Control Flow

Loops, Conditions, Ifs, and a touch of decomp!

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Frankie Cerkvenik, CS106A, 2023

Housekeeping

- First sections happen(ed) today and tomorrow
- Assignment 1 (Bit) is out, will need tomorrow's lecture
- YEAH hours this Friday 4-5pm in Gates B12
- If you are thinking about switching to 106B, do so before tomorrow!
- Weekly review lecture by Clinton on Wednesdays at 1:30
- If you have a chromebook/no laptop...come chat

Today

- **Recap while loops and conditions**
- Introduce if/else statements
- Introduce Decomp

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Recap: `While` Loop

```
while #condition:
    # code that loops
# code that doesn't loop
```

1. First the condition is checked (it should be `True` or `False`, more on that later)
2. If the condition is `True`, the “code that loops” runs, then back to step 1.
3. If the condition is `False`, the looping process is over, and the “code doesn’t loop” runs

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The classic move-forward loop

```
while bit.front_clear():
    bit.move()
# bit will always be blocked here!
```

The classic move-forward loop

```
while bit.front_clear(): ✅
    bit.move()
# bit will always be blocked here!
```

1st loop

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The classic move-forward loop

```
while bit.front_clear():
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```

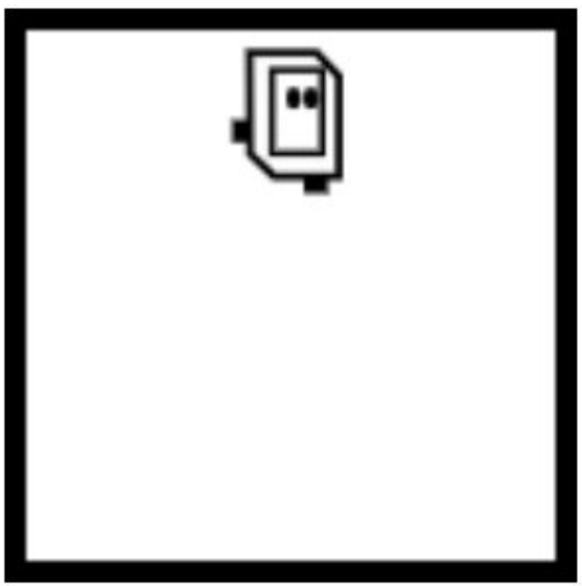

1st loop

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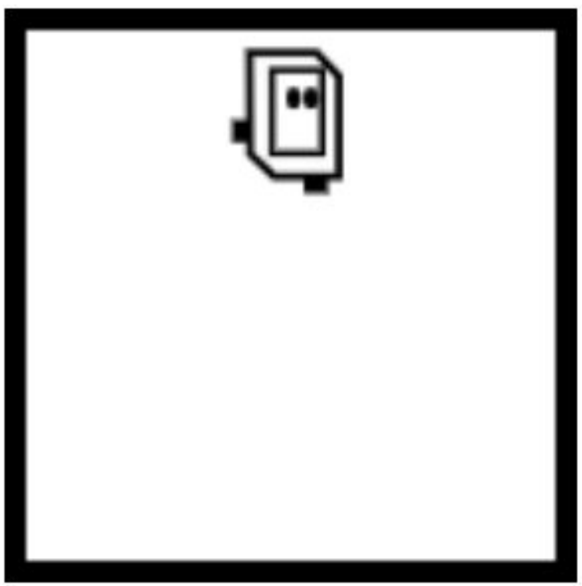
The classic move-forward loop

```
while bit.front_clear(): ✅
    bit.move()
# bit will always be blocked here!
```



2nd loop

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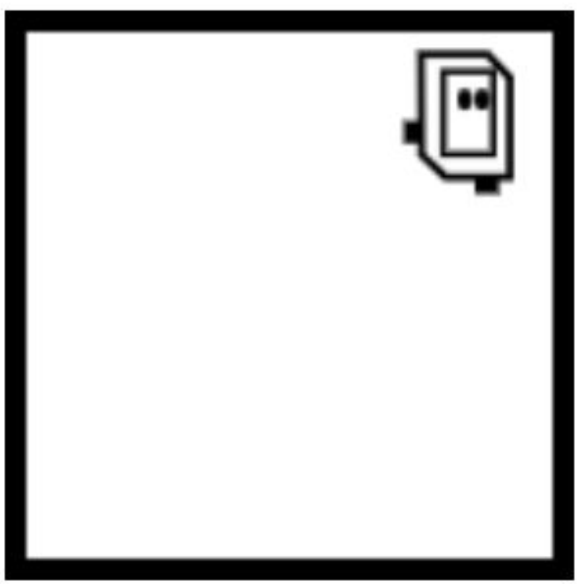
The classic move-forward loop

```
while bit.front_clear():
    bit.move()
# bit will always be blocked here!
```



2nd loop

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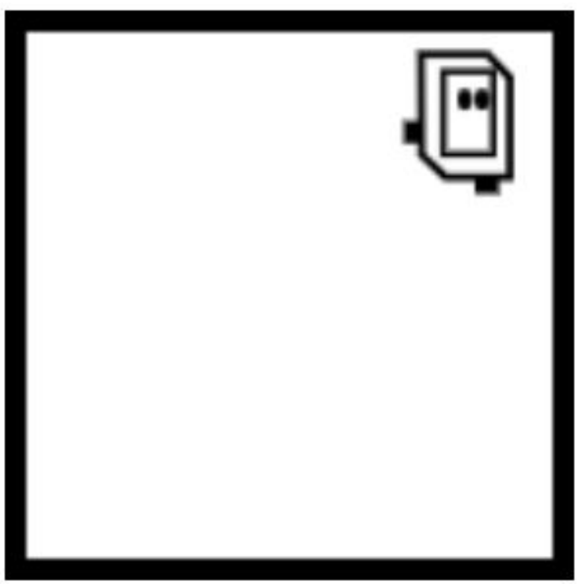
The classic move-forward loop

```
while bit.front_clear(): 🚫
    bit.move()
# bit will always be blocked here!
```



3rd loop?

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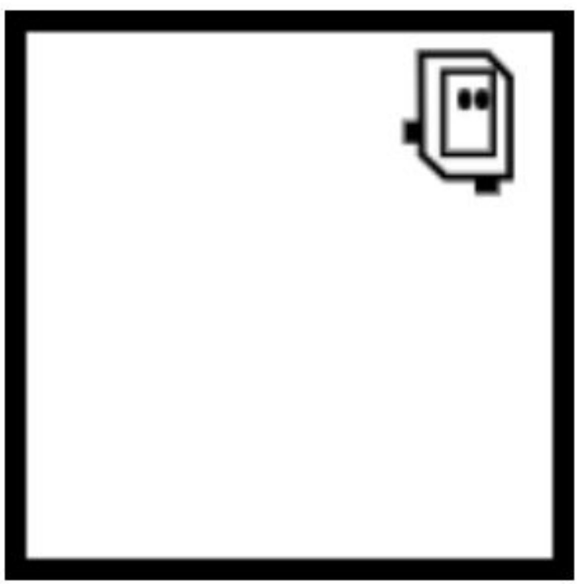
The classic move-forward loop

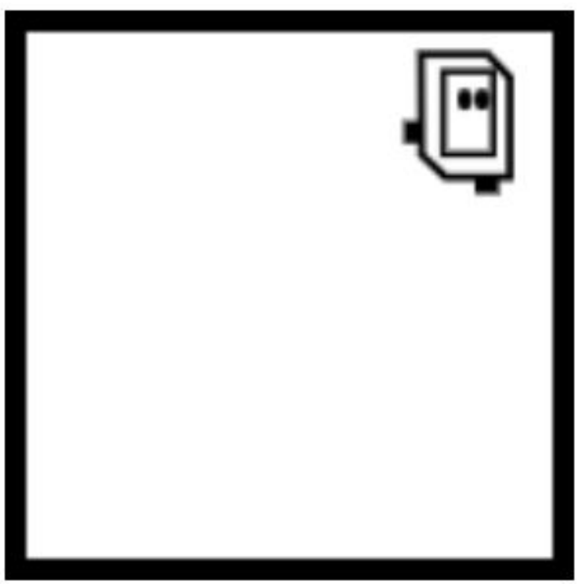
```
while bit.front_clear():
    bit.move()
# bit will always be blocked here!
```



Done looping!

What would happen?

```
while bit.front_clear():
    bit.move()
bit.move()
```



What happens if bit tries to move when it is blocked?

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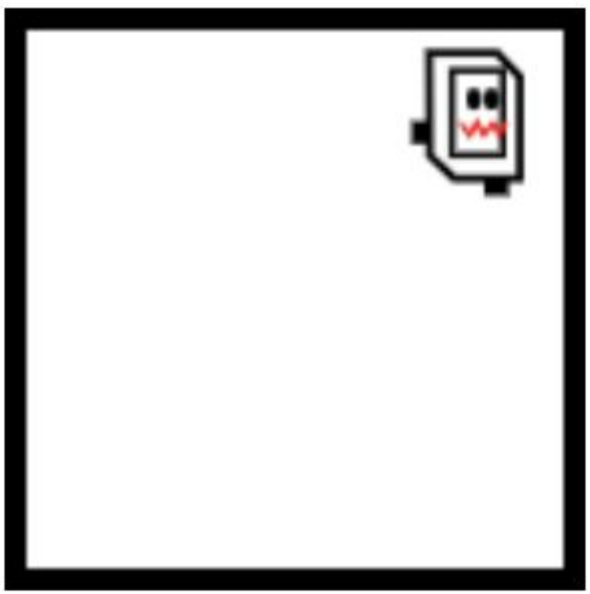
Runtime error!

```
while bit.front_clear():
    bit.move()
bit.move()
```

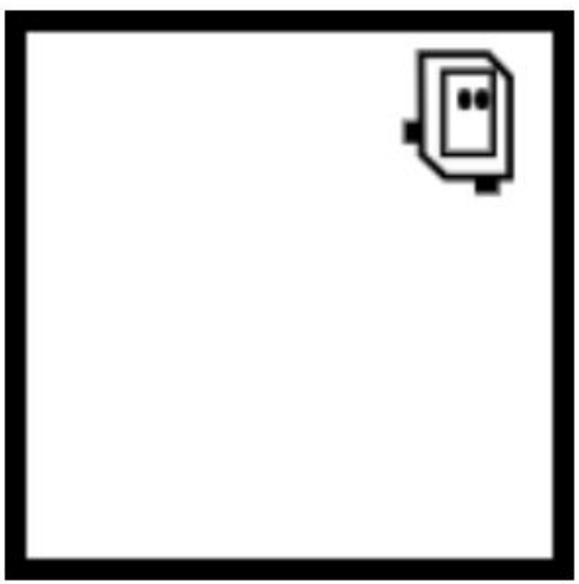


Case-2: **Runtime Error** ✕ re

```
Exception: Bad move,
front is not clear,
in:do_left line 5 (Case
2)
```

The classic move-forward loop

```
while bit.front_clear():
    bit.move()
# bit will always be blocked here!
```



Key idea: must always check if Bit's front is clear before calling `bit.move()`

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The classic infinite loop

```
while bit.front_clear():
    bit.paint('green')
# bit will always be blocked here!
```

1st loop

The classic infinite loop

```
while bit.front_clear():
    bit.paint('green')
# bit will always be blocked here!
```

1st loop

The classic infinite loop

```
while bit.front_clear():
    bit.paint('green')
# bit will always be blocked here!
```

2nd loop

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The classic infinite loop

```
while bit.front_clear():
    bit.paint('green')
# bit will always be blocked here!
```

2nd loop

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The classic infinite loop

```
while bit.front_clear():
    bit.paint('green')
# bit will always be blocked here!
```

3rd loop

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The classic infinite loop

```
while bit.front_clear():
    bit.paint('green')
# bit will always be blocked here!
```

3rd loop

The classic infinite loop

```
while bit.front_clear():
    bit.paint('green')
# bit will always be blocked here!
```

Case-2: **Timed Out** ✕ te

```
Run timed out. Try again,
or possible infinite loop.
```

The classic infinite loop

```
while bit.front_clear():
    bit.paint('green')
# bit will always be blocked here!
```

Key idea: The condition in the while loop should eventually be made False by the body of the while loop

Recap: Conditions

- Conditions are statements that evaluate to either `True` or `False`

```
while bit.front_clear():
    # front_clear returns True or False
```

Recap: Conditions

- Conditions are statements that evaluate to either `True` or `False`

```
while bit.front_clear():
    # front_clear returns True or False
```

- The statement `left == right` is `True` if left is equal to right and `False` otherwise

```
while bit.get_color() == 'green':
    # if bit.get_color returns 'green',
    # this condition is True
```

Recap: Conditions

- Conditions are statements that evaluate to either `True` or `False`

```
while bit.front_clear():
    # front_clear returns True or False
```

- The statement `left == right` is `True` if left is equal to right and `False` otherwise
- Adding the word `not` in front of a conditions changes it from `False` to `True` or from `True` to `False`

```
while not bit.get_color() == 'green':
    # if bit.get_color returns 'green',
    # this condition is False
```

go_niche

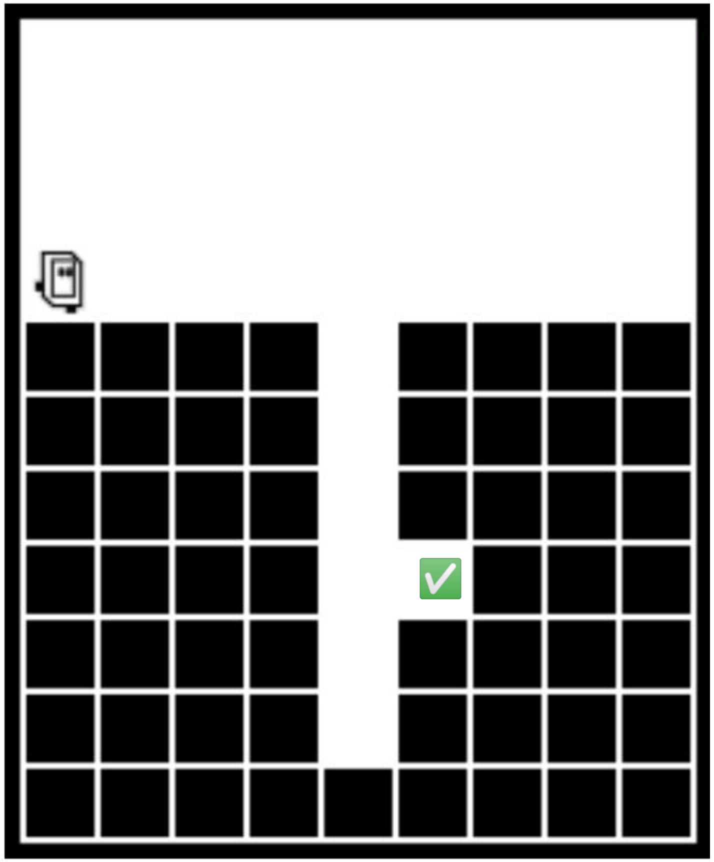
- Bit will start at some level of the world, on the left and facing right

- Every level below her will be blocked

- Except one “hole”

- The hole will have a one-block niche on the right side

- Get Bit to that niche



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Aside: Experimental Server Tricks

- Cmd-Return (Mac) or Ctrl-Return with cursor in code will Run (very handy when pounding away on your code)

- The system knows what the world is supposed to look like when the code works correctly

- If the output is correct at the end of the run, it gets a green checkmark

- "diff" Feature - diagonal red marks on incorrect squares

More practice: Bit Loop

Today

- ~~Recap while loops and conditions~~

- **Introduce if/else statements**

- Introduce Decomp

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If statements

```
if #condition:
    # block 1 runs if condition is True
# block 2 that runs regardless
```

1. First the condition is checked (it should be `True` or `False`, more on that later)
2. If the condition is `True`, the code in block 1 runs, otherwise skip to step 3
3. The code in block 2 runs

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Move bit (at most) once

```
if bit.front_clear(): ✅
    bit.move()
bit.paint('green')
```

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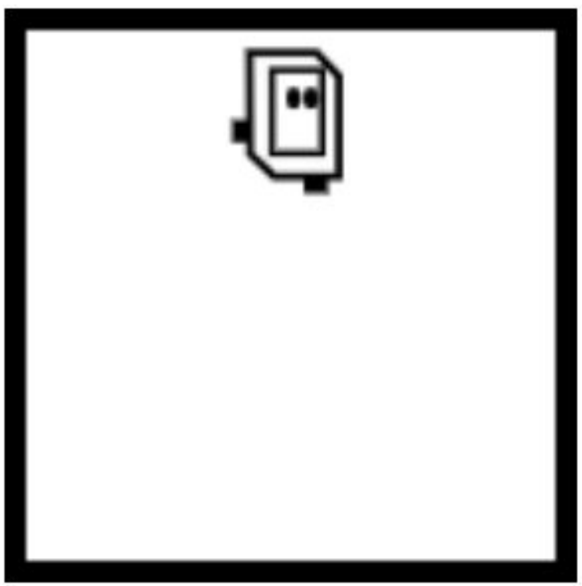
Move bit (at most) once

```
if bit.front_clear():
    bit.move()
bit.paint('green')
```



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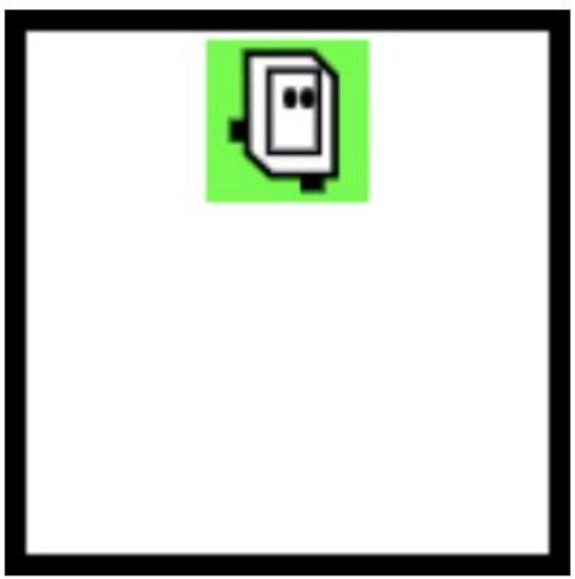
Move bit (at most) once

```
if bit.front_clear():
    bit.move()
bit.paint('green')
```



Bit paints the **second square green**

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Move bit (at most) once

```
if bit.front_clear(): 🚫
    bit.move()
bit.paint('green')
```

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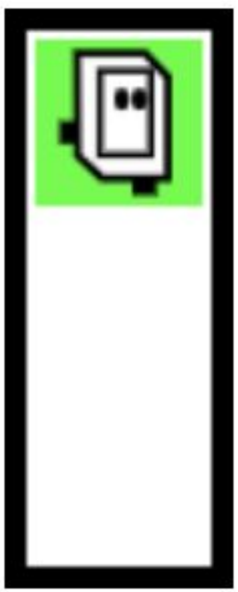
Move bit (at most) once

```
if bit.front_clear():
    bit.move()
bit.paint('green')
```



Bit paints the **first square green**

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Move bit (at most) once

```
if bit.front_clear():
    bit.move()
bit.paint('green')
```

Key idea: Bit may or may not move, but she will always paint green

If/else statements

```
if #condition:
    # block 1 runs if condition is True
else:
    # block 2 runs if condition is False
# block 3 runs regardless
```

Key idea: *exactly one* of block 1 and block 2 will run: never both, never neither. Block 3 always runs

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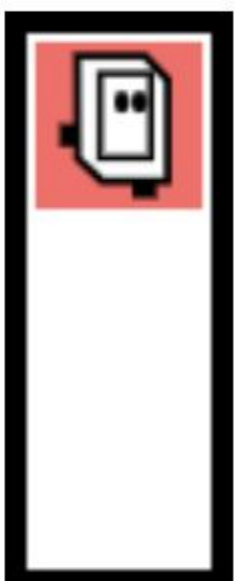
If/else statements

```
if bit.front_clear():
    bit.paint('green')
else:
    bit.paint('red')
bit.right()
```

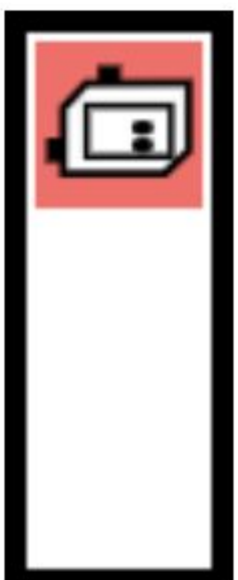
If/else statements

```
if bit.front_clear():
    bit.paint('green')
else:
    bit.paint('red')
bit.right()
```



If/else statements

```
if bit.front_clear():
    bit.paint('green')
else:
    bit.paint('red')
bit.right()
```



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If/else statements

```
if bit.front_clear(): 🚫
    bit.paint('green')
else:
    bit.paint('red')
bit.right()
```

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If/else statements

```
if bit.front_clear():
    bit.paint('green')
else:
    bit.paint('red')
bit.right()
```

If/else statements

```
if bit.front_clear():
    bit.paint('green')
else:
    bit.paint('red')
bit.right()
```

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Put it all together: loops+ifs

double_move

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Today

- ~~Recap while loops and conditions~~
- ~~Introduce if/else statements~~
- **Introduce Decomp**

Another look at functions

- In every bit exercise so far, we have implemented only 1 function to solve the entire problem - we see **`def`** only once

```
def bit_func(filename):
  # all the code to solve the problem!
```

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Another look at functions

- In every bit exercise so far, we have implemented only 1 function to solve the entire problem - we see **`def`** only once
- We often call bit-specific functions while solving:

```
def go_south(bit):
   bit.right()
   if bit.front_clear():
      bit.move()
```

- “Calling” a function means to run its code - your solution function is “called” by the experimental server when you hit run

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Calling functions

- Only Bit knows about `move` and `front_clear`, so we have to access them through Bit when calling with `bit.move()`

- But the function `go_south` is available for anyone to call!

```
def go_south(bit):
    bit.right()
    if bit.front_clear():
        bit.move()
```

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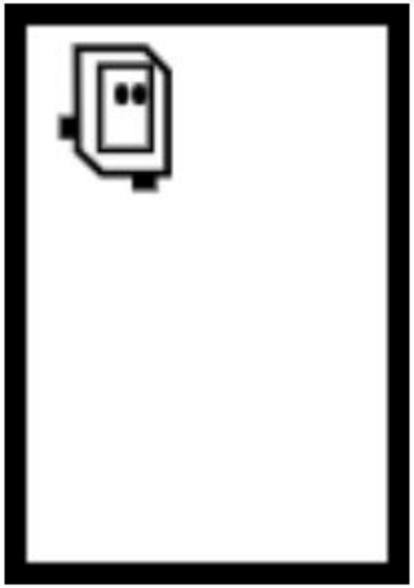
Calling functions

We call `go_south` in another function like so:

```
def go_south(bit):
    bit.right()
    if bit.front_clear():
        bit.move()

def paint_south(filename):
    bit = Bit(filename)
    go_south(bit)
    bit.paint('green')
```

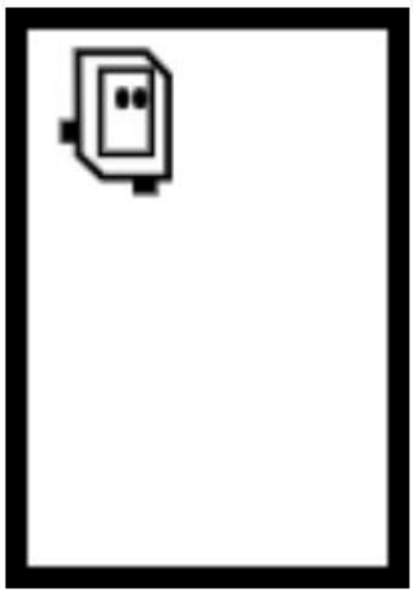
Run paint_south

```
def go_south(bit):
    bit.right()
    if bit.front_clear():
        bit.move()

def paint_south(filename):
    bit = Bit(filename)
    go_south(bit)
    bit.paint('green')
```



Run paint_south

```
def go_south(bit):
    bit.right()
    if bit.front_clear():
        bit.move()

def paint_south(filename):
    bit = Bit(filename)
    go_south(bit) # function call!
    bit.paint('green')
```



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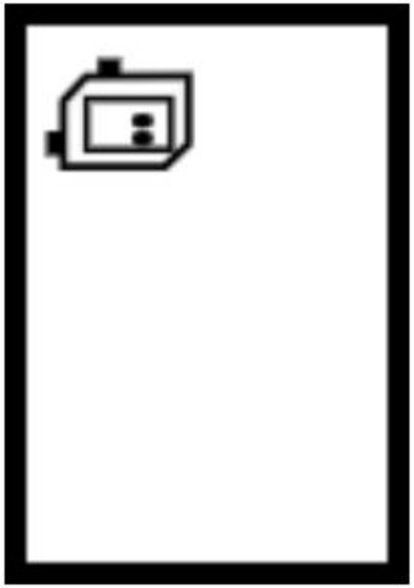
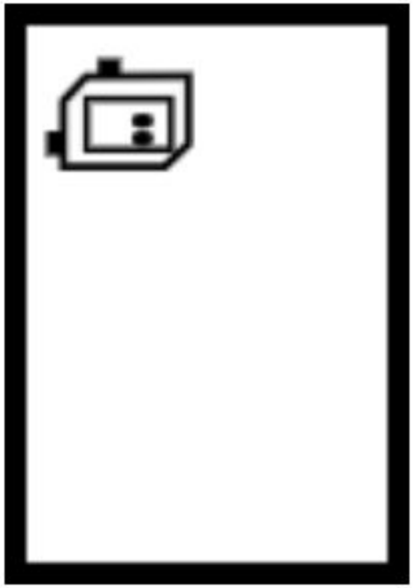
Run paint_south

```
def go_south(bit):
    bit.right()
    if bit.front_clear():
        bit.move()

def paint_south(filename):
    bit = Bit(filename)
    go_south(bit) # pause here
    bit.paint('green')
```



Run paint_south

```
def go_south(bit):
    bit.right()
    if bit.front_clear():
        bit.move()

def paint_south(filename):
    bit = Bit(filename)
    go_south(bit)  # pause here
    bit.paint('green')
```



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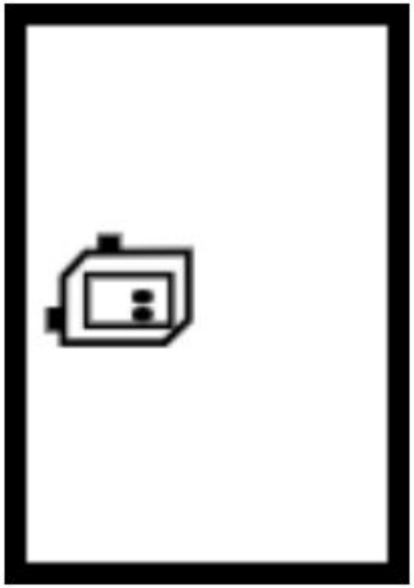
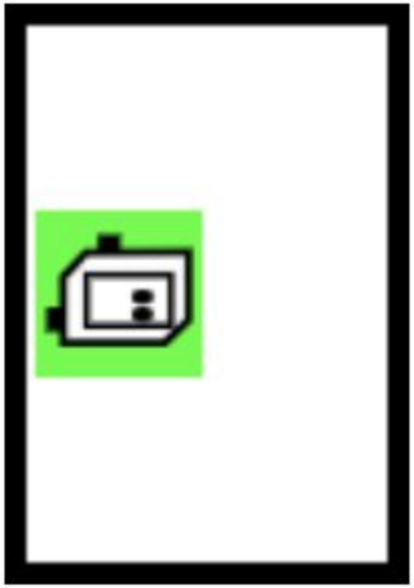
Run paint_south

```
def go_south(bit):
    bit.right()
    if bit.front_clear():
        bit.move() # done!

def paint_south(filename):
    bit = Bit(filename)
    go_south(bit) # done here too!
    bit.paint('green')
```



Run paint_south

```
def go_south(bit):
    bit.right()
    if bit.front_clear():
        bit.move() # done!

def paint_south(filename):
    bit = Bit(filename)
    go_south(bit)
    bit.paint('green')
```



Calling functions recap

```
def func1():
    # code block A

def func2():
    # code block B
    func1()
    # code block C
```

Running func2:

1. Run code block B
2. Run code block A
3. Run code block C

Syntax note

```
def helper_function(bit):
    # must "take in" bit

def main_bit_problem(filename):
    # required first line
    bit = Bit(filename)
    helper_function(bit) # must "pass in" bit
```

We will talk about this more later, but for now, when decomposing Bit functions:

1. Always take in bit when defining (put "**`bit`**" in parenthesis after **`def function_name`**)
2. Always pass in bit when calling

Why make multiple functions?

- Often a task breaks down into smaller logical tasks like:
  "Go to the farthest wall"
  "Spin in a circle"
  "Paint 3 squares"
- Those tasks can be nicely decomposed into separate functions, and then you could call them from your solution, and it becomes nice and readable!

```
def soln(filename):
    bit = Bit(filename)
    go_to_far_wall(bit)
    spin(bit)
    paint_3(bit)
```

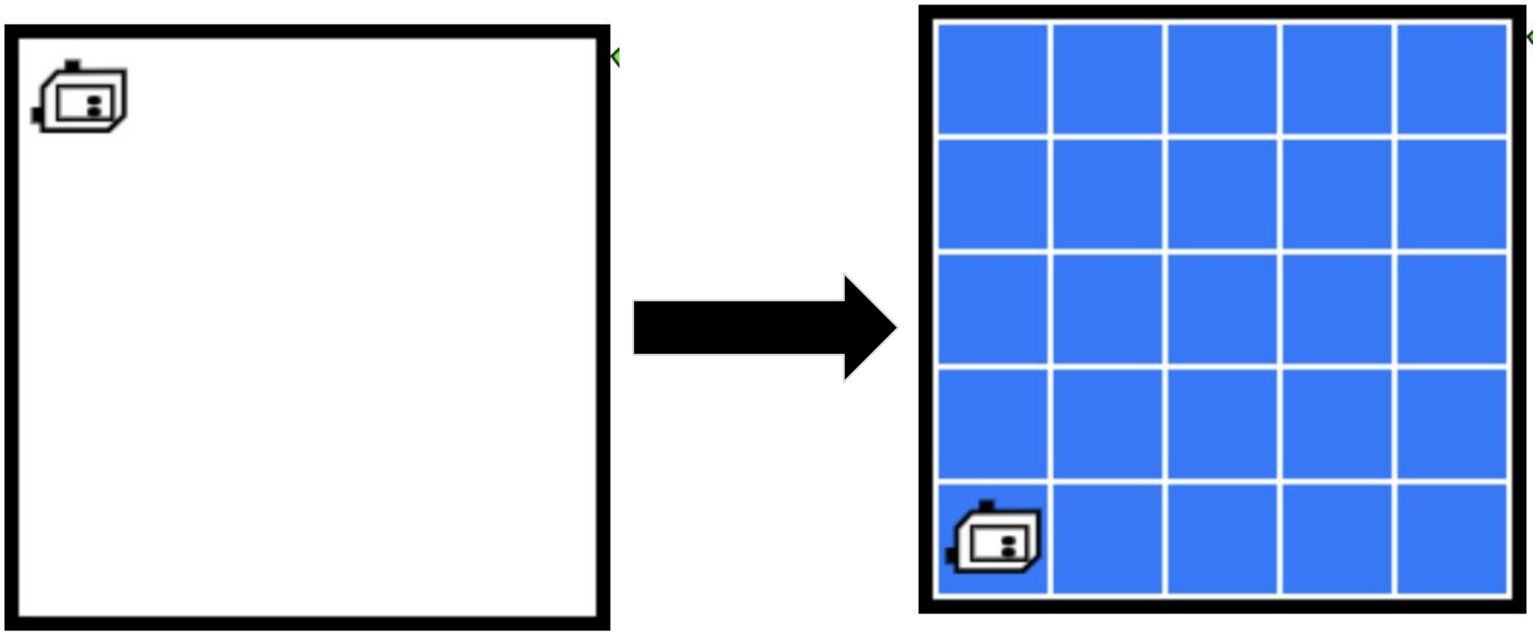
Why make multiple functions?

```
def soln(filename):
    bit = Bit(filename)
    go_to_far_wall(bit)
    spin(bit)
    paint_3(bit)
```

- It is good style to decompose (decomp) your solution
- It makes your code readable for your collaborators (and for Future You)
- It can help you solve a big problem by making you solve several small ones

Put it all together: fill_world_blue

- Bit starts at the top-left corner of the world facing **down**
- The world has no obstacles (black squares)
- Fill every square in the world blue
- Use the provided function **`fill_row_blue()`**



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Investigate fill_row_blue

- When using "helper" functions to solve a bigger problems, it is good to define the pre and post conditions for that helper

- **Pre conditions**: does fill_row_blue assume that bit is facing a certain direction? Does it assume she is unblocked?
- **Post conditions**: What does the world look like after calling fill_row_blue? Where is bit? Where is she facing?

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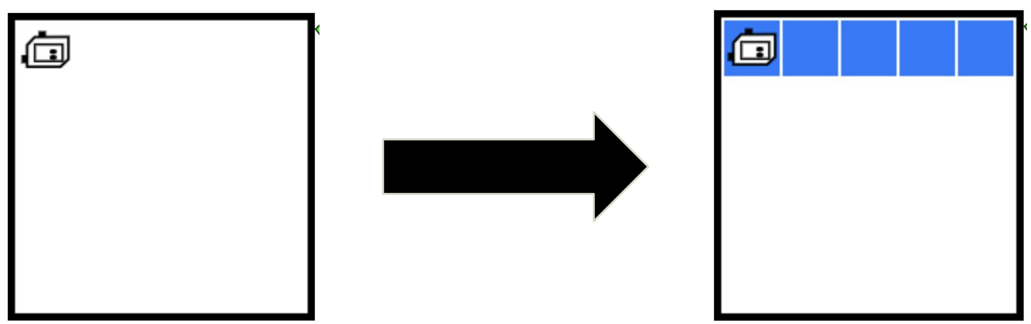
Investigate fill_row_blue

- When using “helper” functions to solve a bigger problems, it is good to define the pre and post conditions for that helper

- **Pre conditions**: Assume bit is facing down at left edge

- **Post conditions**: The row bit is on is blue and she is back where she started, facing down



Lets code: fill_world_blue

If time: blue_dip

Bonus

if/elif and if/elif/else

We will revisit this later in the quarter!

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If/elif statements

```
if #condition1:
    # block A runs if condition1 is True
elif #condition2:
    # block B runs if condition 1 is False
    # and condition2 is true
elif #condition3:
    # block C runs if conditions 1 and 2
    # are False and condition3 is true
    # Can have many more elifs here
```

Key idea: *at most one* of block A, B and C will run, but it's possible for none to run

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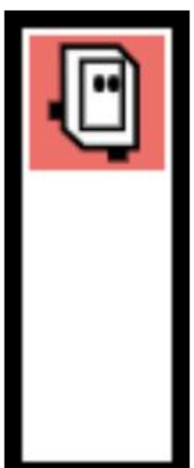
If/elif statements

```
if bit.get_color() == 'red': ✅
    bit.paint('green')
elif bit.get_color() == 'green':
    bit.paint('red')
elif bit.get_color() == None:
    bit.paint('blue')
bit.right()
```



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If/elif statements

```
if bit.get_color() == 'red':
    bit.paint('green')
elif bit.get_color() == 'green':
    bit.paint('red')
elif bit.get_color() == None:
    bit.paint('blue')
bit.right()
```

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If/elif statements

```
if bit.get_color() == 'red':
    bit.paint('green')
elif bit.get_color() == 'green':
    bit.paint('red')
elif bit.get_color() == None:
    bit.paint('blue')
bit.right()
```

Note: we don't check any of the other conditions once we run a block (even though the second condition would now be true)

If/elif statements

```
if bit.get_color() == 'red':
    bit.paint('green')
elif bit.get_color() == 'green':
    bit.paint('red')
elif bit.get_color() == None:
    bit.paint('blue')
bit.right()
```

English summary of this code snippet?

If/elif statements

```
if bit.get_color() == 'red':
    bit.paint('green')
elif bit.get_color() == 'green':
    bit.paint('red')
elif bit.get_color() == None:
    bit.paint('blue')
bit.right()
```

English summary of this code snippet?
If a square is red or green, switch it to be the other one, and if its blank, make it blue.
(do nothing to blue squares)

If/elif/else statements

```
if #condition1:
    # block A runs if condition1 is True
elif #condition2:
    # block B runs if condition 1 is False
    # and condition2 is true
    # Can have many more elifs here
else:
    # block C runs if conditions 1 and 2
    # are False
```

Key idea: *exactly one* of block A, B and C will run, never none, never more than one

If/elif/else statements

```
if bit.front_clear():
    bit.move()
elif bit.right_clear():
    bit.right()
    bit.move()
elif bit.left_clear():
    bit.left()
    bit.move()
else:
    bit.paint('red')
```

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If/elif/else statements

```
if bit.front_clear():
    bit.move()
elif bit.right_clear():
    bit.right()
    bit.move()
elif bit.left_clear():
    bit.left()
    bit.move()
else:
    bit.paint('red')
```

English summary: Bit will move at most once, in the first clear direction she finds, or she will paint red

If/elif/else statements

```python
if bit.front_clear():
    bit.move()
elif bit.right_clear():
    bit.right()
    bit.move()
elif bit.left_clear():
    bit.left()
    bit.move()
```

```python
if bit.front_clear():
    bit.move()
if bit.right_clear():
    bit.right()
    bit.move()
if bit.left_clear():
    bit.left()
    bit.move()
```

How are 3 ifs different from if, elif, elif?

If/elif/else statements

```
if bit.front_clear():
    bit.move()
elif bit.right_clear():
    bit.right()
    bit.move()
elif bit.left_clear():
    bit.left()
    bit.move()
```

```
if bit.front_clear():
    bit.move()
if bit.right_clear():
    bit.right()
    bit.move()
if bit.left_clear():
    bit.left()
    bit.move()
```

How are 3 ifs different from if, elif, elif?

Bit could move at most once with the code on the left, but could move many times on the right

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Recap

- While loops are powerful and we can use any condition as our test to keep going!

- We can also use if statements with any conditions to run something only **once** if the condition is true

- We can decompose big problems into smaller functions, and call them from our main solution function!

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