In [2]:
```
import numpy as np
import pandas as pd
```

In [3]:
```
fts = pd.read_excel('./data/features.xlsx', header=None)
fts = np.array(fts)
fts = [x[0].split()[1] for x in fts]
print(len(fts))
print(fts)
```

```
27
['pr_enrll_any', 'dep_bl_3am_svm', 'inv_bl_3am_svm', 'cr_bl_3am_svm', 'oprd_b
l_3am_svm', 'dep_oacc_ct_svm', 'ira_oacc_ct_svm', 'inv_oacc_ct_svm', 'meac_oa
cc_ct_svm', 'mesd_oacc_ct_svm', 'fsvc_oacc_ct_svm', 'cred_oacc_ct_svm', 'tma_
chnl_dc_ct_svm', 'tma_chnl_cc_ct_svm', 'tma_chnl_bcplt_ct_svm', 'tma_chnl_bct
lr_ct_svm', 'tma_chnl_atm_ct_svm', 'tma_chnl_olb_ct_svm', 'tma_chnl_mob_ct_sv
m', 'tma_chnl_ach_ct_svm', 'tma_chnl_icc_ct_svm', 'tma_chnl_dcc_ct_svm', 'tma
_chnl_mcc_ct_svm', 'tma_chnl_ccc_ct_svm', 'chnl_seg2_svm', 'prd_cat_svm', 'tt
l_cmp_svm']
```

In [4]:
```
fts_omp = [x.replace('svm', 'omp') for x in fts]
fts_tmp = [x.replace('svm', 'tmp') for x in fts]
fts_smp = [x.replace('svm', 'smp') for x in fts]
```

In [5]:
```
df = pd.read_csv('./data/customer_data.csv', header=0, index_col=0)
```

In [7]:
```
df_omp = df[fts_omp]
df_tmp = df[fts_tmp]
df_smp = df[fts_smp]
```

Modelling for 1 month prior information

In [8]:
```
df_omp.head()
```

Out[8]:

	pr_enrll_any	dep_bl_3am_omp	inv_bl_3am_omp	cr_bl_3am_omp	oprd_bl_3am_omp	dep_oac
0	N	10825.31	0.00	0.00	0	
1	N	22156.79	0.00	0.00	0	
2	N	37453.49	0.00	59.41	0	
3	N	64945.93	0.00	500.38	0	
4	N	5399.63	11284.51	0.00	0	

5 rows × 27 columns

In [9]:
```
# Label Encode Categorical Featrues
from sklearn import preprocessing

def clean(input_df):

    df = input_df.copy()

    # Label Encoding
    for col in cat:
        le = preprocessing.LabelEncoder()
        df[str(col)+'_Encoded'] = le.fit_transform(df[col].astype(str))

        del df[col]

    return df
```

In [10]:
```
cat = list()
cat.append('chnl_seg2_omp')
cat.append('prd_cat_omp')

quant = list()
quant.append('dep_bl_3am_omp')
quant.append('inv_bl_3am_omp')
quant.append('cr_bl_3am_omp')
quant.append('tma_chnl_dc_ct_omp')
quant.append('tma_chnl_cc_ct_omp')
quant.append('tma_chnl_bcplt_ct_omp')
quant.append('tma_chnl_bctlr_ct_omp')
quant.append('tma_chnl_atm_ct_omp')
quant.append('tma_chnl_olb_ct_omp')
quant.append('tma_chnl_mob_ct_omp')
quant.append('tma_chnl_ach_ct_omp')

cleaned_omp = clean(df_omp)
cleaned_omp.head()
```

Out[10]:

	pr_enrll_any	dep_bl_3am_omp	inv_bl_3am_omp	cr_bl_3am_omp	oprd_bl_3am_omp	dep_oac
0	N	10825.31	0.00	0.00	0	
1	N	22156.79	0.00	0.00	0	
2	N	37453.49	0.00	59.41	0	
3	N	64945.93	0.00	500.38	0	
4	N	5399.63	11284.51	0.00	0	

5 rows × 27 columns

In [11]:
```
from sklearn.preprocessing import MinMaxScaler
from scipy.stats import skew

def preprocess(input_df,log,onehot):
    df = input_df.copy()

    # log transform the skewed features
    if log:

        #Log transform skewed numeric features:
        skewed_feats = df[quant].apply(lambda x: skew(x)) #compute skewness
        skewed_feats = skewed_feats[skewed_feats > 0.75]
        skewed_feats = skewed_feats.index

        df[skewed_feats] = np.log1p(df[skewed_feats])

    # Convert to one-hot Encoding
    if onehot:
        encoded_features = [x + '_Encoded' for x in cat]

        onehotted = pd.get_dummies(data=df, columns=encoded_features)

        return onehotted
    else:
        return df
```

In [12]:
```
preprocessed_omp = preprocess(cleaned_omp, log=True, onehot=True).dropna()
preprocessed_omp.head()
```

```
/usr/local/lib/python3.7/site-packages/ipykernel_launcher.py:15: RuntimeWarni
ng: invalid value encountered in log1p
  from ipykernel import kernelapp as app
```

Out[12]:

	pr_enrll_any	dep_bl_3am_omp	inv_bl_3am_omp	cr_bl_3am_omp	oprd_bl_3am_omp	dep_oac
0	N	9.289735	0.000000	0.000000	0	
1	N	10.005944	0.000000	0.000000	0	
2	N	10.530882	0.000000	4.101155	0	
3	N	11.081326	0.000000	6.217364	0	
4	N	8.594271	9.331275	0.000000	0	

5 rows × 34 columns

In [13]:
```
le = preprocessing.LabelEncoder()
preprocessed_omp['pr_enrll_any'] = le.fit_transform(preprocessed_omp['pr_enrll
_any'].astype(str))

y_omp = preprocessed_omp['pr_enrll_any']
X_omp = preprocessed_omp.drop(['pr_enrll_any'], axis=1)
```

In [14]:
```
from sklearn.model_selection import train_test_split

X_train_omp, X_test_omp, y_train_omp, y_test_omp = train_test_split(X_omp, y_o
mp, test_size=0.2, random_state=42, shuffle=True)
```

In [15]:
```
from sklearn.linear_model import LogisticRegressionCV

clf = LogisticRegressionCV(cv=5, random_state=0, Cs=[1e-4, 1e-3, 1e-2, 1e-1, 1
, 1e2, 1e3, 1e4], verbose=2).fit(X_train_omp, y_train_omp)
```

```
[Parallel(n_jobs=1)]: Using backend SequentialBackend with 1 concurrent worke
rs.
/usr/local/lib/python3.7/site-packages/sklearn/linear_model/logistic.py:757:
ConvergenceWarning: lbfgs failed to converge. Increase the number of iteratio
ns.
  "of iterations.", ConvergenceWarning)
/usr/local/lib/python3.7/site-packages/sklearn/linear_model/logistic.py:757:
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  "of iterations.", ConvergenceWarning)
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  "of iterations.", ConvergenceWarning)
/usr/local/lib/python3.7/site-packages/sklearn/linear_model/logistic.py:757:
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  "of iterations.", ConvergenceWarning)
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  "of iterations.", ConvergenceWarning)
/usr/local/lib/python3.7/site-packages/sklearn/linear_model/logistic.py:757:
ConvergenceWarning: lbfgs failed to converge. Increase the number of iteratio
ns.
  "of iterations.", ConvergenceWarning)
[Parallel(n_jobs=1)]: Done   1 out of   1 | elapsed:    7.4s remaining:    0.
0s
/usr/local/lib/python3.7/site-packages/sklearn/linear_model/logistic.py:757:
ConvergenceWarning: lbfgs failed to converge. Increase the number of iteratio
ns.
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  "of iterations.", ConvergenceWarning)
/usr/local/lib/python3.7/site-packages/sklearn/linear_model/logistic.py:757:
```

```
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/usr/local/lib/python3.7/site-packages/sklearn/linear_model/logistic.py:757:
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  "of iterations.", ConvergenceWarning)
/usr/local/lib/python3.7/site-packages/sklearn/linear_model/logistic.py:757:
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/usr/local/lib/python3.7/site-packages/sklearn/linear_model/logistic.py:757:
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  "of iterations.", ConvergenceWarning)
/usr/local/lib/python3.7/site-packages/sklearn/linear_model/logistic.py:757:
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  "of iterations.", ConvergenceWarning)
/usr/local/lib/python3.7/site-packages/sklearn/linear_model/logistic.py:757:
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ns.
  "of iterations.", ConvergenceWarning)
/usr/local/lib/python3.7/site-packages/sklearn/linear_model/logistic.py:757:
ConvergenceWarning: lbfgs failed to converge. Increase the number of iteratio
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  "of iterations.", ConvergenceWarning)
/usr/local/lib/python3.7/site-packages/sklearn/linear_model/logistic.py:757:
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ns.
  "of iterations.", ConvergenceWarning)
/usr/local/lib/python3.7/site-packages/sklearn/linear_model/logistic.py:757:
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ns.
  "of iterations.", ConvergenceWarning)
/usr/local/lib/python3.7/site-packages/sklearn/linear_model/logistic.py:757:
ConvergenceWarning: lbfgs failed to converge. Increase the number of iteratio
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  "of iterations.", ConvergenceWarning)
/usr/local/lib/python3.7/site-packages/sklearn/linear_model/logistic.py:757:
ConvergenceWarning: lbfgs failed to converge. Increase the number of iteratio
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  "of iterations.", ConvergenceWarning)
/usr/local/lib/python3.7/site-packages/sklearn/linear_model/logistic.py:757:
ConvergenceWarning: lbfgs failed to converge. Increase the number of iteratio
ns.
  "of iterations.", ConvergenceWarning)
/usr/local/lib/python3.7/site-packages/sklearn/linear_model/logistic.py:757:
ConvergenceWarning: lbfgs failed to converge. Increase the number of iteratio
ns.
  "of iterations.", ConvergenceWarning)
/usr/local/lib/python3.7/site-packages/sklearn/linear_model/logistic.py:757:
ConvergenceWarning: lbfgs failed to converge. Increase the number of iteratio
```

```
ns.
  "of iterations.", ConvergenceWarning)
/usr/local/lib/python3.7/site-packages/sklearn/linear_model/logistic.py:757:
ConvergenceWarning: lbfgs failed to converge. Increase the number of iteratio
ns.
  "of iterations.", ConvergenceWarning)
/usr/local/lib/python3.7/site-packages/sklearn/linear_model/logistic.py:757:
ConvergenceWarning: lbfgs failed to converge. Increase the number of iteratio
ns.
  "of iterations.", ConvergenceWarning)
/usr/local/lib/python3.7/site-packages/sklearn/linear_model/logistic.py:757:
ConvergenceWarning: lbfgs failed to converge. Increase the number of iteratio
ns.
  "of iterations.", ConvergenceWarning)
/usr/local/lib/python3.7/site-packages/sklearn/linear_model/logistic.py:757:
ConvergenceWarning: lbfgs failed to converge. Increase the number of iteratio
ns.
  "of iterations.", ConvergenceWarning)
/usr/local/lib/python3.7/site-packages/sklearn/linear_model/logistic.py:757:
ConvergenceWarning: lbfgs failed to converge. Increase the number of iteratio
ns.
  "of iterations.", ConvergenceWarning)
/usr/local/lib/python3.7/site-packages/sklearn/linear_model/logistic.py:757:
ConvergenceWarning: lbfgs failed to converge. Increase the number of iteratio
ns.
  "of iterations.", ConvergenceWarning)
/usr/local/lib/python3.7/site-packages/sklearn/linear_model/logistic.py:757:
ConvergenceWarning: lbfgs failed to converge. Increase the number of iteratio
ns.
  "of iterations.", ConvergenceWarning)
[Parallel(n_jobs=1)]: Done   5 out of   5 | elapsed:   37.6s finished
/usr/local/lib/python3.7/site-packages/sklearn/linear_model/logistic.py:757:
ConvergenceWarning: lbfgs failed to converge. Increase the number of iteratio
ns.
  "of iterations.", ConvergenceWarning)
```

In [16]:

```
from sklearn.metrics import classification_report

preds_omp = clf.predict(X_test_omp)
print(classification_report(y_test_omp, preds_omp))
```

```
              precision    recall  f1-score   support

           0       0.73      0.81      0.77     14767
           1       0.69      0.58      0.63     10677

   micro avg       0.71      0.71      0.71     25444
   macro avg       0.71      0.70      0.70     25444
weighted avg       0.71      0.71      0.71     25444
```

In [17]:

```
from sklearn.metrics import accuracy_score

print(accuracy_score(y_test_omp, preds_omp))
```

```
0.7137242571922654
```

Modelling 3 month prior information

In [19]:
```
df_tmp.head()
```

Out[19]:

	pr_enrll_any	dep_bl_3am_tmp	inv_bl_3am_tmp	cr_bl_3am_tmp	oprd_bl_3am_tmp	dep_oacc_
0	N	12107.96	0.00	0.00	0	
1	N	21459.42	0.00	0.00	0	
2	N	37769.06	0.00	75.78	0	
3	N	44071.71	0.00	55.00	0	
4	N	3347.64	12149.44	0.00	0	

5 rows × 27 columns

In [20]:
```
cat = list()
cat.append('chnl_seg2_tmp')
cat.append('prd_cat_tmp')

quant = list()
quant.append('dep_bl_3am_tmp')
quant.append('inv_bl_3am_tmp')
quant.append('cr_bl_3am_tmp')
quant.append('tma_chnl_dc_ct_tmp')
quant.append('tma_chnl_cc_ct_tmp')
quant.append('tma_chnl_bcplt_ct_tmp')
quant.append('tma_chnl_bctlr_ct_tmp')
quant.append('tma_chnl_atm_ct_tmp')
quant.append('tma_chnl_olb_ct_tmp')
quant.append('tma_chnl_mob_ct_tmp')
quant.append('tma_chnl_ach_ct_tmp')

cleaned_tmp = clean(df_tmp)
cleaned_tmp.head()
```

Out[20]:

	pr_enrll_any	dep_bl_3am_tmp	inv_bl_3am_tmp	cr_bl_3am_tmp	oprd_bl_3am_tmp	dep_oacc_
0	N	12107.96	0.00	0.00	0	
1	N	21459.42	0.00	0.00	0	
2	N	37769.06	0.00	75.78	0	
3	N	44071.71	0.00	55.00	0	
4	N	3347.64	12149.44	0.00	0	

5 rows × 27 columns

In [21]:
```
preprocessed_tmp = preprocess(cleaned_tmp, log=True, onehot=True).dropna()
preprocessed_tmp.head()
```

```
/usr/local/lib/python3.7/site-packages/ipykernel_launcher.py:15: RuntimeWarni
ng: invalid value encountered in log1p
  from ipykernel import kernelapp as app
```

Out[21]:

	pr_enrll_any	dep_bl_3am_tmp	inv_bl_3am_tmp	cr_bl_3am_tmp	oprd_bl_3am_tmp	dep_oacc_
0	N	9.401701	0.000000	0.000000	0	
1	N	9.973966	0.000000	0.000000	0	
2	N	10.539272	0.000000	4.340944	0	
3	N	10.693596	0.000000	4.025352	0	
4	N	8.116310	9.405121	0.000000	0	

5 rows × 34 columns

In [22]:
```
le = preprocessing.LabelEncoder()
preprocessed_tmp['pr_enrll_any'] = le.fit_transform(preprocessed_tmp['pr_enrll_any'].astype(str))

y_tmp = preprocessed_tmp['pr_enrll_any']
X_tmp = preprocessed_tmp.drop(['pr_enrll_any'], axis=1)
```

In [24]:
```
X_train_tmp, X_test_tmp, y_train_tmp, y_test_tmp = train_test_split(X_tmp, y_tmp, test_size=0.2, random_state=42, shuffle=True)
```

In [25]:
```
clf = LogisticRegressionCV(cv=5, random_state=0, Cs=[1e-4, 1e-3, 1e-2, 1e-1, 1
, 1e2, 1e3, 1e4], verbose=2).fit(X_train_tmp, y_train_tmp)
```

```
[Parallel(n_jobs=1)]: Using backend SequentialBackend with 1 concurrent worke
rs.
/usr/local/lib/python3.7/site-packages/sklearn/linear_model/logistic.py:757:
ConvergenceWarning: lbfgs failed to converge. Increase the number of iteratio
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  "of iterations.", ConvergenceWarning)
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  "of iterations.", ConvergenceWarning)
/usr/local/lib/python3.7/site-packages/sklearn/linear_model/logistic.py:757:
ConvergenceWarning: lbfgs failed to converge. Increase the number of iteratio
ns.
  "of iterations.", ConvergenceWarning)
[Parallel(n_jobs=1)]: Done   1 out of   1 | elapsed:    6.6s remaining:    0.
0s
/usr/local/lib/python3.7/site-packages/sklearn/linear_model/logistic.py:757:
ConvergenceWarning: lbfgs failed to converge. Increase the number of iteratio
ns.
  "of iterations.", ConvergenceWarning)
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  "of iterations.", ConvergenceWarning)
/usr/local/lib/python3.7/site-packages/sklearn/linear_model/logistic.py:757:
ConvergenceWarning: lbfgs failed to converge. Increase the number of iteratio
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  "of iterations.", ConvergenceWarning)
/usr/local/lib/python3.7/site-packages/sklearn/linear_model/logistic.py:757:
ConvergenceWarning: lbfgs failed to converge. Increase the number of iteratio
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  "of iterations.", ConvergenceWarning)
/usr/local/lib/python3.7/site-packages/sklearn/linear_model/logistic.py:757:
ConvergenceWarning: lbfgs failed to converge. Increase the number of iteratio
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  "of iterations.", ConvergenceWarning)
/usr/local/lib/python3.7/site-packages/sklearn/linear_model/logistic.py:757:
```

```
ConvergenceWarning: lbfgs failed to converge. Increase the number of iteratio
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  "of iterations.", ConvergenceWarning)
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/usr/local/lib/python3.7/site-packages/sklearn/linear_model/logistic.py:757:
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/usr/local/lib/python3.7/site-packages/sklearn/linear_model/logistic.py:757:
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ConvergenceWarning: lbfgs failed to converge. Increase the number of iteratio
```

```
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  "of iterations.", ConvergenceWarning)
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  "of iterations.", ConvergenceWarning)
/usr/local/lib/python3.7/site-packages/sklearn/linear_model/logistic.py:757:
ConvergenceWarning: lbfgs failed to converge. Increase the number of iteratio
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  "of iterations.", ConvergenceWarning)
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  "of iterations.", ConvergenceWarning)
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ConvergenceWarning: lbfgs failed to converge. Increase the number of iteratio
ns.
  "of iterations.", ConvergenceWarning)
/usr/local/lib/python3.7/site-packages/sklearn/linear_model/logistic.py:757:
ConvergenceWarning: lbfgs failed to converge. Increase the number of iteratio
ns.
  "of iterations.", ConvergenceWarning)
[Parallel(n_jobs=1)]: Done   5 out of   5 | elapsed:   36.4s finished
/usr/local/lib/python3.7/site-packages/sklearn/linear_model/logistic.py:757:
ConvergenceWarning: lbfgs failed to converge. Increase the number of iteratio
ns.
  "of iterations.", ConvergenceWarning)
```

In [26]:

```python
preds_tmp = clf.predict(X_test_tmp)
print(classification_report(y_test_tmp, preds_tmp))
```

```
              precision    recall  f1-score   support

           0       0.71      0.80      0.75     14840
           1       0.66      0.54      0.59     10602

   micro avg       0.69      0.69      0.69     25442
   macro avg       0.68      0.67      0.67     25442
weighted avg       0.69      0.69      0.69     25442
```

In [27]:

```python
print(accuracy_score(y_test_tmp, preds_tmp))
```

```
0.6920839556638629
```

Modelling 6 months prior information

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

Out[28]:

	pr_enrll_any	dep_bl_3am_smp	inv_bl_3am_smp	cr_bl_3am_smp	oprd_bl_3am_smp	dep_oac
0	N	10258.23	0.00	0.00	0	
1	N	18021.82	0.00	0.00	0	
2	N	37137.98	0.00	36.15	0	
3	N	127342.55	0.00	0.00	0	
4	N	791.01	19432.17	0.00	0	

5 rows × 27 columns

In [29]:
```
cat = list()
cat.append('chnl_seg2_smp')
cat.append('prd_cat_smp')

quant = list()
quant.append('dep_bl_3am_smp')
quant.append('inv_bl_3am_smp')
quant.append('cr_bl_3am_smp')
quant.append('tma_chnl_dc_ct_smp')
quant.append('tma_chnl_cc_ct_smp')
quant.append('tma_chnl_bcplt_ct_smp')
quant.append('tma_chnl_bctlr_ct_smp')
quant.append('tma_chnl_atm_ct_smp')
quant.append('tma_chnl_olb_ct_smp')
quant.append('tma_chnl_mob_ct_smp')
quant.append('tma_chnl_ach_ct_smp')

cleaned_smp = clean(df_smp)
cleaned_smp.head()
```

Out[29]:

	pr_enrll_any	dep_bl_3am_smp	inv_bl_3am_smp	cr_bl_3am_smp	oprd_bl_3am_smp	dep_oac
0	N	10258.23	0.00	0.00	0	
1	N	18021.82	0.00	0.00	0	
2	N	37137.98	0.00	36.15	0	
3	N	127342.55	0.00	0.00	0	
4	N	791.01	19432.17	0.00	0	

5 rows × 27 columns

In [30]:
```
preprocessed_smp = preprocess(cleaned_smp, log=True, onehot=True).dropna()
preprocessed_smp.head()
```

```
/usr/local/lib/python3.7/site-packages/ipykernel_launcher.py:15: RuntimeWarni
ng: invalid value encountered in log1p
  from ipykernel import kernelapp as app
```

Out[30]:

	pr_enrll_any	dep_bl_3am_smp	inv_bl_3am_smp	cr_bl_3am_smp	oprd_bl_3am_smp	dep_oac
0	N	9.235933	0.000000	0.000000	0	
1	N	9.799394	0.000000	0.000000	0	
2	N	10.522422	0.000000	3.614964	0	
3	N	11.754644	0.000000	0.000000	0	
4	N	6.674574	9.874737	0.000000	0	

5 rows × 34 columns

In [31]:
```
le = preprocessing.LabelEncoder()
preprocessed_smp['pr_enrll_any'] = le.fit_transform(preprocessed_smp['pr_enrll
_any'].astype(str))

y_smp = preprocessed_smp['pr_enrll_any']
X_smp = preprocessed_smp.drop(['pr_enrll_any'], axis=1)
```

In [32]:
```
X_train_smp, X_test_smp, y_train_smp, y_test_smp = train_test_split(X_smp, y_s
mp, test_size=0.2, random_state=42, shuffle=True)
```

In [33]:
```
clf = LogisticRegressionCV(cv=5, random_state=0, Cs=[1e-4, 1e-3, 1e-2, 1e-1, 1
, 1e2, 1e3, 1e4], verbose=2).fit(X_train_smp, y_train_smp)
```

```
[Parallel(n_jobs=1)]: Using backend SequentialBackend with 1 concurrent worke
rs.
/usr/local/lib/python3.7/site-packages/sklearn/linear_model/logistic.py:757:
ConvergenceWarning: lbfgs failed to converge. Increase the number of iteratio
ns.
  "of iterations.", ConvergenceWarning)
/usr/local/lib/python3.7/site-packages/sklearn/linear_model/logistic.py:757:
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  "of iterations.", ConvergenceWarning)
/usr/local/lib/python3.7/site-packages/sklearn/linear_model/logistic.py:757:
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  "of iterations.", ConvergenceWarning)
/usr/local/lib/python3.7/site-packages/sklearn/linear_model/logistic.py:757:
ConvergenceWarning: lbfgs failed to converge. Increase the number of iteratio
ns.
  "of iterations.", ConvergenceWarning)
[Parallel(n_jobs=1)]: Done   1 out of   1 | elapsed:    6.6s remaining:    0.
0s
/usr/local/lib/python3.7/site-packages/sklearn/linear_model/logistic.py:757:
ConvergenceWarning: lbfgs failed to converge. Increase the number of iteratio
ns.
  "of iterations.", ConvergenceWarning)
/usr/local/lib/python3.7/site-packages/sklearn/linear_model/logistic.py:757:
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  "of iterations.", ConvergenceWarning)
/usr/local/lib/python3.7/site-packages/sklearn/linear_model/logistic.py:757:
ConvergenceWarning: lbfgs failed to converge. Increase the number of iteratio
ns.
  "of iterations.", ConvergenceWarning)
/usr/local/lib/python3.7/site-packages/sklearn/linear_model/logistic.py:757:
```

```
ConvergenceWarning: lbfgs failed to converge. Increase the number of iteratio
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/usr/local/lib/python3.7/site-packages/sklearn/linear_model/logistic.py:757:
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  "of iterations.", ConvergenceWarning)
/usr/local/lib/python3.7/site-packages/sklearn/linear_model/logistic.py:757:
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  "of iterations.", ConvergenceWarning)
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  "of iterations.", ConvergenceWarning)
/usr/local/lib/python3.7/site-packages/sklearn/linear_model/logistic.py:757:
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  "of iterations.", ConvergenceWarning)
/usr/local/lib/python3.7/site-packages/sklearn/linear_model/logistic.py:757:
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  "of iterations.", ConvergenceWarning)
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  "of iterations.", ConvergenceWarning)
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  "of iterations.", ConvergenceWarning)
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  "of iterations.", ConvergenceWarning)
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  "of iterations.", ConvergenceWarning)
/usr/local/lib/python3.7/site-packages/sklearn/linear_model/logistic.py:757:
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  "of iterations.", ConvergenceWarning)
/usr/local/lib/python3.7/site-packages/sklearn/linear_model/logistic.py:757:
ConvergenceWarning: lbfgs failed to converge. Increase the number of iteratio
ns.
  "of iterations.", ConvergenceWarning)
[Parallel(n_jobs=1)]: Done   5 out of   5 | elapsed:   32.1s finished
/usr/local/lib/python3.7/site-packages/sklearn/linear_model/logistic.py:757:
ConvergenceWarning: lbfgs failed to converge. Increase the number of iteratio
ns.
  "of iterations.", ConvergenceWarning)
```

In [34]:
```
preds_smp = clf.predict(X_test_smp)
print(classification_report(y_test_smp, preds_smp))
```

```
              precision    recall  f1-score   support

           0       0.68      0.78      0.73     14692
           1       0.63      0.50      0.56     10746

   micro avg       0.66      0.66      0.66     25438
   macro avg       0.66      0.64      0.64     25438
weighted avg       0.66      0.66      0.66     25438
```

In [35]:
```
print(accuracy_score(y_test_smp, preds_smp))
```

```
0.6640459155593993
```

In [ ]:
```

```