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import numpy as np
import itertools
import random
import matplotlib.pyplot as plt
import numpy as np

theta=[10,15,17,20]
n=[400,200,300,100]
var=5
sample=[]
import numpy as np
import itertools
import random
import matplotlib.pyplot as plt
import numpy as np

theta=[10,15,17,20]
n=[400,200,300,100]
var=5
sample=[]

for i in range(4):
   sample.append(list(np.random.normal(theta[i],1.0/np.sqrt(var),n[i])))

sample2=list(itertools.chain(*sample))
#shuffle the sample twice
random.shuffle(sample2)
random.shuffle(sample2)
fig=plt.figure()
plt.subplot(2,3,1)
plt.hist(sample2,bins=30,color='white')
plt.title('Part a: Histogram')
plt.xlabel('x')
plt.ylabel('Counts')
plt.subplot(2,3,2)
plt.plot(sample2,'ro')
plt.title('Part d: Data Points')
plt.xlabel('i')
plt.ylabel('xi')

def e10(*x):
   return np.exp(-0.1*len(x)*(np.mean(x)-10.0)**2)
def e15(*x):
   return np.exp(-0.1*len(x)*(np.mean(x)-15.0)**2)
def e17(*x):
   return np.exp(-0.1*len(x)*(np.mean(x)-17.0)**2)
def e20(*x):
   return np.exp(-0.1*len(x)*(np.mean(x)-20.0)**2)
def post10(*x):
   return e10(x)/(e10(x)+e15(x)+e17(x)+e20(x))
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def post15(*x):
   return e15(x)/(e10(x)+e15(x)+e17(x)+e20(x))
def post17(*x):
   return e17(x)/(e10(x)+e15(x)+e17(x)+e20(x))
def post20(*x):
   return e20(x)/(e10(x)+e15(x)+e17(x)+e20(x))

post10_seq=[]
post15_seq=[]
post17_seq=[]
post20_seq=[]
for i in range(1,1000):
   post10_seq.append(post10(sample2[0:i]))
post15_seq.append(post15(sample2[0:i]))
post17_seq.append(post17(sample2[0:i]))
post20_seq.append(post20(sample2[0:i]))
plt.subplot(2,3,3)
plt.plot(post10_seq)
plt.title('Part e: Posterior for Theta=10')
plt.xlabel('Number of Data Points')
plt.ylabel('Posterior')
plt.subplot(2,3,4)
plt.plot(post15_seq)
plt.title('Part e: Posterior for Theta=15')
plt.xlabel('Number of Data Points')
plt.ylabel('Posterior')
plt.subplot(2,3,5)
plt.plot(post17_seq)
plt.title('Part e: Posterior for Theta=17')
plt.xlabel('Number of Data Points')
plt.ylabel('Posterior')
plt.subplot(2,3,6)
plt.plot(post20_seq)
plt.title('Part e: Posterior for Theta=20')
plt.xlabel('Number of Data Points')
plt.ylabel('Posterior')
fig.subplots_adjust(hspace=.4)
plt.show()
print post10_seq[-1],post15_seq[-1],post17_seq[-1],post20_seq[-1]
for i in range(4):
   sample.append(list(np.random.normal(theta[i],1.0/np.sqrt(var),n[i])))

sample2=list(itertools.chain(*sample))
#shuffle the sample twice
random.shuffle(sample2)
random.shuffle(sample2)
fig=plt.figure()
plt.subplot(2,3,1)
plt.hist(sample2,bins=30,color='white')
plt.title('Part a: Histogram')
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plt.xlabel('x')
plt.ylabel('Counts')
plt.subplot(2,3,2)
plt.plot(sample2,'ro')
plt.title('Part d: Data Points')
plt.xlabel('i')
plt.ylabel('xi')

def e10(*x):
   return np.exp(-0.1*len(x)*(np.mean(x)-10.0)**2)
def e15(*x):
   return np.exp(-0.1*len(x)*(np.mean(x)-15.0)**2)
def e17(*x):
   return np.exp(-0.1*len(x)*(np.mean(x)-17.0)**2)
def e20(*x):
   return np.exp(-0.1*len(x)*(np.mean(x)-20.0)**2)

def post10(*x):
   return e10(x)/(e10(x)+e15(x)+e17(x)+e20(x))
def post15(*x):
   return e15(x)/(e10(x)+e15(x)+e17(x)+e20(x))
def post17(*x):
   return e17(x)/(e10(x)+e15(x)+e17(x)+e20(x))
def post20(*x):
   return e20(x)/(e10(x)+e15(x)+e17(x)+e20(x))

post10_seq=[]
post15_seq=[]
post17_seq=[]
post20_seq=[]
for i in range(1,1000):
   post10_seq.append(post10(sample2[0:i]))
post15_seq.append(post15(sample2[0:i]))
post17_seq.append(post17(sample2[0:i]))
post20_seq.append(post20(sample2[0:i]))
plt.subplot(2,3,3)
plt.plot(post10_seq)
plt.title('Part e: Posterior for Theta=10')
plt.xlabel('Number of Data Points')
plt.ylabel('Posterior')
plt.subplot(2,3,4)
plt.plot(post15_seq)
plt.title('Part e: Posterior for Theta=15')
plt.xlabel('Number of Data Points')
plt.ylabel('Posterior')
plt.subplot(2,3,5)
plt.plot(post17_seq)
plt.title('Part e: Posterior for Theta=17')
plt.xlabel('Number of Data Points')
plt.ylabel('Posterior')
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plt.subplot(2,3,6)
plt.plot(post20_seq)
plt.title('Part e: Posterior for Theta=20')
plt.xlabel('Number of Data Points')
plt.ylabel('Posterior')
fig.subplots_adjust(hspace=.4)
plt.show()
print post10_seq[-1],post15_seq[-1],post17_seq[-1],post20_seq[-1]

#part f
from scipy import stats
stats.ttest_1samp(sample2,10)
t10_seq=[]
t15_seq=[]
t17_seq=[]
t20_seq=[]
for i in range(1,1000):
   t10_seq.append(stats.ttest_1samp(sample2[0:i],10)[1])
t15_seq.append(stats.ttest_1samp(sample2[0:i],15)[1])
t17_seq.append(stats.ttest_1samp(sample2[0:i],17)[1])
t20_seq.append(stats.ttest_1samp(sample2[0:i],20)[1])
fig2=plt.figure()
plt.subplot(2,2,1)
plt.plot(t10_seq)
plt.title('Part f: P-Value for Theta=10')
plt.xlabel('Number of Data Points')
plt.ylabel('P-Value')
plt.subplot(2,2,2)
plt.plot(t15_seq)
plt.title('Part f: P-Value for Theta=15')
plt.xlabel('Number of Data Points')
plt.ylabel('P-Value')
plt.subplot(2,2,3)
plt.plot(t17_seq)
plt.title('Part f: P-Value for Theta=17')
plt.xlabel('Number of Data Points')
plt.ylabel('P-Value')
plt.subplot(2,2,4)
plt.plot(t20_seq)
plt.title('Part f: P-Value for Theta=20')
plt.xlabel('Number of Data Points')
plt.ylabel('P-Value')
fig2.subplots_adjust(hspace=.4)
plt.show()
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