CS Bridge, Lecture 3

More Karel Control Flow

CS BRIDGE

2021

KOÇ UNIVERSITY

İZMİR DEMOKRASİ ÜNİVERSİTESİ 2016

LELAND STANFORD JUNIOR UNIVERSITY DIE LUFT DER FREIHEIT WEHT 1891

Learning Goals

1. Code using conditions
2. Trace programs that use loops and conditions
3. Decomposition and top-down design

Lecture Plan

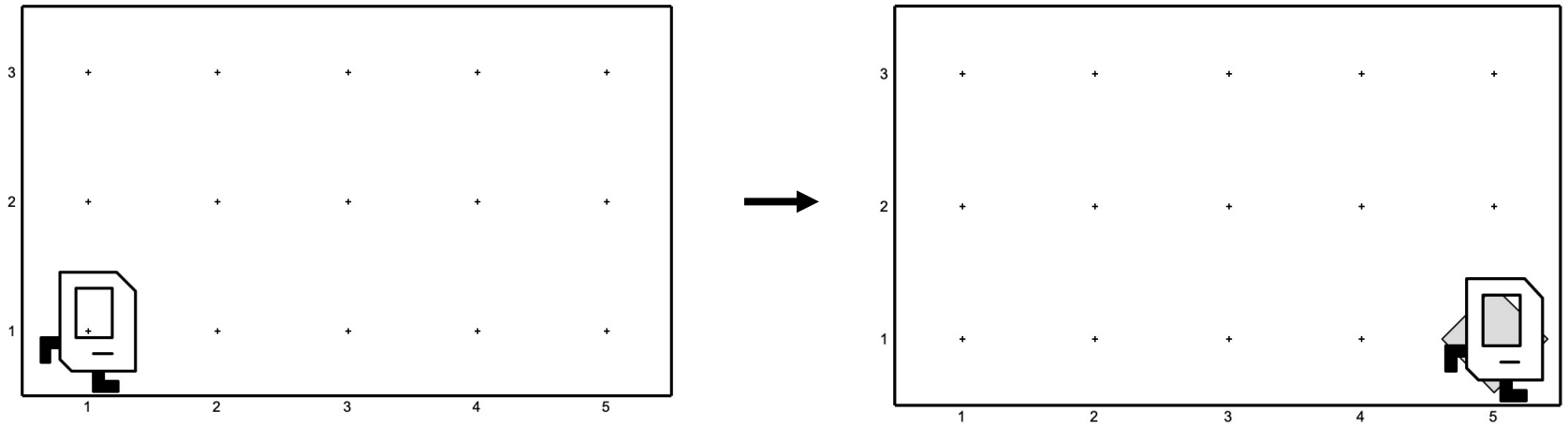
- **Review:** Karel and Control Flow
- If/Else Statements
- Decomposition and Top-Down Design
- **Practice:** Hurdle Jumper

Lecture Plan

- **Review:** Karel and Control Flow
- If/Else Statements
- Decomposition and Top-Down Design
- **Practice:** Hurdle Jumper

A quick question!

Which code will result in the following world?




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

(A)

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

(B)

Indentation

Karel is *very* picky about indentation.

Make sure to indent a code block 1 level further when you:

- Define a new Karel command
- Write a for loop
- Write a while loop

You may nest these. Make sure you keep track of your indentation!

Indentation

Karel is *very* picky about indentation.

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

```
def my_command():
    for i in range(3):
        turn_left()
    put_beeper()
```

Control Flow

Control Flow lets us control the “flow” of our Karel program.

- Example: repeat something 5 times
- Example: repeat something until Karel is blocked

Control Flow: For Loops

Repeats the statements in the body ***count*** times:

```
for i in range(count):
    statement
    statement
    ...
```

Control Flow: While Loops

Repeats the statements in the body until ***condition*** is no longer true.

```
while condition:
    statement
    statement
    ...
```

Each time, Karel executes *all statements*, and **then** checks the condition.

Control Flow: While Loops

Repeats the statements in the body until ***condition*** is no longer true.

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

Even if Karel's front becomes blocked after this **move**, it will still put a beeper, because the condition is not checked until after **all** the lines are executed.

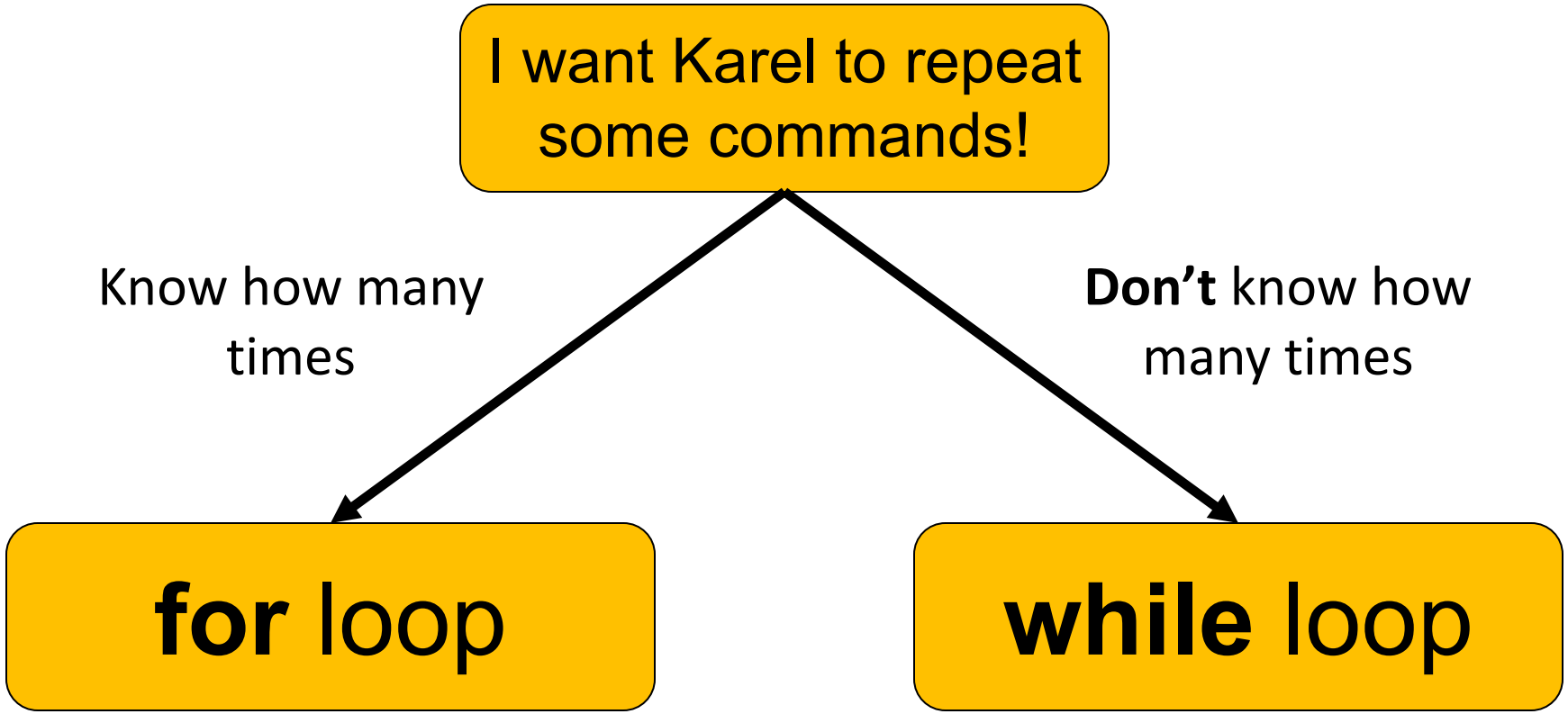
Each time, Karel executes *all statements*, and **then** checks the condition.

Possible Questions

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

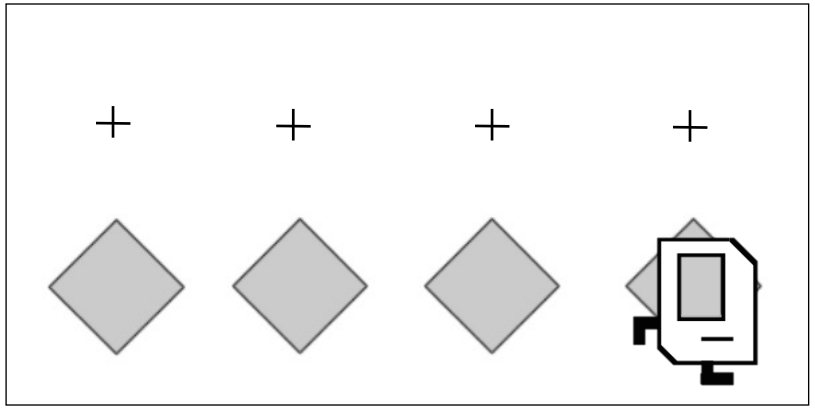
This is taken from the Karel Reference.

Loops Overview



Fencepost

I want Karel to put down a row of beepers until it reaches a wall. How do I do this?



We must put N beepers but move N-1 times!

```
put_beeper()
move()
put_beeper()
move()
...
put_beeper()
```

Fencepost Problem

8 fence segments, but 9 posts!

Fencepost Structure

The fencepost structure is useful when you want to loop a set of statements but do one part of that set 1 *additional* time.

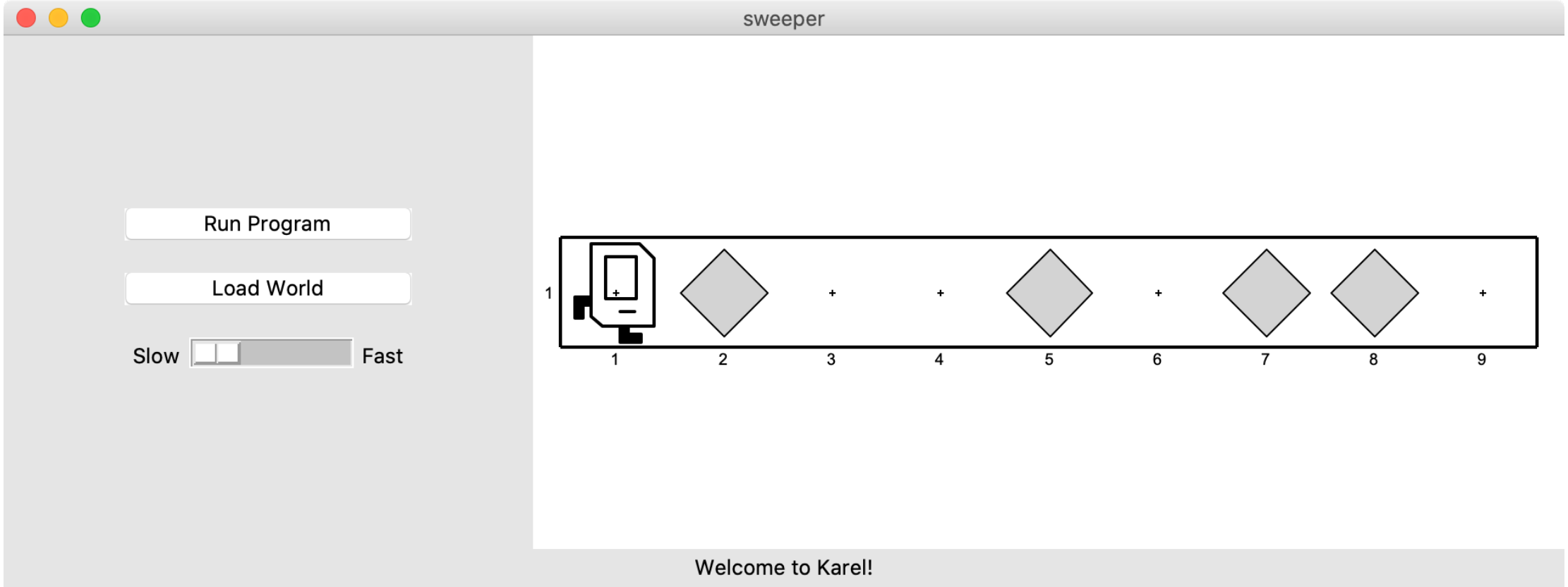
```
put_beeper()                # post
while front_is_clear():
    move()                  # fence
    put_beeper()            # post


# or...
while front_is_clear():
    put_beeper()            # post
    move()                  # fence
put_beeper()                # post
```

Lecture Plan

- **Review:** Karel and Control Flow
- If/Else Statements
- Decomposition and Top-Down Design
- **Practice:** Hurdle Jumper

If Statements

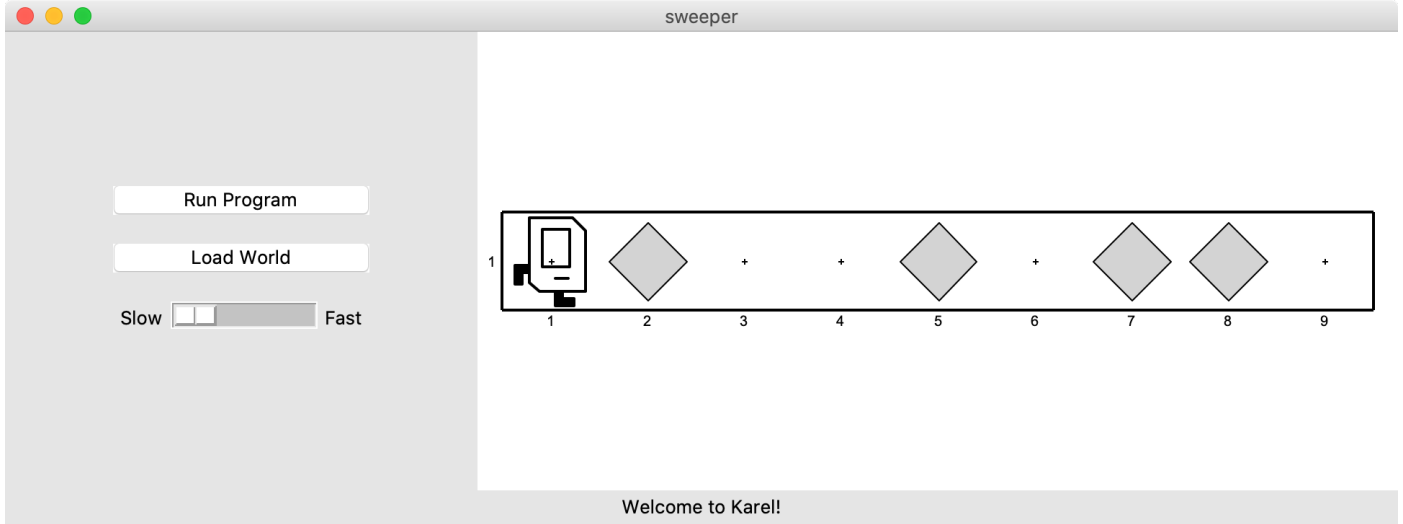
I want to make Karel clean up all beepers in front of it until it reaches a wall. How do I do this?



If Statements

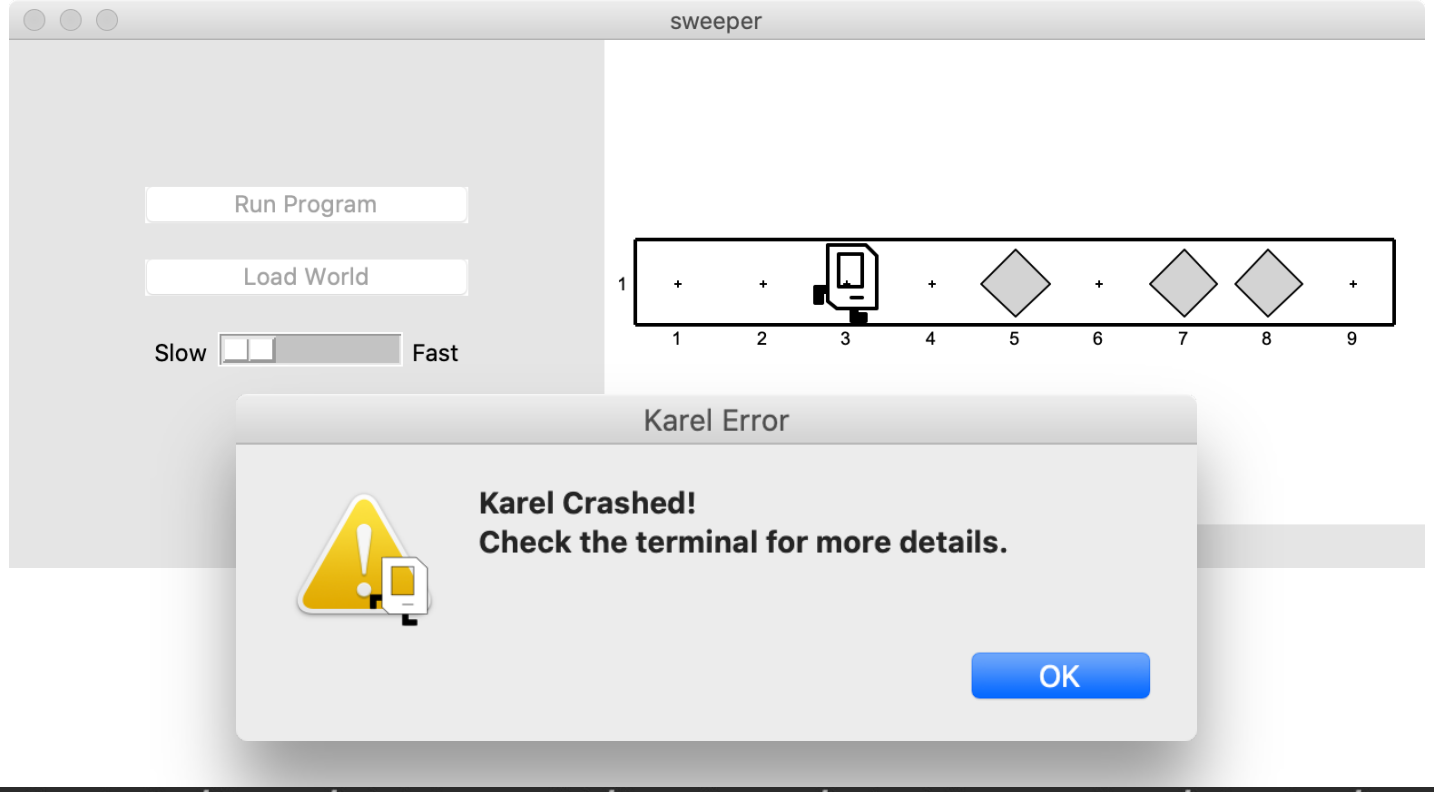
Will this work?

```
while front_is_clear():
    move()
    pick_beeper()
```



No. This may crash, because Karel *cannot pick up beepers if there aren't any*. We don't **always** want Karel to pick up beepers; just when there is a beeper to pick up.

If Statements




```
/usr/local/bin/python3.8 /Users/nicktroccoli/Developer/csbridge-sandbox/starter/Lecture3/sweeper.py
Traceback (most recent call last):
File "/Users/nicktroccoli/Developer/csbridge-sandbox/starter/Lecture3/sweeper.py", line 17, in main
    pick_beeper()
KarelException: Karel crashed while on avenue 3 and street 1, facing East
Invalid action: Karel attempted to pick up a beeper, but there were none on the current corner.
```

If Statements

Instead, use an **if** statement:

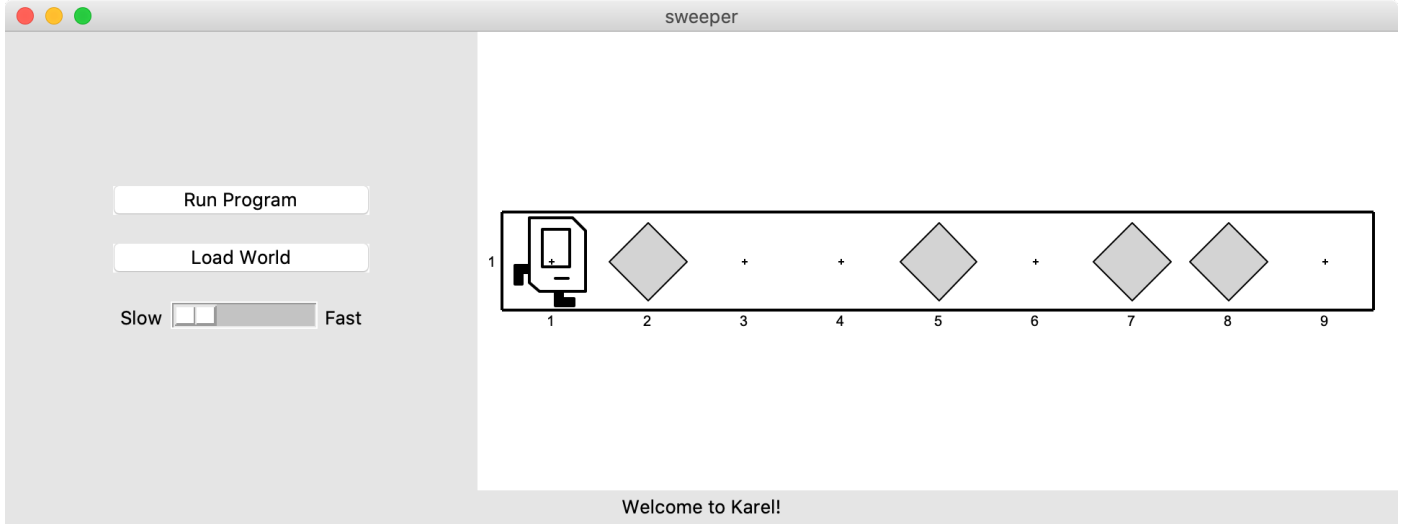
```
if condition:
    statement
    statement
    ...
```

Runs the statements in the body *once* if ***condition*** is true. These are the same conditions you can use for **while** loops!

If Statements

Now we can say:

```
while front_is_clear():
    move()
    if beepers_present():
        pick_beeper()
```



Karel won’t crash because it will only pick up a beeper if there is one.

If Statements and Indentation

```
if condition:
    statements                    # note indenting
```

```
def safe_pick_up():
    if beepers_present():
        pick_beeper() # note indenting
```

If/Else Statements

What if we want to do one thing if some condition is true, and another otherwise? We can add an **else** statement:

```
if condition:
    statement
    statement
    ...
else:
    statement
    statement
    ...
```

This will run the first group of statements if ***condition*** is true; otherwise, it runs the second group of statements.

If/Else Statements

What does this code do?

```
def main():
    if beepers_present():
        pick_beeper()
    else:
        put_beeper()
```

If/Else Statements and Indentation

```
if condition:
    statements          # note indenting
else:
    statements          # note indenting
```

```
def invert_beepers():
    if beepers_present():
        pick_beeper() # note indenting
    else:
        put_beeper()  # note indenting
```

Karel and Control Flow

Congratulations! You've learned all of control flow in Karel.

Control Flow lets us control the "flow" of our Karel program. For example, repeat something more than once, or only do something in certain cases.

Want to repeat something? Use a **for** or **while** loop.

- **for** if we know how many times
- **while** if we don't know how many times

Want to conditionally do something? Use **if** (with an optional **else**)

Lecture Plan

- **Review:** Karel and Control Flow
- If/Else Statements
- Decomposition and Top-Down Design
- **Practice:** Hurdle Jumper

Decomposition

- Breaking down problems into smaller, more approachable sub-problems (e.g. our own Karel commands)

Top-Down Design

- Start from a large task and break it up into smaller pieces
- Ok to write your program in terms of commands that don’t exist yet
- **Goal**: make our programs easily readable by humans
  - Commenting
  - Decomposition

Decomposition and Top-Down Design

- E.g. You wake up and and trying to plan your day

Approach 1

1. Get left foot out of bed
2. Get right foot out of bed
3. Stand up
4. Move to washroom
5. Grab brush
6. Apply toothpaste
7. Brush teeth
8. Get face wash
9. Scrub on face
10. Exit washroom
11. Go to kitchen
12. Crack eggs
13. …

Decomposition and Top-Down Design

- E.g. You wake up and and trying to plan your day

Approach 1

1. Get left foot out of bed
2. Get right foot out of bed
3. Stand up
4. Move to washroom
5. Grab brush
6. Apply toothpaste
7. Brush teeth
8. Get face wash
9. Scrub on face
10. Exit washroom
11. Go to kitchen
12. Crack eggs
13. …

Approach 2

1. Get out of bed
2. Wash up
3. Eat breakfast

Decomposition and Top-Down Design

- E.g. You wake up and and trying to plan your day

Approach 1

1. Get left foot out of bed
2. Get right foot out of bed
3. Stand up
4. Move to washroom
5. Grab brush
6. Apply toothpaste
7. Brush teeth
8. Get face wash
9. Scrub on face
10. Exit washroom
11. Go to kitchen
12. Crack eggs
13. …

Approach 2

1. Get out of bed
    1. Exit bed
    2. Stand up
2. Wash up
3. Eat breakfast

Decomposition and Top-Down Design

- E.g. You wake up and and trying to plan your day

Approach 1

1. Get left foot out of bed
2. Get right foot out of bed
3. Stand up
4. Move to washroom
5. Grab brush
6. Apply toothpaste
7. Brush teeth
8. Get face wash
9. Scrub on face
10. Exit washroom
11. Go to kitchen
12. Crack eggs
13. …

Approach 2

1. Get out of bed
    1. Exit bed
    2. Stand up
2. Wash up
    1. Brush teeth
    2. Wash face
3. Eat breakfast

Decomposition and Top-Down Design

- E.g. You wake up and and trying to plan your day

Approach 1

1. Get left foot out of bed
2. Get right foot out of bed
3. Stand up
4. Move to washroom
5. Grab brush
6. Apply toothpaste
7. Brush teeth
8. Get face wash
9. Scrub on face
10. Exit washroom
11. Go to kitchen
12. Crack eggs
13. …

Approach 2

1. Get out of bed
    1. Exit bed
    2. Stand up
2. Wash up
    1. Brush teeth
    2. Wash face
3. Eat breakfast
    1. Make eggs
    2. Pour juice
    3. Eat

Decomposition and Top-Down Design

- Breaking down problems into smaller, more approachable sub-problems (e.g. our own Karel commands)
- Each piece should solve **one** problem/task (< ~ 20 lines of code)
  - Descriptively-named
  - Well-commented!
- Problems should be solved **top-down**.

Commenting with Pre/Post-Conditions

Precondition: something you *assume* is true at the start of a function or code block

Postcondition: something you *promise* is true at the end of a function or code block

Pre/post-conditions should be documented using comments.

```
def jump_hurdle():
    """
    Karel jumps over one hurdle of arbitrary height.
    Pre-condition:  Karel is facing east next to a hurdle.
    Post-condition: Karel is facing east at the bottom of
                    the other side of the hurdle.
    """
    ascend_hurdle()
    move()
    descend_hurdle()
```

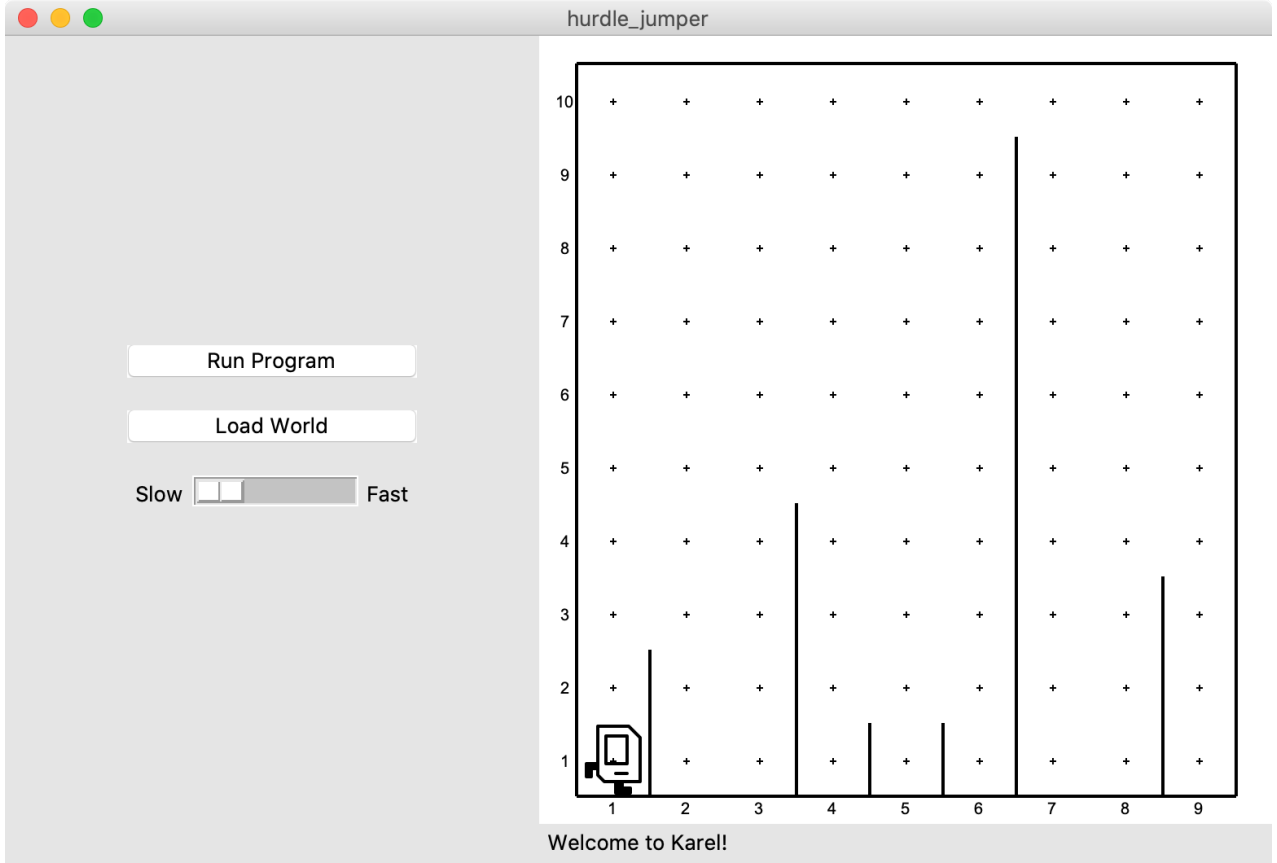
Lecture Plan

- **Review:** Karel and Control Flow
- If/Else Statements
- Decomposition and Top-Down Design
- **Practice:** Hurdle Jumper

Hurdle Jumper

Karel is in the Olympics! We want to write a Karel program that hops hurdles.

- Karel starts at (1,1) facing East and should end up at the end of row 1 facing east.
- The world has 9 columns.
- There are an unknown number of ”hurdles” (walls) of varying heights that Karel must ascend and descend to get to the other side.



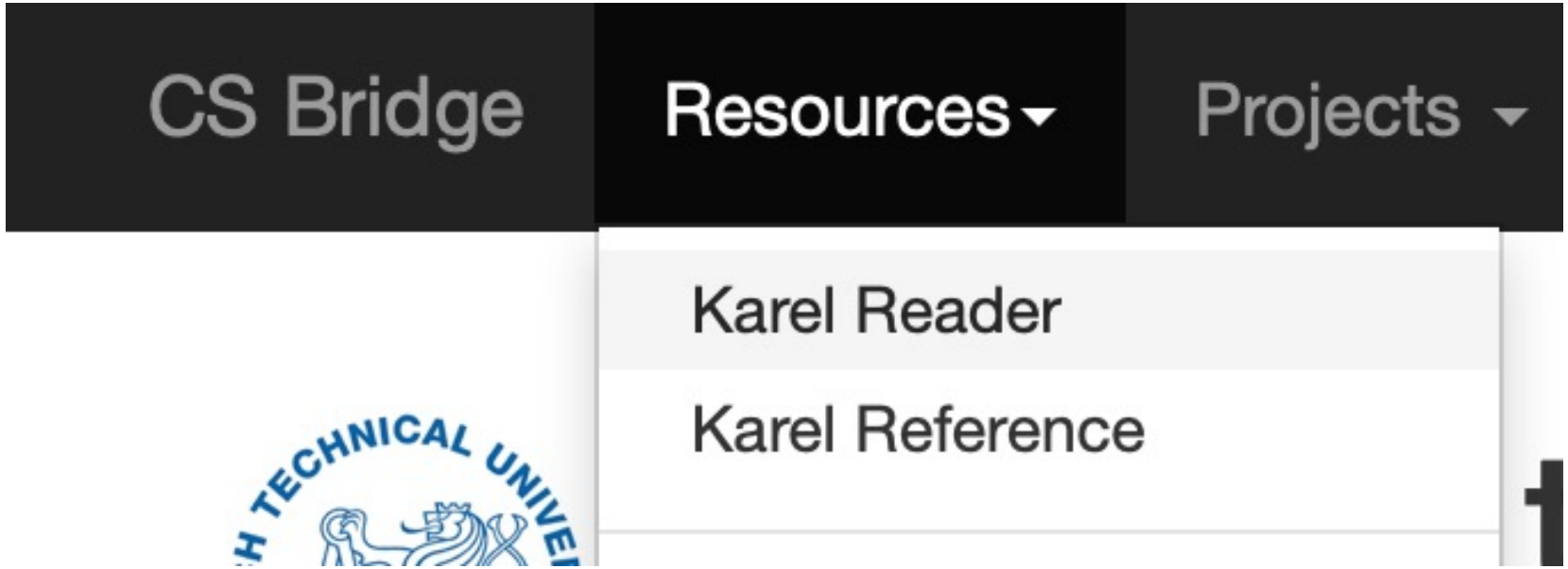
Hurdle Jumper

Demo

Lecture Recap

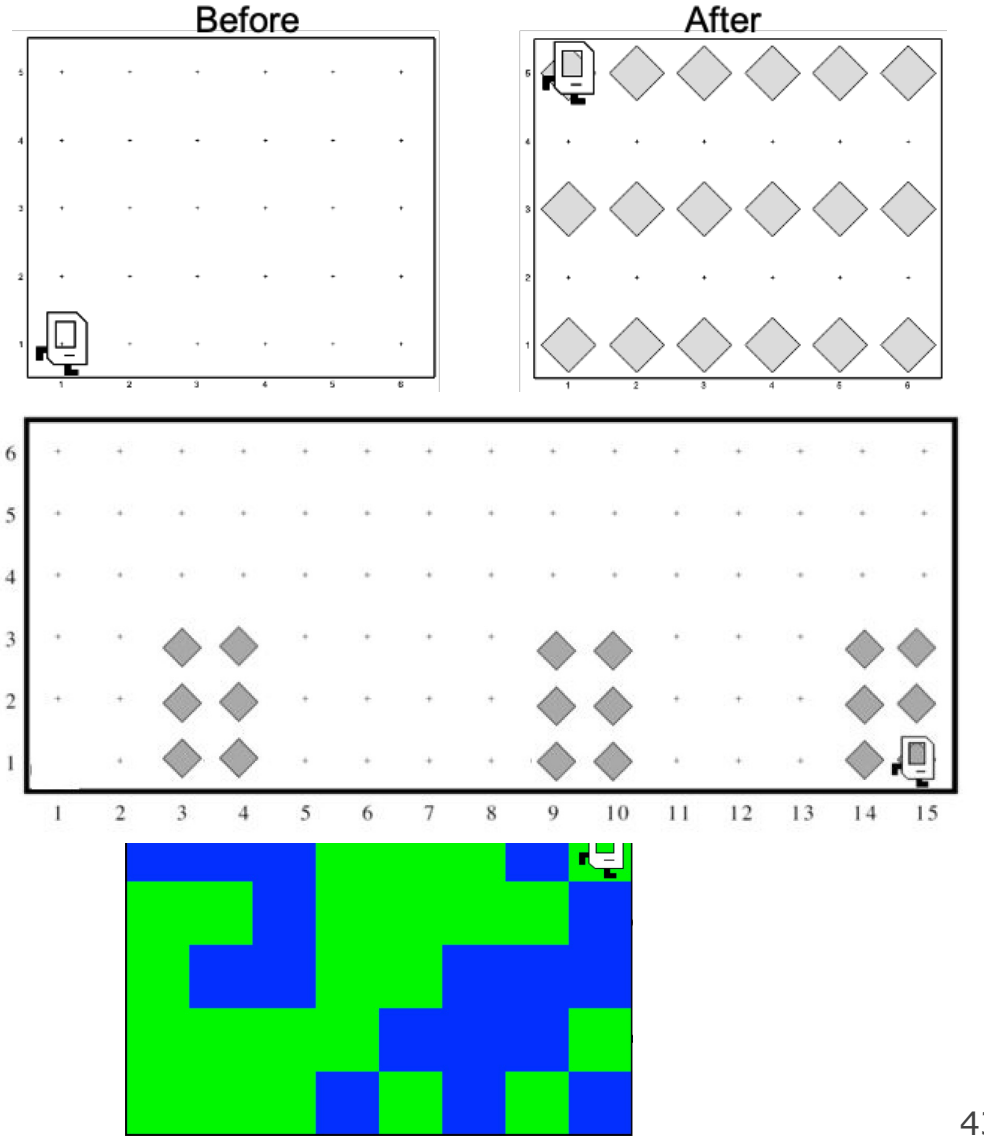
- **Review:** Karel and Control Flow
- If/Else Statements
- Decomposition and Top-Down Design
- **Practice:** Hurdle Jumper

Karel Resources



Rest Of Today

- **Quickstart:** Implement a program where Karel draws stripes with Beepers.
- **Section:** Implement a program where Karel builds Hospitals
- **Project:** Write a program where Karel paints any world randomly with green and blue squares.



What’s Next?

- Time for your section’s quickstart time!
- Check your section’s Ed group for more information