CHAPTER 3
IMPLEMENTING CLASSES

(A. Nguyen)

Classes: information hiding & encapsulation

JC08-3.1

(A. Nguyen)

Objectives

- Write a complete class from scratch, i.e., with all 3 main parts: fields, constructor(s), and methods
- Use your own class (which is similar to using any other class, such as from the Java Library)
- Write documentation, similar to what is in the Java APIs
- Understand the flow of control and know how to trace, by using the debugger (**Step**, **Step Into**, and inspection of variables)

Class

- A class represents a category of objects that share common **characteristics** and **behaviors**; it is a blue print for all objects in that class
- For example,
  - a class many be `BankAccount`
  - an object of that class may be `momsAccount`
- A class has 3 main parts, as documented in the Java API:
  - Instance variables aka fields, to represent the **characteristics**
  - Constructors, to initialize the fields
  - Methods, to represent the **behaviors**

Information hiding – private fields

- A field keeps one piece of information about an object
- A field is declared with a (reserved) word: `public` or `private`:

  `private double balance;` // request RAM space & initialize to 0

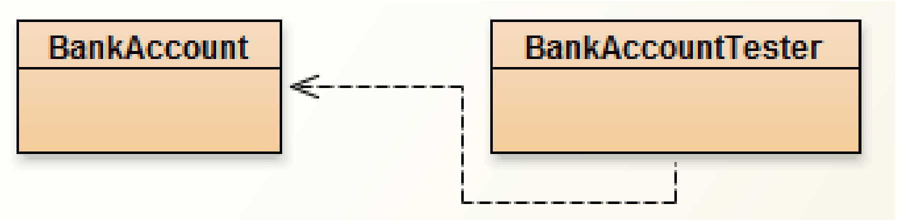
- A field is **often** declared as `private` to “hide” from the client of the class – information hiding – which makes the modification of the information safe

Encapsulation – methods

- A method is a set of instructions to carry out a task and/or return a result
- To be able to use a class, a programmer/you only need to know the method header or method signature (and not how things are done in the body); this is called encapsulation; i.e., a method is a blackbox

Client of a class

- A client of a class A is a class B that uses class A
- BlueJ automatically draws an arrow from the client of a class to that class; e.g.: `BankAccountTester` is a client of class `BankAccount`



Public Interface & Implementing a class

JC08-3.2-3.4

(A. Nguyen)

Parts of a class

- To implement a class or method is to write or code it
- A class has 3 main parts, usually presented in this order:
  - Fields
  - Constructors
  - Methods

Parts of a class

```
public class BankAccount
{
   // Fields
   private double balance;
   // Constructors
   public BankAccount()
   {
      // body– not yet coded
   }
   public BankAccount(double initialBalance)
   {
      // body-- not yet coded
   }
   // Methods
   public void deposit(double amount)
   {
      // body-- not yet coded
   }
   public void withdraw(double amount)
   {
      // body-- not yet coded
   }
   public double getBalance()
   {
      // body-- not yet coded
   }
}
```

Naming convention

- A name in Java must not contain blanks; thus, all words are next to each other, and each word starts with an upper-case letter (or the words are "separated" with an underscore); e.g., `unitPrice`
- Names starting with an upper-case letter are class name (and, thus, constructor name); e.g., `Rectangle`
- Names starting with an lower-case letter are variable names and method names; e.g., `setHeight`
- Reserved words are in all lower-case letters
- Names in all upper-case letters are constants (i.e., unmodifiable); e.g., `Color.RED`

The fields

- It is advisable to declare a field `private`, so that it cannot be modify by other classes; e.g.:

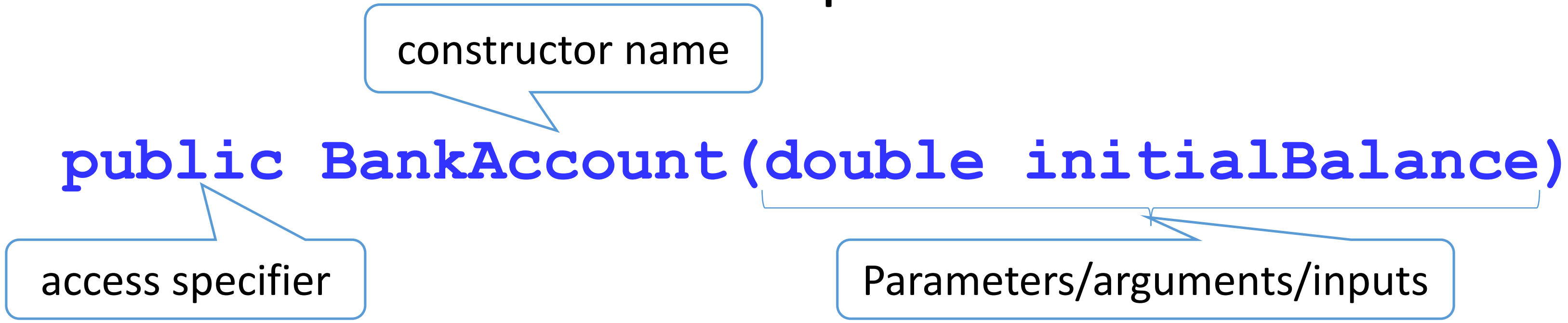
  `private double balance;` // request RAM space & initialize to 0

- A `private` field is accessible by an accessor (whose name usually starts with `get`), and possibly modifiable by a mutator (whose name usually starts with `set`)
- In the absence of the word `private`, the field is `public`
- A field is a kind of variables (instance variable), so it follows the naming rules of variables
- A meaningful field name is a noun

JM02-03

Constructors

- A constructor is a set of statements whose purpose is to initialize the data about an object
- A constructor name is ***always*** the same as its class name (and is capitalized), which is also the same as the name of the source file (i.e., with extension .java)
- A constructor header has 3 parts:



```
public BankAccount(double initialBalance)
```

constructor name

access specifier

Parameters/arguments/inputs

JM02-09

Constructors (cont.)

- When a class has no constructor, Java provides a no-args constructor and set the fields to default values: zero for a numeric value, `null` for an object (i.e., non-existing object), `false` for `boolean`.
- Tip: consult the field names (in the “field” section) to make sure that all fields are initialized in the constructor
- The constructor may be overloaded: same constructor name, with different data types for parameters
- Each parameter is expressed with a data type ***and*** a name; and the parameters are separated by commas (inside the parentheses) – as shown in the API

Constructors: errors

- A constructor does NOT have a return value or `void`, so do not include it in the signature because doing that would make it a method (i.e., no longer a constructor to be called at `new`):

  public ~~double~~ BankAccount(double initialBalance)

  public ~~void~~ BankAccount(double initialBalance)

- Do NOT re-declare a field name in the constructor because re-declaring asks for (different) RAM space for a local variable with the same name as the field:

  ~~double~~ balance = initialBalance;

- For a field that is an object, if you forget to create a new object, the default initialized value is `null` (i.e., non-existing object), which will cause a run-time error when asked to do something

Methods

- A method is a set of Java statements that does a task and/or returns a value
- The programmer who creates a method chooses the method’s name (which is usually a verb), starting with a lower-case letter and an upper-case letter at the beginning of each word; e.g., method `getHeight` of class `Rectangle`

Methods (cont.)

- A method is often declared `public`, so that other classes can call it; `public` methods appear in the API
- A method can also be declared `private`, so that only the methods of its own class can call – `private` methods do not appear in the API
- A method signature has 4 main pieces of information:
  - Access specifier: `public` or `private`
  - Return value or `void`
  - Method name
  - Parameters inside the parentheses
- Note: a data type must precede ***each*** parameter name

Methods (cont.)

- A method may have inputs (called parameters) and/or output (called return value)
- The parameters of a method follow the same rules & convention as those of a constructor

Methods (cont.)

- A method with a return value **must** have a `return` statement:

```
public double getBalance() {
 return balance;
}
```

- A `return` statement, in this case, does two things: (1) quit the method, (2) pass the **one** result (of the same **return type** declared in the method signature) to the calling method
- **Error**: a `return` statement is NOT equivalent to `System.out.println/print` because a print statement simply displays text in the console window & still stays in the current method

Methods (cont.)

- Like a constructor, a method may be overloaded, to do the same task but with different given info: same method name, with different data types for parameters
- Example: overloaded method from the `Rectangle` class:

```
void setBounds(Rectangle r)
void setBounds(int x, int y, int width, int height)
```

Methods (cont.)

- Overloaded methods must have different **data types for parameters**
- The difference in return data type or `void` alone does NOT meet this requirement – see case (1) below
- The difference in the parameter names alone does NOT meet this requirement – see case (2) below

```
public class shape {
    // ...
    public void move (int x, int y) { ... }         Case 1
    public Point move (int x, int y) { ... }
    // ...
    public Point expand(int x, int y) { ... }       Case 2
    public Point expand(int h, int v) { ... }
    // ...
}
```

Documenting the Public Interface

- Documentation comments are written inside /** … */
- For the entire class, place the comments at the beginning of the source file, and use @author and @version
- Example for class BankAccount:

```
/**
 * A bank account has a balance that can be changed by
 * deposits and withdrawals.
 * @author C. Horstmann, modified by A. Nguyen
 * @version v. 1.0
*/
```

- With your source file in BlueJ at top, switch (with the button at top right) from “Source Code” to “Documentation” to see the document

Documenting the Public Interface (cont.)

- For a constructor or method, place the comments ***before*** it, and use @param and/or @return, where appropriate:

```
/**
   Deposits money into the bank account.
   @param amount the amount to deposit
*/
public void deposit(double amount) {…}
```

```
/**
  Gets the current balance of the bank account.
  @return the current balance
*/
public double getBalance() {…}
```

- Switch to “Documentation” to check

Unit Testing

- After writing/coding/implementing a class, you must test to make sure that there are no bugs
- To test, write a Tester class with just the main program (i.e., same structure as HelloWorld), where you:
  - Create one or more object of the class you want to test
  - Have the object(s) call every method you wrote
  - Verify the results along the way, by writing to the console/terminal window

Tracing objects

JC08-3.5

(A. Nguyen)

Tracing technique

- A programmer uses this technique understand what the code does to the values in the method
- Follow the statements in the method, and write/replace the values of the variables
- The BlueJ Debugger can help with the tracing skills
  - Step or Step Into: get to the next statement to be executed
  - See the contents of a variable of primitive data type, or of an object

Local variables

JC08-3.6

(A. Nguyen)

About variables

- There are 3 kinds of variables:
  - Instance variables or fields, belonging to a class – declared inside the body of the class and outside all constructors and methods
  - Parameters or parameter variables, belonging to a constructor or method – declared in the header/signature of a constructor or method
  - Local variables, belonging to a constructor or method – declared inside a constructor or method
- Each kind of variable has a different life span, called scope
- A variable can be used or reassigned only <u>within</u> its scope, i.e., only when it is alive

Scope of variables

- The scope of a field is the entire class; therefore,
  - any constructor or method in the class can use or change it
  - an object carries the values in its field throughout – you can inspect/verify in the debugger
- The scope of a parameter is the entire constructor or method
- The scope of a local variable is from the point it is declared until the end of the block where it is declared (at closing brace)

Initial values of variables

- Programmers do not have to explicitly initialize a field (but it is good practice to). By default, numeric fields are initialized to zeros; and object fields are initialized to null.
- Parameters have (initial) values passed from the calling method.
- Local variables must be initialized before being used, or syntax error.

Errors

- Redeclaring a field means creating a new local variable (of the same name). Then, when the value is assigned to that local variable, the field is untouched. So do NOT redeclare a field. Recall: declare means “give me RAM space”.

```
public BankAcct(double initBal) {
  ~~double~~ balance = initBal;
}
```

- Do remember to initialize a local variable before using it.
- Do not keep *extra* fields; for a **Circle** class, keep **radius**, but NOT **area** or **perimeter** because they can be calculated from **radius** when needed

The “this” Reference

JC08-3.7

(A. Nguyen)

When to use “this”?

- The `this` reserved word refers to “self”. It is used sometimes to **clarify**, and sometimes as a **requirement**.
- When the name of a parameter/input to a method is the same as the name of a field (b/c you cannot think of a good name for the parameter), if there is no `this`, the variable is the parameter:

```
public class Circle {
   private double radius;
   public Circle(double radius)
   {
      radius = radius; // both vars are the parameter/input ← DON’T DO THIS
      this.radius = radius; // this is correct ← DO THIS
   }
   ...
}
```

JM02-09.3

When to use “this”? (cont.)

- When the constructors are overloaded (i.e., same name but different signatures), and you want one constructor to call another:

```
public class Fraction {
   int num;
   int denom;
   public Fraction(int n, int d) {
     num = n;
     denom = d;
   }
   public Fraction() {
     this(1, 1); // “this” refers to the other/overloaded constructor Fraction
   }
   ...
}
```

- The same is done when the methods are overloaded.

Static methods & fields

CALLING METHODS:

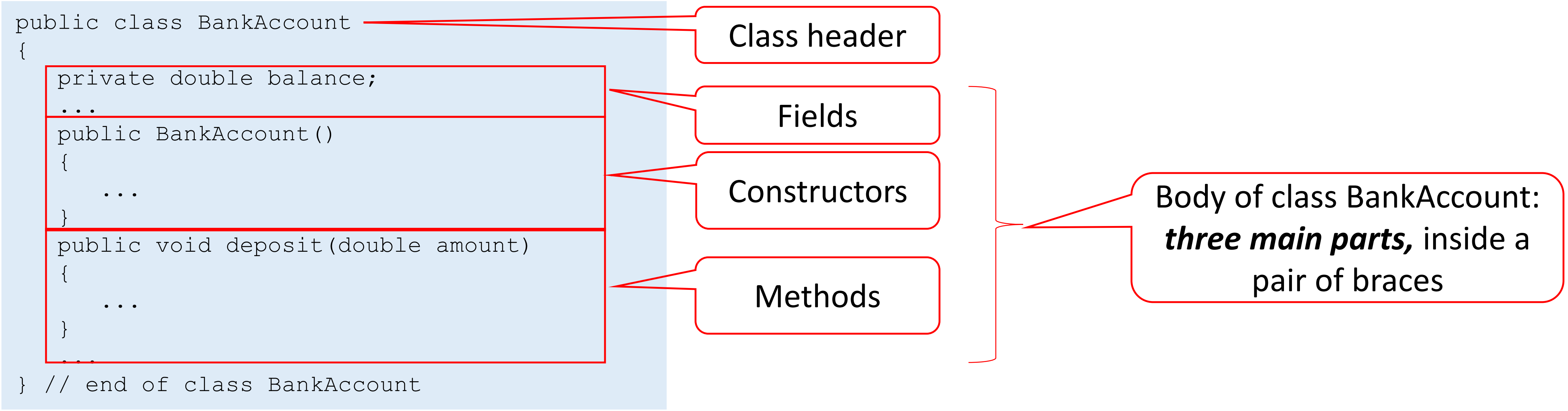
- A method with `static` qualifier belongs to the class, and, hence, is called with the class name as prefix (i.e., it is not necessary to create an object with `new` first): `x = Math.random();`
- A non-static method called by a method of different class must be prefixed by an object already created with `new`: `snoopy.move();`
- A non-static method called by a method of the same class does not need any prefix, or with `this` prefix; e.g., the `multiply` method of `Fraction` may call `reduce`: `reduce();` or `this.reduce();`

ACCESSING FIELDS: Similar rules apply

Organizing classes

Separate files for class & main program

`File BankAccount.java:`



```
public class BankAccount
{
    private double balance;
    ...
    public BankAccount()
    {
       ...
    }
    public void deposit(double amount)
    {
       ...
    }
    ...
} // end of class BankAccount
```

Class header

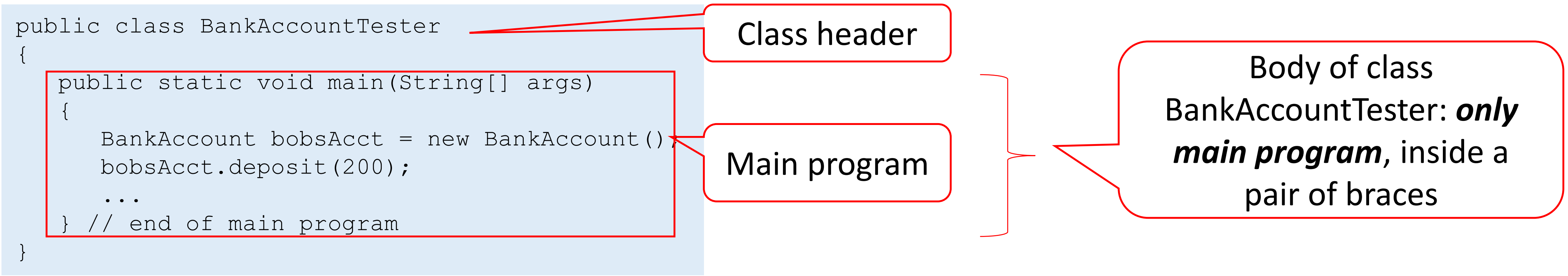
Fields

Constructors

Methods

Body of class BankAccount: ***three main parts,*** inside a pair of braces

`File BankAccountTester.java:`



```
public class BankAccountTester
{
    public static void main(String[] args)
    {
       BankAccount bobsAcct = new BankAccount();
       bobsAcct.deposit(200);
       ...
    } // end of main program
}
```

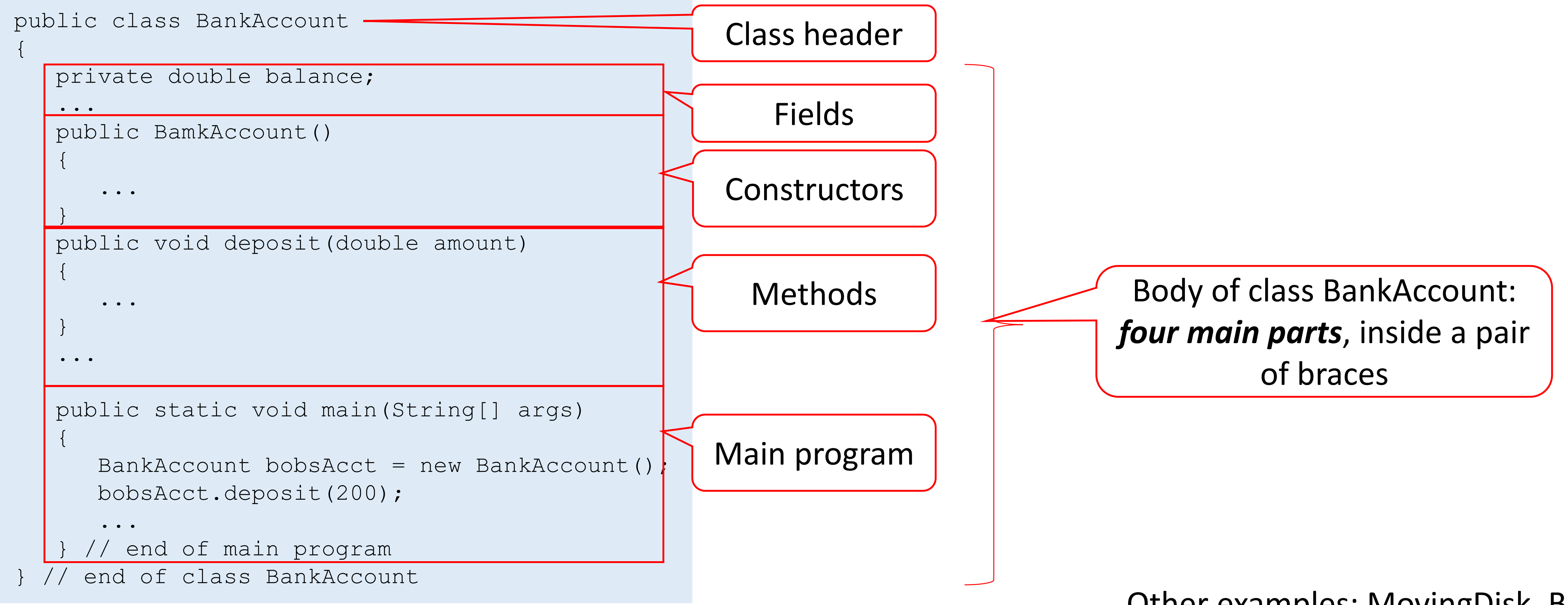
Class header

Main program

Body of class BankAccountTester: ***only main program***, inside a pair of braces

Same file for class & main program

File BankAccount.java:



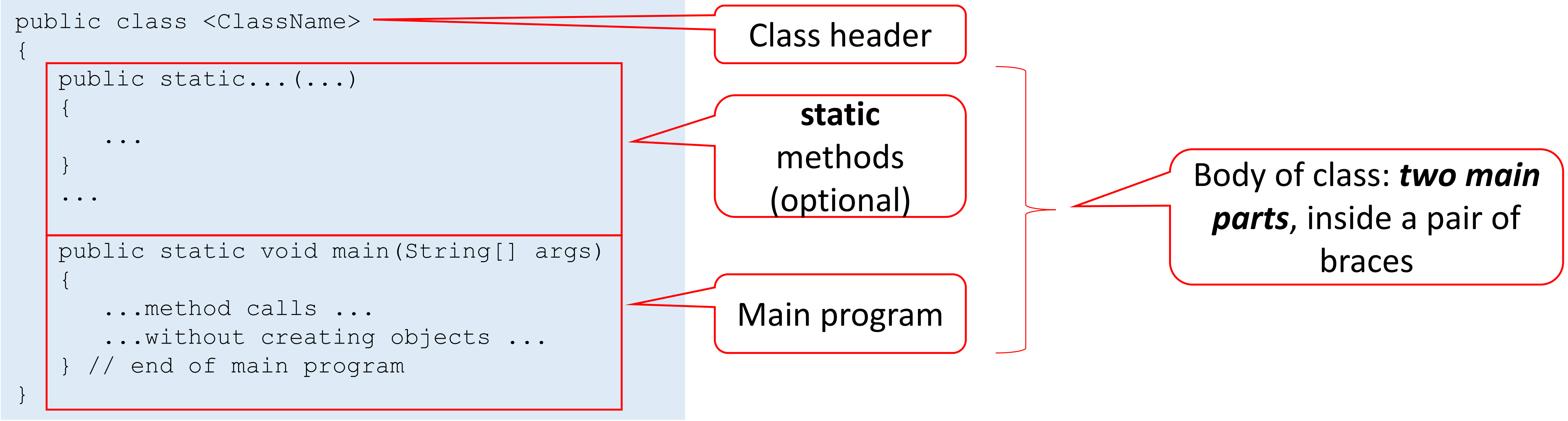
```
public class BankAccount
{
   private double balance;
   ...
   public BamkAccount()
   {
      ...
   }
   public void deposit(double amount)
   {
      ...
   }
   ...

   public static void main(String[] args)
   {
      BankAccount bobsAcct = new BankAccount();
      bobsAcct.deposit(200);
      ...
   } // end of main program
} // end of class BankAccount
```

Body of class BankAccount: ***four main parts***, inside a pair of braces

Other examples: MovingDisk, BMI

Main program with static methods

File <ClassName>.java:



```
public class <ClassName>
{
   public static...(...)
   {
      ...
   }
   ...
   public static void main(String[] args)
   {
      ...method calls ...
      ...without creating objects ...
   } // end of main program
}
```

Class header

static methods (optional)

Main program

Body of class: ***two main parts***, inside a pair of braces

Note that there is not a real class here. And there may be a collection of ***static*** methods or not.
An example of the simplest main program is `HelloWorld`.
This is not object-oriented programming.

THE END