Assignment 2

March 12, 2018

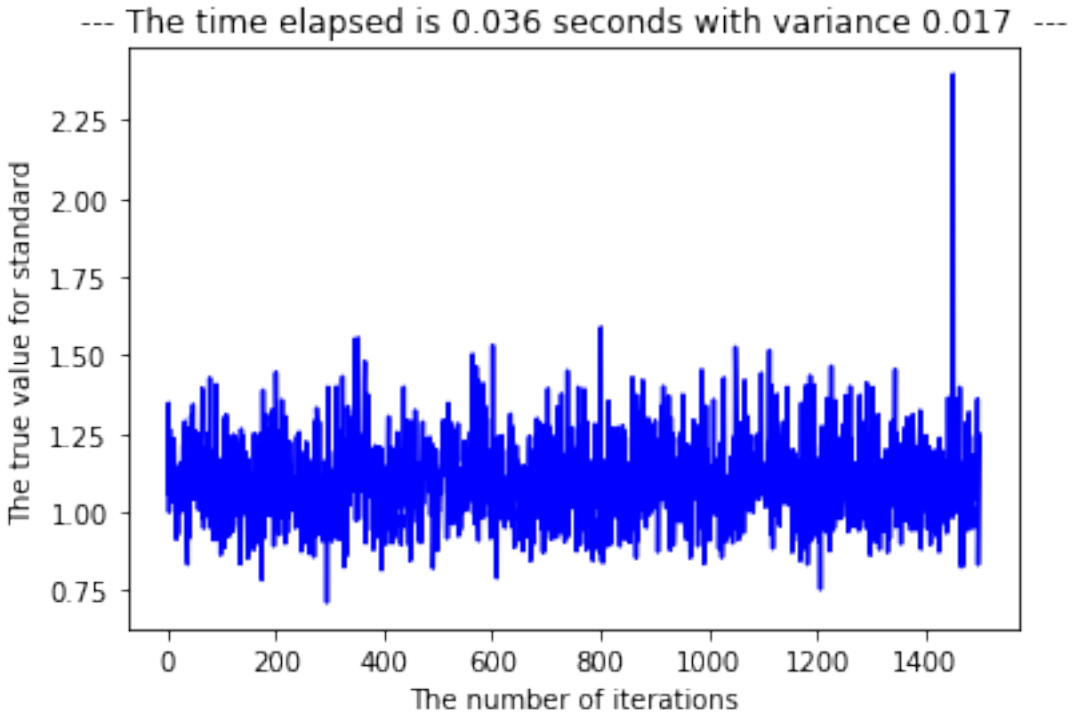
In [16]:
```
import random
import numpy as np
from matplotlib import pyplot as plt
import time
from scipy.stats import norm
from scipy.stats import t

%matplotlib inline
random.seed(999)
```

In [2]:
```
def drawPlot(elapsed_time, samples1, samples2 = None):
    x = [i for i in range(1, len(samples1) + 1)]

    plt.plot(x, samples1, color = 'blue')
    plt.xlabel("The number of iterations")
    plt.ylabel("The true value for standard")
    plt.title("--- The time elapsed is %.5s seconds with variance %.5s
              ---" % (elapsed_time, np.var(samples1)))
    if (samples2):
        plt.figure(0)
        plt.plot(x, samples2, color = 'red')
        plt.xlabel("The number of iterations")
        plt.ylabel("The true value for normalized")
        plt.title("--- The time elapsed is %.5s seconds with variance %.5s
                  ---" % (elapsed_time, np.var(samples2)))
    plt.show()
```

In [7]:
```
def showPlotTimeVariance(samplingMethod, num_iter, num_rep):
    start_time = time.time()
    currentSample1, currentSample2 = samplingMethod(num_iter, num_rep)
    finished_time = time.time()
    elapsed_time = finished_time - start_time

    drawPlot(elapsed_time, currentSample1, currentSample2)
```

In [8]:
```
# Simple MC
f = lambda x: abs(x)
def simpleMC(num_iter, num_rep):
    samples = [0]*num_iter
    for i in range(num_iter):
        data = np.random.standard_t(3, num_rep)
        samples[i] = np.mean(f(data))
    return samples, None
```

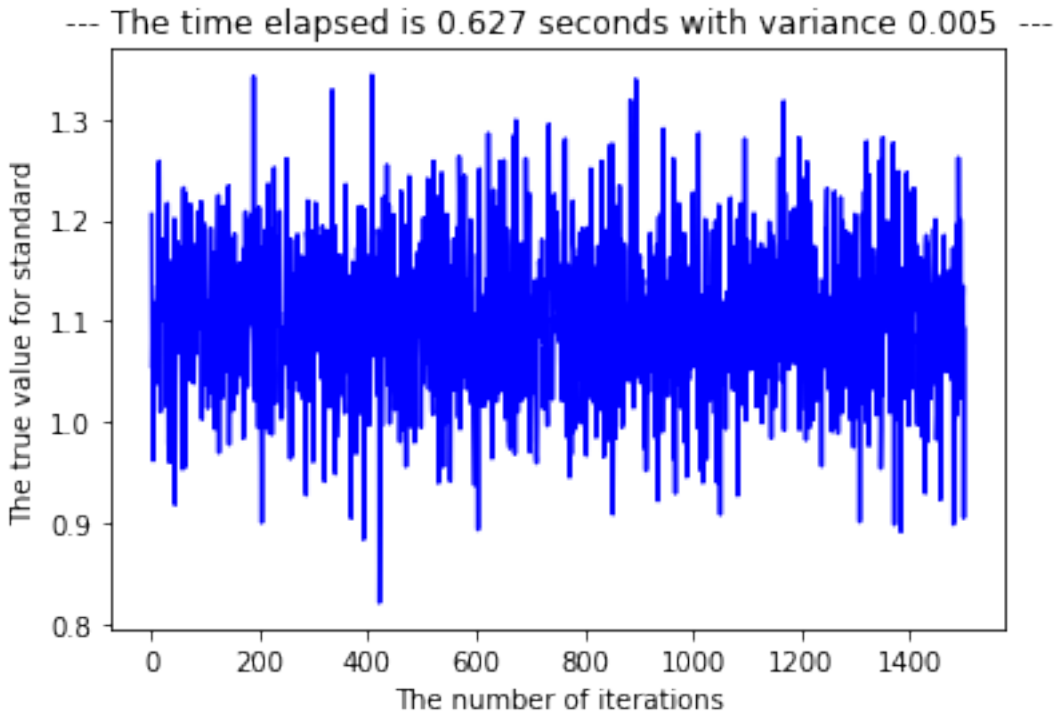
In [9]:
```
showPlotTimeVariance(simpleMC, 1500, 100)
```

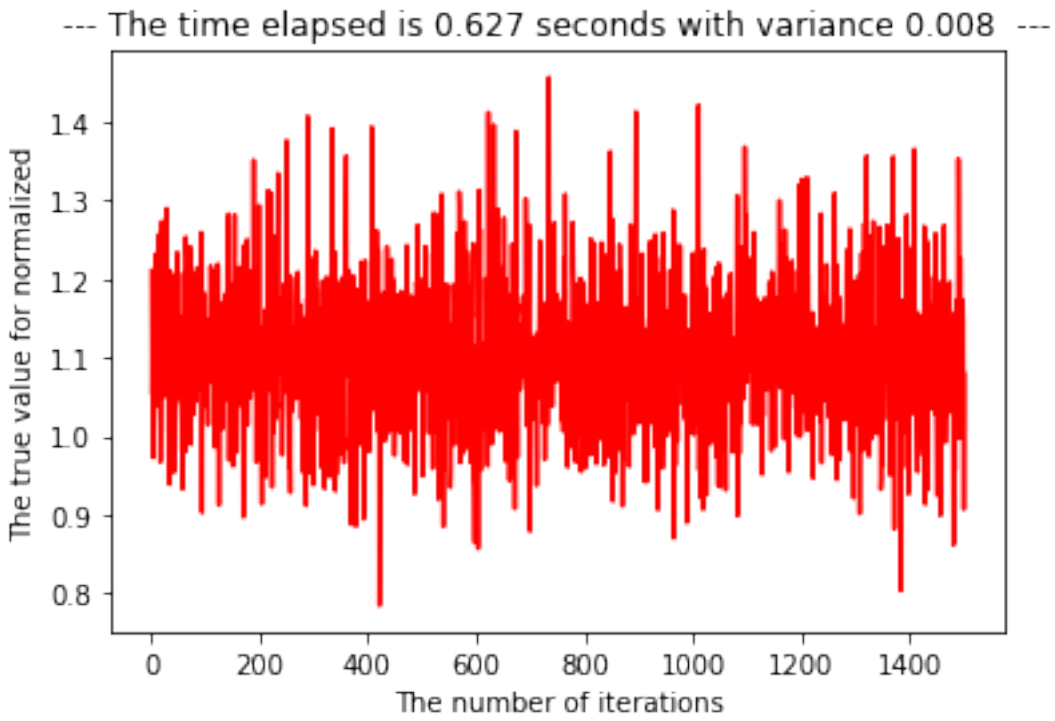


In [10]:
```
# Iportance sampling with t(1) distribution
f = lambda x: abs(x) # test function
pai = lambda x: t.pdf(x, 3)      # correct distribution
q = lambda x: t.pdf(x, 1)     # proposed distribution
w = lambda x: pai(x)/q(x)     # weight function

def importanceSampling1(num_iter, num_rep):
    standard_samples, normalized_samples = [0]*num_iter, [0]*num_iter
    for i in range(num_iter):
        data = np.random.standard_t(1, num_rep)
        weights = w(data)
        standard_samples[i] = np.mean(f(data)*weights)
        normalized_samples[i] = sum(f(data)*weights)/sum(weights)
```

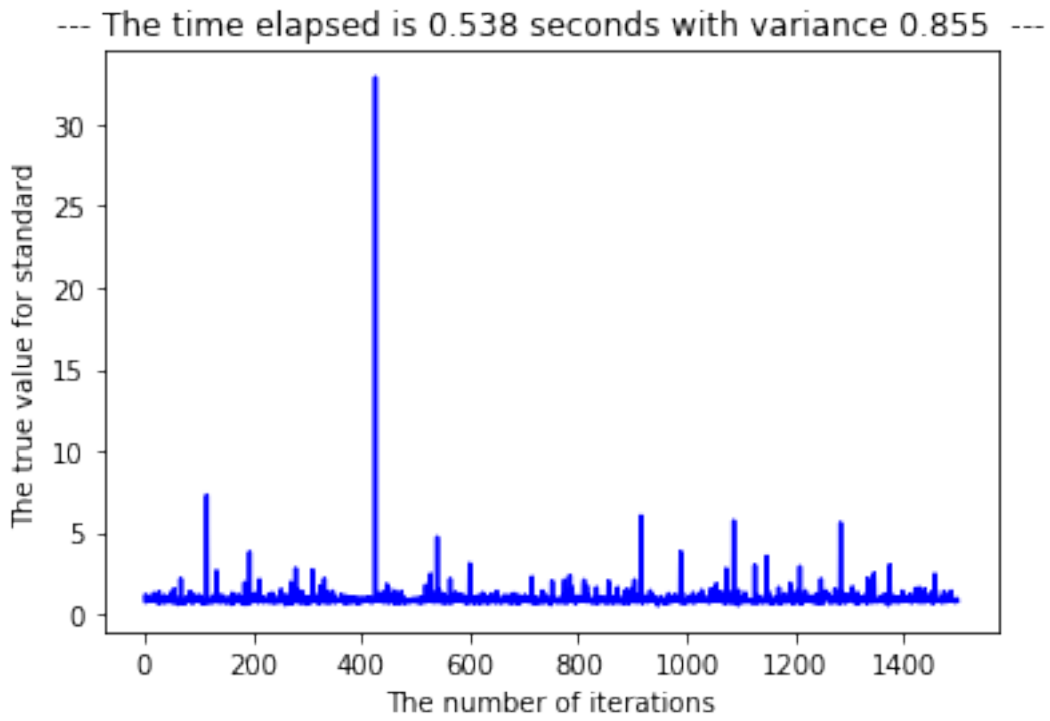
```
        return standard_samples, normalized_samples
```

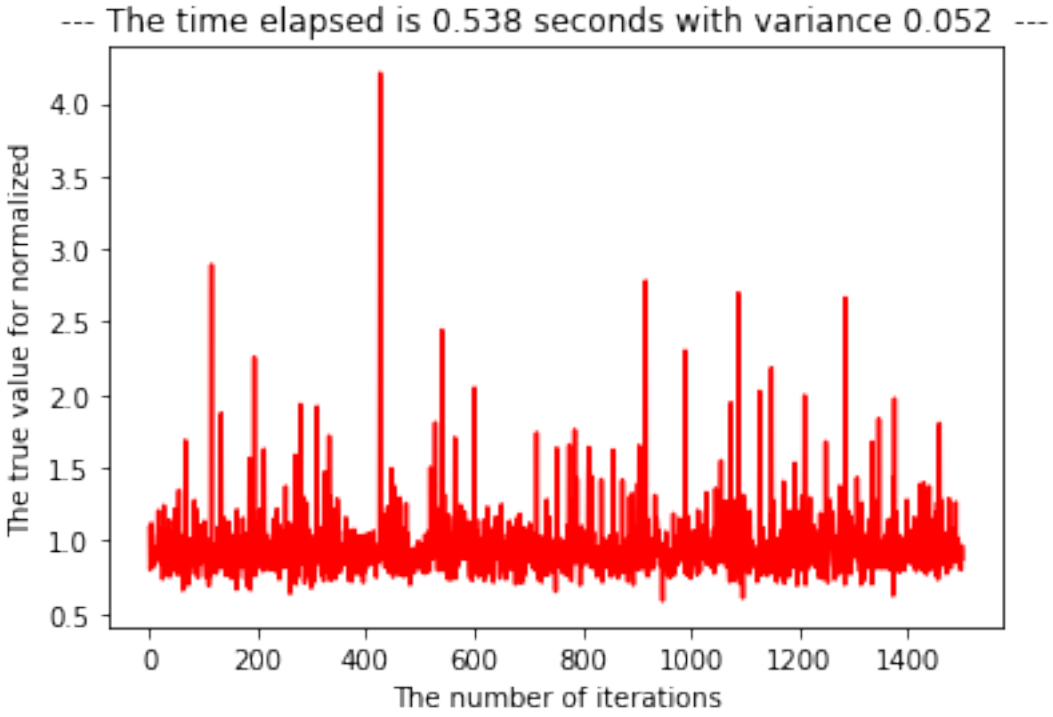
```
In [11]: showPlotTimeVariance(importanceSampling1, 1500, 100)
```






```
In [14]: # Importance sampling with standard normal distribution
         f = lambda x: abs(x) # test function
         pai = lambda x: t.pdf(x, 3)      # correct distribution
         q = lambda x: norm.pdf(x)     # proposed distribution
         w = lambda x: pai(x)/q(x)     # weight function

         def importanceSampling2(num_iter, num_rep):
             standard_samples, normalized_samples = [0]*num_iter, [0]*num_iter
             for i in range(num_iter):
                 data = np.random.standard_normal(num_rep)
                 weights = w(data)
                 standard_samples[i] = np.mean(f(data)*weights)
                 normalized_samples[i] = sum(f(data)*weights)/sum(weights)
             return standard_samples, normalized_samples

In [15]: showPlotTimeVariance(importanceSampling2, 1500, 100)
```


--- The time elapsed is 0.538 seconds with variance 0.855 ---
The true value for standard
The number of iterations
0
5
10
15
20
25
30
0
200
400
600
800
1000
1200
1400


--- The time elapsed is 0.538 seconds with variance 0.052 ---
The true value for normalized
The number of iterations
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
0
200
400
600
800
1000
1200
1400