OVERVIEW OF CRC

- B. Beck and W. Cunningham, A Laboratory for Teaching Object-Oriented Thinking, OOPSLA ’89, October 1-6, 1989.

Outline

- Basics of CRC
  - CRC Cards
  - CRC Process
- Identifying Objects (Classes)
- Identifying Responsibilities
- Assigning Responsibilities
Tuesday’s Quote

*Doing business without advertising [or designing a software system without documenting it] is like winking at a girl in the dark. You know what you’re doing, but nobody else does.*

- Steuart Henderson Britt

CRC Cards

- Invented in 1989 by Kent Beck and Ward Cunningham
- A simple yet powerful analysis/design technique
- Uses a collection of (standard index) cards that are divided into three sections:
  - Class
  - Responsibility
  - Collaborator
Class, Responsibility, and Collaborator

- A **class** represents a collection of similar objects.

- A **responsibility** is anything that a class knows or does.

- A **collaborator** is another class that is used to get information for, or performs actions for the class at hand.

Example

<table>
<thead>
<tr>
<th>Class: Person</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Superclass:</strong></td>
</tr>
<tr>
<td><strong>Subclasses:</strong> Student</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Responsibilities</th>
<th>Collaborations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knows name</td>
<td>AddressBook</td>
</tr>
<tr>
<td>Knows address</td>
<td>PhoneBook</td>
</tr>
<tr>
<td>Knows phone number</td>
<td></td>
</tr>
<tr>
<td>...</td>
<td></td>
</tr>
</tbody>
</table>
More on CRC Cards

- 3x5 (or 4x6) index cards, post-its, etc.
- One class per card
- In addition to CRC, can also write superclasses and subclasses.
- On the back, can write a description of purpose of the class (with its attributes).

Why CRC Cards?
Advantages

- portable: cards can be used anywhere, even away from the computer or office
- anthropomorphic: no computer program can capture the essence of the interactions forced by passing the cards
- level of involvement felt by each team member increases
- useful throughout the life cycle

More advantages

- provides a basis for more formal analysis and design methodologies
- serves as input to a formal method (i.e., a starting point)

- gives a general bound on the size of a class - a card
CRC Approach – The Process

- Exploratory phase
  - Find classes
  - Determine operations and knowledge for each class (responsibilities)
  - Determine how objects collaborate to discharge responsibilities

- Analysis phase
  - Collect classes into subsystems

How to Find Objects and Their Responsibilities?

- Use nouns and verbs in requirements as clues
  - Noun phrases lead to objects
  - Verb phrases lead to responsibilities

- Determine how objects collaborate to fulfill their responsibilities
  - To collaborate, objects will play certain roles

- Why is this important?
  - Objects lead to classes
  - Responsibilities lead to operations or methods
  - Collaborations and roles lead to associations
Outline

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Identifying Objects (Classes)

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- Start with requirements specification

1. Look for noun phrases.
   - Separate into obvious classes, uncertain candidates, and nonsense

2. Refine to a list of candidate classes.
Guidelines for Refining Candidate Classes

- Model physical objects – e.g., disks, printers, geophones.
- Model conceptual objects – e.g., windows, files, shots, picks.
- Choose one word for one concept – what does it mean within the domain?
- Be wary of adjectives – does it really signal a separate class?

Example: Mail-Order System

Imagine that you are developing order-processing software for a mail-order company, a reseller of products purchased from various suppliers.

- Twice a year the company publishes a catalog of products, which is mailed to customers and other interested people.
- Customers purchase products by submitting a list of products with payment to the company. The company fills the order and ships the products to the customer’s address.
- The order processing software will track the order from the time it is received until the product is shipped.
- The company will provide quick service. They should be able to ship a customer’s order by the fastest, most efficient means possible.
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Candidate Classes

<table>
<thead>
<tr>
<th>Nouns and Synonyms</th>
<th>Candidate Class Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>software</td>
<td></td>
</tr>
<tr>
<td>mail-order company</td>
<td></td>
</tr>
<tr>
<td>company, company,</td>
<td></td>
</tr>
<tr>
<td>reseller products</td>
<td></td>
</tr>
<tr>
<td>suppliers</td>
<td></td>
</tr>
<tr>
<td>catalog of products</td>
<td></td>
</tr>
<tr>
<td>customers, interested people</td>
<td></td>
</tr>
<tr>
<td>list of products, order, customer's order</td>
<td></td>
</tr>
<tr>
<td>payment</td>
<td></td>
</tr>
<tr>
<td>customer's address</td>
<td></td>
</tr>
<tr>
<td>time it is received</td>
<td></td>
</tr>
<tr>
<td>time products is shipped</td>
<td></td>
</tr>
<tr>
<td>quick service</td>
<td></td>
</tr>
</tbody>
</table>
Candidate Classes (Cont.)

- Expect the list to evolve as design proceeds
  - Record why you decided to include or reject candidates
  - Candidate class list follows configuration management and version control

A Good Class …

- Has a clear and unambiguous name
- Has a name that is recognizable by domain experts
- Begins with an uppercase letter and is a singular noun
- Has responsibilities
- May actively participates in system
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What Are Responsibilities?

- The *public services* that an object may provide to other objects:
  - The knowledge an object maintains and provides
  - The actions it can perform

- That is,
  - Convey a sense of purpose of an object and its place in the system
  - Record services that a class provides to fulfill roles within the system
  - Record knowledge (maintenance) and manipulation of information in the system
Knowledge and Action

- Knowing responsibilities
  - Knowing about private encapsulated data
  - Knowing about related objects
  - Knowing about things it can derive or calculate

- Doing responsibilities
  - Doing something itself, such as creating an object or doing a calculation
  - Initiating action in other objects
  - Controlling and coordinating activities of other objects

Identifying Responsibilities

- Use mixtures of:
  - Verb phrase identification. Similar to noun phrase identification, except verb phrases are candidate responsibilities.

  - Scenarios and role play. Perform scenario walk-through of the system where different persons “play” the classes, thinking aloud about how they will delegate to other objects.

  - Class enumeration. Enumerate all candidate classes and come up with an initial set of responsibilities.

  - Class relationship examination. Examine all classes and their relationships to compare how they fulfill responsibilities.
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Candidate Responsibilities

<table>
<thead>
<tr>
<th>Verbs and Synonyms</th>
<th>Candidate Responsibility</th>
</tr>
</thead>
<tbody>
<tr>
<td>Publishes a catalog</td>
<td></td>
</tr>
<tr>
<td>Is mailed to customers</td>
<td></td>
</tr>
<tr>
<td>Purchases products; submitting</td>
<td></td>
</tr>
<tr>
<td>Fills the order</td>
<td></td>
</tr>
<tr>
<td>Ships the products; is shipped</td>
<td></td>
</tr>
<tr>
<td>Track the order</td>
<td></td>
</tr>
<tr>
<td>Is received</td>
<td></td>
</tr>
<tr>
<td>Provides quick service</td>
<td></td>
</tr>
</tbody>
</table>

Group Exercise

- Based on the requirement specification of the Weather Monitoring System, identify classes by dividing them into the following three categories:
  - Obvious
  - Discarded
  - Unsere

- Repeat the exercise for candidate responsibilities.