CSCI 141

Lecture 13:
Midterm review; Functions, continued
Announcements

• A2 grades out this afternoon.

• Exam material: range(functions)
  • that is, 0 up to but not including writing your own functions
Announcements

• Sample study problems are posted. Solutions are not verified.
  • Many “execute this code” questions.
  • Underrepresented topics:
    • binary/decimal
    • distinction between statements and expressions
    • computer hardware (CPU, main memory, fetch/decode/execute)
    • Syntax errors
    • Modules and imports
    • Algorithm development
Goals

• Review for the midterm.

• As time allows:
  
  • Know the syntax for defining your own functions
  
  • Know how to define and use functions that take no arguments and return no values
  
  • Know how to use parameters to refer to the input arguments of a function
  
  • Know the meaning of local variables and variable scope and how it relates to function parameters.
  
  • Know how to return a value from a function.
Midterm Review: Questions
Functions, Revisited

What *is* a function, anyway?
• As a user, you can treat a function as a “black box”: all you need to know is:
  • the *inputs*, *effects*, and *return value*.

• Functions are named chunks of code.

\[
\text{Input(s)} \rightarrow \Box \rightarrow \text{Return value}
\]

(Effects)

A bunch of (complicated) stuff is wrapped up in a nice, easy-to-use package.
Writing Functions: Syntax

Looking inside the black box…

\[
def \text{name}(\text{parameters}): \\
\text{statements}
\]

- Input(s)
- (Effects)
- Return value
Writing Functions: Syntax

Looking inside the black box…

```
def name(parameters):
    statements
```

Two important questions:
Writing Functions: Syntax

Looking inside the black box...

```python
def name(parameters):
    statements
```

Two important questions:
1. How does the function use the arguments (inputs) passed to it?
Writing Functions: Syntax

Looking inside the black box…

```
def name(parameters):
    statements
```

Input(s) → (Effects) → Return value

Two important questions:
1. How does the function use the arguments (inputs) passed to it?
2. How does the function return a value?
Writing Functions: Syntax

Looking inside the black box…

```
def name(parameters):
    statements
```

Two important questions:
1. How does the function use the arguments (inputs) passed to it?
2. How does the function return a value?

Let’s dodge these questions for a moment…
Functions: the simplest kind

No arguments, no return value:

```python
def name():
    statements
```

Example:

```python
def print_hello():
    print("Hello, world!")
```
Demo: Function to print a rectangle of # symbols

Input(s):
  • none

Return value:
  • none

---

print_rectangle

---

Effects: prints a 2x50 rectangle of #s to the screen
def print_rectangle():
    """ Prints a 2x50 rectangle of a user-specified character """
    user_char = input("What character? ")
    for i in range(2):
        print(user_char * 50)
def print_rectangle():
    ''' Prints a 2x50 rectangle of a user-specified character ''''
    user_char = input("What character? ")
    for i in range(2):
        print(user_char * 50)

Aside: what’s """ this """ about? Two things in one:
Function to print a rectangle of symbols

```python
def print_rectangle():
    """ Prints a 2x50 rectangle of a user-specified character """
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Aside: what’s """ this """" about? Two things in one:

- **Multiline strings**: An alternate way to write strings that include newlines.
Aside: what’s """" this """" about? Two things in one:

• **Multiline strings**: An alternate way to write strings that include newlines.

• **docstring**: The conventional way to write comments that describe the purpose and behavior of a function.
def print_rectangle():
    """ Prints a 2x50 rectangle of a user-specified character """
    user_char = input("What character? ")
    for i in range(2):
        print(user_char * 50)
Multiline Strings and Docstrings: Demo

def print_rectangle():
    """ Prints a 2x50 rectangle of a user-specified character """
    user_char = input("What character? ")
    for i in range(2):
        print(user_char * 50)

• Multiline strings: printing, assigning, etc.

• A string on a line by itself has no effect on the program.

• Docstrings in functions are like comments (but aren’t, technically)
Docstrings
Docstrings

Docstrings are **not** required by the language.
Docstrings

Docstrings are *not* required by the language.

Docstrings *are* required by me.
Docstrings

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- A docstring tells you **what** the function does, but not **how** it does it.
Docstrings

Docstrings are **not** required by the language.

Docstrings **are** required by me.

- A docstring tells you **what** the function does, but not **how** it does it.

- In other terms, it tells you what you need to know to **use** the function, but not what the function’s author needed to know to **write** it.
def forward(self, distance):
    """Move the turtle forward by the specified distance.

    Aliases: forward | fd

    Argument:
    distance -- a number (integer or float)

    Move the turtle forward by the specified distance, in the direction
    the turtle is headed.

    Example (for a Turtle instance named turtle):
    >>> turtle.position()
    (0.00, 0.00)
    >>> turtle.forward(25)
    >>> turtle.position()
    (25.00,0.00)
    >>> turtle.forward(-75)
    >>> turtle.position()
    (-50.00,0.00)
    """
    self._go(distance)
The (actual) source code for turtle.forward:

```python
def forward(self, distance):
    """Move the turtle forward by the specified distance.
    Aliases: forward | fd
    Argument:
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    >>> turtle.position()
    (-50.00,0.00)
    """
    self._go(distance)
```

Implementation: `self._go(distance)`
Docstrings: Example

Python documentation is generated from the docstrings in the code!

turtle.\texttt{forward}(\texttt{distance})
turtle.\texttt{fd}(\texttt{distance})

<table>
<thead>
<tr>
<th>Parameters:</th>
<th>distance - a number (integer or float)</th>
</tr>
</thead>
</table>

Move the turtle forward by the specified \texttt{distance}, in the direction the turtle is headed.

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turtle.position()
(0.00,0.00)
turtle.forward(25)
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Docstrings: Example

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Move the turtle forward by the specified \textit{distance}, in the direction the turtle is headed.

```python
>>> turtle.position()
(0.00,0.00)
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>>> turtle.position()
(-50.00,0.00)
```
Exercise 1: Define a function named `print_word`, which prompts the user to input a word, and also prompts the user to specify how many times that word should be printed. The function should then print that word to the screen as many times as the user has indicated. Invoke the function (hint: the function takes no parameters (no arguments)).

**Input(s):**
- none

**Return value:**
- none

**print_word**

**Effects:**
- prompts the user to input a word and a number of repetitions
- prints the word that many times
Writing Functions: Syntax

def name(parameters):
    statements

Two important questions:
1. How does the function use the arguments (inputs) passed to it?
2. How does the function return a value?

Let’s dodge these questions for a moment…
Writing Functions: Syntax

1. How does the function use the arguments (inputs) passed to it?

```python
def keyword
function name

def name(parameters):
    statements
```
Writing Functions: Syntax

1. How does the function use the arguments (inputs) passed to it?

```python
def name(parameters):
    statements
```

- `def keyword`: Function definition
- `function name`: Name of the function
- `parameters`: Comma-separated list of inputs
- `inputs`: Variable names that will refer to the input arguments
Demo: Function to print a rectangle of a symbol passed in as an argument.

Input(s):
- character to make a rectangle out of

Return value:
- none

Effects: prints a 2x50 rectangle of the given character to the screen
Writing Functions: Syntax

1. How does the function use the arguments (inputs) passed to it?

```
def keyword function name(parameters):
    statements
```
Writing Functions: Syntax

1. How does the function use the arguments (inputs) passed to it?

```python
def keyword function name:
    statements
```

- **Inputs**: comma-separated list of `parameters`: variable names that will refer to the input arguments
1. How does the function use the arguments (inputs) passed to it?

```
def keyword function name:
    statements
```

Inside the function, the parameters act as **local variables** that refer to the arguments passed into the function.

comma-separated list of **parameters**: variable names that will refer to the input arguments
Exercise 2: Write (define) a function that adds two numbers and prints their sum. Then use that function (invoke it) in a python program.
Parameters vs Arguments

**Parameters**: variable names that will refer to the input arguments.

Parameters (these are new): variables that take on the value of the arguments

```python
def add2(a, b):
    '''Print the sum of a and b'''
    print(a + b)
```

Arguments (we’ve seen these before): values passed into a function.

```
add2(4, 10)
```
Parameters are **Local Variables**

- They **only** exist inside the function.
- Any other variables declared inside a function are also local variables.
- This is an example of a broader concept called **scope**: a variable’s scope is the set of statements in which it is visible/usable.
- A local variable’s scope is limited to the function inside which it’s defined.
Parameters and Local Variables: Demo

- add2.py
Parameters and Local Variables: Demo

- add2.py:
  - parameters as local variables (inaccessible outside fn)
  - other local variables
  - variables getting passed in
  - variables shadowing other variables
Demo: Function to draw a square using a turtle
Demo: Function to draw a square using a turtle

• the convenience of repetition:
  • you can define a function once then call it as many times as you want

• the power of *customized* repetition:
  • you can define a function that takes arguments to customize the task it performs: this is powerful!
  • e.g.: one function to draw any size rectangle.
Writing Functions: Syntax

```
def name(parameters):
    statements
```

Two important questions:

2. How does the function return a value?
Exercise 3

Has a typo. Should say:

• Defines a function that takes a single argument and **prints** the fourth power of the input argument.
Returning values

New statement: the `return` statement

Syntax:    `return` `expression`

Behavior:

1. `expression` is evaluated
2. the function stops executing further statements
3. the value of expression is returned
def keyword | function name

```
def name(parameters):
  statements
```

An indented code block that does any computation, executes any effects, and (optionally) returns a value.

```
inputs
```

coma-separated list of parameters: variable names that will get assigned to the arguments.

effects; return value
Returning values: Why?

• Next time:

• Using the result of one computation as the input to another: function composition.