Object-Oriented Design

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Lecture 18:

Interfaces and Components

Design Workflow: *Architecture and Subsystems*

- Place in the *Design Workflow:*
  - **Architectural Design**
  - Design a Use Case
  - Design a Class
  - **Design a Subsystem**
- concerned with breaking a system up into subsystems that are as independent as possible.
  - Interactions between subsystems are mediated by interfaces.

Interfaces

- Interfaces allow software to be designed to a contract rather than to a specific implementation.
- An interface specifies a named set of public features.
  - Interfaces separate specification of functionality from implementation.
  - Interfaces may be attached to classes, subsystems, components, and any other classifier and define the services offered by these.
  - If a classifier inside a subsystem realizes a public interface, the subsystem or component also realizes the public interface.
  - Anything that realizes an interface agrees to abide by the contract defined by the set of operations specified in the interface.

Interface Semantics

- A classifier realizing an interface has the following responsibilities for each feature:

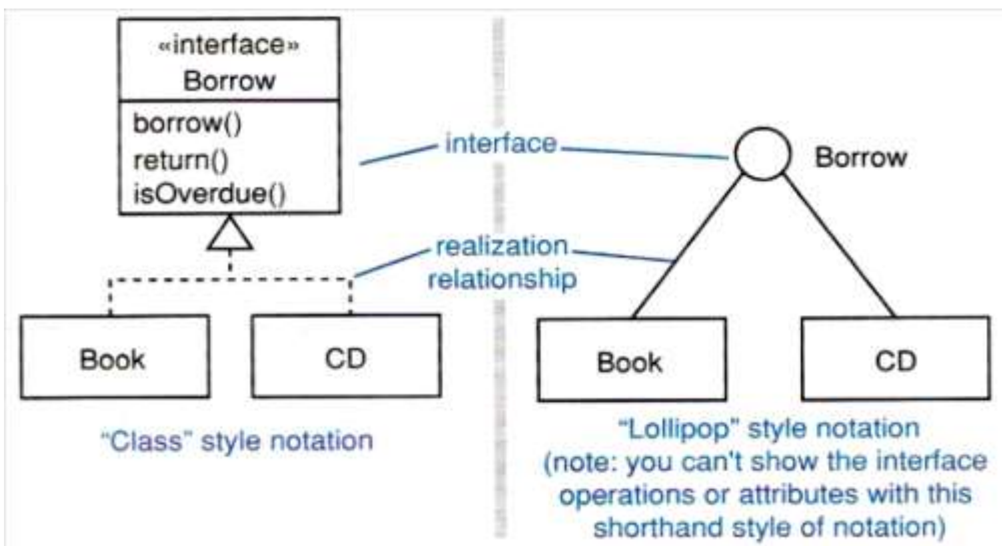
Interface specifies	Realizing classifier
Operation	Must have an operation with the same signature and semantics
Attribute	Must have public operations to set and get the value of the attribute – the realizing classifier is *not* required to actually have the attribute specified by the interface, but it must behave as though it has
Association	Must have an association to the target classifier – if an interface specifies an association to another interface, the implementing classifiers of these interfaces must have an association between them
Constraint	Must support the constraint
Stereotype	Has the stereotype
Tagged value	Has the tagged value
Protocol (e.g., as defined by a protocol state machine – see Section 21.2.1)	Must realize the protocol

Alternative Design Approaches

- ***Designing to an implementation**:*
  - specific classes are connected;
  - to keep things simple (but rigid), design to an implementation.
- ***Designing to a contract**:*
  - a class is connected to an interface that may have many possible realizations;
  - to make things flexible (but possibly more complex), design to a contract.

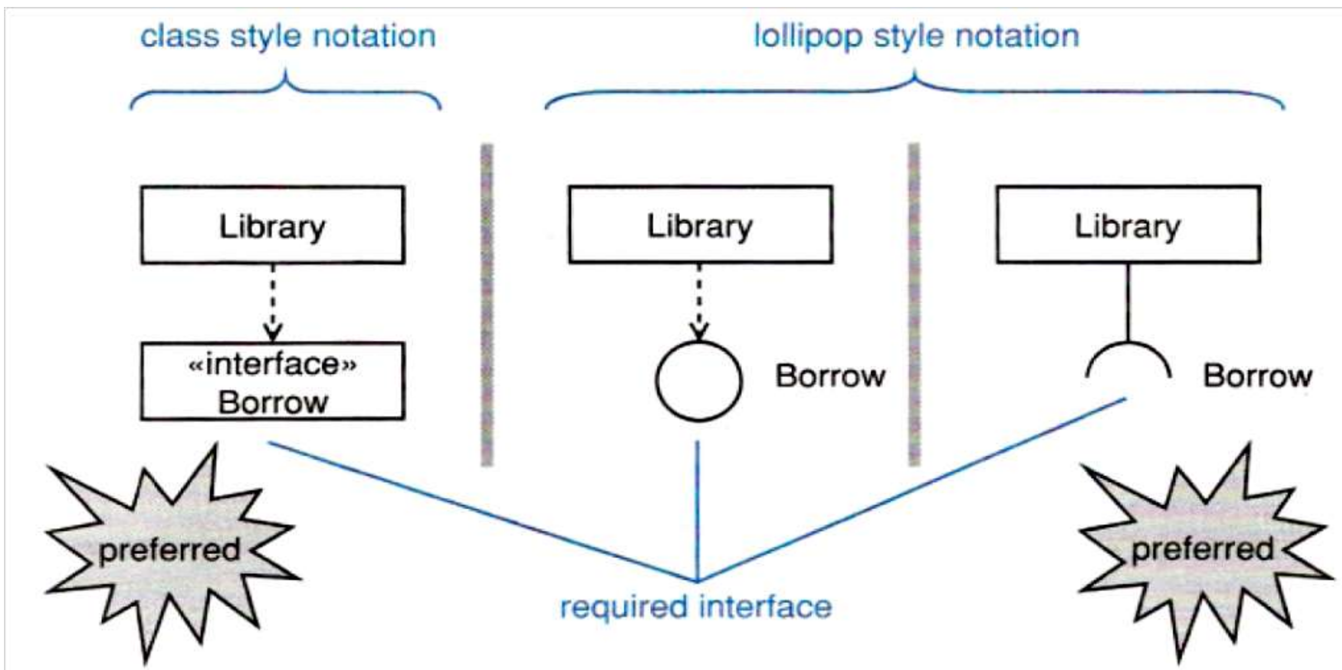
Provided Interface

- An interface provided by a classifier:
  - the classifier realizes the interface;
  - use the" class" style notation when you need to show the operations on the model;
  - use the shorthand "lollipop" style notation when you just want to show the interface without operations.



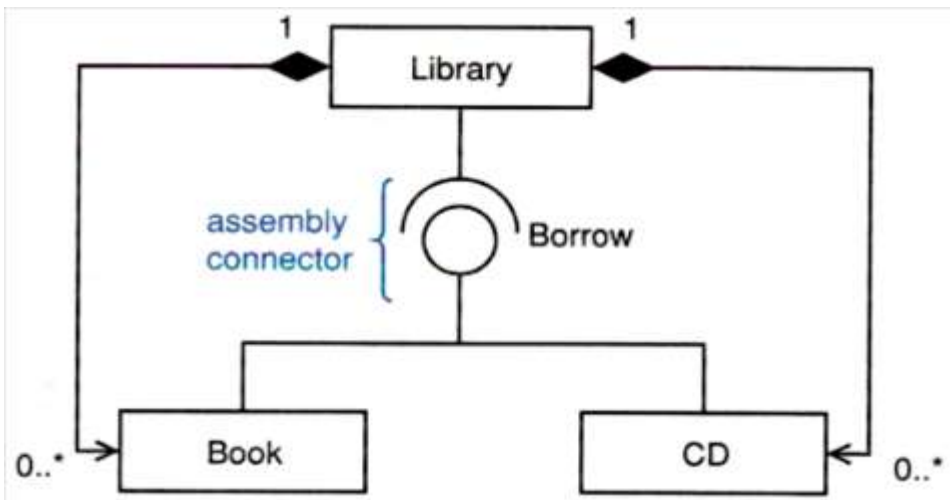
Required Interface

- An interface required by a classifier:
  - the classifier requires another classifier that realizes the interface;
  - show a dependency to a class style interface, a lollipop style interface, or use an assembly connector.

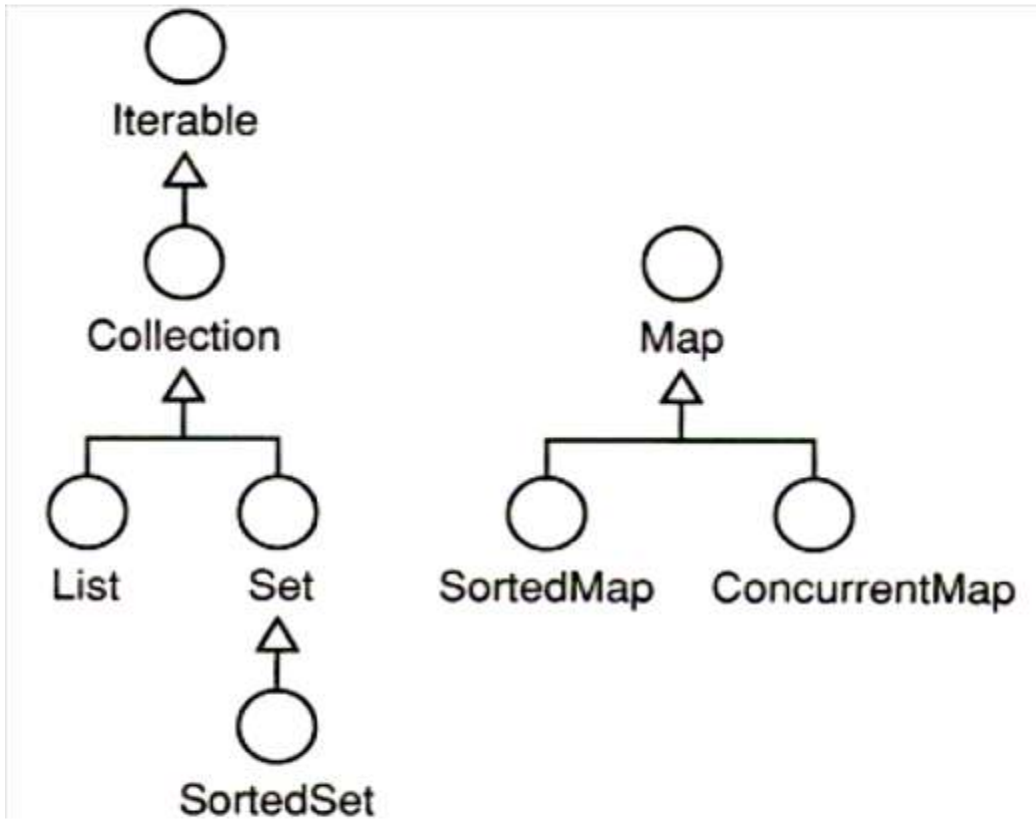


Assembly Connector

- Joins provided and required interfaces.



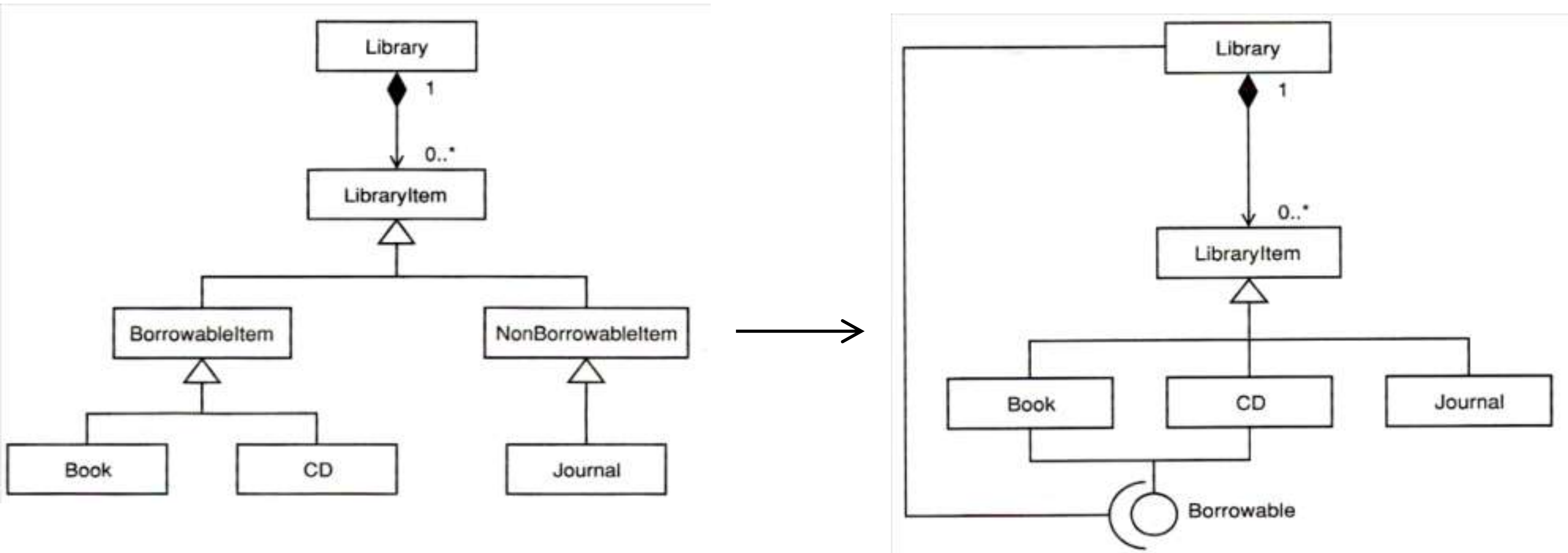
Interface Hierarchies



Interface Realization vs. Inheritance

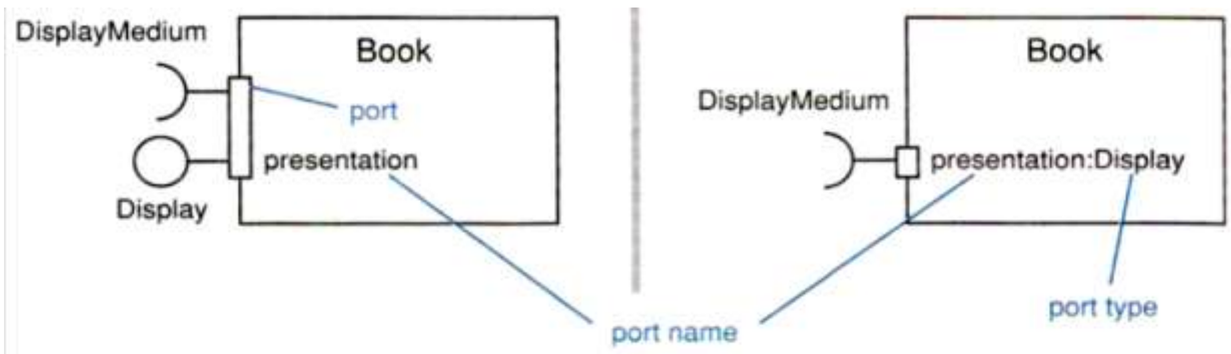
- Interface realization - "realizes a contract specified by".
- Inheritance - "is a".
- Both inheritance and interface realization generate polymorphism.
- Use interfaces to specify the common protocols of classes that should not normally be related by inheritance.

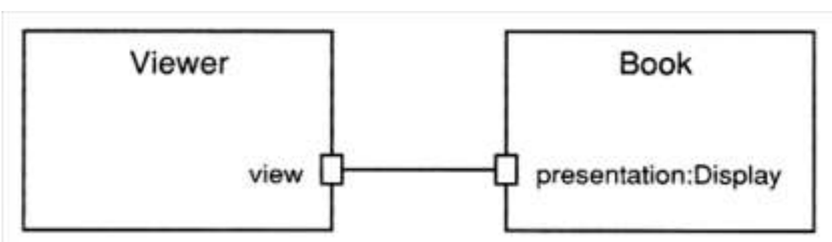
Interface Realization vs. Inheritance: Example

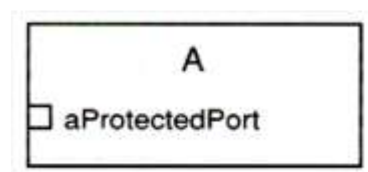


Ports

- Port - groups a semantically cohesive set of provided and required interfaces:
  - may have a name, type, and visibility.

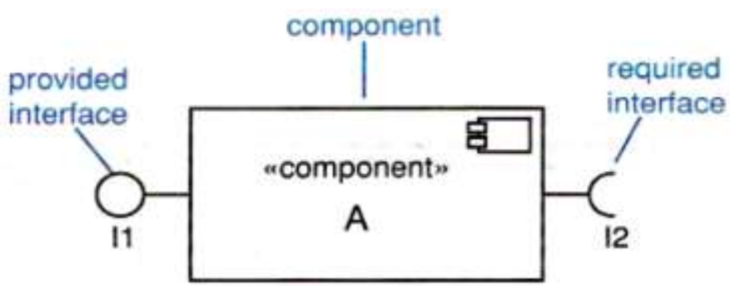


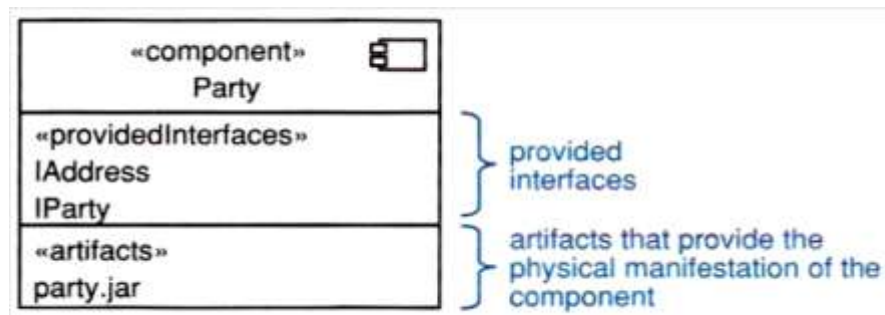




Components

- Component - a modular part of a system that encapsulates its contents and whose manifestation is replaceable within its environment:
  - may have attributes and operations;
  - may participate in relationships;
  - may have internal structure;
  - its external behavior is completely defined by its provided and required interfaces;
  - components manifest one or more artifacts.





Components: Standard Stereotypes

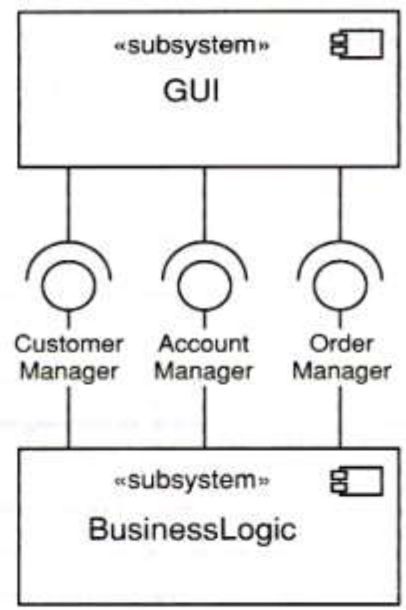
Stereotype	Semantics
«buildComponent»	A component that defines a set of things for organizational or system-level development purposes
«entity»	A persistent information component representing a business concept
«implementation»	A component definition that has no specification itself – it is an implementation for a separate «specification» to which it has a dependency
«specification»	A classifier that specifies a domain of objects without defining the physical implementation of those objects – for example, a component stereotyped by «specification» only has provided and required interfaces and no realizing classifiers
«process»	A transaction-based component
«service»	A stateless, functional component that computes a value
«subsystem»	A unit of hierarchical decomposition for large systems

CBD and Subsystems

- Component-Based Development (CBD) is about constructing software from plug-in parts:
  - you use interfaces to make components "pluggable";
  - by designing to an interface, you allow the possibility of many different realizations by many different components.
- Subsystem - a component that acts as a unit of decomposition for a larger system:
  - a component stereotyped «subsystem»;
  - is used to decompose a large system into manageable chunks;
  - breaking a system down into subsystems is a key to successful CBD using UP.

Subsystems: Applications

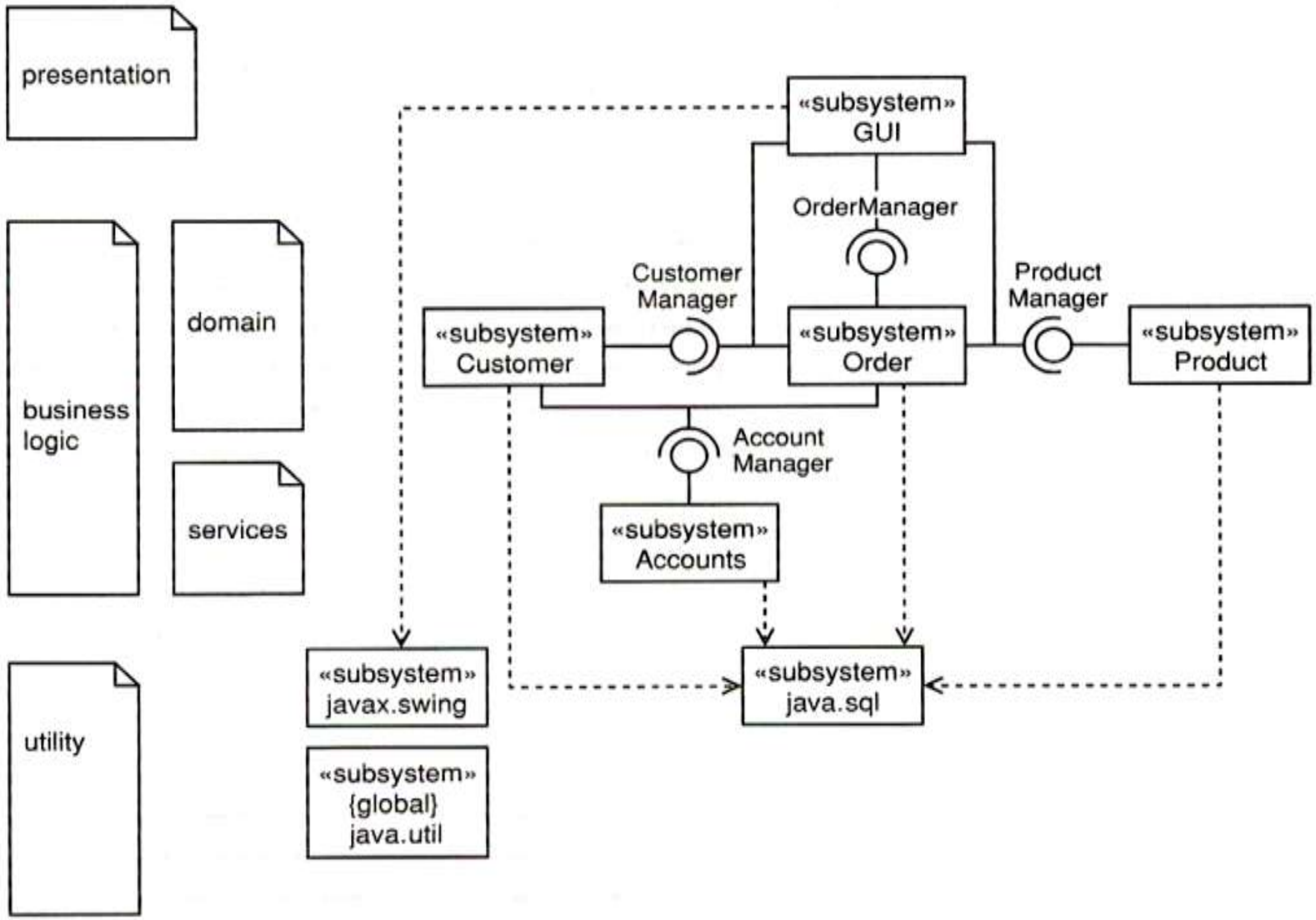
- Subsystems are used to:
  - separate design concerns;
  - represent large-grained components;
  - wrap legacy systems.



Designing with Interfaces

- Use interfaces to hide the implementation details of subsystems:
  - the *Facade* pattern hides a complex implementation behind a simple interface;
  - the *layering* pattern organizes subsystems into semantically cohesive layers:
    - dependencies between layers should only go one way;
    - all dependencies between layers should be mediated by an interface;
    - example layers include presentation, business logic, and utility layers .

Designing with Interfaces: *Layering* Pattern



Finding Interfaces: Guidelines

- challenge associations;
- challenge message sends;
- factor out groups of reusable operations;
- factor out groups of repeating operations;
- factor out groups of repeating attributes;
- look for classes that play the same role in the system;
- look for possibilities for future expansion;
- look for dependencies between components.

Reference

- Arlow, J., Neustadt, I., *UML 2 and the Unified Process: Practical Object-Oriented Analysis and Design*, 2nd Ed. Addison-Wesley, 2005.