PROGRAMMING

Lecture 03

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REVIEW

Characteristics of Python

Instruction set

Arithmetic and logical operations
- +, -, *, /, and **
- and, or, not

Assignment
Conditionals
Iterations
Input/output

} for defining expressions

No pointers
No explicit declarations

A small grid-like 2D world

Basic actions

move (): moving one grid forward
turn_left (): turning left by 90°
pick_beeper(): pick ing up beepers
drop_beeper(): putting down beepers

Our own instructions: functions

Comments

OUTLINE

Conditionals

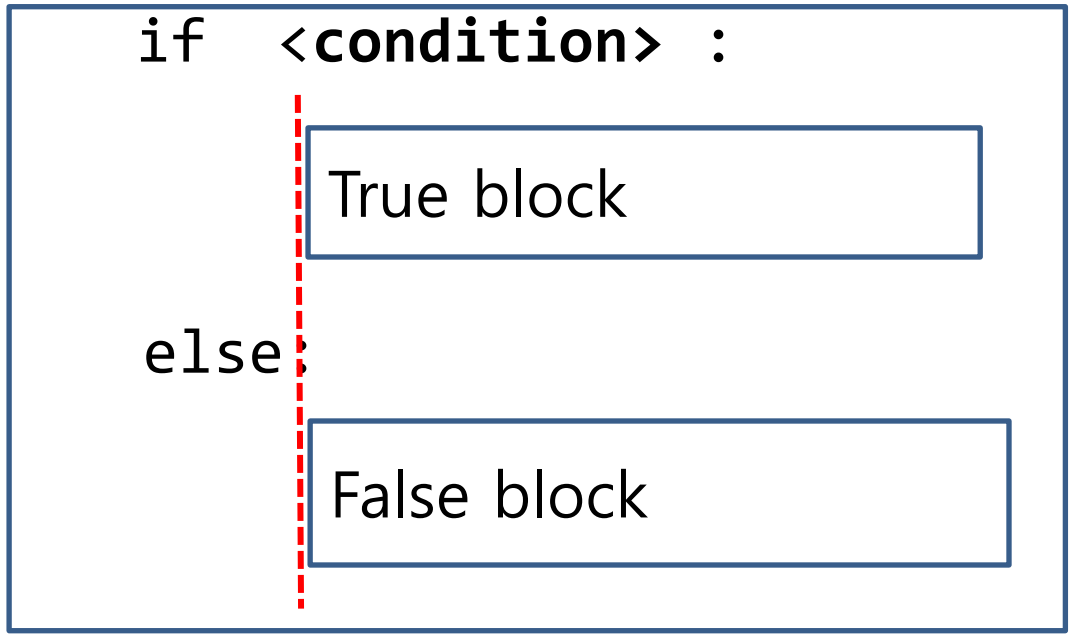
Iterations

- for_loops
- while_loops

Reading assignment:

- Chapter 2 of the text book

CONDITIONALS



<**condition**> has a "True" or "False" value, representing true or false, respectively.

If it is true, the **True block** is executed; otherwise, the False block is executed.

What will be printed ?

```
if True:
     print (“Programming is my  favorite course“)
else:
     print (“Every student will receive an A+”)
```

Now, do you understand?

```
if 5 > 3:
     print (“Programming is my  favorite course”)
else:
     print (“Every student will receive an A+”)
```

Now, what will happen?

```
if False:
   print (“The student will receive an A+”)
```

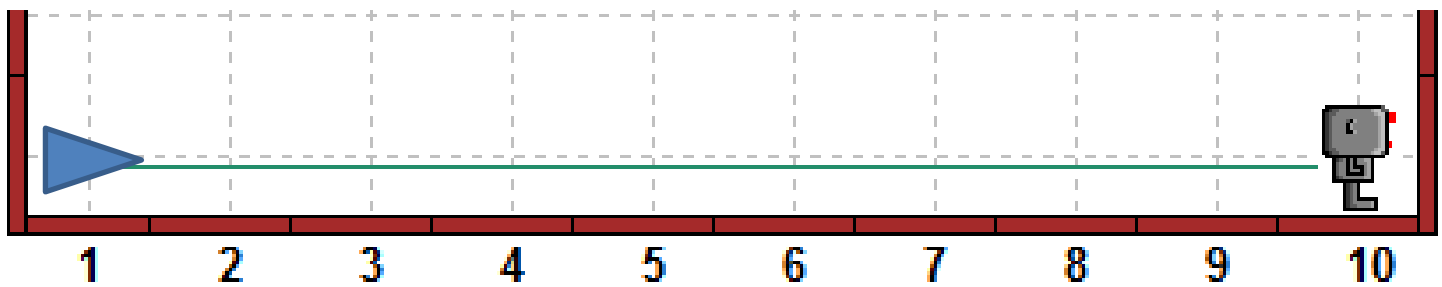
The keyword not inverts the sense of the condition: not True is False, and not False is True.

What is the output?

```
>>print (not 3 < 5)
```

SENSING A BEEPER

We want Hubo to make 9 steps and pick all **beepers** on the way. However, we do not know where beepers are. If there is **no beeper** at a grid point, then **hubo.pick_beeper()** causes an error.



How to sense a beeper?

Use **hubo.on_beeper()**

```
Move forward 9 steps.
   At each step, move
   and pick up a beeper
   if any.
```

```
for i in range(9):
    move_and_pick()
```

Move and pick a beeper if any.

Take a step forward.

Check if there is a beeper.

If yes, pick it up.

```
def  move_and_pick():
     hubo.move()
     if hubo.on_beeper():
          hubo.pick_beeper()
```

No False block!!

Let's do the opposite: we want to drop a beeper, but only if there is no beeper at the current location.

```
if not hubo.on_beeper():
    hubo.drop_beeper()
```

FOLLOWING THE BOUNDARY

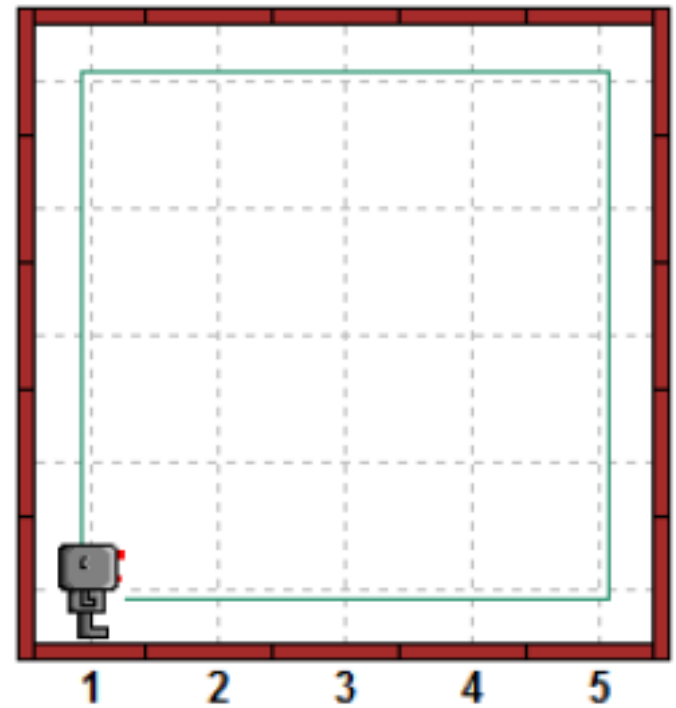
Hubo tries to follow the boundary of the world: He moves forward if there is no wall; otherwise, turn to the left.

```
from cs1robots import *
create_world(avenues =5, streets  = 5)
hubo = Robot()
hubo set_trace("blue")

def move_or_turn():
    if hubo.front_is_clear():
        hubo.move()
    else:
        hubo.turn_left()

for i in range(20):
    move_or_turn()
```

Why 20 ?



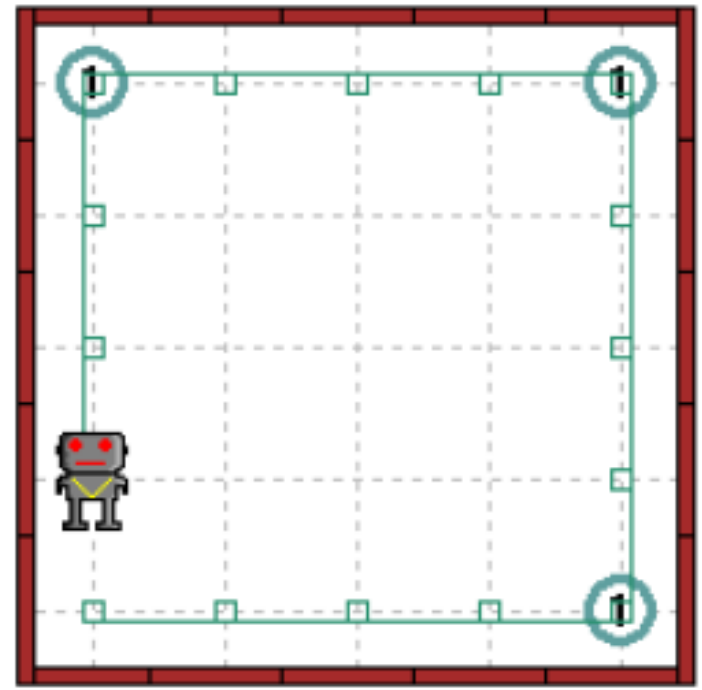
MOVING AND DANCING

```
hubo =Robot(beeper=5)

def dance():
    for i in range(4):
        hubo.turn_left()

def move_or_turn():
    if hubo.front_is_clear():
        dance()
        hubo.move()
    else:
        hubo.turn_left()
        hubo.drop_beeper()

For i in range(18):
    move_or_turn()
```



MULTIPLE CHOICES

elif combines **else** and **if** to express many alternatives without complicated indentation.

```
if hubo.on_beeper():
    hubo.pick_beeper()
elif hubo.front_is_clear():
    hubo.move()
elif hubo.left_is_clear():
    hubo.turn_left()
elif hubo.right_is_clear():
    turn_right()
else:
    turn_around()
```

```
else:
    if hubo.front_is_clear():
        hubo.move()
    else:
        if hubo.left_is_clear():
            hubo.move()
```

WHILE-LOOPS

while <**condition**>:

The block is executed as long as <**condition**> is True; otherwise, it is skipped.

A while-loop repeats instructions as long as a condition is true.

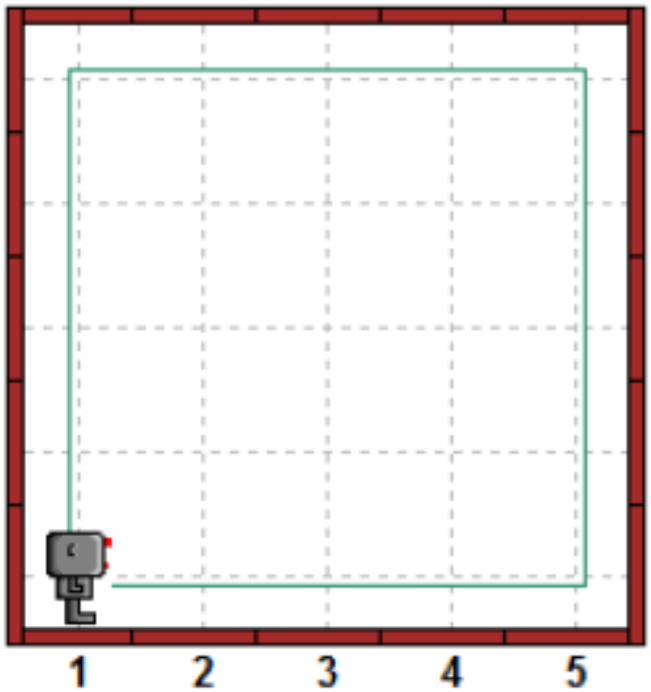
```
while not hubo.on_beeper():
    hubo.move()
```

Move forward as long as there is no beeper

A for-loop repeats some instructions a fixed number of times.

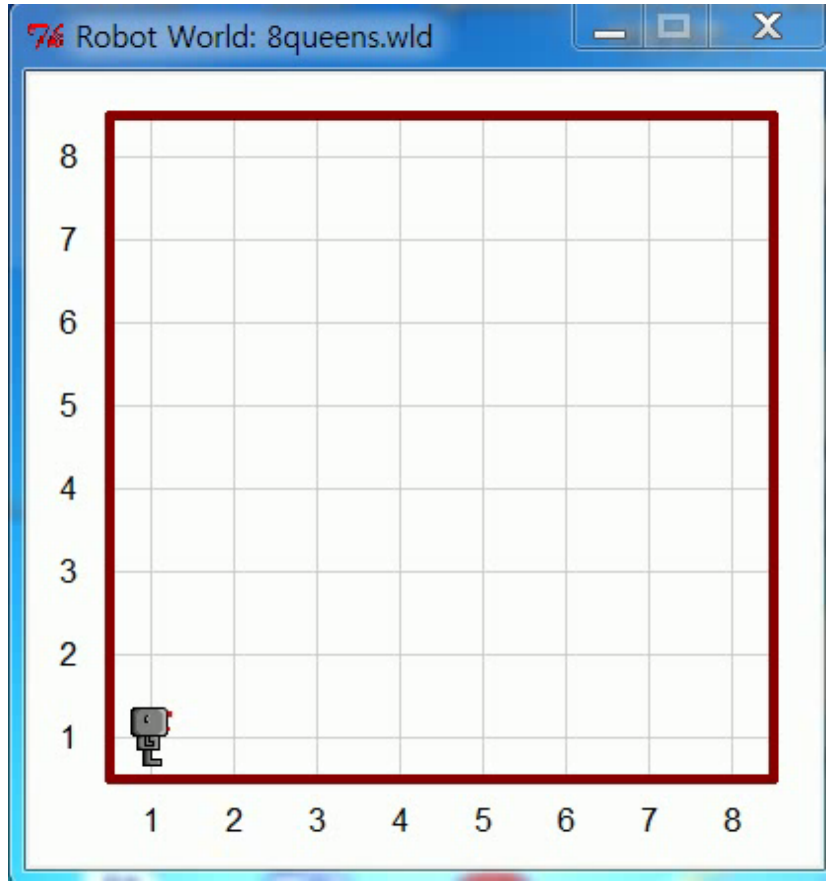
```
for i in range(9):
    hubo.move()
```

Let's write a program to let the robot **walk around the boundary of the world** until he comes back to the **starting point**



1. Put down a beeper to mark the starting point
2. Repeat steps 3 and 4 while no beeper found
3. If not facing a wall, move forward
4. Otherwise, turn left
5. Finish when we found the beeper

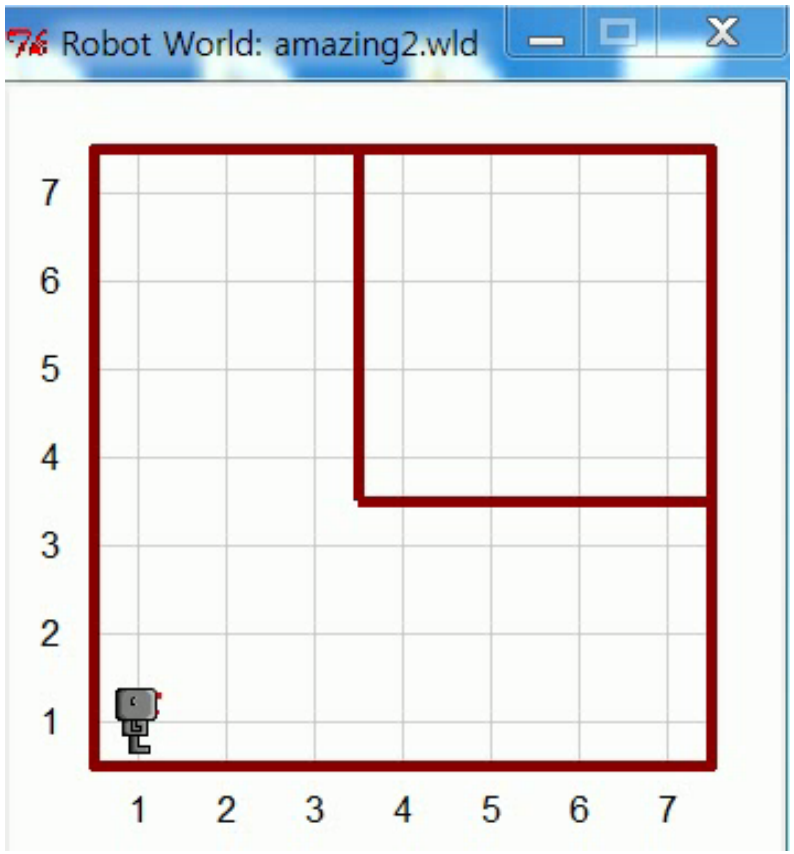
```
hubo.drop_beeper()
hubo.move() Why this?
while not hubo.on_beeper():
    if hubo.front_is_clear():
        hubo.move()
    else:
        hubo.turn_left()
hubo.turn_left()
```



Does this program always work?

Well, ...

How about this case?




```
hubo.drop_beeper()
hubo.move()
while not hubo.on_beeper():
    if hubo.front_is_clear():
        hubo.move()
    else:
        hubo.turn_left()
hubo.turn_left()
```

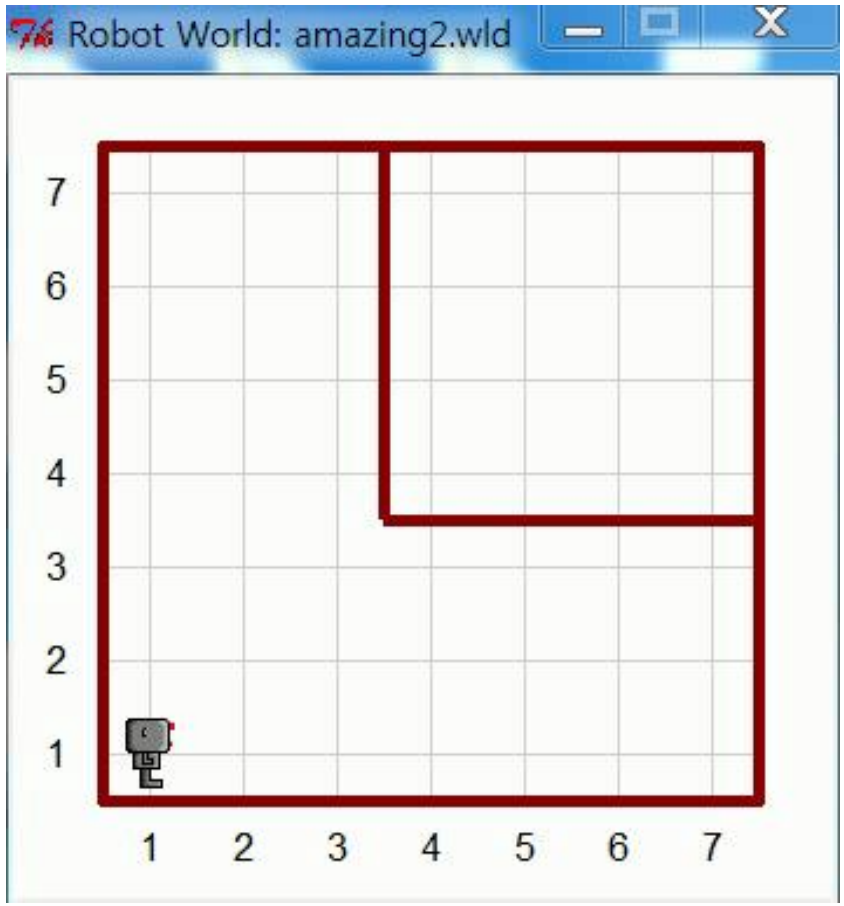
Try the code in the previous page with "amazing2.wld" and see if the previous code works.

Sometimes we need a right turn!

Does this work?

Well, ...

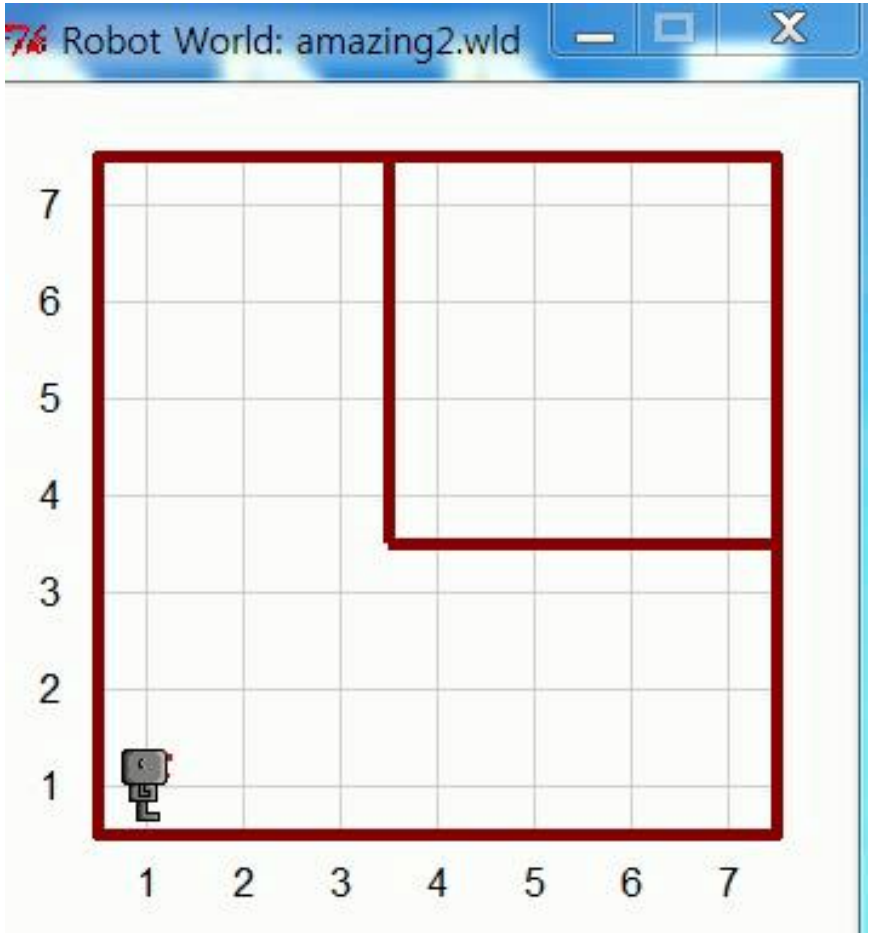
```
hubo.drop_beeper()
hubo.move()
while not hubo.on_beeper():
    if hubo.right_is_clear():
        turn_right()
    elif hubo.front_is_clear():
        hubo.move()
    else:
        hubo.turn_left()
hubo.turn_left()
```



Infinite loop!

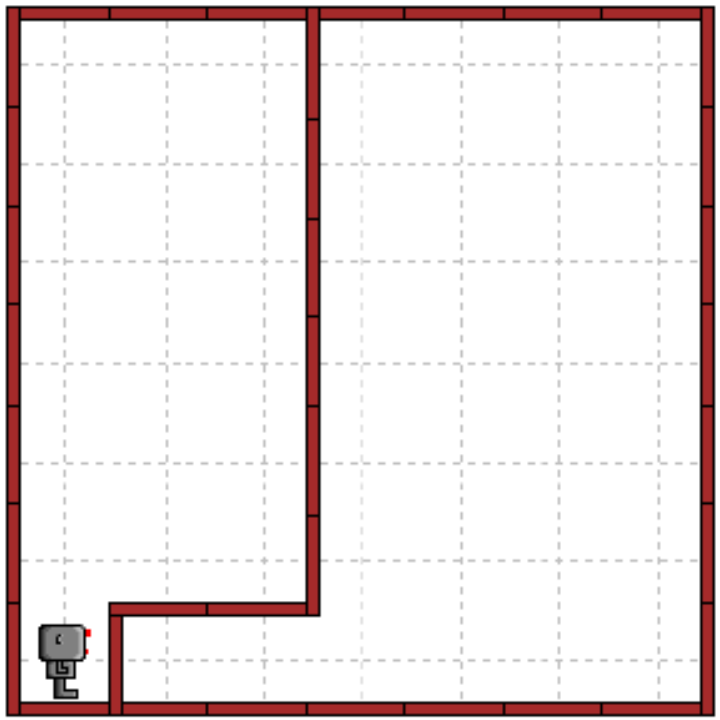
How about this?

```
hubo.drop_beeper()
hubo.move()
while not hubo.on_beeper():
    if hubo.right_is_clear():
        turn_right()
        hubo.move()
    elif hubo.front_is_clear():
        hubo.move()
    else:
        hubo.turn_left()
```



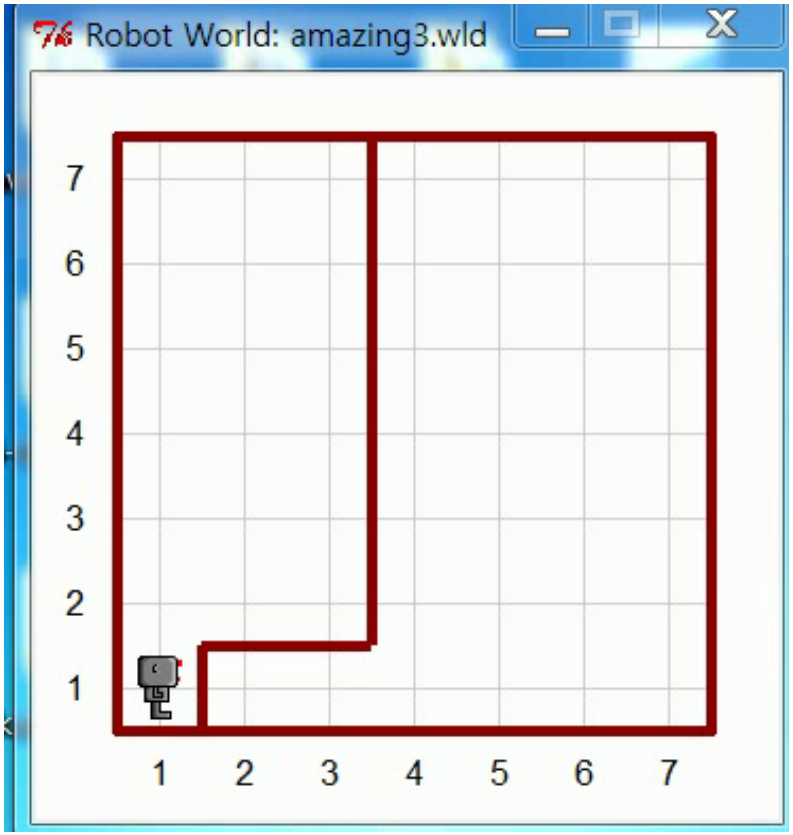
Does this always work?

How about this case?



```
hubo.drop_beeper()
hubo.move()
while not hubo.on_beeper():
    if hubo.right_is_clear():
        turn_right()
        hubo.move()
    elif hubo.front_is_clear():
        hubo.move()
    else:
        hubo.turn_left()
```

Does this work?

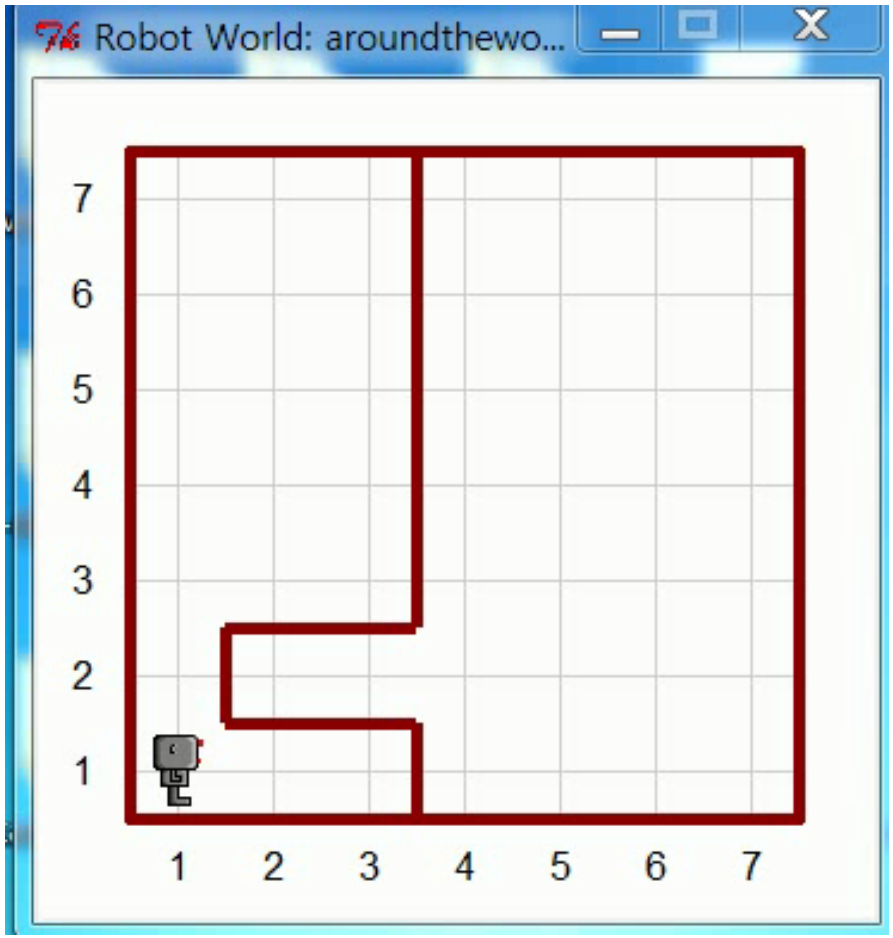


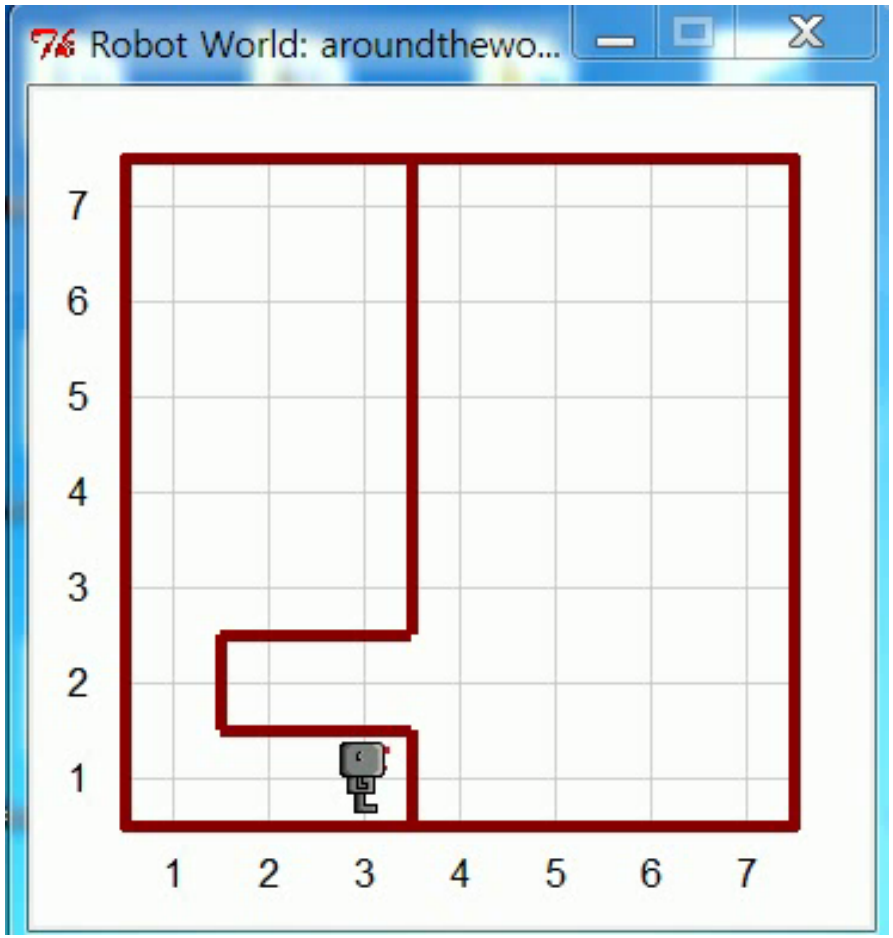

```
hubo.drop_beeper()
while not hubo.front_is_clear():
    hubo.turn_left()
hubo.move()
while not hubo.on_beeper():
    if hubo.right_is_clear():
        turn_right()
        hubo.move()
    elif hubo.front_is_clear():
        hubo.move()
    else:
        hubo.turn_left()
Hubo.turn_left()
```

Does this always work?

Still not perfect !

Very **sensitive** to the **initial position** of Hubo.





```
hubo.drop_beeper()
while not hubo.front_is_clear():
    hubo.turn_left()
hubo.move()
```

```
def mark_and_move():
```

```
while not hubo.on_beeper():
    if hubo.right_is_clear():
        turn_right()
        hubo.move()
    elif hubo.front_is_clear():
        hubo.move()
    else:
        hubo.turn_left()
Hubo.turn_left()
```

```
def follow_wall():
```

```
mark_and_move()
while not hubo.on_beeper():
    follow_wall()
hubo.turn_left()
```

COMMENTS FOR HUMANS

One of the **secrets** of writing **good, correct, elegant programs** is to write them as if you wrote them for a **human reader**, not a computer. Let's clean up our program.

How ? By adding comments !

```
“””
This program lets the robot go around his world counter-
clockwise, stopping when he comes back to his starting point.
“””
#Turn right.
def turn_right():
    for i in range(3):
        hubo.turn_left()
#Mark the starting point and move
def mark_and_move():
    hubo.drop_beeper()
    while not hubo.front_is_clear():
        hubo.turn_left()
    hubo.move()

(continued)
```

```
#Follow the wall at each iteration.
def follow_wall():
    if hubo.right_is_clear():
      # turn right to follow the wall
        right_turn()
        hubo.move()
    elif hubo.front_is_clear():
      # move forward while following the wall
        hubo.move()
   else:
      # turn left to follow the wall
        hubo.turn_left()
(continued)
```

```
def main():
    #Begin actual move.
    mark_and_move()
    #Follow the entire wall.
    while not hubo.on_beeper():
        follow_wall()
    hubo.turn_left()

main()
```

STEPWISE REFINEMENT

1. Start with a **primitive program** that solves a simple problem.
2. Make **small changes**, one at a time to generalize the program.
3. Make sure that each change **does not invalidate** what you have done before.
4. Add appropriate **comments** (not just repeating what the instruction does).
5. Choose **descriptive names**.