

Functions as objects

WRITING FUNCTIONS IN PYTHON



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Functions are just another type of object

Python objects:

```
def x():  
    pass  
x = [1, 2, 3]  
x = {'foo': 42}  
x = pandas.DataFrame()  
x = 'This is a sentence.'  
x = 3  
x = 71.2  
import x
```

Functions as variables

```
def my_function():  
    print('Hello')  
x = my_function  
type(x)
```

```
<type 'function'>
```

```
x()
```

```
Hello
```

```
PrintyMcPrintface = print  
PrintyMcPrintface('Python is awesome!')
```

```
Python is awesome!
```

Lists and dictionaries of functions

```
list_of_functions = [my_function, open, print]
list_of_functions[2]('I am printing with an element of a list!')
```

```
I am printing with an element of a list!
```

```
dict_of_functions = {
    'func1': my_function,
    'func2': open,
    'func3': print
}
dict_of_functions['func3']('I am printing with a value of a dict!')
```

```
I am printing with a value of a dict!
```

Referencing a function

```
def my_function():  
    return 42
```

```
x = my_function  
my_function()
```

```
42
```

```
my_function
```

```
<function my_function at 0x7f475332a730>
```

Functions as arguments

```
def has_docstring(func):  
    """Check to see if the function  
    `func` has a docstring.  
  
    Args:  
        func (callable): A function.  
  
    Returns:  
        bool  
    """  
    return func.__doc__ is not None
```

```
def no():  
    return 42  
  
def yes():  
    """Return the value 42  
    """  
    return 42
```

```
has_docstring(no)
```

```
False
```

```
has_docstring(yes)
```

```
True
```

Defining a function inside another function

```
def foo():  
    x = [3, 6, 9]  
  
    def bar(y):  
        print(y)  
  
    for value in x:  
        bar(x)
```

Defining a function inside another function

```
def foo(x, y):  
    if x > 4 and x < 10 and y > 4 and y < 10:  
        print(x * y)
```

```
def foo(x, y):  
    def in_range(v):  
        return v > 4 and v < 10  
  
    if in_range(x) and in_range(y):  
        print(x * y)
```


Functions as return values

```
def get_function():  
    def print_me(s):  
        print(s)  
  
    return print_me
```

```
new_func = get_function()  
new_func('This is a sentence.')
```

```
This is a sentence.
```

Let's practice!
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Scope

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Names



Names



Scope



Scope



Scope

```
x = 7  
y = 200  
print(x)
```

7

```
def foo():  
    x = 42  
    print(x)  
    print(y)
```

foo()

42
200

print(x)

7

Scope

```
def foo():  
    x = 42  
    print(x)
```

which x?

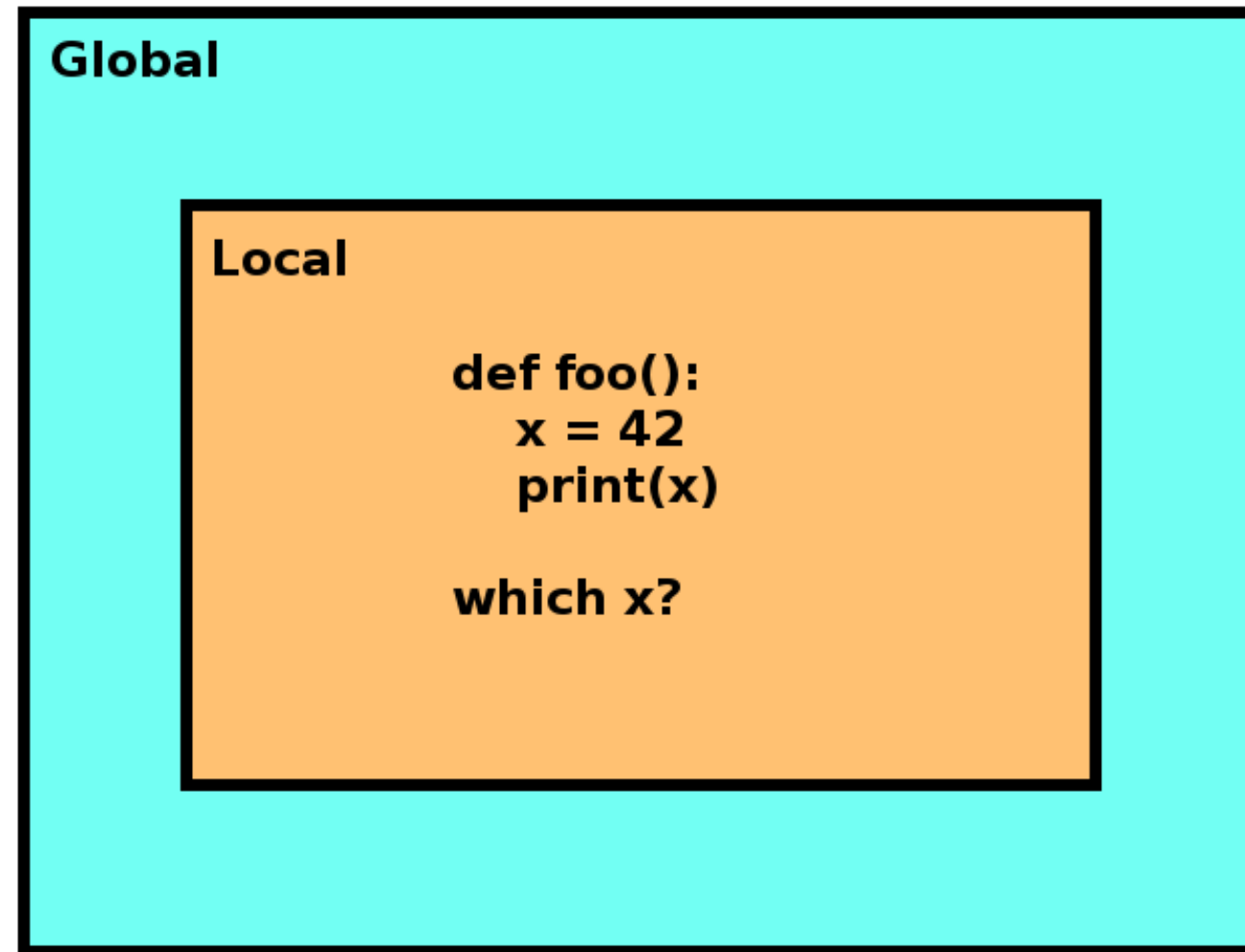
Scope

Local

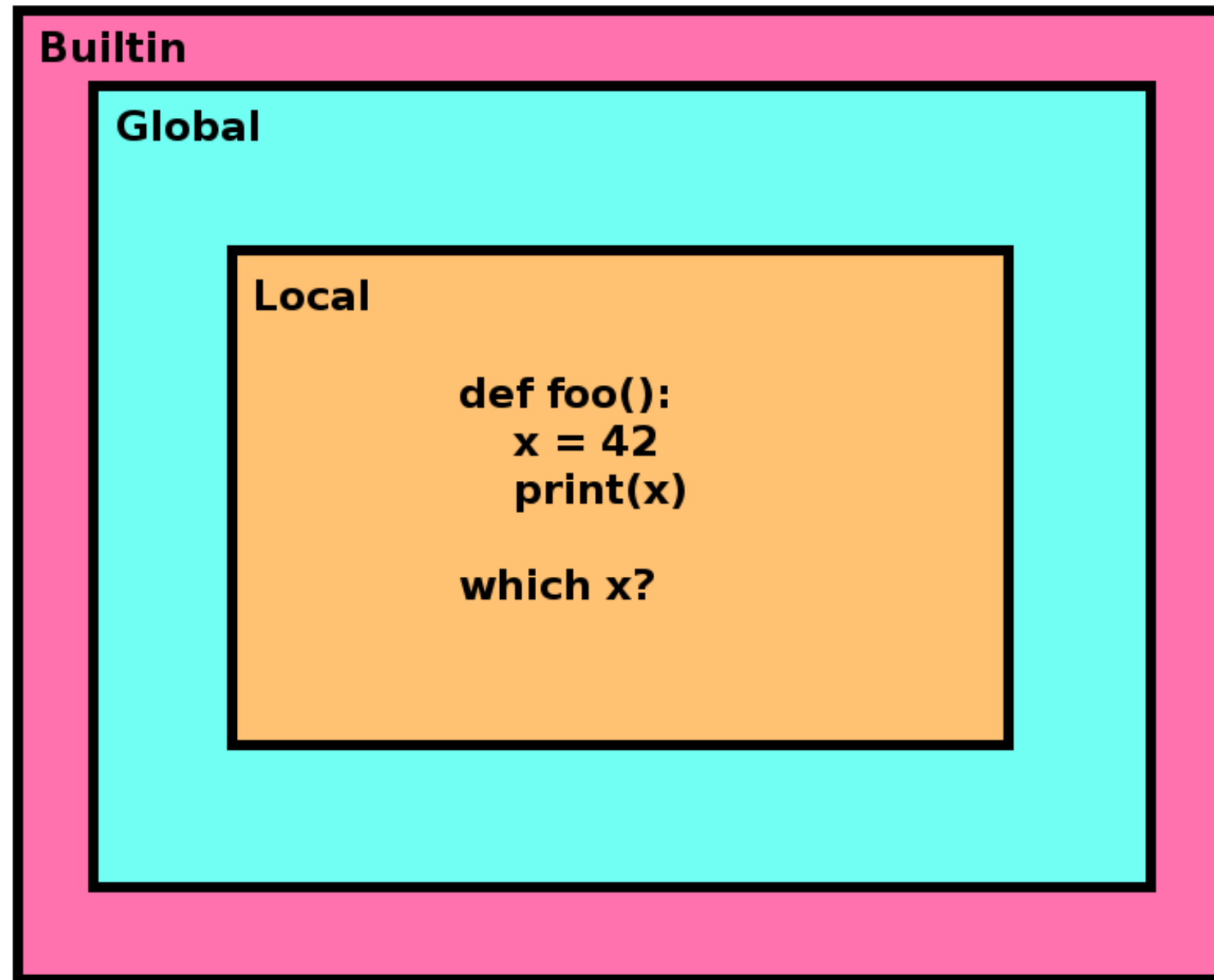
```
def foo():  
    x = 42  
    print(x)
```

which x?

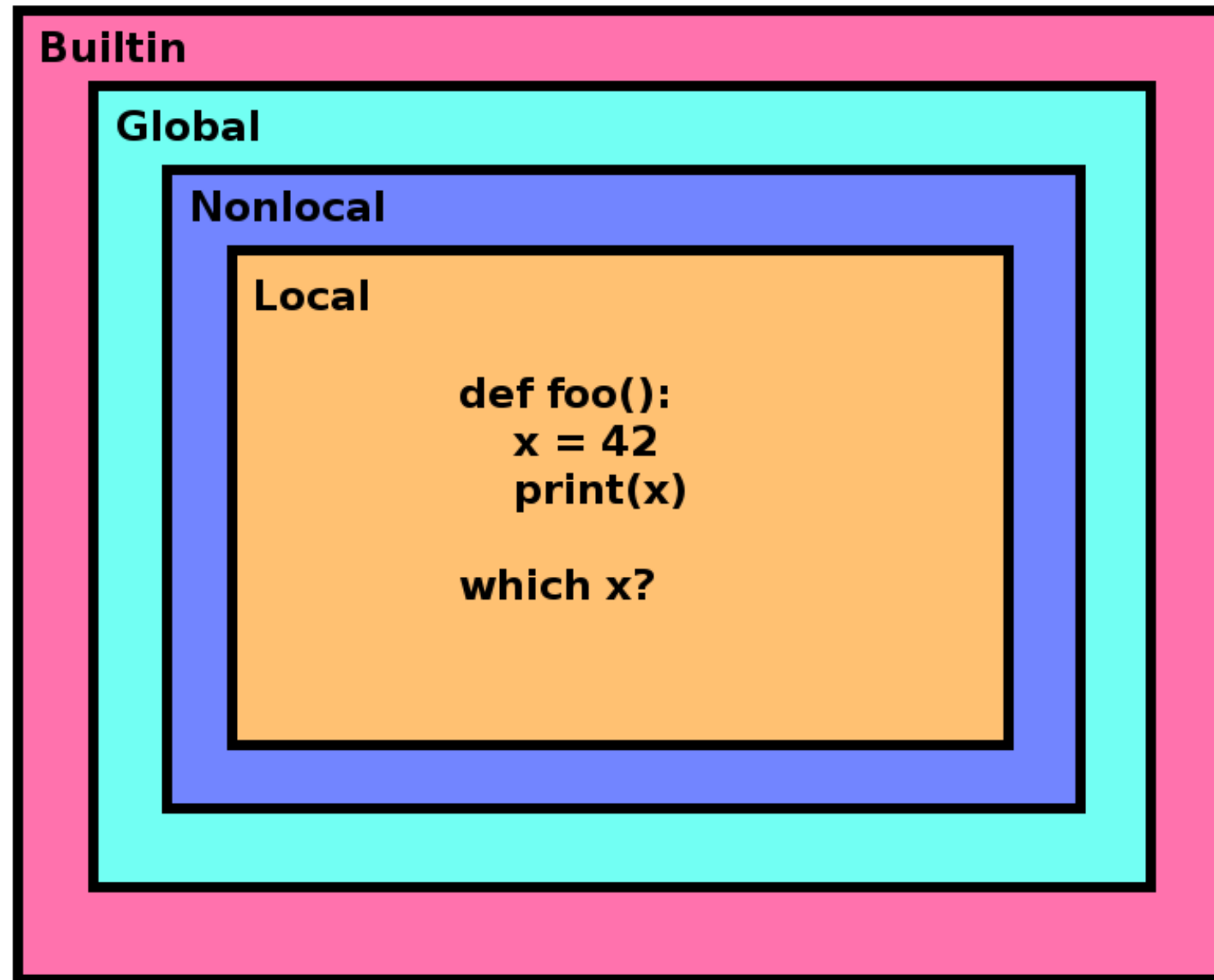
Scope



Scope



Scope



The global keyword

```
x = 7

def foo():
    x = 42
    print(x)

foo()
```

42

```
print(x)
```

7

```
x = 7

def foo():
    global x
    x = 42
    print(x)

foo()
```

42

```
print(x)
```

42

The nonlocal keyword

```
def foo():  
    x = 10  
  
    def bar():  
        x = 200  
        print(x)  
  
    bar()  
    print(x)  
  
foo()
```

```
200  
10
```

```
def foo():  
    x = 10  
  
    def bar():  
        nonlocal x  
        x = 200  
        print(x)  
  
    bar()  
    print(x)  
  
foo()
```

```
200  
200
```

Let's practice!

WRITING FUNCTIONS IN PYTHON

Closures

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Attaching nonlocal variables to nested functions

```
def foo():  
    a = 5  
    def bar():  
        print(a)  
    return bar
```

```
func = foo()
```

```
func()
```

```
5
```

Closures!

```
type(func.__closure__)
```

```
<class 'tuple'>
```

```
len(func.__closure__)
```

```
1
```

```
func.__closure__[0].cell_contents
```

```
5
```

Closures and deletion

```
x = 25

def foo(value):
    def bar():
        print(value)
    return bar

my_func = foo(x)
my_func()
```

25

```
del(x)
my_func()
```

25

```
len(my_func.__closure__)
```

1

```
my_func.__closure__[0].cell_contents
```

25

Closures and overwriting

```
x = 25

def foo(value):
    def bar():
        print(value)
    return bar

x = foo(x)
x()
```

25

```
len(x.__closure__)
```

1

```
x.__closure__[0].cell_contents
```

25

Definitions - nested function

Nested function: A function defined inside another function.

```
# outer function
def parent():
    # nested function
    def child():
        pass
    return child
```

Definitions - nonlocal variables

Nonlocal variables: Variables defined in the parent function that are used by the child function.

```
def parent(arg_1, arg_2):
    # From child()'s point of view,
    # `value` and `my_dict` are nonlocal variables,
    # as are `arg_1` and `arg_2`.
    value = 22
    my_dict = {'chocolate': 'yummy'}

    def child():
        print(2 * value)
        print(my_dict['chocolate'])
        print(arg_1 + arg_2)

    return child
```

Closure: Nonlocal variables attached to a returned function.

```
def parent(arg_1, arg_2):  
    value = 22  
    my_dict = {'chocolate': 'yummy'}  
  
    def child():  
        print(2 * value)  
        print(my_dict['chocolate'])  
        print(arg_1 + arg_2)  
  
    return child  
  
new_function = parent(3, 4)  
  
print([cell.cell_contents for cell in new_function.__closure__])
```

```
[3, 4, 22, {'chocolate': 'yummy'}]
```

Why does all of this matter?

Decorators use:

- Functions as objects
- Nested functions
- Nonlocal scope
- Closures

Let's practice!
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Decorators

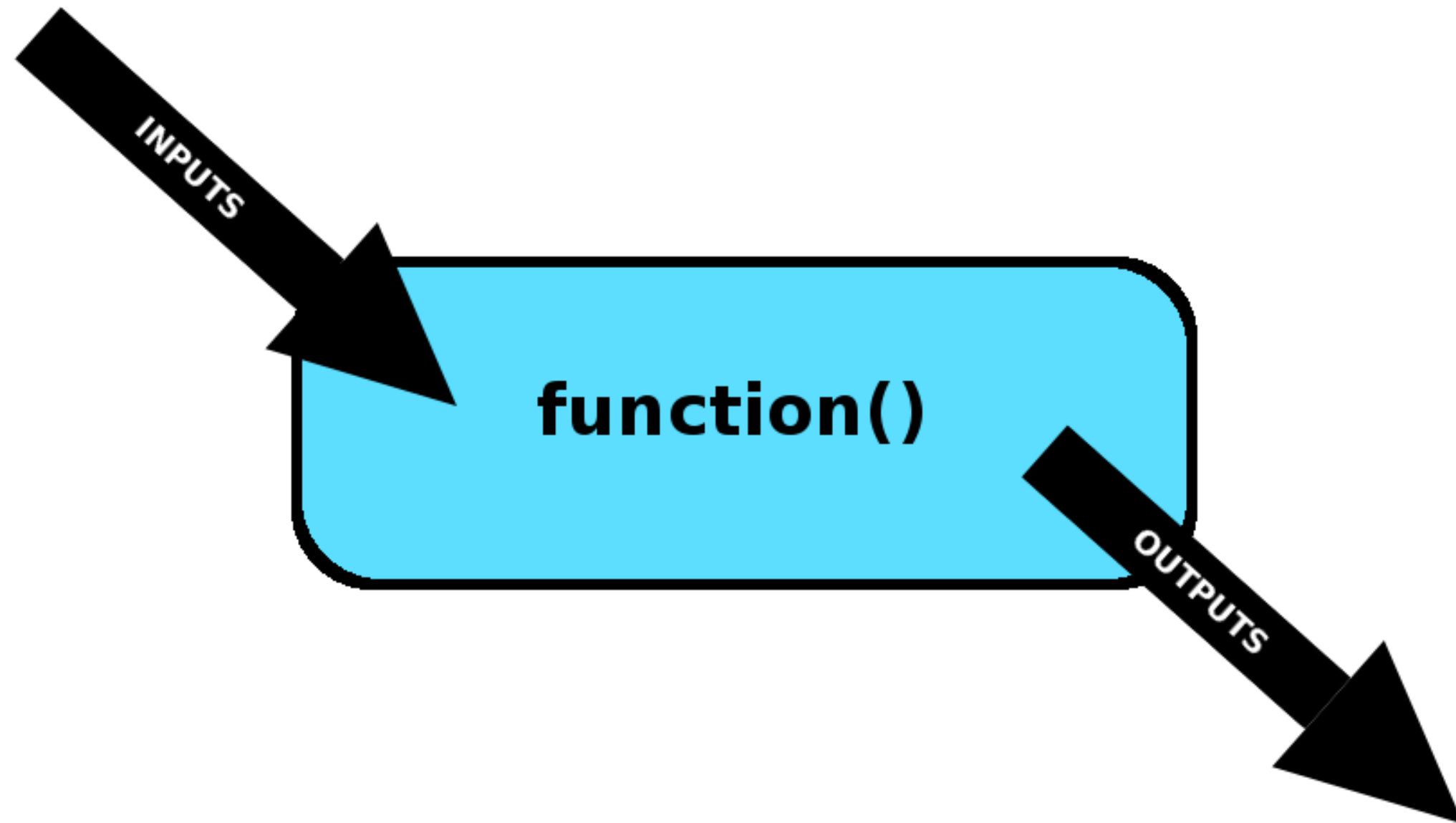
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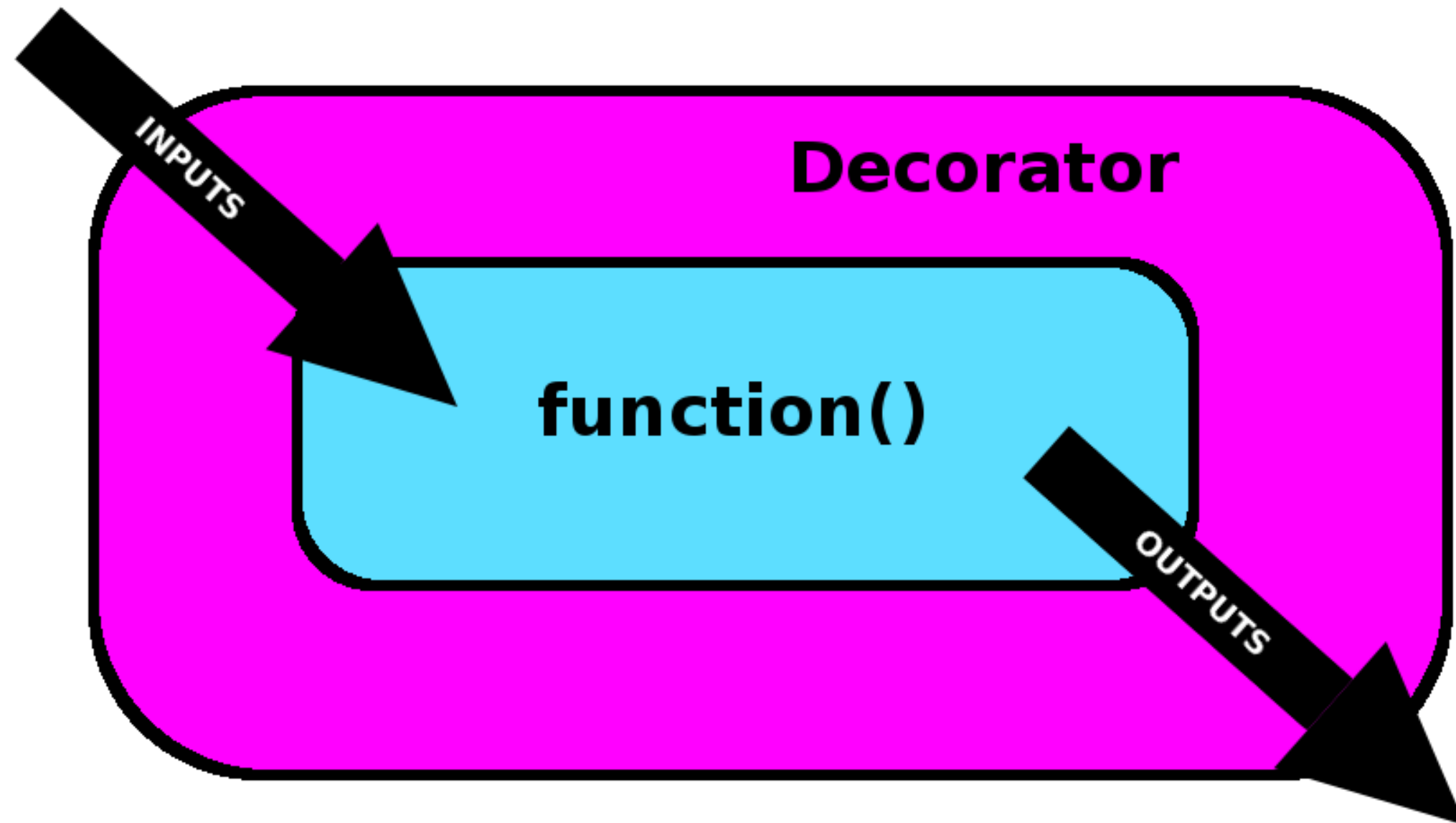
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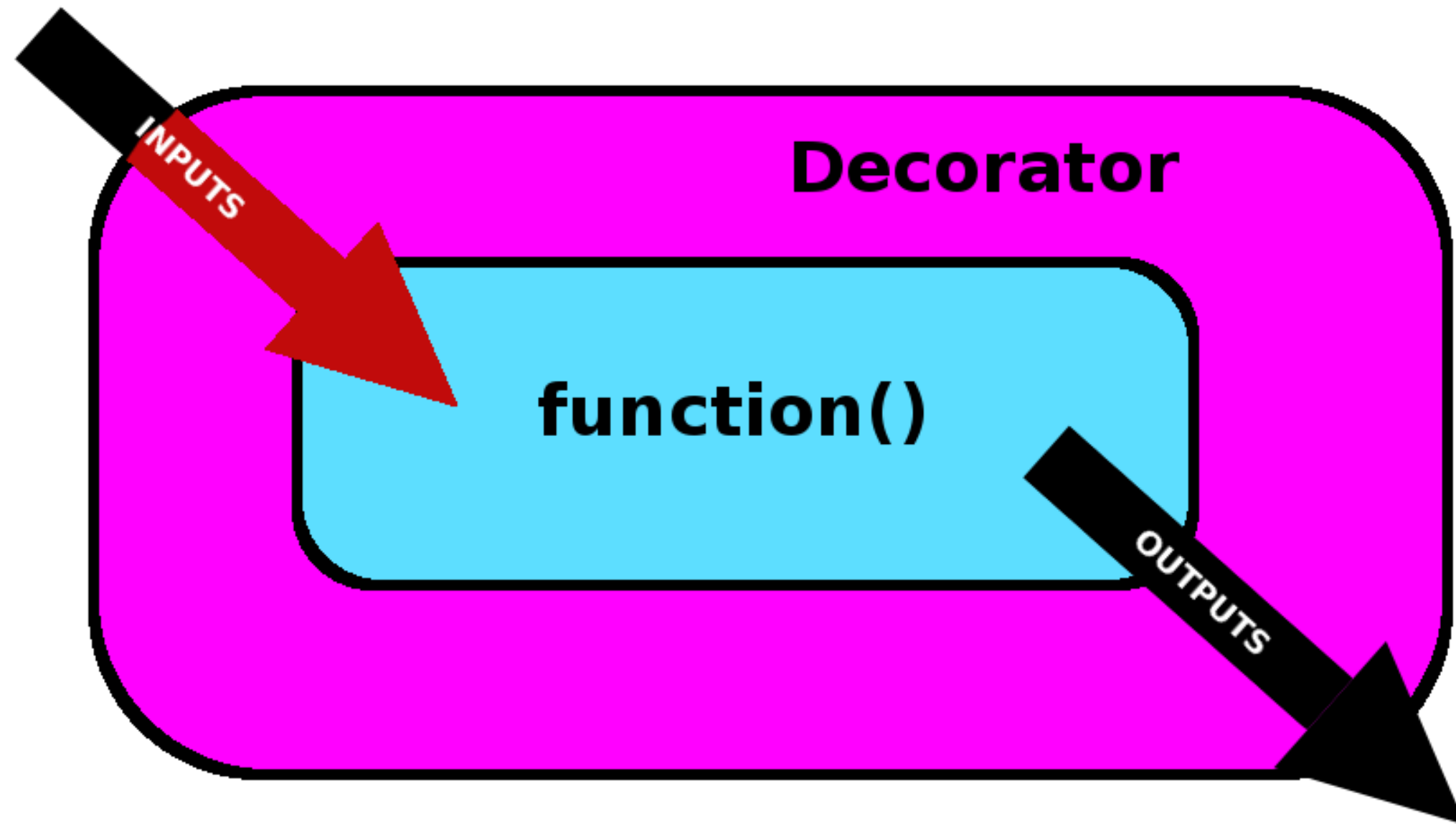
Functions



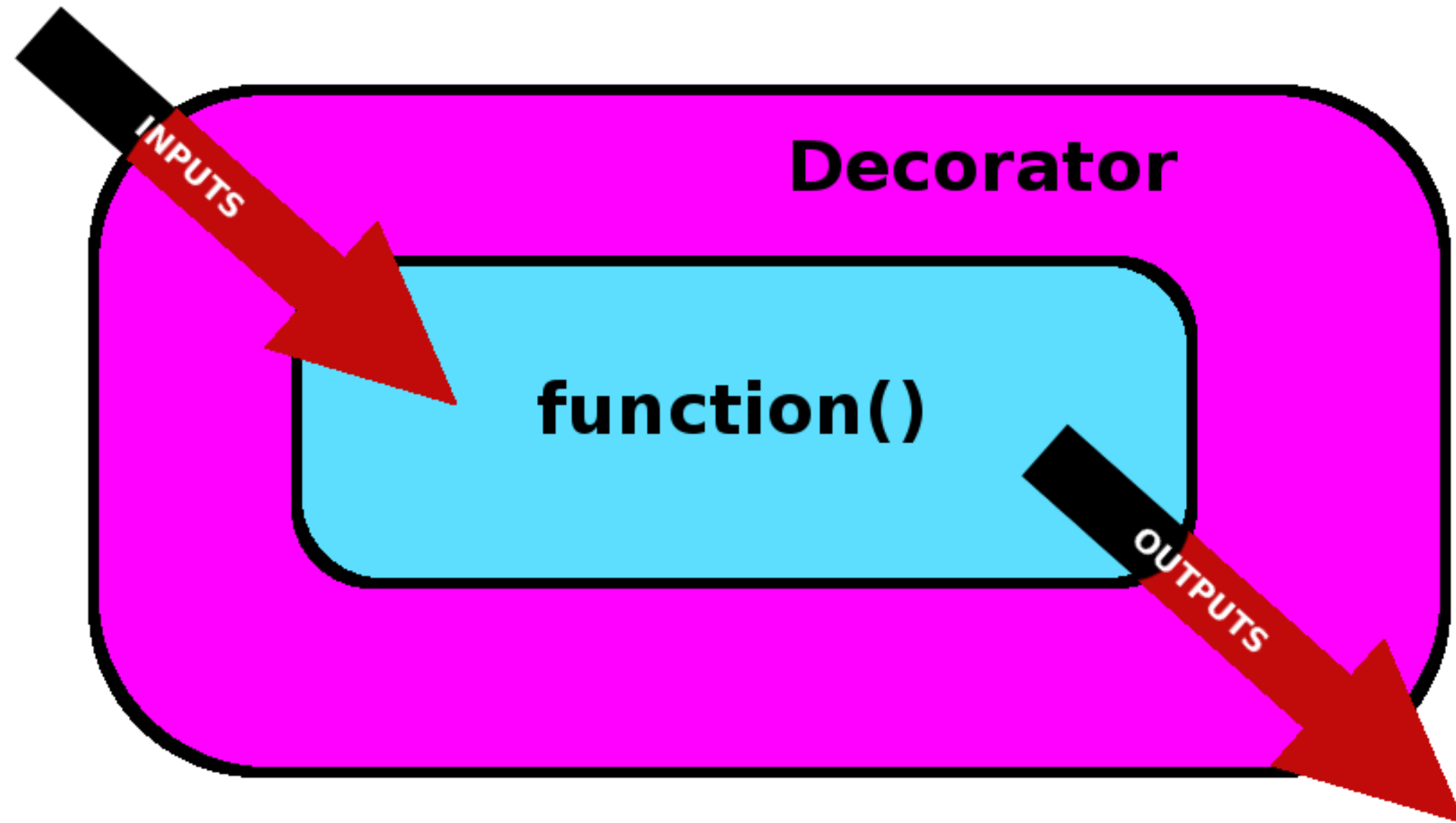
Decorators



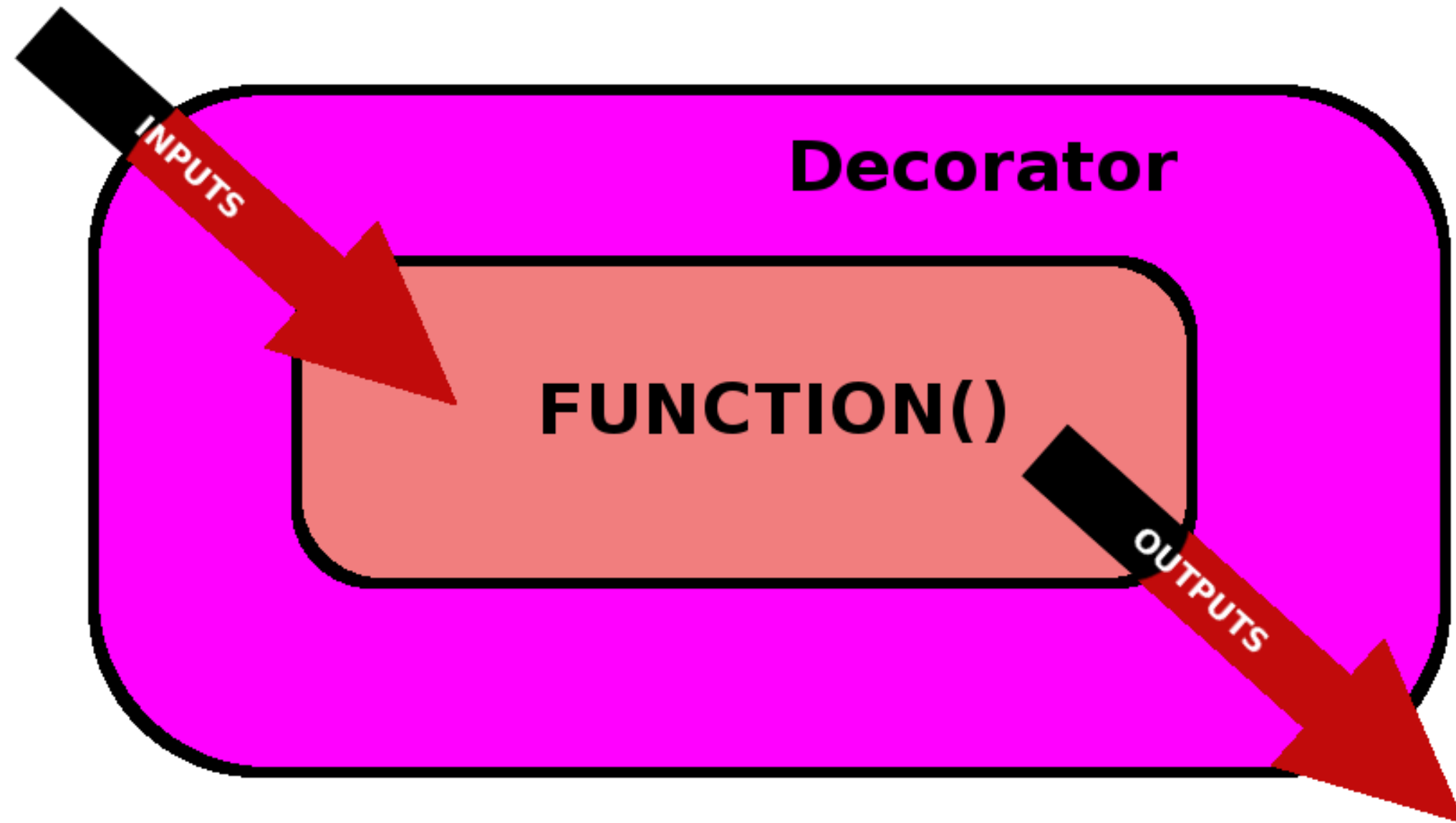
Modify inputs



Modify outputs



Modify function



What does a decorator look like?

```
@double_args  
def multiply(a, b):  
    return a * b  
multiply(1, 5)
```

20

The double_args decorator

```
def multiply(a, b):  
    return a * b  
  
def double_args(func):  
    return func  
  
new_multiply = double_args(multiply)  
new_multiply(1, 5)
```

5

```
multiply(1, 5)
```

5

The double_args decorator

```
def multiply(a, b):  
    return a * b  
  
def double_args(func):  
    # Define a new function that we can modify  
    def wrapper(a, b):  
        # For now, just call the unmodified function  
        return func(a, b)  
    # Return the new function  
    return wrapper  
  
new_multiply = double_args(multiply)  
new_multiply(1, 5)
```

The double_args decorator

```
def multiply(a, b):  
    return a * b  
  
def double_args(func):  
    def wrapper(a, b):  
        # Call the passed in function, but double each argument  
        return func(a * 2, b * 2)  
    return wrapper  
  
new_multiply = double_args(multiply)  
new_multiply(1, 5)
```

The double_args decorator

```
def multiply(a, b):  
    return a * b  
def double_args(func):  
    def wrapper(a, b):  
        return func(a * 2, b * 2)  
    return wrapper  
multiply = double_args(multiply)  
multiply(1, 5)
```

```
20
```

```
multiply.__closure__[0].cell_contents
```

```
<function multiply at 0x7f0060c9e620>
```

Decorator syntax

```
def double_args(func):  
    def wrapper(a, b):  
        return func(a * 2, b * 2)  
    return wrapper
```

```
def multiply(a, b):  
    return a * b
```

```
multiply = double_args(multiply)
```

```
multiply(1, 5)
```

20

```
def double_args(func):  
    def wrapper(a, b):  
        return func(a * 2, b * 2)  
    return wrapper
```

```
@double_args  
def multiply(a, b):  
    return a * b
```

```
multiply(1, 5)
```

20

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