Compsci 101
Functions, Randomness, Selection

Susan Rodger
September 8, 2022
D is for ...

• Debugging
  • A key skill in making your programs run

• Data (Science)
  • Creating information from 0's and 1's

• Dictionary
  • Ultimate Python Data Structure
Prof. Nicki Washington
Duke University

- Research focuses on identity and cultural competence in computing
- Teaches: CompSci 240
- Book: *Unapologetically Dope: Lessons for Black Women and Girls on Surviving and Thriving in the Tech Field*
- On changing the environment, she says:

  “The only way things will change is if those in the majority do the work. This also means that companies should place high expectations of cultural competence on prospective interns and new employees. This, in turn, places more expectations on college and university computing departments to focus on it as well. Only then will we start to see a real paradigm shift.”
Announcements

• Assignment 0 due tonight, 11:30pm
• Assignment 1 out Tuesday
• APT-1 due Sept 15
• Drop/Add over Friday
  • You cannot change lab section without a perm no.
• QZ01-QZ05 submitted by Tuesday, Sept 13, 10:15am
• QZ05 is DUE at 10:15am on Sept 13 will turn off!
• Trouble with Pycharm? Get help

• Remember: Ed Discussion back channel during lecture
Join Duke Mailing lists
compsci@duke.edu

• Mailing list about
  • Jobs, internships, research positions
  • Events related to computer science

• How to join:
  • Go to: lists.duke.edu
  • Be sure to authenticate
  • Add compsci@duke.edu

• BE IN THE KNOW ABOUT COMPSCI!
Plan for the Day

- Review APT
- Print vs. Return
- Python Tutor
- Why use functions?
- Selection (if...elif...else)
- Random library
Finish Slides From Last Time

• Solving an APT
Names and Return 0 Submission

- Take small steps to get all green!

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APT Testing and Submission

• You wrote the code, how is it tested?
  • Submit .py file with function to server
  • Server imports it
  • Server tests and checks by calling your function

• The APT testing framework calls your code!
  • Don’t call us, we’ll call you: Hollywood principle

• Test/Submit + Check Grade
def minutesNeeded(m):
    return 60 + (m-1) * 25

• Wrote formula using code to define a function
• How to use and re-use? By “calling” it
  • Functions allow code to be re-used
  • Len(), float(), minutesNeeded()

time = minutesNeeded(2)
Laundry dissected

```python
def minutesNeeded(m):
    return 60 + (m-1) * 25
```

- Wrote formula using code to define a function
- How to use and re-use? By “calling” it
  - Functions allow code to be re-used
  - Len(), float(), minutesNeeded()

```python
time = minutesNeeded(2)
print(time)
```

Output is 85
Testing Laundry – two ways

1) Locally in Python Program Laundry
   - Get it working before you use apt page

   ```python
   if __name__ == '__main__':
       num = 1
       print("m is", num, minutesNeeded(num))
       num = 2
       print("m is", num, minutesNeeded(num))
       num = 3
       print("m is", num, minutesNeeded(num))
       num = 10
       print("m is", num, minutesNeeded(num))
   ```

2) Run on the apt page
   - Need internet connection, may take time
Testing Laundry – two ways

1) Locally in Python Program Laundry
   - Get it working before you use apt page

```python
if __name__ == '__main__':
    num = 1
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    num = 2
    print("m is", num, minutesNeeded(num))
    num = 3
    print("m is", num, minutesNeeded(num))
    num = 10
    print("m is", num, minutesNeeded(num))
```

2) Run on the apt page
   - Need internet connection, may take time
Where to put/use what in Python file

• Top: docstring with date and username
• Function definitions right after docstring
• Test code inside if __name__ == '__main__':

• Variables inside vs outside a function
  • Only use the variables inside that function
  • Therefore, do not use the variables outside the function (like in the main)
    • Your code will not work on the server
Program execution

• Start at first line
• Ignore comments and blank lines
• Function – recognize, don’t execute
• Statements – executed one line at a time
  • After one statement, next statement
  • Calling a function transfers control to function
  • Function returns control back to where it was called by one of these:
    • Reach last line in the function, returns with None
    • Execute a return statement, return value
Print vs. Return

- **Function ends one of two ways:**
  - Reach end of function
  - Execute return statement
- **Printing is not the same as returning**
  - Print doesn’t leave the function
Python Tutor Tool: Understanding Execution

• **Using PythonTutor:** [http://pythontutor.com](http://pythontutor.com)
  • Tool to trace through code
  • Copy and paste in your code
  • Think about these things as we trace code with Python Tutor
    • How are functions defined?
    • Where does execution begin?
    • What is the global frame?
    • What is a local/function frame?
Trace code with Python Tutor: Start

```python
def greeting(name):
    print("Hello", name)
    print("nice to meet you")

def sum(num1, num2):
    answer = num1 + num2
    return answer

if __name__ == '__main__':
    greeting("Sarah")
    greeting("Bala")
    result = sum(6, 9)
    print(result)
    print(sum(4, 3))
```

Start on Line 1

Click to step through code
Python Tutor Trace: Step 3

Python 3.6
(know limitations)

1 def greeting(name):
2     print("Hello", name)
3     print("nice to meet you")
4
5 def sum(num1, num2):
6     answer = num1 + num2
7     return answer
8
9 if __name__ == '__main__':
10    greeting("Sarah")
11    greeting("Bala")
12    result = sum(6, 9)
13    print(result)
14    print(sum(4, 3))

Saves information where functions are
Python Tutor Trace: Step 5

Python 3.6
(known limitations)

1 def greeting(name):
2     print("Hello", name)
3     print("nice to meet you")
4
5 def sum(num1, num2):
6     answer = num1 + num2
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9 if __name__ == '__main__':
10    greeting("Sarah")
11    greeting("Bala")
12    result = sum(6,9)
13    print(result)
14    print(sum(4,3))

Call greeting and pass value "Sarah" to name
Python Tutor Trace: Step 8

Python 3.6
(known limitations)

```
1 def greeting(name):
2     print("Hello", name)
3     print("nice to meet you")
4
5 def sum(num1, num2):
6     answer = num1 + num2
7     return answer
8
9 if __name__ == '__main__':
10    greeting("Sarah")
11    greeting("Bala")
12    result = sum(6,9)
13    print(result)
14    print(sum(4,3))
```

Print output (drag lower right corner to resize)
Hello Sarah
nice to meet you

Frames
Objects

<table>
<thead>
<tr>
<th>Global frame</th>
</tr>
</thead>
<tbody>
<tr>
<td>greeting</td>
</tr>
<tr>
<td>sum</td>
</tr>
</tbody>
</table>

function

function
greeting(name)
sum(num1, num2)

Finish executing greeting function, no return value, so return None
Call function sum and pass values 6 and 9
Python Tutor Trace: Step 18

Python 3.6
(known limitations)

1 def greeting(name):
2     print("Hello", name)
3     print("nice to meet you")
4
5 def sum(num1, num2):
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9 if __name__ == '__main__':
10    greeting("Sarah")
11    greeting("Bala")
12    result = sum(6,9)
13    print(result)
14    print(sum(4,3))

Finish executing sum function, return the value of answer, which is 15
Python Tutor Trace: Step 24

Python 3.6
(known limitations)

1 def greeting(name):
2     print("Hello", name)
3     print("nice to meet you")
4
5 def sum(num1, num2):
6     answer = num1 + num2
7     return answer
8
9 if __name__ == '__main__':
10    greeting("Sarah")
11    greeting("Bala")
12    result = sum(6, 9)
13    print(result)
14    print(sum(4, 3))

here is the output

Hello Sarah
nice to meet you
Hello Bala
nice to meet you
15
7

Frames

Objects

Global frame

function

greeting(name)

function

sum(num1, num2)

Done executing,
What PythonTutor Demonstrates

• **What happens when program is first “executed”?**
  • Execution starts at top of the file
    • Good practice: “Starting” code is in main program block
  • Functions created and referenced in global frame

• **What happens when function called?**
  • Arguments passed as parameters to function
    • Passed in same order inside parenthesis
    • See green and red arrows when executing
  • Control passes to function which executes
  • Return value replaces function call
WOTO-1 Simple Functions

• **In your groups:**
  • Come to a consensus
Why Use Functions?

• Re-use code/abstractions in multiple contexts
  • Sqrt, wordcount, URL-Webpage examples

• Test code/abstractions separately from their use
  • Develop independently, use with confidence

• Easier to change, re-use in different contexts
  • Relevant to Assignment 1: Faces

• Reduce risk of copy + paste mistakes
if __name__ == '__main__':
    print("Old MacDonald had a farm, Ee-igh, Ee-igh, oh!")
    print("And on his farm he had a pig, Ee-igh, Ee-igh, oh!")
    print("With a oink oink here")
    print("And a oink oink there")
    print("Here a oink there a oink everywhere a oink oink")
    print("Old MacDonald had a farm, Ee-igh, Ee-igh, oh")

    print()
    print("Old MacDonald had a farm, Ee-igh, Ee-igh, oh!")
    print("And on his farm he had a horse, Ee-igh, Ee-igh, oh!")
    print("With a neigh neigh here")
    print("And a neigh neigh there")
    print("Here a neigh there a neigh everywhere a neigh neigh")
    print("Old MacDonald had a farm, Ee-igh, Ee-igh, oh")
How to make code better?

```python
if __name__ == '__main__':
    print("Old MacDonald had a farm, Ee-igh, Ee-igh, oh!")
    print("And on his farm he had a pig, Ee-igh, Ee-igh, oh!")
    print("With a oink oink here")
    print("And a oink oink there")
    print("Here a oink there a oink everywhere a oink oink")
    print("Old MacDonald had a farm, Ee-igh, Ee-igh, oh")

print()
print("Old MacDonald had a farm, Ee-igh, Ee-igh, oh!")
print("And on his farm he had a horse, Ee-igh, Ee-igh, oh!")
print("With a neigh neigh here")
print("And a neigh neigh there")
print("Here a neigh there a neigh everywhere a neigh neigh")
print("Old MacDonald had a farm, Ee-igh, Ee-igh, oh")
```
How to make code better?

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print()
print("Old MacDonald had a farm, Ee-igh, Ee-igh, oh!")
print("And on his farm he had a horse, Ee-igh, Ee-igh, oh!")
print("With a neigh neigh here")
print("And a neigh neigh there")
print("Here a neigh there a neigh everywhere a neigh neigh")
print("Old MacDonald had a farm, Ee-igh, Ee-igh, oh")
```
BetterOldMcDonald.py

```python
def refrain():
    return "E-I-E-I-O\n"

def hadFarm():
    return "Old MacDonald had a farm, "

def verse(animal, sound):
    s = hadFarm() + refrain()
    s += "And on his farm he had a " + animal + "," + refrain()
    s += "With an " + sound + " " + sound + " here\n"
    s += "and an " + sound + " " + sound + " there\n"
    s += "Here an " + sound + ", there an " + sound + "\n"
    s += "Everywhere an " + sound + ", " + sound + "\n"
    s += hadFarm() + refrain()
    return s

if __name__ == '__main__':
    print(verse("pig", "oink"))
    print(verse("horse", "neigh"))
```
```python
def refrain():
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    s += hadFarm() + refrain()
    return s

if __name__ == '__main__':
    print(verse("pig", "oink"))
    print(verse("horse", "neigh"))
```

**What’s new?**
- Move repetitive strings to own function
- Make verse specific strings into parameters
- Build the string and then return
WOTO-2 Old MacDonald

- Discuss what is new in the code
```
BetterOldMcDonald.py

```def refrain():
    return "E-I-E-I-O
"

```def hadFarm():
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```def verse(animal, sound):
    s = hadFarm() + refrain()
    s += "And on his farm he had a " + animal + "," + refrain()
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    s += "and an " + sound + " " + sound + " there\n"
    s += "Here an " + sound + ", there an " + sound + "\n"
    s += "Everywhere an " + sound + ", " + sound + "\n"
    s += hadFarm() + refrain()
    return s

```if __name__ == '__main__':
    print(verse("pig", "oink"))
    print(verse("horse", "neigh"))
```

$s+="..."

is the same as:
$s=s+"..."

"\n" means go to the next line when string is printed
Putting together concepts we have seen

BetterOldMcDonald.py

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    s += "Here an " + sound + ", there an " + sound + "\n"
    s += "Everywhere an " + sound + " " + sound + "\n"
    s += hadFarm() + refrain()
    return s

if __name__ == '__main__':
    print(verse("pig", "oink"))
    print(verse("horse", "neigh"))
```
Putting together concepts we have seen

BetterOldMcDonald.py

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    s += "and an " + sound + " " + sound + " there\n"
    s += "Here an " + sound + ", there an " + sound + "\n"
    s += "Everywhere an " + sound + ", " + sound + "\n"
    s += hadFarm() + refrain()
    return s

if __name__ == '__main__':
    print(verse("pig", "oink"))
    print(verse("horse", "neigh"))
```

Two functions both return a string, put the two strings together.
Try out code? Add a Verse?

• I will make the code from lecture available after class as a .zip file

• Steps:
  1. Create new project
     1. Project Interpreter is what created before
  2. Download zip file
  3. Unzip and copy files into new project
Functions Summarized

• Function call and Function definition related
  • Call must provide correct arguments
  • Names don’t matter, types are important
    • `print(verse(“robot”, 42))`?

• Functions help design, implement, organize
  • Without functions no APIs, no big programs
Making Decisions:

- **Execute different code depending on something**
  - Ask a question
  - Make decision based on answer

- **If condition is true then do something**
  - Condition: true or false
  - Something: any Python code
Selection Syntax

```python
if BOOLEAN_CONDITION:
    CODE_BLOCK_A
else:
    CODE_BLOCK_B
elif BOOLEAN_CONDITION:
    CODE_BLOCK_A
else:
    CODE_BLOCK_C
```

- What is similar and different?
  - What other variations could work?
  - Could only `elif ... else` work?
Selection Syntax

```python
if BOOLEAN_CONDITION:
    CODE_BLOCK_A
else:
    CODE_BLOCK_B
else:
    CODE_BLOCK_C
```

- What is similar and different?
  - What other variations could work?
  - Could only `elif...else` work?
- `if` – required
- `elif` – optional, as many as needed
- `else` – optional, no condition
Example: If

```python
# Example function
def larger(num1, num2):
    if num1 > num2:
        return num1
    return num2

# Check function with provided values
if __name__ == '__main__':
    print(larger(9, 17))
    print(larger(17, 9))
    print(larger(25, 6))
```
Example: If

```python
def larger(num1, num2):
    if num1 > num2:
        return num1
    return num2

if __name__ == '__main__':
    print(larger(9, 17))
    print(larger(17, 9))
    print(larger(25, 6))
```

Output:
17
17
25
Example 2: If-Elif-Else

```python
def pluralize(word):
    if word == "fish":
        return word + "es"
    elif word == "brush":
        return word + "es"
    else:
        return word + "s"

if __name__ == '__main__':
    print(pluralize("brush"))
    print(pluralize("card"))
    print(pluralize("fish"))
    print(pluralize("frog"))
    print(pluralize("fox"))
```

Output:
Example 2: If-Elif-Else

def pluralize(word):
    if word == "fish":
        return word + "es"
    elif word == "brush":
        return word + "es"
    else:
        return word + "s"

if __name__ == '__main__':
    print(pluralize("brush"))
    print(pluralize("card"))
    print(pluralize("fish"))
    print(pluralize("frog"))
    print(pluralize("fox"))

Output:
brushes
cards
fishes
frogs
foxs
Cat Jumping Not Random

Cat always jumps to its right
Cat Jumping Random Direction

Cat jumps right or left, randomly
Random Module

- [https://docs.python.org/3/library/random.html](https://docs.python.org/3/library/random.html)

- **Must import random at top of file to use the library**
  - `import random`

- **Now can use any of random's functions**

- **To call a function from a module**
  - `<MODULE_NAME>.<FUNCTION_NAME>(args)`

- **Example:**
  - `random.randint(a, b)`
  - Return a random integer \( N \) such that \( a \leq N \leq b \).
Random Module

- [https://docs.python.org/3/library/random.html](https://docs.python.org/3/library/random.html)

- Must import random at top of file to use the library
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- Now can use any of random's functions

- To call a function from a module
  - `<MODULE_NAME>`.`<FUNCTION_NAME>`(args)

- Example:
  - random.randint(a, b)
  - Return a random integer N such that a <= N <= b.
Example: Random

```python
import random

def larger(num1, num2):
    if num1 > num2:
        return num1
    return num2

if __name__ == '__main__':
    x = random.randint(1,20)
    y = random.randint(1,20)
    print(x, y, larger(x,y))
    x = random.randint(1,200)
    y = random.randint(1,200)
    print(x, y, larger(x,y))
```

Output:
Example: Random

```python
import random

def larger(num1, num2):
    if num1 > num2:
        return num1
    return num2

if __name__ == '__main__':
    x = random.randint(1,20)
    y = random.randint(1,20)
    print(x, y, larger(x,y))
    x = random.randint(1,200)
    y = random.randint(1,200)
    print(x, y, larger(x,y))
```

Output:

```
20 5 20
78 22 78
```

Run again...

Output:

```
17 6 17
5 123 123
```

Different values every time you run program.
Does it say Meow? Does it Neigh?