

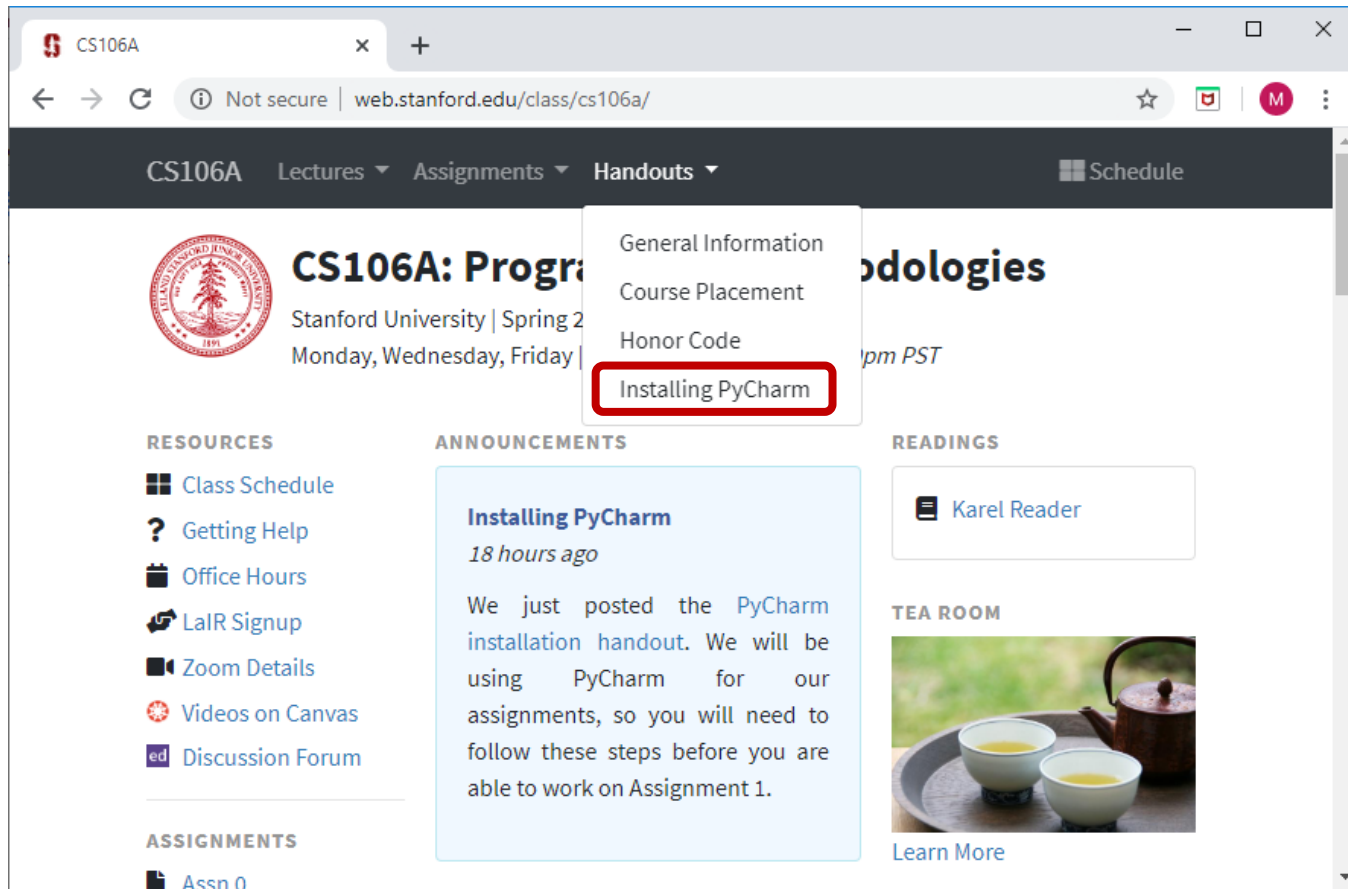
Control Flow

Chris Gregg

CS106A, Stanford University

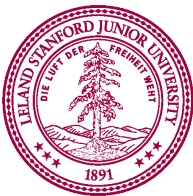
Modified from slides courtesy of
Chris Piech and Mehran Sahami

Install PyCharm

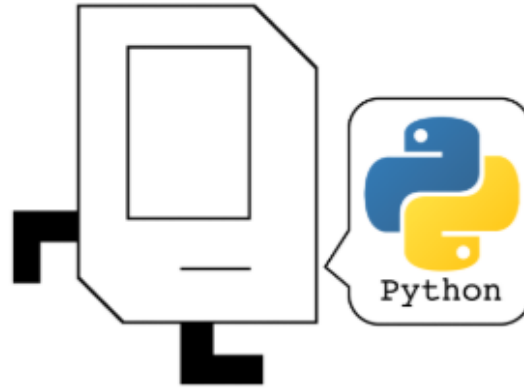


The screenshot shows a web browser window displaying the CS106A course page on Stanford University's website. The browser's address bar shows the URL `web.stanford.edu/class/cs106a/`. The page has a dark navigation bar with links for "Lectures", "Assignments", "Handouts", and "Schedule". A dropdown menu is open from the "Handouts" link, showing options: "General Information", "Course Placement", "Honor Code", and "Installing PyCharm". The "Installing PyCharm" option is highlighted with a red rectangular border. Below the navigation bar, the page features the Stanford University seal, the course title "CS106A: Program", and the semester "Stanford University | Spring 2020". The page is organized into sections: "RESOURCES" (Class Schedule, Getting Help, Office Hours, LaIR Signup, Zoom Details, Videos on Canvas, Discussion Forum), "ANNOUNCEMENTS" (a post titled "Installing PyCharm" from 18 hours ago), "READINGS" (Karel Reader), and "TEA ROOM" (a photo of tea). The "ASSIGNMENTS" section at the bottom shows "Assn 0".

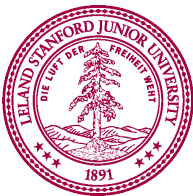
Please follow instructions *closely*.
Email Brahm if you have problems.



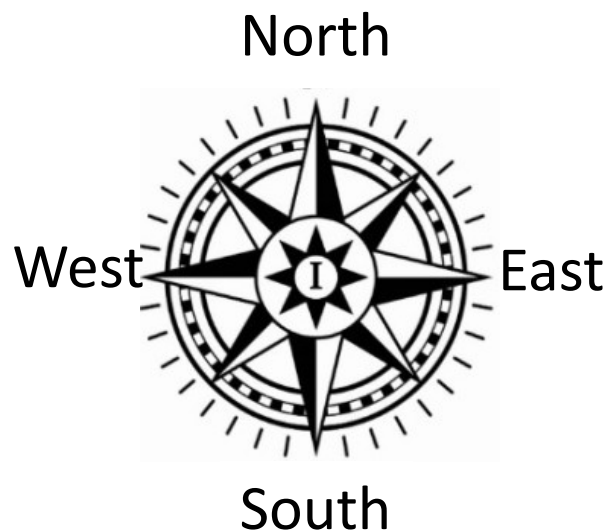
Using Karel and Assignment 1



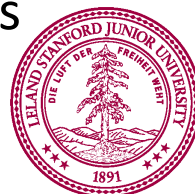
- Reading: Should read the “Karel Reader” on class website
- Handout #3: “Honor Code”
- Handout #4: “Using Karel with PyCharm”
 - Tells you how to get started with writing Karel programs
- Handout #5: “Assignment 1”
 - Set of Karel programs for you to write
 - Due 10:30am (PDT) on Tuesday, June 30th
- Only use features of Karel in the course reader
 - No other features of Python may be used in Karel programs!



Recall, Karel's World



- Grid, where "corner" is intersection of each street/avenue
- Karel is currently on corner (1, 1)
- If Karel moved forward, Karel would be on corner (2, 1)
- Karel's beeper bag can have 0, 1, or more (up to infinite) beepers



First Lesson in Programming Style

```
from karel.stanfordkarel import *
```

```
"""
```

```
File: StepUpKarel.py
```

```
-----
```

```
Karel program, where Karel picks up a beeper,  
jumps up on a step and drops the beeper off.
```

```
"""
```

Multi-line
comment

```
def main():  
    move()  
    pick_beeper()  
    move()  
    turn_left()  
    move()  
    turn_right()  
    move()  
    put_beeper()  
    move()
```

SOFTWARE ENGINEERING PRINCIPLE:
Aim to make programs readable by *humans*

One line
comment

```
# Karel turns to the right
```

```
def turn_right():  
    turn_left()  
    turn_left()  
    turn_left()
```

Descriptive
names
(snake_case)

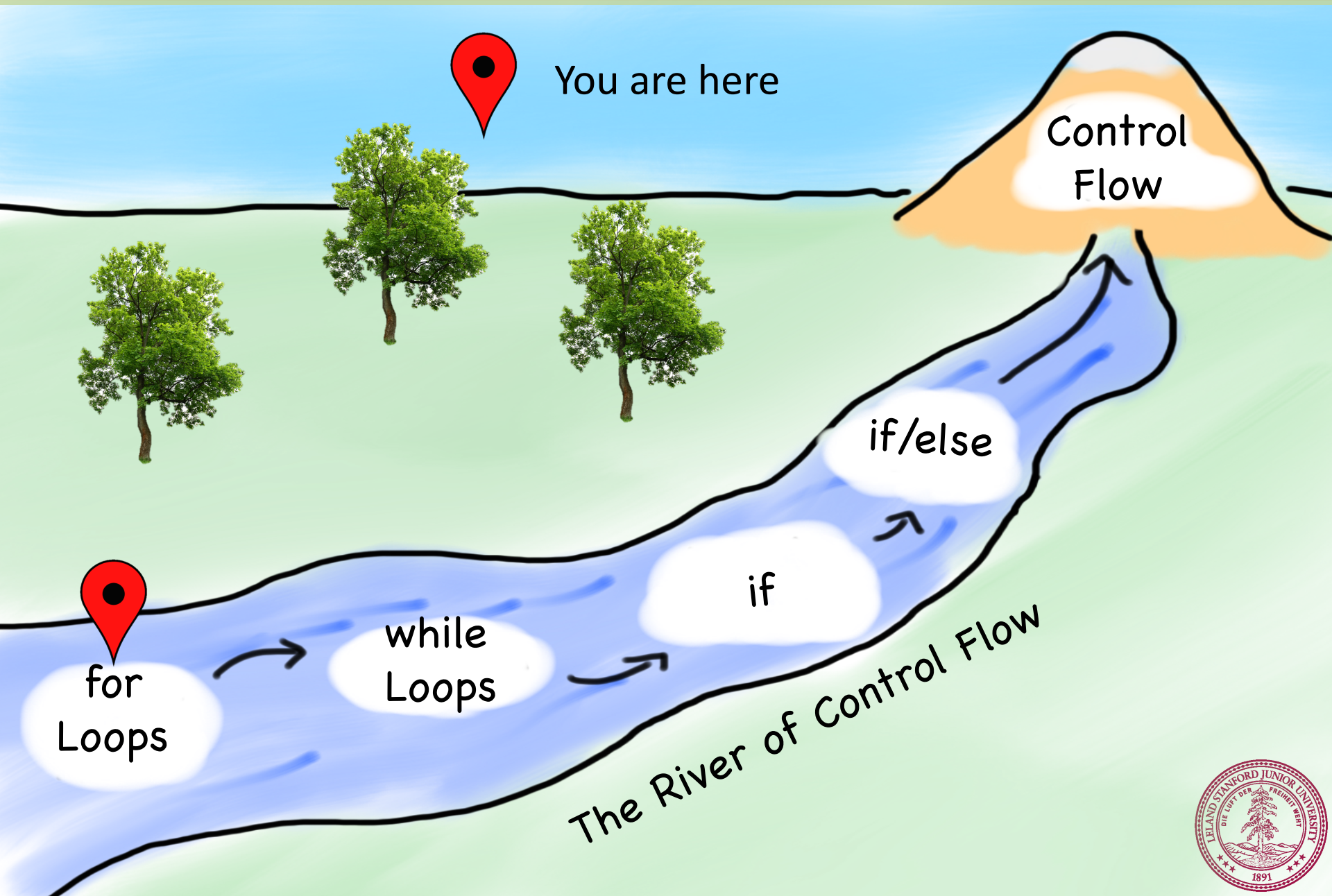


Today's Goal

1. Code using loops and conditions
2. Trace programs that use loops and conditions




Today's Route




for loop

```
for i in range(count) :  
    statements                # note indenting
```

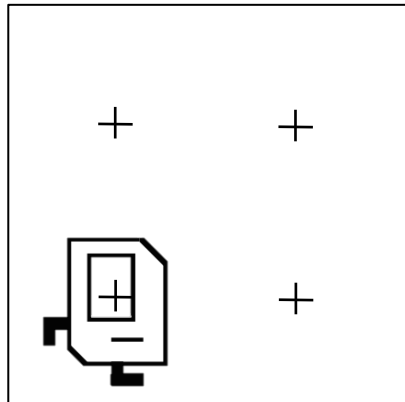


```
def turn_right():  
    for i in range(3):  
        turn_left()          # note indenting
```



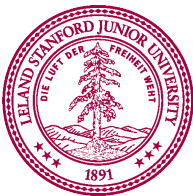
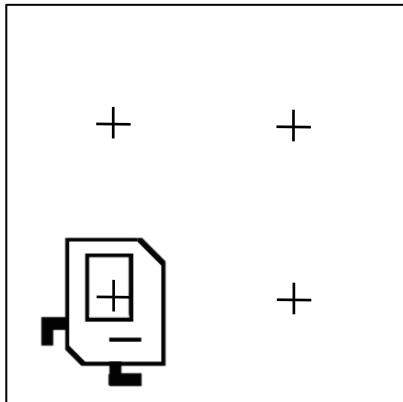
Place Beeper Square

```
def main():  
    for i in range(4):  
        put_beeper()  
        move()  
        turn_left()
```



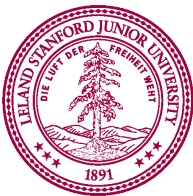
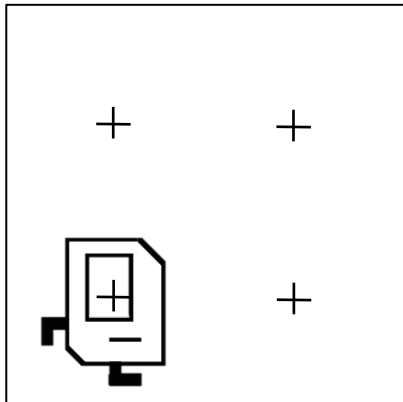
Place Beeper Square

```
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    for i in range(4):  
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        move()  
        turn_left()
```



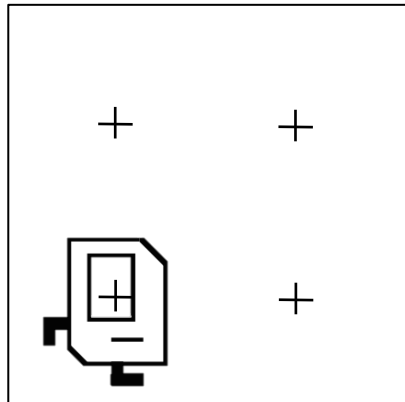
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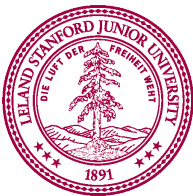


Place Beeper Square

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```

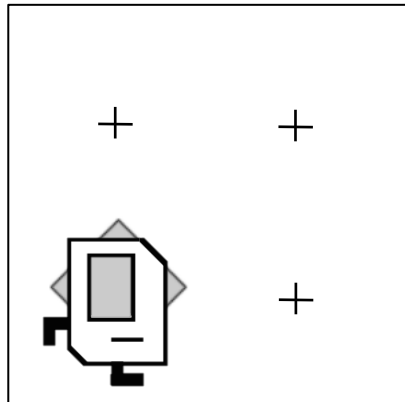


First time
through the
loop

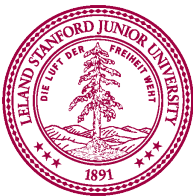


Place Beeper Square

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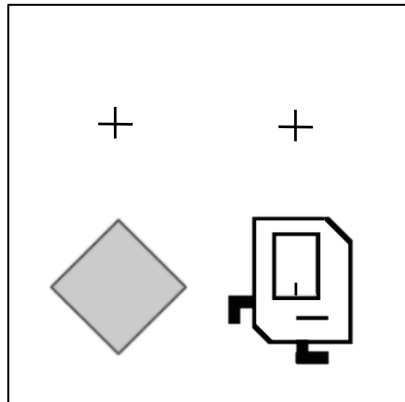


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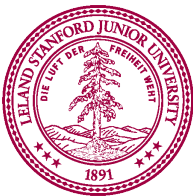


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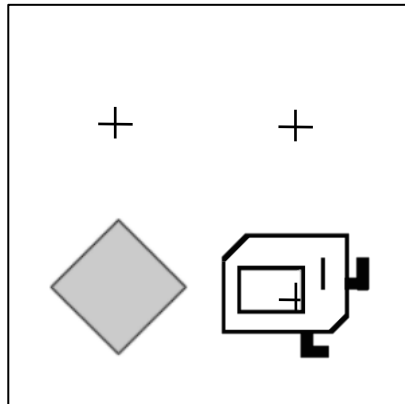


First time
through the
loop

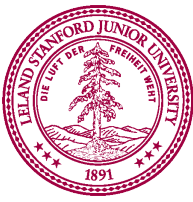


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```

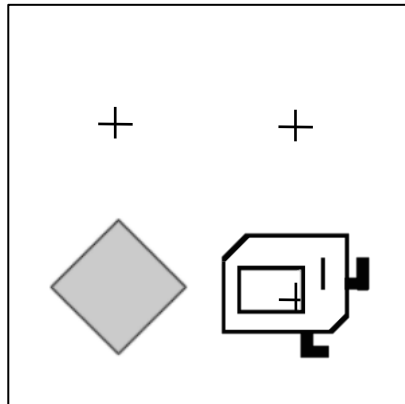


First time
through the
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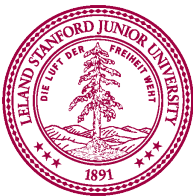


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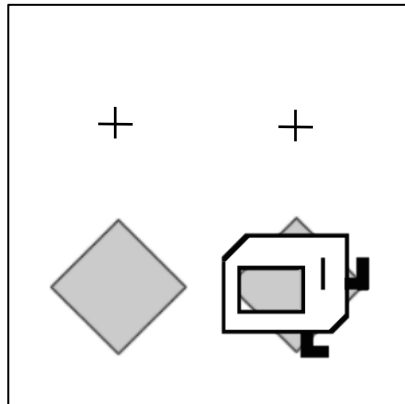


Second time
through the
loop

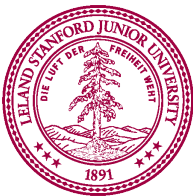


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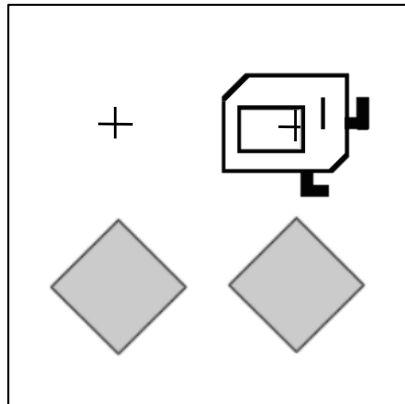


Second time
through the
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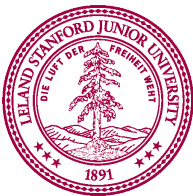


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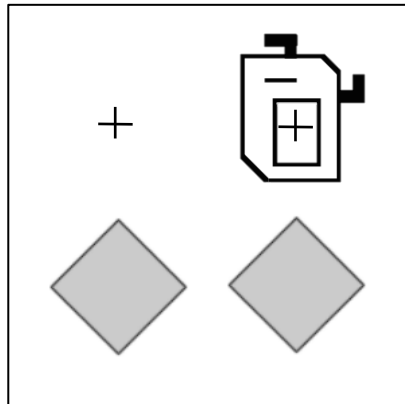


Second time
through the
loop

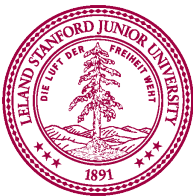


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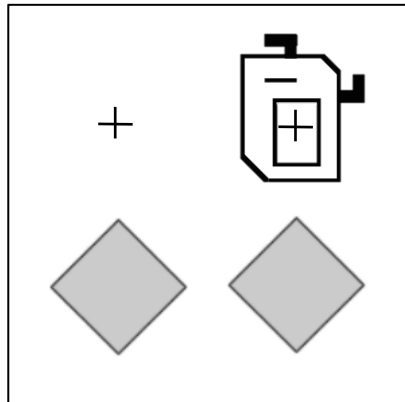


Second time
through the
loop

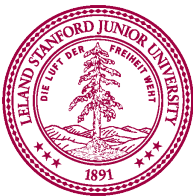


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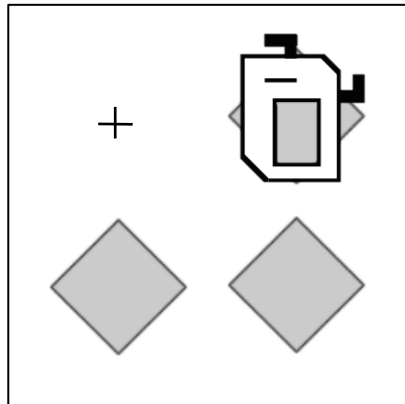


Third time
through the
loop

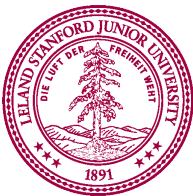


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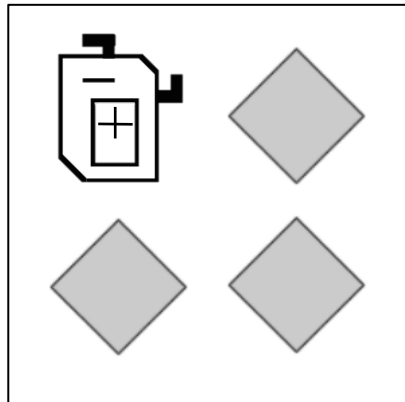


Third time
through the
loop

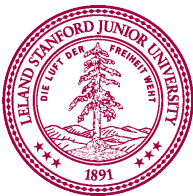


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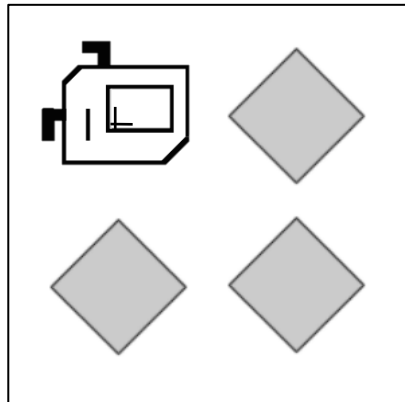


Third time
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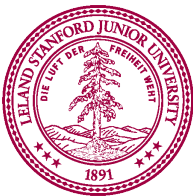


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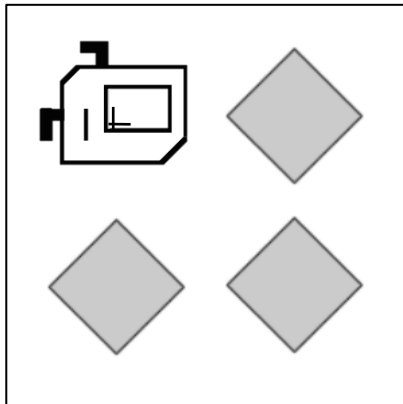


Third time
through the
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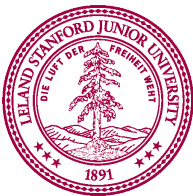


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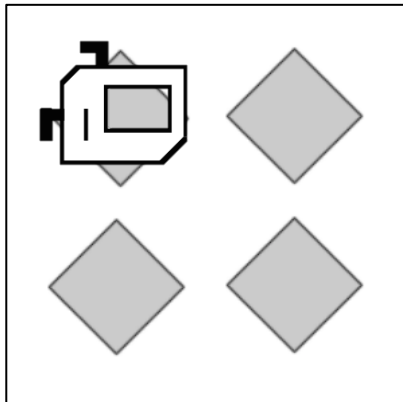


Fourth time
through the
loop

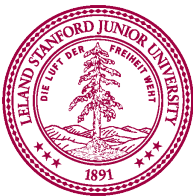


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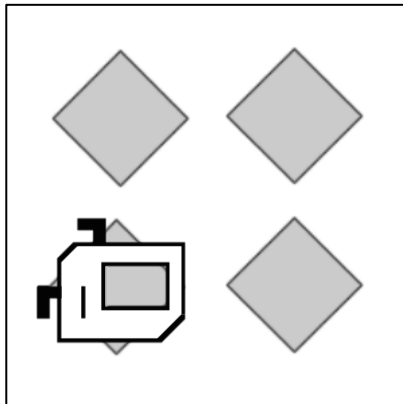


Fourth time
through the
loop

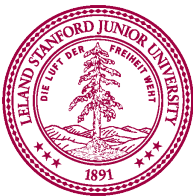


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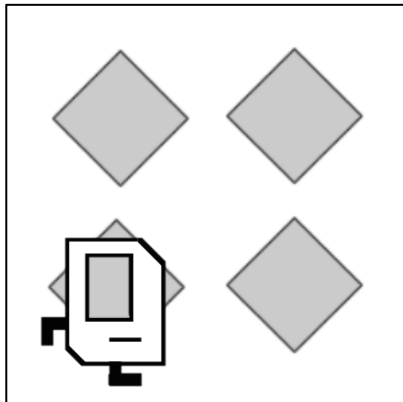


Fourth time
through the
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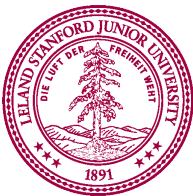


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Fourth time
through the
loop



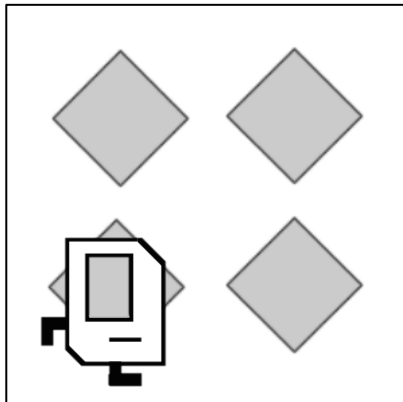
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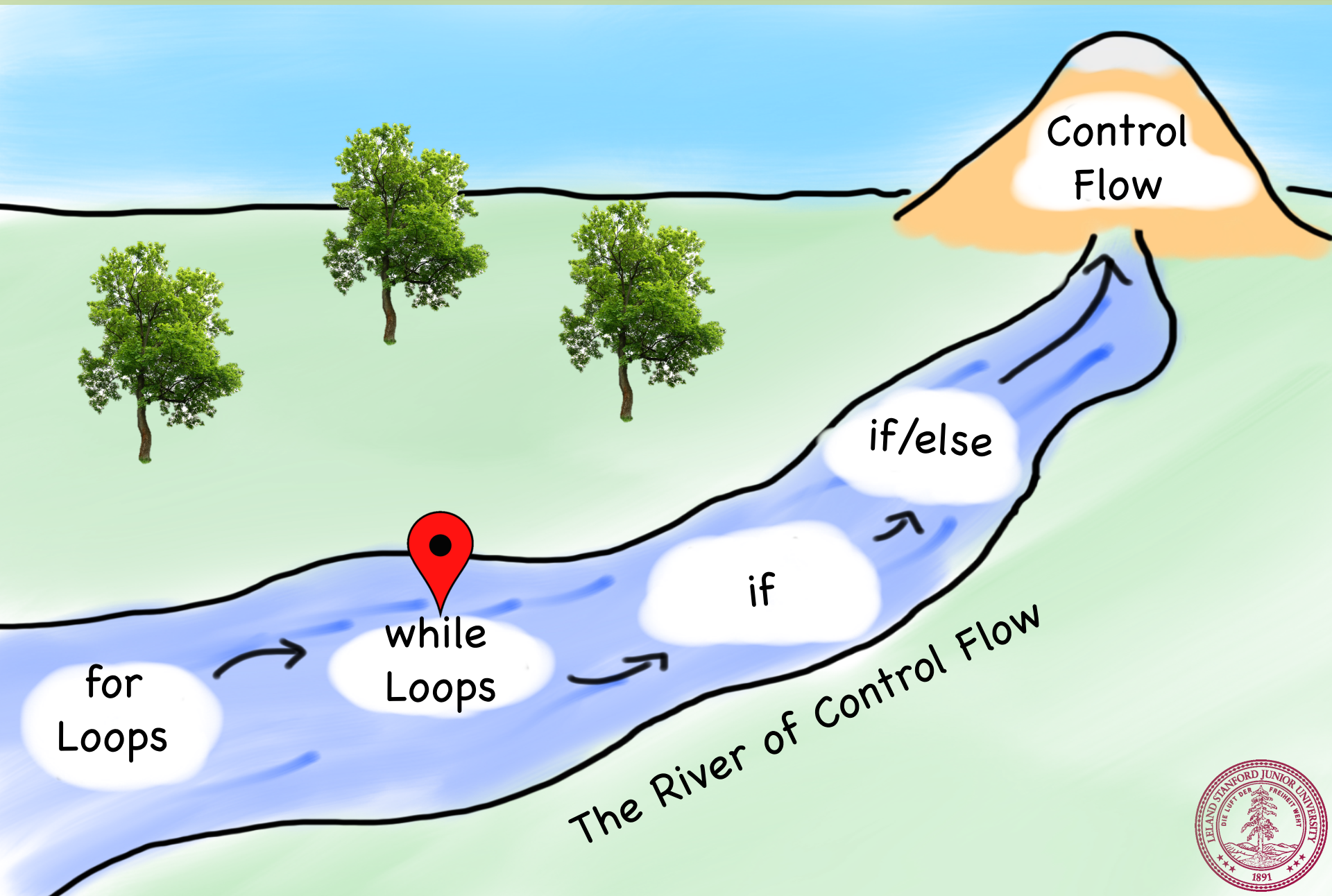


You need the **postcondition** of a loop to match the **precondition**

Done!



Today's Route



while loop

```
while condition:
```

```
    statements
```

```
# note indenting
```

```
def move_to_wall():
```

```
    while front_is_clear():
```

```
        move()
```

```
# note indenting
```

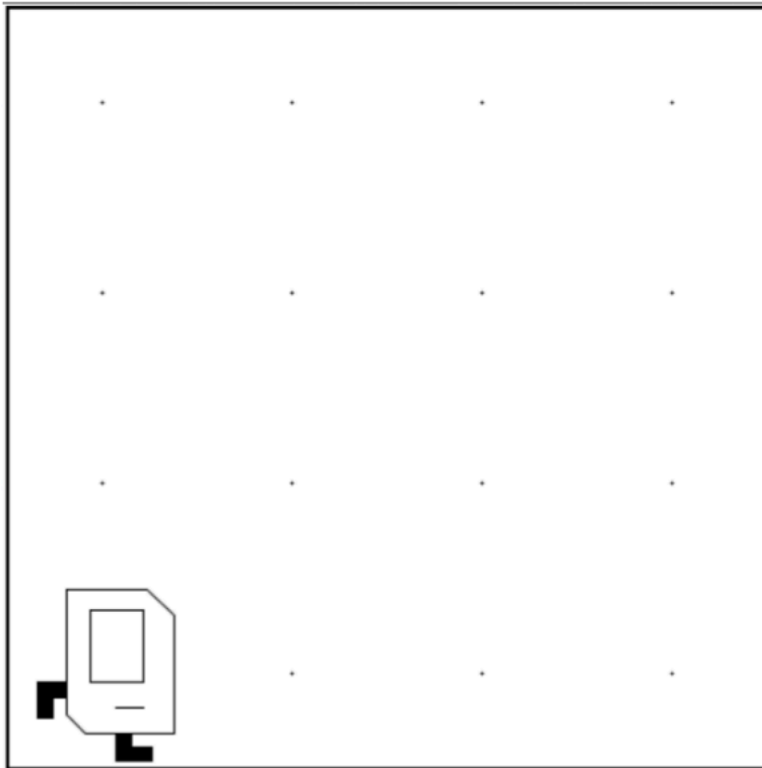
Conditions Karel Can Check For

<i>Test</i>	<i>Opposite</i>	<i>What it checks</i>
<code>front_is_clear()</code>	<code>front_is_blocked()</code>	Is there a wall in front of Karel?
<code>left_is_clear()</code>	<code>left_is_blocked()</code>	Is there a wall to Karel's left?
<code>right_is_clear()</code>	<code>right_is_blocked()</code>	Is there a wall to Karel's right?
<code>beepers_present()</code>	<code>no_beepers_present()</code>	Are there beepers on this corner?
<code>beepers_in_bag()</code>	<code>no_beepers_in_bag()</code>	Any there beepers in Karel's bag?
<code>facing_north()</code>	<code>not_facing_north()</code>	Is Karel facing north?
<code>facing_east()</code>	<code>not_facing_east()</code>	Is Karel facing east?
<code>facing_south()</code>	<code>not_facing_south()</code>	Is Karel facing south?
<code>facing_west()</code>	<code>not_facing_west()</code>	Is Karel facing west?

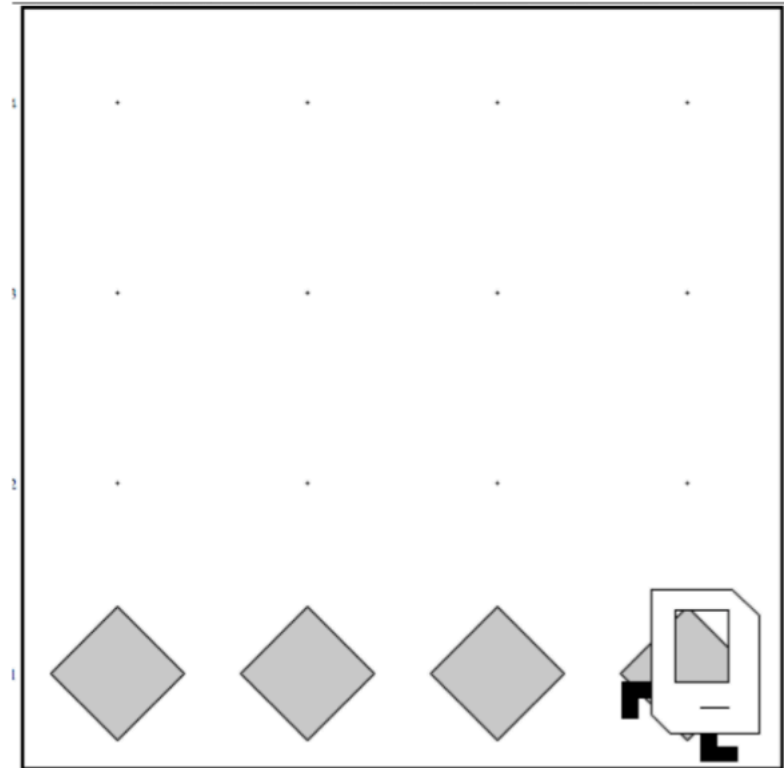
This is in Chapter 10 of the Karel course reader

Task: Place Beeper Line

Before

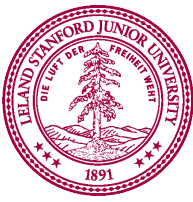


After



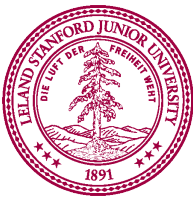
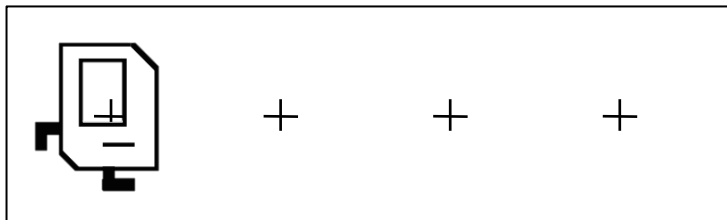
Place Beeper Line

```
def main():  
    while front_is_clear():  
        put_beeper()  
        move()
```



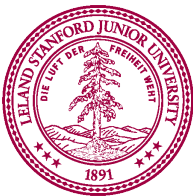
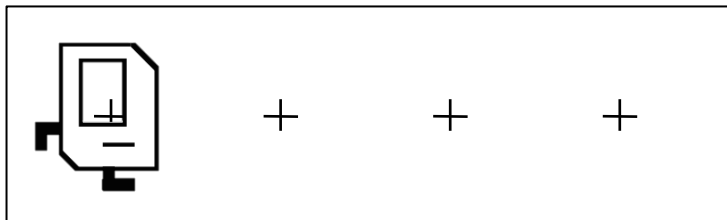
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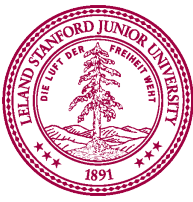
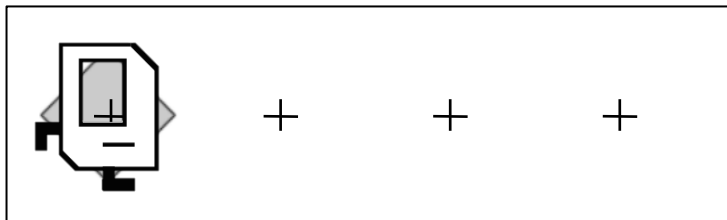
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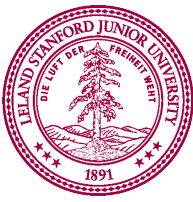
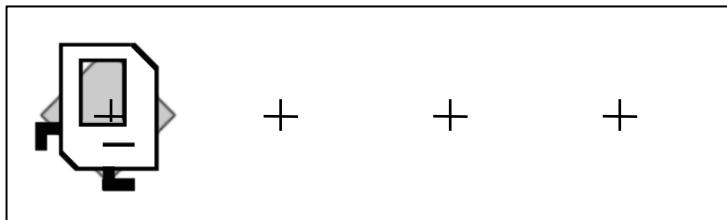
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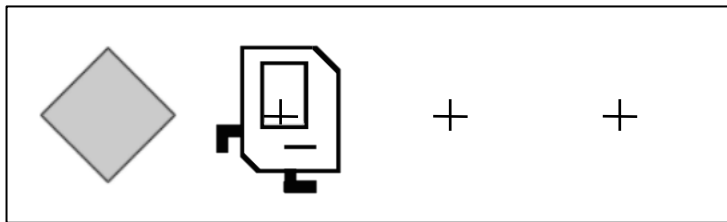
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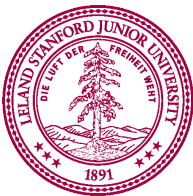
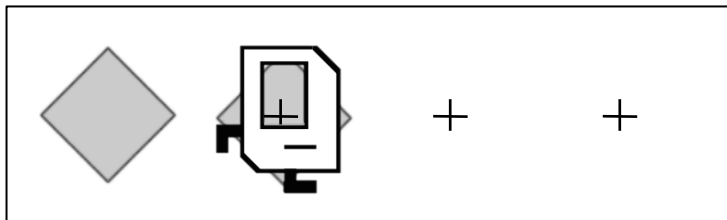
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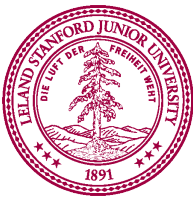
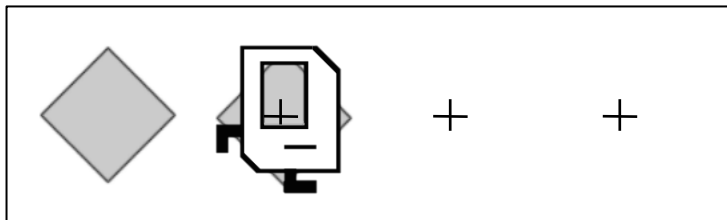
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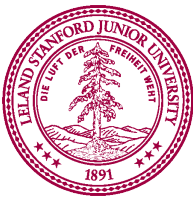
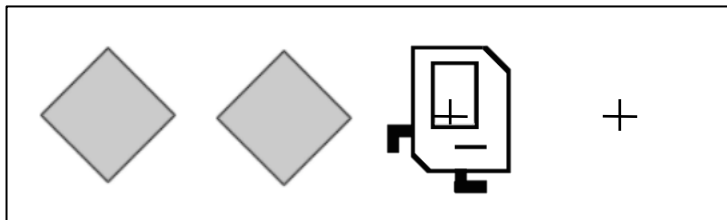
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        move()
```



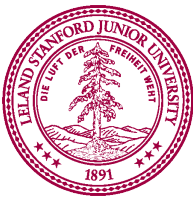
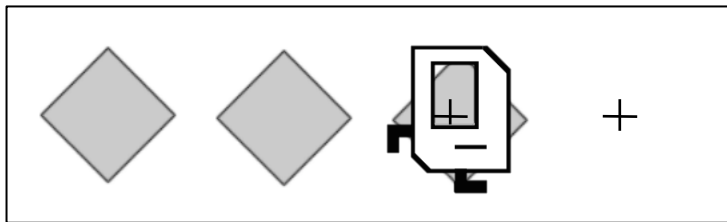
Place Beeper Line

```
def main():  
    while front_is_clear():  
        put_beeper()  
        move()
```



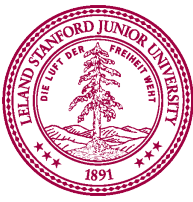
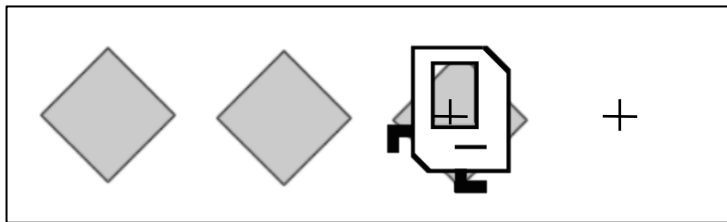
Place Beeper Line

```
def main():  
    while front_is_clear():  
        put_beeper()  
        move()
```



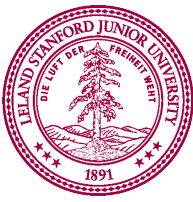
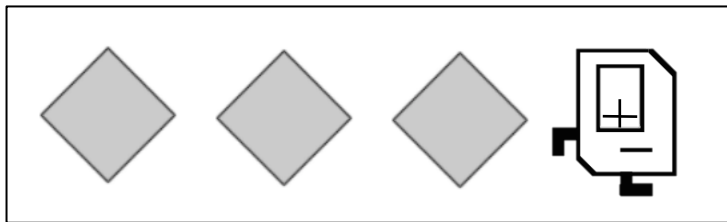
Place Beeper Line

```
def main():  
    while front_is_clear():  
        put_beeper()  
        move()
```



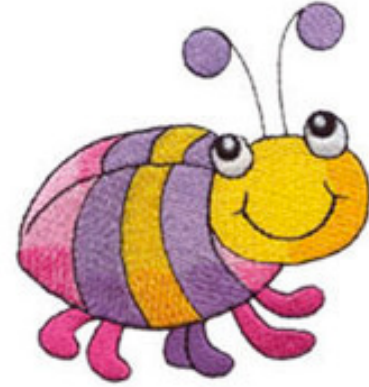
Place Beeper Line

```
def main():  
    while front_is_clear():  
        put_beeper()  
        move()
```



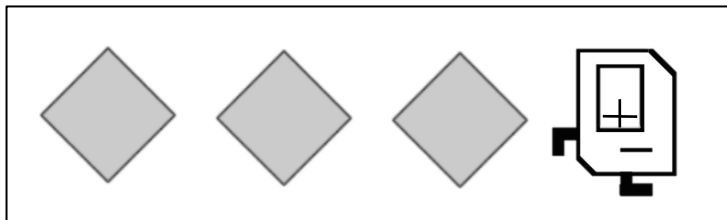
Place Beeper Line

```
def main():  
    while front_is_clear():  
        put_beeper()  
        move()
```

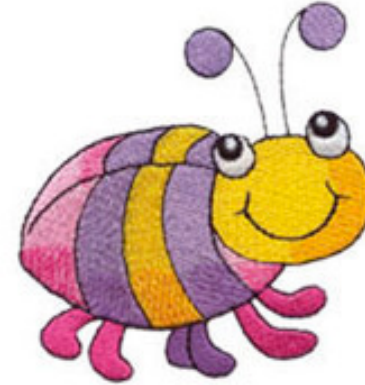


BUGGY!

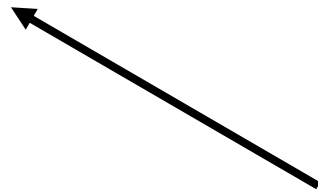
Done!



Place Beeper Line

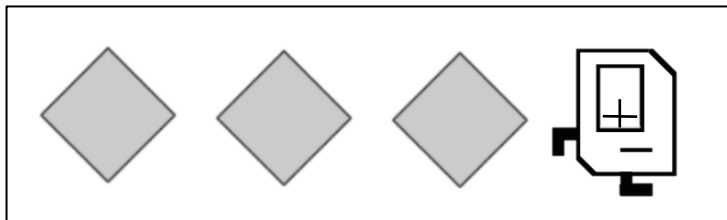


```
def main():  
    while front_is_clear():  
        put_beeper()  
        move()  
    put_beeper()           # add final put_beeper
```



Not in **while** loop

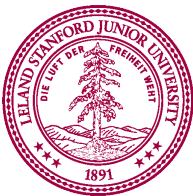
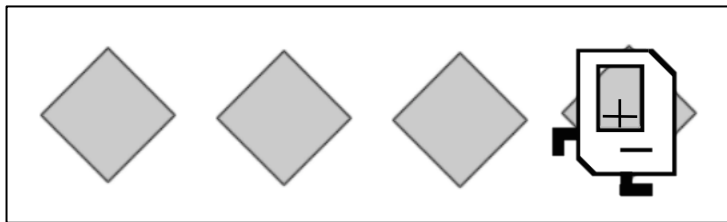
Fixed!



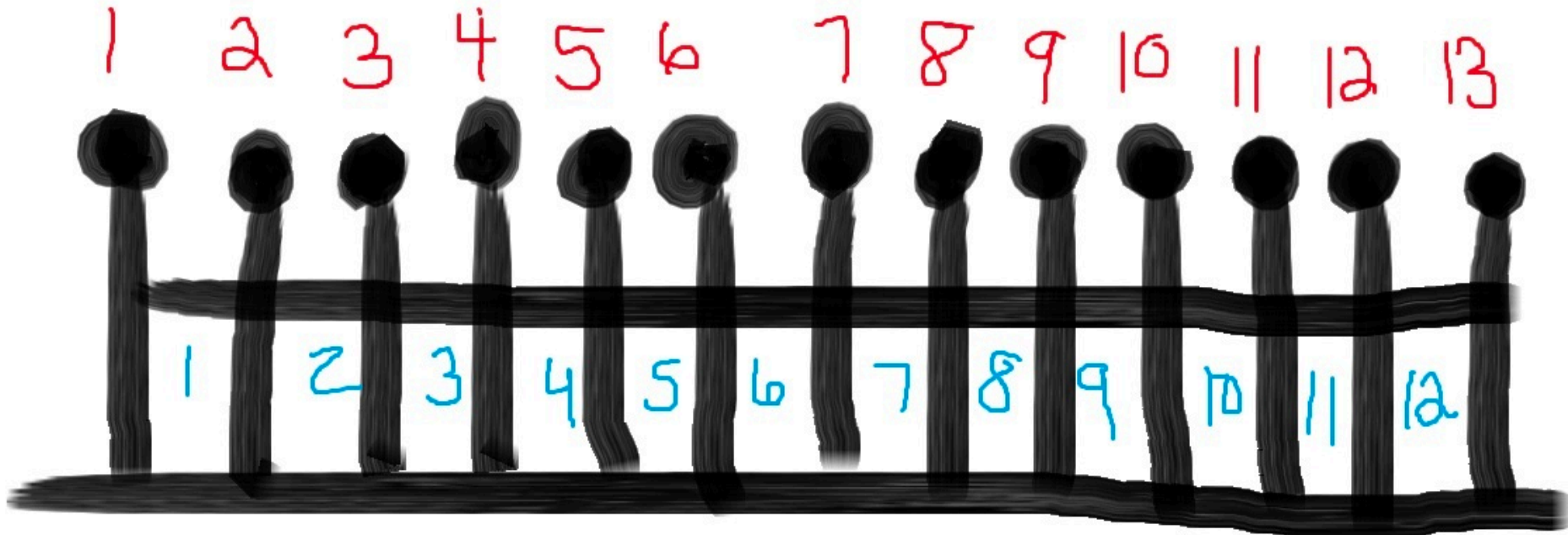
Place Beeper Line

```
def main():  
    while front_is_clear():  
        put_beeper()  
        move()  
    put_beeper()           # add final put_beeper
```

Fixed!



Fence Post Problem

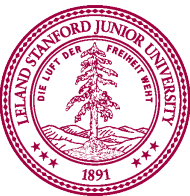


Also sometimes called an “Off By One Error”

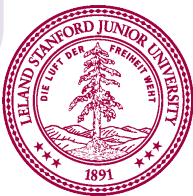
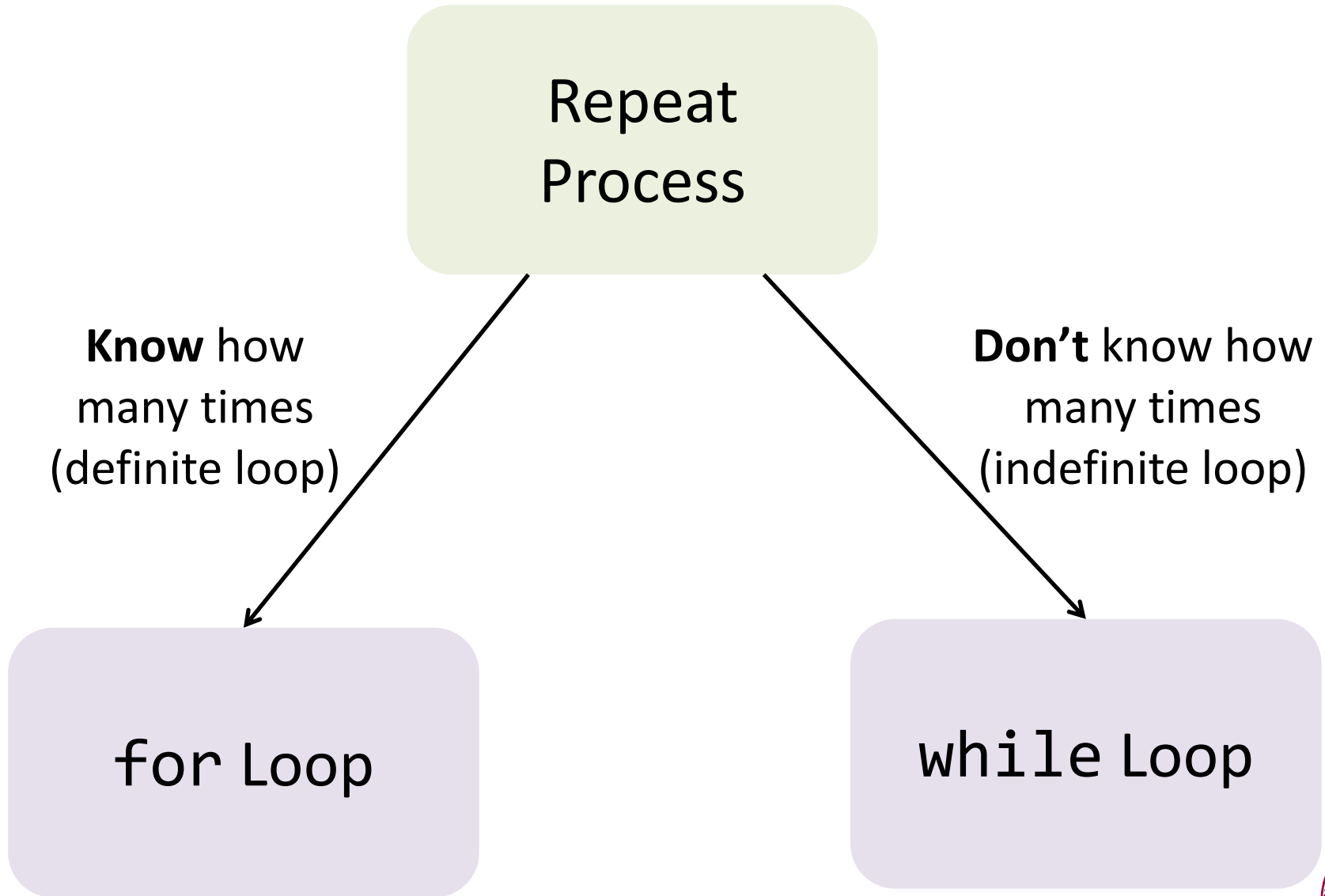


A program executes one line at a time.

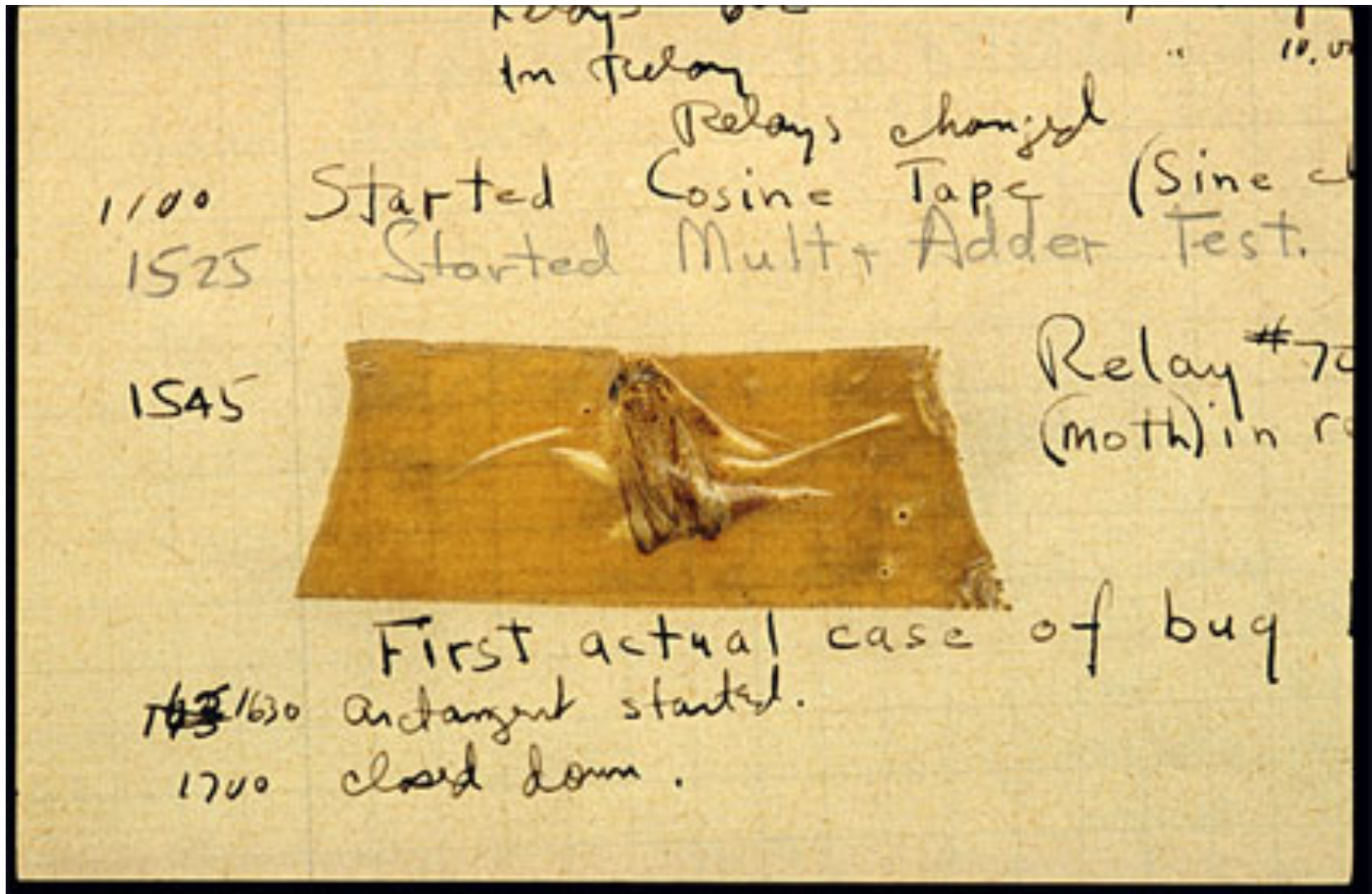
The **while** loop checks its condition only at the start of the code block and before repeating.



Which Loop



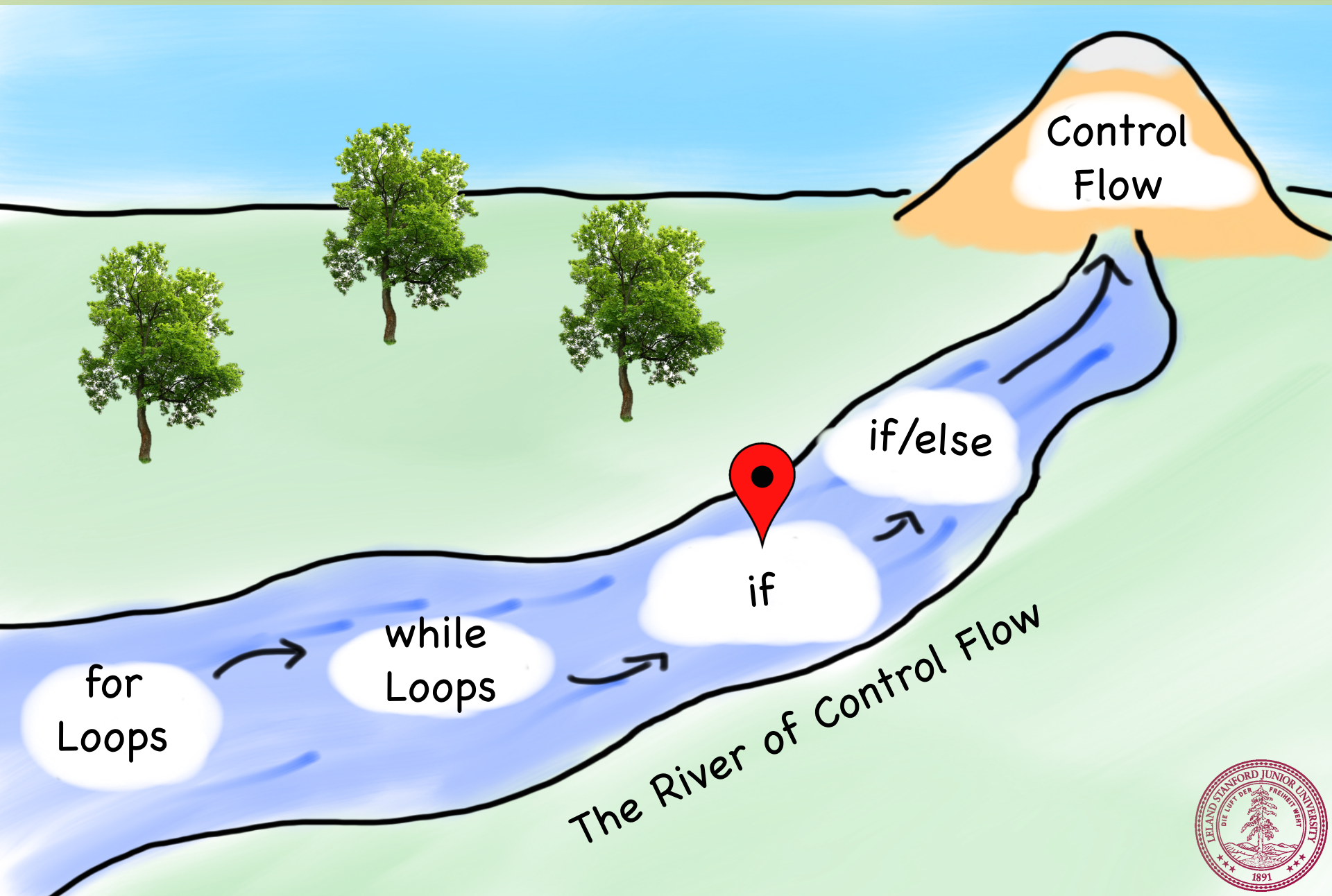
Actual Bug from Marc II



Grace Hopper



Today's Route



if statement

if *condition*:

 *statements*

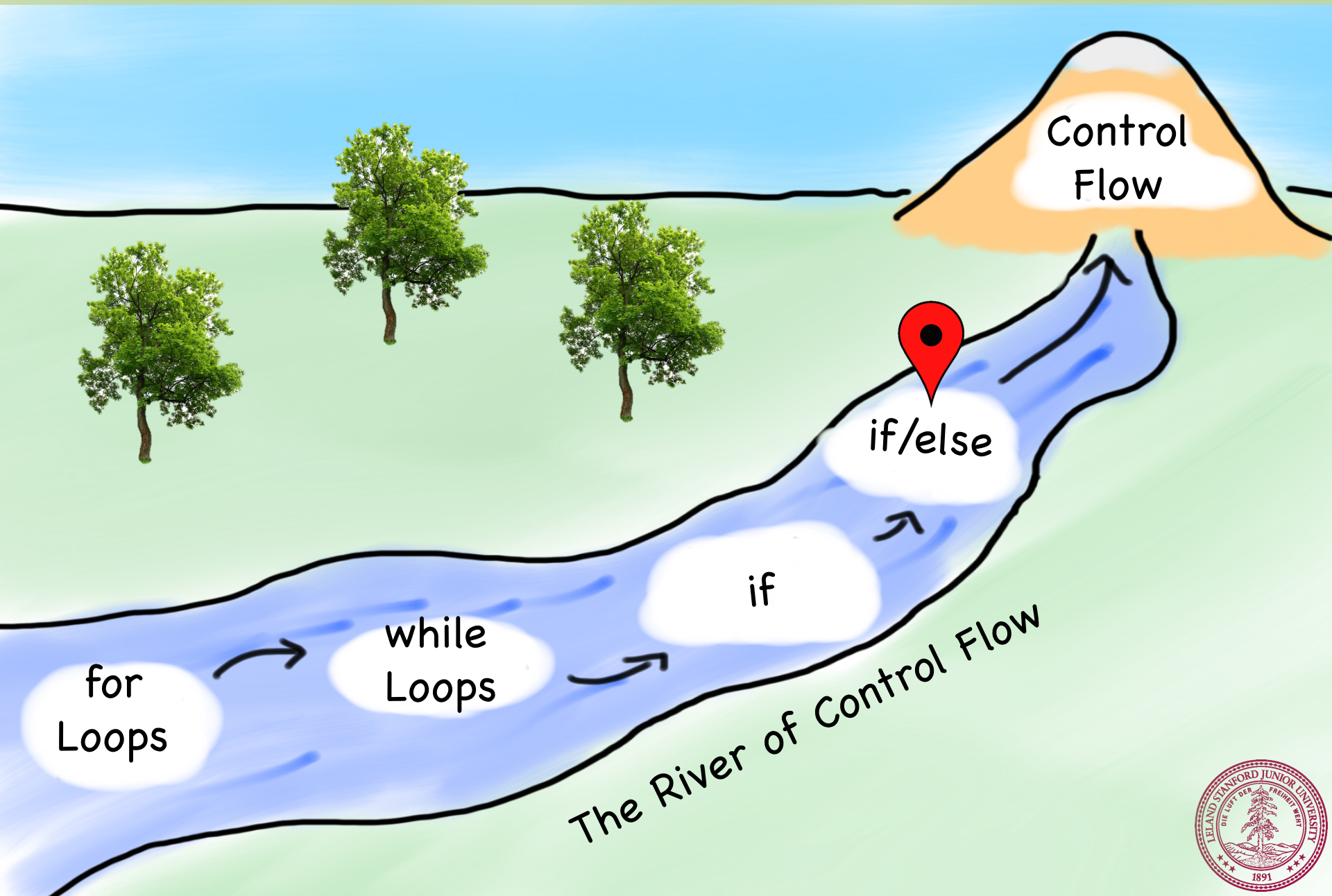
note indenting

def safe_pick_up():

 **if** beepers_present():

  pick_beeper() # note indenting

Today's Route



if-else statement


if *condition*:

 *statements* # note indenting

else:

 *statements* # note indenting

def invert_beeper():

 **if** beepers_present():

 pick_beeper() # note indenting

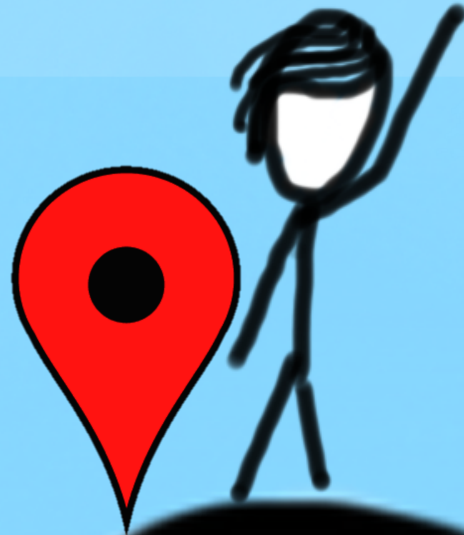
else:

 put_beeper() # note indenting

You just learned most of
programming "control flow"

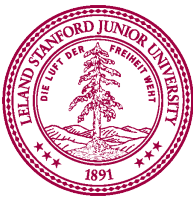
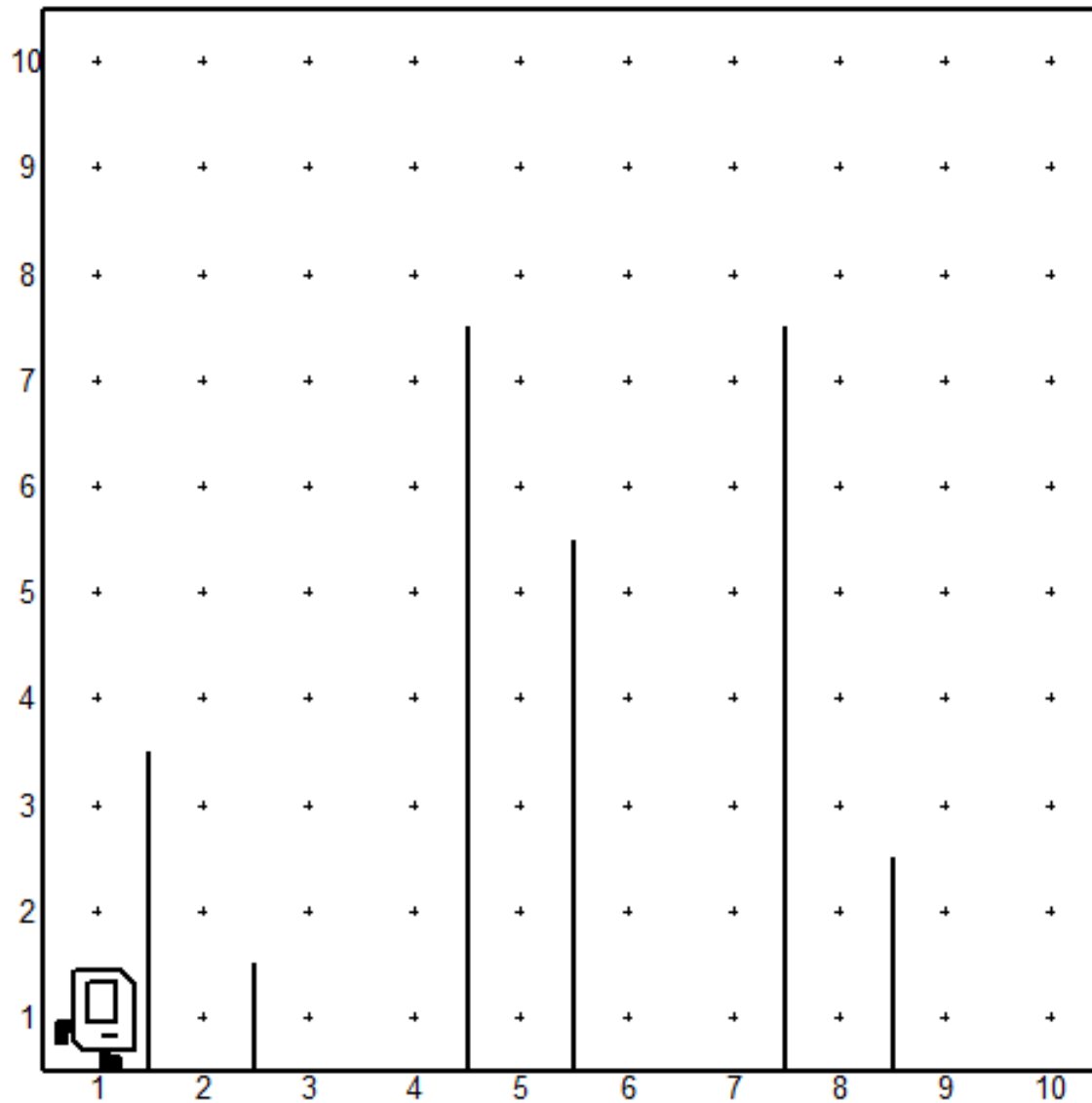
Today's Goal

1. Code using loops and conditions
2. Trace programs that use loops and conditions

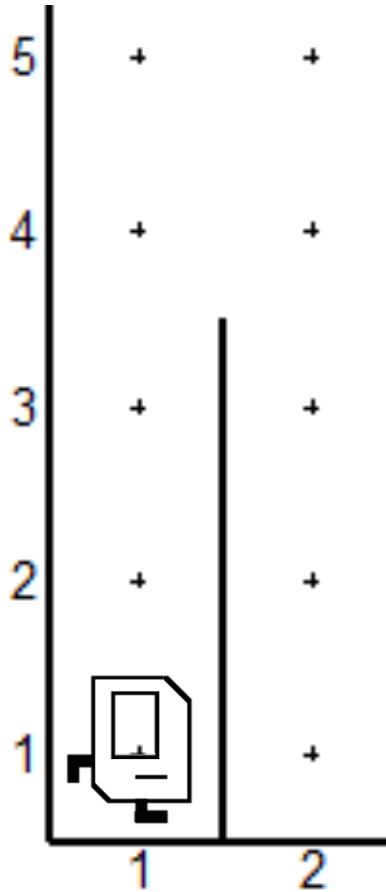


Putting it all together
SteepChaseKarel.py

Steeple Chase

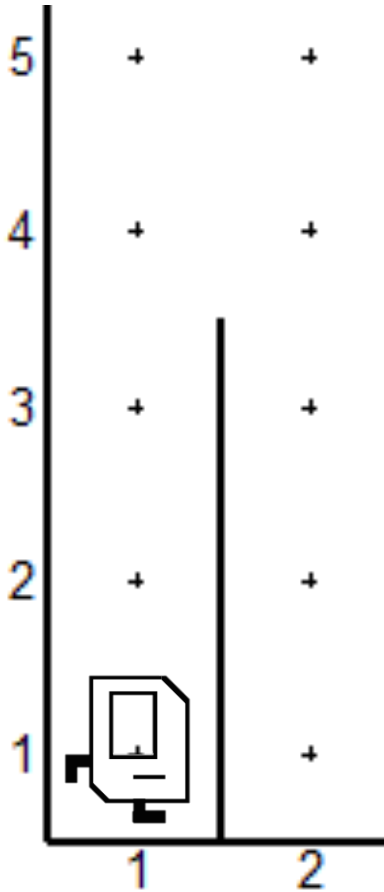


Focus on One Steeple



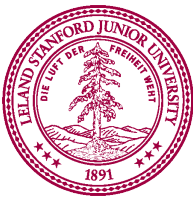
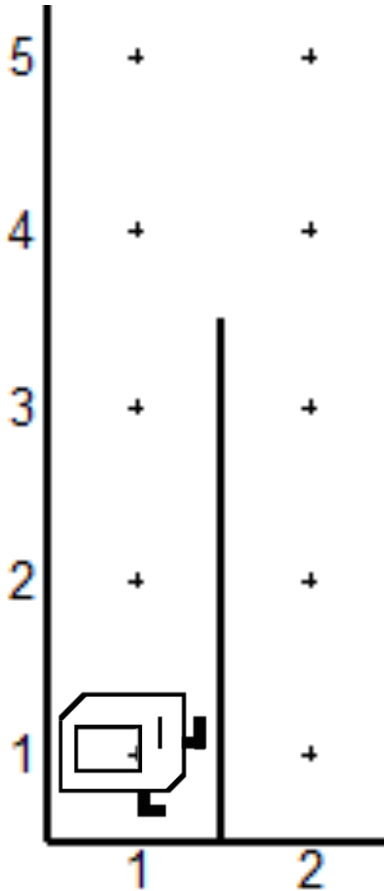
Focus on One Steeple

`turn_left()`



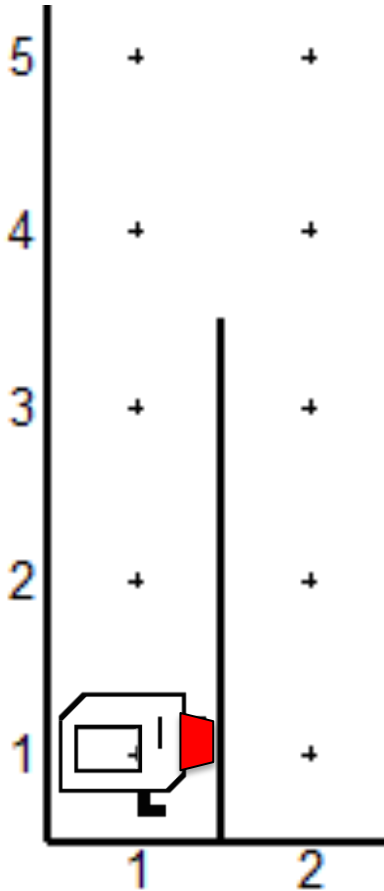
Focus on One Steeple

`turn_left()`



Focus on One Steeple

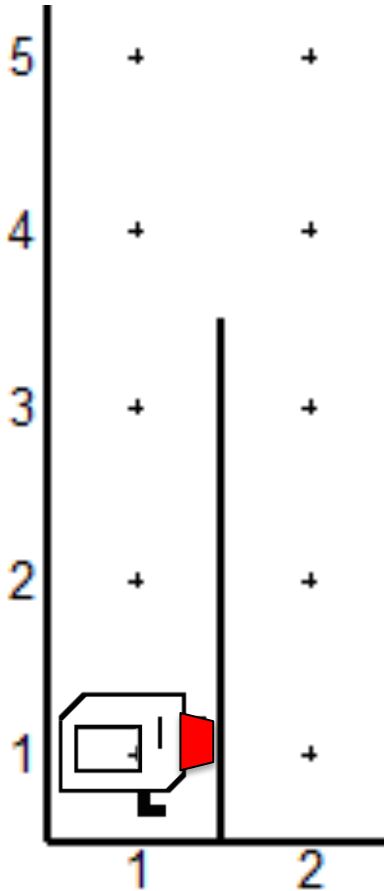
```
turn_left()  
while right_is_blocked():  
    move()
```



Focus on One Steeple

```
turn_left()
```

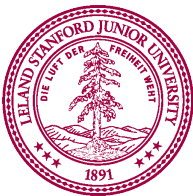
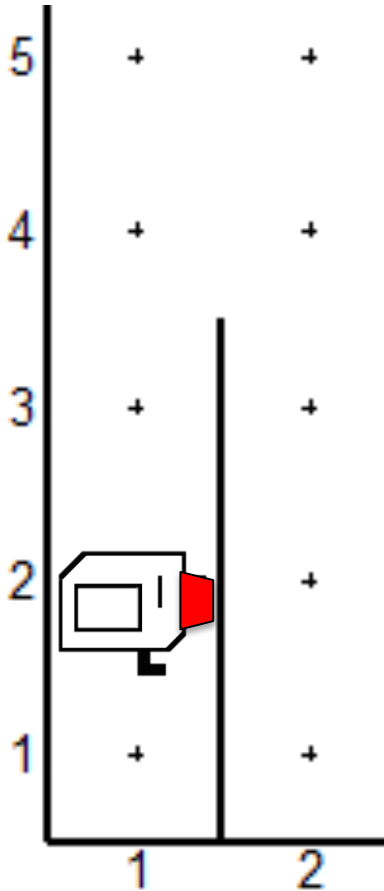
```
while right_is_blocked():  
    move()
```



Focus on One Steeple

```
turn_left()
```

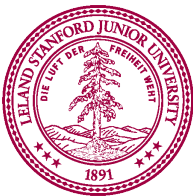
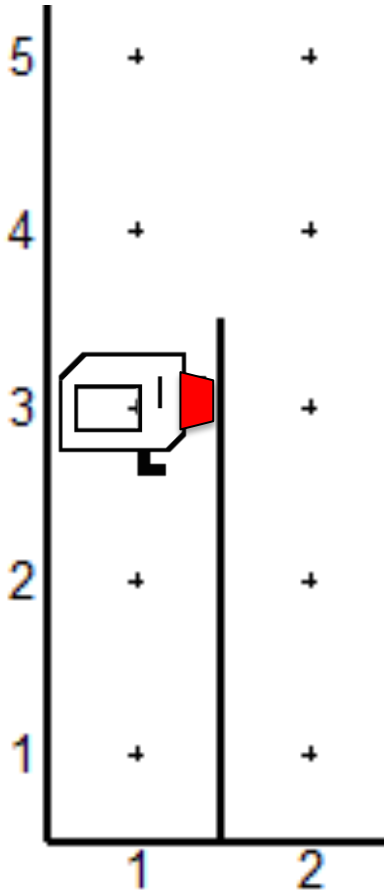
```
while right_is_blocked():  
    move()
```



Focus on One Steeple

```
turn_left()
```

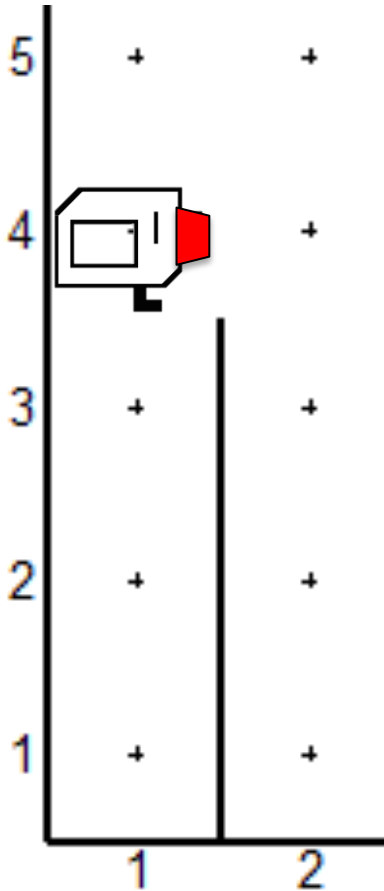
```
while right_is_blocked():  
    move()
```



Focus on One Steeple

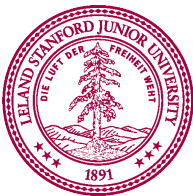
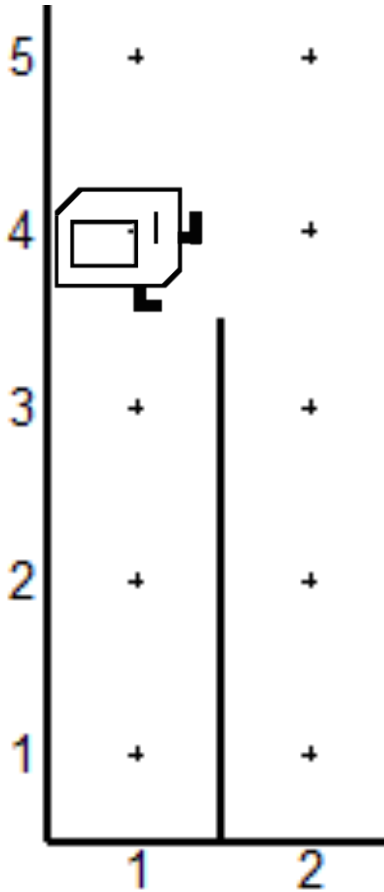
```
turn_left()
```

```
while right_is_blocked():  
    move()
```



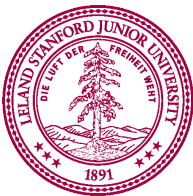
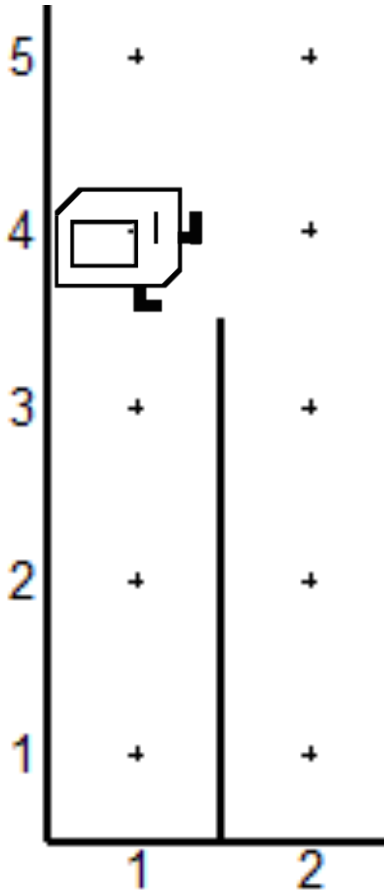
Focus on One Steeple

```
turn_left()  
while right_is_blocked():  
    move()
```



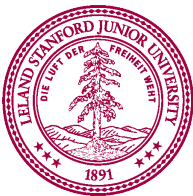
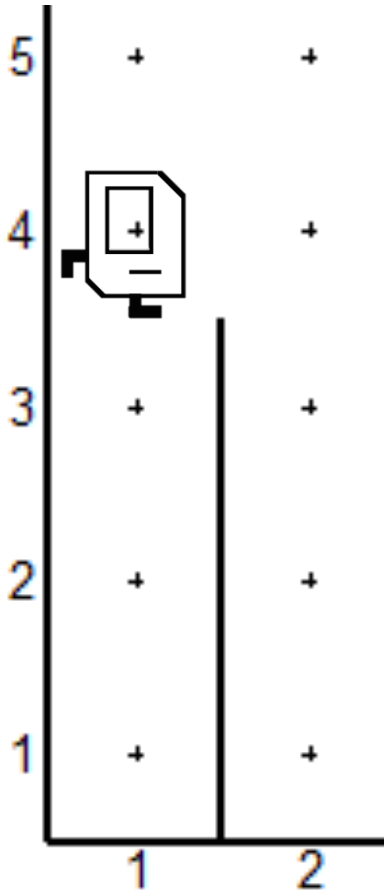
Focus on One Steeple

```
turn_left()  
while right_is_blocked():  
    move()  
turn_right()
```



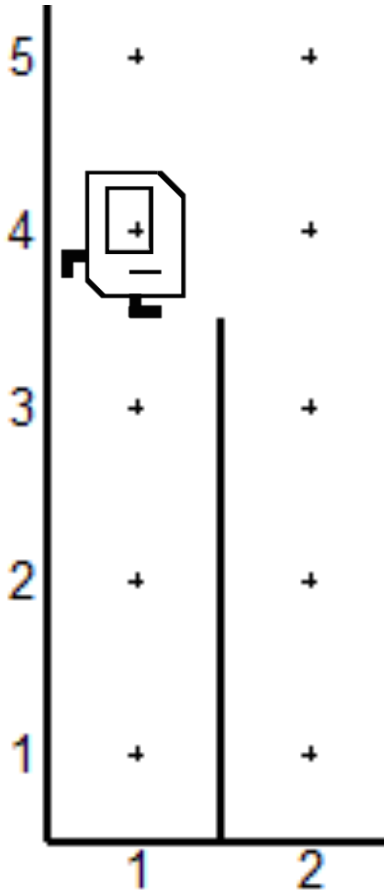
Focus on One Steeple

```
turn_left()  
while right_is_blocked():  
    move()  
    turn_right()
```



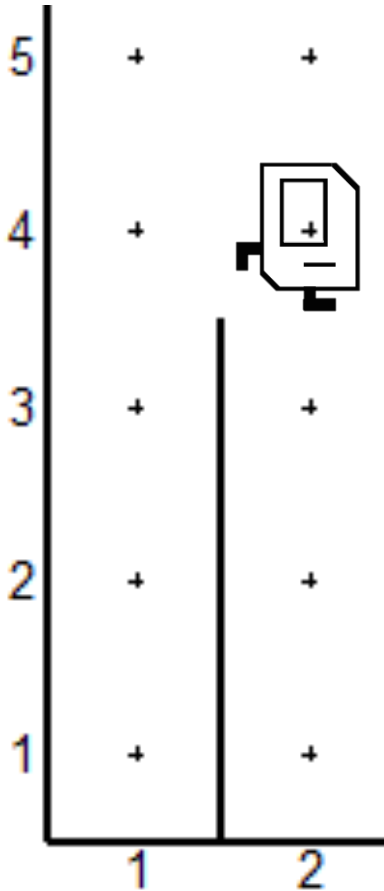
Focus on One Steeple

```
turn_left()  
while right_is_blocked():  
    move()  
turn_right()  
move()
```

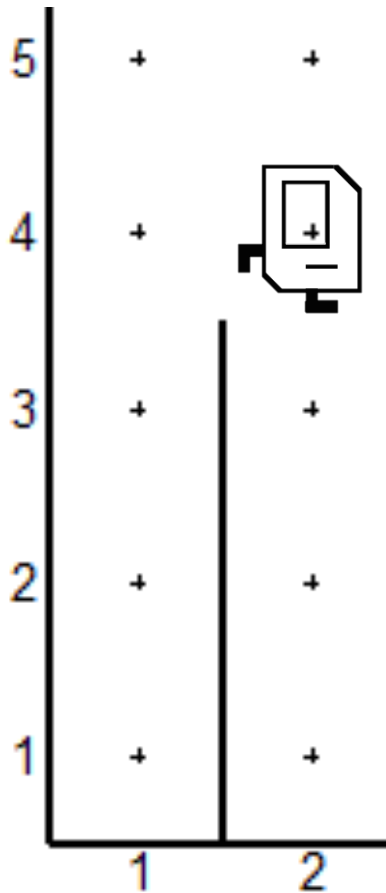


Focus on One Steeple

```
turn_left()  
while right_is_blocked():  
    move()  
turn_right()  
move()
```



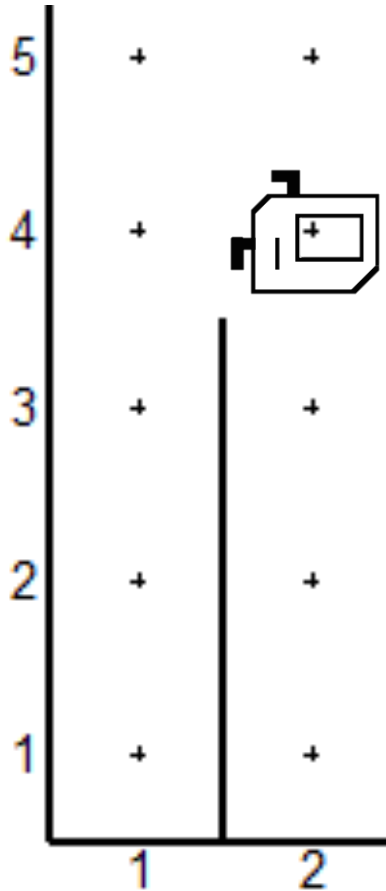
Focus on One Steeple



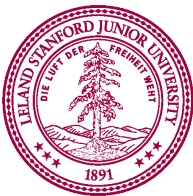
```
turn_left()  
while right_is_blocked():  
    move()  
turn_right()  
move()  
turn_right()
```



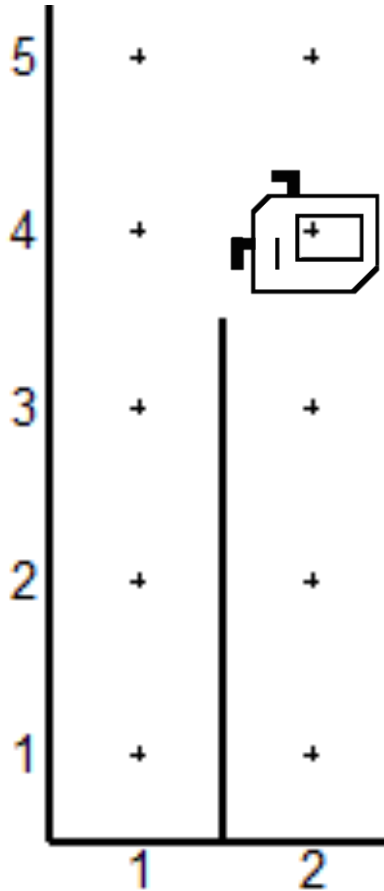
Focus on One Steeple



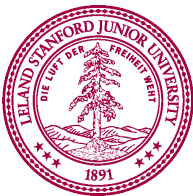
```
turn_left()  
while right_is_blocked():  
    move()  
turn_right()  
move()  
turn_right()
```



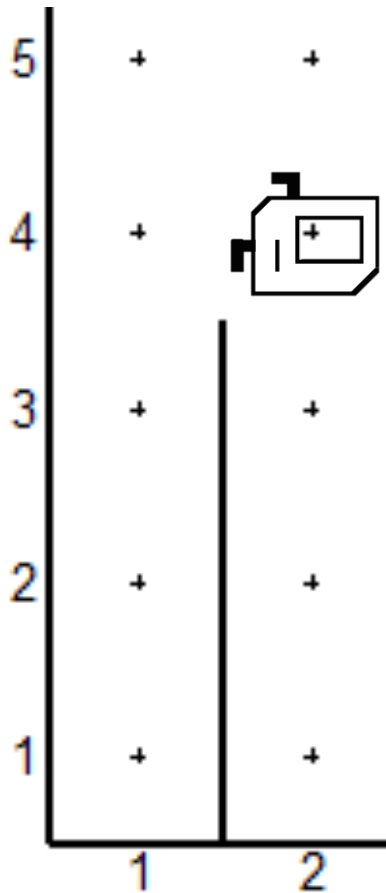
Focus on One Steeple



```
turn_left()  
while right_is_blocked():  
    move()  
turn_right()  
move()  
turn_right()  
move_to_wall()
```

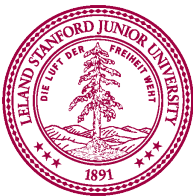


Focus on One Steeple

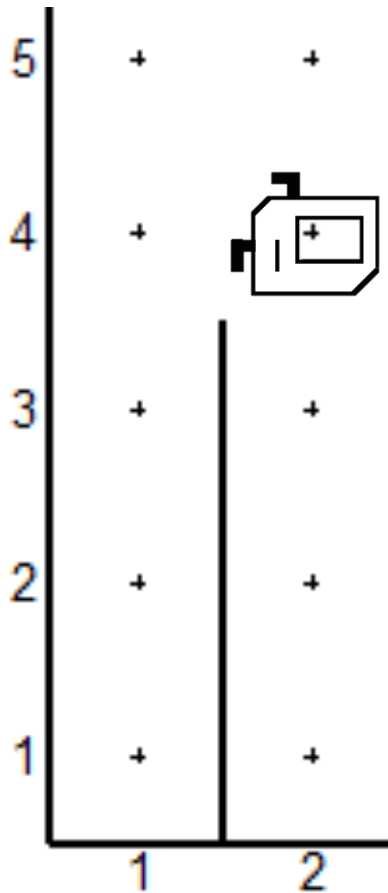


```
turn_left()
while right_is_blocked():
    move()
turn_right()
move()
turn_right()
move_to_wall()
```

```
def move_to_wall():
    while front_is_clear():
        move()
```

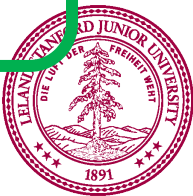


Focus on One Steeple

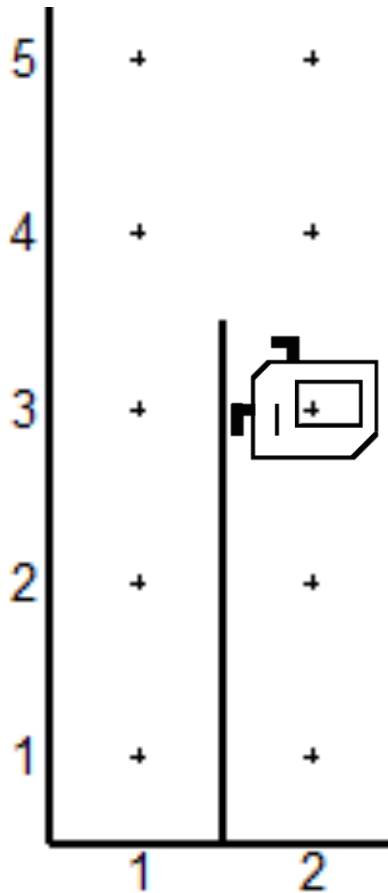


```
turn_left()  
while right_is_blocked():  
    move()  
turn_right()  
move()  
turn_right()  
move_to_wall()
```

```
def move_to_wall():  
    while front_is_clear():  
        move()
```

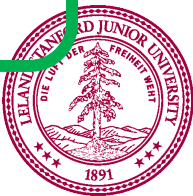


Focus on One Steeple

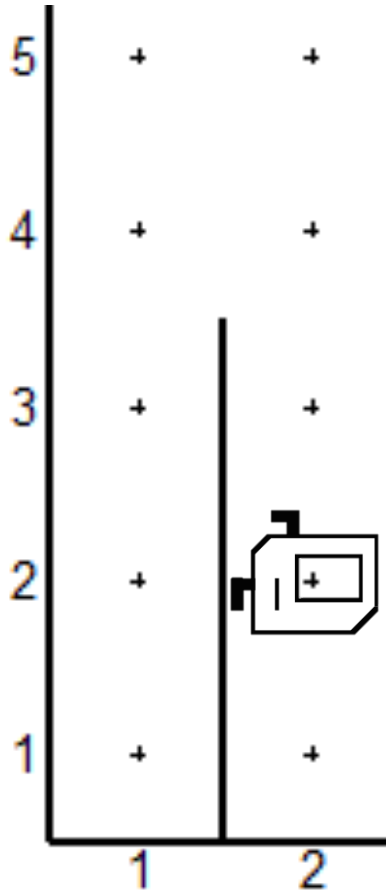


```
turn_left()  
while right_is_blocked():  
    move()  
turn_right()  
move()  
turn_right()  
move_to_wall()
```

```
def move_to_wall():  
    while front_is_clear():  
        move()
```

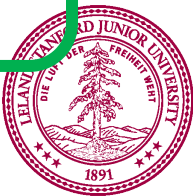


Focus on One Steeple

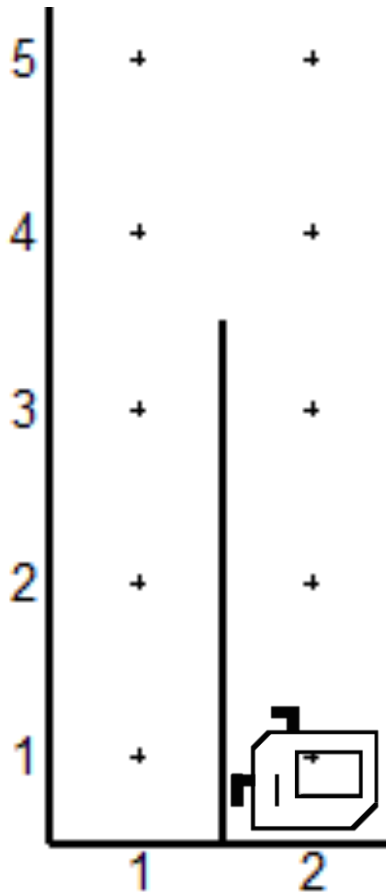


```
turn_left()  
while right_is_blocked():  
    move()  
turn_right()  
move()  
turn_right()  
move_to_wall()
```

```
def move_to_wall():  
    while front_is_clear():  
        move()
```

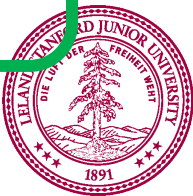


Focus on One Steeple

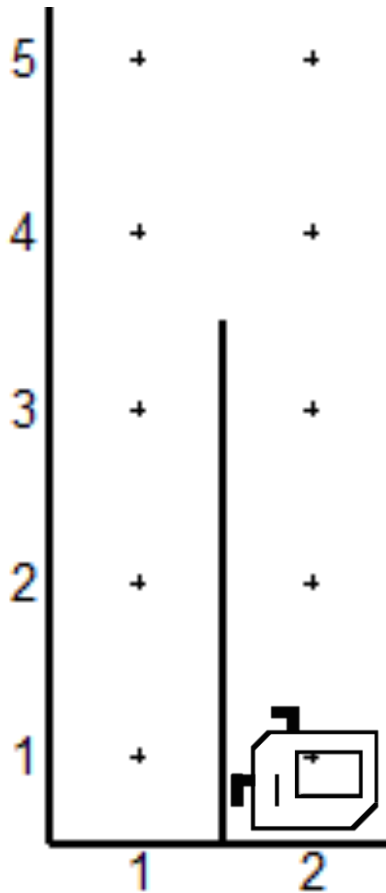


```
turn_left()  
while right_is_blocked():  
    move()  
turn_right()  
move()  
turn_right()  
move_to_wall()
```

```
def move_to_wall():  
    while front_is_clear():  
        move()
```

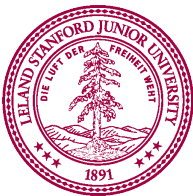


Focus on One Steeple

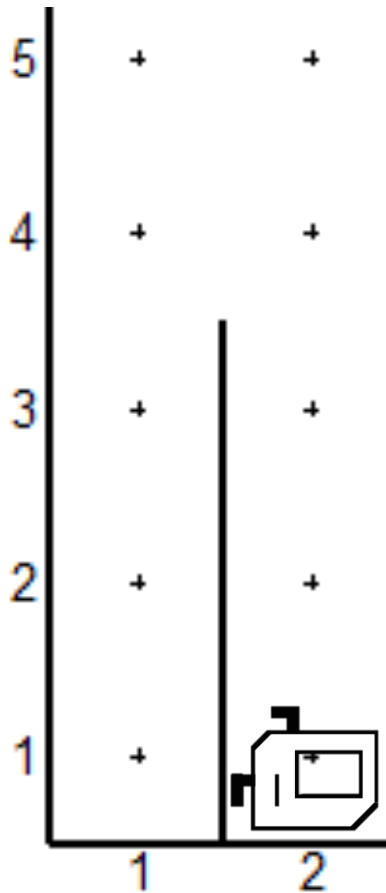


```
turn_left()  
while right_is_blocked():  
    move()  
turn_right()  
move()  
turn_right()  
move_to_wall()
```

```
def move_to_wall():  
    while front_is_clear():  
        move()
```

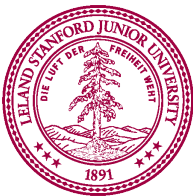


Focus on One Steeple

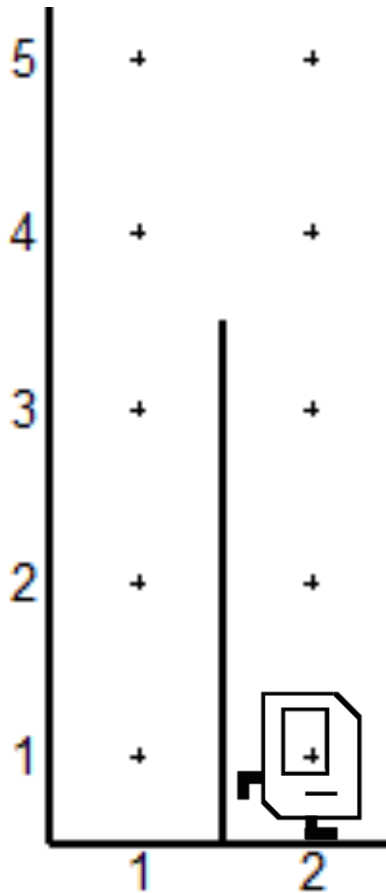


```
turn_left()  
while right_is_blocked():  
    move()  
turn_right()  
move()  
turn_right()  
move_to_wall()  
turn_left()
```

```
def move_to_wall():  
    while front_is_clear():  
        move()
```

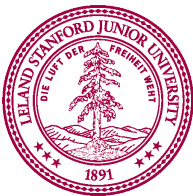


Focus on One Steeple

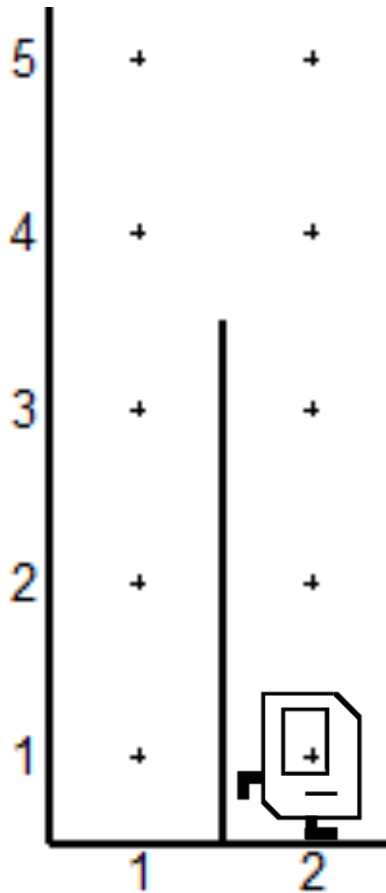


```
turn_left()  
while right_is_blocked():  
    move()  
turn_right()  
move()  
turn_right()  
move_to_wall()  
turn_left()
```

```
def move_to_wall():  
    while front_is_clear():  
        move()
```



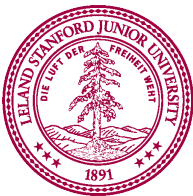
Focus on One Steeple



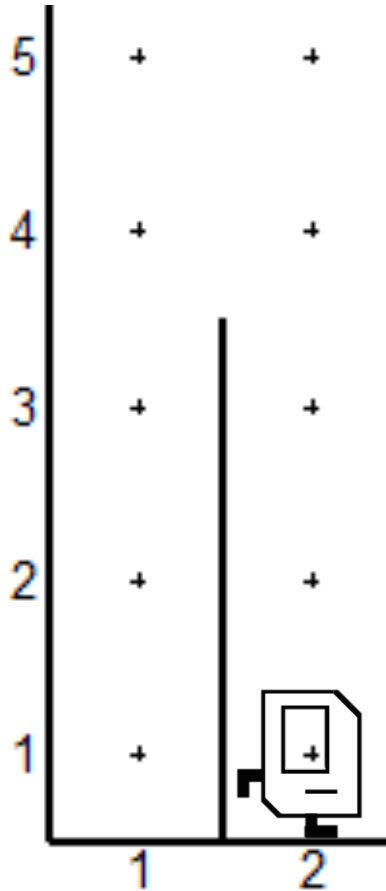
```
turn_left()
while right_is_blocked():
    move()
turn_right()
move()
turn_right()
move_to_wall()
turn_left()
```

You need the
postcondition of
a loop to match
the **precondition**

```
def move_to_wall():
    while front_is_clear():
        move()
```



Focus on One Steeple

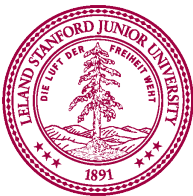


```
turn_left()  
while right_is_blocked():  
    move()  
turn_right()  
move()
```

```
turn_right()  
move_to_wall()  
turn_left()
```

ascend_hurdle()

descend_hurdle()



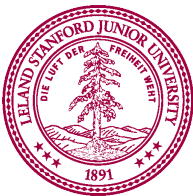
Focus on One Steeple

```
turn_left()  
while right_is_blocked():  
    move()  
turn_right()  
move()
```

```
turn_right()  
move_to_wall()  
turn_left()
```

ascend_hurdle()

descend_hurdle()



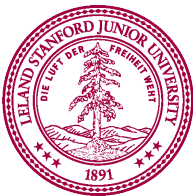
Focus on One Steeple

```
def ascend_hurdle():  
    turn_left()  
    while right_is_blocked():  
        move()  
    turn_right()
```

```
ascend_hurdle()  
move()
```

```
turn_right()  
move_to_wall()  
turn_left()
```

```
descend_hurdle()
```



Focus on One Steeple

```
def ascend_hurdle():
```

```
    turn_left()
```

```
    while right_is_blocked():
```

```
        move()
```

```
    turn_right()
```

`ascend_hurdle()`

`move()`

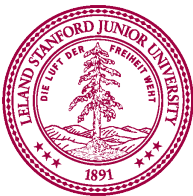
`descend_hurdle()`

```
def descend_hurdle():
```

```
    turn_right()
```

```
    move_to_wall()
```

```
    turn_left()
```

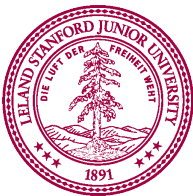


Focus on One Steeple

```
def ascend_hurdle():  
    turn_left()  
    while right_is_blocked():  
        move()  
    turn_right()
```

```
def descend_hurdle():  
    turn_right()  
    move_to_wall()  
    turn_left()
```

```
def jump_hurdle():  
    ascend_hurdle()  
    move()  
    descend_hurdle()
```



A Whole Program:
SteepChaseKarel.py