Inheritance (language independent)

- First view: exploit common interfaces in programming
  - Different kinds of bank accounts
  - Tapestry tmap, iterator, C++ function objects
  - Implementation varies while interface stays the same

- Second view: share code, factor code into parent class
  - Code in parent class shared by subclasses
  - Subclasses can *override* inherited method
    - Can subclasses override and call?

- Polymorphism/late(runtime) binding (compare: static)
  - Actual function called determined when program runs, not when program is compiled
Inheritance guidelines in C++

- **Inherit from Abstract Base Classes (ABC)**
  - one pure virtual function needed (=0)
    - Subclasses must implement, or they’re abstract too
  - must have virtual destructor implemented
  - can have *pure* virtual destructor implemented, but not normally needed

- **Avoid protected data, but sometimes this isn’t possible**
  - data is private, subclasses have it, can’t access it
  - keep protected data to a minimum

- **Single inheritance, assume most functions are virtual**
  - multiple inheritance ok when using ABC, problem with data in super classes
  - virtual: some overhead, but open/closed principle intact
Inheritance Heuristics

- A base/parent class is an interface
  - Subclasses implement the interface
    - Behavior changes in subclasses, but there’s commonality
  - The base/parent class can supply some default behavior
    - Derived classes can use, override, both
  - The base/parent class can have state
    - Protected: inherited and directly accessible
    - Private: inherited but not accessible directly
  - Abstract base classes are a good thing

- Push common behavior as high up as possible in an inheritance hierarchy

- If the subclasses aren’t used polymorphically (e.g., through a pointer to the base class) then the inheritance hierarchy is probably flawed
Inheritance Heuristics in C++

- One pure virtual (aka abstract) function makes a class abstract
  - Cannot be instantiated, but can be constructed (why?)
  - Default in C++ is non-virtual or monomorphic
    - Unreasonable emphasis on efficiency, sacrifices generality
    - If you think subclassing will occur, all methods are virtual
  - Must have virtual destructor, the base class destructor (and constructor) will be called

- We use public inheritance, models is-a relationship
  - Private inheritance means is-implemented-in-terms-of
    - Implementation technique, not design technique
    - Derived class methods call base-class methods, but no “usable-as-a” via polymorphism
    - Access to protected methods, and can redefine virtual funcs
Inheritance and Layering/Aggregation

- Layering (or aggregation) means “uses via instance variable”
  - Use layering/attributes if differences aren’t behavioral
  - Use inheritance when differences are behavioral

- Consider Student class: name, age, gender, sleeping habits
  - Which are attributes, which might be virtual methods

- Lots of classes can lead to lots of problems
  - It’s hard to manage lots of classes in your head
  - Tools help, use speedbar in emacs, other class browsers in IDEs or in comments (e.g., javadoc)

- Inheritance hierarchies cannot be too deep (understandable?)
Inheritance guidelines (see Riel)

- **Watch out for derived classes with only one instance/object**
  - For the CarMaker class is GeneralMotors a subclass or an object?

- **Watch out for derived classes that override behavior with a no-op**
  - Mammal class from which platypus derives, live-birth?

- **Too much subclassing? Base class House**
  - Derived: ElectricallyCooledHouse, SolarHeatedHouse?

- **What to do with a list of fruit that must support apple-coring?**
  - Fruit list is polymorphic (in theory), not everything corable
See filterdemo.cpp

- Filter is an abstract base class, why?
  - What is filter designed to do?
  - What is advantage of chained filter approach?

- Problem: We want to have MinFilter, MaxFilter, MinMaxFilter, etc., lots of different kinds of filters
  - We can’t make a new class for all, there are too many when combined with each other
  - We can use the decorator pattern to solve the problem

- We want to add responsibilities to objects (not classes)
  - Add dynamically, also remove
  - Extension by subclassing impracticle (too many)
  - Create an interface, decorator both is-a and has-a
Decorator

- Filter: specifies an interface, other filters implement the interface
  - Chain filters together by forwarding queries

```
Filter
  Ok()
  isOk()

MinFilter
  Ok()
  isOk()

MaxFilter
  Ok()
  isOk()
```