REPETITION

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REPETITION, OR *ITERATION*, IS THE MOST IMPORTANT CONCEPT WE'LL STUDY IN THIS CLASS

- The key to the power of computer programming is to recognize repetitive patterns and *generalize* those patterns
- Example: print the numbers 1-10 in the Console
- The only way we could do this knowing what we know now would be to use 10 separate `println()` statements

THE BRUTE FORCE SOLUTION

```
println(1);
println(2);
println(3);
println(4);
println(5);
println(6);
println(7);
println(8);
println(9);
println(10);
```

THE BRUTE FORCE SOLUTION: LIMITATIONS

- The brute force solution is correct…but what if we wanted all the numbers from 1 to 1000?
- Brute force involves *way* too much work (and *way* too much code!)
- Instead, we should look for a repetitive pattern
- Here, we want to do *the same thing* to each of the values starting with 1 and going up to 10 (print them to the console)

REPETITION IN PROGRAMMING: THE KEY

- We need to write the operation to be performed in a *general* way (using a **variable**)
- Here, the operation to be performed is

```
println(x);
```

- We want to do that for all the values from 1 to 10

USING A VARIABLE IN THIS SOLUTION

```
1  int x = 1;
2
3  println(x);
4  x += 1;
5  println(x);
6  x += 1;
7  println(x);
8  x += 1;
9  println(x);
10 x += 1;
11 println(x);
12 x += 1;
13 println(x);
14 x += 1;
15 println(x);
16 x += 1;
17 println(x);
18 x += 1;
19 println(x);
20 x += 1;
21 println(x);
22
```

WHAT OPERATIONS ARE BEING REPEATED?

- Done **once** at the beginning:

```
int x = 1;
```

- Done **ten times** in a row:

```
println(x);
x += 1;
```

THE `for` STATEMENT IN PROCESSING

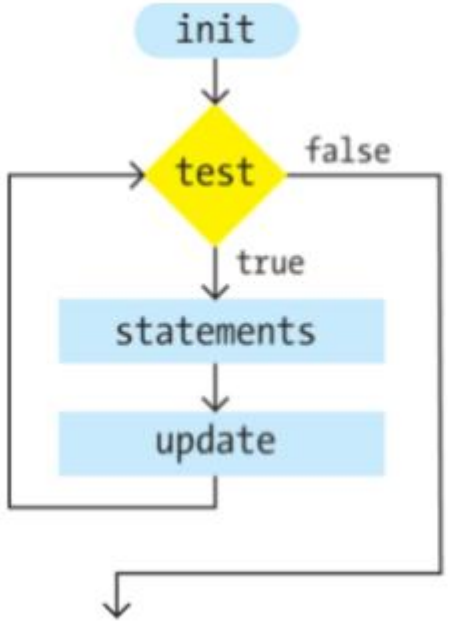
- Purpose: repeatedly execute a block of code a specific number of times

```
for (int x = 1; x <= 10; x++) {
    println(x);
}
```

- What if we wanted all the numbers from 1 to 1000? Much easier this way!

** `x++` could also be written as `x+=1` or `x = x + 1` … they all work!

THE for STATEMENT IN PROCESSING: THE LOGIC



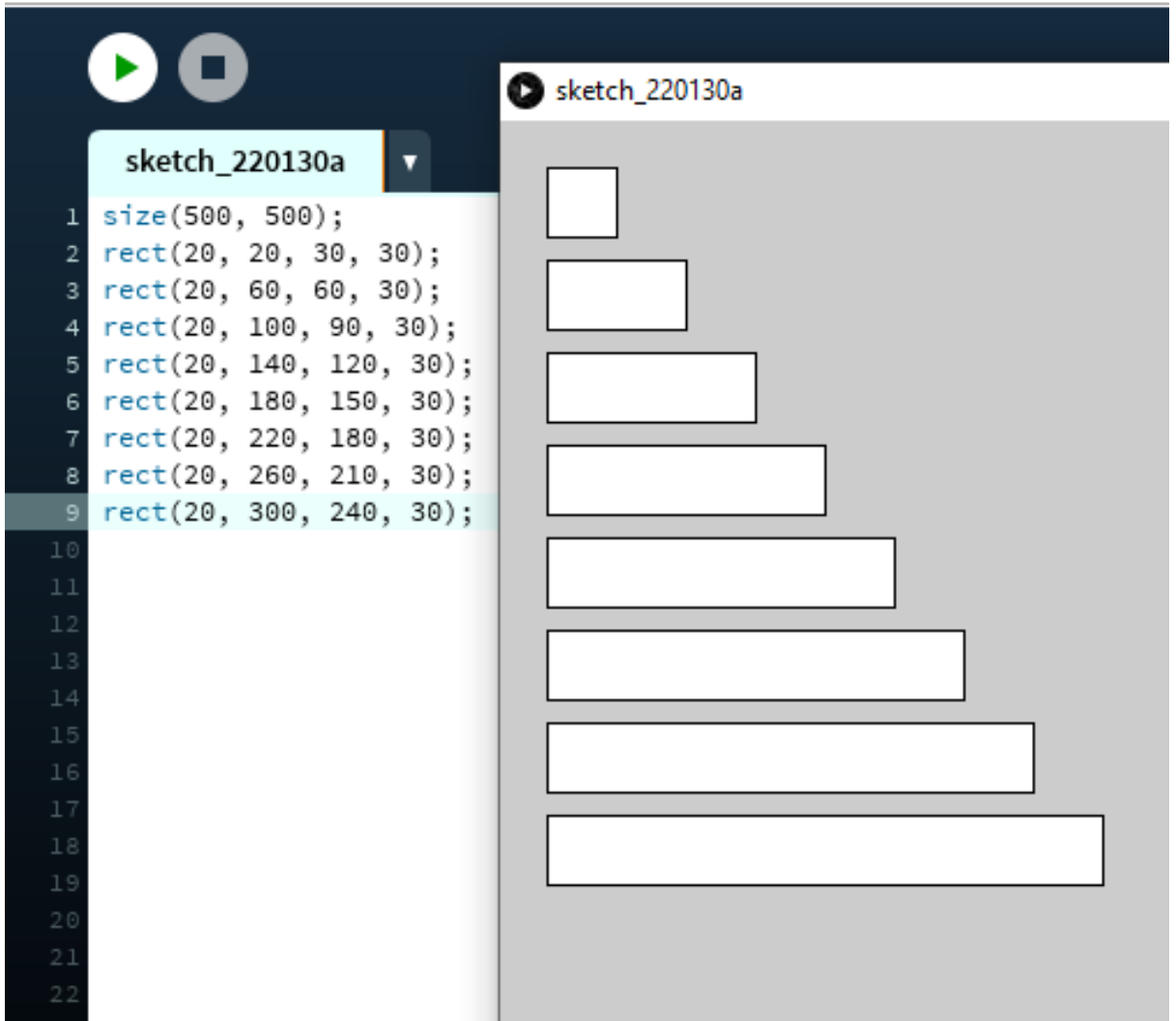

```
for (init; test; update) {
  statements
}
```

WHERE’S THE REPETITION?

WHERE'S THE REPETITION IN THE CODE?

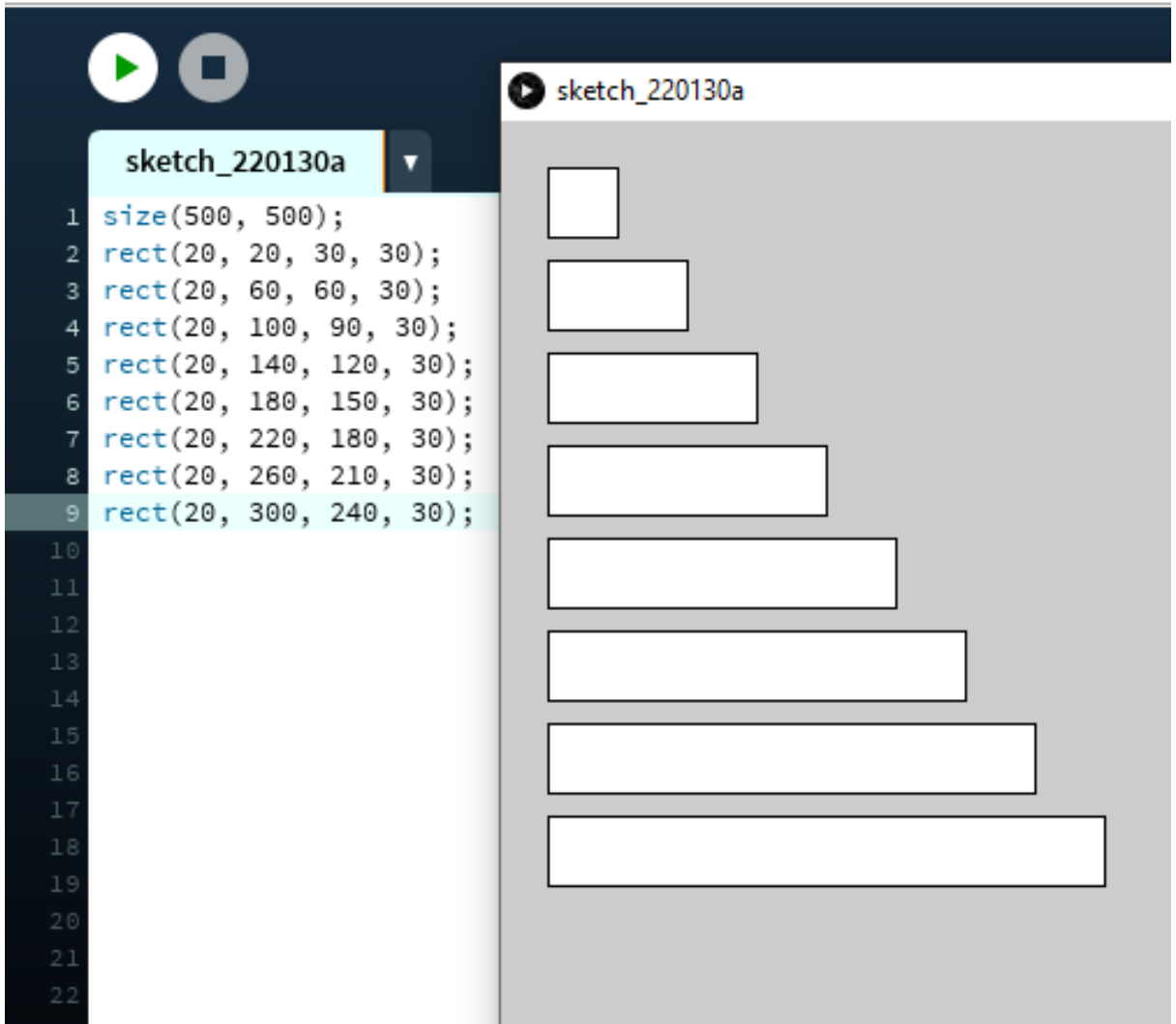
- Consider this example – what does it do?

- What is changing from line to line, and what is staying the same?



WHAT'S CHANGING? WHAT'S THE SAME?

- The **vertical position** of each rectangle changes
- The **width** of each rectangle changes
- But the **horizontal position** and **length** of each rectangle stays the same
- How can we generalize this idea and use repetition?



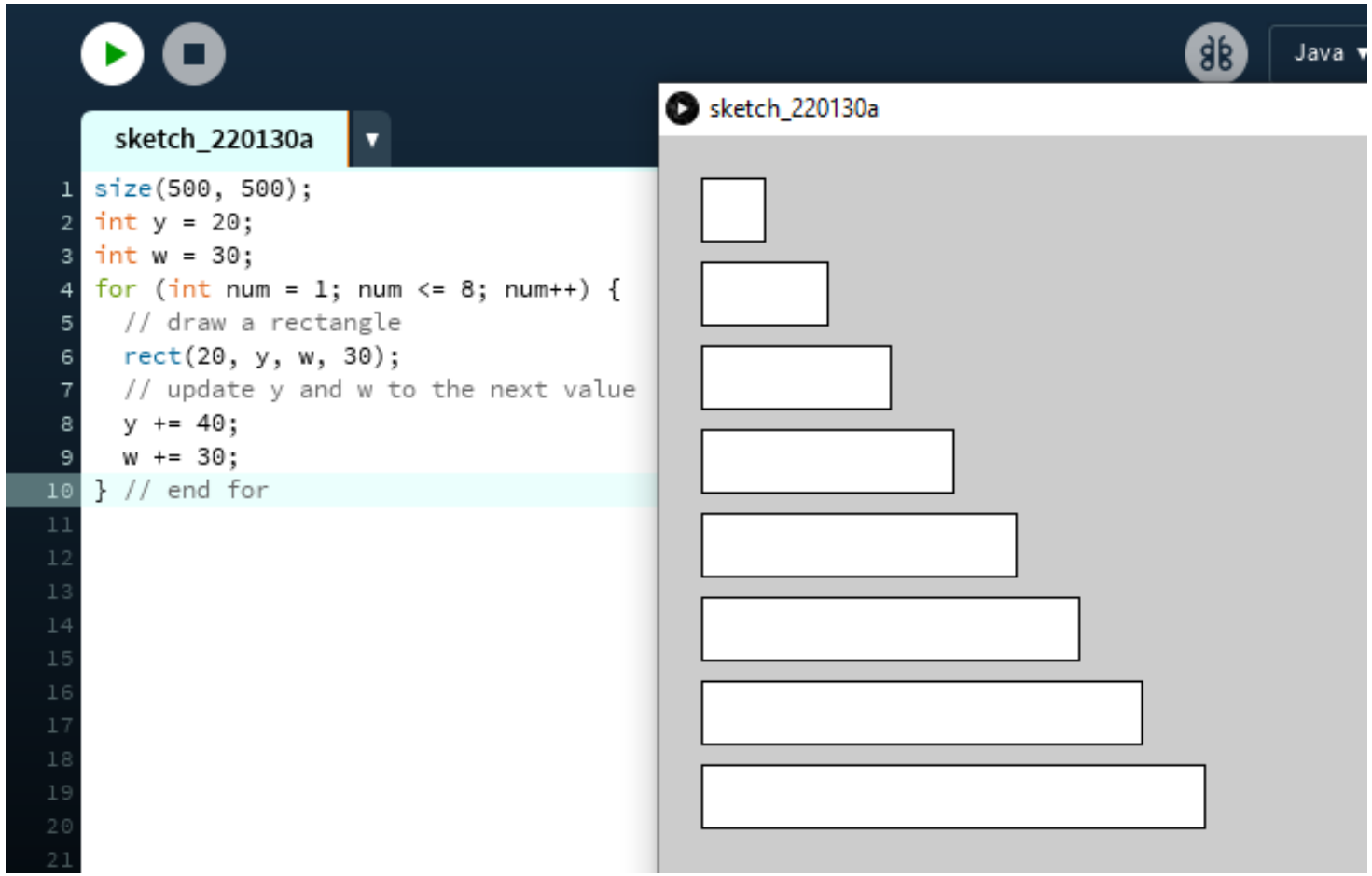
GENERALIZING WITH VARIABLES

- Write the statement *once*, with variables for what changes and constants for everything else
- We can use `y` for the vertical position and `w` for the width of the rectangle

```
rect(20, y, w, 30);
```

- `y` should start at 20 and `w` should start at 30
- Draw the rectangle, then increase `y` by 40 and increase `w` by 30
- Repeat this once for each rectangle to be drawn (in this case, that means 8 times)

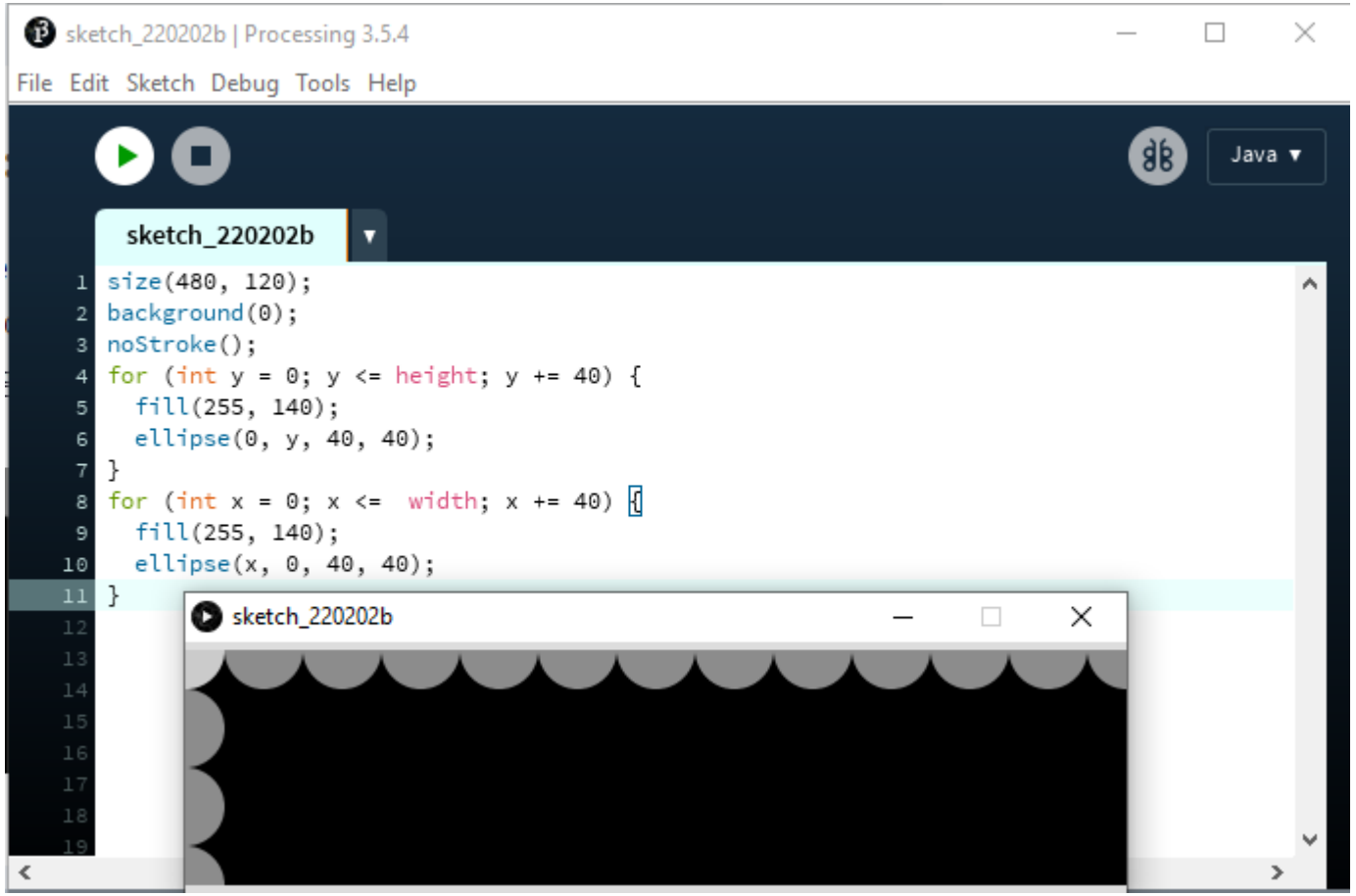
HERE'S THE REPETITION!



- What if we want to make 5 rectangles, or 12?
- Just change the number of times the loop is executed!

AS SERIES OF `for` LOOPS

These `for` loops are adjacent. The vertical circles are drawn by the first loop, and the horizontal circles are drawn by the second loop.



REMEMBER NESTED `if` STATEMENTS?

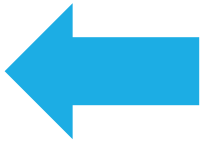
From Lab 2:

```
int x = 0;

void setup() {
  frameRate(10);
} // end setup

void draw() {
  if (keyPressed) {
    if (key == '+') {
      x++;
    }
    else if (key == '-') {
      x--;
    }
    print("x now = ");
    println(x);
  } // end if (keyPressed)

} // end draw
```



The `if` and `else if` that check for the + and – keys are nested inside `if (keyPressed)`. That's why the closing curly brace for `if (keyPressed)` comes *after* the closing curly braces for `if (key == '+')` and if `(key == '-')`.

WE CAN EMBED `for` LOOPS, TOO!

The number of repetitions is multiplied!

- The outer `for` loop starts
- Then the **entire** inner `for` loop runs until the condition `x <= width` is false
- Then the outer for loop updates (`y += 40`) and the **entire** inner for loop runs again until the condition `x <= width` is false
- Then the outer for loop updates again. The process repeats until the outer for loop's condition (`y <= height`) is false
- Be careful with syntax! The outer loop's closing curly brace comes after the inner loop's closing curly brace