CSE 258 - HW 1

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Regression (week 1)

Question. 2

55
```
import numpy as np
```

56
```
def parse_data(fname):
    for line in open(fname):
        yield eval(line)
```

57
```
book_reviews = list(parse_data("fantasy_10000.json"))
```

58
```
book_reviews[0]
```

58
```
{'user_id': '8842281e1d1347389f2ab93d60773d4d',
 'book_id': '18245960',
 'review_id': 'dfdbb7b0eb5a7e4c26d59a937e2e5feb',
 'rating': 5,
 'review_text': 'This is a special book. It started slow for about the first third, then in the middle th
 'date_added': 'Sun Jul 30 07:44:10 -0700 2017',
 'date_updated': 'Wed Aug 30 00:00:26 -0700 2017',
 'read_at': 'Sat Aug 26 12:05:52 -0700 2017',
 'started_at': 'Tue Aug 15 13:23:18 -0700 2017',
 'n_votes': 28,
 'n_comments': 1}
```

59
```
len(book_reviews[0]['review_text'])
```

59
```
2086
```

60
```
data = [d for d in book_reviews if 'review_text' in d]
```

61
```
data[0]['review_text']
```

61
```
'This is a special book. It started slow for about the first third, then in the middle third it started t
```

62
```
def featurize(data, featurizer):
    return [featurizer(d) for d in data]
```

63
```
X = featurize(data, lambda d : [1, len(d['review_text'])])
```

```
64 X[0:10]
```

```
64 [[1, 2086],
    [1, 1521],
    [1, 1519],
    [1, 1791],
    [1, 1762],
    [1, 470],
    [1, 823],
    [1, 532],
    [1, 616],
    [1, 548]]
```

```
65 def extract_labels(data):
       return [d['rating'] for d in data]
```

```
66 y = extract_labels(data)
```

```
67 y[0:10]
```

```
67 [5, 5, 5, 4, 3, 5, 5, 5, 4, 5]
```

```
68 def mean_sq_error(theta, features, labels):
       return np.square(np.matrix(labels).T - np.matmul(np.matrix(features), np.matrix(theta).T))[:,0].mean(
```

```
69 def fit(features, labels):
       theta = np.linalg.lstsq(features, labels)[0]
       mse = mean_sq_error(theta, features, labels)
       return theta, mse
```

```
70 theta, mse = fit(X, y)
```

```
C:\Users\Fabul\AppData\Local\Temp/ipykernel_19652/1547723004.py:2: FutureWarning: `rcond` parameter will
To use the future default and silence this warning we advise to pass `rcond=None`, to keep using the old,
  theta = np.linalg.lstsq(features, labels)[0]
```

```
71 theta
```

```
71 array([3.68568136e+00, 6.87371675e-05])
```

```
72 print("Theta0 = %.4f, Theta1 = %.8f" % (theta[0], theta[1]))
```

```
Theta0 = 3.6857, Theta1 = 0.00006874
```

```
73 print("MSE = %.4f" % mse)
```

```
MSE = 1.5522
```

Question. 3

```
74 import dateutil.parser
```

```
75 data = [d for d in book_reviews if 'review_text' in d and 'date_added' in d]
```

```
76 data[0]['review_text']
```

```
76 'This is a special book. It started slow for about the first third, then in the middle third it started t
```

```
77 data[0]['date_added']
```

```
77 'Sun Jul 30 07:44:10 -0700 2017'
```

```
78 t = dateutil.parser.parse(data[0]['date_added'])
```

```
79 t.weekday()
```

```
79 6
```

```
80 t.year
```

```
80 2017
```

```
81 times = [dateutil.parser.parse(d['date_added']) for d in data]
```

```
82 weekdays = list(set([t.weekday() for t in times]))
   weekdays.sort()
   years = list(set([t.year for t in times]))
   years.sort()
```

```
83 weekdays
```

```
83 [0, 1, 2, 3, 4, 5, 6]
```

```
84 years
```

```
84 [2006, 2007, 2008, 2009, 2010, 2011, 2012, 2013, 2014, 2015, 2016, 2017]
```

```
85 # the featurizer that uses one-hot encoding for weekdays & years
   def featurizer_t_ohe(datum):
       f = [1, len(datum['review_text'])]
       t = dateutil.parser.parse(datum['date_added'])
       f_wkd = [1 if t.weekday() == d else 0 for d in weekdays]
       f_yr = [1 if t.year == y else 0 for y in years]
       return f + f_wkd + f_yr
```

```
86 X = featurize(data, featurizer_t_ohe)
```

```
87 X[0:2]
```

```
87 [[1, 2086, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1],
    [1, 1521, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0]]
```

```
88 print("For example 1: ")
   data[0]
```

For example 1:

88
```
{'user_id': '8842281e1d1347389f2ab93d60773d4d',
 'book_id': '18245960',
 'review_id': 'dfdbb7b0eb5a7e4c26d59a937e2e5feb',
 'rating': 5,
 'review_text': 'This is a special book. It started slow for about the first third, then in the middle th
 'date_added': 'Sun Jul 30 07:44:10 -0700 2017',
 'date_updated': 'Wed Aug 30 00:00:26 -0700 2017',
 'read_at': 'Sat Aug 26 12:05:52 -0700 2017',
 'started_at': 'Tue Aug 15 13:23:18 -0700 2017',
 'n_votes': 28,
 'n_comments': 1}
```

89
```
d0_l = len(data[0]['review_text'])
d0_t = data[0]['date_added']
d0_t_parsed = dateutil.parser.parse(d0_t)

print("where its review length is %d, review date is \"%s\", weekday is %d, and year is %d" % (d0_l, d0_t
print("The feature is " + str(X[0]))
```

```
where its review length is 2086, review date is "Sun Jul 30 07:44:10 -0700 2017", weekday is 6, and year
The feature is [1, 2086, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1]
```

90
```
print("For example 2: ")
data[1]
```

```
For example 2:
```

90
```
{'user_id': '8842281e1d1347389f2ab93d60773d4d',
 'book_id': '5577844',
 'review_id': '52c8ac49496c153e4a97161e36b2db55',
 'rating': 5,
 'review_text': 'A beautiful story. Neil Gaiman is truly a unique storyteller. I did a combo of reading a
 'date_added': 'Wed Sep 24 09:29:29 -0700 2014',
 'date_updated': 'Wed Oct 01 00:31:56 -0700 2014',
 'read_at': 'Tue Sep 30 00:00:00 -0700 2014',
 'started_at': 'Sun Sep 21 00:00:00 -0700 2014',
 'n_votes': 5,
 'n_comments': 1}
```

91
```
d1_l = len(data[1]['review_text'])
d1_t = data[1]['date_added']
d1_t_parsed = dateutil.parser.parse(d1_t)

print("where its review length is %d, review date is \"%s\", weekday is %d, and year is %d" % (d1_l, d1_t
print("The feature is " + str(X[1]))
```

```
where its review length is 1521, review date is "Wed Sep 24 09:29:29 -0700 2014", weekday is 2, and year
The feature is [1, 1521, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0]
```

Question. 4

92
```
# the featurizer that uses the direct value weekdays & years
def featurizer_t_dv(datum):
    f = [1, len(datum['review_text'])]
    t = dateutil.parser.parse(datum['date_added'])
    f.append(t.weekday())
```

```
    f.append(t.year)
    return f
```

```
93 X = featurize(data, featurizer_t_dv)
```

```
94 X[0:2]
```

```
94 [[1, 2086, 6, 2017], [1, 1521, 2, 2014]]
```

```
95 theta, mse = fit(X, y)
```

```
C:\Users\Fabul\AppData\Local\Temp/ipykernel_19652/1547723004.py:2: FutureWarning: `rcond` parameter will
To use the future default and silence this warning we advise to pass `rcond=None`, to keep using the old,
  theta = np.linalg.lstsq(features, labels)[0]
```

```
96 print("The model's MSE by using time values directly is: %.4f" % mse)
```

```
The model's MSE by using time values directly is: 1.5368
```

```
97 X = featurize(data, featurizer_t_ohe)
```

```
98 X[0:2]
```

```
98 [[1, 2086, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1],
    [1, 1521, 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0]]
```

```
99 theta, mse = fit(X, y)
```

```
C:\Users\Fabul\AppData\Local\Temp/ipykernel_19652/1547723004.py:2: FutureWarning: `rcond` parameter will
To use the future default and silence this warning we advise to pass `rcond=None`, to keep using the old,
  theta = np.linalg.lstsq(features, labels)[0]
```

```
100 print("The model's MSE by using one-hot encoding is: %.4f" % mse)
```

```
The model's MSE by using one-hot encoding is: 1.5124
```

Question. 5

```
101 import random
```

```
102 shuffled_data = data.copy()
    random.shuffle(shuffled_data)
```

```
103 split_index = int(len(shuffled_data)/2)
    split_index
```

```
103 5000
```

```
104 training_set = shuffled_data[:split_index]
    test_set = shuffled_data[split_index:]
```

```
105 theta_training, mse_training = fit(featurize(training_set, featurizer_t_dv), extract_labels(training_set)
    mse_test = mean_sq_error(theta_training, featurize(test_set, featurizer_t_dv), extract_labels(test_set))

    C:\Users\Fabul\AppData\Local\Temp/ipykernel_19652/1547723004.py:2: FutureWarning: `rcond` parameter will
    To use the future default and silence this warning we advise to pass `rcond=None`, to keep using the old,
      theta = np.linalg.lstsq(features, labels)[0]

106 print("The model's MSE by using time values directly is: %.4f on training set, %.4f on test set" % (mse_t

    The model's MSE by using time values directly is: 1.5335 on training set, 1.5403 on test set

107 theta_training, mse_training = fit(featurize(training_set, featurizer_t_ohe), extract_labels(training_set
    mse_test = mean_sq_error(theta_training, featurize(test_set, featurizer_t_ohe), extract_labels(test_set))

    C:\Users\Fabul\AppData\Local\Temp/ipykernel_19652/1547723004.py:2: FutureWarning: `rcond` parameter will
    To use the future default and silence this warning we advise to pass `rcond=None`, to keep using the old,
      theta = np.linalg.lstsq(features, labels)[0]

108 print("The model's MSE by using using one-hot encoding is: %.4f on training set, %.4f on test set" % (mse

    The model's MSE by using using one-hot encoding is: 1.5013 on training set, 1.5294 on test set
```

Question. 6

$MAE = \frac{1}{n}\sum_{i=1}^{n}|Y_i - \theta X_i| = \frac{1}{n}\sum_{i=1}^{n}|y_i - \theta_0|$ for the given predictor $y = \theta_0$.

We can further derive:

$MAE = \frac{1}{n}\sum_{y_i>\theta_0}(y_i - \theta_0) + \frac{1}{n}\sum_{y_i<\theta_0}(\theta_0 - y_i) + \frac{1}{n}\sum_{y_i=\theta_0}(0)$

$\frac{\partial MAE}{\partial \theta_0} = \frac{1}{n}\sum_{y_i>\theta_0}(-1) + \frac{1}{n}\sum_{y_i<\theta_0}(1)$

Let $p = \sum_{j=1}^{n}[y_j > \theta_0]$ and $q = \sum_{j=1}^{n}[y_j < \theta_0]$:

$\frac{\partial MAE}{\partial \theta_0} = \frac{1}{n}\cdot p\cdot(-1) + \frac{1}{n}\cdot q\cdot 1$

$\frac{\partial MAE}{\partial \theta_0} = \frac{q-p}{n}$

When $p = q$, we have $MAE' = 0$ indicating the minimum is reached at this point.

It is only when $\theta_0 = \tilde{y}$ that we can satisfy the condition:

$p = q, i.e. \sum_{j=1}^{n}[y_j > \theta_0] = \sum_{j=1}^{n}[y_j < \theta_0]$.

Therefore, for $y = \theta_0$, the best possible value of θ_0 in terms of the Mean Absolute Error is the median of the label y.

```
108
```

CSE 258 - HW 1

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Classification (week 2)

263
```
from urllib.request import urlopen
```

264
```
def parse_data_from_url(fname):
  for l in urlopen(fname):
    yield eval(l)
```

265
```
beer_reviews = list(parse_data_from_url("https://cseweb.ucsd.edu/classes/fa21/cse258-b/data/beer_50000.js
```

266
```
beer_reviews[0]
```

266
```
{'review/appearance': 2.5,
 'beer/style': 'Hefeweizen',
 'review/palate': 1.5,
 'review/taste': 1.5,
 'beer/name': 'Sausa Weizen',
 'review/timeUnix': 1234817823,
 'beer/ABV': 5.0,
 'beer/beerId': '47986',
 'beer/brewerId': '10325',
 'review/timeStruct': {'isdst': 0,
  'mday': 16,
  'hour': 20,
  'min': 57,
  'sec': 3,
  'mon': 2,
  'year': 2009,
  'yday': 47,
  'wday': 0},
 'review/overall': 1.5,
 'review/text': 'A lot of foam. But a lot.\tIn the smell some banana, and then lactic and tart. Not a goo
 'user/profileName': 'stcules',
 'review/aroma': 2.0}
```

Question. 7

267
```
data = [d for d in beer_reviews if 'review/overall' in d and 'review/text' in d]
```

268
```
def featurize(data, featurizer):
    return [featurizer(d) for d in data]
```

```
X = featurize(data, lambda d : [1, len(d['review/text'])])
```

269

270
```
X[0:10]
```

```
[[1, 262],
 [1, 338],
 [1, 396],
 [1, 401],
 [1, 1145],
 [1, 728],
 [1, 471],
 [1, 853],
 [1, 472],
 [1, 1035]]
```

271
```
def extract_labels(data):
    return [1 if d['review/overall'] >= 4 else 0 for d in data]
```

272
```
y = extract_labels(data)
```

273
```
y[0:10]
```

```
[0, 0, 0, 0, 1, 0, 0, 0, 1, 1]
```

274
```
from sklearn import linear_model
```

275
```
mod = linear_model.LogisticRegression(C=1.0, class_weight='balanced')
mod.fit(X,y)
```

```
LogisticRegression(class_weight='balanced')
```

276
```
pred = mod.predict(X)
```

277
```
correct = [(a == b) for a, b in zip(y, pred)]
```

278
```
correct[0:10]
```

```
[True, True, True, True, True, False, True, False, False, True]
```

279
```
sum(correct) / len(correct)
```

```
0.49408
```

280
```
import numpy as np
```

281
```
# True positives, false positives, etc.
TP_ = np.logical_and(pred, y)
FP_ = np.logical_and(pred, np.logical_not(y))
TN_ = np.logical_and(np.logical_not(pred), np.logical_not(y))
FN_ = np.logical_and(np.logical_not(pred), y)

TP = sum(TP_)
```

```
FP = sum(FP_)
TN = sum(TN_)
FN = sum(FN_)

TPR = TP / (TP + FN)
TNR = TN / (TN + FP)
FPR = 1 - TNR
FNR = 1 - TPR

# BER
BER = 1 - 0.5 * (TP / (TP + FN) + TN / (TN + FP))
```

```
print("True Positive: %d" % TP)
print("True Negative: %d" % TN)
print("False Positive: %d" % FP)
print("False Negative: %d" % FN)
print("True Positive Rate: %.4f" % TPR)
print("True Negative Rate: %.4f" % TNR)
print("False Positive Rate: %.4f" % FPR)
print("False Negative Rate: %.4f" % FNR)
print("Balanced Error Rate: %.6f" % BER)
```

```
True Positive: 14201
True Negative: 10503
False Positive: 5885
False Negative: 19411
True Positive Rate: 0.4225
True Negative Rate: 0.6409
False Positive Rate: 0.3591
False Negative Rate: 0.5775
Balanced Error Rate: 0.468303
```

Question. 8

```
# conf = mod.decision_function(X)
```

```
# confSorted = list(zip(conf, y))
# confSorted.sort(key=lambda t: t[0], reverse=True)
```

```
# confSorted[:10]
```

```
prob = mod.predict_proba(X)
probSorted = list(zip(prob, y))
```

```
probSorted[0][0][1]
```

```
0.46054325276076535
```

```
probSorted.sort(key=lambda t : t[0][1], reverse=True)
```

```
probSorted[:10]
```

```
[(array([0.19459931, 0.80540069]), 1),
 (array([0.19643684, 0.80356316]), 1),
```

```
 (array([0.20622631, 0.79377369]), 1),
 (array([0.21202257, 0.78797743]), 1),
 (array([0.21655241, 0.78344759]), 1),
 (array([0.22127384, 0.77872616]), 1),
 (array([0.22724752, 0.77275248]), 0),
 (array([0.23156561, 0.76843439]), 1),
 (array([0.23498476, 0.76501524]), 1),
 (array([0.23606837, 0.76393163]), 0)]
```

290
```
probSorted[-10:]
```

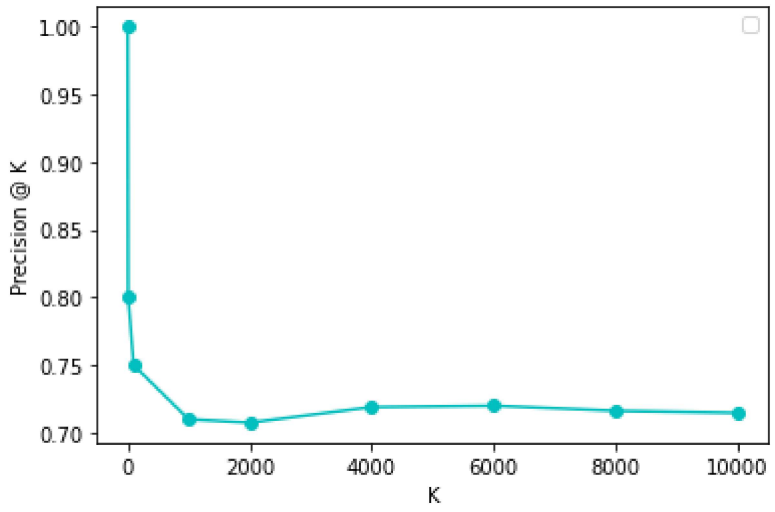
290
```
[(array([0.56239992, 0.43760008]), 1),
 (array([0.56239992, 0.43760008]), 1),
 (array([0.56239992, 0.43760008]), 0),
 (array([0.56239992, 0.43760008]), 1),
 (array([0.56239992, 0.43760008]), 1),
 (array([0.56239992, 0.43760008]), 1),
 (array([0.56239992, 0.43760008]), 1),
 (array([0.56239992, 0.43760008]), 1),
 (array([0.56239992, 0.43760008]), 0),
 (array([0.56239992, 0.43760008]), 0)]
```

291
```
import matplotlib.pyplot as plt
```

292
```
# plot a graph
K = np.array([1, 10, 100, 1000, 2000, 4000, 6000, 8000, 10000])
```

293
```
p_at_k = np.array([sum(map(lambda x : x[1], probSorted[:k])) / k for k in K])
plt.plot(K, p_at_k, 'co-')
plt.xlabel('K')
plt.ylabel('Precision @ K')
plt.legend()
plt.show()
```

```
No handles with labels found to put in legend.
```



Question. 9

294
```
pred_y = [1 if p[1] > p[0] else 0 for p in prob]
probSorted2 = list(zip(prob, y, pred_y))
```

```
295 probSorted2[:10]
```

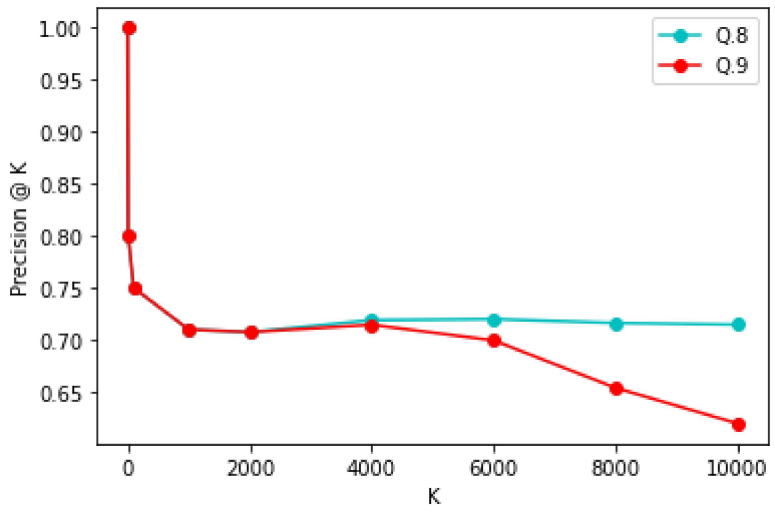
```
295 [(array([0.53945675, 0.46054325]), 0, 0),
     (array([0.53276565, 0.46723435]), 0, 0),
     (array([0.52765121, 0.47234879]), 0, 0),
     (array([0.52721003, 0.47278997]), 0, 0),
     (array([0.46146669, 0.53853331]), 1, 1),
     (array([0.49829621, 0.50170379]), 0, 1),
     (array([0.52102926, 0.47897074]), 0, 0),
     (array([0.48723601, 0.51276399]), 0, 1),
     (array([0.52094091, 0.47905909]), 1, 0),
     (array([0.4711576, 0.5288424]), 1, 1)]
```

```
296 probSorted2.sort(key=lambda t : abs(t[0][1] - 0.5), reverse=True)
```

```
297 probSorted2[:10]
```

```
297 [(array([0.19459931, 0.80540069]), 1, 1),
     (array([0.19643684, 0.80356316]), 1, 1),
     (array([0.20622631, 0.79377369]), 1, 1),
     (array([0.21202257, 0.78797743]), 1, 1),
     (array([0.21655241, 0.78344759]), 1, 1),
     (array([0.22127384, 0.77872616]), 1, 1),
     (array([0.22724752, 0.77275248]), 0, 1),
     (array([0.23156561, 0.76843439]), 1, 1),
     (array([0.23498476, 0.76501524]), 1, 1),
     (array([0.23606837, 0.76393163]), 0, 1)]
```

```
298 p2_at_k = np.array([sum(map(lambda x : 1 if x[1] == x[2] else 0, probSorted2[:k])) / k for k in K])
    plt.plot(K, p_at_k, 'co-', label='Q.8')
    plt.plot(K, p2_at_k, 'ro-', label='Q.9')
    plt.xlabel('K')
    plt.ylabel('Precision @ K')
    plt.legend()
    plt.show()
```




```
299 p2_at_1 = sum(map(lambda x : 1 if x[1] == x[2] else 0, probSorted2[:1])) / 1
    p2_at_100 = sum(map(lambda x : 1 if x[1] == x[2] else 0, probSorted2[:100])) / 100
    p2_at_10000 = sum(map(lambda x : 1 if x[1] == x[2] else 0, probSorted2[:10000])) / 10000
```

```
300 print("precision@1 = %.4f" % p2_at_1)
    print("precision@100 = %.4f" % p2_at_100)
```

```
print("precision@10000 = %.4f" % p2_at_10000)
```

```
precision@1 = 1.0000
precision@100 = 0.7500
precision@10000 = 0.6196
```