Decomposition

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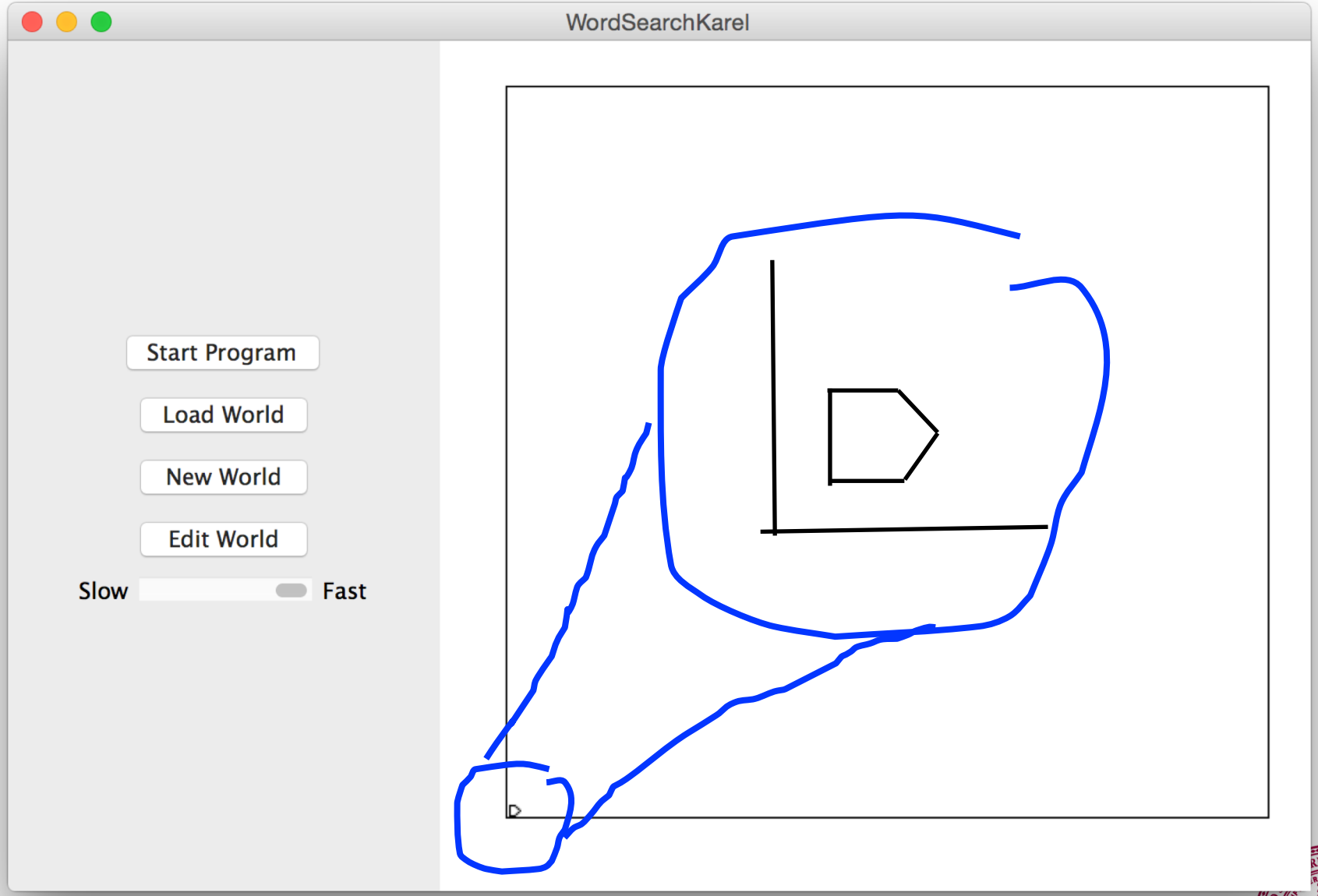
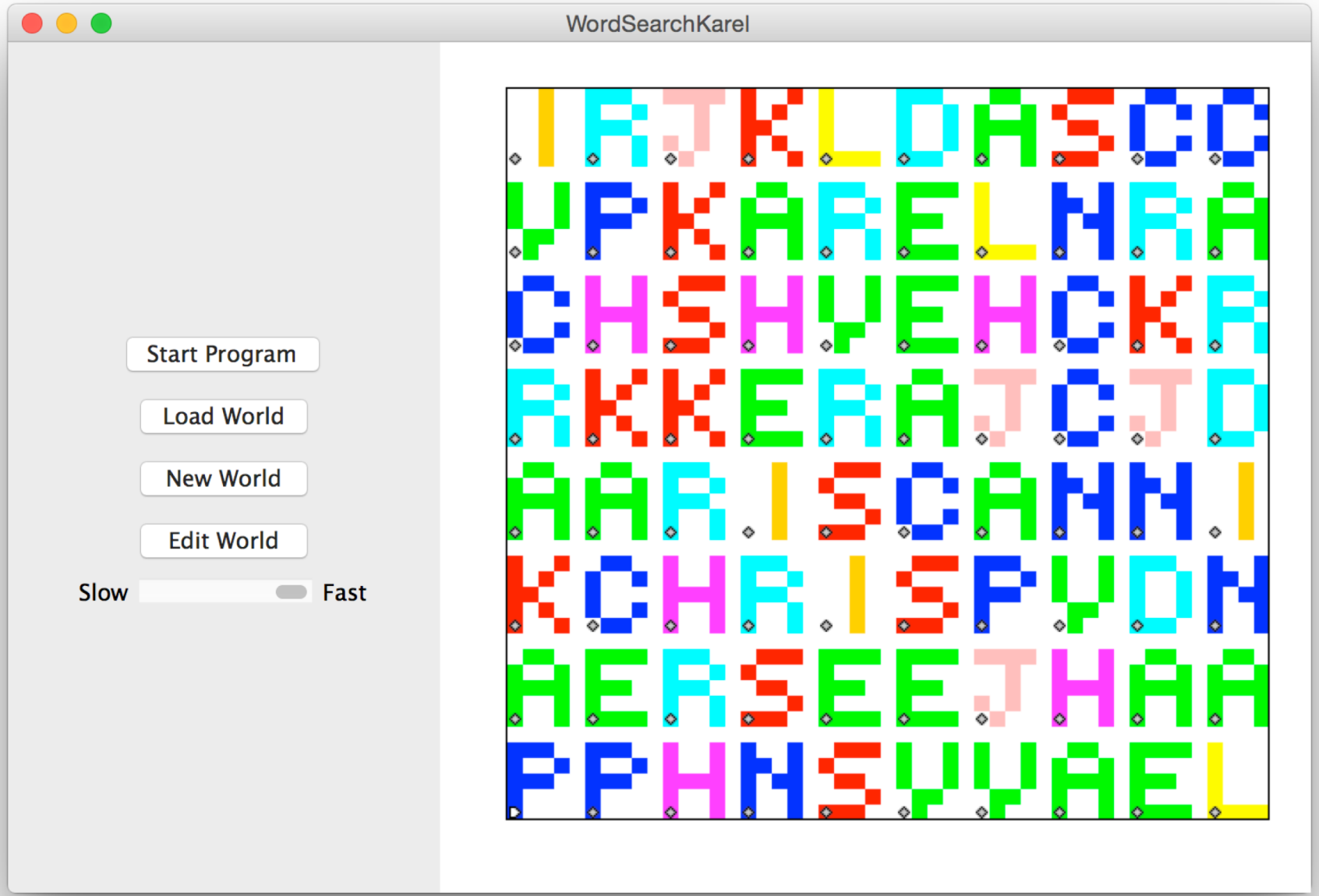
CS106A, Stanford University

Today's Goal

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

First, a cool program


WordSearchKarel
Start Program
Load World
New World
Edit World
Slow
Fast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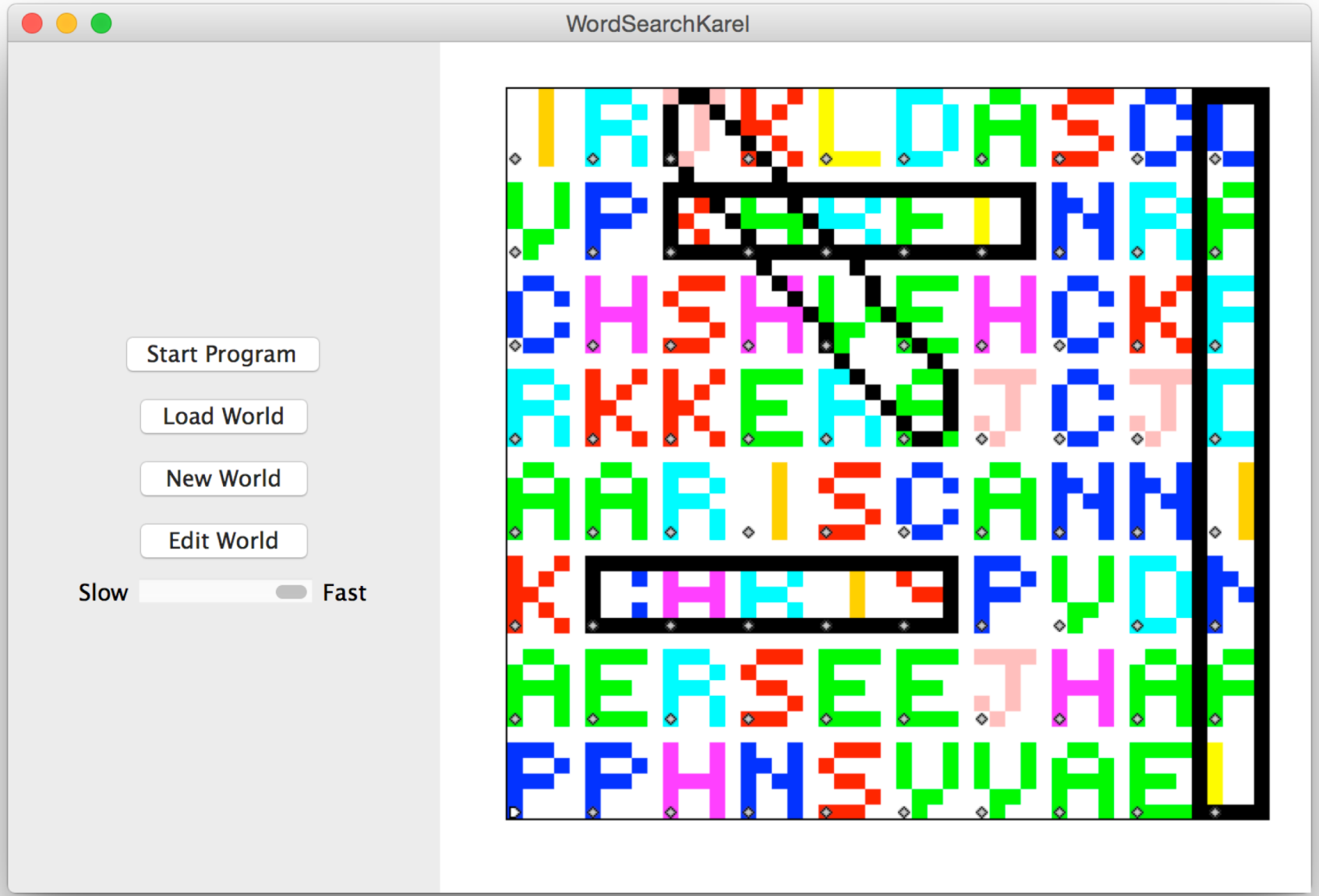
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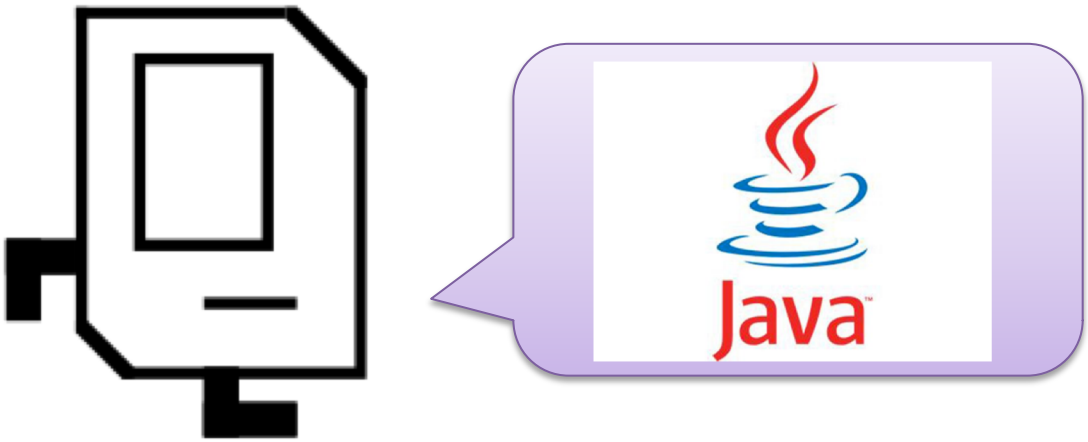
Quick review

Karel the Robot



Methods

```
import stanford.karel.*;

public class MethodExample extends SuperKarel {

    public void run() {
        goToMoon();
    }

    private void goToMoon() {
        buildSpaceship();
        // a few more steps
    }

    private void buildSpaceship() {
        // todo
    }
}
```


For Loops

```
import stanford.karel.*;

public class ForExample extends SuperKarel {

    public void run() {

        // repeats the body 99 times
        for(int i = 0; i < 99; i++) {
        // the "body"
            putBeeper();
        }
    }
}
```


While Loops

```
import stanford.karel.*;

public class WhileExample extends SuperKarel {

    public void run() {

        // while condition holds runs body
        // checks condition after body completes
        while(frontIsClear()) {
            move();
        }
    }

}
```


If Statement

```
import stanford.karel.*;

public class IfExample extends SuperKarel{

    public void run() {

        // If the condition holds, runs body
        if(frontIsClear()) {
            move();
        }
    }

}
```


If / Else Statement

```
import stanford.karel.*;

public class IfExample extends SuperKarel{

    public void run() {

        // If the condition holds,
        if(beepersPresent()) {
            // do this
            pickBeeper();
        } else {
            // otherwise, do this
            putBeeper();
        }
    }

}
```


The Full Karel

Built-in Karel commands:

```
move();
turnLeft();
putBeeper();
pickBeeper();
```

Karel program structure:

```
/*
 * Comments may be included anywhere in
 * the program between a slash-star and
 * the corresponding star-slash characters.
 */

import stanford.karel.*;

/* Definition of the new class */

public class name extends Karel {

   public void run() {
      statements in the body of the method
   }

   definitions of private methods

}
```

Karel condition names:

`frontIsClear()`	`frontIsBlocked()`
`leftIsClear()`	`leftIsBlocked()`
`rightIsClear()`	`rightIsBlocked()`
`beepersPresent()`	`noBeepersPresent()`
`beepersInBag()`	`noBeepersInBag()`
`facingNorth()`	`notFacingNorth()`
`facingEast()`	`notFacingEast()`
`facingSouth()`	`notFacingSouth()`
`facingWest()`	`notFacingWest()`

Conditional statements:

```
if (condition) {
   statements executed if condition is true
}

if (condition) {
   statements executed if condition is true
} else {
   statements executed if condition is false
}
```

Iterative statements:

```
for (int i = 0; i < count; i++) {
   statements to be repeated
}

while (condition) {
   statements to be repeated
}
```

Method definition:

```
private void name () {
   statements in the method body
}
```

New commands in the `SuperKarel` class:

```
turnRight();
turnAround();
paintCorner(color);
```

New conditions in the `SuperKarel` class:

```
random()
random(p)
cornerColorIs(color)
```

Today we will use:

```
frontIsClear()
rightIsBlocked()
beepersPresent()
```


The Full Karel

You might want to combine conditions:

This means "and"

```
if(frontIsClear() && rightIsBlocked()) {
   … some code
}
```

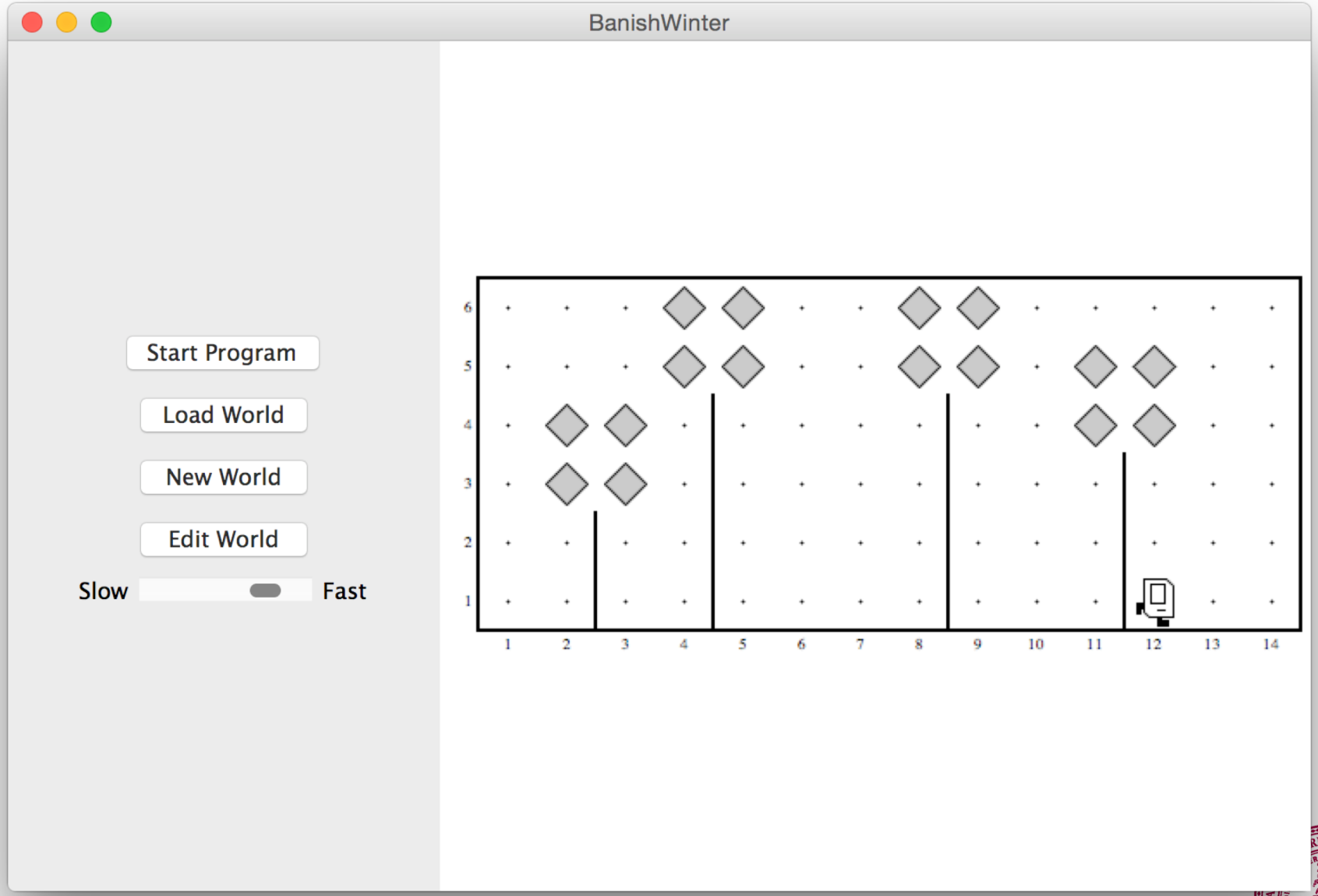
This means "or"

```
if(frontIsClear() || rightIsClear()) {
   … some code
}
```


End review

```
private void friday(){
    banishWinter();
    decomposition();
    doubleBeepers();
    rhoombaKarel();
    if(extraTime()){
        wordSearchKarel();
    }
}
```

Banish Winter



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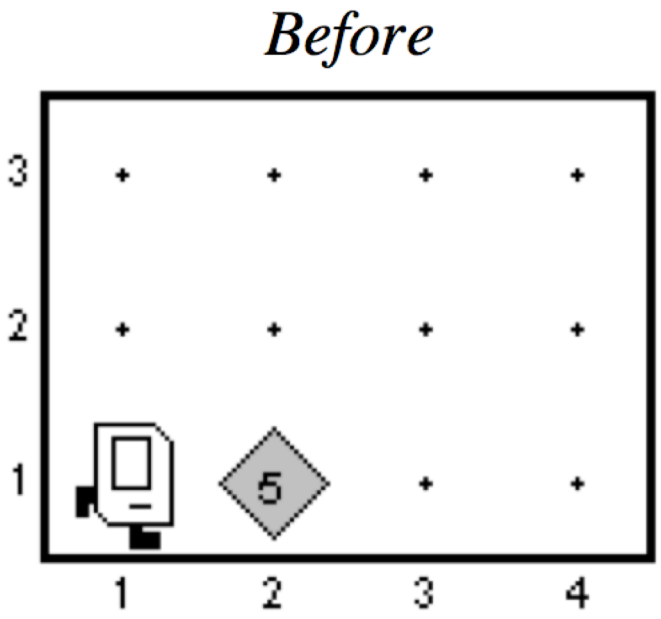
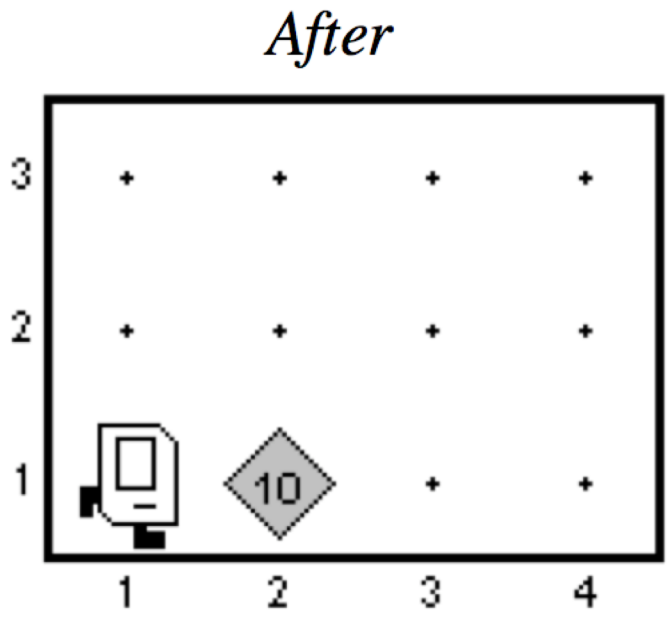
Double Beepers





Muhammed ibn
Musa Al Kwarizmi

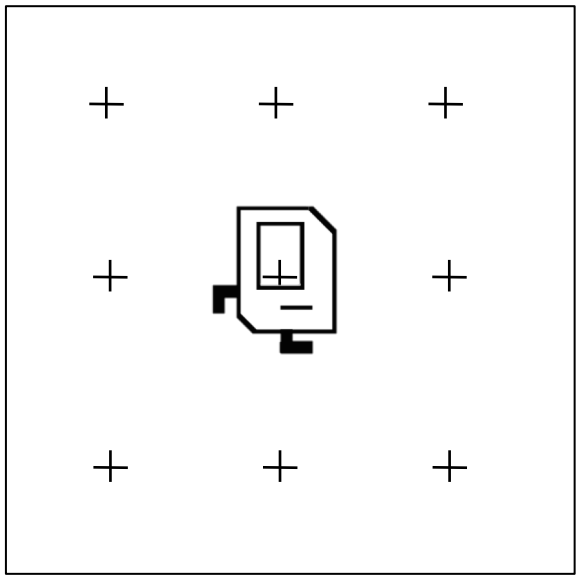

DO
YOUR
THING

Aside: Common Errors

Lather,
Rinse,
Repeat

Infinite Loop

```
private void turnToWall() {
   while(leftIsClear()) {
      turnLeft();
   }
}
```



Infinite Loop

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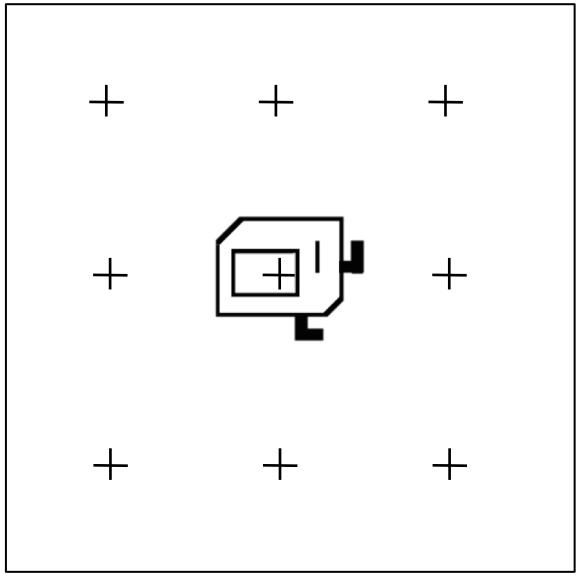

Infinite Loop

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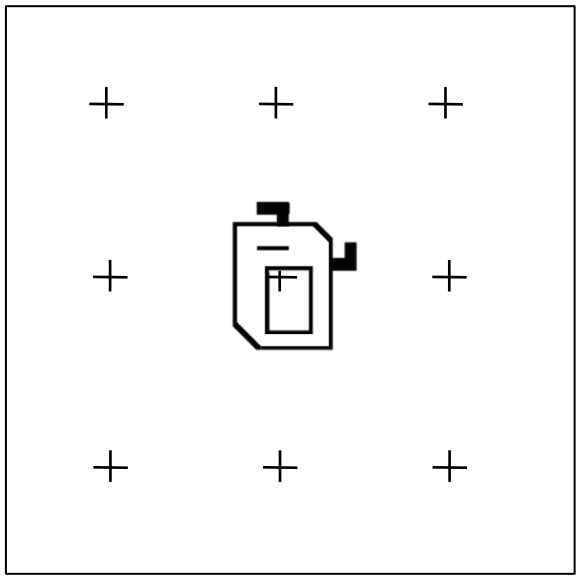
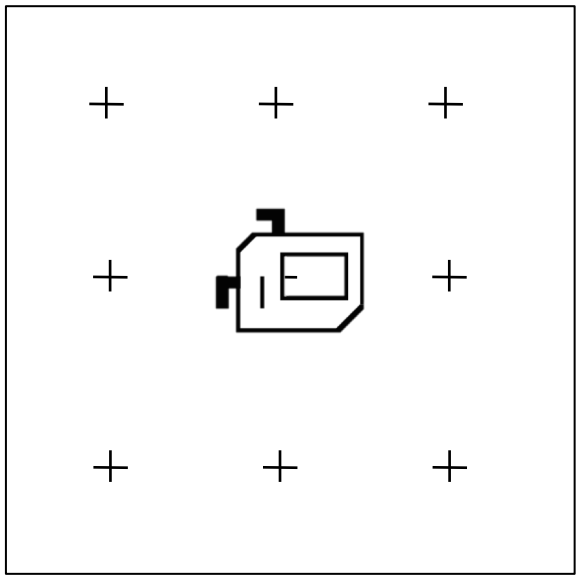


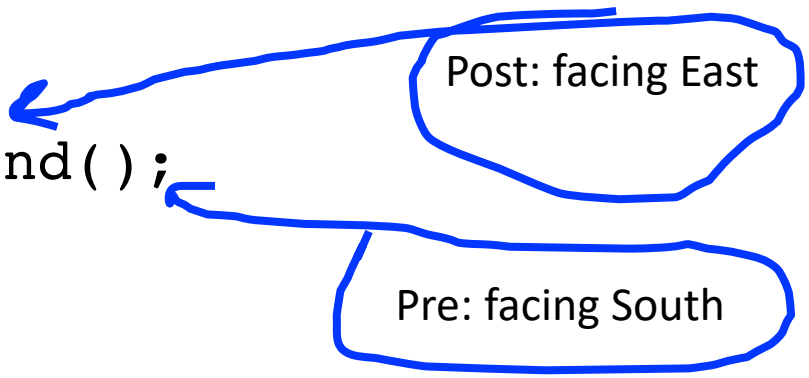
Infinite Loop

```
private void turnToWall() {
   while(leftIsClear()) {
      turnLeft();
   }
}
```



Pre/Post that Don't Match

```
private void addLeavesToTrees() {
      turnLeft();
      climbTree();
      addLeaves();
      descendToGround();
      turnLeft();
}
```



* Pro tip: I also think of while loops as having a pre and post condition, which must match

```
private void friday(){
    banishWinter();
    decomposition();
    doubleBeepers();
    rhoombaKarel();
    if(extraTime()){
        wordSearchKarel();
    }
}
```

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private void friday(){
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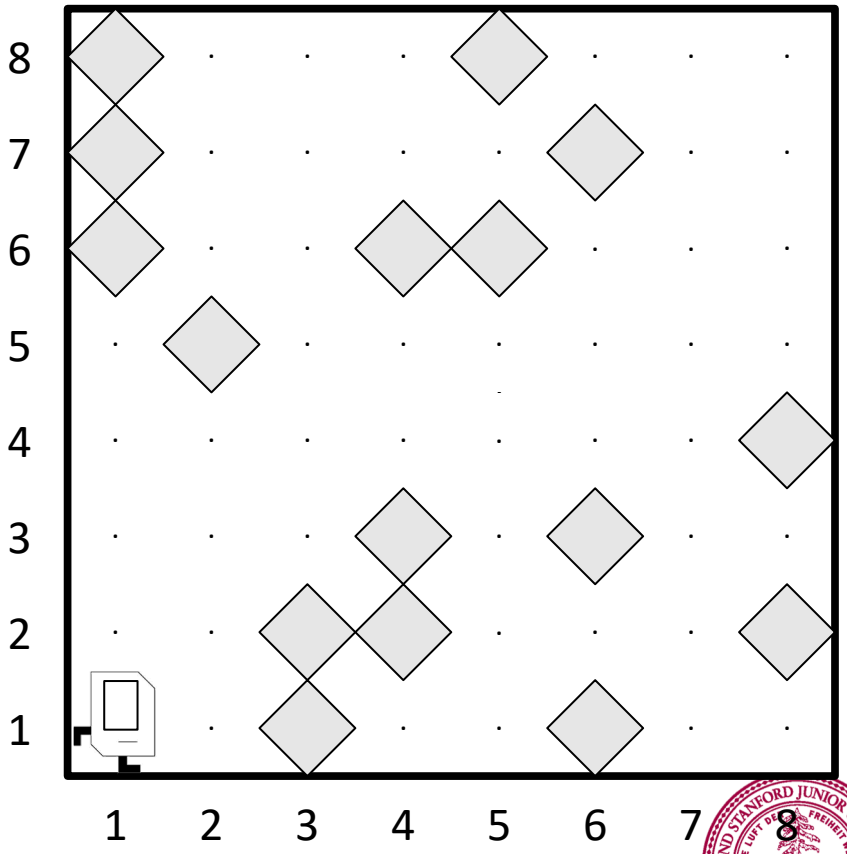
```

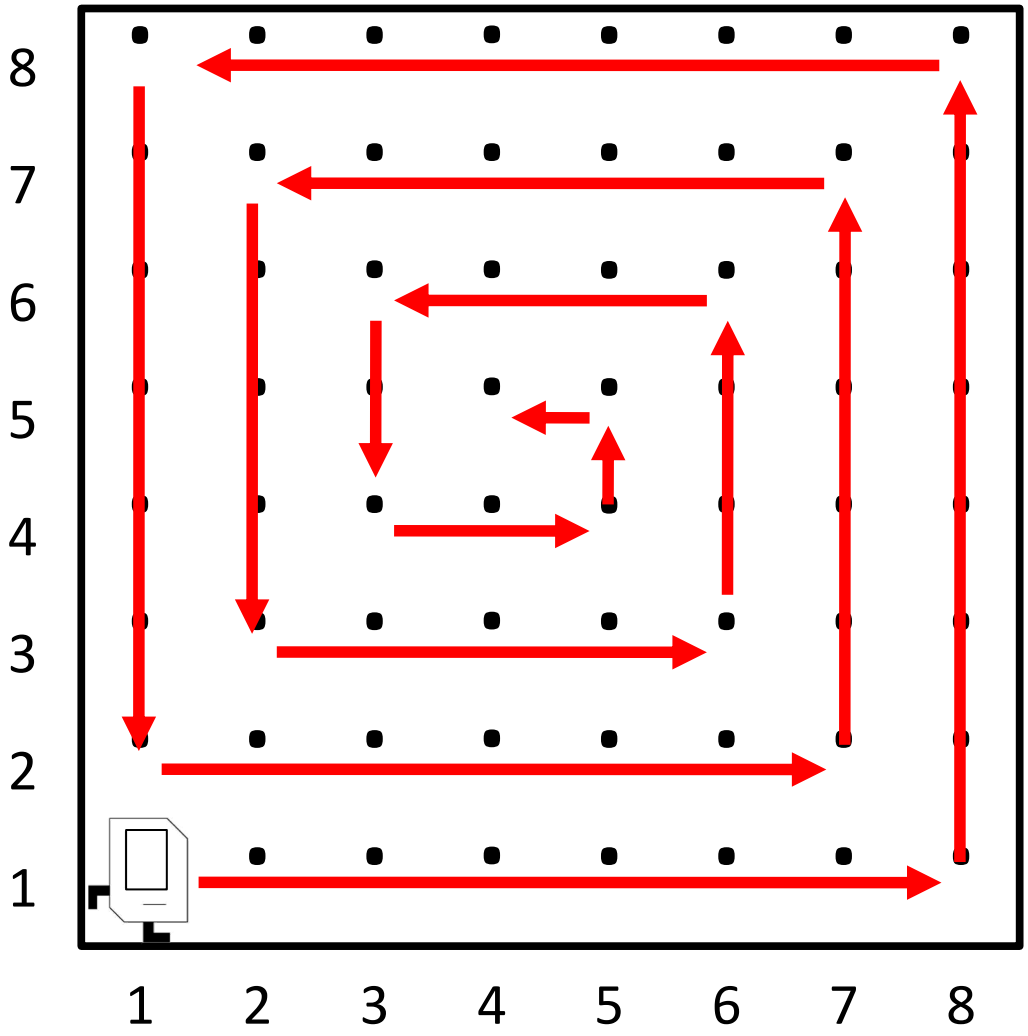
Rhoomba Karel

- 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.

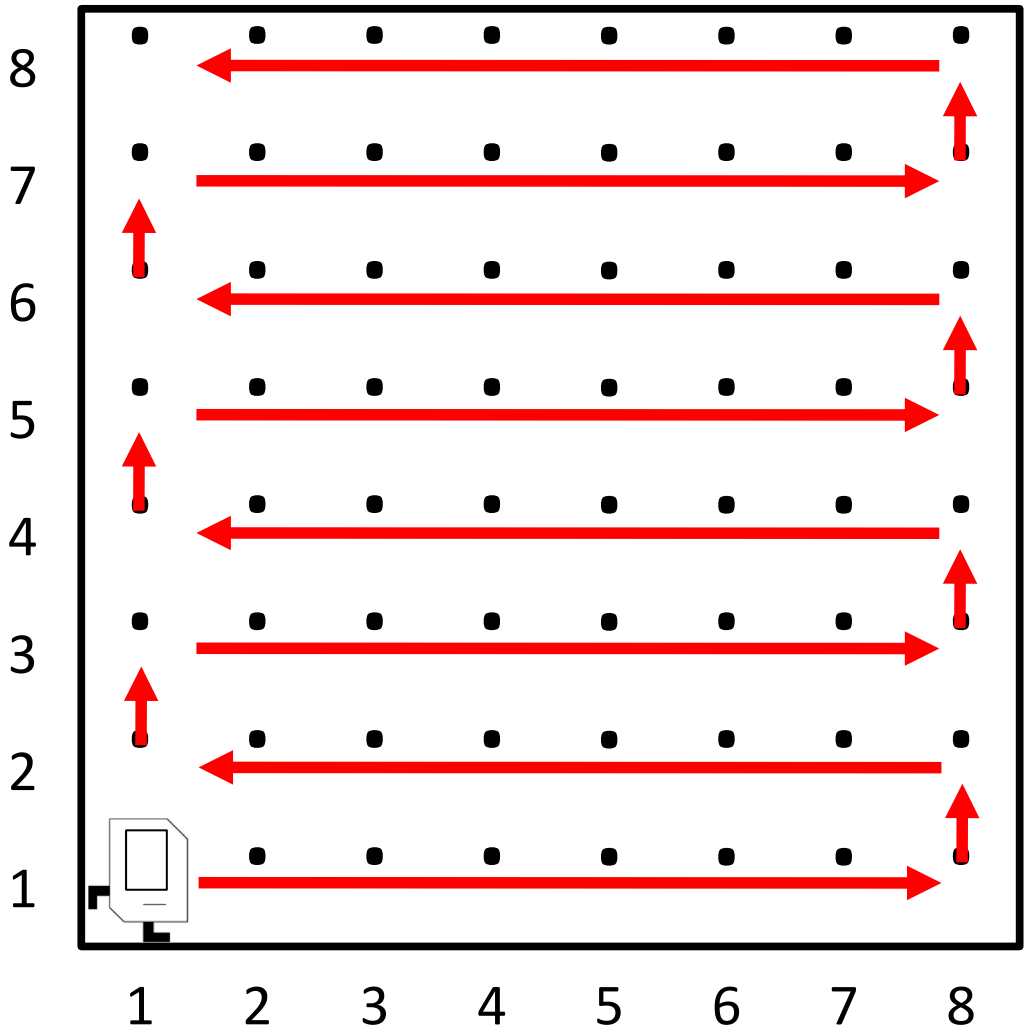


- How should we approach this tricky problem?

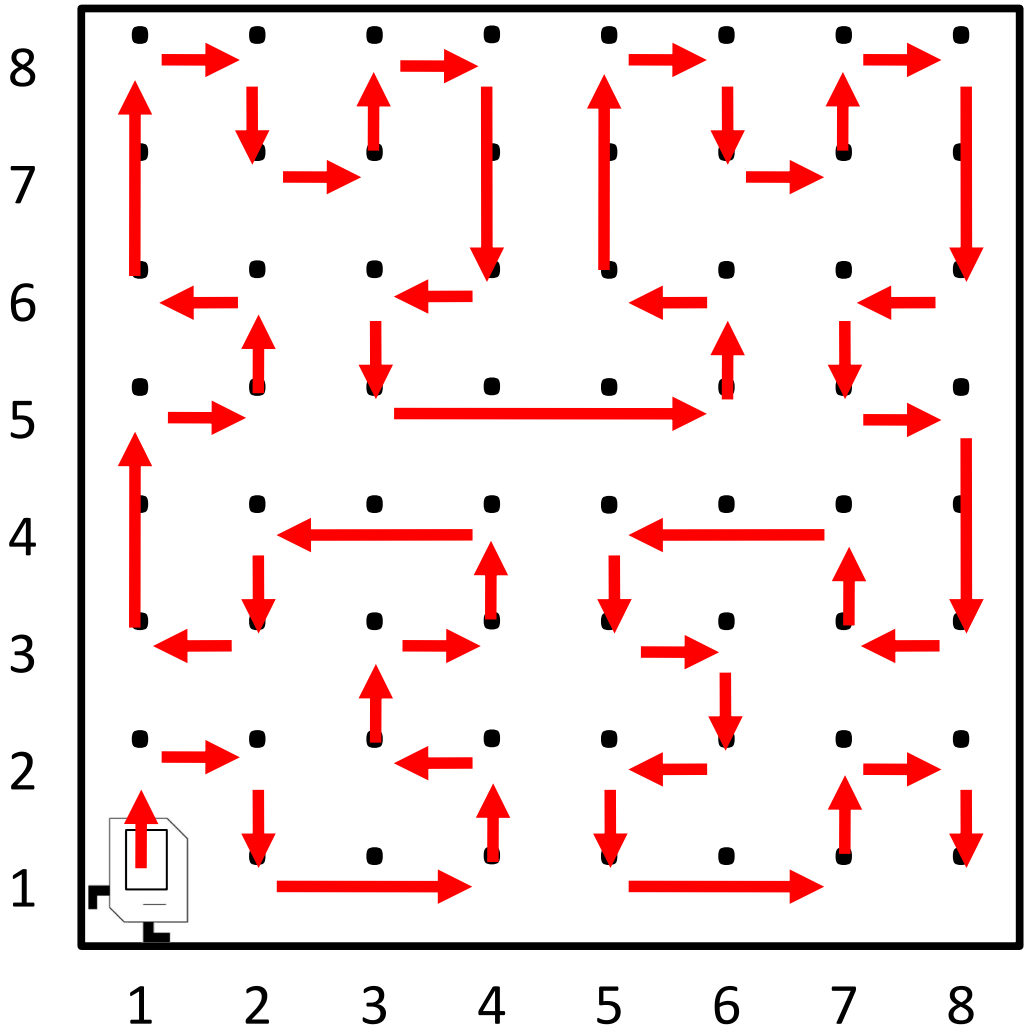
Possible Algorithm 1



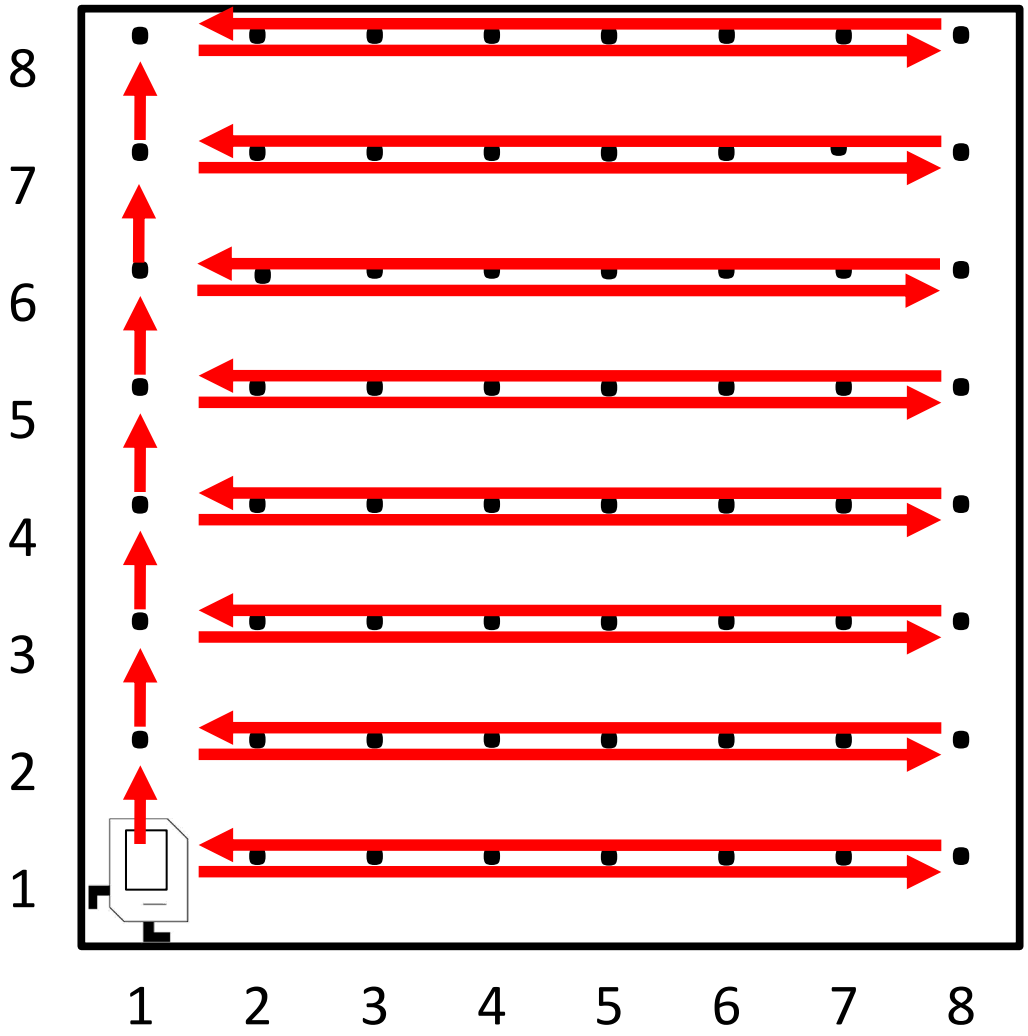
Possible Algorithm 2



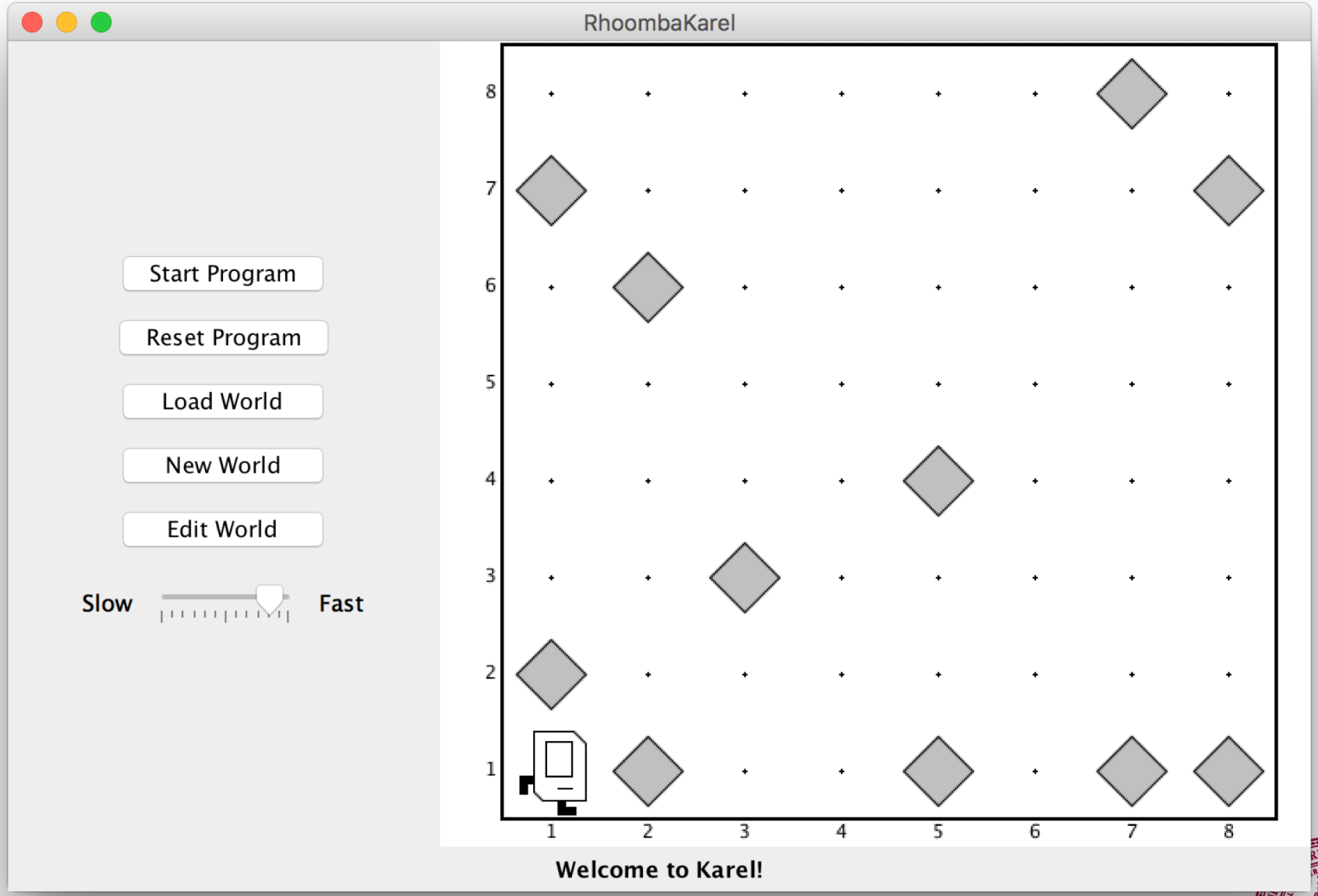
Possible Algorithm 3



Possible Algorithm 4



Rhoomba Karel



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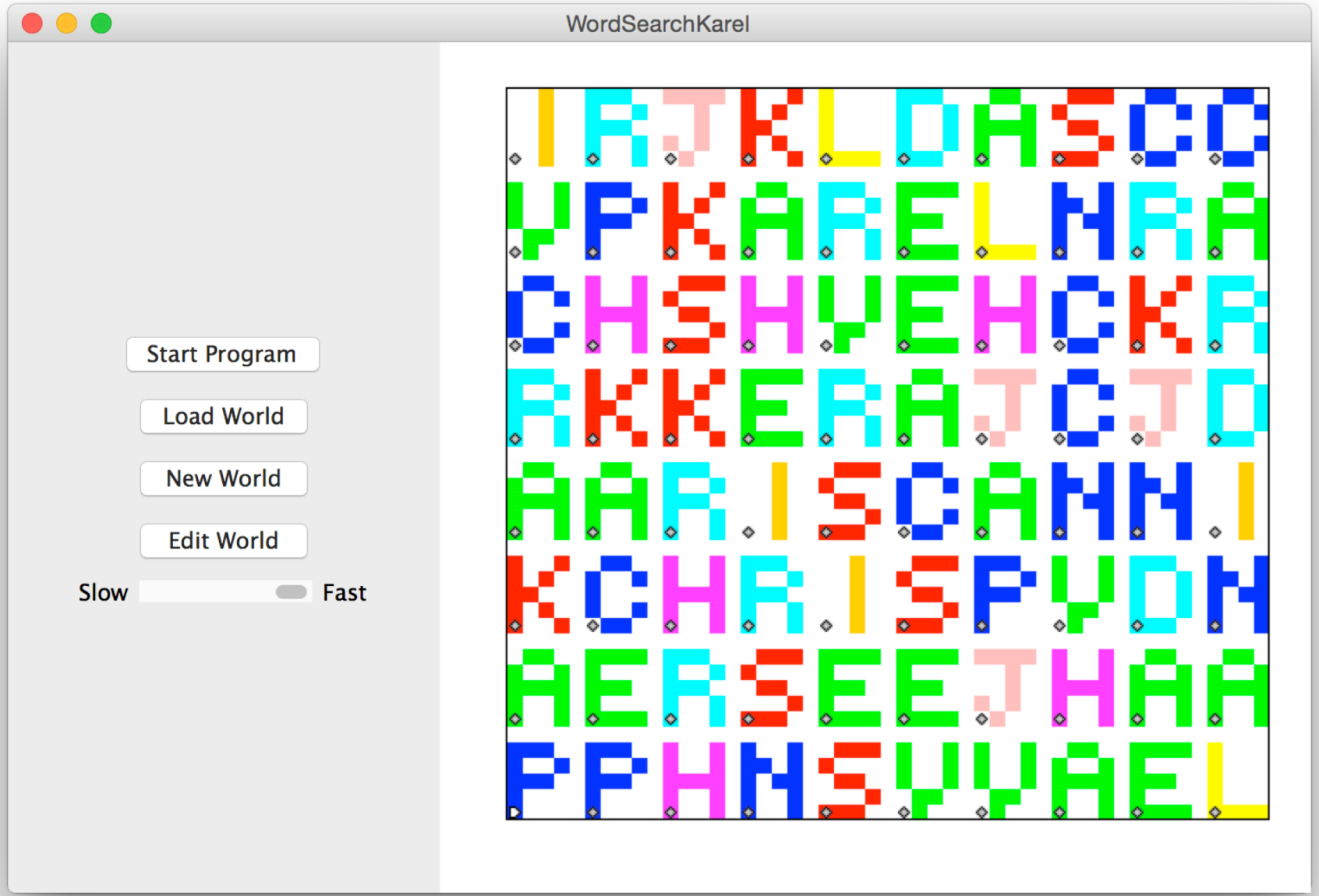
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Happy Friday