In [1]:
```
# Import packages
import numpy
import scipy.optimize
import random
import ast
```

In [2]:
```
# Define read data from download files
def parseDataFromFile(fname):
    for l in open(fname):
        yield eval(l)
```

TASK 1 - REGRESSION

In [3]:
```
# Read data from downloaded fantasy review
print("Reading data...")
data = list(parseDataFromFile("fantasy_10000.json"))
print("done")
```

```
Reading data...
done
```

QUESTION 2: Train the simple predictor to get theta and MSE

In [4]:
```
# Define get length of review_text
def getLength(data):
    if "review_text" in data.keys():
        return len(data["review_text"])
    else: return 0
```

In [5]:
```
# Make feature matrix
def feature(datum):
    return [1, datum]
length = [getLength(d) for d in data]
```

In [6]:
```
# Get X and y
X = [feature(l) for l in length]
y = [d["rating"] for d in data]
```

In [7]:
```
# Get theta
theta, residuals, ranks, s = numpy.linalg.lstsq(X, y)
print("theta is: ", theta)
```

```
theta is:  [3.68568136e+00 6.87371675e-05]

/Users/markzuckerberg/anaconda3/envs/wintertime/lib/python3.7/site
-packages/ipykernel_launcher.py:2: FutureWarning: `rcond` paramete
r will change to the default of machine precision times ``max(M, N
)`` where M and N are the input matrix dimensions.
To use the future default and silence this warning we advise to pa
ss `rcond=None`, to keep using the old, explicitly pass `rcond=-1`
.
```

In [8]:
```
# Define getMSE to get MSE by using residuals
def getMSE(residuals, y):
    MSE = residuals/len(y)
    return MSE
```

In [9]:
```
MSE = getMSE(residuals, y)
print("MSE is: ", float(MSE))
```

```
MSE is:  1.55220866223553
```

QUESTION 3: Get one-hot encoding for the weekday and year

In [10]:
```
import dateutil.parser
# Define function to get the one-hot encoding
def getDate(data):
    weekday = []
    year = []
    for d in data:
        t = dateutil.parser.parse(d['date_added'])
        weekday.append(t.weekday())
        year.append(t.year)
    return weekday, year
```

In [11]:
```
# Make the one-hot encoding of weekday and year
weekday, year = getDate(data)
year_min = min(year)
year_max = max(year)
year = numpy.eye(year_max-year_min+1)[numpy.array(year)-year_min]
weekday = numpy.eye(7)[weekday]
# Get the feature vecotrs for the first two examples
print(weekday[:2])
print(year[:2])
```

```
[[0. 0. 0. 0. 0. 0. 1.]
 [0. 0. 1. 0. 0. 0. 0.]]
[[0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 1.]
 [0. 0. 0. 0. 0. 0. 0. 0. 1. 0. 0. 0.]]
```

QUESTION 4: Report MSE for different feature input

QUESTION 4.1: Use weekday and year directly as features

In [12]:
```
# Get the feature vector
weekday_x, year_x = getDate(data)
x = [feature(l) for l in length]
x = numpy.array([x[i] + [weekday_x[i], year_x[i]] for i in range(le
n(x))])
```

In [13]:
```
theta, residuals, rank, s = numpy.linalg.lstsq(x, y)
```

```
/Users/markzuckerberg/anaconda3/envs/wintertime/lib/python3.7/site
-packages/ipykernel_launcher.py:1: FutureWarning: `rcond` paramete
r will change to the default of machine precision times ``max(M, N
)`` where M and N are the input matrix dimensions.
To use the future default and silence this warning we advise to pa
ss `rcond=None`, to keep using the old, explicitly pass `rcond=-1`
.
  """Entry point for launching an IPython kernel.
```

In [14]:
```
# Get MSE by using residuals
MSE = getMSE(residuals, y)
print("MSE of Question 4.1 is: ", MSE)
```

```
MSE of Question 4.1 is:  [1.53677405]
```

QUESTION 4.2: Use one-hot of weekday and year as features

In [15]:
```
x = numpy.array([[1]+list(year[i]) + list(weekday[i]) + feature(get
Length(d)) for i, d in enumerate(data)])
y = numpy.array(y)
```

In [16]:
```
theta,residuals,rank,s = numpy.linalg.lstsq(x, y)
```

```
/Users/markzuckerberg/anaconda3/envs/wintertime/lib/python3.7/site
-packages/ipykernel_launcher.py:1: FutureWarning: `rcond` paramete
r will change to the default of machine precision times ``max(M, N
)`` where M and N are the input matrix dimensions.
To use the future default and silence this warning we advise to pa
ss `rcond=None`, to keep using the old, explicitly pass `rcond=-1`
.
  """Entry point for launching an IPython kernel.
```

In [17]:
```
# Apply another way to get MSE by using formula
def getMSE2(theta, x, y) :
    predict = theta*x
    predict = numpy.array(predict)
    predict = predict.sum(axis=1)
    error = (y - predict)
    error = numpy.square(error)
    error = numpy.sum(error)
    MSE = 1/len(y)*error
    return MSE
```

In [18]:
```
# Use the second way to get MSE of one-hot encoding
MSE = getMSE2(theta, x, y)
print("MSE for Question 4.2 is: ", MSE)
```

```
MSE for Question 4.2 is:  1.5123578656428205
```

QUESTION 5: Split the data into two sets and perform previous tasks

QUESTION 5.1: Use weekday and year directly as features

In [19]:
```
weekday_x, year_x = getDate(data)
x = [feature(l) for l in length]
x = numpy.array([x[i] + [weekday_x[i], year_x[i]] for i in range(le
n(x))])
xy = list(zip(x, y))
random.shuffle(xy)
x = [d[0] for d in xy]
y = [d[1] for d in xy]
```

In [20]:
```
n = len(y)
X_train = numpy.array(x[:n//2], dtype='float')
X_test = numpy.array(x[n//2:], dtype='float')
y_train = numpy.array(y[:n//2], dtype='float')
y_test = numpy.array(y[n//2:], dtype='float')
```

In [21]:
```
theta,residuals,rank,s = numpy.linalg.lstsq(X_train, y_train)
```

```
/Users/markzuckerberg/anaconda3/envs/wintertime/lib/python3.7/site
-packages/ipykernel_launcher.py:1: FutureWarning: `rcond` paramete
r will change to the default of machine precision times ``max(M, N
)`` where M and N are the input matrix dimensions.
To use the future default and silence this warning we advise to pa
ss `rcond=None`, to keep using the old, explicitly pass `rcond=-1`
.
  """Entry point for launching an IPython kernel.
```

In [22]:
```
MSE = getMSE(residuals, y_train)
print("MSE of training set: ", MSE)
```

```
MSE of training set:  [1.56529997]
```

In [23]:
```
theta,residuals,rank,s = numpy.linalg.lstsq(X_test, y_test)
```

```
/Users/markzuckerberg/anaconda3/envs/wintertime/lib/python3.7/site
-packages/ipykernel_launcher.py:1: FutureWarning: `rcond` paramete
r will change to the default of machine precision times ``max(M, N
)`` where M and N are the input matrix dimensions.
To use the future default and silence this warning we advise to pa
ss `rcond=None`, to keep using the old, explicitly pass `rcond=-1`
.
  """Entry point for launching an IPython kernel.
```

In [24]:
```
MSE = getMSE(residuals, y_test)
print("MSE of testing set: ", MSE)
```

```
MSE of testing set:  [1.50734351]
```

QUESTION 5.2

In [25]:
```
weekday, year = getDate(data)
year_min = min(year)
year_max = max(year)
year = numpy.eye(year_max-year_min+1)[numpy.array(year)-year_min]
weekday = numpy.eye(7)[weekday]
x = numpy.array([[1]+list(year[i]) + list(weekday[i]) + feature(get
Length(d)) for i, d in enumerate(data)])
y = numpy.array(y)
xy = list(zip(x, y))
random.shuffle(xy)
x = [d[0] for d in xy]
y = [d[1] for d in xy]
n = len(y)
X_train = numpy.array(x[:n//2], dtype='float')
X_test = numpy.array(x[n//2:], dtype='float')
y_train = numpy.array(y[:n//2], dtype='float')
y_test = numpy.array(y[n//2:], dtype='float')
```

In [26]:
```
theta,residuals,rank,s = numpy.linalg.lstsq(X_train, y_train)
```

```
/Users/markzuckerberg/anaconda3/envs/wintertime/lib/python3.7/site
-packages/ipykernel_launcher.py:1: FutureWarning: `rcond` paramete
r will change to the default of machine precision times ``max(M, N
)`` where M and N are the input matrix dimensions.
To use the future default and silence this warning we advise to pa
ss `rcond=None`, to keep using the old, explicitly pass `rcond=-1`
.
  """Entry point for launching an IPython kernel.
```

In [27]:
```
MSE = getMSE2(theta, X_train, y_train)
print("MSE of training set: ", MSE)
```

```
MSE of training set:  1.5341596233163826
```

In [28]:
```
theta,residuals,rank,s = numpy.linalg.lstsq(X_test, y_test)
```

```
/Users/markzuckerberg/anaconda3/envs/wintertime/lib/python3.7/site
-packages/ipykernel_launcher.py:1: FutureWarning: `rcond` paramete
r will change to the default of machine precision times ``max(M, N
)`` where M and N are the input matrix dimensions.
To use the future default and silence this warning we advise to pa
ss `rcond=None`, to keep using the old, explicitly pass `rcond=-1`
.
  """Entry point for launching an IPython kernel.
```

In [29]:
```
MSE = getMSE2(theta, X_test, y_test)
print("MSE of testing set: ", MSE)
```

```
MSE of testing set:  1.5720403379627474
```

QUESTION 6

$$\text{MAE} = \frac{\sum_{i=1}^{n} \left| y_i - \hat{y_i} \right|}{n}$$

We assume that **a trivial predictor:** $y = \theta_0$, and only consider $\sum_{i=1}^{n} \left| y_i - \hat{y_i} \right|$, the formula can be expressed as:

$$f(\theta_0) = \sum_{i}^{n} |y_i - \theta_0|$$
$$= \sum_{i}^{k} (\theta_0 - y_i) + \sum_{j}^{n-k} \left(\{ y_j - \theta \right)$$

where $|y_i - \theta_0|$ is divided as a part: $\theta_0 >= y_i$ which has k values and another part: $y_i > \theta_0$ which has $n - k$ values.

The derivative of $f(\theta_0)$ is:

$$\frac{\partial f(\theta_0)}{\partial \theta_0} = 2k - n$$

When $k = n/2$, the derivative of $theta_0$ is equal to 0. Therefore, when θ is larger than half number of y, k equals to $n/2$, which indicates that k is the medians of y.

TASK 2 - CLASSIFICATION

In [30]:
```
# Read data from the beer dataset
print("Reading data...")
dataBeer = list(parseDataFromFile("beer_50000.json"))
print("done")
```

```
Reading data...
done
```

QUESTION 7: Perform logistic regressor

In [31]:
```
# y = [d['review/overall'] >= 4 for d in dataset]
def getY(data):
    if data["review/overall"] >= 4:
        return 1
    else:
        return 0
```

In [32]:
```
# Get length of the "review/text" data
def getReviewLength(data):
    if "review/text" in data.keys():
        return len(data["review/text"])
    else: return 0

def feature(datum):
    return [1, datum]
```

In [33]:
```
reviewLength = [getReviewLength(d) for d in dataBeer]
X = [feature(l) for l in reviewLength]
y = [getY(d) for d in dataBeer]
```

In [34]:
```
# shuffle the data
xy = list(zip(X, y))
random.shuffle(xy)
x = [d[0] for d in xy]
y = [d[1] for d in xy]
```

In [35]:
```
# Split the data with 4/5 as training set and 1/5 as testing set
n = len(xy)
n_train = (4/5)*n
n_test = (1/5)*n
```

In [36]:
```
x_train = x[:int(n_train)]
x_test = x[int(n_train):]
y_train = y[:int(n_train)]
y_test = y[int(n_train):]
len(y_test)
```

Out[36]:
```
10000
```

In [37]:
```
# Train the model by setting class_weight = 'balanced'
from sklearn import linear_model
mod = linear_model.LogisticRegression(C=1.0, class_weight='balanced
')
mod.fit(x_train, y_train)
```

Out[37]:
```
LogisticRegression(C=1.0, class_weight='balanced', dual=False,
                   fit_intercept=True, intercept_scaling=1, l1_rat
io=None,
                   max_iter=100, multi_class='auto', n_jobs=None,
penalty='l2',
                   random_state=None, solver='lbfgs', tol=0.0001,
verbose=0,
                   warm_start=False)
```

In [38]:
```
pred = mod.predict(x_test)
correct = pred == y_test
```

In [39]:
```
TP_ = numpy.logical_and(pred, y_test)
FP_ = numpy.logical_and(pred, numpy.logical_not(y_test))
TN_ = numpy.logical_and(numpy.logical_not(pred), numpy.logical_not(
y_test))
FN_ = numpy.logical_and(numpy.logical_not(pred), y_test)
```

In [40]:
```
TP = sum(TP_)
FP = sum(FP_)
TN = sum(TN_)
FN = sum(FN_)
# Print the result
print("TP is: ", TP)
print("FP is: ", FP)
print("TN is: ", TN)
print("FN is: ", FN)
```

```
TP is:  2858
FP is:  1166
TN is:  2083
FN is:  3893
```

In [41]:
```
# BER
BER = 1 - 0.5 * (TP / (TP + FN) + TN / (TN + FP))
print("Balanced Error Rates of the predictor is: ", BER)
```

```
Balanced Error Rates of the predictor is:  0.46776748280147185
```

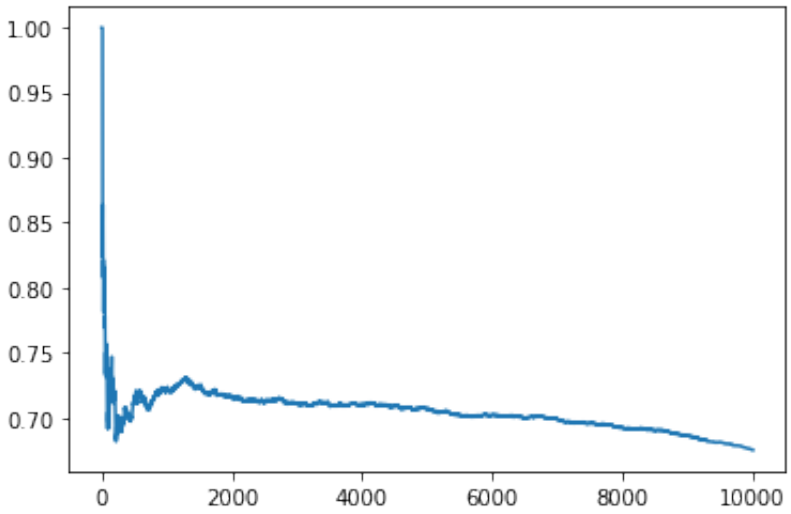
QUSTION 8: Plot the precision@K

In [42]:
```
scores = mod.decision_function(x_test)
scores_labels = list(zip(scores, y_test))
scores_labels.sort(reverse = True)
sortedlabels = [x[1] for x in scores_labels]
```

In [43]:
```
x_axis = [i for i in range(1, 10000)]
y_axis = [sum(sortedlabels[:i])/ i for i in x_axis]
```

In [44]:
```
import matplotlib.pyplot as plt
plt.plot(x_axis, y_axis)
plt.show
```

Out[44]:
```
<function matplotlib.pyplot.show(*args, **kw)>
```



QUESTION 9:

In [45]:
```
scores = mod.decision_function(x_test)
temp = (scores > 0).astype(numpy.int)
scores = abs(scores)
scores_labels = list(zip(scores,temp,y_test))
scores_labels.sort(reverse = True)
sortedlabels = [(1 if item[1] == item[2] else 0) for item in scores
_labels]
```

In [46]:
```
precision_1 = sortedlabels[0]/1
print("precision@1: ", precision_1)
precision_100 = sum(sortedlabels[:100])/ 100
print("precision@100: ", precision_100)
precision_10000 = sum(sortedlabels[:10000])/10000
print("precision@10000: ", precision_10000)
```

```
precision@1:  1.0
precision@100:  0.7
precision@10000:  0.4941
```

In [47]:
```
x_axis = [i for i in range(1, 10000)]
y_axis = [sum(sortedlabels[:i])/ i for i in x_axis]
plt.plot(x_axis, y_axis)
plt.show
```

Out[47]:
```
<function matplotlib.pyplot.show(*args, **kw)>
```