Design Strategies in OO Development

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

Design Strategies
- abstraction
- separation
- composition
- generalization

Software Structures
- objects
- classes
- inheritance
- templates
- design patterns

Software Engineering Goals
- reusability
- extensibility
- flexibility
Abstraction

Modeling entities in software
Only essential aspects should be captured
  - attributes
  - behavior

Wassily Kandinski
Cossacks, 1910-11
Critique??
Abstraction

A named collection of attributes and behavior relevant to modeling a given entity for some particular purpose.

Desirable Properties:

- well named: name conveys aspects of the abstraction
- coherent: makes sense
- accurate: contains only attributes modeled entity contains
- minimal: contains only attributes needed for the purpose
- complete: contains all attributes and behavior needed for the purpose
Mapping Abstraction to Software

- **real-world**
  - entity

- **abstraction**
  - attributes
  - behavior

- **software**
  - \{data, data, \ldots\}
  - \{method, method, \ldots\}

Kafura
In programming, the **independent** specification of an **interface** and one or more **implementations** of that interface.

**What** is to be done

vs

**How** it is to be done

<table>
<thead>
<tr>
<th>Interface</th>
</tr>
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<tbody>
<tr>
<td>visible</td>
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<tr>
<td>hidden</td>
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| Implementation |
Interchangeability of Implementations

Allows the creation of multiple implementations with a common interface.

For example: a List ADT could use a dynamic linked list or a dynamic array for the underlying physical data structure. In either case, the same interface would be appropriate (and the user need not be concerned with the underlying structure in many cases).

Implementations that share a common interface are said to be “plug compatible”.

They may differ in algorithmic complexity, reliability, platform dependencies, etc.
Specificity of Interface

Also allows a single implementation to support multiple interfaces.

This allows the isolation of restricted set used in one situation versus another.

For example, we could have a very general List ADT that supported both standard List operations, and also Stack operations. By “subsetting” the functionality of the ADT into separate interfaces, we could provide both categories of operation, in a natural way, without duplication of shared code.

In essence, we view the implementation as a library of related widgets.
Mapping Abstraction to Software in OO

real-world

entity

abstraction

attributes

behavior

OO software

{data, data,…}

{method, method,…}
General Structure of a Class

class: a named software representation for an abstraction that separates the implementation of the representation from the interface of the representation.

A class models an abstraction, which models an entity (possibly “real”).
A class represents all members of a group of objects (“instances” of the class).
A class provides a public interface and a private implementation.
The hiding of the data and “algorithm” from the user is important. Access restrictions prevent idle or malicious alterations.

```text
{data, data, ….}
{method, method, …}
typical organization
```
object: a distinct instance of a given class that encapsulates its implementation details and is structurally identical to all other instances of that class.

An object “encapsulates” its data and the operations that may be performed on that data.

An object’s private data may ONLY be accessed via the member functions defined within the object’s class.

An object hides details of representation and implementation from the user.

**C++ note:**
Privacy restrictions are enforced at the class level, NOT the object level.
That is, if A and B are of the same type, and A knows B’s name, then A can access the private members of B directly.
If we have two different classes, objects of each can see only the (public) interfaces of the objects of the other.

class A implementation provides methods

class A interface identifies available methods

class B implementation can use class A methods identified in the class A interface
Multiple Instances of a Class

Each instance, or object, usually has different values for the class-defined properties.

Class = Factory    Objects = Products

When developing abstractions, or classes, it may help to think of them as people-like entities with responsibilities and collaborators.

Responsibilities of knowing (respond with information to a query)
Responsibilities of doing (act on something, transform, move, sort, etc.)
Collaborators: associated objects in the system with their own responsibilities
Software Engineering Goals

Objects and classes help programmers achieve a primary software-engineering goal: reusability.

A single class is used repeatedly to create multiple object instances. More importantly, encapsulation prevents other developers from inadvertently modifying an object’s data.

Separation allows different implementations to be used for an interface.