## Introduction to Recursion

Let's explore a bit of recursion as one of our last topics of the course! Recursion will be covered in further courses, but let's get our feet wet for now.

### What is Recursion?

In programming, [Recursion](https://en.wikipedia.org/wiki/Recursion) is when a method calls itself. As we have seen during the course using helper methods can be very useful when it comes to solving problems. In our classic helper method examples, we have commonly called methods from other methods. Recursion is a similar process except we are calling the same method.

As we explore recursion it is important to keep in mind all of the previous concepts we learned about methods. All those method concepts will still apply to recursion!

### A Simple Recursion

Let's write our very first (albeit broken) recursive method:

# recursive method definition:

def say\_hello

p "hello"

say\_hello

end

say\_hello # prints "hello" forever

Notice that the say\_hello method definition contains a call to itself. A recursive method definition still obeys all the evaluation rules as a normal method, so like usual, the code will not run until we call it.

Let's step through how this code evaluates. For clarity, we'll be numbering the calls to say\_hello. The initial call will be number 0:

* When we call say\_hello for the first time (say\_hello\_0), we run the code inside the definition as usual. That means we print out "hello" and call say\_hello again (say\_hello\_1). Now we need to evaluate the call to say\_hello\_1.
* say\_hello\_1 prints "hello" and calls say\_hello\_2, now we need to evaluate say\_hello\_2
* say\_hello\_2 prints "hello" and calls say\_hello\_3
* say\_hello\_3 prints "hello" and calls say\_hello\_4
* ... and this pattern continues forever!

Our say\_hello method enters an infinite loop where one call to the method triggers another call. And that call triggers yet another call, etc.. If you run this code, you will enter an infinite loop. However, the program will crash with a SystemStackError: stack level too deep. Whenever we call a method, some of our system's memory must be allocated to execute that method call. This is known as adding to the stack. Since our say\_hello code continuously calls methods forever, we will run out of space on the stack (run out of memory) and crash!

### Recursive Countdown

In our previous example we saw how our recursive method crashed because it entered an infinite recursive loop. Of course useful recursive methods should not crash, so let's go through the process of building a working one.

Let's build a recursive countDown that starts ticking down numbers:

def count\_down(num)

p num;

count\_down(num - 1)

end

count\_down(10) # this prints decreasing numbers starting at 10 forever

This recursive definition evaluates in a similar way to before, however, now we are passing in decreasing numbers. For any num, every call to countDown(num) will call countDown(num - 1), starting from our initial call to countDown(10):

* countDown(10) prints 10 and calls countDown(9), so next we evaluate countDown(9)...
* countDown(9) prints 9 and calls countDown(8)...
* countDown(8) prints 8 and calls countDown(7)...
* ... and this process continues forever!

In your mind imagine these successive calls:

countDown(10) -> countDown(9) -> countDown(8) ...

Our countdown crashes with a similar error as last time because we entered an infinite loop again. Hmmm, what if we modify our method so that it stops at 0:

def count\_down(num)

if num == 0

p "Houston, we have lift-off!"

return;

end

p num

count\_down(num - 1)

end

count\_down(10) # prints numbers from 10 to 1, and finally "Houston, we have lift-off!"

Now our method stops once we hit 0! Let's say we get to the point where we evaluate countDown(0). That means that the if condition is true, so we print the lift-off message and return. Recall that as soon as we hit a return we exit that method call immediately. Since we immediately return out of our call to countDown(0), countDown(0) never calls countDown(-1), breaking our recursive loop!

### Anatomy of a Recursive Method

In recursive methods, we need to implement a way to stop the recursive loop and prevent it from looping forever. We took care of the infinite loop issue in our countDown by using an if statement that prevents another recursive call. In general, we call such a statement the base case

A recursive method consists of two fundamental parts:

* the base case where we halt the recursion by not making a further call
* the recursive step where we continue the recursion by making another subsequent call

def count\_down(num)

# base case

if num === 0

p "Houston, we have lift-off!"

return;

end

p num

# recursive step

count\_down(num - 1)

end

Next up, let's solve some recursive problems!