PROGRAMMING

Lecture 07

Hanbat National University
Dept. of Computer Engineering
Changbeom Choi

OUTLINE

Functions

Built-in functions and modules

User-defined functions

Keyboard input

Case study: decomposition and abstraction

Reading assignment

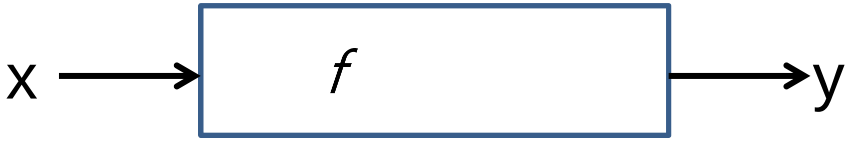
- Chapter 4 of the textbook
- Tutorial on cs1graphics(Chapter 3)
  - http://www.cs1graphics.org/

FUNCTIONS

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

f: X→ Y such that y = f(x),
where x ∈ X and y ∈ Y.

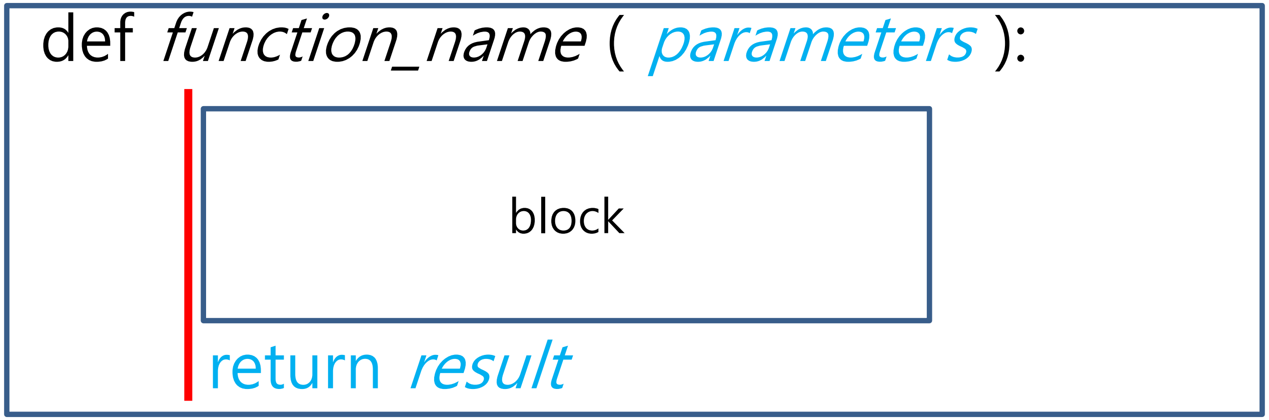
x is the **parameter** of the function., and $f\,(x)$ is the **result** of the function



For instance, consider a function that converts angle to radian:

```
f:[0,360]⟶[0, 2π]  such that y = (π/180) *  x
     where x ∈ [0,360]  and y ∈ [0, 2π]
```

Function definitions



def *function_name* (*parameters*):

block

return *result*

No *parameters* or **multiple** *parameters* allowed
No *returns* or **multiple** *returns* allowed
Result may be an expression

Function calls

```
def func_name(par 1, par 2, .., par k):
        function body
        (block of instructions)
        return result
 res = func_name(arg 1, arg 2, ..., arg k)
```

In general, there is a **positional correspondence** between parameters and arguments.

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

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

function definition (without return)

```
print_twice(“I love programming!”)      #function call
```

```
import math
print_twice(math.pi)     #function call
```

```python
import math
def degrees_to_radians(deg):
    rad = (math.pi / 180.0) * deg
    return rad

ang = 90
radian = degrees_to_radians(ang)
print (radian)
```

function definition (with return)

function call

```
import math
def degrees_to_radians(deg):
    rad = (math.pi / 180.0) * deg
    return rad

ang = 90
radian = degrees_to_radians(ang)
print (radian)
```

module

π

Returns the result.

Positional correspondence

```python
def compute_interest(amount, rate, years):
    value = amount  *  (1+rate/100.0) ** years
    return value

amt, r, yrs = 500, 2.0, 15
print (compute_interest(amt,  r, yrs))
print (compute_interest(700, 5.0, 30))
```

A **parameter** is the name of an object (a local variable), which can only be **recognized** inside a function

BUILT_IN FUNCTIONS AND MODULES

Type conversion functions: converting from one type to another

```
>>>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: by importing them from the **math** module:

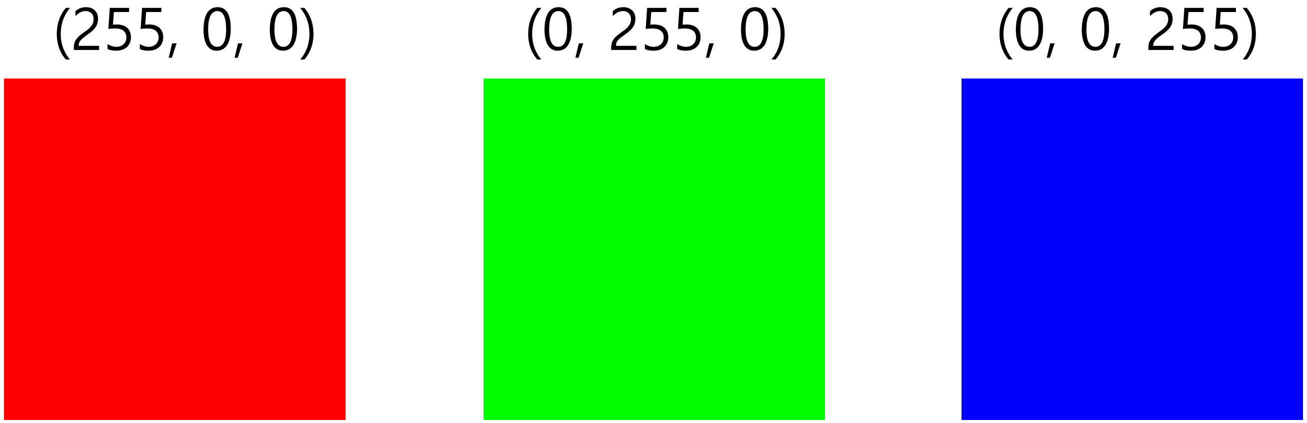
```
import math
degrees = 45
radians = (math.pi/ 180.0) * degrees
print (math.sin(radians))
print (math.sqrt(2) / 2)
```

When using math functions very often, you can use shorter names:

```
import math
sin = math.sin
pi = math.pi
degrees = 45
radians = (pi/180) * degrees
print (sin(radians))
```

USER-DEFINED FUNCTIONS

From color to intensity(luminance)



white: (255, 255, 255) black: (0, 0, 0)

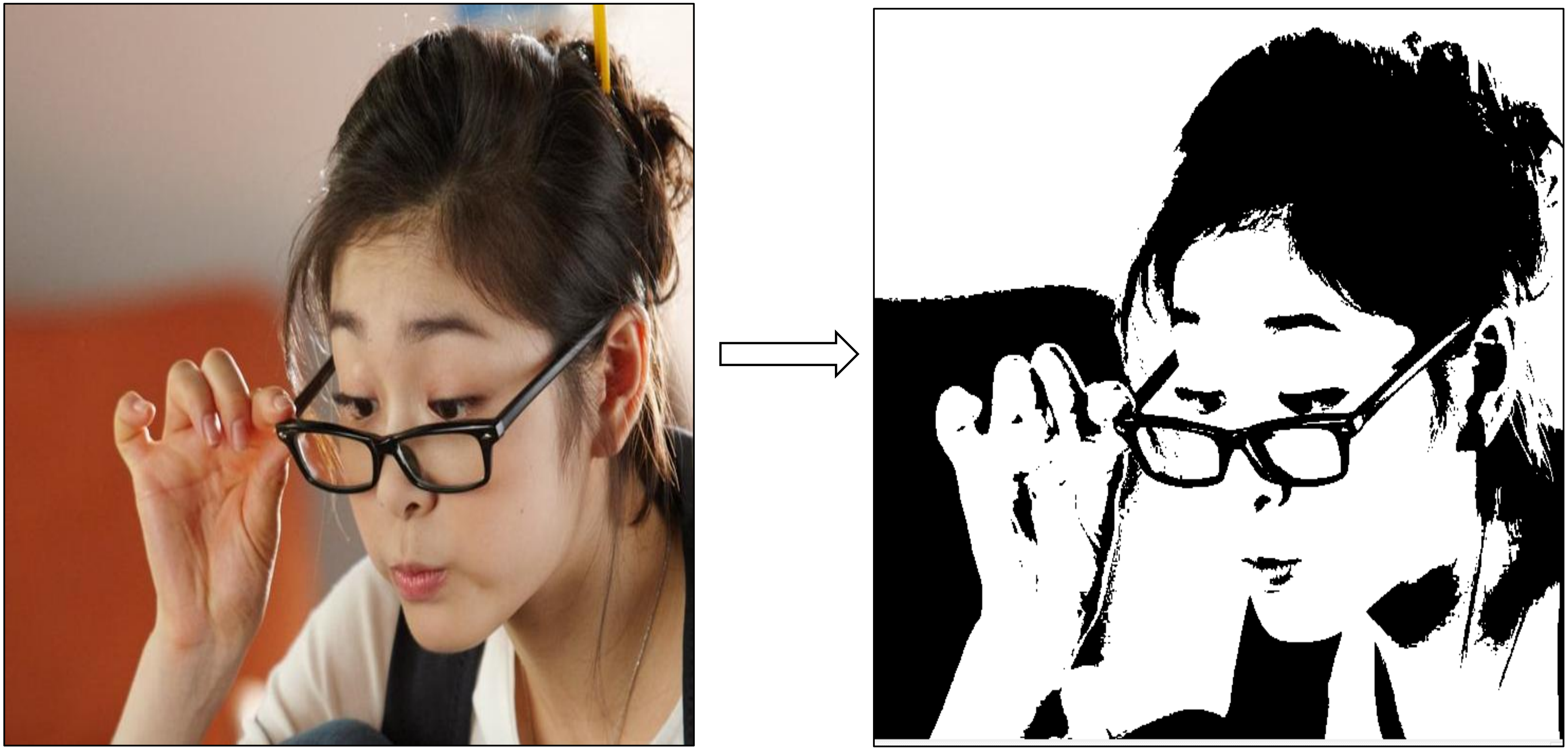
```
def luma (p):
    r, g, b = p
    return int(0.213 * r + 0.715 * g + 0.072 * b)
```

Try this function!

```
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)

from cs1media import *
pict = load_picture("images/yuna.jpg")
blackwhite(pict, 100)
pict.show()
```

(r, g, b)

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



Turning right

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

Neither parameters
nor returns!

```
s = turn_right()
print (s)
```

If there is no returns, Python automatically return a special symbol **None**, which represents “nothing”.

Generalization with parameters

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

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

Now, this works for any robots but not just for Hubo!

Absolute value computation

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

print (absolute(-7))
```

or

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

print (absolute(-7))
```

Multiple returns !

Returning multiple values: A function can return multiple values by returning them as a tuple:

```
def student():
   name = "Hong, Gildong"
   id = 20101234
   return name, id ←          (name,id)
name1,id1 = student()        Unpack the tuple!
```

Predicate functions: functions returning a True or False value.

```
def is_divisible(a, b):
    flag = False
    if a % b == 0:
        flag = True
    return flag
```

or

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

```
x = 9
y = 3
if is_divisible(x, y):
   print (“x is divisible by y.”)
```

KEYBOARD INPUT

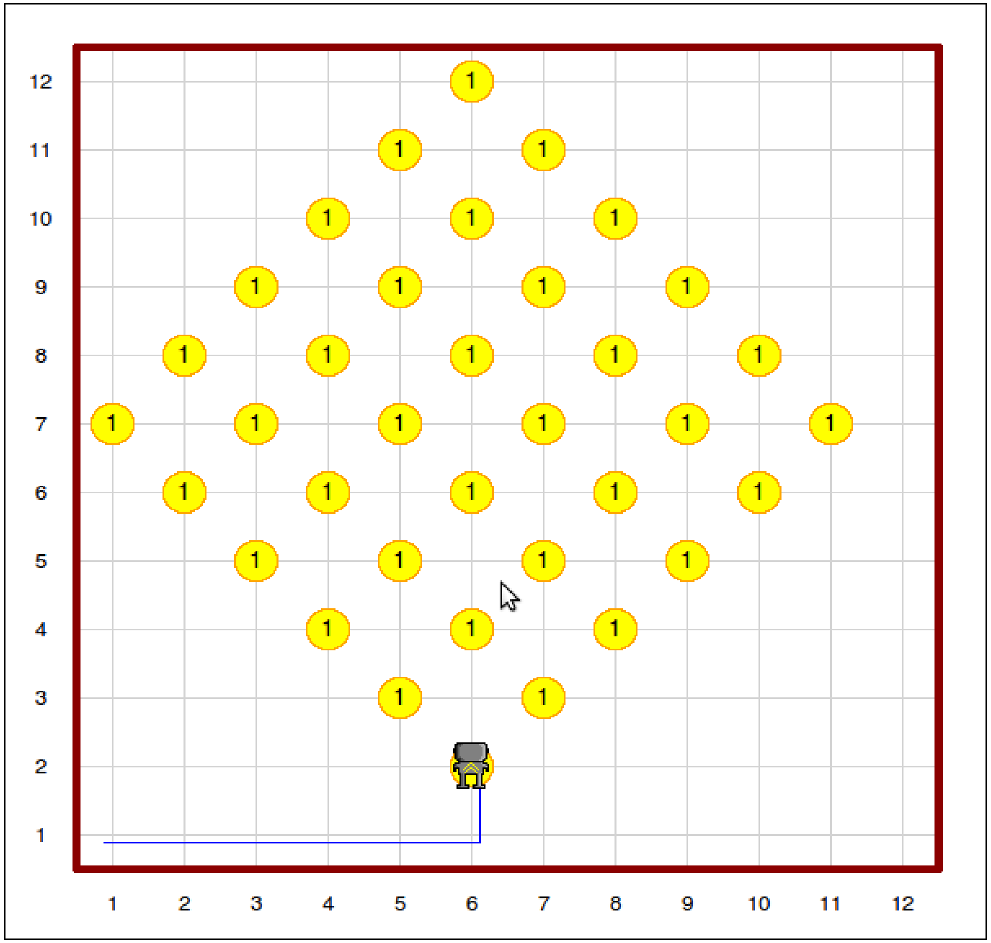
```
name = input("What is your name? ")
print ("Welcome to programming, " + name
)

number = input("Enter a positive integer> ")

n = int(number)   Why?

for i in range(n):

   print ("*" * i)
```

Argument: a prompt displayed on the monitor.

Returned a value: a string

CASE STUDY: DECOMPOSITION & ABSTRACTION

Harvest revisited



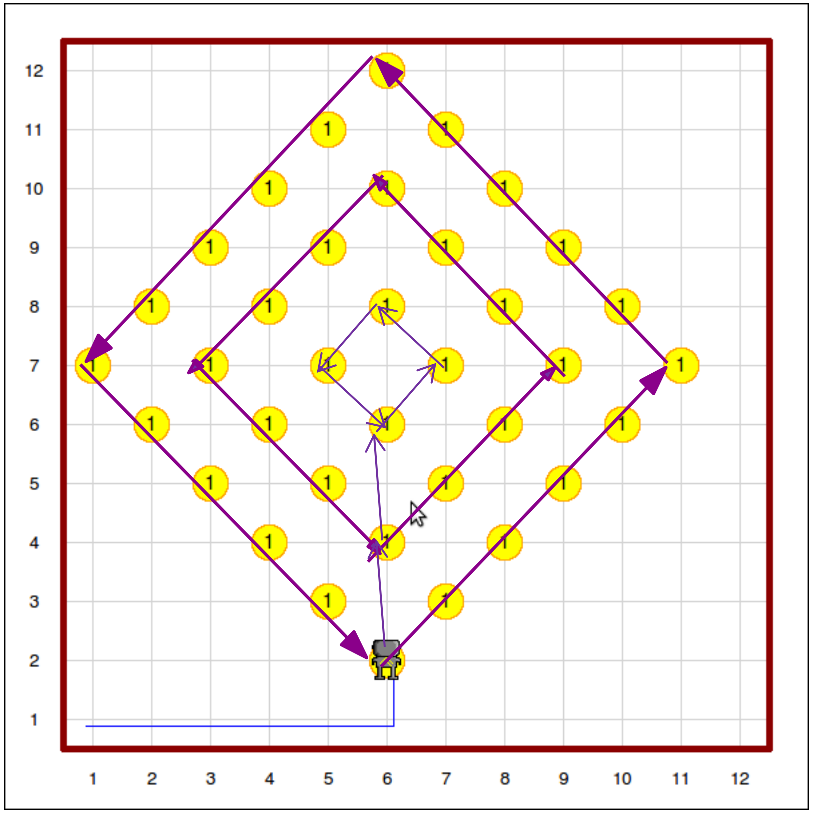
Pseudo code

```
1 Move to the bottom-most point.
2. Pick all beepers
```

```
from cs1robots import *
load-world(“worlds/havest2.wld”)
hubo = Robot()
harvest_all(hubo)
```

```
def harvest_all(robot):
    move_to_buttom(robot)
    pick_beepers(robot)
```

Pseudo-code: step 2



2-1 Pick up all beepers in the out-most layer
2-2 Move to the bottom-most position of the middle layer.

2-3 Pick up all beepers in the middle layer.
2-4 Move to the bottom-most position in the inner-most layer,

2-5. Pick up all beepers in the inner-most layer

Refining the pseudo code: Steps 2.1-2.5

2-1 Pick all beepers in the out-most layer.
2-2 Move to the middle layer.

2-3 Pick all beepers in the middle layer.
2-4 Move to the inner-most layer.

2-5 Pick all beepers in the inner-most layer

2-1 Pick all beepers in the current layer.
2-2 move to the next layer.

2-3 Pick all beepers in the current layer.
2-4 Move to the next layer.

2-5 Pick all beepers in the current layer

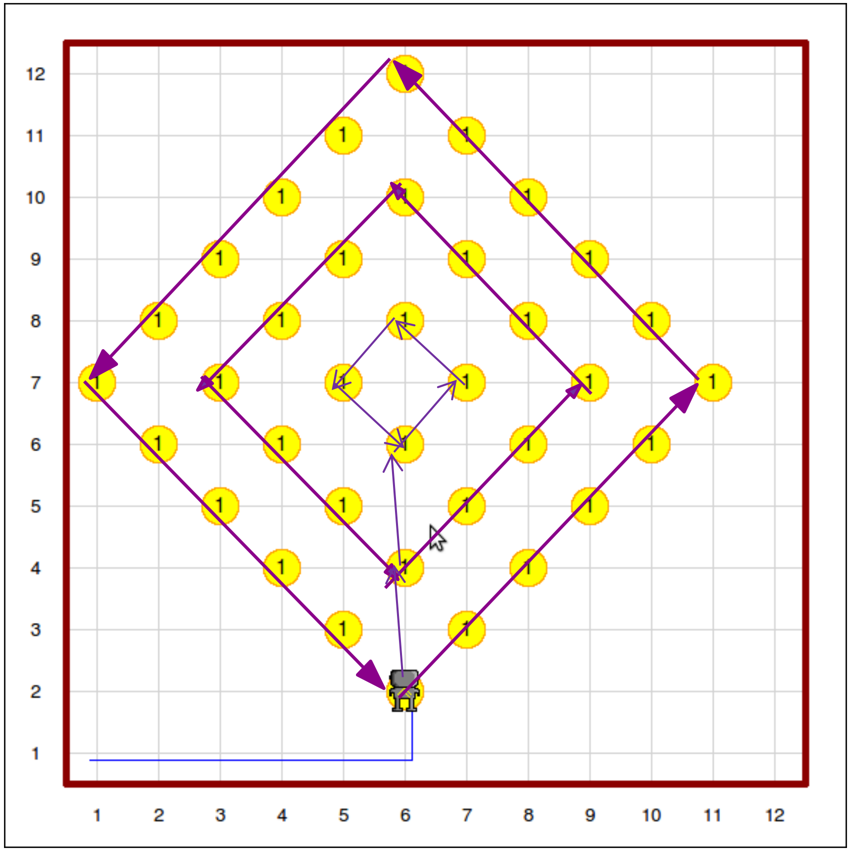
2-1 Pick all beepers in the current layer.
2-2 Move to the next layer.

2-3 Pick all beepers in the current layer.
2-4 Move to the next layer.

2-5 Pick all beepers in the current layer

2. Repeat the following steps three times:
   2.1. Pick all beepers in the current layer.
   2.2. If not in the inner-most layer, move to the next layer.

What is the main difference between layers?



The number of beepers / side!

How to compute it ?

```
5 - 2 * i  for i = 0, 1, 2
```

Why?

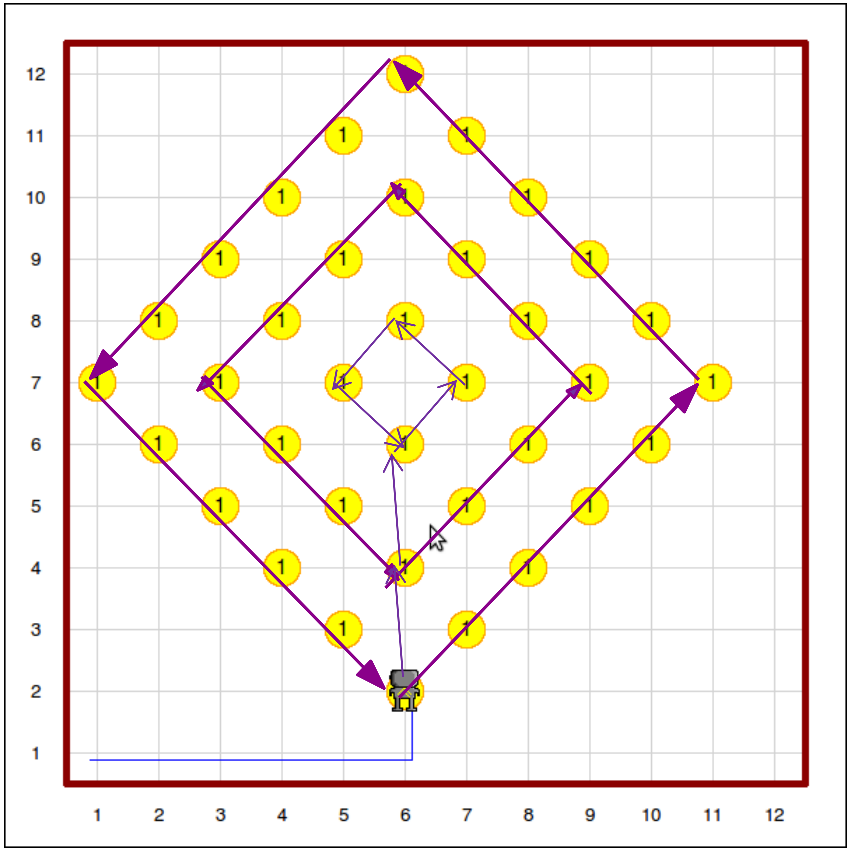
2. Repeat the following steps three times:

2.1. Pick all beepers in the current layer.

2.2. If not the inner-most layer, move to the next layer.

```
def pick_beepers(robot):
    for i in range(3):
        n = 5 – 2 * i
        diamond(robot, n)
        if n > 1 :
            robot.move()
            robot.move()
```

2.1 How to pick-up all beepers in the current layer



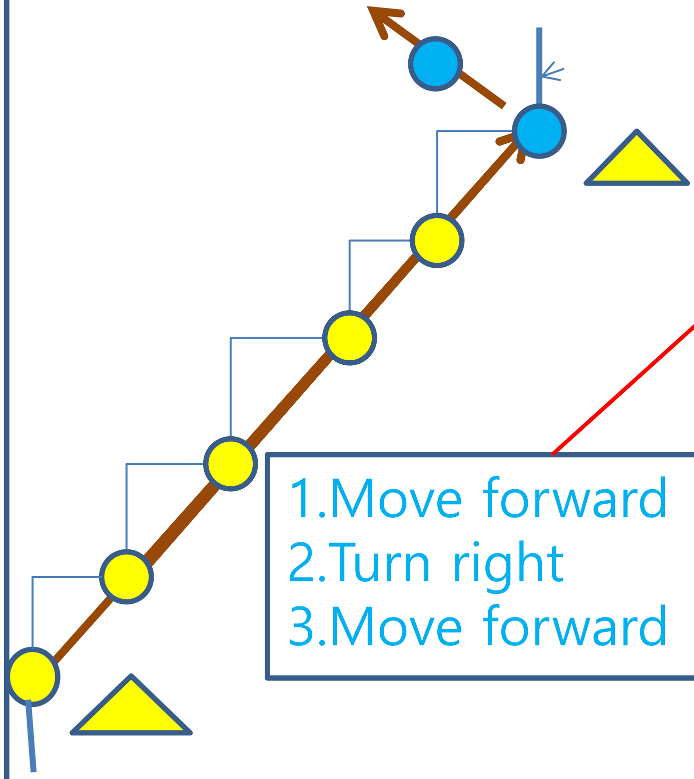
2.1 For each of four sides,
do the followings:

2.1.1 Pick up all beepers
in the current side.

2.1.2 prepare for moving
to the next side.

```
def diamond(robot,n):
    for i in range(4):
        move_and_pick(robot,n)
        for_next_side(robot)
```

2.1.1 How to pick the beepers in the current side



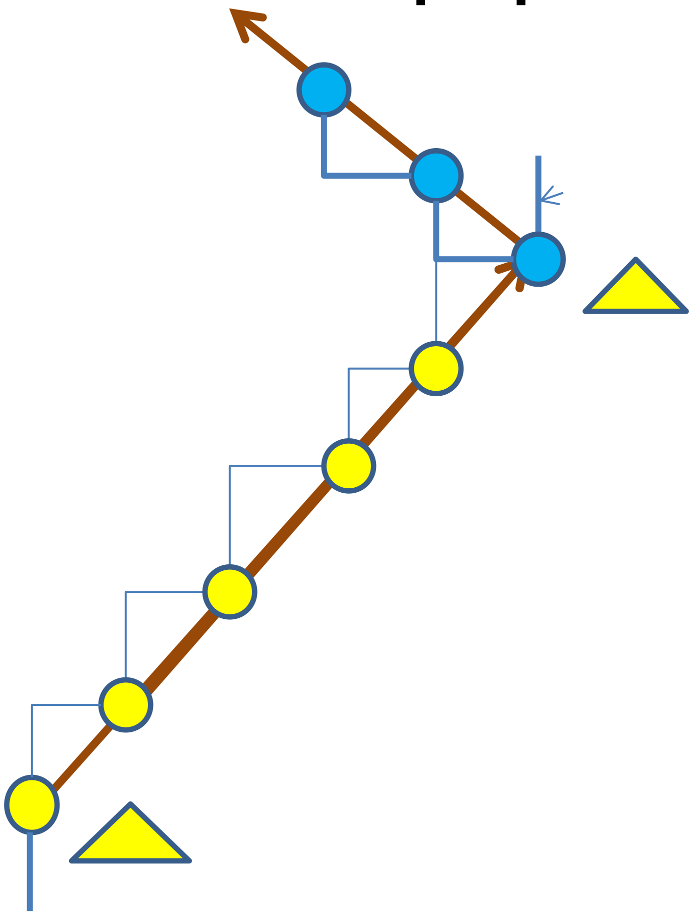
1.Move forward
2.Turn right
3.Move forward

At every position on a side:

1. Pick up a beeper.
2. Go up a stair.
3. Prepare for next stair

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

2.1.2 How to prepare for the next side



Turn left !

```
~~def for_next_side(robot):~~
    ~~robot.turn_left()~~
```

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

```
def turn-right(robot):
    for i in range(3):
        robot.turn_left()
```

Program

```
from cs1robots import *
load_world(“worlds/harvest3.wld”)
hubo = Robot()
```

Put function definitions, here.

```
harvest_all(hubo)
```