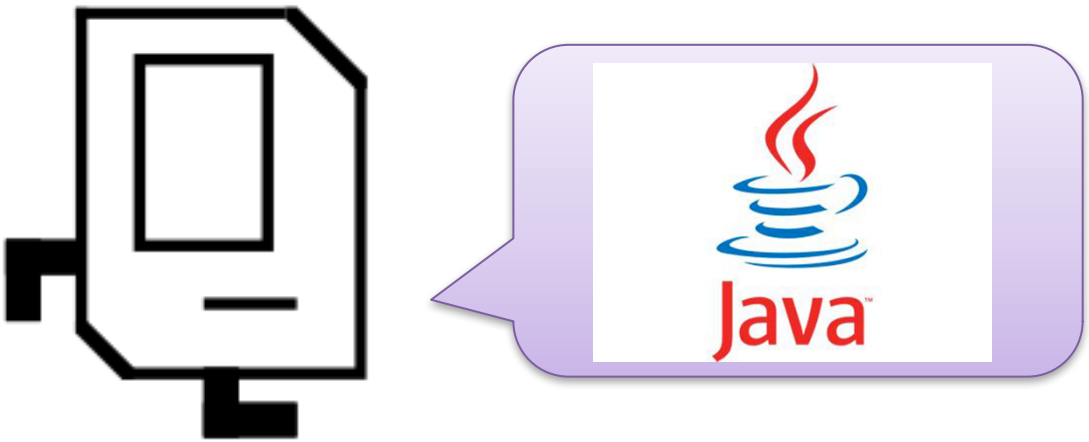
Control Flow

Chris Piech
CS106A, Stanford University

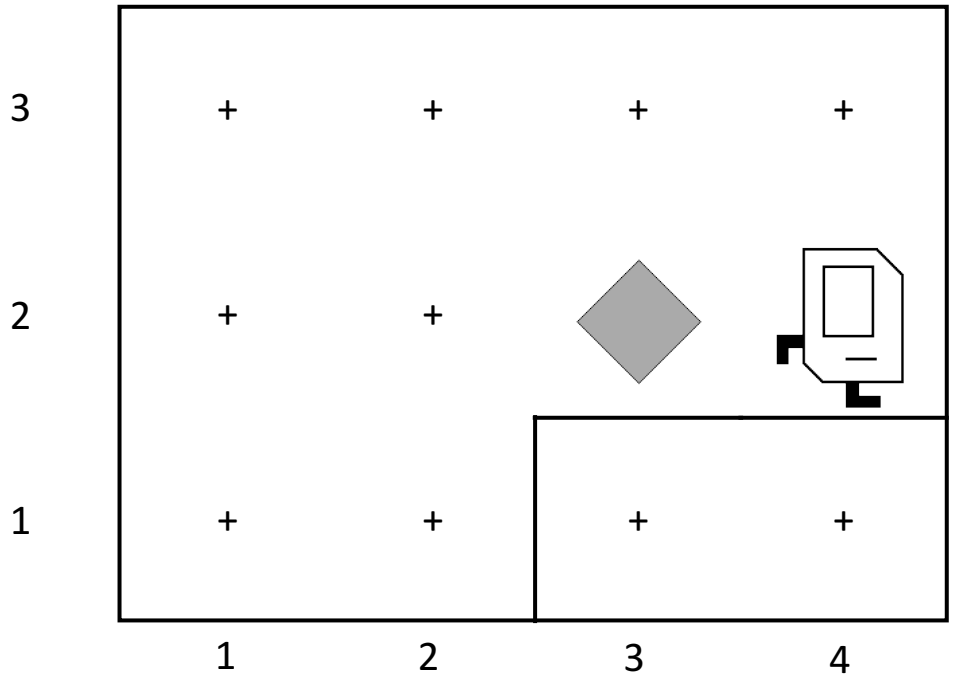
CS106A

Karel the Robot



* While Karel is in Java, when you program your Karel assignment we ask that you stick to the concepts in the course reader

First Challenge



Anatomy of a Program

```
import stanford.karel.*;

public class OurKarelProgram extends Karel {
    public void run() {
        move();
        pickBeeper();
        move();
        turnLeft();
        move();
        turnRight();
        move();
        putBeeper();
        move();
    }

    private void turnRight() {
        turnLeft();
        turnLeft();
        turnLeft();
    }
}
```

This is the program's ***source code***

Anatomy of a Program

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public class OurKarelProgram extends Karel {
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        move();
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    }

    private void turnRight() {
        turnLeft();
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    }
}
```

This piece of the program's ***source code*** is called a ***method***.

Anatomy of a Program

```
import stanford.karel.*;

public class OurKarelProgram extends Karel {
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        move();
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        move();
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    }

    private void turnRight() {
        turnLeft();
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    }
}
```

This line of code gives the ***name*** of the method (here, run)

Anatomy of a Program

```
import stanford.karel.*;

public class OurKarelProgram extends Karel {
    public void run() {
        move();
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        move();
        turnRight();
        move();
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    }

    private void turnRight() {
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        turnLeft();
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}
```

This line of code gives the ***name*** of the method (here, turnRight)

Anatomy of a Program

```
import stanford.karel.*;

public class OurKarelProgram extends Karel {
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        move();
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        move();
    }

    private void turnRight() {
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    }
}
```

This is called an ***import statement***. It tells Java what Karel is.

Anatomy of a Program

```
import stanford.karel.*;

public class OurKarelProgram extends Karel {
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        move();
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    private void turnRight() {
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    }
}
```

This is called a ***code block***

Anatomy of a Program

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        move();
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```


Anatomy of a Program

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Anatomy of a Program

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}
```


Anatomy of a Program

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Anatomy of a Program

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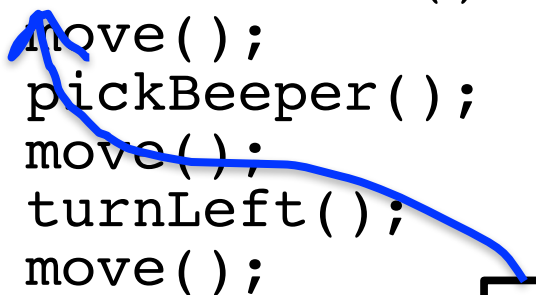
        move();
        turnRight();
        move();
        putBeeper();
        move();
    }

    private void turnRight() {
        turnLeft();
        turnLeft();
        turnLeft();
    }
}
```



The run method is "public" so that Eclipse can call it.

Anatomy of a Program

```
import stanford.karel.*;

public class OurKarelProgram extends Karel {
    public void run() {
        move();
        pickBeeper();
        move();
        turnLeft();
        move();
        turnRight();
        move();
        putBeeper();
        move();
    }

    private void turnRight() {
        turnLeft();
        turnLeft();
        turnLeft();
    }
}
```

The turnRight method is "private" to indicate it is only visible to our current program.

Method Definition

This adds a new command to Karels vocabulary

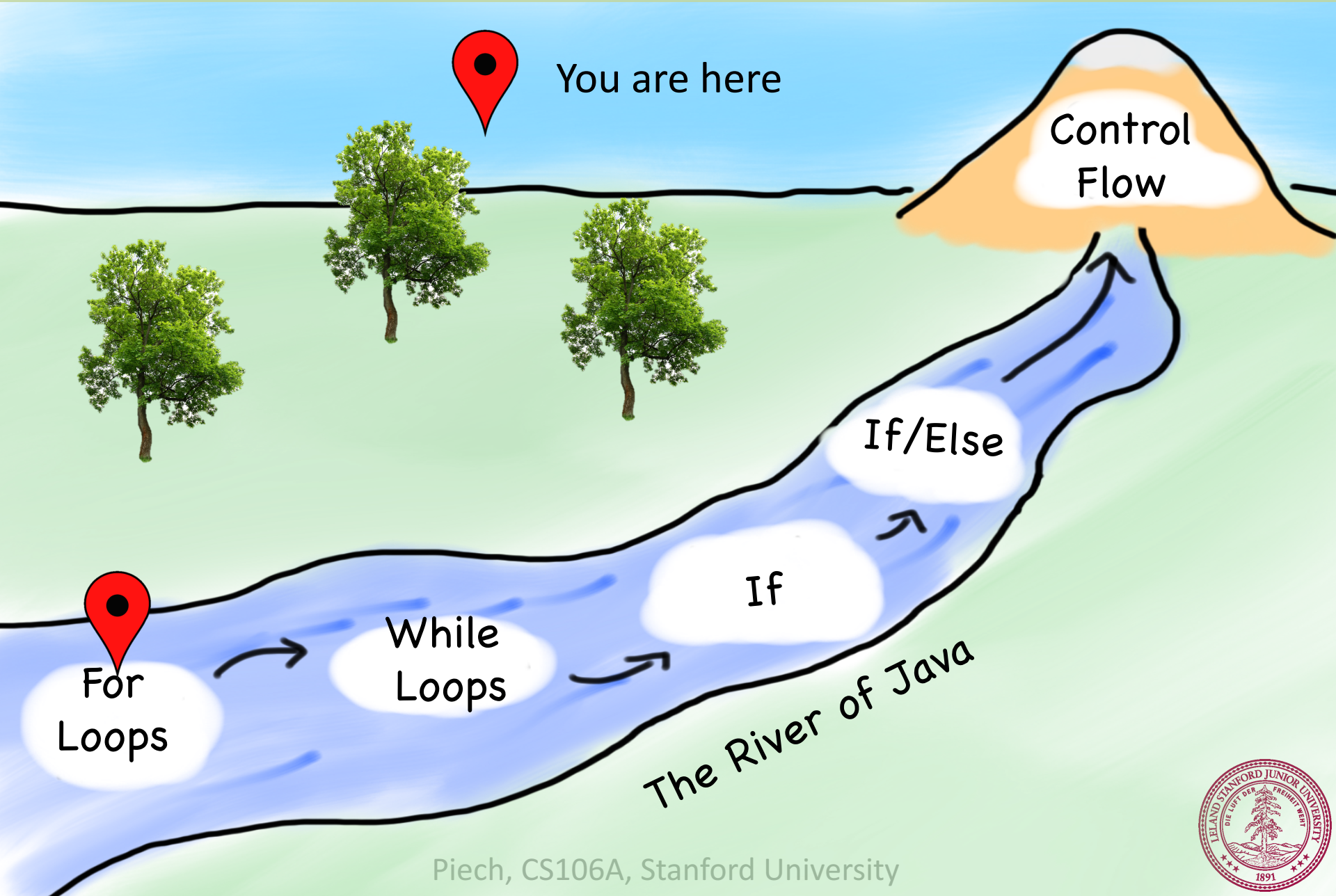
```
private void name() {
    statements in the method body
}
```

Decomposition of Hard Tasks

Today's Goal

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

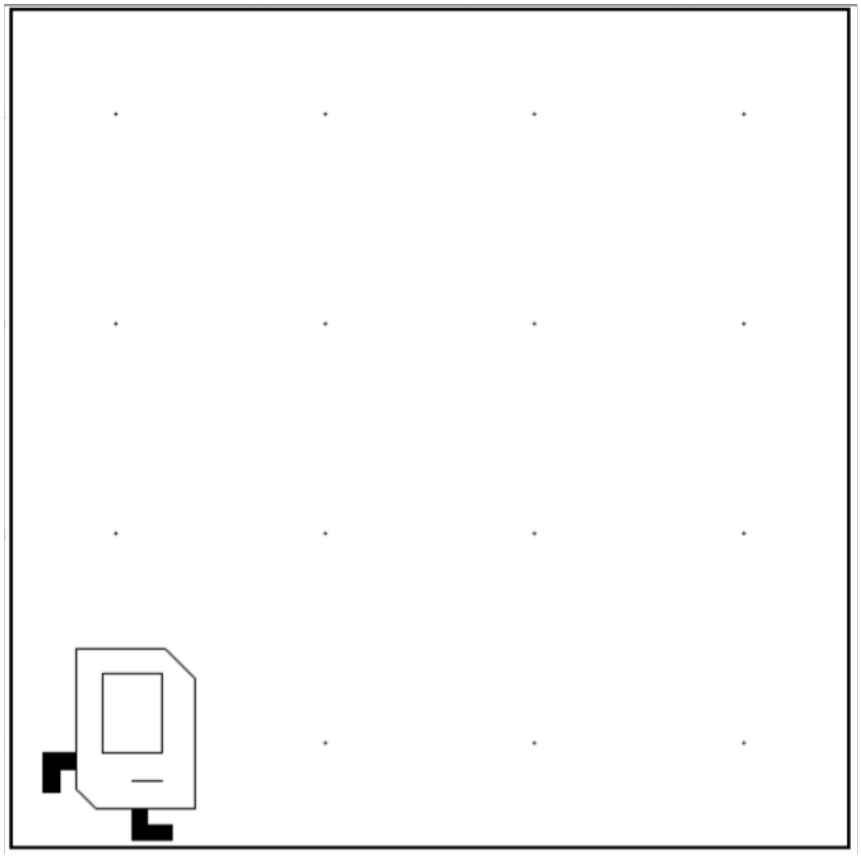
Today's Route



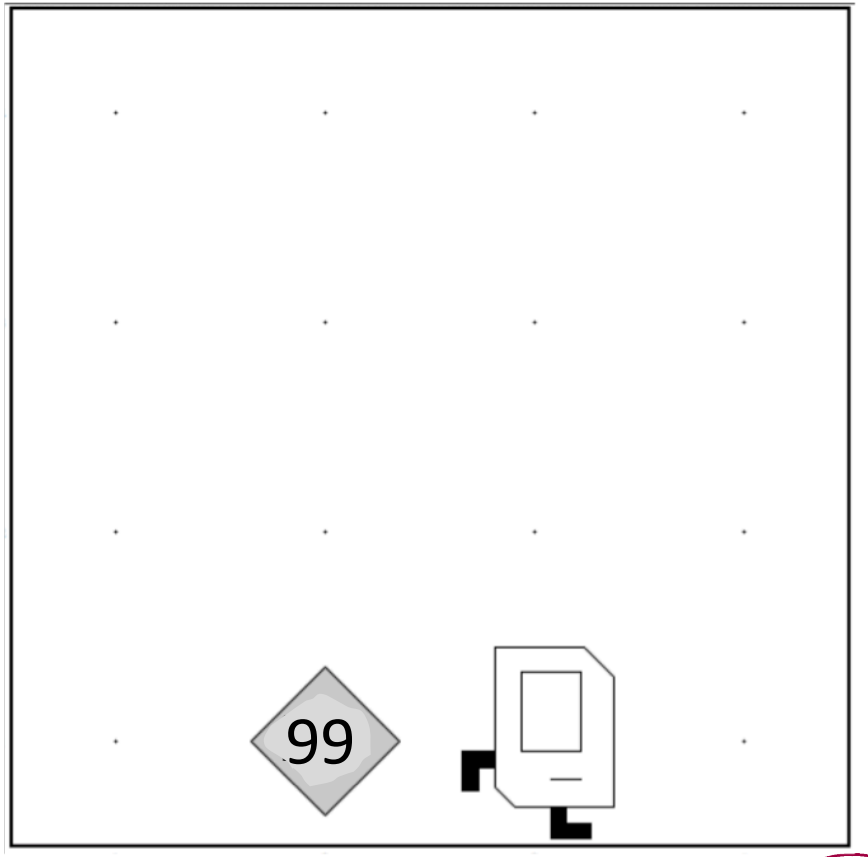
For loops,
While loops,
If/Else statements

Place 99 beepers?

Before



After



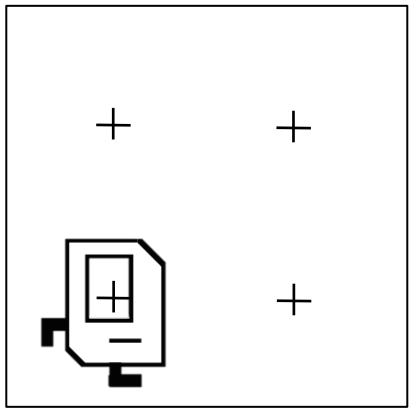
Place 99 beepers

```
public class Place99Beepers extends SuperKarel {
    public void run() {
        move();
        for(int i = 0; i < 99; i++) {
            putBeeper();
        }
        move();
    }
}
```

This “for loop” repeats the code in its “body” 99 times

Place Beeper Square

```
public class BeeperSquare extends SuperKarel {
    public void run() {
        for(int i = 0; i < 4; i++) {
            putBeeper();
            move();
            turnLeft();
        }
    }
}
```



Place Beeper Square

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public class BeeperSquare extends SuperKarel {
    public void run() {
        for(int i = 0; i < 4; i++) {
            putBeeper();
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    }
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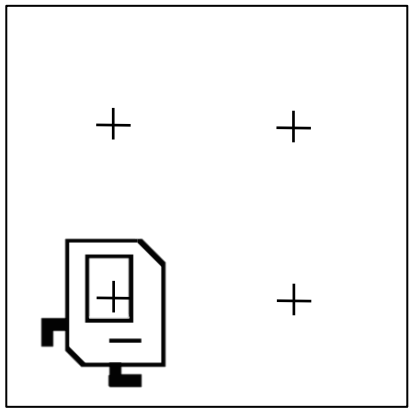
```



First time through the loop

Place Beeper Square

```
public class BeeperSquare extends SuperKarel {
    public void run() {
        for(int i = 0; i < 4; i++) {
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            move();
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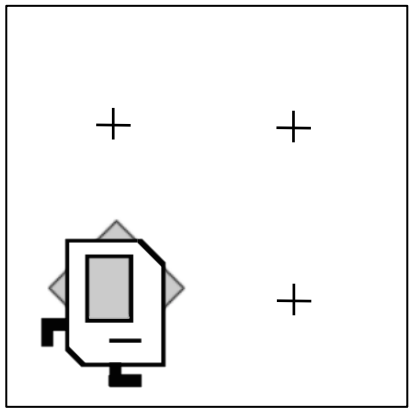
        }
    }
}
```

First time through the loop



Place Beeper Square

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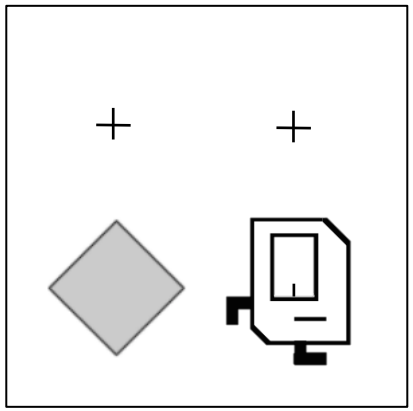
```



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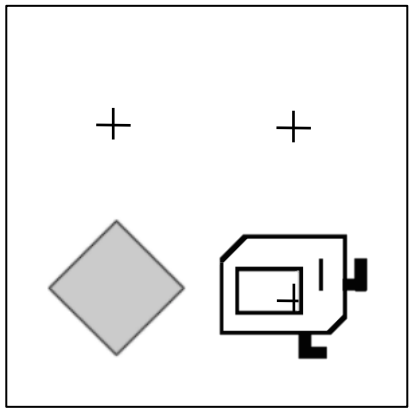

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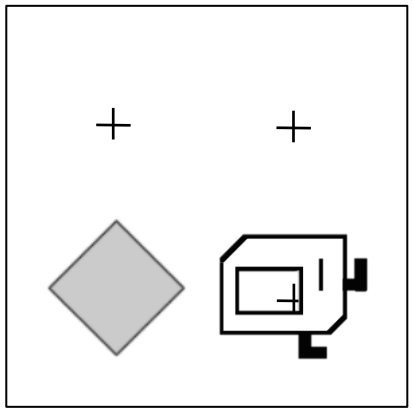

Second time through the loop

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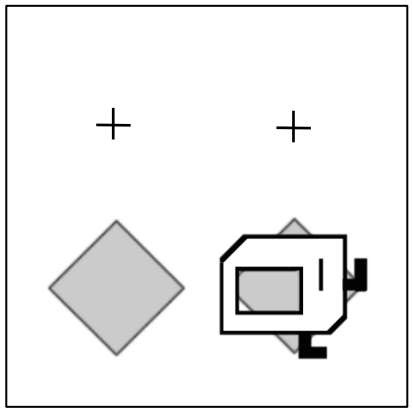

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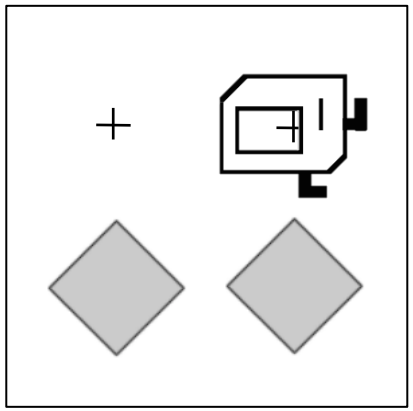

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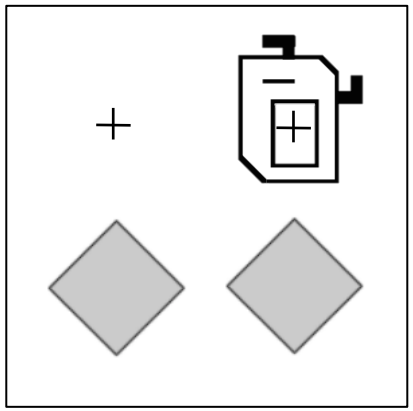

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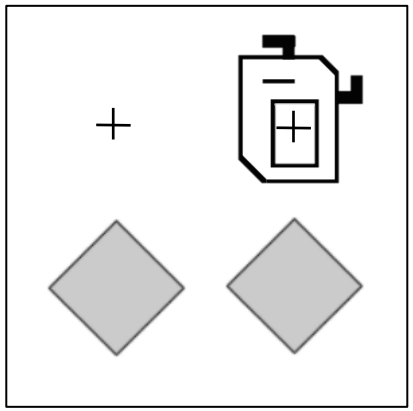

Third time through the loop

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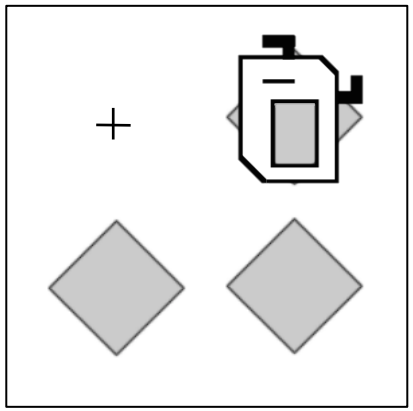

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            move();
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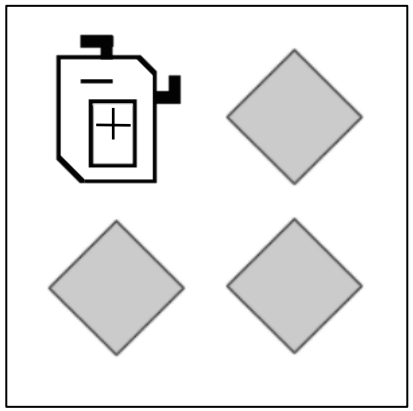

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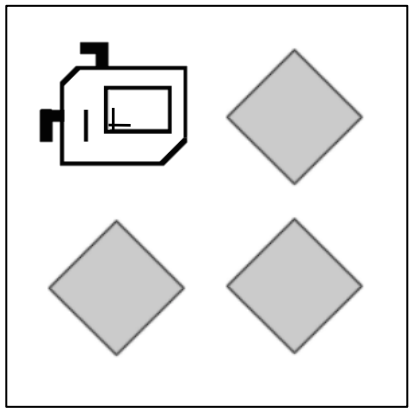

Third time through the loop

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            move();
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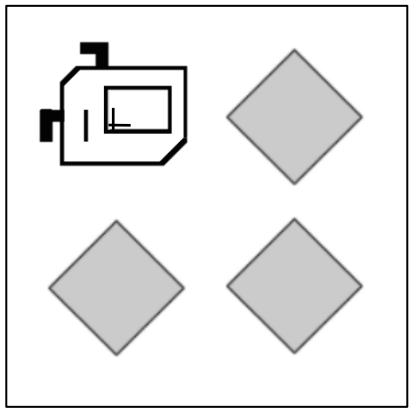
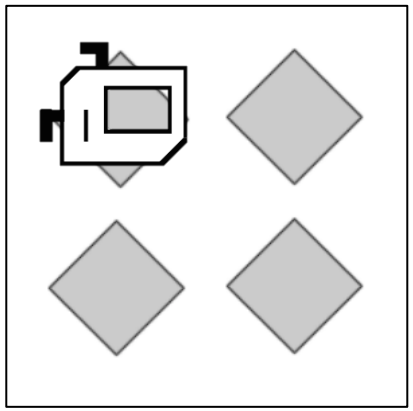
```



Fourth time through the loop

Place Beeper Square

```
public class BeeperSquare extends SuperKarel {
    public void run() {
        for(int i = 0; i < 4; i++) {
            putBeeper();
            move();
            turnLeft();
        }
    }
}
```



Fourth time through the loop

Place Beeper Square

```
public class BeeperSquare extends SuperKarel {
    public void run() {
        for(int i = 0; i < 4; i++) {
            putBeeper();
            move();
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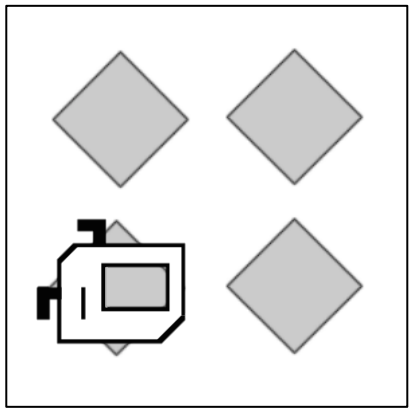
        }
    }
}
```



Fourth time through the loop

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        for(int i = 0; i < 4; i++) {
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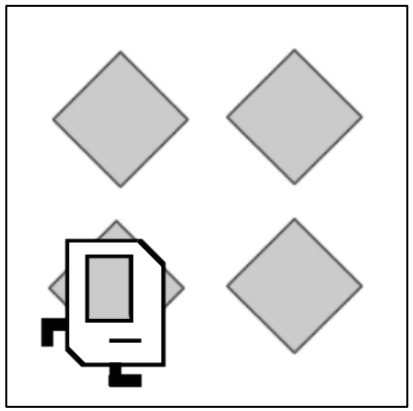

Fourth time through the loop

Place Beeper Square

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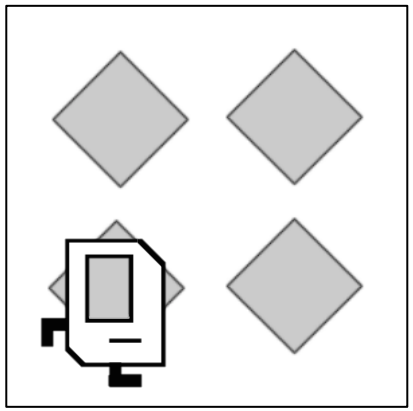
    }
}
```



Exciting!

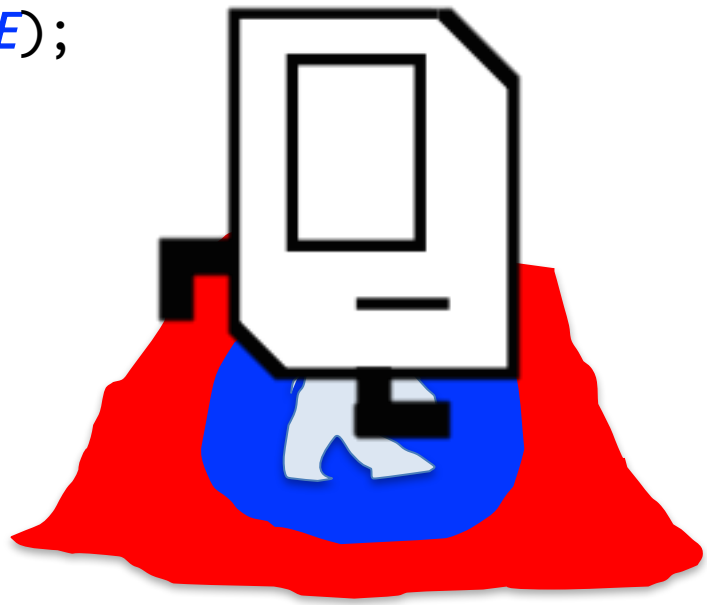
Aside: Super Karel

```
public class BeeperSquare extends SuperKarel {
    public void run() {
        for(int i = 0; i < 4; i++) {
            putBeeper();
            move();
            turnLeft();
        }
    }
}
```

Aside: Super Karel

```
public class BeeperSquare extends SuperKarel {
    public void run() {
        // super karel has a few more commands
        turnRight();
        turnAround();
        paintCorner(BLUE);

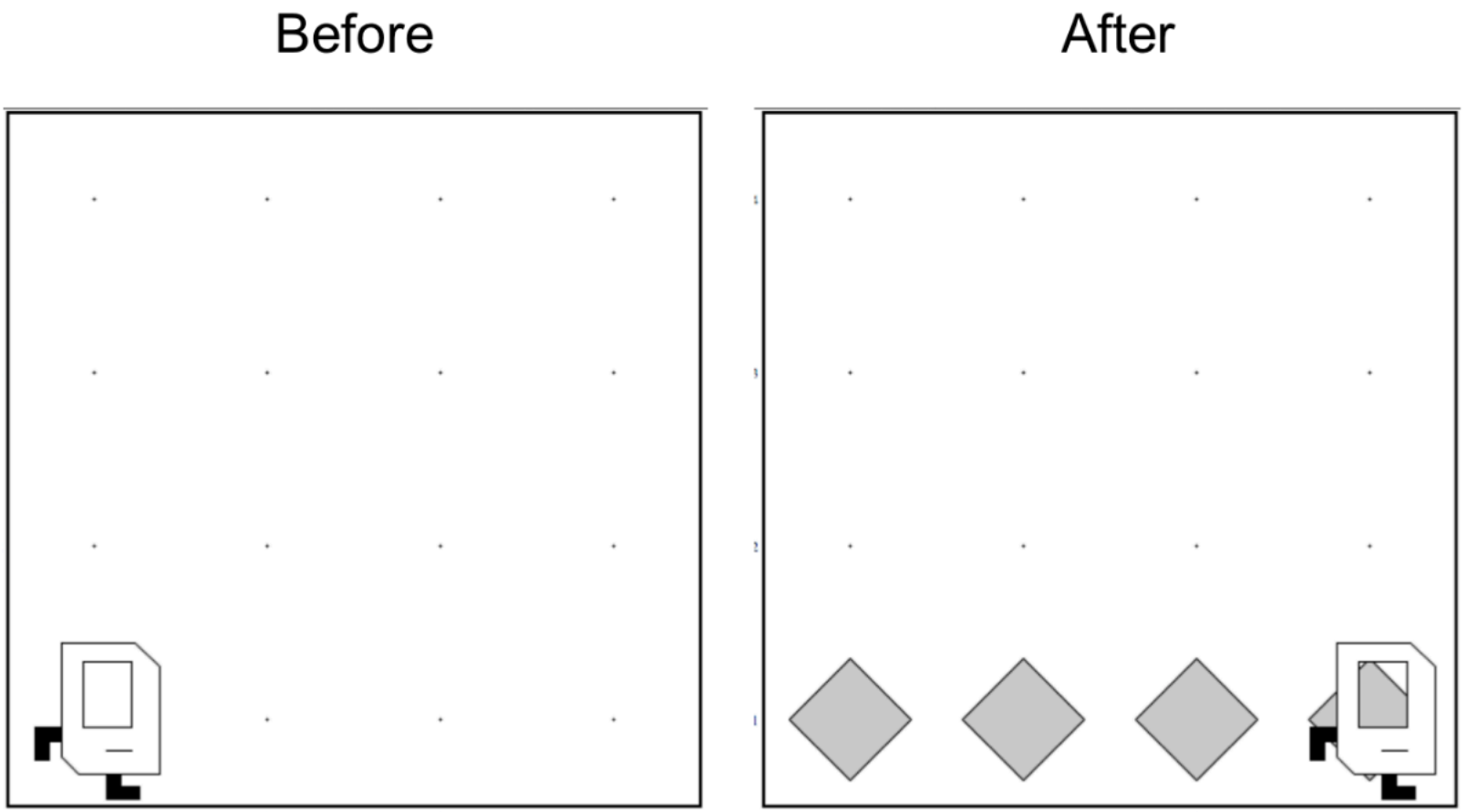
        putBeeper();
        move();
    }
}
```



Next task

Place Beeper Line

Try and solve it!



Place Beeper Line

```
import stanford.karel.*;

public class BeeperLine extends SuperKarel {

    public void run() {
        for(int i = 0; i < 4; i++) {
            putBeeper();
            move();
        }
    }
}
```


Place Beeper Line

```
import stanford.karel.*;

public class BeeperLine extends SuperKarel {

    public void run() {
        for(int i = 0; i < 4; i++) {
            putBeeper();
            move();
        }
    }
}
```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Place Beeper Line

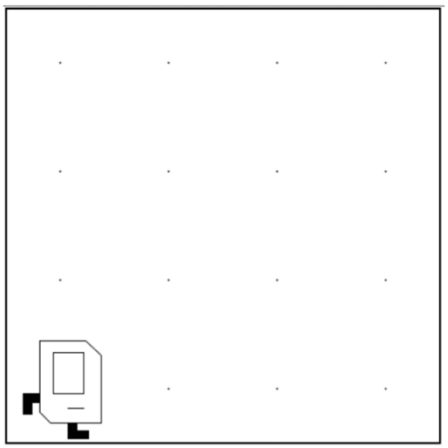
```
import stanford.karel.*;

public class BeeperLine extends SuperKarel {

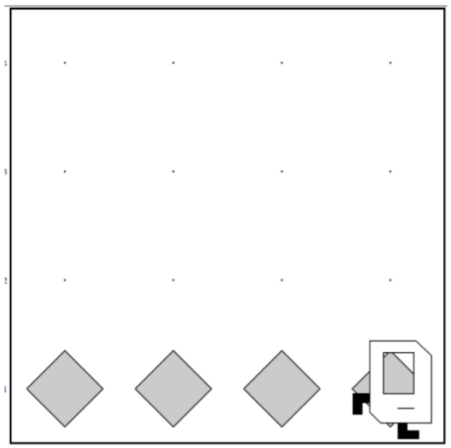
    public void run() {
        for(int i = 0; i < 4; i++) {
            putBeeper();
            move();
        }
    }
}
```

What we want

Before



After



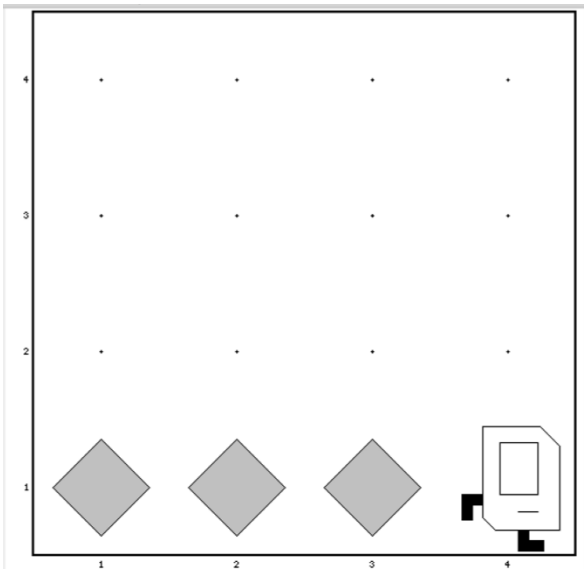
Place Beeper Line

```
import stanford.karel.*;

public class BeeperLine extends SuperKarel {

    public void run() {
        for(int i = 0; i < 3; i++) {
            putBeeper();
            move();
        }
    }

}
```



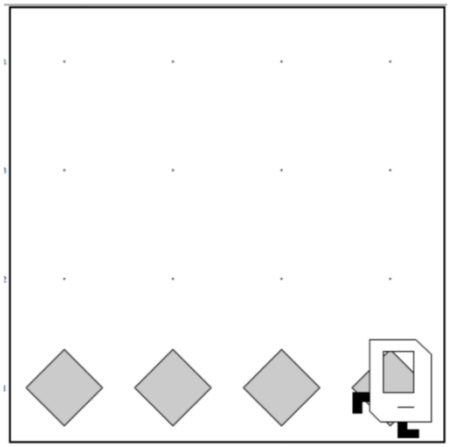
Place Beeper Line

```
import stanford.karel.*;

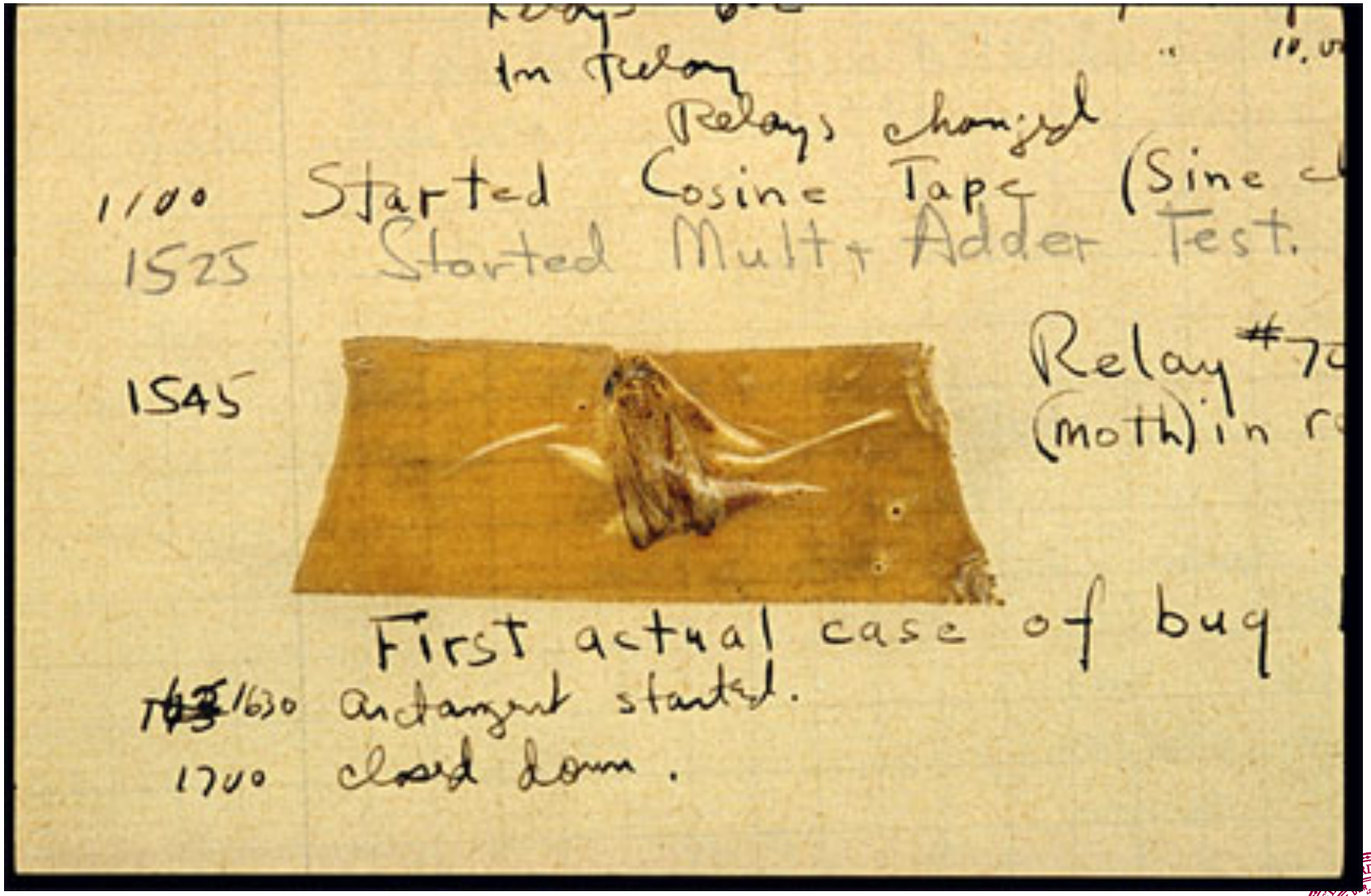
public class BeeperLine extends SuperKarel {

    public void run() {
        for(int i = 0; i < 3; i++) {
            putBeeper();
            move();
        }
        // extra put beeper
        putBeeper();
    }

}
```

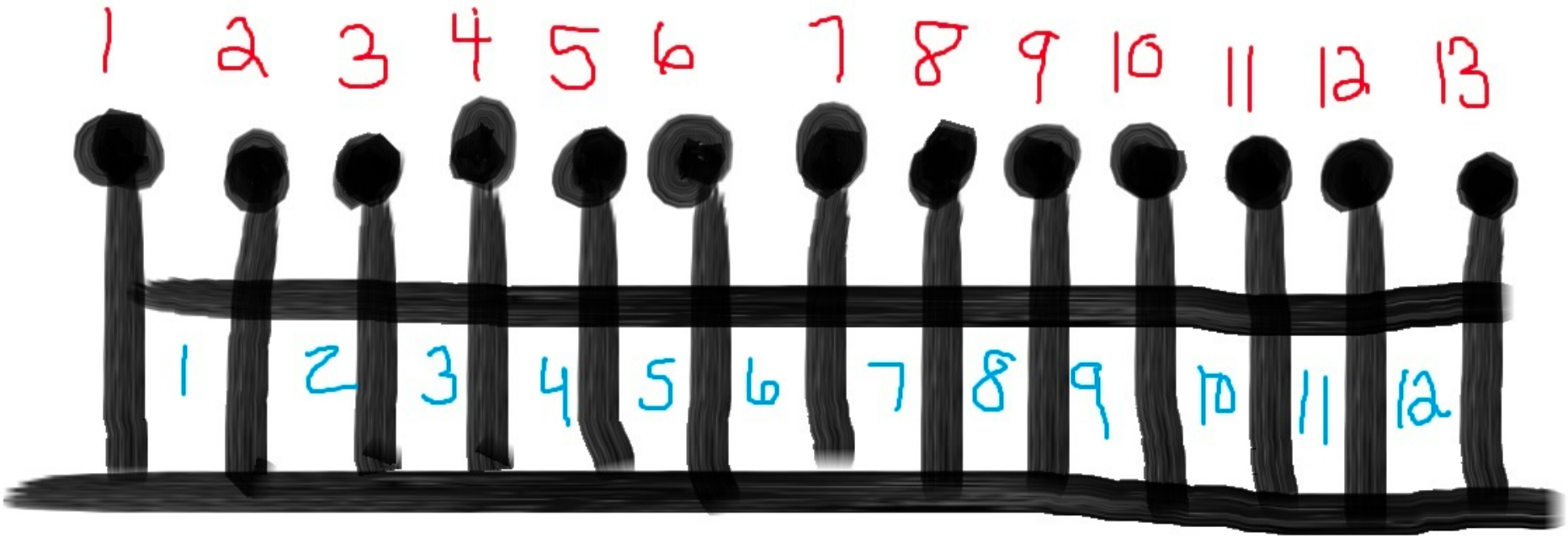


Actual Bug from Marc II



Grace Hopper

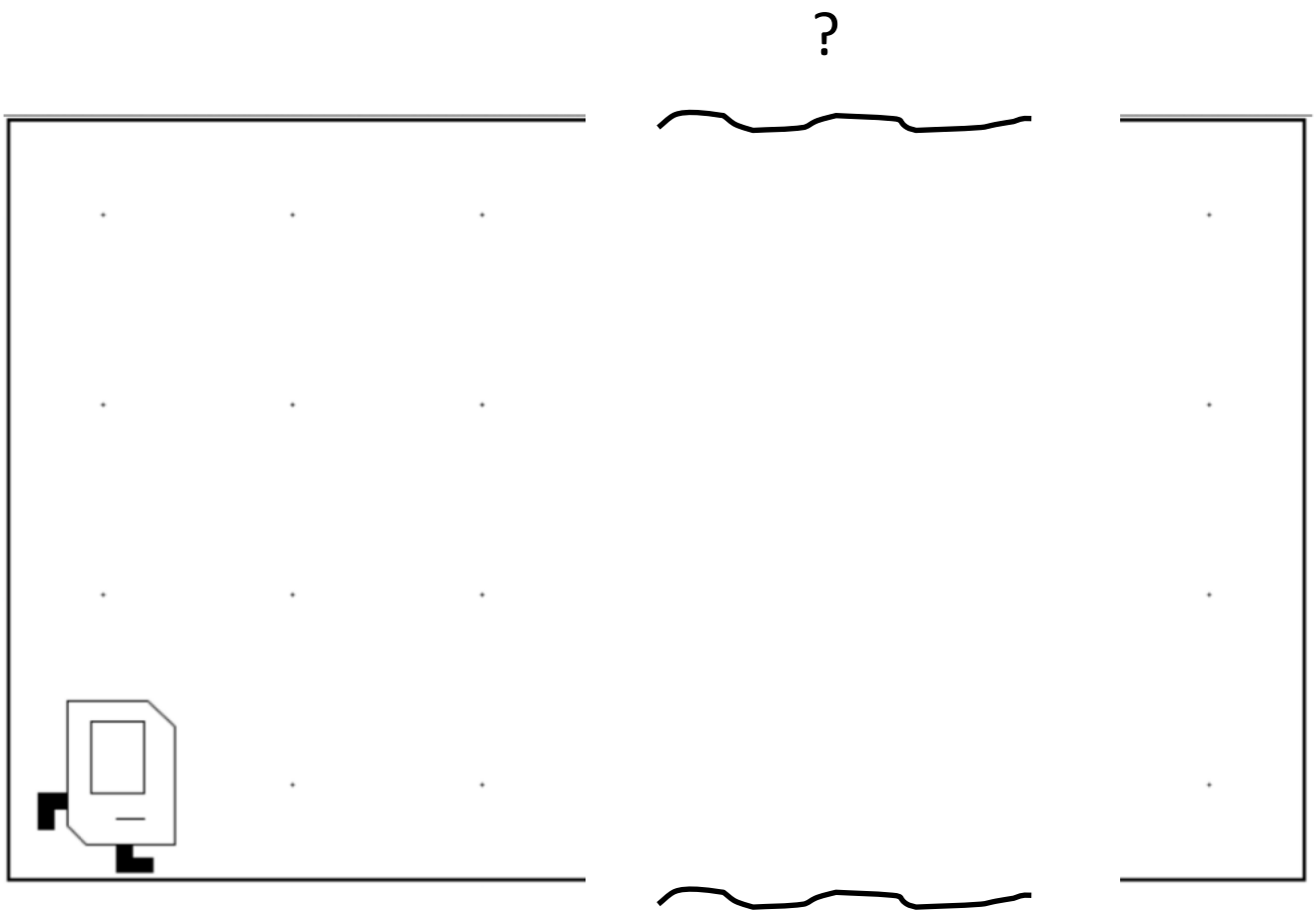
Fence Post Problem



* Also sometimes called an Off By One Error

Unstoppable

Don't Know World Size



While Loop

While Loop

```
import stanford.karel.*;

public class BeeperLine extends SuperKarel {

    public void run() {

        // example while loop
        while(condition) {
            code to repeat
        }

    }

}
```


Possible Conditions

Test	*Opposite*	*What it checks*
`frontIsClear()`	`frontIsBlocked()`	Is there a wall in front of Karel?
`leftIsClear()`	`leftIsBlocked()`	Is there a wall to Karel's left?
`rightIsClear()`	`rightIsBlocked()`	Is there a wall to Karel's right?
`beepersPresent()`	`noBeepersPresent()`	Are there beepers on this corner?
`beepersInBag()`	`noBeepersInBag()`	Any there beepers in Karel's bag?
`facingNorth()`	`notFacingNorth()`	Is Karel facing north?
`facingEast()`	`notFacingEast()`	Is Karel facing east?
`facingSouth()`	`notFacingSouth()`	Is Karel facing south?
`facingWest()`	`notFacingWest()`	Is Karel facing west?

*This is **Table 1** on page 18 of the Karel coursereader.*

Move to Wall

```
import stanford.karel.*;

public class BeeperLine extends SuperKarel {

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        // example while loop
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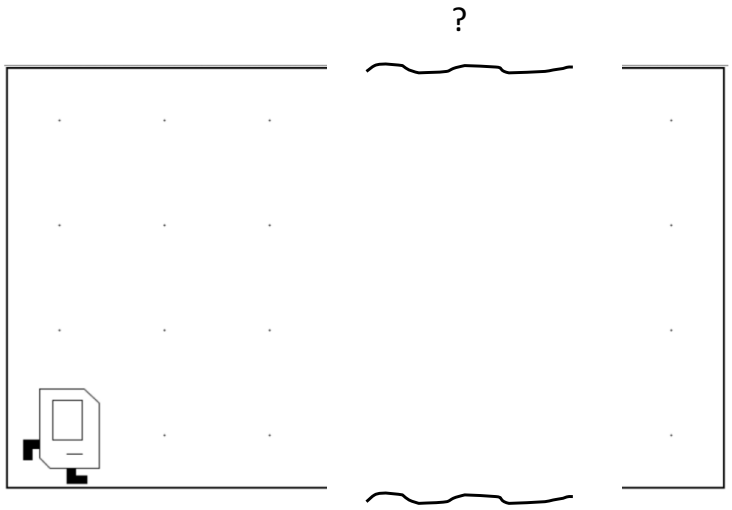
    }

}
```



Move to Wall

```
import stanford.karel.*;

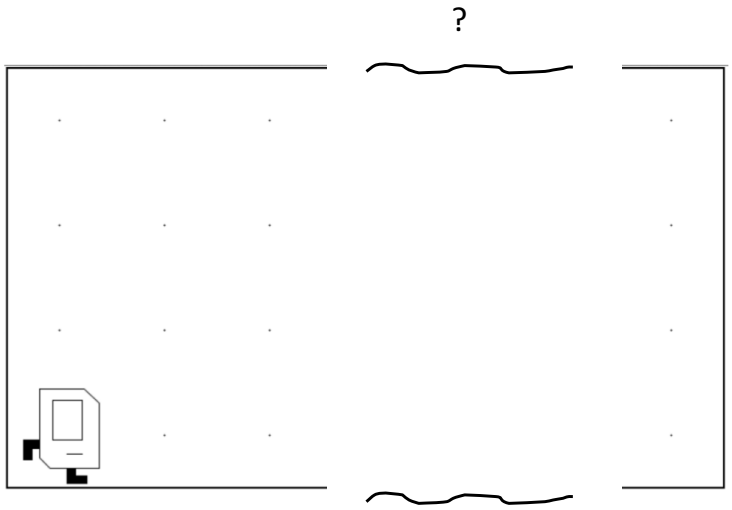
public class BeeperLine extends SuperKarel {

    public void run() {

        // example while loop
        while(frontIsClear()) {
            code to repeat
        }

    }

}
```



Move to Wall

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import stanford.karel.*;

public class BeeperLine extends SuperKarel {

    public void run() {

        // example while loop
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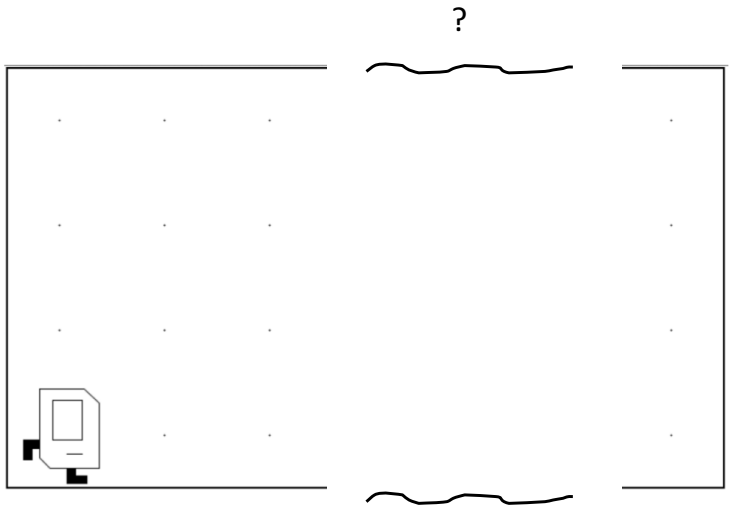
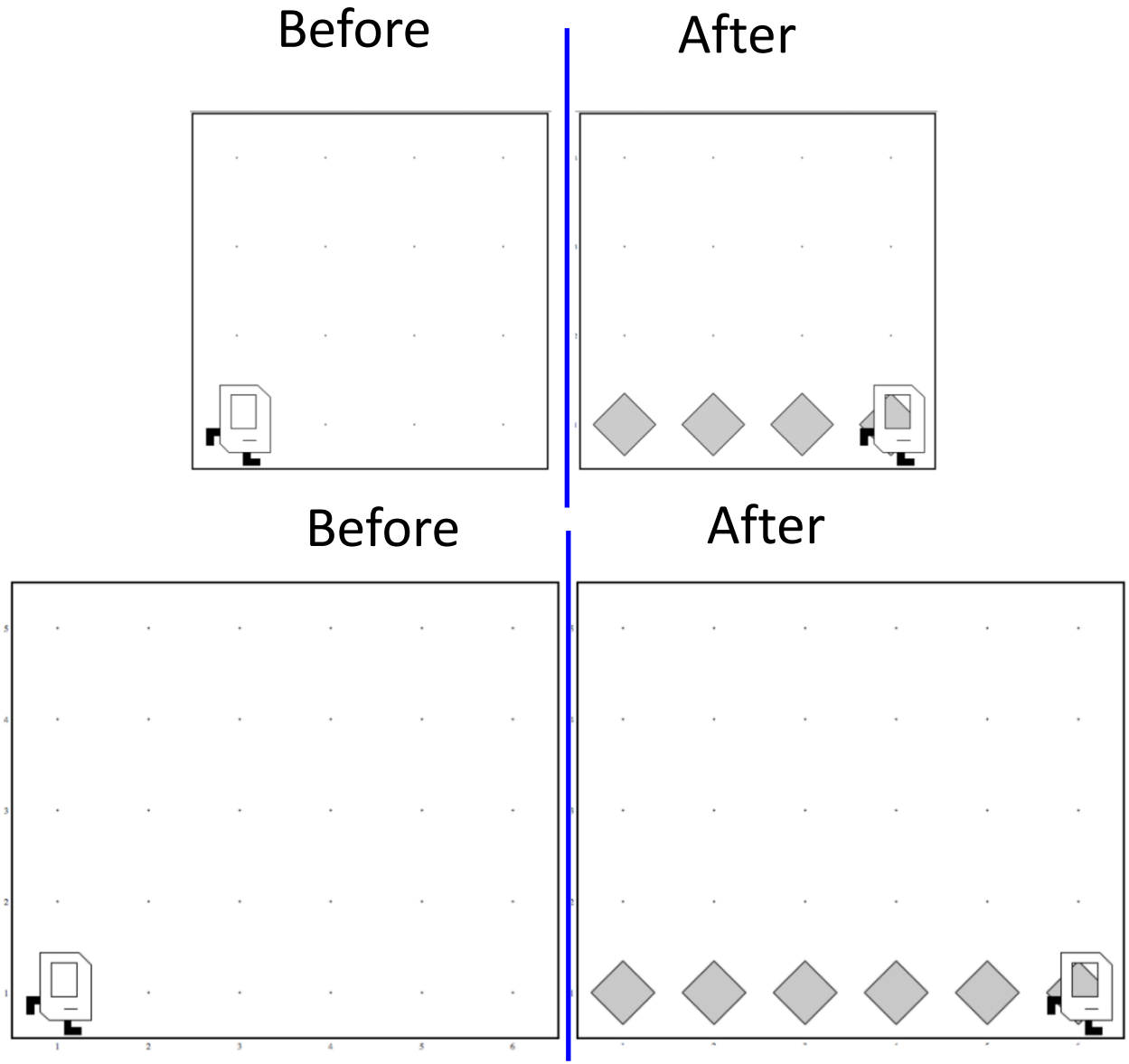


Code that Works in Any World



Place Beeper Line

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```


Place Beeper Line

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import stanford.karel.*;

public class BeeperLine extends SuperKarel {

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            putBeeper();
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    }

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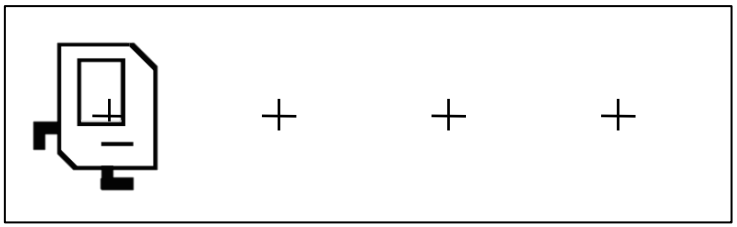

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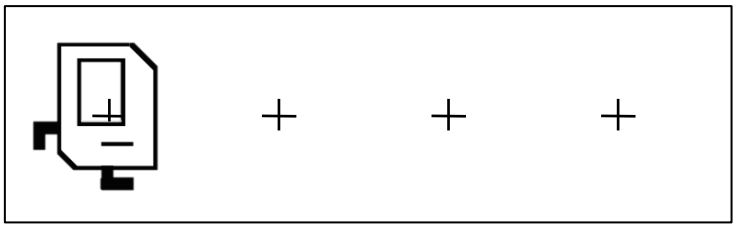

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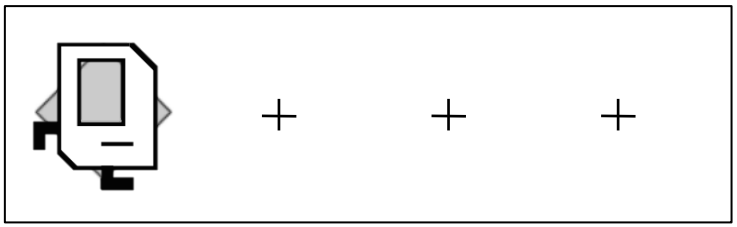

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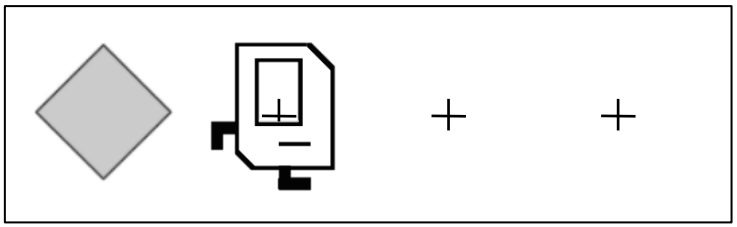

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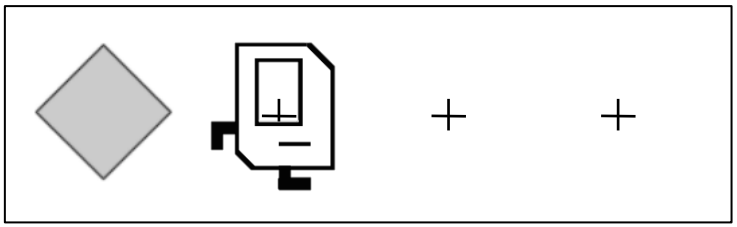

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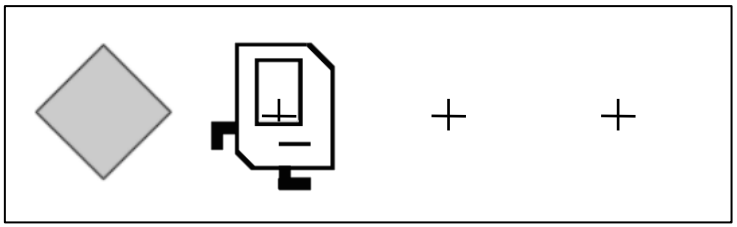

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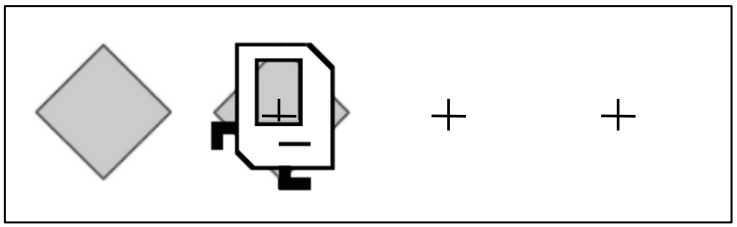

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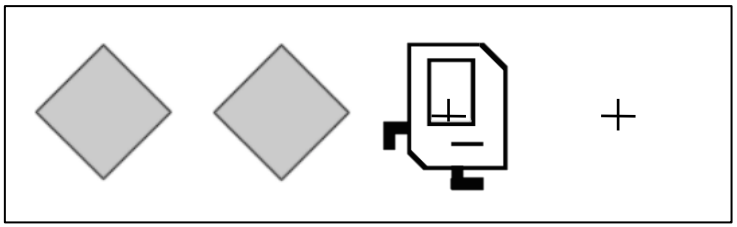

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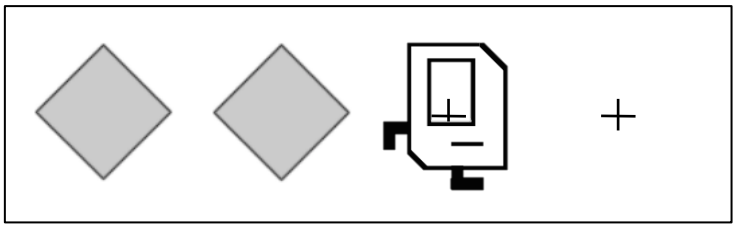

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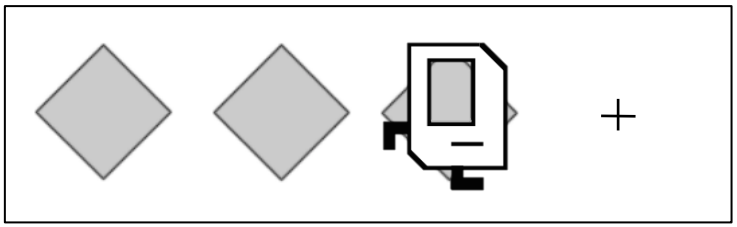

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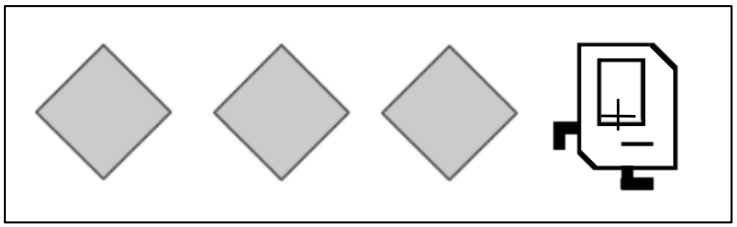

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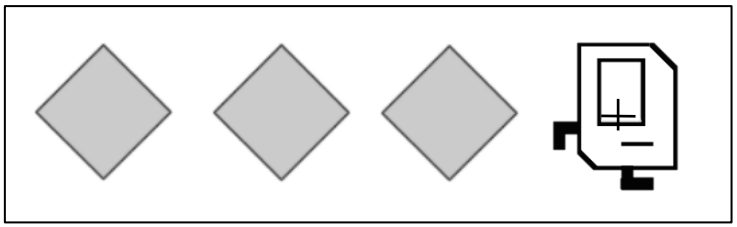

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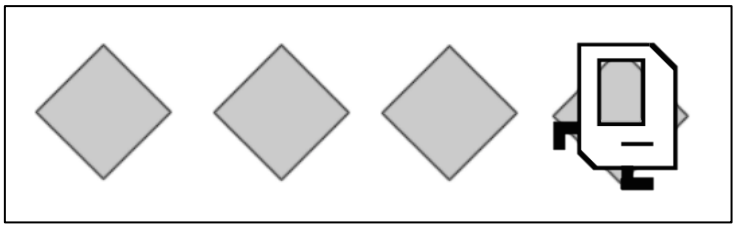

Common misconception:

Place Beeper Line: Redux

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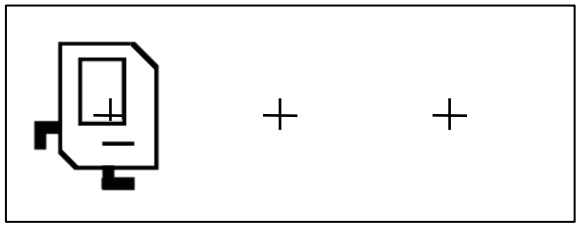

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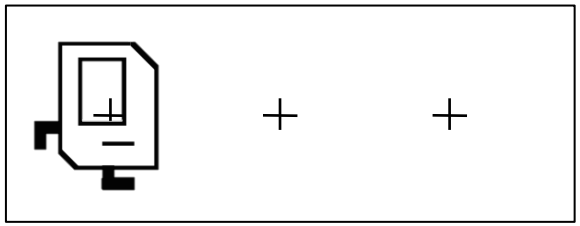

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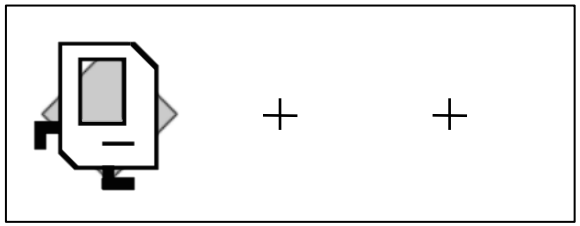

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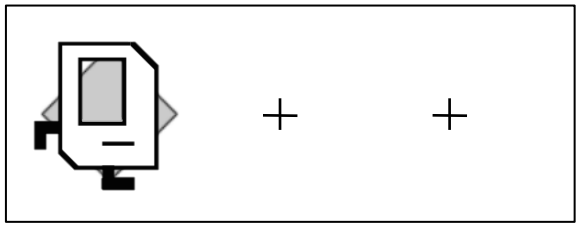

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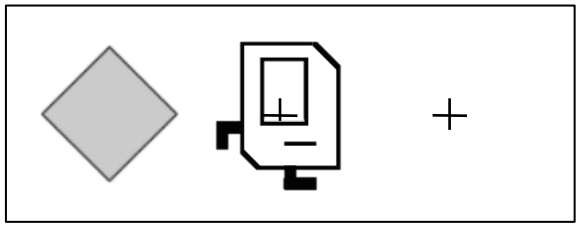

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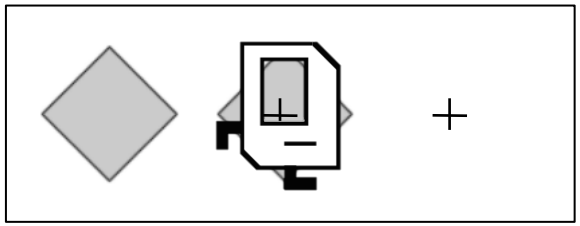

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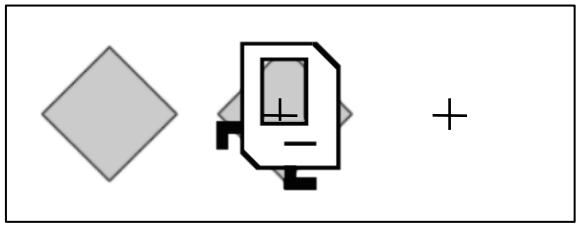

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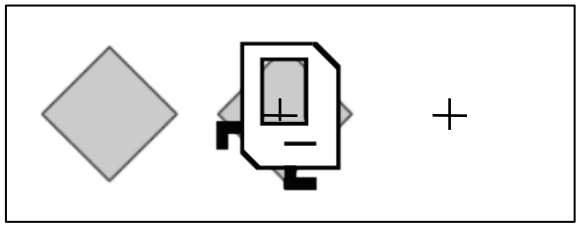

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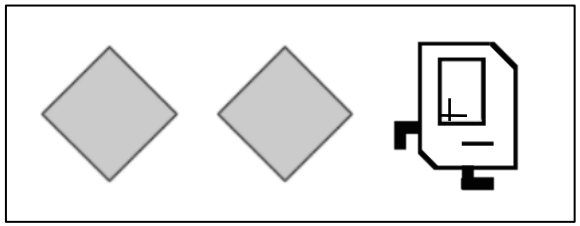
This is incredibly important!



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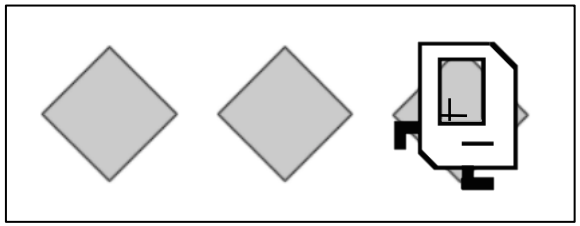

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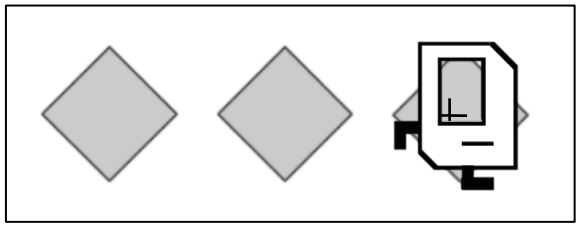

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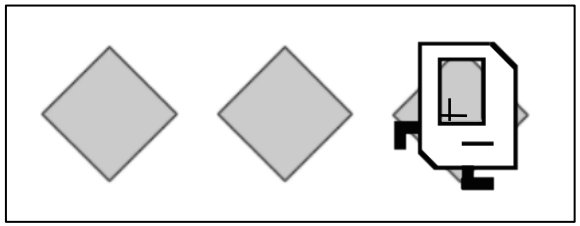

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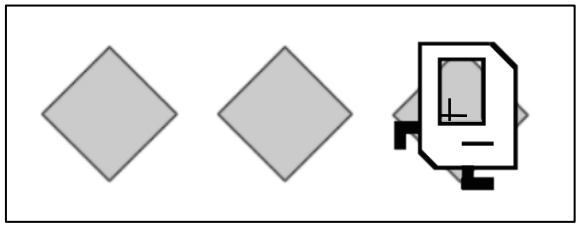
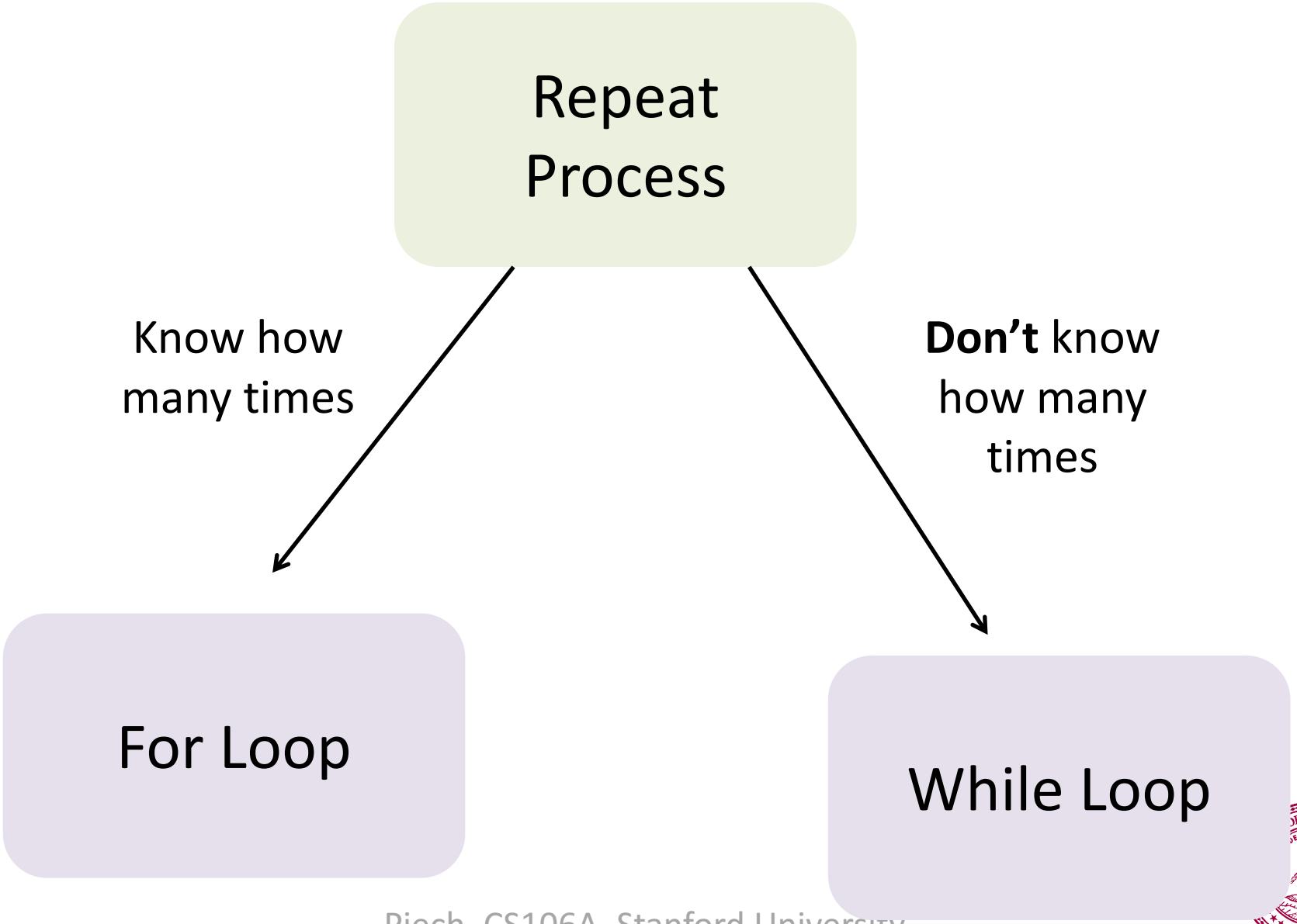


A program executes one line at a time.

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

Which Loop


Repeat Process
Know how many times
Don't know how many times
For Loop
While Loop

What if you only want to repeat one time?

If statement

If Statement

```
import stanford.karel.*;

public class IfExample extends SuperKarel {

    public void run() {

        // example of an if statement
        if(condition) {
            code to run if condition is true
        }

    }

}
```


If Statement

```
import stanford.karel.*;

public class IfExample extends Pretend{

    public void run() {

        // example of an if statement
        if(youLikeBeyonce()) {
            makeSomeNoise();
        }

    }

}
```


If Statement

```
import stanford.karel.*;

public class IfExample extends SuperKarel{

    public void run() {
        safeMove();
    }

    private void safeMove() {
        if(frontIsClear()) {
            move();
        }
    }

}
```


If / Else Statement

```
import stanford.karel.*;

public class IfExample extends SuperKarel{

    public void run() {
        invertBeeper();
    }

    private void invertBeeper() {
        if(beepersPresent()) {
            pickBeeper();
        } else {
            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:

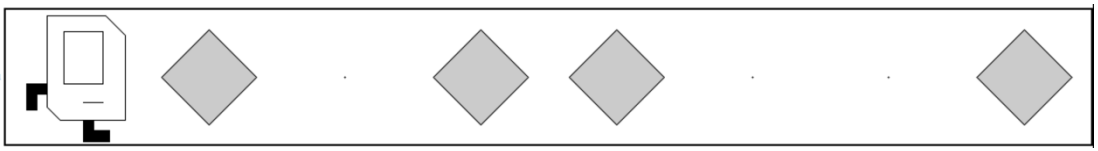
```
turnRight();
turnAround();
paintCorner(color);
```

New conditions in the `SuperKarel` class:

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

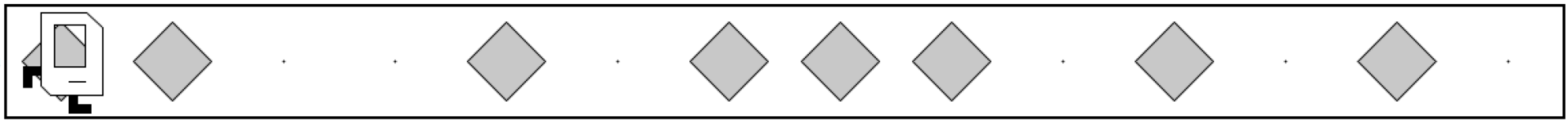

Random Painter

Before:



After:

Before:

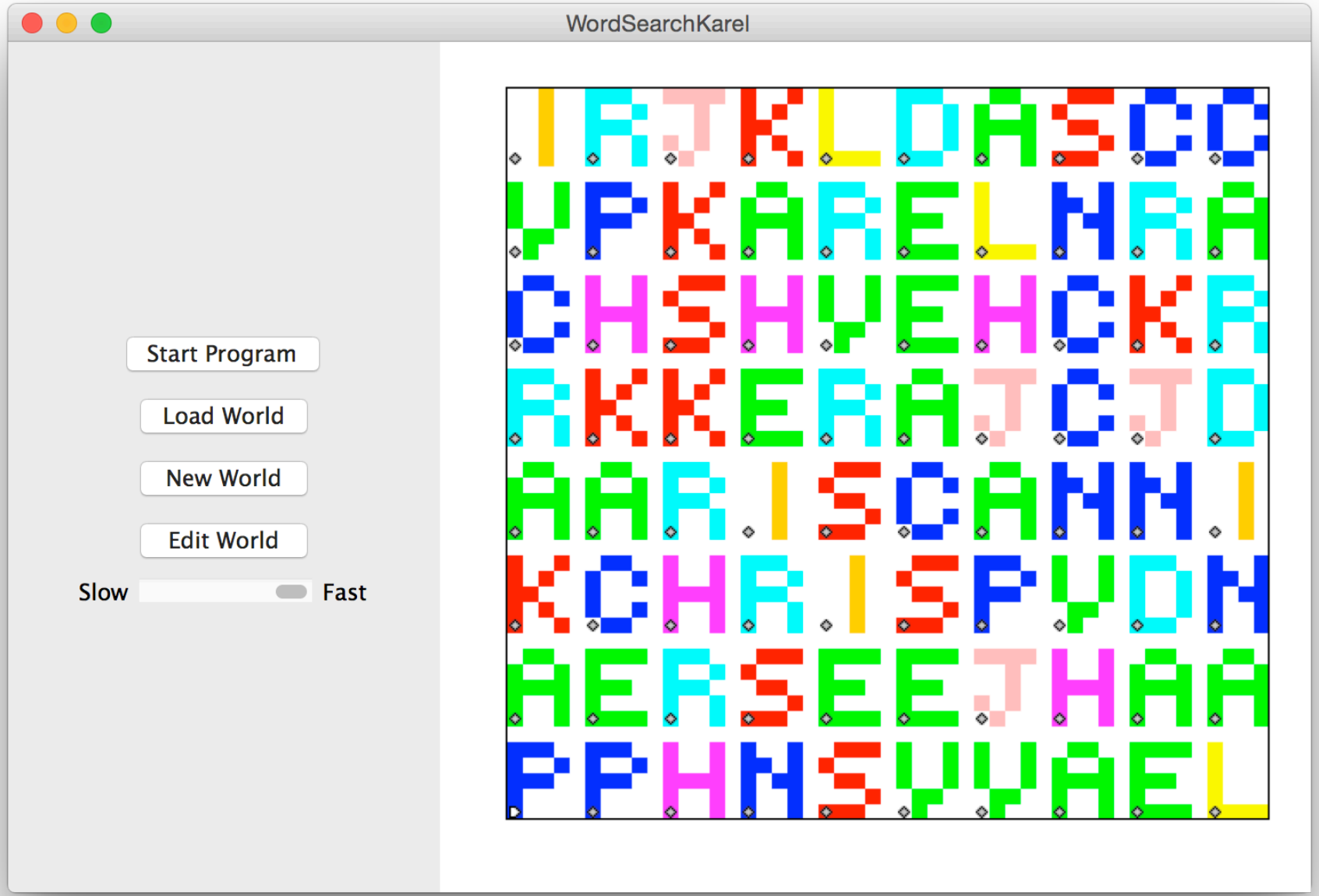


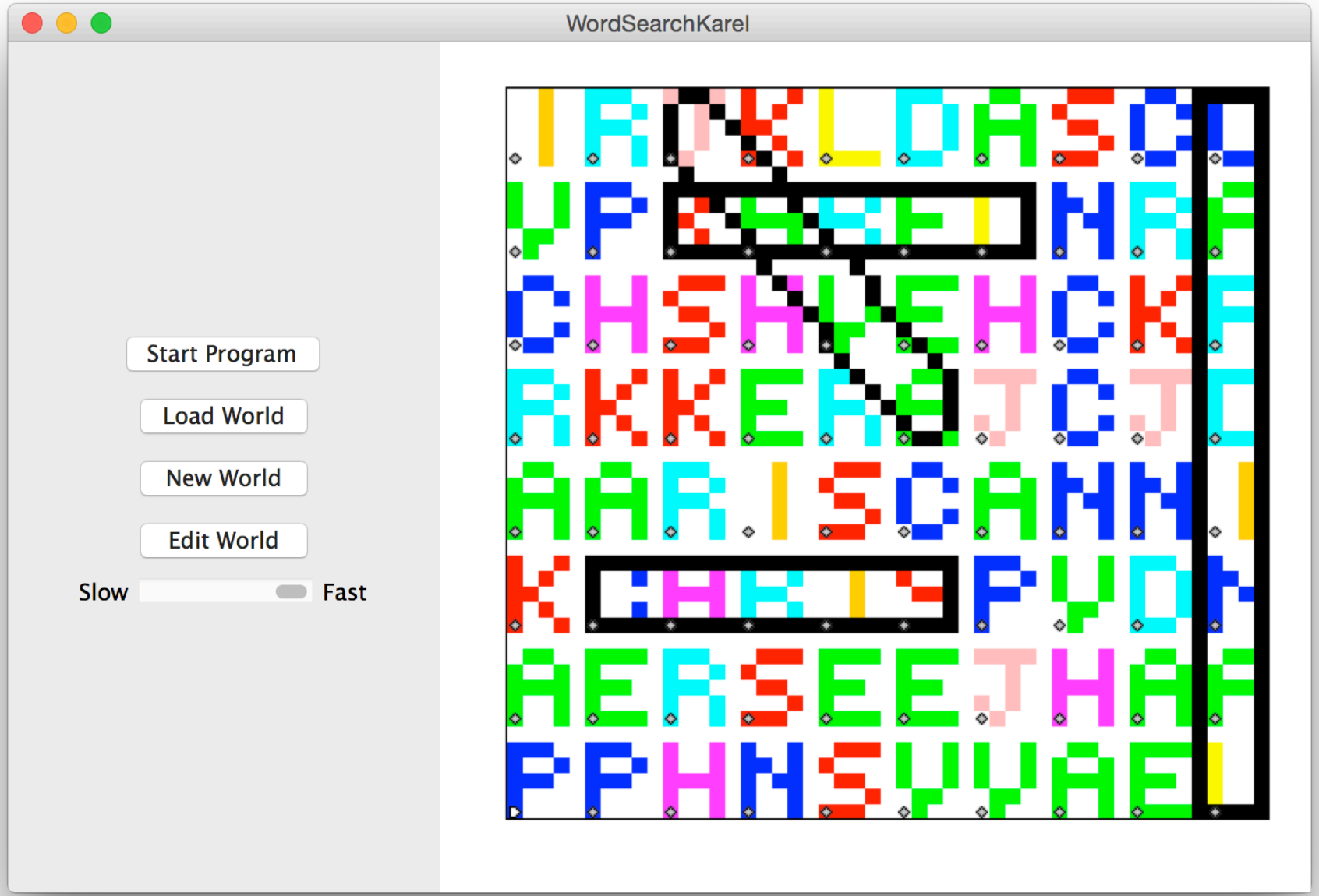
After:

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


WordSearchKarel
Start Program
Load World
New World
Edit World
Slow
Fast


WordSearchKarel
Start Program
Load World
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