Python (v3) Stack Frame Examples

CS21 at Swarthmore College

Basic Example

```
1  def f(x,y):
2    x = x + y
3    print(x)
4    return x
5
6  def main():
7    n = 4
8    out = f(n,2)
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11 main()
```

At the beginning of the program, `main` is called. We create a new stack frame. Since `main` has no parameters, the stack frame is empty.

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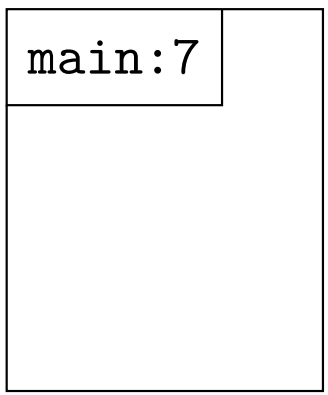

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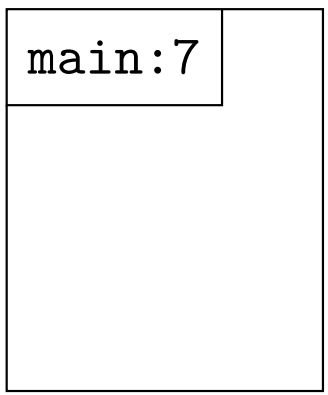

When line 7 of `main` is executed, the variable `n` is set to the value 4. We symbolize this by writing the variable name in the stack frame and creating an object on the heap for the value. We draw an arrow from the variable to its value.

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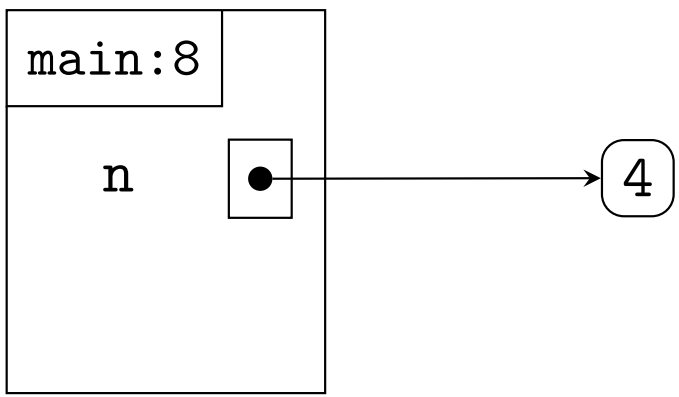

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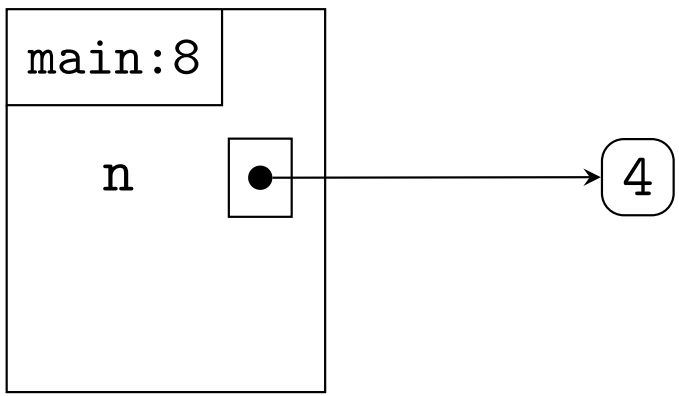

When line 8 is executed, we will call `f`. To do so, we must first determine the value of each of its arguments. In this case, the first parameter is `n`, whose value is currently 4. The second parameter is just 2.

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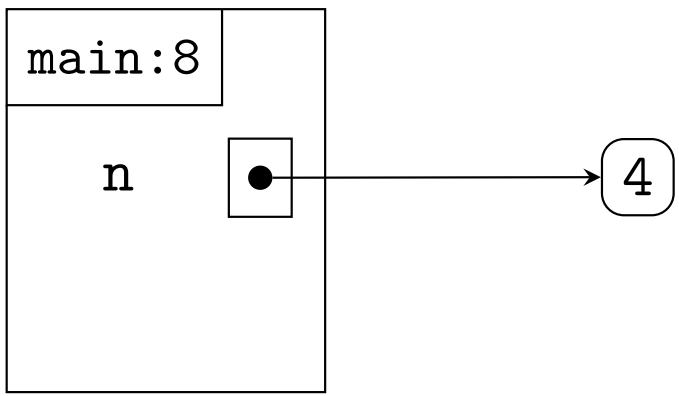

Once we've established the value of the arguments on line 8 (4 and 2, respectively), the `f` function is called. We create a new stack frame. Since `f` has two parameters, we create variables for them in the stack frame. They point to their corresponding values on the heap.

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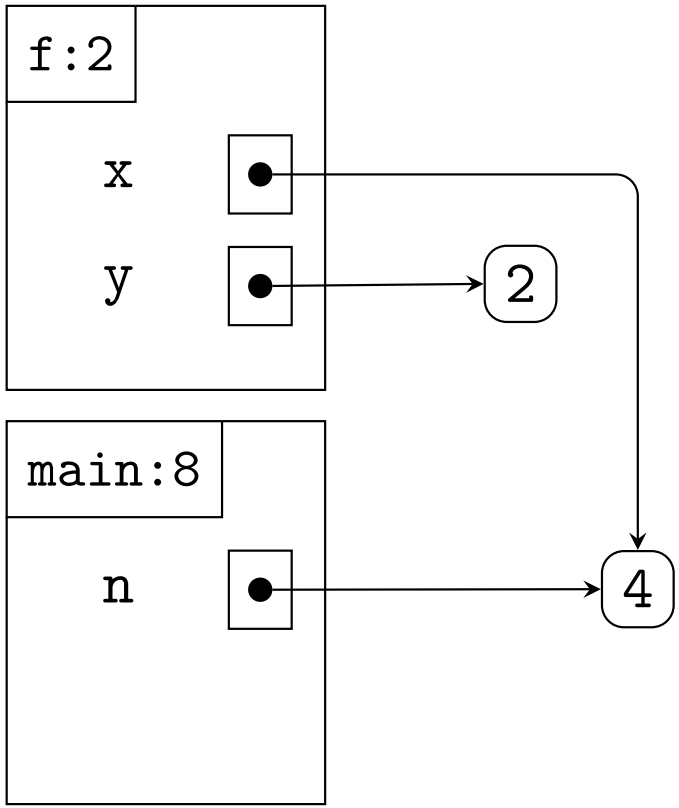

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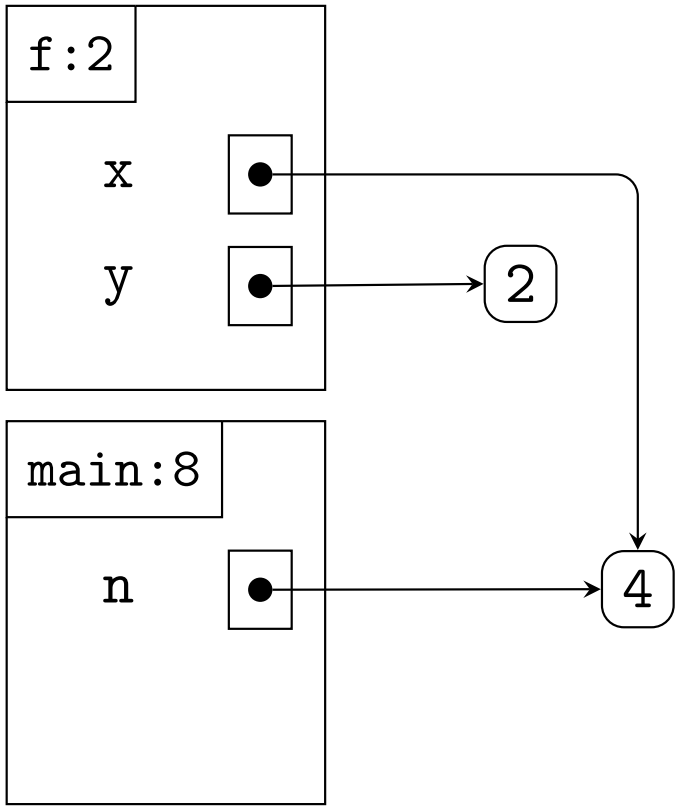

Note that the stack frame for main is keeping track of where we were in that function. When we are done with `f`, we will return to that line.

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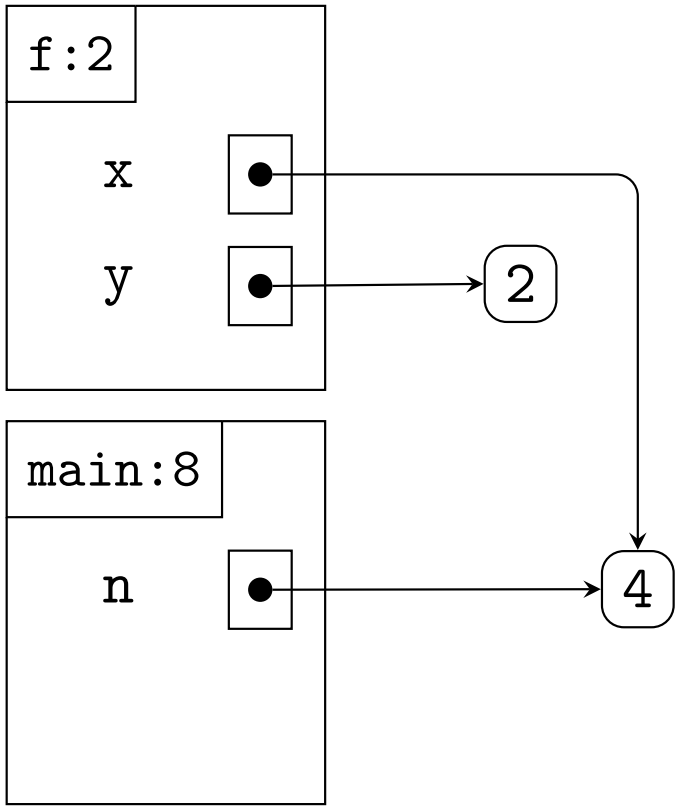

When we run line 2 in `f`, we will update the variable `x` by adding the contents of the variable `y` to it. Since **`int`**`s` are immutable, we will create a *new* object on the heap and make `x` point to it.

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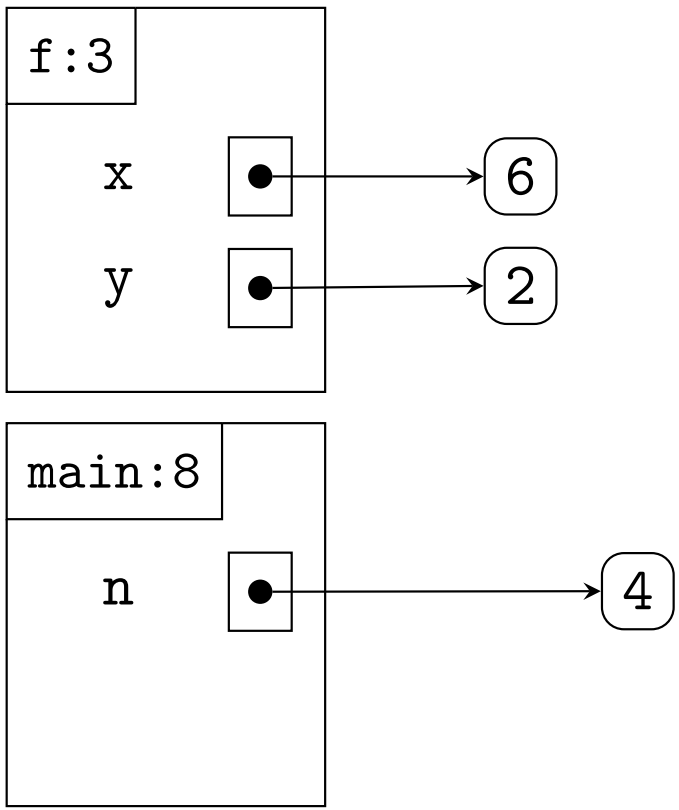

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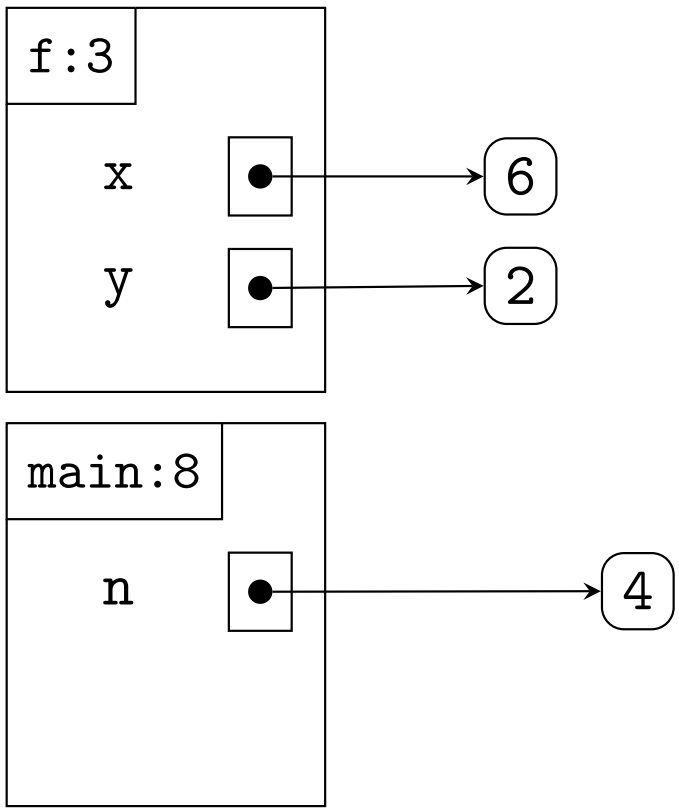

Line 3 will print the contents of the `x` variable: in this case, 6.

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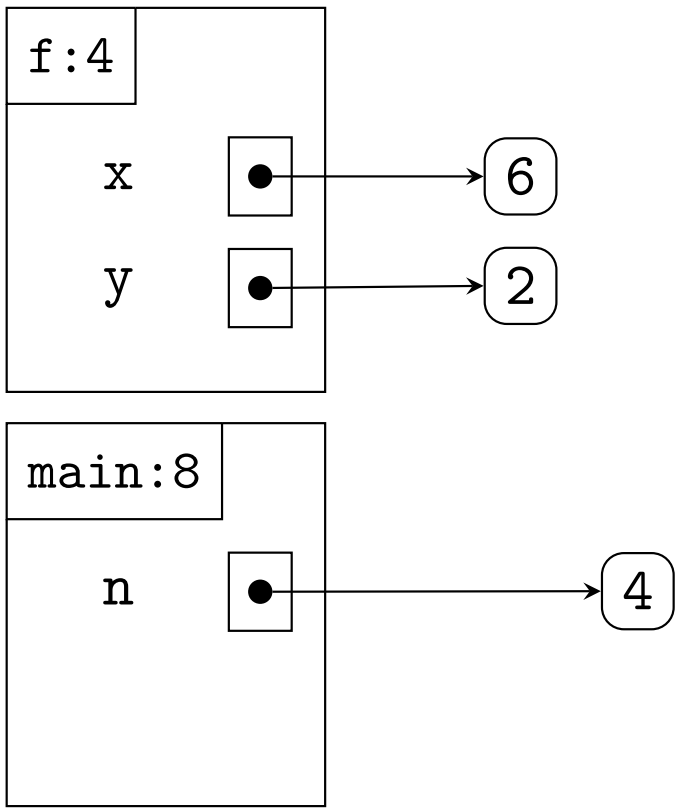

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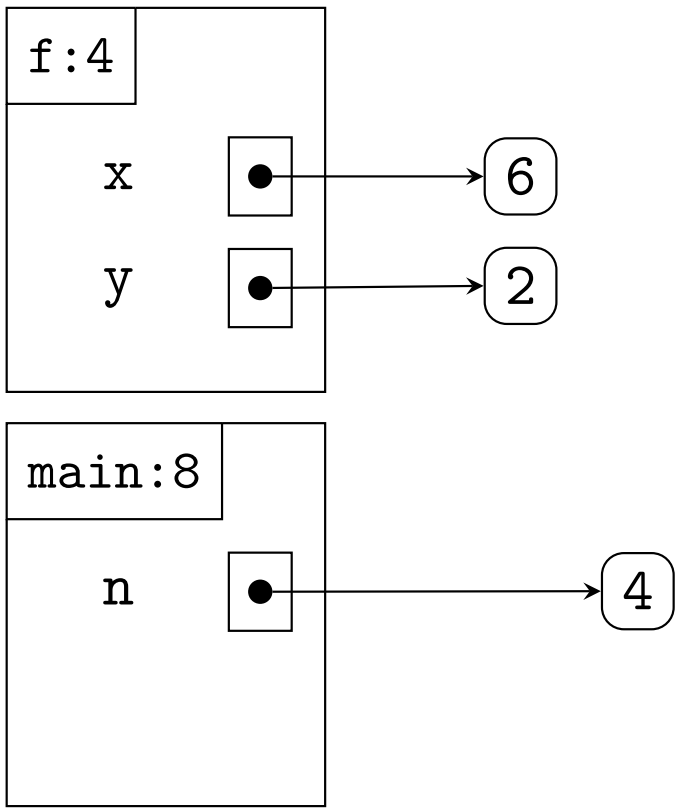

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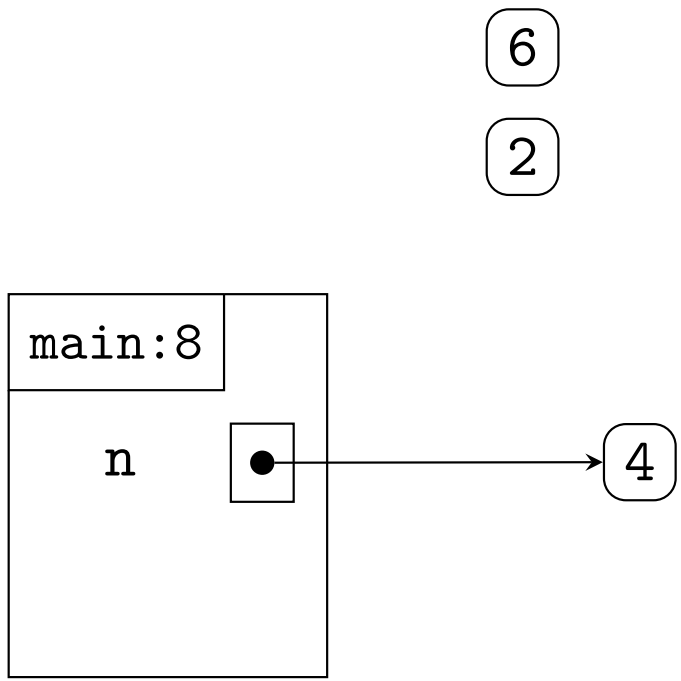

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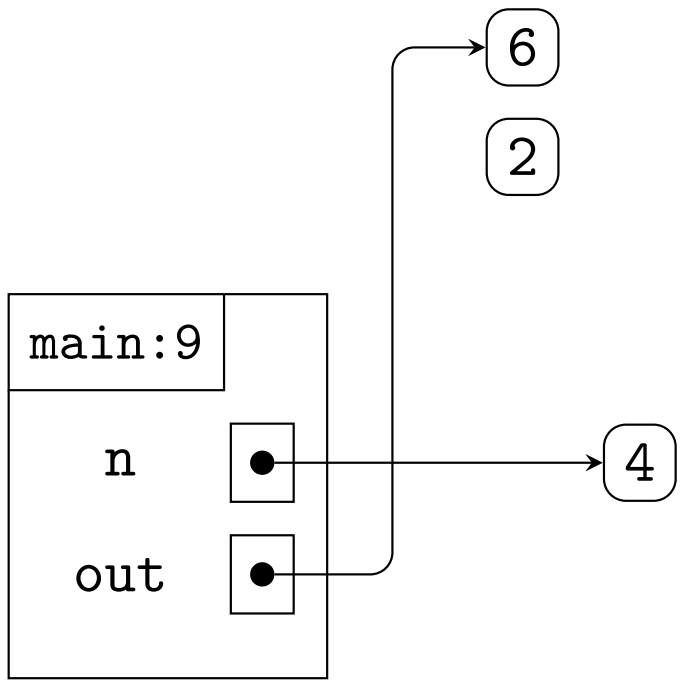

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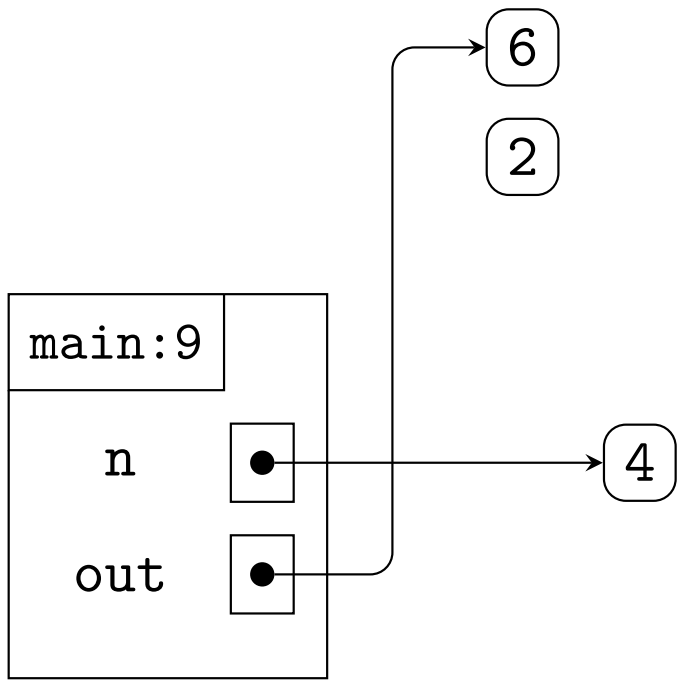

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As before, `main` is called at the start of this program. We create a new stack frame for it.

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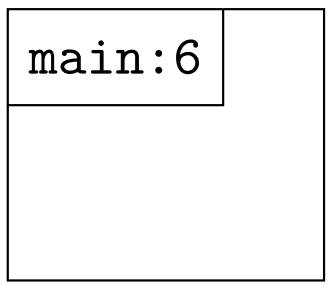

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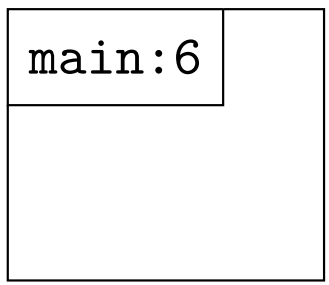

Line 6 of `main` creates a new list containing just the value `1`. A *reference* to that list is stored in the `data` variable. We represent the list by using a rounded box; we represent the reference as an arrow.

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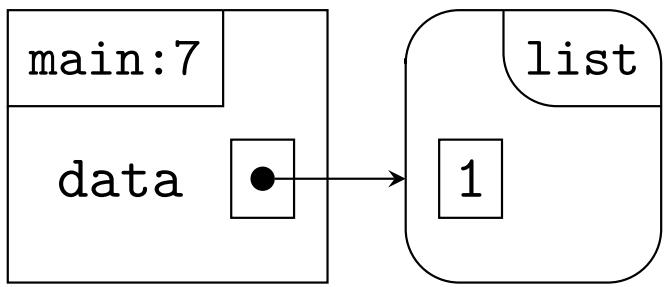

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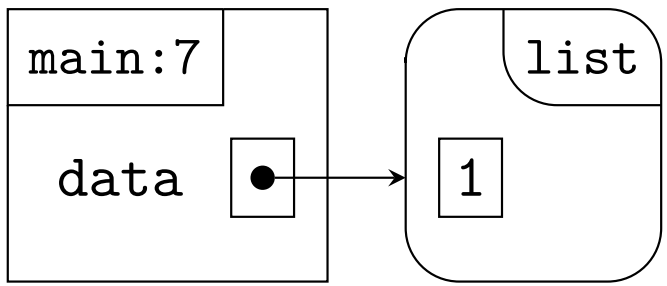

Line 7 of `main` is a function call. Just as before, we create a new stack frame and copy each argument into its corresponding parameter. Here, we copy the value 2 into the variable `x` and we copy the *reference* from `data` into the variable `lst`.

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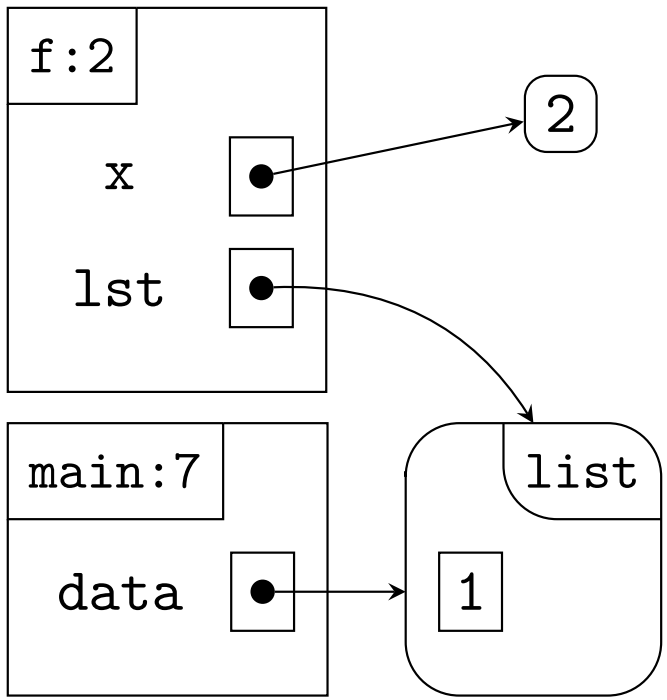

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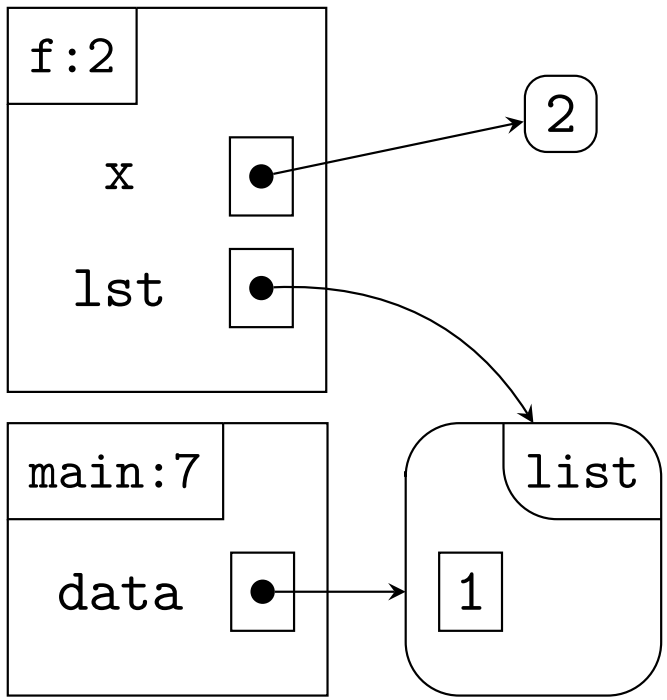

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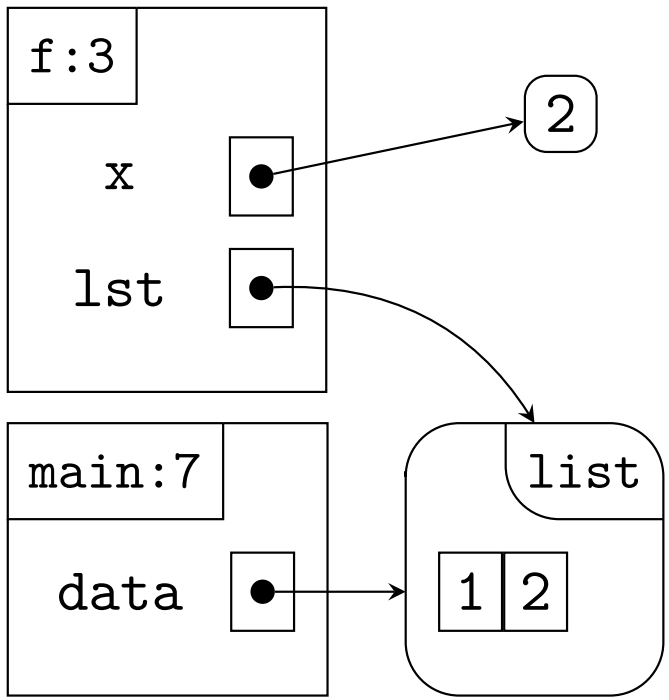

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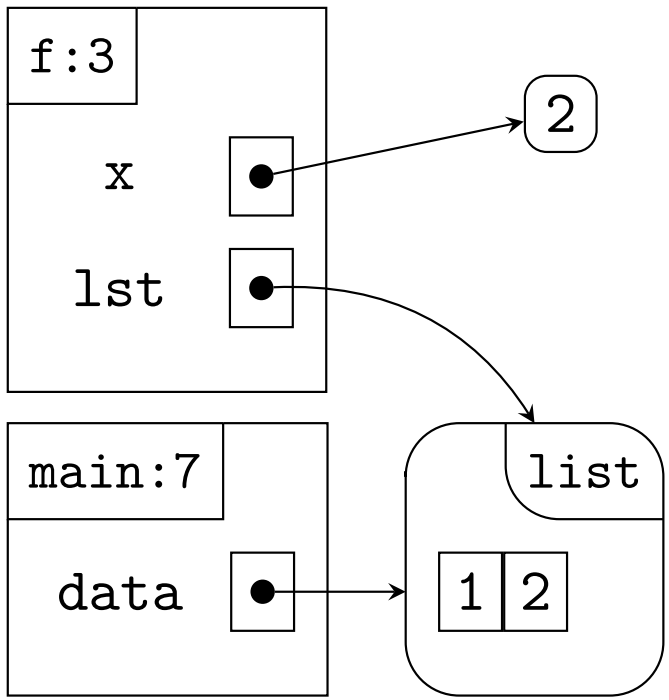

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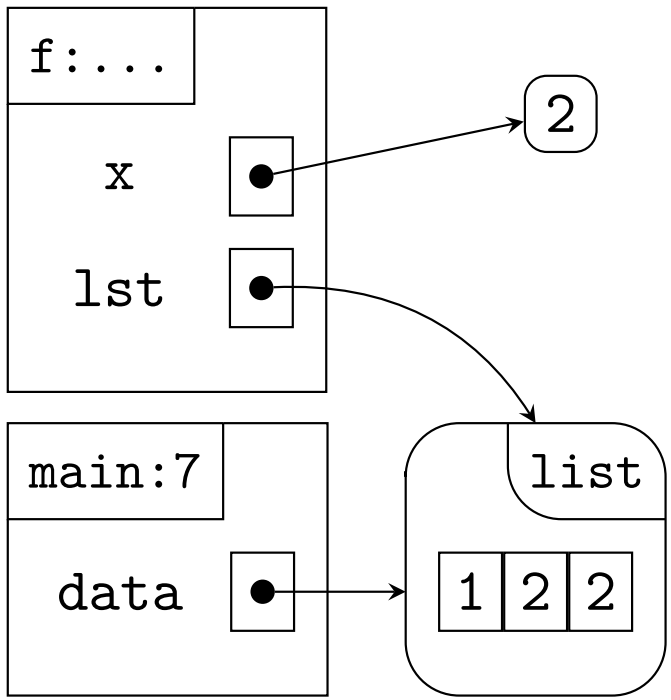

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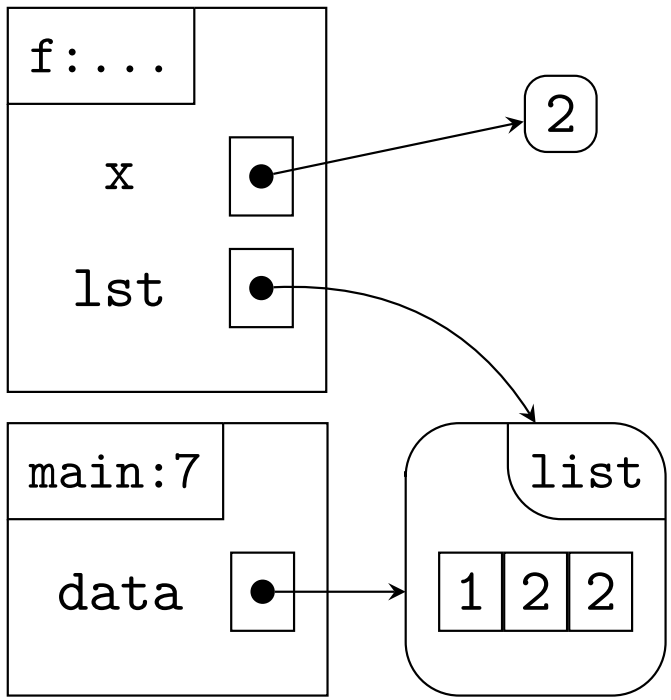

Once we're finished with the `add_twice` function, we destroy its stack frame and return to executing `main`.

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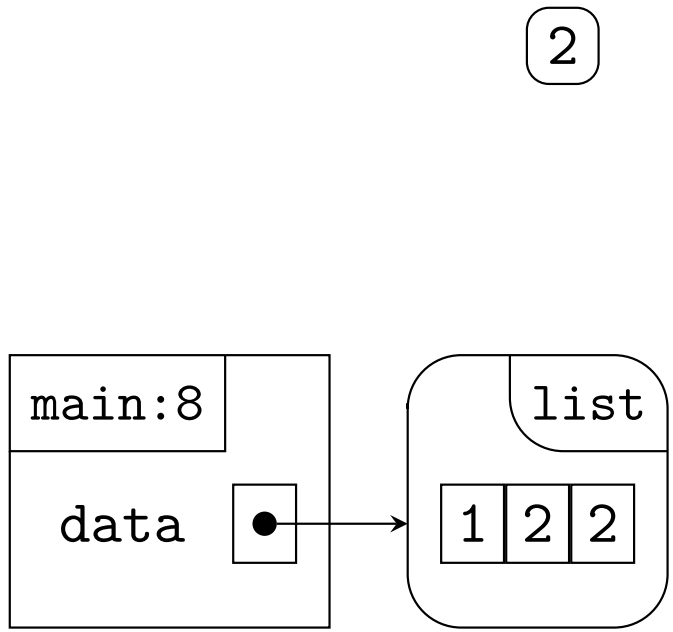

Line 8 of `main` prints the contents of the list to which `data` refers. Because of the call to `add_twice`, this list changed. So `main` prints "`[1,2,2]`".

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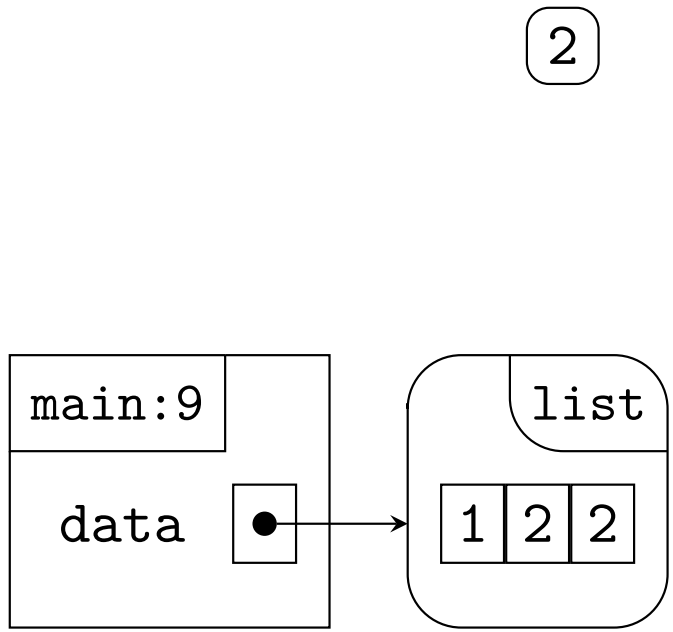

Line 9 of `main` calls `add_twice` again. Just as last time, we copy the arguments into their respective parameters. This time, `x` is set to 3; `lst` is still set to the same reference as `data`.

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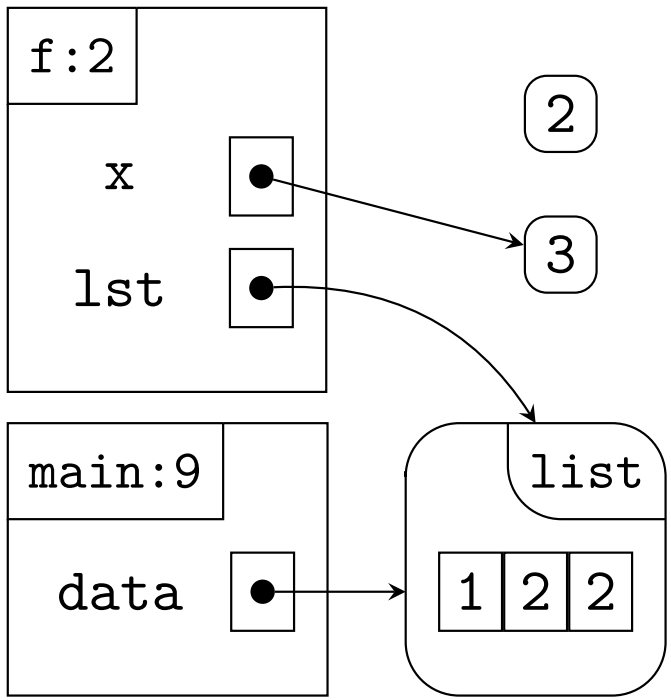
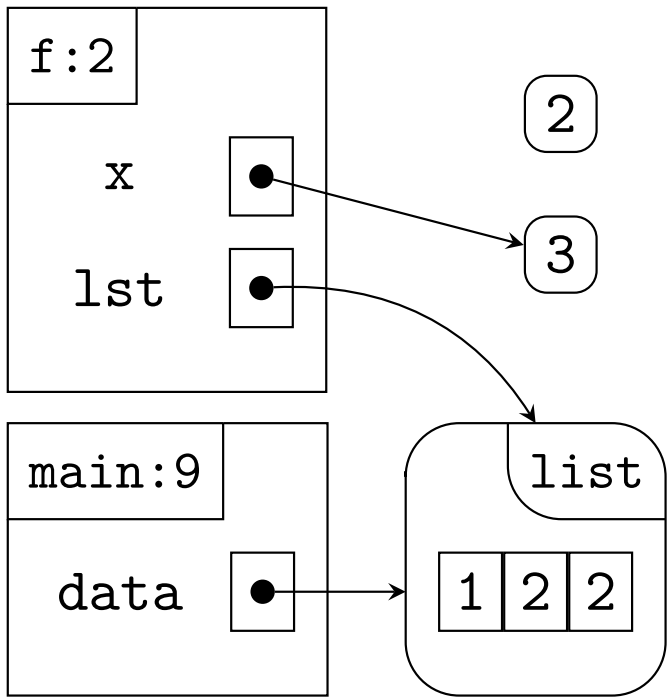


Line 9 of `main` calls `add_twice` again. Just as last time, we copy the arguments into their respective parameters. This time, `x` is set to 3; `lst` is still set to the same reference as `data`.

Lists Example

```
1  def add_twice(x,lst):
2    lst.append(x)
3    lst.append(x)
4
5  def main():
6    data = [1]
7    add_twice(2,data)
8    print(data)
9    add_twice(3,data)
10   print(data)
11
12 main()
```



Once again, `add_twice` adds the value contained in `x` to the list referenced by `lst`; it does this twice.

Lists Example

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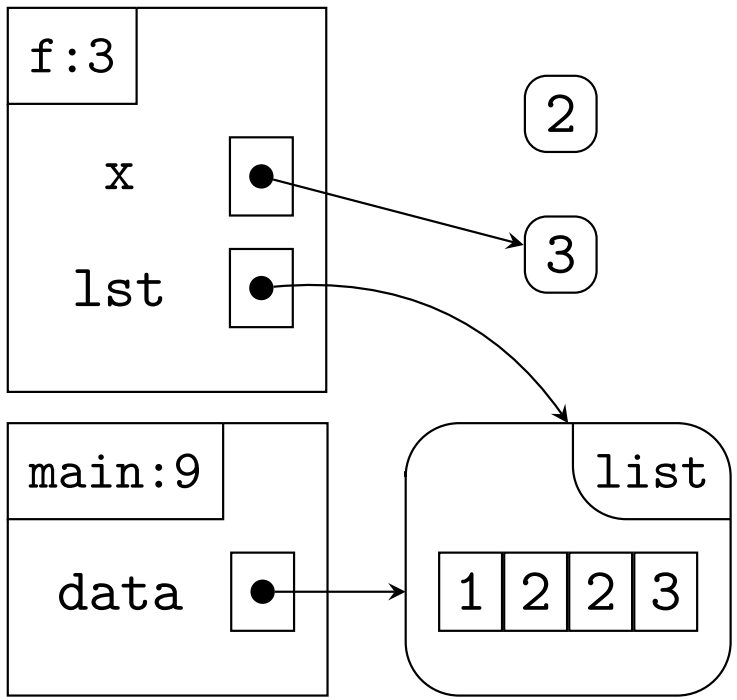

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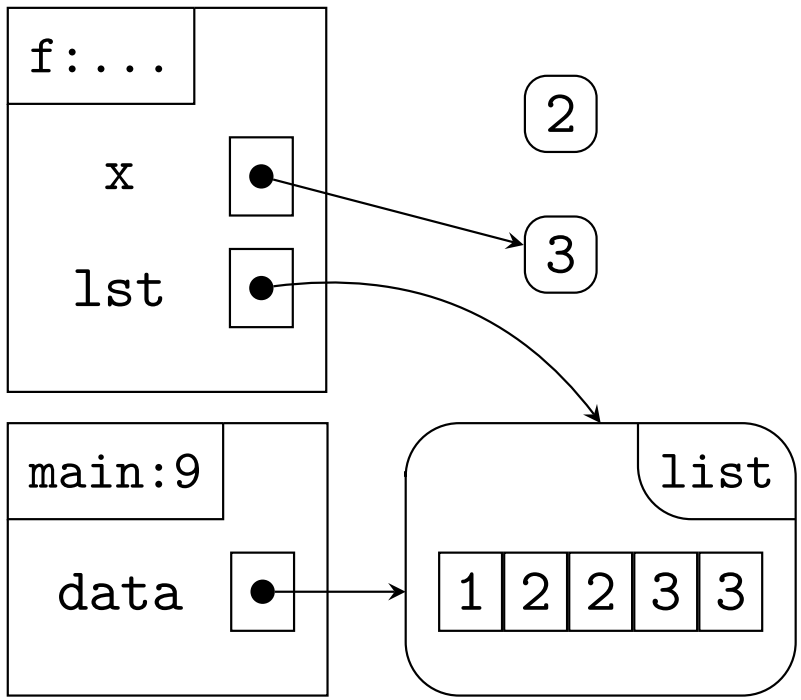

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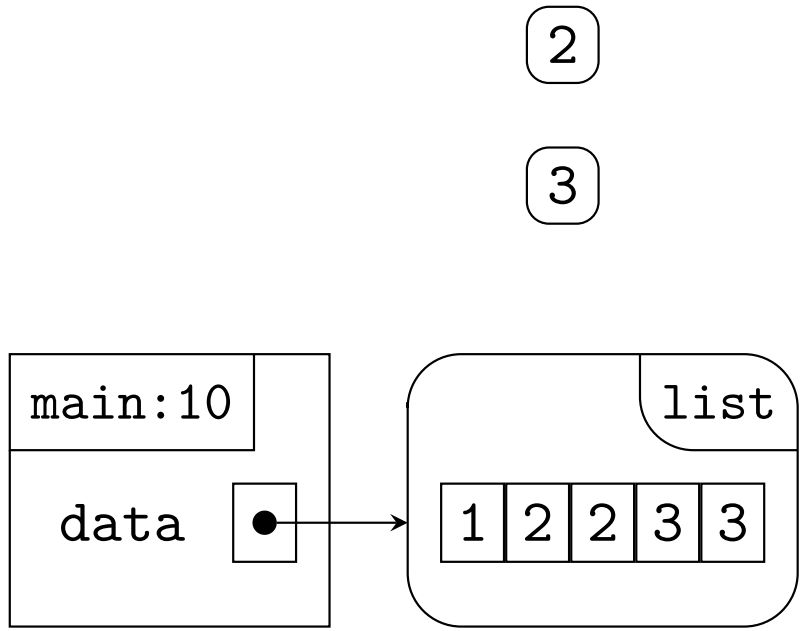

We finish `add_twice`, discarding its stack frame. We return to `main`, where line 10 prints the contents of the list. Because it has been changed again, we print `[1,2,2,3,3]` this time.

Lists Example

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3    lst.append(x)
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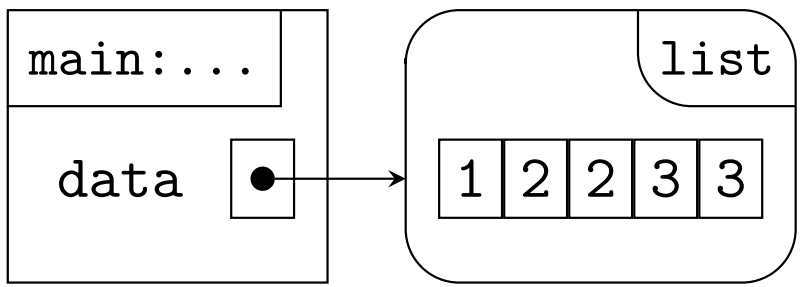
9    add_twice(3,data)
10   print(data)
11
12 main()
```

2

3



With that, the program is finished.

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