

Functions

Rose-Hulman Institute of Technology

Computer Science and Software Engineering

Get SVN project “10-Functions”

Exam 1/2

Super job!

Pick up the exam and last quiz from table

REMINDER

Exam 1 next Thursday

Goals Today

- Files
- Revisit functions with more details
- Make lots of progress on Cross Words

File Processing

- Manipulating data stored on disk
- Key steps:
 - *Open* file for reading or writing
 - Associates file on disk with a *file variable* in program
 - *Manipulate* the file with operations on file variable
 - Read or write information
 - *Close* file
 - Causes final “bookkeeping” to happen

File Writing in Python

- Open file:
 - Syntax: `<filevar> = open(<name>, <mode>)`
 - E.g., `outFile = open('coord.txt', 'w')`
- Write to file:
 - Syntax: `<filevar>.write(<string>)`
 - E.g., `outFile.write("lat={0} long={1}".format(39.4, -87.4))`
- Close file:
 - Syntax: `<filevar>.close()`
 - E.g., `outFile.close()`

This mode
writes file
replacing
contents

File Reading in Python

- Open file: `inFile = open('grades.txt', 'r')`
- Read file:
 - `<filevar>.read()` Returns one BIG string
 - `<filevar>.readline()` Returns next line, including `\n`
 - `<filevar>.readlines()` Returns BIG list of strings, 1 per line
 - `for <id> in <filevar>` Iterates over lines efficiently
- Close file: `inFile.close()`

A “Big” Difference

readlines()

```
inFile = open ('grades.txt', 'r')
for line in inFile.readlines():
    # process line
inFile.close()
```

Looping on file directly

```
inFile = open ('grades.txt', 'r')
for line in inFile:
    # process line
inFile.close()
```

Which uses the most memory?

Q15,16

Why functions?

- A function allows us to group together several statements and give them a name by which they may be invoked.
 - *Abstraction* (easier to remember the name than the code)
 - *Compactness* (avoids duplicate code)
 - *Flexibility* (parameters allow variation)
- Example:
 - **def complain(complaint):**
 print("Customer:", complaint)

Functions in different realms

- Compare the mechanisms for *defining* and *invoking* functions in three different settings:
 - Standard mathematical notation
 - Maple
 - Python

Functions in Mathematics

- Define a function:

- $f(x) = x^2 - 5$

Formal Parameter. Gives a name to refer to the argument in the function's formula.

- Invoke (call) the function:

- $$\frac{f(6) - f(3)}{6 - 3}$$

Two calls to function f . The first with *actual parameter* 6, and the second with 3.

- When the call $f(6)$ is made, the actual parameter 6 is substituted for the formal parameter x , so that the value is $6^2 - 5$.

Functions in Maple

```
> f := x → x2 - 5;  
f := x → x2 - 5
```

Invoke the function.

```
> f(6);  
31
```

```
> 
$$\frac{f(6) - f(3)}{6 - 3};$$
  
9
```

Formal Parameter. Gives a name to refer to the argument in the function's formula.

Two calls to function *f*. The first with *actual parameter* 6, and the second with 3.

Functions in Python

```
>>> def f(x):  
        return x*x - 5  
  
>>> f(6)  
31  
>>> (f(6) - f(3)) / (6 - 3)  
9  
>>>
```

Formal Parameter. Gives a name to refer to the argument in the function's formula.

Two calls to function *f*. The first with *actual parameter* 6, and the second with 3.

- How would you evaluate $f(f(2))$?
- In Mathematics, functions calculate a value.
- In Python we can *also* define functions that instead *do something*, such as print some values.

Review: Parts of a Function Definition

Defining a function called "hello"

```
>>> def hello():  
    print("Hello")  
    print("I'd like to complain about this parrot")
```

Indenting tells interpreter that these lines are part of the hello function

Entering a blank line tells interpreter that we're done defining the hello function

Review: Defining vs. Invoking

- *Defining* a function says what it should do
- *Invoking* (calling) a function makes that happen
 - Parentheses tell the interpreter to invoke the function

```
>>> hello()  
Hello  
I'd like to complain about this parrot
```
 - This function has no *parameters*

Q2

Review: Functions & Parameters

- `def complain(complaint):`

```
    print("Customer: I purchased this parrot not half " +  
          "an hour ago from this very boutique")
```

```
    print("Owner: Oh yes, the Norwegian Blue. " +  
          " What's wrong with it?")
```

```
    print("Customer:", complaint)
```

- `invocation:`

- `complain("It's dead!")`

Python's 4 Steps for Invoking

1. Calling program pauses at the point of the call
2. Formal parameters get assigned the values supplied by the actual parameters
3. Body of the function is executed
4. Control returns to the point in calling program just after where the function was called

```
from math import pi
```

```
def deg_to_rads(deg):
```

```
    rad = deg * pi / 180
```

```
    return rad
```

```
degrees = 45
```

```
radians = deg_to_rads(degrees)
```

```
print("{} deg. = {1:0.3f} rad."
```

```
      .format(degrees, radians))
```

2: deg = 45

3

4

1

If a Function Calls a Function ...

- Trace what happens when the last line of this code executes
- See the **functionExamples.py** module
- Then do the similar one on the quiz

Guaranteed
exam problem!

```
def g(a,b):  
    print(a+b, a-b)
```

```
def f(x, y):  
    g(x, y)  
    g(x+1, y-1)
```

```
f(10, 6)
```

Q3

Functions can “do” or “return”

- Some functions just do things:
 - `hello()`
 - `complain(complaint)`
- Some functions return values:
 - `abs(-1)`
 - `x = math.cos(angle * math.pi / 180)`

Defining Functions that Return Values

- `def square(x):`

“returns x squared”

`return x * x`

return statement

- `def average(scores):`

`total = 0`

`for s in scores:`

`total += s`

`return total / len(scores)`

Why might it be better to return than print when a function performs a calculation?

Q4

return statement

Writing a distance() function

- `def distance(p1, p2):`
 """Parameters are Points, returns distance between them. """
- Should the function return anything?
- Can test this in `functionExamples.py`

Recall: If `p` refers to a `Point`, then use `p.getX()` to get its x-coordinate

Q5

Additional examples

- `mutantFunctions.py`, `numerology.py` & `mutatorExample.py` contain additional examples of defining and using functions
- Do the exercises to get more practice with functions (optional and will not be graded)

Pair programming, but with new partners

New Pairing Partners

Work on Homework 10

Pair Programming Time

Q6, 7