The Python Language (Part 3)

Robert M. Dondero, Ph.D.
Princeton University

Objectives

- We will cover:
  - A subset of Python...
  - That is appropriate for COS 333...
  - Through example programs

Agenda

- **Statements**
- Throwing exceptions
- Modules
- Packages
- Object-oriented programming

Statements

- See **euclidclient1.py**

```
$ python euclidclient1.py
Enter the first integer: 8
Enter the second integer: 12
gcd: 4
lcm: 24
$
```

Statements

- See **euclidclient1.py** (cont.)
  - ***Unpacking assignment statement***

```
x, y = 1, 2
```

Traditional

```
temp = i%j
i = j
j = temp
```

Verbose

```
temp1 = j
temp2 = i%j
i = temp1
j = temp2
```

Python

```
i, j = j, i%j
```

Statements

Assignment statements

```
var = expr
var += expr
var -= expr
var *= expr
var /= expr
var //= expr
var %= expr
var **= expr
var &= expr
var |= expr
var ^= expr
var >>= expr
var <<= expr
```

Statements

Unpacking assignment statement

```
var1,var2,... = iterable
```

No-op statement

```
pass
```

`assert` statement

```
assert expr, message
```

Statements

Function call statement

```
f(expr, name=expr, ...)
```

`return` statement

```
return
return expr
```

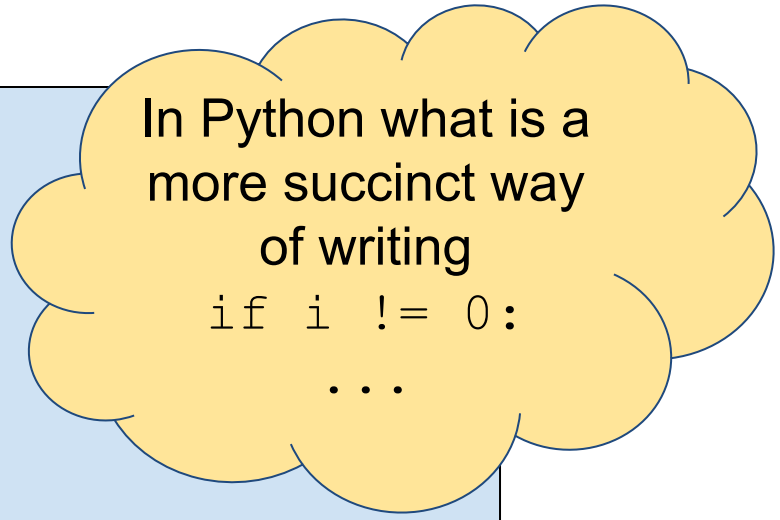
Statements

`if` statement

```
if expr:
    statement(s)
elif expr:
    statement(s)
…
else:
    statement(s)
```

`False`, `0`, `None`, `''`, `""`, `[]`, `()`, and `{}` indicate logical FALSE

Any other value indicates logical TRUE



Statements

`while` statement

```
while expr:
    statement(s)
```

`False`, `0`, `None`, `''`, `""`, `[]`, `()`, and `{}` indicate logical FALSE

Any other value indicates logical TRUE

Statements

`for` statement

```
for var in iterable:
    statement(s)
```

`break` statement

```
break
```

`continue` statement

```
continue
```

```
for i in range(0, 5):
    … i …
for i in range(5):
    … i …
```

Statements

```
try statement
    try:
        statement(s)
    except [ExceptionClass [as var]]:
        statement(s)

raise statement
    raise ExceptionClass(str)
```

Agenda

- Statements
- **Throwing exceptions**
- Modules
- Packages
- Object-oriented programming

Throwing Exceptions

- Recall **euclidclient1.py**

```
$ python euclidclient1.py
Enter the first integer:  0
Enter the second integer:  12
gcd: 12
lcm: 0
$ python euclidclient1.py
Enter the first integer:  0
Enter the second integer:  0
gcd: 0
Traceback (most recent call last):
  File "euclidclient1.py", line 53, in <module>
    main()
  File "euclidclient1.py", line 42, in main
    my_lcm = lcm(i, j)
  File "euclidclient1.py", line 26, in lcm
    return (i // gcd(i, j)) * j
ZeroDivisionError: integer division or modulo by zero
$
```

Throwing Exceptions

- See **euclidclient2.py**

```
$ python euclidclient2.py
Enter the first integer: 8
Enter the second integer: 12
gcd: 4
lcm: 24
$ python euclidclient2.py
Enter the first integer: 0
Enter the second integer: 12
gcd: 12
lcm(i,j) is undefined if i or j is 0
$ python euclidclient2.py
Enter the first integer: 0
Enter the second integer: 0
gcd(i,j) is undefined if i and j are 0
$
```

Throwing Exceptions

```
BaseException
   Exception
      ArithmeticError
         FloatingPointError
         OverflowError (legacy)
         ZeroDivisionError
      AssertionError
      AttributeError
      BufferError
      EOFError
      ImportError
         ModuleNotFoundError
      LookupError
         IndexError
         KeyError
      MemoryError
      NameError
         UnboundLocalError
```

Python standard exception classes

Throwing Exceptions

```
BaseException (cont.)
   Exception (cont.)
      OSError
         BlockingIOError
         ChildProcessError
         ConnectionError
            BrokenPipeError
            ConnectionAbortedError
            ConnectionRefusedError
            ConnectionResetError
         FileExistsError
         FileNotFoundError
         InterruptedError
         IsADirectoryError
         NotADirectoryError
         PermissionError
         ProcessLookupError
         TimeoutError
```

Python standard exceptions (cont.)

Throwing Exceptions

```
BaseException (cont.)
   Exception (cont.)
      ReferenceError
      RuntimeError
         NotImplementedError
         RecursionError
      StopIteration
      StopAsyncIteration
      SyntaxError
         IndentationError
            TabError
      SystemError
      TypeError
      ValueError
         UnicodeError
            UnicodeDecodeError
            UnicodeEncodeError
            UnicodeTranslateError
```

Python standard exceptions (cont.)

Throwing Exceptions

```
BaseException (cont.)
   Exception (cont.)
      Warning
         BytesWarning
         DeprecationWarning
         FutureWarning
         ImportWarning
         PendingDeprecationWarning
         ResourceWarning
         RuntimeWarning
         SyntaxWarning
         UnicodeWarning
         UserWarning
   GeneratorExit
   KeyboardInterrupt
   SystemExit
```

Python standard exceptions (cont.)

Agenda

- Statements
- Throwing exceptions
- **Modules**
- Packages
- Object-oriented programming

Modules

- ***Module***
  - A .py file that is designed to be included into a ***client*** .py file

Modules

- Building and running

```
$ python toplevelmodule.py
```

  - Automatically compiles/interprets included modules

Modules

- See **euclid.py**, **euclidclient3.py**

```
$ python euclidclient3.py
Enter the first integer:  8
Enter the second integer:  12
gcd: 4
lcm: 24
$ python euclidclient3.py
Enter the first integer:  8
Enter the second integer:  0
gcd: 8
lcm(i,j) is undefined if i or j is 0
$ python euclidclient3.py
Enter the first integer:  0
Enter the second integer:  0
gcd(i,j) is undefined if i and j are 0
$
```

Agenda

- Statements
- Throwing exceptions
- Modules
- **Packages**
- Object-oriented programming

Packages

- ***Package***
  - A named group of modules (and other packages)
    - A *module* is stored in a *file*
    - A *package* is stored in a *directory*

Packages

- See **intmath/__init__.py**
  - Declares `intmath` as a package
- See **intmath/euclid.py**
  - A module in the `intmath` package

Packages

- See **euclidclient4.py**

```
$ python euclidclient4.py
Enter the first integer:  8
Enter the second integer:  12
gcd: 4
lcm: 24
$ python euclidclient4.py
Enter the first integer:  8
Enter the second integer:  0
gcd: 8
lcm(i,j) is undefined if i or j is 0
$ python euclidclient4.py
Enter the first integer:  0
Enter the second integer:  0
gcd(i,j) is undefined if i and j are 0
$
```

Agenda

- Statements
- Throwing exceptions
- Modules
- Packages
- **Object-oriented programming**

Object-Oriented Programming

- See **fractionprelim.py**, **fractionprelimclient.py**

```
$ python fractionprelimclient.py
Numerator 1: 1
Denominator 1: 2
Numerator 2: 3
Denominator 2: 4
frac1: 1/2
frac2: 3/4
frac1 does not equal frac2
frac1 is less than frac2
frac1 is less than or equal to frac2
-frac1: -1/2
frac1 + frac2: 5/4
frac1 - frac2: -1/4
frac1 * frac2: 3/8
frac1 / frac2: 2/3
$
```

Object-Oriented Programming

- See **fractionprelim.py**, **fractionprelimclient.py** (cont.)

What is the effect of executing these statements in the client:

```
f = fraction.Fraction(3, 4)
f._num = 6
```

Object-Oriented Programming

- See **fractionprelim.py**, **fractionprelimclient.py** (cont.)

What is the effect of executing these statements in the client:

```
f = fraction.Fraction(3, 4)
f.num = 6
```

Aside: Name Mangling

- Incidentally:
  - Use of leading **double** underscores causes ***name mangling***
    - Example: In Fraction, compiler turns `__num` into `_Fraction__num`

Lecture Summary

- In this lecture we covered these aspects of Python:
  - Throwing exceptions
  - Modules
  - Packages
  - Object-oriented programming
- See also:
  - **Appendix**: Duck Typing

Appendix: Duck Typing

Duck Typing

- Observation:
  - Python uses ***duck typing***

> "When I see a bird that walks like a duck and swims like a duck and quacks like a duck, I call that bird a duck."
>
> -- James Whitcomb Riley

Duck Typing

- Example: Recall **euclid.py**
  - `i` and `j` parameters of `gcd()` can reference objects of any class, as long as they can be:
    - Operands of `==`
    - Arguments to `abs()`
    - Operands of `!=`
    - Operands of `%`

Duck Typing

Language	Object references have types?	Objects have types?	Language classification
C	yes	no	**weakly** typed
Java	yes	yes	**strongly** typed
Python	no	yes	**dynamically (duck)** typed

Duck Typing

- Is duck typing good or bad (vs. strong typing) ?

- See **euclidstrong.py**
  - Which is better, euclid.py or euclidstrong.py?

Duck Typing

- **Style 1**: Don't validate parameter types
  - Validating parameter types is constraining and slow
  - **So euclid.py is better**
- **Style 2**: Validate parameter types
  - Validating parameter types is safe
  - **So euclidstrong.py is better**
- We'll use Style 1

Duck Typing

- Commentary
  - **Small** projects:
    - Maybe need not validate parameter types
  - **Large** projects:
    - Maybe should validate parameter types

Duck Typing

- Commentary
  - But if you feel the need to validate parameter types, then why are you using Python?