Objectives

- Defining your own functions
  - Documentation
  - Testing
  - Development Process
- Broader Issue: Google Search

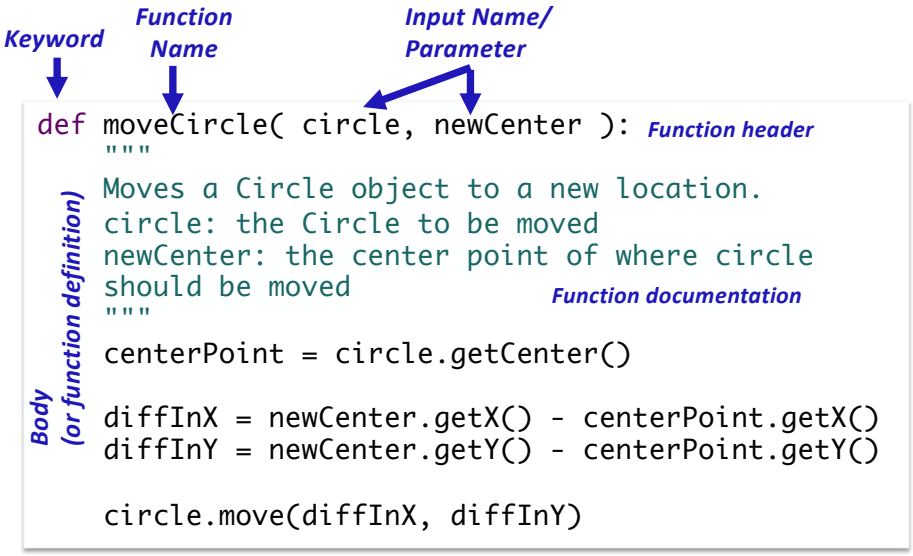
Review

- What are benefits of functions?
- What is the syntax for creating our own functions?
  - How do we indicate that our function requires input?
  - How do we indicate that our function has output?
- What's the difference between output from a function and output from a program?
- How do we call a function we created?
- What does a variable's "*scope*" mean?
- With respect to functions, what are options for how we organize our program?
- How do we document a function? What should its content be?

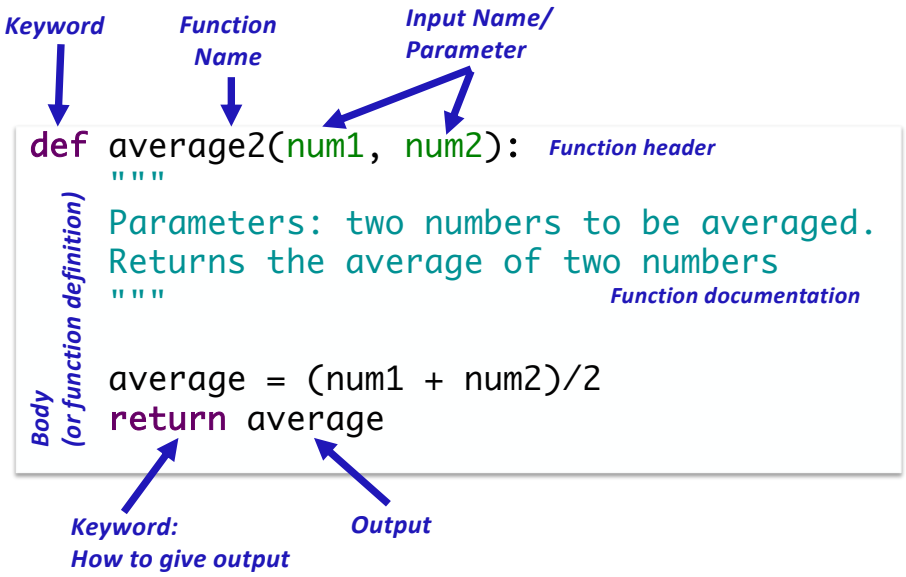
Review: Why Write Functions?

- Allows you to break up a problem into *smaller*, more *manageable* parts
- Makes your code easier to *understand*
- Hides implementation details (*abstraction*)
  - Provides *interface* (input, output)
- Makes part of the code *reusable* so that you:
  - Only have to write function code once
  - Can debug it all at once
    - Isolates errors
  - Can make changes in one function (*maintainability*)

Function Definition Example without Output



Function Definition Example with Output



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Review: `return` vs `print`

- In general, whenever we want output from a function, we'll use `return`
  - Results in a more flexible, reusable function
  - Let whoever called the function figure out what to display
- Use `print` for
  - Debugging your function (then remove)
    - Otherwise, unintended side effect of calling the function
  - When you have a function that is supposed to display something
    - Sometimes, that is what you want.

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Practice: Trace through the Program's Execution

- What is the output of this program?
  - Example: user enters 4

```
def main():
    num = eval(input("Enter a number to be squared: "))
    squared = square(num)
    print("The square is", squared)

def square(n):
    return n * n

main()
```


Practice

- What is the output of this program?
  - Example: user enters 4

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def main():
    num = eval(input("Enter a number to be squared: "))
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    print("The original num was", n)

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def square(n):
    return n * n

main()
```

Error! n does not have a value in function main()

Review: Variable Scope

- Know "lifetime" of variable
  - Only during execution of function
  - Related to idea of "scope"
- Consider: how many functions probably use a variable like x or i? What would the impact be on our programs if all variables had global scope?
  - Example: round(x, n)
- In general, our only *global* variables will be constants because we don't want them to change value
  - e.g., EIEIO

Summary: Variable Scope

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Review: Where are Functions Defined?

- Functions can go inside program script
  - If no `main()` function, defined ***before*** use/called
  - If `main()` function, defined anywhere in script
- Functions can go inside a separate ***module***

Divergence from Text Book: Conventions

Us: `main` at the top

- See an overview of the code (driver) at the top
- Need to scroll down to see function definitions to understand what the main does
  - Mitigated by having descriptive function names
- Need to call main at the bottom

Book: `main` at the bottom

- All functions have already been defined before main
- Need to scroll down to the bottom to see the driver/overview of the program
- Need to call main at the bottom

WHAT ARE CHARACTERISTICS OF A GOOD FUNCTION?

Writing a "Good" Function

- Should be an "intuitive chunk"
  - Doesn't do too much or too little
  - If does too much, try to break into more functions
- Should be reusable
- Should have a descriptive, "action" name
- Should have a comment that tells what the function does

Write the Docstring Comment for sumEvens

```
def main() :
   x=10
   sum = sumEvens( x )
   print("The sum of even #s up to", x, "is", sum)

def sumEvens(limit) :
   """



   """
   total = 0
   for x in range(0, limit, 2):
         total += x
   return total

main()
```

Write the Docstring Comment for sumEvens

```
def main() :
  x=10
  sum = sumEvens( x )
  print("The sum of even #s up to", x, "is", sum)

def sumEvens(limit) :
  """
  Returns the sum of even numbers from 0 up to but
  not including limit, which is an integer
  """
  total = 0
  for x in range(0, limit, 2):
        total += x
  return total

main()
```

Many other correct doc strings

Writing Documentation for Functions

- Good style: Each function (except `main`) ***must*** have a comment that documents its use
- Describes functionality at a high level
- Include the *precondition, postcondition*
- Describe the parameters (their types) and the result of calling the function (precondition and postcondition may cover this)
- The exact format matters less than that the content is there

`main()` is typically covered by the program's description

Practice

1. Define the function to calculate our favorite expression: $i^2 + 3j - 5$
   a. What does the function do?
   b. What is its input?
   c. What is its output?
2. Test the function
3. Use the function

`our_favorite_expression.py`

TESTING FUNCTIONS

Testing Functions

- Functions make it easier for us to test our code
- We can write code to test the functions
  - Test Case:
    - Input: parameters
    - Expected Output: what we expect to be returned
      - Or if state changed as we expected
  - We can verify the function programmatically
    - "programmatically" – automatically execute test cases and verify that the actual returned result is what we expected
    - No user input required!

`test` Module

- Not a standard module
  - Included with our textbook
  - More sophisticated testing modules but this is sufficient for us
- Function:
  - `testEqual(actual, expected[, places=5])`
    - Parameters: actual and expected results for a function.
    - Displays "Pass" and returns True if the test case passes.
    - Displays error message, with expected and actual results, and returns False if test case fails.

Example: Testing sumEvens

```
import test
…
def testSumEvens():
    actual = sumEvens( 10 )
    expected = 20
    test.testEqual( actual, expected )

def sumEvens(limit):
    total = 0
    for x in range(0, limit, 2):
        total += x
    return total
```

This is the actual result from our function

This is what we expect the result to be

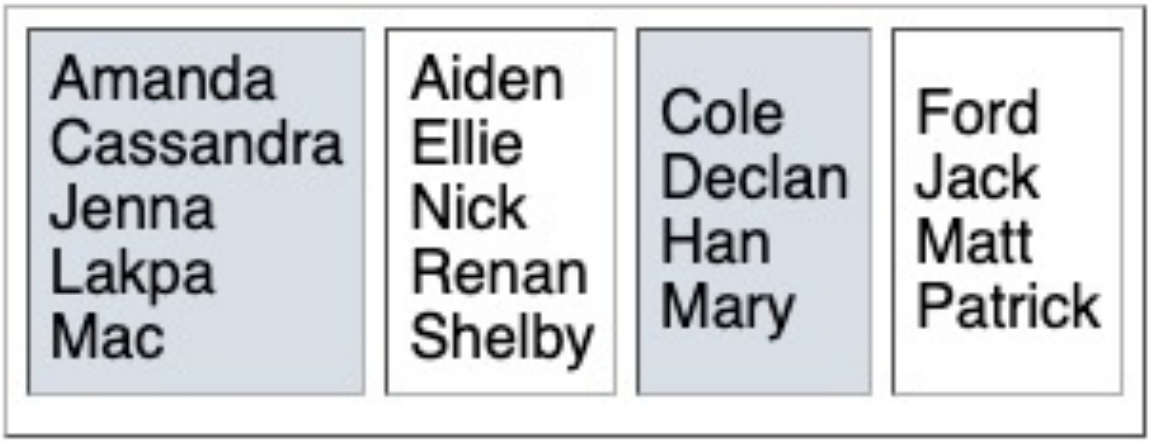
What are other good test cases?

testSumEvens.py

Exam Next Friday

- **Do not panic**
- In-class, on paper
  - Emphasis on critical thinking
- Exam Preparation Document is on course web page
- Similar problems to class and lab
  - Review questions
  - Worksheets
  - Problems
- Content: up through Tuesday's lab 4
  - Practicing what we learned Wed – Mon
- No broader issue next week

Broader Issue Groups



Broader Issue: Google Search

- Why is Google search a "broader issue"?
- How does Google search work?
  - How is it tested?
- What are some ways you think searches could be improved?
  - How do you measure "improved search"?
- Will you use Google differently, now that you know how it works (kind of)?

Broader Issue: Google Search

- What power do search engines have?
- Is Google search biased?

Looking Ahead

- Pre-Lab due before lab on Tuesday
- Exam next Friday