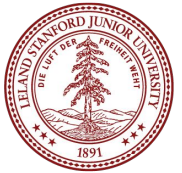
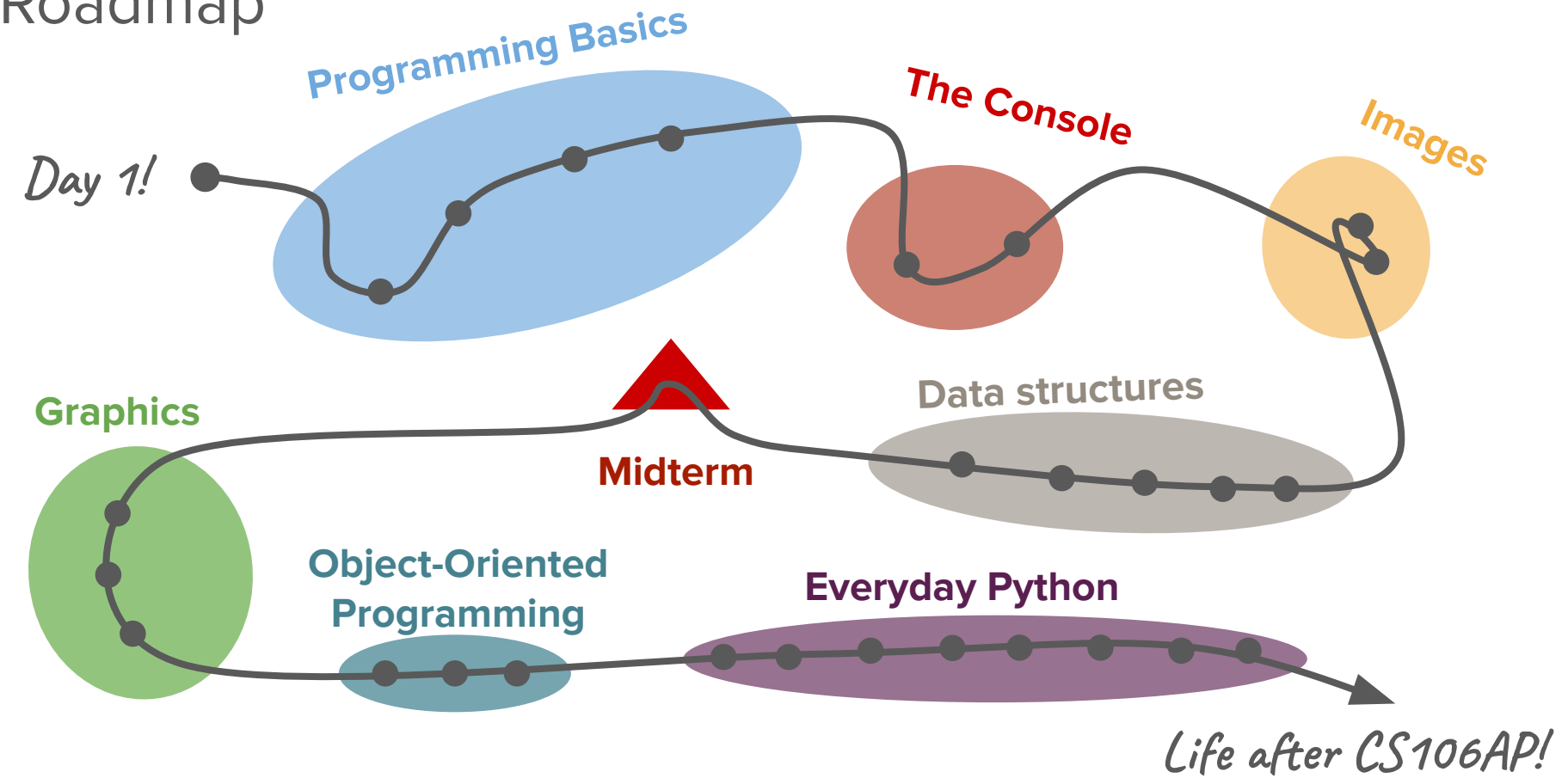
Python Functions

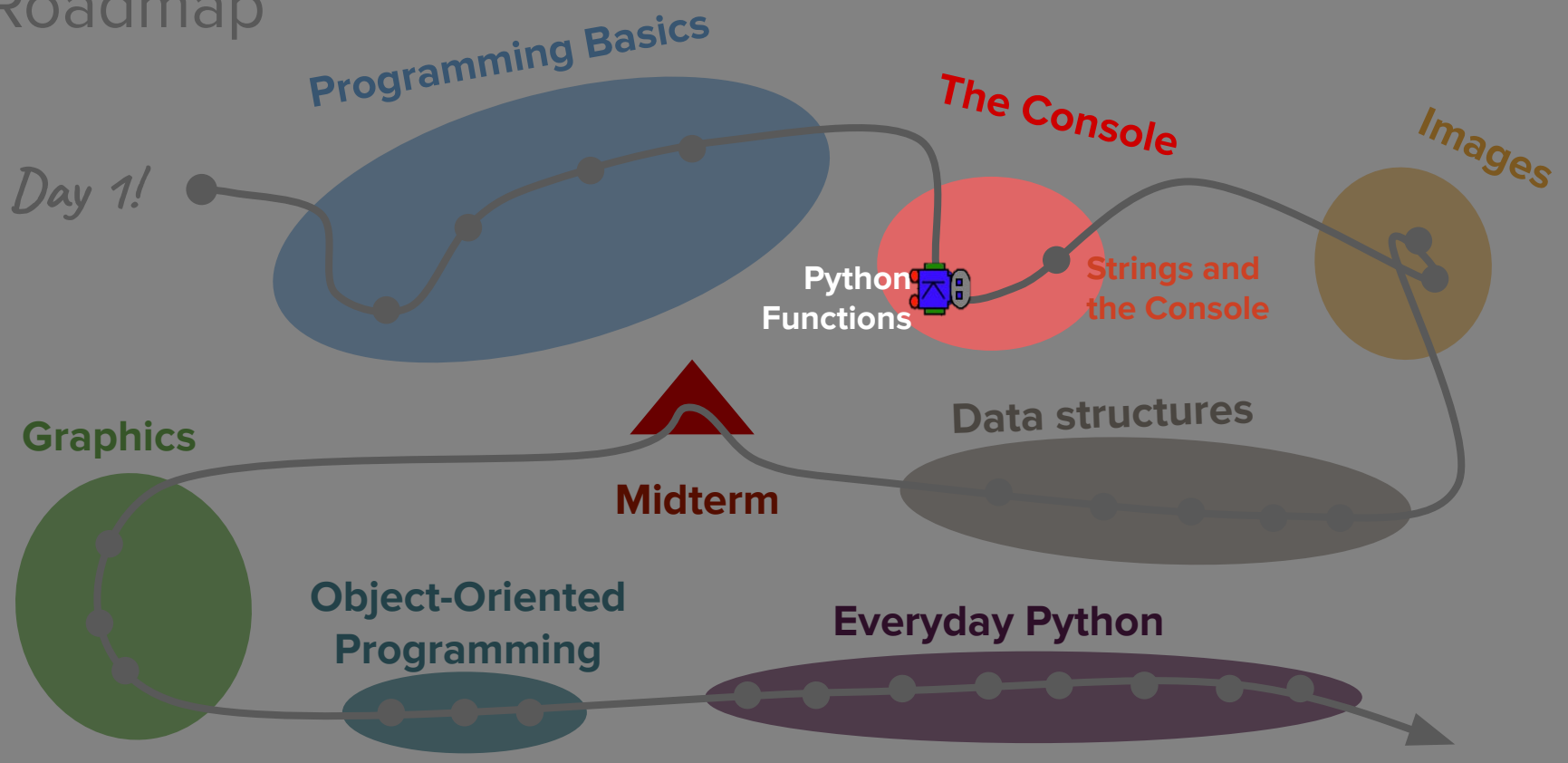
CS106AP Lecture 6



Roadmap


Programming Basics
Day 1!
The Console
Images
Graphics
Midterm
Data structures
Object-Oriented Programming
Everyday Python
Life after CS106AP!

Roadmap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Today's questions

How do we translate what we know from Karel into regular Python code?

How can we make our code more flexible by producing different outputs depending on the input?

Today's topics

1. Introduction and Review
2. Range For Loops
3. Python Functions
4. Variable Scope
5. What's next?

Who am I?

Sonja Johnson-Yu

Sonja Johnson-Yu

Sonja Johnson-Yu

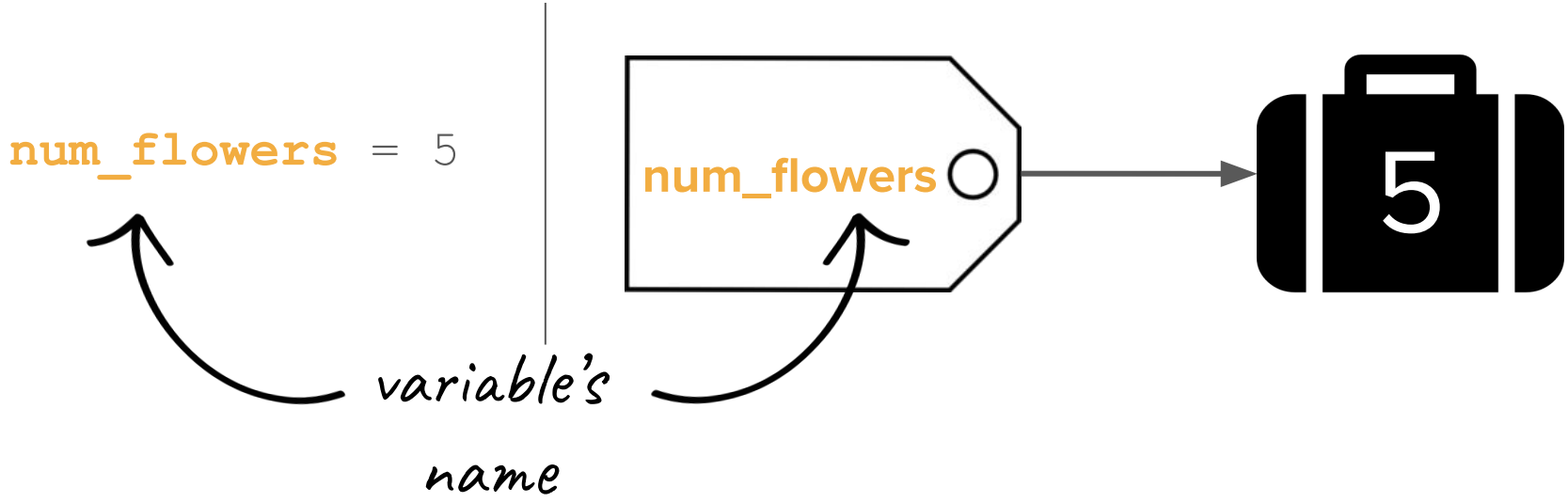
Sonja Johnson-Yu

Review

Variables

What is a variable?

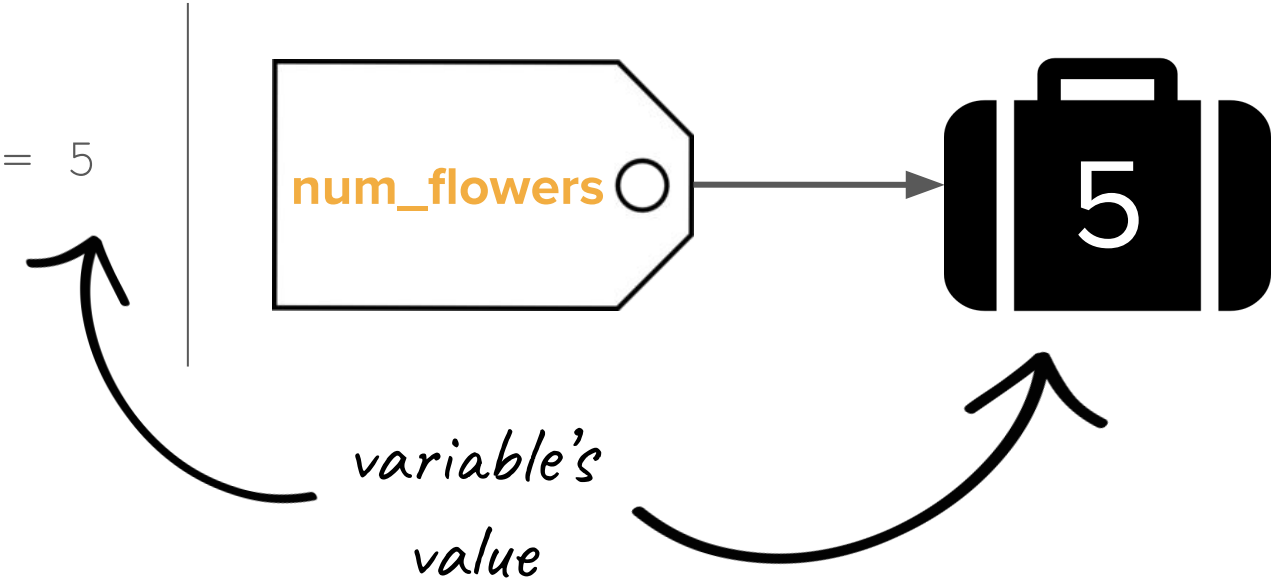
A variable is a container for storing a data value.



What is a variable?

A variable is a container for storing a data value.

```
num_flowers = 5
```



Terminology summary

- Variables have a **name** and are associated with a **value**
- Variable **assignment** is the process of associating a value with the name (use the equals sign =)
- **Retrieval** is the process of getting the value associated with the name (use the variable's name)
  - This is how you use variables!

Expressions

Recall: expressions

- The computer **evaluates** expressions to a single value
- We use **operators** to combine literals and/or variables into **expressions**

Arithmetic operators

*	Multiplication
/	Division
//	Integer division
%	Modulus (remainder)
+	Addition
-	Subtraction

Operator	Precedence
`()`	1
`*, /, //, %`	2
`+, -`	3

Arithmetic operators

*	Multiplication
/	Division
//	Integer division
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Operator	Precedence
()	1
*, /, //, %	2
+, -	3

Integer division takes the largest integer that is equal to or smaller than the quotient

Integer Division Practice!

- 5 + 1 // 2
- 9 // 3
- 8 // 3
- -8 // 3

Integer division takes the largest integer that is equal to or smaller than the quotient

Integer Division Practice!

- 5 + 1 // 2 = 5
- 9 // 3 = 3
- 8 // 3 = 2
- -8 // 3 = -3

Integer division takes the largest integer that is equal to or smaller than the quotient

How can I repeat a task a finite number of times?

While loop with variables

```
counter = 0
while counter < 3:
    do_something()
    counter += 1
```

WARNING: do not use variables on Karel!

While loop with variables

```
counter = 0
while counter < 3:
    do_something()
    counter += 1
```

This is the same thing as:

```
counter = counter + 1
```

While loop with variables

```
counter = 0
while counter < 3:
    do_something()
    counter += 1
```


Generally, `x += y` is the same as:

```
x = x + y
```

While loop with variables

```
counter = 0
while counter < 3:
    do_something()
    counter += 1
```

Generally, `x += y` is the same as:

`x = x + y`

You can also do: `-=`, `*=`, `/=`

While loop with variables

```
counter = 0
while counter < 3:
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    counter += 1
```

Computer scientists count from 0.

While loop with variables

```
counter = 0
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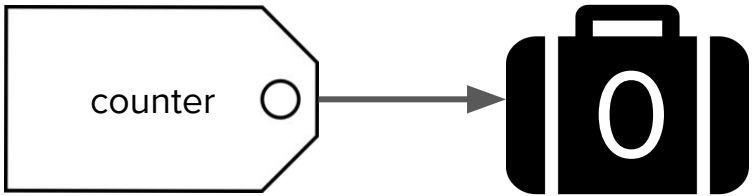
```



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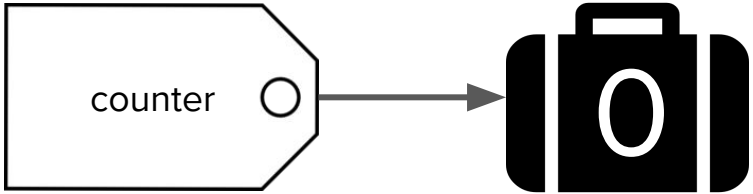

While loop with variables

```
counter = 0
while counter < 3:
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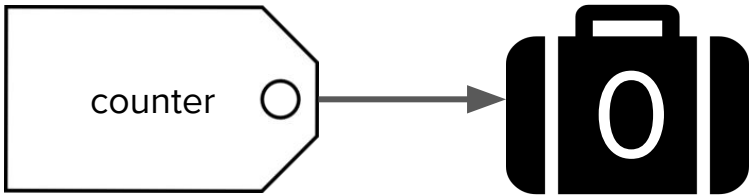
```

True



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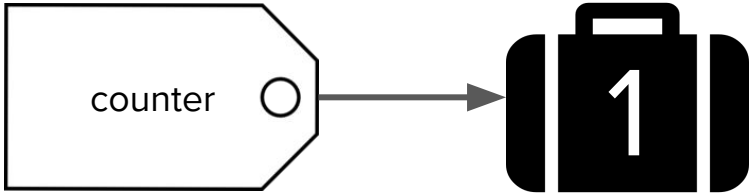

While loop with variables

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while counter < 3:
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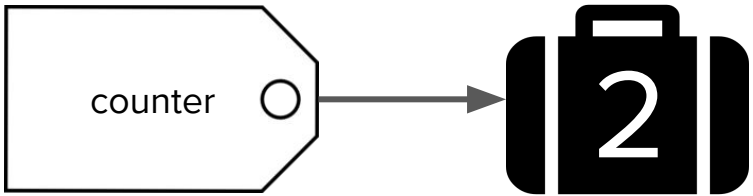
```

True



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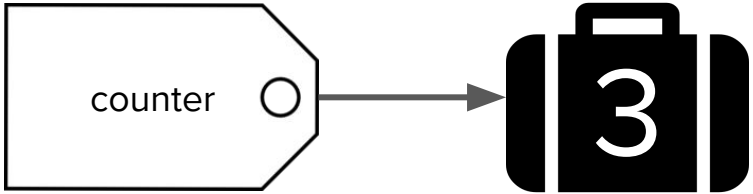
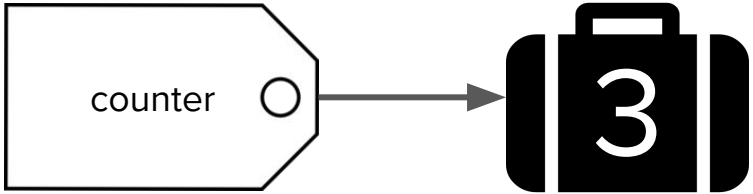


While loop with variables

```
counter = 0
while counter < 3:
    do_something()
    counter += 1
```

False!



For loops

For loop with range

```
for i in range(3):
    do_something()
```

For loop with range

```
for i in range(3):
    do_something()
```

Definition

for loop
A way to repeat a block of code a specific number of times

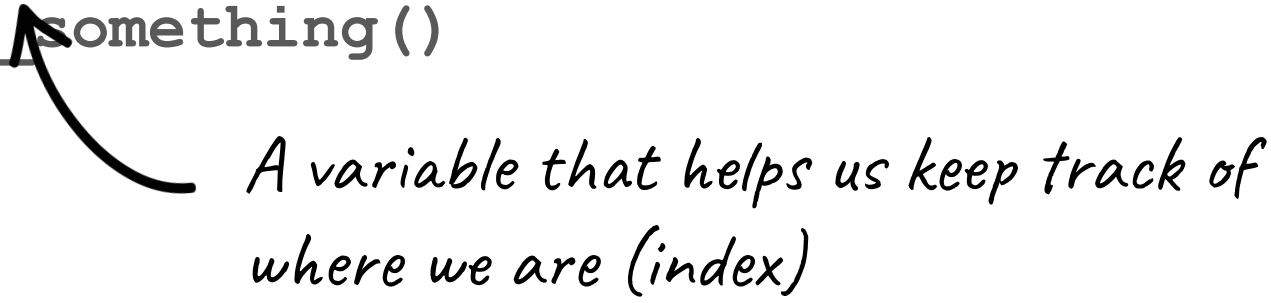
For loop with range

```
for i in range(3):
    do_something()
```

Tells us we're going to loop through one by one

For loop with range

```
for i in range(3):
    do_something()
```



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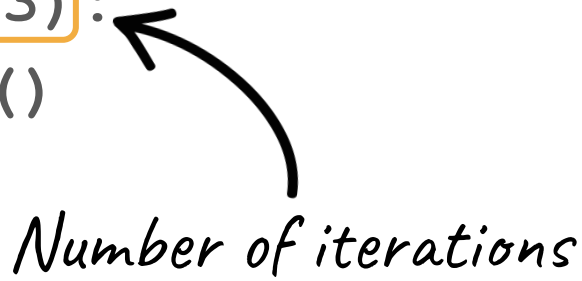


For loop with range

```
for i in range(3):
    do_something()
```

Can be a variable, as long as it's an int!

For loop with range

```
for i in range(3):
    do_something()
```

Range

range(3) -> iterates through 0,1,2

Range

```
range(3) -> iterates through 0,1,2
range(0, 3) -> iterates through 0,1,2
```

Range

```
range(3) -> iterates through 0,1,2
range(0, 3) -> iterates through 0,1,2
range(4, 7) -> iterates through 4,5,6
```

Range

```
for i in range(end_index):
   # assumes 0 is the start index
```

Range

```
for i in range(end_index):
   # assumes 0 is the start index

for i in range(start_index, end_index):
   # end_index is not inclusive!
   # recall: range(4,7) -> 4,5,6
```

How can I make my code more flexible?

Python Functions

print(x)

front_is_clear()

turn_right()

math.sqrt(4)

average(x, y)

predict_temperature()

Karel Functions 

```
def turn_right():
    turn_left()
    turn_left()
    turn_left()
```

Karel Functions 

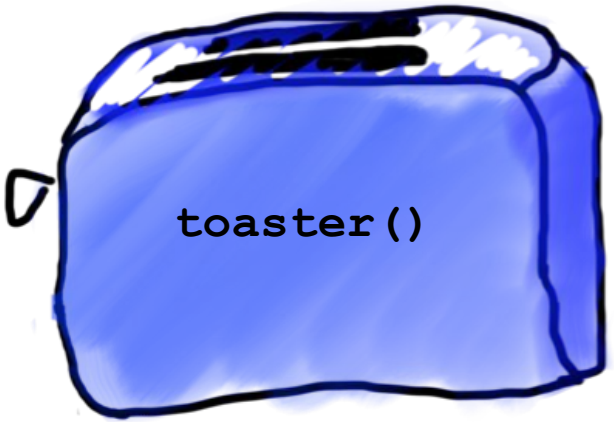
```
def move_x_times():
    # ????
```

Karel Functions 

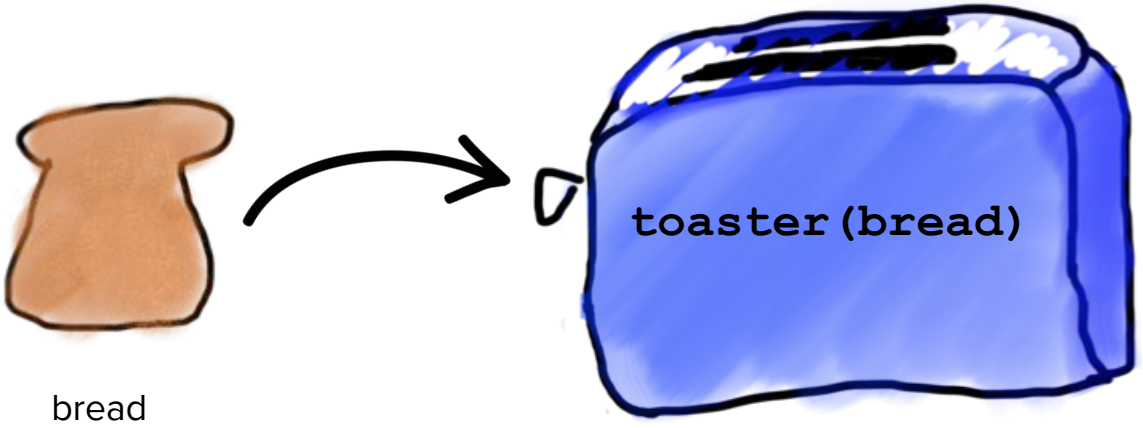
```
def move_x_times():
    # ????
```

How can we make functions more flexible and reusable by producing different outputs?

Function Analogy



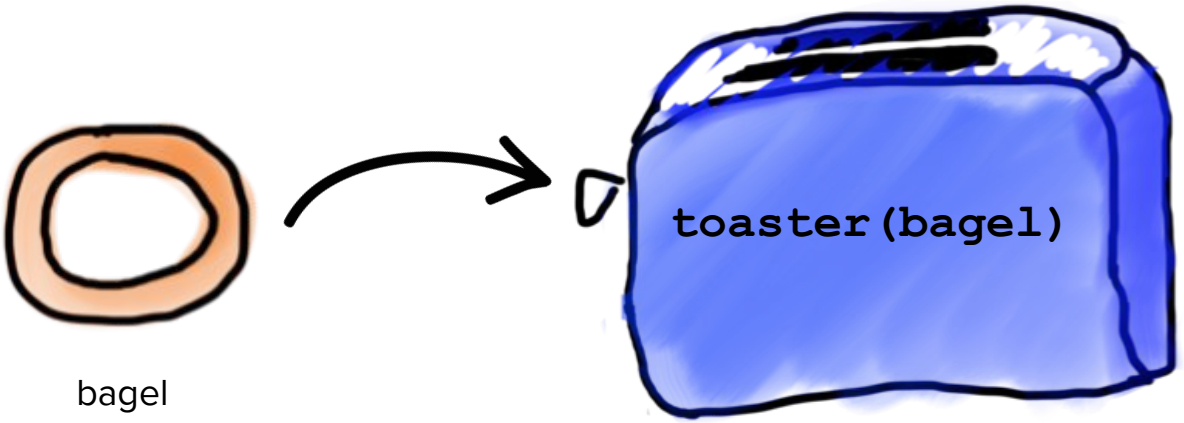
Function Analogy



bread

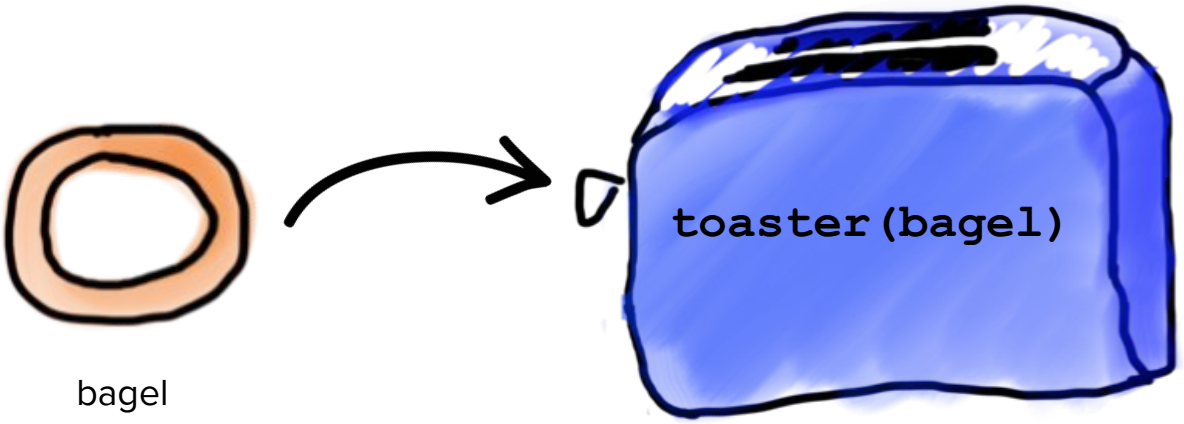
Function Analogy

Function Analogy



bagel

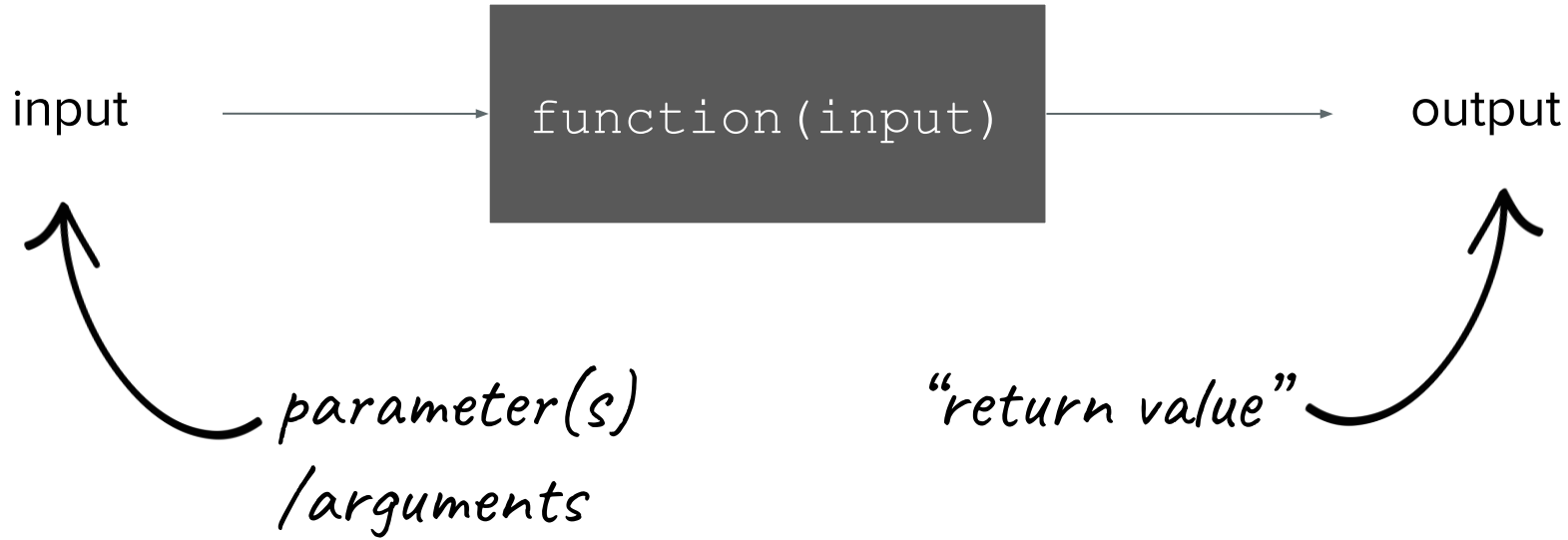
Function Analogy



You don't need a different toaster for toasting bagels! Use the same one.

Function Analogy

Anatomy of a Function



Anatomy of a Function

```
def function_name(param1, param2):
    result = # do something
    return result
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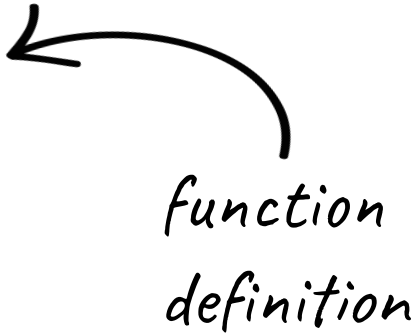

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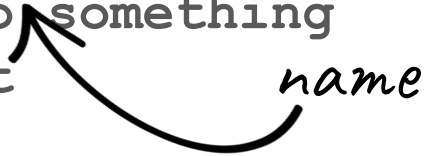

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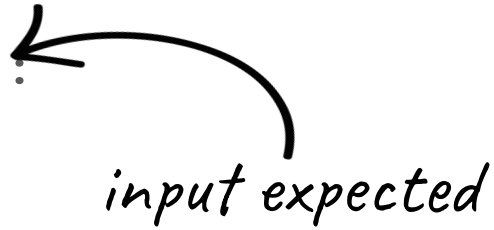

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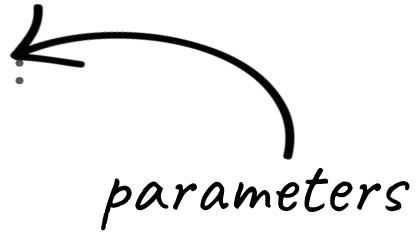

Anatomy of a Function

```
def function_name(param1, param2):
    result = # do something
    return result
```

Definition

parameter(s)
One or more variables that a function expects as input

Anatomy of a Function

```
def function_name(param1, param2):
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    return result
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Anatomy of a Function

```
def function_name(param1, param2):
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```

Think/Pair/Share:

Find the function definition, function name, parameter(s), and return value.

Anatomy of a Function

```
def main():
    mid = average(10.6, 7.2)
    print(mid)


def average(a, b):
    sum = a + b
    return sum / 2
```

Think/Pair/Share:

Find the function definition, function name, parameter(s), and return value in `average`.

Anatomy of a Function

```
def main():
    mid = average(10.6, 7.2)
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```

```
def average(a, b):
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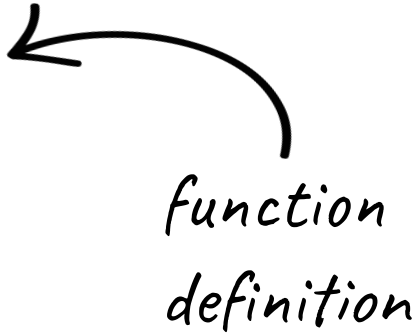

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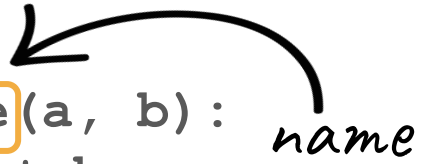


```
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    sum = a + b
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Anatomy of a Function

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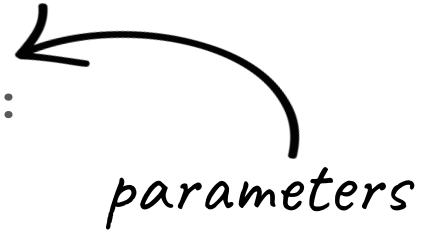

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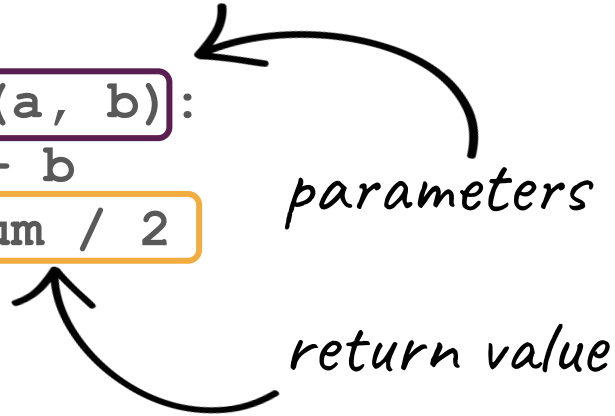

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```
def main():
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def average(a, b):
    sum = a + b
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```

Definition

Return value
Value that a function hands back to the "calling" function

Anatomy of a Function

```
def main():
    mid = average(10.6, 7.2)
    print(mid)


def average(a, b):
    sum = a + b
    return sum / 2
```

Definition

Return value
Value that a function hands back to the "calling" function

What is the "calling" function?

Anatomy of a Function

```
def main():
    mid = average(10.6, 7.2)
    print(mid)
```

caller
(calling function)

```
def average(a, b):
    sum = a + b
    return sum / 2
```

Anatomy of a Function

```
def main():
    mid = average(10.6, 7.2)
    print(mid)
```

caller
(calling function)

```
def average(a, b):
    sum = a + b
    return sum / 2
```

callee
(called function)

Anatomy of a Function

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def main():
    mid = average(10.6, 7.2)
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def average(a, b):
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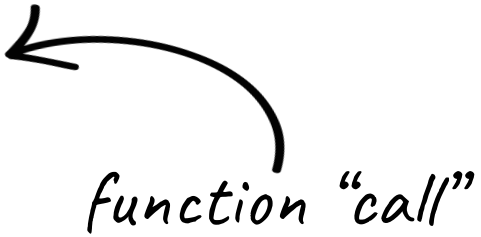

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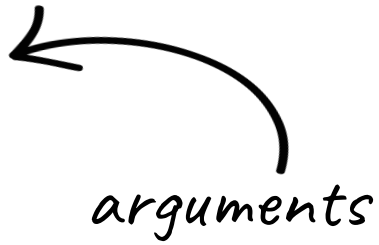

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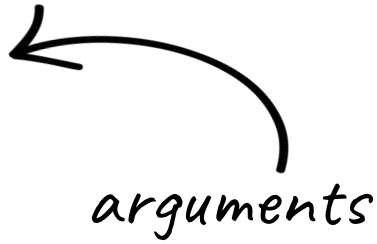

What's the difference between arguments and parameters?

Anatomy of a Function

```
def main():
    mid = average(10.6, 7.2)
    print(mid)


def average(a, b):
    sum = a + b
    return sum / 2
```

parameters are the name of input values in the function definition

Anatomy of a Function

```
def main():
    mid = average(10.6, 7.2)
    print(mid)


def average(a, b):
    sum = a + b
    return sum / 2
```

arguments are the values passed in when function is called!

Anatomy of a Function

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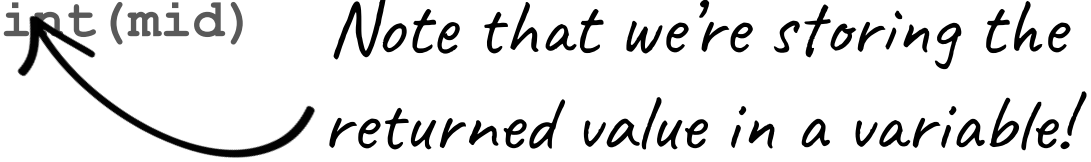
    mid = average(10.6, 7.2)
    print(mid)

def average(a, b):
    sum = a + b
    return sum / 2
```



Recall from last lecture:

```
>>> math.sqrt(4)
2.0
```

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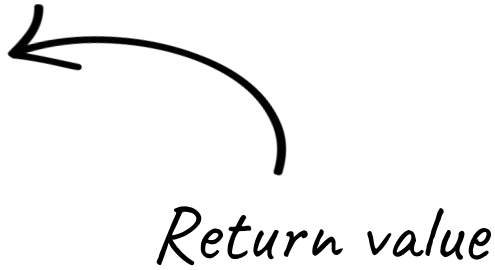
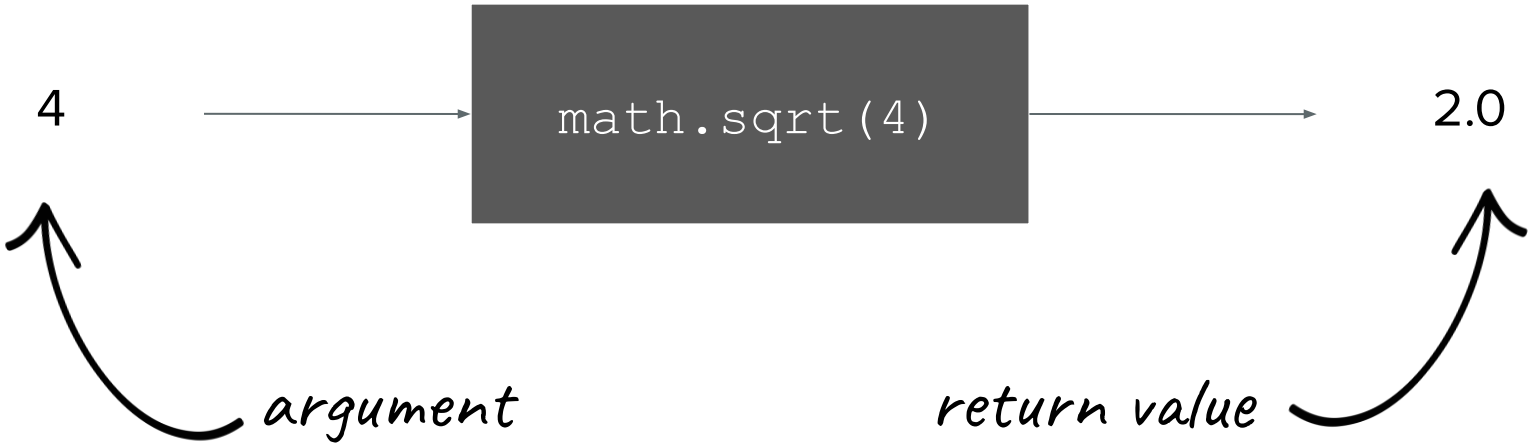


Anatomy of a Function



Think/Pair/Share:

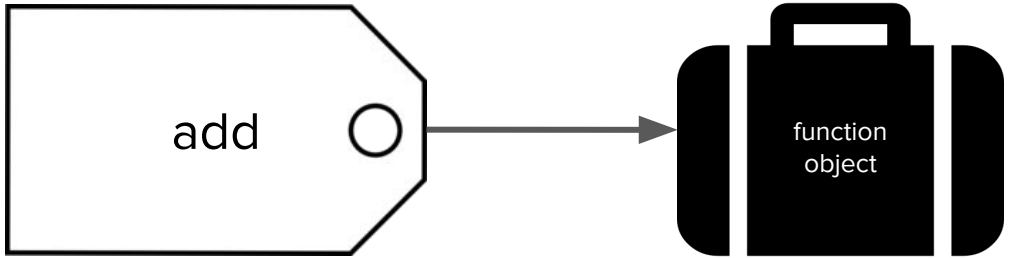
Write a function that takes in two values and outputs the sum of their squares.

Think/Pair/Share:

Write a function that takes in two values and outputs the sum of their squares. [demo]

Functions as Python Objects

```
def add(x, y):
    return x + y
```

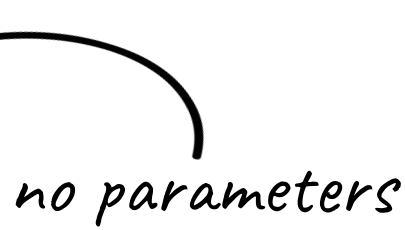


Parameters and return values are optional

```
def turn_right():
    turn_left()
    turn_left()
    turn_left()
```

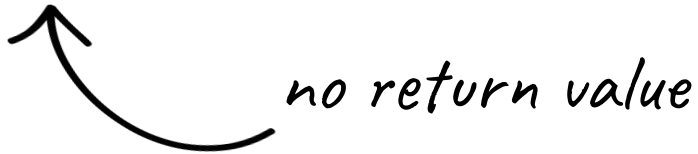
Parameters and return values are optional

```
def turn_right():
    turn_left()
    turn_left()
    turn_left()
```



Parameters and return values are optional

```
def turn_right():
    turn_left()
    turn_left()
    turn_left()
```



When am I allowed to use a variable?

Scope

~~Scope~~ Variable Life Expectancy

Definition

scope

The parts of a program where you can access a variable

Variable Scope

```
def main():
    function_name()
    print(y)
```

```
def function_name():
    x = 2
    y = 3
```

this is the scope where x and y "live"

Variable Scope

```
def main():
    function_name()
    print(y)

def function_name():
    x = 2
    y = 3
```

Variable Scope

```
def main():
    function_name()
    print(y)

def function_name():
    x = 2
    y = 3
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Variable Scope

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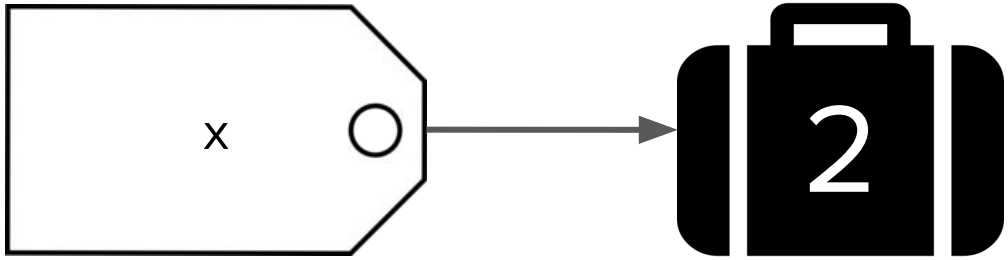
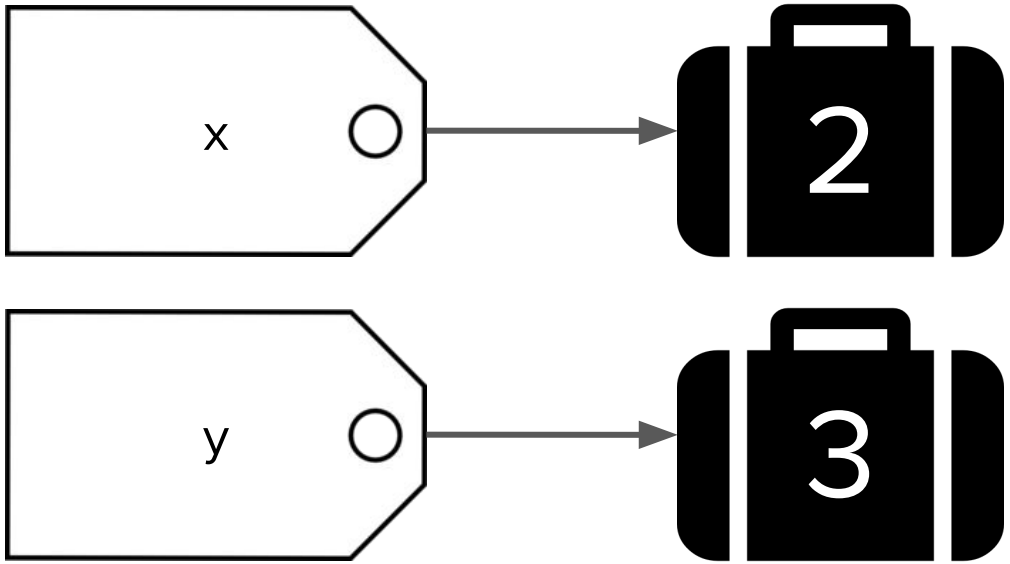


Variable Scope

```
def main():
    function_name()
    print(y)

def function_name():
    x = 2
    y = 3
```



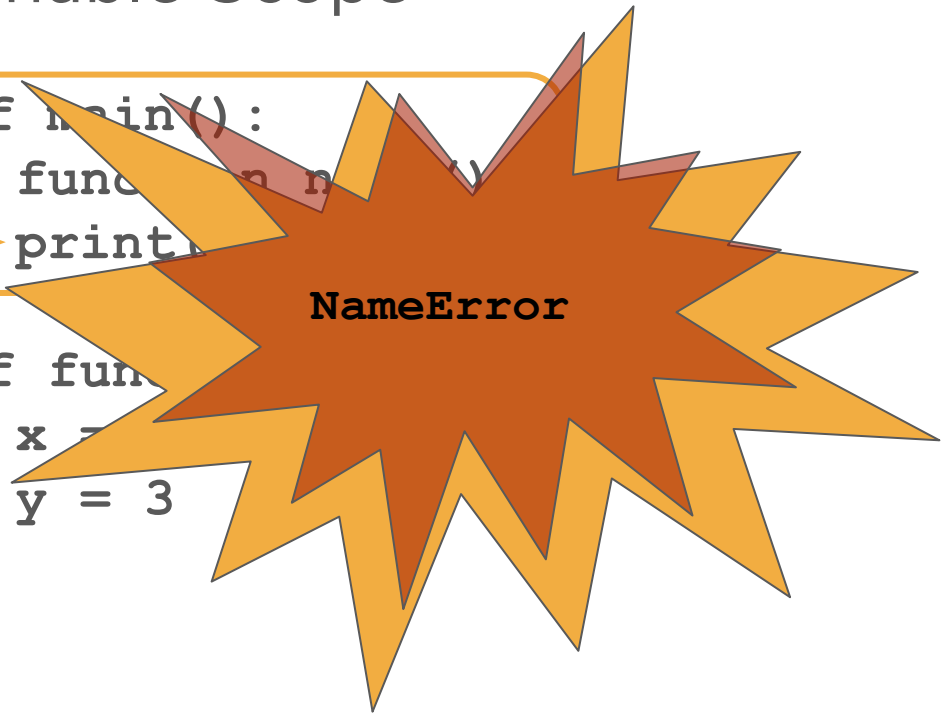
Variable Scope

```
def main():
    function_name()
    print(y)

def function_name():
    x = 2
    y = 3
```

Variable Scope

```
def main():
    func
    print
def fun
    x
    y = 3
```

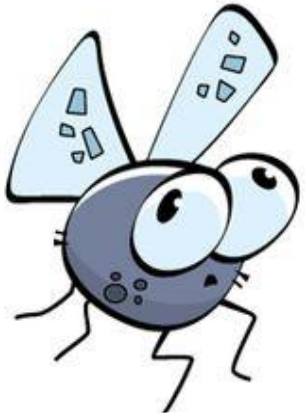


Variable Scope

```
def main():
    function_name()
    print(y)

def function_name():
    x = 2
    y = 3
```

y is now out of scope!

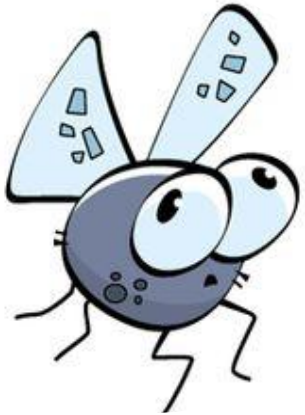


Variable Scope

```
def main():
    function_name()
    print(y)

def function_name():
    x = 2
    y = 3
```

y is now out of scope!



Once a function finishes executing, the variables declared inside of it are no longer accessible!

Unless...

```
def main():
    y = function_name()
    print(y)

def function_name():
    x = 2
    y = 3
    return y
```

Unless...

```
def main():
    y = function_name()
    print(y)

def function_name():
    x = 2
    y = 3
    return y
```

if we return y, we can use it in main()

Let’s put it all together!

Receipt program

- What subtasks can we break this program into?

Receipt program

- What subtasks can we break this program into?
  - calculating tax
  - calculating the tip
  - aggregating tax and tip

[demo]

Today's questions

How do we translate what we know from Karel into regular Python code?

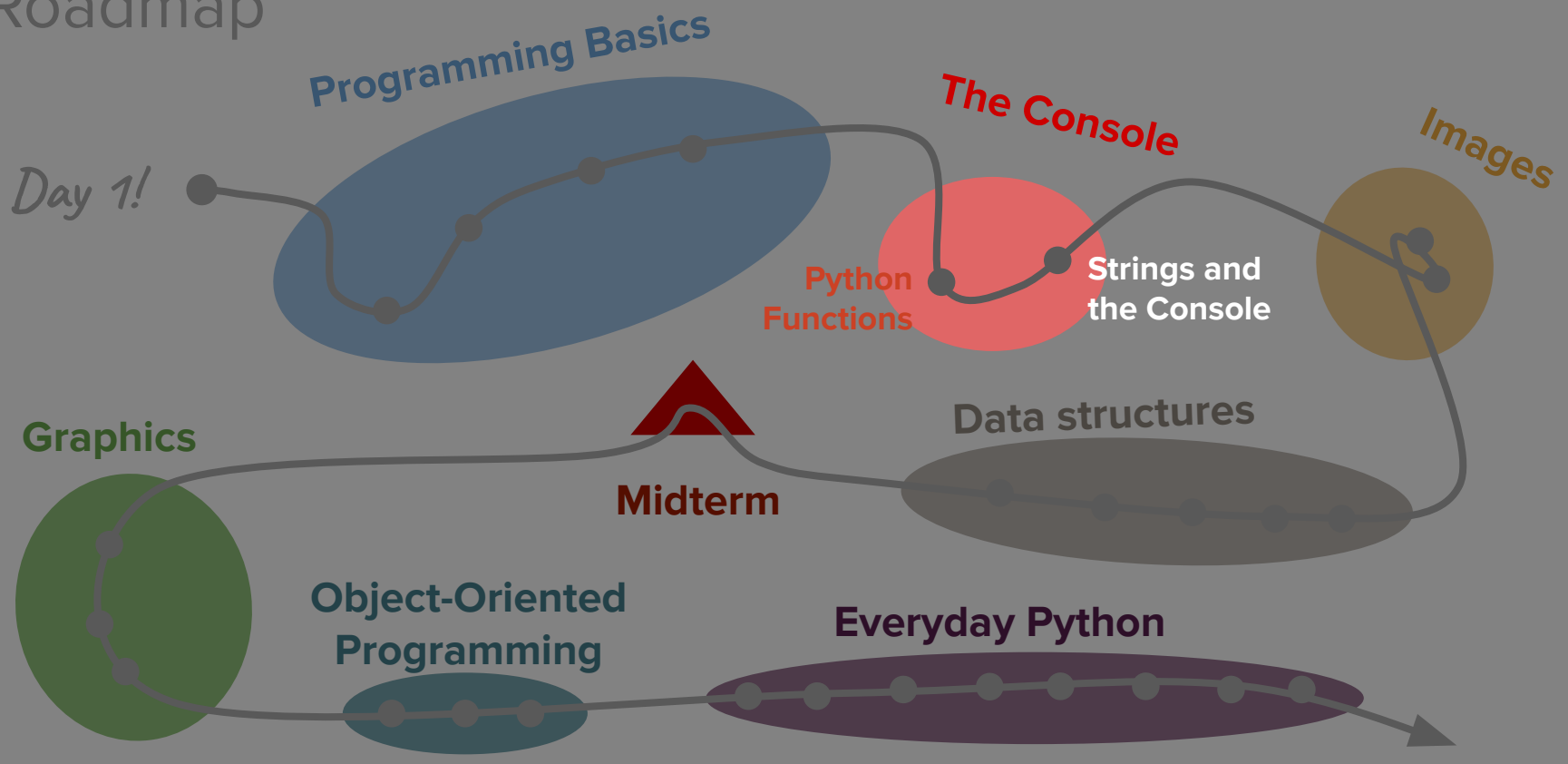
How can we make our code more flexible by producing different outputs depending on the input?

What’s next?

Tomorrow: making programs interactive!

- Strings: representations of text
- Interactive programs

Roadmap


Programming Basics
Day 1!
The Console
Images
Python Functions
Strings and the Console
Graphics
Midterm
Data structures
Object-Oriented Programming
Everyday Python
Life after CS106AP!