Recent Programming Languages의 문제점

- Class, Subclass, Inheritance에 대해 가볍게 대처
- Always taking an easy and simple way
- Multi Paradigm Programming Language를 주장

- Programming Language Theory를 대폭 무시
  - Type에 대한 이론들에 무지와 무시
  - Correctness of Program의 중요성을 간과
  - Abstract Data Type의 기본 취지의 퇴색

본수업에서 강조하는 점

- The Object-Oriented Paradigm의 올바른 이해
  - Historical Background
  - Major Motivation of OOP features

- Class, Class Hierarchy, Inheritance의 Theoretical Famework 의 정확한 이해

Object-Orientations in Computer Science

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Contents

THE OBJECT-ORIENTED PARADIGM

- Historical Background
- Object-Oriented Concepts
  - Core Elements
  - Encapsulation
  - Message Passing
  - Inheritance
  - Late Binding
  - Method Combination
- Benefits

HISTORICAL BACKGROUND (1)

- The Root of OO ➔ SIMULA (1966)
  - Dahl & Nygarrd 66 CACM paper
  - Simulation Language
  - Notion of Class

- SMALLTALK (1970 - 1980)
  - Xerox PARC, Adele Goldberg
  - The first substantial, interactive, display-based implementation
  - An integrated programming language environment
  - User interface
  - Class library

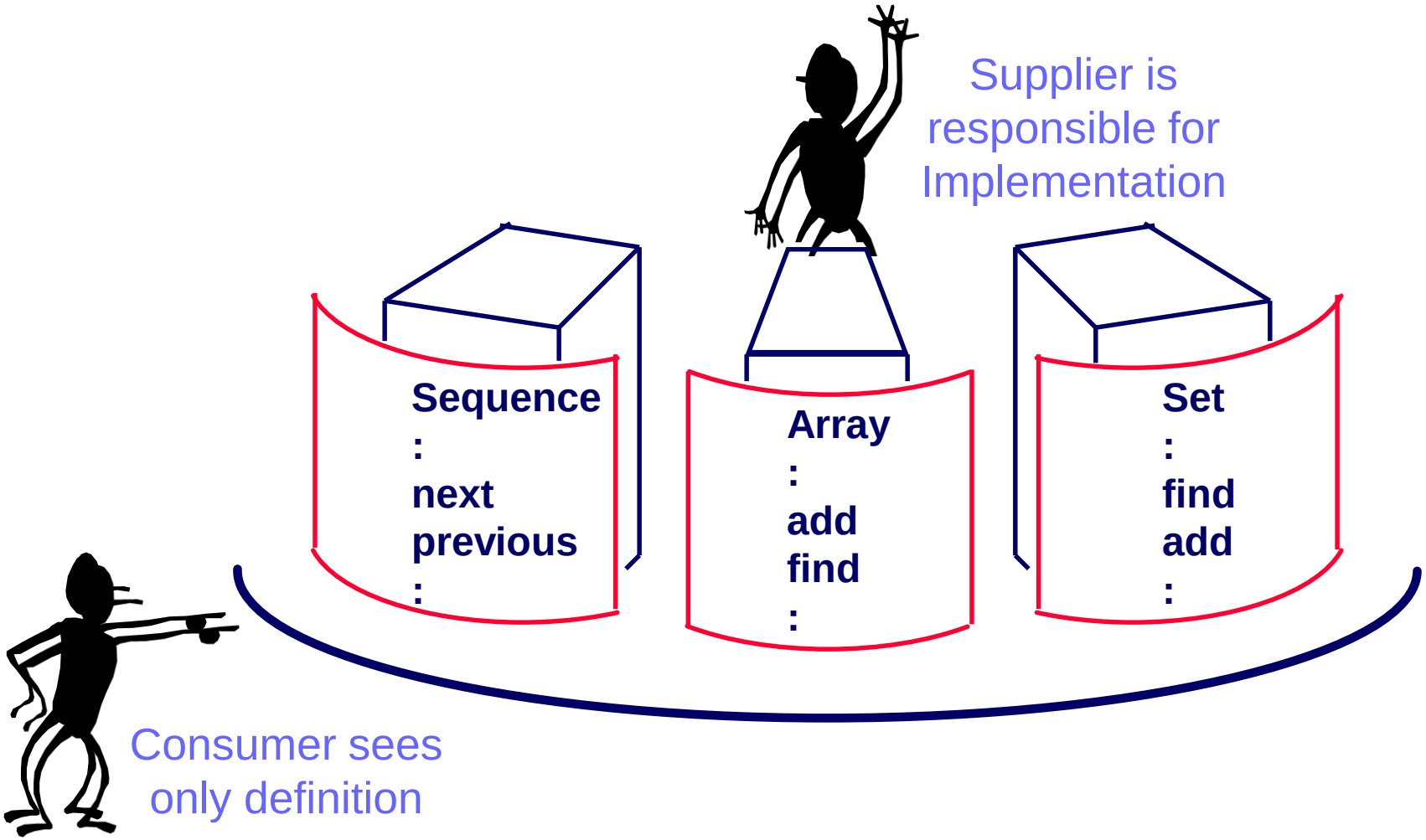
HISTORICAL BACKGROUND (2)

- AI Community (1980's)
  - KR/1, Frame: Knowledge Representation
  - Actor: Concurrent Objects (Carl Hewitt at MIT)
  - Flavors (MIT), Loops (XEROX): OO-Programming in Lisp
- Programming Language Community (1980's)
  - Abstract Data Type, Encapsulation
  - Alphard, CLU, ADA

HISTORICAL BACKGROUND (3)

- Observations
  - 1970's: Age of Structured Programming
  - 1980's: Transition Age from Structured Programming to OOP
    - C ➔ C++
  - 1990's: Object Technology for WWW
    - C++ ➔ Java
  - 2000's: OOP as commodity
    - Most software products are following the OO paradigm

Objects are a new way of packaging software (1985)



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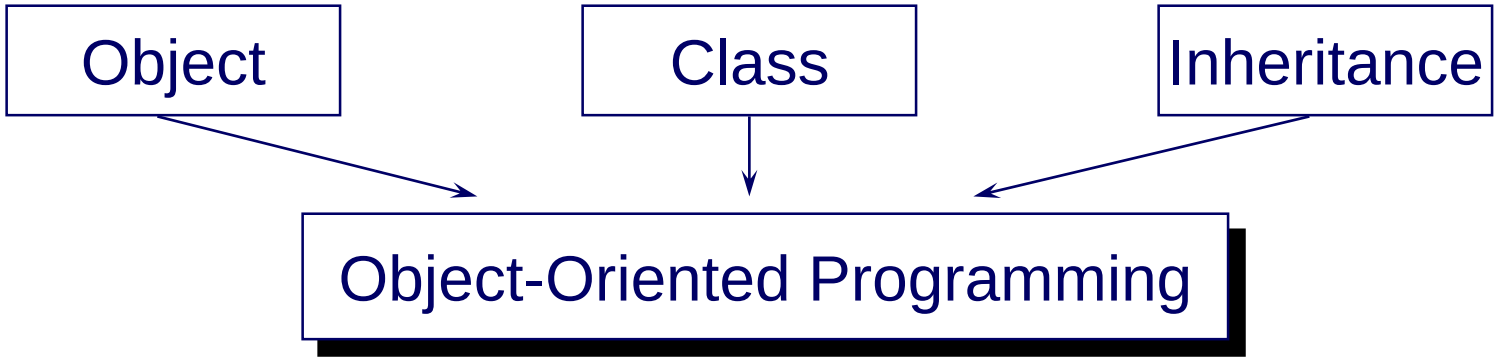
Definitions of The OO Paradigm

- Object-Oriented Technology:
  - *A way to develop* and *package* Software that draws heavily from the common experience and the manner in which real world objects relate to each other

- Object-Oriented Systems:
  - All programming languages, systems, tools and methodologies that support the Object-Oriented Technology

Peter Wegner in “Dimensions of OOPLs”

A programming style which relies on the notion of *object, class and inheritance.*



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Core Features of Object-Oriented Technology

1. Object
2. Message Passing
3. Class / Class Hierarchy
4. Object Identity
5. Complex object
6. Polymorphism

…….

Major Advantages of OOP

- OO provides better paradigms and tools
  - Modeling the real world correctly and easily
  - Interacting easily with a computer
  - Constructing reusable SW components and easily extensible libraries of SW modules
  - Easily modifying and extending implementations of components

- 3 focuses
  - Abstract Data Type, Inheritance, Object Identity

Roles of Object Orientation?

- *Software modeling and development (engineering) disciplines that make it easy to construct complex systems from individual components*

- Provide better concepts and tools to model and represent the real world ➔ modeling

- Provide better methodologies to construct complex SW systems out of modularized reusable SW units ➔ development

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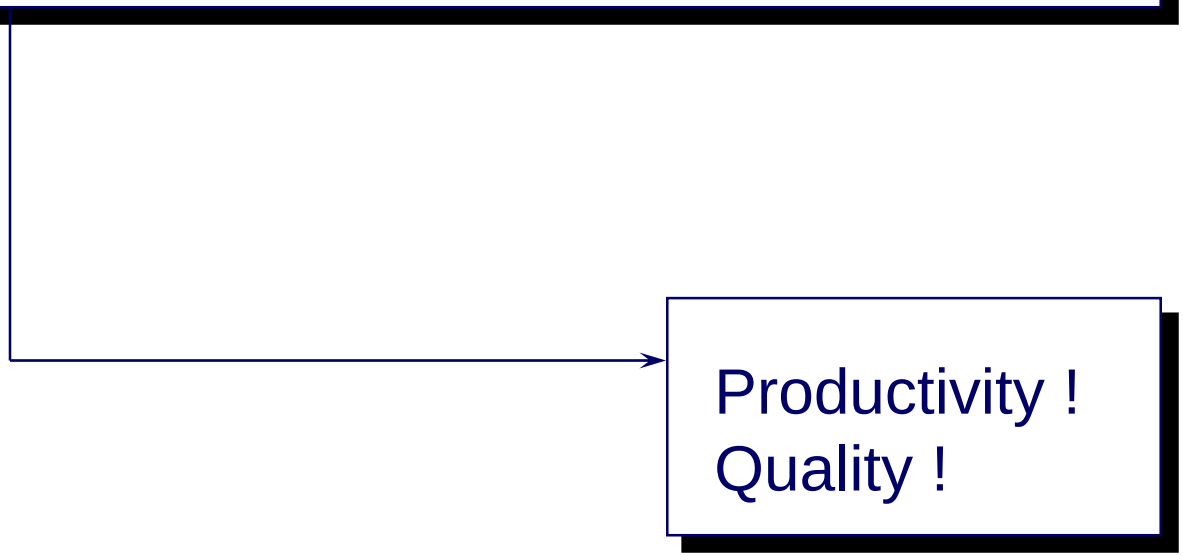
Object-Oriented Software

- **Can model problems better.**
- **Is more understandable.**
- **Is more repairable.**
- **Is more reusable.**



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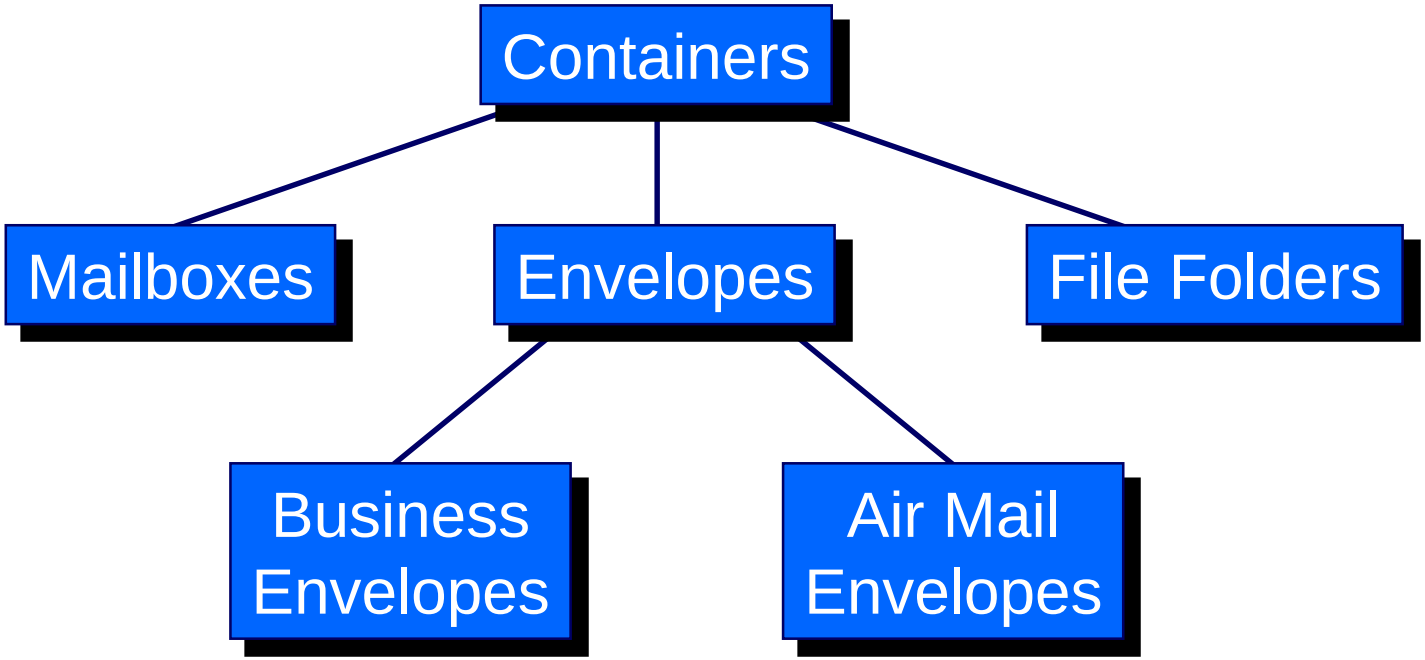
Object-Oriented Systems: Class Hierarchy

- Class hierarchy of Envelope



Computation Model of OOP

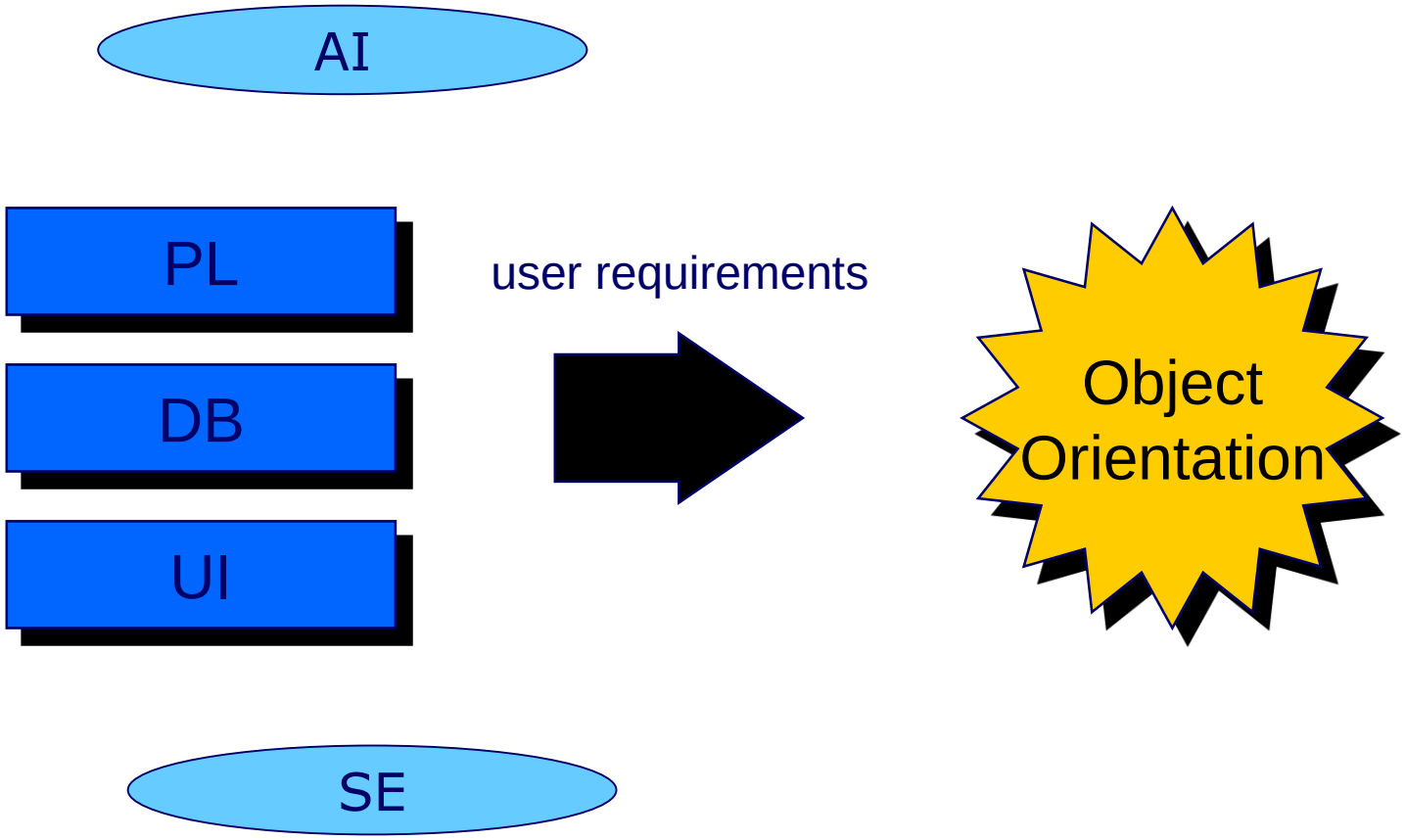
Computation

Computation is viewed as **message passing** among
a collection of self-contained, autonomous objects

Programming

Programming is a process of defining objects and message.
Objects are classified according to their behaviors.
Existing object definitions may be reused when new objects are defined.

Object Orientation everywhere



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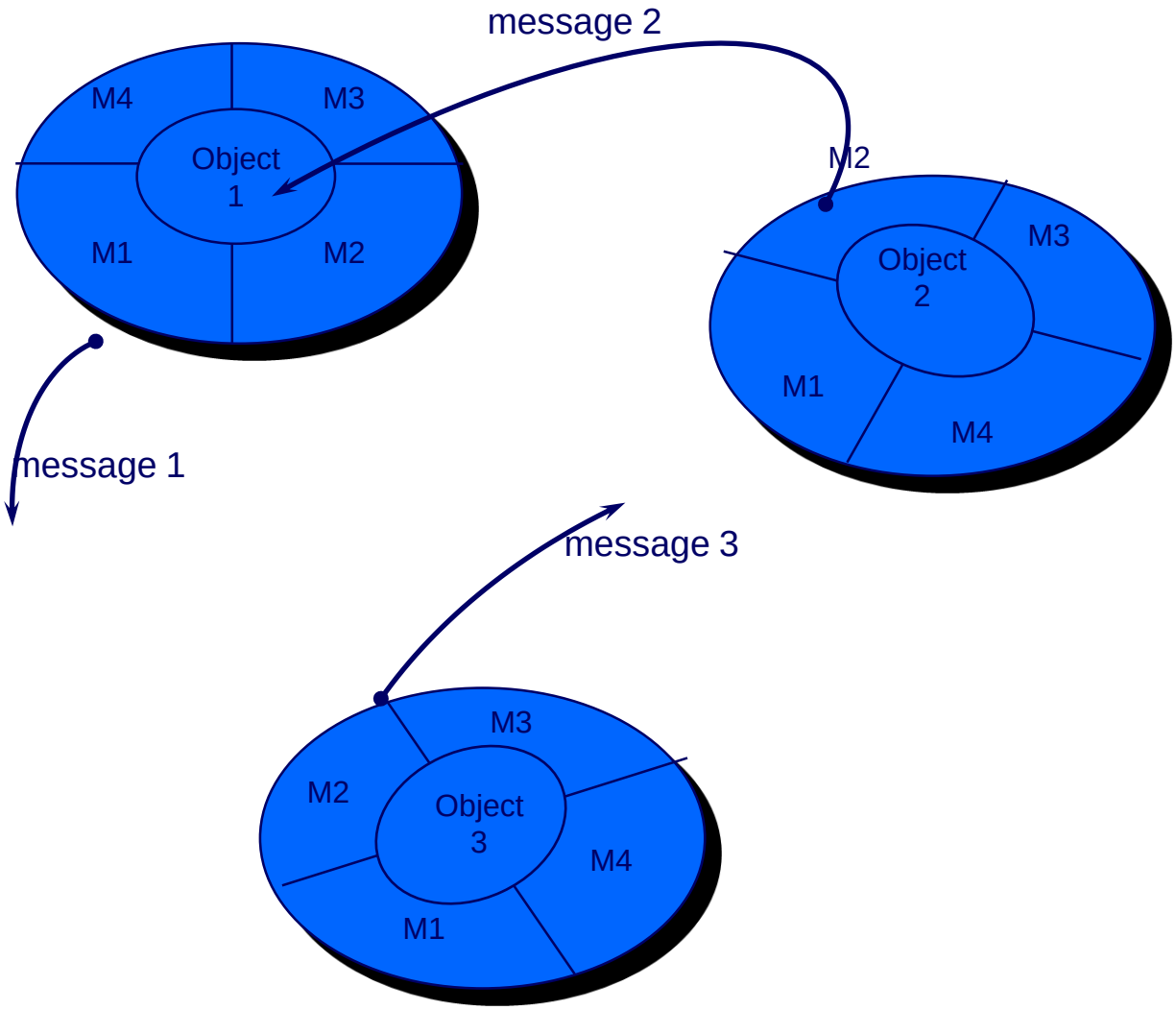
Abstract Data Types (ADTs)

- ADTs extend the notion of a data type through hiding the implementation of the user-defined operations associated with the data type.

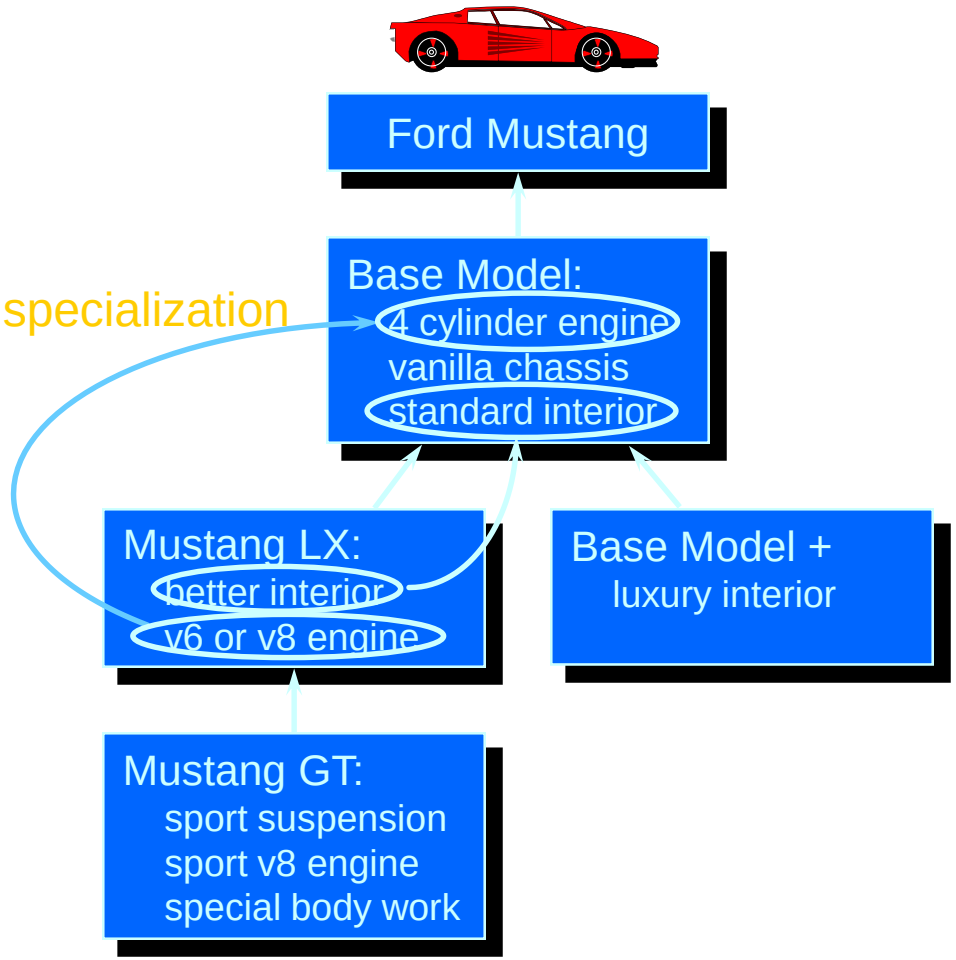
- All manipulations of instances of the data type are done exclusively through *operations* associated with the data type.

Message Passing Paradigm



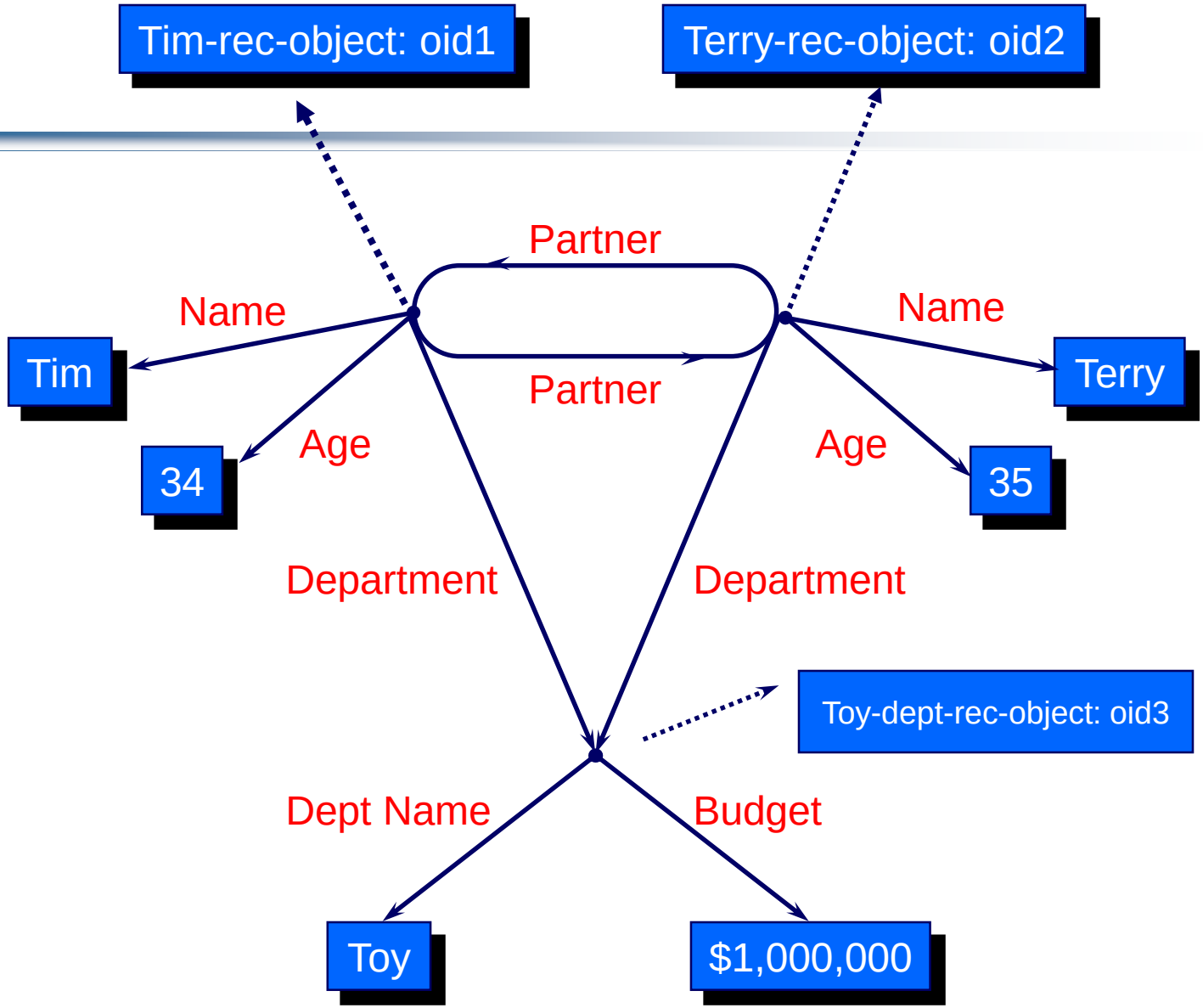
Inheritance

- *Inheriting behavior* enables *code sharing* among software modules.
- *Inheriting representation* enables *structure sharing* among data objects.

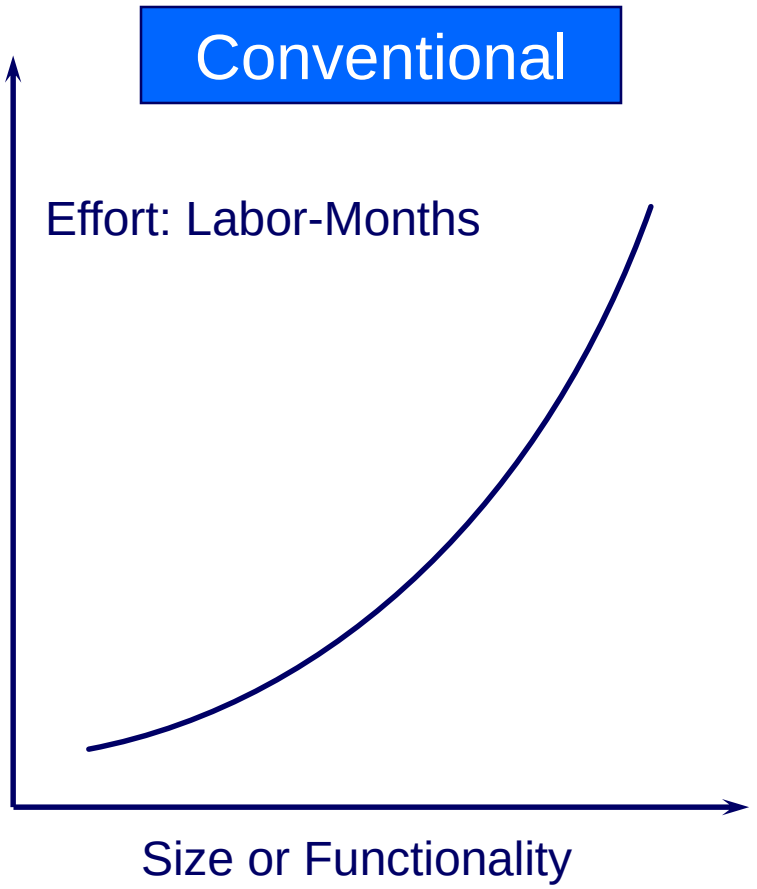


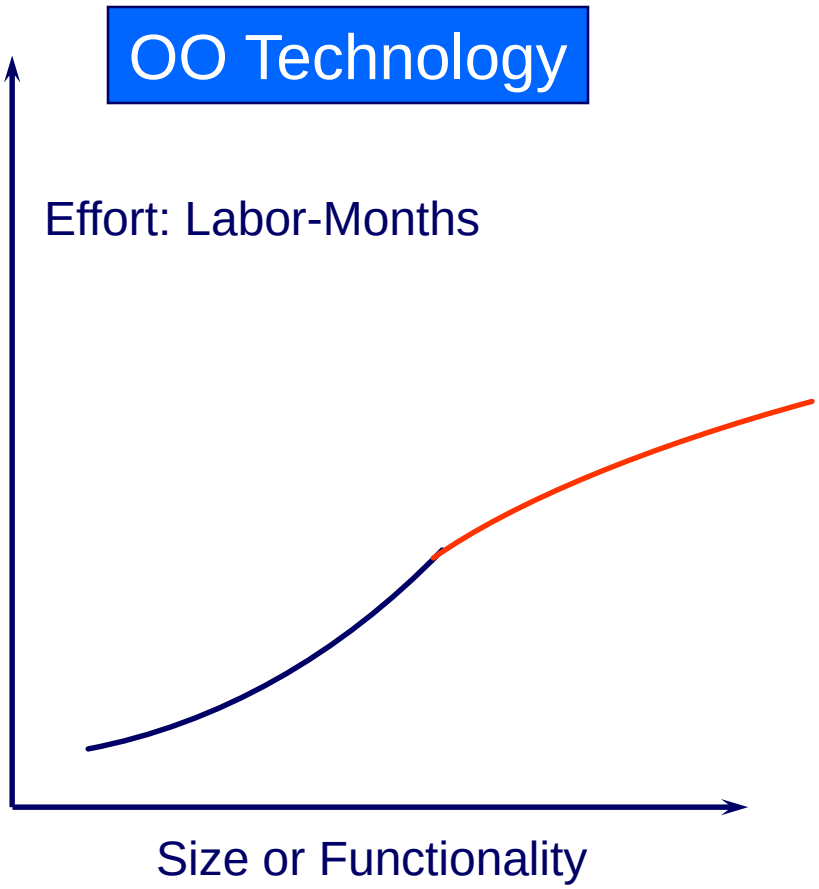
Object Identity

- *Object identity* distinguishes each object from all others.
- With *object identity*, objects can *contain or refer* to other objects.
- *Object identity* organizes objects of object space.
- *ADT* and *inheritance* organizes the classes of objects.


Tim-rec-object: oid1
Terry-rec-object: oid2
Partner
Name
Name
Tim
Partner
Terry
Age
Age
34
35
Department
Department
Toy-dept-rec-object: oid3
Dept Name
Budget
Toy
$1,000,000

The SW Development Effort





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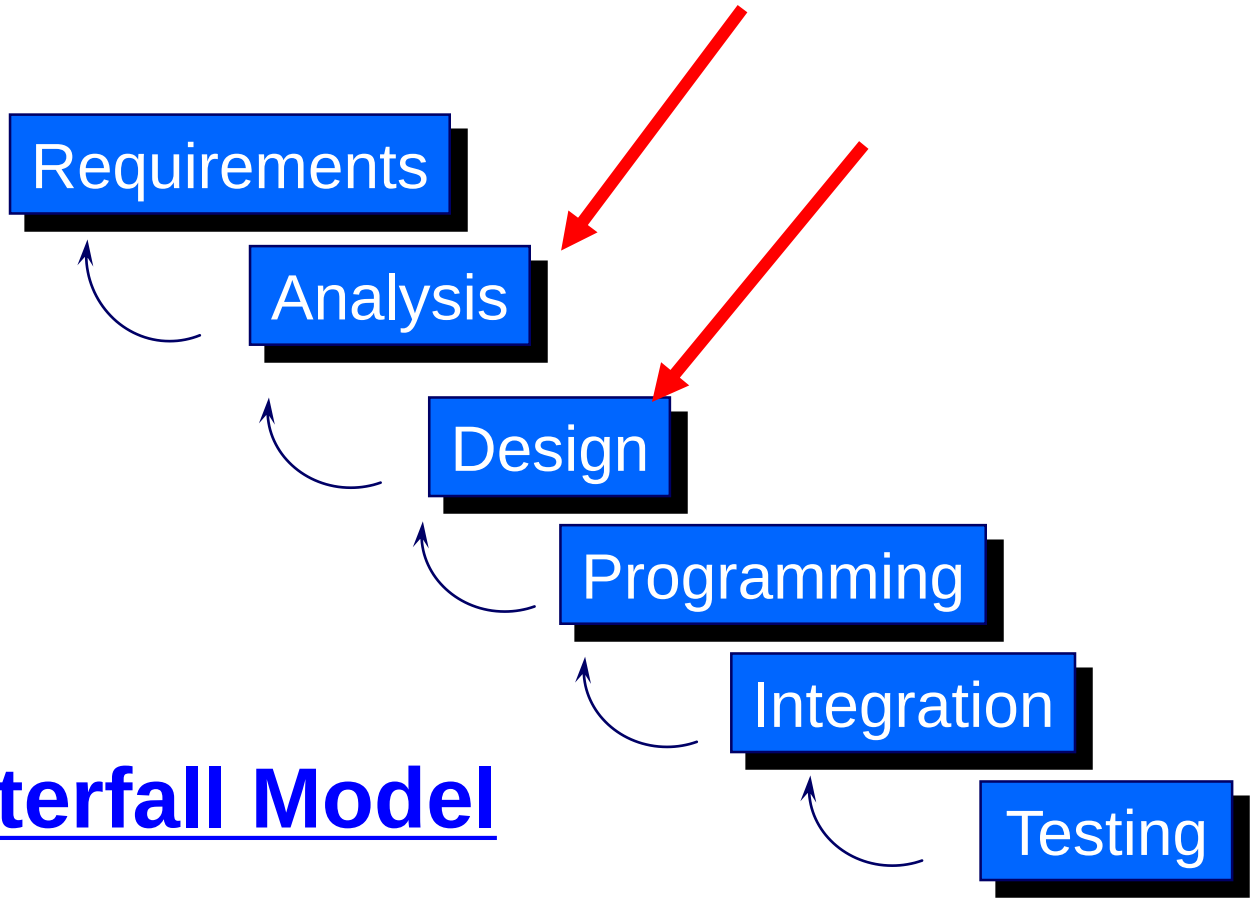
OOP from SW Engineering Viewpoint



Waterfall Model

Object-Oriented Analysis (OOA)

- Provide a detailed description of a system
- Identify WHAT
  - Identify objects, classes, operations
  - Identify object relationships, object interations
- Build real-world models using OO view of the world
- Goals of OOA
  - understand the problem domain
  - increase correctness, consistency, completeness

Object-Oriented Design (OOD)

- Provide the blueprint for implementation
- Specify HOW
  - Specify class definitions, class categories
  - Specify subsystems, system architectures
- OOA + Implementation details

- Goals of OO Design
  - Optimize maintainability, reusability, enhancibility and reliability

SUMMARY
Benefits of Object-Oriented Systems

1. Improve Productivity

2. Model Complexity Efficiently
   - The use of objects as basic modules assists the designer to model complex real-world systems

3. Designed for Change
   - The flexibility of object-oriented code allows a rapid response to changes in their requirements

4. Code Reusablility
   - The reuse of standard components reduces both the development time for new applications and the volume of code generated

5. Enhanced Maintainability
   - The increased maintainability of software makes it more reliable and reduces maintenance costs

Contents

The Evolution of OO in PL [1/4]

- *Assemblers (early 1950s)*: IBM 650, IBM 704
- *FORTRAN (mid 1950s), PL/1, COBOL (late 1950s)*
- *Algol (1960)*
  - Block structure → encapsulation
  - Algol60 (Randll and Russell): Begin-End blocks
- *Simula-67 (Dahl and Nygaard 1966)*
  - Introduced the concepts of *object / class / inheritance*
  - Intended as a simulation language
  - Laid the foundation of OO language
  - A "strongly typed" language

The Evolution of OO in PL [2/4]

- *LISP (MaCarthy 1965)*
  - Functional programming language for many AI applications
- Data Abstraction (Parnas,1972)
  - Grouping of structure and operations
  - Information hiding
  - Alphard (1976), CLU (1977)
- *Ada (late 1970, DoD)*
  - The most important PL supporting ADT

The Evolution of OO in PL [3/4]

- Smalltalk (XEROX PARC 1972)
  - One of the most influential OO language
  - Not just a language
    - A programming environment
    - A menu-based interactive user-interface
    - An initial class hierarchy
  - Not a typed language
  - Everything is an object

The Evolution of OO in PL [4/4]

- Concurrent OOPL (Primary Concern: Concurrency)
  - Actor (Hewitt 1977)
  - ABCL/1 (Yonezawa 1990)
  - Concurrnt C++ (Gehani 1988)
  - Eiffel II (Camerol 1993)
- Extensions, dialects, and versions of *Smalltalk*
  - Smalltalk/V, Smalltalk80
- OO Extentions of conventional PLs
  - C++, Objective-C, Object-Pascal
- OO Extensions of *LISP*
  - *CommonLoops, Common Lisp Object System(CLOS)*

Summary of Evolution of Programming Paradigms

- 1970s: Structured programming
- 1980s: The decade that launched the OO era
  - C → C++
- 1990s: The decade of the full-fledged OOP
  - Moving toward Internet and Web Technology
  - C++ and relatives, Java
  - Various OO extensions of existing PLs

2.2 The Evolution of Data Base Models

The Network and Hierarchical Models

- File management systems
- In the 1950s and 1960s
- Network data model
  - record types and one-to-many relationships
  - *CODASYL-DBTG:* COBOL + DB
- Hierarchical data model
  - A tree-structured hierarchical relationship among record types
  - IBM IMS

The Relational Model

- In 1970, by *Ted Codd* *"The Relational Data Model"*
- Simple and elegant
- *SQL*(Structure Query Language) by Don Chamberlain
  - Declarative
  - Specify what is to be accessed from DBs
  - Based on relational algebra and first-order predicate calculus
- Early Relational DB System (1976)
  - *System/R (IBM), INGRES (U.C. Berkeley)*
- SQL standard: *SQL92, SQL3*
- Major vendor: Oracle, *Informix*, *Sybase*, etc.

2.2 The Evolution of Data Base Models

Trials for Going Beyond RDB

- Semantic data model (early 1980)
  - Motivation: Model the real world as closely as possible
  - ER data model

- Functional data model (early 1980)
  - *Data manipulation capability*
  - Attributes are treated as functions
  - Values are retrieved through applying functions to entities

The Extended and Object-Relational Models

- *Extended* (or *object*) relational model (mid 1980)
  - Incorporated some object-oriented features as incremental extension to relational systems

- *Illustra*, *UniSQL*, *Matisse*

- *SQL3* (ISO-ANSI, 1993)
  - SQL + OO(ADT,inheritance..)

2.2 The Evolution of Data Base Models

The Nested Relational and Complex Object Models

- Nested relational model
  - Have a relation valued attribute
- Complex object model
  - More general
  - Arbitrary composition hierarchies with sets and tuples
    - tree structured object spaces

DBMS Market Trend

- 1990 이후 OODBMS 와 ORDBMS 등장
  - OODBMS: Versant, Object Store, Objectivity
  - ORDBMS: Illustra, UniSQL, Mattisse
  - 3 Big RDBMS: Oracle, Informix, Sybase
- 1997년 Major Big 3 의 ORDBMS 출시
  - Even small guys proposed ORDBMSs
- 2000년 이후: Internet and Web 지원 ORDBMS 체재

The Evolution of OO in User Interfaces

- Graphical User Interface
  - In early 1970s ➔ *mouse*
  - *Menubar, Pulldown menu, Dialog box*
  - Desktop metaphor and direct manipulation
    - *End user data object (ex. icon)*
      - data + procedure required to modify it
  - Automatizing user-interface design
    - Class hierarchy + new screen object design

- The concept of Metaphor
  - Alan Kay: Smalltalk User Interface
  - The physical metaphor is a way of saying that the visual displays of a computer system should present the images of real physical objects with some degree of abstraction
  - UI should have the physical metaphor paradigm
  - Ex. Wastebasket icon, folder icon, ...

References

- Randell, b., and Russel, L. (1964) *ALGOL 60 Implementation*
- Dahl and Nygaard (1966) *Simula - an Alogol-based simulation language*. CACM, 9
- Goldberg and Robson (1983) *Smalltalk-80:The Language and its Implementation*
- Shipman(1981) *The functional data model and the data language DAPLEX*, ACM TODS, 6(1)
- Keene(1988), *Object-Oriented Programming In COMMONLISP*
- Astrahan(1976), *System-R:A relational approach to data management*, ACM TODS, 1(2)
- Stonebraker(1976), *The design and implementation of INGRES*, ACM TODS, 1