 0.7270 - val_loss: 0.7809 - val_accuracy: 0.7325
Epoch 8/25
1563/1563 [==============================] - 13s 8ms/step - loss: 0.7193 - accuracy: 0.7480 - val_loss: 0.7539 - val_accuracy: 0.7386
Epoch 9/25
1563/1563 [==============================] - 13s 8ms/step - loss: 0.6825 - accuracy: 0.7615 - val_loss: 0.7355 - val_accuracy: 0.7467
Epoch 10/25
1563/1563 [==============================] - 13s 8ms/step - loss: 0.6441 - accuracy: 0.7743 - val_loss: 0.6887 - val_accuracy: 0.7643
```

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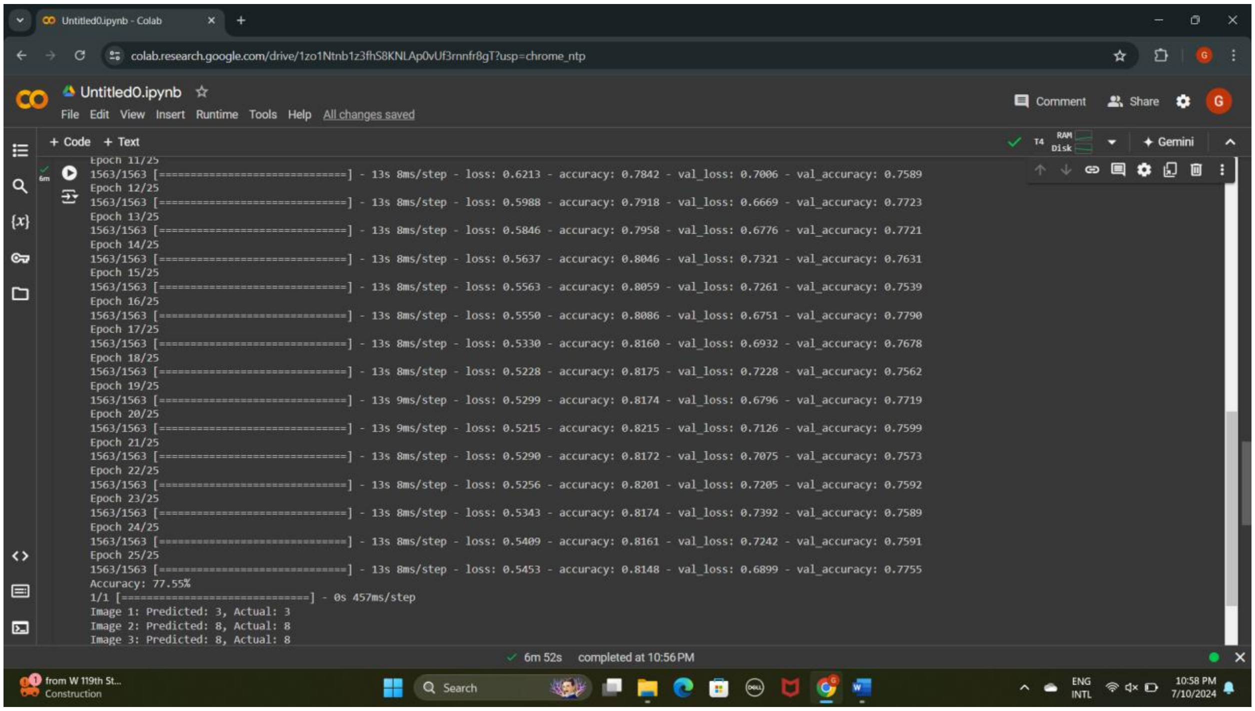
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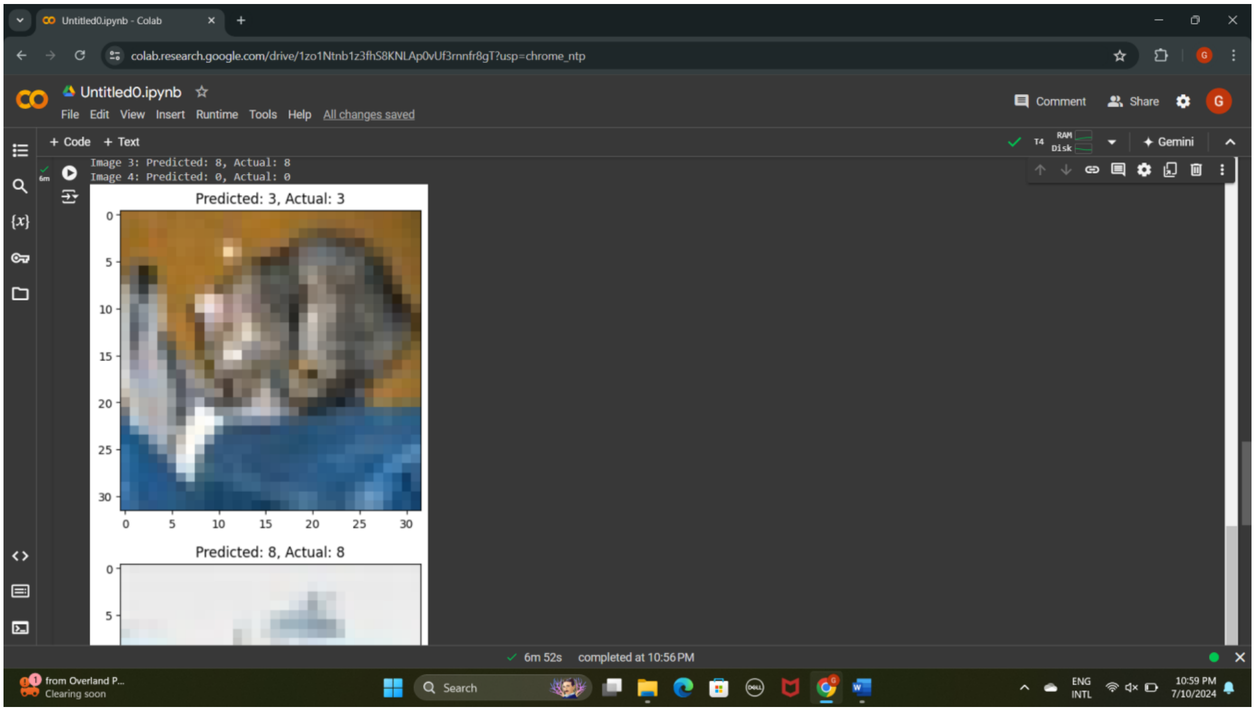
```
Epoch 11/25
1563/1563 [==============================] - 13s 8ms/step - loss: 0.6213 - accuracy: 0.7842 - val_loss: 0.7006 - val_accuracy: 0.7589
Epoch 12/25
1563/1563 [==============================] - 13s 8ms/step - loss: 0.5988 - accuracy: 0.7918 - val_loss: 0.6669 - val_accuracy: 0.7723
Epoch 13/25
1563/1563 [==============================] - 13s 8ms/step - loss: 0.5846 - accuracy: 0.7958 - val_loss: 0.6776 - val_accuracy: 0.7721
Epoch 14/25
1563/1563 [==============================] - 13s 8ms/step - loss: 0.5637 - accuracy: 0.8046 - val_loss: 0.7321 - val_accuracy: 0.7631
Epoch 15/25
1563/1563 [==============================] - 13s 8ms/step - loss: 0.5563 - accuracy: 0.8059 - val_loss: 0.7261 - val_accuracy: 0.7539
Epoch 16/25
1563/1563 [==============================] - 13s 8ms/step - loss: 0.5550 - accuracy: 0.8086 - val_loss: 0.6751 - val_accuracy: 0.7790
Epoch 17/25
1563/1563 [==============================] - 13s 8ms/step - loss: 0.5330 - accuracy: 0.8160 - val_loss: 0.6932 - val_accuracy: 0.7678
Epoch 18/25
1563/1563 [==============================] - 13s 8ms/step - loss: 0.5228 - accuracy: 0.8175 - val_loss: 0.7228 - val_accuracy: 0.7562
Epoch 19/25
1563/1563 [==============================] - 13s 9ms/step - loss: 0.5299 - accuracy: 0.8174 - val_loss: 0.6796 - val_accuracy: 0.7719
Epoch 20/25
1563/1563 [==============================] - 13s 9ms/step - loss: 0.5215 - accuracy: 0.8215 - val_loss: 0.7126 - val_accuracy: 0.7599
Epoch 21/25
1563/1563 [==============================] - 13s 8ms/step - loss: 0.5290 - accuracy: 0.8172 - val_loss: 0.7075 - val_accuracy: 0.7573
Epoch 22/25
1563/1563 [==============================] - 13s 8ms/step - loss: 0.5256 - accuracy: 0.8201 - val_loss: 0.7205 - val_accuracy: 0.7592
Epoch 23/25
1563/1563 [==============================] - 13s 8ms/step - loss: 0.5343 - accuracy: 0.8174 - val_loss: 0.7392 - val_accuracy: 0.7589
Epoch 24/25
1563/1563 [==============================] - 13s 8ms/step - loss: 0.5409 - accuracy: 0.8161 - val_loss: 0.7242 - val_accuracy: 0.7591
Epoch 25/25
1563/1563 [==============================] - 13s 8ms/step - loss: 0.5453 - accuracy: 0.8148 - val_loss: 0.6899 - val_accuracy: 0.7755
Accuracy: 77.55%
1/1 [==============================] - 0s 457ms/step
Image 1: Predicted: 3, Actual: 3
Image 2: Predicted: 8, Actual: 8
Image 3: Predicted: 8, Actual: 8
```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Predicted: 3, Actual: 3
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Predicted: 8, Actual: 8
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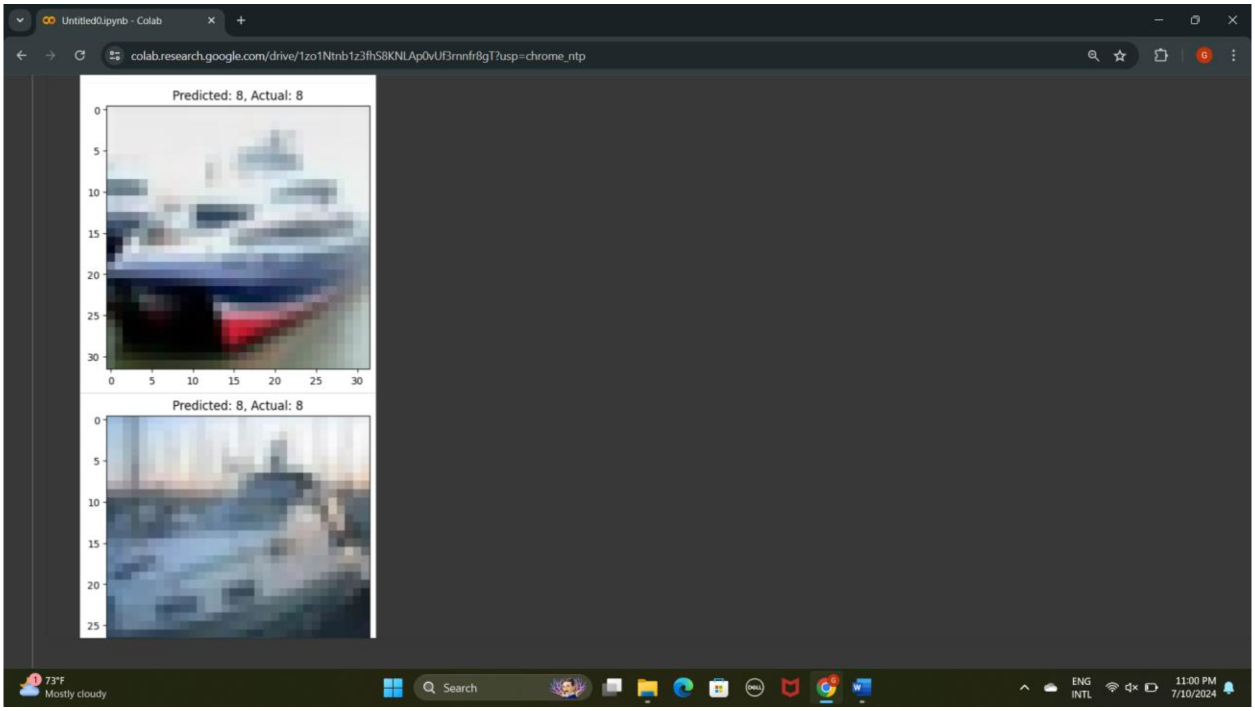
```
Image 3: Predicted: 8, Actual: 8
Image 4: Predicted: 0, Actual: 0
```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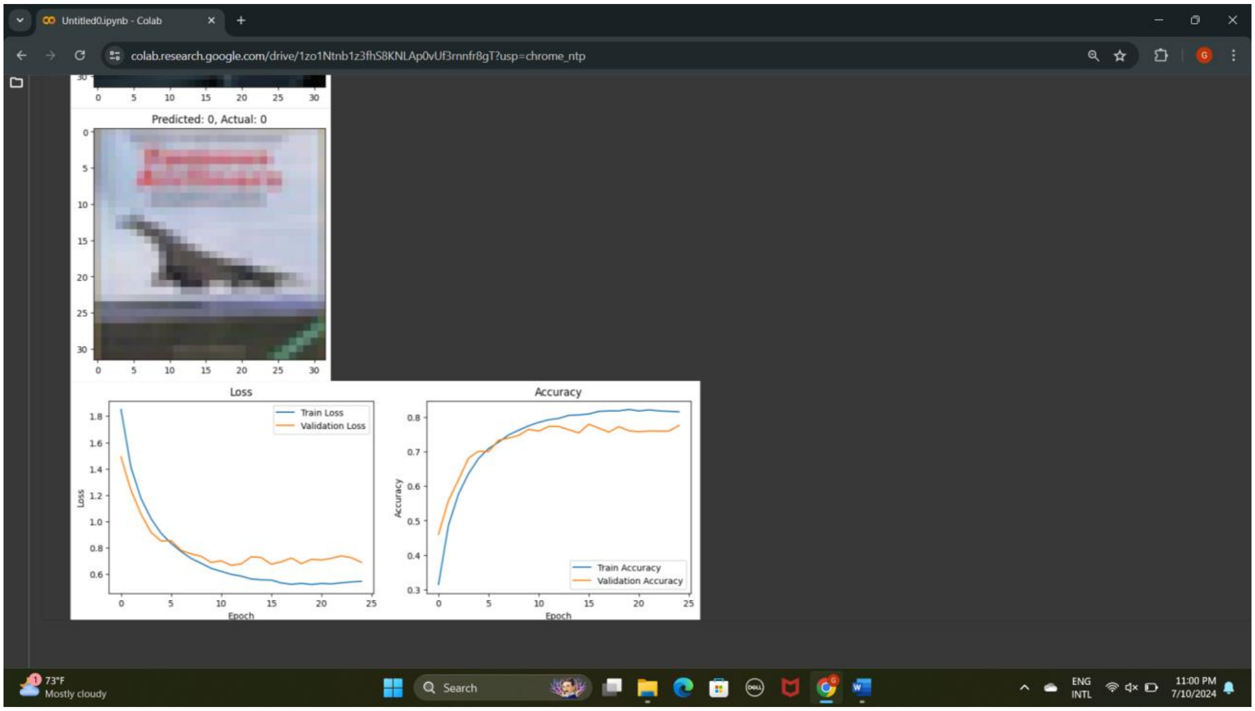
Untitled0.ipynb - Colab
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Predicted: 0, Actual: 0
Loss
Train Loss
Validation Loss
Loss
1.8
1.6
1.4
1.2
1.0
0.8
0.6
Epoch
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Accuracy
Accuracy
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0.6
0.5
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Train Accuracy
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