

Decomposition

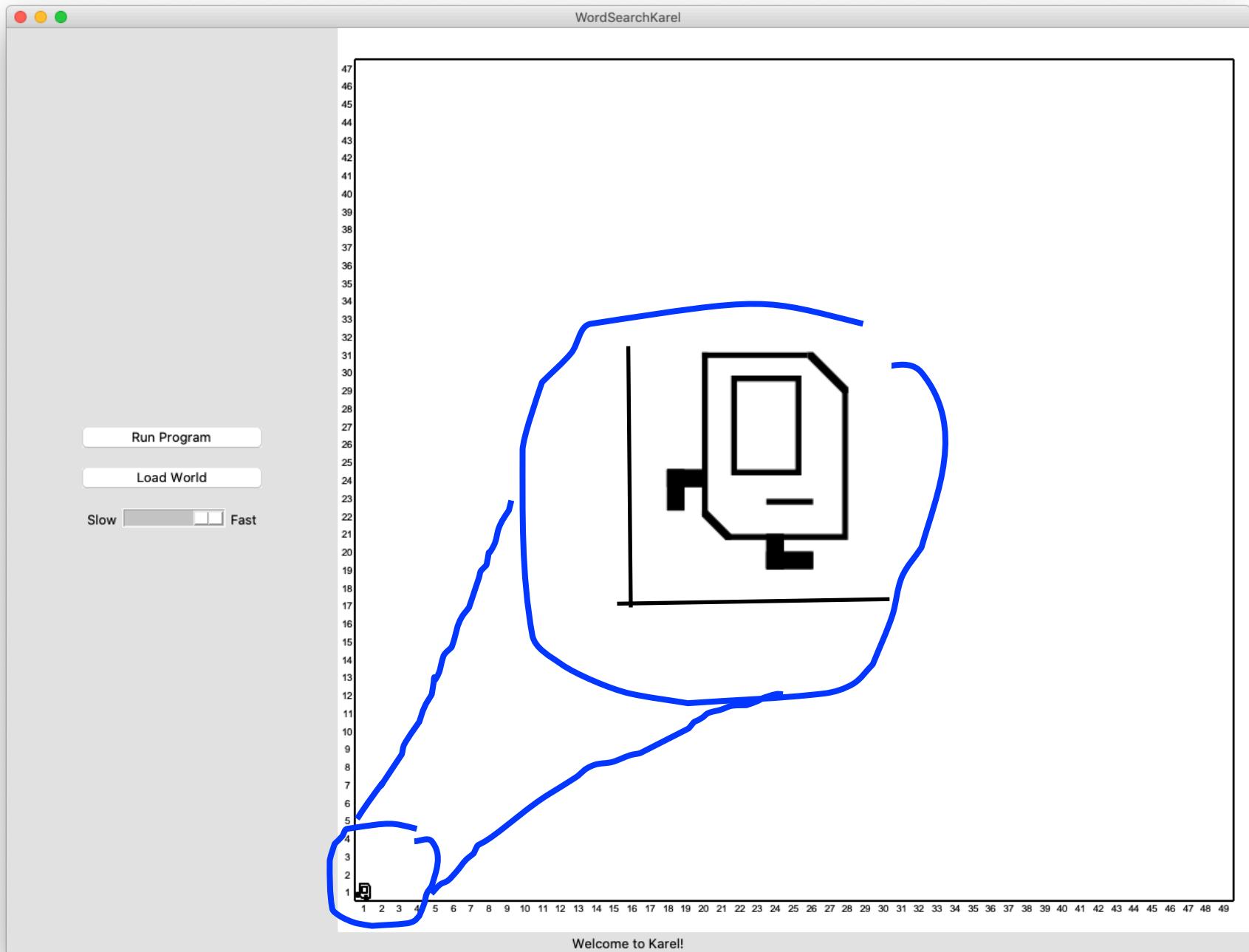
Chris Piech
CS106A, Stanford University

Today's Goal

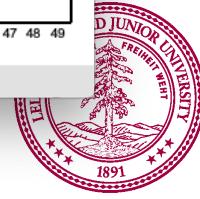
1. Be able to approach a problem “top down” by using decomposition (aka top down refinement)

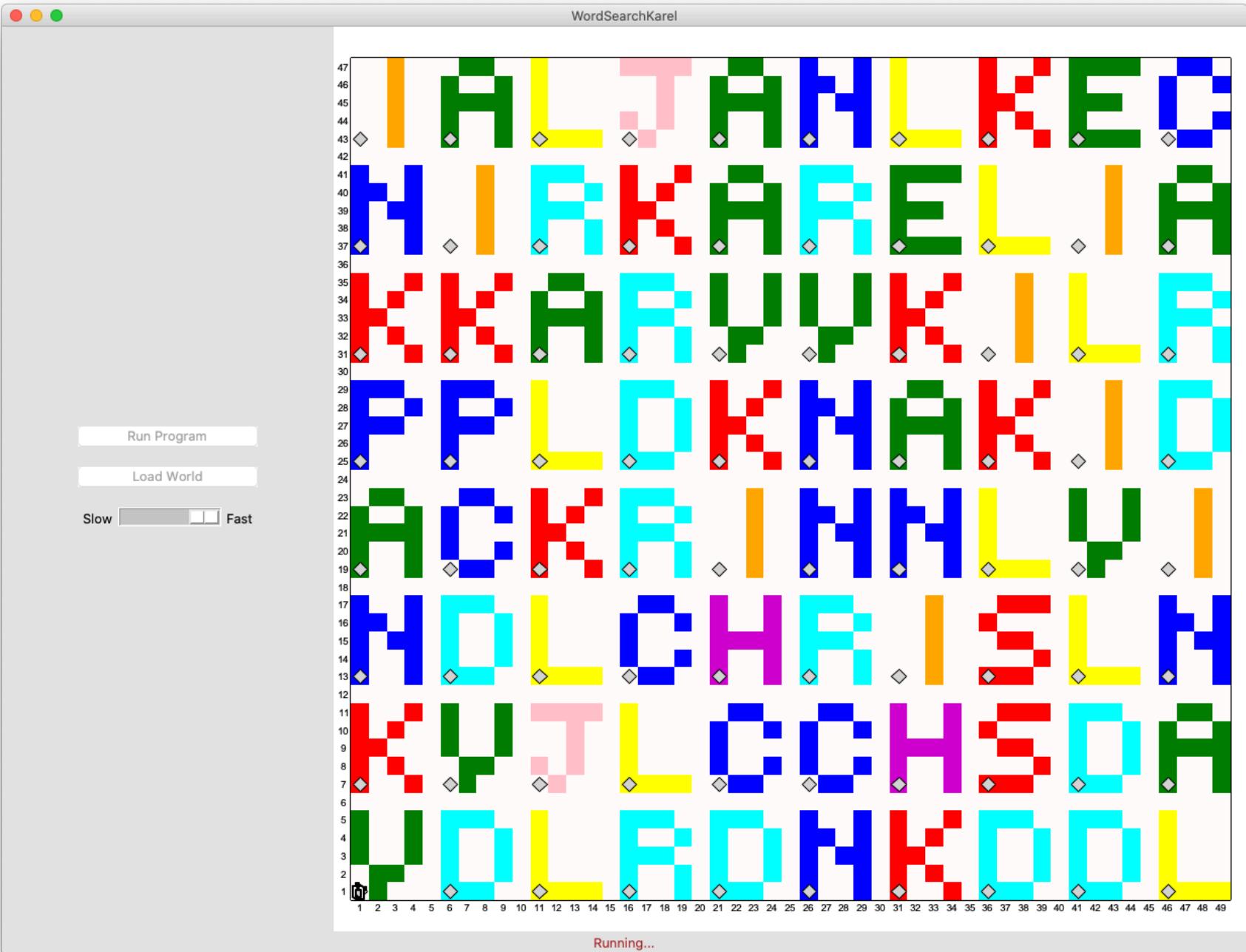


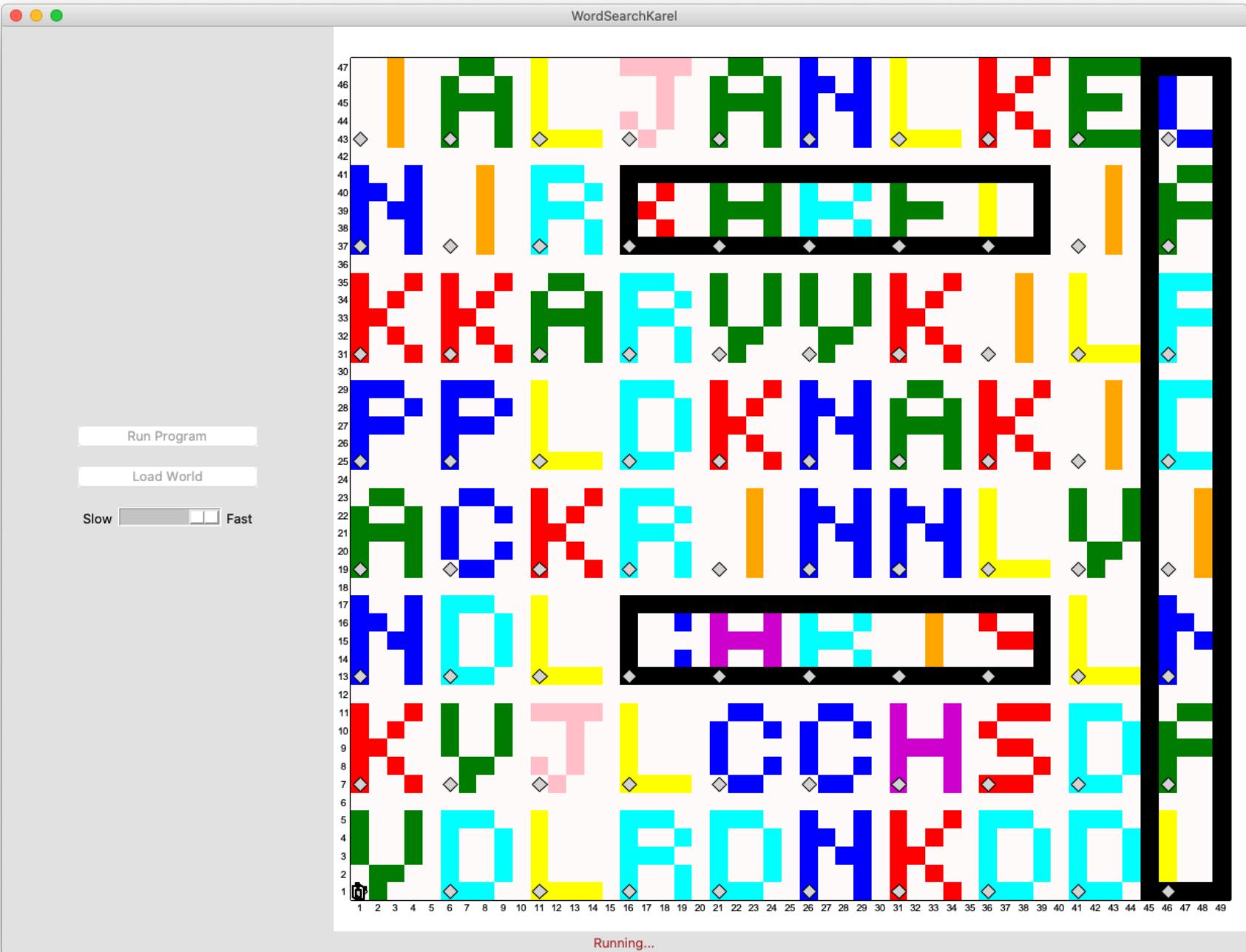
First, a cool program



Welcome to Karel!

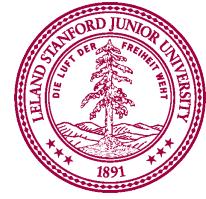
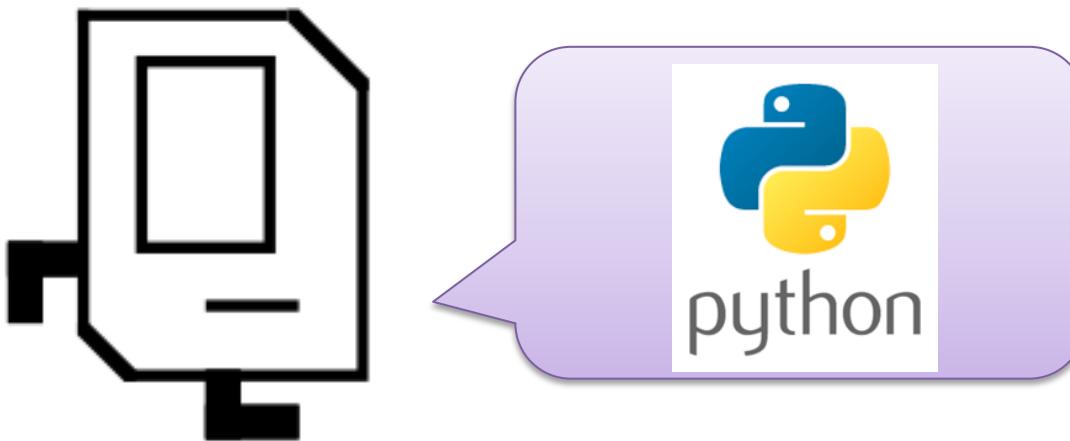






Quick review

Karel the Robot



Functions

```
def main():
    goToMoon()
```

```
def go_to_moon():
    build_spaceship()
    # a few more steps
```

```
def build_spaceship():
    # todo
    put_beeper()
```



For Loops

```
def main():

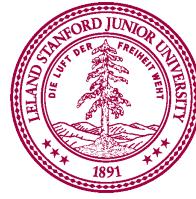
    # repeats the body 99 times
    for i in range(99):
        # the "body"
        put_beeper()
```



While Loops

```
def main():

    # while condition holds runs body
    # checks condition after body completes
    while front_is_clear():
        move()
```



If Statement

```
def main():

    # If the condition holds, runs body
    if front_is_clear():
        move()
```



If / Else Statement

```
def main():

    # If the condition holds,
    if beepers_present():
        # do this
        pick_beeper()
    else :
        # otherwise, do this
        put_beeper()
```



The Full Karel

Base Karel commands:

```
move()  
turn_left()  
put_beeper()  
pick_beeper()
```

Karel program structures:

```
# Comments can be included in any part  
# of a program. They start with a #  
# and include the rest of the line.
```

```
def main():  
    code to execute
```

declarations of other functions

Names of the conditions:

front_is_clear()	front_is_blocked()
beepers_present()	no_beeper_present()
beepers_in_bag()	no_beeper_in_bag()
left_is_clear()	left_is_blocked()
right_is_clear()	right_is_blocked()
facing_north()	not_facing_north()
facing_south()	not_facing_south()
facing_east()	not_facing_east()
facing_west()	not_facing_west()

Conditions:

```
if condition:  
    code run if condition passes
```

```
if condition:  
    code block for "yes"  
else:  
    code block for "no"
```

Loops:

```
for i in range(count):  
    code to repeat
```

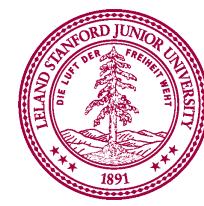
```
while condition:  
    code to repeat
```

Function Declaration:

```
def name():  
    code in the body of the function.
```

Extra Karel Commands:

```
paint_corner(COLOR_NAME)  
corner_color_is(COLOR_NAME)
```



End review

```
def friday():
    # heres our plan
    decomposition()
    double_beeper()
    rhoomba_karel()
    if extra_time():
        word_search_karel()
```

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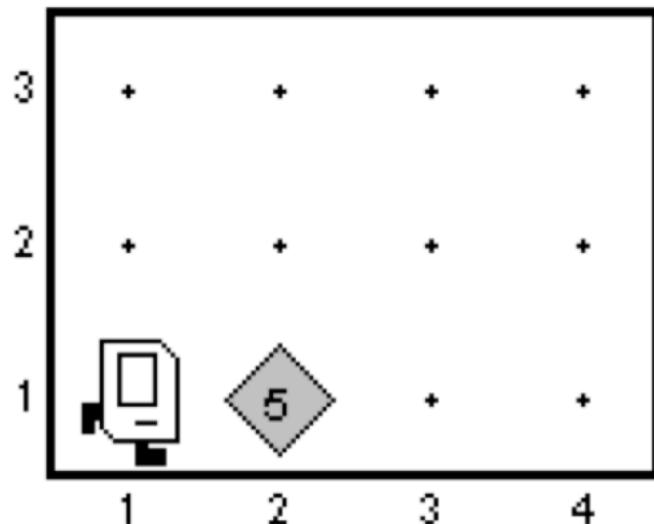


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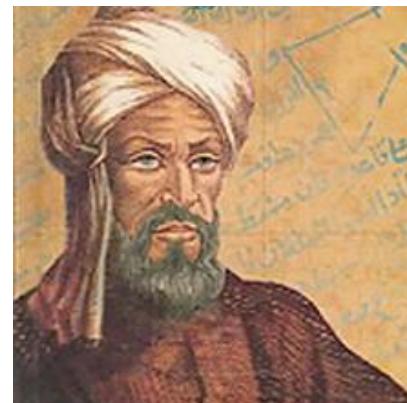
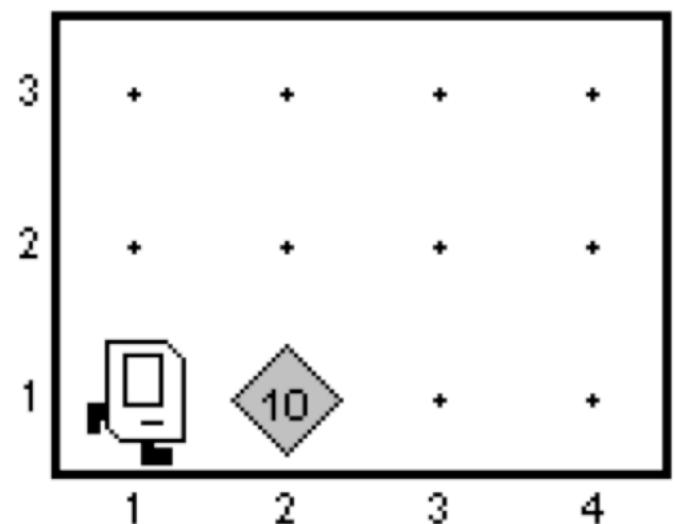
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```

Double Beepers

Before



After



Muhammed ibn
Musa Al Kwarizmi



DO
YOUR
THING

Piech, CS106A, Stanford University



Aside: Common Errors

Lather,
Rinse,
Repeat

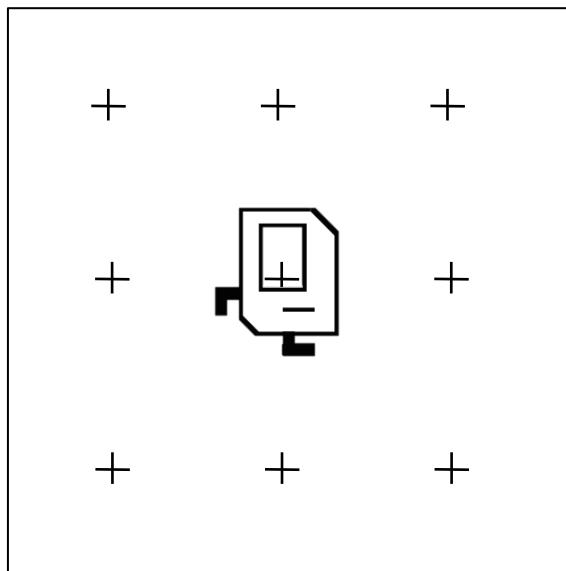
Now that your
hair is longer,
you'll need
Balsam.

conditions
ing healthy
ch easier to
oo. You just
hower after
sure you get
only Wella makes
the original Balsam, and it's
great stuff. Wella Balsam.



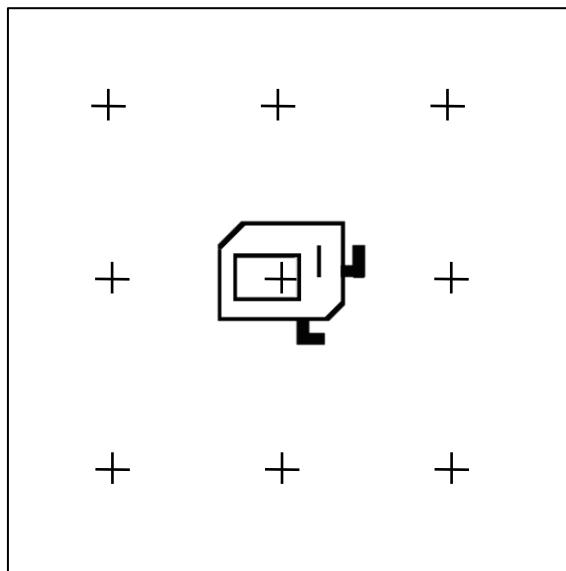
Infinite Loop

```
def turn_to_wall():
    while left_is_clear():
        turn_left()
```



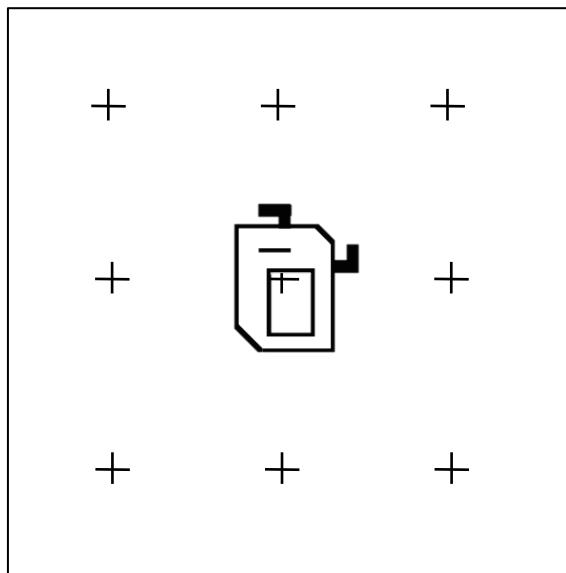
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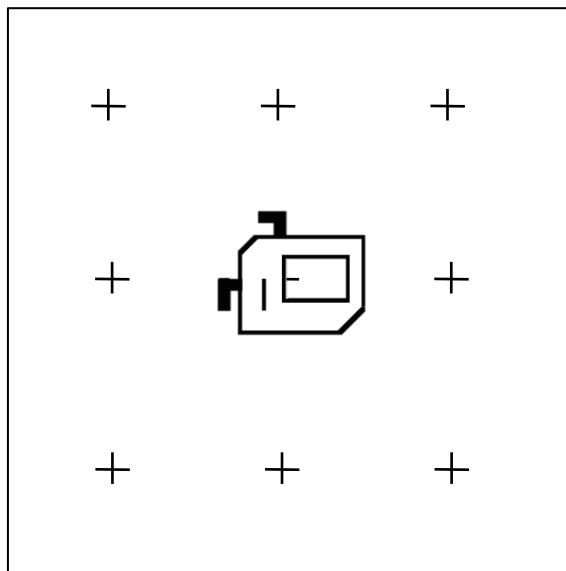
Infinite Loop

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Infinite Loop

```
def turn_to_wall():
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```



Pre/Post that Don't Match

```
def jump_hurdles:  
    for i range(8):  
        if front_is_clear():  
            move()  
        else:  
            jump_hurdle()
```

What do you
assume here?

Does the “post
condition” match?

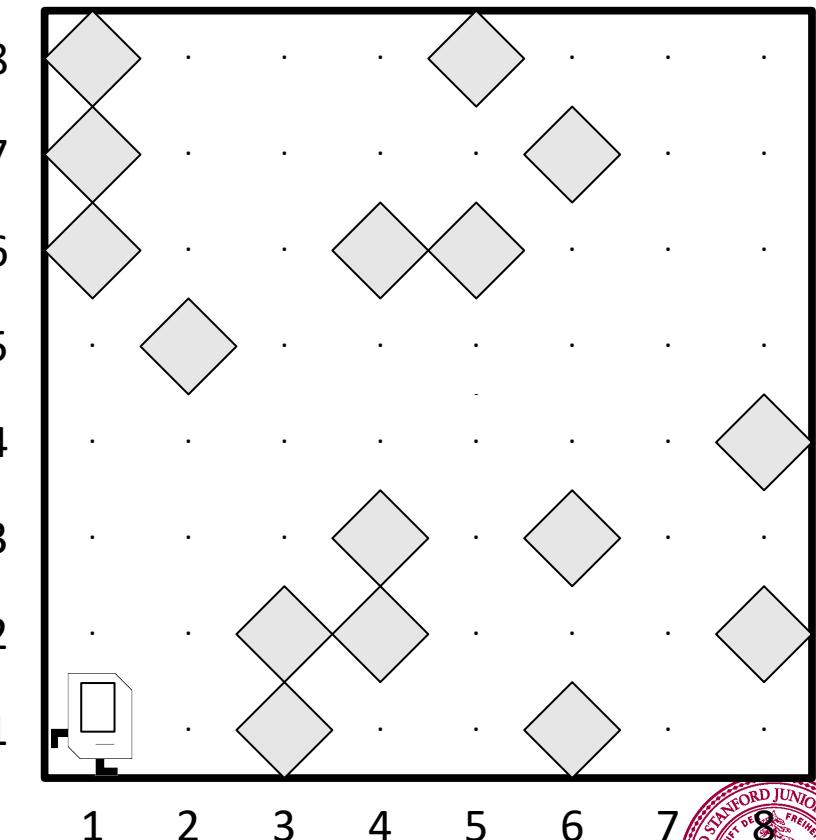


```
def friday():
    # heres our plan
    decomposition()
    double_beeper()
    rhoomba_karel()
    if extra_time():
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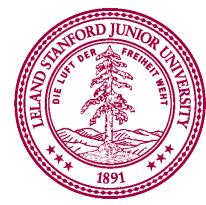
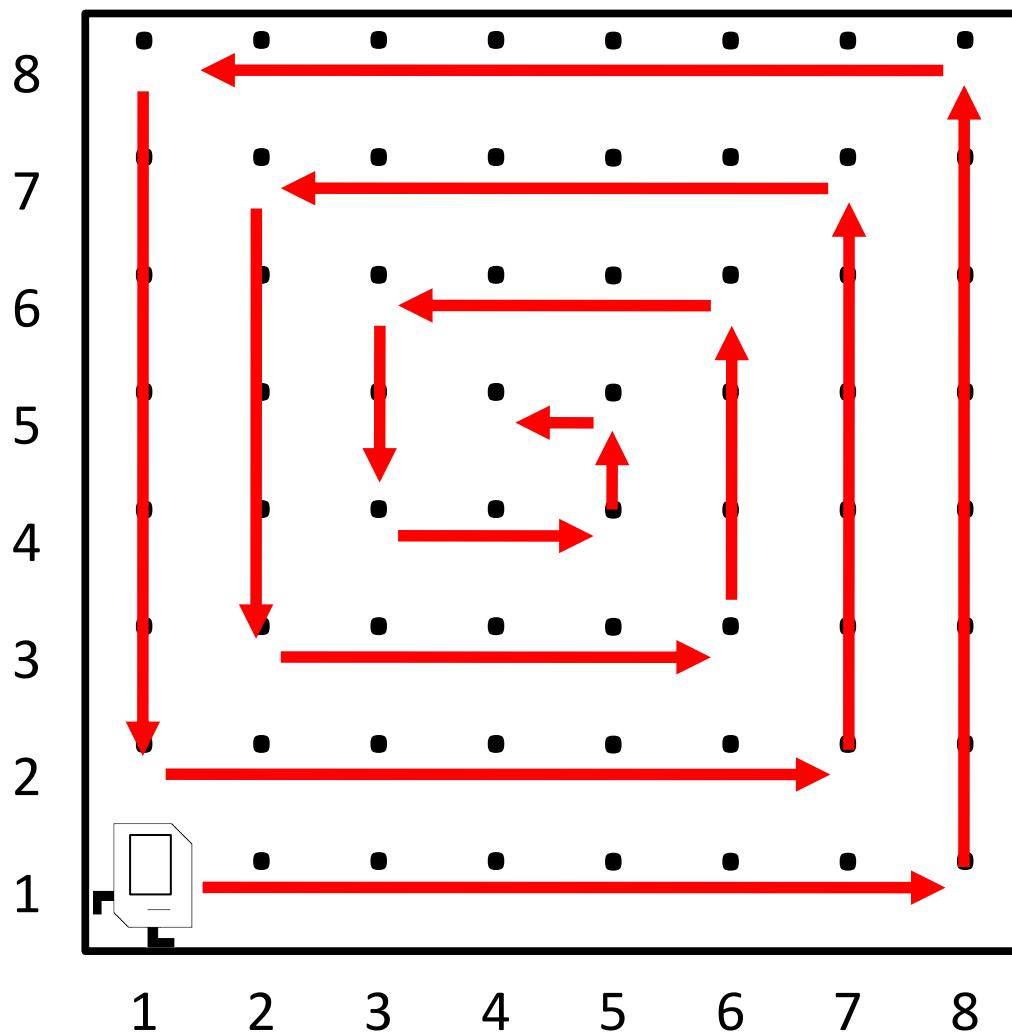
```
def friday():
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    double_beeper()
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```

Rhoomba Karel

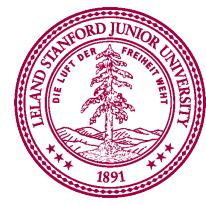
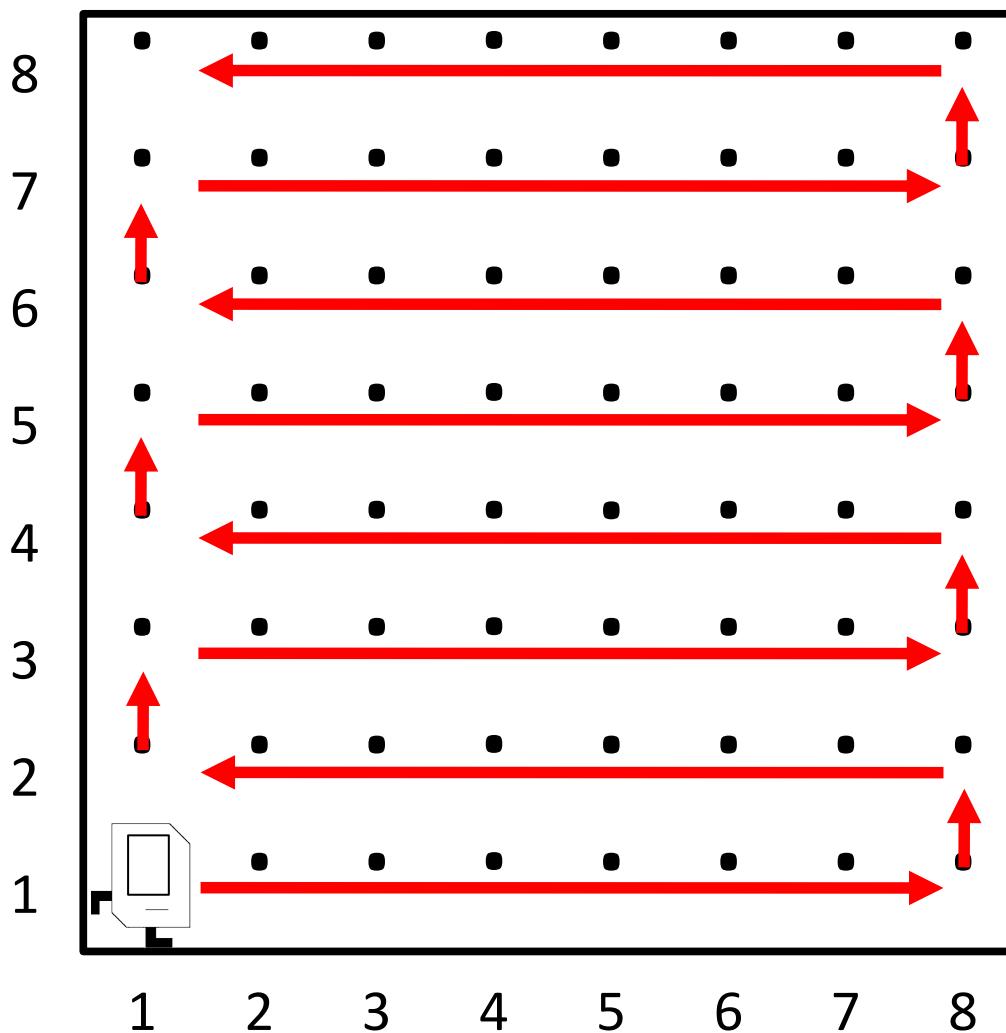
- Write a **Roomba** Karel that sweeps the entire world of all beepers.
 - Karel starts at (1,1) facing East.
 - The world is rectangular, and some squares contain beepers.
 - There are no interior walls.
 - When the program is done, the world should contain 0 beepers.
 - Karel's ending location does not matter.
- How should we approach this tricky problem?



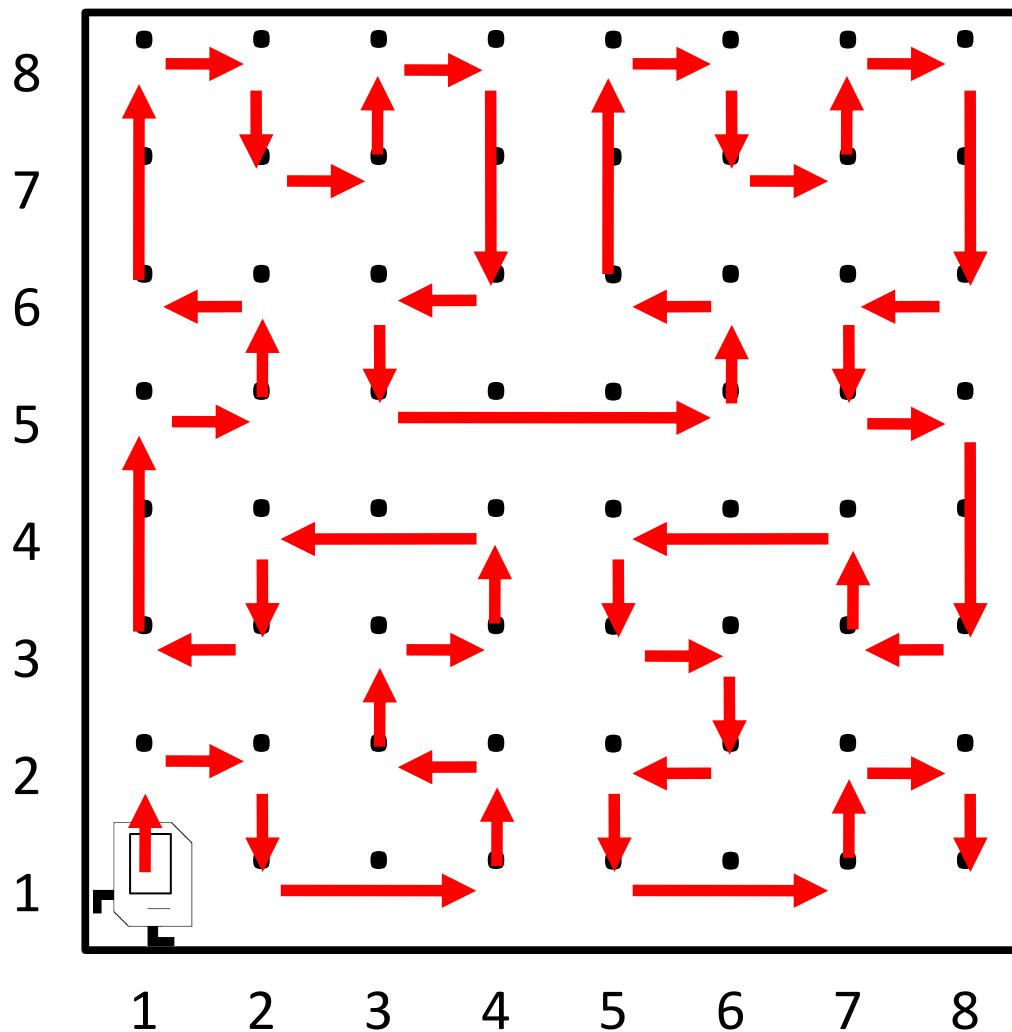
Possible Algorithm 1



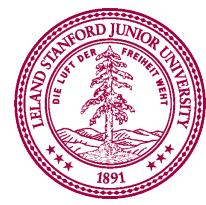
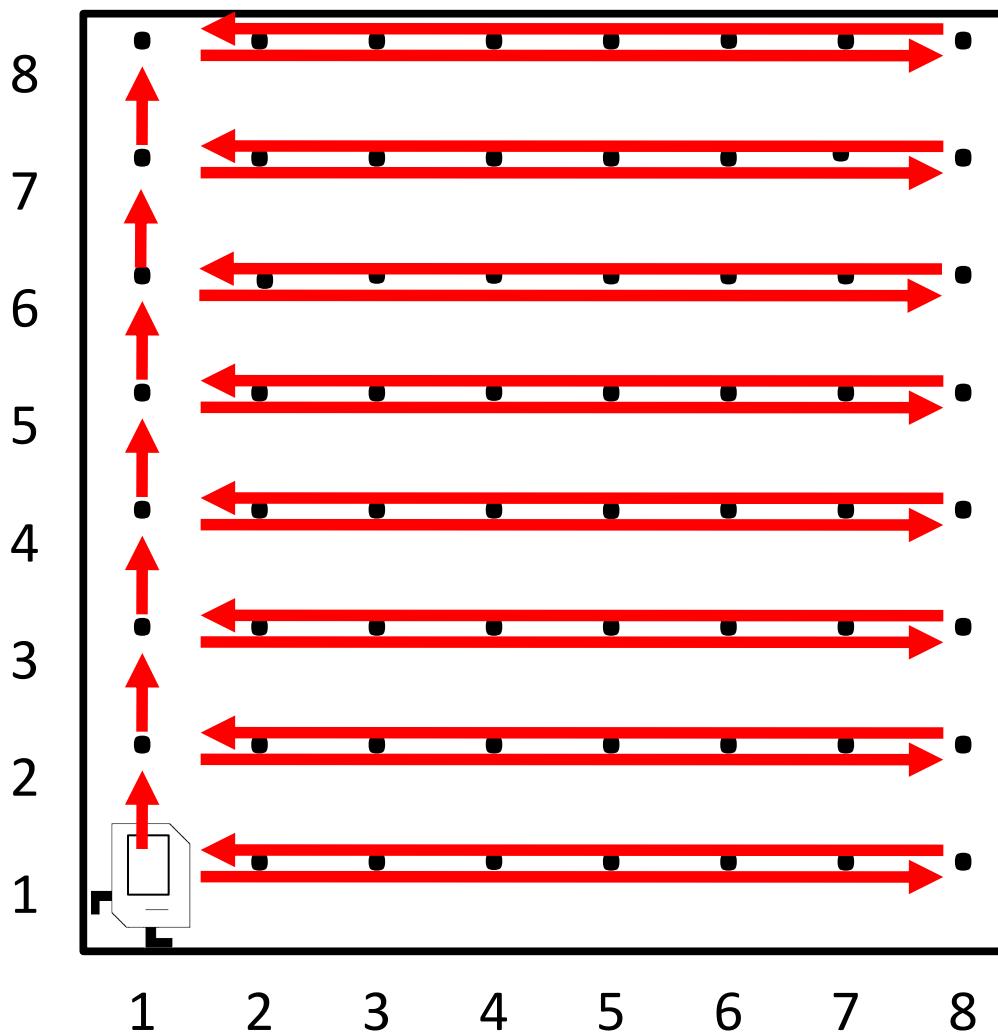
Possible Algorithm 2



Possible Algorithm 3



Possible Algorithm 4



Rhoomba Karel

RhoombaKarel

Welcome to Karel!

Start Program

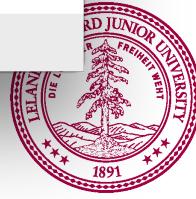
Reset Program

Load World

New World

Edit World

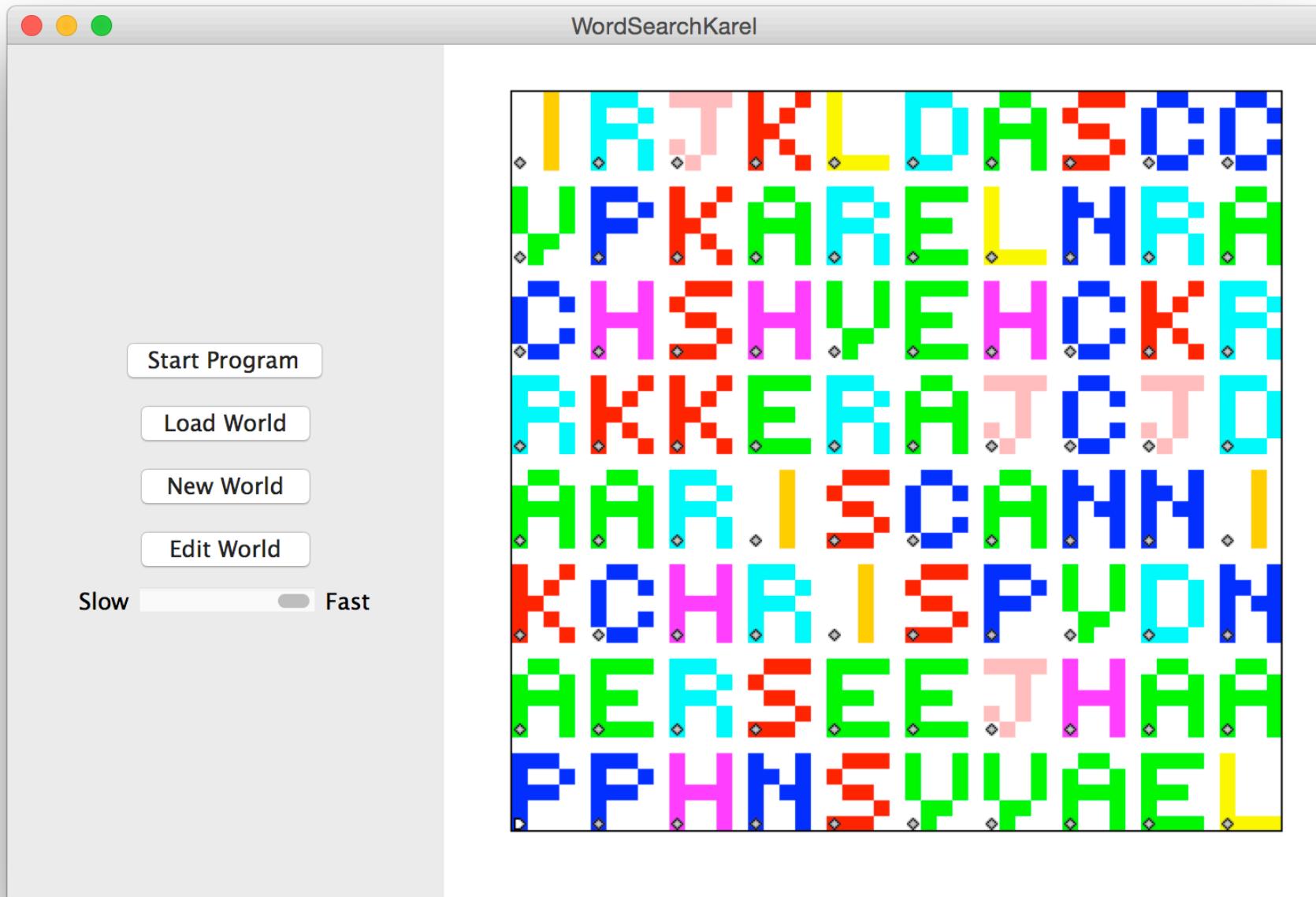
Slow Fast



```
def friday(){
    banishWinter()
    decomposition()
    doubleBeepers()
    rhoombaKarel()
    if(extratime()) {
        wordSearchKarel()
```

```
def friday(){
    banishWinter()
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def friday(){
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    decomposition()
    doubleBeepers()
    rhoombaKarel()
    if(extraTime()) {
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```



Happy Friday