ECE-203 – Programming for Engineers

Contact

Dr. James Shackleford

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Bossone 211

Office Hours: 3 – 4 pm (Tuesday)
Course Website: http://learn.dcollege.net

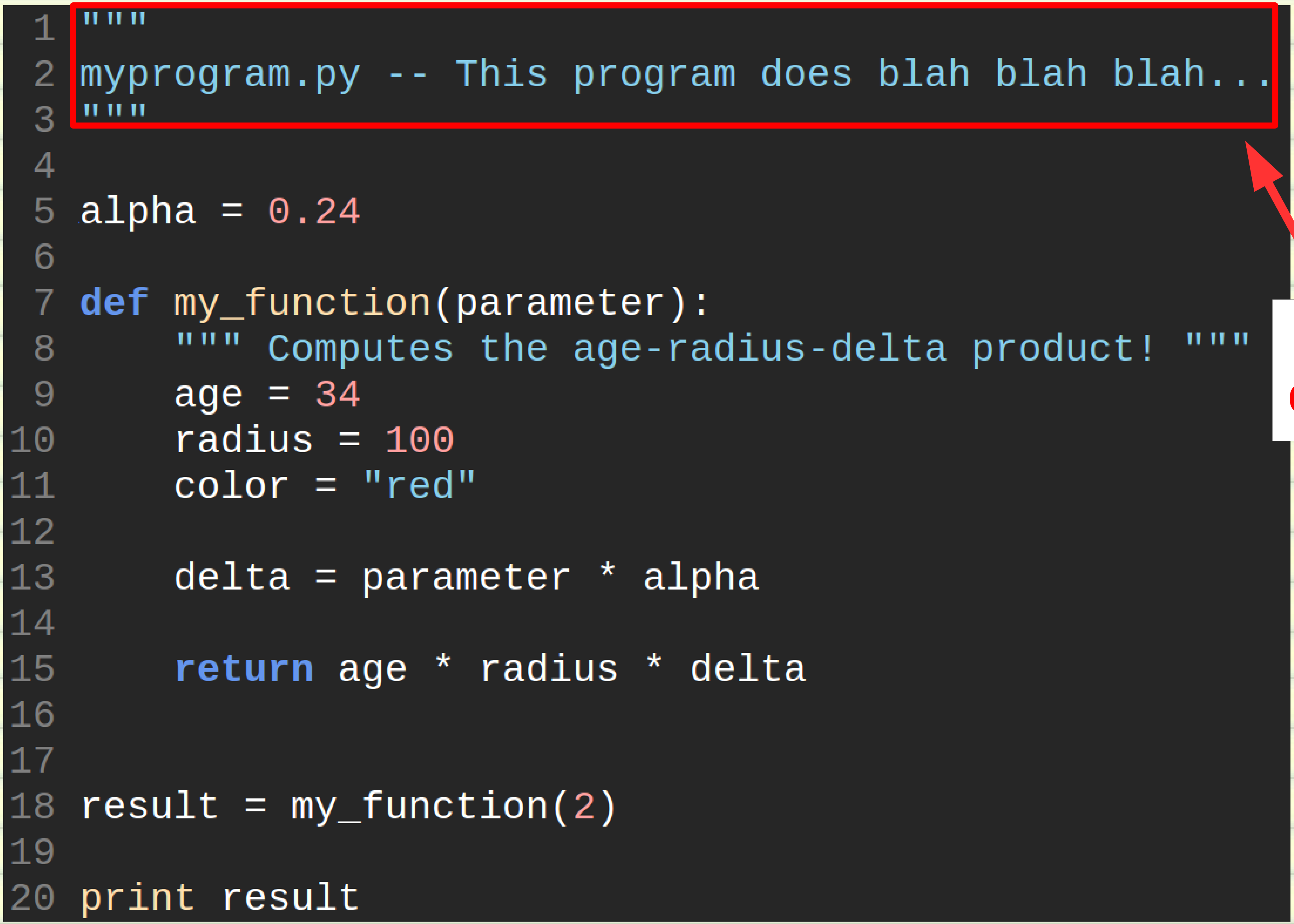
Textbook

Think Python
by Allen Downey
O'Reilly Press, 2015
ISBN-13: 978-1449330729
(Freely available in PDF format, check course website)

Grading

- 10% In-lab Programming Assignments
- 10% Take-Home Programming Assignments
- 35% Mid-term Exam
- 45% Final Exam

Anatomy of an (almost) “proper” Python program



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myprogram.py -- This program does blah blah blah...
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alpha = 0.24

def my_function(parameter):
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    age = 34
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result = my_function(2)

print result
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module docstring

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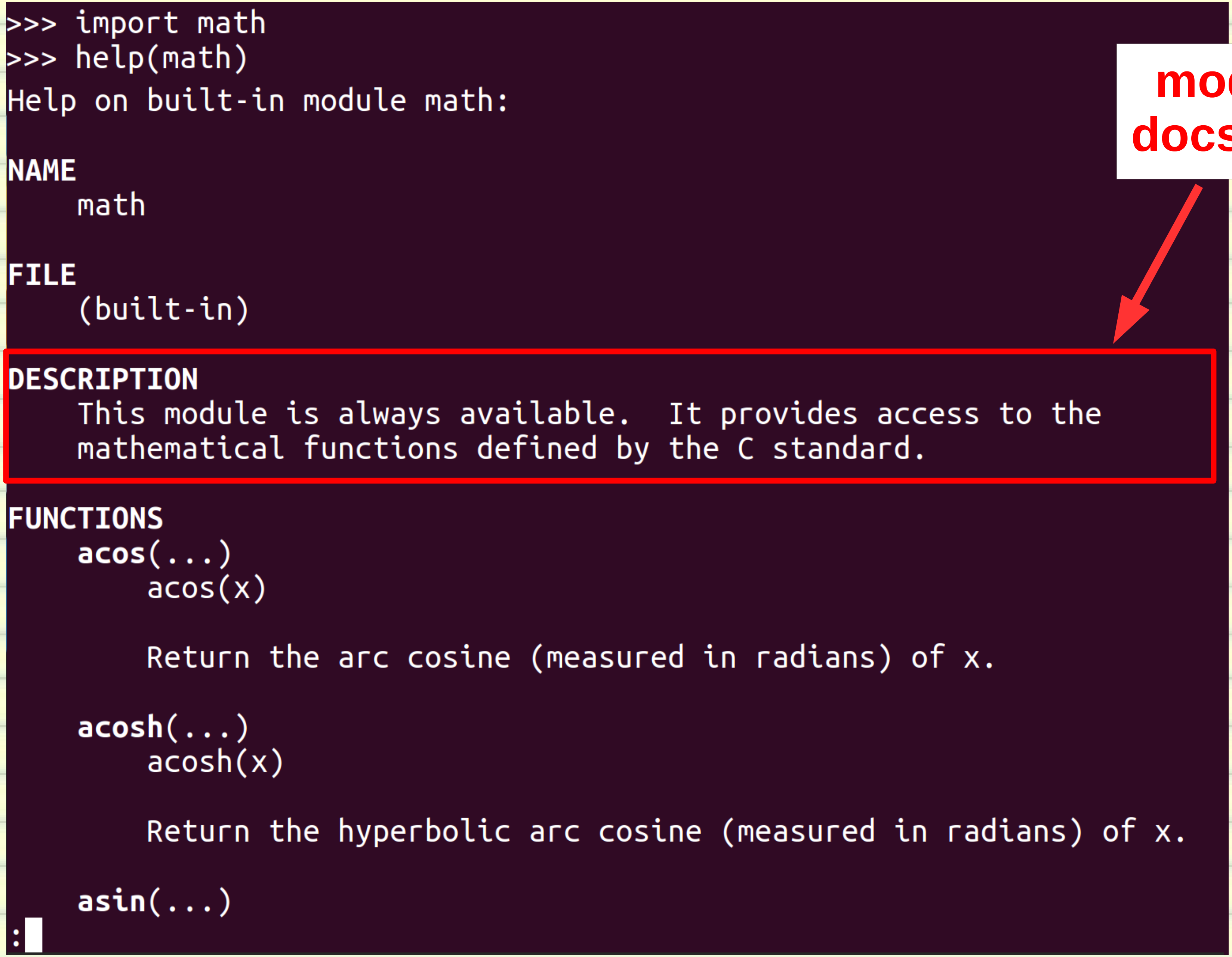

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>>> help(math)
Help on built-in module math:

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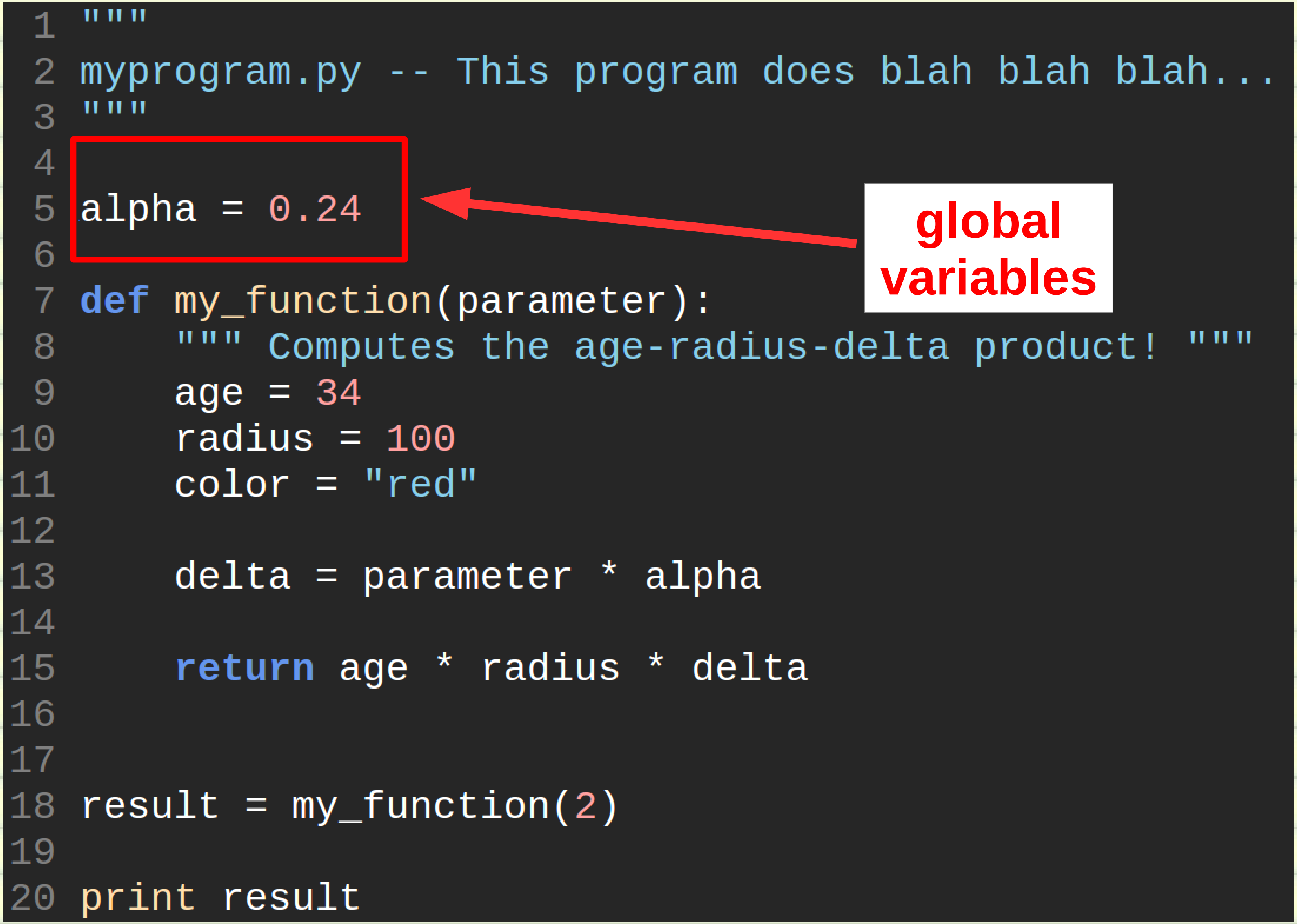

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global variables

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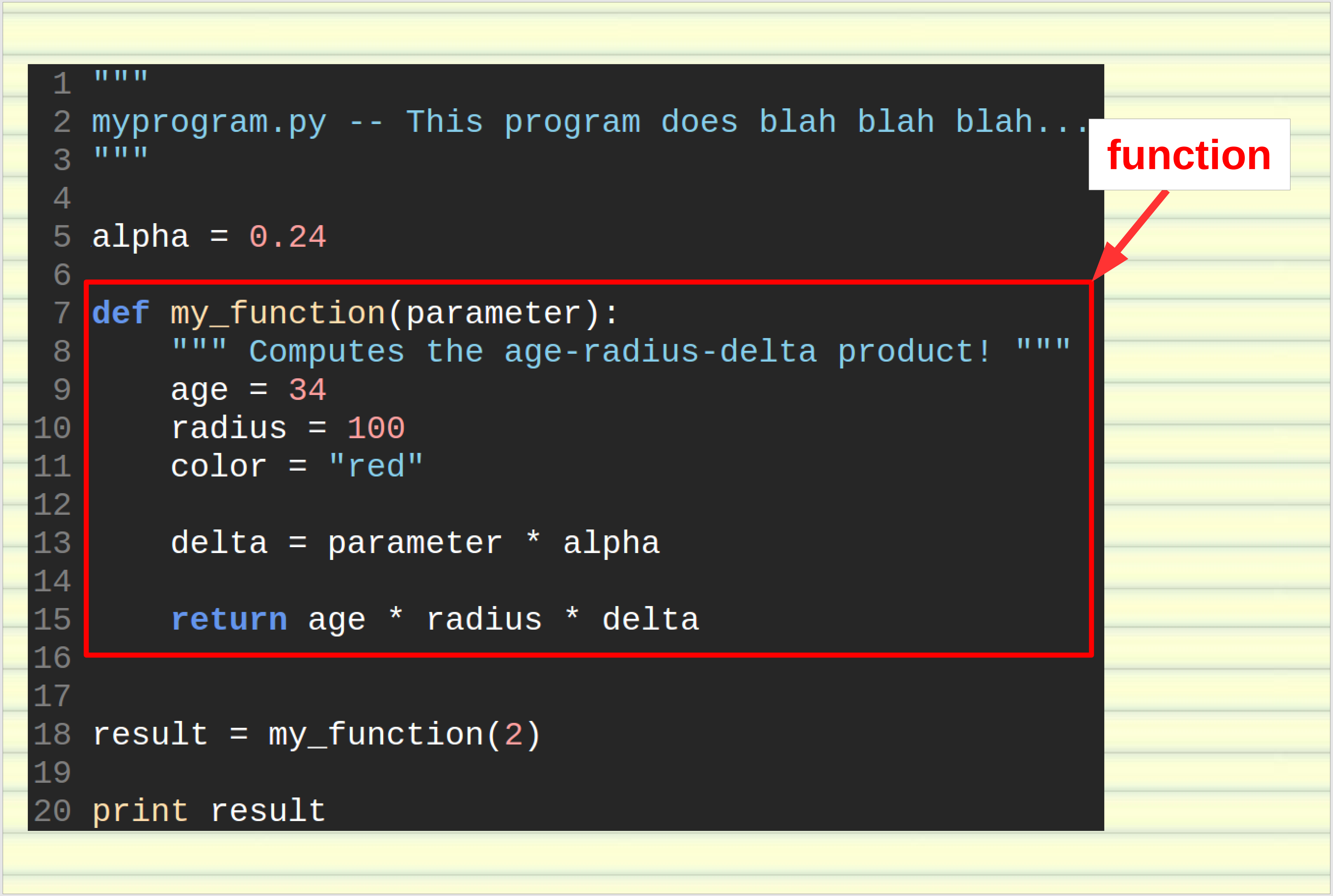

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function

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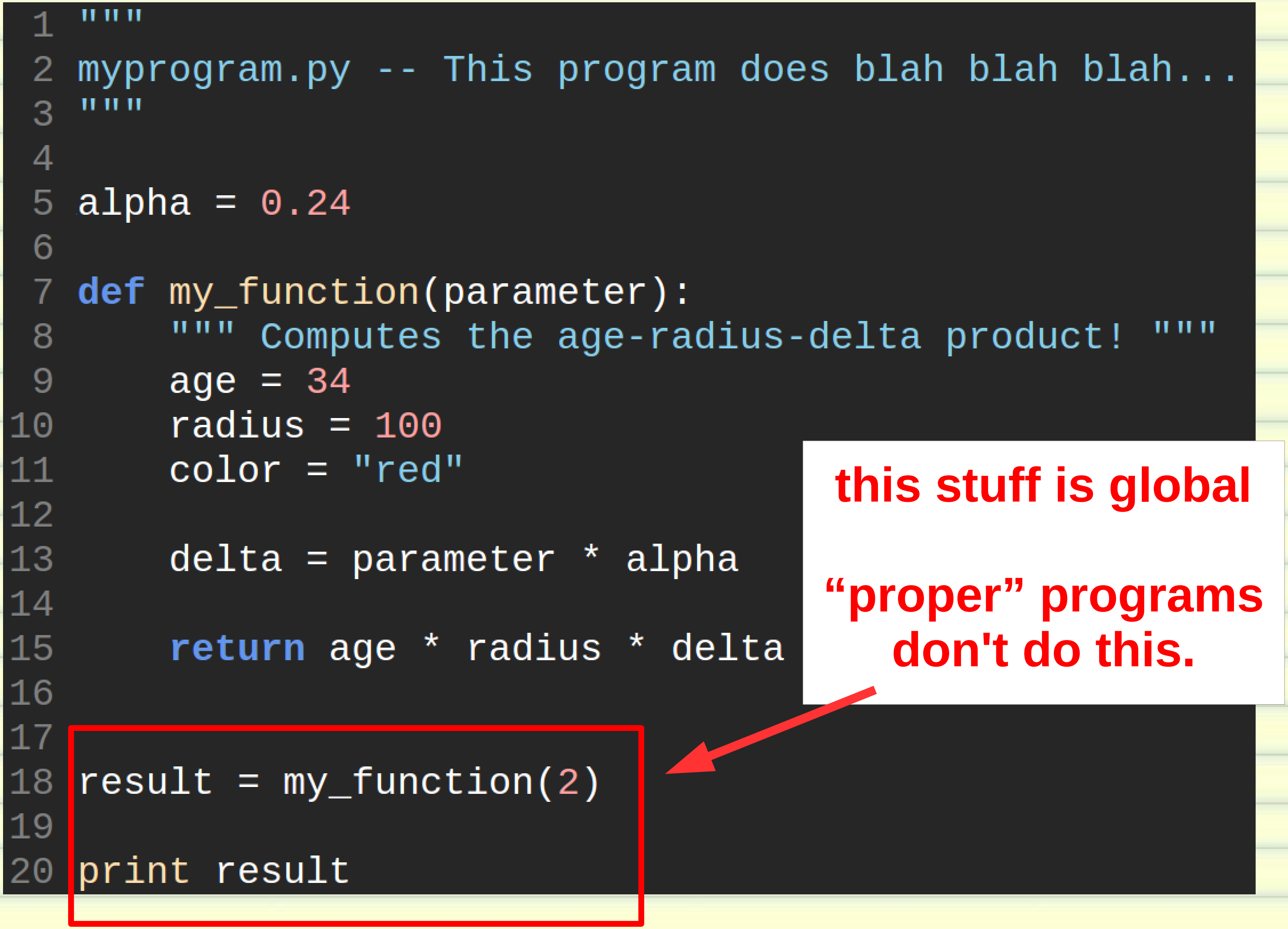

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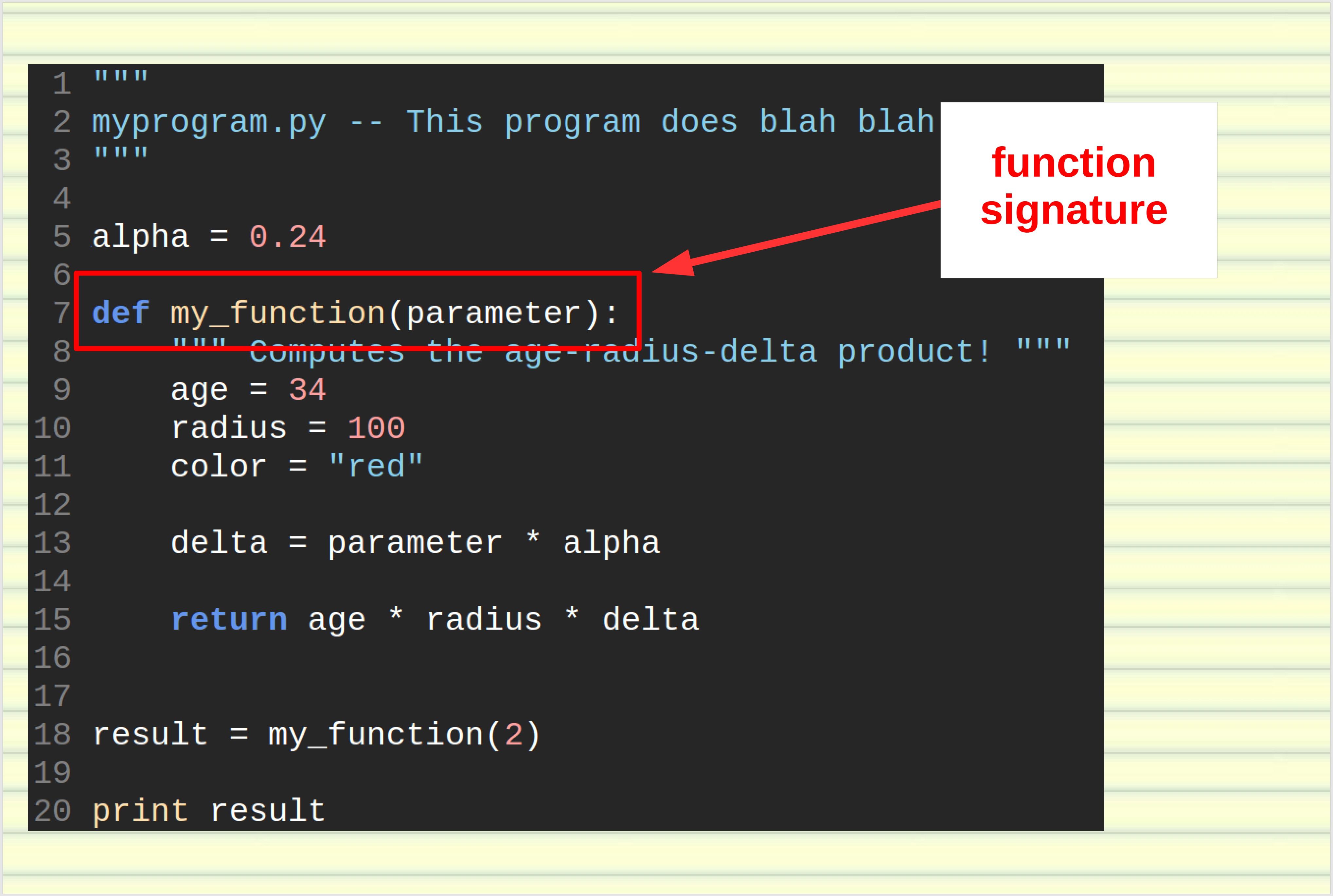
this stuff is global

“proper” programs don't do this.

Anatomy of a Python function



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function signature

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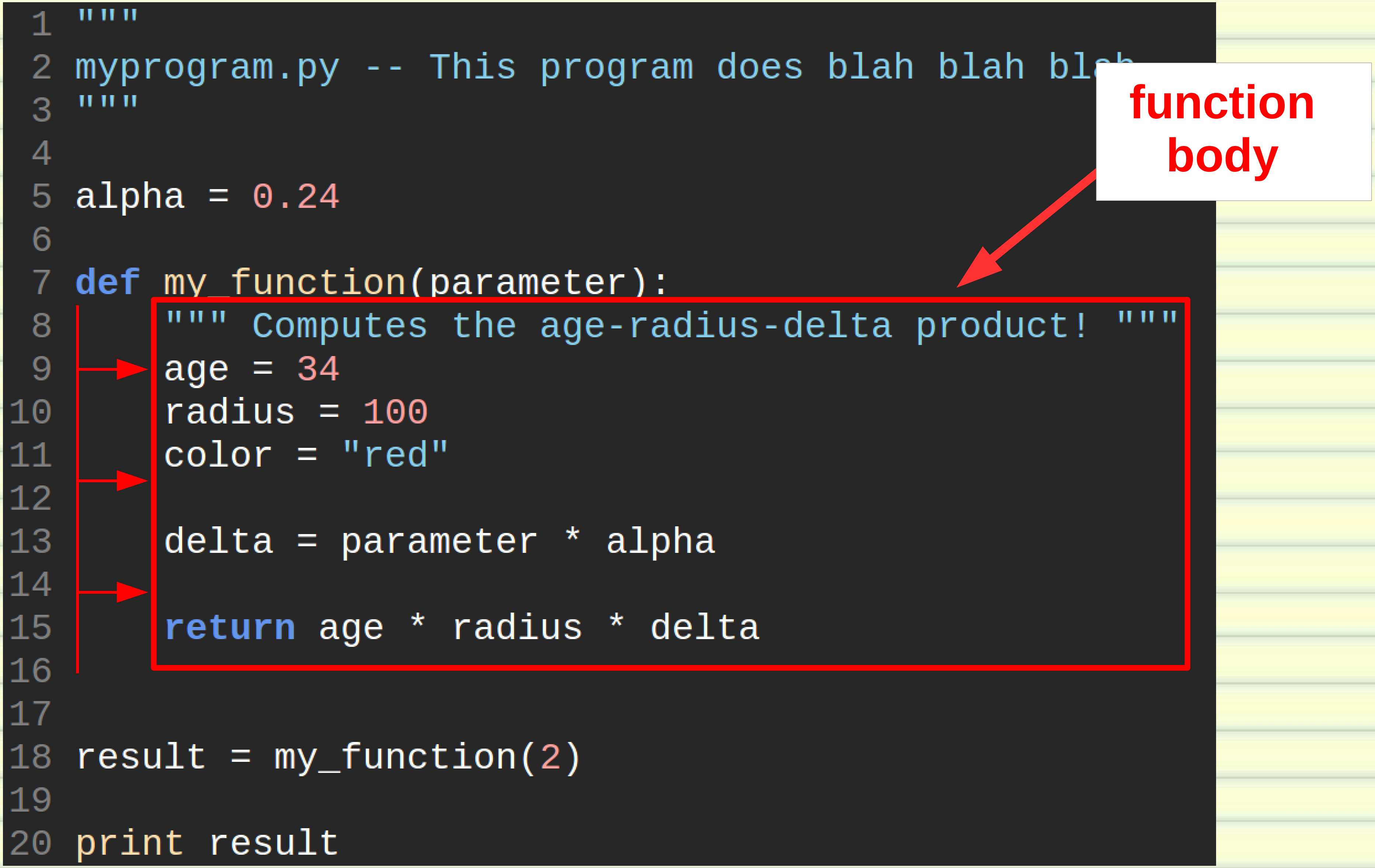

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function body

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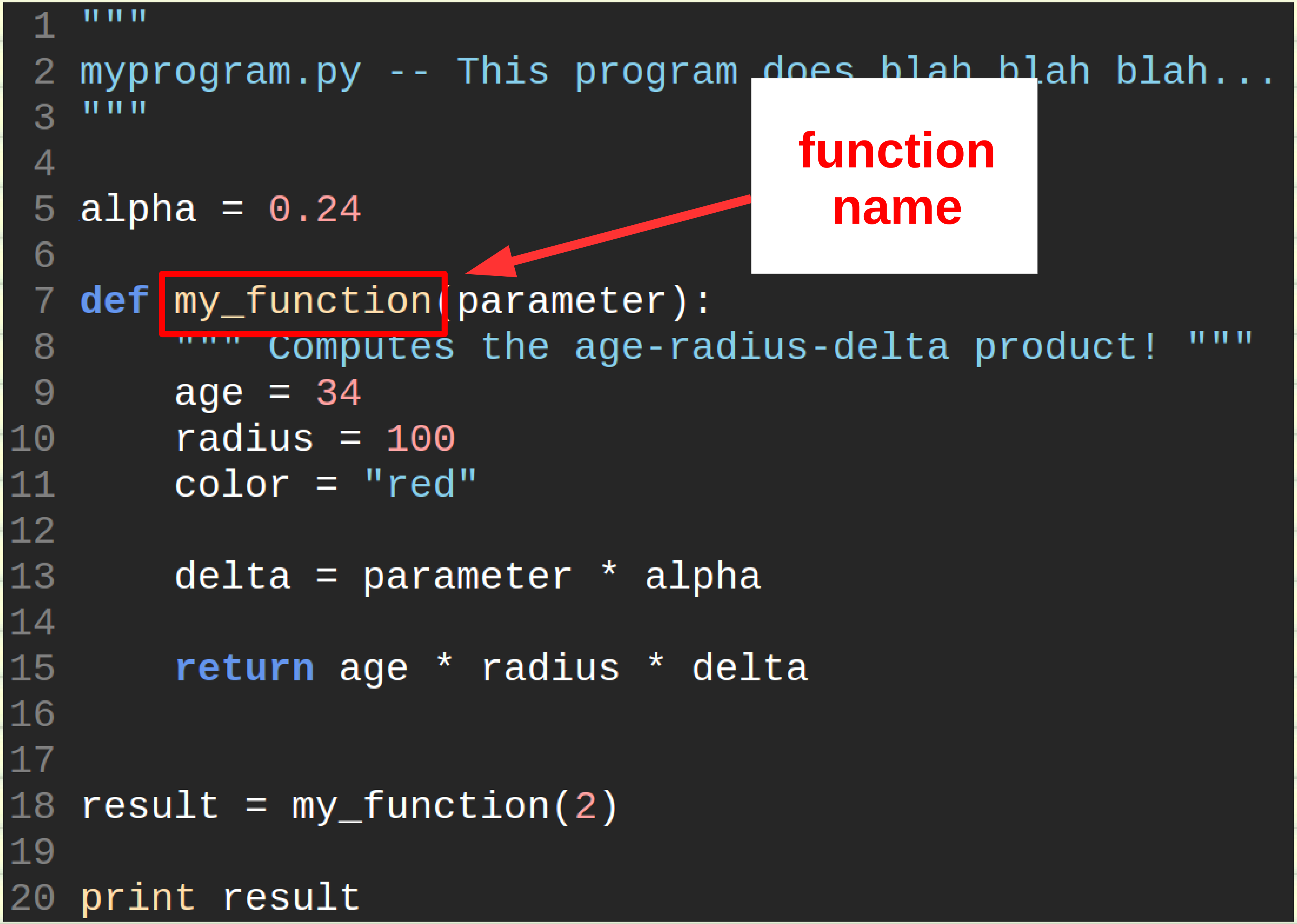

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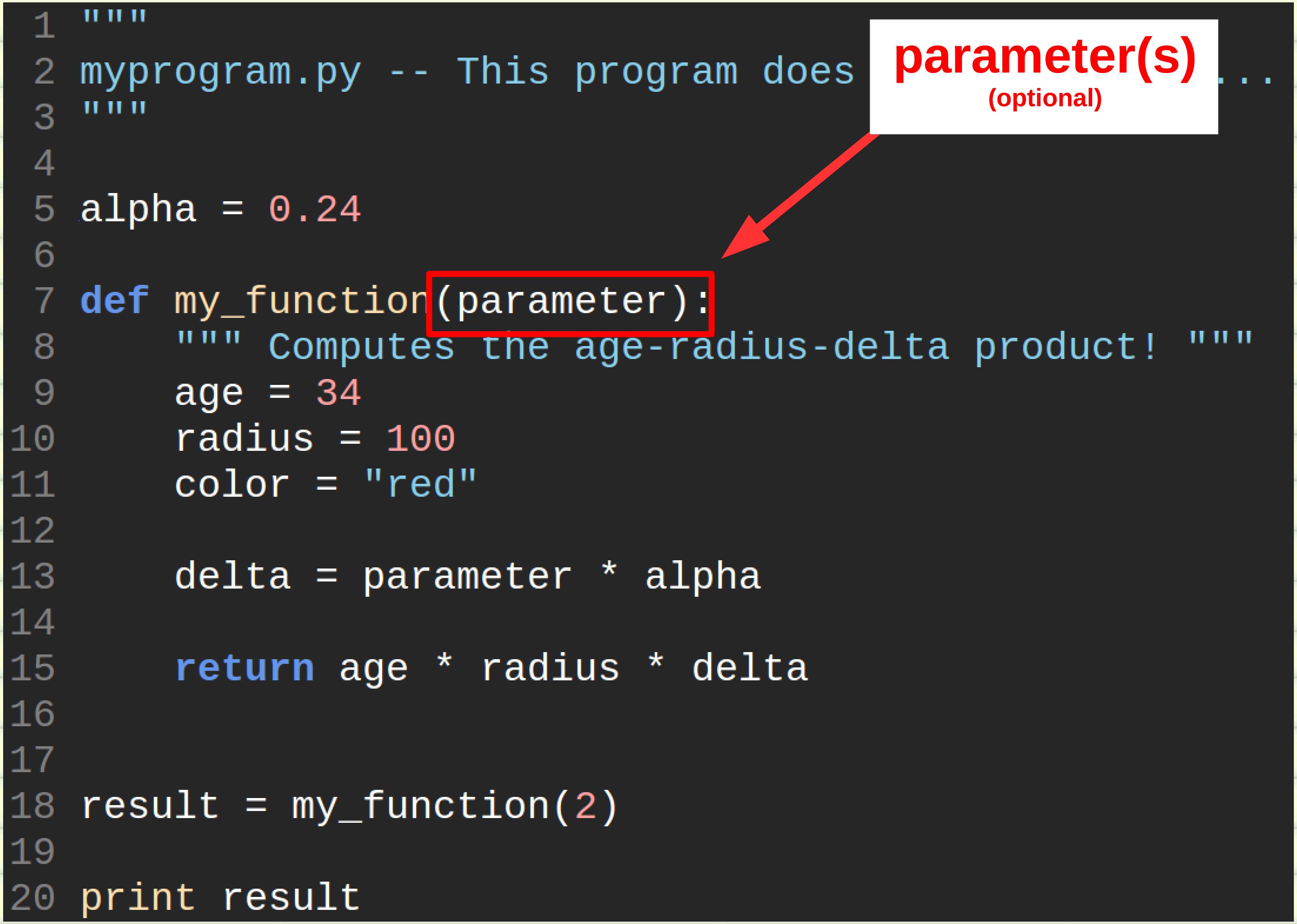

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parameter(s)

(optional)

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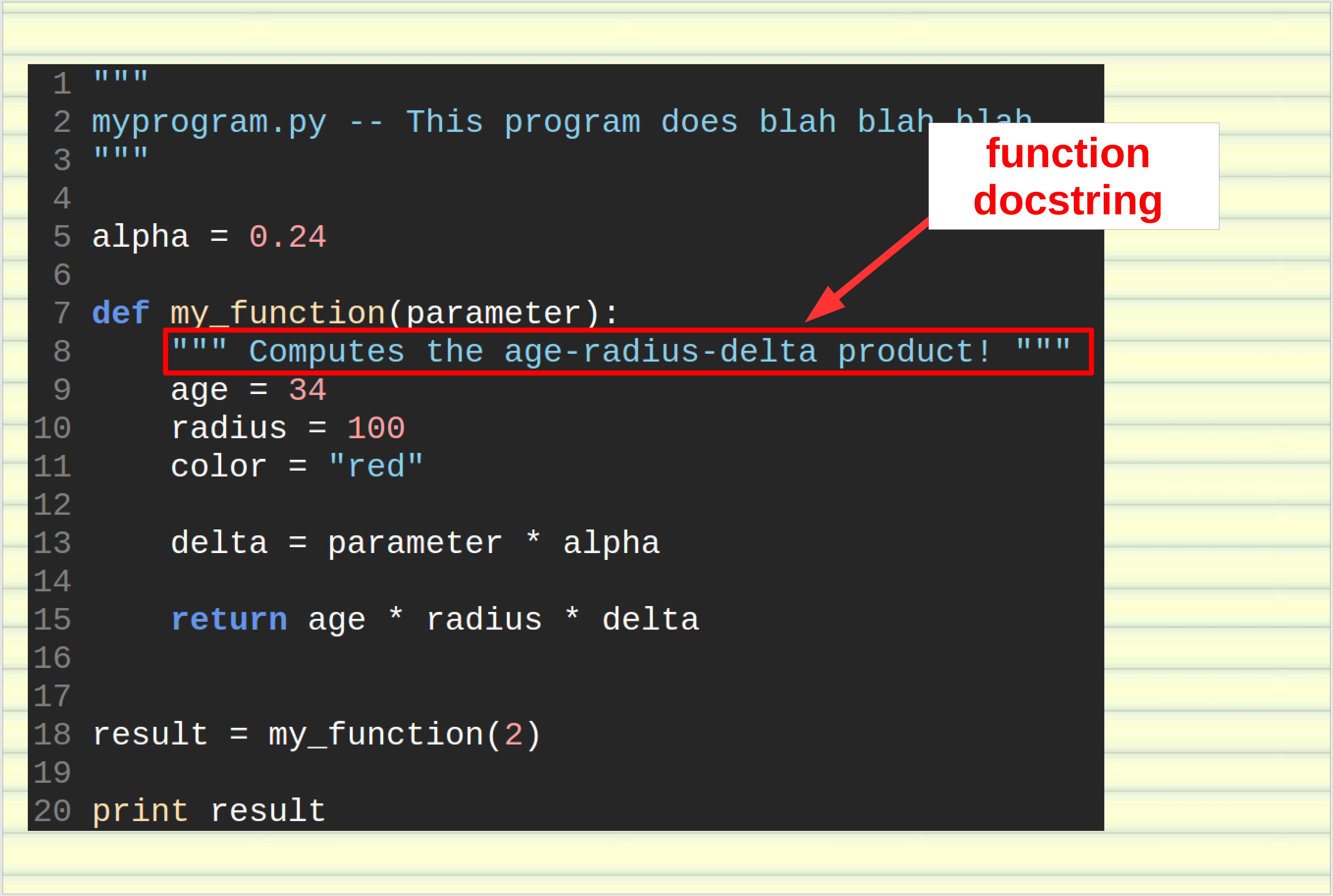

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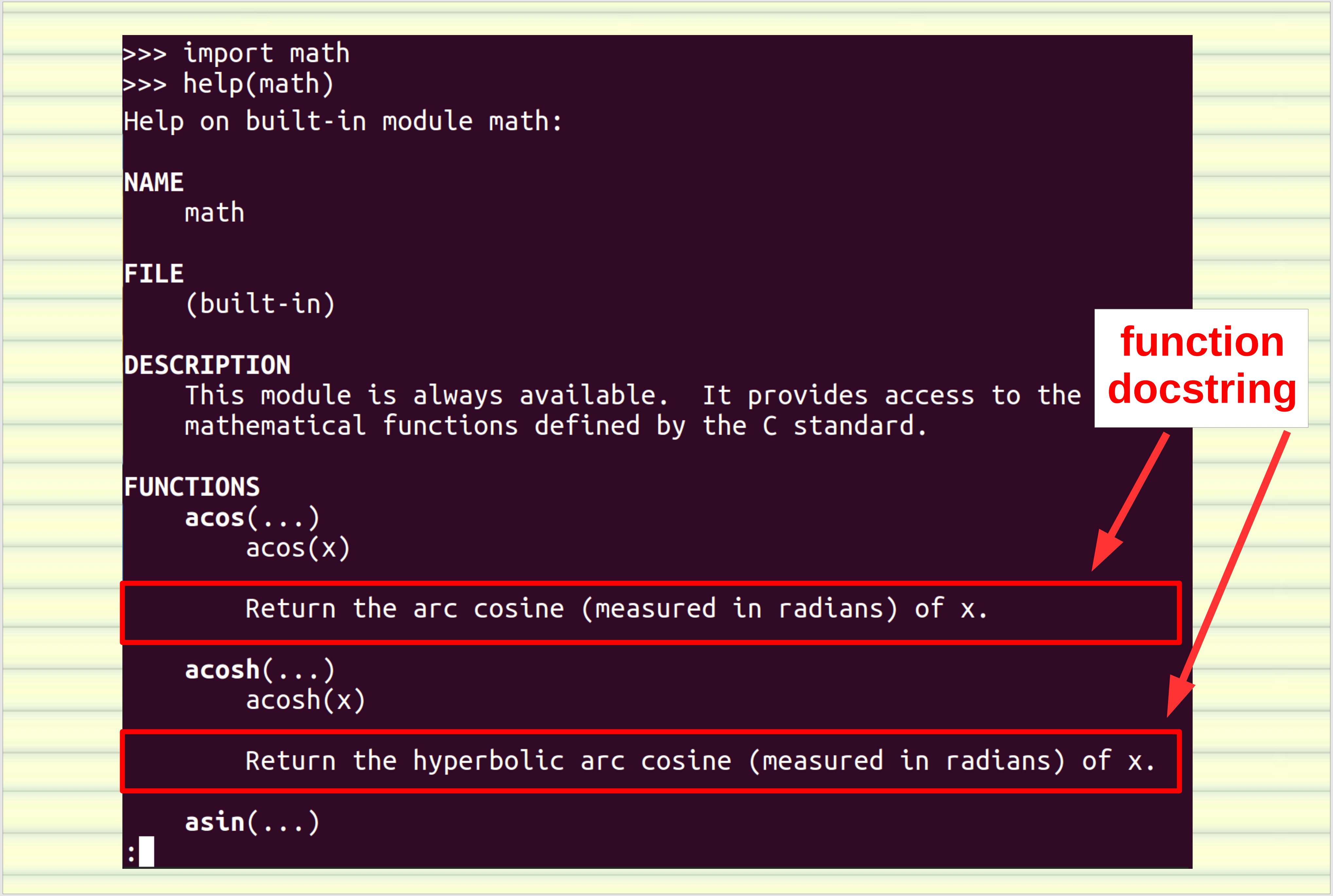

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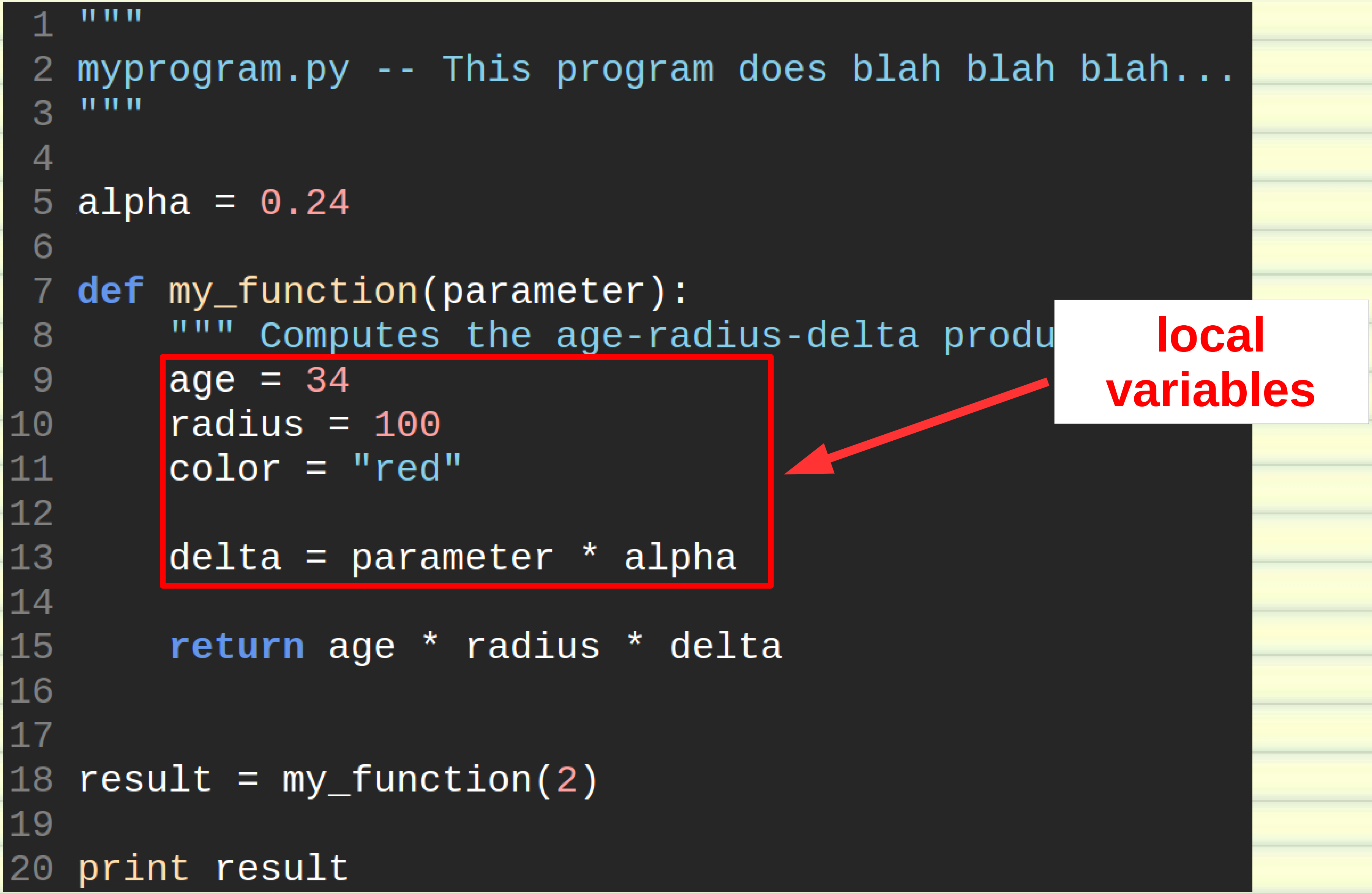

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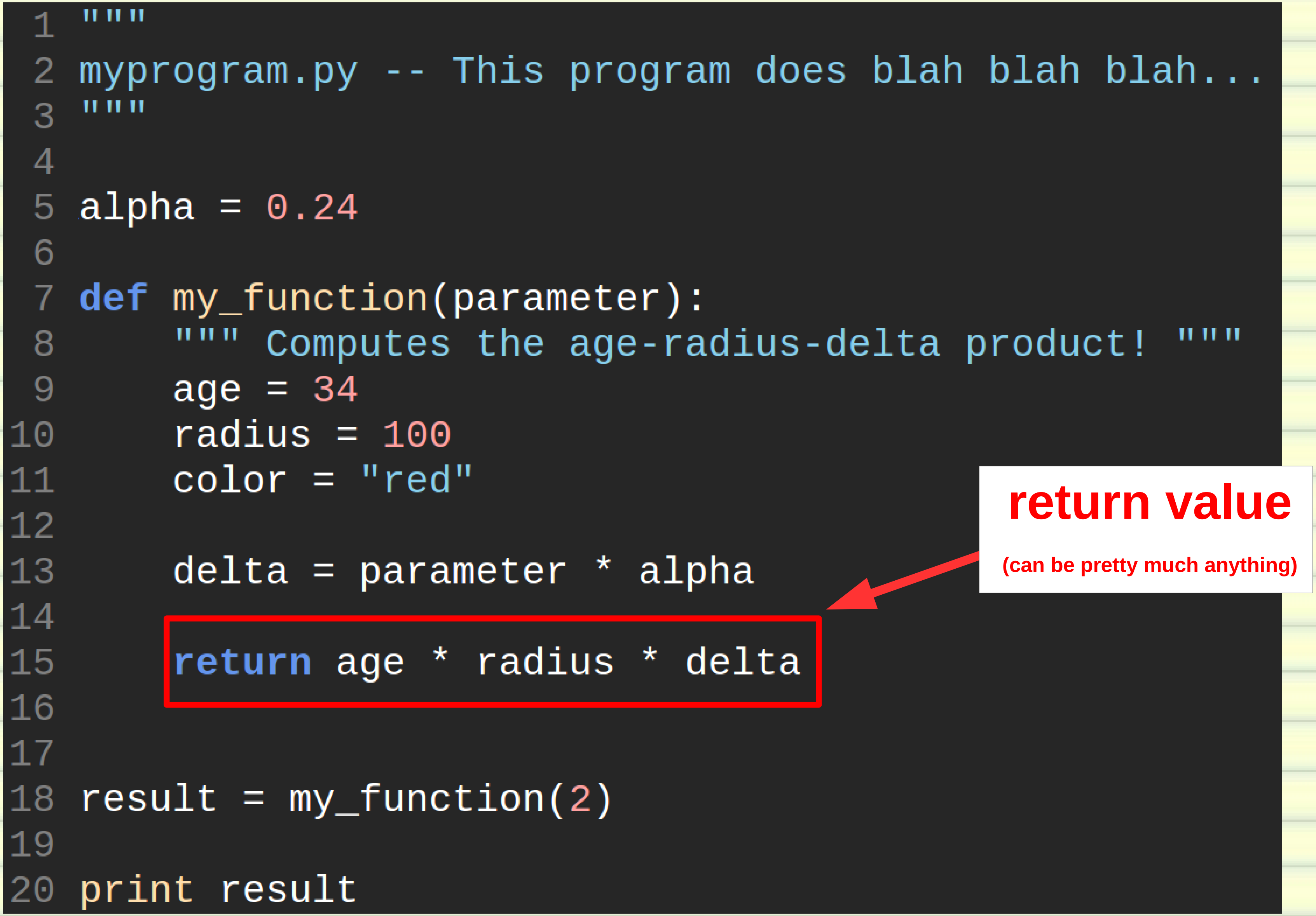
local variables

Anatomy of a Python function



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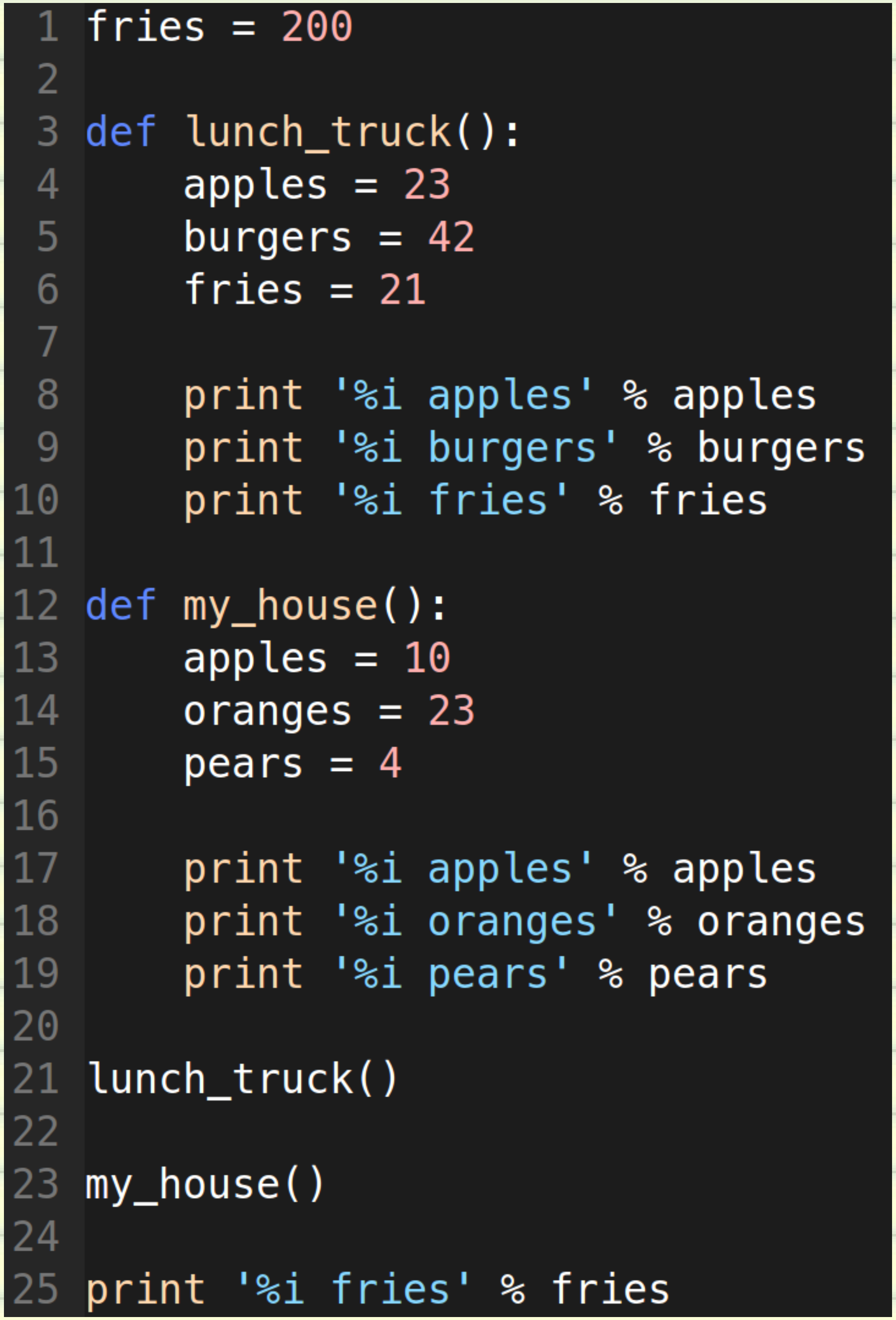
return value

(can be pretty much anything)

Namespaces & Variable Scope



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lunch_truck()

my_house()

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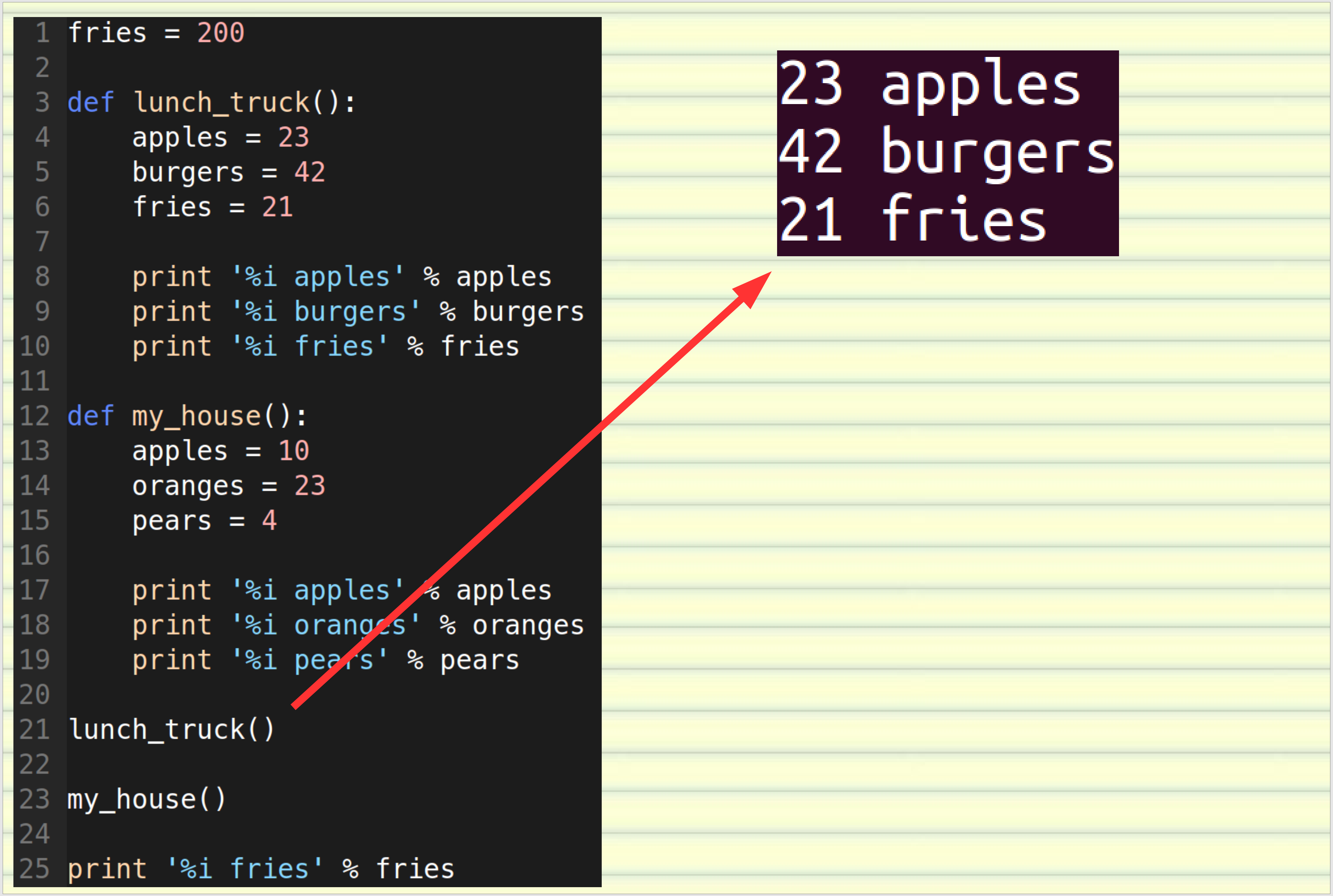
Namespaces & Variable Scope



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23 apples
42 burgers
21 fries
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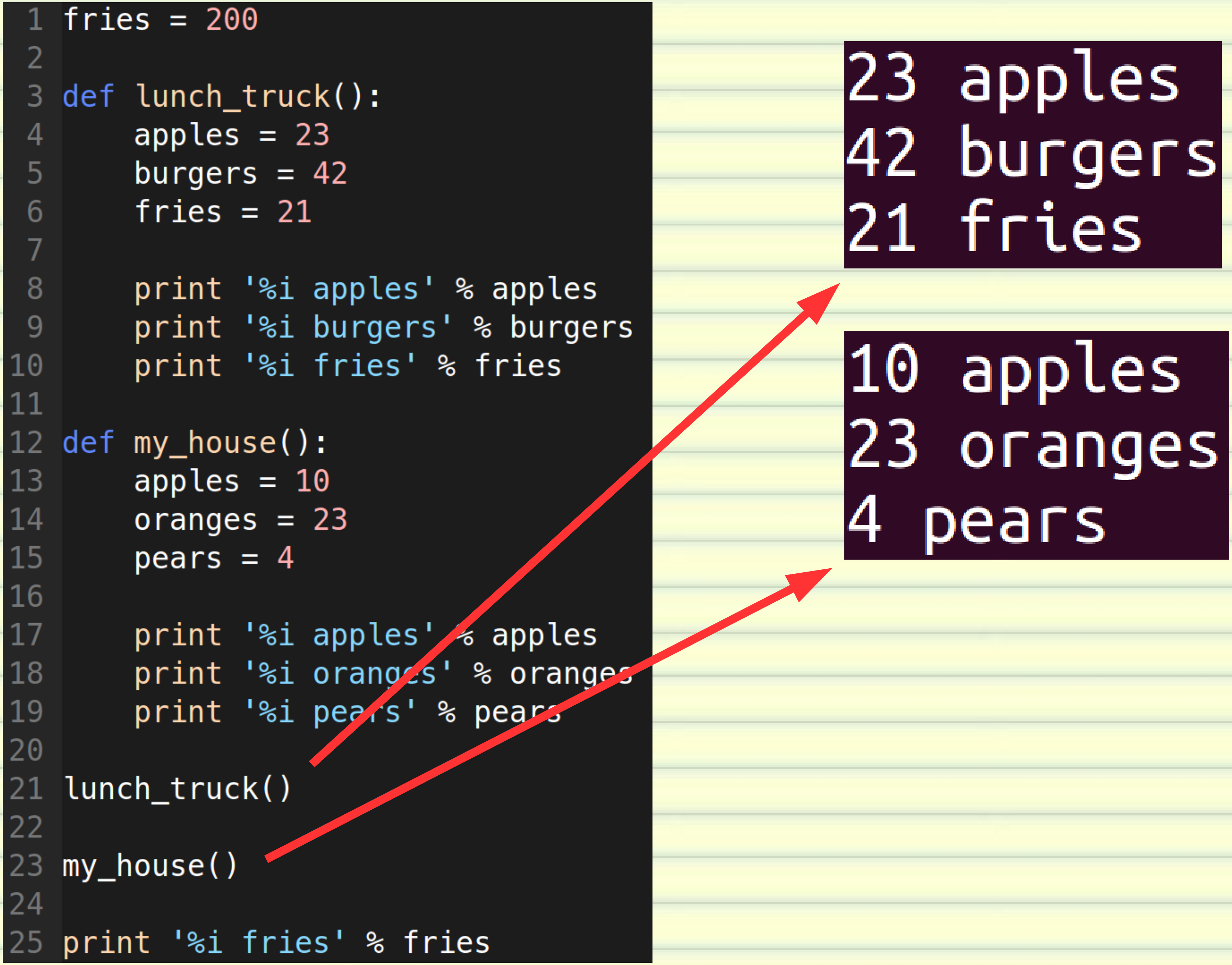

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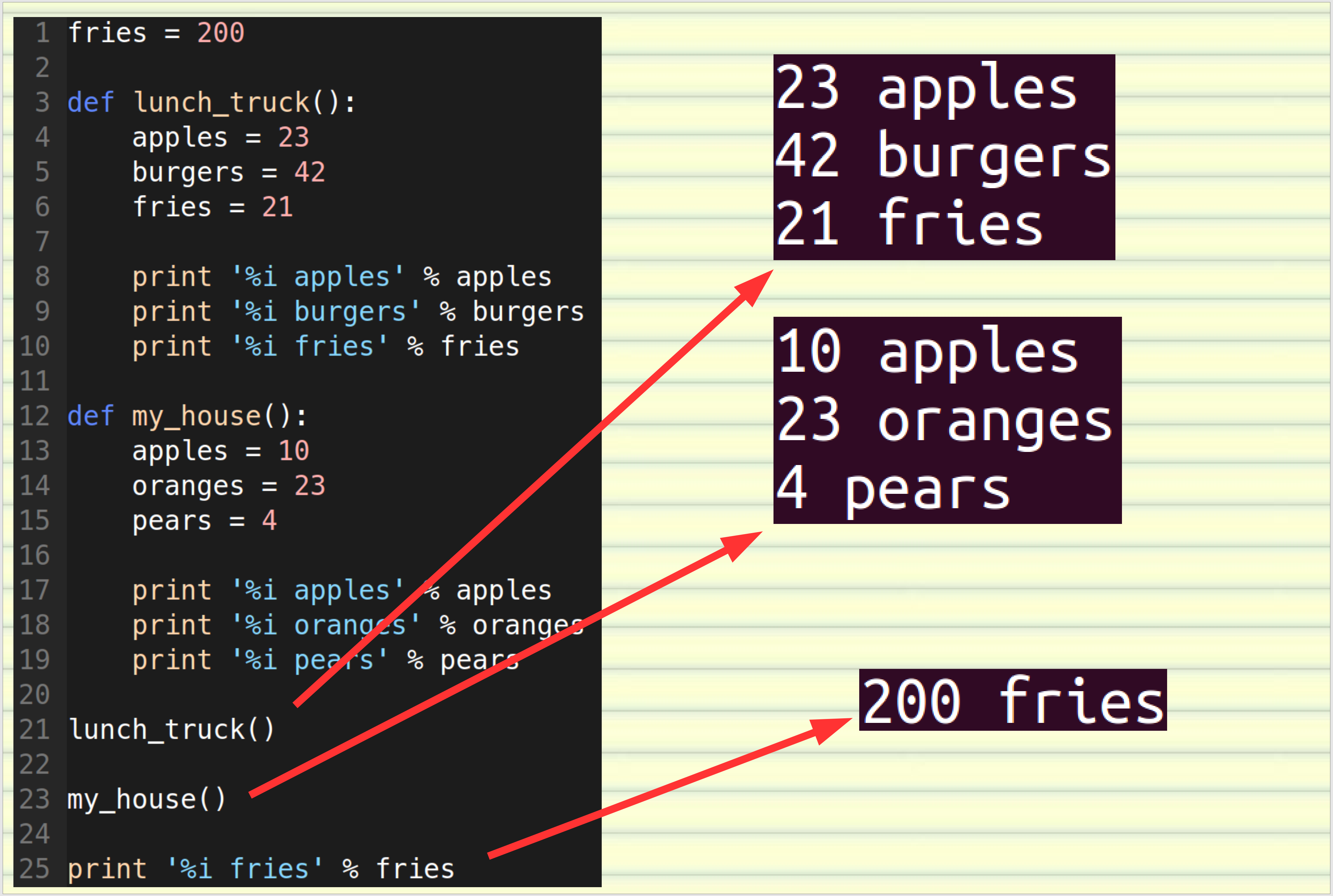

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```
200 fries
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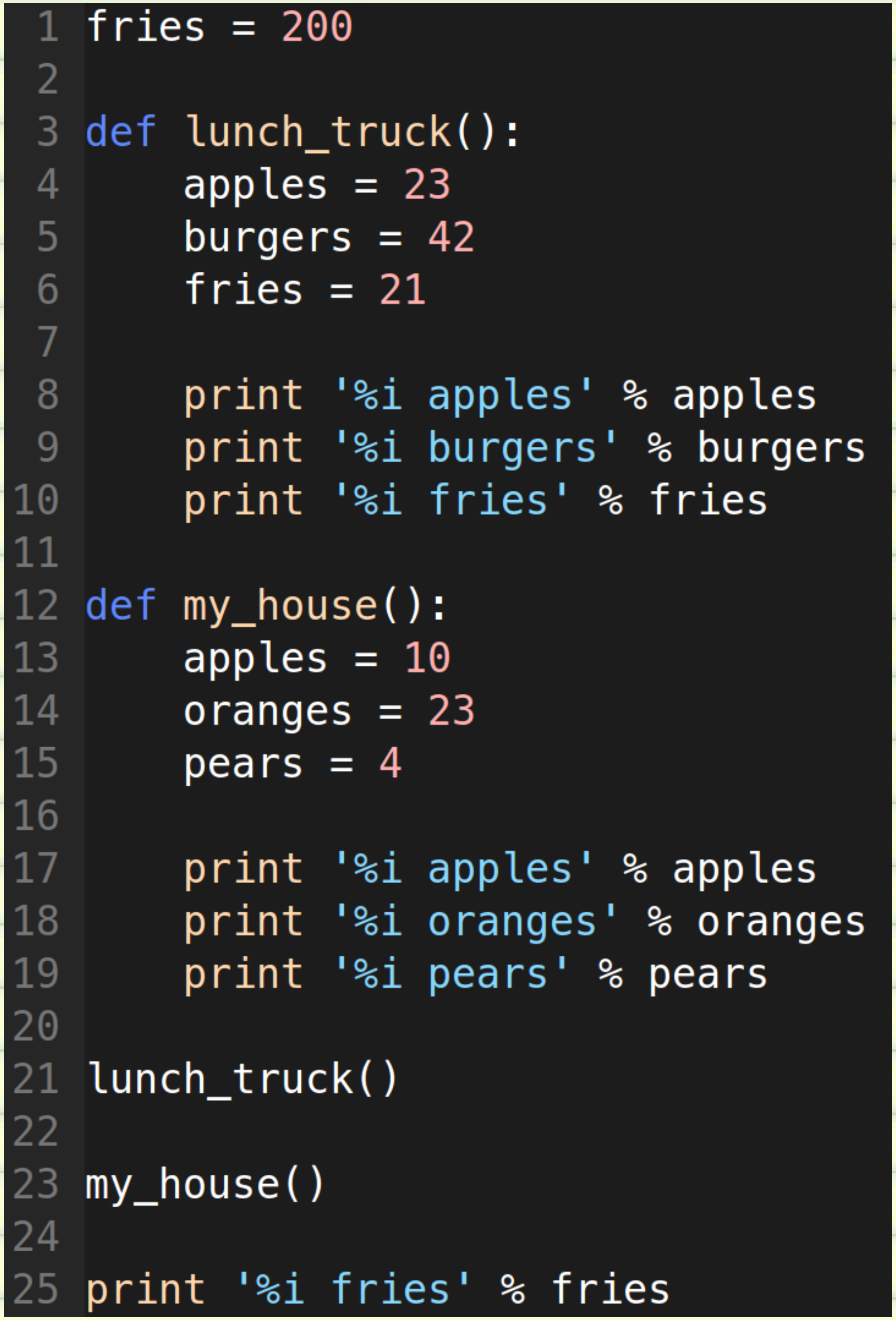

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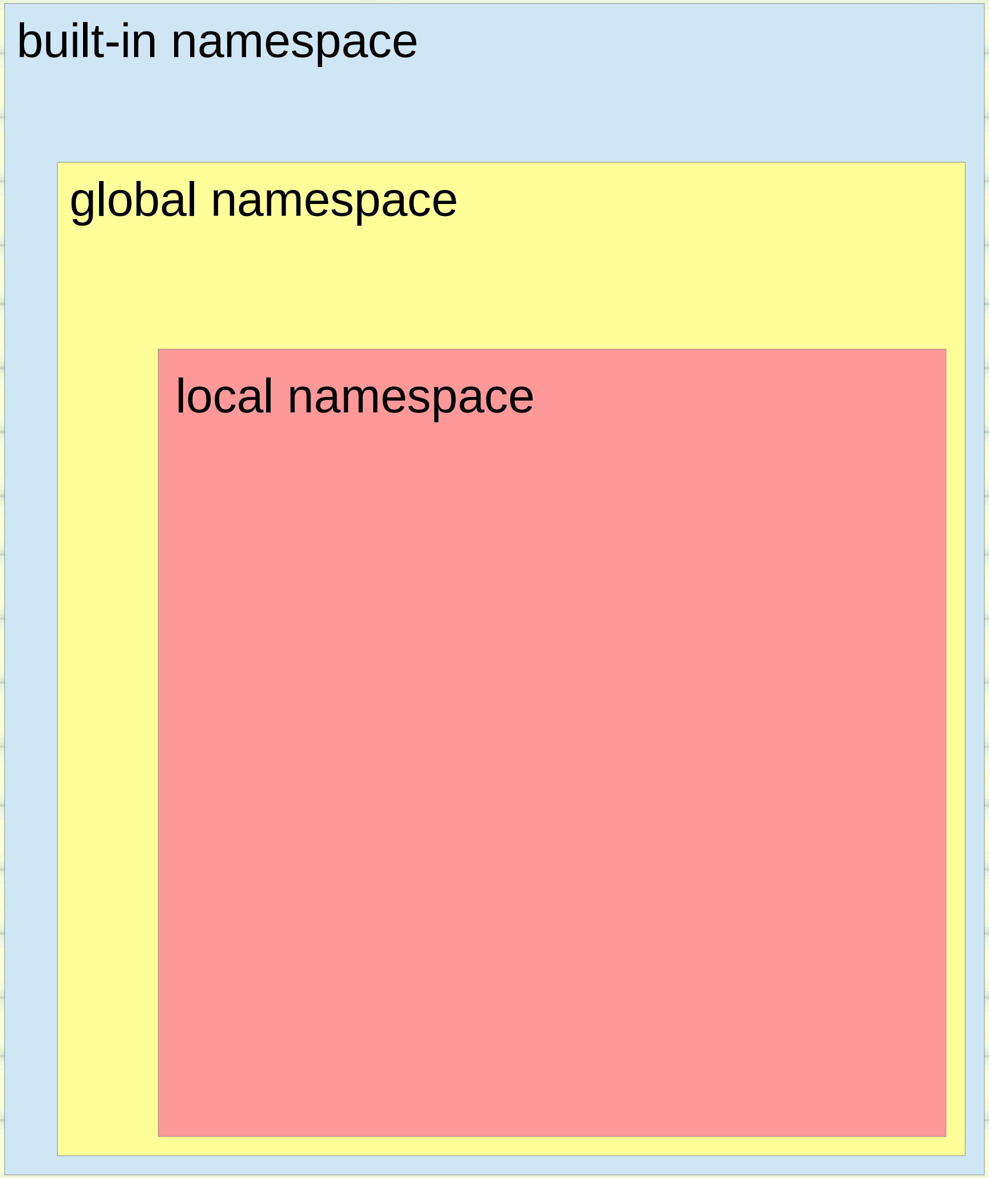

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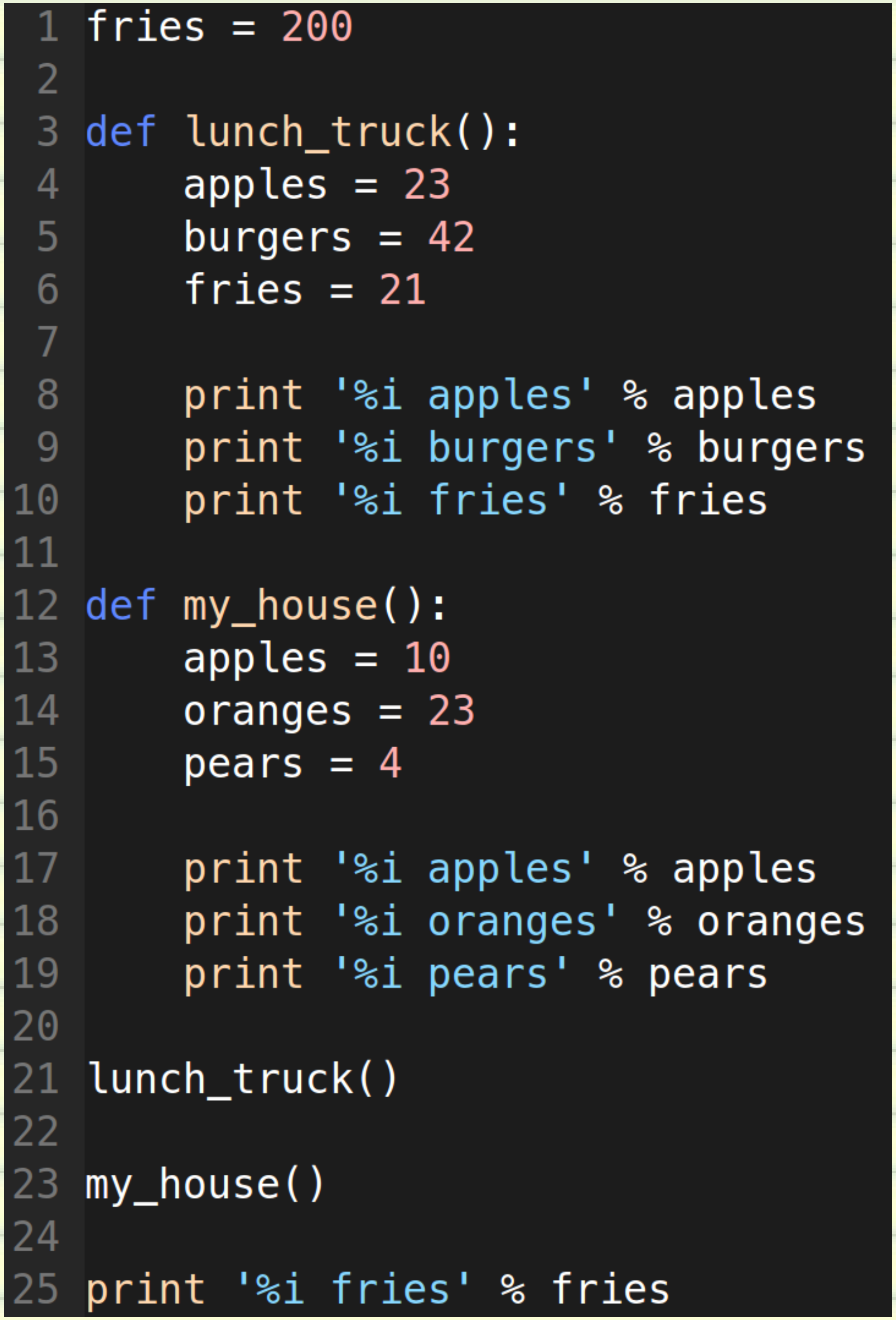

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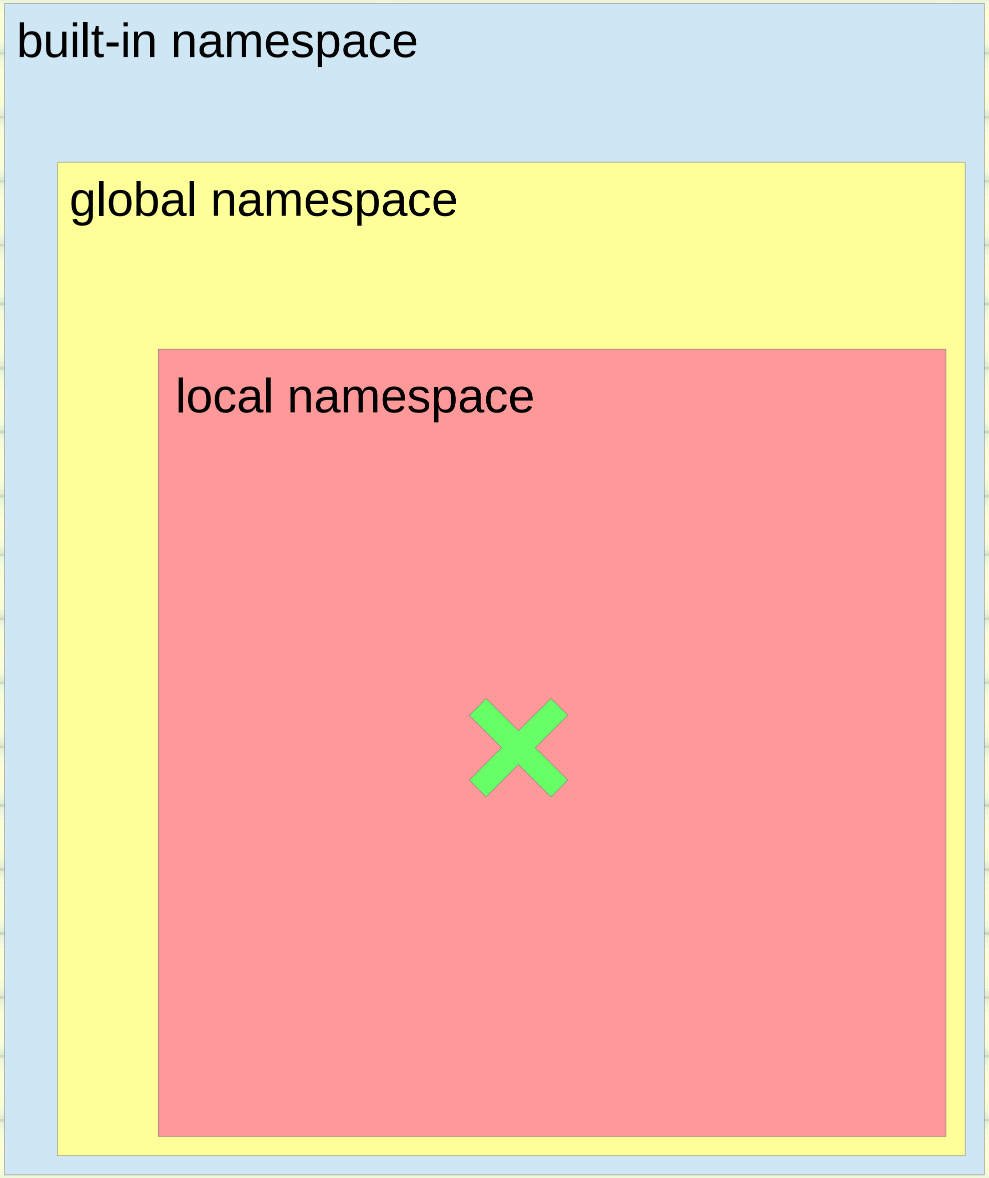
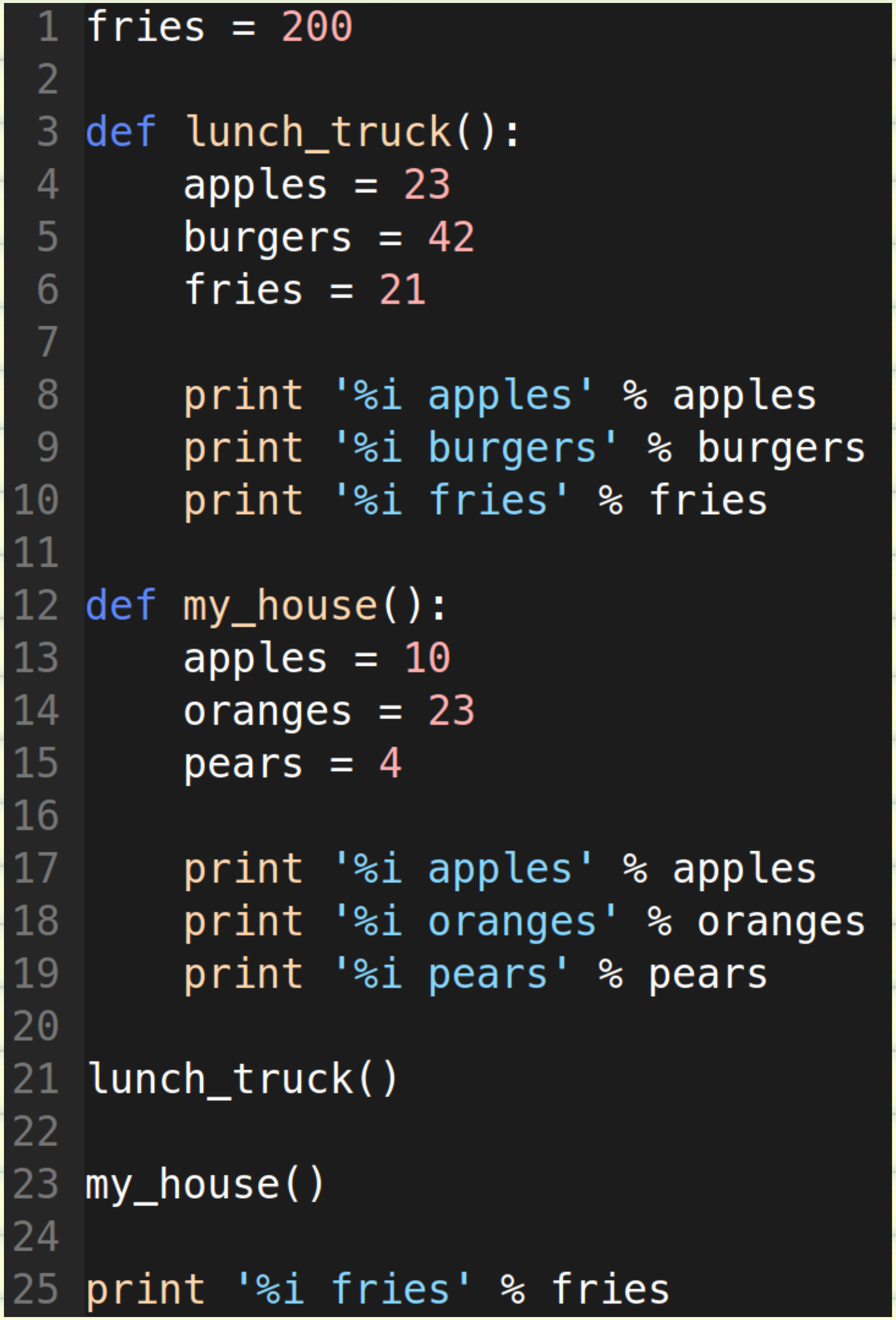


built-in namespace

global namespace

local namespace

Namespaces & Variable Scope



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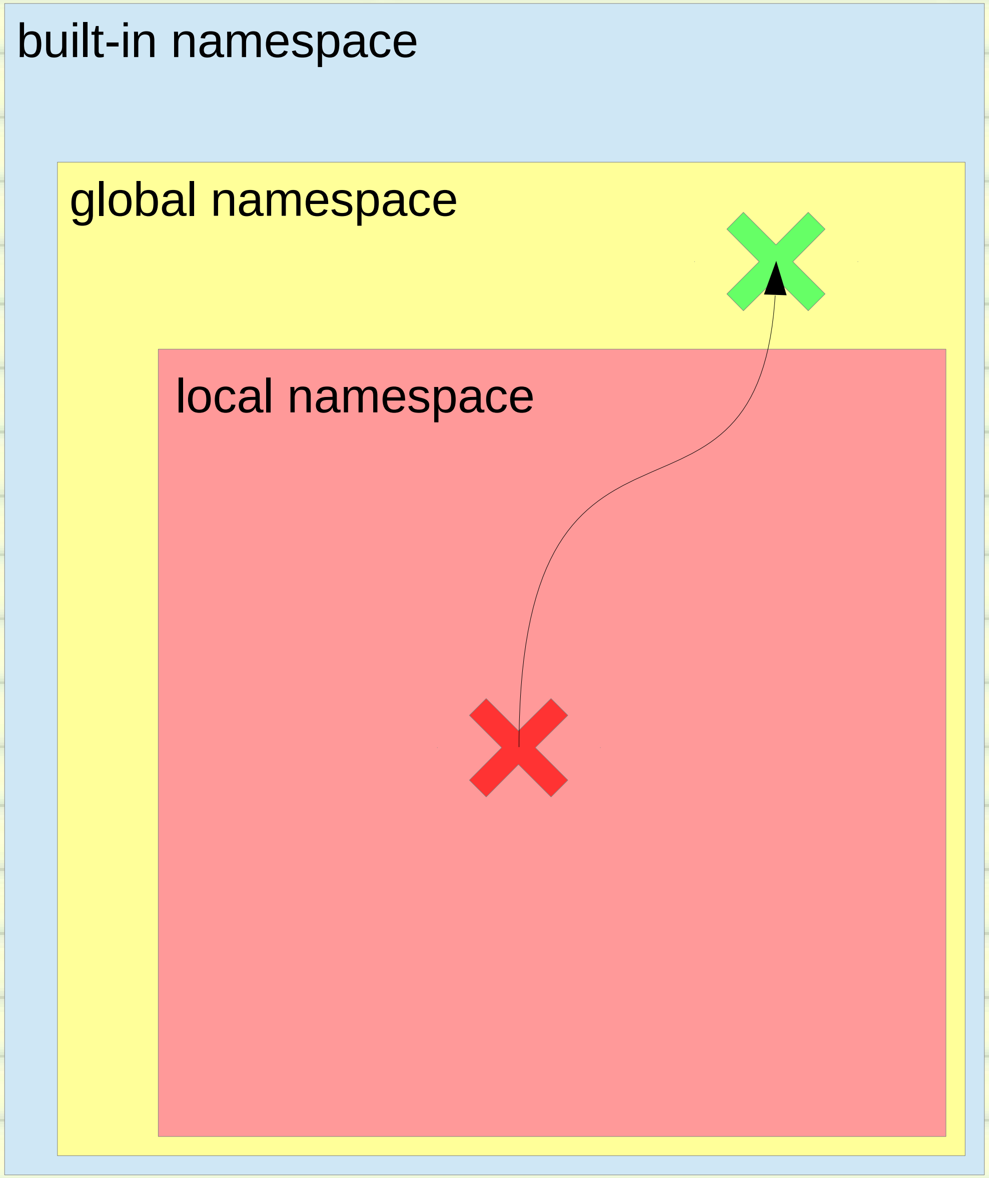

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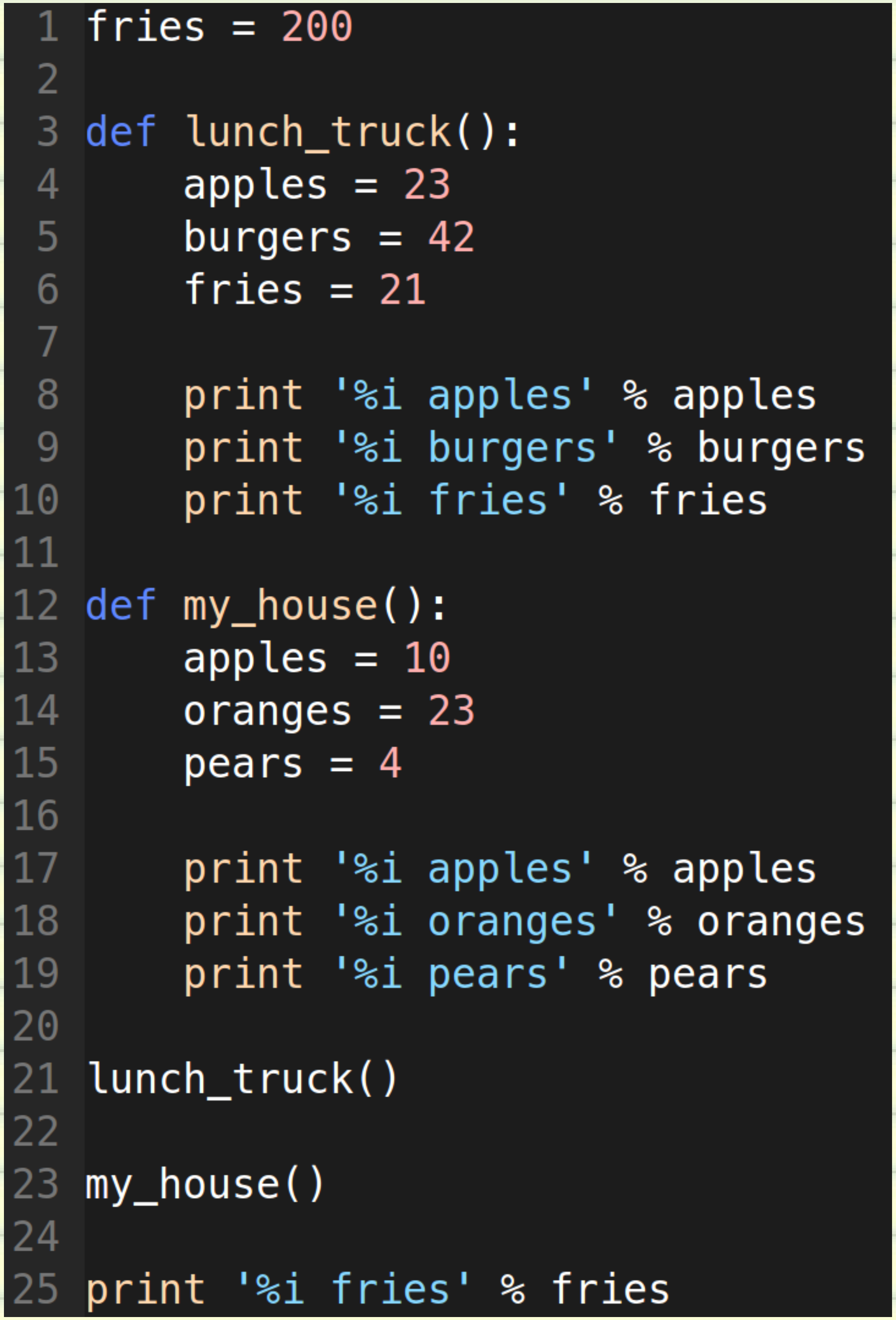

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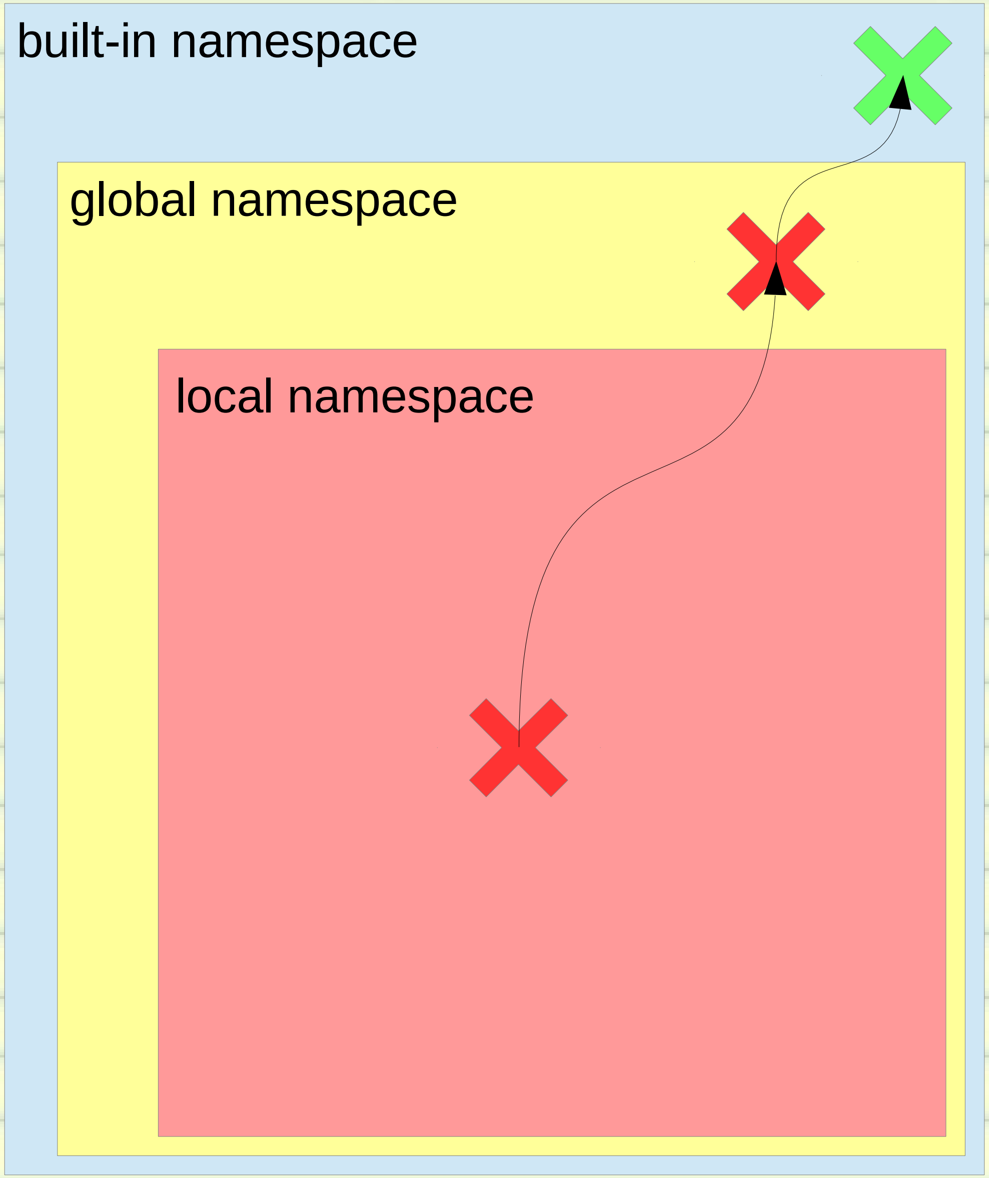

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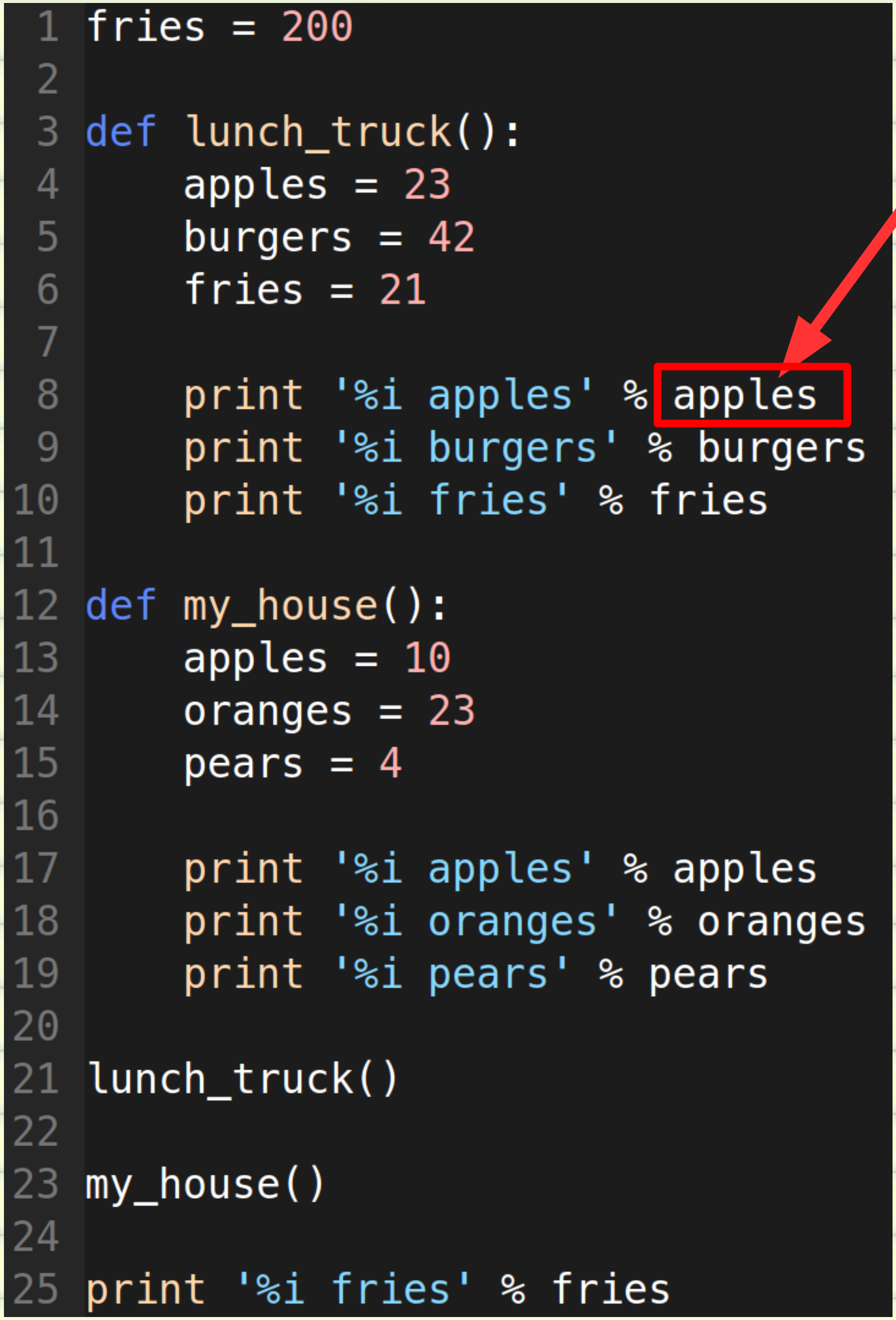

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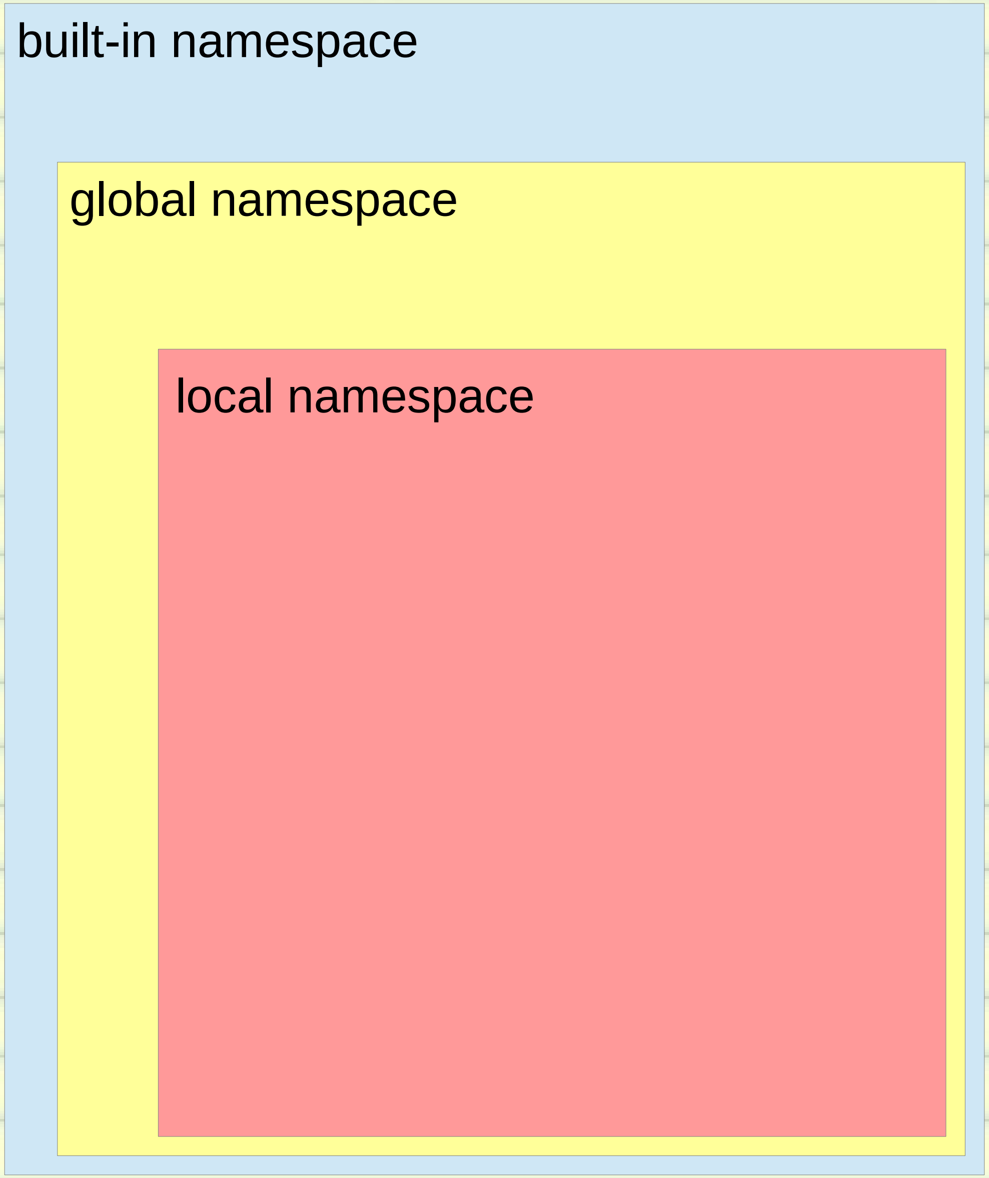

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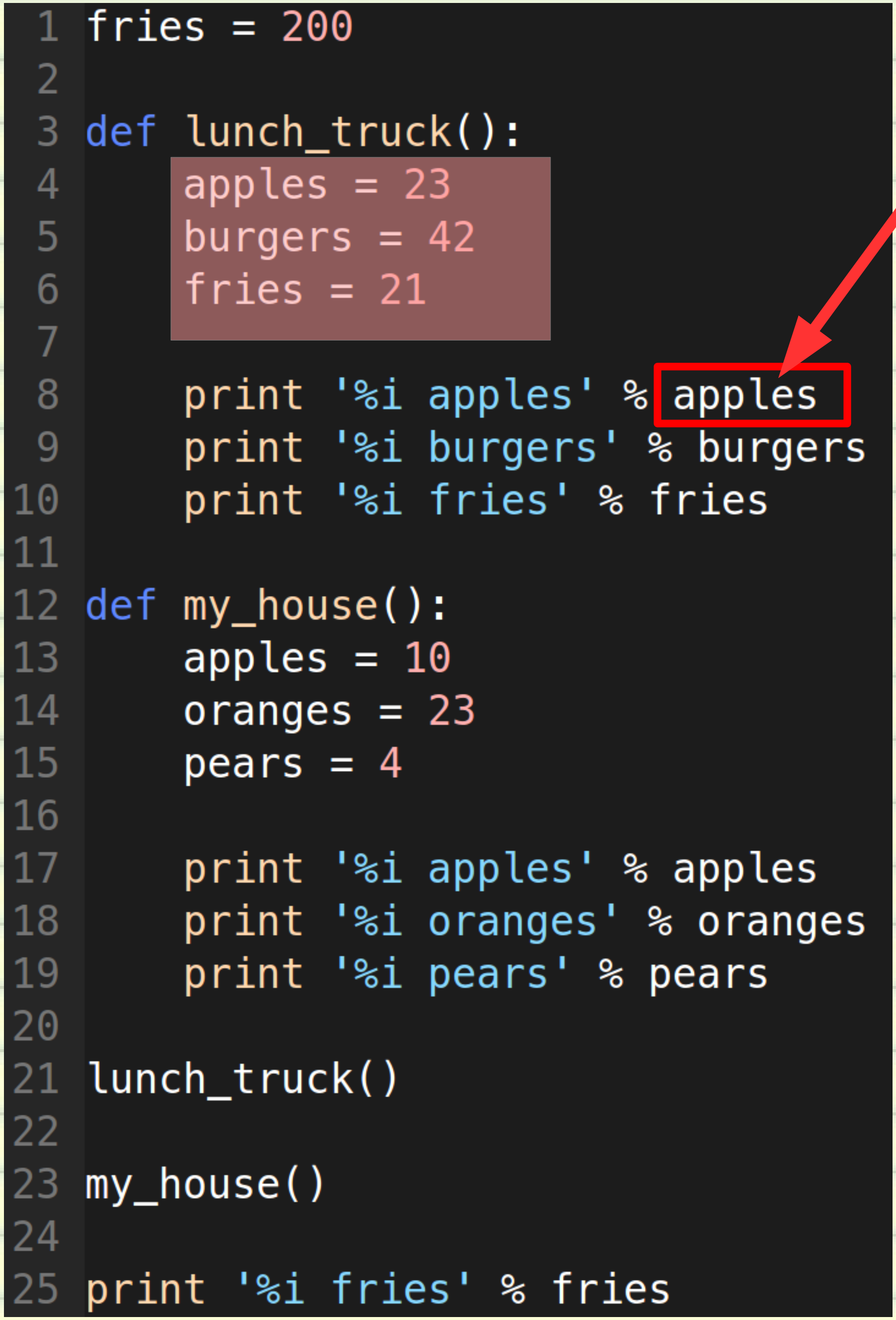

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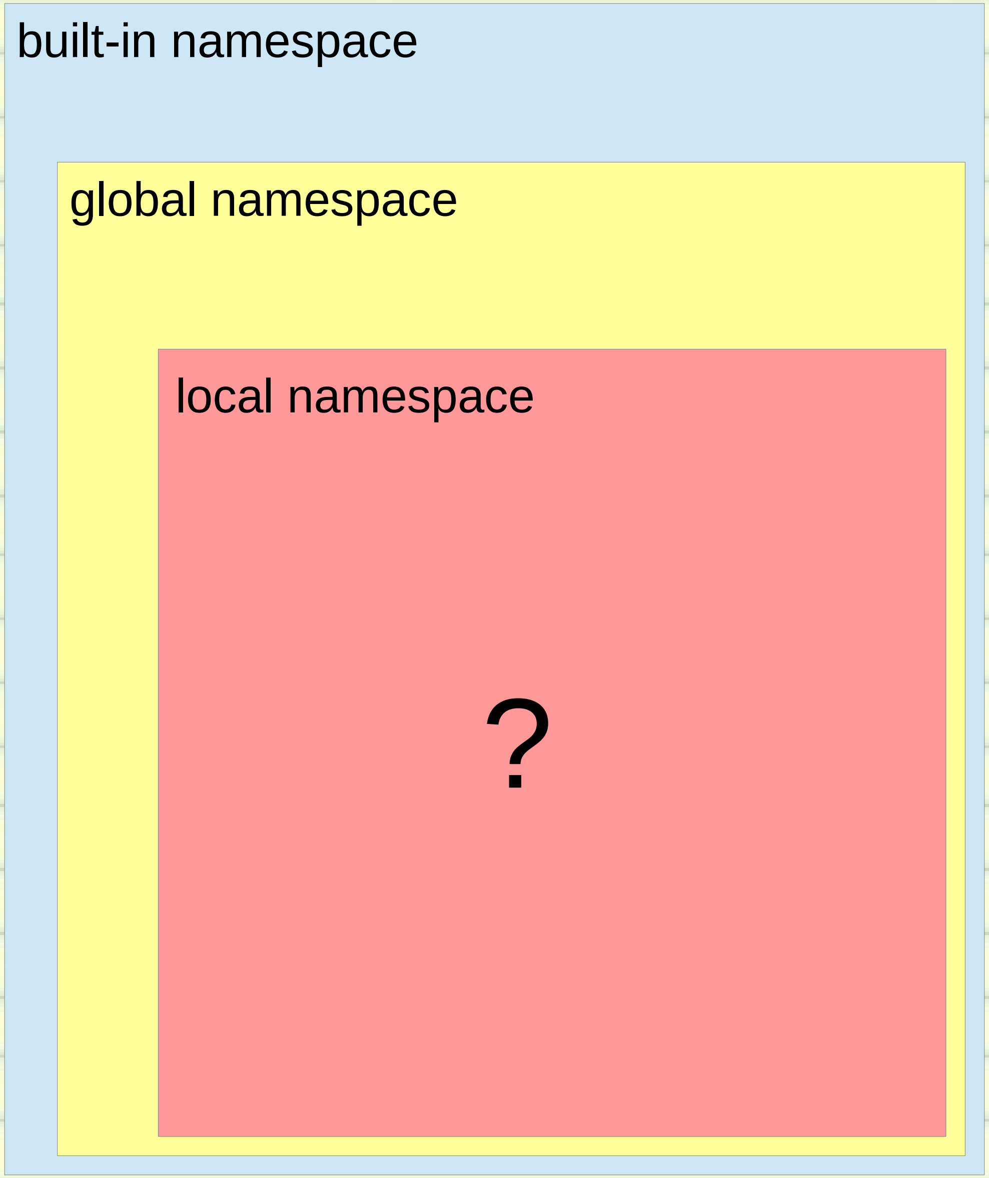

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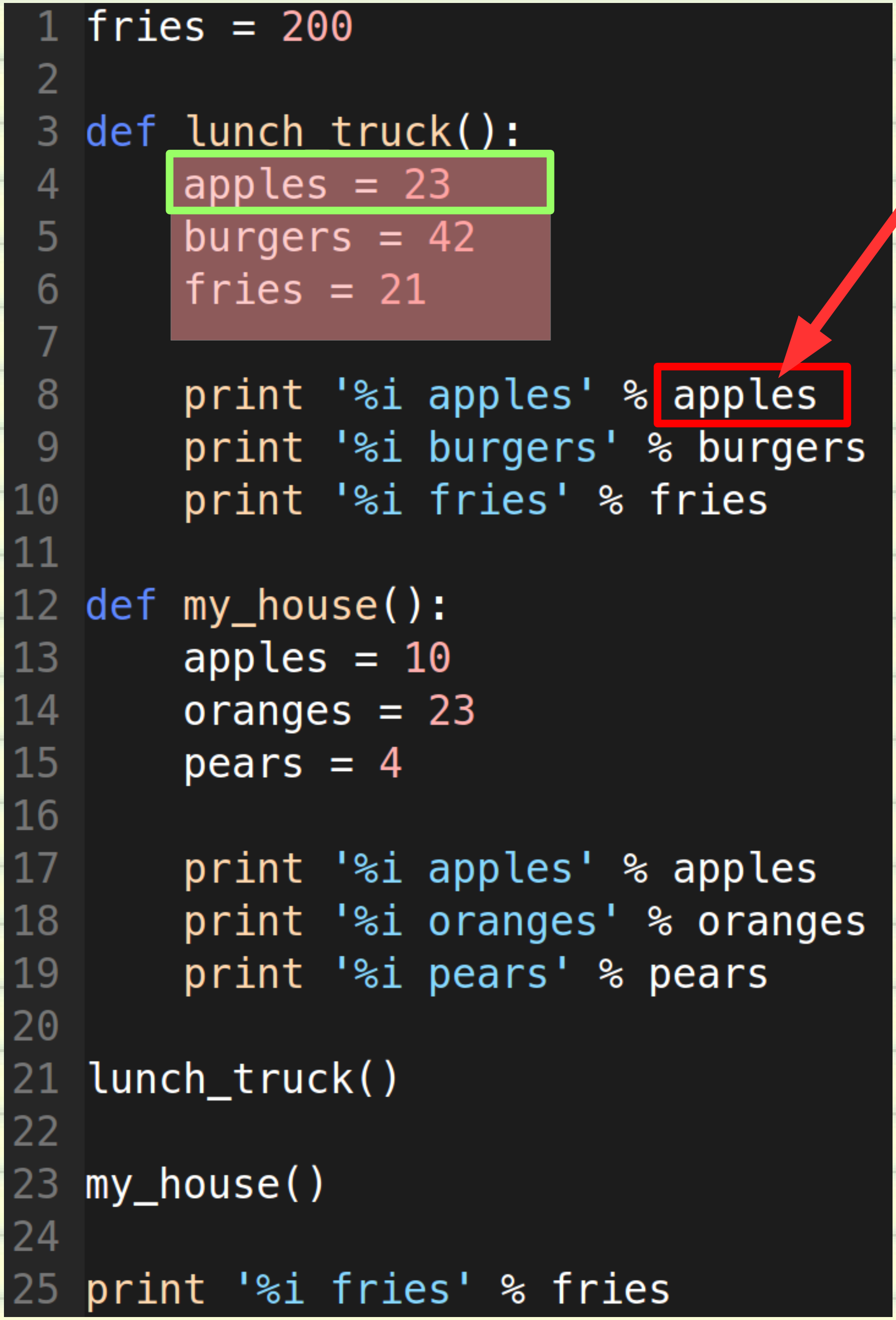

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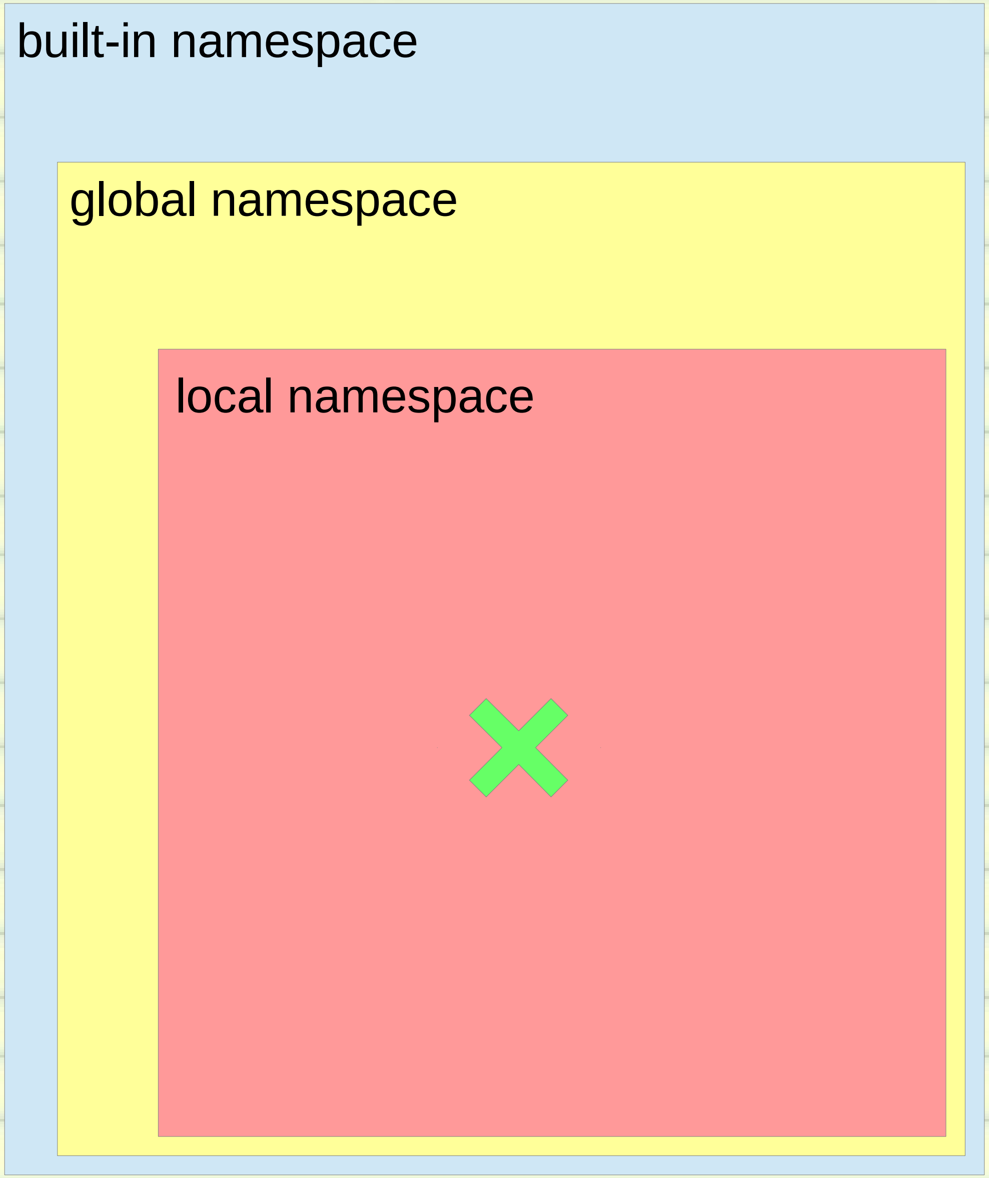

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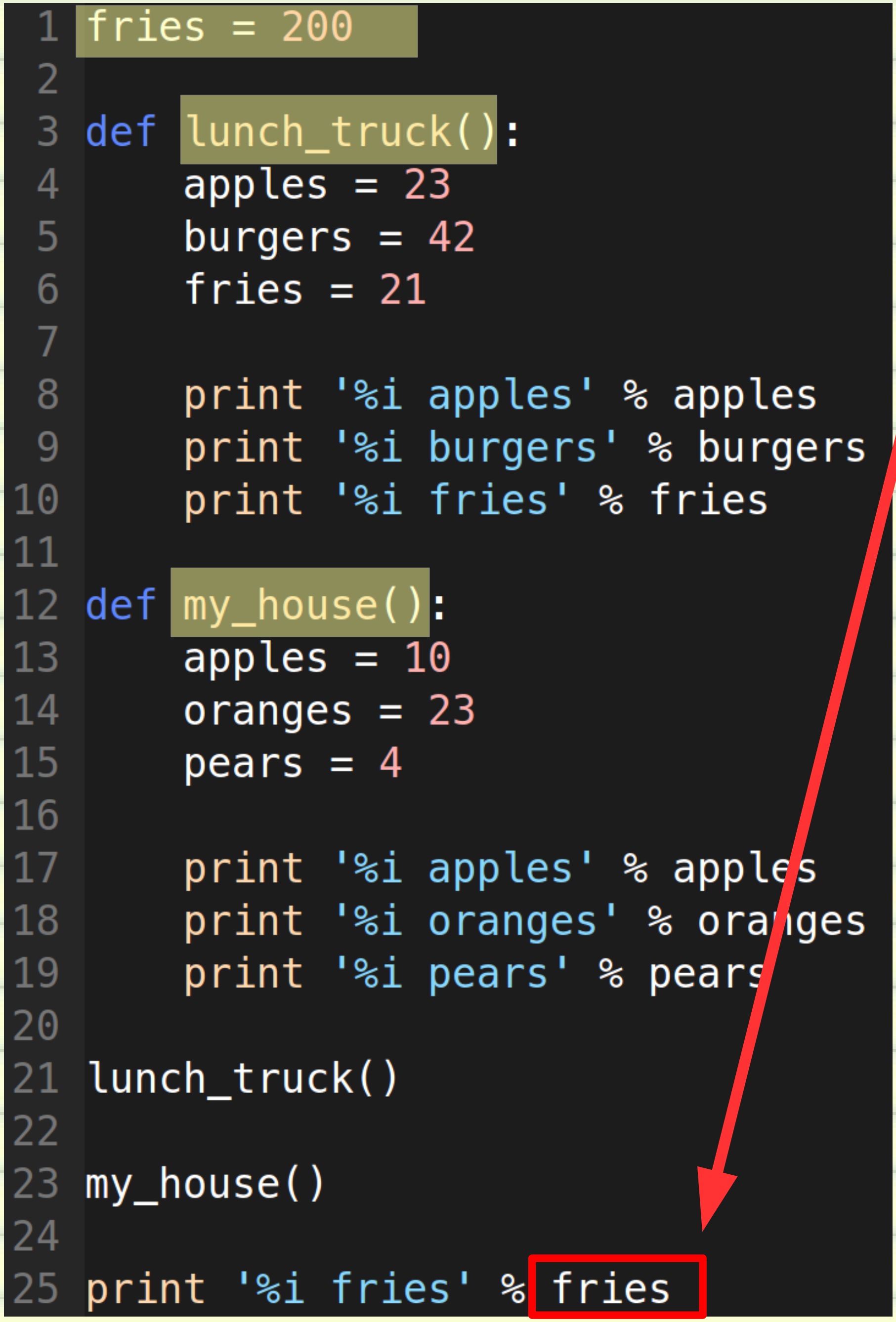

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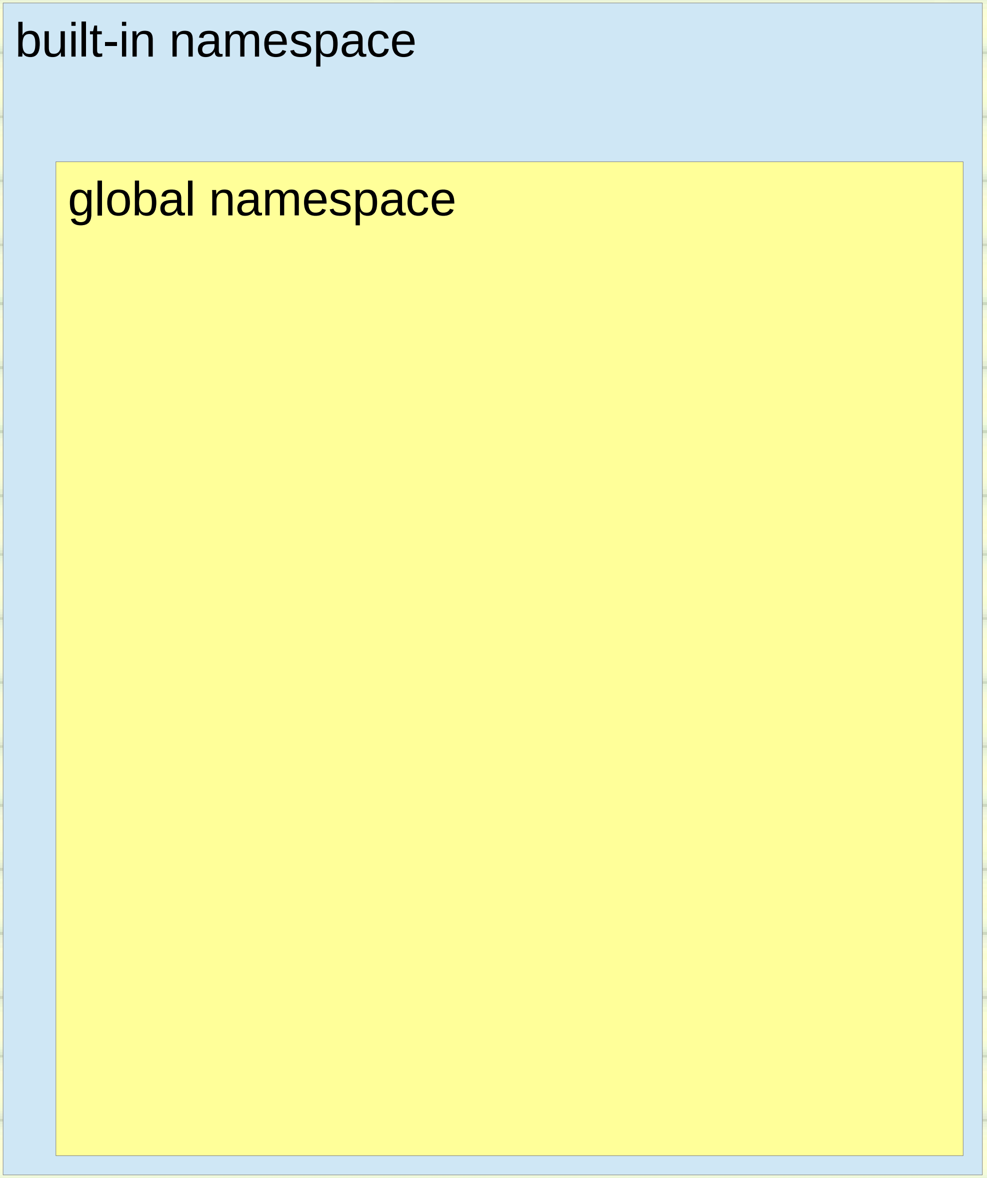

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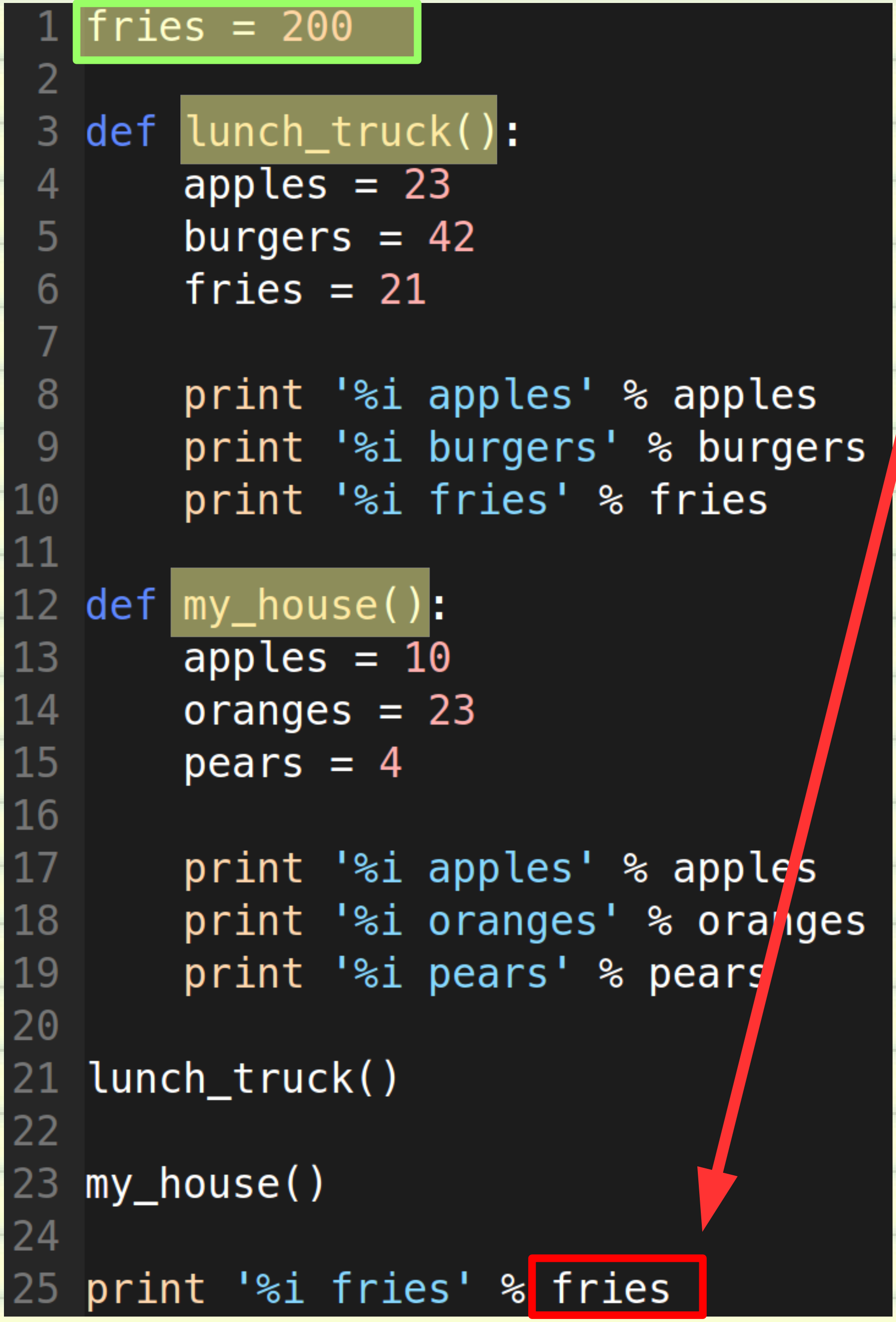

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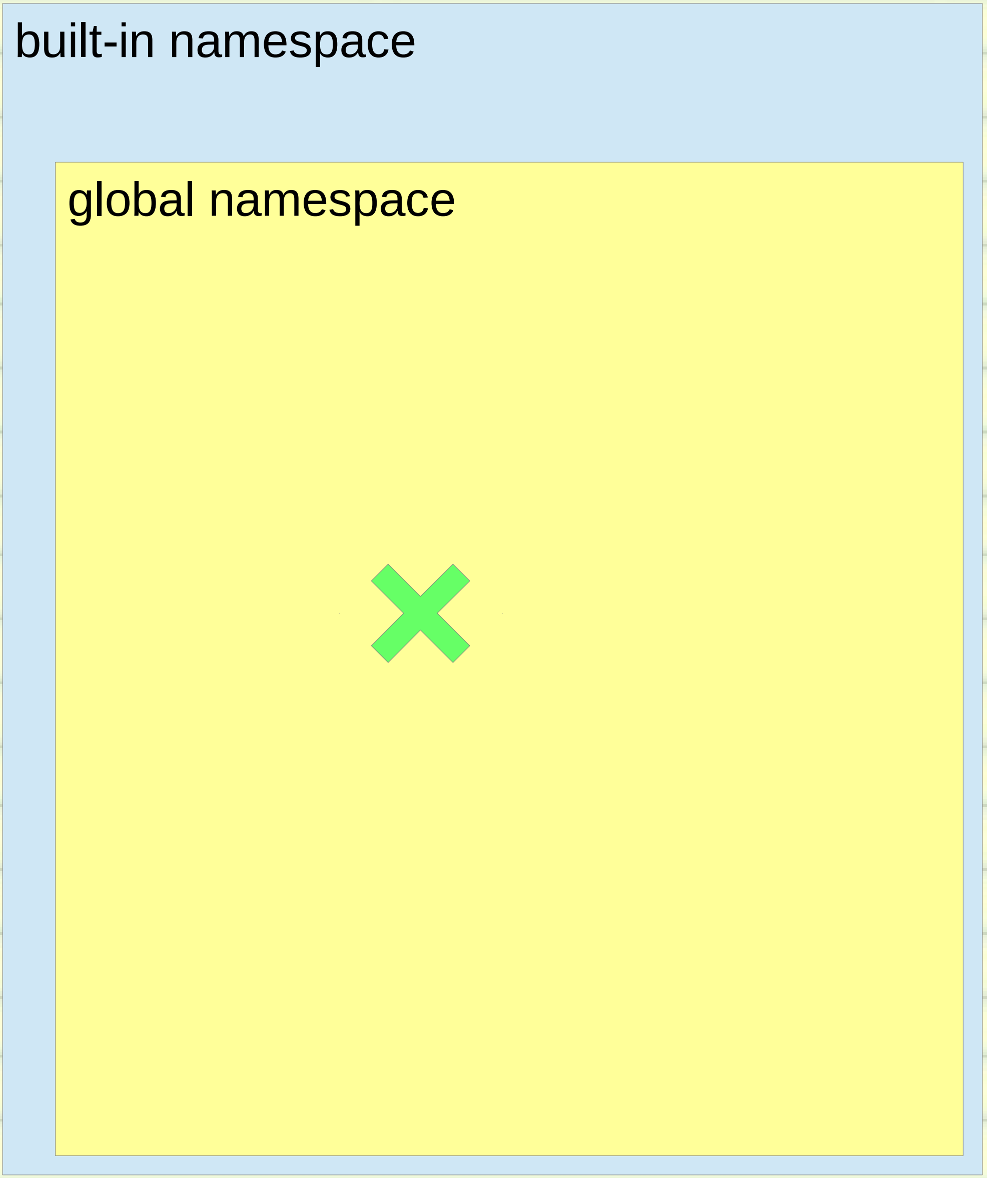

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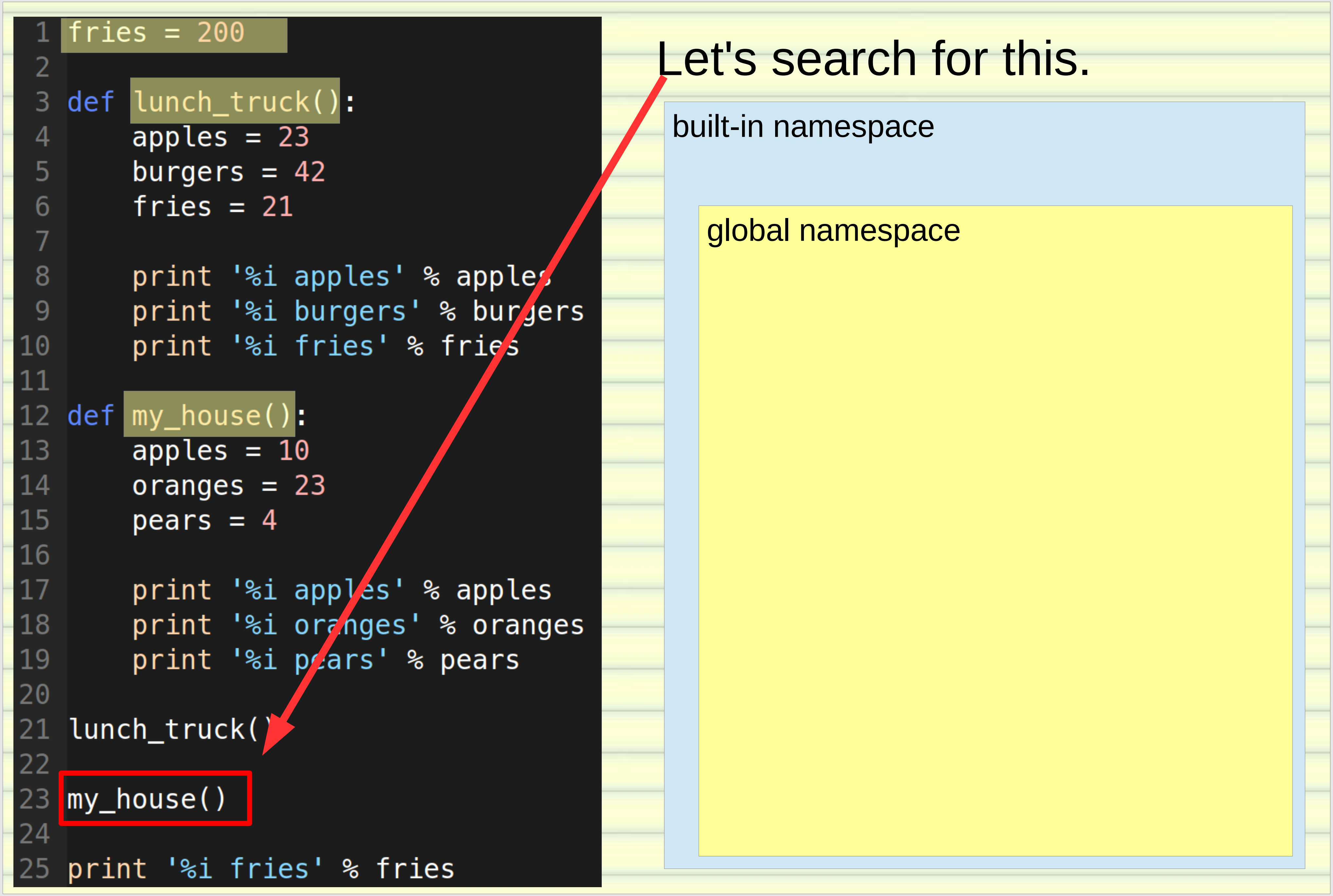

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print '%i fries' % fries
```
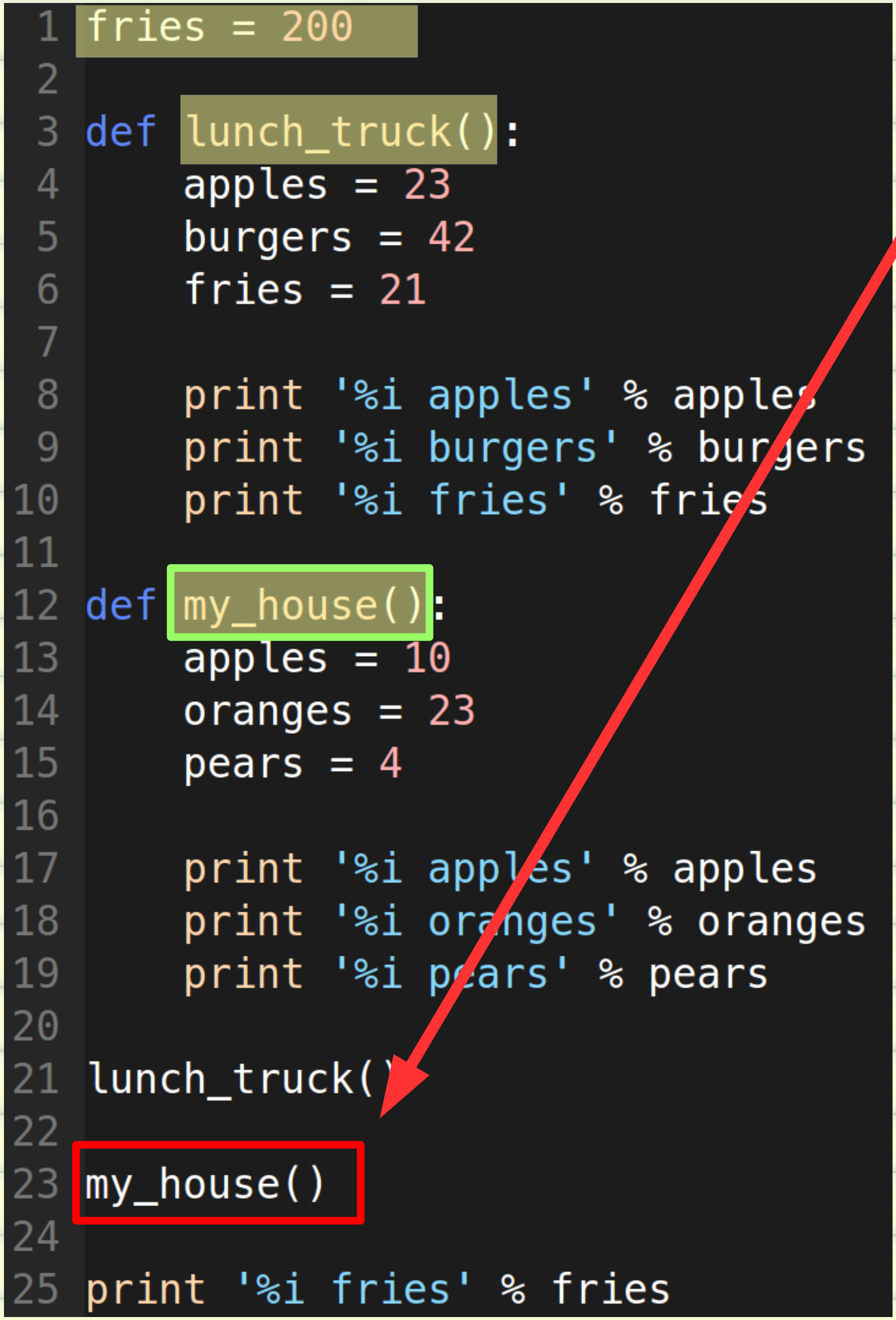
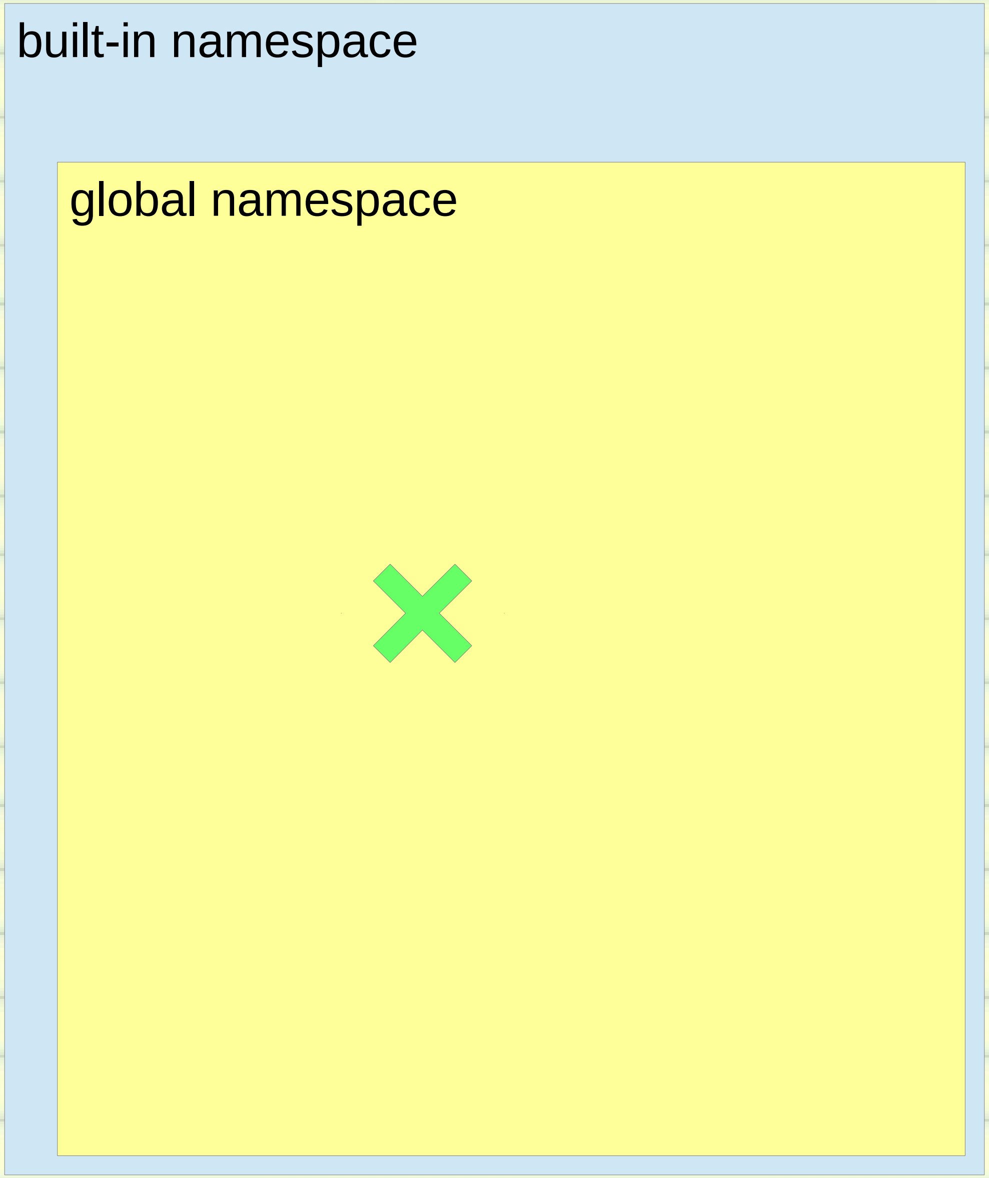

Let's search for this.

Namespaces & Variable Scope



```
fries = 200

def lunch_truck():
    apples = 23
    burgers = 42
    fries = 21

    print '%i apples' % apples
    print '%i burgers' % burgers
    print '%i fries' % fries

def my_house():
    apples = 10
    oranges = 23
    pears = 4

    print '%i apples' % apples
    print '%i oranges' % oranges
    print '%i pears' % pears

lunch_truck()

my_house()

print '%i fries' % fries
```

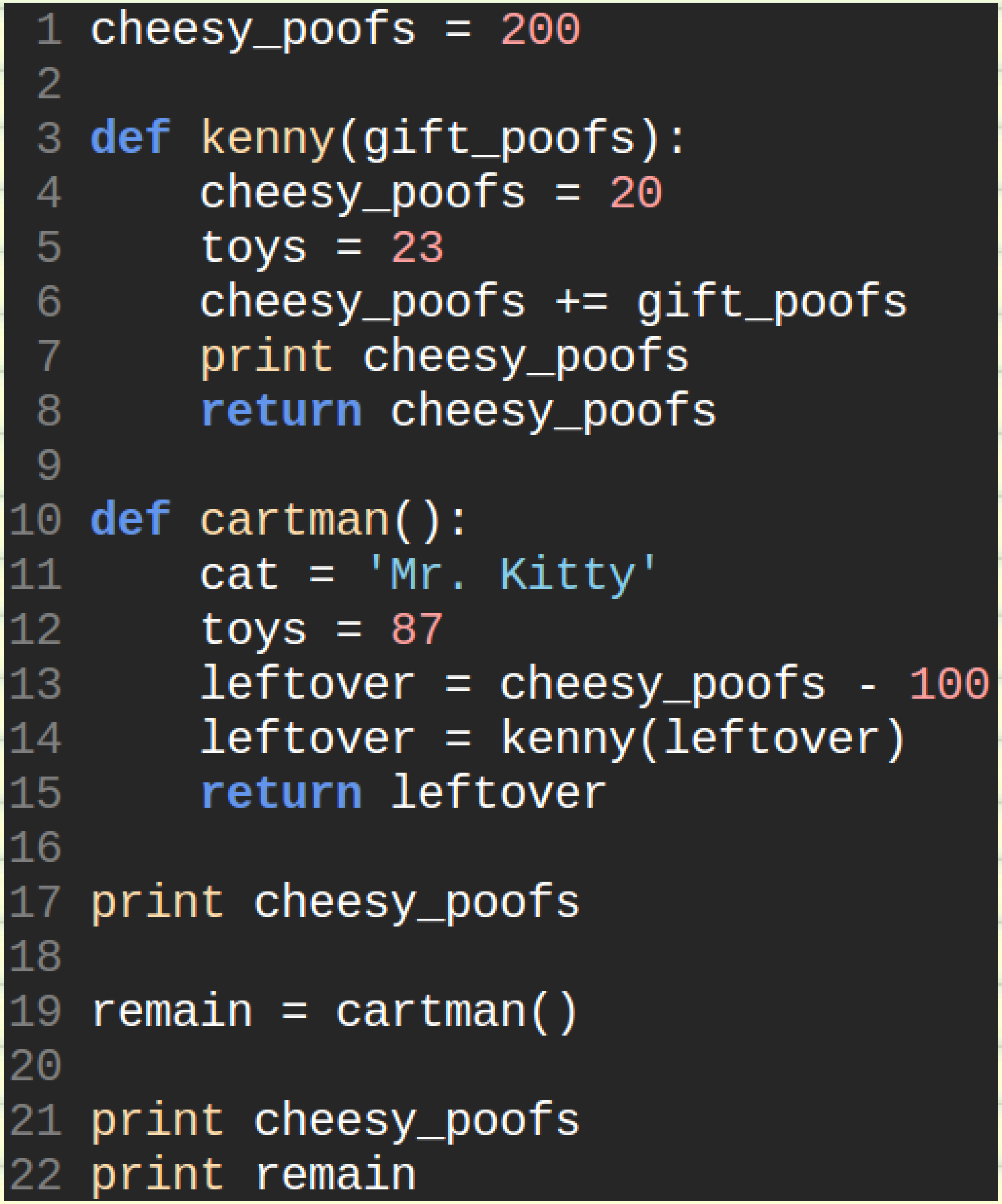
Let's search for this.



built-in namespace

global namespace

Namespaces & Variable Scope



```
cheesy_poofs = 200

def kenny(gift_poofs):
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    toys = 23
    cheesy_poofs += gift_poofs
    print cheesy_poofs
    return cheesy_poofs

def cartman():
    cat = 'Mr. Kitty'
    toys = 87
    leftover = cheesy_poofs - 100
    leftover = kenny(leftover)
    return leftover

print cheesy_poofs

remain = cartman()

print cheesy_poofs
print remain
```
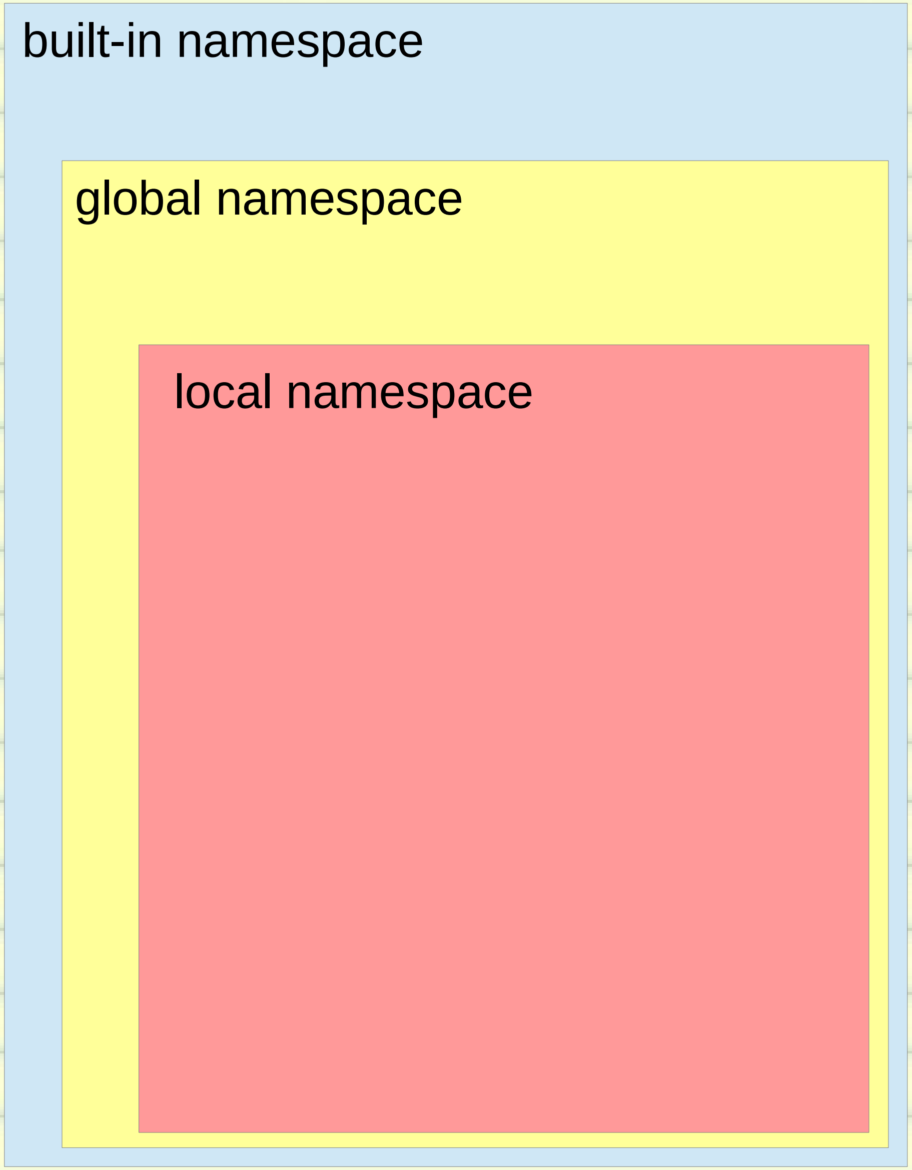

New Code.

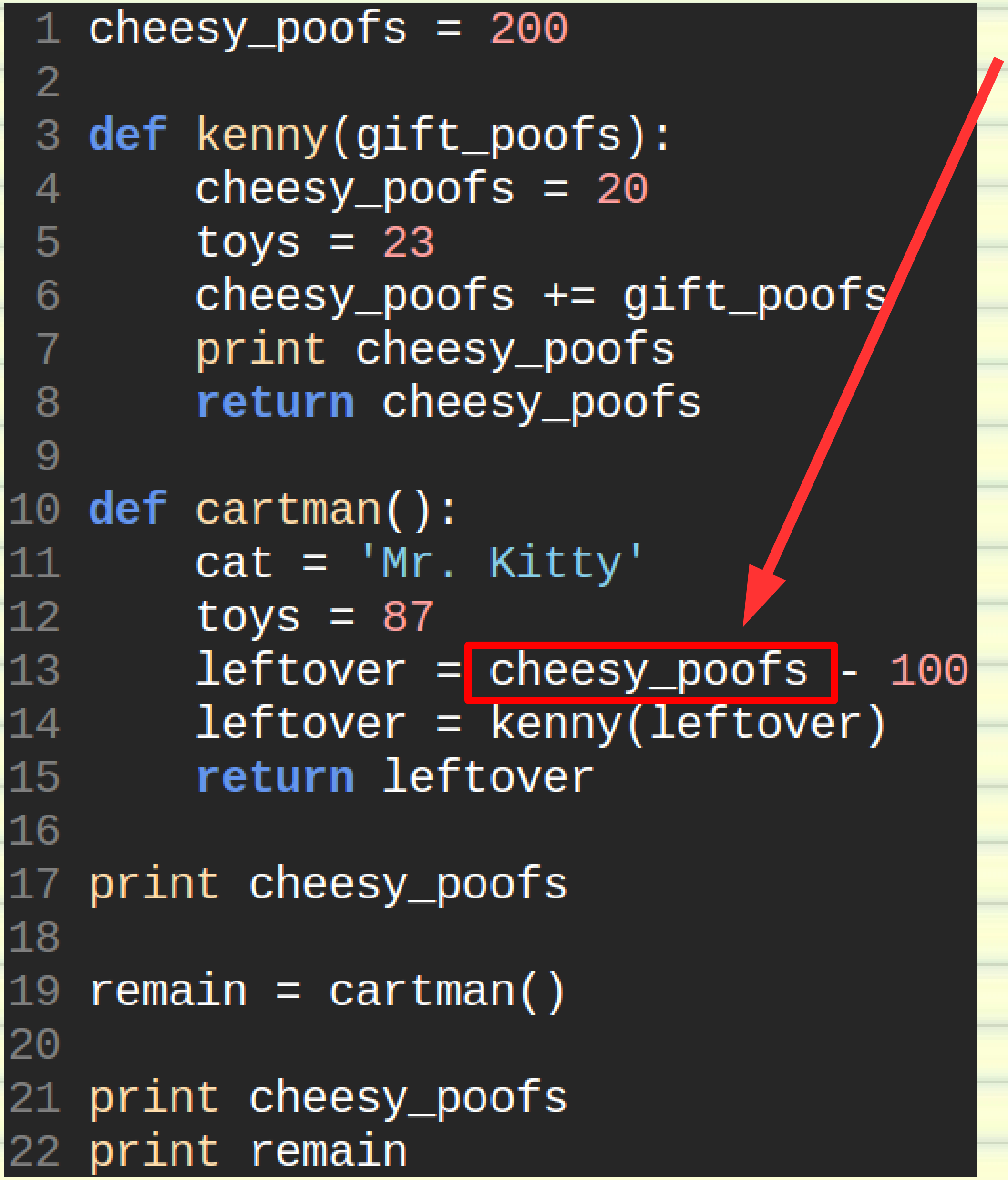


built-in namespace

global namespace

local namespace

Namespaces & Variable Scope



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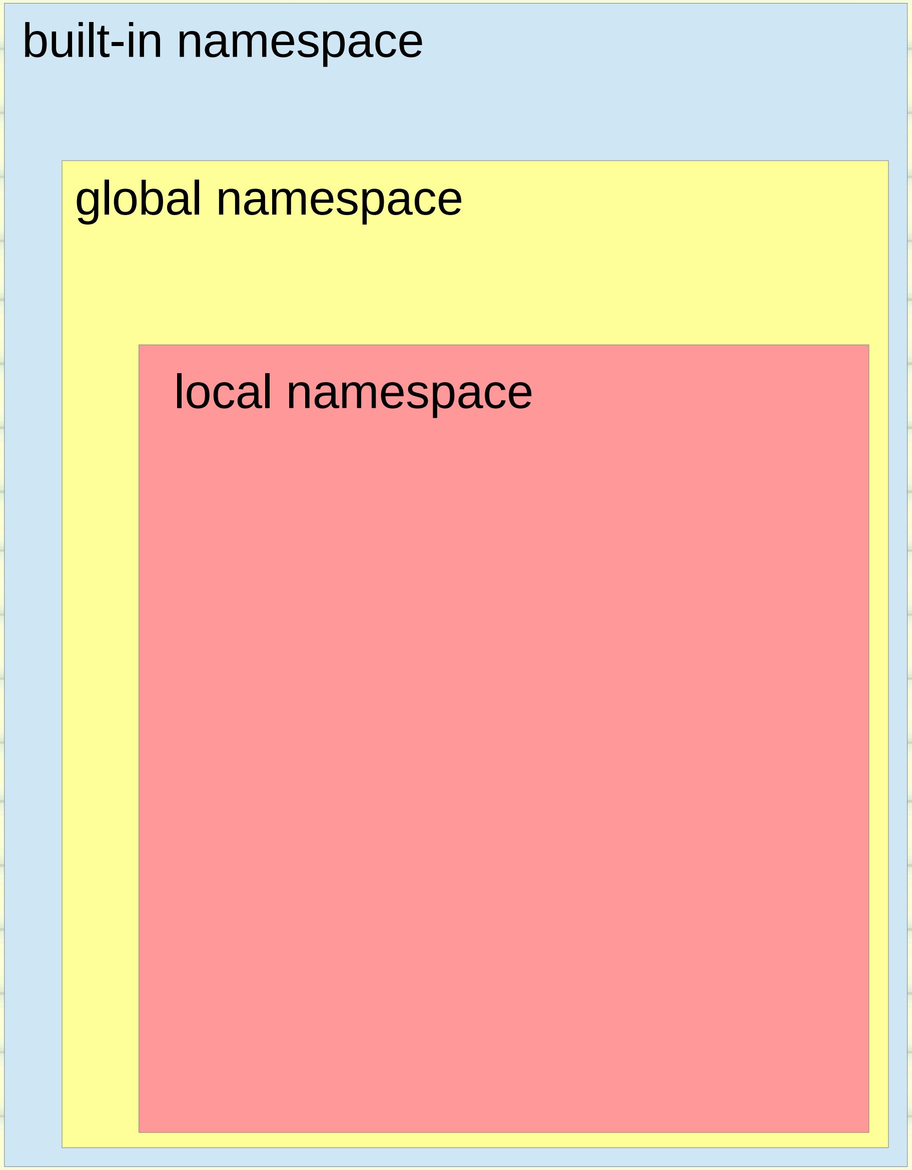
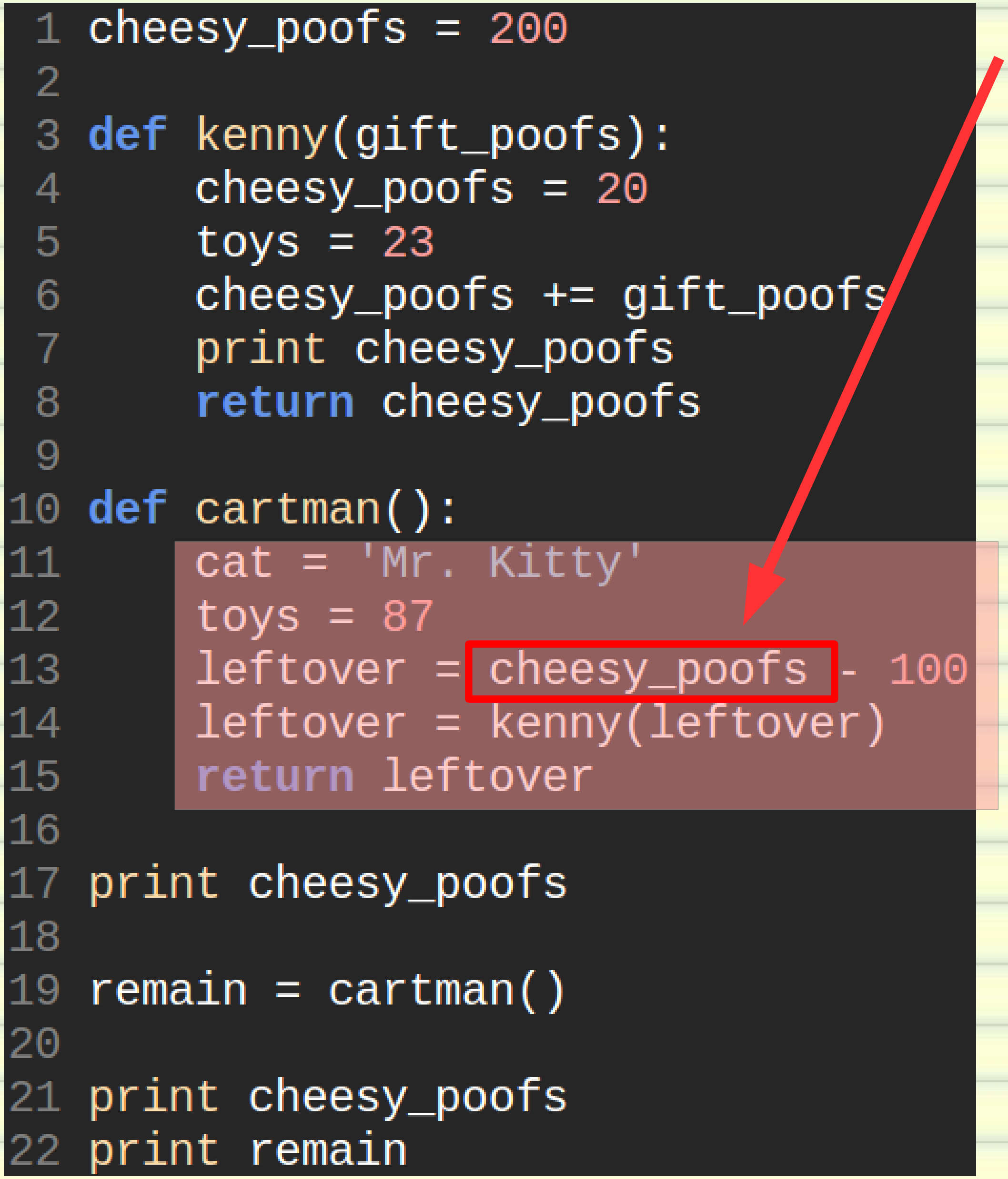


Namespaces & Variable Scope



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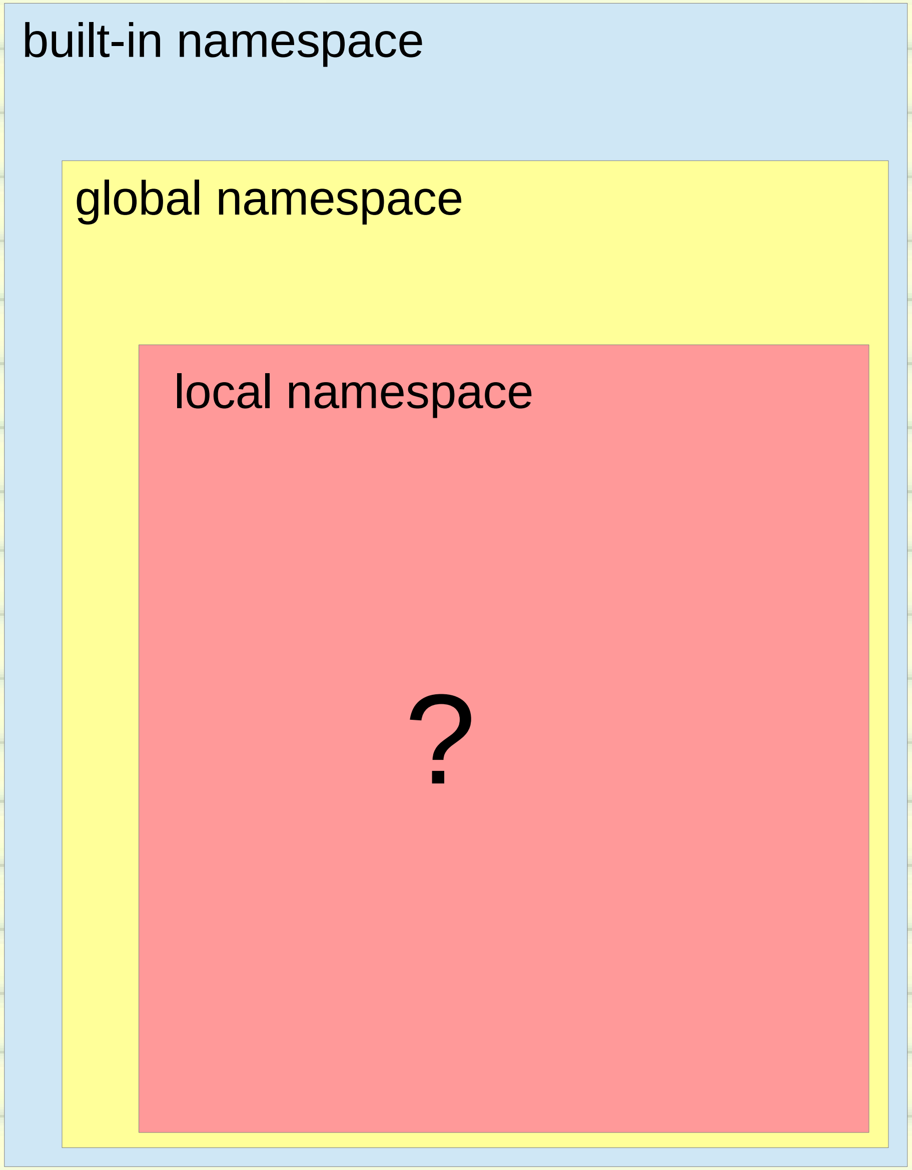
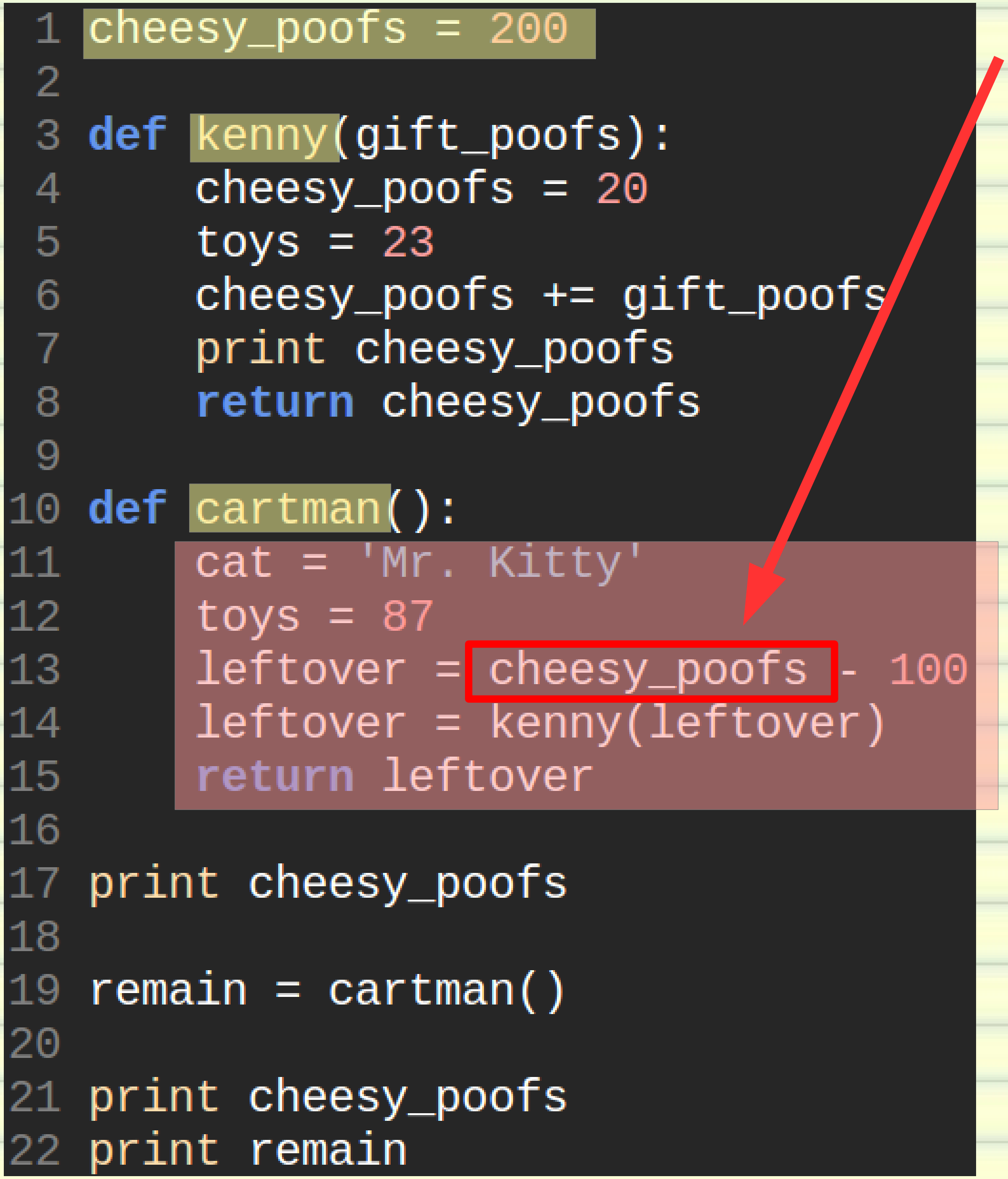


Namespaces & Variable Scope



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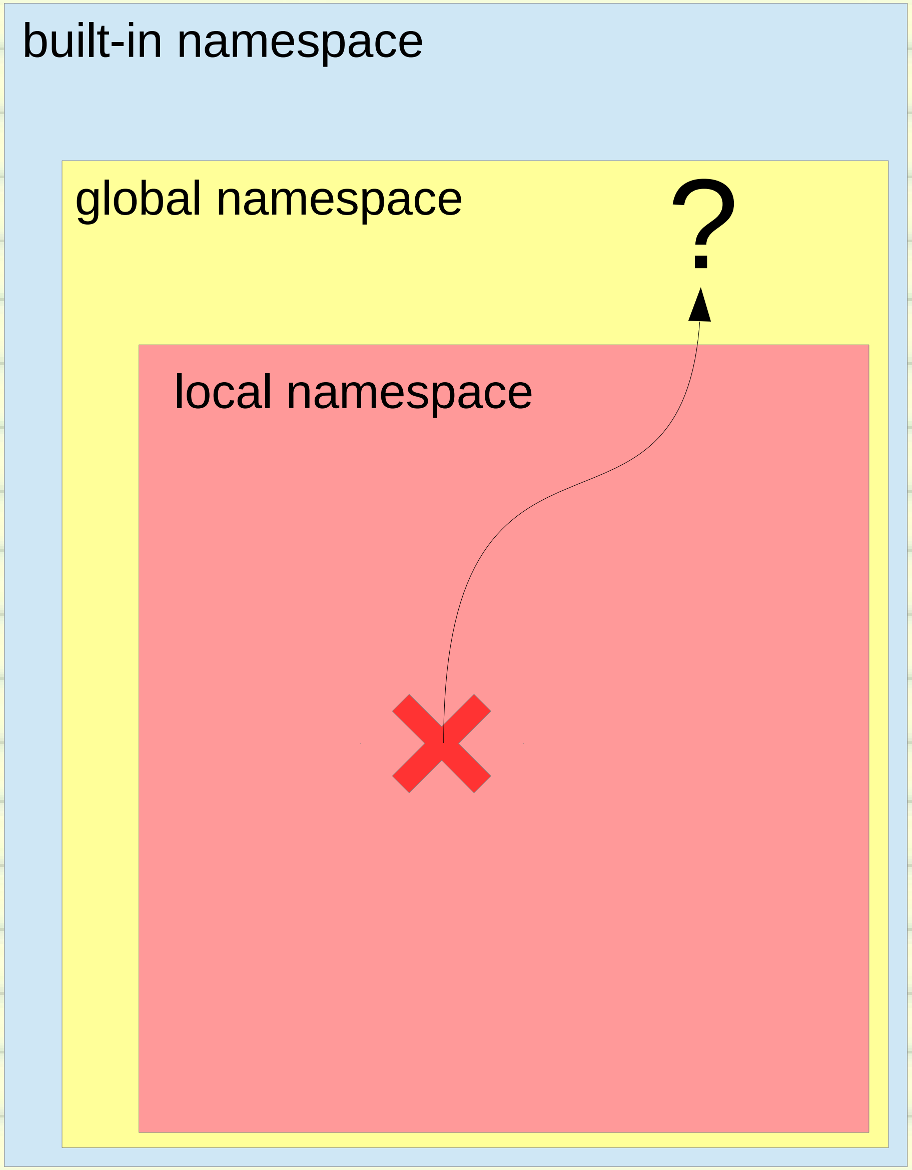
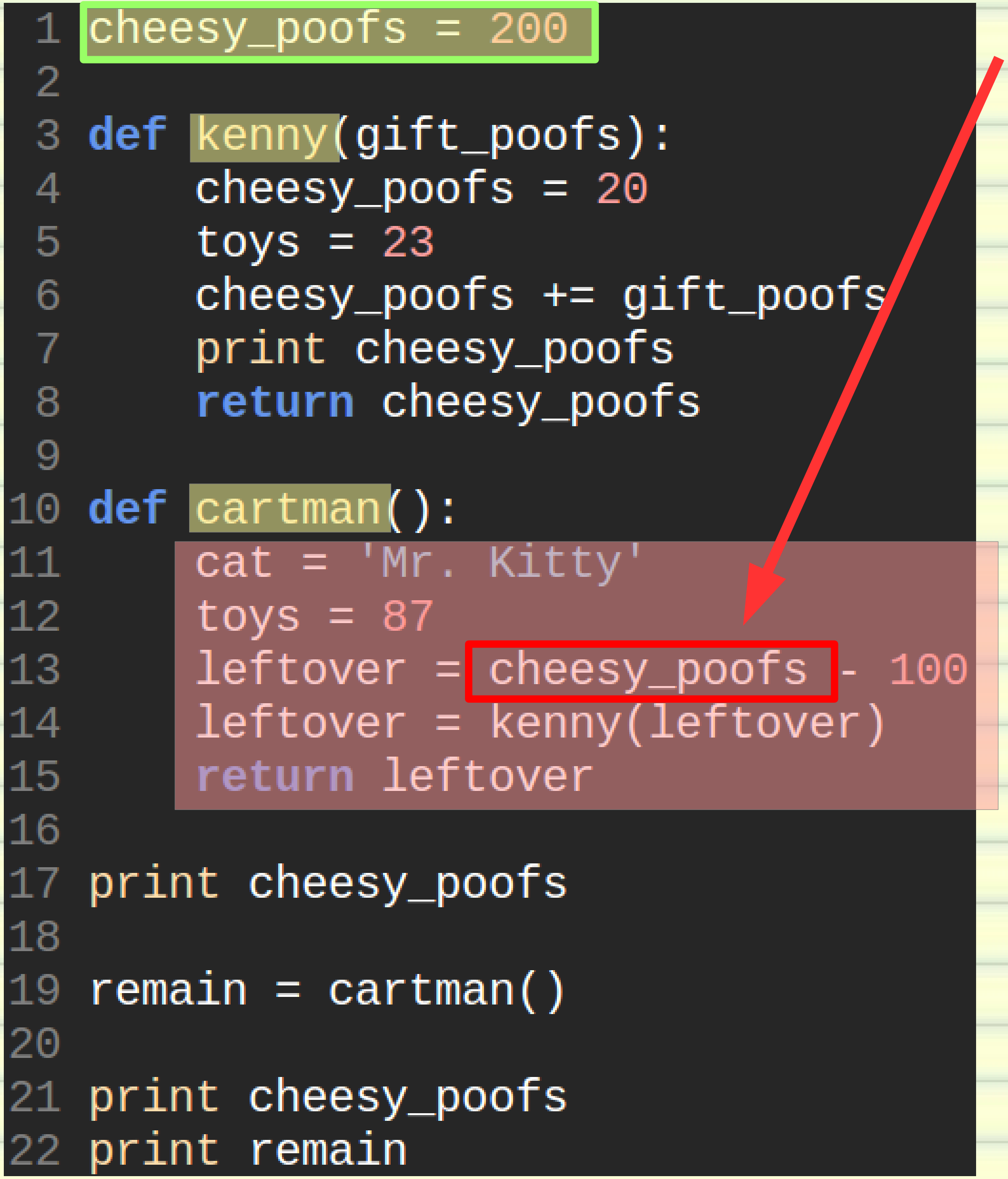


Namespaces & Variable Scope



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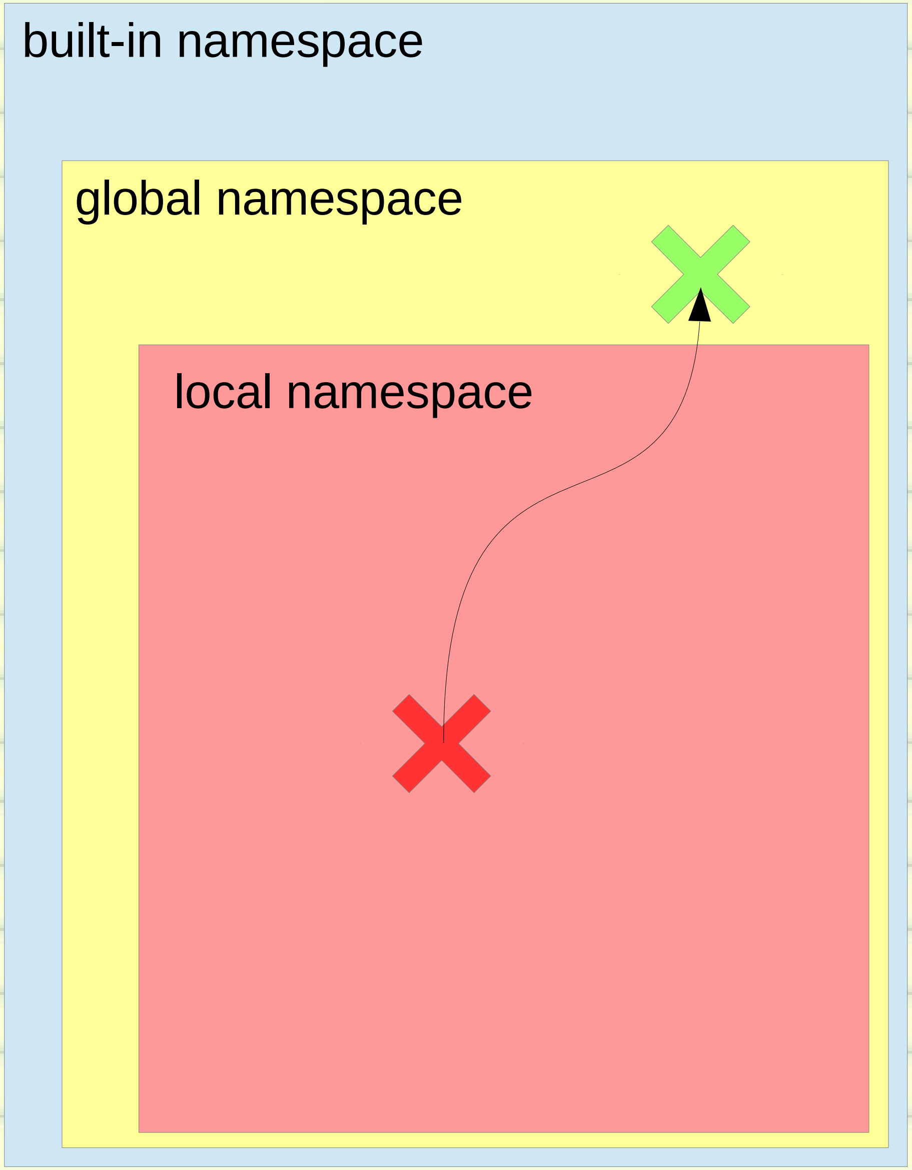
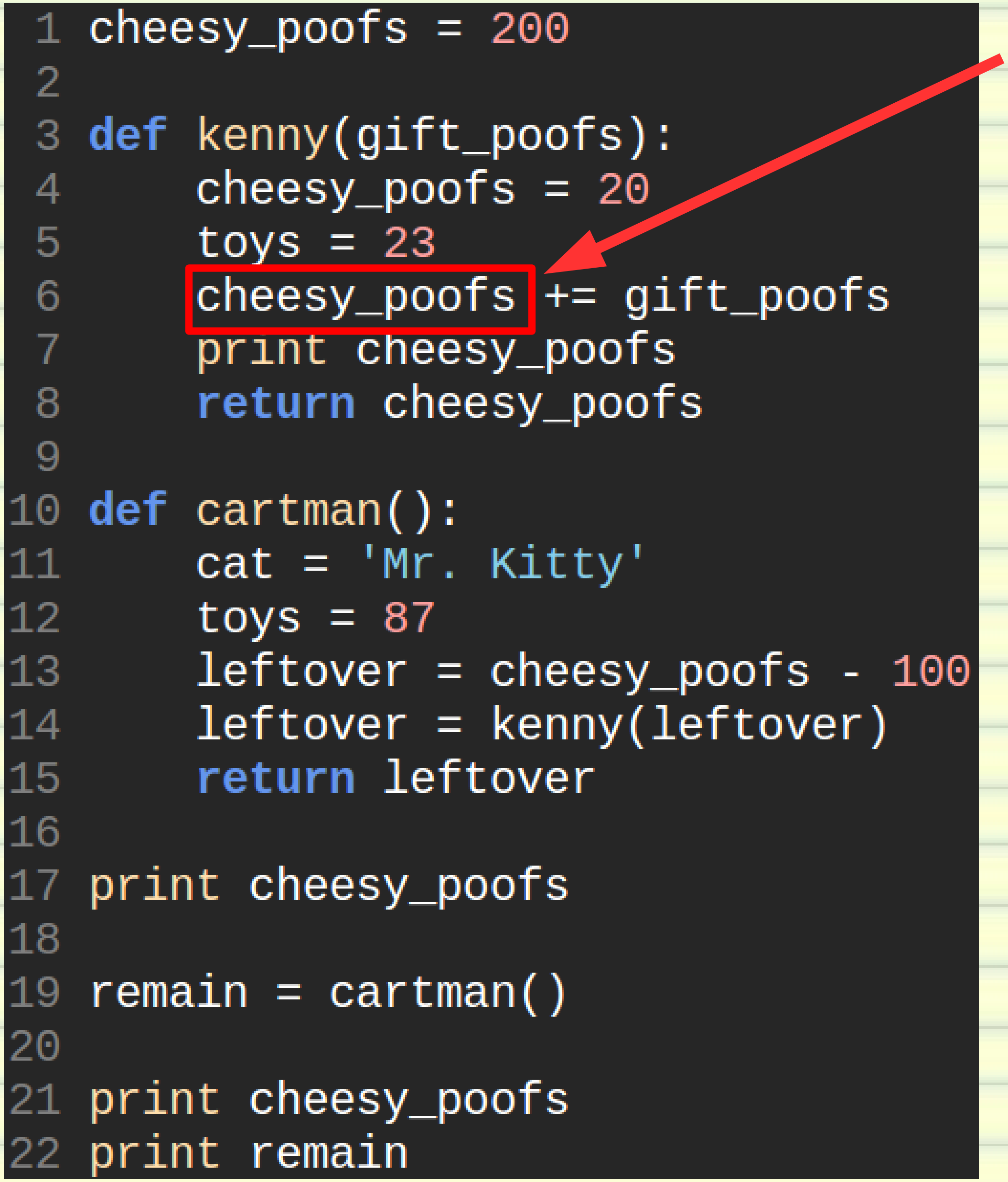


Namespaces & Variable Scope



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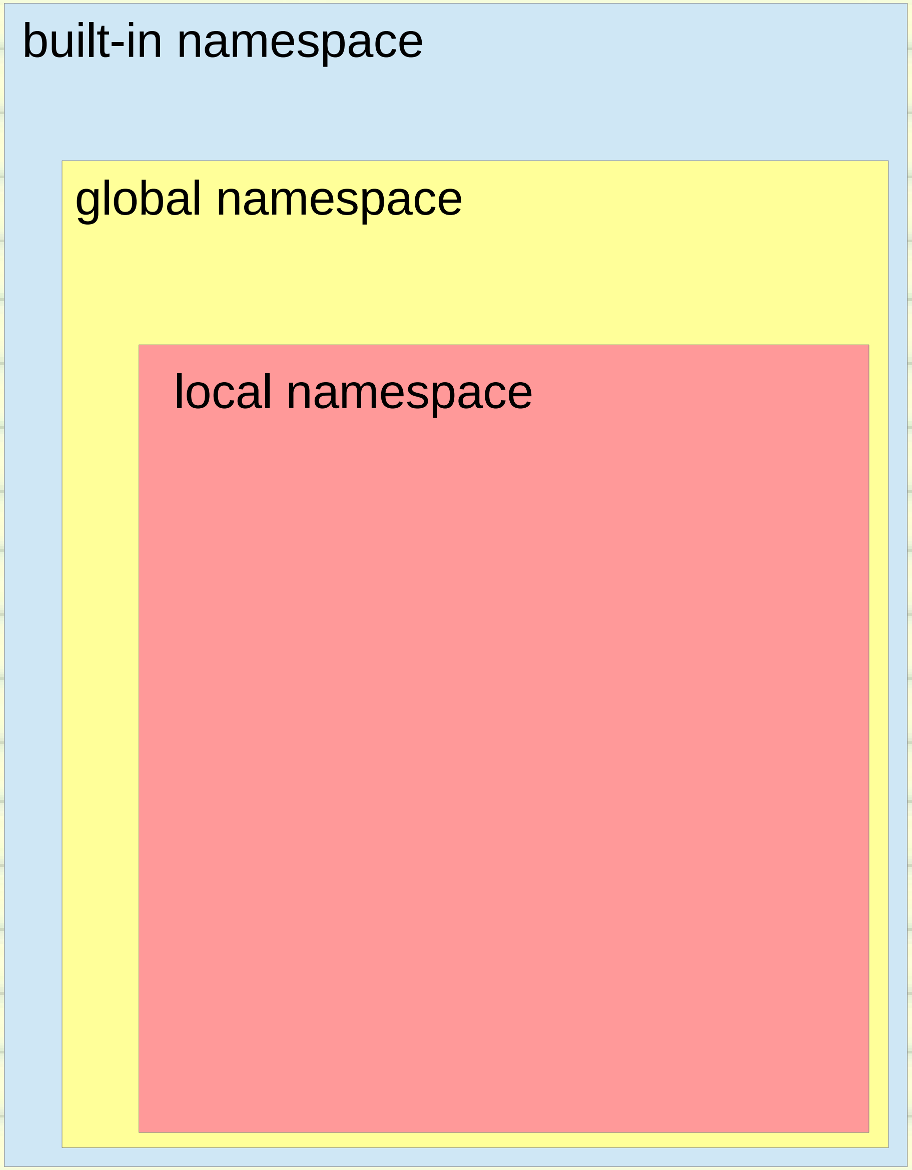
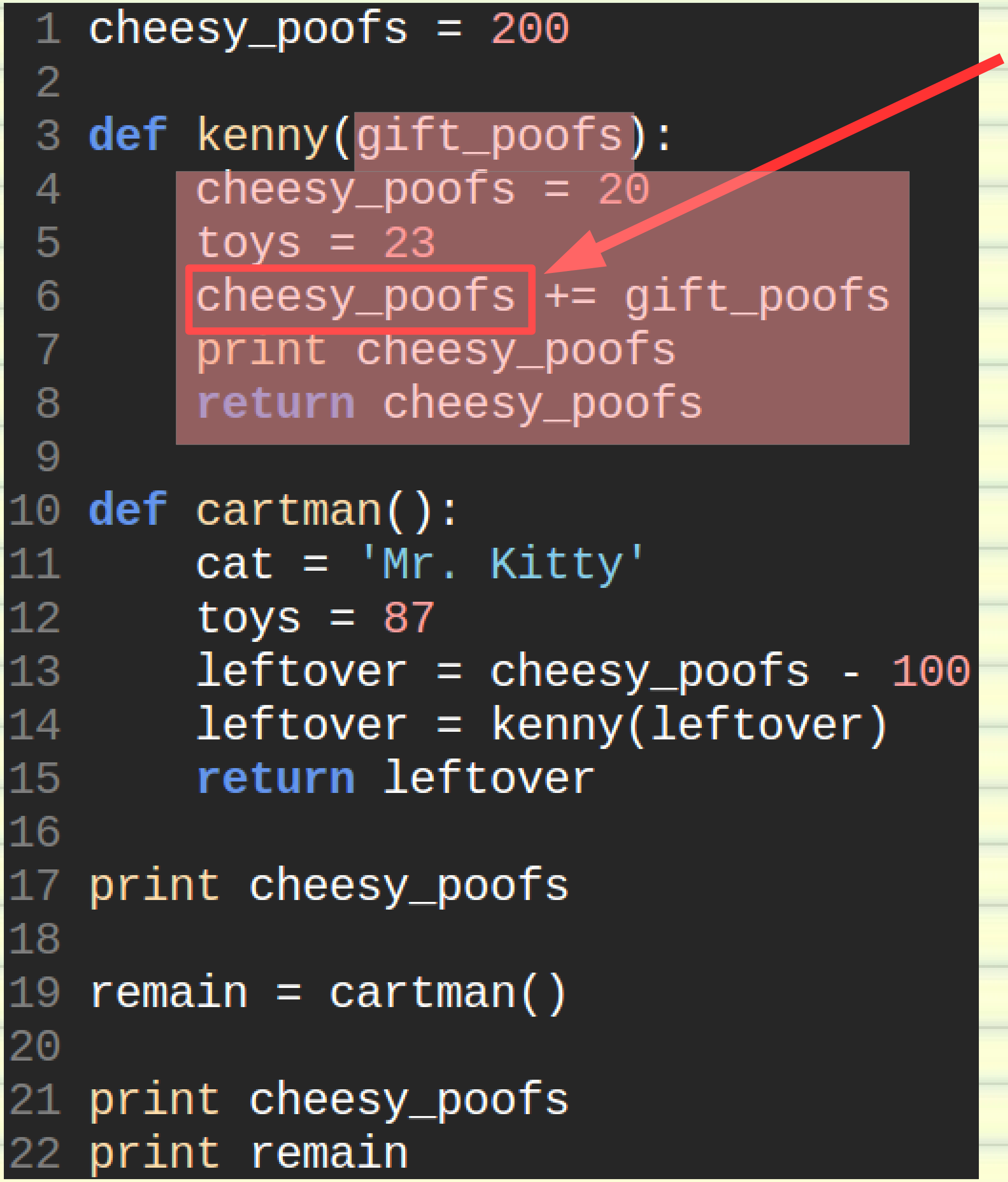


Namespaces & Variable Scope



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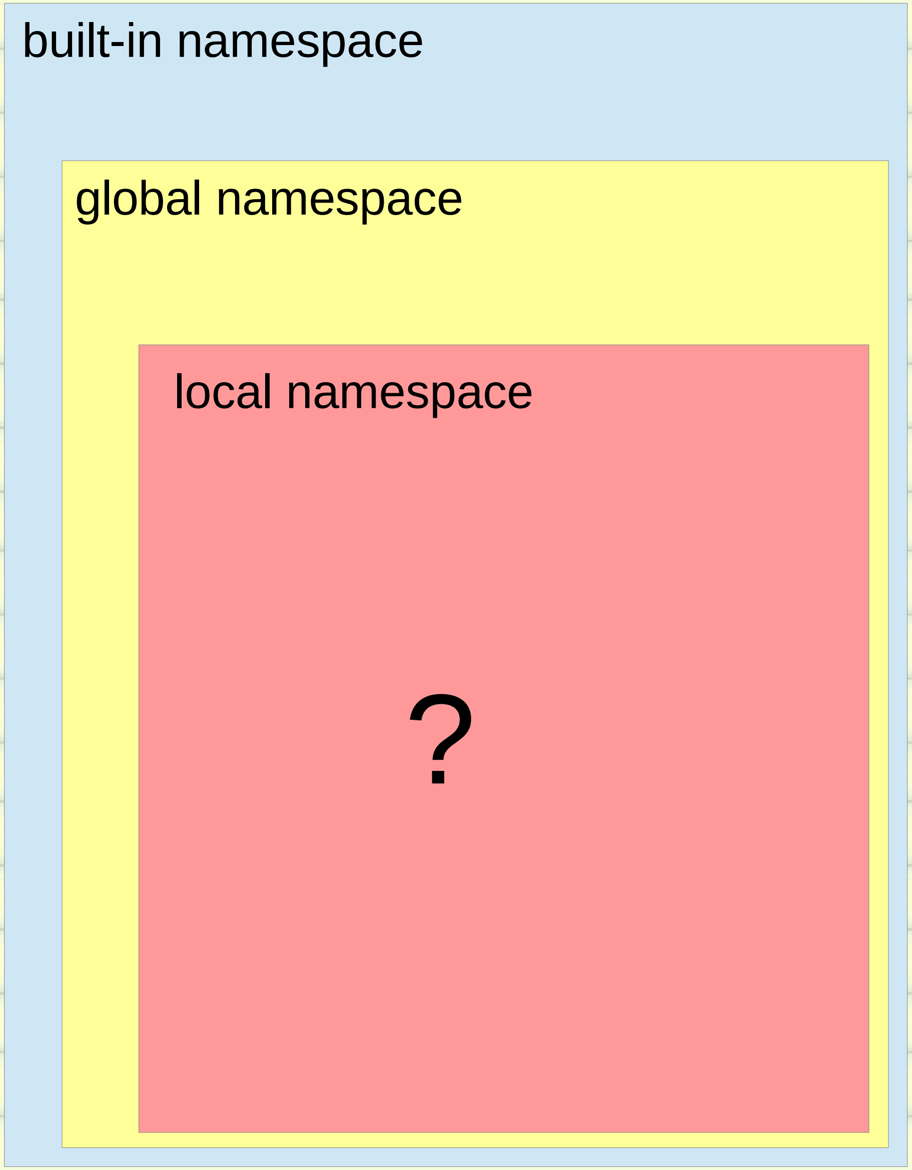
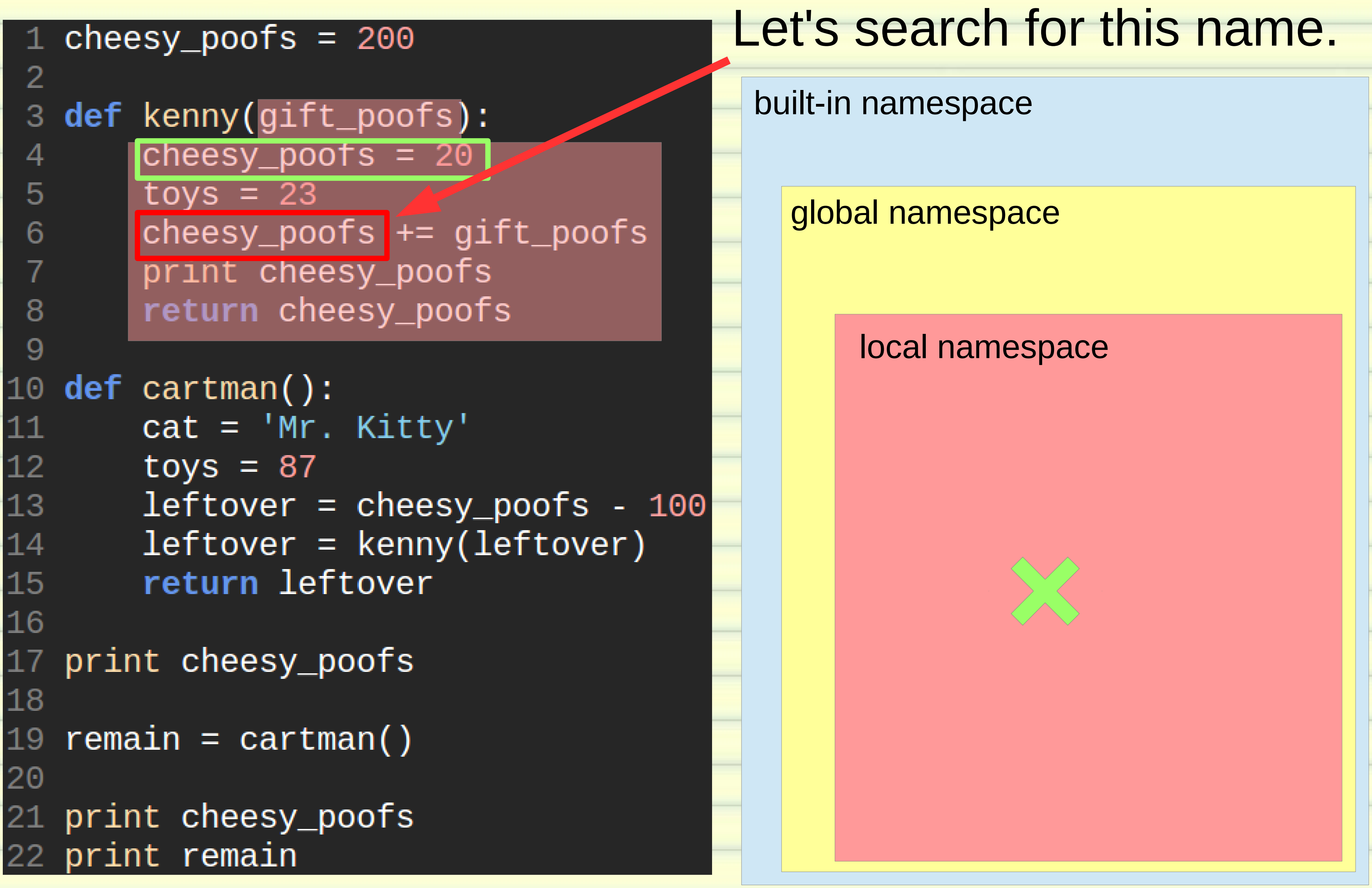


Namespaces & Variable Scope



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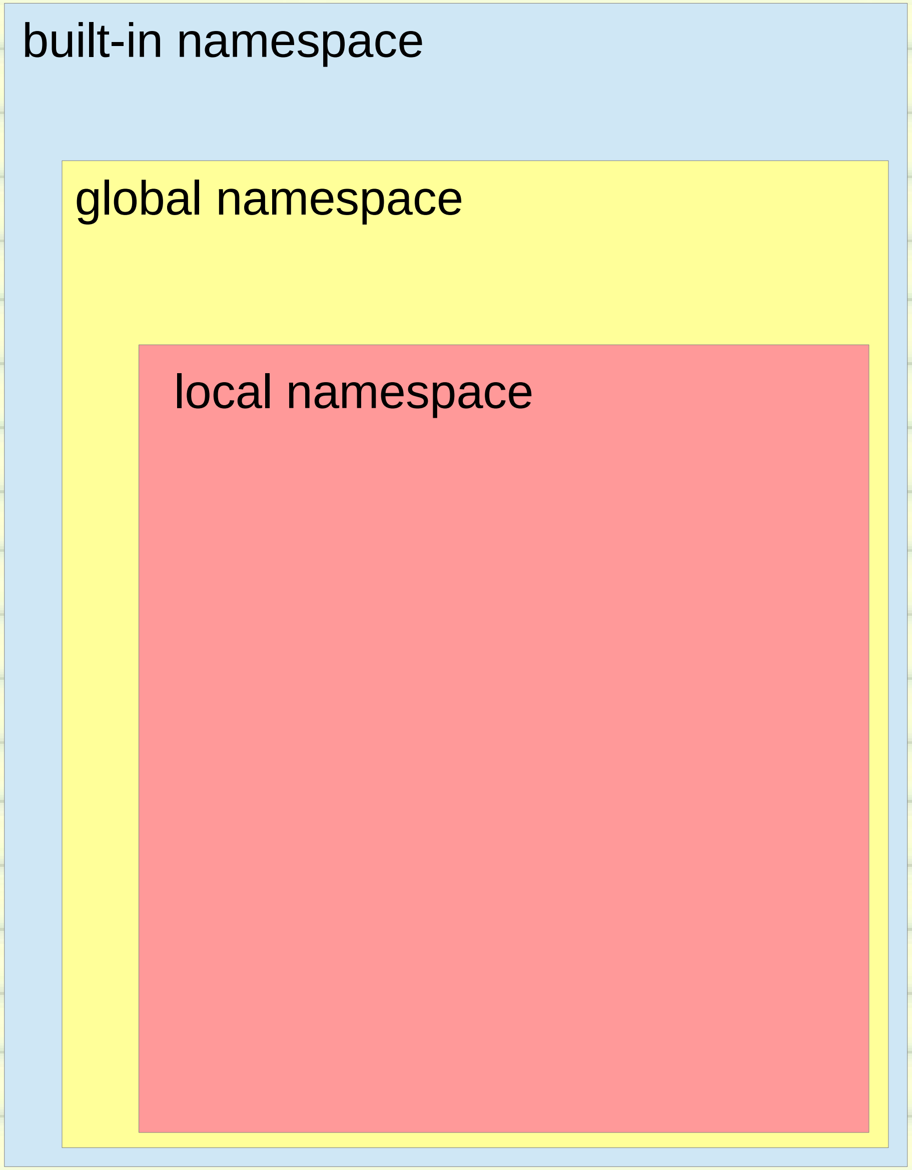
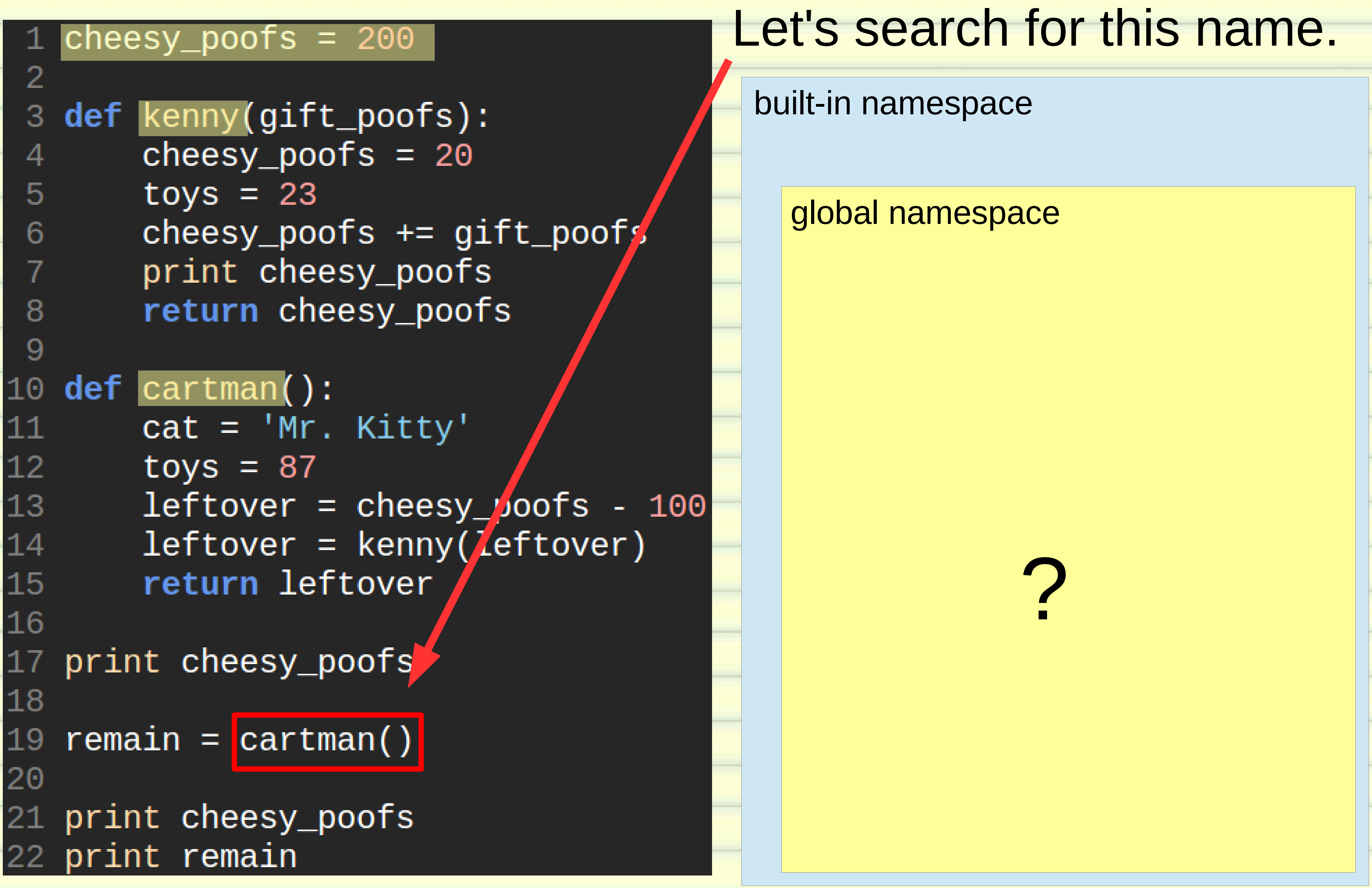


Namespaces & Variable Scope



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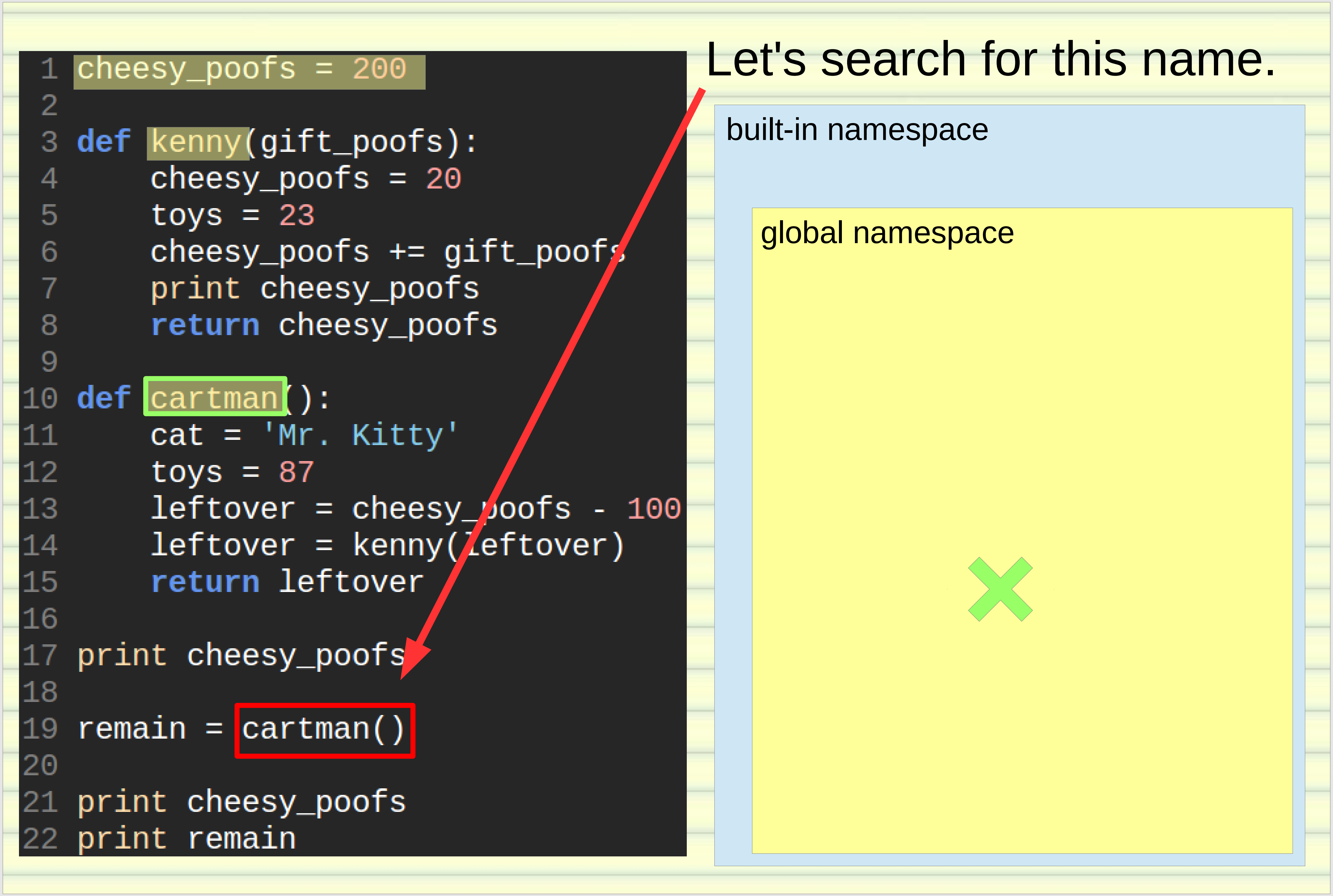

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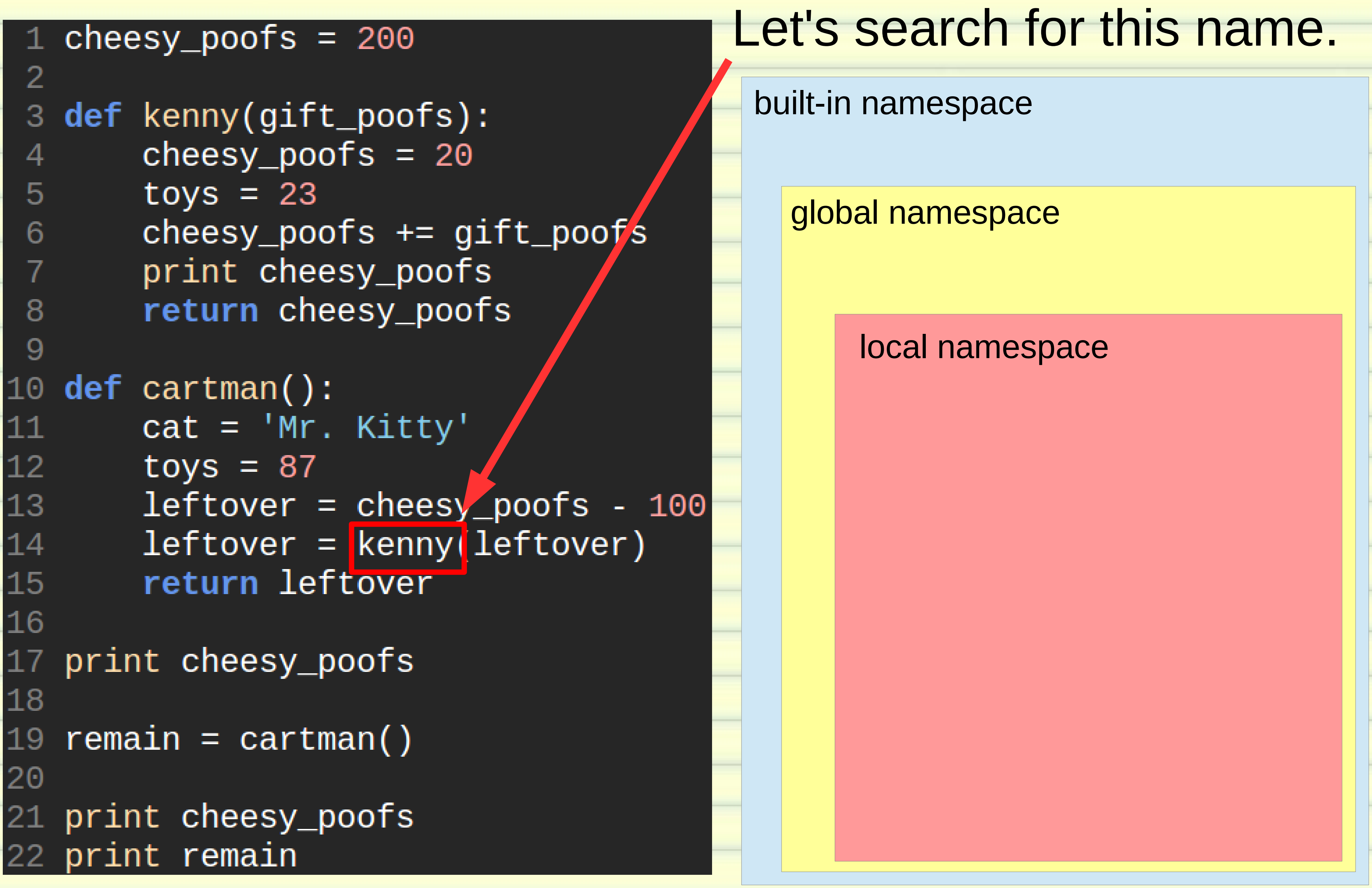

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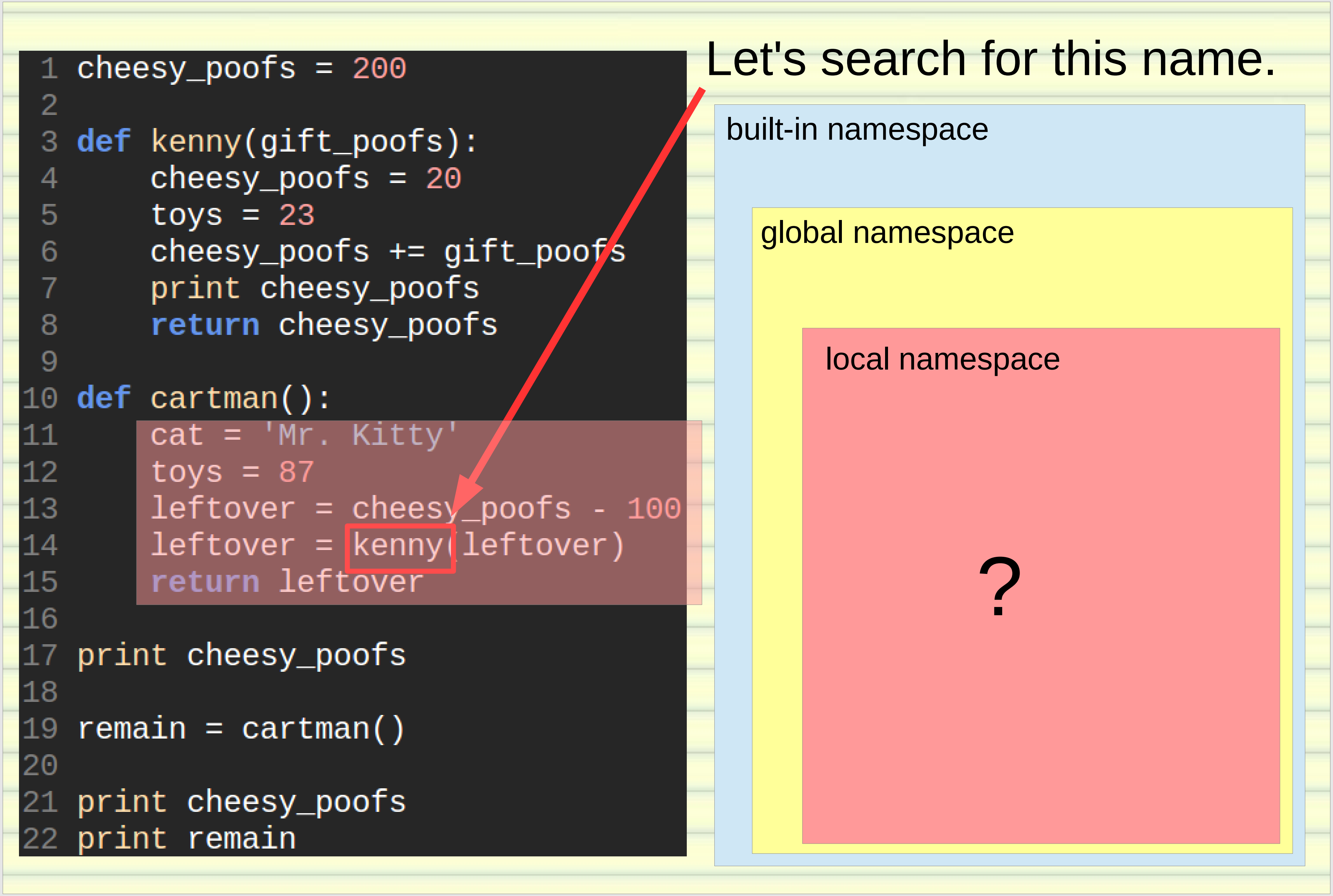
Let's search for this name.

built-in namespace

global namespace

local namespace

Namespaces & Variable Scope



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Let's search for this name.

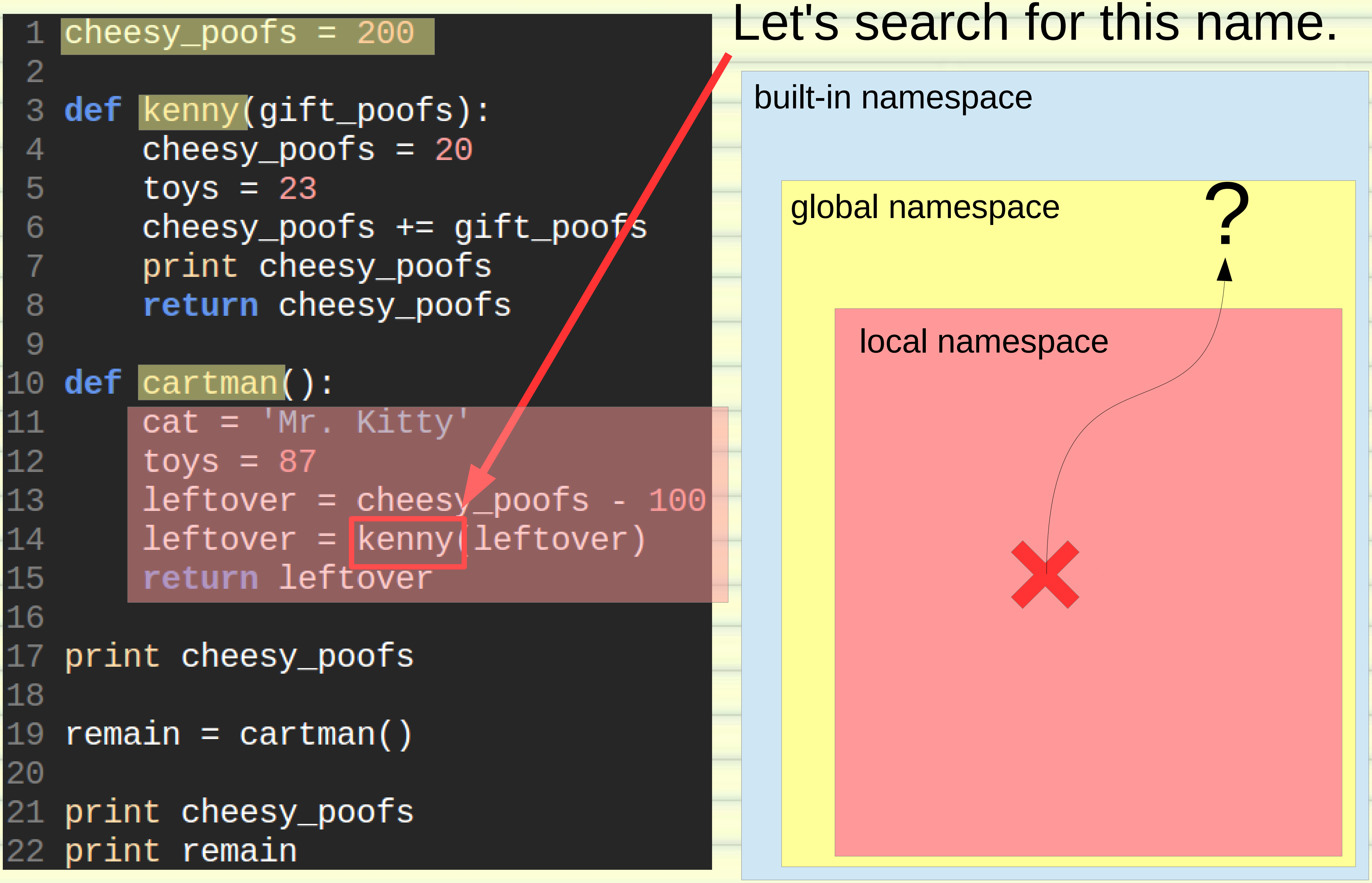
built-in namespace

global namespace

local namespace

?

Namespaces & Variable Scope



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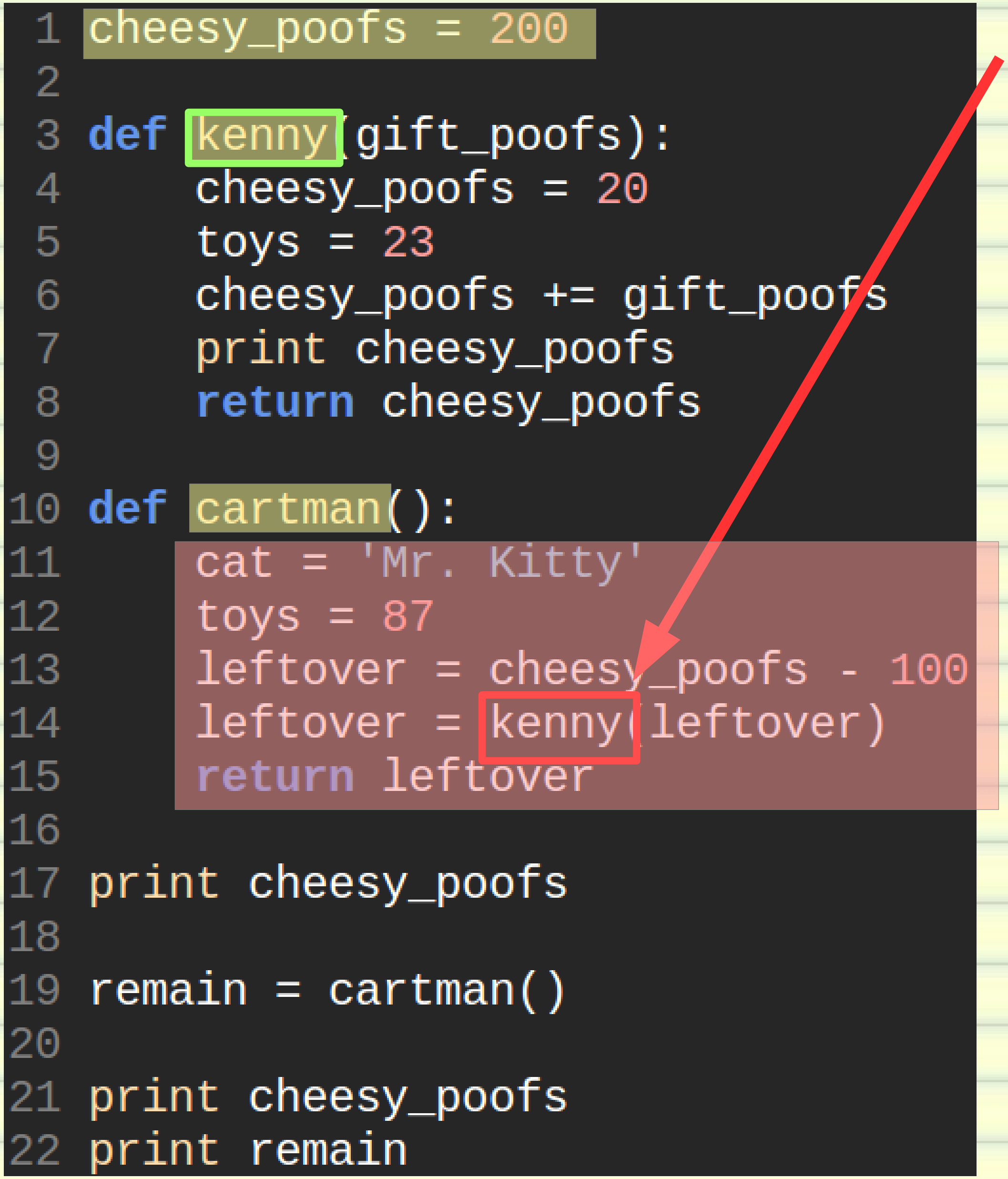
Let's search for this name.

Namespaces & Variable Scope



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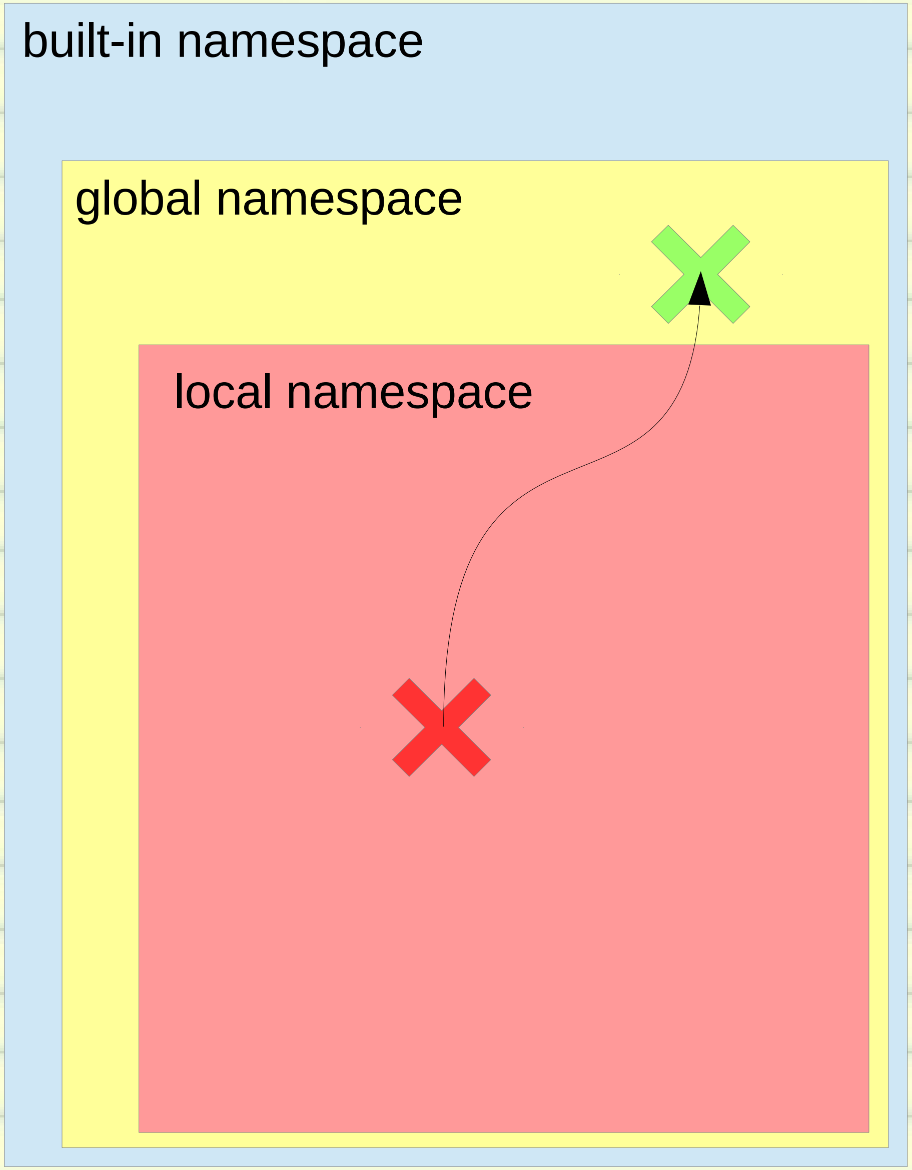
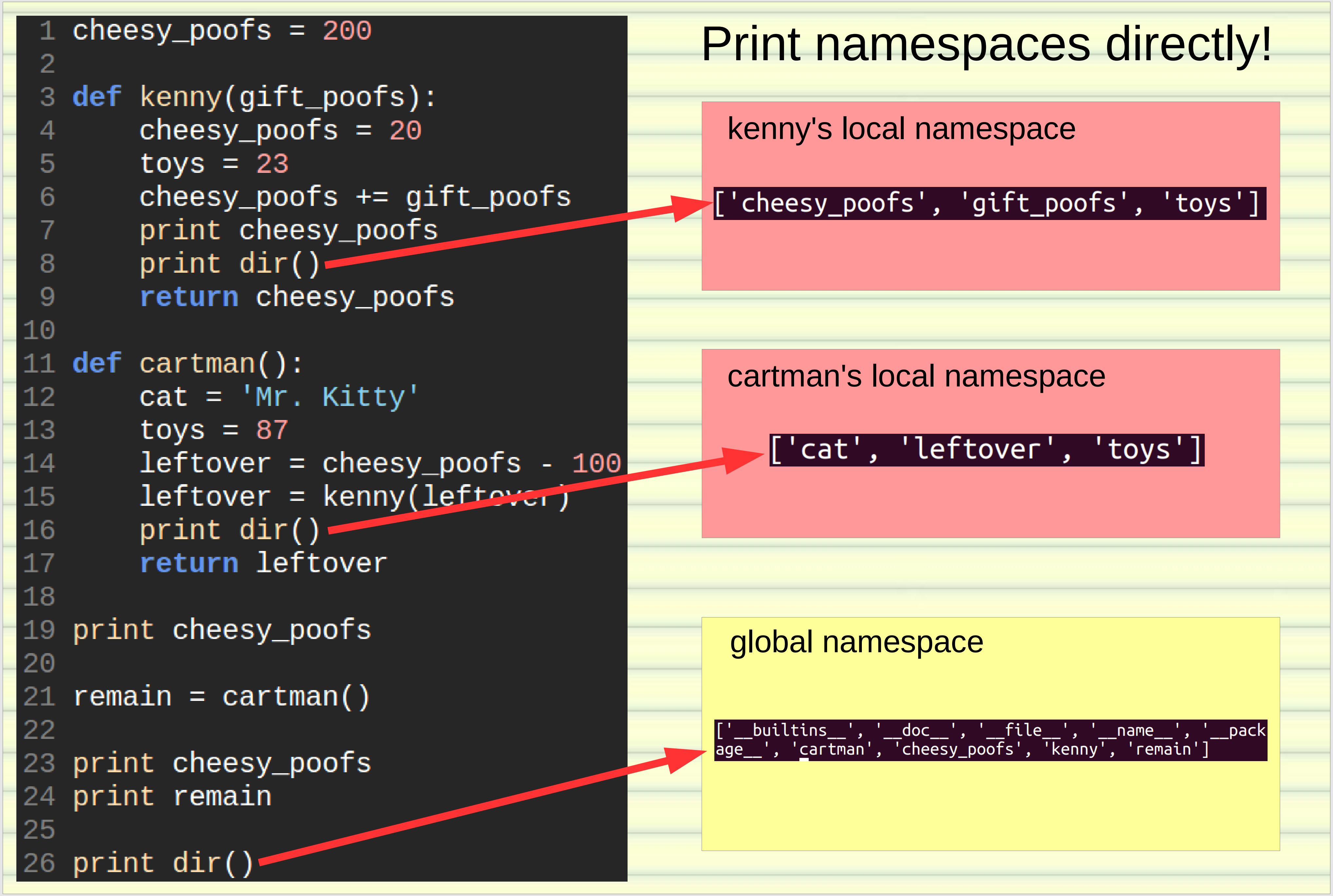


Namespaces & Variable Scope



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def kenny(gift_poofs):
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print cheesy_poofs

remain = cartman()

print cheesy_poofs
print remain

print dir()
```

Print namespaces directly!

kenny's local namespace

```
['cheesy_poofs', 'gift_poofs', 'toys']
```

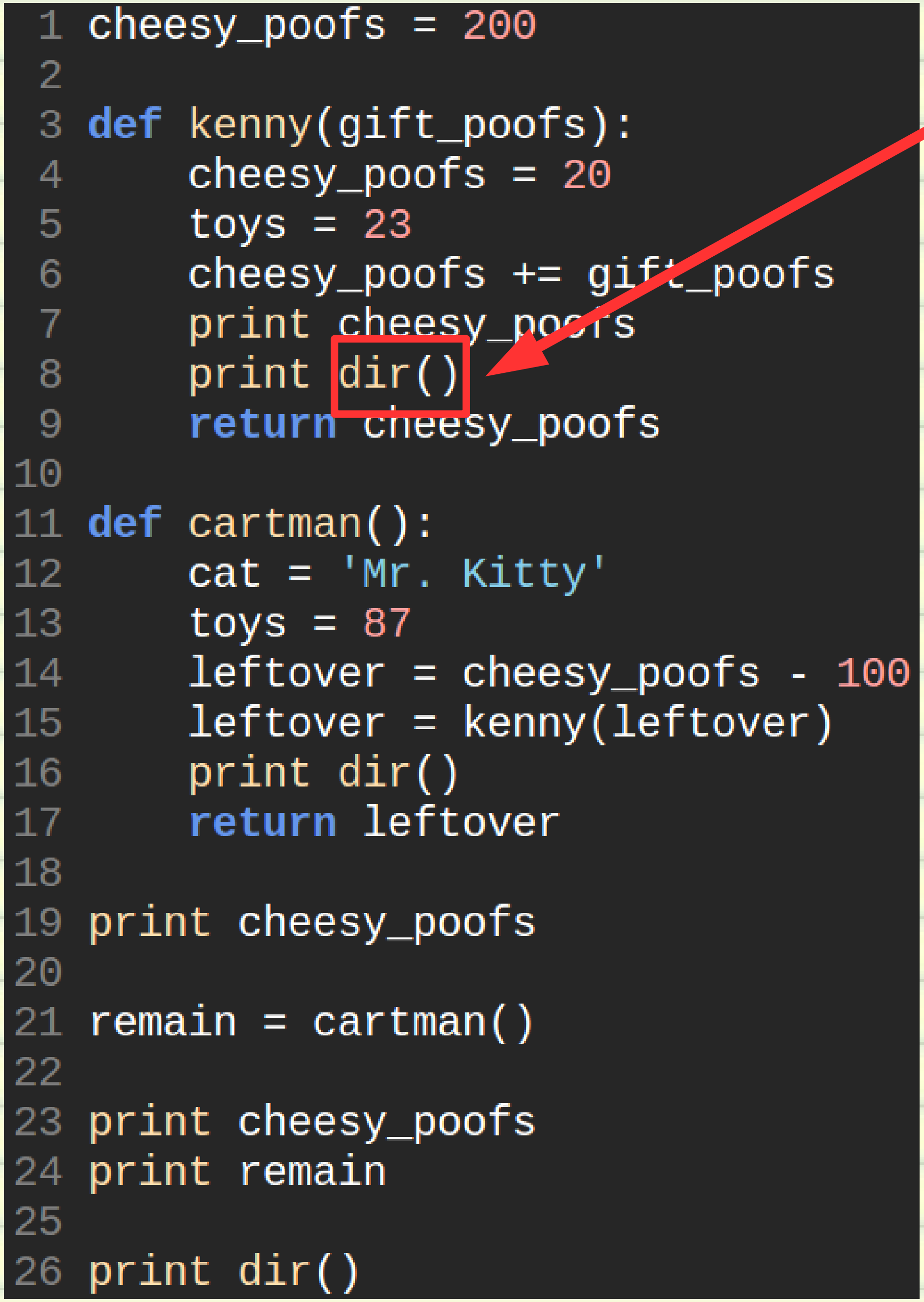
cartman's local namespace

```
['cat', 'leftover', 'toys']
```

global namespace

```
['__builtins__', '__doc__', '__file__', '__name__', '__pack
age__', 'cartman', 'cheesy_poofs', 'kenny', 'remain']
```

Namespaces & Variable Scope



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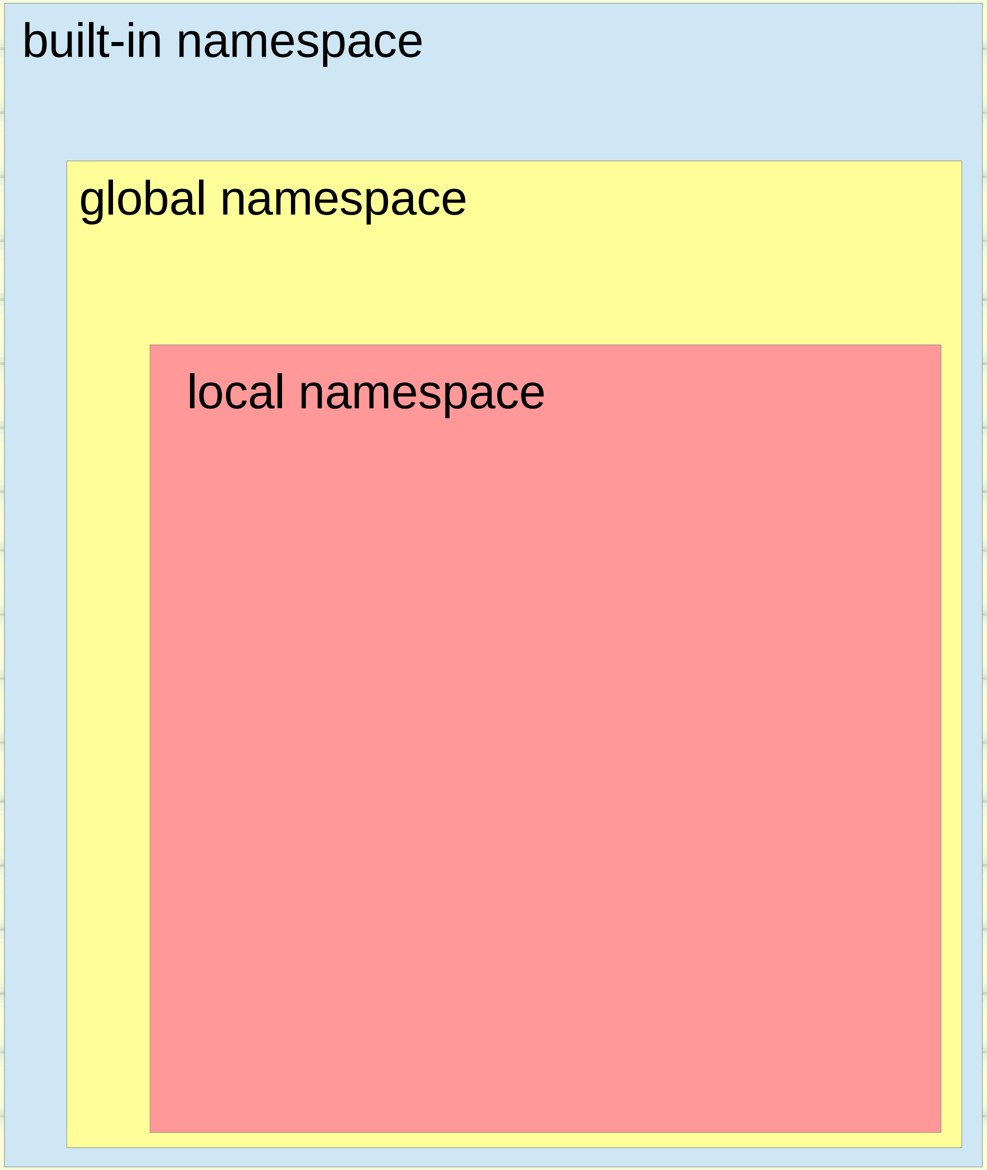
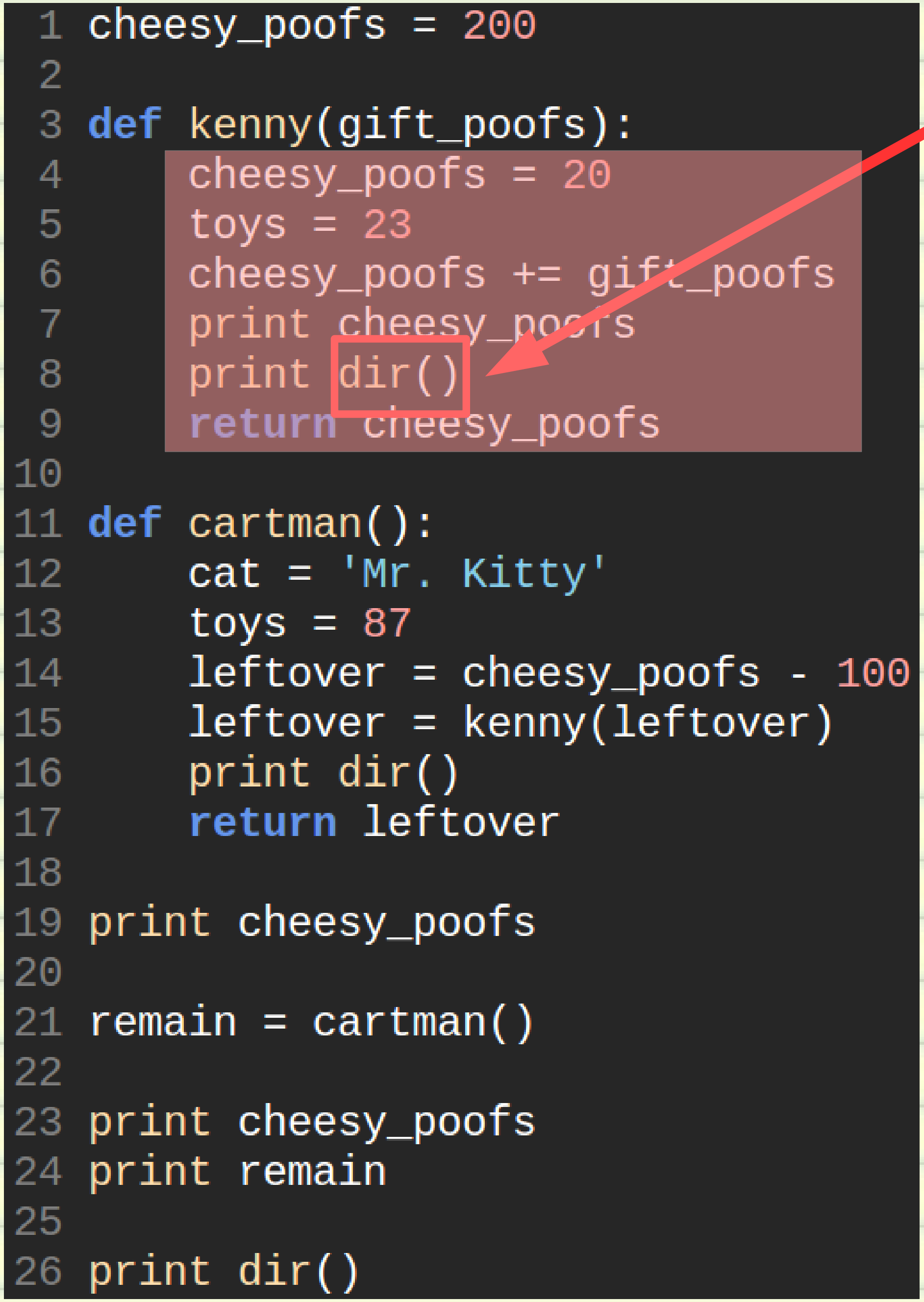
btw...

Let's search for this name.



Namespaces & Variable Scope



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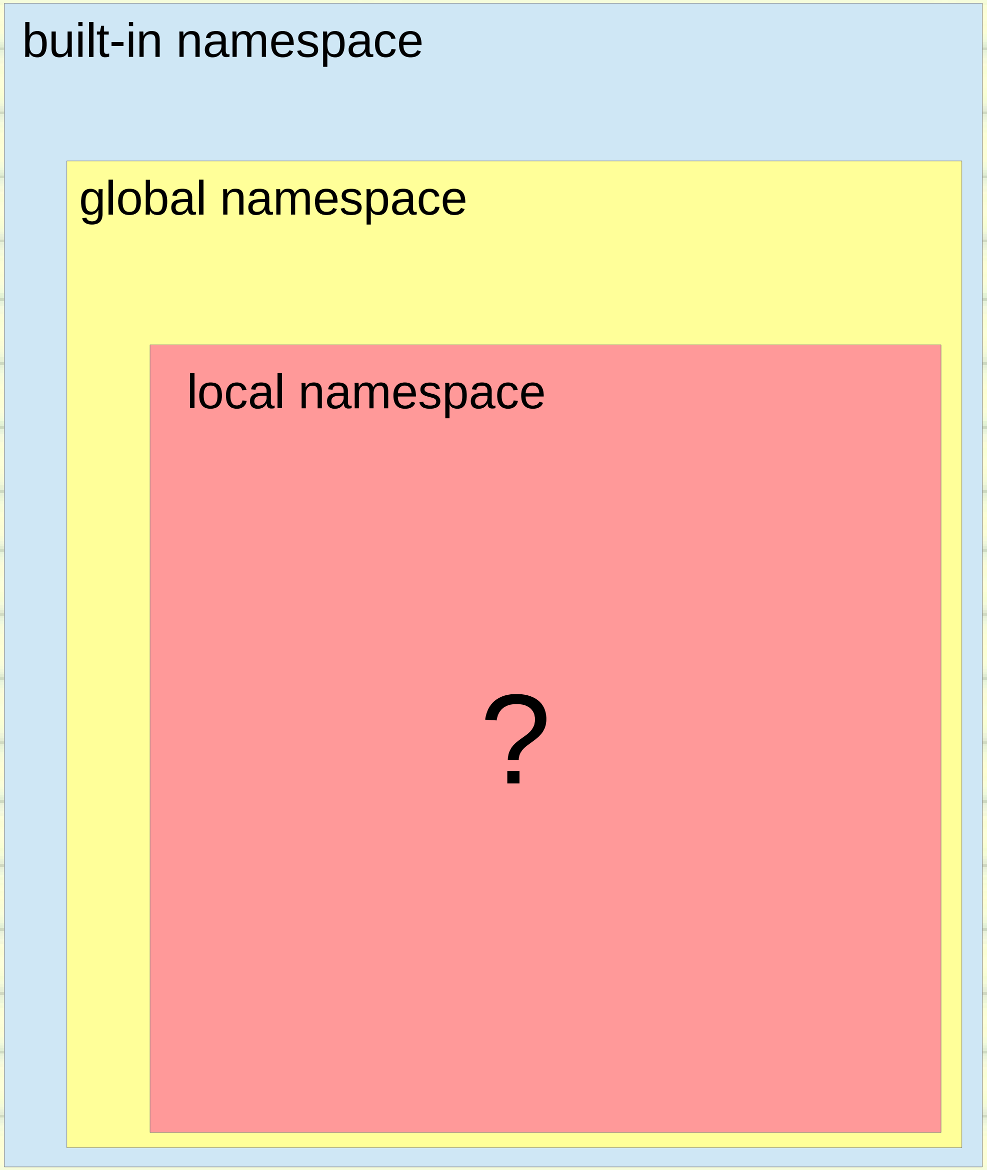
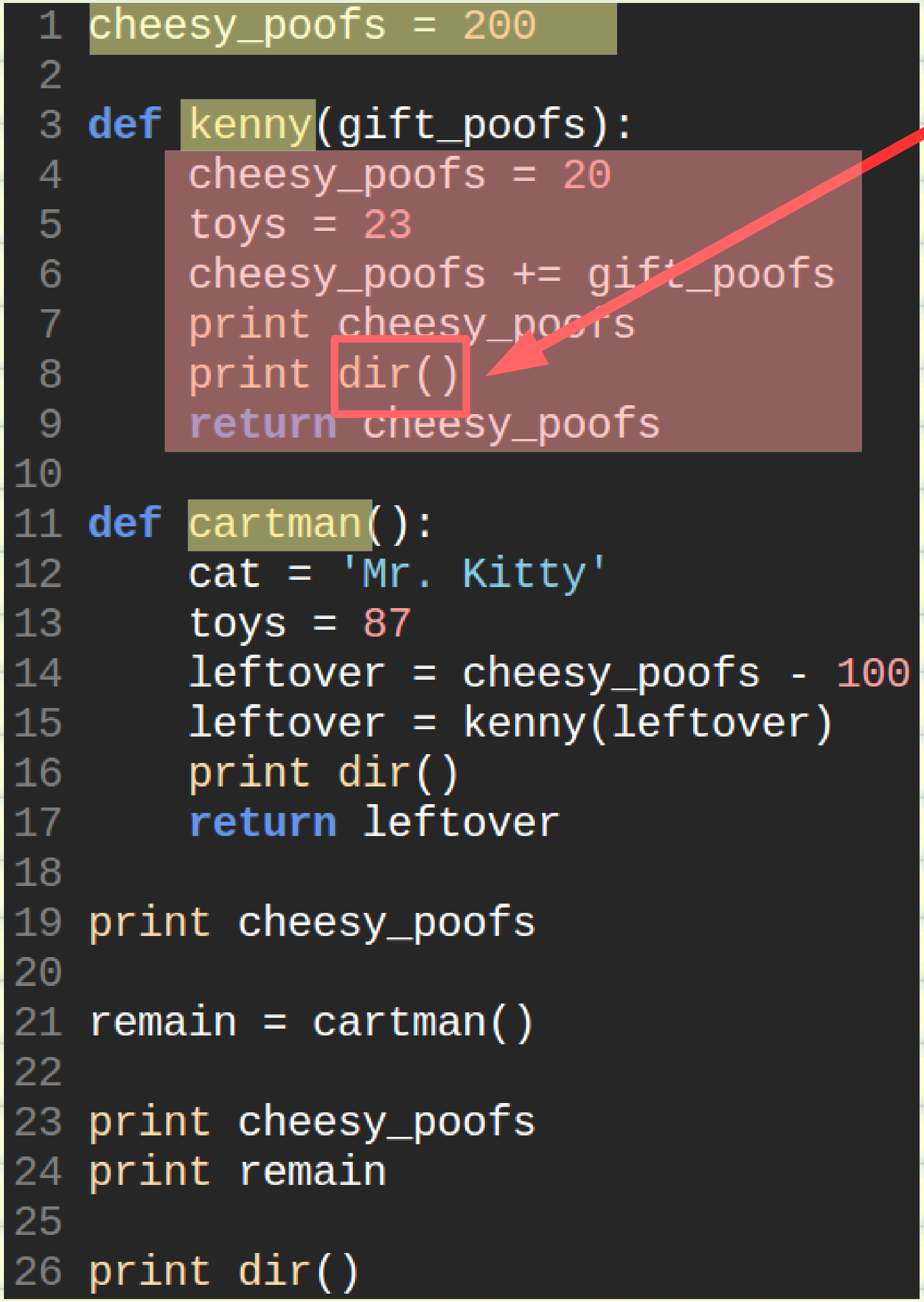


Namespaces & Variable Scope



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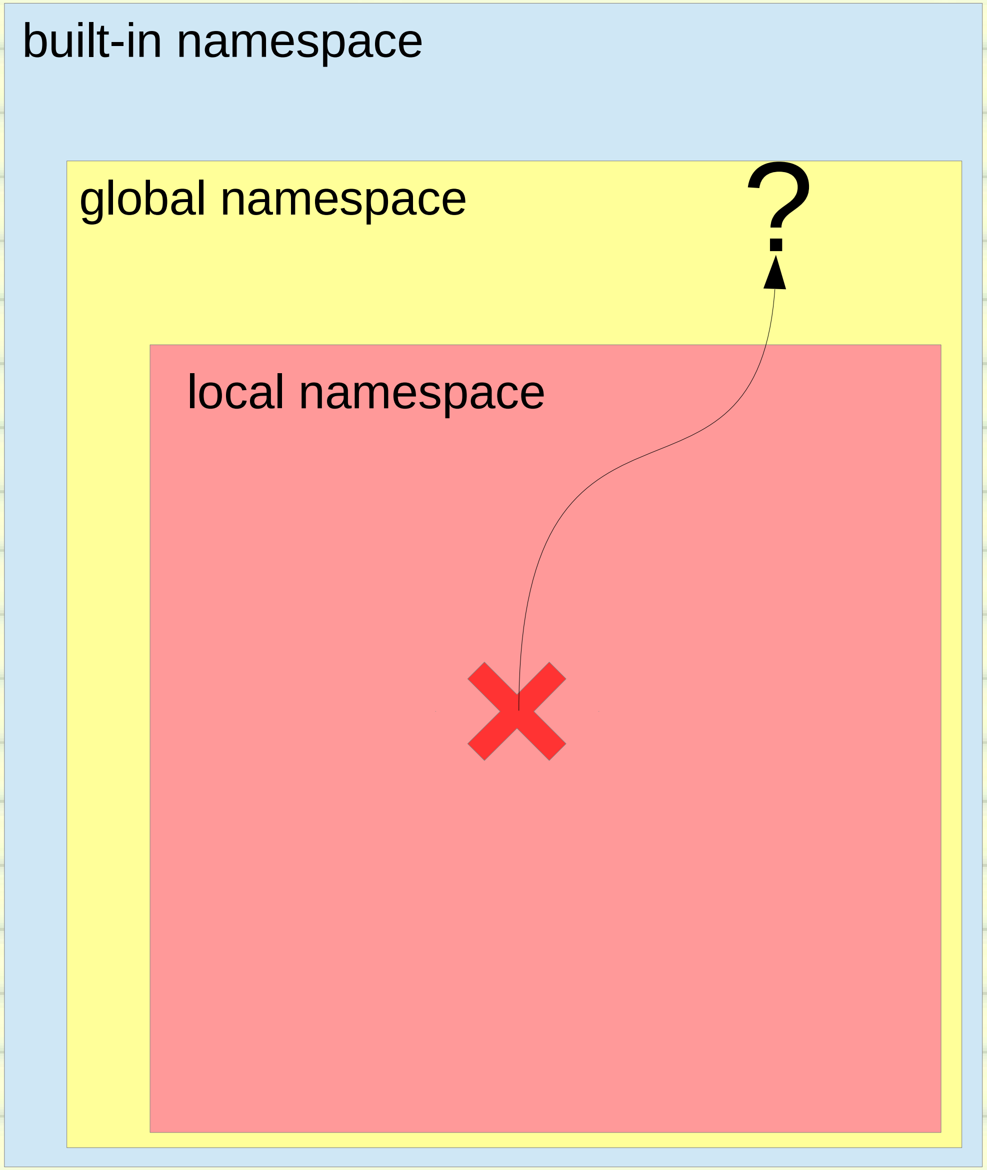


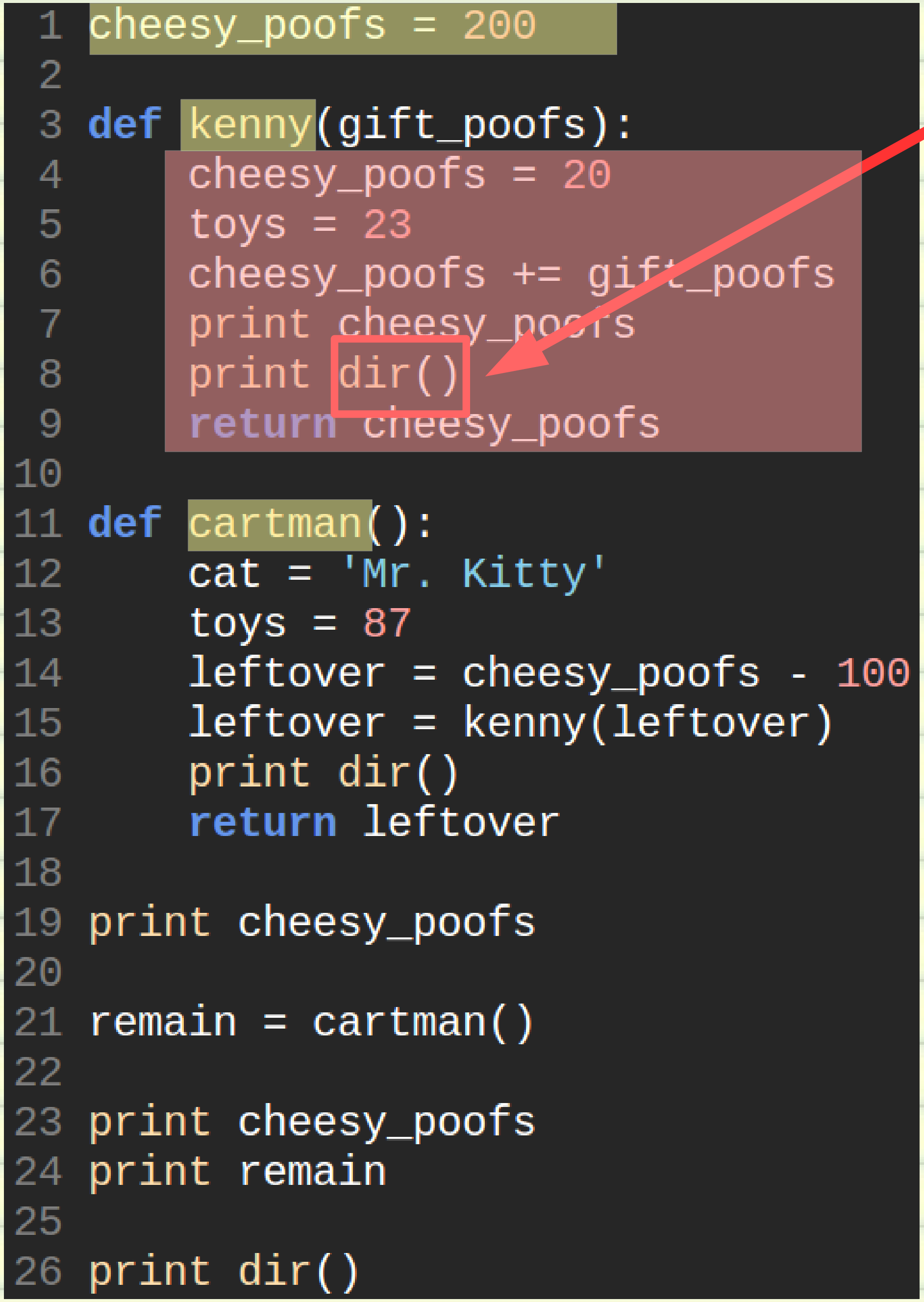
built-in namespace

global namespace

?

local namespace

Namespaces & Variable Scope



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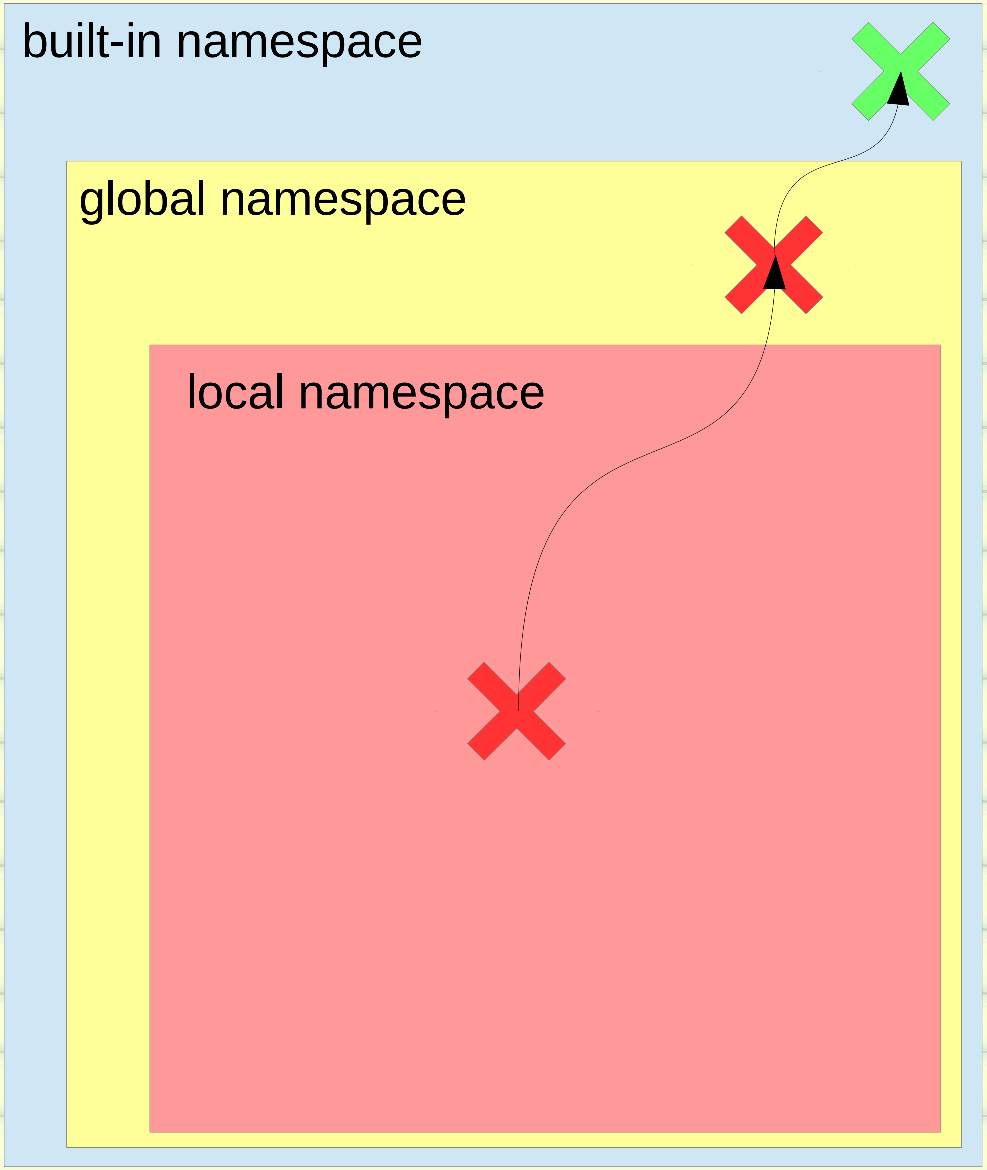
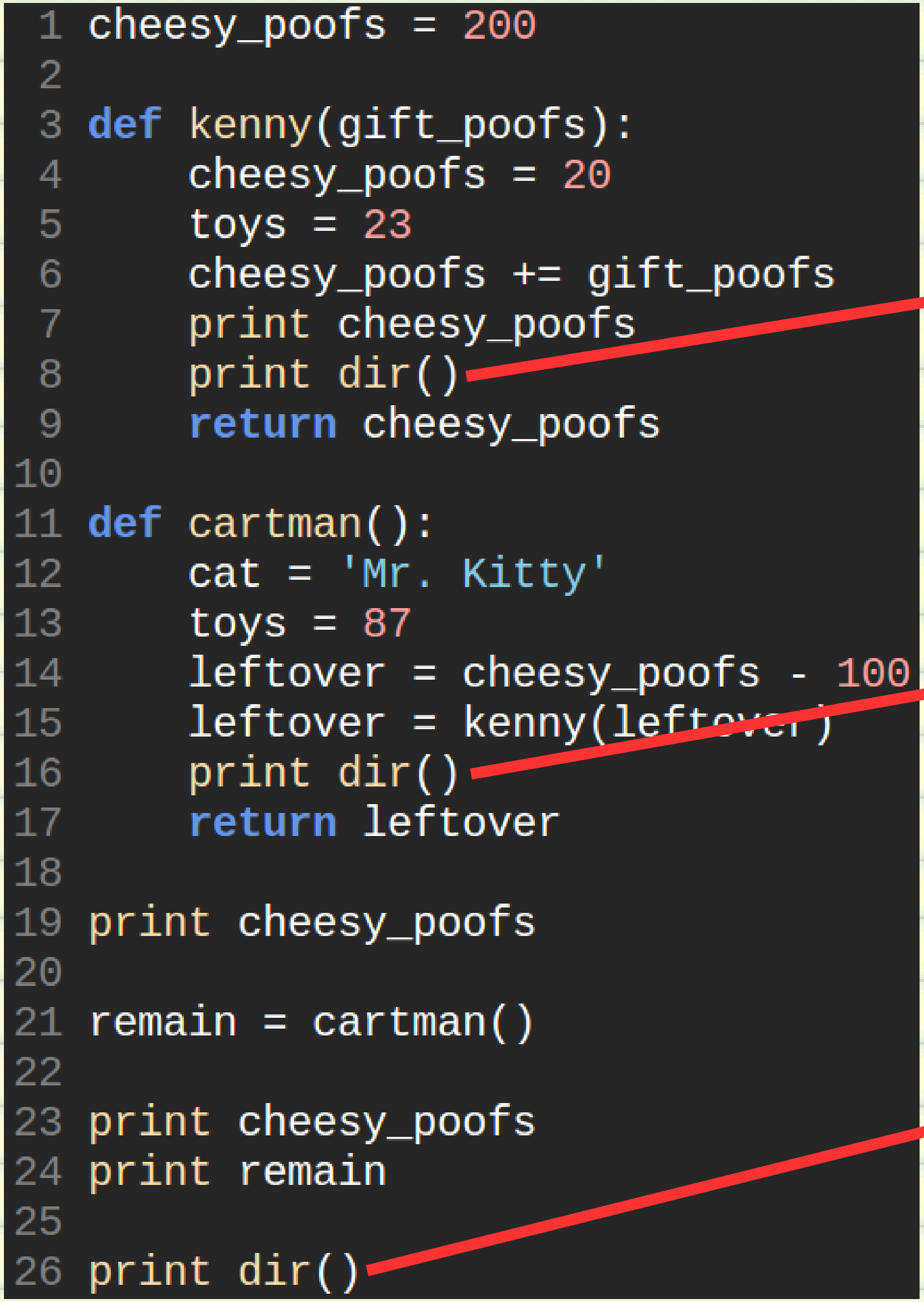


Namespaces & Variable Scope



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```
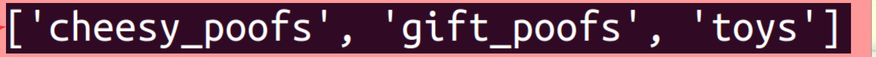
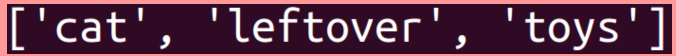

Print namespaces directly!

kenny's local namespace



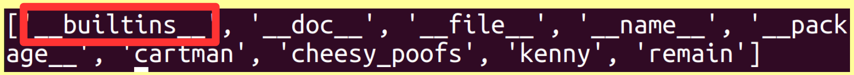
```
['cheesy_poofs', 'gift_poofs', 'toys']
```

cartman's local namespace



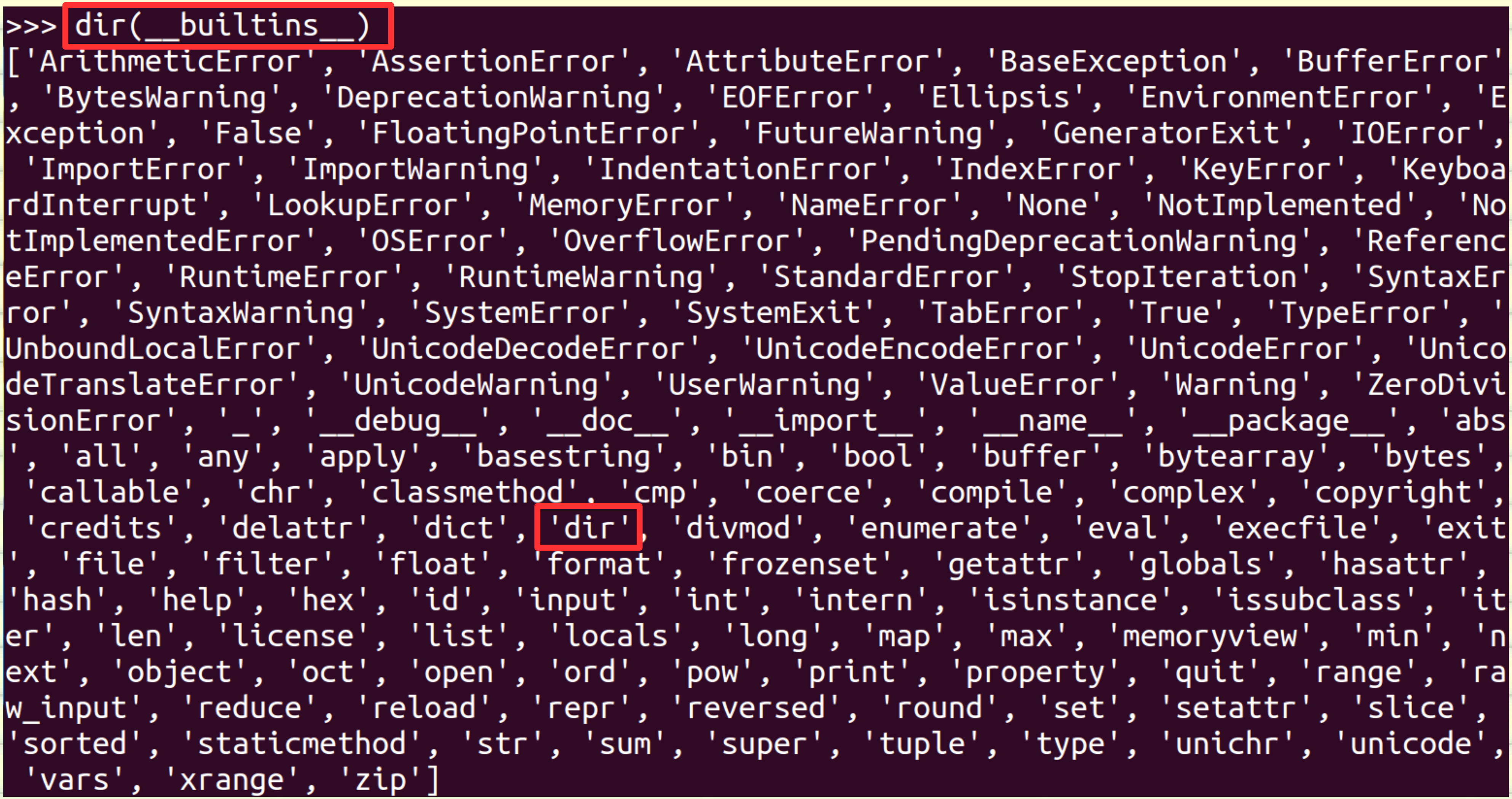
```
['cat', 'leftover', 'toys']
```

global namespace



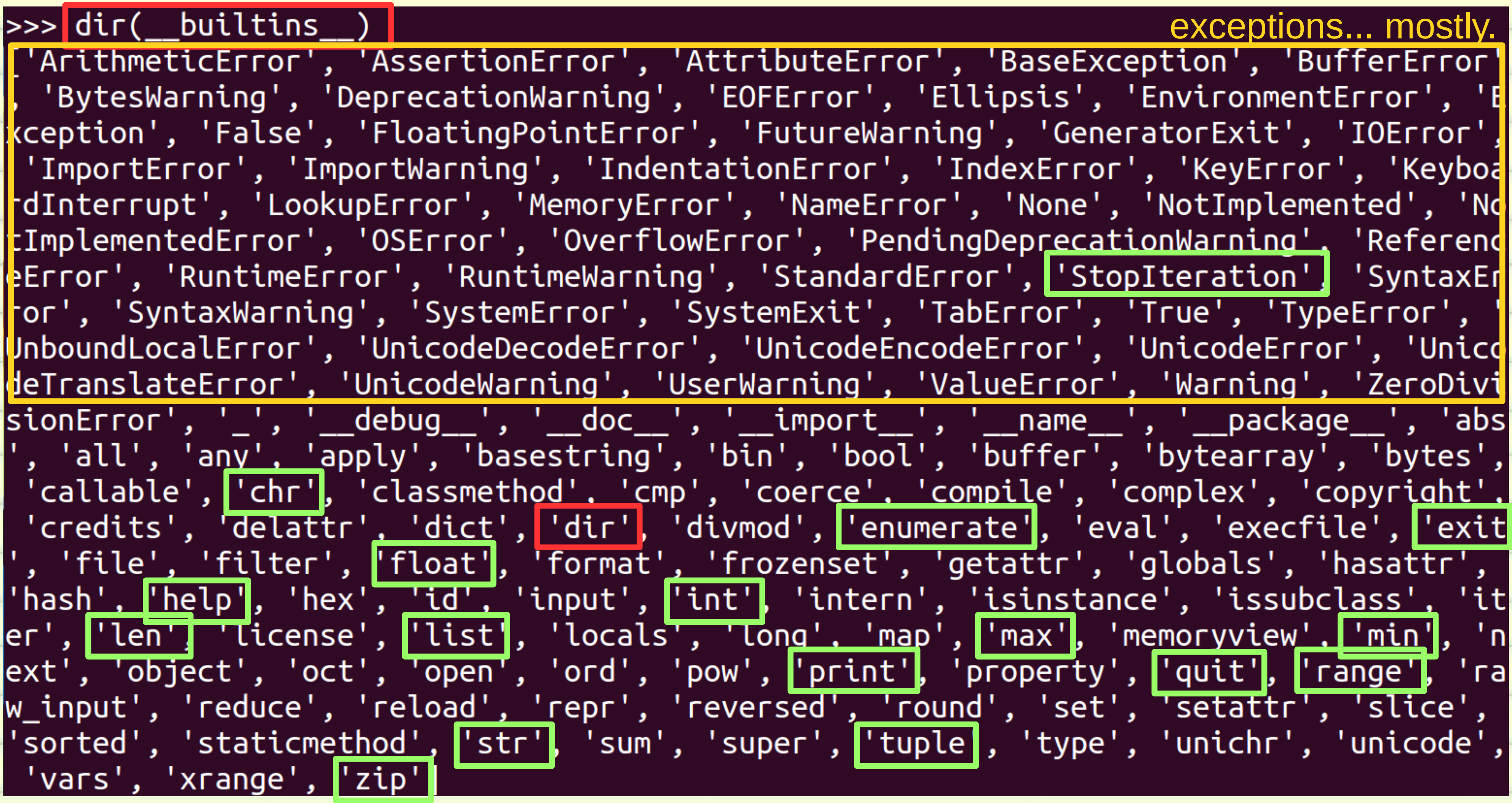
```
['__builtins__', '__doc__', '__file__', '__name__', '__pack
age__', 'cartman', 'cheesy_poofs', 'kenny', 'remain']
```

Namespaces & Variable Scope



```
>>> dir(__builtins__)
['ArithmeticError', 'AssertionError', 'AttributeError', 'BaseException', 'BufferError'
, 'BytesWarning', 'DeprecationWarning', 'EOFError', 'Ellipsis', 'EnvironmentError', 'E
xception', 'False', 'FloatingPointError', 'FutureWarning', 'GeneratorExit', 'IOError',
 'ImportError', 'ImportWarning', 'IndentationError', 'IndexError', 'KeyError', 'Keyboa
rdInterrupt', 'LookupError', 'MemoryError', 'NameError', 'None', 'NotImplemented', 'No
tImplementedError', 'OSError', 'OverflowError', 'PendingDeprecationWarning', 'Referenc
eError', 'RuntimeError', 'RuntimeWarning', 'StandardError', 'StopIteration', 'SyntaxEr
ror', 'SyntaxWarning', 'SystemError', 'SystemExit', 'TabError', 'True', 'TypeError', '
UnboundLocalError', 'UnicodeDecodeError', 'UnicodeEncodeError', 'UnicodeError', 'Unico
deTranslateError', 'UnicodeWarning', 'UserWarning', 'ValueError', 'Warning', 'ZeroDivi
sionError', '_', '__debug__', '__doc__', '__import__', '__name__', '__package__', 'abs
', 'all', 'any', 'apply', 'basestring', 'bin', 'bool', 'buffer', 'bytearray', 'bytes',
 'callable', 'chr', 'classmethod', 'cmp', 'coerce', 'compile', 'complex', 'copyright',
 'credits', 'delattr', 'dict', 'dir', 'divmod', 'enumerate', 'eval', 'execfile', 'exit
', 'file', 'filter', 'float', 'format', 'frozenset', 'getattr', 'globals', 'hasattr',
'hash', 'help', 'hex', 'id', 'input', 'int', 'intern', 'isinstance', 'issubclass', 'it
er', 'len', 'license', 'list', 'locals', 'long', 'map', 'max', 'memoryview', 'min', 'n
ext', 'object', 'oct', 'open', 'ord', 'pow', 'print', 'property', 'quit', 'range', 'ra
w_input', 'reduce', 'reload', 'repr', 'reversed', 'round', 'set', 'setattr', 'slice',
'sorted', 'staticmethod', 'str', 'sum', 'super', 'tuple', 'type', 'unichr', 'unicode',
 'vars', 'xrange', 'zip']
```

Namespaces & Variable Scope



exceptions... mostly.

```
>>> dir(__builtins__)
['ArithmeticError', 'AssertionError', 'AttributeError', 'BaseException', 'BufferError'
, 'BytesWarning', 'DeprecationWarning', 'EOFError', 'Ellipsis', 'EnvironmentError', 'E
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 'callable', 'chr', 'classmethod', 'cmp', 'coerce', 'compile', 'complex', 'copyright',
 'credits', 'delattr', 'dict', 'dir', 'divmod', 'enumerate', 'eval', 'execfile', 'exit
', 'file', 'filter', 'float', 'format', 'frozenset', 'getattr', 'globals', 'hasattr',
'hash', 'help', 'hex', 'id', 'input', 'int', 'intern', 'isinstance', 'issubclass', 'it
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ext', 'object', 'oct', 'open', 'ord', 'pow', 'print', 'property', 'quit', 'range', 'ra
w_input', 'reduce', 'reload', 'repr', 'reversed', 'round', 'set', 'setattr', 'slice',
'sorted', 'staticmethod', 'str', 'sum', 'super', 'tuple', 'type', 'unichr', 'unicode',
 'vars', 'xrange', 'zip']
```
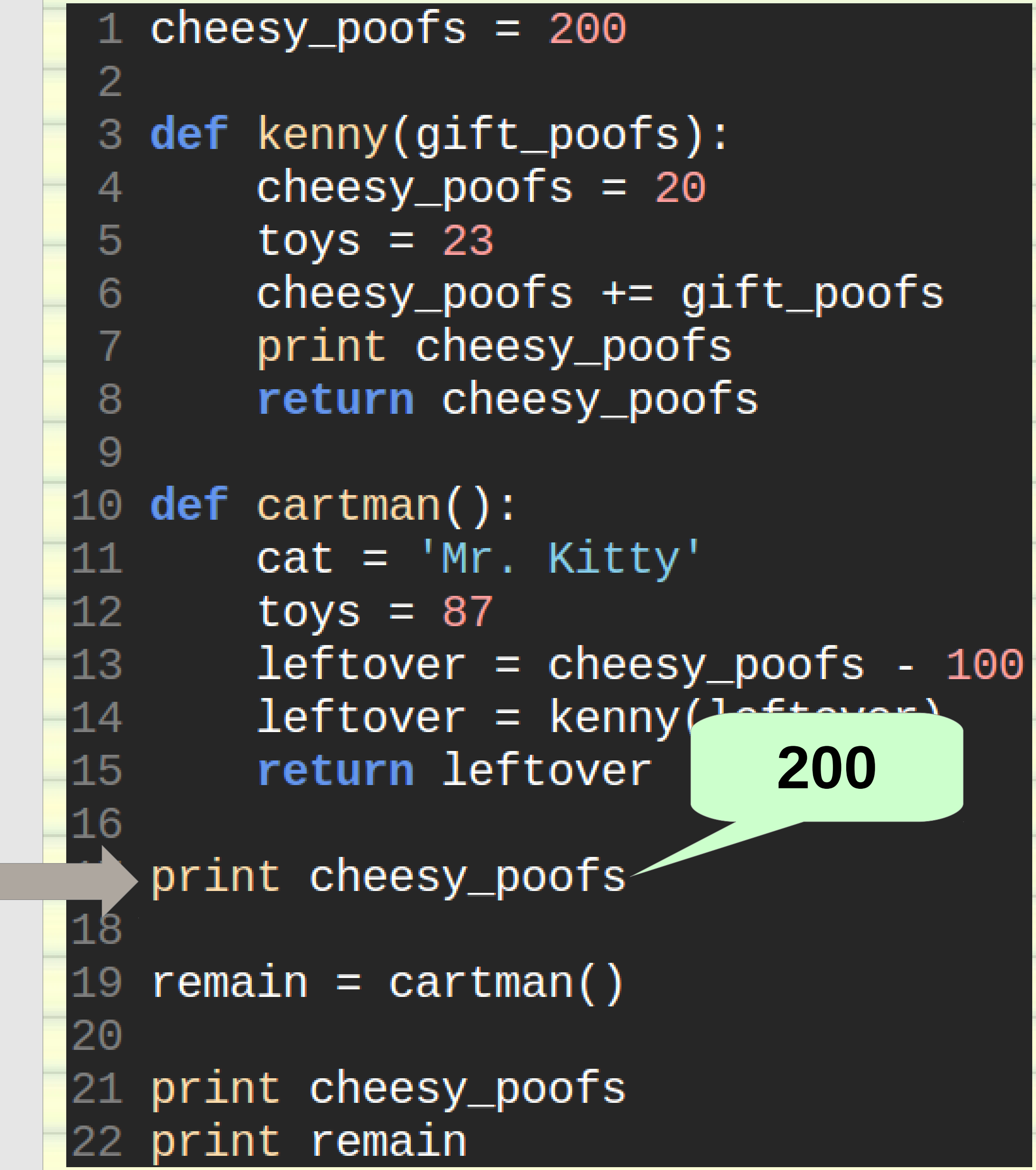
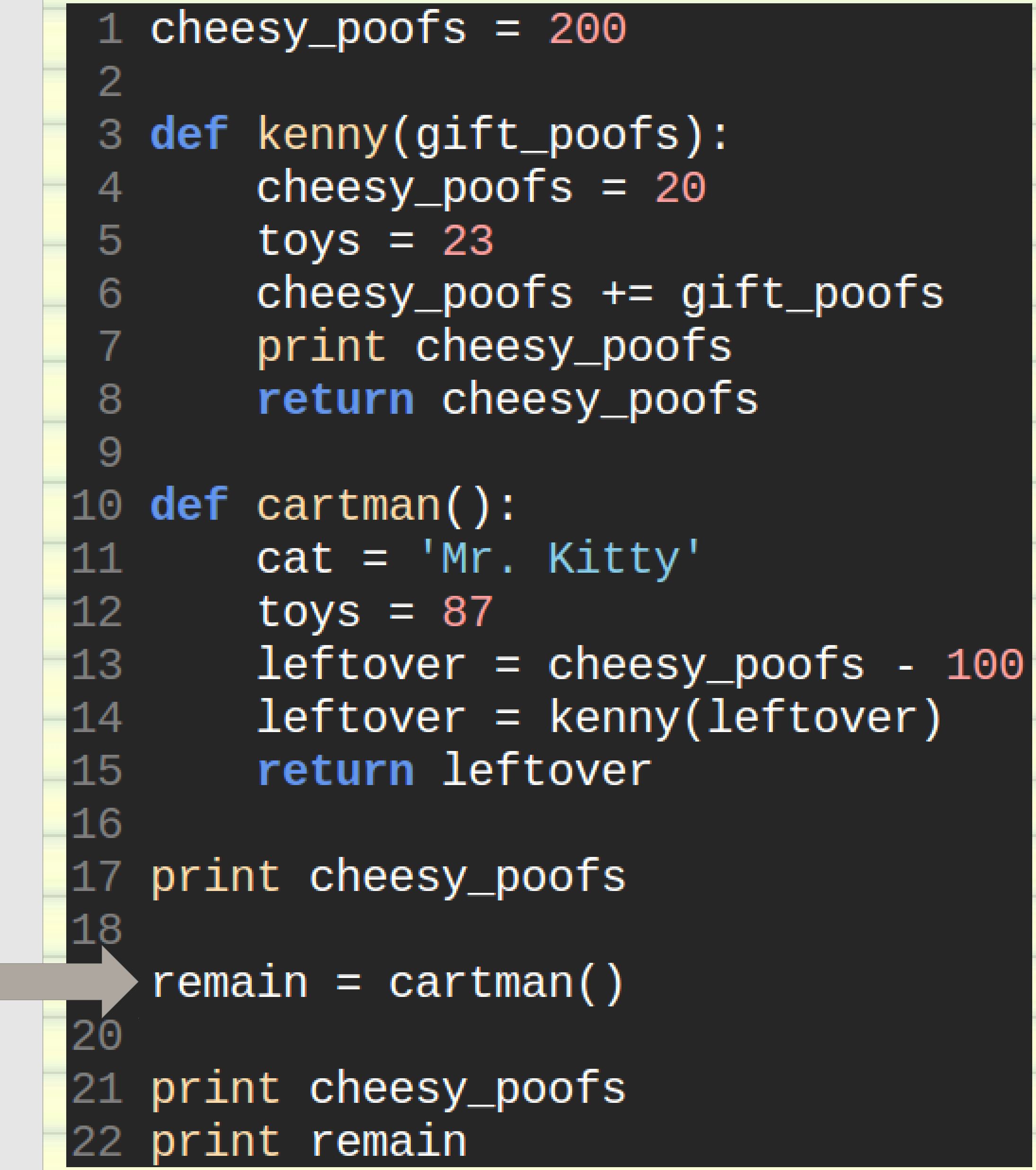

Namespaces & Variable Scope



```
cheesy_poofs = 200

def kenny(gift_poofs):
    cheesy_poofs = 20
    toys = 23
    cheesy_poofs += gift_poofs
    print cheesy_poofs
    return cheesy_poofs

def cartman():
    cat = 'Mr. Kitty'
    toys = 87
    leftover = cheesy_poofs - 100
    leftover = kenny(leftover)
    return leftover

print cheesy_poofs

remain = cartman()

print cheesy_poofs
print remain
```

Let's trace this code.

Namespaces & Variable Scope



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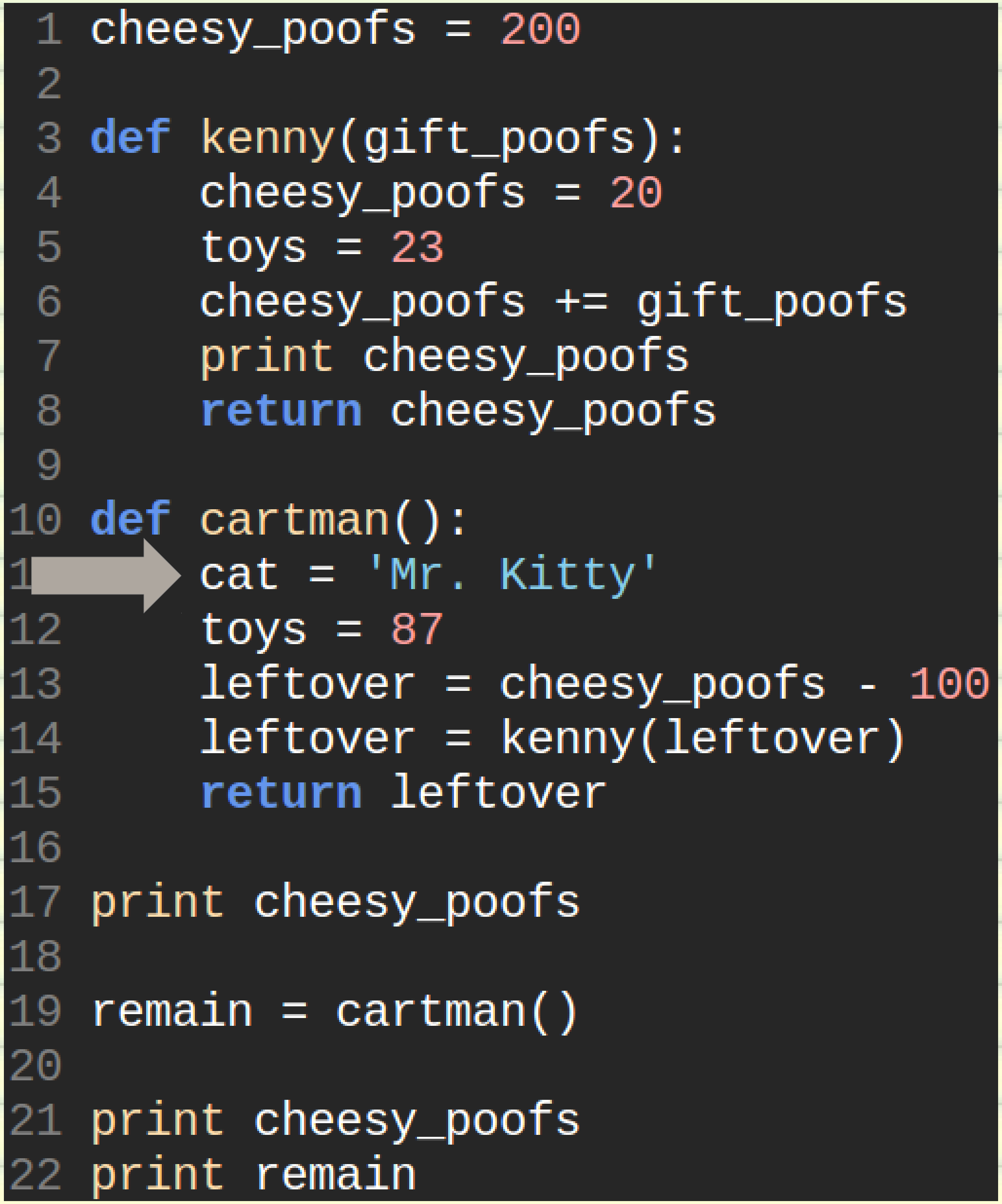
print cheesy_poofs
print remain
```

Let's trace this code.

Namespaces & Variable Scope



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print remain
```
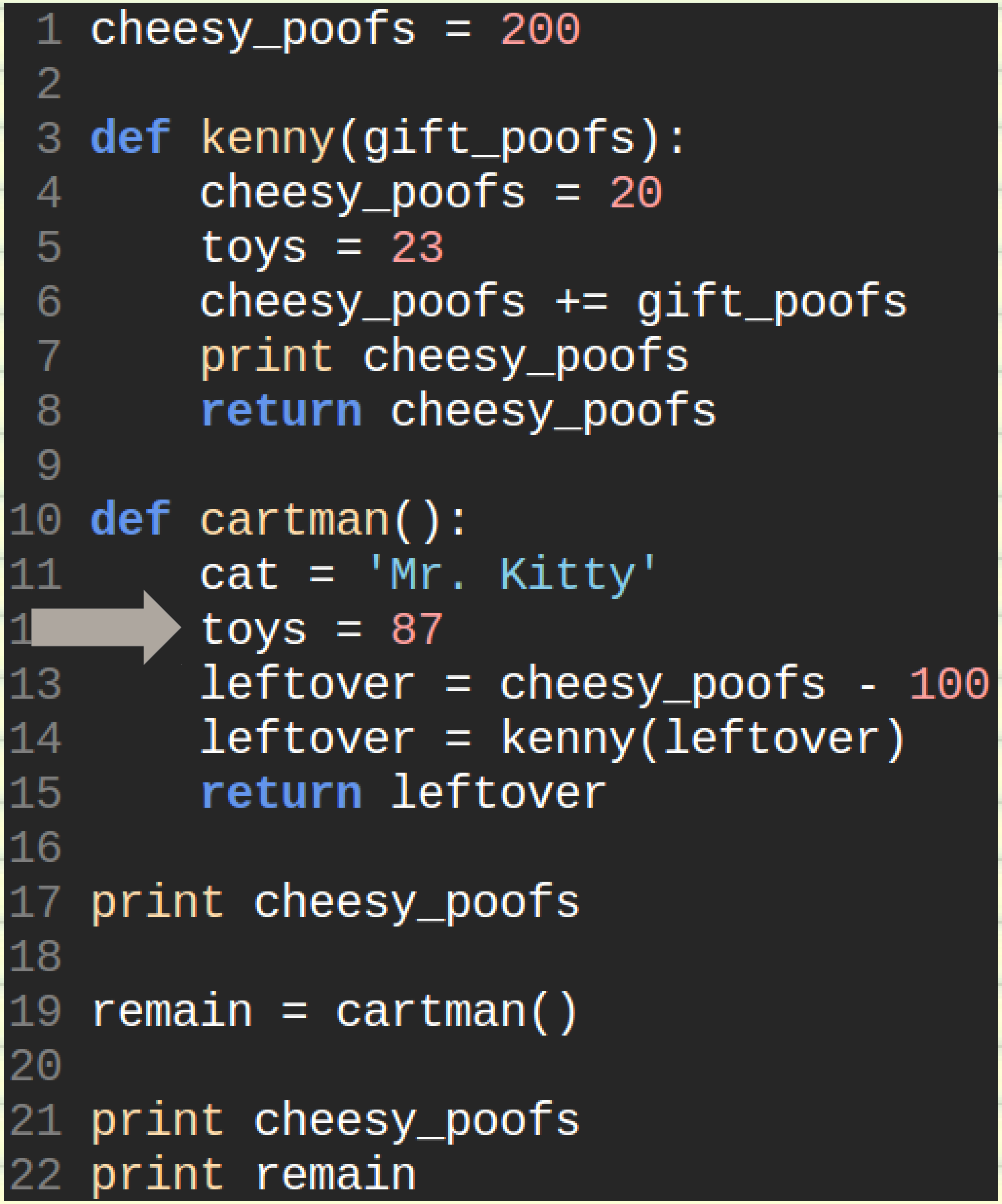

Let's trace this code.

Namespaces & Variable Scope



```python
cheesy_poofs = 200

def kenny(gift_poofs):
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remain = cartman()

print cheesy_poofs
print remain
```
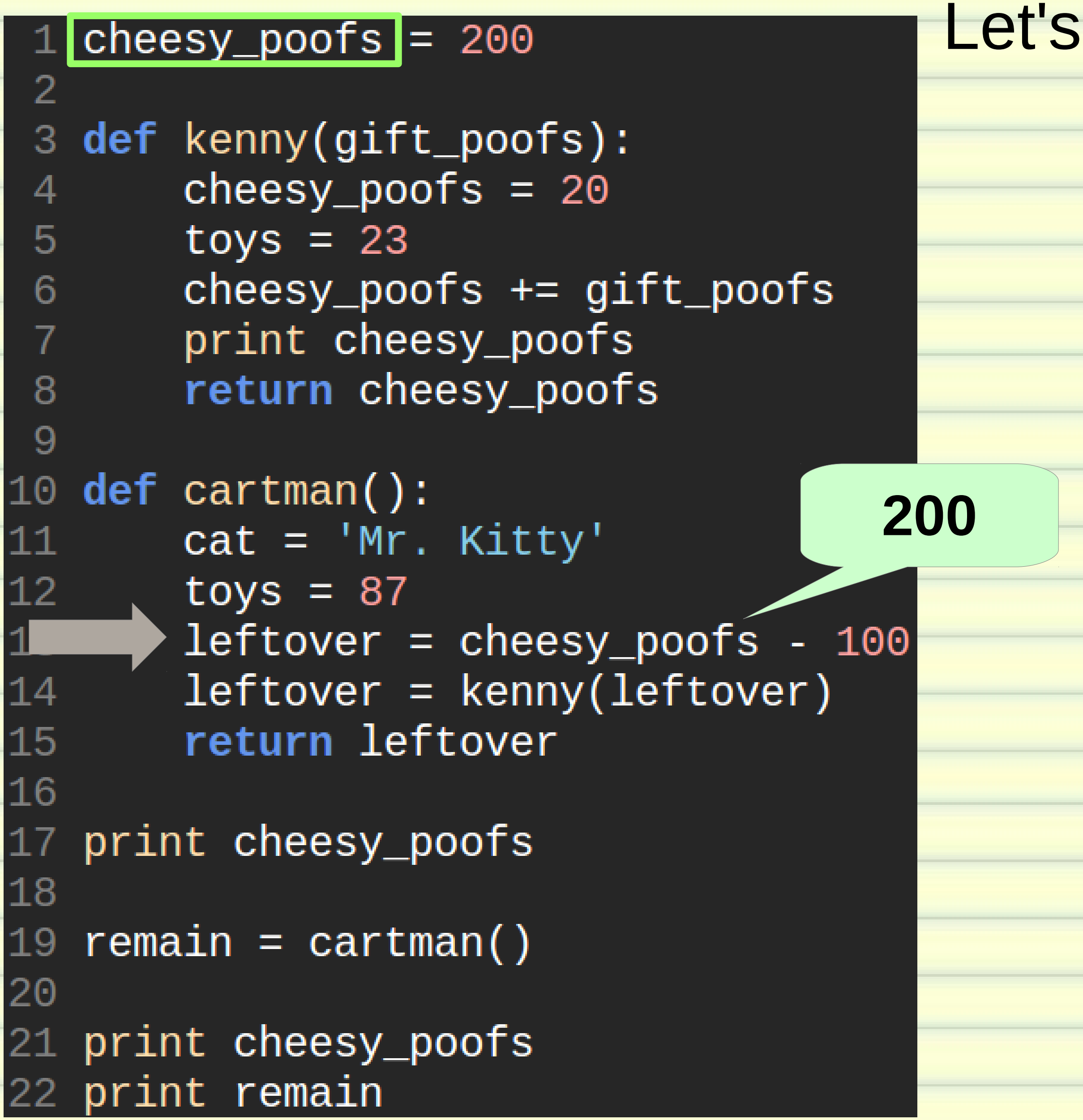

Let's trace this code.

Namespaces & Variable Scope



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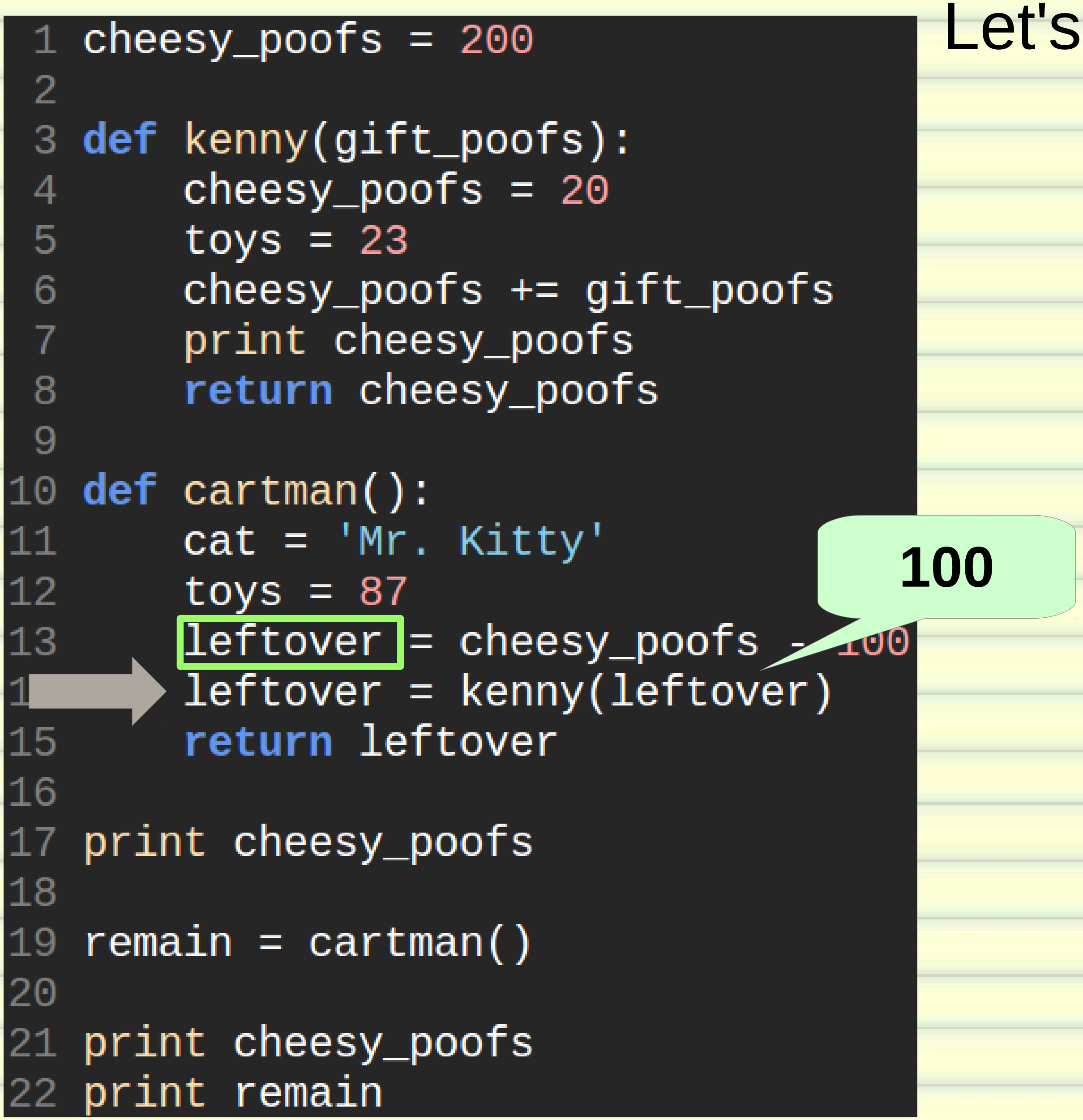
remain = cartman()

print cheesy_poofs
print remain
```

Let's trace this code.

Namespaces & Variable Scope



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print cheesy_poofs
print remain
```
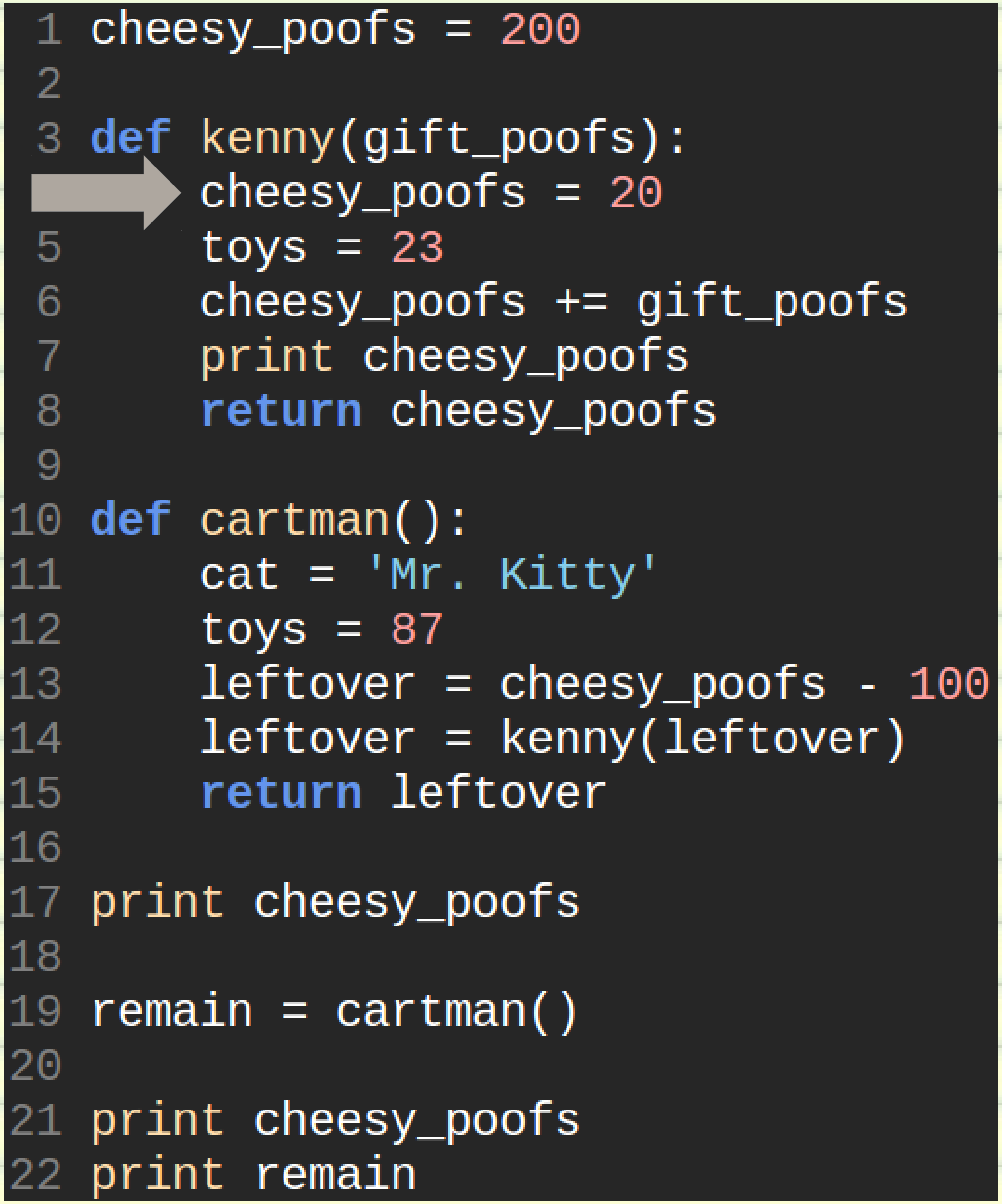

Let's trace this code.

Namespaces & Variable Scope



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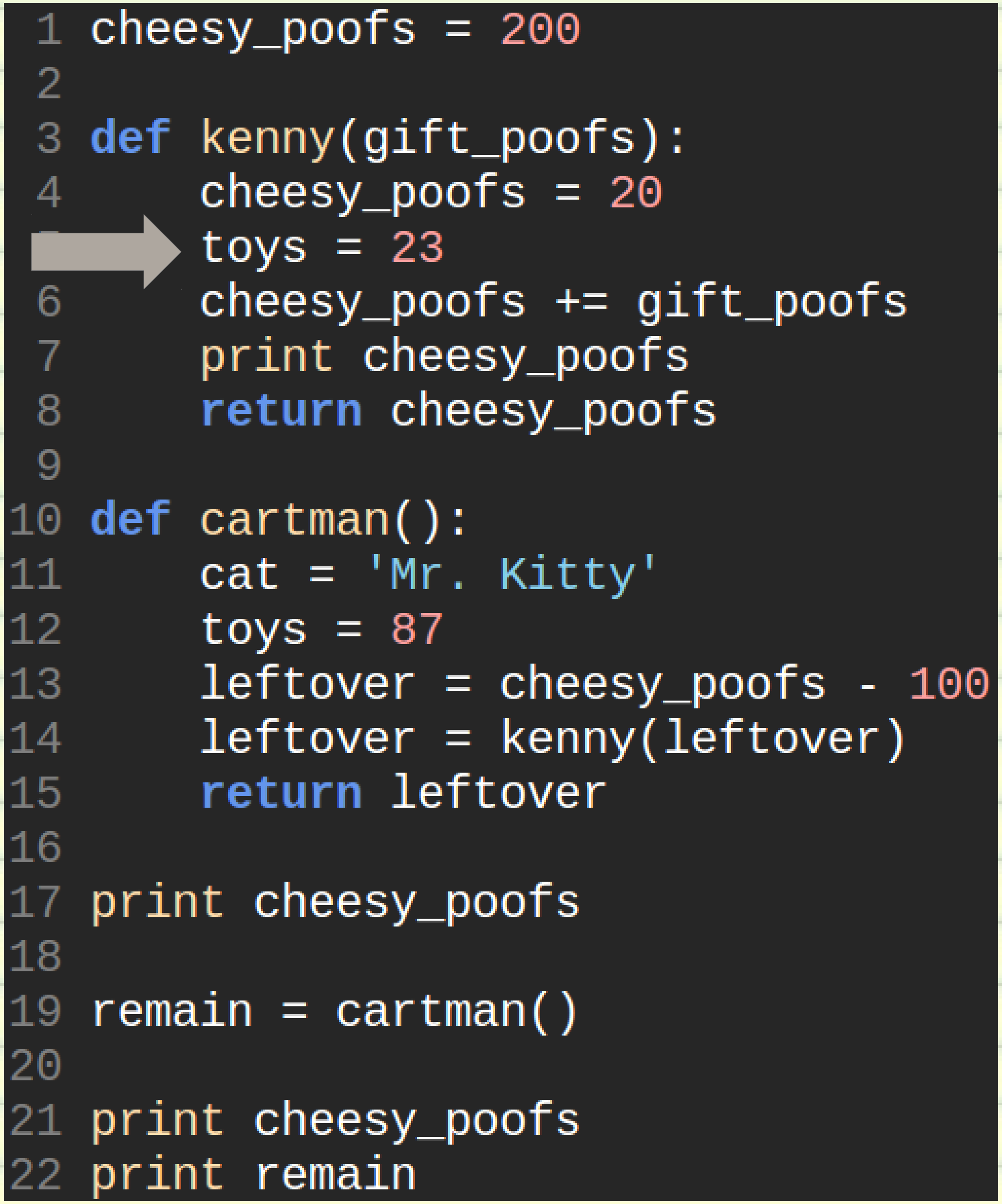
Let's trace this code.

Namespaces & Variable Scope



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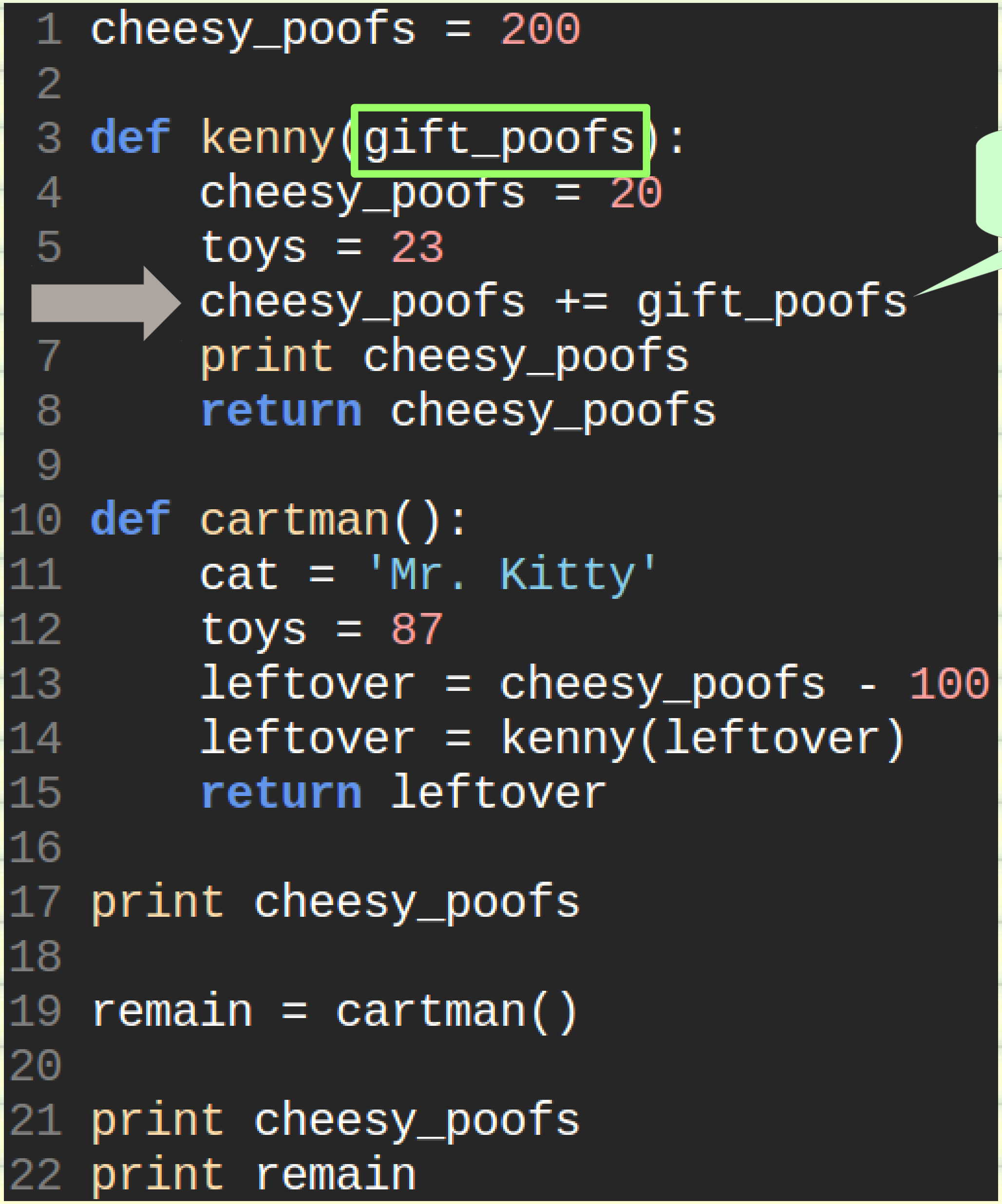
Let's trace this code.

Namespaces & Variable Scope



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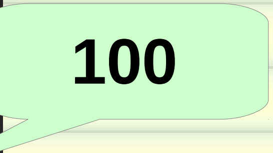
    return leftover

print cheesy_poofs

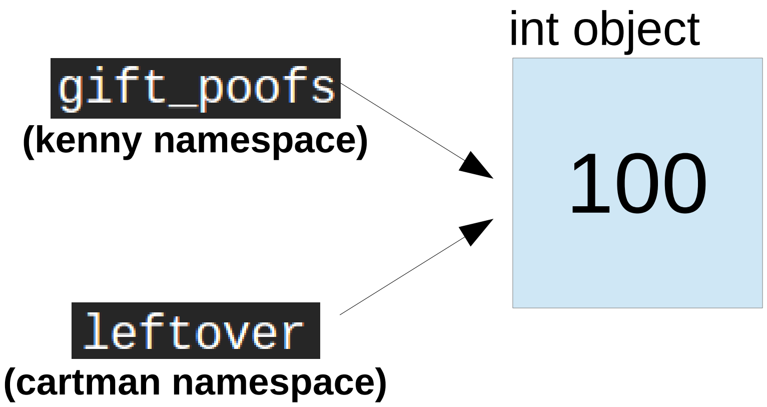
remain = cartman()

print cheesy_poofs
print remain
```

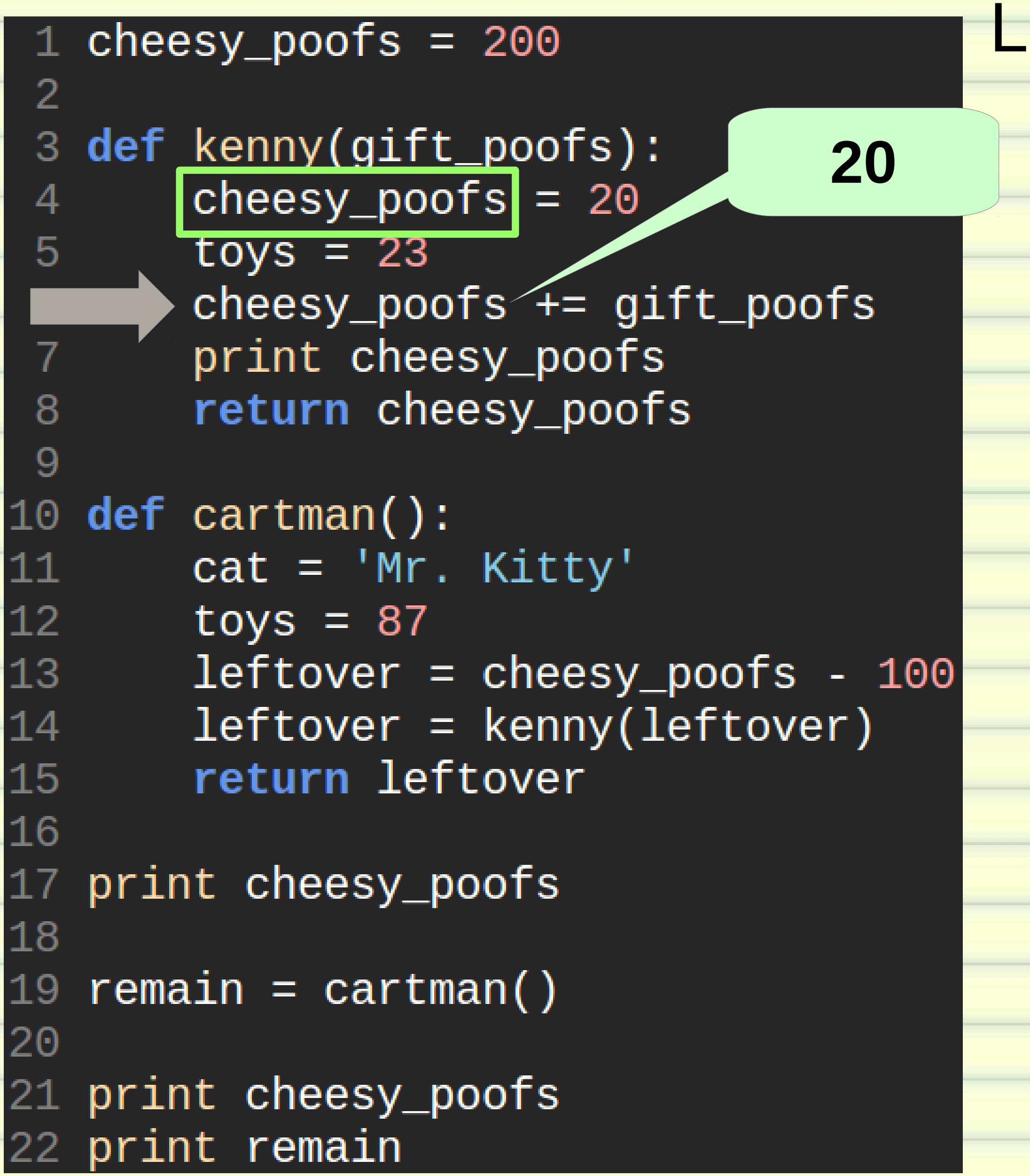


Let's trace this code.

Note:



Namespaces & Variable Scope



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    return leftover

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```
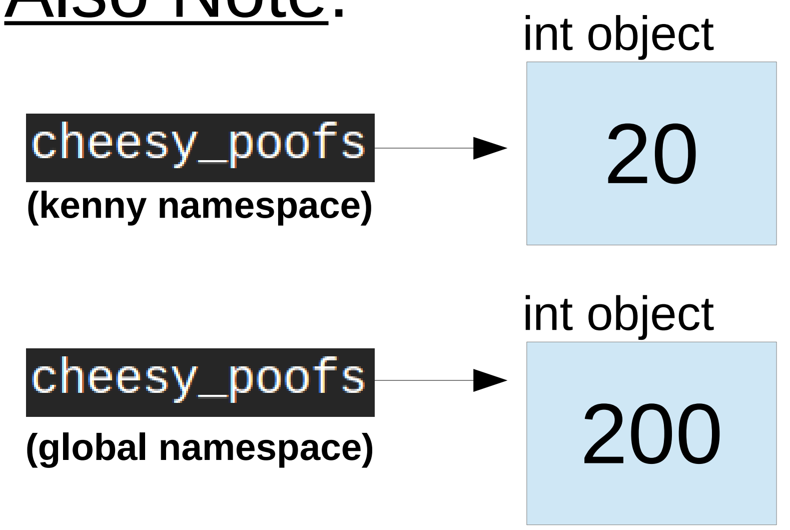
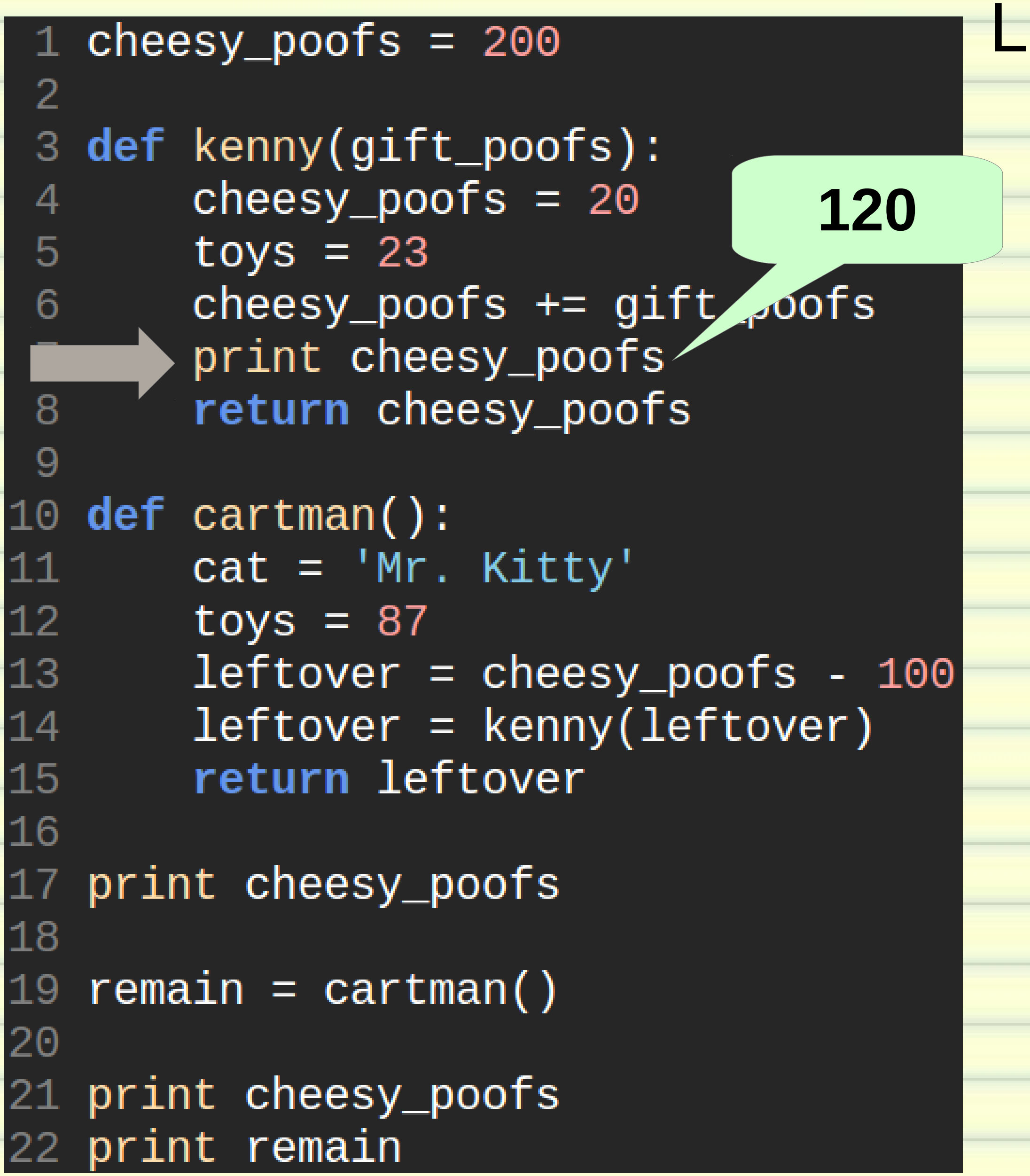

Let's trace this code.

Also Note:



Namespaces & Variable Scope



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remain = cartman()

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Let's trace this code.

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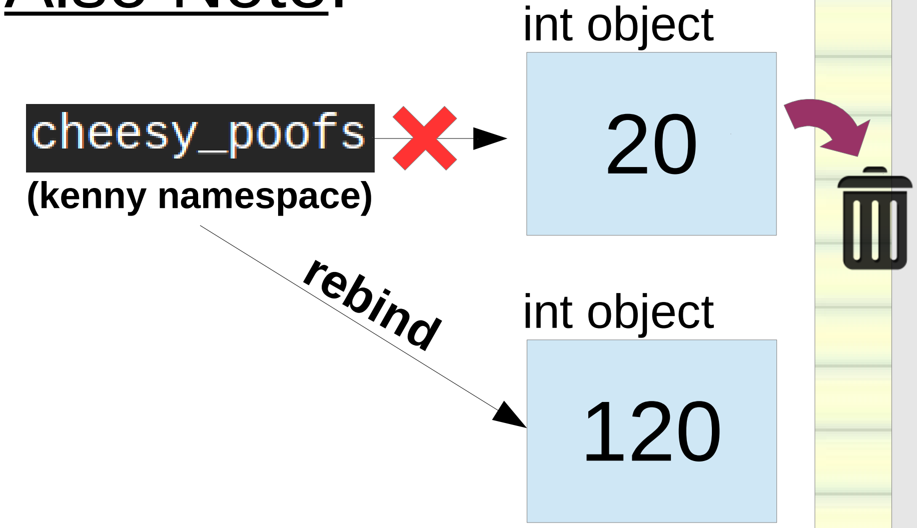
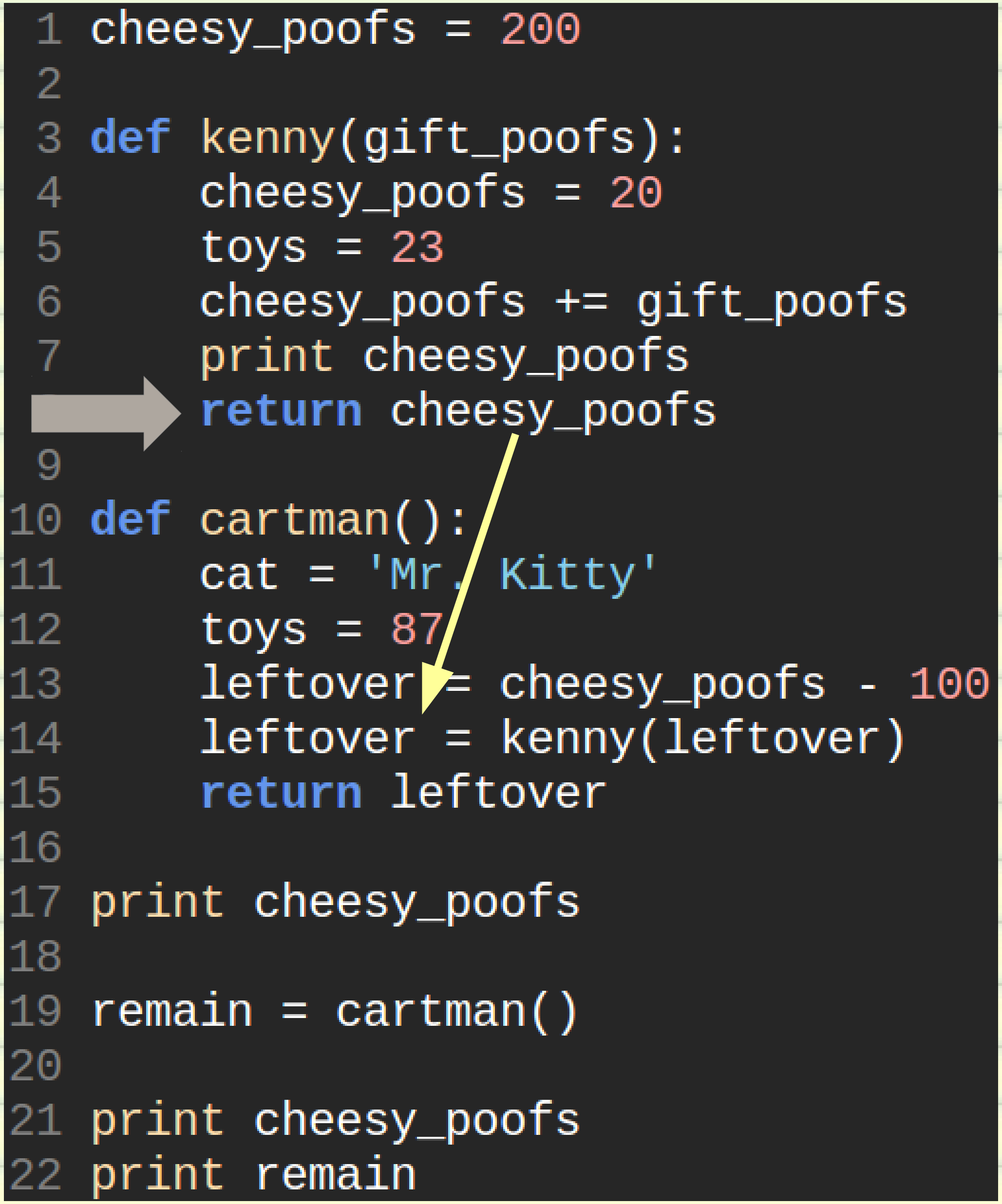


Namespaces & Variable Scope



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    leftover = cheesy_poofs - 100
    leftover = kenny(leftover)
    return leftover

print cheesy_poofs

remain = cartman()

print cheesy_poofs
print remain
```

Let's trace this code.

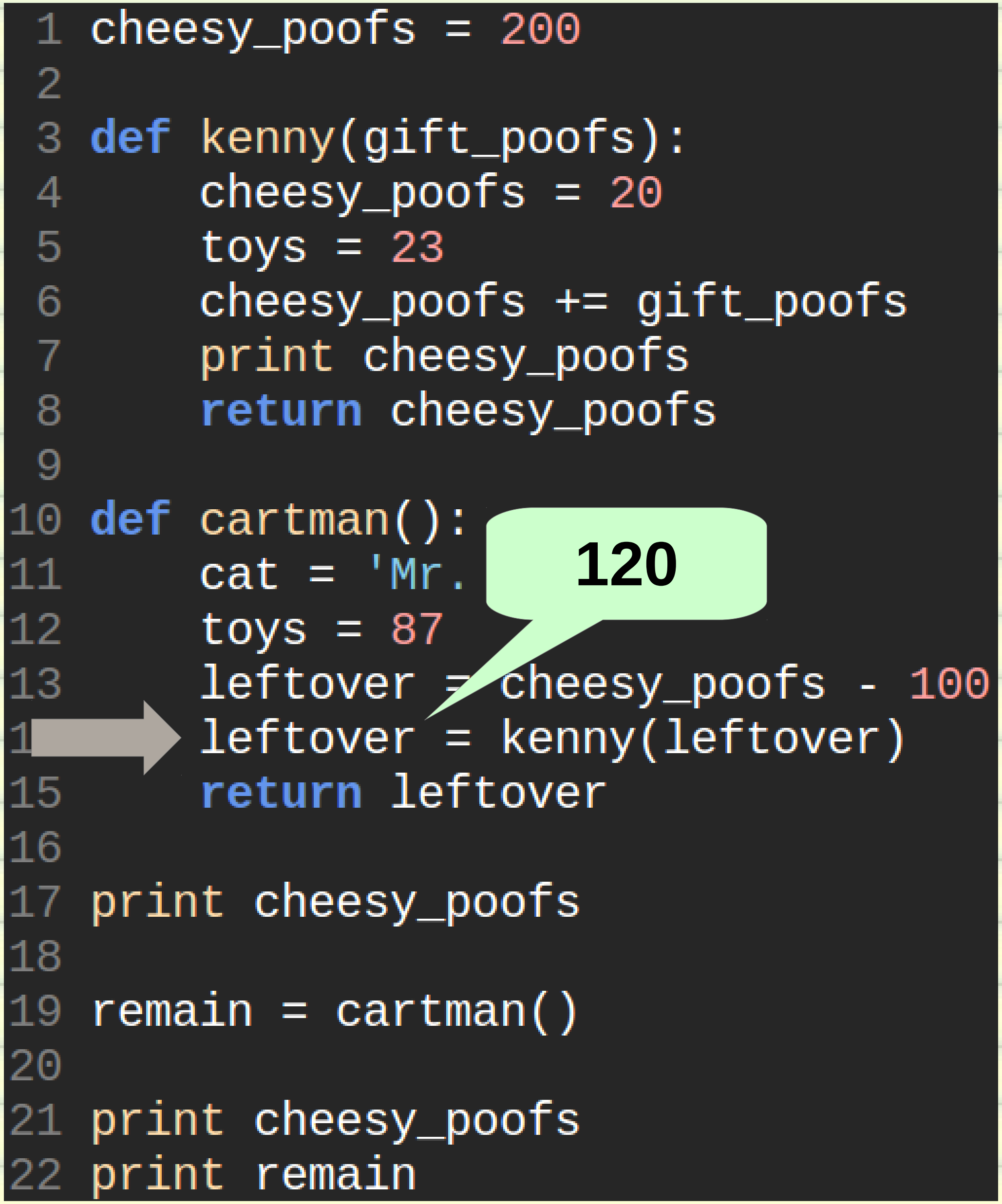
kenny's local namespace gets torn down.

```
['cheesy_poofs', 'gift_poofs', 'toys']
```

the names are destroyed.

if this results in objects with 0 references, those objects are also destroyed

Namespaces & Variable Scope



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remain = cartman()

print cheesy_poofs
print remain
```
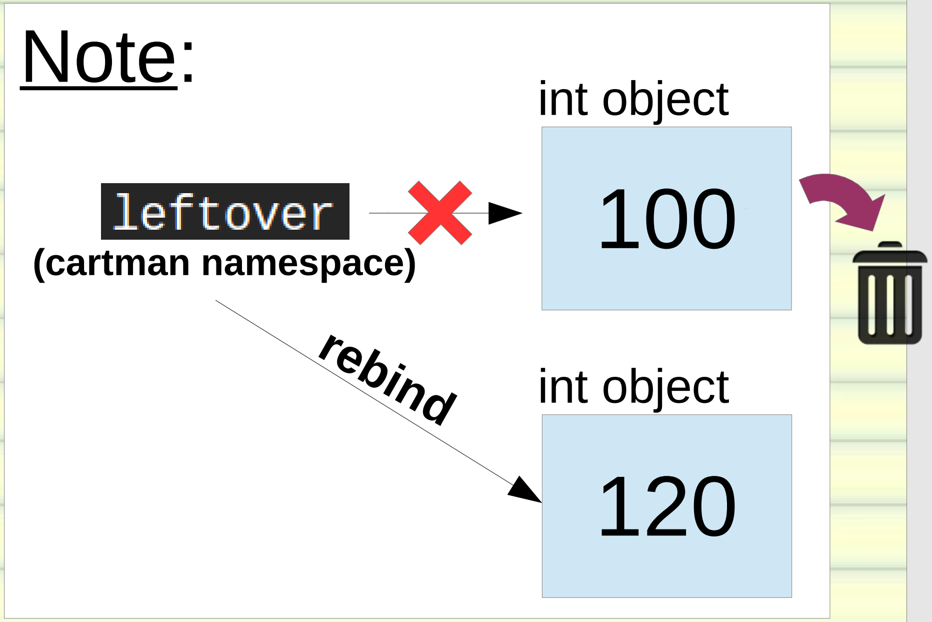
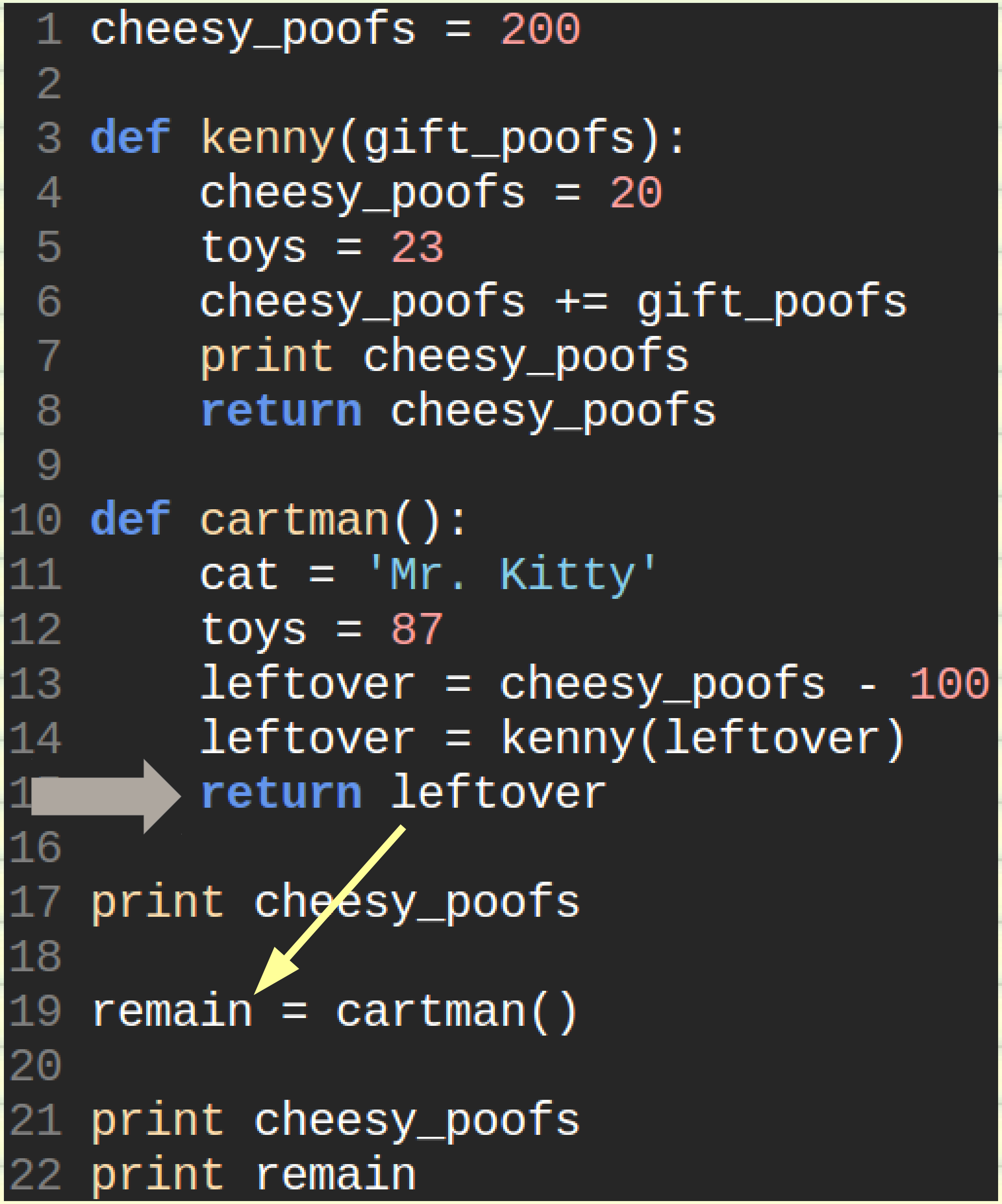

Let's trace this code.



Note:

Namespaces & Variable Scope



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    return leftover

print cheesy_poofs

remain = cartman()

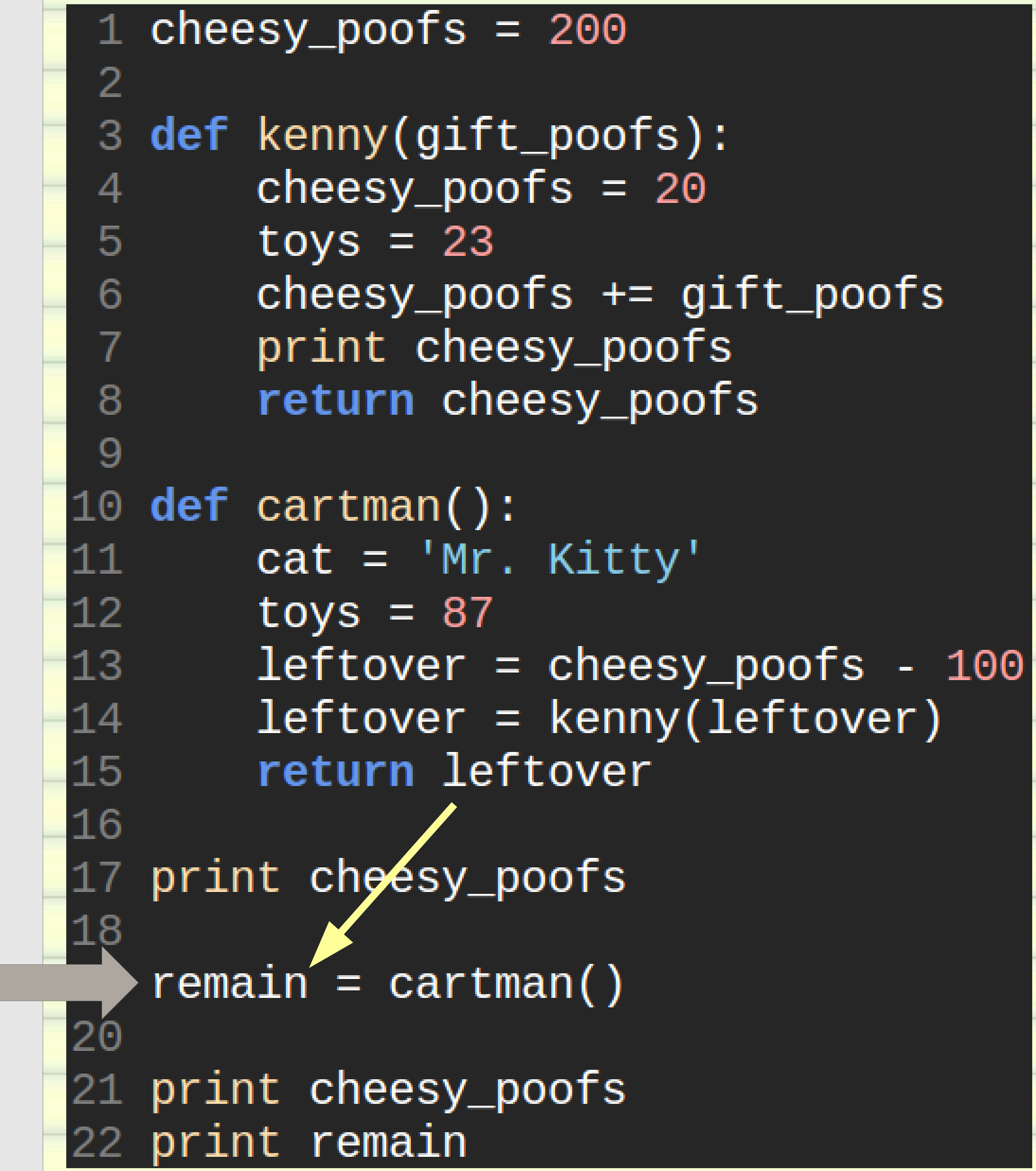
print cheesy_poofs
print remain
```

Let's trace this code.

cartman's local namespace gets torn down.

`['cat', 'leftover', 'toys']`

Namespaces & Variable Scope



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print cheesy_poofs

remain = cartman()

print cheesy_poofs
print remain
```
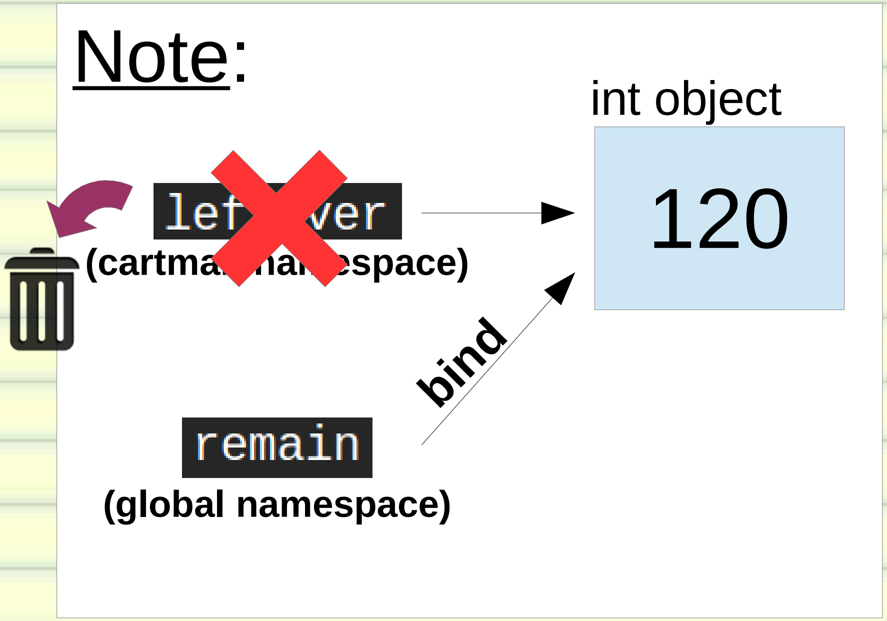
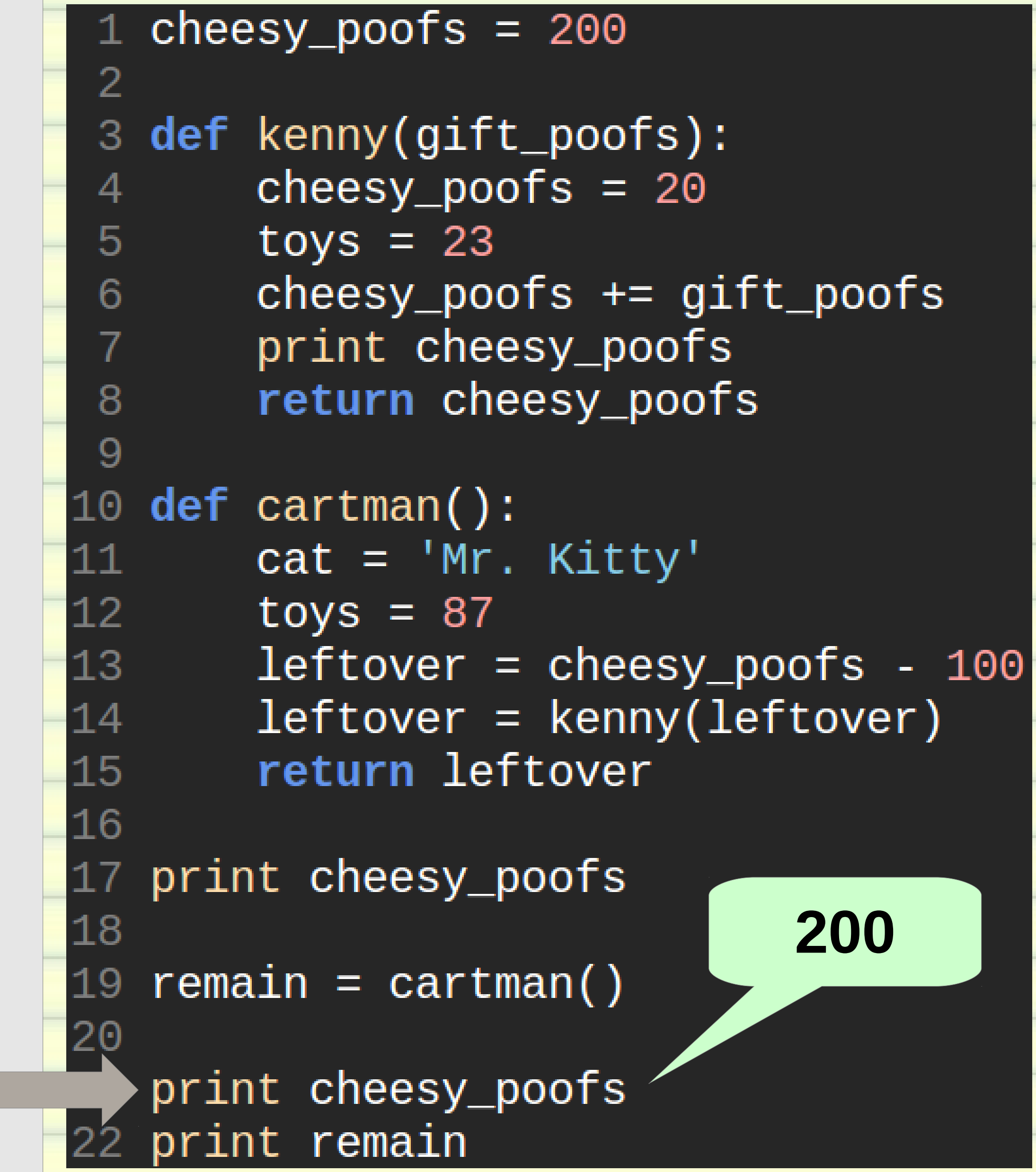

Let's trace this code.



Namespaces & Variable Scope



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print cheesy_poofs

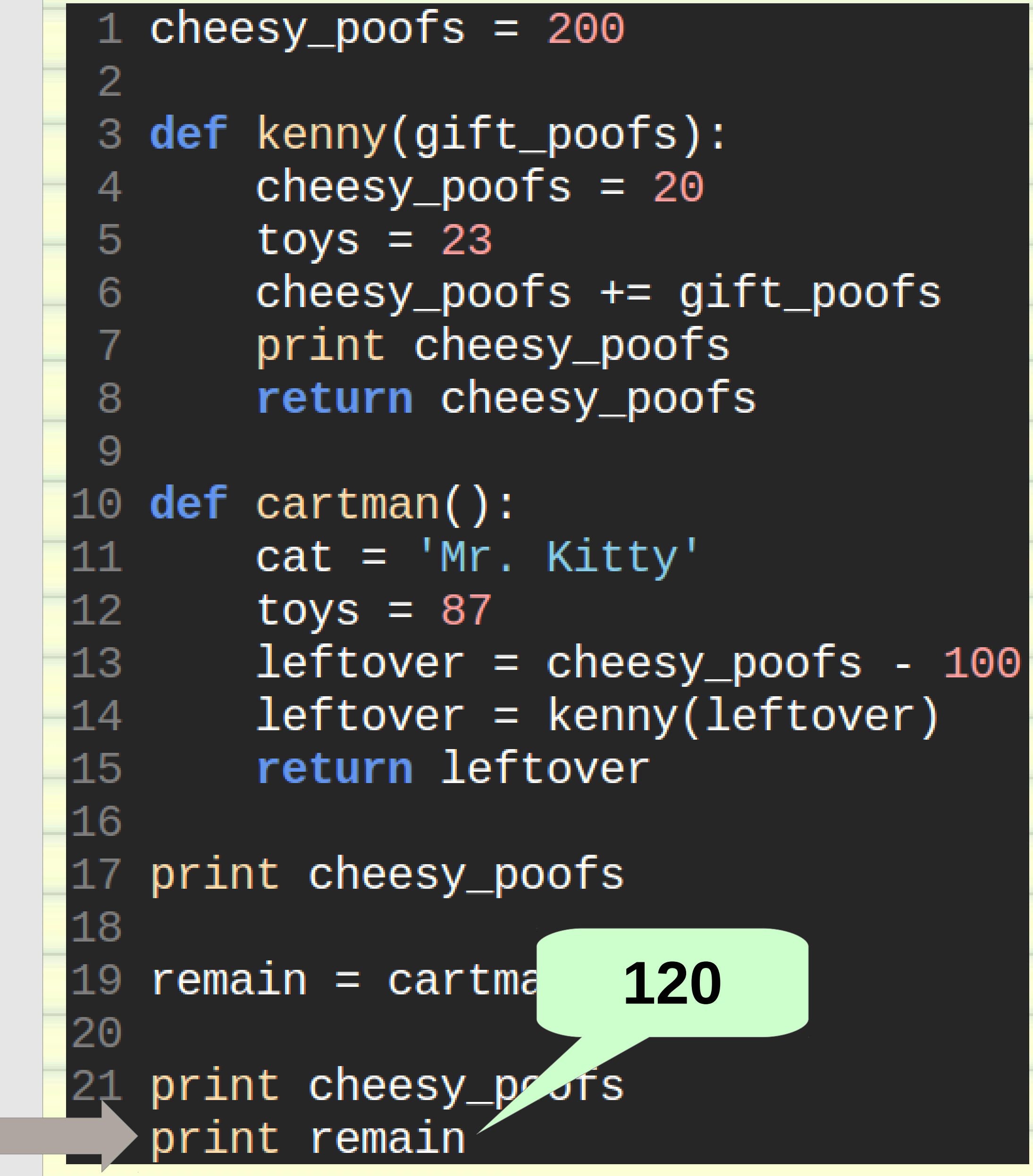
remain = cartman()

print cheesy_poofs
print remain
```

200

Let's trace this code.

Namespaces & Variable Scope



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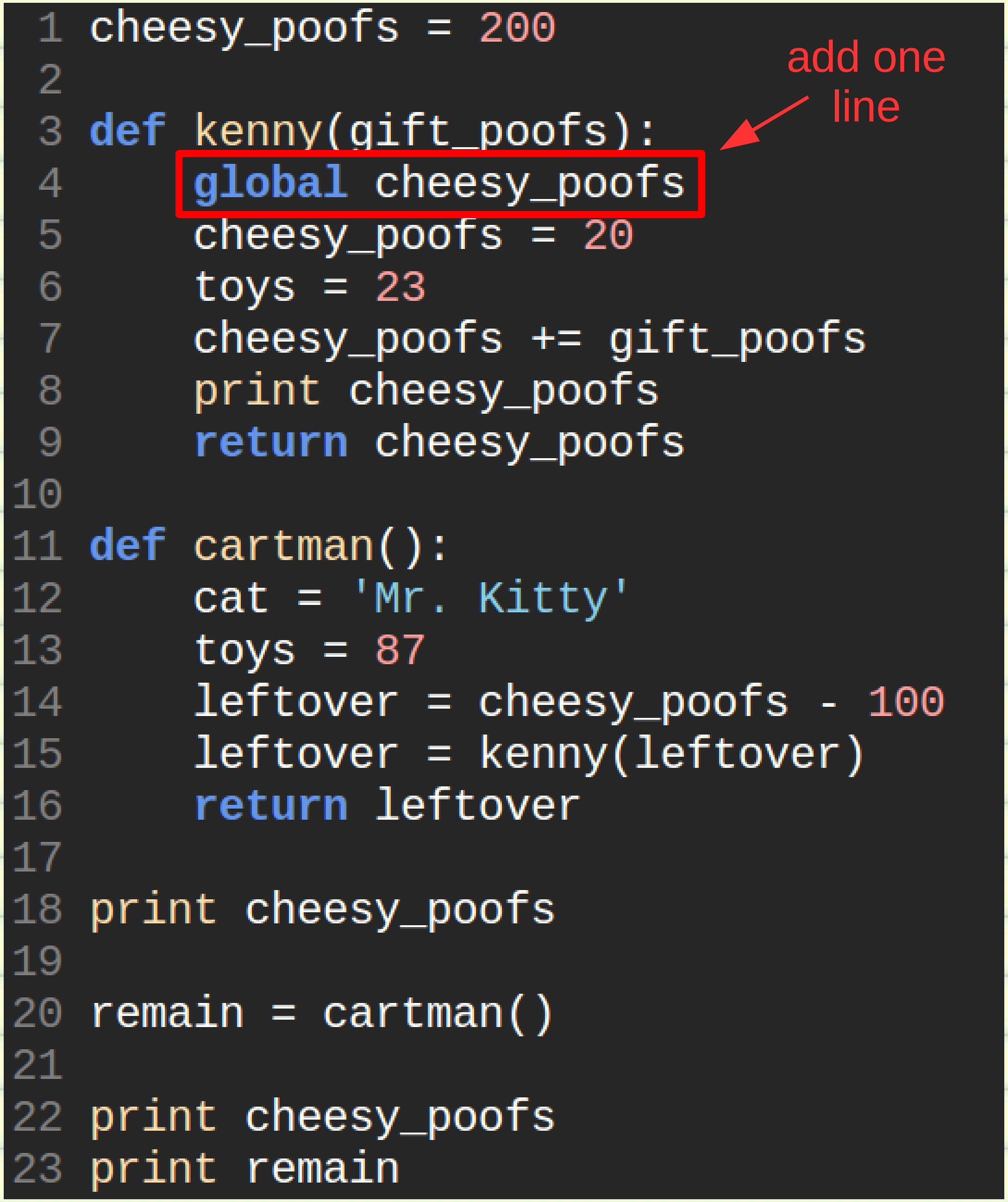
Let's trace this code.

Namespaces & Variable Scope



```
cheesy_poofs = 200

def kenny(gift_poofs):
    global cheesy_poofs
    cheesy_poofs = 20
    toys = 23
    cheesy_poofs += gift_poofs
    print cheesy_poofs
    return cheesy_poofs

def cartman():
    cat = 'Mr. Kitty'
    toys = 87
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    leftover = kenny(leftover)
    return leftover

print cheesy_poofs

remain = cartman()

print cheesy_poofs
print remain
```

add one line

The **global** keyword...

what does it do?

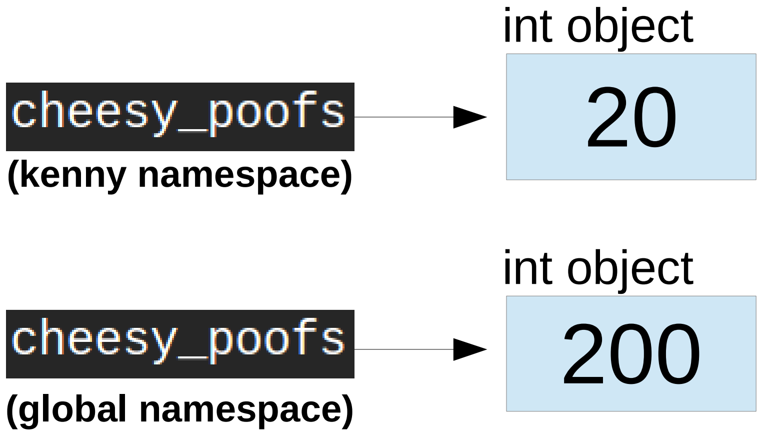
Namespaces & Variable Scope

```
 1 cheesy_poofs = 200
 2
 3 def kenny(gift_poofs):
 4     global cheesy_poofs
       cheesy_poofs = 20
 6     toys = 23
 7     cheesy_poofs += gift_poofs
 8     print cheesy_poofs
 9     return cheesy_poofs
10
11 def cartman():
12     cat = 'Mr. Kitty'
13     toys = 87
14     leftover = cheesy_poofs - 100
15     leftover = kenny(leftover)
16     return leftover
17
18 print cheesy_poofs
19
20 remain = cartman()
21
22 print cheesy_poofs
23 print remain
```

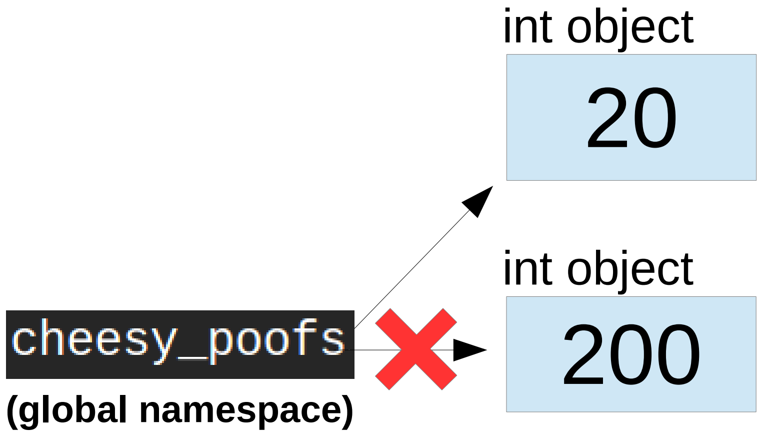
add one line

The **global** keyword...

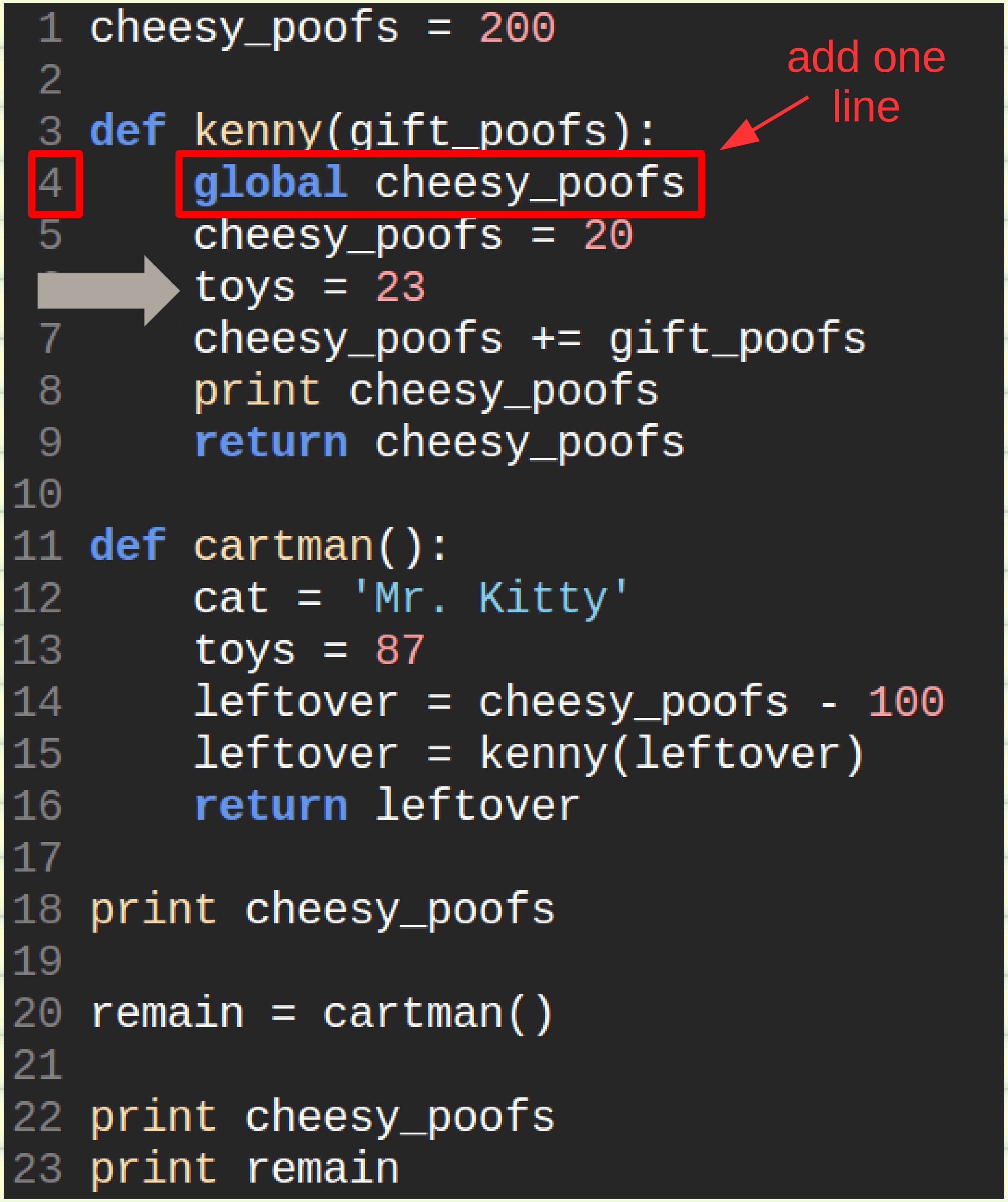
Without **line 4**



***With* line 4**



Namespaces & Variable Scope



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18 print cheesy_poofs
19
20 remain = cartman()
21
22 print cheesy_poofs
23 print remain
```
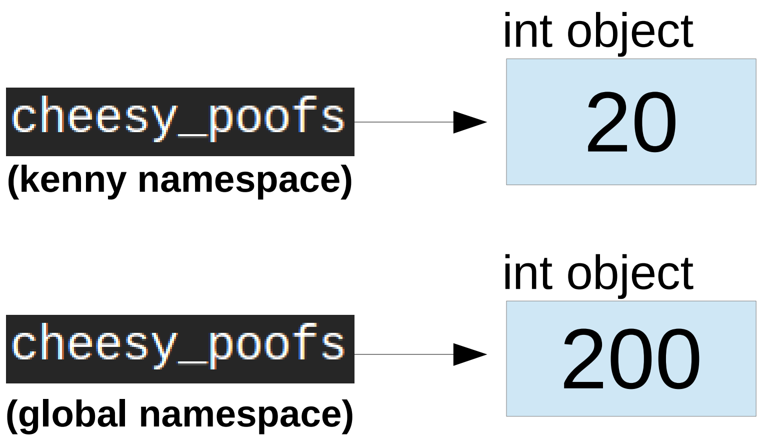

add one line

The **global** keyword...

Without **line 4**



int object

cheesy_poofs

(kenny namespace)

20

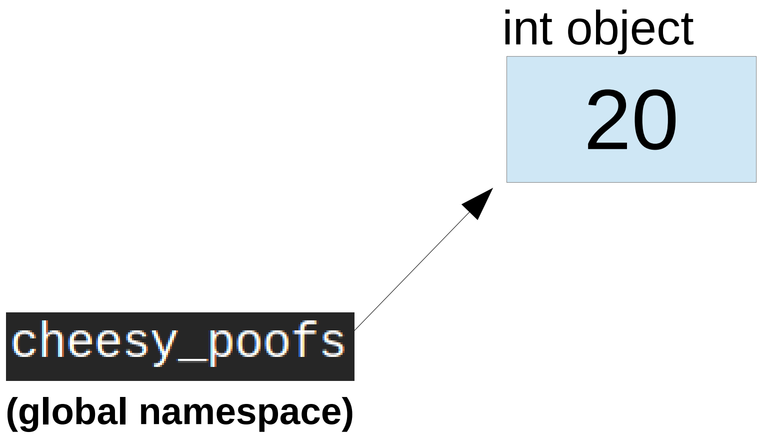
int object

cheesy_poofs

(global namespace)

200

With **line 4**



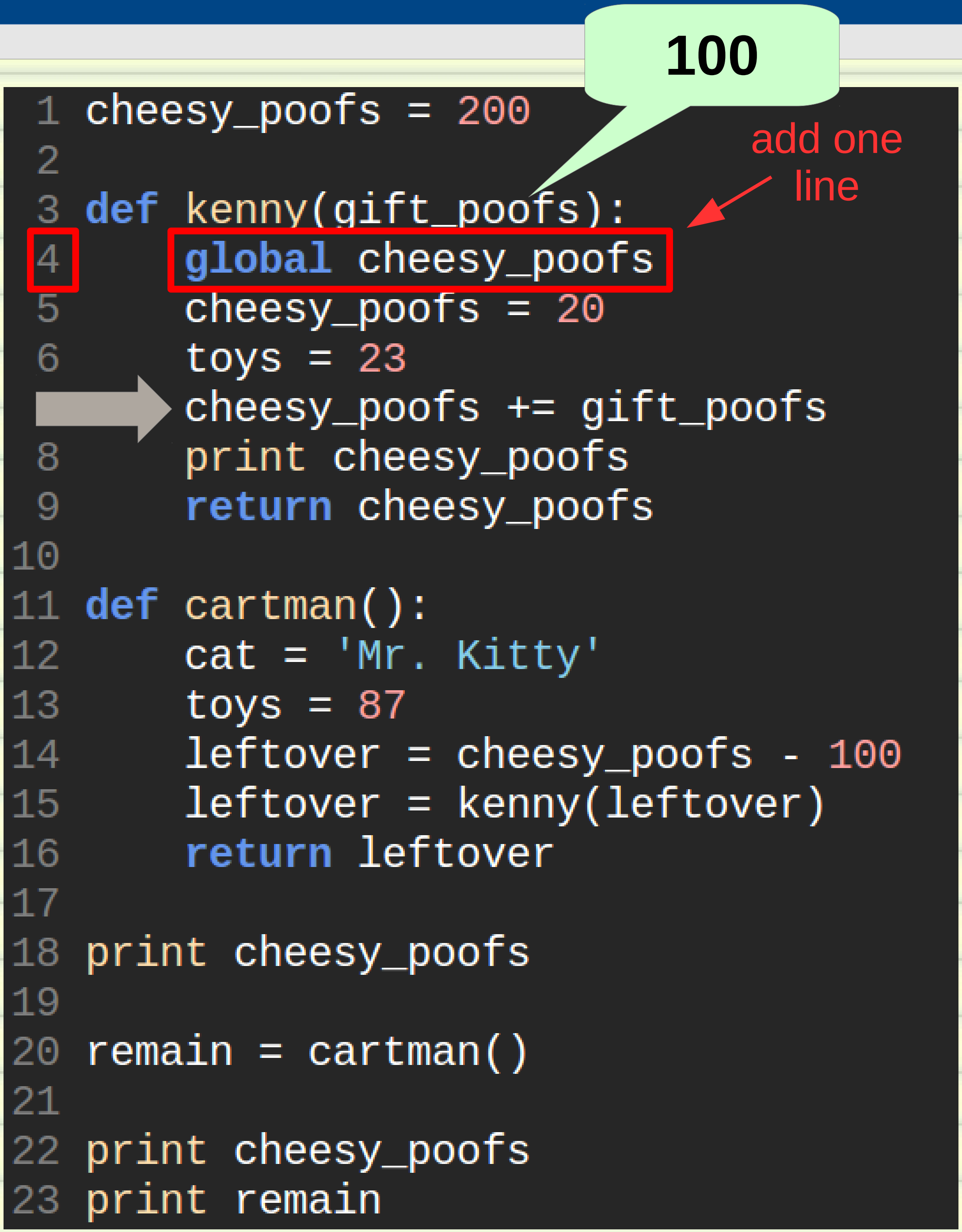
int object

20

cheesy_poofs

(global namespace)

Namespaces & Variable Scope

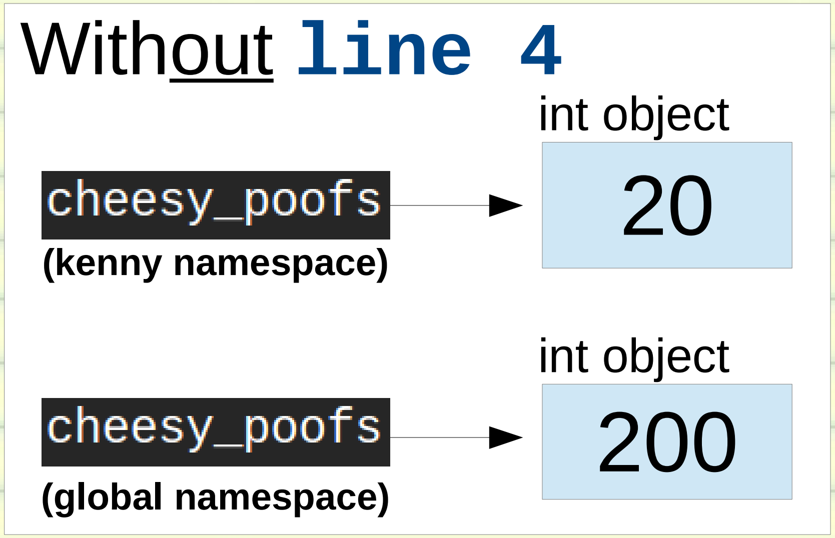


```
 1 cheesy_poofs = 200
 2
 3 def kenny(gift_poofs):
 4     global cheesy_poofs
 5     cheesy_poofs = 20
 6     toys = 23
       cheesy_poofs += gift_poofs
 8     print cheesy_poofs
 9     return cheesy_poofs
10
11 def cartman():
12     cat = 'Mr. Kitty'
13     toys = 87
14     leftover = cheesy_poofs - 100
15     leftover = kenny(leftover)
16     return leftover
17
18 print cheesy_poofs
19
20 remain = cartman()
21
22 print cheesy_poofs
23 print remain
```

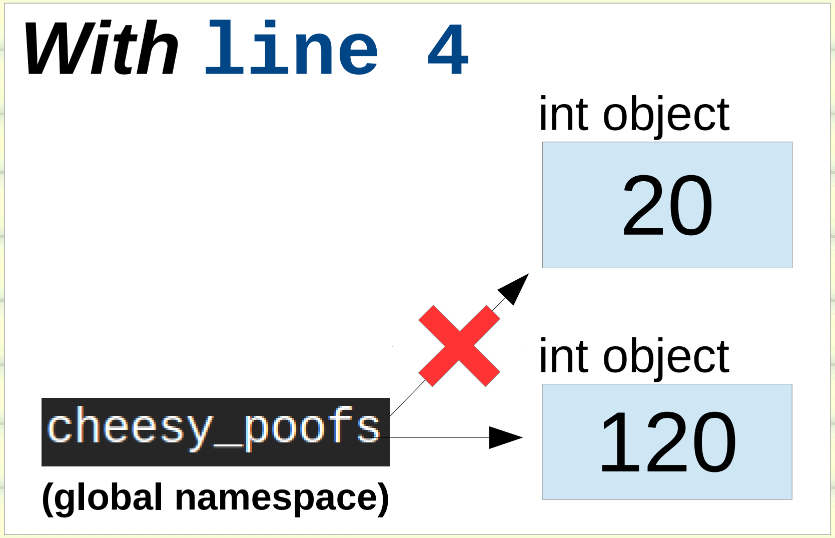
100

add one line

The **global** keyword...



Without **line 4**



***With* line 4**

Namespaces & Variable Scope

```
 1 cheesy_poofs = 200
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19
20 remain = cartman()
21
22 print cheesy_poofs
23 print remain
```
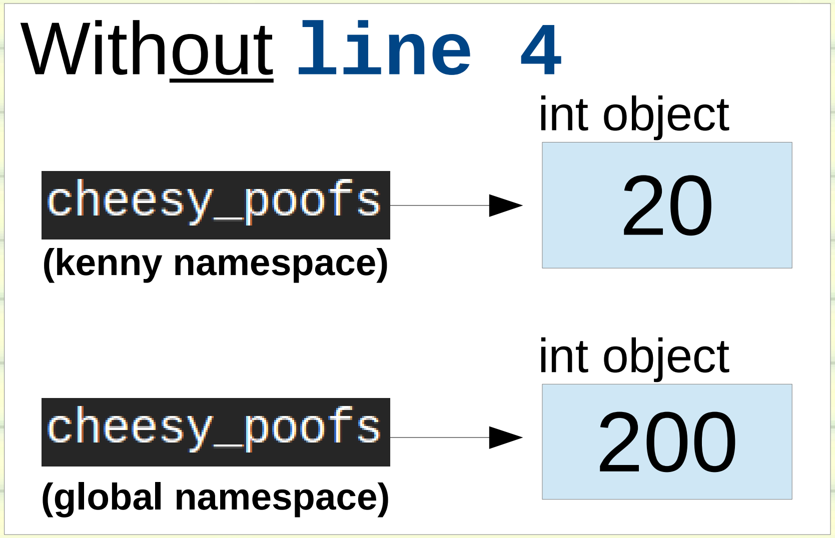
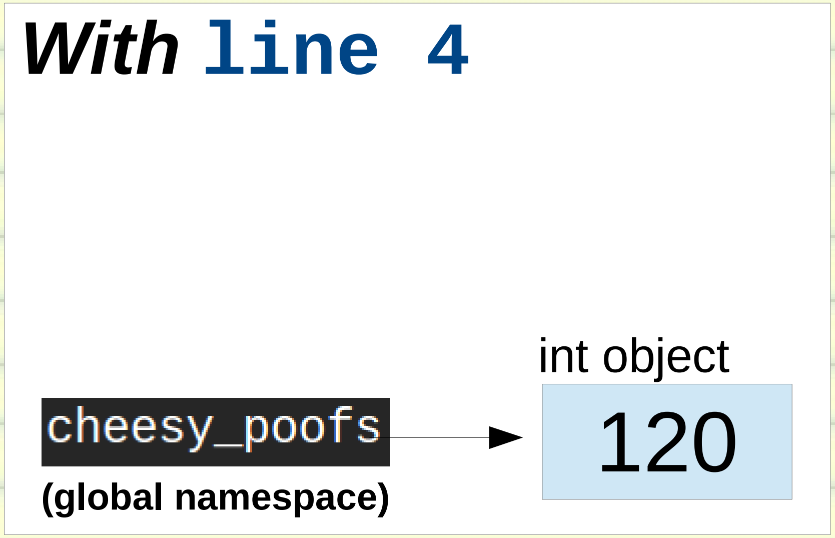

add one line

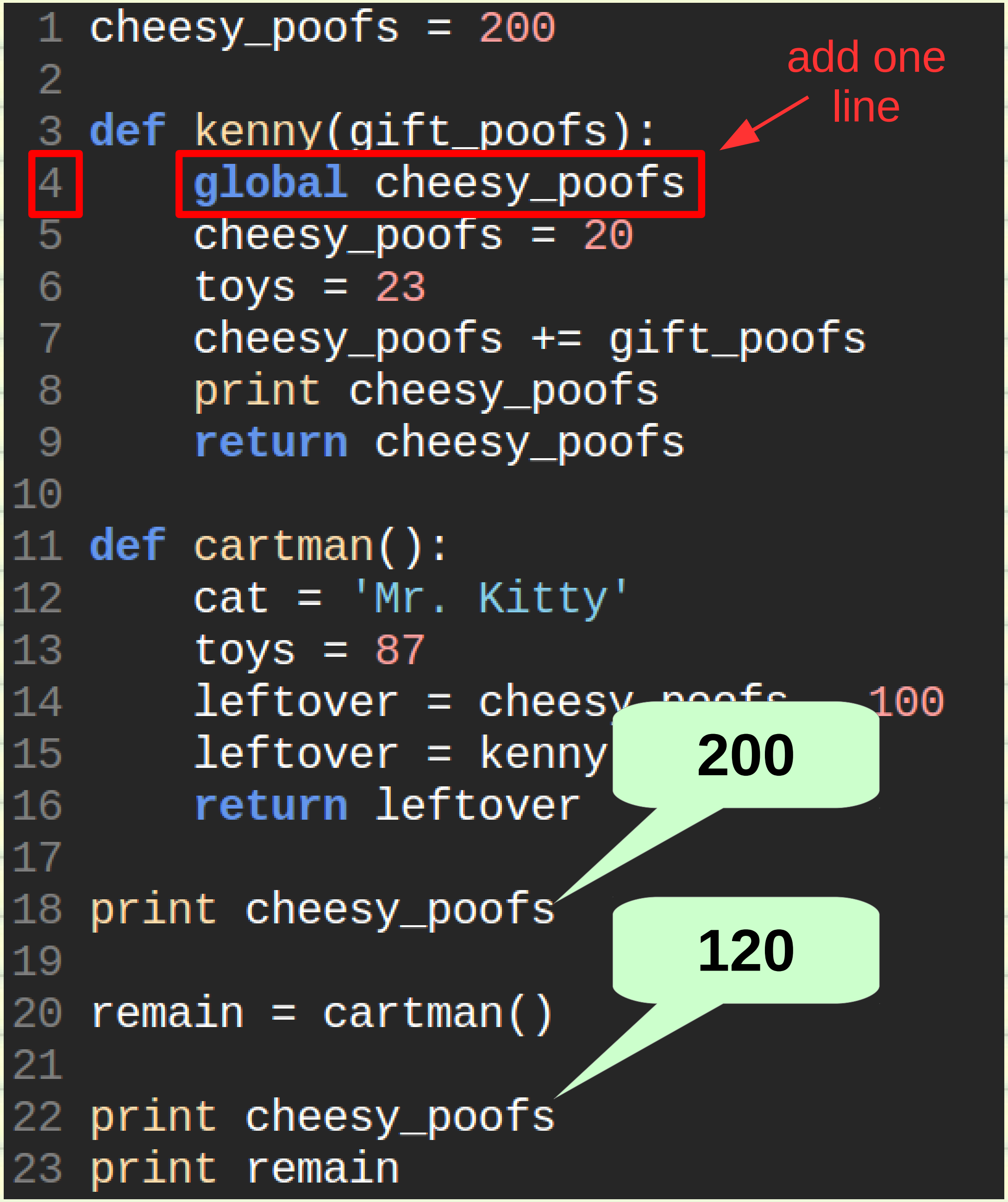
120

The **global** keyword...





Namespaces & Variable Scope



```
cheesy_poofs = 200

def kenny(gift_poofs):
    global cheesy_poofs
    cheesy_poofs = 20
    toys = 23
    cheesy_poofs += gift_poofs
    print cheesy_poofs
    return cheesy_poofs

def cartman():
    cat = 'Mr. Kitty'
    toys = 87
    leftover = cheesy_poofs - 100
    leftover = kenny
    return leftover

print cheesy_poofs

remain = cartman()

print cheesy_poofs
print remain
```

add one line

200

120

The **global** keyword...

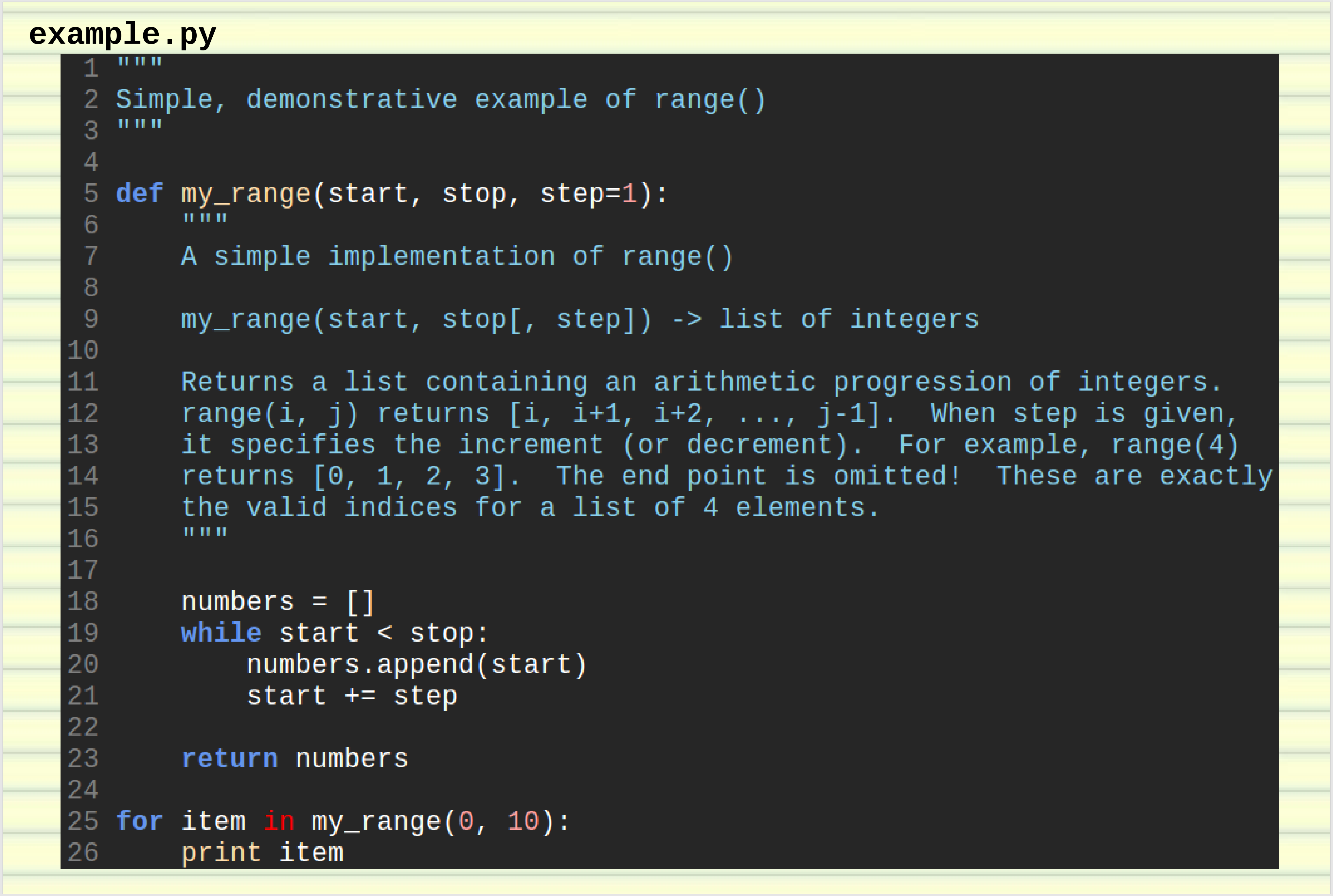
lets you manipulate a global name inside your function's namespace

Whoa, can't see the forest for the trees!

Let's look at a simple, practical function to implement.

`range()`

Using Functions



example.py

```python
"""
Simple, demonstrative example of range()
"""

def my_range(start, stop, step=1):
    """
    A simple implementation of range()

    my_range(start, stop[, step]) -> list of integers

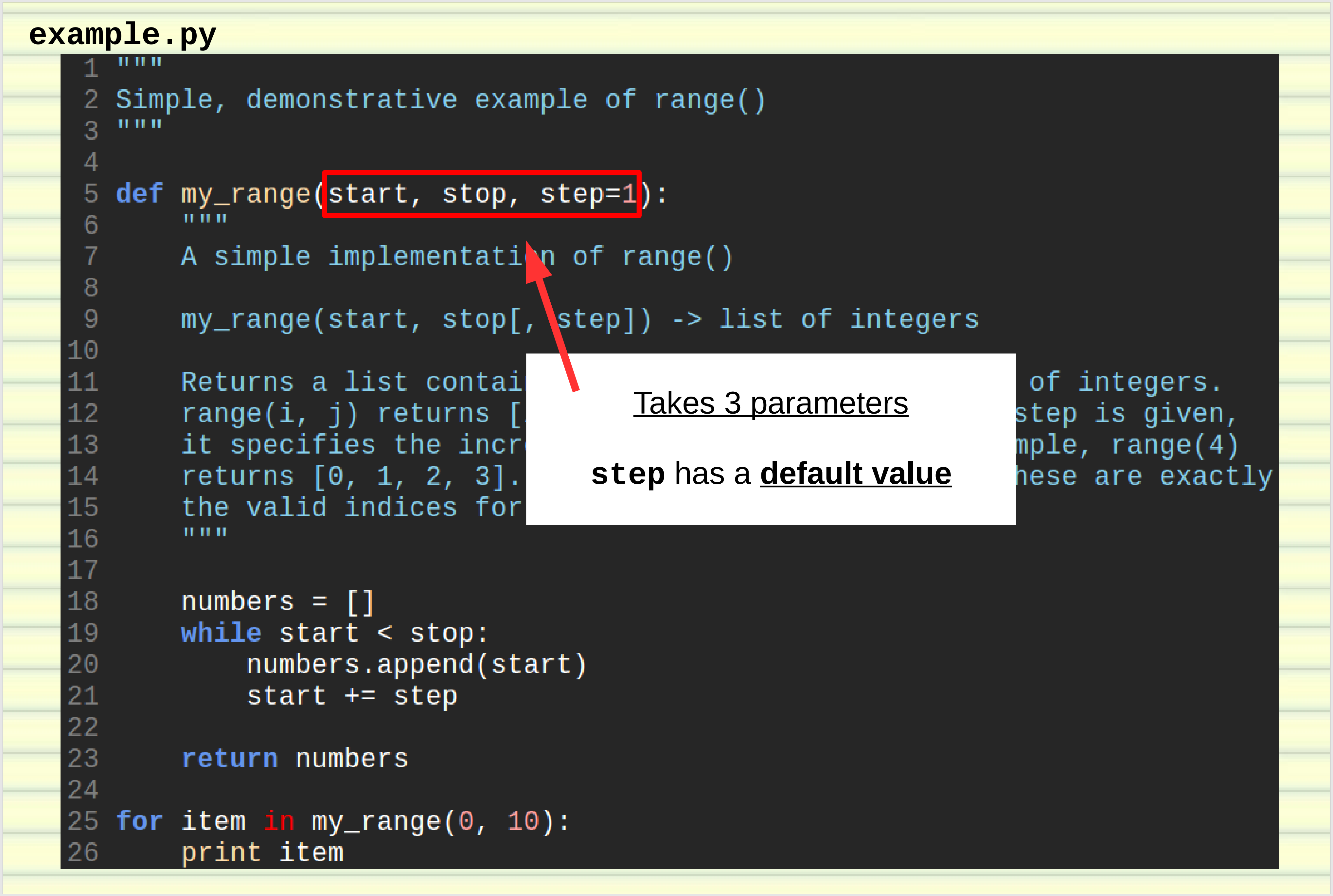
    Returns a list containing an arithmetic progression of integers.
    range(i, j) returns [i, i+1, i+2, ..., j-1].  When step is given,
    it specifies the increment (or decrement).  For example, range(4)
    returns [0, 1, 2, 3].  The end point is omitted!  These are exactly
    the valid indices for a list of 4 elements.
    """

    numbers = []
    while start < stop:
        numbers.append(start)
        start += step

    return numbers

for item in my_range(0, 10):
    print item
```

Using Functions



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    return numbers

for item in my_range(0, 10):
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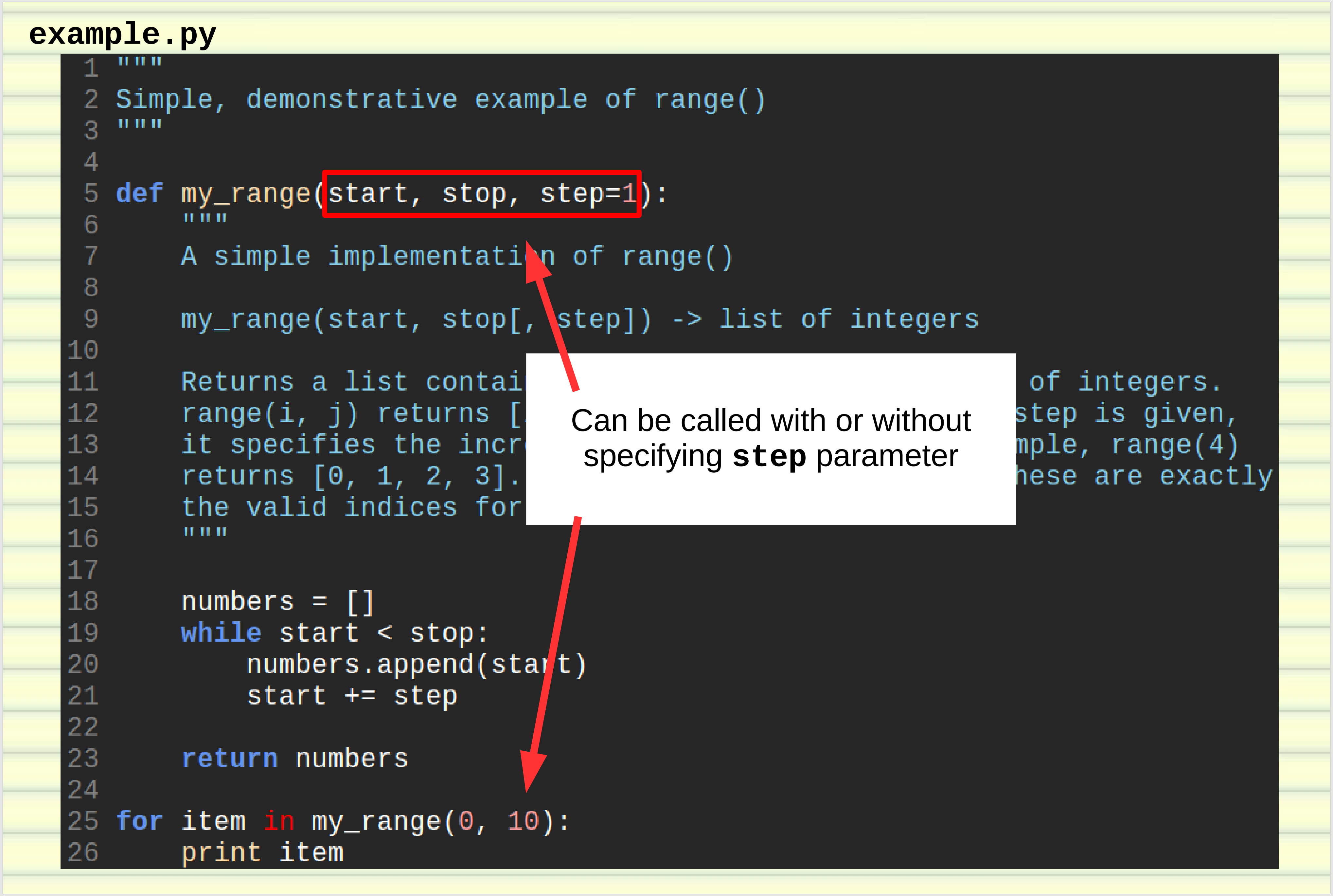
```

<u>Takes 3 parameters</u>

`step` has a **<u>default value</u>**

Using Functions



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    """

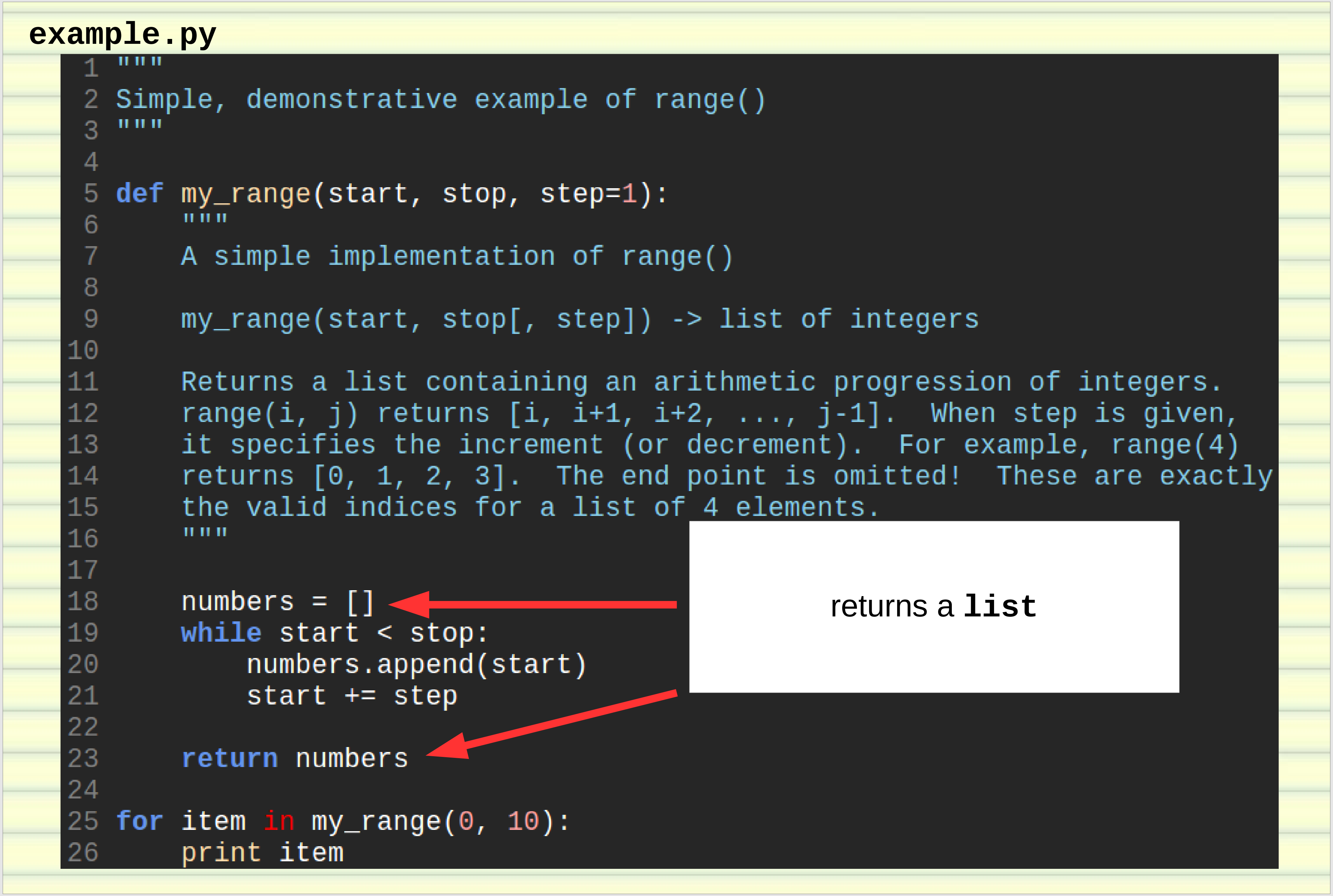
    numbers = []
    while start < stop:
        numbers.append(start)
        start += step

    return numbers

for item in my_range(0, 10):
    print item
```

Can be called with or without specifying **step** parameter

Using Functions



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    """

    numbers = []
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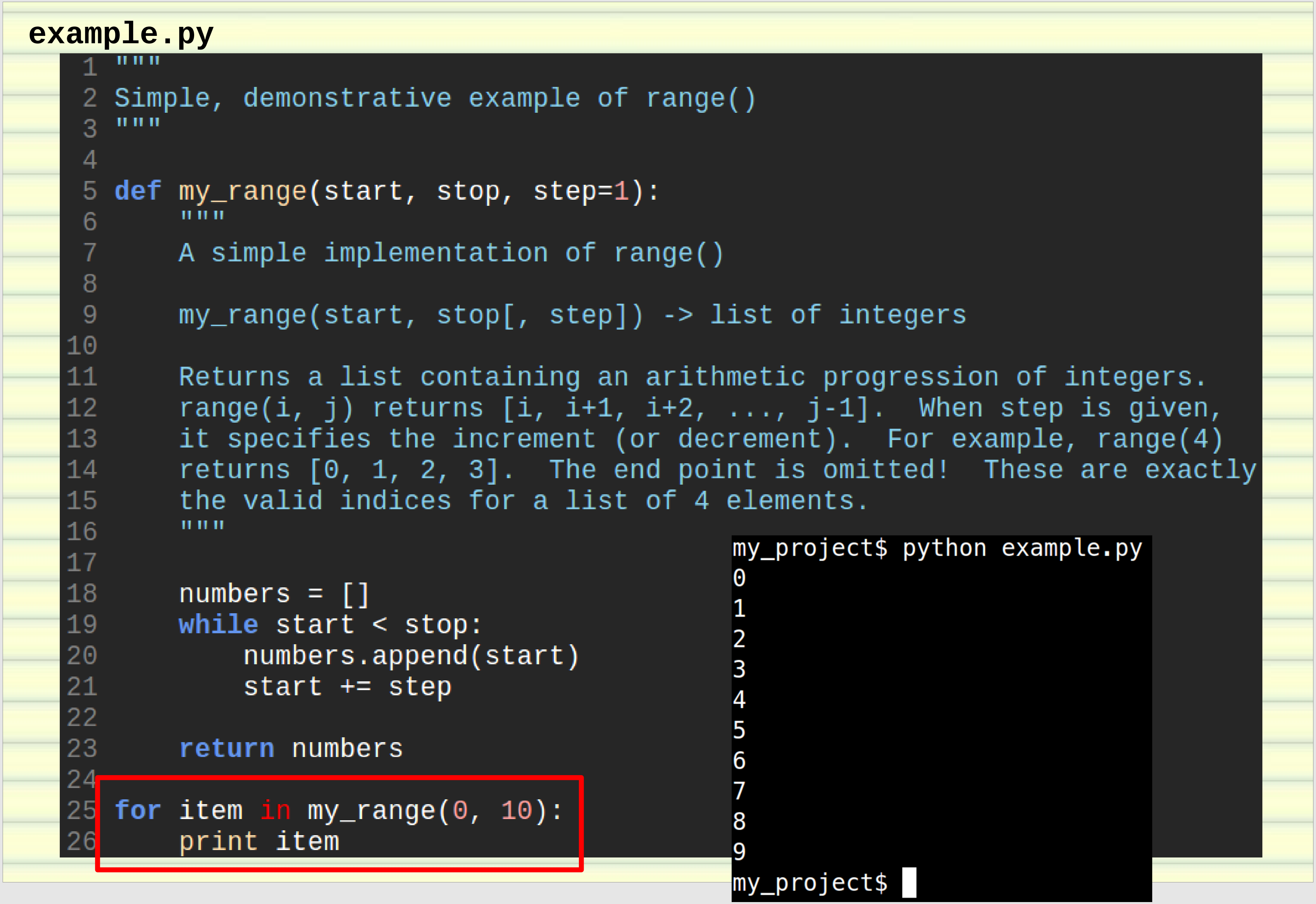
        start += step

    return numbers

for item in my_range(0, 10):
    print item
```

returns a `list`

Using Functions



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    """

    numbers = []
    while start < stop:
        numbers.append(start)
        start += step

    return numbers

for item in my_range(0, 10):
    print item
```

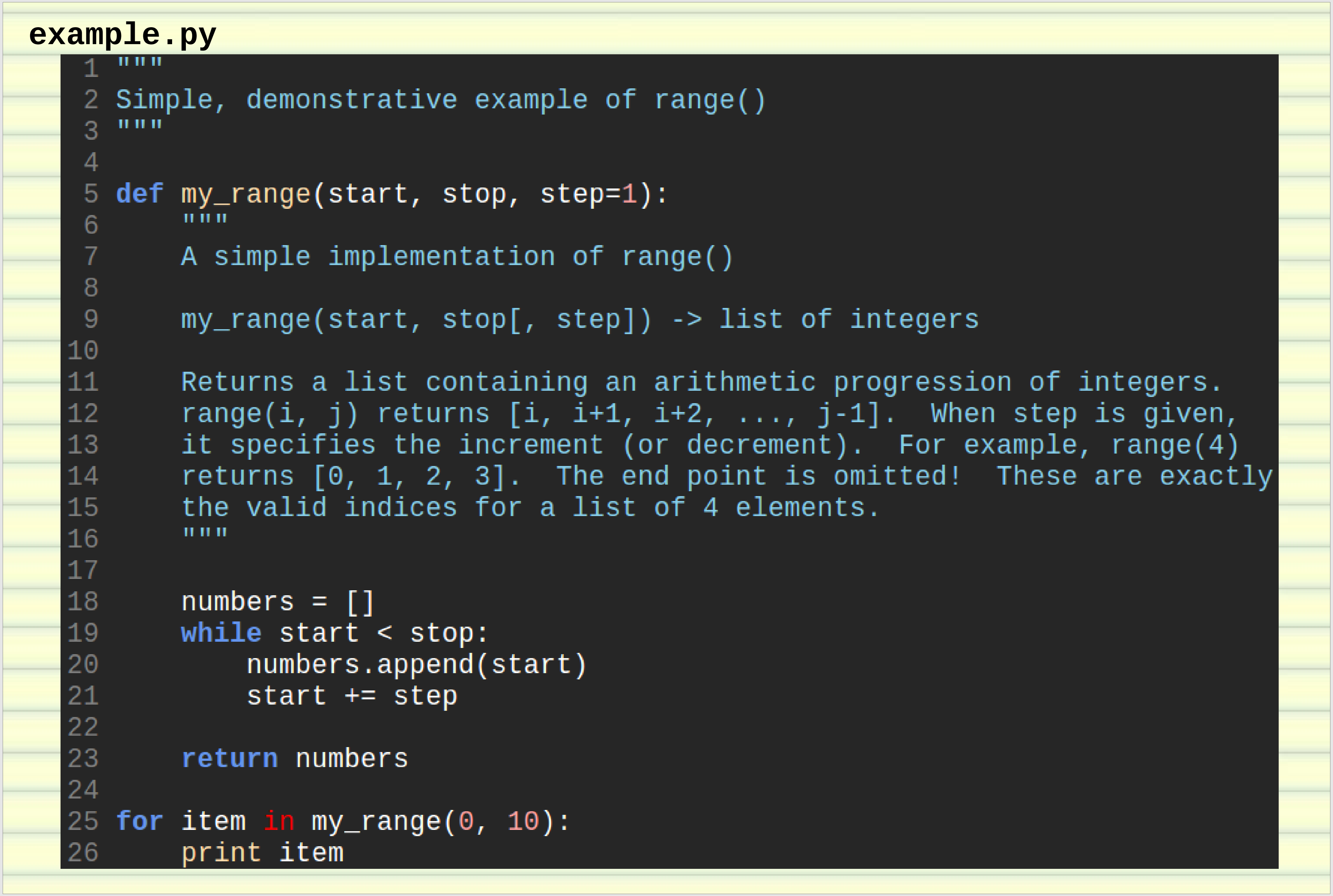
```
my_project$ python example.py
0
1
2
3
4
5
6
7
8
9
my_project$
```

Using Functions -- import

You can reuse useful functions you write in other Python programs using

```
import
```

Using Functions -- import



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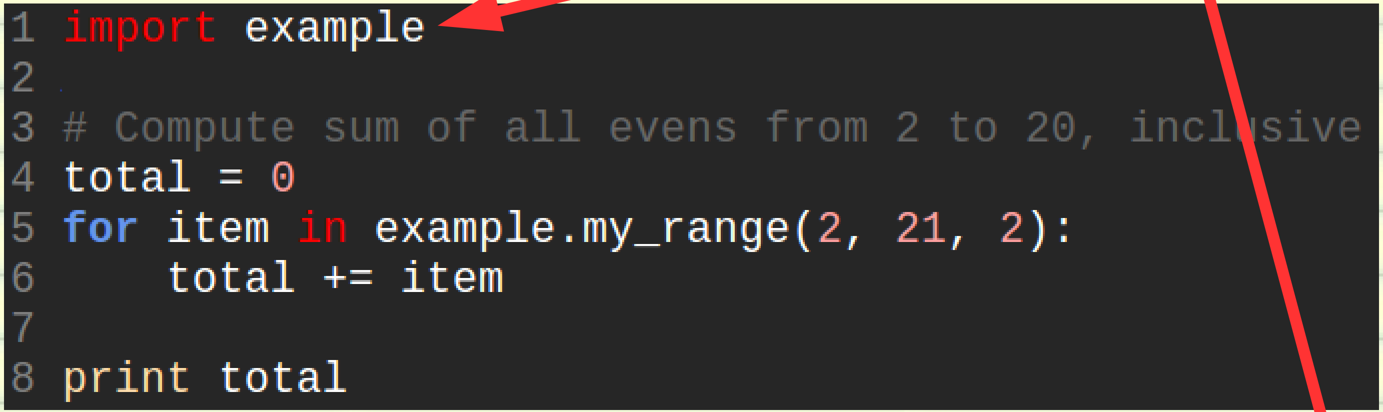
    numbers = []
    while start < stop:
        numbers.append(start)
        start += step

    return numbers

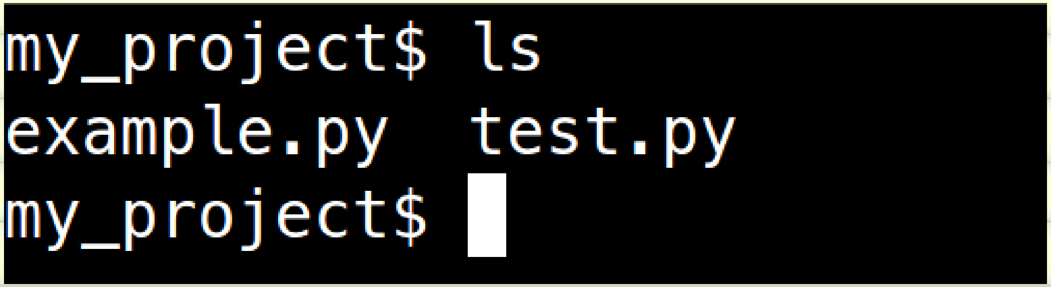
for item in my_range(0, 10):
    print item
```

Using Functions -- import

test.py (in the same directory as example.py)



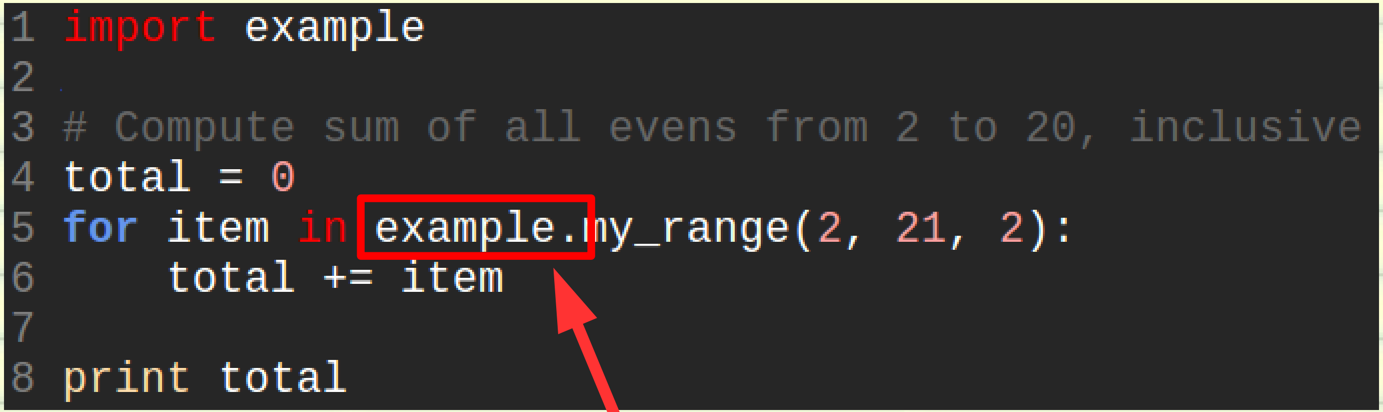
```python
import example

# Compute sum of all evens from 2 to 20, inclusive
total = 0
for item in example.my_range(2, 21, 2):
    total += item

print total
```



```
my_project$ ls
example.py  test.py
my_project$ 
```

Using Functions -- import

test.py   (in the same directory as example.py)

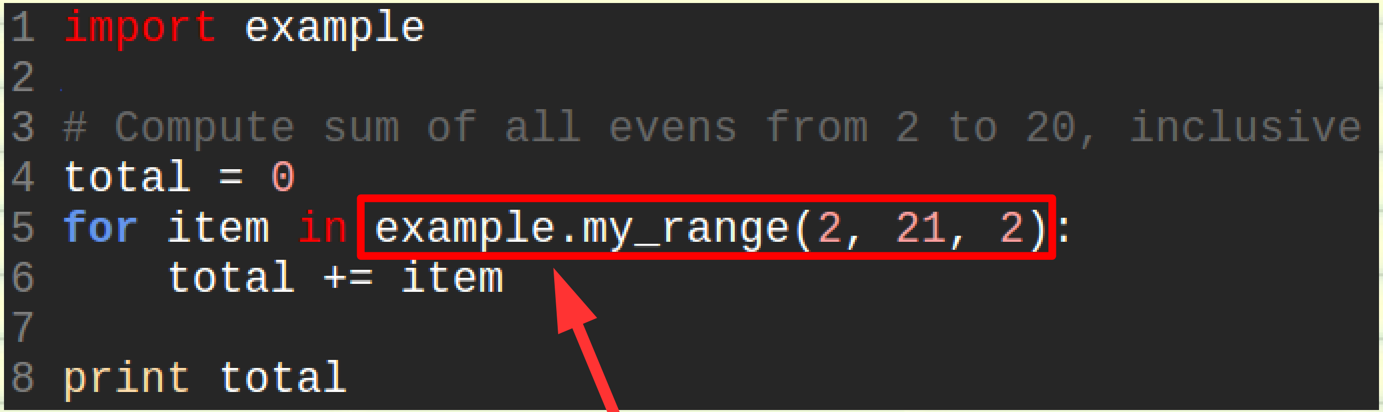


```
import example

# Compute sum of all evens from 2 to 20, inclusive
total = 0
for item in example.my_range(2, 21, 2):
    total += item

print total
```

everything from **example.py** gets loaded into its own ***namespace***

Using Functions -- import

test.py (in the same directory as example.py)

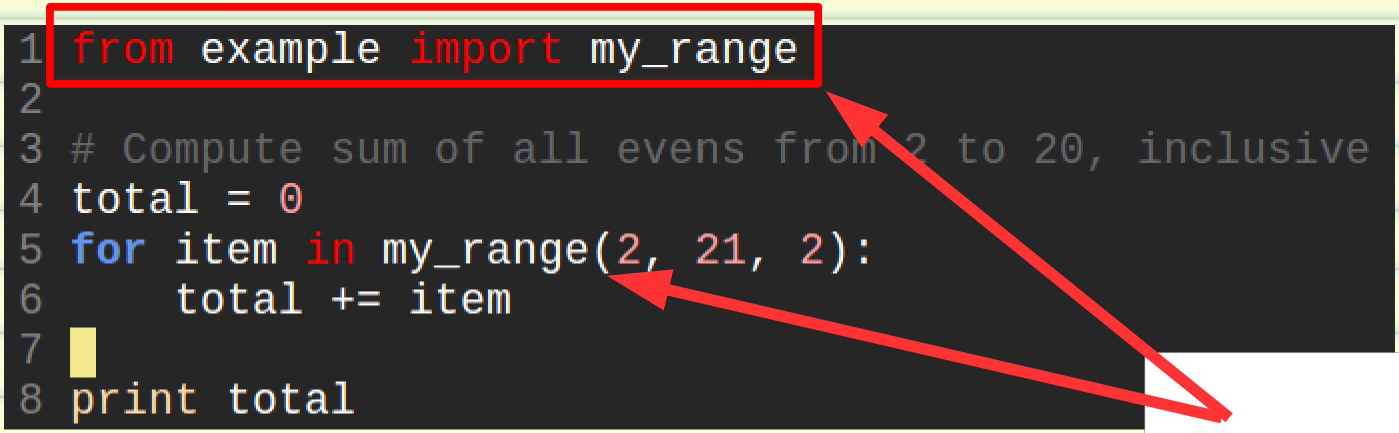


```
import example

# Compute sum of all evens from 2 to 20, inclusive
total = 0
for item in example.my_range(2, 21, 2):
    total += item

print total
```

we access **`my_range()`** from within the **`example`** **namespace** using this notation

Using Functions -- import

test.py (in the same directory as example.py)



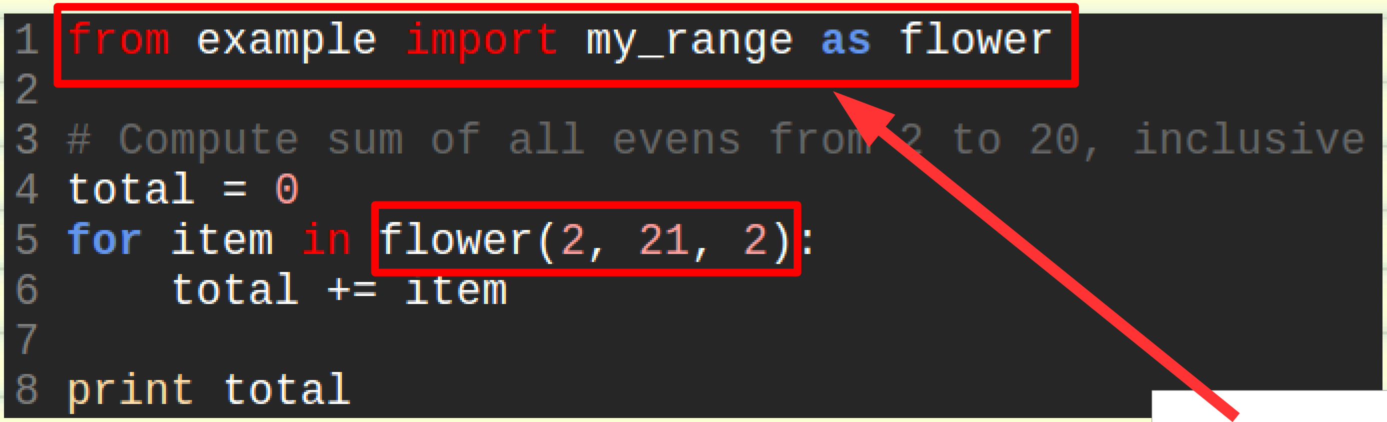
```
from example import my_range

# Compute sum of all evens from 2 to 20, inclusive
total = 0
for item in my_range(2, 21, 2):
    total += item

print total
```

OR

we can import **`my_range`** into the global namespace

Using Functions -- import

test.py (in the same directory as example.py)



```
from example import my_range as flower

# Compute sum of all evens from 2 to 20, inclusive
total = 0
for item in flower(2, 21, 2):
    total += item

print total
```

if **my_range** is already being used in the global namespace

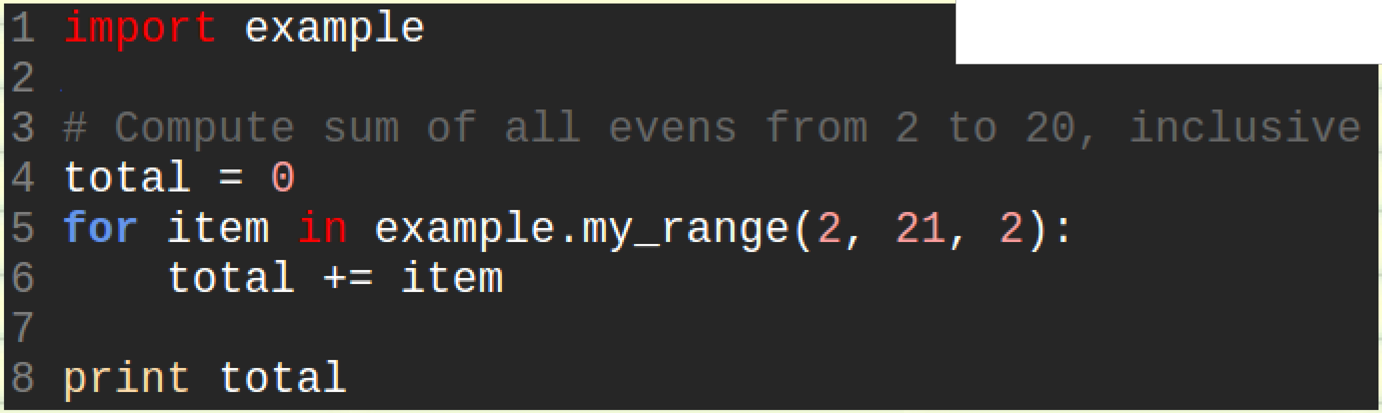
or if we just don't like the name **my_range**

we can import it into the global namespace using a custom name

Using Functions -- import

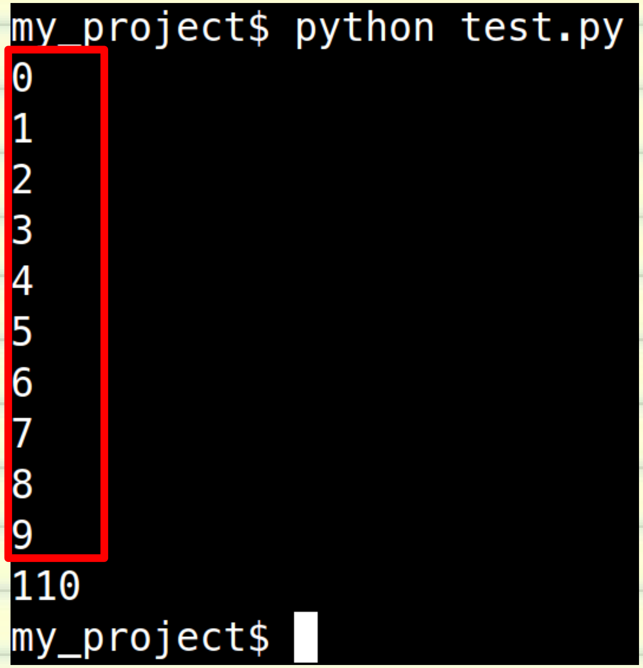
test.py (in the same directory as example.py)

Anyway, so we run this thing.



```
import example

# Compute sum of all evens from 2 to 20, inclusive
total = 0
for item in example.my_range(2, 21, 2):
    total += item

print total
```

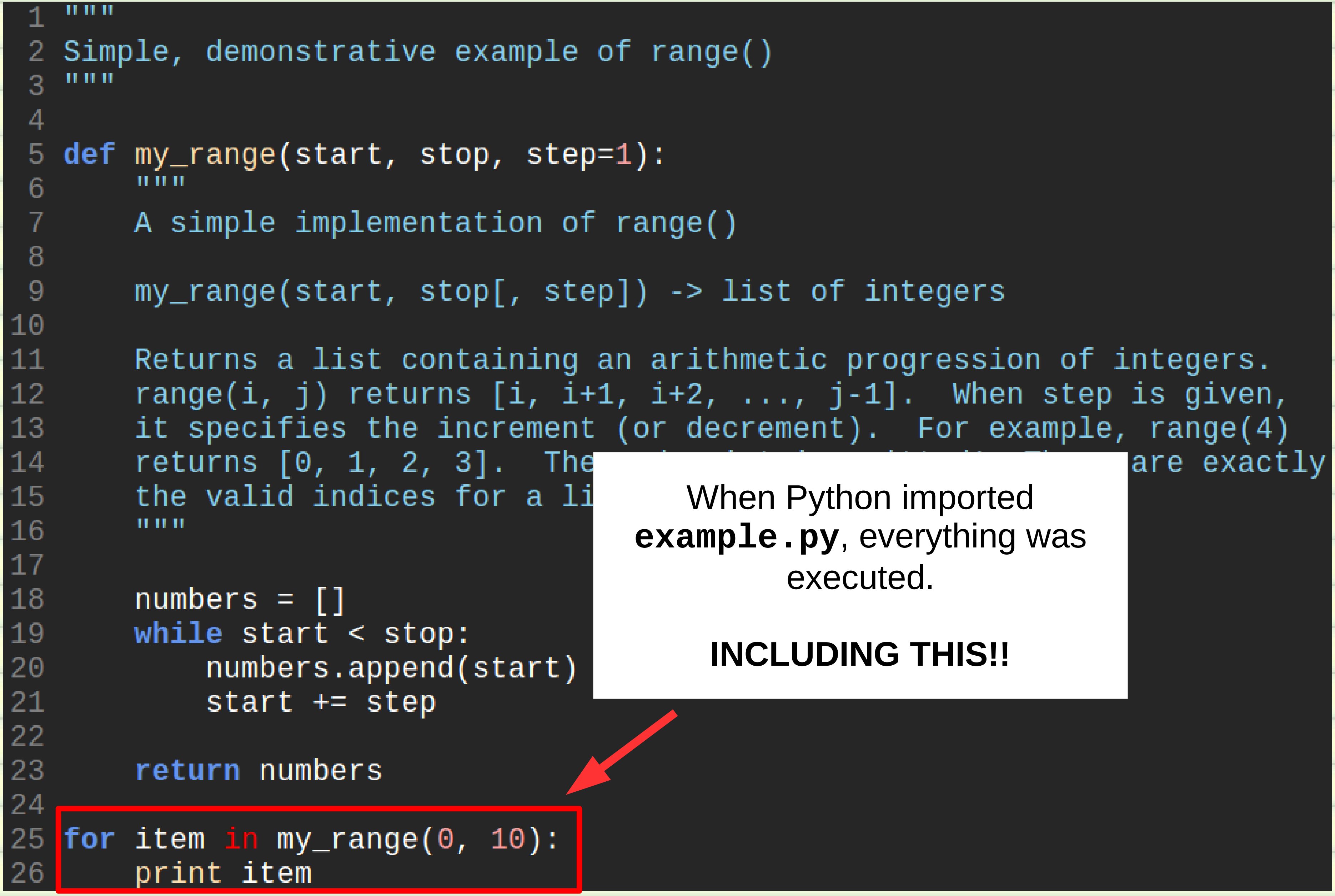
What happened here?!



```
my_project$ python test.py
0
1
2
3
4
5
6
7
8
9
110
my_project$ 
```

Using Functions -- import

example.py



```
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Simple, demonstrative example of range()
"""

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    A simple implementation of range()

    my_range(start, stop[, step]) -> list of integers

    Returns a list containing an arithmetic progression of integers.
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    it specifies the increment (or decrement).  For example, range(4)
    returns [0, 1, 2, 3].  The                              are exactly
    the valid indices for a li
    """

    numbers = []
    while start < stop:
        numbers.append(start)
        start += step

    return numbers

for item in my_range(0, 10):
    print item
```
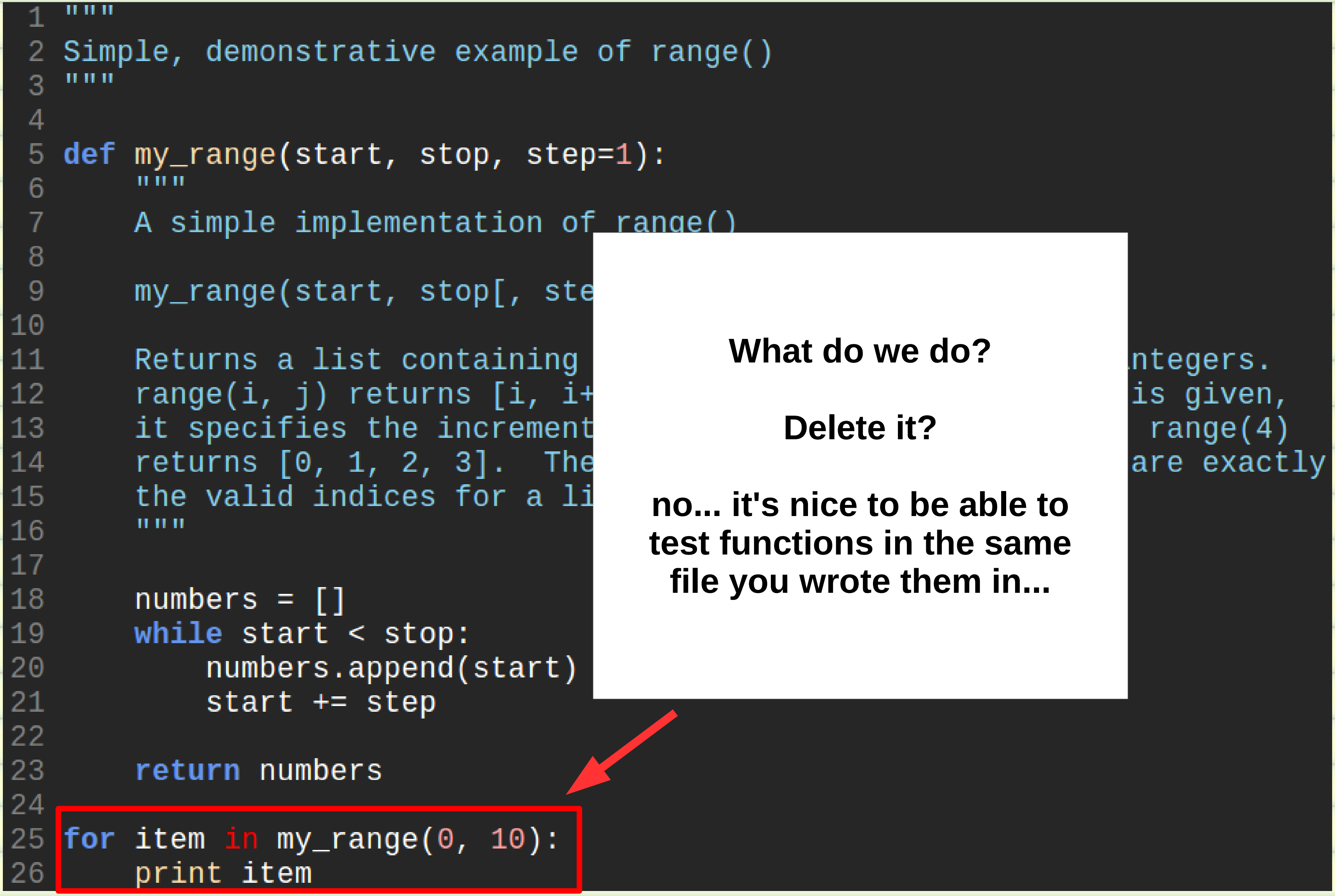

When Python imported **example.py**, everything was executed.

INCLUDING THIS!!

Using Functions -- import

example.py



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    """

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        start += step

    return numbers

for item in my_range(0, 10):
    print item
```

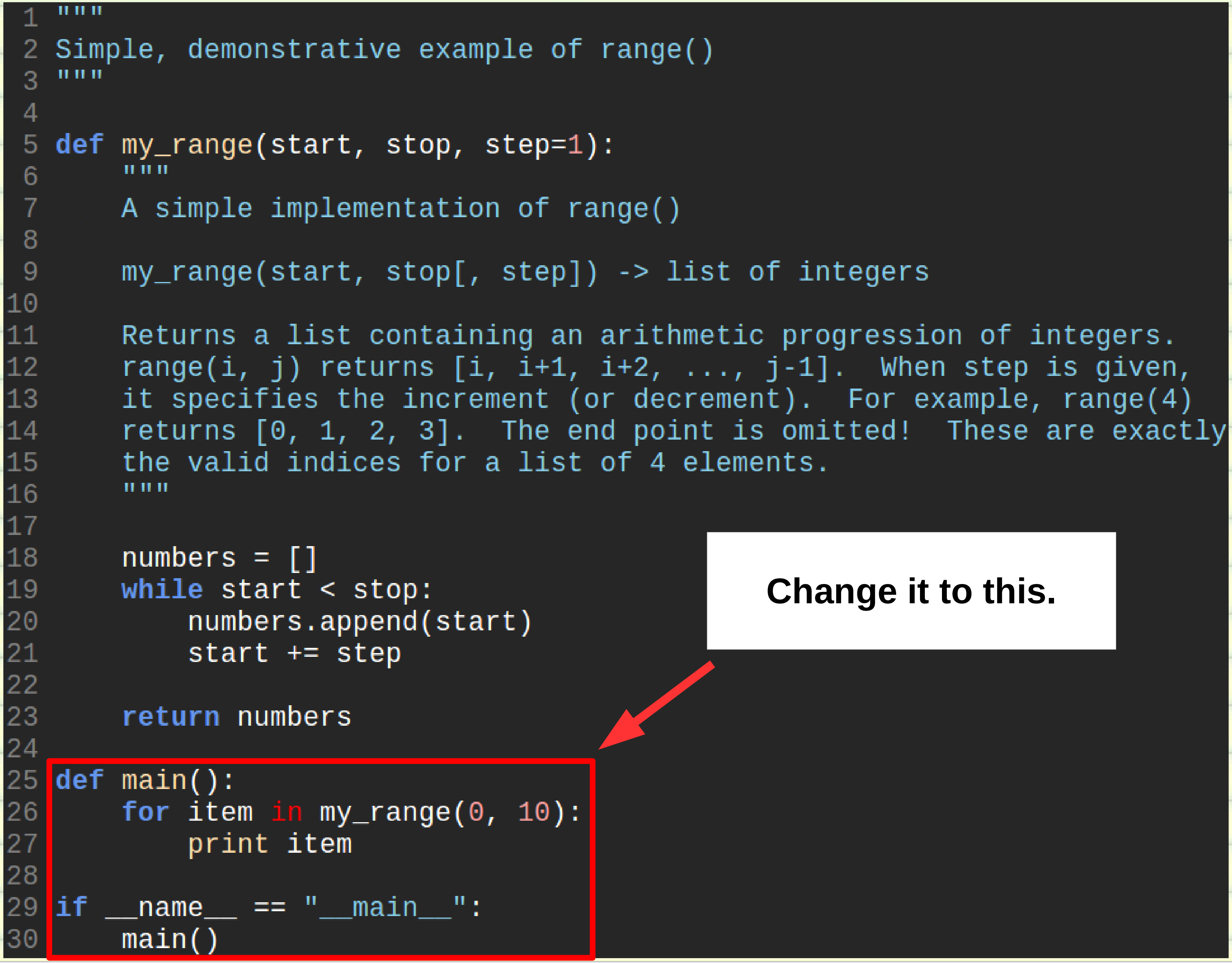
What do we do?

Delete it?

no... it's nice to be able to test functions in the same file you wrote them in...

Using Functions -- import

example.py



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    """

    numbers = []
    while start < stop:
        numbers.append(start)
        start += step

    return numbers

def main():
    for item in my_range(0, 10):
        print item

if __name__ == "__main__":
    main()
```
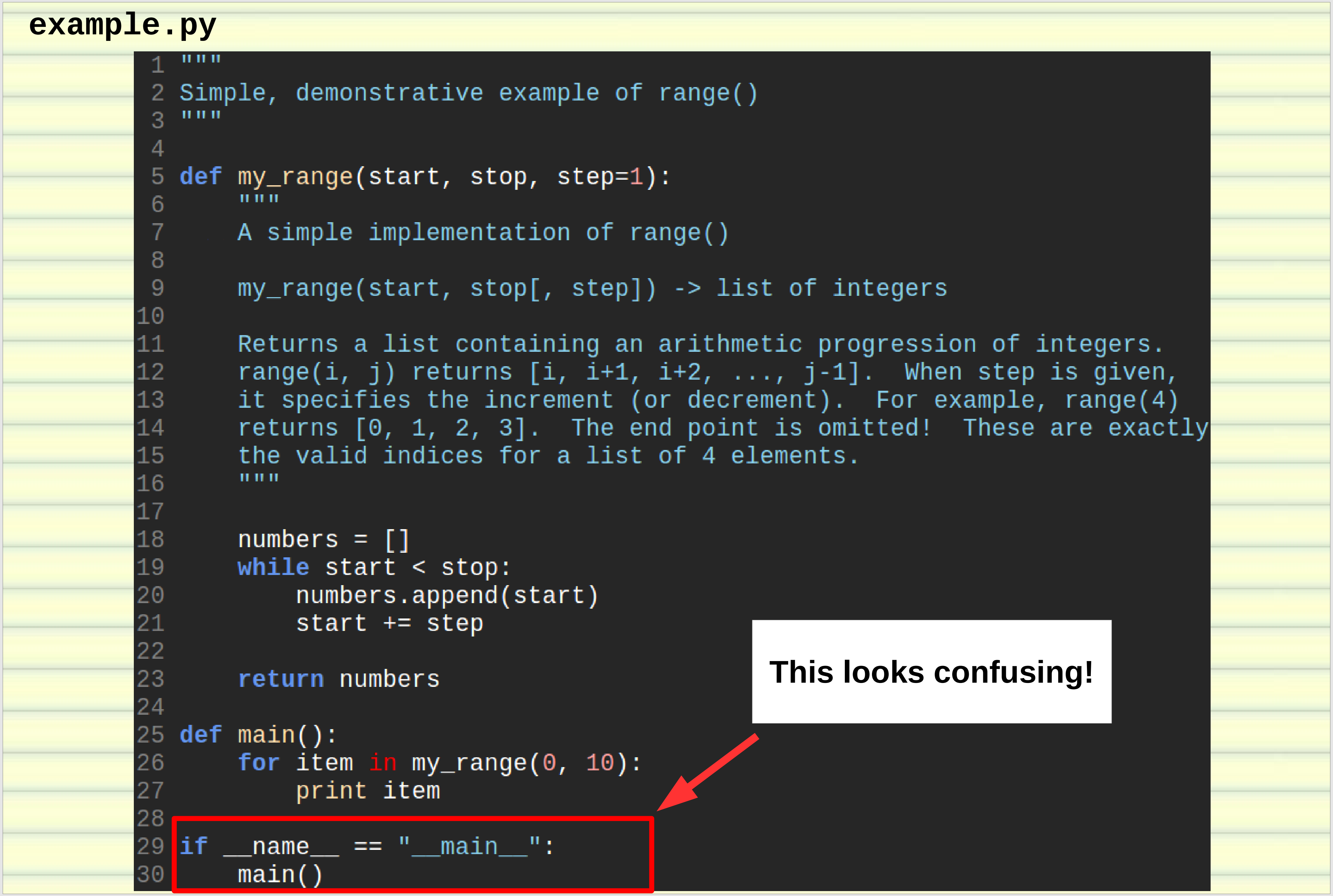

Change it to this.

Using Functions -- import



example.py

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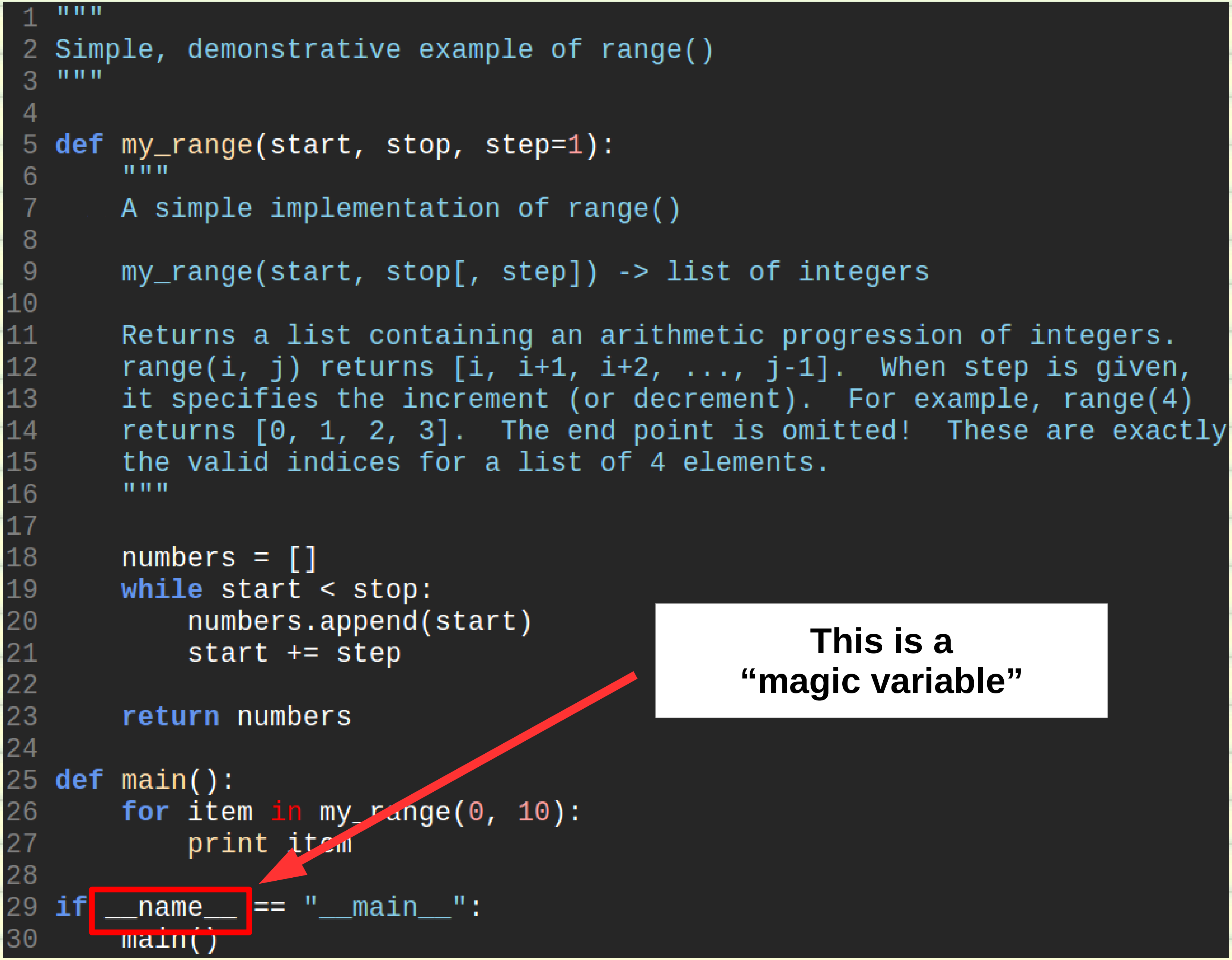
This looks confusing!

Using Functions -- import

example.py



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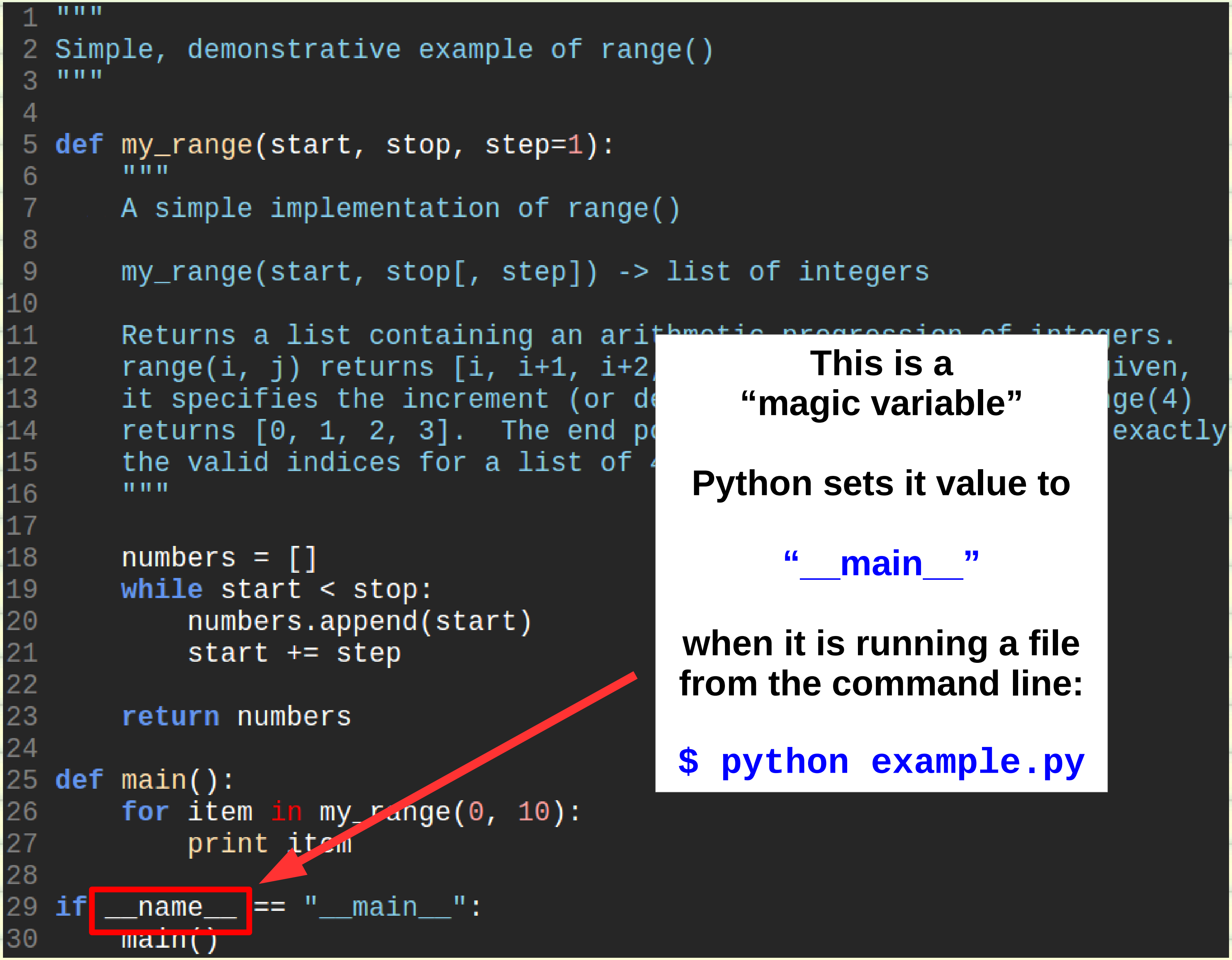
This is a “magic variable”

Using Functions -- import

example.py



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    """

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    return numbers

def main():
    for item in my_range(0, 10):
        print item

if __name__ == "__main__":
    main()
```

This is a "magic variable"

Python sets it value to

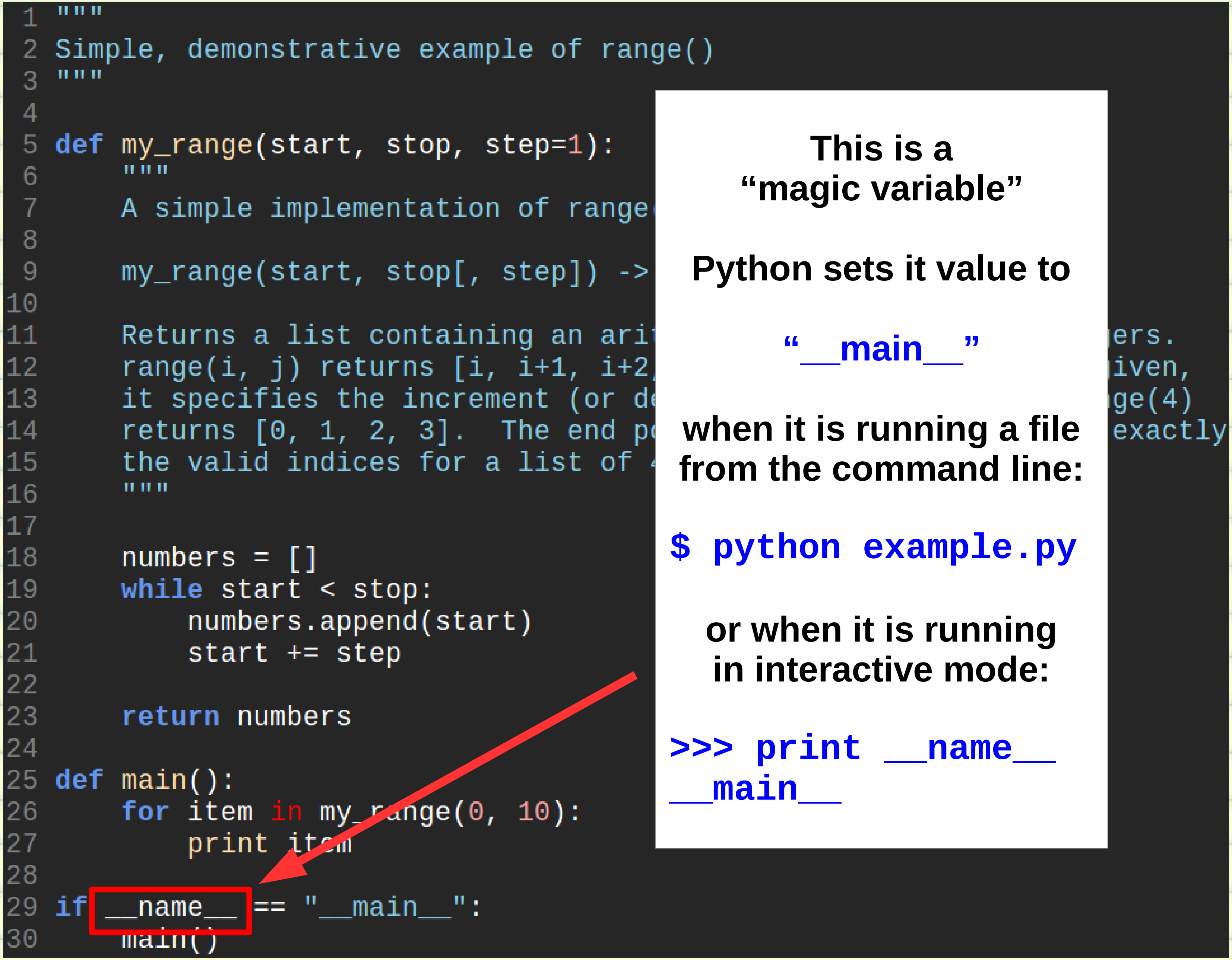
"__main__"

when it is running a file from the command line:

`$ python example.py`

Using Functions -- import

example.py



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```

This is a “magic variable”

Python sets it value to

“__main__”

when it is running a file from the command line:

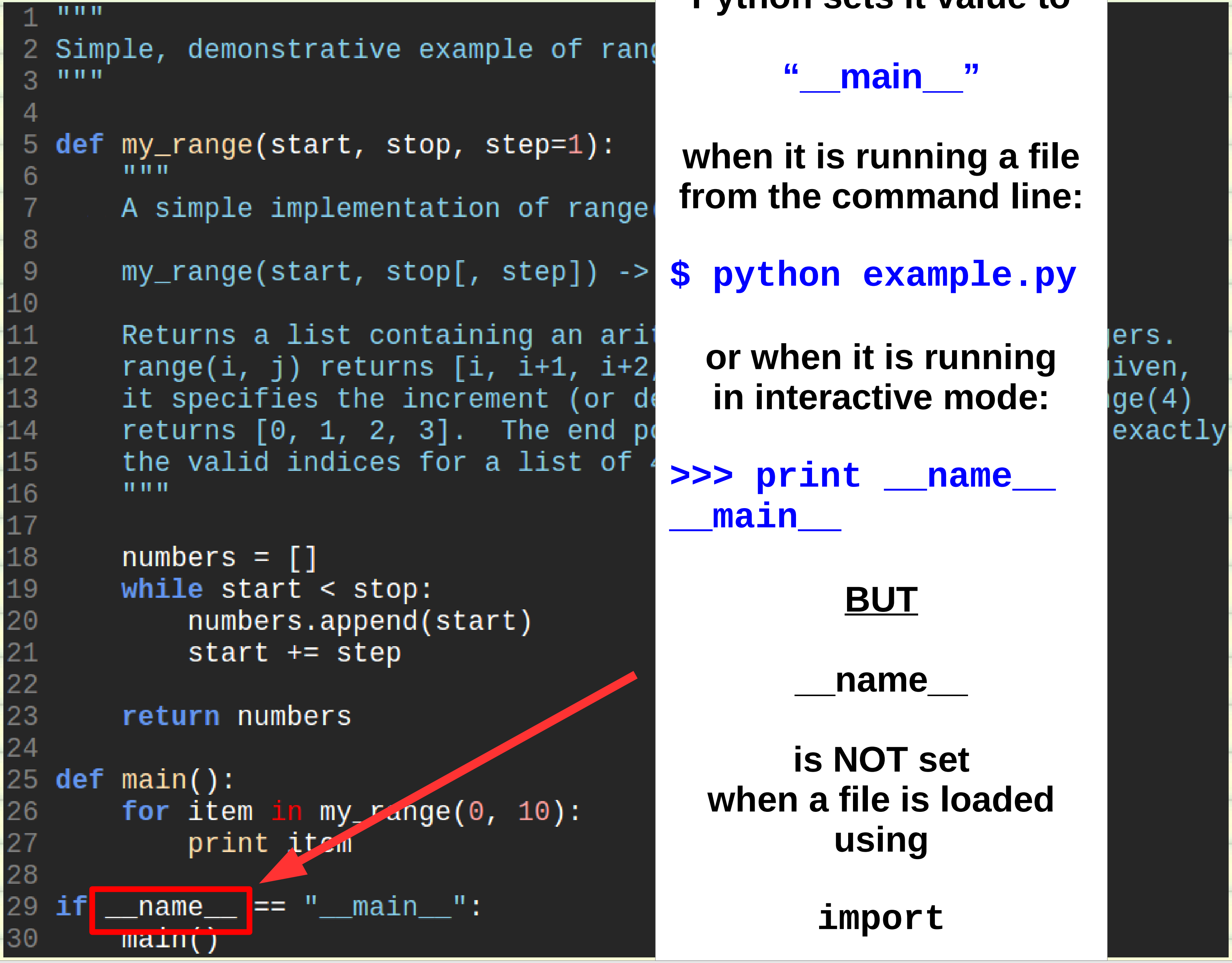
```
$ python example.py
```

or when it is running in interactive mode:

```
>>> print __name__
__main__
```

Using Functions -- import

example.py



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if __name__ == "__main__":
    main()
```

This is a "magic variable"

Python sets it value to

"__main__"

when it is running a file from the command line:

```
$ python example.py
```

or when it is running in interactive mode:

```
>>> print __name__
__main__
```

BUT

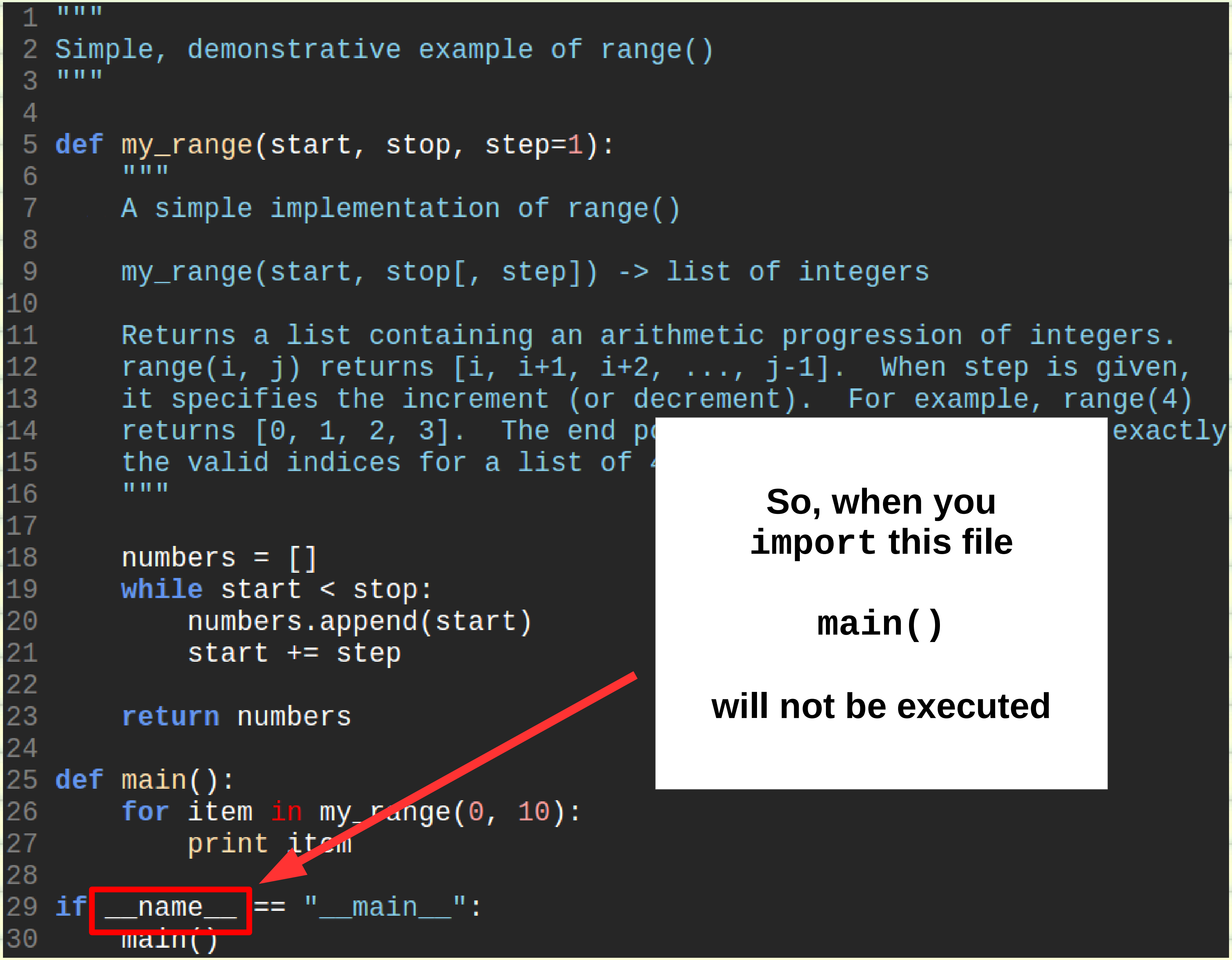
__name__

is NOT set when a file is loaded using

`import`

Using Functions -- import

example.py



```
"""
Simple, demonstrative example of range()
"""

def my_range(start, stop, step=1):
    """
    A simple implementation of range()

    my_range(start, stop[, step]) -> list of integers

    Returns a list containing an arithmetic progression of integers.
    range(i, j) returns [i, i+1, i+2, ..., j-1].  When step is given,
    it specifies the increment (or decrement).  For example, range(4)
    returns [0, 1, 2, 3].  The end po                          exactly
    the valid indices for a list of 4
    """

    numbers = []
    while start < stop:
        numbers.append(start)
        start += step

    return numbers

def main():
    for item in my_range(0, 10):
        print item

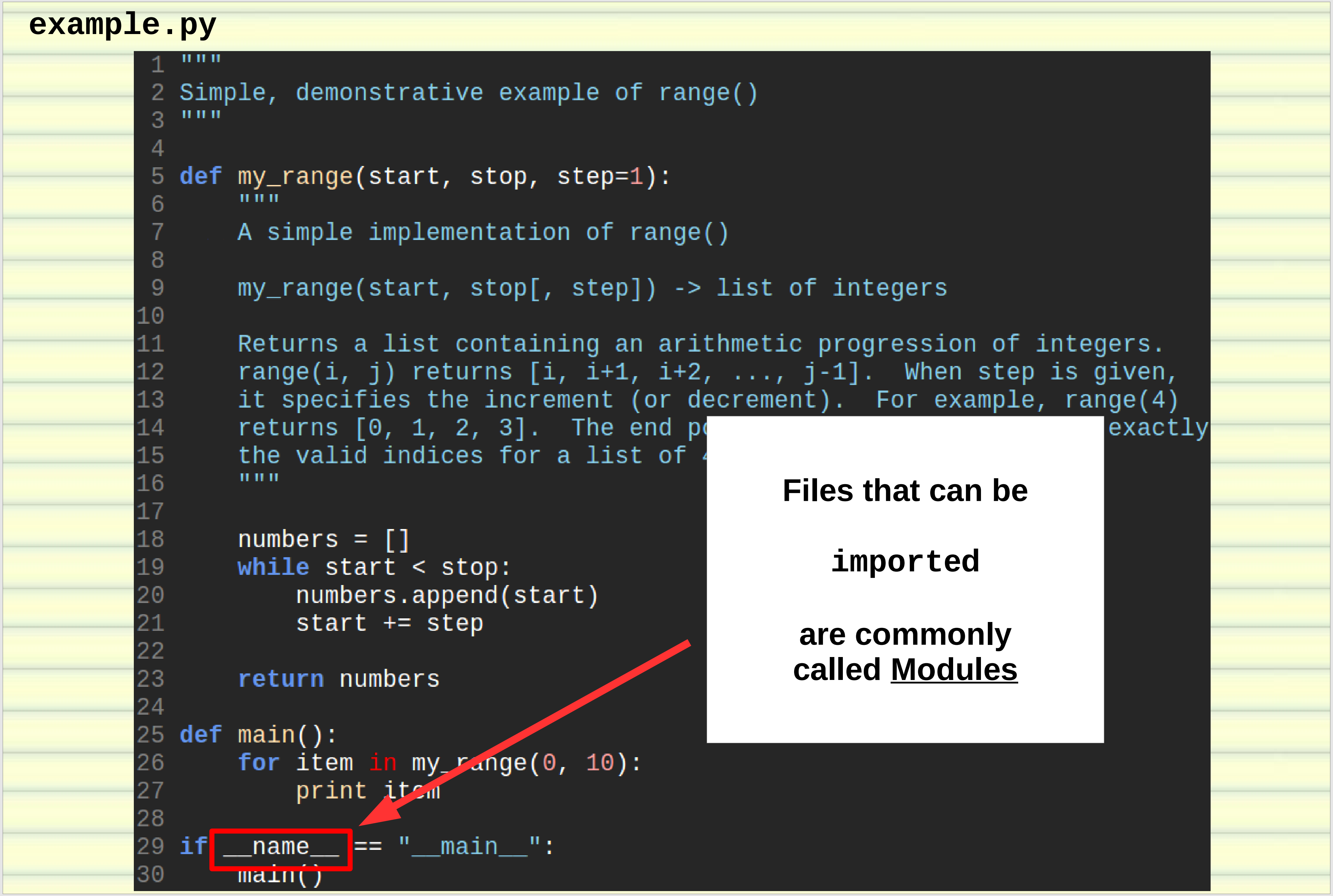
if __name__ == "__main__":
    main()
```

So, when you `import` this file

`main()`

will not be executed

Using Functions -- import



example.py

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if __name__ == "__main__":
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```

Files that can be

`imported`

are commonly called <u>Modules</u>

Using Functions -- import

Questions?