Module 7

Object Modeling using UML

Lesson 15

Use Case Model

Specific Instructional Objectives

At the end of this lesson the student will be able to:

- Identify different use cases of a system.
- Identify the purpose of use cases.
- Represent use cases for a particular system.
- Explain the utility of the use case diagram.
- Factorize use cases into different component use cases.
- Explain the organization of use cases.

Use Case Model

The use case model for any system consists of a set of “use cases”. Intuitively, use cases represent the different ways in which a system can be used by the users. A simple way to find all the use cases of a system is to ask the question: “What the users can do using the system?” Thus for the Library Information System (LIS), the use cases could be**:**

- issue-book
- query-book
- return-book
- create-member
- add-book, etc

Use cases correspond to the high-level functional requirements. The use cases partition the system behavior into transactions, such that each transaction performs some useful action from the user’s point of view. To complete each transaction may involve either a single message or multiple message exchanges between the user and the system to complete.

Purpose of use cases

The purpose of a use case is to define a piece of coherent behavior without revealing the internal structure of the system. The use cases do not mention any specific algorithm to be used or the internal data representation, internal structure of the software, etc. A use case typically represents a sequence of interactions between the user and the system. These interactions consist of one mainline sequence. The mainline sequence represents the normal interaction

between a user and the system. The mainline sequence is the most occurring sequence of interaction. For example, the mainline sequence of the withdraw cash use case supported by a bank ATM drawn, complete the transaction, and get the amount. Several variations to the main line sequence may also exist. Typically, a variation from the mainline sequence occurs when some specific conditions hold. For the bank ATM example, variations or alternate scenarios may occur, if the password is invalid or the amount to be withdrawn exceeds the amount balance. The variations are also called alternative paths. A use case can be viewed as a set of related scenarios tied together by a common goal. The mainline sequence and each of the variations are called scenarios or instances of the use case. Each scenario is a single path of user events and system activity through the use case.

Representation of use cases

Use cases can be represented by drawing a use case diagram and writing an accompanying text elaborating the drawing. In the use case diagram, each use case is represented by an ellipse with the name of the use case written inside the ellipse. All the ellipses (i.e. use cases) of a system are enclosed within a rectangle which represents the system boundary. The name of the system being modeled (such as Library Information System) appears inside the rectangle.

The different users of the system are represented by using the stick person icon. Each stick person icon is normally referred to as an actor. An actor is a role played by a user with respect to the system use. It is possible that the same user may play the role of multiple actors. Each actor can participate in one or more use cases. The line connecting the actor and the use case is called the communication relationship. It indicates that the actor makes use of the functionality provided by the use case. Both the human users and the external systems can be represented by stick person icons. When a stick person icon represents an external system, it is annotated by the stereotype <<external system>>.

Example 1:

The use case model for the Tic-tac-toe problem is shown in fig. 7.2. This software has only one use case “play move”. Note that the use case “get-user-move” is not used here. The name “get-user-move” would be inappropriate because the use cases should be named from the users’ perspective.

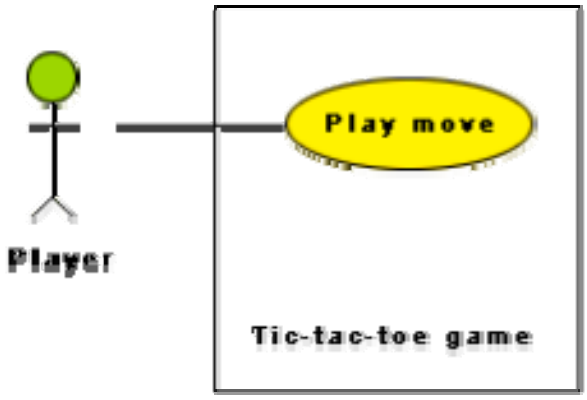

Fig. 7.2: Use case model for tic-tac-toe game

Text Description

Each ellipse on the use case diagram should be accompanied by a text description. The text description should define the details of the interaction between the user and the computer and other aspects of the use case. It should include all the behavior associated with the use case in terms of the mainline sequence, different variations to the normal behavior, the system responses associated with the use case, the exceptional conditions that may occur in the behavior, etc. The behavior description is often written in a conversational style describing the interactions between the actor and the system. The text description may be informal, but some structuring is recommended. The following are some of the information which may be included in a use case text description in addition to the mainline sequence, and the alternative scenarios.

Contact persons: This section lists the personnel of the client organization with whom the use case was discussed, date and time of the meeting, etc.

Actors: In addition to identifying the actors, some information about actors using this use case which may help the implementation of the use case may be recorded.

Pre-condition: The preconditions would describe the state of the system before the use case execution starts.

Post-condition: This captures the state of the system after the use case has successfully completed.

Non-functional requirements: This could contain the important constraints for the design and implementation, such as platform and

environment conditions, qualitative statements, response time requirements, etc.

Exceptions, error situations: This contains only the domain-related errors such as lack of user's access rights, invalid entry in the input fields, etc. Obviously, errors that are not domain related, such as software errors, need not be discussed here.

Sample dialogs: These serve as examples illustrating the use case.

Specific user interface requirements: These contain specific requirements for the user interface of the use case. For example, it may contain forms to be used, screen shots, interaction style, etc.

Document references: This part contains references to specific domain-related documents which may be useful to understand the system operation.

Example 2:

The use case model for the Supermarket Prize Scheme described in Lesson 5.2 is shown in fig. 7.3. As discussed earlier, the use cases correspond to the high-level functional requirements. From the problem description and the context diagram in fig. 5.5, we can identify three use cases: "register-customer", "register-sales", and "select-winners". As a sample, the text description for the use case "register-customer" is shown.

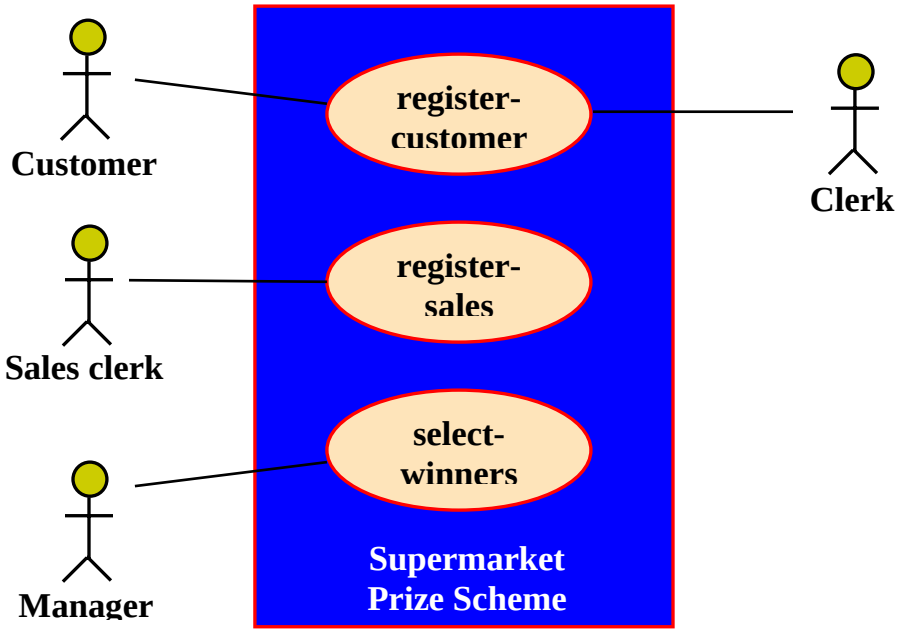

Fig. 7.3 Use case model for Supermarket Prize Scheme

Text description

U1: register-customer: Using this use case, the customer can register himself by providing the necessary details.

Scenario 1: Mainline sequence

1. **Customer: select register customer option.**
2. **System: display prompt to enter name, address, and telephone number.**
3. **Customer: enter the necessary values.**
4. **System: display the generated id and the message that the customer has been successfully registered.**

Scenario 2: at step 4 of mainline sequence

1. **System: displays the message that the customer has already registered.**

Scenario 2: at step 4 of mainline sequence

1. **System: displays the message that some input information has not been entered. The system display a prompt to enter the missing value.**

The description for other use cases is written in a similar fashion.

Utility of use case diagrams

From use case diagram, it is obvious that the utility of the use cases are represented by ellipses. They along with the accompanying text description serve as a type of requirements specification of the system and form the core model to which all other models must conform. But, what about the actors (stick person icons)? One possible use of identifying the different types of users (actors) is in identifying and implementing a security mechanism through a login system, so that each actor can involve only those functionalities to which he is entitled to. Another possible use is in preparing the documentation (e.g. users' manual) targeted at each category of user. Further, actors help in identifying the use cases and understanding the exact functioning of the system.

Factoring of use cases

It is often desirable to factor use cases into component use cases. Actually, factoring of use cases are required under two situations. First, complex use cases need to be factored into simpler use cases. This would not only make the behavior associated with the use case much more comprehensible, but also

make the corresponding interaction diagrams more tractable. Without decomposition, the interaction diagrams for complex use cases may become too large to be accommodated on a single sized (A4) paper. Secondly, use cases need to be factored whenever there is common behavior across different use cases. Factoring would make it possible to define such behavior only once and reuse it whenever required. It is desirable to factor out common usage such as error handling from a set of use cases. This makes analysis of the class design much simpler and elegant. However, a word of caution here. Factoring of use cases should not be done except for achieving the above two objectives. From the design point of view, it is not advantageous to break up a use case into many smaller parts just for the shake of it.

UML offers three mechanisms for factoring of use cases as follows:

Generalization

Use case generalization can be used when one use case that is similar to another, but does something slightly differently or something more. Generalization works the same way with use cases as it does with classes. The child use case inherits the behavior and meaning of the parent use case. The notation is the same too (as shown in fig. 7.4). It is important to remember that the base and the derived use cases are separate use cases and should have separate text descriptions.

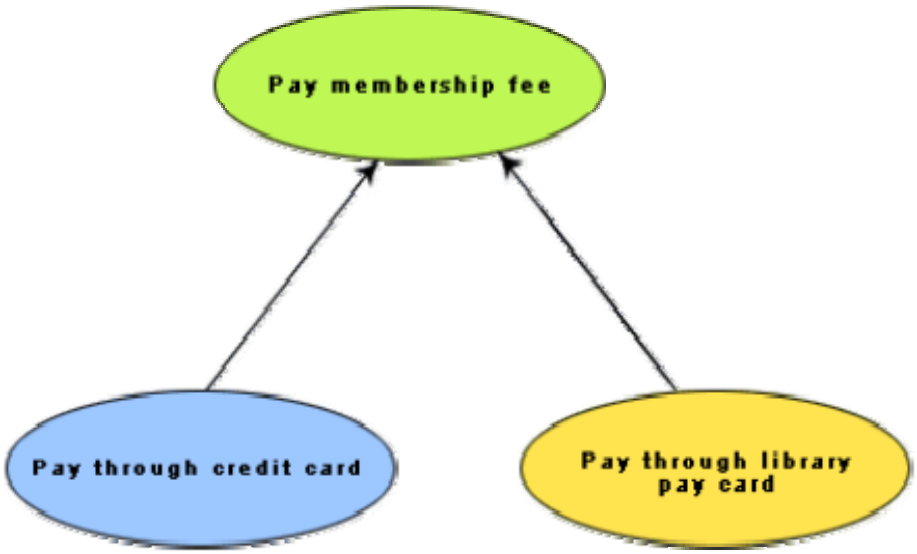

Fig. 7.4: Representation of use case generalization

Includes

The includes relationship in the older versions of UML (prior to UML 1.1) was known as the uses relationship. The includes relationship involves one use case including the behavior of another use case in its sequence of events and actions. The includes relationship occurs when a chunk of behavior that is similar across a number of use cases. The factoring of such behavior will help in not repeating the specification and implementation across different use cases. Thus, the includes relationship explores the issue of reuse by factoring out the commonality across use cases. It can also be gainfully employed to decompose a large and complex use cases into more manageable parts. As shown in fig. 7.5, the includes relationship is represented using a predefined stereotype <<include>>. In the includes relationship, a base use case compulsorily and automatically includes the behavior of the common use cases. As shown in example fig. 7.6, issue-book and renew-book both include check-reservation use case. The base use case may include several use cases. In such cases, it may interleave their associated common use cases together. The common use case becomes a separate use case and the independent text description should be provided for it.

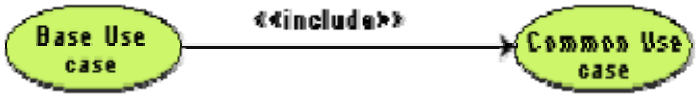

Fig. 7.5: Representation of use case inclusion

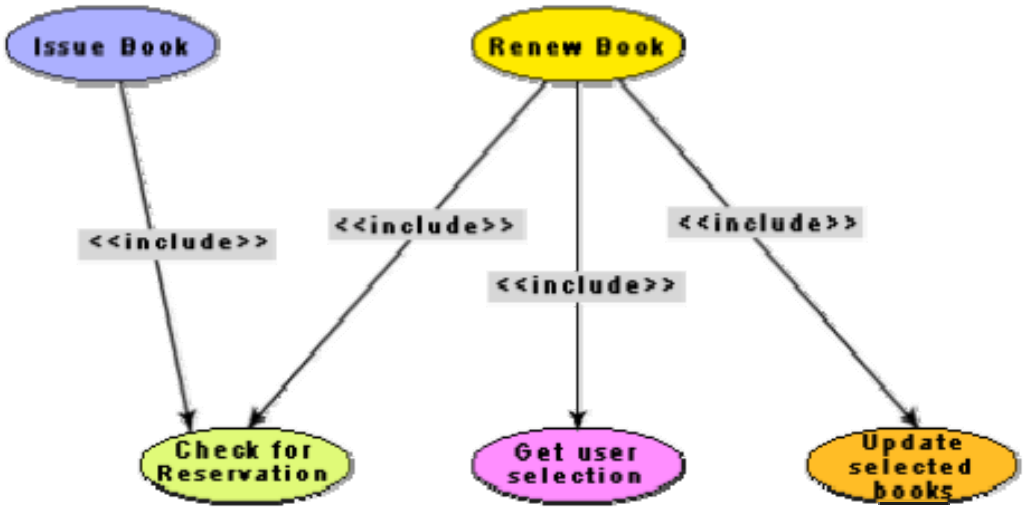

Fig. 7.6: Example use case inclusion

Extends

The main idea behind the extends relationship among the use cases is that it allows you to show optional system behavior. An optional system behavior is extended only under certain conditions. This relationship among use cases is also predefined as a stereotype as shown in fig. 7.7. The extends relationship is similar to generalization. But unlike generalization, the extending use case can add additional behavior only at an extension point only when certain conditions are satisfied. The extension points are points within the use case where variation to the mainline (normal) action sequence may occur. The extends relationship is normally used to capture alternate paths or scenarios.

Fig. 7.7: Example use case extension

Organization of use cases

When the use cases are factored, they are organized hierarchically. The high-level use cases are refined into a set of smaller and more refined use cases as shown in fig. 7.8. Top-level use cases are super-ordinate to the refined use cases. The refined use cases are sub-ordinate to the top-level use cases. Note that only the complex use cases should be decomposed and organized in a hierarchy. It is not necessary to decompose simple use cases. The functionality of the super-ordinate use cases is traceable to their sub-ordinate use cases. Thus, the functionality provided by the super-ordinate use cases is composite of the functionality of the sub-ordinate use cases. In the highest level of the use case model, only the fundamental use cases are shown. The focus is on the application context. Therefore, this level is also referred to as the context diagram. In the context diagram, the system limits are emphasized. In the top-level diagram, only those use cases with which external users of the system. The subsystem-level use cases specify the services offered by the subsystems. Any number of levels involving the subsystems may be utilized. In the lowest level of the use case hierarchy, the class-level use cases specify the functional fragments or operations offered by the classes.

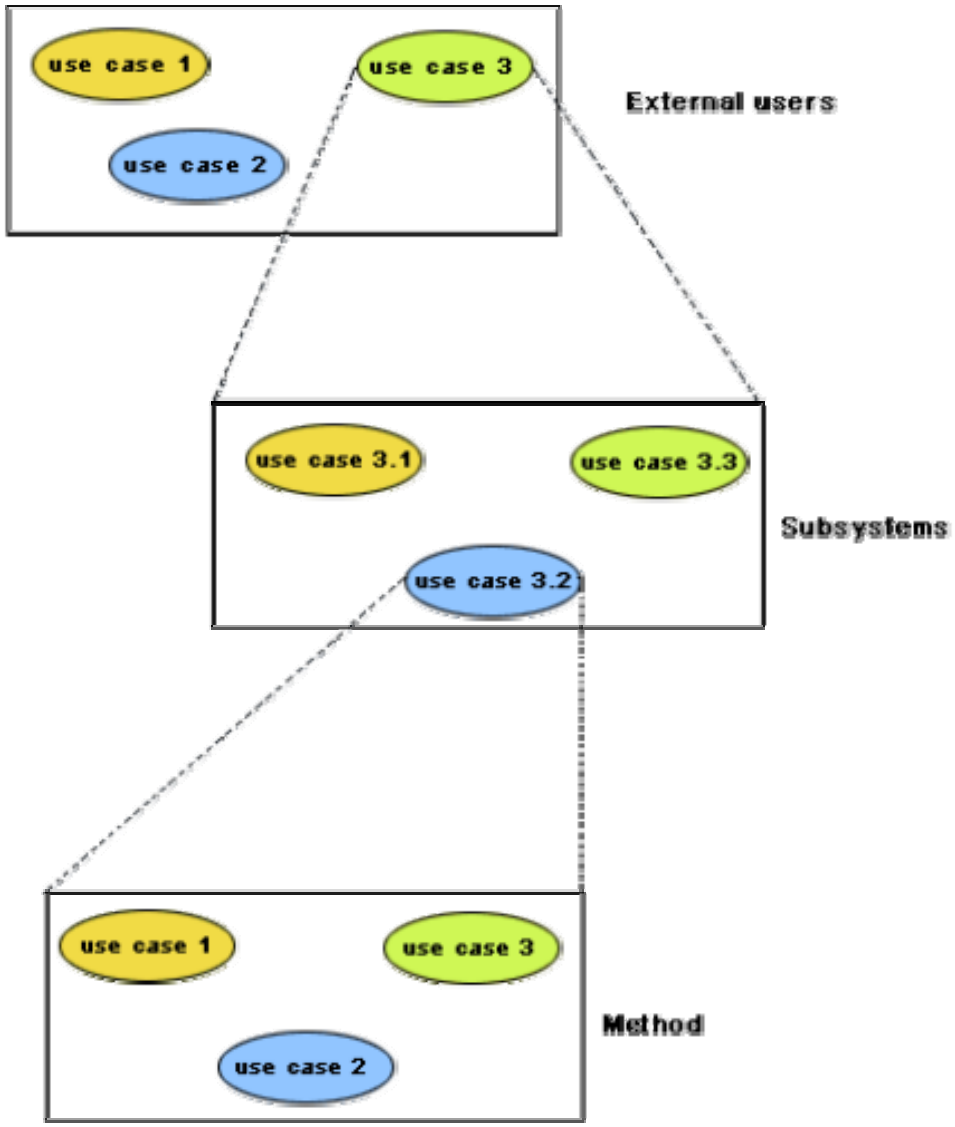

Fig. 7.8: Hierarchical organization of use cases