In [2]:

```
from sklearn.feature_extraction.text import CountVectorizer
from sklearn.feature_extraction.text import TfidfTransformer, TfidfVectorizer
from sklearn.naive_bayes import MultinomialNB, BernoulliNB
from sklearn import metrics
from sklearn.metrics import accuracy_score, confusion_matrix
from sklearn.feature_selection import SelectKBest, mutual_info_classif, f_classif, chi2
import nltk
import pandas as pd
from sklearn import metrics
import numpy as np
from sklearn.pipeline import Pipeline
import matplotlib.pyplot as plt
from sklearn.decomposition import PCA
from sklearn.tree import DecisionTreeClassifier
from sklearn import preprocessing, linear_model, metrics, datasets, multiclass, svm
from sklearn.model_selection import train_test_split, cross_val_score
import seaborn as sns
from sklearn.ensemble import RandomForestClassifier, AdaBoostClassifier
from sklearn.tree import DecisionTreeClassifier
from sklearn import metrics
from sklearn.metrics import accuracy_score
from sklearn.model_selection import KFold, cross_val_score
from random import randint
import pickle
```

In [9]:

```
# loading data
df = pd.read_csv('./Consumer_Complaints.csv')
df.shape
```

```
C:\Users\admin\AppData\Local\Temp\ipykernel_11884\98951488.py:2: DtypeWarning: Columns (5
,11) have mixed types. Specify dtype option on import or set low_memory=False.
  df = pd.read_csv('./Consumer_Complaints.csv')
```

Out[9]:

```
(670598, 18)
```

In [10]:

```
df['ZIP code']=df['ZIP code'].astype(str)
print(df.dtypes)
```

```
Date received                   object
Product                         object
Sub-product                     object
Issue                           object
Sub-issue                       object
Consumer complaint narrative    object
Company public response         object
Company                         object
State                           object
ZIP code                        object
Tags                            object
Consumer consent provided?      object
Submitted via                   object
Date sent to company            object
Company response to consumer    object
Timely response?                object
Consumer disputed?              object
Complaint ID                     int64
dtype: object
```

In [11]:

```
df.dtypes
```

Out[11]:

```
Date received                   object
Product                         object
Sub-product                     object
Issue                           object
Sub-issue                       object
Consumer complaint narrative    object
Company public response         object
Company                         object
State                           object
ZIP code                        object
Tags                            object
Consumer consent provided?      object
Submitted via                   object
Date sent to company            object
Company response to consumer    object
Timely response?                object
Consumer disputed?              object
Complaint ID                     int64
dtype: object
```

In [12]:

```
pd.notnull(df['Consumer complaint narrative']).value_counts()
```

Out[12]:

```
False    555894
True     114704
Name: Consumer complaint narrative, dtype: int64
```

In [13]:

```
Data = df[['Product','Consumer complaint narrative']]
Data = Data[pd.notnull(Data['Consumer complaint narrative'])]
Data
```

Out[13]:

	Product	Consumer complaint narrative
57729	Credit card	Received Capital One charge card offer XXXX. A...
57787	Debt collection	I do n't know how they got my cell number. I t...
57838	Credit card	I 'm a longtime member of Charter One Bank/RBS...
57848	Credit reporting	After looking at my credit report, I saw a col...
57852	Debt collection	I received a call from a XXXX XXXX from XXXX @...
...	...	...
670582	Mortgage	My mother XXXX in XXXX with a reverse mortgage...
670588	Credit card	Chase rejects customer payments claiming that ...
670590	Credit card	I filed for chapter XXXX protection 5 years ag...
670594	Mortgage	We purchased our home in XX/XX/XXXX at the pea...
670596	Credit card	I have had an American Express card for over t...

114704 rows × 2 columns

In [14]:

```
Data.shape
```

Out[14]:

```
(114704, 2)
```

In [15]:

```
pd.DataFrame(df.Product.unique()).values
```

Out[15]:

```
array([['Consumer Loan'],
       ['Bank account or service'],
       ['Mortgage'],
       ['Debt collection'],
       ['Credit card'],
       ['Credit reporting'],
       ['Student loan'],
       ['Money transfers'],
       ['Payday loan'],
       ['Other financial service'],
       ['Prepaid card'],
       ['Virtual currency']], dtype=object)
```

In [16]:

```
df2 = Data.sample(10000, random_state=1).copy()
```

In [17]:

```
df2.replace({'Product':
             {'Credit reporting, credit repair services, or other personal consumer repo
rts':
              '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 [18]:

```
pd.DataFrame(df2.Product.unique())
```

Out[18]:

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

In [19]:

```
df2['category_id'] = df2['Product'].factorize()[0]
category_id_df = df2[['Product', 'category_id']].drop_duplicates()


category_to_id = dict(category_id_df.values)
id_to_category = dict(category_id_df[['category_id', 'Product']].values)
```

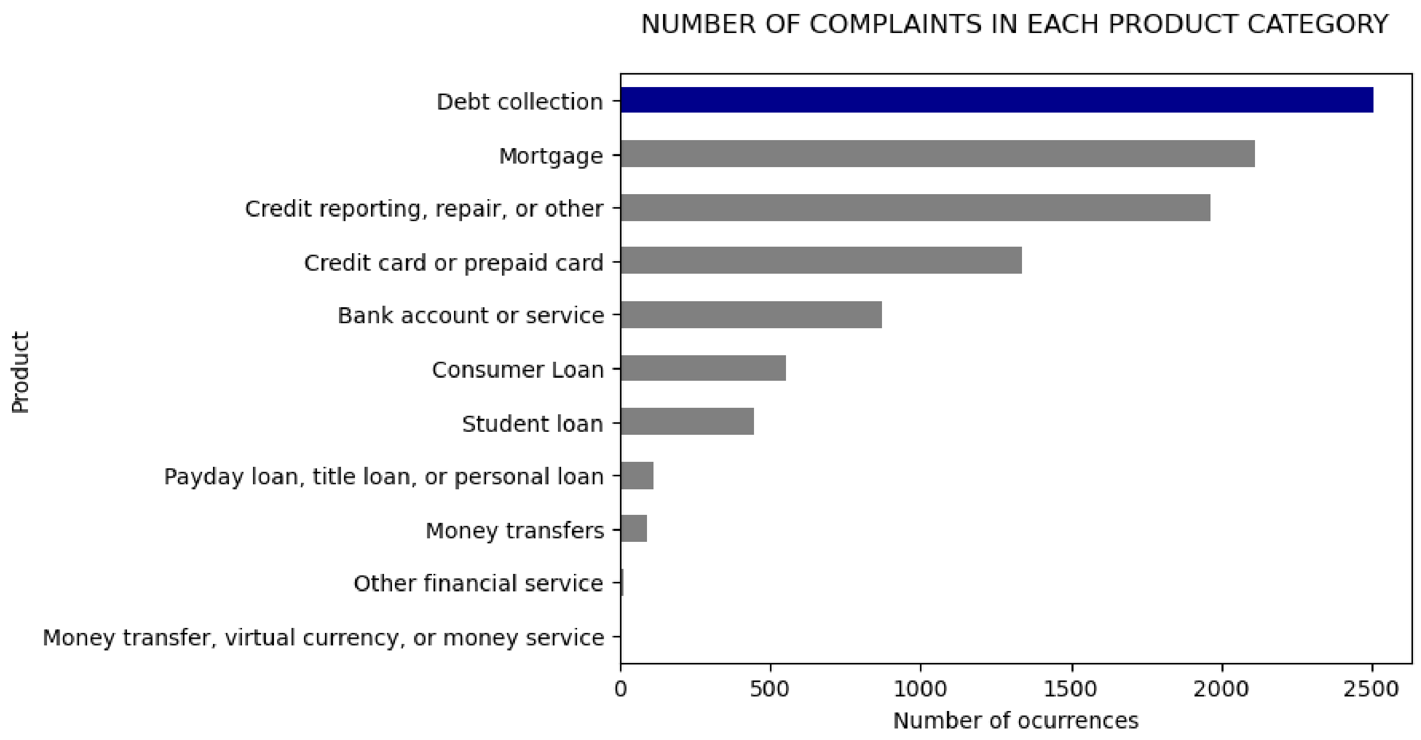
```
df2.head()
```

Out[19]:

	Product	Consumer complaint narrative	category_id
235971	Credit reporting, repair, or other	I have been notified by XXXX XXXX XXXX that my...	0
222288	Mortgage	INDY MAC WAS MY LOAN SERVICING COMPANY FROM TH...	1
103986	Consumer Loan	In 2006 my identity was stolen when my vehicle...	2
629167	Debt collection	Harris and Harris from XXXX IL has been callin...	3
500008	Debt collection	They have called twice already this morning, u...	3

In [20]:

```
fig = plt.figure()
colors = ['grey','grey','grey','grey','grey','grey','grey','grey','grey',
    'grey','darkblue','darkblue','darkblue']
df2.groupby('Product')['Consumer complaint narrative'].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 [21]:

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

# We transform each complaint into a vector
features = tfidf.fit_transform(df2['Consumer complaint narrative']).toarray()

labels = df2.category_id

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 26574 features (TF-IDF score of unigrams a
nd bigrams)
```

In [195]:

```
X = df2['Consumer complaint narrative'] # Collection of documents
y = df2['Product'] # Target or the labels we want to predict (i.e., the 13 different comp
laints of products)
```

```
train_x, valid_x,  train_y, valid_y = train_test_split(X, y,
                                                      test_size=0.25,
                                                      random_state = 0)
```

In [196]:

```
X_tr, X_te, Y_tr, Y_te = train_test_split(X, y,
                                                      test_size=0.25,
                                                      random_state = 0)
```

In [206]:

```
classifiers = ['RandomForest',
              'DecisionTree']

models = [RandomForestClassifier(n_estimators=200, random_state=0),
          DecisionTreeClassifier(random_state=0)]


def acc_score(df,label):
    Score = pd.DataFrame({"Classifier":classifiers})
    j = 0
    acc = []
    X_train,X_test,Y_train,Y_test,indices_train,indices_test = train_test_split(df,
                                                                   label,
                                                                   df2.index, test_size=0.2
5,
                                                                   random_state=1)
    for i in models:
        model = i
        model.fit(X_train,Y_train)
        predictions = model.predict(X_test)
        acc.append(accuracy_score(Y_test,predictions))
        j = j+1
    Score["Accuracy"] = acc
    Score.sort_values(by="Accuracy", ascending=False,inplace = True)
    Score.reset_index(drop=True, inplace=True)
    return Score

def plot(score,x,y,c = "b"):
    gen = [1,2,3,4,5]
    plt.figure(figsize=(6,4))
    ax = sns.pointplot(x=gen, y=score,color = c )
    ax.set(xlabel="Generation", ylabel="Accuracy")
    ax.set(ylim=(x,y))
```

In [207]:

```
def initilization_of_population(size,n_feat):
    population = []
    for i in range(size):
        chromosome = np.ones(n_feat,dtype=np.bool)
        chromosome[:int(0.3*n_feat)]=False
        np.random.shuffle(chromosome)
        population.append(chromosome)
    return population


def fitness_score(population):
    scores = []
    for chromosome in population:
        logmodel.fit(X_train[:, chromosome], Y_train)
        predictions = logmodel.predict(X_test[:, chromosome])
        scores.append(accuracy_score(Y_test,predictions))
    scores, population = np.array(scores), np.array(population)
    inds = np.argsort(scores)
    return list(scores[inds][::-1]), list(population[inds,:][::-1])


def selection(pop_after_fit,n_parents):
    population_nextgen = []
    for i in range(n_parents):
        population_nextgen.append(pop_after_fit[i])
    return population_nextgen


def crossover(pop_after_sel):
    pop_nextgen = pop_after_sel
    for i in range(0,len(pop_after_sel),2):
        new_par = []
        child_1 , child_2 = pop_nextgen[i] , pop_nextgen[i+1]
        new_par = np.concatenate((child_1[:len(child_1)//2],child_2[len(child_1)//2:]))
        pop_nextgen.append(new_par)
    return pop_nextgen


def mutation(pop_after_cross,mutation_rate,n_feat):
    mutation_range = int(mutation_rate*n_feat)
    pop_next_gen = []
    for n in range(0,len(pop_after_cross)):
        chromo = pop_after_cross[n]
        rand_posi = []
        for i in range(0,mutation_range):
            pos = randint(0,n_feat-1)
            rand_posi.append(pos)
        for j in rand_posi:
            chromo[j] = not chromo[j]
        pop_next_gen.append(chromo)
    return pop_next_gen

def generations(df,label,size,n_feat,n_parents,mutation_rate,n_gen,X_train,
                                   X_test, Y_train, Y_test):
    best_chromo= []
    best_score= []
    population_nextgen=initilization_of_population(size,n_feat)
    for i in range(n_gen):
        scores, pop_after_fit = fitness_score(population_nextgen)
        print('Best score in generation',i+1,':',scores[:1])  #2
        pop_after_sel = selection(pop_after_fit,n_parents)
        pop_after_cross = crossover(pop_after_sel)
        population_nextgen = mutation(pop_after_cross,mutation_rate,n_feat)
        best_chromo.append(pop_after_fit[0])
        best_score.append(scores[0])
    return best_chromo,best_score
```

In [202]:

```
score1 = acc_score(features,labels)
score1
```

Out[202]:

	Classifier	Accuracy
0	RandomForest	0.7908
1	DecisionTree	0.6988

In [170]:

```
print(features.shape)
```

```
(10000, 26548)
```

In [208]:

```
logmodel = RandomForestClassifier(n_estimators=200, random_state=0,max_depth=20, criteri
on='gini')
X_train,X_test, Y_train, Y_test = train_test_split(features, labels,
                                                    test_size=0.25,
                                                    random_state = 0)
```

```
chromo_df_bc,score_bc=generations(features,labels,size=80,n_feat=features.shape[1],n_par
ents=64,mutation_rate=0.20,n_gen=5,
                                 X_train = X_train,X_test = X_test,Y_train = Y_train,Y_test = Y
_test)
```

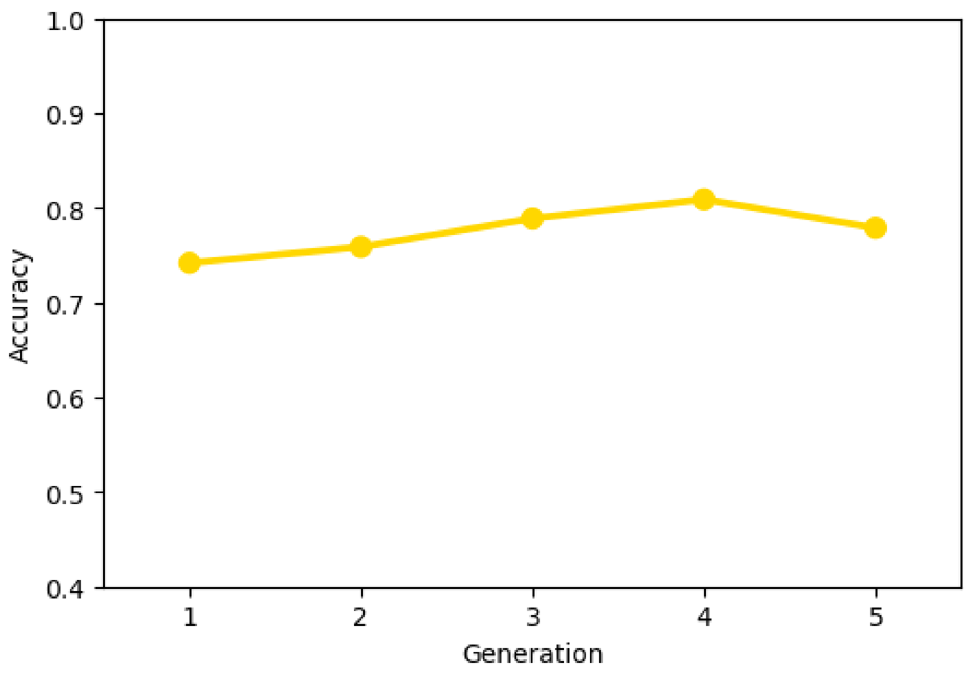
```
C:\Users\admin\AppData\Local\Temp\ipykernel_9876\893577769.py:4: DeprecationWarning: `np.
bool` is a deprecated alias for the builtin `bool`. To silence this warning, use `bool` b
y itself. Doing this will not modify any behavior and is safe. If you specifically wanted
the numpy scalar type, use `np.bool_` here.
Deprecated in NumPy 1.20; for more details and guidance: https://numpy.org/devdocs/releas
e/1.20.0-notes.html#deprecations
  chromosome = np.ones(n_feat,dtype=np.bool)
```

```
Best score in generation 1 : [0.742]

---------------------------------------------------------------------------
KeyboardInterrupt                         Traceback (most recent call last)
~\AppData\Local\Temp\ipykernel_9876\1552356192.py in <module>
      3                                                       test_size=0.25,
      4                                                       random_state = 0)
----> 5 chromo_df_bc,score_bc=generations(features,labels,size=80,n_feat=features.shape[1
],n_parents=64,mutation_rate=0.20,n_gen=5,
      6                                  X_train = X_train,X_test = X_test,Y_train = Y_train,Y_t
est = Y_test)

~\AppData\Local\Temp\ipykernel_9876\893577769.py in generations(df, label, size, n_feat,
n_parents, mutation_rate, n_gen, X_train, X_test, Y_train, Y_test)
     57     population_nextgen=initilization_of_population(size,n_feat)
     58     for i in range(n_gen):
---> 59         scores, pop_after_fit = fitness_score(population_nextgen)
     60         print('Best score in generation',i+1,':',scores[:1])  #2
     61         pop_after_sel = selection(pop_after_fit,n_parents)

~\AppData\Local\Temp\ipykernel_9876\893577769.py in fitness_score(population)
     12     scores = []
     13     for chromosome in population:
---> 14         logmodel.fit(X_train[:, chromosome], Y_train)
     15         predictions = logmodel.predict(X_test[:, chromosome])
     16         scores.append(accuracy_score(Y_test,predictions))

~\anaconda3\lib\site-packages\sklearn\base.py in wrapper(estimator, *args, **kwargs)
   1149                 )
   1150             ):
-> 1151                 return fit_method(estimator, *args, **kwargs)
   1152 
   1153         return wrapper

~\anaconda3\lib\site-packages\sklearn\ensemble\_forest.py in fit(self, X, y, sample_weigh
t)
    346         if issparse(y):
    347             raise ValueError("sparse multilabel-indicator for y is not supported.
")
--> 348         X, y = self._validate_data(
    349             X, y, multi_output=True, accept_sparse="csc", dtype=DTYPE
    350         )

~\anaconda3\lib\site-packages\sklearn\base.py in _validate_data(self, X, y, reset, valida
te_separately, cast_to_ndarray, **check_params)
    619                 y = check_array(y, input_name="y", **check_y_params)
    620             else:
--> 621                 X, y = check_X_y(X, y, **check_params)
    622             out = X, y
    623 

~\anaconda3\lib\site-packages\sklearn\utils\validation.py in check_X_y(X, y, accept_spars
e, accept_large_sparse, dtype, order, copy, force_all_finite, ensure_2d, allow_nd, multi_
output, ensure_min_samples, ensure_min_features, y_numeric, estimator)
   1145         )
   1146 
-> 1147     X = check_array(
   1148         X,
   1149         accept_sparse=accept_sparse,
~\anaconda3\lib\site-packages\sklearn\utils\validation.py in check_array(array, accept_sp
arse, accept_large_sparse, dtype, order, copy, force_all_finite, ensure_2d, allow_nd, ens
ure_min_samples, ensure_min_features, estimator, input_name)
    915                     array = xp.astype(array, dtype, copy=False)
    916                 else:
--> 917                     array = _asarray_with_order(array, order=order, dtype=dtype,
xp=xp)
    918             except ComplexWarning as complex_warning:
    919                 raise ValueError(

~\anaconda3\lib\site-packages\sklearn\utils\_array_api.py in _asarray_with_order(array, d
type, order, copy, xp)
    378             array = numpy.array(array, order=order, dtype=dtype)
    379         else:
--> 380             array = numpy.asarray(array, order=order, dtype=dtype)
    381 
    382         # At this point array is a NumPy ndarray. We convert it to an array

KeyboardInterrupt:
```

Best score in generation 1 : [0.742] Best score in generation 2 : [0.759] Best score in generation 3 : [0.789] Best score in generation 4 : [0.812] Best score in generation 5 : [0.779]

In [210]:

```
plot(best_score,0.4,1.0,c = "gold")
```



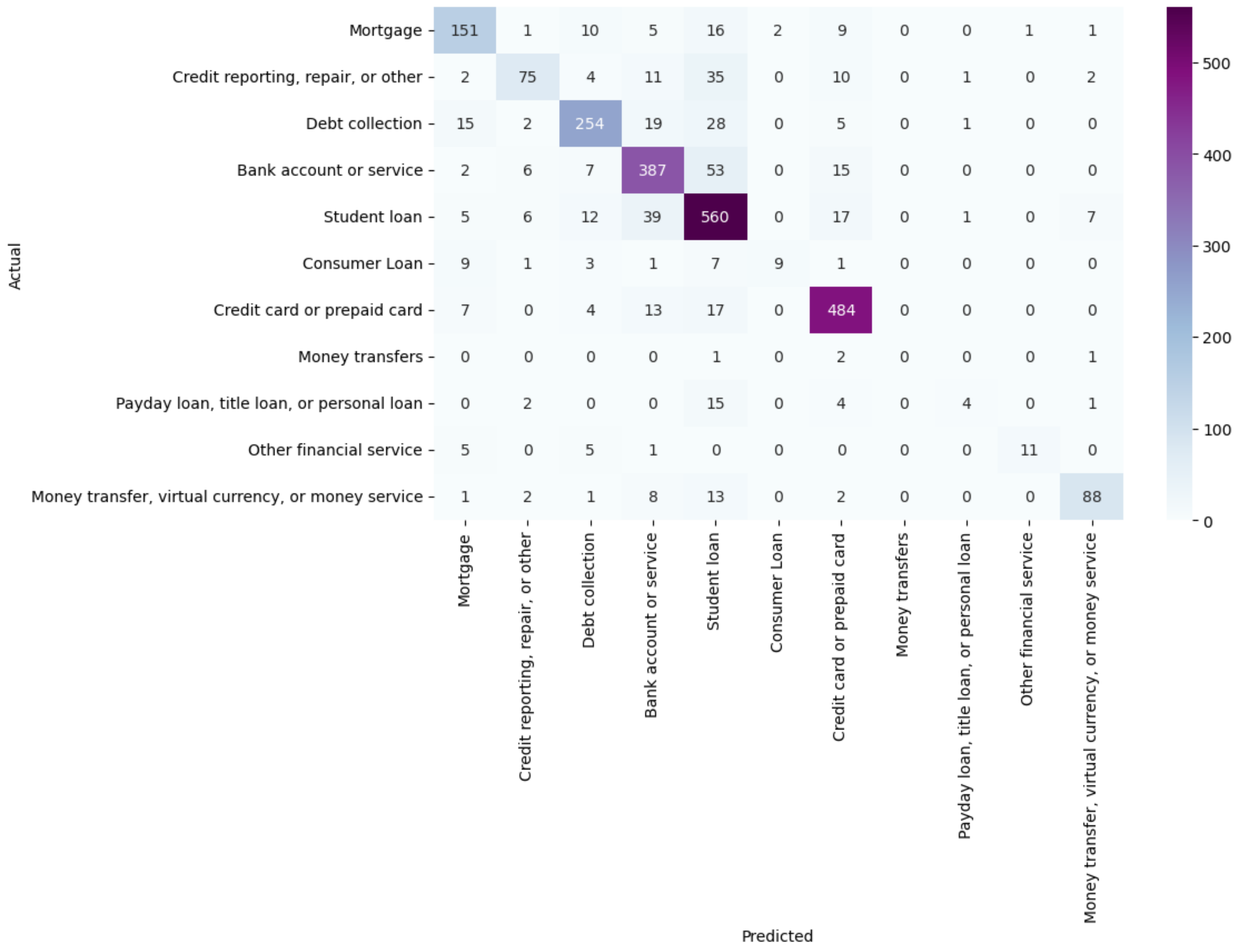
In [ ]:

In [89]:

```
def heat_conf():
    # confusion matrix
    conf_mat = confusion_matrix(valid_y, predicted)
    print(conf_mat)
    # visualizing confusion matrix
    #category_id_df = Data[['product','category_id']].drop_duplicates().sort_values('cate
gory_id')
    #category_id_df
    fig, ax = plt.subplots(figsize=(10,6))
    sns.heatmap(conf_mat, annot=True,fmt='d',cmap='BuPu',xticklabels=Data['Product'].uniq
ue(),yticklabels=Data['Product'].unique())
    plt.ylabel('Actual')
    plt.xlabel('Predicted')
    plt.show()
```

```
heat_conf()
```

```
[[151   1  10   5  16   2   9   0   0   1   1]
 [  2  75   4  11  35   0  10   0   1   0   2]
 [ 15   2 254  19  28   0   5   0   1   0   0]
 [  2   6   7 387  53   0  15   0   0   0   0]
 [  5   6  12  39 560   0  17   0   1   0   7]
 [  9   1   3   1   7   9   1   0   0   0   0]
 [  7   0   4  13  17   0 484   0   0   0   0]
 [  0   0   0   0   1   0   2   0   0   0   1]
 [  0   2   0   0  15   0   4   0   4   0   1]
 [  5   0   5   1   0   0   0   0   0  11   0]
 [  1   2   1   8  13   0   2   0   0   0  88]]
```



In [90]:

```
print("Classification Report:")
print(metrics.classification_report(valid_y, predicted))
```

```
Classification Report:
              precision    recall  f1-score   support

           0       0.77      0.77      0.77       196
           1       0.79      0.54      0.64       140
           2       0.85      0.78      0.81       324
           3       0.80      0.82      0.81       470
           4       0.75      0.87      0.80       647
           5       0.82      0.29      0.43        31
           6       0.88      0.92      0.90       525
           7       0.00      0.00      0.00         4
           8       0.57      0.15      0.24        26
           9       0.92      0.50      0.65        22
          10       0.88      0.77      0.82       115

    accuracy                           0.81      2500
   macro avg       0.73      0.58      0.62      2500
```

```
weighted avg       0.81      0.81      0.80      2500
```

```
C:\Users\admin\anaconda3\lib\site-packages\sklearn\metrics\_classification.py:1469: Undef
inedMetricWarning: Precision and F-score are ill-defined and being set to 0.0 in labels w
ith no predicted samples. Use `zero_division` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
C:\Users\admin\anaconda3\lib\site-packages\sklearn\metrics\_classification.py:1469: Undef
inedMetricWarning: Precision and F-score are ill-defined and being set to 0.0 in labels w
ith no predicted samples. Use `zero_division` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
C:\Users\admin\anaconda3\lib\site-packages\sklearn\metrics\_classification.py:1469: Undef
inedMetricWarning: Precision and F-score are ill-defined and being set to 0.0 in labels w
ith no predicted samples. Use `zero_division` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
```

In [ ]:

```
# save the model to disk
filename = 'finalized_model.sav'
pickle.dump(model, open(filename, 'wb'))
```

In [4]:

```
filename = 'finalized_model.sav'
loaded_model = pickle.load(open(filename, 'rb'))
```

In [22]:

```
texts = ["This account popped up on my credit and it is not mines. I have filled out all
the correct docs to show that i am victim of identity thief and will attach the ftc repor
t with this complaint. Please block and remove this from my credit please XXXX XXXX XXXX
Account Number: XXXX XXXX / 2019"]
#text_features = tfidf_vect.transform(texts)
predictions = loaded_model.predict(texts)
# print(predictions)
print(texts)
print("   -Predicted as: {}".format(predictions[0]))
```

```
['This account popped up on my credit and it is not mines. I have filled out all the corr
ect docs to show that i am victim of identity thief and will attach the ftc report with t
his complaint. Please block and remove this from my credit please XXXX XXXX XXXX Account
Number: XXXX XXXX / 2019']
   -Predicted as: Credit reporting, repair, or other
```

In [45]:

```
complaint = [""" i am a student who's soon  going to graduate from the highschool and go
to college, i have applied for a loan 3 months ago with no response."""
]
predictions = loaded_model.predict(complaint)
print(complaint)
print("   -Predicted as: {}".format(predictions[0]))
```

```
[" i am a student who's soon  going to graduate from the highschool and go to college, i
have applied for a loan 3 months ago with no response."]
   -Predicted as: Student loan
```

In [42]:

```
new_complaint = ["""Our Mortgage company Roundpoint has been over charging us on Mortgage
insurance last year and now they are charging us more this year. My husband has been talk
ing with them since XX/XX/XXXX and each time they say they will fix the problem and it is
not fixed. We asked to speak to someone higher then the person on the phone and they stat
e management will not talk to customers. We are very frustrated with this not being resol
ved. We do not know if this is an honest mistake and the phone people can not figure it o
ut but if sounds very fishy that management will not talk to their customers. I do not kn
ow if this is an honest company but after speaking to XXXX people an not getting it resol
ved I think this company is doing this on purpose."""]
predictions = loaded_model.predict(new_complaint)
print(new_complaint)
print("    -Predicted as: {}".format(predictions[0]))
```

```
['Our Mortgage company Roundpoint has been over charging us on Mortgage insurance last ye
ar and now they are charging us more this year. My husband has been talking with them sin
ce XX/XX/XXXX and each time they say they will fix the problem and it is not fixed. We as
ked to speak to someone higher then the person on the phone and they state management wil
l not talk to customers. We are very frustrated with this not being resolved. We do not k
now if this is an honest mistake and the phone people can not figure it out but if sounds
very fishy that management will not talk to their customers. I do not know if this is an
honest company but after speaking to XXXX people an not getting it resolved I think this
company is doing this on purpose.']
   -Predicted as: Mortgage
```

In [41]:

```
Data[Data['Consumer complaint narrative'] == new_complaint[0]]
```

Out[41]:

	Product	Consumer complaint narrative
616470	Mortgage	Our Mortgage company Roundpoint has been over ...

In [ ]:

```

```