What is String in Java?

Generally, String is a sequence of characters. But in Java, string is an object that represents a sequence of characters. The java.lang.String class is used to create a string object.

How to create a string object?

There are two ways to create String object:

1. By string literal
2. By new keyword

1) String Literal

Java String literal is created by using double quotes. For Example:

1. String s="welcome";

Each time you create a string literal, the JVM checks the "string constant pool" first. If the string already exists in the pool, a reference to the pooled instance is returned. If the string doesn't exist in the pool, a new string instance is created and placed in the pool. For example:

1. String s1="Welcome";
2. String s2="Welcome";//It doesn't create a new instance



In the above example, only one object will be created. Firstly, JVM will not find any string object with the value "Welcome" in string constant pool that is why it will create a new object. After that it will find the string with the value "Welcome" in the pool, it will not create a new object but will return the reference to the same instance.

Note: String objects are stored in a special memory area known as the "string constant pool".

Why Java uses the concept of String literal?

To make Java more memory efficient (because no new objects are created if it exists already in the string constant pool).

2) By new keyword

1. String s=**new** String("Welcome");//creates two objects and one reference variable

In such case, [JVM](https://www.javatpoint.com/jvm-java-virtual-machine) will create a new string object in normal (non-pool) heap memory, and the literal "Welcome" will be placed in the string constant pool. The variable s will refer to the object in a heap (non-pool).

Immutable String in Java

A String is an unavoidable type of variable while writing any application program. String references are used to store various attributes like username, password, etc. In Java, **String objects are immutable**. Immutable simply means unmodifiable or unchangeable.

Once String object is created its data or state can't be changed but a new String object is created.

Let's try to understand the concept of immutability by the example given below:

**Testimmutablestring.java**

1. **class** Testimmutablestring{
2. **public** **static** **void** main(String args[]){
3. String s="Sachin";
4. s.concat(" Tendulkar");//concat() method appends the string at the end
5. System.out.println(s);//will print Sachin because strings are immutable objects
6. }
7. }

[**Test it Now**](https://www.javatpoint.com/opr/test.jsp?filename=Testimmutablestring)

**Output:**

Sachin

Now it can be understood by the diagram given below. Here Sachin is not changed but a new object is created with Sachin Tendulkar. That is why String is known as immutable.



As you can see in the above figure that two objects are created but ***s*** reference variable still refers to "Sachin" not to "Sachin Tendulkar".

But if we explicitly assign it to the reference variable, it will refer to "Sachin Tendulkar" object.

For example:

**Testimmutablestring1.java**

1. **class** Testimmutablestring1{
2. **public** **static** **void** main(String args[]){
3. String s="Sachin";
4. s=s.concat(" Tendulkar");
5. System.out.println(s);
6. }
7. }

[**Test it Now**](https://www.javatpoint.com/opr/test.jsp?filename=Testimmutablestring1)

**Output:**

Sachin Tendulkar

In such a case, s points to the "Sachin Tendulkar". Please notice that still Sachin object is not modified.

Why String objects are immutable in Java?

As Java uses the concept of String literal. Suppose there are 5 reference variables, all refer to one object "Sachin". If one reference variable changes the value of the object, it will be affected by all the reference variables. That is why String objects are immutable in Java.

Following are some features of String which makes String objects immutable.

**1. ClassLoader:**

A ClassLoader in Java uses a String object as an argument. Consider, if the String object is modifiable, the value might be changed and the class that is supposed to be loaded might be different.

To avoid this kind of misinterpretation, String is immutable.

AD

**2. Thread Safe:**

As the String object is immutable we don't have to take care of the synchronization that is required while sharing an object across multiple threads.

**3. Security:**

As we have seen in class loading, immutable String objects avoid further errors by loading the correct class. This leads to making the application program more secure. Consider an example of banking software. The username and password cannot be modified by any intruder because String objects are immutable. This can make the application program more secure.

**4. Heap Space:**

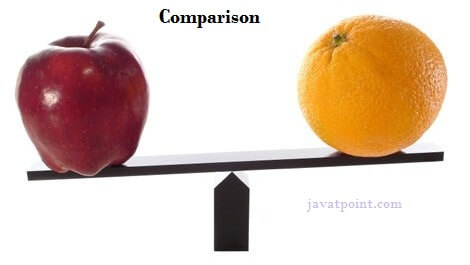
AD

The immutability of String helps to minimize the usage in the heap memory. When we try to declare a new String object, the JVM checks whether the value already exists in the String pool or not. If it exists, the same value is assigned to the new object. This feature allows Java to use the heap space efficiently.

Why String class is Final in Java?

The reason behind the String class being final is because no one can override the methods of the String class. So that it can provide the same features to the new String objects as well as to the old ones.

Java String compare



We can compare String in Java on the basis of content and reference.

It is used in **authentication** (by equals() method), **sorting** (by compareTo() method), **reference matching** (by == operator) etc.

There are three ways to compare String in Java:

1. By Using equals() Method
2. By Using == Operator
3. By compareTo() Method

1) By Using equals() Method

The String class equals() method compares the original content of the string. It compares values of string for equality. String class provides the following two methods:

* **public boolean equals(Object another)** compares this string to the specified object.
* **public boolean equalsIgnoreCase(String another)** compares this string to another string, ignoring case.

**Teststringcomparison1.java**

1. **class** Teststringcomparison1{
2. **public** **static** **void** main(String args[]){
3. String s1="Sachin";
4. String s2="Sachin";
5. String s3=**new** String("Sachin");
6. String s4="Saurav";
7. System.out.println(s1.equals(s2));//true
8. System.out.println(s1.equals(s3));//true
9. System.out.println(s1.equals(s4));//false
10. }
11. }

[**Test it Now**](https://www.javatpoint.com/opr/test.jsp?filename=Teststringcomparison1)

**Output:**

true

true

false

In the above code, two strings are compared using **equals()** method of **String** class. And the result is printed as boolean values, **true** or **false**.

**Teststringcomparison2.java**

1. **class** Teststringcomparison2{
2. **public** **static** **void** main(String args[]){
3. String s1="Sachin";
4. String s2="SACHIN";
6. System.out.println(s1.equals(s2));//false
7. System.out.println(s1.equalsIgnoreCase(s2));//true
8. }
9. }

[**Test it Now**](https://www.javatpoint.com/opr/test.jsp?filename=Teststringcomparison2)

**Output:**

false

true

In the above program, the methods of **String** class are used. The **equals()** method returns true if String objects are matching and both strings are of same case. **equalsIgnoreCase()** returns true regardless of cases of strings.

[Click here for more about equals() method](https://www.javatpoint.com/java-string-equals)

2) By Using == operator

The == operator compares references not values.

**Teststringcomparison3.java**

1. **class** Teststringcomparison3{
2. **public** **static** **void** main(String args[]){
3. String s1="Sachin";
4. String s2="Sachin";
5. String s3=**new** String("Sachin");
6. System.out.println(s1==s2);//true (because both refer to same instance)
7. System.out.println(s1==s3);//false(because s3 refers to instance created in nonpool)
8. }
9. }

[**Test it Now**](https://www.javatpoint.com/opr/test.jsp?filename=Teststringcomparison3)

**Output:**

true

false

3) String compare by compareTo() method

The above code, demonstrates the use of **==** operator used for comparing two ***String*** objects.

AD

3) By Using compareTo() method

The String class compareTo() method compares values lexicographically and returns an integer value that describes if first string is less than, equal to or greater than second string.

Suppose s1 and s2 are two String objects. If:

* **s1 == s2** : The method returns 0.
* **s1 > s2** : The method returns a positive value.
* **s1 < s2** : The method returns a negative value.

AD

**Teststringcomparison4.java**

AD

1. **class** Teststringcomparison4{
2. **public** **static** **void** main(String args[]){
3. String s1="Sachin";
4. String s2="Sachin";
5. String s3="Ratan";
6. System.out.println(s1.compareTo(s2));//0
7. System.out.println(s1.compareTo(s3));//1(because s1>s3)
8. System.out.println(s3.compareTo(s1));//-1(because s3 < s1 )
9. }
10. }

[**Test it Now**](https://www.javatpoint.com/opr/test.jsp?filename=Teststringcomparison4)

**Output:**

0

1

-1

String Concatenation in Java

In Java, String concatenation forms a new String that is the combination of multiple strings. There are two ways to concatenate strings in Java:

1. By + (String concatenation) operator
2. By concat() method

1) String Concatenation by + (String concatenation) operator

Java String concatenation operator (+) is used to add strings. For Example:

**TestStringConcatenation1.java**

1. **class** TestStringConcatenation1{
2. **public** **static** **void** main(String args[]){
3. String s="Sachin"+" Tendulkar";
4. System.out.println(s);//Sachin Tendulkar
5. }
6. }

[**Test it Now**](https://www.javatpoint.com/opr/test.jsp?filename=TestStringConcatenation1)

**Output:**

Sachin Tendulkar

The **Java compiler transforms** above code to this:

1. String s=(**new** StringBuilder()).append("Sachin").append(" Tendulkar).toString();

In Java, String concatenation is implemented through the StringBuilder (or StringBuffer) class and it's append method. String concatenation operator produces a new String by appending the second operand onto the end of the first operand. The String concatenation operator can concatenate not only String but primitive values also. For Example:

**TestStringConcatenation2.java**

1. **class** TestStringConcatenation2{
2. **public** **static** **void** main(String args[]){
3. String s=50+30+"Sachin"+40+40;
4. System.out.println(s);//80Sachin4040
5. }
6. }

[**Test it Now**](https://www.javatpoint.com/opr/test.jsp?filename=TestStringConcatenation2)

**Output:**

80Sachin4040

Note: After a string literal, all the + will be treated as string concatenation operator.

2) String Concatenation by concat() method

The String concat() method concatenates the specified string to the end of current string. Syntax:

1. **public** String concat(String another)

Let's see the example of String concat() method.

**TestStringConcatenation3.java**

1. **class** TestStringConcatenation3{
2. **public** **static** **void** main(String args[]){
3. String s1="Sachin ";
4. String s2="Tendulkar";
5. String s3=s1.concat(s2);
6. System.out.println(s3);//Sachin Tendulkar
7. }
8. }

[**Test it Now**](https://www.javatpoint.com/opr/test.jsp?filename=TestStringConcatenation3)

**Output:**

Sachin Tendulkar

Substring in Java

A part of String is called **substring**. In other words, substring is a subset of another String. Java String class provides the built-in substring() method that extract a substring from the given string by using the index values passed as an argument. In case of substring() method startIndex is inclusive and endIndex is exclusive.

Suppose the string is "**computer**", then the substring will be com, compu, ter, etc.

Note: Index starts from 0.

You can get substring from the given String object by one of the two methods:

1. **public String substring(int startIndex):**  
   This method returns new String object containing the substring of the given string from specified startIndex (inclusive). The method throws an IndexOutOfBoundException when the startIndex is larger than the length of String or less than zero.
2. **public String substring(int startIndex, int endIndex):**  
   This method returns new String object containing the substring of the given string from specified startIndex to endIndex. The method throws an IndexOutOfBoundException when the startIndex is less than zero or startIndex is greater than endIndex or endIndex is greater than length of String.

In case of String:

* **startIndex:** inclusive
* **endIndex:** exclusive

Let's understand the startIndex and endIndex by the code given below.

1. String s="hello";
2. System.out.println(s.substring(0,2)); //returns he  as a substring

In the above substring, 0 points the first letter and 2 points the second letter i.e., e (because end index is exclusive).

Example of Java substring() method

**TestSubstring.java**

1. **public** **class** TestSubstring{
2. **public** **static** **void** main(String args[]){
3. String s="SachinTendulkar";
4. System.out.println("Original String: " + s);
5. System.out.println("Substring starting from index 6: " +s.substring(6));//Tendulkar
6. System.out.println("Substring starting from index 0 to 6: "+s.substring(0,6)); //Sachin
7. }
8. }

**Output:**

Original String: SachinTendulkar

Substring starting from index 6: Tendulkar

Substring starting from index 0 to 6: Sachin

The above [Java programs](https://www.javatpoint.com/java-programs), demonstrates variants of the ***substring()*** method of ***String*** class. The startindex is inclusive and endindex is exclusive.

Java StringBuffer Class

Java StringBuffer class is used to create mutable (modifiable) String objects. The StringBuffer class in Java is the same as String class except it is mutable i.e. it can be changed.

Note: Java StringBuffer class is thread-safe i.e. multiple threads cannot access it simultaneously. So it is safe and will result in an order.

Important Constructors of StringBuffer Class

|  |  |
| --- | --- |
| **Constructor** | **Description** |
| StringBuffer() | It creates an empty String buffer with the initial capacity of 16. |
| StringBuffer(String str) | It creates a String buffer with the specified string.. |
| StringBuffer(int capacity) | It creates an empty String buffer with the specified capacity as length. |

Important methods of StringBuffer class

|  |  |  |
| --- | --- | --- |
| **Modifier and Type** | **Method** | **Description** |
| public synchronized StringBuffer | append(String s) | It is used to append the specified string with this string. The append() method is overloaded like append(char), append(boolean), append(int), append(float), append(double) etc. |
| public synchronized StringBuffer | insert(int offset, String s) | It is used to insert the specified string with this string at the specified position. The insert() method is overloaded like insert(int, char), insert(int, boolean), insert(int, int), insert(int, float), insert(int, double) etc. |
| public synchronized StringBuffer | replace(int startIndex, int endIndex, String str) | It is used to replace the string from specified startIndex and endIndex. |
| public synchronized StringBuffer | delete(int startIndex, int endIndex) | It is used to delete the string from specified startIndex and endIndex. |
| public synchronized StringBuffer | reverse() | is used to reverse the string. |
| public int | capacity() | It is used to return the current capacity. |
| public void | ensureCapacity(int minimumCapacity) | It is used to ensure the capacity at least equal to the given minimum. |
| public char | charAt(int index) | It is used to return the character at the specified position. |
| public int | length() | It is used to return the length of the string i.e. total number of characters. |
| public String | substring(int beginIndex) | It is used to return the substring from the specified beginIndex. |
| public String | substring(int beginIndex, int endIndex) | It is used to return the substring from the specified beginIndex and endIndex. |

What is a mutable String?

A String that can be modified or changed is known as mutable String. StringBuffer and StringBuilder classes are used for creating mutable strings.

Java StringBuilder Class

Java StringBuilder class is used to create mutable (modifiable) String. The Java StringBuilder class is same as StringBuffer class except that it is non-synchronized. It is available since JDK 1.5.

Important Constructors of StringBuilder class

|  |  |
| --- | --- |
| **Constructor** | **Description** |
| StringBuilder() | It creates an empty String Builder with the initial capacity of 16. |
| StringBuilder(String str) | It creates a String Builder with the specified string. |
| StringBuilder(int length) | It creates an empty String Builder with the specified capacity as length. |

Important methods of StringBuilder class

|  |  |
| --- | --- |
| **Method** | **Description** |
| public StringBuilder append(String s) | It is used to append the specified string with this string. The append() method is overloaded like append(char), append(boolean), append(int), append(float), append(double) etc. |
| public StringBuilder insert(int offset, String s) | It is used to insert the specified string with this string at the specified position. The insert() method is overloaded like insert(int, char), insert(int, boolean), insert(int, int), insert(int, float), insert(int, double) etc. |
| public StringBuilder replace(int startIndex, int endIndex, String str) | It is used to replace the string from specified startIndex and endIndex. |
| public StringBuilder delete(int startIndex, int endIndex) | It is used to delete the string from specified startIndex and endIndex. |
| public StringBuilder reverse() | It is used to reverse the string. |
| public int capacity() | It is used to return the current capacity. |
| public void ensureCapacity(int minimumCapacity) | It is used to ensure the capacity at least equal to the given minimum. |
| public char charAt(int index) | It is used to return the character at the specified position. |
| public int length() | It is used to return the length of the string i.e. total number of characters. |
| public String substring(int beginIndex) | It is used to return the substring from the specified beginIndex. |
| public String substring(int beginIndex, int endIndex) | It is used to return the substring from the specified beginIndex and endIndex. |

Difference between String and StringBuffer

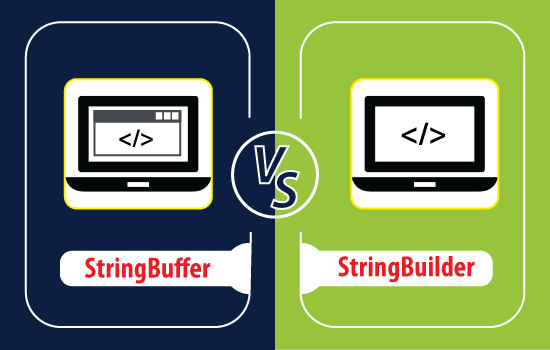
There are many differences between String and StringBuffer. A list of differences between String and StringBuffer are given below:

|  |  |  |
| --- | --- | --- |
| **No.** | **String** | **StringBuffer** |
| 1) | The String class is immutable. | The StringBuffer class is mutable. |
| 2) | String is slow and consumes more memory when we concatenate too many strings because every time it creates new instance. | StringBuffer is fast and consumes less memory when we concatenate t strings. |
| 3) | String class overrides the equals() method of Object class. So you can compare the contents of two strings by equals() method. | StringBuffer class doesn't override the equals() method of Object class. |
| 4) | String class is slower while performing concatenation operation. | StringBuffer class is faster while performing concatenation operation. |
| 5) | String class uses String constant pool. | StringBuffer uses Heap memory |

Difference between StringBuffer and StringBuilder

Java provides three classes to represent a sequence of characters: String, StringBuffer, and StringBuilder. The String class is an immutable class whereas StringBuffer and StringBuilder classes are mutable. There are many differences between StringBuffer and StringBuilder. The StringBuilder class is introduced since JDK 1.5.

A list of differences between StringBuffer and StringBuilder is given below:



|  |  |  |
| --- | --- | --- |
| **No.** | **StringBuffer** | **StringBuilder** |
| 1) | StringBuffer is *synchronized* i.e. thread safe. It means two threads can't call the methods of StringBuffer simultaneously. | StringBuilder is *non-synchronized* i.e. not thread safe. It means two threads can call the methods of StringBuilder simultaneously. |
| 2) | StringBuffer is *less efficient* than StringBuilder. | StringBuilder is *more efficient* than StringBuffer. |
| 3) | StringBuffer was introduced in Java 1.0 | StringBuilder was introduced in Java 1.5 |

How to create Immutable class?

There are many immutable classes like String, Boolean, Byte, Short, Integer, Long, Float, Double etc. In short, all the wrapper classes and String class is immutable. We can also create immutable class by creating final class that have final data members as the example given below:

Example to create Immutable class

In this example, we have created a final class named Employee. It have one final datamember, a parameterized constructor and getter method.

**ImmutableDemo.java**

1. **public** **final** **class** Employee
2. {
3. **final** String pancardNumber;
4. **public** Employee(String pancardNumber)
5. {
6. **this**.pancardNumber=pancardNumber;
7. }
8. **public** String getPancardNumber(){
9. **return** pancardNumber;
10. }
11. }
12. **public** **class** ImmutableDemo
13. {
14. **public** **static** **void** main(String ar[])
15. {
16. Employee e = **new** Employee("ABC123");
17. String s1 = e.getPancardNumber();
18. System.out.println("Pancard Number: " + s1);
19. }
20. }

**Output:**

Pancard Number: ABC123

The above class is immutable because:

* The instance variable of the class is final i.e. we cannot change the value of it after creating an object.
* The class is final so we cannot create the subclass.
* There is no setter methods i.e. we have no option to change the value of the instance variable.

These points makes this class as immutable.

Java toString() Method

If you want to represent any object as a string, **toString() method** comes into existence.

The toString() method returns the String representation of the object.

If you print any object, Java compiler internally invokes the toString() method on the object. So overriding the toString() method, returns the desired output, it can be the state of an object etc. depending on your implementation.

Advantage of Java toString() method

By overriding the toString() method of the Object class, we can return values of the object, so we don't need to write much code.

Understanding problem without toString() method

Let's see the simple code that prints reference.

**Student.java**

1. **class** Student{
2. **int** rollno;
3. String name;
4. String city;
6. Student(**int** rollno, String name, String city){
7. **this**.rollno=rollno;
8. **this**.name=name;
9. **this**.city=city;
10. }
12. **public** **static** **void** main(String args[]){
13. Student s1=**new** Student(101,"Raj","lucknow");
14. Student s2=**new** Student(102,"Vijay","ghaziabad");
16. System.out.println(s1);//compiler writes here s1.toString()
17. System.out.println(s2);//compiler writes here s2.toString()
18. }
19. }

**Output:**

Student@1fee6fc

Student@1eed786

As you can see in the above example, printing s1 and s2 prints the hashcode values of the objects but I want to print the values of these objects. Since Java compiler internally calls toString() method, overriding this method will return the specified values. Let's understand it with the example given below:

Example of Java toString() method

Let's see an example of toString() method.

**Student.java**

1. **class** Student{
2. **int** rollno;
3. String name;
4. String city;
6. Student(**int** rollno, String name, String city){
7. **this**.rollno=rollno;
8. **this**.name=name;
9. **this**.city=city;
10. }
12. **public** String toString(){//overriding the toString() method
13. **return** rollno+" "+name+" "+city;
14. }
15. **public** **static** **void** main(String args[]){
16. Student s1=**new** Student(101,"Raj","lucknow");
17. Student s2=**new** Student(102,"Vijay","ghaziabad");
19. System.out.println(s1);//compiler writes here s1.toString()
20. System.out.println(s2);//compiler writes here s2.toString()
21. }
22. }

**Output:**

101 Raj lucknow

102 Vijay ghaziabad

In the above program, Java compiler internally calls ***toString()*** method, overriding this method will return the specified values of ***s1*** and ***s2*** objects of Student class.