CmpE 343
Introduction to Probability and Statistics for Computer Engineers
Fall 2019
Homework 4

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Code

```
1   import numpy as np
2
3   N_POINT = 100000
4   N_PI    = 100
5
6   def apprPi(point_num):
7       X = np.random.rand(point_num)
8       Y = np.random.rand(point_num)
9
10      in_circle = 0
11
12      for i in range(0,point_num):
13          if(X[i]**2 + Y[i]**2 <= 1):
14              in_circle = in_circle + 1
15
16      appr_pi = 4*in_circle/point_num
17
18      return appr_pi
19
20  pi_array = [apprPi(N_POINT) for i in range(0,N_PI)]
21
22  avg_pi = np.average(pi_array)
23  var_pi = np.var(pi_array)
24
25  print(pi_array)
26  print("Avg: ", avg_pi)
27  print("Var: ", var_pi)
```

Solution

Random sample of pi values

$$\begin{bmatrix}
3.13256 & 3.14552 & 3.14812 & 3.13776 & 3.13716 & 3.13468 & 3.13136 & 3.14256 & 3.14484 & 3.13436 \\
3.1332 & 3.13956 & 3.13476 & 3.13532 & 3.13956 & 3.1394 & 3.1332 & 3.1442 & 3.14436 & 3.14252 \\
3.13652 & 3.14716 & 3.14024 & 3.14548 & 3.14716 & 3.13764 & 3.14912 & 3.13832 & 3.1432 & 3.14976 \\
3.14224 & 3.1418 & 3.13944 & 3.14764 & 3.13488 & 3.13224 & 3.14388 & 3.14152 & 3.13572 & 3.14316 \\
3.1542 & 3.13776 & 3.1358 & 3.136 & 3.14672 & 3.14492 & 3.13324 & 3.1474 & 3.1388 & 3.1584 \\
3.14212 & 3.14288 & 3.1336 & 3.15032 & 3.14212 & 3.14384 & 3.15056 & 3.13288 & 3.13664 & 3.13756 \\
3.13748 & 3.1458 & 3.13552 & 3.12928 & 3.147 & 3.14876 & 3.13944 & 3.1456 & 3.14588 & 3.14112 \\
3.13652 & 3.14568 & 3.14144 & 3.13904 & 3.1434 & 3.13324 & 3.14432 & 3.14836 & 3.14952 & 3.14036 \\
3.13188 & 3.1428 & 3.1556 & 3.14248 & 3.14004 & 3.15148 & 3.14016 & 3.14024 & 3.14248 & 3.1516 \\
3.13208 & 3.13956 & 3.1352 & 3.13868 & 3.14584 & 3.14572 & 3.1422 & 3.13804 & 3.14688 & 3.13616
\end{bmatrix}$$

$$\bar{X} = \frac{1}{100}\sum_{i=1}^{100} X_i$$

$$\bar{X} = 3.1413476$$

$$S^2 = \frac{1}{100-1}\sum_{i=1}^{100}\left(X_i - \bar{X}\right)^2$$

$$S^2 = \frac{1}{99}\sum_{i=1}^{100}\left(X_i - \bar{X}\right)^2$$

$$S^2 = 3.456779824 \cdot 10^{-5}$$

$$S = 0.00587943859$$

Givens

$\bar{X} = 3.1413476$
$S = 0.00587943859$
$n = 100$

Hypothesis

$H_0 : \mu = 3.2$
$H_1 : \mu \neq 3.2$

Critical Region

$\alpha = 0.05$
Two-tailed
$t_{\alpha/2}$ = 1.9842
$-t_{\alpha/2}$ = -1.9842

$$T > t_{\alpha/2} \ ; \ T < -t_{\alpha/2}$$

$$T > 1.9842 \ ; \ T < -1.9842$$

Solution

$$T = \frac{\bar{X} - \mu}{S/\sqrt{n}}$$

$$T = \frac{3.1413476 - 3.14159265359}{0.00587943859/\sqrt{100}}$$

$$T = -0.4167979010$$

Since, T value lies between $t_{\alpha/2}$ and $-t_{\alpha/2}$ values, in other words since T is not in the critical region, we are failed to reject H_0.