IC252: Data Science II

by Adarsh Santoria(b21176)

QUESTIONS WITH SOLUTIONS DISPLAYED IN TERMINAL AND CODE

1. Simulate a fair coin from the throw of a fair die in three different ways. These can be:

• Method 1: Output H if d = 1, 2, or 3 and T if d = 4, 5, or 6

• Method 2: Output H if d = 1 and T if d = 2 and don't output anything for other values of d. This is a wasteful method.

• Method 3: Your own method, different from the above.

How will you be sure that the output is correct? Suppose your function is called die2coin. If you call this function N number of times (⇑ 10, 000 and above), and count the number of times it gave H and the number of times it gave T, then we can decide if die2coin is correct. Expected output: A plot, with proper labels, that convinces you that the generated coin is fair. Required input: Accept the type of method used (1,2 or 3), N

Interface of the function: die2coin(int m, int N), where m is the type of method used; N, the number of times to repeat; and returns 'H' or 'T'.

Spyder

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C:\Users\HP

C:\Users\HP\untitled16.py

untitled2.py | untitled3.py | untitled14.py | untitled15.py | untitled16.py*

```
import matplotlib.pyplot as plt          #importing required modules
from random import randint as r
def die2coin(m ,N):                      #making a function
    H=0                                  #make variable H & T to respectively
    T=0                                  #initialise number of heads and tails from 0
    for i in range(N):                   #run a loop for number of throws
        n=r(1,6)                         #randomly take any number from 1 to 6 as in die
        if( m == 1):                     #checking the type of method
            if (n == 1) or(n == 2) or (n == 3):
                H = H+1                  #H or T based on situation by 1
            else:
                T=T+1
        if(m==2):
            if (n == 1):
                H = H+1
            elif(n == 2):
                T=T+1
        if(m==3):
            if (n == 2) or (n == 3):
                H = H+1
            elif (n==4) or (n==5):
                T=T+1
    print("Head occurs ",H,"times")      #printing total no. of H & T
    print("Tail occurs ",T,"times")
    #Ploting the bar graph
    plt.bar(["Heads","Tails"],[H,T], color ='maroon')
    plt.xlabel("Outcomes")               #labelling the graph
    plt.ylabel("No. of outcomes")
    plt.show()
m=int(input("type of method:"))
N=int(input("no. of times to repeat:",))
die2coin(m,N)
```

Console 4/A

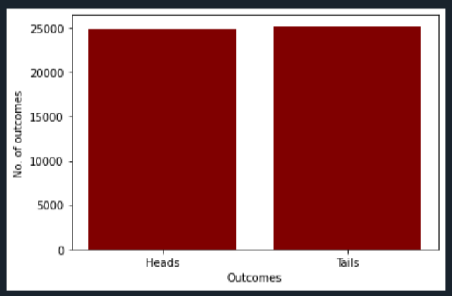
```
Python 3.7.9 (tags/v3.7.9:13c94747c7, Aug 17 2020, 18:58:18) [M
Type "copyright", "credits" or "license" for more information.

IPython 7.31.1 -- An enhanced Interactive Python.

In [1]: runfile('C:/Users/HP/untitled16.py', wdir='C:/Users/HP'

type of method:1

no. of times to repeat:50000
Head occurs  24834 times
Tail occurs  25166 times
```




```
In [2]:
```

IPython Console

LSP Python: ready

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32°C Haz

2. Same as the previous question, but this time, generate a biased coin from a fair die. Plots are required as before. You can just use one method.

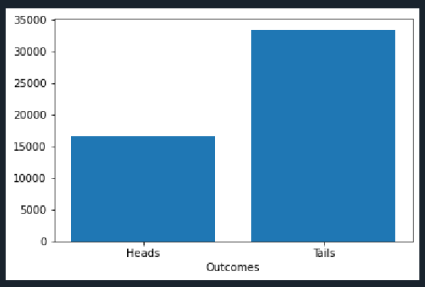
Expected output: A plot, with proper labels, that convinces you that the generated coin is biased.

Required input: N, the number of times to repeat.

Use a similar function interface: die2BiasedCoin(int N); returns ‘H’ or ‘T’.

```
# -*- coding: utf-8 -*-
"""
Created on Sat Mar 12 14:07:49 2022

@author: HP
"""
import matplotlib.pyplot as plt        #importing required modules
from random import randint as r
def die2BiasedCoin(N):                 #making a function
    H=0                                #make variable H & T to respectively
    T=0                                #initialise number of heads and tails from 0
    for i in range(N):                 #run a loop for number of throws
        n=r(1,6)                       #randomly take any number from 1 to 6 as in die
        if (n == 2) or (n == 3):       #taking a biased situation where 2 out of 6 cause Head
            H = H+1                    #H or T based on situation by 1
        else:
            T=T+1
    print("Head occurs ",H,"times")    #printing total no. of H & T
    print("Tail occurs ",T,"times")
    #Ploting the bar graph
    plt.bar(["Heads","Tails"],[H,T])
    plt.xlabel("Outcomes")             #labelling the graph
N=int(input("no. of times to repeat:"))
die2BiasedCoin(N)
```

```
Python 3.7.9 (tags/v3.7.9:13c94747c7, Aug 17 2020, 18:58:18) [MSC
Type "copyright", "credits" or "license" for more information.

IPython 7.31.1 -- An enhanced Interactive Python.

In [1]: runfile('C:/Users/HP/untitled17.py', wdir='C:/Users/HP')

no. of times to repeat:50000
Head occurs  16635 times
Tail occurs  33365 times
```




```
In [2]:
```

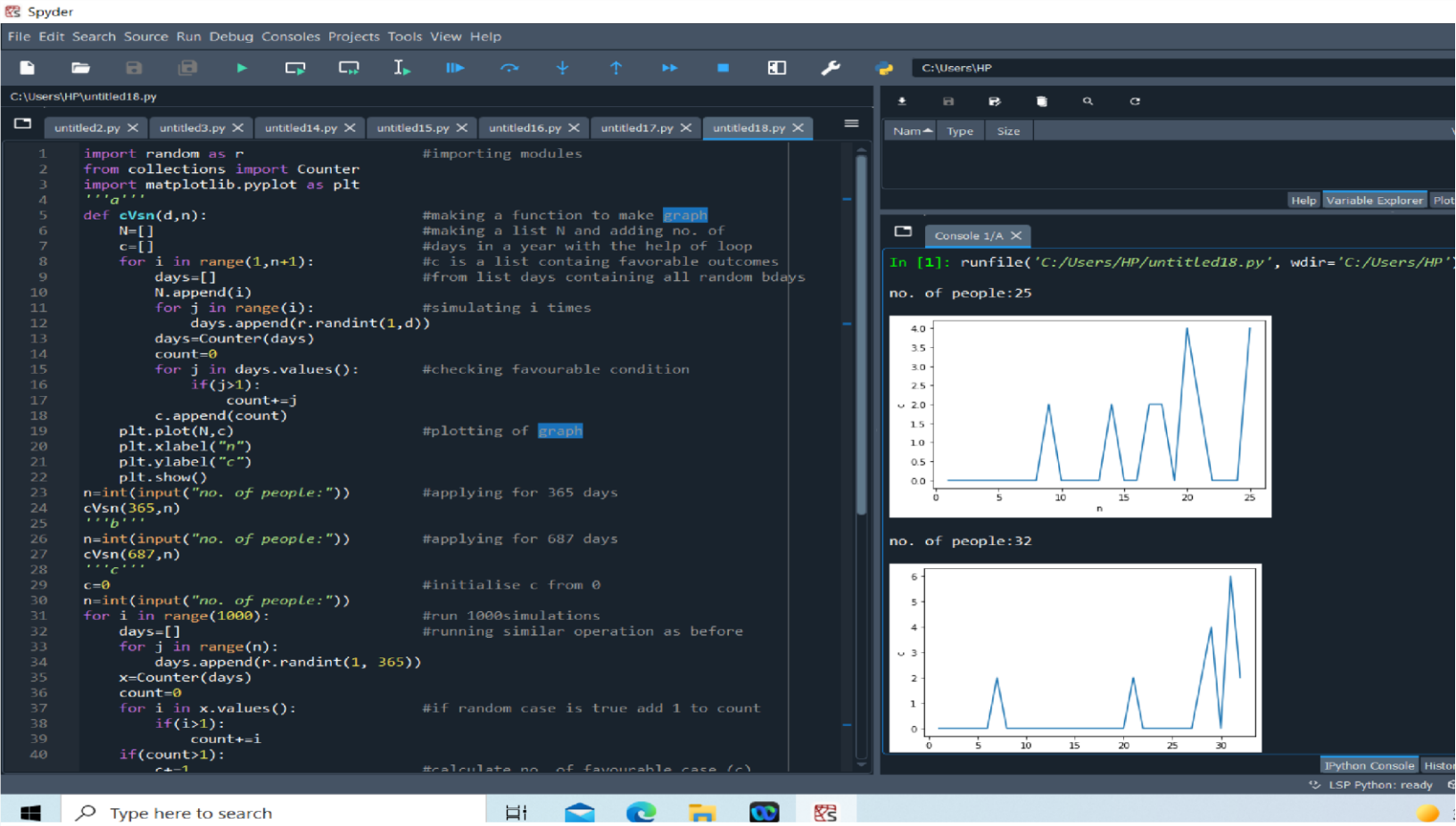
3.This question is derived from the birthday paradox. Let the number of people in the room be n. Generate a random number between 1 and 365, n times. This simulates n birthdays. Count how many common birthdays are present between at least two people, and let this be denoted by c. Plot c versus n, as n varies from 1 to 366 for the following cases:

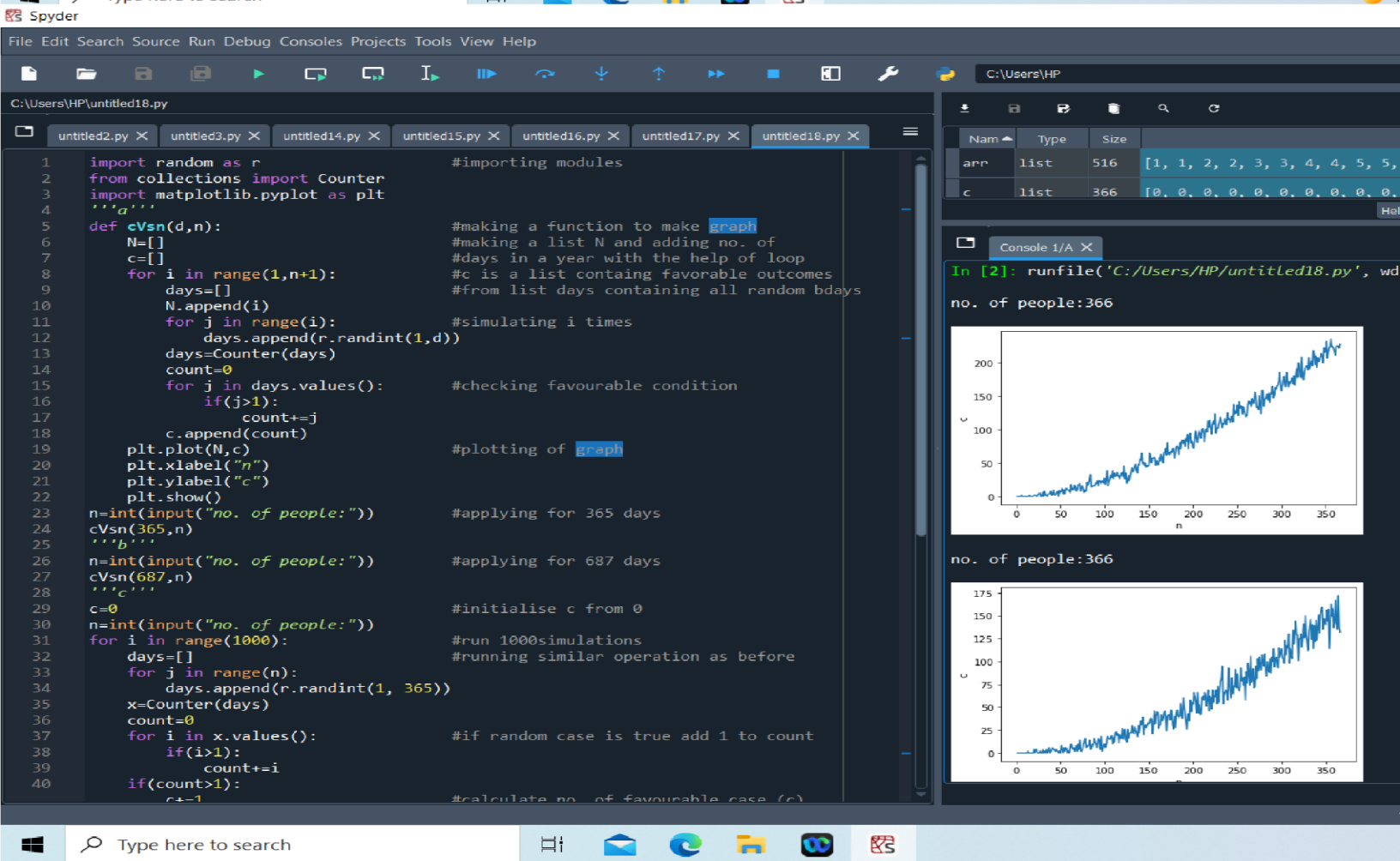
(a) When each birthday is equally likely. c should be 2 when n is around 25 or so.

(b) When the birthdays are computed on Mars. Each Martin year is 687 days. c should be 2 for n around 32.

(c) For n around 50, there is a high chance that c is at least 2. Demonstrate this by simulating this situation1000 times and computing the average probability. You should get the average probability close to 0.99. This basically means that in a group of 50 people, you can be almost sure that two of them share the same birthday.

(d) When birthdays between 1-150 are twice as likely as 151-365.





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untitled2.py | untitled3.py | untitled14.py | untitled15.py | untitled16.py | untitled17.py | untitled18.py

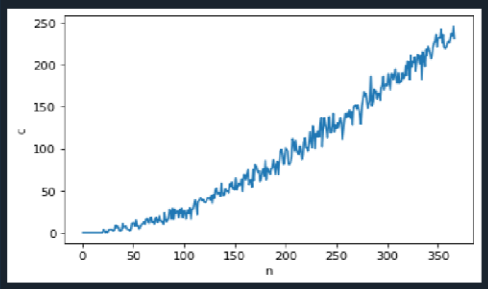
```
28  '''c'''
29  c=0                                 #initialise c from 0
30  n=int(input("no. of people:"))
31  for i in range(1000):               #run 1000simulations
32      days=[]                         #running similar operation as before
33      for j in range(n):
34          days.append(r.randint(1, 365))
35      x=Counter(days)
36      count=0
37      for i in x.values():            #if random case is true add 1 to count
38          if(i>1):
39              count+=i
40      if(count>1):
41          c+=1                        #calculate no. of favourable case (c)
42  print("Average probabilty that c is atleast 2 is",(c/1000))
43  #probability is printed with the help of it's formula
44  '''d'''
45  N=[]
46  c=[]                                #similar operations are performed as in a
47  arr=[]
48  for i in range(1,367):
49      N.append(i)                     #but probability of days between 1 and 150
50      if(i<151):                      #are twice  as compared to between 151 and 365
51          arr.append(i)               #as arr conatains the prior souble
52          arr.append(i)
53      else:
54          arr.append(i)
55  for n in range(1,367):
56      days=[]
57      for i in range(n):
58          days.append(r.choice(arr))
59      x=Counter(days)
60      count=0
61      for i in x.values():
62          if(i>1):
63              count=count+i
64      c.append(count)                 #plotting of graph
65  plt.plot(N,c)
66  plt.xlabel("n")
67  plt.ylabel("c")
```

Nam	Type	Size	
arr	list	516	[1, 1, 2, 2, 3, 3, 4, 4, 5, 5, .
c	list	366	[0. 0. 0. 0. 0. 0. 0. 0. 0. 0. .

Help

Console 1/A

```
no. of people:50
Average probabilty that c is atleast 2 is 0.964
```




```
In [3]:
```

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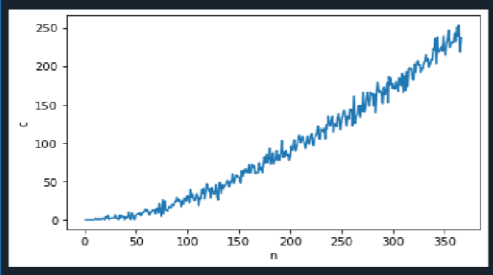
```
28  '''c'''
29  c=0                                 #initialise c from 0
30  n=int(input("no. of people:"))
31  for i in range(1000):               #run 1000simulations
32      days=[]                         #running similar operation as before
33      for j in range(n):
34          days.append(r.randint(1, 365))
35      x=Counter(days)
36      count=0
37      for i in x.values():            #if random case is true add 1 to count
38          if(i>1):
39              count+=i
40      if(count>1):
41          c+=1                        #calculate no. of favourable case (c)
42  print("Average probabilty that c is atleast 2 is",(c/1000))
43  #probability is printed with the help of it's formula
44  '''d'''
45  N=[]
46  c=[]                                #similar operations are performed as in a
47  arr=[]
48  for i in range(1,367):
49      N.append(i)                     #but probability of days between 1 and 150
50      if(i<151):                      #are twice  as compared to between 151 and 365
51          arr.append(i)               #as arr conatains the prior souble
52          arr.append(i)
53      else:
54          arr.append(i)
55  for n in range(1,367):
56      days=[]
57      for i in range(n):
58          days.append(r.choice(arr))
59      x=Counter(days)
60      count=0
61      for i in x.values():
62          if(i>1):
63              count=count+i
64      c.append(count)                 #plotting of graph
65  plt.plot(N,c)
66  plt.xlabel("n")
67  plt.ylabel("c")
```

Nam	Type	Size	
arr	list	516	[1, 1, 2, 2, 3, 3, 4, 4, 5, 5,
c	list	366	[0. 0. 0. 0. 0. 0. 0. 0. 0. 0.

Console 1/A

```
no. of people:366
Average probabilty that c is atleast 2 is 1.0
```




```
In [4]:
```

REVISED 3. This question is derived from the birthday paradox. Let the number of people in the room be n. Estimate the probability pn that out of n people, at least one match occurs (in other words, at least two people share a birthday.)

Plot pn versus n for $2 \leq n \leq 100$ for the following cases.

(a) When each birthday is equally likely. In earth, the probability is about 0.5 for n = 23.

(b) When the birthdays are computed on Mars. Each Martin year is 669 days. The probability is about 0.5 when n = 31.

(c) When birthdays between 1-150 are twice as likely as 151-365.

Hint: The experiment is binary (outcome is success or failure.) We define success if there is a match. Determine if there is match by counting the number of occurrences for each birthday. If there is no match, then it is a failure. A useful Python class for counting is Collections.counter. Also, remember to repeat the experiment a large number of times (I did it 10000 times for each n.) The whole code is less than 50 lines

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C:\Users\HP

C:\Users\HP\untitled19.py

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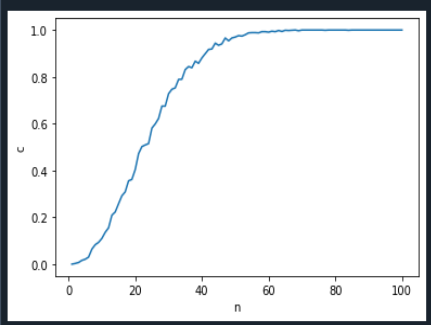
```
# -*- coding: utf-8 -*-
"""
Created on Sun Mar 13 01:01:14 2022

@author: HP
"""
import random as r                      #importing modules
from collections import Counter
import matplotlib.pyplot as plt
def bday(n,d):                          #making a function
    N=[]                                #making a list N and adding no. of
    c=[]                                #days in a year with the help of loop
    for i in range(1,n+1):              #c is a list containg favorable outcomes
        N.append(i)
        t=0
        for k in range(1000):           #running 1000 simulations
            days=[]
            count=False
            for j in range(1,i+1):
                days.append(r.randint(1,d))
            da=Counter(days)            #randomly taking a day
            for j in da.values():       #checking favourable condition
                if(j>1):
                    count=True
                    break
            if count:                   #counting no. of favourable cases
                t+=1
        c.append(t/1000)                #appending probability to the list
    plt.plot(N,c)                       #plotting of graph
    plt.xlabel("n")
    plt.ylabel("c")
    plt.show()
'''a'''
bday(100,365)                           #100 people in 365 days pf year
'''b'''
bday(100,669)                           #100 people in 669 days of year
'''c'''
N=[]                                #making a list N and adding no. of
c=[]
arr=[]
```

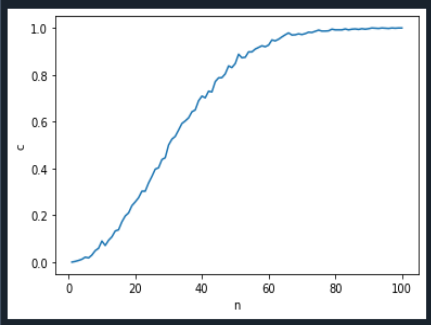
Nam	Type	Size	Value
arr	list	200	[1, 1, 2, 2, 3, 3, 4, 4, 5, 5, ...]

Help | Variable Explorer | Plots | Files

Console 1/A


```
In [4]: runfile('C:/Users/HP/untitled19.py', wdir='C:/Users/HP')
```





IPython Console | History

LSP Python: ready

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C:\Users\HP

C:\Users\HP\untitled19.py

untitled2.py | untitled3.py | untitled14.py | untitled15.py | untitled18.py | untitled19.py*

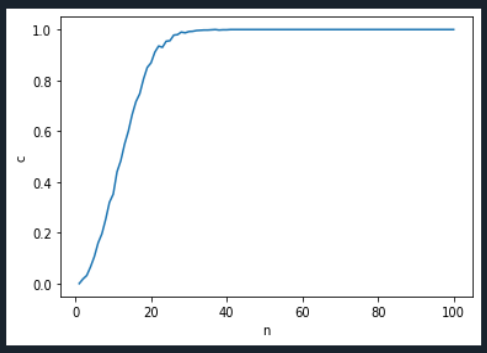
```
    plt.xlabel("n")
    plt.ylabel("c")
    plt.show()
'''a'''
bday(100,365)                       #100 people in 365 days pf year
'''b'''
bday(100,669)                       #100 people in 669 days of year
'''c'''
N=[]                                #making a list N and adding no. of
c=[]
arr=[]                             #n is number of people
n=int(input("number of people:"))   #similar operations are performed
for i in range(1,n+1):              #but probability of days between 1 and 150
    if(i<151):                      #are twice  as compared to between 151 and 365
        arr.append(i)               #as arr conatains the prior double
        arr.append(i)
    else:
        arr.append(i)               #days in a year with the help of loop
for i in range(1,n+1):              #c is a list containg favorable outcomes
    N.append(i)
    t=0
    for k in range(1000):          #running 1000 simulations
        days=[]
        count=False
        for j in range(1,i+1):
            days.append(r.choice(arr))
        da=Counter(days)           #randomly taking a day
        for j in da.values():      #checking favourable condition
            if(j>1):
                count=True
                break
        if count:                  #counting no. of favourable cases
            t+=1
    c.append(t/1000)               #appending probability to the list
plt.plot(N,c)                      #plotting of graph
plt.xlabel("n")
plt.ylabel("c")
plt.show()
```

Nam	Type	Size	
arr	list	200	[1, 1, 2, 2, 3, 3, 4, 4, 5, 5,

Help

Console 2/A

```
number of people:100
```




```
In [2]:
```

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