[Lab 4]

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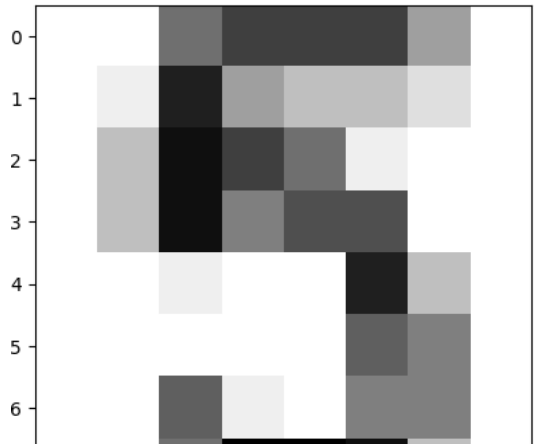
Link github: [Data_Mining/Week3 at main · Shu2301/Data_Mining · GitHub]

```
#Import necessary modules
   from sklearn import datasets
   import matplotlib.pyplot as  plt

   #Load the digits dataset: digits
   digits =  datasets.load_digits()


   #Display image 1010
   plt.imshow(digits.images[1010], cmap = plt.cm.gray_r, interpolation = 'nearest')
   plt.show()
```



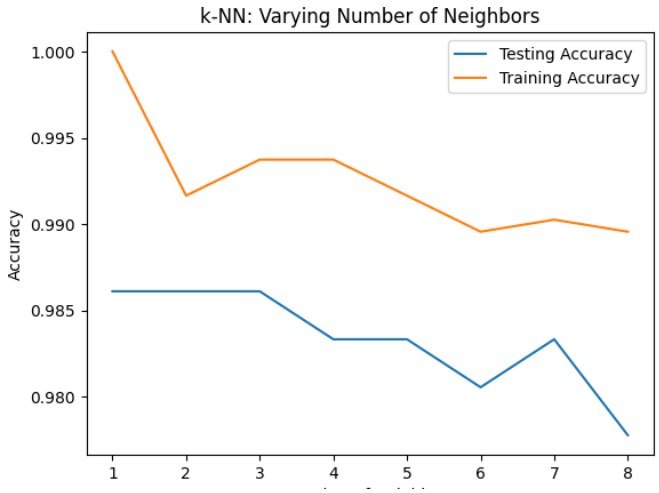

```
   from  sklearn.model_selection   import   train_test_split
   X =  digits.data
   Y= digits.target

   #Split into training and test set
   X_train, X_test, Y_train, Y_test = train_test_split(X, Y, test_size = 0.2, random_state = 42, stratify = Y)


   #Import necessary modules
   from sklearn.neighbors import KNeighborsClassifier

   import numpy as np

   #Create a k-NN classifier with 3  nightbors:  knn
   knn = KNeighborsClassifier(n_neighbors = 3)

   #Fit the classifier to the training data
   knn.fit(X_train, Y_train)

   #Print the accuracy
   print("Accuracy: {0}".format(knn.score(X_test, Y_test)))
```

```
        Accuracy: 0.9861111111111112
```

```
   #Setup arrays to sore train nad test accuracies
   neighbors  =  np.arange(1,  9)
   train_accuracy = np.empty(len(neighbors))
   test_accuracy = np.empty(len(neighbors))

   #Loop over different values of k
   for i,  k in enumerate(neighbors):
      #Setup a k-NN Classifier with k neighbors: knn
      knn = KNeighborsClassifier(n_neighbors = k)
```

```
#FIt the classifier to the training data
knn.fit(X_train, Y_train)

#Compute accuracy on the training set
train_accuracy[i] = knn.score(X_train, Y_train)
```

```
    #Compute accuracy on the training set
    test_accuracy[i] = knn.score(X_test, Y_test)

#Generate plot
plt.title('k-NN: Varying Number of Neighbors')
plt.plot(neighbors, test_accuracy, label = 'Testing Accuracy')
plt.plot(neighbors, train_accuracy, label = 'Training Accuracy')
plt.legend()
plt.xlabel('Number of Neighbors')
plt.ylabel('Accuracy')
plt.show()
```




```
from future import print_function
import torch
import torch.nn as nn
import torch.nn.functional as P
from torch.autograd import Variable


from torchvision import datasets, transforms
mnist = datasets.MNIST(root = '.', train = True, download = True)
```

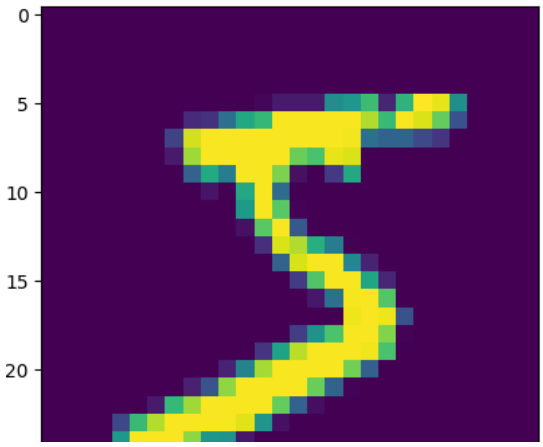
```
Downloading http://yann.lecun.com/exdb/mnist/train-images-idx3-ubyte.gz
Downloading http://yann.lecun.com/exdb/mnist/train-images-idx3-ubyte.gz to ./MNIST/raw/train-images-idx3-ubyte.gz
100%|██████████| 9912422/9912422 [00:00<00:00, 170547429.40it/s]Extracting ./MNIST/raw/train-images-idx3-ubyte.gz to ./MNIST/raw


Downloading http://yann.lecun.com/exdb/mnist/train-labels-idx1-ubyte.gz
Downloading h  ttp://yann.lecun.com/exdb/mnist/train-labels-idx1-ubyte.gz to ./MNIST/raw/train-labels-idx1-ubyte.gz
100%|██████████| 28881/28881 [00:00<00:00, 7437112.83it/s]
Extracting ./MNIST/raw/train-labels-idx1-ubyte.gz to ./MNIST/raw

Downloading http://yann.lecun.com/exdb/mnist/t10k-images-idx3-ubyte.gz
Downloading http://yann.lecun.com/exdb/mnist/t10k-images-idx3-ubyte.gz to ./MNIST/raw/t10k-images-idx3-ubyte.gz
100%|██████████| 1648877/1648877 [00:00<00:00, 65664261.95it/s]Extracting ./MNIST/raw/t10k-images-idx3-ubyte.gz to ./MNIST/raw


Downloading http://yann.lecun.com/exdb/mnist/t10k-labels-idx1-ubyte.gz
Downloading http://yann.lecun.com/exdb/mnist/t10k-labels-idx1-ubyte.gz to ./MNIST/raw/t10k-labels-idx1-ubyte.gz
100%|██████████| 4542/4542 [00:00<00:00, 13530205.09it/s]Extracting ./MNIST/raw/t10k-labels-idx1-ubyte.gz to ./MNIST/raw
```

```
print("Number of training examples", mnist.train_data.shape)
print("Image information", mnist[0])
```

```
/usr/local/lib/python3.9/dist-packages/torchvision/datasets/mnist.py:75: UserWarning: train_data has been renamed data
  warnings.warn("train_data has been renamed data")
Number of training examples torch.Size([60000, 28, 28])
Image information (<PIL.Image.Image image mode=L size=28x28 at 0x7F334271F040>, 5)
```

```
import matplotlib.pyplot as plt
%matplotlib inline
plt.imshow(mnist[0][0])
```

```
<matplotlib.image.AxesImage at 0x7f333fee30d0>
```




```
class Net(nn.Module):
  def __init__(self):
    super(Net, self).__init__()

    self.fully = nn.Sequential(
        nn.Linear(28*28, 10)
    )

  def forward(self, x):
    x = x.view([-1, 28*28])
    x = self.fully(x)
    x = F.log_softmax(x, dim = 1)
    return x
```

```
train_loader = torch.utils.data.DataLoader(datasets.MNIST(root = '.', train = True, transform = transforms.Compose([transforms.ToTensor()])),
test_loader = torch.utils.data.DataLoader(datasets.MNIST(root = '.', train = False, transform = transforms.Compose([transforms.ToTensor()])),
```

```
def train():
  learning_rate = 1e-3
  num_epochs = 3

  net = Net()
  optimizer = torch.optim.Adam(net.parameters(), lr = learning_rate)

  for epoch in range(num_epochs):
    for batch_idx, (data, target) in enumerate(train_loader):
      output = net(data)

      loss = F.nll_loss(output, target)
      optimizer.zero_grad()
      loss.backward()
      optimizer.step()

      if batch_idx % 100 == 0:
        print('Epoch = %f. Batch = %s. Loss' % (epoch,batch_idx, loss.item()))

  return net
```

```
net = train()
```

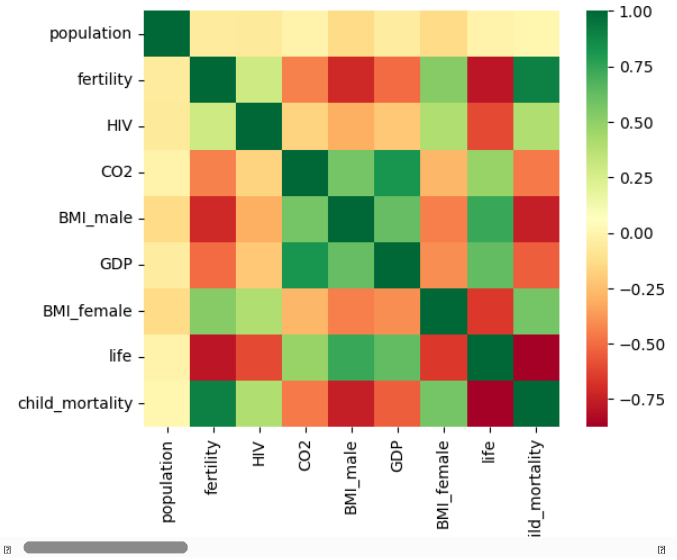
```
net.eval()
test_loss = 0
correct = 0
total = 0

for data, target in test_loader:
```

```
    total += len(target)
    output = net(data)
    pred = output.max(1, keepdim = True)[1]
    correct += target.eq(pred.view_as(target)).sum()

print("Correct out of %s" % total, correct.item())
print("Percentage accuracy", correct.item()*100/10000.)
```

```
#Import numpy and pandas
import numpy as np
import pandas as pd
import seaborn as sns
import matplotlib.pyplot as plot

#Read the CSV file into a DataFrame: df
df = pd.read_csv('gapminder.csv')
```

```
ax = sns.heatmap(df.corr(), square = True, cmap = 'RdYlGn')
plt.show()
```

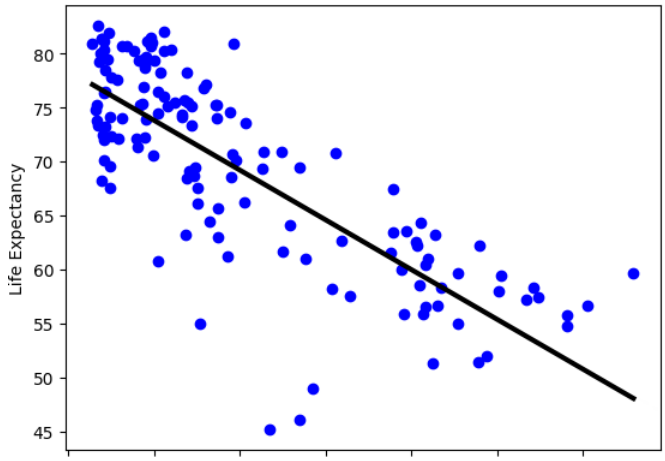
```
<ipython-input-16-3cf57014a7aa>:1: FutureWarning: The default val
  ax = sns.heatmap(df.corr(), square = True, cmap = 'RdYlGn')
```




```
from sklearn.linear_model import LinearRegression, LogisticRegression
from sklearn.linear_model import LinearRegression
from sklearn.metrics import mean_squared_error
from sklearn.model_selection import train_test_split

x_fertility = df['fertility'].values.reshape(-1,1)
y_life = df['life'].values.reshape(-1,1)
prediction_space = np.linspace(min(x_fertility), max(x_fertility)).reshape(-1,1)

#Create training and test sets
x_train, x_test, y_train, y_test = train_test_split(x_fertility, y_life, test_size = 0.3, random_state = 42)

#Create the regression model: reg_all
reg = LinearRegression()

#Fit the regression to the training data
reg.fit(x_train, y_train)
y_predict = reg.predict(prediction_space)

#Print accuracy
print(reg.score(x_fertility, y_life))

#Plot regression Line
plt.scatter(x_fertility, y_life, color = 'blue')
plt.plot(prediction space, y predict, color = 'black', linewidth = 3)
```

```
plt.ylabel('Life Expectancy')
plt.xlabel('Fertility ')
plt.show
```

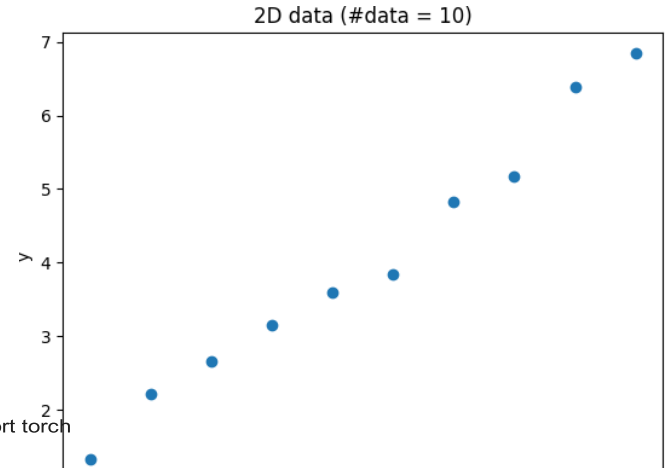
```
0.6162438752151917
<function matplotlib.pyplot.show(close=None, block=None)>
```




```
features = pd.read_csv('gapminder.csv')
df =  pd.read_csv('gapminder.csv')
del features['life']
del features['Region']

y_life = df['life'].values.reshape(-1,1)

#Create training and test sets
x_train, x_test, y_train, y_test = train_test_split(features, y_life, test_size = 0.3, random_state = 42)

#Create the regression model: reg_all
reg_all = LinearRegression()

#Fit the regression to the training data
reg_all.fit(x_train, y_train)

#Print accuracy
print(reg_all.score(features, y_life))
```

```
0.8914651485793176
```

```
import matplotlib.pyplot as plt
%matplotlib inline
import numpy as np


N = 10 #Number of data points
m = .9
c = 1
x = np.linspace(0,2*np.pi, N)
y = m*x + c + np.random.normal(0, .3, x.shape)
plt.figure()
plt.plot(x, y, 'o')
plt.xlabel('x')
plt.ylabel('y')
plt.title('2D data (#data = %d)' % N)
plt.show()
```




```
import torch
from torch.utils.data import Dataset
class MyDataset(Dataset):
  def __init__(self, x, y):
    self.x = x
    self.y = y

  def __len__(self):
    return len(self.x)

  def __getitem__(self, idx):
    sample = {
        'feature': torch.tensor([1, self.x[idx]]),
        'label': torch.tensor([self.y[idx]])}
    return sample


dataset = MyDataset(x, y)
for i in range(len(dataset)):
  sample = dataset[i]
  print(i, sample['feature'], sample['label'])
```

```
0 tensor([1., 0.], dtype=torch.float64) tensor([1.3291], dtype=torch.float64)
1 tensor([1.0000, 0.6981], dtype=torch.float64) tensor([2.2222], dtype=torch.float64)
2 tensor([1.0000, 1.3963], dtype=torch.float64) tensor([2.6650], dtype=torch.float64)
3 tensor([1.0000, 2.0944], dtype=torch.float64) tensor([3.1505], dtype=torch.float64)
4 tensor([1.0000, 2.7925], dtype=torch.float64) tensor([3.5954], dtype=torch.float64)
5 tensor([1.0000, 3.4907], dtype=torch.float64) tensor([3.8335], dtype=torch.float64)
6 tensor([1.0000, 4.1888], dtype=torch.float64) tensor([4.8242], dtype=torch.float64)
7 tensor([1.0000, 4.8869], dtype=torch.float64) tensor([5.1775], dtype=torch.float64)
8 tensor([1.0000, 5.5851], dtype=torch.float64) tensor([6.3916], dtype=torch.float64)
9 tensor([1.0000, 6.2832], dtype=torch.float64) tensor([6.8490], dtype=torch.float64)
```

```
from torch.utils.data import DataLoader

dataset = MyDataset(x, y)
batch_size = 4
shuffle = True
num_workers = 4
dataloader = DataLoader(dataset, batch_size = batch_size, shuffle = shuffle, num_workers = num_workers)
```

```
/usr/local/lib/python3.9/dist-packages/torch/utils/data/dataloader.py:561: UserWarning: This DataLoader will create 4 worker processes
  warnings.warn(_create_warning_msg(
```

```
import pprint as pp
for i_batch, samples in enumerate(dataloader):
  print('\nbatch# = %s' % i_batch)
  print('samples: ')
  pp.pprint(samples)
```

```
/usr/local/lib/python3.9/dist-packages/torch/utils/data/dataloader.py:561: UserWarning: This DataLoader will create 4 worker processes
  warnings.warn(_create_warning_msg(

batch# = 0
samples:
{'feature': tensor([[1.0000, 2.0944],
          [1.0000, 5.5851],
          [1.0000, 6.2832],
```

```
            [1.0000, 4.1888]], dtype=torch.float64),
     'label': tensor([[3.1505],
            [6.3916],
            [6.8490],
            [4.8242]], dtype=torch.float64)}

    batch# = 1
    samples:
    {'feature': tensor([[1.0000, 3.4907],
            [1.0000,  1.3963],
            [1.0000,  0.6981],
            [1.0000, 0.0000]], dtype=torch.float64),
     'label': tensor([[3.8335],
            [2.6650],
            [2.2222],
            [1.3291]], dtype=torch.float64)}

    batch# = 2
    samples:
    {'feature': tensor([[1.0000, 4.8869],
            [1.0000, 2.7925]], dtype=torch.float64),
     'label': tensor([[5.1775],
            [3.5954]], dtype=torch.float64)}
```

```
import torch.nn as nn
import torch.nn.functional as F
class MyModel(nn.Module):
  def __init__(self,input_dim, output_dim):
    super(MyModel, sel).__init__()
    self.linear = nn.Linear(input_dim, output_dim)

  def forward(self, x):
    out = self.linear(x)
    return out


input_dim = 2
output_dim = 1

model = MyModel(input_dim, output_dim)


cost = nn.MSELoss()


num_epochs = 10
l_rate = 0.01
optimiser = torch.optim.SGD(model.parameters(), lr = l_rate)

dataset = MyDataset(x, y)
batch_size = 4
shuffle = True
num_workers = 4
training_sample_generator = DataLoader(dateset, batch_size=batch_size, shuffle=suffle, num_workers=num_workers)
for epoch in range(num_epochs):
  print ('Epoch = %s' % epoch)
    for batch_i, samples in enumerate(training_sample_generator):
        predictions = model(samples['feature'])
        error = cost(predictions, samples['label'])
        print('\tBatch = %s, Error = %s' % (batch_i, error.item()))

        optimiser.zero_grad()
        error.backward()
        optimiser.step()


x_for_plotting = np.linspace(0, 2*np.pi, 1000)
design_matrix = torch.tensor(np.vstack([np.ones(x_for_plotting.shape), x_for_plotting]).T, dtype=torch.float32)
print('Design matrix shape:', design_matrix.shape)
y_for_pltting = model.forward(design_matrix)
print('y_for_plotting:', y_for_plotting.shape)

y_for_plotting = model.forward(design_matrix)
print('y_for_plotting shape:', y_for_plotting.shape)


plt.figure()
plt.plot(x,y,'o')
plt.plot(x_for_plottingm y_for_plotting.data.numpy(), 'r-')
```

```
plt.xlabel('x')
plt.ylabel('y')
plt.title('2D data (#data = %d)' % N)
plt.show()


def item_cf(M, metric='cosine'):
  pred = np.copy(m)
  n_users, n_items = M.shape
  avg_ratings = np.nanmean(M, axis=0)
  sim_items = sim_matrix(M, 'item', metric)
  for i in range(n_users):
    for j in range(n_items):
      if np.isnan(M[i,j]):
        pred[i,j] = avg_ratings[j] + np.nansum(sim_items[j] * (M[i,:] - avg_ratings)) / sum(sim_items[j])
  return pred


evaluateRS(M, M_result, 'user_cf', 'cosine')
evaluateRS(M, M_result, 'user_cf', 'correlation')
evaluateRS(M, M_result, 'item_cf', 'cosin')
evaluateRS(M, M_result, 'item_cf', 'correlation')
```