Abstract data types

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October 12, 2017

User-defined types

Decide which types you want; provide a full set of operations for each type

- User-defined types follow nearly the same rules for naming, scope, allocation, lifetime, etc., as does a built-in type such as `int` or `char`
  - User-defined types address the shortcomings of pseudo-types that can be created through modular programming

- A user-defined type is also known as an abstract data type (ADT)
  - Stroustrup prefers the term user-defined type as a reasonable definition of an abstract data type would require a mathematical "abstract" specification

Abstract Data Types (ADT)

- An Abstract Data Type (ADT) consists of
  - An interface
    - Communicating the set of operations that can be performed
  - The allowable behaviors
    - The way we expect instances of the ADT to respond to operations

- The implementation of an ADT consists of
  - An internal representation
  - A set of methods implementing the interface
  - A set of representation invariants, true initially and preserved by all methods

Ex: Sphere

- **Interface:**
  - Create
  - Move
  - Resize
  - Check if point within sphere
  - Volume

- **Allowable behaviors:**
  - Any position is ok, most recent position is used, resize ok as long as $r >= 0$

- **Internal representation:**
  - x, y, z (center) and r (radius)

- **Representation invariant:**
  - $r >= 0$

Ex: Student management software

- ***You've been asked to write a program that manages students for a lecture section…***

- What student information should we include in a record?
  - There are many attributes that are used to characterize a student… what are the essential characteristics with respect to our program?

- What operations should be allowed?
  - Add a new student to the class?
  - Searching the class for a student?
  - Deleting a student who dropped the class?

Ex: Student management software

- **What** attributes and operations we select during this process of abstraction defines our *abstract data type (ADT)*

- **How** the student records will be stored in memory and **how** these operations are implemented *do* **not**

ADT mathematical models?

- Simply describe the underlying the data structuring mechanism independent of programming language syntax

Arrays

- Mapping specific objects in some range domain R for each value in some finite index domain I

- Denoted I→R

Sequences (Lists, Strings)

- Ordered collections of any number of elements of a base domain C

- Denoted C^*. $C^* = \{\}$ $+ \, C + C \times C + C \times C \times C + $ ...