Intermediate! python

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List comprehension

Anatomy of a list comprehension:

new list = [transform iterate filter]

How to use list comprehension (LC)

- Say you want to print the square of the odd numbers in a list :

```
some_list = [1, 2, 3, 4, 5]
```

- The end result will be: `[1, 9, 25]`
- How can we do this using a list comprehension?

How to use LC

1. First things first:

```
[]
```

2. Iterate over the sequence:

```
[for num in my_list]
```

3. Write the filter condition:

```
[for num in my_list if num % 2 == 1]
```

4. Include the transformed result:

```
[num**2 for num in my_list if num % 2 == 1]
```

5. Optional: save result to a new list

```
squared_ints = [num**2 for num in my_list \
                if num % 2 == 1]
```

When to use LC

- When you’re using a loop to transform a sequence
- When you don’t want to write code like this:

```
numbers = [0,1,2,3,4,5,6,7,8,9]
size = len(numbers)
evens = []
while i < size:
    if i % 2 == 0:
        evens.append(i)
    i += 1
```

```
evens = [i for i in range(10) if i % 2 == 0]
```

When NOT to use LC

Don’t use list comprehensions for:

- deeply nested iterations,
- complicated transformations, or
- code that would be easier understood if it were written using **for** or **while** loops.

Iterators

Iterator: An object that implements the iterator protocol.

Iterators must implement these two methods:

1. **__iter__()**
2. **next()**

Iterable object: an object that can yield objects one at a time.

Iterate? Iterable? Iterator?

- To **iterate**: given a collection of values, take one value after the other from the collection.
- An **iterable** is an object that you can get an iterator from either:
  1. An **__iter__()** method
  2. A **__getitem__()** method
- An **iterator** is an object from which you can get one value at a time with **next()**.

You’ve seen this before!

Looping over...

- lists
- strings
- dictionary keys
- files

```
for n in [5,6,7,8,9]:
    print n
```

```
for key in {"x": 1, "y": 2}
    print key
```

Iterables

How to use iterators

```
my_iter = iter(collection)
```

has a __next__() method

How to use iterators

```
>>> s = 'abc'
>>> it = iter(s)
>>> it
<iterator object at 0x1014b6110>
>>> next(it)
'a'
>>> next(it)
'b'
```

How to use iterators

```
>>> next(it)
'c'
>>> next(it)
StopIteration
```

When to use iterators

You already do!

Generators

- Generators are functions that use **yield** expressions.
- When called, generators immediately return an **iterator.**
- Using **next()**, the iterator advances the generator to its next yield expression.

First: a regular function

```python
def firstn(n):
    num, nums = 0, []
    while num < n:
        nums.append(num)
        num += 1
    return nums

sum_of_first_n = sum(firstn(1000000))
```

How to use generators

```
def firstn(n):
    num = 0
    while num < n:
        yield num
        num += 1

sum_of_first_n = sum(firstn(1000000))
```

Generator expressions

- A generalization of list comprehensions and generators
- Yield one item at a time

Generator expressions (lazy!)

Syntax:

```
lc_doubles = [2 * n for n in [1,2,3,4,5]]
```

```
genexp = (2 * n for n in [1,2,3,4,5])
genexp_doubles = list(genexp)
```

Materialize

```
genexp = (2 * n for n in range(1,6))
genexp_doubles = list(genexp)
```

- Providing the generator expression as an argument to **list()** builds the entire list.
- Use **range()** or **xrange()** to create sequences of numbers.

- Other built-in functions that take iterables:
  - sorted()
  - min(), max()
  - sum()
  - dict()
  - all(), any()

Generator expression example

```
>>> gen = (value for value in [4,5,6,7,8,9]\
          if value > 5)
>>> gen
<generator object <genexpr> at 0x103bb6d70>
>>> next(gen)
6
>>> min(gen)
7
>>> min(gen)
ValueError: min() arg is an empty sequence
```

Equivalent functions

This generator:

```
def pos_generator(seq):
    for x in seq:
        if x >= 0:
            yield x
```

Is equivalent to this generator expression:

```
def pos_gen_exp(seq):
    return (x for x in seq if x >= 0)
```

And they both produce the same result:

```
>>> list(pos_generator(range(-5, 5))) == \
    list(pos_gen_exp(range(-5, 5)))
True
```

When to use generators

- You have a lot of data to iterate over
- To avoid materialization

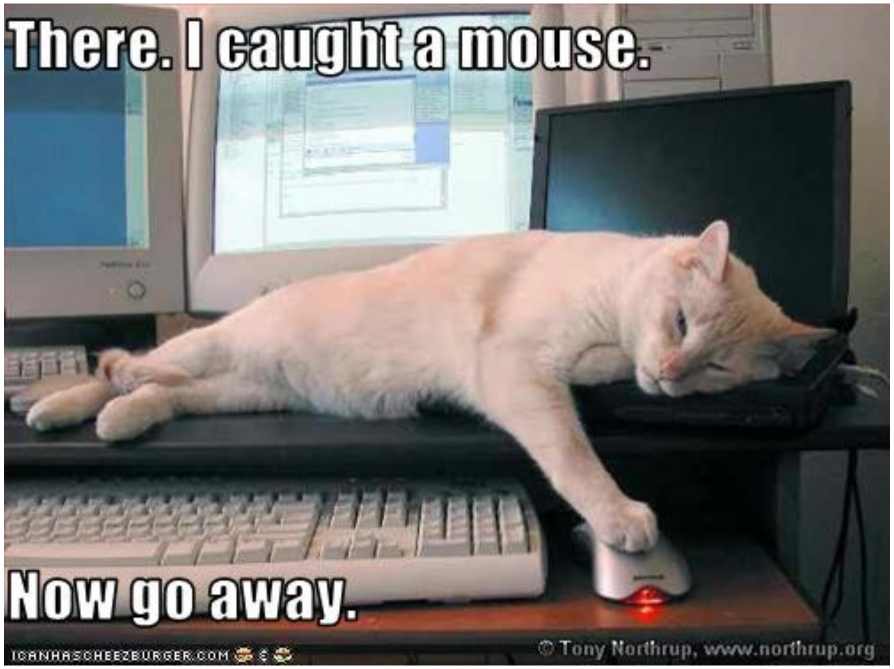
When to NOT use generators

- Slicing is necessary
- They can be tricky to debug
  - Can only access values one at a time, not the whole collection

Lambdas

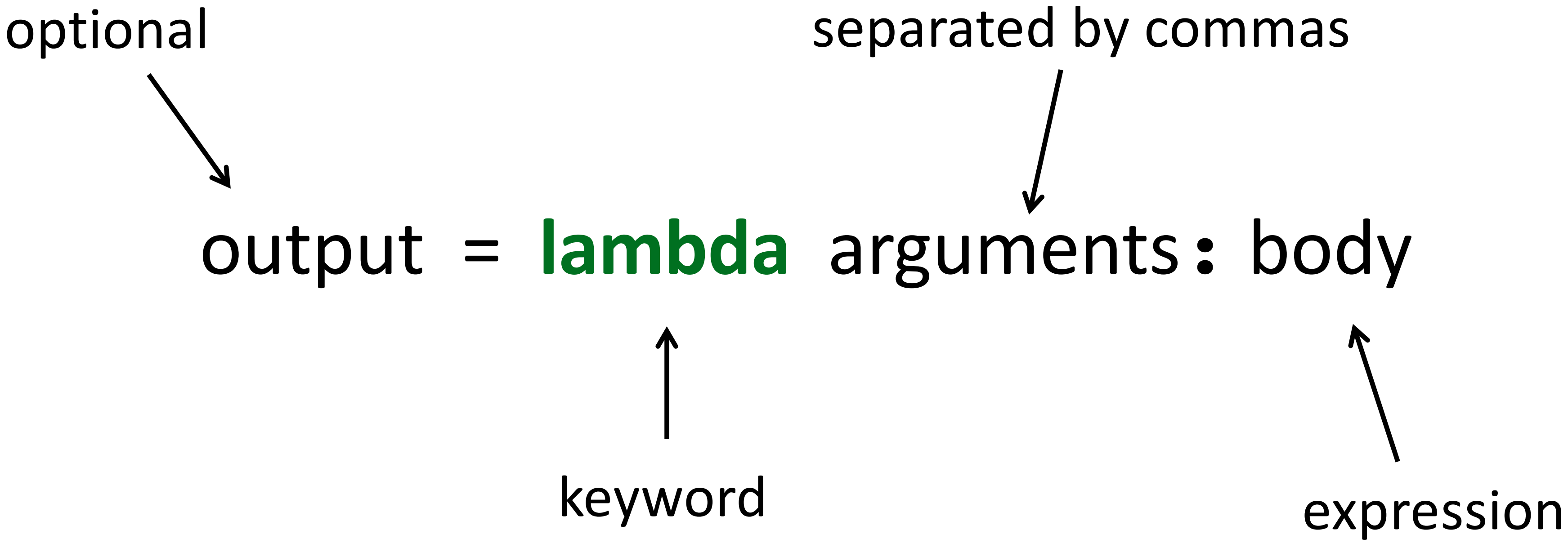
Python has two tools for building functions:

1. **def**
2. **lambda**



Lambdas are just shorthand for creating anonymous functions.

Lambda recipe



optional

separated by commas

```
output = lambda arguments: body
```

keyword

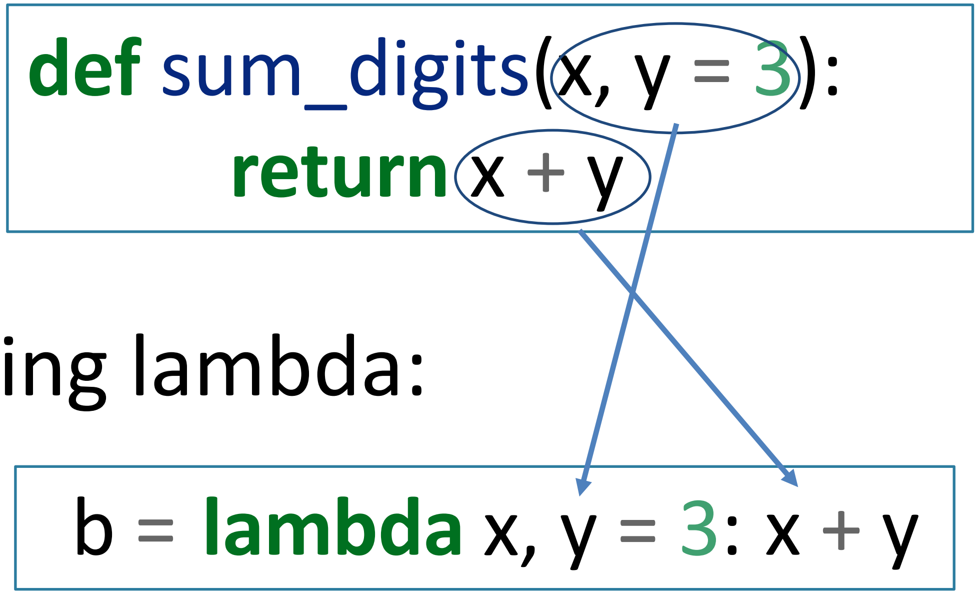
expression

Expression?

```
def name(arg):
    return expression
```

How to use lambdas

Start with an imperative function:



```
def sum_digits(x, y = 3):
        return x + y
```

Rewrite using lambda:

```
b = lambda x, y = 3: x + y
```

Check:

```
b(5)      # 8
b(5,1)    # 6
```

When to use a lambda

- Need a quick one-liner to provide a minor bit of functionality to some other feature
- Functional programming
- Convenient for data analysis: transform data with minimal typing

When to NOT use a lambda

- When the following are necessary:
  - Multiple/multi-line expressions
  - Control structures
  - Variable assignment
- When what you really need is a function

Also....

Just because you can add a docstring doesn’t mean you should:

```
my_lambda.__doc__ = "awful idea"
```

Playtime!

Suggested order:

1. List comprehensions
2. Lambdas
3. Iterators
4. Generators

Github repository:

github.com/cterp/wwc-intermediate-python

Reading list

1. https://docs.python.org/
2. Slatkin, Brett: Effective Python: 59 Specific Ways to Write Better Python. Addison-Wedley, 2015.
3. Alchin, Marty: Pro Python: Advanced coding techniques and tools. Apress, 2010.
4. Anything Matt Harrison writes about Python.

What to do next

Module suggestions:

- iterator
- collections
  - Counting!
- itertools

This workshop was really only about one thing…

Lazily materialize objects whenever possible.