Programming in Java
Part II – Classes

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Agenda

Classes
instance variables, methods, static, ...

Constructors
default, multiple, the keyword “this”, …

Initialization

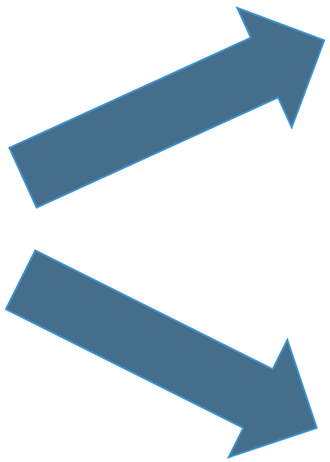
Equality and equivalence

Wrapper classes
unboxing, boxing, …

Classes

A class is a template for data objects

Inside a class it is possible to define



data elements
(called instance variables)

functions
(called methods)

Classes

Class Book with three instance variables

```
public class Book {
  String title;
  String author;
  int numberOfPages;
}
```

```
Book b1 = new Book();
Book b2 = new Book();
Book b3;
b3 = new Book();
```

New instances of the class can be created with new

The instance variables can be accessed with the dot notation

```
b1.title = "Java 8 Lambdas";
```

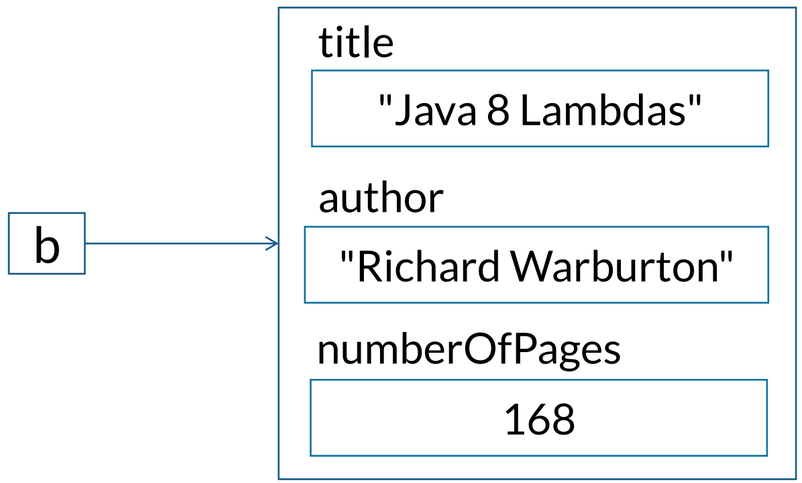
Classes

```
public class ExampleBooks {
  public static void main(String[] args) {

    Book b = new Book();

    b.title = "Java 8 Lambdas";
    b.author = "Richard Warburton";
    b.numberOfPages = 168;
    System.out.println(b.title + " : " + b.author +
                       " : " + b.numberOfPages);
  }
}
```

```
public class Book {
  String title;
  String author;
  int numberOfPages;
}
```



Constructors

- ✓ The constructors allow the creation of instances that are properly initialized

- ✓ A constructor is a method that:
has the same name of class to which it belongs and
has no specification for the return value.

- ✓ It is possible to define more than one constructor for a single class

Constructors

```
public class Book {
  String title;
  String author;
  int numberOfPages;

  Book(String tit,String aut,int num) {
    title = tit;
    author = aut;
    numberOfPages = num;
  }
}
```

Once a constructor has been defined, the default constructor Book() is not available any more.

```
public class ExampleBooks2 {
  public static void main(String[] args) {
  Book b = new Book("Java 8 Lambdas","Richard Warburton",168);
  System.out.println(b.title + " : " + b.author + " : " + b.numberOfPages);
  }
}
```

Multiple constructors

```
public class Book {
  String title;
  String author;
  int numberOfPages;
  String ISBN;

  Book(String tit,String aut,int num) {
    title = tit; author = aut;
    numberOfPages = num;
    ISBN = "unknown";
  }

  Book(String tit,String aut,int num,String isbn) {
    title = tit; author = aut;
    numberOfPages = num;
    ISBN = isbn;
  }
}
```

It must be possibly to identify them based on the argument definition

```
a = new Book("Java 8 Lambdas","Richard Warburton",168);
```

```
b = new Book("Java 8 Lambdas","Richard Warburton",168,"0-13-027363");
```

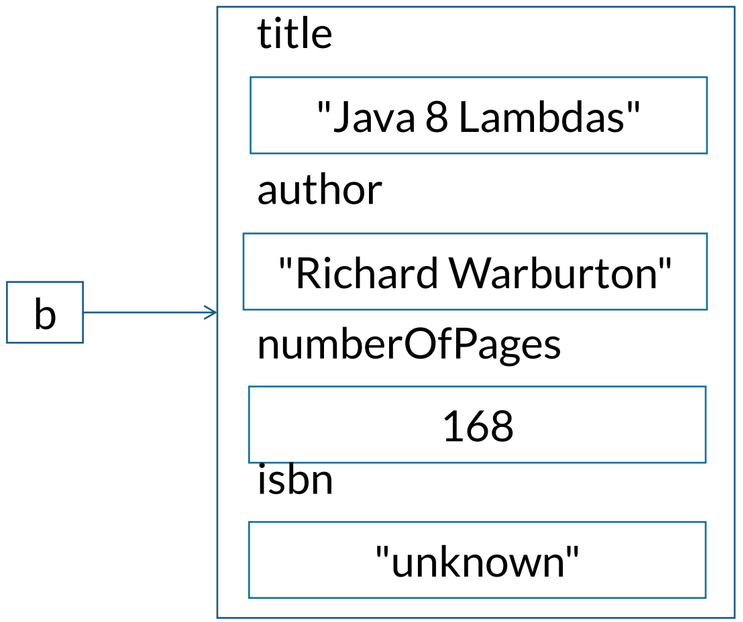
Methods

- ✓ A method is used to implement the messages that an instance (or a class) can receive.
- ✓ It is called by using the dot notation.
- ✓ It is implemented as a function, specifying arguments and type of the return value.

Methods

```
public class Book {
...
public String getInitials() {
   String initials = "";
   for(int i = 0;i < author.length();i++) {
    char currentChar = author.charAt(i);
    if (currentChar >= 'A' && currentChar <='Z')
     initials = initials + currentChar + '.';
   }
   return initials;
  }
}
```

```
b = new Book("Java 8 Lambdas",
                    "Richard Warburton",168);
System.out.println(b.getInitials());
```



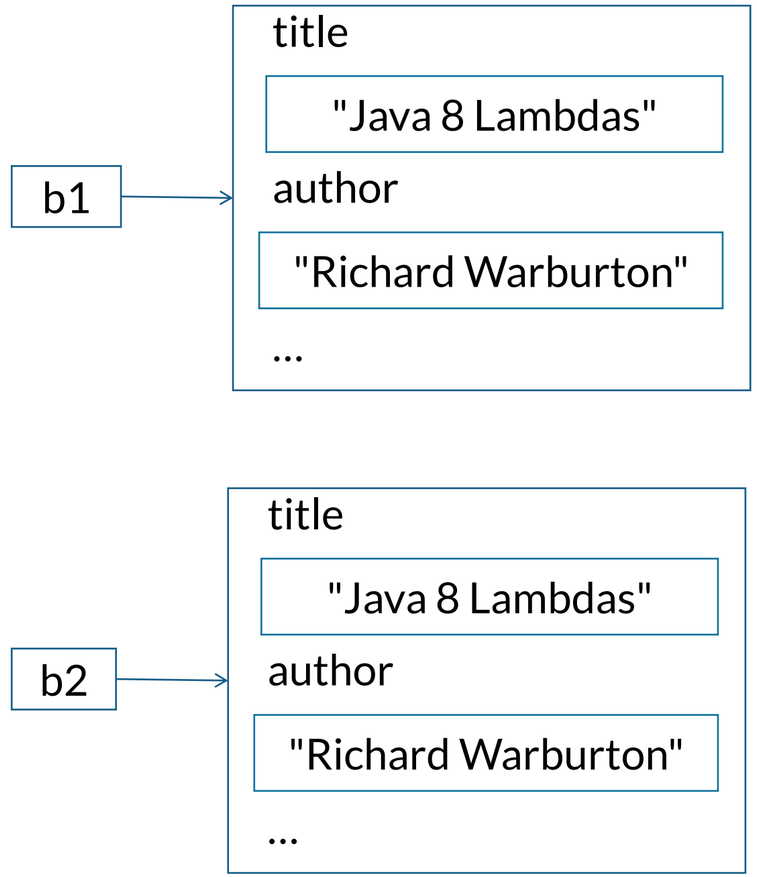

```
Initials: R.W.
```

Equality and equivalence

```
public class ExampleBooks6 {
 public static void main(String[] args) {

  Book b1 = new Book("Java 8 Lambdas","Richard Warburton",168);
  Book b2 = new Book("Java 8 Lambdas","Richard Warburton",168);

  if (b1 == b2)
   System.out.println("Same");
  else
   System.out.println("Different");
 }
}
```



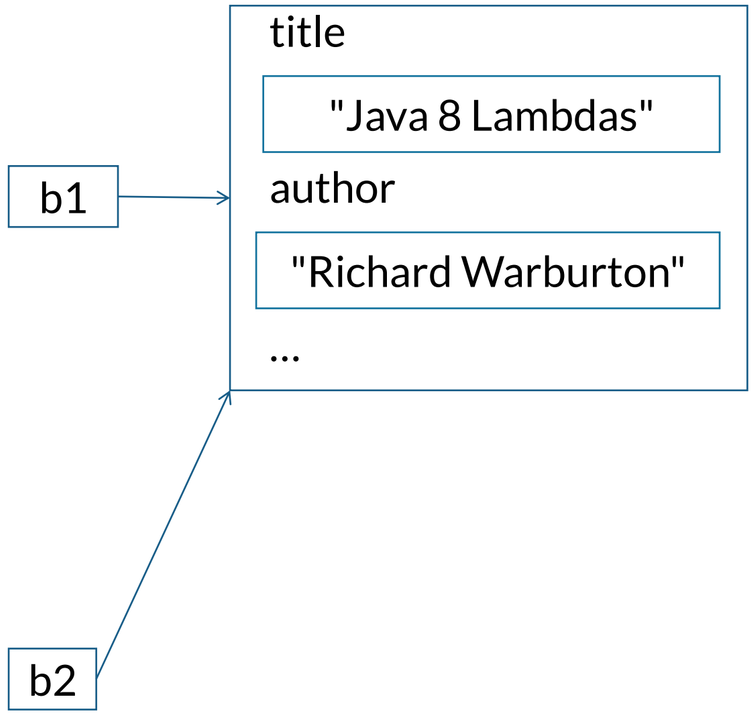

```
$ java ExampleBooks6
Different
```

Equality and equivalence

```
public class ExampleBooks6a {
 public static void main(String[] args) {

  Book b1 = new Book("Java 8 Lambdas","Richard Warburton",168);
  Book b2 = b1;

  if (b1 == b2)
   System.out.println("Same");
  else
   System.out.println("Different");
 }
}
```




```
$ java ExampleBooks6a
Same
```

Static instance variables

- ✓ Class variables are fields that belong to the class and do not exist in each instance.

- ✓ There is always only one copy of this data field, independently of the number of the instances that were created.

Static instance variables

```
public class Book {
 …
 static String location;
 …
 public void setLocation(String name) {
  location = name;
 }
 public String getLocation() {
  return location;
 }
}
```

```
Book b1,b2;
b1 = new Book("Java 8 Lambdas","Richard Warburton",168);
b2 = new Book("Java in a nutshell","David Flanagan",353);
b1.setLocation("Kampar");
System.out.println("Location of book b1: " + b1.getLocation());
System.out.println("Location of book b2: " + b2.getLocation());
```

```
Location of book b1: Kampar
Location of book b2: Kampar
```

Static methods

- ✓ With the same idea of the static data members, it is possible to define class methods or static methods
- ✓ These methods do not work directly with instances but with the class
- ✓ Can access only static instance variables

Static methods

The method getLocation() is a good candidate to be defined as a static method

```
public class Book {
 …
 static String location;
 …
 public static String getLocation() {
   return "Books are located in" + location;
 }
}
```

```
Book b1,b2;
b1 = new Book("Java 8 Lambdas","Richard Warburton",168);
b2 = new Book("Java in a nutshell","David Flanagan",353);
b1.setLocation("Kampar");
System.out.println(b2.getLocation());
System.out.println(Book.getLocation());
```

```
Book are located in: Kampar
Books are located in: Kampar
```

Instance variables initialization

- ✓ All instance variables are guaranteed to have an initial value.
- ✓ The value is 0 for basic types and null for references
- ✓ Instance variables can be also initialized by calling instance methods

Instance variables initialization

```
public class Values {
   int x = 2;
   int y;
   float f = inverse(x);
   String s;
   Book b;
  Values(String str) { s = str; }
  public float inverse(int value) { return 1.0F / value; }
  public void dump() { System.out.println("" + x + "," + y + "," + f + "," + s + "," + b);
  }
}
```

```
public class InitialValues {
  public static void main(String[] args)
{
   Values v = new Values("hello");
   v.dump()
  }
}
```

```
$ java InitialValues
2, 0, 0.5, hello, null
```

Initialization block

a block of code inside the body of a class, but outside any methods or constructors, used for initialization

```
public class Values2 {
  private int x;
  private static String s;
  {
    x = 123;
  }
  static {
    s = "abc"
  }
}
```

instance initialization block:
executed once per instance

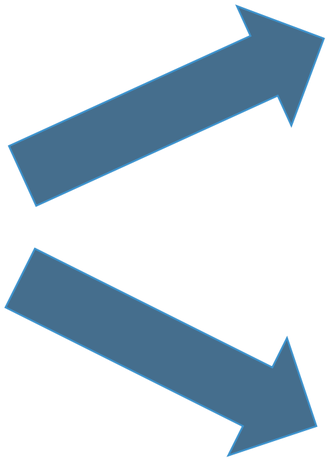
static initialization block:
executed once per class

why should we use them?

The keyword “this”

The keyword this, when used inside a method, refers to the receiver object

It has two main uses:



to return a reference to the receiver object from a method

to call constructors from other constructors.

The keyword “this”

The class Book has two constructors

```
Book(String tit,String aut,int num) {
 title = tit; author = aut; numberOfPages = num;
 ISBN = "unknown";
}
Book(String tit,String aut,int num,String isbn) {
 title = tit; author = aut; numberOfPages = num;
 ISBN = isbn;
}
```

```
Book(String tit,String aut,int num,String isbn) {
 this(tit,aut,num);
 ISBN = isbn;
}
```

It is better to define the second constructor in terms of the first one

do you see any possible drawback?

The keyword “this”

The method setLocation() in the previous Book class could have been defined as:

```
public class Book {
 ...
 static String location;
 ...
 public Book setLocation(String name) {
  location = name;
  return this;
 }
}
```

Operations can be performed now in "cascade" mode

```
Book b1;
b1 = new Book("Java 8 Lambdas","Richard Warburton",168);

System.out.println("Initials: " + b1.setLocation("Kampar").getInitials());
```

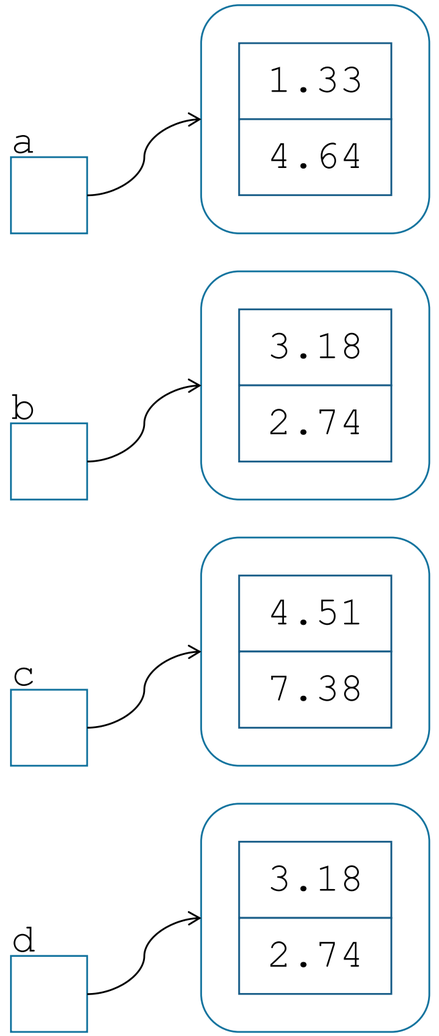
A complete example

```
public class TestComplex {

 public static void main(String[] args) {
  Complex a = new Complex(1.33,4.64);
  Complex b = new Complex(3.18,2.74);
  Complex c = a.add(b);

  System.out.println("c=a+b=" + c.getReal() + " " + c.getImaginary());

  Complex d = c.sub(a);
  System.out.println("d=c-a=" + d.getReal() + " " + d.getImaginary());
 }
}
```




```
$ java TestComplex
c=a+b= 4.51 7.38 d=c-a= 3.18 2.74
```

A complete example

```
public class Complex {

 double real;    // real part
 double im;      // imaginary part

 Complex(double real, double im) {
  this.real = real;
  this.im = im;
 }

 public double getReal() {
  return real;
 }

 public double getImaginary() {
  return im;
 }
```

```
a = new Complex(1.33,4.64);
```

```
double realPart = a.getReal();
```

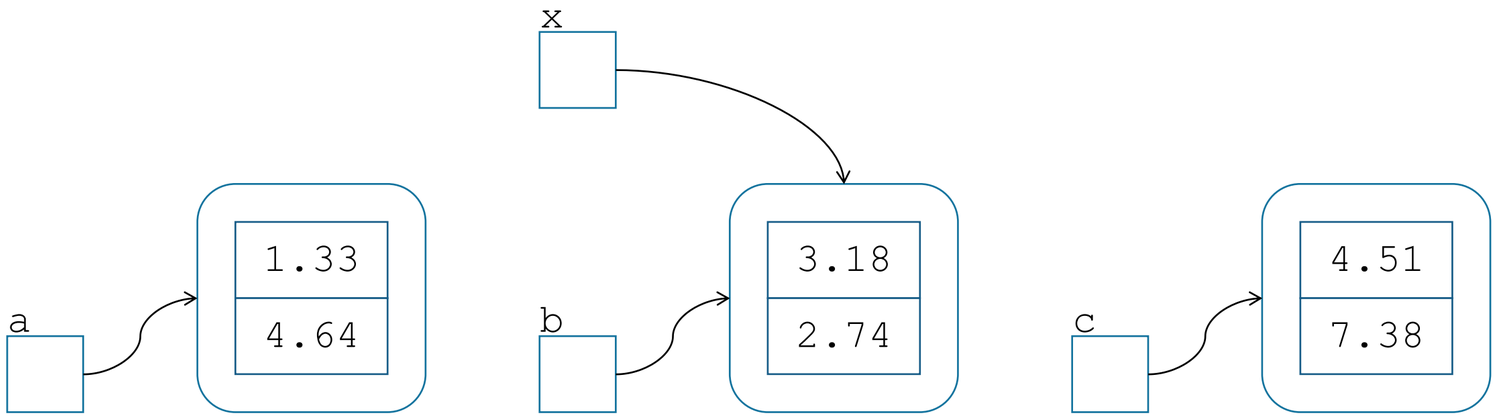
```
double imPart = a.getImmaginary();
```

A complete example

```
public Complex add(Complex x) {
  return new Complex(real + x.real,im + x.im);
}

public Complex sub(Complex x) {
  return new Complex(real - x.real,im - x.im);
}
```

```
Complex c = a.add(b);
```



A complete example

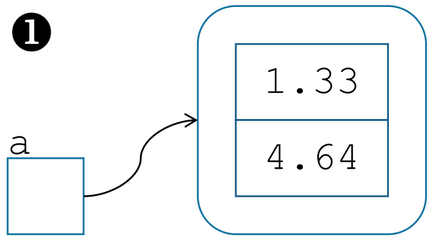
```
public Complex addReal(double x)
{
 real += x;
 return this;
}
Complex(Complex x) {
 this(x.real,x.im);
}
```

The method addReal() increments just the real part of the receptor of the message with the value passed as argument

❶
❷
❸

```
Complex a = new Complex(1.33,4.64);
a.addReal(2.0);
a.addReal(3.0).addReal(3.23);
```

❶



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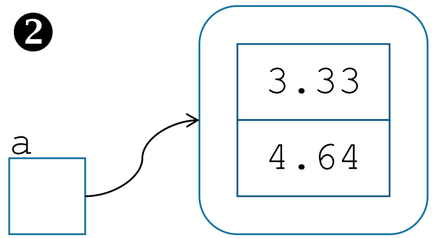

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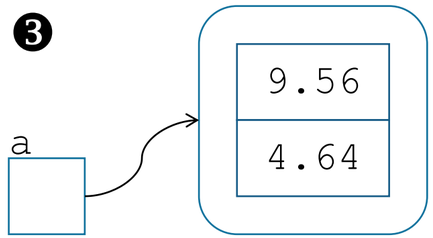

The new constructor can be used for assignment operations

```
Complex b = new Complex(a);
```

Type wrappers

- ✓ Primitive types are used for performance reasons, however many situations require an object
- ✓ Type wrappers are classes that encapsulate primitive types within an object
- ✓ There exist one type wrapper class for each primitive type

Boxing and unboxing

boxing and unboxing operations are provided to encapsulate/extract the values to/from an object.

```
Integer iObject = Integer.valueOf(21);
int i = iObject.intValue();
```

```
Integer iObject = 21;
int i = iObject;
```

However, auto-boxing and auto-unboxing operations are provided to make easier to work with wrapped objects:

However… these operations add overhead, to be used only when required.

Wrapper classes

There are many options to create and handle objects of wrapper classes

```
Integer iObject = Integer.valueOf(21);
int i = iObject.intValue();

Double dObject = Double.valueOf("121.1");
double d = dObject.doubleValue();
int x = dObject.intValue();
```

```
String str = "123.45";
float f = Float.parseFloat(str);

int i = Integer.MAX_VALUE;

Character c = Character.valueOf('a');
Boolean b = Character.isLowerCase(c);
```

and nice support from the classes

Thank you!

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