DAI_ASSIGNMENT_1_Q3.ipynb

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Q3. Use the CIFAR10 dataset, take 5 classes and perform the classification. Print confusion matrix for 5 classes. [Download Dataset from here]
[20 Marks] Note: Code for Confusion matrix must be done from scratch, else no marks will be awarded.

```
[2] from tensorflow.keras import datasets
    import numpy as np
    filtered_images=[]
    (train_images, train_labels), (test_images, test_labels)= datasets.cifar10.load_data()
    print('Images Shape: {}'.format(train_images.shape))
    print('Labels Shape: {}'.format(train_labels.shape))
    for i in range(0,5):
      idx = (train_labels == i).reshape(train_images.shape[0])
      # print('Index Shape: {}'.format(idx.shape))
      filtered_images.append(train_images[idx])
    print('Filtered Images Shape: {}'.format(np.array(filtered_images).shape))
```

```
Images Shape: (50000, 32, 32, 3)
Labels Shape: (50000, 1)
Filtered Images Shape: (5, 5000, 32, 32, 3)
```

```
[3] # Train Images
    Xtrain_airplane = np.array(filtered_images[0])
    Xtrain_automobile = np.array(filtered_images[1])
    Xtrain_bird = np.array(filtered_images[2])
    Xtrain_cat = np.array(filtered_images[3])
    Xtrain_deer = np.array(filtered_images[4])
```

```
[4] filtered_labels = []
    for i in range(0,5):
      idx = (train_labels == i).reshape(train_labels.shape[0])
      filtered_labels.append(train_labels[idx])
    print('Filtered labels Shape: {}'.format(np.array(filtered_labels).shape))
```

```
Filtered labels Shape: (5, 5000, 1)
```

```
[5] # Train Labels
    Ytrain_airplane = filtered_labels[0]
    Ytrain_automobile = filtered_labels[1]
    Ytrain_bird = filtered_labels[2]
    Ytrain_cat = filtered_labels[3]
    Ytrain_deer = filtered_labels[4]
```

```
[6] filtered_images_test = []
    for i in range(0,5):
      idx = (test_labels == i).reshape(test_images.shape[0])
      # print('Index Shape: {}'.format(idx.shape))
      filtered_images_test.append(test_images[idx])
    print('Filtered Images Shape: {}'.format(np.array(filtered_images_test).shape))
```

```
Filtered Images Shape: (5, 1000, 32, 32, 3)
```

```
[7] # Test Images
    Xtest_airplane = np.array(filtered_images_test[0])
    Xtest_automobile = np.array(filtered_images_test[1])
    Xtest_bird = np.array(filtered_images_test[2])
    Xtest_cat = np.array(filtered_images_test[3])
    Xtest_deer = np.array(filtered_images_test[4])
```

```
[8] filtered_labels_test = []
    for i in range(0,5):
      idx = (test_labels == i).reshape(test_labels.shape[0])
      filtered_labels_test.append(test_labels[idx])
    print('Filtered labels Shape: {}'.format(np.array(filtered_labels_test).shape))
```

```
Filtered labels Shape: (5, 1000, 1)
```

```
[9] # Test Labels
    Ytest_airplane = filtered_labels_test[0]
    Ytest_automobile = filtered_labels_test[1]
    Ytest_bird = filtered_labels_test[2]
    Ytest_cat = filtered_labels_test[3]
    Ytest_deer = filtered_labels_test[4]
```

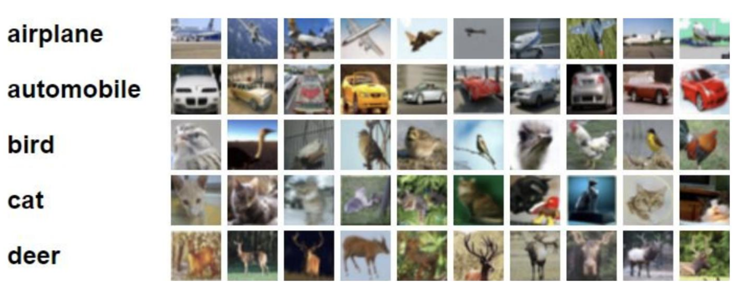
```
[10] X_train = np.concatenate((Xtrain_airplane,
                              Xtrain_automobile,
                              Xtrain_bird,
                              Xtrain_cat,
                              Xtrain_deer))

     Y_train = np.concatenate((Ytrain_airplane,
                              Ytrain_automobile,
                              Ytrain_bird,
                              Ytrain_cat,
                              Ytrain_deer))

     X_test = np.concatenate((Xtest_airplane,
                              Xtest_automobile,
                              Xtest_bird,
                              Xtest_cat,
                              Xtest_deer))

     Y_test = np.concatenate((Ytest_airplane,
                              Ytest_automobile,
                              Ytest_bird,
                              Ytest_cat,
                              Ytest_deer))
     print(X_train.shape)
     print(Y_train.shape)
     print(X_test.shape)
     print(Y_test.shape)
```

```
(25000, 32, 32, 3)
(25000, 1)
(5000, 32, 32, 3)
(5000, 1)
```

Hurray! We have completed the preprocessing of the data

```
[11] classes = ["airplane",#0
               "automobile",#1
               "bird",#2
               "cat",#3
               "deer",#4
               ]
```

from question 1 we have learned that we will be dealing with class labels and plotting images multiple times. Thus we can define a function which will handle label and image showing.



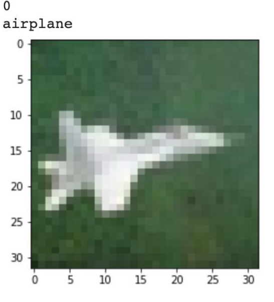

```
[ ]
```

```
[ ]
```

```
[12] import matplotlib.pyplot as plt
     import numpy as np
     def show_label_and_image(X,Y,index):
       print("The image in training set is desiplayed as:")
       plt.imshow(np.array(X[index]))
       print("The label associated with this image is in training set:")
       print(Y[index][0])
       print(classes[Y[index][0]])
```

```
[13] show_label_and_image(X_train, Y_train, 4)
```

```
The image in training set is desiplayed as:
The label associated with this image is in training set:
0
airplane
```




```
[14] X_train = X_train / 255.0
     X_test = X_test / 255.0
```

Considering 5 classes as: "airplane",#0 "automobile",#1 "bird",#2 "cat",#3 "deer",#4

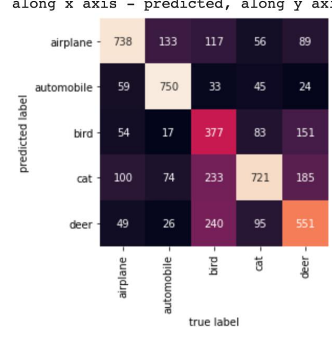
```
[18] import tensorflow as tf
     from tensorflow.keras import layers, models

     ann = models.Sequential([
             layers.Flatten(input_shape=(32,32,3)),
             layers.Dense(256, activation='relu'),
             layers.Dense(256, activation='relu'),
             layers.Dense(10, activation='sigmoid')
         ])

     ann.compile(optimizer='SGD',
                   loss='sparse_categorical_crossentropy',
                   metrics=['accuracy'])

     ann.fit(X_train, Y_train, epochs=10)
```

```
Epoch 1/10
782/782 [==============================] - 5s 6ms/step - loss: 1.4584 - accuracy: 0.3935
Epoch 2/10
782/782 [==============================] - 5s 6ms/step - loss: 1.1908 - accuracy: 0.5275
Epoch 3/10
782/782 [==============================] - 5s 6ms/step - loss: 1.1268 - accuracy: 0.5511
Epoch 4/10
782/782 [==============================] - 5s 6ms/step - loss: 1.0755 - accuracy: 0.5796
Epoch 5/10
782/782 [==============================] - 5s 6ms/step - loss: 1.0421 - accuracy: 0.5915
Epoch 6/10
782/782 [==============================] - 5s 6ms/step - loss: 1.0208 - accuracy: 0.5966
Epoch 7/10
782/782 [==============================] - 4s 6ms/step - loss: 0.9764 - accuracy: 0.6201
Epoch 8/10
782/782 [==============================] - 5s 6ms/step - loss: 0.9544 - accuracy: 0.6228
Epoch 9/10
782/782 [==============================] - 5s 6ms/step - loss: 0.9371 - accuracy: 0.6351
Epoch 10/10
782/782 [==============================] - 5s 6ms/step - loss: 0.9133 - accuracy: 0.6420
<tensorflow.python.keras.callbacks.History at 0x7f5d9d3f86a0>
```

Evaluation Metrics using inbuilt function

```
[24] from sklearn.metrics import confusion_matrix , classification_report
     import numpy as np
     y_pred = ann.predict(X_test)
     y_pred_classes = [np.argmax(element) for element in y_pred]

     print("Classification Report: \n", classification_report(Y_test, y_pred_classes))
     print("Confusion Matrix: \n", confusion_matrix(Y_test, y_pred_classes))
     print("along x axis - predicted, along y axis - Actual")

     import seaborn as sns

     matrix = confusion_matrix(Y_test, y_pred_classes)
     sns.heatmap(matrix, square=True, annot=True, fmt='d', cbar=False,
                 xticklabels=classes,
                 yticklabels=classes)
     plt.xlabel('true label')
     plt.ylabel('predicted label');
```

```
Classification Report:
               precision    recall  f1-score   support

           0       0.65      0.74      0.69      1000
           1       0.82      0.75      0.78      1000
           2       0.55      0.38      0.45      1000
           3       0.55      0.72      0.62      1000
           4       0.57      0.55      0.56      1000

    accuracy                           0.63      5000
   macro avg       0.63      0.63      0.62      5000
weighted avg       0.63      0.63      0.62      5000

Confusion Matrix:
 [[738  59  54 100  49]
 [133 750  17  74  26]
 [117  33 377 233 240]
 [ 56  45  83 721  95]
 [ 89  24 151 185 551]]
along x axis - predicted, along y axis - Actual
```



Evaluation Metrics and Confusion matrix

without using inbuilt function

```
[25] # This is what we have as of now
     Y_actual = Y_test
     Y_pred = y_pred_classes
```

```
[27] print(len(Y_actual))
     print(len(Y_pred))
```

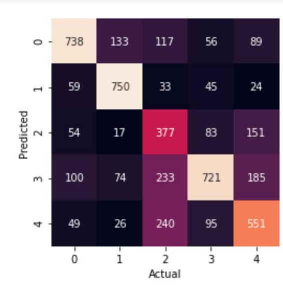
```
5000
5000
```

```
[38] # np.array(Y_actual[:,0])
     Y_pred
     import pandas as pd
     data = {
         'Y_actual': Y_actual[:,0],
         'Y_pred': Y_pred
     }
     df = pd.DataFrame(data, columns=['Y_actual','Y_pred'])
```

```
[52] count=0
     for i in range(5000):
       if(df.Y_actual.iloc[i] == df.Y_pred.iloc[i]):
         count=count+1
       else:
         pass
     print(count)
     print("out of 5000 are correctly classified")
```

```
3137
out of 5000 are correctly classified
```

```
[61]
     confusion_matrix = pd.crosstab(df['Y_pred'], df['Y_actual'], rownames=['Predicted'], colnames=['Actual'])

     sns.heatmap(confusion_matrix, annot=True, square=True, fmt='d', cbar=False,)
     plt.show()
```




```
[63] confusion_matrix
```

Actual	0	1	2	3	4
Predicted					
0	738	133	117	56	89
1	59	750	33	45	24
2	54	17	377	83	151
3	100	74	233	721	185
4	49	26	240	95	551

```
[82] Y_actual = Y_actual[:,0].tolist()
```

```
[83] Y_pred = Y_pred
```

```
[89] rows, cols = (5, 5)
     labels = np.array([0,1,2,3,4])
     # arr = [[0]*cols]*rows
     arr = np.zeros((len(labels), len(labels)))
     for i in range(rows):
       for j in range(cols):
         arr[i,j] = np.sum((Y_actual == labels[i]) & (Y_pred == labels[j]))

     np.array(arr).T
```

```
array([[738., 133., 117.,  56.,  89.],
       [ 59., 750.,  33.,  45.,  24.],
       [ 54.,  17., 377.,  83., 151.],
       [100.,  74., 233., 721., 185.],
       [ 49.,  26., 240.,  95., 551.]])
```

```
[ ] # # Dont know why this did not work????
    # rows, cols = (5, 5)
    # labels = np.array([0,1,2,3,4])
    # arr = [[0]*cols]*rows
    # # arr = np.zeros((len(labels), len(labels)))
    # for i in range(rows):
    #   for j in range(cols):
    #     arr[i][j] = np.sum((Y_actual == labels[i]) & (Y_pred == labels[j]))

    # np.array(arr).T
```

```
[16] # This will waste a lot of time, dont go with this approach :(
     # # cifar10_list[0][1][i][0]
     # for i in range (0,50000):
     #   if(cifar10_list[0][1][i][0]>4):
     #     np.delete(cifar10_list[0][1], i)
     #     np.delete(cifar10_list[0][0], i)
     #     print("deleted", cifar10_list[0][1][i][0])
     # # cifar10_list[0][1]
     # # cifar10_list[0][0]
     # print(len(cifar10_list[0][1]), " in Train Dataset after deletion")
```

```
[17] # This will waste a lot of time, dont go with this approach :(
     # # cifar10_list[1][1][i][0]
     # for i in range (0,10000):
     #   if(cifar10_list[1][1][i][0]>4):
     #     np.delete(cifar10_list[1][1], i)
     #     np.delete(cifar10_list[1][0], i)
     # # cifar10_list[0][1]
     # # cifar10_list[0][0]
     # print(len(cifar10_list[1][1]), " in Test Dataset after deletion")
```