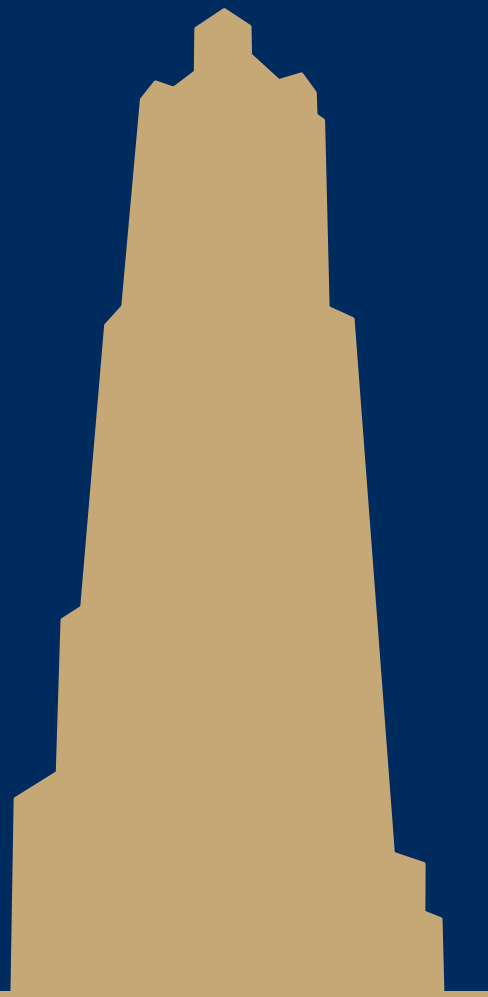
CS/COE 1520

pitt.edu/~ach54/cs1520

Python



~~Python~~ Guido van Rossum

- Guido van Rossum started development on Python in 1989 as a project to keep him busy over the holiday break when his office was closed
  - van Rossum is Python's "Benevolent Dictator for Life"
  - Worked for Google from 2005-2013, and currently works at Dropbox
    - Both employers had him spend 50% of his time working on Python

Python

- An interpreted language
- Version 2.0 was released in Oct. 2000
- Version 3.0 was released in Dec. 2008
  - 3.0 was a *backwards-incompatible* release
    - Because of this Python 2.7 is still actively used by many
    - 3.7 is the current latest version of Python
    - We will be using 3.x versions of Python in this course!
      - Be aware of the difference when checking online resources and running Python code on your computer!

Hello World

```
print("Hello World!")
```

Basic syntax

```
import random

# basic syntax overview example
r = random.randint(0, 100)
while r < 85:
    if r > 70:
        print(r, ":  so close!", sep="")
    elif r > 45:    # yes, the else if syntax is odd...
        print(r, end="")
        print(":  Getting there...")
    else:
        print("{}:  Still so far away!".format(r))

    r = random.randint(0, 100)
print("OUT!")
```

Typing

- Like JavaScript, Python is dynamically typed
- However, *unlike* JavaScript, Python is *strongly* typed
  - 1 + "1" will raise an error
    - 1 + int("1") is fine, as is str(1) + "1"
  - 1 == "1" will return false
    - Not the same value, one is a string, one an int
    - Python does not have a === operator

Numerical types

- int
- float
  - 7 / 2
    - = 3.5
  - 7 // 2
    - = 3
  - 7.0 / 2.0
    - = 3.5
  - 7.0 // 2.0
    - = 3.0

Numerical operators

- Generally the same as C
  - +, -, *, /, % all work as expected
- Python-specific operators:
  - //
    - Integer division
  - **
    - Exponentiation

Booleans

- `True`
- `False`
- Comparison operators:
  - and
  - or
  - not
    - `(True and False) or (not False) == True`

Strings

- Can be "double quoted"
- or 'single quoted'
- or """TRIPLE

  QUOTED"""
  - '''triple singles also work'''
- Plenty of string methods available
  - Note specifically that they can be indexed and sliced

String slicing

```
s = "slicing is fun!!"

print(s[0])
print(s[2:7])
print(s[-5])
print(s[-5:-2])
print(s[11:])
print(s[:7])
print(s[-5:])
```

Functions

```
def say_hi():
    print("Hi")


def shout(message="Hi"):
    print(message, "!", sep="")


shout()
shout("I love python")
shout(message="And keyword arguments")
```

Tuples

- Immutable sequences
  - `t = ("CS", 1520, "Hobaugh")`
  - `t[2] = "Farnan" # ERROR!`

Special cases with tuples

- How do you create an empty tuple?
- How about a tuple with only 1 item in it?

Tuple packing and unpacking

- Note that the () can be omitted in tuple definition:
  - `s = "CS", 1520, "Hobaugh"`
  - `t == s  # True`
- Further tuples can be "unpacked":
  - `a, b, c = t`
    - `a == "CS"`
    - `b == 1520`
    - `c == "Hobaugh"`

Returning tuples

- Note that tuples can be used to make it seem like a function returns multiple values:

```
def mult_ret():
    return "one", "two", "three"
a, b, c = mult_ret()
```

Lists

- Mutable sequences
  - ```
    l = [1, 2, 5]

    l[0] = 0

    l.append(3)
    ```
  - ```
    if 3 in l:
        print(3, "is in", l)
    ```

Dictionaries

- Key/value stores
  - ```
    d = {"Hobaugh":1520, "Farnan":10}
    ```
    ```
    d["Ramirez"] = 401
    ```
    ```
    d["Garrison"] = "0008"
    ```
  - ```
    "0008" in d
    ```
  - ```
    "Garrison" in d
    ```
    ```

Sets

- Unordered collections with no duplicate elements
  - `s = {1, 2, 2, 3, 3, 3}`
  - `print(s)`
    - `# prints: {1, 2, 3}`

Collection function examples

- `set()`
  - Produces an empty set: `{}`
- `set([1, 2, 2, 3, 3, 3])`
  - Produces `{1, 2, 3}`
- `list(range(10))`
  - Produces `[0, 1, 2, 3, 4, 5, 6, 7, 8, 9]`
- `dict([("k1", "v1"), ("k2", "v2"), ("k3", "v3")])`
  - Produces `{'k1':'v1', 'k2':'v2', 'k3':'v3'}`

Looping

- Already saw a while example…
- `for` is quite interesting, though:
  - ```
    crazy_list = ["a", 1, 1.0, "d"]
    for item in crazy_list:
        print(item)
    ```
  - ```
    for i in range(len(crazy_list)):
        print(crazy_list[i])
    ```

Can loop over dictionaries as well:

- `crazy_dict = {1:"one", 2:"two", 3:"three"}`
- ```
  for k in crazy_dict:
      print(k, crazy_dict[k])
  ```
- ```
  for k, v in crazy_dict.items():
      print(k, v)
  ```

List comprehensions

- Succinct way to initialize lists:
  - `squares = [x**2 for x in range(10)]`
  - `names = ["ADAM", "HOBAUGH"]`

    `low = [n.lower() for n in names if n == "ADAM"]`

Iterators

- Both lists, range objects, etc. are *iterable*
  - Meaning that an *iterator* can be created for either type
    - Iterators must implement the method `__next__()`
      - Successive calls to `__next__()` will iterate through the items in the collection
      - When no more items remain in the collection, all future calls to `__next__()` should raise a `StopIteration` exception
    - Can be created via the `iter()` function

Exceptions and try statements

```
try:
    result = x / y
except ZeroDivisionError:
    print("division by zero!")
else:
    print("result is", result)
finally:
    print("executing finally clause")


try:
    raise Exception("foo", "bar")
except Exception as e:
    print(e)
    print(type(e))
    print(e.args)
```

Breakdown of a for loop

```
temp_iter = iter(crazy_list)
while True:
    try:
        item = temp_iter.__next__()
    except StopIteration:
        break

    print(item)
```

Generators

- Functions that use the `yield` keyword to return values in order to create iterators
  - State is maintained between function calls to the generator

```
def enum(seq):
    n = 0
    for i in seq:
        yield n, i
        n += 1

def fibonacci():
    i = j = 1
    while True:
        r, i, j = i, j, i + j
        yield r
```

Decorators

```
def plus_one(original_function):
    def new_function(x, y):
        return original_function(x, y) + 1
    return new_function


@plus_one
def add(x, y):
    return x + y
```

Basic File I/O

```
outf = open("example.txt", "w")
for i in range(10):
    outf.write(str(i) + "\n")
outf.close()


inf = open("example.txt")
for line in inf:
    print(line.strip())
inf.close()
```

Contexts and the with statement

```
with open("example.txt") as inf:
    for line in inf:
        print(line.strip())
```

Defining your own contexts

```
from contextlib import contextmanager

@contextmanager
def tag(name):
    print("<{}>".format(name))
    yield
    print("</{}>".format(name))

with tag("h1"):
    print("foo")
```

Basic OO

```
class Person:
    def __init__(self, name, age):
        self.name = name
        self.age = age

    def display(self):
        print("Name:", self.name)
        print("Age:", self.age)
        print()
```

Basic Inheritance

```
class Student(Person):
    def __init__(self, name, age):
        super().__init__(name, age)

        self.classes = []

    def add_class(self, new):
        self.classes.append(new)

    def display(self):
        super().display()
        print("Classes:", self.classes)
        print()
```

Class variables

```
class Dog:
    tricks = []
    def __init__(self, name):
        self.name = name
    def add_trick(self, trick):
        self.tricks.append(trick)


f = Dog("Fido")
b = Dog("Buddy")
f.add_trick("roll over")
b.add_trick("play dead")
print(f.tricks)
```

Instance variables

```
class Dog:
    def __init__(self, name):
        self.tricks = []
        self.name = name
    def add_trick(self, trick):
        self.tricks.append(trick)


f = Dog("Fido")
b = Dog("Buddy")
f.add_trick("roll over")
b.add_trick("play dead")
print(f.tricks)
```

Modules

- Any Python file is a module that can be imported into other Python modules with `import`
- Let `a.py` contain:
  - ```
    def print_n():
        for i in range(10):
            print(i)
    def print_l():
        for l in ["a", "b", "c"]:
            print(l)
    ```
- Can then (in other files):
  - ```
    import a
    a.print_n()
    ```
  - ```
    from a import print_l
    print_l()
    ```
    ```

Writing Python files

- Consider:
  - Running `python a.py` from the command line
  - Having `import a` in another Python file
- How can we have the former produce output while still being able to use the latter to pull in definitions??
  - Both will evaluate each line of a.py
  - However, `python a.py` will have `__name__` set to `"__main__"`
  - Hence, we can choose what to do if run as a script:
    - At the end of a.py, have:
      - ```
        if __name__ == "__main__":
            print("Producing output!")
        ```
        ```

Handy built in functions:

- len()
- sorted()
- min(), max()
- int(), str(), bool(), float()
- repr()
- type()
- help()
- …

To wrap up…

- This is only a brief introduction to Python
- There are *many* topics that we neared by did not touch upon
  - E.g.,
    - Multiple inheritance
    - Packages
    - Protocols
      - E.g.,
        - Containers
        - Iterators
        - Context Managers
    - …