Importing:

```
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
%matplotlib inline
import seaborn as sns
import warnings
warnings.filterwarnings('ignore')

pd.set_option('display.max_columns', 500)
```

Reading the dataset:

```
df = pd.read_csv('telecom_churn_data.csv')
df.head()
```

```
   mobile_number  circle_id  loc_og_t2o_mou  std_og_t2o_mou
loc_ic_t2o_mou  \
0     7000842753        109             0.0             0.0
0.0
1     7001865778        109             0.0             0.0
0.0
2     7001625959        109             0.0             0.0
0.0
3     7001204172        109             0.0             0.0
0.0
4     7000142493        109             0.0             0.0
0.0

  last_date_of_month_6 last_date_of_month_7 last_date_of_month_8  \
0            6/30/2014            7/31/2014            8/31/2014
1            6/30/2014            7/31/2014            8/31/2014
2            6/30/2014            7/31/2014            8/31/2014
3            6/30/2014            7/31/2014            8/31/2014
4            6/30/2014            7/31/2014            8/31/2014

  last_date_of_month_9   arpu_6   arpu_7   arpu_8   arpu_9
onnet_mou_6  \
0            9/30/2014  197.385  214.816  213.803   21.100
NaN
1            9/30/2014   34.047  355.074  268.321   86.285
24.11
2            9/30/2014  167.690  189.058  210.226  290.714
11.54
3            9/30/2014  221.338  251.102  508.054  389.500
99.91
4            9/30/2014  261.636  309.876  238.174  163.426
50.31
```

```
   onnet_mou_7  onnet_mou_8  onnet_mou_9  offnet_mou_6
offnet_mou_7  \
0          NaN         0.00          NaN           NaN            NaN

1        78.68         7.68        18.34         15.74          99.84

2        55.24        37.26        74.81        143.33         220.59

3        54.39       310.98       241.71        123.31         109.01

4       149.44        83.89        58.78         76.96          91.88


   offnet_mou_8  offnet_mou_9  roam_ic_mou_6  roam_ic_mou_7
roam_ic_mou_8  \
0          0.00           NaN            NaN            NaN
0.00
1        304.76         53.76            0.0           0.00
0.00
2        208.36        118.91            0.0           0.00
0.00
3         71.68        113.54            0.0          54.86
44.38
4        124.26         45.81            0.0           0.00
0.00

   roam_ic_mou_9  roam_og_mou_6  roam_og_mou_7  roam_og_mou_8
roam_og_mou_9  \
0            NaN            NaN            NaN           0.00
NaN
1           0.00            0.0           0.00           0.00
0.00
2          38.49            0.0           0.00           0.00
70.94
3           0.00            0.0          28.09          39.04
0.00
4           0.00            0.0           0.00           0.00
0.00

   loc_og_t2t_mou_6  loc_og_t2t_mou_7  loc_og_t2t_mou_8
loc_og_t2t_mou_9  \
0               NaN               NaN              0.00
NaN
1             23.88             74.56              7.68
18.34
2              7.19             28.74             13.58
14.39
3             73.68             34.81             10.61
15.49
```

```
4              50.31             149.44              83.89
58.78

   loc_og_t2m_mou_6  loc_og_t2m_mou_7  loc_og_t2m_mou_8
loc_og_t2m_mou_9  \
0                NaN               NaN               0.00
NaN
1              11.51             75.94             291.86
53.76
2              29.34             16.86              38.46
28.16
3             107.43             83.21              22.46
65.46
4              67.64             91.88             124.26
37.89

   loc_og_t2f_mou_6  loc_og_t2f_mou_7  loc_og_t2f_mou_8
loc_og_t2f_mou_9  \
0                NaN               NaN               0.00
NaN
1               0.00              0.00               0.00
0.00
2              24.11             21.79              15.61
22.24
3               1.91              0.65               4.91
2.06
4               0.00              0.00               0.00
1.93

   loc_og_t2c_mou_6  loc_og_t2c_mou_7  loc_og_t2c_mou_8
loc_og_t2c_mou_9  \
0                NaN               NaN               0.00
NaN
1                0.0              2.91               0.00
0.00
2                0.0            135.54              45.76
0.48
3                0.0              0.00               0.00
0.00
4                0.0              0.00               0.00
0.00

   loc_og_mou_6  loc_og_mou_7  loc_og_mou_8  loc_og_mou_9
std_og_t2t_mou_6  \
0           NaN           NaN          0.00           NaN
NaN
1         35.39        150.51        299.54         72.11
0.23
2         60.66         67.41         67.66         64.81
4.34
```

```
3        183.03         118.68          37.99          83.03
26.23
4        117.96         241.33         208.16          98.61
0.00

   std_og_t2t_mou_7  std_og_t2t_mou_8  std_og_t2t_mou_9
std_og_t2m_mou_6  \
0               NaN              0.00               NaN
NaN
1              4.11              0.00              0.00
0.00
2             26.49             22.58              8.76
41.81
3             14.89            289.58            226.21
2.99
4              0.00              0.00              0.00
9.31

   std_og_t2m_mou_7  std_og_t2m_mou_8  std_og_t2m_mou_9
std_og_t2f_mou_6  \
0               NaN              0.00               NaN
NaN
1              0.46              0.13              0.00
0.00
2             67.41             75.53              9.28
1.48
3              1.73              6.53              9.99
0.00
4              0.00              0.00              0.00
0.00

   std_og_t2f_mou_7  std_og_t2f_mou_8  std_og_t2f_mou_9
std_og_t2c_mou_6  \
0               NaN              0.00               NaN
NaN
1              0.00              0.00               0.0
0.0
2             14.76             22.83               0.0
0.0
3              0.00              0.00               0.0
0.0
4              0.00              0.00               0.0
0.0

   std_og_t2c_mou_7  std_og_t2c_mou_8  std_og_t2c_mou_9  std_og_mou_6
\
0               NaN               0.0               NaN           NaN

1               0.0               0.0               0.0          0.23
```

```
2               0.0               0.0               0.0          47.64

3               0.0               0.0               0.0          29.23

4               0.0               0.0               0.0           9.31


   std_og_mou_7  std_og_mou_8  std_og_mou_9  isd_og_mou_6
isd_og_mou_7  \
0           NaN          0.00           NaN           NaN
NaN
1          4.58          0.13          0.00           0.0
0.0
2        108.68        120.94         18.04           0.0
0.0
3         16.63        296.11        236.21           0.0
0.0
4          0.00          0.00          0.00           0.0
0.0

   isd_og_mou_8  isd_og_mou_9  spl_og_mou_6  spl_og_mou_7
spl_og_mou_8  \
0           0.0           NaN           NaN           NaN
0.00
1           0.0           0.0          4.68         23.43
12.76
2           0.0           0.0         46.56        236.84
96.84
3           0.0           0.0         10.96          0.00
18.09
4           0.0           0.0          0.00          0.00
0.00

   spl_og_mou_9  og_others_6  og_others_7  og_others_8  og_others_9  \
0           NaN          NaN          NaN          0.0          NaN
1          0.00         0.00          0.0          0.0          0.0
2         42.08         0.45          0.0          0.0          0.0
3         43.29         0.00          0.0          0.0          0.0
4          5.98         0.00          0.0          0.0          0.0

   total_og_mou_6  total_og_mou_7  total_og_mou_8  total_og_mou_9  \
0            0.00            0.00            0.00            0.00
1           40.31          178.53          312.44           72.11
2          155.33          412.94          285.46          124.94
3          223.23          135.31          352.21          362.54
4          127.28          241.33          208.16          104.59

   loc_ic_t2t_mou_6  loc_ic_t2t_mou_7  loc_ic_t2t_mou_8
loc_ic_t2t_mou_9  \
0               NaN               NaN              0.16
```

```
NaN
1              1.61              29.91              29.23
116.09
2            115.69              71.11              67.46
148.23
3             62.08              19.98               8.04
41.73
4            105.68              88.49             233.81
154.56

   loc_ic_t2m_mou_6  loc_ic_t2m_mou_7  loc_ic_t2m_mou_8
loc_ic_t2m_mou_9  \
0               NaN               NaN               4.13
NaN
1             17.48             65.38             375.58
56.93
2             14.38             15.44              38.89
38.98
3            113.96             64.51              20.28
52.86
4            106.84            109.54             104.13
48.24

   loc_ic_t2f_mou_6  loc_ic_t2f_mou_7  loc_ic_t2f_mou_8
loc_ic_t2f_mou_9  \
0               NaN               NaN               1.15
NaN
1              0.00              8.93               3.61
0.00
2             99.48            122.29              49.63
158.19
3             57.43             27.09              19.84
65.59
4              1.50              0.00               0.00
0.00

   loc_ic_mou_6  loc_ic_mou_7  loc_ic_mou_8  loc_ic_mou_9
std_ic_t2t_mou_6  \
0           NaN           NaN          5.44           NaN
NaN
1         19.09        104.23        408.43        173.03
0.00
2        229.56        208.86        155.99        345.41
72.41
3        233.48        111.59         48.18        160.19
43.48
4        214.03        198.04        337.94        202.81
0.00

   std_ic_t2t_mou_7  std_ic_t2t_mou_8  std_ic_t2t_mou_9
```

```
std_ic_t2m_mou_6  \
0                NaN               0.00                NaN
NaN
1               0.00               2.35               0.00
5.90
2              71.29              28.69              49.44
45.18
3              66.44               0.00             129.84
1.33
4               0.00               0.86               2.31
1.93

   std_ic_t2m_mou_7  std_ic_t2m_mou_8  std_ic_t2m_mou_9
std_ic_t2f_mou_6  \
0                NaN               0.00                NaN
NaN
1               0.00              12.49              15.01
0.00
2             177.01             167.09             118.18
21.73
3              38.56               4.94              13.98
1.18
4               0.25               0.00               0.00
0.00

   std_ic_t2f_mou_7  std_ic_t2f_mou_8  std_ic_t2f_mou_9
std_ic_t2o_mou_6  \
0                NaN               0.00                NaN
NaN
1               0.00               0.00               0.00
0.0
2              58.34              43.23               3.86
0.0
3               0.00               0.00               0.00
0.0
4               0.00               0.00               0.00
0.0

   std_ic_t2o_mou_7  std_ic_t2o_mou_8  std_ic_t2o_mou_9  std_ic_mou_6
\
0                NaN               0.0                NaN           NaN

1                0.0               0.0                0.0          5.90

2                0.0               0.0                0.0        139.33

3                0.0               0.0                0.0         45.99

4                0.0               0.0                0.0          1.93
```

```
   std_ic_mou_7  std_ic_mou_8  std_ic_mou_9  total_ic_mou_6
total_ic_mou_7  \
0           NaN          0.00           NaN            0.00
0.00
1          0.00         14.84         15.01           26.83
104.23
2        306.66        239.03        171.49          370.04
519.53
3        105.01          4.94        143.83          280.08
216.61
4          0.25          0.86          2.31          216.44
198.29

   total_ic_mou_8  total_ic_mou_9  spl_ic_mou_6  spl_ic_mou_7
spl_ic_mou_8  \
0            5.44            0.00           NaN           NaN
0.0
1          423.28          188.04          0.00           0.0
0.0
2          395.03          517.74          0.21           0.0
0.0
3           53.13          305.38          0.59           0.0
0.0
4          338.81          205.31          0.00           0.0
0.0

   spl_ic_mou_9  isd_ic_mou_6  isd_ic_mou_7  isd_ic_mou_8
isd_ic_mou_9  \
0           NaN           NaN           NaN           0.0
NaN
1          0.00          1.83          0.00           0.0
0.00
2          0.45          0.00          0.85           0.0
0.01
3          0.55          0.00          0.00           0.0
0.00
4          0.18          0.00          0.00           0.0
0.00

   ic_others_6  ic_others_7  ic_others_8  ic_others_9
total_rech_num_6  \
0          NaN          NaN          0.0          NaN
4
1         0.00         0.00          0.0         0.00
4
2         0.93         3.14          0.0         0.36
5
3         0.00         0.00          0.0         0.80
10
```

```
4         0.48         0.00          0.0         0.00
5

   total_rech_num_7  total_rech_num_8  total_rech_num_9
total_rech_amt_6  \
0                 3                 2                 6
362
1                 9                11                 5
74
2                 4                 2                 7
168
3                11                18                14
230
4                 6                 3                 4
196

   total_rech_amt_7  total_rech_amt_8  total_rech_amt_9
max_rech_amt_6  \
0               252               252                 0
252
1               384               283               121
44
2               315               116               358
86
3               310               601               410
60
4               350               287               200
56

   max_rech_amt_7  max_rech_amt_8  max_rech_amt_9 date_of_last_rech_6
\
0             252             252               0           6/21/2014

1             154              65              50           6/29/2014

2             200              86             100           6/17/2014

3              50              50              50           6/28/2014

4             110             110              50           6/26/2014


  date_of_last_rech_7 date_of_last_rech_8 date_of_last_rech_9  \
0           7/16/2014            8/8/2014           9/28/2014
1           7/31/2014           8/28/2014           9/30/2014
2           7/24/2014           8/14/2014           9/29/2014
3           7/31/2014           8/31/2014           9/30/2014
4           7/28/2014            8/9/2014           9/28/2014

   last_day_rch_amt_6  last_day_rch_amt_7  last_day_rch_amt_8  \
```

```
0                  252                  252                  252
1                   44                   23                   30
2                    0                  200                   86
3                   30                   50                   50
4                   50                  110                  110

   last_day_rch_amt_9 date_of_last_rech_data_6
date_of_last_rech_data_7  \
0                   0                6/21/2014
7/16/2014
1                   0                      NaN
7/25/2014
2                   0                      NaN
NaN
3                  30                      NaN
NaN
4                  50                  6/4/2014
NaN

  date_of_last_rech_data_8 date_of_last_rech_data_9  total_rech_data_6
\
0                 8/8/2014                      NaN                1.0

1                8/10/2014                      NaN                NaN

2                      NaN                9/17/2014                NaN

3                      NaN                      NaN                NaN

4                      NaN                      NaN                1.0


   total_rech_data_7  total_rech_data_8  total_rech_data_9
max_rech_data_6  \
0                1.0                1.0                NaN
252.0
1                1.0                2.0                NaN
NaN
2                NaN                NaN                1.0
NaN
3                NaN                NaN                NaN
NaN
4                NaN                NaN                NaN
56.0

   max_rech_data_7  max_rech_data_8  max_rech_data_9  count_rech_2g_6
\
0            252.0            252.0              NaN              0.0

1            154.0             25.0              NaN              NaN
```

```
2               NaN               NaN              46.0               NaN

3               NaN               NaN               NaN               NaN

4               NaN               NaN               NaN               1.0


   count_rech_2g_7  count_rech_2g_8  count_rech_2g_9  count_rech_3g_6
\
0              0.0              0.0               NaN               1.0

1              1.0              2.0               NaN               NaN

2              NaN              NaN               1.0               NaN

3              NaN              NaN               NaN               NaN

4              NaN              NaN               NaN               0.0


   count_rech_3g_7  count_rech_3g_8  count_rech_3g_9
av_rech_amt_data_6  \
0              1.0              1.0               NaN
252.0
1              0.0              0.0               NaN
NaN
2              NaN              NaN               0.0
NaN
3              NaN              NaN               NaN
NaN
4              NaN              NaN               NaN
56.0

   av_rech_amt_data_7  av_rech_amt_data_8  av_rech_amt_data_9
vol_2g_mb_6  \
0               252.0               252.0                NaN
30.13
1               154.0                50.0                NaN
0.00
2                 NaN                 NaN               46.0
0.00
3                 NaN                 NaN                NaN
0.00
4                 NaN                 NaN                NaN
0.00

   vol_2g_mb_7  vol_2g_mb_8  vol_2g_mb_9  vol_3g_mb_6  vol_3g_mb_7  \
0         1.32         5.75          0.0        83.57       150.76
1       108.07       365.47          0.0         0.00         0.00
2         0.00         0.00          0.0         0.00         0.00
```

```
3         0.00         0.00          0.0         0.00         0.00
4         0.00         0.00          0.0         0.00         0.00

   vol_3g_mb_8  vol_3g_mb_9  arpu_3g_6  arpu_3g_7  arpu_3g_8
arpu_3g_9  \
0       109.61         0.00     212.17     212.17     212.17
NaN
1         0.00         0.00        NaN       0.00       0.00
NaN
2         0.00         8.42        NaN        NaN        NaN
2.84
3         0.00         0.00        NaN        NaN        NaN
NaN
4         0.00         0.00       0.00        NaN        NaN
NaN

   arpu_2g_6  arpu_2g_7  arpu_2g_8  arpu_2g_9  night_pck_user_6  \
0     212.17     212.17     212.17        NaN               0.0
1        NaN      28.61       7.60        NaN               NaN
2        NaN        NaN        NaN        0.0               NaN
3        NaN        NaN        NaN        NaN               NaN
4       0.00        NaN        NaN        NaN               0.0

   night_pck_user_7  night_pck_user_8  night_pck_user_9  monthly_2g_6
\
0               0.0               0.0               NaN             0

1               0.0               0.0               NaN             0

2               NaN               NaN               0.0             0

3               NaN               NaN               NaN             0

4               NaN               NaN               NaN             0


   monthly_2g_7  monthly_2g_8  monthly_2g_9  sachet_2g_6  sachet_2g_7
\
0             0             0             0            0            0

1             1             0             0            0            0

2             0             0             0            0            0

3             0             0             0            0            0

4             0             0             0            1            0


   sachet_2g_8  sachet_2g_9  monthly_3g_6  monthly_3g_7  monthly_3g_8
\
```

```
0             0             0              1              1              1

1             2             0              0              0              0

2             0             1              0              0              0

3             0             0              0              0              0

4             0             0              0              0              0


   monthly_3g_9  sachet_3g_6  sachet_3g_7  sachet_3g_8  sachet_3g_9  \
0             0            0            0            0            0
1             0            0            0            0            0
2             0            0            0            0            0
3             0            0            0            0            0
4             0            0            0            0            0

   fb_user_6  fb_user_7  fb_user_8  fb_user_9   aon  aug_vbc_3g
jul_vbc_3g  \
0        1.0        1.0        1.0        NaN   968        30.4
0.0
1        NaN        1.0        1.0        NaN  1006         0.0
0.0
2        NaN        NaN        NaN        1.0  1103         0.0
0.0
3        NaN        NaN        NaN        NaN  2491         0.0
0.0
4        0.0        NaN        NaN        NaN  1526         0.0
0.0

   jun_vbc_3g  sep_vbc_3g
0      101.20        3.58
1        0.00        0.00
2        4.17        0.00
3        0.00        0.00
4        0.00        0.00
```

Handling the missing values:

```
# Cheking percent of missing values in columns
df_missing_columns =
(round(((df.isnull().sum()/len(df.index))*100),2).to_frame('null')).so
rt_values('null', ascending=False)
df_missing_columns
```

```
                     null
arpu_3g_6           74.85
night_pck_user_6    74.85
total_rech_data_6   74.85
```

```
arpu_2g_6           74.85
max_rech_data_6     74.85
...                   ...
max_rech_amt_7       0.00
max_rech_amt_6       0.00
total_rech_amt_9     0.00
total_rech_amt_8     0.00
sep_vbc_3g           0.00

[226 rows x 1 columns]
```

```
# List the columns having more than 30% missing values
col_list_missing_30 =
list(df_missing_columns.index[df_missing_columns['null'] > 30])

# Delete the columns having more than 30% missing values
df = df.drop(col_list_missing_30, axis=1)

df.shape
```

```
(99999, 186)
```

```
#Deleting the date columns as the date columns are not required in our
analysis
# List the date columns
date_cols = [k for k in df.columns.to_list() if 'date' in k]
print(date_cols)
# Dropping date columns
df = df.drop(date_cols, axis=1)
```

```
['last_date_of_month_6', 'last_date_of_month_7',
'last_date_of_month_8', 'last_date_of_month_9', 'date_of_last_rech_6',
'date_of_last_rech_7', 'date_of_last_rech_8', 'date_of_last_rech_9']
```

```
# Drop circle_id column
df = df.drop('circle_id', axis=1)

df.shape
```

```
(99999, 177)
```

Filter high-value customers:

```
df['avg_rech_amt_6_7'] = (df['total_rech_amt_6'] +
df['total_rech_amt_7'])/2

X = df['avg_rech_amt_6_7'].quantile(0.7)
X
```

```
368.5
```

```
df = df[df['avg_rech_amt_6_7'] >= X]
df.head()
```

```
    mobile_number  loc_og_t2o_mou  std_og_t2o_mou  loc_ic_t2o_mou
arpu_6  \
7      7000701601             0.0             0.0             0.0
1069.180
8      7001524846             0.0             0.0             0.0
378.721
13     7002191713             0.0             0.0             0.0
492.846
16     7000875565             0.0             0.0             0.0
430.975
17     7000187447             0.0             0.0             0.0
690.008

      arpu_7    arpu_8   arpu_9  onnet_mou_6  onnet_mou_7  onnet_mou_8
\
7   1349.850  3171.480  500.000        57.84        54.68        52.29

8    492.223   137.362  166.787       413.69       351.03        35.08

13   205.671   593.260  322.732       501.76       108.39       534.24

16   299.869   187.894  206.490        50.51        74.01        70.61

17    18.980    25.499  257.583      1185.91         9.28         7.79


    onnet_mou_9  offnet_mou_6  offnet_mou_7  offnet_mou_8
offnet_mou_9  \
7           NaN        453.43        567.16        325.91
NaN
8         33.46         94.66         80.63        136.48
108.71
13       244.81        413.31        119.28        482.46
214.06
16        31.34        296.29        229.74        162.76
224.39
17       558.51         61.64          0.00          5.54
87.89

    roam_ic_mou_6  roam_ic_mou_7  roam_ic_mou_8  roam_ic_mou_9
roam_og_mou_6  \
7           16.23          33.49          31.64            NaN
23.74
8            0.00           0.00           0.00           0.00
0.00
13          23.53         144.24          72.11         136.78
7.98
```

```
16           0.00           2.83           0.00           0.00
0.00
17           0.00           4.76           4.81           0.00
0.00

    roam_og_mou_7  roam_og_mou_8  roam_og_mou_9  loc_og_t2t_mou_6  \
7           12.59          38.06            NaN             51.39
8            0.00           0.00           0.00            297.13
13          35.26           1.44          12.78             49.63
16          17.74           0.00           0.00             42.61
17           8.46          13.34          17.98             38.99

    loc_og_t2t_mou_7  loc_og_t2t_mou_8  loc_og_t2t_mou_9
loc_og_t2m_mou_6  \
7              31.38             40.28               NaN
308.63
8             217.59             12.49             26.13
80.96
13             6.19             36.01              6.14
151.13
16            65.16             67.38             26.88
273.29
17             0.00              0.00             36.41
58.54

    loc_og_t2m_mou_7  loc_og_t2m_mou_8  loc_og_t2m_mou_9
loc_og_t2f_mou_6  \
7             447.38            162.28               NaN
62.13
8              70.58             50.54             34.58
0.00
13             47.28            294.46            108.24
4.54
16            145.99            128.28            201.49
0.00
17             0.00              0.00              9.38
0.00

    loc_og_t2f_mou_7  loc_og_t2f_mou_8  loc_og_t2f_mou_9
loc_og_t2c_mou_6  \
7              55.14             53.23               NaN
0.0
8              0.00              0.00              0.00
0.0
13             0.00             23.51              5.29
0.0
16             4.48             10.26              4.66
0.0
17             0.00              0.00              0.00
0.0
```

```
    loc_og_t2c_mou_7  loc_og_t2c_mou_8  loc_og_t2c_mou_9  loc_og_mou_6
\
7                0.0              0.00               NaN        422.16

8                0.0              7.15               0.0        378.09

13               0.0              0.49               0.0        205.31

16               0.0              0.00               0.0        315.91

17               0.0              0.00               0.0         97.54


    loc_og_mou_7  loc_og_mou_8  loc_og_mou_9  std_og_t2t_mou_6  \
7         533.91        255.79           NaN              4.30
8         288.18         63.04         60.71            116.56
13         53.48        353.99        119.69            446.41
16        215.64        205.93        233.04              7.89
17          0.00          0.00         45.79           1146.91

    std_og_t2t_mou_7  std_og_t2t_mou_8  std_og_t2t_mou_9
std_og_t2m_mou_6  \
7              23.29             12.01               NaN
49.89
8             133.43             22.58              7.33
13.69
13             85.98            498.23            230.38
255.36
16              2.58              3.23              4.46
22.99
17              0.81              0.00            504.11
1.55

    std_og_t2m_mou_7  std_og_t2m_mou_8  std_og_t2m_mou_9
std_og_t2f_mou_6  \
7              31.76             49.14               NaN
6.66
8              10.04             75.69             74.13
0.00
13             52.94            156.94             96.01
0.00
16             64.51             18.29             13.79
0.00
17              0.00              0.00             78.51
0.00

    std_og_t2f_mou_7  std_og_t2f_mou_8  std_og_t2f_mou_9
std_og_t2c_mou_6  \
7              20.08             16.68               NaN
```

```
0.0
8                0.00               0.00               0.00
0.0
13               0.00               0.00               0.00
0.0
16               0.00               0.00               4.43
0.0
17               0.00               0.00               0.00
0.0

    std_og_t2c_mou_7  std_og_t2c_mou_8  std_og_t2c_mou_9  std_og_mou_6
\
7                 0.0               0.0               NaN          60.86

8                 0.0               0.0               0.0         130.26

13                0.0               0.0               0.0         701.78

16                0.0               0.0               0.0          30.89

17                0.0               0.0               0.0        1148.46


    std_og_mou_7  std_og_mou_8  std_og_mou_9  isd_og_mou_6
isd_og_mou_7  \
7          75.14         77.84           NaN           0.0
0.18
8         143.48         98.28         81.46           0.0
0.00
13        138.93        655.18        326.39           0.0
0.00
16         67.09         21.53         22.69           0.0
0.00
17          0.81          0.00        582.63           0.0
0.00

    isd_og_mou_8  isd_og_mou_9  spl_og_mou_6  spl_og_mou_7
spl_og_mou_8  \
7          10.01           NaN          4.50          0.00
6.50
8           0.00           0.0          0.00          0.00
10.23
13          1.29           0.0          0.00          0.00
4.78
16          0.00           0.0          0.00          3.26
5.91
17          0.00           0.0          2.58          0.00
0.00

    spl_og_mou_9  og_others_6  og_others_7  og_others_8
```

```
og_others_9  \
7             NaN          0.00           0.0           0.0           NaN

8            0.00          0.00           0.0           0.0           0.0

13           0.00          0.00           0.0           0.0           0.0

16           0.00          0.00           0.0           0.0           0.0

17           2.64          0.93           0.0           0.0           0.0


    total_og_mou_6  total_og_mou_7  total_og_mou_8  total_og_mou_9  \
7           487.53          609.24          350.16            0.00
8           508.36          431.66          171.56          142.18
13          907.09          192.41         1015.26          446.09
16          346.81          286.01          233.38          255.74
17         1249.53            0.81            0.00          631.08

    loc_ic_t2t_mou_6  loc_ic_t2t_mou_7  loc_ic_t2t_mou_8
loc_ic_t2t_mou_9  \
7              58.14             32.26             27.31
NaN
8              23.84              9.84              0.31
4.03
13             67.88              7.58             52.58
24.98
16             41.33             71.44             28.89
50.23
17             34.54              0.00              0.00
40.91

    loc_ic_t2m_mou_6  loc_ic_t2m_mou_7  loc_ic_t2m_mou_8
loc_ic_t2m_mou_9  \
7             217.56            221.49            121.19
NaN
8              57.58             13.98             15.48
17.34
13            142.88             18.53            195.18
104.79
16            226.81            149.69            150.16
172.86
17             47.41              2.31              0.00
43.86

    loc_ic_t2f_mou_6  loc_ic_t2f_mou_7  loc_ic_t2f_mou_8
loc_ic_t2f_mou_9  \
7             152.16            101.46             39.53
NaN
8               0.00              0.00              0.00
```

```
0.00
13               4.81               0.00               7.49
8.51
16               8.71               8.68              32.71
65.21
17               0.00               0.00               0.00
0.71

    loc_ic_mou_6  loc_ic_mou_7  loc_ic_mou_8  loc_ic_mou_9
std_ic_t2t_mou_6  \
7         427.88        355.23        188.04           NaN
36.89
8          81.43         23.83         15.79         21.38
0.00
13        215.58         26.11        255.26        138.29
115.68
16        276.86        229.83        211.78        288.31
68.79
17         81.96          2.31          0.00         85.49
8.63

    std_ic_t2t_mou_7  std_ic_t2t_mou_8  std_ic_t2t_mou_9
std_ic_t2m_mou_6  \
7              11.83             30.39               NaN
91.44
8               0.58              0.10              0.00
22.43
13             38.29            154.58             62.39
308.13
16             78.64              6.33             16.66
18.68
17              0.00              0.00              0.00
1.28

    std_ic_t2m_mou_7  std_ic_t2m_mou_8  std_ic_t2m_mou_9
std_ic_t2f_mou_6  \
7             126.99            141.33               NaN
52.19
8               4.08              0.65             13.53
0.00
13             29.79            317.91            151.51
0.00
16             73.08             73.93             29.58
0.51
17              0.00              0.00              1.63
0.00

    std_ic_t2f_mou_7  std_ic_t2f_mou_8  std_ic_t2f_mou_9
std_ic_t2o_mou_6  \
7              34.24             22.21               NaN
```

```
0.0
8                0.00               0.00                0.0
0.0
13               0.00               1.91                0.0
0.0
16               0.00               2.18                0.0
0.0
17               0.00               0.00                0.0
0.0

    std_ic_t2o_mou_7  std_ic_t2o_mou_8  std_ic_t2o_mou_9  std_ic_mou_6
\
7                 0.0               0.0               NaN        180.54

8                 0.0               0.0               0.0         22.43

13                0.0               0.0               0.0        423.81

16                0.0               0.0               0.0         87.99

17                0.0               0.0               0.0          9.91


    std_ic_mou_7  std_ic_mou_8  std_ic_mou_9  total_ic_mou_6
total_ic_mou_7  \
7         173.08        193.94           NaN          626.46
558.04
8           4.66          0.75         13.53          103.86
28.49
13         68.09        474.41        213.91          968.61
172.58
16        151.73         82.44         46.24          364.86
381.56
17          0.00          0.00          1.63           91.88
2.31

    total_ic_mou_8  total_ic_mou_9  spl_ic_mou_6  spl_ic_mou_7
spl_ic_mou_8  \
7           428.74            0.00          0.21           0.0
0.0
8            16.54           34.91          0.00           0.0
0.0
13         1144.53          631.86          0.45           0.0
0.0
16          294.46          334.56          0.00           0.0
0.0
17            0.00           87.13          0.00           0.0
0.0

    spl_ic_mou_9  isd_ic_mou_6  isd_ic_mou_7  isd_ic_mou_8
```

```
isd_ic_mou_9  \
7            NaN          2.06         14.53         31.59
NaN
8            0.0          0.00          0.00          0.00
0.00
13           0.0        245.28         62.11        393.39
259.33
16           0.0          0.00          0.00          0.23
0.00
17           0.0          0.00          0.00          0.00
0.00

    ic_others_6  ic_others_7  ic_others_8  ic_others_9
total_rech_num_6  \
7         15.74        15.19        15.14          NaN
5
8          0.00         0.00         0.00         0.00
19
13        83.48        16.24        21.44        20.31
6
16         0.00         0.00         0.00         0.00
10
17         0.00         0.00         0.00         0.00
19

    total_rech_num_7  total_rech_num_8  total_rech_num_9
total_rech_amt_6  \
7                  5                 7                 3
1580
8                 21                14                15
437
13                 4                11                 7
507
16                 6                 2                 1
570
17                 2                 4                10
816

    total_rech_amt_7  total_rech_amt_8  total_rech_amt_9
max_rech_amt_6  \
7                790              3638                 0
1580
8                601               120               186
90
13               253               717               353
110
16               348               160               220
110
17                 0                30               335
110
```

```
    max_rech_amt_7  max_rech_amt_8  max_rech_amt_9  last_day_rch_amt_6
\
7              790            1580               0                   0

8              154              30              36                  50

13             110             130             130                 110

16             110             130             220                 100

17               0              30             130                  30


    last_day_rch_amt_7  last_day_rch_amt_8  last_day_rch_amt_9
vol_2g_mb_6  \
7                    0                 779                   0
0.0
8                    0                  10                   0
0.0
13                  50                   0                   0
0.0
16                 100                 130                 220
0.0
17                   0                   0                   0
0.0

    vol_2g_mb_7  vol_2g_mb_8  vol_2g_mb_9  vol_3g_mb_6  vol_3g_mb_7  \
7           0.0         0.00          0.0          0.0         0.00
8         356.0         0.03          0.0          0.0       750.95
13          0.0         0.02          0.0          0.0         0.00
16          0.0         0.00          0.0          0.0         0.00
17          0.0         0.00          0.0          0.0         0.00

    vol_3g_mb_8  vol_3g_mb_9  monthly_2g_6  monthly_2g_7  monthly_2g_8
\
7          0.00          0.0             0             0             0

8         11.94          0.0             0             1             0

13         0.00          0.0             0             0             0

16         0.00          0.0             0             0             0

17         0.00          0.0             0             0             0


    monthly_2g_9  sachet_2g_6  sachet_2g_7  sachet_2g_8
sachet_2g_9  \
7              0            0            0            0            0
```

```
8                0             0              1              3              0

13               0             0              0              3              0

16               0             0              0              0              0

17               0             0              0              0              0


    monthly_3g_6  monthly_3g_7  monthly_3g_8  monthly_3g_9
sachet_3g_6  \
7               0             0             0             0
0
8               0             0             0             0
0
13              0             0             0             0
0
16              0             0             0             0
0
17              0             0             0             0
0

    sachet_3g_7  sachet_3g_8  sachet_3g_9   aon  aug_vbc_3g
jul_vbc_3g  \
7             0            0            0   802       57.74
19.38
8             0            0            0   315       21.03
910.65
13            0            0            0  2607        0.00
0.00
16            0            0            0   511        0.00
2.45
17            0            0            0   667        0.00
0.00

    jun_vbc_3g  sep_vbc_3g  avg_rech_amt_6_7
7        18.74         0.0            1185.0
8       122.16         0.0             519.0
13        0.00         0.0             380.0
16       21.89         0.0             459.0
17        0.00         0.0             408.0

df.shape

(30011, 178)
```

Handling missing values in rows:

```
# Count the rows having more than 50% missing values
df_missing_rows_50 = df[(df.isnull().sum(axis=1)) >
```

```
(len(df.columns)//2)]
df_missing_rows_50.shape
```

```
(114, 178)
```

```
# Deleting the rows having more than 50% missing values
df = df.drop(df_missing_rows_50.index)
df.shape
```

```
(29897, 178)
```

```
# Checking the missing values in columns again
df_missing_columns =
(round(((df.isnull().sum()/len(df.index))*100),2).to_frame('null')).so
rt_values('null', ascending=False)
df_missing_columns
```

```
                     null
loc_ic_mou_9         5.32
og_others_9          5.32
loc_og_t2t_mou_9     5.32
loc_ic_t2t_mou_9     5.32
loc_og_t2m_mou_9     5.32
...                   ...
max_rech_amt_7       0.00
max_rech_amt_8       0.00
max_rech_amt_9       0.00
last_day_rch_amt_6   0.00
avg_rech_amt_6_7     0.00

[178 rows x 1 columns]
```

```
# Listing the columns of MOU Sep(9)
print(((df_missing_columns[df_missing_columns['null'] ==
5.32]).index).to_list())
```

```
['loc_ic_mou_9', 'og_others_9', 'loc_og_t2t_mou_9',
'loc_ic_t2t_mou_9', 'loc_og_t2m_mou_9', 'loc_og_t2f_mou_9',
'loc_og_t2c_mou_9', 'std_ic_t2m_mou_9', 'loc_og_mou_9',
'std_og_t2t_mou_9', 'roam_og_mou_9', 'std_ic_t2o_mou_9',
'std_og_t2m_mou_9', 'std_og_t2f_mou_9', 'spl_og_mou_9',
'std_og_t2c_mou_9', 'std_og_mou_9', 'isd_og_mou_9',
'std_ic_t2t_mou_9', 'std_ic_mou_9', 'onnet_mou_9', 'spl_ic_mou_9',
'ic_others_9', 'isd_ic_mou_9', 'loc_ic_t2f_mou_9', 'offnet_mou_9',
'loc_ic_t2m_mou_9', 'std_ic_t2f_mou_9', 'roam_ic_mou_9']
```

```
# Creating a dataframe with the condition, in which MOU for Sep(9) are
null
df_null_mou_9 = df[(df['loc_og_t2m_mou_9'].isnull()) &
(df['loc_ic_t2f_mou_9'].isnull()) & (df['roam_og_mou_9'].isnull()) &
(df['std_ic_t2m_mou_9'].isnull()) &
```

```
  (df['loc_og_t2t_mou_9'].isnull()) &
(df['std_ic_t2t_mou_9'].isnull()) & (df['loc_og_t2f_mou_9'].isnull())
& (df['loc_ic_mou_9'].isnull()) &
  (df['loc_og_t2c_mou_9'].isnull()) & (df['loc_og_mou_9'].isnull()) &
(df['std_og_t2t_mou_9'].isnull()) & (df['roam_ic_mou_9'].isnull()) &
  (df['loc_ic_t2m_mou_9'].isnull()) &
(df['std_og_t2m_mou_9'].isnull()) & (df['loc_ic_t2t_mou_9'].isnull())
& (df['std_og_t2f_mou_9'].isnull()) &
  (df['std_og_t2c_mou_9'].isnull()) & (df['og_others_9'].isnull()) &
(df['std_og_mou_9'].isnull()) & (df['spl_og_mou_9'].isnull()) &
  (df['std_ic_t2f_mou_9'].isnull()) & (df['isd_og_mou_9'].isnull()) &
(df['std_ic_mou_9'].isnull()) & (df['offnet_mou_9'].isnull()) &
  (df['isd_ic_mou_9'].isnull()) & (df['ic_others_9'].isnull()) &
(df['std_ic_t2o_mou_9'].isnull()) & (df['onnet_mou_9'].isnull()) &
  (df['spl_ic_mou_9'].isnull())]

df_null_mou_9.head()
```

```
     mobile_number  loc_og_t2o_mou  std_og_t2o_mou  loc_ic_t2o_mou
arpu_6  \
7       7000701601             0.0             0.0             0.0
1069.180
97      7000589828             0.0             0.0             0.0
374.863
111     7001300706             0.0             0.0             0.0
596.301
143     7000106299             0.0             0.0             0.0
695.609
188     7000340381             0.0             0.0             0.0
734.641

       arpu_7    arpu_8  arpu_9  onnet_mou_6  onnet_mou_7  onnet_mou_8
\
7    1349.850  3171.480   500.0        57.84        54.68        52.29

97    294.023   183.043     0.0       433.59       415.66       221.06

111   146.073     0.000     0.0        55.19         3.26          NaN

143    39.981     0.000     0.0      1325.91        28.61          NaN

188   183.668     0.000     0.0         4.38         0.98          NaN


     onnet_mou_9  offnet_mou_6  offnet_mou_7  offnet_mou_8
offnet_mou_9  \
7            NaN        453.43        567.16        325.91
NaN
97           NaN         74.54         43.66         31.86
NaN
```

```
111           NaN          45.51          12.34            NaN
NaN
143           NaN          13.91           1.89            NaN
NaN
188           NaN         105.16          39.39            NaN
NaN

     roam_ic_mou_6  roam_ic_mou_7  roam_ic_mou_8  roam_ic_mou_9  \
7            16.23          33.49          31.64            NaN
97            0.00           0.00           6.16            NaN
111           0.00           0.00            NaN            NaN
143           0.00           8.94            NaN            NaN
188           0.00           0.00            NaN            NaN

     roam_og_mou_6  roam_og_mou_7  roam_og_mou_8  roam_og_mou_9  \
7            23.74          12.59          38.06            NaN
97            0.00           0.00          23.91            NaN
111           0.00           0.00            NaN            NaN
143           0.00           8.53            NaN            NaN
188           0.00           0.00            NaN            NaN

     loc_og_t2t_mou_6  loc_og_t2t_mou_7  loc_og_t2t_mou_8
loc_og_t2t_mou_9  \
7               51.39             31.38             40.28
NaN
97               2.83             16.19              9.73
NaN
111             55.19              3.26               NaN
NaN
143             18.89              6.83               NaN
NaN
188              4.38              0.98               NaN
NaN

     loc_og_t2m_mou_6  loc_og_t2m_mou_7  loc_og_t2m_mou_8
loc_og_t2m_mou_9  \
7              308.63            447.38            162.28
NaN
97              16.99             23.14             17.79
NaN
111             43.83             12.34               NaN
NaN
143              8.58              1.56               NaN
NaN
188             99.81             38.98               NaN
NaN

     loc_og_t2f_mou_6  loc_og_t2f_mou_7  loc_og_t2f_mou_8
loc_og_t2f_mou_9  \
7               62.13             55.14             53.23
```

```
NaN
97                3.54               1.46               1.83
NaN
111               0.00               0.00                NaN
NaN
143               0.00               0.00                NaN
NaN
188               5.34               0.41                NaN
NaN

     loc_og_t2c_mou_6  loc_og_t2c_mou_7  loc_og_t2c_mou_8
loc_og_t2c_mou_9  \
7                 0.00               0.0                0.0
NaN
97                0.40               0.0                0.0
NaN
111               0.00               0.0                NaN
NaN
143               2.09               0.0                NaN
NaN
188               0.00               0.0                NaN
NaN

     loc_og_mou_6  loc_og_mou_7  loc_og_mou_8  loc_og_mou_9
std_og_t2t_mou_6  \
7          422.16        533.91        255.79           NaN
4.30
97          23.38         40.81         29.36           NaN
430.76
111         99.03         15.61           NaN           NaN
0.00
143         27.48          8.39           NaN           NaN
1307.01
188        109.54         40.38           NaN           NaN
0.00

     std_og_t2t_mou_7  std_og_t2t_mou_8  std_og_t2t_mou_9
std_og_t2m_mou_6  \
7               23.29             12.01               NaN
49.89
97             399.46            191.31               NaN
53.59
111              0.00               NaN               NaN
0.00
143             13.58               NaN               NaN
1.95
188              0.00               NaN               NaN
0.00

     std_og_t2m_mou_7  std_og_t2m_mou_8  std_og_t2m_mou_9
```

```
std_og_t2f_mou_6  \
7               31.76             49.14                NaN
6.66
97              13.81              8.33                NaN
0.00
111              0.00               NaN                NaN
1.30
143              0.00               NaN                NaN
0.00
188              0.00               NaN                NaN
0.00

     std_og_t2f_mou_7  std_og_t2f_mou_8  std_og_t2f_mou_9
std_og_t2c_mou_6  \
7               20.08             16.68                NaN
0.0
97               0.00              0.00                NaN
0.0
111              0.00               NaN                NaN
0.0
143              0.00               NaN                NaN
0.0
188              0.00               NaN                NaN
0.0

     std_og_t2c_mou_7  std_og_t2c_mou_8  std_og_t2c_mou_9
std_og_mou_6  \
7                 0.0               0.0                NaN
60.86
97                0.0               0.0                NaN
484.36
111               0.0               NaN                NaN
1.30
143               0.0               NaN                NaN
1308.96
188               0.0               NaN                NaN
0.00

     std_og_mou_7  std_og_mou_8  std_og_mou_9  isd_og_mou_6
isd_og_mou_7  \
7           75.14         77.84           NaN           0.0
0.18
97         413.28        199.64           NaN           0.0
0.00
111          0.00           NaN           NaN           0.0
0.00
143         13.58           NaN           NaN           0.0
0.00
188          0.00           NaN           NaN           0.0
0.00
```

```
     isd_og_mou_8  isd_og_mou_9  spl_og_mou_6  spl_og_mou_7
spl_og_mou_8  \
7           10.01           NaN          4.50          0.00
6.50
97           0.00           NaN          2.54         11.81
2.01
111           NaN           NaN          0.38          2.71
NaN
143           NaN           NaN          3.38          0.00
NaN
188           NaN           NaN          0.00          0.00
NaN

     spl_og_mou_9  og_others_6  og_others_7  og_others_8  og_others_9
\
7             NaN         0.00          0.0          0.0           NaN

97            NaN         0.86          0.0          0.0           NaN

111           NaN         1.29          0.0          NaN           NaN

143           NaN         1.20          0.0          NaN           NaN

188           NaN         0.00          0.0          NaN           NaN


     total_og_mou_6  total_og_mou_7  total_og_mou_8  total_og_mou_9  \
7            487.53          609.24          350.16             0.0
97           511.16          465.91          231.03             0.0
111          102.01           18.33            0.00             0.0
143         1341.03           21.98            0.00             0.0
188          109.54           40.38            0.00             0.0

     loc_ic_t2t_mou_6  loc_ic_t2t_mou_7  loc_ic_t2t_mou_8
loc_ic_t2t_mou_9  \
7               58.14             32.26             27.31
NaN
97              11.61             32.89              4.46
NaN
111             50.01             16.66               NaN
NaN
143             30.19              7.06               NaN
NaN
188             21.18             13.44               NaN
NaN

     loc_ic_t2m_mou_6  loc_ic_t2m_mou_7  loc_ic_t2m_mou_8
loc_ic_t2m_mou_9  \
7              217.56            221.49            121.19
```

```
NaN
97               16.94              26.94              26.63
NaN
111             160.68              58.53                NaN
NaN
143              27.98               1.35                NaN
NaN
188             217.03              56.63                NaN
NaN

     loc_ic_t2f_mou_6  loc_ic_t2f_mou_7  loc_ic_t2f_mou_8
loc_ic_t2f_mou_9  \
7               152.16            101.46              39.53
NaN
97                0.98              0.63               0.00
NaN
111               5.06              0.40                NaN
NaN
143              10.13              0.00                NaN
NaN
188              18.28              2.94                NaN
NaN

     loc_ic_mou_6  loc_ic_mou_7  loc_ic_mou_8  loc_ic_mou_9
std_ic_t2t_mou_6  \
7          427.88        355.23        188.04           NaN
36.89
97          29.54         60.48         31.09           NaN
0.49
111        215.76         75.59           NaN           NaN
0.00
143         68.31          8.41           NaN           NaN
25.56
188        256.49         73.03           NaN           NaN
0.00

     std_ic_t2t_mou_7  std_ic_t2t_mou_8  std_ic_t2t_mou_9
std_ic_t2m_mou_6  \
7               11.83             30.39                NaN
91.44
97               1.36              1.06                NaN
0.00
111              0.00               NaN                NaN
0.00
143              0.00               NaN                NaN
0.00
188              0.00               NaN                NaN
0.00

     std_ic_t2m_mou_7  std_ic_t2m_mou_8  std_ic_t2m_mou_9
```

```
std_ic_t2f_mou_6  \
7              126.99             141.33                NaN
52.19
97               4.16               0.00                NaN
0.00
111              0.00                NaN                NaN
1.13
143              0.00                NaN                NaN
0.00
188              0.00                NaN                NaN
0.00

     std_ic_t2f_mou_7  std_ic_t2f_mou_8  std_ic_t2f_mou_9
std_ic_t2o_mou_6  \
7               34.24              22.21                NaN
0.0
97               0.00               0.00                NaN
0.0
111              0.00                NaN                NaN
0.0
143              0.00                NaN                NaN
0.0
188              0.00                NaN                NaN
0.0

     std_ic_t2o_mou_7  std_ic_t2o_mou_8  std_ic_t2o_mou_9
std_ic_mou_6  \
7                 0.0                0.0                NaN
180.54
97                0.0                0.0                NaN
0.49
111               0.0                NaN                NaN
1.13
143               0.0                NaN                NaN
25.56
188               0.0                NaN                NaN
0.00

     std_ic_mou_7  std_ic_mou_8  std_ic_mou_9  total_ic_mou_6
total_ic_mou_7  \
7          173.08        193.94           NaN          626.46
558.04
97           5.53          1.06           NaN           32.04
67.84
111          0.00           NaN           NaN          217.04
75.59
143          0.00           NaN           NaN           93.88
8.41
188          0.00           NaN           NaN          256.49
73.03
```

```
     total_ic_mou_8  total_ic_mou_9  spl_ic_mou_6  spl_ic_mou_7
spl_ic_mou_8  \
7            428.74             0.0          0.21           0.0
0.0
97            32.16             0.0          0.63           0.0
0.0
111            0.00             0.0          0.00           0.0
NaN
143            0.00             0.0          0.00           0.0
NaN
188            0.00             0.0          0.00           0.0
NaN

     spl_ic_mou_9  isd_ic_mou_6  isd_ic_mou_7  isd_ic_mou_8
isd_ic_mou_9  \
7             NaN          2.06         14.53         31.59
NaN
97            NaN          0.00          0.00          0.00
NaN
111           NaN          0.00          0.00           NaN
NaN
143           NaN          0.00          0.00           NaN
NaN
188           NaN          0.00          0.00           NaN
NaN

     ic_others_6  ic_others_7  ic_others_8  ic_others_9
total_rech_num_6  \
7          15.74        15.19        15.14          NaN
5
97          1.36         1.83         0.00          NaN
14
111         0.15         0.00          NaN          NaN
12
143         0.00         0.00          NaN          NaN
31
188         0.00         0.00          NaN          NaN
6

     total_rech_num_7  total_rech_num_8  total_rech_num_9
total_rech_amt_6  \
7                   5                 7                 3
1580
97                 17                14                 3
432
111                 8                 5                 2
704
143                 6                 4                 2
796
```

```
188                  1                  0                  0
864

     total_rech_amt_7  total_rech_amt_8  total_rech_amt_9
max_rech_amt_6  \
7                 790               3638                  0
1580
97                328                206                  0
36
111               178                  0                  0
154
143                40                  0                  0
90
188               120                  0                  0
252

     max_rech_amt_7  max_rech_amt_8  max_rech_amt_9
last_day_rch_amt_6  \
7                790            1580                0
0
97                44              36                0
30
111               50               0                0
154
143               30               0                0
10
188              120               0                0
252

     last_day_rch_amt_7  last_day_rch_amt_8  last_day_rch_amt_9
vol_2g_mb_6  \
7                     0                 779                   0
0.00
97                   20                   0                   0
0.00
111                  30                   0                   0
284.50
143                   0                   0                   0
0.00
188                 120                   0                   0
58.44

     vol_2g_mb_7  vol_2g_mb_8  vol_2g_mb_9  vol_3g_mb_6
vol_3g_mb_7  \
7            0.0          0.0          0.0          0.0          0.0

97           0.0          0.0          0.0          0.0          0.0

111          0.0          0.0          0.0          0.0          0.0
```

```
143          0.0           0.0           0.0           0.0           0.0

188          0.0           0.0           0.0        1522.4           0.0


     vol_3g_mb_8  vol_3g_mb_9  monthly_2g_6  monthly_2g_7
monthly_2g_8  \
7            0.0          0.0             0             0
0
97           0.0          0.0             0             0
0
111          0.0          0.0             1             0
0
143          0.0          0.0             0             0
0
188          0.0          0.0             0             0
0

     monthly_2g_9  sachet_2g_6  sachet_2g_7  sachet_2g_8  sachet_2g_9
\
7               0            0            0            0            0

97              0            0            0            0            0

111             0            0            0            0            0

143             0            0            0            0            0

188             0            0            0            0            0


     monthly_3g_6  monthly_3g_7  monthly_3g_8  monthly_3g_9
sachet_3g_6  \
7               0             0             0             0
0
97              0             0             0             0
0
111             0             0             0             0
1
143             0             0             0             0
0
188             2             0             0             0
0

     sachet_3g_7  sachet_3g_8  sachet_3g_9  aon  aug_vbc_3g
jul_vbc_3g  \
7              0            0            0  802       57.74
19.38
97             0            0            0  502        0.00
0.00
```

```
111             0             0             0  332        0.00
0.00
143             0             0             0  264        0.00
0.00
188             0             0             0  244        0.00
831.48
```

```
     jun_vbc_3g  sep_vbc_3g  avg_rech_amt_6_7
7         18.74         0.0            1185.0
97         0.00         0.0             380.0
111        0.00         0.0             441.0
143        0.00         0.0             418.0
188     1223.04         0.0             492.0
```

```
df_null_mou_9.shape
```

```
(1590, 178)
```

```
# Deleting the records for which MOU for Sep(9) are null
df = df.drop(df_null_mou_9.index)
```

```
# Again Cheking percent of missing values in columns
df_missing_columns =
(round(((df.isnull().sum()/len(df.index))*100),2).to_frame('null')).so
rt_values('null', ascending=False)
df_missing_columns
```

```
                   null
isd_og_mou_8       0.55
roam_ic_mou_8      0.55
loc_og_mou_8       0.55
std_ic_t2o_mou_8   0.55
roam_og_mou_8      0.55
...                 ...
total_og_mou_9     0.00
total_og_mou_8     0.00
total_og_mou_7     0.00
total_og_mou_6     0.00
avg_rech_amt_6_7   0.00

[178 rows x 1 columns]
```

```
# Listing the columns of MOU Aug(8)
print(((df_missing_columns[df_missing_columns['null'] ==
0.55]).index).to_list())
```

```
['isd_og_mou_8', 'roam_ic_mou_8', 'loc_og_mou_8', 'std_ic_t2o_mou_8',
'roam_og_mou_8', 'loc_ic_t2f_mou_8', 'loc_og_t2t_mou_8',
'std_ic_t2f_mou_8', 'std_og_t2m_mou_8', 'loc_og_t2m_mou_8',
'std_og_t2t_mou_8', 'std_ic_t2m_mou_8', 'loc_og_t2f_mou_8',
'spl_og_mou_8', 'loc_ic_mou_8', 'loc_og_t2c_mou_8',
```

```
'std_ic_t2t_mou_8', 'loc_ic_t2m_mou_8', 'std_og_t2f_mou_8',
'spl_ic_mou_8', 'std_ic_mou_8', 'offnet_mou_8', 'ic_others_8',
'og_others_8', 'loc_ic_t2t_mou_8', 'onnet_mou_8', 'isd_ic_mou_8',
'std_og_t2c_mou_8', 'std_og_mou_8']

# Creating a dataframe with the condition, in which MOU for Aug(8) are
null
df_null_mou_8 = df[(df['loc_og_t2m_mou_8'].isnull()) &
(df['loc_ic_t2f_mou_8'].isnull()) & (df['roam_og_mou_8'].isnull()) &
(df['std_ic_t2m_mou_8'].isnull()) &
  (df['loc_og_t2t_mou_8'].isnull()) &
(df['std_ic_t2t_mou_8'].isnull()) & (df['loc_og_t2f_mou_8'].isnull())
& (df['loc_ic_mou_8'].isnull()) &
  (df['loc_og_t2c_mou_8'].isnull()) & (df['loc_og_mou_8'].isnull()) &
(df['std_og_t2t_mou_8'].isnull()) & (df['roam_ic_mou_8'].isnull()) &
  (df['loc_ic_t2m_mou_8'].isnull()) &
(df['std_og_t2m_mou_8'].isnull()) & (df['loc_ic_t2t_mou_8'].isnull())
& (df['std_og_t2f_mou_8'].isnull()) &
  (df['std_og_t2c_mou_8'].isnull()) & (df['og_others_8'].isnull()) &
(df['std_og_mou_8'].isnull()) & (df['spl_og_mou_8'].isnull()) &
  (df['std_ic_t2f_mou_8'].isnull()) & (df['isd_og_mou_8'].isnull()) &
(df['std_ic_mou_8'].isnull()) & (df['offnet_mou_8'].isnull()) &
  (df['isd_ic_mou_8'].isnull()) & (df['ic_others_8'].isnull()) &
(df['std_ic_t2o_mou_8'].isnull()) & (df['onnet_mou_8'].isnull()) &
  (df['spl_ic_mou_8'].isnull())]

df_null_mou_8.head()
```

```
      mobile_number  loc_og_t2o_mou  std_og_t2o_mou  loc_ic_t2o_mou
arpu_6  \
375      7002252754             0.0             0.0             0.0
580.477
578      7000248548             0.0             0.0             0.0
569.612
788      7000636808             0.0             0.0             0.0
532.742
1802     7000516213             0.0             0.0             0.0
810.455
4837     7002192662             0.0             0.0             0.0
649.150

       arpu_7  arpu_8   arpu_9  onnet_mou_6  onnet_mou_7  onnet_mou_8
\
375   111.878     0.0  378.881       249.43        39.64          NaN

578   237.289     0.0    4.440       718.01       212.73          NaN

788   546.756     0.0  269.274      1173.39       891.83          NaN

1802    0.000     0.0    0.000        91.33          NaN          NaN
```

```
4837  149.572     0.0    0.250      1354.24         85.13           NaN


      onnet_mou_9  offnet_mou_6  offnet_mou_7  offnet_mou_8
offnet_mou_9  \
375         245.06          62.24          37.24            NaN
144.53
578           0.00         487.06         139.71            NaN
1.26
788         149.34          61.59         137.14            NaN
428.36
1802          0.00        1371.04            NaN            NaN
0.00
4837          0.43          50.63          37.13            NaN
0.00

      roam_ic_mou_6  roam_ic_mou_7  roam_ic_mou_8  roam_ic_mou_9  \
375           25.49          19.43            NaN           0.00
578            0.00           2.01            NaN           6.43
788            0.00           1.48            NaN           0.00
1802           1.21            NaN            NaN           0.00
4837           0.00          12.84            NaN           1.25

      roam_og_mou_6  roam_og_mou_7  roam_og_mou_8  roam_og_mou_9  \
375          312.59          78.58            NaN           0.00
578            0.00           6.30            NaN           1.26
788            0.00          14.43            NaN           0.00
1802          11.23            NaN            NaN           3.91
4837           0.00          44.78            NaN           0.43

      loc_og_t2t_mou_6  loc_og_t2t_mou_7  loc_og_t2t_mou_8
loc_og_t2t_mou_9  \
375               0.00              0.00               NaN
11.54
578              11.28             27.89               NaN
0.00
788              31.06             27.49               NaN
7.39
1802             17.86               NaN               NaN
0.00
4837              6.71              1.35               NaN
0.00

      loc_og_t2m_mou_6  loc_og_t2m_mou_7  loc_og_t2m_mou_8
loc_og_t2m_mou_9  \
375               0.00              0.00               NaN
25.31
578              42.24             46.94               NaN
0.00
```

```
788               34.66              60.86                NaN
34.23
1802              84.51                NaN                NaN
0.00
4837              15.18              15.76                NaN
0.00

      loc_og_t2f_mou_6  loc_og_t2f_mou_7  loc_og_t2f_mou_8
loc_og_t2f_mou_9  \
375                0.0               0.0                NaN
0.0
578                0.0               0.0                NaN
0.0
788                0.0               0.0                NaN
0.0
1802               0.0               NaN                NaN
0.0
4837               0.0               0.0                NaN
0.0

      loc_og_t2c_mou_6  loc_og_t2c_mou_7  loc_og_t2c_mou_8
loc_og_t2c_mou_9  \
375                0.00              0.0                NaN
0.41
578                2.33              0.0                NaN
0.00
788                0.00              0.0                NaN
5.58
1802              10.29              NaN                NaN
0.00
4837               0.00              0.0                NaN
0.00

      loc_og_mou_6  loc_og_mou_7  loc_og_mou_8  loc_og_mou_9  \
375           0.00          0.00           NaN         36.86
578          53.53         74.84           NaN          0.00
788          65.73         88.36           NaN         41.63
1802        102.38           NaN           NaN          0.00
4837         21.89         17.11           NaN          0.00

      std_og_t2t_mou_6  std_og_t2t_mou_7  std_og_t2t_mou_8
std_og_t2t_mou_9  \
375                0.00              0.00               NaN
233.51
578              706.73            178.53               NaN
0.00
788             1142.33            854.08               NaN
141.94
1802              73.46               NaN               NaN
0.00
```

```
4837           1347.53              48.48                NaN
0.00

      std_og_t2m_mou_6  std_og_t2m_mou_7  std_og_t2m_mou_8
std_og_t2m_mou_9  \
375               0.00              0.00                NaN
118.79
578             442.48             92.76                NaN
0.00
788              26.93             67.24                NaN
388.54
1802           1207.86               NaN                NaN
0.00
4837             35.44             11.88                NaN
0.00

      std_og_t2f_mou_6  std_og_t2f_mou_7  std_og_t2f_mou_8
std_og_t2f_mou_9  \
375                0.0               0.0                NaN
0.0
578                0.0               0.0                NaN
0.0
788                0.0               0.0                NaN
0.0
1802               0.0               NaN                NaN
0.0
4837               0.0               0.0                NaN
0.0

      std_og_t2c_mou_6  std_og_t2c_mou_7  std_og_t2c_mou_8
std_og_t2c_mou_9  \
375                0.0               0.0                NaN
0.0
578                0.0               0.0                NaN
0.0
788                0.0               0.0                NaN
0.0
1802               0.0               NaN                NaN
0.0
4837               0.0               0.0                NaN
0.0

      std_og_mou_6  std_og_mou_7  std_og_mou_8  std_og_mou_9
isd_og_mou_6  \
375           0.00          0.00           NaN        352.31
0.0
578        1149.21        271.29           NaN          0.00
0.0
788        1169.26        921.33           NaN        530.49
0.0
```

```
1802       1281.33           NaN           NaN          0.00
0.0
4837       1382.98         60.36           NaN          0.00
0.0

      isd_og_mou_7  isd_og_mou_8  isd_og_mou_9  spl_og_mou_6
spl_og_mou_7  \
375            0.0           NaN           0.0          0.00
0.00
578            0.0           NaN           0.0          2.58
1.21
788            0.0           NaN           0.0          0.00
4.85
1802           NaN           NaN           0.0         91.94
NaN
4837           0.0           NaN           0.0          0.00
0.00

      spl_og_mou_8  spl_og_mou_9  og_others_6  og_others_7
og_others_8  \
375            NaN          4.78         0.00          0.0
NaN
578            NaN          0.00         1.55          0.0
NaN
788            NaN          5.58         0.00          0.0
NaN
1802           NaN          0.00         1.53          NaN
NaN
4837           NaN          0.00         0.00          0.0
NaN

      og_others_9  total_og_mou_6  total_og_mou_7  total_og_mou_8  \
375           0.0            0.00            0.00             0.0
578           0.0         1206.88          347.36             0.0
788           0.0         1234.99         1014.54             0.0
1802          0.0         1477.19            0.00             0.0
4837          0.0         1404.88           77.48             0.0

      total_og_mou_9  loc_ic_t2t_mou_6  loc_ic_t2t_mou_7
loc_ic_t2t_mou_8  \
375           393.96              0.00              0.00
NaN
578             0.00             48.01             63.39
NaN
788           577.71             54.19             52.64
NaN
1802            0.00             17.68               NaN
NaN
4837            0.00            104.46              3.15
NaN
```

```
      loc_ic_t2t_mou_9  loc_ic_t2m_mou_6  loc_ic_t2m_mou_7
loc_ic_t2m_mou_8  \
375               6.74              0.00              0.00
NaN
578               0.00             83.09             64.31
NaN
788              12.51             54.69            187.96
NaN
1802              0.00             39.46               NaN
NaN
4837              0.00            162.01             17.94
NaN

      loc_ic_t2m_mou_9  loc_ic_t2f_mou_6  loc_ic_t2f_mou_7
loc_ic_t2f_mou_8  \
375              38.53              0.00              0.00
NaN
578               0.00              0.00              0.00
NaN
788              81.83              1.16              2.01
NaN
1802              0.00              0.70               NaN
NaN
4837              0.00              0.00              0.00
NaN

      loc_ic_t2f_mou_9  loc_ic_mou_6  loc_ic_mou_7  loc_ic_mou_8  \
375                0.0          0.00          0.00           NaN
578                0.0        131.11        127.71           NaN
788                0.0        110.06        242.63           NaN
1802               0.0         57.84           NaN           NaN
4837               0.0        266.48         21.09           NaN

      loc_ic_mou_9  std_ic_t2t_mou_6  std_ic_t2t_mou_7
std_ic_t2t_mou_8  \
375          45.28              0.00              0.00
NaN
578           0.00             24.98             46.43
NaN
788          94.34             14.55              5.48
NaN
1802          0.00              1.88               NaN
NaN
4837          0.00             35.11             31.96
NaN

      std_ic_t2t_mou_9  std_ic_t2m_mou_6  std_ic_t2m_mou_7
std_ic_t2m_mou_8  \
375               8.31              0.00              0.00
```

```
NaN
578                0.00               1.63              16.69
NaN
788               25.61              11.49              62.19
NaN
1802               0.00              11.98                NaN
NaN
4837               0.00              48.48               0.00
NaN

      std_ic_t2m_mou_9  std_ic_t2f_mou_6  std_ic_t2f_mou_7
std_ic_t2f_mou_8  \
375               27.31               0.00                0.0
NaN
578                0.00               0.00                0.0
NaN
788               13.93               0.00                0.0
NaN
1802               0.00               0.00                NaN
NaN
4837               0.00               0.28                0.0
NaN

      std_ic_t2f_mou_9  std_ic_t2o_mou_6  std_ic_t2o_mou_7
std_ic_t2o_mou_8  \
375                0.0                0.0                0.0
NaN
578                0.0                0.0                0.0
NaN
788                0.0                0.0                0.0
NaN
1802               0.0                0.0                NaN
NaN
4837               0.0                0.0                0.0
NaN

      std_ic_t2o_mou_9  std_ic_mou_6  std_ic_mou_7  std_ic_mou_8  \
375                0.0          0.00          0.00           NaN
578                0.0         26.61         63.13           NaN
788                0.0         26.04         67.68           NaN
1802               0.0         13.86           NaN           NaN
4837               0.0         83.88         31.96           NaN

      std_ic_mou_9  total_ic_mou_6  total_ic_mou_7  total_ic_mou_8  \
375          35.63            0.00            0.00             0.0
578           0.00          157.73          190.84             0.0
788          39.54          140.74          310.31             0.0
1802          0.00           71.71            0.00             0.0
4837          0.00          350.36           53.06             0.0
```

```
      total_ic_mou_9  spl_ic_mou_6  spl_ic_mou_7  spl_ic_mou_8
spl_ic_mou_9  \
375            80.91          0.00           0.0           NaN
0.00
578             0.00          0.00           0.0           NaN
0.00
788           134.14          0.73           0.0           NaN
0.25
1802            0.00          0.00           NaN           NaN
0.00
4837            0.00          0.00           0.0           NaN
0.00

      isd_ic_mou_6  isd_ic_mou_7  isd_ic_mou_8  isd_ic_mou_9
ic_others_6  \
375            0.0           0.0           NaN           0.0
0.00
578            0.0           0.0           NaN           0.0
0.00
788            0.0           0.0           NaN           0.0
3.89
1802           0.0           NaN           NaN           0.0
0.00
4837           0.0           0.0           NaN           0.0
0.00

      ic_others_7  ic_others_8  ic_others_9  total_rech_num_6  \
375           0.0          NaN          0.0                17
578           0.0          NaN          0.0                19
788           0.0          NaN          0.0                10
1802          NaN          NaN          0.0                21
4837          0.0          NaN          0.0                11

      total_rech_num_7  total_rech_num_8  total_rech_num_9
total_rech_amt_6  \
375                  6                 3                11
700
578                 10                 0                 4
717
788                  7                 4                 5
714
1802                 3                 0                 0
955
4837                 6                 3                 4
666

      total_rech_amt_7  total_rech_amt_8  total_rech_amt_9
max_rech_amt_6  \
375               130                 0               440
80
```

```
578                 220                   0                   0
110
788                 494                   0                 336
128
1802                  0                   0                   0
110
4837                176                   0                   0
110

      max_rech_amt_7  max_rech_amt_8  max_rech_amt_9
last_day_rch_amt_6  \
375                50               0              50
30
578                50               0               0
27
788               128               0             130
128
1802               0               0               0
30
4837              110               0               0
20

      last_day_rch_amt_7  last_day_rch_amt_8  last_day_rch_amt_9
vol_2g_mb_6  \
375                    0                   0                  30
0.0
578                   30                   0                   0
0.0
788                    0                   0                 130
0.0
1802                   0                   0                   0
0.0
4837                   0                   0                   0
0.0

      vol_2g_mb_7  vol_2g_mb_8  vol_2g_mb_9  vol_3g_mb_6  vol_3g_mb_7
\
375          0.0          0.0          0.0          0.0          0.0

578          0.0          0.0          0.0          0.0          0.0

788          0.0          0.0          0.0          0.0          0.0

1802         0.0          0.0          0.0          0.0          0.0

4837         0.0          0.0          0.0          0.0          0.0


      vol_3g_mb_8  vol_3g_mb_9  monthly_2g_6  monthly_2g_7
monthly_2g_8  \
```

```
375            0.0           0.0              0              0
0
578            0.0           0.0              0              0
0
788            0.0           0.0              0              0
0
1802           0.0           0.0              0              0
0
4837           0.0           0.0              0              0
0

      monthly_2g_9  sachet_2g_6  sachet_2g_7  sachet_2g_8  sachet_2g_9
\
375              0            0            0            0            0

578              0            0            0            0            0

788              0            0            0            0            0

1802             0            0            0            0            0

4837             0            0            0            0            0


      monthly_3g_6  monthly_3g_7  monthly_3g_8  monthly_3g_9
sachet_3g_6  \
375              0             0             0             0
0
578              0             0             0             0
0
788              0             0             0             0
0
1802             0             0             0             0
0
4837             0             0             0             0
0

      sachet_3g_7  sachet_3g_8  sachet_3g_9   aon  aug_vbc_3g
jul_vbc_3g  \
375             0            0            0  1102         0.0
0.0
578             0            0            0   274         0.0
0.0
788             0            0            0   936         0.0
0.0
1802            0            0            0   755         0.0
0.0
4837            0            0            0   520         0.0
0.0
```

```
      jun_vbc_3g  sep_vbc_3g  avg_rech_amt_6_7
375          0.0         0.0             415.0
578          0.0         0.0             468.5
788          0.0         0.0             604.0
1802         0.0         0.0             477.5
4837         0.0         0.0             421.0
```

```
# Deleting the records for which MOU for Aug(8) are null
df = df.drop(df_null_mou_8.index)
```

```
# Again cheking percent of missing values in columns
df_missing_columns =
(round(((df.isnull().sum()/len(df.index))*100),2).to_frame('null')).so
rt_values('null', ascending=False)
df_missing_columns
```

```
                   null
roam_ic_mou_6      0.44
spl_og_mou_6       0.44
og_others_6        0.44
loc_ic_t2t_mou_6   0.44
loc_og_t2m_mou_6   0.44
...                 ...
isd_og_mou_9       0.00
isd_og_mou_8       0.00
std_og_mou_9       0.00
std_og_mou_8       0.00
avg_rech_amt_6_7   0.00

[178 rows x 1 columns]
```

```
# Listing the columns of MOU Jun(6)
print(((df_missing_columns[df_missing_columns['null'] ==
0.44]).index).to_list())
```

```
['roam_ic_mou_6', 'spl_og_mou_6', 'og_others_6', 'loc_ic_t2t_mou_6',
'loc_og_t2m_mou_6', 'loc_og_t2c_mou_6', 'loc_ic_t2m_mou_6',
'isd_og_mou_6', 'loc_og_t2t_mou_6', 'std_og_t2m_mou_6',
'loc_ic_t2f_mou_6', 'ic_others_6', 'roam_og_mou_6', 'loc_ic_mou_6',
'std_og_mou_6', 'loc_og_t2f_mou_6', 'isd_ic_mou_6',
'std_ic_t2t_mou_6', 'std_ic_mou_6', 'std_og_t2t_mou_6',
'std_ic_t2o_mou_6', 'std_og_t2f_mou_6', 'std_ic_t2f_mou_6',
'spl_ic_mou_6', 'onnet_mou_6', 'std_og_t2c_mou_6', 'std_ic_t2m_mou_6',
'offnet_mou_6', 'loc_og_mou_6']
```

```
# Creating a dataframe with the condition, in which MOU for Jun(6) are
null
df_null_mou_6 = df[(df['loc_og_t2m_mou_6'].isnull()) &
(df['loc_ic_t2f_mou_6'].isnull()) & (df['roam_og_mou_6'].isnull()) &
(df['std_ic_t2m_mou_6'].isnull()) &
  (df['loc_og_t2t_mou_6'].isnull()) &
```

```
(df['std_ic_t2t_mou_6'].isnull()) & (df['loc_og_t2f_mou_6'].isnull())
& (df['loc_ic_mou_6'].isnull()) &
  (df['loc_og_t2c_mou_6'].isnull()) & (df['loc_og_mou_6'].isnull()) &
(df['std_og_t2t_mou_6'].isnull()) & (df['roam_ic_mou_6'].isnull()) &
  (df['loc_ic_t2m_mou_6'].isnull()) &
(df['std_og_t2m_mou_6'].isnull()) & (df['loc_ic_t2t_mou_6'].isnull())
& (df['std_og_t2f_mou_6'].isnull()) &
  (df['std_og_t2c_mou_6'].isnull()) & (df['og_others_6'].isnull()) &
(df['std_og_mou_6'].isnull()) & (df['spl_og_mou_6'].isnull()) &
  (df['std_ic_t2f_mou_6'].isnull()) & (df['isd_og_mou_6'].isnull()) &
(df['std_ic_mou_6'].isnull()) & (df['offnet_mou_6'].isnull()) &
  (df['isd_ic_mou_6'].isnull()) & (df['ic_others_6'].isnull()) &
(df['std_ic_t2o_mou_6'].isnull()) & (df['onnet_mou_6'].isnull()) &
  (df['spl_ic_mou_6'].isnull())]

df_null_mou_6.head()
```

```
      mobile_number  loc_og_t2o_mou  std_og_t2o_mou  loc_ic_t2o_mou
arpu_6  \
77       7001328263             0.0             0.0             0.0
30.000
364      7002168045             0.0             0.0             0.0
0.000
423      7000635248             0.0             0.0             0.0
213.802
934      7002152278             0.0             0.0             0.0
48.000
1187     7000486275             0.0             0.0             0.0
0.000

       arpu_7   arpu_8   arpu_9  onnet_mou_6  onnet_mou_7  onnet_mou_8
\
77     82.378  674.950  158.710          NaN        34.23       149.69

364   792.112  989.368  923.040          NaN       433.49       198.96

423   304.194  149.710  329.643          NaN         0.00         0.00

934   764.152  500.030  194.400          NaN        14.24        17.48

1187  757.170  995.719    0.000          NaN      1366.71      2268.91


      onnet_mou_9  offnet_mou_6  offnet_mou_7  offnet_mou_8
offnet_mou_9  \
77           6.31           NaN         39.44        179.18
57.68
364        571.99           NaN        845.11        923.58
828.29
423          0.00           NaN         10.03          1.45
```

```
0.34
934          7.69           NaN         16.99         76.86
43.64
1187         0.00           NaN          7.78         36.13
0.00

      roam_ic_mou_6  roam_ic_mou_7  roam_ic_mou_8  roam_ic_mou_9  \
77              NaN            0.0           0.00            0.0
364             NaN            0.0           0.00            0.0
423             NaN            0.0           0.00            0.0
934             NaN            0.0           8.81            0.0
1187            NaN            0.0           8.08            0.0

      roam_og_mou_6  roam_og_mou_7  roam_og_mou_8  roam_og_mou_9  \
77              NaN            0.0           0.00           0.00
364             NaN            0.0           0.00           0.00
423             NaN            0.0           0.00           0.00
934             NaN            0.0           1.56           0.00
1187            NaN            0.0          25.23           0.21

      loc_og_t2t_mou_6  loc_og_t2t_mou_7  loc_og_t2t_mou_8
loc_og_t2t_mou_9  \
77                 NaN             34.23            149.69
6.31
364                NaN             28.78              7.46
64.73
423                NaN              0.00              0.00
0.00
934                NaN              0.08             17.48
7.69
1187               NaN              4.76             46.18
0.00

      loc_og_t2m_mou_6  loc_og_t2m_mou_7  loc_og_t2m_mou_8
loc_og_t2m_mou_9  \
77                 NaN             32.18            101.63
29.41
364                NaN             78.78            584.76
490.71
423                NaN              0.00              0.58
0.33
934                NaN             16.99             63.23
39.99
1187               NaN              7.78             31.29
0.00

      loc_og_t2f_mou_6  loc_og_t2f_mou_7  loc_og_t2f_mou_8
loc_og_t2f_mou_9  \
77                 NaN              0.91             29.86
28.26
```

```
364                  NaN              21.58               9.43
0.00
423                  NaN               0.00               0.00
0.00
934                  NaN               0.00              12.08
3.65
1187                 NaN               0.00               0.00
0.00

      loc_og_t2c_mou_6  loc_og_t2c_mou_7  loc_og_t2c_mou_8
loc_og_t2c_mou_9  \
77                   NaN               0.0                3.9
0.00
364                  NaN               0.0                0.0
2.78
423                  NaN               0.0                0.0
0.00
934                  NaN               0.0                0.0
0.00
1187                 NaN               0.0                0.0
0.00

      loc_og_mou_6  loc_og_mou_7  loc_og_mou_8  loc_og_mou_9  \
77             NaN         67.33        281.19         63.99
364            NaN        129.14        601.66        555.44
423            NaN          0.00          0.58          0.33
934            NaN         17.08         92.79         51.34
1187           NaN         12.54         77.48          0.00

      std_og_t2t_mou_6  std_og_t2t_mou_7  std_og_t2t_mou_8
std_og_t2t_mou_9  \
77                   NaN               0.00               0.00
0.00
364                  NaN             404.71             191.49
507.26
423                  NaN               0.00               0.00
0.00
934                  NaN              14.16               0.00
0.00
1187                 NaN            1361.94            2202.03
0.00

      std_og_t2m_mou_6  std_og_t2m_mou_7  std_og_t2m_mou_8
std_og_t2m_mou_9  \
77                   NaN               0.00               0.00
0.00
364                  NaN             722.01             321.41
302.91
423                  NaN               0.00               0.25
0.00
```

```
934                 NaN               0.00               0.00
0.00
1187                NaN               0.00               1.13
0.00

      std_og_t2f_mou_6  std_og_t2f_mou_7  std_og_t2f_mou_8
std_og_t2f_mou_9  \
77                  NaN               6.35              40.09
0.0
364                 NaN               0.00               0.00
0.0
423                 NaN               0.00               0.61
0.0
934                 NaN               0.00               0.00
0.0
1187                NaN               0.00               0.00
0.0

      std_og_t2c_mou_6  std_og_t2c_mou_7  std_og_t2c_mou_8
std_og_t2c_mou_9  \
77                  NaN               0.0                0.0
0.0
364                 NaN               0.0                0.0
0.0
423                 NaN               0.0                0.0
0.0
934                 NaN               0.0                0.0
0.0
1187                NaN               0.0                0.0
0.0

      std_og_mou_6  std_og_mou_7  std_og_mou_8  std_og_mou_9
isd_og_mou_6  \
77             NaN          6.35         40.09          0.00
NaN
364            NaN       1126.73        512.91        810.18
NaN
423            NaN          0.00          0.86          0.00
NaN
934            NaN         14.16          0.00          0.00
NaN
1187           NaN       1361.94       2203.16          0.00
NaN

      isd_og_mou_7  isd_og_mou_8  isd_og_mou_9  spl_og_mou_6
spl_og_mou_7  \
77            2.93         28.04          3.25           NaN
0.00
364           0.00          0.00          0.00           NaN
45.14
```

```
423          10.03          0.00          0.01           NaN
0.00
934          20.13          8.41          0.00           NaN
0.00
1187          0.00          0.00          0.00           NaN
3.34

      spl_og_mou_8  spl_og_mou_9  og_others_6  og_others_7
og_others_8  \
77             7.58          0.00          NaN          0.0
0.0
364           13.84         37.74          NaN          0.0
0.0
423            0.00          0.00          NaN          0.0
0.0
934            0.00          0.00          NaN          0.0
0.0
1187           1.78          0.00          NaN          0.0
0.0

      og_others_9  total_og_mou_6  total_og_mou_7  total_og_mou_8  \
77            0.0             0.0           76.61          356.93
364           0.0             0.0         1301.03         1128.43
423           0.0             0.0           10.03            1.45
934           0.0             0.0           51.38          101.21
1187          0.0             0.0         1377.84         2282.43

      total_og_mou_9  loc_ic_t2t_mou_6  loc_ic_t2t_mou_7
loc_ic_t2t_mou_8  \
77             67.24               NaN             79.46
191.24
364          1403.38               NaN              7.41
10.23
423             0.34               NaN              0.00
0.00
934            51.34               NaN              0.39
20.09
1187            0.00               NaN             19.34
56.38

      loc_ic_t2t_mou_9  loc_ic_t2m_mou_6  loc_ic_t2m_mou_7
loc_ic_t2m_mou_8  \
77                5.26               NaN             43.31
94.18
364              17.46               NaN             69.39
93.48
423               0.00               NaN              0.00
0.00
934              12.19               NaN              4.53
51.16
```

```
1187              0.00               NaN             28.19
16.31

      loc_ic_t2m_mou_9  loc_ic_t2f_mou_6  loc_ic_t2f_mou_7
loc_ic_t2f_mou_8  \
77               16.39               NaN              2.03
0.00
364              44.89               NaN              0.00
0.83
423               0.00               NaN              0.00
0.00
934              59.83               NaN              7.80
17.08
1187              0.00               NaN              0.00
0.00

      loc_ic_t2f_mou_9  loc_ic_mou_6  loc_ic_mou_7  loc_ic_mou_8  \
77               15.78           NaN        124.81        285.43
364               0.00           NaN         76.81        104.54
423               0.00           NaN          0.00          0.00
934               5.13           NaN         12.73         88.34
1187              0.00           NaN         47.54         72.69

      loc_ic_mou_9  std_ic_t2t_mou_6  std_ic_t2t_mou_7
std_ic_t2t_mou_8  \
77           37.44               NaN              8.00
0.00
364          62.36               NaN              5.81
10.09
423           0.00               NaN              0.00
0.00
934          77.16               NaN              0.00
0.00
1187          0.00               NaN            125.44
149.81

      std_ic_t2t_mou_9  std_ic_t2m_mou_6  std_ic_t2m_mou_7
std_ic_t2m_mou_8  \
77                0.00               NaN              0.00
0.00
364              22.36               NaN             37.94
86.63
423               0.00               NaN              0.00
0.00
934               0.00               NaN              0.00
0.00
1187              0.00               NaN              9.84
17.06

      std_ic_t2m_mou_9  std_ic_t2f_mou_6  std_ic_t2f_mou_7
```

```
std_ic_t2f_mou_8  \
77                0.00               NaN                0.0
0.00
364              34.49               NaN                0.0
0.00
423               0.00               NaN                0.0
0.36
934               0.00               NaN                0.0
0.00
1187              0.00               NaN                0.0
0.00

      std_ic_t2f_mou_9  std_ic_t2o_mou_6  std_ic_t2o_mou_7
std_ic_t2o_mou_8  \
77               15.93               NaN                0.0
0.0
364               0.00               NaN                0.0
0.0
423               0.00               NaN                0.0
0.0
934               0.00               NaN                0.0
0.0
1187              0.00               NaN                0.0
0.0

      std_ic_t2o_mou_9  std_ic_mou_6  std_ic_mou_7  std_ic_mou_8  \
77                 0.0           NaN          8.00          0.00
364                0.0           NaN         43.76         96.73
423                0.0           NaN          0.00          0.36
934                0.0           NaN          0.00          0.00
1187               0.0           NaN        135.29        166.88

      std_ic_mou_9  total_ic_mou_6  total_ic_mou_7  total_ic_mou_8  \
77           15.93             0.0          135.38          289.33
364          56.86             0.0          185.14          219.59
423           0.00             0.0            8.31            0.36
934           0.00             0.0           14.69          100.94
1187          0.00             0.0          182.84          239.58

      total_ic_mou_9  spl_ic_mou_6  spl_ic_mou_7  spl_ic_mou_8
spl_ic_mou_9  \
77             53.38           NaN           0.0           0.0
0.0
364           129.19           NaN           0.0           0.0
0.0
423             0.00           NaN           0.0           0.0
0.0
934            78.99           NaN           0.0           0.0
0.0
1187            0.00           NaN           0.0           0.0
```

```
0.0

      isd_ic_mou_6  isd_ic_mou_7  isd_ic_mou_8  isd_ic_mou_9
ic_others_6  \
77             NaN          2.56          0.50          0.00
NaN
364            NaN         64.56         18.31          9.96
NaN
423            NaN          8.31          0.00          0.00
NaN
934            NaN          1.96         12.59          1.83
NaN
1187           NaN          0.00          0.00          0.00
NaN

      ic_others_7  ic_others_8  ic_others_9  total_rech_num_6  \
77            0.0         3.39          0.0                 4
364           0.0         0.00          0.0                 4
423           0.0         0.00          0.0                 4
934           0.0         0.00          0.0                 3
1187          0.0         0.00          0.0                 2

      total_rech_num_7  total_rech_num_8  total_rech_num_9
total_rech_amt_6  \
77                   5                 3                 3
0
364                 12                24                20
0
423                  4                 3                 3
252
934                  4                 9                 4
0
1187                20                24                 6
0

      total_rech_amt_7  total_rech_amt_8  total_rech_amt_9
max_rech_amt_6  \
77                1154               750                 0
0
364                970              1104              1214
0
423                591                 0               382
252
934               1302               150               108
0
1187               883              1160                 0
0

      max_rech_amt_7  max_rech_amt_8  max_rech_amt_9
last_day_rch_amt_6  \
```

```
77               1000              750                0
0
364               154              154              250
0
423               339                0              252
252
934               550              150               54
0
1187              150              250                0
0

      last_day_rch_amt_7  last_day_rch_amt_8  last_day_rch_amt_9
vol_2g_mb_6  \
77                     0                 750                   0
0.0
364                   50                  50                   0
0.0
423                    0                   0                   0
3.3
934                    0                 150                   0
0.0
1187                  30                   0                   0
0.0

      vol_2g_mb_7  vol_2g_mb_8  vol_2g_mb_9  vol_3g_mb_6  vol_3g_mb_7
\
77          96.48         0.00         0.00         0.00         0.00

364        565.78      2108.66         0.00         0.00         0.00

423         38.45         0.00         4.52       669.36       837.18

934          0.31        38.77        78.66         0.00      1045.79

1187         0.00         0.00         0.00         0.00         0.00


      vol_3g_mb_8  vol_3g_mb_9  monthly_2g_6  monthly_2g_7
monthly_2g_8  \
77           0.00         0.00             0             1
0
364          0.00         0.00             0             1
1
423          0.00       423.59             0             0
0
934        245.91       471.48             0             0
0
1187         0.00         0.00             0             0
0
```

```
      monthly_2g_9  sachet_2g_6  sachet_2g_7  sachet_2g_8  sachet_2g_9
\
77               0            0            0            0            0

364              0            0            0            2            0

423              0            0            0            0            0

934              0            0            0            0            0

1187             0            0            0            0            0


      monthly_3g_6  monthly_3g_7  monthly_3g_8  monthly_3g_9
sachet_3g_6  \
77               0             0             0             0
0
364              0             0             0             0
0
423              1             1             0             1
0
934              0             1             1             0
0
1187             0             0             0             0
0

      sachet_3g_7  sachet_3g_8  sachet_3g_9   aon  aug_vbc_3g
jul_vbc_3g  \
77              0            0            0  1894        0.00
0.00
364             0            1            0   424        0.00
0.00
423             0            0            0   945       73.55
266.94
934             0            2            1   490      188.83
215.00
1187            0            0            0   737        0.00
0.00

      jun_vbc_3g  sep_vbc_3g  avg_rech_amt_6_7
77          0.00        0.00             577.0
364         0.00        0.00             485.0
423        63.04        0.00             421.5
934         0.00       24.18             651.0
1187        0.00        0.00             441.5
```

```
# Deleting the records for which MOU for Jun(6) are null
df = df.drop(df_null_mou_6.index)
```

```
# Again cheking percent of missing values in columns
df_missing_columns =
(round(((df.isnull().sum()/len(df.index))*100),2).to_frame('null')).so
rt_values('null', ascending=False)
df_missing_columns
```

```
                   null
loc_ic_t2f_mou_7   0.12
isd_ic_mou_7       0.12
loc_og_t2f_mou_7   0.12
loc_og_t2c_mou_7   0.12
loc_og_mou_7       0.12
...                 ...
spl_og_mou_6       0.00
spl_og_mou_8       0.00
spl_og_mou_9       0.00
og_others_6        0.00
avg_rech_amt_6_7   0.00

[178 rows x 1 columns]
```

```
# Listing the columns of MOU Jul(7)
print(((df_missing_columns[df_missing_columns['null'] ==
0.12]).index).to_list())
```

```
['loc_ic_t2f_mou_7', 'isd_ic_mou_7', 'loc_og_t2f_mou_7',
'loc_og_t2c_mou_7', 'loc_og_mou_7', 'std_og_t2t_mou_7',
'std_og_t2f_mou_7', 'std_og_t2c_mou_7', 'std_og_mou_7', 'ic_others_7',
'isd_og_mou_7', 'spl_og_mou_7', 'loc_og_t2t_mou_7', 'og_others_7',
'spl_ic_mou_7', 'loc_ic_t2t_mou_7', 'std_ic_mou_7',
'loc_ic_t2m_mou_7', 'std_ic_t2o_mou_7', 'std_ic_t2f_mou_7',
'loc_ic_mou_7', 'std_ic_t2t_mou_7', 'loc_og_t2m_mou_7',
'std_og_t2m_mou_7', 'std_ic_t2m_mou_7', 'roam_ic_mou_7',
'onnet_mou_7', 'roam_og_mou_7', 'offnet_mou_7']
```

```
# Creating a dataframe with the condition, in which MOU for Jul(7) are
null
df_null_mou_7 = df[(df['loc_og_t2m_mou_7'].isnull()) &
(df['loc_ic_t2f_mou_7'].isnull()) & (df['roam_og_mou_7'].isnull()) &
(df['std_ic_t2m_mou_7'].isnull()) &
  (df['loc_og_t2t_mou_7'].isnull()) &
(df['std_ic_t2t_mou_7'].isnull()) & (df['loc_og_t2f_mou_7'].isnull())
& (df['loc_ic_mou_7'].isnull()) &
  (df['loc_og_t2c_mou_7'].isnull()) & (df['loc_og_mou_7'].isnull()) &
(df['std_og_t2t_mou_7'].isnull()) & (df['roam_ic_mou_7'].isnull()) &
  (df['loc_ic_t2m_mou_7'].isnull()) &
(df['std_og_t2m_mou_7'].isnull()) & (df['loc_ic_t2t_mou_7'].isnull())
& (df['std_og_t2f_mou_7'].isnull()) &
  (df['std_og_t2c_mou_7'].isnull()) & (df['og_others_7'].isnull()) &
(df['std_og_mou_7'].isnull()) & (df['spl_og_mou_7'].isnull()) &
```

```
  (df['std_ic_t2f_mou_7'].isnull()) & (df['isd_og_mou_7'].isnull()) &
(df['std_ic_mou_7'].isnull()) & (df['offnet_mou_7'].isnull()) &
  (df['isd_ic_mou_7'].isnull()) & (df['ic_others_7'].isnull()) &
(df['std_ic_t2o_mou_7'].isnull()) & (df['onnet_mou_7'].isnull()) &
  (df['spl_ic_mou_7'].isnull())]

df_null_mou_7.head()
```

	mobile_number	loc_og_t2o_mou	std_og_t2o_mou	loc_ic_t2o_mou
5616	7001238202	0.0	0.0	0.0
9451	7001477649	0.0	0.0	0.0
9955	7001658068	0.0	0.0	0.0
10724	7001391499	0.0	0.0	0.0
12107	7000131738	0.0	0.0	0.0

	arpu_6	arpu_7	arpu_8	arpu_9	onnet_mou_6	onnet_mou_7
5616	760.815	531.088	992.818	1144.676	324.91	NaN
9451	1129.566	0.000	128.252	802.648	11.89	NaN
9955	925.028	189.000	789.761	445.707	46.39	NaN
10724	894.818	85.000	207.040	363.314	117.21	NaN
12107	1803.475	0.000	0.600	25.243	1742.61	NaN

	onnet_mou_8	onnet_mou_9	offnet_mou_6	offnet_mou_7	offnet_mou_8
5616	386.13	1180.29	350.29	NaN	399.64
9451	1.46	33.89	259.18	NaN	26.21
9955	43.39	56.61	333.78	NaN	196.53
10724	97.01	35.43	119.79	NaN	12.79
12107	0.00	0.00	278.79	NaN	14.29

	offnet_mou_9	roam_ic_mou_6	roam_ic_mou_7	roam_ic_mou_8
5616	887.76	463.63	NaN	221.46
9451	241.18	9.98	NaN	1.73
9955	144.73	0.00	NaN	0.00

```
10724          92.04            0.00             NaN            0.00
12107           4.50            0.00             NaN            0.00

       roam_ic_mou_9  roam_og_mou_6  roam_og_mou_7  roam_og_mou_8  \
5616             0.0         505.71            NaN         175.93
9451             0.0           5.66            NaN           2.46
9955             0.0           0.00            NaN           0.00
10724            0.0           0.00            NaN           0.00
12107            0.0           0.00            NaN           0.00

       roam_og_mou_9  loc_og_t2t_mou_6  loc_og_t2t_mou_7
loc_og_t2t_mou_8  \
5616             0.0            145.91               NaN
243.43
9451             0.0              6.73               NaN
1.46
9955             0.0             46.39               NaN
43.39
10724            0.0            115.08               NaN
97.01
12107            0.0             96.08               NaN
0.00

       loc_og_t2t_mou_9  loc_og_t2m_mou_6  loc_og_t2m_mou_7
loc_og_t2m_mou_8  \
5616            1108.38              0.85               NaN
184.78
9451              20.84            171.46               NaN
20.54
9955              56.61            227.91               NaN
163.68
10724             34.98             86.39               NaN
6.59
12107              0.00             64.98               NaN
0.86

       loc_og_t2m_mou_9  loc_og_t2f_mou_6  loc_og_t2f_mou_7
loc_og_t2f_mou_8  \
5616            300.19              1.13               NaN
7.94
9451            148.88              0.00               NaN
0.00
9955            121.54            104.69               NaN
28.96
10724            55.44             17.18               NaN
6.19
12107             0.00              0.00               NaN
0.00

       loc_og_t2f_mou_9  loc_og_t2c_mou_6  loc_og_t2c_mou_7
```

```
loc_og_t2c_mou_8  \
5616               67.11               0.00                NaN
12.51
9451                0.00               0.00                NaN
0.00
9955               21.04               0.00                NaN
0.00
10724              28.08               0.00                NaN
0.00
12107               0.00              50.03                NaN
13.43

       loc_og_t2c_mou_9  loc_og_mou_6  loc_og_mou_7  loc_og_mou_8  \
5616               18.89        147.89           NaN        436.16
9451                0.00        178.19           NaN         22.01
9955                0.00        379.01           NaN        236.04
10724               0.05        218.66           NaN        109.81
12107               4.50        161.06           NaN          0.86

       loc_og_mou_9  std_og_t2t_mou_6  std_og_t2t_mou_7
std_og_t2t_mou_8  \
5616         1475.69              0.96               NaN
17.06
9451          169.73              5.16               NaN
0.00
9955          199.21              0.00               NaN
0.00
10724         118.51              2.13               NaN
0.00
12107           0.00           1646.53               NaN
0.00

       std_og_t2t_mou_9  std_og_t2m_mou_6  std_og_t2m_mou_7
std_og_t2m_mou_8  \
5616               69.51             15.91                NaN
144.04
9451               13.05              0.00                NaN
0.00
9955                0.00              0.00                NaN
0.00
10724               0.45              2.43                NaN
0.00
12107               0.00            140.16                NaN
0.00

       std_og_t2m_mou_9  std_og_t2f_mou_6  std_og_t2f_mou_7
std_og_t2f_mou_8  \
5616              490.61              0.00                NaN
0.0
9451                0.00              0.00                NaN
```

```
0.0
9955                1.26               1.16                NaN
2.9
10724               7.18               6.09                NaN
0.0
12107               0.00               1.26                NaN
0.0

       std_og_t2f_mou_9  std_og_t2c_mou_6  std_og_t2c_mou_7
std_og_t2c_mou_8  \
5616              13.33               0.0                NaN
0.0
9451               0.00               0.0                NaN
0.0
9955               0.00               0.0                NaN
0.0
10724              1.28               0.0                NaN
0.0
12107              0.00               0.0                NaN
0.0

       std_og_t2c_mou_9  std_og_mou_6  std_og_mou_7  std_og_mou_8  \
5616                0.0         16.88           NaN        161.11
9451                0.0          5.16           NaN          0.00
9955                0.0          1.16           NaN          2.90
10724               0.0         10.66           NaN          0.00
12107               0.0       1787.96           NaN          0.00

       std_og_mou_9  isd_og_mou_6  isd_og_mou_7  isd_og_mou_8
isd_og_mou_9  \
5616         573.46          0.00           NaN          0.00
0.00
9451          13.05         74.91           NaN          4.74
92.29
9955           1.26         53.14           NaN         31.06
33.69
10724          8.91         16.86           NaN          6.21
2.18
12107          0.00          0.00           NaN          0.00
0.00

       spl_og_mou_6  spl_og_mou_7  spl_og_mou_8  spl_og_mou_9
og_others_6  \
5616           4.71           NaN         12.56         18.89
0.00
9451           7.13           NaN          0.00          1.08
0.00
9955           0.00           NaN          0.00          0.00
0.00
10724          0.00           NaN          0.00          0.05
```

```
0.00
12107         72.61            NaN         13.43          4.50
1.76

       og_others_7  og_others_8  og_others_9  total_og_mou_6
total_og_mou_7  \
5616           NaN          0.0          0.0          169.49
0.0
9451           NaN          0.0          0.0          265.41
0.0
9955           NaN          0.0          0.0          433.33
0.0
10724          NaN          0.0          0.0          246.19
0.0
12107          NaN          0.0          0.0         2023.41
0.0

       total_og_mou_8  total_og_mou_9  loc_ic_t2t_mou_6
loc_ic_t2t_mou_7  \
5616           609.84         2068.06             78.76
NaN
9451            26.76          276.16             17.24
NaN
9955           270.01          234.18             80.98
NaN
10724          116.03          129.66            887.04
NaN
12107           14.29            4.50             65.76
NaN

       loc_ic_t2t_mou_8  loc_ic_t2t_mou_9  loc_ic_t2m_mou_6
loc_ic_t2m_mou_7  \
5616             233.66            558.84              1.36
NaN
9451               0.60             36.69            130.09
NaN
9955              32.69            112.14            201.38
NaN
10724            200.51            408.66            104.18
NaN
12107              1.73              5.88             92.18
NaN

       loc_ic_t2m_mou_8  loc_ic_t2m_mou_9  loc_ic_t2f_mou_6
loc_ic_t2f_mou_7  \
5616              11.53             75.31              6.61
NaN
9451              16.54            110.19             25.46
NaN
9955             169.24            155.58             41.68
```

```
NaN
10724              22.24              76.39              16.74
NaN
12107               5.59               2.75               0.00
NaN

       loc_ic_t2f_mou_8  loc_ic_t2f_mou_9  loc_ic_mou_6  loc_ic_mou_7
\
5616               0.00             31.81         86.74            NaN

9451               8.76             40.24        172.81            NaN

9955              25.68             12.33        324.04            NaN

10724              1.61             28.18       1007.98            NaN

12107              0.00              0.00        157.94            NaN


       loc_ic_mou_8  loc_ic_mou_9  std_ic_t2t_mou_6  std_ic_t2t_mou_7
\
5616         245.19        665.98              0.00               NaN

9451          25.91        187.14              1.50               NaN

9955         227.63        280.06              0.00               NaN

10724        224.38        513.24              0.00               NaN

12107          7.33          8.63            103.66               NaN


       std_ic_t2t_mou_8  std_ic_t2t_mou_9  std_ic_t2m_mou_6
std_ic_t2m_mou_7  \
5616              12.13             42.39             21.76
NaN
9451               0.00              0.00              0.41
NaN
9955               0.00              0.00              0.98
NaN
10724              0.00              0.00              5.94
NaN
12107              0.00              0.00              3.01
NaN

       std_ic_t2m_mou_8  std_ic_t2m_mou_9  std_ic_t2f_mou_6
std_ic_t2f_mou_7  \
5616             110.99            263.98               0.0
NaN
9451               0.00             12.29               0.0
NaN
```

```
9955                2.13               2.58                0.0
NaN
10724               0.00               4.88                0.0
NaN
12107               0.00               0.00                0.0
NaN

       std_ic_t2f_mou_8  std_ic_t2f_mou_9  std_ic_t2o_mou_6
std_ic_t2o_mou_7  \
5616                0.00               6.43                0.0
NaN
9451                0.00               4.48                0.0
NaN
9955                0.23               0.00                0.0
NaN
10724              10.03               1.26                0.0
NaN
12107               0.00               0.00                0.0
NaN

       std_ic_t2o_mou_8  std_ic_t2o_mou_9  std_ic_mou_6  std_ic_mou_7
\
5616                0.0               0.0         21.76           NaN

9451                0.0               0.0          1.91           NaN

9955                0.0               0.0          0.98           NaN

10724               0.0               0.0          5.94           NaN

12107               0.0               0.0        106.68           NaN


       std_ic_mou_8  std_ic_mou_9  total_ic_mou_6  total_ic_mou_7  \
5616         123.13        312.81          189.81             0.0
9451           0.00         16.78          217.33             0.0
9955           2.36          2.58          332.33             0.0
10724         10.03          6.14         1140.54             0.0
12107          0.00          0.00          265.03             0.0

       total_ic_mou_8  total_ic_mou_9  spl_ic_mou_6  spl_ic_mou_7  \
5616           397.13         1020.16          0.00           NaN
9451            43.44          307.43          0.00           NaN
9955           506.94          526.54          0.00           NaN
10724          342.78          642.33          0.14           NaN
12107            7.33            8.63          0.00           NaN

       spl_ic_mou_8  spl_ic_mou_9  isd_ic_mou_6  isd_ic_mou_7
isd_ic_mou_8  \
5616           0.00          0.13         81.29           NaN
```

```
28.79
9451           0.00          0.00         42.59           NaN
17.53
9955           0.00          0.00          7.29           NaN
173.61
10724          0.08          0.09        126.13           NaN
106.53
12107          0.00          0.00          0.00           NaN
0.00

       isd_ic_mou_9  ic_others_6  ic_others_7  ic_others_8
ic_others_9  \
5616          41.23         0.00          NaN         0.00
0.00
9451         103.49         0.00          NaN         0.00
0.00
9955         229.44         0.00          NaN       103.33
14.45
10724        116.83         0.33          NaN         1.74
5.99
12107          0.00         0.40          NaN         0.00
0.00

       total_rech_num_6  total_rech_num_7  total_rech_num_8
total_rech_num_9  \
5616                  5                 7                 9
13
9451                 14                 4                 4
9
9955                  6                 1                 4
3
10724                 8                 3                 3
5
12107                17                 2                 1
2

       total_rech_amt_6  total_rech_amt_7  total_rech_amt_8
total_rech_amt_9  \
5616                776               780               904
1591
9451               1206                 0               223
991
9955               1385                 0               835
912
10724              1020                 0               360
480
12107              1990                 0                 0
30

       max_rech_amt_6  max_rech_amt_7  max_rech_amt_8  max_rech_amt_9
```

```
\
5616                250              330              200               289

9451                250                0              130               130

9955                350                0              300               479

10724               500                0              130               150

12107               250                0                0                30


       last_day_rch_amt_6  last_day_rch_amt_7  last_day_rch_amt_8  \
5616                  250                   0                 130
9451                  250                   0                 130
9955                  250                   0                 300
10724                 500                   0                 130
12107                 110                   0                   0

       last_day_rch_amt_9  vol_2g_mb_6  vol_2g_mb_7  vol_2g_mb_8
vol_2g_mb_9  \
5616                  250         0.00          0.0        11.26
83.32
9451                  130       321.86          0.0         0.00
431.85
9955                  479         0.00          0.0         0.00
0.00
10724                   0         0.00          0.0         0.00
0.00
12107                  30         0.00          0.0         0.00
0.00

       vol_3g_mb_6  vol_3g_mb_7  vol_3g_mb_8  vol_3g_mb_9
monthly_2g_6  \
5616           0.0          0.0        79.94        668.4
0
9451           0.0          0.0         0.00          0.0
1
9955           0.0          0.0         0.00          0.0
0
10724          0.0          0.0         0.00          0.0
0
12107          0.0          0.0         0.00          0.0
0

       monthly_2g_7  monthly_2g_8  monthly_2g_9  sachet_2g_6
sachet_2g_7  \
5616              0             1             1            0
0
9451              0             0             1            1
```

```
0
9955               0              0              0              0
0
10724              0              0              0              0
0
12107              0              0              0              0
0

       sachet_2g_8  sachet_2g_9  monthly_3g_6  monthly_3g_7
monthly_3g_8  \
5616             0            0             0             0
0
9451             0            2             0             0
0
9955             0            0             0             0
0
10724            0            0             0             0
0
12107            0            0             0             0
0

       monthly_3g_9  sachet_3g_6  sachet_3g_7  sachet_3g_8
sachet_3g_9   aon  \
5616              0            0            0            0
0   576
9451              0            0            0            0
0   672
9955              0            0            0            0
0  3107
10724             0            0            0            0
0  2664
12107             0            0            0            0
0   219

       aug_vbc_3g  jul_vbc_3g  jun_vbc_3g  sep_vbc_3g
avg_rech_amt_6_7
5616        63.38         0.0         0.0      163.39
778.0
9451         0.00         0.0         0.0        0.00
603.0
9955         0.00         0.0         0.0        0.00
692.5
10724        0.00         0.0         0.0        0.00
510.0
12107        0.00         0.0         0.0        0.00
995.0
```

```
# Deleting the records for which MOU for Jul(7) are null
df = df.drop(df_null_mou_7.index)
```

```
# Again cheking percent of missing values in columns
df_missing_columns =
(round(((df.isnull().sum()/len(df.index))*100),2).to_frame('null')).so
rt_values('null', ascending=False)
df_missing_columns
```

```
                    null
mobile_number        0.0
total_rech_num_7     0.0
std_ic_mou_7         0.0
std_ic_mou_8         0.0
std_ic_mou_9         0.0
...                  ...
std_og_mou_7         0.0
std_og_mou_8         0.0
std_og_mou_9         0.0
isd_og_mou_6         0.0
avg_rech_amt_6_7     0.0

[178 rows x 1 columns]
```

```
df.shape
```

```
(27991, 178)
```

```
# Checking percentage of rows we have lost while handling the missing
values
round((1- (len(df.index)/30011)),2)
```

```
0.07
```

Tagging the Churned Customers:

```
df['churn'] = np.where((df['total_ic_mou_9']==0) &
(df['total_og_mou_9']==0) & (df['vol_2g_mb_9']==0) &
(df['vol_3g_mb_9']==0), 1, 0)

df.head()
```

```
    mobile_number  loc_og_t2o_mou  std_og_t2o_mou  loc_ic_t2o_mou
arpu_6  \
8      7001524846             0.0             0.0             0.0
378.721
13     7002191713             0.0             0.0             0.0
492.846
16     7000875565             0.0             0.0             0.0
430.975
17     7000187447             0.0             0.0             0.0
690.008
21     7002124215             0.0             0.0             0.0
514.453
```

```
     arpu_7   arpu_8   arpu_9  onnet_mou_6  onnet_mou_7
onnet_mou_8  \
8   492.223  137.362  166.787       413.69       351.03        35.08

13  205.671  593.260  322.732       501.76       108.39       534.24

16  299.869  187.894  206.490        50.51        74.01        70.61

17   18.980   25.499  257.583      1185.91         9.28         7.79

21  597.753  637.760  578.596       102.41       132.11        85.14


    onnet_mou_9  offnet_mou_6  offnet_mou_7  offnet_mou_8
offnet_mou_9  \
8         33.46         94.66         80.63        136.48
108.71
13       244.81        413.31        119.28        482.46
214.06
16        31.34        296.29        229.74        162.76
224.39
17       558.51         61.64          0.00          5.54
87.89
21       161.63        757.93        896.68        983.39
869.89

    roam_ic_mou_6  roam_ic_mou_7  roam_ic_mou_8  roam_ic_mou_9
roam_og_mou_6  \
8            0.00           0.00           0.00           0.00
0.00
13          23.53         144.24          72.11         136.78
7.98
16           0.00           2.83           0.00           0.00
0.00
17           0.00           4.76           4.81           0.00
0.00
21           0.00           0.00           0.00           0.00
0.00

    roam_og_mou_7  roam_og_mou_8  roam_og_mou_9  loc_og_t2t_mou_6  \
8            0.00           0.00           0.00            297.13
13          35.26           1.44          12.78             49.63
16          17.74           0.00           0.00             42.61
17           8.46          13.34          17.98             38.99
21           0.00           0.00           0.00              4.48

    loc_og_t2t_mou_7  loc_og_t2t_mou_8  loc_og_t2t_mou_9
loc_og_t2m_mou_6  \
8             217.59             12.49             26.13
```

```
80.96
13               6.19              36.01               6.14
151.13
16              65.16              67.38              26.88
273.29
17               0.00               0.00              36.41
58.54
21               6.16              23.34              29.98
91.81

    loc_og_t2m_mou_7  loc_og_t2m_mou_8  loc_og_t2m_mou_9
loc_og_t2f_mou_6  \
8               70.58              50.54              34.58
0.00
13              47.28             294.46             108.24
4.54
16             145.99             128.28             201.49
0.00
17               0.00               0.00               9.38
0.00
21              87.93             104.81             107.54
0.75

    loc_og_t2f_mou_7  loc_og_t2f_mou_8  loc_og_t2f_mou_9
loc_og_t2c_mou_6  \
8                0.00               0.00               0.00
0.0
13               0.00              23.51               5.29
0.0
16               4.48              10.26               4.66
0.0
17               0.00               0.00               0.00
0.0
21               0.00               1.58               0.00
0.0

    loc_og_t2c_mou_7  loc_og_t2c_mou_8  loc_og_t2c_mou_9  loc_og_mou_6
\
8                 0.0               7.15               0.0        378.09

13                0.0               0.49               0.0        205.31

16                0.0               0.00               0.0        315.91

17                0.0               0.00               0.0         97.54

21                0.0               0.00               0.0         97.04


    loc_og_mou_7  loc_og_mou_8  loc_og_mou_9  std_og_t2t_mou_6  \
```

```
8          288.18          63.04          60.71             116.56
13          53.48         353.99         119.69             446.41
16         215.64         205.93         233.04               7.89
17           0.00           0.00          45.79            1146.91
21          94.09         129.74         137.53              97.93

    std_og_t2t_mou_7  std_og_t2t_mou_8  std_og_t2t_mou_9
std_og_t2m_mou_6  \
8              133.43             22.58              7.33
13.69
13              85.98            498.23            230.38
255.36
16               2.58              3.23              4.46
22.99
17               0.81              0.00            504.11
1.55
21             125.94             61.79            131.64
665.36

    std_og_t2m_mou_7  std_og_t2m_mou_8  std_og_t2m_mou_9
std_og_t2f_mou_6  \
8               10.04             75.69             74.13
0.0
13              52.94            156.94             96.01
0.0
16              64.51             18.29             13.79
0.0
17               0.00              0.00             78.51
0.0
21             808.74            876.99            762.34
0.0

    std_og_t2f_mou_7  std_og_t2f_mou_8  std_og_t2f_mou_9
std_og_t2c_mou_6  \
8                 0.0               0.0               0.00
0.0
13                0.0               0.0               0.00
0.0
16                0.0               0.0               4.43
0.0
17                0.0               0.0               0.00
0.0
21                0.0               0.0               0.00
0.0

    std_og_t2c_mou_7  std_og_t2c_mou_8  std_og_t2c_mou_9  std_og_mou_6
\
8                 0.0               0.0               0.0        130.26

13                0.0               0.0               0.0        701.78
```

```
16                0.0               0.0               0.0          30.89

17                0.0               0.0               0.0        1148.46

21                0.0               0.0               0.0         763.29


    std_og_mou_7  std_og_mou_8  std_og_mou_9  isd_og_mou_6
isd_og_mou_7  \
8          143.48         98.28         81.46           0.0
0.0
13         138.93        655.18        326.39           0.0
0.0
16          67.09         21.53         22.69           0.0
0.0
17           0.81          0.00        582.63           0.0
0.0
21         934.69        938.79        893.99           0.0
0.0

    isd_og_mou_8  isd_og_mou_9  spl_og_mou_6  spl_og_mou_7
spl_og_mou_8  \
8           0.00           0.0          0.00          0.00
10.23
13          1.29           0.0          0.00          0.00
4.78
16          0.00           0.0          0.00          3.26
5.91
17          0.00           0.0          2.58          0.00
0.00
21          0.00           0.0          0.00          0.00
0.00

    spl_og_mou_9  og_others_6  og_others_7  og_others_8
og_others_9  \
8           0.00         0.00          0.0          0.0           0.0

13          0.00         0.00          0.0          0.0           0.0

16          0.00         0.00          0.0          0.0           0.0

17          2.64         0.93          0.0          0.0           0.0

21          0.00         0.00          0.0          0.0           0.0


    total_og_mou_6  total_og_mou_7  total_og_mou_8  total_og_mou_9  \
8           508.36          431.66          171.56          142.18
13          907.09          192.41         1015.26          446.09
```

```
16          346.81          286.01          233.38          255.74
17         1249.53            0.81            0.00          631.08
21          860.34         1028.79         1068.54         1031.53

    loc_ic_t2t_mou_6  loc_ic_t2t_mou_7  loc_ic_t2t_mou_8
loc_ic_t2t_mou_9  \
8               23.84              9.84              0.31
4.03
13              67.88              7.58             52.58
24.98
16              41.33             71.44             28.89
50.23
17              34.54              0.00              0.00
40.91
21               2.48             10.19             19.54
17.99

    loc_ic_t2m_mou_6  loc_ic_t2m_mou_7  loc_ic_t2m_mou_8
loc_ic_t2m_mou_9  \
8               57.58             13.98             15.48
17.34
13             142.88             18.53            195.18
104.79
16             226.81            149.69            150.16
172.86
17              47.41              2.31              0.00
43.86
21             118.23             74.63            129.16
113.46

    loc_ic_t2f_mou_6  loc_ic_t2f_mou_7  loc_ic_t2f_mou_8
loc_ic_t2f_mou_9  \
8                0.00              0.00              0.00
0.00
13               4.81              0.00              7.49
8.51
16               8.71              8.68             32.71
65.21
17               0.00              0.00              0.00
0.71
21               4.61              2.84             10.39
8.41

    loc_ic_mou_6  loc_ic_mou_7  loc_ic_mou_8  loc_ic_mou_9
std_ic_t2t_mou_6  \
8          81.43         23.83         15.79         21.38
0.00
13        215.58         26.11        255.26        138.29
115.68
16        276.86        229.83        211.78        288.31
```

```
68.79
17         81.96           2.31           0.00          85.49
8.63
21        125.33          87.68         159.11         139.88
14.06

    std_ic_t2t_mou_7  std_ic_t2t_mou_8  std_ic_t2t_mou_9
std_ic_t2m_mou_6  \
8                 0.58              0.10              0.00
22.43
13               38.29            154.58             62.39
308.13
16               78.64              6.33             16.66
18.68
17                0.00              0.00              0.00
1.28
21                5.98              0.18             16.74
67.69

    std_ic_t2m_mou_7  std_ic_t2m_mou_8  std_ic_t2m_mou_9
std_ic_t2f_mou_6  \
8                 4.08              0.65             13.53
0.00
13               29.79            317.91            151.51
0.00
16               73.08             73.93             29.58
0.51
17                0.00              0.00              1.63
0.00
21               38.23            101.74             95.98
0.00

    std_ic_t2f_mou_7  std_ic_t2f_mou_8  std_ic_t2f_mou_9
std_ic_t2o_mou_6  \
8                  0.0              0.00               0.0
0.0
13                 0.0              1.91               0.0
0.0
16                 0.0              2.18               0.0
0.0
17                 0.0              0.00               0.0
0.0
21                 0.0              0.00               0.0
0.0

    std_ic_t2o_mou_7  std_ic_t2o_mou_8  std_ic_t2o_mou_9  std_ic_mou_6
\
8                  0.0               0.0               0.0         22.43

13                 0.0               0.0               0.0        423.81
```

```
16                0.0                0.0                0.0          87.99

17                0.0                0.0                0.0           9.91

21                0.0                0.0                0.0          81.76


    std_ic_mou_7  std_ic_mou_8  std_ic_mou_9  total_ic_mou_6
total_ic_mou_7  \
8           4.66          0.75         13.53          103.86
28.49
13         68.09        474.41        213.91          968.61
172.58
16        151.73         82.44         46.24          364.86
381.56
17          0.00          0.00          1.63           91.88
2.31
21         44.21        101.93        112.73          207.09
131.89

    total_ic_mou_8  total_ic_mou_9  spl_ic_mou_6  spl_ic_mou_7
spl_ic_mou_8  \
8            16.54           34.91          0.00           0.0
0.0
13         1144.53          631.86          0.45           0.0
0.0
16          294.46          334.56          0.00           0.0
0.0
17            0.00           87.13          0.00           0.0
0.0
21          261.04          252.61          0.00           0.0
0.0

    spl_ic_mou_9  isd_ic_mou_6  isd_ic_mou_7  isd_ic_mou_8
isd_ic_mou_9  \
8            0.0          0.00          0.00          0.00
0.00
13           0.0        245.28         62.11        393.39
259.33
16           0.0          0.00          0.00          0.23
0.00
17           0.0          0.00          0.00          0.00
0.00
21           0.0          0.00          0.00          0.00
0.00

    ic_others_6  ic_others_7  ic_others_8  ic_others_9
total_rech_num_6  \
8          0.00         0.00         0.00         0.00
```

```
19
13        83.48         16.24         21.44         20.31
6
16         0.00          0.00          0.00          0.00
10
17         0.00          0.00          0.00          0.00
19
21         0.00          0.00          0.00          0.00
22

    total_rech_num_7  total_rech_num_8  total_rech_num_9
total_rech_amt_6  \
8                  21                14                15
437
13                  4                11                 7
507
16                  6                 2                 1
570
17                  2                 4                10
816
21                 26                27                17
600

    total_rech_amt_7  total_rech_amt_8  total_rech_amt_9
max_rech_amt_6  \
8                 601               120               186
90
13                253               717               353
110
16                348               160               220
110
17                  0                30               335
110
21                680               718               680
50

    max_rech_amt_7  max_rech_amt_8  max_rech_amt_9  last_day_rch_amt_6
\
8              154              30              36                   50

13             110             130             130                  110

16             110             130             220                  100

17               0              30             130                   30

21              50              50              50                   30


    last_day_rch_amt_7  last_day_rch_amt_8  last_day_rch_amt_9
```

```
vol_2g_mb_6  \
8                     0                   10                    0
0.0
13                   50                    0                    0
0.0
16                  100                  130                  220
0.0
17                    0                    0                    0
0.0
21                   20                   50                   30
0.0

    vol_2g_mb_7  vol_2g_mb_8  vol_2g_mb_9  vol_3g_mb_6  vol_3g_mb_7  \
8         356.0         0.03          0.0          0.0       750.95
13          0.0         0.02          0.0          0.0         0.00
16          0.0         0.00          0.0          0.0         0.00
17          0.0         0.00          0.0          0.0         0.00
21          0.0         0.00          0.0          0.0         0.00

    vol_3g_mb_8  vol_3g_mb_9  monthly_2g_6  monthly_2g_7  monthly_2g_8
\
8         11.94          0.0             0             1             0

13         0.00          0.0             0             0             0

16         0.00          0.0             0             0             0

17         0.00          0.0             0             0             0

21         0.00          0.0             0             0             0


    monthly_2g_9  sachet_2g_6  sachet_2g_7  sachet_2g_8
sachet_2g_9  \
8              0            0            1            3             0

13             0            0            0            3             0

16             0            0            0            0             0

17             0            0            0            0             0

21             0            0            0            0             0


    monthly_3g_6  monthly_3g_7  monthly_3g_8  monthly_3g_9
sachet_3g_6  \
8              0             0             0             0
0
13             0             0             0             0
0
```

```
16              0              0              0              0
0
17              0              0              0              0
0
21              0              0              0              0
0

    sachet_3g_7  sachet_3g_8  sachet_3g_9   aon  aug_vbc_3g
jul_vbc_3g  \
8             0            0            0   315       21.03
910.65
13            0            0            0  2607        0.00
0.00
16            0            0            0   511        0.00
2.45
17            0            0            0   667        0.00
0.00
21            0            0            0   720        0.00
0.00

    jun_vbc_3g  sep_vbc_3g  avg_rech_amt_6_7  churn
8       122.16         0.0             519.0      0
13        0.00         0.0             380.0      0
16       21.89         0.0             459.0      0
17        0.00         0.0             408.0      0
21        0.00         0.0             640.0      0
```

```
# List the columns for churn month(9)
col_9 = [col for col in df.columns.to_list() if '_9' in col]
print(col_9)
```

```
['arpu_9', 'onnet_mou_9', 'offnet_mou_9', 'roam_ic_mou_9',
'roam_og_mou_9', 'loc_og_t2t_mou_9', 'loc_og_t2m_mou_9',
'loc_og_t2f_mou_9', 'loc_og_t2c_mou_9', 'loc_og_mou_9',
'std_og_t2t_mou_9', 'std_og_t2m_mou_9', 'std_og_t2f_mou_9',
'std_og_t2c_mou_9', 'std_og_mou_9', 'isd_og_mou_9', 'spl_og_mou_9',
'og_others_9', 'total_og_mou_9', 'loc_ic_t2t_mou_9',
'loc_ic_t2m_mou_9', 'loc_ic_t2f_mou_9', 'loc_ic_mou_9',
'std_ic_t2t_mou_9', 'std_ic_t2m_mou_9', 'std_ic_t2f_mou_9',
'std_ic_t2o_mou_9', 'std_ic_mou_9', 'total_ic_mou_9', 'spl_ic_mou_9',
'isd_ic_mou_9', 'ic_others_9', 'total_rech_num_9', 'total_rech_amt_9',
'max_rech_amt_9', 'last_day_rch_amt_9', 'vol_2g_mb_9', 'vol_3g_mb_9',
'monthly_2g_9', 'sachet_2g_9', 'monthly_3g_9', 'sachet_3g_9']
```

```
# Deleting the churn month columns
df = df.drop(col_9, axis=1)

# Dropping sep_vbc_3g column
df = df.drop('sep_vbc_3g', axis=1)

round(100*(df['churn'].mean()),2)
```

```
3.39
```

Converting mobile_number and churn datatype to object:

```
df['mobile_number'] = df['mobile_number'].astype(object)
df['churn'] = df['churn'].astype(object)

df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
Int64Index: 27991 entries, 8 to 99997
Columns: 136 entries, mobile_number to churn
dtypes: float64(109), int64(25), object(2)
memory usage: 29.3+ MB
```

```
# List only the numeric columns
numeric_cols = df.select_dtypes(exclude=['object']).columns
print(numeric_cols)
```

```
Index(['loc_og_t2o_mou', 'std_og_t2o_mou', 'loc_ic_t2o_mou', 'arpu_6',
       'arpu_7', 'arpu_8', 'onnet_mou_6', 'onnet_mou_7',
'onnet_mou_8',
       'offnet_mou_6',
       ...
       'monthly_3g_7', 'monthly_3g_8', 'sachet_3g_6', 'sachet_3g_7',
       'sachet_3g_8', 'aon', 'aug_vbc_3g', 'jul_vbc_3g', 'jun_vbc_3g',
       'avg_rech_amt_6_7'],
      dtype='object', length=134)
```

```
# Removing outliers below 10th and above 90th percentile
for col in numeric_cols:
    q1 = df[col].quantile(0.10)
    q3 = df[col].quantile(0.90)
    iqr = q3-q1
    range_low  = q1-1.5*iqr
    range_high = q3+1.5*iqr
    # Assigning the filtered dataset into data
    data = df.loc[(df[col] > range_low) & (df[col] < range_high)]

data.shape
```

```
(27705, 136)
```

```
# List the columns of total mou, rech_num and rech_amt
[total for total in data.columns.to_list() if 'total' in total]
```

```
['total_og_mou_6',
 'total_og_mou_7',
 'total_og_mou_8',
 'total_ic_mou_6',
 'total_ic_mou_7',
```

```
 'total_ic_mou_8',
 'total_rech_num_6',
 'total_rech_num_7',
 'total_rech_num_8',
 'total_rech_amt_6',
 'total_rech_amt_7',
 'total_rech_amt_8']

# Total mou at good phase incoming and outgoing
data['total_mou_good'] = (data['total_og_mou_6'] +
data['total_ic_mou_6'])

# Avg. mou at action phase
# We are taking average because there are two months(7 and 8) in
action phase
data['avg_mou_action'] = (data['total_og_mou_7'] +
data['total_og_mou_8'] + data['total_ic_mou_7'] +
data['total_ic_mou_8'])/2

# Difference avg_mou_good and avg_mou_action
data['diff_mou'] = data['avg_mou_action'] - data['total_mou_good']

# Checking whether the mou has decreased in action phase
data['decrease_mou_action'] = np.where((data['diff_mou'] < 0), 1, 0)

data.head()
```

```
   mobile_number  loc_og_t2o_mou  std_og_t2o_mou  loc_ic_t2o_mou
arpu_6  \
8     7001524846             0.0             0.0             0.0
378.721
13    7002191713             0.0             0.0             0.0
492.846
16    7000875565             0.0             0.0             0.0
430.975
17    7000187447             0.0             0.0             0.0
690.008
21    7002124215             0.0             0.0             0.0
514.453

     arpu_7   arpu_8  onnet_mou_6  onnet_mou_7  onnet_mou_8
offnet_mou_6  \
8   492.223  137.362       413.69       351.03        35.08
94.66
13  205.671  593.260       501.76       108.39       534.24
413.31
16  299.869  187.894        50.51        74.01        70.61
296.29
17   18.980   25.499      1185.91         9.28         7.79
61.64
21  597.753  637.760       102.41       132.11        85.14
```

```
757.93

    offnet_mou_7  offnet_mou_8  roam_ic_mou_6  roam_ic_mou_7
roam_ic_mou_8  \
8          80.63        136.48           0.00           0.00
0.00
13        119.28        482.46          23.53         144.24
72.11
16        229.74        162.76           0.00           2.83
0.00
17          0.00          5.54           0.00           4.76
4.81
21        896.68        983.39           0.00           0.00
0.00

    roam_og_mou_6  roam_og_mou_7  roam_og_mou_8  loc_og_t2t_mou_6  \
8            0.00           0.00           0.00            297.13
13           7.98          35.26           1.44             49.63
16           0.00          17.74           0.00             42.61
17           0.00           8.46          13.34             38.99
21           0.00           0.00           0.00              4.48

    loc_og_t2t_mou_7  loc_og_t2t_mou_8  loc_og_t2m_mou_6
loc_og_t2m_mou_7  \
8             217.59             12.49             80.96
70.58
13              6.19             36.01            151.13
47.28
16             65.16             67.38            273.29
145.99
17              0.00              0.00             58.54
0.00
21              6.16             23.34             91.81
87.93

    loc_og_t2m_mou_8  loc_og_t2f_mou_6  loc_og_t2f_mou_7
loc_og_t2f_mou_8  \
8             50.54              0.00              0.00
0.00
13           294.46              4.54              0.00
23.51
16           128.28              0.00              4.48
10.26
17             0.00              0.00              0.00
0.00
21           104.81              0.75              0.00
1.58

    loc_og_t2c_mou_6  loc_og_t2c_mou_7  loc_og_t2c_mou_8  loc_og_mou_6
\
```

```
8                0.0               0.0              7.15        378.09

13               0.0               0.0              0.49        205.31

16               0.0               0.0              0.00        315.91

17               0.0               0.0              0.00         97.54

21               0.0               0.0              0.00         97.04


    loc_og_mou_7  loc_og_mou_8  std_og_t2t_mou_6  std_og_t2t_mou_7  \
8         288.18         63.04            116.56            133.43
13         53.48        353.99            446.41             85.98
16        215.64        205.93              7.89              2.58
17          0.00          0.00           1146.91              0.81
21         94.09        129.74             97.93            125.94

    std_og_t2t_mou_8  std_og_t2m_mou_6  std_og_t2m_mou_7
std_og_t2m_mou_8  \
8              22.58             13.69             10.04
75.69
13            498.23            255.36             52.94
156.94
16              3.23             22.99             64.51
18.29
17              0.00              1.55              0.00
0.00
21             61.79            665.36            808.74
876.99

    std_og_t2f_mou_6  std_og_t2f_mou_7  std_og_t2f_mou_8
std_og_t2c_mou_6  \
8                0.0               0.0               0.0
0.0
13               0.0               0.0               0.0
0.0
16               0.0               0.0               0.0
0.0
17               0.0               0.0               0.0
0.0
21               0.0               0.0               0.0
0.0

    std_og_t2c_mou_7  std_og_t2c_mou_8  std_og_mou_6  std_og_mou_7  \
8                0.0               0.0        130.26        143.48
13               0.0               0.0        701.78        138.93
16               0.0               0.0         30.89         67.09
17               0.0               0.0       1148.46          0.81
21               0.0               0.0        763.29        934.69
```

```
    std_og_mou_8  isd_og_mou_6  isd_og_mou_7  isd_og_mou_8
spl_og_mou_6  \
8          98.28           0.0           0.0          0.00
0.00
13        655.18           0.0           0.0          1.29
0.00
16         21.53           0.0           0.0          0.00
0.00
17          0.00           0.0           0.0          0.00
2.58
21        938.79           0.0           0.0          0.00
0.00

    spl_og_mou_7  spl_og_mou_8  og_others_6  og_others_7  og_others_8
\
8           0.00         10.23         0.00          0.0          0.0

13          0.00          4.78         0.00          0.0          0.0

16          3.26          5.91         0.00          0.0          0.0

17          0.00          0.00         0.93          0.0          0.0

21          0.00          0.00         0.00          0.0          0.0


    total_og_mou_6  total_og_mou_7  total_og_mou_8
loc_ic_t2t_mou_6  \
8           508.36          431.66          171.56             23.84

13          907.09          192.41         1015.26             67.88

16          346.81          286.01          233.38             41.33

17         1249.53            0.81            0.00             34.54

21          860.34         1028.79         1068.54              2.48


    loc_ic_t2t_mou_7  loc_ic_t2t_mou_8  loc_ic_t2m_mou_6
loc_ic_t2m_mou_7  \
8               9.84              0.31             57.58
13.98
13              7.58             52.58            142.88
18.53
16             71.44             28.89            226.81
149.69
17              0.00              0.00             47.41
2.31
21             10.19             19.54            118.23
```

```
74.63

    loc_ic_t2m_mou_8  loc_ic_t2f_mou_6  loc_ic_t2f_mou_7
loc_ic_t2f_mou_8  \
8               15.48              0.00               0.00
0.00
13             195.18              4.81               0.00
7.49
16             150.16              8.71               8.68
32.71
17               0.00              0.00               0.00
0.00
21             129.16              4.61               2.84
10.39

    loc_ic_mou_6  loc_ic_mou_7  loc_ic_mou_8  std_ic_t2t_mou_6  \
8          81.43         23.83         15.79              0.00
13        215.58         26.11        255.26            115.68
16        276.86        229.83        211.78             68.79
17         81.96          2.31          0.00              8.63
21        125.33         87.68        159.11             14.06

    std_ic_t2t_mou_7  std_ic_t2t_mou_8  std_ic_t2m_mou_6
std_ic_t2m_mou_7  \
8               0.58              0.10              22.43
4.08
13             38.29            154.58            308.13
29.79
16             78.64              6.33              18.68
73.08
17              0.00              0.00               1.28
0.00
21              5.98              0.18              67.69
38.23

    std_ic_t2m_mou_8  std_ic_t2f_mou_6  std_ic_t2f_mou_7
std_ic_t2f_mou_8  \
8               0.65              0.00               0.0
0.00
13             317.91              0.00               0.0
1.91
16             73.93              0.51               0.0
2.18
17              0.00              0.00               0.0
0.00
21             101.74              0.00               0.0
0.00

    std_ic_t2o_mou_6  std_ic_t2o_mou_7  std_ic_t2o_mou_8  std_ic_mou_6
\
```

```
8                0.0               0.0               0.0          22.43

13               0.0               0.0               0.0         423.81

16               0.0               0.0               0.0          87.99

17               0.0               0.0               0.0           9.91

21               0.0               0.0               0.0          81.76


    std_ic_mou_7  std_ic_mou_8  total_ic_mou_6  total_ic_mou_7  \
8           4.66          0.75          103.86           28.49
13         68.09        474.41          968.61          172.58
16        151.73         82.44          364.86          381.56
17          0.00          0.00           91.88            2.31
21         44.21        101.93          207.09          131.89

    total_ic_mou_8  spl_ic_mou_6  spl_ic_mou_7  spl_ic_mou_8
isd_ic_mou_6  \
8            16.54          0.00           0.0           0.0
0.00
13         1144.53          0.45           0.0           0.0
245.28
16          294.46          0.00           0.0           0.0
0.00
17            0.00          0.00           0.0           0.0
0.00
21          261.04          0.00           0.0           0.0
0.00

    isd_ic_mou_7  isd_ic_mou_8  ic_others_6  ic_others_7  ic_others_8
\
8            0.00          0.00         0.00         0.00         0.00

13          62.11        393.39        83.48        16.24        21.44

16           0.00          0.23         0.00         0.00         0.00

17           0.00          0.00         0.00         0.00         0.00

21           0.00          0.00         0.00         0.00         0.00


    total_rech_num_6  total_rech_num_7  total_rech_num_8
total_rech_amt_6  \
8                 19                21                14
437
13                 6                 4                11
507
16                10                 6                 2
```

```
570
17                 19                  2                  4
816
21                 22                 26                 27
600

    total_rech_amt_7  total_rech_amt_8  max_rech_amt_6  max_rech_amt_7
\
8                601               120              90             154

13               253               717             110             110

16               348               160             110             110

17                 0                30             110               0

21               680               718              50              50


    max_rech_amt_8  last_day_rch_amt_6  last_day_rch_amt_7  \
8               30                  50                   0
13             130                 110                  50
16             130                 100                 100
17              30                  30                   0
21              50                  30                  20

    last_day_rch_amt_8  vol_2g_mb_6  vol_2g_mb_7  vol_2g_mb_8
vol_3g_mb_6  \
8                   10          0.0        356.0         0.03
0.0
13                   0          0.0          0.0         0.02
0.0
16                 130          0.0          0.0         0.00
0.0
17                   0          0.0          0.0         0.00
0.0
21                  50          0.0          0.0         0.00
0.0

    vol_3g_mb_7  vol_3g_mb_8  monthly_2g_6  monthly_2g_7  monthly_2g_8
\
8        750.95        11.94             0             1             0

13         0.00         0.00             0             0             0

16         0.00         0.00             0             0             0

17         0.00         0.00             0             0             0

21         0.00         0.00             0             0             0
```

```
    sachet_2g_6  sachet_2g_7  sachet_2g_8  monthly_3g_6  monthly_3g_7
\
8             0            1            3             0             0

13            0            0            3             0             0

16            0            0            0             0             0

17            0            0            0             0             0

21            0            0            0             0             0


    monthly_3g_8  sachet_3g_6  sachet_3g_7  sachet_3g_8   aon
aug_vbc_3g  \
8              0            0            0            0   315
21.03
13             0            0            0            0  2607
0.00
16             0            0            0            0   511
0.00
17             0            0            0            0   667
0.00
21             0            0            0            0   720
0.00

    jul_vbc_3g  jun_vbc_3g  avg_rech_amt_6_7 churn  total_mou_good  \
8       910.65      122.16             519.0     0          612.22
13        0.00        0.00             380.0     0         1875.70
16        2.45       21.89             459.0     0          711.67
17        0.00        0.00             408.0     0         1341.41
21        0.00        0.00             640.0     0         1067.43

    avg_mou_action  diff_mou  decrease_mou_action
8          324.125  -288.095                    1
13        1262.390  -613.310                    1
16         597.705  -113.965                    1
17           1.560 -1339.850                    1
21        1245.130   177.700                    0
```

```
# Avg rech number at action phase
data['avg_rech_num_action'] = (data['total_rech_num_7'] +
data['total_rech_num_8'])/2

# Difference total_rech_num_6 and avg_rech_action
data['diff_rech_num'] = data['avg_rech_num_action'] -
data['total_rech_num_6']
```

```
# Checking if rech_num has decreased in action phase
data['decrease_rech_num_action'] = np.where((data['diff_rech_num'] <
0), 1, 0)

data.head()
```

```
   mobile_number  loc_og_t2o_mou  std_og_t2o_mou  loc_ic_t2o_mou
arpu_6  \
8     7001524846             0.0             0.0             0.0
378.721
13    7002191713             0.0             0.0             0.0
492.846
16    7000875565             0.0             0.0             0.0
430.975
17    7000187447             0.0             0.0             0.0
690.008
21    7002124215             0.0             0.0             0.0
514.453

     arpu_7   arpu_8  onnet_mou_6  onnet_mou_7  onnet_mou_8
offnet_mou_6  \
8   492.223  137.362       413.69       351.03        35.08
94.66
13  205.671  593.260       501.76       108.39       534.24
413.31
16  299.869  187.894        50.51        74.01        70.61
296.29
17   18.980   25.499      1185.91         9.28         7.79
61.64
21  597.753  637.760       102.41       132.11        85.14
757.93

    offnet_mou_7  offnet_mou_8  roam_ic_mou_6  roam_ic_mou_7
roam_ic_mou_8  \
8          80.63        136.48           0.00           0.00
0.00
13        119.28        482.46          23.53         144.24
72.11
16        229.74        162.76           0.00           2.83
0.00
17          0.00          5.54           0.00           4.76
4.81
21        896.68        983.39           0.00           0.00
0.00

    roam_og_mou_6  roam_og_mou_7  roam_og_mou_8  loc_og_t2t_mou_6  \
8            0.00           0.00           0.00            297.13
13           7.98          35.26           1.44             49.63
16           0.00          17.74           0.00             42.61
17           0.00           8.46          13.34             38.99
```

```
21           0.00           0.00           0.00               4.48

    loc_og_t2t_mou_7  loc_og_t2t_mou_8  loc_og_t2m_mou_6
loc_og_t2m_mou_7  \
8              217.59             12.49             80.96
70.58
13               6.19             36.01            151.13
47.28
16              65.16             67.38            273.29
145.99
17               0.00              0.00             58.54
0.00
21               6.16             23.34             91.81
87.93

    loc_og_t2m_mou_8  loc_og_t2f_mou_6  loc_og_t2f_mou_7
loc_og_t2f_mou_8  \
8               50.54              0.00              0.00
0.00
13             294.46              4.54              0.00
23.51
16             128.28              0.00              4.48
10.26
17               0.00              0.00              0.00
0.00
21             104.81              0.75              0.00
1.58

    loc_og_t2c_mou_6  loc_og_t2c_mou_7  loc_og_t2c_mou_8  loc_og_mou_6
\
8                0.0               0.0              7.15        378.09

13               0.0               0.0              0.49        205.31

16               0.0               0.0              0.00        315.91

17               0.0               0.0              0.00         97.54

21               0.0               0.0              0.00         97.04


    loc_og_mou_7  loc_og_mou_8  std_og_t2t_mou_6  std_og_t2t_mou_7  \
8         288.18         63.04            116.56            133.43
13         53.48        353.99            446.41             85.98
16        215.64        205.93              7.89              2.58
17          0.00          0.00           1146.91              0.81
21         94.09        129.74             97.93            125.94

    std_og_t2t_mou_8  std_og_t2m_mou_6  std_og_t2m_mou_7
std_og_t2m_mou_8  \
```

```
8               22.58              13.69              10.04
75.69
13             498.23             255.36              52.94
156.94
16               3.23              22.99              64.51
18.29
17               0.00               1.55               0.00
0.00
21              61.79             665.36             808.74
876.99

    std_og_t2f_mou_6  std_og_t2f_mou_7  std_og_t2f_mou_8
std_og_t2c_mou_6  \
8                0.0               0.0               0.0
0.0
13               0.0               0.0               0.0
0.0
16               0.0               0.0               0.0
0.0
17               0.0               0.0               0.0
0.0
21               0.0               0.0               0.0
0.0

    std_og_t2c_mou_7  std_og_t2c_mou_8  std_og_mou_6  std_og_mou_7  \
8                0.0               0.0        130.26        143.48
13               0.0               0.0        701.78        138.93
16               0.0               0.0         30.89         67.09
17               0.0               0.0       1148.46          0.81
21               0.0               0.0        763.29        934.69

    std_og_mou_8  isd_og_mou_6  isd_og_mou_7  isd_og_mou_8
spl_og_mou_6  \
8          98.28           0.0           0.0          0.00
0.00
13        655.18           0.0           0.0          1.29
0.00
16         21.53           0.0           0.0          0.00
0.00
17          0.00           0.0           0.0          0.00
2.58
21        938.79           0.0           0.0          0.00
0.00

    spl_og_mou_7  spl_og_mou_8  og_others_6  og_others_7  og_others_8
\
8           0.00         10.23         0.00          0.0          0.0

13          0.00          4.78         0.00          0.0          0.0
```

```
16           3.26           5.91          0.00           0.0           0.0

17           0.00           0.00          0.93           0.0           0.0

21           0.00           0.00          0.00           0.0           0.0


    total_og_mou_6  total_og_mou_7  total_og_mou_8
loc_ic_t2t_mou_6  \
8            508.36          431.66          171.56              23.84

13           907.09          192.41         1015.26              67.88

16           346.81          286.01          233.38              41.33

17         1249.53            0.81            0.00              34.54

21           860.34         1028.79         1068.54               2.48


    loc_ic_t2t_mou_7  loc_ic_t2t_mou_8  loc_ic_t2m_mou_6
loc_ic_t2m_mou_7  \
8               9.84              0.31             57.58
13.98
13              7.58             52.58            142.88
18.53
16             71.44             28.89            226.81
149.69
17              0.00              0.00             47.41
2.31
21             10.19             19.54            118.23
74.63

    loc_ic_t2m_mou_8  loc_ic_t2f_mou_6  loc_ic_t2f_mou_7
loc_ic_t2f_mou_8  \
8              15.48              0.00              0.00
0.00
13            195.18              4.81              0.00
7.49
16            150.16              8.71              8.68
32.71
17              0.00              0.00              0.00
0.00
21            129.16              4.61              2.84
10.39

    loc_ic_mou_6  loc_ic_mou_7  loc_ic_mou_8  std_ic_t2t_mou_6  \
8          81.43         23.83         15.79              0.00
13        215.58         26.11        255.26            115.68
16        276.86        229.83        211.78             68.79
```

```
17         81.96          2.31          0.00              8.63
21        125.33         87.68        159.11             14.06

    std_ic_t2t_mou_7  std_ic_t2t_mou_8  std_ic_t2m_mou_6
std_ic_t2m_mou_7  \
8                 0.58              0.10             22.43
4.08
13               38.29            154.58            308.13
29.79
16               78.64              6.33             18.68
73.08
17                0.00              0.00              1.28
0.00
21                5.98              0.18             67.69
38.23

    std_ic_t2m_mou_8  std_ic_t2f_mou_6  std_ic_t2f_mou_7
std_ic_t2f_mou_8  \
8                 0.65              0.00               0.0
0.00
13              317.91              0.00               0.0
1.91
16               73.93              0.51               0.0
2.18
17                0.00              0.00               0.0
0.00
21              101.74              0.00               0.0
0.00

    std_ic_t2o_mou_6  std_ic_t2o_mou_7  std_ic_t2o_mou_8  std_ic_mou_6
\
8                0.0               0.0               0.0         22.43

13               0.0               0.0               0.0        423.81

16               0.0               0.0               0.0         87.99

17               0.0               0.0               0.0          9.91

21               0.0               0.0               0.0         81.76


    std_ic_mou_7  std_ic_mou_8  total_ic_mou_6  total_ic_mou_7  \
8           4.66          0.75          103.86           28.49
13         68.09        474.41          968.61          172.58
16        151.73         82.44          364.86          381.56
17          0.00          0.00           91.88            2.31
21         44.21        101.93          207.09          131.89

    total_ic_mou_8  spl_ic_mou_6  spl_ic_mou_7  spl_ic_mou_8
```

```
isd_ic_mou_6  \
8             16.54          0.00           0.0           0.0
0.00
13          1144.53          0.45           0.0           0.0
245.28
16           294.46          0.00           0.0           0.0
0.00
17             0.00          0.00           0.0           0.0
0.00
21           261.04          0.00           0.0           0.0
0.00

    isd_ic_mou_7  isd_ic_mou_8  ic_others_6  ic_others_7  ic_others_8
\
8            0.00          0.00         0.00         0.00          0.00

13          62.11        393.39        83.48        16.24         21.44

16           0.00          0.23         0.00         0.00          0.00

17           0.00          0.00         0.00         0.00          0.00

21           0.00          0.00         0.00         0.00          0.00


    total_rech_num_6  total_rech_num_7  total_rech_num_8
total_rech_amt_6  \
8                  19                21                14
437
13                  6                 4                11
507
16                 10                 6                 2
570
17                 19                 2                 4
816
21                 22                26                27
600

    total_rech_amt_7  total_rech_amt_8  max_rech_amt_6  max_rech_amt_7
\
8                601               120              90             154

13               253               717             110             110

16               348               160             110             110

17                 0                30             110               0

21               680               718              50              50
```

```
    max_rech_amt_8  last_day_rch_amt_6  last_day_rch_amt_7  \
8               30                  50                   0
13             130                 110                  50
16             130                 100                 100
17              30                  30                   0
21              50                  30                  20

    last_day_rch_amt_8  vol_2g_mb_6  vol_2g_mb_7  vol_2g_mb_8
vol_3g_mb_6  \
8                   10          0.0        356.0         0.03
0.0
13                   0          0.0          0.0         0.02
0.0
16                 130          0.0          0.0         0.00
0.0
17                   0          0.0          0.0         0.00
0.0
21                  50          0.0          0.0         0.00
0.0

    vol_3g_mb_7  vol_3g_mb_8  monthly_2g_6  monthly_2g_7  monthly_2g_8
\
8        750.95        11.94             0             1             0

13         0.00         0.00             0             0             0

16         0.00         0.00             0             0             0

17         0.00         0.00             0             0             0

21         0.00         0.00             0             0             0


    sachet_2g_6  sachet_2g_7  sachet_2g_8  monthly_3g_6  monthly_3g_7
\
8             0            1            3             0             0

13            0            0            3             0             0

16            0            0            0             0             0

17            0            0            0             0             0

21            0            0            0             0             0


    monthly_3g_8  sachet_3g_6  sachet_3g_7  sachet_3g_8   aon
aug_vbc_3g  \
8              0            0            0            0   315
21.03
13             0            0            0            0  2607
```

```
0.00
16              0             0             0             0   511
0.00
17              0             0             0             0   667
0.00
21              0             0             0             0   720
0.00

    jul_vbc_3g  jun_vbc_3g  avg_rech_amt_6_7 churn  total_mou_good  \
8       910.65      122.16             519.0     0          612.22
13        0.00        0.00             380.0     0         1875.70
16        2.45       21.89             459.0     0          711.67
17        0.00        0.00             408.0     0         1341.41
21        0.00        0.00             640.0     0         1067.43

    avg_mou_action  diff_mou  decrease_mou_action  avg_rech_num_action
\
8          324.125  -288.095                    1                 17.5

13        1262.390  -613.310                    1                  7.5

16         597.705  -113.965                    1                  4.0

17           1.560 -1339.850                    1                  3.0

21        1245.130   177.700                    0                 26.5


    diff_rech_num  decrease_rech_num_action
8            -1.5                         1
13            1.5                         0
16           -6.0                         1
17          -16.0                         1
21            4.5                         0
```

```
# Avg rech_amt in action phase
data['avg_rech_amt_action'] = (data['total_rech_amt_7'] +
data['total_rech_amt_8'])/2

# Difference of action phase rech amt and good phase rech amt
data['diff_rech_amt'] = data['avg_rech_amt_action'] -
data['total_rech_amt_6']

# Checking if rech_amt has decreased in action phase
data['decrease_rech_amt_action'] = np.where((data['diff_rech_amt'] <
0), 1, 0)

data.head()
```

```
   mobile_number  loc_og_t2o_mou  std_og_t2o_mou  loc_ic_t2o_mou
arpu_6  \
```

```
8     7001524846              0.0              0.0              0.0
378.721
13    7002191713              0.0              0.0              0.0
492.846
16    7000875565              0.0              0.0              0.0
430.975
17    7000187447              0.0              0.0              0.0
690.008
21    7002124215              0.0              0.0              0.0
514.453

     arpu_7   arpu_8  onnet_mou_6  onnet_mou_7  onnet_mou_8
offnet_mou_6  \
8   492.223  137.362       413.69       351.03        35.08
94.66
13  205.671  593.260       501.76       108.39       534.24
413.31
16  299.869  187.894        50.51        74.01        70.61
296.29
17   18.980   25.499      1185.91         9.28         7.79
61.64
21  597.753  637.760       102.41       132.11        85.14
757.93

    offnet_mou_7  offnet_mou_8  roam_ic_mou_6  roam_ic_mou_7
roam_ic_mou_8  \
8          80.63        136.48           0.00           0.00
0.00
13        119.28        482.46          23.53         144.24
72.11
16        229.74        162.76           0.00           2.83
0.00
17          0.00          5.54           0.00           4.76
4.81
21        896.68        983.39           0.00           0.00
0.00

    roam_og_mou_6  roam_og_mou_7  roam_og_mou_8  loc_og_t2t_mou_6  \
8            0.00           0.00           0.00            297.13
13           7.98          35.26           1.44             49.63
16           0.00          17.74           0.00             42.61
17           0.00           8.46          13.34             38.99
21           0.00           0.00           0.00              4.48

    loc_og_t2t_mou_7  loc_og_t2t_mou_8  loc_og_t2m_mou_6
loc_og_t2m_mou_7  \
8             217.59             12.49             80.96
70.58
13              6.19             36.01            151.13
47.28
```

```
16             65.16             67.38            273.29
145.99
17              0.00              0.00             58.54
0.00
21              6.16             23.34             91.81
87.93

    loc_og_t2m_mou_8  loc_og_t2f_mou_6  loc_og_t2f_mou_7
loc_og_t2f_mou_8  \
8              50.54              0.00              0.00
0.00
13            294.46              4.54              0.00
23.51
16            128.28              0.00              4.48
10.26
17              0.00              0.00              0.00
0.00
21            104.81              0.75              0.00
1.58

    loc_og_t2c_mou_6  loc_og_t2c_mou_7  loc_og_t2c_mou_8  loc_og_mou_6
\
8                0.0               0.0              7.15        378.09

13               0.0               0.0              0.49        205.31

16               0.0               0.0              0.00        315.91

17               0.0               0.0              0.00         97.54

21               0.0               0.0              0.00         97.04


    loc_og_mou_7  loc_og_mou_8  std_og_t2t_mou_6  std_og_t2t_mou_7  \
8         288.18         63.04            116.56            133.43
13         53.48        353.99            446.41             85.98
16        215.64        205.93              7.89              2.58
17          0.00          0.00           1146.91              0.81
21         94.09        129.74             97.93            125.94

    std_og_t2t_mou_8  std_og_t2m_mou_6  std_og_t2m_mou_7
std_og_t2m_mou_8  \
8              22.58             13.69             10.04
75.69
13            498.23            255.36             52.94
156.94
16              3.23             22.99             64.51
18.29
17              0.00              1.55              0.00
0.00
```

```
21             61.79            665.36            808.74
876.99

    std_og_t2f_mou_6  std_og_t2f_mou_7  std_og_t2f_mou_8
std_og_t2c_mou_6  \
8                0.0               0.0               0.0
0.0
13               0.0               0.0               0.0
0.0
16               0.0               0.0               0.0
0.0
17               0.0               0.0               0.0
0.0
21               0.0               0.0               0.0
0.0

    std_og_t2c_mou_7  std_og_t2c_mou_8  std_og_mou_6  std_og_mou_7  \
8                0.0               0.0        130.26        143.48
13               0.0               0.0        701.78        138.93
16               0.0               0.0         30.89         67.09
17               0.0               0.0       1148.46          0.81
21               0.0               0.0        763.29        934.69

    std_og_mou_8  isd_og_mou_6  isd_og_mou_7  isd_og_mou_8
spl_og_mou_6  \
8          98.28           0.0           0.0          0.00
0.00
13        655.18           0.0           0.0          1.29
0.00
16         21.53           0.0           0.0          0.00
0.00
17          0.00           0.0           0.0          0.00
2.58
21        938.79           0.0           0.0          0.00
0.00

    spl_og_mou_7  spl_og_mou_8  og_others_6  og_others_7  og_others_8
\
8           0.00         10.23         0.00          0.0          0.0

13          0.00          4.78         0.00          0.0          0.0

16          3.26          5.91         0.00          0.0          0.0

17          0.00          0.00         0.93          0.0          0.0

21          0.00          0.00         0.00          0.0          0.0


    total_og_mou_6  total_og_mou_7  total_og_mou_8
```

```
loc_ic_t2t_mou_6  \
8           508.36          431.66          171.56              23.84

13          907.09          192.41         1015.26              67.88

16          346.81          286.01          233.38              41.33

17         1249.53            0.81            0.00              34.54

21          860.34         1028.79         1068.54               2.48


    loc_ic_t2t_mou_7  loc_ic_t2t_mou_8  loc_ic_t2m_mou_6
loc_ic_t2m_mou_7  \
8               9.84              0.31             57.58
13.98
13              7.58             52.58            142.88
18.53
16             71.44             28.89            226.81
149.69
17              0.00              0.00             47.41
2.31
21             10.19             19.54            118.23
74.63

    loc_ic_t2m_mou_8  loc_ic_t2f_mou_6  loc_ic_t2f_mou_7
loc_ic_t2f_mou_8  \
8              15.48              0.00              0.00
0.00
13            195.18              4.81              0.00
7.49
16            150.16              8.71              8.68
32.71
17              0.00              0.00              0.00
0.00
21            129.16              4.61              2.84
10.39

    loc_ic_mou_6  loc_ic_mou_7  loc_ic_mou_8  std_ic_t2t_mou_6  \
8          81.43         23.83         15.79              0.00
13        215.58         26.11        255.26            115.68
16        276.86        229.83        211.78             68.79
17         81.96          2.31          0.00              8.63
21        125.33         87.68        159.11             14.06

    std_ic_t2t_mou_7  std_ic_t2t_mou_8  std_ic_t2m_mou_6
std_ic_t2m_mou_7  \
8               0.58              0.10             22.43
4.08
13             38.29            154.58            308.13
```

```
29.79
16             78.64              6.33             18.68
73.08
17              0.00              0.00              1.28
0.00
21              5.98              0.18             67.69
38.23

    std_ic_t2m_mou_8  std_ic_t2f_mou_6  std_ic_t2f_mou_7
std_ic_t2f_mou_8  \
8               0.65              0.00               0.0
0.00
13            317.91              0.00               0.0
1.91
16             73.93              0.51               0.0
2.18
17              0.00              0.00               0.0
0.00
21            101.74              0.00               0.0
0.00

    std_ic_t2o_mou_6  std_ic_t2o_mou_7  std_ic_t2o_mou_8  std_ic_mou_6
\
8                0.0               0.0               0.0         22.43

13               0.0               0.0               0.0        423.81

16               0.0               0.0               0.0         87.99

17               0.0               0.0               0.0          9.91

21               0.0               0.0               0.0         81.76


    std_ic_mou_7  std_ic_mou_8  total_ic_mou_6  total_ic_mou_7  \
8           4.66          0.75          103.86           28.49
13         68.09        474.41          968.61          172.58
16        151.73         82.44          364.86          381.56
17          0.00          0.00           91.88            2.31
21         44.21        101.93          207.09          131.89

    total_ic_mou_8  spl_ic_mou_6  spl_ic_mou_7  spl_ic_mou_8
isd_ic_mou_6  \
8            16.54          0.00           0.0           0.0
0.00
13         1144.53          0.45           0.0           0.0
245.28
16          294.46          0.00           0.0           0.0
0.00
17            0.00          0.00           0.0           0.0
```

```
0.00
21          261.04          0.00           0.0           0.0
0.00

    isd_ic_mou_7  isd_ic_mou_8  ic_others_6  ic_others_7  ic_others_8
\
8           0.00          0.00         0.00         0.00          0.00

13         62.11        393.39        83.48        16.24         21.44

16          0.00          0.23         0.00         0.00          0.00

17          0.00          0.00         0.00         0.00          0.00

21          0.00          0.00         0.00         0.00          0.00


    total_rech_num_6  total_rech_num_7  total_rech_num_8
total_rech_amt_6  \
8                 19                21                14
437
13                 6                 4                11
507
16                10                 6                 2
570
17                19                 2                 4
816
21                22                26                27
600

    total_rech_amt_7  total_rech_amt_8  max_rech_amt_6  max_rech_amt_7
\
8                601               120              90             154

13               253               717             110             110

16               348               160             110             110

17                 0                30             110               0

21               680               718              50              50


    max_rech_amt_8  last_day_rch_amt_6  last_day_rch_amt_7  \
8               30                  50                   0
13             130                 110                  50
16             130                 100                 100
17              30                  30                   0
21              50                  30                  20

    last_day_rch_amt_8  vol_2g_mb_6  vol_2g_mb_7  vol_2g_mb_8
```

```
vol_3g_mb_6  \
8                   10          0.0        356.0          0.03
0.0
13                   0          0.0          0.0          0.02
0.0
16                 130          0.0          0.0          0.00
0.0
17                   0          0.0          0.0          0.00
0.0
21                  50          0.0          0.0          0.00
0.0

    vol_3g_mb_7  vol_3g_mb_8  monthly_2g_6  monthly_2g_7  monthly_2g_8
\
8        750.95        11.94             0             1             0

13         0.00         0.00             0             0             0

16         0.00         0.00             0             0             0

17         0.00         0.00             0             0             0

21         0.00         0.00             0             0             0


    sachet_2g_6  sachet_2g_7  sachet_2g_8  monthly_3g_6  monthly_3g_7
\
8             0            1            3             0             0

13            0            0            3             0             0

16            0            0            0             0             0

17            0            0            0             0             0

21            0            0            0             0             0


    monthly_3g_8  sachet_3g_6  sachet_3g_7  sachet_3g_8   aon
aug_vbc_3g  \
8              0            0            0            0   315
21.03
13             0            0            0            0  2607
0.00
16             0            0            0            0   511
0.00
17             0            0            0            0   667
0.00
21             0            0            0            0   720
0.00
```

```
    jul_vbc_3g  jun_vbc_3g  avg_rech_amt_6_7 churn  total_mou_good  \
8       910.65      122.16             519.0     0          612.22
13        0.00        0.00             380.0     0         1875.70
16        2.45       21.89             459.0     0          711.67
17        0.00        0.00             408.0     0         1341.41
21        0.00        0.00             640.0     0         1067.43

    avg_mou_action  diff_mou  decrease_mou_action  avg_rech_num_action
\
8          324.125  -288.095                    1                 17.5

13        1262.390  -613.310                    1                  7.5

16         597.705  -113.965                    1                  4.0

17           1.560 -1339.850                    1                  3.0

21        1245.130   177.700                    0                 26.5


    diff_rech_num  decrease_rech_num_action  avg_rech_amt_action  \
8            -1.5                         1                360.5
13            1.5                         0                485.0
16           -6.0                         1                254.0
17          -16.0                         1                 15.0
21            4.5                         0                699.0

    diff_rech_amt  decrease_rech_amt_action
8           -76.5                         1
13          -22.0                         1
16         -316.0                         1
17         -801.0                         1
21           99.0                         0
```

```
# ARUP in action phase
data['avg_arpu_action'] = (data['arpu_7'] + data['arpu_8'])/2

# Difference of good and action phase ARPU
data['diff_arpu'] = data['avg_arpu_action'] - data['arpu_6']

# Checking whether the arpu has decreased on the action month
data['decrease_arpu_action'] = np.where(data['diff_arpu'] < 0, 1, 0)

data.head()
```

```
   mobile_number  loc_og_t2o_mou  std_og_t2o_mou  loc_ic_t2o_mou
arpu_6  \
8     7001524846             0.0             0.0             0.0
378.721
13    7002191713             0.0             0.0             0.0
492.846
```

```
16    7000875565             0.0             0.0             0.0
430.975
17    7000187447             0.0             0.0             0.0
690.008
21    7002124215             0.0             0.0             0.0
514.453

     arpu_7   arpu_8  onnet_mou_6  onnet_mou_7  onnet_mou_8
offnet_mou_6  \
8   492.223  137.362       413.69       351.03        35.08
94.66
13  205.671  593.260       501.76       108.39       534.24
413.31
16  299.869  187.894        50.51        74.01        70.61
296.29
17   18.980   25.499      1185.91         9.28         7.79
61.64
21  597.753  637.760       102.41       132.11        85.14
757.93

    offnet_mou_7  offnet_mou_8  roam_ic_mou_6  roam_ic_mou_7
roam_ic_mou_8  \
8          80.63        136.48           0.00           0.00
0.00
13        119.28        482.46          23.53         144.24
72.11
16        229.74        162.76           0.00           2.83
0.00
17          0.00          5.54           0.00           4.76
4.81
21        896.68        983.39           0.00           0.00
0.00

    roam_og_mou_6  roam_og_mou_7  roam_og_mou_8  loc_og_t2t_mou_6  \
8            0.00           0.00           0.00            297.13
13           7.98          35.26           1.44             49.63
16           0.00          17.74           0.00             42.61
17           0.00           8.46          13.34             38.99
21           0.00           0.00           0.00              4.48

    loc_og_t2t_mou_7  loc_og_t2t_mou_8  loc_og_t2m_mou_6
loc_og_t2m_mou_7  \
8             217.59             12.49             80.96
70.58
13              6.19             36.01            151.13
47.28
16             65.16             67.38            273.29
145.99
17              0.00              0.00             58.54
0.00
```

```
21               6.16              23.34              91.81
87.93

    loc_og_t2m_mou_8  loc_og_t2f_mou_6  loc_og_t2f_mou_7
loc_og_t2f_mou_8  \
8               50.54              0.00               0.00
0.00
13             294.46              4.54               0.00
23.51
16             128.28              0.00               4.48
10.26
17               0.00              0.00               0.00
0.00
21             104.81              0.75               0.00
1.58

    loc_og_t2c_mou_6  loc_og_t2c_mou_7  loc_og_t2c_mou_8  loc_og_mou_6
\
8                 0.0               0.0               7.15        378.09

13                0.0               0.0               0.49        205.31

16                0.0               0.0               0.00        315.91

17                0.0               0.0               0.00         97.54

21                0.0               0.0               0.00         97.04


    loc_og_mou_7  loc_og_mou_8  std_og_t2t_mou_6  std_og_t2t_mou_7  \
8         288.18         63.04            116.56            133.43
13         53.48        353.99            446.41             85.98
16        215.64        205.93              7.89              2.58
17          0.00          0.00           1146.91              0.81
21         94.09        129.74             97.93            125.94

    std_og_t2t_mou_8  std_og_t2m_mou_6  std_og_t2m_mou_7
std_og_t2m_mou_8  \
8               22.58             13.69              10.04
75.69
13             498.23            255.36              52.94
156.94
16               3.23             22.99              64.51
18.29
17               0.00              1.55               0.00
0.00
21              61.79            665.36             808.74
876.99

    std_og_t2f_mou_6  std_og_t2f_mou_7  std_og_t2f_mou_8
```

```
std_og_t2c_mou_6  \
8                0.0               0.0               0.0
0.0
13               0.0               0.0               0.0
0.0
16               0.0               0.0               0.0
0.0
17               0.0               0.0               0.0
0.0
21               0.0               0.0               0.0
0.0

    std_og_t2c_mou_7  std_og_t2c_mou_8  std_og_mou_6  std_og_mou_7  \
8                0.0               0.0        130.26        143.48
13               0.0               0.0        701.78        138.93
16               0.0               0.0         30.89         67.09
17               0.0               0.0       1148.46          0.81
21               0.0               0.0        763.29        934.69

    std_og_mou_8  isd_og_mou_6  isd_og_mou_7  isd_og_mou_8
spl_og_mou_6  \
8          98.28           0.0           0.0          0.00
0.00
13        655.18           0.0           0.0          1.29
0.00
16         21.53           0.0           0.0          0.00
0.00
17          0.00           0.0           0.0          0.00
2.58
21        938.79           0.0           0.0          0.00
0.00

    spl_og_mou_7  spl_og_mou_8  og_others_6  og_others_7  og_others_8
\
8           0.00         10.23         0.00          0.0          0.0

13          0.00          4.78         0.00          0.0          0.0

16          3.26          5.91         0.00          0.0          0.0

17          0.00          0.00         0.93          0.0          0.0

21          0.00          0.00         0.00          0.0          0.0


    total_og_mou_6  total_og_mou_7  total_og_mou_8
loc_ic_t2t_mou_6  \
8           508.36          431.66          171.56             23.84

13          907.09          192.41         1015.26             67.88
```

```
16          346.81          286.01          233.38             41.33

17         1249.53            0.81            0.00             34.54

21          860.34         1028.79         1068.54              2.48


    loc_ic_t2t_mou_7  loc_ic_t2t_mou_8  loc_ic_t2m_mou_6
loc_ic_t2m_mou_7  \
8               9.84              0.31             57.58
13.98
13              7.58             52.58            142.88
18.53
16             71.44             28.89            226.81
149.69
17              0.00              0.00             47.41
2.31
21             10.19             19.54            118.23
74.63

    loc_ic_t2m_mou_8  loc_ic_t2f_mou_6  loc_ic_t2f_mou_7
loc_ic_t2f_mou_8  \
8              15.48              0.00              0.00
0.00
13            195.18              4.81              0.00
7.49
16            150.16              8.71              8.68
32.71
17              0.00              0.00              0.00
0.00
21            129.16              4.61              2.84
10.39

    loc_ic_mou_6  loc_ic_mou_7  loc_ic_mou_8  std_ic_t2t_mou_6  \
8          81.43         23.83         15.79              0.00
13        215.58         26.11        255.26            115.68
16        276.86        229.83        211.78             68.79
17         81.96          2.31          0.00              8.63
21        125.33         87.68        159.11             14.06

    std_ic_t2t_mou_7  std_ic_t2t_mou_8  std_ic_t2m_mou_6
std_ic_t2m_mou_7  \
8               0.58              0.10             22.43
4.08
13             38.29            154.58            308.13
29.79
16             78.64              6.33             18.68
73.08
17              0.00              0.00              1.28
```

```
0.00
21              5.98              0.18             67.69
38.23

    std_ic_t2m_mou_8  std_ic_t2f_mou_6  std_ic_t2f_mou_7
std_ic_t2f_mou_8  \
8               0.65              0.00               0.0
0.00
13            317.91              0.00               0.0
1.91
16             73.93              0.51               0.0
2.18
17              0.00              0.00               0.0
0.00
21            101.74              0.00               0.0
0.00

    std_ic_t2o_mou_6  std_ic_t2o_mou_7  std_ic_t2o_mou_8  std_ic_mou_6
\
8                0.0               0.0               0.0         22.43

13               0.0               0.0               0.0        423.81

16               0.0               0.0               0.0         87.99

17               0.0               0.0               0.0          9.91

21               0.0               0.0               0.0         81.76


    std_ic_mou_7  std_ic_mou_8  total_ic_mou_6  total_ic_mou_7  \
8           4.66          0.75          103.86           28.49
13         68.09        474.41          968.61          172.58
16        151.73         82.44          364.86          381.56
17          0.00          0.00           91.88            2.31
21         44.21        101.93          207.09          131.89

    total_ic_mou_8  spl_ic_mou_6  spl_ic_mou_7  spl_ic_mou_8
isd_ic_mou_6  \
8            16.54          0.00           0.0           0.0
0.00
13         1144.53          0.45           0.0           0.0
245.28
16          294.46          0.00           0.0           0.0
0.00
17            0.00          0.00           0.0           0.0
0.00
21          261.04          0.00           0.0           0.0
0.00
```

```
    isd_ic_mou_7  isd_ic_mou_8  ic_others_6  ic_others_7  ic_others_8
\
8           0.00          0.00         0.00         0.00          0.00

13         62.11        393.39        83.48        16.24         21.44

16          0.00          0.23         0.00         0.00          0.00

17          0.00          0.00         0.00         0.00          0.00

21          0.00          0.00         0.00         0.00          0.00


    total_rech_num_6  total_rech_num_7  total_rech_num_8
total_rech_amt_6  \
8                  19                21                14
437
13                  6                 4                11
507
16                 10                 6                 2
570
17                 19                 2                 4
816
21                 22                26                27
600

    total_rech_amt_7  total_rech_amt_8  max_rech_amt_6  max_rech_amt_7
\
8                601               120              90             154

13               253               717             110             110

16               348               160             110             110

17                 0                30             110               0

21               680               718              50              50


    max_rech_amt_8  last_day_rch_amt_6  last_day_rch_amt_7  \
8               30                  50                   0
13             130                 110                  50
16             130                 100                 100
17              30                  30                   0
21              50                  30                  20

    last_day_rch_amt_8  vol_2g_mb_6  vol_2g_mb_7  vol_2g_mb_8
vol_3g_mb_6  \
8                   10          0.0        356.0         0.03
0.0
13                   0          0.0          0.0         0.02
```

```
0.0
16                 130          0.0          0.0          0.00
0.0
17                   0          0.0          0.0          0.00
0.0
21                  50          0.0          0.0          0.00
0.0

    vol_3g_mb_7  vol_3g_mb_8  monthly_2g_6  monthly_2g_7  monthly_2g_8
\
8        750.95        11.94             0             1             0

13         0.00         0.00             0             0             0

16         0.00         0.00             0             0             0

17         0.00         0.00             0             0             0

21         0.00         0.00             0             0             0


    sachet_2g_6  sachet_2g_7  sachet_2g_8  monthly_3g_6  monthly_3g_7
\
8             0            1            3             0             0

13            0            0            3             0             0

16            0            0            0             0             0

17            0            0            0             0             0

21            0            0            0             0             0


    monthly_3g_8  sachet_3g_6  sachet_3g_7  sachet_3g_8   aon
aug_vbc_3g  \
8              0            0            0            0   315
21.03
13             0            0            0            0  2607
0.00
16             0            0            0            0   511
0.00
17             0            0            0            0   667
0.00
21             0            0            0            0   720
0.00

    jul_vbc_3g  jun_vbc_3g  avg_rech_amt_6_7 churn  total_mou_good  \
8       910.65      122.16             519.0     0          612.22
13        0.00        0.00             380.0     0         1875.70
16        2.45       21.89             459.0     0          711.67
```

```
17         0.00         0.00              408.0     0          1341.41
21         0.00         0.00              640.0     0          1067.43

    avg_mou_action  diff_mou  decrease_mou_action  avg_rech_num_action
\
8          324.125  -288.095                    1                 17.5

13        1262.390  -613.310                    1                  7.5

16         597.705  -113.965                    1                  4.0

17           1.560 -1339.850                    1                  3.0

21        1245.130   177.700                    0                 26.5


    diff_rech_num  decrease_rech_num_action  avg_rech_amt_action  \
8            -1.5                         1                360.5
13            1.5                         0                485.0
16           -6.0                         1                254.0
17          -16.0                         1                 15.0
21            4.5                         0                699.0

    diff_rech_amt  decrease_rech_amt_action  avg_arpu_action
diff_arpu  \
8           -76.5                         1         314.7925   -
63.9285
13          -22.0                         1         399.4655   -
93.3805
16         -316.0                         1         243.8815  -
187.0935
17         -801.0                         1          22.2395  -
667.7685
21           99.0                         0         617.7565
103.3035

    decrease_arpu_action
8                      1
13                     1
16                     1
17                     1
21                     0

# VBC in action phase
data['avg_vbc_3g_action'] = (data['jul_vbc_3g'] +
data['aug_vbc_3g'])/2

# Difference of good and action phase VBC
data['diff_vbc'] = data['avg_vbc_3g_action'] - data['jun_vbc_3g']
```

```
# Checking whether the VBC has decreased on the action month
data['decrease_vbc_action'] = np.where(data['diff_vbc'] < 0 , 1, 0)

data.head()
```

```
   mobile_number  loc_og_t2o_mou  std_og_t2o_mou  loc_ic_t2o_mou
arpu_6  \
8     7001524846             0.0             0.0             0.0
378.721
13    7002191713             0.0             0.0             0.0
492.846
16    7000875565             0.0             0.0             0.0
430.975
17    7000187447             0.0             0.0             0.0
690.008
21    7002124215             0.0             0.0             0.0
514.453

     arpu_7   arpu_8  onnet_mou_6  onnet_mou_7  onnet_mou_8
offnet_mou_6  \
8   492.223  137.362       413.69       351.03        35.08
94.66
13  205.671  593.260       501.76       108.39       534.24
413.31
16  299.869  187.894        50.51        74.01        70.61
296.29
17   18.980   25.499      1185.91         9.28         7.79
61.64
21  597.753  637.760       102.41       132.11        85.14
757.93

    offnet_mou_7  offnet_mou_8  roam_ic_mou_6  roam_ic_mou_7
roam_ic_mou_8  \
8          80.63        136.48           0.00           0.00
0.00
13        119.28        482.46          23.53         144.24
72.11
16        229.74        162.76           0.00           2.83
0.00
17          0.00          5.54           0.00           4.76
4.81
21        896.68        983.39           0.00           0.00
0.00

    roam_og_mou_6  roam_og_mou_7  roam_og_mou_8  loc_og_t2t_mou_6  \
8            0.00           0.00           0.00            297.13
13           7.98          35.26           1.44             49.63
16           0.00          17.74           0.00             42.61
17           0.00           8.46          13.34             38.99
21           0.00           0.00           0.00              4.48
```

```
    loc_og_t2t_mou_7  loc_og_t2t_mou_8  loc_og_t2m_mou_6
loc_og_t2m_mou_7  \
8              217.59             12.49              80.96
70.58
13               6.19             36.01             151.13
47.28
16              65.16             67.38             273.29
145.99
17               0.00              0.00              58.54
0.00
21               6.16             23.34              91.81
87.93

    loc_og_t2m_mou_8  loc_og_t2f_mou_6  loc_og_t2f_mou_7
loc_og_t2f_mou_8  \
8               50.54              0.00               0.00
0.00
13             294.46              4.54               0.00
23.51
16             128.28              0.00               4.48
10.26
17               0.00              0.00               0.00
0.00
21             104.81              0.75               0.00
1.58

    loc_og_t2c_mou_6  loc_og_t2c_mou_7  loc_og_t2c_mou_8  loc_og_mou_6
\
8                 0.0               0.0               7.15        378.09

13                0.0               0.0               0.49        205.31

16                0.0               0.0               0.00        315.91

17                0.0               0.0               0.00         97.54

21                0.0               0.0               0.00         97.04


    loc_og_mou_7  loc_og_mou_8  std_og_t2t_mou_6  std_og_t2t_mou_7  \
8         288.18         63.04            116.56            133.43
13         53.48        353.99            446.41             85.98
16        215.64        205.93              7.89              2.58
17          0.00          0.00           1146.91              0.81
21         94.09        129.74             97.93            125.94

    std_og_t2t_mou_8  std_og_t2m_mou_6  std_og_t2m_mou_7
std_og_t2m_mou_8  \
8               22.58             13.69              10.04
```

```
75.69
13            498.23             255.36              52.94
156.94
16              3.23              22.99              64.51
18.29
17              0.00               1.55               0.00
0.00
21             61.79             665.36             808.74
876.99

    std_og_t2f_mou_6  std_og_t2f_mou_7  std_og_t2f_mou_8
std_og_t2c_mou_6  \
8                0.0               0.0                0.0
0.0
13               0.0               0.0                0.0
0.0
16               0.0               0.0                0.0
0.0
17               0.0               0.0                0.0
0.0
21               0.0               0.0                0.0
0.0

    std_og_t2c_mou_7  std_og_t2c_mou_8  std_og_mou_6  std_og_mou_7  \
8                0.0               0.0        130.26        143.48
13               0.0               0.0        701.78        138.93
16               0.0               0.0         30.89         67.09
17               0.0               0.0       1148.46          0.81
21               0.0               0.0        763.29        934.69

    std_og_mou_8  isd_og_mou_6  isd_og_mou_7  isd_og_mou_8
spl_og_mou_6  \
8          98.28           0.0           0.0          0.00
0.00
13        655.18           0.0           0.0          1.29
0.00
16         21.53           0.0           0.0          0.00
0.00
17          0.00           0.0           0.0          0.00
2.58
21        938.79           0.0           0.0          0.00
0.00

    spl_og_mou_7  spl_og_mou_8  og_others_6  og_others_7  og_others_8
\
8           0.00         10.23         0.00          0.0          0.0

13          0.00          4.78         0.00          0.0          0.0

16          3.26          5.91         0.00          0.0          0.0
```

```
17          0.00          0.00          0.93          0.0           0.0

21          0.00          0.00          0.00          0.0           0.0


    total_og_mou_6  total_og_mou_7  total_og_mou_8
loc_ic_t2t_mou_6  \
8           508.36          431.66          171.56              23.84

13          907.09          192.41         1015.26              67.88

16          346.81          286.01          233.38              41.33

17         1249.53            0.81            0.00              34.54

21          860.34         1028.79         1068.54               2.48


    loc_ic_t2t_mou_7  loc_ic_t2t_mou_8  loc_ic_t2m_mou_6
loc_ic_t2m_mou_7  \
8               9.84              0.31             57.58
13.98
13              7.58             52.58            142.88
18.53
16             71.44             28.89            226.81
149.69
17              0.00              0.00             47.41
2.31
21             10.19             19.54            118.23
74.63

    loc_ic_t2m_mou_8  loc_ic_t2f_mou_6  loc_ic_t2f_mou_7
loc_ic_t2f_mou_8  \
8              15.48              0.00              0.00
0.00
13            195.18              4.81              0.00
7.49
16            150.16              8.71              8.68
32.71
17              0.00              0.00              0.00
0.00
21            129.16              4.61              2.84
10.39

    loc_ic_mou_6  loc_ic_mou_7  loc_ic_mou_8  std_ic_t2t_mou_6  \
8          81.43         23.83         15.79              0.00
13        215.58         26.11        255.26            115.68
16        276.86        229.83        211.78             68.79
17         81.96          2.31          0.00              8.63
```

```
21        125.33          87.68        159.11              14.06

    std_ic_t2t_mou_7  std_ic_t2t_mou_8  std_ic_t2m_mou_6
std_ic_t2m_mou_7  \
8                 0.58              0.10              22.43
4.08
13              38.29            154.58            308.13
29.79
16              78.64              6.33              18.68
73.08
17               0.00              0.00               1.28
0.00
21               5.98              0.18              67.69
38.23

    std_ic_t2m_mou_8  std_ic_t2f_mou_6  std_ic_t2f_mou_7
std_ic_t2f_mou_8  \
8                 0.65              0.00                0.0
0.00
13              317.91              0.00                0.0
1.91
16               73.93              0.51                0.0
2.18
17               0.00              0.00                0.0
0.00
21              101.74              0.00                0.0
0.00

    std_ic_t2o_mou_6  std_ic_t2o_mou_7  std_ic_t2o_mou_8  std_ic_mou_6
\
8                  0.0               0.0               0.0          22.43

13                 0.0               0.0               0.0         423.81

16                 0.0               0.0               0.0          87.99

17                 0.0               0.0               0.0           9.91

21                 0.0               0.0               0.0          81.76


    std_ic_mou_7  std_ic_mou_8  total_ic_mou_6  total_ic_mou_7  \
8           4.66          0.75          103.86           28.49
13         68.09        474.41          968.61          172.58
16        151.73         82.44          364.86          381.56
17          0.00          0.00           91.88            2.31
21         44.21        101.93          207.09          131.89

    total_ic_mou_8  spl_ic_mou_6  spl_ic_mou_7  spl_ic_mou_8
isd_ic_mou_6  \
```

```
8             16.54          0.00           0.0           0.0
0.00
13          1144.53          0.45           0.0           0.0
245.28
16           294.46          0.00           0.0           0.0
0.00
17             0.00          0.00           0.0           0.0
0.00
21           261.04          0.00           0.0           0.0
0.00

    isd_ic_mou_7  isd_ic_mou_8  ic_others_6  ic_others_7  ic_others_8
\
8           0.00          0.00         0.00         0.00         0.00

13         62.11        393.39        83.48        16.24        21.44

16          0.00          0.23         0.00         0.00         0.00

17          0.00          0.00         0.00         0.00         0.00

21          0.00          0.00         0.00         0.00         0.00


    total_rech_num_6  total_rech_num_7  total_rech_num_8
total_rech_amt_6  \
8                 19                21                14
437
13                 6                 4                11
507
16                10                 6                 2
570
17                19                 2                 4
816
21                22                26                27
600

    total_rech_amt_7  total_rech_amt_8  max_rech_amt_6  max_rech_amt_7
\
8                601               120              90             154

13               253               717             110             110

16               348               160             110             110

17                 0                30             110               0

21               680               718              50              50


    max_rech_amt_8  last_day_rch_amt_6  last_day_rch_amt_7  \
```

```
8                30                  50                   0
13              130                 110                  50
16              130                 100                 100
17               30                  30                   0
21               50                  30                  20

    last_day_rch_amt_8  vol_2g_mb_6  vol_2g_mb_7  vol_2g_mb_8
vol_3g_mb_6  \
8                   10          0.0        356.0         0.03
0.0
13                   0          0.0          0.0         0.02
0.0
16                 130          0.0          0.0         0.00
0.0
17                   0          0.0          0.0         0.00
0.0
21                  50          0.0          0.0         0.00
0.0

    vol_3g_mb_7  vol_3g_mb_8  monthly_2g_6  monthly_2g_7  monthly_2g_8
\
8        750.95        11.94             0             1             0

13         0.00         0.00             0             0             0

16         0.00         0.00             0             0             0

17         0.00         0.00             0             0             0

21         0.00         0.00             0             0             0


    sachet_2g_6  sachet_2g_7  sachet_2g_8  monthly_3g_6  monthly_3g_7
\
8             0            1            3             0             0

13            0            0            3             0             0

16            0            0            0             0             0

17            0            0            0             0             0

21            0            0            0             0             0


    monthly_3g_8  sachet_3g_6  sachet_3g_7  sachet_3g_8   aon
aug_vbc_3g  \
8              0            0            0            0   315
21.03
13             0            0            0            0  2607
0.00
```

```
16             0            0            0            0   511
0.00
17             0            0            0            0   667
0.00
21             0            0            0            0   720
0.00

    jul_vbc_3g  jun_vbc_3g  avg_rech_amt_6_7 churn  total_mou_good  \
8       910.65      122.16             519.0     0          612.22
13        0.00        0.00             380.0     0         1875.70
16        2.45       21.89             459.0     0          711.67
17        0.00        0.00             408.0     0         1341.41
21        0.00        0.00             640.0     0         1067.43

    avg_mou_action  diff_mou  decrease_mou_action  avg_rech_num_action
\
8          324.125  -288.095                    1                 17.5

13        1262.390  -613.310                    1                  7.5

16         597.705  -113.965                    1                  4.0

17           1.560 -1339.850                    1                  3.0

21        1245.130   177.700                    0                 26.5


    diff_rech_num  decrease_rech_num_action  avg_rech_amt_action  \
8            -1.5                         1                360.5
13            1.5                         0                485.0
16           -6.0                         1                254.0
17          -16.0                         1                 15.0
21            4.5                         0                699.0

    diff_rech_amt  decrease_rech_amt_action  avg_arpu_action
diff_arpu  \
8           -76.5                         1         314.7925   -
63.9285
13          -22.0                         1         399.4655   -
93.3805
16         -316.0                         1         243.8815  -
187.0935
17         -801.0                         1          22.2395  -
667.7685
21           99.0                         0         617.7565
103.3035

    decrease_arpu_action  avg_vbc_3g_action  diff_vbc
decrease_vbc_action
8                      1           465.840   343.680
```

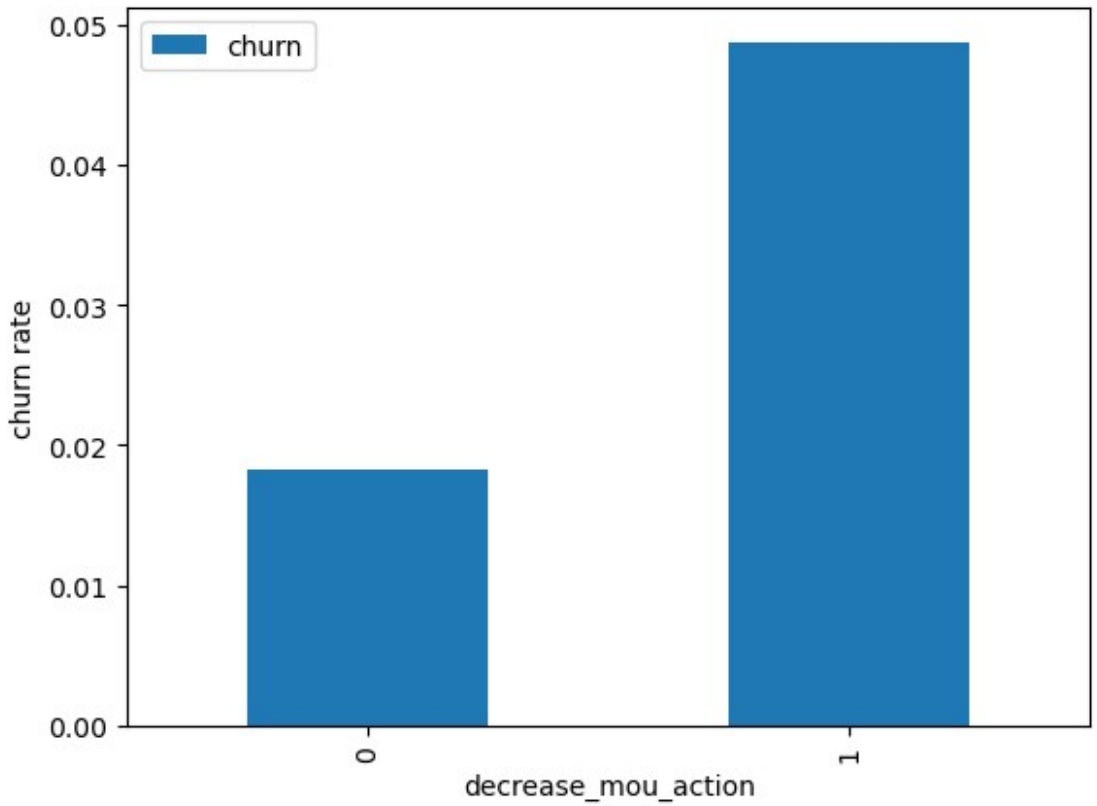
```
0
13                          1               0.000     0.000
0
16                          1               1.225   -20.665
1
17                          1               0.000     0.000
0
21                          0               0.000     0.000
0
```

EDA:

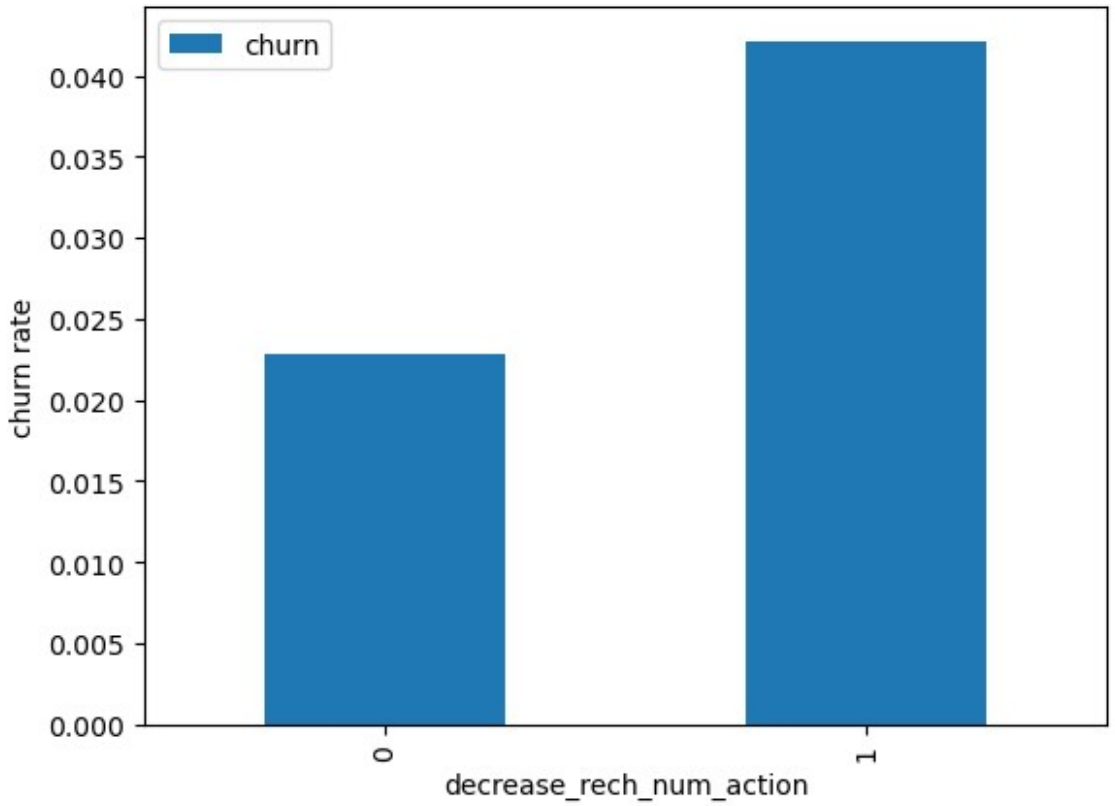
```
# Converting churn column to int in order to do aggfunc in the pivot
table
data['churn'] = data['churn'].astype('int64')
```

Churn Rates:

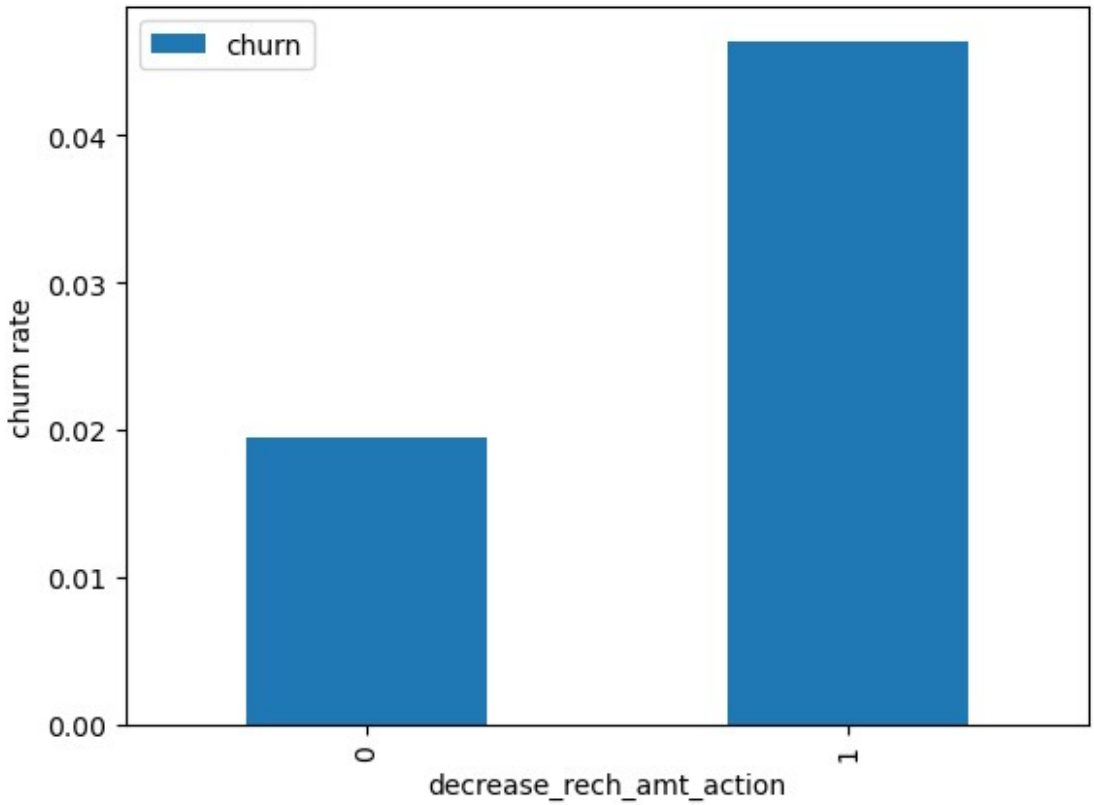
```
data.pivot_table(values='churn', index='decrease_mou_action',
aggfunc='mean').plot.bar()
plt.ylabel('churn rate')
plt.show()
```



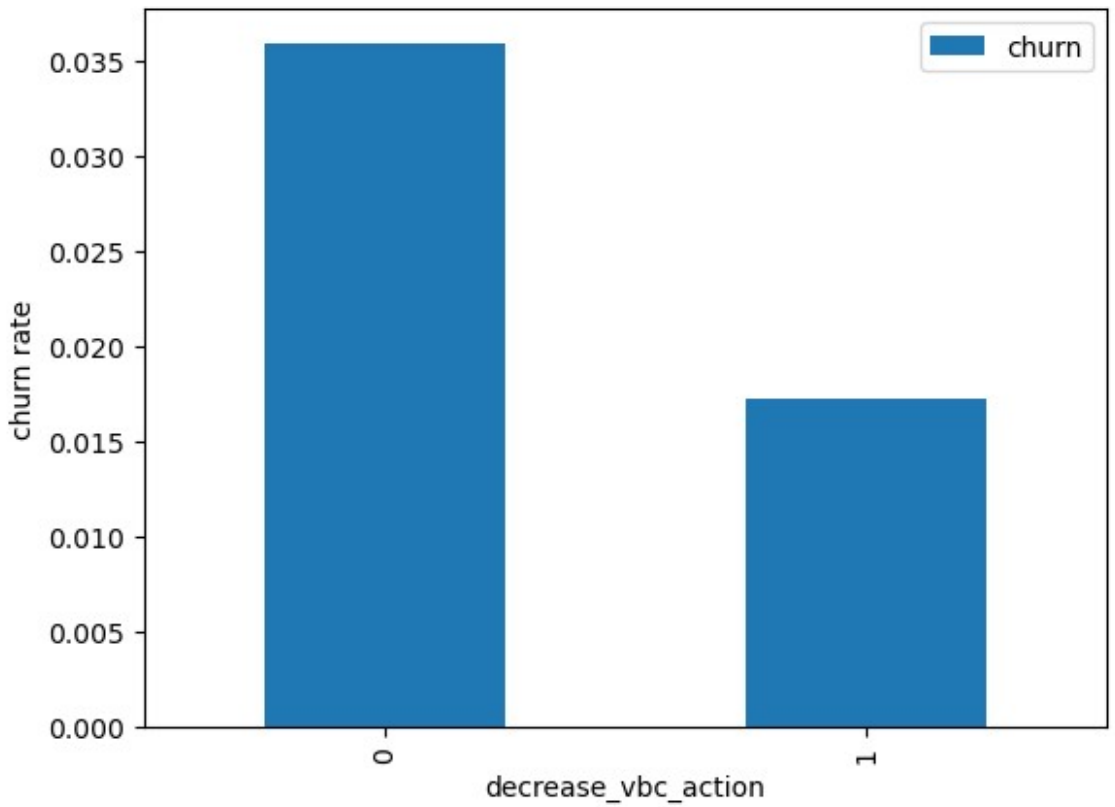
```
data.pivot_table(values='churn', index='decrease_rech_num_action',
aggfunc='mean').plot.bar()
plt.ylabel('churn rate')
plt.show()
```




```
data.pivot_table(values='churn', index='decrease_rech_amt_action',
aggfunc='mean').plot.bar()
plt.ylabel('churn rate')
plt.show()
```

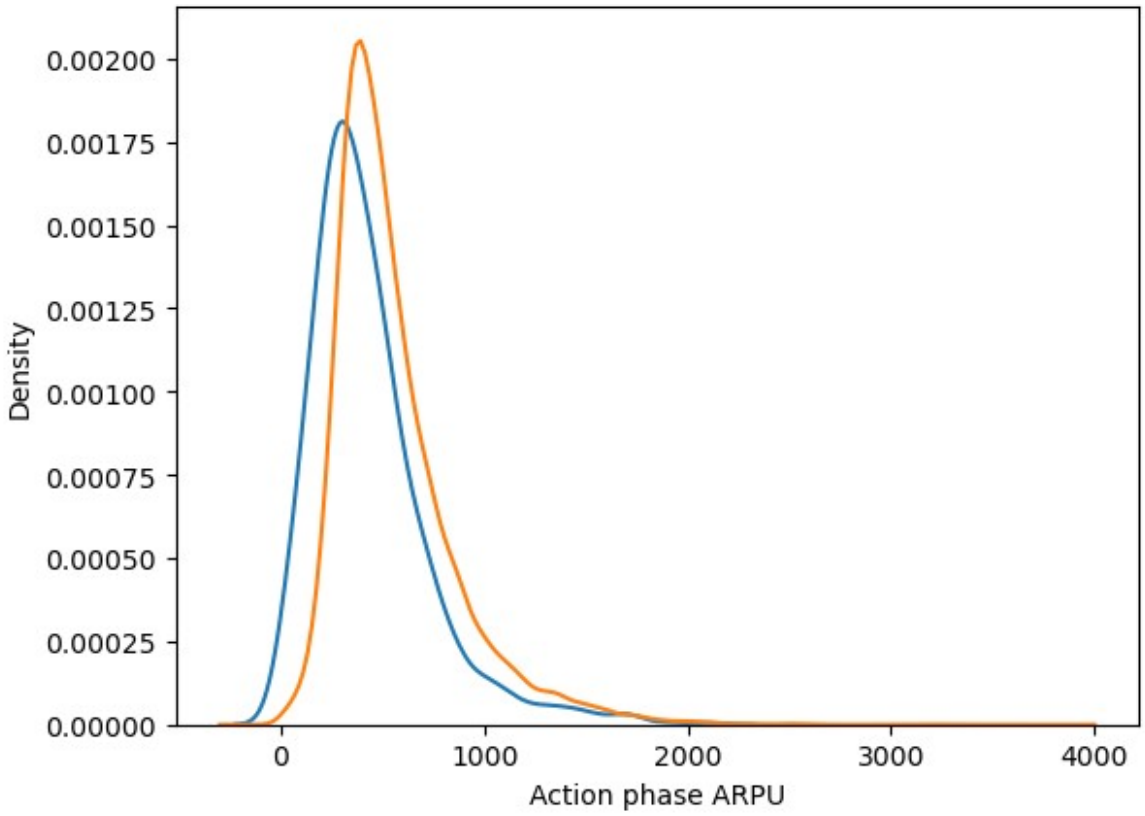



```
data.pivot_table(values='churn', index='decrease_vbc_action',
aggfunc='mean').plot.bar()
plt.ylabel('churn rate')
plt.show()
```



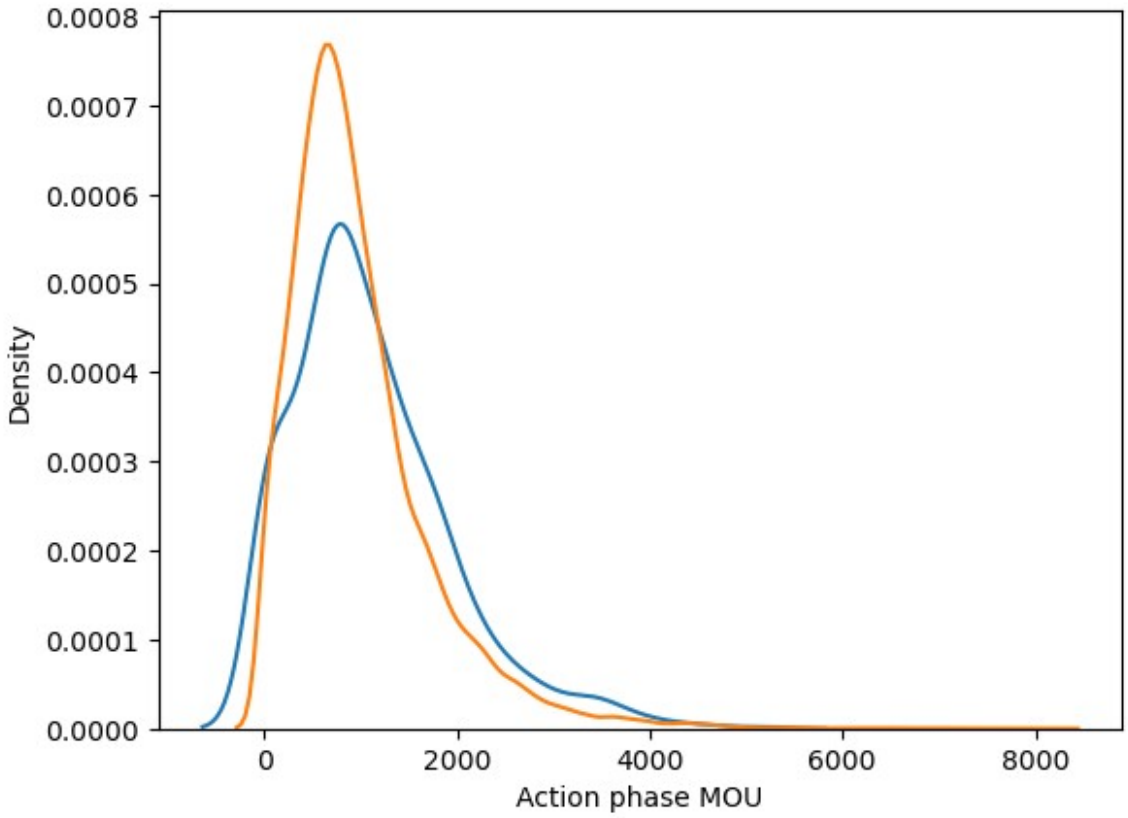

```
# Creating churn dataframe
data_churn = data[data['churn'] == 1]
# Creating not churn dataframe
data_non_churn = data[data['churn'] == 0]

# Distribution plot
ax =
sns.distplot(data_churn['avg_arpu_action'],label='churn',hist=False)
ax = sns.distplot(data_non_churn['avg_arpu_action'],label='not
churn',hist=False)
ax.set(xlabel='Action phase ARPU')
```

```
[Text(0.5, 0, 'Action phase ARPU')]
```

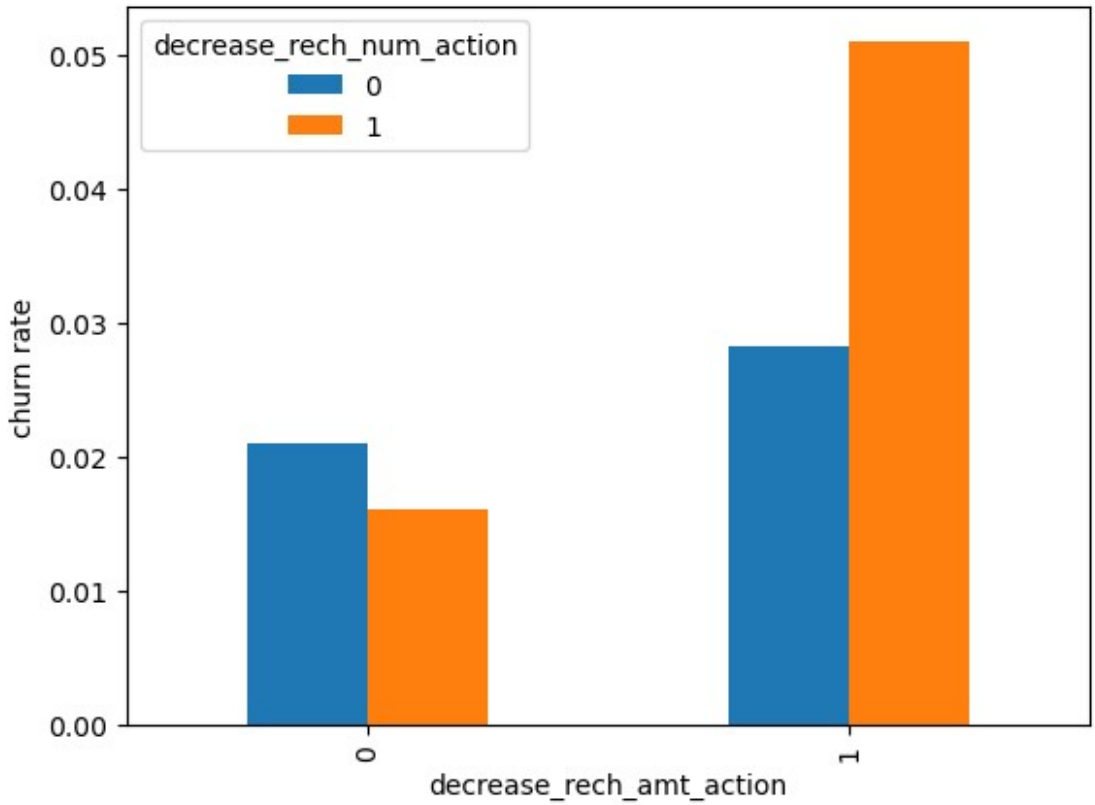



```
# Distribution plot
ax =
sns.distplot(data_churn['total_mou_good'],label='churn',hist=False)
ax = sns.distplot(data_non_churn['total_mou_good'],label='non
churn',hist=False)
ax.set(xlabel='Action phase MOU')
```

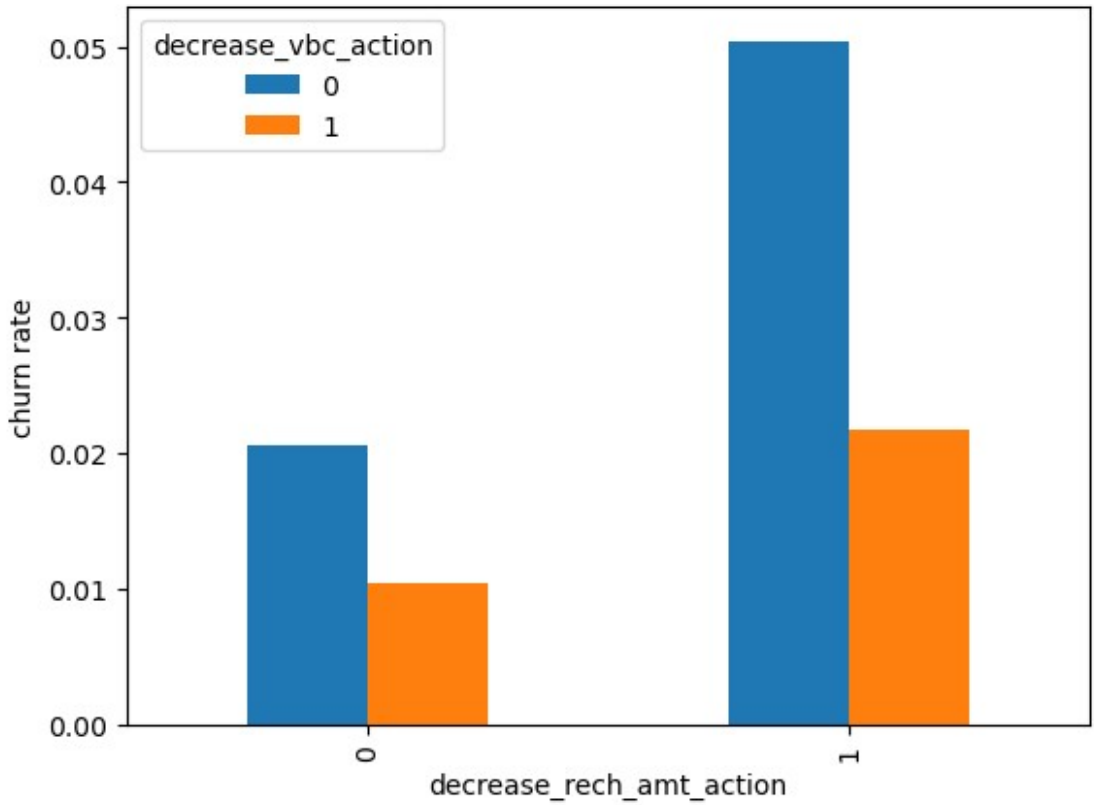
```
[Text(0.5, 0, 'Action phase MOU')]
```



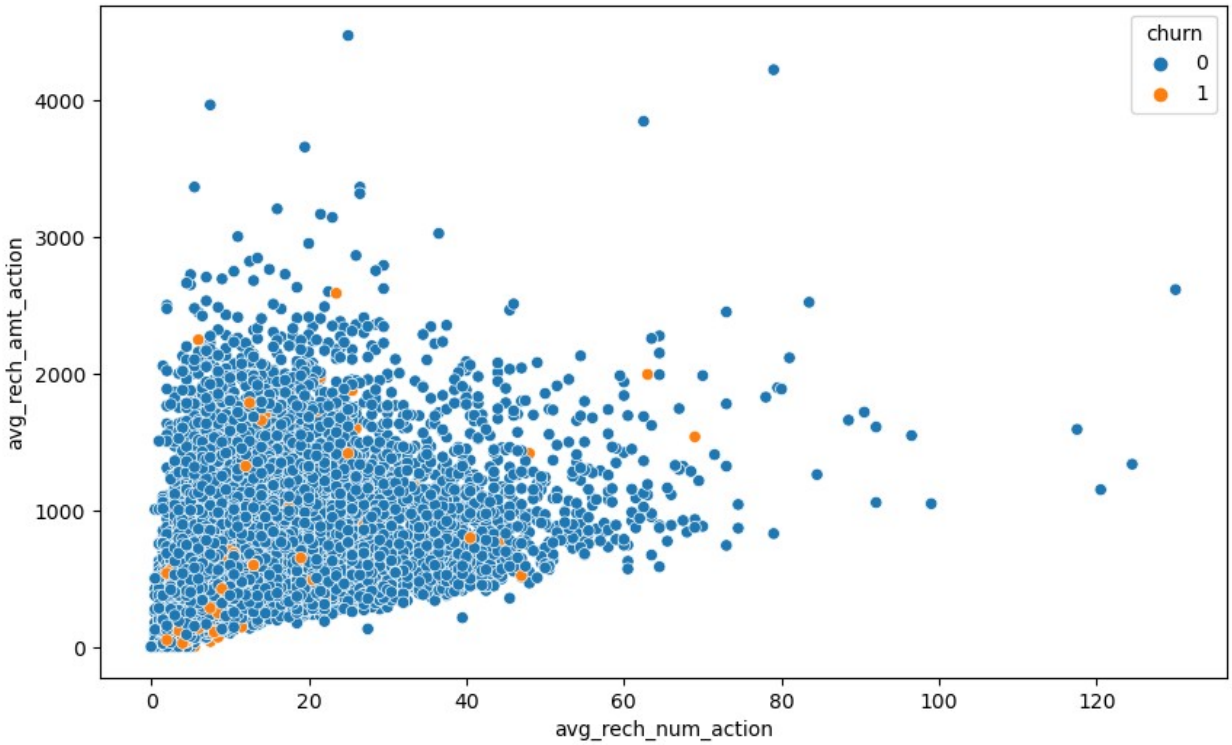

```
data.pivot_table(values='churn', index='decrease_rech_amt_action',
columns='decrease_rech_num_action', aggfunc='mean').plot.bar()
plt.ylabel('churn rate')
plt.show()
```




```
data.pivot_table(values='churn', index='decrease_rech_amt_action',
columns='decrease_vbc_action', aggfunc='mean').plot.bar()
plt.ylabel('churn rate')
plt.show()
```




```
plt.figure(figsize=(10,6))
ax = sns.scatterplot('avg_rech_num_action','avg_rech_amt_action',
hue='churn', data=data)
```




```
data =
data.drop(['total_mou_good','avg_mou_action','diff_mou','avg_rech_num_
action','diff_rech_num','avg_rech_amt_action',

'diff_rech_amt','avg_arpu_action','diff_arpu','avg_vbc_3g_action','dif
f_vbc','avg_rech_amt_6_7'], axis=1)
```

Train-Test Split:

```
# Import library
from sklearn.model_selection import train_test_split

# Putting feature variables into X
X = data.drop(['mobile_number','churn'], axis=1)

# Putting target variable to y
y = data['churn']

# Splitting data into train and test set 80:20
X_train, X_test, y_train, y_test = train_test_split(X, y,
train_size=0.8, test_size=0.2, random_state=100)
```

Feature Scaling:

```
# Standardization method
from sklearn.preprocessing import StandardScaler
```

```
# Instantiate the Scaler
scaler = StandardScaler()

# List of the numeric columns
cols_scale = X_train.columns.to_list()
# Removing the derived binary columns
cols_scale.remove('decrease_mou_action')
cols_scale.remove('decrease_rech_num_action')
cols_scale.remove('decrease_rech_amt_action')
cols_scale.remove('decrease_arpu_action')
cols_scale.remove('decrease_vbc_action')

# Fit the data into scaler and transform
X_train[cols_scale] = scaler.fit_transform(X_train[cols_scale])

X_train.head()
```

```
       loc_og_t2o_mou  std_og_t2o_mou  loc_ic_t2o_mou    arpu_6
arpu_7  \
76637             0.0             0.0             0.0  0.177042 -
0.565237
44417             0.0             0.0             0.0 -1.385359
4.245131
77582             0.0             0.0             0.0 -0.185183
0.470514
48224             0.0             0.0             0.0 -0.871138
0.761096
76321             0.0             0.0             0.0  0.307153
0.183378

         arpu_8  onnet_mou_6  onnet_mou_7  onnet_mou_8
offnet_mou_6  \
76637 -0.615403     0.342004    -0.607254    -0.528515     -0.153098

44417  2.814453    -0.542001    -0.146232    -0.118059     -0.772620

77582  0.439043    -0.475845    -0.539126    -0.408638     -0.320016

48224  0.363448    -0.592545    -0.594671    -0.522008     -0.787657

76321  0.873588    -0.192921    -0.085344    -0.012023      1.064736


       offnet_mou_7  offnet_mou_8  roam_ic_mou_6  roam_ic_mou_7  \
76637     -0.662893      0.076469      -0.226857       0.205784
44417      2.703900      2.265268      -0.226857      -0.174352
77582     -0.513282     -0.236643      -0.226857      -0.174352
48224     -0.682141     -0.681495      -0.226857      -0.174352
76321      0.978616      0.927164      -0.194707      -0.174352

       roam_ic_mou_8  roam_og_mou_6  roam_og_mou_7  roam_og_mou_8  \
```

```
76637      -0.080821      -0.262731      -0.231835      -0.199342
44417      -0.177592      -0.262731      -0.231835      -0.222177
77582      -0.177592      -0.262731      -0.231835      -0.222177
48224      -0.177592      -0.262731      -0.231835      -0.222177
76321      -0.177592      -0.113932      -0.231835      -0.222177

       loc_og_t2t_mou_6  loc_og_t2t_mou_7  loc_og_t2t_mou_8
loc_og_t2m_mou_6  \
76637         -0.322715         -0.372360         -0.354566
0.151967
44417         -0.273693          0.081994         -0.016667          -
0.649268
77582         -0.052711         -0.204119          0.005938
0.246349
48224         -0.266482         -0.270904         -0.214459          -
0.524821
76321         -0.012575          0.482944          0.632439
0.891634

       loc_og_t2m_mou_7  loc_og_t2m_mou_8  loc_og_t2f_mou_6
loc_og_t2f_mou_7  \
76637         -0.420117         -0.642896         -0.323654          -
0.340270
44417          0.616324         -0.090497         -0.338403          -
0.340270
77582         -0.061381          0.406662          0.989539
0.206052
48224         -0.431653         -0.524363         -0.248002
0.027366
76321          0.527985          1.159083          0.462834
0.664664

       loc_og_t2f_mou_8  loc_og_t2c_mou_6  loc_og_t2c_mou_7
loc_og_t2c_mou_8  \
76637         -0.332085         -0.221854         -0.211338          -
0.248213
44417         -0.332085         -0.221854         -0.211338          -
0.248213
77582         -0.247684         -0.221854         -0.211338          -
0.248213
48224         -0.332085          1.248293          2.109168
2.084050
76321          0.237747          2.244788         -0.211338
0.657101

       loc_og_mou_6  loc_og_mou_7  loc_og_mou_8  std_og_t2t_mou_6  \
76637     -0.126098     -0.533371     -0.658333          0.613923
44417     -0.614628      0.419754     -0.087647         -0.418751
77582      0.182883     -0.164394      0.250207         -0.478943
48224     -0.524196     -0.450632     -0.492487         -0.480467
```

```
76321      0.596098      0.694210      1.161870         -0.223093

       std_og_t2t_mou_7  std_og_t2t_mou_8  std_og_t2m_mou_6
std_og_t2m_mou_7  \
76637         -0.439814         -0.371548         -0.185381         -
0.424027
44417         -0.197208         -0.103563         -0.383541
2.679038
77582         -0.466869         -0.445767         -0.505317         -
0.498443
48224         -0.488583         -0.445767         -0.510751         -
0.506520
76321         -0.377256         -0.361596          0.629624
0.783843

       std_og_t2m_mou_8  std_og_t2f_mou_6  std_og_t2f_mou_7
std_og_t2f_mou_8  \
76637          0.497949         -0.163033         -0.158166         -
0.158073
44417          2.668757         -0.163033         -0.158166         -
0.158073
77582         -0.452982         -0.163033         -0.158166         -
0.119193
48224         -0.443640         -0.163033         -0.158166         -
0.158073
76321          0.413605         -0.163033         -0.158166         -
0.158073

       std_og_t2c_mou_6  std_og_t2c_mou_7  std_og_t2c_mou_8
std_og_mou_6  \
76637               0.0               0.0               0.0
0.289420
44417               0.0               0.0               0.0     -
0.550271
77582               0.0               0.0               0.0     -
0.674185
48224               0.0               0.0               0.0     -
0.678920
76321               0.0               0.0               0.0
0.272238

       std_og_mou_7  std_og_mou_8  isd_og_mou_6  isd_og_mou_7
isd_og_mou_8  \
76637     -0.592755      0.091351     -0.095491     -0.105549     -
0.083560
44417      1.713768      1.751601     -0.095491     -0.105549     -
0.083560
77582     -0.662370     -0.606634     -0.095491     -0.059942     -
0.083560
48224     -0.682604     -0.601006     -0.095491     -0.105549     -
```

```
0.083560
76321      0.283579      0.040314     -0.095491     -0.105549
0.056227

       spl_og_mou_6  spl_og_mou_7  spl_og_mou_8  og_others_6
og_others_7  \
76637     -0.333192     -0.333239     -0.110669    -0.307087    -
0.021261
44417     -0.333192     -0.333239     -0.322875    -0.307087    -
0.021261
77582     -0.333192     -0.187585      0.020521    -0.307087    -
0.021261
48224      0.264222      0.579254      0.479916    -0.217152    -
0.021261
76321      0.823369     -0.231599     -0.014003    -0.307087    -
0.021261

       og_others_8  total_og_mou_6  total_og_mou_7  total_og_mou_8  \
76637    -0.019099        0.178334       -0.878440       -0.282817
44417    -0.019099       -0.892633        1.835821        1.536431
77582    -0.019099       -0.524717       -0.723561       -0.417350
48224    -0.019099       -0.939094       -0.883022       -0.803678
76321    -0.019099        0.632796        0.658928        0.673762

       loc_ic_t2t_mou_6  loc_ic_t2t_mou_7  loc_ic_t2t_mou_8
loc_ic_t2m_mou_6  \
76637         -0.266913         -0.331719         -0.361200         -
0.505072
44417         -0.422316          0.011236         -0.062530         -
0.585292
77582         -0.168724         -0.194188         -0.037712         -
0.035050
48224         -0.311061         -0.347324         -0.292352         -
0.078351
76321         -0.293169          0.227840          0.381658         -
0.426551

       loc_ic_t2m_mou_7  loc_ic_t2m_mou_8  loc_ic_t2f_mou_6
loc_ic_t2f_mou_7  \
76637         -0.458802         -0.658630         -0.348956         -
0.341145
44417          0.344107         -0.105327         -0.348956         -
0.341145
77582         -0.112331          0.122642          0.035354         -
0.226783
48224          0.182610         -0.386260         -0.348956         -
0.339548
76321          0.059920          0.151332          0.032724
0.087562
```

```
       loc_ic_t2f_mou_8  loc_ic_mou_6  loc_ic_mou_7  loc_ic_mou_8  \
76637         -0.267723     -0.546581     -0.550273     -0.689043
44417         -0.347484     -0.684844      0.189497     -0.156465
77582         -0.032671     -0.108400     -0.218631      0.061930
48224         -0.342360     -0.270442     -0.116039     -0.472536
76321         -0.072552     -0.449208      0.178701      0.294310

       std_ic_t2t_mou_6  std_ic_t2t_mou_7  std_ic_t2t_mou_8
std_ic_t2m_mou_6  \
76637         -0.161028         -0.154808         -0.015655         -
0.155433
44417         -0.201883         -0.191149         -0.156852         -
0.313283
77582         -0.201883         -0.191149         -0.211830         -
0.318368
48224         -0.201883         -0.191149         -0.211830         -
0.318368
76321         -0.201883         -0.191149          0.006309         -
0.074465

       std_ic_t2m_mou_7  std_ic_t2m_mou_8  std_ic_t2f_mou_6
std_ic_t2f_mou_7  \
76637          0.245509         -0.193470         -0.151088         -
0.154416
44417          0.030736         -0.127395         -0.151088         -
0.154416
77582         -0.257341         -0.273050         -0.151088         -
0.154416
48224         -0.327187         -0.282889         -0.151088         -
0.154416
76321          0.834605         -0.029874          0.007922         -
0.103470

       std_ic_t2f_mou_8  std_ic_t2o_mou_6  std_ic_t2o_mou_7
std_ic_t2o_mou_8  \
76637         -0.145034               0.0               0.0
0.0
44417         -0.145034               0.0               0.0
0.0
77582         -0.144498               0.0               0.0
0.0
48224         -0.145034               0.0               0.0
0.0
76321         -0.007858               0.0               0.0
0.0

       std_ic_mou_6  std_ic_mou_7  std_ic_mou_8  total_ic_mou_6  \
76637     -0.223572      0.054576     -0.171473       -0.595060
44417     -0.360033     -0.113938     -0.196568       -0.768527
77582     -0.363680     -0.310730     -0.333660       -0.266815
```

```
48224     -0.363680     -0.358443     -0.341045       -0.410121
76321     -0.166785      0.441950     -0.019826       -0.295689

       total_ic_mou_7  total_ic_mou_8  spl_ic_mou_6  spl_ic_mou_7  \
76637       -0.488322       -0.695983      -0.32758     -0.091097
44417        0.081383       -0.246180      -0.32758     -0.091097
77582       -0.341971       -0.110566      -0.32758     -0.091097
48224       -0.280073       -0.574504      -0.32758      0.692876
76321        1.535642        1.476830      -0.32758     -0.091097

       spl_ic_mou_8  isd_ic_mou_6  isd_ic_mou_7  isd_ic_mou_8
ic_others_6  \
76637     -0.253722     -0.159145     -0.165185     -0.160355    -
0.095128
44417     -0.253722     -0.159145     -0.165185     -0.160355    -
0.095128
77582     -0.253722     -0.145254     -0.125510     -0.160355    -
0.095128
48224     -0.253722     -0.159145     -0.165185     -0.160355    -
0.095128
76321     -0.253722      0.764862      3.091804      3.285291
0.524591

       ic_others_7  ic_others_8  total_rech_num_6  total_rech_num_7  \
76637    -0.122138    -0.106000          0.217883         -0.419014
44417    -0.122138    -0.106000         -0.644063          3.712370
77582    -0.122138    -0.106000         -0.644063         -0.313081
48224    -0.122138    -0.106000         -0.213090          0.322516
76321    19.878070    18.102019         -0.644063         -0.207148

       total_rech_num_8  total_rech_amt_6  total_rech_amt_7
total_rech_amt_8  \
76637          0.044523          0.088303         -0.769872          -
0.570923
44417          2.282402         -1.310958          3.958327
2.877251
77582         -0.381740         -0.065373          0.654316
0.398380
48224          0.257654         -0.895763          0.620468
0.427890
76321          0.257654         -0.321500          0.112760
0.834225

       max_rech_amt_6  max_rech_amt_7  max_rech_amt_8
last_day_rch_amt_6  \
76637       -0.079749       -0.107353       -0.222292
0.423106
44417       -0.753512       -0.455738       -0.294618           -
0.408602
77582       -0.092706       -0.107353       -0.077638
```

```
0.151202
48224       -0.079749        0.524902        0.579877           -
0.568546
76321       -0.300018       -0.262191       -0.222292
0.151202

       last_day_rch_amt_7  last_day_rch_amt_8  vol_2g_mb_6
vol_2g_mb_7  \
76637           -0.813590           -0.745726    -0.158283
0.454756
44417           -0.423604           -0.275080    -0.283744    -
0.276447
77582            0.200372            0.257291    -0.144907    -
0.118274
48224           -0.579599           -0.514261    -0.129650    -
0.123234
76321            0.200372            0.257291    -0.283744    -
0.276447

       vol_2g_mb_8  vol_3g_mb_6  vol_3g_mb_7  vol_3g_mb_8
monthly_2g_6  \
76637     1.244475     0.328358     0.848931    -0.329023
2.284614
44417    -0.259105    -0.324930    -0.349768    -0.335270     -
0.340791
77582    -0.018957     0.700229     1.490995     1.117469     -
0.340791
48224    -0.120329     2.102341     4.551937     2.878366
2.284614
76321    -0.259105    -0.324930    -0.349768    -0.335270     -
0.340791

       monthly_2g_7  monthly_2g_8  sachet_2g_6  sachet_2g_7
sachet_2g_8  \
76637     2.178305     -0.328849     3.204652     1.773057
1.745129
44417    -0.348515     -0.328849    -0.299208    -0.317626    -
0.338422
77582     2.178305     -0.328849     0.284769     0.727716
0.703354
48224    -0.348515     -0.328849    -0.299208    -0.317626    -
0.338422
76321    -0.348515     -0.328849    -0.299208    -0.317626    -
0.338422

       monthly_3g_6  monthly_3g_7  monthly_3g_8  sachet_3g_6
sachet_3g_7  \
76637    -0.298681     -0.300081     -0.301197     -0.16188    -
0.160519
44417    -0.298681     -0.300081     -0.301197     -0.16188    -
```

```
0.160519
77582     -0.298681     -0.300081     -0.301197      1.03250
1.988521
48224      1.584129      6.695454      3.281161     -0.16188    -
0.160519
76321     -0.298681     -0.300081     -0.301197     -0.16188    -
0.160519

       sachet_3g_8       aon  aug_vbc_3g  jul_vbc_3g  jun_vbc_3g  \
76637    -0.146661 -0.509556   -0.324997   -0.338332   -0.032583
44417    -0.146661 -0.884874   -0.339808   -0.338332   -0.317058
77582     1.820414  1.181411    2.342626    1.965731    1.189782
48224    -0.146661 -1.025617   -0.339808   -0.338332   -0.317058
76321    -0.146661 -0.648260   -0.339808   -0.338332   -0.317058

       decrease_mou_action  decrease_rech_num_action  \
76637                    1                         1
44417                    0                         0
77582                    1                         0
48224                    0                         0
76321                    0                         0

       decrease_rech_amt_action  decrease_arpu_action
decrease_vbc_action
76637                         1                     1
1
44417                         0                     0
0
77582                         0                     0
0
48224                         0                     0
0
76321                         0                     0
0

# Transform the test set
X_test[cols_scale] = scaler.transform(X_test[cols_scale])
X_test.head()

       loc_og_t2o_mou  std_og_t2o_mou  loc_ic_t2o_mou    arpu_6
arpu_7  \
5704              0.0             0.0             0.0  0.280204 -
0.318483
64892             0.0             0.0             0.0  0.084955 -
0.814767
39613             0.0             0.0             0.0  0.580284
0.121878
93118             0.0             0.0             0.0  0.675978
0.736183
81235             0.0             0.0             0.0  3.901497
```

```
0.828475

         arpu_8  onnet_mou_6  onnet_mou_7  onnet_mou_8
offnet_mou_6  \
5704   0.630203    -0.619183    -0.637742    -0.538175      0.608858

64892 -0.500458    -0.629329    -0.646247    -0.560938     -0.314708

39613  1.016326    -0.401743    -0.455056    -0.298176      0.840667

93118 -0.551999     0.150901     0.142507    -0.252783     -0.083998

81235  2.319996     4.977103     1.683836     2.385666      0.075648


       offnet_mou_7  offnet_mou_8  roam_ic_mou_6  roam_ic_mou_7  \
5704       0.342453      1.895103       0.019810      -0.174352
64892     -0.600361     -0.443135       0.159624      -0.174352
39613      0.478537      1.116829      -0.226857      -0.174352
93118     -0.137735     -0.583408      -0.226857      -0.174352
81235     -0.294198     -0.184465      -0.226857      -0.174352

       roam_ic_mou_8  roam_og_mou_6  roam_og_mou_7  roam_og_mou_8  \
5704       -0.177592       0.520481      -0.231835      -0.222177
64892      -0.177592       0.011124      -0.231835      -0.222177
39613      -0.177592      -0.262731      -0.231835      -0.222177
93118      -0.177592      -0.262731      -0.231835      -0.222177
81235       0.241661      -0.262731      -0.231835       2.143657

       loc_og_t2t_mou_6  loc_og_t2t_mou_7  loc_og_t2t_mou_8
loc_og_t2m_mou_6  \
5704          -0.334519         -0.349792         -0.245889          -
0.209155
64892         -0.334648         -0.365370         -0.296837          -
0.468284
39613          0.087099         -0.015188          0.220683
1.974621
93118          0.576025          0.653102          0.001547
0.456342
81235          2.172569          0.096374          0.857835
0.374053

       loc_og_t2m_mou_7  loc_og_t2m_mou_8  loc_og_t2f_mou_6
loc_og_t2f_mou_7  \
5704          -0.262736         -0.295046         -0.195189          -
0.340270
64892         -0.430786         -0.559971         -0.327460          -
0.340270
39613          1.479252          2.682818         -0.120014          -
0.195175
```

```
93118          0.302126         -0.415625          1.137035
0.859212
81235          0.163610          0.273982         -0.124772         -
0.340270

       loc_og_t2f_mou_8  loc_og_t2c_mou_6  loc_og_t2c_mou_7
loc_og_t2c_mou_8  \
5704          -0.332085          0.060650         -0.211338         -
0.248213
64892         -0.332085         -0.221854         -0.211338         -
0.248213
39613          0.725617         -0.221854         -0.211338         -
0.248213
93118          0.329467         -0.221854         -0.211338         -
0.248213
81235         -0.332085         -0.221854         -0.211338         -
0.248213

       loc_og_mou_6  loc_og_mou_7  loc_og_mou_8  std_og_t2t_mou_6  \
5704      -0.360120     -0.420070     -0.365739         -0.469038
64892     -0.535671     -0.535317     -0.568145         -0.480467
39613      1.327579      0.900113      1.901775         -0.480467
93118      0.728515      0.679835     -0.246438         -0.152891
81235      1.621196      0.147433      0.706861          4.343952

       std_og_t2t_mou_7  std_og_t2t_mou_8  std_og_t2m_mou_6
std_og_t2m_mou_7  \
5704          -0.488583         -0.445767          0.617438
0.545049
64892         -0.488583         -0.441893         -0.056616         -
0.349636
39613         -0.488583         -0.445767         -0.246652         -
0.245338
93118         -0.223518         -0.266714         -0.378266         -
0.315896
81235          1.878690          1.811176         -0.093858         -
0.347210

       std_og_t2m_mou_8  std_og_t2f_mou_6  std_og_t2f_mou_7
std_og_t2f_mou_8  \
5704           2.325447         -0.163033         -0.158166         -
0.158073
64892         -0.117788         -0.163033         -0.158166         -
0.146841
39613         -0.240062          0.877452         -0.158166         -
0.158073
93118         -0.390018         -0.163033         -0.158166         -
0.158073
81235         -0.438810         -0.163033         -0.158166         -
0.158073
```

```
       std_og_t2c_mou_6  std_og_t2c_mou_7  std_og_t2c_mou_8
std_og_mou_6  \
5704                0.0               0.0               0.0
0.096043
64892               0.0               0.0               0.0     -
0.370111
39613               0.0               0.0               0.0     -
0.476234
93118               0.0               0.0               0.0     -
0.365215
81235               0.0               0.0               0.0
2.897919

       std_og_mou_7  std_og_mou_8  isd_og_mou_6  isd_og_mou_7
isd_og_mou_8  \
5704       0.043595      1.290694     -0.095491     -0.105549      -
0.08356
64892     -0.574262     -0.375602     -0.095491     -0.105549      -
0.08356
39613     -0.502235     -0.461931     -0.095491     -0.105549      -
0.08356
93118     -0.372235     -0.445935     -0.095491     -0.105549      -
0.08356
81235      1.023481      0.895212     -0.095491     -0.105549      -
0.08356

       spl_og_mou_6  spl_og_mou_7  spl_og_mou_8  og_others_6
og_others_7  \
5704       0.961014      0.702674      0.491423     0.277486    -
0.021261
64892     -0.314344     -0.333239     -0.322875    -0.307087    -
0.021261
39613     -0.333192     -0.333239     -0.322875    -0.307087    -
0.021261
93118     -0.269795     -0.270168     -0.277304    -0.023794    -
0.021261
81235      0.032909     -0.333239     -0.322875    -0.307087    -
0.021261

       og_others_8  total_og_mou_6  total_og_mou_7  total_og_mou_8  \
5704     -0.019099       -0.102091       -0.180668        0.990936
64892    -0.019099       -0.677933       -0.862246       -0.666258
39613    -0.019099        0.350399        0.038799        0.607679
93118    -0.019099        0.093527        0.034876       -0.552663
81235    -0.019099        3.654782        1.030999        1.190698

       loc_ic_t2t_mou_6  loc_ic_t2t_mou_7  loc_ic_t2t_mou_8
loc_ic_t2m_mou_6  \
5704          -0.381893         -0.203679          0.031197         -
```

```
0.132443
64892         -0.194737         -0.392042         -0.319817
0.096598
39613         -0.057041         -0.362172         -0.277572         -
0.292883
93118          1.565994          1.120165          0.702190
0.490441
81235          0.065999          0.187198         -0.094552
0.734727

       loc_ic_t2m_mou_7  loc_ic_t2m_mou_8  loc_ic_t2f_mou_6
loc_ic_t2f_mou_7  \
5704          -0.332588          0.101421         -0.348956         -
0.341145
64892         -0.086155         -0.117805         -0.337995         -
0.331166
39613         -0.502505         -0.295910         -0.209964         -
0.323382
93118          0.385202          0.108161         -0.163926         -
0.079091
81235          0.302005          0.090765         -0.268279         -
0.184272

       loc_ic_t2f_mou_8  loc_ic_mou_6  loc_ic_mou_7  loc_ic_mou_8  \
5704          -0.300474     -0.345776     -0.393827      0.044328
64892         -0.330775     -0.084685     -0.324380     -0.296514
39613         -0.249231     -0.266447     -0.594119     -0.388014
93118          0.047090      1.146405      0.860483      0.447737
81235         -0.347484      0.510931      0.280662     -0.035266

       std_ic_t2t_mou_6  std_ic_t2t_mou_7  std_ic_t2t_mou_8
std_ic_t2m_mou_6  \
5704          -0.201883         -0.191149         -0.211830
0.074310
64892         -0.201883         -0.147833          0.037686
2.450522
39613         -0.201883         -0.191149         -0.211830         -
0.177371
93118         -0.127109         -0.120493         -0.150713         -
0.201302
81235          3.734627          1.989978          3.309777         -
0.236203

       std_ic_t2m_mou_7  std_ic_t2m_mou_8  std_ic_t2f_mou_6
std_ic_t2f_mou_7  \
5704          -0.199548         -0.232537         -0.151088         -
0.154416
64892          1.695279          1.661751          0.653318
2.222523
39613         -0.277000         -0.301699          0.150824         -
```

```
0.154416
93118         -0.276309         -0.290413         -0.151088         -
0.154416
81235         -0.276605         -0.285108         -0.151088         -
0.154416

       std_ic_t2f_mou_8  std_ic_t2o_mou_6  std_ic_t2o_mou_7
std_ic_t2o_mou_8  \
5704          -0.145034               0.0               0.0
0.0
64892          0.720886               0.0               0.0
0.0
39613         -0.145034               0.0               0.0
0.0
93118         -0.145034               0.0               0.0
0.0
81235         -0.145034               0.0               0.0
0.0

       std_ic_mou_6  std_ic_mou_7  std_ic_mou_8  total_ic_mou_6  \
5704      -0.082033     -0.271250     -0.303617       -0.365356
64892      1.733010      1.360917      1.351592        0.636557
39613     -0.220925     -0.324159     -0.355027       -0.350807
93118     -0.237232     -0.281305     -0.314516        0.884028
81235      1.928118      0.984408      1.508258        1.164932

       total_ic_mou_7  total_ic_mou_8  spl_ic_mou_6  spl_ic_mou_7  \
5704        -0.421554       -0.114210      -0.32758     -0.091097
64892        0.357025        0.239376      -0.32758     -0.091097
39613       -0.678777       -0.505344      -0.32758     -0.091097
93118        0.592237        0.229602      -0.32758     -0.091097
81235        0.602767        0.514801      -0.32758     -0.091097

       spl_ic_mou_8  isd_ic_mou_6  isd_ic_mou_7  isd_ic_mou_8
ic_others_6  \
5704      -0.253722     -0.159145      0.158481     -0.160355    -
0.095128
64892     -0.253722      0.182316     -0.067598     -0.160355    -
0.058726
39613     -0.253722     -0.159145     -0.165185     -0.160355    -
0.095128
93118     -0.253722     -0.082219     -0.165185     -0.160355    -
0.095128
81235     -0.253722     -0.159145     -0.165185     -0.160355    -
0.095128

       ic_others_7  ic_others_8  total_rech_num_6  total_rech_num_7  \
5704     -0.122138    -0.106000         -0.105347          0.216583
64892     3.356552     0.217399          0.002397         -0.630880
39613    -0.122138    -0.055442         -0.644063         -0.948679
```

```
93118    -0.122138    -0.106000         -0.644063          0.004717
81235    -0.122138    -0.106000          1.403060          0.004717

       total_rech_num_8  total_rech_amt_6  total_rech_amt_7
total_rech_amt_8  \
5704           0.897048          0.131441         -0.290803
0.441510
64892         -0.168609          0.104480         -0.733421         -
0.393860
39613         -0.808003          0.463057         -0.566789
0.863736
93118         -0.594872          1.164036          0.565792         -
0.836516
81235          0.257654          3.784618          0.615261
2.734239

       max_rech_amt_6  max_rech_amt_7  max_rech_amt_8
last_day_rch_amt_6  \
5704        -0.079749       -0.275094       -0.222292
0.071230
64892       -0.079749        0.176516        0.224819           -
0.568546
39613        1.896189        1.860379        1.940933
2.862251
93118        0.866109        0.511999        0.566726
1.190837
81235        0.555142       -0.120256        1.224242
0.071230

       last_day_rch_amt_7  last_day_rch_amt_8  vol_2g_mb_6
vol_2g_mb_7  \
5704             0.184772           -0.514261     2.663370
1.615419
64892           -0.423604           -0.745726     3.112133
5.231577
39613            2.766475            2.340479    -0.283744    -
0.276447
93118            1.136336           -0.745726    -0.283744    -
0.276447
81235           -0.423604            0.797376     4.450365
2.091568

       vol_2g_mb_8  vol_3g_mb_6  vol_3g_mb_7  vol_3g_mb_8
monthly_2g_6  \
5704     -0.174947    -0.324930    -0.178911     0.236482
2.284614
64892     3.280065     1.346894     0.097599     0.071840
4.910020
39613    -0.259105    -0.324930    -0.349768    -0.335270     -
0.340791
```

```
93118    -0.259105    -0.324930    -0.349768    -0.335270     -
0.340791
81235     1.427774    -0.324930    -0.349768    -0.335270     -
0.340791

       monthly_2g_7  monthly_2g_8  sachet_2g_6  sachet_2g_7
sachet_2g_8  \
5704      -0.348515     -0.328849     0.284769     1.773057
1.745129
64892      2.178305      2.381677    -0.299208    -0.317626
1.745129
39613     -0.348515     -0.328849    -0.299208    -0.317626    -
0.338422
93118     -0.348515     -0.328849    -0.299208    -0.317626    -
0.338422
81235     -0.348515     -0.328849     1.452722     0.727716
0.182466

       monthly_3g_6  monthly_3g_7  monthly_3g_8  sachet_3g_6
sachet_3g_7  \
5704      -0.298681     -0.300081     -0.301197      1.03250
0.914001
64892     -0.298681     -0.300081     -0.301197     -0.16188    -
0.160519
39613     -0.298681     -0.300081     -0.301197     -0.16188    -
0.160519
93118     -0.298681     -0.300081     -0.301197     -0.16188    -
0.160519
81235      1.584129     -0.300081      1.489982      2.22688
1.988521

       sachet_3g_8       aon  aug_vbc_3g  jul_vbc_3g  jun_vbc_3g  \
5704      1.820414  0.003445   -0.133609    0.020306   -0.317058
64892    -0.146661  0.351226    1.677391    1.705824    4.389368
39613    -0.146661  2.402212   -0.339808   -0.338332   -0.317058
93118    -0.146661  1.331334   -0.339808   -0.338332   -0.317058
81235     0.836877 -0.407568   -0.339808   -0.338332   -0.317058

       decrease_mou_action  decrease_rech_num_action  \
5704                     0                         0
64892                    1                         1
39613                    1                         1
93118                    1                         0
81235                    1                         1

       decrease_rech_amt_action  decrease_arpu_action
decrease_vbc_action
5704                          1                     1
0
64892                         1                     1
```

```
1
39613                          1                      0
0
93118                          1                      1
0
81235                          1                      1
0
```

Model With PCA:

```
#Import PCA
from sklearn.decomposition import PCA

# Instantiate PCA
pca = PCA(random_state=42)

# Fit train set on PCA
pca.fit(X_train)
```

```
PCA(random_state=42)
```

```
# Principal components
pca.components_
```

```
array([[-3.20564485e-19,  1.11022302e-16, -0.00000000e+00, ...,
        -1.07346345e-02, -9.68482451e-03,  9.99904011e-03],
       [-1.60714422e-19,  0.00000000e+00, -1.66533454e-16, ...,
        -1.37579722e-02, -1.22852355e-02, -1.69648792e-02],
       [ 7.02496386e-20, -1.24900090e-16,  4.85722573e-17, ...,
        -1.95381254e-02, -1.87159439e-02,  3.51135542e-02],
       ...,
       [ 0.00000000e+00, -7.09946613e-02,  8.70675282e-02, ...,
         6.93889390e-17,  1.73472348e-18, -3.98986399e-17],
       [ 0.00000000e+00, -6.59517545e-03,  1.44650065e-02, ...,
         7.65446734e-17,  7.58941521e-18, -3.20923843e-17],
       [ 9.99996658e-01, -2.47687677e-03,  5.97910388e-04, ...,
         2.98155597e-19,  3.25260652e-19, -1.46909394e-17]])
```

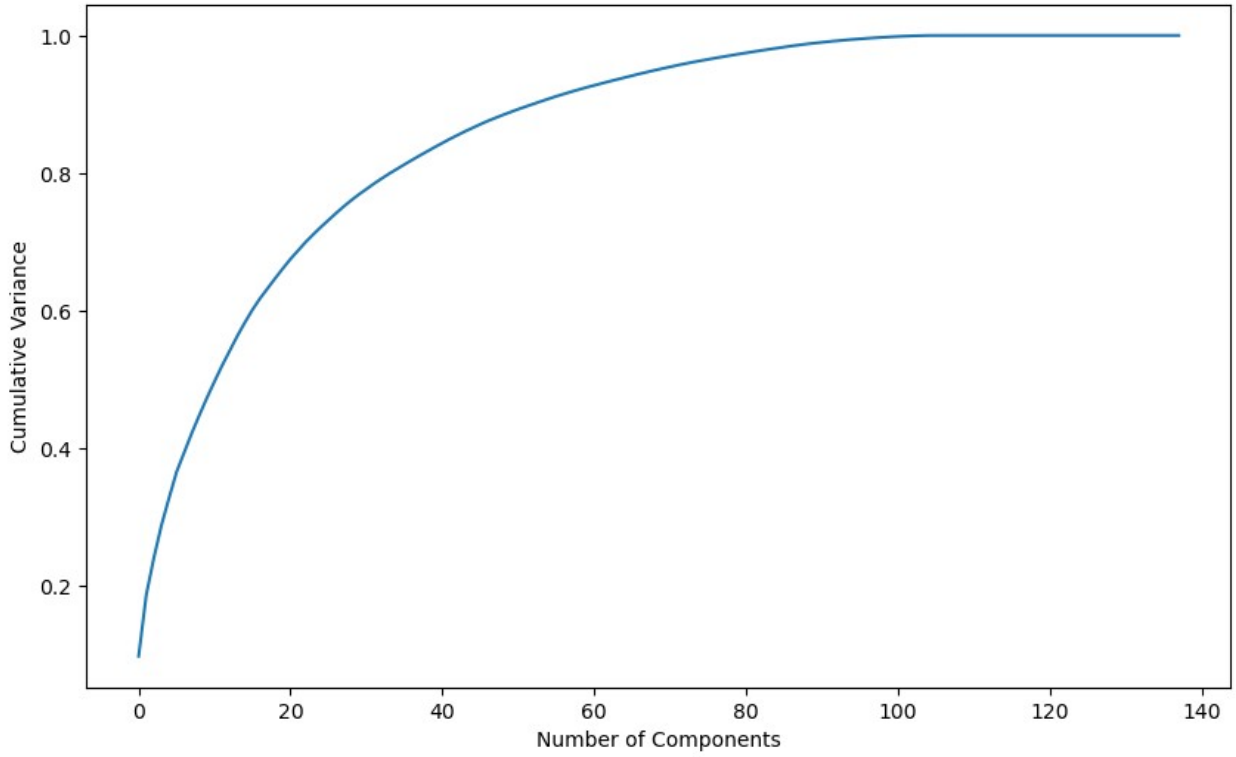
```
# Cumuliative varinace of the PCs
variance_cumu = np.cumsum(pca.explained_variance_ratio_)
print(variance_cumu)
```

```
[0.09825349 0.18709261 0.24088761 0.2883275  0.32798442 0.36609355
 0.39444897 0.42237794 0.44850192 0.47371472 0.49752572 0.52059546
 0.54229743 0.56350921 0.58315905 0.6016858  0.61813022 0.63293898
 0.64736378 0.66156044 0.67520537 0.68765645 0.69984057 0.71093521
 0.72160536 0.73180318 0.74173576 0.75139276 0.76048501 0.76889371
 0.7768848  0.78462758 0.79205887 0.79918754 0.80590777 0.81247571
 0.81896067 0.82534164 0.83161288 0.83770289 0.84376501 0.84959825
 0.85517748 0.86061454 0.86584275 0.87089985 0.8757824  0.88025793
 0.88457894 0.88878312 0.89283235 0.89670077 0.9005251  0.90424925
```

```
 0.90796057 0.91152051 0.91494825 0.91825106 0.92144558 0.92451668
 0.92747602 0.93038039 0.93322992 0.93604145 0.93880554 0.94154835
 0.94425275 0.94692886 0.94944619 0.95193451 0.95436333 0.95672582
 0.95904642 0.961167   0.96322525 0.96522079 0.96717096 0.96910572
 0.97096924 0.97282327 0.97464388 0.97641079 0.97813494 0.97981207
 0.9814719  0.98307596 0.98466282 0.98615641 0.98753979 0.98880201
 0.99000818 0.9911786  0.99222098 0.99325441 0.99416242 0.99502649
 0.99585783 0.99657595 0.99725427 0.99786984 0.99846736 0.99895847
 0.99937265 0.99969781 0.99991637 0.99996401 0.99998599 0.99999758
 0.99999938 0.99999979 1.         1.         1.         1.
 1.         1.         1.         1.         1.         1.
 1.         1.         1.         1.         1.         1.
 1.         1.         1.         1.         1.         1.
 1.         1.         1.         1.         1.         1.        ]
```

```
# Plotting scree plot
fig = plt.figure(figsize = (10,6))
plt.plot(variance_cumu)
plt.xlabel('Number of Components')
plt.ylabel('Cumulative Variance')
```

```
Text(0, 0.5, 'Cumulative Variance')
```




```
# Importing incremental PCA
from sklearn.decomposition import IncrementalPCA
```

```
# Instantiate PCA with 60 components
pca_final = IncrementalPCA(n_components=60)

# Fit and transform the X_train
X_train_pca = pca_final.fit_transform(X_train)

X_test_pca = pca_final.transform(X_test)
```

Logistic Regression Model:

```
# Importing scikit logistic regression module
from sklearn.linear_model import LogisticRegression

# Impoting metrics
from sklearn import metrics
from sklearn.metrics import confusion_matrix

# Importing libraries for cross validation
from sklearn.model_selection import KFold
from sklearn.model_selection import cross_val_score
from sklearn.model_selection import GridSearchCV

# Creating KFold object with 5 splits
folds = KFold(n_splits=5, shuffle=True, random_state=4)

# Specify params
params = {"C": [0.01, 0.1, 1, 10, 100, 1000]}

# Specifing score as recall as we are more focused on acheiving the
higher sensitivity than the accuracy
model_cv = GridSearchCV(estimator = LogisticRegression(),
                        param_grid = params,
                        scoring= 'recall',
                        cv = folds,
                        verbose = 1,
                        return_train_score=True)

# Fit the model
model_cv.fit(X_train_pca, y_train)
```

```
Fitting 5 folds for each of 6 candidates, totalling 30 fits
```

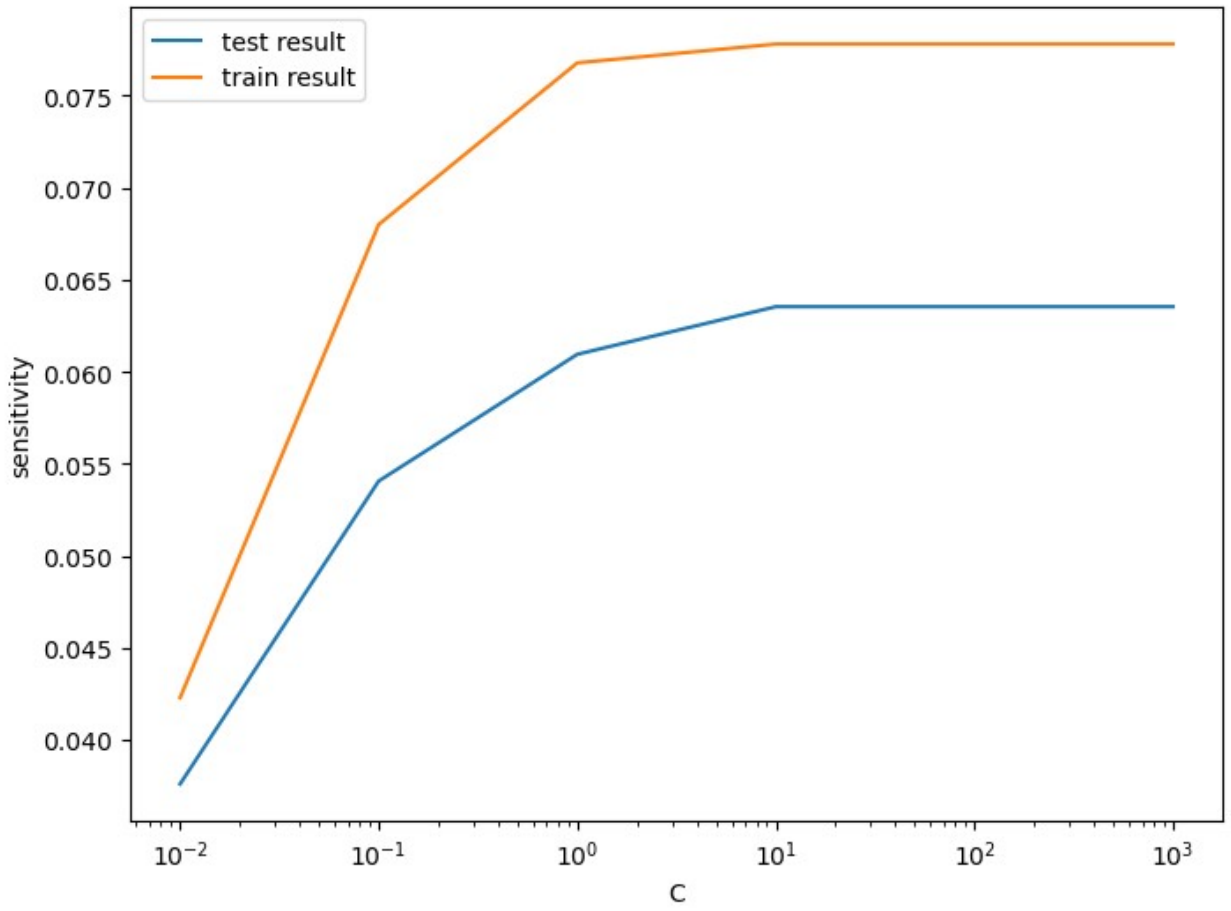
```
GridSearchCV(cv=KFold(n_splits=5, random_state=4, shuffle=True),
             estimator=LogisticRegression(),
             param_grid={'C': [0.01, 0.1, 1, 10, 100, 1000]},
             return_train_score=True, scoring='recall', verbose=1)
```

```
# results of grid search CV
cv_results = pd.DataFrame(model_cv.cv_results_)
cv_results
```

```
   mean_fit_time  std_fit_time  mean_score_time  std_score_time
param_C  \
0       0.066955      0.006613         0.001706        0.000162
0.01
1       0.176696      0.014135         0.001862        0.000229
0.1
2       0.212599      0.026409         0.001672        0.000138
1
3       0.214728      0.028868         0.001528        0.000016
10
4       0.199139      0.011242         0.001647        0.000071
100
5       0.221268      0.013491         0.001606        0.000058
1000

        params  split0_test_score  split1_test_score
split2_test_score  \
0  {'C': 0.01}           0.035971           0.048780
0.055172
1   {'C': 0.1}           0.064748           0.060976
0.062069
2     {'C': 1}           0.064748           0.060976
0.068966
3    {'C': 10}           0.064748           0.067073
0.068966
4   {'C': 100}           0.064748           0.067073
0.068966
5  {'C': 1000}           0.064748           0.067073
0.068966

   split3_test_score  split4_test_score  mean_test_score
std_test_score  \
0           0.020690           0.027397         0.037602
0.012857
1           0.048276           0.034247         0.054063
0.011421
2           0.068966           0.041096         0.060950
0.010364
3           0.068966           0.047945         0.063540
0.007950
4           0.068966           0.047945         0.063540
0.007950
5           0.068966           0.047945         0.063540
0.007950

   rank_test_score  split0_train_score  split1_train_score  \
0                6            0.043333            0.043478
1                5            0.070000            0.069565
2                4            0.083333            0.078261
3                1            0.083333            0.080000
```

```
4                1            0.083333            0.080000
5                1            0.083333            0.080000

   split2_train_score  split3_train_score  split4_train_score  \
0            0.043771            0.042088            0.038786
1            0.079125            0.060606            0.060708
2            0.085859            0.067340            0.069140
3            0.087542            0.067340            0.070826
4            0.087542            0.067340            0.070826
5            0.087542            0.067340            0.070826

   mean_train_score  std_train_score
0          0.042291         0.001845
1          0.068001         0.006900
2          0.076787         0.007417
3          0.077808         0.007595
4          0.077808         0.007595
5          0.077808         0.007595
```

```
# plot of C versus train and validation scores

plt.figure(figsize=(8, 6))
plt.plot(cv_results['param_C'], cv_results['mean_test_score'])
plt.plot(cv_results['param_C'], cv_results['mean_train_score'])
plt.xlabel('C')
plt.ylabel('sensitivity')
plt.legend(['test result', 'train result'], loc='upper left')
plt.xscale('log')
```




```
# Best score with best C
best_score = model_cv.best_score_
best_C = model_cv.best_params_['C']

print(" The highest test sensitivity is {0} at C =
{1}".format(best_score, best_C))
```

```
 The highest test sensitivity is 0.06353952242655339 at C = 10
```

```
# Instantiate the model with best C
logistic_pca = LogisticRegression(C=best_C)

# Fit the model on the train set
log_pca_model = logistic_pca.fit(X_train_pca, y_train)

# Predictions on the train set
y_train_pred = log_pca_model.predict(X_train_pca)

# Confusion matrix
confusion = metrics.confusion_matrix(y_train, y_train_pred)
print(confusion)
```

```
[[21374    51]
 [  686    53]]
```

```
TP = confusion[1,1] # true positive
TN = confusion[0,0] # true negatives
FP = confusion[0,1] # false positives
FN = confusion[1,0] # false negatives

# Accuracy
print("Accuracy:-",metrics.accuracy_score(y_train, y_train_pred))

# Sensitivity
print("Sensitivity:-",TP / float(TP+FN))

# Specificity
print("Specificity:-", TN / float(TN+FP))
```

```
Accuracy:- 0.9667478794441436
Sensitivity:- 0.07171853856562922
Specificity:- 0.9976196032672112
```

```
# Prediction on the test set
y_test_pred = log_pca_model.predict(X_test_pca)

# Confusion matrix
confusion = metrics.confusion_matrix(y_test, y_test_pred)
print(confusion)
```

```
[[5335   13]
 [ 176   17]]
```

```
TP = confusion[1,1] # true positive
TN = confusion[0,0] # true negatives
FP = confusion[0,1] # false positives
FN = confusion[1,0] # false negatives

# Accuracy
print("Accuracy:-",metrics.accuracy_score(y_test, y_test_pred))

# Sensitivity
print("Sensitivity:-",TP / float(TP+FN))

# Specificity
print("Specificity:-", TN / float(TN+FP))
```

```
Accuracy:- 0.9658906334596643
Sensitivity:- 0.08808290155440414
Specificity:- 0.9975691847419597
```