Compsci 101
Functions, Randomness, Selection

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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 can still turn in due to Drop/Add
- Assignment 1 out later today
- Prelab 2 out today!
- APT-1 due Jan. 26
- Drop/Add over Tomorrow! 1/25
  - You cannot change lab section without a perm no.
- QZ01-QZ05 submitted by Thursday, Jan 26, 10:15am
- QZ05 is DUE at 10:15am on Jan 26 will turn off!
- Trouble with Pycharm? Get help
- Remember: Ed Discussion back channel during lecture
WOTO grading

• WOTO's are the forms we do in lecture
• We expect you to come to class and do them.
• We understand occasionally you may miss class. The WOTOs must be completed by the next night!
• Tuesday WOTO by Wed night, Thur WOTO by Fri night!

• You should be submitting them late only a few times
• Lecture Video is put up later the day of lecture on today's date on our calendar webpage
• Video is NOT always guaranteed to work – many mess-ups!

Join SAGE

• STEM Advancement through Group Engagement
• Small groups of students working on additional problems related to CompSci 101
• Limited spots
• Sign up now on Academic Resource Center website
• See Ed Discussion Post (pinned at the top)

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!

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

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()

```
time = minutesNeeded(2)
```

Output is 85
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

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
  - 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

- Start on Line 1
  - Click to step through code
Python Tutor Trace: Step 3

```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))
```

Saves information where functions are called.

Python Tutor Trace: Step 5

```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))
```

Call greeting and pass value "Sarah" to name.

Python Tutor Trace: Step 8

```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))
```

Finish executing greeting function, no return value, so return None.

Python Tutor Trace: Step 15

```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))
```

Call function sum and pass values 6 and 9.
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

Old MacDonald Song!

```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?

```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")
```

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

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

WOTO-2 Old MacDonald

- Discuss what is new in the code

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

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

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

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

- Move repetitive strings to own function
- Make verse specific strings into parameters
- Build the string and then return
- Discuss what is new in the code
- Move repetitive strings to own function
- Make verse specific strings into parameters
- Build the string and then return
Putting together concepts we have seen

**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 + " " + 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"))
```

Function call inside another function call

Two functions both return a string, put the two strings together

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**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

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**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

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

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

Example: If

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

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
```

Output:
17
17
25

Example2: If-Elif-Else

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

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

Example2: If-Elif-Else

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

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

Randomness

- Want things to happen randomly
- Games are not interesting if the same things happen every time you play them!
Cat Jumping Not Random
Cat always jumps to its right

Cat Jumping Random Direction
Cat jumps right or left, randomly
Randomness in Python?
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 $a \leq N \leq b$. 

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
```