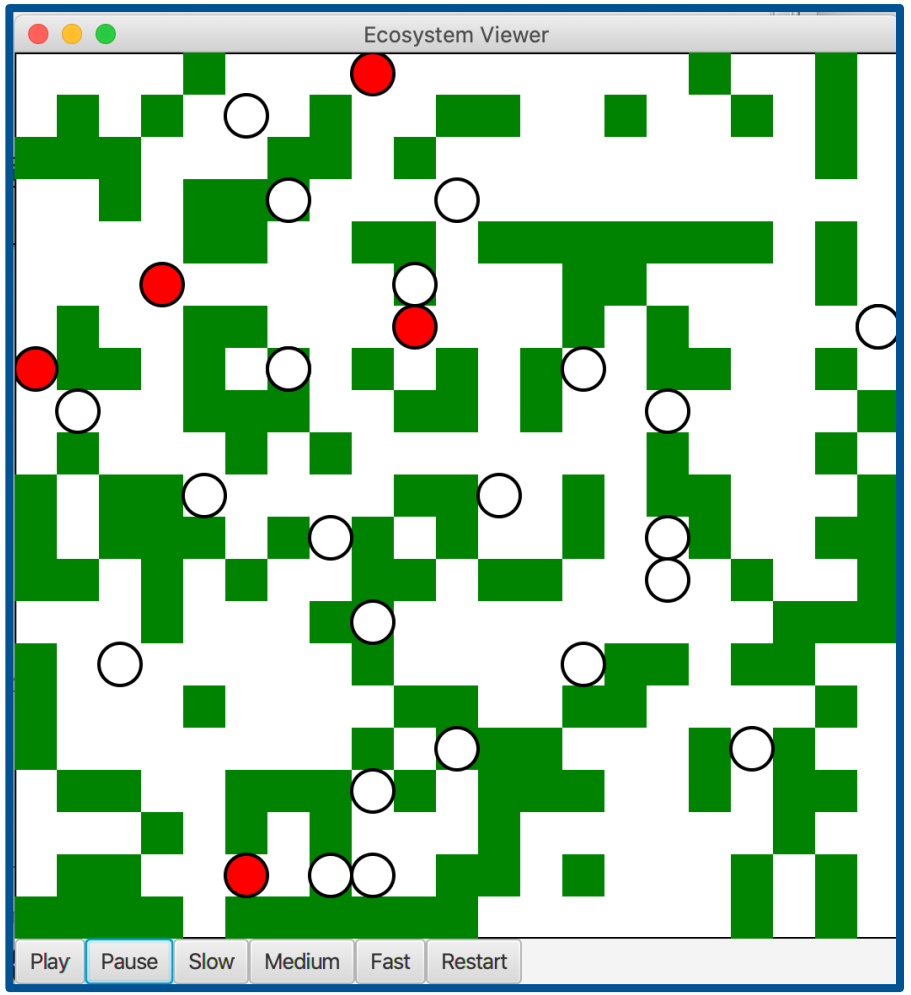
Arrays

Common problem: needing many objects in a program

Imagine you are writing a program to simulate an ecosystem.

- You want several "Fox" objects (red circles),
- A lot of "Rabbit" objects (white circles) that will be eaten by foxes,
- And a lot of "Grass" objects (green squares) that will be eaten by rabbits.

What does this look like in code?



Do we need separate variables for each object?!

```
class Ecosystem
{
    int worldWidth;
    int worldHeight;

    Fox fox0;
    Fox fox1;
    Fox fox2;
    Fox fox3;
    Fox fox4;

    Rabbit rab0;
    Rabbit rab1;
    Rabbit rab2;
    Rabbit rab3;
    Rabbit rab4;
    Rabbit rab5;
    Rabbit rab6;
```

There must be a better way…

When you need many objects of a single type, use an array

```
class Ecosystem
{
    int worldWidth;
    int worldHeight;

    Fox[] foxes;
    Rabbit[] rabbits;
    Grass[] grass;

    Ecosystem(Fox[] foxes, Rabbit[] rabbits, Grass[] grass)
    {
        this.worldWidth = 20;
        this.worldHeight = 20;

        this.foxes = foxes;
        this.rabbits = rabbits;
        this.grass = grass;
    }
}
```

[ ] makes the datatype 'plural', and defines an array of that type

Arrays are lists of a single type

```
class ArrayExamples
{
    int[] myNumbers = {1, 2, 2, 8, -7};

    double[] myOtherNumbers = {3.14, 0.999, 1.0};

    boolean[] quizAnswers = {true, true, false, true, false};

    String[] someWords = {"a", "aah","aardvark", "aargh", "ab",
        "abacus", "abandon", "abase"};

    Fraction[] fractions = {new Fraction(1, 2), new Fraction(3, 5)};
}
```

Syntax for arrays

```
int[] variableName = {5, 6, 11};
```

Start with a datatype. Any kind of datatype may be used to make an array.

Syntax for arrays

```
int[] variableName = {5, 6, 11};
```

Square brackets indicate that we want to make an array of that datatype.

The brackets look like a box or container. Think: “a box full of ints.”

Syntax for arrays

```
int[] variableName = {5, 6, 11};
```

Any variable name may be used. It is best to use a descriptive plural noun.

Syntax for arrays

```
int[] variableName = {5, 6, 11};
```

Initialize the array with a comma-separated list enclosed in curly brackets.

Arrays may not have a mixture of different datatypes

```
int[] badArray = {5, 7.3, “hi”};
```

Not allowed!

Arrays have "slots" that can be indexed

The **length** of an array is the number of slots it contains.

An **element** of an array is a piece of data inside the array in a particular slot.

An **index** is a number describing the position of the element (starting from zero).

If the length is 8, the last index must be 7 since we start counting from zero.

Arrays have "slots" that can be indexed

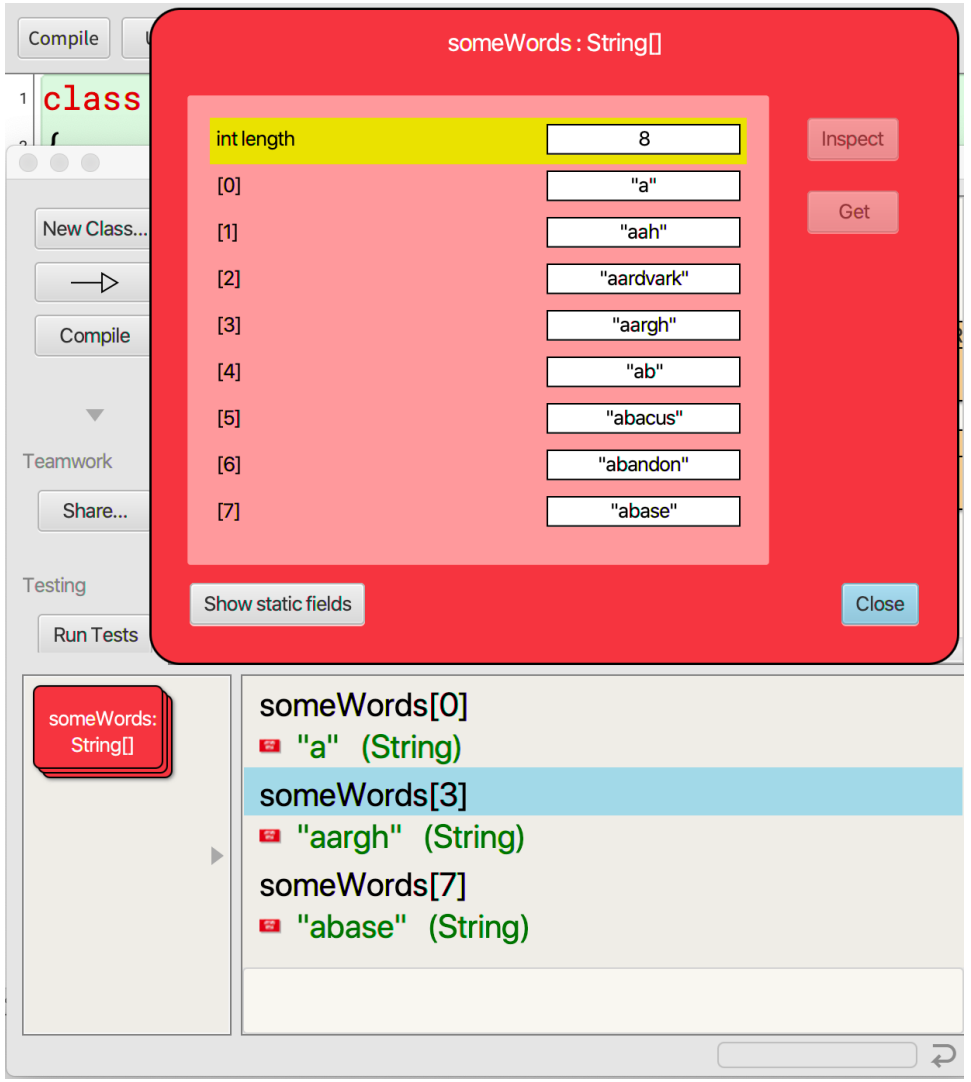
Example:

`someWords` is an array of `String` with **length** 8.

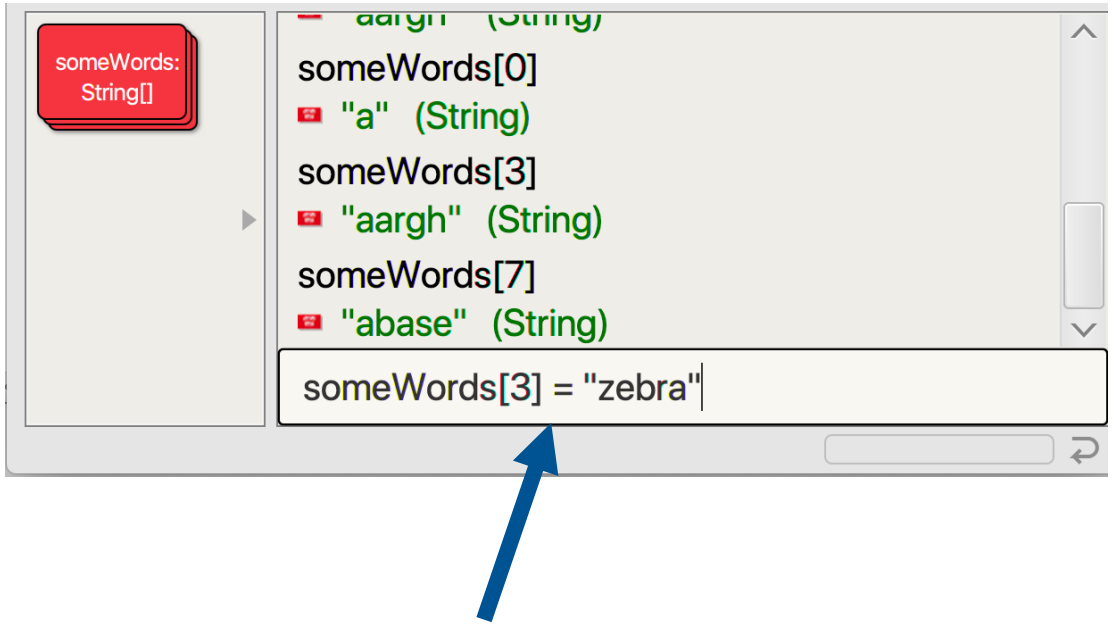
`"aargh"` is an **element** of `someWords`.

The **index** of `"aargh"` is 3, although it is the fourth String in the array.

`"aargh"` is bound to the array variable `someWords[3]`.

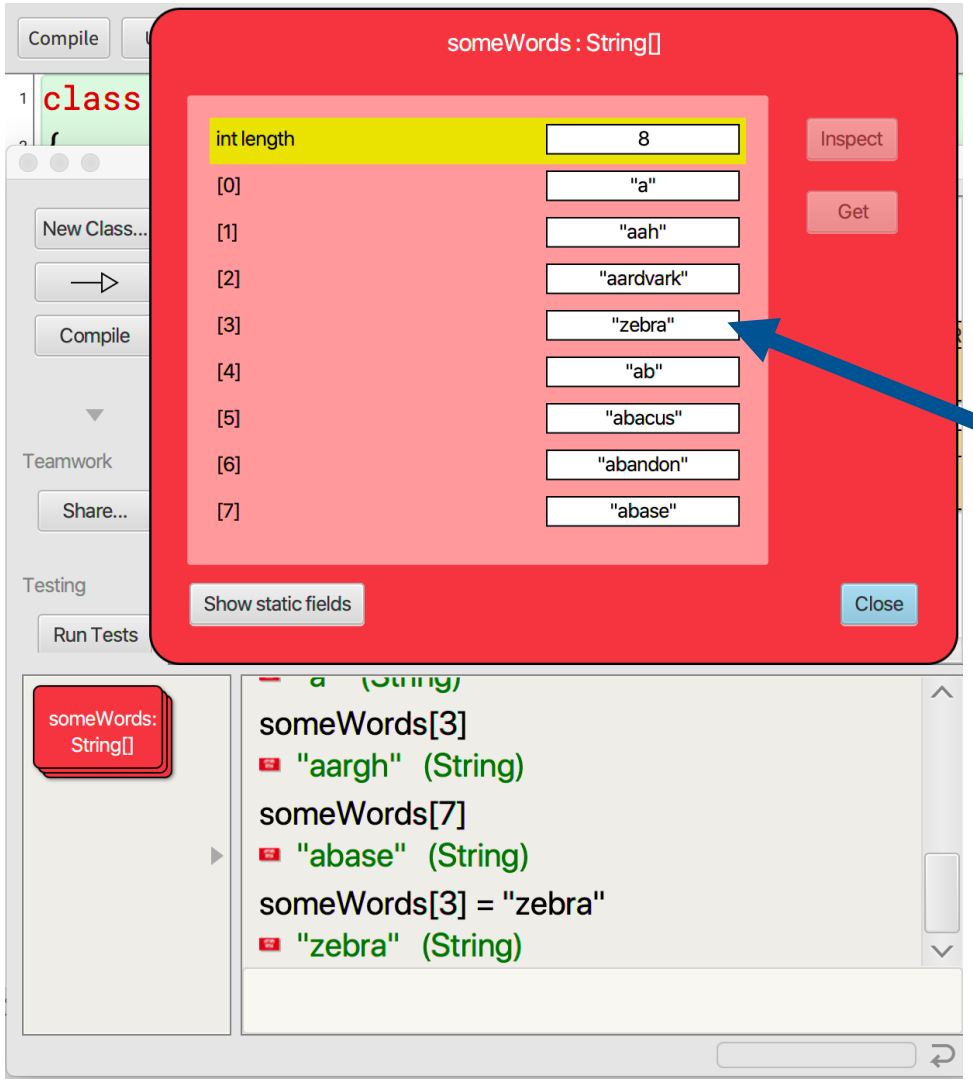


Changing an element in an array



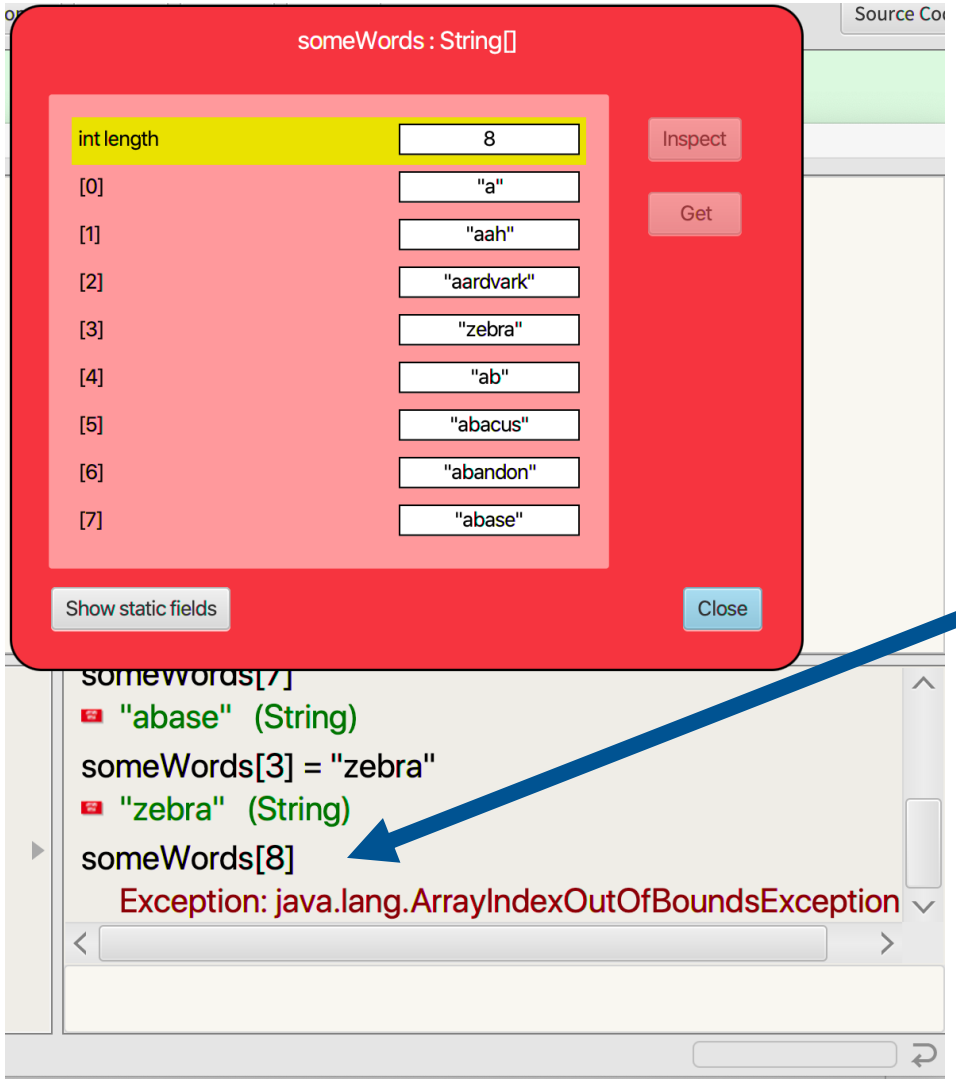
Change what is in an array by setting the element's array variable to a new value

Changing an element in an array



The element at index 3 is now “zebra”

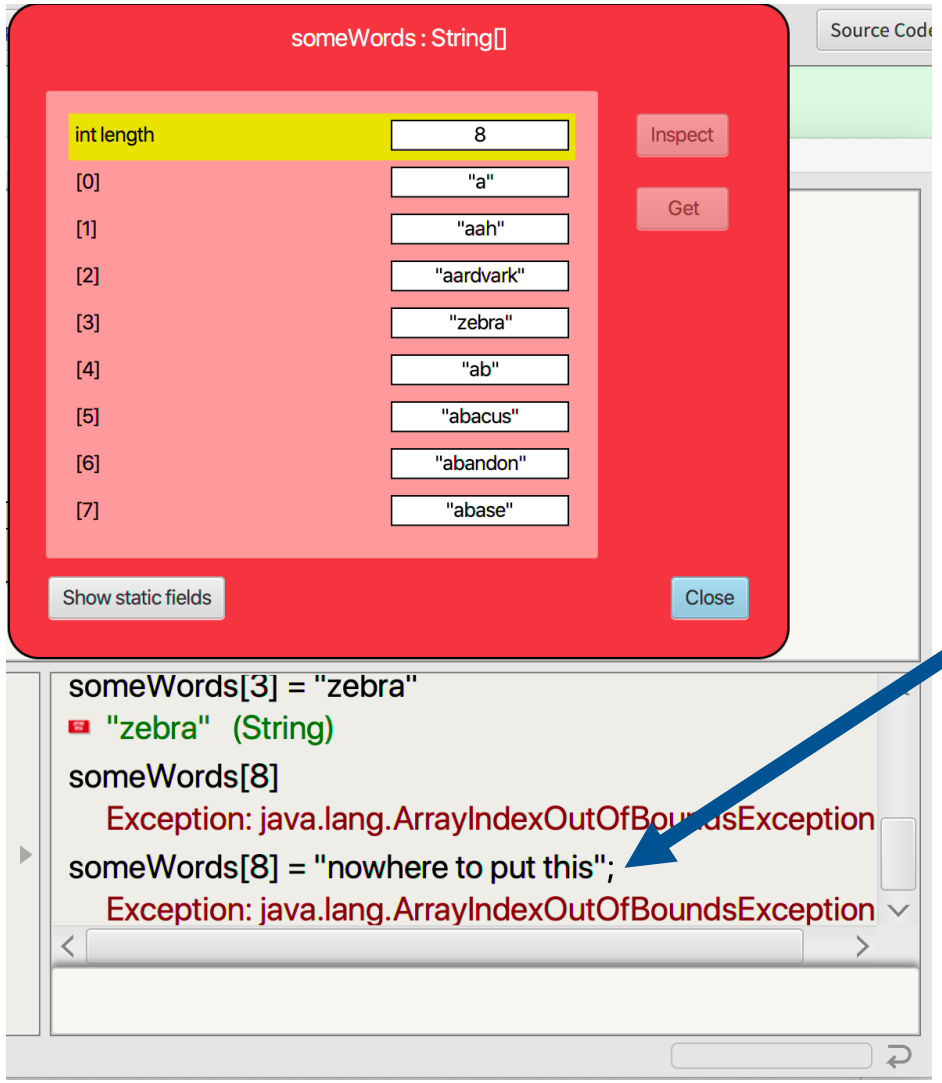
Watch out for indexing out of bounds



No element with index 8 exists!

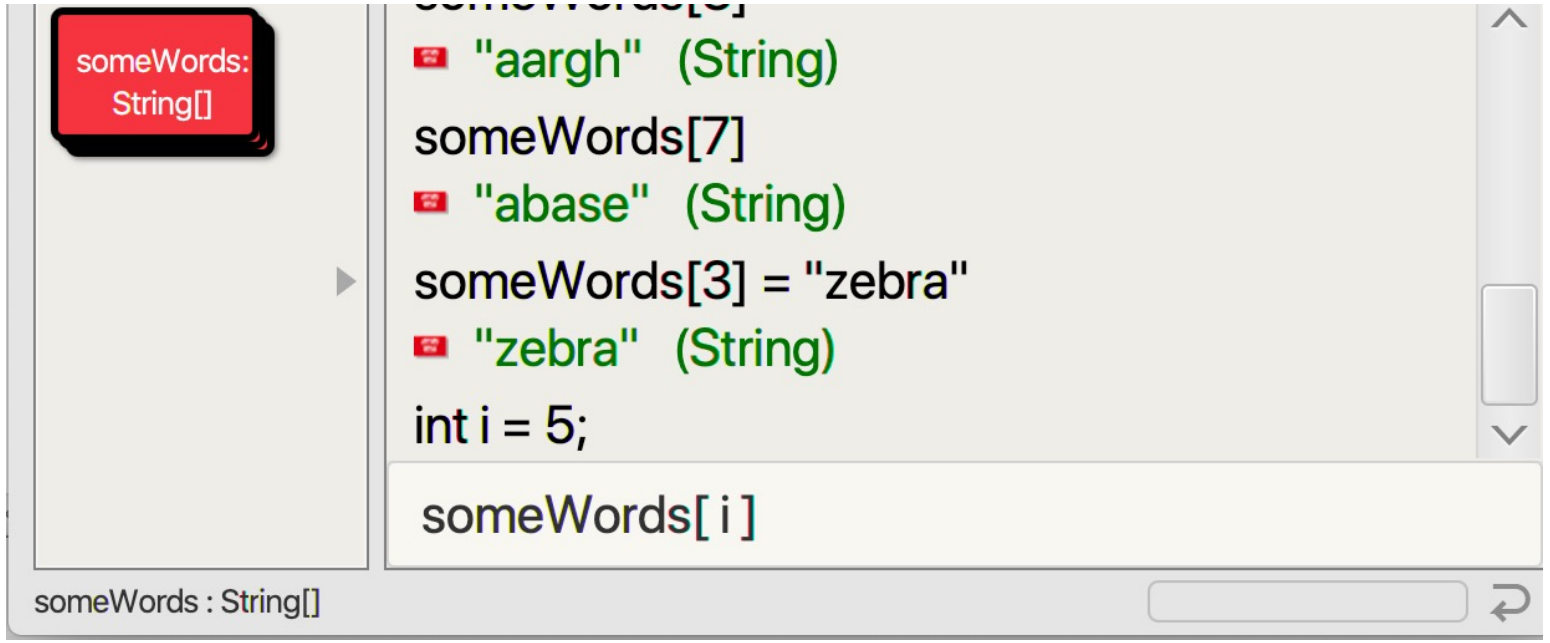
Arrays have a fixed size.

They do not expand or shrink after creation.



Not possible to expand an array or add elements beyond the end.

Useful trick: you can index with a variable



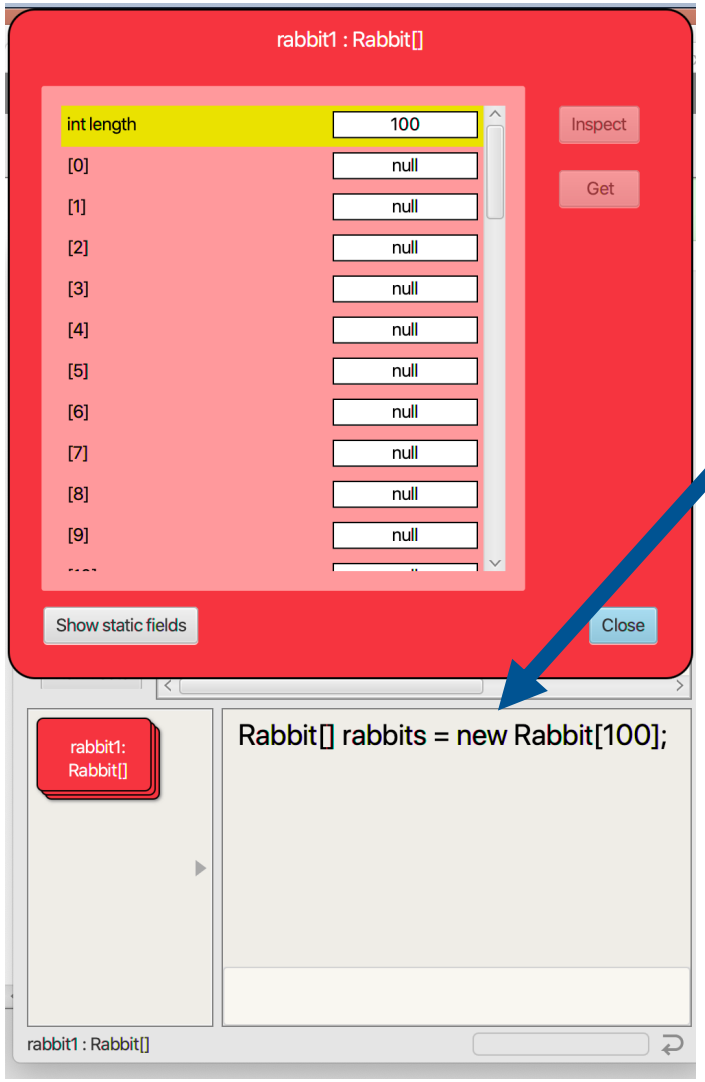
If we declare a variable `i = 5`, `someWords[i]` is the same as typing `someWords[5]`

Useful trick: you can index with a variable

What does the following code do?

```
String[] animalNoises = {"Moo", "Quack",
"Meow", "Oink", "Baa", "Squeak", "Ribbit"};
int i = 2;
while (i < 7)
{
    System.out.println(animalNoises[i]);
    i++;
}
```

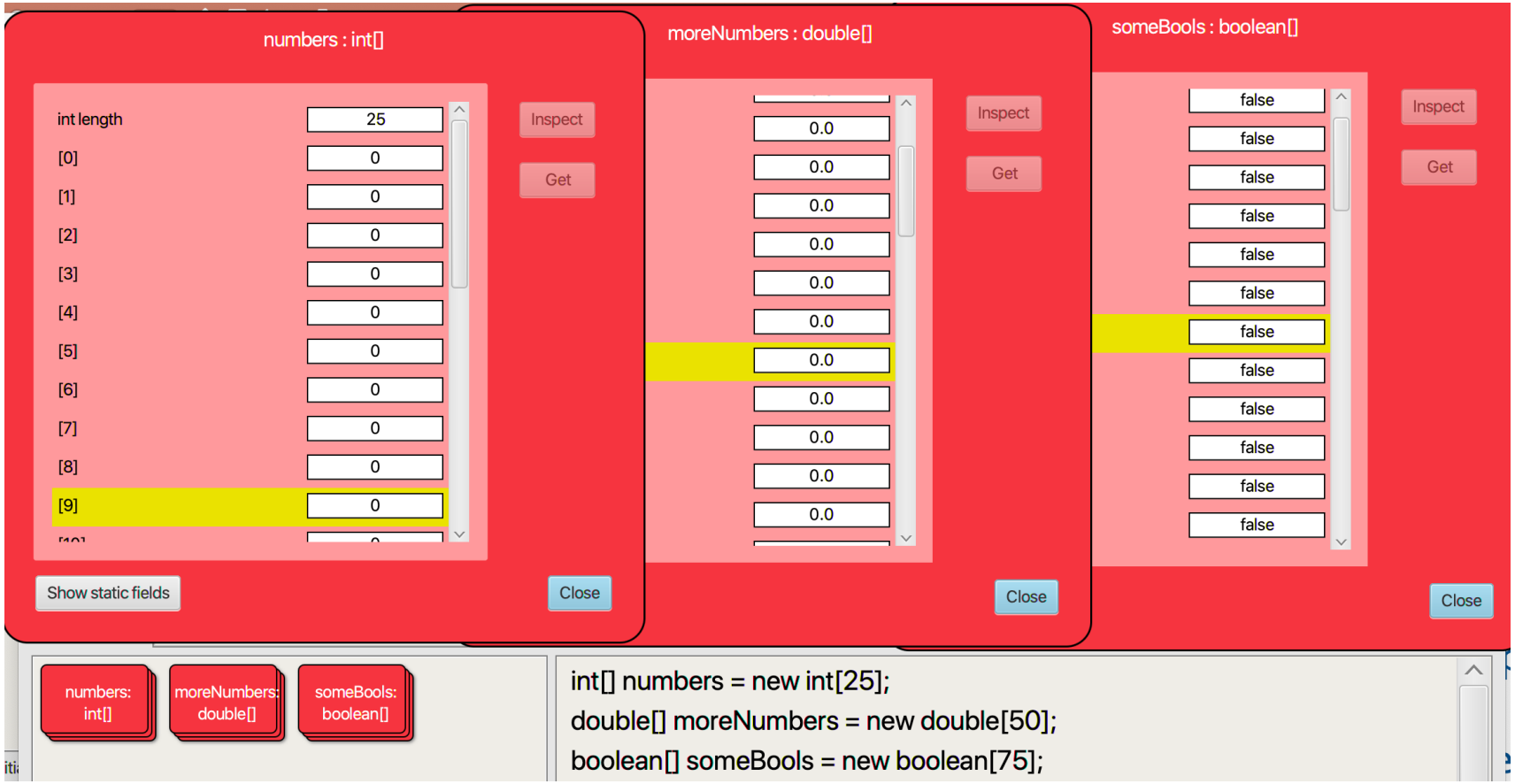
Another useful feature: create an empty array of a given size



`new Datatype[100]` can create an empty array with 100 slots to hold a particular datatype.

In general, the default value in each slot is `null`, which we will interpret as "no available object yet".

"Empty" arrays of primitive datatypes actually have a default value



The default value of numeric types is zero.
The default for booleans is false.

Working with empty arrays

What does the following code do?

```
int[] nums = new int[50];
int i = 0;
while (i < 50)
{
    nums[i] = i * 2;
    i++;
}
```

Working with empty arrays

What does the following code do?

```
int[] nums = new int[50];
int i = 0;
while (i < 50)
{
    nums[i] = i * 2;
    i++;
}
```

Loops are very useful for filling arrays with values and for working with arrays in general.

We will learn more useful loop types in the next lessons.