OBJECT-ORIENTED LANGUAGE AND THEORY

1. INTRODUCTION TO OBJECT TECHNOLOGY

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Outline

1. Object-Oriented Technology
2. Object and Class
3. Java programming language
4. Examples and Exercises

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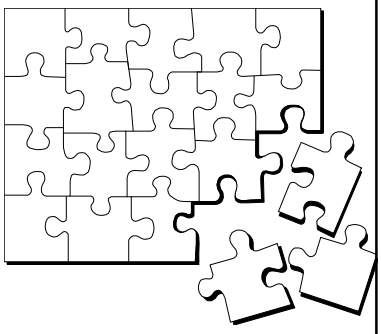
3 3

1.1 Object Technology

- Object technology is a set of rules (abstraction, encapsulation, polymophism), instructions to build a software, together with languages, databases and other tools to support these rules.



(*Object Technology - A Manager's Guide*, Taylor, 1997)

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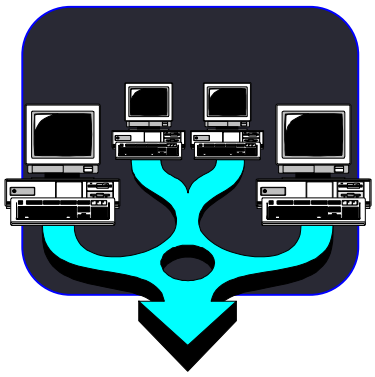
1.2 Where is the object technology used?

- Client/Server Systems and Web development
  - Object technology allows companies to encapsulate information in objects and to distribute its computation/processing via Internet or via a network.



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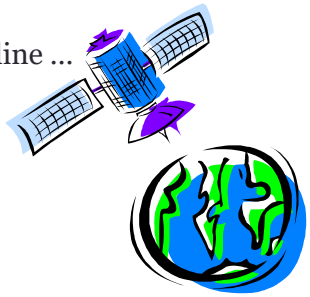
1.2. Where is the object technology used? (2)

- Mobile development (Android)
- Embedded system
- Real-time systems
  - Object technology allows real-time systems to be developed with higher quality and in a more flexible way
    - Satellite systems
    - Defense systems and space airline …



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The power of the object technology

- Allow re-using source code and architectures
- Reflecting more closely the real world
- More stable, a system change is done in a small part of the system
- More adaptable with changes

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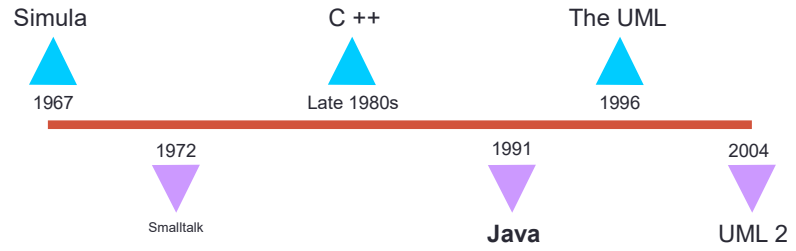
Milestones of the object technology



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1.3 Evolution of programming languages

- Assembly language
- Structure/Procedure programming languages
  - Pascal, C
- Object programming languages
  - C++, Java, C#.NET, Python...

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a. Assembly language

```
;CLEAR SCREEN USING BIOS
CLR: MOV AX,0600H       ;SCROLL SCREEN
     MOV BH,30          ;COLOUR
     MOV CX,0000        ;FROM
     MOV DX,184FH       ;TO 24,79
     INT 10H            ;CALL BIOS;
;INPUTTING OF A STRING
KEY: MOV AH,0AH         ;INPUT REQUEST
     LEA DX,BUFFER      ;POINT TO BUFFER WHERE STRING STORED
     INT 21H            ;CALL DOS
     RET                ;RETURN FROM SUBROUTINE TO MAIN PROGRAM;
; DISPLAY STRING TO SCREEN
SCR: MOV AH,09          ;DISPLAY REQUEST
     LEA DX,STRING      ;POINT TO STRING
     INT 21H            ;CALL DOS
     RET                ;RETURN FROM THIS SUBROUTINE;
```

Assembly code

- Is a sequence programming language, is very close to machine codes of CPU.
- Hard to remember, to write, especially for complex systems.
- Hard to fix, to maintain.

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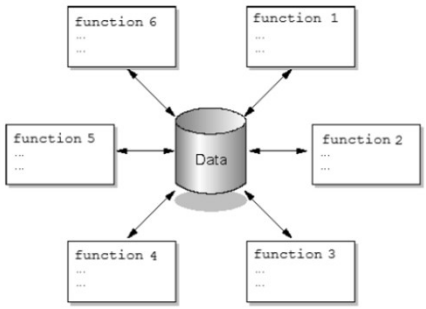
b. Structure/Procedure programming languages

- Build a program based on functions/procedures/sub-programs
- Data and data processing unit (functions) are separate
- Functions are not forced to follow a common rule for accessing data



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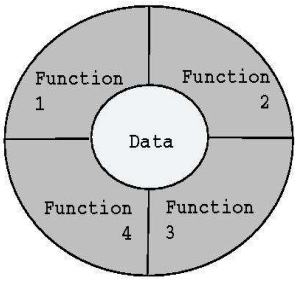
c. Object programming languages

- Characterizing elements of a problem in form of "đối tượng" (object).
- Object-oriented is a technique to model a system by objects.



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Evolution of programming languages

- ***Is the history and evolution of abstraction***
  - Assembly : Abstraction of data type/basic command
  - Structure langugues: control abstraction + functional abstraction
  - OO languages: Data abstraction

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Reading exercises

- Read and summarize some differences between struture programming and OOP

http://www.desy.de/gna/html/cc/Tutorial/node3.htm

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What about other programming paradigms?

- Aspect-Oriented Programming
- Functional Programming

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Outline

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Alan Kay' concepts

1. All are objects.
2. A software program can be considered as a set of objects interacting with each other
3. An object in a program has its own data and its own memory.
4. An object has all characteristics of its class.
5. All objects of a class have the same behavior

Alan Kay

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2.1 Object

- **Object** is the key to understand the object technology
- In a OO system, all are objects

Writing a OO program means to build
a model of some parts in the real world

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2.1 What is object?

- Objects in the real world
  - For example, a car
- Related to a car:
  - Car information such as: color, speed,...
  - Car activities: moving forward, reversing, stopping,...

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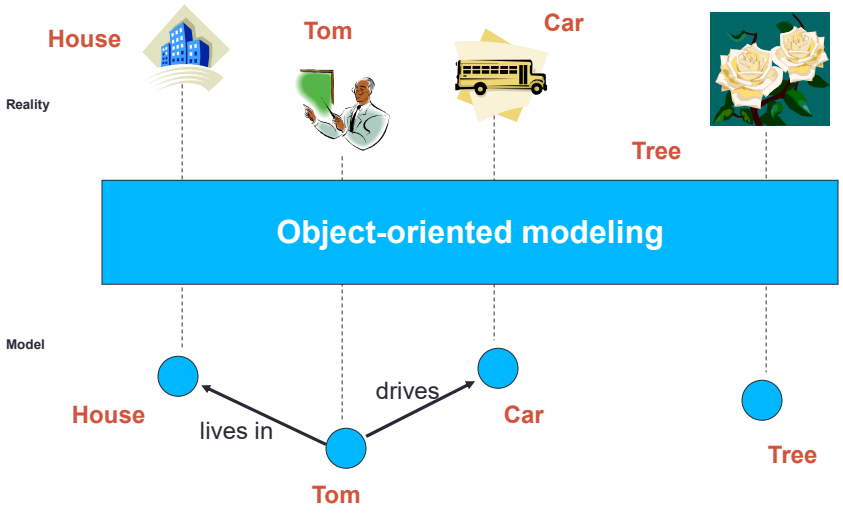
What is object?



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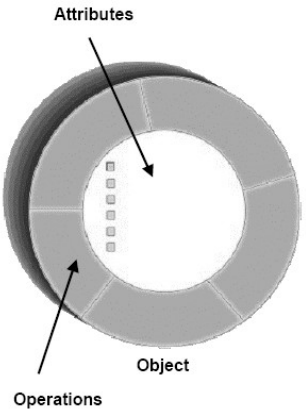
What is object?

- Is an entity encapsulated in form of *state* and *behavior*.
  - **State** is represented by attributes and relationships.
  - **Behaviour** is represented by operations and methods.



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An object has a state

- The state of an object is one of the possible conditions that the object exists.
- The state of an object can change over time

Name: J Clark
Employee ID: 567138
Date Hired: July 25, 1991
Status: Tenured
Discipline: Finance
Maximum Course Load: 3 classes

Professor Clark

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State

Dave
Age: 32
Height: 6’ 2”

Brett
Age: 35
Height: 5’ 10”

Gary
Age: 61
Height: 5’ 8”

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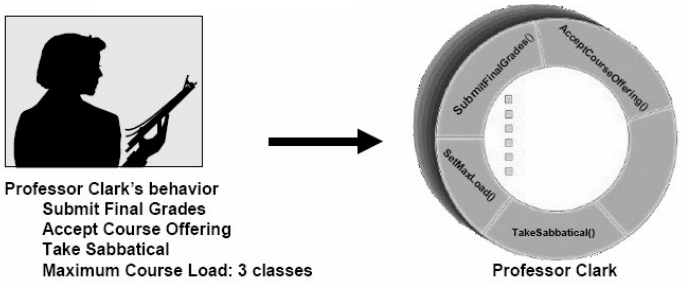
An object has its behavior

- Behavior determines how an object acts and reacts to requests from other objects.
- Object behavior is represented by the operations that the object can perform.



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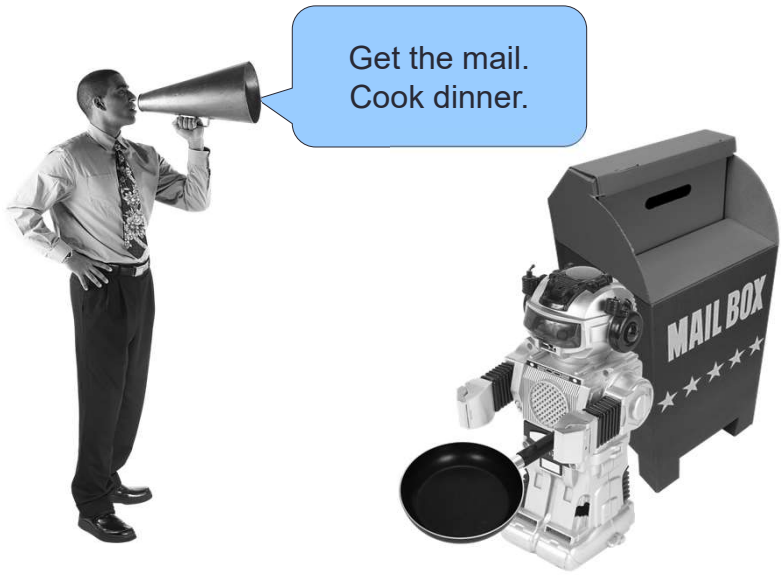
Behavior



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An object has an unique identity

- Each object has its own unique identity, although two objects may share the same state (attributes and relationships)

Professor "J Clark" teaches Biology

Professor "J Clark" teaches Biology

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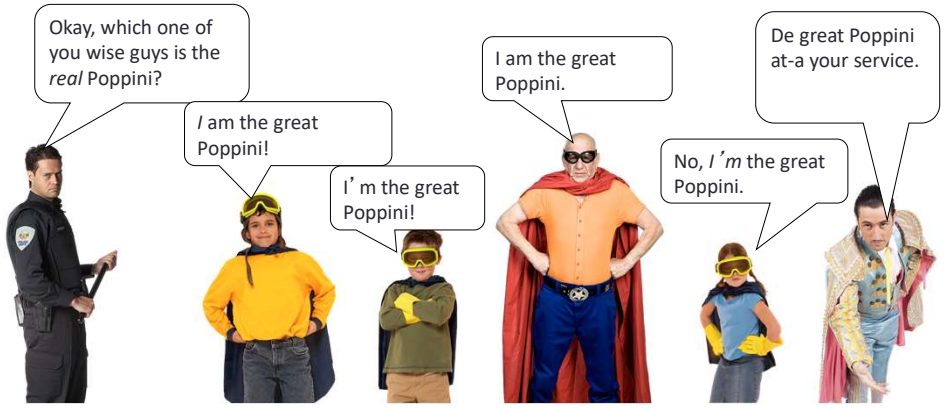
ID



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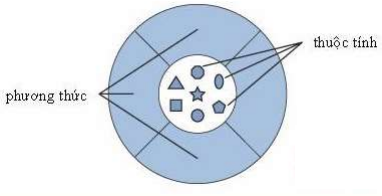
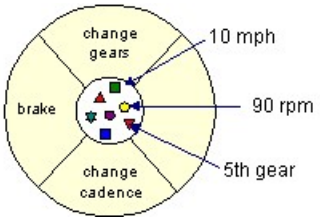
Object



Software object



Software object **Xe Đạp**

Object is an entity encapsulating **attributes** và các **methods** involving.

Attributes are defined by a specific value called **representation attributes**.

A specific object is called a **representation**.

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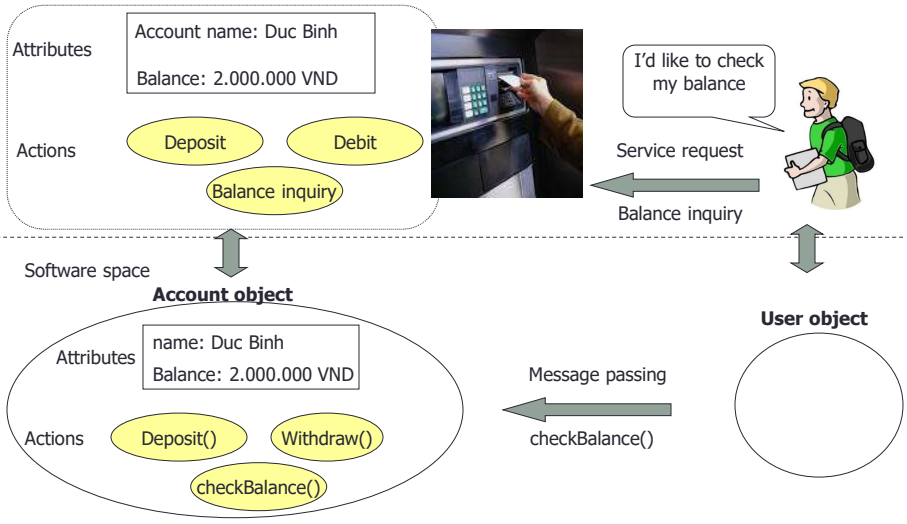
Software objects and a real-life problem

Problem of bank account management –ATM ther – electronic payment



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2.2 Class

- A class is a blueprint or prototype for all the objects of a same type
  - Example: class Bike is a common blueprint for many bike objects that are created
- A class defines common attributes and methods for all the objects of some type
- An object is a detailed representation of a class.
  - Example: a bike object is a representation of the class Bicycle
- Each object can have different attribute's representation
  - Example: a bike can be at the 5th gear while another bike can be at the 3rd gear.

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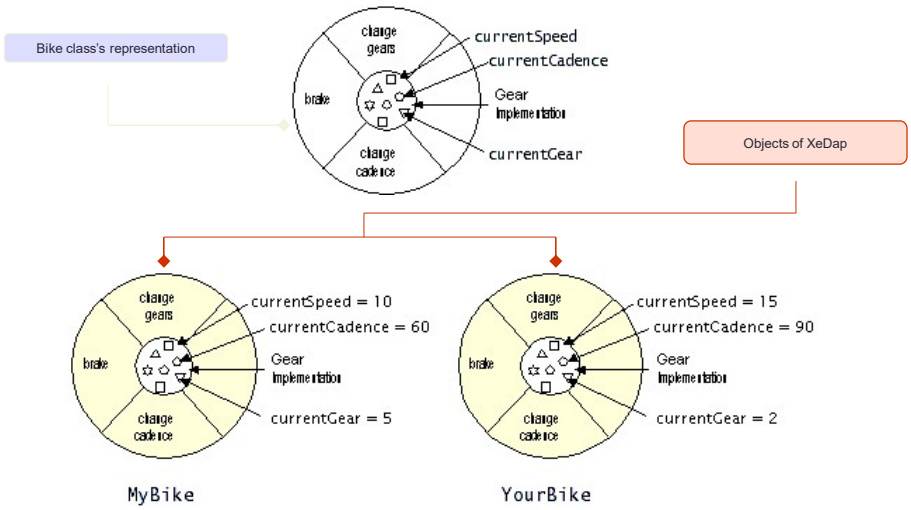
Example: Bike class



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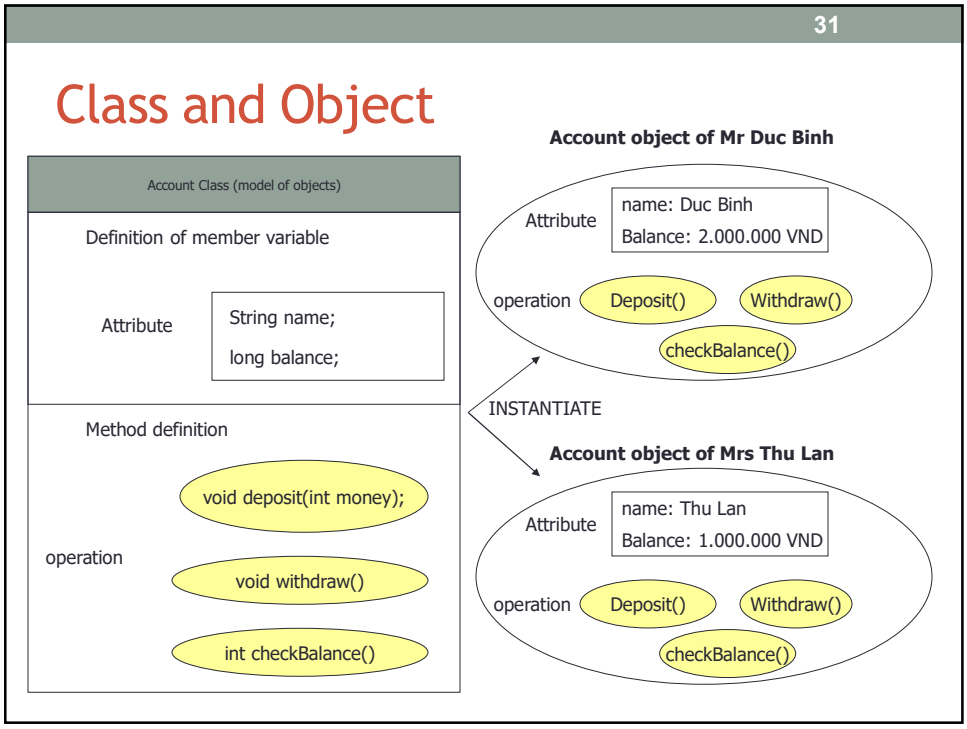
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Class and Object
Account Class (model of objects)
Definition of member variable
Attribute
String name;
long balance;
Method definition
operation
void deposit(int money);
void withdraw()
int checkBalance()
Account object of Mr Duc Binh
Attribute
name: Duc Binh
Balance: 2.000.000 VND
operation
Deposit()
Withdraw()
checkBalance()
INSTANTIATE
Account object of Mrs Thu Lan
Attribute
name: Thu Lan
Balance: 1.000.000 VND
operation
Deposit()
Withdraw()
checkBalance()

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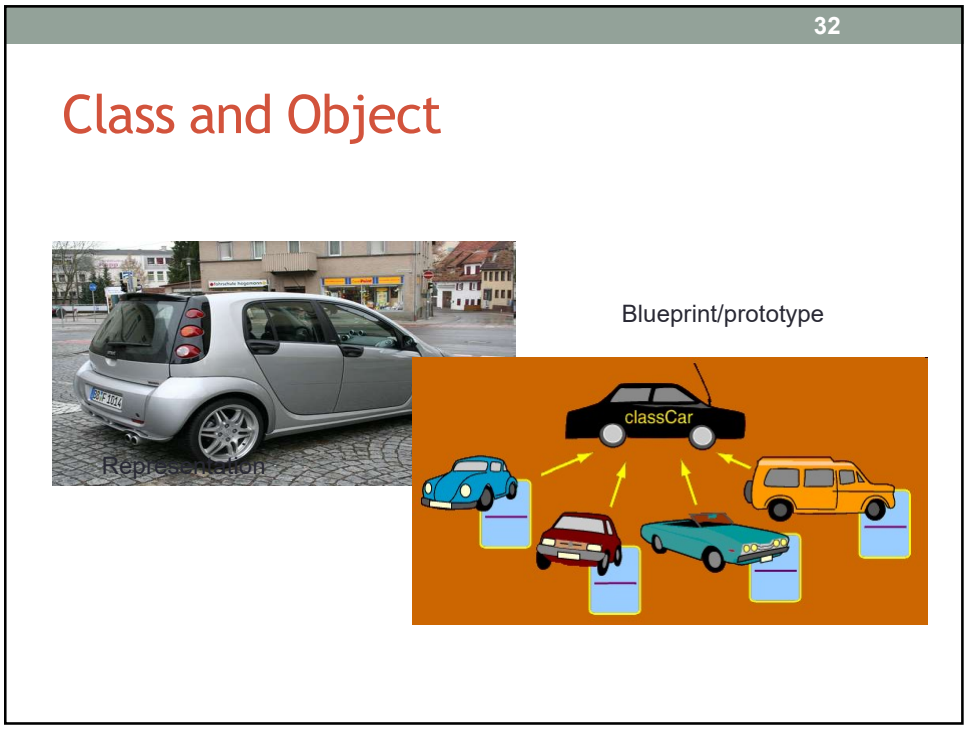
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Class and Object
Blueprint/prototype
classCar

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Quick question

- Given the Amazon online shopping system. Provide some examples about class and object in this system?
- The same question for HUST Student Information System?

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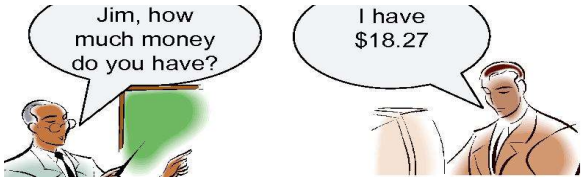
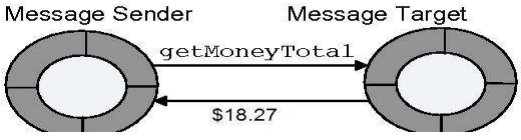
2.3 Interactions between objects

- Communication between objects in the real world



- Objects and their interactions in programming
  - Objects communicate to each other by message passing



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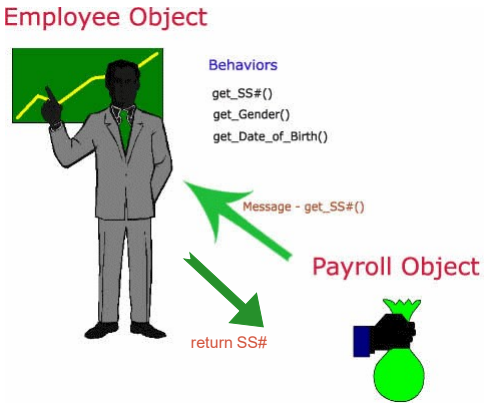
Message passing

- A program (built via OOP) is a set of objects exchanging messages between them



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2.4 Structure-Oriented vs. OO?

- Structure-Oriented:
  - data structures + algorithms = Program
- Object-Oriented:
  - objects + messages = Program

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Procedural-oriented vs. Object-oriented

- Procedural Programming:
  - Main components are procedures, functions
  - Data is independent with procedures
- Object-oriented programming
  - Main components are objects
  - Data is associated to function (method) in an object
  - Each data structure has methods executing on it

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Examples of class and object in some OOP languages

Class declaration: *each class* is, by default, an *extension of* `Object` (can be omitted)

Class constructor: *initialises* the various *fields*

Class method: *retrieves* and/or *modifies* the *state* of the class

Class fields: `private` means they *can not be accessed* from *outside* the class

```
public class Time extends Object {
    private int hour;
    private int minute;
    private int second;

    public Time () {
        setTime(0, 0, 0);
    }

    public void setTime (int h, int m, int s) {
        hour = ( ( h >= 0 && h < 24 ) ? h : 0 );
        minute = ( ( m >= 0 && m < 60 ) ? m : 0 );
        second = ( ( s >= 0 && s < 60 ) ? s : 0 );
    }
}
```

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Java: Program and object

```
public class Test {

    public static void main (String args[]) {
        Time time = new Time();

        time.hour = 7;
        time.minute = 15;
        time.second = 30;
    }
}
```

```
Test.java:6: hour has private access in Time
      time.hour = 7;
           ^
Time.java:7: minute has private access in Time
      time.minute = 15;
           ^
Time.java:8: second has private access in Time
      time.second = 30;
           ^
3 errors
```

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Outline

1. Object-Oriented Technology
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3. Java programming languages
4. Examples and Exercises

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3.1 What is Java?

- Java is a object-oriented programming language developped by Sun Microsystems, and now bought by Oracle
- Java is a popular programming language
  - Initially used for building control processor applications inside the electronics consumer devices such as cell phones, microwaves ...
  - Initially used in 1995

Green Team and James Gosling (the leader)

Sun microsystems

JAVA

ORACLE

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J2SE (Java 2 Platform Standard Edition)

- http://java.sun.com/j2se
- Java 2 Runtime Environment, Standard Edition (J2RE):
  - Executable Environment or JRE provides Java APIs, Java Virtual Machine (JVM) and other necessary components to run applets and applications written in Java.
- Java 2 Software Development Kit, Standard Edition (J2SDK)
  - Super set of JRE, and contains everything in the JRE, additional tools such as compilers and the debugger need to develop applets and applications.

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J2EE (Java 2 Platform Enterprise Edition)

- http://java.sun.com/j2ee
- Service-Oriented Architecture (SOA) và Web services
- Web Applications
  - Servlet/JSP
  - JSF…
- Enterprise Applications
  - EJB
  - JavaMail…
- …

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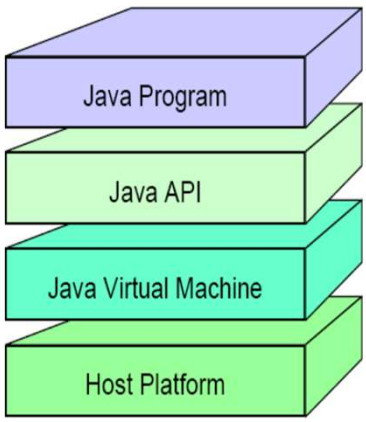
3.2 Java platform

- Platform is environment for development of deployment.
- Java platform can be run on all OSs
  - Other platforms depend on hardware
  - Java platform provides:
    - Java Virtual Machine (JVM).
    - Application Programming Interface (API).



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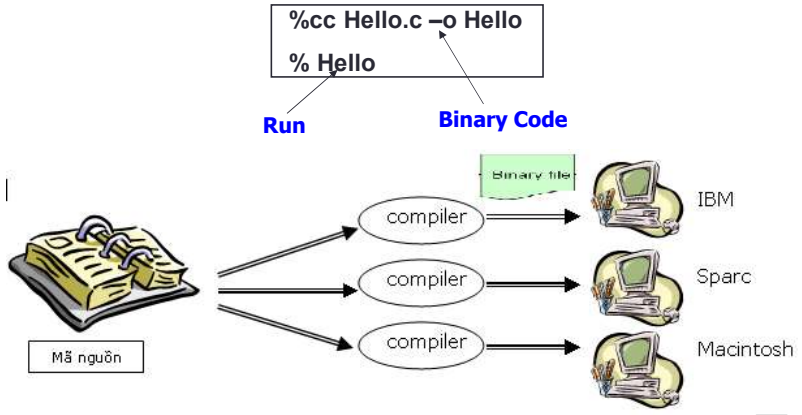
3.3. Compiling model of Java

- a. Classical compiling model:
  - Source code is compiled into binary code.



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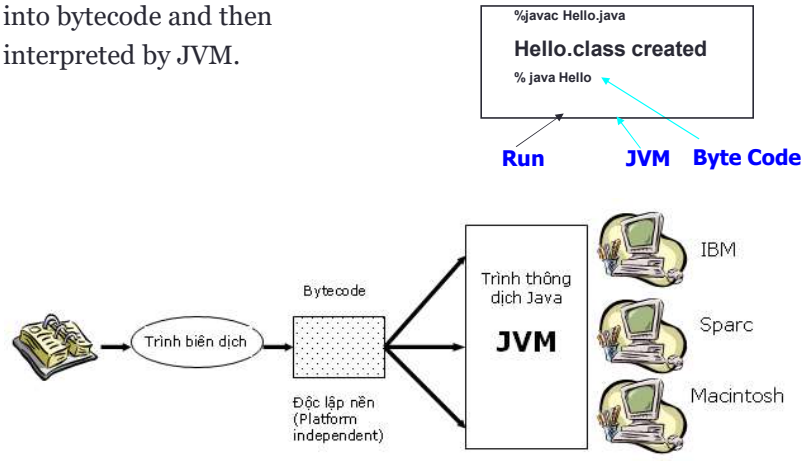
3.3. Compiling model of Java (2)

- b. Compiling model of Java:
  - Source code is compiled into bytecode and then interpreted by JVM.



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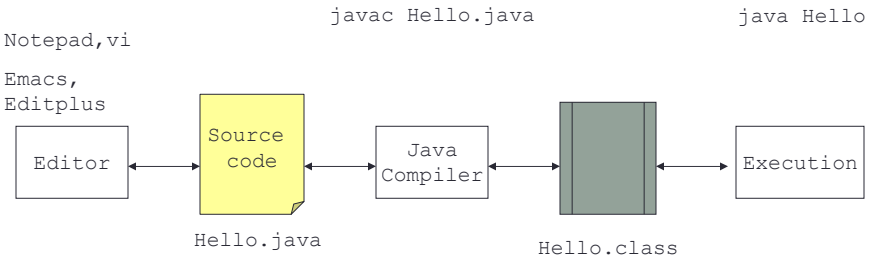
Making procedure of Java Application



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3.3. Compiling Model of Java (3)

- Java Virtual Machine:
  - JVM is the heart of Java language
    - Bring the feature "Write once, run everywhere"
  - Provides environment to execute instructions:
    - Load file .class
    - Manage memory
    - Garbage collections
  - The Interpreter "**Just In Time** - JIT"
    - Transform bytecode to machine code for each type of CPU.

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3.4. Features of Java

- Java is designed to be:
  - A powerful programming language, full of OO features and completely OO.
  - Easy to learn, syntax is similar to C++
  - Platform independance
  - Support the development of applications in network environment
  - Ideal for Web application

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3.4. Features of Java (2)

- Powerful
  - Class library: Hundreds of classes already written with utility functions.
  - Java uses pointer model without accessing directly to the memory; memory can not be over-written.
- Object-Oriented
  - Java supports software development by using OO
  - Software built in Java includes classes and objects

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3.4. Features of Java (3)

- Simple
  - Keywords
    - Java has 50 keywords
      - Compared to Cobol VB that have hundreds of keywords
- Network capable
  - Java supports the development of distributed applications
  - Some applications of Java are designed in order to be accessed via Web browser.

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3.4. Features of Java (3)

- Java has 50 key words
  - assert (New in 1.5) enum (New in 1.5)

abstract	boolean	break	byte
case	catch	char	class
const	continue	default	do
double	else	extends	final
finally	float	For	goto
If	implements	import	instanceof
int	interface	long	native
new	package	private	protected
public	return	short	static
strictfp	super	switch	synchronized
this	throw	throws	transient
try	void	volatile	while

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3.4. Features of Java (5)

- Multi-threaded
  - Allows a program to run more than one task at the same time.
- Portable
  - Programs can be written once and run on different platforms
  - Based on compiler/interpreter model
    (WORE – Write Once, Run Everywhere)

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3.4. Features of Java (6)

- Development Environment
  - Java Development Kit
    - Free on Sun Website: java.sun.com
    - Including: Compiler, JVM and existing classes
  - Integrated Development Environments (IDEs): Providing:
    - Complex Text Editors
    - Debugging Tools
    - Graphics Development Tools

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3.5. Applications in Java

- Application
  - Do not need to run on browsers
  - Can call functions through commands or option menu (GUI)
  - main() method is the starting point of the program execution
- Applet
  - GUI application running on browser in the client side.
  - Can be viewed by appletviewer or embedded in Web browser with JVM installed.

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3.5. Applications in Java (2)

- Web application
  - Create dynamic content on Server instead of on browsers.
  - Used in Server application
  - Servlet: manage requests from browsers and send the responses back
  - JavaServer Page (JSP): HTML pages with embedded Java code.

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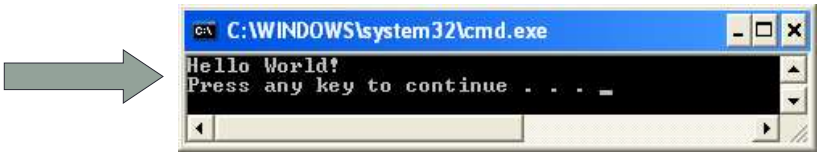
Example 1 - HelloWorld

```
// HelloWorld.java
// Chuong trinh hien thi dong chu "Hello World"
public class HelloWorld {
/* Phuong thuc main se duoc goi dau tien
 trong bat cu ung dung Java nao*/
 public static void main(String args[]){
      System.out.println( "Hello World!" );
 } // ket thuc phuong thuc main
} // ket thuc lop HelloWorld
```



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Example 1 (Cont.)

- Comment
  - In one line: Starts with //
  - In multiple lines: /* ... */
- Java distinguish between lowercase and uppercase
- Keywords in Java:
  - class: Class definition
  - public: Access permission
- Class name containing main function must have the same name with the file .java.

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Installing and Running Java application

- Step 1: Install jdk, install environment variables (if using cmd)
- Step 2: Install Eclipse or Netbean IDE
- Step 3: Coding
- Step 4: Compile
  - cmd: javac HelloWorld.java
  - Eclipse/Netbean: Build automatically (Look at Console to see syntax errors if any)/F11 (Project) or F9 (File)
- Step 5: Run program
  - cmd: java HelloWorld
  - Eclipse/Netbean: Run as Java application (Alt+Shift+X+J)/F6 (Project) or Shift-F6 (File)

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Environment Variables

- PATH = %PATH%;C:\Program Files\Java\jdkx.x\bin
- JAVA_HOME=C:\Program Files\Java\jdkx.x
- CLASSPATH = C:\Program Files\Java\jdkx.x\lib;.;C:\Program Files\Java\jdkx.x\include

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Example 2 - GUI

```
import javax.swing.JOptionPane;
public class FirstDialog{
 public static void main(String[] args){
     JOptionPane.showMessageDialog(null,
                        "Xin chao ban!");
     System.exit(0);
 }
}
```

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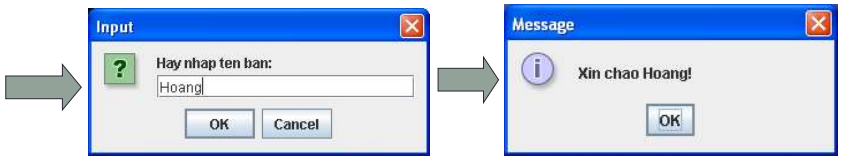
Example 3 - Data Input/Output

```
import javax.swing.JOptionPane;
public class HelloNameDialog{
 public static void main(String[] args){
      String result;
      result = JOptionPane.showInputDialog("Hay nhap
                                        ten ban:");
      JOptionPane.showMessageDialog(null,
                        "Xin chao "+ result + "!");
      System.exit(0);
 }
}
```



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Example of Class and Object in Java

Class declaration: *each class* is, by default, an *extension of* `Object` (can be omitted)

Class constructor: *initialises* the various *fields*

Class method: *retrieves* and/or *modifies* the *state* of the class

```
public class Time extends Object {
    private int hour;
    private int minute;
    private int second;

    public Time () {
        setTime(0, 0, 0);
    }

    public void setTime (int h, int m, int s) {
        hour = ( ( h >= 0 && h < 24 ) ? h : 0 );
        minute = ( ( m >= 0 && m < 60 ) ? m : 0 );
        second = ( ( s >= 0 && s < 60 ) ? s : 0 );
    }
}
```

Class fields: `private` means they *can not be accessed* from *outside* the class

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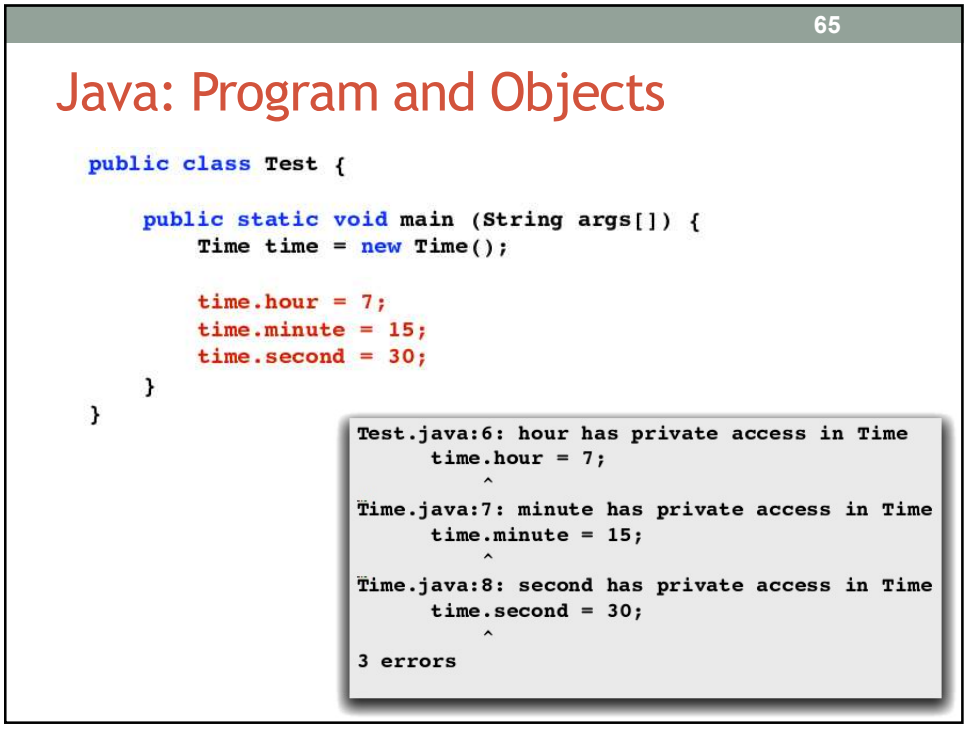
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Java: Program and Objects
public class Test {
public static void main (String args[]) {
Time time = new Time();
time.hour = 7;
time.minute = 15;
time.second = 30;
}
}
Test.java:6: hour has private access in Time
time.hour = 7;
^
Time.java:7: minute has private access in Time
time.minute = 15;
^
Time.java:8: second has private access in Time
time.second = 30;
^
3 errors

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