Advanced Software Engineering

Bahman Arasteh
(Ph.D, Software Engineering)
Department of Computer Engineering
Azad University of Tabriz
E-mail: *b_arasteh@iaut.ac.ir*

Today's Goals

Introducing the Principles of object-Oriented for Handling Software complexity

Contents

Introduction

In the Early Days of Software:

- The basic cost of system design was related to the HW cost.
- The role of SW was considered secondary.
- Most SW was developed by a single programmer.
- The design process was often done implicitly by the programmer.
- The capability of the HW was limited.
- The software was often small.
- Documentation was not needed.

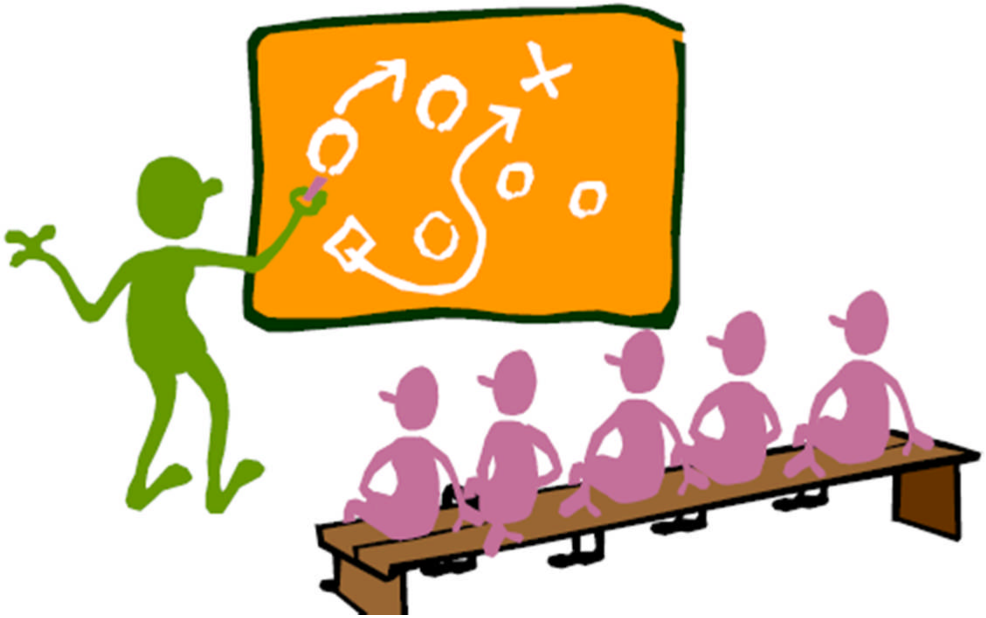
Introduction

In the today’s Software:

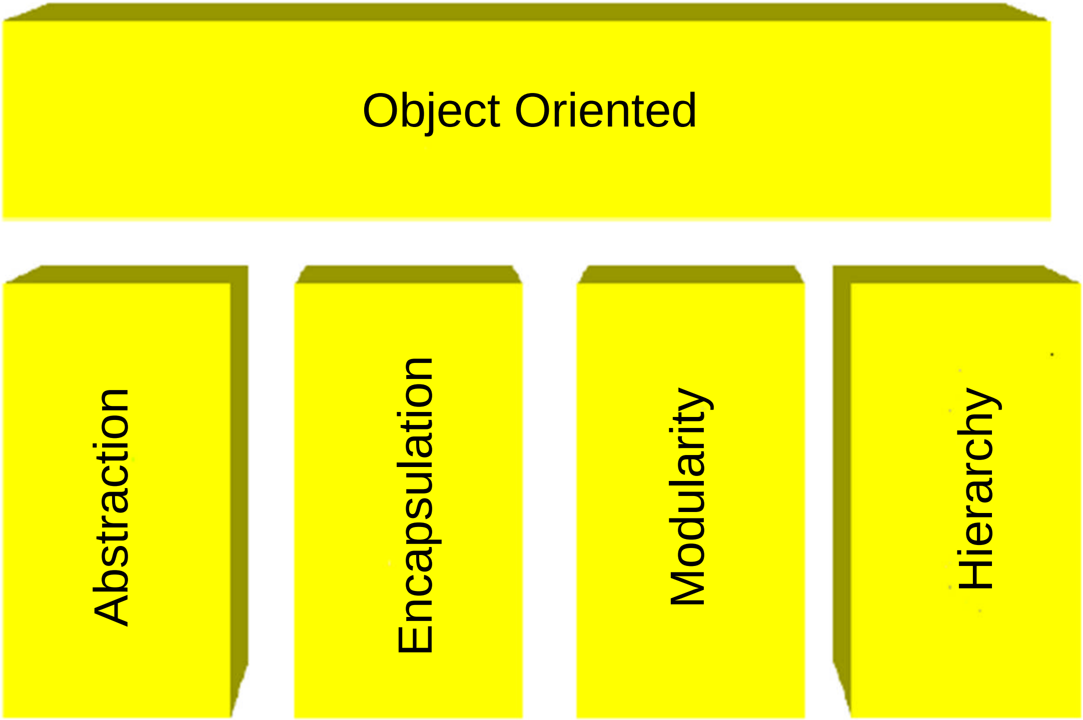
- The basic cost of system design is related to the SW.
- The role of SW is fundamental.
- Most SW is developed by a team.
- The design process is done explicitly.
- Analysis and design methods are required.
- Documentation is required.
- The need for complex software is rising.

Design Methods

- Structured Design
- Data-Driven Design
- Object-Oriented Design



Principles of Object Oriented



Object Oriented

Abstraction

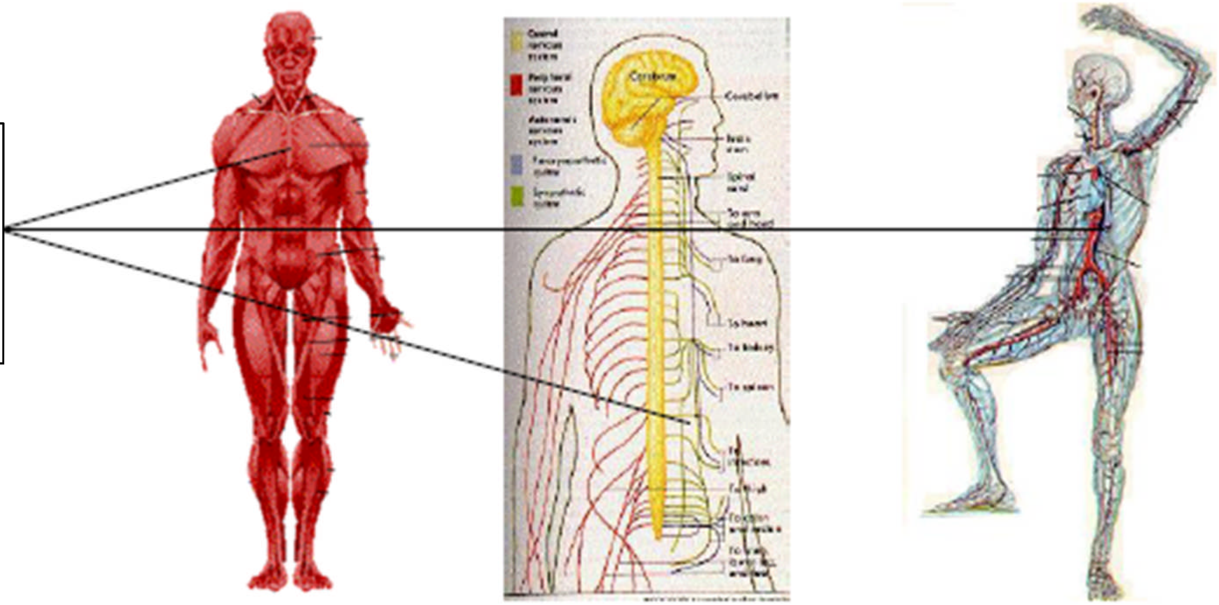
Encapsulation

Modularity

Hierarchy

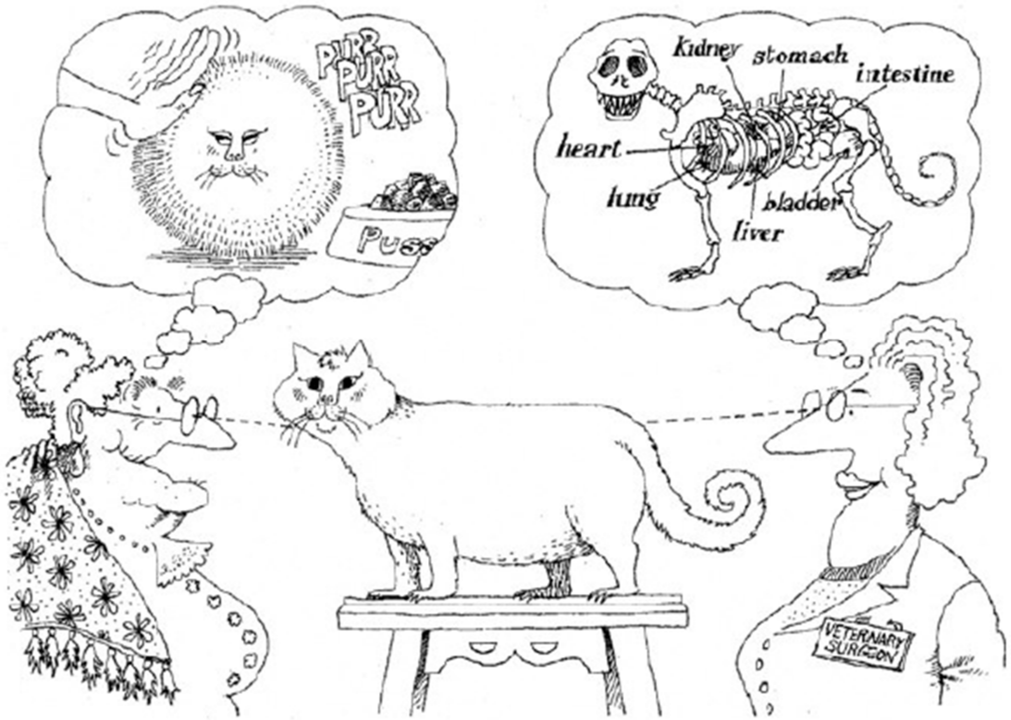
Abstraction

Different views of a human body



Abstraction

- The process of focusing on the main and principle characteristics and behaviors of a phenomenon and ignoring the temporary characteristics and details.



Abstraction

Abstraction considerably controls SW complexity.

Abstraction

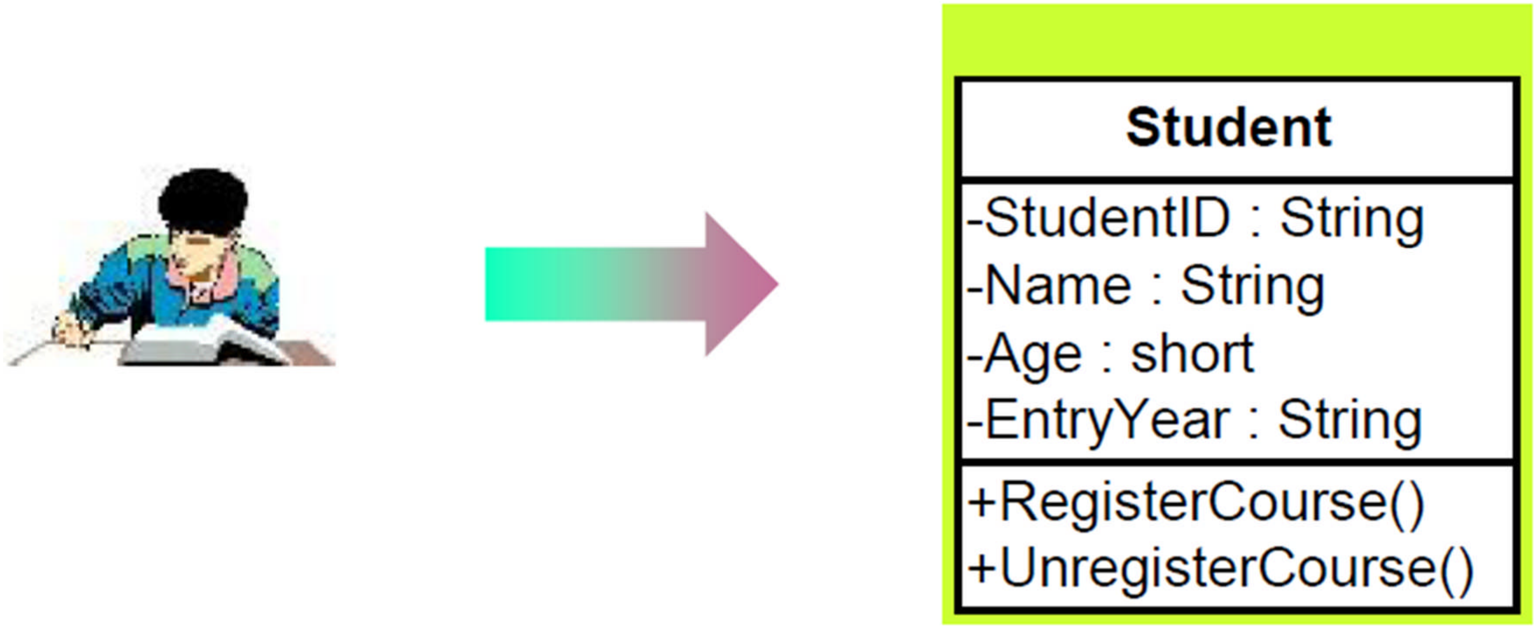
- Type of Abstraction:
  - Entity Abstraction
  - Procedural Abstraction
  - Virtual Abstraction

Abstraction

- Entity Abstraction :
    - presenting a suitable model for a real entity

Real Object: Student

Abstraction: Student



Student

-StudentID : String
-Name : String
-Age : short
-EntryYear : String

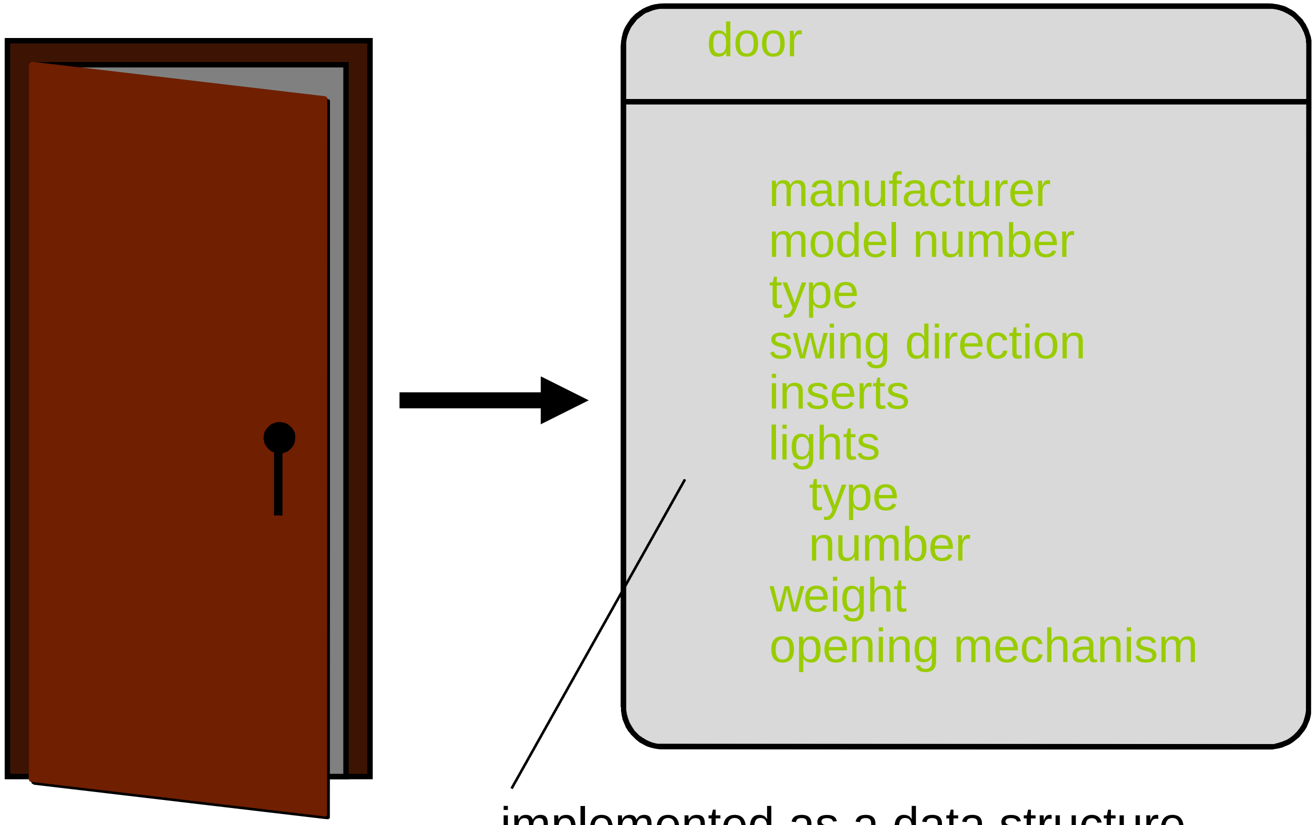
+RegisterCourse()
+UnregisterCourse()

Abstraction

- Procedural Abstraction:
  - Give a name to an algorithm
  - Use the name to execute that algorithm within another one
  - Example:
    - procedure sort (list) // algorithm for sorting a list
    - sort (list-of-names) // Means APPLY the sort procedure to the list of names.
  - Abstraction allows you to separate details of how to carry out the procedure from the algorithm that uses the procedure

Abstraction

– Data Abstraction



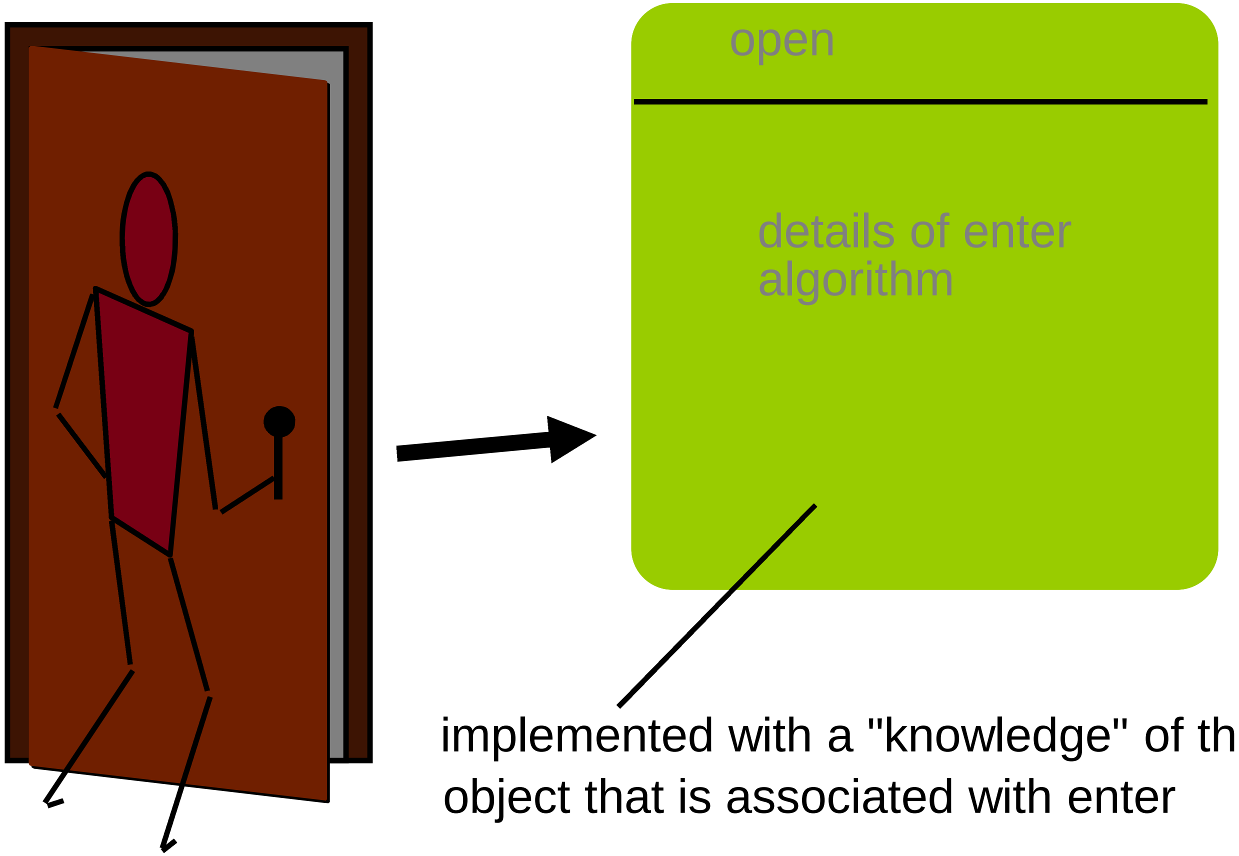
door

manufacturer
model number
type
swing direction
inserts
lights
  type
  number
weight
opening mechanism

implemented as a data structure

Abstraction

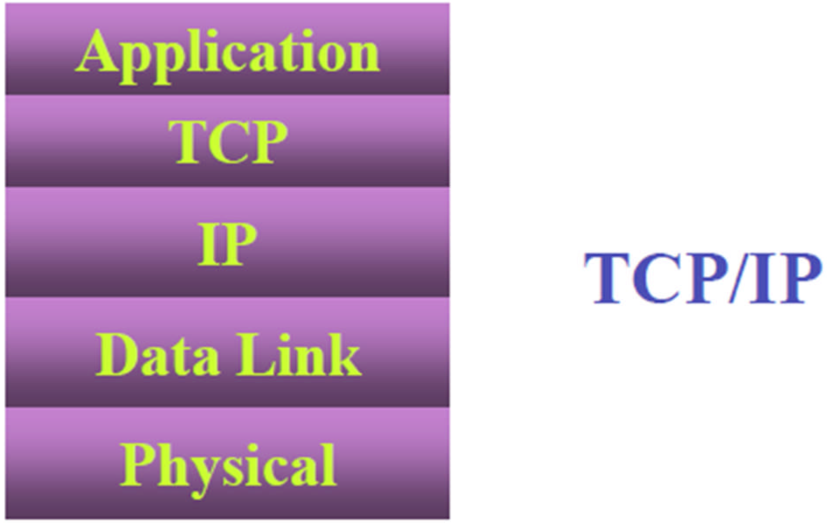
– Procedural Abstraction



implemented with a "knowledge" of the object that is associated with enter

Abstraction

- Virtual Abstraction



Features of Abstraction

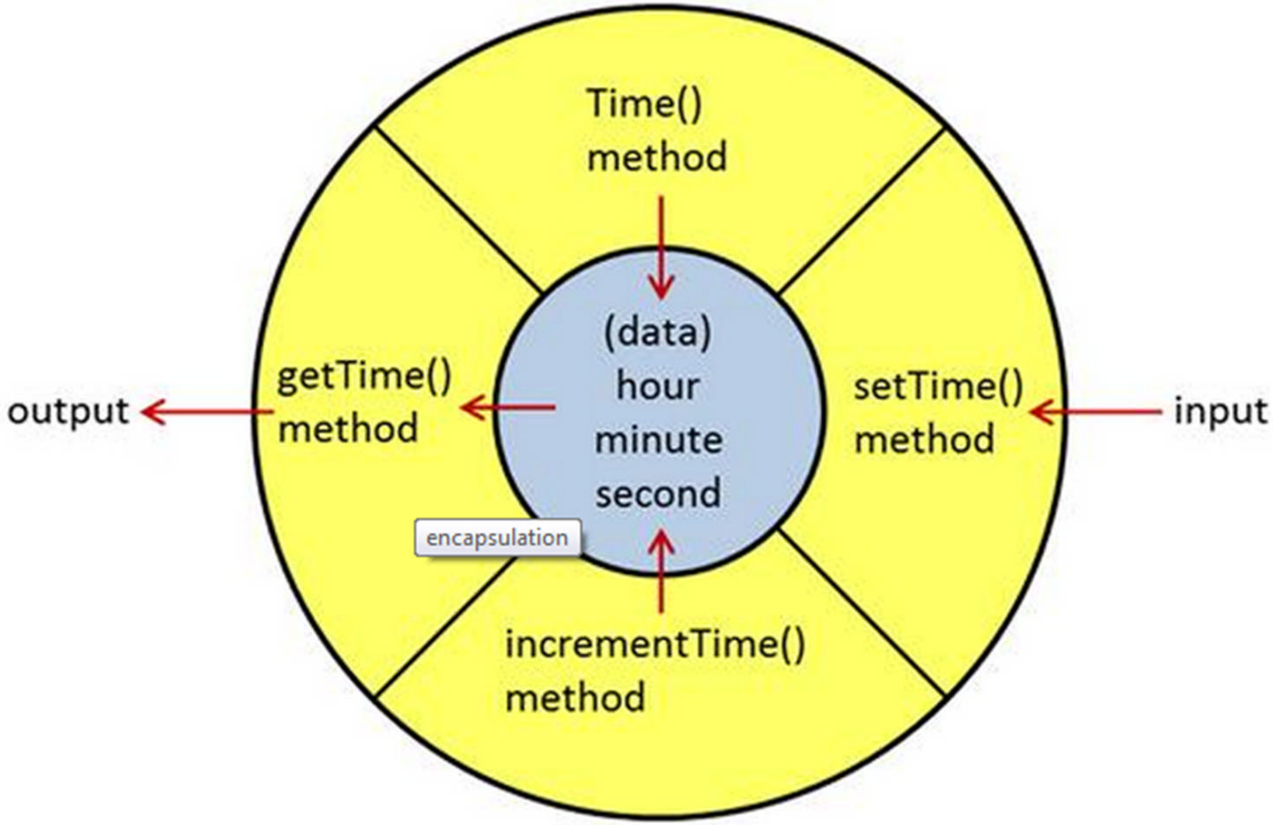
- There are different types of abstractions for an Object.
- Abstraction focus on the external view of an object.
- All Abstractions have static and dynamic features.

Encapsulation

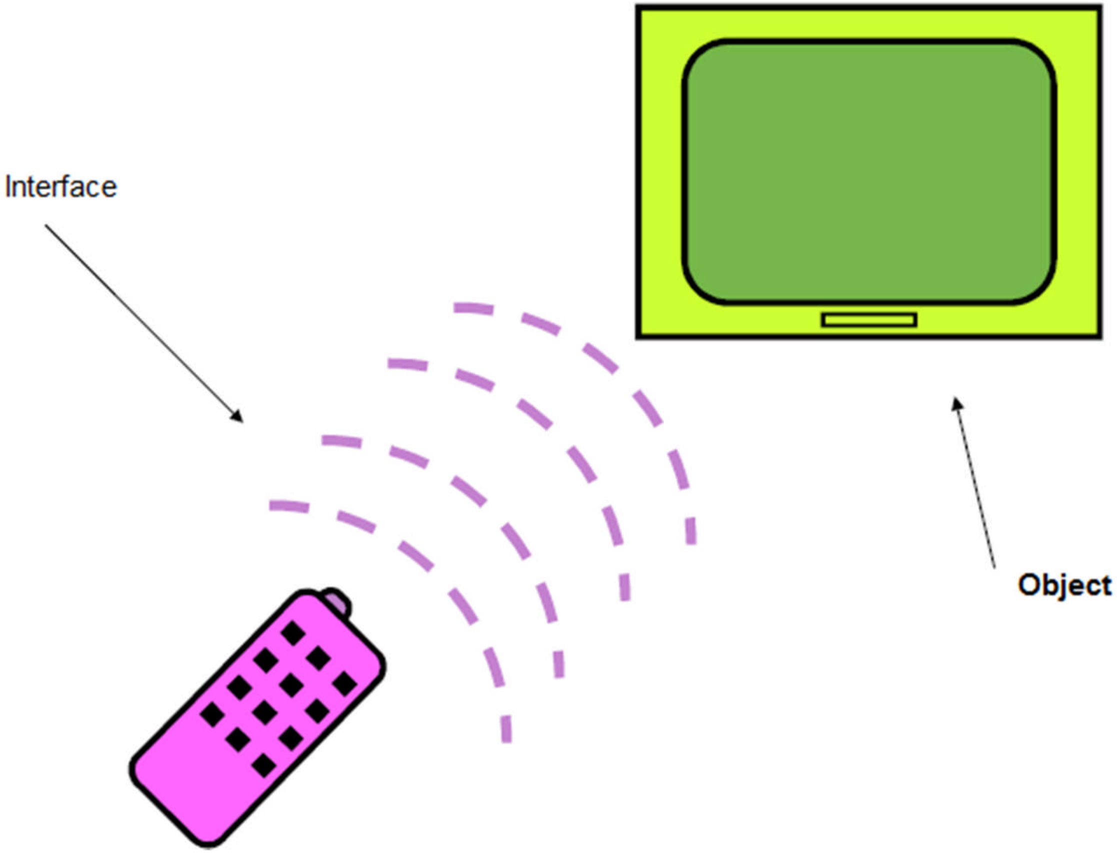
- Encapsulation is the packing of data and functions into a single component.
- It allows selective hiding of properties and methods in an object by building an impenetrable wall to protect the code from accidental corruption.

Encapsulation

- Each object includes: Interface + Internal structure (Data + Mthods)



Encapsulation



Encapsulation

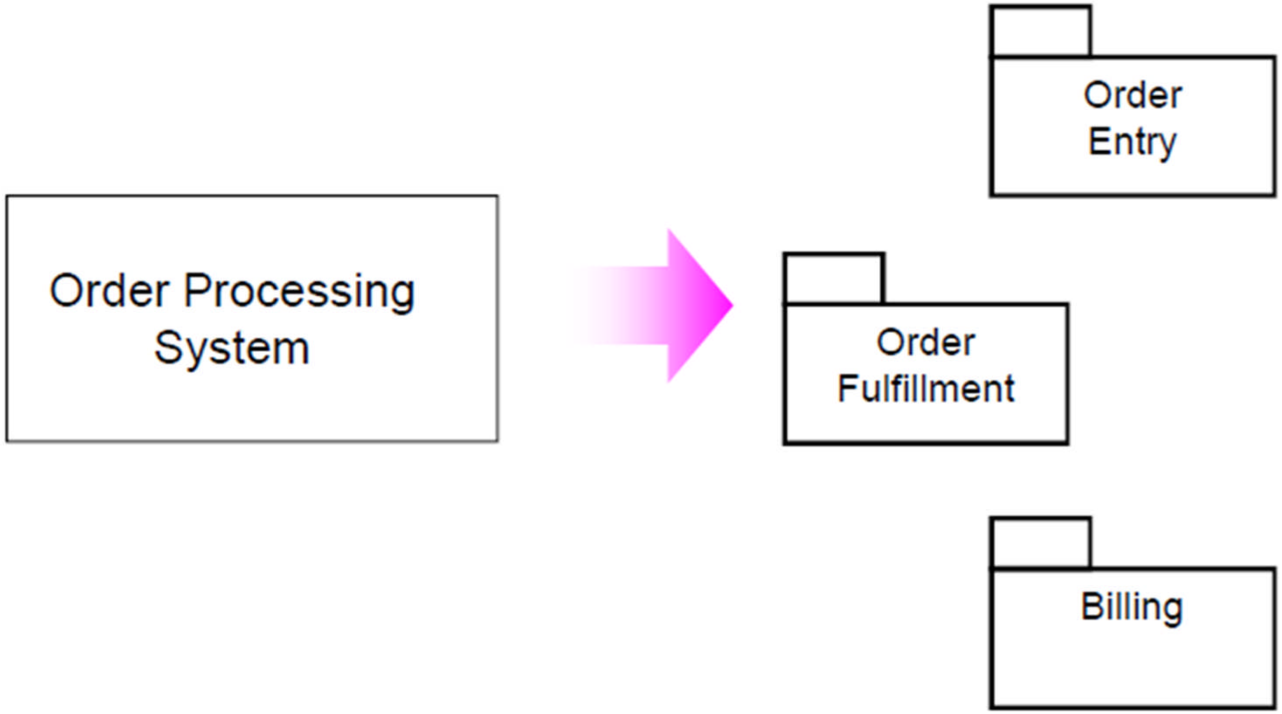
Encapsulation considerably controls SW complexity.

Modularity

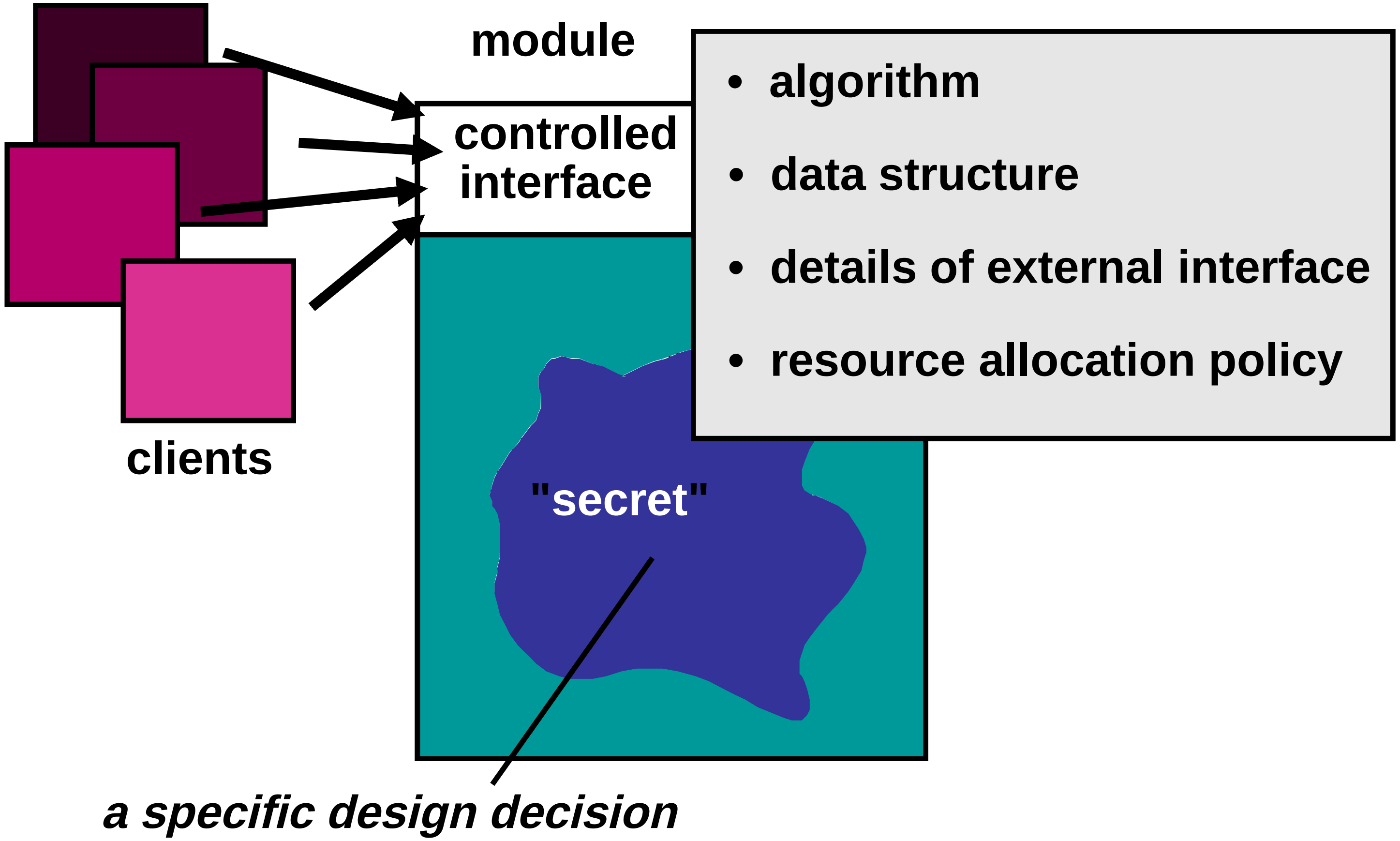
- Modules:
  - Set of dependent components
    - Files in C, C++, …
    - Classes or objects
    - Standard components in .NET, Java Beans, .Com
    - Web Services
- Modular system:
  - Set of cohesive components with a minimal coupling.

Modularity

– Example:



Modularity



module

controlled interface

clients

- algorithm
- data structure
- details of external interface
- resource allocation policy

"secret"

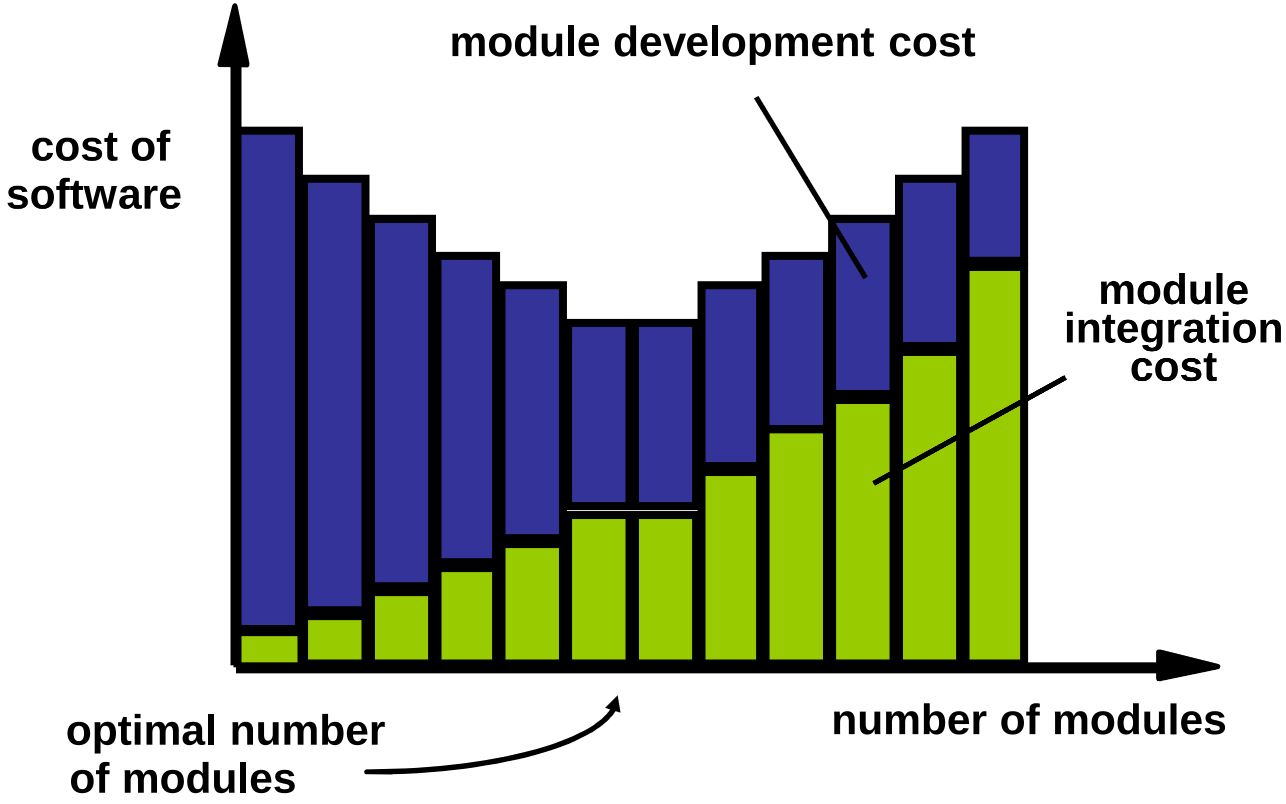
a specific design decision

Modularity

- The role of modularity to reduce SW complexity:
  - Dividing a problem into smaller and simpler subp-roblems.
  - Example:
    - Divide problem *p* into sub-problems *p1, p2, p3*
      - *Complexity (p) > complexity(p1) + complexity (p2) + complexity (p3)*
      - *E(p) > E(p1) + E(p2) + E(p3)*

Modularity

What is the "right" number of modules for a specific software design?



Modularity

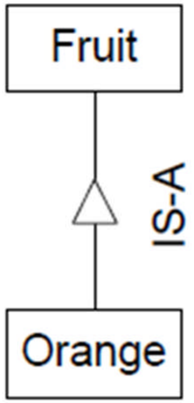
Modularity considerably controls SW complexity.

Hierarchy

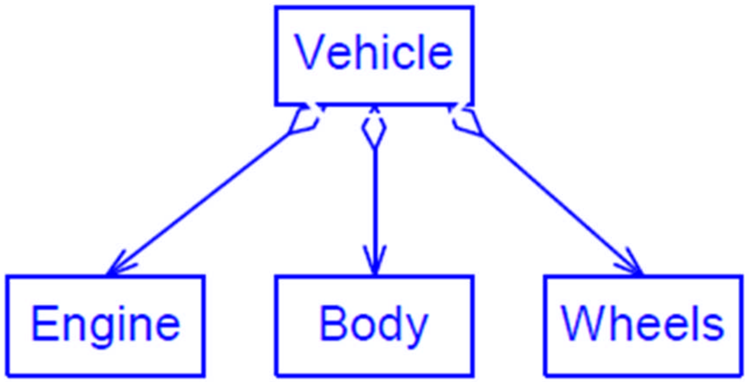
– Hierarchy is another aspect of OO design.

– Types of Hierarchy:

  - Is-a
  - Part-of



Orange IS-A Fruit

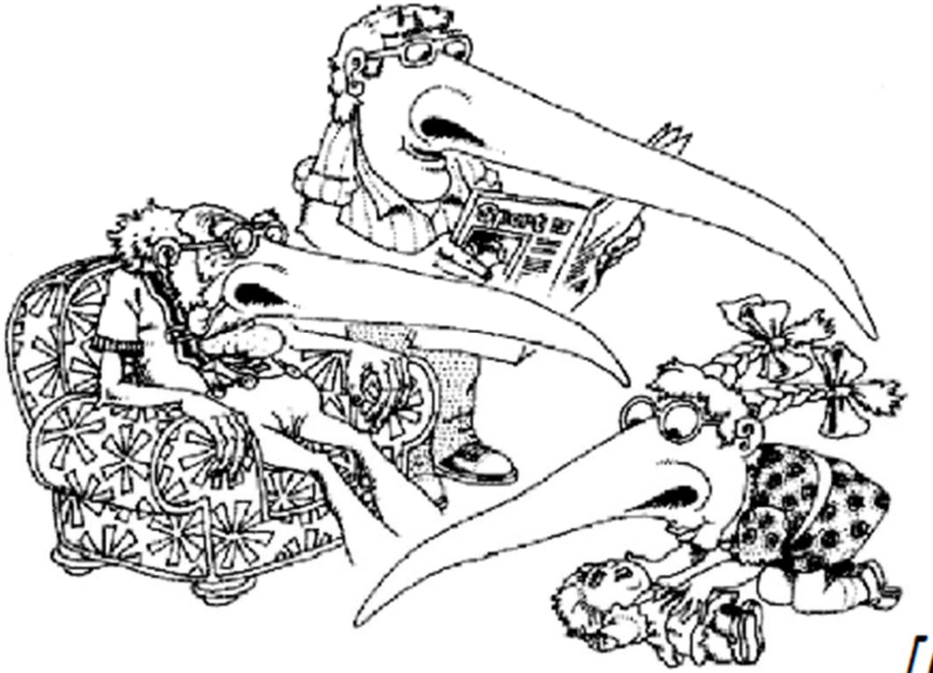


The Vehicle *HAS-An* Engine

The Engine is *PART-OF* Vehicle

Hierarchy

- Inheritance is one Is-a hierarchy



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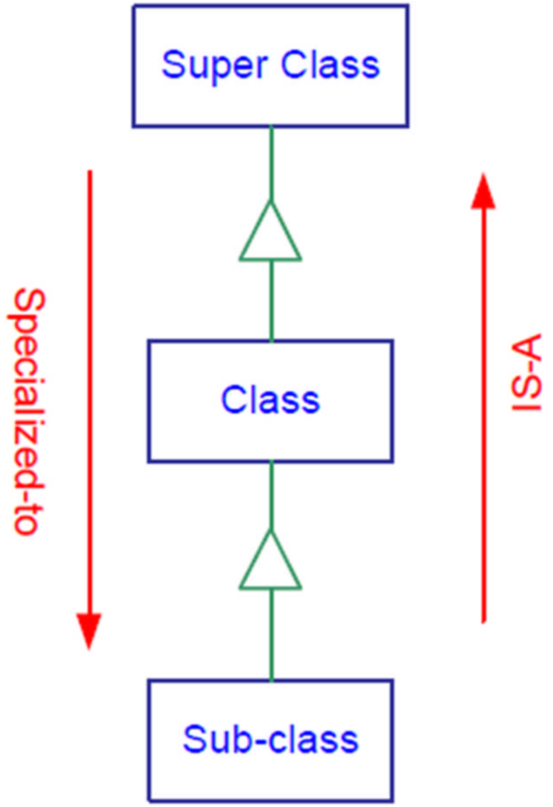
Hierarchy



Hierarchy

- The Effect of hierarchy in the complexity reduction:
  - Better realization of the system
  - Using Part-of hierarchy clarifies the relation between objects
  - Using Is-a hierarchy controls the amount of redundancy in the SW

Hierarchy

Hierarchy considerably controls SW complexity.

Advantage of Object Oriented

- Reducing the development and maintenance cost
- Increasing the scalability of the system
- Increasing the reusability
- Suitability for distributed systems
- Better control on the SW complexity

End