C# Strings

In C#, string is an object of **System.String** class that represent sequence of characters. We can perform many operations on strings such as concatenation, comparision, getting substring, search, trim, replacement etc.

1. String Declaration and Initialization

- **Declare a string without initialization:**

```
string str1;
```

- **Declare a string with initialization:**

```
string str2 = "THILLAI";
string str3 = "TAMIZHVANI";
```

- **Declare a string with an empty string:**

```
string str4 = string.Empty;
```

- **Declare a string with null:**

```
string str5 = null;
```

- **Declare a string from a character array:**

```
char[] char_arr = new char[] { 'T', 'A', 'M', 'I', 'Z', 'H' };
String str6 = new string(char_arr);
```

2. String vs string

- **In C#, the `string` keyword is just an alias for `String`. Both are equivalent, and you can use either to define string variables.**

```
string str1 = "Hello";
String str2 = "World";
```

3. String Immutable

- **Strings in C# are immutable, meaning once created, they cannot be modified.**

```
string msg = "welcome";
msg = "welcome to tutlane";
```

Explanation: The original "welcome" string is discarded, and a new string "welcome to tutlane" is created.

4. String Literals in Regular

- **Regular literals in C# are sequences of characters enclosed in double quotation marks (" ").**
- **Useful for embedding escape characters like \n, \t, ', ", etc.**

```
string names = "THILLAI\nTAMILZH\nTAMIZHILLAI";
Console.WriteLine(names);
// Output:
// THILLAI
// TAMILZH
// TAMIZHILLAI

string msg = "Hello \"WORLD\" ";
Console.WriteLine(msg);
// Output: Hello "WORLD"
```

5. String Literals in Verbatim

- **Verbatim literals are indicated by the special character @.**
- **Useful for representing multiline strings or strings with backslash characters.**

```
string imagepath = @"C:\Users\Thillai\TAMIL.jpg";
Console.WriteLine(imagepath);
// Output: C:\Users\Thillai\TAMIL.jpg

string msg = @"THIS,
IS STRING VERBATIM
FORMAT";
Console.WriteLine(msg);
// Output:
// THIS,
// IS STRING VERBATIM
// FORMAT

string msg2 = @"MY daughter name was ""TAMIZHILLAI"" ";
Console.WriteLine(msg2);
// Output: MY daughter name was "TAMIZHILLAI"
```

6. String Format

- **Format strings are strings whose contents are determined dynamically at runtime.**
- **Use the `Format` method to embed placeholders in braces, which will be replaced by values at runtime.**

```
string name = "Thillai Shanmugam";
string location = "Kumbakonam";
string user = string.Format("Name: {0}, Location: {1}", name, location);
Console.WriteLine(user);
// Output: Name: Thillai Shanmugam, Location: Kumbakonam
```

7. Access Individual Characters from Strings

- **Access individual characters in a string using the `[]` indexer.**

```
string name = "Thillai Shanmugam";
for (int i = 0; i < name.Length; i++)
{
    Console.Write(name[i]);
}
// Output: Thillai Shanmugam
```

8. String Properties

- **`Chars` - Gets the characters from the current string object based on the specified position.**

```
string name = "Thillai";
char firstChar = name[0];
Console.WriteLine(firstChar); // Output: T
```

- **Length - Returns the number of characters in the current string object.**

```
string name = "Shanmugam";
int length = name.Length;
Console.WriteLine(length); // Output: 9
```

C# String Methods Example

This example demonstrates various String methods in C#. Each method is used to manipulate or query the string, with the output clearly displayed to illustrate its functionality.

Code Example

```
using System;

namespace StringMethodsExample
{
    class Program
    {
        static void Main(string[] args)
        {
            string str1 = "Hello, World!";
            string str2 = "Hello, C#";
            string str3 = "    Learn C# Programming    ";

            // 1. Clone
            string clonedString = (string)str1.Clone();
            Console.WriteLine($"Cloned String: {clonedString}");

            // 2. Compare
            int compareResult = String.Compare(str1, str2);
            Console.WriteLine($"Compare Result (str1 vs str2): {compareResult}");

            // 3. CompareOrdinal
            int compareOrdinalResult = String.CompareOrdinal(str1, str2);
            Console.WriteLine($"CompareOrdinal Result (str1 vs str2): {compareOrdinalResult}");

            // 4. CompareTo
            int compareToResult = str1.CompareTo(str2);
            Console.WriteLine($"CompareTo Result (str1 vs str2): {compareToResult}");

            // 5. Concat
            string concatenatedString = String.Concat(str1, " ", str2);
            Console.WriteLine($"Concatenated String: {concatenatedString}");

            // 6. Contains
            bool containsResult = str1.Contains("World");
            Console.WriteLine($"Contains 'World': {containsResult}");

            // 7. Copy
            string copiedString = String.Copy(str1);
            Console.WriteLine($"Copied String: {copiedString}");

            // 8. CopyTo
```

```
char[] charArray = new char[5];
str1.CopyTo(7, charArray, 0, 5);
Console.WriteLine($"CopyTo Result: {new string(charArray)}");

// 9. EndsWith
bool endsWithResult = str1.EndsWith("World!");
Console.WriteLine($"EndsWith 'World!': {endsWithResult}");

// 10. Equals
bool equalsResult = String.Equals(str1, str2);
Console.WriteLine($"Equals (str1 vs str2): {equalsResult}");

// 11. Format
string formattedString = String.Format("Welcome to {0} Programming", "C#");
Console.WriteLine($"Formatted String: {formattedString}");

// 12. GetEnumerator
var enumerator = str1.GetEnumerator();
Console.Write("GetEnumerator Result: ");
while (enumerator.MoveNext())
{
    Console.Write(enumerator.Current + " ");
}
Console.WriteLine();

// 13. GetHashCode
int hashCode = str1.GetHashCode();
Console.WriteLine($"GetHashCode: {hashCode}");

// 14. GetType
Type type = str1.GetType();
Console.WriteLine($"GetType: {type}");

// 15. GetTypeCode
TypeCode typeCode = str1.GetTypeCode();
Console.WriteLine($"GetTypeCode: {typeCode}");

// 16. IndexOf
int indexOfResult = str1.IndexOf("World");
Console.WriteLine($"IndexOf 'World': {indexOfResult}");

// 17. Insert
string insertedString = str1.Insert(7, "Beautiful ");
Console.WriteLine($"Inserted String: {insertedString}");

// 18. Intern
string internedString = String.Intern(str2);
Console.WriteLine($"Interned String: {internedString}");

// 19. IsInterned
string isInternedResult = String.IsInterned(str2);
Console.WriteLine($"IsInterned Result: {isInternedResult}");

// 20. IsNormalized
bool isNormalizedResult = str1.IsNormalized();
Console.WriteLine($"IsNormalized: {isNormalizedResult}");

// 21. IsNullOrEmpty
bool isNullOrEmptyResult = String.IsNullOrEmpty(str1);
Console.WriteLine($"IsNullOrEmpty: {isNullOrEmptyResult}");
```

```
// 22. IsNullOrWhiteSpace
bool isNullOrWhiteSpaceResult = String.IsNullOrWhiteSpace(str3);
Console.WriteLine($"IsNullOrWhiteSpace: {isNullOrWhiteSpaceResult}");

// 23. Join
string[] words = { "Learn", "C#", "Programming" };
string joinedString = String.Join(" ", words);
Console.WriteLine($"Joined String: {joinedString}");

// 24. LastIndexOf
int lastIndexOfResult = str1.LastIndexOf('o');
Console.WriteLine($"LastIndexOf 'o': {lastIndexOfResult}");

// 25. LastIndexOfAny
char[] chars = { 'H', 'W' };
int lastIndexOfAnyResult = str1.LastIndexOfAny(chars);
Console.WriteLine($"LastIndexOfAny 'H' or 'W': {lastIndexOfAnyResult}");

// 26. Normalize
string normalizedString = str1.Normalize();
Console.WriteLine($"Normalized String: {normalizedString}");

// 27. PadLeft
string padLeftString = str1.PadLeft(20);
Console.WriteLine($"PadLeft: '{padLeftString}'");

// 28. PadRight
string padRightString = str1.PadRight(20);
Console.WriteLine($"PadRight: '{padRightString}'");

// 29. Remove
string removedString = str1.Remove(7);
Console.WriteLine($"Removed String: {removedString}");

// 30. Replace
string replacedString = str1.Replace("World", "Everyone");
Console.WriteLine($"Replaced String: {replacedString}");

// 31. Split
string[] splitArray = str3.Split(' ');
Console.WriteLine("Split Result:");
foreach (string s in splitArray)
{
    Console.WriteLine($"'{s}'");
}

// 32. StartsWith
bool startsWithResult = str1.StartsWith("Hello");
Console.WriteLine($"StartsWith 'Hello': {startsWithResult}");

// 33. Substring
string substringResult = str1.Substring(7);
Console.WriteLine($"Substring from index 7: {substringResult}");

// 34. ToCharArray
char[] toCharArrayResult = str1.ToCharArray();
Console.WriteLine("ToCharArray Result:");
foreach (char c in toCharArrayResult)
{
```

```
            Console.WriteLine(c);
        }

        // 35. ToLower
        string toLowerResult = str1.ToLower();
        Console.WriteLine($"ToLower: {toLowerResult}");

        // 36. ToLowerInvariant
        string toLowerInvariantResult = str1.ToLowerInvariant();
        Console.WriteLine($"ToLowerInvariant: {toLowerInvariantResult}");

        // 37. ToString
        string toStringResult = str1.ToString();
        Console.WriteLine($"ToString: {toStringResult}");

        // 38. ToUpper
        string toUpperResult = str1.ToUpper();
        Console.WriteLine($"ToUpper: {toUpperResult}");

        // 39. Trim
        string trimmedString = str3.Trim();
        Console.WriteLine($"Trimmed String: '{trimmedString}'");

        // 40. TrimEnd
        string trimEndString = str3.TrimEnd();
        Console.WriteLine($"TrimEnd: '{trimEndString}'");

        // 41. TrimStart
        string trimStartString = str3.TrimStart();
        Console.WriteLine($"TrimStart: '{trimStartString}'");
    }
  }
}
```

Output

```
Cloned String: Hello, World!
Compare Result (str1 vs str2): 1
CompareOrdinal Result (str1 vs str2): 1
CompareTo Result (str1 vs str2): 1
Concatenated String: Hello, World! Hello, C#
Contains 'World': True
Copied String: Hello, World!
CopyTo Result: World
EndsWith 'World!': True
Equals (str1 vs str2): False
Formatted String: Welcome to C# Programming
GetEnumerator Result: H e l l o ,   W o r l d !
GetHashCode: -694847
GetType: System.String
GetTypeCode: String
IndexOf 'World': 7
Inserted String: Hello, Beautiful World!
Interned String: Hello, C#
IsInterned Result: Hello, C#
IsNormalized: True
IsNullOrEmpty: False
IsNullOrWhiteSpace: False
Joined String: Learn C# Programming
LastIndexOf 'o': 8
```

```
LastIndexOfAny 'H' or 'W': 7
Normalized String: Hello, World!
PadLeft: '     Hello, World!'
PadRight: 'Hello, World!     '
Removed String: Hello,
Replaced String: Hello, Everyone!
Split Result:
''
''
''
'Learn'
'C#'
'Programming'
''
''
''
StartsWith 'Hello': True
Substring from index 7: World!
ToCharArray Result:
H
e
l
l
o
,

W
o
r
l
d
!
ToLower: hello, world!
ToLowerInvariant: hello, world!
ToString: Hello, World!
ToUpper: HELLO, WORLD!
Trimmed String: 'Learn C# Programming'
TrimEnd: '   Learn C# Programming'
TrimStart: 'Learn C# Programming   '
```

Explanation

- **Cloning**: Clone() creates a copy of the string.
- **Comparison**: Compare(), CompareOrdinal(), and CompareTo() compare two strings based on their sort order.
- **Concatenation**: Concat() joins multiple strings together.
- **Contains**: Contains() checks if a substring exists within the string.
- **Copy**: Copy() and CopyTo() methods create and copy strings.
- **EndsWith**: EndsWith() checks if the string ends with a specific substring.
- **Equality**: Equals() checks if two strings have the same value.
- **Formatting**: Format() replaces placeholders with values.
- **Enumeration**: GetEnumerator() retrieves characters in a string.
- **Hash Code**: GetHashCode() returns the string's hash code.
- **Type Info**: GetType() and GetTypeCode() return type information.
- **Indexing**: IndexOf() and LastIndexOf() locate characters or substrings.
- **Insertion**: Insert() adds a substring at a specific index.
- **Interning**: Intern() and IsInterned() manage string interning.

- **Normalization**: IsNormalized() and Normalize() ensure consistent Unicode formatting.
- **Null/Empty/Whitespace**: IsNullOrEmpty() and IsNullOrWhiteSpace() check for empty or whitespace-only strings.
- **Joining**: Join() combines array elements into a single string.
- **Padding**: PadLeft() and PadRight() align strings with spaces.
- **Removal**: Remove() deletes parts of a string.
- **Replacement**: Replace() substitutes one substring for another.
- **Splitting**: Split() divides a string into an array based on delimiters.
- **Start Check**: StartsWith() checks if a string begins with a specific substring.
- **Substrings**: Substring() extracts a portion of the string.
- **Character Array**: ToCharArray() converts a string to a character array.
- **Case Conversion**: ToLower(), ToLowerInvariant(), and ToUpper() change the case of a string.
- **Trimming**: Trim(), TrimEnd(), and TrimStart() remove whitespace.

C# StringBuilder Class

The StringBuilder class in C# is used to represent a mutable string of characters. Unlike the string class, which is immutable (cannot be changed once created), the StringBuilder allows for modifications to the string without creating new instances, which can be more efficient for scenarios where frequent changes to the string are required.

The StringBuilder class is part of the System.Text namespace and provides a variety of methods for manipulating strings.

Why Use StringBuilder?

- **Efficiency**: Modifying a string using StringBuilder does not create a new object in memory, which reduces overhead and improves performance, especially in loops or when performing many modifications.
- **Mutable Strings**: StringBuilder is mutable, meaning that once an instance is created, the same instance is used for all modifications, reducing memory consumption.

Common StringBuilder Methods

1. **Append**: Appends a string to the end of the current StringBuilder.
2. **AppendFormat**: Appends a formatted string (e.g., using placeholders) to the StringBuilder.
3. **Insert**: Inserts a string at a specified index.
4. **Remove**: Removes a specified number of characters starting at a given index.
5. **Replace**: Replaces all occurrences of a specified string with another string.

Example Usage of StringBuilder Methods

```
using System;
using System.Text;

namespace StringBuilderExample
{
    class Program
    {
        static void Main(string[] args)
```

```
    {
        // 1. Append: Adding strings to the StringBuilder
        StringBuilder sb = new StringBuilder("Suresh");
        sb.Append(", Rohini");
        sb.Append(", Trishika");
        Console.WriteLine(sb);
        // Output: Suresh, Rohini, Trishika

        // 2. AppendFormat: Adding formatted string
        int amount = 146;
        StringBuilder sb1 = new StringBuilder("Total");
        sb1.AppendFormat(": {0:c}", amount);
        Console.WriteLine(sb1);
        // Output: Total: $146.00

        // 3. Insert: Inserting a string at a specific position
        StringBuilder sb2 = new StringBuilder("Welcome Tutlane");
        sb2.Insert(8, "to ");
        Console.WriteLine(sb2);
        // Output: Welcome to Tutlane

        // 4. Remove: Removing characters from a specific index
        StringBuilder sb3 = new StringBuilder("Welcome to Tutlane");
        sb3.Remove(8, 3); // Removing "to "
        Console.WriteLine(sb3);
        // Output: Welcome Tutlane

        // 5. Replace: Replacing occurrences of a string
        StringBuilder sb4 = new StringBuilder("Welcome to Tutlane");
        sb4.Replace("Tutlane", "C#");
        Console.WriteLine(sb4);
        // Output: Welcome to C#
    }
  }
}
```

Explanation

1. **Append**: The Append method is used to add strings to the end of the current StringBuilder instance. This is useful for concatenating strings without creating multiple string instances.
    - **Output**: Suresh, Rohini, Trishika
2. **AppendFormat**: The AppendFormat method formats the string using placeholders and appends it to the StringBuilder.
    - **Output**: Total: $146.00
3. **Insert**: The Insert method allows you to insert a string at a specific position in the StringBuilder.
    - **Output**: Welcome to Tutlane
4. **Remove**: The Remove method removes a specified number of characters starting from a given index.
    - **Output**: Welcome Tutlane (removes "to ")
5. **Replace**: The Replace method replaces all occurrences of a specified string with another string in the StringBuilder.
    - **Output**: Welcome to C# (replaces "Tutlane" with "C#")

When to Use StringBuilder?

- Use StringBuilder when you need to perform multiple operations on a string, such as appending, inserting, or removing characters, especially in loops or when handling large amounts of text.
- For simple, infrequent string manipulations, the string class might still be more straightforward and readable.

String

Example:

```
string str1 = "Welcome";
str1 = "Welcome to Tutlance";
```

Memory Representation:

RAM

Stack
str1 -> 0x02345
str1 -> 0x07896
Heap
0x02345: "Welcome"
0x07896: "Welcome to Tutlance"

Explanation:

- When you initially assign str1 = "Welcome", the string "Welcome" is stored in the heap at address 0x02345.
- When you modify str1 to "Welcome to Tutlance", a new string is created in the heap at address 0x07896.
- The original memory location is discarded, and str1 now points to the new address 0x07896.

Summary:

- **Strings are immutable**: Every time you modify a string, a new memory location is allocated in the heap, and the reference is updated on the stack.

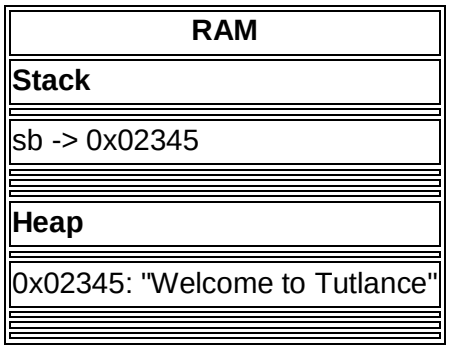
StringBuilder

Example:

csharp
Copy code

```
StringBuilder sb = new StringBuilder("Welcome");
sb.Append(" to Tutlance");
```

Memory Representation:



Explanation:

- When you create the StringBuilder with "Welcome", the string is stored in the heap at address 0x02345.
- When you modify the string by appending " to Tutlance", the same memory location in the heap (0x02345) is updated with the new value "Welcome to Tutlance".
- No new memory allocation occurs, and the reference remains unchanged on the stack.

Summary:

- **StringBuilder is mutable**: Modifications to the string are done in place, without creating new memory locations in the heap, making it more memory-efficient for repeated operations.