In [ ]:
```
import pandas as pd
import numpy as np
from scipy import stats

from scipy.stats import pearsonr
from scipy.stats import spearmanr
from scipy.stats import kendalltau
from scipy.stats import chi2_contingency
import seaborn as sns
import matplotlib.pyplot as plt
# for min_max scaling
from sklearn.preprocessing import MinMaxScaler
```

In [ ]:
```
data = pd.read_csv('data.csv', delimiter='}', encoding="UTF-16")
data
```

Out[ ]:

	target	c1	c2	c3	c4	c5	c6	c7	c8
0	0.0	0.6	3.848024360038754	-0.12489928599664912	-0.876288	a	0.0	1.0	0.0
1	0.0	-9999.0	3.686711750399645	2.7465579865302554	-16840.562852	fr	0.0	_	0.0
2	1.0	0.6	1.7903405757001267	-0.3791833083216618	1.115662	w	1.0	4.0	inf
3	0.0	0.3	2.1368573082176185	1.8436547163343175	-2.593336	w	0.0	1.0	0.0
4	0.0	0.3	3.3008362240888207	1.492122687471352	-3.033777	f	0.0	3.0	0.0
...	...	...	...	...	...	...	...	...	...
999995	1.0	0.2	2.7723286859391183	0.3152747929660493	-1.702342	fr	1.0	1.0	0.0
999996	0.0	0.1	inf	inf	-3.269701	a	0.0	3.0	0.0
999997	0.0	0.5	inf	inf	-2.049132	f	0.0	1.0	-inf
999998	0.0	0.9	1.0094653348000295	-0.19162749567540516	-1.001801	d	0.0	2.0	1.0
999999	1.0	0.3	1.8487116575771474	-0.3196058449170467	-0.003627	a	1.0	1.0	-1.0

1000000 rows × 14 columns

In [ ]:
```
#find out if there are any missing values and their possible sum
missing_values_count = data.isna().sum()
missing_values_count
```

Out[ ]:
```
target    0
c1        0
c2        0
c3        0
c4        0
```

```
c5        0
c6        0
c7        0
c8        0
c9        0
c10       0
c11       0
c12       0
c13       0
dtype: int64
```

In [ ]:
```
data.isnull().sum()
```

Out[ ]:
```
target    0
c1        0
c2        0
c3        0
c4        0
c5        0
c6        0
c7        0
c8        0
c9        0
c10       0
c11       0
c12       0
c13       0
dtype: int64
```

In [ ]:
```
#get all the info of dataset
data.info()
```

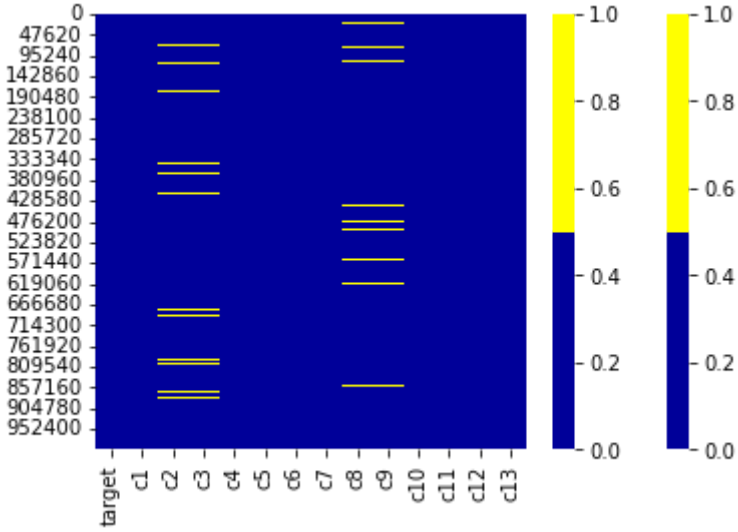
```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 1000000 entries, 0 to 999999
Data columns (total 14 columns):
 #   Column  Non-Null Count    Dtype  
---  ------  --------------    -----  
 0   target  1000000 non-null  object 
 1   c1      1000000 non-null  float64
 2   c2      1000000 non-null  object 
 3   c3      1000000 non-null  object 
 4   c4      1000000 non-null  float64
 5   c5      1000000 non-null  object 
 6   c6      1000000 non-null  object 
 7   c7      1000000 non-null  object 
 8   c8      1000000 non-null  object 
 9   c9      1000000 non-null  object 
 10  c10     1000000 non-null  object 
 11  c11     1000000 non-null  object 
 12  c12     1000000 non-null  object 
 13  c13     1000000 non-null  object 
dtypes: float64(2), object(12)
memory usage: 106.8+ MB
```

So there is no obvious NaN values in our dataset, only two columns with fully numerical (float64) data. Also we can observe non-numerical values such as "inf" or "_" in target and other columns. We should convert not-fully numerical colums into numerical ones.

In [ ]:
```
#to find out and visualize what columns contain inf data, we will use data visualiza
cols = data.columns[:14] # 14 columns
colours = ['#000099', '#ffff00'] # specify the colours - yellow has -inf. blue is ot
```

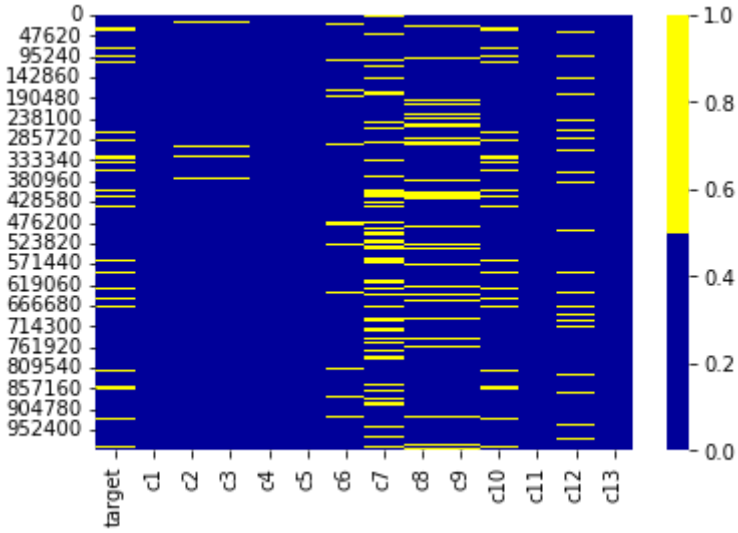
```
sns.heatmap(data[cols]=='-inf', cmap=sns.color_palette(colours))
sns.heatmap(data[cols]=='inf', cmap=sns.color_palette(colours))
```

Out[ ]:
```
<AxesSubplot:>
```



In [ ]:
```
#to find out and visualize "_", where yellow indicates "_" presence
cols = data.columns[:14] # first 14 columns
colours = ['#000099', '#ffff00'] # specify the colours - yellow has -inf. blue is ot
sns.heatmap(data[cols]=='_', cmap=sns.color_palette(colours))
```

Out[ ]:
```
<AxesSubplot:>
```



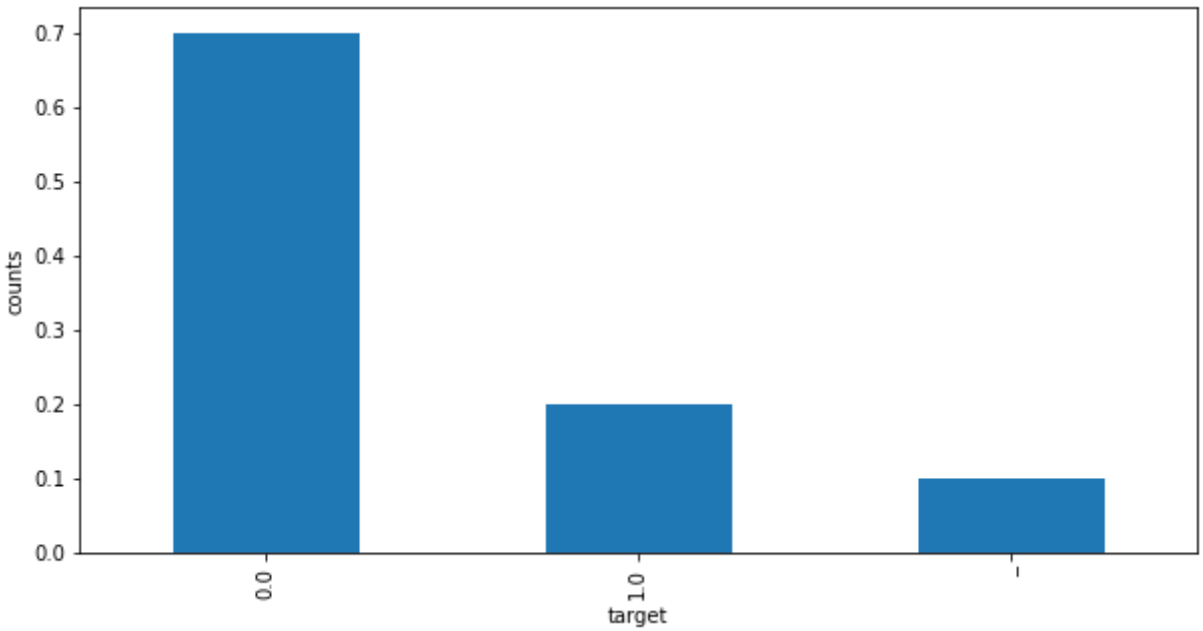
Observing columns data distribution

In [ ]:
```
#function for making plot for each column
def make_plot(col_name, type='bar'):
    print(data[col_name].value_counts())
    plt.figure(figsize=(10,5))
    data[col_name].value_counts(normalize=True).plot(kind=type)
    plt.ylabel('counts')
    plt.xlabel(col_name)
    plt.plot()
```

Target column

In [ ]:
```
make_plot('target')
```

```
0.0    700383
1.0    200486
_       99131
Name: target, dtype: int64
```



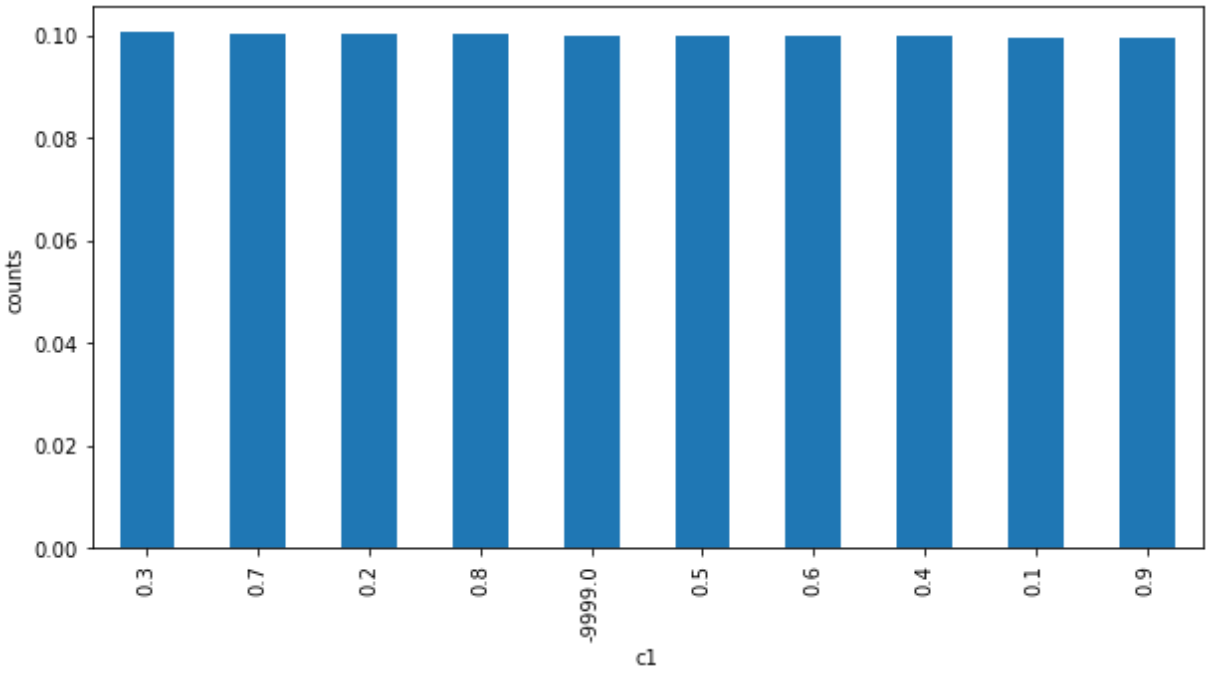
As we have missing values in 'target', we should obviously drop these rows

In [ ]:
```
data.drop(data.loc[data['target']=='_'].index, inplace=True)
```

c1

In [ ]:
```
make_plot('c1')
```

```
 0.3       90560
 0.7       90414
 0.2       90184
 0.8       90157
-9999.0    90075
 0.5       90072
 0.6       90064
 0.4       89965
 0.1       89694
 0.9       89684
Name: c1, dtype: int64
```



We may observe that -9999.0 is the substitute for missing values. So we can 1) check correlation between target and c1 with such missing values 2) without -9999.0

In [ ]:
```
# Pearson's Correlation test function
def pearson_corr(col_name, dataset = data):
    data1 = pd.to_numeric(dataset['target'])
    data2 = dataset[col_name]
    stat, p = pearsonr(data1, data2)
    print('stat=%.3f, p=%.3f' % (stat, p))
    if p > 0.05:
        print('Probably independent')
    else:
        print('Probably dependent')
```

In [ ]:
```
# Spearman's Rank Correlation Test function
def spearman_corr(col_name, dataset = data):
        data1 = pd.to_numeric(dataset['target'])
        data2 = dataset[col_name]
        stat, p = spearmanr(data1, data2)
        print('stat=%.3f, p=%.3f' % (stat, p))
        if p > 0.05:
                print('Probably independent')
        else:
                print('Probably dependent')
```

In [ ]:
```
# Chi-Squared Test function
def chi_corr(col_name, dataset = data):
        table = [pd.to_numeric(dataset['target']), pd.to_numeric(dataset[col_name])]
        stat, p, dof, expected = chi2_contingency(table)
        print('stat=%.3f, p=%.3f' % (stat, p))
        if p > 0.05:
                print('Probably independent')
        else:
                print('Probably dependent')
```

In [ ]:
```
#without -9999.0
data_c1 = data.drop(data.loc[data['c1']==-9999.0].index)
```

In [ ]:
```
print("Pearson's Correlation test with missing values")
pearson_corr('c1')
print("Pearson's Correlation test without missing values")
pearson_corr('c1', data_c1)

print("Spearman's Rank Correlation test with missing values")
spearman_corr('c1')
print("Spearman's Rank Correlation without missing values")
spearman_corr('c1', data_c1)

print("Chi-Squared test")
chi_corr('c1', data_c1)
```

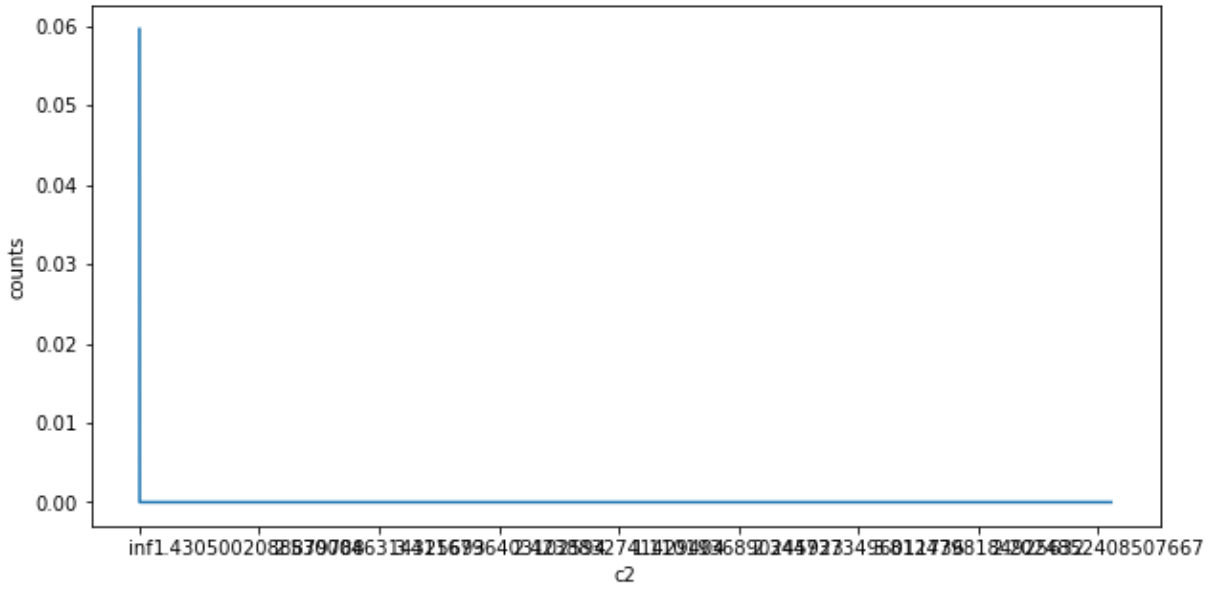
```
Pearson's Correlation test with missing values
stat=-0.000, p=0.767
Probably independent
Pearson's Correlation test without missing values
stat=-0.001, p=0.602
Probably independent
Spearman's Rank Correlation test with missing values
stat=-0.001, p=0.549
Probably independent
Spearman's Rank Correlation without missing values
stat=-0.001, p=0.602
Probably independent
Chi-Squared test
stat=321341.329, p=1.000
Probably independent
```

So, we should drop this column from the dataset

c2

In [ ]:
```
make_plot('c2', 'line')
```

```
inf                  53705
-inf                 18168
_                    18067
3.848024360038754        1
2.377579712128918        1
                     ...
1.6017666274767692       1
3.3786542306331118       1
2.746859400102414        1
3.846121594797114        1
1.8487116575771474       1
Name: c2, Length: 810932, dtype: int64
```



For conducting statistical test, we should drop missing values from the column

In [ ]:
```
data_c2 = data.drop(data.loc[data['c2']=='_'].index)
inf_filt = (data_c2['c2'] != 'inf') & (data_c2['c2']!='-inf')
data_c2= data_c2.loc[inf_filt]
data_c2['c2'].value_counts()
```

Out[ ]:
```
3.848024360038754     1
3.4962168321079936    1
3.3423928112720644    1
3.3150851132279096    1
1.3226113637249024    1
                     ..
1.6017666274767692    1
3.3786542306331118    1
2.746859400102414     1
3.846121594797114     1
1.8487116575771474    1
Name: c2, Length: 810929, dtype: int64
```

In [ ]:
```
#normalize c2
(pd.to_numeric(data_c2['c2']) - pd.to_numeric(data_c2['c2'].min())) / (pd.to_numeric
```

Out[ ]:
```
0         0.949342
1         0.895571
2         0.263446
3         0.378952
4         0.766946
            ...
999991    0.513372
999992    0.696945
999995    0.590776
999998    0.003153
999999    0.282903
Name: c2, Length: 810929, dtype: float64
```

In [ ]:
```
#function for conducting correlation tests
def correl_tests (col_name, dataset=data, num_arr=[]):
    filt_arr = []
    if (np.array_equal(num_arr, filt_arr)):
        num_arr= pd.to_numeric(dataset[col_name])
    data1 = pd.to_numeric(dataset['target'])
    data2 = num_arr
```

```
    print("Pearson's Correlation Test")
    stat, p = pearsonr(data1, data2)
    print('stat=%.3f, p=%.3f' % (stat, p))
    if p > 0.05:
        print('Probably independent')
    else:
        print('Probably dependent')
    print("Spearman's Rank Correlation Test")
    stat, p = spearmanr(data1, data2)
    print('stat=%.3f, p=%.3f' % (stat, p))
    if p > 0.05:
            print('Probably independent')
    else:
            print('Probably dependent')
    print("Kendall's Rank Correlation Test")
    stat, p = kendalltau(data1, data2)
    print('stat=%.3f, p=%.3f' % (stat, p))
    if p > 0.05:
            print('Probably independent')
    else:
            print('Probably dependent')
```

In [ ]:
```
correl_tests('c2', data_c2)
```

```
Pearson's Correlation Test
stat=0.001, p=0.568
Probably independent
Spearman's Rank Correlation Test
stat=0.001, p=0.569
Probably independent
Kendall's Rank Correlation Test
stat=0.001, p=0.569
Probably independent
```

In [ ]:
```
chi_corr('c2', data_c2)
```

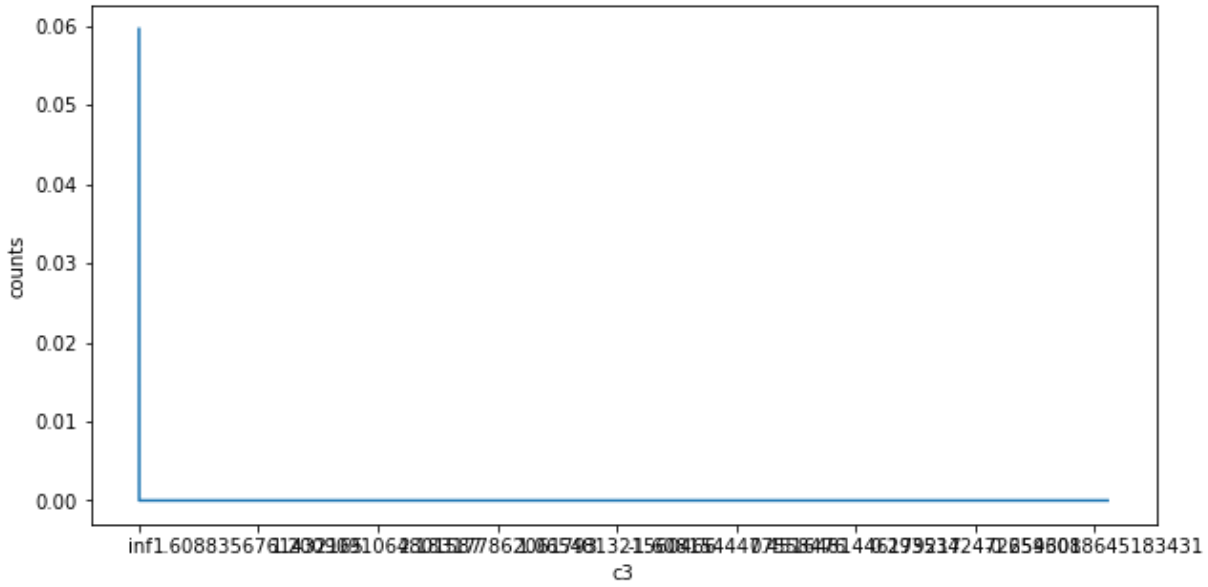
```
stat=537556.080, p=1.000
Probably independent
```

So, we should drop this column from the dataset

c3

In [ ]:
```
make_plot('c3', 'line')
```

```
inf                    53705
-inf                   18168
_                      18067
-0.12489928599664912       1
2.1269779692610187         1
                       ...
-2.9393222516006237        1
1.7188109618191807         1
1.2192488127677694         1
0.4330490423852811         1
-0.3196058449170467        1
Name: c3, Length: 810932, dtype: int64
```



In [ ]:
```
data_c3 = data.drop(data.loc[data['c3']=='_'].index)
inf_filt = (data_c3['c3'] != 'inf') & (data_c3['c3']!='-inf')
data_c3= data_c3.loc[inf_filt]
data_c3['c3'].value_counts()
```

Out[ ]:
```
-0.12489928599664912    1
0.2859699481058606      1
1.9172070176576632      1
1.3596228421196344      1
-0.24973878869414046    1
                       ..
-2.9393222516006237     1
1.7188109618191807      1
1.2192488127677694      1
0.4330490423852811      1
-0.3196058449170467     1
Name: c3, Length: 810929, dtype: int64
```

In [ ]:
```
#scaling data in c3 column
scaler = MinMaxScaler(feature_range=(0,1))
arr= pd.to_numeric(data_c3['c3'])
arr = arr.to_numpy()
arr = arr.reshape(-1,1)
scaled = scaler.fit_transform(arr)
scaled
```

Out[ ]:
```
array([[0.35958402],
       [0.71958869],
       [0.32770354],
       ...,
       [0.41477019],
       [0.35121807],
       [0.33517298]])
```

In [ ]:
```
#convert scaled array to 1d array and add new column
scaled = scaled.flatten()
se = pd.Series(scaled)
data_c3['c3_new'] = se.values
```

In [ ]:
```
correl_tests('c3_new', data_c3)
```

```
Pearson's Correlation Test
stat=-0.000, p=0.664
Probably independent
Spearman's Rank Correlation Test
stat=-0.001, p=0.474
Probably independent
Kendall’s Rank Correlation Test
stat=-0.001, p=0.474
Probably independent
```

We can also do not drop -inf and inf but change it to -9999.0 and 9999.0 values

In [ ]:
```
data_c3_r = data.drop(data.loc[data['c3']=='_'].index)
data_c3_r['c3'].replace({"-inf": -9999.0, "inf": 9999.0}, inplace=True)
```

In [ ]:
```
correl_tests('c3', data_c3_r)
```

```
Pearson's Correlation Test
stat=-0.000, p=0.880
Probably independent
Spearman's Rank Correlation Test
stat=-0.001, p=0.482
Probably independent
Kendall’s Rank Correlation Test
stat=-0.001, p=0.482
Probably independent
C:\Users\Maria Anatoliivna\anaconda3\lib\site-packages\scipy\stats\stats.py:4812: Ru
ntimeWarning: overflow encountered in longlong_scalars
  (2 * xtie * ytie) / m + x0 * y0 / (9 * m * (size - 2)))
```

In [ ]:
```
#scaling data in c3 column
scaler = MinMaxScaler(feature_range=(0,1))
arr= pd.to_numeric(data_c3_r['c3'])
arr = arr.to_numpy()
arr = arr.reshape(-1,1)
scaled = scaler.fit_transform(arr)
scaled
```

Out[ ]:
```
array([[0.49999375],
       [0.50013734],
       [0.49998104],
       ...,
       [1.        ],
       [0.49999042],
       [0.49998402]])
```

In [ ]:
```
scaled = scaled.flatten()
se = pd.Series(scaled)
data_c3_r['c3_new'] = se.values
```

In [ ]:
```
correl_tests('c3_new', data_c3_r)
```

```
Pearson's Correlation Test
stat=-0.000, p=0.880
Probably independent
Spearman's Rank Correlation Test
stat=-0.001, p=0.482
Probably independent
Kendall’s Rank Correlation Test
```

```
stat=-0.001, p=0.482
Probably independent
```

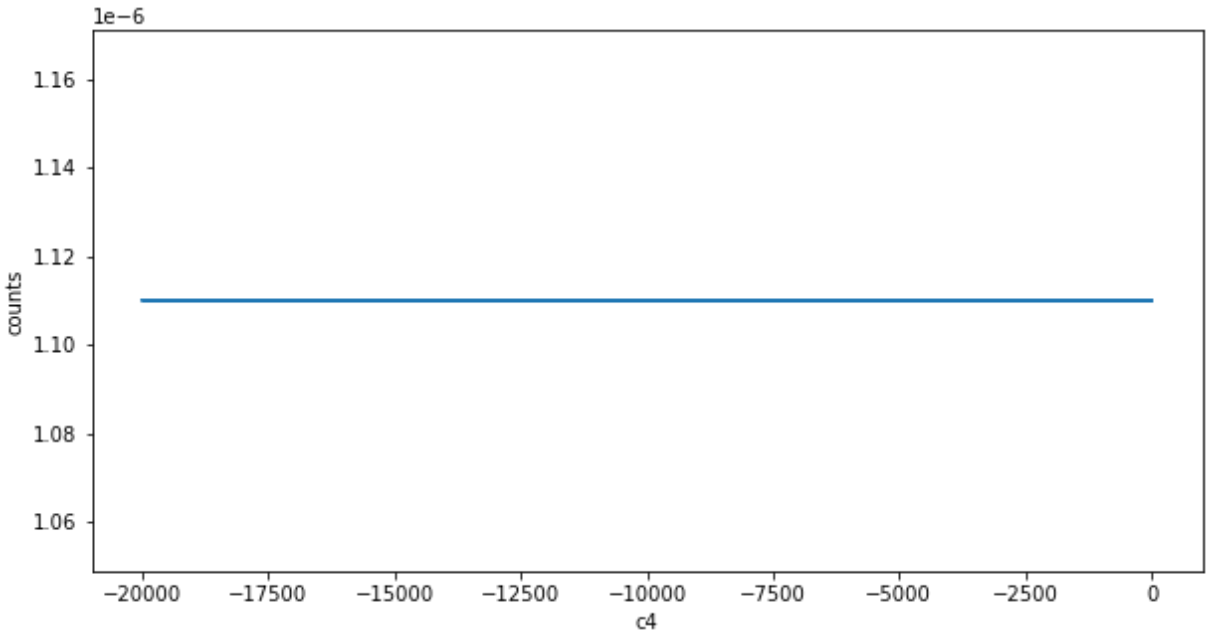
```
C:\Users\Maria Anatoliivna\anaconda3\lib\site-packages\scipy\stats\stats.py:4812: Ru
ntimeWarning: overflow encountered in longlong_scalars
  (2 * xtie * ytie) / m + x0 * y0 / (9 * m * (size - 2)))
```

So, we should drop this column from the dataset

c4

In [ ]:
```
make_plot('c4','line')
```

```
-0.876288    1
 0.692955    1
 1.017884    1
-2.623874    1
-4.183971    1
            ..
-0.734159    1
-0.506208    1
 1.873705    1
-1.072168    1
-0.003627    1
Name: c4, Length: 900869, dtype: int64
```



Column c4 has only unique values

In [ ]:
```
correl_tests('c4',data)
```

```
Pearson's Correlation Test
stat=-0.000, p=0.706
Probably independent
Spearman's Rank Correlation Test
stat=0.000, p=0.997
Probably independent
Kendall’s Rank Correlation Test
stat=0.000, p=0.997
Probably independent
```

In [ ]:
```
#scaling data in c4 column
data_c4 = data.copy()
scaler = MinMaxScaler(feature_range=(0,1))
```

```
arr= pd.to_numeric(data_c4['c4'])
arr = arr.to_numpy()
arr = arr.reshape(-1,1)
scaled = scaler.fit_transform(arr)
scaled
```

Out[ ]:
```
array([[0.99967491],
       [0.15810445],
       [0.99977446],
       ...,
       [0.9996163 ],
       [0.99966864],
       [0.99971852]])
```

In [ ]:
```
#convert scaled array to 1d array and add new column
scaled = scaled.flatten()
se = pd.Series(scaled)
data_c4['c4_new'] = se.values
```

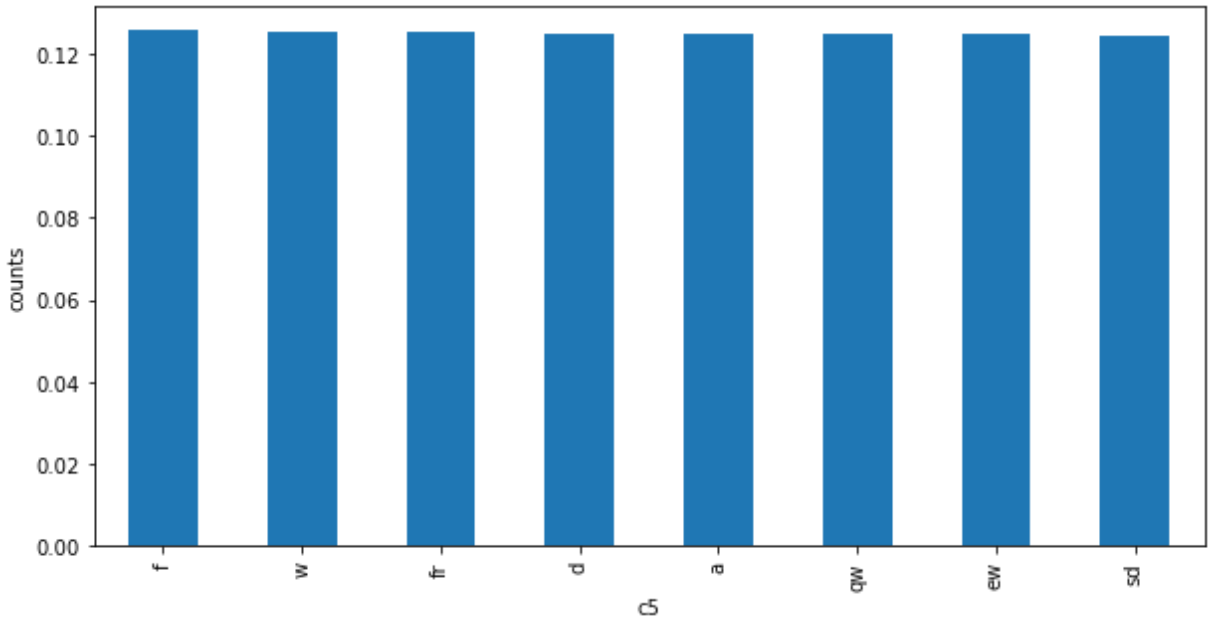
In [ ]:
```
correl_tests('c4_new', data_c4)
```

```
Pearson's Correlation Test
stat=-0.000, p=0.706
Probably independent
Spearman's Rank Correlation Test
stat=0.000, p=0.997
Probably independent
Kendall’s Rank Correlation Test
stat=0.000, p=0.997
Probably independent
```

c5

In [ ]:
```
make_plot('c5')
```

```
f     113128
w     112872
fr    112677
d     112637
a     112527
qw    112512
ew    112511
sd    112005
Name: c5, dtype: int64
```



In [ ]:
```
#convert str data into numerical
lst = pd.factorize(data['c5'])[0]
arr = np.array(lst)
arr
```

Out[ ]:
```
array([0, 1, 2, ..., 3, 7, 0], dtype=int64)
```

In [ ]:
```
#normalize array data
norm = np.linalg.norm(arr)
normal_array = arr/norm
```

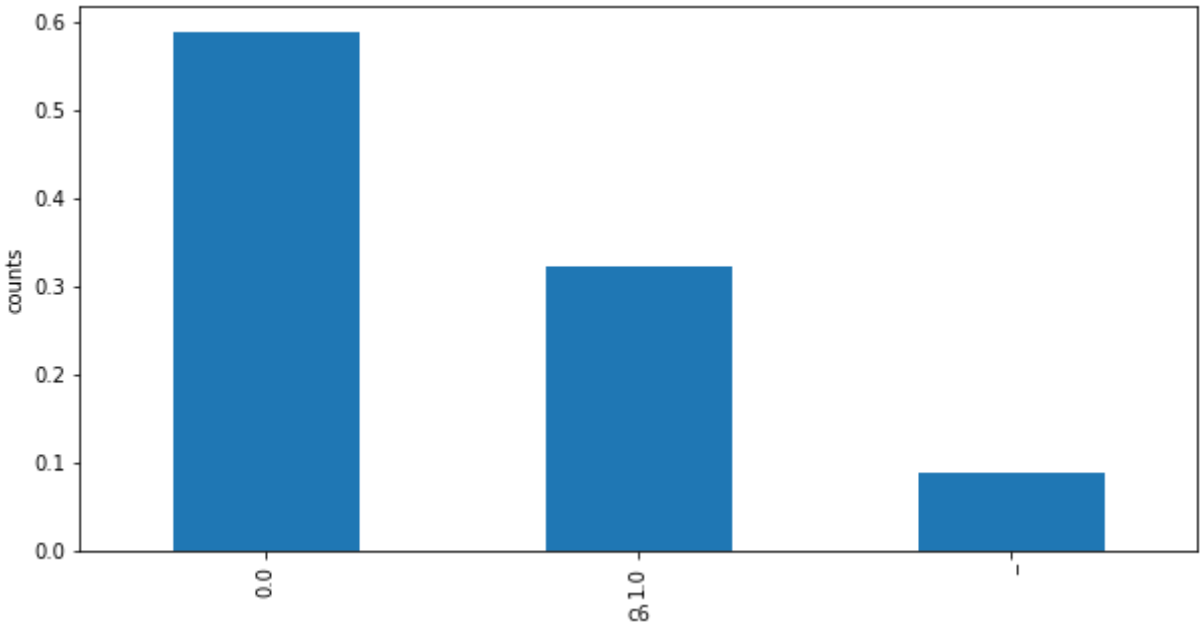
In [ ]:
```
correl_tests('c5', data, normal_array)
```

```
Pearson's Correlation Test
stat=-0.000, p=0.954
Probably independent
Spearman's Rank Correlation Test
stat=-0.000, p=0.954
Probably independent
Kendall’s Rank Correlation Test
stat=-0.000, p=0.954
Probably independent
C:\Users\Maria Anatoliivna\anaconda3\lib\site-packages\scipy\stats\stats.py:4812: Ru
ntimeWarning: overflow encountered in longlong_scalars
  (2 * xtie * ytie) / m + x0 * y0 / (9 * m * (size - 2)))
```

c6

In [ ]:
```
make_plot('c6')
```

```
0.0    530414
1.0    290444
_       80011
Name: c6, dtype: int64
```



In [ ]:
```
data_c6 = data.drop(data.loc[data['c6']=='_'].index)
```

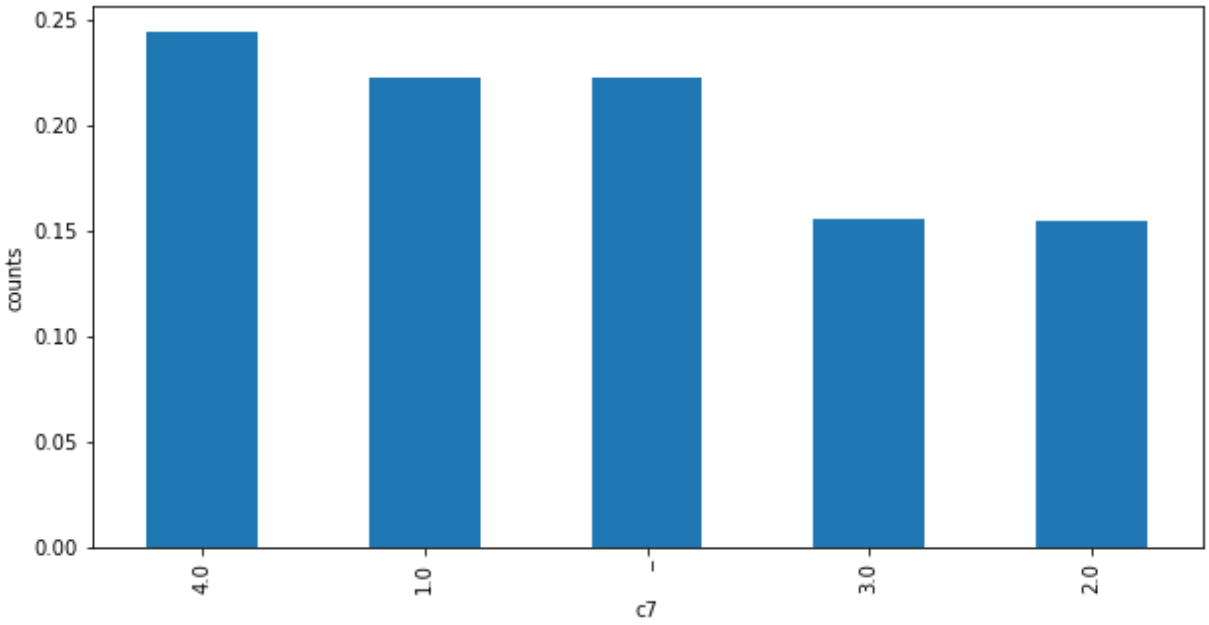
In [ ]:
```
correl_tests('c6',data_c6)
```

```
Pearson's Correlation Test
stat=0.502, p=0.000
Probably dependent
Spearman's Rank Correlation Test
stat=0.502, p=0.000
Probably dependent
Kendall’s Rank Correlation Test
stat=0.502, p=0.000
Probably dependent
C:\Users\Maria Anatoliivna\anaconda3\lib\site-packages\scipy\stats\stats.py:4812: Ru
ntimeWarning: overflow encountered in longlong_scalars
  (2 * xtie * ytie) / m + x0 * y0 / (9 * m * (size - 2)))
```

c7

In [ ]:
```
make_plot('c7')
```

```
4.0    219997
1.0    200601
_      200260
3.0    140451
2.0    139560
Name: c7, dtype: int64
```



In [ ]:
```
data_c7 = data.drop(data.loc[data['c7']=='_'].index)
```

In [ ]:
```
correl_tests('c7',data_c7)
```

```
Pearson's Correlation Test
stat=0.069, p=0.000
Probably dependent
Spearman's Rank Correlation Test
stat=0.075, p=0.000
Probably dependent
Kendall’s Rank Correlation Test
stat=0.069, p=0.000
Probably dependent
C:\Users\Maria Anatoliivna\anaconda3\lib\site-packages\scipy\stats\stats.py:4812: Ru
ntimeWarning: overflow encountered in longlong_scalars
  (2 * xtie * ytie) / m + x0 * y0 / (9 * m * (size - 2)))
```

In [ ]:
```
data_c7_r = data.copy()
data_c7_r['c7'].replace({"_": 9999.0}, inplace=True)
#scaling data in c7 column
scaler = MinMaxScaler(feature_range=(0,1))
arr= pd.to_numeric(data_c7_r['c7'])
arr = arr.to_numpy()
arr = arr.reshape(-1,1)
scaled = scaler.fit_transform(arr)
scaled = scaled.flatten()
se = pd.Series(scaled)
data_c7_r['c7_new'] = se.values
```

In [ ]:
```
correl_tests('c7_new',data_c7_r)
```

```
Pearson's Correlation Test
stat=0.100, p=0.000
Probably dependent
Spearman's Rank Correlation Test
stat=0.116, p=0.000
Probably dependent
Kendall’s Rank Correlation Test
```

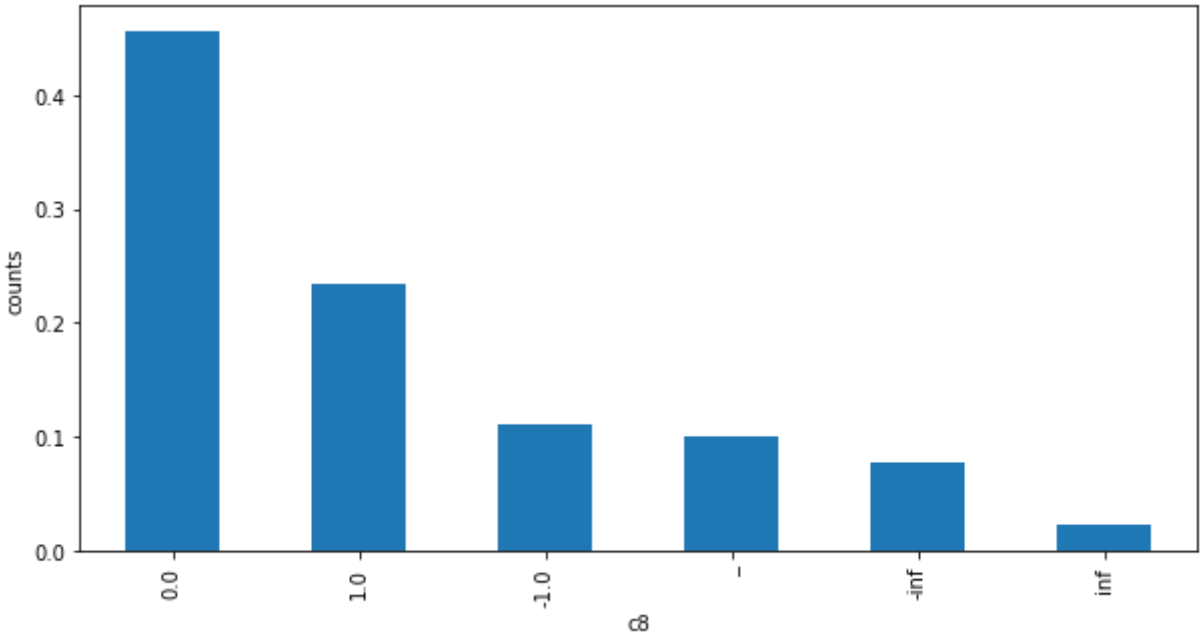
```
stat=0.104, p=0.000
Probably dependent
```

```
C:\Users\Maria Anatoliivna\anaconda3\lib\site-packages\scipy\stats\stats.py:4812: Ru
ntimeWarning: overflow encountered in longlong_scalars
  (2 * xtie * ytie) / m + x0 * y0 / (9 * m * (size - 2)))
```

c8

In [ ]:
```
make_plot('c8')
```

```
0.0     410271
1.0     210522
-1.0     99912
_        90217
-inf     69785
inf      20162
Name: c8, dtype: int64
```



In [ ]:
```
data_c8 = data.drop(data.loc[data['c8']=='_'].index)
inf_filt = (data_c8['c8'] != 'inf') & (data_c8['c8']!='-inf')
data_c8= data_c8.loc[inf_filt]
data_c8['c8'].value_counts()
```

Out[ ]:
```
0.0     410271
1.0     210522
-1.0     99912
Name: c8, dtype: int64
```

In [ ]:
```
correl_tests('c8', data_c8)
```

```
Pearson's Correlation Test
stat=-0.651, p=0.000
Probably dependent
Spearman's Rank Correlation Test
stat=-0.621, p=0.000
Probably dependent
Kendall’s Rank Correlation Test
stat=-0.595, p=0.000
Probably dependent
```

```
C:\Users\Maria Anatoliivna\anaconda3\lib\site-packages\scipy\stats\stats.py:4812: Ru
ntimeWarning: overflow encountered in longlong_scalars
  (2 * xtie * ytie) / m + x0 * y0 / (9 * m * (size - 2)))
```

In [ ]:
```
col_mean = pd.to_numeric(data_c8['c8']).mean()
col_mean
data_c8_r = data.copy()
data_c8_r['c8'].replace({"-inf": -9999.0, "inf": 9999.0, "_": col_mean}, inplace=Tru
data_c8_r['c8'].value_counts()
```

Out[ ]:
```
0.0                   410271
1.0                   210522
-1.0                   99912
0.15347472266738818    90217
-9999.0                69785
9999.0                 20162
Name: c8, dtype: int64
```

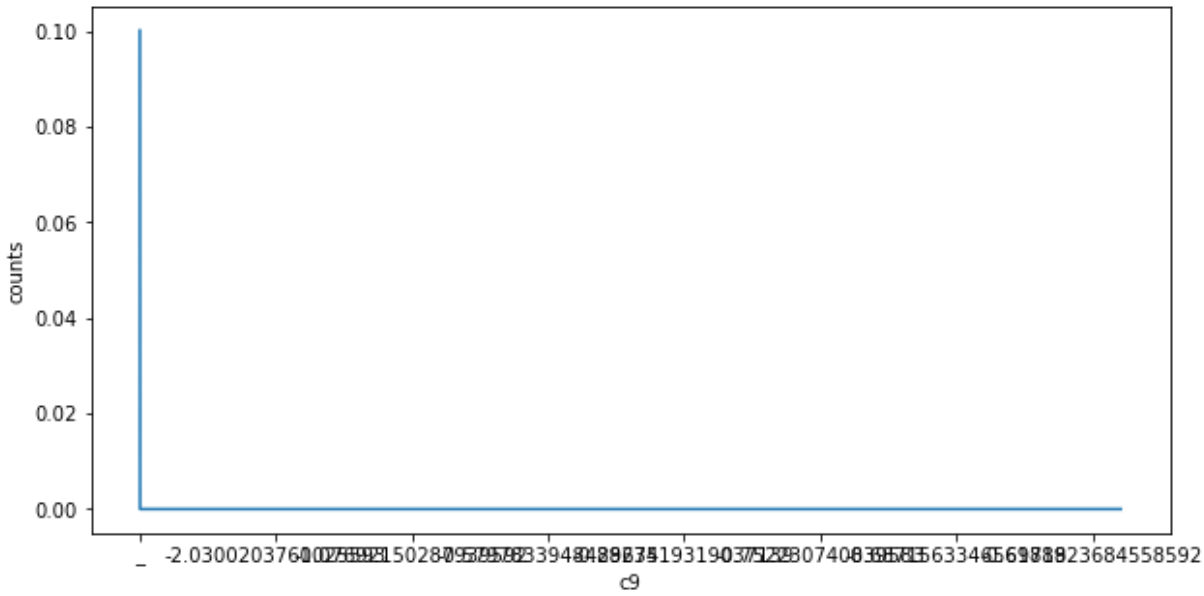
In [ ]:
```
correl_tests('c8', data_c8_r)
```

```
Pearson's Correlation Test
stat=0.268, p=0.000
Probably dependent
Spearman's Rank Correlation Test
stat=-0.274, p=0.000
Probably dependent
Kendall’s Rank Correlation Test
stat=-0.251, p=0.000
Probably dependent
```

c9

In [ ]:
```
make_plot('c9', 'line')
```

```
_                     90217
-inf                  69785
inf                   20162
-1.4022953844807486       1
-2.611484478944758        1
                        ...
-0.2196693847000153       1
0.7553389739328342        1
-4.067226508015141        1
-0.98355215475623         1
-1.8913900139639952       1
Name: c9, Length: 720708, dtype: int64
```



In [ ]:
```
data_c9 = data.drop(data.loc[data['c9']=='_'].index)
inf_filt = (data_c9['c9'] != 'inf') & (data_c9['c9']!='-inf')
data_c9= data_c9.loc[inf_filt]
data_c9['c9'].value_counts()
```

Out[ ]:
```
-1.4022953844807486     1
-2.611484478944758      1
-2.8438437046765377     1
1.0874307557873788      1
-0.21610818998772663    1
                       ..
-0.2196693847000153     1
0.7553389739328342      1
-4.067226508015141      1
-0.98355215475623       1
-1.8913900139639952     1
Name: c9, Length: 720705, dtype: int64
```

In [ ]:
```
correl_tests('c9', data_c9)
```

```
Pearson's Correlation Test
stat=-0.289, p=0.000
Probably dependent
Spearman's Rank Correlation Test
stat=-0.272, p=0.000
Probably dependent
Kendall’s Rank Correlation Test
stat=-0.222, p=0.000
Probably dependent
```

In [ ]:
```
#scaling data in c9 column
scaler = MinMaxScaler(feature_range=(0,1))
arr= pd.to_numeric(data_c9['c9'])
arr = arr.to_numpy()
arr = arr.reshape(-1,1)
scaled = scaler.fit_transform(arr)
scaled
```

Out[ ]:
```
array([[0.44937109],
       [0.24267668],
       [0.518375  ],
       ...,
       [0.65716557],
       [0.83762845],
       [0.38802392]])
```

In [ ]:
```
#convert scaled array to 1d array and add new column
scaled = scaled.flatten()
se = pd.Series(scaled)
data_c9['c9_new'] = se.values
```

In [ ]:
```
correl_tests('c9_new', data_c9)
```

```
Pearson's Correlation Test
stat=-0.289, p=0.000
Probably dependent
Spearman's Rank Correlation Test
stat=-0.272, p=0.000
Probably dependent
Kendall’s Rank Correlation Test
```

```
stat=-0.222, p=0.000
Probably dependent
```

In [ ]:
```
data_c9_r = data.copy()
col_mean = pd.to_numeric(data_c9['c9']).mean()
data_c9_r['c9'].replace({"_": col_mean, "inf": 9999.0, "-inf": -9999.0}, inplace=Tru
correl_tests('c9', data_c9_r)
data_c9_r['c9'].value_counts()
```

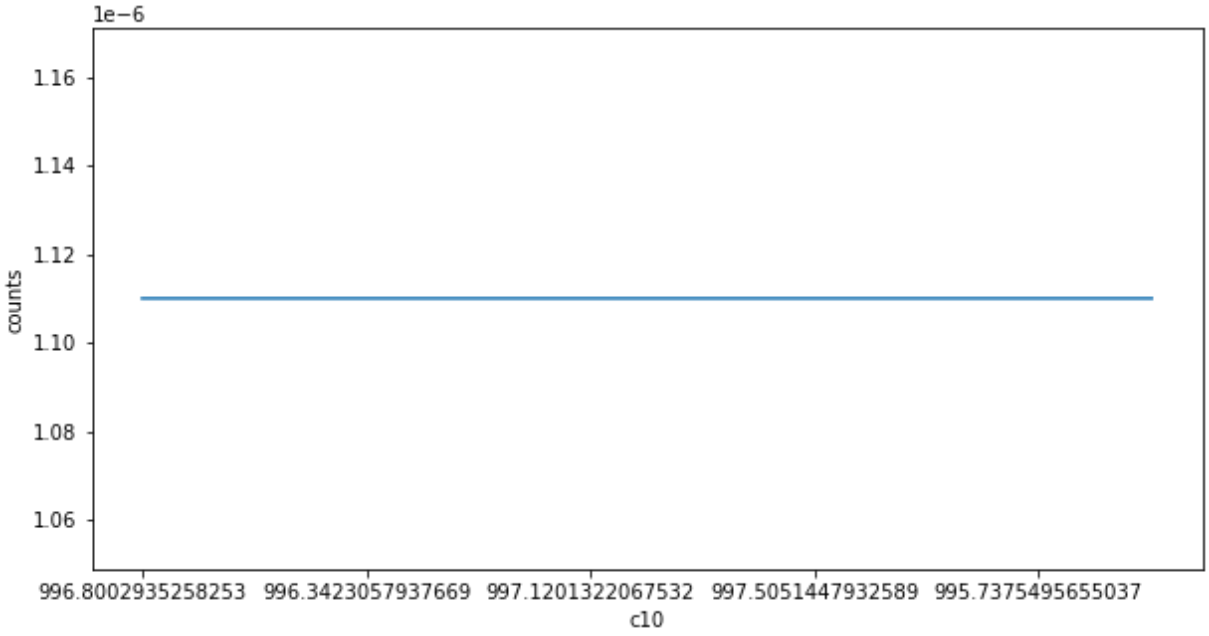
```
Pearson's Correlation Test
stat=0.268, p=0.000
Probably dependent
Spearman's Rank Correlation Test
stat=-0.066, p=0.000
Probably dependent
Kendall’s Rank Correlation Test
C:\Users\Maria Anatoliivna\anaconda3\lib\site-packages\scipy\stats\stats.py:4812: Ru
ntimeWarning: overflow encountered in longlong_scalars
  (2 * xtie * ytie) / m + x0 * y0 / (9 * m * (size - 2)))
stat=-0.054, p=0.000
Probably dependent
```

Out[ ]:
```
-0.8469089109433051    90217
-9999.0                69785
9999.0                 20162
-1.4022953844807486        1
-2.611484478944758         1
                         ...
-0.2196693847000153        1
0.7553389739328342         1
-4.067226508015141         1
-0.98355215475623          1
-1.8913900139639952        1
Name: c9, Length: 720708, dtype: int64
```

c10

In [ ]:
```
make_plot('c10', 'line')
```

```
996.8002935258253     1
999.893508333398      1
995.6928385739434     1
1000.6259995023979    1
1000.2294345207205    1
                     ..
997.0389832404381     1
998.7878049085126     1
996.980482706664      1
997.093209727735      1
999.6925599702948     1
Name: c10, Length: 900869, dtype: int64
```



In [ ]:
```
correl_tests('c10',data)
```

```
Pearson's Correlation Test
stat=0.307, p=0.000
Probably dependent
Spearman's Rank Correlation Test
stat=0.288, p=0.000
Probably dependent
Kendall’s Rank Correlation Test
stat=0.235, p=0.000
Probably dependent
```

In [ ]:
```
#scaling data in c10 column
data_c10 = data.copy()
scaler = MinMaxScaler(feature_range=(0,1))
arr= pd.to_numeric(data_c10['c10'])
arr = arr.to_numpy()
arr = arr.reshape(-1,1)
scaled = scaler.fit_transform(arr)
#convert scaled array to 1d array and add new column
scaled = scaled.flatten()
se = pd.Series(scaled)
data_c10['10'] = se.values
```

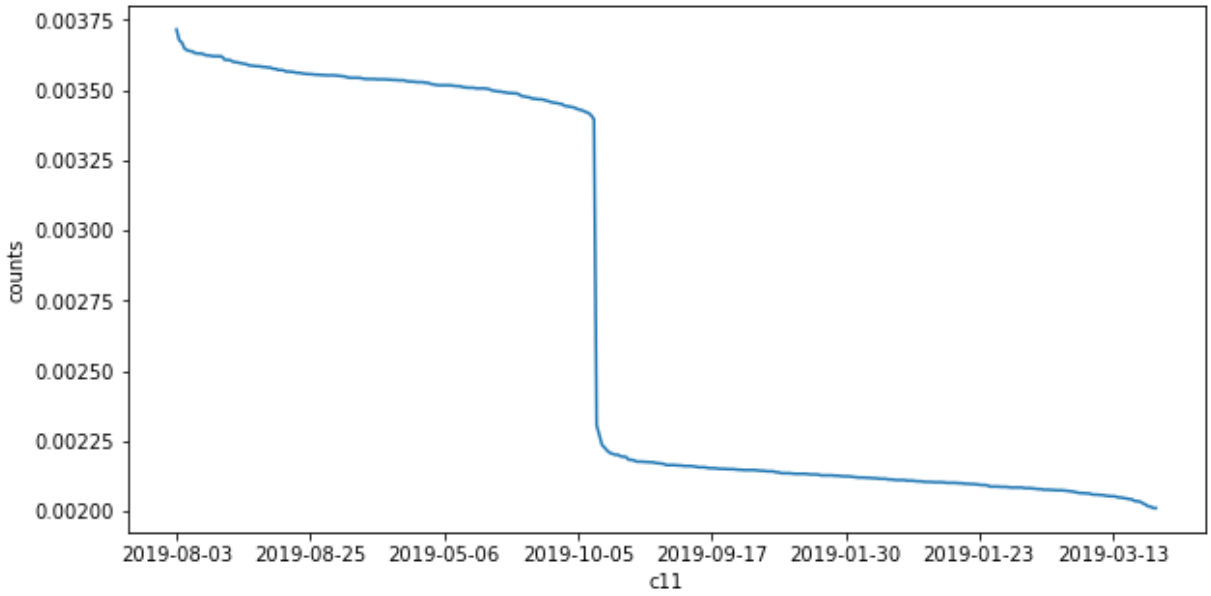
In [ ]:
```
correl_tests('c10',data_c10)
```

```
Pearson's Correlation Test
stat=0.307, p=0.000
Probably dependent
Spearman's Rank Correlation Test
stat=0.288, p=0.000
Probably dependent
Kendall’s Rank Correlation Test
stat=0.235, p=0.000
Probably dependent
```

c11

In [ ]:
```
make_plot('c11', 'line')
```

```
2019-08-03    3348
2019-09-15    3314
2019-03-18    3306
2019-06-16    3287
2019-12-29    3281
              ...
2019-08-09    1824
2019-07-10    1818
2019-12-31    1817
2019-08-06    1812
2019-11-26    1812
Name: c11, Length: 367, dtype: int64
```



In [ ]:

```
data_c11 = data.drop(data.loc[data['c11']=='_'].index)
print(data_c11.shape)
data_c11['c11'] = pd.to_datetime(data_c11['c11'])
data_c11_1 = data_c11.set_index('c11')
data_c11_1=data['c11'].index.values.astype(float)
data_c11_1
```

Out[ ]:

```
(897773, 14)
array([0.00000e+00, 1.00000e+00, 2.00000e+00, ..., 9.99997e+05,
       9.99998e+05, 9.99999e+05])
```

In [ ]:

```
scaler = MinMaxScaler(feature_range=(0,1))
arr = data_c11_1.reshape(-1,1)
scaled = scaler.fit_transform(arr)
scaled = scaled.flatten()
se = pd.Series(scaled)
data_c11_new = data.copy()
print(data_c11.shape)
data_c11_new['c11_new'] = se.values
data_c11_new['c11_new'].value_counts()
```

Out[ ]:

```
(897773, 14)
0.000000    1
0.666405    1
0.666393    1
0.666394    1
0.666395    1
           ..
0.333174    1
0.333176    1
0.333177    1
```

```
0.333179    1
1.000000    1
Name: c11_new, Length: 900869, dtype: int64
```

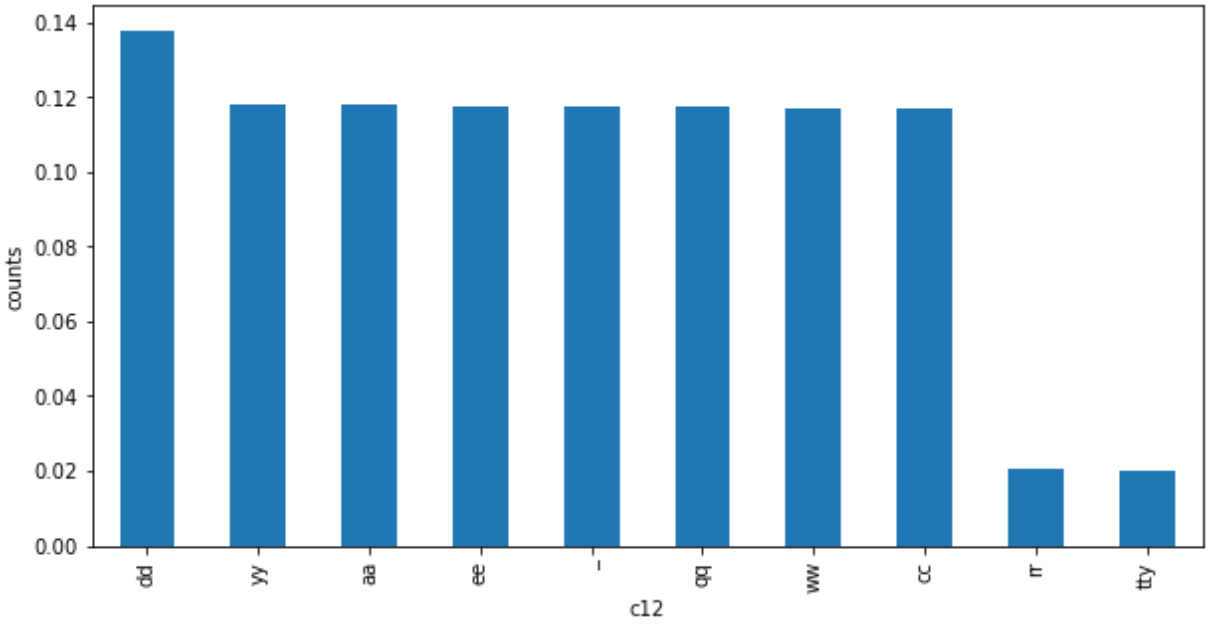
In [ ]:
```
correl_tests('c11_new',data_c11_new)
```

```
Pearson's Correlation Test
stat=0.001, p=0.537
Probably independent
Spearman's Rank Correlation Test
stat=0.001, p=0.537
Probably independent
Kendall’s Rank Correlation Test
stat=0.001, p=0.537
Probably independent
```

c12

In [ ]:
```
make_plot('c12')
```

```
dd     124115
yy     106141
aa     106022
ee     105928
_      105686
qq     105664
ww     105339
cc     105219
rr      18520
tty     18235
Name: c12, dtype: int64
```



In [ ]:
```
data_c12 = data.drop(data.loc[data['c12']=='_'].index)
data_c12['c12'].value_counts()
```

Out[ ]:
```
dd     124115
yy     106141
aa     106022
ee     105928
qq     105664
ww     105339
cc     105219
```

```
rr      18520
tty     18235
Name: c12, dtype: int64
```

In [ ]:
```
#convert str data into numerical
lst = pd.factorize(data_c12['c12'])[0]
arr = np.array(lst)
arr
```

Out[ ]:
```
array([0, 1, 2, ..., 4, 0, 6], dtype=int64)
```

In [ ]:
```
#normalize array data
norm = np.linalg.norm(arr)
normal_array = arr/norm
```

In [ ]:
```
#execute correlation tests
correl_tests('c12', data_c12, normal_array)
```

```
Pearson's Correlation Test
stat=0.178, p=0.000
Probably dependent
Spearman's Rank Correlation Test
stat=0.149, p=0.000
Probably dependent
Kendall’s Rank Correlation Test
stat=0.129, p=0.000
Probably dependent
C:\Users\Maria Anatoliivna\anaconda3\lib\site-packages\scipy\stats\stats.py:4812: Ru
ntimeWarning: overflow encountered in longlong_scalars
  (2 * xtie * ytie) / m + x0 * y0 / (9 * m * (size - 2)))
```

In [ ]:
```
#new normalized numerical column from c12
data_c12_r = data.copy()
lst = pd.factorize(data_c12_r['c12'])[0]
arr = np.array(lst)
norm = np.linalg.norm(arr)
normal_array = arr/norm
normal_array
data_c12_r['c12'] = pd.DataFrame(normal_array, columns = ['c12'])
data_c12_r['c12'].value_counts()
```

Out[ ]:
```
0.000714    111993
0.001666     95622
0.001428     95439
0.000476     95434
0.000952     95229
0.000000     95110
0.001190     94948
0.000238     94783
0.001904     16681
0.002142     16469
Name: c12, dtype: int64
```

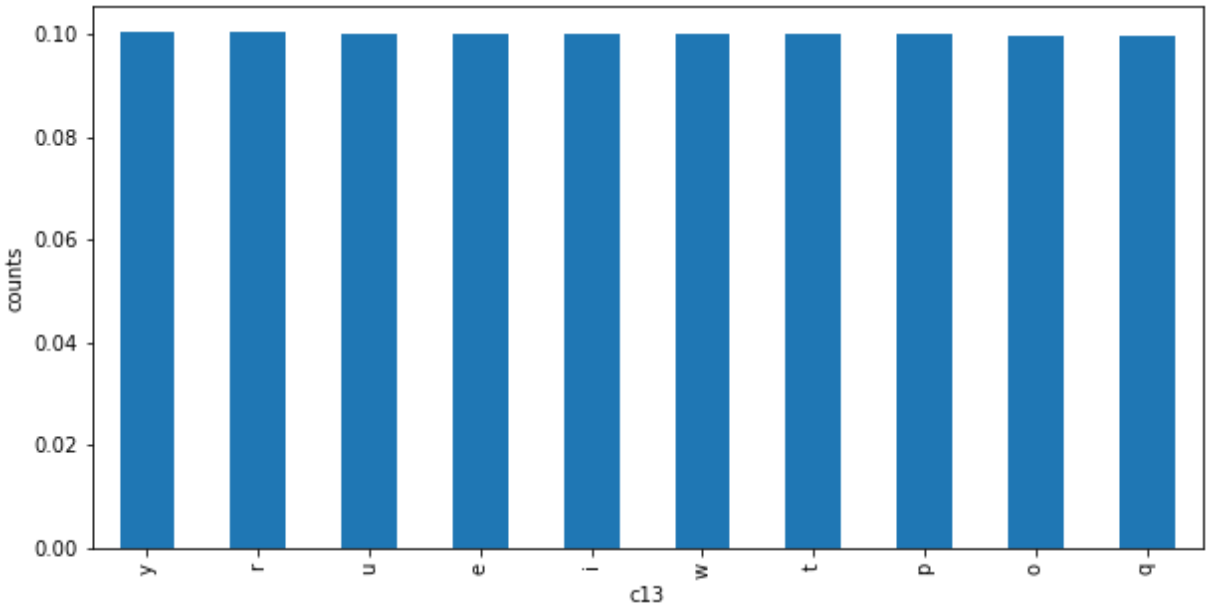
In [ ]:
```
data_c12_r['c12'].isna().sum()
```

Out[ ]:
```
89161
```

c13

In [ ]:
```
make_plot('c13')
```

```
y    90490
r    90327
u    90138
e    90133
i    90102
w    90094
t    90014
p    89996
o    89858
q    89717
Name: c13, dtype: int64
```



In [ ]:
```
#convert str data into numerical
lst = pd.factorize(data['c13'])[0]
arr = np.array(lst)
arr
```

Out[ ]:
```
array([0, 1, 2, ..., 8, 1, 3], dtype=int64)
```

In [ ]:
```
#normalize array data
norm = np.linalg.norm(arr)
normal_array = arr/norm
```

In [ ]:
```
correl_tests('c13', data, normal_array)
```

```
Pearson's Correlation Test
stat=-0.002, p=0.040
Probably dependent
Spearman's Rank Correlation Test
stat=-0.002, p=0.040
Probably dependent
Kendall’s Rank Correlation Test
stat=-0.002, p=0.040
Probably dependent
C:\Users\Maria Anatoliivna\anaconda3\lib\site-packages\scipy\stats\stats.py:4812: Ru
ntimeWarning: overflow encountered in longlong_scalars
  (2 * xtie * ytie) / m + x0 * y0 / (9 * m * (size - 2)))
```

In [ ]:
```
#new normalized numerical column from c13
```

```
data_c13_r = data.copy()
lst = pd.factorize(data_c13_r['c13'])[0]
arr = np.array(lst)
norm = np.linalg.norm(arr)
normal_array = arr/norm
normal_array
data_c13_r['c13'] = pd.DataFrame(normal_array, columns = ['c13'])
```

Conclusion

Column name	Action
target	drop missing values
c1	drop column
c2	drop column
c3	drop column
c4	leave column
c5	drop column
c6	leave the column
c7	leave the column
c8	leave the column
c9	leave the column
c10	leave the column
c11	drop column
c12	replace text data column with the numerical
c13	replace text data column with the numerical

</p>

Modified dataset

In [ ]:
```
#function for dropping columns
def drop_col(col_name):
    data.drop(col_name, axis=1, inplace=True)
```

In [ ]:
```
cols = ('c1', 'c2', 'c3', 'c5', 'c11',)
for c in cols:
    drop_col(c)
```

In [ ]:
```
data['c4'] = data_c4['c4_new'].copy()
data['c6'].replace({"_": 9999.0}, inplace=True)
data['c7'] = data_c7_r['c7_new'].copy()
data['c8'] = data_c8_r['c8'].astype(float).copy()
data['c9']= data_c9_r['c9'].astype(float).copy()
data['c10'] = data_c10['10'].astype(float).copy()
data['c12']= data_c12_r['c12'].copy()
```

```
data['c13']= data_c13_r['c13'].copy()

dataplot = sns.heatmap(data.corr(), cmap="YlGnBu", annot=True)
plt.show()
```