Single-Dimensional Arrays

Opening Problem

Read one hundred numbers, compute their average, and find out how many numbers are above the average.

- **Why Use Arrays?**

A variable can hold only one value at any given time. This isn't really a problem in most of our programs, since we usually declare as many variables as we need to store values. However, sometimes this can be a limitation that causes problems in your program solutions.

Why Use Arrays?

An example can be a program that records grades for a set of four courses and displays only those courses that are above the average:

```
int NUM_COURSES = 4
double grade1 = 0
double grade2 = 0
double grade3 = 0
double grade4 = 0
double totalGrade = 0
double avgGrade = 0
Print "Enter first grade: "
Get grade1
Print "Enter second grade: "
Get grade2
Print "Enter third grade: "
Get grade3
Print "Enter fourth grade: "
Get grade4
avgGrade = (grade1 + grade2 + grade3 + grade4) / NUM_COURSES
```

Why Use Arrays?

```
Print "Average:  ", avgGrade
Print "Grades above average:"
If grade1 > avgGrade Then
        Print "Grade #1: ", grade1
If grade2 > avgGrade Then
        Print "Grade #2: ", grade2
If grade3 > avgGrade Then
        Print "Grade #3: ", grade3
If grade4 > avgGrade Then
        Print "Grade #4: ", grade4
```

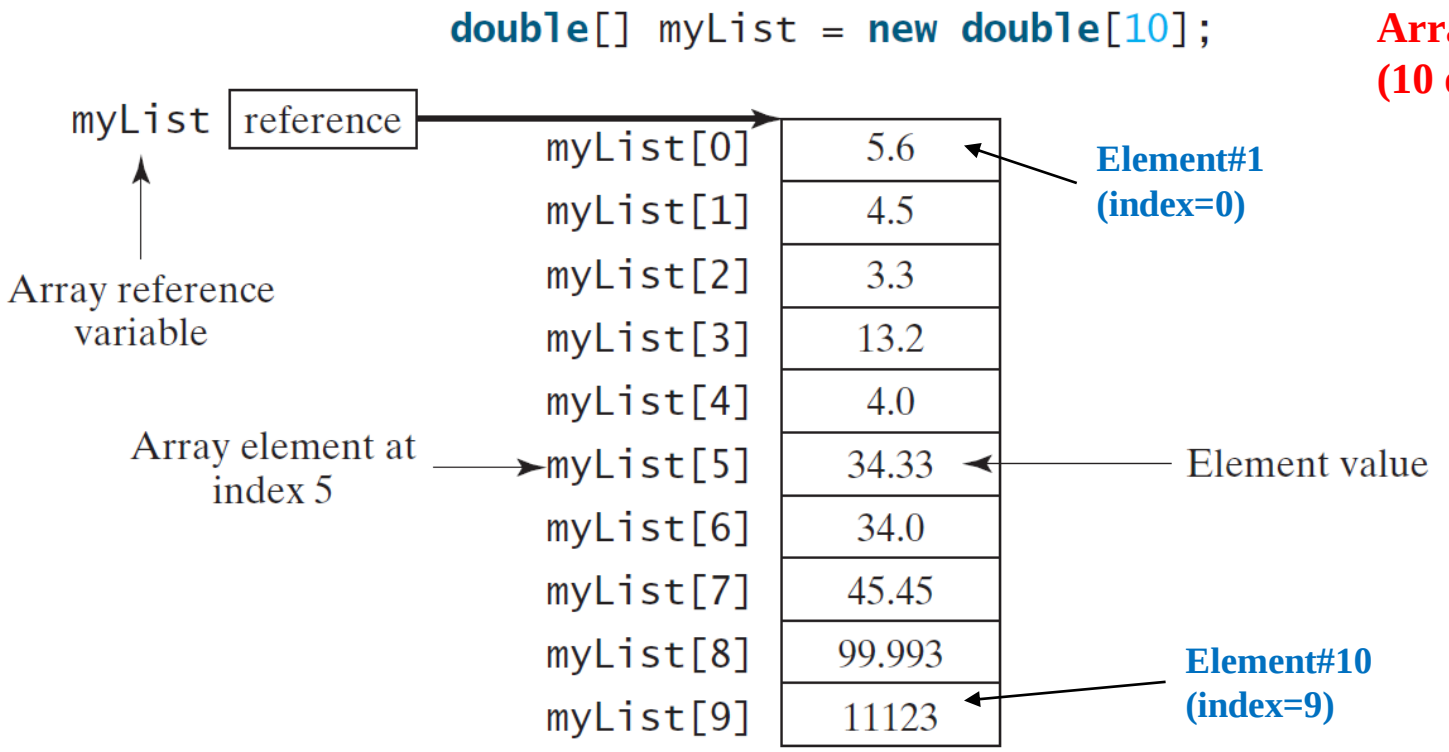
This simple solution works fine, but what if you wanted to use the same program to calculate another student's average with six courses?

What if you wanted to work this program for all your courses in your entire program upon graduation? You would have to keep adding extra variables each time you wanted to run the program with a different number of courses.

As a deployable program, this is not an option: You can't expect your users to alter the programming code whenever they want to enter a different number of grades.

Introducing Arrays

Arrays help solve this problem. An array is similar to a variable, except that it can hold more than one value. Array is a data structure that represents a collection of the same types of data. An array is made up of a set of "slots" or **elements**, where each element holds one value. For example, an array with 10 elements can hold four different values:



- To access an element of an array, whether to place a value in the array or read a value from the array, you need to specify which of the elements you want to access. For example, do you want to place a new value in the third element or do you want to print the value in the last element? You identify the element by its **index** or **subscript**. The element's index is its position or slot number in the array. For example, in our grades array above, the value 4.5 is element #2.
- In Java, array indexes always start at 0, so the first element in the array actually has an index or subscript of 0, the second element has a subscript of 1, and so on. The length, or number of elements, in the array is always one more than the highest index value. For example, the grades array has a length of 10 and its highest index value is 9. The grades array's first index value is 0.

Coding With Arrays

To use an array in Java, you have to declare or define it, just as you would with any other variable. The difference is that you have to use the square brackets [] to show that you are declaring an array:

```
double[] grades;
```

This statement declares an array called "grades" that will hold a set of double values. This array variable is currently not pointing to anything; the variable is not really empty, it just hasn't been given an array yet. In other words, we have not yet allocated storage for the array; we've only just indicated that this variable will eventually point to an array of double values.

Note

An array can only hold one kind of data/object. You can't declare an array that holds, for example, ints and Strings, or doubles and ints. An array has to be all ints, or all doubles, or all Strings, or all of whatever type of data or object is appropriate.

To create the array and allocate storage for the array, you need to specify the type of data the array will hold, and the length, or number of elements, in the array. This next statement creates and allocates storage for an array of 4 double values, and assigns that array to the grades array variable:

```
grades = new double[4];
```

This grades array will have indexes from 0 to 3, because we have defined it to have 4 elements. If we wanted to, we could have declared the array variable and allocated storage for the array in one statement:

```
double[] grades = new double[4];
```

In this case, we've created an empty array of doubles with storage for 4 elements and stored a reference to that array in the variable grades.

In this case, we've created an empty array of doubles with storage for 4 elements and stored a reference to that array in the variable grades.

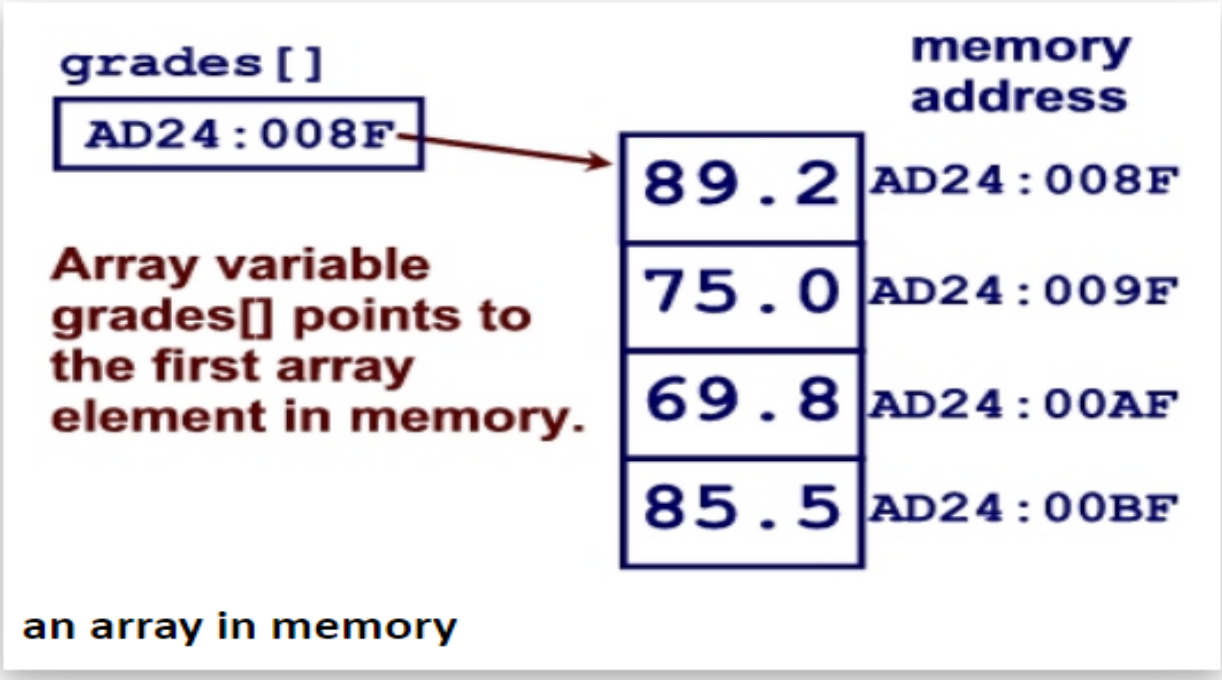
Whether you declare the variable and create the array in one statement or in two statements depends on the nature of your program. If you happen to know how many elements the array will need, you can declare it and allocate storage for it right away. However, this won't always be the case, as we'll see with some of our examples in the next few sessions.

Important!

Note that the statement `double[] grades = new double[4];` only creates the array object. It does not place any values into the array. When an array is created for any of Java's primitive types, each element is automatically initialized to that type's null value. If you want any other value to be stored in the array, it is up to you to write the code to do that.

To access an array in Java, you specify the subscript or index in the square brackets:

```
// stores values in all the elements
grades[0] = 89.2;
grades[1] = 75.0;
grades[2] = 69.8;
grades[3] = 85.5;
// prints the value in the third element:
System.out.println("Grade #3: " + grades[2]);
```



an array in memory

Declaring Array Variables

- `datatype[] arrayRefVar;`

  Example:

  ```
  double[] myList;
  ```

- `datatype arrayRefVar[];` // This style is allowed, but not preferred

  Example:

  ```
  double myList[];
  ```

Creating Arrays

```
arrayRefVar = new datatype[arraySize];
```

Example:

```
myList = new double[10];
```

`myList[0]` references the first element in the array.

`myList[9]` references the last element in the array.

Declaring and Creating in One Step

- `datatype[] arrayRefVar = new datatype[arraySize];`

```
double[] myList = new double[10];
```

- `datatype arrayRefVar[] = new datatype[arraySize];`

```
double myList[] = new double[10];
```

The Length of an Array

Once an array is created, its size is fixed. It cannot be changed. You can find its size using

```
arrayRefVar.length
```

For example,

```
myList.length returns 10
```

Default Values

When an array is created, its elements are assigned the default value of

0 for the numeric primitive data types,

'\u0000' for char types, and

false for boolean types.

Indexed Variables

The array elements are accessed through the index. The array indices are *0-based*, i.e., it starts from 0 to arrayRefVar.length-1. In the example in Figure 6.1, myList holds ten double values and the indices are from 0 to 9.

Each element in the array is represented using the following syntax, known as an *indexed variable*:

```
arrayRefVar[index];
```

Using Indexed Variables

After an array is created, an indexed variable can be used in the same way as a regular variable. For example, the following code adds the value in myList[0] and myList[1] to myList[2].

```
myList[2] = myList[0] + myList[1];
```

Array Initializers

- Declaring, creating, initializing in one step:

```
double[] myList = {1.9, 2.9, 3.4, 3.5};
```

This shorthand syntax must be in one statement.

Declaring, creating, initializing Using the Shorthand Notation

```
double[] myList = {1.9, 2.9, 3.4, 3.5};
```

This shorthand notation is equivalent to the following statements:

```
double[] myList = new double[4];

myList[0] = 1.9;

myList[1] = 2.9;

myList[2] = 3.4;

myList[3] = 3.5;
```

CAUTION

Using the shorthand notation, you have to declare, create, and initialize the array all in one statement. Splitting it would cause a syntax error. For example, the following is wrong:

```
double[] myList;

myList = {1.9, 2.9, 3.4, 3.5};
```

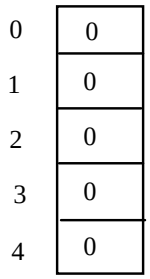
animation

Trace Program with Arrays

Declare array variable values, create an array, and assign its reference to values

```
public class Test {
  public static void main(String[] args) {
    int[] values = new int[5];
    for (int i = 1; i < 5; i++) {
      values[i] = i + values[i-1];
    }
    values[0] = values[1] + values[4];
  }
}
```

After the array is created



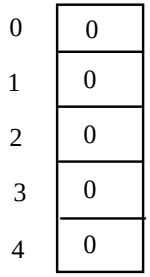
animation

Trace Program with Arrays

i becomes 1

```
public class Test {
  public static void main(String[] args) {
    int[] values = new int[5];
    for (int i = 1; i < 5; i++) {
      values[i] = i + values[i-1];
    }
    values[0] = values[1] + values[4];
  }
}
```

After the array is created



animation

Trace Program with Arrays

i (=1) is less than 5

```
public class Test {
  public static void main(String[] args) {
    int[] values = new int[5];
    for (int i = 1; i < 5; i++) {
      values[i] = i + values[i-1];
    }
    values[0] = values[1] + values[4];
  }
}
```

After the array is created

0	0
1	0
2	0
3	0
4	0

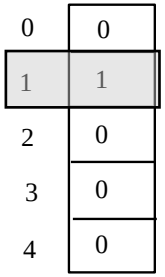
animation

Trace Program with Arrays

After this line is executed, value[1] is 1

```
public class Test {
  public static void main(Strin      gs) {
    int[] values = new int[5];
    for (int i = 1; i < 5; i++) {
      values[i] = i + values[i-1];
    }
    values[0] = values[1] + values[4];
  }
}
```

After the first iteration



animation

Trace Program with Arrays

After i++, i becomes 2

```
public class Test {
  public static void main(String[] args) {
    int[] values = new int[5];
    for (int i = 1; i < 5; i++) {
      values[i] = i + values[i-1];
    }
    values[0] = values[1] + values[4];
  }
}
```

After the first iteration

0	0
1	1
2	0
3	0
4	0

animation

Trace Program with Arrays

```
public class Test {
  public static void main(String[]
      args) {
    int[] values = new int[5];
    for (int i = 1; i < 5; i++) {
      values[i] = i + values[i-1];
    }
    values[0] = values[1] +
      values[4];
  }
}
```

i (= 2) is less than 5

After the first iteration

0	0
1	1
2	0
3	0
4	0

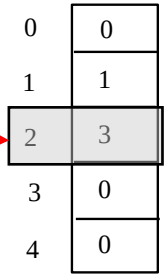
animation

Trace Program with Arrays

After this line is executed, values[2] is 3 (2 + 1)

```
public class Test {
  public static void main(Strin      gs) {
    int[] values = new int[5];
    for (int i = 1; i < 5; i++) {
      values[i] = i + values[i-1];
    }
    values[0] = values[1] + values[4];
  }
}
```

After the second iteration



animation

Trace Program with Arrays

After this, i becomes 3.

```
public class Test {
  public static void main(String[] args) {
    int[] values = new int[5];
    for (int i = 1; i < 5; i++) {
      values[i] = i + values[i-1];
    }
    values[0] = values[1] + values[4];
  }
}
```

After the second iteration

0	0
1	1
2	3
3	0
4	0

animation

Trace Program with Arrays

i (=3) is still less than 5.

```
public class Test {
  public static void main(String[] args) {
    int[] values = new int[5];
    for (int i = 1; i < 5; i++) {
      values[i] = i + values[i-1];
    }
    values[0] = values[1] + values[4];
  }
}
```

After the second iteration

0	0
1	1
2	3
3	0
4	0

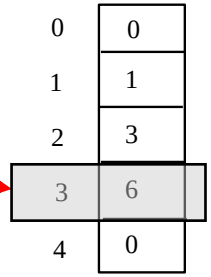
animation

Trace Program with Arrays

After this line, values[3] becomes 6 (3 + 3)

```
public class Test {
  public static void main(String[] arg
    int[] values = new int[5];
    for (int i = 1; i < 5; i++) {
      values[i] = i + values[i-1];
    }
    values[0] = values[1] + values[4];
  }
}
```

After the third iteration



animation

Trace Program with Arrays

After this, i becomes 4

```
public class Test {
  public static void main(String[] args) {
    int[] values = new int[5];
    for (int i = 1; i < 5; i++) {
      values[i] = i + values[i-1];
    }
    values[0] = values[1] + values[4];
  }
}
```

After the third iteration

0	0
1	1
2	3
3	6
4	0

animation

Trace Program with Arrays

i (=4) is still less than 5

```
public class Test {
  public static void main(String[] args) {
    int[] values = new int[5];
    for (int i = 1; i < 5; i++) {
      values[i] = i + values[i-1];
    }
    values[0] = values[1] + values[4];
  }
}
```

After the third iteration

0	0
1	1
2	3
3	6
4	0

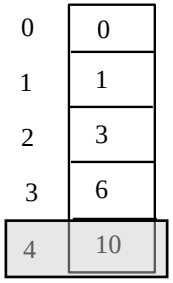
animation

Trace Program with Arrays

After this, values[4] becomes 10 (4 + 6)

```
public class Test {
  public static void main(Stri      args) {
    int[] values = new int[5];
    for (int i = 1; i < 5; i++) {
      values[i] = i + values[i-1];
    }
    values[0] = values[1] + values[4];
  }
}
```

After the fourth iteration



animation

Trace Program with Arrays

After i++, i becomes 5

```
public class Test {
  public static void main(String[] arg
    int[] values = new int[5];
    for (int i = 1; i < 5; i++) {
      values[i] = i + values[i-1];
    }
    values[0] = values[1] + values[4];
  }
}
```

After the fourth iteration

0	0
1	1
2	3
3	6
4	10

animation

Trace Program with Arrays

i (=5) < 5 is false. Exit the loop

```
public class Test {
  public static void main(String[] args) {
    int[] values = new int[5];
    for (int i = 1; i < 5; i++) {
      values[i] = i + values[i-1];
    }
    values[0] = values[1] + values[4];
  }
}
```

After the fourth iteration

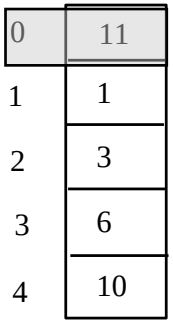
0	0
1	1
2	3
3	6
4	10

animation

Trace Program with Arrays

After this line, values[0] is 11 (1 + 10)

```
public class Test {
  public static void m      ring[] args) {
    int[] values = ne      [5];
    for (int i = 1; i      ; i++) {
      values[i] = i      values[i-1];
    }
    values[0] = values[1] + values[4];
  }
}
```



Processing Arrays

See the examples in the text.

1. (Initializing arrays with input values)
2. (Initializing arrays with random values)
3. (Printing arrays)
4. (Summing all elements)
5. (Finding the largest element)
6. (Finding the smallest index of the largest element)
7. (*Random shuffling*)
8. (*Shifting elements*)

Processing Arrays

Arrays are useful when you want to process a list of data, such as a list of grades. If you wanted to total or sum the grades in the list, you might think to add all the array elements together:

```
totalGrade = grades[0] + grades[1] + grades[2] + grades[3];
```

This works, but what if your array had 10 elements? What if your array had 100 elements? There is a more efficient way of performing operations on every element in an array: use a loop.

Loops work well when processing an array because you can start at element 0 and repeatedly perform an operation on every element in the array until you get to the last element. To make this work, you need to know the length of your array and you need a counter (or just use a for loop):

```
for (int i=0; i<grades.length; i++)
        totalGrade += grades[i];
```

Processing Arrays

Notice that in the loop, my loop condition is `i<grades.length`. An array contains a public attribute called "length" which always contains the number of elements in the array. Do not confuse this with a String object's length() method! These are not the same thing! grades.length is referring to the value in the length attribute of the grades array.

The statement `totalGrade += grades[i];` is accumulating the grades from each element in the array. For the first iteration of the for-loop, the counter i is 0, so in this case, the compiler would be `totalGrade += grades[0];`. For the second iteration of the array, the counter i is 1, so the compiler would read `totalGrade += grades[1];`. For the third iteration of the array, the counter i is 2, so the compiler would read `totalGrade += grades[2];`, and for the last iteration, the counter i is 3 so the compiler would read `totalGrade += grades[3];`. After this, the counter is incremented to 4. The condition states that the loop terminates when the counter i is no longer less than grades.length (which has a value of 4). Since the counter i's value of 4 is no longer less than the grades.length value of 4, the loop ends. At this point, totalGrade holds the sum of all the elements in the array.

Initializing arrays with input values

```
java.util.Scanner input = new java.util.Scanner(System.in);
System.out.print("Enter " + myList.length + " values: ");
for (int i = 0; i < myList.length; i++)
  myList[i] = input.nextDouble();
```

Initializing arrays with random values

```
for (int i = 0; i < myList.length; i++) {
  myList[i] = Math.random() * 100;
}
```

Printing arrays

```
for (int i = 0; i < myList.length; i++) {
  System.out.print(myList[i] + " ");
}
```

Summing all elements

```
double total = 0;
for (int i = 0; i < myList.length; i++) {
  total += myList[i];
}
```

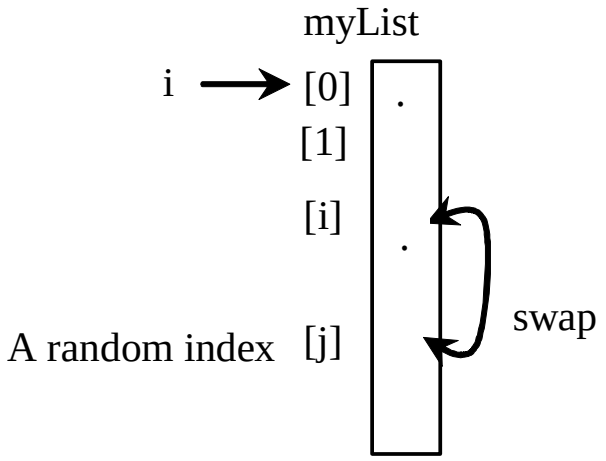
Finding the largest element

```
double max = myList[0];
for (int i = 1; i < myList.length; i++) {
  if (myList[i] > max) max = myList[i];
}
```

Random shuffling

```
for (int i = 0; i < myList.length - 1; i++) {
  // Generate an index j randomly
  int j = (int)(Math.random()
    * myList.length);

  // Swap myList[i] with myList[j]
  double temp = myList[i];
  myList[i] = myList[j];
  myList[j] = temp;
}
```

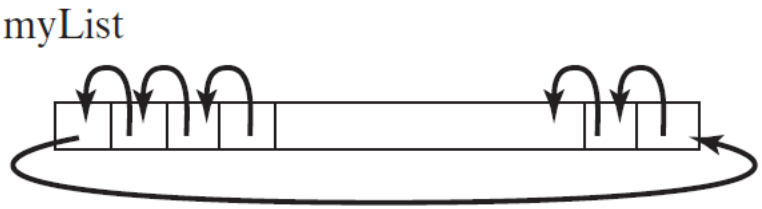


Shifting Elements

```
double temp = myList[0]; // Retain the first element

// Shift elements left
for (int i = 1; i < myList.length; i++) {
  myList[i - 1] = myList[i];
}

// Move the first element to fill in the last position
myList[myList.length - 1] = temp;
```



Enhanced for Loop (for-each loop)

JDK 1.5 introduced a new for loop that enables you to traverse the complete array sequentially without using an index variable. For example, the following code displays all elements in the array myList:

```
for (double value: myList)
  System.out.println(value);
```

In general, the syntax is

```
for (elementType value: arrayRefVar) {
  // Process the value
}
```

You still have to use an index variable if you wish to traverse the array in a different order or change the elements in the array.

SLATE

Exercises#1 - Week 9

Opening Problem

Read one hundred numbers, compute their average, and find out how many numbers are above the average.

AnalyzeNumbers Run

Companion Website

Problem: Lotto Numbers

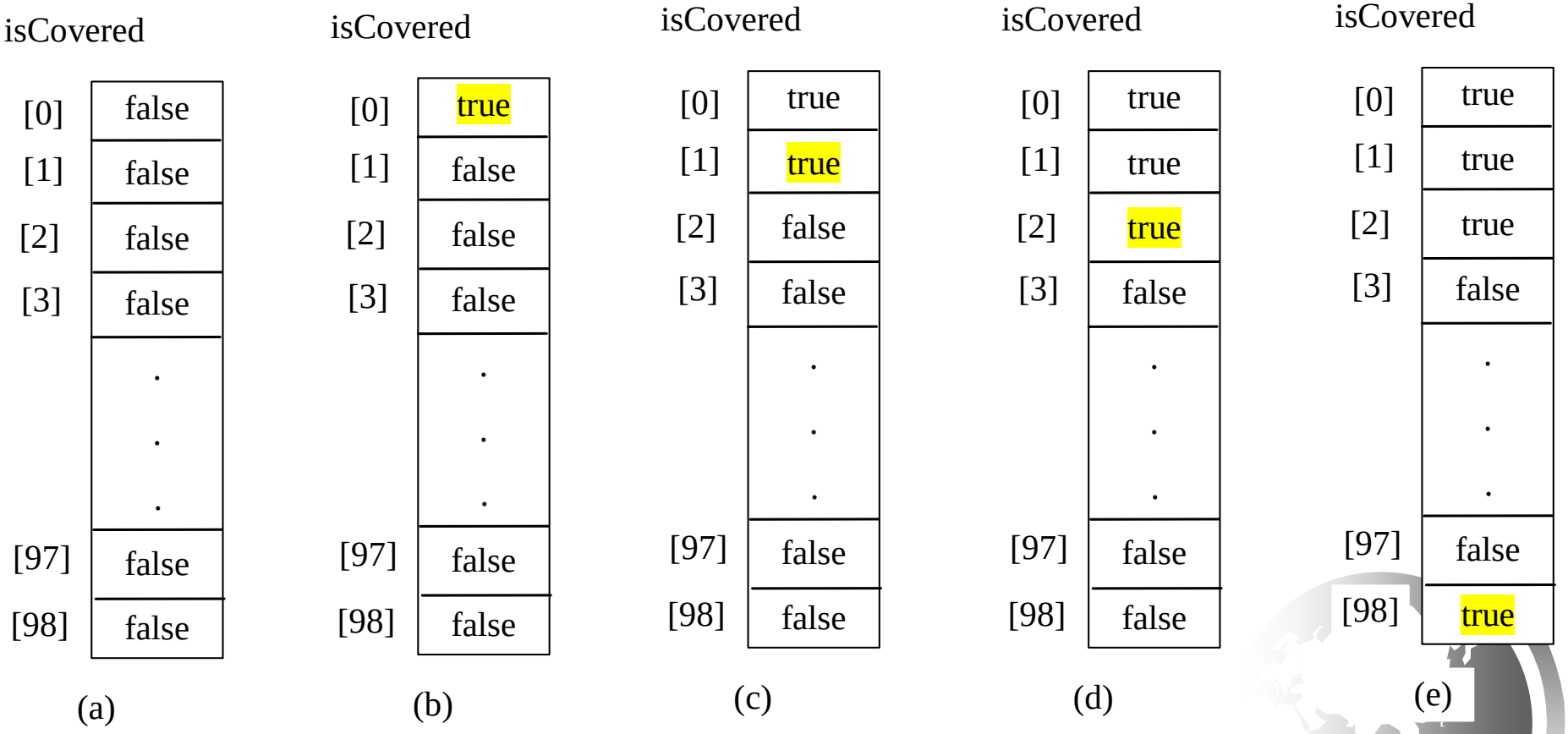
Suppose you play the Pick-10 lotto. Each ticket has 10 unique numbers ranging from 1 to 99. You buy a lot of tickets. You like to have your tickets to cover all numbers from 1 to 99. Write a program that reads the ticket numbers from a file and checks whether all numbers are covered. Assume the last number in the file is 0.

Lotto Numbers Sample Data

LottoNumbers Run

Companion Website

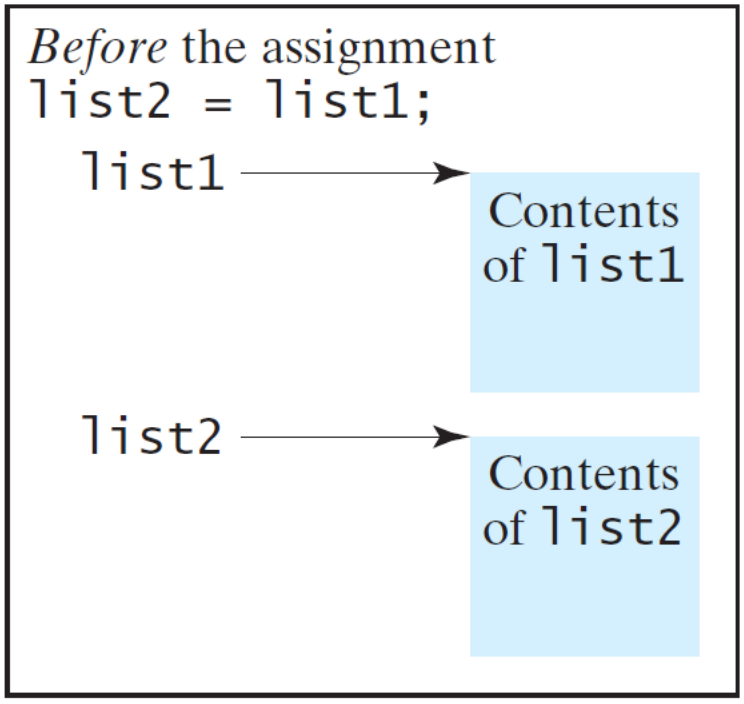
Problem: Lotto Numbers

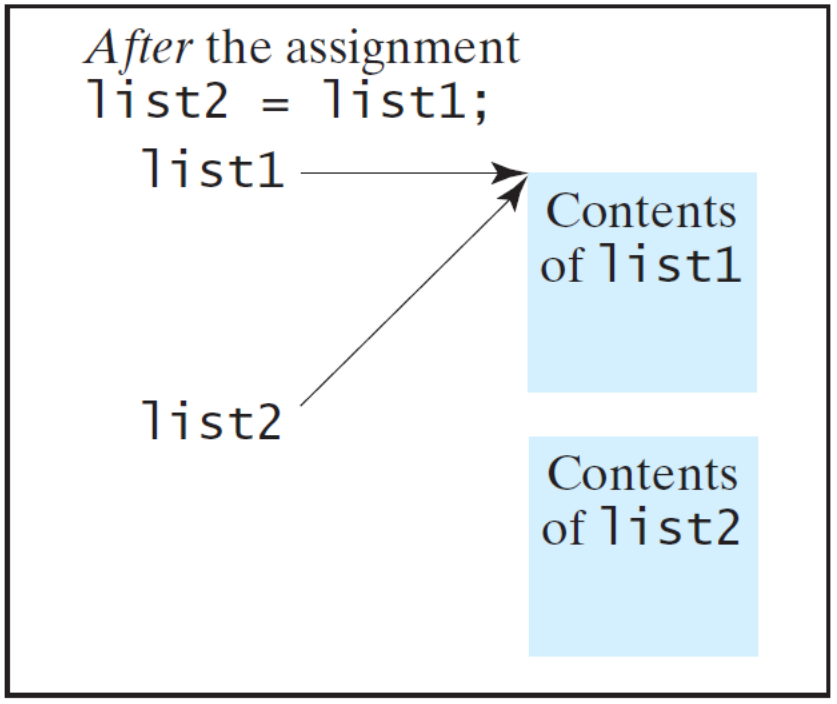


Copying Arrays

Often, in a program, you need to duplicate an array or a part of an array. In such cases you could attempt to use the assignment statement (=), as follows:

list2 = list1;





Copying Arrays

Using a loop:

```
int[] sourceArray = {2, 3, 1, 5, 10};
int[] targetArray = new
  int[sourceArray.length];

for (int i = 0; i < sourceArrays.length; i++)
   targetArray[i] = sourceArray[i];
```

The `arraycopy` Utility

```
arraycopy(sourceArray, src_pos,
  targetArray, tar_pos, length);
```

Example:

```
System.arraycopy(sourceArray, 0,
  targetArray, 0, sourceArray.length);
```

animation

Trace the reverse Method

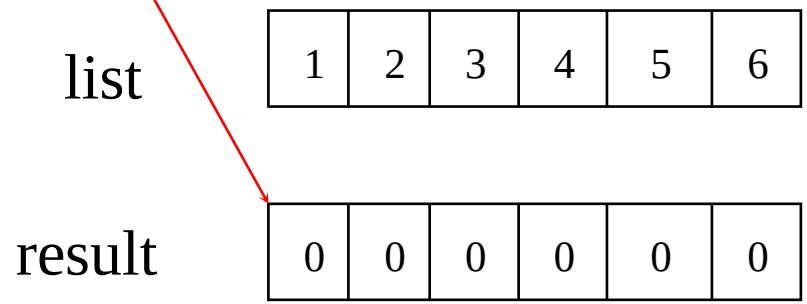
```
int[] list1 = {1, 2, 3, 4, 5, 6};
int[] list2 = reverse(list1);
```

Declare result and create array

```
public static int[] reverse(int[] list) {
  int[] result = new int[list.length];

  for (int i = 0, j = result.length - 1;
       i < list.length; i++, j--) {
    result[j] = list[i];
  }

  return result;
}
```



animation

Trace the reverse Method, cont.

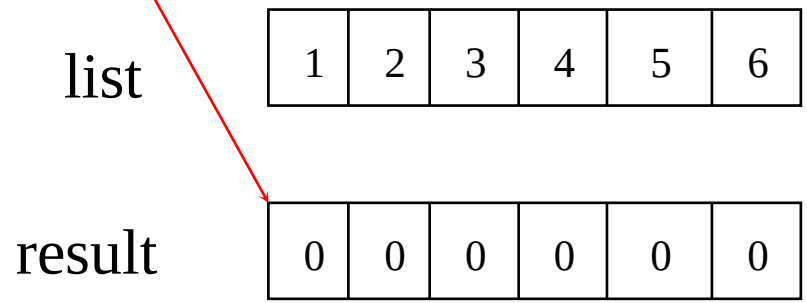
```
int[] list1 = {1, 2, 3, 4, 5, 6};
int[] list2 = reverse(list1);
```

```
public static int[] reverse(int[] list) {
  int[] result = new int[list.length];

  for (int i = 0, j = result.length - 1;
       i < list.length; i++, j--) {
    result[j] = list[i];
  }

  return result;
}
```

i = 0 and j = 5



animation

Trace the reverse Method, cont.

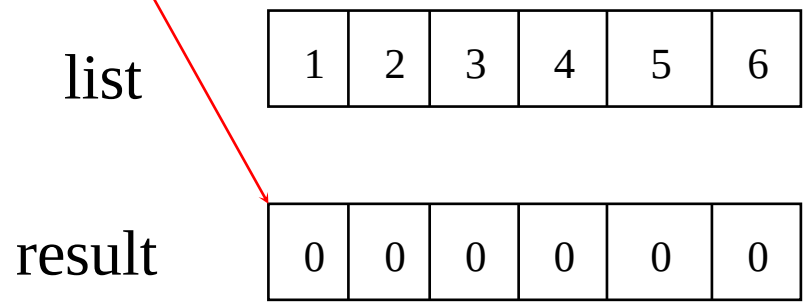
```
int[] list1 = {1, 2, 3, 4, 5, 6};
int[] list2 = reverse(list1);
```

i (= 0) is less than 6

```
public static int[] reverse(int[] list) {
  int[] result = new int[list.length];

  for (int i = 0, j = result.length - 1;
       i < list.length; i++, j--) {
    result[j] = list[i];
  }

  return result;
}
```



animation

Trace the reverse Method, cont.

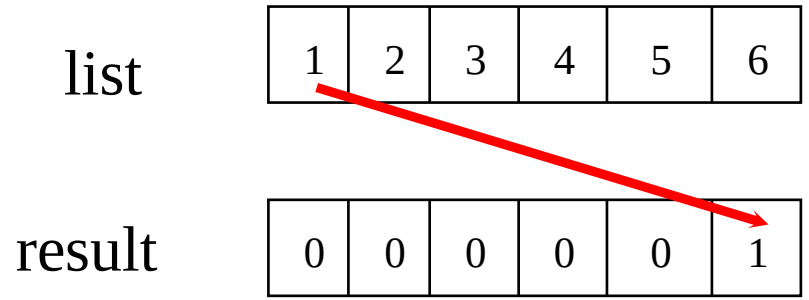
```
int[] list1 = {1, 2, 3, 4, 5, 6};
int[] list2 = reverse(list1);
```

```
public static int[] reverse(int[] list) {
  int[] result = new int[list.length];

  for (int i = 0, j = result.length - 1;
       i < list.length; i++, j--) {
    result[j] = list[i];
  }

  return result;
}
```

i = 0 and j = 5
Assign list[0] to result[5]



animation

Trace the reverse Method, cont.

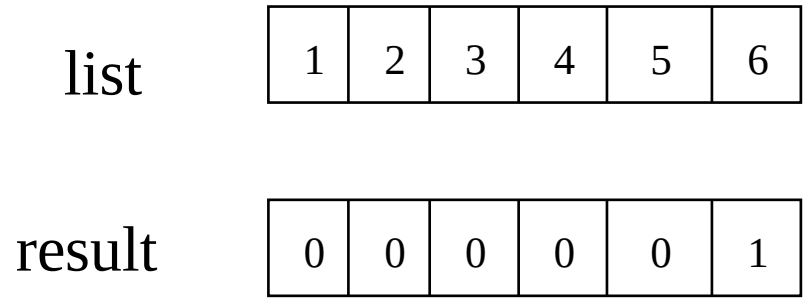
```
int[] list1 = {1, 2, 3, 4, 5, 6};
int[] list2 = reverse(list1);
```

```
public static int[] reverse(int[] list) {
  int[] result = new int[list.length];

  for (int i = 0, j = result.length - 1;
       i < list.length; i++, j--) {
    result[j] = list[i];
  }

  return result;
}
```

After this, i becomes 1 and j becomes 4



animation

Trace the reverse Method, cont.

```
int[] list1 = {1, 2, 3, 4, 5, 6};
int[] list2 = reverse(list1);
```

```
public static int[] reverse(int[] list) {
  int[] result = new int[list.length];

  for (int i = 0, j = result.length - 1;
       i < list.length; i++, j--) {
    result[j] = list[i];
  }

  return result;
}
```

i (=1) is less than 6

list	1	2	3	4	5	6

result	0	0	0	0	0	1

animation

Trace the reverse Method, cont.

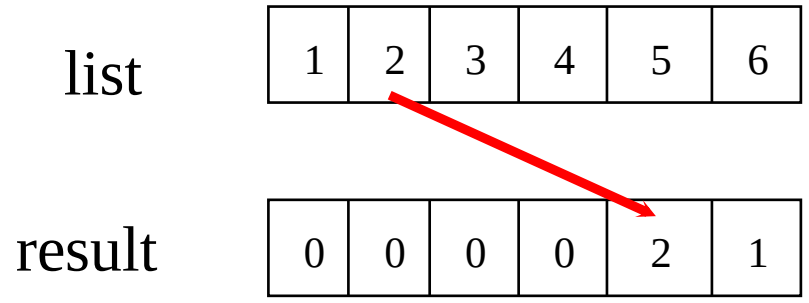
```
int[] list1 = {1, 2, 3, 4, 5, 6};
int[] list2 = reverse(list1);
```

```
public static int[] reverse(int[] list) {
  int[] result = new int[list.length];

  for (int i = 0, j = result.length - 1;
       i < list.length; i++, j--) {
    result[j] = list[i];
  }

  return result;
}
```

i = 1 and j = 4
Assign list[1] to result[4]



animation

Trace the reverse Method, cont.

```
int[] list1 = {1, 2, 3, 4, 5, 6};
int[] list2 = reverse(list1);
```

```
public static int[] reverse(int[] list) {
  int[] result = new int[list.length];

  for (int i = 0, j = result.length - 1;
       i < list.length; i++, j--) {
    result[j] = list[i];
  }

  return result;
}
```

After this, i becomes 2 and j becomes 3

list	1	2	3	4	5	6

result	0	0	0	0	2	1

animation

Trace the reverse Method, cont.

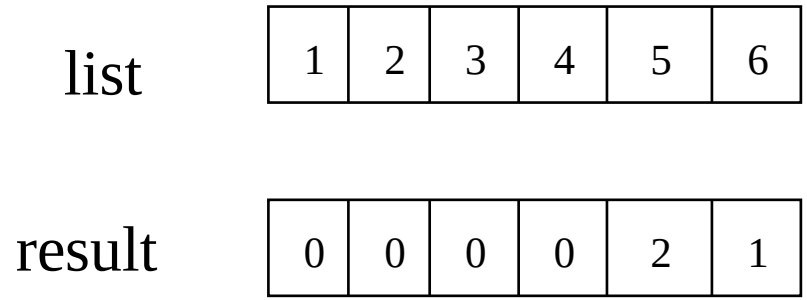
```
int[] list1 = {1, 2, 3, 4, 5, 6};
int[] list2 = reverse(list1);
```

```
public static int[] reverse(int[] list) {
  int[] result = new int[list.length];

  for (int i = 0, j = result.length - 1;
       i < list.length; i++, j--) {
    result[j] = list[i];
  }

  return result;
}
```

i (=2) is still less than 6



animation

Trace the reverse Method, cont.

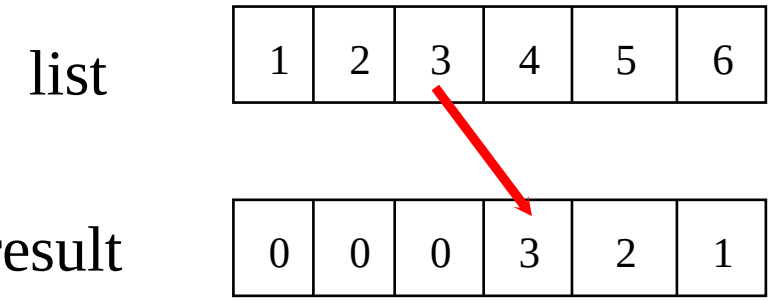
```
int[] list1 = {1, 2, 3, 4, 5, 6};
int[] list2 = reverse(list1);
```

```
public static int[] reverse(int[] list) {
  int[] result = new int[list.length];

  for (int i = 0, j = result.length - 1;
       i < list.length; i++, j--) {
    result[j] = list[i];
  }

  return result;
}
```

i = 2 and j = 3
Assign list[i] to result[j]



animation

Trace the reverse Method, cont.

```
int[] list1 = {1, 2, 3, 4, 5, 6};
int[] list2 = reverse(list1);
```

```
public static int[] reverse(int[] list) {
  int[] result = new int[list.length];

  for (int i = 0, j = result.length - 1;
       i < list.length; i++, j--) {
    result[j] = list[i];
  }

  return result;
}
```

After this, i becomes 3 and j becomes 2

list	1	2	3	4	5	6

result	0	0	0	3	2	1

animation

Trace the reverse Method, cont.

```
int[] list1 = {1, 2, 3, 4, 5, 6};
int[] list2 = reverse(list1);
```

```
public static int[] reverse(int[] list) {
  int[] result = new int[list.length];

  for (int i = 0, j = result.length - 1;
       i < list.length; i++, j--) {
    result[j] = list[i];
  }

  return result;
}
```

i (=3) is still less than 6

list	1	2	3	4	5	6

result	0	0	0	3	2	1

animation

Trace the reverse Method, cont.

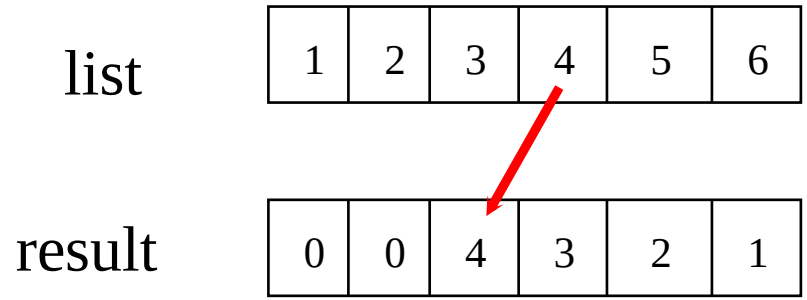
```
int[] list1 = {1, 2, 3, 4, 5, 6};
int[] list2 = reverse(list1);
```

```
public static int[] reverse(int[] list) {
  int[] result = new int[list.length];

  for (int i = 0, j = result.length - 1;
       i < list.length; i++, j--) {
    result[j] = list[i];
  }

  return result;
}
```

i = 3 and j = 2
Assign list[i] to result[j]



animation

Trace the reverse Method, cont.

```
int[] list1 = {1, 2, 3, 4, 5, 6};
int[] list2 = reverse(list1);
```

```
public static int[] reverse(int[] list) {
  int[] result = new int[list.length];

  for (int i = 0, j = result.length - 1;
       i < list.length; i++, j--) {
    result[j] = list[i];
  }

  return result;
}
```

After this, i becomes 4 and j becomes 1

list	1	2	3	4	5	6

result	0	0	4	3	2	1

animation

Trace the reverse Method, cont.

```
int[] list1 = {1, 2, 3, 4, 5, 6};
int[] list2 = reverse(list1);
```

```
public static int[] reverse(int[] list) {
  int[] result = new int[list.length];

  for (int i = 0, j = result.length - 1;
       i < list.length; i++, j--) {
    result[j] = list[i];
  }

  return result;
}
```

i (=4) is still less than 6

list	1	2	3	4	5	6

result	0	0	4	3	2	1

animation

Trace the reverse Method, cont.

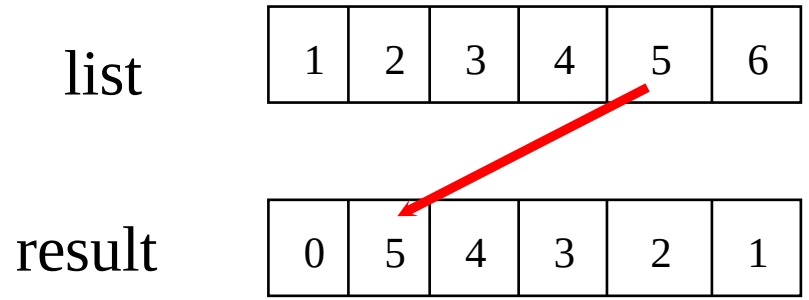
```
int[] list1 = {1, 2, 3, 4, 5, 6};
int[] list2 = reverse(list1);
```

```
public static int[] reverse(int[] list) {
  int[] result = new int[list.length];

  for (int i = 0, j = result.length - 1;
       i < list.length; i++, j--) {
    result[j] = list[i];
  }

  return result;
}
```

i = 4 and j = 1
Assign list[i] to result[j]



animation

Trace the reverse Method, cont.

```
int[] list1 = {1, 2, 3, 4, 5, 6};
int[] list2 = reverse(list1);
```

```
public static int[] reverse(int[] list) {
  int[] result = new int[list.length];

  for (int i = 0, j = result.length - 1;
       i < list.length; i++, j--) {
    result[j] = list[i];
  }

  return result;
}
```

After this, i becomes 5 and j becomes 0

list	1	2	3	4	5	6

result	0	5	4	3	2	1

animation

Trace the reverse Method, cont.

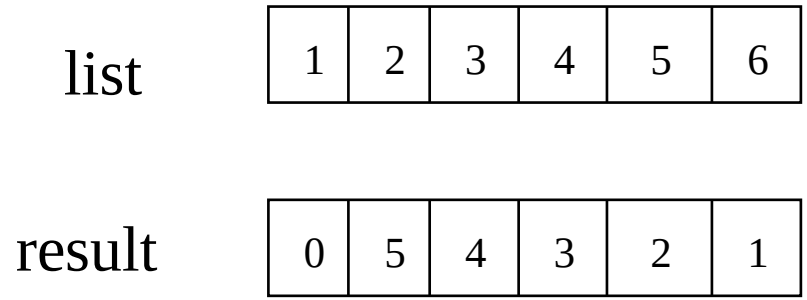
```
int[] list1 = {1, 2, 3, 4, 5, 6};
int[] list2 = reverse(list1);
```

```
public static int[] reverse(int[] list) {
  int[] result = new int[list.length];

  for (int i = 0, j = result.length - 1;
       i < list.length; i++, j--) {
    result[j] = list[i];
  }

  return result;
}
```

i (=5) is still less than 6



animation

Trace the reverse Method, cont.

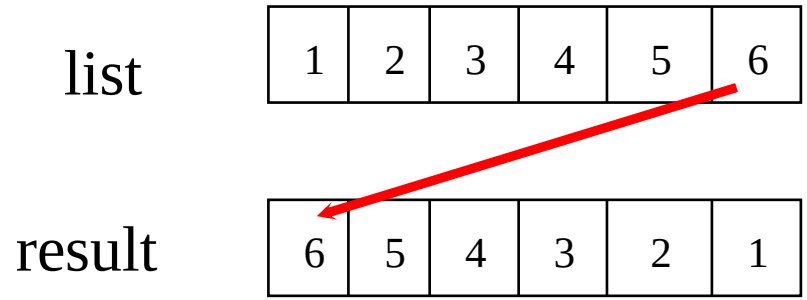
```
int[] list1 = {1, 2, 3, 4, 5, 6};
int[] list2 = reverse(list1);
```

```
public static int[] reverse(int[] list) {
  int[] result = new int[list.length];

  for (int i = 0, j = result.length - 1;
       i < list.length; i++, j--) {
    result[j] = list[i];
  }

  return result;
}
```

i = 5 and j = 0
Assign list[i] to result[j]



animation

Trace the reverse Method, cont.

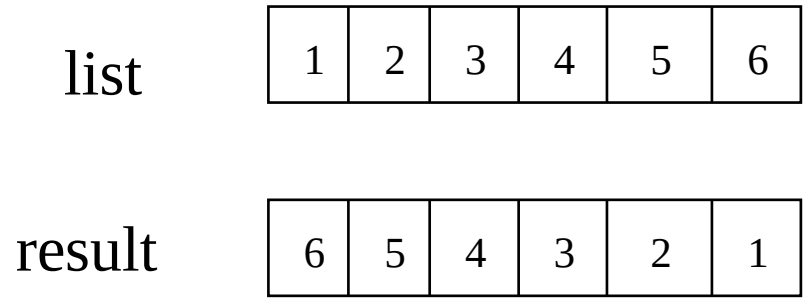
```
int[] list1 = {1, 2, 3, 4, 5, 6};
int[] list2 = reverse(list1);
```

```
public static int[] reverse(int[] list) {
  int[] result = new int[list.length];

  for (int i = 0, j = result.length - 1;
       i < list.length; i++, j--) {
    result[j] = list[i];
  }

  return result;
}
```

After this, i becomes 6 and j becomes -1



animation

Trace the reverse Method, cont.

```
int[] list1 = {1, 2, 3, 4, 5, 6};
int[] list2 = reverse(list1);
```

```
public static int[] reverse(int[] list) {
  int[] result = new int[list.length];

  for (int i = 0, j = result.length - 1;
       i < list.length; i++, j--) {
    result[j] = list[i];
  }

  return result;
}
```

i (=6) < 6 is false. So exit the loop.

list	1	2	3	4	5	6

result	6	5	4	3	2	1

animation

Trace the reverse Method, cont.

```
int[] list1 = {1, 2, 3, 4, 5, 6};
int[] list2 = reverse(list1);
```

```
public static int[] reverse(int[] list) {
  int[] result = new int[list.length];

  for (int i = 0, j = result.length - 1;
       i < list.length; i++, j--) {
    result[j] = list[i];
  }

  return result;
}
```

Return result