CSCI 141

Lecture 15
More Scope; Return Values; A4; Tuples

Announcements

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- A4 out today! Due Wednesday 11/13

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  - It's big.
  - It's bad.
  - 11/11 is a holiday.
  - Start early and get help if you're stuck.

Goals

- Be able to execute functions the way Python does, and understand the implications for local variables and scope.
- Know how to return a value from a function, and understand the behavior of the `return` statement.
- Understand the task assigned in A4 and how to approach it.
- Understand the basic usage of tuples:
  - using tuples to return multiple values from a function
  - packing and unpacking via assignment

QOTD

In which of the lines marked with comments is the variable **`v2`** in scope?

In which of the lines marked with comments is the variable **`v3`** in scope?

```python
# M1
def a(v1, v2):
    # M2
    v3 = v1 + v2
    # M3
    print(v3)

# M4
a(4, 6)
# M5
```

How to Execute Function Calls

```python
def axpy(a, x, y):
    """ Print a*x + y """
    product = a * x
    result = product + y
    print(result)

a1 = 2
x1 = 3
print(axpy(a1, x1, 4))
print(a1)
```

1. Evaluate all arguments
2. Draw a local "box" inside the current "box"
3. Assign argument values to parameter variables in the local box
4. Execute the function body
5. When done, erase the local box

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If multiple variables exist with the same name, use the **innermost** one available.

QOTD

- What does this program print?

```
def f(x):
    g(3 * x)

def g(x):
    print(x + 2)

f(4)
```

QOTD

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Variable Scope

```python
def print_rectangle_area(width, height):
    """ Print the area of a width-by-height
        rectangle """

    area = width * height
    print(area)

w = 4
h = 3
a = w * h
print_rectangle_area(w, h)

```

What if I want to do **further computation** with the result of the rectangle area?

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```

What if I want to do **further computation** with the result of the rectangle area?

It got printed, then it was gone…

Writing Functions: Syntax

```
def name(parameters):
    statements
```

Two important questions:

1. How does the function use the arguments (inputs) passed to it?
2. **How does the function return a value?**

Returning values

New statement: the `return` statement

Syntax: `return` *`expression`*

Behavior:

1. *`expression`* is evaluated
2. the function stops executing further statements
3. the value of expression is returned
   i.e., the function call **evaluates** to the returned value

Returning values

New statement: the `return` statement

Syntax: `return` *`expression`*

this can **only** appear inside a function definition!

Behavior:

1. *`expression`* is evaluated
2. the function stops executing further statements
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   i.e., the function call **evaluates** to the returned value

Demo: add2.py

- Make add2 return instead of print
- Assign result to a variable
- function composition: call add2 on the results of add2 calls

Function Syntax: Summary

def keyword

function name

```
def name(parameters):
    """ docstring """
    statements
```

Specification

inputs

comma-separated list of parameters: variable names that will get assigned to the arguments

An indented code block that does any computation, executes any effects, and (optionally) returns a value

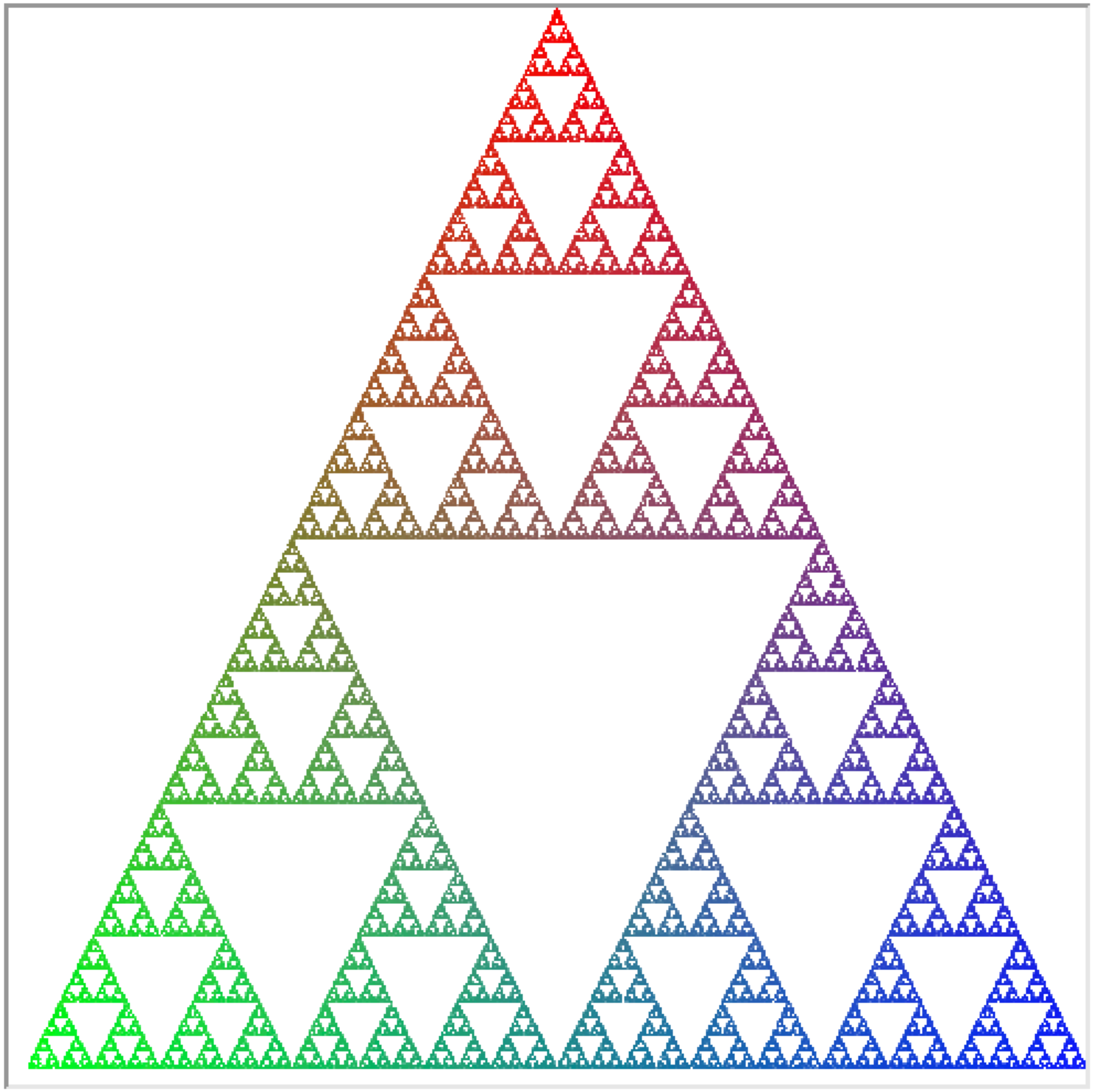
effects; return value

Why are functions great?

- **Concise** - wrap something complicated in an easy-to-use package:
  - define a function once then easily call it anywhere
- **Customizable** - make the easy-to-use package do different things:
  - customize the task your function performs based on its arguments
- **Composable** - use the result of one computation as input to (or as one step in) another.

A4

Your task:
Draw this.



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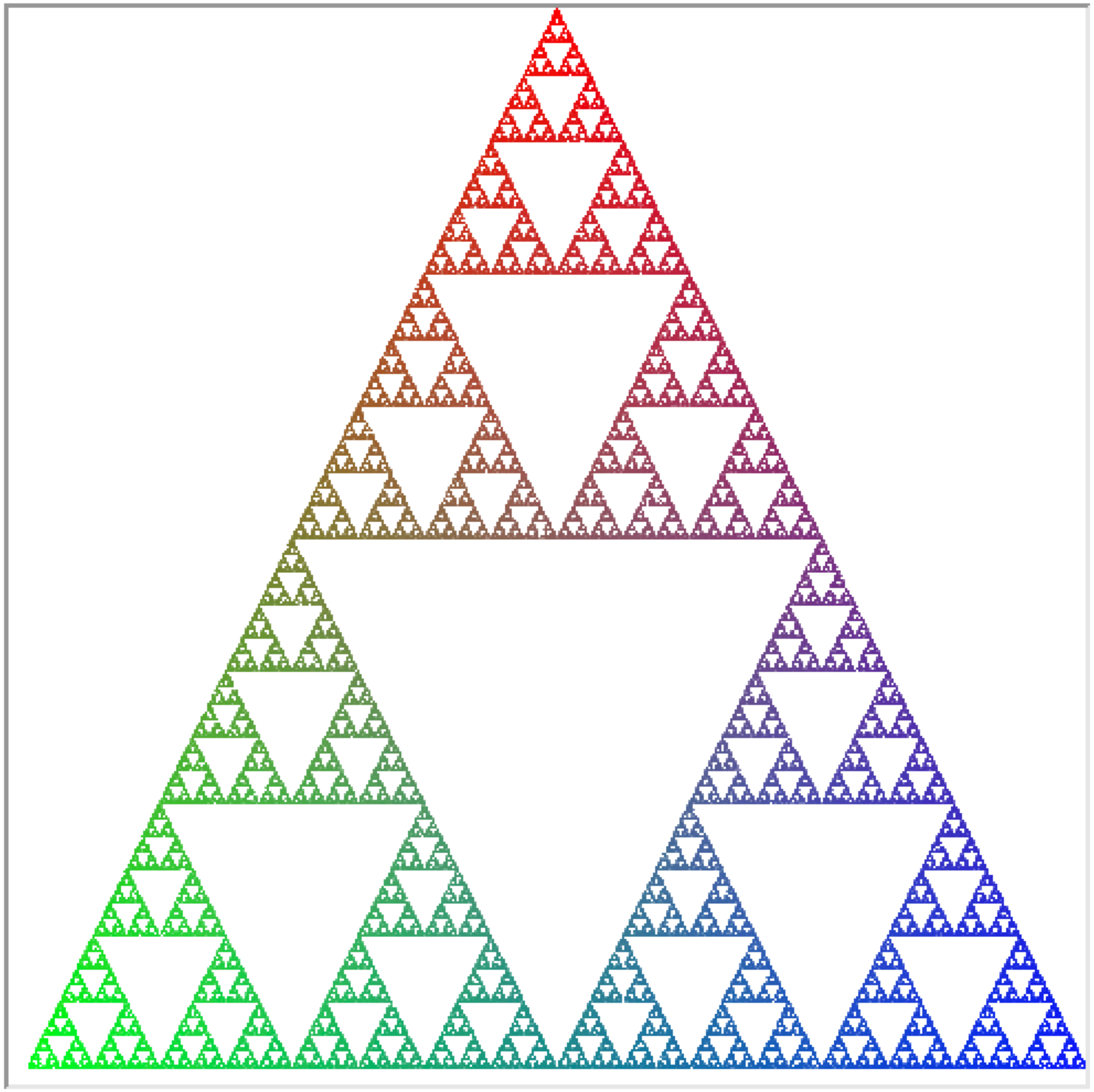

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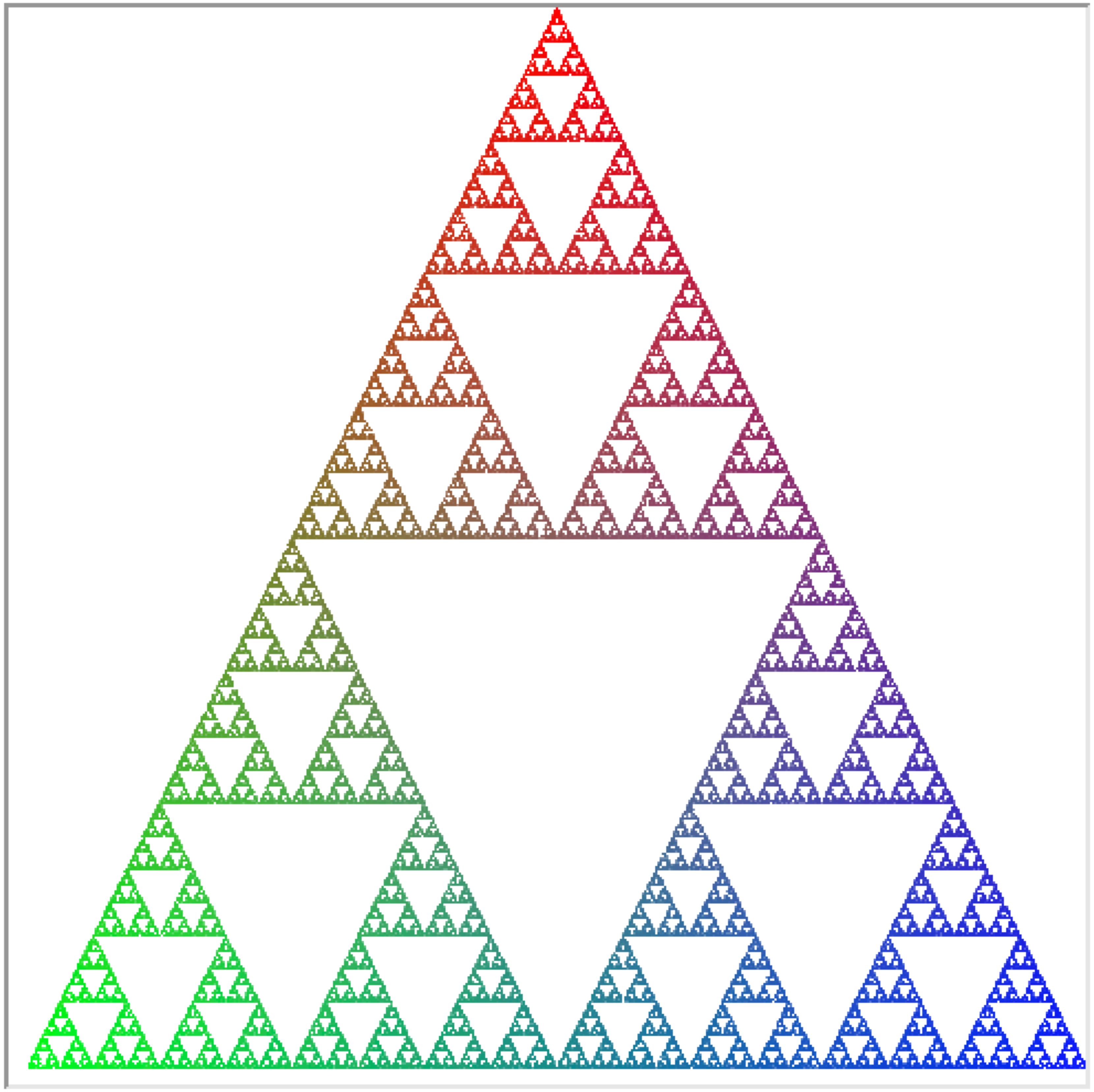
No.



A4: Pseudocode

```
# Let p be a random point in the window
# loop 10000 times:
#     c = a random corner of the triangle
#     m = the midpoint between p and c
#     choose a color for m
#     color the pixel at m
#     p=m
```

This pseudocode draws that crazy triangle thing.

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Demo:

- making up function names

Midpoint Function

```
def midpoint(p1x, p1y, p2x, p2y):
    """ Return the midpoint between
        (p1x, p1y) and (p2x, p2y)
    """
    # code here
```

(mid_x, mid_y)

This is **two** things!?
Can we return two things?

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```

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    return mid_x, mid_y
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Midpoint Function

```
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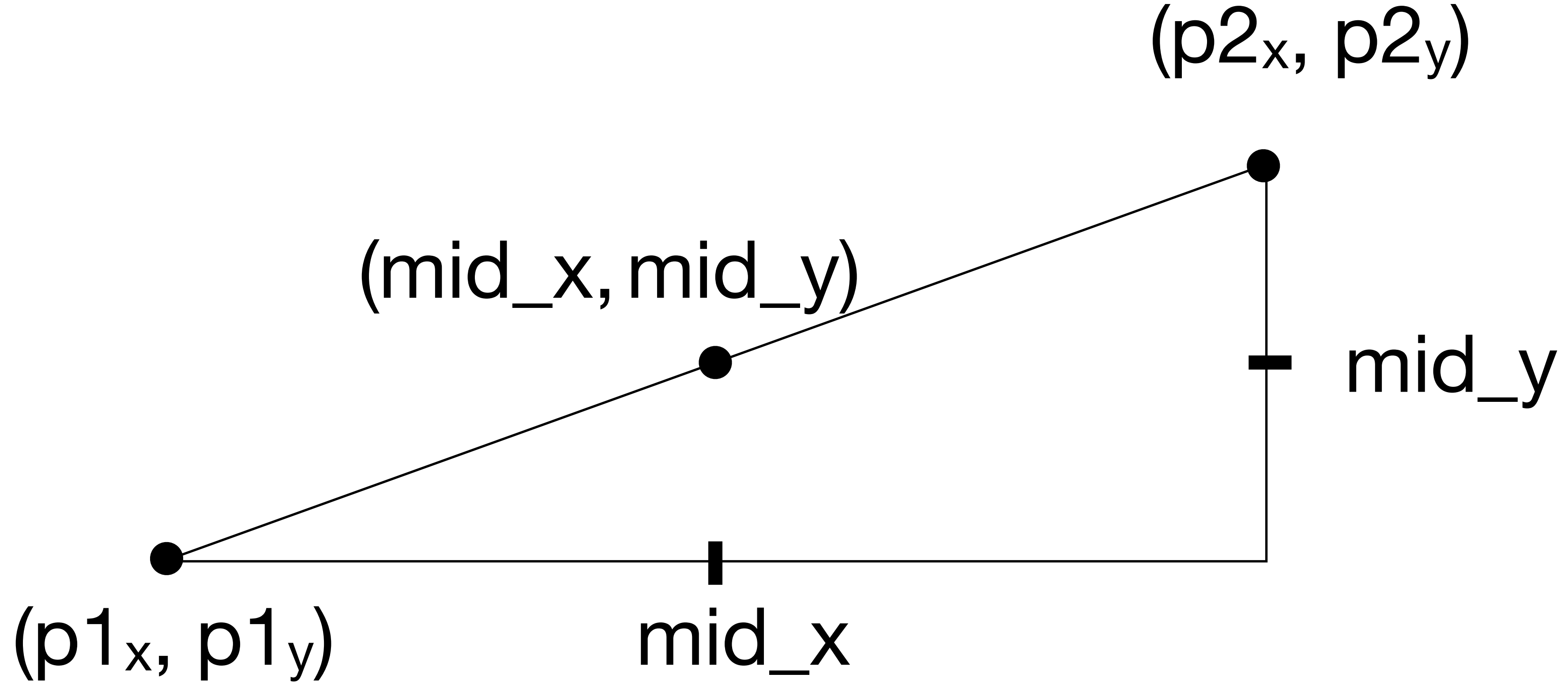
Okay, but how do you actually calculate this?



(whiteboard)

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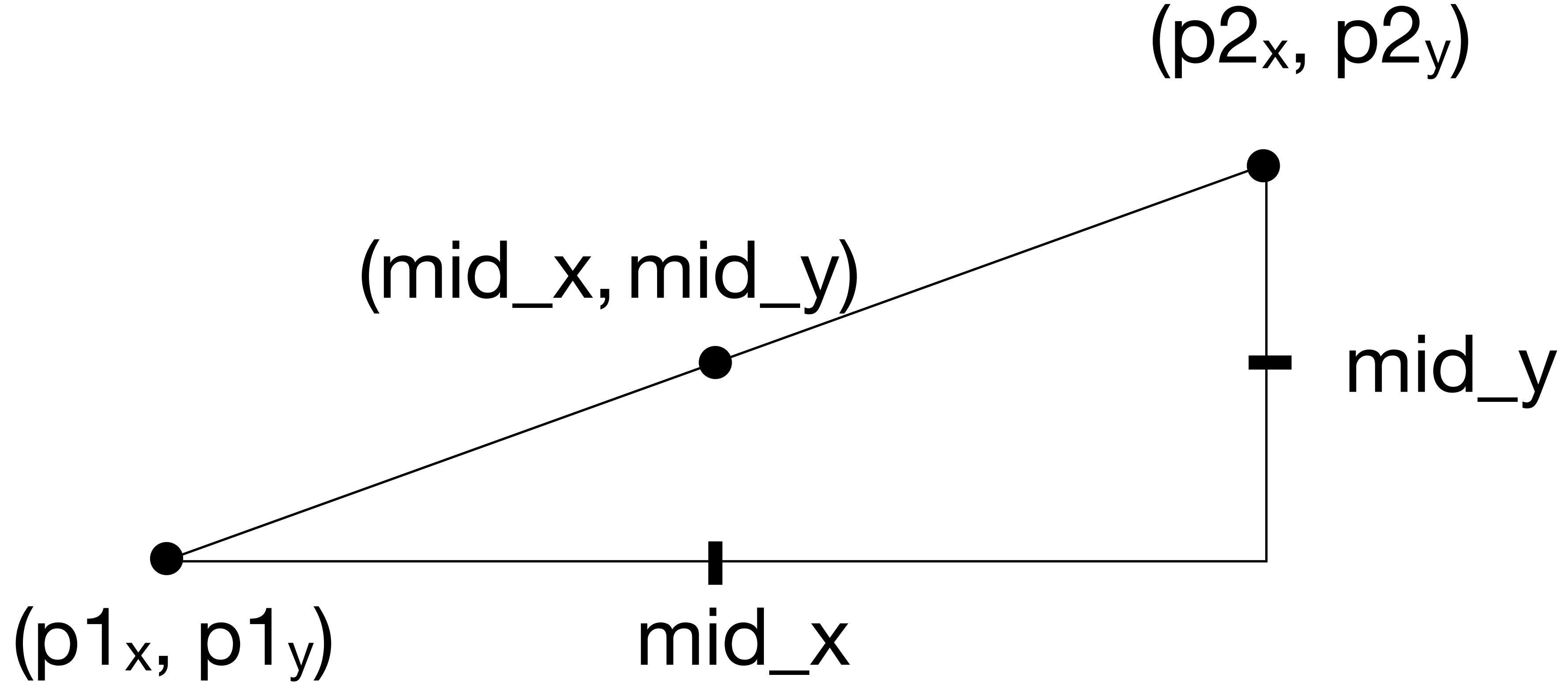

(whiteboard)

mid_x = $(p1_x + p2_x) / 2$

mid_y = $(p1_y + p2_y) / 2$

Returning Multiple Values

- You can return multiple values from a function by grouping them into a comma-separated sequence:

```
    return mid_x, mid_y
```

- You can assign each to a variable when calling the function:

```
mx, my = midpoint(p1x, p1y, p2x, p2y)
```

These are actually tuples

- A tuple is a sequence of values, optionally enclosed in parens.

```
(1, 4, “Mufasa”)
```

- You can “pack” and “unpack” them using assignment statements:

```
v = (1, 4, “Mufasa”)

(a, b, c) = v
```

These are actually tuples

- Tuples can also be passed *into* functions as arguments:

```
def midpoint(p1, p2):
    """Compute the midpoint between p1 and p2"""
    p1x, p1y = p1
    p2x, p2y = p2

    # . . .
    # return mx, my
```

Tuples: Demo