String(module 22)
Assignment

Q.1 In Java, a `String` is a sequence of characters. It's a fundamental data type that represents text.

Key Characteristics:

- **Immutable**: Once a `String` object is created, its value cannot be changed. Any operation that appears to modify a String actually creates a new String object [1] with the modified content.
- **Object:** In Java, `String` is an object, not a primitive data type like `int`, `double`, etc. This means it has methods associated with it that you can use to manipulate the string.
- **Character** Sequence: A String is composed of a sequence of characters, such as letters, numbers, symbols, and spaces

Creating Strings:

- **Literal:**

  String greeting = "Hello, world!";

  Using the `new` keyword:

  String name = new String("John Doe");

Q.2 In Java, there is primarily one type of String:

1. `java.lang.String`

- This is the built-in class for representing strings in Java.
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- It's immutable, meaning once a String object is created, its value cannot be changed.
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- It provides a rich set of methods for manipulating and working with strings (as discussed in the previous response).

Other String-Related Concepts:

- **StringBuilder:** This class is mutable. You can modify the contents of a `StringBuilder` object without creating a new object each time. It's more efficient for operations that involve frequent string modifications, such as appending or inserting characters.

- **StringBuffer:** Similar to `StringBuilder`, but it is thread-safe. This means it is designed to be used in multithreaded environments where multiple threads might try to modify the string simultaneously. However, it's generally less efficient than `StringBuilder` in single-threaded environments.
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While there are classes like `StringBuilder` and `StringBuffer` that offer more flexibility for string manipulation, `java.lang.String` is the fundamental and most commonly used type for representing strings in Java.

Q.3 You can create String objects in Java in several ways, but the two most common are:

1. String Literals

- This is the most common and direct way.
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- You enclose a sequence of characters within double quotes.
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- Java automatically creates a String object for you.
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- String literals are stored in the String Constant Pool (SCP), a special memory area in the heap. This optimizes memory usage by reusing String objects with the same value

```
String message = "Hello, World!";

String name = "Java";
```

2. Using the `new` keyword

- You explicitly create a new String object using the `new` keyword and one of the String class constructors.
- String objects created with `new` are stored on the regular heap memory, not the SCP.

```
String greeting = new String("Good morning!");

char[] charArray = {'J', 'a', 'v', 'a'};

String fromCharArray = new String(charArray); // Creates a String from a char array
```

Q.4 The String Constant Pool (SCP), also known as the String Pool or String Intern Pool, is a special area in the heap memory of the Java Virtual Machine (JVM) that stores String literals. It was designed to improve memory efficiency and performance by reusing String objects with the same value.

Purpose:

- Memory Optimization: The SCP stores only one copy of each unique String literal. If you create multiple String literals with the same value, they all refer to the same object in the pool, saving memory.
- Performance Improvement: String comparisons are faster when using literals because you can compare references (memory addresses) instead of comparing the actual character sequences.

How it Works:

1. String Literals: When you create a String using a literal (e.g., `String str = "hello";`), the JVM first checks if a String with the same value ("hello" in this case) already exists in the SCP.
2. Existing String: If a String with the same value exists, the JVM simply returns a reference to that existing String object in the pool. No new object is created.
3. New String: If a String with the same value does not exist, the JVM creates a new String object in the SCP and returns a reference to it.

Q.5 Mutability in object-oriented programming refers to the ability to change the internal state of an object after it has been created.

Immutable Objects

- Definition: An immutable object is an object whose internal state cannot be changed after it is created.
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- Characteristics:
    - Once created, the object's values remain constant.
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    - Any operation that appears to modify an immutable object actually creates a new object with the modified values.
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    - Immutable objects are inherently thread-safe because multiple threads can access them without the risk of data corruption.
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Example:

String originalString = "hello";

String uppercaseString = originalString.toUpperCase();

System.out.println(originalString); // Output: hello

System.out.println(uppercaseString); // Output: HELLO

Mutable Objects

- **Definition:** A mutable object is an object whose internal state can be changed after it is created.
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- **Characteristics:**
    - Methods can modify the object's properties or internal data.
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    - Require careful synchronization in multithreaded environments to prevent data corruption.
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Example:

- **StringBuilder in Java:**
    - You can use methods like `append()`, `insert()`, `delete()` to modify the contents of a StringBuilder object directly.

StringBuilder sb = new StringBuilder("hello");

sb.append(", world!");

System.out.println(sb.toString()); // Output: hello, world!

Q.6 The String Constant Pool (SCP) is located in the heap memory of the Java Virtual Machine (JVM). However, its specific location within the heap has changed over different Java versions:

- Before Java 7: The SCP was located in the PermGen (Permanent Generation) space of the heap. PermGen was a fixed-size portion of the heap used to store class metadata and other permanent data.
- Java 7 and later: The SCP was moved to the main heap area. This change was made for several reasons, including:

- Avoiding OutOfMemoryError: The PermGen space had a fixed size, which could lead to `OutOfMemoryError` if the SCP became too large. Moving it to the main heap, which is dynamically resizable, helped to address this issue.
- Improved Garbage Collection: Garbage collection is more efficient in the main heap compared to PermGen.