Principles of Computer Science I

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CSC 120 – Fall 2006

Lecture Unit 3 - Implementing Classes

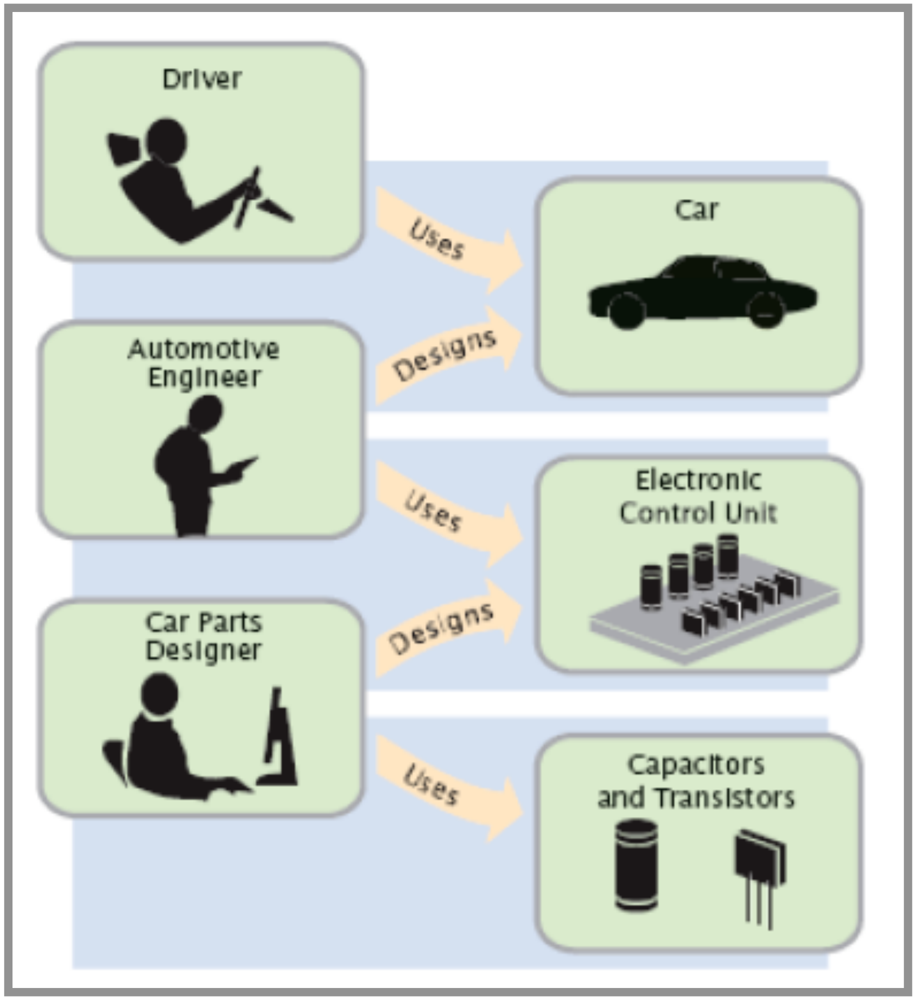
Lecture Outline

- Implementing classes, methods, constructors
- Instance fields and local variables
- Documenting code
  - *Javadoc*

Black Boxes

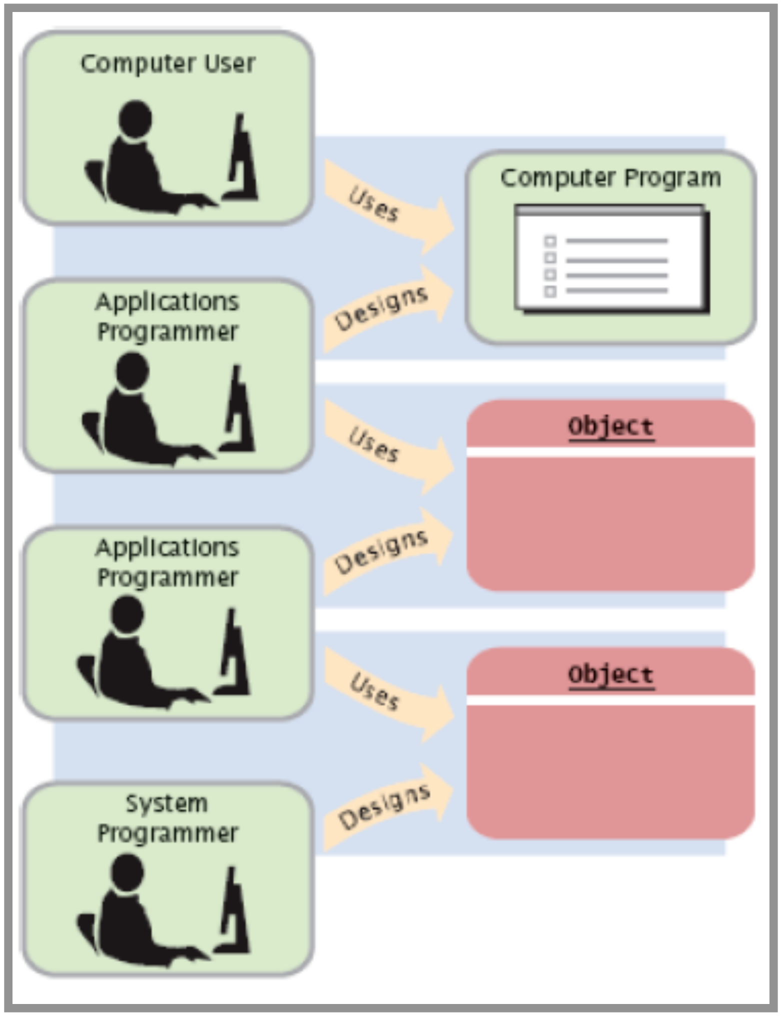
- ‘Black box’ - device whose inner workings are hidden
  - Car - electronic control module
  - Java - objects
- *Encapsulation* - hiding unimportant details
- *Abstraction* - taking away inessential features until essence of concept remains

Levels of Abstraction: Car



- Users do not need to understand the ‘black boxes’
  - Leads to efficiency, ease-of-use
- Interaction of black box with outside world is well-defined
  - Drivers interact using pedals, buttons, etc.
  - Mechanic tests engine control module (ECM) sends the right firing signals to the spark plugs
  - ECM manufacturers use transistors and capacitors, black boxes magically produced by an electronics component manufacturer

Levels of Abstraction: Software



- Old times: computer programs manipulated primitive types such as numbers and characters
  - Too much for human programmers
  - Solution: Design software ‘black boxes’
- Abstraction: invent higher-level data structures
- Encapsulation: programmer using object knows behavior, not internal implementation

Software Design

- In software design, you can design good and bad abstractions with equal facility
  - Understanding what makes good design is an important part of the education of a software engineer
- First, define behavior of a class; then, implement it

Designing a Class: BankAcct

- Behavior of a bank account
  - Deposit money
  - Withdraw money
  - Get balance
- Method definitions
  - Access specifier
  - Return type
  - Name
  - Parameter list
  - Body

Syntax: Method Definition

```
accessSpecifier returnType
                               methodName(paramType paramName, …)
{
    method body
};
```

Example:

```
public void deposit( double amount ) {
     …
}; // end method deposit
```

Purpose:

To define the behavior of a method

Constructors

- A constructor initializes the internal data of an object
    - Is a special method
    - Constructor name must be the same as the class
- Constructor body is executed when a new object is *instantiated*
- All constructors of a class have the same name
- Compiler can tell constructors apart because they take different parameters

Syntax: Constructor Definition

```
accessSpecifier ClassName(paramType paramName, …)
{
   constructor body
};
```

Example:

```
   public BankAccount( double initialBalance ) {
      …
   }; // end constructor
```

Purpose:

To define the behavior of a constructor

BankAccount Public Interface

- The public constructors and methods of a class form the *public interface*

```
public class BankAccount {

    // Constructors
    public BankAccount() {
        // body - filled in later
    }

    public BankAccount(double initialBalance) {
        // body - filled in later
    }

    // Methods
    public void deposit(double amount) {
        // body - filled in later
    }

    public void withdraw(double amount) {
        // body - filled in later
    }

    public double getBalance() {
        // body - filled in later
    }

    // private fields ... filled in later
}
```

Syntax: Class Definition

```
accessSpecifier class ClassName
{
   constructors
   methods
   fields
}
```

Example:

(see previous slide)

Purpose:

To define a class, its public interface, and its implementation details

Using BankAccount

- Write code to instantiate (create) two accounts with some initial balances, then transfer money from one account to another
- Write code to empty (withdraw all money from) a bank account

Comments

- Ignored by the computer (compiler)
- Comments make programs easier to understand for humans
- Use comments liberally, but make them meaningful
- Two forms of Java comments
  - Comments between `/*` and `*/` can extend over several lines
  - Using two slashes `//` makes the rest of the line become a comment

javadoc Commenting Style

- Standard form for documentation comments
- javadoc automatically generates HTML (web) pages describing your classes based on comments in source code
- javadoc comment starts with `/**`
  - First line describes method/class purpose
  - For each parameter, give line starting with `@param`
  - Supply line starting with `@return` describing return value

javadoc Method Comments

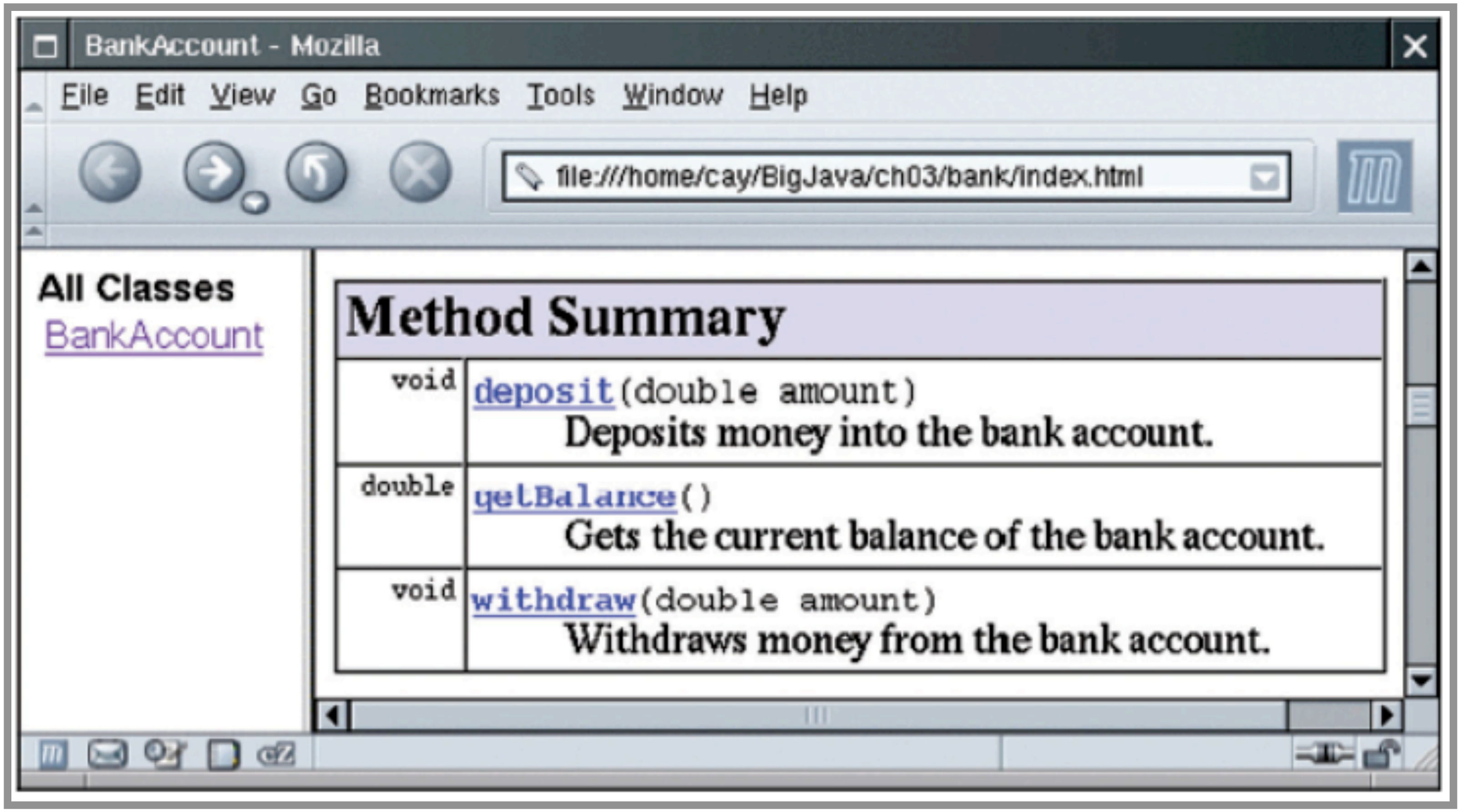
```java
/**
   Withdraws money from the bank account.
   @param amount the amount to withdraw
*/
public void withdraw(double amount)
{
   double newBalance = balance - amount;
   balance = newBalance;
}

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

javadoc Class Comment

```
/**
   A bank account has a balance that can be changed by
   deposits and withdrawals.
*/
public class BankAccount
{
    ...
}
```

- Provide comments for
  - Every class
  - Every method
  - Every parameter
  - Every return value

javadoc Output



All Classes

BankAccount

Method Summary	
void	deposit(double amount) Deposits money into the bank account.
double	getBalance() Gets the current balance of the bank account.
void	withdraw(double amount) Withdraws money from the bank account.

Instance Fields

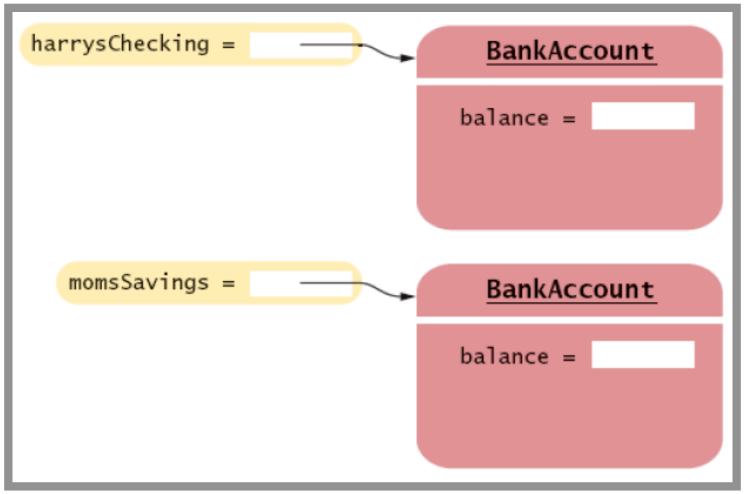
- Object stores its data in *instance fields*
- Field: storage location inside memory
- Instance: an object of a class

```
public class BankAccount
{
   . . .
   private double balance;
}
```

- Instance field declaration:
  - Access specifier (usually `private`)
  - Type of the field (like `double`)
  - Name of the field (like `balance`)

Instance Fields (Syntax)

- Every object of a class has its own set of instance fields



```
accessSpecifier class ClassName
{
   ...
   accessSpecifier fieldType fieldName;
   ...
}
```

Example:

(see previous slide)

Purpose:

To define a field that is present in every object of a class

Accessing Instance Fields

- Methods of the same class can access `private` fields
- Methods/code outside the class cannot

- Encapsulation = Hiding data (fields) and providing access through public interface (methods)

Implementing Constructors and Methods

- Constructors contain code to initialize instance fields of object
- Some methods do not return a value
- Other methods return a result (`getBalance`)
  - Use a **`return`** statement to exit a method immediately/return a value
- BankAccount.java

```
public class BankAccount {

    // Constructors
    public BankAccount() {
        // body - filled in later
    }

    public BankAccount(double initialBalance) {
        // body - filled in later
    }

    // Methods
    public void deposit(double amount) {
        // body - filled in later
    }

    public void withdraw(double amount) {
        // body - filled in later
    }

    public double getBalance() {
        // body - filled in later
    }

    private double balance;
}
```

Syntax: return Statement

```
return expression;
```

or

```
return;
```

Example:

```
   return balance;
```

Purpose:

To specify the value that a method returns, and exit the method immediately. The return value becomes the value of the method call expression.

Constructor Call Example

```
BankAccount harrysChecking = new BankAccount(1000);
```

- Create a new object of type `BankAccount`
- Call the second constructor (since a construction parameter is supplied)
- Set the parameter variable `initialBalance` to `1000`
- Set the `balance` instance field of the newly created object to `initialBalance`
- Return an object reference, that is, the memory location of the object, as the value of the new expression
- Store that object reference in the `harrysChecking` variable

Method Call Example

```
harrysChecking.deposit(500);
```

- Set the parameter variable `amount` to `500`
- Fetch the `balance` field of the object whose location is stored in `harrysChecking`
- Add the value of `amount` to `balance` and store the result in the variable `newBalance`
- Store the value of `newBalance` in the `balance` instance field, overwriting the old value

Checkpoint

- How would you implement the `translate` method of the `Rectangle` class?

Testing a Class

- Test class (sometimes called a ‘driver class’)
  - Class with a `main` method that contains code to test another class
- Typical steps:
  - Construct one or more objects of the class that is being tested
  - Invoke one or more methods
  - Print out one or more results
- Running test program (typical steps):
  - Make a new subfolder for your program
  - Make two files, one for each class
  - Compile both files
  - Run the test program

BankAccountTester.java

Summary: Designing and Implementing Classes

- Find out what an object of the class is supposed to do
- Specify the public interface
- Document the public interface
- Determine instance fields
- Implement constructors and methods
- Test the class

- Example: *Cash Register*

CashRegister.java
CashRegisterTester.java

Categories of Variables

- Three categories of variables
  - Instance fields (`balance` in `BankAccount`)
  - Local variables (`newBalance` in `deposit` method)
  - Parameter variables (`amount` in `deposit` method)

- Two important differences
  - Lifetime
  - Initialization

Variable Lifetimes

- Instance variables belong to object
  - Remain ‘alive’ until object is no longer being used
  - Java runtime system (virtual machine-JVM) contains program called *garbage collector* that periodically reclaims memory space of unused objects

- Local and parameter variables belong to a method
  - The ‘die’ when the method is exited

Variable Initialization

- Local variables must be initialized
  - Compiler will complain if you don’t
- Parameter variables are initialized with argument values in the method call
- Instance fields are initialized with default value (either 0 or null)
  - Common cause of errors: forgetting to initialize instance variables in a constructor

Implicit Parameters

- The implicit parameter of a method is the object on which the method is invoked
- The `this` keyword refers to the object that is passed as the implicit parameter
- Every method has one implicit parameter
  - Using the name of an instance field inside the method means the instance field of the implicit parameter object
    - Can always use the keyword `this` inside a method to explicitly refer to the implicit parameter
  - Exception: static methods do not have implicit parameter (Ch. 9)

Calling One Constructor from Another

- Also uses the `this` keyword followed by parentheses as shorthand

Voting Machines