CS1101 Programming and Problem Solving

Dr. Gina Bai

Spring 2023

Logistics

- **ZY-8B** on zyBook > Assignments
  - Due: **Wednesday, April 12**, at 11:59pm
- **ZY-9** on zyBook > Assignments
  - Due: **Wednesday, April 19**, at 11:59pm
- **PA11 – A, B** on zyBook > Chap 11
  - Due: **Thursday, April 20**, at 11:59pm
- Midterm Exam 2 Regrade Request
  - Due: Tuesday, April 11

Recap

1. An object is an entity that encapsulates __________ and __________.

   State (data) and Behavior (methods)

2. (True/False) A class is an object.

   False

3. A class is a _________ for constructing objects.

   Blueprint / Template

Recap

Q: What is the difference between an accessor method and a mutator method?

A. A class can have many accessors but only one mutator.

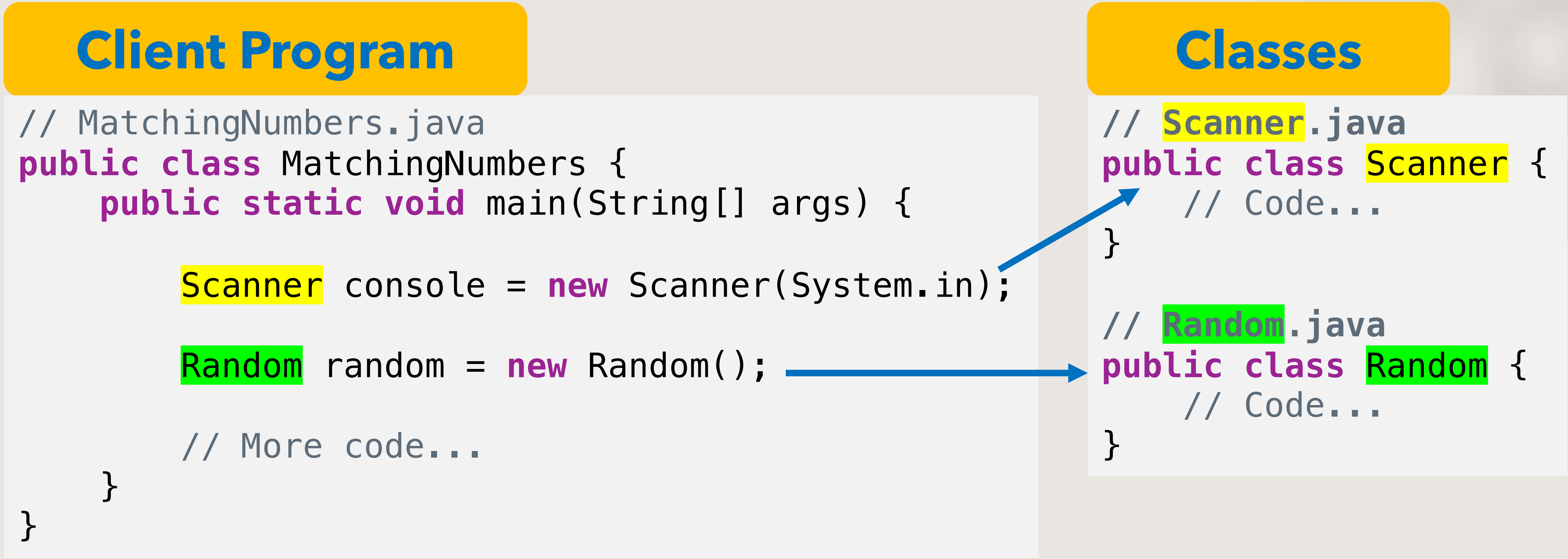
B. Accessors are methods whose code never changes, and mutators are methods where the programmer can change the code over time.

C. Accessors must always use the return type 'void', while mutators do not.

[✓ D.] An accessor provides the client access to data in the object, while a mutator lets the client change the object's state.

E. Accessors' names often begin with 'set', while mutators' names often begin with 'get' or 'is'.

Recap – Client Programs and Classes

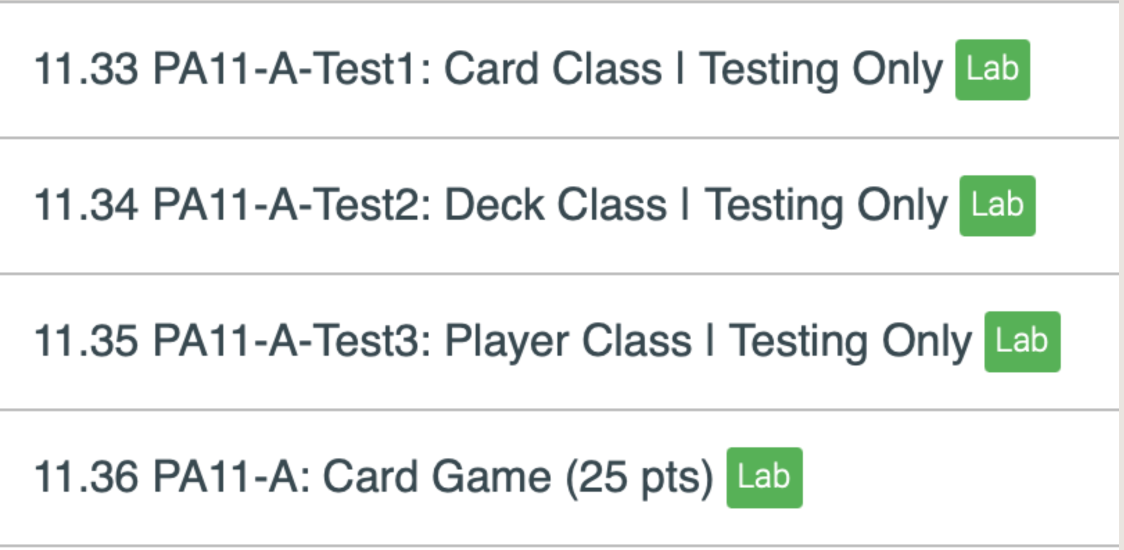


Client Program

```java
// MatchingNumbers.java
public class MatchingNumbers {
    public static void main(String[] args) {

        Scanner console = new Scanner(System.in);

        Random random = new Random();

        // More code...
    }
}
```

Classes

```java
// Scanner.java
public class Scanner {
    // Code...
}

// Random.java
public class Random {
    // Code...
}
```



11.33 PA11-A-Test1: Card Class | Testing Only Lab

11.34 PA11-A-Test2: Deck Class | Testing Only Lab

11.35 PA11-A-Test3: Player Class | Testing Only Lab

11.36 PA11-A: Card Game (25 pts) Lab

Implement Card.java in PA11-A-Test1: Card Class

Implement Deck.java in PA11-A-Test2: Deck Class

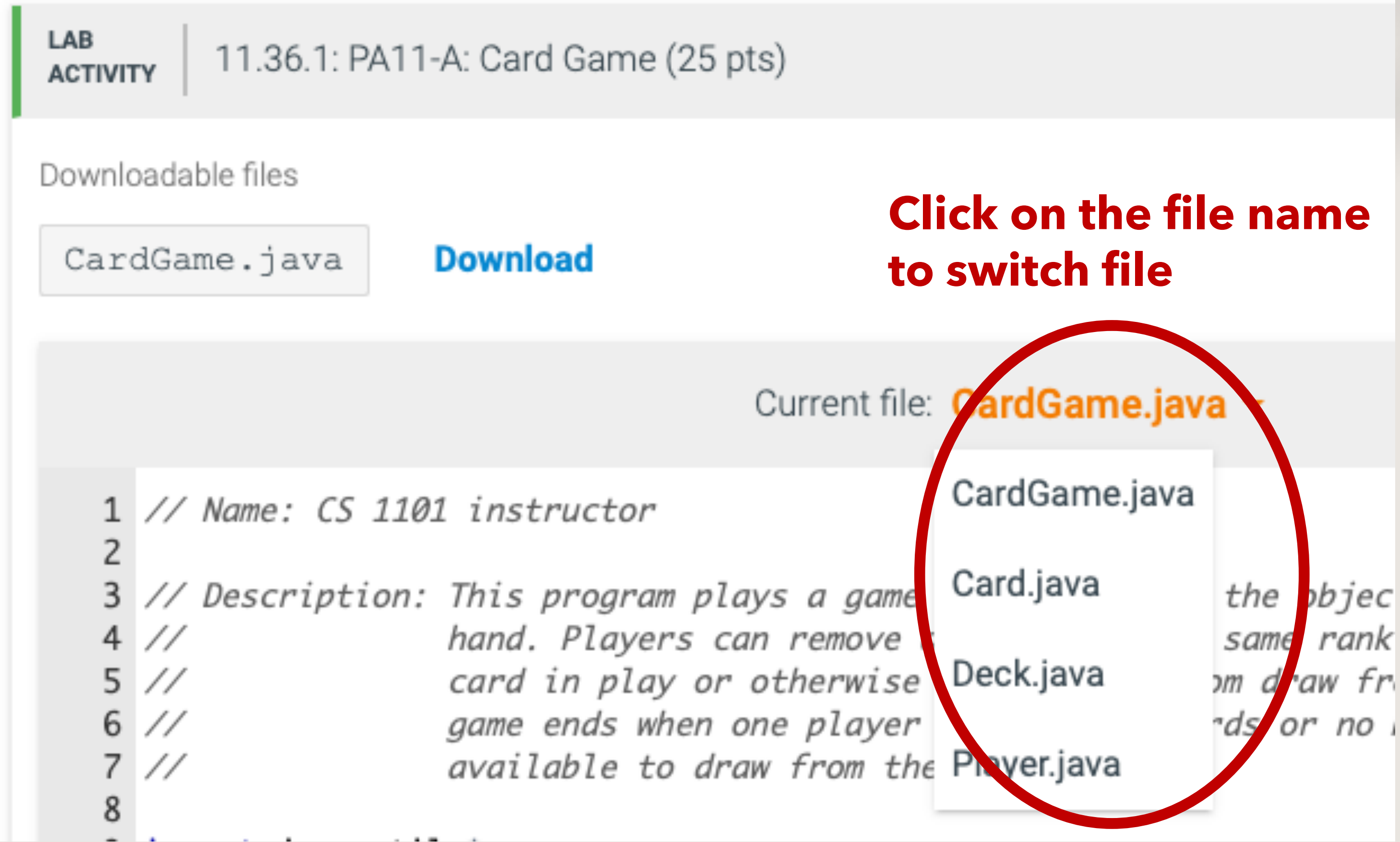
Implement Player.java in PA11-A-Test3: Player Class

Submit Card.java, Deck.java, and Player.java
in PA11-A: Card Game

CardGame.java is the provided client program/driver.

MUST-DO: Run all the files against the tests!

Same for PA11-B



LAB ACTIVITY | 11.36.1: PA11-A: Card Game (25 pts)

Downloadable files

CardGame.java Download

Click on the file name to switch file

Current file: CardGame.java

```
// Name:  CS 1101 instructor

// Description:  This program plays a game                  the objec
//                hand. Players can remove                  same rank
//                card in play or otherwise                 om draw fr
//                game ends when one player                 rds or no
//                available to draw from the
```

Constructors

zyBook Chap 9.4, 9.5, 9.9

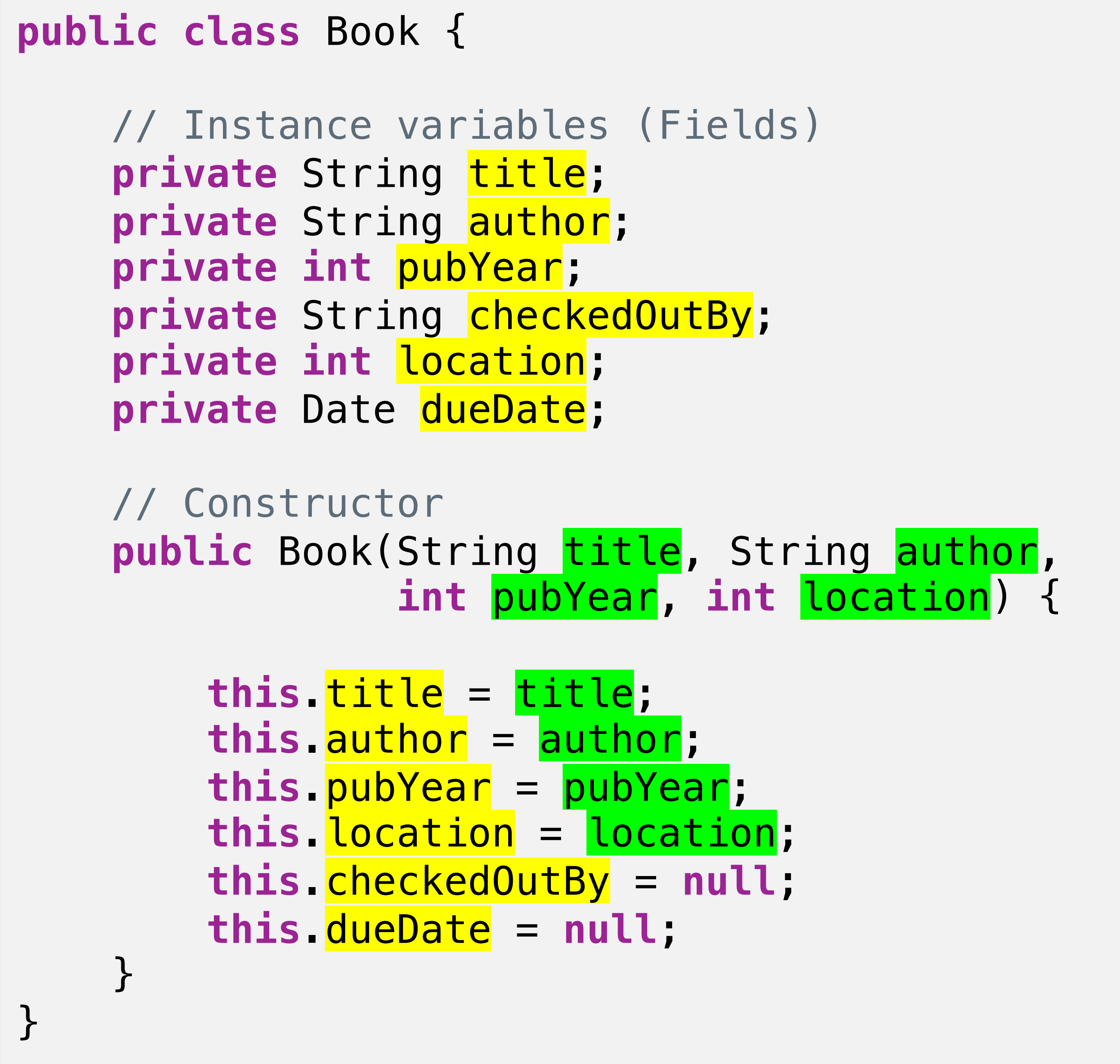
Constructor

Constructor → A special method that **initializes the state** of new objects as they are created:

- Constructor's name **matches** the **class name**
- **NO return type**
- **Parameters** are used to **specify the object's initial state**
- Access object's fields and methods directly

Constructor – Book

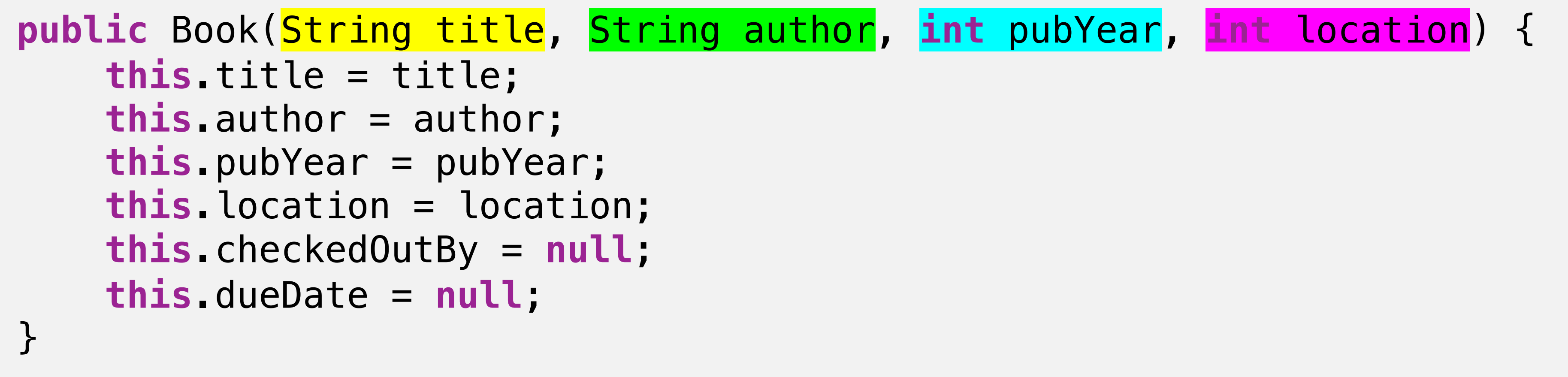
- **Initializing the fields** in the constructor in the Book Class



```java
public class Book {

    // Instance variables (Fields)
    private String title;
    private String author;
    private int pubYear;
    private String checkedOutBy;
    private int location;
    private Date dueDate;

    // Constructor
    public Book(String title, String author,
                int pubYear, int location) {

        this.title = title;
        this.author = author;
        this.pubYear = pubYear;
        this.location = location;
        this.checkedOutBy = null;
        this.dueDate = null;
    }
}
```

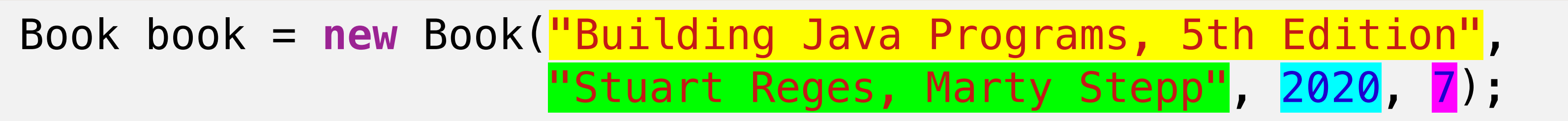
Constructor – Book

- Initializing the fields in the constructor in the Book Class



```
public Book(String title, String author, int pubYear, int location) {
    this.title = title;
    this.author = author;
    this.pubYear = pubYear;
    this.location = location;
    this.checkedOutBy = null;
    this.dueDate = null;
}
```

- Constructing a Book object with the **specified constructor** in the **client program**



```
Book book = new Book("Building Java Programs, 5th Edition",
                     "Stuart Reges, Marty Stepp", 2020, 7);
```

Method Overloading

- Method overloading is a feature that allows a class to have **more than one method** with the **same name**, but with **different sets of parameters**

Constructor Overloading

- A class can have **multiple constructors** and each one must accept a **unique set** of **parameters**
    - Paradigm → **One constructor contains true initialization code** – all other constructors call it with the keyword `this`

```
public Book(String title, String author, int pubYear, int location) {
    this.title = title;
    this.author = author;
    this.pubYear = pubYear;
    this.location = location;
    this.checkedOutBy = null;
    this.dueDate = null;
}

public Book(String title, String author, int pubYear) {
    this(title, author, pubYear, 0); // calling the first constructor
}
```

`this` is used used to call one constructor from another

Common Constructor Bugs

Re-declaring fields as local variables (“shadowing”)

- This code declares local variables with the same name as the fields, rather than storing values into the fields. **The fields remain default value**

```
import java.util.Date;

public class Book {
    private String title;
    private String author;
    private int pubYear;
    private String checkedOutBy;
    private int location;
    private Date dueDate;

    public Book(String newTitle, String newAuthor,
            int newPubYear, int newLocation) {
        String title = newTitle;
        String author = newAuthor;
        int pubYear = newPubYear;
        int location = newLocation;
        String checkedOutBy = null;
        Date dueDate = null;
    }
}
```

Common Constructor Bugs

Giving the constructor a **return type**

- This is not a constructor, but an **instance method** named Book.

```
import java.util.Date;

public class Book {
    private String title;
    private String author;
    private int pubYear;
    private String checkedOutBy;
    private int location;
    private Date dueDate;

    public void Book(String title, String author,
                     int pubYear, int location) {
        this.title = title;
        this.author = author;
        this.pubYear = pubYear;
        this.location = location;
        this.checkedOutBy = null;
        this.dueDate = null;
    }
}
```

Default Constructor

- If no constructors are specified in the class, the **default constructor** exists that **takes no parameters**. It will initialize fields to their **default values**.
  - `<ClassName> a = new <ClassName>();`

```java
// Default constructor that takes no parameters
Book book = new Book();

// Initialize the fields with the setter methods
book.setTitle("Building Java Programs, 5th Edition");
book.setAuthor("Stuart Reges, Marty Stepp");
book.setPubYear(2020);
book.setLocation(7);
```

Constructor with No Parameters

Once we write a constructor, we can no longer use the default constructor (constructor automatically supplied by Java with no parameters)

- If we need a constructor with no parameters in addition to the other constructors we create, we need to define it ourselves.
  - Only create a constructor with no parameters if it makes sense for your object.

Object Methods

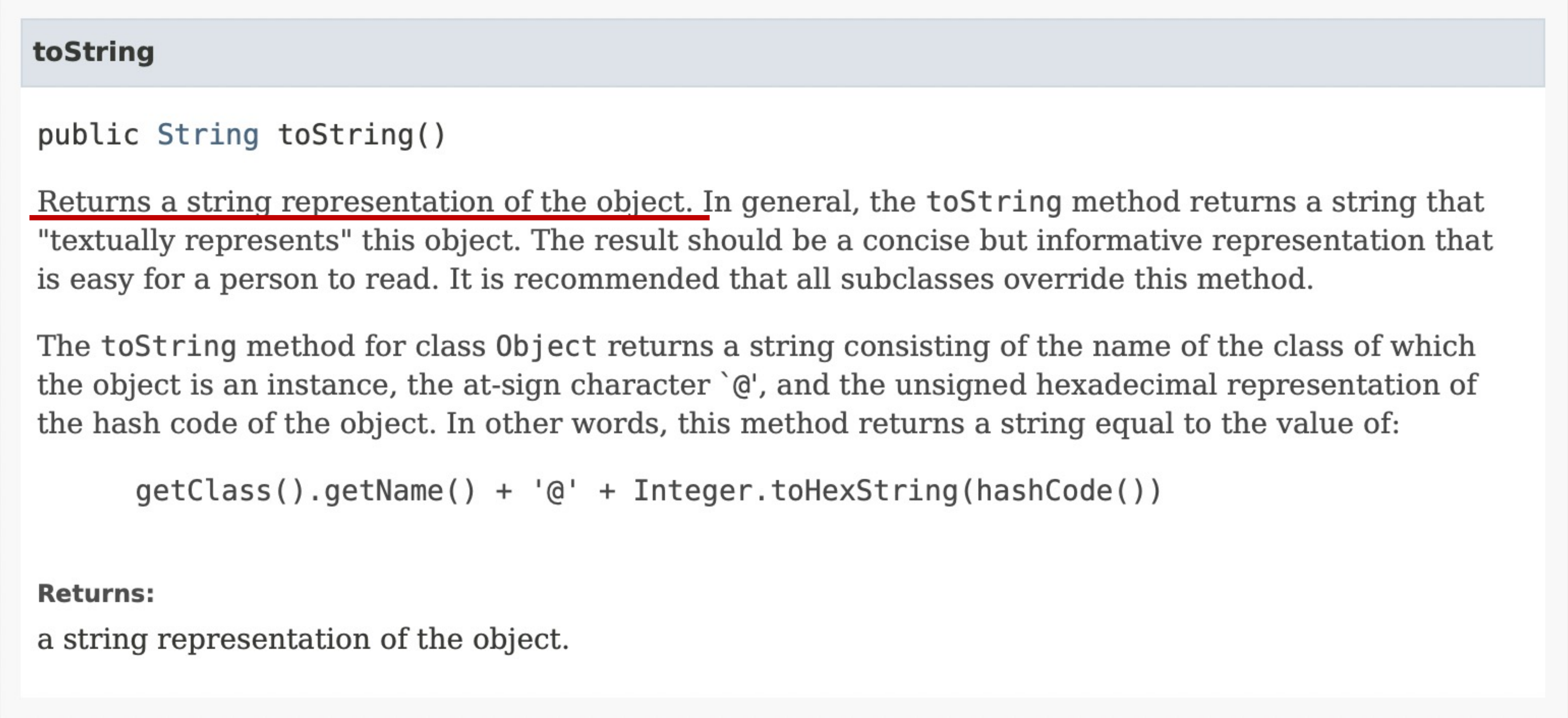
zyBook Chap 10.4

`Object` Class (`public class Object`)

`Object` Class is the **root** of the class hierarchy

- Every class has `Object` as a superclass
- All objects implement the methods of this class
- There are special methods that we want to override in our own classes that create instances of an object
  - `toString()`
  - `equals()`
  - Methods come from the `Object` class and must match the syntax EXACTLY

toString() in Object Class



toString

```
public String toString()
```

Returns a string representation of the object. In general, the `toString` method returns a string that "textually represents" this object. The result should be a concise but informative representation that is easy for a person to read. It is recommended that all subclasses override this method.

The `toString` method for class `Object` returns a string consisting of the name of the class of which the object is an instance, the at-sign character `` `@' ``, and the unsigned hexadecimal representation of the hash code of the object. In other words, this method returns a string equal to the value of:

```
    getClass().getName() + '@' + Integer.toHexString(hashCode())
```

Returns:

a string representation of the object.

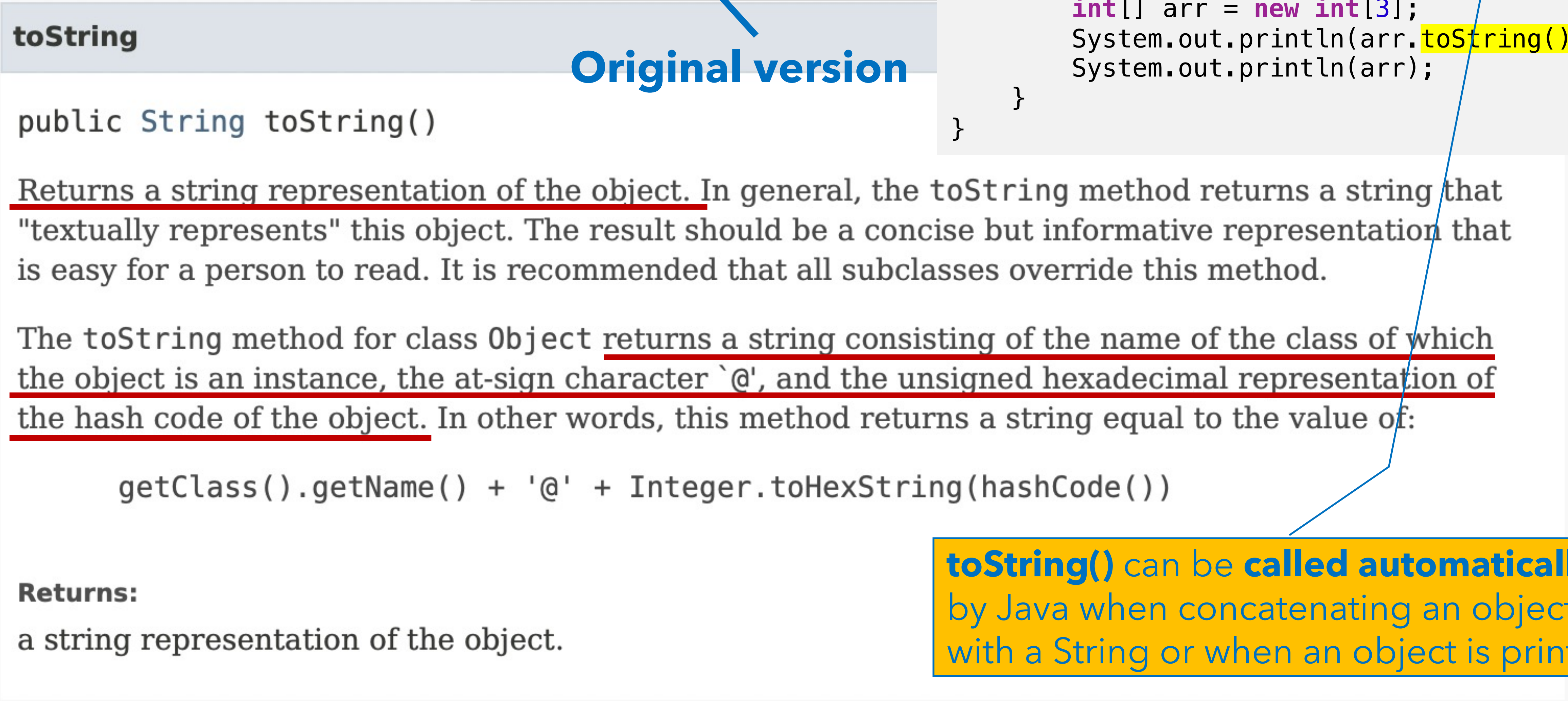
toString()

Overridden version

```
$ javac ToStringDemo.java
$ java ToStringDemo
java.awt.Point[x=1,y=2]
java.awt.Point[x=1,y=2]
[I@6d06d69c
[I@6d06d69c
```

Original version

```java
import java.awt.*;

public class ToStringDemo {
    public static void main (String[] args) {
        Point p = new Point(1, 2);
        System.out.println(p.toString());
        System.out.println(p);

        int[] arr = new int[3];
        System.out.println(arr.toString());
        System.out.println(arr);
    }
}
```



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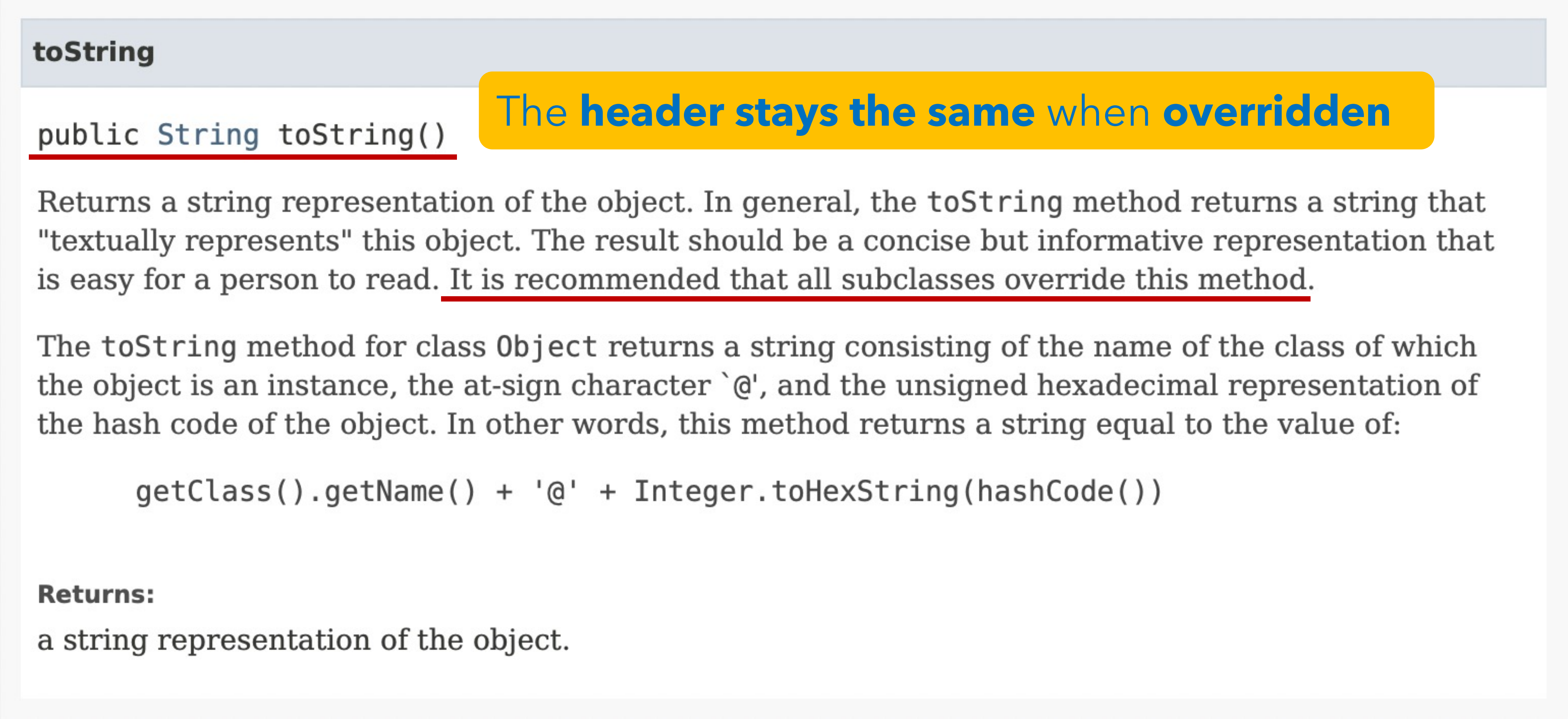
```
getClass().getName() + '@' + Integer.toHexString(hashCode())
```

Returns:

a string representation of the object.

toString() can be **called automatically** by Java when concatenating an object with a String or when an object is printed

toString()



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```
    getClass().getName() + '@' + Integer.toHexString(hashCode())
```

Returns:

a string representation of the object.

The **header stays the same** when **overridden**

Override toString() in Book Class

```java
public class BookClient {
    public static void main(String[] args) {
        Book book = new Book("Building Java Programs, 5th Edition",
                             "Stuart Reges, Marty Stepp", 2020, 7);
        System.out.println(book.toString());
    }
}
```

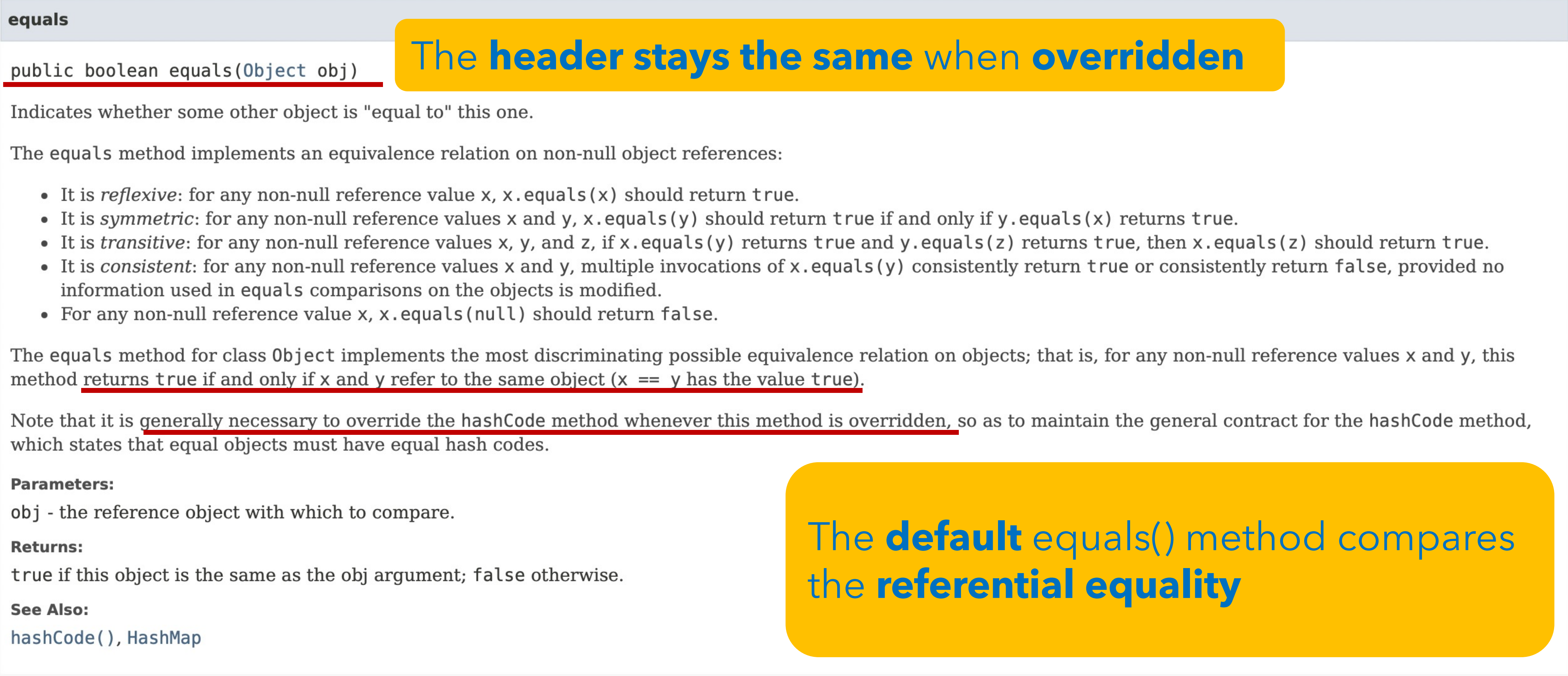
```
$ javac BookClient.java
$ java BookClient
Building Java Programs, 5th Edition by Stuart Reges, Marty Stepp in 2020.
```

```java
public class Book {
    // ... Instance Variables ...

    // ... Instance Methods ...
    public Book(String title, String author, int pubYear, int location) {
        this.title = title;
        this.author = author;
        this.pubYear = pubYear;
        this.location = location;
        this.checkedOutBy = null;
        this.dueDate = null;
    }

    public String toString() {
        return this.title + " by " + this.author + " in " + this.pubYear + ".";
    }
}
```

equals() in Object Class



equals

```
public boolean equals(Object obj)
```

Indicates whether some other object is "equal to" this one.

The `equals` method implements an equivalence relation on non-null object references:

- It is *reflexive*: for any non-null reference value `x`, `x.equals(x)` should return `true`.
- It is *symmetric*: for any non-null reference values `x` and `y`, `x.equals(y)` should return `true` if and only if `y.equals(x)` returns `true`.
- It is *transitive*: for any non-null reference values `x`, `y`, and `z`, if `x.equals(y)` returns `true` and `y.equals(z)` returns `true`, then `x.equals(z)` should return `true`.
- It is *consistent*: for any non-null reference values `x` and `y`, multiple invocations of `x.equals(y)` consistently return `true` or consistently return `false`, provided no information used in `equals` comparisons on the objects is modified.
- For any non-null reference value `x`, `x.equals(null)` should return `false`.

The `equals` method for class `Object` implements the most discriminating possible equivalence relation on objects; that is, for any non-null reference values `x` and `y`, this method returns `true` if and only if `x` and `y` refer to the same object (`x == y` has the value `true`).

Note that it is generally necessary to override the `hashCode` method whenever this method is overridden, so as to maintain the general contract for the `hashCode` method, which states that equal objects must have equal hash codes.

Parameters:

`obj` - the reference object with which to compare.

Returns:

`true` if this object is the same as the obj argument; `false` otherwise.

See Also:

`hashCode()`, `HashMap`

The **header stays the same** when **overridden**

The **default** equals() method compares the **referential equality**

Override equals()

Compares two objects for **equality of SOME or ALL fields**

- Implemented within the class definition of the object under comparison
  - Compares the implicit parameter (current object) with the object passed as a parameter
  - That is, we need **the object to be compared** to be the **same object type** as the current object via
    - `instanceof` operator
    - Object casting

Object Casting

- Widening Typecasting with Objects (Upcasting)
  - Cast a reference along the class hierarchy in a direction from the subclasses towards the root class
    - E.g., cast a Dog object into an Animal object

- Narrowing Typecasting with Objects (Downcasting)
  - Cast a reference along the class hierarchy in a direction from the root class towards the subclasses
    - E.g., cast an Animal object into a Dog object

Downcasting + `instanceof` Keyword

We often use **`instanceof`** operator before downcasting to check if the object belongs to the specific type:

```
<obj> instanceof <objType>
```

- also checks if the object is **`null`**
- If the real object doesn't match the type we downcast to, then **ClassCastException** will be thrown at runtime

Override equals() in Book Class

```java
public class Book {

    // ... Some instance variables and methods here ...

    public boolean equals(Object obj) {
        // The parameter obj could be any type of Object, such as a Point
        // Hence, we need to check if obj is an instance of Book Class
        if (obj instanceof Book) {
            // Object casting
            // Tell the compiler to treat the obj as if it is a Book object
            Book b = (Book) obj;
            // title and author are Strings, and hence compared with equals()
            // pubYear is an int, and hence compared with ==
            return title.equals(b.getTitle()) && author.equals(b.getAuthor())
                   && pubYear == b.getPubYear();
        } else {
            return false;
        }
    }
}
```

Override equals() in Book Class

```java
import java.awt.*;

public class BookClient {
    public static void main(String[] args) {
        Book b1 = new Book("Building Java Programs, 5th Edition", "Stuart Reges, Marty Stepp", 2020, 7);
        Book b2 = new Book("Building Java Programs, 5th Edition", "Stuart Reges, Marty Stepp", 2020, 6);
        Book b3 = new Book("Building Java Programs, 4th Edition", "Stuart Reges, Marty Stepp", 2016, 7);
        Book b4 = null;
        Point p = new Point(1, 2);

        System.out.println("b1.equals(b2) is " + b1.equals(b2));
        System.out.println("b1.equals(b3) is " + b1.equals(b3));
        System.out.println("b1.equals(b4) is " + b1.equals(b4));
        System.out.println("b1.equals(p) is " + b1.equals(p));
    }
}
```

```
$ javac BookClient.java
$ java BookClient
b1.equals(b2) is true
b1.equals(b3) is false
b1.equals(b4) is false
b1.equals(p) is false
```