

```
In [146... import pandas as pd
import numpy as np
import scipy
import os

import matplotlib.pyplot as plt

from sklearn.naive_bayes import GaussianNB
from sklearn.linear_model import LogisticRegression
from sklearn import ensemble
from sklearn.ensemble import RandomForestClassifier
from sklearn.metrics import brier_score_loss, precision_score, recall_score, f1_score
from sklearn.metrics import confusion_matrix, roc_curve

from sklearn.preprocessing import StandardScaler
from sklearn.feature_extraction import DictVectorizer
from sklearn.cluster import KMeans

import random

from scipy.stats import ttest_ind
```

```
In [147... PartDRawData = "c:\\FIP\\PartD_Prescriber_PUF_NPI_Drug_17.txt"
```

```
In [4]: partD_pd = pd.read_csv(PartDRawData, sep="\t")
```

```
In [152... partD_pd.shape
```

```
Out[152... (25209130, 21)
```

```
In [5]: partD_Drug_pd1= partD_pd.loc[:,['npi','nppes_provider_city','nppes_provider_s',
                                         'nppes_provider_last_org_name',
                                         'nppes_provider_first_name', \
                                         'specialty_description', \
                                         'drug_name', \
                                         'generic_name', \
                                         'total_drug_cost', \
                                         'total_claim_count', \
                                         'total_day_supply']]
```

```
In [6]: partD_pd1 = partD_Drug_pd1
```

```
In [7]: partD_Drug_pd = partD_pd.loc[:,['npi','drug_name','total_drug_cost','total_cla
partD_Drug_pd['npi'] = partD_Drug_pd.npi.astype(object)
```

```
In [8]: partD_Spec_pd1= partD_pd.loc[:,['npi','specialty_description']]
```

```
In [9]: partD_Spec_pd1.head(0)
```

Out[9]: npi specialty_description

```
In [10]: partD_Drug_pd.head()
```

Out[10]:

	npi	drug_name	total_drug_cost	total_claim_count	total_day_supply
0	1003000126	AMLODIPINE BESYLATE	59.21	13	390
1	1003000126	ATORVASTATIN CALCIUM	259.48	27	765
2	1003000126	CEPHALEXIN	98.99	17	123
3	1003000126	CIPROFLOXACIN HCL	120.43	12	95
4	1003000126	DOXYCYCLINE HYCLATE	300.76	17	105

```
In [11]: partD_pd0= partD_pd.loc[:,['npi','nppes_provider_city','nppes_provider_state',  
                                     'nppes_provider_last_org_name',  
                                     'nppes_provider_first_name','s
```

```
In [12]: partD_pd0.head()
```

Out[12]:

	npi	nppes_provider_city	nppes_provider_state	nppes_provider_last_org_na
0	1003000126	CUMBERLAND	MD	ENKESH/
1	1003000126	CUMBERLAND	MD	ENKESH/
2	1003000126	CUMBERLAND	MD	ENKESH/
3	1003000126	CUMBERLAND	MD	ENKESH/
4	1003000126	CUMBERLAND	MD	ENKESH/

```
In [13]: partD_catfpd = partD_pd0.drop_duplicates()
```

```
In [14]: partD_catfpd.head()
```

Out[14]:

	npi	nppes_provider_city	nppes_provider_state	nppes_provider_last_org_na
0	1003000126	CUMBERLAND	MD	ENKESHAFI
16	1003000142	TOLEDO	OH	KHALIL
38	1003000167	DAYTON	NV	ESCOBAR
40	1003000282	NASHVILLE	TN	BLAKEMORE
42	1003000407	BROOKVILLE	PA	GIRARDI



```
In [15]: rename_dict = {'nppes_provider_first_name':'first_name', 'nppes_provider_last_name':'last_name'}
partD_catfpd = partD_catfpd.rename(columns=rename_dict)
```

```
In [16]: partD_catfpd.head()
```

Out[16]:

	npi	city	state	last_name	first_name	Speciality
0	1003000126	CUMBERLAND	MD	ENKESHAFI	ARDALAN	Internal Medicine
16	1003000142	TOLEDO	OH	KHALIL	RASHID	Anesthesiology
38	1003000167	DAYTON	NV	ESCOBAR	JULIO	Dentist
40	1003000282	NASHVILLE	TN	BLAKEMORE	ROSIE	Nurse Practitioner
42	1003000407	BROOKVILLE	PA	GIRARDI	DAVID	Family Practice

```
In [17]: group_cols = ['npi']

agg_dict = {'total_drug_cost':['sum','mean','max'], \
            'total_claim_count':['sum','mean','max'], \
            'total_day_supply':['sum','mean','max']}

partD_pd2 = partD_catfpd.groupby(group_cols).agg(agg_dict).astype(float)
```

```
In [18]: partD_pd2.head(-10)
```

Out[18]:

npi	total_drug_cost			total_claim_count			
	sum	mean	max	sum	mean	max	sum
1003000126	12374.60	773.412500	9326.11	385.0	24.062500	52.0	8053.0
1003000142	113868.77	5175.853182	52305.09	1846.0	83.909091	338.0	55569.0
1003000167	151.75	75.875000	89.80	38.0	19.000000	24.0	157.0
1003000282	659.99	329.995000	383.12	54.0	27.000000	32.0	1472.0
1003000407	73501.23	1204.938197	12322.78	2286.0	37.475410	241.0	41901.0
...	...	...	...	...	...	...	...
1992998736	21715.30	603.202778	5140.46	729.0	20.250000	51.0	43230.0
1992998819	1850.33	1850.330000	1850.33	23.0	23.000000	23.0	187.0
1992998926	981344.44	65422.962667	324463.75	377.0	25.133333	109.0	24287.0
1992999031	2317795.96	60994.630526	731701.81	1453.0	38.236842	223.0	50619.0
1992999122	689229.13	3961.086954	45476.25	12354.0	71.000000	741.0	729260.0

917999 rows × 9 columns

In [19]:

```
level0 = partD_pd2.columns.get_level_values(0)
level1 = partD_pd2.columns.get_level_values(1)
partD_pd2.columns = level0 + '_' + level1
partD_fpd = partD_pd2.reset_index()
```

In [20]:

```
partD_fpd.head()
```

Out[20]:

	npi	total_drug_cost_sum	total_drug_cost_mean	total_drug_cost_max	total
0	1003000126	12374.60	773.412500	9326.11	
1	1003000142	113868.77	5175.853182	52305.09	
2	1003000167	151.75	75.875000	89.80	
3	1003000282	659.99	329.995000	383.12	
4	1003000407	73501.23	1204.938197	12322.78	

```
In [21]: partD_fpd.count()
```

```
Out[21]:  napi                      918009
          total_drug_cost_sum      918009
          total_drug_cost_mean     918009
          total_drug_cost_max      918009
          total_claim_count_sum    918009
          total_claim_count_mean   918009
          total_claim_count_max    918009
          total_day_supply_sum     918009
          total_day_supply_mean    918009
          total_day_supply_max     918009
          dtype: int64
```

```
In [22]: partD_allpd = pd.merge(partD_fpd,partD_catfpd, how = 'left',on = 'npi')
```

```
In [23]: partD_allpd.head()
```

Out[23]:

	npi	total_drug_cost_sum	total_drug_cost_mean	total_drug_cost_max	total
0	1003000126	12374.60	773.412500	9326.11	
1	1003000142	113868.77	5175.853182	52305.09	
2	1003000167	151.75	75.875000	89.80	
3	1003000282	659.99	329.995000	383.12	
4	1003000407	73501.23	1204.938197	12322.78	

```
In [24]: partD_allpd.count()
```

```
Out[24]:  napi                      918009
          total_drug_cost_sum      918009
          total_drug_cost_mean     918009
          total_drug_cost_max      918009
          total_claim_count_sum    918009
          total_claim_count_mean   918009
          total_claim_count_max    918009
          total_day_supply_sum     918009
          total_day_supply_mean    918009
          total_day_supply_max     918009
          city                     918009
          state                    918009
          last_name                917983
          first_name               917997
          Speciality               918009
          dtype: int64
```

```
In [25]: PaymentRawData = "c:\\FIP\\OP_DTL_GNRL_PGYR2017_P01172020.csv"
```

```
In [26]: payment_pd = pd.read_csv(PaymentRawData)
```

```
C:\Users\debpr\Anaconda3\lib\site-packages\IPython\core\interactiveshell.py:30
58: DtypeWarning: Columns (4,7,9,11,14,16,17,21,22,23,24,28,35,36,37,40,41,42,
43,52,53,54,55,56,57,58,59,60,61,62,63,64,65,66,67,68,69,70,71,72) have mixed
types. Specify dtype option on import or set low_memory=False.
      interactivity=interactivity, compiler=compiler, result=result)
```

```
In [27]: payment_fpd = payment_pd.loc[:,['Physician_First_Name', \
                                          'Physician_Last_Name', \
                                          'Recipient_City', \
                                          'Recipient_State', \
                                          'Total_Amount_of_Payment_USDollar']]
```

```
In [28]: payment_fpd.head()
```

```
Out[28]:
```

	Physician_First_Name	Physician_Last_Name	Recipient_City	Recipient_State	Total_A
0	MARION	ANTHONY	PLEASANTON	CA	
1	ELISABETH	ANTON	BELLEVUE	WA	
2	PETER	AHN	PHILADELPHIA	PA	
3	PETER	AHN	PHILADELPHIA	PA	
4	DAVID	MANSUR	CLEVELAND	OH	



```
In [29]: payment_fpd.count()
```

```
Out[29]: Physician_First_Name      11193330
Physician_Last_Name              11193162
Recipient_City                   11235931
Recipient_State                  11235584
Total_Amount_of_Payment_USDollars 11235934
dtype: int64
```

```
In [30]: payment_fpd1 = payment_fpd.groupby(['Physician_First_Name', 'Physician_Last_Na
        .agg({'Total_Amount_of_Payment_USDollars':
```

```
In [31]: level0 = payment_fpd1.columns.get_level_values(0)
```

```
In [32]: level1 = payment_fpd1.columns.get_level_values(1)
```

```
In [33]: payment_fpd1.columns = level0 + '_' + level1
```

```
In [34]: payment_fpd1.reset_index()
```

Out[34]:

	Physician_First_Name	Physician_Last_Name	Recipient_City	Recipient_State
0	,BIRUTE	PUMPUTIS	VALPARAISO	IN
1	-RAFIK	GIRGIS	GLENDORA	CA
2	-cheryl	Chu	Los Angeles	CA
3	-rafik	Girgis	Glendora	CA
4	.ALEKSANDR	ITKIN	SAN DIEGO	CA
...	...	...	...	...
1093203	ythan	Webster	Roanoke	VA
1093204	zeeshan	sardar	PHILADELPHIA	PA
1093205	zhuoran	zhao	San Francisco	CA
1093206	ziad	Abbud	Neptune	NJ
1093207	ziad	el-hayek	parma	OH

1093208 rows × 5 columns

```
In [35]: payment_fpd1.head()
```

Out[35]:

Total_Amc

Physician_First_Name	Physician_Last_Name	Recipient_City	Recipient_State
,BIRUTE	PUMPUTIS	VALPARAISO	IN
-RAFIK	GIRGIS	GLENDORA	CA
-cheryl	Chu	Los Angeles	CA
-rafik	Girgis	Glendora	CA
.ALEKSANDR	ITKIN	SAN DIEGO	CA

In [36]:

rename_dict = {'Physician_First_Name':'first_name', 'Physician_Last_Name':'last_name', 'Recipient_City':'city', 'Recipient_State':'state', 'Total_Amount':'total_payment_sum'}
payment_fpd1 = payment_fpd1.rename(columns=rename_dict)

In [37]:

payment_fpd1.head()

Out[37]:

Total_Payr

Physician_First_Name	Physician_Last_Name	Recipient_City	Recipient_State
,BIRUTE	PUMPUTIS	VALPARAISO	IN
-RAFIK	GIRGIS	GLENDORA	CA
-cheryl	Chu	Los Angeles	CA
-rafik	Girgis	Glendora	CA
.ALEKSANDR	ITKIN	SAN DIEGO	CA

In [38]:

payment_fpd2 = payment_fpd1.reset_index()

In [39]:

rename_dict = {'Physician_First_Name':'first_name', 'Physician_Last_Name':'last_name', 'Recipient_City':'city', 'Recipient_State':'state', 'Total_Amount':'total_payment_sum'}
payment_fpd2 = payment_fpd2.rename(columns=rename_dict)

In [40]:

payment_fpd2 = payment_fpd2.sort_values('Total_Payment_Sum', ascending=False)

In [41]:

payment_fpd2.head()


```
Out[41]:
```

	first_name	last_name	city	state	Total_Payment_Sum
405570	JAMES	GAMMIE	Baltimore	MD	26843529.80
955640	STEPHEN	BURKHART	SAN ANTONIO	TX	22969245.26
155646	CHARLES	GOODIS	ALBUQUERQUE	NM	22880446.67
557952	KEVIN	FOLEY	Memphis	TN	17038512.75
392912	IVAN	OSORIO	KANSAS CITY	KS	8740393.58

```
In [42]: print(payment_fpd2.dtypes)
```

```
first_name      object
last_name       object
city            object
state           object
Total_Payment_Sum float64
dtype: object
```

```
In [43]: payment_fpd2.apply(lambda x: x.astype(str).str.upper())
```

```
Out[43]:
```

	first_name	last_name	city	state	Total_Payment_Sum
405570	JAMES	GAMMIE	BALTIMORE	MD	26843529.8
955640	STEPHEN	BURKHART	SAN ANTONIO	TX	22969245.26
155646	CHARLES	GOODIS	ALBUQUERQUE	NM	22880446.670000006
557952	KEVIN	FOLEY	MEMPHIS	TN	17038512.75
392912	IVAN	OSORIO	KANSAS CITY	KS	8740393.58
...	...	...	...	...	...
956957	STEPHEN	GREVIOUS	NORWALK	CT	0.03
548209	KEITH	VAUX	SAN DIEGO	CA	0.03
914065	SARA	LITTLE	PORT JERVIS	NY	0.03
210972	DARIUS	ADAMS	MORRISTOWN	NJ	0.03
824614	RAMON	VALDERRAMA	NEW YORK	NY	0.03

1093208 rows × 5 columns

```
In [44]: payment_fpd2.head()
```

Out[44]:

	first_name	last_name	city	state	Total_Payment_Sum
405570	JAMES	GAMMIE	Baltimore	MD	26843529.80
955640	STEPHEN	BURKHART	SAN ANTONIO	TX	22969245.26
155646	CHARLES	GOODIS	ALBUQUERQUE	NM	22880446.67
557952	KEVIN	FOLEY	Memphis	TN	17038512.75
392912	IVAN	OSORIO	KANSAS CITY	KS	8740393.58

In [45]:

```
pay_partD_fpd = pd.merge (partD_allpd, payment_fpd2, how = 'left', on = ['last_n
```

In [46]:

```
pay_partD_fpd.head()
```

Out[46]:

	npi	total_drug_cost_sum	total_drug_cost_mean	total_drug_cost_max	total
0	1003000126	12374.60	773.412500	9326.11	
1	1003000142	113868.77	5175.853182	52305.09	
2	1003000167	151.75	75.875000	89.80	
3	1003000282	659.99	329.995000	383.12	
4	1003000407	73501.23	1204.938197	12322.78	

In [47]:

```
pay_partD_fpd.count()
```

```
Out[47]:  npi                918009
          total_drug_cost_sum  918009
          total_drug_cost_mean 918009
          total_drug_cost_max  918009
          total_claim_count_sum 918009
          total_claim_count_mean 918009
          total_claim_count_max 918009
          total_day_supply_sum  918009
          total_day_supply_mean 918009
          total_day_supply_max  918009
          city                918009
          state               918009
          last_name           917983
          first_name          917997
          Speciality          918009
          Total_Payment_Sum    382721
          dtype: int64
```

```
In [48]: IELERawdata = "c:\\FIP\\LEIE.csv"
         IELE_pd = pd.read_csv(IELERawdata)
```

```
C:\Users\debpr\Anaconda3\lib\site-packages\IPython\core\interactiveshell.py:30
58: DtypeWarning: Columns (3) have mixed types. Specify dtype option on import
or set low_memory=False.
      interactivity=interactivity, compiler=compiler, result=result)
```

```
In [49]: IELE_pd.head()
```

Out[49]:

	LASTNAME	FIRSTNAME	MIDNAME	BUSNAME	GENERAL	SPECIALTY	UPIN
0	NaN	NaN		#1 MARKETING SERVICE, INC	OTHER BUSINESS	SOBER HOME	NaN
1	NaN	NaN		14 LAWRENCE AVE PHARMACY	PHARMACY	NaN	NaN
2	NaN	NaN		143 MEDICAL EQUIPMENT CO	DME COMPANY	DME - OXYGEN	NaN
3	NaN	NaN		184TH STREET PHARMACY CORP	OTHER BUSINESS	PHARMACY	NaN
4	NaN	NaN		1951 FLATBUSH AVENUE PHARMACY	PHARMACY	NaN	NaN

In [50]:

```
npifraud_pd0 = IELE_pd.loc[:,['NPI','EXCLTYPE']]
```

In [51]:

```
npifraud_pd0.head()
```

Out[51]:

	NPI	EXCLTYPE
0	0	1128a1
1	0	1128a1
2	0	1128b7
3	1922348218	1128a1
4	0	1128b5

In [52]:

```
npifraud_pd1 = npifraud_pd0.query('NPI !=0')
```

In [53]:

```
npifraud_pd1.count()
```

```
Out[53]: NPI          5489
         EXCLTYPE    5489
         dtype: int64
```

```
In [54]: rename_dict = {'NPI':'npi', 'EXCLTYPE':'is_fraud'}
         npi_fraud_pd = npifraud_pd1.rename(columns=rename_dict)
```

```
In [55]: npi_fraud_pd.head()
```

```
Out[55]:
```

	npi	is_fraud
3	1922348218	1128a1
23	1942476080	1128b8
27	1275600959	1128a1
30	1891731758	1128b8
58	1851631543	1128b7

```
In [56]: npi_fraud_pd['is_fraud'] = 1
```

```
In [57]: npi_fraud_pd.head()
```

```
Out[57]:
```

	npi	is_fraud
3	1922348218	1
23	1942476080	1
27	1275600959	1
30	1891731758	1
58	1851631543	1

```
In [58]: print(npi_fraud_pd.dtypes)
```

```
npi          int64
is_fraud     int64
dtype: object
```

```
In [59]: # Features Engineering
         Features_pd1 = pd.merge(pay_partD_fpd, npi_fraud_pd, how='left', on='npi')
```

```
In [60]: Features_pd1.count()
```

```
Out[60]:  napi                      918012
          total_drug_cost_sum      918012
          total_drug_cost_mean     918012
          total_drug_cost_max      918012
          total_claim_count_sum    918012
          total_claim_count_mean   918012
          total_claim_count_max    918012
          total_day_supply_sum     918012
          total_day_supply_mean    918012
          total_day_supply_max     918012
          city                      918012
          state                    918012
          last_name                917986
          first_name              918000
          Speciality              918012
          Total_Payment_Sum       382724
          is_fraud                 368
          dtype: int64
```

```
In [61]: Features_pd1.describe()
```

```
Out[61]:
```

	napi	total_drug_cost_sum	total_drug_cost_mean	total_drug_cost_max
count	9.180120e+05	9.180120e+05	9.180120e+05	9.180120e+05
mean	1.499678e+09	1.264841e+05	3.697505e+03	3.343104e+04
std	2.878975e+08	3.567932e+05	1.737574e+04	1.209231e+05
min	1.003000e+09	0.000000e+00	0.000000e+00	0.000000e+00
25%	1.245682e+09	5.658800e+02	1.800950e+02	2.917800e+02
50%	1.497957e+09	7.413850e+03	8.005217e+02	3.649825e+03
75%	1.740696e+09	1.003794e+05	2.756595e+03	2.246262e+04
max	1.993000e+09	2.629355e+07	5.899316e+06	1.388153e+07



```
In [62]: Features_pd1.fillna(0, inplace=True)
```

```
In [63]: Features_pd1
```

Out[63]:

	npi	total_drug_cost_sum	total_drug_cost_mean	total_drug_cost_max
0	1003000126	12374.60	773.412500	9326.11
1	1003000142	113868.77	5175.853182	52305.09
2	1003000167	151.75	75.875000	89.80
3	1003000282	659.99	329.995000	383.12
4	1003000407	73501.23	1204.938197	12322.78
...	...	...	...	...
918007	1992999759	15881.82	547.648966	9068.62
918008	1992999791	1362.33	454.110000	782.27
918009	1992999825	3378.47	422.308750	2020.37
918010	1992999833	305.81	101.936667	122.89
918011	1992999882	619.92	103.320000	126.04

918012 rows × 17 columns



In [64]:

Features_pd1[Features_pd1['is_fraud']==1].count()

```
Out[64]:  napi                                368
          total_drug_cost_sum                 368
          total_drug_cost_mean                368
          total_drug_cost_max                 368
          total_claim_count_sum               368
          total_claim_count_mean              368
          total_claim_count_max               368
          total_day_supply_sum                368
          total_day_supply_mean               368
          total_day_supply_max                368
          city                                368
          state                                368
          last_name                           368
          first_name                           368
          Speciality                           368
          Total_Payment_Sum                   368
          is_fraud                             368
          dtype: int64
```

```
In [65]: FeaturesAll_pd=Features_pd1
```

```
In [66]: # Scaling the features
FeaturesAll_pd['total_drug_cost_sum'] = FeaturesAll_pd['total_drug_cost_sum']
FeaturesAll_pd['total_claim_count_sum'] = FeaturesAll_pd['total_claim_count_sum']
FeaturesAll_pd['total_day_supply_sum'] = FeaturesAll_pd['total_day_supply_sum']
FeaturesAll_pd['Total_Payment_Sum'] = FeaturesAll_pd['Total_Payment_Sum'].map

FeaturesAll_pd['total_drug_cost_mean'] = FeaturesAll_pd['total_drug_cost_mean']
FeaturesAll_pd['total_claim_count_mean'] = FeaturesAll_pd['total_claim_count_mean']
FeaturesAll_pd['total_day_supply_mean'] = FeaturesAll_pd['total_day_supply_mean']

FeaturesAll_pd['total_drug_cost_max'] = FeaturesAll_pd['total_drug_cost_max']
FeaturesAll_pd['total_claim_count_max'] = FeaturesAll_pd['total_claim_count_max']
FeaturesAll_pd['total_day_supply_max'] = FeaturesAll_pd['total_day_supply_max']

FeaturesAll_pd['claim_max-mean'] = FeaturesAll_pd['total_claim_count_max'] - FeaturesAll_pd['total_claim_count_mean']
FeaturesAll_pd['supply_max-mean'] = FeaturesAll_pd['total_day_supply_max'] - FeaturesAll_pd['total_day_supply_mean']
FeaturesAll_pd['drug_max-mean'] = FeaturesAll_pd['total_drug_cost_max'] - FeaturesAll_pd['total_drug_cost_mean']
```

```
In [67]: FeaturesAll_pd
```


Out[67]:

	npi	total_drug_cost_sum	total_drug_cost_mean	total_drug_cost_max
0	1003000126	4.092566	2.888972	3.969747
1	1003000142	5.056408	3.714066	4.718552
2	1003000167	2.183981	1.885785	1.958086
3	1003000282	2.820195	2.519821	2.584467
4	1003000407	4.866301	3.081325	4.090744
...	...	...	...	...
918007	1992999759	4.200928	2.739295	3.957589
918008	1992999791	3.134601	2.658116	2.893911
918009	1992999825	3.528849	2.626657	3.305646
918010	1992999833	2.486870	2.012570	2.093036
918011	1992999882	2.793036	2.018368	2.103940

918012 rows × 20 columns



```
In [68]: FeaturesAll_pd['npi'] = FeaturesAll_pd.npi.astype(object)
```

```
In [69]: categorical_features = ['npi','last_name', 'Speciality','first_name','city',
```

```
In [70]: numerical_features = ['total_drug_cost_sum', 'total_drug_cost_mean', 'Total_Pay',  
    'total_drug_cost_max', 'total_claim_count_sum',  
    'total_claim_count_mean', 'total_claim_count_max',  
    'total_day_supply_sum', 'total_day_supply_mean', 'total_day_supply_max',  
    'claim_max-mean', 'supply_max-mean', 'drug_max-mean']
```

```
In [71]: target = ['is_fraud']
```

```
In [72]: allvars = categorical_features + numerical_features + target
```

```
In [73]: y = FeaturesAll_pd["is_fraud"].values
```

```
X = FeaturesAll_pd[allvars].drop('is_fraud',axis=1)
```

```
In [74]: # scikit learn
from sklearn.model_selection import train_test_split
from sklearn.preprocessing import StandardScaler
#from sklearn.preprocessing import OneHotEncoder
from sklearn.preprocessing import LabelEncoder
from sklearn.feature_extraction import DictVectorizer
from sklearn.linear_model import LogisticRegression
from sklearn.ensemble import RandomForestClassifier
from sklearn.metrics import roc_curve, auc
```

```
In [75]: X_train, X_valid, y_train, y_valid = train_test_split(X, y, test_size=0.2, random_state=42)
print(X_train.shape)
print(X_valid.shape)
```

```
(734409, 19)
```

```
(183603, 19)
```

```
In [76]: X_train[numerical_features] = X_train.loc[:,numerical_features].fillna(0)
X_valid[numerical_features] = X_valid.loc[:,numerical_features].fillna(0)
X_train[categorical_features] = X_train.loc[:,categorical_features].fillna('N')
X_valid[categorical_features] = X_valid.loc[:,categorical_features].fillna('N')
```

C:\Users\debpr\Anaconda3\lib\site-packages\pandas\core\frame.py:3494: SettingWithCopyWarning:

A value is trying to be set on a copy of a slice from a DataFrame.

Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: http://pandas.pydata.org/pandas-docs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy

```
self[k1] = value[k2]
```

```
In [77]: scaler= StandardScaler()
X_train[numerical_features] = scaler.fit_transform(X_train[numerical_features])
X_valid[numerical_features] = scaler.transform(X_valid[numerical_features].values)
```

```
C:\Users\debpr\Anaconda3\lib\site-packages\ipykernel_launcher.py:2: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: http://pandas.pydata.org/pandas-docs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy

C:\Users\debpr\Anaconda3\lib\site-packages\pandas\core\indexing.py:494: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: http://pandas.pydata.org/pandas-docs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy
    self.obj[item] = s
C:\Users\debpr\Anaconda3\lib\site-packages\ipykernel_launcher.py:3: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: http://pandas.pydata.org/pandas-docs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy
    This is separate from the ipykernel package so we can avoid doing imports until
C:\Users\debpr\Anaconda3\lib\site-packages\pandas\core\indexing.py:494: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: http://pandas.pydata.org/pandas-docs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy
    self.obj[item] = s
```

```
In [78]: print(X_train[numerical_features].dtypes)
```

```
total_drug_cost_sum      float64
total_drug_cost_mean     float64
Total_Payment_Sum        float64
total_drug_cost_max       float64
total_claim_count_sum    float64
total_claim_count_mean   float64
total_claim_count_max    float64
total_day_supply_sum     float64
total_day_supply_mean    float64
total_day_supply_max     float64
claim_max-mean           float64
supply_max-mean          float64
drug_max-mean            float64
dtype: object
```

```
In [79]: ix_ran = FeaturesAll_pd.index.values
         np.random.shuffle(ix_ran)

         df_len = len(FeaturesAll_pd)
         train_len = int(df_len * 0.8) # 80% for training

         ix_train = ix_ran[:train_len]
         ix_valid = ix_ran[train_len:]

         df_train = FeaturesAll_pd.ix[ix_train]
         df_valid = FeaturesAll_pd.ix[ix_valid]

         print(len(ix_train))
         print(len(ix_valid))
```

```
C:\Users\debpr\Anaconda3\lib\site-packages\ipykernel_launcher.py:11: FutureWarning:
.ix is deprecated. Please use
.loc for label based indexing or
.iloc for positional indexing

See the documentation here:
http://pandas.pydata.org/pandas-docs/stable/user_guide/indexing.html#ix-indexer-is-deprecated
# This is added back by InteractiveShellApp.init_path()
C:\Users\debpr\Anaconda3\lib\site-packages\ipykernel_launcher.py:12: FutureWarning:
.ix is deprecated. Please use
.loc for label based indexing or
.iloc for positional indexing

See the documentation here:
http://pandas.pydata.org/pandas-docs/stable/user_guide/indexing.html#ix-indexer-is-deprecated
if sys.path[0] == '':
734409
183603
```

```
In [80]: print(df_train.dtypes)
```

```
mpi                                object
total_drug_cost_sum                float64
total_drug_cost_mean               float64
total_drug_cost_max                float64
total_claim_count_sum              float64
total_claim_count_mean             float64
total_claim_count_max              float64
total_day_supply_sum               float64
total_day_supply_mean              float64
total_day_supply_max               float64
city                               object
state                             object
last_name                          object
first_name                         object
Speciality                         object
Total_Payment_Sum                  float64
is_fraud                           float64
claim_max-mean                     float64
supply_max-mean                    float64
drug_max-mean                      float64
dtype: object
```

```
In [81]: # Drug Weighted_Scores
```

```
partD_drug_train = pd.merge(partD_Drug_pd,df_train[['npi','is_fraud']], how='left')
partD_drug_All = pd.merge(partD_Drug_pd,FeaturesAll_pd[['npi','is_fraud']], how='left')
```

```
In [82]: print(len(partD_drug_train[partD_drug_train['is_fraud']==1]))
```

12719

```
In [83]: # get unique drug names
drugs = set([ drugx for drugx in partD_drug_train['drug_name'].values if isin
print(len(drugs))
```

2778

```
In [84]: print("Total records in train set : ")
print(len(partD_drug_train))
print("Total Fraud in train set : ")
print(len(partD_drug_train[partD_drug_train['is_fraud']==1]))
partD_drug_train.head()
```

Total records in train set :

20165202

Total Fraud in train set :

12719

Out[84]:

	npi	drug_name	total_drug_cost	total_claim_count	total_day_supply
0	1003000126	AMLODIPINE BESYLATE	59.21	13	390
1	1003000126	ATORVASTATIN CALCIUM	259.48	27	765
2	1003000126	CEPHALEXIN	98.99	17	123
3	1003000126	CIPROFLOXACIN HCL	120.43	12	95
4	1003000126	DOXYCYCLINE HYCLATE	300.76	17	105



```
In [85]: cols = ['total_drug_cost','total_claim_count','total_day_supply']
```

```
In [86]: partD_drug_train_Group = partD_drug_train.groupby(['drug_name', 'is_fraud'])
partD_drug_All_Group = partD_drug_All.groupby(['drug_name', 'is_fraud'])
```

```
In [87]: drug_keys = partD_drug_train_Group.groups.keys()
print(len(drug_keys))
```

3593

In [88]: `drug_keys`

```
Out[88]: dict_keys([('1ST TIER UNIFINE PENTIPS', 0.0), ('1ST TIER UNIFINE PENTIPS PLU  
S', 0.0), ('ABACAVIR', 0.0), ('ABACAVIR-LAMIVUDINE', 0.0), ('ABACAVIR-LAMIVUD  
INE-ZIDOVUDINE', 0.0), ('ABELCET', 0.0), ('ABILIFY', 0.0), ('ABILIFY MAINTEN  
A', 0.0), ('ABILIFY MAINTENA', 1.0), ('ABRAXANE', 0.0), ('ABSORICA', 0.0),  
( 'ABSTRAL', 0.0), ('ACAMPROSATE CALCIUM', 0.0), ('ACARBOSE', 0.0), ('ACARBOS  
E', 1.0), ('ACCOLATE', 0.0), ('ACCUPRIL', 0.0), ('ACCURETIC', 0.0), ('ACEBUTO  
LOL HCL', 0.0), ('ACEBUTOLOL HCL', 1.0), ('ACETAMIN-CAFF-DIHYDROCODEINE', 0.  
0), ('ACETAMINOPHEN-CODEINE', 0.0), ('ACETAMINOPHEN-CODEINE', 1.0), ('ACETAZO  
LAMIDE', 0.0), ('ACETAZOLAMIDE', 1.0), ('ACETAZOLAMIDE SODIUM', 0.0), ('ACETI  
C ACID', 0.0), ('ACETIC ACID-ALUMINUM', 0.0), ('ACETYLCYSTEINE', 0.0), ('ACIP  
HEX', 0.0), ('ACIPHEX SPRINKLE', 0.0), ('ACITRETIN', 0.0), ('ACTEMRA', 0.0),  
( 'ACTHIB', 0.0), ('ACTIGALL', 0.0), ('ACTIMMUNE', 0.0), ('ACTIQ', 0.0), ('ACT  
IVELLA', 0.0), ('ACTONEL', 0.0), ('ACTOPLUS MET', 0.0), ('ACTOPLUS MET XR',  
0.0), ('ACTOS', 0.0), ('ACULAR', 0.0), ('ACULAR LS', 0.0), ('ACUVAIL', 0.0),  
( 'ACYCLOVIR', 0.0), ('ACYCLOVIR', 1.0), ('ACYCLOVIR SODIUM', 0.0), ('ACZONE',  
0.0), ('ADACEL TDAP', 0.0), ('ADAGEN', 0.0), ('ADAPALENE', 0.0), ('ADCIRCA',  
0.0), ('ADDERALL', 0.0), ('ADDERALL XR', 0.0), ('ADEFOVIR DIPIVOXIL', 0.0),  
( 'ADEMPAS', 0.0), ('ADLYXIN', 0.0), ('ADRENALIN', 0.0), ('ADRUCIL', 0.0), ('A  
DVAIR DISKUS', 0.0), ('ADVAIR DISKUS', 1.0), ('ADVAIR HFA', 0.0), ('ADVAIR HF  
A', 1.0), ('ADVOCATE PEN NEEDLES', 0.0), ('ADVOCATE SYRINGES', 0.0), ('ADZENY  
S XR-ODT', 0.0), ('AEROSPAN', 0.0), ('AFEDITAB CR', 0.0), ('AFINITOR', 0.0),  
( 'AFINITOR DISPERZ', 0.0), ('AFREZZA', 0.0), ('AGGRENOL', 0.0), ('AGRYLIN',  
0.0), ('AK-POLY-BAC', 0.0), ('AKYNZEO', 0.0), ('ALBENZA', 0.0), ('ALBUMIN (HU  
MAN)', 0.0), ('ALBUTEROL SULFATE', 0.0), ('ALBUTEROL SULFATE', 1.0), ('ALCLOM  
ETASONE DIPROPIONATE', 0.0), ('ALCOHOL PADS', 0.0), ('ALCOHOL PADS', 1.0),  
( 'ALCOHOL PREP PADS', 0.0), ('ALCOHOL PREP PADS', 1.0), ('ALCOHOL SWAB', 0.  
0), ('ALCOHOL SWABS', 0.0), ('ALCOHOL SWABS', 1.0), ('ALCOHOL WIPES', 0.0),  
( 'ALDACTAZIDE', 0.0), ('ALDACTONE', 0.0), ('ALDARA', 0.0), ('ALDURAZYME', 0.  
0), ('ALECENSA', 0.0), ('ALENDRONATE SODIUM', 0.0), ('ALENDRONATE SODIUM', 1.  
0), ('ALFUZOSIN HCL ER', 0.0), ('ALFUZOSIN HCL ER', 1.0), ('ALIMTA', 0.0),  
( 'ALINIA', 0.0), ('ALLOPURINOL', 0.0), ('ALLOPURINOL', 1.0), ('ALLZITAL', 0.  
0), ('ALLZITAL', 1.0), ('ALMOTRIPTAN MALATE', 0.0), ('ALOCRIL', 0.0), ('ALOGLI  
IPTIN', 0.0), ('ALOGLIPTIN-METFORMIN', 0.0), ('ALOGLIPTIN-PIOGLITAZONE', 0.  
0), ('ALOMIDE', 0.0), ('ALORA', 0.0), ('ALOSETRON HCL', 0.0), ('ALOXI', 0.0),  
( 'ALPHAGAN P', 0.0), ('ALPRAZOLAM', 0.0), ('ALPRAZOLAM', 1.0), ('ALPRAZOLAM E  
R', 0.0), ('ALPRAZOLAM ER', 1.0), ('ALPRAZOLAM ODT', 0.0), ('ALPRAZOLAM XR',  
0.0), ('ALREX', 0.0), ('ALTACE', 0.0), ('ALTAVERA', 0.0), ('ALTOPREV', 0.0),  
( 'ALVESCO', 0.0), ('ALYACEN', 0.0), ('AMABELZ', 0.0), ('AMANTADINE', 0.0),  
( 'AMANTADINE', 1.0), ('AMARYL', 0.0), ('AMBIEN', 0.0), ('AMBIEN CR', 0.0),  
( 'AMBISOME', 0.0), ('AMCINONIDE', 0.0), ('AMERGE', 0.0), ('AMETHYST', 0.0),  
( 'AMICAR', 0.0), ('AMIKACIN SULFATE', 0.0), ('AMILORIDE HCL', 0.0), ('AMILORI  
DE HCL', 1.0), ('AMILORIDE-HYDROCHLOROTHIAZIDE', 0.0), ('AMIODARONE HCL', 0.  
0), ('AMIODARONE HCL', 1.0), ('AMITIZA', 0.0), ('AMITIZA', 1.0), ('AMITRIPTYL  
INE HCL', 0.0), ('AMITRIPTYLINE HCL', 1.0), ('AMLODIPINE BESYLATE', 0.0), ('A  
MLODIPINE BESYLATE', 1.0), ('AMLODIPINE BESYLATE-BENZAEPRIIL', 0.0), ('AMLODIP  
INE BESYLATE-BENZAEPRIIL', 1.0), ('AMLODIPINE-ATORVASTATIN', 0.0), ('AMLODIPIN  
E-ATORVASTATIN', 1.0), ('AMLODIPINE-OLMESARTAN', 0.0), ('AMLODIPINE-OLMESARTA  
N', 1.0), ('AMLODIPINE-VALSARTAN', 0.0), ('AMLODIPINE-VALSARTAN', 1.0), ('AML  
ODIPINE-VALSARTAN-HCTZ', 0.0), ('AMLODIPINE-VALSARTAN-HCTZ', 1.0), ('AMMONIUM
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N', 0.0), ('VICODIN ES', 0.0), ('VICODIN HP', 0.0), ('VICTOZA 2-PAK', 0.0), ('VICTOZA 2-PAK', 1.0), ('VICTOZA 3-PAK', 0.0), ('VICTOZA 3-PAK', 1.0), ('VID EX EC', 0.0), ('VIEKIRA PAK', 0.0), ('VIEKIRA XR', 0.0), ('VIENVA', 0.0), ('V IGAMOX', 0.0), ('VIGAMOX', 1.0), ('VIIBRYD', 0.0), ('VIIBRYD', 1.0), ('VIMIZI M', 0.0), ('VIMOVO', 0.0), ('VIMPAT', 0.0), ('VIMPAT', 1.0), ('VINCRISTINE SU LFATE', 0.0), ('VINORELBINE TARTRATE', 0.0), ('VIOKACE', 0.0), ('VIORELE', 0.0), ('VIRACEPT', 0.0), ('VIRAMUNE', 0.0), ('VIRAMUNE XR', 0.0), ('VIREAD', 0.0), ('VIREAD', 1.0), ('VIRT-C DHA', 0.0), ('VIRT-CAPS', 0.0), ('VIRT-PN', 0.0), ('VIRT-PN DHA', 0.0), ('VISTARIL', 0.0), ('VITAFOL GUMMIES', 0.0), ('VITA FOL ULTRA', 0.0), ('VITAFOL-OB+DHA', 0.0), ('VITAFOL-ONE', 0.0), ('VITAMIN D 2', 0.0), ('VIVELLE-DOT', 0.0), ('VIVITROL', 0.0), ('VIVLODEX', 0.0), ('VOL-C ARE RX', 0.0), ('VOL-NATE', 0.0), ('VOL-PLUS', 0.0), ('VOLTAREN', 0.0), ('VOL TAREN', 1.0), ('VORICONAZOLE', 0.0), ('VOSEVI', 0.0), ('VOTRIENT', 0.0), ('VP -PNV-DHA', 0.0), ('VP-VITE RX', 0.0), ('VPRIV', 0.0), ('VRAYLAR', 0.0), ('VRA YLAR', 1.0), ('VUSION', 0.0), ('VYFEMLA', 0.0), ('VYTORIN', 0.0), ('VYTORIN', 1.0), ('VYVANSE', 0.0), ('VYVANSE', 1.0), ('WARFARIN SODIUM', 0.0), ('WARFARI N SODIUM', 1.0), ('WATER', 0.0), ('WEBCOL', 0.0), ('WELCHOL', 0.0), ('WELCHO L', 1.0), ('WELLBUTRIN SR', 0.0), ('WELLBUTRIN XL', 0.0), ('WERA', 0.0), ('WY MZYA FE', 0.0), ('XADAGO', 0.0), ('XALATAN', 0.0), ('XALATAN', 1.0), ('XALKOR I', 0.0), ('XANAX', 0.0), ('XANAX XR', 0.0), ('XARELTO', 0.0), ('XARELTO', 1.0), ('XARTEMIS XR', 0.0), ('XELJANZ', 0.0), ('XELJANZ XR', 0.0), ('XENAZINE', 0.0), ('XENICAL', 0.0), ('XEOMIN', 0.0), ('XERMELO', 0.0), ('XGEVA', 0.0), ('XIAFLEX', 0.0), ('XIFAXAN', 0.0), ('XIFAXAN', 1.0), ('XIGDUO XR', 0.0), ('X IIDRA', 0.0), ('XODOL 10-300', 0.0), ('XODOL 7.5-300', 0.0), ('XOLAIR', 0.0), ('XOLAIR', 1.0), ('XOPENEX', 0.0), ('XOPENEX CONCENTRATE', 0.0), ('XOPENEX HF A', 0.0), ('XOPENEX HFA', 1.0), ('XTAMPZA ER', 0.0), ('XTAMPZA ER', 1.0), ('X TANDI', 0.0), ('XTANDI', 1.0), ('XULANE', 0.0), ('XULTOPHY 100-3.6', 0.0), ('XYLOCAINE', 0.0), ('XYLOCAINE-MPF', 0.0), ('XYLON 10', 0.0), ('XYREM', 0.0), ('XYZAL', 0.0), ('YASMIN 28', 0.0), ('YAZ', 0.0), ('YF-VAX', 0.0), ('YOSP RALA', 0.0), ('YUVAFEM', 0.0), ('ZAFIRLUKAST', 0.0), ('ZALEPLON', 0.0), ('ZAL EPLON', 1.0), ('ZANAFLEX', 0.0), ('ZANTAC', 0.0), ('ZARAH', 0.0), ('ZARONTI N', 0.0), ('ZARXIO', 0.0), ('ZATEAN-PN DHA', 0.0), ('ZATEAN-PN PLUS', 0.0), ('ZAVESCA', 0.0), ('ZEBUTAL', 0.0), ('ZEGERID', 0.0), ('ZEJULA', 0.0), ('ZELA PAR', 0.0), ('ZELBORAF', 0.0), ('ZEMAIRA', 0.0), ('ZEMBRACE SYMTOUCH', 0.0), ('ZEMPLAR', 0.0), ('ZENCHENT', 0.0), ('ZENCHENT FE', 0.0), ('ZENPEP', 0.0), ('ZENZEDI', 0.0), ('ZEPATIER', 0.0), ('ZERBAXA', 0.0), ('ZERIT', 0.0), ('ZEST ORETIC', 0.0), ('ZESTRIL', 0.0), ('ZETIA', 0.0), ('ZETIA', 1.0), ('ZETONNA', 0.0), ('ZIAC', 0.0), ('ZIAGEN', 0.0), ('ZIDOVUDINE', 0.0), ('ZILEUTON ER', 0.0), ('ZINBRYTA', 0.0), ('ZIOPTAN', 0.0), ('ZIPRASIDONE HCL', 0.0), ('ZIPRASID ONE HCL', 1.0), ('ZIPSOR', 0.0), ('ZIRGAN', 0.0), ('ZITHROMAX', 0.0), ('ZOCO R', 0.0), ('ZOFRAN', 0.0), ('ZOFRAN ODT', 0.0), ('ZOHYDRO ER', 0.0), ('ZOHYDR O ER', 1.0), ('ZOLADEX', 0.0), ('ZOLEDRONIC ACID', 0.0), ('ZOLINZA', 0.0), ('ZOLMITRIPTAN', 0.0), ('ZOLMITRIPTAN ODT', 0.0), ('ZOLOFT', 0.0), ('ZOLOFT', 1.0), ('ZOLPIDEM TARTRATE', 0.0), ('ZOLPIDEM TARTRATE', 1.0), ('ZOLPIDEM TART RATE ER', 0.0), ('ZOLPIDEM TARTRATE ER', 1.0), ('ZOMACTON', 0.0), ('ZOMETA', 0.0), ('ZOMIG', 0.0), ('ZOMIG ZMT', 0.0), ('ZONALON', 0.0), ('ZONEGRAN', 0.0), ('ZONISAMIDE', 0.0), ('ZONISAMIDE', 1.0), ('ZONTIVITY', 0.0), ('ZONTIVIT Y', 1.0), ('ZORTRESS', 0.0), ('ZORVOLEX', 0.0), ('ZORVOLEX', 1.0), ('ZOSTAVA X', 0.0), ('ZOSTAVAX', 1.0), ('ZOSYN', 0.0), ('ZOSYN', 1.0), ('ZOVIA 1-35E',

```
0.0), ('ZOVIA 1-50E', 0.0), ('ZOVIRAX', 0.0), ('ZUBSOLV', 0.0), ('ZUBSOLV',
1.0), ('ZUPLENZ', 0.0), ('ZURAMPIC', 0.0), ('ZYCLARA', 0.0), ('ZYDELIG', 0.
0), ('ZYFLO', 0.0), ('ZYFLO CR', 0.0), ('ZYKADIA', 0.0), ('ZYLET', 0.0), ('ZY
LOPRIM', 0.0), ('ZYMAXID', 0.0), ('ZYPREXA', 0.0), ('ZYPREXA RELPREVV', 0.0),
('ZYPREXA ZYDIS', 0.0), ('ZYPREXA ZYDIS', 1.0), ('ZYTIGA', 0.0), ('ZYTIGA',
1.0), ('ZYVOX', 0.0)])
```

```
In [89]: drug_with_isfraud = [drugx for drugx in drugs if ((drugx,0.0) in drug_keys )]
```

```
In [90]: from scipy.stats import ttest_ind
re_drug_tt = dict()
for drugx in drug_with_isfraud:
    for colx in cols:
        fraud_0 = partD_drug_train_Group.get_group((drugx,0.0))[colx].values
        fraud_1 = partD_drug_train_Group.get_group((drugx,1.0))[colx].values
        # print len(fraud_0), len(fraud_1)
        if (len(fraud_0)>2) & (len(fraud_1)>2) :
            tt = ttest_ind(fraud_0, fraud_1)
            re_drug_tt[(drugx, colx)] = tt
```

```
In [91]: #Setting Probilities
Prob_005 = [(key, p) for (key, (t, p)) in re_drug_tt.items() if p <=0.05]
print(len(Prob_005))
```

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```
In [92]: inx=100
drug_name = Prob_005[inx][0][0]
print(drug_name)
df_bar = pd.concat([partD_drug_All_Group.get_group((Prob_005[inx][0][0],0.0))
df_bar.head()
```

IBU

```
Out[92]:
```

	npi	drug_name	total_drug_cost	total_claim_count	total_day_supply	s
961	1003002817	IBU	95.76	20	363	
3167	1003008855	IBU	50.96	12	262	
4435	1003011214	IBU	155.95	20	580	
5177	1003012857	IBU	144.24	34	282	
5568	1003013608	IBU	87.11	12	420	



```
In [93]: Feture_DrugWeighted = []
new_col_all =[]
```

```

for i, p005x in enumerate(Prob_005):
    #if i>4:
    #    break
    drug_name = p005x[0][0]
    cat_name = p005x[0][1]

    new_col = drug_name+'_'+cat_name
    new_col_all.append(new_col)

    drug_0 = partD_drug_All_Group.get_group((drug_name,0.0))[['npi', cat_name]
    drug_1 = partD_drug_All_Group.get_group((drug_name,1.0))[['npi', cat_name]

    drug_01 = pd.concat([drug_0, drug_1])
    drug_01.rename(columns={cat_name: new_col}, inplace=True)
    Feture_DrugWeighted.append(drug_01)

```

```

In [94]: npi_col = FeaturesAll_pd[['npi']]

w_npi = []

for n, nx in enumerate(Feture_DrugWeighted):
    nggx = pd.merge(npi_col, nx.drop_duplicates(['npi']), on='npi', how='left')
    w_npi.append(nggx)

```

```

In [95]: FeaturesAll_pd1 = FeaturesAll_pd

```

```

In [96]: for wx in w_npi:
    col_n = wx.columns[1]
    FeaturesAll_pd1[col_n] = wx[col_n].values

wx = w_npi[0]
wx.columns[1]
col_n = wx.columns[1]

```

```

In [97]: len(wx[col_n].values)
FeaturesAll_pd1.fillna(0)

```

Out[97]:

	npi	total_drug_cost_sum	total_drug_cost_mean	total_drug_cost_max
593816	1003000126	4.092566	2.888972	3.969747
493584	1003000142	5.056408	3.714066	4.718552
761450	1003000167	2.183981	1.885785	1.958086
160806	1003000282	2.820195	2.519821	2.584467
178678	1003000407	4.866301	3.081325	4.090744
...	...	...	...	...
481077	1992999759	4.200928	2.739295	3.957589
352034	1992999791	3.134601	2.658116	2.893911
583453	1992999825	3.528849	2.626657	3.305646
606940	1992999833	2.486870	2.012570	2.093036
869023	1992999882	2.793036	2.018368	2.103940

918012 rows × 165 columns



In [98]:

```
new_col_all
```



```
Out[98]: ['MORPHINE SULFATE ER_total_drug_cost',
'MORPHINE SULFATE ER_total_claim_count',
'MORPHINE SULFATE ER_total_day_supply',
'SODIUM CHLORIDE_total_claim_count',
'SODIUM CHLORIDE_total_day_supply',
'FENTANYL_total_drug_cost',
'FENTANYL_total_claim_count',
'FENTANYL_total_day_supply',
'SULFAMETHOXAZOLE-TRIMETHOPRIM_total_drug_cost',
'SULFAMETHOXAZOLE-TRIMETHOPRIM_total_claim_count',
'ESCITALOPRAM OXALATE_total_day_supply',
'AMOXICILLIN_total_drug_cost',
'AMOXICILLIN_total_day_supply',
'ECONAZOLE NITRATE_total_drug_cost',
'ECONAZOLE NITRATE_total_claim_count',
'ECONAZOLE NITRATE_total_day_supply',
'ONDANSETRON ODT_total_day_supply',
'ACYCLOVIR_total_drug_cost',
'AMITRIPTYLINE HCL_total_drug_cost',
'BUTALBITAL-ACETAMINOPHEN-CAFFE_total_drug_cost',
'BUTALBITAL-ACETAMINOPHEN-CAFFE_total_claim_count',
'BENAZEPRIL-HYDROCHLOROTHIAZIDE_total_drug_cost',
'BENAZEPRIL-HYDROCHLOROTHIAZIDE_total_claim_count',
'BENAZEPRIL-HYDROCHLOROTHIAZIDE_total_day_supply',
'IBUPROFEN_total_drug_cost',
'IBUPROFEN_total_claim_count',
'IBUPROFEN_total_day_supply',
'LYRICA_total_drug_cost',
'LYRICA_total_claim_count',
'LYRICA_total_day_supply',
'PROAIR HFA_total_drug_cost',
'PROAIR HFA_total_claim_count',
'PROAIR HFA_total_day_supply',
'ASPIRIN-DIPYRIDAMOLE ER_total_claim_count',
'AZELASTINE HCL_total_claim_count',
'OXYCODONE HCL_total_drug_cost',
'OXYCODONE HCL_total_claim_count',
'OXYCODONE HCL_total_day_supply',
'GLIPIZIDE_total_drug_cost',
'GLIPIZIDE_total_day_supply',
'CEPHALEXIN_total_drug_cost',
'CEPHALEXIN_total_claim_count',
'METOPROLOL SUCCINATE_total_drug_cost',
'METOPROLOL SUCCINATE_total_day_supply',
'CARISOPRODOL_total_claim_count',
'CARISOPRODOL_total_day_supply',
'NAPROXEN_total_drug_cost',
'NAPROXEN_total_claim_count',
'NAPROXEN_total_day_supply',
```

'LOSARTAN POTASSIUM_total_day_supply',
'PROMETHAZINE HCL_total_drug_cost',
'PROMETHAZINE HCL_total_claim_count',
'PROMETHAZINE HCL_total_day_supply',
'MELOXICAM_total_claim_count',
'CHLORHEXIDINE GLUCONATE_total_claim_count',
'CHLORHEXIDINE GLUCONATE_total_day_supply',
'ALPRAZOLAM_total_drug_cost',
'ALPRAZOLAM_total_claim_count',
'ALPRAZOLAM_total_day_supply',
'ATENOLOL_total_drug_cost',
'ATENOLOL_total_day_supply',
'OXYMORPHONE HCL ER_total_drug_cost',
'SERTRALINE HCL_total_drug_cost',
'SERTRALINE HCL_total_day_supply',
'HYDROCHLOROTHIAZIDE_total_drug_cost',
'HYDROCHLOROTHIAZIDE_total_day_supply',
'AZITHROMYCIN_total_claim_count',
'CICLOPIROX_total_drug_cost',
'INSULIN SYRINGE_total_day_supply',
'TIZANIDINE HCL_total_drug_cost',
'TIZANIDINE HCL_total_claim_count',
'TIZANIDINE HCL_total_day_supply',
'FLUCONAZOLE_total_claim_count',
'TESTOSTERONE CYPIONATE_total_drug_cost',
'TESTOSTERONE CYPIONATE_total_claim_count',
'SIMVASTATIN_total_drug_cost',
'SIMVASTATIN_total_day_supply',
'COMBIVENT RESPIMAT_total_drug_cost',
'COMBIVENT RESPIMAT_total_claim_count',
'COMBIVENT RESPIMAT_total_day_supply',
'ZOLPIDEM TARTRATE_total_claim_count',
'HYDROCODONE-ACETAMINOPHEN_total_drug_cost',
'HYDROCODONE-ACETAMINOPHEN_total_claim_count',
'HYDROCODONE-ACETAMINOPHEN_total_day_supply',
'CLINDAMYCIN HCL_total_drug_cost',
'CLINDAMYCIN HCL_total_day_supply',
'METHADONE HCL_total_drug_cost',
'METHADONE HCL_total_claim_count',
'METHADONE HCL_total_day_supply',
'DOXEPIN HCL_total_drug_cost',
'DOXEPIN HCL_total_claim_count',
'DOXEPIN HCL_total_day_supply',
'DICLOFENAC SODIUM_total_drug_cost',
'FLUOCINONIDE_total_drug_cost',
'FLUOCINONIDE_total_day_supply',
'LEVOTHYROXINE SODIUM_total_day_supply',
'DEXTROAMPHETAMINE-AMPHETAMINE_total_claim_count',
'DEXTROAMPHETAMINE-AMPHETAMINE_total_day_supply',

```

'CYCLOBENZAPRINE HCL_total_claim_count',
'CYCLOBENZAPRINE HCL_total_day_supply',
'IBU_total_claim_count',
'IBU_total_day_supply',
'DIGOXIN_total_drug_cost',
'DIGOXIN_total_claim_count',
'DIGOXIN_total_day_supply',
'BUPRENORPHINE HCL_total_drug_cost',
'BUPRENORPHINE HCL_total_claim_count',
'BUPRENORPHINE HCL_total_day_supply',
'MODAFINIL_total_claim_count',
'MODAFINIL_total_day_supply',
'GABAPENTIN_total_drug_cost',
'GABAPENTIN_total_claim_count',
'GABAPENTIN_total_day_supply',
'ACETAMINOPHEN-CODEINE_total_drug_cost',
'ACETAMINOPHEN-CODEINE_total_claim_count',
'ACETAMINOPHEN-CODEINE_total_day_supply',
'LIDOCAINE_total_drug_cost',
'LIDOCAINE_total_claim_count',
'LIDOCAINE_total_day_supply',
'CILOSTAZOL_total_drug_cost',
'CILOSTAZOL_total_claim_count',
'CILOSTAZOL_total_day_supply',
'HYDROMORPHONE HCL_total_drug_cost',
'HYDROMORPHONE HCL_total_claim_count',
'HYDROMORPHONE HCL_total_day_supply',
'VENLAFAXINE HCL ER_total_drug_cost',
'VENLAFAXINE HCL ER_total_day_supply',
'TRAMADOL HCL_total_drug_cost',
'TRAMADOL HCL_total_day_supply',
'DRONABINOL_total_drug_cost',
'DRONABINOL_total_day_supply',
'VENTOLIN HFA_total_drug_cost',
'VENTOLIN HFA_total_claim_count',
'VENTOLIN HFA_total_day_supply',
'JENTADUETO_total_claim_count',
'OXYCODONE-ACETAMINOPHEN_total_drug_cost',
'OXYCODONE-ACETAMINOPHEN_total_claim_count',
'OXYCODONE-ACETAMINOPHEN_total_day_supply',
'DIAZEPAM_total_claim_count',
'DIAZEPAM_total_day_supply',
'ALLOPURINOL_total_drug_cost',
'ALLOPURINOL_total_day_supply',
'OXYCONTIN_total_drug_cost',
'OXYCONTIN_total_claim_count',
'OXYCONTIN_total_day_supply']

```

```
In [99]: FeaturesAll_pd1[new_col_all].describe()
```

Out[99]:

	MORPHINE SULFATE ER_total_drug_cost	MORPHINE SULFATE ER_total_claim_count	MORPHINE SULFATE ER_total_day_supply	CHLORIDE_total_
count	54323.000000	54323.000000	54323.000000	
mean	3452.790606	54.497506	1555.618265	
std	7213.213882	105.796107	3103.331318	
min	42.390000	11.000000	21.000000	
25%	720.815000	15.000000	404.000000	
50%	1383.230000	24.000000	690.000000	
75%	3133.460000	48.000000	1341.000000	
max	262484.290000	2860.000000	84456.000000	

8 rows × 145 columns



In [100... FeaturesAll_pd1['drug_mean'] = FeaturesAll_pd1[new_col_all].mean(axis=1)

In [101... FeaturesAll_pd['drug_mean'] = FeaturesAll_pd['drug_mean'].map(lambda x: np.log

In [102... FeaturesAll_pd1['drug_sum'] = FeaturesAll_pd1[new_col_all].sum(axis=1)
FeaturesAll_pd['drug_sum'] = FeaturesAll_pd['drug_sum'].map(lambda x: np.log10

In [103... FeaturesAll_pd1['drug_variance'] = FeaturesAll_pd1[new_col_all].var(axis=1)

In [104... FeaturesAll_pd1

Out[104...

	npi	total_drug_cost_sum	total_drug_cost_mean	total_drug_cost_max
593816	1003000126	4.092566	2.888972	3.969747
493584	1003000142	5.056408	3.714066	4.718552
761450	1003000167	2.183981	1.885785	1.958086
160806	1003000282	2.820195	2.519821	2.584467
178678	1003000407	4.866301	3.081325	4.090744
...	...	...	...	...
481077	1992999759	4.200928	2.739295	3.957589
352034	1992999791	3.134601	2.658116	2.893911
583453	1992999825	3.528849	2.626657	3.305646
606940	1992999833	2.486870	2.012570	2.093036
869023	1992999882	2.793036	2.018368	2.103940

918012 rows × 168 columns



In []:

In []:

In [105...

```
df_train = FeaturesAll_pd1.ix[ix_train]
df_valid = FeaturesAll_pd1.ix[ix_valid]

df_train.fillna(0)
df_valid.fillna(0)
```

```
C:\Users\debpr\Anaconda3\lib\site-packages\ipykernel_launcher.py:1: FutureWarning:
.ix is deprecated. Please use
.loc for label based indexing or
.iloc for positional indexing

See the documentation here:
http://pandas.pydata.org/pandas-docs/stable/user_guide/indexing.html#ix-indexer-is-deprecated
"""Entry point for launching an IPython kernel.
C:\Users\debpr\Anaconda3\lib\site-packages\ipykernel_launcher.py:2: FutureWarning:
.ix is deprecated. Please use
.loc for label based indexing or
.iloc for positional indexing

See the documentation here:
http://pandas.pydata.org/pandas-docs/stable/user_guide/indexing.html#ix-indexer-is-deprecated
```

Out[105]...

	npi	total_drug_cost_sum	total_drug_cost_mean	total_drug_cost_max
438548	1790986990	3.717641	3.019004	3.691204
207538	1790987055	1.936865	1.936865	1.936865
762303	1790987063	2.798975	2.102756	2.349608
245938	1790987089	2.409984	1.936229	2.264180
819406	1790987105	2.854646	2.854646	2.854646
...	...	...	...	...
481077	1992999759	4.200928	2.739295	3.957589
352034	1992999791	3.134601	2.658116	2.893911
583453	1992999825	3.528849	2.626657	3.305646
606940	1992999833	2.486870	2.012570	2.093036
869023	1992999882	2.793036	2.018368	2.103940

183603 rows × 168 columns



In [106]...

```
df_valid.columns
```

```
Out[106...] Index(['npi', 'total_drug_cost_sum', 'total_drug_cost_mean',
      'total_drug_cost_max', 'total_claim_count_sum',
      'total_claim_count_mean', 'total_claim_count_max',
      'total_day_supply_sum', 'total_day_supply_mean', 'total_day_supply_max',
      ...
      'DIAZEPAM_total_claim_count', 'DIAZEPAM_total_day_supply',
      'ALLOPURINOL_total_drug_cost', 'ALLOPURINOL_total_day_supply',
      'OXYCONTIN_total_drug_cost', 'OXYCONTIN_total_claim_count',
      'OXYCONTIN_total_day_supply', 'drug_mean', 'drug_sum', 'drug_variance'],
      dtype='object', length=168)
```

```
In [107...] #Create the Specialty Weight
spec_dict = []
spec_fraud_1 = df_train[df_train['is_fraud']==1]['Speciality']
```

```
In [108...] from collections import Counter
counts = Counter(spec_fraud_1)
spec_dict = dict(counts)
```

```
In [109...] FeaturesAll_pd1['Spec_Weight'] = FeaturesAll_pd1['Speciality'].map(lambda x: ...)
```

```
In [110...] df_train = FeaturesAll_pd1.ix[ix_train]
df_valid = FeaturesAll_pd1.ix[ix_valid]
```

C:\Users\debpr\Anaconda3\lib\site-packages\ipykernel_launcher.py:1: FutureWarning:

.ix is deprecated. Please use
.loc for label based indexing or
.iloc for positional indexing

See the documentation here:

http://pandas.pydata.org/pandas-docs/stable/user_guide/indexing.html#ix-indexer-is-deprecated

"""Entry point for launching an IPython kernel.

C:\Users\debpr\Anaconda3\lib\site-packages\ipykernel_launcher.py:2: FutureWarning:

.ix is deprecated. Please use
.loc for label based indexing or
.iloc for positional indexing

See the documentation here:

http://pandas.pydata.org/pandas-docs/stable/user_guide/indexing.html#ix-indexer-is-deprecated

```
In [111...] len(df_train[df_train['is_fraud'] == 1])
```

Out[111... 292

```
In [112... print(df_train.dtypes)
```

```
npi                object
total_drug_cost_sum float64
total_drug_cost_mean float64
total_drug_cost_max float64
total_claim_count_sum float64
...
OXYCONTIN_total_day_supply float64
drug_mean               float64
drug_sum                float64
drug_variance           float64
Spec_Weight             int64
Length: 169, dtype: object
```

```
In [113... df_train.fillna(0)
```

Out[113...

		npi	total_drug_cost_sum	total_drug_cost_mean	total_drug_cost_max
593816	1003000126		4.092566	2.888972	3.969747
493584	1003000142		5.056408	3.714066	4.718552
761450	1003000167		2.183981	1.885785	1.958086
160806	1003000282		2.820195	2.519821	2.584467
178678	1003000407		4.866301	3.081325	4.090744
...	...		...	...	...
220752	1790986925		5.026466	3.880391	4.925252
125004	1790986933		3.026864	2.329524	2.544490
54061	1790986941		2.279667	1.980912	2.016824
864274	1790986966		2.682452	2.207131	2.256694
886982	1790986974		5.289774	4.444690	5.086008

734409 rows × 6 columns

```
In [114... df_valid.fillna(0)
```


Out[114...

	npi	total_drug_cost_sum	total_drug_cost_mean	total_drug_cost_max
438548	1790986990	3.717641	3.019004	3.691204
207538	1790987055	1.936865	1.936865	1.936865
762303	1790987063	2.798975	2.102756	2.349608
245938	1790987089	2.409984	1.936229	2.264180
819406	1790987105	2.854646	2.854646	2.854646
...	...	...	...	...
481077	1992999759	4.200928	2.739295	3.957589
352034	1992999791	3.134601	2.658116	2.893911
583453	1992999825	3.528849	2.626657	3.305646
606940	1992999833	2.486870	2.012570	2.093036
869023	1992999882	2.793036	2.018368	2.103940

183603 rows × 169 columns



In [115...

```
numerical_features1 = numerical_features + ['drug_sum', 'Spec_Weight']
```

In [116...

```
numerical_features1
```

Out[116...

```
['total_drug_cost_sum',  
 'total_drug_cost_mean',  
 'Total_Payment_Sum',  
 'total_drug_cost_max',  
 'total_claim_count_sum',  
 'total_claim_count_mean',  
 'total_claim_count_max',  
 'total_day_supply_sum',  
 'total_day_supply_mean',  
 'total_day_supply_max',  
 'claim_max-mean',  
 'supply_max-mean',  
 'drug_max-mean',  
 'drug_sum',  
 'Spec_Weight']
```

In []:

```
In [117... positives=len(df_train[df_train['is_fraud'] == 1])
positives
```

```
Out[117... 292
```

```
In [118... dataset_size=len(df_train)
dataset_size
```

```
Out[118... 734409
```

```
In [119... per_ones=(float(positives)/float(dataset_size))*100
per_ones
```

```
Out[119... 0.03975986133067542
```

```
In [120... negatives=float(dataset_size-positives)
t=negatives/positives
t
```

```
Out[120... 2514.099315068493
```

```
In [121... BalancingRatio= positives/dataset_size
BalancingRatio
```

```
Out[121... 0.00039759861330675416
```

```
In [122... BalancingRatio= positives/dataset_size
BalancingRatio
```

```
Out[122... 0.00039759861330675416
```

```
In [ ]:
```

```
In [123... X= df_train[numerical_features1].values
Y = df_train['is_fraud'].values
clf = LogisticRegression(C=1e5, class_weight={0:1, 1:4000}, n_jobs=3)
clf.fit(X,Y)
y_p=clf.predict_proba(X)
```

```
C:\Users\debpr\Anaconda3\lib\site-packages\sklearn\linear_model\logistic.py:43
2: FutureWarning: Default solver will be changed to 'lbfgs' in 0.22. Specify a
solver to silence this warning.
```

```
FutureWarning)
```

```
C:\Users\debpr\Anaconda3\lib\site-packages\sklearn\linear_model\logistic.py:15
44: UserWarning: 'n_jobs' > 1 does not have any effect when 'solver' is set to
'liblinear'. Got 'n_jobs' = 3.
```

```
" = {}".format(effective_n_jobs(self.n_jobs)))
```

```
In [124... params_0 = {'n_estimators': 100, 'max_depth': 8, 'min_samples_split': 3, 'lea
params_1 = {'n_estimators': 500, 'max_depth': 10, 'min_samples_split': 5, 'cla

scaler = StandardScaler()

clfs = [
    LogisticRegression(C=1e5, class_weight= {0:1, 1:2514}, n_jobs=5),

    GaussianNB(),

    ensemble.RandomForestClassifier(**params_1),

    ensemble.ExtraTreesClassifier(**params_1),

    ensemble.GradientBoostingClassifier(**params_0)

]
```

```
In [125... X_train = df_train[numerical_features1].values

y_train = df_train['is_fraud'].values

X_train = scaler.fit_transform(X_train)

X_valid = df_valid[numerical_features1].values
y_valid = df_valid['is_fraud'].values
X_valid_x= scaler.transform(X_valid)
```

```
In [126... prob_result = []
df_m = []
clfs_fited = []
for clf in clfs:
    print("%s:" % clf.__class__.__name__)
    clf.fit(X_train, y_train)
    clfs_fited.append(clf)
    y_pred = clf.predict(X_valid_x)
    prob_pos = clf.predict_proba(X_valid_x)[: , 1]
    prob_result.append(prob_pos)
    m = confusion_matrix(y_valid, y_pred)
    clf_score = brier_score_loss(y_valid, prob_pos, pos_label=y_valid.max())
    print("\tBrier: %1.5f" % (clf_score))
    print("\tPrecision: %1.5f" % precision_score(y_valid, y_pred))
    print("\tRecall: %1.5f" % recall_score(y_valid, y_pred))
    print("\tF1: %1.5f" % f1_score(y_valid, y_pred))
    print("\tauc: %1.5f" % roc_auc_score(y_valid, prob_pos))
    print("\tAccuracy: %1.5f\n" % accuracy_score(y_valid, y_pred))
    df_m.append(
```

```
pd.DataFrame(m, index=['True Negative', 'True Positive'], columns=['P  
)
```

LogisticRegression:

```
C:\Users\debpr\Anaconda3\lib\site-packages\sklearn\linear_model\logistic.py:43  
2: FutureWarning: Default solver will be changed to 'lbfgs' in 0.22. Specify a  
solver to silence this warning.
```

```
FutureWarning)
```

```
C:\Users\debpr\Anaconda3\lib\site-packages\sklearn\linear_model\logistic.py:15  
44: UserWarning: 'n_jobs' > 1 does not have any effect when 'solver' is set to  
'liblinear'. Got 'n_jobs' = 5.
```

```
" = {}".format(effective_n_jobs(self.n_jobs)))
```

Brier: 0.22671
Precision: 0.00073
Recall: 0.65789
F1: 0.00145
auc: 0.67744
Accuracy: 0.62555

GaussianNB:

Brier: 0.00548
Precision: 0.00115
Recall: 0.01316
F1: 0.00212
auc: 0.61570
Accuracy: 0.99488

RandomForestClassifier:

Brier: 0.04947
Precision: 0.00200
Recall: 0.07895
F1: 0.00391
auc: 0.71774
Accuracy: 0.98333

ExtraTreesClassifier:

Brier: 0.15010
Precision: 0.00099
Recall: 0.39474
F1: 0.00198
auc: 0.69883
Accuracy: 0.83511

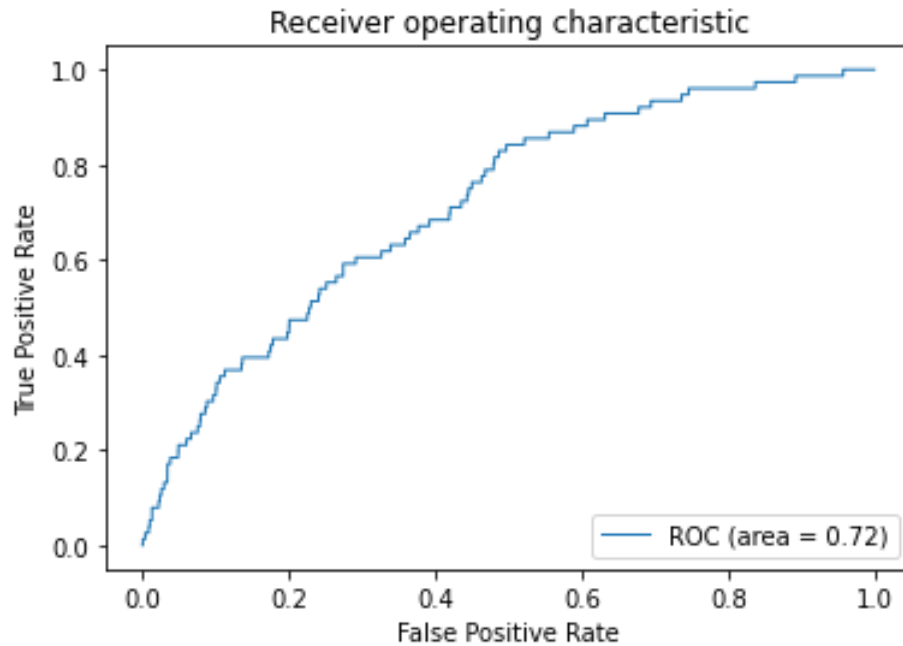
GradientBoostingClassifier:

Brier: 0.00080
Precision: 0.01333
Recall: 0.01316
F1: 0.01325
auc: 0.67603
Accuracy: 0.99919

```
In [127... fpr, tpr, thresholds = roc_curve(y_valid, prob_result[2])
```

```
In [128... fpr, tpr, thresholds = roc_curve(y_valid, prob_result[2])
roc_auc = auc(fpr, tpr)
plt.plot(fpr, tpr, lw=1, label='ROC (area = %0.2f)' % roc_auc)
plt.xlim([-0.05, 1.05])
plt.ylim([-0.05, 1.05])
plt.xlabel('False Positive Rate')
plt.ylabel('True Positive Rate')
```

```
plt.title('Receiver operating characteristic')
plt.legend(loc="lower right")
plt.show()
```



In [129...

m

Out[129... array([[183453, 74],
[75, 1]], dtype=int64)

In [130... X_valid_x[0]

Out[130... array([-0.11853889, 0.15953108, 0.59242696, 0.20967059, -0.69654097,
-1.24766823, -0.96141074, -0.5083302 , -0.57096415, -0.57829914,
-0.63166835, -0.50143326, 0.25524295, -0.23454024, 1.62109627])

In [131... df_train

Out[131...

	npi	total_drug_cost_sum	total_drug_cost_mean	total_drug_cost_max
593816	1003000126	4.092566	2.888972	3.969747
493584	1003000142	5.056408	3.714066	4.718552
761450	1003000167	2.183981	1.885785	1.958086
160806	1003000282	2.820195	2.519821	2.584467
178678	1003000407	4.866301	3.081325	4.090744
...	...	...	...	...
220752	1790986925	5.026466	3.880391	4.925252
125004	1790986933	3.026864	2.329524	2.544490
54061	1790986941	2.279667	1.980912	2.016824
864274	1790986966	2.682452	2.207131	2.256694
886982	1790986974	5.289774	4.444690	5.086008

734409 rows × 169 columns



In [132...

X_valid_x[1]

Out[132...

```
array([-1.51659971, -1.2952079 ,  0.36949694, -1.40529175, -1.26771914,
        -0.47171971, -0.92246538, -1.37743858, -1.07968694, -1.23435305,
        -1.18777193, -1.28920355, -1.31745957, -0.32395815,  0.0772416 ])
```

In [133...

y_pred = clf.predict(X_valid_x)

In [134...

y_pred

Out[134...

```
array([0., 0., 0., ..., 0., 0., 0.])
```

In [135...

X_train[0]

Out[135...

```
array([ 0.17580909, -0.01527296, -0.77052688,  0.46608395,  0.20160072,
        -0.24072507, -0.1863803 ,  0.108827 , -0.22907934, -0.05881123,
        -0.12337776,  0.21832414,  1.21115731, -0.29965648,  1.62109627])
```

In [153...

```
feature_importance = clfs_fited[2].feature_importances_
# make importances relative to max importance
feature_importance = 100.0 * (feature_importance / feature_importance.max())
sorted_idx = np.argsort(feature_importance)
```

```
In [154... feature_importance[sorted_idx]
```

```
Out[154... array([ 44.229221 ,  46.06615724,  46.32629575,  47.46613081,
        47.57418307,  50.14372325,  56.21753059,  57.81815599,
        58.63888811,  58.81457006,  61.99445656,  72.88707111,
        91.60169541,  92.11134126, 100.          ])
```

```
In [155... features = [numerical_features1[ix] for ix in sorted_idx]
bardata = {"name":features[:, :-1], "importance percent":feature_importance[sor
```

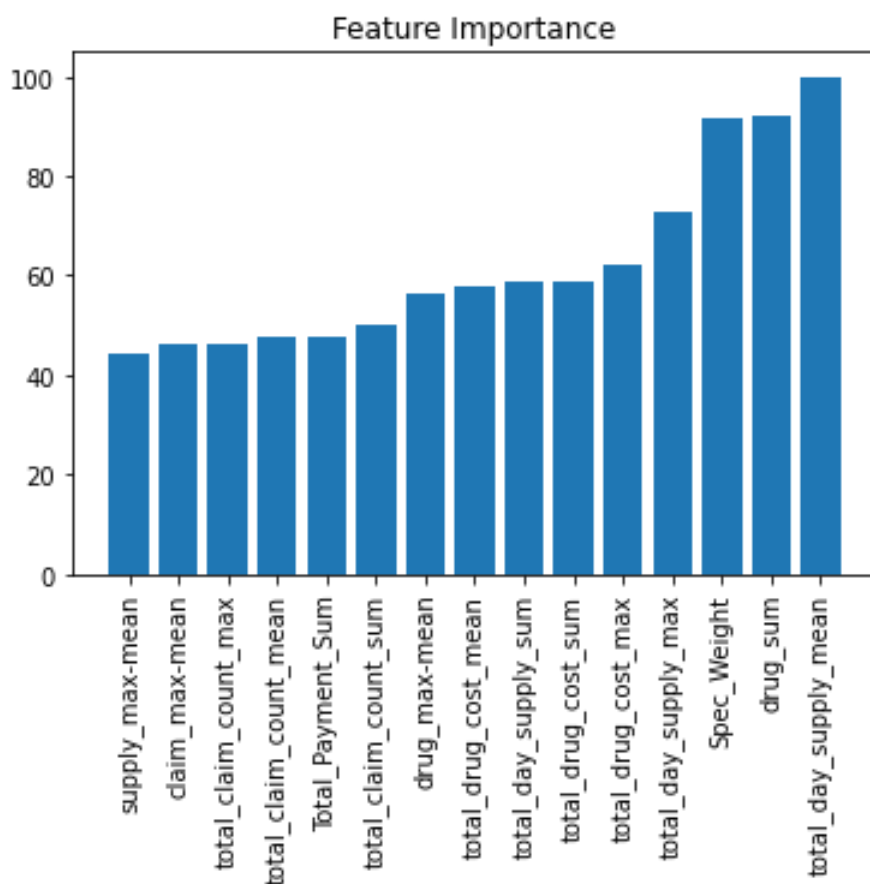
```
In [156... plt.figure()

# Create plot title
plt.title("Feature Importance")

# Add bars
plt.bar(range(X.shape[1]), feature_importance[sorted_idx])

# Add feature names as x-axis labels
plt.xticks(range(X.shape[1]), features, rotation=90)

# Show plot
plt.show()
```



```
In [ ]:
```