Direct Vs. Indirect Recursion

This lesson goes over two different types of recursion: direct and indirect recursion.

We'll cover the following

Direct Recursion

Direct recursion occurs when a function calls itself.

This results in a **one-step** recursive call, meaning that the function makes a recursive call inside its own function body.

Syntax of Direct Recursion

```
def function1(p1, p2, ..., pn) :
  # Some code here
  function1(p1, p2, ..., pn)
  # Some code here
```

Printing Natural Numbers from 1 to n Using Direct Recursion

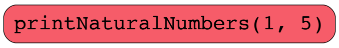
Let's take a look at an example of a function that prints natural numbers from 1 to n:

```
def printNaturalNumbers(lowerRange, upperRange):
  # Base Case
  if lowerRange > upperRange :
    return

  print(lowerRange)

  # Recursive Case
  printNaturalNumbers(lowerRange + 1, upperRange);

# Driver Code
n = 5
printNaturalNumbers(1, n)
```

Printing numbers from 1 to n using direct recursion

In the code snippet above, if `lowerRange` is less than `upperRange`, we print the `lowerRange`, increase it, and call the function again. If `lowerRange` is greater than `upperRange`, we halt all function calls.

The slides below show how function calls are being performed and returned.



Function calls of direct recursion method

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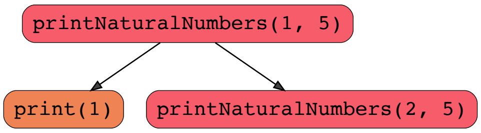

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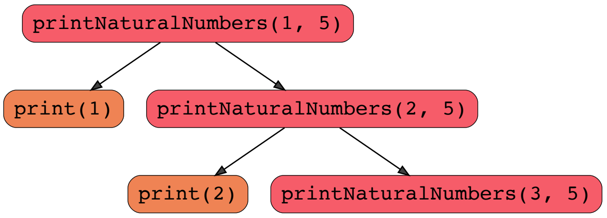

printNaturalNumbers(1, 5)

print(1)

printNaturalNumbers(2, 5)

print(2)

printNaturalNumbers(3, 5)

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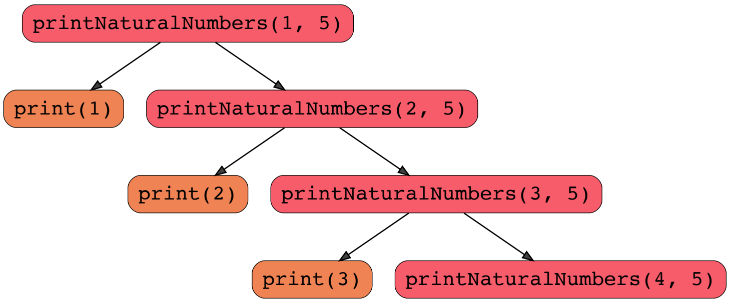

printNaturalNumbers(1, 5)

print(1)

printNaturalNumbers(2, 5)

print(2)

printNaturalNumbers(3, 5)

print(3)

printNaturalNumbers(4, 5)

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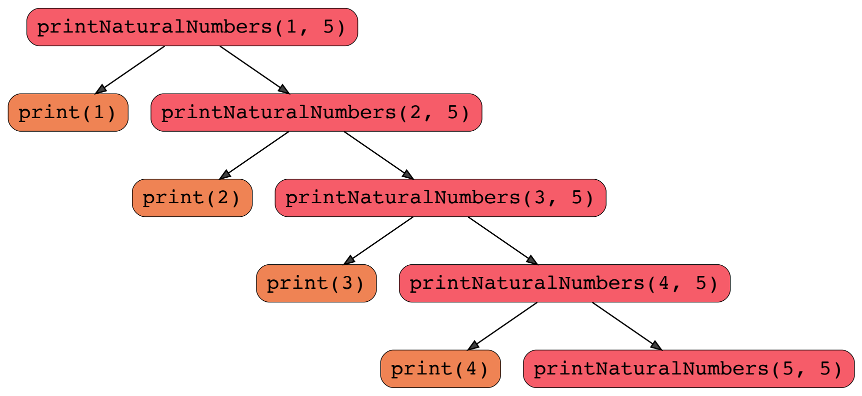

printNaturalNumbers(1, 5)

print(1)

printNaturalNumbers(2, 5)

print(2)

printNaturalNumbers(3, 5)

print(3)

printNaturalNumbers(4, 5)

print(4)

printNaturalNumbers(5, 5)

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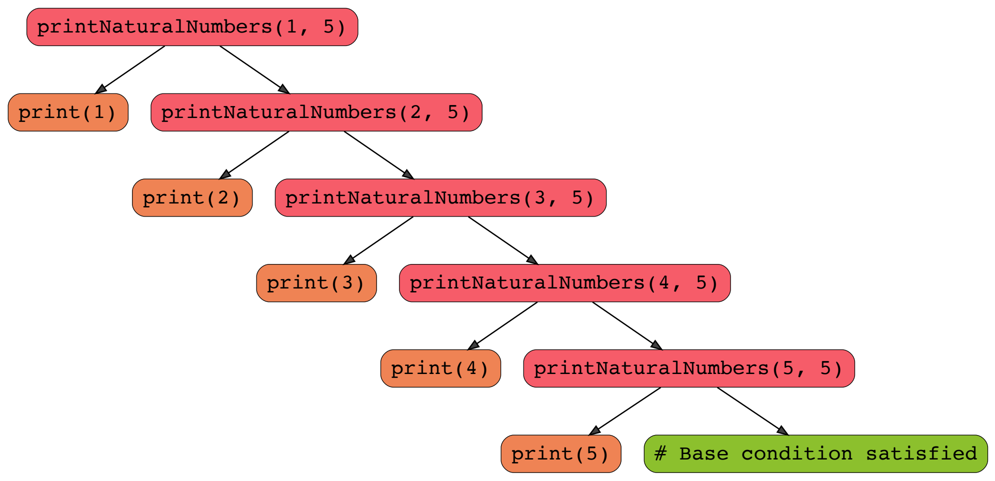

printNaturalNumbers(1, 5)

print(1)

printNaturalNumbers(2, 5)

print(2)

printNaturalNumbers(3, 5)

print(3)

printNaturalNumbers(4, 5)

print(4)

printNaturalNumbers(5, 5)

print(5)

Base condition satisfied

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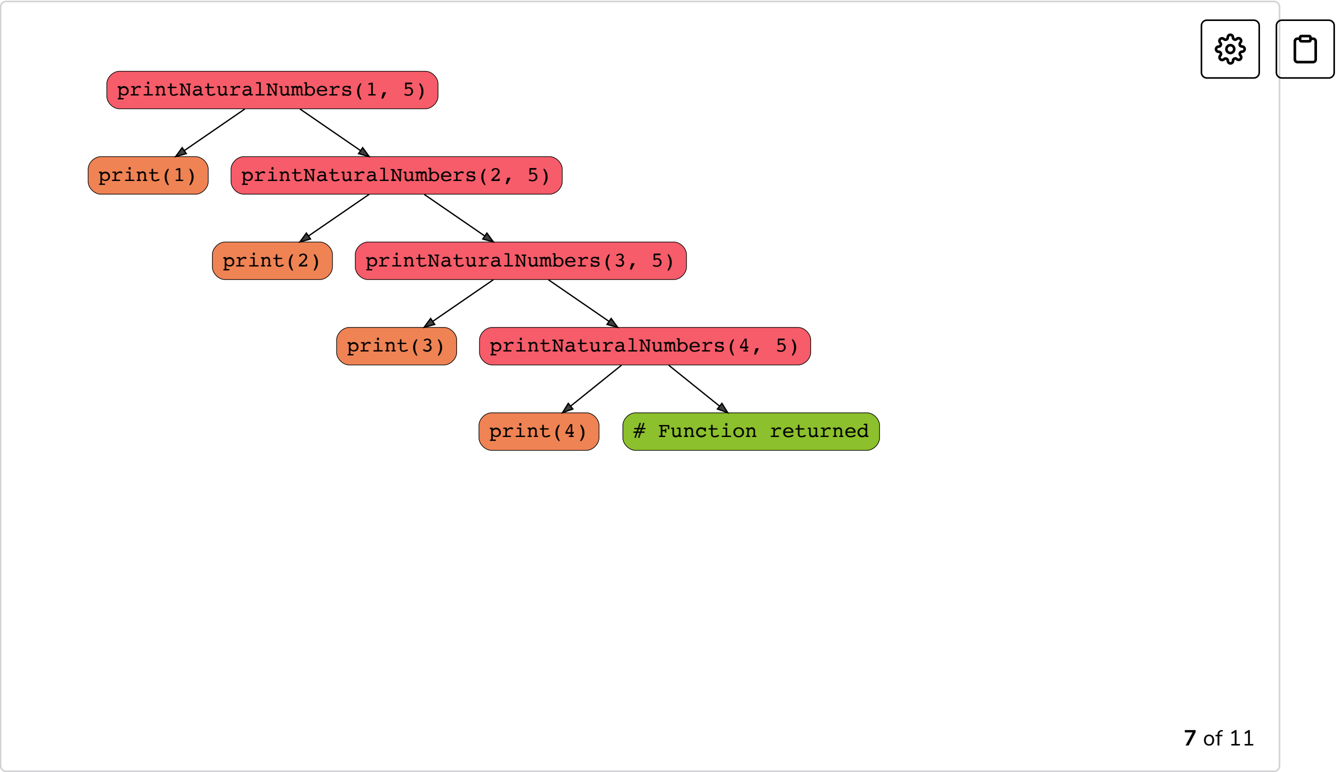
printNaturalNumbers(1, 5)
print(1)
printNaturalNumbers(2, 5)
print(2)
printNaturalNumbers(3, 5)
print(3)
printNaturalNumbers(4, 5)
print(4)
# Function returned

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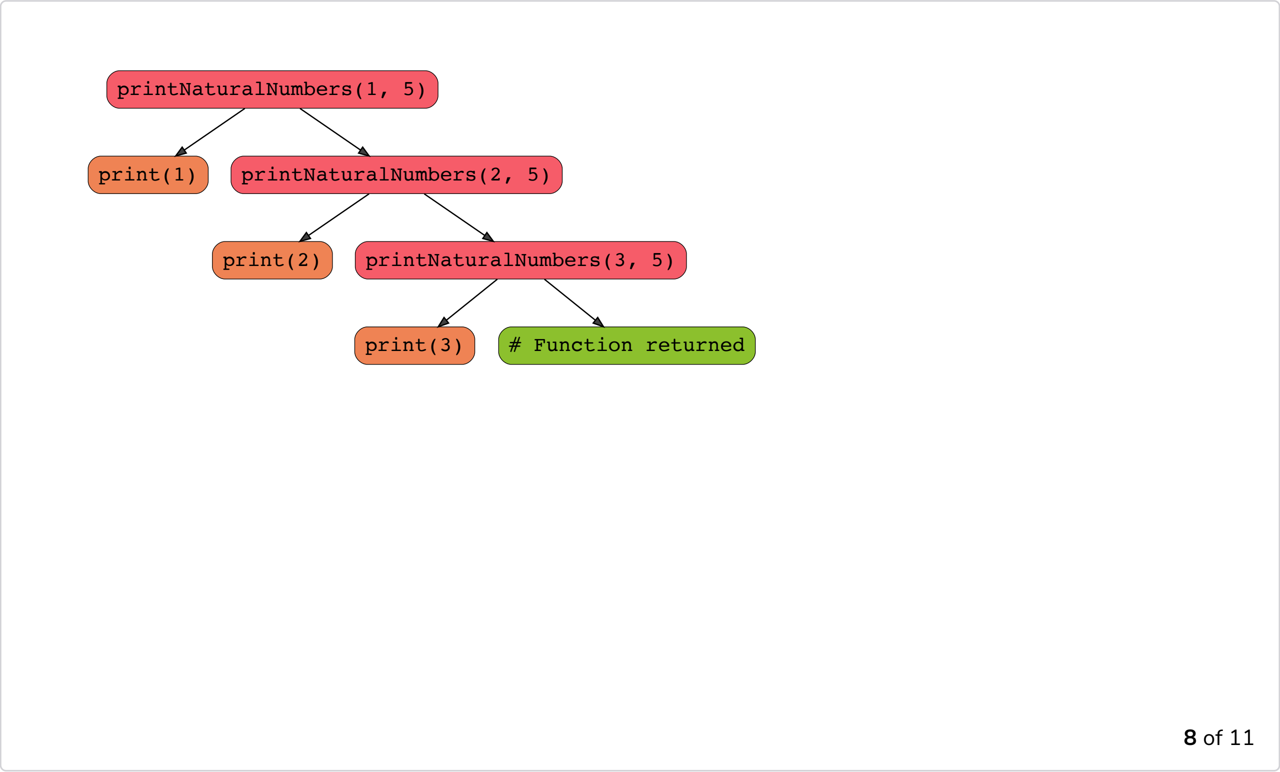
printNaturalNumbers(1, 5)
print(1)
printNaturalNumbers(2, 5)
print(2)
printNaturalNumbers(3, 5)
print(3)
# Function returned

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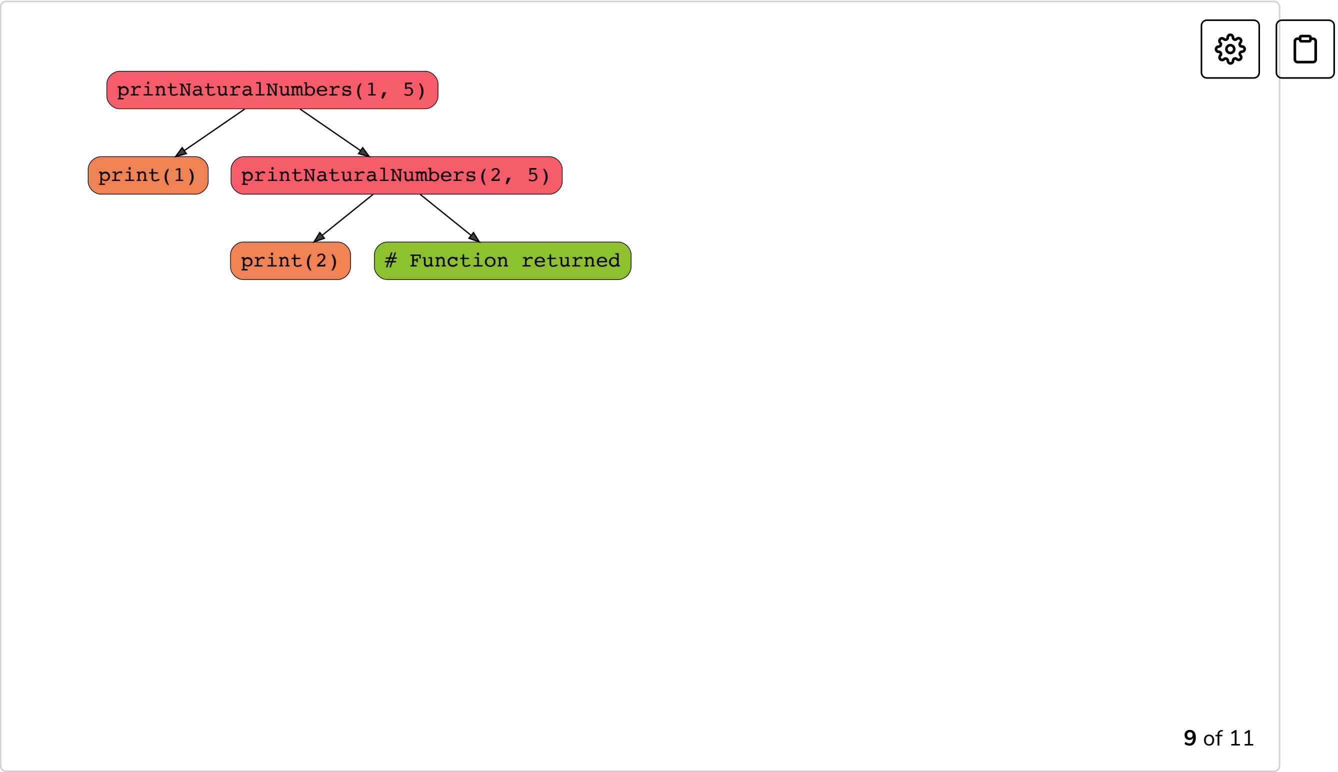

printNaturalNumbers(1, 5)

print(1)

printNaturalNumbers(2, 5)

print(2)

Function returned

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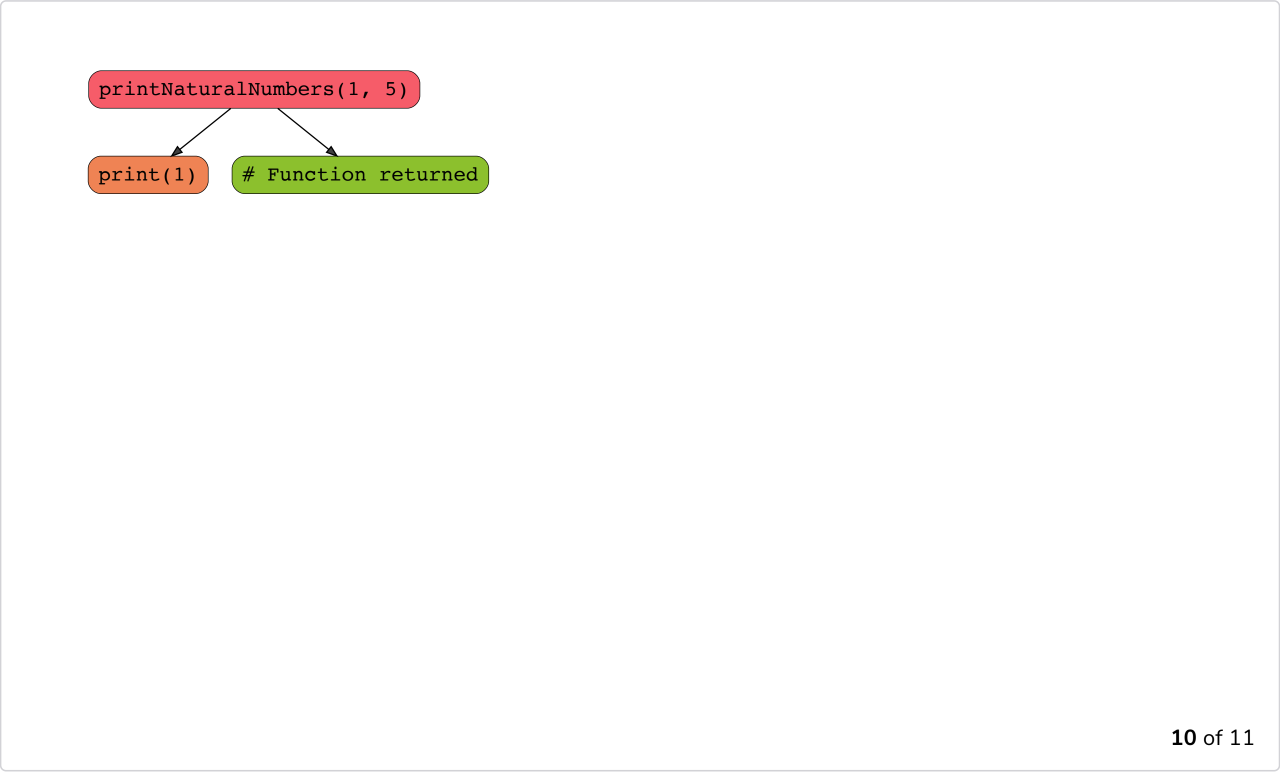

printNaturalNumbers(1, 5)

print(1)

Function returned

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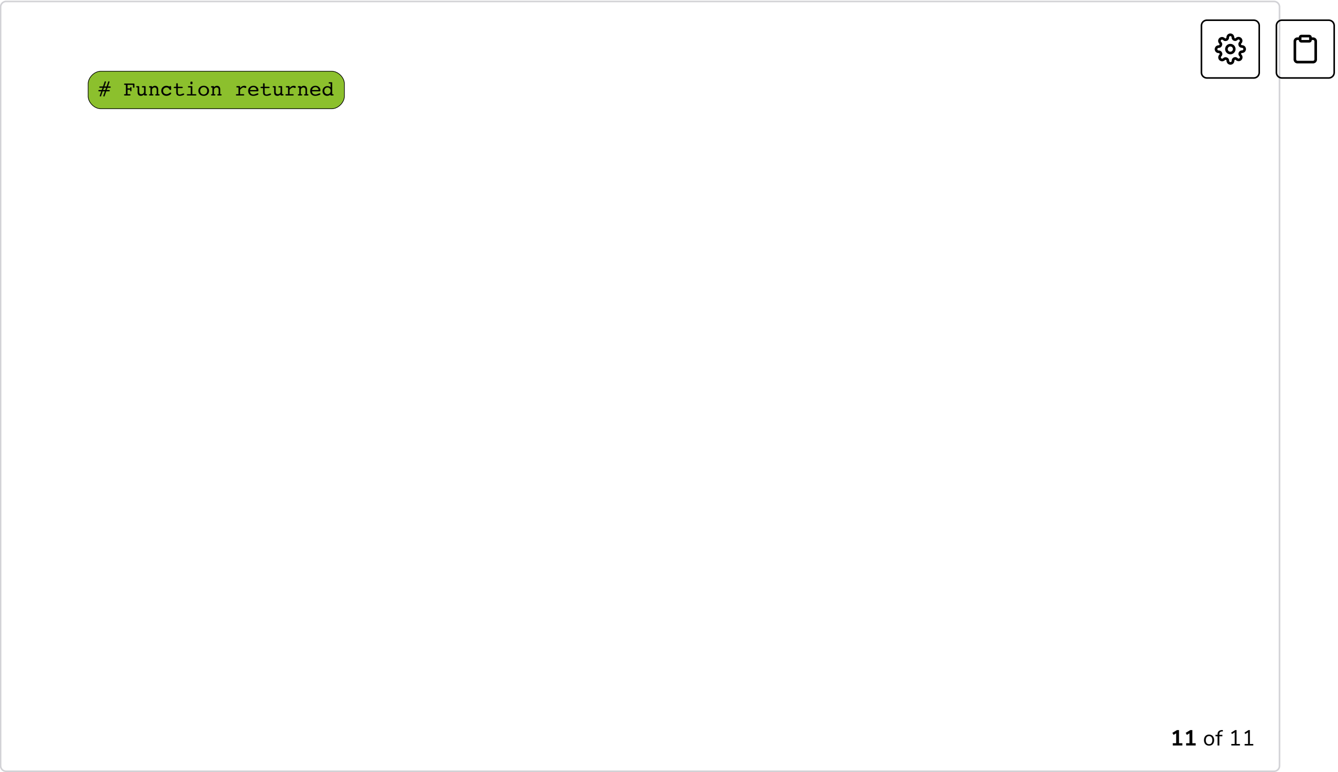


Indirect Recursion

Indirect recursion (also called **mutual recursion**) occurs when a function calls another function until the original function is called, again.

For example, if function `function1()` calls another function, `function2()`, `function2()` eventually calls the original function `function1()` - This completes the process of indirect recursion.

Syntax of Indirect Recursion

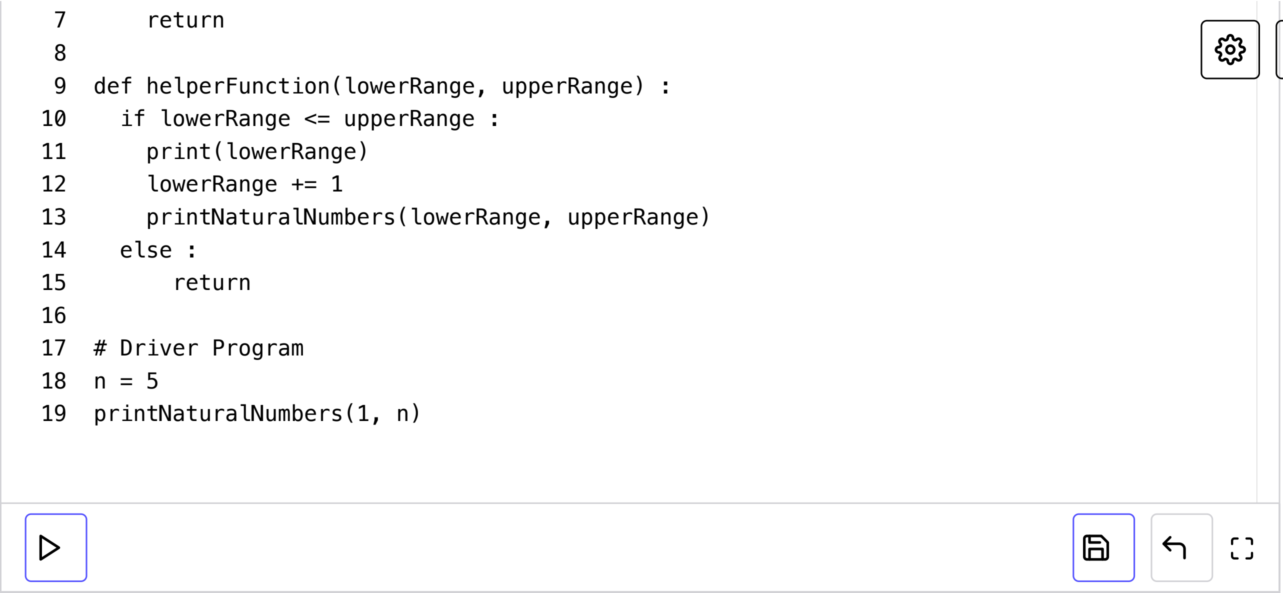
```
def function1(p1, p2, ..., pn) :
  # Some code here
  function2(p1, p2, ..., pn)
  # Some code here

def function2(p1, p2, ..., pn) :
  # Some code here
  function1(p1, p2, ..., pn)
  # Some code here
```

Printing Natural Numbers from 1 to n Using Indirect Method

Let's take a look at an example that prints natural numbers from 1 to n:

```
def printNaturalNumbers(lowerRange, upperRange) :
  if lowerRange <= upperRange :
    print(lowerRange)
    lowerRange += 1
    helperFunction(lowerRange, upperRange)
  else :
```



```
    return

def helperFunction(lowerRange, upperRange) :
  if lowerRange <= upperRange :
    print(lowerRange)
    lowerRange += 1
    printNaturalNumbers(lowerRange, upperRange)
  else :
      return

# Driver Program
n = 5
printNaturalNumbers(1, n)
```

Printing numbers from 1 to n using indirect recursion

In this code snippet, we have two functions: `printNaturalNumbers()` and `helperFunction()`. Both functions will check if `lowerRange` is greater than `upperRange`. If not, they will `lowerRange` and call the other function.

This may not look like **recursion** at first, but, if we analyze the code flow, we see that the first function always calls itself *indirectly*.

$printNaturalNumbers() -> helperFunction() -> printNaturalNumbers -> ... $

Take a look at the code flow:

Indirect recursion method

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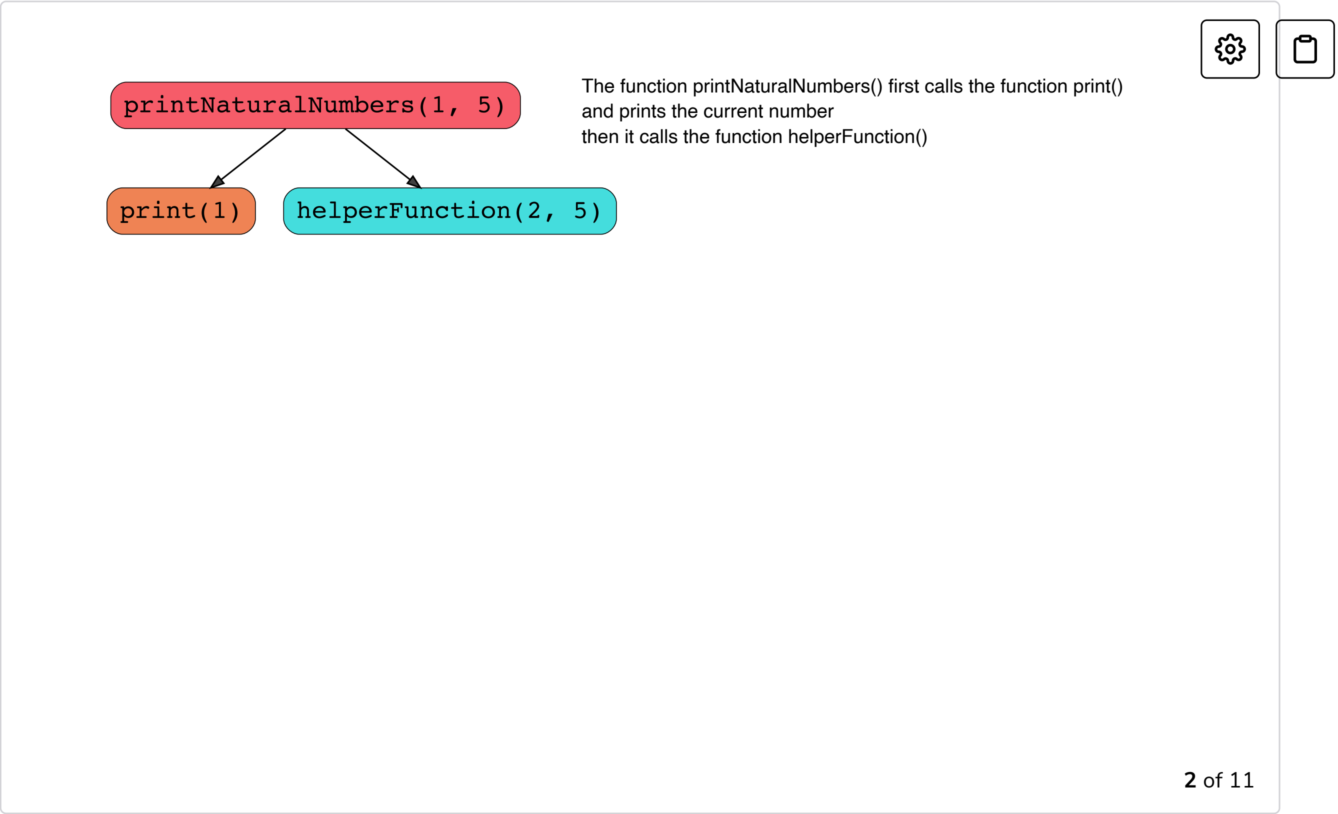

printNaturalNumbers(1, 5)

print(1)

helperFunction(2, 5)

The function printNaturalNumbers() first calls the function print()
and prints the current number
then it calls the function helperFunction()

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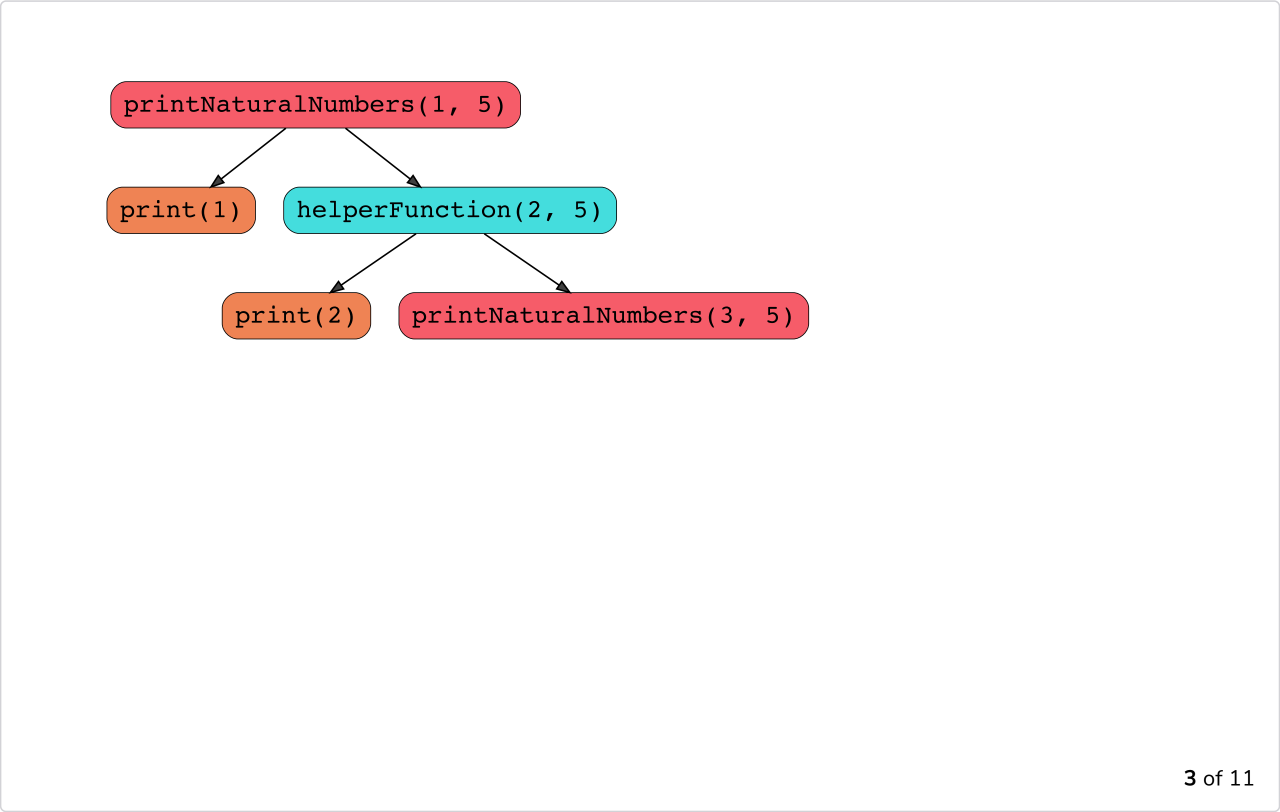

printNaturalNumbers(1, 5)

print(1)

helperFunction(2, 5)

print(2)

printNaturalNumbers(3, 5)

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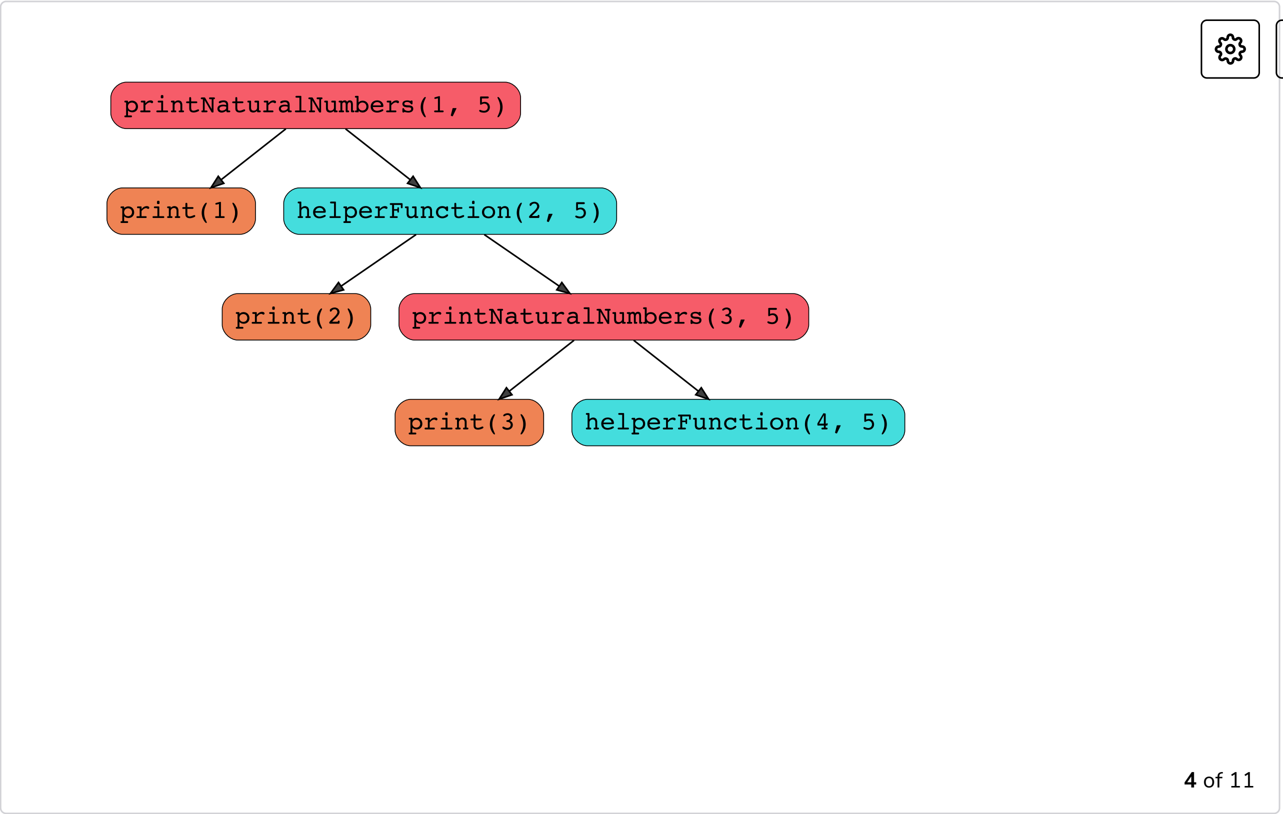
printNaturalNumbers(1, 5)
print(1)
helperFunction(2, 5)
print(2)
printNaturalNumbers(3, 5)
print(3)
helperFunction(4, 5)

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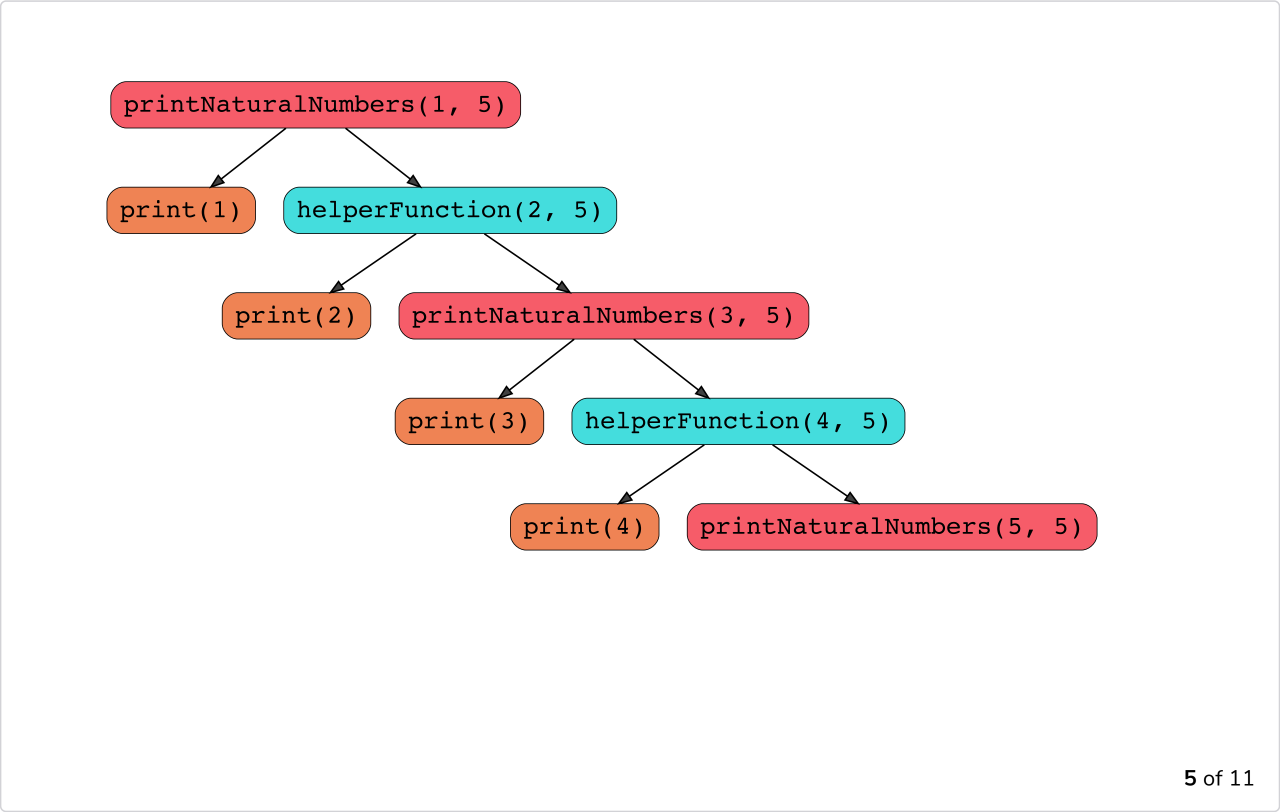
printNaturalNumbers(1, 5)
print(1)
helperFunction(2, 5)
print(2)
printNaturalNumbers(3, 5)
print(3)
helperFunction(4, 5)
print(4)
printNaturalNumbers(5, 5)

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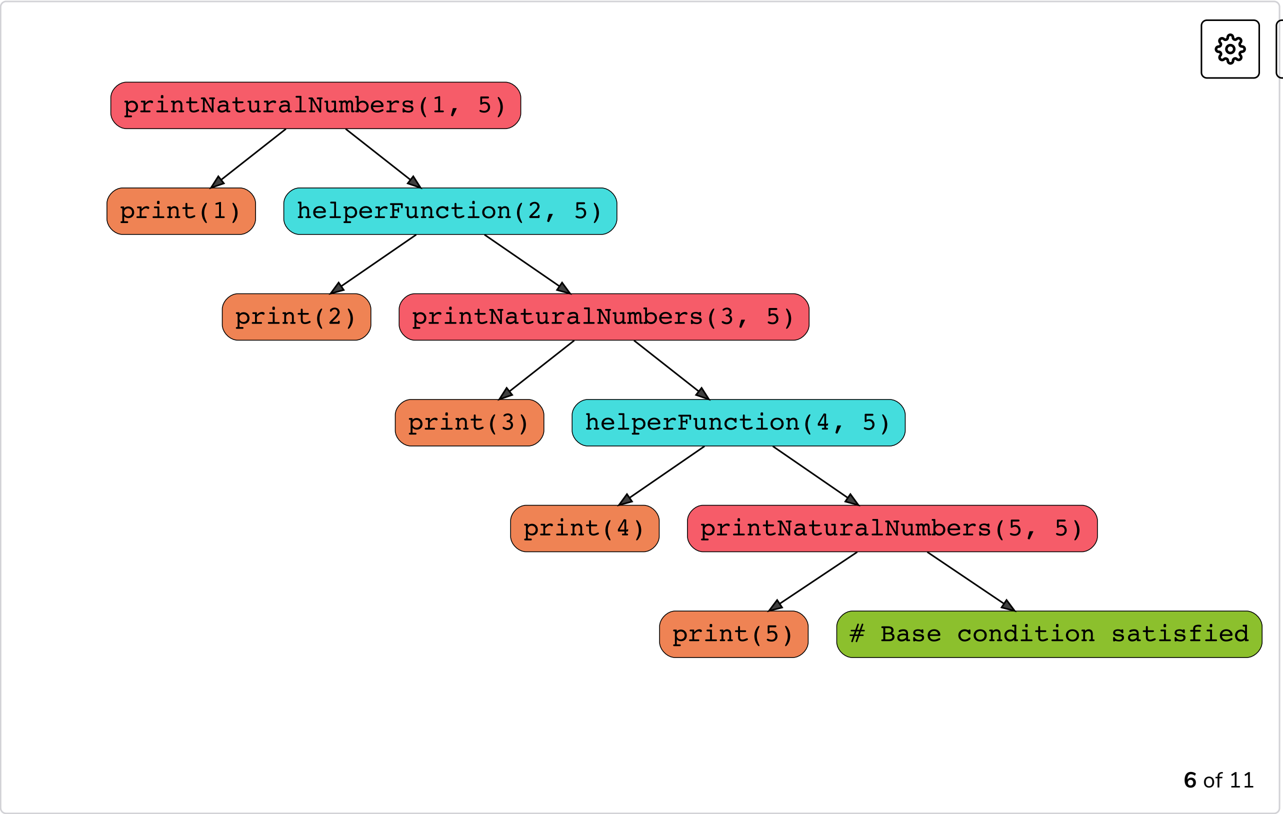
printNaturalNumbers(1, 5)
print(1)
helperFunction(2, 5)
print(2)
printNaturalNumbers(3, 5)
print(3)
helperFunction(4, 5)
print(4)
printNaturalNumbers(5, 5)
print(5)
# Base condition satisfied
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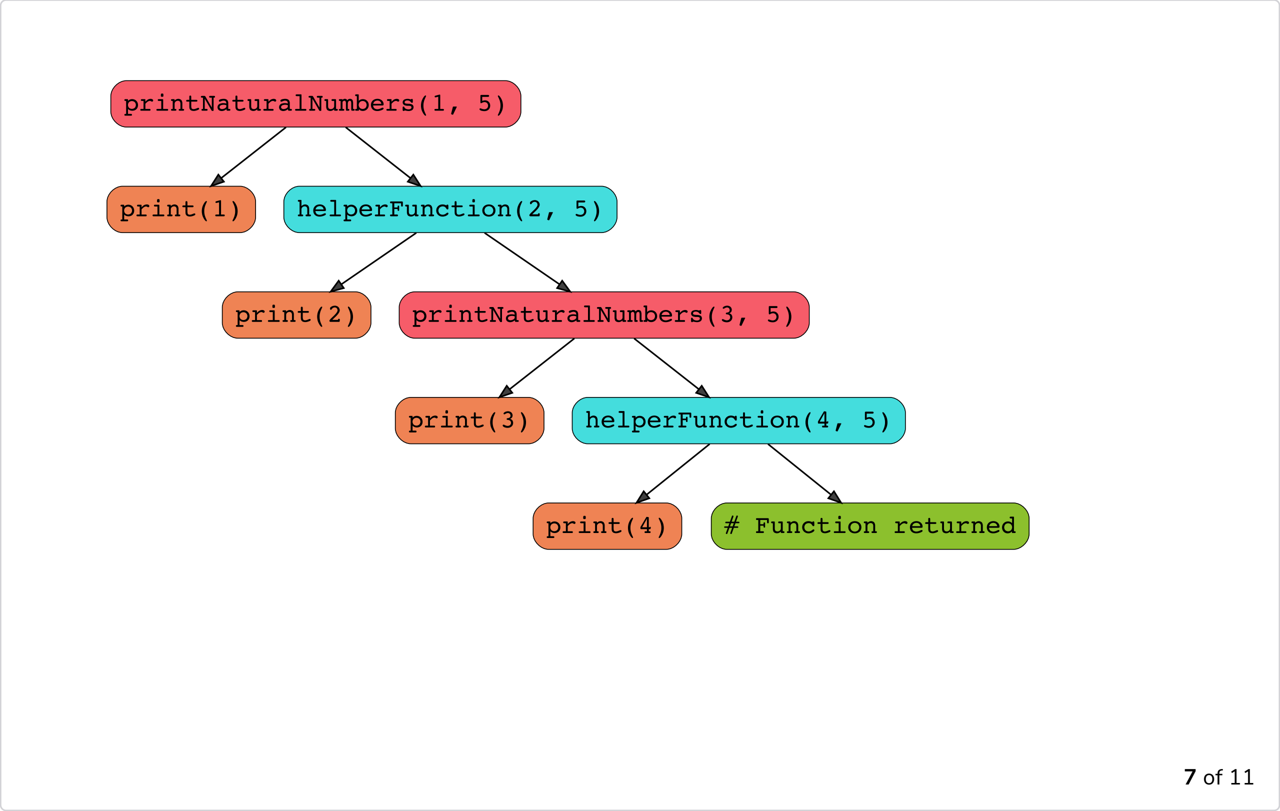
printNaturalNumbers(1, 5)
print(1)
helperFunction(2, 5)
print(2)
printNaturalNumbers(3, 5)
print(3)
helperFunction(4, 5)
print(4)
# Function returned
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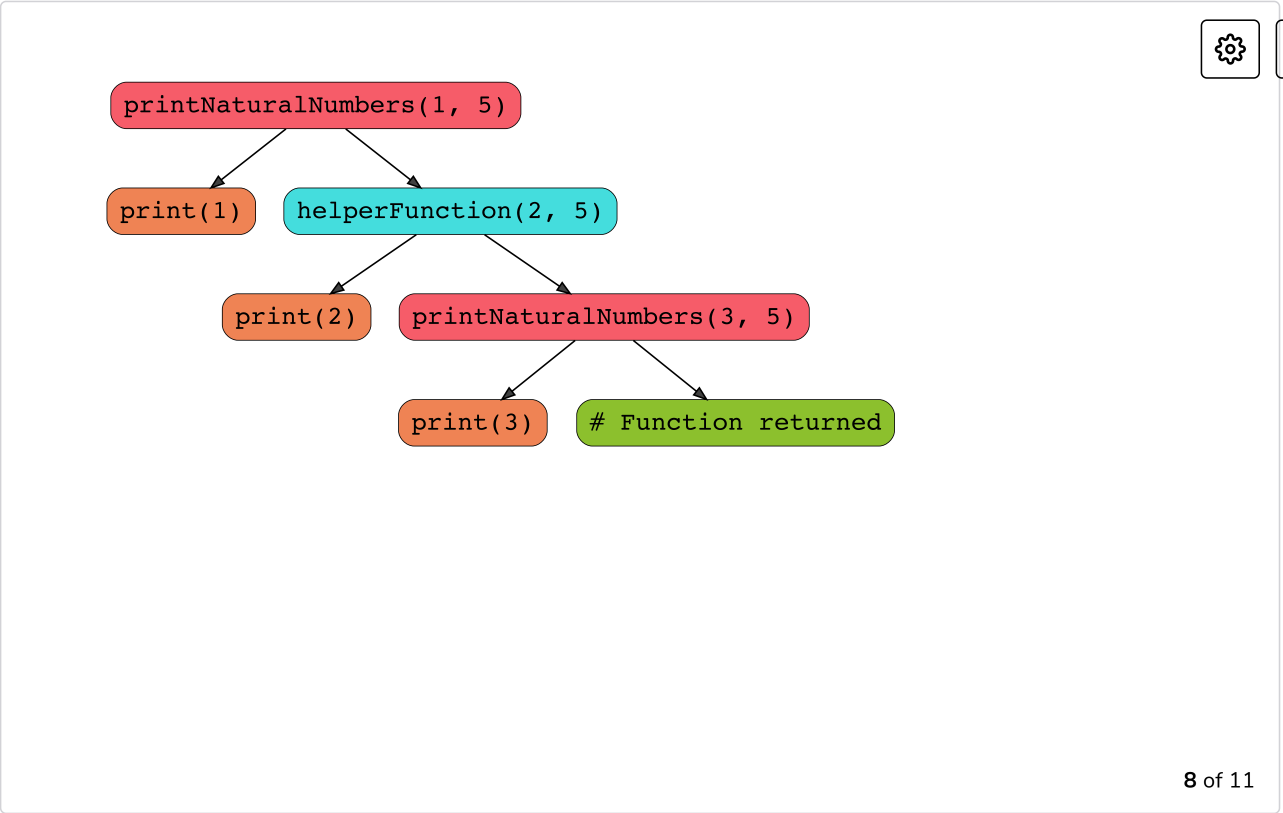
printNaturalNumbers(1, 5)
print(1)
helperFunction(2, 5)
print(2)
printNaturalNumbers(3, 5)
print(3)
# Function returned
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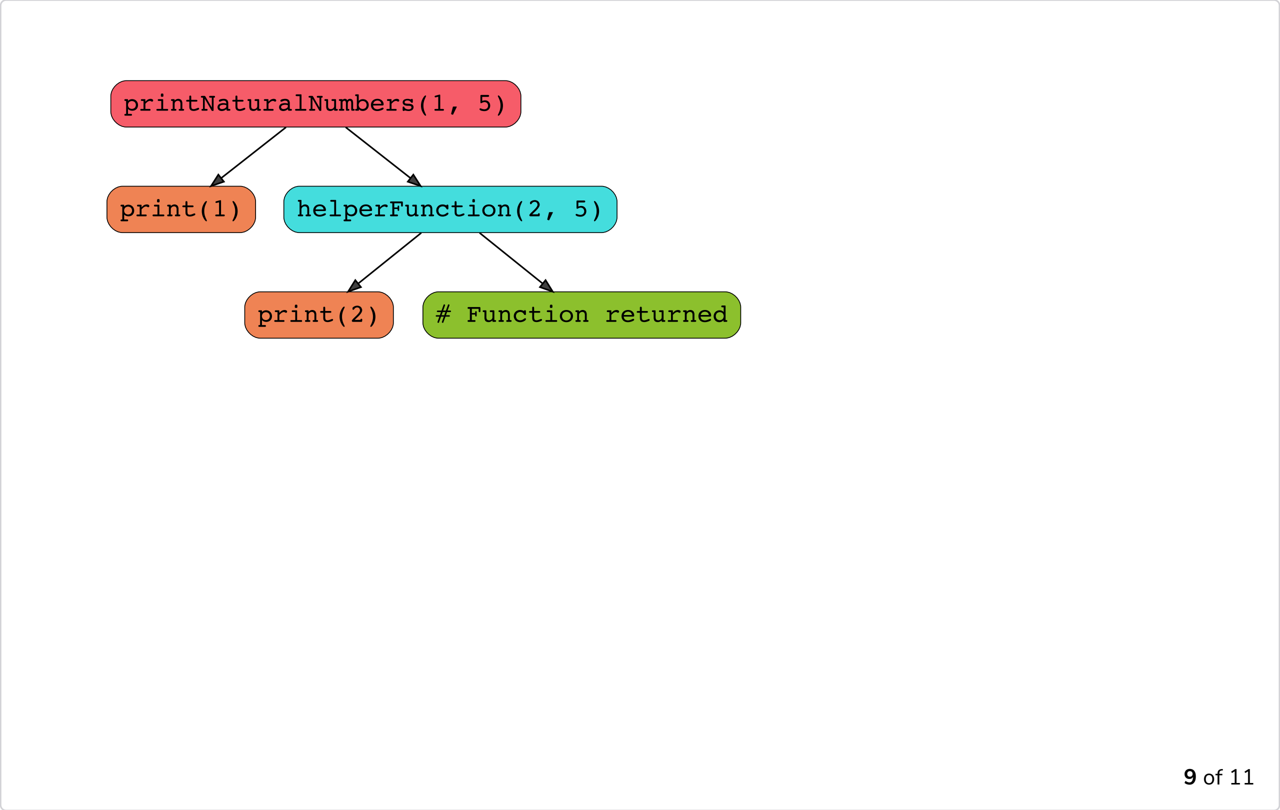
printNaturalNumbers(1, 5)
print(1)
helperFunction(2, 5)
print(2)
# Function returned
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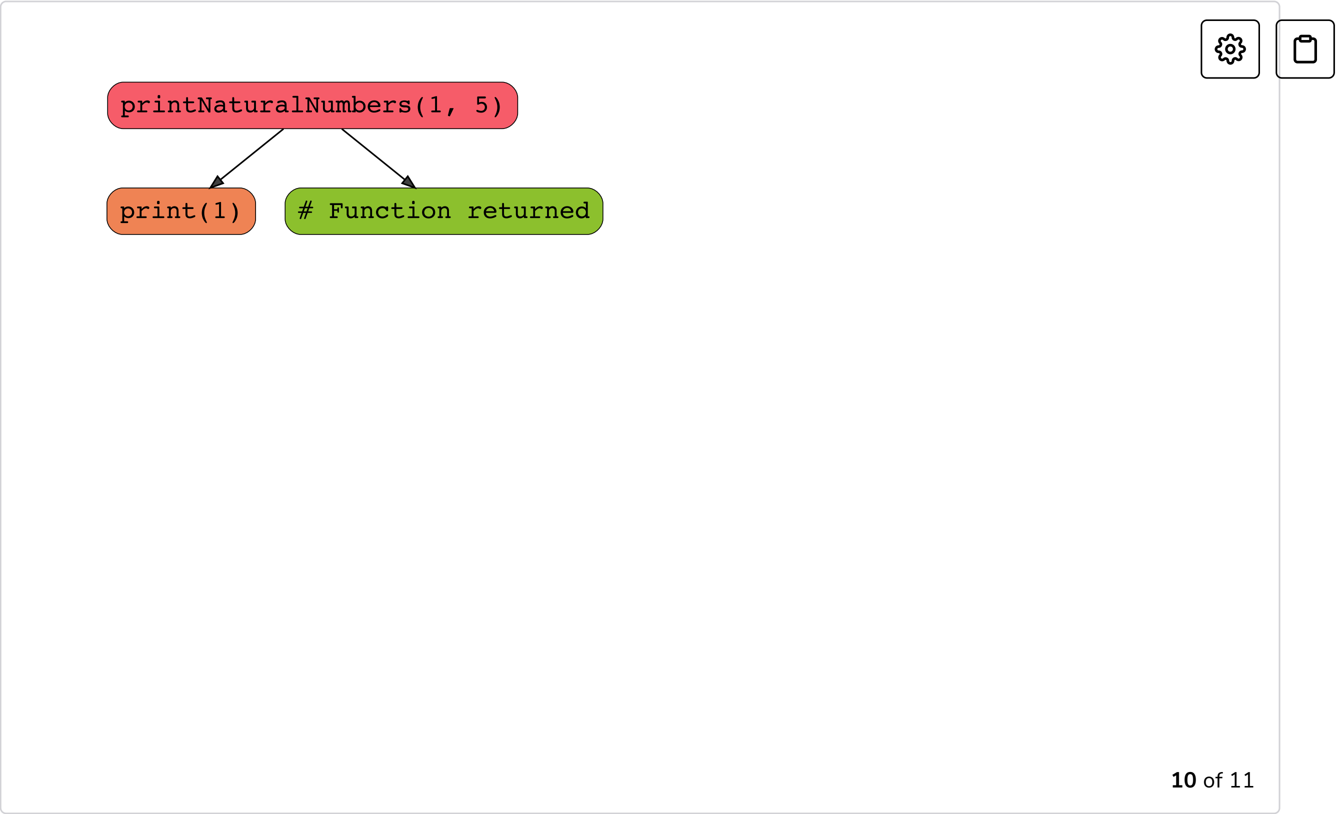

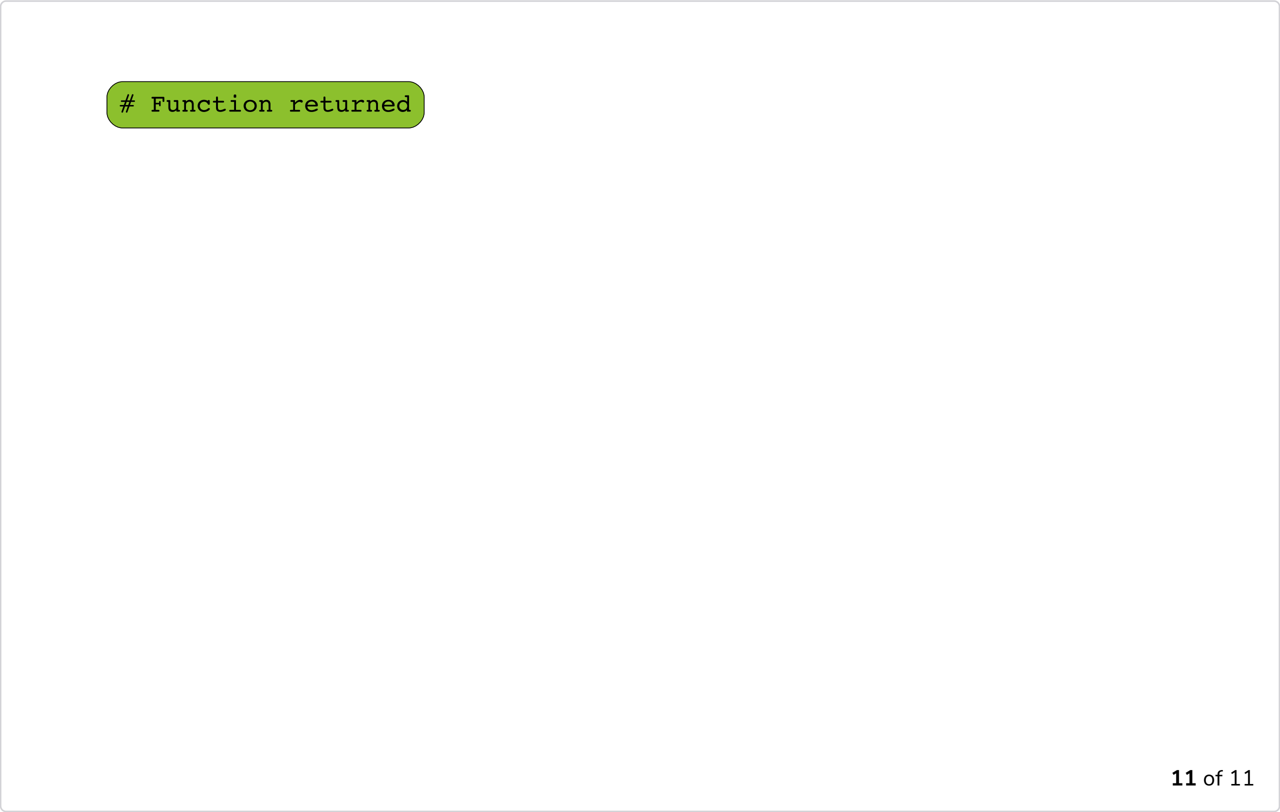

Now that we have gone over the concept of direct and indirect recursion, let’s move on to the next lesson and find out when we should use recursion.

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When to Use Recursion?

☑ Completed

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