CS101 - Functions with Parameters and Return Values

Lecture 4

School of Computing
KAIST

Roadmap

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Last week we learned

- Objects
- Types
- Variables
- Methods
- Tuples

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- Types
- Variables
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- Tuples

This week we will learn

- Functions with parameters and return values

Functions

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The name **function** comes from mathematics. A function is a mapping from one set to another set:

$$f : \mathbb{R} \rightarrow \mathbb{R}$$
$$x \rightarrow \pi \times \frac{x}{180.0}$$

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In Python, functions also take **arguments** and return a **result**:

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def to_radians(deg):
  return (deg / 180.0) * math.pi
```

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In Python, functions also take **arguments** and return a **result**:

```
def to_radians(deg):
  return (deg / 180.0) * math.pi
```

```
>>> a = to_radians(90)
>>> print(a)
1.5707963267948966
```

Useful functions

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Python comes with many built-in functions.

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Type conversion functions convert from one type to another type:

```
>>> int("32")
32
>>> int(17.3)
17
>>> float(17)
17.0
>>> float("3.1415")
3.1415
>>> str(17) + " " + str(3.1415)
'17 3.1415'
>>> complex(17)
(17 + 0j)
```

Math functions

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To use math functions, we need to tell Python that we want to use the **math** module:

```
import math
degrees = 45
radians = degrees / 360.0 * 2 * math.pi
print(math.sin(radians))
print(math.sqrt(2) / 2)
```

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```

When using math functions often, we can use shorter names:

```
import math
sin = math.sin
pi = math.pi
radians = degrees / 360.0 * 2 * pi
print(sin(radians))
```

Defining functions with parameters

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The function definition uses **names** for the arguments of the function. These names are called **parameters**:

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def compute_interest(amount, rate, years):
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Inside the function, the parameter is just a name:

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  value = amount * (1 + rate/100.0) ** years
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When we have computed the result of the function, we **return** it from the function. The function ends at this point, and the result object is given back:

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return value
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We can now call the function with different argument values:

```
>>> s1 = compute_interest(200, 7, 1)
>>> s2 = compute_interest(500, 1, 20)
```

Converting to black-and-white

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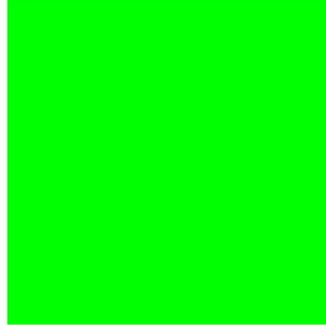
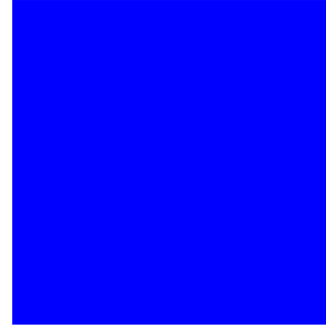


$(0, 0, 255)$



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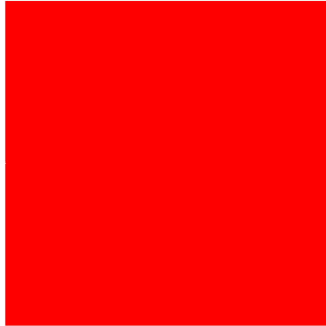

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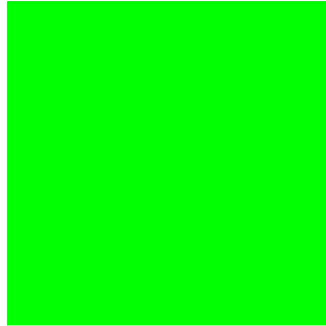

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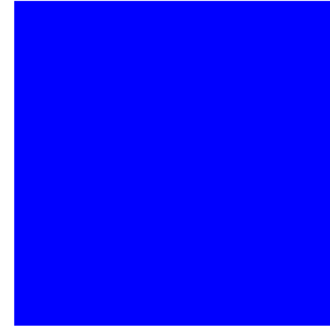

A good formula is:

```
def luma(p):
  r, g, b = p
  return int(0.213 * r + 0.715 * g + 0.072 * b)
```

More than one return in a function

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Compute the absolute value (like builtin function **abs**):

```
def absolute(x):
  if x < 0:
    return -x
  else:
    return x
```

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  return x
```

But not like this:

```
def absolute(x):
  if x < 0:
    return -x
  if x > 0:
    return x
```

Returning a boolean

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A function that tests a condition and returns either **True** or **False** is often called a **predicate**:

```
# is integer a divisible by b?
def is_divisible(a, b):
  if a % b == 0:
    return True
  else:
    return False
```

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  print('x is divisible by y')
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```
if is_divisible(x, y):
  print('x is divisible by y')
```

Easier:

```
def is_divisible(a, b):
  return a % b == 0
```

Functions without results

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We have seen many functions that do not use **return**:

```
def turn_right():
  for i in range(3):
    hubo.turn_left()
```

Functions without results

We have seen many functions that do not use **return**:

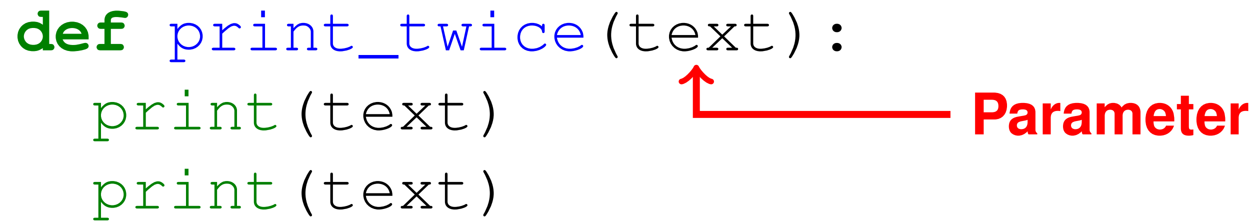
```
def turn_right():
  for i in range(3):
    hubo.turn_left()
```

In fact, a function that does not call **return** automatically returns **None**:

```
>>> s = turn_right()
>>> print(s)
None
```

Calling functions

When a function is called, the **arguments** of the function call are assigned to the **parameters**:



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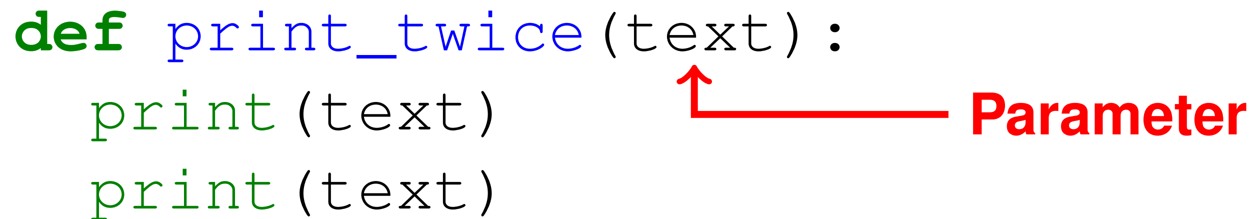

The number of arguments in the function call must be the same as the number of parameters.

```
>>> print_twice("I love CS101")
I love CS101
I love CS101
>>> print_twice(math.pi)
3.14159265359
3.14159265359
```

Hubo's family

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We can now write a `turn_right` function that will work for any robot, not just for Hubo:

```
def turn_right(robot):
  for i in range(3):
    robot.turn_left()

ami = Robot("yellow")
hubo = Robot("blue")
turn_right(ami)
turn_right(hubo)
```

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```
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  for i in range(3):
    robot.turn_left()

ami = Robot("yellow")
hubo = Robot("blue")
turn_right(ami)
turn_right(hubo)
```

Remember: A **parameter** is a **name** for an object. The name can only be used **inside** the function.

Harvesting again

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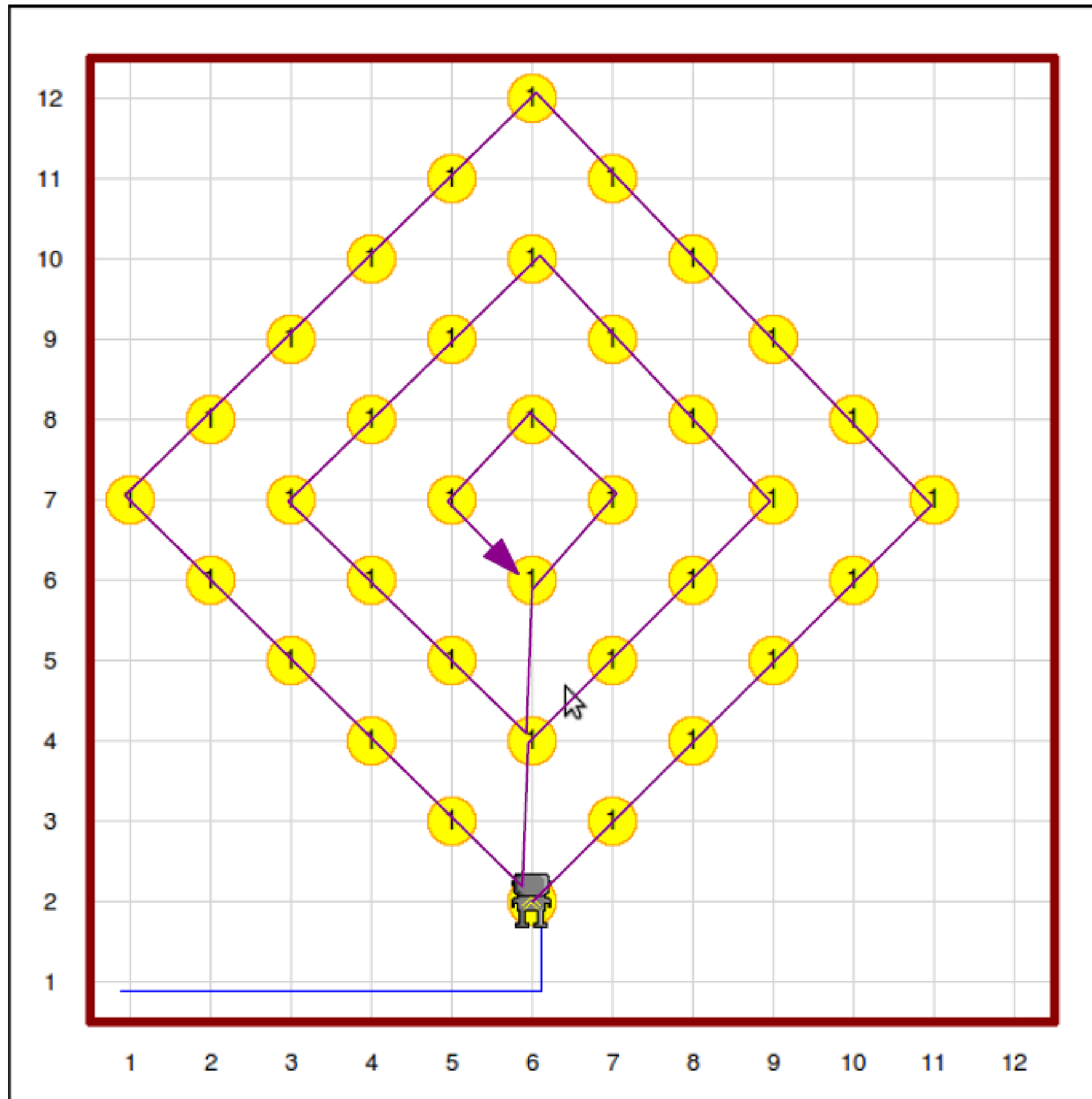

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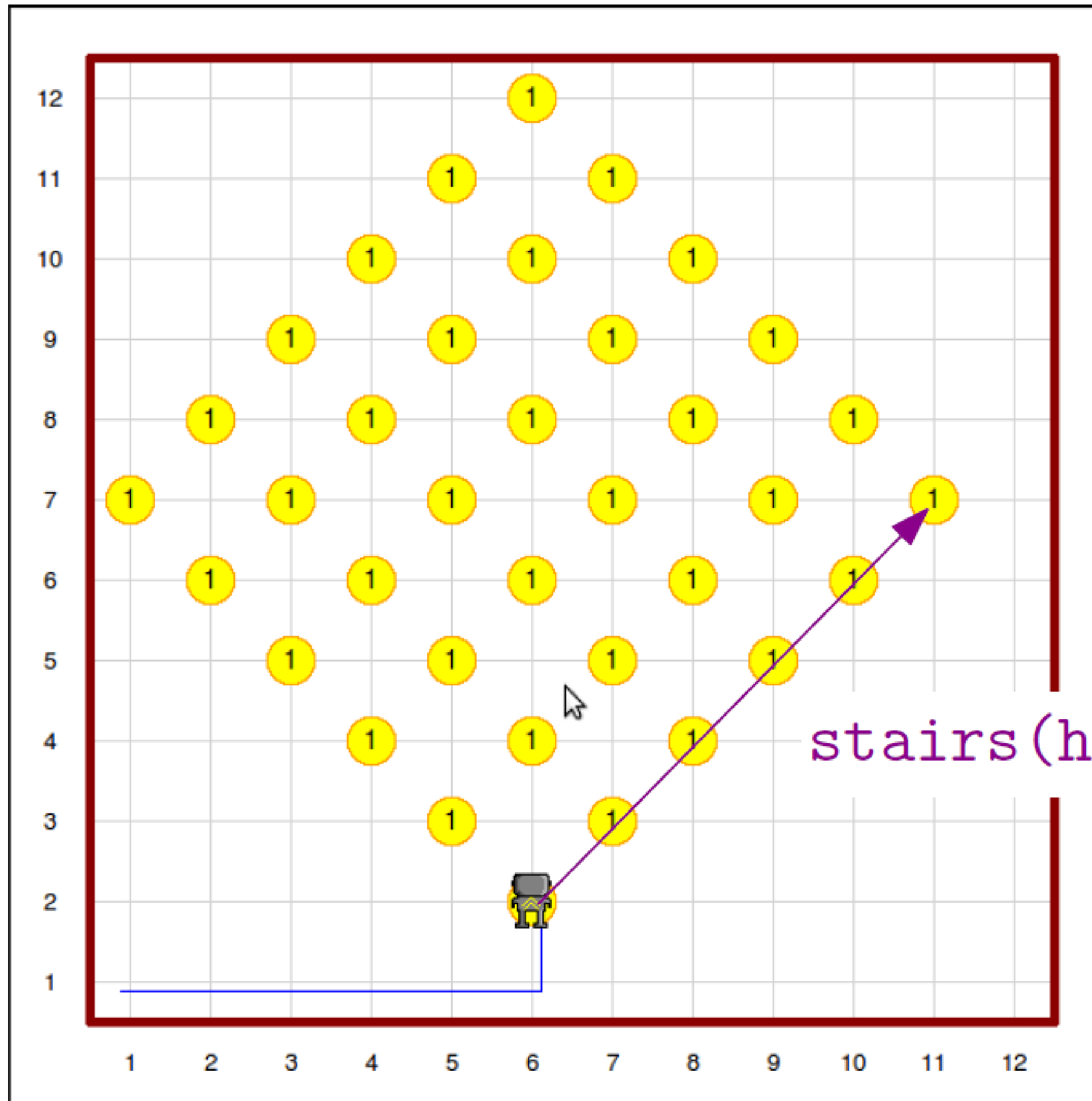

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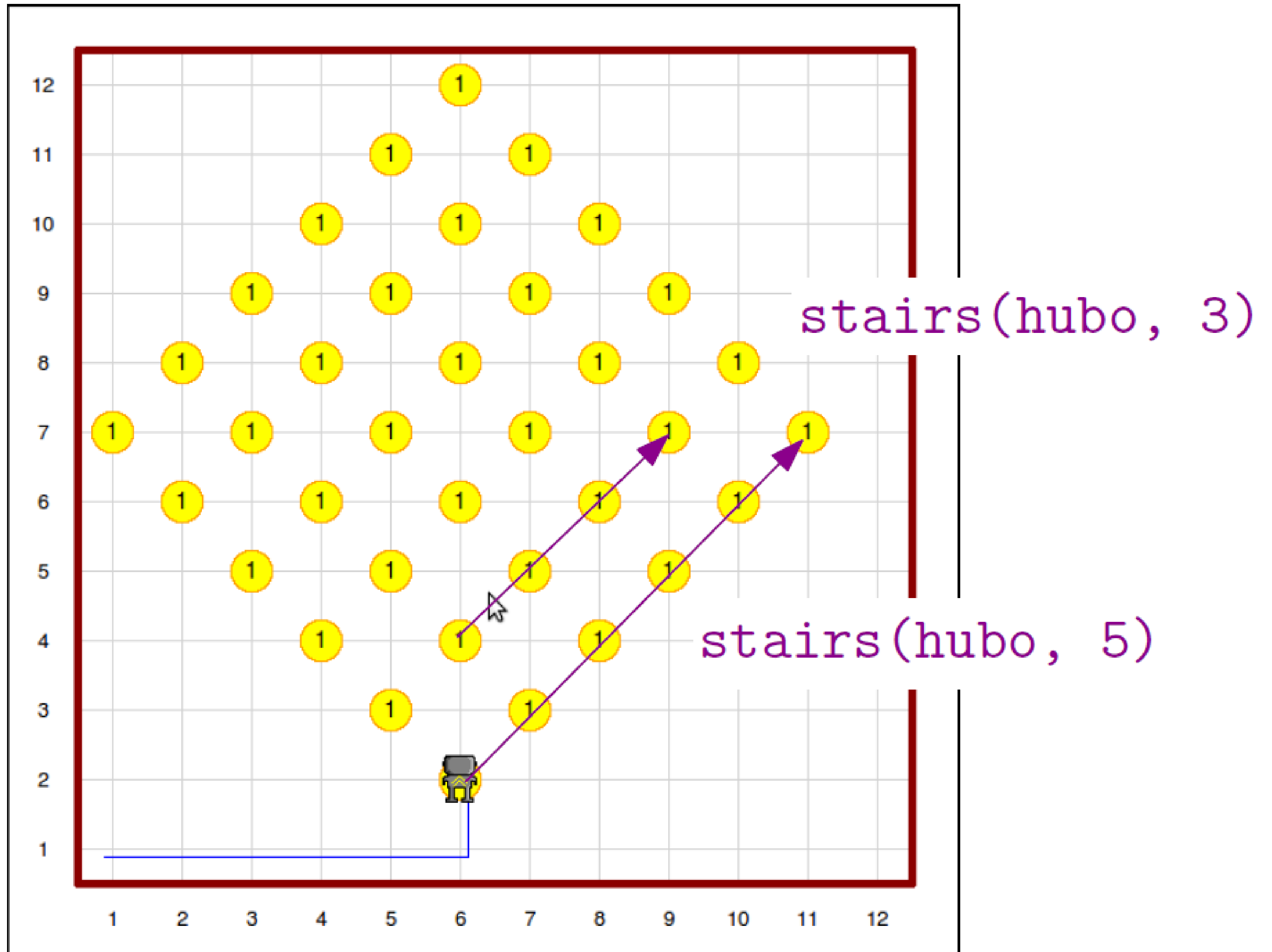

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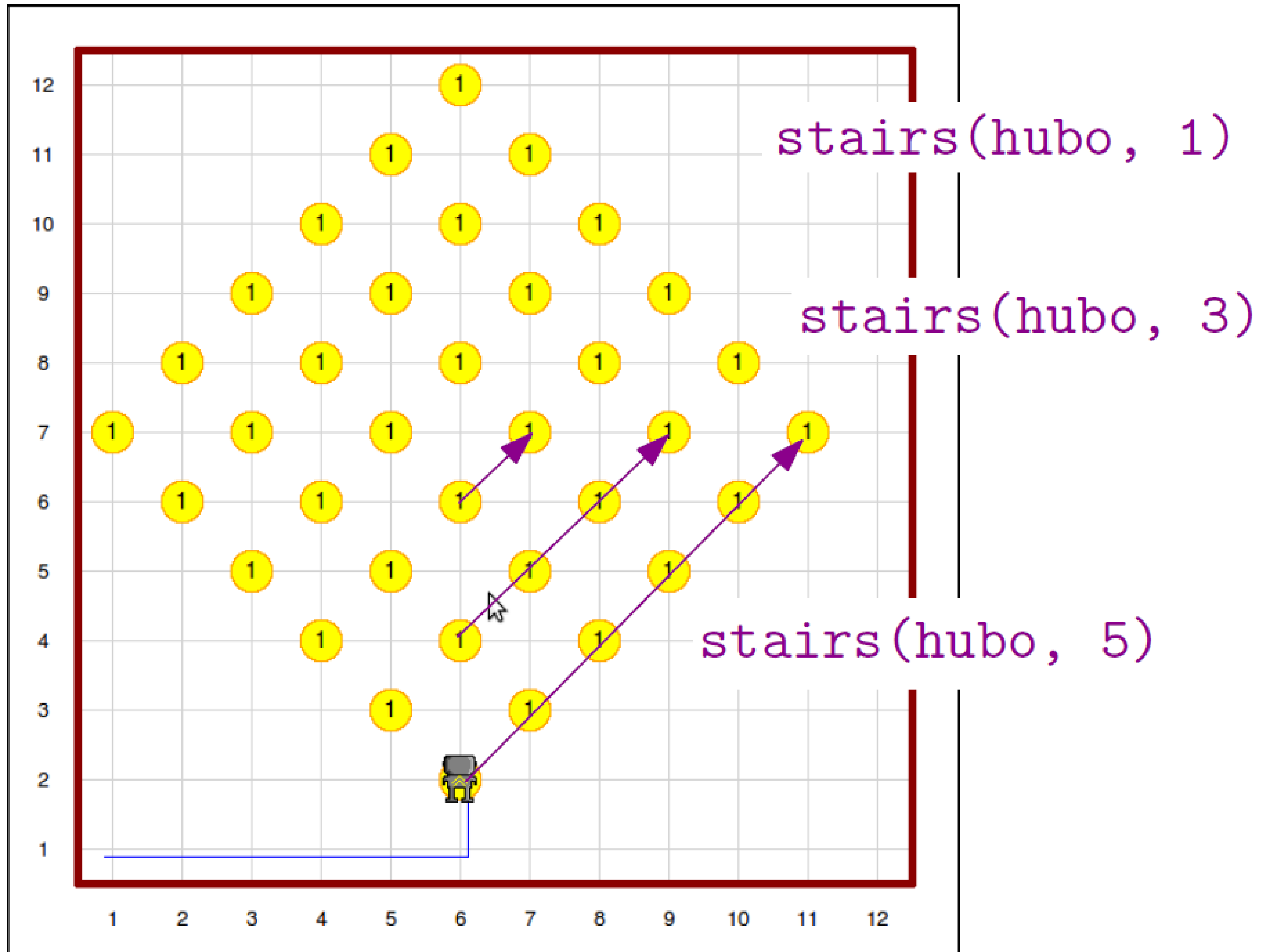

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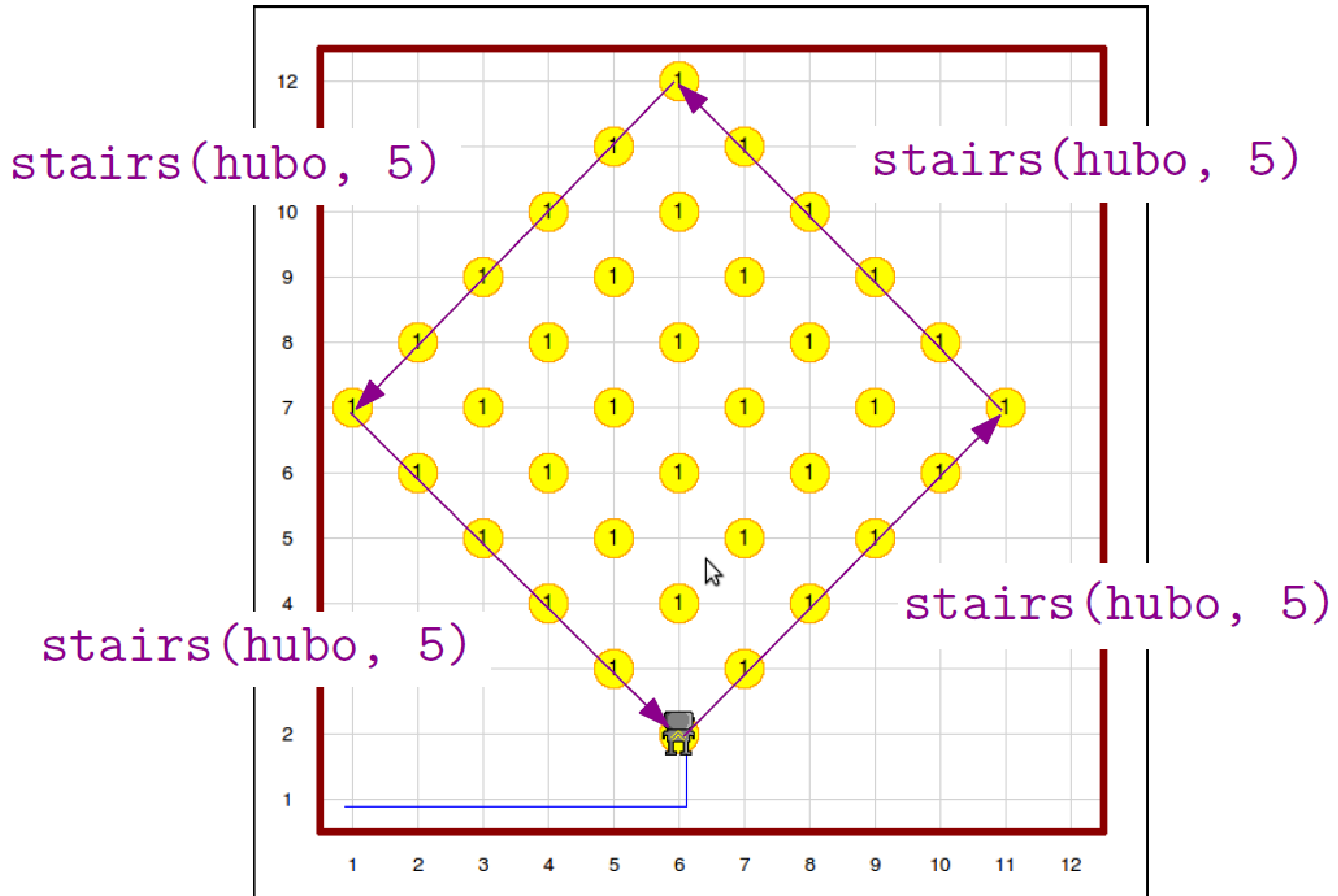

Harvesting again

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```
def stairs(robot, n):
  for i in range(n):
    robot.pick_beeper()
    robot.move()
    turn_right(robot)
    robot.move()
    robot.turn_left()

def diamond(robot, n):
  for i in range(4):
    stairs(robot, n)
    robot.turn_left()
```

```
def harvest_all(robot):
  for i in range(3):
    n = 5 - 2 * i
    diamond(robot, n)
    robot.move()
    robot.move()
```

Converting to black and white, again

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```
white = (255, 255, 255)
black = (0, 0, 0)

def blackwhite(img, threshold):
  w, h = img.size()
  for y in range(h):
    for x in range(w):
      v = luma(img.get(x, y))
      if v > threshold:
        img.set(x, y, white)
      else:
        img.set(x, y, black)

pict = load_picture("../photos/yuna1.jpg")
blackwhite(pict, 100)
pict.show()
```

Returning more than one value

A function can only return one value.

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But this value can be a tuple, and functions can return arbitrarily many values by returning them as a tuple:

```
def student():
    name = "Hong, Gildong"
    id = 20101234
    return name, id
```

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But this value can be a tuple, and functions can return arbitrarily many values by returning them as a tuple:

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def student():
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  return name, id
```

Often function results are unpacked immediately:

```
name, id = student()
```

Keyboard input

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The **input** function prints a message and waits for the user to enter a string on the keyboard. When the user presses the Enter key, the whole string is returned:

```
name = input("What is your name? ")
print("Welcome to CS101, " + name)
```

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name = input("What is your name? ")
print("Welcome to CS101, " + name)
```

If we need a number, we should convert the string:

```
raw_n = input("Enter a positive integer> ")
n = int(raw_n)
for i in range(n):
  print("*" * i)
```