CSE 2400
Applied Statistics
Spring 2017
Python Assignment 1
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Part 1

a) Monte Carlo simulation from section 2.8 of *Python Programming in Contex*

Code:

```python
#!/usr/bin/env python3
# -*- coding: utf-8 -*-
"""
Created on Fri Feb 17 14:33:24 2017

@author: antonmdv
"""

import timeit
import random
import math

start = timeit.default_timer()

n = 100000000
inCircle = 0


for i in range(n):
    x = random.random()
    y = random.random()

    d = math.sqrt(x**2 + y**2)

    if d <= 1:
        inCircle += 1

pi = inCircle/n * 4

stop = timeit.default_timer()

print('N value => ',n)
print('Pi => ',pi)
print('Runtime => ', (stop - start),' seconds')
```

Console Output for 10 <= n <= 100000000:

```
In [28]: runfile('/Users/antonmdv/Desktop/Spring2017/Prob and
Stats/Pythin Assignment/monteCarloSimulation.py', wdir='/Users/
antonmdv/Desktop/Spring2017/Prob and Stats/Pythin Assignment')
N value =>  10
Pi =>  3.1415288
Runtime =>  2.1047017071396112e-05  seconds

In [29]: runfile('/Users/antonmdv/Desktop/Spring2017/Prob and
Stats/Pythin Assignment/monteCarloSimulation.py', wdir='/Users/
antonmdv/Desktop/Spring2017/Prob and Stats/Pythin Assignment')
N value =>  100
Pi =>  3.1415288
Runtime =>  0.00012173299910500646  seconds

In [30]: runfile('/Users/antonmdv/Desktop/Spring2017/Prob and
Stats/Pythin Assignment/monteCarloSimulation.py', wdir='/Users/
antonmdv/Desktop/Spring2017/Prob and Stats/Pythin Assignment')
N value =>  1000
Pi =>  3.1415288
Runtime =>  0.0008372200536541641  seconds

In [31]: runfile('/Users/antonmdv/Desktop/Spring2017/Prob and
Stats/Pythin Assignment/monteCarloSimulation.py', wdir='/Users/
antonmdv/Desktop/Spring2017/Prob and Stats/Pythin Assignment')
N value =>  10000
Pi =>  3.1415288
Runtime =>  0.008636130020022392  seconds

In [32]: runfile('/Users/antonmdv/Desktop/Spring2017/Prob and
Stats/Pythin Assignment/monteCarloSimulation.py', wdir='/Users/
antonmdv/Desktop/Spring2017/Prob and Stats/Pythin Assignment')
N value =>  100000
Pi =>  3.1415288
Runtime =>  0.08820281800581142  seconds
```

```
In [33]: runfile('/Users/antonmdv/Desktop/Spring2017/Prob and
Stats/Pythin Assignment/monteCarloSimulation.py', wdir='/Users/
antonmdv/Desktop/Spring2017/Prob and Stats/Pythin Assignment')
N value =>  1000000
Pi =>  3.1415288
Runtime =>  0.8789605990168639  seconds

In [34]: runfile('/Users/antonmdv/Desktop/Spring2017/Prob and
Stats/Pythin Assignment/monteCarloSimulation.py', wdir='/Users/
antonmdv/Desktop/Spring2017/Prob and Stats/Pythin Assignment')
N value =>  10000000
Pi =>  3.1415288
Runtime =>  9.531051158963237  seconds

In [35]: runfile('/Users/antonmdv/Desktop/Spring2017/Prob and
Stats/Pythin Assignment/monteCarloSimulation.py', wdir='/Users/
antonmdv/Desktop/Spring2017/Prob and Stats/Pythin Assignment')
N value =>  100000000
Pi =>  3.1415288
Runtime =>  90.8634021289763  seconds
```

b) Monte Carlo simulation using SciPy

Code:

```
#!/usr/bin/env python3
# -*- coding: utf-8 -*-
"""
Created on Fri Feb 17 14:01:03 2017

@author: antonmdv
"""

import scipy
import timeit

start = timeit.default_timer()

N=100000000

x_array = scipy.random.rand(N)
y_array = scipy.random.rand(N)

N_qtr_circle = sum(x_array**2+y_array**2 < 1)
# Number of pts within the quarter circle x^2 + y^2 < 1 centered at the origin with radius
r=1.
# True area of quarter circle is pi/4 and has N_qtr_circle points within it.
# True area of the square is 1 and has N points within it, hence we approximate pi with
pi_approx = 4*float(N_qtr_circle)/N

stop = timeit.default_timer()

print('N value => ',N)
print('Pi => ',pi_approx)
print('Runtime => ', (stop - start),' seconds')
```

Console Output for 10 <= n <= 100000000:

```
In [11]: runfile('/Users/antonmdv/Desktop/Spring2017/Prob and
Stats/Pythin Assignment/probAndStatsPython.py', wdir='/Users/
antonmdv/Desktop/Spring2017/Prob and Stats/Pythin Assignment')
N value =>  10
Pi =>  2.8
Runtime =>  9.007600601762533e-05  seconds

In [12]: runfile('/Users/antonmdv/Desktop/Spring2017/Prob and
Stats/Pythin Assignment/probAndStatsPython.py', wdir='/Users/
antonmdv/Desktop/Spring2017/Prob and Stats/Pythin Assignment')
N value =>  100
Pi =>  3.4
Runtime =>  0.0004388130037114024  seconds

In [13]: runfile('/Users/antonmdv/Desktop/Spring2017/Prob and
Stats/Pythin Assignment/probAndStatsPython.py', wdir='/Users/
antonmdv/Desktop/Spring2017/Prob and Stats/Pythin Assignment')
N value =>  1000
Pi =>  3.2
Runtime =>  0.0024016789975576103  seconds

In [14]: runfile('/Users/antonmdv/Desktop/Spring2017/Prob and
Stats/Pythin Assignment/probAndStatsPython.py', wdir='/Users/
antonmdv/Desktop/Spring2017/Prob and Stats/Pythin Assignment')
N value =>  10000
Pi =>  3.1716
Runtime =>  0.01859870000043884  seconds

In [15]: runfile('/Users/antonmdv/Desktop/Spring2017/Prob and
Stats/Pythin Assignment/probAndStatsPython.py', wdir='/Users/
antonmdv/Desktop/Spring2017/Prob and Stats/Pythin Assignment')
N value =>  100000
Pi =>  3.1374
Runtime =>  0.1775964549742639  seconds

In [16]: runfile('/Users/antonmdv/Desktop/Spring2017/Prob and
Stats/Pythin Assignment/probAndStatsPython.py', wdir='/Users/
antonmdv/Desktop/Spring2017/Prob and Stats/Pythin Assignment')
N value =>  1000000
Pi =>  3.140896
Runtime =>  1.81924096099101  seconds

In [17]: runfile('/Users/antonmdv/Desktop/Spring2017/Prob and
Stats/Pythin Assignment/probAndStatsPython.py', wdir='/Users/
antonmdv/Desktop/Spring2017/Prob and Stats/Pythin Assignment')
N value =>  10000000
Pi =>  3.1413312
Runtime =>  18.6542553009931  seconds

In [18]: runfile('/Users/antonmdv/Desktop/Spring2017/Prob and
Stats/Pythin Assignment/probAndStatsPython.py', wdir='/Users/
antonmdv/Desktop/Spring2017/Prob and Stats/Pythin Assignment')
N value =>  100000000
Pi =>  3.1415288
Runtime =>  189.15012587502133  seconds
```

Part 2

Problems : 3.20, 3.24, 3.31, 3.33, 4.16, 4.18, 4.21, 4.24, 4.25(twice)
Note: Problems are in coded and displayed in order

```
#!/usr/bin/env python3
# -*- coding: utf-8 -*-
"""
Created on Fri Feb 17 16:15:18 2017

@author: antonmdv
"""

import scipy
import random
import math
import numpy as np

from scipy.stats import binom
from scipy.stats import nbinom
from scipy.stats import poisson
from scipy.stats import bernoulli
from scipy.stats import geom
from scipy.stats import norm
#from scipy.stats import normal

###############################################################################
#CHAPTER 3
###############################################################################
print('')
print('CHAPTER 3')
print('')

###############################################################################
#Problem: 3.20
n = 20
p = 0.05
x = 3

s = binom.pmf(x, n, p, loc=0)
k = nbinom.pmf(5, 2, p, loc=0)

print('Problem: 3.20')
print('a: ',s)
print('b: ',(1-k))
print('')

###############################################################################
#Problem: 3.24

n = 10
p = 0.2
x1 = 1
x2 = 2
x3 = 3
x4 = 4
#s = geom.pmf(3,p)
s = 1 - ((geom.pmf(x1,p))+(geom.pmf(x2,p))+(geom.pmf(x3,p))+(geom.pmf(x4,p)))
k = binom.pmf(x1,n,p)

print('Problem: 3.24')
print('a: ',s)
print('b: ',k)
print('')

```

```
#######################################################################
#Problem: 3.31

n = 20
p = 0.8
x1 = 18
x2 = 19
x3 = 20

s = ((binom.pmf(x1, n, p, loc=0))+(binom.pmf(x2, n, p, loc=0))+(binom.pmf(x3, n, p, loc=0)))
#k =
print('Problem: 3.31')
print('a: ',s)
print('b: ',1/p)
print('')

#######################################################################
#Problem: 3.33

lmbd = 0.25
x = 2

s = binom.pmf(1,3,lmbd)
k = poisson.pmf(1,lmbd)
z = 1-((binom.pmf(1, 12, k))+(binom.pmf(2, 12, k))+(binom.pmf(0, 12, k)))

print('Problem: 3.33')
print('a: ',1-s)
print('b: ',z)
print('')

#######################################################################
#CHAPTER 4
#######################################################################print('')
print('')
print('CHAPTER 4')
print('')

#######################################################################
#Problem: 4.16
a = norm.cdf(1.25)
b = norm.cdf(1.25)
c = norm.sf(1.25)
d = 2*(norm.cdf(1.25))-1
e = norm.cdf(6) # approx 1
f = 1-norm.cdf(6) # approx 0
g = norm.ppf(.8)

print('Problem: 4.16')
print('a: ',a)
print('b: ',b)
print('c: ',c)
print('d: ',d)
print('e: ',e)
print('f: ',f)
print('g: ',g)
print('')

```

```
119 ##########################################################################
120 #Problem: 4.18
121 a = norm.cdf(2.7)
122 b = 1-norm.cdf(-2.39)
123 c = 1-(norm.cdf(2.7)-norm.cdf(0.31))
124 d = 1-(2*norm.cdf(1.195)-1)
125 e = norm.cdf(4) #approx 1
126 f = e-norm.cdf(-1)
127 g = 2*(norm.ppf(.67))-3
128
129 print('Problem: 4.18')
130 print('a: ',a)
131 print('b: ',b)
132 print('c: ',c)
133 print('d: ',d)
134 print('e: ',e)
135 print('f: ',f)
136 print('g: ',g)
137 print('')
138
139 ##########################################################################
140 #Problem: 4.21
141 a = 1-norm.cdf(1.29)
142 b = (3*(norm.ppf(.2)))+79
143
144 print('Problem: 4.21')
145 print('a: ',a)
146 print('b: ',b)
147 print('')
148
149 ##########################################################################
150 #Problem: 4.24
151 a = norm.cdf((1200-(82*15))/(math.sqrt(16*82)))
152
153 print('Problem: 4.21')
154 print('a: ',a)
155 print('')
156 ##########################################################################
157 #Problem: 4.25 normal approximation to the binomial
158 a = norm.cdf(0.32)-norm.cdf(-0.95)
159 b = 1-norm.cdf((7.5-18)/3.15)
160
161 print('Problem: 4.25 => normal approximation to the binomial')
162 print('a: ',a)
163 print('b: ',b)
164 print('')
165 ##########################################################################
166 #Problem: 4.25 using binomial directly
167 a = binom.pmf(20,400,0.06)-(binom.pmf(25,400,0.06)-binom.pmf(20,400,0.06))
168 b = 1-(binom.pmf(8,40,0.45))
169
170 print('Problem: 4.25 => using binomial directly')
171 print('a: ',a)
172 print('b: ',b)
173 #print('')
```

Sample Output from console:

```
In [277]: runfile('/Users/antonmdv/Desktop/Part2.py', wdir='/Users/antonmdv/Desktop')

CHAPTER 3

Problem: 3.20
a:  0.0595821477687
b:  0.988393285937

Problem: 3.24
a:  0.4096
b:  0.268435456

Problem: 3.31
a:  0.206084718948
b:  1.25

Problem: 3.33
a:  0.578125
b:  0.422818573469


CHAPTER 4

Problem: 4.16
a:  0.894350226333
b:  0.894350226333
c:  0.105649773667
d:  0.788700452666
e:  0.999999999013
f:  9.86587700424e-10
g:  0.841621233573

Problem: 4.18
a:  0.996533026197
b:  0.991575813601
c:  0.625186495625
d:  0.232087030116
e:  0.999968328758
f:  0.841313074827
g:  -2.12017366865

Problem: 4.21
a:  0.0985253290497
b:  76.4751362993

Problem: 4.21
a:  0.20376830373

Problem: 4.25 => normal approximation to the binomial
a:  0.454459708415
b:  0.999570939667

Problem: 4.25 => using binomial directly
a:  0.0449585012955
b:  0.999364290105
```