[220 / 319] Creating Functions

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Learning Objectives Today

Function syntax:
- basics, return, tabbing

Input/output:
- parameters
- three types of arguments
- print vs. return

Module:
- Keywords: import, as, from
- creating custom modules

Tracing:
- what happens when?
- PythonTutor

Please continue reading
Chapter 3 of Think Python

Also read 220 bonus:
"Creating Fruitful Functions"

link on schedule

Main Code:

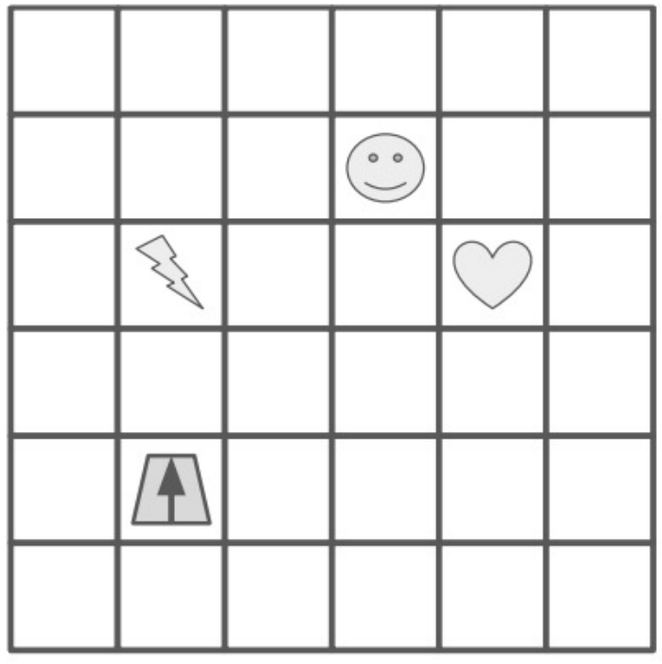
1. Put 2 in the “moves” box
2. Perform the steps under “Move Code”, then continue to step 3
3. Rotate the robot 90 degrees to the right (so arrow points to right)
4. Put 3 in the “moves” box
5. Perform the steps under “Move Code”, then continue to step 6
6. Whatever symbol the robot is sitting on, write that symbol in the “resut” box

Move Code:

A. If “moves” is 0, stop performing these steps in “Move Code”, and go back to where you last were in “Main Code” to complete more steps
B. Move the robot forward one square, in the direction the arrow is pointing
C. Decrease the value in “moves” by one
D. Go back to step A

how do we write functions like move code?

Functions are like “mini programs”, as in our robot worksheet problem



Types of functions

Sometimes functions **do** things

- Like "Move Code"
- May produce output with print
- May change variables

Sometimes functions **produce** values

- Similar to mathematical functions
- Many might say a function "returns a value"
- Downey calls these functions "fruitful" functions
  (we'll use this, but don't expect people to generally be aware of this terminology)

Sometimes functions do both!

Math to Python

Math: $f(x) = x^2$

Python:

```
def f(x):
    return x ** 2
```

1. In Python, start a function definition with "def" (short for definition), and use a colon (":") instead of an equal sign ("=")
2. In Python, put the "return" keyword before the expression associated with the function
3. In Python, indent before the statement(s)

Math to Python

Math: $g(r) = \pi r^2$

Python:

```
def g(r):
    return 3.14 * r ** 2
```

```
def get_area(radius):
    return 3.14 * radius ** 2
```

4 Computing the area from the radius

5 In Python, it's common to have longer names for functions and arguments

Math to Python

Math: $g(r) = \pi r^2$

Python:

```
def get_area(diameter):
    radius = diameter / 2
    return 3.14 * radius ** 2
```

6 It's also common to have more than one line of code (all indented)

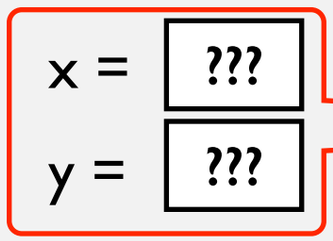
Can we implement our own version of popular math functions?

```
abs(x)

sqrt(x)

pow(base, exp)
```

demos...

Rules for filling parameters...

```
def foo(x, y=-1):
```



function declaration

not actual code, but imagine parameters as variables that are automatically initialized for you

```
foo(99, 100)
```

function invocation

1. positional arguments

Rules for filling parameters...

```
def foo(x, y=-1):
```

x = 99

y = 100

```
foo(99, 100)
```

```
def foo(x, y=-1):
```

x = 100

y = 99

```
foo(y=99, x=100)
```

```
def foo(x, y=-1):
```

x = 99

y = -1

```
foo(99)
```

1 positional arguments

2 keyword arguments

3 default arguments

common pitfall: *confusing keyword arguments and default arguments*

worksheet practice...

pre-installed (e.g., math)
- sqrt()
- sin(), cos()
- pi, *etc.*

built in
- input()
- print()
- len()
- *etc.*

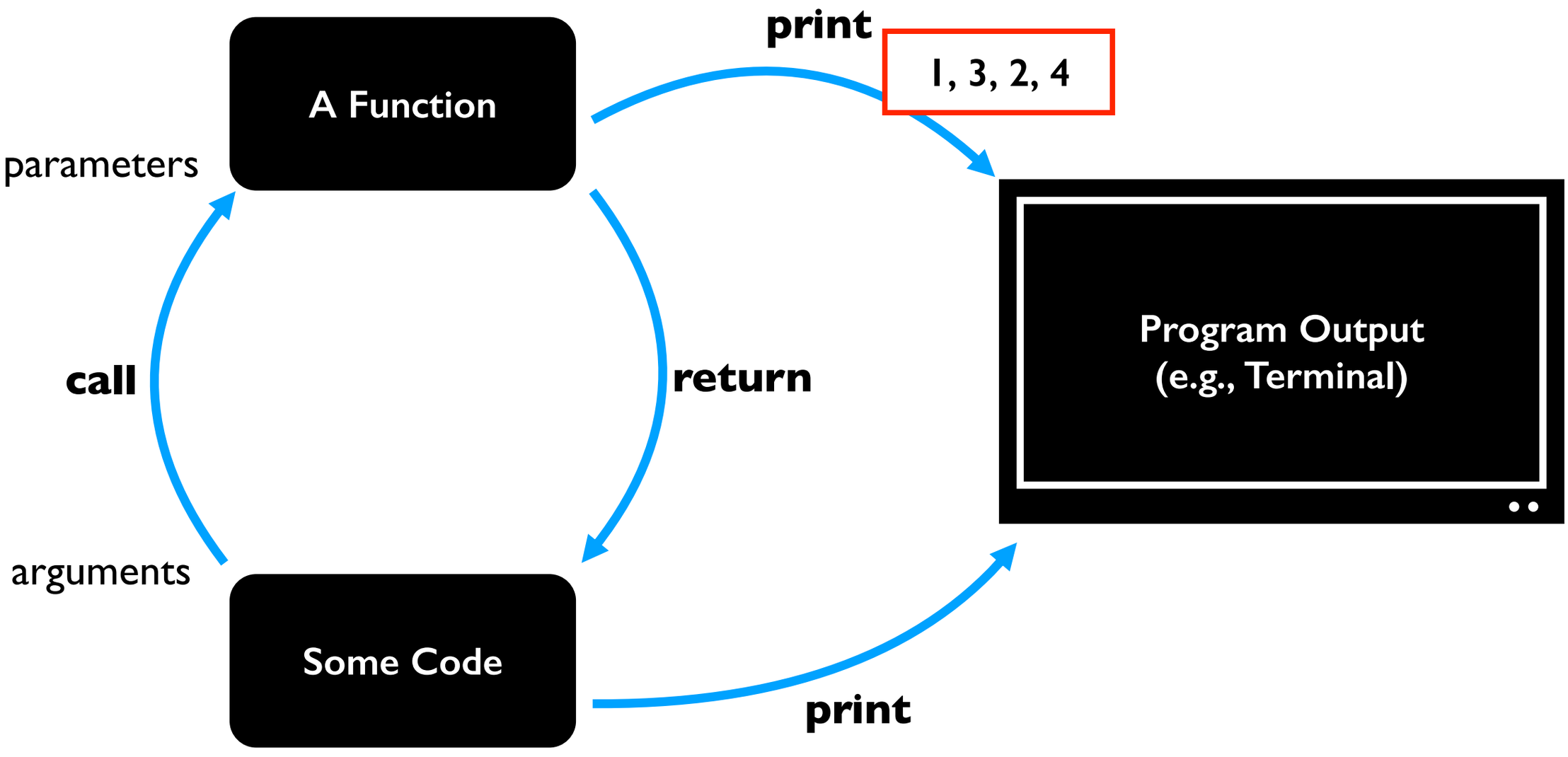
*Where do **modules** come from?*

installed (e.g., jupyter)
- pip install jupyter
- pip install ...

custom
- dog
- cat
- ...

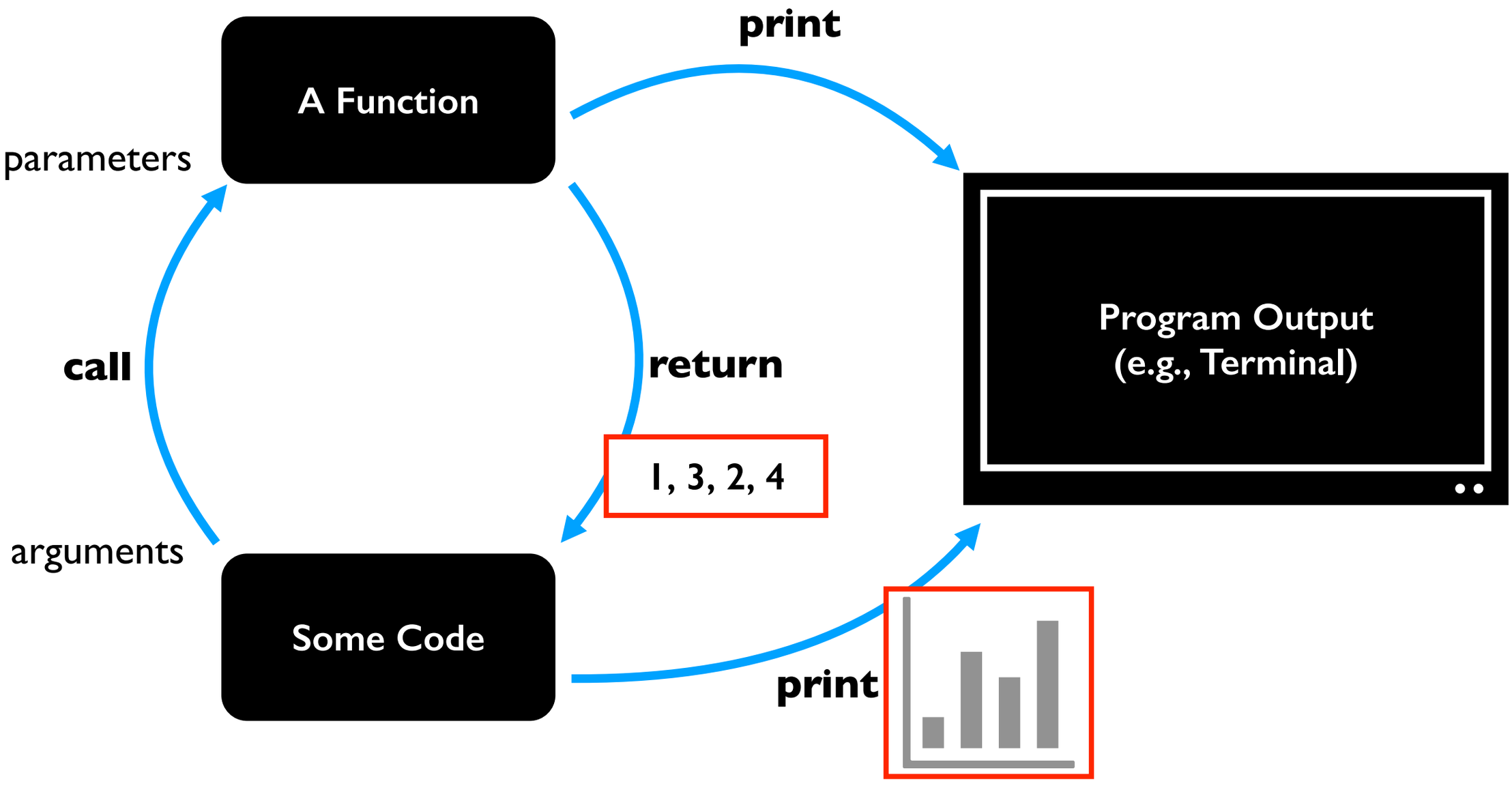
demos...

Print vs. Return



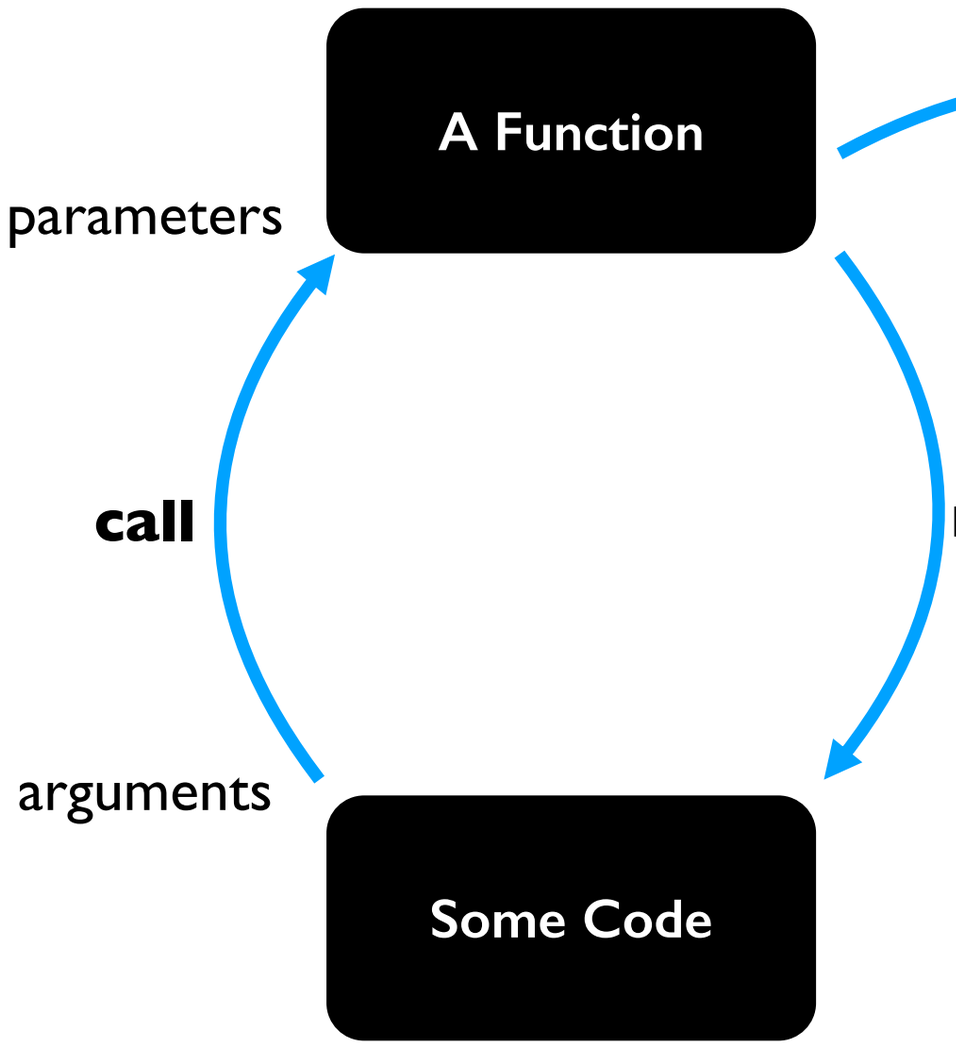
we could call print from multiple places

Print vs. Return



returning, instead of **printing**, gives callers different options for how to use the result

Print vs. Return



print: a function can print as much as it likes

return: you only get to answer once, then function stops

https://memegenerator.net/instance/56355449/millionaire-regis-is-that-your-final-answer

countdown example...

returning, instead of **printing**, gives callers different options for how to use the result

Checking Examples with PythonTutor

Wed: Creating Functions (Sep 22)

- Positional Params
- Keyword Params
- Return Values

Read: Downey Ch 3 ("Adding New Functions" to "Flow of Execution" and "Fruitful and Void Functions")

Read: Creating Fruitful Functions

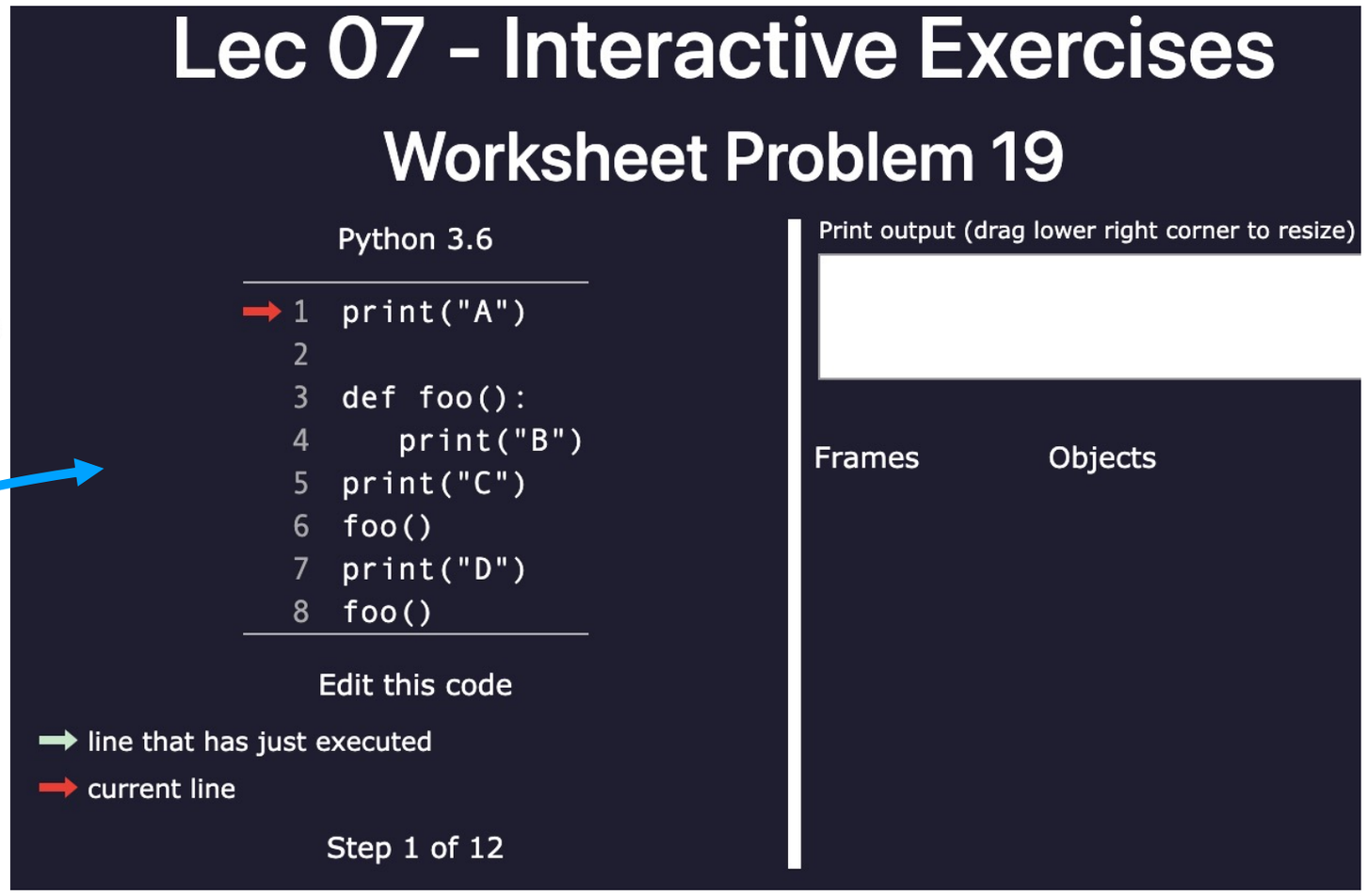
Due: P2

Link to Slides

Link to worksheet: pdf, docx

Interactive Exercises

Assigned: Lab-P3, P3



...

Challenge: Approximation Program

input: a number from user

output: is it approximately equal to an important number? (pi or zero)

```
python approx.py
please enter a number: 3.14
close to zero?  False
close to pi?    True
```

```
python approx.py
please enter a number: 0.000001
close to zero?  True
close to pi?    False
```

```
python approx.py
please enter a number: 3
close to zero?  False
close to pi?    False
```

what is error between 4 and 8?

- 100%
- 50%

$$\frac{\text{abs}(8 - 4)}{\text{max}(\text{abs}(4), \text{abs}(8))}$$