Strings and Text Processing

Processing and Manipulating Text Using the .NET String Class

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STRINGS

What is String?

What is String?

- Strings are sequences of characters (texts)
- The string data type in C#
  - Declared by the string keyword
  - Maps to System.String .NET data type
- Strings are enclosed in quotes:

```
string s = "Hello, C#";
```

- Concatenated using the "+" operator:

```
string s = "Hello" + " " + "C#";
```

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In C# Strings are Immutable, use Unicode

- Strings are immutable (read-only) sequences of characters
- Accessible by index (read-only)

```
string str = "Hello, C#";
char ch = str[2]; // OK
str[2] = 'a';     // Error!
```

- Strings use Unicode (can use most alphabets, e.g. Arabic)

```
string greeting = "你好"; // (lí-hó) Taiwanese
```

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Initializing a String

- Initializing from a string literal:

```
string str = "Hello, C#";
```

- Reading a string from the console:

```
string name = Console.ReadLine();
Console.WriteLine("Hi, " + name);
```

- Converting a string from and to a char array:

```
string str = new String(new char[] {'s', 't', 'r'});
char[] charArr = str.ToCharArray();
// ['s', 't', 'r']
```

MANIPULATING STRINGS

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Concatenating

- Use the + or the += operators

```
string text = "Hello" + ", " + "world!";
//"Hello, world!"
```

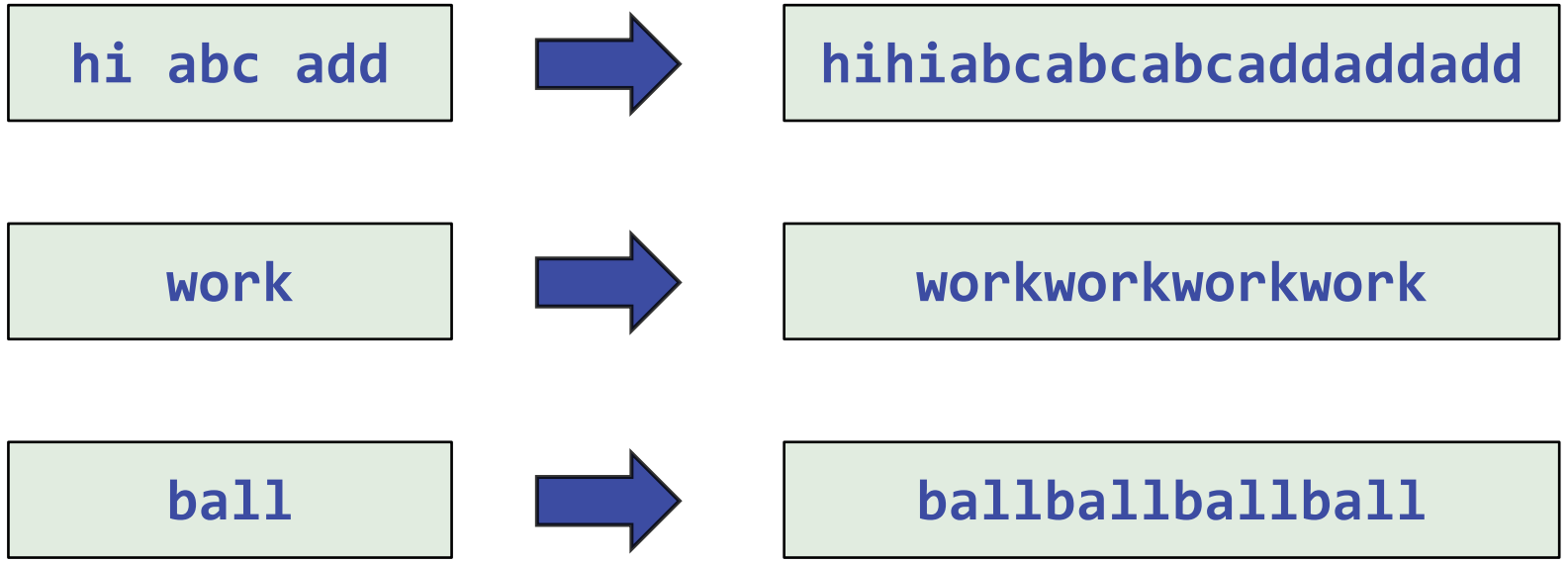
```
string text = "Hello, ";
text += "John"; //"Hello, John"
```

- Use the Concat() method

```
string greet = "Hello, ";
string name = "John";
string result = string.Concat(greet, name);
Console.WriteLine(result); //"Hello, John"
```

Problem: Repeat Strings

- Read an array from strings
- Repeat each word n times, where n is the length of the word



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Solution: Repeat Strings

```
string[] words = Console.ReadLine().Split();
string result = "";
foreach (string word in words)
{
  int repeatTimes = word.Length;
  for (int i = 0; i < repeatTimes; i++)
    result += word;
}
Console.WriteLine(result);
```

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Searching (1)

- IndexOf() - returns the first match index or -1

```
string fruits = "banana, apple, kiwi, banana, apple";
Console.WriteLine(fruits.IndexOf("banana")); //0
Console.WriteLine(fruits.IndexOf("orange")); //-1
```

- LastIndexOf() - finds the last occurrence

```
string fruits = "banana, apple, kiwi, banana, apple";
Console.WriteLine(fruits.LastIndexOf("banana"));    //21
Console.WriteLine(fruits.LastIndexOf("orange"));    //-1
```

Substring

- Substring(int startIndex, int length)

```
string card = "10C";
string power = card.Substring(0, 2);
Console.WriteLine(power); //10
```

- Substring(int startIndex)

```
string text = "My name is John";
string extractWord = text.Substring(11);
Console.WriteLine(extractWord); //John
```

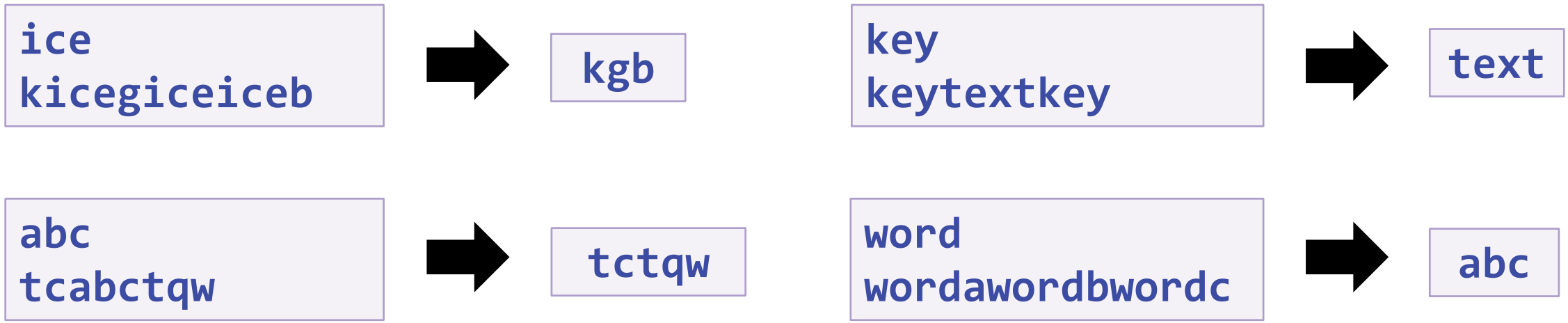
Searching (2)

- Contains() - Check whether one string contains other string

```
string text = "I love fruits.";
Console.WriteLine(text.Contains("fruits")); //True
Console.WriteLine(text.Contains("banana")); //False
```

Problem: Substring

- You are given a text and a remove word
- Remove all substrings that are equal to the remove word



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Solution: Substring

```
string key = Console.ReadLine();
string text = Console.ReadLine();

int index = text.IndexOf(key);

while (index != -1)
{
    text = text.Remove(index, key.Length);
    index = text.IndexOf(key);
}

Console.WriteLine(text);
```

Splitting (1)

- **Split** a string by given **separator**

```
string text = "Hello, john@uni.com, you have been using
john@uni.com in your registration";
string[] words = text.Split(", ");
//words[]:
//"Hello"
//"john@uni.com"
//"you have been using john@uni.com in your registration"
```

Splitting (2)

- Split can be used with multiple separators

```
char[] separators = new char[] { ' ', ',', '.' };
string text = "Hello, I am John.";
string[] words = text.Split(separators);
//"Hello", "", "I", "am", "John", ""
```

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Splitting (3)

- Using **`StringSplitOptions.RemoveEmptyEntries`** to remove empty array elements from the array returned

```
char[] separators = new char[] { ' ', ',', '.' };
string text = "Hello, I am John.";
string[] words = text
 .Split(separators, StringSplitOptions.RemoveEmptyEntries);
//"Hello", "I", "am", "John"
```

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Replacing

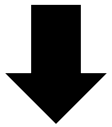
- Replace(match, replacement) – replaces all occurrences
- The result is a new string (strings are immutable)

```
string text = "Hello, john@uni.com, you have been using
john@uni.com in your registration.";
string replacedText = text
            .Replace("john@uni.com", "john@softschool.com");
Console.WriteLine(replacedText);
//Output:
//Hello, john@softschool.com, you have been using
john@softschool.com in your registration.
```

Problem: Text Filter

- You are given a text and a string of banned words
- Replace all banned words in the text with asterisks

```
Linux, Windows
It is not Linux, it is GNU/Linux. Linux is merely the
kernel, while GNU adds the functionality...
```



```
It is not *****, it is GNU/*****. ***** is merely
the kernel, while GNU adds the functionality...
```

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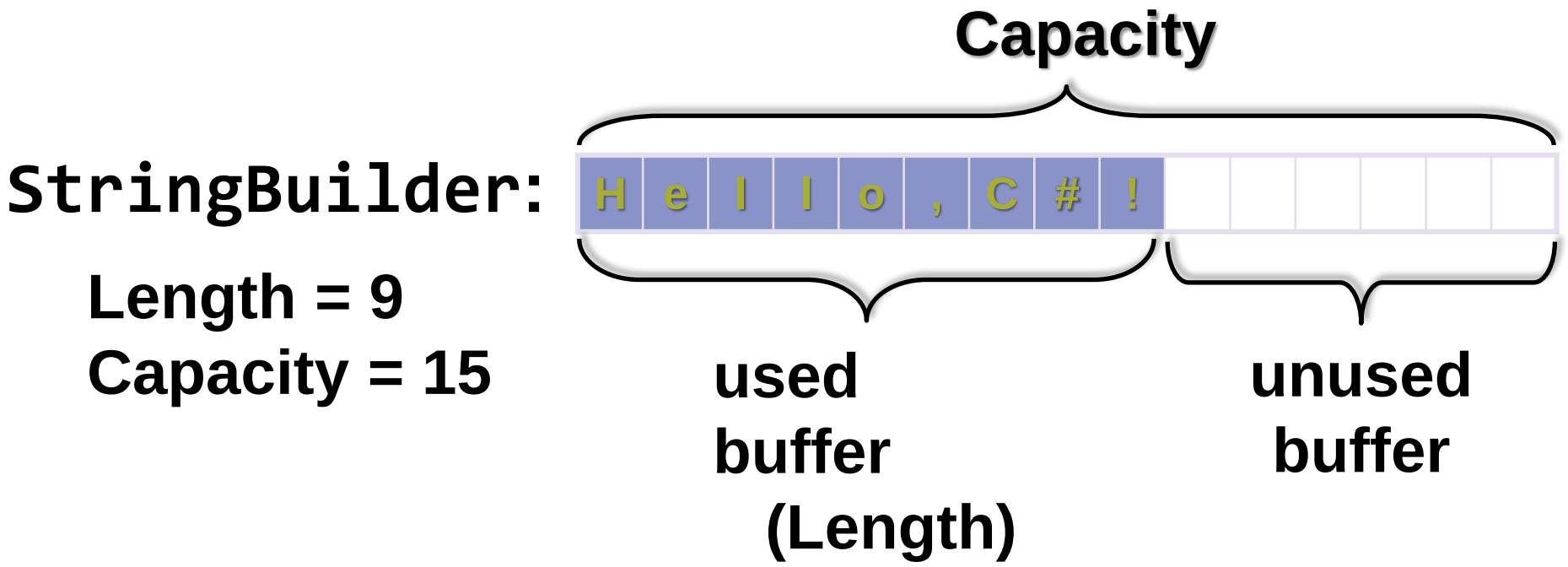
Solution: Text Filter

```
string[] banWords = Console.ReadLine()
  .Split(…); // TODO: add separators
string text = Console.ReadLine();
foreach (var banWord in banWords)
{
  if (text.Contains(banWord))
  {
    text = text.Replace(banWord,
      new string('*', banWord.Length));
  }
}
Console.WriteLine(text);
```

BUILDING AND MODIFYING STRINGS

Using the StringBuilder Class

StringBuilder: How It Works?



- **StringBuilder** keeps a buffer space, allocated in advance
  - Do not allocate memory for most operations → performance

Using StringBuilder Class

- Use the StringBuilder to build / modify strings

```
StringBuilder sb = new StringBuilder();
sb.Append("Hello, ");
sb.Append("John! ");
sb.Append("I sent you an email.");
Console.WriteLine(sb);
//Hello, John! I sent you an email.
```

use System.Text

Concatenation vs StringBuilder (1)

- Concatenating strings is a slow operation because each iteration creates a new string

```
Stopwatch sw = new Stopwatch();
sw.Start();
string text = "";
for (int i = 0; i < 200000; i++)
    text += i;
sw.Stop();
Console.WriteLine(sw.ElapsedMilliseconds); //73625
```

Concatenation vs StringBuilder (2)

- Using StringBuilder

```
Stopwatch sw = new Stopwatch();
sw.Start();
StringBuilder text = new StringBuilder();
for (int i = 0; i < 200000; i++)
    text.Append(i);
sw.Stop();
Console.WriteLine(sw.ElapsedMilliseconds);
//16
```

StringBuilder Methods (1)

- Append(…) – add text or a string representation of an object to the end of a string

```
StringBuilder sb = new StringBuilder();
sb.Append("Hello Peter, how are you?");
```

- Length – holds the length of the string in the buffer

```
sb.Append("Hello Peter, how are you?");
Console.WriteLine(sb.Length); // 32
```

- Clear(…) – removes all characters

StringBuilder Methods (2)

- [int index] – return char on current index

```
StringBuilder sb= new StringBuilder();
sb.Append("Hello Peter, how are you?");
Console.WriteLine(sb[1]); // e
```

- Insert(int index, string str) – inserts a string at the specified character position

```
sb.Insert(11, " Ivanov");
Console.WriteLine(sb); // Hello Peter Ivanov, how are you?
```

StringBuilder Methods (3)

- Replace(string oldValue, string newValue) – replaces all occurrences of a specified string with another specified string

```
sb.Append("Hello Peter, how are you?");
sb.Replace("Peter", "George");
```

- ToString() – converts the value of this instance to a String

```
string text = sb.ToString();
Console.WriteLine(text);
//Hello George, how are you?
```

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Summary

- Strings are immutable sequences of Unicode characters
- String processing methods
  - Concat(), IndexOf(), Contains(),Substring(), Split(), Replace(), …