Deep Learning CS551 Assignment 1 Solution by Vipin_2011MT22

```
# importing library
import numpy as np
import pandas as pd
from sympy import *
import sys
import seaborn as sns
import matplotlib.pyplot as plt
import scipy.linalg as la
import sklearn
from sklearn.model_selection import train_test_split
from sklearn.linear_model import LinearRegression
from sklearn.linear_model import LogisticRegression
from sklearn.model_selection import cross_val_score, cross_val_predict
```

Q1. Find out the eigen value and eigen vector of a given matrix using python library

X = [[1, 2, 3], [2, 3, 4], [4, 5, 6]]

```
m = np.array([[1, 2, 3],
              [2, 3, 4],
              [4, 5, 6]])

w, v = np.linalg.eig(m)

print("Eigen values of the given square array:\n", w, "\n\n")
print("Eigenvectors of the given square array:\n", v)
```

```
Eigen values of the given square array:
 [ 1.08309519e+01 -8.30951895e-01 -1.24701000e-16]


Eigenvectors of the given square array:
 [[ 0.34416959  0.72770285  0.40824829]
 [ 0.49532111  0.27580256 -0.81649658]
 [ 0.79762415 -0.62799801  0.40824829]]
```

Q2. Find the dot product of two vectors v = [1,2] and w =[1,1]

```
a = [1,2]
b = [1, 1]

dotproduct= np.dot(a, b)

print("Dot product of two vectors:\n", dotproduct)
```

```
Dot product of two vectors:
 3
```

Q3. Find out the trace of a matrix given below using python.

X = [[1, 2, 3], [4, 5, 6], [7, 8, 9]]

```
m = np.array([[1,2,3],[4,5,6],[7,8,9]])

trace = m.trace()

print("Trace of a matrix:\n", trace)
```

```
Trace of a matrix:
 15
```

Q4: Write a python program to perform the following set of operations on the augmented matrix derived from the system of linear equations given below.

(a) Generate Row Echelon Form (REF)

(b) Generate Reduced Row Echelon Form (RREF)

(c) Perform Gaussian elimination to solve the below system of linear equation

(d) Perform Gauss–Jordan elimination to solve the below system of linear equation

Test Case:

Input:

X+y+2z = 9, 2x+4y-3z = 1, 3x+6y-5z =0

Output:

x = 1, y =2 , z =3

(a)

```
A = np.array([[1,1,2],[2,4,-3],[3,6,-5]], dtype='float')
B = np.array([[9],[1],[0]], dtype='float')
M = np.hstack([A,B])
print("Augumented matrix derived from system of linear equation is: \n\n ", M)
```

```
Augumented matrix derived from system of linear equation is:

  [[ 1.  1.  2.  9.]
 [ 2.  4. -3.  1.]
 [ 3.  6. -5.  0.]]
```

```
def REF(M):
    r, c = M.shape
    if r == 0 or c == 0:
        return M
    for i in range(len(M)):
        if M[i,0] != 0:
            break
    else:
        y = REF(M[:,1:])
        return np.hstack([M[:,:1], y])
    if i > 0:
        ith_row = M[i].copy()
        M[i] = M[0]
        M[0] = ith_row
    M[0] = M[0] / M[0,0]
    M[1:] -= M[0] * M[1:,0:1]
    y = REF(M[1:,1:])
    return np.vstack([M[:1], np.hstack([M[1:,:1], y]) ])


print("Generate Row Echelon Form (REF): \n\n", REF(M))
```

```
Generate Row Echelon Form (REF):

 [[ 1.   1.   2.   9. ]
 [ 0.   1.  -3.5 -8.5]
 [ 0.   0.   1.   3. ]]
```

(b)

```
def RREF(M):
    A = np.array(M, dtype=np.float64)
    i = 0
    j = 0
    while True:
        while all(A.T[j] == 0.0):
```

```
        while all(A.T[j] == 0.0):
            j += 1
            if j == len(A[0]) - 1 : break
        if A[i][j] == 0:
            i_ = i
            while A[i_][j] == 0:
                i_ += 1
                if i_ == len(A) - 1 : break
            A[[i, i_]] = A[[i_, i]]
        A[i] = A[i] / A[i][j]
        for i_ in range(len(A)):
            if i_ != i:
                A[i_] = A[i_] - A[i] * A[i_][j] / A[i][j]
        if (i == len(A) - 1) or (j == len(A[0]) - 1): break
        i += 1
        j += 1
    return A

print("Generate Reduced Row Echelon Form (RREF): \n\n", RREF(M))
```

```
 Generate Reduced Row Echelon Form (RREF):

 [[1. 0. 0. 1.]
 [0. 1. 0. 2.]
 [0. 0. 1. 3.]]
```

(c)

```
print("Gauss elimination to solve given syatem of linear equation \n\n")

n = int(input('Enter number of unknowns: '))
R = np.zeros((n,n+1))
x = np.zeros(n)
print('Enter Augmented Matrix Coefficients:')
for i in range(n):
    for j in range(n+1):
        R[i][j] = input( 'R['+str(i)+']['+ str(j)+']=')

for i in range(n):
    if R[i][i] == 0.0:
        sys.exit('Divide by zero detected!')
    for j in range(i+1, n):
        ratio = R[j][i]/R[i][i]
        for k in range(n+1):
            R[j][k] = R[j][k] - ratio * R[i][k]
x[n-1] = R[n-1][n]/R[n-1][n-1]
for i in range(n-2,-1,-1):
    x[i] = R[i][n]
    for j in range(i+1,n):
        x[i] = x[i] - R[i][j]*x[j]
    x[i] = x[i]/R[i][i]
```

```
for i in range(n):
    print('\n\nX%d = %0.2f' %(i,x[i]), end = '\t')
```

```
Gauss elimination to solve given syatem of linear equation


Enter number of unknowns: 3
Enter Augmented Matrix Coefficients:
R[0][0]=1
R[0][1]=1
R[0][2]=2
R[0][3]=9
R[1][0]=2
R[1][1]=4
R[1][2]=-3
R[1][3]=1
R[2][0]=3
R[2][1]=6
R[2][2]=-5
R[2][3]=0


X0 = 1.00

X1 = 2.00

X2 = 3.00
```

(d)

```
print("Gauss Jordan elimination to solve given syatem of linear equation \n\n")

n = int(input('Enter number of unknowns: '))
D = np.zeros((n,n+1))
x = np.zeros(n)
print('Enter Augmented Matrix Coefficients:')
for i in range(n):
    for j in range(n+1):
        D[i][j] = float(input( 'D['+str(i)+']['+ str(j)+']='))

for i in range(n):
    if D[i][i] == 0.0:
        sys.exit('Divide by zero detected!')
    for j in range(n):
        if i != j:
            ratio = D[j][i]/D[i][i]

            for k in range(n+1):
                D[j][k] = D[j][k] - ratio * D[i][k]

for i in range(n):
    x[i] = D[i][n]/D[i][i]
```

```
for i in range(n):
    print('\n\n X%d = %0.2f' %(i,x[i]), end = '\t')
```

```
Gauss Jordan elimination to solve given syatem of linear equation


Enter number of unknowns: 3
Enter Augmented Matrix Coefficients:
D[0][0]=1
D[0][1]=1
D[0][2]=2
D[0][3]=9
D[1][0]=2
D[1][1]=4
D[1][2]=-3
D[1][3]=1
D[2][0]=3
D[2][1]=6
D[2][2]=-5
D[2][3]=0


 X0 = 1.00

 X1 = 2.00

 X2 = 3.00
```

Matrix factorization using SGD

Q5. Assume R is a mXn matrix with each entry is an integer in [0, 5] i.e. moving rating m users have given to n movies. Find the factorization of matrix R = P Q using approximation method.

Where P and Q have size (k × m) and (k × n) and k<m and k<n.

Update rule for Pc and Qc (column vectors of P, Q respectively) are as follows:

Pc<- Pc +s*(eQc-t*Pc)

Qc<- Qc +s*(ePc-t*Qc)

Where s, t are from [0,1]. e= R_{i, j} - (Pc) Qc .

E = ||R − P Q||

1)Find k, s and t for least E. (use hyperopt or sklearn library for gridsearch.)

2)Plot graph for E vs k.

*Each user (Pc) and movie (Qc) are defined by k features (k sized 1-d vector) which best describes their characteristics in latent space.

(a)

```
def matrix_factorization(R, P, Q, K,s,t):
  e = 0
  iteration = 2000
  Q = Q.T
  for l in range(iteration):
    for i in range(len(R)):
      for j in range(len(R[i])):
        if R[i][j] > 0:
          eij = R[i][j] - np.dot(P[i,:],Q[:,j])
          for k in range(K):
            P[i][k] = P[i][k] + s * (eij * Q[k][j] - t * P[i][k])
            Q[k][j] = Q[k][j] + s * (eij * P[i][k] - t * Q[k][j])
    # error in prediction
    for i in range(len(R)):
      for j in range(len(R[i])):
        if R[i][j] > 0:
          for k in range(K):
            e = e + (R[i][j] - np.dot(P[i,:],Q[:,j]))
  return np.dot(P,Q),e

R = np.random.randint(6, size=(5, 4))
n = len(R)
m = len(R[0])

s_value = [0.0001,0.0002,0.0003,0.0004,0.0005]
t_value = [0.01,0.02,0.03,0.04,0.05]

err = []
a = []
b = []
k = []
for s in s_value:
  for t in t_value:
    for K in range(1,5):
      P = np.random.rand(n,K)
      Q = np.random.rand(m,K)
      E,error = matrix_factorization(R, P, Q, K,s,t)
      err.append(error)
      a.append(s)
      b.append(t)
      k.append(K)
result = pd.DataFrame.from_dict({"Error":err,"s":a,"t":b,"K":k})
result

minvalue = result['Error'].min()
minvalue

minindex = result['Error'].idxmin()
```

```
minindex

print('For least Error:')
print('Value of s is: ',result.s[minindex])
print('Value of t is: ',result.t[minindex])
print('Value of K is: ',result.K[minindex])
```

```
For least Error:
Value of s is:  0.0005
Value of t is:  0.02
Value of K is:  1
```

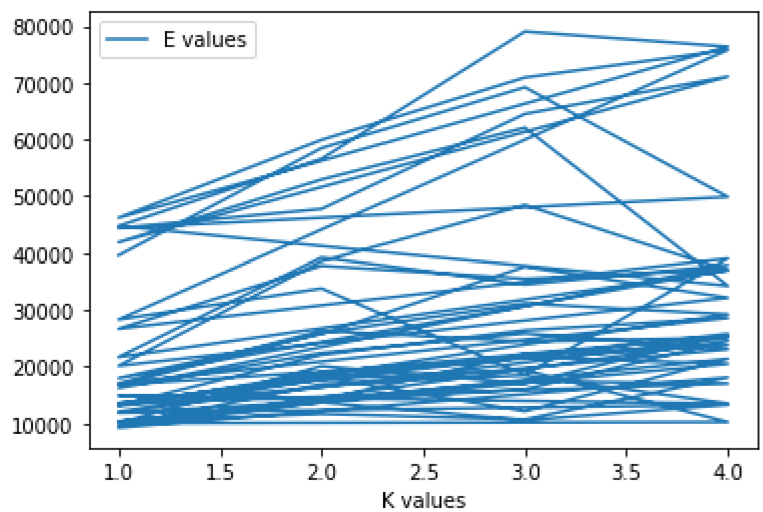
(b)

```
#Plot for E vs K
d = {'E values' : result['Error'],
     'K values' : result['K']}

df = pd.DataFrame(d)

df.plot(x='K values',y='E values')
```

```
<matplotlib.axes._subplots.AxesSubplot at 0x7fc2b14a9b50>
```



Q6. Find the partial derivative of ||LU − A|| (a function of squared frobenius norm) with respect to U. Where L, U and A are all matrices.

```
#Defining function for partial derivative of ||LU-A|| wrt U
```

```
def parder(L,U,A):
  L_transpose = [[L[j][i] for j in range(len(L))] for i in range(len(L[0]))]
  a = L*U-A
  z = L_transpose*a
  PD = 2*z
  return PD
```

```
#Testing frobenius norm partial derivative by taking any random matrix L U A

L = np.matrix([[4,3,6],[8,6,2],[7,6,5]])
U = np.matrix([[8,3,4],[8,3,7],[7, 5, 5]])
A = np.matrix([[9,3,3],[7,2,5],[6,5,7]])

print("Frobenius norm partial derivative wrt U:\n\n")
parder(L,U,A)
```

```
Frobenius norm partial derivative wrt U:


matrix([[3022, 1392, 2042],
        [3384, 1604, 2324],
        [4004, 1862, 2724]])
```

Linear Regression

Q7. Find the linear regression model which best predicts the dependent variable (“sales”) on validation dataset.

- Divide data in 80-20 % for training and testing set.
- Use 10 fold cross validation set (10% of training dataset).

Find regression co-efficients and intercepts. Report confusion matrix on test dataset.

Link: https://raw.githubusercontent.com/manishbhnau/Repo/master/Advertising.csv

```
df = pd.read_csv("https://raw.githubusercontent.com/manishbhnau/Repo/master/Advertising.csv")

df.drop(["Unnamed: 0"],axis = 1, inplace = True);

df.head()
```

	TV	radio	newspaper	sales
0	230.1	37.8	69.2	22.1
1	44.5	39.3	45.1	10.4

Televison

```
X = df[['TV']].values
y = df['sales'].values
print(f'Shape of X is {X.shape}\nShape of y is {y.shape}')
```

```
Shape of X is (200, 1)
Shape of y is (200,)
```

```
#Splitting Training and Test Set
X_train,X_test,y_train,y_test = train_test_split(X,y,test_size=0.20,random_state=1)
print(X_train.shape, X_test.shape, y_train.shape, y_test.shape)
```

```
(160, 1) (40, 1) (160,) (40,)
```

```
# fit a model
regression_model = LinearRegression()
model = regression_model.fit(X_train, y_train)
```

```
print('intercept:', model.intercept_)
print('coefficients for radio:', model.coef_)
```

```
intercept: 6.799773449796853
coefficients for radio: [0.0492751]
```

```
# Perform 10-fold cross validation
score = cross_val_score(LinearRegression(),X_train,y_train,cv = 10)
print('Cross-validated scores:', score)
```

```
Cross-validated scores: [0.75636914 0.73169911 0.69356755 0.57315893 0.64699324 0.48797
 0.5235431  0.63498864 0.57887311 0.36986269]
```

```
print('Mean of 10-fold cross validation score : ',score.mean())
```

```
Mean of 10-fold cross validation score :  0.5997027430081798
```

```
#Making prediction using model
y_pred = model.predict(X_test)
y_pred
```

```
array([17.18696362, 16.77798032, 11.51540011, 20.60665526, 19.30579273,
       20.77419058, 14.84639657, 15.70871075, 10.2785952 , 17.41362906,
       14.90552669, 10.20961007, 17.37913649, 12.21017895, 17.92609005,
       12.99365298, 13.28930355, 21.12404376,  8.0612159 , 17.18203611,
       11.74699305, 10.14062494,  8.03657835, 12.09191872, 12.36293175,
       16.08320147,  8.92353007, 19.05941725, 15.01885941, 18.63072392,
       18.6208689 , 18.35478338, 14.17625527, 15.18639473, 19.03970721,
       15.91073864, 17.75855473, 13.17597083, 17.48261419,  7.76556532])
```

```
# Make cross validated predictions
cross_validate_y_pred = cross_val_predict(model, X_test, y_test, cv=10)
cross_validate_y_pred
```

```
array([16.57253732, 16.25411645, 12.15684554, 19.23499614, 17.80120059,
       18.85181007, 14.61059124, 15.2275599 , 11.24751965, 16.76343116,
       14.8244816 , 11.19418902, 16.75895863, 12.47477299, 17.21229   ,
       13.12413955, 13.56674972, 20.31407182,  9.06429139, 16.91919278,
       12.48625128, 11.2667708 ,  9.6694758 , 12.74810292, 12.88053424,
       15.74211276, 10.23499543, 18.03137557, 14.82223455, 17.67159028,
       17.66381578, 17.45390417, 14.1965258 , 14.97354154, 17.93757233,
       15.53071869, 17.06564654, 13.63388628, 16.85900291,  9.58219512])
```

```
from sklearn.metrics import mean_squared_error
print('MSE value of test and model predicted value :',mean_squared_error(y_test,y_pred))
print('MSE value of test and cross validate predicted value :',mean_squared_error(y_test,cros
```

```
MSE value of test and model predicted value : 10.85934532560827
MSE value of test and cross validate predicted value : 10.725417660885508
```

radio

```
X = df[['radio']].values
y = df['sales'].values
print(f'Shape of X is {X.shape}\nShape of y is {y.shape}')
```

```
Shape of X is (200, 1)
Shape of y is (200,)
```

```
#Splitting Training and Test Set
X_train,X_test,y_train,y_test = train_test_split(X,y,test_size=0.20,random_state=1)
print(X_train.shape, X_test.shape, y_train.shape, y_test.shape)
```

```
(160, 1) (40, 1) (160,) (40,)
```

```
# fit a model
regression_model = LinearRegression()
model = regression_model.fit(X_train, y_train)
```

```
print('intercept:', model.intercept_)
```

```
print('coefficients for radio:', model.coef_)
```

```
intercept: 9.1341254885822
coefficients for radio: [0.20071881]
```

```
# Perform 10-fold cross validation
score = cross_val_score(LinearRegression(),X_train,y_train,cv = 10)
print('Cross-validated scores:', score)
```

```
Cross-validated scores: [ 0.47321943  0.13504887  0.03841532  0.28746501 -0.01960751  0
  0.21809692  0.47974202  0.4437043   0.24720168]
```

```
print('Mean of 10-fold cross validation score : ',score.mean())
```

```
Mean of 10-fold cross validation score :  0.29488669016731234
```

```
#Making prediction using model
y_pred = model.predict(X_test)
y_pred
```

```
array([19.08977823, 13.61015485,  9.41513182, 11.16138542, 13.40943604,
       17.56431531, 15.47683974, 11.30188859, 12.34562637, 13.87108929,
       13.32914852, 13.248861  , 13.95137682, 18.72848438, 10.78001969,
       16.5406494 , 12.82735151,  9.95707259, 16.9621589 , 15.05533025,
       11.06102602, 16.48043376, 14.29259878, 11.94418876, 12.6266327 ,
       12.76713586, 14.49331759, 14.57360511, 17.56431531, 12.48612954,
       17.46395591,  9.81656943, 16.27971496, 10.69973217, 15.19583341,
       13.3492204 ,  9.81656943, 10.27822268, 17.94568104, 13.16857348])
```

```
# Make cross validated predictions
cross_validate_y_pred = cross_val_predict(model, X_test, y_test, cv=10)
cross_validate_y_pred
```

```
array([20.00382024, 14.50805049, 10.30066632, 12.05206547, 14.21352928,
       18.23925965, 16.21667048, 12.17149214, 13.48660036, 15.07144575,
       14.50840857, 14.42499566, 15.12780355, 20.74060646, 11.40165708,
       18.17003706, 13.89852238, 10.49249854, 18.80510218, 16.54235907,
       12.2864571 , 18.26630233, 15.85221666, 13.26095039, 13.73248075,
       13.88176947, 15.71588805, 15.80119589, 18.4547924 , 13.31965289,
       18.35330743, 10.62015266, 17.35344442, 11.52363   , 16.22103442,
       14.29174332, 10.99879457, 11.46050899, 19.12898321, 14.35124272])
```

```
from sklearn.metrics import mean_squared_error
print('MSE value of test and model predicted value :',mean_squared_error(y_test,y_pred))
print('MSE value of test and cross validate predicted value :',mean_squared_error(y_test,cros
```

```
MSE value of test and model predicted value : 11.940633086605168
MSE value of test and cross validate predicted value : 12.17345112142154
```

newspaper

```
X = df[['newspaper']].values
y = df['sales'].values
print(f'Shape of X is {X.shape}\nShape of y is {y.shape}')
```

```
Shape of X is (200, 1)
Shape of y is (200,)
```

```
#Splitting Training and Test Set
X_train,X_test,y_train,y_test = train_test_split(X,y,test_size=0.20,random_state=1)
print(X_train.shape, X_test.shape, y_train.shape, y_test.shape)
```

```
(160, 1) (40, 1) (160,) (40,)
```

```
# fit a model
regression_model = LinearRegression()
model = regression_model.fit(X_train, y_train)
```

```
print('intercept:', model.intercept_)
print('coefficients for radio:', model.coef_)
```

```
intercept: 11.70578033481604
coefficients for radio: [0.07029362]
```

```
# Perform 10-fold cross validation
score = cross_val_score(LinearRegression(),X_train,y_train,cv = 10)
print('Cross-validated scores:', score)
```

```
Cross-validated scores: [ 0.07349645  0.02570977  0.17597472 -0.34566573  0.18354374  0
 -0.39536792  0.03611138 -0.01639868  0.27285977]
```

```
print('Mean of 10-fold cross validation score : ',score.mean())
```

```
Mean of 10-fold cross validation score :  0.015913961991653586
```

```
#Making prediction using model
y_pred = model.predict(X_test)
y_pred
```

```
array([14.35584982, 13.92705874, 12.22595313, 13.21006381, 13.81458895,
       16.35921801, 15.42431285, 15.81092777, 14.57376005, 15.75469287,
       15.03769794, 12.99215359, 11.98695482, 15.31887242, 15.67736989,
       17.27303507, 14.1379396 , 12.30327611, 12.359511  , 12.359511  ,
       11.95883737, 19.71925306, 14.7494941 , 12.4719808 , 14.41911408,
       13.50529702, 14.17308641, 13.31550424, 11.95883737, 13.31550424,
```

```
       13.00621231, 17.66667935, 12.12754206, 14.18011577, 13.13274083,
       13.25223998, 12.62662676, 13.90597065, 13.61776681, 12.90077188])
```

```
# Make cross validated predictions
cross_validate_y_pred = cross_val_predict(model, X_test, y_test, cv=10)
cross_validate_y_pred
```

```
array([14.70871381, 14.73038253, 14.81634696, 14.76661547, 14.5054726 ,
       14.04036295, 14.21124578, 14.14057995, 15.04806399, 15.07105    ,
       15.05709421, 15.01727915, 14.60009172, 14.87470119, 14.90424778,
       15.03575907, 15.03068935, 15.04201517, 15.04166802, 15.04166802,
       15.00313932, 16.23924856, 15.44764599, 15.0848748 , 15.00635277,
       14.91703997, 14.98230702, 14.89849038, 13.78083079, 14.29094294,
       14.17464794, 15.92700211, 14.4094351 , 14.73213784, 14.56747103,
       14.58625852, 15.12156393, 15.07172393, 15.08295162, 15.11088393])
```

```
from sklearn.metrics import mean_squared_error
print('MSE value of test and model predicted value :',mean_squared_error(y_test,y_pred))
print('MSE value of test and cross validate predicted value :',mean_squared_error(y_test,cros
```

```
MSE value of test and model predicted value : 21.855358682807495
MSE value of test and cross validate predicted value : 20.857324867911906
```

Q8. This question involves the use of multiple linear regression on the Auto data set

(https://www.kaggle.com/uciml/autompg-dataset).

Compute the matrix of correlations between the variables

- Fit a least square linear model, You will need to exclude the name variable which is qualitative.
- Use the multiple linear regression with mp

```
mpg_df = pd.read_csv("auto-mpg.csv")

mpg_df = mpg_df.drop('car name', axis=1)

mpg_df.head()
```

	mpg	cylinders	displacement	horsepower	weight	acceleration	model year	origin
0	18.0	8	307.0	130	3504	12.0	70	1

```
pd.unique(mpg_df.origin)

mpg_df['origin'] = mpg_df['origin'].replace({1: 'america', 2: 'europe', 3: 'asia'})
mpg_df = pd.get_dummies(mpg_df, columns=['origin'], drop_first=True)
mpg_df.head()
```

	mpg	cylinders	displacement	horsepower	weight	acceleration	model year	origin_asia
0	18.0	8	307.0	130	3504	12.0	70	0
1	15.0	8	350.0	165	3693	11.5	70	0
2	18.0	8	318.0	150	3436	11.0	70	0
3	16.0	8	304.0	150	3433	12.0	70	0
4	17.0	8	302.0	140	3449	10.5	70	0

```
mpg_df = mpg_df.replace('?', np.nan)
```

```
mpg_df[mpg_df.isnull().any(axis=1)]
```

	mpg	cylinders	displacement	horsepower	weight	acceleration	model year	origin_asia
32	25.0	4	98.0	NaN	2046	19.0	71	0
126	21.0	6	200.0	NaN	2875	17.0	74	0
330	40.9	4	85.0	NaN	1835	17.3	80	0
336	23.6	4	140.0	NaN	2905	14.3	80	0
354	34.5	4	100.0	NaN	2320	15.8	81	0
374	23.0	4	151.0	NaN	3035	20.5	82	0

```
mpg_df = mpg_df.apply(lambda x: x.fillna(x.median()),axis=0)

mpg_df['horsepower'] = mpg_df['horsepower'].astype('float64')

mpg_df.head()
```

	mpg	cylinders	displacement	horsepower	weight	acceleration	model year	origin_asia
0	18.0	8	307.0	130.0	3504	12.0	70	0

```
print("Compute the matric correlation between variable\n\n\n")
mpg_df.corr()
```

```
Compute the matric correlation between variable
```

	mpg	cylinders	displacement	horsepower	weight	acceleration	
mpg	1.000000	-0.775396	-0.804203	-0.773453	-0.831741	0.420289	0
cylinders	-0.775396	1.000000	0.950721	0.841284	0.896017	-0.505419	-0
displacement	-0.804203	0.950721	1.000000	0.895778	0.932824	-0.543684	-0
horsepower	-0.773453	0.841284	0.895778	1.000000	0.862442	-0.686590	-0
weight	-0.831741	0.896017	0.932824	0.862442	1.000000	-0.417457	-0
acceleration	0.420289	-0.505419	-0.543684	-0.686590	-0.417457	1.000000	0
model year	0.579267	-0.348746	-0.370164	-0.413733	-0.306564	0.288137	1
origin_asia	0.442174	-0.396479	-0.433505	-0.318972	-0.440817	0.109144	0
origin_europe	0.259022	-0.352861	-0.373886	-0.282877	-0.298843	0.204473	-0

```
X = mpg_df.drop('mpg', axis=1)
y = mpg_df[['mpg']]

X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.3, random_state=1)

regression_model = LinearRegression()
regression_model.fit(X_train, y_train)
```

```
LinearRegression(copy_X=True, fit_intercept=True, n_jobs=None, normalize=False)
```

```
print("intercept = ",regression_model.intercept_)
```

```
intercept =  [-21.28473412]
```

```
for idx, col_name in enumerate(X_train.columns):
    print("The coefficient for {} is {}".format(col_name, regression_model.coef_[0][idx]))
```

```
The coefficient for cylinders is -0.3948079661648318
The coefficient for displacement is 0.028945510765487518
The coefficient for horsepower is -0.021752207723547454
The coefficient for weight is -0.007352032065147351
The coefficient for acceleration is 0.06191936600761743
```

```
The coefficient for model year is 0.8369338917644998
The coefficient for origin_asia is 2.395265036593775
The coefficient for origin_europe is 3.0012830009185154
```

```
regression_model.score(X_train, y_train)
```

```
0.8141025501610559
```

```
regression_model.score(X_test, y_test)
```

```
0.8433135132808829
```

```
X1 = mpg_df[["weight"]]
y1 = mpg_df[['mpg']]

X1_train, X1_test, y1_train, y1_test = train_test_split(X1, y1, test_size=0.3, random_state=1

regression_model = LinearRegression()
regression_model.fit(X1_train, y1_train)
```

```
LinearRegression(copy_X=True, fit_intercept=True, n_jobs=None, normalize=False)
```

```
regression_model.score(X1_train, y1_train)
```

```
0.6746712988680122
```

```
print("intercept = ",regression_model.intercept_)
```

```
intercept =  [46.18746114]
```

```
print("coeffiecient = ",regression_model.coef_)
```

```
coeffiecient =  [[-0.00765699]]
```

Logistic Regression:

Q9. The objective is to build a classifier that can predict whether an application will be admitted to the university (class 0) or not (class 1).

Dataset details :The data consists of marks of two exams for 100 applicants. The target value takes on binary values 1,0. 1 means the applicant was admitted to the university whereas 0 means the applicant didn't get an admission. Download data from the following link.

Dataset link: https://github.com/animesh-agarwal/Machine-Learning/blob/master/LogisticRegression/data/marks.txt

(a) Calculate precision, recall, accuracy and f1 score.

(b) Visualize the confusion matrix using Heatmap.

```
marks_df = pd.read_csv("https://raw.githubusercontent.com/animesh-agarwal/Machine-Learning/ma
marks_df.rename(columns = {0:'MARKS_1',1:'MARKS_2',2:'ADMISSION'},inplace = True)
marks_df.head()
```

	MARKS_1	MARKS_2	ADMISSION
0	34.623660	78.024693	0
1	30.286711	43.894998	0
2	35.847409	72.902198	0
3	60.182599	86.308552	1
4	79.032736	75.344376	1

```
X = marks_df.drop('ADMISSION', axis=1)
y = marks_df[['ADMISSION']]

X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.2, random_state=1)

logistic_model = LogisticRegression()
logistic_model.fit(X_train, y_train)

y_pred = logistic_model.predict(X_test)
```

```
/usr/local/lib/python3.7/dist-packages/sklearn/utils/validation.py:760: DataConversionWa
  y = column_or_1d(y, warn=True)
```

```
from sklearn.metrics import precision_score
from sklearn.metrics import recall_score
from sklearn.metrics import accuracy_score
from sklearn.metrics import f1_score

precision = precision_score(y_test, y_pred, labels=[1,2], average='micro')
print('Precision: ', precision)

recall = recall_score(y_test, y_pred, average='binary')
print("recall: ", recall)

accuracy = accuracy_score(y_test,y_pred)
```

```
print('accuracy: ',accuracy)

score = f1_score(y_test, y_pred, average='binary')
print('F-Measure: ',score)
```

```
Precision:  0.8333333333333334
recall:  0.9090909090909091
accuracy:  0.85
F-Measure:  0.8695652173913043
```

```
print("confusion matrix using Heatmap \n\n\n")

M = confusion_matrix(y_test,y_pred)
sns.heatmap(M, cmap="Blues", annot=True,annot_kws={"size": 16})
```

```
confusion matrix using Heatmap



<matplotlib.axes._subplots.AxesSubplot at 0x7fc2b156ff50>
```