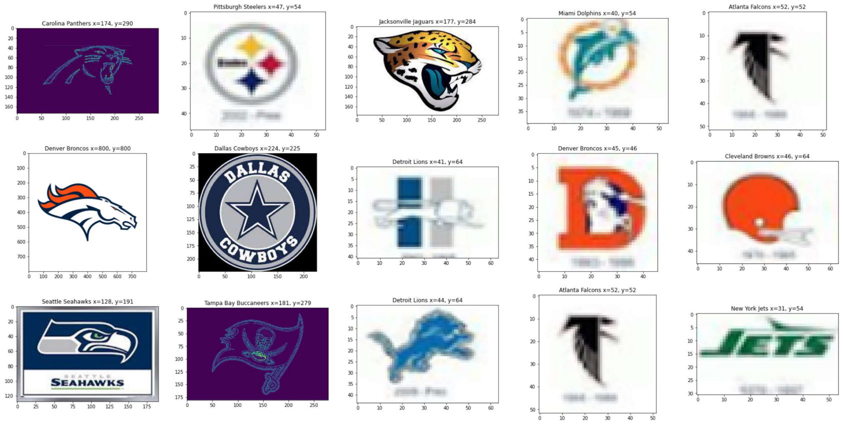
```
import numpy as np
import pandas as pd
import torch
from torch import optim
import torch.nn as nn
from PIL import Image
import os
```

```
from skimage import filters, color, morphology, io
import matplotlib.pyplot as plt
import numpy as np
import random
import skimage as si

from google.colab import auth
from google.colab import drive

import gspread

from google.auth import default
from PIL import Image

#autenticating to google
auth.authenticate_user()
creds, _ = default()
gc = gspread.authorize(creds)

drive.mount('/content/drive')
```

```
     Drive already mounted at /content/drive; to attempt to forcibly remount, call drive.mount("/content/drive", force_remount=True).
```

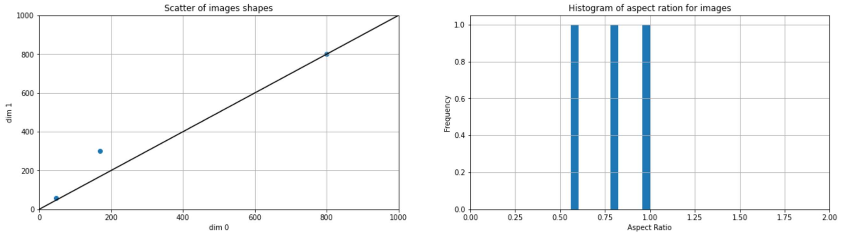
```
sh = gc.open_by_url('https://docs.google.com/spreadsheets/d/1eNgK86cm6L1OVI5iavk7mY3UQUd1VHeXgwXSTyNNuRw/edit?usp=sharing')
ws = sh.worksheet('train')

df = pd.DataFrame(ws.get_all_records())

n1 = 3
n2 = 5

fig, axs = plt.subplots(n1, n2, figsize=(32, 16))

for i in range(n1):
  for j in range(n2):
    z = random.randint(0, len(df)-1)
    pic = np.array(Image.open(df.loc[z]["filepath"]))
    shape = np.shape(pic)
    axs[i, j].imshow(pic)
    axs[i, j].set_title('%s x=%.f, y=%.f' % (df.loc[z]["team_name"], shape[0], shape[1]))
```


Carolina Panthers x=174, y=290
Pittsburgh Steelers x=47, y=54
Jacksonville Jaguars x=177, y=284
Miami Dolphins x=40, y=54
Atlanta Falcons x=52, y=52
Denver Broncos x=800, y=800
Dallas Cowboys x=224, y=225
DALLAS
COWBOYS
Detroit Lions x=41, y=64
Denver Broncos x=45, y=46
Cleveland Browns x=46, y=64
Seattle Seahawks x=128, y=191
SEATTLE
SEAHAWKS
Tampa Bay Buccaneers x=181, y=279
Detroit Lions x=44, y=64
Atlanta Falcons x=52, y=52
New York Jets x=31, y=54
JETS

```
import numpy as np

sample_df = df.sample(frac=0.01, ignore_index=True)

N = len(sample_df)
shape = np.zeros((2, N))

for i in range(N):
    tmp = np.shape(np.array(Image.open(sample_df.loc[i]["filepath"]).convert('L')))
    shape[:, i] = [tmp[0], tmp[1]]

fig, axs = plt.subplots(1, 2, figsize=(20, 5))

axs[0].scatter(shape[0, :], shape[1, :])
axs[0].plot(range(0, 1000), range(0, 1000), 'k')
axs[0].set_ylabel('dim 1')
```

```
axs[0].set_xlabel('dim 0')
axs[0].grid()
axs[0].set_title('Scatter of images shapes')
axs[0].set_xlim([0, 1000])
axs[0].set_ylim([0, 1000])

axs[1].hist(shape[0, :]/shape[1, :])
axs[1].grid()
axs[1].set_xlabel('Aspect Ratio')
axs[1].set_ylabel('Frequency')
axs[1].set_title('Histogram of aspect ration for images')
axs[1].set_xlim([0, 2])

print("Average height " + str(sum(shape[1, :]) / len(shape[1, :])))
```

```
/usr/local/lib/python3.8/dist-packages/PIL/Image.py:975: UserWarning: Palette imag
  warnings.warn(
Average height 385.6666666666667
```

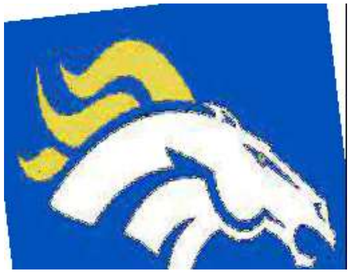


```
from torch.utils.data import Dataset

class CustomDataset(Dataset):
  def __init__(self, X, y, BatchSize, transform):
    super().__init__()
    self.BatchSize = BatchSize
    self.y = y
    self.X = X
    self.transform = transform

  def num_of_batches(self):
    """
    Detect the total number of batches
    """
    return math.floor(len(self.list_IDs) / self.BatchSize)

  def __getitem__(self,idx):
    class_id = self.y[idx]
    img = Image.open(self.X[idx])
    img = img.convert("RGBA").convert("RGB")
    img = self.transform(img)
    return img, torch.tensor(int(class_id))

  def __len__(self):
    return len(self.X)
```

```
from sklearn.model_selection import train_test_split
from torch.utils.data import DataLoader
from torchvision import transforms

# Shuffle dataframe
df = df.sample(frac=1)

X = df.iloc[:,0]
y = df.iloc[:,2]

transform = transforms.Compose([
                transforms.Resize([256,256]),
                transforms.RandomRotation(20, fill=256),
                transforms.ToTensor(),
                transforms.RandomAffine(degrees=0, translate=(0.025, 0.025), fill=256),
                transforms.Normalize([0.5], [0.5])
            ])

test_transform = transforms.Compose([
                transforms.Resize([256,256]),
                transforms.ToTensor(),
                transforms.Normalize((0.5,), (0.5,)),
            ])

train_ratio = 0.80
validation_ratio = 0.1
test_ratio = 0.1
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=1 - train_ratio, stratify = y, random_state = 0)
X_val, X_test, y_val, y_test = train_test_split(X_test, y_test, test_size=test_ratio/(test_ratio + validation_ratio), random_state = 0)

dataset_stages = ['train', 'val', 'test']

batch_size = 16
image_datasets = {'train' : CustomDataset(X_train.values, y_train.values, batch_size, transform), 'val' : CustomDataset(X_val.values, y_val.values, batch_size, test_transform), 'test' : Cu
dataloaders = {x: DataLoader(image_datasets[x], batch_size=image_datasets[x].BatchSize,
                                            shuffle=True, num_workers=0)
            for x in dataset_stages}

dataset_sizes = {x: len(image_datasets[x]) for x in dataset_stages}

print(dataset_sizes)
```

```
{'train': 256, 'val': 32, 'test': 32}
```

```
nparray = image_datasets['train'][12][0].cpu().numpy()
image = transforms.ToPILImage()(image_datasets['train'][12][0].cpu()).convert("RGB")
display(image)
```



```
import time

device = torch.device("cuda:0" if torch.cuda.is_available() else "cpu")

def train_model(model, criterion, optimizer, scheduler, num_epochs=15):
    since = time.time()
    best_acc = 0.0

    for epoch in range(num_epochs):
        print('Epoch {}/{}'.format(epoch, num_epochs - 1))
        print('-' * 10)
        # Each epoch has a training and validation phase
        for phase in ['train', 'val']:
            if phase == 'train':
                model.train()  # Set model to training mode
            else:
                model.eval()   # Set model to evaluate mode

            running_loss = 0.0
            running_corrects = 0
            num_batches = 0
            outputs = None
            # Iterate over data.
            for inputs, labels in dataloaders[phase]:
                # Loading Bar
                if (phase == 'train'):
                    num_batches += 1
                    percentage_complete = ((num_batches * batch_size) / (dataset_sizes[phase])) * 100
                    percentage_complete = np.clip(percentage_complete, 0, 100)
                    print("{:0.2f}".format(percentage_complete), "% complete", end="\r")

                inputs = inputs.to(device)
                labels = labels.to(device)

                # zero the parameter gradients
                optimizer.zero_grad()

                # forward
                # track history if only in train
                with torch.set_grad_enabled(phase == 'train'):
                    outputs = model(inputs)
                    loss = criterion(outputs.float(), labels)

                    # backward + optimize only if in training phase
                    if phase == 'train':
                        loss.backward()
                        # TODO: try removal
                        torch.nn.utils.clip_grad_norm_(model.parameters(), 1)
                        optimizer.step()

                # statistics
                running_loss += loss.item() * inputs.size(0)

                predicted = torch.max(outputs.data, 1)[1]
                running_correct = (predicted == labels).sum()
                running_corrects += running_correct
            if phase == 'train':
                scheduler.step()

            epoch_loss = running_loss / dataset_sizes[phase]

            epoch_acc = running_corrects / dataset_sizes[phase]
            #epoch_acc = sum(epoch_acc) / len(epoch_acc)

            print('{} Loss: {:.4f} Acc: {:.4f}'.format(
                phase, epoch_loss, epoch_acc.item()))

    time_elapsed = time.time() - since
    print('Training complete in {:.0f}m {:.0f}s'.format(
        time_elapsed // 60, time_elapsed % 60))
    return model
```

```
from torchvision import models
from torch.optim import lr_scheduler

model_ft = models.squeezenet1_1(pretrained=True)
model_ft.num_classes = 32 #this is am important compoent of the output model
model_ft.classifier._modules["1"] = nn.Conv2d(512, model_ft.num_classes, kernel_size=(1, 1))
for param in model_ft.parameters():
    param.requires_grad = False
for param in model_ft.classifier.parameters():
    param.requires_grad = True

criterion = nn.CrossEntropyLoss()

optimizer_ft = optim.Adam(model_ft.parameters(), lr=0.01)

exp_lr_scheduler = lr_scheduler.StepLR(optimizer_ft, step_size=7, gamma=0.1)

model_ft = train_model(model_ft.to(device), criterion, optimizer_ft, exp_lr_scheduler, 15)
```

```
Epoch 1/14
----------
train Loss: 159.2531 Acc: 0.0234
val Loss: 7.6000 Acc: 0.2188
Epoch 2/14
----------
train Loss: 79.3299 Acc: 0.0195
```

```
val Loss: 2.2878 Acc: 0.4062
Epoch 5/14
----------
train Loss: 1.8191 Acc: 0.5938
val Loss: 1.7701 Acc: 0.4688
Epoch 6/14
----------
train Loss: 1.2943 Acc: 0.7188
val Loss: 1.3828 Acc: 0.5938
Epoch 7/14
----------
train Loss: 1.0076 Acc: 0.7695
val Loss: 1.3290 Acc: 0.6250
Epoch 8/14
----------
train Loss: 1.0009 Acc: 0.7852
val Loss: 1.2691 Acc: 0.6250
Epoch 9/14
----------
train Loss: 0.9485 Acc: 0.7852
val Loss: 1.2447 Acc: 0.6562
Epoch 10/14
----------
train Loss: 0.8635 Acc: 0.8242
val Loss: 1.2506 Acc: 0.6562
Epoch 11/14
----------
train Loss: 0.8894 Acc: 0.8047
val Loss: 1.1966 Acc: 0.6562
Epoch 12/14
----------
train Loss: 0.8936 Acc: 0.7891
val Loss: 1.1513 Acc: 0.6562
Epoch 13/14
----------
train Loss: 0.7530 Acc: 0.8359
val Loss: 1.1350 Acc: 0.6875
Epoch 14/14
----------
train Loss: 0.8291 Acc: 0.8203
val Loss: 1.1350 Acc: 0.6875
Training complete in 2m 28s
```

```
from sklearn.metrics import accuracy_score
from PIL import Image as im


accuracy_scores = []
predicted = []
labels = []

running_corrects = 0
outputs = None
for inputs, labels in dataloaders['test']:
    model_ft.eval()


    inputs = inputs.to(device)
    labels = labels.to(device)

    outputs = model_ft(inputs)
    predicted = torch.max(outputs.data, 1)[1]
    running_correct = (predicted == labels).sum()
    running_corrects += running_correct

accuracy = running_corrects / dataset_sizes['test']
print("Accuracy: " + str(accuracy.item()))
```

```
     Accuracy: 0.75
```

```
y_test.value_counts()

ur_mom = ["Arizona Cardinals", "Atlanta Falcons", "Baltimore Ravens", "Buffalo Bills", "Carolina Panthers", "Chicago Bears",
          "Cincinnati Bengals", "Cleveland Browns", "Dallas Cowboys", "Denver Broncos", "Detroit Lions", "Green Bay Packers",
          "Houston Texans", "Indianapolis Colts", "Jacksonville Jaguars", "Kansas City Chiefs", "Las Vegas Raiders",
          "Los Angeles Chargers", "Los Angeles Rams", "Miami Dolphins", "Minnesota Vikings", "New England Patriots",
          "New Orleans Saints", "New York Giants", "New York Jets", "Philadephia Eagles", "Pittsburgh Steelers",
          "San Francisco 49ers", "Seattle Seahawks", "Tampa Bay Buccaneers", "Tennessee Titans", "Washington Commanders"]

for i in range(0, len(labels)):
  print("Expected Result: ", ur_mom[labels[i]])
  print("         Predicted Result: ", ur_mom[predicted[i]])
  print()
```

```
     Expected Result:  Green Bay Packers
              Predicted Result:  Green Bay Packers

     Expected Result:  Los Angeles Rams
              Predicted Result:  Los Angeles Rams

     Expected Result:  Baltimore Ravens
              Predicted Result:  Baltimore Ravens

     Expected Result:  Tampa Bay Buccaneers
              Predicted Result:  San Francisco 49ers

     Expected Result:  Seattle Seahawks
              Predicted Result:  Seattle Seahawks

     Expected Result:  Philadephia Eagles
              Predicted Result:  Cleveland Browns

     Expected Result:  Dallas Cowboys
              Predicted Result:  Cleveland Browns

     Expected Result:  Minnesota Vikings
              Predicted Result:  Minnesota Vikings

     Expected Result:  Las Vegas Raiders
              Predicted Result:  Las Vegas Raiders

     Expected Result:  New York Giants
              Predicted Result:  New York Giants

     Expected Result:  New Orleans Saints
              Predicted Result:  New Orleans Saints

     Expected Result:  Denver Broncos
              Predicted Result:  Denver Broncos
```

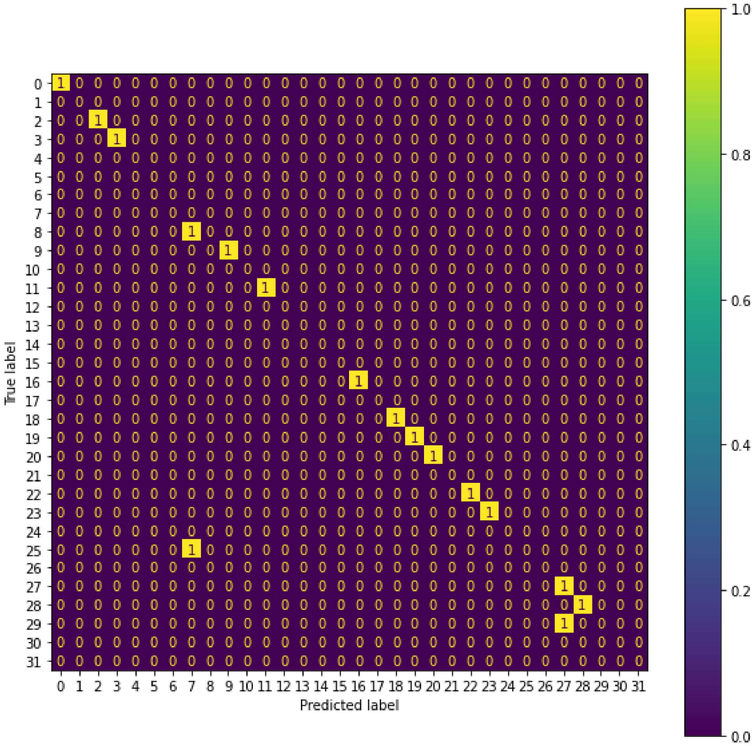
```
Expected Result:  Miami Dolphins
         Predicted Result:  Miami Dolphins

Expected Result:  Arizona Cardinals
         Predicted Result:  Arizona Cardinals

Expected Result:  San Francisco 49ers
         Predicted Result:  San Francisco 49ers

Expected Result:  Buffalo Bills
         Predicted Result:  Buffalo Bills
```

```
temp_X = ["/content/drive/MyDrive/DS_Project/TestMaterial.png"]
temp_y = [31]

display(Image.open(temp_X[0]))

hi = CustomDataset(temp_X, temp_y, 1, transform)
yoit = DataLoader(hi, batch_size=1, shuffle=True, num_workers=0)

for yo,yoyo in yoit:
  model_ft.eval()
  man = model_ft(yo.to(device))
  woman = torch.max(man.data, 1)[1]
  print(ur_mom[woman])
```

```
Washington Commanders
```

```
from sklearn.metrics import confusion_matrix, ConfusionMatrixDisplay

array = range(0,32)
cm = confusion_matrix(labels, predicted, labels=array)
disp = ConfusionMatrixDisplay(confusion_matrix=cm, display_labels=array)
fig, ax = plt.subplots(figsize=(10,10))
disp.plot(ax=ax)
```

```
<sklearn.metrics._plot.confusion_matrix.ConfusionMatrixDisplay at 0x7f387d1bc3a0>
```



	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
21	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
23	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
26	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
27	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
28	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
29	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

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