



Module 21

Partha Pratim
Das

Objectives &
Outline

ISA
Relationship

Inheritance in
C++

Semantics

Summary

Module 21: Programming in C++

Inheritance: Part 1

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Module Objectives

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Summary

- Revisit ISA Relationship in OOAD and understand how hierarchy can be created in C++ with Inheritance



Module Outline

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Summary

- ISA Relationship
- Inheritance in C++
 - Semantics
 - Data Members and Object Layout
 - Member Functions
 - Overriding
 - Overloading
 - protected Access
 - Constructor & Destructor
 - Object Lifetime
- Example – Phone Hierarchy
- Inheritance in C++ (private)
 - Implemented-As Semantics



ISA Relationship

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Summary

- We often find one object is a *specialization* / *generalization* of another
- OOAD models this using **ISA** relationship
- C++ models **ISA** relationship by *Inheritance* of classes



ISA Relationship

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● Rose ISA Flower

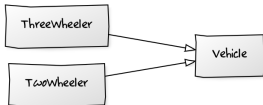
- Rose has the properties of Flower – like fragrance, having petals etc.
- Rose has some additional properties – like rosy fragrance
- Rose is a *specialization* of Flower
- Flower is a *generalization* of Rose

● Red Rose ISA Rose

- Red Rose has the properties of Rose – like rosy fragrance etc.
- Red Rose has some additional properties – like it is red
- Red Rose is a *specialization* of Rose
- Rose is a *generalization* of Red Rose



● TwoWheeler ISA Vehicle; ThreeWheeler ISA Vehicle



● Manager ISA Employee





Inheritance in C++: Hierarchy

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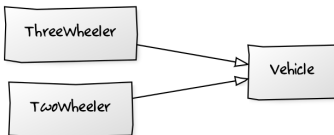
Summary

- **Manager ISA Employee [Single Inheritance]**



```
class Employee;           // Base Class = Employee
class Manager: public Employee; // Derived Class = Manager
```

- **TwoWheeler ISA Vehicle; ThreeWheeler ISA Vehicle [Hybrid Inheritance]**



```
class Vehicle;           // Base Class = Employee -- Root
class TwoWheeler: public Vehicle; // Derived Class = TwoWheeler
class ThreeWheeler: public Vehicle; // Derived Class = ThreeWheeler
```

- **Red Rose ISA Rose ISA Flower [Multi-Level Inheritance]**



```
class Flower;           // Base Class = Flower -- Root
class Rose: public Flower; // Derived Class = Rose; Base Class = Rose
class RedRose: public Rose; // Derived Class = RedRose;
```



Inheritance in C++: Phones

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Summary

- Landline Phone

- Call: By dial / keyboard
- Answer

- Mobile Phone

- Call: By keyboard –
shows number
 - By Number
 - By Name
- Answer
- Redial
- Set Ring Tone
- Add Contact
 - Number
 - Name

- Smart Phone

- Call: By touchscreen –
shows number & photo
 - By Number
 - By Name
- Answer
- Redial
- Set Ring Tone
- Add Contact
 - Number
 - Name
 - Photo

- There exists a substantial overlap between the functionality of the phones
- A mobile phone is more capable than a land line phone and can perform (almost) all its functions
- A smart phone is more capable than a mobile phone and can perform (almost) all its functions
- **These phones belong to a Specialization / Generalization hierarchy**



Inheritance in C++: Semantics

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Objectives & Outline

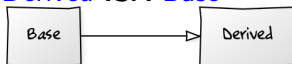
ISA Relationship

Inheritance in C++

Semantics

Summary

- Derived **ISA** Base



```
class Base; // Base Class = Base
class Derived: public Base; // Derived Class = Derived
```

- Use keyword **public** after class name to denote inheritance
- Name of the Base class follow the keyword

"Public inheritance means "is-a." Everything that applies to base classes must also apply to derived classes, because every derived class object is a base class object"
– Scott Meyers in Item 32, Effective C++ (3rd. Edition)



Inheritance in C++: Semantics

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ISA Relationship

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Summary

- **Derived ISA Base**
- **Data Members**
 - **Derived** class *inherits* all data members of **Base** class
 - **Derived** class may *add* data members of its own
- **Member Functions**
 - **Derived** class *inherits* all member functions of **Base** class
 - **Derived** class may *override* a member function of **Base** class by *redefining* it with the *same signature*
 - **Derived** class may *overload* a member function of **Base** class by *redefining* it with the *same name*; but *different signature*
- **Access Specification**
 - **Derived** class *cannot access private* members of **Base** class
 - **Derived** class *can access protected* members of **Base** class
- **Construction-Destruction**
 - A *constructor* of the **Derived** class *must first* call a *constructor* of the **Base** class to construct the **Base** class instance of the **Derived** class
 - The *destructor* of the **Derived** class *must* call the *destructor* of the **Base** class to destruct the **Base** class instance of the **Derived** class



Worksheet

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Summary

- Revisited Hierarchy or ISA Relationship in OOAD
- Introduced the Semantics of Inheritance in C++



Instructor and TAs

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