In [1]:
```
import pandas as pd
import numpy as np
from scipy.stats import randint
import seaborn as sns # used for plot interactive graph.
import matplotlib.pyplot as plt
import seaborn as sns
from io import StringIO
from sklearn.feature_extraction.text import TfidfVectorizer
from sklearn.feature_selection import chi2
from IPython.display import display
from sklearn.model_selection import train_test_split
from sklearn.feature_extraction.text import TfidfTransformer
from sklearn.naive_bayes import MultinomialNB
from sklearn.linear_model import LogisticRegression
from sklearn.ensemble import RandomForestClassifier
from sklearn.svm import LinearSVC
from sklearn.model_selection import cross_val_score
from sklearn.metrics import confusion_matrix
from sklearn import metrics
import warnings
warnings.filterwarnings("ignore", category=FutureWarning)
```

In [2]:
```
from mpl_toolkits.mplot3d import Axes3D
from sklearn.preprocessing import StandardScaler
import matplotlib.pyplot as plt # plotting
```

In [102]:
```
!pip install zipcodes # installing Zipcodes library .
```

```
Collecting zipcodes
  Downloading zipcodes-1.2.0-py2.py3-none-any.whl (719 kB)
     |████████████████████████████████| 719 kB 14.3 MB/s eta 0:00:01
Installing collected packages: zipcodes
Successfully installed zipcodes-1.2.0
```

In [3]:
```
df = pd.read_csv('/Users/swapnilthorat/Desktop/Study/consumer_complaints_project/complaints.csv')
```

```
/Users/swapnilthorat/opt/anaconda3/lib/python3.8/site-packages/IPython/core/interactiveshell.py:3165: DtypeWarning: Columns (9) have mixed types.Specify dtype option on import or set low_memory=False.
  has_raised = await self.run_ast_nodes(code_ast.body, cell_name,
```

In [4]:
```
df.shape
```

Out[4]:
```
(2586668, 18)
```

In [5]:
```
list(df.columns)
```

Out[5]:
```
['Date received',
 'Product',
 'Sub-product',
 'Issue',
 'Sub-issue',
 'Consumer complaint narrative',
 'Company public response',
 'Company',
 'State',
 'ZIP code',
 'Tags',
 'Consumer consent provided?',
 'Submitted via',
 'Date sent to company',
 'Company response to consumer',
 'Timely response?',
 'Consumer disputed?',
 'Complaint ID']
```

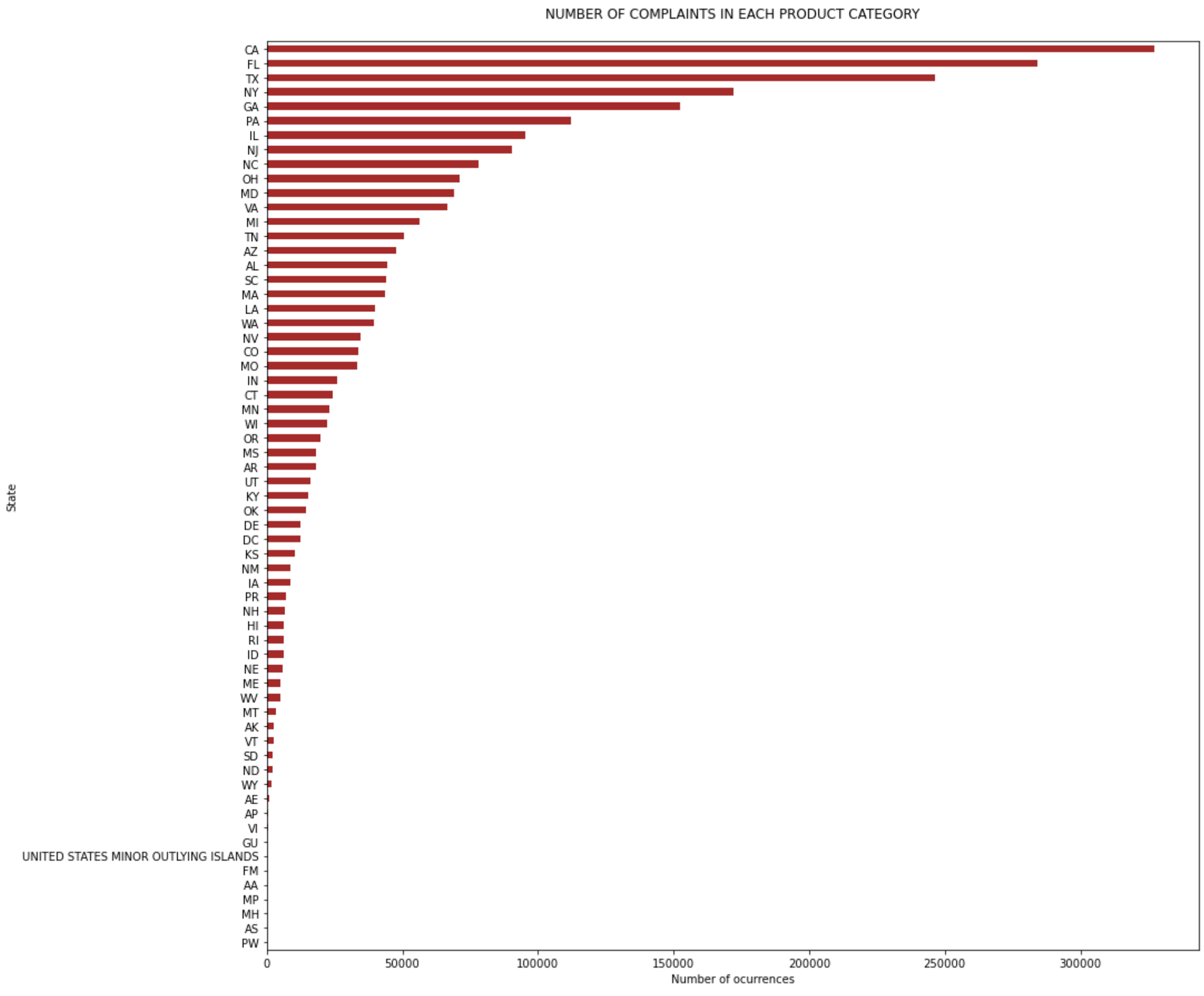
In [6]:
```
df.head(2).T
```

Out[6]:

	0	1
Date received	2022-03-31	2022-02-02
Product	Debt collection	Credit reporting, credit repair services, or o...
Sub-product	I do not know	Credit reporting
Issue	Attempts to collect debt not owed	Problem with a credit reporting company's inve...
Sub-issue	Debt is not yours	Investigation took more than 30 days
Consumer complaint narrative	NaN	NaN
Company public response	NaN	Company has responded to the consumer and the ...
Company	ENCORE CAPITAL GROUP INC.	TRANSUNION INTERMEDIATE HOLDINGS, INC.
State	SC	NY
ZIP code	29020.0	12919.0
Tags	NaN	NaN
Consumer consent provided?	NaN	Consent not provided
Submitted via	Web	Web
Date sent to company	2022-03-31	2022-02-02
Company response to consumer	Closed with explanation	Closed with non-monetary relief
Timely response?	Yes	Yes
Consumer disputed?	NaN	NaN
Complaint ID	5392247	5177559

In [7]:
```
fig = plt.figure(figsize=(15,15))
df.groupby(['State'])['Complaint ID'].count().sort_values().plot.barh(
    ylim=0, color='brown', title= 'NUMBER OF COMPLAINTS IN EACH PRODUCT CATEGORY\n')
plt.xlabel('Number of ocurrences', fontsize = 10)
```

Out[7]:
```
Text(0.5, 0, 'Number of ocurrences')
```

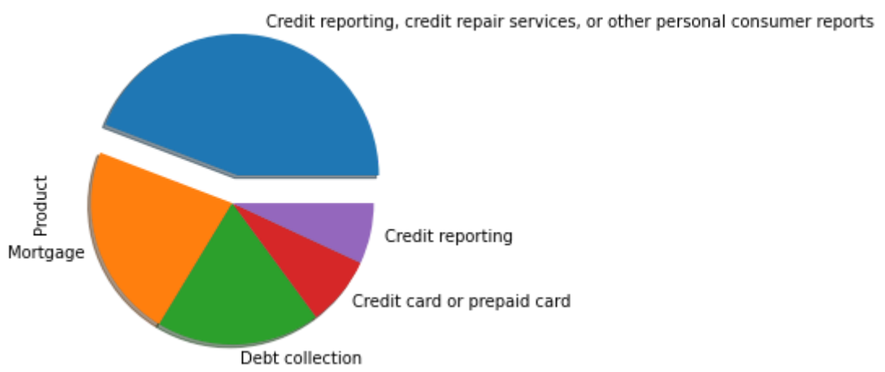


In [8]:
```
# California has the highest number of complaints as compared to others. Let's see what are these complaints about.
```

In [9]:
```
df[df['State'] == 'CA']['Product'].value_counts()
```

Out[9]:
```
Credit reporting, credit repair services, or other personal consumer reports    115409
Mortgage                                                                         57929
Debt collection                                                                  48955
Credit card or prepaid card                                                      20822
Credit reporting                                                                 18119
Checking or savings account                                                      17040
Credit card                                                                      12318
Bank account or service                                                          12164
Student loan                                                                      6854
Money transfer, virtual currency, or money service                                5276
Consumer Loan                                                                     3797
Vehicle loan or lease                                                             3638
Payday loan, title loan, or personal loan                                         2806
Money transfers                                                                    768
Payday loan                                                                        693
Prepaid card                                                                       561
Other financial service                                                            132
Name: Product, dtype: int64
```

In [10]:
```
df[df['State'] == 'CA']['Product'].value_counts().head(5).plot.pie(explode=[0.2,0,0,0,0],shadow=True)
# Unsquish the pie.
import matplotlib.pyplot as plt
plt.gca().set_aspect('equal')
```

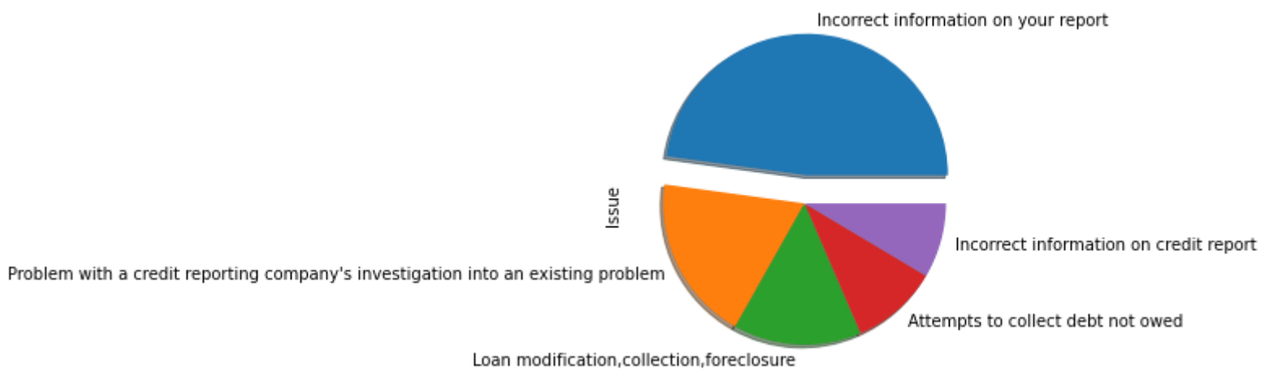



```
# The state of California mainly has most complaints are: Credit reporting, credit repair services, or other personal consumer reports. Let's find out what kind of issues are raised for this particular product.
```

In [11]:
```
df[df['State'] == 'CA']['Issue'].value_counts().head(10)
```

Out[11]:
```
Incorrect information on your report                                    72771
Problem with a credit reporting company's investigation into an existing problem    28879
Loan modification,collection,foreclosure                                22282
Attempts to collect debt not owed                                       15159
Incorrect information on credit report                                  12994
Loan servicing, payments, escrow account                                11195
Improper use of your report                                             11149
Managing an account                                                     10776
Cont'd attempts collect debt not owed                                    8454
Trouble during payment process                                           7655
Name: Issue, dtype: int64
```

In [12]:
```
df[df['State'] == 'CA']['Issue'].value_counts().head(5).plot.pie(explode=[0.2,0,0,0,0],shadow=True)
# Unsquish the pie.
import matplotlib.pyplot as plt
plt.gca().set_aspect('equal')
```




```
# The primary issues for all the complaints in California are Loan modification,collection,foreclosure,Loan servicing, payments, escrow account.
```

In [13]:
```
p_product_discussions = round(df["Product"].value_counts() / len(df["Product"]) * 100,2)
print(p_product_discussions)
```

```
Credit reporting, credit repair services, or other personal consumer reports    40.14
Debt collection                                                                  16.10
Mortgage                                                                         13.58
Credit reporting                                                                  5.43
Credit card or prepaid card                                                       5.43
Checking or savings account                                                       4.58
Credit card                                                                       3.45
Bank account or service                                                           3.33
Student loan                                                                      2.56
Money transfer, virtual currency, or money service                                1.50
Vehicle loan or lease                                                             1.24
Consumer Loan                                                                     1.22
Payday loan, title loan, or personal loan                                         0.84
Payday loan                                                                       0.21
Money transfers                                                                   0.21
Prepaid card                                                                      0.15
Other financial service                                                           0.04
Virtual currency                                                                  0.00
Name: Product, dtype: float64
```

In [14]:
```
!pip install plotly==5.7.0
```

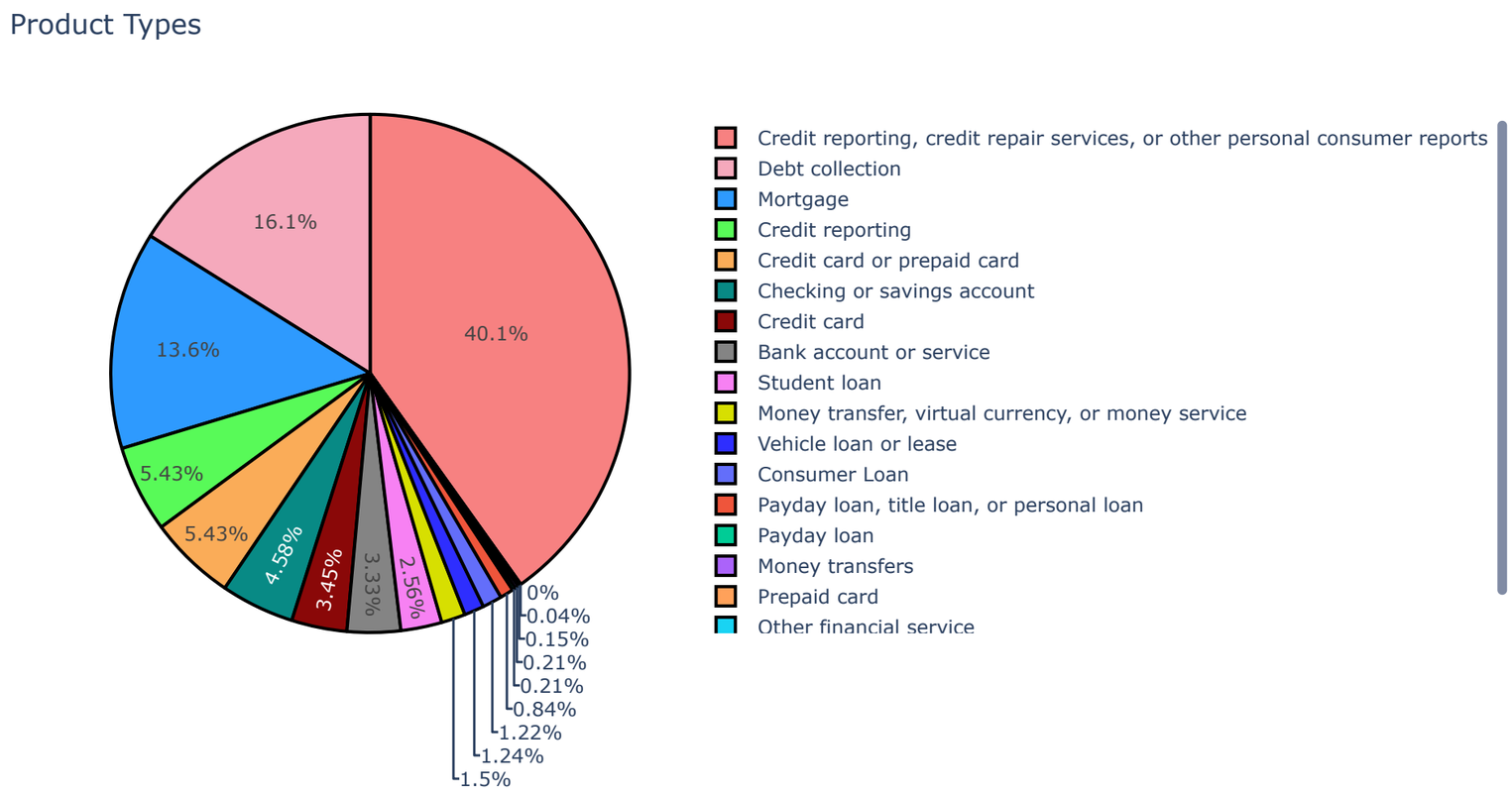
```
Requirement already satisfied: plotly==5.7.0 in ./opt/anaconda3/lib/python3.8/site-packages (5.7.0)
Requirement already satisfied: six in ./opt/anaconda3/lib/python3.8/site-packages (from plotly==5.7.0) (1.15.0)
Requirement already satisfied: tenacity>=6.2.0 in ./opt/anaconda3/lib/python3.8/site-packages (from plotly==5.7.0) (8.0.1)
```

In [15]:
```
import plotly.graph_objs as go
```

In [16]:
```
from plotly.offline import download_plotlyjs, init_notebook_mode, plot, iplot
init_notebook_mode(connected=True)
```

In [17]:
```
# various product types.
```

In [18]:
```
labels = list(p_product_discussions.index)
values = p_product_discussions.values.tolist()
colors = ['#F78181', '#F5A9BC', '#2E9AFE', '#58FA58', '#FAAC58', '#088A85', '#8A0808', '#848484', '#F781F3', '#D7DF01', '#2E2EFE']

import plotly.graph_objs as go
product_pie = go.Pie(labels=labels, values=values,
                          marker=dict(colors=colors,
                         line=dict(color='#000000', width=2)))

layout = go.Layout(title='Product Types')

fig = go.Figure(data=[product_pie], layout=layout)
iplot(fig)
```



In [19]:
```
import plotly.tools as tls
```

In [20]:
```
disputed = df['Consumer disputed?'].value_counts()
company_response = df['Company response to consumer'].value_counts()
top5_disputed = df['Company'].loc[df['Consumer disputed?'] == 'Yes'].value_counts()[:5]
top5_nodispute = df['Company'].loc[df['Consumer disputed?'] == 'No'].value_counts()[:5]
```

In [21]:
```
total_complaints_plotly = go.Bar(
            x=disputed.index.values,
            y=disputed.values,
    text = 'Complaints',
    showlegend=False,
    marker=dict(
        color=['#40FF00', '#FF0000'])
    )

top5_disputes_plotly = go.Bar(
            x=top5_disputed.index.values,
            y=top5_disputed.values,
    text='Disputes',
    showlegend=False,
    marker=dict(
        color=top5_disputed.values,
        colorscale='Reds')
    )

top5_nodisputes_plotly = go.Bar(
            x=top5_nodispute.index.values,
            y=top5_nodispute.values,
    text='No Disputes',
    showlegend=False,
    marker=dict(
        color=top5_nodispute.values,
        colorscale='Blues')
    )

# Lower Subplot
customer_res_plotly = go.Bar(
            x=company_response.index.values,
            y=company_response.values,
    text='Customer Response',
    showlegend=False,
        marker=dict(
        color=df['Company response to consumer'].value_counts().values,
        colorscale = [[0.0, 'rgb(165,0,38)'], [0.1111111111111111, 'rgb(215,48,39)'], [0.2222222222222222, 'rgb(244,109,67)'],
                      [0.3333333333333333, 'rgb(253,174,97)'], [0.4444444444444444, 'rgb(254,224,144)'],
                      [0.5555555555555556, 'rgb(224,243,248)'], [0.6666666666666666, 'rgb(171,217,233)'],
                      [0.7777777777777778, 'rgb(116,173,209)'], [0.8888888888888888, 'rgb(69,117,180)'],
                      [1.0, 'rgb(49,54,149)']],
        reversescale = True
        )
)

fig = tls.make_subplots(rows=2, cols=3, specs=[[{}, {}, {}], [{'colspan': 3}, None, None]],
                          subplot_titles=('Did the Customer Disputed?',
                                          'Disputes',
                                         'No Disputes',
                                         'Company response to consumer'))

# First three Subplots
fig.append_trace(total_complaints_plotly, 1, 1)
fig.append_trace(top5_disputes_plotly , 1, 2)
fig.append_trace(top5_nodisputes_plotly , 1, 3)

# Lower Subplot
fig.append_trace(customer_res_plotly, 2, 1)



fig['layout'].update(showlegend=True, height=1000, width=1000, title='Sectors')
iplot(fig, filename='Complaints')
```

```
/Users/swapnilthorat/opt/anaconda3/lib/python3.8/site-packages/plotly/tools.py:461: DeprecationWarning:

plotly.tools.make_subplots is deprecated, please use plotly.subplots.make_subplots instead
```

In [22]:
```
df['Date received'] = pd.to_datetime(df['Date received'])
df['year_received'], df['month_received'] = df['Date received'].dt.year, df['Date received'].dt.month
df.head()
```

Out[22]:

	Date received	Product	Sub-product	Issue	Sub-issue	Consumer complaint narrative	Company public response	Company	State	ZIP code	Tags	Consumer consent provided?	Submitted via	Date sent to company	Company response to consumer	Timely response?	Consumer disputed?	Complaint ID	year_received	month_rec
0	2022-03-31	Debt collection	I do not know	Attempts to collect debt not owed	Debt is not yours	NaN	NaN	ENCORE CAPITAL GROUP INC.	SC	29020.0	NaN	NaN	Web	2022-03-31	Closed with explanation	Yes	NaN	5392247	2022	
1	2022-02-02	Credit reporting, credit repair services, or o...	Credit reporting	Problem with a credit reporting company's inve...	Investigation took more than 30 days	NaN	Company has responded to the consumer and the ...	TRANSUNION INTERMEDIATE HOLDINGS, INC.	NY	12919.0	NaN	Consent not provided	Web	2022-02-02	Closed with non-monetary relief	Yes	NaN	5177559	2022	
2	2022-03-14	Credit reporting, credit repair services, or o...	Credit reporting	Incorrect information on your report	Information belongs to someone else	NaN	NaN	EQUIFAX, INC.	WA	98056.0	NaN	NaN	Web	2022-03-14	Closed with explanation	Yes	NaN	5321616	2022	
3	2022-03-14	Credit reporting, credit repair services, or o...	Credit reporting	Problem with a credit reporting company's inve...	Investigation took more than 30 days	NaN	NaN	EQUIFAX, INC.	GA	31909.0	NaN	NaN	Web	2022-03-14	Closed with explanation	Yes	NaN	5319887	2022	
4	2022-03-14	Credit reporting, credit repair services, or o...	Credit reporting	Problem with a credit reporting company's inve...	Their investigation did not fix an error on yo...	NaN	NaN	EQUIFAX, INC.	OH	44133.0	NaN	Other	Web	2022-03-14	Closed with explanation	Yes	NaN	5320509	2022	

In [23]:
```
# Create a Line Plot by the top 5 companies  by year who had more customer interaction cases (Disputes and No Disputes)
sorting_groups = df.groupby(['year_received', 'Consumer disputed?'])['Company'].apply(lambda x: x.value_counts())
d = {'CRM': sorting_groups}
```

In [24]:
```
year_crm = pd.DataFrame(data=d).reset_index()
year_crm.sort_values(by='CRM', ascending=False)

crm_df = year_crm.rename(columns={"level_2": "Company"})
```

In [25]:
```
print(crm_df)
```

```
       year_received Consumer disputed?  \
0               2011                 No
1               2011                 No
2               2011                 No
3               2011                 No
4               2011                 No
...              ...                ...
18232           2017                Yes
18233           2017                Yes
18234           2017                Yes
18235           2017                Yes
18236           2017                Yes

                                  Company  CRM
0      BANK OF AMERICA, NATIONAL ASSOCIATION  431
1                      JPMORGAN CHASE & CO.  298
2                           CITIBANK, N.A.  255
3         CAPITAL ONE FINANCIAL CORPORATION  201
4                      WELLS FARGO & COMPANY  170
...                                      ...  ...
18232           GREAT WESTERN BANCORP, INC.    1
18233                     ID Analytics, Inc.    1
18234                  SUMMIT FUNDING, INC.    1
18235               Amcap Investments, LLC     1
18236                         N.A.R., Inc.    1

[18237 rows x 4 columns]
```

```
# Conditionals Top 5 Companies with dispues (Bank of America, Wells Fargo, JP Morgan, Equifax, CitiBank)
#boa_disputes = crm_df.loc[(crm_df['Company'] == 'Bank of America') & (crm_df['Consumer disputed?'] == 'Yes')]
#jp_disputes = crm_df.loc[(crm_df['Company'] == 'JPMorgan Chase & Co.') & (crm_df['Consumer disputed?'] == 'Yes')]
#citi_disputes = crm_df.loc[(crm_df['Company'] == 'Citibank') & (crm_df['Consumer disputed?'] == 'Yes')]
#wfc_disputes = crm_df.loc[(crm_df['Company'] == 'Wells Fargo & Company') & (crm_df['Consumer disputed?'] == 'Yes')]
#eq_disputes = crm_df.loc[(crm_df['Company'] == 'Equifax') & (crm_df['Consumer disputed?'] == 'Yes')]

#CAPITAL ONE FINANCIAL CORPORATION
#equi_disputes = crm_df.loc[(crm_df['Company'] == 'Equifax') & (crm_df['Consumer disputed?'] == 'Yes')]

# Establish the year (Continue Here tomorrow!)
#years = boa_disputes['year_received'].values.tolist()
```

In [26]:
```
crm_df.head()
```

Out[26]:

	year_received	Consumer disputed?	Company	CRM
0	2011	No	BANK OF AMERICA, NATIONAL ASSOCIATION	431
1	2011	No	JPMORGAN CHASE & CO.	298
2	2011	No	CITIBANK, N.A.	255
3	2011	No	CAPITAL ONE FINANCIAL CORPORATION	201
4	2011	No	WELLS FARGO & COMPANY	170

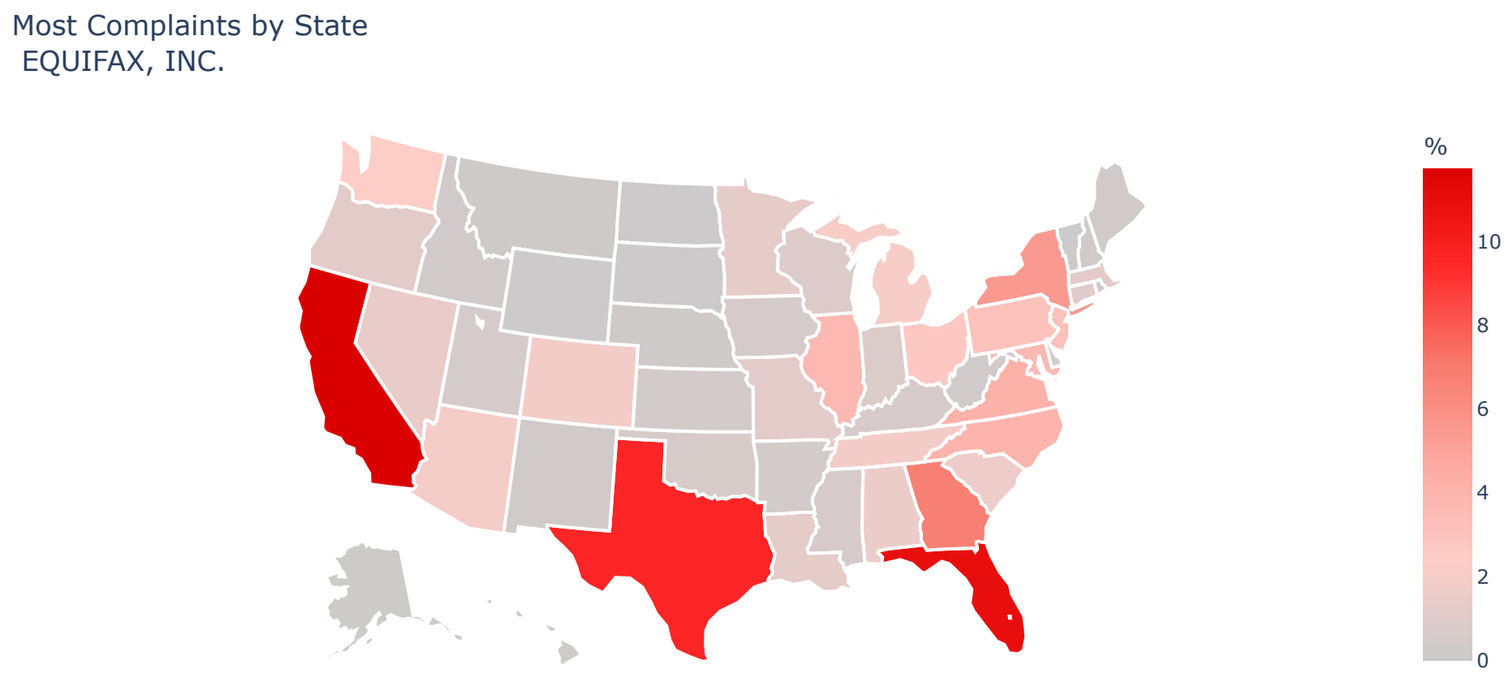
In [27]:
```
df.groupby(['Company'])['Complaint ID'].count().sort_values(ascending=False).head(5)
```

Out[27]:
```
Company
EQUIFAX, INC.                              411157
TRANSUNION INTERMEDIATE HOLDINGS, INC.     315288
Experian Information Solutions Inc.        293034
BANK OF AMERICA, NATIONAL ASSOCIATION      111489
WELLS FARGO & COMPANY                       95231
Name: Complaint ID, dtype: int64
```

In [28]:
```
dispute_presence = df.loc[df['Consumer disputed?'] == 'Yes']
cross_month = pd.crosstab(dispute_presence['State'], dispute_presence['Company']).apply(lambda x: x/x.sum() * 100)
```

In [29]:
```
# EQUIFAX, INC. has the highest number of complaints among all the other companies. Lets see where are these complains from.
```

In [30]:
```
#  Share of Most disputes for Bank of America.
df_Eq = pd.DataFrame(cross_month['EQUIFAX, INC.']).reset_index().sort_values(by="EQUIFAX, INC.", ascending=False).round(2)
df_Eq = df_Eq.rename(columns={'EQUIFAX, INC.': 'share of complaints'})

for col in df_Eq.columns:
    df_Eq[col] = df_Eq[col].astype(str)


scl = [[0.0, 'rgb(202, 202, 202)'],[0.2, 'rgb(253, 205, 200)'],[0.4, 'rgb(252, 169, 161)'],
            [0.6, 'rgb(247, 121, 108  )'],[0.8, 'rgb(255, 39, 39)'],[1.0, 'rgb(219, 0, 0)']]


df_Eq['text'] = "State Code: " + df_Eq['State'] + '<br>'


data = [ dict(
        type='choropleth',
        colorscale = scl,
        autocolorscale = False,
        locations = df_Eq['State'],
        z = df_Eq['share of complaints'],
        locationmode = 'USA-states',
        text = df_Eq['text'],
        marker = dict(
            line = dict (
                color = 'rgb(255,255,255)',
                width = 2
            ) ),
        colorbar = dict(
            title = "%")
        ) ]

layout = dict(
    title = 'Most Complaints by State <br> EQUIFAX, INC.',
    geo = dict(
        scope = 'usa',
        projection=dict(type='albers usa'),
        showlakes = True,
        lakecolor = 'rgb(255, 255, 255)')
)

fig = dict(data=data, layout=layout)
iplot(fig, filename='d3-cloropleth-map')
```



In [ ]:

In [31]:
```
df.head()
```

Out[31]:

	Date received	Product	Sub-product	Issue	Sub-issue	Consumer complaint narrative	Company public response	Company	State	ZIP code	Tags	Consumer consent provided?	Submitted via	Date sent to company	Company response to consumer	Timely response?	Consumer disputed?	Complaint ID	year_received	month_rec
0	2022-03-31	Debt collection	I do not know	Attempts to collect debt not owed	Debt is not yours	NaN	NaN	ENCORE CAPITAL GROUP INC.	SC	29020.0	NaN	NaN	Web	2022-03-31	Closed with explanation	Yes	NaN	5392247	2022	
1	2022-02-02	Credit reporting, credit repair services, or o...	Credit reporting	Problem with a credit reporting company's inve...	Investigation took more than 30 days	NaN	Company has responded to the consumer and the ...	TRANSUNION INTERMEDIATE HOLDINGS, INC.	NY	12919.0	NaN	Consent not provided	Web	2022-02-02	Closed with non-monetary relief	Yes	NaN	5177559	2022	
2	2022-03-14	Credit reporting, credit repair services, or o...	Credit reporting	Incorrect information on your report	Information belongs to someone else	NaN	NaN	EQUIFAX, INC.	WA	98056.0	NaN	NaN	Web	2022-03-14	Closed with explanation	Yes	NaN	5321616	2022	
3	2022-03-14	Credit reporting, credit repair services, or o...	Credit reporting	Problem with a credit reporting company's inve...	Investigation took more than 30 days	NaN	NaN	EQUIFAX, INC.	GA	31909.0	NaN	NaN	Web	2022-03-14	Closed with explanation	Yes	NaN	5319887	2022	
4	2022-03-14	Credit reporting, credit repair services, or o...	Credit reporting	Problem with a credit reporting company's inve...	Their investigation did not fix an error on yo...	NaN	NaN	EQUIFAX, INC.	OH	44133.0	NaN	Other	Web	2022-03-14	Closed with explanation	Yes	NaN	5320509	2022	

In [32]:
```
df1 = df[['Product', 'Consumer complaint narrative']].copy()
```

In [33]:
```
df1 = df1[pd.notnull(df1['Consumer complaint narrative'])]
```

In [34]:
```
df1.columns = ['Product', 'Consumer_complaint']
```

In [35]:
```
df1.shape
```

Out[35]:
```
(906080, 2)
```

In [36]:
```
total = df1['Consumer_complaint'].notnull().sum()
round((total/len(df)*100),1)
```

Out[36]:
```
35.0
```

In [37]:
```
pd.DataFrame(df.Product.unique()).values
```

Out[37]:
```
array([['Debt collection'],
       ['Credit reporting, credit repair services, or other personal consumer reports'],
       ['Checking or savings account'],
       ['Mortgage'],
       ['Credit card or prepaid card'],
       ['Vehicle loan or lease'],
       ['Payday loan, title loan, or personal loan'],
       ['Money transfer, virtual currency, or money service'],
       ['Student loan'],
       ['Credit reporting'],
       ['Consumer Loan'],
       ['Bank account or service'],
       ['Credit card'],
       ['Money transfers'],
       ['Prepaid card'],
       ['Payday loan'],
       ['Other financial service'],
       ['Virtual currency']], dtype=object)
```

In [38]:
```
df2 = df1.sample(10000, random_state=1).copy()
```

In [39]:
```
df2.replace({'Product':
             {'Credit reporting, credit repair services, or other personal consumer reports':
              'Credit reporting, repair, or other',
              'Credit reporting': 'Credit reporting, repair, or other',
             'Credit card': 'Credit card or prepaid card',
             'Prepaid card': 'Credit card or prepaid card',
             'Payday loan': 'Payday loan, title loan, or personal loan',
             'Money transfer': 'Money transfer, virtual currency, or money service',
             'Virtual currency': 'Money transfer, virtual currency, or money service'}},
            inplace= True)
```

In [40]:
```
pd.DataFrame(df2.Product.unique())
```

Out[40]:

	0
0	Debt collection
1	Credit reporting, repair, or other
2	Mortgage
3	Consumer Loan
4	Credit card or prepaid card
5	Checking or savings account
6	Payday loan, title loan, or personal loan
7	Student loan
8	Vehicle loan or lease
9	Money transfer, virtual currency, or money ser...
10	Bank account or service
11	Money transfers
12	Other financial service

In [41]:
```
df2['category_id'] = df2['Product'].factorize()[0]
```

In [42]:
```
category_id_df = df2[['Product', 'category_id']].drop_duplicates()
```

In [43]:
```
category_to_id = dict(category_id_df.values)
```

In [44]:
```
id_to_category = dict(category_id_df[['category_id', 'Product']].values)
```

In [45]:
```
df2.head()
```

Out[45]:

	Product	Consumer_complaint	category_id
643725	Debt collection	I received a bill from XXXX XXXX after an emer...	0
911557	Credit reporting, repair, or other	TransUnion consistently (for TEN years!) has...	1
1058589	Credit reporting, repair, or other	I am writing this due to non-compliance with t...	1
1967987	Credit reporting, repair, or other	The only names I have ever used are as followe...	1
2559710	Mortgage	Real Time Resolutions offered a settlement of ...	2

In [46]:
```
fig = plt.figure(figsize=(8,6))
colors = ['grey','grey','grey','grey','grey','grey', 'slateblue','slateblue','slateblue','blue','blue','blue',
    'mediumblue','mediumblue','darkblue','darkblue', 'midnightblue']
df2.groupby('Product').Consumer_complaint.count().sort_values().plot.barh(
    ylim=0, color=colors, title= 'NUMBER OF COMPLAINTS IN EACH PRODUCT CATEGORY\n')
plt.xlabel('Number of ocurrences', fontsize = 10);
```

In [47]:
```
tfidf = TfidfVectorizer(sublinear_tf=True, min_df=5,
                        ngram_range=(1, 2),
                        stop_words='english')
```

In [48]:
```
features = tfidf.fit_transform(df2.Consumer_complaint).toarray()
```

In [49]:
```
labels = df2.category_id
```

In [50]:
```
print("Each of the %d complaints is represented by %d features (TF-IDF score of unigrams and bigrams)" %(features.shape))
```

```
Each of the 10000 complaints is represented by 27734 features (TF-IDF score of unigrams and bigrams)
```

In [51]:
```
N = 3
for Product, category_id in sorted(category_to_id.items()):
  features_chi2 = chi2(features, labels == category_id)
  indices = np.argsort(features_chi2[0])
  feature_names = np.array(tfidf.get_feature_names())[indices]
  unigrams = [v for v in feature_names if len(v.split(' ')) == 1]
  bigrams = [v for v in feature_names if len(v.split(' ')) == 2]
  print("\n==> %s:" %(Product))
  print("  * Most Correlated Unigrams are: %s" %(', '.join(unigrams[-N:])))
  print("  * Most Correlated Bigrams are: %s" %(', '.join(bigrams[-N:])))
```

```
==> Bank account or service:
  * Most Correlated Unigrams are: atm, citigold, overdraft
  * Most Correlated Bigrams are: 35 00, xxxx 35, overdraft fee

==> Checking or savings account:
  * Most Correlated Unigrams are: bank, deposited, deposit
  * Most Correlated Bigrams are: overdraft fees, savings account, checking account

==> Consumer Loan:
  * Most Correlated Unigrams are: argue, vehicle, nissan
  * Most Correlated Bigrams are: loan today, car payments, gm financial

==> Credit card or prepaid card:
  * Most Correlated Unigrams are: citi, amex, card
  * Most Correlated Bigrams are: annual fee, american express, credit card

==> Credit reporting, repair, or other:
  * Most Correlated Unigrams are: accounts, equifax, report
  * Most Correlated Bigrams are: credit reporting, identity theft, credit report

==> Debt collection:
  * Most Correlated Unigrams are: collect, collection, debt
  * Most Correlated Bigrams are: debt collector, collection agency, collect debt

==> Money transfer, virtual currency, or money service:
  * Most Correlated Unigrams are: app, paypal, coinbase
  * Most Correlated Bigrams are: transfer money, paypal account, cash app

==> Money transfers:
  * Most Correlated Unigrams are: manufacturer, ship, paypal
  * Most Correlated Bigrams are: contacted paypal, stopped payments, money paypal

==> Mortgage:
  * Most Correlated Unigrams are: modification, escrow, mortgage
  * Most Correlated Bigrams are: escrow account, loan modification, mortgage company

==> Other financial service:
  * Most Correlated Unigrams are: consolidating, consolidate, negotiating
  * Most Correlated Bigrams are: nearly months, xxxx requests, check clear

==> Payday loan, title loan, or personal loan:
  * Most Correlated Unigrams are: borrowed, loan, payday
  * Most Correlated Bigrams are: payday loan, illegal state, title loan

==> Student loan:
  * Most Correlated Unigrams are: loans, student, navient
  * Most Correlated Bigrams are: income based, loan forgiveness, student loan

==> Vehicle loan or lease:
  * Most Correlated Unigrams are: santander, vehicle, car
  * Most Correlated Bigrams are: ally financial, bought car, motor finance
```

In [52]:
```
X = df2['Consumer_complaint'] # Collection of documents
y = df2['Product'] # Target or the labels we want to predict (i.e., the 13 different complaints of products)

X_train, X_test, y_train, y_test = train_test_split(X, y,
                                                    test_size=0.25,
                                                    random_state = 0)
```

In [53]:
```
models = [
    RandomForestClassifier(n_estimators=100, max_depth=5, random_state=0),
    LinearSVC(),
    MultinomialNB(),
    LogisticRegression(random_state=0),
]
```

In [54]:
```
CV = 5
cv_df = pd.DataFrame(index=range(CV * len(models)))

entries = []
for model in models:
  model_name = model.__class__.__name__
  accuracies = cross_val_score(model, features, labels, scoring='accuracy', cv=CV)
  for fold_idx, accuracy in enumerate(accuracies):
    entries.append((model_name, fold_idx, accuracy))

cv_df = pd.DataFrame(entries, columns=['model_name', 'fold_idx', 'accuracy'])
```

```
/Users/swapnilthorat/opt/anaconda3/lib/python3.8/site-packages/sklearn/model_selection/_split.py:666: UserWarning:

The least populated class in y has only 4 members, which is less than n_splits=5.

/Users/swapnilthorat/opt/anaconda3/lib/python3.8/site-packages/sklearn/model_selection/_split.py:666: UserWarning:

The least populated class in y has only 4 members, which is less than n_splits=5.

/Users/swapnilthorat/opt/anaconda3/lib/python3.8/site-packages/sklearn/model_selection/_split.py:666: UserWarning:

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The least populated class in y has only 4 members, which is less than n_splits=5.

/Users/swapnilthorat/opt/anaconda3/lib/python3.8/site-packages/sklearn/linear_model/_logistic.py:763: ConvergenceWarning:

lbfgs failed to converge (status=1):
STOP: TOTAL NO. of ITERATIONS REACHED LIMIT.

Increase the number of iterations (max_iter) or scale the data as shown in:
    https://scikit-learn.org/stable/modules/preprocessing.html (https://scikit-learn.org/stable/modules/preprocessing.html)
Please also refer to the documentation for alternative solver options:
    https://scikit-learn.org/stable/modules/linear_model.html#logistic-regression (https://scikit-learn.org/stable/modules/linear_model.html#logistic-regression)

/Users/swapnilthorat/opt/anaconda3/lib/python3.8/site-packages/sklearn/linear_model/_logistic.py:763: ConvergenceWarning:

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Please also refer to the documentation for alternative solver options:
    https://scikit-learn.org/stable/modules/linear_model.html#logistic-regression (https://scikit-learn.org/stable/modules/linear_model.html#logistic-regression)

/Users/swapnilthorat/opt/anaconda3/lib/python3.8/site-packages/sklearn/linear_model/_logistic.py:763: ConvergenceWarning:

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/Users/swapnilthorat/opt/anaconda3/lib/python3.8/site-packages/sklearn/linear_model/_logistic.py:763: ConvergenceWarning:

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Please also refer to the documentation for alternative solver options:
    https://scikit-learn.org/stable/modules/linear_model.html#logistic-regression (https://scikit-learn.org/stable/modules/linear_model.html#logistic-regression)

/Users/swapnilthorat/opt/anaconda3/lib/python3.8/site-packages/sklearn/linear_model/_logistic.py:763: ConvergenceWarning:

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Please also refer to the documentation for alternative solver options:
    https://scikit-learn.org/stable/modules/linear_model.html#logistic-regression (https://scikit-learn.org/stable/modules/linear_model.html#logistic-regression)
```

In [55]:
```
print(cv_df)
```

```
                 model_name  fold_idx  accuracy
0    RandomForestClassifier         0    0.4475
1    RandomForestClassifier         1    0.4460
2    RandomForestClassifier         2    0.4460
3    RandomForestClassifier         3    0.4460
4    RandomForestClassifier         4    0.4475
5                 LinearSVC         0    0.8075
6                 LinearSVC         1    0.8075
7                 LinearSVC         2    0.7930
8                 LinearSVC         3    0.7880
9                 LinearSVC         4    0.7930
10            MultinomialNB         0    0.6380
11            MultinomialNB         1    0.6280
12            MultinomialNB         2    0.6230
13            MultinomialNB         3    0.6355
14            MultinomialNB         4    0.6345
15       LogisticRegression         0    0.7850
16       LogisticRegression         1    0.7870
17       LogisticRegression         2    0.7765
18       LogisticRegression         3    0.7805
19       LogisticRegression         4    0.7820
```

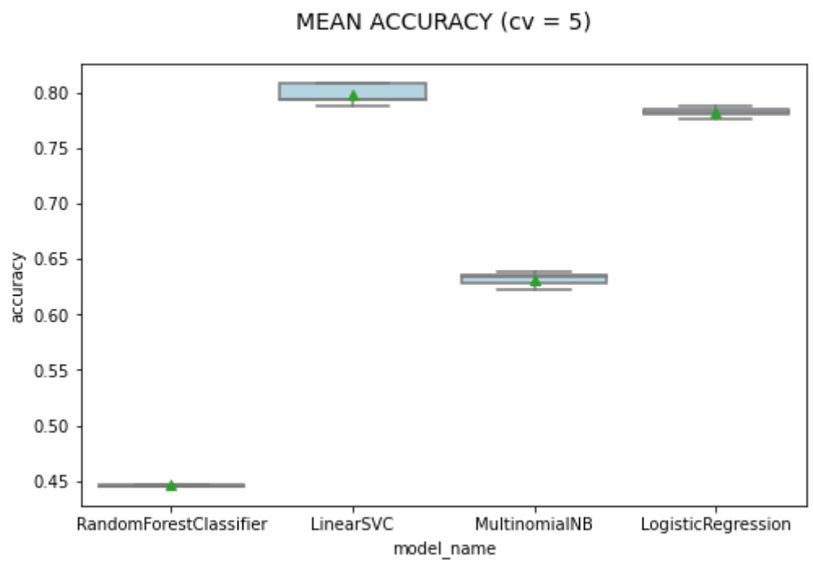
In [56]:
```
mean_accuracy = cv_df.groupby('model_name').accuracy.mean()
std_accuracy = cv_df.groupby('model_name').accuracy.std()

acc = pd.concat([mean_accuracy, std_accuracy], axis= 1,
          ignore_index=True)
acc.columns = ['Mean Accuracy', 'Standard deviation']
acc
```

Out[56]:

model_name	Mean Accuracy	Standard deviation
LinearSVC	0.7978	0.009087
LogisticRegression	0.7822	0.004071
MultinomialNB	0.6318	0.006150
RandomForestClassifier	0.4466	0.000822

In [57]:
```
plt.figure(figsize=(8,5))
sns.boxplot(x='model_name', y='accuracy',
            data=cv_df,
            color='lightblue',
            showmeans=True)
plt.title("MEAN ACCURACY (cv = 5)\n", size=14);
```



In [58]:
```
X_train, X_test, y_train, y_test,indices_train,indices_test = train_test_split(features,
                                                               labels,
                                                               df2.index, test_size=0.25,
                                                               random_state=1)
model = LinearSVC()
model.fit(X_train, y_train)
y_pred = model.predict(X_test)
```

In [59]:
```
print('\t\t\t\tCLASSIFICATIION METRICS\n')
print(metrics.classification_report(y_test, y_pred,
                                    target_names= df2['Product'].unique()))
```

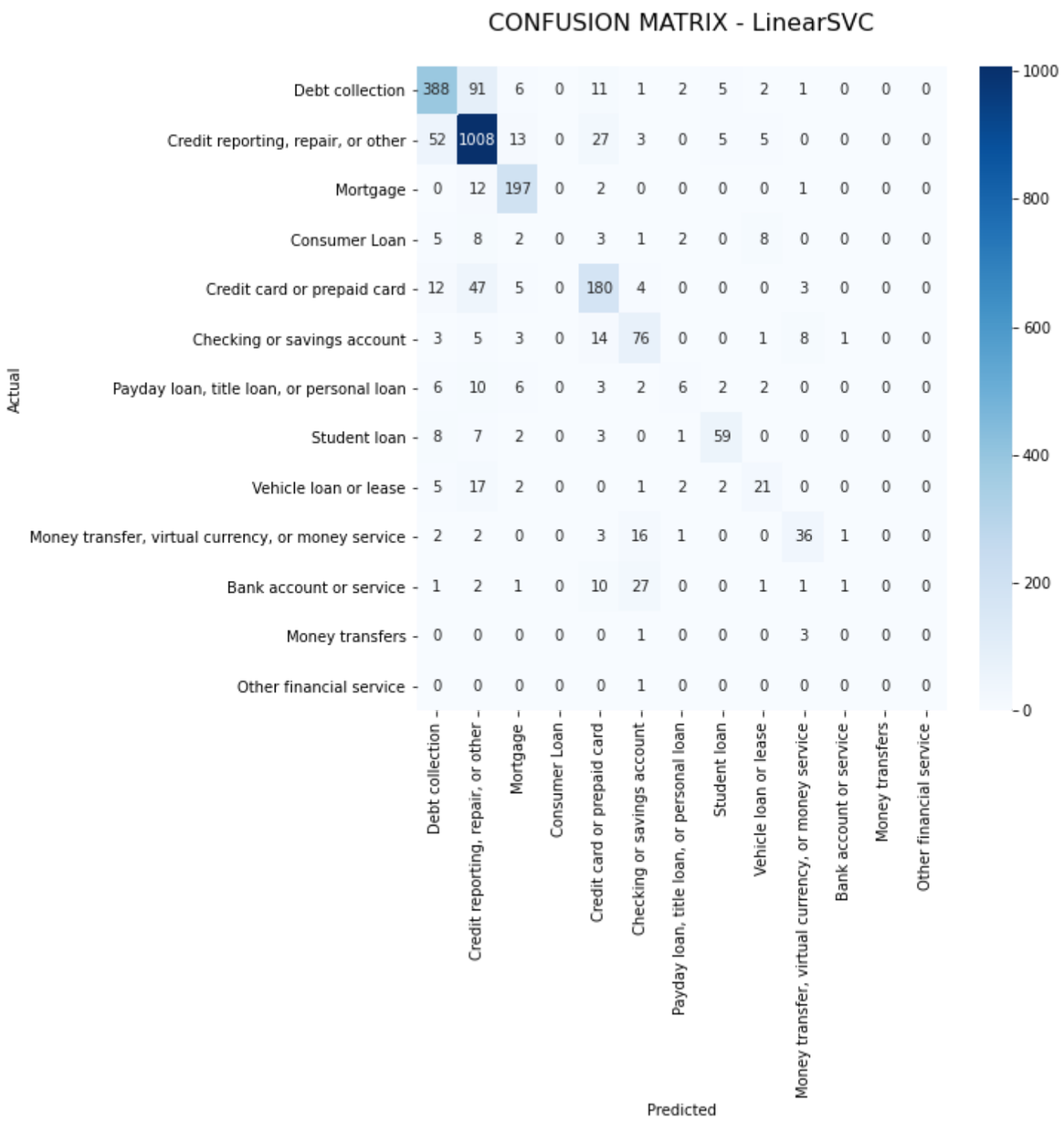
```
                                    CLASSIFICATIION METRICS

                                                precision    recall  f1-score   support

                                Debt collection       0.80      0.77      0.78       507
                  Credit reporting, repair, or other       0.83      0.91      0.87      1113
                                           Mortgage       0.83      0.93      0.88       212
                                      Consumer Loan       0.00      0.00      0.00        29
                           Credit card or prepaid card       0.70      0.72      0.71       251
                           Checking or savings account       0.57      0.68      0.62       111
          Payday loan, title loan, or personal loan       0.43      0.16      0.24        37
                                        Student loan       0.81      0.74      0.77        80
                                Vehicle loan or lease       0.53      0.42      0.47        50
 Money transfer, virtual currency, or money service       0.68      0.59      0.63        61
                               Bank account or service       0.33      0.02      0.04        44
                                      Money transfers       0.00      0.00      0.00         4
                              Other financial service       0.00      0.00      0.00         1

                                             accuracy                           0.79      2500
```

In [60]:
```
conf_mat = confusion_matrix(y_test, y_pred)
fig, ax = plt.subplots(figsize=(8,8))
sns.heatmap(conf_mat, annot=True, cmap="Blues", fmt='d',
            xticklabels=category_id_df.Product.values,
            yticklabels=category_id_df.Product.values)
plt.ylabel('Actual')
plt.xlabel('Predicted')
plt.title("CONFUSION MATRIX - LinearSVC\n", size=16);
```



In [61]:
```
model.fit(features, labels)

N = 4
for Product, category_id in sorted(category_to_id.items()):
  indices = np.argsort(model.coef_[category_id])
  feature_names = np.array(tfidf.get_feature_names())[indices]
  unigrams = [v for v in reversed(feature_names) if len(v.split(' ')) == 1][:N]
  bigrams = [v for v in reversed(feature_names) if len(v.split(' ')) == 2][:N]
  print("\n==> '{}':".format(Product))
  print("  * Top unigrams: %s" %(', '.join(unigrams)))
  print("  * Top bigrams: %s" %(', '.join(bigrams)))
```

```
==> 'Bank account or service':
  * Top unigrams: bank, overdraft, citigold, chase
  * Top bigrams: overdraft fee, gave xxxx, xxxx 35, xxxx 15

==> 'Checking or savings account':
  * Top unigrams: bank, deposited, checking, funds
  * Top bigrams: debit card, overdraft fees, said fraud, xxxx number

==> 'Consumer Loan':
  * Top unigrams: argue, loan, vehicle, leased
  * Top bigrams: car payments, unable unwilling, gm financial, loan today

==> 'Credit card or prepaid card':
  * Top unigrams: card, amex, capital, charge
  * Top bigrams: balance transfer, late fee, available credit, credit limit

==> 'Credit reporting, repair, or other':
  * Top unigrams: equifax, experian, transunion, report
  * Top bigrams: xxxx xxxx, xxxx reported, authorized account, reporting agency

==> 'Debt collection':
  * Top unigrams: debt, collection, collect, company
  * Top bigrams: calls xxxx, verify debt, report ftc, request validation

==> 'Money transfer, virtual currency, or money service':
  * Top unigrams: coinbase, paypal, transfer, app
  * Top bigrams: link account, cash app, transferring money, used xxxx

==> 'Money transfers':
  * Top unigrams: paypal, transaction, funds, monies
  * Top bigrams: send money, account discover, discover bank, stopped payments

==> 'Mortgage':
  * Top unigrams: mortgage, escrow, modification, foreclosure
  * Top bigrams: escrow account, mortgage company, mr cooper, home loans

==> 'Other financial service':
  * Top unigrams: consolidate, negotiating, consolidating, discharge
  * Top bigrams: check clear, tax form, pay student, causing credit

==> 'Payday loan, title loan, or personal loan':
  * Top unigrams: loan, borrowed, title, illegal
  * Top bigrams: title loan, 00 loan, high balance, apply credit

==> 'Student loan':
  * Top unigrams: navient, loans, school, fedloan
  * Top bigrams: student loan, sallie mae, incorrect address, loan forgiveness

==> 'Vehicle loan or lease':
  * Top unigrams: car, vehicle, santander, finance
  * Top bigrams: motor finance, ally financial, bought car, auto loan
```

In [62]:
```
X_train, X_test, y_train, y_test = train_test_split(X, y,
                                                    test_size=0.25,
                                                    random_state = 0)

tfidf = TfidfVectorizer(sublinear_tf=True, min_df=5,
                        ngram_range=(1, 2),
                        stop_words='english')

fitted_vectorizer = tfidf.fit(X_train)
tfidf_vectorizer_vectors = fitted_vectorizer.transform(X_train)

model = LinearSVC().fit(tfidf_vectorizer_vectors, y_train)
```

In [63]:
```
new_complaint = """I have been enrolled back at Rutgers University University in the 05/01/2021. Recently, i have been harassed by \
Navient for the last month. I have faxed in paperwork providing them with everything they needed. And yet I am still getting \
phone calls for payments. Furthermore, Navient is now reporting to the credit bureaus that I am late. At this point, \
Navient needs to get their act together to avoid me taking further action. I have been enrolled the entire time and my \
deferment should be valid with my planned graduation date being the 05/16/2021."""
print(model.predict(fitted_vectorizer.transform([new_complaint])))
```

```
['Student loan']
```

In [64]:
```
new_complaint = """I have been enrolled back at Rutgers University University in the 05/01/2021. ..... At this point, \
Navient needs to get their act together to avoid me taking further action. I have been enrolled the entire time and my \
deferment should be valid with my planned graduation date being the 05/16/2021."""
print(model.predict(fitted_vectorizer.transform([new_complaint])))
```

```
['Student loan']
```

In [65]:
```
new_complaint_2 = """Equifax exposed my personal information without my consent, as part of their recent data breach. \
In addition, they dragged their feet in the announcement of the report, and even allowed their upper management to sell \
off stock before the announcement."""
print(model.predict(fitted_vectorizer.transform([new_complaint_2])))
```

```
['Credit reporting, repair, or other']
```

In [ ]: