Chapter 7:
Single-Dimensional Array

7.1. Introduction

👉What is an Array?

✨**Array** is a collection of elements of the same type stored in continue memory locations.

✨Array can store primitive data types and objects.

👉Why use Array?

✨Store many values in one place.

✨Useful for organizing data.

✨Efficient for searching, sorting, and manipulating data.

✨Widely used for data analysis, graphics, and game development.

👉How Array work?

✨Store in continuous memory locations.

✨Each element is accessed using an index.

✨The first element is at index `0`, the second at index `1`, and so on.

✨The last element is at index `length - 1`.

👉Types of Arrays

✨**Single-Dimensional Array**: A linear list of elements, accessed using a single index.

✨**Sparse Array**: Array with a large number of empty or default values, often used to save memory in cases where most elements are not needed.

✨**Static Array**: Fixed-size Array that cannot change size after creation, such as standard Array in Java.

- ✨ **Multi-Dimensional Array**: Array with more than one dimension, such as 2D Array (matrices) or 3D Array (cubes).
- ✨ **Dynamic Array**: Array that can grow or shrink in size during runtime, typically implemented using data structures like `ArrayList` in Java.
- ✨ **Object Array**: Array that store objects of a specific class or type, allowing for more complex data structures.
- ✨ **Associative Array**: Array that use keys instead of indices to access elements, often implemented as hash tables or dictionaries.
- ✨ **Jagged Array**: Array of Array, where each sub-array can have a different length.

7.2. Array Basics

👉Declaring Array Variables

✨An array variable must be declared to reference the array and specify the element type.

Syntax: Single-Dimensional Array Declaration

```
elementType[] arrayRefVar;
// or
elementType arrayRefVar[];
```

Explanation:

✨ The `elementType` specifies the type of elements in the array (e.g., `int`, `double`, `String`).

✨ The `arrayRefVar` is the name of the array reference variable.

✨ The brackets `[]` indicate that the variable is an array.

👉Assigning Array Variables

✨Declaring an array variable alone does not allocate memory for the array elements.

✨To allocate memory, you must use the `new` operator to create the array.

Syntax: Creating an Array

```
arrayRefVar = new elementType[Arrayize];
// or combine declaration and creation:
elementType[] arrayRefVar = new elementType[Arrayize];
```

Note: If you don't use `new`, the array reference variable will be `null`.

Example: Creating a Double Array

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

Explanation:

✨ This creates an array named `myList` that can hold 10 `double` values.

✨ The size of the array is specified in square brackets `[]` after the type.

✨ The array is created in memory, and the reference variable `myList` points to it.

✨ The array is initialized with default values (`0.0` for `double`).

👉Array Size and Default Values

✨The size of an array is fixed once it is created and accessed using `arrayRefVar.length`.

✨**Default values**:

- ✨ `0` for numeric types
- ✨ `\u0000` for `char`
- ✨ `false` for `boolean`
- ✨ `null` for object references

👉Accessing Array Elements

✨You can access and modify elements in an array using the index.

✨The index starts at `0` and goes up to `arrayRefVar.length - 1`.

Example: Modify an array element

```
myList[0] = 5.6;
```

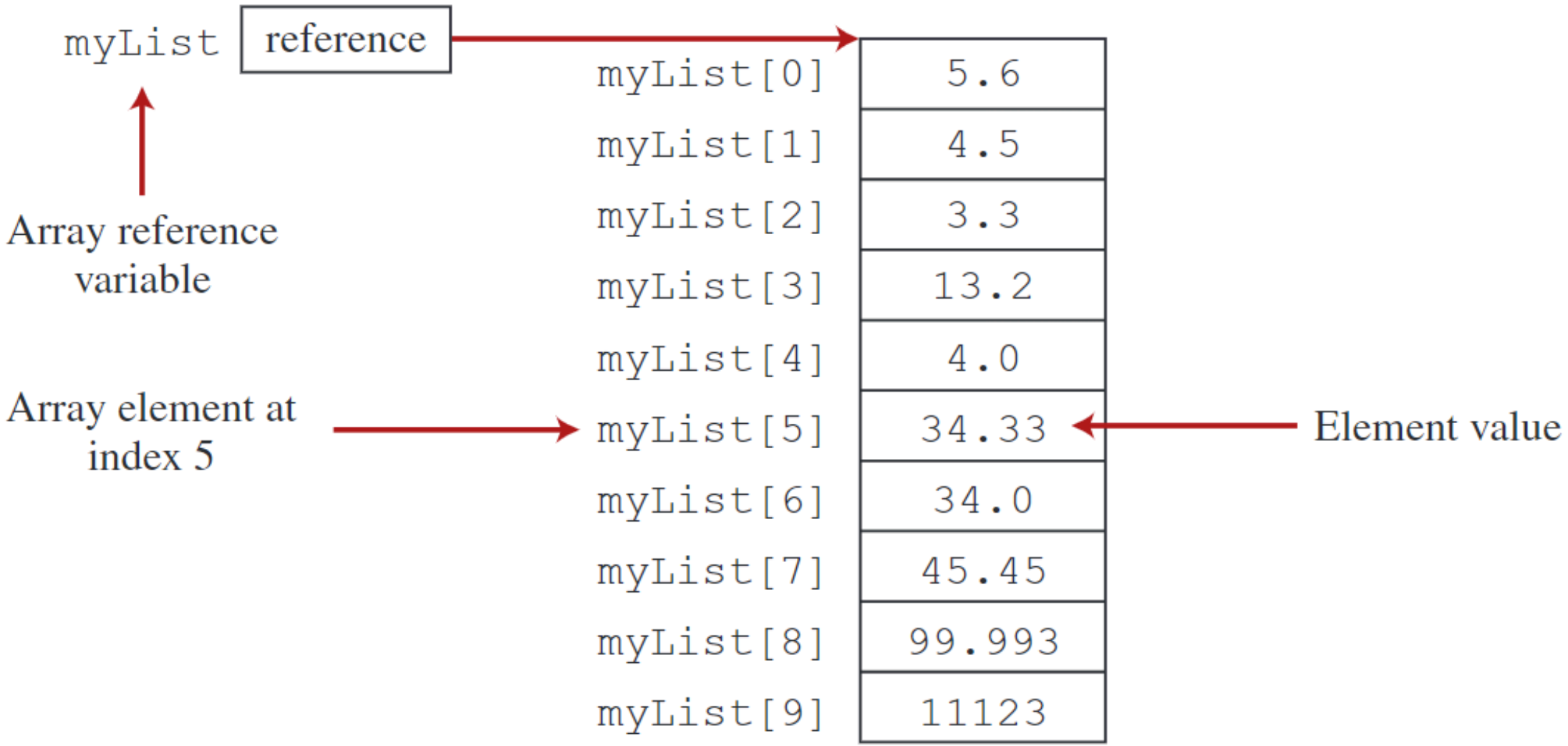
👉Array Initializers

✨Shorthand notation for declaring, creating, and initializing Array in one statement:

```
elementType[] arrayRefVar = {value_0, value_1, ..., value_k};
```

Example:

```
double[] myList = {
    5.6, 4.5, 3.3, 13.2, 4.0, 34.33,
    34.0, 45.45, 99.993, 11123
};
```


myList
reference
Array reference variable
Array element at index 5
myList[0]
5.6
myList[1]
4.5
myList[2]
3.3
myList[3]
13.2
myList[4]
4.0
myList[5]
34.33
myList[6]
34.0
myList[7]
45.45
myList[8]
99.993
myList[9]
11123
Element value

👉Using Array

Example: Filling an Array with Random Values

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

Explanation: Fills `myList` with random values (0 to 100) using `Math.random()`, which generates a random double between 0.0 and 1.0, scaled by 100.

Example: Printing Array Elements

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

Output:

```
5.6 4.5 3.3 13.2 4.0 34.33 34.0 45.45 99.993 11123
```

Explanation: Prints each element of `myList` on the same line, separated by spaces.

Example: Calculating the Sum of Array Elements

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

Explanation: Sums all elements in `myList` and stores the result in `total`.

Example: Finding the Maximum Value in an Array

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

Explanation:

✨ Finds the maximum value in `myList` by comparing each element with the current maximum.

✨ Initializes `max` with the first element and updates it if a larger element is found.

👉Foreach Loops

✨The `foreach` loop is also known as the enhanced for loop in Java, which simplifies the syntax for iterating through Array and collections.

Syntax:

```
for (elementType element : arrayRefVar) {
    // Code to process each element
}
```

Note: This simplifies the code and reduces the risk of index-related errors, making it a more readable and concise way to iterate through Array and collections.

Example: Using Foreach Loop

```
for (double e : myList) {
    System.out.println(e);
}
```

Explanation:

✨ The `foreach` loop iterates through each element `e` in `myList`, printing each element without needing an index variable.

👉Common Errors with Array

✨**Off-by-One Error**: This occurs when indices are incorrectly calculated, so always ensure they range from `0` to `arrayRefVar.length - 1`.

✨**ArrayIndexOutOfBoundsException**: This happens when trying to access an index outside the array's bounds; always validate index values before accessing elements.

✨**NullPointerException**: Ensure the array reference is properly initialized before attempting to access or modify its elements.

✨ **Type Mismatch**: Verify that the array's declared type matches the type of values being assigned to its elements.

✨ **Uninitialized Elements**: Be cautious of default values in uninitialized array elements (e.g., `0` for `int`, `null` for objects).

✨ **Incorrect Array Size**: Always allocate an array size that fits the intended data to avoid insufficient or excessive memory usage.

7.3. Case Study: Analyzing Numbers

Practice.

7.4. Case Study: Deck of Cards

Practice.

7.5. Copying Array

👉Assignment vs. Copying

✨Using the assignment statement (`=`) does not copy array contents.

✨It only copies the reference, causing both variables to refer to the same array.

Example: Assignment Statement

```
list2 = list1;
```

Explanation:

✨Both `list1` and `list2` will reference the same array after this statement.

👉Methods to Copy Array

Using a Loop

✨You can copy an array manually using a loop.

Example: Copying an Array Using a Loop

```
int[] sourceArray = {2, 3, 1, 5, 10};
int[] targetArray = new int[sourceArray.length];
for (int i = 0; i < sourceArray.length; i++) {
    targetArray[i] = sourceArray[i];
}
```

Using `System.arraycopy()`

✨You can use the `System.arraycopy()` method to copy an array efficiently.

Syntax:

```
System.arraycopy(sourceArray, srcPos, targetArray, tarPos, length);
```

Example: Copying an Array Using `System.arraycopy()`

```
int[] sourceArray = {2, 3, 1, 5, 10};
int[] targetArray = new int[sourceArray.length];
System.arraycopy(sourceArray, 0, targetArray, 0, sourceArray.length);
```

Note: `System.arraycopy()` is more efficient than a manual loop for copying large arrays.

Using `clone()`:

✨You can use the `clone()` method to create a shallow copy of an array.

Note: It is important to understand that `clone()` creates a shallow copy of the array, meaning that if the array contains objects, only the references to those objects are copied, not the objects themselves.

Example: Cloning an Array

```
int[] sourceArray = {2, 3, 1, 5, 10};
int[] clonedArray = sourceArray.clone();
```

Explanation:

- ✨ The `clonedArray` is a new array that contains the same elements as `sourceArray`.
- ✨ Changes made to the elements of `clonedArray` will not affect `sourceArray`, and vice versa.
- ✨ However, if the array contains objects, modifications to the objects will be reflected in both arrays since the references are shared.

Note: Use `clone()` method cautiously when working with arrays of objects to avoid unintended side effects.

👉Important Notes

✨**Shallow Copy**: Methods like `clone()` create a shallow copy, meaning they copy the elements but not any objects that the elements might reference.

✨**Garbage Collection**: When an array reference is reassigned, the original array may become unreferenced and eligible for garbage collection.

7.6. Passing Array to Methods

👉Passing an Array to a Method

✨When passing an array to a method, the reference of the array is passed, not the actual array.

✨This allows the method to modify the original array.

Key Points:

✨Array can be passed as arguments to methods, similar to primitive type values.

✨Passing an array means passing its reference, enabling the method to:

- ✨Access the array elements.
- ✨Modify the array elements directly.

Example: Method to Print Array Elements:

```
public static void printArray(int[] array) {
    for (int i = 0; i < array.length; i++) {
        System.out.print(array[i] + " ");
    }
}
```

Output:

```
3 1 2 6 4 2
```

Example: Calling the `printArray` Method

✨ Pass an array as an argument to call this method.

```
int[] numbers = {3, 1, 2, 6, 4, 2};
printArray(numbers);
```

✨ You can also pass an anonymous array directly.

```
printArray(new int[]{3, 1, 2, 6, 4, 2});
```

👉Passing-by-Value and Passing-by-Sharing

Passing-by-Value

✨In Java, primitive types are passed by value.

✨This means that a copy of the value is passed to the method, and changes made to the parameter do not affect the original variable.

Passing-by-Sharing

- ✨ In Java, all arguments are passed by value.
- ✨ But, when passing an array, the reference to the array is passed by value.
- ✨ This means that the method receives a copy of the reference, allowing it to modify the original array but not the reference itself.

Example: Demonstrating Pass-by-Sharing

```
public class TestArrayArguments {
    public static void main(String[] args) {
        int x = 1;
        int[] y = new int[10];
        m(x, y);
        System.out.println("x is " + x);
        System.out.println("y[0] is " + y[0]);
    }

    public static void m(int number, int[] numbers) {
        number = 1001;
        numbers[0] = 5555;
    }
}
```

.

Output:

```
x is 1
y[0] is 5555
```

Explanation:

- ✨ After calling `m(x, y)`, `x` stays 1 because it is passed by value, while `y[0]` changes to 5555 since the array reference is passed.
- ✨ The method `m` can modify the array `y` directly, but changes to `number` do not affect `x` in the `main` method.
- ✨ Array are passed by reference, allowing modifications to the original array, while primitive types are passed by value.

👉Array in Memory

- ✨In Java, primitive types are stored in **Stack memory**.
  - ✨**Stack memory** is a static memory area used for local variables and method calls.
- ✨But, Array is stored in **Heap memory**.
  - ✨**Heap memory** is a dynamic memory area used for objects and arrays.
- ✨When an array is passed to a method, the reference to the array is passed, allowing the method to modify the original array.


alt text

Example: Swapping Elements in an Array

```
public class SwapArrayElements {
    public static void main(String[] args) {
        int[] array = {1, 2, 3, 4};
        swap(array[0], array[1]); // This won't swap the elements
        swapFirstTwoInArray(array); // This will swap the elements
    }
    public static void swap(int x, int y) {
        int temp = x;
        x = y;
        y = temp;
    }
    public static void swapFirstTwoInArray(int[] array) {
        int temp = array[0];
        array[0] = array[1];
        array[1] = temp;
    }
}
```

Explanation:

- ✨ The first method `swap` attempts to swap the values of `x` and `y`, but it only swaps the local copies, not the original array elements.
- ✨ The second method `swapFirstTwoInArray` modifies the original array directly, swapping the first two elements.
- ✨ The output of the program will show that the first method does not change the array, while the second method successfully swaps the first two elements.

7.7. Returning an Array from a Method

👉Method Declaration

✨In Java, a method can return arrays.

✨The method should return the array's reference.

Syntax:

```
public static elementType[] methodName(argumentType) {
    // Method body
}
```

Note: The return type is specified as `elementType[]`, indicating that the method returns an array of the specified type.

👉Using the `reverse` Array

Example: Reverse an 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;
}
```

Explanation:

✨ The method `reverse` creates a new array `result` to store the reversed elements.

✨ A loop copies elements from the input array `list` to the `result` array in reverse order.

✨ The method returns the `result` array.

Example: To use the `reverse` method:

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

Explanation:

✨ The `list1` array contains the original elements.

✨ The `list2` array will contain the elements of `list1` in reverse order.

Notes:

- ✨ When a method returns an array, it returns a reference to the array. The caller can use this reference to access and modify the array elements.
- ✨ Returning a reference is efficient because it avoids copying the entire array.

7.8. Case Study: Counting the Occurrences of Each Letter

Practice.

7.9. Variable-Length Argument Lists

👉Syntax for Variable-Length Parameters

✨Java allows methods to accept a variable number of arguments of the same type, which can be treated as an array.

✨In the method declaration, use the ellipsis (`...`) to specify a variable-length parameter.

Syntax:

```
typeName... parameterName
```

Example:

```
public static void methodName(typeName... parameterName) {
    // Method body
}
```

👉Rules for Variable-Length Parameters

✨Only one variable-length parameter can be specified in a method.

✨The variable-length parameter must be the last parameter in the method.

✨Any regular parameters must precede it.

👉Passing Arguments

✨Java treats the variable-length parameter as an array.

✨You can pass an array or a variable number of arguments to the variable-length parameter.

Example: Print Maximum Value from Variable-Length Arguments

```
public class VarArgsDemo {
    public static void main(String[] args) {
        printMax(34, 3, 3, 2, 56.5);
        printMax(new double[]{1, 2, 3});
    }
    public static void printMax(double... numbers) {
        if (numbers.length == 0) {
            System.out.println("No argument passed");
            return;
        }
        double result = numbers[0];
        for (int i = 1; i < numbers.length; i++) {
            if (numbers[i] > result)
                result = numbers[i];
        }
        System.out.println("The max value is " + result);
    }
}
```

Explanation:

- ✨ The `printMax` method accepts a variable number of `double` arguments.
- ✨ It finds the maximum value among the passed arguments.
- ✨ The method can be called with a variable number of arguments or an array of `double` values.
- ✨ If no arguments are passed, it prints a message indicating that no argument was provided.
- ✨ The method uses a loop to iterate through the `numbers` array and find the maximum value.

Note: When invoking a method with a variable number of arguments, Java creates an array and passes the arguments to it.

7.10. Searching Array

- ✨ **Searching** is the process of looking for a specific element within an array.
- ✨ There are various algorithms for searching, including linear search and binary search.
  - ✨ **Linear Search**: A simple search algorithm that checks each element in the array sequentially.
  - ✨ **Binary Search**: A more efficient search algorithm that works on sorted arrays by dividing the search space in half.

👉Linear Search

✨**Linear Search** compares the key element sequentially with each element in the array.

- ✨If the key matches an element, the search ends, and the index of that element is returned.
- ✨If the key is not found, the search continues until all elements are checked.
- ✨If the key is not found, the method returns `-1`.

Example: Linear Search Implementation

```
public class LinearSearch {
    public static int linearSearch(int[] list, int key) {
        for (int i = 0; i < list.length; i++) {
            if (key == list[i]) {
                return i;
            }
        }
        return -1;
    }
}
```

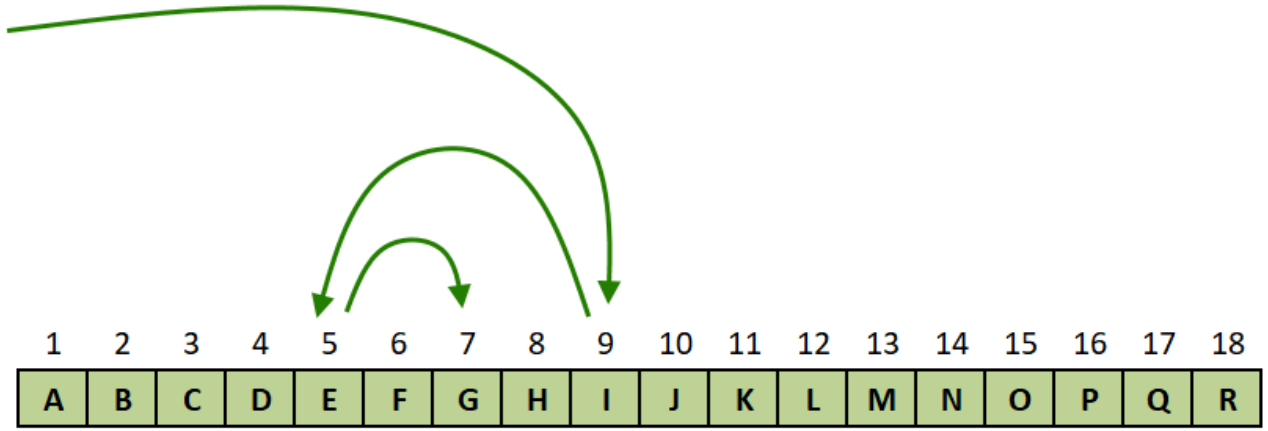
👉Binary Search

- ✨**Binary search** compares the key element with the middle element of a sorted array.
  - ✨If the key is less than the middle element, the search continues in the left half of the array.
  - ✨If the key is greater than the middle element, the search continues in the right half of the array.
  - ✨This process is repeated until the key is found or the search space is empty.

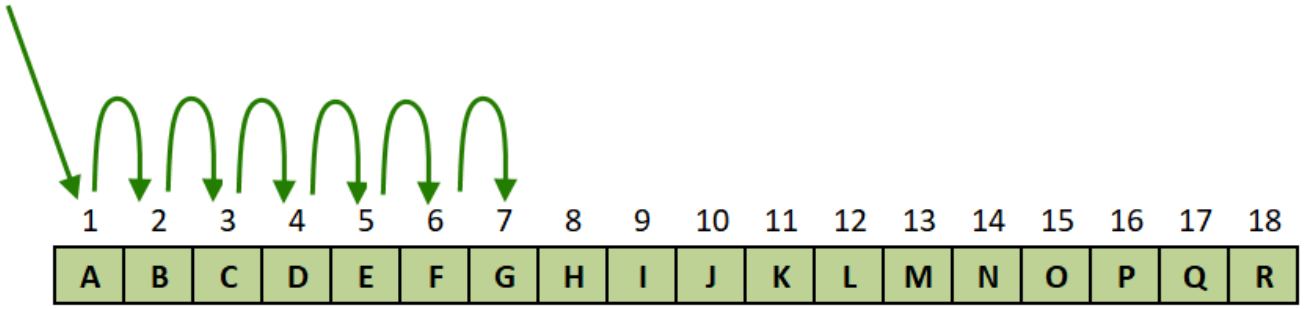
Example: Binary Search Implementation

```
public class BinarySearch {
    public static int binarySearch(int[] list, int key) {
        int low = 0;
        int high = list.length
        - 1;

        while (high >= low) {
            int mid = (low + high) / 2;
            if (key < list[mid]) {
                high = mid
                - 1;
            } else if (key == list[mid]) {
                return mid;
            } else {
                low = mid + 1;
            }
        }
        return -low
        - 1; // Key not found
    }
}
```



Binary Search - Find 'G' in sorted list A-R



Linear Search - Find 'G' in sorted list A-R

Comparison:

- ✨ **Linear Search**: Time complexity is $O(n)$, where n is the number of elements. It is suitable for small or unsorted Array.
- ✨ **Binary Search**: Time complexity is $O(\ln n)$, where n is the number of elements. It is efficient for large, sorted Array.

7.11. Sorting Array

- ✨ **Sorting** is a common task in computer programming, and many algorithms have been developed to accomplish it.
- ✨ Sorting algorithms can be classified into two main categories:
  - ✨ **Internal Sorting**: Sorting data that fits into memory.
  - ✨ **External Sorting**: Sorting data that does not fit into memory.

👉Sorting Algorithms

- ✨**Selection Sort Algorithm**
- ✨**Bubble Sort Algorithm**
- ✨**Insertion Sort Algorithm**
- ✨**Merge Sort Algorithm**
- ✨**Quick Sort Algorithm**
- ✨**Heap Sort Algorithm**
- ✨**Shell Sort Algorithm**
- ✨**Radix Sort Algorithm**
- ✨**Counting Sort Algorithm**
- ✨**Bucket Sort Algorithm**
- ✨etc.

👉Selection Sort Algorithm

✨**Selection Sort Algorithm** sorts an array by repeatedly finding the smallest element and swapping it with the element at the current position.

✨The process is repeated for each position in the array until the entire array is sorted.

👉Steps of Selection Sort

✨**Step 1**: Start with the first element as the minimum.

✨**Step 2**: Compare the minimum with the rest of the elements in the array.

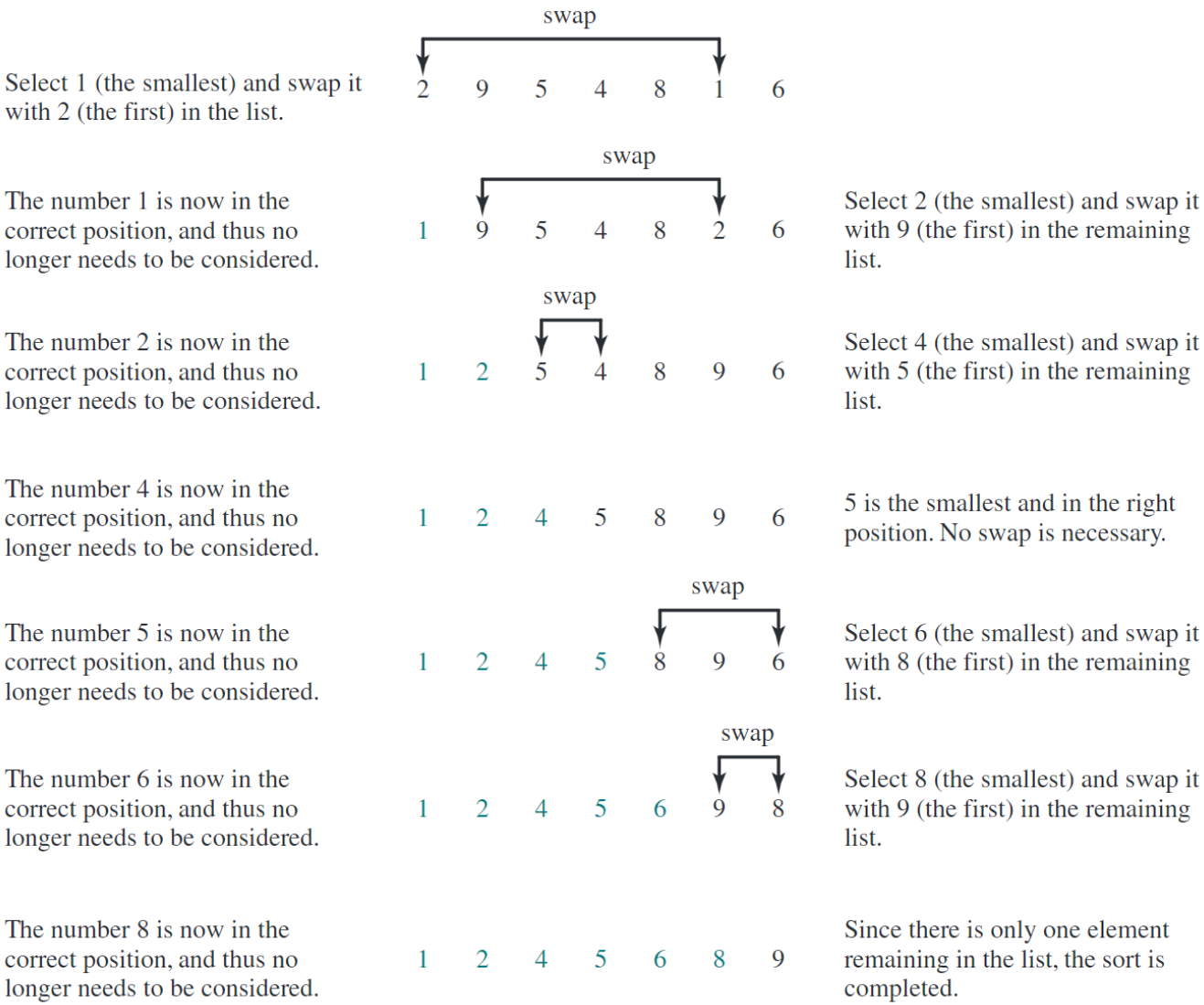
✨**Step 3**: If a smaller element is found, update the minimum.

✨**Step 4**: Swap the minimum with the first element.

✨**Step 5**: Move to the next element and repeat the process until the array is sorted.

✨**Step 6**: Continue until the entire array is sorted.

Example: Sorting a List `{2, 9, 5, 4, 8, 1, 6}` using Selection Sort Algorithm


swap
Select 1 (the smallest) and swap it with 2 (the first) in the list.
2 9 5 4 8 1 6
swap
The number 1 is now in the correct position, and thus no longer needs to be considered.
1 9 5 4 8 2 6
Select 2 (the smallest) and swap it with 9 (the first) in the remaining list.
swap
The number 2 is now in the correct position, and thus no longer needs to be considered.
1 2 5 4 8 9 6
Select 4 (the smallest) and swap it with 5 (the first) in the remaining list.
The number 4 is now in the correct position, and thus no longer needs to be considered.
1 2 4 5 8 9 6
5 is the smallest and in the right position. No swap is necessary.
swap
The number 5 is now in the correct position, and thus no longer needs to be considered.
1 2 4 5 8 9 6
Select 6 (the smallest) and swap it with 8 (the first) in the remaining list.
swap
The number 6 is now in the correct position, and thus no longer needs to be considered.
1 2 4 5 6 9 8
Select 8 (the smallest) and swap it with 9 (the first) in the remaining list.
The number 8 is now in the correct position, and thus no longer needs to be considered.
1 2 4 5 6 8 9
Since there is only one element remaining in the list, the sort is completed.

👉Implementing Selection Sort

- ✨The selection sort can be implemented in Java with a nested loop.
- ✨The outer loop iterates through the array, while the inner loop finds the minimum element in the unsorted portion of the array.
- ✨The minimum element is then swapped with the current element.

Example: Selection Sort Implementation

```
public class SelectionSort {
    /** The method for sorting the numbers */
    public static void selectionSort(double[] list) {
        for (int i = 0; i < list.length - 1; i++) {
            // Find the minimum in the list[i..list.length-1]
            double currentMin = list[i];
            int currentMinIndex = i;
            for (int j = i + 1; j < list.length; j++) {
                if (currentMin > list[j]) {
                    currentMin = list[j];
                    currentMinIndex = j;
                }
            }
            // Swap list[i] with list[currentMinIndex] if necessary
            if (currentMinIndex != i) {
                list[currentMinIndex] = list[i];
                list[i] = currentMin;
            }
        }
    }
}
```

Explanation:

✨ This method sorts an array of double elements using selection sort.

✨ The outer loop iterates through each element in the array.

✨ The inner loop finds the minimum element in the unsorted portion of the array.

✨ If a smaller element is found, it swaps it with the current element.

👉Tracing the Algorithm

✨To trace the algorithm, you can print the array at each step to see how it changes.

✨This helps visualize the sorting process and understand how selection sort works.

```
double[] list = {1, 9, 4.5, 6.6, 5.7, -4.5};

SelectionSort.selectionSort(list);
```

👉Modifying Selection Sort

✨To understand the selection sort better, you can modify it to sort in different ways:

- ✨To sort numbers in increasing order, keep the current implementation.
- ✨To sort numbers in decreasing order, modify the selectionSort method to find the maximum instead of the minimum in each iteration.

7.12. The Array Class

✨ **The `Array` class** is part of the `java.util` package and provides methods for sorting, searching, comparing, filling, and converting arrays to strings.

- ✨ **Sorting**:
  - ✨ **The `sort` method**: Sorts an entire array or a specified range within an array.
  - ✨ **The `parallelSort` method**: Optimized for multi-core processors to sort arrays in parallel.
- ✨ **Searching**:
  - ✨ **The `binarySearch` method**: Searches for a key in a sorted array and returns its index. If not found, returns `- (insertionPoint + 1)`.

- ✨ **Comparing**:
  - ✨ **The `equals` method**: Checks if two arrays are strictly equal (same length and elements).
- ✨ **Filling**:
  - ✨ **The `fill` method**: Fills an entire array or a specified range within an array with a given value.
- ✨ **Converting to Strings**:
  - ✨ **The `toString` method**: Returns a string representation of the array.

👉Sorting Array

✨**The `sort` Method**: Sorts an entire array or a specified range within an array.

```
double[] numbers = {6.0, 4.4, 1.9, 2.9, 3.4, 3.5};

java.util.Array.sort(numbers);
// Sorts the entire array

char[] chars = {'a', 'A', '4', 'F', 'D', 'P'};

java.util.Array.sort(chars, 1, 3);
// Sorts part of the array (chars[1] to chars[2])
```

✨ **Then `parallelSort` Method**: Similar to `sort` but optimized for multi-core processors.

```
java.util.Array.parallelSort(numbers);
// Sorts the entire array in parallel

java.util.Array.parallelSort(chars, 1, 3);
// Sorts part of the array in parallel
```

👉Searching Array

✨ `binarySearch` Method: Searches for a key in a sorted array and returns its index. If the key is not found, returns `-(insertionPoint + 1)`.

```
int[] list = {2, 4, 7, 10, 11, 45, 50, 59, 60, 66, 69, 70, 79};

int index = java.util.Array.binarySearch(list, 11);
// Returns 4

int notFoundIndex = java.util.Array.binarySearch(list, 12);
// Returns -6
```

👉Comparing Array

✨ `equals` Method: Checks if two Array are strictly equal (same length and elements).

```
int[] list1 = {2, 4, 7, 10};
int[] list2 = {2, 4, 7, 10};

boolean areEqual = java.util.Array.equals(list1, list2);
// Returns true
```

👉Filling Array

✨ `fill` Method: Fills an entire array or a specified range within an array with a given value.

```
int[] list = new int[10];

java.util.Array.fill(list, 5);
// Fills entire array with 5

java.util.Array.fill(list, 2, 5, 8);
// Fills list[2] to list[4] with 8
```

👉Converting Array to Strings

✨ `toString` Method: Returns a string representation of the array.

Example: Converting an Array to a String

```
int[] list = {2, 4, 7, 10};
String Arraytring = java.util.Array.toString(list);
```

Output:

```
[2, 4, 7, 10]
```

7.13. Command-Line Arguments

- ✨ Command-line arguments in Java allow passing information to a program during execution.
- ✨ These arguments are passed as a `String[]` to the `main` method, the program's entry point.
- ✨ They enable customization of program behavior or provide input data without altering the code.

Note: You can execute a Java program by using another programming language.

👉The `main` Method

✨The `main` method in Java can receive command-line arguments as an array of strings (`String[] args`).

Syntax:

```
public static void main(String[] args) {
    // Code to process args
}
```

👉Passing Arguments

✨Command-line arguments are passed when executing a program from the command line.

Example: Command to run a Java program with arguments

```
java TestMain arg0 arg1 arg2
```

✨The `arg0`, `arg1`, and `arg2` are the arguments passed to `TestMain`.

👉Tip for Using Command-Line Arguments

Example: Use Python code to run Java code with command-line arguments.

✨Java code `JavaMain.java`:

```
public class JavaMain {
    public static void main(String[] args) {
        System.out.println("Hello, " + args[0]);
    }
}
```

✨ Python code `PythonMain.py`:

```python
import subprocess

# Execute the Java program with command-line arguments
result = subprocess.run(
    ["java", "JavaMain.java", "arg0"],
    capture_output=True,
    text=True
)

# Print the output of the Java program
print(result.stdout)
```

Usage:

```
python PythonMain.py .
```

Output:

```
Hello, arg0 .
```

👉Handling Arguments in the `main` Method

✨You can access and process each argument using `args` array in the `main` method.

Example: Printing Command-Line Arguments.

```
public class TestMain {
    public static void main(String[] args) {
        for (int i = 0; i < args.length; i++) {
            System.out.println(args[i]);
        }
    }
}
```

👉Creating Array for Arguments

✨The Java interpreter creates an array to hold the command-line arguments and passes it to `args`.

✨If no arguments are passed, the array length is 0.

Example: Simple Calculator

✨Create a program to perform basic arithmetic operations using command-line arguments.

Example: Simple Calculator Program

```
public class Calculator {
    public static void main(String[] args) {
        if (args.length != 3) {
            System.out.println("java Calculator num1 operator num2");
            return;
        }
        int num1 = Integer.parseInt(args[0]);
        int num2 = Integer.parseInt(args[2]);
        char op = args[1].charAt(0);
        int result = switch (op) {
            case '+' -> num1 + num2;
            case '-' -> num1 - num2;
            case '*' -> num1 * num2;
            case '/' -> num1 / num2;
            default -> throw new IllegalArgumentException("Invalid");
        };
        System.out.println(num1 + " " + op + " " + num2 +
            " = " + result);
    }
}
```

Usage:

```
java Calculator 5 + 3
```

Output:

```
5 + 3 = 8
```

Explanation: The program accepts two numbers and an operator as command-line arguments, performs the specified operation, and outputs the result.
Notes: All command-line arguments are treated as strings, even if they represent numbers.

End of the Chapter