CSC 108H: Introduction to Computer Programming

Summer 2012

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Administration

- Help Centre is open.
  - BA 2270 M-R 2-4.
- CDF is closed from M Jun 4th 5pm to 11am T June 5th.
- Exercise 1 deadline extended to Sunday.
- Exercise 2 will be posted before next Lecture.

Last Week

- More Functions.
  - `print` makes the computer show something on the screen.
  - `return` ends a function and causes it to return the value of the expression.
  - Function documentation.
    - The first line after a function should be a description of what it does enclosed in '".
      - Returned by `help(function_name)`.
  - Function design.

Function Review

- What is this function missing?

```
def foo():
    return 10
```

- What gets printed to the screen, and in what order?

```
def foo(x):
    print x + 10
    return 15
y = 12
foo(y)
print foo(y+4)
```

Function Review

- What is this function missing?
- What gets printed to the screen, and in what order?

```
def foo(x):
    print x + 10
    return 15
y = 12
foo(y)
print foo(y+4)
```

```
def foo():
    '''NoneType -> int
    returns 10.'''
    return 10
```

22

26

15

Last Week

- Scope.
  - Variable scope is used to determine which variable is used when there are multiple variables with the same name.
  - Variables can be global and local.
    - local variables are defined within functions.
    - global variables are defined in the body of code.
  - To determine which variable is used if there are multiple function calls we use a call stack.
    - Each time there is a function call, a new namespace is created on the call stack.

Scope Review

- What does the call stack look like at the indicated points?

```
def foo(x):
    if x < 10:
        return 10
    else:
        return goo(x-5)

def goo(x):
    if x < 10:
        return 10
    else:
        return foo(x-5)

x = 20

foo(x)
```

Scope Review

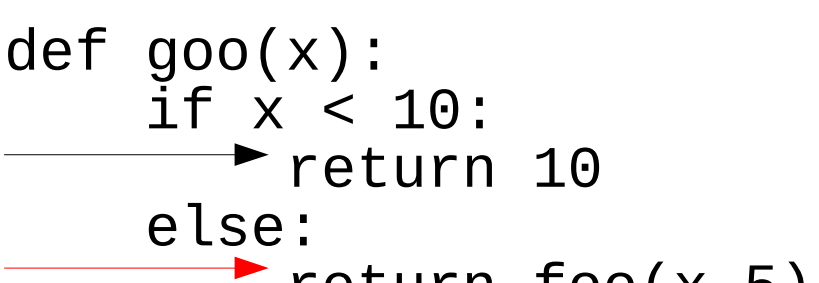
- What does the call stack look like at the indicated points?

```
def foo(x):
    if x < 10:
        return 10
    else:
        return goo(x-5)

def goo(x):
    if x < 10:
        return 10
    else:
        return foo(x-5)

x = 20

foo(x)
```



goo
x: 0x2
foo
x: 0x1
Global
x: 0x1

Scope Review

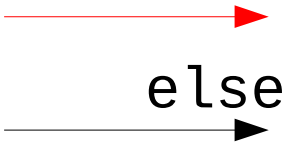
- What does the call stack look like at the indicated points?

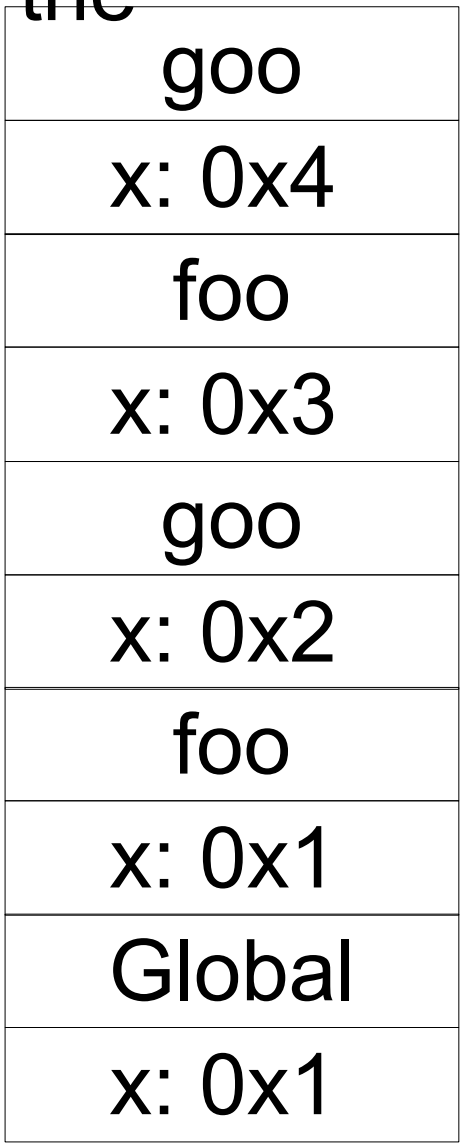
```
def foo(x):
    if x < 10:
        return 10
    else:
        return goo(x-5)

def goo(x):
    if x < 10:
        return 10
    else:
        return foo(x-5)

x = 20

foo(x)
```





Last Week

- Booleans.
  - New type.
  - Can be `True` or `False`.
  - Can compare booleans with `and`, `or`, `not`.
  - Can use relational operators to generate booleans.
    - `<`, `>`, `<=`, `>=`, `!=`, `==`.
- Conditionals.
  - Used to selectively execute blocks of code based on booleans.
  - `if`, `else`, `elif`.

Booleans

What do these expressions evaluate to?

(bool(x) and not(bool(x))

(True or False) and bool(-10)

True != False

What values does x need to execute each print statement?

```
x = ?
if (x == 50):
    print 'a'
elif (x < 50):
    print 'b'
elif (x > 25):
    print 'c'
else:
    print 'd'
```

Booleans

What do these expressions evaluate to?

(bool(x) and not(bool(x))

False

(True or False) and bool(-10)

True

True != False

True

What values does x need to execute each print statement?

```
x = 50, 24, 60, NA
if (x == 50):
    print 'a'
elif (x < 50):
    print 'b'
elif (x > 25):
    print 'c'
else:
    print 'd'
```

Using text

- So far we've seen three types:
  - ints, floats, and booleans.
- Allow for number manipulation and logic manipulation
- Don't allow for text manipulation.
- Text manipulation needs a new type - strings.
  - A string is a sequence of characters.
  - A character is a single letter/punctuation mark/etc.

Strings

- Two types: `str` and `unicode`.
  - We'll use `str` in this course.
  - It contains the roman alphabet, numbers a few symbols.
- Use `str` to refer to the type in docstrings.
  - `'''NoneType -> str'''`
- Strings are denoted by single or double quotes.
  - `“This is a string”`
  - `'This is not”`
- `“”` is an empty string.

String operations

- Strings can be 'added'.
  - We call this concatenation.
  - `“str” + “ing”` results in `“string”`.
- Can also be multiplied, sort of.
  - You can't multiply a string with itself, but the multiplication operator functions as a copy.
  - So `“copy”*3` results in `“copycopycopy”`.
- None of the other arithmetic operators are defined for strings.
  - so /, -, **, and % generate errors.

String questions

- Which of the following expressions evaluate to legal strings?
- 'abab”
- '" abababe'
- '"abababab"'
- 'avvrr' + “bab”
- 4 + 'abb' + “ab”
- “a” + “b” - “b”
- 3 * “abab” + “vbr”
- '"abe"' * 99
- '"bbb"' * '99'
- 'string'
- “string”

String questions

- Which of the following expressions evaluate to legal strings?
- 'abab”
- '" abababe'
- '"ababab"'
- 'avvrr' + “bab”
- 4 + 'abb' + “ab”
- “a” + “b” - “b”
- 3 * “abab” + “vbr”
- '"abe"'" * 99
- '"bbb"' * '99'
- 'string'
- “string”

String operations

- Can also compare strings using relational operators.
  - So two strings can be compared using <,>, !=, etc.
  - If the letters are all upper case or all lower case, the order is lexicographic (dictionary style).
  - Upper case letters are 'smaller' than lower case letters, which can cause odd behaviour.
    - `'aaa' < 'ab'`
    - `'aaa' < 'aB'`
  - Can compare punctuation marks, but there's no intuition for the results.

String operations

- Can check if substrings are in a string using `in`.
  - `possible_substring in big_string` returns `True` iff `possible_substring` is in `big_string`.
  - `possible_substring` needs to be contiguously within `big_string` for this to return `True`, it will return `False` otherwise.
- Long strings that span multiple lines can be made using '''.
  - Note that this relates to docstrings.

Escape Characters

- Denoted by a backslash, they indicate to python that the next character is a special character.
  - `\n` - a new line
  - `\'` - a single quote
  - `\”` - a double quote
  - `\\` - a backslash
  - `\t` - a tab.

String functions

- `len(string)` will return an int that is the number of characters in the string.
- `ord(char)` will return the integer code of that character.
- `chr(x)` will return a character that corresponds to the integer `x`.
  - `x` should be between 0 and 255.

Type Conversions

- If we want to add a number or boolean to a string, we need to convert it to a string first.
- `str(x)` converts `x` to a `str`.
- This is automatically done when `print` is used.
- Strings can be converted to booleans.
  - `False` iff string is empty.
- Strings of numbers can be converted to floats or integers.
- Strings of numbers with one decimal point can be converted to floats.

String Questions

- What do the following strings look like?
- '\n\n\\ Hi, things'

- str(True) + '\n\” This is true'

- str(34) + '\" +str(44)

- str(bool(“”))

String Questions

- What do the following strings look like?
- '\n\n\\ Hi, things'

'''
\ Hi, things'''

- str(True) + '\n\" This is true'

'''True
“This is true'''

- str(34) + '\" +str(44)

'''34'44'''

- str(bool(“”))

'''False'''

Mixing strings with other types

- Print can display mixed types.
  - They must be separated with a comma.
  - `print “string”, x, “ “, real_num`
- Can be awkward.
  - `print “Person“, name, “has height”, height, “age“, age, “weight“, weight`

String formatting

- Can use special characters to tell python to insert a type into a string.
- `print “My age is %d.” % age`
- The %d tells python to take age, and format it as an integer.
- %s says to take a value and format it as a string.
- %f says to take a value and format it as a float.
- %.2f says to pad the float to 2 decimal places.

Multiple variables

- What if we want multiple variables in our string?
  - `print “Person“, name, “has height”, \`
    `height, “age“, age, “weight“, weight`
- We put them in parentheses separated by commas.
  - `print “Person %s has weight %.2f \`
    `and age %d and height %d.“ \`
    `% (name, weight, age, height)`

Break, the first

Break Question.

- Given the variables age, height, name; write out formatted strings that evaluate to:

  'My name is <name>'.

  'My name is <name> and I am called <name>.

  'I am <age> years old and this tall: <height>'

  '"My name is <name>

  I am <age> years old."'

  'My height is %s <height> %s'

- Do not use '".

Break Question.

- Given the variables age, height, name; write out formatted strings that evaluate to:

  'My name is %s' % name

  'My name is %s and I am called %s' % (name, name)

  'I am %d years old and this tall: %d' % (age, height)

  'My name is %s\nI am %s years old.' % (name, age)

  'My height is %s %s %s' % ('%s', height, '%s')

- Do not use '".

User input

- Thus far, the only way we've had of giving input to a program is to hardcode it in the code.
- Inefficient and not user-friendly.
- Python allows us to ask for user input using raw_input().
- Returns a string!
  - So it may need to be converted.

Modules

- Sometimes we want to use other people's code.
- Or make our own code available for use.
- But we don't want to mix our code with that of others.
- Modules allow us to do this.
- A Module is a group of related functions and variables.
  - Each file in python is a module.

Using modules

- To use a module, one needs to `import` it.
  - At the top of a file by convention.
- Importing a module causes python to run each line of code in the module.
- To use a function in a module one uses.

```
module_name.function_name()
```

  - We can also run a module. Then we just use `function_name()`

Using modules

- Note that we can run files, and each file is a module.
  - If we are just running a file, then we only use the function name, not `module_name.function_name`
  - Functions defined within a module are local functions, in the same way that variables within a function are local variables.
  - Global variables within a module can be accessed by `module_name.variable_name`.
    - Rare that this is necessary.

Which are legal?

```
import foo
foo.foo(12)
goo(12)
```

```
import foo
def goo(x):
    return x
foo.foo(12)
goo(12)
```

```
import foo
def goo(x):
    return x
foo(12)
goo(12)
```

Which are legal?

```
import foo
foo.foo(12)
goo(12)
```

```
import foo
def goo(x):
    return x
foo.foo(12)
goo(12)
```

```
import foo
def goo(x):
    return x
foo(12)
goo(12)
```

Importing Modules

- When a file is imported, every line in the file is run.
  - It it is just function definitions this doesn't cause much trouble.
  - But it can be annoying if there is code that you don't care about or testing code in the module.

__name__

- In addition to variables that are defined in the module, each module has a variable that is called `__name__`.
- If we import a module called `module_m`, then

  `module_m.__name__ == “module_m”`
- But if we run a module, then
  - `__name__ == “__main__”`
- Recall that if we are running a module, we don't need the module name as a prefix.

if __name__ == '__main__'

- It is very common to see modules that have the following code:

```
if __name__ == '__main__':
    block
```

- The block will be executed if the module is being run.
- A useful place to put testing code.

Another way to import things.

- `from module_name import fn_name1(), fn_name2()`
  - Will import fn_name1 and fn_name 2
  - These functions are referenced by just `fn_name1()`
- Can also use * as a wildcard to import all the functions.
  - `from module_name import *`
- What if two modules have a function with the same name?
- The most recent one stays.

Break, the second.

Break, the second.

- When will these modules print 'running'

```
print 'running'
```

```
if __name__ == '__main__':
    print 'running'
```

```
__name__ == '__main__'
```

```
if __name__ == '__main__':
    print 'running'
```

Break, the second.

- When will these modules print 'running'

```
print 'running'
```

- All the time.

```
if __name__ == '__main__':
    print 'running'
```

- When the module is being run

```
__name__ == '__main__'
```

```
if __name__ == '__main__':
    print 'running'
```

- All the time

Methods

- We've seen that modules can have their own functions.
- A similar thing is true of values.
- Values contain functions that assume one of the inputs is the value. We call these methods.
- These are called by `value.fn_name()`
- Or, if we've assigned a value to a variable we can use `variable_name.fn_name()`
- We can call `help(type)` to figure out what methods a type has available to it.

String methods

- Can find them by using `help(str)`.
- Useful ones include:
- `s.replace(old, new)` - a copy of `s` with all instances of `old` replaced by `new`.
- `s.count(substr)` – return the number of instances of substr in the string.
- `s.lower()` - shift to lower case letters.
- `s.upper()` - shift to capitalised letters.
- None of these change `s`.

String methods

- `s.strip()` - returns a copy of s with leading and trailing whitespace removed.
  - Note, doesn't touch middle whitespace.
  - whitespace refers to spaces, tabs and new lines.
  - Essentially, anything that doesn't contain a visible character.
- `s.strip(chars)` - strips all of the characters in the given string instead.

String method questions

- What do the following statements evaluate to?
- x = ' AAAAbb bb'
- x.count('b')
- x.count('B')
- x.count('Ab')
- x.lower()
- x.strip()
- 'bb'.replace('b','bb')

String method questions

- What do the following statements evaluate to?
- x = ' AAAAbb bb'

  None
- x.count('b')

  4
- x.count('B')

  0
- x.count('Ab')

  1
- x.lower()

  ' aaaabb bb'
- x.strip()

  'AAAAbb bb'
- 'bb'.replace('b','bb')

  'bbbb'

Getting method information

- Most direct way is to use help().
- But help isn't searchable. Can use dir() to browse.
  - Sometimes you know what you want, and you think it might already exist.
- An alternative is to check the standard library:
  - http://docs.python.org/library/
  - Being able to browse this is useful skill.
- Modules are found in:
  - http://docs.python.org/py-modindex.html

Remember!

- Functions belong to modules.
- Methods belong to objects.
  - All of the basic types in python are objects.
  - We will learn how to make our own later.
  - This is covered in greater detail in 148.
- `len(str)` is a function
- `str.lower()` is a method.
- Subtle but important distinction.

Lab Review

- Next weeks lab covers Booleans and conditionals.
- You need to:
  - Be comfortable with using boolean operators (`and, or, not`) on booleans.
  - Using `if` statements to selectively execute blocks of code based on the value of boolean expressions.