Introduction to iterators

PYTHON DATA SCIENCE TOOLBOX (PART 2)

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Iterating with a for loop

- We can iterate over a list using a for loop

```
employees = ['Nick', 'Lore', 'Hugo']
for employee in employees:
    print(employee)
```

```
Nick
Lore
Hugo
```

Iterating with a for loop

- We can iterate over a string using a for loop

```
for letter in 'DataCamp':
    print(letter)
```

```
D
a
t
a
C
a
m
p
```

Iterating with a for loop

- We can iterate over a range object using a for loop

```
for i in range(4):
    print(i)
```

```
0
1
2
3
```

Iterators vs. iterables

- Iterable
  - Examples: lists, strings, dictionaries, file connections
  - An object with an associated `iter()` method
  - Applying `iter()` to an iterable creates an iterator
- Iterator
  - Produces next value with `next()`

Iterating over iterables: next()

```
word = 'Da'
it = iter(word)
next(it)
```

```
'D'
```

```
next(it)
```

```
'a'
```

```
next(it)
```

```
StopIteration                    Traceback (most recent call last)
<ipython-input-11-2cdb14c0d4d6> in <module>()
-> 1 next(it)
StopIteration:
```

Iterating at once with *

```
word = 'Data'
it = iter(word)
print(*it)
```

```
D a t a
```

```
print(*it)
```

- No more values to go through!

Iterating over dictionaries

```
pythonistas = {'hugo': 'bowne-anderson', 'francis': 'castro'}
for key, value in pythonistas.items():
    print(key, value)
```

```
francis castro
hugo bowne-anderson
```

Iterating over file connections

```
file = open('file.txt')
it = iter(file)
print(next(it))
```

```
This is the first line.
```

```
print(next(it))
```

```
This is the second line.
```

Let's practice!

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Playing with iterators

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Using enumerate()

```
avengers = ['hawkeye', 'iron man', 'thor', 'quicksilver']
e = enumerate(avengers)
print(type(e))
```

```
<class 'enumerate'>
```

```
e_list = list(e)
print(e_list)
```

```
[(0, 'hawkeye'), (1, 'iron man'), (2, 'thor'), (3, 'quicksilver')]
```

enumerate() and unpack

```
avengers = ['hawkeye', 'iron man', 'thor', 'quicksilver']
for index, value in enumerate(avengers):
    print(index, value)
```

```
0 hawkeye
1 iron man
2 thor
3 quicksilver
```

```
for index, value in enumerate(avengers, start=10):
    print(index, value)
```

```
10 hawkeye
11 iron man
12 thor
13 quicksilver
```

Using zip()

```
avengers = ['hawkeye', 'iron man', 'thor', 'quicksilver']
names = ['barton', 'stark', 'odinson', 'maximoff']
z = zip(avengers, names)
print(type(z))
```

```
<class 'zip'>
```

```
z_list = list(z)
print(z_list)
```

```
[('hawkeye', 'barton'), ('iron man', 'stark'),
('thor', 'odinson'), ('quicksilver', 'maximoff')]
```

zip() and unpack

```
avengers = ['hawkeye', 'iron man', 'thor', 'quicksilver']
names = ['barton', 'stark', 'odinson', 'maximoff']
for z1, z2 in zip(avengers, names):
    print(z1, z2)
```

```
hawkeye barton
iron man stark
thor odinson
quicksilver maximoff
```

Print zip with *

```
avengers = ['hawkeye', 'iron man', 'thor', 'quicksilver']
names = ['barton', 'stark', 'odinson', 'maximoff']
z = zip(avengers, names)
print(*z)
```

```
('hawkeye', 'barton') ('iron man', 'stark')
('thor', 'odinson') ('quicksilver', 'maximoff')
```

Let's practice!

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Using iterators to load large files into memory

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Loading data in chunks

- There can be too much data to hold in memory
- Solution: load data in chunks!
- Pandas function: `read_csv()`
  - Specify the chunk: `chunk_size`

Iterating over data

```
import pandas as pd
result = []
for chunk in pd.read_csv('data.csv', chunksize=1000):
    result.append(sum(chunk['x']))
total = sum(result)
print(total)
```

```
4252532
```

Iterating over data

```
import pandas as pd
total = 0
for chunk in pd.read_csv('data.csv', chunksize=1000):
    total += sum(chunk['x'])
print(total)
```

```
4252532
```

Let's practice!

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Congratulations!

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What's next?

- List comprehensions and generators
- List comprehensions:
  - Create lists from other lists, DataFrame columns, etc.
  - Single line of code
  - More efficient than using a for loop

Let's practice!

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List comprehensions

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Populate a list with a for loop

```
nums = [12, 8, 21, 3, 16]
new_nums = []
for num in nums:
    new_nums.append(num + 1)
print(new_nums)
```

```
[13, 9, 22, 4, 17]
```

A list comprehension

```
nums = [12, 8, 21, 3, 16]
new_nums = [num + 1 for num in nums]
print(new_nums)
```

```
[13, 9, 22, 4, 17]
```

For loop and list comprehension syntax

```
new_nums = [num + 1 for num in nums]
```

```
for num in nums:
    new_nums.append(num + 1)
print(new_nums)
```

```
[13, 9, 22, 4, 17]
```

List comprehension with range()

```
result = [num for num in range(11)]
print(result)
```

```
[0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10]
```

List comprehensions

- Collapse for loops for building lists into a single line
- Components
  - Iterable
  - Iterator variable (represent members of iterable)
  - Output expression

Nested loops (1)

```
pairs_1 = []
for num1 in range(0, 2):
    for num2 in range(6, 8):
        pairs_1.append(num1, num2)
print(pairs_1)
```

```
[(0, 6), (0, 7), (1, 6), (1, 7)]
```

- How to do this with a list comprehension?

Nested loops (2)

```
pairs_2 = [(num1, num2) for num1 in range(0, 2) for num2 in range(6, 8)]
print(pairs_2)
```

```
[(0, 6), (0, 7), (1, 6), (1, 7)]
```

- Tradeoff: readability

Let's practice!

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Advanced comprehensions

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Conditionals in comprehensions

- Conditionals on the iterable

```
[num ** 2 for num in range(10) if num % 2 == 0]
```

```
[0, 4, 16, 36, 64]
```

- Python documentation on the `%` operator: The `%` (modulo) operator yields the remainder from the division of the first argument by the second.

```
5 % 2
```

```
1
```

```
6 % 2
```

```
0
```

Conditionals in comprehensions

- Conditionals on the output expression

```
[num ** 2 if num % 2 == 0 else 0 for num in range(10)]
```

```
[0, 0, 4, 0, 16, 0, 36, 0, 64, 0]
```

Dict comprehensions

- Create dictionaries
- Use curly braces `{}` instead of brackets `[]`

```
pos_neg = {num: -num for num in range(9)}
print(pos_neg)
```

```
{0: 0, 1: -1, 2: -2, 3: -3, 4: -4, 5: -5, 6: -6, 7: -7, 8: -8}
```

```
print(type(pos_neg))
```

```
<class 'dict'>
```

Let's practice!

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Introduction to generator expressions

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Generator expressions

- Recall list comprehension

```
[2 * num for num in range(10)]
```

```
[0, 2, 4, 6, 8, 10, 12, 14, 16, 18]
```

- Use `( )` instead of `[ ]`

```
(2 * num for num in range(10))
```

```
<generator object <genexpr> at 0x1046bf888>
```

List comprehensions vs. generators

- List comprehension - returns a list
- Generators - returns a generator object
- Both can be iterated over

Printing values from generators (1)

```
result = (num for num in range(6))
for num in result:
    print(num)
```

```
0
1
2
3
4
5
```

```
result = (num for num in range(6))
print(list(result))
```

```
[0, 1, 2, 3, 4, 5]
```

Printing values from generators (2)

```
result = (num for num in range(6))
```

- Lazy evaluation

```
print(next(result))
```

```
0
```

```
print(next(result))
```

```
1
```

```
print(next(result))
```

```
2
```

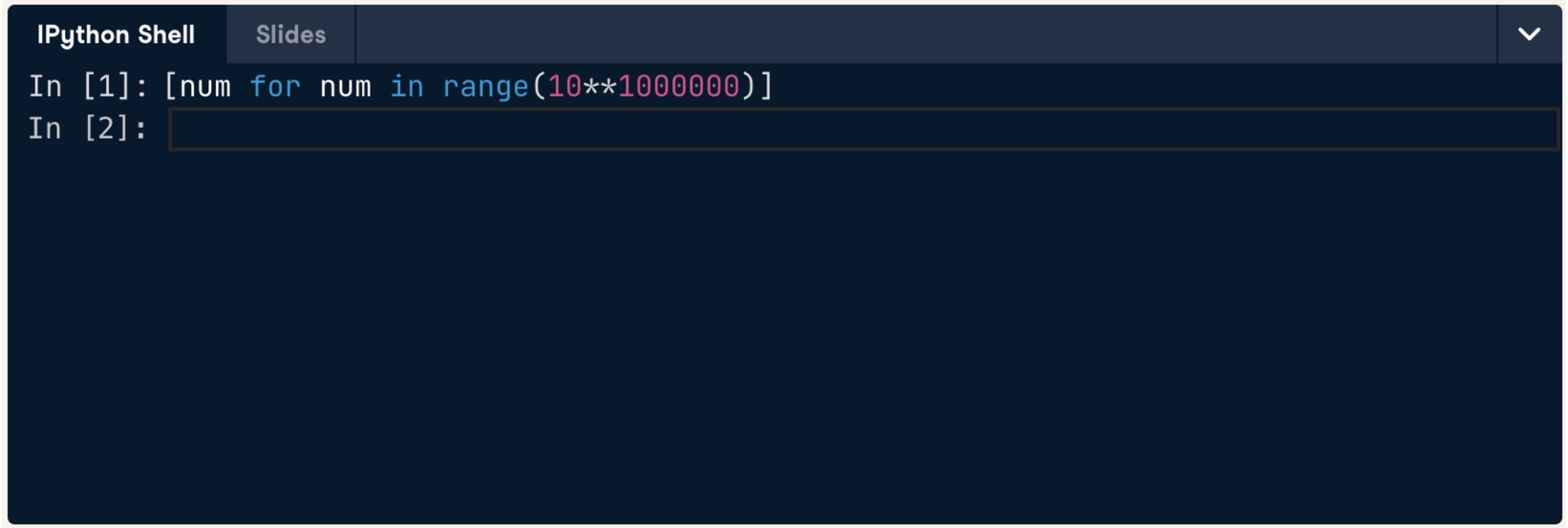
```
print(next(result))
```

```
3
```

```
print(next(result))
```

```
4
```

Generators vs list comprehensions



Generators vs list comprehensions

IPython Shell | Slides

```
In [1]: [num for num in range(10**1000000)]
In [2]:
```

IPython Shell | Slides

The code took too long to execute.

If the problem persists, please report an issue.

Restart Session

Generators vs list comprehensions

IPython Shell | Slides

```
In [1]: (num for num in range(10**1000000))
Out[1]: <generator object <genexpr> at 0x7f8c2447a7d8>

In [2]:
```

Conditionals in generator expressions

```
even_nums = (num for num in range(10) if num % 2 == 0)
print(list(even_nums))
```

```
[0, 2, 4, 6, 8]
```

Generator functions

- Produces generator objects when called
- Defined like a regular function - `def`
- Yields a sequence of values instead of returning a single value
- Generates a value with `yield` keyword

Build a generator function

- sequence.py

```
def num_sequence(n):
    """Generate values from 0 to n."""
    i = 0
    while i < n:
        yield i
        i += 1
```

Use a generator function

```
result = num_sequence(5)
print(type(result))
```

```
<class 'generator'>
```

```
for item in result:
    print(item)
```

```
0
1
2
3
4
```

Let's practice!

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Wrapping up comprehensions and generators.

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Re-cap: list comprehensions

- Basic

```
[output expression for iterator variable in iterable]
```

- Advanced

```
[output expression +
conditional on output for iterator variable in iterable +
conditional on iterable]
```

Let's practice!

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Welcome to the case study!

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World bank data

- Data on world economies for over half a century
- Indicators
  - Population
  - Electricity consumption
  - CO2 emissions
  - Literacy rates
  - Unemployment
  - Mortality rates

Using zip()

```
avengers = ['hawkeye', 'iron man', 'thor', 'quicksilver']
names = ['barton', 'stark', 'odinson', 'maximoff']
z = zip(avengers, names)
print(type(z))
```

```
<class 'zip'>
```

```
print(list(z))
```

```
[('hawkeye', 'barton'), ('iron man', 'stark'),
('thor', 'odinson'), ('quicksilver', 'maximoff')]
```

Defining a function

- raise.py

```
def raise_both(value1, value2):
    """Raise value1 to the power of value2
    and vice versa."""
    new_value1 = value1 ** value2
    new_value2 = value2 ** value1
    new_tuple = (new_value1, new_value2)
    return new_tuple
```

Re-cap: list comprehensions

Basic

```
[output expression for iterator variable in iterable]
```

Advanced

```
[output expression +
conditional on output for iterator variable in iterable +
conditional on iterable]
```

Let's practice!

PYTHON DATA SCIENCE TOOLBOX (PART 2)

Using Python generators for streaming data

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Generators for the large data limit

- Use a generator to load a file line by line
- Works on streaming data!
- Read and process the file until all lines are exhausted

Build a generator function

- sequence.py

```
def num_sequence(n):
    """Generate values from 0 to n."""
    i = 0
    while i < n:
        yield i
        i += 1
```

Let's practice!

PYTHON DATA SCIENCE TOOLBOX (PART 2)

Using pandas' read_csv iterator for streaming data

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Reading files in chunks

- Up next:
  - `read_csv()` function and `chunk_size` argument
  - Look at specific indicators in specific countries
  - Write a function to generalize tasks

Let's practice!

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Final thoughts

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You've applied your skills in:

- User-defined functions
- Iterators
- List comprehensions
- Generators

Let's practice!

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