# OO Analysis and Design Guidelines

# Domains To Model

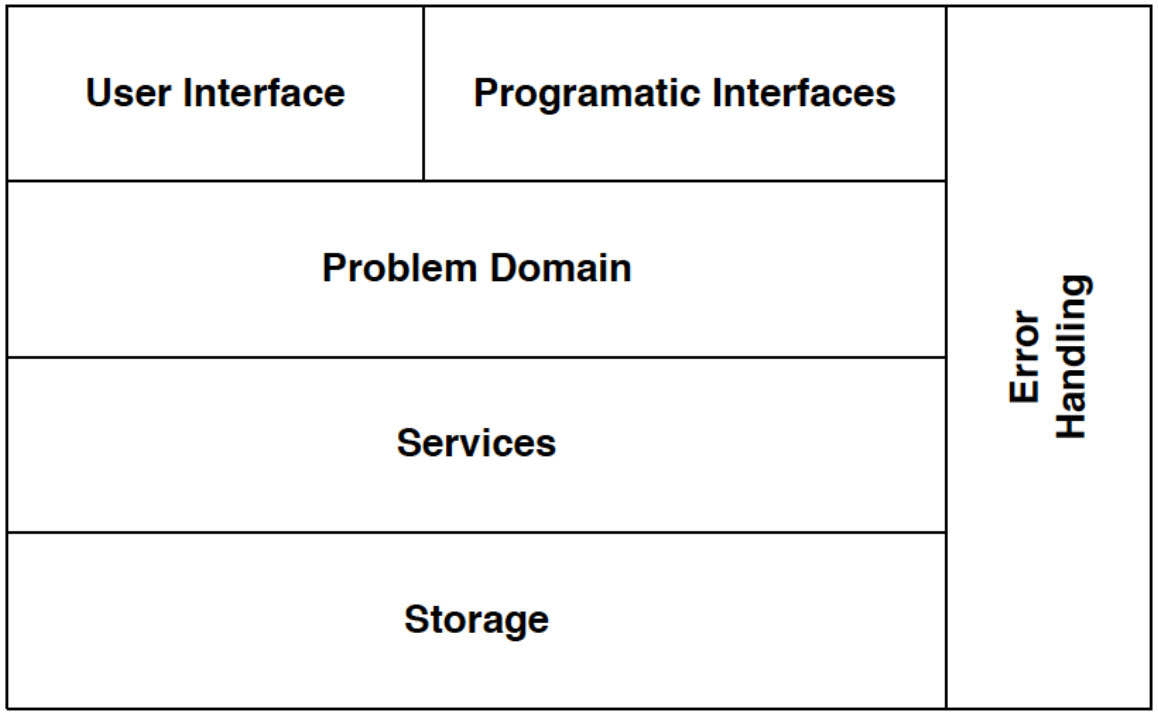
Every real-world system should be designed in several explicit domains.

- Business problem.
- Persistent storage of data.
- User interface.
- System context / network environment / security.
- Functional distribution.
- Solution ***infrastructure***.

Be careful not to mix responsibilities across domains.

- Separate concerns.

# Layered Architecture Model



# Model Physical & Conceptual Entities

OO Programming originated as a better way to think about writing *simulators* - programs intended to behave exactly like some real physical process.

**Physical**:

- Domain entities: automobiles, airplanes, …
- System entities: printers, modems, sensors, actuators, ...

**Conceptual**:

- Priority, Access privilege, Data format converter, Transaction manager, Memory manager, Data Structures
  - Graph / Tree / Queue / Stack / HashMap

# Model Categories of Classes

- Animal
  - Dog
    - » German Shepherd
    - » Poodle
    - » Mutt
  - Cat
- Magnetic Media
  - Disk
  - Tape

Natural categories often make good inheritance hierarchies.

# Model Groups of Objects

- Game Layout
  - Rows
    - » Sticks
- Corporation
  - Divisions
    - » Departments
      - ◆Employees

Groups of objects a modeled by ***composition*** and ***aggregation***.

***Collections*** are special kinds of groups.

# Model External Things You Must Call

Very important in the real world.

- Examples:
  - legacy code and data sources.
  - The operating system, if you call it.
  - vendor packages.
  - system interfaces.
- Identify the services provided.
- Create objects that are responsible for providing the services.
- Consider a ***proxy*** object for remote services to encapsulate the distributed communications.

# Checking Your Classes

- Every class should have a clear name that sounds like a thing, not a function. ClassNames in Java should always begin with a capital letter and use MixedCaseLikeThis.
- Every class should have a clear purpose that applies to all of its subclasses.
- Classes that are similar but not identical might suggest inheritance, or possibly delegation to a third, shared class.
- Classes should only overlap if they have an inheritance relationship, and then one class should completely overlap the other.
  - Otherwise, classes should ***separate their concerns***.
- Classes may collaborate to fulfill their responsibilities.
- Classes should have semantically related attributes and methods.

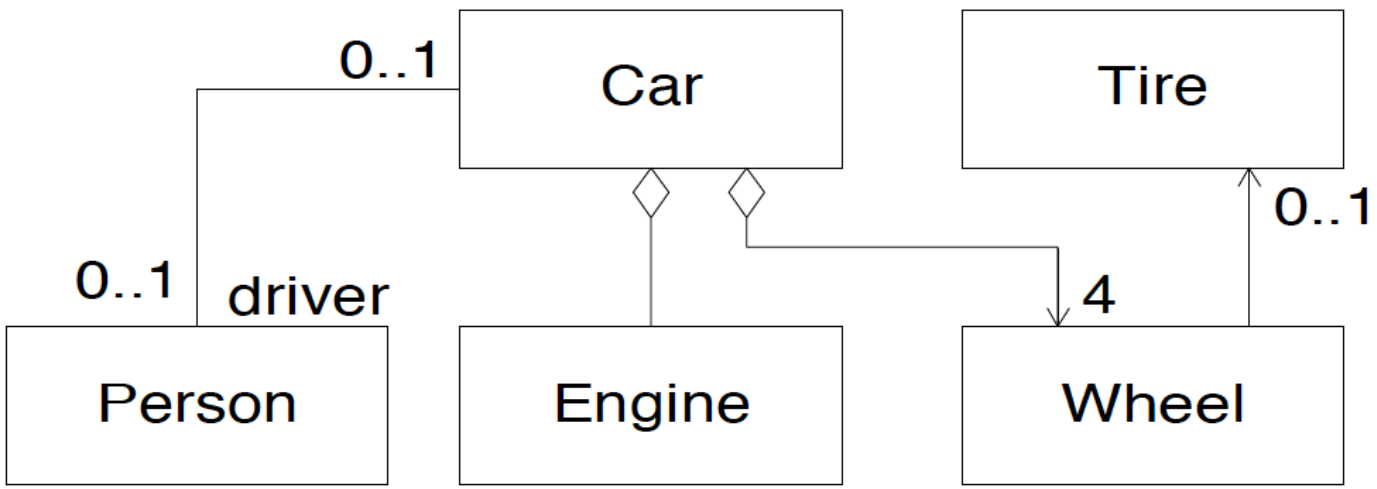
# Relationship Types

- Composition
  - B ***is part of*** A
  - A ***contains*** B
  - A ***has a collection of*** Bs
- Subclass / Superclass
  - A ***is a kind of*** B
  - A ***is a specialization of*** B
  - A ***behaves like*** B
- Collaborative
  - A ***delegates to*** B
  - A ***needs help from*** B
  - A and B are ***peers***.

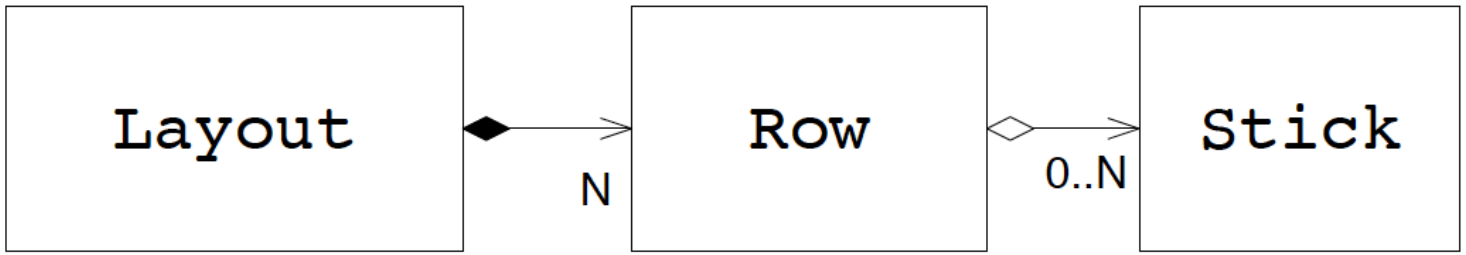
# Composition / Aggregation

The diamond symbol can represent more than one concept:

- Part / whole relationships (most common)
- Has - a
- Has - a - collection - of
- Is - composed - of



# Composition & Aggregation




Composition:

- UML blackens the ***composition*** diamond.
- The hollow diamond is used for ***aggregation***.
- Composition is a stronger association than aggregation. The difference is that with composition, the part never has more than one whole, and the part and the whole always have a shared lifetime.

# Composition, Aggregation, & Associations

**Composition:**

- A book is composed of its pages and cover.

**Aggregation:**

- A bookshelf holds a collection of books that changes over time.

**Association:**

- A book has an associated author.

**Dependency:**

- A person reads a book, then gives it to a friend.

# Association Semantics

For Composition / Aggregation:

- Can the containee be contained within more than one container?
- Are the lifetimes of the two objects exactly the same?
- Does one object own/control the other's memory?
- Can the association be labeled ***part of*** or ***composed of***?
- Or would it be better labeled ***collection of***?

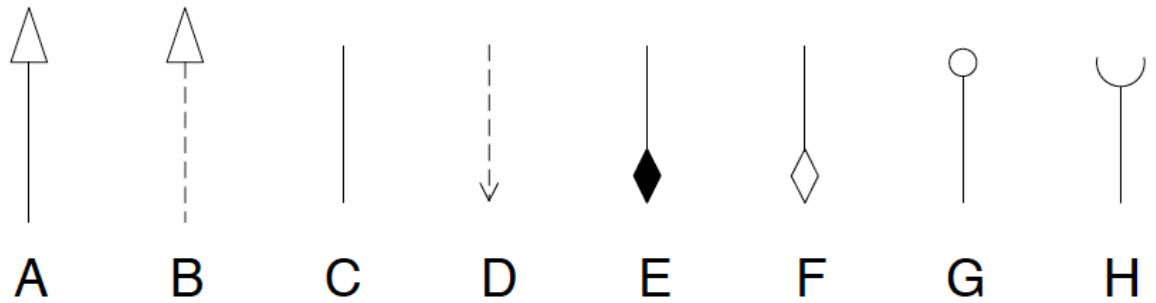
For Associations / Dependencies:

- Is the association transient, permanent, or somewhere in between?

Sometimes these distinctions are not black and white.

Consider the memory management implications (especially in C++).

# UML Association Review




A) Implementation Inheritance (Generalization)

B) Interface Inheritance (Realization)

C) Bidirectional Association

D) Unidirectional Dependency

E) Composition

F) Aggregation

G) Provided Interface (Lollypop)

H) Required Interface (Socket)

# Assigning Responsibilities

- Think about how the program will actually work.
- State responsibilities as generally as possible.
- Keep information about one thing in one place.
- Responsibilities can be shared or delegated.
- A class with no responsibilities is likely superfluous.
- Refactor your design whenever it gets too complicated.
- Break up big, complex classes.
- Centralized “intelligence” is inflexible.
- Avoid complexity in the graph of interacting objects.
- Poor choices lead to fragile systems.

# Interfaces

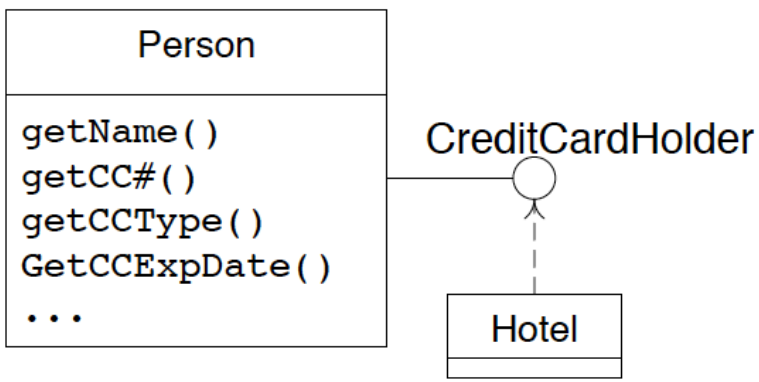
The client object sends a message to an object with a known interface; any class that implements the given interface will do.

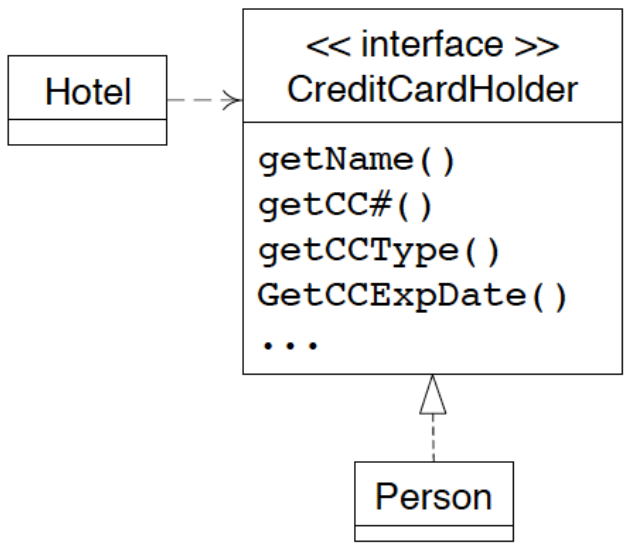
Example: Class `Person` can implement a `CreditCardInfo` interface, used by an airline reservation program.

- The program doesn't know or care about `Person`, only about objects that implement the `CreditCardInfo` interface.
- There might also be a `Corporation` class that implements the `CreditCardInfo` interface.
- The `Person` class can change dramatically without the reservation program having to be changed at all.

# Interfaces

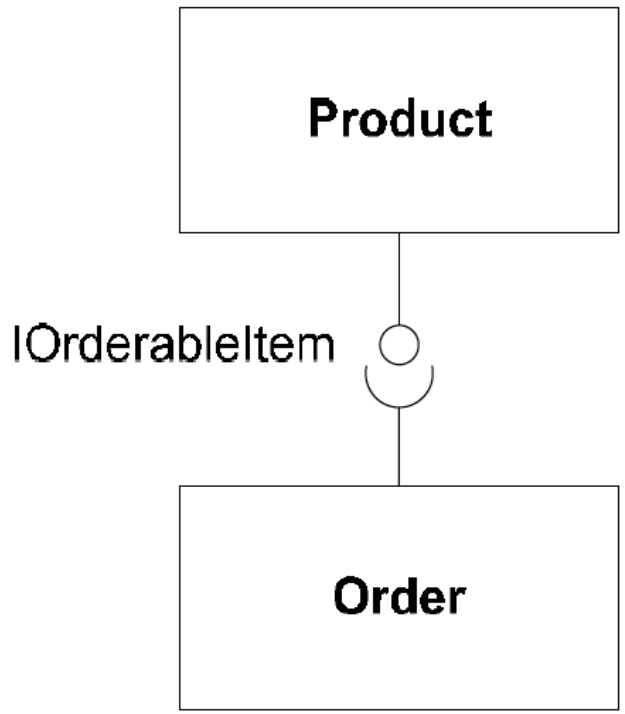
- Java interfaces may define ***no implementation***.
- C++ interfaces are built with ***purely abstract*** classes.
- The use of this so-called ***lollipop notation*** is optional.



# Interfaces and Sockets

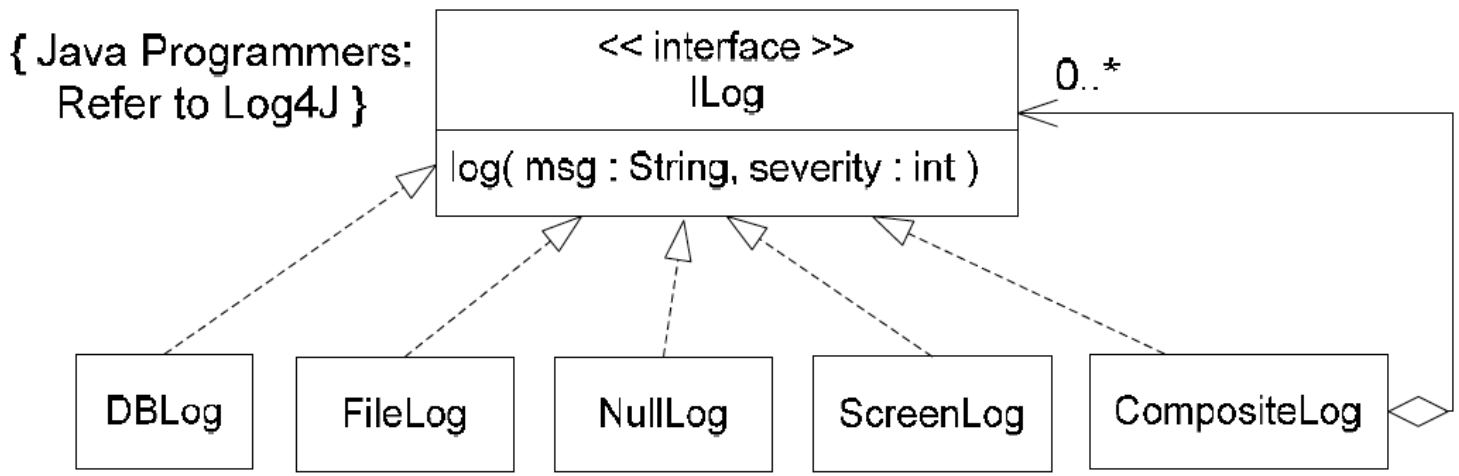
- Product is-a-kind-of IOrderableItem (it implements the interface).
- Order requires an IOrderableItem (this is called a ***socket***).



# Interface Example

Interfaces may be represented...

- Using the "lollipop" notation, as in the previous slide.
- As a class adorned with the <<interface>> stereotype.
- By naming convention, IWhatever.
- Note the dotted line on the inheritance relationship.



# Interface Example

- You decide that your Video Store system could be used to manage other businesses that rent things (e.g., ski shops & libraries).
- You make a new abstract class called RentableObject with rent() and return() methods.
- Make Video extend RentableObject.
- This sounds easy, but… core system classes like Video may already be in a different inheritance hierarchy.
- In C++ you can use multiple implementation inheritance, but in Java you can't.
- Instead, create an interface: IRentableObject.