C Object-oriented Programming

C.1 Overview

- Motivation for the OO paradigm
- Software-design methods
- Basic terms of OO programming
- The Evolution of the object model
- Fundamental concepts of the OO paradigm
- Objetct-oriented Analysis and Design

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C.3 Motivation for the OO Paradigm

1 Goals

- Increasing complexity of large software
  - "industrial-strength" software [Boo94]
    - ➤ impossible for one developer to comprehend all details of its design
    - ➤ very long life span
    - ➤ many users depend on their proper functioning
    - ➤ many people responsible for maintenance and enhancement
- → Software Crisis
  - Hardware increasingly capable
  - Software becomes larger and larger
  - Costs for maintenance and enhancement rise dramatically
  - Not enough good software developers to create the software users need

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C.4 Software-Design Methods

1 Classification [Boo94]

- Top-down structured design (composite design)
- Object-oriented design

2 Classes of Programming Languages

… at least the most important ones

- Procedural / imperative
- Functional
- Object-oriented

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1 Goals (2)

- Increase the productivity of programmers
  - Design patterns for repeatedly occurring problems
  - Reusage of existing software
  - Better extensibility of software by modularization and clear interfaces
  - Incremental development from small & simple to huge & complex systems
  - Better control over complexity and costs of software maintenance
- Shift from the needs of the machine to abstractions of the problem domain
  - Better understanding of the problem
  - Terminology of the problem domain is reflected in the software solution
    - ➤ better understanding of the solution

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3 Top-Down Structured Design (Composite Design)

- Units of decomposition: Subroutine
- **Algorithmic decomposition**
- Not suitable for structuring today's large and complex software systems
- Top-down structured design cannot describe:
  - – data abstraction & information hiding
  - – concurrency
- Problems arise when applications are very complex or when object-oriented languages have to be used
- Widely used technique
- Procedural languages ideally suited for implementations

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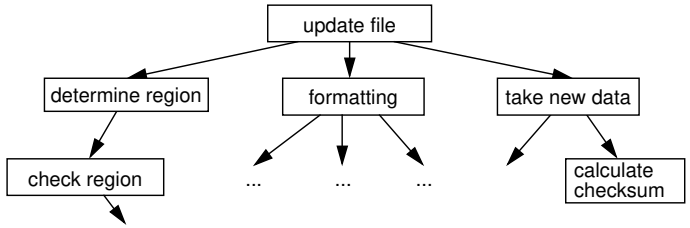
3 Top-Down Structured Design (2) (Composite Design)

- Example:



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4 Object-oriented Design

Bertrand Meyer:[Mey88]
Computing systems perform certain actions on certain objects;
to obtain flexible and reusable systems,
it is better to base the structure of software
on the objects than on the actions.

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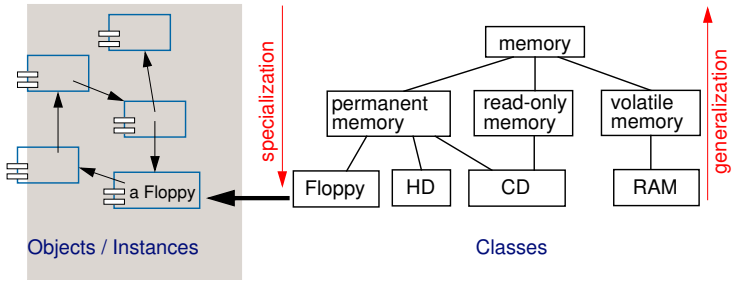
4 … Object-oriented Design (2)

- Software system is modeled as a collection of cooperating objects
- Each object is
  an instance of a class
  in a hierarchy of classes
- Example of a class hierarchy:



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4 … Object-oriented Design (3)

- Concepts reflected in the structure of modern programming languages
  - ➤ Smalltalk
  - ➤ C++
  - ➤ Eiffel
  - ➤ Java
  - ➤ Ada
- General basis: object-oriented decomposition
- Advantages:
  - + Reusage of common mechanisms
    - ➔ software becomes smaller
  - + Modifications and improvements of the software become easier
  - + Results are less complex
  - + Better understanding of the principal's ideas

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C.5 Object-oriented Programming

1 Definition (Grady Booch)

OOP is a method of implementation in which programs are organized as

cooperative collections of objects,

each of which represents an

instance of some class,

and whose classes are all members of a hierarchy of classes united via

inheritance relationships.

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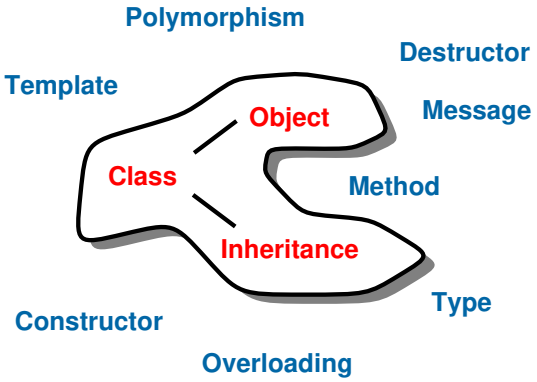
2 Basic Terms



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3 Objects & Methods

- Software developer's view:
  - an object is a "thing" from the problem domain
    - has a state
    - has behavior
    - has a unique identity
- Program-technical point of view:
  - an encapsulated unit of data and functions that operate on this data
  - an object has a clear interface (operations = **methods**)

→ **object-based programming languages** [Weg87]

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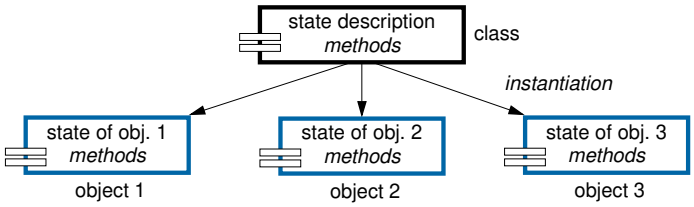
4 Classes

- Software developer's view:
  - a class is a set of objects with common structure and common behavior
- Program-technical point of view:
  - a class is a template for objects
    - each object is an instance of a class
    - object creation = *instantiation*



→ **class-based programming languages**
= objects & classes

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