Spring 2024

Neural Networks & Deep Learning - ICP-8

Image classification with CNN

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Github Link: https://github.com/LithinVemulapalli/Neural-Networks-Assignments

Programming elements:

1. About CNN

2. Hyperparameters of CNN

3. Image classification with CNN

In class programming: 1. Tune hyperparameter and make necessary addition to the baseline model to improve validation accuracy and reduce validation loss.

2. Provide logical description of which steps lead to improved response and what was its impact on architecture behavior.

3. Create at least two more visualizations using matplotlib (Other than provided in the source file)

4. Use dataset of your own choice and implement baseline models provided.

5. Apply modified architecture to your own selected dataset and train it.

6. Evaluate your model on testing set.

7. Save the improved model and use it for prediction on testing data

8. Provide plot of confusion matric

9. Provide Training and testing Loss and accuracy plots in one plot using subplot command and history object.

10. Provide at least two more visualizations reflecting your solution.

11. Provide logical description of which steps lead to improved response for new dataset when compared with baseline model and enhance architecture and what was its impact on architecture behavior.

CODE & SCREENSHOTS FOR RESULTS:

```
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns
import tensorflow as tf
from tensorflow.keras.datasets import mnist

from tensorflow.keras.optimizers import RMSprop
from keras.preprocessing import image
from tensorflow.keras.preprocessing.image import ImageDataGenerator
from tensorflow.keras.layers import Dense, Flatten, Conv2D, MaxPooling2D, Dropout, BatchNormalization

%matplotlib inline
```

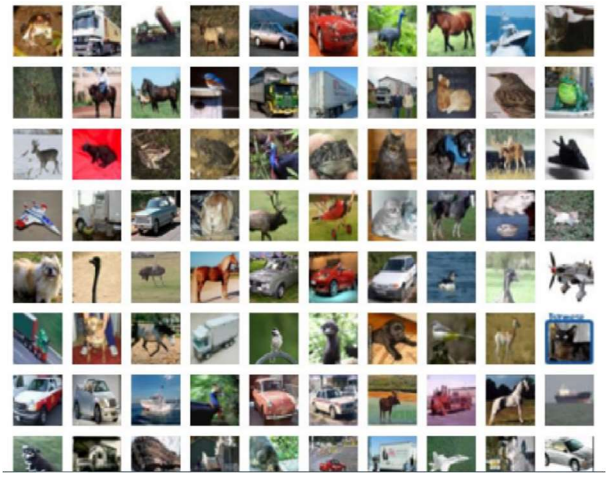
Extract data and train and test dataset

```
#cifar100 = tf.keras.datasets.cifar100
(X_train,Y_train) , (X_test,Y_test) = cifar10.load_data()
```

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

Let's look into the dataset images

```
plt.figure(figsize = (16,16))
for i in range(100):
  plt.subplot(10,10,1+i)
  plt.axis('off')
  plt.imshow(X_train[i], cmap = 'gray')
```



```
from sklearn.model_selection import train_test_split
x_train, x_val, y_train, y_val = train_test_split(X_train,Y_train,test_size=0.2)
```

```
from keras.utils.np_utils import to_categorical
y_train = to_categorical(y_train, num_classes = 10)
y_val = to_categorical(y_val, num_classes = 10)
```

```
print(x_train.shape)
print(y_train.shape)
print(x_val.shape)
print(y_val.shape)
print(X_test.shape)
print(Y_test.shape)
```

```
(40000, 32, 32, 3)
(40000, 10)
(10000, 32, 32, 3)
(10000, 10)
(10000, 32, 32, 3)
(10000, 1)
```

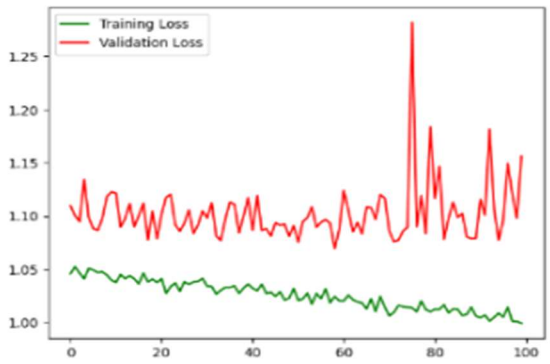
```
train_datagen = ImageDataGenerator(
    preprocessing_function = tf.keras.applications.vgg19.preprocess_input,
    rotation_range=10,
    zoom_range = 0.1,
    width_shift_range = 0.1,
    height_shift_range = 0.1,
    shear_range = 0.1,
    horizontal_flip = True
)
train_datagen.fit(x_train)

val_datagen = ImageDataGenerator(preprocessing_function = tf.keras.applications.vgg19.preprocess_input)
val_datagen.fit(x_val)
```

```
from keras.callbacks import ReduceLROnPlateau
learning_rate_reduction = ReduceLROnPlateau(monitor='val_accuracy',
                                            patience=3,
                                            verbose=1,
                                            factor=0.5,
                                            min_lr=0.00001)
```

Out[76]: <matplotlib.legend.Legend at 0x7f75101e8160>

In [77]:
```
loss = history.history['loss']
val_loss = history.history['val_loss']

plt.figure()
plt.plot(loss,color = 'green',label = 'Training Loss')
plt.plot(val_loss,color = 'red',label = 'Validation Loss')
plt.legend()
```

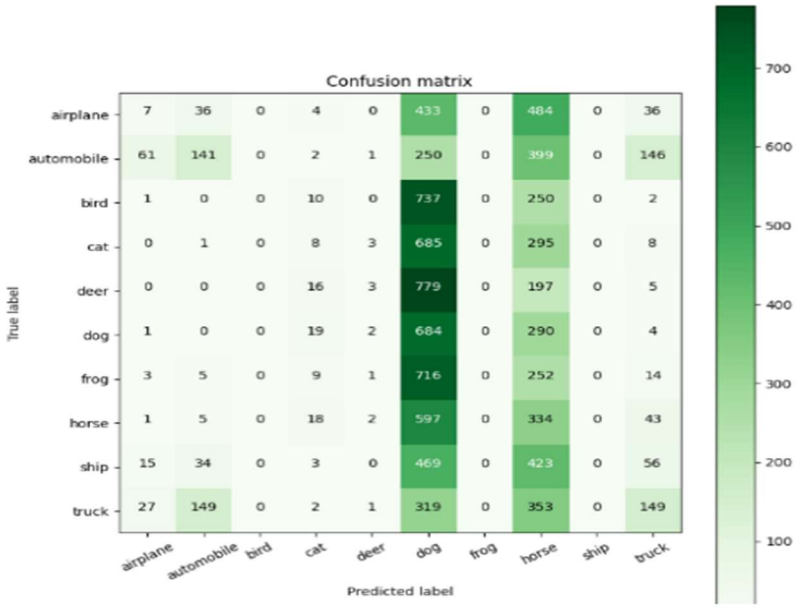
Out[77]: <matplotlib.legend.Legend at 0x7f75101e8d30>




```
import itertools
def plot_confusion_matrix(cm, classes,
                          normalize=False,
                          title='Confusion matrix',
                          cmap=plt.cm.Greens):
    """
    This function prints and plots the confusion matrix.
    Normalization can be applied by setting `normalize=True`.
    """
    plt.imshow(cm, interpolation='nearest', cmap=cmap)
    plt.title(title)
    plt.colorbar()
    tick_marks = np.arange(len(classes))
    plt.xticks(tick_marks, classes, rotation=30)
    plt.yticks(tick_marks, classes)

    if normalize:
        cm = cm.astype('float') / cm.sum(axis=1)[:, np.newaxis]
        print("Normalized confusion matrix")
    else:
        print('Confusion matrix, without normalization')

    #print(cm)

    thresh = cm.max() / 2.
    for i, j in itertools.product(range(cm.shape[0]), range(cm.shape[1])):
        plt.text(j, i, cm[i, j],
            horizontalalignment="center",
            color="white" if cm[i, j] > thresh else "black")

    plt.tight_layout()
    plt.ylabel('True label')
    plt.xlabel('Predicted label')
```

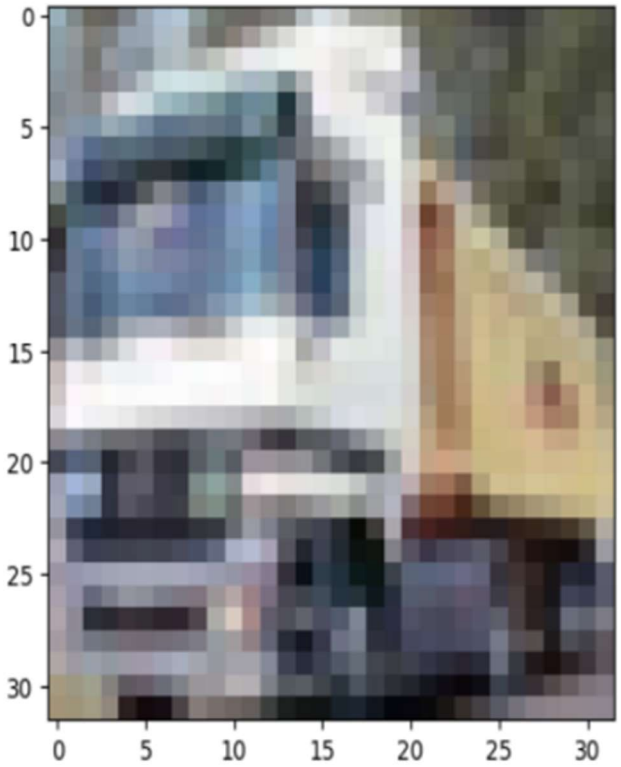
```
plt.figure(figsize=(8,8))
plot_confusion_matrix(cm,classes)
```

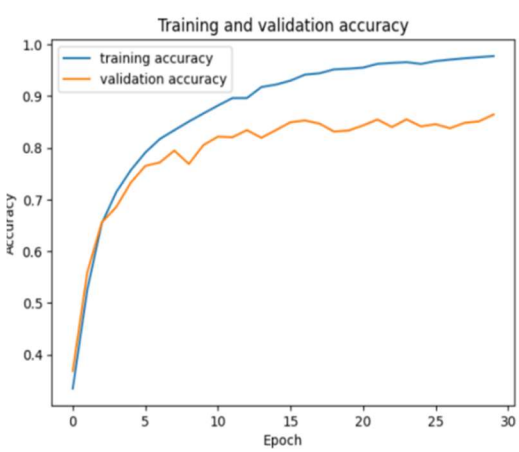
```
Confusion matrix, without normalization
```




```
# check data
plt.imshow(x_train[1])
print(x_train[1].shape)
```

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




Training and validation accuracy
training accuracy
validation accuracy
Accuracy
Epoch
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0
5
10
15
20
25
30


Training and validation loss
training loss
validation loss
Loss
Epoch
2.5
2.0
1.5
1.0
0.5
0.0
0
5
10
15
20
25
30