

Thinking in Objects

CSE 114, Computer Science 1

Stony Brook University

<http://www.cs.stonybrook.edu/~cse114>

Immutable Objects and Classes

- Immutable object: the contents of an object cannot be changed once the object is created - its class is called an immutable class
- Example immutable class: no set method in the Circle class

```
public class Circle{  
    private double radius;  
    public Circle() { }  
    public Circle(double radius) {  
        this.radius = radius;  
    }  
    public double getRadius() {  
        return radius;  
    }  
}
```

- radius is private and cannot be changed without a set method
- A class with all private data fields and without mutators is not necessarily immutable!

What Class is Immutable?

1. It must mark all data fields private!
2. Provide no mutator methods!
3. Provide no accessor methods that would return a reference to a mutable data field object!

Example mutable

```
public class Student {
    private int id;
    private BirthDate birthDate;
    public Student(int ssn, int year,
        int month, int day) {
        id = ssn;
        birthDate =
            new BirthDate(year, month, day);
    }
    public int getId() {
        return id;
    }
    public BirthDate getBirthDate() {
        return birthDate;
    }
}
```

```
public class BirthDate {
    private int year;
    private int month;
    private int day;

    public BirthDate(int newYear,
        int newMonth, int newDay) {
        year = newYear;
        month = newMonth;
        day = newDay;
    }
    public void setYear(int newYear) {
        year = newYear;
    }
    public int getYear() {
        return year;
    }
}
```

```
public class Test {
    public static void main(String[] args) {
        Student student = new Student(111223333, 1998, 1, 1);
        BirthDate date = student.getBirthDate();
        date.setYear(2050);
        // Now the student birth year is changed:
        System.out.println(student.getBirthDate().getYear()); // 2050
    }
}
```

Scope of Variables

- **Data Field Variables** can be declared anywhere inside a class
 - The scope of instance and static variables is the entire class!
 - Initialized with default values.

VS.

- The scope of a **local variable** starts from its declaration and continues to the end of the block that contains the variable
 - A local variable must be initialized explicitly before it can be used.

The **this** Keyword

- The **this** keyword is the name of a reference that refers to an object itself
- Common uses of the **this** keyword:
 1. Reference a class's “*hidden*” *data fields*
 2. To enable a constructor to invoke another constructor of the same class as the first statement in the constructor.

Reference the Hidden Data Fields

```
public class Foo {  
    private int i = 5;  
    private static double k = 0;  
  
    void setI(int i) {  
        this.i = i;  
    }  
  
    static void setK(double k) {  
        Foo.k = k;  
    }  
}
```

Suppose that f1 and f2 are two objects of Foo.

Invoking f1.setI(10) is to execute
 this.i = 10, where **this** refers f1

Invoking f2.setI(45) is to execute
 this.i = 45, where **this** refers f2

Calling Overloaded Constructor

```
public class Circle {  
    private double radius;
```

```
    public Circle(double radius) {  
        this.radius = radius;  
    }
```

→ this must be explicitly used to reference the data field radius of the object being constructed

```
    public Circle() {  
        this(1.0);  
    }
```

→ this is used to invoke another constructor

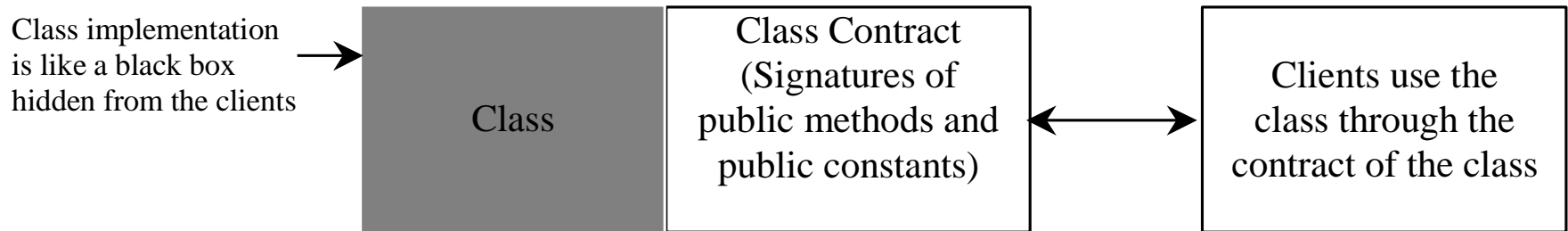
```
    public double getArea() {  
        return this.radius * this.radius * Math.PI;  
    }  
}
```

↓
Every instance variable belongs to an instance represented by this, which is normally omitted

Class Abstraction and Encapsulation

Abstraction = separate class implementation from the use of the class

- The creator of the class provides a description of the class and let the user know how the class can be used.
- The user does not need to know how the class is implemented: it is encapsulated and hidden.



Designing the Loan Class

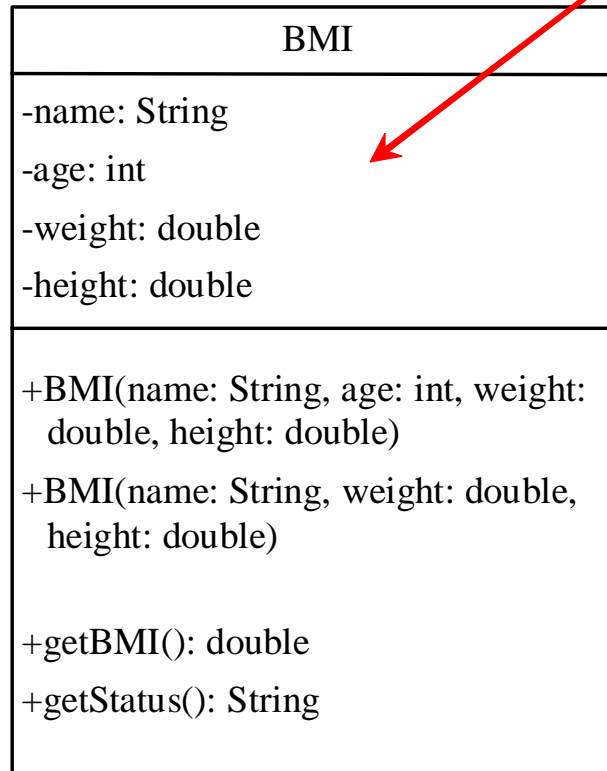
Loan	
-annualInterestRate: double	The annual interest rate of the loan (default: 2.5).
-numberOfYears: int	The number of years for the loan (default: 1)
-loanAmount: double	The loan amount (default: 1000).
-loanDate: Date	The date this loan was created.
+Loan()	Constructs a default Loan object.
+Loan(annualInterestRate: double, numberOfYears: int, loanAmount: double)	Constructs a loan with specified interest rate, years, and loan amount.
+getAnnualInterestRate(): double	Returns the annual interest rate of this loan.
+getNumberOfYears(): int	Returns the number of the years of this loan.
+getLoanAmount(): double	Returns the amount of this loan.
+getLoanDate(): Date	Returns the date of the creation of this loan.
+setAnnualInterestRate(annualInterestRate: double): void	Sets a new annual interest rate to this loan.
+setNumberOfYears(numberOfYears: int): void	Sets a new number of years to this loan.
+setLoanAmount(loanAmount: double): void	Sets a new amount to this loan.
+getMonthlyPayment(): double	Returns the monthly payment of this loan.
+getTotalPayment(): double	Returns the total payment of this loan.

```

public class Loan {
    private double annualInterestRate;
    private int numberOfYears;
    private double loanAmount;
    private java.util.Date loanDate;
    public Loan() {
        this(2.5, 1, 1000);
    }
    public Loan(double annualInterestRate, int numberOfYears,
        double loanAmount) {
        this.annualInterestRate = annualInterestRate;
        this.numberOfYears = numberOfYears;
        this.loanAmount = loanAmount;
        loanDate = new java.util.Date();
    }
    public double getMonthlyPayment() {
        double monthlyInterestRate = annualInterestRate / 1200;
        double monthlyPayment = loanAmount * monthlyInterestRate / (1 -
            (Math.pow(1 / (1 + monthlyInterestRate), numberOfYears * 12)));
        return monthlyPayment;
    }
    public double getTotalPayment() {
        double totalPayment = getMonthlyPayment() * numberOfYears * 12;
        return totalPayment;
    } ...
}

```

The BMI Class



The get methods for these data fields are provided in the class, but omitted in the UML diagram for brevity.

The name of the person.

The age of the person.

The weight of the person in pounds.

The height of the person in inches.

Creates a BMI object with the specified name, age, weight, and height.

Creates a BMI object with the specified name, weight, height, and a default age 20.

Returns the BMI

Returns the BMI status (e.g., normal, overweight, etc.)

```

public class BMI {
    private String name;
    private int age;
    private double weight; // in pounds
    private double height; // in inches
    public static final double KILOGRAMS_PER_POUND = 0.45359237;
    public static final double METERS_PER_INCH = 0.0254;
    public BMI(String name, int age, double weight, double height) {
        this.name = name; this.age = age; this.weight = weight; this.height = height;
    }
    public double getBMI() {
        double bmi = weight * KILOGRAMS_PER_POUND /
            ((height * METERS_PER_INCH) * (height * METERS_PER_INCH));
        return Math.round(bmi * 100) / 100.0;
    }
    public String getStatus() {
        double bmi = getBMI();
        if (bmi < 16) return "seriously underweight";
        else if (bmi < 18) return "underweight";
        else if (bmi < 24) return "normal weight";
        else if (bmi < 29) return "over weight";
        else if (bmi < 35) return "seriously over weight";
        else return "gravely over weight";
    }
    public String getName() {    return name;    }
    public int getAge() {    return age;    }
    public double getWeight() {    return weight;    }
    public double getHeight() {    return height;    }
}

```

Example: The Course Class

Course	
-name: String	The name of the course.
-students: String[]	The students who take the course.
-numberOfStudents: int	The number of students (default: 0).
+Course(name: String)	Creates a Course with the specified name.
+getName(): String	Returns the course name.
+addStudent(student: String): void	Adds a new student to the course list.
+getStudents(): String[]	Returns the students for the course.
+getNumberOfStudents(): int	Returns the number of students for the course.

```
public class Course {  
    private String courseName;  
    private String[] students = new String[100];  
    private int numberOfStudents;  
    public Course(String courseName) {  
        this.courseName = courseName;  
    }  
    public void addStudent(String student) {  
        students[numberOfStudents] = student;  
        numberOfStudents++;  
    }  
    public String[] getStudents() {  
        return students;  
    }  
    public int getNumberOfStudents() {  
        return numberOfStudents;  
    }  
    public String getCourseName() {  
        return courseName;  
    }  
}
```

Example: The `StackOfIntegers` Class

StackOfIntegers	
-elements: int[]	
-size: int	
+StackOfIntegers()	
+StackOfIntegers(capacity: int)	
+empty(): boolean	
+peek(): int	
+push(value: int): int	
+pop(): int	
+getSize(): int	

An array to store integers in the stack.

The number of integers in the stack.

Constructs an empty stack with a default capacity of 16.

Constructs an empty stack with a specified capacity.

Returns true if the stack is empty.

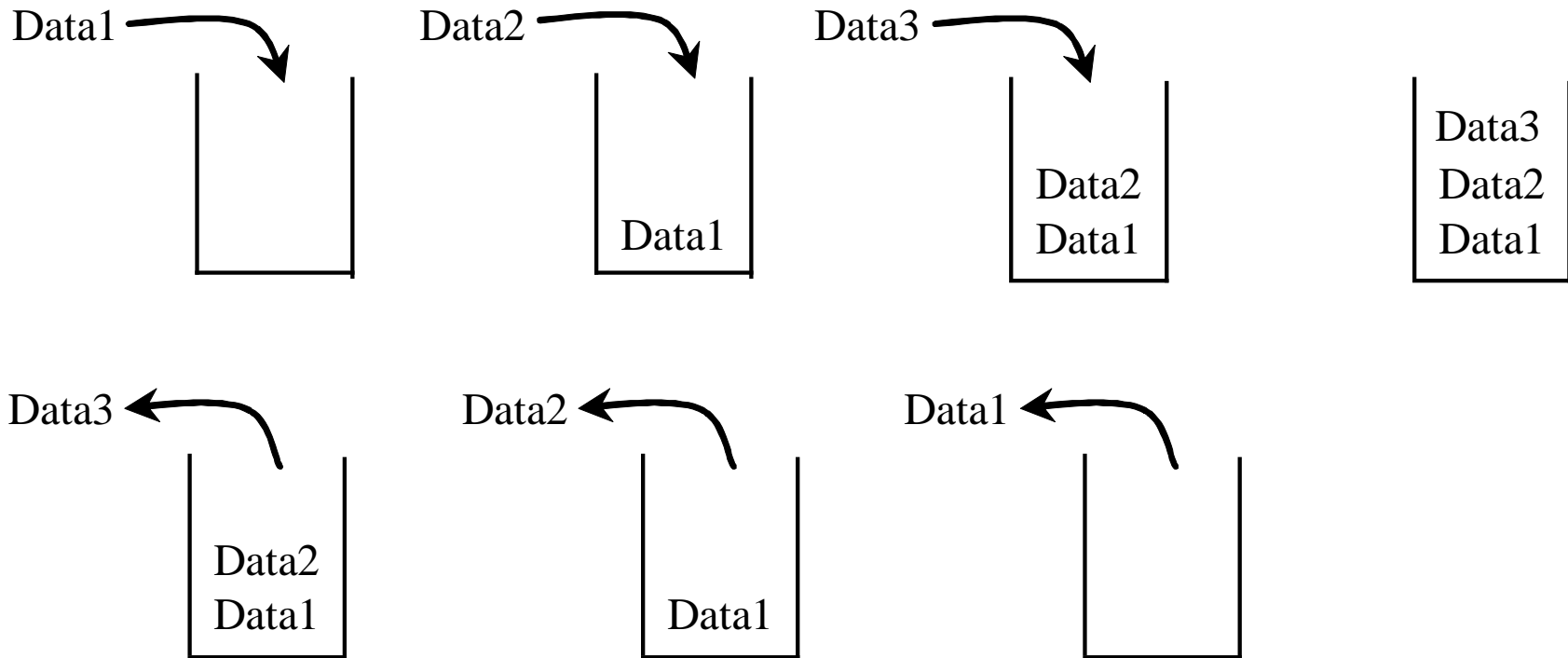
Returns the integer at the top of the stack without removing it from the stack.

Stores an integer into the top of the stack.

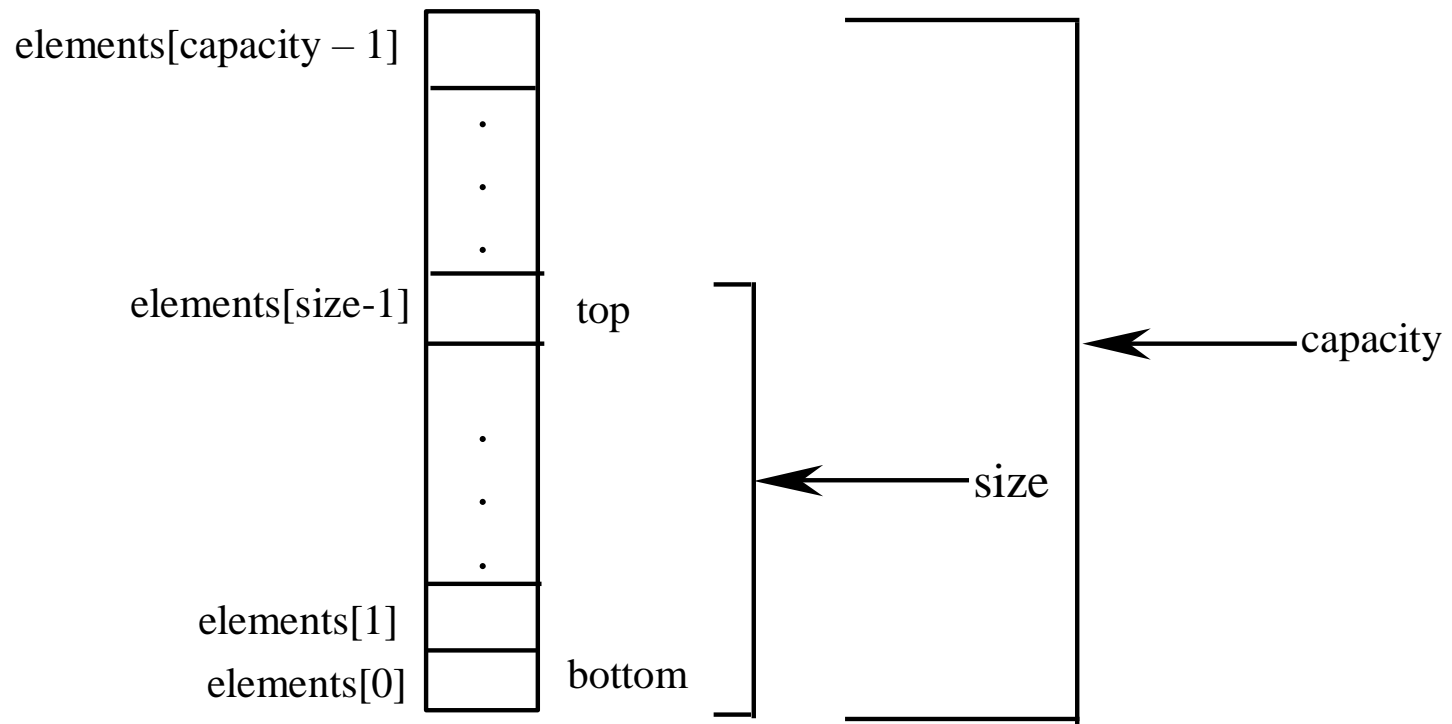
Removes the integer at the top of the stack and returns it.

Returns the number of elements in the stack.

Designing the `StackOfIntegers` Class



Implementing `StackOfIntegers` Class



```

public class StackOfIntegers {
    private int[] elements;
    private int size;
    public static final int DEFAULT_CAPACITY = 16;
    public StackOfIntegers() {
        this(DEFAULT_CAPACITY);
    }
    public StackOfIntegers(int capacity) {
        elements = new int[capacity];
    }
    public void push(int value) {
        if (size >= elements.length) {
            int[] temp = new int[elements.length * 2];
            System.arraycopy(elements, 0, temp, 0, elements.length);
            elements = temp;
        }
        elements[size++] = value;
    }
    public int pop() {
        return elements[--size];
    }
    public int peek() {
        return elements[size - 1];
    }
    public int getSize() {
        return size;
    }
}

```

Constructing Strings

- Pattern:

```
String newString = new String(stringLiteral);
```

- Example:

```
String message = new String("Welcome to Java");
```

- Since strings are used frequently, Java provides a shorthand initializer for creating a string:

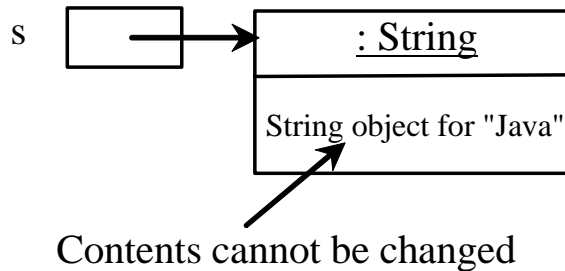
```
String message = "Welcome to Java";
```

Strings Are Immutable

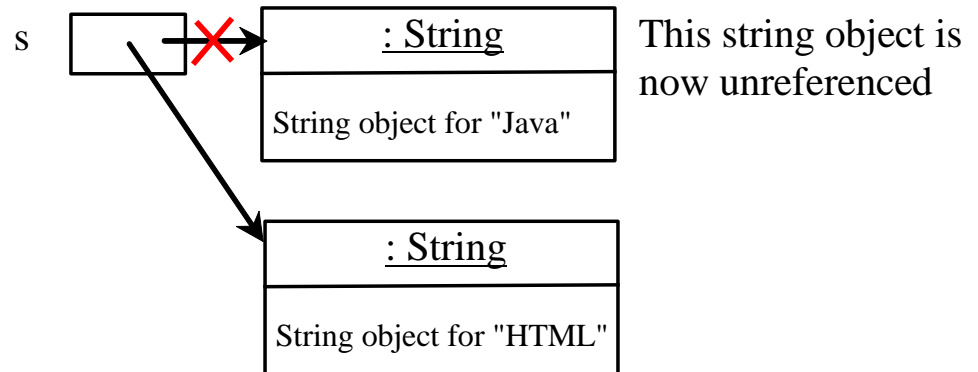
- A String object is immutable; its contents cannot be changed

```
String s = "Java";  
s = "HTML";
```

After executing `String s = "Java";`



After executing `s = "HTML";`



Interned Strings

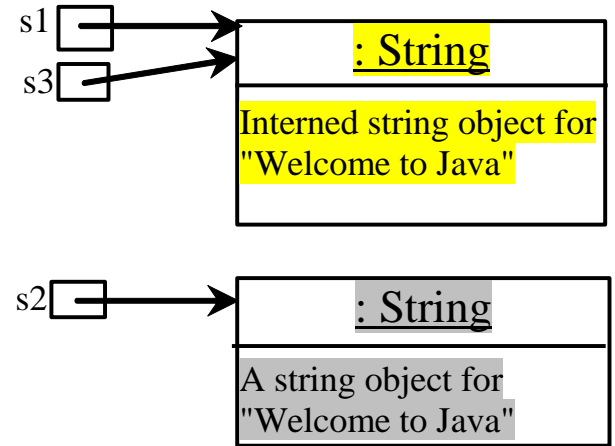
```
String s1 = "Welcome to Java";
```

```
String s2 = new String("Welcome to Java");
```

```
String s3 = "Welcome to Java";
```

```
System.out.println("s1 == s2 is " + (s1 == s2));
```

```
System.out.println("s1 == s3 is " + (s1 == s3));
```



display

s1 == s2 is false

s1 == s3 is true

- A new object is created if you use the new operator.
- If you use the string initializer, no new object is created if the interned object is already created.

The String Class methods

- Compare strings
- Obtaining String length
- Retrieving Individual Characters in a string
- String Concatenation (concat)
- Substrings (substring(index), substring(start, end))
- Comparisons (equals, compareTo)
- String Conversions
- Finding a Character or a Substring in a String
- Conversions between Strings and Arrays
- Converting Characters and Numeric Values to Strings

String Comparisons

- `equals(Object object) :`

```
String s1 = new String("Welcome");  
String s2 = "Welcome";
```

```
if (s1.equals(s2)) {  
    // s1 and s2 have the same contents  
}
```

```
if (s1 == s2) {  
    // s1 and s2 have the same reference  
}
```


String Comparisons

- `compareTo(Object object) :`

```
String s1 = new String("Welcome");  
String s2 = "Welcome";
```

```
if (s1.compareTo(s2) > 0) {  
    // s1 is greater than s2  
}else if (s1.compareTo(s2) == 0) {  
    // s1 and s2 have the same contents  
}else{  
    // s1 is less than s2  
}
```

String Comparisons

java.lang.String

+equals(s1: String): boolean

+equalsIgnoreCase(s1: String):
boolean

+compareTo(s1: String): int

+compareToIgnoreCase(s1: String):
int

+regionMatches(toffset: int, s1: String,
offset: int, len: int): boolean

+regionMatches(ignoreCase: boolean,
toffset: int, s1: String, offset: int,
len: int): boolean

+startsWith(prefix: String): boolean

+endsWith(suffix: String): boolean

Returns true if this string is equal to string s1.

Returns true if this string is equal to string s1 case-insensitive.

Returns an integer greater than 0, equal to 0, or less than 0 to indicate whether this string is greater than, equal to, or less than s1.

Same as compareTo except that the comparison is case-insensitive.

Returns true if the specified subregion of this string exactly matches the specified subregion in string s1.

Same as the preceding method except that you can specify whether the match is case-sensitive.

Returns true if this string starts with the specified prefix.

Returns true if this string ends with the specified suffix.

String Length, Characters, and Combining Strings

java.lang.String
+length(): int
+charAt(index: int): char
+concat(s1: String): String

Returns the number of characters in this string.

Returns the character at the specified index from this string.

Returns a new string that concatenate this string with string s1.

Finding String Length

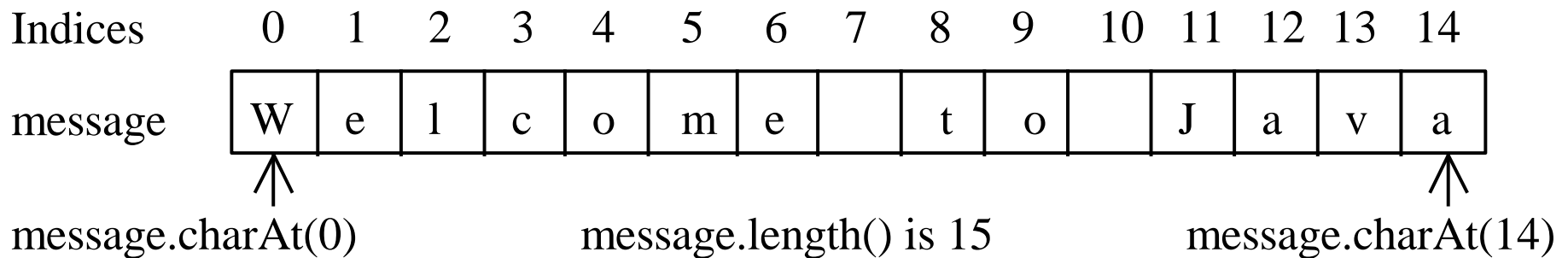
- Finding string length using the `length()` method:

```
message = "Welcome";
```

```
message.length() // returns 7
```

Retrieving Individual Characters in a String

- Use **`message.charAt(index)`** → **`char`**
- Index starts from 0



Extracting Substrings

java.lang.String

+substring(beginIndex: int):
String

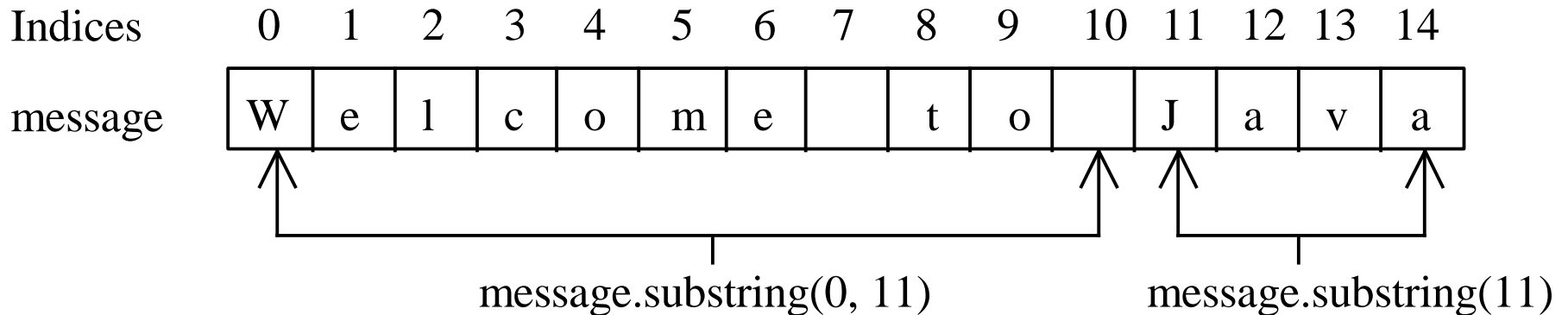
+substring(beginIndex: int,
endIndex: int): String

Returns this string's substring that begins with the character at the specified beginIndex and extends to the end of the string.

Returns this string's substring that begins at the specified beginIndex and extends to the character at index endIndex – 1. Note that the character at endIndex is not part of the substring.

Extracting Substrings

```
String s1 = "Welcome to Java";  
String s2 = s1.substring(0, 11) + "HTML";
```



s2 will be "Welcome to HTML"

Converting, Replacing, and Splitting Strings

java.lang.String

+toLowerCase(): String

Returns a new string with all characters converted to lowercase.

+toUpperCase(): String

Returns a new string with all characters converted to uppercase.

+trim(): String

Returns a new string with blank characters trimmed on both sides.

+replace(oldChar: char,
newChar: char): String

Returns a new string that replaces all matching character in this string with the new character.

+replaceFirst(oldString: String,
newString: String): String

Returns a new string that replaces the first matching substring in this string with the new substring.

+replaceAll(oldString: String,
newString: String): String

Returns a new string that replace all matching substrings in this string with the new substring.

+split(delimiter: String):
String[]

Returns an array of strings consisting of the substrings split by the delimiter.

Examples

"Welcome".toLowerCase() returns a new string, "welcome".

"Welcome".toUpperCase() returns a new string, "WELCOME".

" Welcome ".trim() returns a new string, "Welcome".

"Welcome".replace('e', 'A') returns a new string, "WAlcomA".

"Welcome".replaceFirst("e", "AB") returns a new string, "WABlcome".

"Welcome".replaceAll("e", "AB") returns a new string, "WABlcomAB".

"Welcome".replaceAll("el", "AB") returns a new string, "WABcome".

Splitting a String

```
String[] tokens = "Java#HTML#Perl".split("#");  
for(int i = 0; i < tokens.length; i++)  
    System.out.print(tokens[i] + "    ");
```

displays

Java HTML Perl

Matching, Replacing and Splitting by Patterns

- The replaceAll, replaceFirst, and split methods can be used with a regular expression
- Example: the following statement returns a new string that replaces \$, +, or # in "a+b\$#c" by the string NNN.

```
String s = "a+b$#c".replaceAll("[$+#]", "NNN");  
System.out.println(s);
```

Result: aNNNbNNNNNNNc

- Here the regular expression [\$+#] specifies a pattern that matches \$, +, or #

Matching, Replacing and Splitting by Patterns

- The following statement splits the string into an array of strings delimited by some punctuation marks:

```
String[] tokens = "Java,C?C#,C++".split("[.,:;?]");  
  
for (int i = 0; i < tokens.length; i++)  
    System.out.println(tokens[i]);
```

Output:

Java

C

C#

C++

Finding a Character or a Substring in a String

java.lang.String	
+indexOf(ch: char): int	Returns the index of the first occurrence of ch in the string. Returns -1 if not matched.
+indexOf(ch: char, fromIndex: int): int	Returns the index of the first occurrence of ch after fromIndex in the string. Returns -1 if not matched.
+indexOf(s: String): int	Returns the index of the first occurrence of string s in this string. Returns -1 if not matched.
+indexOf(s: String, fromIndex: int): int	Returns the index of the first occurrence of string s in this string after fromIndex. Returns -1 if not matched.
+lastIndexOf(ch: int): int	Returns the index of the last occurrence of ch in the string. Returns -1 if not matched.
+lastIndexOf(ch: int, fromIndex: int): int	Returns the index of the last occurrence of ch before fromIndex in this string. Returns -1 if not matched.
+lastIndexOf(s: String): int	Returns the index of the last occurrence of string s. Returns -1 if not matched.
+lastIndexOf(s: String, fromIndex: int): int	Returns the index of the last occurrence of string s before fromIndex. Returns -1 if not matched.

Finding a Character or a Substring in a String

`"Welcome to Java".indexOf('W')` returns 0.

`"Welcome to Java".indexOf('x')` returns -1.

`"Welcome to Java".indexOf('o', 5)` returns 9.

`"Welcome to Java".indexOf("come")` returns 3.

`"Welcome to Java".indexOf("Java", 5)` returns 11.

`"Welcome to Java".indexOf("java", 5)` returns -1.

`"Welcome to Java".lastIndexOf('a')` returns 14.

Indices	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
message	W	e	l	c	o	m	e		t	o		J	a	v	a

Convert Character and Numbers to Strings

- The String class provides several static valueOf methods for converting a character, an array of characters, and numeric values to strings
 - valueOf with different argument types char, char[], double, long, int, and float
 - Example: convert a double value to a string:

String.valueOf(5.44) → "5.44"

The Character Class

java.lang.Character

+Character(value: char)
+charValue(): char
+compareTo(anotherCharacter: Character): int
+equals(anotherCharacter: Character): boolean
+isDigit(ch: char): boolean
+isLetter(ch: char): boolean
+isLetterOrDigit(ch: char): boolean
+isLowerCase(ch: char): boolean
+isUpperCase(ch: char): boolean
+toLowerCase(ch: char): char
+toUpperCase(ch: char): char

Constructs a character object with char value
Returns the char value from this object
Compares this character with another
Returns true if this character equals to another
Returns true if the specified character is a digit
Returns true if the specified character is a letter
Returns true if the character is a letter or a digit
Returns true if the character is a lowercase letter
Returns true if the character is an uppercase letter
Returns the lowercase of the specified character
Returns the uppercase of the specified character

Examples

```
Character charObject = new Character('b');
```

```
charObject.compareTo(new Character('a'))  
    returns 1
```

```
charObject.compareTo(new Character('b'))  
    returns 0
```

```
charObject.compareTo(new Character('c'))  
    returns -1
```

```
charObject.compareTo(new Character('d'))  
    returns -2
```

```
charObject.equals(new Character('b'))  
    returns true
```

```
charObject.equals(new Character('d'))  
    returns false
```

StringBuilder and StringBuffer

- The StringBuilder/StringBuffer class is an alternative to the String class:
 - StringBuilder/StringBuffer can be used wherever a string is used
 - StringBuilder/StringBuffer is more flexible than String
 - You can add, insert, or append new contents into a string buffer, whereas the value of a String object is fixed once the string is created

StringBuilder Constructors

java.lang.StringBuilder

+StringBuilder()

Constructs an empty string builder with capacity 16.

+StringBuilder(capacity: int)

Constructs a string builder with the specified capacity.

+StringBuilder(s: String)

Constructs a string builder with the specified string.

Modifying Strings in the Builder

java.lang.StringBuilder

```
+append(data: char[]): StringBuilder
+append(data: char[], offset: int, len: int):
  StringBuilder
+append(v: aPrimitiveType): StringBuilder

+append(s: String): StringBuilder
+delete(startIndex: int, endIndex: int):
  StringBuilder
+deleteCharAt(index: int): StringBuilder
+insert(index: int, data: char[], offset: int,
  len: int): StringBuilder
+insert(offset: int, data: char[]):
  StringBuilder
+insert(offset: int, b: aPrimitiveType):
  StringBuilder
+insert(offset: int, s: String): StringBuilder
+replace(startIndex: int, endIndex: int, s:
  String): StringBuilder
+reverse(): StringBuilder
+setCharAt(index: int, ch: char): void
```

Appends a char array into this string builder.

Appends a subarray in data into this string builder.

Appends a primitive type value as a string to this builder.

Appends a string to this string builder.

Deletes characters from startIndex to endIndex.

Deletes a character at the specified index.

Inserts a subarray of the data in the array to the builder at the specified index.

Inserts data into this builder at the position offset.

Inserts a value converted to a string into this builder.

Inserts a string into this builder at the position offset.

Replaces the characters in this builder from startIndex to endIndex with the specified string.

Reverses the characters in the builder.

Sets a new character at the specified index in this builder.

Examples

```
StringBuilder stringBuilder =  
    new StringBuilder();  
stringBuilder.append("Java");  
stringBuilder.insert(2, "HTML and ");  
stringBuilder.delete(3, 4);  
stringBuilder.deleteCharAt(5);  
stringBuilder.reverse();  
stringBuilder.replace(4, 8, "HTML");  
stringBuilder.setCharAt(0, 'w');
```

stringBuilder:

Java

JaHTML and va

JaHML and va

JaHMLand va

av dnaLMHaJ

av dHTMLHaJ

wv dHTMLHaJ

The toString, capacity, length, setLength, and charAt Methods

java.lang.StringBuilder

+toString(): String

+capacity(): int

+charAt(index: int): char

+length(): int

+setLength(newLength: int): void

+substring(startIndex: int): String

+substring(startIndex: int, endIndex: int):
String

+trimToSize(): void

Returns a string object from the string builder.

Returns the capacity of this string builder.

Returns the character at the specified index.

Returns the number of characters in this builder.

Sets a new length in this builder.

Returns a substring starting at startIndex.

Returns a substring from startIndex to endIndex-1.

Reduces the storage size used for the string builder.

Command-Line Parameters

```
class TestMain {  
    public static void main(String[] args) {  
        ...  
    }  
}
```

- Run with:

```
java TestMain arg0 arg1 arg2 ... argn
```

or EclipseIDE arguments

Processing Command-Line Parameters

- In the main method, get the arguments from `args[0]`, `args[1]`, ..., `args[n]`, which corresponds to `arg0`, `arg1`, ..., `argn` in the command line or EclipseIDE arguments

```
javac Calculator.java
```

```
java Calculator 1 + 2
```

```
3
```


Command-Line Parameters

```
public class Calculator {  
    public static void main(String[] args) {  
        if (args.length != 3) {  
            System.out.println("Usage: java Calculator  
                                operand1 operator operand2");  
            System.exit(0);  
        }  
        int result = 0;  
        switch (args[1].charAt(0)) {  
            case '+':      result = Integer.parseInt(args[0]) +  
                           Integer.parseInt(args[2]);  
                           break;  
            ...  
        }  
    }  
}
```

Matching, Replacing and Splitting by Patterns

- You can match, replace, or split a string by **specifying a pattern**
= *regular expressions*

```
"Java is fun".matches("Java.*") ;
```

```
"Java is cool".matches("Java.*") ;
```

Social security numbers is **xxx-xx-xxxx**, where **x** is a digit:

```
[\\d]{3}-[\\d]{2}-[\\d]{4}
```

An even number ends with digits **0, 2, 4, 6, or 8**:

```
[\\d]*[02468]
```

Telephone numbers **(xxx) xxx-xxxx**, where **x** is a digit and the first digit cannot be zero:

```
\\([1-9][\\d]{2}\\) [\\d]{3}-[\\d]{4}
```

Regular Expressions

Regular Expression	Matches	Example
<code>x</code>	a specified character <code>x</code>	Java matches Java
<code>.</code>	any single character	Java matches J..a
<code>(ab cd)</code>	ab or cd	ten matches t(en im)
<code>[abc]</code>	a, b, or c	Java matches Ja[uvw x]a
<code>[^abc]</code>	any character except a, b, or c	Java matches Ja[^ars]a
<code>[a-z]</code>	a through z	Java matches [A-M]av[a-d]
<code>[^a-z]</code>	any character except a through z	Java matches Jav[^b-d]
<code>[a-e[m-p]]</code>	a through e or m through p	Java matches [A-G[I-M]]av[a-d]
<code>[a-e&&[c-p]]</code>	intersection of a-e with c-p	Java matches [A-P&&[I-M]]av[a-d]
<code>\d</code>	a digit, same as [1-9]	Java2 matches "Java[\\d]"
<code>\D</code>	a non-digit	\$Java matches "[\\D][\\D]ava"
<code>\w</code>	a word character	Java matches "[\\w]ava"
<code>\W</code>	a non-word character	\$Java matches "[\\W][\\w]ava"
<code>\s</code>	a whitespace character	"Java 2" matches "Java\\s2"
<code>\S</code>	a non-whitespace char	Java matches "[\\S]ava"
<code>p*</code>	zero or more occurrences of pattern <code>p</code>	Java matches "[\\w]*"
<code>p+</code>	one or more occurrences of pattern <code>p</code>	Java matches "[\\w]+"
<code>p?</code>	zero or one occurrence of pattern <code>p</code>	Java matches "[\\w]?Java"
<code>p{n}</code>	exactly <code>n</code> occurrences of pattern <code>p</code>	Java matches "[\\w]?ava"
<code>p{n,}</code>	at least <code>n</code> occurrences of pattern <code>p</code>	Java matches "[\\w]{4}"
<code>p{n,m}</code>	between <code>n</code> and <code>m</code> occurrences (inclusive)	Java matches "[\\w]{3,}"
		Java matches "[\\w]{1,9}"

Replacing and Splitting Strings

java.lang.String

+matches(regex: String): boolean

Returns true if this string matches the pattern.

+replaceAll(regex: String,
replacement: String): String

Returns a new string that replaces all
matching substrings with the replacement.

+replaceFirst(regex: String,
replacement: String): String

Returns a new string that replaces the first
matching substring with the replacement.

+split(regex: String): String[]

Returns an array of strings consisting of the
substrings split by the matches.

Examples

```
String s = "Java Java Java".replaceAll("v\\w", "wi") ;  
// "Jawi Jawi Jawi"
```

```
String s2 = "Java Java Java".replaceFirst("v\\w", "wi") ;  
// "Jawi Java Java"
```

```
String[] s3 = "Java1HTML2Perl".split("\\d") ;  
// ["Java", "HTML", "Perl"]
```

Designing a Class

- Coherence: A class should describe a single entity
- Separating responsibilities: A single entity with too many responsibilities can be broken into several classes to separate responsibilities
- Classes are designed for reuse!
- Provide a public no-arg constructor and override the **equals** method and the **toString** method defined in the **Object** class whenever possible

Designing a Class

- Follow standard Java programming style and naming conventions:
 - Choose informative names for classes, data fields, and methods,
 - Place the data declaration before the constructor, and place constructors before methods,
 - Always provide a constructor and initialize variables to avoid programming errors.