CMSC201
Computer Science I for Majors

Lecture 11 – Functions (cont)

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Last Class We Covered

- Functions
  - Why they're useful
  - When you should use them
- Defining functions
- Calling functions
- Variable scope
- Passing arguments

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Any Questions from Last Time?

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Today's Objectives

- To introduce value-returning functions
  - Common problems
  - Solutions to common problems
- To better grasp how values in the scope of a function actually work
- To practice function calls

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Review: Parts of a Function

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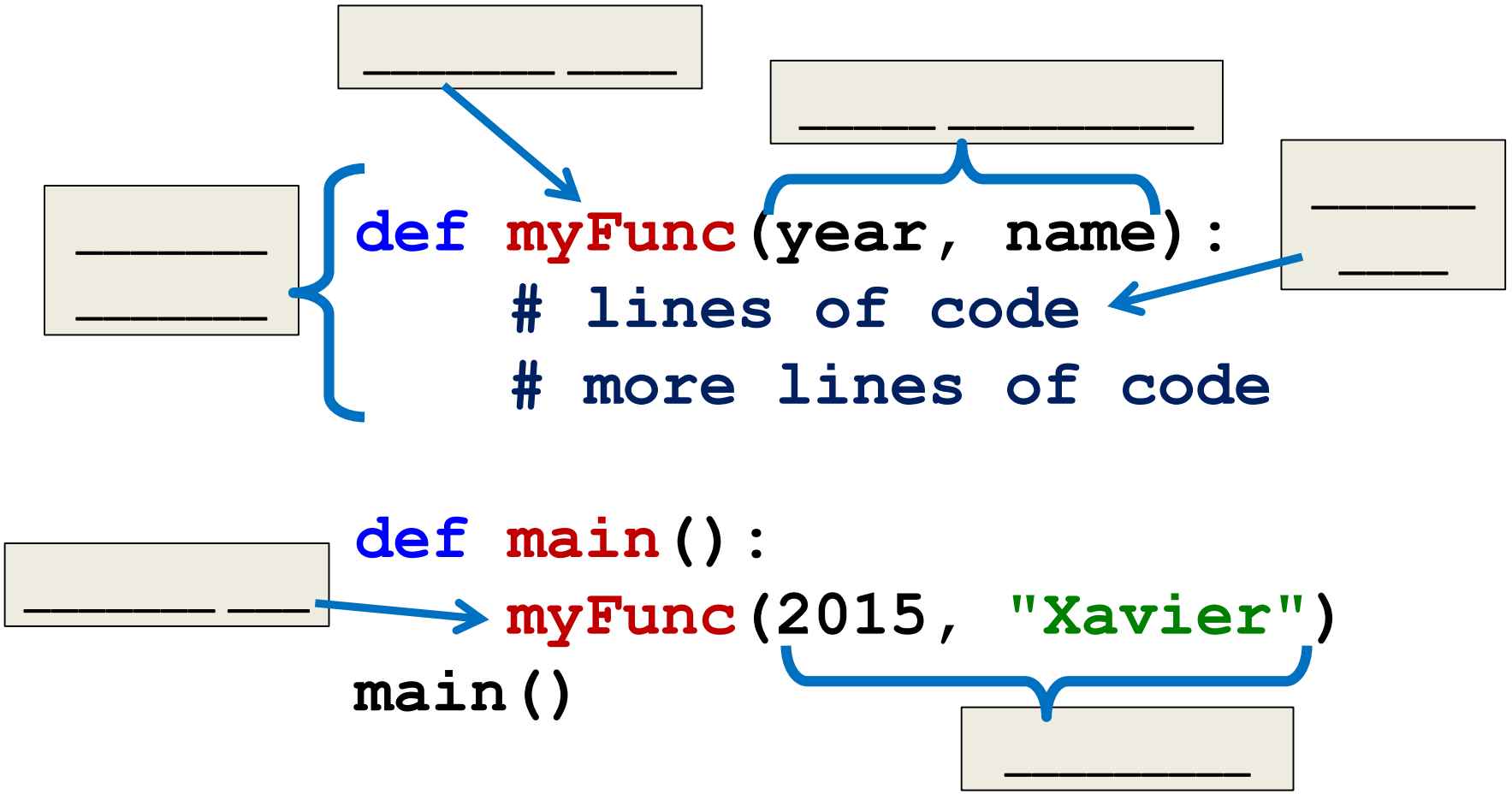
Function Vocabulary



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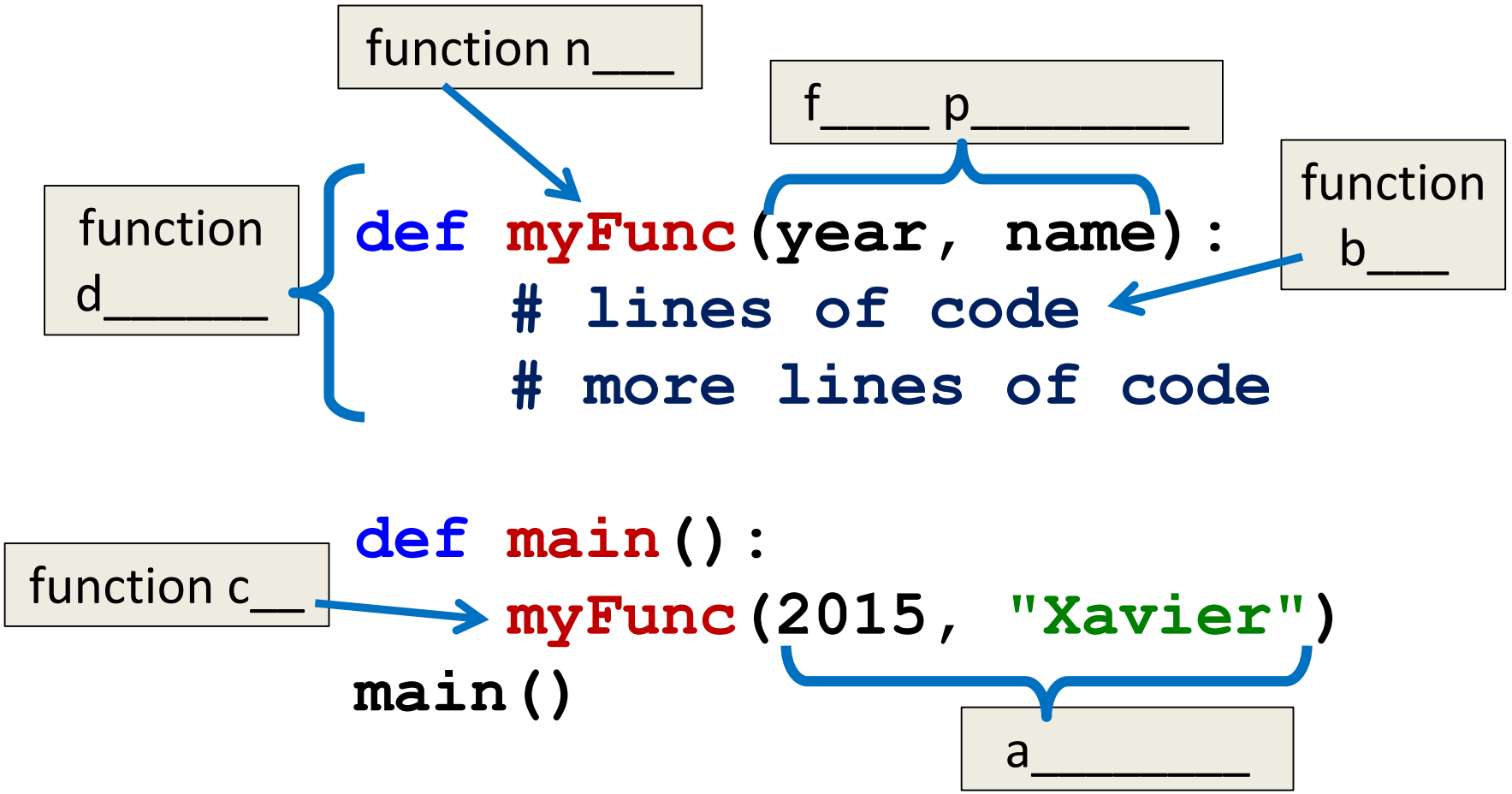
Function Vocabulary



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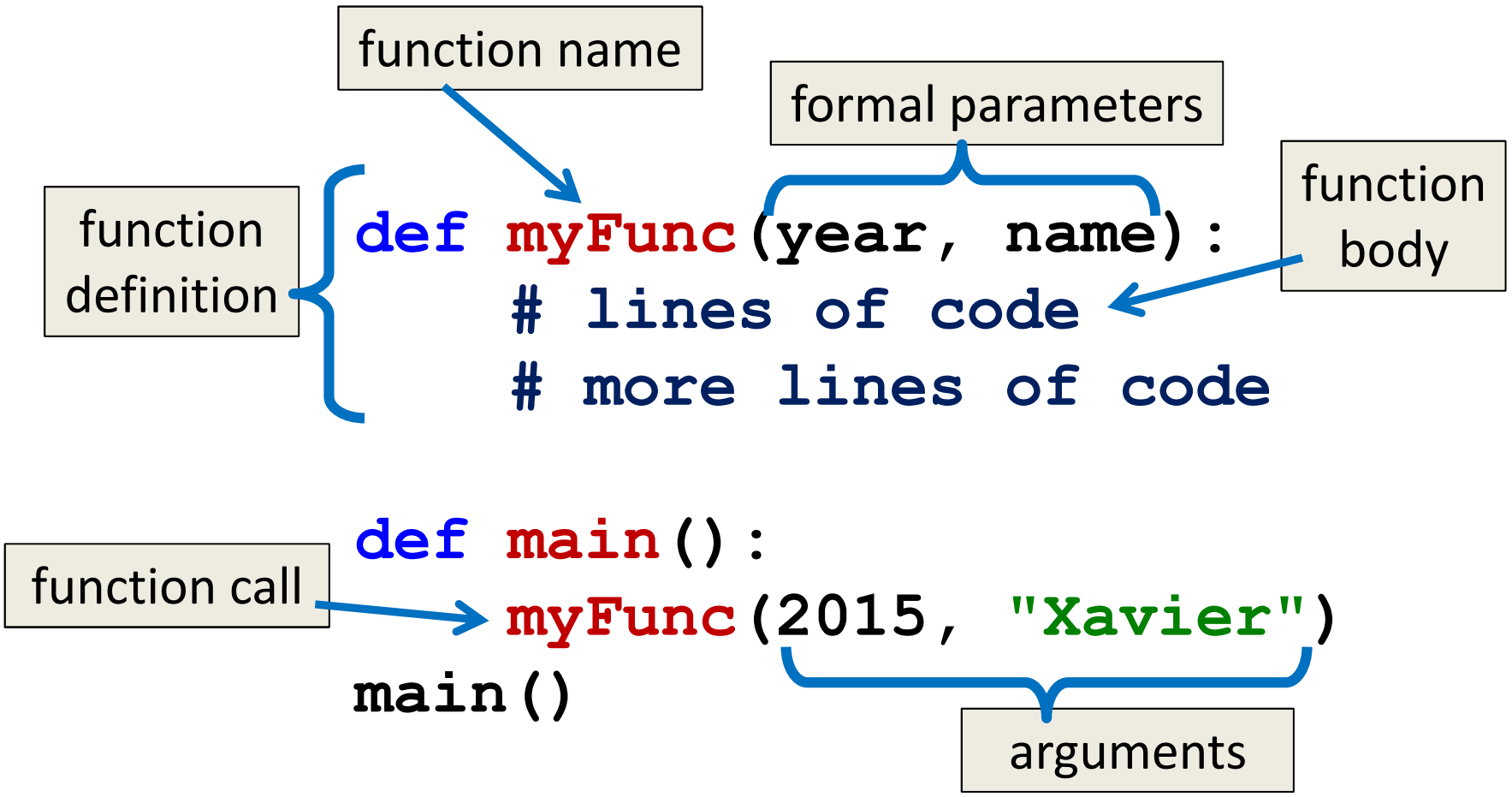
Function Vocabulary



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File Layout and Constants

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Layout of a Python File

header comment

constants

definitions and function headers for all functions other than **main()**

main() definition

call to **main()**

```
# File:    gradeGetter.py
# Author:  Dr. Gibson

MIN_GRADE = 0
MAX_GRADE = 100

# getInput()  gets a value between...
# Parameters: minn; an integer...
def getInput(minn, maxx):
    msg = "Please enter..."
    # more code here
    return val

def main():
    grade = getInput(MIN_GRADE, MAX_GRADE)
    print("You got a", grade)

main()
```


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Note On Global Constants

- ***Globals*** are variables declared outside of any function (including **`main()`**)
- Accessible globally in your program
  - To all functions and code

- Your programs may not have global variables
- Your programs may use global **constants**
  - In fact, constants should be global

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Return Statements

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Giving Information to a Function

- Passing parameters provides a mechanism for initializing the variables in a function
- Parameters act as ***inputs*** to a function
- We can call a function many times and get different results by changing its parameters

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Getting Information from a Function

- We've already seen numerous examples of functions that return values

  `int()`, **`len()`**, **`input()`**, etc.

- For example, **`len()`**
  - Takes in any list or string as its parameter
  - Counts the number of elements (or characters)
  - And returns an integer value

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Functions that Return Values

- To have a function return a value after it is called, we need to use the **`return`** keyword

```
def square(num):
    ans = num * num
    # return the square
    return ans
```


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Handling Return Values

- When Python encounters **`return`**, it...
  - Exits the function (immediately!)
    - Even if it's not the end of the function
  - Returns control back to where the function was called from
- The expression in the return statement is evaluated, then sent back to the caller as a ***return value***

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Code Trace: Return from `square()`

Let's follow the flow of the code

```
def main():
    x = 5
    y = square(x)
    print(y)
main()
```

```
def square(num):
    ans = num * num
    return ans
```

Step 1: Call `main()`

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Code Trace: Return from `square()`

Let's follow the flow of the code

```
def main():
    x = 5
    y = square(x)
    print(y)
main()
```

```
def square(num):
    ans = num * num
    return ans
```

Step 1: Call **`main()`**

Step 2: Pass control to **`def main()`**

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Code Trace: Return from `square()`

Let's follow the flow of the code

x: 5

```
def main():
    x = 5
    y = square(x)
    print(y)
main()
```

```
def square(num):
    ans = num * num
    return ans
```

Step 1: Call **`main()`**
Step 2: Pass control to **`def main()`**
Step 3: Set **`x = 5`**

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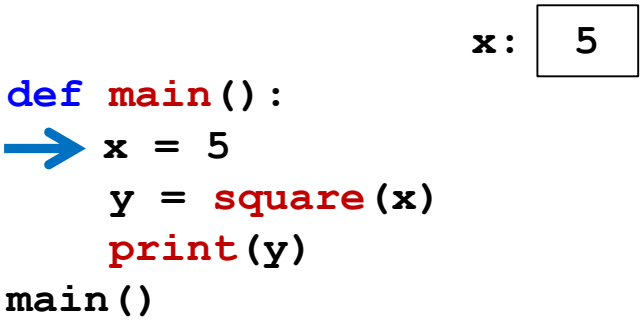
Code Trace: Return from `square()`

Let's follow the flow of the code




```
def square(num):
    ans = num * num
    return ans
```

Step 1: Call **`main()`**
Step 2: Pass control to **`def main()`**
Step 3: Set **`x = 5`**
Step 4: See the function call to **`square()`**

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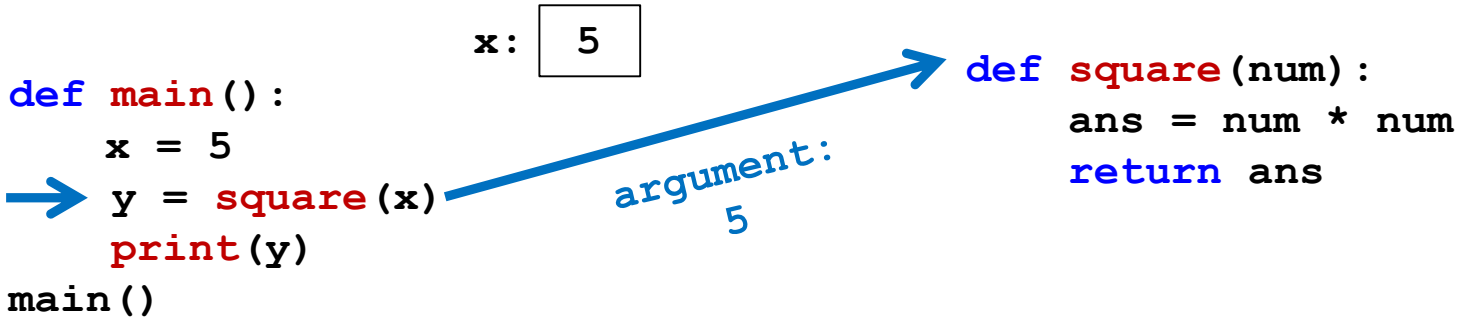
Code Trace: Return from `square()`

Let's follow the flow of the code



Step 1: Call **`main()`**
Step 2: Pass control to **`def main()`**
Step 3: Set **`x = 5`**
Step 4: See the function call to **`square()`**
Step 5: Pass control from **`main()`** to **`square()`**, sending the argument **`5`**

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Code Trace: Return from `square()`

Let's follow the flow of the code

```
def main():
    x = 5
    y = square(x)
    print(y)
main()
```

x: 5

```
def square(num):
    ans = num * num
    return ans
```

num: 5

Step 1: Call **`main()`**
Step 2: Pass control to **`def main()`**
Step 3: Set **`x = 5`**
Step 4: See the function call to **`square()`**
Step 5: Pass control from **`main()`** to **`square()`**, sending the argument **`5`**
Step 6: Set the value of the formal parameter **`num`** in **`square()`** to **`5`**

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Code Trace: Return from `square()`

Let's follow the flow of the code

```
def main():
    x = 5
    y = square(x)
    print(y)
main()
```

x: 5

```
def square(num):
    ans = num * num
    return ans
```

num: 5

ans: 25

Step 1: Call `main()`
Step 2: Pass control to `def main()`
Step 3: Set `x = 5`
Step 4: See the function call to `square()`
Step 5: Pass control from `main()` to `square()`, sending the argument `5`
Step 6: Set the value of the formal parameter `num` in `square()` to `5`
Step 7: Calculate `ans = num * num`

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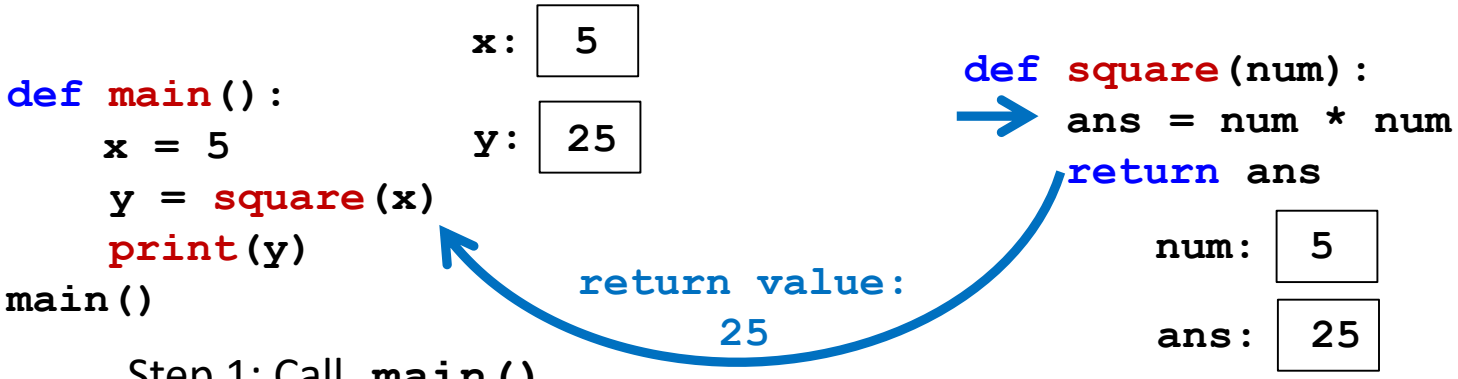
Code Trace: Return from `square()`

Let's follow the flow of the code



Step 1: Call **`main()`**
Step 2: Pass control to **`def main()`**
Step 3: Set **`x = 5`**
Step 4: See the function call to **`square()`**
Step 5: Pass control from **`main()`** to **`square()`**, sending the argument **`5`**
Step 6: Set the value of the formal parameter **`num`** in **`square()`** to **`5`**
Step 7: Calculate **`ans = num * num`**
Step 8: Return the value **`25`** to **`main()`** and set **`y =`** the returned value

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Code Trace: Return from `square()`

Let's follow the flow of the code

```
def main():
    x = 5
    y = square(x)
    print(y)
main()
```

x: 5

y: 25

```
def square(num):
    ans = num * num
    return ans
```

Step 1: Call `main()`
Step 2: Pass control to `def main()`
Step 3: Set `x = 5`
Step 4: See the function call to `square()`
Step 5: Pass control from `main()` to `square()`, sending the argument `5`
Step 6: Set the value of the formal parameter `num` in `square()` to `5`
Step 7: Calculate `ans = num * num`
Step 8: Return the value `25` to `main()` and set `y =` the returned value
Step 9: Print value of `y`

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Island Example

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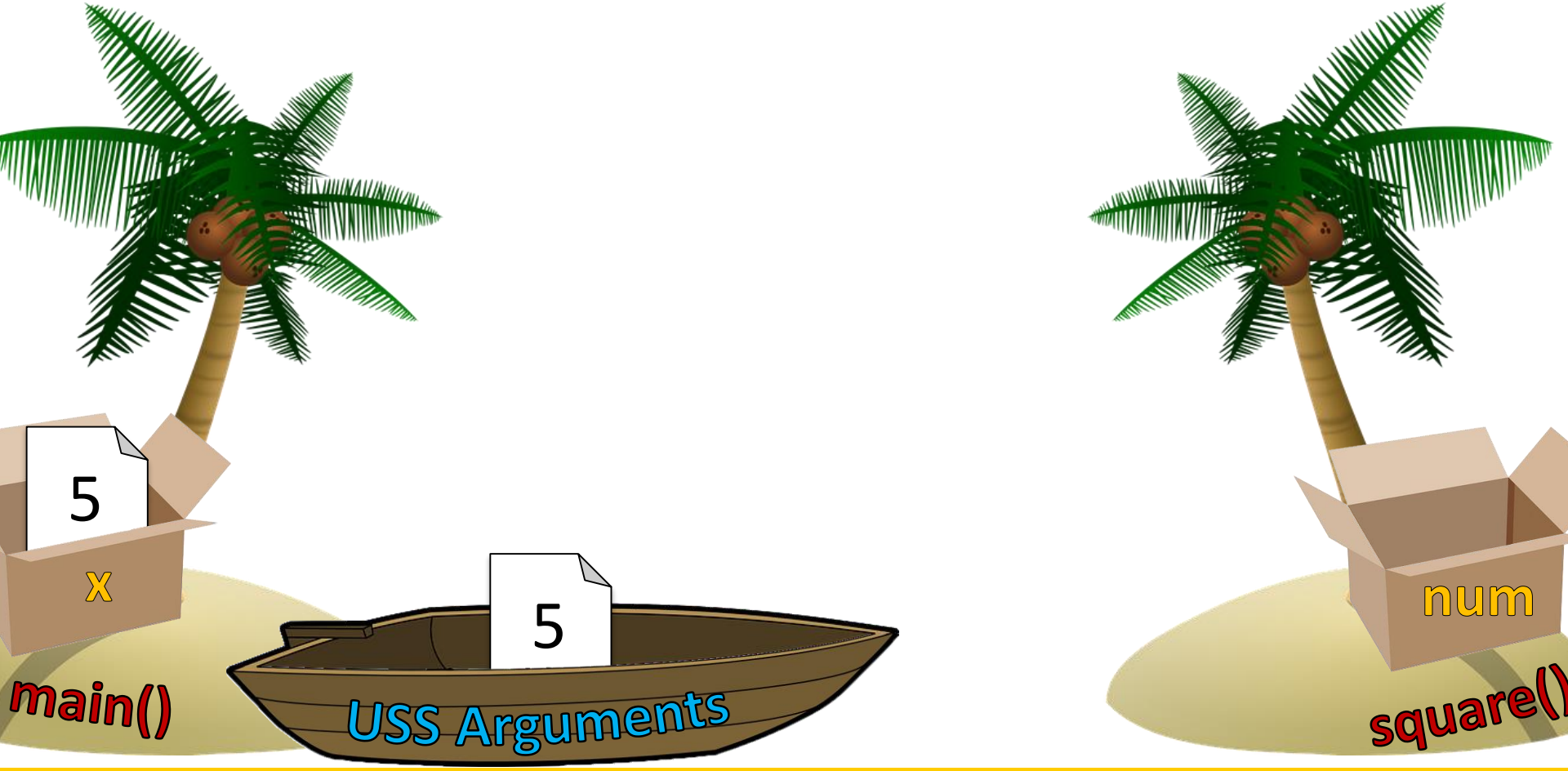
1. Function `square()` is called

a. Make copy of `x`'s value



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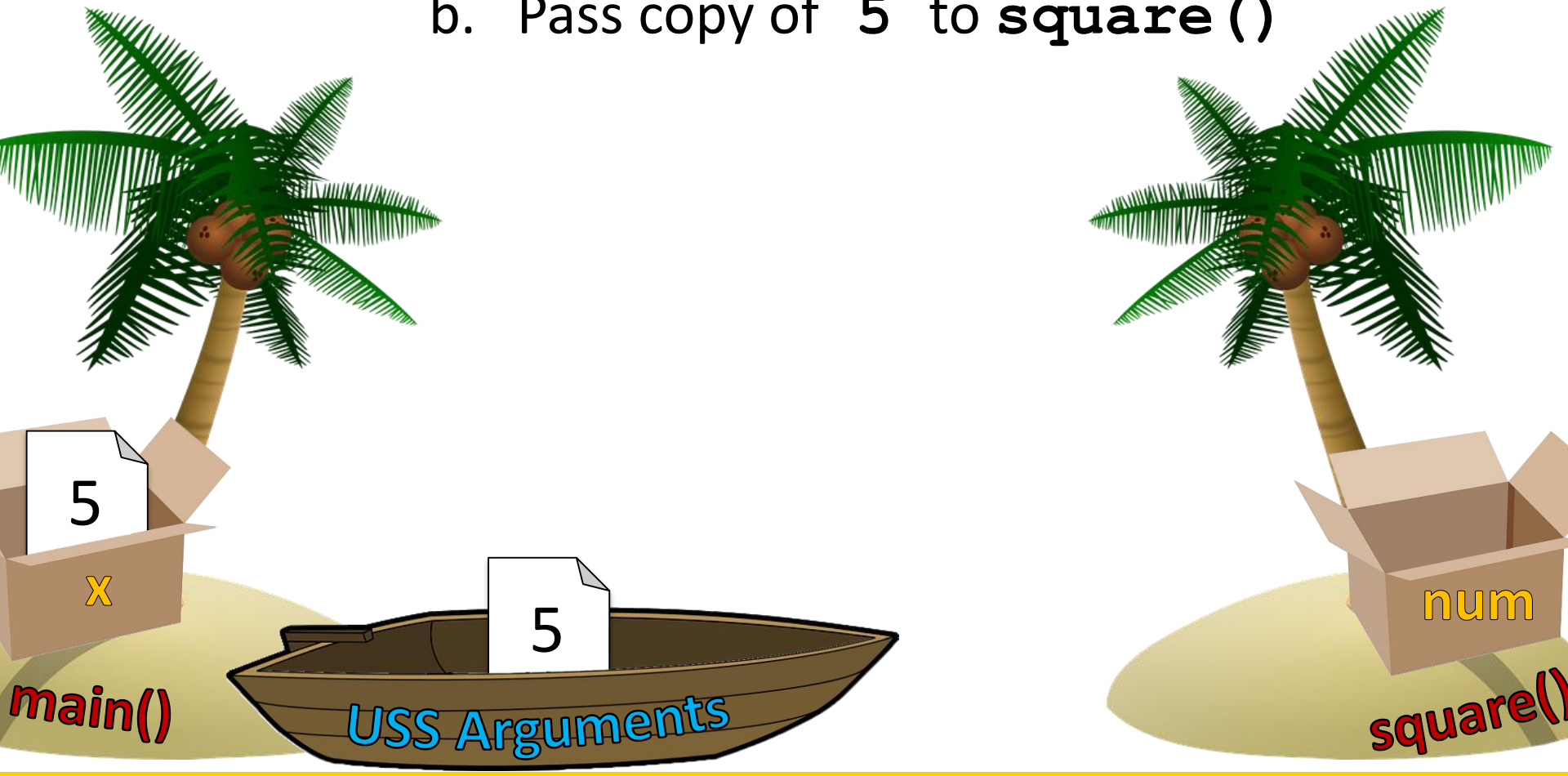
1. Function **`square()`** is called
   a. Make copy of **`x`**'s value
   b. Pass copy of **`5`** to **`square()`**



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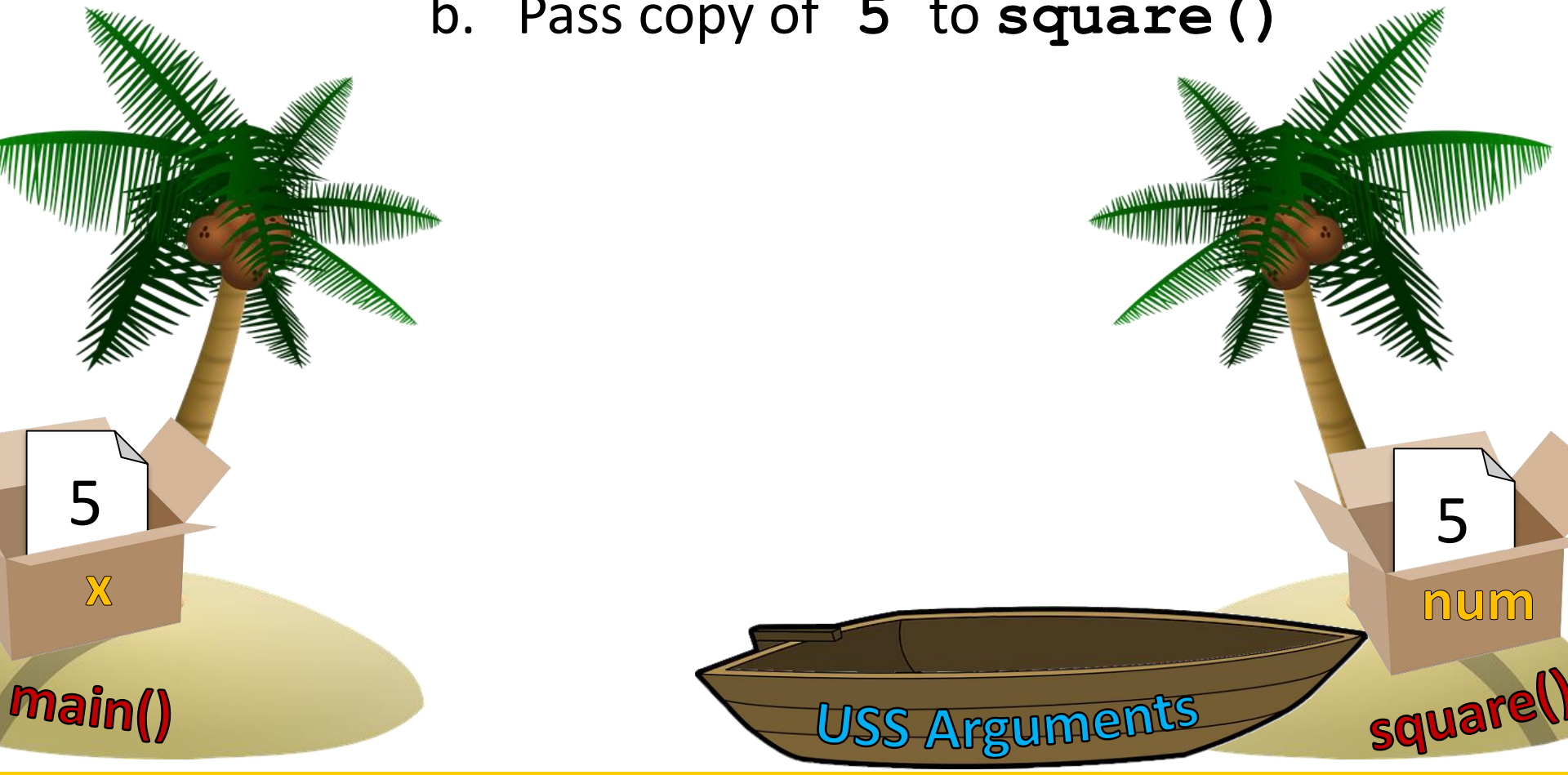

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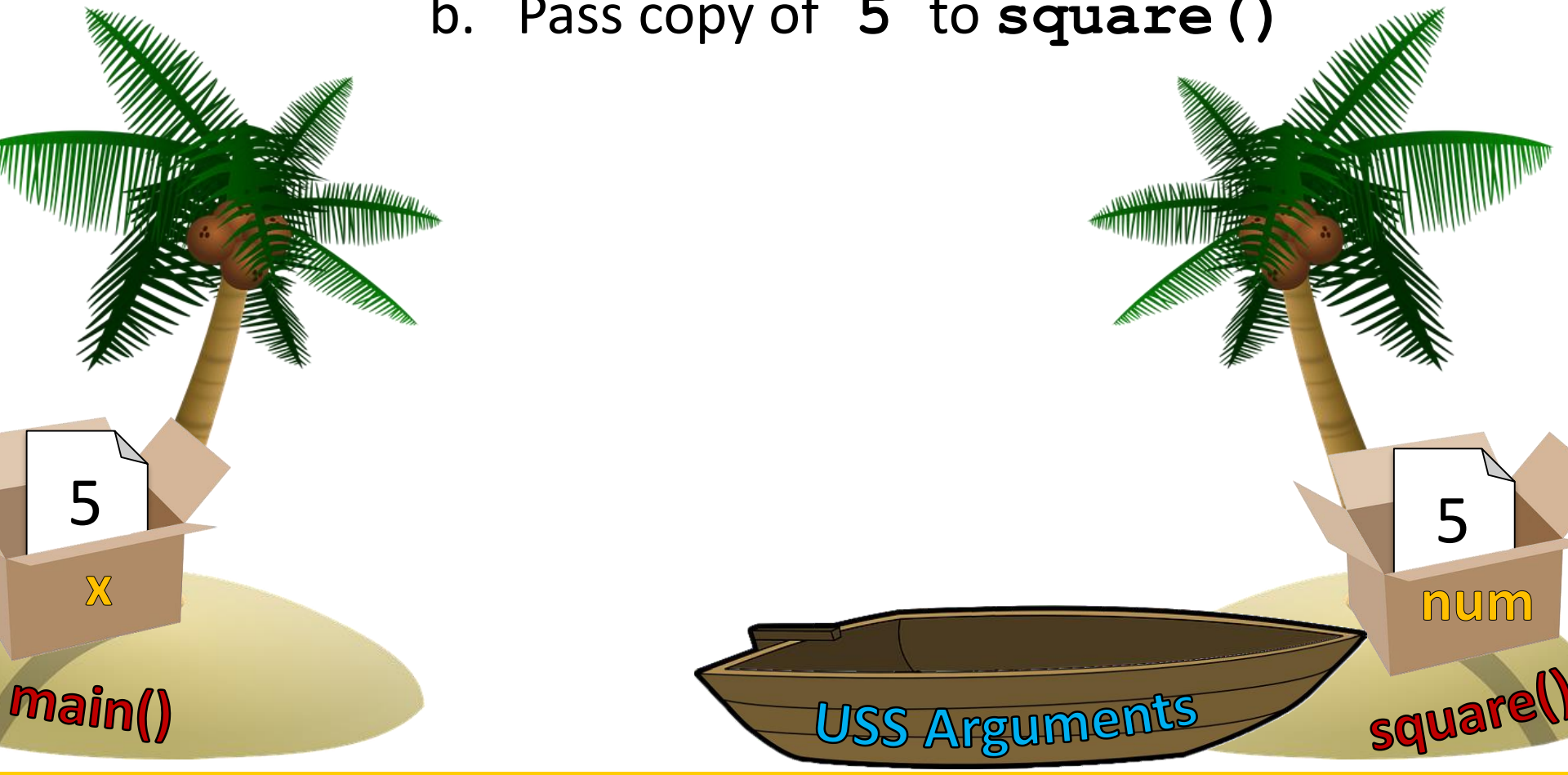

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1. Function **`square()`** is called
   a. Make copy of **`x`**'s value
   b. Pass copy of **`5`** to **`square()`**
   c. Execute **`num * num`**
      a. Save in variable **`ans`**

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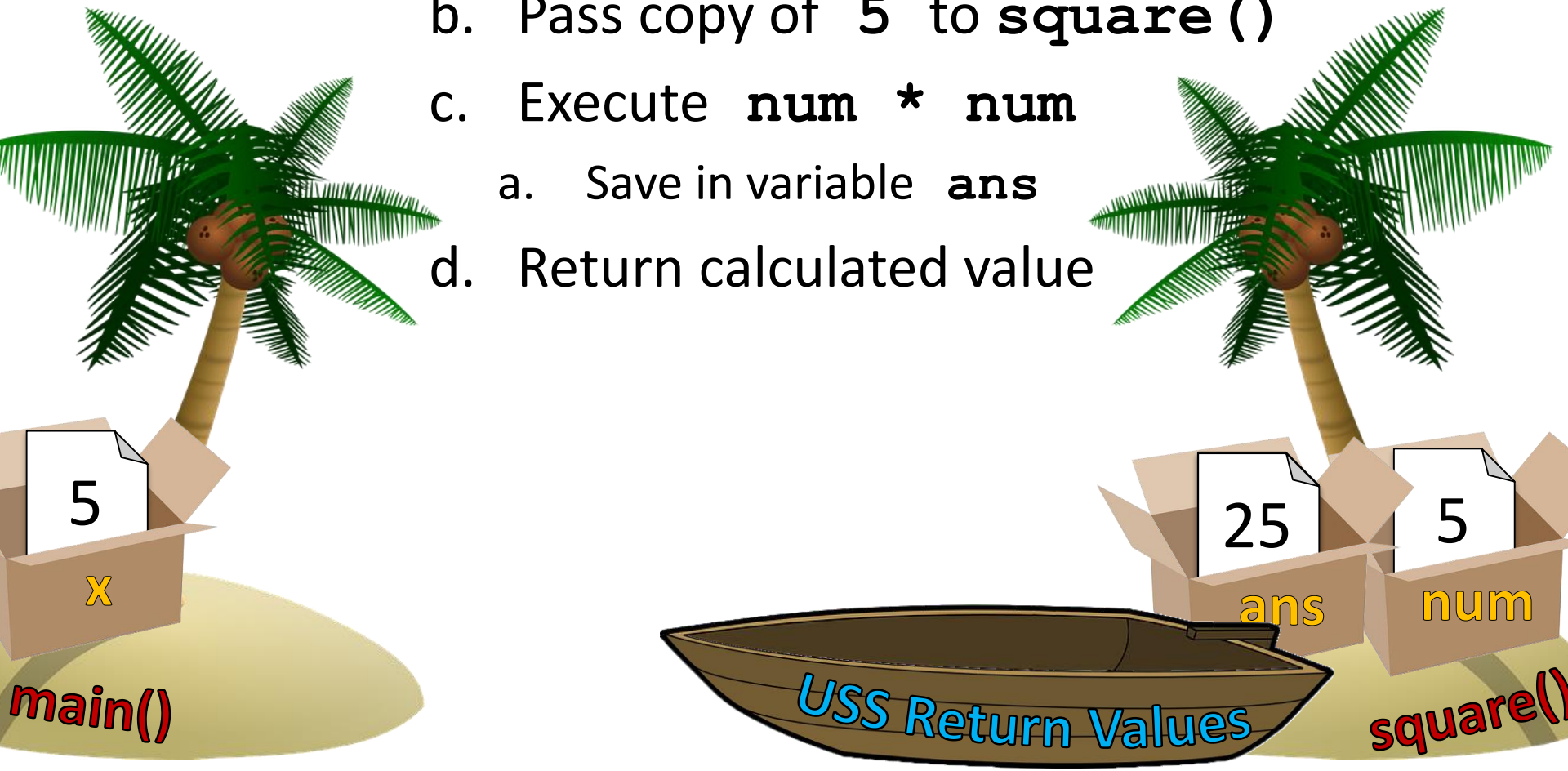
1. Function **`square()`** is called
   a. Make copy of **`x`**'s value
   b. Pass copy of **`5`** to **`square()`**
   c. Execute **`num * num`**
      a. Save in variable **`ans`**
   d. Return calculated value



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1. Function **`square()`** is called
   a. Make copy of **`x`**'s value
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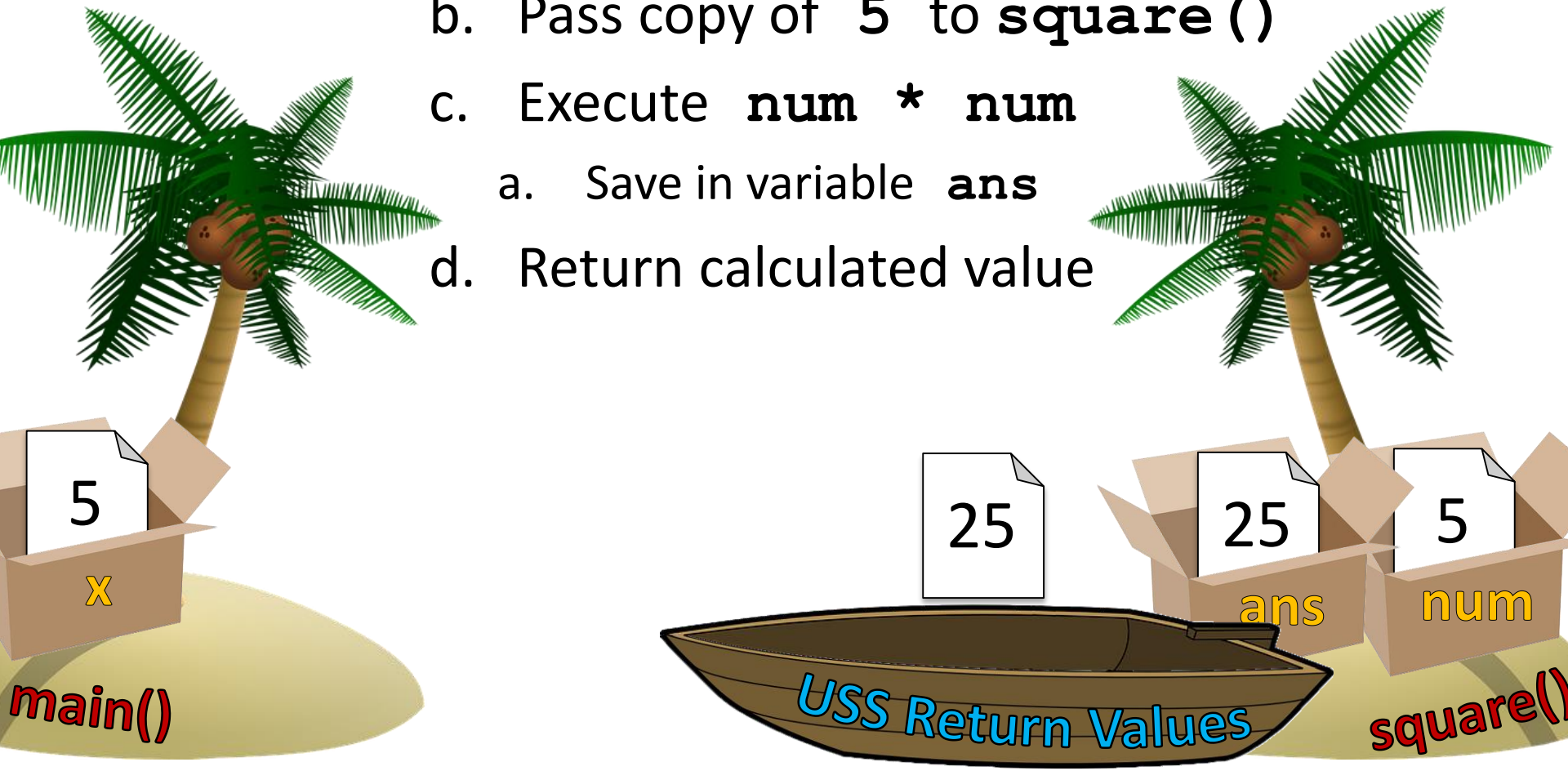

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1. Function **`square()`** is called
   a. Make copy of **`x`**'s value
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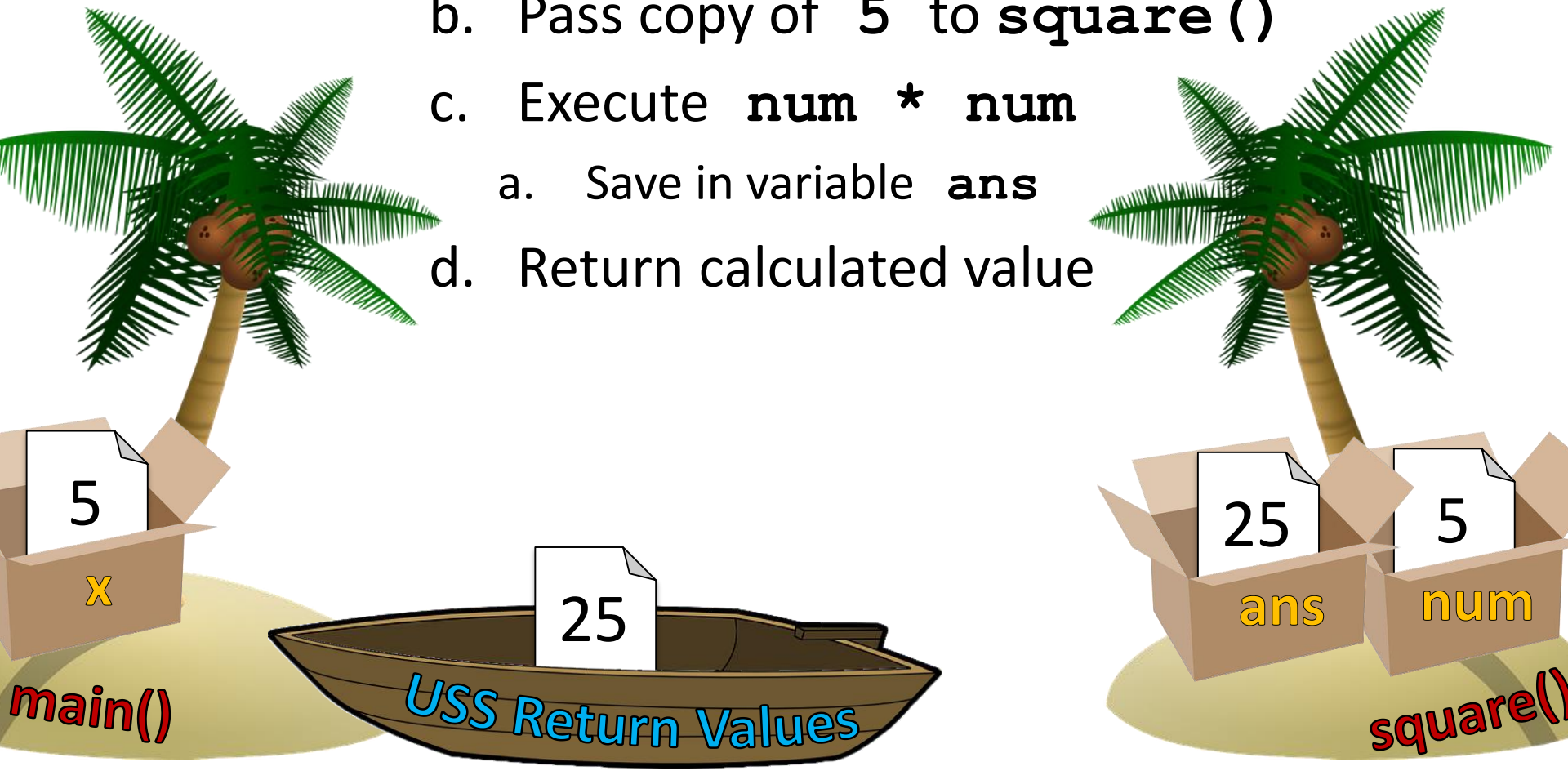

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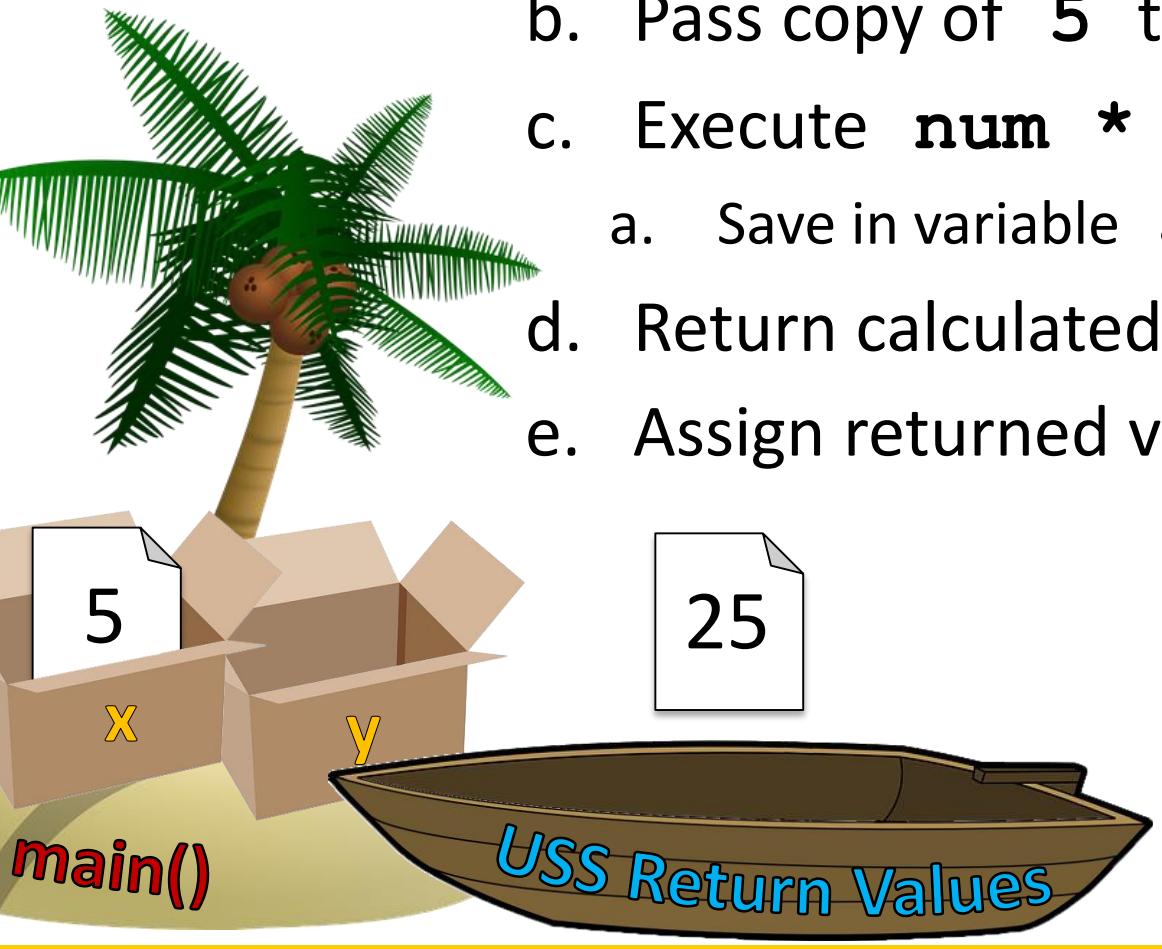
1. Function **`square()`** is called
   a. Make copy of **`x`**'s value
   b. Pass copy of **`5`** to **`square()`**
   c. Execute **`num * num`**
      a. Save in variable **`ans`**
   d. Return calculated value
   e. Assign returned value to **`y`**



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`None` and Common Problems

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Every Function Returns *Something*

- All Python functions return a value
  - Even if they don't have a **`return`** statement

- Functions without an explicit **`return`** pass back a special object, called **`None`**
  - **`None`** is the absence of a value

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Example (That We'll Break Soon)

- Here is a simple toy example:

```
def multiply(num1, num2):
    print("doing", num1, "*", num2)
    answer = num1 * num2
    return answer
```

What is the output of this code?

- Assume that this code is in **`main()`**:

```
product = multiply(6, 3)
print("result is", product)
```

```
doing 6 * 3
result is 18
```


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Problem #1

- Forgetting to write a **`return`** statement

```
def multiply(num1, num2):
    print("doing", num1, "*", num2)
    answer = num1 * num2

product = multiply(3, 5)
print("result is", product)
```

- What is the code's output now?

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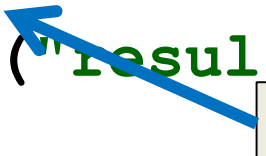
Problem #1

- Forgetting to write a **`return`** statement

```
def multiply(num1, num2):
    print("doing", num1, "*", num2)
    answer = num1 * num2

product = multiply(3, 5)
print("result is", product)
```

```
doing 3 * 5
result is None
```



Variable given the return value has a value of **`None`**

- What is the co

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Problem #2

- Forgetting to assign the returned value

```
def multiply(num1, num2):
    print("doing", num1, "*", num2)
    return num1 * num2

multiply(7, 8)
print("result is", product)
```

- What is the code's output now?

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Problem #2

- Forgetting to assign the returned value

```
def multiply(num1, num2):
    print("doing", num1, "*", num2)
    return num1 * num2


multiply(7, 8)
print("result is", product)
```

```
doing 7 * 8
[syntax error]
```

- What is the code's output r

Should have assigned **product** to the return value of **multiply**

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Common Errors and Problems

- If your value-returning functions produce strange messages, check to make sure you used the **`return`** correctly!

```
TypeError: unsupported operand type(s)
for *: 'NoneType' and 'int'
```

```
TypeError: 'NoneType' object is not
iterable
```


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“Modifying” Parameters

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Bank Interest Example

- Suppose you are writing a program that manages bank accounts
- One function we would need to create is one to accumulate interest on the account

```
def addInterest(balance, rate):
    newBalance = balance * (1 + rate)
    balance = newBalance
```


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Bank Interest Example

- We want to set the balance of the account to a new value that includes the interest amount

```
def addInterest(balance, rate):
    newBalance = balance * (1 + rate)
    balance = newBalance

def main():
    amount = 1000
    rate = 0.05
    addInterest(amount, rate)
    print(amount)
main()
```

What is the output of this code?

1000

Is this what we wanted to happen?

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What's Going On?

- It was intended that the 5% would be added to the amount, returning $1050
- Was $1000 the desired output?

- No – so what went wrong?
- This is a very common mistake to make!
  - Let's trace through the code and figure it out

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Tracing the Bank Interest Code

- First, we create two variables that are local to **`main()`**

local variables of **`main()`**

```
def addInterest(balance, rate):
    newBalance = balance * (1 + rate)
    balance = newBalance

def main():
    amount = 1000
    rate = 0.05
    addInterest(amount, rate)
    print(amount)
main()
```


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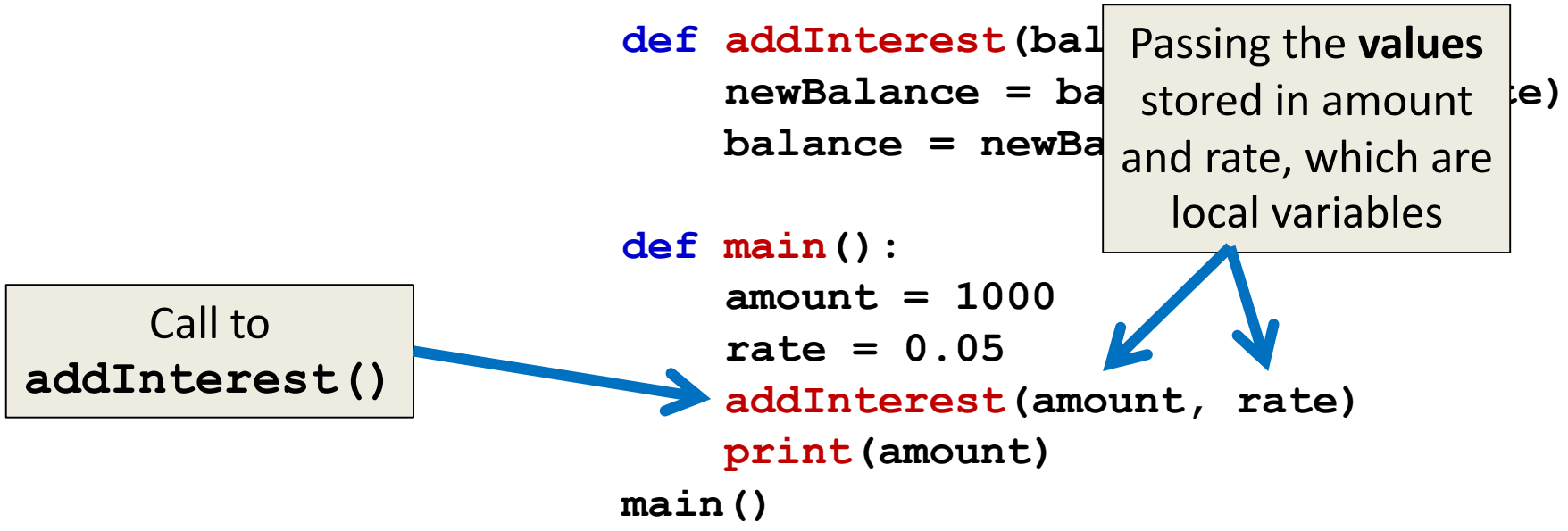
Tracing the Bank Interest Code

- Second, we call **`addInterest()`** and pass the values of the local variables of **`main()`** as arguments



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Tracing the Bank Interest Code

- Third, when control is passed to **`addInterest()`**, the formal parameters (balance and rate) are set to the value of the arguments (amount and rate)

Control passes to **`addInterest()`**

```
def addInterest(balance, rate):
    newBalance = balance * (1 + rate)
    balance = newBalance

def main():
    amount = 1
    rate = 0.05
    addInterest(amount, rate)
    print(amount)
main()
```

balance = 1000
rate = 0.05

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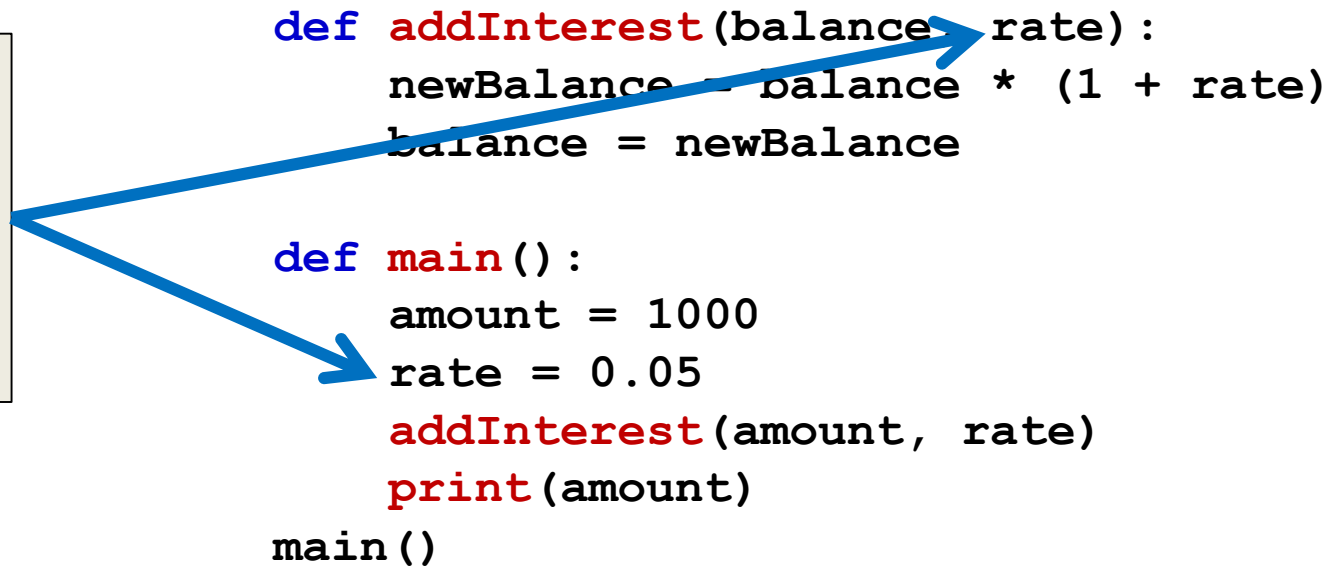
Tracing the Bank Interest Code

- Even though the parameter **`rate`** appears in both **`main()`** and **`addInterest()`**, they are two separate variables because of scope

Even though rate exists in both **`main()`** and **`addInterest()`**, they are in two separate scopes



```
def addInterest(balance, rate):
    newBalance = balance * (1 + rate)
    balance = newBalance

def main():
    amount = 1000
    rate = 0.05
    addInterest(amount, rate)
    print(amount)
main()
```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Scope

- In other words, the ***formal parameters*** of a function only receive the values of the ***arguments***

- The function does not have access to the original variable in **`main()`**

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New Bank Interest Code

```
def addInterest(balance, rate):
    newBalance = balance * (1 + rate)
    return newBalance

def main():
    amount = 1000
    rate = 0.05
    amount = addInterest(amount, rate)
    print(amount)
main()
```


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New Bank Interest Code

```
def addInterest(balance, rate):
    newBalance = balance * (1 + rate)
    return newBalance

def main():
    amount = 1000
    rate = 0.05
    amount = addInterest(amount, rate)
    print(amount)
main()
```

These are the only parts we changed

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Daily emacs Shortcut

- **M + %**
  - (Meta + Shift + 5)
  - Search and replace
    - Keeps correct case! (cat -> dog, Cat -> Dog, CAT -> DOG)

- First, type the thing to search for; hit Enter
- Second, type the thing replace it with; Enter
  - Hit “y” or “n” for each highlighted instance to indicate if you want to replace that one

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Announcements

- HW 5 is out on Blackboard now
  - Due by Friday (March 15th) at 8:59:59 PM
- We'll hand back the midterms next class
  - Survey #1 is due Tuesday at midnight
  - During class:
    - Cover correct answers to exam
    - Discuss ways to improve on future exams
    - Extra credit opportunity

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