In [ ]:

```
# Author : Amir Shokri
# github link : https://github.com/amirshnll/Bank-Marketing
# dataset link : http://archive.ics.uci.edu/ml/datasets/Bank+Marketing
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```

Read data

In [1]:

```
import pandas as pd

DataName='bank-full.csv'
print('-----------Loading Data------------------')
data_pd = pd.read_csv(DataName)
print(data_pd.describe)
```

```
-----------Loading Data------------------
<bound method NDFrame.describe of        age           job   marital  educati
on default  balance housing loan  \
0       58    management   married   tertiary      no     2143     yes   no
1       44    technician    single  secondary      no       29     yes   no
2       33  entrepreneur   married  secondary      no        2     yes  yes
3       47   blue-collar   married    unknown      no     1506     yes   no
4       33       unknown    single    unknown      no        1      no   no
...    ...           ...       ...        ...     ...      ...     ...  ...
45206   51    technician   married   tertiary      no      825      no   no
45207   71       retired  divorced    primary      no     1729      no   no
45208   72       retired   married  secondary      no     5715      no   no
45209   57   blue-collar   married  secondary      no      668      no   no
45210   37  entrepreneur   married  secondary      no     2971      no   no

         contact  day month  duration  campaign  pdays  previous poutcome
y
0        unknown    5   may       261         1     -1         0  unknown   n
o
1        unknown    5   may       151         1     -1         0  unknown   n
o
2        unknown    5   may        76         1     -1         0  unknown   n
o
3        unknown    5   may        92         1     -1         0  unknown   n
o
4        unknown    5   may       198         1     -1         0  unknown   n
o
...          ...  ...   ...       ...       ...    ...       ...      ...
...
45206   cellular   17   nov       977         3     -1         0  unknown  ye
s
45207   cellular   17   nov       456         2     -1         0  unknown  ye
s
45208   cellular   17   nov      1127         5    184         3  success  ye
s
45209  telephone   17   nov       508         4     -1         0  unknown   n
o
45210   cellular   17   nov       361         2    188        11    other   n
o

[45211 rows x 17 columns]>
```

Preproccessing

In [3]:
```python
print('-----------Preproccessing----------------')

from sklearn.preprocessing import LabelEncoder
import numpy as np
encoder = LabelEncoder()
dic_str={"job":1,"marital":2,"education":3,"default":4,"housing":6,"loan":7,"c
ontact":8,"month":10,"poutcome":15,"y":16}
for col_name, col_idx in dic_str.items():
    print("colums: {0} to int".format(dic_str[col_name]))
    lbl_txt=np.array(data_pd.iloc[:,col_idx])
    data_pd[col_name]=encoder.fit_transform(lbl_txt.reshape(-1, 1))
data_pd
```

```
-----------Preproccessing----------------
colums: 1 to int
colums: 2 to int
colums: 3 to int
colums: 4 to int
colums: 6 to int
colums: 7 to int
colums: 8 to int
colums: 10 to int
colums: 15 to int
colums: 16 to int
```

```
C:\Users\Human\anaconda3\lib\site-packages\sklearn\utils\validation.py:73: Da
taConversionWarning: A column-vector y was passed when a 1d array was expecte
d. Please change the shape of y to (n_samples, ), for example using ravel().
  return f(**kwargs)
```

Out[3]:

	age	job	marital	education	default	balance	housing	loan	contact	day	month	dura
0	58	4	1	2	0	2143	1	0	2	5	8	
1	44	9	2	1	0	29	1	0	2	5	8	
2	33	2	1	1	0	2	1	1	2	5	8	
3	47	1	1	3	0	1506	1	0	2	5	8	
4	33	11	2	3	0	1	0	0	2	5	8	
...	...	...	...	...	...	...	...	...	...	...	...	
45206	51	9	1	2	0	825	0	0	0	17	9	
45207	71	5	0	0	0	1729	0	0	0	17	9	
45208	72	5	1	1	0	5715	0	0	0	17	9	1
45209	57	1	1	1	0	668	0	0	1	17	9	
45210	37	2	1	1	0	2971	0	0	0	17	9	

45211 rows × 17 columns

normalize

In [4]:

```
from sklearn import preprocessing
Data_lable=data_pd.iloc[:,-1]
Data_main=data_pd.iloc[:,:-1]
from sklearn.preprocessing import MinMaxScaler
scaler = MinMaxScaler()
scaler.fit(Data_main)
Data_main=scaler.transform(Data_main)
print(Data_main)
```

```
[[0.51948052 0.36363636 0.5        ... 0.         0.         1.        ]
 [0.33766234 0.81818182 1.         ... 0.         0.         1.        ]
 [0.19480519 0.18181818 0.5        ... 0.         0.         1.        ]
 ...
 [0.7012987  0.45454545 0.5        ... 0.21215596 0.01090909 0.66666667]
 [0.50649351 0.09090909 0.5        ... 0.         0.         1.        ]
 [0.24675325 0.18181818 0.5        ... 0.21674312 0.04       0.33333333]]
```

'DT','KNN','NB','MLP','LR'

In [5]:

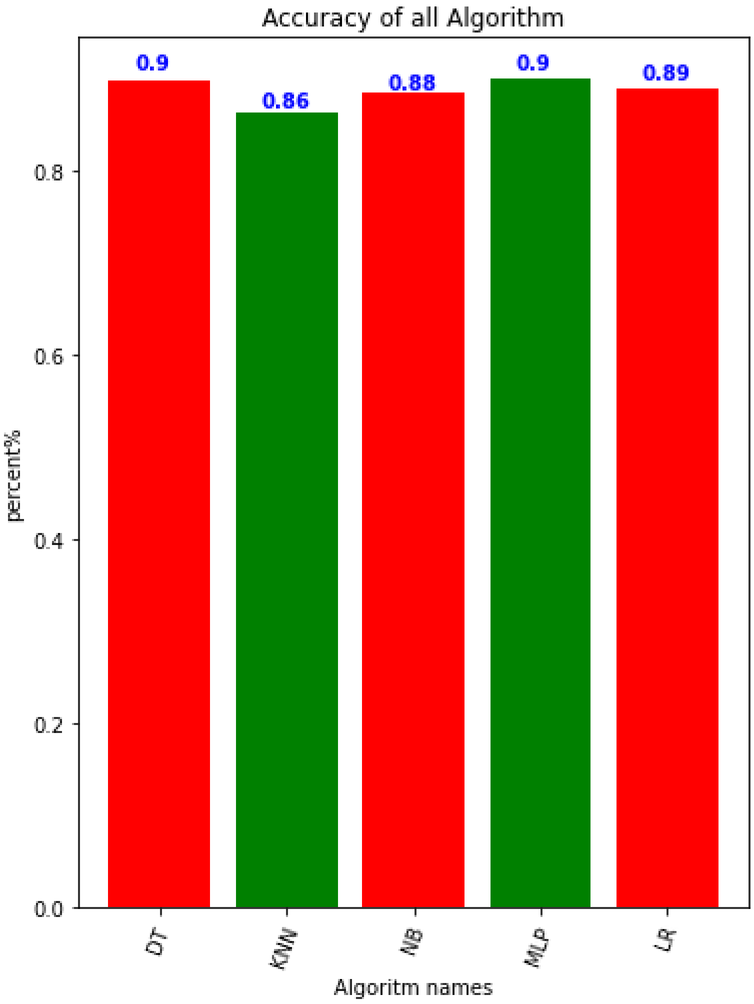
```
import numpy as np
import os
from pytictoc import TicToc
import matplotlib.pyplot as plt
from sklearn.metrics import classification_report, confusion_matrix
from sklearn.metrics import accuracy_score
from sklearn.neighbors import KNeighborsClassifier
from sklearn.tree import DecisionTreeClassifier
from sklearn.naive_bayes import BernoulliNB
from sklearn.linear_model import LogisticRegression
from sklearn.neural_network import MLPClassifier


def run_all_algorithm(Train_data,Test_data,Train_lable,Test_lable,str_out):


    print(np.shape(Test_data))
    print(np.shape(Train_data))
    print(np.shape(Train_lable))
    print(np.shape(Test_lable))

    algorithms_name=['DT','KNN','NB','MLP','LR']
    alg_num=len(algorithms_name)
    accuracy_array=np.zeros(alg_num)
    precision_array=np.zeros(alg_num)
    recall_array=np.zeros(alg_num)
    f1_score_array=np.zeros(alg_num)
    time_array=np.zeros(alg_num)

    t = TicToc()


    print('---------------------DT---------------------')
    K=0;
    t.tic() #Start timer
    classifier_DT = DecisionTreeClassifier(max_depth=10,random_state=0)
    classifier_DT.fit(Train_data, Train_lable)
    Test_predict = classifier_DT.predict(Test_data)
    Con_matrix=confusion_matrix(Test_lable, Test_predict)
    TimeDT=t.tocvalue() #Time elapsed since t.tic()
    classfi_report=classification_report(Test_lable, Test_predict,output_dict=
True)

    # save to array
    accuracy_array[K]=accuracy_score(Test_lable, Test_predict)
    precision_array[K]= classfi_report['macro avg']['precision']
    recall_array[K]= classfi_report['macro avg']['recall']
    f1_score_array[K]= classfi_report['macro avg']['f1-score']
    time_array[K]=TimeDT


    print('--------------NB----------------')
    K+=1;
    t.tic() #Start timer
    classifier = BernoulliNB()
    classifier.fit(Train_data, Train_lable)
    Test_predict = classifier.predict(Test_data)
    TimeNB=t.tocvalue() #Time elapsed since t.tic()
    Con_matrix=confusion_matrix(Test_lable, Test_predict)
    classfi_report=classification_report(Test_lable, Test_predict,output_dict=
True)


    # save to array
    accuracy_array[K]=accuracy_score(Test_lable, Test_predict)
    precision_array[K]= classfi_report['macro avg']['precision']
    recall_array[K]= classfi_report['macro avg']['recall']
    f1_score_array[K]= classfi_report['macro avg']['f1-score']
    time_array[K]=TimeNB
    print('---------------------KNN---------------------')
    K+=1;
    t.tic() #Start timer
    classifier=KNeighborsClassifier(n_neighbors=100)
    classifier.fit(Train_data, Train_lable)
    Test_predict = classifier.predict(Test_data)
    TimeKNN=t.tocvalue() #Time elapsed since t.tic()
    Con_matrix=confusion_matrix(Test_lable, Test_predict)
    classfi_report=classification_report(Test_lable, Test_predict,output_dict=
True)

    # save to array
    accuracy_array[K]=accuracy_score(Test_lable, Test_predict)
    precision_array[K]= classfi_report['macro avg']['precision']
    recall_array[K]= classfi_report['macro avg']['recall']
    f1_score_array[K]= classfi_report['macro avg']['f1-score']
    time_array[K]=TimeKNN


    print('---------------------MLP---------------------')
    K+=1;
    t.tic() #Start timer
    classifier=MLPClassifier( solver='adam', random_state=0,hidden_layer_sizes
=[15,5], max_iter=200)
    classifier.fit(Train_data, Train_lable)
    Test_predict = classifier.predict(Test_data)
    TimeMLP=t.tocvalue() #Time elapsed since t.tic()
    Con_matrix=confusion_matrix(Test_lable, Test_predict)
    classfi_report=classification_report(Test_lable, Test_predict,output_dict=
True)

    # save to array
    accuracy_array[K]=accuracy_score(Test_lable, Test_predict)
    precision_array[K]= classfi_report['macro avg']['precision']
    recall_array[K]= classfi_report['macro avg']['recall']
    f1_score_array[K]= classfi_report['macro avg']['f1-score']
    time_array[K]=TimeMLP


    print('---------------------LogisticRegression---------------------')
    K+=1;
    t.tic() #Start timer
    classifier=LogisticRegression()
    classifier.fit(Train_data, Train_lable)
    Test_predict = classifier.predict(Test_data)
    TimeLR=t.tocvalue() #Time elapsed since t.tic()
    Con_matrix=confusion_matrix(Test_lable, Test_predict)
    classfi_report=classification_report(Test_lable, Test_predict,output_dict=
True)

    # save to array
    accuracy_array[K]=accuracy_score(Test_lable, Test_predict)
    precision_array[K]= classfi_report['macro avg']['precision']
    recall_array[K]= classfi_report['macro avg']['recall']
    f1_score_array[K]= classfi_report['macro avg']['f1-score']
    time_array[K]=TimeLR







    H=6
    L=8




    print('--------------------result--------------------------')
    fig1=plt.figure(figsize=(H, L)) #
    plt.bar(algorithms_name, accuracy_array,color = ['red', 'green'])
    plt.xticks(algorithms_name, rotation=70)
    plt.ylabel('percent%')
    plt.title('Accuracy of all Algorithm')
    plt.xlabel("Algoritm names")
    for i, v in enumerate(accuracy_array):
        v=round(v,2)
        plt.text(i-0.2 , v+0.01 , str(v), color='blue', fontweight='bold')
    fig1.show()
    plt.savefig(os.path.join(str_out+' accuracy.png'), dpi=300, format='png',
bbox_inches='tight') # use format='svg' or 'pdf' for vectorial pictures


    fig2=plt.figure(figsize=(H, L)) #
    plt.bar(algorithms_name, precision_array,color = ['red', 'green'])
    plt.xticks(algorithms_name, rotation=70)
    plt.ylabel('percent%')
    plt.title('Precision of all Algorithm')
    plt.xlabel("Algoritm names")
    for i, v in enumerate(precision_array):
        v=round(v,2)
        plt.text(i-0.2 , v+0.01 , str(v), color='blue', fontweight='bold')
    fig2.show()
    plt.savefig(os.path.join(str_out+' precision.png'), dpi=300, format='png',
bbox_inches='tight') # use format='svg' or 'pdf' for vectorial pictures




    fig3=plt.figure(figsize=(H, L)) #
    plt.bar(algorithms_name, recall_array,color = ['red', 'green'])
    plt.xticks(algorithms_name, rotation=70)
    plt.ylabel('percent%')
    plt.title('Recallof all Algorithm')
    plt.xlabel("Algoritm names")
    for i, v in enumerate(recall_array):
        v=round(v,2)
        plt.text(i-0.2 , v+0.01 , str(v), color='blue', fontweight='bold')
    fig3.show()
    plt.savefig(os.path.join(str_out+' recall.png'), dpi=300, format='png', bb
ox_inches='tight') # use format='svg' or 'pdf' for vectorial pictures



    fig4=plt.figure(figsize=(H, L)) #
    plt.bar(algorithms_name, f1_score_array,color = ['red', 'green'])
    plt.xticks(algorithms_name, rotation=70)
    plt.ylabel('percent%')
    plt.title('f1-score of all Algorithm')
    plt.xlabel("Algoritm names")
    for i, v in enumerate(f1_score_array):
        v=round(v,2)
        plt.text(i-0.2 , v+0.01 , str(v), color='blue', fontweight='bold')
    fig4.show()
    plt.savefig(os.path.join(str_out+' f1_score.png'), dpi=300, format='png',
bbox_inches='tight') # use format='svg' or 'pdf' for vectorial pictures



    fig5=plt.figure(figsize=(H, L)) #
    plt.bar(algorithms_name, time_array,color = ['blue', 'green'])
    plt.xticks(algorithms_name, rotation=70)
    plt.ylabel('time(s)')
    plt.title('time of all Algorithm')
    plt.xlabel("Algoritm names")
    for i, v in enumerate(time_array):
        v=round(v,2)
        plt.text(i-0.2 , v+0.01 , str(v), color='blue', fontweight='bold')
    plt.savefig(os.path.join(str_out+' time.png'), dpi=300, format='png', bbox
_inches='tight') # use format='svg' or 'pdf' for vectorial pictures
    fig5.show()


    np.savetxt(str_out+'accuracy.csv', accuracy_array, delimiter=',')
    np.savetxt(str_out+' precision_array.csv', precision_array, delimiter=',')
    np.savetxt(str_out+'recall_array.csv', recall_array, delimiter=',')
    np.savetxt(str_out+' time_array.csv', time_array, delimiter=',')
    np.savetxt(str_out+' f1-score.csv', f1_score_array, delimiter=',')
```

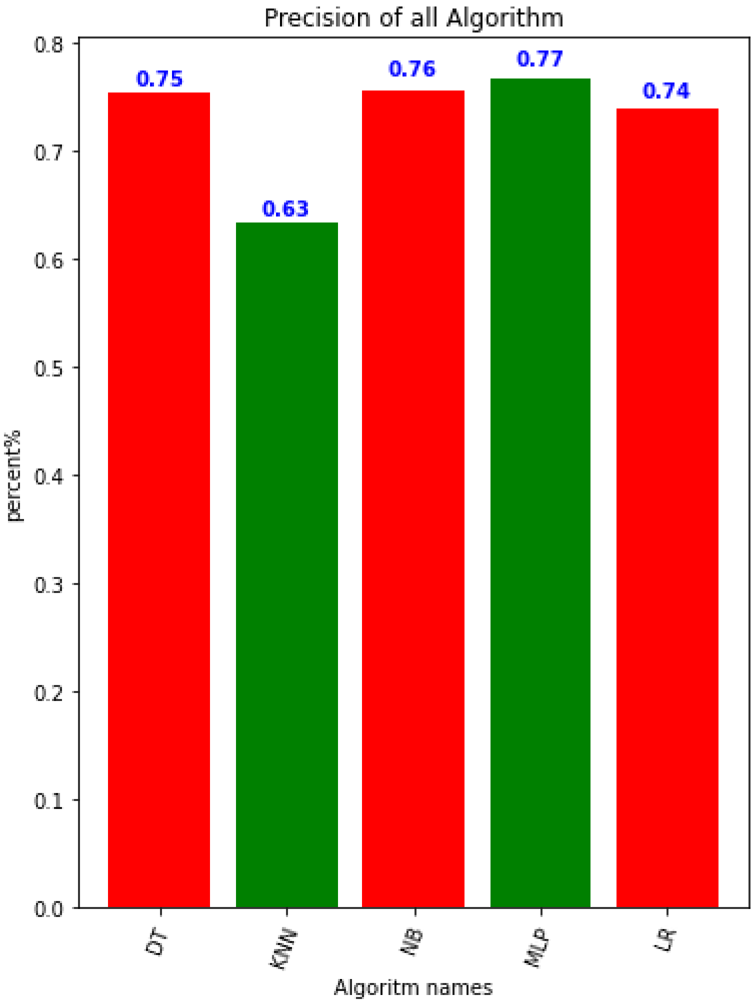
train_test_split

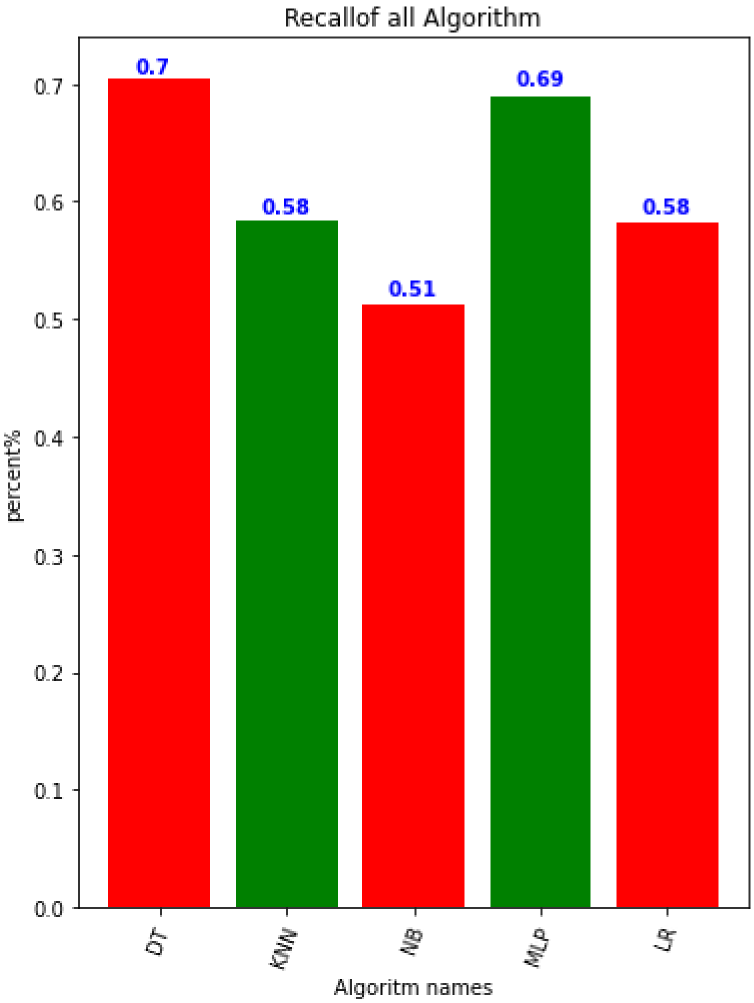
In [6]:

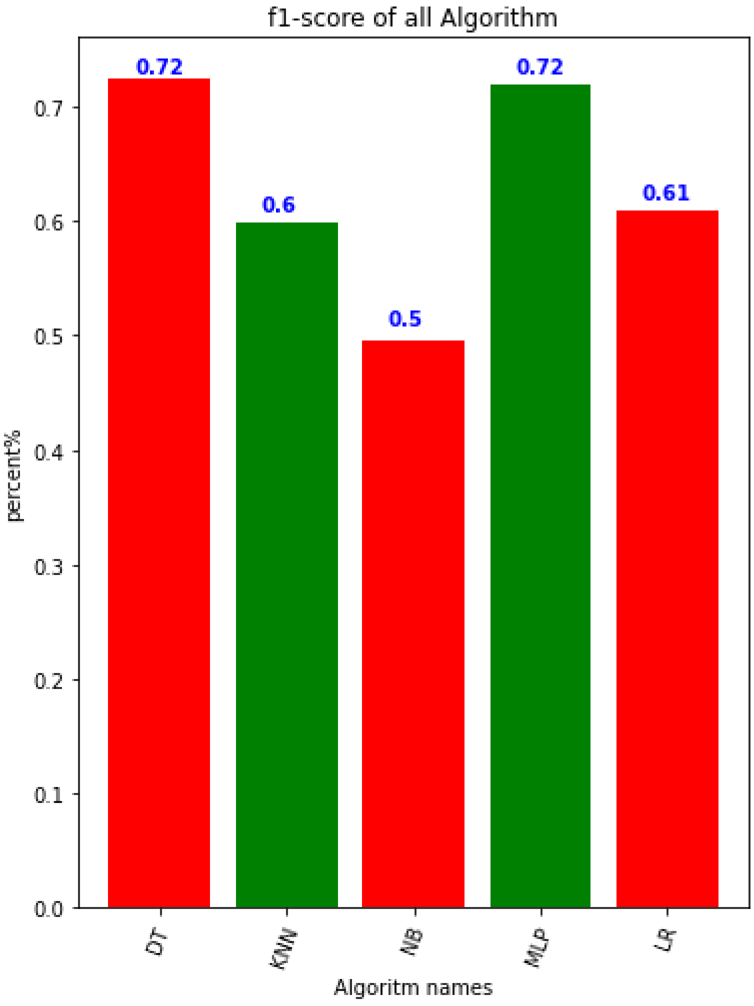
```
from sklearn.model_selection import train_test_split
Train_data, Test_data, Train_lable, Test_lable = train_test_split(Data_main, D
ata_lable, test_size=0.20)
run_all_algorithm(Train_data, Test_data, Train_lable, Test_lable ,"")
```

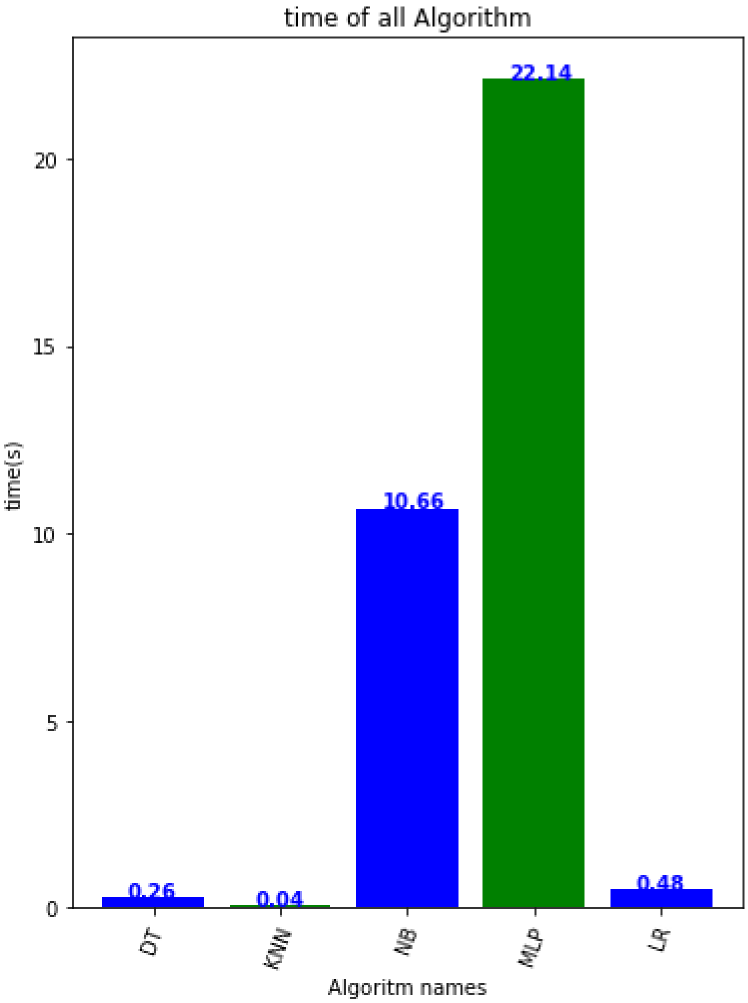
```
(9043, 16)
(36168, 16)
(36168,)
(9043,)
---------------------DT---------------------
--------------NB----------------
---------------------KNN---------------------
---------------------MLP---------------------
---------------------LogisticRegression---------------------
--------------------result--------------------------

<ipython-input-5-1f9a66e710f1>:142: UserWarning: Matplotlib is currently usin
g module://ipykernel.pylab.backend_inline, which is a non-GUI backend, so can
not show the figure.
  fig1.show()
<ipython-input-5-1f9a66e710f1>:155: UserWarning: Matplotlib is currently usin
g module://ipykernel.pylab.backend_inline, which is a non-GUI backend, so can
not show the figure.
  fig2.show()
<ipython-input-5-1f9a66e710f1>:170: UserWarning: Matplotlib is currently usin
g module://ipykernel.pylab.backend_inline, which is a non-GUI backend, so can
not show the figure.
  fig3.show()
<ipython-input-5-1f9a66e710f1>:184: UserWarning: Matplotlib is currently usin
g module://ipykernel.pylab.backend_inline, which is a non-GUI backend, so can
not show the figure.
  fig4.show()
<ipython-input-5-1f9a66e710f1>:199: UserWarning: Matplotlib is currently usin
g module://ipykernel.pylab.backend_inline, which is a non-GUI backend, so can
not show the figure.
  fig5.show()
```


Accuracy of all Algorithm
0.9
0.86
0.88
0.9
0.89
0.8
0.6
0.4
0.2
0.0
percent%
DT
KNN
NB
MLP
LR
Algoritm names


Precision of all Algorithm
percent%
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.75
0.63
0.76
0.77
0.74
DT
KNN
NB
MLP
LR
Algoritm names


Recallof all Algorithm
percent%
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.7
0.58
0.51
0.69
0.58
DT
KNN
NB
MLP
LR
Algoritm names


f1-score of all Algorithm
0.72
0.6
0.5
0.72
0.61
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
percent%
DT
KNN
NB
MLP
LR
Algoritm names


time of all Algorithm
time(s)
0
5
10
15
20
0.26
0.04
10.66
22.14
0.48
DT
KNN
NB
MLP
LR
Algoritm names

In [ ]: