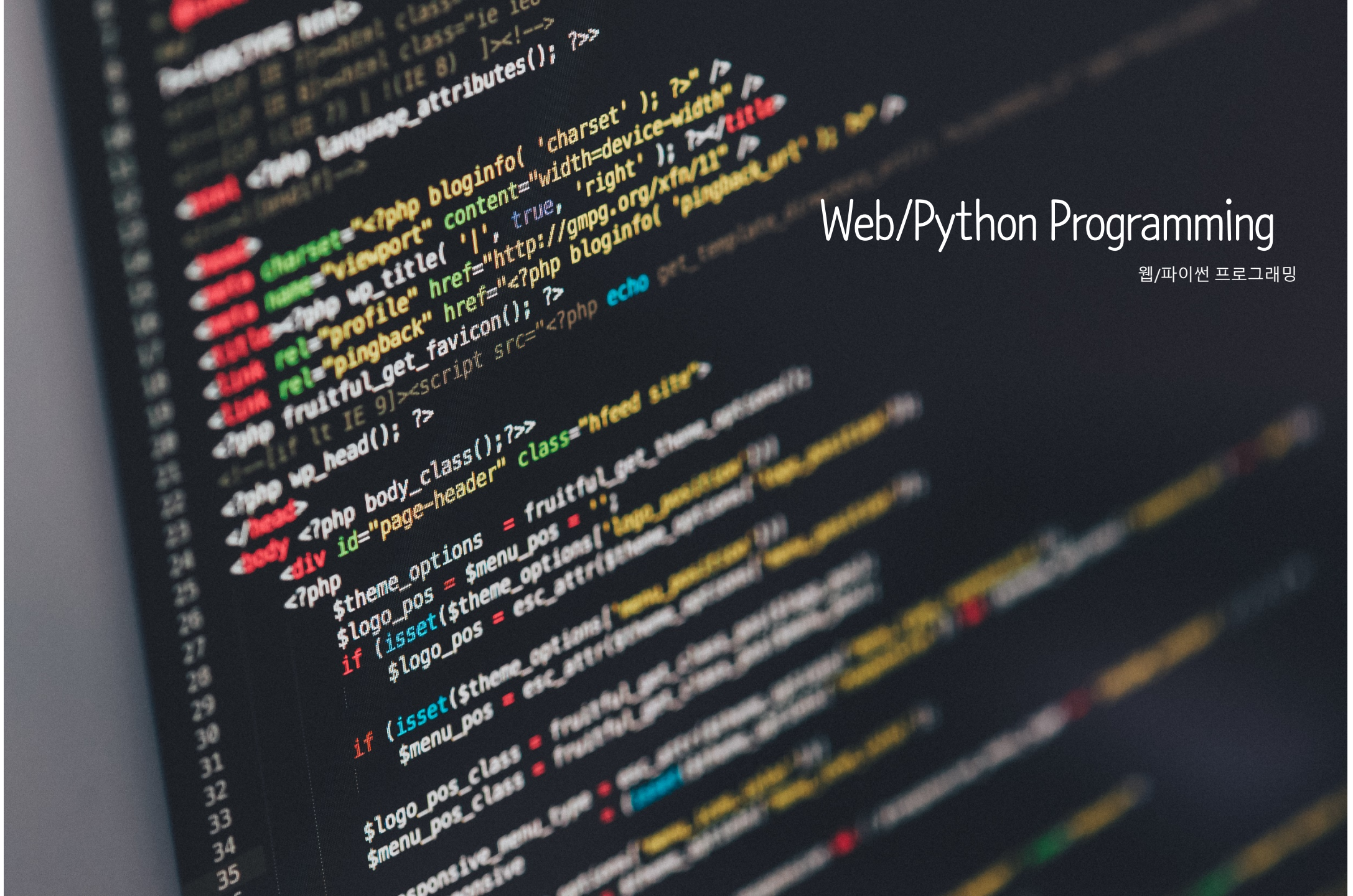


Web/Python Programming

웹/파이썬 프로그래밍

Today

- Review variables and computer memory
- Python-provided functions
- Defining your own functions
- Local variables
- Tracing function calls in the memory model

Variables

- Let's give a name to a value
  - `X, species5618, degrees_celsius`
  - `777obj(X), no-way(X), hello!(X)`
- Assignment statement

```
>>> degrees_celsius = 26.0
```

- You can assign a new value to the existing variable

```
>>> degrees_celsius = 26.0
>>> degrees_celsius
26.0
>>> 9 / 5 * degrees_celsius + 32
78.80000000000001
>>> degrees_celsius / degrees_celsius
1.0
```

```
>>> degrees_celsius = 26.0
>>> 9 / 5 * degrees_celsius + 32
78.80000000000001
>>> degrees_celsius = 0.0
>>> 9 / 5 * degrees_celsius + 32
32.0
```

- Note that = means "assignment", not "equality"

Values, variables, and computer memory

- Every location in the computer's memory has a **memory address**
- **Object**: a value at a memory address with a type

```
26.0          id1          float
```

- **Variable** contains the memory address of the object

```
degrees_celsius
```

Values, variables, and computer memory

- **Object**: a value at a memory address with a type

`26.0` `id1` `float`

- **Variable** contains the memory address of the object

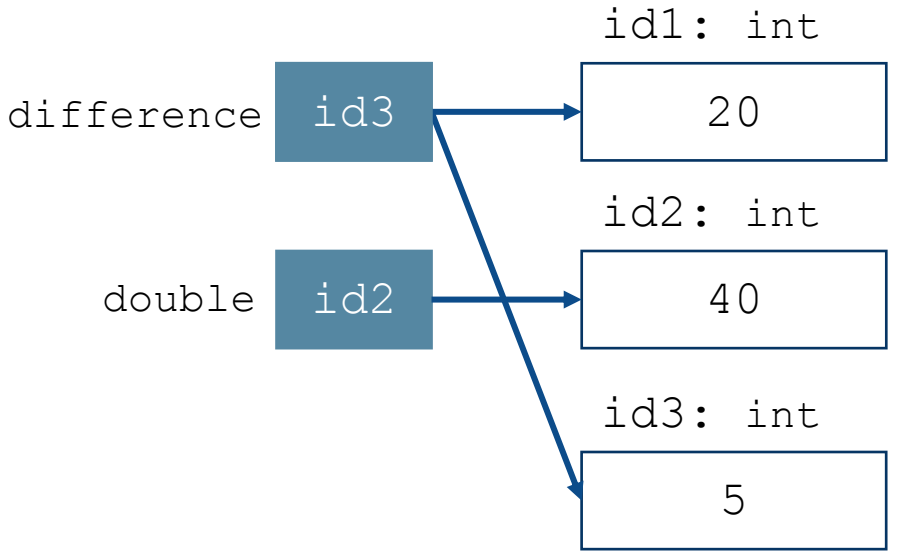
`degrees_celsius`

  - Value `26.0` has the memory address `id1`.
  - The object at the memory address `id1` has type `float` and the value `26.0`
  - Variable `degree_celsius` contains the memory address `id1`.

Assignment statement

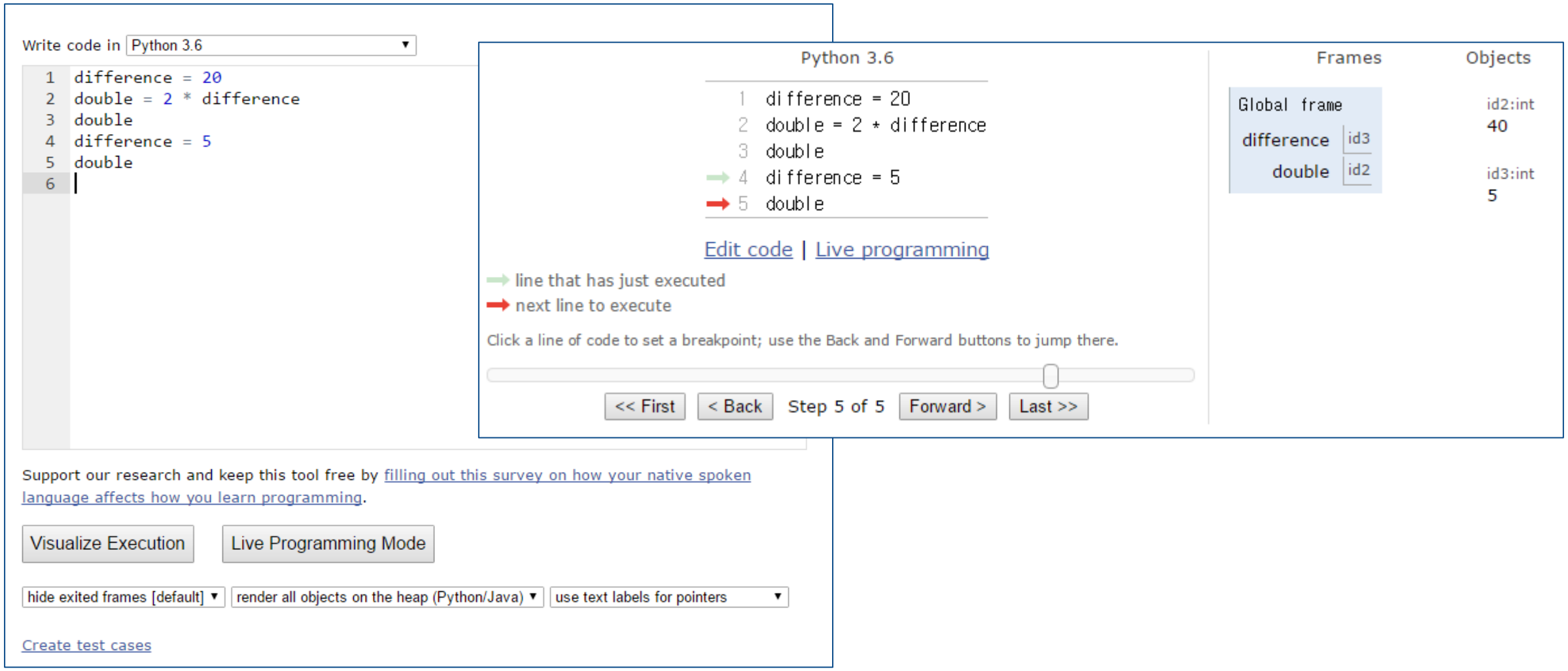
```
>>> degrees_celsius = 26.0 + 5
>>> degrees_celsius
31.0
```


```
>>> difference = 20
>>> double = 2 * difference
>>> double
40
>>> difference = 5
>>> double
40
```



Memory visualization

- `http://pythontutor.com/visualize.html`



Functions

- In mathematics

$$y = f(x) = x^2 + 3x + 2$$

$$f(2) = 12$$

$$z = f(x, y) = x^2 y + 4x + 1$$

$$f(2,3) = 21$$

- Python build-in functions

```
>>> abs(-9)
9
>>> pow(3,2)
9
>>> round(4.3)
4
>>> pow( abs(-2), round(4.3) )
16
>>> round(-3.5)
-4
```

Functions

$$y = f(x)$$

$$\text{출력} = f(\text{입력})$$

Typecast

- Functions that convert from one type to another

```
>>> int(34.6)
34
>>> int(-4.3)
-4
>>>float(21)
21.0
```

help( )

```
>>> help(abs)
Help on built-in function abs in module builtins:

abs(x, /)
    Return the absolute value of the argument.

>>> help(pow)
Help on built-in function pow in module builtins:

pow(x, y, z=None, /)
    Equivalent to x**y (with two arguments) or x**y % z (with three arguments)

    Some types, such as ints, are able to use a more efficient algorithm when
    invoked using the three argument form.

>>> help(round)
Help on built-in function round in module builtins:

round(...)
    round(number[, ndigits]) -> number

    Round a number to a given precision in decimal digits (default 0 digits).
    This returns an int when called with one argument, otherwise the
    same type as the number. ndigits may be negative.

>>>
```

```
>>> pow(2,4)
16
>>> pow(2,4,3)
1
>>> round(3.141592)
3
>>> round(3.141592,2)
3.14
```

id( ) : Memory addresses

- **Object**: a value at a memory address with a type

  26.0 id1 float

- **Variable** contains the memory address of the object

degrees_celsius

```
>>> help(id)
Help on built-in function id in module builtins:

id(obj, /)
    Return the identity of an object.

    This is guaranteed to be unique among simultaneously existing objects.
    (CPython uses the object's memory address.)
```

```
>>> id(-9)
2112378679184
>>> id(23.1)
2112332606104
>>> shoe_size = 8.5
>>> id(shoe_size)
2112332606080
>>> shoe_size = 9.0
>>> id(shoe_size)
2112332606104
>>> id(abs)
2112332504736
>>> id(round)
2112332531824
>>>
```

Defining your own functions

```
>>> convert_to_celsius(212)
100.0
```

```
>>> convert_to_celsius(212)
Traceback (most recent call last):
  File "<pyshell#48>", line 1, in <module>
    convert_to_celsius(212)
NameError: name 'convert_to_celsius' is not defined
```

```
>>> def convert_to_celsius (fahrenheit):
        return (fahrenheit - 32) * 5/9
```

How Python executes

```
>>> def convert_to_celsius (fahrenheit):
        return (fahrenheit - 32) * 5/9

>>> convert_to_celsius(212)
100.0
>>>
```

How Python executes

```
>>> def convert_to_celsius (fahrenheit):
        return (fahrenheit - 32) * 5/9
```

- Python executes the function definition – creates the function object

How Python executes

```
>>> def convert_to_celsius (fahrenheit):
        return (fahrenheit - 32) * 5/9

>>> convert_to_celsius(212)
```

- Python executes the function definition – creates the function object
- Python executes function call
  - It assigns 212 to fahrenheit

How Python executes

```
>>> def convert_to_celsius (fahrenheit):
        return (fahrenheit - 32) * 5/9

>>> convert_to_celsius(212)
100.0
```

- Python executes the function definition – creates the function object
- Python executes function call
  - It assigns 212 to fahrenheit
- Python executes the return statement
  - (212 – 32) * 5/9
  - The result of calling `convert_to_celsius(212)` is 100.0

How Python executes

```
>>> def convert_to_celsius (fahrenheit):
        return (fahrenheit - 32) * 5/9

>>> convert_to_celsius(212)
100.0
>>>
```

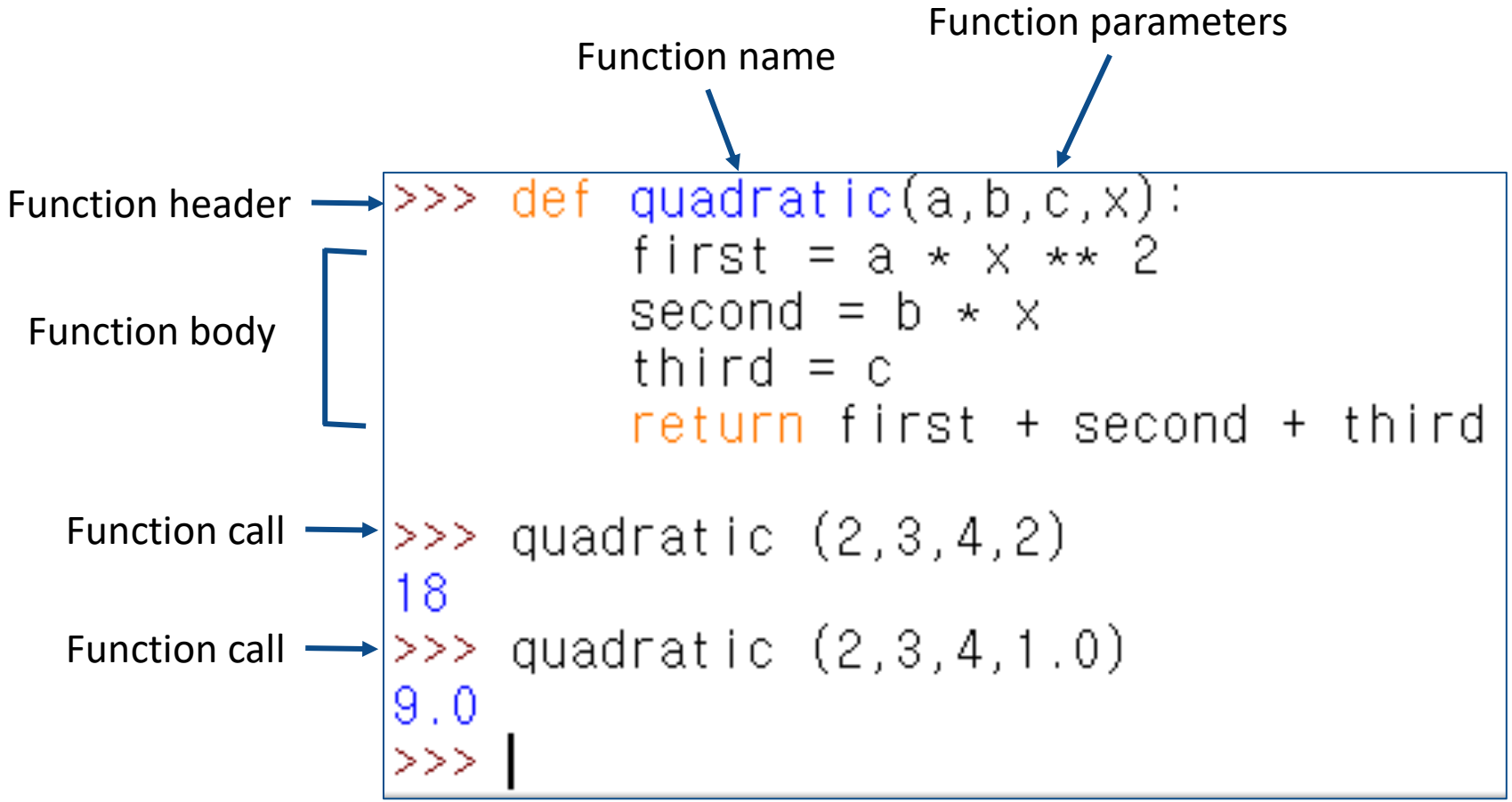
- Python executes the function definition – creates the function object
- Python executes function call
  - It assigns 212 to fahrenheit
- Python executes the return statement
  - (212 – 32) * 5/9
  - The result of calling `convert_to_celsius(212)` is 100.0
- Once Python has finished executing the function call, it returns to the place where the function was originally called.

Keywords

- We cannot use `def` and `return` as either variable names or as function names

```
>>> def = 3
SyntaxError: invalid syntax
```

Local variables



- Local variables are created within a function
- `first, second, third` are local variables of the function `quadratic`
- Function parameters are also local variables

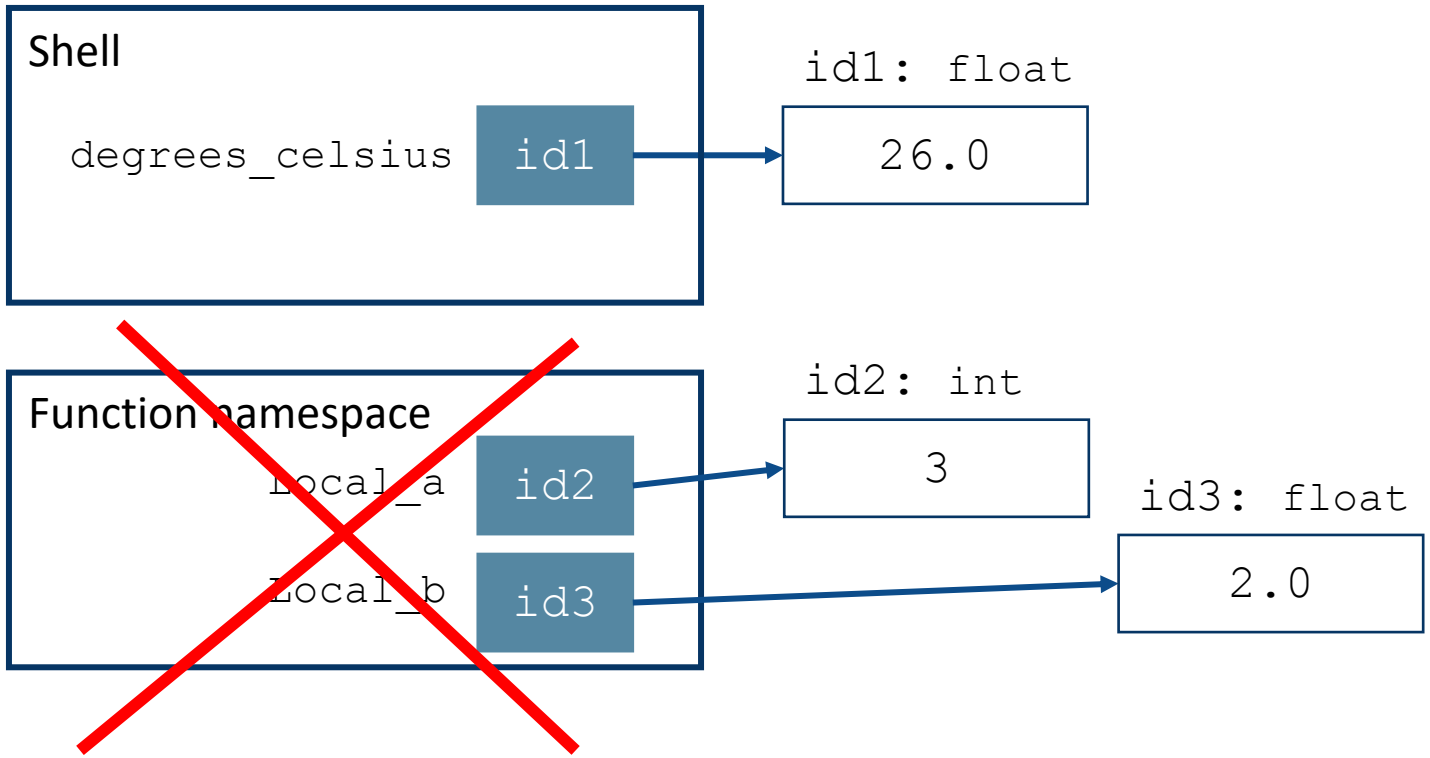
Errors

- Number of parameters
- Redefinition is ok
- Local variables

```
>>> def quadratic(a,b,c,x):
        first = a * x ** 2
        second = b * x
        third = c
        return first + second + third

>>> quadratic (2,3,4,2)
18
>>> quadratic (2,3,4,1.0)
9.0
>>> quadratic ( 2,3,4)
Traceback (most recent call last):
  File "<pyshell#68>", line 1, in <module>
    quadratic ( 2,3,4)
TypeError: quadratic() missing 1 required positional argument: 'x'
>>> def quadratic (a,b,x):
        first = a * x **2
        second = b * x
        return first + second

>>> quadratic ( 2,3,4,2)
Traceback (most recent call last):
  File "<pyshell#75>", line 1, in <module>
    quadratic ( 2,3,4,2)
TypeError: quadratic() takes 3 positional arguments but 4 were given
>>> quadratic(2,3,2)
14
>>> first
Traceback (most recent call last):
  File "<pyshell#77>", line 1, in <module>
    first
NameError: name 'first' is not defined
```

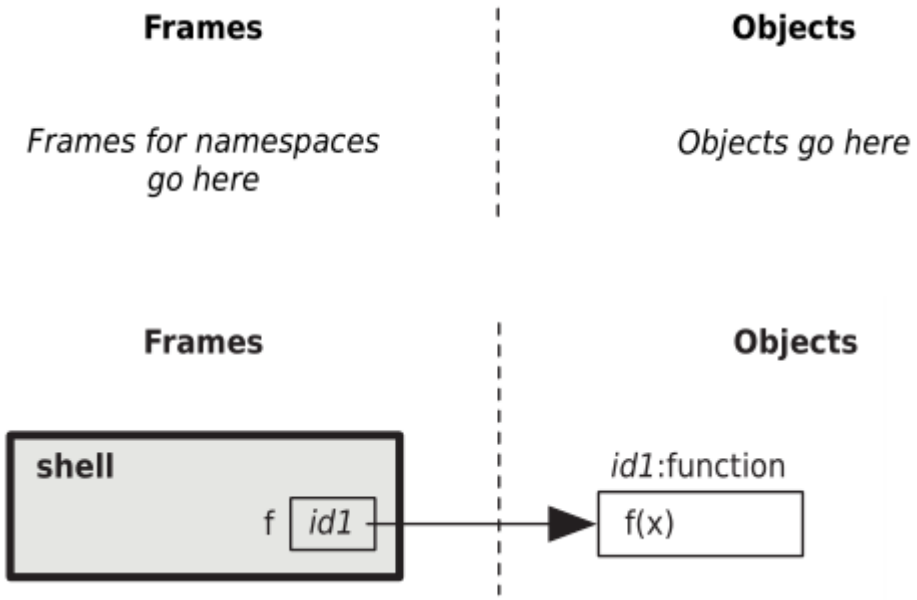
Local variables and namespaces

- When Python executes a function call, it creates a namespace to store local variables for that call
- When the function returns, the namespace is no longer tracked.



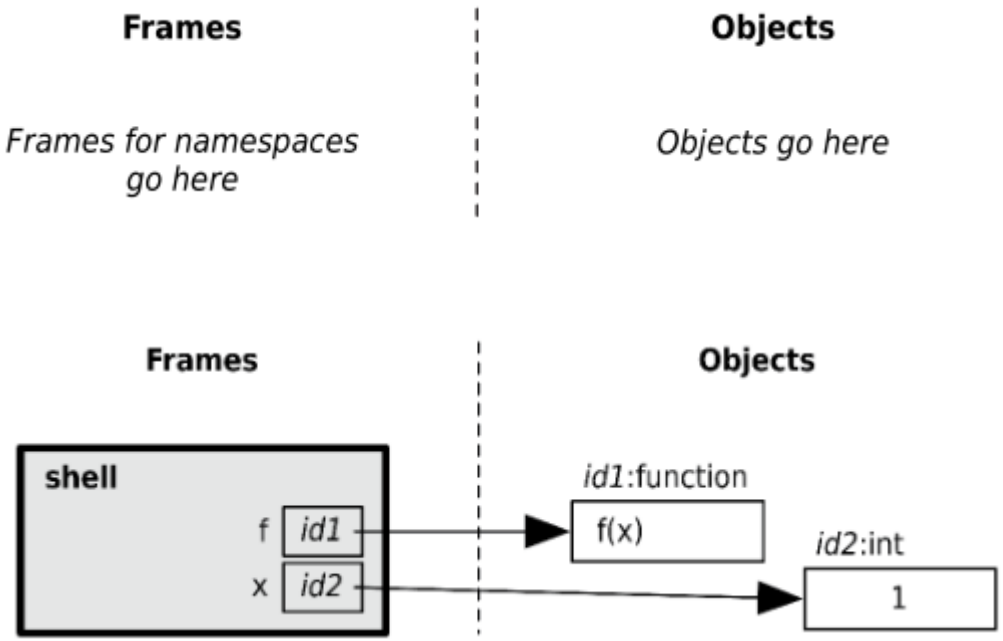
Tracing function calls

```
>>> def f(x):
        x = 2 * x
        return x

>>> x = 1
>>> x = f (x + 1 ) + f(x + 2)
>>> x
```



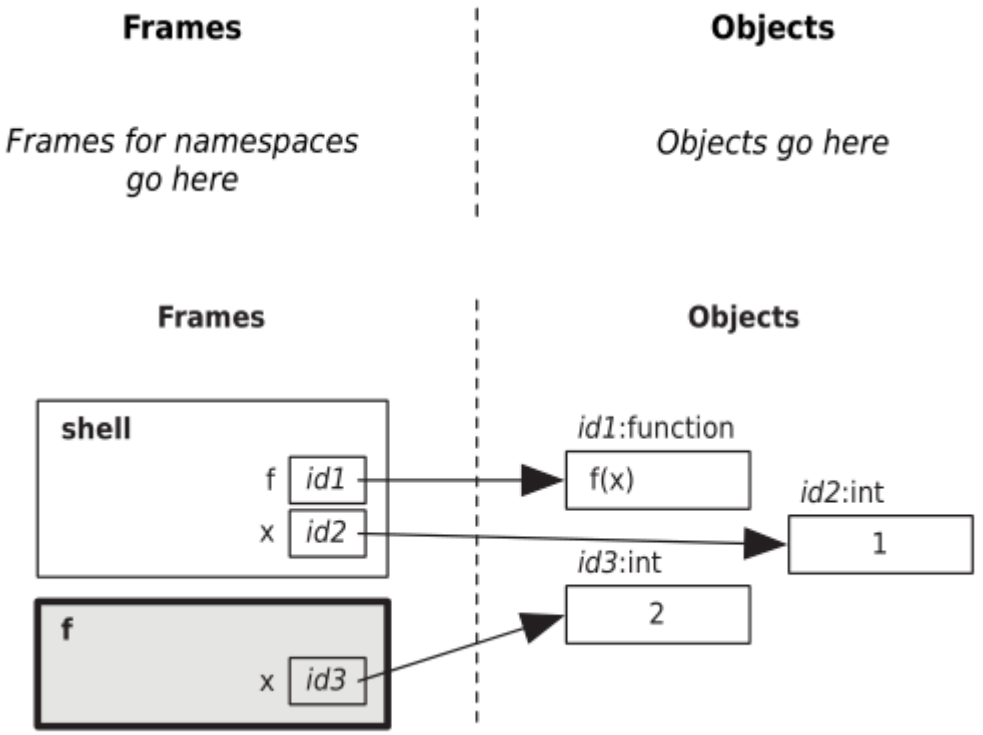
Tracing function calls

```
>>> def f(x):
        x = 2 * x
        return x

>>> x = 1
>>> x = f (x + 1 ) + f(x + 2)
>>> x
```



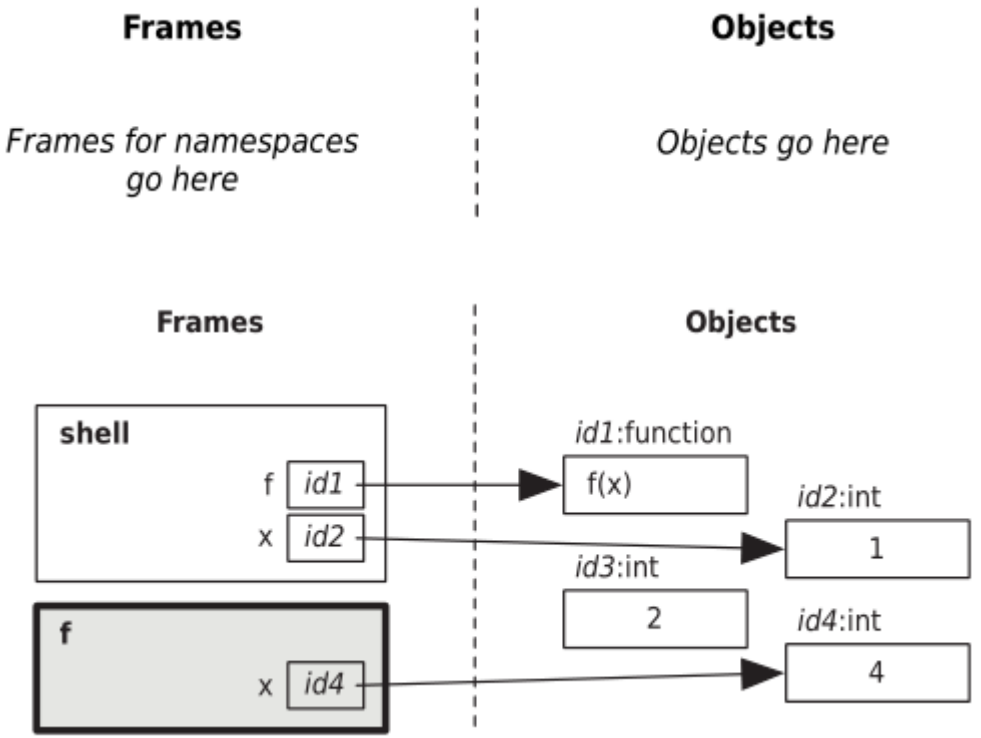
Tracing function calls

```
>>> def f(x):
        x = 2 * x
        return x

>>> x = 1
>>> x = f (x + 1 ) + f(x + 2)
>>> x
```



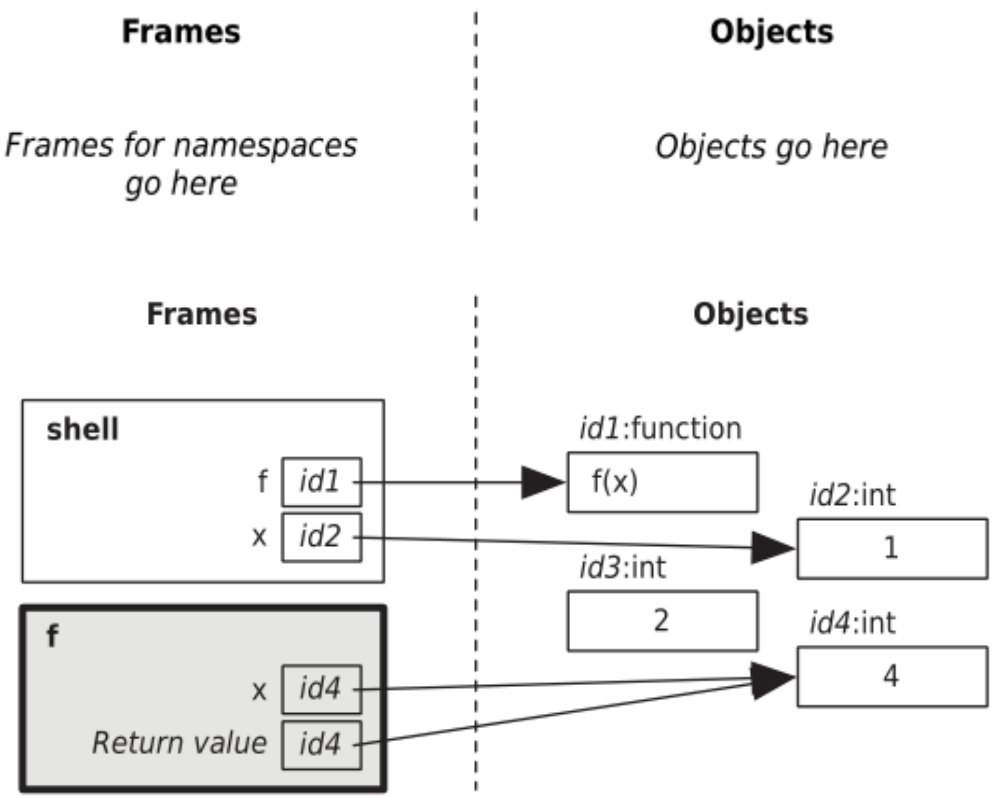
Tracing function calls

```
>>> def f(x):
        x = 2 * x
        return x

>>> x = 1
>>> x = f (x + 1 ) + f(x + 2)
>>> x
```



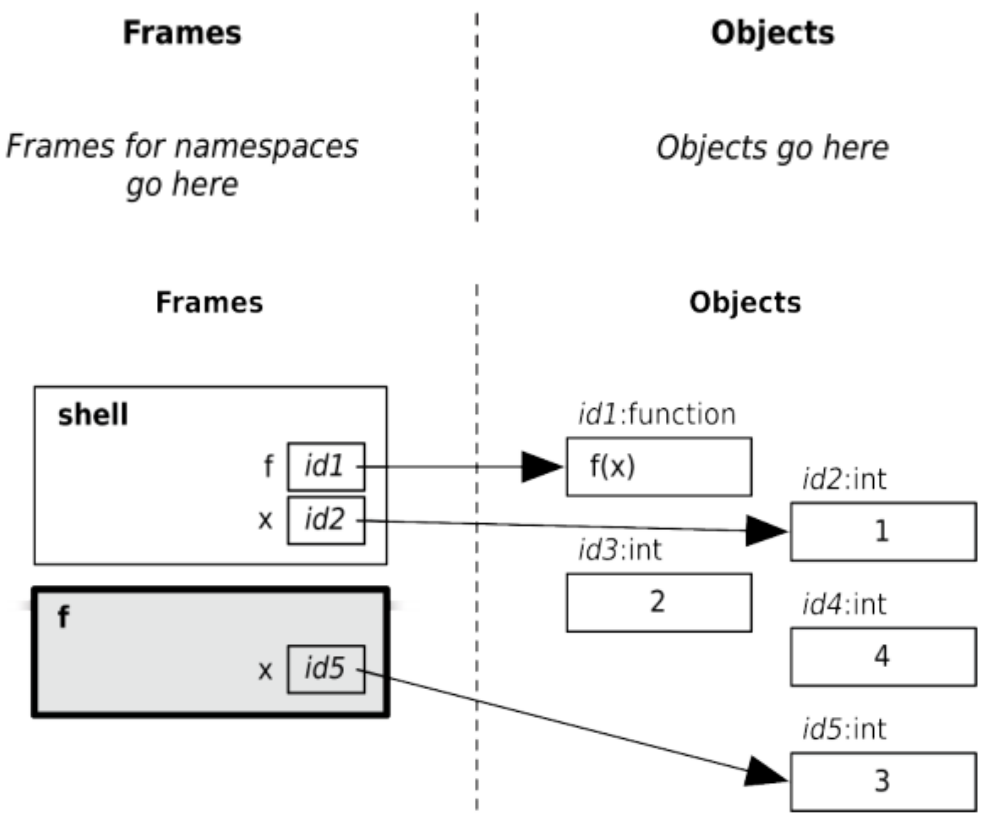
Tracing function calls

```
>>> def f(x):
        x = 2 * x
        return x

>>> x = 1
>>> x = f (x + 1 ) + f(x + 2)
>>> x
```



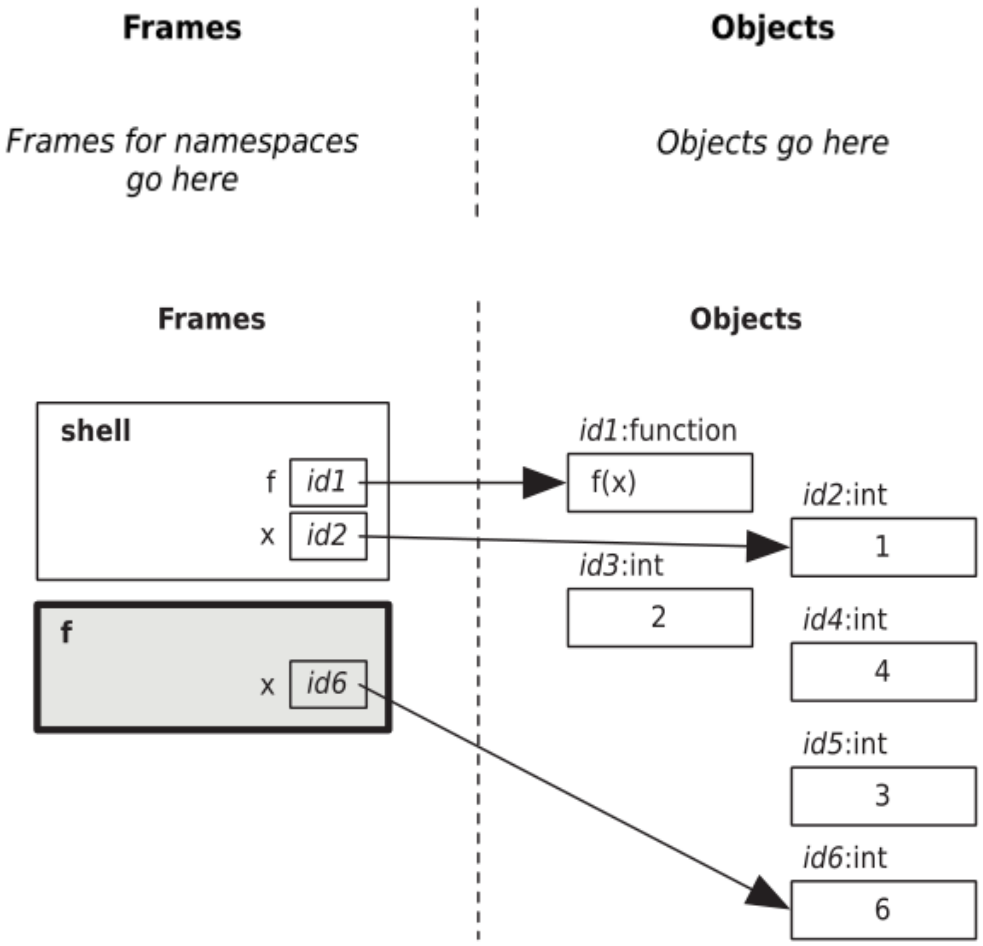
Tracing function calls

```
>>> def f(x):
        x = 2 * x
        return x

>>> x = 1
>>> x = f (x + 1 ) + f(x + 2)
>>> x
```



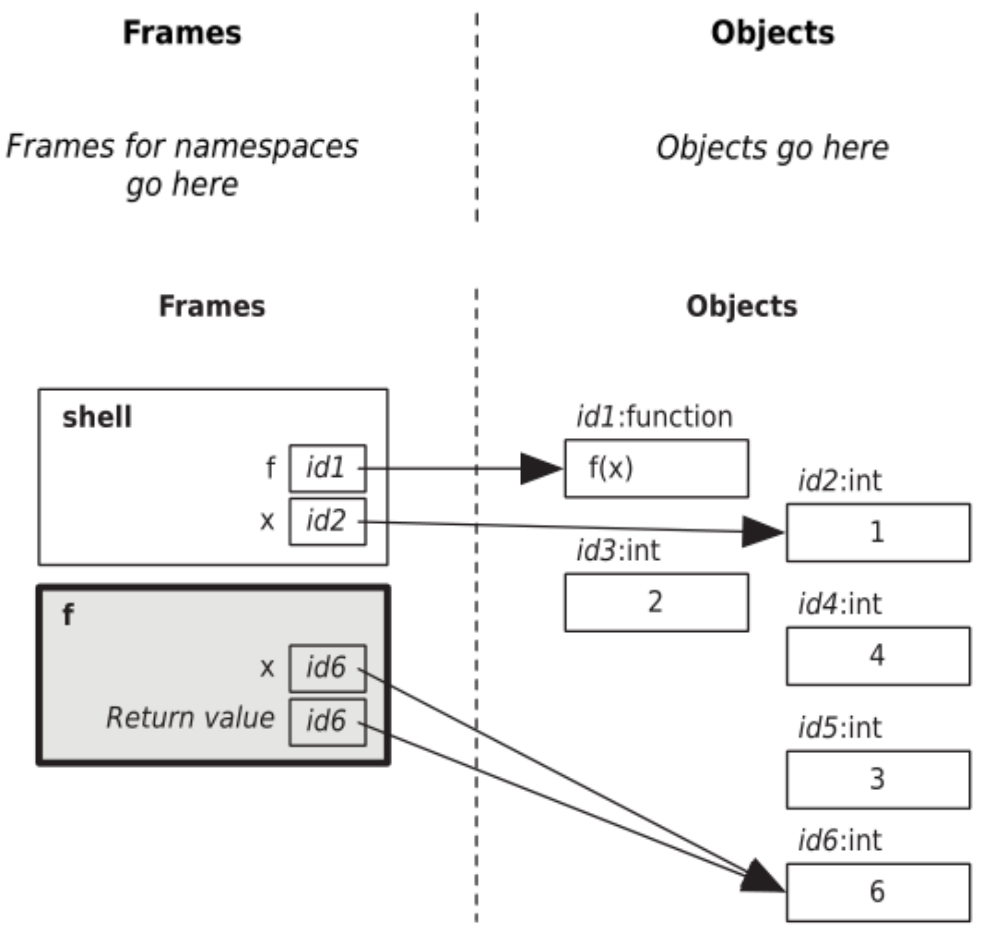
Tracing function calls

```
>>> def f(x):
        x = 2 * x
        return x

>>> x = 1
>>> x = f (x + 1 ) + f(x + 2)
>>> x
```



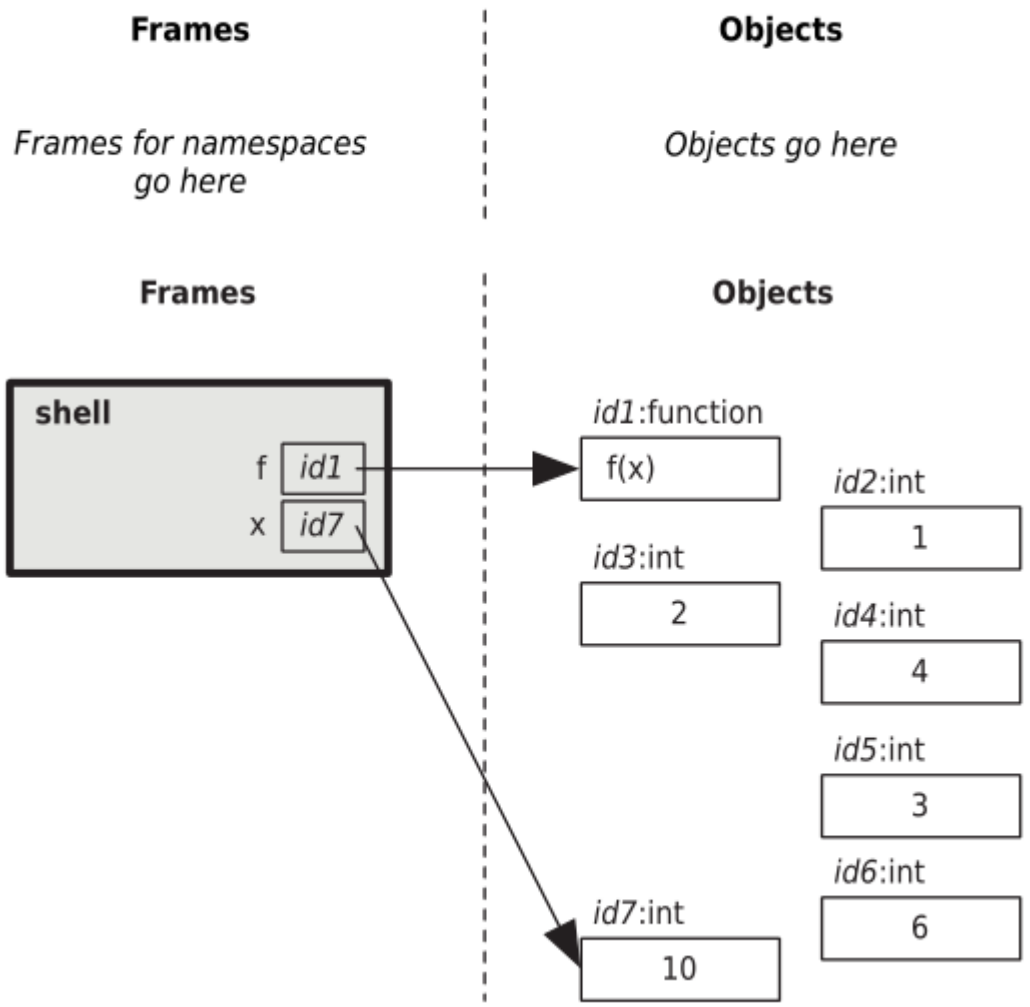
Tracing function calls

```
>>> def f(x):
        x = 2 * x
        return x

>>> x = 1
>>> x = f (x + 1 ) + f(x + 2)
>>> x
```



Tracing function calls

```
>>> def f(x):
        x = 2 * x
        return x

>>> x = 1
>>> x = f (x + 1 ) + f(x + 2)
>>> x
```



Let’s use Editor Window from now on

- To better understand the return value of the function

Editor

```
def sum(a,b):
    return a+b

sum(3,4)
```

Shell

```
RESTART:
C:/Users/jiyoung/AppData/Local/Programs/Python/Python35/Scripts/test01.py
```

Let’s use Editor Window from now on

- To better understand the return value of the function

Editor

```
def sum(a,b):
    return a+b

result = sum(3,4)
```

Shell

```
RESTART:
C:/Users/jiyoung/AppD
ata/Local/Programs/Py
thon/Python35/Scripts
/test01.py
```

Let’s use Editor Window from now on

- To better understand the return value of the function

Editor

```
def sum(a,b):
    return a+b

result = sum(3,4)
print(result)
```

Shell

```
RESTART:
C:/Users/jiyoung/AppD
ata/Local/Programs/Py
thon/Python35/Scripts
/test01.py

7
```

Let’s use Editor Window from now on

- To better understand the return value of the function

Editor

```
def sum(a,b):
    return a+b

print(sum(3,4))
```

Shell

```
RESTART:
C:/Users/jiyoung/AppData/Local/Programs/Python/Python35/Scripts/test01.py

7
```

Function with no parameters

- Function with no input
- Just execution

```
def say():
    return 'Hello'

say()
```

Function with no parameters

- Function with no input
- Just execution

```
def say():
    return 'Hello'

print(say())
```

Function with no parameters

- Function with no input
- Just execution

```
def say():
    return 'Hello'

word = say()
print(word)
```

Function with no return value

- Every function has only one return value
- If the return value is not defined in the function definition, the return value is `None`

```
def say():
    print('Hello')


say()
```

Function with no return value

- Every function has only one return value
- If the return value is not defined in the function definition, the return value is `None`

```
def say():
    print('Hello')


print(say())
```

Function with no return value

- Every function has only one return value
- If the return value is not defined in the function definition, the return value is `None`

```
def say():
    print('Hello')

word = say()
print(word)
```