

Introduction to Programming

CS101

Fall 2011

Lecture #4



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

$$f : \mathbb{R} \rightarrow \mathbb{R}$$

$$x \mapsto \pi \times \frac{x}{180.0}$$



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

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



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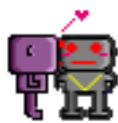
In Python, functions also take **arguments** and return a **result**:

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

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

```
>>> print a
```

```
1.5707963267948966
```



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)
```



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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print math.sin(radians)
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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

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

```
def compute_interest(amount, rate, years):
```



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Inside the function, the parameter is just a name:

```
    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:

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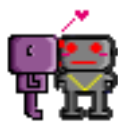
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```
    return value
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We can now call the function with different argument values:

```
>>> s1 = compute_interest(200, 7, 1)
```

```
>>> s2 = compute_interest(500, 1, 20)
```



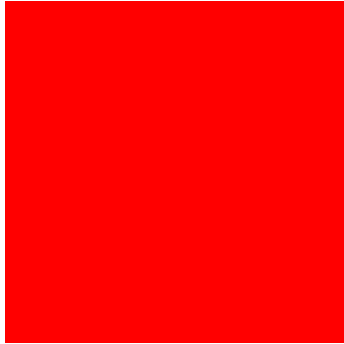
Converting to black-and-white

What is the light intensity (**luminance**) of pixel (r, g, b) ?

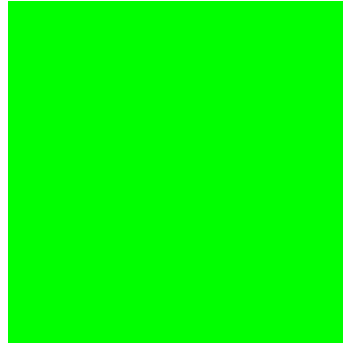


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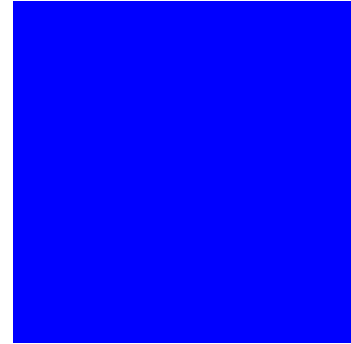
$(255, 0, 0)$



$(0, 255, 0)$



$(0, 0, 255)$



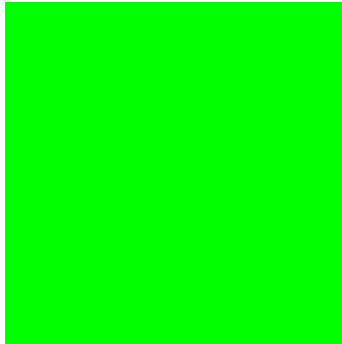


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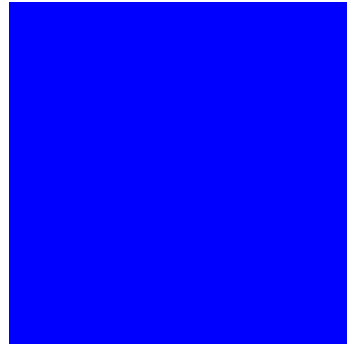
$(255, 0, 0)$



$(0, 255, 0)$



$(0, 0, 255)$



A good formula is:

```
def luminance(p):  
    r, g, b = p  
    return int(0.299 * r + 0.587 * g + 0.114 * b)
```




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

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



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The same function can be written like this:

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

But not like this:

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



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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A predicate (function) can be used directly in an **if** or **while** statement:

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



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is integer a divisible by b?

```
def is_divisible(a, b):
```

```
    if a % b == 0:
```

```
        return True
```

```
    else:
```

```
        return False
```

Easier:

```
def is_divisible(a, b):
```

```
    return a % b == 0
```

A predicate (function) can be used directly in an **if** or **while** statement:

```
if is_divisible(x, y):
```

```
    print 'x is divisible by y'
```



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

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

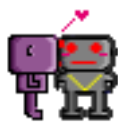


We have seen many functions that do not use **return**:

```
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
```

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

```
def print_twice(text):
```

```
    print text
```

```
    print text
```



Parameter



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

```
def print_twice(text):  
    print text  
    print text
```

Parameter

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
```



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)
```

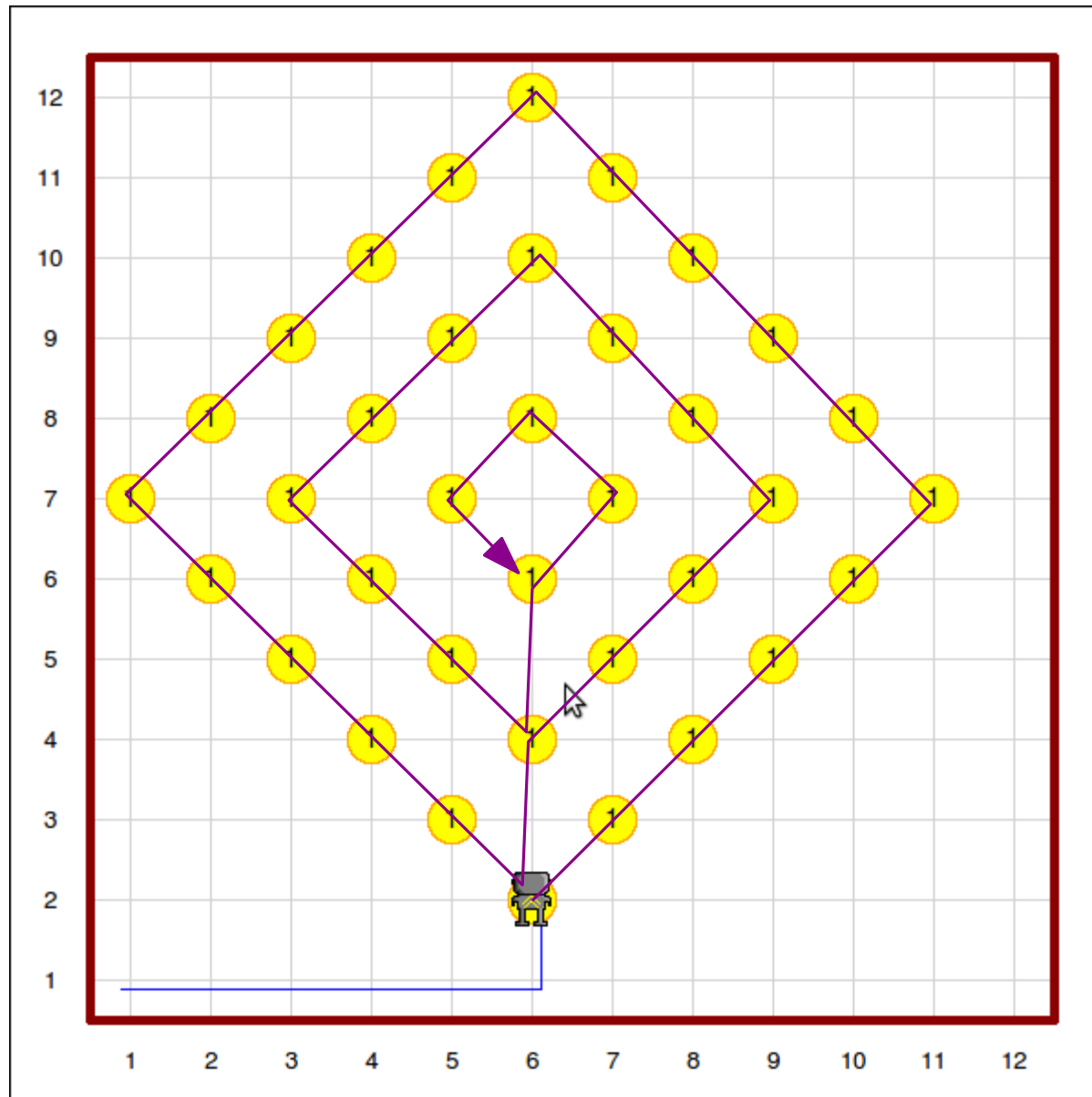
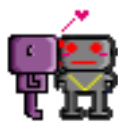


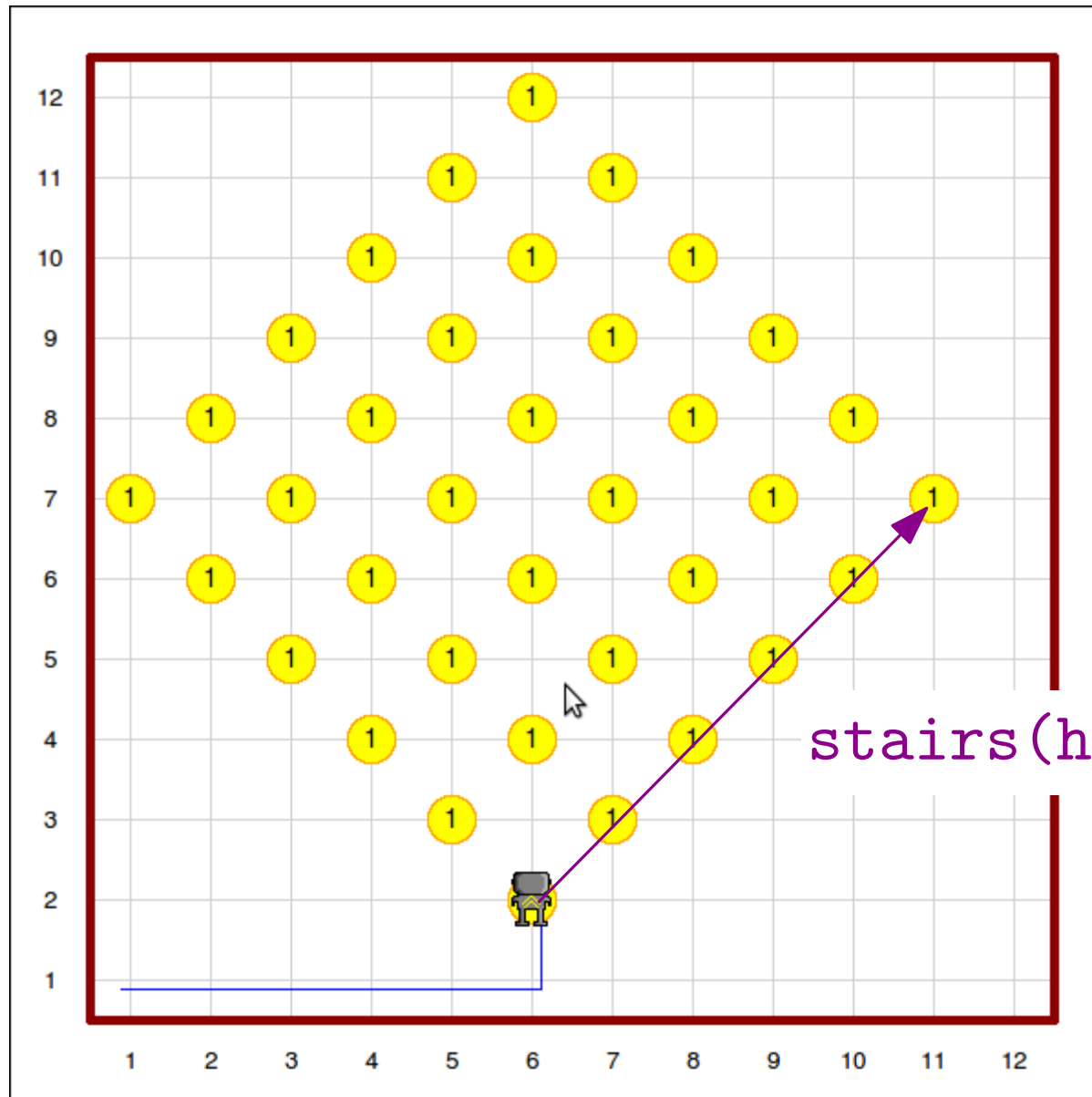
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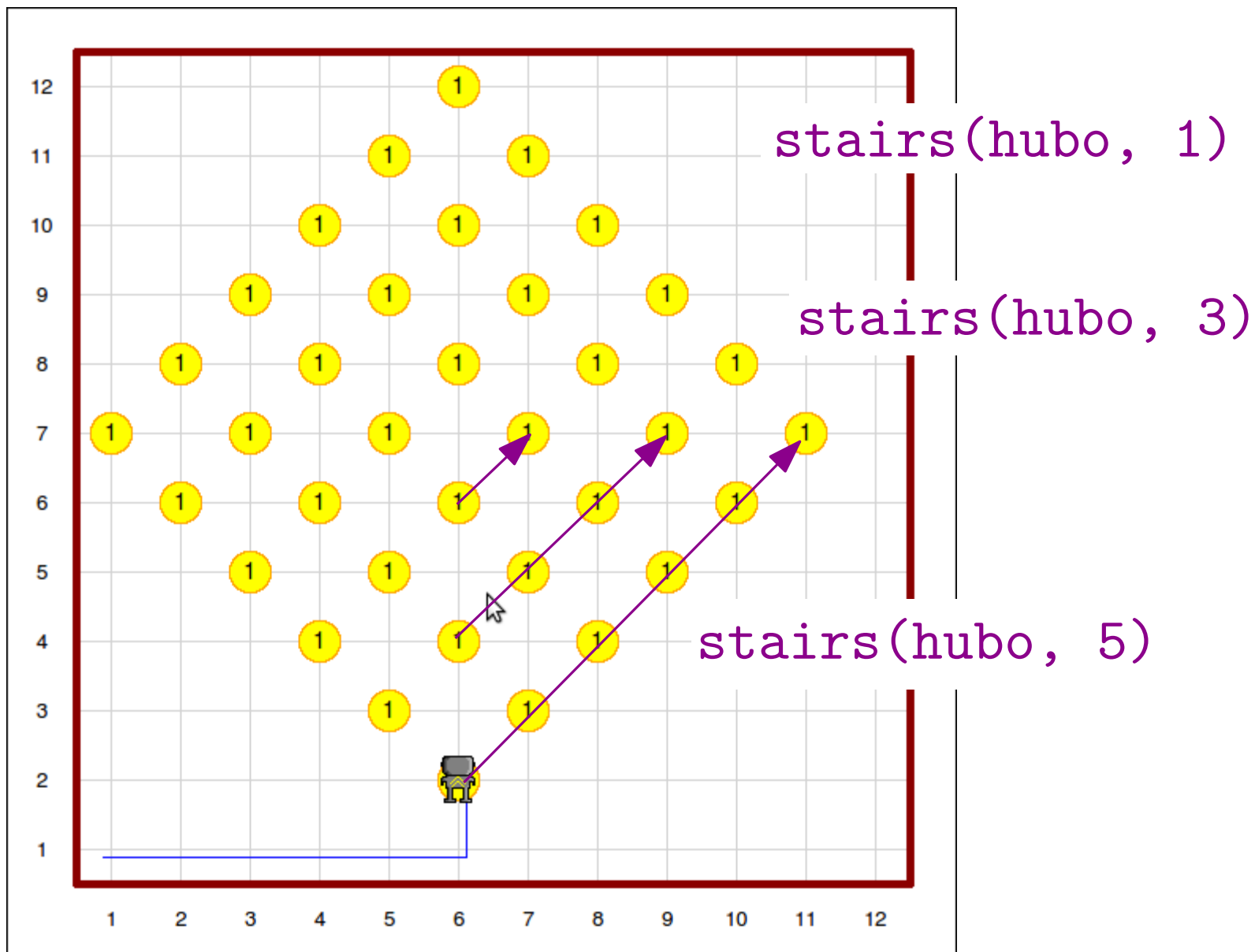
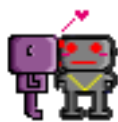
```
ami = Robot("yellow")  
hubo = Robot("blue")  
turn_right(ami)  
turn_right(hubo)
```

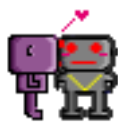
Remember: A `parameter` is a `name` for an object. The name can only be used `inside` the function.









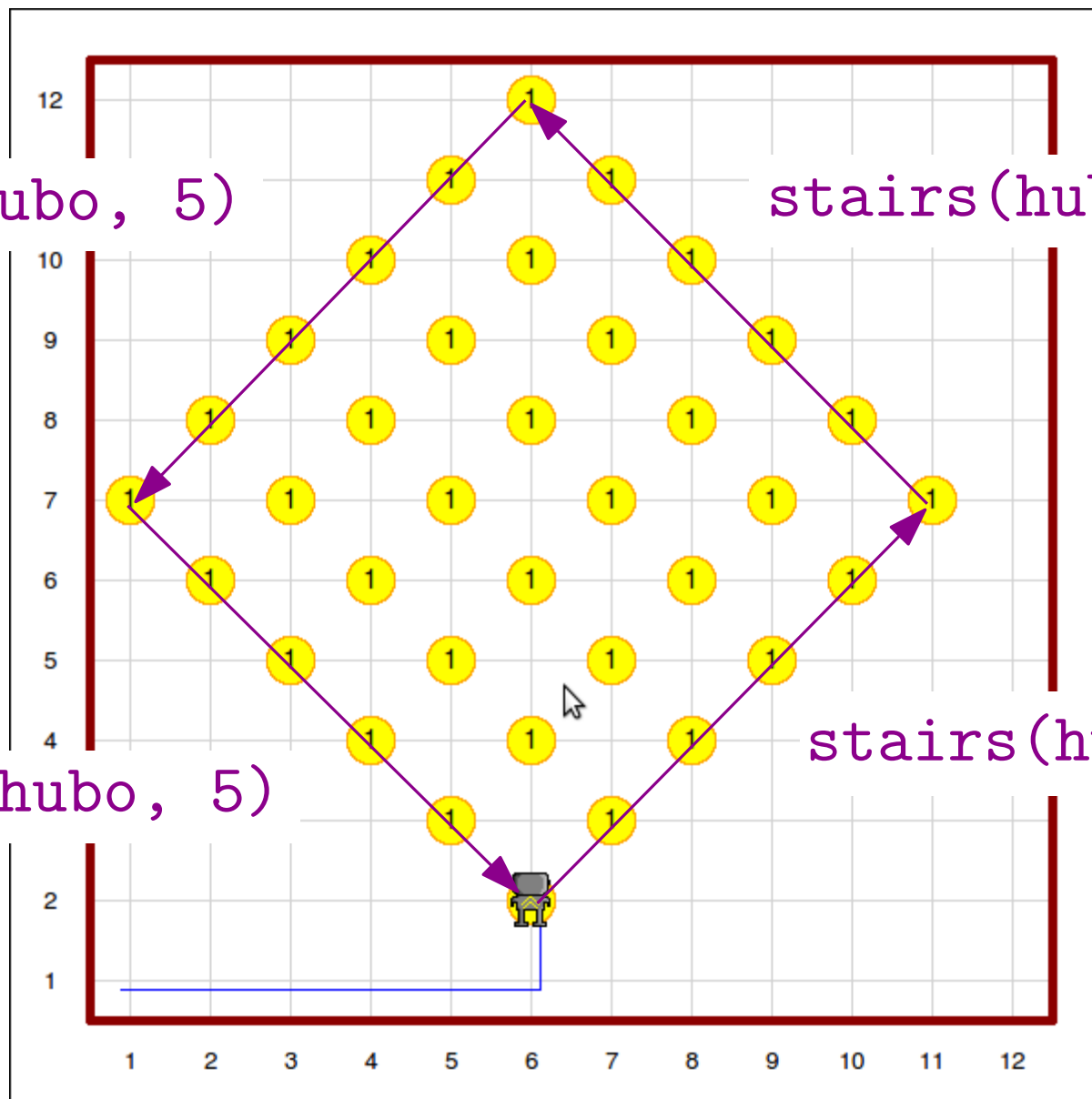


stairs(hubo, 5)

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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)  
        hubo.move()  
        hubo.move()
```



```
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 = luminance(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:

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

Often function results are unpacked immediately:

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



The `raw_input` function waits for the user to enter a string on the keyboard. When the user presses the Enter key, the whole string is returned:

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



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

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

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