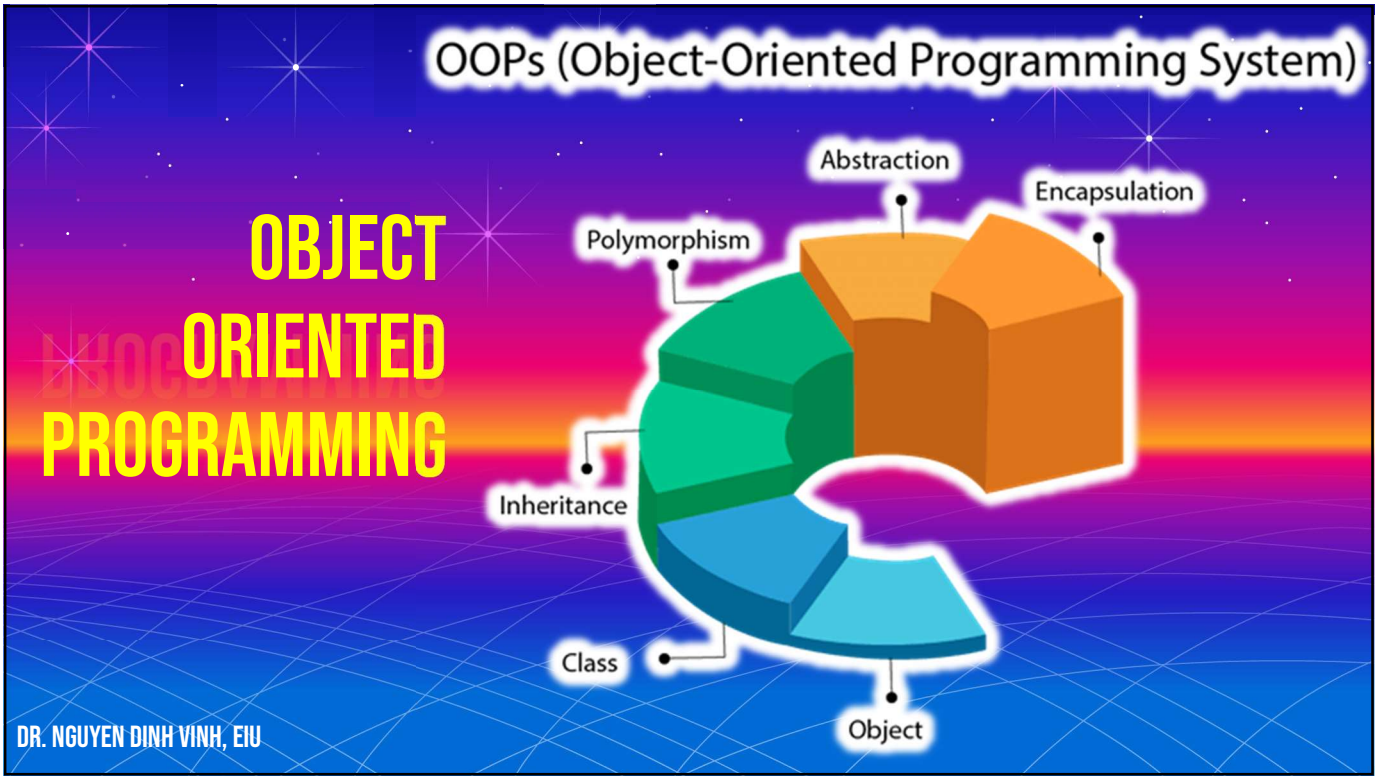

EIU
TRƯỜNG ĐẠI HỌC QUỐC TẾ MIỀN ĐÔNG
EASTERN INTERNATIONAL UNIVERSITY
CSE203 – OBJECT ORIENTED PROGRAMMING
ENCAPSULATION – ABSTRACTION – INHERITANCE - POLYMORPHISM
Mobile programming

1


OOPs (Object-Oriented Programming System)
OBJECT ORIENTED PROGRAMMING
Abstraction
Encapsulation
Polymorphism
Inheritance
Class
Object
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"WHY DO YOU WANT THIS JOB?"
"WHAT'S YOUR BIGGEST WEAKNESS?"
COMMON INTERVIEW QUESTIONS
(And How to Answer Them!)
"WHY SHOULD WE HIRE YOU?"
"WHAT ARE YOUR SALARY EXPECTATIONS?"
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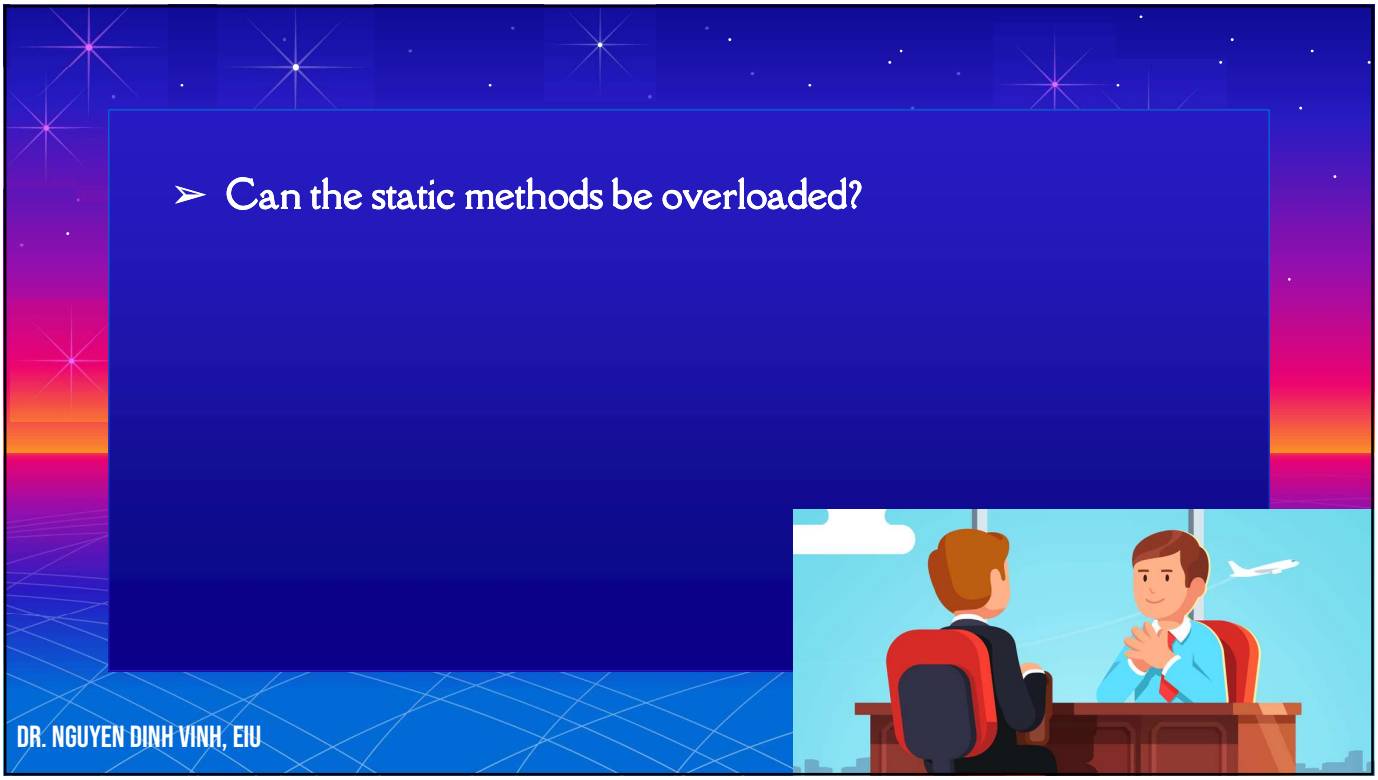
➢ Can the static methods be overloaded?
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- Difference between static methods, static variables, and static classes in java?

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- What are the differences between constructor and method of a class in Java?

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- Can you call a constructor of a class inside the another constructor?

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Constructor Chaining

```
public class InterviewBit{

    InterviewBit(){
        this("Hi InterviewBit!");
    }

    InterviewBit(String s){
        System.out.println(s);
    }

    public static void main(String[]args){
        InterviewBit ib = new InterviewBit();
    }
}
```


InterviewBit

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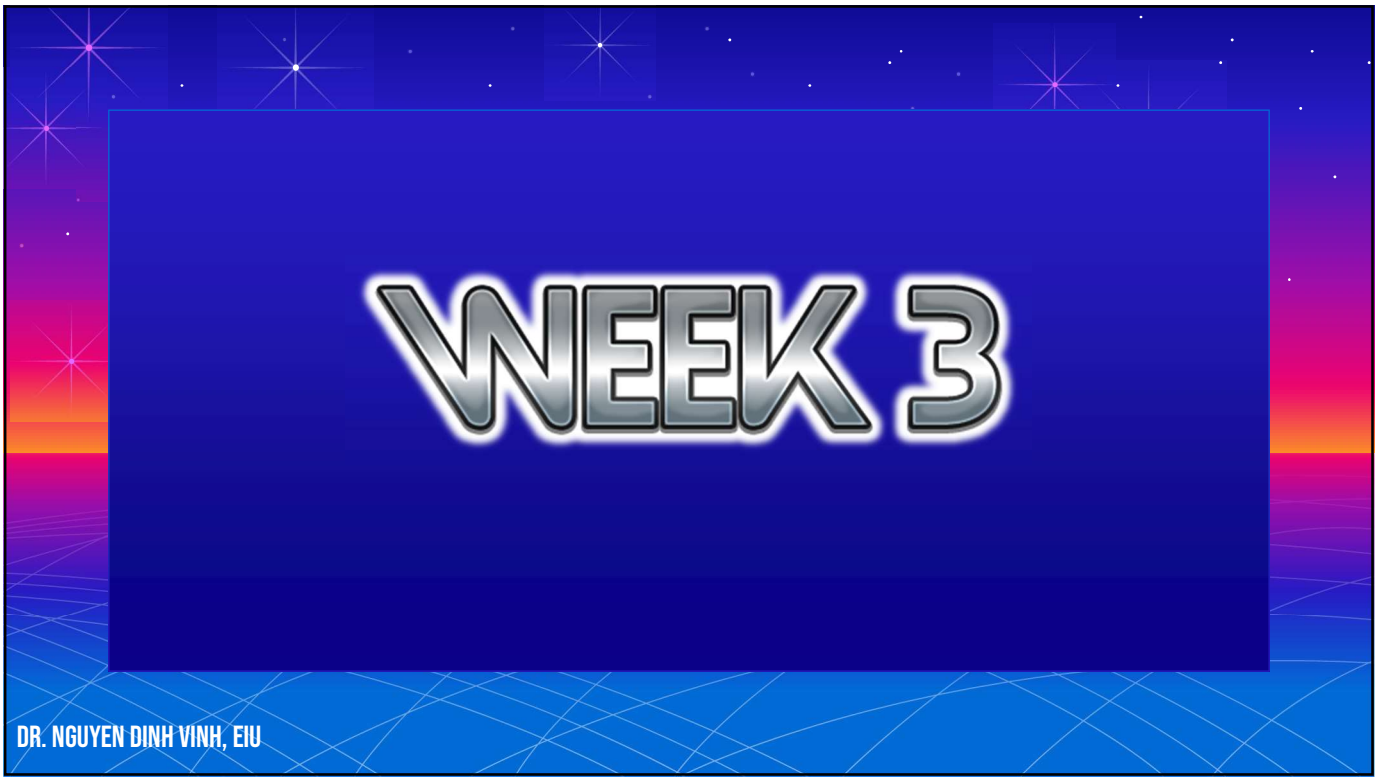
WEEK 3
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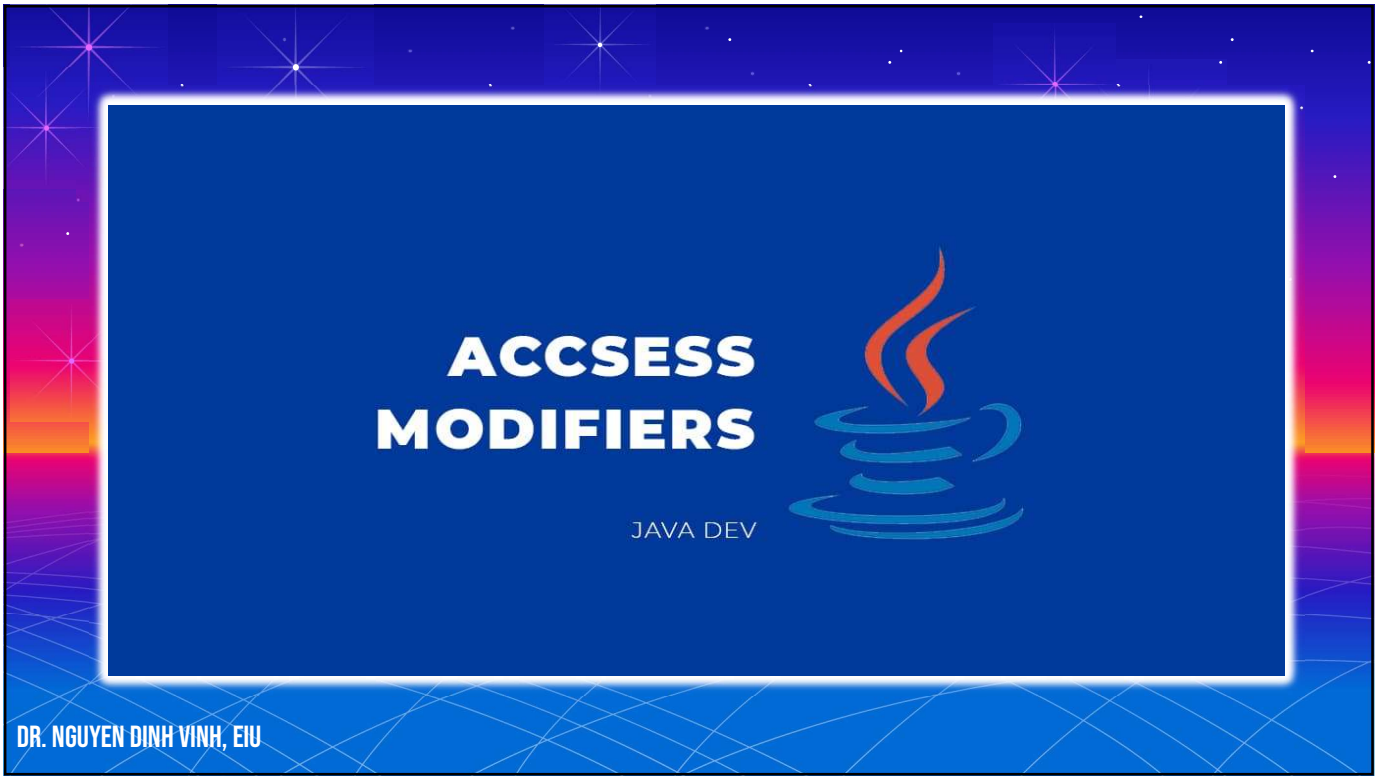
ACCSESS
MODIFIERS
JAVA DEV
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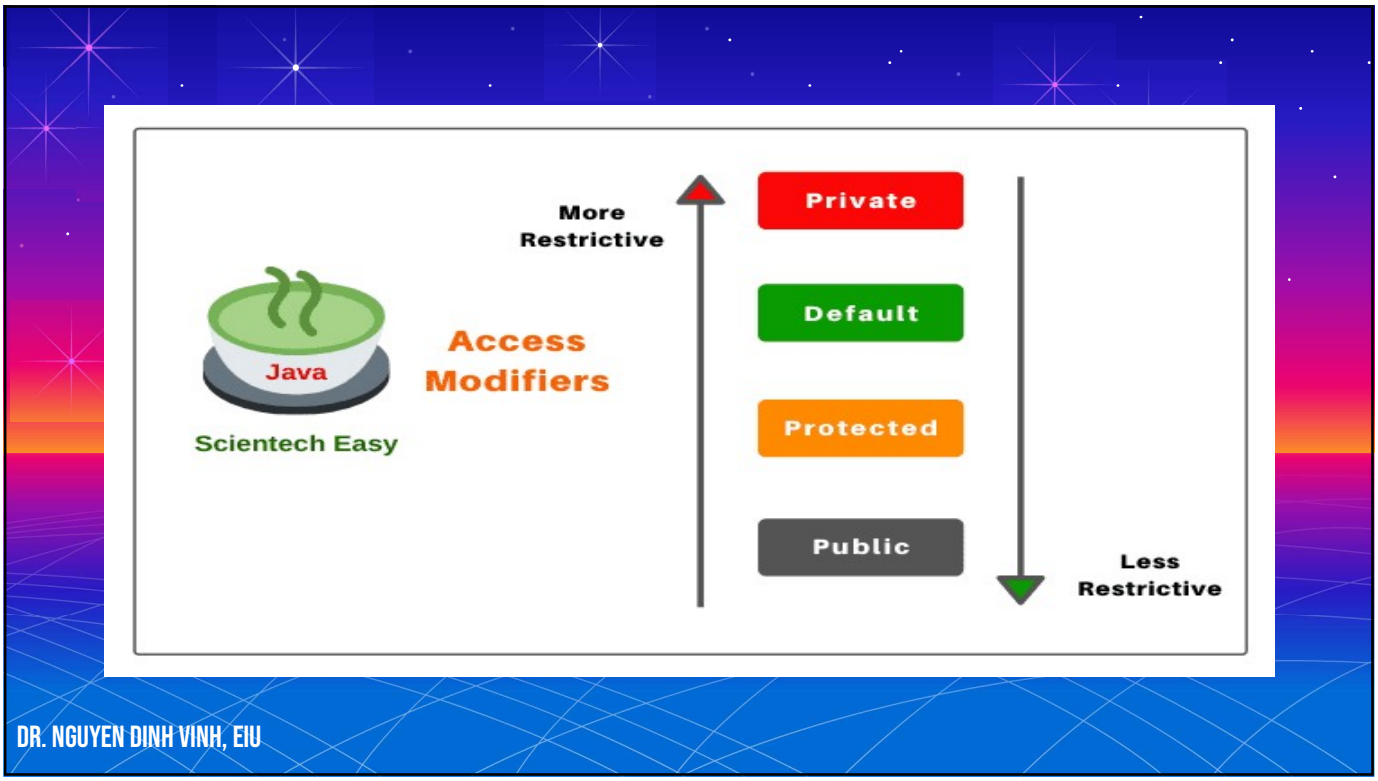
More
Restrictive
Private
Default
Protected
Public
Less
Restrictive
Java
Scientech Easy
Access
Modifiers
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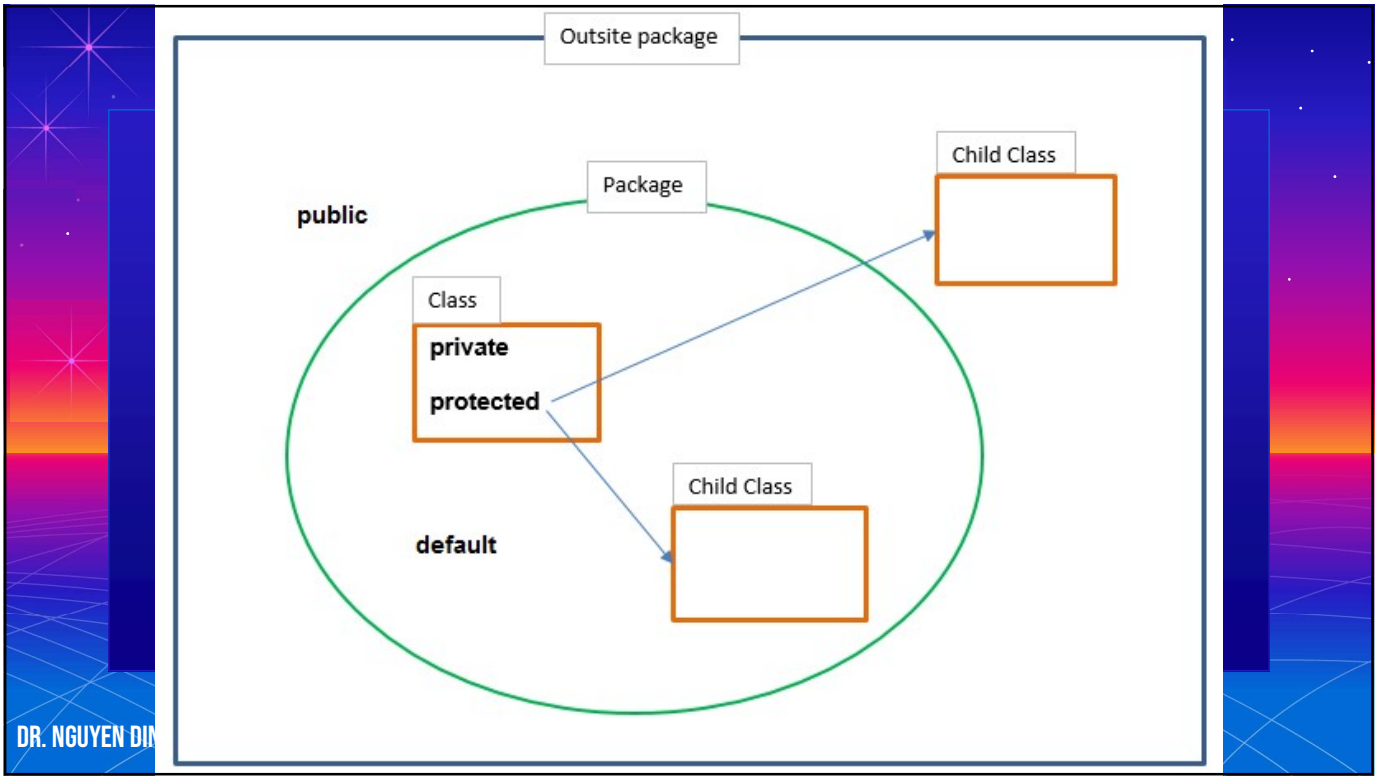
Outsite package
Package
public
Class
private
protected
Child Class
Child Class
default
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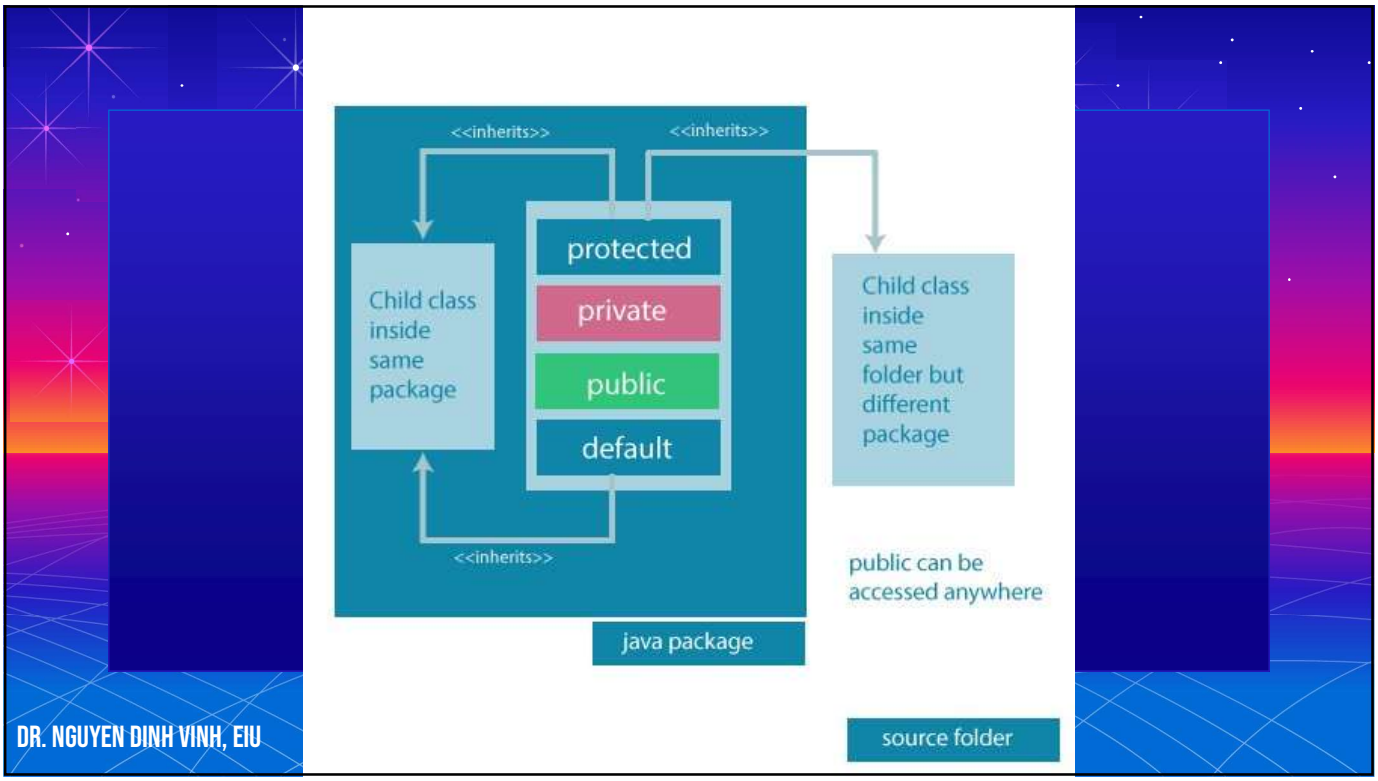
<<inherits>>
<<inherits>>
protected
private
public
default
Child class inside same package
Child class inside same folder but different package
<<inherits>>
public can be accessed anywhere
java package
source folder
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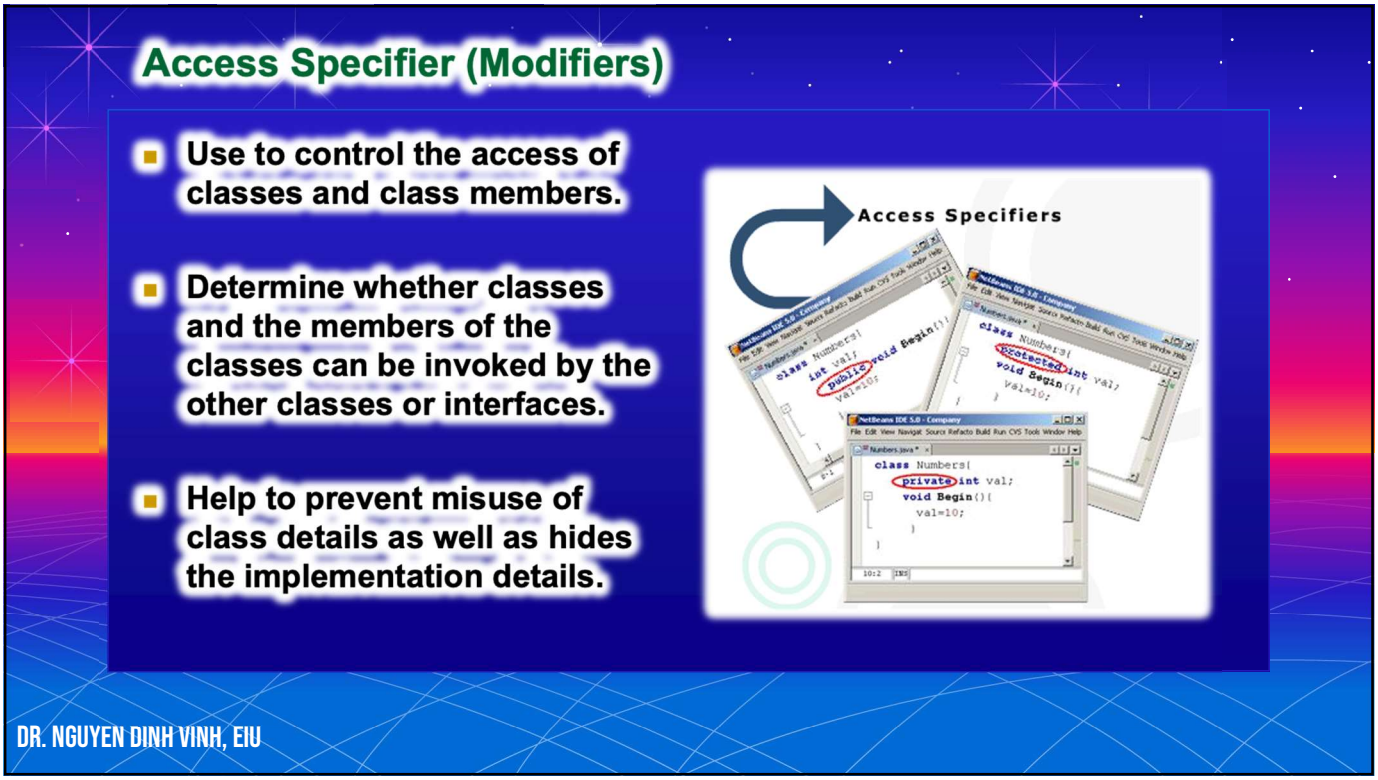
Access Specifier (Modifiers)
Use to control the access of classes and class members.
Determine whether classes and the members of the classes can be invoked by the other classes or interfaces.
Help to prevent misuse of class details as well as hides the implementation details.
Access Specifiers
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Java Access modifiers (class)

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At the top level or class level – public, or *package-private* (no explicit modifier) is allowed.

```
public class Student
{

}
```

```
class Student
{

}
```

```
protected class Student
{

}
```

```
private class Student
{

}
```

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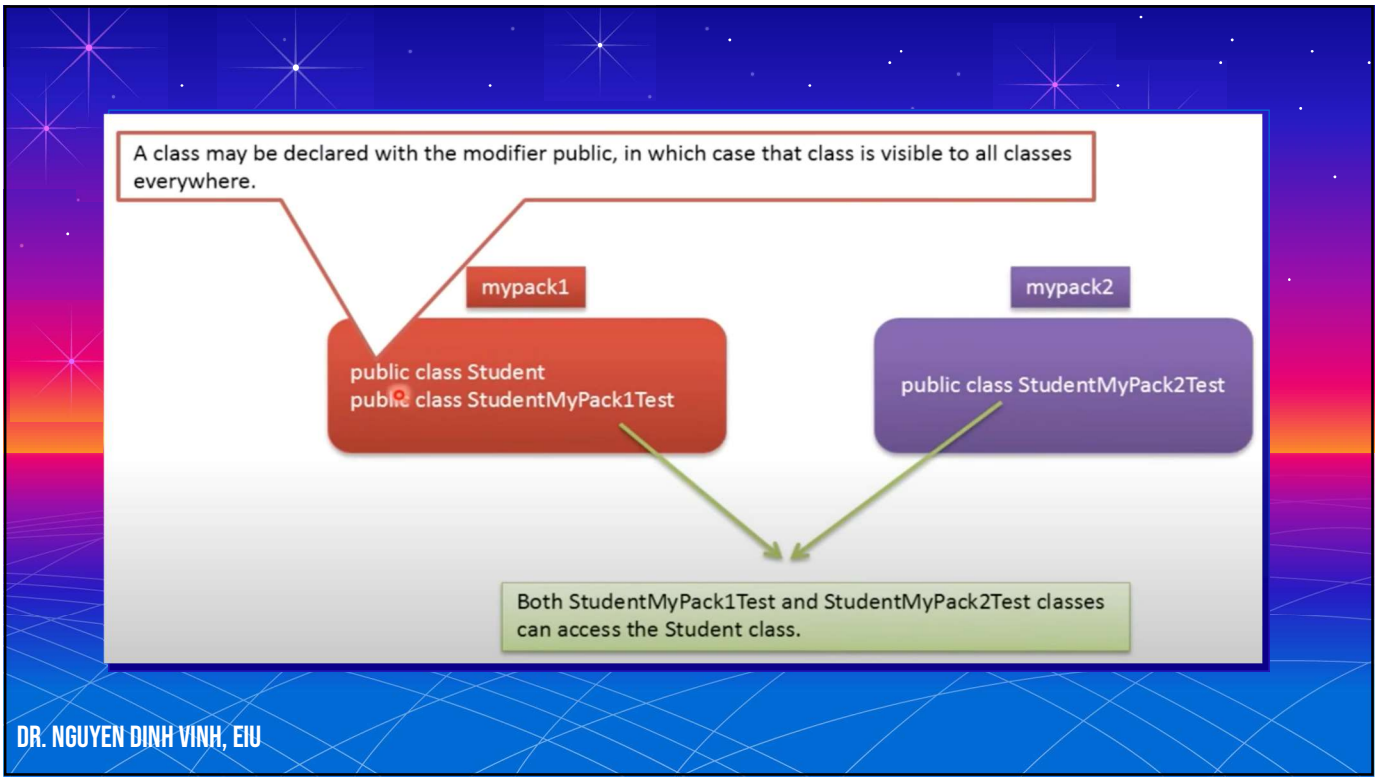
A class may be declared with the modifier public, in which case that class is visible to all classes everywhere.
mypack1
public class Student
public class StudentMyPack1Test
mypack2
public class StudentMyPack2Test
Both StudentMyPack1Test and StudentMyPack2Test classes can access the Student class.
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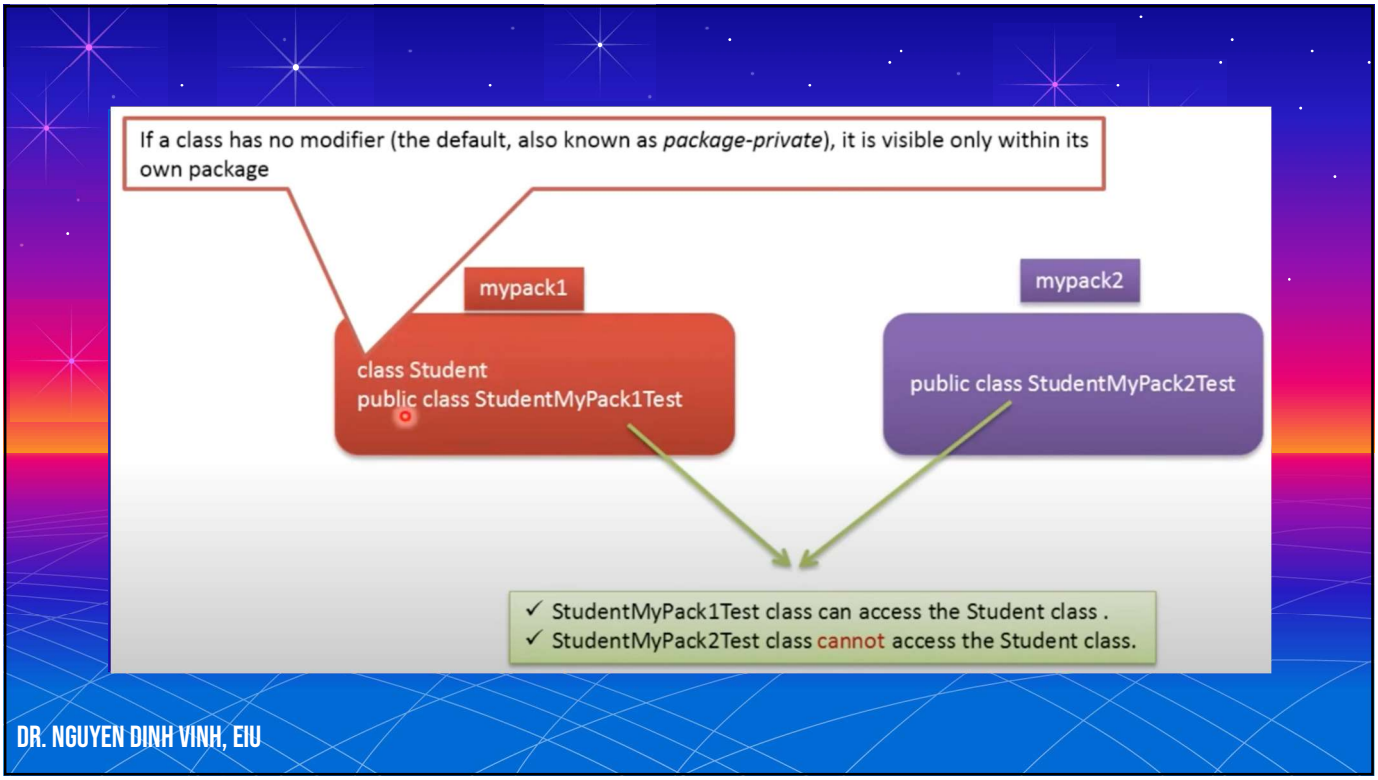
If a class has no modifier (the default, also known as *package-private*), it is visible only within its own package
mypack1
class Student
public class StudentMyPack1Test
mypack2
public class StudentMyPack2Test
✓ StudentMyPack1Test class can access the Student class .
✓ StudentMyPack2Test class cannot access the Student class.
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Tips on Choosing an Access Level

- **Use the most restrictive access level that makes sense for a particular member.**
  - Use private unless you have a good reason not to.
- **Avoid public fields except for constants.**
  - Public fields tend to link you to a particular implementation and limit your flexibility in changing your code.

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Java Access modifiers (field)

At the **field/attribute** level —public, private, protected, or package-private (no explicit modifier) is allowed.

```
public class Student
{
   public String name;
}
```

```
public class Student
{
   private String name;
}
```

```
public class Student
{
   protected String name;
}
```

```
public class Student
{
   String name;
}
```

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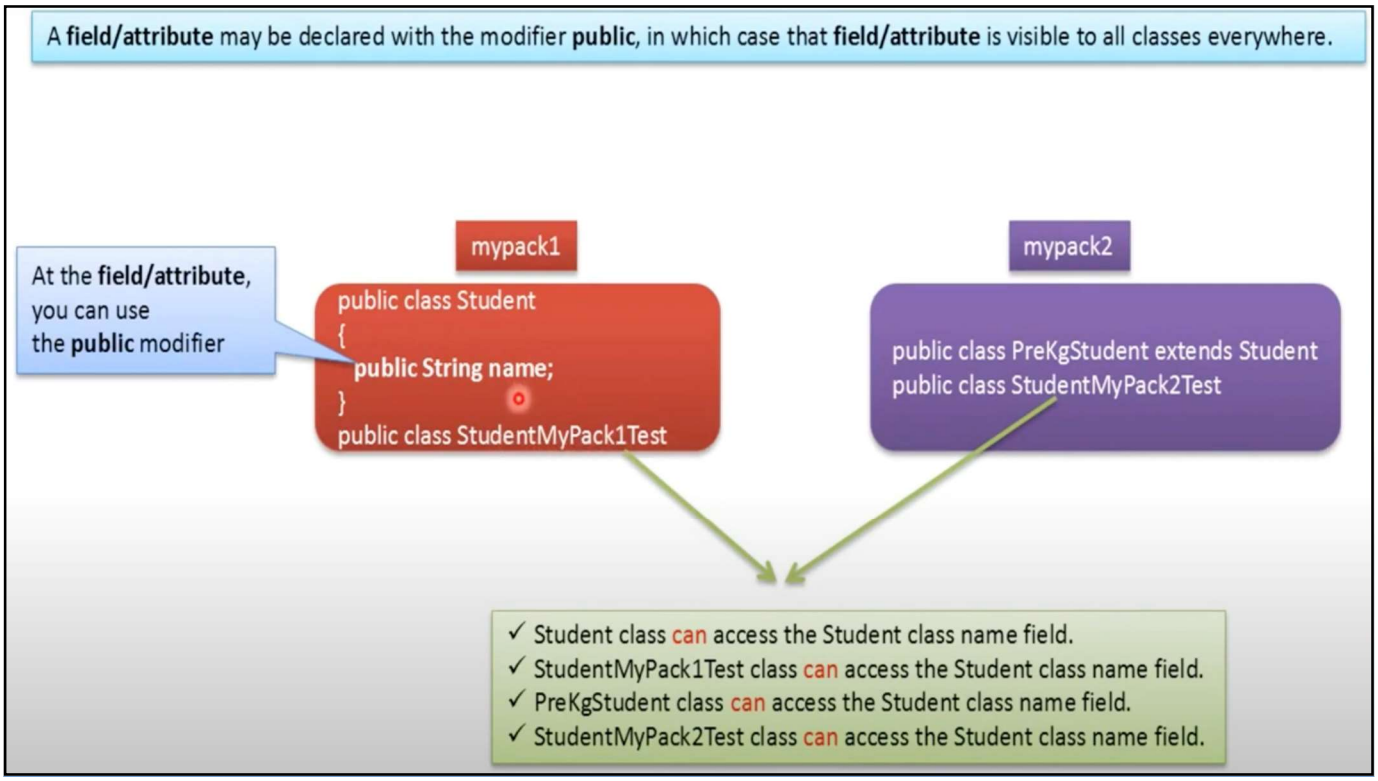
A field/attribute may be declared with the modifier public, in which case that field/attribute is visible to all classes everywhere.
At the field/attribute, you can use the public modifier
mypack1
public class Student
{
public String name;
}
public class StudentMyPack1Test
mypack2
public class PreKgStudent extends Student
public class StudentMyPack2Test
✓ Student class can access the Student class name field.
✓ StudentMyPack1Test class can access the Student class name field.
✓ PreKgStudent class can access the Student class name field.
✓ StudentMyPack2Test class can access the Student class name field.

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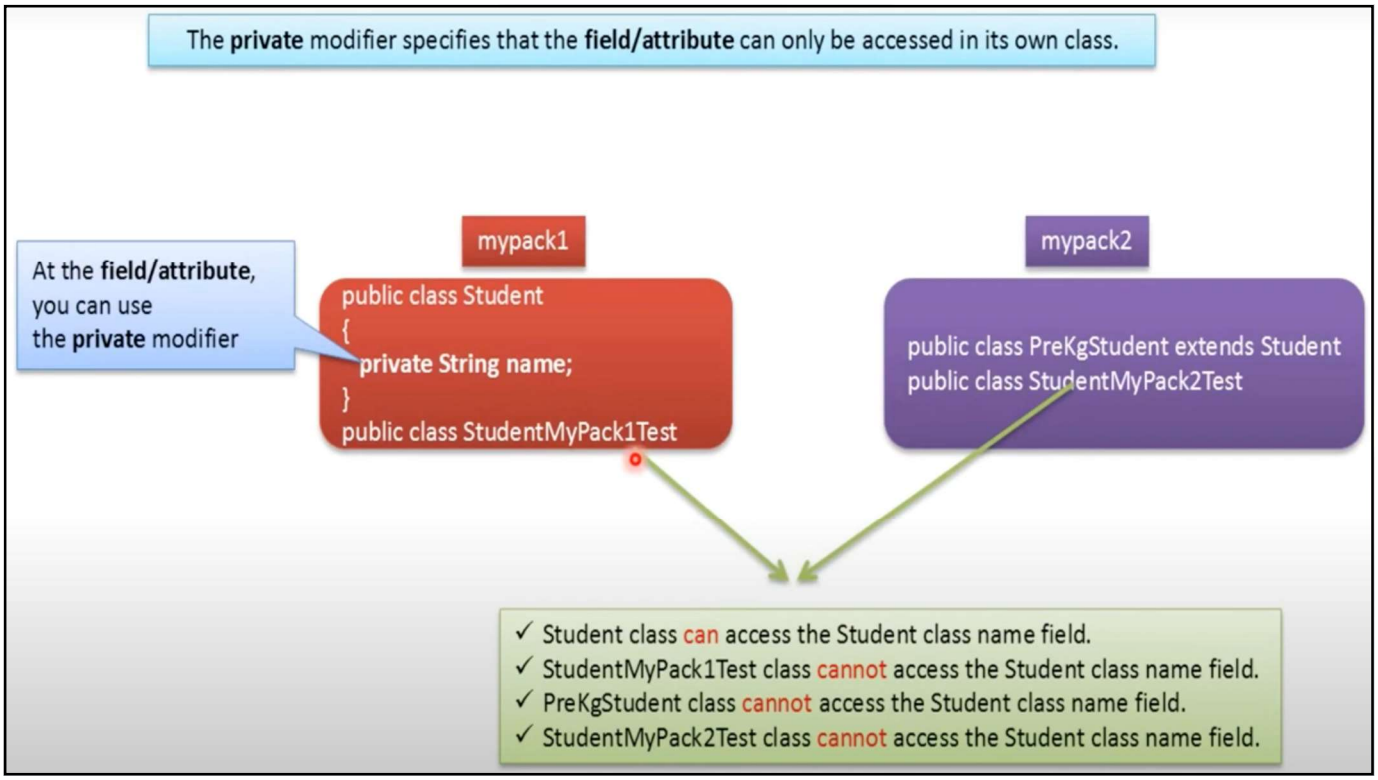
The private modifier specifies that the field/attribute can only be accessed in its own class.
At the field/attribute, you can use the private modifier
mypack1
public class Student
{
private String name;
}
public class StudentMyPack1Test
mypack2
public class PreKgStudent extends Student
public class StudentMyPack2Test
✓ Student class can access the Student class name field.
✓ StudentMyPack1Test class cannot access the Student class name field.
✓ PreKgStudent class cannot access the Student class name field.
✓ StudentMyPack2Test class cannot access the Student class name field.

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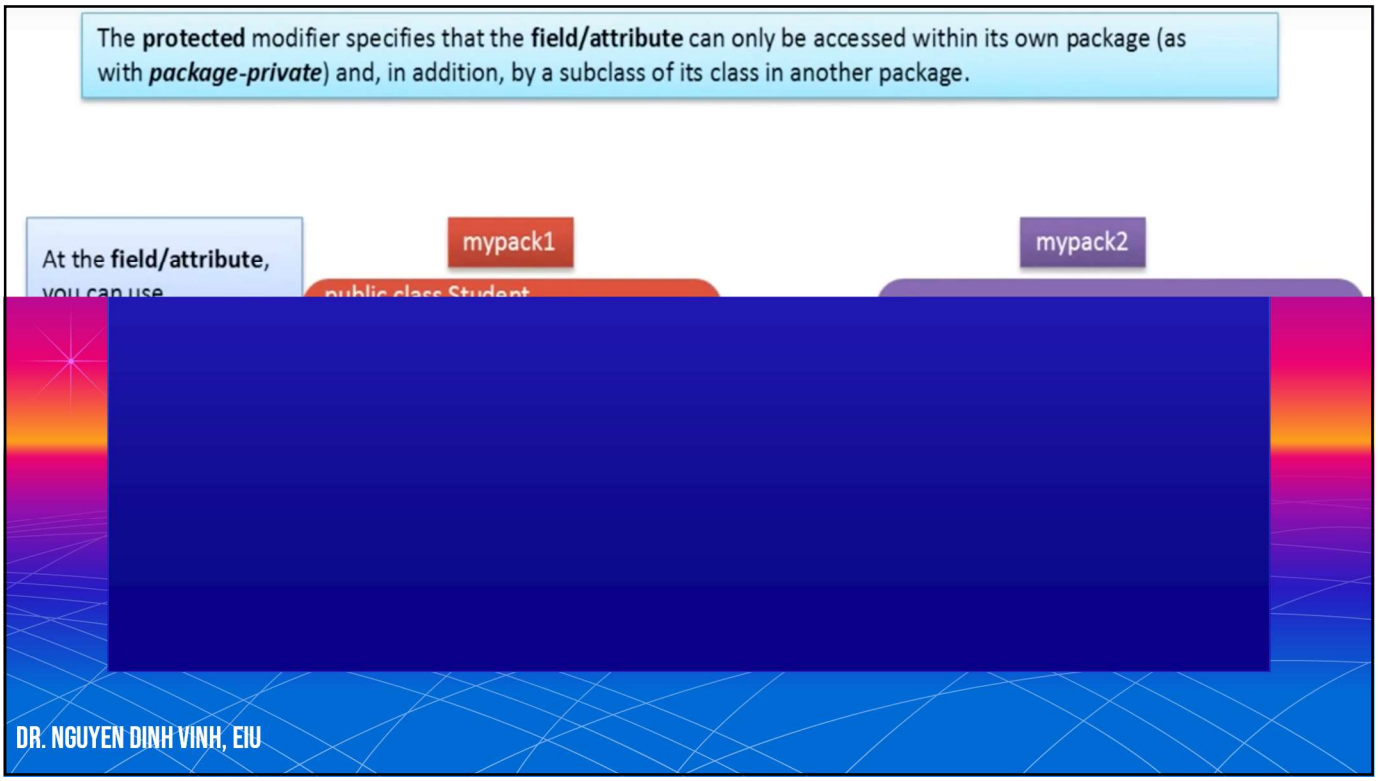
The protected modifier specifies that the field/attribute can only be accessed within its own package (as with package-private) and, in addition, by a subclass of its class in another package.
At the field/attribute,
mypack1
mypack2
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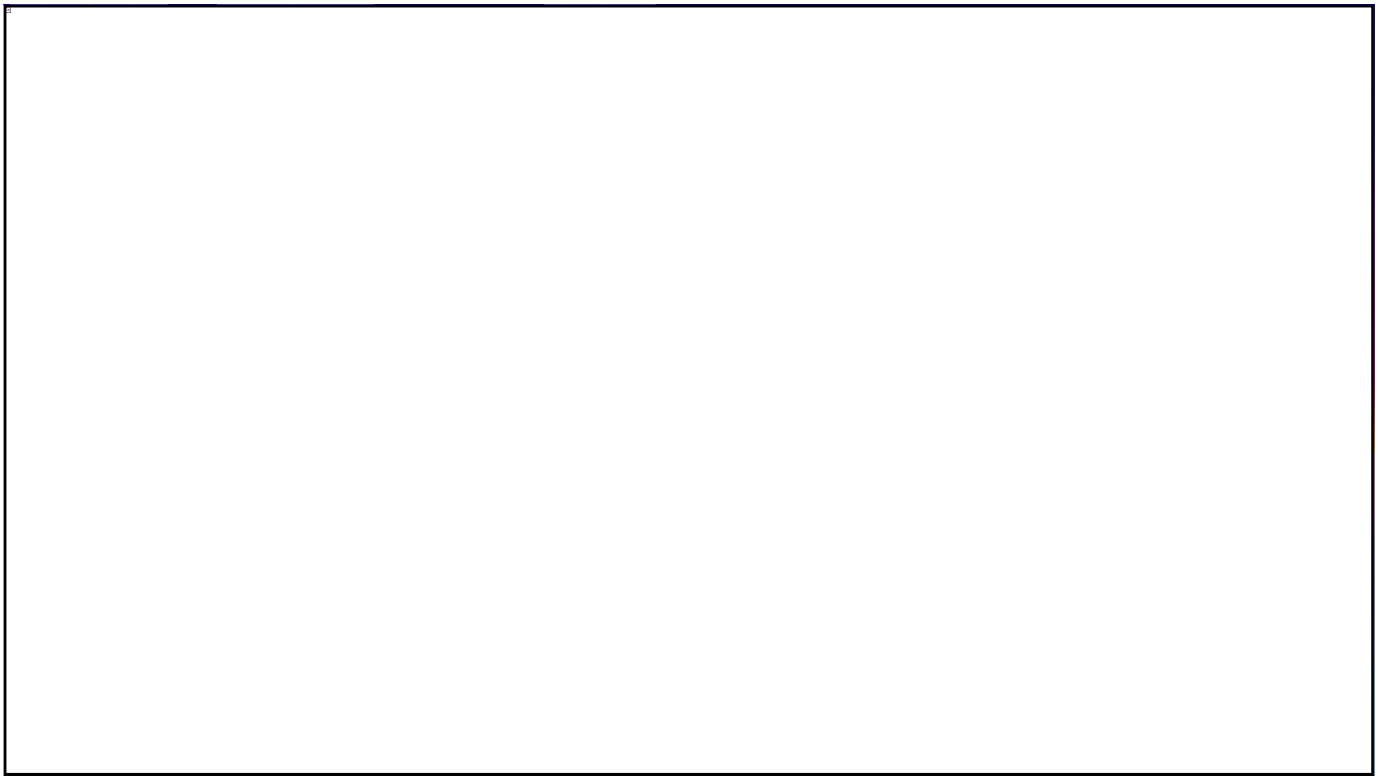

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Java Access modifiers (method)

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At the method level —public, private, protected, or package-private (no explicit modifier) is allowed.

```
public class Student
{
   public void display()
   {
     System.out.println("hello");
   }
}
```

```
public class Student
{
   private void display()
   {
     System.out.println("hello");
   }
}
```

```
public class Student
{
   protected void display()
   {
     System.out.println("hello");
   }
}
```

```
public class Student
{
    void display()
   {
     System.out.println("hello");
   }
}
```


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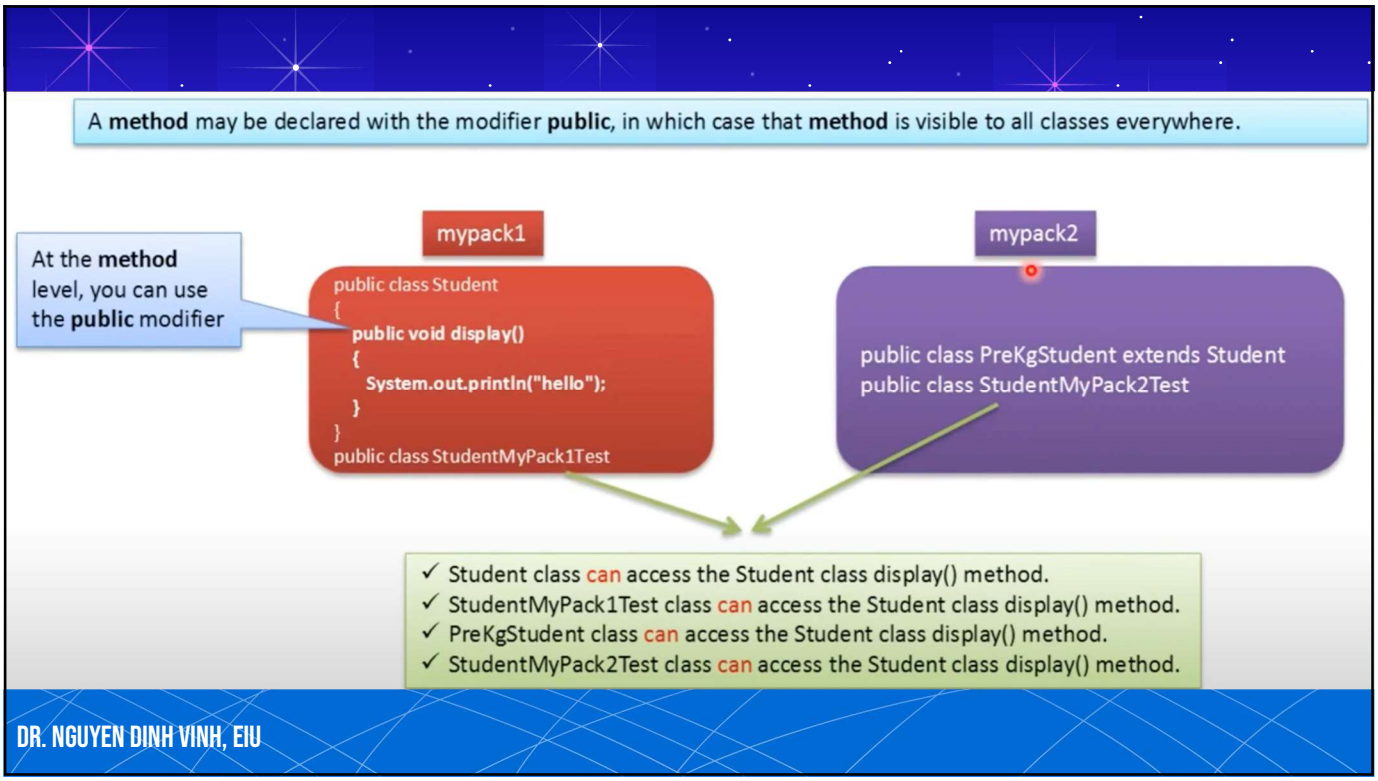
A method may be declared with the modifier public, in which case that method is visible to all classes everywhere.
At the method level, you can use the public modifier
mypack1
public class Student
{
public void display()
{
System.out.println("hello");
}
}
public class StudentMyPack1Test
mypack2
public class PreKgStudent extends Student
public class StudentMyPack2Test
✓ Student class can access the Student class display() method.
✓ StudentMyPack1Test class can access the Student class display() method.
✓ PreKgStudent class can access the Student class display() method.
✓ StudentMyPack2Test class can access the Student class display() method.
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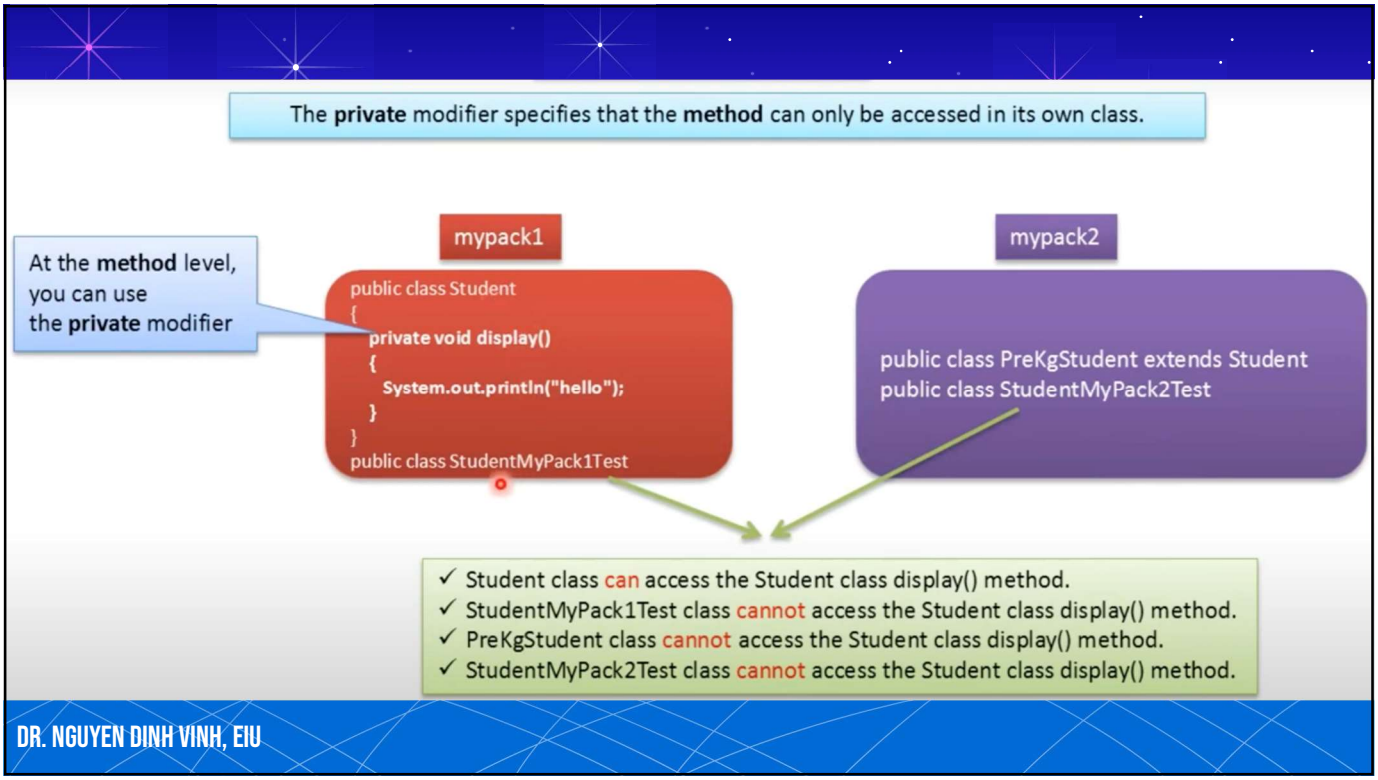
The private modifier specifies that the method can only be accessed in its own class.
At the method level, you can use the private modifier
mypack1
public class Student
{
private void display()
{
System.out.println("hello");
}
}
public class StudentMyPack1Test
mypack2
public class PreKgStudent extends Student
public class StudentMyPack2Test
✓ Student class can access the Student class display() method.
✓ StudentMyPack1Test class cannot access the Student class display() method.
✓ PreKgStudent class cannot access the Student class display() method.
✓ StudentMyPack2Test class cannot access the Student class display() method.
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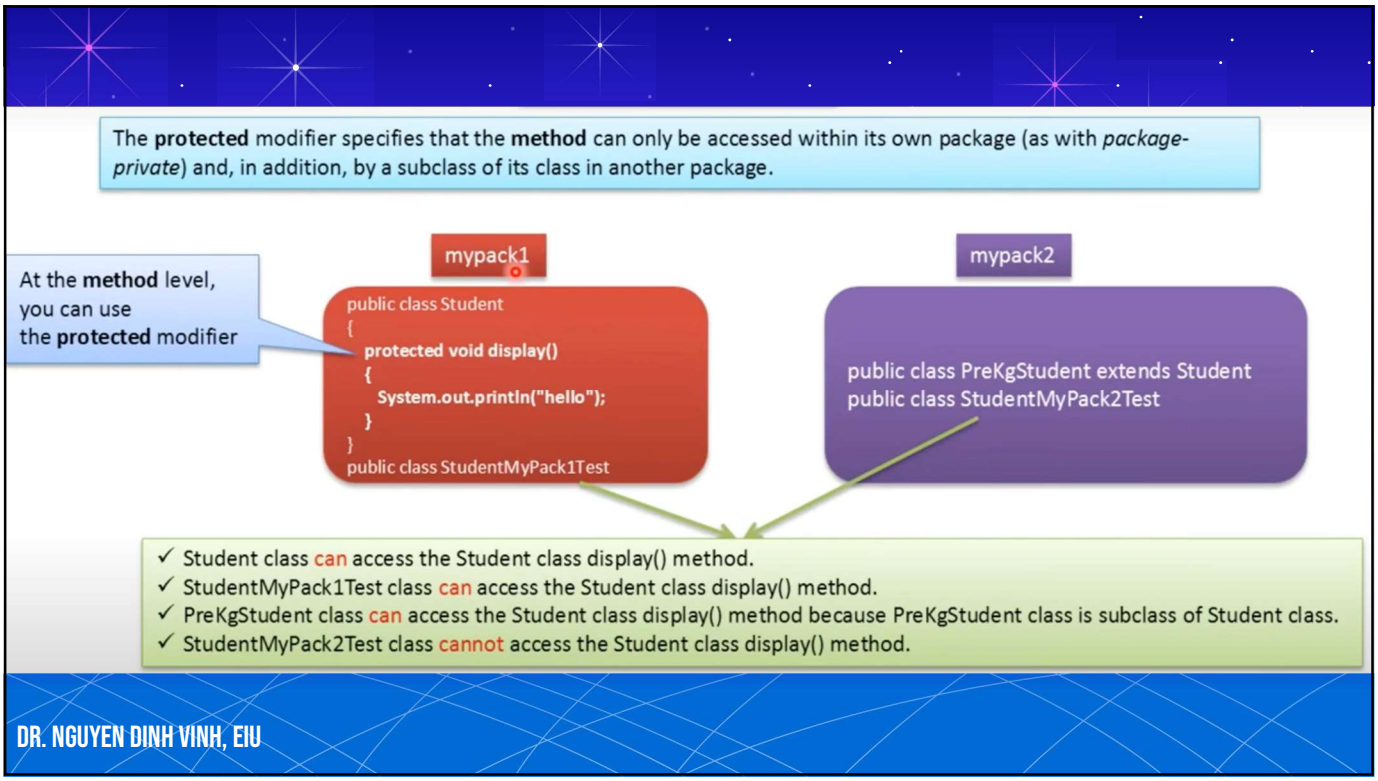
The protected modifier specifies that the method can only be accessed within its own package (as with package-private) and, in addition, by a subclass of its class in another package.
At the method level, you can use the protected modifier
mypack1
public class Student
{
protected void display()
{
System.out.println("hello");
}
}
public class StudentMyPack1Test
mypack2
public class PreKgStudent extends Student
public class StudentMyPack2Test
✓ Student class can access the Student class display() method.
✓ StudentMyPack1Test class can access the Student class display() method.
✓ PreKgStudent class can access the Student class display() method because PreKgStudent class is subclass of Student class.
✓ StudentMyPack2Test class cannot access the Student class display() method.
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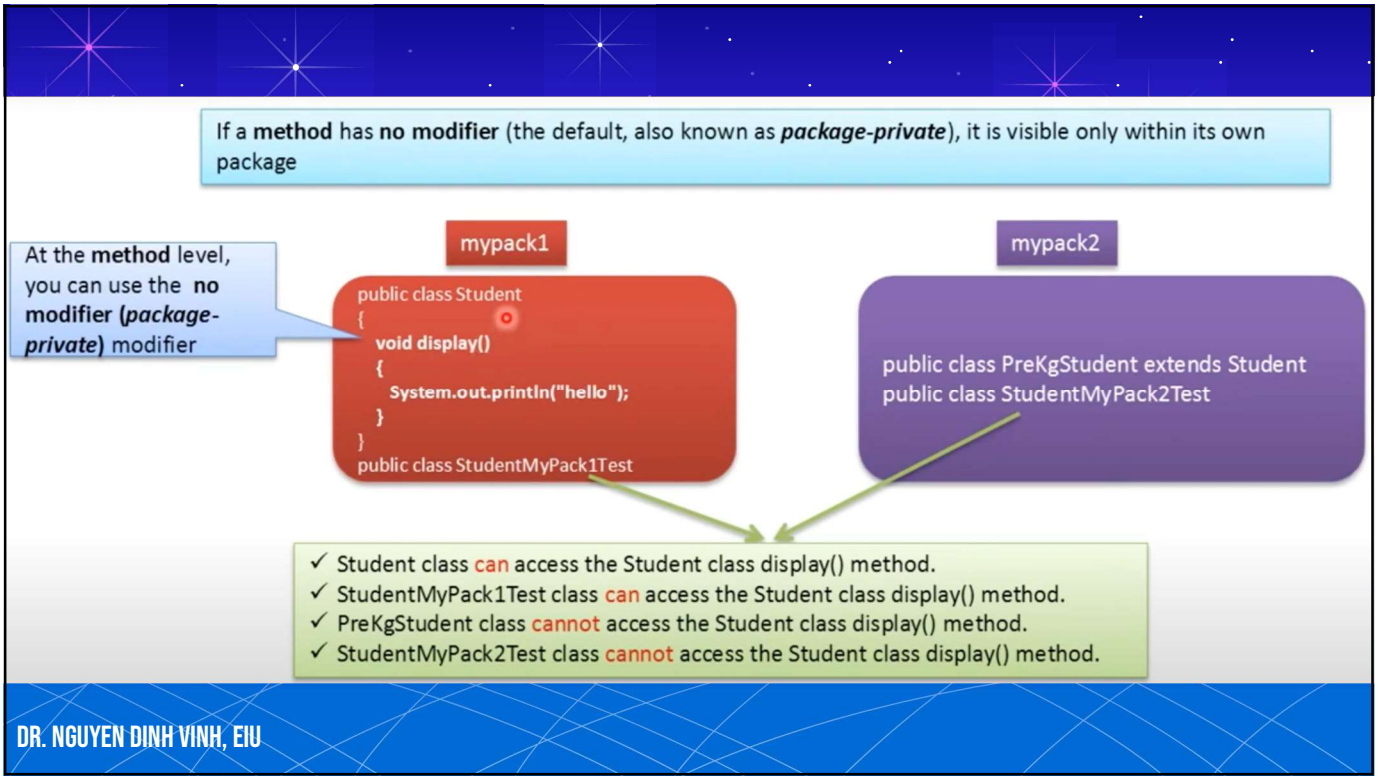
If a method has no modifier (the default, also known as package-private), it is visible only within its own package
At the method level, you can use the no modifier (package-private) modifier
mypack1
public class Student
{
void display()
{
System.out.println("hello");
}
}
public class StudentMyPack1Test
mypack2
public class PreKgStudent extends Student
public class StudentMyPack2Test
✓ Student class can access the Student class display() method.
✓ StudentMyPack1Test class can access the Student class display() method.
✓ PreKgStudent class cannot access the Student class display() method.
✓ StudentMyPack2Test class cannot access the Student class display() method.
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Java Access modifiers (constructor)

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At the Constructor level —public, private, protected, or package-private (no explicit modifier) is allowed.

```
public class Student
{
    public Student()
    {
        System.out.println("Default constructor ...");
    }
}
```

```
public class Student
{
    private Student()
    {
        System.out.println("Default constructor ...");
    }
}
```

```
public class Student
{
    protected Student()
    {
        System.out.println("Default constructor ...");
    }
}
```

```
public class Student
{
    Student()
    {
        System.out.println("Default constructor ...");
    }
}
```

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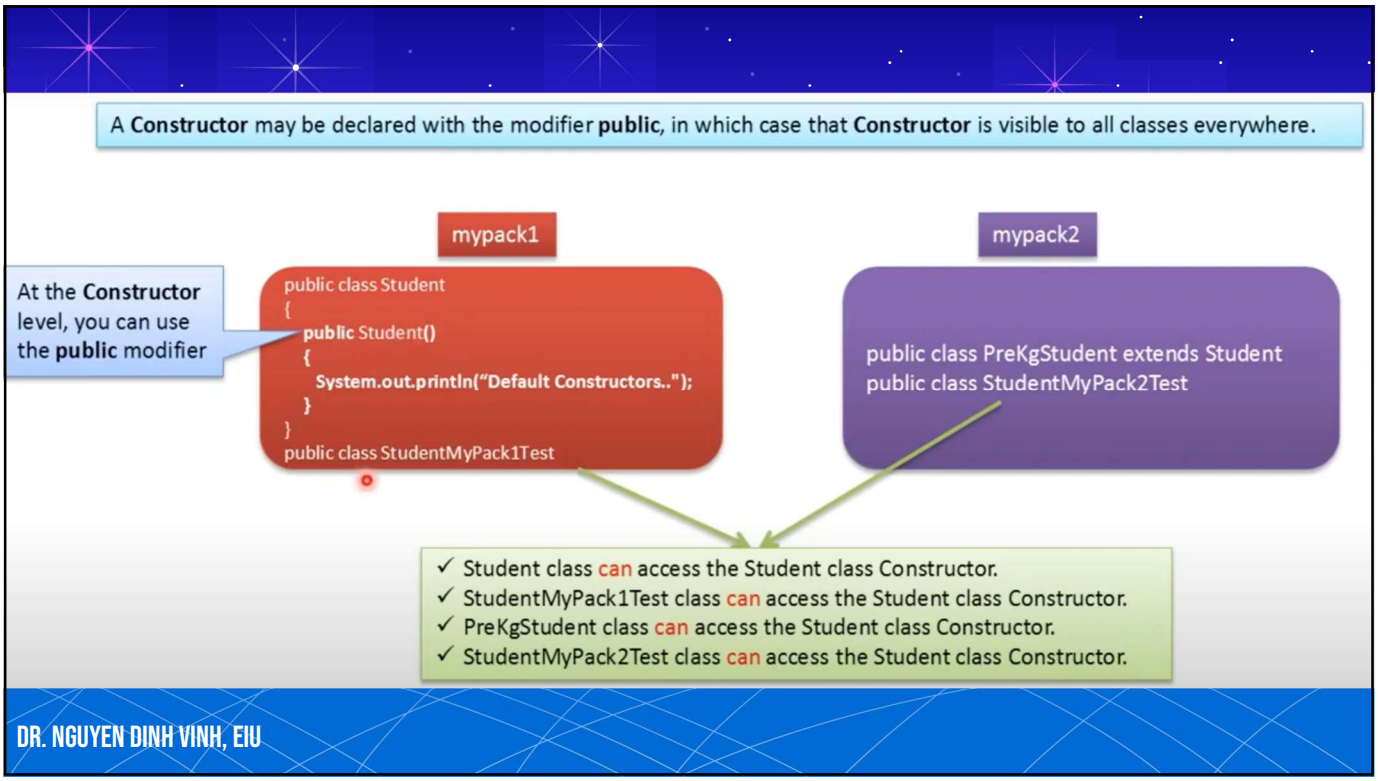
A Constructor may be declared with the modifier public, in which case that Constructor is visible to all classes everywhere.
mypack1
mypack2
At the Constructor level, you can use the public modifier
public class Student
{
public Student()
{
System.out.println("Default Constructors..");
}
}
public class StudentMyPack1Test
public class PreKgStudent extends Student
public class StudentMyPack2Test
✓ Student class can access the Student class Constructor.
✓ StudentMyPack1Test class can access the Student class Constructor.
✓ PreKgStudent class can access the Student class Constructor.
✓ StudentMyPack2Test class can access the Student class Constructor.
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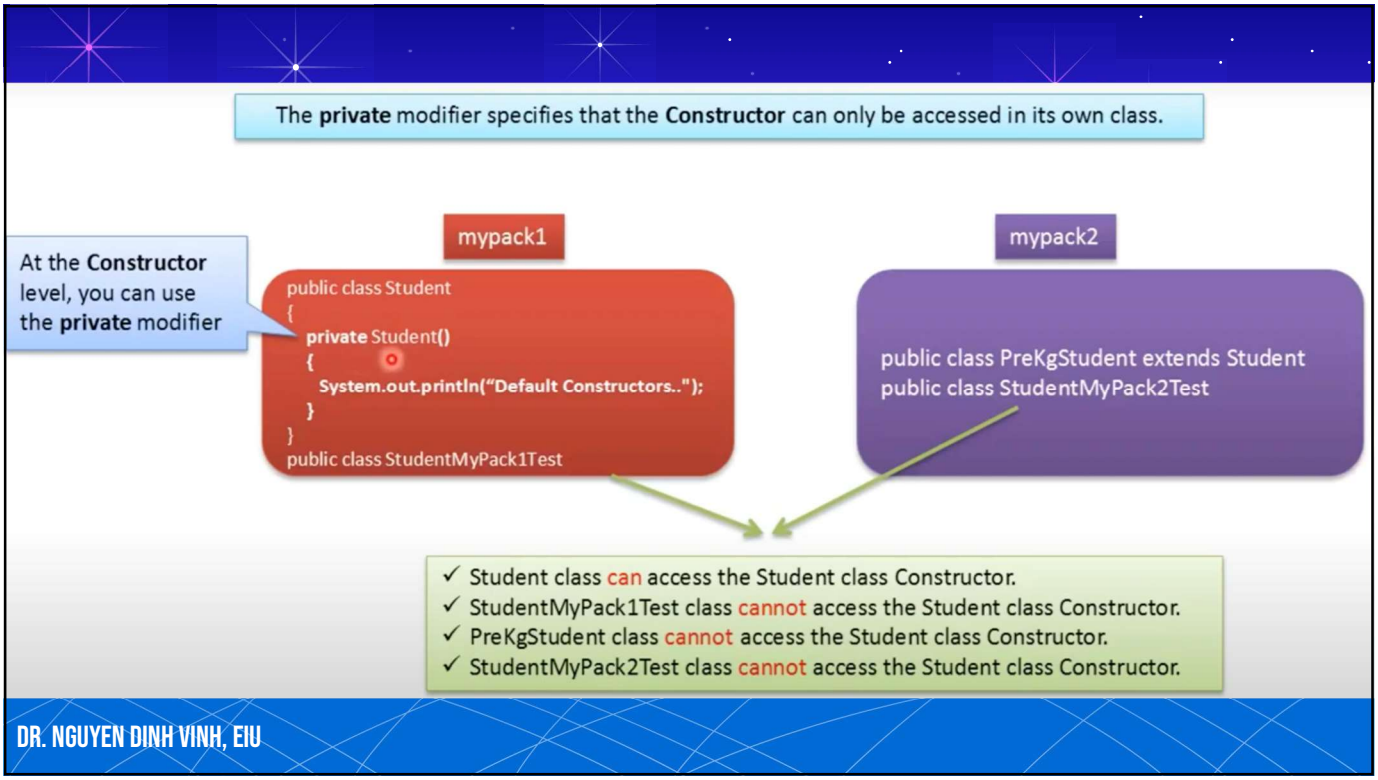
The private modifier specifies that the Constructor can only be accessed in its own class.
mypack1
mypack2
At the Constructor level, you can use the private modifier
public class Student
{
private Student()
{
System.out.println("Default Constructors..");
}
}
public class StudentMyPack1Test
public class PreKgStudent extends Student
public class StudentMyPack2Test
✓ Student class can access the Student class Constructor.
✓ StudentMyPack1Test class cannot access the Student class Constructor.
✓ PreKgStudent class cannot access the Student class Constructor.
✓ StudentMyPack2Test class cannot access the Student class Constructor.
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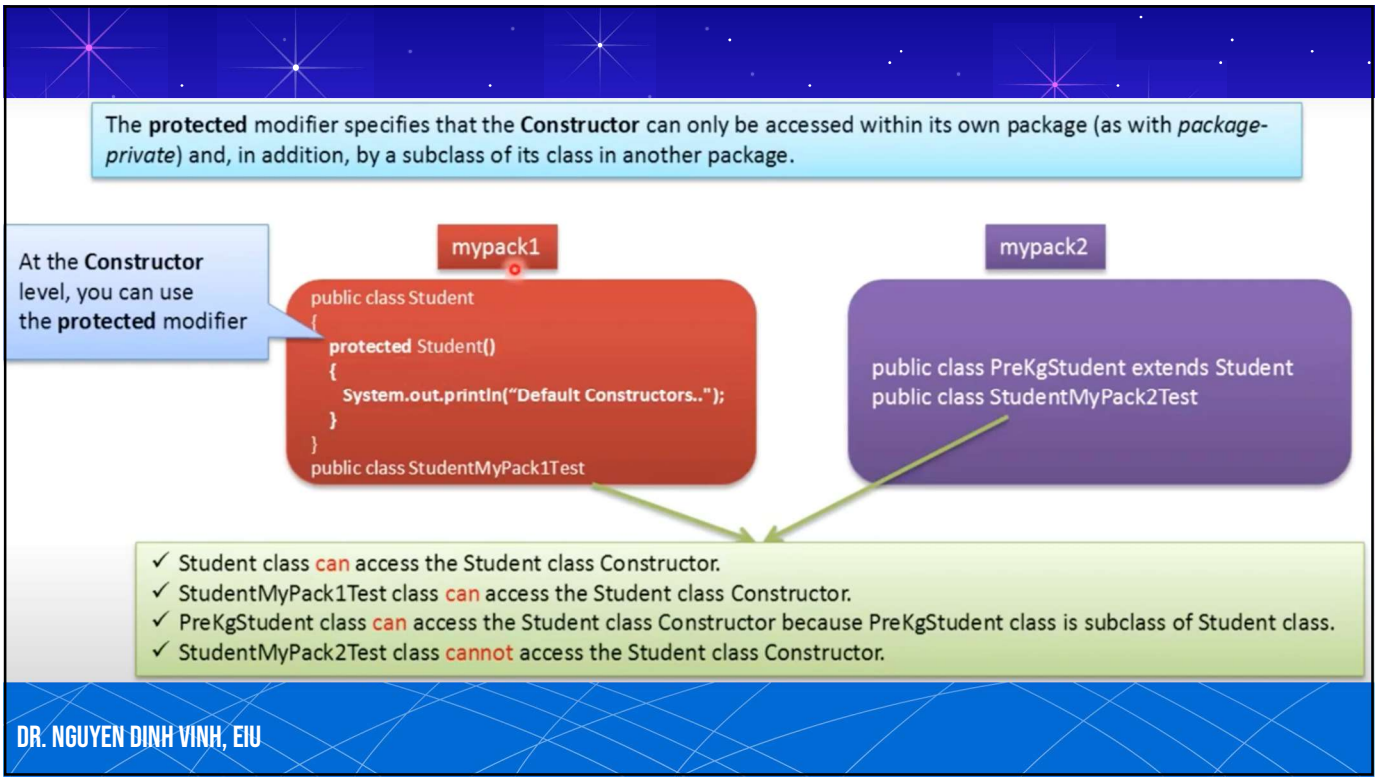
The protected modifier specifies that the Constructor can only be accessed within its own package (as with package-private) and, in addition, by a subclass of its class in another package.
At the Constructor level, you can use the protected modifier
mypack1
public class Student
{
protected Student()
{
System.out.println("Default Constructors..");
}
}
public class StudentMyPack1Test
mypack2
public class PreKgStudent extends Student
public class StudentMyPack2Test
✓ Student class can access the Student class Constructor.
✓ StudentMyPack1Test class can access the Student class Constructor.
✓ PreKgStudent class can access the Student class Constructor because PreKgStudent class is subclass of Student class.
✓ StudentMyPack2Test class cannot access the Student class Constructor.
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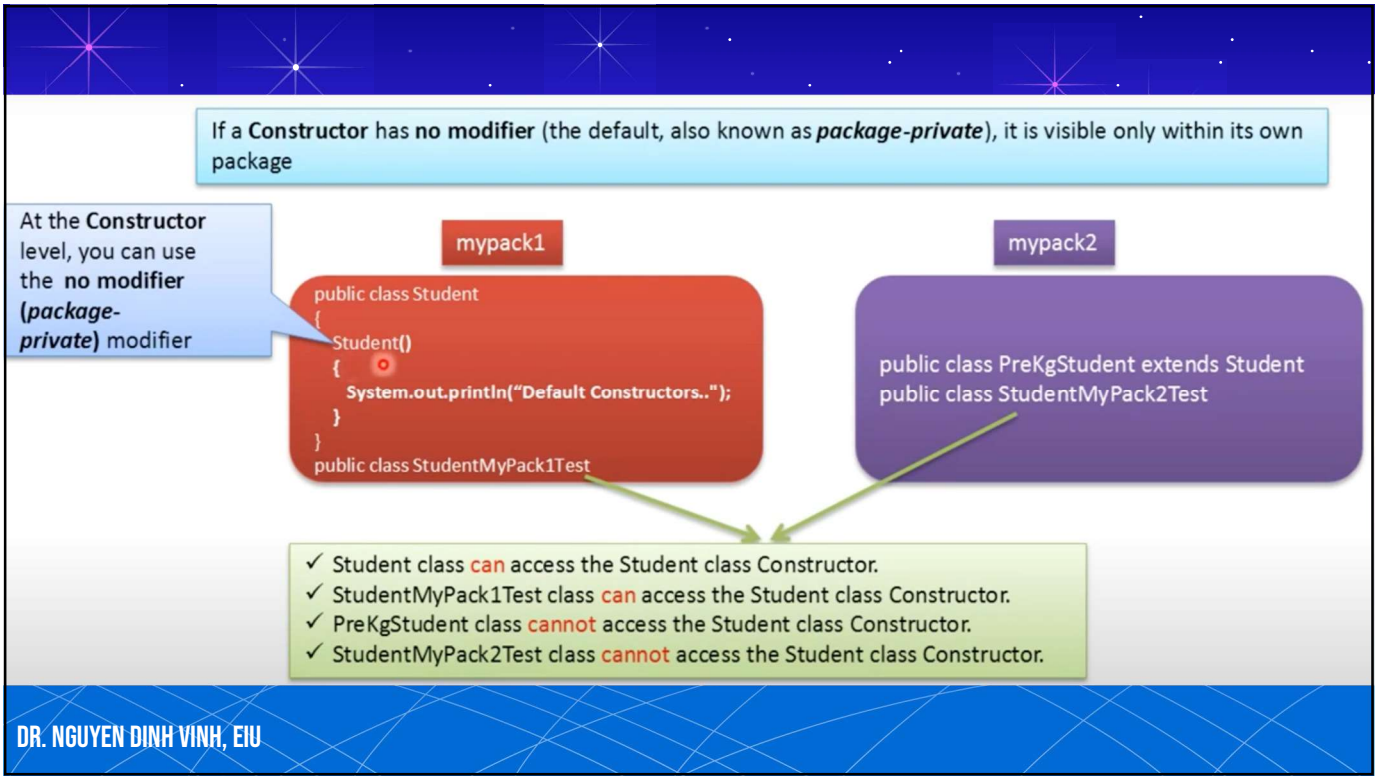
If a Constructor has no modifier (the default, also known as package-private), it is visible only within its own package
At the Constructor level, you can use the no modifier (package-private) modifier
mypack1
public class Student
{
Student()
{
System.out.println("Default Constructors..");
}
}
public class StudentMyPack1Test
mypack2
public class PreKgStudent extends Student
public class StudentMyPack2Test
✓ Student class can access the Student class Constructor.
✓ StudentMyPack1Test class can access the Student class Constructor.
✓ PreKgStudent class cannot access the Student class Constructor.
✓ StudentMyPack2Test class cannot access the Student class Constructor.
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What is Access Levels in Java? | Java Access Levels

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The first data column indicates whether the class itself has access to the member defined by the access level. As you can see, a class always has access to its own members.

The second column indicates whether classes in the same package as the class have access to the member.

The third column indicates whether subclasses of the class declared outside this package have access to the member.

The fourth column indicates whether all classes have access to the member.

Modifier	Class	Package	Subclass	World
public	Y	Y	Y	Y
Protected	Y	Y	Y	N
no modifier	Y	Y	N	N
private	Y	N	N	N

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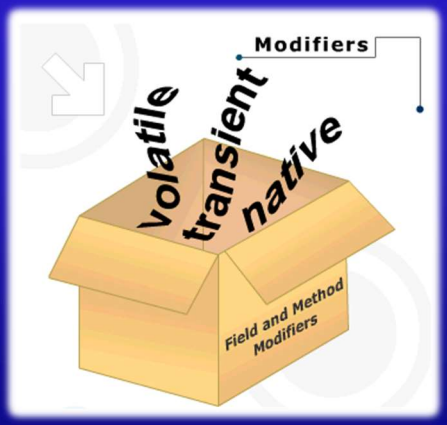
Field and Method Modifiers

- Use to identify fields and methods that need to be declare for controlling access to users.



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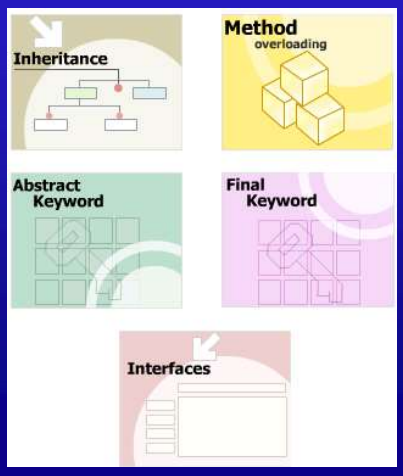
INHERITANCE, INTERFACES AND POLYMORPHISM



- Inheritance
- Constructor Inheritance
- Overriding Methods
- Overloading of methods
- "abstract" class
- Using "final" keyword
- Interfaces
- Polymorphism

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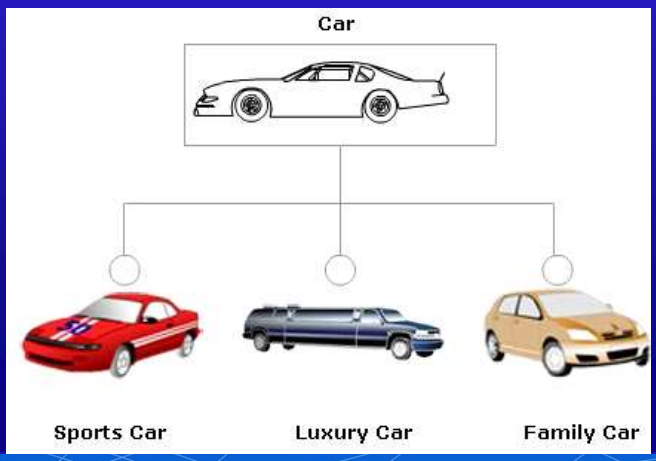
WHAT IS INHERITANCE?



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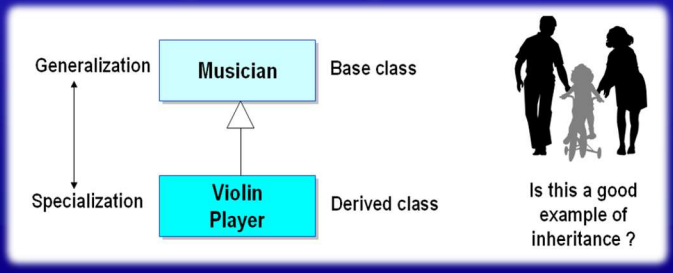
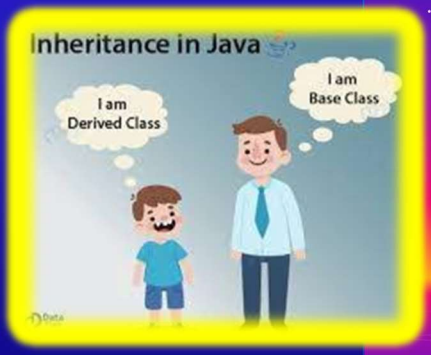
Basic concepts of Inheritance

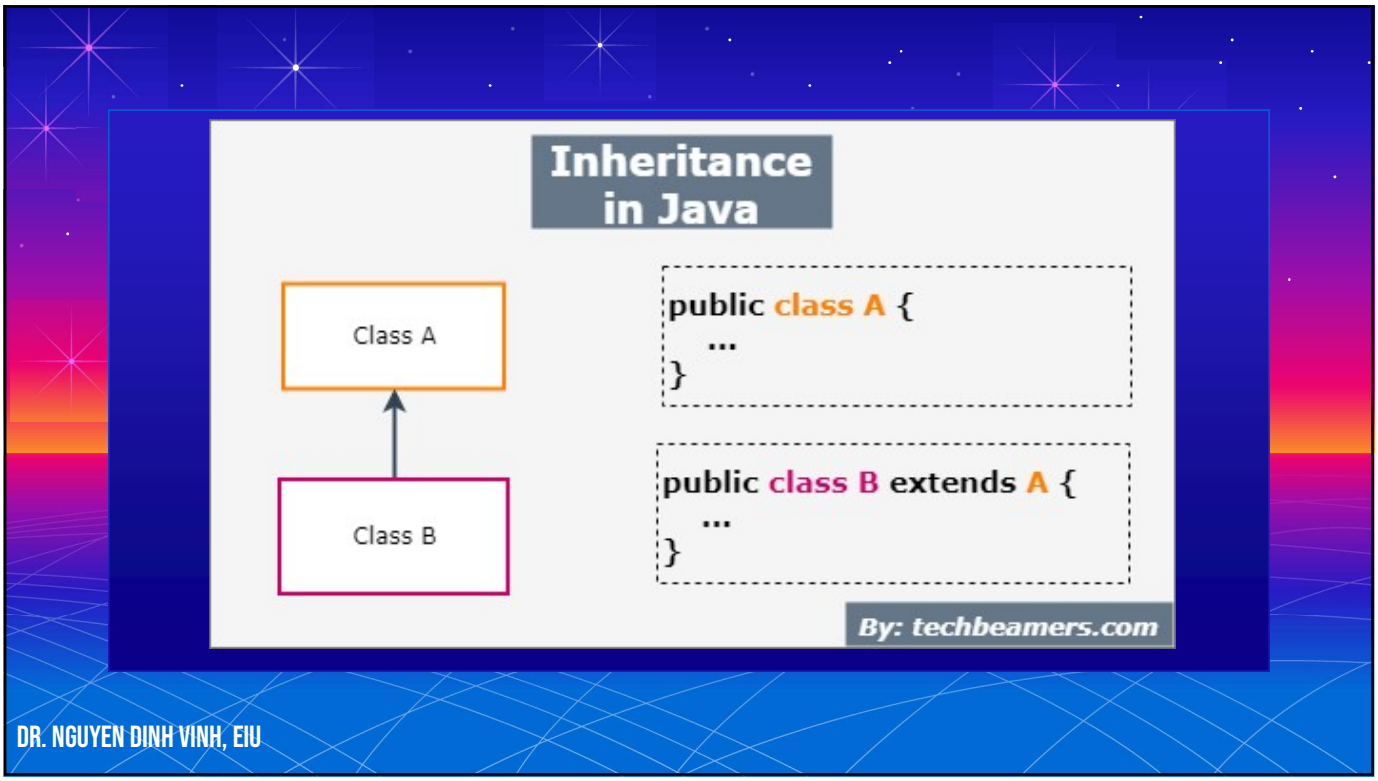
- **Superclass**
  - The class from which the subclass is derived is called a
    - Base class or parent class.
- **Subclass**
  - Class that is derived from another class
    - Derived class, extended class, or child class



Is this a good example of inheritance ?



74


Inheritance in Java
Class A
Class B
public class A {
...
}
public class B extends A {
...
}
By: techbeamers.com
DR. NGUYEN DINH VINH, EIU

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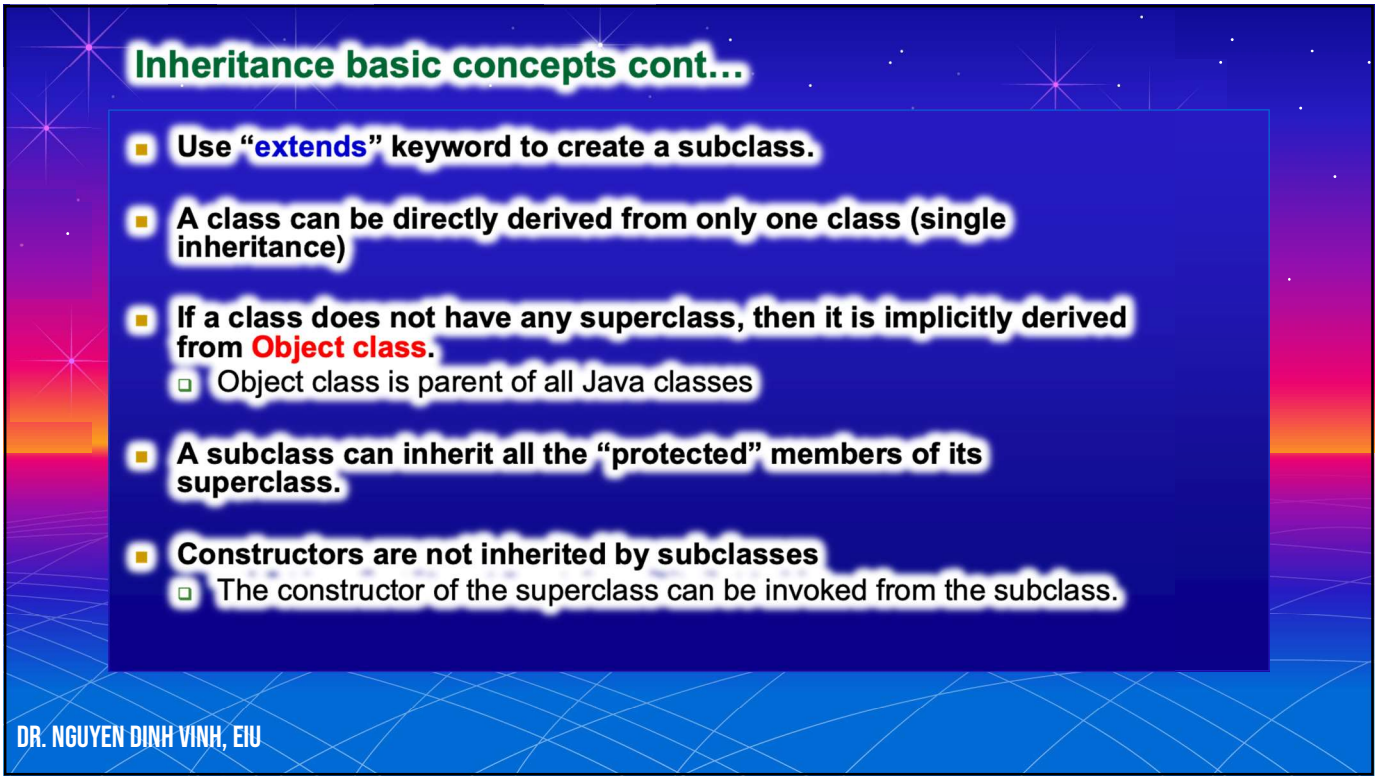
Inheritance basic concepts cont…
Use "extends" keyword to create a subclass.
A class can be directly derived from only one class (single inheritance)
If a class does not have any superclass, then it is implicitly derived from Object class.
Object class is parent of all Java classes
A subclass can inherit all the "protected" members of its superclass.
Constructors are not inherited by subclasses
The constructor of the superclass can be invoked from the subclass.
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```
class Calculator {
    int add(int a , int b)
    {
        return a + b;
    }

    int sub(int a , int b)
    {
        return a - b;
    }
}
```

```
public class AdvancedCalculator extends Calculator {
    int mult(int a , int b)
    {
        return a * b;
    }

    int div(int a , int b)
    {
        return a / b;
    }
public static void main(String args[])
{
    AdvancedCalculator cal = new AdvancedCalculator();

    System.out.println( cal.add(1, 2) );
    System.out.println( cal.sub(1, 2) );
    System.out.println( cal.mult(1, 2) );
    System.out.println( cal.div(1, 2) );
```


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```
/**
 *
 * @author dinhvinhnguyen
 */
class Parent {

    int num = 1;
    int a;

    Parent(int a)
    {
        this.a = a;
    }

    void disp( ) {
        System.out.println("Number from Parent class " + num);
    }

    void getA( ) {
        System.out.println("Value of a " + a);
    }
}
```


78

```
 *
 * @author dinhvinhnguyen
 */
public class Children extends Parent {

    int num = 2;

    Children(int a) {
        super( a );
    }

    void disp( ) {
        System.out.println("Number from Child class " + num);
    }

    void methodToCallSuperKeyword( ) {
        System.out.println(super.num);
        super.disp();
    }

}
```


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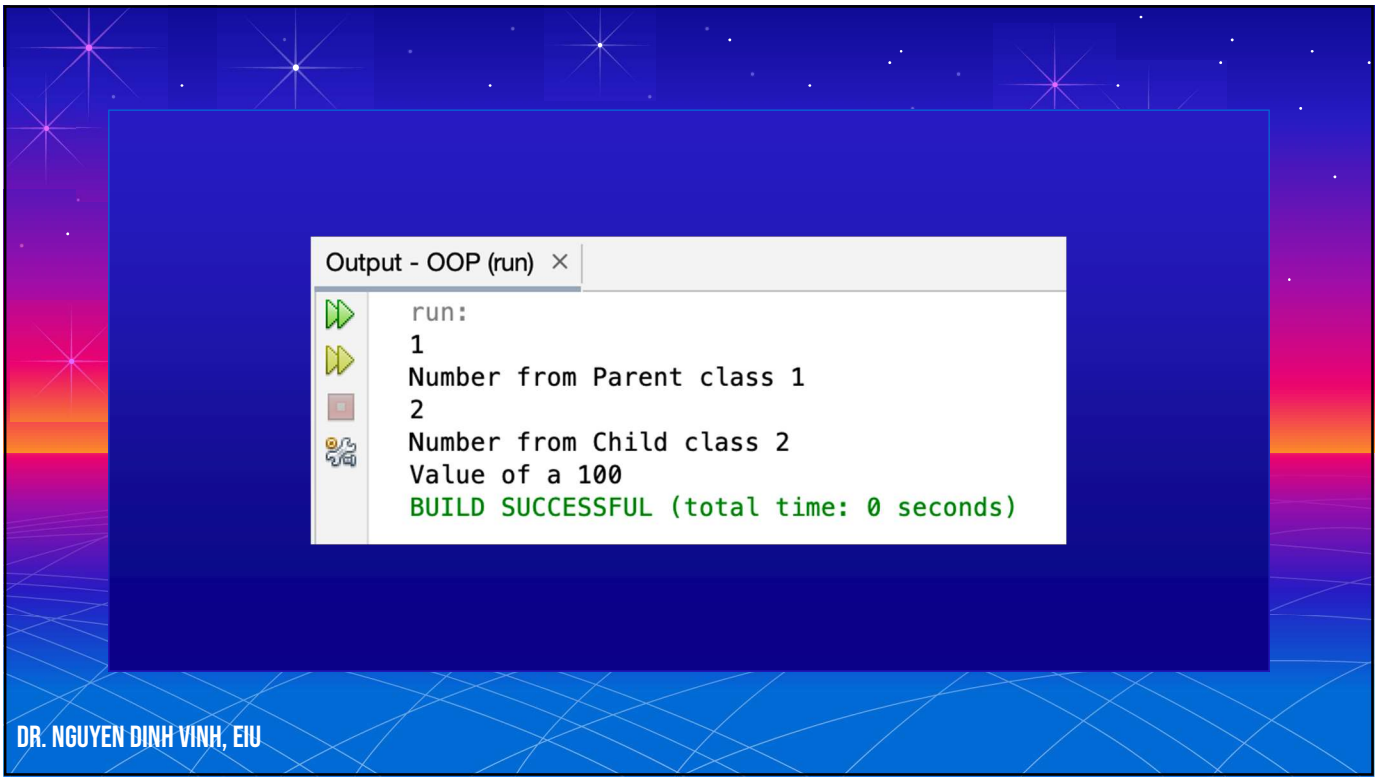
```
/**
 *
 * @author dinhvinhnguyen
 */
public class Test {
    public static void main(String args[]) {

        Children child = new Children(100);

        child.methodToCallSuperKeyword();
        System.out.println(child.num);

        child.disp();
        child.getA();
    }
}
```


80


Output - OOP (run)
run:
1
Number from Parent class 1
2
Number from Child class 2
Value of a 100
BUILD SUCCESSFUL (total time: 0 seconds)
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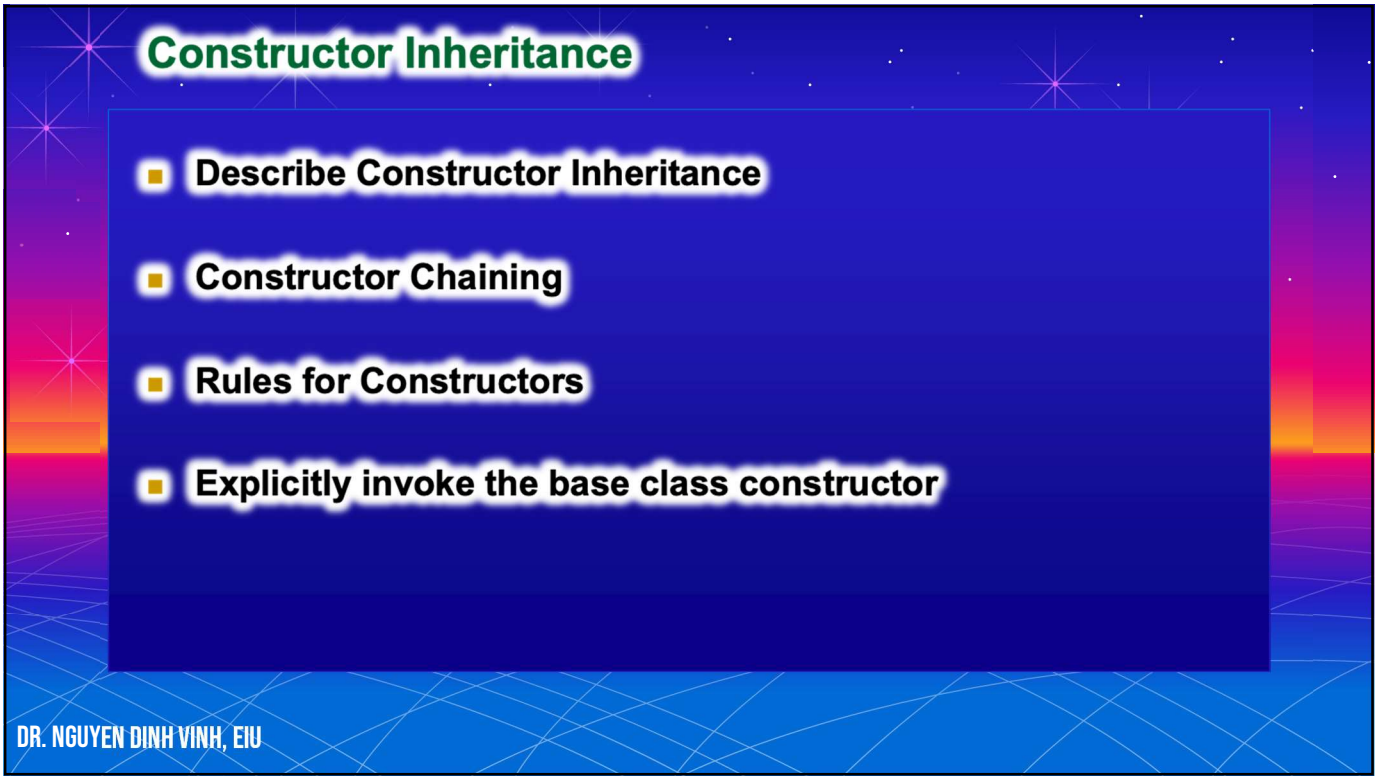
Constructor Inheritance
Describe Constructor Inheritance
Constructor Chaining
Rules for Constructors
Explicitly invoke the base class constructor
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Constructor Inheritance

- In Java, cannot inherit constructors like inherit methods.
- The instance of the derived class will always first invoke the constructor of the base class followed by the constructor of the derived class.
- Can explicitly invoke the base class constructor by using the super keyword in the derived class constructor declaration

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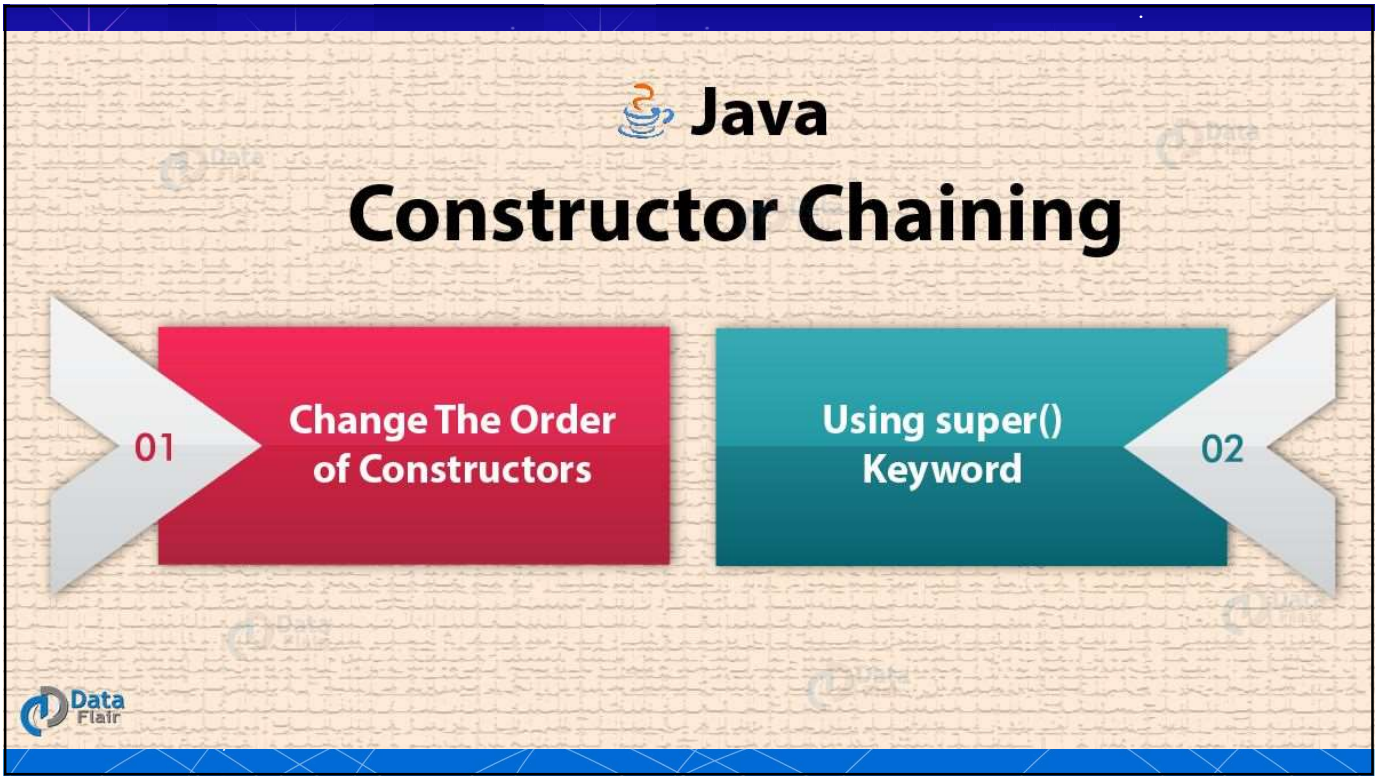


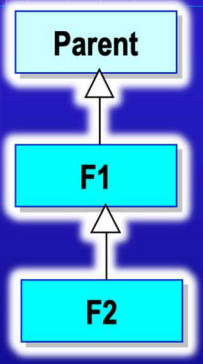
84

Constructor Chaining

```
public class Parent
{
    public Parent()
    {
        System.out.println("Invoke parent default constructor");
    }
}
```

```
public class F1 extends Parent
{
    public F1()
    {
        System.out.println("Invoke F1 default constructor");
    }
}
```

```
public class F2 extends F1
{
    public F2()
    {
        System.out.println("Invoke F2 default constructor");
    }
}
```



85

Constructor Chaining

```
public static void main(String [] args)
{
    new F2();
}
```

1. Object
2. Parent() call super()
3. F1() call super ()
4. F2() call super()
5. Main() call new F2()

- The instance of the derived class will always first invoke the constructor of the base class followed by the constructor of the derived class

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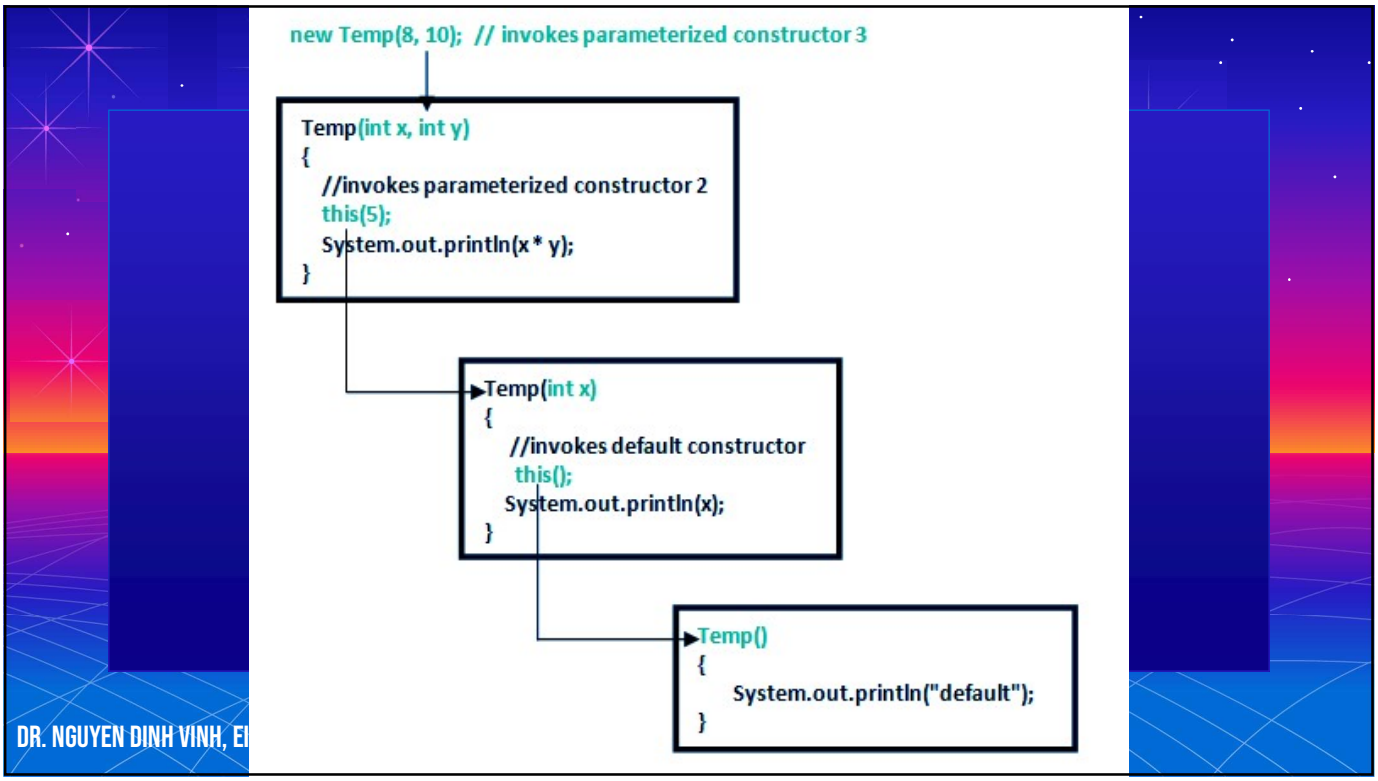

87

Rules for Constructors *(MUST be clear and remember)*

- A default constructor will be automatically generated by the compiler if no constructor is specified within the class.
- The default constructor is ALWAYS a no-arg constructor.
- If there is a constructor defined in the class, the default constructor is no longer used.
- If you don't explicitly call a base class constructor in a derived class constructor, the compiler attempts to silently insert a call to the base class's default constructor before executing the code in the derived class constructor

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Can you see any bug?

```
public class Parent
{
    private int a;

    public Parent(int value)
    {
        a = value;
        System.out.println("Invoke parent parameter constructor");
    }
}
```

```
public class F1 extends Parent
{
    public F1()
    {
        System.out.println("Invoke F1 default constructor");
    }
}
```

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How to fixed?

```
public class Parent
{
    private int a;

    public Parent()
    {
        a = 0;
        System.out.println("Invoke parent default constructor");
    }

    public Parent(int value)
    {
        a = value;
        System.out.println("Invoke parent parameter constructor");
    }
}
```

```
public class F1 extends Parent
{
    public F1()
    {
        System.out.println("Invoke F1 default constructor");
    }
}
```

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Explicitly invoke the base class constructor

```
public class Parent
{
    private int a;

    public Parent(int value)
    {
        a = value;
        System.out.println("Invoke parent parameter constructor");
    }
}
```

```
public class F1 extends Parent
{
    public F1(int value)
    {
        super (value);
        System.out.println("Invoke F1 default constructor");
    }
}
```

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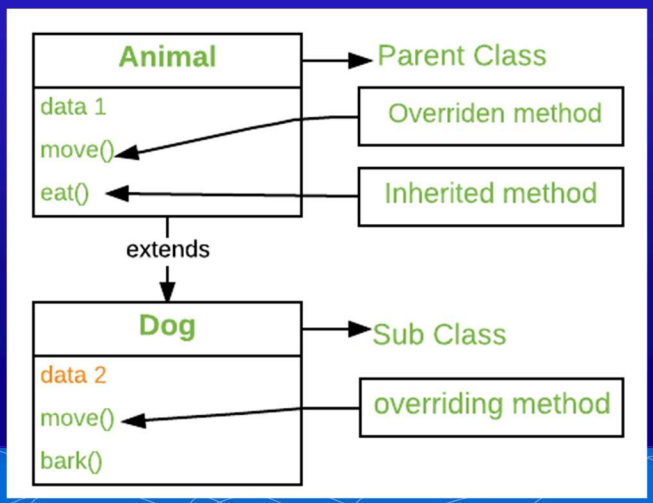
OVERRIDING METHODS



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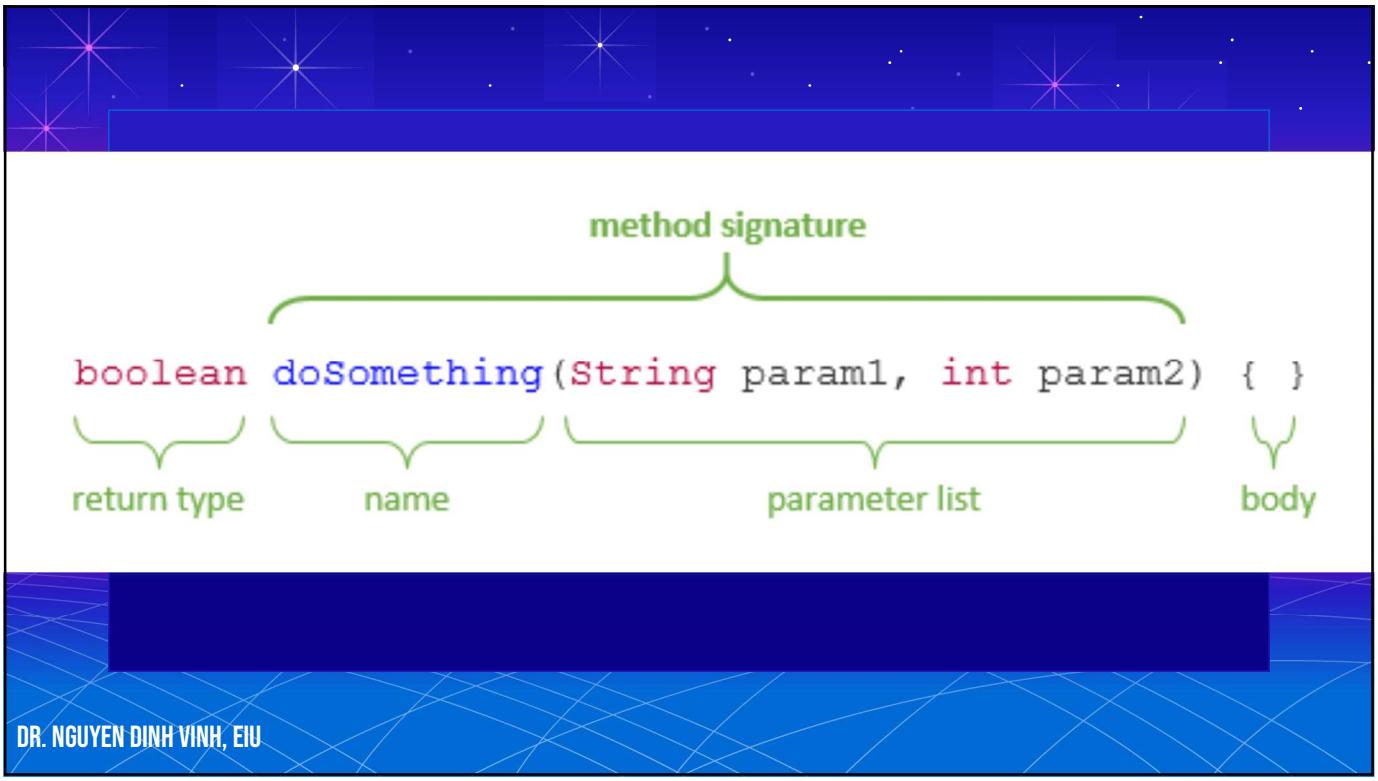
method signature
boolean doSomething(String param1, int param2) { }
return type
name
parameter list
body
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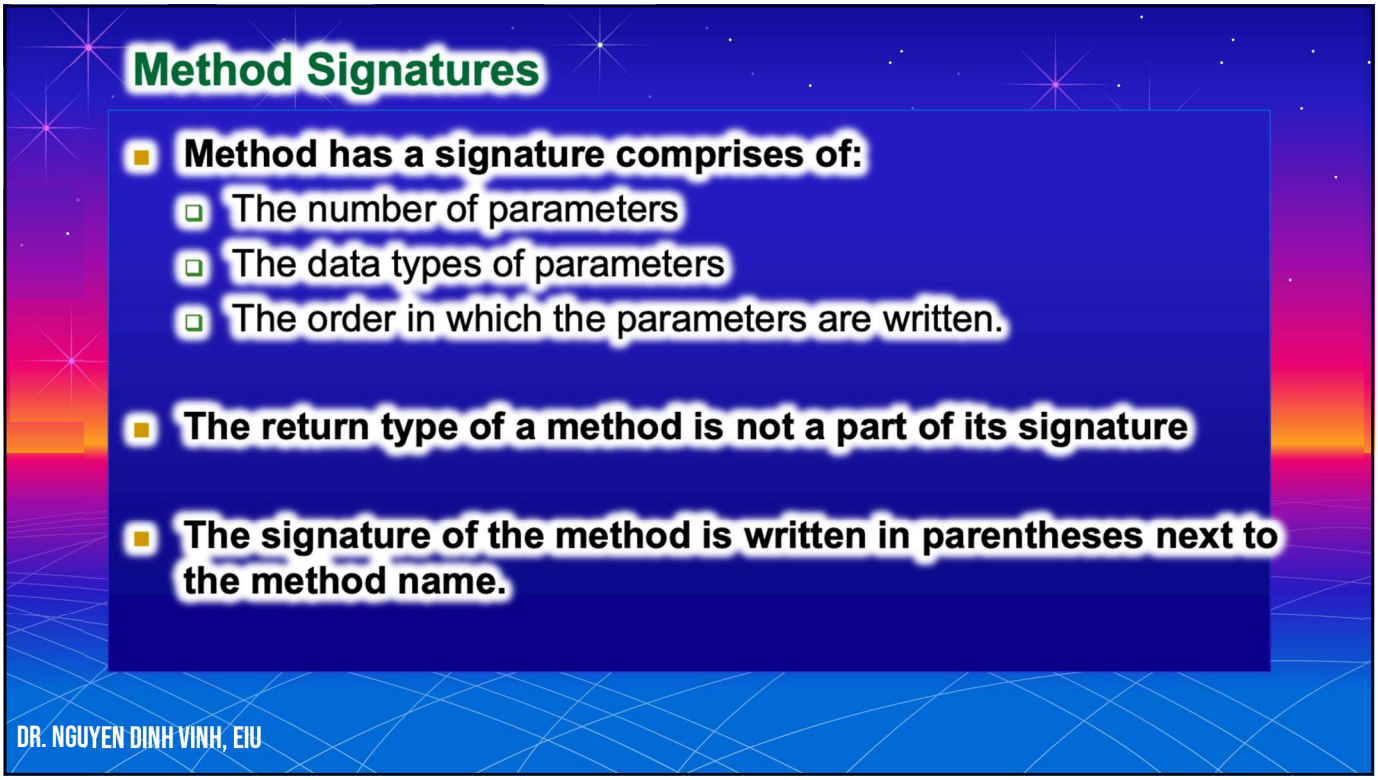
Method Signatures
Method has a signature comprises of:
The number of parameters
The data types of parameters
The order in which the parameters are written.
The return type of a method is not a part of its signature
The signature of the method is written in parentheses next to the method name.
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Overriding Methods

- Subclass define new method with the same signature as the superclass method.
- Overridden method cannot have a weaker "access specifier" than the "access specifier" of the method it overrides.
  - Superclass: protected
  - Subclass: public

  - Superclass: public
  - Subclass: protected

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Rules for Java Method Overriding

STEP 01 — Method must have same name as in the parent class

STEP 02 — Method must have same parameter as in the parent class.

STEP 03 — There must be IS-A relationship (inheritance).

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Example of Overriding Methods

```
public class Parent
{
    public void printInfor()
    {
        System.out.println("Calling printInfor()method of Parent");
    }
}
```

```
public class F1 extends Parent
{
    public void printInfor()
    {
        System.out.println("Calling printInfor()method of F1");
    }
}
```


98

"super" keyword

- Use to access superclass's members and constructors from subclass

99

Example of Using "super" keyword

```
public class Parent
{
    public void printInfor()
    {
        System.out.println("Calling printInfor()method of Parent");
    }
}

public class F1 extends Parent
{
    public void printInfor()
    {
        super.printInfor();
        System.out.println("Calling printInfor()method of F1");
    }
}
```

```
public static void main (String [] args)
{
    F1 f1 = new F1();

    f1.printInfor();
}
```

```
Console
<terminated> Parent [Java Application] C:\Program Files\Java\jdk1.5.0_11\bin\j
Calling printInfor()method of Parent
Calling printInfor()method of F1
```


100

Method Overloading

```
public static int sum(int x, int y) {
    return x + y;
}

public static int sum(int x, int y, int z) {
    return x + y + z;
}
```


101

Overloading Methods

- Declaring more than one method with the same method name but different signatures
- Constructor overloading
  - Allows multiple ways of creating instances

102

Example of Overloading Methods

```
public class OverloadClass
{
    private int a;

    public OverloadClass()
    {
        a= 0;
    }

    public OverloadClass(int value)
    {
        a = value;
    }

    public int add(int valOne, int valTwo)
    {
        return (valOne + valTwo);
    }

    public float add(float valOne, float valTwo
    {
        return (valOne + valTwo);
    }
}
```


103

"this" keyword

- Refer to the current object of the class.
- Used to resolve conflicts between variables having same names and to pass the current object as a parameter
- Cannot use the "this" keyword with static variables and methods,

```
public class Rectangle
{
    private float length;
    private float width;

    public Rectangle()
    {
        this.length = 0;
        this.width = 0;
    }

    public Rectangle(float length, float width)
    {
        this.length = length;
        this.width = width;
    }

    public float area()
    {
        return (length * width);
    }
}
```

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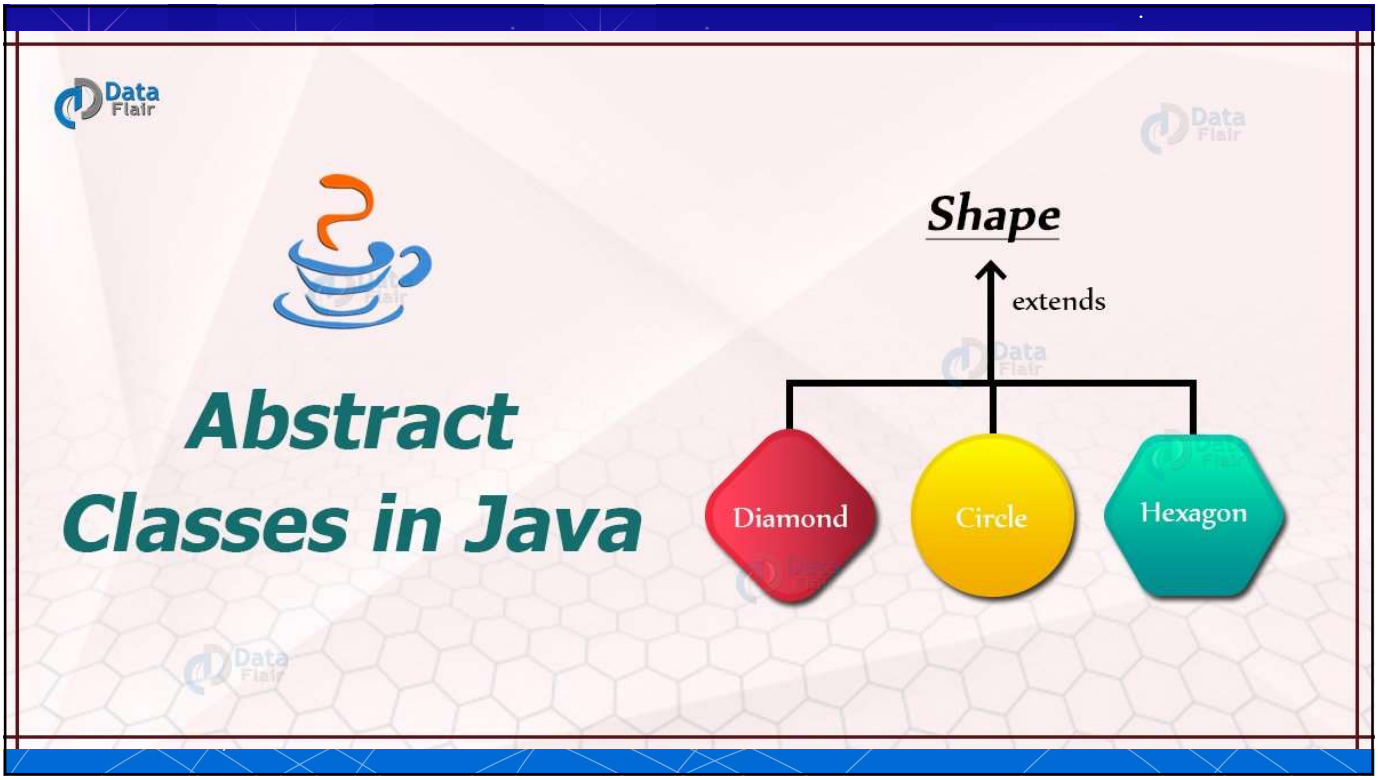


105

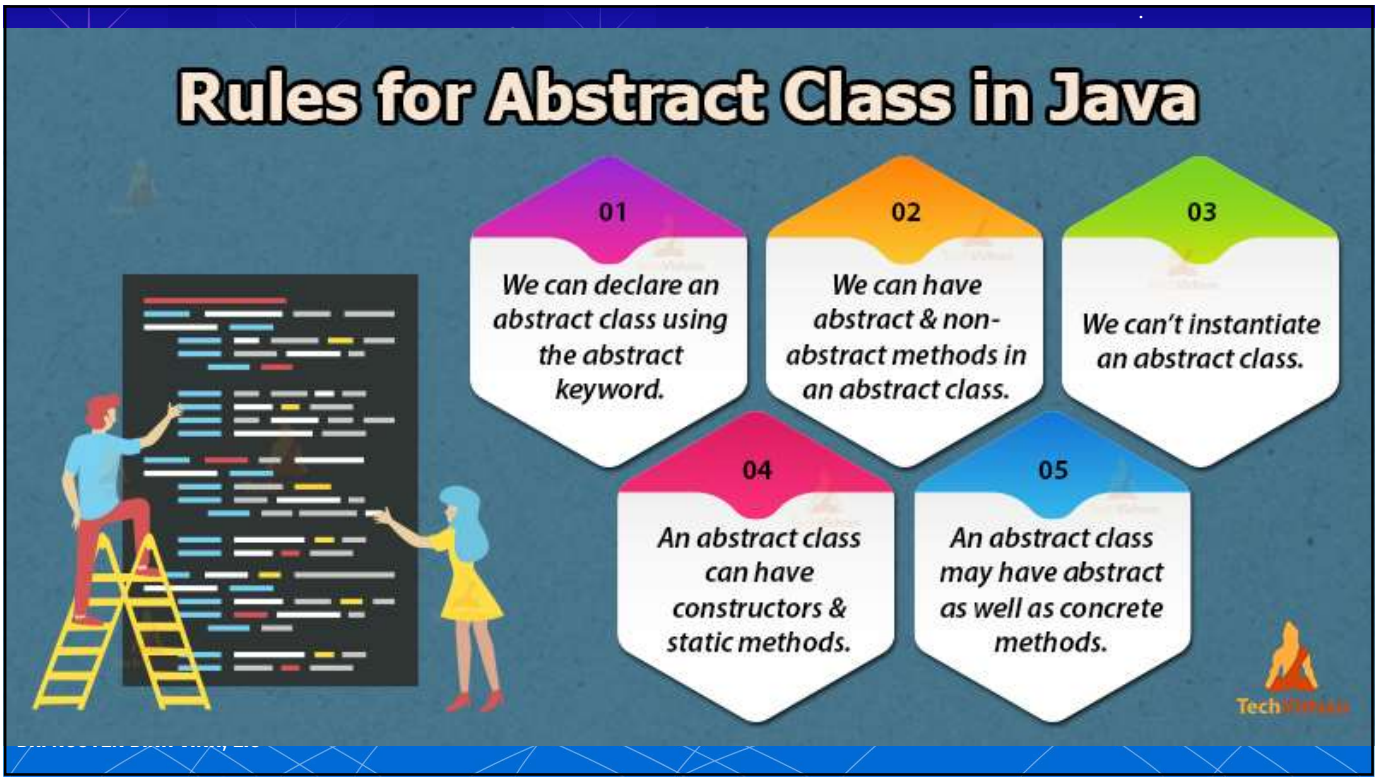
"abstract" Classes

- To serve as a framework that provides certain behavior for other classes.
- Contain zero or more abstract methods
- Cannot be instantiated.
- Can be inherited.
- The subclass must implement "abstract methods" declared in base class
  - Otherwise it must be declared as abstract.
- Declare an abstract class by using the keyword abstract precede class keyword

106

```
abstract class Person {
    String name;
   abstract String getDetails();

   }
class Student extends Person{
     int rollNo;

}

class Teacher extends Person{

}
class Employee extends Person{
```


107



108

"abstract" Methods

- **Method has only declaration and no implementation**
  - Is prefixed with the "abstract" keyword.
  - The declaration does not contain any braces and is terminated by a semicolon.
- **An abstract method is only a contract that the subclass will provide its implementation**
- **If a class includes abstract methods, the class itself must be declared abstract**

109

```
abstract class Animals{
    private String name;

    // All kind of animals eat food to make this common to all animals
    public void eat(){
        System.out.println(" Eating ..........");
    }

    // The animals make different sounds. They will provide their own implementation
    abstract void sound();
}

class Cat extends Animals{

    @Override
    void sound() {
        System.out.println("Meoww Meoww ........");
    }
}
```

abstract class

abstract method

abstract method implementation

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Example of "abstract" Classes and "abstract" Methods

```
public abstract class Person
{
    protected int id;
    protected String name;

    public Person(int id, String name)
    {
        this.id = id;
        this.name = name;
    }

    public abstract void displayInfor();
}
```

```
public class Student extends Person
{
    public Student(int id, String name)
    {
        super(id, name);
    }

    public void displayInfor()
    {
        System.out.println("Student id: " + super.id);
        System.out.println("Student name: " + super.name);
    }
}
```

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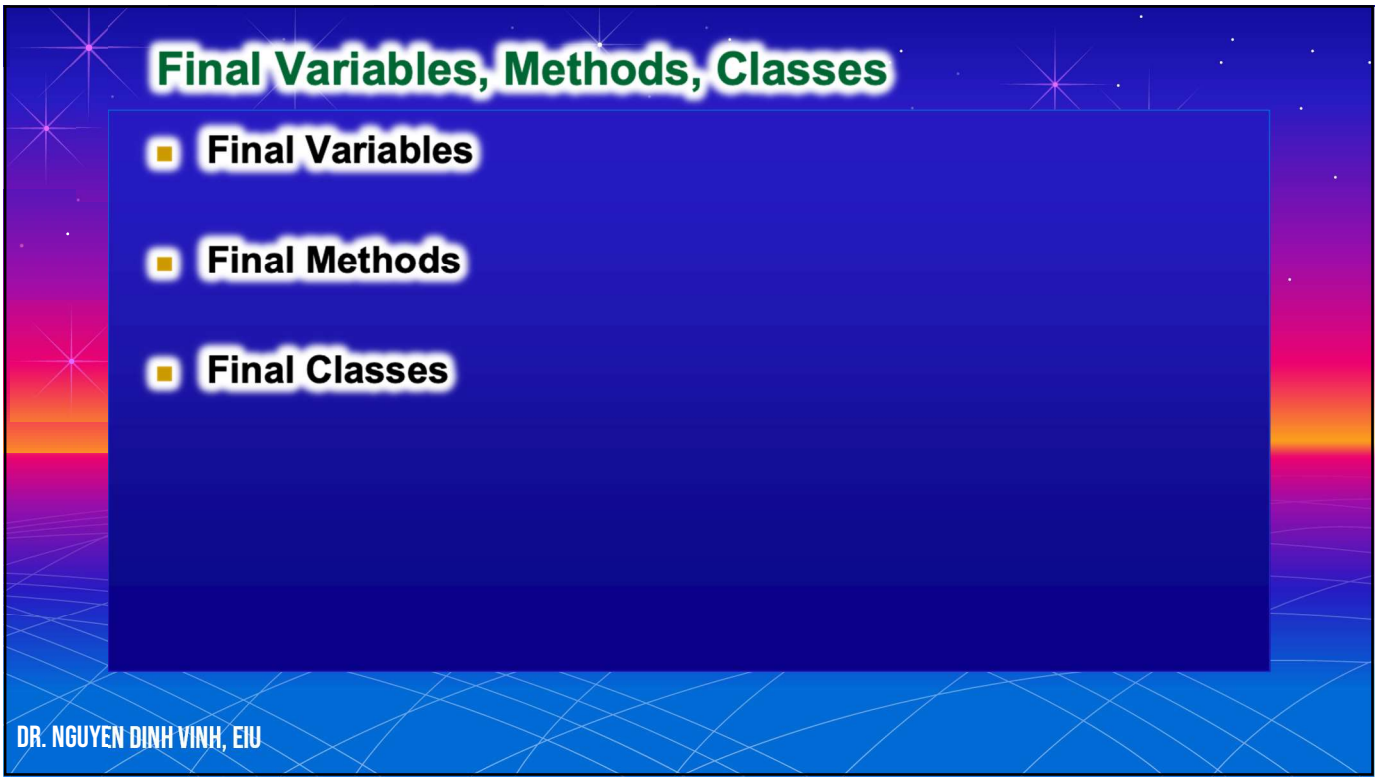
Final Variables, Methods, Classes
Final Variables
Final Methods
Final Classes
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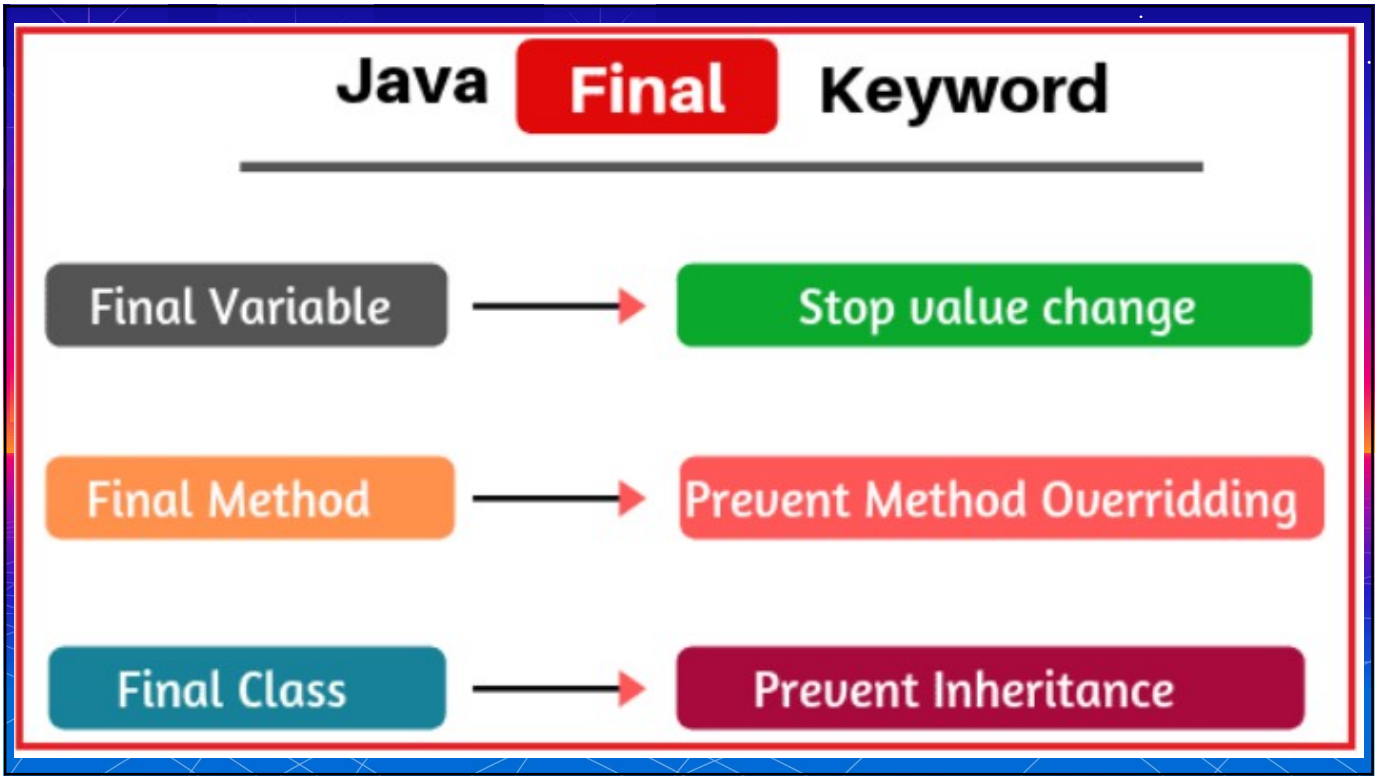
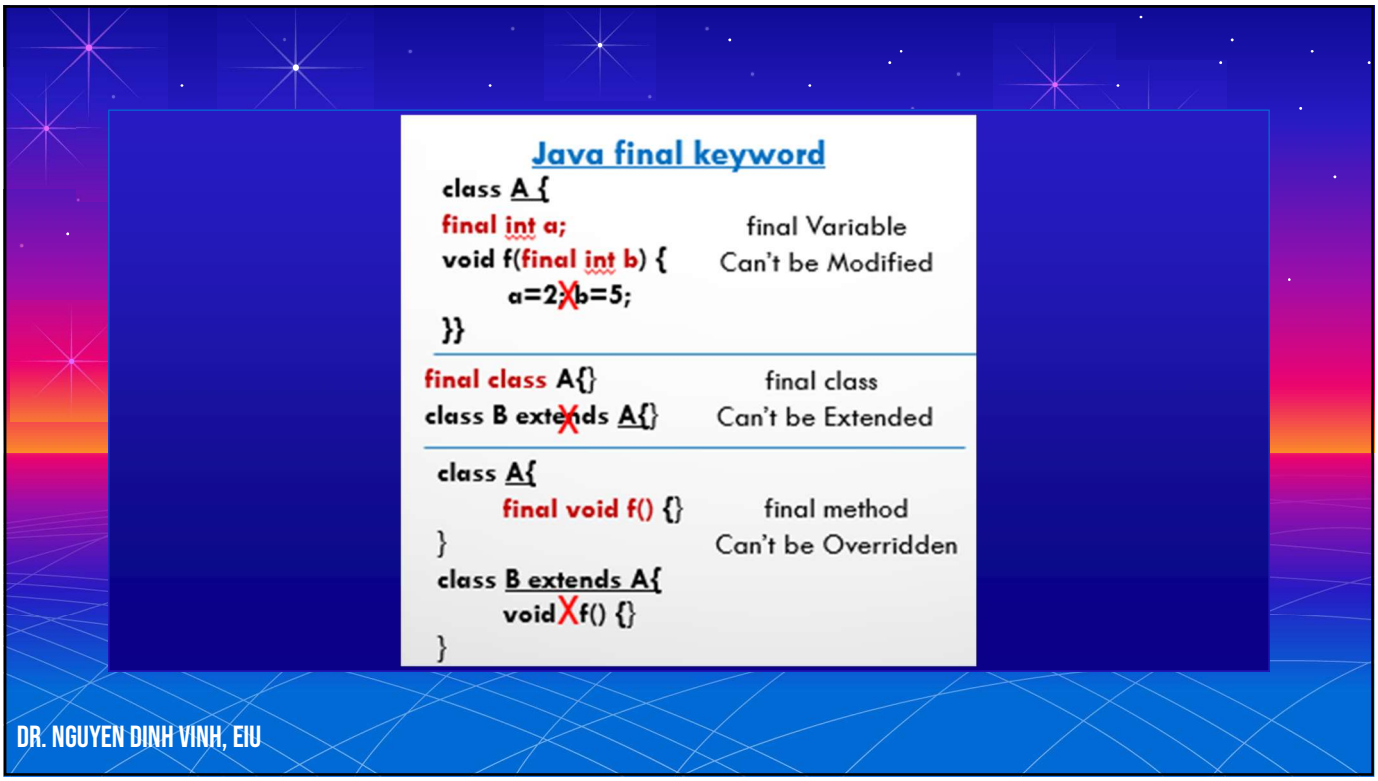
112


Java Final Keyword
Final Variable
Stop value change
Final Method
Prevent Method Overridding
Final Class
Prevent Inheritance

113


Java final keyword
class A {
final int a;
void f(final int b) {
a=2;b=5;
}}
final Variable
Can't be Modified
final class A{}
class B extends A{}
final class
Can't be Extended
class A{
final void f() {}
}
class B extends A{
void f() {}
}
final method
Can't be Overridden
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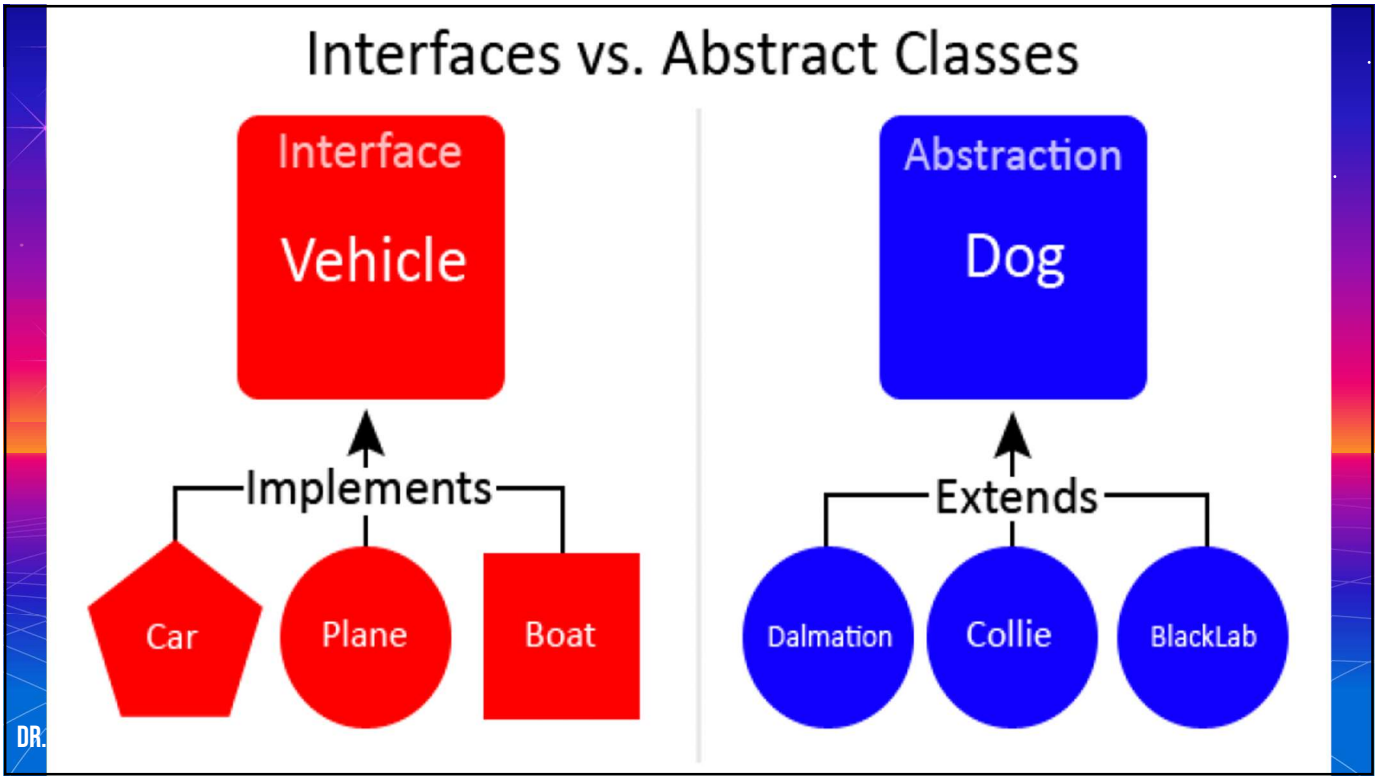
114


Interfaces vs. Abstract Classes
Interface
Vehicle
Implements
Car
Plane
Boat
Abstraction
Dog
Extends
Dalmation
Collie
BlackLab
DR.

115

What is an Interface?

- An interface is defined as a reference type
- Has only final variables, abstract methods signatures.
  - Interface Methods Do Not Contain Method Bodies
- Cannot be instantiated.
- Can only be inherited by classes or other interfaces.
- A class that implements an interface is *required to provide implementations for all the methods* of the interface or else should be declared abstract.

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Example of Interface

```
public interface UserDao {

    public final String TABLE ="User";

    public void create(User user);

    public void delete(int id);

    public void update(int id, User user);

}
```

```
public class UserDaoImpl implements UserDao {

    public void create(User user) {
        // ...
    }

    public void delete(int id) {
        // ...
    }

    public void update(int id, User user) {
        // ....
    }
}
```


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Example of Implementing Multiple Interfaces

```
public interface Quackable
{
    public void quack();
}
```

```
public interface Flyable
{
    public void fly();
}
```

```
public class RedheadDuck implements Quackable, Flyable
{
    public void quack()
    {
    }

    public void fly()
    {
    }
}
```

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Abstract Class

1. *abstract* keyword
2. Subclasses *extends* abstract class
3. Abstract class can have implemented methods and 0 or more abstract methods
4. We can extend only one abstract class

Interface

1. *interface* keyword
2. Subclasses *implements* interfaces
3. Java 8 onwards, Interfaces can have default and static methods
4. We can implement multiple interfaces

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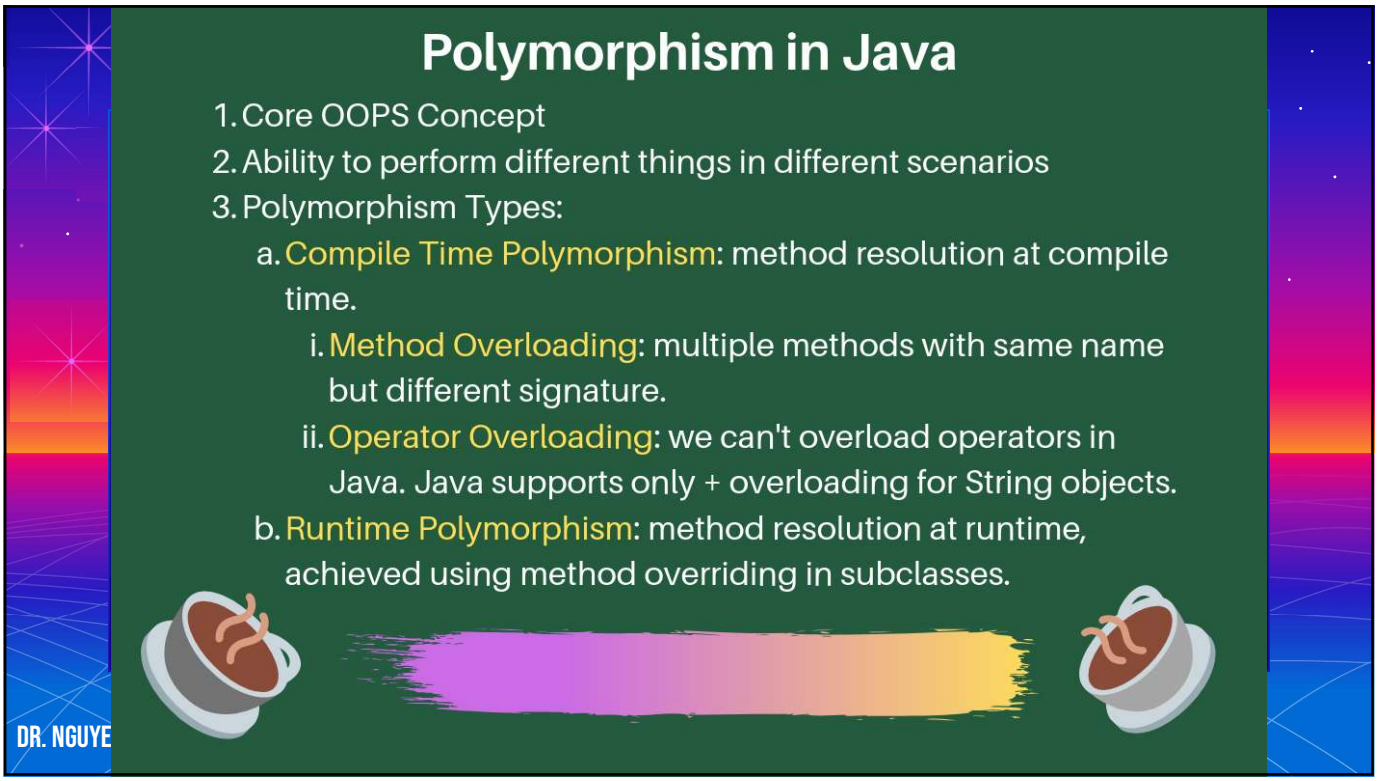
Polymorphism in Java
1. Core OOPS Concept
2. Ability to perform different things in different scenarios
3. Polymorphism Types:
a. Compile Time Polymorphism: method resolution at compile time.
i. Method Overloading: multiple methods with same name but different signature.
ii. Operator Overloading: we can't overload operators in Java. Java supports only + overloading for String objects.
b. Runtime Polymorphism: method resolution at runtime, achieved using method overriding in subclasses.
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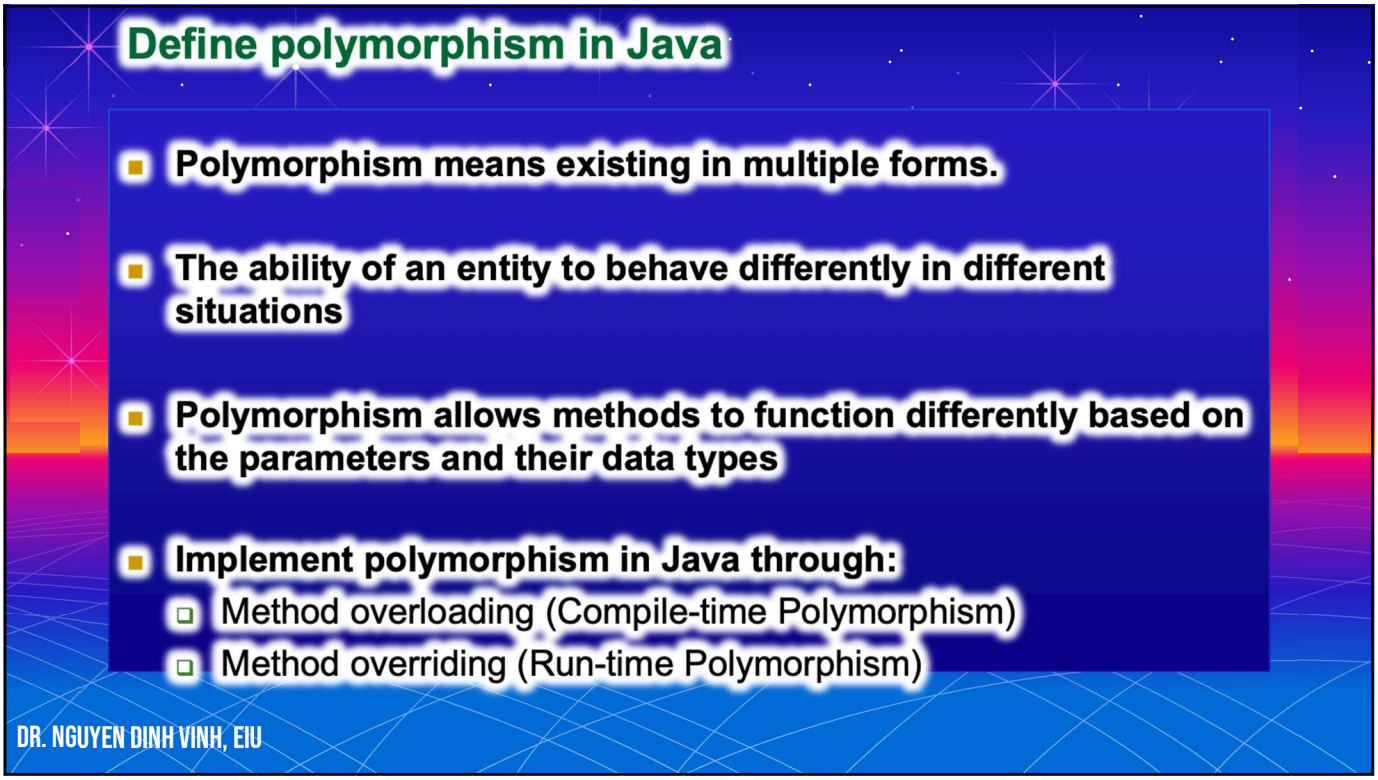
120


Define polymorphism in Java
Polymorphism means existing in multiple forms.
The ability of an entity to behave differently in different situations
Polymorphism allows methods to function differently based on the parameters and their data types
Implement polymorphism in Java through:
Method overloading (Compile-time Polymorphism)
Method overriding (Run-time Polymorphism)
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Example of polymorphism in Java (Compile-Time)

```
public class A {
    public void doSomething()
    {
        System.out.println("A() do something");
    }
    public void doSomething(int a)
    {
        System.out.println("A() do something with parameter "+ a);
    }
}
public class Main {

    public static void main(String[] args) {
        A a = new A();
        a.doSomething();
        a.doSomething(5);
    }
}
```

```
file:///C:/Users/kimcong.nguyen/Documents/Visual Studio 2008/Projects/
A() do something
A() do something with parameter 5
```


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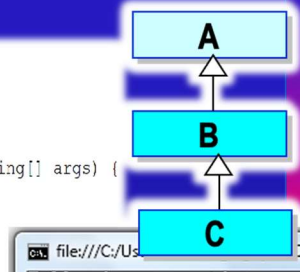
Example of polymorphism in Java (Run-Time)

```
public class A {
    public void doSomething()
    {
        System.out.println("A() do something");
    }
}
public class B extends A{
    public void doSomething()
    {
        System.out.println("B() do something");
    }
}
public class C extends B{
    public void doSomething()
    {
        System.out.println("C() do something");
    }
}
```

```
public class Main {

    public static void main(String[] args) {
        A a;
        B b=new B();
        C c=new C();

        a=b;
        a.doSomething();

        a=c;
        a.doSomething();

        b.doSomething();

        b=c;
        b.doSomething();

    }
}
```




```
B() do something
C() do something
B() do something
C() do something
```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Compile-time and Run-time Polymorphism

- **Compile-time Polymorphism**
  - Implemented through **method overloading**
  - Executed at the compile-time
  - Referred to as **static polymorphism**
- **Run-time Polymorphism**
  - Implemented through **method overriding**
  - Executed at run-time
  - Referred to as **dynamic polymorphism**

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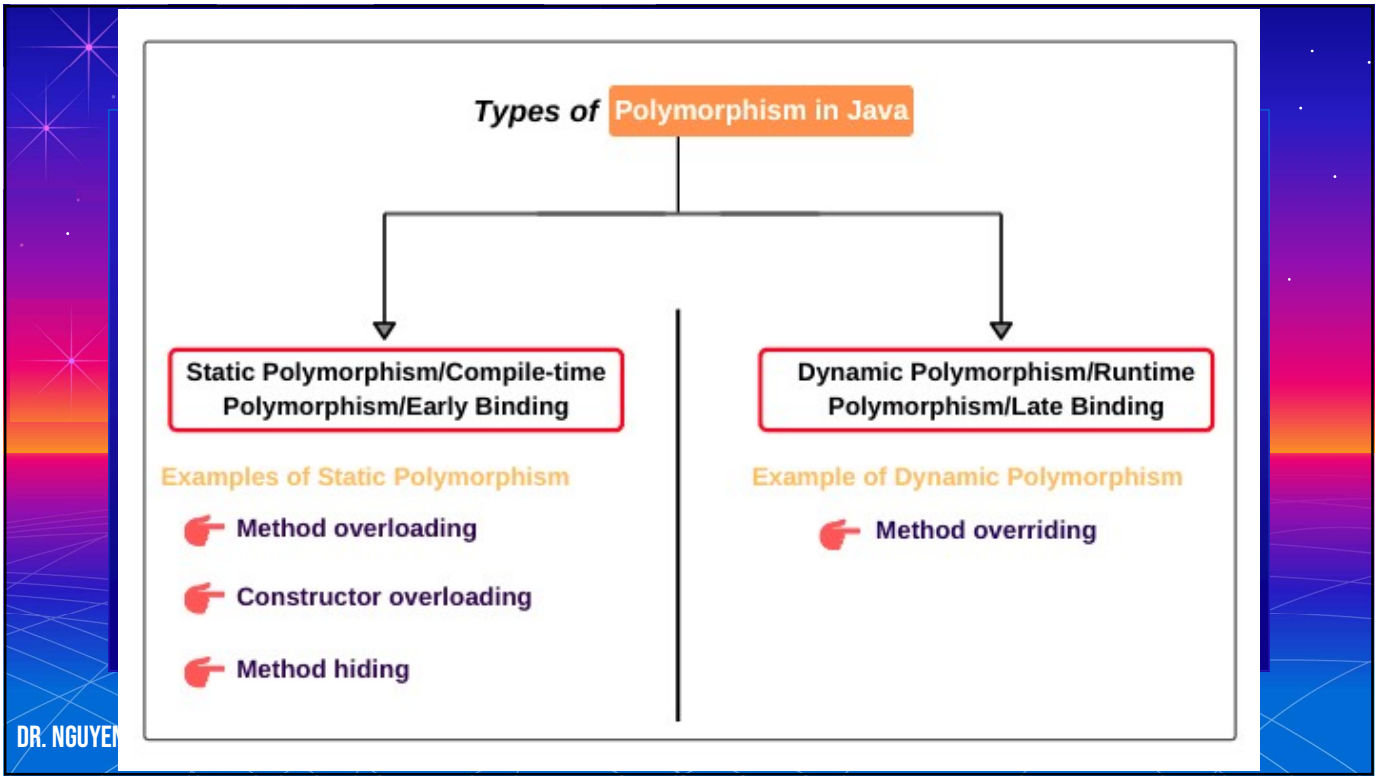

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Compile time vs Runtime
#1. When does the time start?
Compile time
This is when the code is translated from programming language to a language that a machine understands.
Runtime
This is when a code is run in the runtime environment and starts from the time code execution starts till the point the code is stopped by the user or OS.
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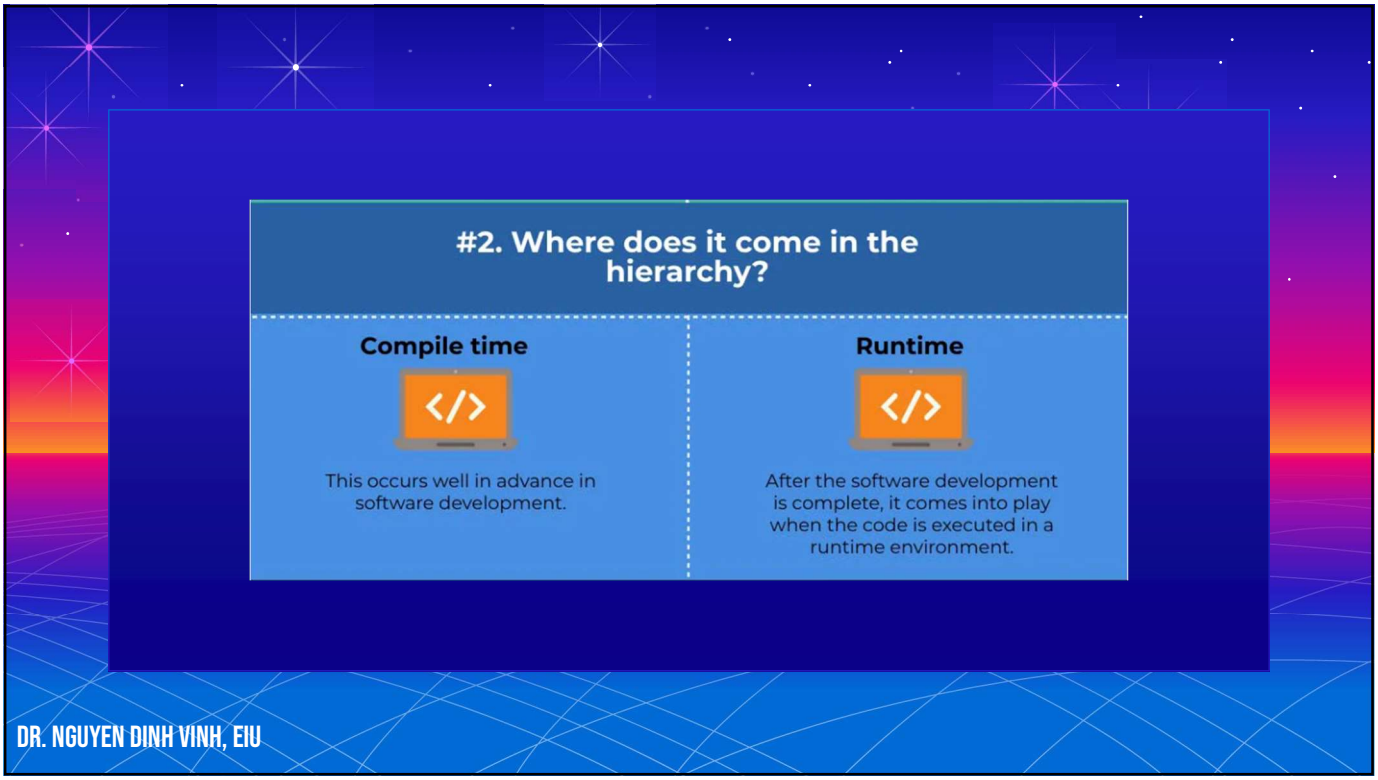
#2. Where does it come in the hierarchy?
Compile time
This occurs well in advance in software development.
Runtime
After the software development is complete, it comes into play when the code is executed in a runtime environment.
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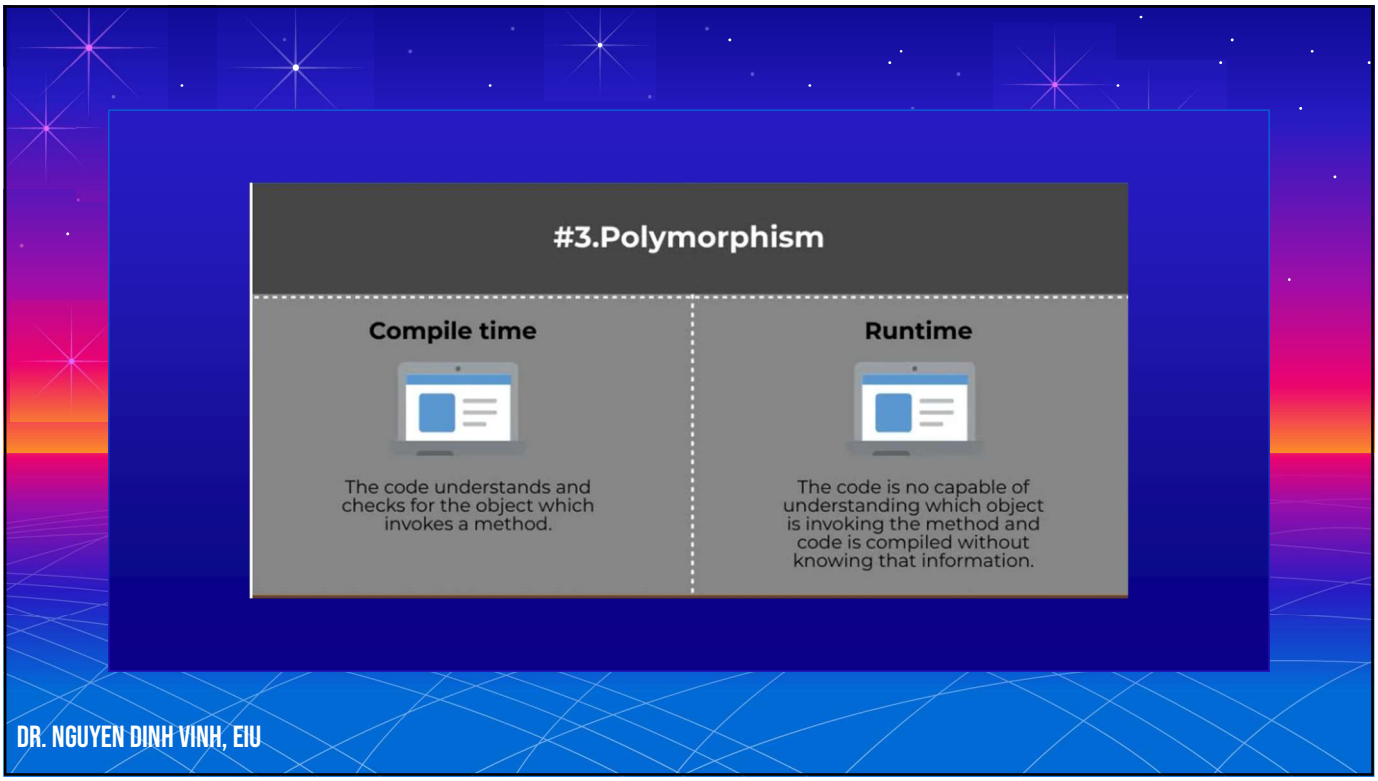
#3.Polymorphism
Compile time
The code understands and checks for the object which invokes a method.
Runtime
The code is no capable of understanding which object is invoking the method and code is compiled without knowing that information.
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Bonus
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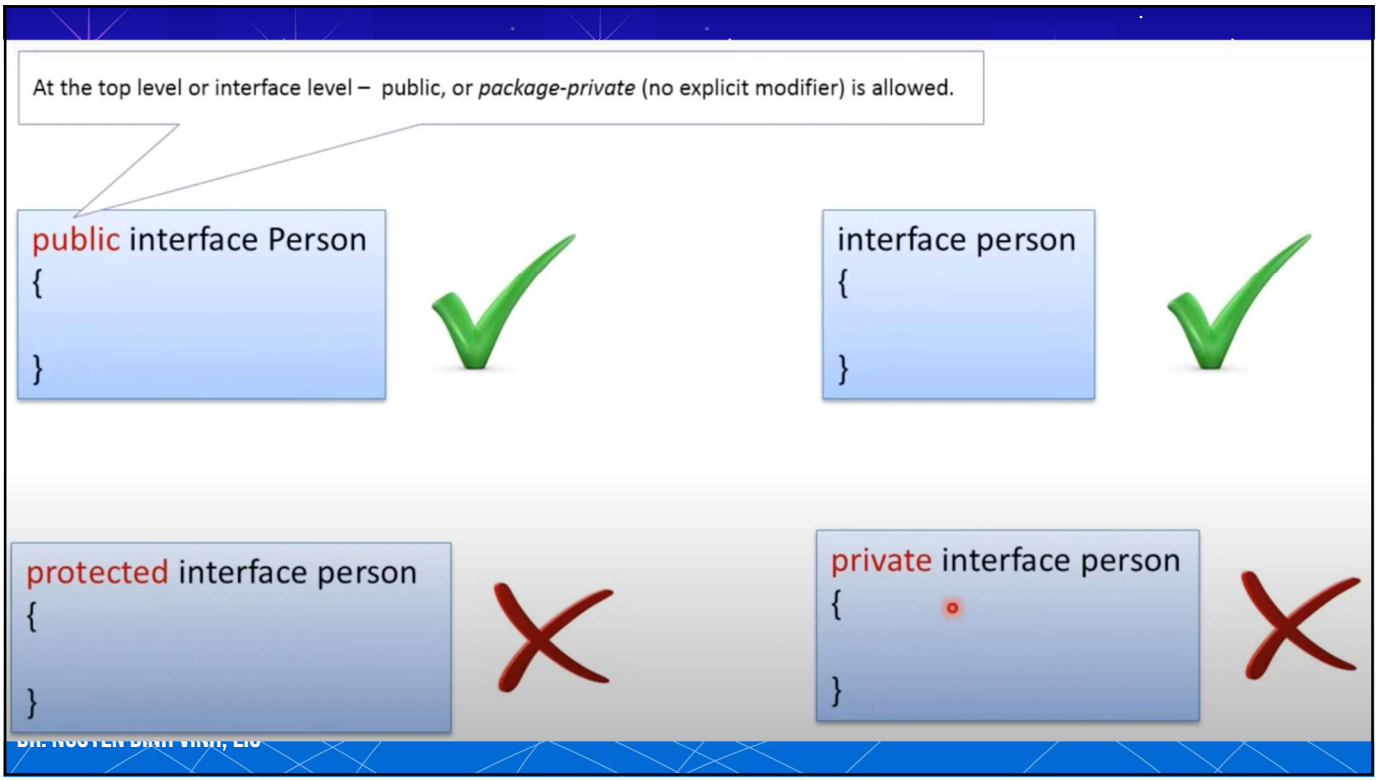
At the top level or interface level – public, or *package-private* (no explicit modifier) is allowed.
public interface Person
{
}
interface person
{
}
protected interface person
{
}
private interface person
{
}

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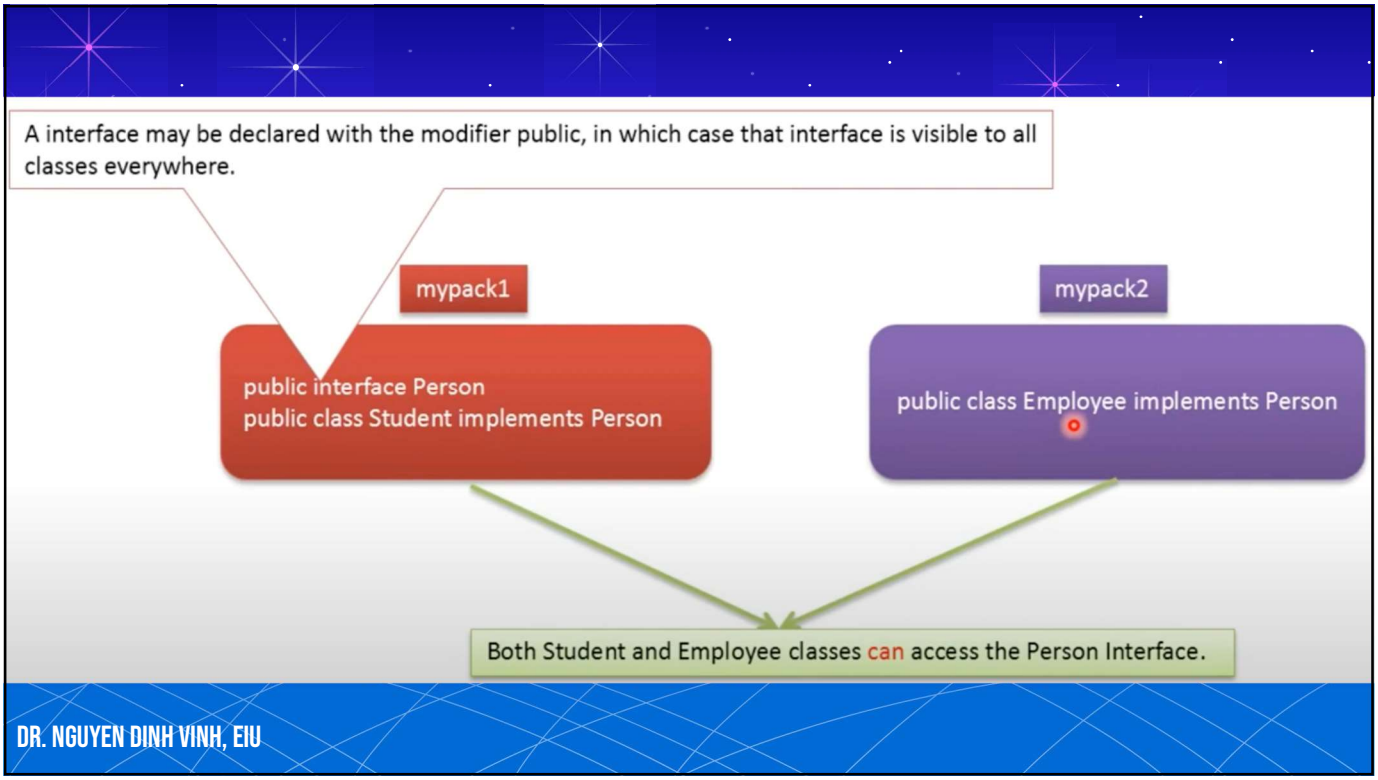
A interface may be declared with the modifier public, in which case that interface is visible to all classes everywhere.
mypack1
public interface Person
public class Student implements Person
mypack2
public class Employee implements Person
Both Student and Employee classes can access the Person Interface.
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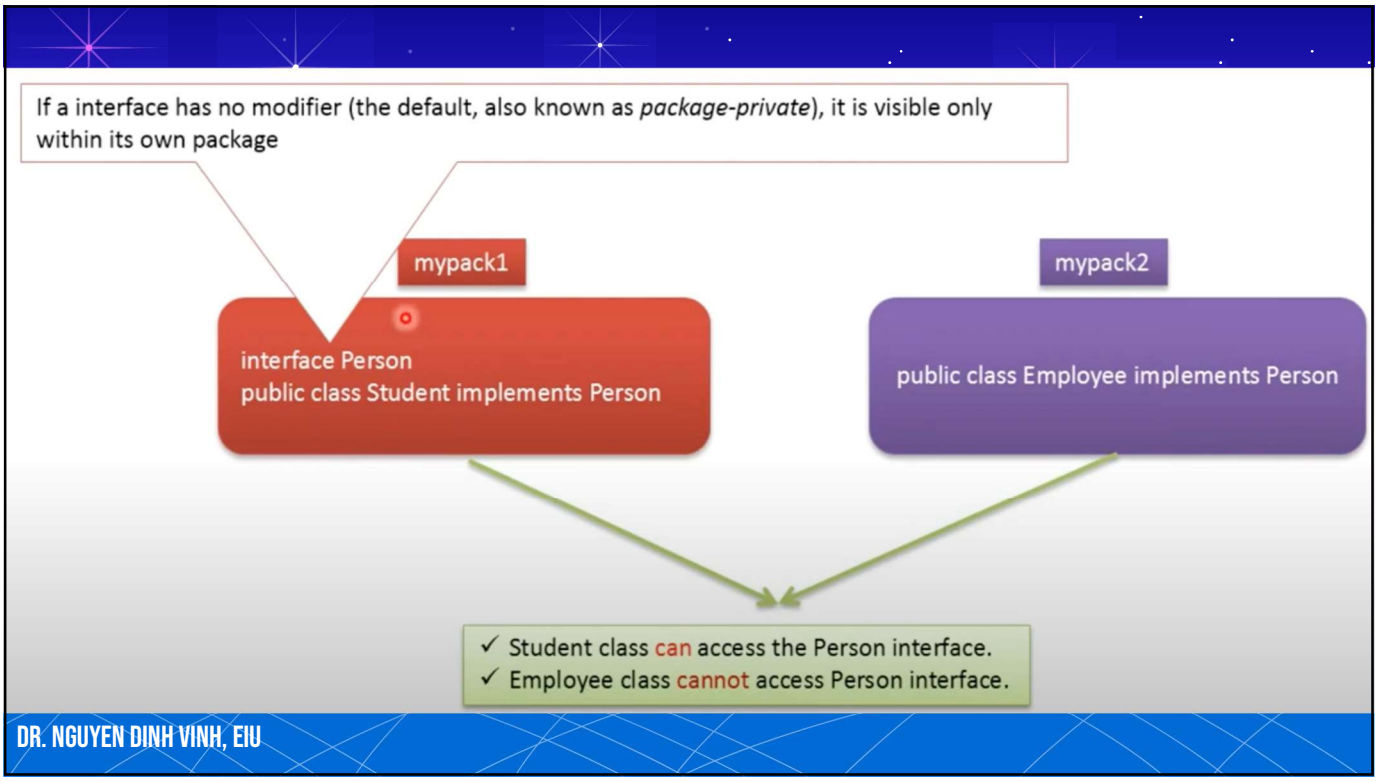
If a interface has no modifier (the default, also known as *package-private*), it is visible only within its own package
mypack1
interface Person
public class Student implements Person
mypack2
public class Employee implements Person
✓ Student class can access the Person interface.
✓ Employee class cannot access Person interface.
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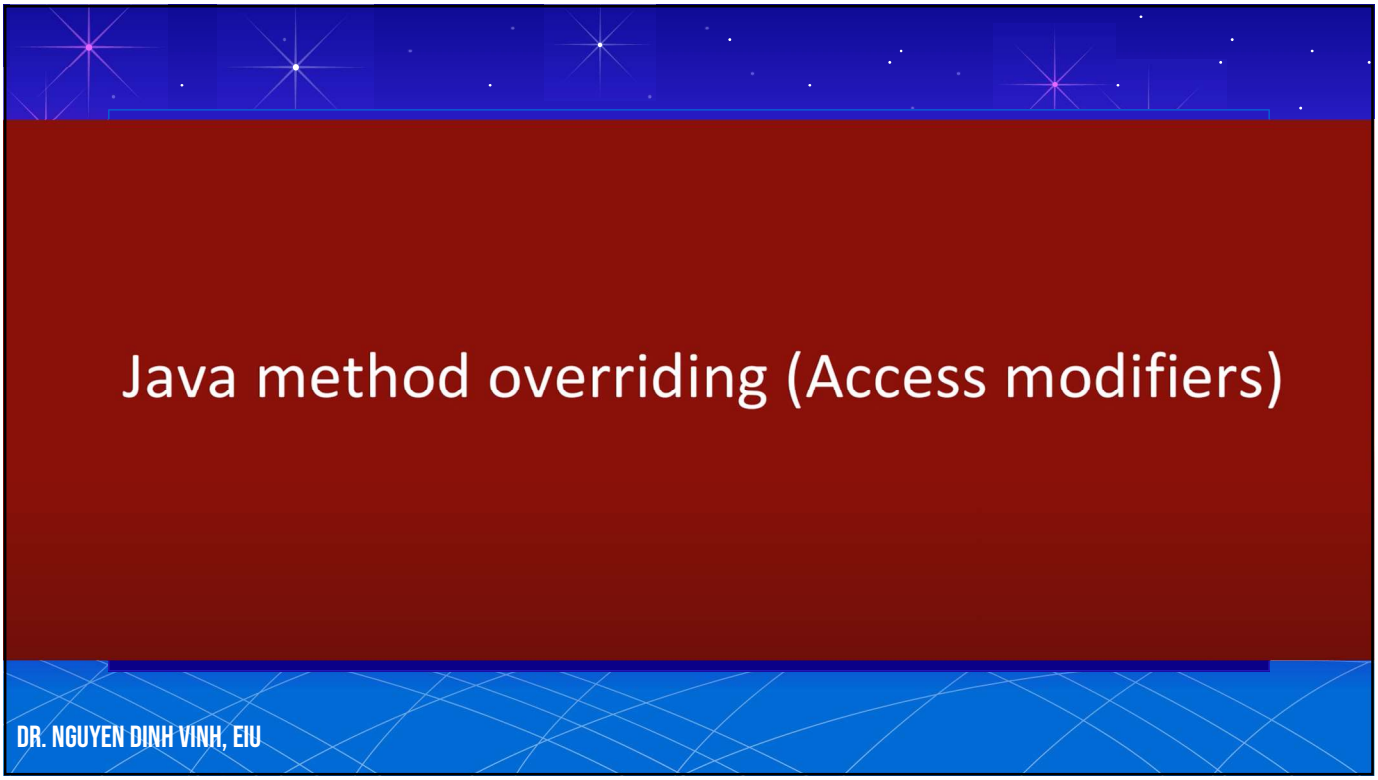
Java method overriding (Access modifiers)
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The access specifier for an overriding method can allow more, but not less access than the overridden method. For example, a protected instance method in the superclass can be made public, but not private, in the subclass.

```
public class Animal
{
        protected void run()
        {
          System.out.println("Animal runs slowly");
        }
}

public class Tiger extends Animal
{
        protected void run()
        {
           System.out.println("Tiger runs fast.");
        }
}
```

```
public class Animal
{
        protected void run()
        {
          System.out.println("Animal runs slowly");
        }
}

public class Tiger extends Animal
{
        public void run()
        {
           System.out.println("Tiger runs fast.");
        }
}
```

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```
public class Animal
{
        protected void run()
        {
          System.out.println("Animal runs slowly");
        }
}

public class Tiger extends Animal
{
        void run()
        {
           System.out.println("Tiger runs fast.");
        }
}
```

```
public class Animal
{
        protected void run()
        {
          System.out.println("Animal runs slowly");
        }
}

public class Tiger extends Animal
{
        private void run()
        {
           System.out.println("Tiger runs fast.");
        }
}
```

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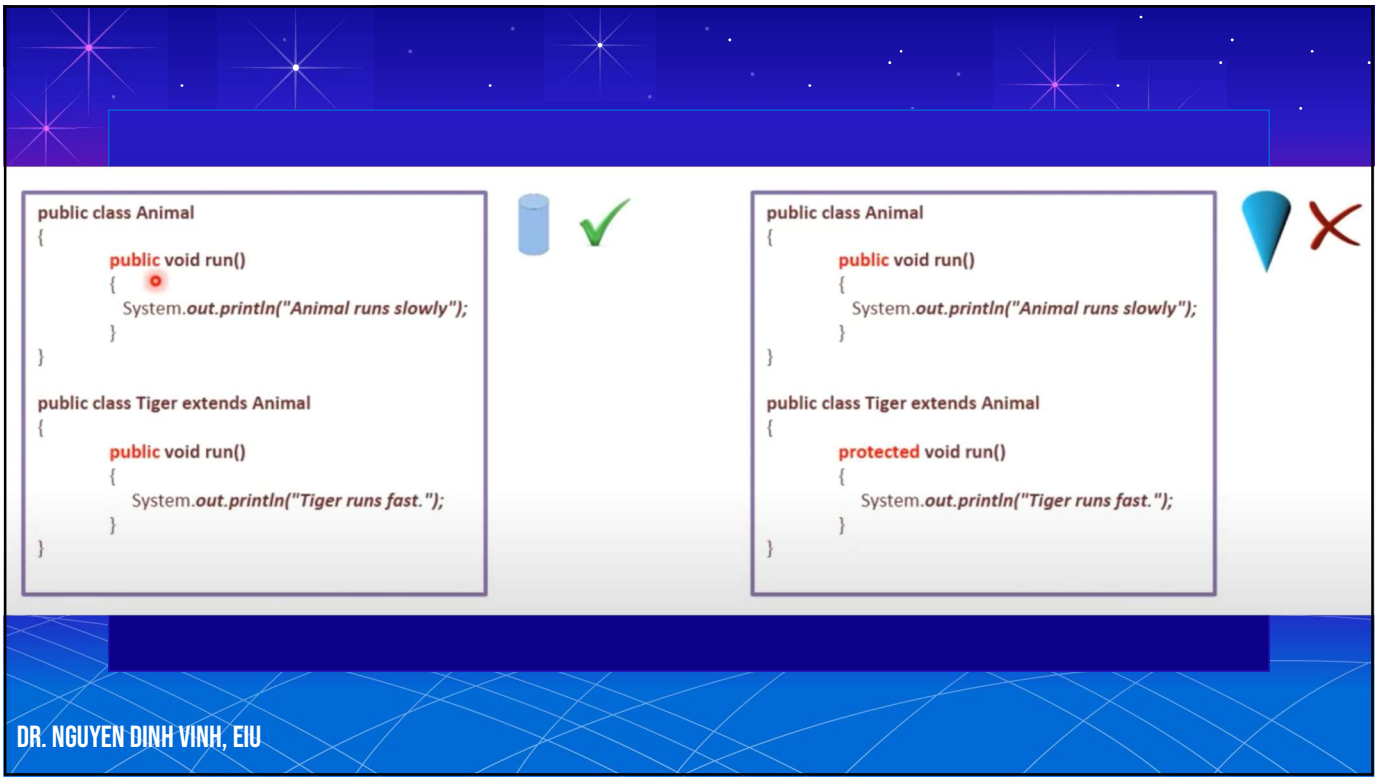
public class Animal
{
public void run()
{
System.out.println("Animal runs slowly");
}
}
public class Tiger extends Animal
{
public void run()
{
System.out.println("Tiger runs fast.");
}
}
public class Animal
{
public void run()
{
System.out.println("Animal runs slowly");
}
}
public class Tiger extends Animal
{
protected void run()
{
System.out.println("Tiger runs fast.");
}
}
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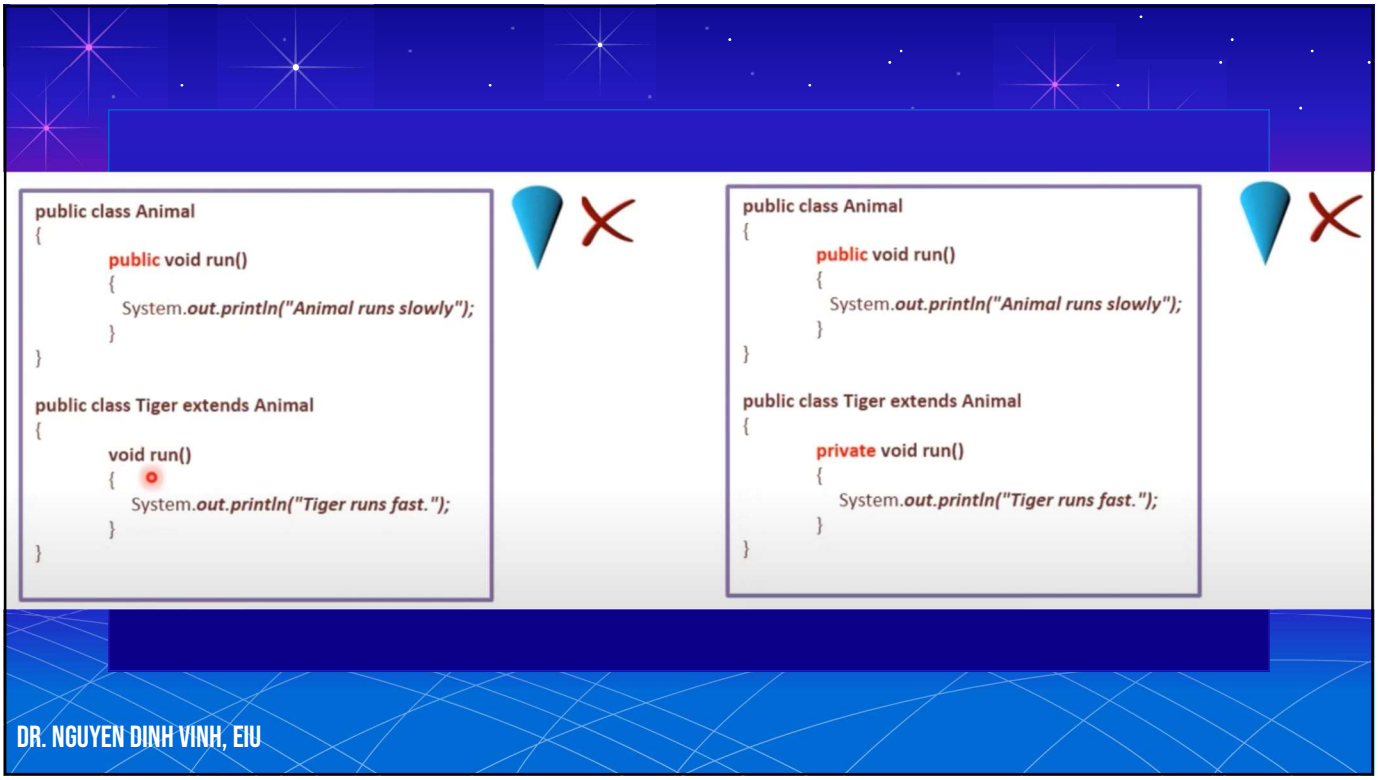
public class Animal
{
public void run()
{
System.out.println("Animal runs slowly");
}
}
public class Tiger extends Animal
{
void run()
{
System.out.println("Tiger runs fast.");
}
}
public class Animal
{
public void run()
{
System.out.println("Animal runs slowly");
}
}
public class Tiger extends Animal
{
private void run()
{
System.out.println("Tiger runs fast.");
}
}
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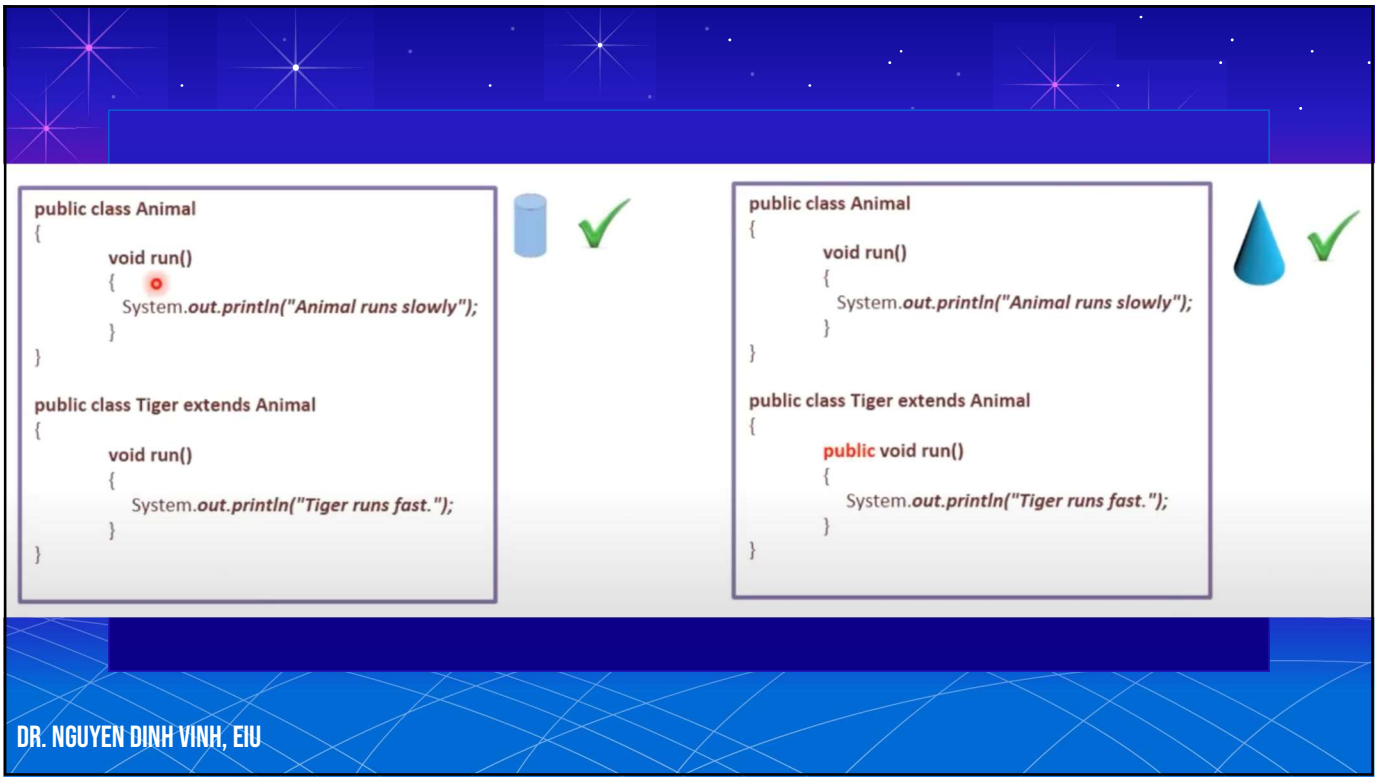
public class Animal
{
void run()
{
System.out.println("Animal runs slowly");
}
}
public class Tiger extends Animal
{
void run()
{
System.out.println("Tiger runs fast.");
}
}
public class Animal
{
void run()
{
System.out.println("Animal runs slowly");
}
}
public class Tiger extends Animal
{
public void run()
{
System.out.println("Tiger runs fast.");
}
}
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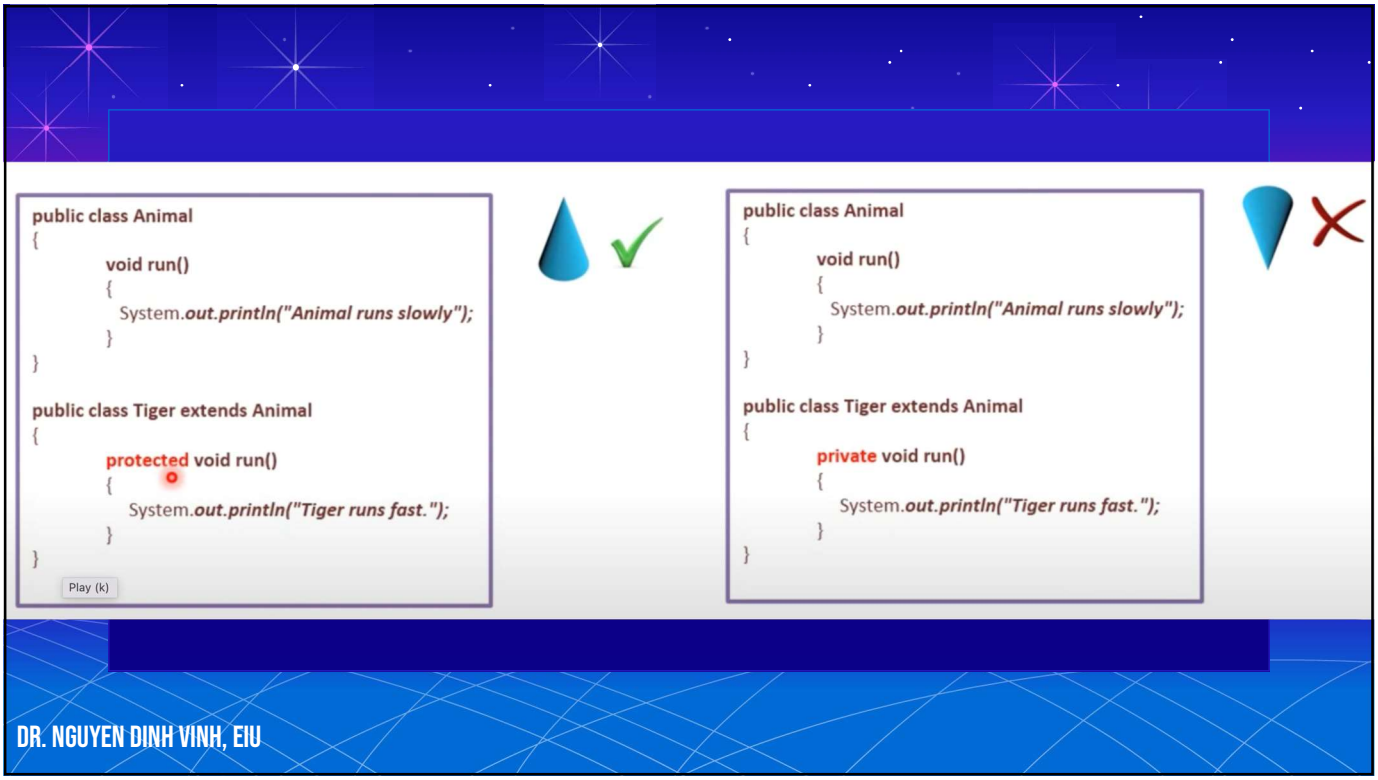
public class Animal
{
void run()
{
System.out.println("Animal runs slowly");
}
}
public class Tiger extends Animal
{
protected void run()
{
System.out.println("Tiger runs fast.");
}
}
Play (k)
public class Animal
{
void run()
{
System.out.println("Animal runs slowly");
}
}
public class Tiger extends Animal
{
private void run()
{
System.out.println("Tiger runs fast.");
}
}
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Java method overriding (static modifier)

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We will get a compile-time error if you attempt to change an instance method in the superclass to a static method in the subclass, and vice versa.

```
public class Animal
{
        public void run()
        {
           System.out.println("Animal runs slowly");
        }
}

public class Tiger extends Animal
{
        public static void run()
        {
          System.out.println("Tiger runs fast.");
        }
}
```

```
public class Animal
{
        public static void run()
        {
           System.out.println("Animal runs slowly");
        }
}

public class Tiger extends Animal
{
        public void run()
        {
          System.out.println("Tiger runs fast.");
        }
}
```

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This is allowed because each static method belongs to its own class.

```
public class Animal
{
        public static void run()
        {
            System.out.println("Animal runs slowly");
        }
}

public class Tiger extends Animal
{
        public static void run()
        {
          System.out.println("Tiger runs fast.");
        }
}
```

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Exercises

Build a polygon interface (IPolygon) including methods for calculating area and perimeter. Create classes Rectangle, circle, parallelogram, trapezoid... inherited from the IPolygon polygon interface.

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References

- **E-Book**
  - Java Programming, 8th Edition Joyce Farrel
  - JDK Document 1.8
  - Java Tutorial
  - Java Tutorial Example
- **Website**
  - http://www.oracle.com/technetwork/articles/javase/jdk-netbeans-jsp-142931.html

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THANK YOU

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