In [1]:
```python
##Setting directory
import os
os.chdir('C:/Users/TOTAGOUSER4/Documents/Totago Technologies/Data Science/Projects/BCG')
```

In [2]:
```python
#Importing Libraries
import pandas as pd
import numpy as np
import time
from sklearn import preprocessing
import matplotlib.pyplot as plt
import seaborn as sns
from sklearn.preprocessing import StandardScaler
from sklearn import preprocessing
from sklearn.datasets import make_classification
from sklearn.model_selection import cross_val_score
from sklearn.model_selection import RepeatedStratifiedKFold
from sklearn.linear_model import LogisticRegression
from sklearn.neighbors import KNeighborsClassifier
from sklearn.tree import DecisionTreeClassifier
from sklearn.svm import SVC
from sklearn.ensemble import RandomForestClassifier
from sklearn.naive_bayes import GaussianNB
from sklearn.ensemble import StackingClassifier
from matplotlib import pyplot
from numpy import mean
from numpy import std
from sklearn.ensemble import AdaBoostClassifier
from xgboost import XGBClassifier
from lightgbm import LGBMClassifier
from catboost import CatBoostClassifier
from sklearn.metrics import roc_auc_score, log_loss
from sklearn.preprocessing import LabelEncoder
from sklearn.metrics import precision_recall_fscore_support as score
from sklearn.model_selection import train_test_split
from sklearn.ensemble import GradientBoostingClassifier
```

Datasets

In [3]:
```python
import pandas as pd
cust_data = pd.read_csv('ml_case_training_data.csv')
price_data = pd.read_csv('ml_case_training_hist_data.csv')
churn_data = pd.read_csv('ml_case_training_output.csv')
```

In [4]:
```python
#Customer Dataset
cust_data.head(10)
```

Out[4]:

	id	activity_new	campaign_disc_ele	channel_sales	cons_12m
0	48ada52261e7cf58715202705a0451c9	esoiiifxdlbkcsluxmfuacbdckommixw	NaN	lmkebamcaaclubfxadlmueccxoimlema	309275
1	24011ae4ebbe3035111d65fa7c15bc57	NaN	NaN	foosdfpfkusacimwkcsosbicdxkicaua	0
2	d29c2c54acc38ff3c0614d0a653813dd	NaN	NaN	NaN	4660
3	764c75f661154dac3a6c254cd082ea7d	NaN	NaN	foosdfpfkusacimwkcsosbicdxkicaua	544
4	bba03439a292a1e166f80264c16191cb	NaN	NaN	lmkebamcaaclubfxadlmueccxoimlema	1584
5	568bb38a1afd7c0fc49c77b3789b59a3	sfisfxfcocfpcmckuekokxuseixdaoeu	NaN	foosdfpfkusacimwkcsosbicdxkicaua	121335
6	149d57cf92fc41cf94415803a877cb4b	NaN	NaN	NaN	4425
7	1aa498825382410b098937d65c4ec26d	NaN	NaN	usilxuppasemubllopkaafesmlibmsdf	8302
8	7ab4bf4878d8f7661dfc20e9b8e18011	sscfoipxikopfskekuobeuxkxmwsuucb	NaN	foosdfpfkusacimwkcsosbicdxkicaua	45097
9	01495c955be7ec5e7f3203406785aae0	NaN	NaN	foosdfpfkusacimwkcsosbicdxkicaua	29552

10 rows × 32 columns

In [5]:
```python
#Pricing Data
price_data.head(10)
```

Out[5]:

	id	price_date	price_p1_var	price_p2_var	price_p3_var	price_p1_fix	price_p2_fix	price_p3_fix
0	038af19179925da21a25619c5a24b745	2015-01-01	0.151367	0.0	0.0	44.266931	0.0	0.0
1	038af19179925da21a25619c5a24b745	2015-02-01	0.151367	0.0	0.0	44.266931	0.0	0.0
2	038af19179925da21a25619c5a24b745	2015-03-01	0.151367	0.0	0.0	44.266931	0.0	0.0
3	038af19179925da21a25619c5a24b745	2015-04-01	0.149626	0.0	0.0	44.266931	0.0	0.0
4	038af19179925da21a25619c5a24b745	2015-05-01	0.149626	0.0	0.0	44.266931	0.0	0.0
5	038af19179925da21a25619c5a24b745	2015-06-01	0.149626	0.0	0.0	44.266930	0.0	0.0
6	038af19179925da21a25619c5a24b745	2015-07-01	0.150321	0.0	0.0	44.444710	0.0	0.0
7	038af19179925da21a25619c5a24b745	2015-08-01	0.145859	0.0	0.0	44.444710	0.0	0.0
8	038af19179925da21a25619c5a24b745	2015-09-01	0.145859	0.0	0.0	44.444710	0.0	0.0
9	038af19179925da21a25619c5a24b745	2015-10-01	0.145859	0.0	0.0	44.444710	0.0	0.0

In [6]:
```python
#Churn data
churn_data.head(10)
```

Out[6]:

	id	churn
0	48ada52261e7cf58715202705a0451c9	0
1	24011ae4ebbe3035111d65fa7c15bc57	1
2	d29c2c54acc38ff3c0614d0a653813dd	0
3	764c75f661154dac3a6c254cd082ea7d	0
4	bba03439a292a1e166f80264c16191cb	0
5	568bb38a1afd7c0fc49c77b3789b59a3	0
6	149d57cf92fc41cf94415803a877cb4b	0
7	1aa498825382410b098937d65c4ec26d	1
8	7ab4bf4878d8f7661dfc20e9b8e18011	1
9	01495c955be7ec5e7f3203406785aae0	0

Data Cleaning

Dealing with missing data

In [7]:
```python
#Checking for null values in Customer Details Dataset
cust_data.isnull().sum()
```

Out[7]:
```
id                              0
activity_new                 9545
campaign_disc_ele           16096
channel_sales                4218
cons_12m                        0
cons_gas_12m                    0
cons_last_month                 0
date_activ                      0
date_end                        2
date_first_activ            12588
date_modif_prod               157
date_renewal                   40
forecast_base_bill_ele      12588
forecast_base_bill_year     12588
forecast_bill_12m           12588
forecast_cons               12588
forecast_cons_12m               0
forecast_cons_year              0
forecast_discount_energy      126
forecast_meter_rent_12m         0
forecast_price_energy_p1      126
forecast_price_energy_p2      126
forecast_price_pow_p1         126
has_gas                         0
imp_cons                        0
margin_gross_pow_ele           13
margin_net_pow_ele             13
nb_prod_act                     0
net_margin                     15
num_years_antig                 0
origin_up                      87
pow_max                         3
dtype: int64
```

Columns with null values - activity_new, campaign_disc_ele, channel_sales, date_end, date_first_activ, date_modif_prod, date_renewal, forecast_base_bill_ele, forecast_base_bill_year, forecast_bill_12m, forecast_cons, forecast_discount_energy, forecast_price_energy_p1, forecast_price_energy_p2, forecast_price_pow_p1, margin_gross_pow_ele, margin_net_pow_ele, net_margin, origin_up, pow_max

In [8]:
```python
#Checking for null values in Price Dataset
price_data.isnull().sum()
```

Out[8]:
```
id                 0
price_date         0
price_p1_var    1359
price_p2_var    1359
price_p3_var    1359
price_p1_fix    1359
price_p2_fix    1359
price_p3_fix    1359
dtype: int64
```

Columns with missing data - price_p1_var, price_p2_var, price_p3_var, price_p1_fix, price_p2_fix, price_p3_fix

In [9]:
```python
#Checking for null values in Churn Dataset
churn_data.isnull().sum()
```

Out[9]:
```
id       0
churn    0
dtype: int64
```

In [10]:
```python
#Converting the dates to datetime
import datetime
for a in ['date_activ', 'date_end', 'date_first_activ', 'date_modif_prod', 'date_renewal']:
    cust_data[a] = pd.to_datetime(cust_data[a], format='%Y %m %d ')

cust_data.head(10)
```

Out[10]:

	id	activity_new	campaign_disc_ele	channel_sales	cons_12m
0	48ada52261e7cf58715202705a0451c9	esoiiifxdlbkcsluxmfuacbdckommixw	NaN	lmkebamcaaclubfxadlmueccxoimlema	309275
1	24011ae4ebbe3035111d65fa7c15bc57	NaN	NaN	foosdfpfkusacimwkcsosbicdxkicaua	0
2	d29c2c54acc38ff3c0614d0a653813dd	NaN	NaN	NaN	4660
3	764c75f661154dac3a6c254cd082ea7d	NaN	NaN	foosdfpfkusacimwkcsosbicdxkicaua	544
4	bba03439a292a1e166f80264c16191cb	NaN	NaN	lmkebamcaaclubfxadlmueccxoimlema	1584
5	568bb38a1afd7c0fc49c77b3789b59a3	sfisfxfcocfpcmckuekokxuseixdaoeu	NaN	foosdfpfkusacimwkcsosbicdxkicaua	121335
6	149d57cf92fc41cf94415803a877cb4b	NaN	NaN	NaN	4425
7	1aa498825382410b098937d65c4ec26d	NaN	NaN	usilxuppasemubllopkaafesmlibmsdf	8302
8	7ab4bf4878d8f7661dfc20e9b8e18011	sscfoipxikopfskekuobeuxkxmwsuucb	NaN	foosdfpfkusacimwkcsosbicdxkicaua	45097
9	01495c955be7ec5e7f3203406785aae0	NaN	NaN	foosdfpfkusacimwkcsosbicdxkicaua	29552

10 rows × 32 columns

No nulls here

In [11]:
```python
# Filling up nulls in Customer Details Dataset

#Filling with zeros
for col in ['forecast_base_bill_ele', 'forecast_base_bill_year', 'forecast_bill_12m', 'forecast_cons',
'forecast_discount_energy', 'forecast_price_energy_p1', 'forecast_price_energy_p2', 'forecast_price_pow
_p1', 'margin_gross_pow_ele', 'margin_net_pow_ele', 'net_margin', 'pow_max']:
    cust_data[col].fillna(0, inplace = True)

#Filling with null keyword
for col in ['channel_sales', 'origin_up']:
    cust_data[col].fillna('Null', inplace = True)

#Filling Dates with activation date
for col in ['date_end', 'date_first_activ', 'date_modif_prod', 'date_renewal']:
    cust_data[col].fillna(cust_data['date_activ'], inplace = True)

#Dropping Some columns
cust_data.drop(columns=['activity_new', 'campaign_disc_ele', ], inplace=True)

cust_data.head(10)
```

Out[11]:

	id	channel_sales	cons_12m	cons_gas_12m	cons_last_month	date_activ	date_e
0	48ada52261e7cf58715202705a0451c9	lmkebamcaaclubfxadlmueccxoimlema	309275	0	10025	2012-11-07	2016-1
1	24011ae4ebbe3035111d65fa7c15bc57	foosdfpfkusacimwkcsosbicdxkicaua	0	54946	0	2013-06-15	2016-0
2	d29c2c54acc38ff3c0614d0a653813dd	Null	4660	0	0	2009-08-21	2016-0
3	764c75f661154dac3a6c254cd082ea7d	foosdfpfkusacimwkcsosbicdxkicaua	544	0	0	2010-04-16	2016-0
4	bba03439a292a1e166f80264c16191cb	lmkebamcaaclubfxadlmueccxoimlema	1584	0	0	2010-03-30	2016-0
5	568bb38a1afd7c0fc49c77b3789b59a3	foosdfpfkusacimwkcsosbicdxkicaua	121335	0	12400	2010-04-08	2016-0
6	149d57cf92fc41cf94415803a877cb4b	Null	4425	0	526	2010-01-13	2016-0
7	1aa498825382410b098937d65c4ec26d	usilxuppasemubllopkaafesmlibmsdf	8302	0	1998	2011-12-09	2016-1
8	7ab4bf4878d8f7661dfc20e9b8e18011	foosdfpfkusacimwkcsosbicdxkicaua	45097	0	0	2011-12-02	2016-1
9	01495c955be7ec5e7f3203406785aae0	foosdfpfkusacimwkcsosbicdxkicaua	29552	0	1260	2010-04-21	2016-0

10 rows × 30 columns

In [12]:
```python
# Filling up nulls in Price Dataset

for col in ['price_p1_var', 'price_p2_var', 'price_p3_var', 'price_p1_fix', 'price_p2_fix', 'price_p3_f
ix']:
    price_data[col].fillna(0, inplace = True)

price_data.head(10)
```

Out[12]:

	id	price_date	price_p1_var	price_p2_var	price_p3_var	price_p1_fix	price_p2_fix	price_p3_fix
0	038af19179925da21a25619c5a24b745	2015-01-01	0.151367	0.0	0.0	44.266931	0.0	0.0
1	038af19179925da21a25619c5a24b745	2015-02-01	0.151367	0.0	0.0	44.266931	0.0	0.0
2	038af19179925da21a25619c5a24b745	2015-03-01	0.151367	0.0	0.0	44.266931	0.0	0.0
3	038af19179925da21a25619c5a24b745	2015-04-01	0.149626	0.0	0.0	44.266931	0.0	0.0
4	038af19179925da21a25619c5a24b745	2015-05-01	0.149626	0.0	0.0	44.266931	0.0	0.0
5	038af19179925da21a25619c5a24b745	2015-06-01	0.149626	0.0	0.0	44.266930	0.0	0.0
6	038af19179925da21a25619c5a24b745	2015-07-01	0.150321	0.0	0.0	44.444710	0.0	0.0
7	038af19179925da21a25619c5a24b745	2015-08-01	0.145859	0.0	0.0	44.444710	0.0	0.0
8	038af19179925da21a25619c5a24b745	2015-09-01	0.145859	0.0	0.0	44.444710	0.0	0.0
9	038af19179925da21a25619c5a24b745	2015-10-01	0.145859	0.0	0.0	44.444710	0.0	0.0

In [13]:
```python
#Cross checking nulls and checking variable types for Customer Details Dataset
cust_data.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 16096 entries, 0 to 16095
Data columns (total 30 columns):
 #   Column                    Non-Null Count  Dtype
---  ------                    --------------  -----
 0   id                        16096 non-null  object
 1   channel_sales             16096 non-null  object
 2   cons_12m                  16096 non-null  int64
 3   cons_gas_12m              16096 non-null  int64
 4   cons_last_month           16096 non-null  int64
 5   date_activ                16096 non-null  datetime64[ns]
 6   date_end                  16096 non-null  datetime64[ns]
 7   date_first_activ          16096 non-null  datetime64[ns]
 8   date_modif_prod           16096 non-null  datetime64[ns]
 9   date_renewal              16096 non-null  datetime64[ns]
 10  forecast_base_bill_ele    16096 non-null  float64
 11  forecast_base_bill_year   16096 non-null  float64
 12  forecast_bill_12m         16096 non-null  float64
 13  forecast_cons             16096 non-null  float64
 14  forecast_cons_12m         16096 non-null  float64
 15  forecast_cons_year        16096 non-null  int64
 16  forecast_discount_energy  16096 non-null  float64
 17  forecast_meter_rent_12m   16096 non-null  float64
 18  forecast_price_energy_p1  16096 non-null  float64
 19  forecast_price_energy_p2  16096 non-null  float64
 20  forecast_price_pow_p1     16096 non-null  float64
 21  has_gas                   16096 non-null  object
 22  imp_cons                  16096 non-null  float64
 23  margin_gross_pow_ele      16096 non-null  float64
 24  margin_net_pow_ele        16096 non-null  float64
 25  nb_prod_act               16096 non-null  int64
 26  net_margin                16096 non-null  float64
 27  num_years_antig           16096 non-null  int64
 28  origin_up                 16096 non-null  object
 29  pow_max                   16096 non-null  float64
dtypes: datetime64[ns](5), float64(15), int64(6), object(4)
memory usage: 3.7+ MB
```

In [14]:
```python
#Cross checking nulls and checking variable types for price Dataset
price_data.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 193002 entries, 0 to 193001
Data columns (total 8 columns):
 #   Column        Non-Null Count   Dtype
---  ------        --------------   -----
 0   id            193002 non-null  object
 1   price_date    193002 non-null  object
 2   price_p1_var  193002 non-null  float64
 3   price_p2_var  193002 non-null  float64
 4   price_p3_var  193002 non-null  float64
 5   price_p1_fix  193002 non-null  float64
 6   price_p2_fix  193002 non-null  float64
 7   price_p3_fix  193002 non-null  float64
dtypes: float64(6), object(2)
memory usage: 11.8+ MB
```

Merge Data

In [20]:
```python
# Inner join customer data and churn data

Data = pd.merge(cust_data, churn_data, left_on = 'id', right_on = 'id')

Data.head(10)
```

Out[20]:

	id	channel_sales	cons_12m	cons_gas_12m	cons_last_month	date_activ	date_e
0	48ada52261e7cf58715202705a0451c9	lmkebamcaaclubfxadlmueccxoimlema	309275	0	10025	2012-11-07	2016-1
1	24011ae4ebbe3035111d65fa7c15bc57	foosdfpfkusacimwkcsosbicdxkicaua	0	54946	0	2013-06-15	2016-0
2	d29c2c54acc38ff3c0614d0a653813dd	Null	4660	0	0	2009-08-21	2016-0
3	764c75f661154dac3a6c254cd082ea7d	foosdfpfkusacimwkcsosbicdxkicaua	544	0	0	2010-04-16	2016-0
4	bba03439a292a1e166f80264c16191cb	lmkebamcaaclubfxadlmueccxoimlema	1584	0	0	2010-03-30	2016-0
5	568bb38a1afd7c0fc49c77b3789b59a3	foosdfpfkusacimwkcsosbicdxkicaua	121335	0	12400	2010-04-08	2016-0
6	149d57cf92fc41cf94415803a877cb4b	Null	4425	0	526	2010-01-13	2016-0
7	1aa498825382410b098937d65c4ec26d	usilxuppasemubllopkaafesmlibmsdf	8302	0	1998	2011-12-09	2016-1
8	7ab4bf4878d8f7661dfc20e9b8e18011	foosdfpfkusacimwkcsosbicdxkicaua	45097	0	0	2011-12-02	2016-1
9	01495c955be7ec5e7f3203406785aae0	foosdfpfkusacimwkcsosbicdxkicaua	29552	0	1260	2010-04-21	2016-0

10 rows × 31 columns

In [21]:
```python
#dropping the price date, so as to group the data by id
price_dataset = price_data.drop(['price_date'], axis = 1)

#grouping the data by id, and summing the prices
new_price_data = price_dataset.groupby(["id"]).sum()


new_price_data.head(10)
```

Out[21]:

id	price_p1_var	price_p2_var	price_p3_var	price_p1_fix	price_p2_fix	price_p3_fix
0002203ffbb812588b632b9e628cc38d	1.492061	1.245525	0.877924	488.420789	293.052462	195.368327
0004351ebdd665e6ee664792efc4fd13	1.757118	0.000000	0.000000	532.625404	0.000000	0.000000
0010bcc39e42b3c2131ed2ce55246e3c	2.178702	0.000000	0.000000	543.836520	0.000000	0.000000
0010ee3855fdea87602a5b7aba8e42de	1.425085	1.179509	0.828384	487.769130	292.661462	195.107656
00114d74e963e47177db89bc70108537	1.775110	0.000000	0.000000	531.203164	0.000000	0.000000
00126c87cf78d7604278f0a9adeb689e	1.437678	1.193008	0.843651	487.932042	292.759214	195.172828
0013f326a839a2f6ad87a1859952d227	1.512911	1.266503	0.899048	488.746620	293.247960	195.498660
00184e957277eeef733a7b563fdabd06	1.771648	0.000000	0.000000	531.203164	0.000000	0.000000
001987ed9dbdab4efa274a9c7233e1f4	1.473067	1.227485	0.876366	487.769126	292.661464	195.107662
0019baf3ed1242cd99b3cb592030446f	3.209391	0.000000	0.000000	695.543164	0.000000	0.000000

In [22]:
```python
#Join it to Price data.
Dataset = pd.merge(Data, new_price_data, left_on = 'id', right_on = 'id', indicator = True)

Dataset.head(10)
```

Out[22]:

	id	channel_sales	cons_12m	cons_gas_12m	cons_last_month	date_activ	date_e
0	48ada52261e7cf58715202705a0451c9	lmkebamcaaclubfxadlmueccxoimlema	309275	0	10025	2012-11-07	2016-1
1	24011ae4ebbe3035111d65fa7c15bc57	foosdfpfkusacimwkcsosbicdxkicaua	0	54946	0	2013-06-15	2016-0
2	d29c2c54acc38ff3c0614d0a653813dd	Null	4660	0	0	2009-08-21	2016-0
3	764c75f661154dac3a6c254cd082ea7d	foosdfpfkusacimwkcsosbicdxkicaua	544	0	0	2010-04-16	2016-0
4	bba03439a292a1e166f80264c16191cb	lmkebamcaaclubfxadlmueccxoimlema	1584	0	0	2010-03-30	2016-0
5	568bb38a1afd7c0fc49c77b3789b59a3	foosdfpfkusacimwkcsosbicdxkicaua	121335	0	12400	2010-04-08	2016-0
6	149d57cf92fc41cf94415803a877cb4b	Null	4425	0	526	2010-01-13	2016-0
7	1aa498825382410b098937d65c4ec26d	usilxuppasemubllopkaafesmlibmsdf	8302	0	1998	2011-12-09	2016-1
8	7ab4bf4878d8f7661dfc20e9b8e18011	foosdfpfkusacimwkcsosbicdxkicaua	45097	0	0	2011-12-02	2016-1
9	01495c955be7ec5e7f3203406785aae0	foosdfpfkusacimwkcsosbicdxkicaua	29552	0	1260	2010-04-21	2016-0

10 rows × 38 columns

Feature Engineering

In [23]:
```python
Dataset.isnull().sum()
```

Out[23]:
```
id                          0
channel_sales               0
cons_12m                    0
cons_gas_12m                0
cons_last_month             0
date_activ                  0
date_end                    0
date_first_activ            0
date_modif_prod             0
date_renewal                0
forecast_base_bill_ele      0
forecast_base_bill_year     0
forecast_bill_12m           0
forecast_cons               0
forecast_cons_12m           0
forecast_cons_year          0
forecast_discount_energy    0
forecast_meter_rent_12m     0
forecast_price_energy_p1    0
forecast_price_energy_p2    0
forecast_price_pow_p1       0
has_gas                     0
imp_cons                    0
margin_gross_pow_ele        0
margin_net_pow_ele          0
nb_prod_act                 0
net_margin                  0
num_years_antig             0
origin_up                   0
pow_max                     0
churn                       0
price_p1_var                0
price_p2_var                0
price_p3_var                0
price_p1_fix                0
price_p2_fix                0
price_p3_fix                0
_merge                      0
dtype: int64
```

no null values

In [24]:
```python
Dataset.info()
```

```
<class 'pandas.core.frame.DataFrame'>
Int64Index: 16096 entries, 0 to 16095
Data columns (total 38 columns):
 #   Column                    Non-Null Count  Dtype
---  ------                    --------------  -----
 0   id                        16096 non-null  object
 1   channel_sales             16096 non-null  object
 2   cons_12m                  16096 non-null  int64
 3   cons_gas_12m              16096 non-null  int64
 4   cons_last_month           16096 non-null  int64
 5   date_activ                16096 non-null  datetime64[ns]
 6   date_end                  16096 non-null  datetime64[ns]
 7   date_first_activ          16096 non-null  datetime64[ns]
 8   date_modif_prod           16096 non-null  datetime64[ns]
 9   date_renewal              16096 non-null  datetime64[ns]
 10  forecast_base_bill_ele    16096 non-null  float64
 11  forecast_base_bill_year   16096 non-null  float64
 12  forecast_bill_12m         16096 non-null  float64
 13  forecast_cons             16096 non-null  float64
 14  forecast_cons_12m         16096 non-null  float64
 15  forecast_cons_year        16096 non-null  int64
 16  forecast_discount_energy  16096 non-null  float64
 17  forecast_meter_rent_12m   16096 non-null  float64
 18  forecast_price_energy_p1  16096 non-null  float64
 19  forecast_price_energy_p2  16096 non-null  float64
 20  forecast_price_pow_p1     16096 non-null  float64
 21  has_gas                   16096 non-null  object
 22  imp_cons                  16096 non-null  float64
 23  margin_gross_pow_ele      16096 non-null  float64
 24  margin_net_pow_ele        16096 non-null  float64
 25  nb_prod_act               16096 non-null  int64
 26  net_margin                16096 non-null  float64
 27  num_years_antig           16096 non-null  int64
 28  origin_up                 16096 non-null  object
 29  pow_max                   16096 non-null  float64
 30  churn                     16096 non-null  int64
 31  price_p1_var              16096 non-null  float64
 32  price_p2_var              16096 non-null  float64
 33  price_p3_var              16096 non-null  float64
 34  price_p1_fix              16096 non-null  float64
 35  price_p2_fix              16096 non-null  float64
 36  price_p3_fix              16096 non-null  float64
 37  _merge                    16096 non-null  category
dtypes: category(1), datetime64[ns](5), float64(21), int64(7), object(4)
memory usage: 4.7+ MB
```

Data types are fine

Now, Let's generate some features.

Feature needed;

Those present are; channel_sales, cons_12m, cons_gas_12m, cons_12m, cons_gas_12m, cons_last_month, forecast_cons_12m, forecast_cons_year, forecast_discount_energy, forecast_meter_rent_12m, forecast_price_energy_p1, forecast_price_energy_p2, forecast_price_pow_p1, has_gas, imp_cons, margin_gross_pow_ele, margin_net_pow_ele, nb_prod_act, net_margin, num_years_antig, origin_up, pow_max, price_p1_var, price_p2_var, price_p3_var, price_p1_fix, price_p2_fix, price_p3_fix

Those to be generated; num_months_antig (number of months the Customer has spent), num_years_renewal (time before contract renewal), avg_month_elec (Average consuption of electricity per month), avg_month_gas (Average consumption of gas per month),

In [25]:
```python
#generating Average consuption of electricity per month
Dataset['avg_month_elec'] = round(Dataset['cons_12m']/12, 2)

#generating Average consumption of gas per month
Dataset['avg_month_gas'] = round(Dataset['cons_gas_12m']/12, 2)

# generating time before contract renewal
Dataset['num_years_renewal']  = ((Dataset['date_renewal']).dt.year - (Dataset['date_activ']).dt.year)

Dataset.head(10)
```

Out[25]:

	id	channel_sales	cons_12m	cons_gas_12m	cons_last_month	date_activ	date_e
0	48ada52261e7cf58715202705a0451c9	lmkebamcaaclubfxadlmueccxoimlema	309275	0	10025	2012-11-07	2016-1
1	24011ae4ebbe3035111d65fa7c15bc57	foosdfpfkusacimwkcsosbicdxkicaua	0	54946	0	2013-06-15	2016-0
2	d29c2c54acc38ff3c0614d0a653813dd	Null	4660	0	0	2009-08-21	2016-0
3	764c75f661154dac3a6c254cd082ea7d	foosdfpfkusacimwkcsosbicdxkicaua	544	0	0	2010-04-16	2016-0
4	bba03439a292a1e166f80264c16191cb	lmkebamcaaclubfxadlmueccxoimlema	1584	0	0	2010-03-30	2016-0
5	568bb38a1afd7c0fc49c77b3789b59a3	foosdfpfkusacimwkcsosbicdxkicaua	121335	0	12400	2010-04-08	2016-0
6	149d57cf92fc41cf94415803a877cb4b	Null	4425	0	526	2010-01-13	2016-0
7	1aa498825382410b098937d65c4ec26d	usilxuppasemubllopkaafesmlibmsdf	8302	0	1998	2011-12-09	2016-1
8	7ab4bf4878d8f7661dfc20e9b8e18011	foosdfpfkusacimwkcsosbicdxkicaua	45097	0	0	2011-12-02	2016-1
9	01495c955be7ec5e7f3203406785aae0	foosdfpfkusacimwkcsosbicdxkicaua	29552	0	1260	2010-04-21	2016-0

10 rows × 41 columns

In [26]:
```python
#Feature Selection

features = Dataset[['channel_sales', 'cons_12m', 'cons_gas_12m', 'cons_last_month', 'forecast_cons_12m'
, 'forecast_cons_year',
                    'forecast_discount_energy', 'forecast_meter_rent_12m', 'forecast_price_energy_p1', 'foreca
st_price_energy_p2',
                    'forecast_price_pow_p1', 'has_gas', 'imp_cons', 'margin_gross_pow_ele', 'margin_net_pow_el
e', 'nb_prod_act',
                    'net_margin', 'num_years_antig', 'origin_up', 'pow_max', 'price_p1_var', 'price_p2_var',
'price_p3_var',
                    'price_p1_fix', 'price_p2_fix', 'price_p3_fix', 'num_years_renewal', 'avg_month_elec', 'av
g_month_gas']]

target = Dataset['churn']
```

In [27]:
```python
#Creating dummies for categorical data
Features = pd.get_dummies(features)
```

In [29]:
```python
#Splitting dataset to test and train

from sklearn.model_selection import train_test_split
x_train, x_test, y_train, y_test = train_test_split(Features, target, test_size=0.30, random_state=4, s
tratify=target)
```

Data Modelling

Model 1 - Logistic Regression

In [40]:
```python
lr = LogisticRegression(max_iter = 100000, dual = False)

start = time.time()
lr_model = lr.fit(x_train, y_train)
end = time.time()
fit_time = (end - start)

start = time.time()
y_pred = lr_model.predict(x_test)
end = time.time()
pred_time = (end - start)


precision, recall, fscore, train_support = score(y_test, y_pred, pos_label= 1, average='binary')
print('Fit time: {} / Predict time: {} ---- Precision: {} / Recall: {} / Accuracy: {}'.format(
    round(fit_time, 3), round(pred_time, 3), round(precision, 3), round(recall, 3), round((y_pred==y_te
st).sum()/len(y_pred), 3)))
```

```
Fit time: 1.164 / Predict time: 0.007 ---- Precision: 0.0 / Recall: 0.0 / Accuracy: 0.895
```

poor model. No precision and recall.

.

Model 2 - Random Forest Classifier

In [43]:
```python
rf = RandomForestClassifier(n_estimators=200, max_depth=None, n_jobs=-1)

start = time.time()
rf_model = rf.fit(x_train, y_train)
end = time.time()
fit_time = (end - start)

start = time.time()
y_pred2 = rf_model.predict(x_test)
end = time.time()
pred_time = (end - start)


precision, recall, fscore, train_support = score(y_test, y_pred2, pos_label= 1, average='binary')
print('Fit time: {} / Predict time: {} ---- Precision: {} / Recall: {} / Accuracy: {}'.format(
    round(fit_time, 3), round(pred_time, 3), round(precision, 3), round(recall, 3), round((y_pred2==y_t
est).sum()/len(y_pred2), 3)))
```

```
Fit time: 2.549 / Predict time: 0.115 ---- Precision: 0.698 / Recall: 0.063 / Accuracy: 0.904
```

Moderate precision and better accuracy, but low recall.

.

Model 3 - Gradient Boost Classifier

In [45]:
```python
gb = GradientBoostingClassifier(n_estimators=150, max_depth=11)

start = time.time()
gb_model = gb.fit(x_train, y_train)
end = time.time()
fit_time = (end - start)

start = time.time()
y_pred3 = gb_model.predict(x_test)
end = time.time()
pred_time = (end - start)


precision, recall, fscore, train_support = score(y_test, y_pred3, pos_label= 1.0, average='binary')
print('Fit time: {} / Predict time: {} ---- Precision: {} / Recall: {} / Accuracy: {}'.format(
    round(fit_time, 3), round(pred_time, 3), round(precision, 3), round(recall, 3), round((y_pred3==y_t
est).sum()/len(y_pred3), 3)))
```

```
Fit time: 30.353 / Predict time: 0.101 ---- Precision: 0.588 / Recall: 0.104 / Accuracy: 0.904
```

Moderate precision and accuracy, but recall is still low.

.

Model 4 - Stacking Classifier

In [94]:

```python
# get a stacking ensemble of models
def get_stacking():
    level0 = list()
    #level0.append(('lr', LogisticRegression(max_iter = 100000, dual = False)))
    #level0.append(('knn', KNeighborsClassifier()))
    #level0.append(('cart', DecisionTreeClassifier()))
    #level0.append(('svm', SVC()))
    #level0.append(('bayes', GaussianNB()))
    level0.append(('rfc', RandomForestClassifier(n_estimators = 150, max_depth= None, n_jobs=-1)))
    level0.append(('Gboost', GradientBoostingClassifier(n_estimators = 150, max_depth= 15)))
    level0.append(('catboost', CatBoostClassifier()))
    level0.append(('xgboost', XGBClassifier()))
    level0.append(('lightgbm', LGBMClassifier()))

    level1 = CatBoostClassifier()

    model = StackingClassifier(estimators=level0, final_estimator=level1, cv=5, n_jobs=-1)
    return model


#Fitting and Prediction
model = get_stacking()

start = time.time()
mod = model.fit(x_train, y_train)
end = time.time()
fit_time = (end - start)

start = time.time()
y_pred4 = mod.predict(x_test)
end = time.time()
pred_time = (end - start)


precision, recall, fscore, train_support = score(y_test, y_pred4, pos_label= 1.0, average='binary')
print('Fit time: {} / Predict time: {} ---- Precision: {} / Recall: {} / Accuracy: {}'.format(
    round(fit_time, 3), round(pred_time, 3), round(precision, 3), round(recall, 3), round((y_pred4==y_
test).sum()/len(y_pred4), 3)))
```

```
Learning rate set to 0.028977
0:	learn: 0.6649866	total: 176ms	remaining: 2m 55s
1:	learn: 0.6389073	total: 187ms	remaining: 1m 33s
2:	learn: 0.6147597	total: 199ms	remaining: 1m 6s
3:	learn: 0.5922265	total: 213ms	remaining: 52.9s
4:	learn: 0.5712575	total: 222ms	remaining: 44.3s
5:	learn: 0.5516817	total: 233ms	remaining: 38.5s
6:	learn: 0.5337357	total: 243ms	remaining: 34.4s
7:	learn: 0.5169147	total: 253ms	remaining: 31.4s
8:	learn: 0.5014785	total: 263ms	remaining: 28.9s
9:	learn: 0.4881150	total: 270ms	remaining: 26.7s
10:	learn: 0.4747684	total: 280ms	remaining: 25.2s
11:	learn: 0.4623130	total: 290ms	remaining: 23.9s
12:	learn: 0.4506394	total: 301ms	remaining: 22.8s
13:	learn: 0.4398709	total: 312ms	remaining: 21.9s
14:	learn: 0.4299300	total: 321ms	remaining: 21.1s
15:	learn: 0.4207525	total: 332ms	remaining: 20.4s
16:	learn: 0.4120193	total: 341ms	remaining: 19.7s
17:	learn: 0.4040078	total: 351ms	remaining: 19.2s
18:	learn: 0.3966984	total: 362ms	remaining: 18.7s
19:	learn: 0.3897398	total: 372ms	remaining: 18.3s
20:	learn: 0.3832186	total: 382ms	remaining: 17.8s
21:	learn: 0.3772181	total: 394ms	remaining: 17.5s
22:	learn: 0.3716754	total: 404ms	remaining: 17.2s
23:	learn: 0.3667101	total: 414ms	remaining: 16.8s
24:	learn: 0.3618430	total: 425ms	remaining: 16.6s
25:	learn: 0.3573058	total: 435ms	remaining: 16.3s
26:	learn: 0.3531940	total: 446ms	remaining: 16.1s
27:	learn: 0.3491803	total: 456ms	remaining: 15.8s
28:	learn: 0.3455013	total: 467ms	remaining: 15.6s
29:	learn: 0.3421013	total: 478ms	remaining: 15.4s
30:	learn: 0.3389116	total: 488ms	remaining: 15.2s
31:	learn: 0.3359010	total: 498ms	remaining: 15.1s
32:	learn: 0.3332157	total: 508ms	remaining: 14.9s
33:	learn: 0.3306455	total: 519ms	remaining: 14.7s
34:	learn: 0.3283569	total: 530ms	remaining: 14.6s
35:	learn: 0.3261776	total: 540ms	remaining: 14.5s
36:	learn: 0.3240392	total: 550ms	remaining: 14.3s
37:	learn: 0.3220423	total: 560ms	remaining: 14.2s
38:	learn: 0.3201951	total: 572ms	remaining: 14.1s
39:	learn: 0.3184778	total: 582ms	remaining: 14s
40:	learn: 0.3168612	total: 592ms	remaining: 13.9s
41:	learn: 0.3153295	total: 603ms	remaining: 13.8s
42:	learn: 0.3139459	total: 614ms	remaining: 13.7s
43:	learn: 0.3126256	total: 624ms	remaining: 13.6s
44:	learn: 0.3113729	total: 636ms	remaining: 13.5s
45:	learn: 0.3102449	total: 646ms	remaining: 13.4s
46:	learn: 0.3091261	total: 658ms	remaining: 13.4s
47:	learn: 0.3080571	total: 669ms	remaining: 13.3s
48:	learn: 0.3071012	total: 679ms	remaining: 13.2s
49:	learn: 0.3061847	total: 690ms	remaining: 13.1s
50:	learn: 0.3052643	total: 700ms	remaining: 13s
51:	learn: 0.3044467	total: 710ms	remaining: 12.9s
52:	learn: 0.3036708	total: 721ms	remaining: 12.9s
53:	learn: 0.3028959	total: 731ms	remaining: 12.8s
54:	learn: 0.3022207	total: 741ms	remaining: 12.7s
55:	learn: 0.3015504	total: 753ms	remaining: 12.7s
56:	learn: 0.3009494	total: 763ms	remaining: 12.6s
57:	learn: 0.3003660	total: 774ms	remaining: 12.6s
58:	learn: 0.2998280	total: 784ms	remaining: 12.5s
59:	learn: 0.2993032	total: 795ms	remaining: 12.5s
60:	learn: 0.2988478	total: 806ms	remaining: 12.4s
61:	learn: 0.2983989	total: 817ms	remaining: 12.4s
62:	learn: 0.2979291	total: 828ms	remaining: 12.3s
63:	learn: 0.2974882	total: 838ms	remaining: 12.2s
64:	learn: 0.2971528	total: 847ms	remaining: 12.2s
65:	learn: 0.2967422	total: 858ms	remaining: 12.1s
66:	learn: 0.2964130	total: 868ms	remaining: 12.1s
67:	learn: 0.2960745	total: 878ms	remaining: 12s
68:	learn: 0.2957386	total: 888ms	remaining: 12s
69:	learn: 0.2954691	total: 897ms	remaining: 11.9s
70:	learn: 0.2951924	total: 908ms	remaining: 11.9s
71:	learn: 0.2949242	total: 918ms	remaining: 11.8s
72:	learn: 0.2946996	total: 931ms	remaining: 11.8s
73:	learn: 0.2944511	total: 942ms	remaining: 11.8s
74:	learn: 0.2941618	total: 952ms	remaining: 11.7s
75:	learn: 0.2939124	total: 963ms	remaining: 11.7s
76:	learn: 0.2936728	total: 972ms	remaining: 11.7s
77:	learn: 0.2934063	total: 982ms	remaining: 11.6s
78:	learn: 0.2932057	total: 992ms	remaining: 11.6s
79:	learn: 0.2929872	total: 1s	remaining: 11.5s
80:	learn: 0.2927823	total: 1.01s	remaining: 11.5s
81:	learn: 0.2926065	total: 1.02s	remaining: 11.4s
82:	learn: 0.2924109	total: 1.03s	remaining: 11.4s
83:	learn: 0.2922775	total: 1.04s	remaining: 11.4s
84:	learn: 0.2920671	total: 1.05s	remaining: 11.3s
85:	learn: 0.2919162	total: 1.06s	remaining: 11.3s
86:	learn: 0.2917284	total: 1.07s	remaining: 11.3s
87:	learn: 0.2915312	total: 1.09s	remaining: 11.3s
88:	learn: 0.2913851	total: 1.1s	remaining: 11.2s
89:	learn: 0.2913008	total: 1.1s	remaining: 11.2s
90:	learn: 0.2911188	total: 1.12s	remaining: 11.1s
91:	learn: 0.2909645	total: 1.13s	remaining: 11.1s
92:	learn: 0.2908332	total: 1.14s	remaining: 11.1s
93:	learn: 0.2907000	total: 1.15s	remaining: 11.1s
94:	learn: 0.2905329	total: 1.16s	remaining: 11s
95:	learn: 0.2903614	total: 1.17s	remaining: 11s
96:	learn: 0.2902783	total: 1.18s	remaining: 11s
97:	learn: 0.2901841	total: 1.19s	remaining: 10.9s
98:	learn: 0.2900604	total: 1.2s	remaining: 10.9s
99:	learn: 0.2899196	total: 1.21s	remaining: 10.9s
100:	learn: 0.2898066	total: 1.22s	remaining: 10.8s
101:	learn: 0.2896983	total: 1.23s	remaining: 10.8s
102:	learn: 0.2895330	total: 1.24s	remaining: 10.8s
103:	learn: 0.2894568	total: 1.25s	remaining: 10.8s
104:	learn: 0.2893581	total: 1.26s	remaining: 10.7s
105:	learn: 0.2892512	total: 1.27s	remaining: 10.7s
106:	learn: 0.2891725	total: 1.28s	remaining: 10.7s
107:	learn: 0.2890023	total: 1.29s	remaining: 10.7s
108:	learn: 0.2888655	total: 1.3s	remaining: 10.6s
109:	learn: 0.2887879	total: 1.31s	remaining: 10.6s
110:	learn: 0.2886617	total: 1.32s	remaining: 10.6s
111:	learn: 0.2885967	total: 1.33s	remaining: 10.6s
112:	learn: 0.2884889	total: 1.34s	remaining: 10.5s
113:	learn: 0.2884505	total: 1.35s	remaining: 10.5s
114:	learn: 0.2883678	total: 1.36s	remaining: 10.5s
115:	learn: 0.2882465	total: 1.37s	remaining: 10.5s
116:	learn: 0.2881861	total: 1.38s	remaining: 10.4s
117:	learn: 0.2880899	total: 1.39s	remaining: 10.4s
118:	learn: 0.2879922	total: 1.4s	remaining: 10.4s
119:	learn: 0.2878760	total: 1.41s	remaining: 10.4s
120:	learn: 0.2877662	total: 1.42s	remaining: 10.3s
121:	learn: 0.2876426	total: 1.43s	remaining: 10.3s
122:	learn: 0.2875710	total: 1.44s	remaining: 10.3s
123:	learn: 0.2874606	total: 1.45s	remaining: 10.3s
124:	learn: 0.2873281	total: 1.46s	remaining: 10.3s
125:	learn: 0.2872345	total: 1.47s	remaining: 10.2s
126:	learn: 0.2871663	total: 1.48s	remaining: 10.2s
127:	learn: 0.2871248	total: 1.49s	remaining: 10.2s
128:	learn: 0.2869922	total: 1.5s	remaining: 10.2s
129:	learn: 0.2869569	total: 1.51s	remaining: 10.1s
130:	learn: 0.2868620	total: 1.52s	remaining: 10.1s
131:	learn: 0.2867222	total: 1.53s	remaining: 10.1s
132:	learn: 0.2865885	total: 1.54s	remaining: 10.1s
133:	learn: 0.2864392	total: 1.55s	remaining: 10s
134:	learn: 0.2863917	total: 1.56s	remaining: 10s
135:	learn: 0.2862856	total: 1.58s	remaining: 10s
136:	learn: 0.2861875	total: 1.59s	remaining: 9.99s
137:	learn: 0.2860779	total: 1.6s	remaining: 9.97s
138:	learn: 0.2860052	total: 1.61s	remaining: 9.95s
139:	learn: 0.2859118	total: 1.62s	remaining: 9.93s
140:	learn: 0.2857881	total: 1.63s	remaining: 9.91s
141:	learn: 0.2856545	total: 1.64s	remaining: 9.89s
142:	learn: 0.2856006	total: 1.65s	remaining: 9.88s
143:	learn: 0.2855086	total: 1.66s	remaining: 9.86s
144:	learn: 0.2854194	total: 1.67s	remaining: 9.84s
145:	learn: 0.2852908	total: 1.68s	remaining: 9.82s
146:	learn: 0.2851601	total: 1.69s	remaining: 9.8s
147:	learn: 0.2850771	total: 1.7s	remaining: 9.78s
148:	learn: 0.2849989	total: 1.71s	remaining: 9.77s
149:	learn: 0.2849520	total: 1.72s	remaining: 9.75s
150:	learn: 0.2848739	total: 1.73s	remaining: 9.73s
151:	learn: 0.2847605	total: 1.74s	remaining: 9.71s
152:	learn: 0.2846300	total: 1.75s	remaining: 9.7s
153:	learn: 0.2845756	total: 1.76s	remaining: 9.69s
154:	learn: 0.2845022	total: 1.77s	remaining: 9.67s
155:	learn: 0.2843873	total: 1.78s	remaining: 9.65s
156:	learn: 0.2842985	total: 1.79s	remaining: 9.64s
157:	learn: 0.2842252	total: 1.8s	remaining: 9.62s
158:	learn: 0.2841338	total: 1.81s	remaining: 9.6s
159:	learn: 0.2840497	total: 1.82s	remaining: 9.59s
160:	learn: 0.2839665	total: 1.83s	remaining: 9.57s
161:	learn: 0.2838726	total: 1.85s	remaining: 9.55s
162:	learn: 0.2838139	total: 1.86s	remaining: 9.53s
163:	learn: 0.2837195	total: 1.87s	remaining: 9.51s
164:	learn: 0.2836880	total: 1.88s	remaining: 9.5s
165:	learn: 0.2835797	total: 1.89s	remaining: 9.49s
166:	learn: 0.2834871	total: 1.9s	remaining: 9.48s
167:	learn: 0.2833778	total: 1.91s	remaining: 9.46s
168:	learn: 0.2833025	total: 1.92s	remaining: 9.44s
169:	learn: 0.2832046	total: 1.93s	remaining: 9.43s
170:	learn: 0.2831728	total: 1.94s	remaining: 9.41s
171:	learn: 0.2831108	total: 1.95s	remaining: 9.39s
172:	learn: 0.2830315	total: 1.96s	remaining: 9.37s
173:	learn: 0.2829546	total: 1.97s	remaining: 9.36s
174:	learn: 0.2828789	total: 1.98s	remaining: 9.34s
175:	learn: 0.2828315	total: 1.99s	remaining: 9.33s
176:	learn: 0.2827421	total: 2s	remaining: 9.31s
177:	learn: 0.2826795	total: 2.01s	remaining: 9.3s
178:	learn: 0.2826192	total: 2.02s	remaining: 9.28s
179:	learn: 0.2825590	total: 2.03s	remaining: 9.27s
180:	learn: 0.2824883	total: 2.04s	remaining: 9.25s
181:	learn: 0.2823551	total: 2.05s	remaining: 9.23s
182:	learn: 0.2822520	total: 2.06s	remaining: 9.21s
183:	learn: 0.2822232	total: 2.07s	remaining: 9.2s
184:	learn: 0.2821278	total: 2.08s	remaining: 9.18s
185:	learn: 0.2820890	total: 2.09s	remaining: 9.16s
186:	learn: 0.2820291	total: 2.1s	remaining: 9.15s
187:	learn: 0.2819858	total: 2.11s	remaining: 9.13s
188:	learn: 0.2818821	total: 2.12s	remaining: 9.12s
189:	learn: 0.2818185	total: 2.13s	remaining: 9.1s
190:	learn: 0.2817707	total: 2.15s	remaining: 9.09s
191:	learn: 0.2816442	total: 2.15s	remaining: 9.07s
192:	learn: 0.2815585	total: 2.17s	remaining: 9.05s
193:	learn: 0.2814689	total: 2.17s	remaining: 9.04s
194:	learn: 0.2813915	total: 2.19s	remaining: 9.02s
195:	learn: 0.2813089	total: 2.2s	remaining: 9.01s
196:	learn: 0.2812648	total: 2.21s	remaining: 9s
197:	learn: 0.2812097	total: 2.22s	remaining: 8.98s
198:	learn: 0.2811095	total: 2.23s	remaining: 8.97s
199:	learn: 0.2810071	total: 2.24s	remaining: 8.95s
200:	learn: 0.2809455	total: 2.25s	remaining: 8.94s
201:	learn: 0.2808918	total: 2.26s	remaining: 8.92s
202:	learn: 0.2808499	total: 2.27s	remaining: 8.91s
203:	learn: 0.2807782	total: 2.28s	remaining: 8.89s
204:	learn: 0.2807011	total: 2.29s	remaining: 8.87s
205:	learn: 0.2806479	total: 2.3s	remaining: 8.86s
206:	learn: 0.2805691	total: 2.31s	remaining: 8.84s
207:	learn: 0.2805118	total: 2.32s	remaining: 8.83s
208:	learn: 0.2804519	total: 2.33s	remaining: 8.81s
209:	learn: 0.2803603	total: 2.34s	remaining: 8.8s
210:	learn: 0.2803204	total: 2.35s	remaining: 8.79s
211:	learn: 0.2802973	total: 2.36s	remaining: 8.78s
212:	learn: 0.2802234	total: 2.37s	remaining: 8.76s
213:	learn: 0.2801729	total: 2.38s	remaining: 8.75s
214:	learn: 0.2800799	total: 2.4s	remaining: 8.75s
215:	learn: 0.2800321	total: 2.4s	remaining: 8.73s
216:	learn: 0.2799679	total: 2.42s	remaining: 8.72s
217:	learn: 0.2798920	total: 2.43s	remaining: 8.7s
218:	learn: 0.2798309	total: 2.44s	remaining: 8.69s
219:	learn: 0.2797840	total: 2.45s	remaining: 8.67s
220:	learn: 0.2797317	total: 2.46s	remaining: 8.66s
221:	learn: 0.2796186	total: 2.46s	remaining: 8.64s
222:	learn: 0.2795515	total: 2.48s	remaining: 8.63s
223:	learn: 0.2794481	total: 2.48s	remaining: 8.61s
224:	learn: 0.2793410	total: 2.5s	remaining: 8.6s
225:	learn: 0.2793285	total: 2.51s	remaining: 8.58s
226:	learn: 0.2792705	total: 2.52s	remaining: 8.57s
227:	learn: 0.2791844	total: 2.53s	remaining: 8.56s
228:	learn: 0.2791196	total: 2.54s	remaining: 8.55s
229:	learn: 0.2790638	total: 2.55s	remaining: 8.53s
230:	learn: 0.2790156	total: 2.56s	remaining: 8.52s
231:	learn: 0.2789583	total: 2.57s	remaining: 8.51s
232:	learn: 0.2789172	total: 2.58s	remaining: 8.49s
233:	learn: 0.2788020	total: 2.59s	remaining: 8.48s
234:	learn: 0.2786857	total: 2.6s	remaining: 8.47s
235:	learn: 0.2786154	total: 2.61s	remaining: 8.45s
236:	learn: 0.2785356	total: 2.62s	remaining: 8.44s
237:	learn: 0.2784711	total: 2.63s	remaining: 8.43s
238:	learn: 0.2784083	total: 2.64s	remaining: 8.41s
239:	learn: 0.2783345	total: 2.65s	remaining: 8.4s
240:	learn: 0.2782378	total: 2.66s	remaining: 8.39s
241:	learn: 0.2781785	total: 2.67s	remaining: 8.38s
242:	learn: 0.2781165	total: 2.69s	remaining: 8.37s
243:	learn: 0.2780262	total: 2.69s	remaining: 8.35s
244:	learn: 0.2779802	total: 2.71s	remaining: 8.34s
245:	learn: 0.2779262	total: 2.72s	remaining: 8.33s
246:	learn: 0.2778767	total: 2.73s	remaining: 8.32s
247:	learn: 0.2777978	total: 2.74s	remaining: 8.3s
248:	learn: 0.2777641	total: 2.75s	remaining: 8.29s
249:	learn: 0.2776940	total: 2.76s	remaining: 8.28s
250:	learn: 0.2776211	total: 2.77s	remaining: 8.26s
251:	learn: 0.2775328	total: 2.78s	remaining: 8.25s
252:	learn: 0.2774423	total: 2.79s	remaining: 8.23s
253:	learn: 0.2773939	total: 2.8s	remaining: 8.22s
254:	learn: 0.2773498	total: 2.81s	remaining: 8.21s
255:	learn: 0.2772849	total: 2.82s	remaining: 8.19s
256:	learn: 0.2772269	total: 2.83s	remaining: 8.18s
257:	learn: 0.2771974	total: 2.84s	remaining: 8.17s
258:	learn: 0.2771746	total: 2.85s	remaining: 8.15s
259:	learn: 0.2771222	total: 2.86s	remaining: 8.14s
260:	learn: 0.2770377	total: 2.87s	remaining: 8.13s
261:	learn: 0.2769416	total: 2.88s	remaining: 8.12s
262:	learn: 0.2768956	total: 2.89s	remaining: 8.1s
263:	learn: 0.2768664	total: 2.9s	remaining: 8.09s
264:	learn: 0.2768214	total: 2.91s	remaining: 8.07s
265:	learn: 0.2767820	total: 2.92s	remaining: 8.06s
266:	learn: 0.2767090	total: 2.93s	remaining: 8.05s
267:	learn: 0.2766557	total: 2.94s	remaining: 8.03s
268:	learn: 0.2766125	total: 2.95s	remaining: 8.02s
269:	learn: 0.2765749	total: 2.96s	remaining: 8.01s
270:	learn: 0.2764701	total: 2.97s	remaining: 7.99s
271:	learn: 0.2764043	total: 2.98s	remaining: 7.98s
272:	learn: 0.2763528	total: 2.99s	remaining: 7.97s
273:	learn: 0.2762768	total: 3s	remaining: 7.96s
274:	learn: 0.2761873	total: 3.01s	remaining: 7.94s
275:	learn: 0.2761229	total: 3.02s	remaining: 7.93s
276:	learn: 0.2760574	total: 3.03s	remaining: 7.92s
277:	learn: 0.2760174	total: 3.04s	remaining: 7.9s
278:	learn: 0.2759449	total: 3.05s	remaining: 7.89s
279:	learn: 0.2758500	total: 3.06s	remaining: 7.88s
280:	learn: 0.2757974	total: 3.07s	remaining: 7.86s
281:	learn: 0.2757235	total: 3.08s	remaining: 7.85s
282:	learn: 0.2756207	total: 3.09s	remaining: 7.84s
283:	learn: 0.2755196	total: 3.1s	remaining: 7.83s
284:	learn: 0.2754697	total: 3.11s	remaining: 7.81s
285:	learn: 0.2753798	total: 3.13s	remaining: 7.81s
286:	learn: 0.2753182	total: 3.14s	remaining: 7.8s
287:	learn: 0.2752601	total: 3.15s	remaining: 7.79s
288:	learn: 0.2752347	total: 3.19s	remaining: 7.85s
289:	learn: 0.2751436	total: 3.21s	remaining: 7.86s
290:	learn: 0.2751111	total: 3.23s	remaining: 7.86s
291:	learn: 0.2750813	total: 3.24s	remaining: 7.86s
292:	learn: 0.2750298	total: 3.25s	remaining: 7.85s
293:	learn: 0.2749561	total: 3.27s	remaining: 7.85s
294:	learn: 0.2748231	total: 3.29s	remaining: 7.85s
295:	learn: 0.2747389	total: 3.3s	remaining: 7.84s
296:	learn: 0.2746465	total: 3.31s	remaining: 7.83s
297:	learn: 0.2745501	total: 3.33s	remaining: 7.84s
298:	learn: 0.2744973	total: 3.34s	remaining: 7.83s
299:	learn: 0.2744063	total: 3.35s	remaining: 7.82s
300:	learn: 0.2743319	total: 3.38s	remaining: 7.85s
301:	learn: 0.2742787	total: 3.41s	remaining: 7.88s
302:	learn: 0.2742490	total: 3.42s	remaining: 7.87s
303:	learn: 0.2741545	total: 3.45s	remaining: 7.91s
304:	learn: 0.2740760	total: 3.47s	remaining: 7.9s
305:	learn: 0.2739930	total: 3.49s	remaining: 7.91s
306:	learn: 0.2738736	total: 3.51s	remaining: 7.92s
307:	learn: 0.2738009	total: 3.53s	remaining: 7.92s
308:	learn: 0.2737452	total: 3.56s	remaining: 7.95s
309:	learn: 0.2736468	total: 3.57s	remaining: 7.94s
310:	learn: 0.2735886	total: 3.59s	remaining: 7.94s
311:	learn: 0.2735038	total: 3.6s	remaining: 7.94s
312:	learn: 0.2734433	total: 3.61s	remaining: 7.93s
313:	learn: 0.2733827	total: 3.63s	remaining: 7.92s
314:	learn: 0.2733055	total: 3.64s	remaining: 7.92s
315:	learn: 0.2732765	total: 3.65s	remaining: 7.91s
316:	learn: 0.2731883	total: 3.67s	remaining: 7.91s
317:	learn: 0.2731250	total: 3.69s	remaining: 7.9s
318:	learn: 0.2730743	total: 3.7s	remaining: 7.89s
319:	learn: 0.2729531	total: 3.71s	remaining: 7.89s
320:	learn: 0.2728173	total: 3.73s	remaining: 7.88s
321:	learn: 0.2727435	total: 3.74s	remaining: 7.87s
322:	learn: 0.2726552	total: 3.75s	remaining: 7.86s
323:	learn: 0.2726094	total: 3.76s	remaining: 7.85s
324:	learn: 0.2724731	total: 3.78s	remaining: 7.85s
325:	learn: 0.2723887	total: 3.8s	remaining: 7.85s
326:	learn: 0.2722916	total: 3.82s	remaining: 7.85s
327:	learn: 0.2721956	total: 3.83s	remaining: 7.84s
328:	learn: 0.2721003	total: 3.84s	remaining: 7.84s
329:	learn: 0.2720351	total: 3.86s	remaining: 7.83s
330:	learn: 0.2719800	total: 3.87s	remaining: 7.82s
331:	learn: 0.2719023	total: 3.88s	remaining: 7.81s
332:	learn: 0.2718611	total: 3.89s	remaining: 7.79s
333:	learn: 0.2717589	total: 3.9s	remaining: 7.78s
334:	learn: 0.2716639	total: 3.91s	remaining: 7.76s
335:	learn: 0.2715714	total: 3.92s	remaining: 7.75s
336:	learn: 0.2714715	total: 3.93s	remaining: 7.73s
337:	learn: 0.2713461	total: 3.94s	remaining: 7.72s
338:	learn: 0.2713070	total: 3.95s	remaining: 7.7s
339:	learn: 0.2712323	total: 3.96s	remaining: 7.69s
340:	learn: 0.2711861	total: 3.97s	remaining: 7.67s
341:	learn: 0.2711118	total: 3.98s	remaining: 7.66s
342:	learn: 0.2709987	total: 3.99s	remaining: 7.64s
343:	learn: 0.2709389	total: 4s	remaining: 7.63s
344:	learn: 0.2708446	total: 4.01s	remaining: 7.62s
345:	learn: 0.2707362	total: 4.02s	remaining: 7.6s
346:	learn: 0.2705974	total: 4.03s	remaining: 7.59s
347:	learn: 0.2705436	total: 4.04s	remaining: 7.57s
348:	learn: 0.2704689	total: 4.05s	remaining: 7.56s
349:	learn: 0.2703267	total: 4.06s	remaining: 7.54s
350:	learn: 0.2702359	total: 4.07s	remaining: 7.53s
351:	learn: 0.2701215	total: 4.08s	remaining: 7.51s
352:	learn: 0.2700593	total: 4.09s	remaining: 7.5s
353:	learn: 0.2699553	total: 4.1s	remaining: 7.48s
354:	learn: 0.2698852	total: 4.11s	remaining: 7.47s
355:	learn: 0.2697563	total: 4.12s	remaining: 7.46s
356:	learn: 0.2696489	total: 4.13s	remaining: 7.44s
357:	learn: 0.2695817	total: 4.14s	remaining: 7.43s
358:	learn: 0.2694854	total: 4.15s	remaining: 7.41s
359:	learn: 0.2693877	total: 4.16s	remaining: 7.4s
360:	learn: 0.2693221	total: 4.17s	remaining: 7.39s
361:	learn: 0.2692370	total: 4.18s	remaining: 7.37s
362:	learn: 0.2691356	total: 4.19s	remaining: 7.36s
363:	learn: 0.2690310	total: 4.2s	remaining: 7.34s
364:	learn: 0.2689507	total: 4.21s	remaining: 7.33s
365:	learn: 0.2689135	total: 4.22s	remaining: 7.32s
366:	learn: 0.2688449	total: 4.23s	remaining: 7.3s
367:	learn: 0.2687514	total: 4.24s	remaining: 7.29s
368:	learn: 0.2686777	total: 4.25s	remaining: 7.27s
369:	learn: 0.2686097	total: 4.26s	remaining: 7.26s
370:	learn: 0.2685026	total: 4.27s	remaining: 7.25s
371:	learn: 0.2684075	total: 4.28s	remaining: 7.23s
372:	learn: 0.2683634	total: 4.29s	remaining: 7.22s
373:	learn: 0.2683063	total: 4.3s	remaining: 7.2s
374:	learn: 0.2681883	total: 4.31s	remaining: 7.19s
375:	learn: 0.2681251	total: 4.32s	remaining: 7.18s
376:	learn: 0.2680450	total: 4.33s	remaining: 7.16s
377:	learn: 0.2679567	total: 4.34s	remaining: 7.15s
378:	learn: 0.2678762	total: 4.36s	remaining: 7.14s
379:	learn: 0.2678161	total: 4.37s	remaining: 7.12s
380:	learn: 0.2677278	total: 4.38s	remaining: 7.11s
381:	learn: 0.2676240	total: 4.38s	remaining: 7.09s
382:	learn: 0.2675241	total: 4.39s	remaining: 7.08s
383:	learn: 0.2674693	total: 4.41s	remaining: 7.07s
384:	learn: 0.2673802	total: 4.42s	remaining: 7.05s
385:	learn: 0.2672818	total: 4.43s	remaining: 7.04s
386:	learn: 0.2672292	total: 4.44s	remaining: 7.03s
387:	learn: 0.2671287	total: 4.46s	remaining: 7.03s
388:	learn: 0.2670732	total: 4.48s	remaining: 7.04s
389:	learn: 0.2669610	total: 4.49s	remaining: 7.03s
390:	learn: 0.2669148	total: 4.51s	remaining: 7.02s
391:	learn: 0.2668534	total: 4.52s	remaining: 7.01s
392:	learn: 0.2667247	total: 4.53s	remaining: 6.99s
393:	learn: 0.2666686	total: 4.54s	remaining: 6.99s
394:	learn: 0.2666067	total: 4.55s	remaining: 6.97s
395:	learn: 0.2664942	total: 4.57s	remaining: 6.96s
396:	learn: 0.2663896	total: 4.58s	remaining: 6.95s
397:	learn: 0.2662961	total: 4.59s	remaining: 6.95s
398:	learn: 0.2662607	total: 4.6s	remaining: 6.93s
399:	learn: 0.2662104	total: 4.62s	remaining: 6.93s
400:	learn: 0.2661159	total: 4.63s	remaining: 6.92s
401:	learn: 0.2660636	total: 4.64s	remaining: 6.9s
402:	learn: 0.2660299	total: 4.66s	remaining: 6.9s
403:	learn: 0.2659801	total: 4.67s	remaining: 6.88s
404:	learn: 0.2658429	total: 4.68s	remaining: 6.87s
405:	learn: 0.2657499	total: 4.69s	remaining: 6.87s
406:	learn: 0.2656412	total: 4.7s	remaining: 6.85s
407:	learn: 0.2655546	total: 4.71s	remaining: 6.84s
408:	learn: 0.2654769	total: 4.73s	remaining: 6.83s
409:	learn: 0.2654008	total: 4.74s	remaining: 6.82s
410:	learn: 0.2653051	total: 4.75s	remaining: 6.81s
411:	learn: 0.2652317	total: 4.77s	remaining: 6.81s
412:	learn: 0.2651745	total: 4.78s	remaining: 6.8s
413:	learn: 0.2650888	total: 4.79s	remaining: 6.78s
414:	learn: 0.2650148	total: 4.81s	remaining: 6.78s
415:	learn: 0.2649780	total: 4.82s	remaining: 6.76s
416:	learn: 0.2648771	total: 4.83s	remaining: 6.75s
417:	learn: 0.2648072	total: 4.84s	remaining: 6.75s
418:	learn: 0.2647501	total: 4.86s	remaining: 6.73s
419:	learn: 0.2646669	total: 4.87s	remaining: 6.72s
420:	learn: 0.2645962	total: 4.88s	remaining: 6.71s
421:	learn: 0.2645054	total: 4.89s	remaining: 6.7s
422:	learn: 0.2644271	total: 4.91s	remaining: 6.69s
423:	learn: 0.2643290	total: 4.92s	remaining: 6.68s
424:	learn: 0.2642539	total: 4.93s	remaining: 6.67s
425:	learn: 0.2641800	total: 4.94s	remaining: 6.66s
426:	learn: 0.2641258	total: 4.96s	remaining: 6.65s
427:	learn: 0.2640642	total: 4.97s	remaining: 6.64s
428:	learn: 0.2639919	total: 4.98s	remaining: 6.63s
429:	learn: 0.2639212	total: 4.99s	remaining: 6.62s
430:	learn: 0.2638397	total: 5s	remaining: 6.61s
431:	learn: 0.2637336	total: 5.01s	remaining: 6.59s
432:	learn: 0.2636712	total: 5.03s	remaining: 6.58s
433:	learn: 0.2636117	total: 5.04s	remaining: 6.57s
434:	learn: 0.2635371	total: 5.05s	remaining: 6.56s
435:	learn: 0.2634693	total: 5.07s	remaining: 6.55s
436:	learn: 0.2634112	total: 5.08s	remaining: 6.54s
437:	learn: 0.2633422	total: 5.09s	remaining: 6.53s
438:	learn: 0.2632465	total: 5.1s	remaining: 6.52s
439:	learn: 0.2631880	total: 5.11s	remaining: 6.5s
440:	learn: 0.2630867	total: 5.12s	remaining: 6.49s
441:	learn: 0.2630325	total: 5.13s	remaining: 6.48s
442:	learn: 0.2629537	total: 5.14s	remaining: 6.46s
443:	learn: 0.2628880	total: 5.15s	remaining: 6.45s
444:	learn: 0.2627911	total: 5.16s	remaining: 6.44s
445:	learn: 0.2627196	total: 5.17s	remaining: 6.42s
446:	learn: 0.2626331	total: 5.18s	remaining: 6.41s
447:	learn: 0.2625598	total: 5.19s	remaining: 6.4s
448:	learn: 0.2625181	total: 5.2s	remaining: 6.38s
449:	learn: 0.2624678	total: 5.21s	remaining: 6.37s
450:	learn: 0.2624203	total: 5.22s	remaining: 6.36s
451:	learn: 0.2623191	total: 5.23s	remaining: 6.34s
452:	learn: 0.2622706	total: 5.24s	remaining: 6.33s
453:	learn: 0.2622491	total: 5.25s	remaining: 6.32s
454:	learn: 0.2621864	total: 5.26s	remaining: 6.31s
455:	learn: 0.2620988	total: 5.28s	remaining: 6.29s
456:	learn: 0.2620646	total: 5.28s	remaining: 6.28s
457:	learn: 0.2619948	total: 5.29s	remaining: 6.27s
458:	learn: 0.2619249	total: 5.3s	remaining: 6.25s
459:	learn: 0.2618210	total: 5.32s	remaining: 6.24s
460:	learn: 0.2617321	total: 5.33s	remaining: 6.23s
461:	learn: 0.2617083	total: 5.33s	remaining: 6.21s
462:	learn: 0.2616606	total: 5.34s	remaining: 6.2s
463:	learn: 0.2615494	total: 5.36s	remaining: 6.19s
464:	learn: 0.2614655	total: 5.37s	remaining: 6.17s
465:	learn: 0.2614212	total: 5.38s	remaining: 6.16s
466:	learn: 0.2613408	total: 5.39s	remaining: 6.15s
467:	learn: 0.2612085	total: 5.4s	remaining: 6.13s
468:	learn: 0.2611363	total: 5.41s	remaining: 6.12s
469:	learn: 0.2610670	total: 5.42s	remaining: 6.11s
470:	learn: 0.2610058	total: 5.43s	remaining: 6.1s
471:	learn: 0.2609420	total: 5.44s	remaining: 6.08s
472:	learn: 0.2608606	total: 5.45s	remaining: 6.07s
473:	learn: 0.2607809	total: 5.46s	remaining: 6.06s
474:	learn: 0.2607170	total: 5.47s	remaining: 6.04s
475:	learn: 0.2606370	total: 5.48s	remaining: 6.03s
476:	learn: 0.2605836	total: 5.49s	remaining: 6.02s
477:	learn: 0.2605078	total: 5.5s	remaining: 6s
478:	learn: 0.2604211	total: 5.51s	remaining: 5.99s
479:	learn: 0.2603521	total: 5.52s	remaining: 5.98s
480:	learn: 0.2602378	total: 5.53s	remaining: 5.97s
481:	learn: 0.2601742	total: 5.54s	remaining: 5.95s
482:	learn: 0.2600778	total: 5.55s	remaining: 5.94s
483:	learn: 0.2600168	total: 5.56s	remaining: 5.93s
484:	learn: 0.2599015	total: 5.57s	remaining: 5.92s
485:	learn: 0.2598203	total: 5.58s	remaining: 5.9s
486:	learn: 0.2597679	total: 5.59s	remaining: 5.89s
487:	learn: 0.2597031	total: 5.6s	remaining: 5.88s
488:	learn: 0.2596188	total: 5.61s	remaining: 5.87s
489:	learn: 0.2595655	total: 5.62s	remaining: 5.85s
490:	learn: 0.2594833	total: 5.63s	remaining: 5.84s
491:	learn: 0.2594163	total: 5.64s	remaining: 5.83s
492:	learn: 0.2593090	total: 5.65s	remaining: 5.81s
493:	learn: 0.2591877	total: 5.66s	remaining: 5.8s
494:	learn: 0.2591102	total: 5.67s	remaining: 5.79s
495:	learn: 0.2590768	total: 5.68s	remaining: 5.78s
496:	learn: 0.2590176	total: 5.69s	remaining: 5.76s
497:	learn: 0.2589811	total: 5.7s	remaining: 5.75s
498:	learn: 0.2589229	total: 5.71s	remaining: 5.74s
499:	learn: 0.2588482	total: 5.72s	remaining: 5.72s
500:	learn: 0.2587619	total: 5.73s	remaining: 5.71s
501:	learn: 0.2587005	total: 5.74s	remaining: 5.7s
502:	learn: 0.2586523	total: 5.75s	remaining: 5.69s
503:	learn: 0.2585534	total: 5.76s	remaining: 5.67s
504:	learn: 0.2585043	total: 5.77s	remaining: 5.66s
505:	learn: 0.2583977	total: 5.79s	remaining: 5.65s
506:	learn: 0.2583434	total: 5.8s	remaining: 5.64s
507:	learn: 0.2582804	total: 5.81s	remaining: 5.62s
508:	learn: 0.2582530	total: 5.82s	remaining: 5.61s
509:	learn: 0.2581504	total: 5.83s	remaining: 5.6s
510:	learn: 0.2580450	total: 5.84s	remaining: 5.58s
511:	learn: 0.2580145	total: 5.84s	remaining: 5.57s
512:	learn: 0.2579379	total: 5.86s	remaining: 5.56s
513:	learn: 0.2578453	total: 5.87s	remaining: 5.55s
514:	learn: 0.2577691	total: 5.88s	remaining: 5.53s
515:	learn: 0.2576575	total: 5.89s	remaining: 5.52s
516:	learn: 0.2576367	total: 5.9s	remaining: 5.51s
517:	learn: 0.2575811	total: 5.91s	remaining: 5.5s
518:	learn: 0.2574846	total: 5.92s	remaining: 5.49s
519:	learn: 0.2573881	total: 5.93s	remaining: 5.47s
520:	learn: 0.2572966	total: 5.94s	remaining: 5.46s
521:	learn: 0.2572178	total: 5.95s	remaining: 5.45s
522:	learn: 0.2570972	total: 5.96s	remaining: 5.43s
523:	learn: 0.2570310	total: 5.97s	remaining: 5.42s
524:	learn: 0.2569905	total: 5.98s	remaining: 5.41s
525:	learn: 0.2569105	total: 5.99s	remaining: 5.4s
526:	learn: 0.2568173	total: 6s	remaining: 5.38s
527:	learn: 0.2567968	total: 6.01s	remaining: 5.37s
528:	learn: 0.2567715	total: 6.02s	remaining: 5.36s
529:	learn: 0.2567397	total: 6.03s	remaining: 5.35s
530:	learn: 0.2566849	total: 6.04s	remaining: 5.33s
531:	learn: 0.2565970	total: 6.05s	remaining: 5.32s
532:	learn: 0.2565193	total: 6.06s	remaining: 5.31s
533:	learn: 0.2564888	total: 6.07s	remaining: 5.3s
534:	learn: 0.2564140	total: 6.08s	remaining: 5.29s
535:	learn: 0.2563300	total: 6.09s	remaining: 5.27s
536:	learn: 0.2563009	total: 6.1s	remaining: 5.26s
537:	learn: 0.2562264	total: 6.11s	remaining: 5.25s
538:	learn: 0.2561800	total: 6.12s	remaining: 5.23s
539:	learn: 0.2561214	total: 6.13s	remaining: 5.22s
540:	learn: 0.2560114	total: 6.14s	remaining: 5.21s
541:	learn: 0.2559446	total: 6.15s	remaining: 5.2s
542:	learn: 0.2558699	total: 6.16s	remaining: 5.18s
543:	learn: 0.2558173	total: 6.17s	remaining: 5.17s
544:	learn: 0.2557425	total: 6.18s	remaining: 5.16s
545:	learn: 0.2556341	total: 6.19s	remaining: 5.15s
546:	learn: 0.2555371	total: 6.2s	remaining: 5.14s
547:	learn: 0.2554516	total: 6.21s	remaining: 5.13s
548:	learn: 0.2553930	total: 6.22s	remaining: 5.11s
549:	learn: 0.2553566	total: 6.23s	remaining: 5.1s
550:	learn: 0.2552868	total: 6.24s	remaining: 5.09s
551:	learn: 0.2552378	total: 6.25s	remaining: 5.08s
552:	learn: 0.2551559	total: 6.26s	remaining: 5.06s
553:	learn: 0.2551206	total: 6.27s	remaining: 5.05s
554:	learn: 0.2550338	total: 6.28s	remaining: 5.04s
555:	learn: 0.2549960	total: 6.29s	remaining: 5.03s
556:	learn: 0.2549285	total: 6.3s	remaining: 5.01s
557:	learn: 0.2548629	total: 6.31s	remaining: 5s
558:	learn: 0.2548335	total: 6.32s	remaining: 4.99s
559:	learn: 0.2548004	total: 6.33s	remaining: 4.98s
560:	learn: 0.2547354	total: 6.34s	remaining: 4.96s
561:	learn: 0.2546699	total: 6.36s	remaining: 4.95s
562:	learn: 0.2546267	total: 6.37s	remaining: 4.94s
563:	learn: 0.2545399	total: 6.38s	remaining: 4.93s
564:	learn: 0.2544427	total: 6.39s	remaining: 4.92s
565:	learn: 0.2543756	total: 6.39s	remaining: 4.9s
566:	learn: 0.2543440	total: 6.41s	remaining: 4.89s
567:	learn: 0.2542989	total: 6.42s	remaining: 4.88s
568:	learn: 0.2542220	total: 6.42s	remaining: 4.87s
569:	learn: 0.2541484	total: 6.43s	remaining: 4.86s
570:	learn: 0.2541210	total: 6.45s	remaining: 4.84s
571:	learn: 0.2540291	total: 6.46s	remaining: 4.83s
572:	learn: 0.2539237	total: 6.46s	remaining: 4.82s
573:	learn: 0.2538797	total: 6.47s	remaining: 4.8s
574:	learn: 0.2538540	total: 6.49s	remaining: 4.79s
575:	learn: 0.2537614	total: 6.5s	remaining: 4.78s
576:	learn: 0.2537221	total: 6.51s	remaining: 4.77s
577:	learn: 0.2536289	total: 6.52s	remaining: 4.76s
578:	learn: 0.2535573	total: 6.53s	remaining: 4.75s
579:	learn: 0.2535327	total: 6.54s	remaining: 4.73s
580:	learn: 0.2534666	total: 6.55s	remaining: 4.72s
581:	learn: 0.2533584	total: 6.56s	remaining: 4.71s
582:	learn: 0.2532842	total: 6.57s	remaining: 4.7s
583:	learn: 0.2532589	total: 6.58s	remaining: 4.69s
584:	learn: 0.2531767	total: 6.59s	remaining: 4.67s
585:	learn: 0.2530811	total: 6.6s	remaining: 4.66s
586:	learn: 0.2530098	total: 6.61s	remaining: 4.65s
587:	learn: 0.2529357	total: 6.62s	remaining: 4.64s
588:	learn: 0.2528672	total: 6.63s	remaining: 4.63s
589:	learn: 0.2527723	total: 6.64s	remaining: 4.61s
590:	learn: 0.2527545	total: 6.65s	remaining: 4.6s
591:	learn: 0.2526495	total: 6.66s	remaining: 4.59s
592:	learn: 0.2525622	total: 6.67s	remaining: 4.58s
593:	learn: 0.2524970	total: 6.68s	remaining: 4.57s
594:	learn: 0.2524083	total: 6.69s	remaining: 4.55s
595:	learn: 0.2523236	total: 6.7s	remaining: 4.54s
596:	learn: 0.2522430	total: 6.71s	remaining: 4.53s
597:	learn: 0.2521921	total: 6.72s	remaining: 4.52s
598:	learn: 0.2521167	total: 6.73s	remaining: 4.51s
599:	learn: 0.2520423	total: 6.74s	remaining: 4.5s
600:	learn: 0.2519682	total: 6.75s	remaining: 4.48s
601:	learn: 0.2519039	total: 6.76s	remaining: 4.47s
602:	learn: 0.2518223	total: 6.77s	remaining: 4.46s
603:	learn: 0.2517423	total: 6.78s	remaining: 4.45s
604:	learn: 0.2516274	total: 6.79s	remaining: 4.43s
605:	learn: 0.2515169	total: 6.8s	remaining: 4.42s
606:	learn: 0.2514941	total: 6.81s	remaining: 4.41s
607:	learn: 0.2514093	total: 6.82s	remaining: 4.4s
608:	learn: 0.2513535	total: 6.83s	remaining: 4.39s
609:	learn: 0.2513111	total: 6.84s	remaining: 4.38s
610:	learn: 0.2512082	total: 6.86s	remaining: 4.36s
611:	learn: 0.2511175	total: 6.87s	remaining: 4.36s
612:	learn: 0.2510593	total: 6.88s	remaining: 4.34s
613:	learn: 0.2510359	total: 6.89s	remaining: 4.33s
614:	learn: 0.2509776	total: 6.9s	remaining: 4.32s
615:	learn: 0.2508922	total: 6.91s	remaining: 4.31s
616:	learn: 0.2508689	total: 6.92s	remaining: 4.3s
617:	learn: 0.2508174	total: 6.93s	remaining: 4.28s
618:	learn: 0.2507622	total: 6.94s	remaining: 4.27s
619:	learn: 0.2507213	total: 6.95s	remaining: 4.26s
620:	learn: 0.2506889	total: 6.96s	remaining: 4.25s
621:	learn: 0.2505848	total: 6.97s	remaining: 4.24s
622:	learn: 0.2505150	total: 6.98s	remaining: 4.22s
623:	learn: 0.2504238	total: 6.99s	remaining: 4.21s
624:	learn: 0.2503833	total: 7s	remaining: 4.2s
625:	learn: 0.2503432	total: 7.01s	remaining: 4.19s
626:	learn: 0.2502625	total: 7.02s	remaining: 4.18s
627:	learn: 0.2501989	total: 7.03s	remaining: 4.17s
628:	learn: 0.2501152	total: 7.04s	remaining: 4.15s
629:	learn: 0.2500604	total: 7.05s	remaining: 4.14s
630:	learn: 0.2500048	total: 7.06s	remaining: 4.13s
631:	learn: 0.2499303	total: 7.07s	remaining: 4.12s
632:	learn: 0.2498915	total: 7.08s	remaining: 4.11s
633:	learn: 0.2497891	total: 7.09s	remaining: 4.09s
634:	learn: 0.2497623	total: 7.1s	remaining: 4.08s
635:	learn: 0.2496728	total: 7.11s	remaining: 4.07s
636:	learn: 0.2496053	total: 7.12s	remaining: 4.06s
637:	learn: 0.2495244	total: 7.13s	remaining: 4.05s
638:	learn: 0.2494591	total: 7.14s	remaining: 4.04s
639:	learn: 0.2493809	total: 7.16s	remaining: 4.03s
640:	learn: 0.2493072	total: 7.17s	remaining: 4.01s
641:	learn: 0.2492715	total: 7.18s	remaining: 4s
642:	learn: 0.2492119	total: 7.19s	remaining: 3.99s
643:	learn: 0.2491553	total: 7.2s	remaining: 3.98s
644:	learn: 0.2490586	total: 7.21s	remaining: 3.97s
645:	learn: 0.2489928	total: 7.22s	remaining: 3.96s
646:	learn: 0.2489260	total: 7.23s	remaining: 3.95s
647:	learn: 0.2488740	total: 7.25s	remaining: 3.94s
648:	learn: 0.2488205	total: 7.26s	remaining: 3.92s
649:	learn: 0.2487391	total: 7.27s	remaining: 3.92s
650:	learn: 0.2486720	total: 7.29s	remaining: 3.91s
651:	learn: 0.2486026	total: 7.3s	remaining: 3.9s
652:	learn: 0.2484925	total: 7.32s	remaining: 3.89s
653:	learn: 0.2484319	total: 7.33s	remaining: 3.88s
654:	learn: 0.2483410	total: 7.35s	remaining: 3.87s
655:	learn: 0.2482713	total: 7.36s	remaining: 3.86s
656:	learn: 0.2482234	total: 7.37s	remaining: 3.85s
657:	learn: 0.2481903	total: 7.38s	remaining: 3.84s
658:	learn: 0.2481115	total: 7.4s	remaining: 3.83s
659:	learn: 0.2480370	total: 7.42s	remaining: 3.82s
660:	learn: 0.2479856	total: 7.43s	remaining: 3.81s
661:	learn: 0.2479169	total: 7.44s	remaining: 3.8s
662:	learn: 0.2478633	total: 7.45s	remaining: 3.79s
663:	learn: 0.2478039	total: 7.47s	remaining: 3.78s
664:	learn: 0.2477864	total: 7.48s	remaining: 3.77s
665:	learn: 0.2477155	total: 7.49s	remaining: 3.76s
666:	learn: 0.2476154	total: 7.5s	remaining: 3.75s
667:	learn: 0.2475390	total: 7.51s	remaining: 3.73s
668:	learn: 0.2474461	total: 7.53s	remaining: 3.72s
669:	learn: 0.2474006	total: 7.54s	remaining: 3.71s
670:	learn: 0.2473277	total: 7.55s	remaining: 3.7s
671:	learn: 0.2473169	total: 7.56s	remaining: 3.69s
672:	learn: 0.2472624	total: 7.58s	remaining: 3.68s
673:	learn: 0.2472343	total: 7.59s	remaining: 3.67s
674:	learn: 0.2471717	total: 7.6s	remaining: 3.66s
675:	learn: 0.2471481	total: 7.61s	remaining: 3.65s
676:	learn: 0.2470965	total: 7.62s	remaining: 3.64s
677:	learn: 0.2470223	total: 7.64s	remaining: 3.63s
678:	learn: 0.2469909	total: 7.65s	remaining: 3.61s
679:	learn: 0.2469360	total: 7.66s	remaining: 3.6s
680:	learn: 0.2468814	total: 7.67s	remaining: 3.59s
681:	learn: 0.2468464	total: 7.68s	remaining: 3.58s
682:	learn: 0.2467420	total: 7.69s	remaining: 3.57s
683:	learn: 0.2466404	total: 7.7s	remaining: 3.56s
684:	learn: 0.2465895	total: 7.71s	remaining: 3.54s
685:	learn: 0.2465596	total: 7.72s	remaining: 3.53s
686:	learn: 0.2465101	total: 7.73s	remaining: 3.52s
687:	learn: 0.2464622	total: 7.74s	remaining: 3.51s
688:	learn: 0.2463877	total: 7.75s	remaining: 3.5s
689:	learn: 0.2463624	total: 7.76s	remaining: 3.49s
690:	learn: 0.2462588	total: 7.78s	remaining: 3.48s
691:	learn: 0.2461973	total: 7.79s	remaining: 3.47s
692:	learn: 0.2461345	total: 7.8s	remaining: 3.46s
693:	learn: 0.2460130	total: 7.82s	remaining: 3.45s
694:	learn: 0.2459568	total: 7.83s	remaining: 3.44s
695:	learn: 0.2459383	total: 7.84s	remaining: 3.43s
696:	learn: 0.2458615	total: 7.86s	remaining: 3.41s
697:	learn: 0.2457590	total: 7.87s	remaining: 3.4s
698:	learn: 0.2457144	total: 7.89s	remaining: 3.4s
699:	learn: 0.2456298	total: 7.9s	remaining: 3.38s
700:	learn: 0.2455578	total: 7.91s	remaining: 3.37s
701:	learn: 0.2454660	total: 7.93s	remaining: 3.37s
702:	learn: 0.2453867	total: 7.94s	remaining: 3.35s
703:	learn: 0.2453268	total: 7.95s	remaining: 3.34s
704:	learn: 0.2452968	total: 7.96s	remaining: 3.33s
705:	learn: 0.2452308	total: 7.98s	remaining: 3.32s
706:	learn: 0.2451790	total: 7.99s	remaining: 3.31s
707:	learn: 0.2451031	total: 8s	remaining: 3.3s
708:	learn: 0.2449957	total: 8.01s	remaining: 3.29s
709:	learn: 0.2449153	total: 8.02s	remaining: 3.28s
710:	learn: 0.2448696	total: 8.03s	remaining: 3.27s
711:	learn: 0.2448156	total: 8.05s	remaining: 3.25s
712:	learn: 0.2447431	total: 8.06s	remaining: 3.24s
713:	learn: 0.2446790	total: 8.07s	remaining: 3.23s
714:	learn: 0.2446068	total: 8.08s	remaining: 3.22s
715:	learn: 0.2445296	total: 8.1s	remaining: 3.21s
716:	learn: 0.2444832	total: 8.11s	remaining: 3.2s
717:	learn: 0.2443633	total: 8.12s	remaining: 3.19s
718:	learn: 0.2443419	total: 8.13s	remaining: 3.18s
719:	learn: 0.2442800	total: 8.14s	remaining: 3.17s
720:	learn: 0.2442387	total: 8.16s	remaining: 3.16s
721:	learn: 0.2441667	total: 8.17s	remaining: 3.15s
722:	learn: 0.2441190	total: 8.18s	remaining: 3.13s
723:	learn: 0.2440689	total: 8.19s	remaining: 3.12s
724:	learn: 0.2439732	total: 8.2s	remaining: 3.11s
725:	learn: 0.2439597	total: 8.21s	remaining: 3.1s
726:	learn: 0.2439094	total: 8.22s	remaining: 3.09s
727:	learn: 0.2438610	total: 8.24s	remaining: 3.08s
728:	learn: 0.2437958	total: 8.25s	remaining: 3.07s
729:	learn: 0.2437660	total: 8.26s	remaining: 3.05s
730:	learn: 0.2436937	total: 8.27s	remaining: 3.04s
731:	learn: 0.2436340	total: 8.28s	remaining: 3.03s
732:	learn: 0.2436060	total: 8.29s	remaining: 3.02s
733:	learn: 0.2435338	total: 8.31s	remaining: 3.01s
734:	learn: 0.2434775	total: 8.32s	remaining: 3s
735:	learn: 0.2433867	total: 8.33s	remaining: 2.99s
736:	learn: 0.2433470	total: 8.35s	remaining: 2.98s
737:	learn: 0.2432745	total: 8.36s	remaining: 2.97s
738:	learn: 0.2431809	total: 8.37s	remaining: 2.95s
739:	learn: 0.2431186	total: 8.38s	remaining: 2.94s
740:	learn: 0.2430582	total: 8.39s	remaining: 2.93s
741:	learn: 0.2430159	total: 8.4s	remaining: 2.92s
742:	learn: 0.2429872	total: 8.42s	remaining: 2.91s
743:	learn: 0.2429237	total: 8.43s	remaining: 2.9s
744:	learn: 0.2428290	total: 8.44s	remaining: 2.89s
745:	learn: 0.2427753	total: 8.45s	remaining: 2.88s
746:	learn: 0.2427003	total: 8.47s	remaining: 2.87s
747:	learn: 0.2425889	total: 8.48s	remaining: 2.86s
748:	learn: 0.2425073	total: 8.49s	remaining: 2.85s
749:	learn: 0.2424804	total: 8.5s	remaining: 2.83s
750:	learn: 0.2424567	total: 8.51s	remaining: 2.82s
751:	learn: 0.2423488	total: 8.53s	remaining: 2.81s
752:	learn: 0.2423335	total: 8.54s	remaining: 2.8s
753:	learn: 0.2422467	total: 8.56s	remaining: 2.79s
754:	learn: 0.2422157	total: 8.57s	remaining: 2.78s
755:	learn: 0.2421901	total: 8.58s	remaining: 2.77s
756:	learn: 0.2421315	total: 8.59s	remaining: 2.76s
757:	learn: 0.2420401	total: 8.61s	remaining: 2.75s
758:	learn: 0.2419462	total: 8.62s	remaining: 2.74s
759:	learn: 0.2418800	total: 8.63s	remaining: 2.73s
760:	learn: 0.2418316	total: 8.65s	remaining: 2.71s
761:	learn: 0.2417926	total: 8.66s	remaining: 2.7s
762:	learn: 0.2417457	total: 8.67s	remaining: 2.69s
763:	learn: 0.2416855	total: 8.7s	remaining: 2.69s
764:	learn: 0.2416122	total: 8.73s	remaining: 2.68s
765:	learn: 0.2415420	total: 8.75s	remaining: 2.67s
766:	learn: 0.2415014	total: 8.77s	remaining: 2.66s
767:	learn: 0.2414702	total: 8.78s	remaining: 2.65s
768:	learn: 0.2413995	total: 8.79s	remaining: 2.64s
769:	learn: 0.2413131	total: 8.83s	remaining: 2.64s
770:	learn: 0.2412790	total: 8.85s	remaining: 2.63s
771:	learn: 0.2412257	total: 8.87s	remaining: 2.62s
772:	learn: 0.2411086	total: 8.89s	remaining: 2.61s
773:	learn: 0.2410662	total: 8.9s	remaining: 2.6s
774:	learn: 0.2410525	total: 8.91s	remaining: 2.59s
775:	learn: 0.2409859	total: 8.94s	remaining: 2.58s
776:	learn: 0.2409644	total: 8.95s	remaining: 2.57s
777:	learn: 0.2409035	total: 8.96s	remaining: 2.56s
778:	learn: 0.2408743	total: 8.97s	remaining: 2.54s
779:	learn: 0.2407897	total: 8.99s	remaining: 2.53s
780:	learn: 0.2407485	total: 9.01s	remaining: 2.53s
781:	learn: 0.2407032	total: 9.02s	remaining: 2.51s
782:	learn: 0.2405982	total: 9.03s	remaining: 2.5s
783:	learn: 0.2405676	total: 9.05s	remaining: 2.49s
784:	learn: 0.2404254	total: 9.07s	remaining: 2.48s
785:	learn: 0.2403595	total: 9.08s	remaining: 2.47s
786:	learn: 0.2403455	total: 9.09s	remaining: 2.46s
787:	learn: 0.2402882	total: 9.1s	remaining: 2.45s
788:	learn: 0.2402299	total: 9.12s	remaining: 2.44s
789:	learn: 0.2402096	total: 9.13s	remaining: 2.43s
790:	learn: 0.2401550	total: 9.14s	remaining: 2.42s
791:	learn: 0.2401368	total: 9.16s	remaining: 2.4s
792:	learn: 0.2400645	total: 9.17s	remaining: 2.39s
793:	learn: 0.2399986	total: 9.18s	remaining: 2.38s
794:	learn: 0.2399052	total: 9.21s	remaining: 2.37s
795:	learn: 0.2398434	total: 9.24s	remaining: 2.37s
796:	learn: 0.2397685	total: 9.25s	remaining: 2.36s
797:	learn: 0.2396903	total: 9.27s	remaining: 2.35s
798:	learn: 0.2396076	total: 9.3s	remaining: 2.34s
799:	learn: 0.2395705	total: 9.32s	remaining: 2.33s
800:	learn: 0.2394928	total: 9.34s	remaining: 2.32s
801:	learn: 0.2394072	total: 9.36s	remaining: 2.31s
802:	learn: 0.2392955	total: 9.37s	remaining: 2.3s
803:	learn: 0.2392718	total: 9.39s	remaining: 2.29s
804:	learn: 0.2391859	total: 9.4s	remaining: 2.28s
805:	learn: 0.2391185	total: 9.43s	remaining: 2.27s
```

```
806:	learn: 0.2390403	total: 9.44s	remaining: 2.26s
807:	learn: 0.2390213	total: 9.45s	remaining: 2.25s
808:	learn: 0.2389390	total: 9.48s	remaining: 2.24s
809:	learn: 0.2388568	total: 9.5s	remaining: 2.23s
810:	learn: 0.2388192	total: 9.51s	remaining: 2.22s
811:	learn: 0.2387470	total: 9.53s	remaining: 2.21s
812:	learn: 0.2386603	total: 9.54s	remaining: 2.19s
813:	learn: 0.2386067	total: 9.55s	remaining: 2.18s
814:	learn: 0.2384967	total: 9.57s	remaining: 2.17s
815:	learn: 0.2384226	total: 9.58s	remaining: 2.16s
816:	learn: 0.2383655	total: 9.6s	remaining: 2.15s
817:	learn: 0.2383058	total: 9.61s	remaining: 2.14s
818:	learn: 0.2382095	total: 9.62s	remaining: 2.13s
819:	learn: 0.2381853	total: 9.63s	remaining: 2.11s
820:	learn: 0.2381400	total: 9.64s	remaining: 2.1s
821:	learn: 0.2380810	total: 9.66s	remaining: 2.09s
822:	learn: 0.2380235	total: 9.66s	remaining: 2.08s
823:	learn: 0.2379579	total: 9.68s	remaining: 2.07s
824:	learn: 0.2379054	total: 9.69s	remaining: 2.06s
825:	learn: 0.2378780	total: 9.7s	remaining: 2.04s
826:	learn: 0.2378180	total: 9.71s	remaining: 2.03s
827:	learn: 0.2377591	total: 9.73s	remaining: 2.02s
828:	learn: 0.2377121	total: 9.74s	remaining: 2.01s
829:	learn: 0.2376583	total: 9.75s	remaining: 2s
830:	learn: 0.2376092	total: 9.77s	remaining: 1.99s
831:	learn: 0.2375455	total: 9.78s	remaining: 1.97s
832:	learn: 0.2374775	total: 9.79s	remaining: 1.96s
833:	learn: 0.2374430	total: 9.8s	remaining: 1.95s
834:	learn: 0.2373598	total: 9.81s	remaining: 1.94s
835:	learn: 0.2373058	total: 9.82s	remaining: 1.93s
836:	learn: 0.2372481	total: 9.84s	remaining: 1.92s
837:	learn: 0.2371875	total: 9.85s	remaining: 1.91s
838:	learn: 0.2371392	total: 9.87s	remaining: 1.89s
839:	learn: 0.2370964	total: 9.88s	remaining: 1.88s
840:	learn: 0.2369918	total: 9.89s	remaining: 1.87s
841:	learn: 0.2369277	total: 9.91s	remaining: 1.86s
842:	learn: 0.2368330	total: 9.93s	remaining: 1.85s
843:	learn: 0.2367340	total: 9.95s	remaining: 1.84s
844:	learn: 0.2366650	total: 9.96s	remaining: 1.83s
845:	learn: 0.2365782	total: 9.98s	remaining: 1.82s
846:	learn: 0.2365223	total: 9.99s	remaining: 1.8s
847:	learn: 0.2364044	total: 10s	remaining: 1.79s
848:	learn: 0.2363858	total: 10s	remaining: 1.78s
849:	learn: 0.2362828	total: 10s	remaining: 1.77s
850:	learn: 0.2362360	total: 10.1s	remaining: 1.76s
851:	learn: 0.2361828	total: 10.1s	remaining: 1.75s
852:	learn: 0.2361277	total: 10.1s	remaining: 1.74s
853:	learn: 0.2360863	total: 10.1s	remaining: 1.73s
854:	learn: 0.2360388	total: 10.1s	remaining: 1.71s
855:	learn: 0.2359855	total: 10.1s	remaining: 1.7s
856:	learn: 0.2358866	total: 10.1s	remaining: 1.69s
857:	learn: 0.2358313	total: 10.1s	remaining: 1.68s
858:	learn: 0.2357583	total: 10.2s	remaining: 1.67s
859:	learn: 0.2356109	total: 10.2s	remaining: 1.66s
860:	learn: 0.2355830	total: 10.2s	remaining: 1.65s
861:	learn: 0.2355154	total: 10.2s	remaining: 1.63s
862:	learn: 0.2354370	total: 10.2s	remaining: 1.62s
863:	learn: 0.2353617	total: 10.2s	remaining: 1.61s
864:	learn: 0.2353081	total: 10.3s	remaining: 1.6s
865:	learn: 0.2352212	total: 10.3s	remaining: 1.59s
866:	learn: 0.2351304	total: 10.3s	remaining: 1.58s
867:	learn: 0.2350773	total: 10.3s	remaining: 1.56s
868:	learn: 0.2349603	total: 10.3s	remaining: 1.55s
869:	learn: 0.2348904	total: 10.3s	remaining: 1.54s
870:	learn: 0.2348119	total: 10.3s	remaining: 1.53s
871:	learn: 0.2347430	total: 10.4s	remaining: 1.52s
872:	learn: 0.2346815	total: 10.4s	remaining: 1.51s
873:	learn: 0.2346197	total: 10.4s	remaining: 1.5s
874:	learn: 0.2345572	total: 10.4s	remaining: 1.48s
875:	learn: 0.2345302	total: 10.4s	remaining: 1.47s
876:	learn: 0.2344719	total: 10.4s	remaining: 1.46s
877:	learn: 0.2344298	total: 10.4s	remaining: 1.45s
878:	learn: 0.2343924	total: 10.4s	remaining: 1.44s
879:	learn: 0.2343774	total: 10.4s	remaining: 1.43s
880:	learn: 0.2343143	total: 10.5s	remaining: 1.41s
881:	learn: 0.2342603	total: 10.5s	remaining: 1.4s
882:	learn: 0.2342127	total: 10.5s	remaining: 1.39s
883:	learn: 0.2341360	total: 10.5s	remaining: 1.38s
884:	learn: 0.2340148	total: 10.5s	remaining: 1.37s
885:	learn: 0.2339635	total: 10.5s	remaining: 1.35s
886:	learn: 0.2338881	total: 10.6s	remaining: 1.34s
887:	learn: 0.2337920	total: 10.6s	remaining: 1.33s
888:	learn: 0.2337048	total: 10.6s	remaining: 1.32s
889:	learn: 0.2336396	total: 10.6s	remaining: 1.31s
890:	learn: 0.2335697	total: 10.6s	remaining: 1.3s
891:	learn: 0.2334873	total: 10.6s	remaining: 1.28s
892:	learn: 0.2334139	total: 10.6s	remaining: 1.27s
893:	learn: 0.2333111	total: 10.7s	remaining: 1.26s
894:	learn: 0.2332471	total: 10.7s	remaining: 1.25s
895:	learn: 0.2331614	total: 10.7s	remaining: 1.24s
896:	learn: 0.2330505	total: 10.7s	remaining: 1.23s
897:	learn: 0.2329600	total: 10.7s	remaining: 1.21s
898:	learn: 0.2328860	total: 10.7s	remaining: 1.2s
899:	learn: 0.2327957	total: 10.7s	remaining: 1.19s
900:	learn: 0.2327234	total: 10.7s	remaining: 1.18s
901:	learn: 0.2326473	total: 10.7s	remaining: 1.17s
902:	learn: 0.2325859	total: 10.7s	remaining: 1.15s
903:	learn: 0.2325426	total: 10.8s	remaining: 1.14s
904:	learn: 0.2324719	total: 10.8s	remaining: 1.13s
905:	learn: 0.2323982	total: 10.8s	remaining: 1.12s
906:	learn: 0.2323262	total: 10.8s	remaining: 1.11s
907:	learn: 0.2322589	total: 10.8s	remaining: 1.09s
908:	learn: 0.2321740	total: 10.8s	remaining: 1.08s
909:	learn: 0.2321083	total: 10.8s	remaining: 1.07s
910:	learn: 0.2320256	total: 10.8s	remaining: 1.06s
911:	learn: 0.2319687	total: 10.8s	remaining: 1.05s
912:	learn: 0.2319331	total: 10.9s	remaining: 1.03s
913:	learn: 0.2318573	total: 10.9s	remaining: 1.02s
914:	learn: 0.2317974	total: 10.9s	remaining: 1.01s
915:	learn: 0.2317292	total: 10.9s	remaining: 999ms
916:	learn: 0.2316673	total: 10.9s	remaining: 987ms
917:	learn: 0.2316151	total: 10.9s	remaining: 975ms
918:	learn: 0.2315464	total: 10.9s	remaining: 963ms
919:	learn: 0.2315153	total: 10.9s	remaining: 951ms
920:	learn: 0.2314489	total: 10.9s	remaining: 939ms
921:	learn: 0.2314321	total: 11s	remaining: 927ms
922:	learn: 0.2313761	total: 11s	remaining: 915ms
923:	learn: 0.2313074	total: 11s	remaining: 903ms
924:	learn: 0.2312435	total: 11s	remaining: 891ms
925:	learn: 0.2311317	total: 11s	remaining: 880ms
926:	learn: 0.2310775	total: 11s	remaining: 868ms
927:	learn: 0.2310176	total: 11s	remaining: 856ms
928:	learn: 0.2309415	total: 11s	remaining: 844ms
929:	learn: 0.2308881	total: 11.1s	remaining: 832ms
930:	learn: 0.2307982	total: 11.1s	remaining: 820ms
931:	learn: 0.2307178	total: 11.1s	remaining: 808ms
932:	learn: 0.2306485	total: 11.1s	remaining: 796ms
933:	learn: 0.2305853	total: 11.1s	remaining: 784ms
934:	learn: 0.2305364	total: 11.1s	remaining: 772ms
935:	learn: 0.2304854	total: 11.1s	remaining: 760ms
936:	learn: 0.2304440	total: 11.1s	remaining: 748ms
937:	learn: 0.2303786	total: 11.1s	remaining: 736ms
938:	learn: 0.2303615	total: 11.1s	remaining: 724ms
939:	learn: 0.2302874	total: 11.2s	remaining: 712ms
940:	learn: 0.2302128	total: 11.2s	remaining: 700ms
941:	learn: 0.2301922	total: 11.2s	remaining: 688ms
942:	learn: 0.2301236	total: 11.2s	remaining: 676ms
943:	learn: 0.2300605	total: 11.2s	remaining: 664ms
944:	learn: 0.2299695	total: 11.2s	remaining: 652ms
945:	learn: 0.2298825	total: 11.2s	remaining: 640ms
946:	learn: 0.2298652	total: 11.2s	remaining: 629ms
947:	learn: 0.2298216	total: 11.2s	remaining: 617ms
948:	learn: 0.2297884	total: 11.3s	remaining: 605ms
949:	learn: 0.2296846	total: 11.3s	remaining: 593ms
950:	learn: 0.2296257	total: 11.3s	remaining: 581ms
951:	learn: 0.2295680	total: 11.3s	remaining: 569ms
952:	learn: 0.2294987	total: 11.3s	remaining: 557ms
953:	learn: 0.2294571	total: 11.3s	remaining: 545ms
954:	learn: 0.2293884	total: 11.3s	remaining: 534ms
955:	learn: 0.2292748	total: 11.3s	remaining: 522ms
956:	learn: 0.2292050	total: 11.4s	remaining: 510ms
957:	learn: 0.2291515	total: 11.4s	remaining: 498ms
958:	learn: 0.2290925	total: 11.4s	remaining: 486ms
959:	learn: 0.2290272	total: 11.4s	remaining: 474ms
960:	learn: 0.2289776	total: 11.4s	remaining: 463ms
961:	learn: 0.2289300	total: 11.4s	remaining: 451ms
962:	learn: 0.2288565	total: 11.4s	remaining: 439ms
963:	learn: 0.2288219	total: 11.4s	remaining: 427ms
964:	learn: 0.2287685	total: 11.5s	remaining: 415ms
965:	learn: 0.2287431	total: 11.5s	remaining: 404ms
966:	learn: 0.2286917	total: 11.5s	remaining: 392ms
967:	learn: 0.2286206	total: 11.5s	remaining: 380ms
968:	learn: 0.2285754	total: 11.5s	remaining: 368ms
969:	learn: 0.2284932	total: 11.5s	remaining: 356ms
970:	learn: 0.2283977	total: 11.5s	remaining: 345ms
971:	learn: 0.2283269	total: 11.5s	remaining: 333ms
972:	learn: 0.2282376	total: 11.6s	remaining: 321ms
973:	learn: 0.2281874	total: 11.6s	remaining: 309ms
974:	learn: 0.2281418	total: 11.6s	remaining: 297ms
975:	learn: 0.2280450	total: 11.6s	remaining: 285ms
976:	learn: 0.2279867	total: 11.6s	remaining: 273ms
977:	learn: 0.2279570	total: 11.6s	remaining: 262ms
978:	learn: 0.2278881	total: 11.6s	remaining: 250ms
979:	learn: 0.2278537	total: 11.6s	remaining: 238ms
980:	learn: 0.2277790	total: 11.7s	remaining: 226ms
981:	learn: 0.2276869	total: 11.7s	remaining: 214ms
982:	learn: 0.2275899	total: 11.7s	remaining: 202ms
983:	learn: 0.2275489	total: 11.7s	remaining: 190ms
984:	learn: 0.2274976	total: 11.7s	remaining: 178ms
985:	learn: 0.2274252	total: 11.7s	remaining: 166ms
986:	learn: 0.2274051	total: 11.7s	remaining: 155ms
987:	learn: 0.2273847	total: 11.8s	remaining: 143ms
988:	learn: 0.2273327	total: 11.8s	remaining: 131ms
989:	learn: 0.2273140	total: 11.8s	remaining: 119ms
990:	learn: 0.2272563	total: 11.8s	remaining: 107ms
991:	learn: 0.2271867	total: 11.8s	remaining: 95.2ms
992:	learn: 0.2271611	total: 11.8s	remaining: 83.3ms
993:	learn: 0.2271211	total: 11.8s	remaining: 71.4ms
994:	learn: 0.2270302	total: 11.8s	remaining: 59.5ms
995:	learn: 0.2269429	total: 11.8s	remaining: 47.6ms
996:	learn: 0.2268293	total: 11.9s	remaining: 35.7ms
997:	learn: 0.2267565	total: 11.9s	remaining: 23.8ms
998:	learn: 0.2267285	total: 11.9s	remaining: 11.9ms
999:	learn: 0.2266726	total: 11.9s	remaining: 0us
Fit time: 304.012 / Predict time: 0.309 ---- Precision: 0.603 / Recall: 0.086 / Accuracy: 0.904
```

Better precision and accuracy, but lesser recall

Feature Importance

In [117]:

```
#Feature importance
a = list(rf_model.feature_importances_)
b = list(x_train.columns)
Importance = pd.DataFrame(a, b)
Importance.columns = ['rate']
Importance.index.name = 'features'
Importance
```

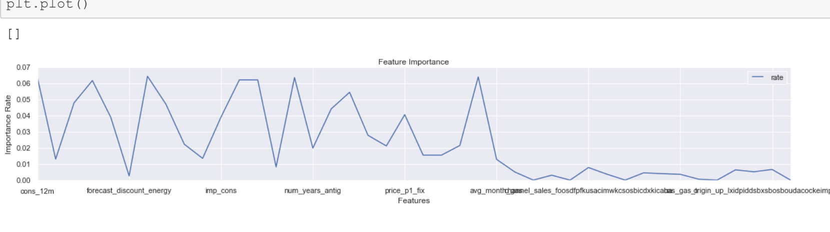
Out[117]:

	rate
features	
cons_12m	6.408873e-02
cons_gas_12m	1.303210e-02
cons_last_month	4.797514e-02
forecast_cons_12m	6.185288e-02
forecast_cons_year	3.903601e-02
forecast_discount_energy	2.596345e-03
forecast_meter_rent_12m	6.450617e-02
forecast_price_energy_p1	4.720647e-02
forecast_price_energy_p2	2.230799e-02
forecast_price_pow_p1	1.350855e-02
imp_cons	3.914730e-02
margin_gross_pow_ele	6.226601e-02
margin_net_pow_ele	6.222992e-02
nb_prod_act	8.176263e-03
net_margin	6.368568e-02
num_years_antig	1.987934e-02
pow_max	4.427367e-02
price_p1_var	5.455972e-02
price_p2_var	2.783122e-02
price_p3_var	2.122168e-02
price_p1_fix	4.065866e-02
price_p2_fix	1.552335e-02
price_p3_fix	1.551251e-02
num_years_renewal	2.149524e-02
avg_month_elec	6.408821e-02
avg_month_gas	1.288652e-02
channel_sales_Null	4.999474e-03
channel_sales_epumfxlbckeskwekxbiuasklxalciiuu	5.503094e-06
channel_sales_ewpakwlliwisiwduibdlfmalxowmwpci	3.052638e-03
channel_sales_fixdbufsefwooaasfcxdxadsiekoceaa	4.761124e-09
channel_sales_foosdfpfkusacimwkcsosbicdxkicaua	7.819597e-03
channel_sales_lmkebamcaaclubfxadlmueccxoimlema	3.699609e-03
channel_sales_sddiedcslfslkckwlfkdpoeeailfpeds	1.789653e-05
channel_sales_usilxuppasemubllopkaafesmlibmsdf	4.506107e-03
has_gas_f	4.022844e-03
has_gas_t	3.591622e-03
origin_up_Null	5.735202e-04
origin_up_ewxeelcelemmiwuafmddpobolfuxioce	4.284786e-06
origin_up_kamkkxfxxuwbdslkwifmmcsiusiuosws	6.369728e-03
origin_up_ldkssxwpmemidmecebumciepifcamkci	5.169048e-03
origin_up_lxidpiddsbxsbosboudacockeimpuepw	6.619106e-03
origin_up_usapbepcfoloekilkwsdiboslwaxobdp	3.341915e-06

In [141]:

```
#Plotting the Feature Importance
Importance.reset_index().plot(x='features')
plt.title('Feature Importance')
plt.ylabel('Importance Rate', fontdict = None, labelpad = None)
plt.xlabel('Features', fontdict = None, labelpad = None)
plt.plot()
```

Out[141]: []



Hypotheses

-Hypothesis 1 - It is possible to predict customers likely to churn using a predictive model

Models have been created based on several variables, making it possible to predict Customer churn.

-Hypothesis 2 - Churn is driven by customer price sensitivity

Price is only one of the major drivers of Customer Churn, but there are still several other factors that drive churn as shown in the feature importance above; factors like electricity and gas consumption and forecast rate, subscription, time frame, prices, etc.

-Hypothesis 3 - Client wants to try discounting strategy. SME division head suggests that offering customers at high propensity to churn a 20% discount might be effective

forecast_discount_energy is one of he factors with low effect on Customer churn. So, discount may not necessarily reduce churn.