PYTHON DATA SCIENCE TOOLBOX II

List comprehensions

Populate a list with a for loop

```
In [1]: nums = [12, 8, 21, 3, 16]

In [2]: new_nums = []

In [3]: for num in nums:
   ...:     new_nums.append(num + 1)

In [4]: print(new_nums)
[13, 9, 22, 4, 17]
```

A list comprehension

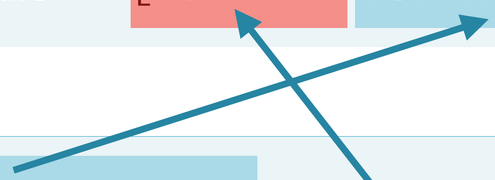
```
In [1]: nums = [12, 8, 21, 3, 16]

In [2]: new_nums = [num + 1 for num in nums]

In [3]: print(new_nums)
[13, 9, 22, 4, 17]
```

For loop and list comprehension syntax

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



```
In [2]: for num in nums:
   ...:     new_nums.append(num + 1)

In [3]: print(new_nums)
[13, 9, 22, 4, 17]
```

List comprehension with range()

```
In [1]: result = [num for num in range(11)]

In [2]: 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)

```
In [1]: pairs_1 = []

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

In [3]: print(pairs_1)
[(0, 6), (0, 7), (1, 6), (1, 7)]
```

- How to do this with a list comprehension?

Nested loops (2)

```
In [1]: pairs_2 = [(num1, num2) for num1 in range(0, 2) for num2
in range(6, 8)]

In [2]: print(pairs_2)
[(0, 6), (0, 7), (1, 6), (1, 7)]
```

- Tradeoff: readability

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Advanced comprehensions

Conditionals in comprehensions

- Conditionals on the iterable

```
In [1]: [num ** 2 for num in range(10) if num % 2 == 0]
Out[1]: [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.

```
In [1]: 5 % 2
Out[1]: 1

In [2]: 6 % 2
Out[2]: 0
```

Conditionals in comprehensions

- Conditionals on the output expression

```
In [2]: [num ** 2 if num % 2 == 0 else 0 for num in range(10)]
Out[2]: [0, 0, 4, 0, 16, 0, 36, 0, 64, 0]
```

Dict comprehensions

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

```
In [1]: pos_neg = {num: -num for num in range(9)}

In [2]: print(pos_neg)
{0: 0, 1: -1, 2: -2, 3: -3, 4: -4, 5: -5, 6: -6, 7: -7, 8: -8}

In [3]: print(type(pos_neg))
<class 'dict'>
```

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Introduction to generators

Generator expressions

- Recall list comprehension

```
In [1]: [2 * num for num in range(10)]
Out[1]: [0, 2, 4, 6, 8, 10, 12, 14, 16, 18]
```

- Use ( ) instead of [ ]

```
In [2]: (2 * num for num in range(10))
Out[2]: <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)

```
In [1]: result = (num for num in range(6))

In [2]: for num in result:
  ....:     print(num)
0
1
2
3
4
5
```

```
In [1]: result = (num for num in range(6))

In [2]: print(list(result))
[0, 1, 2, 3, 4, 5]
```

Printing values from generators (2)

```
In [1]: result = (num for num in range(6))

In [2]: print(next(result))
0

In [3]: print(next(result))
1

In [4]: print(next(result))
2

In [5]: print(next(result))
3

In [6]: print(next(result))
4
```

Lazy evaluation

Generators vs list comprehensions

IPython Shell

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

In [2]:
```

IPython Shell

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

In [2]:
```

Your session has been disconnected.
The performed operation was too resource-intensive.

Restart Session

Generators vs list comprehensions

IPython Shell

```
In [1]: (num for num in range(10**1000000))
Out[1]: <generator object <genexpr> at 0x7f8aca2601f8>

In [2]:
```

Conditionals in generator expressions

```
In [1]: even_nums = (num for num in range(10) if num % 2 == 0)

In [2]: 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

```
In [1]: result = num_sequence(5)

In [2]: print(type(result))
<class 'generator'>

In [3]: for item in result:
   ....:     print(item)
0
1
2
3
4
```

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Wrap-up: comprehensions

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]
```

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Let’s practice!