

Don't repeat yourself

CREATING ROBUST PYTHON WORKFLOWS



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What will you learn?

Learning Objectives:

- Follow best practices
- Use helpful technologies
- Write Python code that is easy to
 - read
 - use
 - maintain
 - share

- Develop your own personal workflow
 - Steps you take
 - Tools you use
 - Can evolve over time



The DRY principle

```
# Read in dataset info from text files  
with open('diabetes.txt', 'r') as file:  
    diabetes = file.read()  
  
with open('boston.txt', 'r') as file:  
    boston = file.read()  
  
with open('iris.txt', 'r') as file:  
    iris = file.read()
```

- DRY (Don't Repeat Yourself)
- WET (Waste Everyone's Time)



Functions

One of the repetitive code blocks:

```
# Read in diabetes.txt
with open('diabetes.txt', 'r') as file:
    diabetes = file.read()
```

A function definition:

```
# Define a function to read text files
def read(filename):
    with open(filename, 'r') as file:
        return file.read()
```

- `filename` parameter
 - represents any possible filename
- "diabetes.txt" argument
 - a specific filename

A function call:

```
# Use read() to read in diabetes.txt
diabetes = read("diabetes.txt")
```

Repetitive function calls

```
# Define a function to read text files
def read(filename):
    with open(filename, 'r') as file:
        return file.read()
```

```
# Use read() to read text files
diabetes = read("diabetes.txt")
boston = read("boston.txt")
iris = read("iris.txt")
```

- Define a function
- One `with` statements instead of three
- Three repetitive function calls

List comprehensions

```
# Create a list of filenames  
filenames = ["diabetes.txt",  
             "boston.txt",  
             "iris.txt"]  
  
# Read files with a list comprehension  
file_list = [read(f)  
            for f  
            in filenames]
```

- Avoid writing out each function call
- Use a list comprehension
 - Similar to a `for` loop:

```
# View file contents  
for f in filenames:  
    read(f)
```

Multiple assignment

```
# Create a list of filenames  
filenames = ["diabetes.txt",  
             "boston.txt",  
             "iris.txt"]  
  
# Read files with a list comprehension  
file_list = [read(f)  
            for f  
            in filenames]  
  
diabetes, boston, iris = file_list
```

- Use multiple assignment
- Unpack the list
- Into multiple variables

Multiple assignment

```
# Create a list of filenames  
filenames = ["diabetes.txt",  
             "boston.txt",  
             "iris.txt"]  
  
# Read files with a list comprehension  
diabetes, boston, iris = [read(f)  
                         for f  
                         in filenames]
```

- Use multiple assignment
- Unpack the list comprehension
- Into multiple variables
- DRY code!



Standard library

```
from pathlib import Path

# Create a list of filenames
filenames = ["diabetes.txt",
             "boston.txt",
             "iris.txt"]

# Use pathlib in a list comprehension
diabetes, boston, iris = [
    Path(f).read_text()
    for f in filenames
]
```

- `read_text()` method
- `Path` class
 - Opens and closes file automatically
 - No need for `with` statements
 - Not a built-in object
 - Must be imported before use
- `pathlib` module
 - Standard library
 - Included with Python

Generator expressions

```
from pathlib import Path

# Create a list of filenames
filenames = ["diabetes.txt",
             "boston.txt",
             "iris.txt"]

# Use pathlib in a generator expression
diabetes, boston, iris = (
    Path(f).read_text()
    for f in filenames
)
```

- To turn a list comprehension
- Into a generator expression
- Replace square brackets: []
- With parentheses: ()
- Generator expression produce generators
- Generators
 - Keep track of generated values
 - Can run out of values

Summary

- Don't Repeat Yourself (DRY)
- Tools in our DRY toolbox:
 - Functions (e.g. `read()`)
 - Methods (e.g. `read_text()`)
 - `for` loops
 - List comprehensions
 - Generator expressions
 - Python standard library, e.g. `pathlib`

**Let's practice writing
DRY code!**

CREATING ROBUST PYTHON WORKFLOWS

Modularity

CREATING ROBUST PYTHON WORKFLOWS



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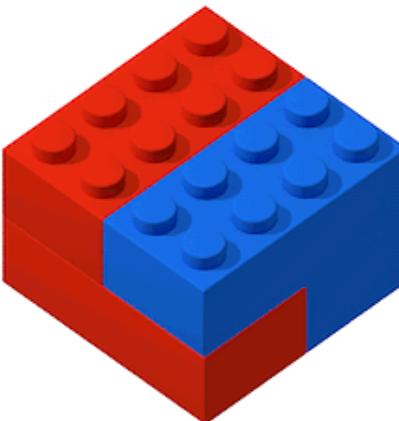
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What is modularity?

- Independent, reusable objects
- Each object only has one job
- Separate code into modules and scripts

Modules and scripts

- Python code files
- `.py` extensions



Modules versus scripts

Modules

- Are imported
- Provide tools
- Define functions

The `say` module:

```
def hello():
    print("Hello World!")
```

Scripts

- Are run
- Perform actions
- Call functions

A script:

```
import say
say.hello()
```

Function definition and calls

```
def hello():  
    print("Hello World!")
```

```
hello()
```

```
Hello World!
```

```
import say  
  
say.hello()
```

```
Hello World!  
Hello World!
```

Function definition and calls

```
def hello():  
    print("Hello World!")
```

```
hello()
```

Hello World!

```
from say import hello  
  
hello()
```

Hello World!
Hello World!

Module-script hybrid

```
def hello():
    print("Hello World!")
if __name__ == '__main__':
    hello()
```

Hello World!

```
from say import hello
hello()
```

Hello World!

The `__name__` variable

```
def name():
    print(__name__)

if __name__ == '__main__':
    name()
```

`__main__`

When run as a script:

- `__name__` is '`__main__`'
- the `if` statement code block is run

```
import say
```

```
say.name()
```

say

When imported as a module:

- `__name__` is the module name
- the `if` statement code block is skipped

One function to rule them all

```
from pathlib import Path

def do_everything(filename, match):
    matches = (line for line in Path(filename).open() if match in line)
    flat = (string for sublist in matches for string in sublist)
    num_gen = (int(substring) for string in flat
               for substring in string.split() if substring.isdigit())
    return zip(num_gen, num_gen)
```

- Many responsibilities: obtain matches, extract numbers etc.

One job per function

```
def generate_matches(filename, match):
    return (line for line in Path(filename).open() if match in line)

def flatten(nested_list):
    return (string for sublist in nested_list for string in sublist)

def generate_numbers(string_source):
    return (int(substring) for string in string_source
            for substring in string.split() if substring.isdigit())

def pair(generator):
    return zip(generator, generator)
```

Iterators

```
def pair(items):  
    iterator = iter(items)  
    return zip(iterator, iterator)  
  
pairs = list(pair([1, 2, 3, 4]))  
pairs
```

```
[(1, 2), (3, 4)]
```

iter()

- turns its input (e.g. list)
- into an iterator (e.g. list_iterator)

```
type(iter([1, 2, 3, 4]))
```

list_iterator

Generators are iterators

```
def pair(items):  
    iterator = iter(items)  
    return zip(iterator, iterator)  
  
pairs = list(pair([1, 2, 3, 4]))  
pairs
```

```
[(1, 2), (3, 4)]
```

`iter()` has no effect on generators:

```
type(iter(x for x in [1, 2, 3, 4]))
```

generator

Adaptable functions

```
def pair(items):  
    iterator = iter(items)  
    return zip(iterator, iterator)  
  
pairs = list(pair([1, 2, 3, 4]))  
list(flatten(pairs))
```

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

- Modular functions
 - Adaptable
 - Reusable
 - For example, `flatten()` can
 - Recreate the original list
 - From the `pairs` variable

REUSE



Let's practice writing modular code!

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Abstraction

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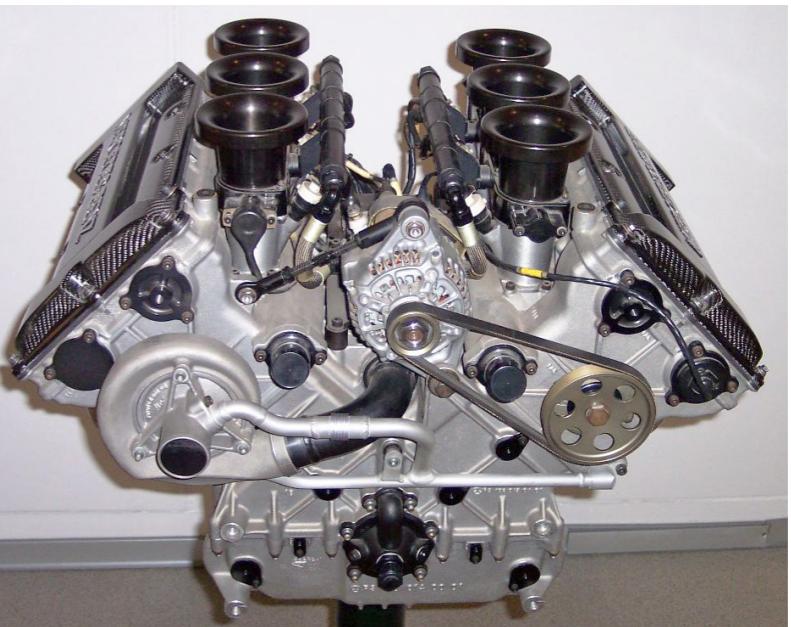


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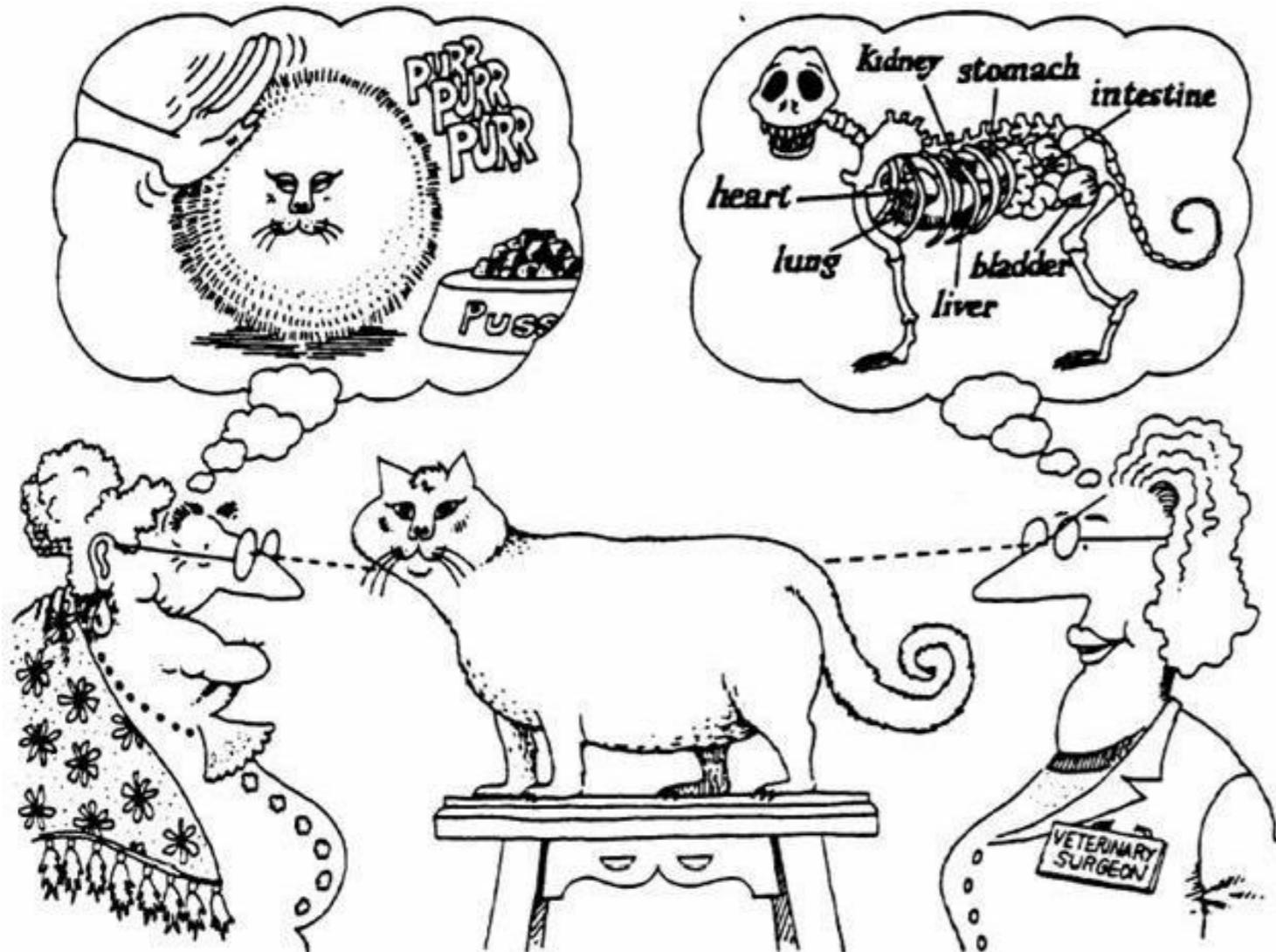
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Abstraction

- Hide implementation details
- Design user interfaces
- Facilitate code reuse
- Car example:
 - Engine
 - Combustion
 - Electric



Classes



Booch, G. et al. *Object-Oriented Analysis and Design with Applications*. Addison-Wesley, 2007, p. 45.

- Templates for creating Python objects
- Represent real-life objects
- `Cat` class example:
 - User interface:
 - `feed()` and `rub()` methods
 - Implementation details:
 - Feline anatomy

Class definition

```
from pathlib import Path

class TextFile:

    def __init__(self, file):
        self.text = Path(file).read_text()
```

- The `TextFile` class
 - Represents any text file
 - Creates `TextFile` instances
 - Represent specific text files

Instantiation

```
diabetes = TextFile('diabetes.txt')  
diabetes.text[:20]
```

'.. _diabetes_dataset'

- `TextFile` creates instances
 - By passing the `file` argument
 - To the `__init__()` method

```
def __init__(self, file):  
    self.text = Path(file).read_text()
```

Instance attributes

```
from pathlib import Path

class TextFile:

    def __init__(self, filename):
        self.text = Path(filename).read_text()
        self.words = ''.join(c if c.isalpha() else ' ' for c in self.text).split()
```

Instance methods

```
from pathlib import Path

class TextFile:

    def __init__(self, filename):
        self.text = Path(filename).read_text()
        self.words = ''.join(c if c.isalpha() else ' ' for c in self.text).split()

    def len_dict(self):
        return {word: len(word) for word in self.words}
```

Method chaining

```
from pandas import DataFrame  
  
(DataFrame(diabetes.len_dict().items())  
 .sort_values(by=1, ascending=False)  
 .head(n=4)  
)
```

```
          0   1  
40  characteristics  15  
17    measurements  12  
31  quantitative  12  
54    information  11
```

- `DataFrame` instance methods

```
def head(self, n=5):  
    return self.iloc[:n]
```

- Accept `DataFrame` instances
 - As their `self` argument
- Return `DataFrame` instances
 - By returning `self`
- Work well in method chains

Class attributes

```
class TextFile:  
  
    instances = []  
  
    def __init__(self, file):  
        self.text = Path(file).read_text()  
        self.__class__.instances.append(file)
```

TextFile.instances

```
[]
```

Class methods

```
class TextFile:  
  
    instances = []  
  
    def __init__(self, file):  
        self.text = Path(file).read_text()  
        self.__class__.instances.append(file)  
  
    @classmethod  
    def instantiate(cls, filenames):  
        return (cls(filename) for filename in filenames)
```

Class methods

```
class TextFile:  
  
    instances = []  
  
    def __init__(self, file):  
        self.text = Path(file).read_text()  
        self.__class__.instances.append(file)  
  
    @classmethod  
    def instantiate(cls, filenames):  
        return map(cls, filenames)
```

Instantiate

```
iris = TextFile('iris.txt')

boston, diabetes = TextFile.instantiate(['boston.txt', 'diabetes.txt'])

TextFile.instances
```

```
['iris.txt', 'boston.txt', 'diabetes.txt']
```

**Let's practice
defining classes and
methods!**

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