PYTHON DATA SCIENCE TOOLBOX I

User-defined functions

You'll learn:

- Define functions without parameters
- Define functions with one parameter
- Define functions that return a value
- Later: multiple arguments, multiple return values

Built-in functions

- `str()`

```
In [1]: x = str(5)

In [2]: print(x)
'5'

In [3]: print(type(x))
<class 'str'>
```

Defining a function

```
In [1]: def square():
   ...:     new_value = 4 ** 2
   ...:     print(new_value)

In [2]: square()
16
```

Function header

Function body (Indented)

Function parameters

```
In [1]: def square(value):
   ...:     new_value = value ** 2
   ...:     print(new_value)

In [2]: square(4)
16

In [3]: square(5)
25
```

parameter

argument

Return values from functions

- Return a value from a function using `return`

```
In [1]: def square(value):
   ...:     new_value = value ** 2
   ...:     return new_value

In [12]: num = square(4)

In [13]: print(num)
16
```

Docstrings

- Docstrings describe what your function does
- Serve as documentation for your function
- Placed in the immediate line after the function header
- In between triple double quotes """

```
In [1]: def square(value):
   ...:     """Return the square of a value."""
   ...:     new_value = value ** 2
   ...:     return new_value
```

PYTHON DATA SCIENCE TOOLBOX I

Let’s practice!

PYTHON DATA SCIENCE TOOLBOX I

Multiple parameters and return values

Multiple function parameters

- Accept more than 1 parameter:

```
In [1]: def raise_to_power(value1, value2):
   ...:     """Raise value1 to the power of value2."""
   ...:     new_value = value1 ** value2
   ...:     return new_value
```

- Call function: # of arguments = # of parameters

```
In [2]: result = raise_to_power(2, 3)

In [3]: print(result)
8
```

A quick jump into tuples

- Make functions return multiple values: Tuples!
- Tuples:
  - Like a list - can contain multiple values
  - Immutable - can't modify values!
  - Constructed using parentheses ( )

```
In [1]: even_nums = (2, 4, 6)

In [2]: print(type(even_nums))
<class 'tuple'>
```

Unpacking tuples

- Unpack a tuple into several variables:

```
In [1]: even_nums = (2, 4, 6)

In [2]: a, b, c = even_nums

In [3]: print(a)
2

In [4]: print(b)
4

In [5]: print(c)
6
```

Accessing tuple elements

- Access tuple elements like you do with lists:

```
In [1]: even_nums = (2, 4, 6)

In [2]: print(even_nums[1])
4

In [3]: second_num = even_nums[1]

In [4]: print(second_num)
4
```

- Uses zero-indexing

Returning multiple values

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
```

```
In [1]: result = raise_both(2, 3)

In [2]: print(result)
(8, 9)
```

PYTHON DATA SCIENCE TOOLBOX I

Let’s practice!

PYTHON DATA SCIENCE TOOLBOX I

Bringing it all together

You've learned:

- How to write functions
  - Accept multiple parameters
  - Return multiple values

- Up next: Functions for analyzing Twitter data

Basic ingredients of 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
```

Function header

Function body

PYTHON DATA SCIENCE TOOLBOX I

Let’s practice!

PYTHON DATA SCIENCE TOOLBOX I

Congratulations!

Next chapters:

- Functions with default arguments
- Functions that accept an arbitrary number of parameters
- Nested functions
- Error-handling within functions
- More function use in data science!

See you in the next chapter!

PYTHON DATA SCIENCE TOOLBOX I

Scope and user-defined functions

Crash course on scope in functions

- Not all objects are accessible everywhere in a script
- Scope - part of the program where an object or *name* may be accessible
  - Global scope - defined in the main body of a script
  - Local scope - defined inside a function
  - Built-in scope - names in the pre-defined built-ins module

Global vs. local scope (1)

```
In [1]: def square(value):
   ...:     """Returns the square of a number."""
   ...:     new_val = value ** 2
   ...:     return new_val

In [2]: square(3)
Out[2]: 9

In [3]: new_val
---------------------------------------------------------------
NameError                                 Traceback (most recent call last)
<ipython-input-3-3cc6c6de5c5c> in <module>()
----> 1 new_value
NameError: name 'new_val' is not defined
```

Global vs. local scope (2)

```
In [1]: new_val = 10

In [2]: def square(value):
   ...:     """Returns the square of a number."""
   ...:     new_val = value ** 2
   ...:     return new_val

In [3]: square(3)
Out[3]: 9

In [4]: new_val
Out[4]: 10
```

Global vs. local scope (3)

```
In [1]: new_val = 10

In [2]: def square(value):
   ...:     """Returns the square of a number."""
   ...:     new_value2 = new_val ** 2
   ...:     return new_value2

In [3]: square(3)
Out[3]: 100

In [4]: new_val = 20

In [5]: square(3)
Out[5]: 400
```

Global vs. local scope (4)

```
In [1]: new_val = 10

In [2]: def square(value):
   ...:     """Returns the square of a number."""
   ...:     global new_val
   ...:     new_val = new_val ** 2
   ...:     return new_val

In [3]: square(3)
Out[3]: 100

In [4]: new_val
Out[4]: 100
```

PYTHON DATA SCIENCE TOOLBOX I

Let’s practice!

PYTHON DATA SCIENCE TOOLBOX I

Nested functions

Nested functions (1)

nested.py

```
def outer( … ):
    """ … """
    x = …

    def inner( … ):
        """ … """
        y = x ** 2

    return …
```

Nested functions (2)

square3.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
```

Nested functions (3)

mod2plus5.py

```
def mod2plus5(x1, x2, x3):
    """Returns the remainder plus 5 of three values."""

    def inner(x):
        """Returns the remainder plus 5 of a value."""
        return x % 2 + 5

    return (inner(x1), inner(x2), inner(x3))
```

```
In [1]: print(mod2plus5(1, 2, 3))
(6, 5, 6)
```

Returning functions

raise.py

```
def raise_val(n):
    """Return the inner function."""

    def inner(x):
    """Raise x to the power of n."""
        raised = x ** n
        return raised

    return inner
```

```
In [1]: square = raise_val(2)
In [2]: cube = raise_val(3)
In [3]: print(square(2), cube(4))
4 64
```

Using nonlocal

nonlocal.py

```
def outer():
    """Prints the value of n."""
    n = 1

    def inner():
        nonlocal n
        n = 2
        print(n)

    inner()
    print(n)
```

```
In [1]: outer()
2
2
```

Scopes searched

- Local scope
- Enclosing functions
- Global
- Built-in

PYTHON DATA SCIENCE TOOLBOX I

Let’s practice!

PYTHON DATA SCIENCE TOOLBOX I

Default and flexible arguments

You'll learn:

- Writing functions with default parameters
- Using flexible arguments
  - Pass any number of arguments to a functions

Add a default argument

```
In [1]: def power(number, pow=1):
  ....:     """Raise number to the power of pow."""
  ....:     new_value = number ** pow
  ....:     return new_value

In [2]: power(9, 2)
Out[2]: 81

In [3]: power(9, 1)
Out[3]: 9

In [4]: power(9)
Out[4]: 9
```

Flexible arguments: *args (1)

add_all.py

```
def add_all(*args):
    """Sum all values in *args together."""

    # Initialize sum
    sum_all = 0

    # Accumulate the sum
    for num in args:
        sum_all += num

    return sum_all
```

Flexible arguments: *args (2)

```
In [1]: add_all(1)
Out[1]: 1

In [2]: add_all(1, 2)
Out[2]: 3

In [3]: add_all(5, 10, 15, 20)
Out[3]: 50
```

Flexible arguments: **kwargs

```
In [1]: print_all(name="Hugo Bowne-Anderson", employer="DataCamp")
name: Hugo Bowne-Anderson
employer: DataCamp
```

Flexible arguments: **kwargs

kwargs.py

```
def print_all(**kwargs):
    """Print out key-value pairs in **kwargs."""

    # Print out the key-value pairs
    for key, value in kwargs.items():
        print(key + ": " + value)
```

```
In [1]: print_all(name="dumbledore", job="headmaster")
job: headmaster
name: dumbledore
```

PYTHON DATA SCIENCE TOOLBOX I

Let’s practice!

PYTHON DATA SCIENCE TOOLBOX I

Bringing it all together

Next exercises:

- Generalized functions:
  - Count occurrences for any column
  - Count occurrences for an arbitrary number of columns

Add a default argument

power.py

```
def power(number, pow=1):
    """Raise number to the power of pow."""
    new_value = number ** pow
    return new_value
```

```
In [1]: power(9, 2)
Out[1]: 81

In [2]: power(9)
Out[2]: 9
```

Flexible arguments: *args (1)

add_all.py

```
def add_all(*args):
    """Sum all values in *args together."""

    # Initialize sum
    sum_all = 0

    # Accumulate the sum
    for num in args:
        sum_all = sum_all + num

    return sum_all
```

PYTHON DATA SCIENCE TOOLBOX I

Let’s practice!

PYTHON DATA SCIENCE TOOLBOX I

Lambda functions

Lambda functions

```
In [1]: raise_to_power = lambda x, y: x ** y

In [2]: raise_to_power(2, 3)
Out[2]: 8
```

Anonymous functions

- Function map takes two arguments: `map(func, seq)`
- `map()` applies the function to ALL elements in the sequence

```
In [1]: nums = [48, 6, 9, 21, 1]

In [2]: square_all = map(lambda num: num ** 2, nums)

In [3]: print(square_all)
<map object at 0x103e065c0>

In [4]: print(list(square_all))
[2304, 36, 81, 441, 1]
```

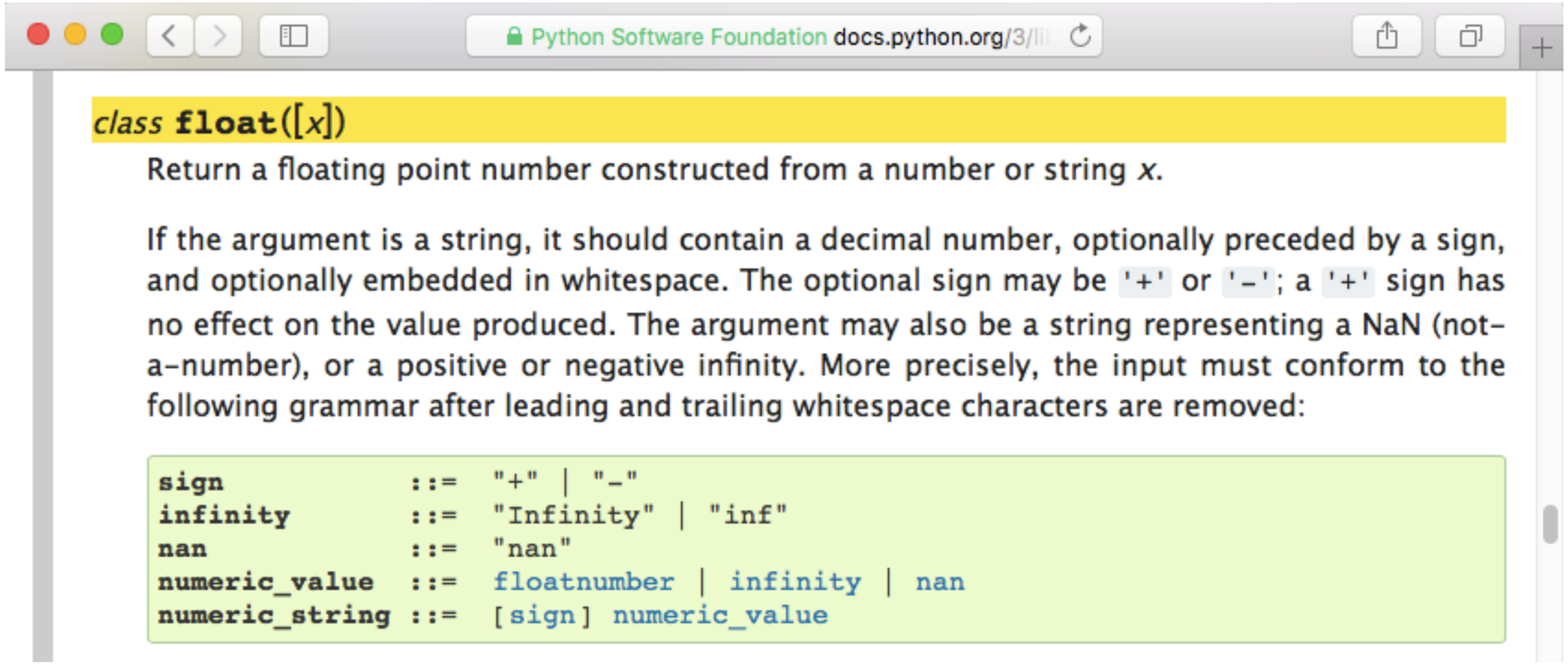
PYTHON DATA SCIENCE TOOLBOX I

Let’s practice!

PYTHON DATA SCIENCE TOOLBOX I

Introduction to error handling

The float() function



Passing an incorrect argument

```
In [1]: float(2)
Out[1]: 2.0

In [2]: float('2.3')
Out[2]: 2.3

In [3]: float('hello')
---------------------------------------------------------------
ValueError                                Traceback (most recent call last)
<ipython-input-3-d0ce8bccc8b2> in <module>()
----> 1 float('hi')
ValueError: could not convert string to float: 'hello'
```

Passing valid arguments

```
In [1]: def sqrt(x):
   ...:     """Returns the square root of a number."""
   ...:     return x ** (0.5)

In [2]: sqrt(4)
Out[2]: 2.0

In [3]: sqrt(10)
Out[3]: 3.1622776601683795
```

Passing invalid arguments

```
In [4]: sqrt('hello')
---------------------------------------------------------------------
TypeError                                 Traceback (most recent call last)
<ipython-input-4-cfb99c64761f> in <module>()
----> 1 sqrt('hello')

<ipython-input-1-939b1a60b413> in sqrt(x)
      1 def sqrt(x):
----> 2     return x**(0.5)

TypeError: unsupported operand type(s) for ** or pow(): 'str' and
'float'
```

Errors and exceptions

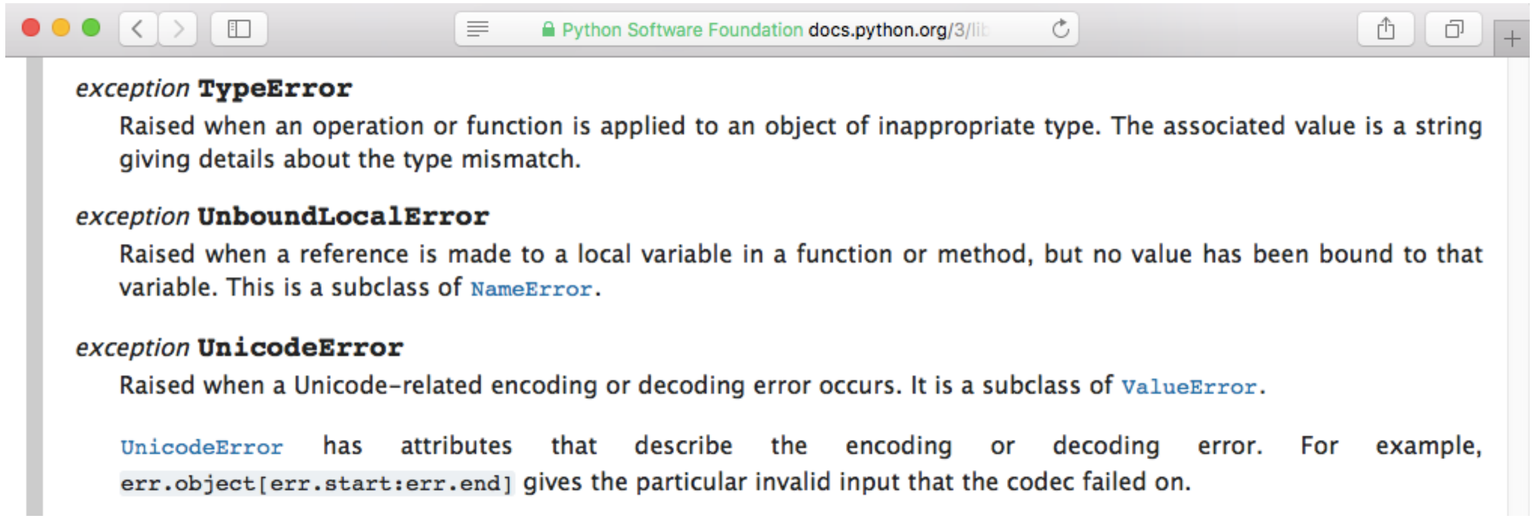
- Exceptions - caught during execution
- Catch exceptions with `try-except` clause
  - Runs the code following `try`
  - If there's an exception, run the code following `except`

Errors and exceptions

```
In [1]: def sqrt(x):
   ...:     """Returns the square root of a number."""
   ...:     try:
   ...:         return x ** 0.5
   ...:     except:
   ...:         print('x must be an int or float')

In [2]: sqrt(4)
Out[2]: 2.0

In [3]: sqrt(10.0)
Out[3]: 3.1622776601683795

In [4]: sqrt('hi')
x must be an int or float
```

Errors and exceptions

```
In [1]: def sqrt(x):
   ...:     """Returns the square root of a number."""
   ...:     try:
   ...:         return x ** 0.5
   ...:     except TypeError:
   ...:         print('x must be an int or float')
```



Errors and exceptions

```
In [2]: sqrt(-9)
Out[2]: (1.8369701987210297e-16+3j)
```

```
In [3]: def sqrt(x):
   ...:     """Returns the square root of a number."""
   ...:     if x < 0:
   ...:         raise ValueError('x must be non-negative')
   ...:     try:
   ...:         return x ** 0.5
   ...:     except TypeError:
   ...:         print('x must be an int or float')
```

Errors and exceptions

```
In [4]: sqrt(-2)
---------------------------------------------------------------
ValueError                                Traceback (most recent call last)
<ipython-input-2-4cf32322fa95> in <module>()
----> 1 sqrt(-2)

<ipython-input-1-a7b8126942e3> in sqrt(x)
      1 def sqrt(x):
      2     if x < 0:
----> 3         raise ValueError('x must be non-negative')
      4     try:
      5         return x**(0.5)

ValueError: x must be non-negative
```

PYTHON DATA SCIENCE TOOLBOX I

Let’s practice!

PYTHON DATA SCIENCE TOOLBOX I

Bringing it all together

Errors and exceptions

sqrt.py

```
def sqrt(x):
    try:
        return x ** 0.5
    except:
        print('x must be an int or float')
```

```
In [1]: sqrt(4)
Out[1]: 2.0

In [2]: sqrt('hi')
x must be an int or float
```

Errors and exceptions

sqrt.py

```
def sqrt(x):
    if x < 0:
        raise ValueError('x must be non-negative')
    try:
        return x ** 0.5
    except TypeError:
        print('x must be an int or float')
```

PYTHON DATA SCIENCE TOOLBOX I

Let’s practice!

PYTHON DATA SCIENCE TOOLBOX I

Congratulations!

What you've learned:

- Write functions that accept single and multiple arguments
- Write functions that return one or many values
- Use default, flexible, and keyword arguments
- Global and local scope in functions
- Write lambda functions
- Handle errors

There's more to learn!

- Create lists with list comprehensions
- Iterators - you've seen them before!
- Case studies to apply these techniques to Data Science

PYTHON DATA SCIENCE TOOLBOX I

Congratulations!