Spring 2024: CS5720 Neural Networks & Deep Learning - ICP-7
Assignment-7
NAME: Bhavana Billa
STUDENT ID:700756590

Github Link:

https://github.com/BillaBhavana7/neuralN

```
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import tensorflow as tf
from tensorflow import keras
from tensorflow.keras.optimizers import RMSprop, Adam
from sklearn.metrics import ConfusionMatrixDisplay
from sklearn.metrics import classification_report, confusion_matrix
import warnings
warnings.filterwarnings("ignore")
```

```
(x_train, y_train), (x_test, y_test)  = keras.datasets.cifar10.load_data()
```

```
Downloading data from https://www.cs.toronto.edu/~kriz/cifar-10-python.tar.gz
170498071/170498071 [==============================] - 2s 0us/step
```

```
classes = ["airplane","automobile","bird","cat","deer","dog","frog","horse","ship","truck"]
```

```
y_train = y_train.reshape(-1,)
```

```
# Reshape converting 2D to 1D
y_test = y_test.reshape(-1,)
y_train = y_train.reshape(-1,)
```

```
# This code normalazation
x_train = x_train / 255.0
x_test = x_test / 255.0
```

```
x_train.shape
```

```
(50000, 32, 32, 3)
```

```
from tensorflow.keras import layers, models
lenet = keras.models.Sequential([
    keras.layers.Conv2D(32, kernel_size=3, strides=1,  activation='relu', input_shape=(32,32,3), padding='sa
    keras.layers.Conv2D(32, kernel_size=3, strides=1, activation='relu', padding='same'), #C2
    keras.layers.MaxPooling2D(pool_size=2, strides=2), #S1
    keras.layers.Dropout(0.25),
    keras.layers.Conv2D(64, kernel_size=3, strides=1, activation='relu', padding='same'), #C3
    keras.layers.Conv2D(64, kernel_size=3, strides=1, activation='relu', padding='same'), #C4
    keras.layers.MaxPooling2D(pool_size=2, strides=2), #S2
    keras.layers.Dropout(0.25),
    keras.layers.Conv2D(128, kernel_size=3, strides=1, activation='relu', padding='same'), #C5
    keras.layers.Conv2D(128, kernel_size=3, strides=1, activation='relu', padding='same'), #C6
    keras.layers.MaxPooling2D(pool_size=2, strides=2), #S3
    keras.layers.Dropout(0.25),
    keras.layers.Flatten(), #Flatten
    keras.layers.Dense(512, activation='relu'), #F1
    keras.layers.Dropout(0.5),
    keras.layers.Dense(10, activation='softmax') #Output layer
])
```

```
lenet.summary()
```

```
Model: "sequential"
_________________________________________________________________
 Layer (type)                Output Shape              Param #
=================================================================
 conv2d (Conv2D)             (None, 32, 32, 32)        896

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

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

 dropout (Dropout)           (None, 16, 16, 32)        0

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

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

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

 dropout_1 (Dropout)         (None, 8, 8, 64)          0

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

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

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

 dropout_2 (Dropout)         (None, 4, 4, 128)         0

 flatten (Flatten)           (None, 2048)              0

 dense (Dense)               (None, 512)               1049088
```

```
lenet.compile(optimizer='adam', loss=keras.losses.sparse_categorical_crossentropy, metrics=['accuracy'])
```

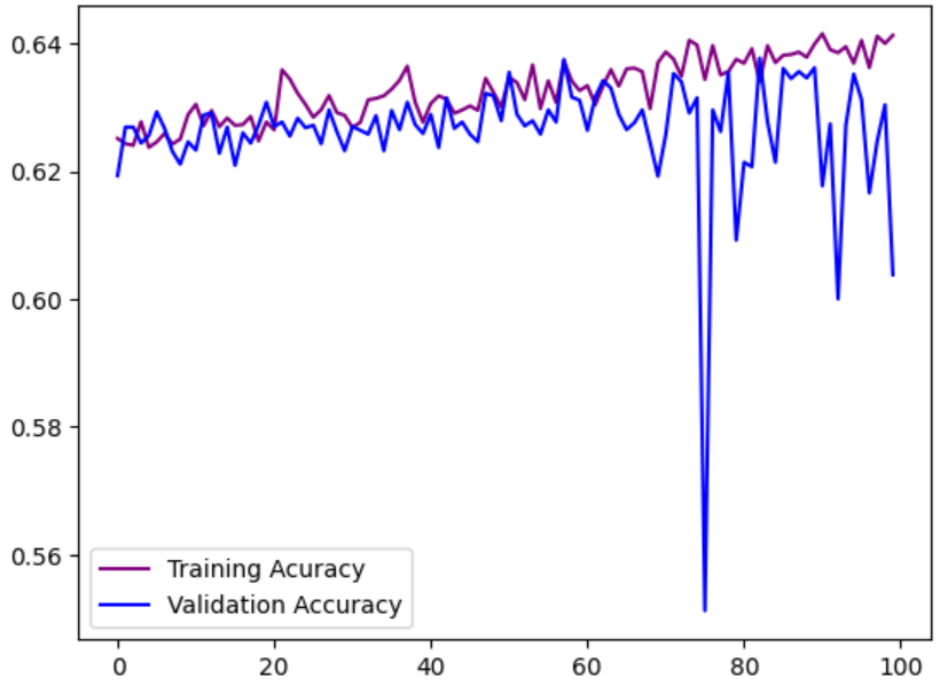
```
hist = lenet.fit(x_train, y_train, epochs=5, validation_data=(x_test, y_test),verbose=1)
```

```
Epoch 1/5
1563/1563 [==============================] - 397s 254ms/step - loss: 1.2135 - accuracy: 0.5651 - val_loss: 1.
0869 - val_accuracy: 0.6111
Epoch 2/5
1563/1563 [==============================] - 406s 260ms/step - loss: 1.0362 - accuracy: 0.6328 - val_loss: 0.
8905 - val_accuracy: 0.6853
Epoch 3/5
1563/1563 [==============================] - 403s 258ms/step - loss: 0.9405 - accuracy: 0.6669 - val_loss: 0.
8178 - val_accuracy: 0.7106
Epoch 4/5
1563/1563 [==============================] - 395s 253ms/step - loss: 0.8742 - accuracy: 0.6951 - val_loss: 0.
8158 - val_accuracy: 0.7195
Epoch 5/5
1563/1563 [==============================] - 390s 250ms/step - loss: 0.8228 - accuracy: 0.7124 - val_loss: 0.
7578 - val_accuracy: 0.7349
```

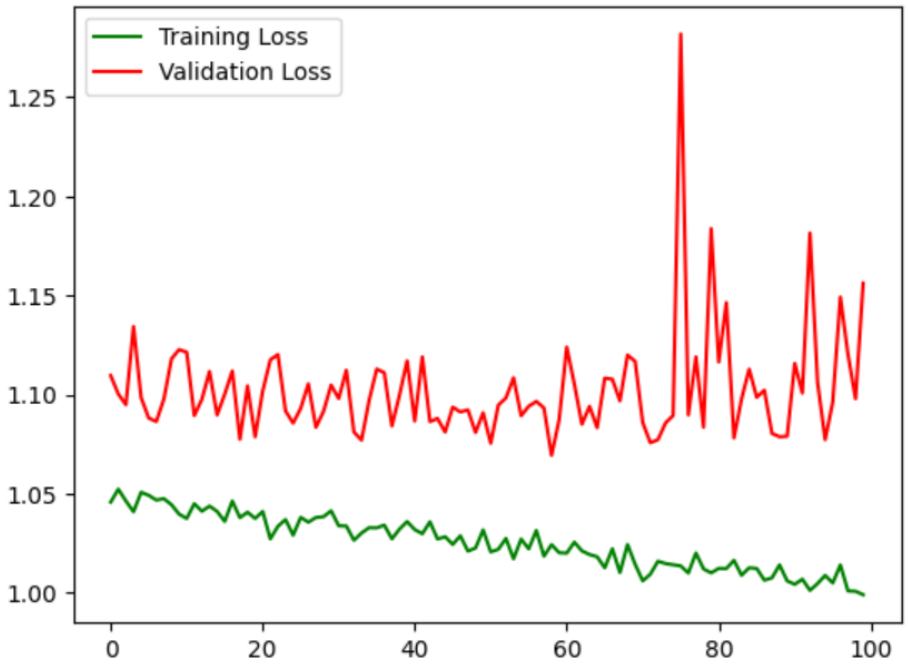
```
aug_data = keras.preprocessing.image.ImageDataGenerator(
    rotation_range=10,
    width_shift_range=0.1,
    height_shift_range=0.1,
    zoom_range=0.1,
    horizontal_flip=True,
    fill_mode='nearest')

aug_data.fit(x_train)

from tensorflow.keras import layers, models
lenet =  keras.models.Sequential([
         keras.layers.Conv2D(32, kernel_size=3, activation='relu', input_shape=(32,32,3), padding='same'
         keras.layers.BatchNormalization(),
         keras.layers.Conv2D(32, kernel_size=3, activation='relu', padding='same'),
         keras.layers.BatchNormalization(),
         keras.layers.MaxPooling2D(pool_size=2),
         keras.layers.Dropout(0.25),
         keras.layers.Conv2D(64, kernel_size=3, activation='relu', padding='same'),
         keras.layers.BatchNormalization(),
         keras.layers.Conv2D(64, kernel_size=3, activation='relu', padding='same'),
         keras.layers.BatchNormalization(),
         keras.layers.MaxPooling2D(pool_size=2),
         keras.layers.Dropout(0.25),
         keras.layers.Conv2D(128, kernel_size=3, activation='relu', padding='same'),
         keras.layers.BatchNormalization(),
         keras.layers.Conv2D(128, kernel_size=3, activation='relu', padding='same'),
         keras.layers.BatchNormalization(),
         keras.layers.MaxPooling2D(pool_size=2),
         keras.layers.Dropout(0.25),
          keras.layers.Flatten(),
```

```
# summarize history for accuracy
plt.plot(history.history['accuracy'])
plt.plot(history.history['val_accuracy'])
plt.title("Accuracy by LeNet on CIFAR-10 Data")
plt.ylabel('Accuracy')
plt.xlabel('Epochs')
plt.legend(['Train', 'Validation'], loc='upper left')
plt.show()
# summarize history for loss
plt.plot(history.history['loss'])
plt.plot(history.history['val_loss'])
plt.title('Loss by LeNet on CIFAR-10 Data')
plt.ylabel('Loss')
plt.xlabel('Epochs')
plt.legend(['Train', 'Validation'])
plt.show()
```

```
<matplotlib.legend.Legend at 0x7f75101e8160>
```




```
<matplotlib.legend.Legend at 0x7f75101e8d30>
```

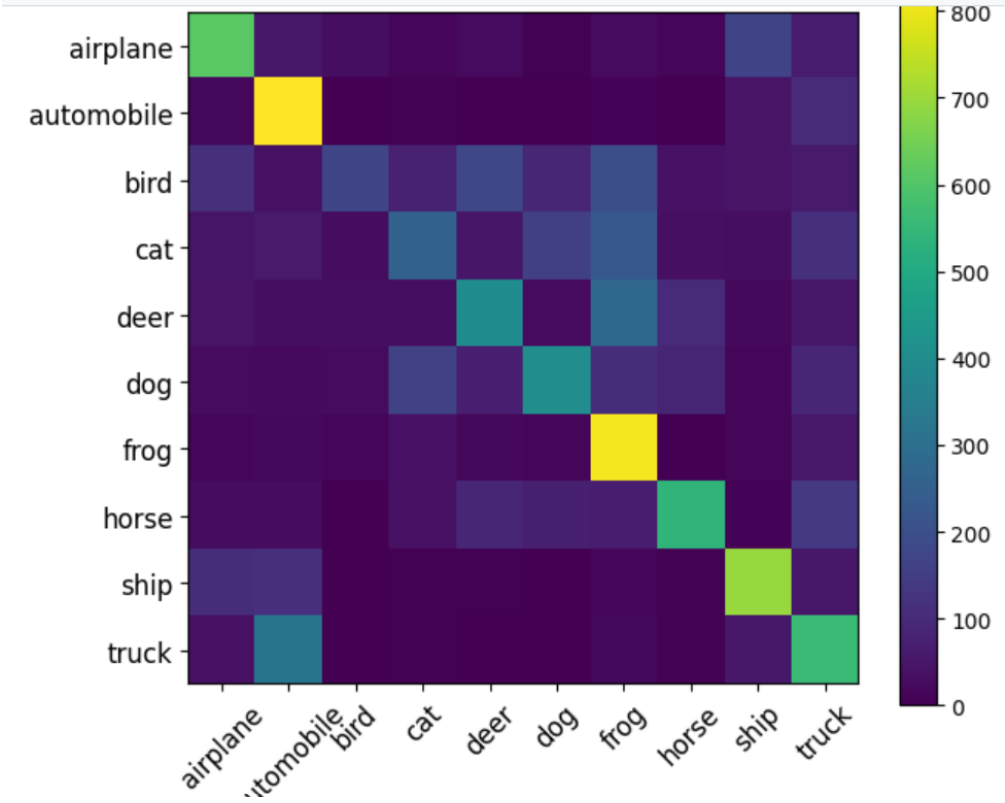


```
from sklearn.metrics import confusion_matrix
from sklearn.metrics import ConfusionMatrixDisplay
y_predictions= lenet.predict(x_test)
y_predictions.reshape(-1,)
y_predictions= np.argmax(y_predictions, axis=1)

confusion_matrix(y_test, y_predictions)
```

```
313/313 [==============================] - 22s 71ms/step
array([[612,  54,  29,  14,  23,   4,  24,  11, 167,  62],
       [ 19, 823,   0,   4,   1,   0,   9,   1,  43, 100],
       [114,  36, 173,  76, 174,  89, 199,  39,  42,  58],
       [ 47,  61,  27, 256,  51, 155, 228,  35,  29, 111],
       [ 44,  29,  29,  29, 399,  24, 279,  97,  18,  52],
       [ 24,  20,  23, 163,  70, 403, 108,  85,  14,  90],
       [ 10,  19,  13,  41,  19,  16, 813,   2,  10,  57],
       [ 27,  28,   3,  36,  88,  72,  63, 537,   8, 138],
       [109, 111,   2,   6,   5,   2,  14,   4, 695,  52],
       [ 37, 321,   0,   5,   1,   0,  17,   4,  54, 561]])
```

```
# confusion matrix and accuracy
from sklearn.metrics import confusion_matrix, accuracy_score
plt.figure(figsize=(7, 6))
plt.title('Confusion matrix', fontsize=16)
plt.imshow(confusion_matrix(y_test, y_predictions))
plt.xticks(np.arange(10), classes, rotation=45, fontsize=12)
plt.yticks(np.arange(10), classes, fontsize=12)
plt.colorbar()
plt.show()
```

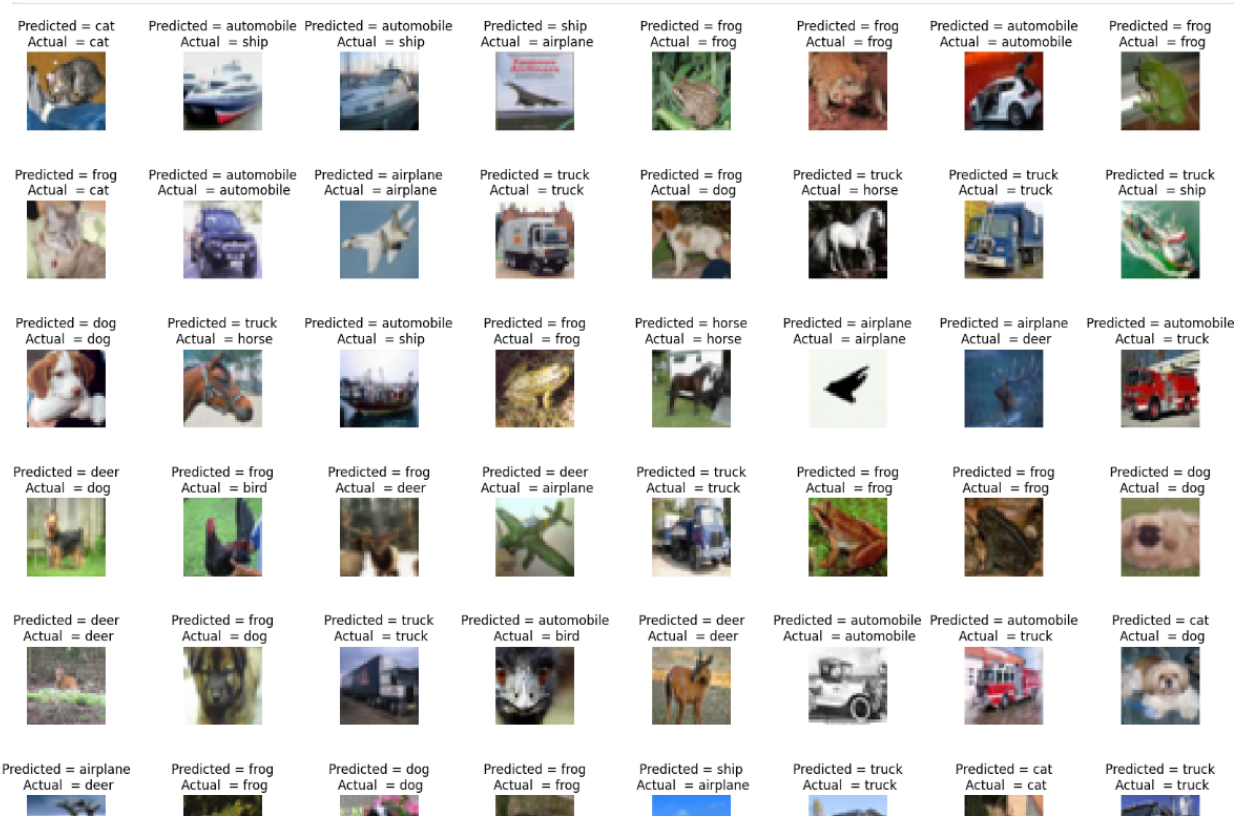
Code | Blame 624 lines (624 loc) · 607 KB Code 55% faster with GitHub Copilot Raw




```
print("Test accuracy:", accuracy_score(y_test, y_predictions))
```

```
Test accuracy: 0.5272
```

```
L = 8
W = 8
fig, axes = plt.subplots(L, W, figsize = (20,20))
axes = axes.ravel() #

for i in np.arange(0, L * W):
    axes[i].imshow(x_test[i])
    axes[i].set_title("Predicted = {}\n Actual  = {}".format(classes[y_predictions[i]], classes[y_test[i]]))
    axes[i].axis('off')

plt.subplots_adjust(wspace=1)
```




```
from tensorflow.keras.models import Sequential
from tensorflow.keras.layers import Dense, Conv2D, Dropout, Flatten, MaxPooling2D
from tensorflow.keras.optimizers import SGD, Adam
```

```
#Define Alexnet Model
AlexNet = Sequential()
AlexNet.add(Conv2D(filters=16,kernel_size=(3,3),strides=(4,4),input_shape=(32,32,3), activation='relu'))
AlexNet.add(MaxPooling2D(pool_size=(2,2),strides=(2,2)))
AlexNet.add(Conv2D(60,(5,5),padding='same',activation='relu'))
AlexNet.add(MaxPooling2D(pool_size=(2,2),strides=(2,2)))
AlexNet.add(Conv2D(60,(3,3),padding='same',activation='relu'))
AlexNet.add(Conv2D(30,(3,3),padding='same',activation='relu'))
AlexNet.add(Conv2D(20,(3,3),padding='same',activation='relu'))
AlexNet.add(MaxPooling2D(pool_size=(2,2),strides=(2,2)))
AlexNet.add(Flatten())
AlexNet.add(Dense(200, activation='relu'))
AlexNet.add(Dropout(0.1))
AlexNet.add(Dense(200, activation='relu'))
AlexNet.add(Dropout(0.1))
AlexNet.add(Dense(10,activation='softmax'))

AlexNet.compile(optimizer='SGD', loss=keras.losses.sparse_categorical_crossentropy, metrics=['accuracy'])
AlexNet.summary()
```

```
Model: "sequential_4"
_________________________________________________________________
 Layer (type)                Output Shape              Param #
=================================================================
 conv2d_24 (Conv2D)          (None, 8, 8, 16)          448

 max_pooling2d_12 (MaxPooli  (None, 4, 4, 16)          0
 ng2D)

 conv2d_25 (Conv2D)          (None, 4, 4, 60)          24060

 max_pooling2d_13 (MaxPooli  (None, 2, 2, 60)          0
 ng2D)

 conv2d_26 (Conv2D)          (None, 2, 2, 60)          32460

 conv2d_27 (Conv2D)          (None, 2, 2, 30)          16230

 conv2d_28 (Conv2D)          (None, 2, 2, 20)          5420

 max_pooling2d_14 (MaxPooli  (None, 1, 1, 20)          0
 ng2D)

 flatten_4 (Flatten)         (None, 20)                0

 dense_8 (Dense)             (None, 200)               4200

 dropout_16 (Dropout)        (None, 200)               0

 dense_9 (Dense)             (None, 200)               40200

 dropout_17 (Dropout)        (None, 200)               0

 dense_10 (Dense)            (None, 10)                2010
```