Object Oriented Programming

Using C++ Programming Language

RECAP

Object Orientation

A technique for system modeling

Model

– A model is an abstraction of something

- Prototype/Architecture of a building

– Purpose is to understand the product before developing it

Object

– State (attributes)

– Well-defined behavior (operations)

– Unique identity

Lecture # 2

Information Hiding / Encapsulation / Abstraction / Messages / Classes

Information Hiding

- Information relevant to an object is stored/packed inside it.

- Hidden/not accessible directly for outside world.

- Only object itself can manipulated the data/information under controlled environment.

Example – Information Hiding Human

- Ahmad's name is stored within his brain

- We can't access his name directly

- Rather we can ask him to tell his name

Example – Information Hiding

- A phone stores several phone numbers

- We can't read the numbers directly from the SIM card / phone memory.

- Rather phone-set reads this information for us, Display in readable format and manipulate safely

Advantages of Information Hiding

- Simplifies the model by hiding its implementation details, hides complexity of inside architecture.

- Object its self handles data changes, It restrict the change propagation

Encapsulation

- Data and behavior related together are defined inside an object. They are tightly coupled/dependent inside an object

- Both the information structure and implementation details of its operations are hidden from the outer

Example – Encapsulation

- Ahmad stores his personal information and knows how to translate it to the desired language

- We don't know
  - How the data is stored
  - How Ahmad translates this information

Example – Encapsulation

- A Phone stores phone numbers in digital format and knows how to convert it into human-readable characters

- We don't know
  - How the data is stored
  - How it is converted to human-readable characters

Encapsulation – Advantages

- Simplicity and clarity
- Low complexity
- Better understanding
- Avoid undesirable effects
- Security

Object has an Interface

- An object encapsulates data and behavior
- So how objects interact with each other?
- Each object provides an interface (operations)
- Other objects communicate through this interface

Example – Interface of a Car

- Steer Wheels
- Accelerate
- Change Gear
- Apply Brakes
- Turn Lights On/Off

Example – Interface of a Phone

- Input Number
- Place Call
- Disconnect Call
- Add number to address book
- Send Message
- Update number

Implementation

- Provides services offered by the object interface

- This includes
  - Data structures to hold object state
  - Functionality that provides required services

Example – Implementation of Steering

- Data Structure
  - Mechanical structure of steering

- Functionality
  - Mechanism to rotate tyre

Example – Implementation of Address Book in a Phone

- Data Structure
  - SIM card
  - Internal Memory

- Functionality
  - Read/write circuitry

Separation of Interface & Implementation

- Means change in implementation does not effect object interface

- This is achieved via principles of information hiding and encapsulation

Example – Separation of Interface & Implementation

- A driver can drive a car independent of engine type (petrol, diesel or CNG)

- Because interface does not change with the implementation

Example – Separation of Interface & Implementation

- A driver can apply brakes independent of brakes type (Cylindrical, disk)

- Again, reason is the same interface

Advantages of Separation

- Users need not to worry about a change until the interface is same

- Low Complexity (as implementation details are hidden)

- Direct access to information structure of an object can result errors/unstable state.

Messages

- Objects communicate through messages
- They send messages (stimuli) by invoking appropriate operations on the target object
- The number and kind of messages that can be sent to an object depends upon its interface

Examples – Messages

A Person sends message (stimulus) "stop" to a Car by applying brakes

- A Person sends message "place call" to a Phone by pressing appropriate button
- Or simple a functional call of an object by other is regarded as message passing

Abstraction

- Abstraction is a way to cope with complexity.

- Principle of abstraction:

"Capture only those details about an object that are relevant to current perspective"

Example – Abstraction

Ahmad is a PhD student and teaches BS students

- Attributes
  - Name   - Employee ID
  - Student Roll No   - Designation
  - Year of Study   - Salary
  - CGPA   - Age

Example – Abstraction

Teacher's Perspective

- Attributes
  - Name   - Employee ID
  - Student Roll No   - Designation
  - Year of Study   - Salary
  - CGPA   - Age

Example – Abstraction

Ahmad is a PhD student and teaches BS students

- behaviour
  - Study
  - GiveExam
  - PlaySports
  - DeliverLecture
  - DevelopExam
  - TakeExam
  - Eat
  - Walk

Example – Abstraction

Student's Perspective

- Attributes
  - Name   - Employee ID
  - Student Roll No   - Designation
  - Year of Study   - Salary
  - CGPA   - Age

Example – Abstraction

Student's Perspective

- behaviour
  - Study   - DevelopExam
  - GiveExam   - TakeExam
  - PlaySports   - Eat
  - DeliverLecture   - Walk

Example – Abstraction

- behaviour
  - Study
  - GiveExam
  - PlaySports
  - DeliverLecture
  - DevelopExam
  - TakeExam
  - Eat
  - Walk

Example – Abstraction

A cat can be viewed with different perspectives

- Ordinary Perspective

  A pet animal with
  - Four Legs
  - A Tail
  - Two Ears
  - Sharp Teeth

- Surgeon's Perspective

  A being with
  - A Skeleton
  - Heart
  - Kidney
  - Stomach

Example – Abstraction

Engineer's View

Owner's View

Abstraction – Advantages

- Simplifies the model by hiding irrelevant details

- Abstraction provides the freedom to defer implementation decisions by avoiding commitment to details

Classes

- In an OO model, some of the objects exhibit identical characteristics (information structure and behavior)

- We say that they belong to the same class

Example – Class

- Ahmad studies mathematics
- Sara studies Computers Science
- Mohsin studies chemistry

- Each one is a Student
- We say these objects are *instances* of the Student class

Example – Class

- Circle is an closed oval shape
- Square is a closed rectangular shape
- Line is open shape with start and ending point

- Each one is a shape
- We say these objects are *instances* of the shape class

Graphical Representation of Classes

(Class Name)

(attributes)

(operations)

Normal

(Class Name)
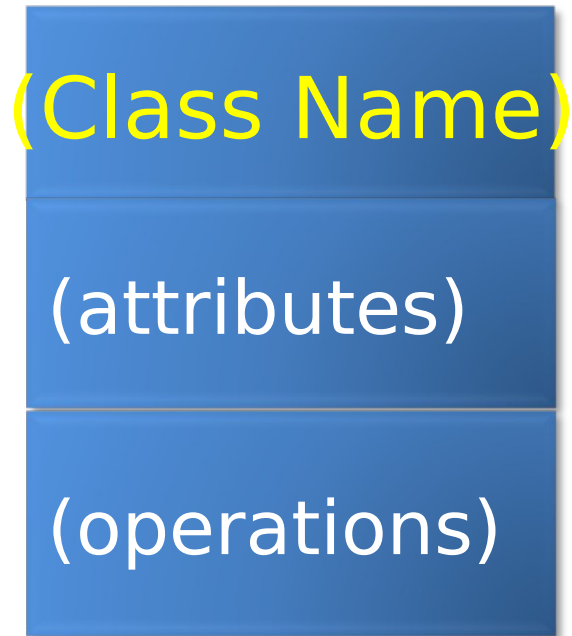
Suppressed Form

Example – Graphical Representation of Classes

Circle

center
radius

draw
computeArea

Normal

Circle

Suppressed
Form

Example – Graphical Representation of Classes

Student

name
age
gender

Study
GiveExam

Normal

Student

Suppressed Form

Q & A