In [2]:
```
import numpy as np
import json
import pandas as pd
from sklearn import metrics
from sklearn.model_selection import KFold
from sklearn.naive_bayes import GaussianNB
from sklearn.naive_bayes import BernoulliNB
from sklearn.linear_model import LogisticRegression
```

In [3]:
```
# loading data from training data
f = open('./whats-cooking/train.json','r')
train_data = json.loads(f.read())
f.close()
```

In [57]:
```
# loading data from testing data
f = open('./whats-cooking/test.json','r')
test_data = json.loads(f.read())
f.close()
```

In [17]:
```
#(b) count
dish_count = len(train_data)
cuisine = []
uniq_ingredients = []

for d in train_data:
    cuisine.append(d['cuisine'])
    uniq_ingredients += d['ingredients']

uniq_ingredients = np.unique(uniq_ingredients)
cuisine = np.unique(cuisine)
cuisine_count = len(cuisine)
uniq_ingredients_count = len(uniq_ingredients)

print("dish count: {}".format(dish_count))
print("unique cuisines: {}".format(cuisine_count))
print("unique ingredients: {}".format(uniq_ingredients_count))
```

```
dish count: 39774
unique cuisines: 20
unique ingredients: 6714
```

In [38]:
```
#(c) Represent each dish by a binary ingredient feature vector.
#https://stackoverflow.com/questions/45312377/how-to-one-hot-encode-from
-a-pandas-column-containing-a-list
from sklearn.preprocessing import MultiLabelBinarizer
train_data_df = pd.DataFrame(train_data)
mlb = MultiLabelBinarizer()
binary_train_data_df = train_data_df.join(pd.DataFrame(mlb.fit_transform
(train_data_df.pop('ingredients')),
                          columns=mlb.classes_,
                          index=train_data_df.index))
binary_train_data_df
```

Out[38]:

	id	cuisine	(oz.) tomato sauce	(oz.) tomato paste	(10 oz.) frozen chopped spinach	(10 oz.) frozen chopped spinach, thawed and squeezed dry	(14 oz.) sweetened condensed milk	(14.5 oz.) diced tomatoes	(15 oz.) refried beans
0	10259	greek	0	0	0	0	0	0	0
1	25693	southern_us	0	0	0	0	0	0	0
2	20130	filipino	0	0	0	0	0	0	0
3	22213	indian	0	0	0	0	0	0	0
4	13162	indian	0	0	0	0	0	0	0
...	...	...	...	...	...	...	...	...	...
39769	29109	irish	0	0	0	0	0	0	0
39770	11462	italian	0	0	0	0	0	0	0
39771	2238	irish	0	0	0	0	0	0	0
39772	41882	chinese	0	0	0	0	0	0	0
39773	2362	mexican	0	0	0	0	0	0	0

39774 rows × 6716 columns

In [39]:
```
# convert dataframe to nparray
train_labels = df['cuisine'].to_numpy()
binary_train_data_df.drop(['id','cuisine'], axis=1, inplace=True)
binary_train_data = binary_train_data_df.to_numpy()
binary_train_data
```

Out[39]:
```
array([[0, 0, 0, ..., 0, 0, 0],
       [0, 0, 0, ..., 0, 0, 0],
       [0, 0, 0, ..., 0, 0, 0],
       ...,
       [0, 0, 0, ..., 0, 0, 0],
       [0, 0, 0, ..., 0, 0, 0],
       [0, 0, 0, ..., 0, 0, 0]])
```

In [40]:
```
#print(binary_train_data.shape)
```

```
(39774, 6714)
```

In [46]:
```
#(d) Using Naïve Bayes Classifier to perform 3 fold cross-validation on
 the training set
# Report your average classification accuracy.
# Try both Gaussian distribution prior assumption and Bernoulli distribu
tion prior assumption.
gaussian = GaussianNB()
bernoulli = BernoulliNB()
Gaussian_accuracy = []
Bernoulli_accuracy = []
kf = KFold(n_splits=3)
for train_index, test_index in kf.split(binary_train_data):
    trainx = binary_train_data[train_index]
    testx = binary_train_data[test_index]
    trainy = train_labels[train_index]
    testy = train_labels[test_index]
    gaussian.fit(trainx, trainy)
    score_gaussian = gaussian.score(testx, testy)
    Gaussian_accuracy.append(score_gaussian)
    avg_score_g = np.average(Gaussian_accuracy)
    bernoulli.fit(trainx, trainy)
    score_bernoulli = bernoulli.score(testx, testy)
    Bernoulli_accuracy.append(score_bernoulli)
    avg_score_b = np.average(Bernoulli_accuracy)
    print("Average accuracy of Gaussian:", avg_score_g)
    print("Average accuracy of Bernoulli:", avg_score_b)
```

```
Average accuracy of Gaussian: 0.37901644290239855
Average accuracy of Bernoulli: 0.684190677326897
Average accuracy of Gaussian: 0.3809775230049781
Average accuracy of Bernoulli: 0.6818524664353598
Average accuracy of Gaussian: 0.3798461306381053
Average accuracy of Bernoulli: 0.6835369839593705
```

(e) For Gaussian prior and Bernoulli prior which performs better in terms of cross-validation accuracy? Why? Please give specific arguments.

Average accuracy of Gaussian prior is aroung 0.38 and average accuracy of Bernoulli is around 0.68. Bernoulli performs better in terms of cross-validation accuracy. The ingredients have two features which are represented by 0 or 1 (i.e. existing or non-existing), which is better described by a Bernoulli model. Thus, Bernoulli distribution prior assumption is better.

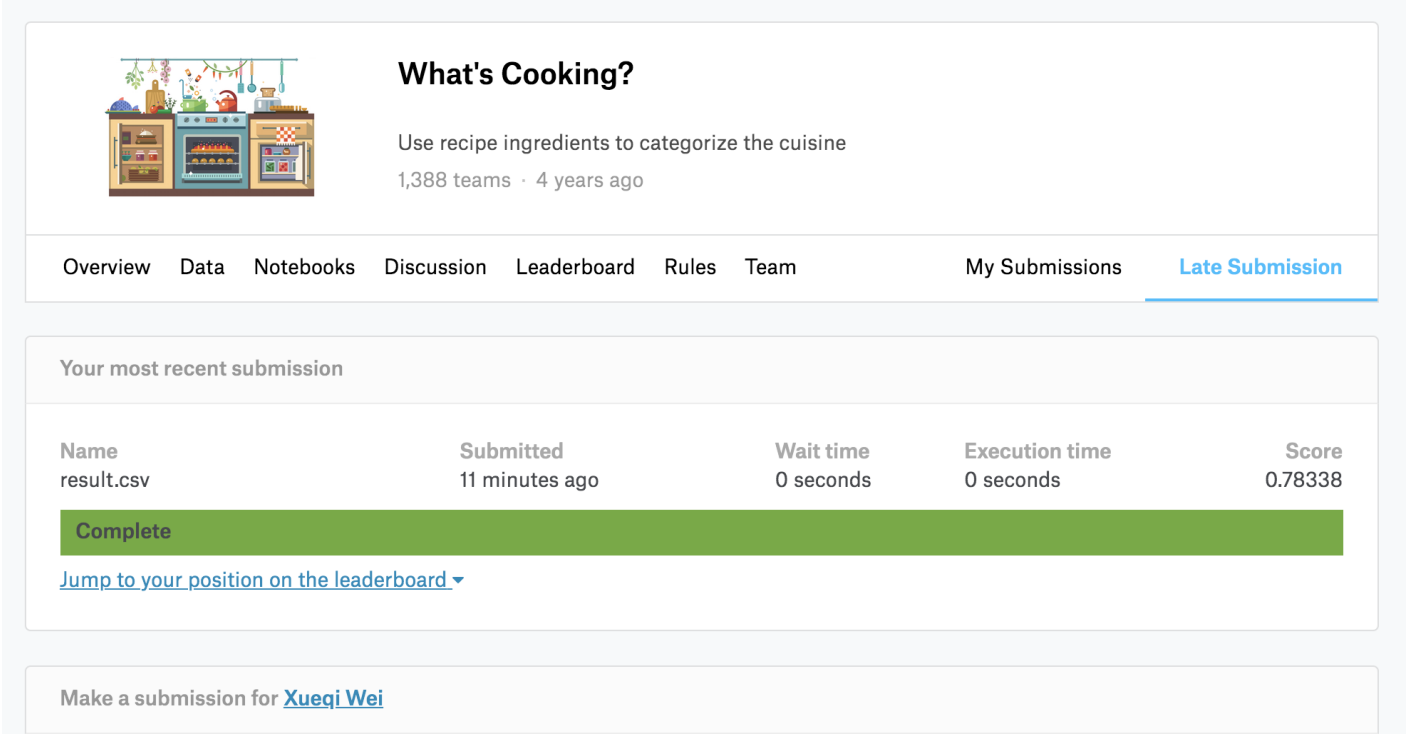
In [48]:
```
# (f) Using Logistic Regression Model to perform 3 fold cross-validation
on the training set
# Report your average classification accuracy

# import warnings filter
import warnings
# ignore all future warnings
warnings.simplefilter('ignore')

logreg = LogisticRegression()
logreg_accuracy = []
for train_index, test_index in kf.split(binary_train_data):
    trainx = binary_train_data[train_index]
    testx = binary_train_data[test_index]
    trainy = train_labels[train_index]
    testy = train_labels[test_index]
    logreg.fit(trainx, trainy)
    score_logreg = logreg.score(testx, testy)
    logreg_accuracy.append(score_logreg)
    avg_score_l = np.average(logreg_accuracy)
    print("Average accuracy of LogisticRegression:", avg_score_l)
```

```
Average accuracy of LogisticRegression: 0.7758334590435964
Average accuracy of LogisticRegression: 0.773985518177704
Average accuracy of LogisticRegression: 0.7755568964650275
```

In [67]:
```
# (g) Train your best-performed classifier with all of the training dat
a, and generate test labels on
# test set. Submit your results to Kaggle and report the accuracy.

# Average accuracy of LogisticRegression is about 0.77, which is the bes
t-performed classifier
# train LogisticRegression with all of the training data

# prepare test data
binary_test_data = np.zeros([len(test_data), uniq_ingredients_count])

for i, dish in enumerate(test_data):
    for j in dish['ingredients']:
        if j in uniq_ingredients:
            binary_test_data[i][np.where(uniq_ingredients == j)] = 1
```

In [74]:
```
#train model
logreg.fit(binary_train_data, train_labels)
pred = logreg.predict(binary_test_data)
```

In [75]:
```
#output
df = pd.DataFrame(data = {"id" : test_id, "cuisine" : pred})
df.to_csv(path_or_buf="result.csv", index=False)
```



The accuracy on Kaggle after submission is 0.78338.