```
from tensorflow.keras.layers import Dense
from tensorflow.keras.models import Sequential
from tensorflow.keras.optimizers import Nadam

from sklearn.model_selection import  train_test_split
import pandas as pd
from sklearn.neighbors import KNeighborsClassifier
import numpy as np
import seaborn as sns
from sklearn.metrics import confusion_matrix,accuracy_score
import matplotlib.pyplot as plt

from google.colab import files

uploaded = files.upload()
```

```
<IPython.core.display.HTML object>

Saving Simulink_ДПТ_10В.csv to Simulink_ДПТ_10В.csv
```

```
df = pd.read_csv('Simulink_ДПТ_10В.csv',delimiter=';')
```

```
/usr/local/lib/python3.8/dist-packages/IPython/core/
interactiveshell.py:3326: DtypeWarning: Columns
(1,2,3,4,5,6,7,8,9,10,11,12,13,14,15) have mixed types.Specify dtype
option on import or set low_memory=False.
  exec(code_obj, self.user_global_ns, self.user_ns)
```

```
df
```

```
                    T           Uдс(вход2)            Unnamed: 2  \
0                 NaN                   U1               U2_diff
1        0.000000e+00                    0                     0
2        1.169967e-66  1.16996669923822e-66  3.15544362088405e-30
3        1.843200e-21  1.84320000000000e-21  1.60000000000000e-10
4        3.981307e-19  3.98130696143209e-19  9.60000000000000e-10
...               ...                   ...                   ...
1000028  9.999999e+00              9.999999              0.999997
1000029  9.999999e+00              9.999999              0.999998
1000030  9.999999e+00              9.999999              0.999999
1000031  9.999999e+00              9.999999                   1.0
1000032  9.999999e+00              9.999999                   1.0

                    Unnamed: 3             Uдт(вход3)
Unnamed: 5  \
0                       U3_int                     U4
U5_diff
1                            0                      0
0
2        -1.14702617601537e-70  -1.14702617601537e-70
2.36658271566097e-22
3         5.81611368201348e-51   5.81611368201348e-51
```

```
0.0119999934720000
4         4.93977239027873e-29   4.93977239027873e-29
0.0839997192963500
...                        ...                    ...
...
1000028               9.995423               9.995423
0.000002
1000029               9.995433               9.995433
0.000002
1000030               9.995443               9.995443
0.000002
1000031               9.995453               9.995453
0.000002
1000032               9.995456               9.995456
0.000002

                  Unnamed: 6            Uрт(выход)        Unnamed: 8
\
0                     U6_int                    U7           U8_ditt

1                          0                     0                 0

2        2.36658271566097e-22  6.49981499390246e-68                 0

3          0.0119999934720000  1.02400000000000e-22  198.988003852207

4          0.0839997192963500  2.21183720079561e-20  198.915999227722

...                       ...                   ...               ...

1000028              0.000002              0.555556         -0.000001

1000029              0.000002              0.555556         -0.000001

1000030              0.000002              0.555556         -0.000001

1000031              0.000002              0.555556         -0.000001

1000032              0.000002              0.555556              -0.0


                  Unnamed: 9                  Iобщ           Unnamed:
11  \
0                     U9_int                   U10
U11_diff
1                          0                     0
0
2        3.15544362088405e-29  3.15544362088405e-29
1.49352366668537e-51
```

```
3        1.60000000254710e-09  1.60000000254710e-09
3.83999791104000e-12
4        9.60000009167708e-09  9.60000009167708e-09
1.38239548785200e-10
...                       ...                   ...
...
1000028              6.815096              6.815096                   -
0.0
1000029              6.815103              6.815103                   -
0.0
1000030              6.815109              6.815109                   -
0.0
1000031              6.815116              6.815116                   -
0.0
1000032              6.815118              6.815118                   -
0.0

                 Unnamed: 12                    wn           Unnamed:
14  \
0                    U12_int                   U13
U14_diff
1                          0                     0
0
2        4.73316543132195e-22  1.29996299878049e-67
3.89988899746073e-65
3          0.0239999869440000  2.04800000000000e-22
6.14400000000000e-20
4           0.167999438592700  4.42367440159121e-20
1.32710232047736e-17
...                       ...                   ...
...
1000028              0.000004              1.111111
333.333314
1000029              0.000004              1.111111
333.333314
1000030              0.000004              1.111111
333.333314
1000031              0.000004              1.111111
333.333314
1000032              0.000004              1.111111
333.333314

                 Unnamed: 15
0                    U15_int
1                          0
2        1.23592415711364e-35
3        3.84000000000000e-10
4        1.65119790059671e-08
...                       ...
1000028             -0.000053
```

```
1000029             -0.000053
1000030             -0.000053
1000031             -0.000053
1000032             -0.000053

[1000033 rows x 16 columns]
```

```
df=df.drop(index=0)
```

```
df
```

```
                    T            Uдс(вход2)            Unnamed: 2  \
1        0.000000e+00                     0                     0
2        1.169967e-66  1.16996669923822e-66  3.15544362088405e-30
3        1.843200e-21  1.84320000000000e-21  1.60000000000000e-10
4        3.981307e-19  3.98130696143209e-19  9.60000000000000e-10
5        5.491037e-17  5.49103709210333e-17  4.96000000000000e-09
...               ...                   ...                   ...
1000028  9.999999e+00              9.999999              0.999997
1000029  9.999999e+00              9.999999              0.999998
1000030  9.999999e+00              9.999999              0.999999
1000031  9.999999e+00              9.999999                   1.0
1000032  9.999999e+00              9.999999                   1.0

                    Unnamed: 3             Uдт(вход3)
Unnamed: 5  \
1                             0                      0
0
2        -1.14702617601537e-70  -1.14702617601537e-70
2.36658271566097e-22
3         5.81611368201348e-51   5.81611368201348e-51
0.0119999934720000
4         4.93977239027873e-29   4.93977239027873e-29
0.0839997192963500
5         3.92430326568353e-26   3.92430326568353e-26
0.443992277431536
...                        ...                    ...
...
1000028              9.995423               9.995423
0.000002
1000029              9.995433               9.995433
0.000002
1000030              9.995443               9.995443
0.000002
1000031              9.995453               9.995453
0.000002
1000032              9.995456               9.995456
0.000002

                   Unnamed: 6            Uрт(выход)        Unnamed: 8
```

```
\
1                           0                    0                 0

2        2.36658271566097e-22  6.49981499390246e-68                 0

3          0.0119999934720000  1.02400000000000e-22  198.988003852207

4          0.0839997192963500  2.21183720079561e-20  198.915999227722

5           0.443992277431536  3.05057616227963e-18  198.556007635631

...                       ...                   ...               ...

1000028              0.000002              0.555556         -0.000001

1000029              0.000002              0.555556         -0.000001

1000030              0.000002              0.555556         -0.000001

1000031              0.000002              0.555556         -0.000001

1000032              0.000002              0.555556              -0.0


                   Unnamed: 9                   Iобщ           Unnamed:
11  \
1                           0                      0
0
2        3.15544362088405e-29  3.15544362088405e-29
1.49352366668537e-51
3        1.60000000254710e-09  1.60000000254710e-09
3.83999791104000e-12
4        9.60000009167708e-09  9.60000009167708e-09
1.38239548785200e-10
5        4.96000024448086e-08  4.96000024448086e-08
3.69017776823749e-09
...                       ...                   ...
...
1000028              6.815096              6.815096                  -
0.0
1000029              6.815103              6.815103                  -
0.0
1000030              6.815109              6.815109                  -
0.0
1000031              6.815116              6.815116                  -
0.0
1000032              6.815118              6.815118                  -
0.0
```

```
                  Unnamed: 12                      wn           Unnamed:
14  \
1                           0                       0
0
2         4.73316543132195e-22  1.29996299878049e-67
3.89988899746073e-65
3           0.0239999869440000  2.04800000000000e-22
6.14400000000000e-20
4            0.167999438592700  4.42367440159121e-20
1.32710232047736e-17
5            0.887984554863073  6.10115232455925e-18
1.83034569736778e-15
...                        ...                   ...
...
1000028              0.000004              1.111111
333.333314
1000029              0.000004              1.111111
333.333314
1000030              0.000004              1.111111
333.333314
1000031              0.000004              1.111111
333.333314
1000032              0.000004              1.111111
333.333314

                  Unnamed: 15
1                           0
2         1.23592415711364e-35
3         3.84000000000000e-10
4         1.65119790059671e-08
5         4.54268668540751e-07
...                        ...
1000028             -0.000053
1000029             -0.000053
1000030             -0.000053
1000031             -0.000053
1000032             -0.000053

[1000032 rows x 16 columns]
```

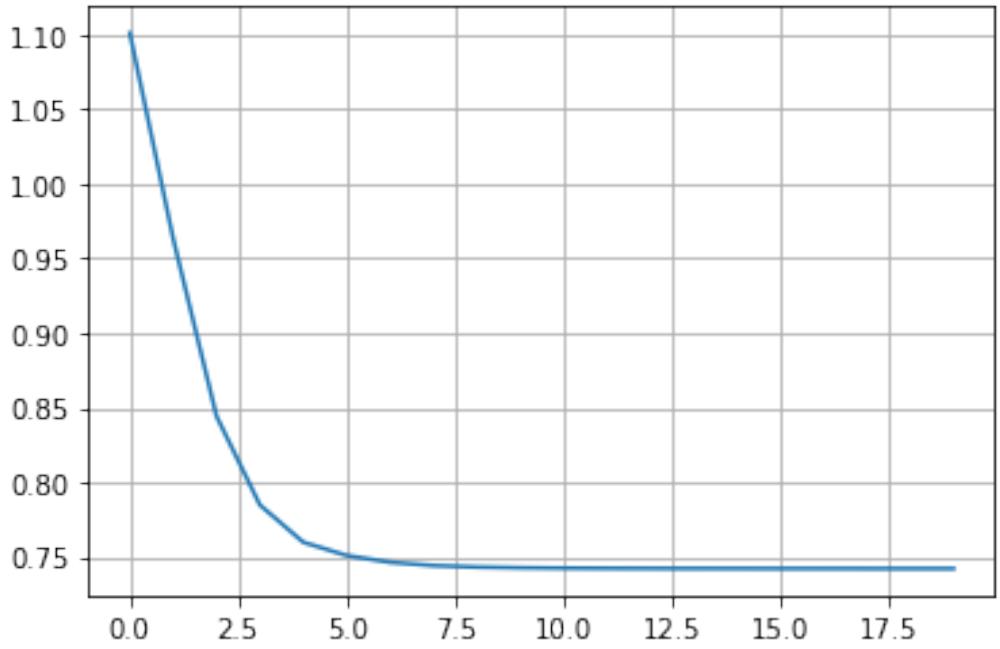
```
from sklearn.metrics import max_error

from sklearn.preprocessing import StandardScaler


df1=df[['T','Unnamed: 9',  'Iобщ',    'Unnamed: 11',  'Unnamed: 12',
      'wn' ,     'Unnamed: 14',  'Unnamed: 15']]

scaler = StandardScaler().fit(df1)

df1=scaler.transform(df1)
```

```
df2=df[['Удс(вход2)',      'Unnamed: 2',   'Unnamed: 3',
     'Удт(вход3)'    ,'Unnamed: 5'   ,'Unnamed: 6'   ,'Урт(выход)']]

scaler = StandardScaler().fit(df2)

df2=scaler.transform(df2)

from sklearn.model_selection import train_test_split
X_train1 ,X_test1,y_train1,y_test1=train_test_split(
df1,
df2,
test_size=0.20
)

model = Sequential([
                  Dense(13,activation='sigmoid', input_shape=[8]),
                  Dense(11, activation='sigmoid', input_shape=[8]),
                  Dense(9, activation='sigmoid', input_shape=[8]),
                  Dense(7, activation='sigmoid', input_shape=[8]),
                        ])
model.compile(loss='mean_squared_error', optimizer=Nadam(lr=0.0001),
metrics=['mean_absolute_error'])

X_train1 = np.asarray(X_train1).astype(np.float32)

y_train1 = np.asarray(y_train1).astype(np.float32)

X_test1 = np.asarray(X_test1).astype(np.float32)

history=model.fit(X_train1, y_train1, batch_size=200, epochs=20)

res = model.predict(X_test1, verbose = 0)
res = np.array(res)
detres = res * scaler.scale_[-1] + scaler.mean_[-1]
detsource = y_test1 * scaler.scale_[-1] + scaler.mean_[-1]

print(detres)
print(model.layers[0].get_weights())
plt.plot(history.history['loss'])
plt.grid(True)
plt.show()

Epoch 1/20

/usr/local/lib/python3.8/dist-packages/keras/optimizers/optimizer_v2/
nadam.py:78: UserWarning: The `lr` argument is deprecated, use
`learning_rate` instead.
  super(Nadam, self).__init__(name, **kwargs)

4001/4001 [==============================] - 6s 1ms/step - loss:
1.1012 - mean_absolute_error: 0.6454
```

```
Epoch 2/20
4001/4001 [==============================] - 5s 1ms/step - loss:
0.9634 - mean_absolute_error: 0.5198
Epoch 3/20
4001/4001 [==============================] - 5s 1ms/step - loss:
0.8443 - mean_absolute_error: 0.4197
Epoch 4/20
4001/4001 [==============================] - 5s 1ms/step - loss:
0.7849 - mean_absolute_error: 0.3743
Epoch 5/20
4001/4001 [==============================] - 5s 1ms/step - loss:
0.7599 - mean_absolute_error: 0.3481
Epoch 6/20
4001/4001 [==============================] - 5s 1ms/step - loss:
0.7509 - mean_absolute_error: 0.3369
Epoch 7/20
4001/4001 [==============================] - 5s 1ms/step - loss:
0.7464 - mean_absolute_error: 0.3293
Epoch 8/20
4001/4001 [==============================] - 5s 1ms/step - loss:
0.7442 - mean_absolute_error: 0.3257
Epoch 9/20
4001/4001 [==============================] - 5s 1ms/step - loss:
0.7432 - mean_absolute_error: 0.3249
Epoch 10/20
4001/4001 [==============================] - 5s 1ms/step - loss:
0.7427 - mean_absolute_error: 0.3245
Epoch 11/20
4001/4001 [==============================] - 5s 1ms/step - loss:
0.7425 - mean_absolute_error: 0.3242
Epoch 12/20
4001/4001 [==============================] - 6s 1ms/step - loss:
0.7423 - mean_absolute_error: 0.3239
Epoch 13/20
4001/4001 [==============================] - 6s 1ms/step - loss:
0.7423 - mean_absolute_error: 0.3237
Epoch 14/20
4001/4001 [==============================] - 5s 1ms/step - loss:
0.7422 - mean_absolute_error: 0.3234
Epoch 15/20
4001/4001 [==============================] - 5s 1ms/step - loss:
0.7422 - mean_absolute_error: 0.3232
Epoch 16/20
4001/4001 [==============================] - 5s 1ms/step - loss:
0.7422 - mean_absolute_error: 0.3229
Epoch 17/20
4001/4001 [==============================] - 5s 1ms/step - loss:
0.7422 - mean_absolute_error: 0.3226
Epoch 18/20
4001/4001 [==============================] - 5s 1ms/step - loss:
```

```
0.7422 - mean_absolute_error: 0.3223
Epoch 19/20
4001/4001 [==============================] - 5s 1ms/step - loss:
0.7421 - mean_absolute_error: 0.3221
Epoch 20/20
4001/4001 [==============================] - 5s 1ms/step - loss:
0.7421 - mean_absolute_error: 0.3220
[[0.55758274 0.55530196 0.55530196 ... 0.55530196 0.55530196
0.55747634]
 [0.5553021  0.6297774  0.6297726  ... 0.55530214 0.5553025  0.5553021
]
 [0.5752796  0.55530196 0.55530196 ... 0.55530196 0.55530196
0.57527846]
 ...
 [0.555302   0.6570569  0.65700257 ... 0.555305   0.55530685 0.555302
]
 [0.555302   0.653774   0.65354085 ... 0.55530256 0.5553034  0.555302
]
 [0.555302   0.6572921  0.6572858  ... 0.55531836 0.5553198
0.55530196]]
[array([[-0.38773367, -0.19059043, -2.8898568 ,  0.2512025 , -
0.6072035 ,
         0.91008675, -1.3847708 ,  1.2638124 ,  0.24831836, -
0.65324146,
        -0.3785339 , -1.4666837 ,  0.0652221 ],
       [ 1.6788678 ,  1.5311464 ,  1.0213298 , -1.1211855 , -
0.13667743,
        -0.8148778 , -1.276097  , -0.5602227 , -1.1077905 ,
0.12833633,
         1.2376262 , -1.3899841 ,  0.83659065],
       [ 1.6719214 ,  1.447256  ,  0.98517746, -1.0694246 , -
0.07866496,
        -0.3462141 , -0.97524697, -0.8573471 , -0.8313965 , -
0.13685569,
         1.4421283 , -1.6009767 ,  1.3436425 ],
       [-0.20821501, -0.20049605,  0.4791772 , -0.17485228, -
0.06406721,
        -0.4185824 , -0.54062533, -0.75162685, -0.81762785,
0.10748944,
         0.20270288, -0.1469431 , -0.2510594 ],
       [-0.05586456, -0.04715582,  0.03088687, -0.08127035, -
0.03251934,
        -0.15885721, -0.02782091, -0.32128105, -0.10629448, -
0.03724622,
        -0.08350988, -0.15395367, -0.10278604],
       [-0.02215724,  0.03952196, -2.7825553 , -0.1335898 , -
0.81433785,
         0.2394147 , -0.86800057,  1.2414325 ,  0.36269435, -0.6360786
,
        -0.07879678, -1.7482498 , -0.45204934],
```

```
       [-0.12330174, -0.22578602, -3.415827  , -0.12134934, -0.9423826
,
         0.5538462 , -1.487874  ,  1.3873376 , -0.40463126, -
0.26731324,
        -0.10876487, -2.3290699 , -0.27660993],
       [-0.23315041,  0.10517702,  1.0526392 , -0.71298105, -
0.46748102,
        -0.45379454,  0.34570205, -0.0255143 ,  0.08112771,
0.12865318,
        -0.6555678 , -0.23296534, -0.10000278]], dtype=float32),
array([ 0.0728178 , -0.22849657, -0.5368915 ,  1.2274625 ,
1.0987822 ,
        0.06047882,  1.3142412 ,  0.41828984,  1.014615  ,
0.78299713,
       -0.00743077,  2.430956  ,  0.06408177], dtype=float32)]
```




```
res = model.predict(X_test1, verbose = 0)
res = np.array(res)
detres = res * scaler.scale_[-1] + scaler.mean_[-1]
detsource = y_test1 * scaler.scale_[-1] + scaler.mean_[-1]

x=[]

from numpy import arange
for i in arange(-10.0, 10.0, 0.1):
  x.append(i)

myarray = np.asarray(x)

v=myarray.reshape(-1,8)
```

```
detres.shape
```

```
(200007, 7)
```

```
X_test1.shape
```

```
(200007, 8)
```

```
sss=model.predict(v)
y_test1[:25].shape
```

```
1/1 [==============================] - 0s 14ms/step
```

```
(25, 7)
```

```
from sklearn import metrics
print("Максимальная ошибка  на тестовом наборе:
{:.2f}".format(metrics.mean_absolute_error(sss,detsource[:25])))
```

```
Максимальная ошибка  на тестовом наборе: 0.53
```

```
y_test1
```

```
array([[ 2.75967146e-02, -5.09462352e-01, -4.84004402e-01, ...,
         2.24690394e-03,  2.24690394e-03,  2.75967146e-02],
       [ 2.50237898e-03,  7.29532961e-01,  7.29013591e-01, ...,
         4.49731304e-05,  4.49731304e-05,  2.50237898e-03],
       [ 1.91009093e-01, -8.55276983e-01, -8.27392991e-01, ...,
         1.64429316e-02,  1.64429316e-02,  1.91009093e-01],
       ...,
       [ 2.48811447e-03,  1.03857339e+00,  1.03138294e+00, ...,
         4.36791216e-05,  4.36791216e-05,  2.48811447e-03],
       [ 2.48970184e-03,  9.60809269e-01,  9.55297526e-01, ...,
         4.38238854e-05,  4.38238854e-05,  2.48970184e-03],
       [ 2.48679346e-03,  1.15180924e+00,  1.14217431e+00, ...,
         4.35582774e-05,  4.35582774e-05,  2.48679346e-03]])
```

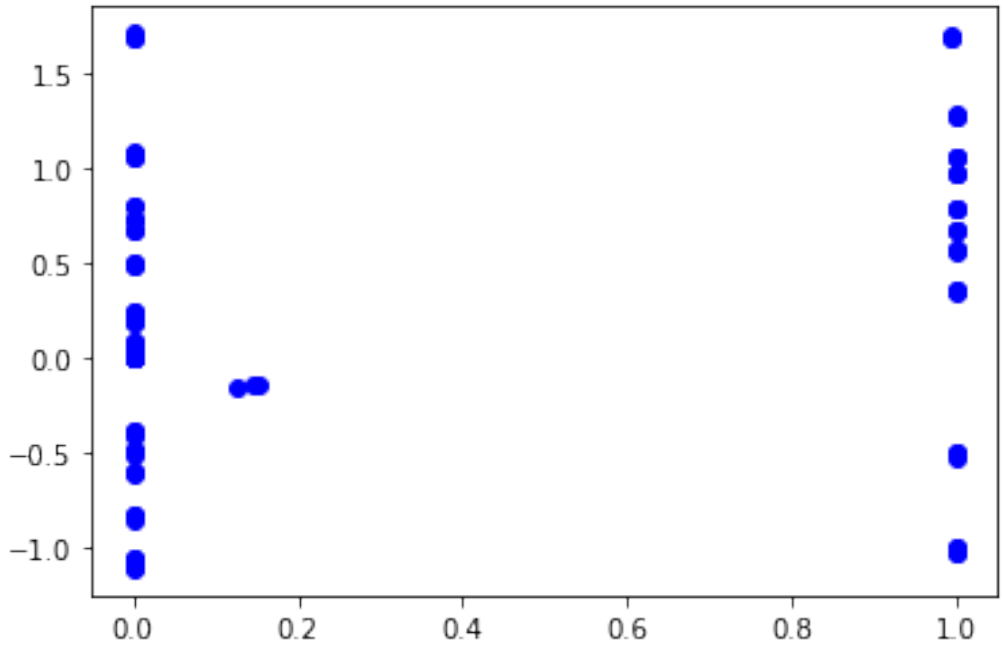
```
sss
```

```
array([[ -3.4593062 ,  -1.6511676 ,  -1.557725  ,  -1.5189536 ,
         -17.639482  , -17.36426   ,  -3.4362965 ],
       [ -3.572784  ,  -1.6854769 ,  -1.5922087 ,  -1.5532039 ,
         -17.093292  , -16.825266  ,  -3.5504932 ],
       [ -3.700366  ,  -1.7234143 ,  -1.6277994 ,  -1.5886106 ,
         -16.422525  , -16.163864  ,  -3.6789112 ],
       [ -3.8316143 ,  -1.7640986 ,  -1.6632187 ,  -1.6240796 ,
         -15.612964  , -15.366903  ,  -3.8112826 ],
       [ -3.9462328 ,  -1.8052561 ,  -1.6961787 ,  -1.657631  ,
         -14.656165  , -14.427353  ,  -3.9276018 ],
       [ -4.0115204 ,  -1.8423026 ,  -1.7227623 ,  -1.6857778 ,
         -13.548343  , -13.343042  ,  -3.995555  ],
       [ -3.9828923 ,  -1.8669822 ,  -1.7362865 ,  -1.7022777 ,
         -12.2810545 , -12.106896  ,  -3.9708586 ],
```

```
       [ -3.8110592 ,  -1.8650113 ,  -1.7250017 ,  -1.6955305 ,
        -10.820709  , -10.685295  ,  -3.803937  ],
       [ -3.4571664 ,  -1.8112957 ,  -1.6676459 ,  -1.6436409 ,
         -9.088382  ,  -8.995593  ,  -3.4542594 ],
       [ -2.905838  ,  -1.6612338 ,  -1.5259517 ,  -1.5067674 ,
         -6.9812875 ,  -6.925237  ,  -2.9032147 ],
       [ -2.1545892 ,  -1.3465536 ,  -1.2390392 ,  -1.2231706 ,
         -4.489319  ,  -4.4531436 ,  -2.1468353 ],
       [ -1.1974071 ,  -0.817021  ,  -0.7536267 ,  -0.7432533 ,
         -1.8859826 ,  -1.859961  ,  -1.1872523 ],
       [ -0.06935954,  -0.16137516,  -0.14235628,  -0.14493406,
          0.22121954,   0.2224834 ,  -0.07257009],
       [  1.0983648 ,   0.3739648 ,   0.34805143,   0.32998514,
          1.2844368 ,   1.2523206 ,   1.072848  ],
       [  2.0987089 ,   0.66050637,   0.5783168 ,   0.54886794,
          1.5133954 ,   1.4583608 ,   2.0557013 ],
       [  2.7692637 ,   0.77200997,   0.64254844,   0.60504746,
          1.7117981 ,   1.6456212 ,   2.7137666 ],
       [  3.129013  ,   0.7974435 ,   0.6506351 ,   0.6066923 ,
          2.2634864 ,   2.194923  ,   3.06314   ],
       [  3.3016186 ,   0.77741396,   0.63687694,   0.58778524,
          3.0299835 ,   2.9644618 ,   3.227045  ],
       [  3.3890758 ,   0.73023283,   0.6059027 ,   0.55293226,
          3.8126593 ,   3.7527528 ,   3.307662  ],
       [  3.4443917 ,   0.66725886,   0.56078804,   0.50500655,
          4.5213366 ,   4.4678283 ,   3.357799  ],
       [  3.488679  ,   0.5959858 ,   0.50589824,   0.4480989 ,
          5.140953  ,   5.093733  ,   3.3981752 ],
       [  3.5281005 ,   0.5211717 ,   0.4453684 ,   0.3861133 ,
          5.6844015 ,   5.6429887 ,   3.434599  ],
       [  3.5631166 ,   0.44579136,   0.38241816,   0.32210684,
          6.169419  ,   6.1332006 ,   3.46727   ],
       [  3.592548  ,   0.37170565,   0.31932497,   0.25825155,
          6.610944  ,   6.579281  ,   3.4948397 ],
       [  3.6151366 ,   0.30006564,   0.2575997 ,   0.19599378,
          7.019755  ,   6.992018  ,   3.5159435 ]], dtype=float32)
```

```
import matplotlib.cm as cm
import matplotlib.pyplot as plt
import matplotlib.colors as mcolors
import numpy as np

cmap, norm = mcolors.from_levels_and_colors([0, 2, 5, 6], ['red',
'green', 'blue'])

plt.scatter(sss,y_test1[:25],c='blue')
```

```
<matplotlib.collections.PathCollection at 0x7f6d65220a90>
```




```
y_train1.shape
```

```
(800025, 7)
```

```
X_test1.dtype
```

```
dtype('float32')
```