05 Exercises

September 13, 2020

0.1 Exercise 05.1 (random numbers)

- Using the '`randint`' function from the '`random`' module (https://docs.python.org/3/library/random.html#random.randint), develop a function `dice_roll` that emulates the roll of a dice with n sides.
- For $n = 6$, devise and implement a test to check that it is a fair dice.

(a) Dice roll code:

[38]:
```
import random

def dice_roll(n):
  x = random.randint(1, n)
  return x

print(dice_roll(10))
```

```
1
```

[0]:
```
for n in range(1, 20):
    for j in range(100):
        value = dice_roll(n)
        assert value >= 1 and value <= n
```

(b) Test for fairness

[0]:
```
# YOUR CODE HERE
raise NotImplementedError()
```

0.2 Exercise 05.2 (data compression)

For devices with limited memory, data compression can be important. Data compression is a field of its own, but with libraries we can compress (and uncompress) data easily without being expert in the details.

Below is a program code for compressing a passage from Hamlet, by Shakespeare.

[45]:
```
# Import the compression module
import zlib
```

```
# Create a string that we wish to compress
text = """
Welcome, dear Rosencrantz and Guildenstern!
Moreover that we much did long to see you,
The need we have to use you did provoke
Our hasty sending. Something have you heard
Of Hamlet's transformation; so call it,
Sith nor the exterior nor the inward man
Resembles that it was. What it should be,
More than his father's death, that thus hath put him
So much from the understanding of himself,
I cannot dream of: I entreat you both,
That, being of so young days brought up with him,
And sith so neighbour'd to his youth and havior,
That you vouchsafe your rest here in our court
Some little time: so by your companies
To draw him on to pleasures, and to gather,
So much as from occasion you may glean,
Whether aught, to us unknown, afflicts him thus,
That, open'd, lies within our remedy."""

# Convert Python string to bytes and check type
text_bytes = text.encode("utf-8")
print(type(text_bytes))

# Get number of bytes used to store string
print("Number of bytes for uncompressed string:", len(text_bytes))

# Compress string and get number of byes used for compressed string
text_comp = zlib.compress(text_bytes)
print("Number of bytes for compressed string:", len(text_comp))

# Display the compression efficiency
print("Compression efficiency: ", len(text_comp)/len(text_bytes))

# Decompress the string
text_decomp = zlib.decompress(text_comp)

# Check that original and decompressed string are the same (more on aseret)
if text != text_decomp.decode("utf-8"):
    print("Problem: original and decompressed string differ.")
```

```
<class 'bytes'>
Number of bytes for uncompressed string: 785
Number of bytes for compressed string: 466
Compression efficiency:  0.5936305732484076
```

Using the above as a guide, examine the compression efficiency of

1. Compressing one large string made up of the the passage by Shakespeare repeated 100 times; and
2. Compressing a random string of the same length as the repeated Shakespeare passage.

To help you, the below function generates random string of length `N`:

[49]:
```
import random
import string

def random_string(N):
    return ''.join([random.choice(string.ascii_letters + string.digits) for n␣
 ↪in range(N)])

print(random_string(8))
```

```
EpoWuH1X
```

0.2.1 Solution

[0]:
```
# Create a string
text = """
Welcome, dear Rosencrantz and Guildenstern!
Moreover that we much did long to see you,
The need we have to use you did provoke
Our hasty sending. Something have you heard
Of Hamlet's transformation; so call it,
Sith nor the exterior nor the inward man
Resembles that it was. What it should be,
More than his father's death, that thus hath put him
So much from the understanding of himself,
I cannot dream of: I entreat you both,
That, being of so young days brought up with him,
And sith so neighbour'd to his youth and havior,
That you vouchsafe your rest here in our court
Some little time: so by your companies
To draw him on to pleasures, and to gather,
So much as from occasion you may glean,
Whether aught, to us unknown, afflicts him thus,
That, open'd, lies within our remedy."""
```

Import the necessary modules:

[0]:
```
import random
import string
import zlib
```

Repeat the Shakespeare string 100 times, and compress:

[82]:
```
# Convert Python string to bytes and check type
text100=text*100
text_bytes = text100.encode("utf-8")
print(type(text_bytes))

# Get number of bytes used to store string
print("Number of bytes for uncompressed string:", len(text_bytes))

# Compress string and get number of byes used for compressed string
text_comp = zlib.compress(text_bytes)
print("Number of bytes for compressed string:", len(text_comp))
```

```
<class 'bytes'>
Number of bytes for uncompressed string: 78500
Number of bytes for compressed string: 925
```

Create random string and compress:

[80]:
```
import random
import string

def random_string(N):
    return ''.join([random.choice(string.ascii_letters + string.digits) for n␣
 ↪in range(N)])

txt = random_string(78500)
print(txt)

# Convert Python string to bytes and check type
txt_bytes = txt.encode("utf-8")
print(type(txt_bytes))

# Get number of bytes used to store string
print("Number of bytes for uncompressed string:", len(txt_bytes))

# Compress string and get number of byes used for compressed string
txt_comp = zlib.compress(txt_bytes)
print("Number of bytes for compressed string:", len(txt_comp))
```

```
MBPfNy18WKhOQnXeE2HZBBzJ96syS5XwPh8qIVvmYWIqTOuTrKB4wREoS7ZOHkX9geIwSsox4Ga10Uur
Z8xt6WcZLtCpRyMmHatXoaHXNjVWGNVRQEeoShM2LucRke4POXlzRuXWslejwJuvS2hNGJqEbA4hDdL3
4dimKGLMblo1mPtOeNjBp0ge0hvmIrIILLOYtZkvb86C4Vgn3SJPcGPNy9wblRYLnhngEwiB6Z6Sx059
QGzrtHXMJUmuxWSXZCNFbIlAiKkaMmmkJTfw9YZtYwi4UxIKLHWm2fMd3gnu3CGJj9s2m0NCb9J3Sl9r
9dPfgjP2q3vIRNvjEsDQ7bp1xZYf6eWp6irUuogxEcNFIVabhqDCApwdhafTw6t5pEqkKLDZmKmoPyHf
WIVhE4dsyIWMWzndpwwy7CXkIacCeJDorbq6oQh9RysxJuilno9kPuLQNYhYIxRLrlR3HvafC17y63gF
GnD12ODfLgxUW0wSP2SRYva3eiKRZOkVeuWlZ1EVyEj2LmqsjxeXGnQ54LMNoXHkhwJIkwLv2JYdutzA
n2A3MjfaJePsGcjbarg4RWmfXX5J2qvTn4aVls1O4sApwPNYszvkwURUhiUzV24UZZajpc0dIfQwOIvg
P6JqIYle4gELmbgC4De72zw6uc8ZG3FoO9eLYhcwnxmYcz2pRk4S9f99HyCSH19e8Jvtwwumh8OKQKRv
```

pGI6W7z4Bbfq7VIBckFFCNL0ZtIqU1nkVuRNDypNh3uMsvJZfZBPllIfwiGgThQ9Pdz4w3rTS06HYOwx
KOyGQQMb1imFNMo6H6lU1iiaa95jR3acJi3S2wOdiZLZflVogGdM2WEwxAP0gkgHPWE6CPzpugfMb1gv
SianmMtUtTuNIFtCKx8qvBuS9teoD4dhuNCigX3zcNxUZnqw05PhxhpmDohQYV62I6fnCuZtrpYGi1nP
RKMGO7MRPCNlQtHWGH8XmXJKd3YbSCtIaLYipLCAUCbkj6jPO0Dh9Uuxh7qhhyfFryfwoqh0gNS8q3jl
kxrZ7lpsEtTeJPpHvGufEpi4rHXFhLnylf826XbT0cu0zDwkPcHtvFPgJ7mglFQr6s28QcTR38jg4Mhd
gb6VjXDhvhIpEGbIGrZamgn6cLU1Cn7cTEf2JFgli16jsErBksRqA42enf4WdOB6SzHKzhhHEM8COwew
QF3ip9MwIXGEhDUyZTM3ktQjbgk1ToUNxeyWGdUNBqoQudjmeWDWTLLZbUtkr9FaEp3kkqUYZC8TnUnu
EhPJh7KU6zPvC3GhvrStybY6PebH0ViomwiAcznBXYHksSswfihUH0rKQiYz7DBFTGbdzPBLNCQa0fsW
cHljwQ7CY4HkCVOxsROlJM8tHukbQt9unOdjigg7ugKQuky22UfmPr1LHvwspTx4Hm6SXzbJNEScZcW6
IqP60Th2cl3KqqH3QAqpazXcqNig5qwa57sdYDDQ0gY2Rv3C3WfFEErqg0T0pGb9kGGkBqBNbklTYnS4
AJns0eJto2vO7pVOvEImqyjg1gCiQXCLAKnRGHrQDyl1Z8mUKaUEuemQxJposbHkBNuq5dSIVUO2MPtW
y5wpy0j5S4yA3zH8bvAWubQ5oXCiFgnnTGr7yThrX30o9BHtZ4l5uyNi58rvZzFOI2D6LNINTQMtMmOG
e0epEn8SJhjj6XdrzR0Aib9805k9hSGjOaWfXgFvN7SEYgfS17pCmlxUVI5dbW4h7LzJOCjj0eboxyoy
z7TO4Shs57H4neNYDAvJ2PP0JWLglJPRXtIZAyeOIT2jpO1H2r4wIzTgt5PhdGnSFSolB7RW4SjxA83C
i7sXq1F2i1NRkLUBbFOU9DK8AAbk4biS9Sv8vvdXdKLW6TkkJeX4cean5Vnl0llue1c69Cm6vhQYyksV
z9FbGTyRQg438bPQNyJqhXTEls5cUXntRPJwd2AfLfawnWcpdCYWRiNykjtFsi55sIGFTtuRx1rloa30
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cWSB83Jv3LluaPZqoVj7KcODs9bt1ZxT6qm65yFYBAVz8dg9txfSMSoP4HtxPD5fEI7gUSrhDMVgmkz0
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7BfR5MfFvUY1APgw5qFJhEPhhRatTe7bBwaEa4Yyv6KBFbZOE7e5qXafCc8u5viNbizFe7n8xQJ2oLew
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VRObOsj6AHkNioTJCP3kshJDNQgnsz9aZ1Yeh7bzEwDXmyEQicQr5ltHOhVrHkjlNFN9hEsJqrUbcXW4
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yJAvQpUylOILlGy0G72mqRaL9cz0N89kak9cqhCJDjst0AFgbSdMpVXKcUzEIERXTmOlAHIJ1DQAFwjF
bV96X1Z8sM7zYdDpj5vpQTGqqT1E51qur0gUK3McktVAaZd0EkqgmvlXvLoILkJKDM6BuWemF7Bki4aN
T6DuDiICXD7sNalXh7Vg2JZWKnRTX2MyuievGA00v3zlCUOl7dyEl6scmmRXRWumfWEEurAINPA6Wxdz

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BB4FWCAnlEllWV31Ew96Ug7tyd2hwPO0iLj9sXC3ej4aEGLfRpFe6c46K03J6yYeyxeSK9qqrAR31Gl0
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1hgjFMoQjHeb0vJYLYgWGpPcsEY1hLybsaMxvmMVQikSATaTdZ3yDSbafGgvIlzg5JFMRSDw7S7TjDKQ
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2u4tfYAUXgYdmTJ7CIk02cuRBAWI0emzWv3qbNJSfl75PnZq4dCI7e0i9d8iJ1RrD5YljzstqdzLpPyX
RyFag6lj59j8PPYAWBZDCuxdZqATfKvUyogTz5OvvyF4NfQ70jqodUxc8mjLqzov1Gu4Ik4FlfDzQRfp
JpvE3xJpTQkda5DB7b4Pvqm8EY77T2V2lA0ni3gnPd6Sh0Zdb6y8cQoDpPVhdfwgvVC98ddEdKvfsd0o
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ZKShMPJklZPD0dmkLaZ47Wuo9Nw3MYpIfjKH4oQk2kMI8L6wWIX1lELX8TDQIUJptBs8xzPqiG4lPcf9
gFmhqPv86lk1GGF3Ik61i7HdgFWSW38006GNMREJQzil7s5wlGO8yzwk0eWAYrqO1sA13UtbkkFhPmRd
4zGQgfZcwIbrEqpFWc8ViaEN6I6q2UWxxRX9IpIbjFcWMQYfWu666GzvjkECXG2P0grrXgtKA9wl5nou
W9lWmslFRs83R7RHs2Zb8JltEoqwyDvmRNevgbpTJ0PDzvui5vDf2aDeSdMqHrXs1kJ8qoqSaSjrTOMn
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0zxTjhnJEMiKsl0lzf7Ij4NisZOydvsdsmePOVUlilHBkXXLjF9lulvwMXic29HAreRrREfUQhR31kQ0
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QA0dx2fFgOeNUJUPvPXsmosMOBr1MWhv0pKk37lr9wg4MIWgcjEyUtzIutWE7z2KzD6SKxz7pFEsaPVG
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RBWhdNlIK4bm1IcwQLFgN7j1JnxbNQD3xLcRyMvEyJsrGzNQcWYpGVfnWmpTBlGzuH2nRWsSVFW9x56C
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```
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cm4e1Qose8iwTC2CcQIg
<class 'bytes'>
Number of bytes for uncompressed string: 78500
Number of bytes for compressed string: 59037
```

Compare compression efficiency:

[83]:
```
# Display the compression efficiency
print("Compression efficiency Case 1: ", len(text_comp)/len(text_bytes))

# Decompress the string
text_decomp = zlib.decompress(text_comp)

# Check that original and decompressed string are the same (more on aseret)
if text != text_decomp.decode("utf-8"):
    print("Problem: original and decompressed string differ.")
#raise NotImplementedError()


# Display the compression efficiency
print("Compression efficiency Case 2: ", len(txt_comp)/len(txt_bytes))

# Decompress the string
txt_decomp = zlib.decompress(txt_comp)

# Check that original and decompressed string are the same (more on aseret)
if txt != txt_decomp.decode("utf-8"):
    print("Problem: original and decompressed string differ.")
```

```
Compression efficiency Case 1:  0.01178343949044586
Problem: original and decompressed string differ.
Compression efficiency Case 2:  0.752063694267516
```