summer2019-assignment6

August 3, 2019

In [75]:
```
import numpy as np
from math import log, sqrt
import random
import scipy.stats as st
import pandas as pd
import matplotlib.pyplot as plt
%cd '/Users/xiaoyingliu/desktop'
```

```
/Users/xiaoyingliu/Desktop
```

In [72]:
```
data=pd.read_csv('data.csv')
```

In [73]:
```
data.head()
```

Out[73]:

	correct	n1	n2
0	1	5	7
1	1	4	8
2	1	1	13
3	1	3	1
4	1	1	2

In [74]:
```
n2=data['n2']
n1=data['n1']
a=data['correct']
step=300
```

In [ ]:
```
#1. explain why we need log instead of unlog
#ANS: according to the log rule, log(a*b)=log(a)+log(b), if we use logrithm verison of
#complex vector multiplication on it. This will make the operation more efficient, con
#necessary.
```

In [ ]:
```
#2. explain why the form of will avoid us from integration
#Accorning to bayes rule, p(W'|D)=p(W' and D)/p(D), while p(W|D)=p(W and D)/p(D). Both
#eliminate p(D), we do need integration to calculate p(D). In such way, we avoid doing
```

In [76]:
```
#3.Write functions to compute something proportional to the log prior and log posteri
#model. You will prevent later frustration by ensuring that your prior correctly hand
```

```
        #(what should it return?)
        def compute_ll(n1, n2, a, W):
            #accuracy is the raw data column
            # this function takes a numpy array for n1, n2, and the accuracy (0/1), whether t
            # as well as W, the hypothesis
            # and returns the *log* likelihood of the responses, log P(acc | n1, n2, W)
            assert(len(n1) == len(n2) == len(a))
            ll = 0.0
            for i in range(len(n1)):
                p = 1.0-scipy.stats.norm.cdf(0, loc=abs(n1[i]-n2[i]), scale=W*sqrt(n1[i]**2 +
                if a[i] == 1:
                    ll += log(p) if p > 0.0 else float("-inf")
                elif a[i] == 0:
                    ll += log(1.0-p) if p < 1.0 else float("-inf")
                else:
                    assert(False, "a[i] must be 0 or 1")
            return ll
```

In [77]:
```
def compute_prior(w):
    if w<0:
        return float("-inf")
    else:
        prior=log(st.expon.pdf(w))
        return np.sum(prior)
```

In [159]:
```
#4.
def compute_posterior(n1,n2,a,step):
    w=[]
    post=[]

    curr_w=np.random.randn()
    while(curr_w<0):
        curr_w=np.random.randn()
    curr_prior=compute_prior(curr_w)
    curr_ll=log_likelihood(n1,n2,a,curr_w)
    curr_post=curr_prior+curr_ll

    for i in range(step):
        prop_w=curr_w+np.random.randn()*0.05
        prop_prior=compute_prior(prop_w)
        prop_ll=compute_ll(n1,n2,a,prop_w)
        prop_post=prop_prior+prop_ll

        if((prop_ll>curr_ll) or np.exp(prop_ll-curr_ll)>random.random()):
            curr_w=prop_w
            curr_prior,curr_ll,curr_post=prop_prior,prop_ll,prop_post
```

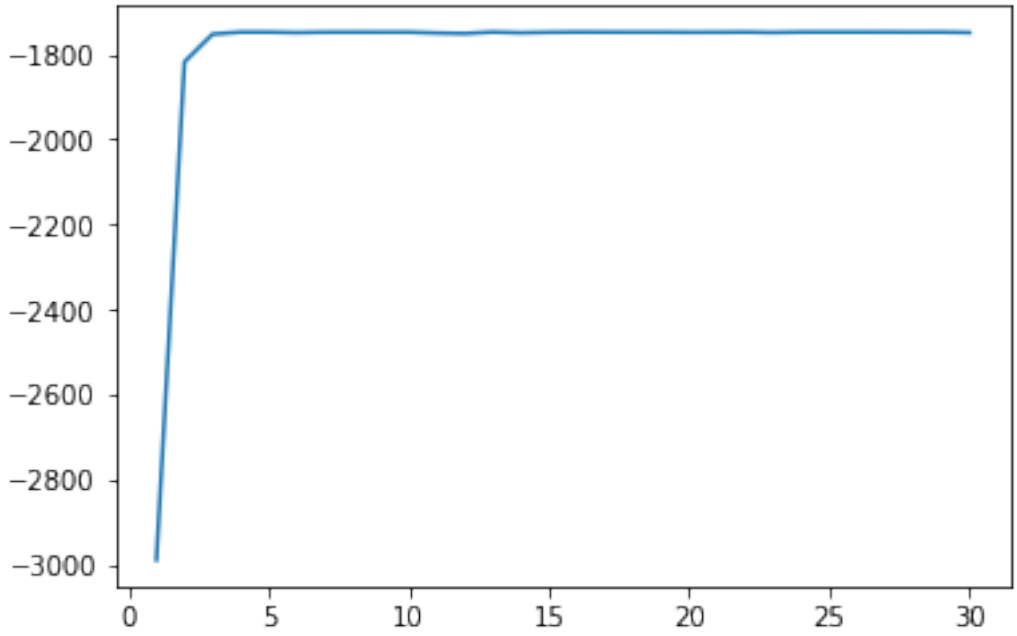
```
            if i%10==0:
                w.append(curr_w)
                post.append(curr_post)

            if i%200==0:
                print(count)

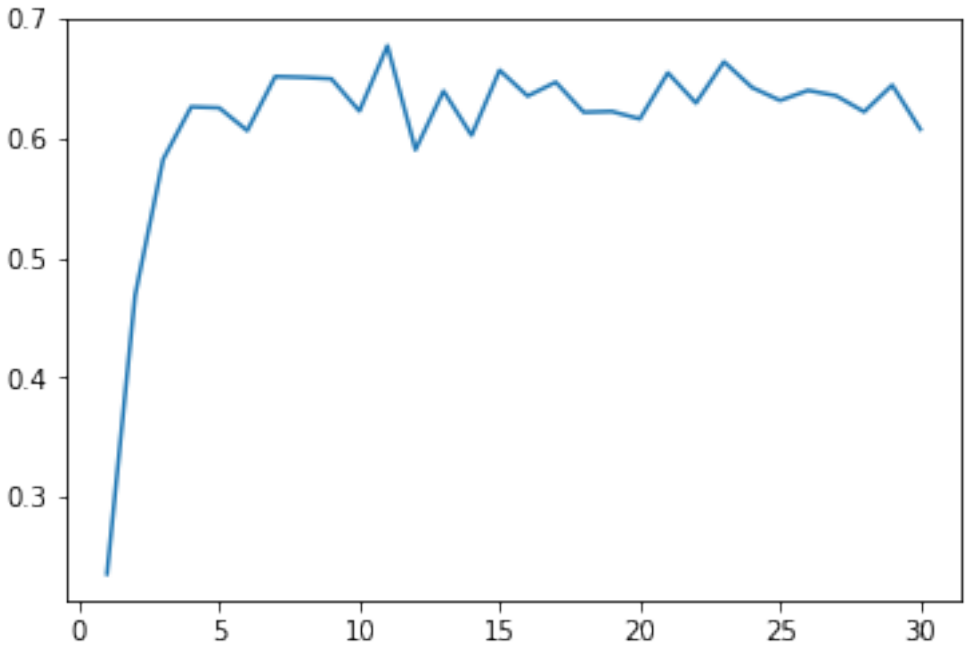
        return w,post
```

In [90]:
```
w,post=compute_posterior(n1,n2,a,step)
```

In [93]:
```
#4(a)
x=range(1,31)
plt.plot(x,post)
plt.show()
```



In [94]:
```
#4(b)
x=range(1,31)
plt.plot(x,w)
plt.show()
```



In [146]:
```
#4(c)a histogram of the samples of W over the first 10,000 samples after 1000 sample
random.seed(12345)
w,post=compute_posterior(n1,n2,a,10000)
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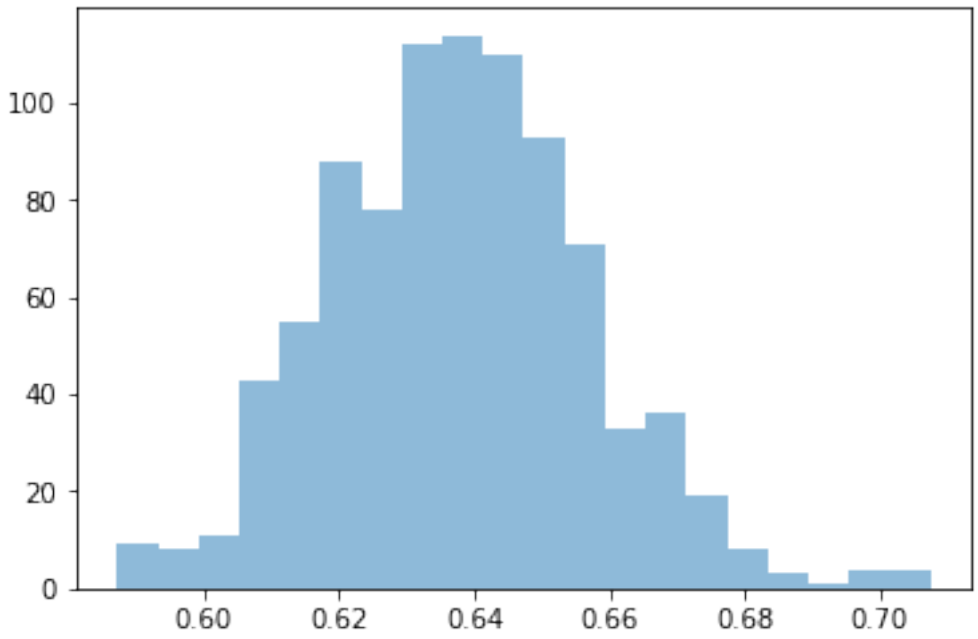
In [147]:
```
#test cell
w_10000=w
w_without_burn_in=w_10000[100:1000]
```

In [149]:
```
plt.hist(w_without_burn_in,bins=20,alpha=0.5)
plt.show()
```



```
In [152]: #5. Use your sampler to determine the probability that W is in the interval [0.2,0.3
          #probability?
          def interval_prob(w):
              count=0
              for i in w:
                  if i>=0.2 and i<=0.3:
                      count+=1
              return count/len(w)

In [153]: interval_prob(w_10000)

Out[153]: 0.0

In [139]: # 6.
          random.seed(567)
          #(a) a simulation that tries both of these options (you'll want to run more than one
          #time!)
          #option 1: one chain for 200 steps
          w_200,post_200=compute_posterior(n1,n2,a,200)
          #option 2: two chains and 100 step for each
          w_f100,post_f100=compute_posterior(n1,n2,a,100)
          w_s100,post_s100=compute_posterior(n1,n2,a,100)
          w_100=w_f100+w_s100
          post_100=post_f100+post_s100

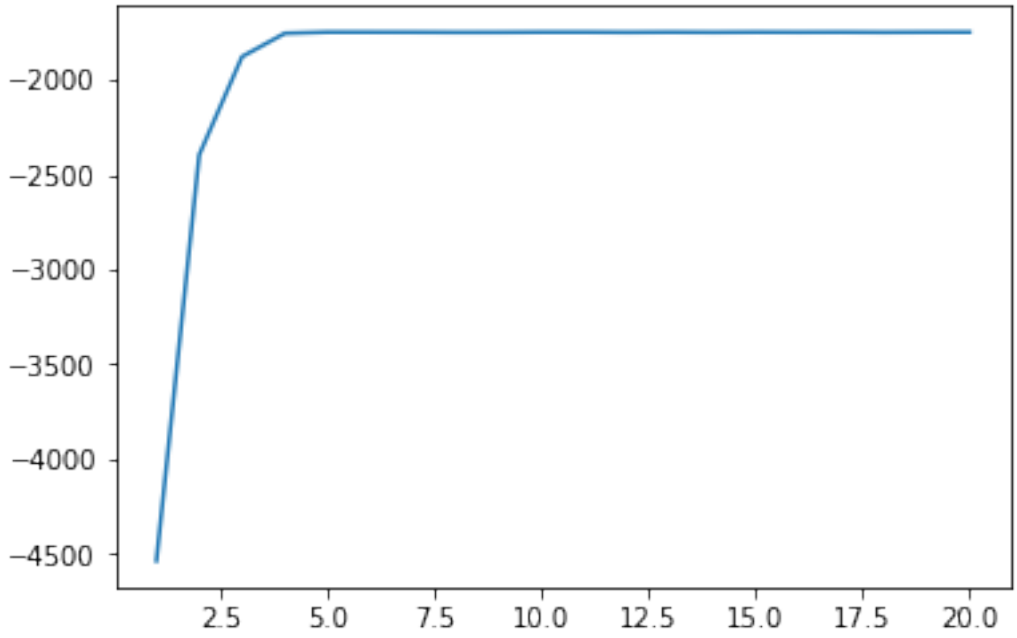
In [140]: #(b) #the higher the avg posterior is, the better.just compare the avg posterior
          avg_post_200=sum(post_200)/len(post_200)
          avg_post_100=sum(post_100)/len(post_100)
          avg_post_200

Out[140]: -1926.6038021690547

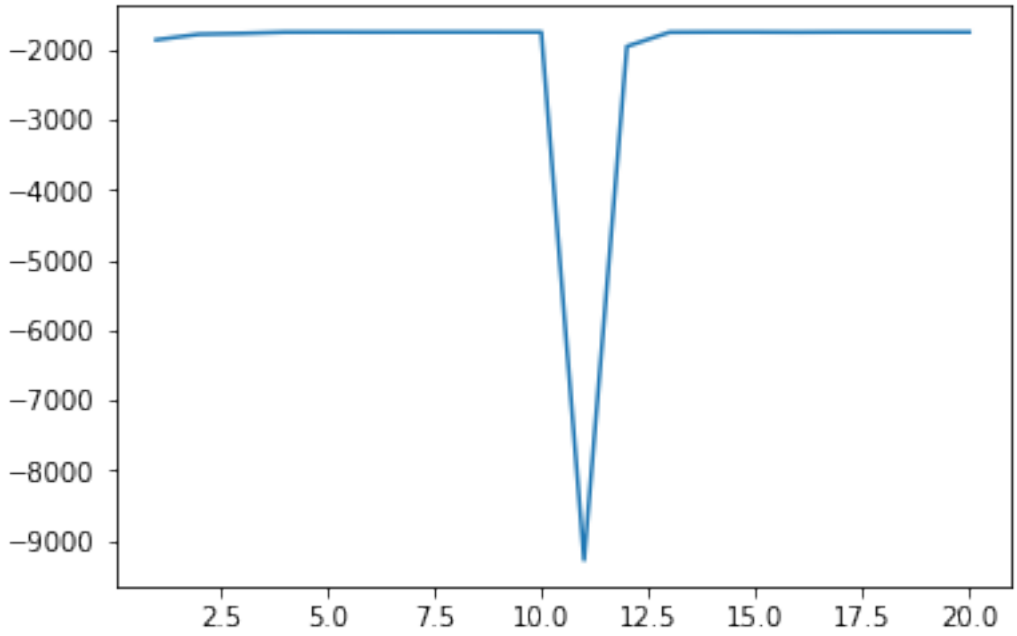
In [141]: avg_post_100

Out[141]: -2143.0432620022425

In [142]: #visualization of two options
          #option1 :
          x=range(1,21)
          plt.plot(x,post_200)
          plt.show()
```



In [143]:
```
#option2:
x=range(1,21)
plt.plot(x,post_100)
plt.show()
```



```
In [ ]: #Since the higher the avg posterior is, the better the estimate is. According to the v
```