Chapter 7: Structural Modeling

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Structural Modeling

Chapter 7
Key Ideas

- A structural or conceptual model describes the structure of the data that supports the business processes in an organization.

- The structure of data used in the system is represented through **CRD cards**, **class diagrams**, and **object diagrams**.
STRUCTURAL MODELS
Purpose of Structural Models

- Reduce the “semantic gap” between the real world and the world of software
- Create a vocabulary for analysts and users
- Represent things, ideas, and concepts of importance in the application domain
Classes

- Templates for creating instances or objects
  - Concrete
  - Abstract
- Typical examples:
  - Application domain, user interface, data structure, file structure, operating environment, document, and multimedia classes
Attributes

- Units of information relevant to the description of the class
- Only attributes important to the task should be included
Operations

- Action that instances/objects can take
- Focus on relevant problem-specific operations (at this point)
Relationships

- Generalization
  - Enables inheritance of attributes and operations
- Aggregation
  - Relates parts to wholes
- Association
  - Miscellaneous relationships between classes
Your Turn

- What classes, attributes, and operations that would be required to describe the process of registration for campus housing?
CLASS-RESPONSIBILITY-COLLABORATION CARDS
Responsibilities and Collaborations

- Responsibilities
  - Knowing
  - Doing
- Collaboration
  - Objects working together to service a request
## A CRC Card

### Front:

**Class Name:** Patient  
**ID:** 3  
**Type:** Concrete, Domain  
**Description:** An Individual that needs to receive or has received medical attention  
**Associated Use Cases:** 2

### Responsibilities

- Make appointment
- Calculate last visit
- Change status
- Provide medical history

### Collaborators

- Appointment
- Medical history
Back of CRC Card

<table>
<thead>
<tr>
<th>Attributes:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Amount (double)</td>
<td></td>
</tr>
<tr>
<td>Insurance carrier (text)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Relationships:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Generalization (a-kind-of):</td>
<td>Person</td>
</tr>
<tr>
<td>Aggregation (has-parts):</td>
<td>Medical History</td>
</tr>
<tr>
<td>Other Associations:</td>
<td>Appointment</td>
</tr>
</tbody>
</table>
CLASS DIAGRAMS
Example Class Diagram
## Class Diagram Syntax

<table>
<thead>
<tr>
<th>A CLASS</th>
<th>Class 1</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>-attribute</td>
</tr>
<tr>
<td></td>
<td>+operation ()</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>AN ATTRIBUTE</th>
<th>Attribute name/ derived attribute name</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>AN OPERATION</th>
<th>operation name ()</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>AN ASSOCIATION</th>
<th>1..* 0..1 verb phrase</th>
</tr>
</thead>
</table>
More on Attributes

- Derived attributes
  - /age, for example can be calculated from birth date and current date

- Visibility
  - Public
  - Protected
  - Private
More on Operations

- Constructor
  - Creates object

- Query
  - Makes information about state available

- Update
  - Changes values of some or all attributes
Generalization and Aggregation

- Generalization shows that a subclass inherits from a superclass
  - Doctors, nurses, admin personnel are kinds of employees
- Aggregation classes comprise other classes
  - Health team class comprised of doctor, nurses, admin personnel classes
More on Relationships

- Class can be related to itself (role)
- Multiplicity
  - Exactly one, zero or more, one or more, zero or one, specified range, multiple disjoint ranges
- Association class
Simplifying Class Diagrams

- The view mechanism shows a subset of information
- Packages show aggregations of classes (or any elements in UML)
FIGURE 7-5  Example Object Diagram

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**Object Diagrams**

- **Patient**
  - amount
  - insurance carrier
  + make appointment()
  + calculate last visit()
  + change status()
  + provide medical history()

- **Appointment**
  - time
  - date
  - reason
  + cancel without notice()

- **Doctor**

- **Symptom**
  - name

**Example: John Doe: Patient**
- lastname = “Doe”
- firstname = “John”
- address = “1000 Main Street”
- phone = “555-555-5555”
- birthdate = 01/01/72
- age = 32
- amount = $0.00
- insurance carrier = “1ID Health Insurance”

**Example: Appt1: Appointment**
- time = 3:00
- date = 7/7/2004
- reason = “pain in neck”

**Example: Dr. Smith: Doctor**
- lastname = “Smith”
- firstname = “Jane”
- address = “Doctor’s Clinic”
- phone = “999-555-5555”
- birthdate = 12/12/64
- age = 39

**Example: Symptom1: Symptom**
- name = “muscle pain”
CREATING CRC CARDS AND CLASS DIAGRAMS
Object Identification

- Textual analysis of use-case information
  - Nouns suggest classes
  - Verbs suggest operations
- Creates a rough first cut
- Common object list
- Incidents
- Roles
Patterns

- Useful groupings of classes that recur in various situations

Transactions
- Transaction class
- Transaction line item class
- Item class
- Location class
- Participant class
Steps for Object Identification and Structural Modeling

1. Create CRC cards by performing textual analysis on the use-cases.
2. Brainstorm additional candidate classes, attributes, operations, and relationships by using the common object list approach.
3. Role-play each use-case using the CRC cards.
4. Create the class diagram based on the CRC cards.
5. Review the structural model for missing and/or unnecessary classes, attributes, operations, and relationships.
6. Incorporate useful patterns.
7. Review the structural model.
Create CRC cards.
Examine common object lists.
Role-play the CRC cards.
Create the class diagram.
Review the class diagram.
Incorporate patterns.
Review the model.
CD Selections

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Dennis: SAD
Fig: 7-12  W-29  100% of size
Fine Line Illustrations (516) 501-0400
Summary

- **CRC cards** capture the essential elements of a class.
- **Class and object diagrams** show the underlying structure of an object-oriented system.
- Constructing the structural model is an iterative process involving: *textual analysis, brainstorming objects, role playing, creating the diagrams, and incorporating useful patterns.*
Expanding the Domain

- A quirky and interesting tutorial regarding CRC cards can be found at:
  - http://www.csc.calpoly.edu/~dbutler/tutorials/winter96/crc_b/
EOC Question Chapter 7

1. Describe to a businessperson the multiplicity of a relationship between two classes.
2. Why are assumptions important to a structural model?
3. What is an association class?
4. Contrast the following sets of terms:
   - Object; Class; Instance
   - Property; Method; Attribute
   - Superclass; Subclass
   - Concrete Class; Abstract Class
5. Give three examples of derived attributes that may exist on a class diagram. How would they be denoted on the class diagram?
EOC Question Chapter 7

6. What are the different types of visibility? How would they be denoted on a class diagram?

7. Draw the relationships that are described by the following business rules. Include the multiplicities for each relationship.

A patient must be assigned to only one doctor, and a doctor can have one or many patients.

An employee has one phone extension, and a unique phone extension is assigned to an employee.

A movie theater shows at least one movie, and a movie can be shown at up to four other movie theaters around town.

A movie either has one star, two co-stars, or more than ten people starring together. A star must be in at least one movie.
EOC Question Chapter 7

8. How do you designate the reading direction of a relationship on a class diagram?

9. For what purpose is an association class used in a class diagram? Give an example of an association class that may be found in a class diagram that captures students and the courses that they have taken.

10. Give two examples of aggregation, generalization, and association relationships. How is each type of association depicted on a class diagram?
EOC Question Chapter 7

11. Identify the following operations as constructor, query, or update. Which operations would not need to be shown in the class rectangle?

- Calculate employee raise (raise percent)
- Calculate sick days()
- Increment number of employee vacation days()
- Locate employee name()
- Place request for vacation (vacation day)
- Find employee address()
- Insert employee()
- Change employee address()
- Insert spouse()