Lab 08

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Assignment performed by:

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Link: https://github.com/fafasonga/advstat-labs


```
In [103]: import pandas as pd
          import numpy as np
          from tqdm import tqdm
          import scipy.stats as st
          import matplotlib.pyplot as plt
          from scipy.optimize import minimize
          from sklearn.linear_model import LinearRegression
```

1 Assignment 1

1.1 Loading Datasets

```
In [14]: data1 = pd.read_csv("./ds-boot-2.csv", sep='\t')
```

```
In [15]: data1.head()
```

```
Out[15]:    id       p1   p2   p3       p4    p5       p6       p7       p8       p9  \
         0  11  6.48148  3.0  5.0  7.75000   0.0  7.16667  8.16667  9.66667  6.16667
         1  12  5.74074  4.0  8.0  7.33333   8.0  8.83333  9.75000  9.66667  9.00000
         2  25  7.59259  7.0  8.0  7.66667   8.0  9.66667  9.50000  6.16667  9.66667
         3  31  5.96297  4.0  8.0  9.33333  10.0  9.33333  7.00000  8.50000  9.66667
         4  48  5.44444  1.0  3.5  6.41667   9.0  8.50000  7.08333  6.33333  9.00000

            ...      p24      p25  p26      p27  p28   y1     y2    y3    y4    y5
         0  ...  1.66667  3.16667  0.0  0.00000  0.0  1.0   5.00  7.44  1.18  4.38
         1  ...  2.50000  5.50000  5.0  8.66667  8.0  4.5   4.25  8.93  2.00  6.03
         2  ...  3.50000  3.50000  9.0  6.50000  7.0  7.5  11.00  8.97  2.00  9.12
         3  ...  0.00000  0.00000  0.0  0.00000  0.0  4.0   6.25  8.93  1.82  6.41
         4  ...  0.00000  0.00000  0.0  0.00000  0.0  0.0   3.00  8.08  1.36  3.67

         [5 rows x 34 columns]
```

1.2 Estimating Mean, Median, Error and confidence Interval

```
In [16]: def bootstrap(X, B=1000, s=np.mean):
             sample = np.random.choice(X, size=(B, len(X)))
```

```
        estimations = s(sample, axis=1)
        est = estimations.mean()
        error = (((estimations - est) ** 2).sum() / (B - 1)) ** 0.5
        conf_int = np.percentile(estimations, [2.5, 97.5])
        return est, error, conf_int
```

```
In [19]: print(bootstrap(data1['y1'], s=np.mean))
```

```
(4.0254124999999998, 0.43989813760143975, array([ 3.1996875,  4.8503125]))
```

```
In [20]: print(bootstrap(data1['y1'], s=np.median))
```

```
(4.0054999999999996, 0.54407330918339103, array([ 3.,  6.]))
```

```
In [25]: target = ['y1', 'y2', 'y3', 'y4', 'y5']
```

```
In [29]: for label in target:
             print(label, 'mean:', bootstrap(data1[label], s=np.mean))
             print(label, 'meadian:', bootstrap(data1[label], s=np.median))
```

```
('y1', 'mean:', (4.0225625000000003, 0.44275302945190437, array([ 3.1371875,  4.9003125])))
('y1', 'meadian:', (4.0182500000000001, 0.53783706287890409, array([ 3.,  6.])))
('y2', 'mean:', (5.5227937499999999, 0.53026086267130679, array([ 4.4809375,  6.5753125])))
('y2', 'meadian:', (6.1651249999999997, 0.66438657338472307, array([ 4.625,  7.25 ])))
('y3', 'mean:', (7.3128430000000009, 0.45754116825335689, array([ 6.35858125,  8.11305625])))
('y3', 'meadian:', (8.3044249999999984, 0.27978818023783802, array([ 7.96,  8.92])))
('y4', 'mean:', (1.5286759999999999, 0.10993528398865246, array([ 1.29313125,  1.72755   ])))
('y4', 'meadian:', (1.8497199999999998, 0.13321399163589226, array([ 1.64,  2.  ])))
('y5', 'mean:', (5.6435752499999996, 0.45151077922757971, array([ 4.7133125 ,  6.55406875])))
('y5', 'meadian:', (6.1481299999999992, 0.44503872029584418, array([ 5.09    ,  7.04625])))
```

1.3 Linear Reagression of Initial Sample

```
In [31]: features = ['p1', 'p2', 'p3', 'p4', 'p5', 'p6']
```

```
In [34]: for label in target:
             model = LinearRegression()
             model.fit(data1[features], data1[label])
             print(label, model.coef_)
```

```
('y1', array([ 0.19590832,  0.29677494, -0.18401943,  0.02210887,  0.13189801,
        0.28986106]))
('y2', array([ 0.12744323,  0.18071353,  0.03383592,  0.10825791, -0.05377676,
        0.57520423]))
('y3', array([ 0.15867643,  0.01838332,  0.12772208,  0.29122447,  0.17922699,
        0.23654851]))
('y4', array([-0.00486422,  0.00423981,  0.11801823,  0.02819031,  0.06902863,
        0.00098964]))
('y5', array([ 0.152759  ,  0.16444265,  0.01372641,  0.1348942 ,  0.10091446,
        0.34552193]))
```

```
In [41]: ''' returns estimations of coefficients (with intercept) and 95% confidence intervals'''
```

```
Out[41]: ' returns estimations of coefficients (with intercept) and 95% confidence intervals'
```

```
In [46]: def coeffs_bootstrap(X, Y, B=1000, model_class=LinearRegression):

             n = X.shape[0]
             coeffs = []
             for b in range(B):
                 model = model_class()
                 idx = np.random.randint(n, size=n)
                 model.fit(X.as_matrix()[idx, :], Y.as_matrix()[idx])
                 coeffs.append(np.append(model.coef_, model.intercept_))
             coeffs = np.array(coeffs)
             conf_int = np.percentile(coeffs, [2.5, 97.5], axis=0)
             return coeffs.mean(axis=0), conf_int


         for label in targets:
             coeffs, intervals = coeffs_bootstrap(data1[features], data1[label])
             print(label,
                   'coef', coeffs[:-1], 'inpt', coeffs[-1],
                   'from', intervals[0][:-1], '    ', intervals[0][-1],
                   'to  ', intervals[1][:-1], '    ', intervals[1][-1])
```

```
('y1', 'coef', array([ 0.22463472,  0.28980205, -0.10382083,  0.08125146,  0.11644295,
        0.15215769]), 'inpt', -0.41910306506748296, 'from', array([ -1.40856474e-01,  -2.29086371e-04,
        -4.16708187e-01,  -4.28611544e-01,  -6.51422751e-01]), '    ', -1.5770405968985788, 'to  ', arra
        0.63016197]), '    ', 0.19862459178211342)
('y2', 'coef', array([ 0.12663644,  0.1667847 ,  0.12882126,  0.15719443, -0.05688789,
        0.4505047 ]), 'inpt', -0.57658408788651783, 'from', array([-0.33377816, -0.17864577, -0.47830489
       -0.40707145]), '    ', -1.8721329917677563, 'to  ', array([ 0.62772802,  0.51895294,  0.9030343
        0.89073681]), '    ', 0.044147174173777975)
('y3', 'coef', array([ 0.14284834,  0.02293654,  0.10997328,  0.29424803,  0.19422908,
        0.25047633]), 'inpt', 0.59394802278581382, 'from', array([-0.02319219, -0.12887419, -0.13574963
        0.08008447]), '    ', 0.12156386822031259, 'to  ', array([ 0.34324145,  0.14931606,  0.34657332
        0.52436244]), '    ', 1.5549078117119659)
('y4', 'coef', array([-0.0068014 ,  0.00369745,  0.1123937 ,  0.03663883,  0.06645114,
        0.00278617]), 'inpt', 0.16352285098141914, 'from', array([-0.07835879, -0.04661939,  0.0236164
       -0.05942521]), '    ', 0.0025354324960521601, 'to  ', array([ 0.06908237,  0.04289823,  0.2055900
        0.09860887]), '    ', 0.45798030791012839)
('y5', 'coef', array([ 0.15660345,  0.15835752,  0.07123004,  0.18233068,  0.08581595,
        0.2632244 ]), 'inpt', -0.10523573325319747, 'from', array([-0.06399186, -0.03372856, -0.22236054
       -0.23347076]), '    ', -0.60510108586200617, 'to  ', array([ 0.42009691,  0.32933409,  0.45092234
        0.533443  ]), '    ', 0.28852436458369435)
```

2 Assignment 2

2.1 Loading Datasets

```
In [65]: data2 = pd.read_csv("./ds-boot-1.csv", sep='\t')
```

```
In [66]: data2
```

```
Out[66]:       day  bugsPerDay  cummBugs
         0       1           0         0
```

1	2	1	1
2	3	0	1
3	4	2	3
4	5	1	4
5	6	0	4
6	7	0	4
7	8	0	4
8	9	0	4
9	10	0	4
10	11	0	4
11	12	0	4
12	13	3	7
13	14	1	8
14	15	2	10
15	16	0	10
16	17	0	10
17	18	0	10
18	19	0	10
19	20	0	10
20	21	0	10
21	22	2	12
22	23	0	12
23	24	0	12
24	25	0	12
25	26	0	12
26	27	0	12
27	28	1	13
28	29	0	13
29	30	0	13
...	...	...	...
1297	1298	2	5521
1298	1299	3	5524
1299	1300	0	5524
1300	1301	1	5525
1301	1302	0	5525
1302	1303	0	5525
1303	1304	3	5528
1304	1305	1	5529
1305	1306	1	5530
1306	1307	16	5546
1307	1308	0	5546
1308	1309	0	5546
1309	1310	0	5546
1310	1311	1	5547
1311	1312	6	5553
1312	1313	11	5564
1313	1314	3	5567
1314	1315	3	5570
1315	1316	0	5570
1316	1317	0	5570
1317	1318	1	5571
1318	1319	1	5572
1319	1320	5	5577
1320	1321	4	5581

```
1321  1322           4       5585
1322  1323           0       5585
1323  1324           0       5585
1324  1325           1       5586
1325  1326           3       5589
1326  1327           1       5590

[1327 rows x 3 columns]
```

In [67]:
```
data2.head()
```

Out[67]:

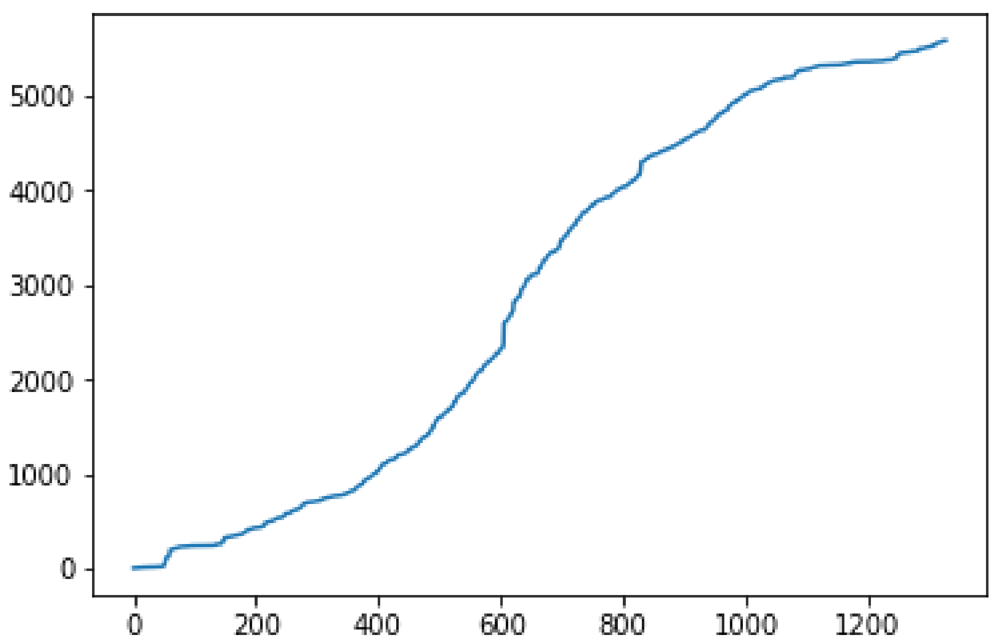
	day	bugsPerDay	cummBugs
0	1	0	0
1	2	1	1
2	3	0	1
3	4	2	3
4	5	1	4

In [68]:
```
data2.describe()
```

Out[68]:

	day	bugsPerDay	cummBugs
count	1327.000000	1327.000000	1327.000000
mean	664.000000	4.212509	2894.581763
std	383.216214	8.803797	2013.662007
min	1.000000	0.000000	0.000000
25%	332.500000	0.000000	765.000000
50%	664.000000	2.000000	3186.000000
75%	995.500000	6.000000	4994.500000
max	1327.000000	224.000000	5590.000000

In [69]:
```
plt.plot(data2['cummBugs'])
plt.show()
```



```
In [90]: x = np.array(data2.day)
         y = np.array(data2.cummBugs)
```

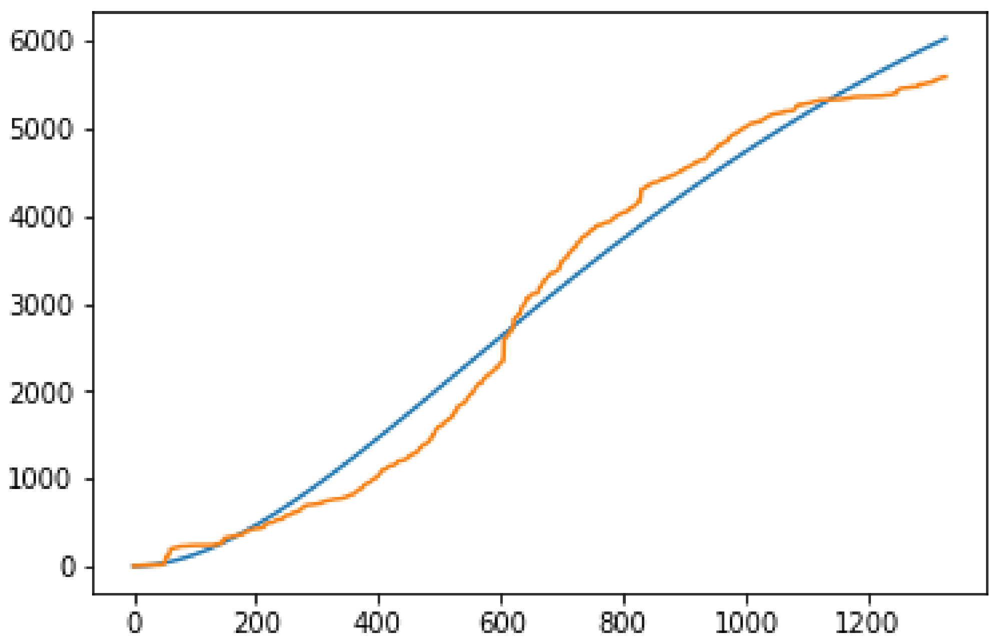
```
In [98]: def predict(a,b,x):
             return a * (1 - (1 + b * x) * np.exp(-b * x))
```

```
In [99]: def estimate(X, Y):
             def loss(ds):
                 return np.mean((predict(ds[0],ds[1], X) - Y) ** 2)
             return minimize(loss,  [5000., 0.001], tol=1e-25).x
```

```
In [100]: ds = estimate(x,y)
          print ds
```

```
[  8.54124017e+03   1.85849254e-03]
```

```
In [101]: plt.plot(predict(ds[0], ds[1], x))
          plt.plot(y)
          plt.show()
```



2.2 Bootstrap Estimations:

```
In [105]: exp_len = 900
          B = 1000
          bs_ds = []
          for _ in tqdm(range(B)):
              samp_len = np.random.geometric(1.0/(exp_len + 1.0))
              if samp_len >= len(data2):
                  samp_len = len(data2) - 1
```

```
            start_ind = np.random.randint(0, len(data2) - samp_len)
            samp_ind = np.array(range(start_ind, start_ind + samp_len))
            x_bs = x[samp_ind]
            y_bs = y[samp_ind]
            bs_ds.append(estimate(x_bs,y_bs))
        bs_ds = np.array(bs_ds)
```

```
 73%|[U+2588][U+2588][U+2588][U+2588][U+2588][U+2588][U+2588][U+258E]  | 729/1000 [00:27<00:10, 26.81it/
  rhok = 1.0 / (numpy.dot(yk, sk))
100%|[U+2588][U+2588][U+2588][U+2588][U+2588][U+2588][U+2588][U+2588][U+2588][U+2588]| 1000/1000 [00:36<
```

In [106]:
```
deltas = ds - bs_ds
deltas_l = np.percentile(deltas, 2.5,axis = 0)
deltas_r = np.percentile(deltas, 97.5,axis = 0)
l_bound = ds - deltas_r
r_bound = ds - deltas_l
```

In [107]:
```
pd.DataFrame([{'est': ds[i],
     'l': l_bound[i],
     'r': r_bound[i]} for i in range(2)])
```

Out[107]:

	est	l	r
0	8541.240171	997.769587	1.899618e+06
1	0.001858	0.000087	1.012131e+00