CMSC 132:
Object-Oriented Programming II

Software Development IV

Department of Computer Science

University of Maryland, College Park

Overview

- Object-oriented design
  - Goals
  - Techniques
  - Object-oriented view
  - Examples

Object-Oriented Design

- Goals
  - Improve software design
    - Reduce implementation effort
    - Scalable to large software projects
  - Try to take advantage of two techniques
    - Abstraction
    - Encapsulation

Techniques – Abstraction

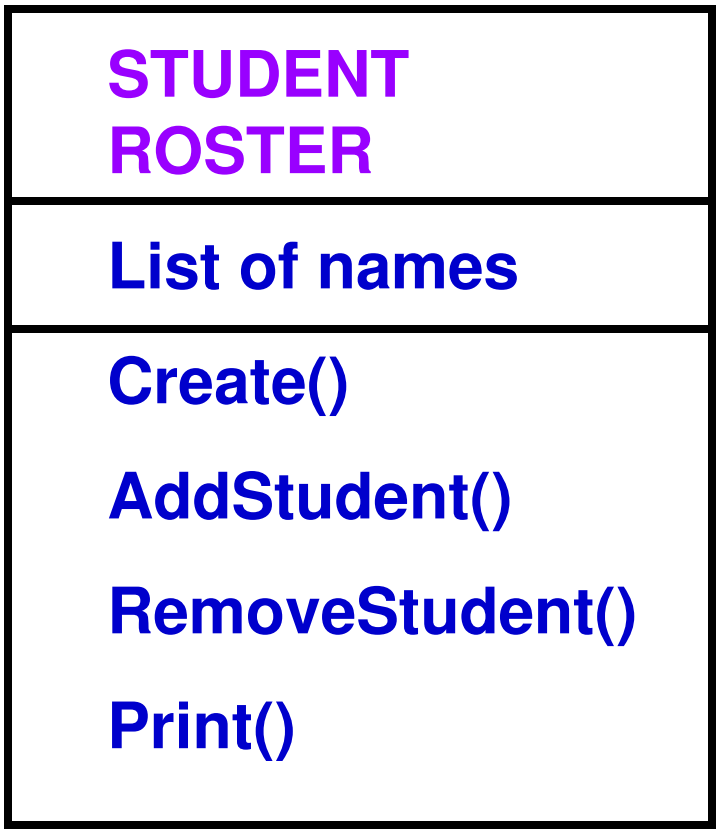
- Abstraction
  - Provide simple high-level model of
    - Physical entity
    - Activity
- Helpful for managing complexity
- Enables information hiding
  - Can change implementation & representation
  - Will not affect other software components

Types of Abstraction

- **Procedural abstraction**
  - Specify what actions should be performed
  - Hide algorithms
- **Data abstraction**
  - Specify data objects for problem
  - Hide representation

Abstraction Example

- Abstraction of a Student Roster
  - Data
    - List of student names
  - Actions
    - Create roster
    - Add student
    - Remove student
    - Print roster



Techniques – Encapsulation

- **Encapsulation**
  - Confine information so it is only visible / accessible through an associated external interface
- **Approach**
  - For some entity X in program
    - Abstract data in X
    - Abstract actions on data in X
    - Collect data & actions on X in same location
  - Protects and hides X

Encapsulation

- Extension of abstraction
  - Always abstract data & function together
  - Encapsulated entity $\Rightarrow$ Abstract Data Type (ADT)
- Examples
  - List ADT
    - May be implemented as array, linked list, etc…
  - Java collections library

Benefits of Encapsulation

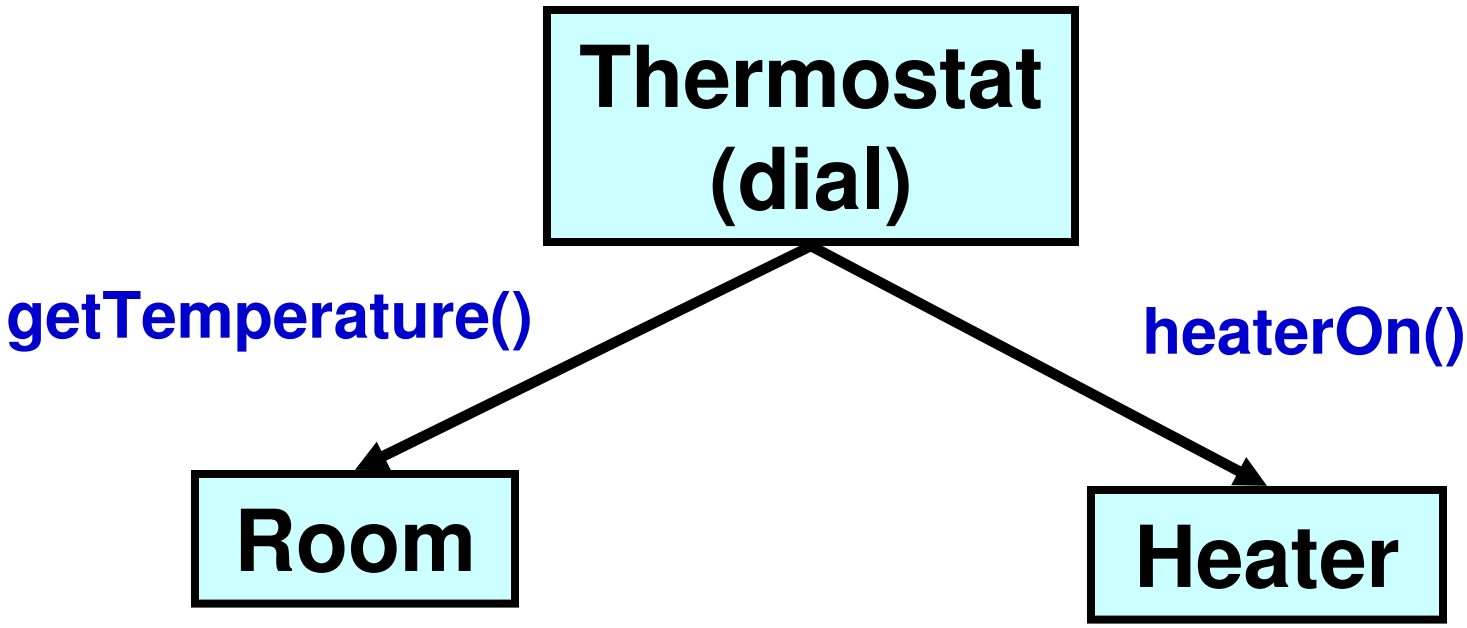
- Easier to make code modifications
  - Due to information hiding
- Promotes code reuse
  - Interface to data structure clearly defined
  - Easier to reuse code
- Code reuse increases productivity

Object-Oriented Design

- View software as
  - A collection of entities (objects)
  - Functions associated with each object
  - Communication between objects
- Exploits abstraction & encapsulation
- Can rely on programming language support

Object-Oriented View

- **Example problem description**
  - **Thermostat uses dial setting to control a heater to maintain constant temperature in room**



History of Object-Oriented Design

- Preceded by procedure-oriented view
  - Earliest approach to programming
  - Uses procedure abstraction
  - Similar to actual machine instructions
  - Focus on control flow, program scope
  - Examples: Fortran, Cobol, Pascal, Basic
- Example
  - Thermostat()
    1. Get room temperature
    2. If (temperature < setting) turn heater on
    3. Else turn heater off
    4. Goto step 1

OO Programming Languages

- **Development history**
  - **Simula (Dahl & Nygaard, 1962)**
    - **Modeling discrete event simulation**
  - **Smalltalk (Kay, 1972)**
    - **General programming**
  - **C++ (Stroustrup, 1979)**
    - **Manage complexity in huge software projects**
  - **Java (Gosling, 1991)**
    - **Designed for embedded processors**

Factors in Success of OO Design

- Growing demand
  - More experience with large software projects
- Improvements in language design
  - Made OO programming easier
- Improvements compiler technology
  - Support more language features efficiently
- Improvements in hardware
  - Handled inefficiencies in OO programming
  - Made performance less critical

Elements of Object-Oriented Design

- Objects
  - Entities in program
- Methods
  - Functions associated with objects
- Classes
  - Groups of objects with similar properties
- Inheritance
  - Relationship between classes

Objects

- **Definition**
  - Entity that has state, behavior, and identity
  - State (data)
    - Properties possessed by object
    - Current values of those properties
  - Behavior (methods)
    - How objects react to changes in state
    - How objects interact with each other
  - Identity (references)
    - Mechanism to distinguish between objects

Object Example

- Thermostat
  - State
    - DesiredTemp
    - CurrentTemp
    - HeaterState
  - Behavior
    - SetDesiredTemp()
    - TurnHeaterOn()
    - TurnHeaterOff()
  - Identity
    - this

Object Example

- **Thermostat**
  - **State**

	Property	Value
DesiredTemp	integer	78°
CurrentTemp	integer	72°
HeaterState	boolean	ON

Object State

- **Properties**
  - **Static, unchanging**
  - **May view as types**
- **Values**
  - **Dynamic, changes**
  - **Within bounds set by properties**

Methods

- Definition
  - Procedures associated with object
- Specify behavior of objects
- Invocation $\Rightarrow$ sending message to object
- Example
  - myThermostat.setDesiredTemp(78)
  - myThermostat.turnHeaterOn()
  - myThermostat.turnHeaterOff()

Method Types

- **Accessor**
  - Return state information
- **Mutator**
  - Modify state information
- **Constructor**
  - Create & initialize new object
- **Destructor**
  - Remove object & free up resources