Numerical Python

randomness

CS101 Lecture #18

2016-11-30

Administrivia

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- Homework #8 is due Friday, Dec. 2.
- Homework #9 is due Friday, Dec. 9.
- Midterm #2 is Monday, Dec. 19 from 7–10 p.m.

Warmup Quiz

Question #1

```
x = np.zeros( (3,3) )
for i in range( 3 ):
    for j in range( 3 ):
        x[i,j] = i*j + j
```

A

$$\begin{pmatrix} 0 & 0 & 0 \\ 1 & 2 & 3 \\ 2 & 4 & 6 \end{pmatrix}$$

B

$$\begin{pmatrix} 0 & 0 & 0 \\ 0 & 2 & 4 \\ 0 & 4 & 8 \end{pmatrix}$$

C

$$\begin{pmatrix} 0 & 1 & 2 \\ 0 & 2 & 4 \\ 0 & 3 & 6 \end{pmatrix}$$

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C $\begin{pmatrix} 0 & 1 & 2 \\ 0 & 2 & 4 \\ 0 & 3 & 6 \end{pmatrix}\star$

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- What are some sources of true randomness?
- Consider the following two sequences:

$$7\,8\,5\,3\,9\,8\,1\,6\,3\,3\,9\,7\,4\,4\,8\,3\,0\,9\,6\,1\,5\,6\,6\,0\,8\,4\ldots$$

$$+1, -\frac{1}{3}, +\frac{1}{5}, -\frac{1}{7}, -\frac{1}{9}, -\frac{1}{11}, +\frac{1}{13}, -\frac{1}{15}, \ldots$$

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- What are some sources of true randomness?
- Consider the following two sequences:

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$$+1, -\frac{1}{3}, +\frac{1}{5}, -\frac{1}{7}, -\frac{1}{9}, -\frac{1}{11}, +\frac{1}{13}, -\frac{1}{15}, \ldots$$

- These are derived from the same rule ($\pi/4$)–but one seems "random" to us.

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- It then returns a new number unpredictable to you (but predictable to the formula!) each time you query the function.
- NumPy uses the Mersenne twister, based on prime number distributions (but you don't need to know this).
- Dozens of distributions are available—let's see a few.

randint

- `randint` returns a random (pseudorandom) integer in a range (which works the same as `range`).

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np.random.randint( 10 )  # random int, [0,10)
np.random.randint( 1,7 ) # random int, [1, 7)
np.random.randint( 0,10, size=(5,5) ) # in array
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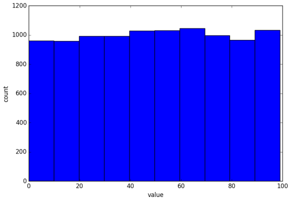

Example

- Number guessing (a game for the easily entertained):

```
import numpy as np
number = np.random.randint(10)+1
guess = input( ’Guess the number between 1 and 1
while guess != number:
    guess = input( ’Nope.  Try again:’ )
print( ’You did it.  Hooray.’ )
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import numpy as np
number = np.random.randint(10)+1
guess = input( 'Guess the number between 1 and 1
while int( guess ) != number:
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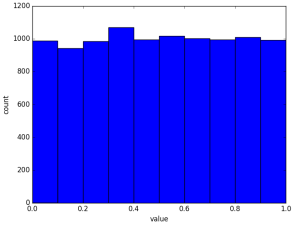

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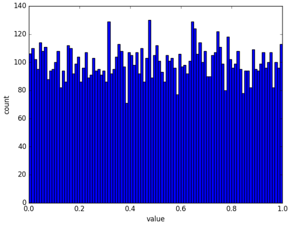

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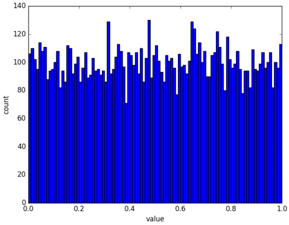

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np.random.randn()         # random normal number
np.random.randn() + 1.0   # mean 1.0
(np.random.randn()) * 4   # variance 4.0
```

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x = np.random.randn( 10000 )
plt.hist(x,bins=20)
plt.show()
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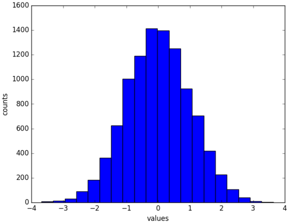

choice

- `choice` randomly samples a one-dimensional array (rather, the first dimension of the array).

```
x = [ 'red', 'orange', 'yellow', 'green', 'blue'
np.random.choice(x)       # random color
```

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x = np.arange(1,53)
c = np.random.choice( x, size=5, replace=False )
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choice

- `choice` randomly samples a one-dimensional array but can do so without replacement.
- Replacement means the difference between pulling a card from a deck and putting it back before drawing again (or not).

```
x = np.arange(1,53)
c = np.random.choice( x, size=5, replace=False )
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- The foregoing code draws five cards from a deck (no repeat cards allowed).

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- `shuffle` randomly reorders an array in place.
- What is its return type?

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- What is its return type?

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```

- The foregoing code shuffles a deck of cards.

Question

Which of the following will not reproduce the behavior of a six-sided die in c?

A
```
c = np.random.randn( 6 ) + 1
```

B
```
x = np.arange( 1,7 )
c = np.random.choice( x )
```

C
```
c = np.random.randint( 6 )+1
```

D
```
d = np.random.uniform( 0,6 )
c = int(d) + 1
```

Question

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- Example: Mad Libs

Mad Libs #1

```
import numpy as np

adjs = []
for line in open('adjectives.txt').readlines():
    adjs.append( line.strip() )
names = []
for line in open('names.txt').readlines():
    names.append( line.strip().split(',') )
verbs = []
for line in open('verbs.txt').readlines():
    verbs.append( line.strip().split(',') )
nouns = []
for line in open('nouns.txt').readlines():
    nouns.append( line.strip() )
# note that names and verbs have a slightly different structu
# than adj and nouns
```

Mad Libs #2

```
adj1 = adjs[np.random.randint(len(adjs))]
noun1 = nouns[np.random.randint(len(nouns))]
name = names[np.random.randint(len(names))]
verb = verbs[np.random.randint(len(verbs))]
adj2 = adjs[np.random.randint(len(adjs))]
noun2 = nouns[np.random.randint(len(nouns))]

phrase = adj1.title() + ' ' + noun1 + ' ' + \
         name[0] + ' was so ' + adj2 + ' that ' + \
         name[1] + ' ' + verb[1] + ' a ' + \
         noun2 + '.'
```

So what?

- Our first toy example was pretty lame. What else can we do?
- Example: Mad Libs
- Random walk

Random walk #1

```
import numpy as np
import matplotlib.pyplot as plt

x = np.zeros( ( 100,1 ) )
y = np.zeros( ( 100,1 ) )
```

Random walk #2

```
for i in range( 1,len(x) ):
    dir = np.random.randint(4)
    if dir == 0:
        x[i] = x[i-1]
        y[i] = y[i-1]+1
    if dir == 1:
        x[i] = x[i-1]+1
        y[i] = y[i-1]
    if dir == 2:
        x[i] = x[i-1]
        y[i] = y[i-1]-1
    if dir == 3:
        x[i] = x[i-1]-1
        y[i] = y[i-1]

plt.plot(x,y)
plt.show()
```

So what?

- Our first toy example was pretty lame. What else can we do?
- Example: Mad Libs
- Random walk
- Think of others: games, for instance.
- Also, scientific applications (quantum mechanics).