# consumer complaints

July 17, 2020

## 1 Consumer Complaints Classification with LSTM

This script looks into the consumer complaints from Bank of America in California. It applies LSTM on complaint classification and figures out the products consumers are not satisfied with.

[1]:
```
import pandas as pd

OUTPUT_FOLDER = os.getcwd() + '/output/'

data = pd.read_excel('consumer_complaints_CA.xlsx')
df = (pd.DataFrame(data, columns = ['product','consumer_complaint_narrative'])
        .dropna()
        .set_axis(['product', 'complaint'], axis = 1, inplace = False)
        .reset_index(drop = True))

## regroup product labels
df['product'] = df['product'].replace({
    'Consumer Loan': 'Consumer loan',
    'Payday loan': 'Consumer loan',
    'Student loan': 'Consumer loan',
    'Prepaid card': 'Bank account or service'
})

df.head()
```

```
␣
↪---------------------------------------------------------------------------

IndexError                                Traceback (most recent call␣
↪last)

<ipython-input-1-25000a0a2760> in <module>
  3 OUTPUT_FOLDER = os.getcwd() + '/output/'
  4
----> 5 data = pd.read_excel('consumer_complaints_CA.xlsx')
  6 df = (pd.DataFrame(data, columns =␣
↪['product','consumer_complaint_narrative'])
```

```
        7         .dropna()


      ~/opt/anaconda3/lib/python3.7/site-packages/pandas/io/excel/_base.py in␣
↪read_excel(io, sheet_name, header, names, index_col, usecols, squeeze, dtype,␣
↪engine, converters, true_values, false_values, skiprows, nrows, na_values,␣
↪keep_default_na, verbose, parse_dates, date_parser, thousands, comment,␣
↪skipfooter, convert_float, mangle_dupe_cols, **kwds)
      332         convert_float=convert_float,
      333         mangle_dupe_cols=mangle_dupe_cols,
  --> 334         **kwds,
      335     )
      336


      ~/opt/anaconda3/lib/python3.7/site-packages/pandas/io/excel/_base.py in␣
↪parse(self, sheet_name, header, names, index_col, usecols, squeeze,␣
↪converters, true_values, false_values, skiprows, nrows, na_values,␣
↪parse_dates, date_parser, thousands, comment, skipfooter, convert_float,␣
↪mangle_dupe_cols, **kwds)
      883             convert_float=convert_float,
      884             mangle_dupe_cols=mangle_dupe_cols,
  --> 885             **kwds,
      886         )
      887


      ~/opt/anaconda3/lib/python3.7/site-packages/pandas/io/excel/_base.py in␣
↪parse(self, sheet_name, header, names, index_col, usecols, squeeze, dtype,␣
↪true_values, false_values, skiprows, nrows, na_values, verbose, parse_dates,␣
↪date_parser, thousands, comment, skipfooter, convert_float, mangle_dupe_cols,␣
↪**kwds)
      436                 sheet = self.get_sheet_by_name(asheetname)
      437             else:  # assume an integer if not a string
  --> 438                 sheet = self.get_sheet_by_index(asheetname)
      439
      440             data = self.get_sheet_data(sheet, convert_float)


      ~/opt/anaconda3/lib/python3.7/site-packages/pandas/io/excel/_xlrd.py in␣
↪get_sheet_by_index(self, index)
       44
       45     def get_sheet_by_index(self, index):
  ---> 46         return self.book.sheet_by_index(index)
       47
       48     def get_sheet_data(self, sheet, convert_float):
```

```
        ~/opt/anaconda3/lib/python3.7/site-packages/xlrd/book.py in␣
↪sheet_by_index(self, sheetx)
        464         :returns: A :class:`~xlrd.sheet.Sheet`.
        465         """
    --> 466         return self._sheet_list[sheetx] or self.get_sheet(sheetx)
        467
        468     def sheet_by_name(self, sheet_name):


        IndexError: list index out of range
```

### 1.1 Text Pre-processing

- Remove stop words
- Tokenize, convert to lower case and remove punctuation
- Stem tokens using PorterStemmer

[2]:
```
from gensim.utils import simple_preprocess
from gensim.parsing.porter import PorterStemmer
from gensim.parsing.preprocessing import remove_stopwords

porter_stemmer = PorterStemmer()

## function to clean raw text
def clean_txt(message):

    ### remove stop words
    message_no_stopwrd = remove_stopwords(message)

    ### simple preprocess
    tokens = simple_preprocess(message_no_stopwrd, deacc = True)

    ### stemming tokens
    tokens_stemmed = [porter_stemmer.stem(token) for token in tokens]

    return tokens_stemmed

## print raw text after cleaning
df_token = df.assign(tokens = df['complaint'].apply(lambda x: clean_txt(x)))
df_token['complaint'] = [' '.join(token) for token in df_token['tokens']]
df_token.head()
```

[2]:

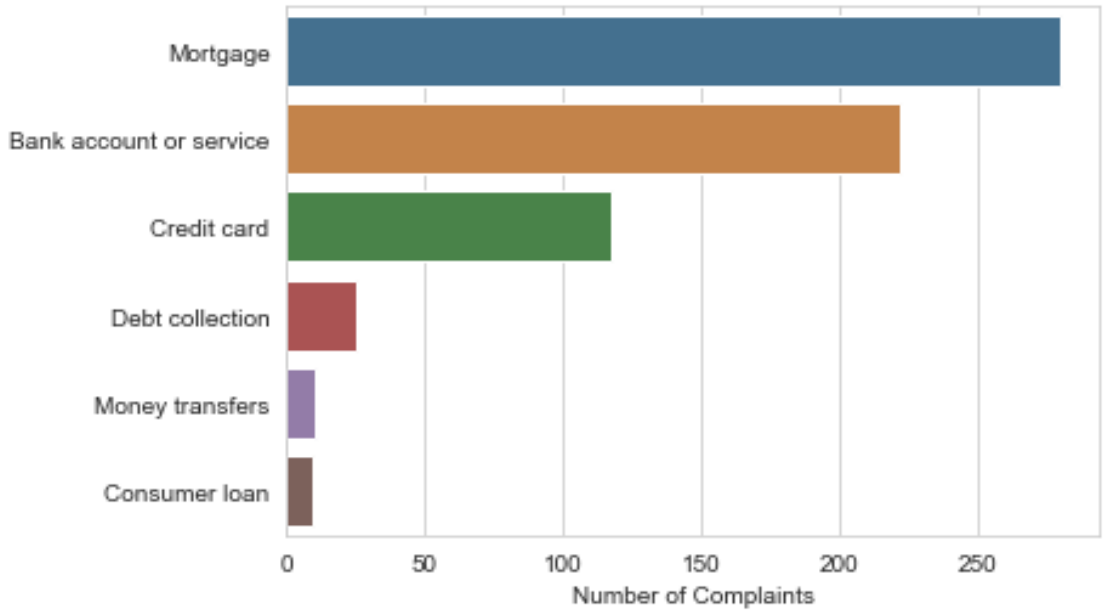
| | product | complaint |
|---|---|---|
| 0 | Mortgage | want file complaint bank america for foreclos … |
| 1 | Mortgage | got payment work loan modif dept xxxx in order… |
| 2 | Bank account or service | thi bank america gave monei let know type coll… |

```
3  Bank account or service  mistak younger xxxx bank america last year dep…
4  Bank account or service  refinanc home chose preserv home equiti line c…

                                                  tokens
0  [want, file, complaint, bank, america, for, fo…
1  [got, payment, work, loan, modif, dept, xxxx, …
2  [thi, bank, america, gave, monei, let, know, t…
3  [mistak, younger, xxxx, bank, america, last, y…
4  [refinanc, home, chose, preserv, home, equiti,…
```

## 1.2 Exploring Data

### 1.2.1 Inbalanced samples

[3]:
```
import seaborn as sns
import matplotlib.pyplot as plt

sns.set_style("whitegrid")
ax = sns.countplot(y = 'product', data = df_token, saturation = 0.5, order =␣
 ↪df_token['product'].value_counts().index)
ax.set(xlabel = 'Number of Complaints', ylabel = '')
plt.show()
```

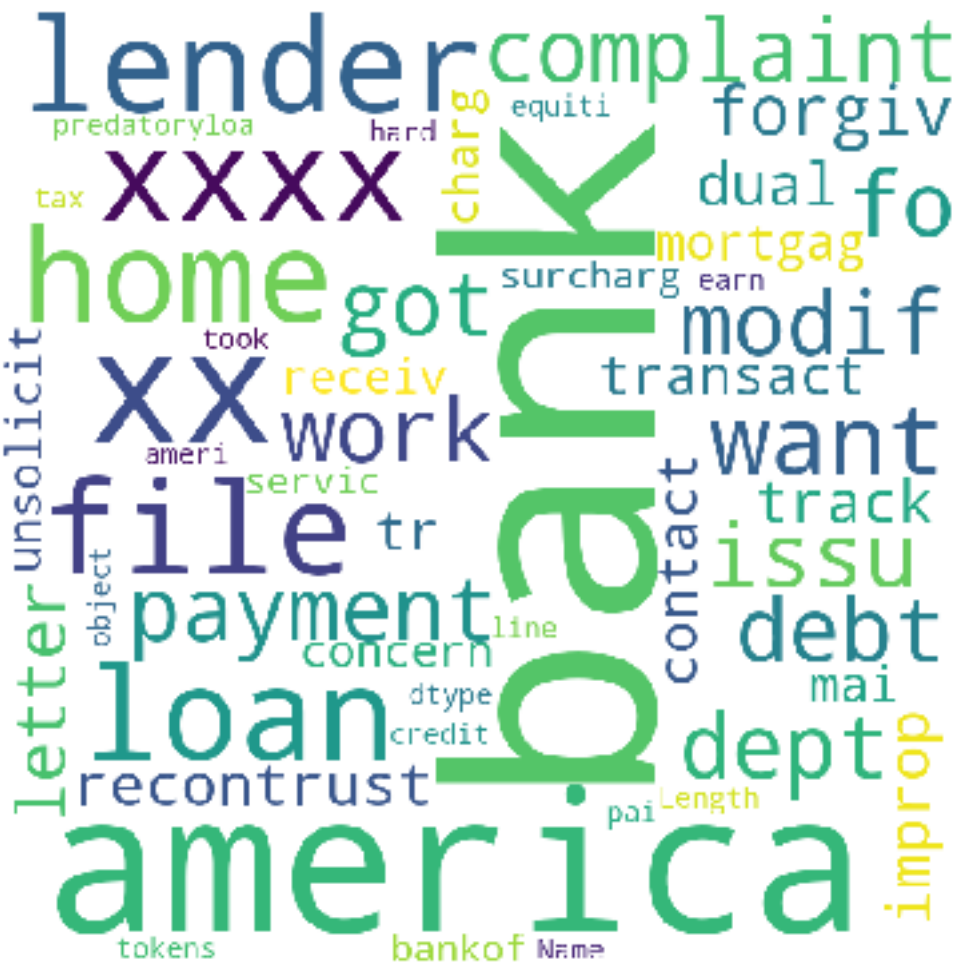


### 1.3 Word Cloud

[4]:
```
from wordcloud import WordCloud

## function to generate word cloud
def word_cloud_plotter(review_column):

    ### generate word cloud
    wordcloud = WordCloud(width = 800, height = 800,
                    background_color = 'white',
                    min_font_size = 10).generate(str(review_column))

    ### plot word cloud
    plt.figure(figsize = (5, 5), facecolor = None)
    plt.imshow(wordcloud)
    plt.axis("off")
    plt.tight_layout(pad = 0)

    plt.show()
```

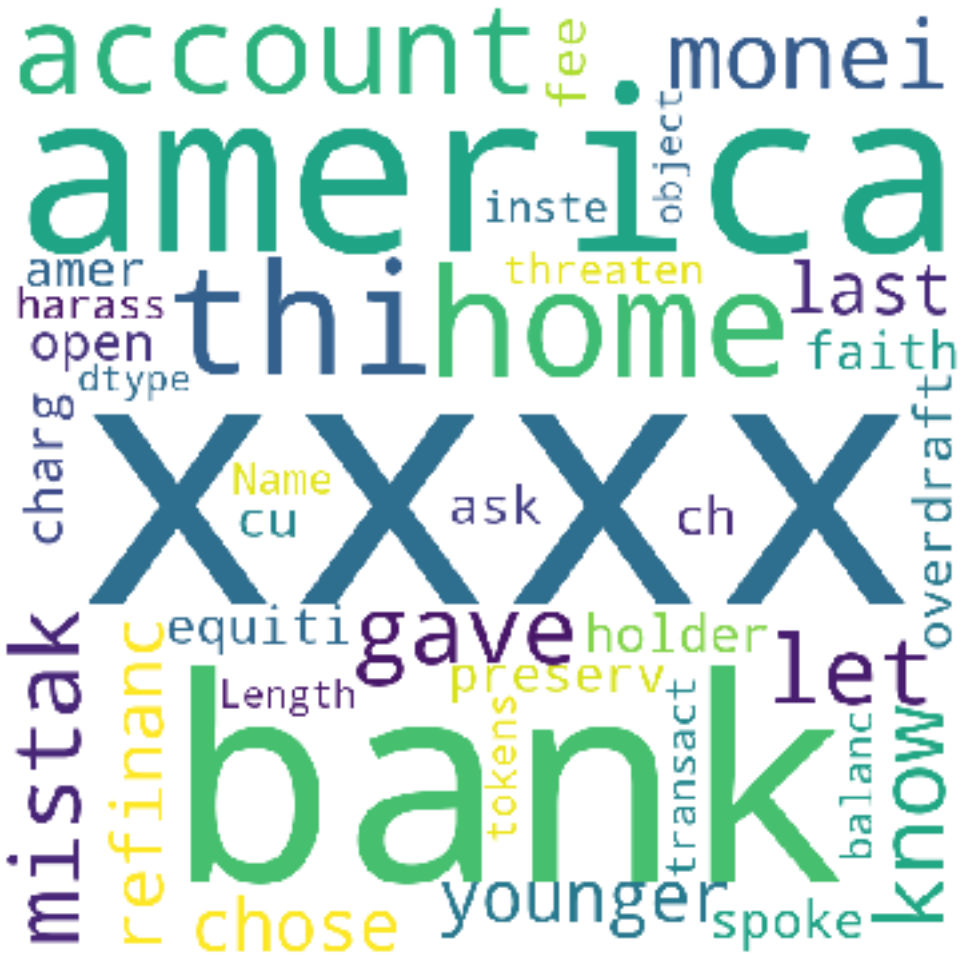
#### 1.3.1 (1) Mortgage

[5]:
```
word_cloud_plotter(df_token.query('product == "Mortgage"')['tokens'])
```




### 1.3.2 (2) Bank Account or Service

[6]:
```
word_cloud_plotter(df_token.query('product == "Bank account or␣
↪service"')['tokens'])
```




### 1.3.3 (3) Credit Card

[7]:
```
word_cloud_plotter(df_token.query('product == "Credit card"')['tokens'])
```


### 1.4 Word Embeddings

#### 1.4.1 (1) Word2Vec Models

[8]:
```
from gensim.models import Word2Vec

## function to train models for work embeddings
def save_wEmbed(model_type, tokens):

    ### set up output folder
    word2vec_model_file = OUTPUT_FOLDER + 'word2vec_' + model_type + '.model'

    ### set up parameters
    size = 1000
    window = 3
    min_count = 1
```

```
    workers = 3
    sg = int(model_type == 'sGram')

    ### train model
    w2v_model = Word2Vec(tokens,
                         min_count = min_count,
                         size = size,
                         workers = workers,
                         window = window,
                         sg = 1)
    ### save model
    w2v_model.save(word2vec_model_file)
```

[9]:
```
# # extract tokens to fit
# stemmed_tokens = pd.Series(df_token['complaint']).values

# # save CBOW
# save_wEmbed('CBOW', stemmed_tokens)

# # save skip-gram
# save_wEmbed('sGram', stemmed_tokens)
```

### 1.4.2 (2) Word2Vec CBOW & skip-gram

[10]:
```
import numpy as np

## function to write vectorized reviews using work2vec model
def save_X_word2vec(model_type):

    ### set up output filename
    word2vec_filename = OUTPUT_FOLDER + 'X_word2vec_' + model_type + '.csv'

    ### load word2vec model
    w2v_model = Word2Vec.load(OUTPUT_FOLDER + 'word2vec_' + model_type + '.
↪model')

    ### write csv file
    with open(word2vec_filename, 'w+') as word2vec_file:
        for index, row in df_token.iterrows():
            model_vector = (np.mean([w2v_model[token] for token in␣
↪row['complaint']], axis=0)).tolist()
            if index == 0:
                header = ",".join(str(ele) for ele in range(1000))
                word2vec_file.write(header)
                word2vec_file.write("\n")
            # Check if the line exists else it is vector of zeros
```

```
            if type(model_vector) is list:
                line1 = ",".join( [str(vector_element) for vector_element in␣
 ↪model_vector] )
            else:
                line1 = ",".join([str(0) for i in range(1000)])
            word2vec_file.write(line1)
            word2vec_file.write('\n')


# save_X_word2vec('CBOW')
# save_X_word2vec('sGram')

# X_cbow = pd.read_csv(OUTPUT_FOLDER + 'X_word2vec_CBOW.csv')
# X_sgram = pd.read_csv(OUTPUT_FOLDER + 'X_word2vec_sGram.csv')
```

## 1.5 Modeling

### 1.5.1 (1) Sequence and pad complaints

[18]:
```
from sklearn.model_selection import train_test_split
from keras.preprocessing.text import Tokenizer
from keras.preprocessing.sequence import pad_sequences

## split training and testing
data_train, data_test = train_test_split(df_token, test_size = 0.20,␣
 ↪random_state = 2020)

## sequence of token index to represent sentence - training
max_vocab = 50000
tokenizer = Tokenizer(num_words = max_vocab, lower = True, char_level = False)
tokenizer.fit_on_texts(data_train["tokens"].tolist())
training_sequences = tokenizer.texts_to_sequences(data_train["tokens"].tolist())
train_word_index = tokenizer.word_index

## pad sequence - training
max_sequence_length = 400
embedding_dim = 1000
train_cnn_data = pad_sequences(training_sequences, maxlen = max_sequence_length)

## sequence & pad - testing
test_sequences = tokenizer.texts_to_sequences(data_test["tokens"].tolist())
test_cnn_data = pad_sequences(test_sequences, maxlen = max_sequence_length)

## get dummies for complaint labels
y_train = pd.get_dummies(data_train['product']).values
y_test = pd.get_dummies(data_test['product']).values
```

### 1.5.2 (2) Set up rnn using pretrained embeddings weights

[19]:
```
import tensorflow as tf
from tensorflow import keras
from tensorflow.keras import layers


## function to get embedding weights
def get_word2vec_weights(model_type):
    word_model = Word2Vec.load(OUTPUT_FOLDER + 'word2vec_' + model_type + '.
 ↪model')
    train_embedding_weights = np.zeros((len(train_word_index) + 1,␣
 ↪embedding_dim))
    for word, index in train_word_index.items():
        train_embedding_weights[index,:] = word_model[word] if word in␣
 ↪word_model else np.random.rand(embedding_dim)
    return train_embedding_weights


## function to setup rnn
def rnn(embeddings, max_sequence_length, num_words, embedding_dim,␣
 ↪labels_index):
    model = keras.Sequential(
        [
            layers.Input(shape=(max_sequence_length), dtype='int32'),
            layers.Embedding(num_words,
                             embedding_dim,
                             weights=[embeddings],
                             input_length=max_sequence_length,
                             trainable=False),
            layers.LSTM(256),
            layers.Dense(128, activation='relu'),
            layers.Dense(0.2),
            layers.Dropout(0.2),
            layers.Dense(labels_index, activation = 'softmax')
        ]
    )
    model.compile(optimizer = 'adam', loss = 'categorical_crossentropy',␣
 ↪metrics = ['accuracy'])
    return model
```

### 1.5.3 (3) Model with CBOW

[20]:
```
## set up rnn using skip-gram
model = rnn(
    embeddings = get_word2vec_weights('CBOW'),
    max_sequence_length = max_sequence_length,
```

```
    num_words = len(train_word_index) + 1,
    embedding_dim = embedding_dim,
    labels_index = len(list(df_token['product'].unique()))
)

## train rnn model
history = model.fit(
    train_cnn_data,
    y_train,
    epochs = 5,
    validation_split = 0.33,
    shuffle = True,
    batch_size = 34
)

## predict on testing
accr = model.evaluate(test_cnn_data, y_test)
print('Test set\n  Loss: {:0.3f}\n  Accuracy: {:0.3f}'.format(accr[0], accr[1]))
```

```
Epoch 1/5
11/11 [==============================] - 17s 2s/step - loss: 1.7918 - accuracy:
0.3268 - val_loss: 1.7918 - val_accuracy: 0.3600
Epoch 2/5
11/11 [==============================] - 17s 2s/step - loss: 1.7918 - accuracy:
0.3268 - val_loss: 1.7918 - val_accuracy: 0.3600
Epoch 3/5
11/11 [==============================] - 15s 1s/step - loss: 1.7918 - accuracy:
0.3268 - val_loss: 1.7918 - val_accuracy: 0.3600
Epoch 4/5
11/11 [==============================] - 16s 1s/step - loss: 1.7918 - accuracy:
0.3268 - val_loss: 1.7918 - val_accuracy: 0.3600
Epoch 5/5
11/11 [==============================] - 16s 1s/step - loss: 1.7918 - accuracy:
0.3268 - val_loss: 1.7918 - val_accuracy: 0.3600
5/5 [==============================] - 2s 355ms/step - loss: 1.7918 - accuracy:
0.3233
Test set
  Loss: 1.792
  Accuracy: 0.323
```

### 1.5.4 (4) Model with skip-Gram

[21]:
```
## set up rnn using skip-gram
model = rnn(
    embeddings = get_word2vec_weights('sGram'),
    max_sequence_length = max_sequence_length,
    num_words = len(train_word_index) + 1,
```

```
    embedding_dim = embedding_dim,
    labels_index = len(list(df_token['product'].unique()))
)

## train rnn model
history = model.fit(
    train_cnn_data,
    y_train,
    epochs = 5,
    validation_split = 0.33,
    shuffle = True,
    batch_size = 34
)

## predict on testing
accr = model.evaluate(test_cnn_data, y_test)
print('Test set\n  Loss: {:0.3f}\n  Accuracy: {:0.3f}'.format(accr[0], accr[1]))
```

```
Epoch 1/5
11/11 [==============================] - 16s 1s/step - loss: 1.7918 - accuracy:
0.3268 - val_loss: 1.7918 - val_accuracy: 0.3600
Epoch 2/5
11/11 [==============================] - 16s 1s/step - loss: 1.7918 - accuracy:
0.3268 - val_loss: 1.7918 - val_accuracy: 0.3600
Epoch 3/5
11/11 [==============================] - 15s 1s/step - loss: 1.7918 - accuracy:
0.3268 - val_loss: 1.7918 - val_accuracy: 0.3600
Epoch 4/5
11/11 [==============================] - 16s 1s/step - loss: 1.7918 - accuracy:
0.3268 - val_loss: 1.7918 - val_accuracy: 0.3600
Epoch 5/5
11/11 [==============================] - 17s 2s/step - loss: 1.7918 - accuracy:
0.3268 - val_loss: 1.7918 - val_accuracy: 0.3600
5/5 [==============================] - 2s 393ms/step - loss: 1.7918 - accuracy:
0.3233
Test set
  Loss: 1.792
  Accuracy: 0.323
```