Outline

- Design Hierarchy
- Design philosophies
  - Procedural
  - Modular
  - Object-oriented
- Object-oriented design strategies
- Course overview

Design Hierarchy

- Describe system in terms of components, and components in terms of subcomponents
- Requires abstraction - hiding of details of components
- Top-down: decompose system into components
- Bottom-up: build system from small components

Procedural Programming

- Problem is divided into sequence of subproblems to be solved
- Program is sequence of procedure calls
- Think in terms of tasks and subtasks
- Languages: C, Pascal, Fortran, COBOL, etc

Procedural Design

- Key: identify simple tasks that can be programmed easily
- Design notations:
  - structure charts - which procedures call which
  - dataflow diagrams - how data moves from one task (“process”) to another (business apps)

Problems in Procedural Programs

- Large program made up of many small procedures
- Not clear which does what to what data
- No enforced control over access to data
- Difficult to fix bugs, modify, and use procedures in other programs
Software Engineering Goals

- **Reusability** – components can be used in many applications
- **Extensibility** – ease of change
- **Flexibility** – modifications do not “break” system

Modular Programming

- Data and procedures collected (and hidden) in module
- Can make so that only procedures in module can modify data
- Design: think about necessary data types, and wrap modules around data
- Languages: Ada 83, Modula, SML,…

Problems with Modules

- Modules solve most problems of procedural programs
- Allows information hiding
- Only have encapsulation if data of type is stored in module
- Want module to be data
- Difficult if want more than one copy

Object-Oriented Programming

- Think of building program from parts
  Like building a machine!
- Parts are *objects* that interact to solve problem
- Define *classes* of objects that can be reused
- Think in terms of objects and interactions
- Languages: C++, Java, Eiffel, Smalltalk, etc

Why Object-Oriented?

- Procedures organized around objects
  – Data access easier to understand
  – Data access easier to control
  • “Easier” to avoid design problems

(Shhh, Can you keep a secret?)

- Object interactions are defined by methods, which are just procedures
- Programs still sequences of “procedure” calls, but think of as interacting objects
Generalization in OOP

- Two approaches to defining classes in terms of others
  - Inheritance – “inherit” properties of other classes
  - Parameterized classes (templates) – class defined in terms of parameter classes
- Design patterns are solutions to common design problems

Object-Oriented Design

- Identify objects and classes
  - strategies: abstraction and separation
- Identify how objects interact in system
  - strategy: composition
- Identify hierarchies of related classes
  - strategy: generalization

Object-Oriented Design Strategies

- Abstraction – modeling essential properties
- Separation – treat what and how independently
- Composition – building complex structures from simpler ones
- Generalization – identifying common elements

Connections

Course Overview

- C++ classes
- Design notations
- Composition
- Design
- Generalization
- Design