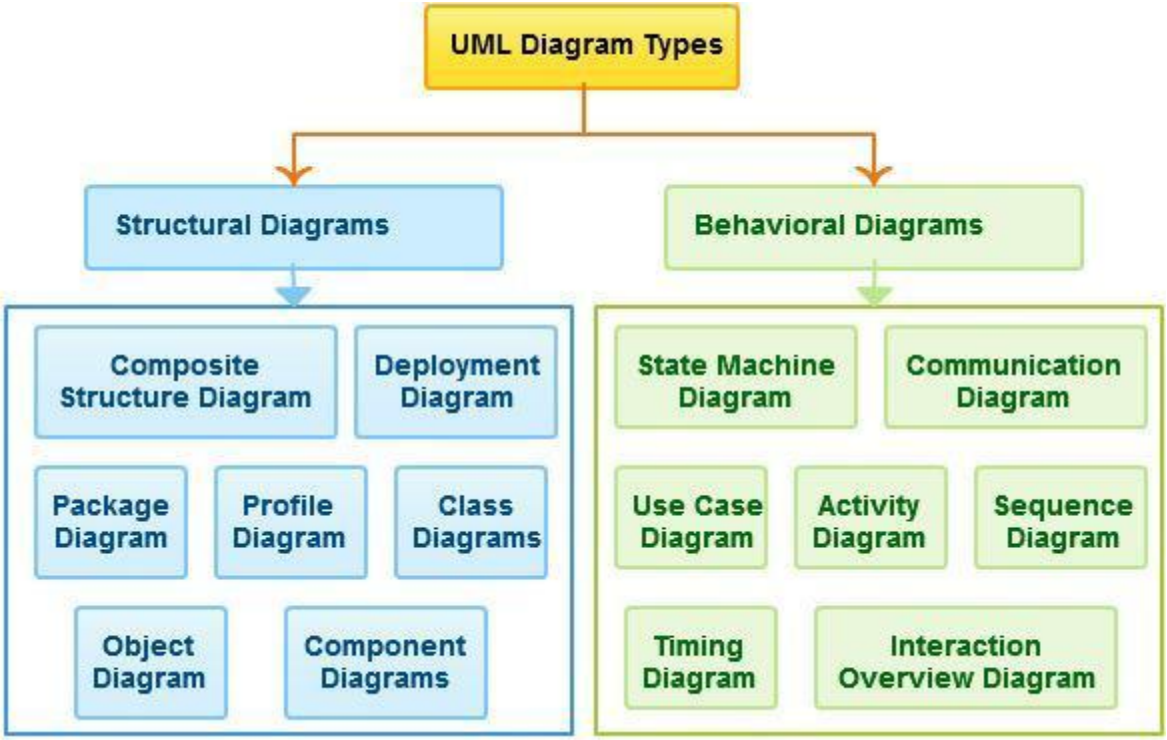
**Introduction to UML**

- **UML –** Unified Modeling Language diagram is designed to let developers and customers view a software system from a different perspective and in varying degrees of abstraction.
- One reason UML has become a standard modeling language is that it is programming-language independent.
- Since UML is not a methodology, it does not require any formal work products.
- In an effort to promote Object Oriented designs, three leading object oriented programming researchers joined ranks to combine their languages:
    - **i.** Grady Booch (BOOCH)
    - **ii.** James Rumbaugh (OML: object modeling technique)
    - **iii.** Ivar Jacobsen (OOSE: object oriented software eng) and come up with an industry standard [mid 1990's].

## Types of UML Diagram



**Structural Diagrams**

- Structure diagrams emphasize on the things that must be present in the system being modeled.
- Since structure diagrams represent the structure, they are used extensively in documenting the software architecture of software systems.

**Behavioral Diagrams**

- Behavior diagrams emphasize on what must happen in the system being modeled.
- Since behavior diagrams illustrate the behavior of a system, they are used extensively to describe the functionality of software systems.

# Use Case Diagram

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**Introduction:**

- A use case diagram describes how a system interacts with outside actors.
- It is a graphical representation of the interaction among the elements and system.
- Each use case representation a piece of functionality that a system provides to its user.
- Use case identifies the functionality of a system.
- Use case diagram allows for the specification of higher level user goals that the system must carry out.
- These goals are not necessarily to tasks or actions, but can be more general required functionality of the system.
- You can apply use case to capture the intended behavior of the system you are developing, without having to specify how that behavior is implemented.
- A use case diagram at its simplest is a representation of a user's interaction with the system and depicting the specifications of a use case.
- A use case diagram contains four components.
  i. The boundary, which defines the system of interest in relation to the world around it.
  ii. The actors, usually individuals involved with the system defined according to their roles.
  iii. The use cases, which the specific roles are played by the actors within and around the system.
  iv. The relationships between and among the actors and the use cases.

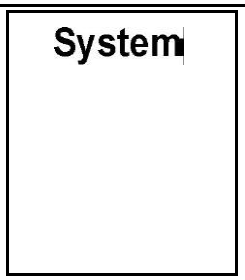
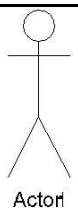
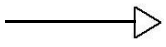
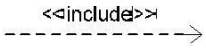
**Purpose:**

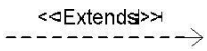
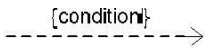
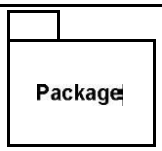
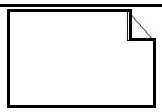
- The main purpose of the use case diagram is to capture the dynamic aspect of a system.
- Use case diagram shows, what software is supposed to do from user point of view.
- It describes the behavior of system from user's point.
- It provides functional description of system and its major processes.
- Use case diagram defines the scope of the system you are building.

**When to Use: Use Cases Diagrams**

- Use cases are used in almost every project.
- They are helpful in exposing requirements and planning the project.
- During the initial stage of a project most use cases should be defined.

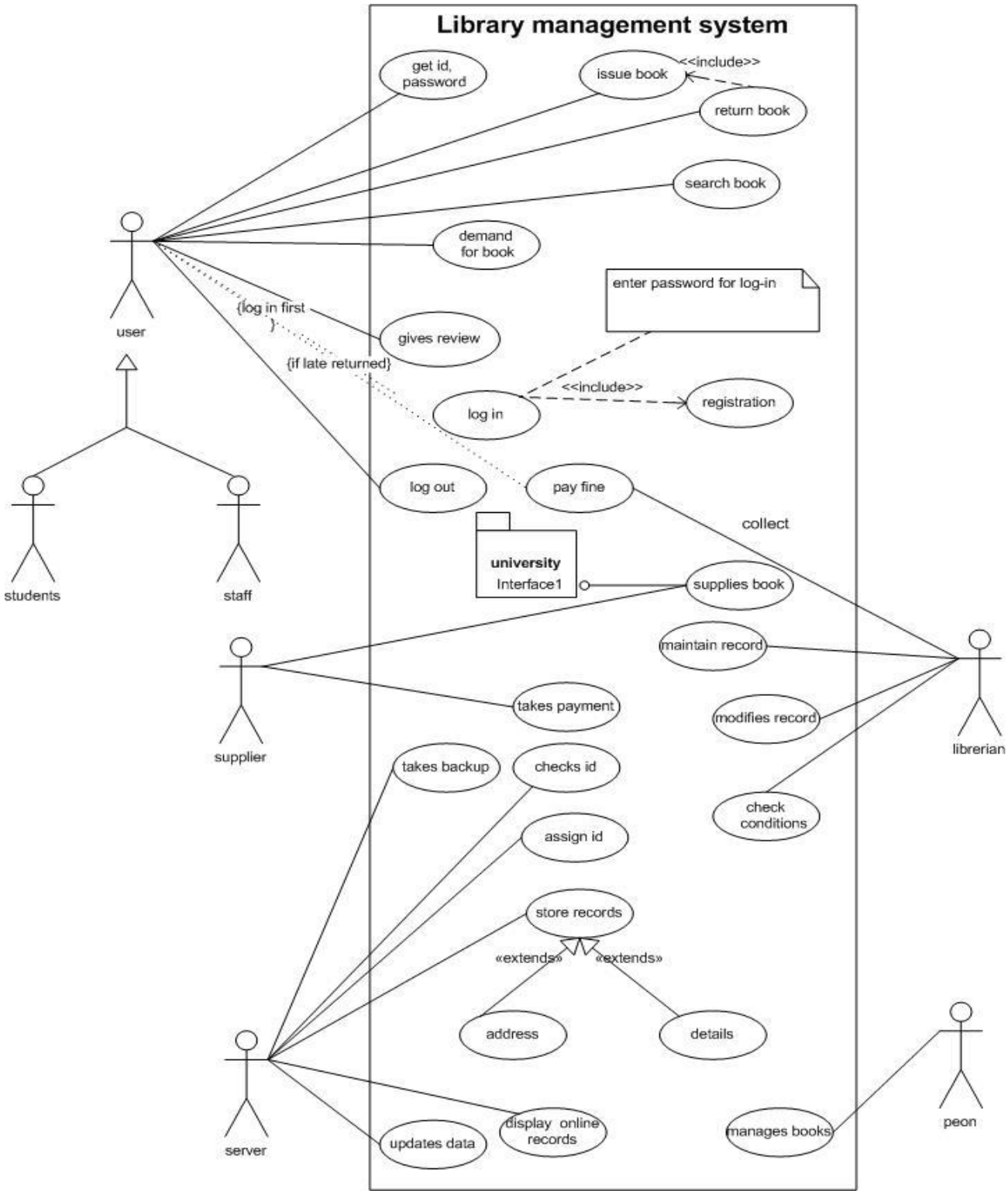
## Use Case Notations

| No. | Name | Notation | Description |
|---|---|---|---|
| 1 | System boundary |  | The scope of a system can be represented by a system Boundary. The use cases of the system are placed inside the system boundary, while the actors who Interact with the system are put outside the system. The use cases in the system make up the total Requirements of the system. |
| 2 | Use case |  | A use case represents a user goal that can be achieved by accessing the system or software application. |
| 3 | Actor |  | Actors are the entities that interact with a system. Although in most cases, actors are used to represent the users of system, actors can actually be anything that needs to exchange information with the system. So an actor may be people, computer hardware, other systems, etc. Note that actor represent a role that a user can play, but not a specific user. |
| 4 | Association |  | Actor and use case can be associated to indicate that the actor participates in that use case. Therefore, an association corresponds to a sequence of actions between the actor and use case in achieving the use case. |
| 5 | Generalization |  | A generalization relationship is used to represent inheritance relationship between model elements of same type. |
| 6 | Include |  | An include relationship specifies how the behavior for the inclusion use case is inserted into the behavior defined for the base use case. |

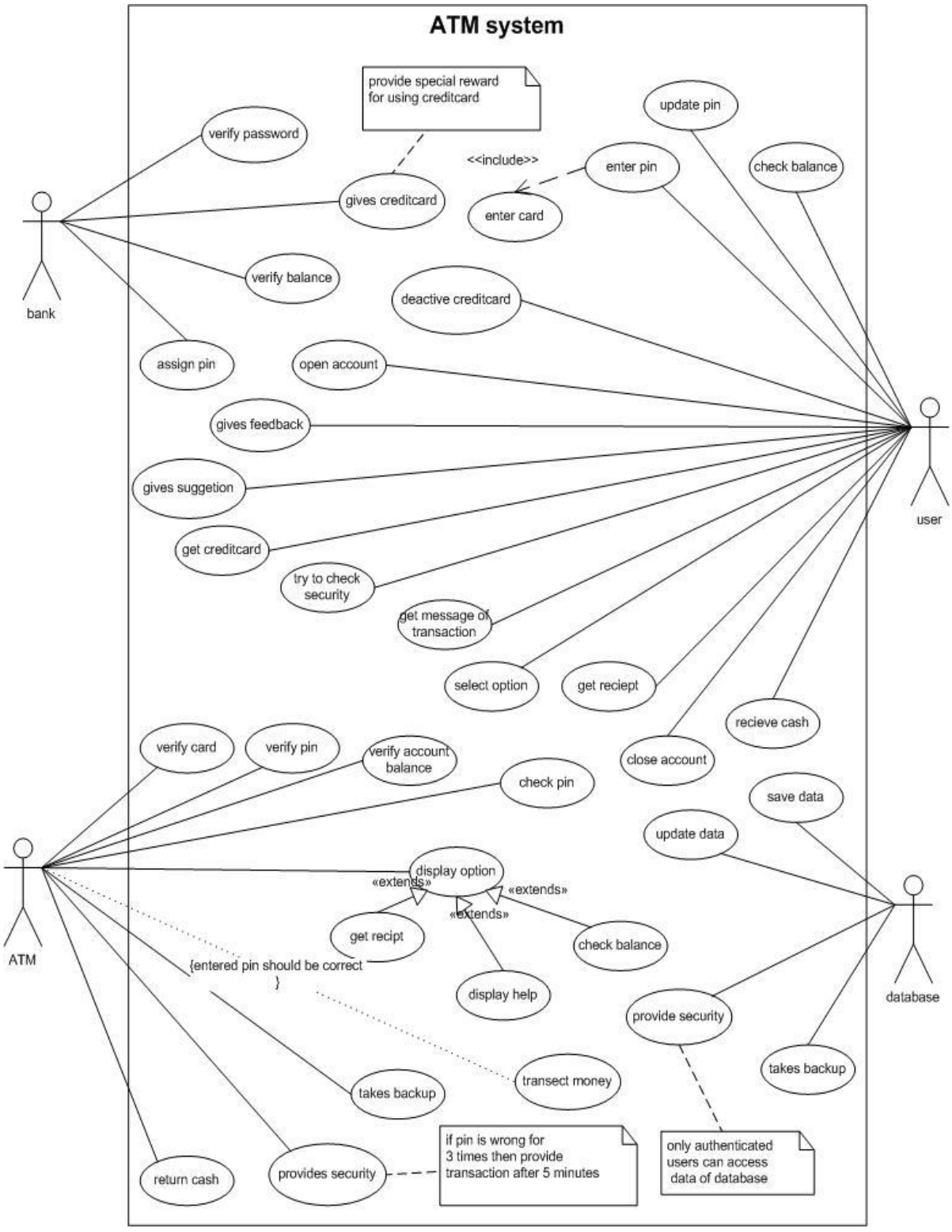
| | | | |
|---|---|---|---|
| 7 | Extends |  | An extend relationship specifies how the behavior of the extension use case can be inserted into the behavior defined for the base use case. |
| 8 | Constraint |  | Show condition exists between actors an activity. |
| 9 | Package |  | Package is defined as collection of classes. Classes are unified together using a package. |
| 10 | Interface |  | Interface is used to connect package and use-case. Head is linked with package and tail linked with use-case. |
| 11 | Note |  | Note is generally used to write comment in use-case diagram. |
| 12 | Anchor |  | Anchor is used to connect a note the use case in use case diagram |

**Examples:**

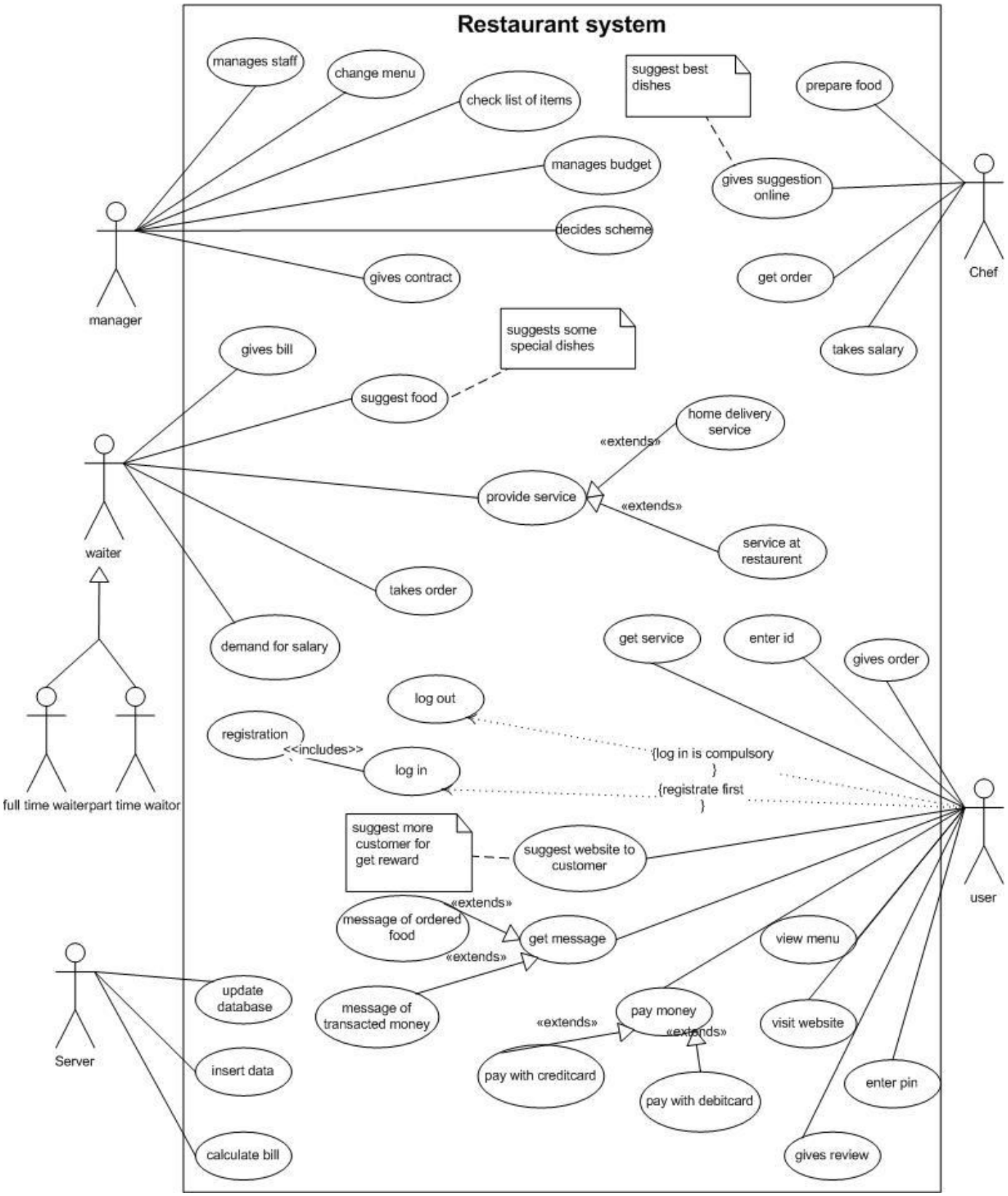
**Draw Use case diagram for Library management System**



**Draw Use-case Diagram For ATM System**



**Draw Use-case diagram for online restaurant system**



**Draw Use-case for Online Reservation System**

**Draw Use-case diagram for online shopping system**

# Class Diagram

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**Introduction**

- The class diagram is a static diagram.
- A class model captures the static structure of a system by characterizing the objects in the system, the relationship between the objects, and the attributes and operations for each class of objects.
- The class diagram can be mapped directly with object oriented languages.
- The class model is the most important amonethe three models.
- Class diagram provide a graphical notation for modeling classes and their relationship.
- They are concise, easy to understand, and work well in practice.
- Class diagrams are the backbone of almost every object-oriented method including UML.
- They describe the static structure of a system.

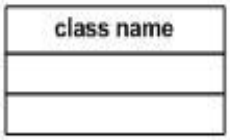
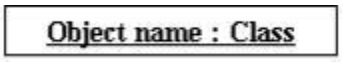
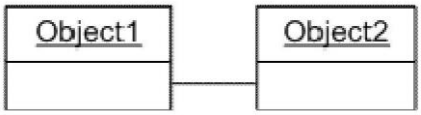
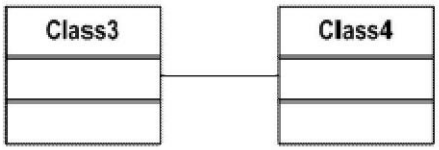
**Purpose**

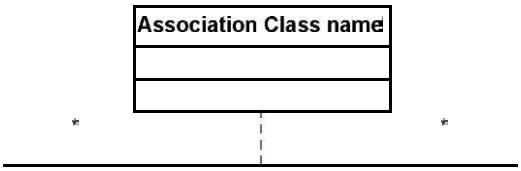
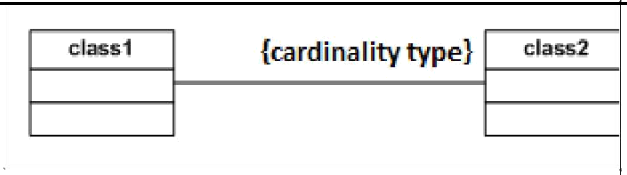
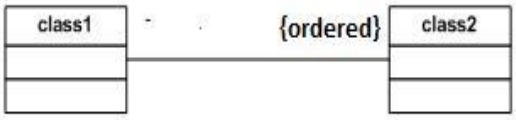
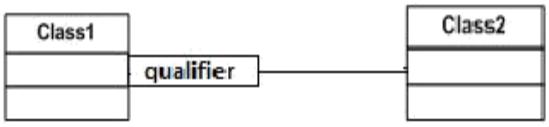
- Analysis and design of the static view of an application.
- Describe responsibilities of a system.
- Base for component and deployment diagrams.

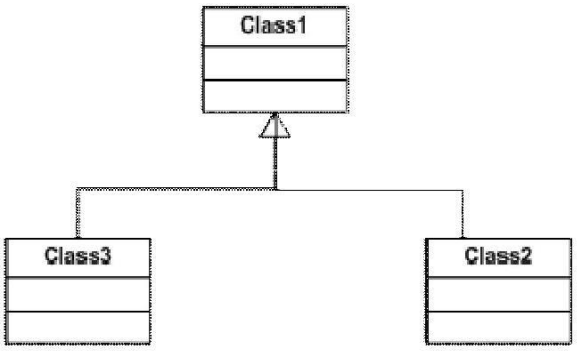
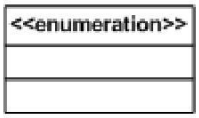
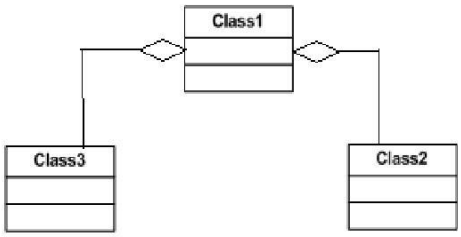
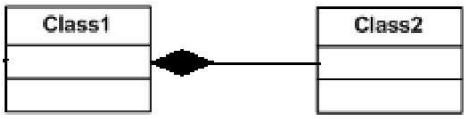
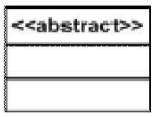
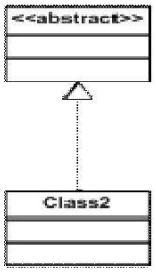
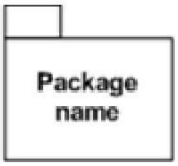
**When to use : Class Diagram**

- Useful for Forward and Reverse engineering.
- Class diagrams are useful both for abstract modeling and for designing actual programs.
- Developer uses class diagram for implementation decision.
- Business analysts can use class diagrams to model systems from the business perspective.

**Class Diagram Notations**

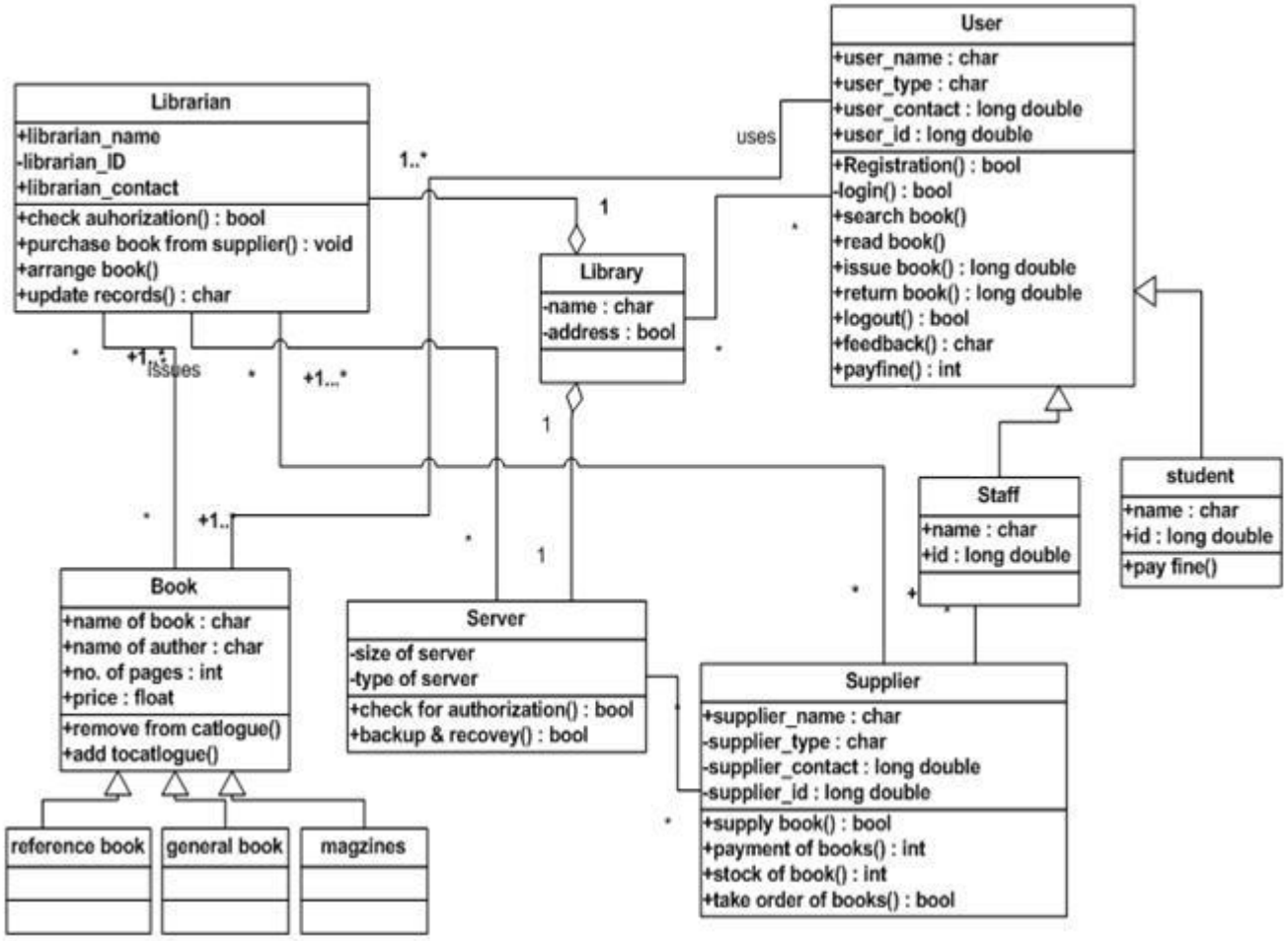
| Sr. No. | Name | Symbol | Meaning |
|---|---|---|---|
| 1. | Class |   | Class is an entity of the class diagram. It describes a group of objects with same properties & behavior. |
| 2. | Object |   | An object is an instance or occurrence of a class. |
| 3. | Link |   | A link is a physical or conceptual connection among objects |
| 4. | Association |   | An association is a description of a links with common structure & common semantics. |
| 5. | Multiplicity | Ex.<br>1 to 1<br>1 to *<br>* to *<br>* to 1<br>1 to 0….2<br>   | Multiplicity specifies the number of instances of one class that may relate to a single instance of an associated class.<br>It is a constraint on the cardinality of a set. |

| | | | |
|---|---|---|---|
| 6. | Association class |  | It is an association that is a class which describes the association with attributes. |
| 7. | cardinality |  | It describes the count of elements from collection. |
| 8. | ordering |  | It is used to indicate an ordered set of objects with no duplication allowed. |
| 9. | bag |  | A bag is a collection of unordered elements with duplicates allowed. |
| 10. | sequence |  | A sequence is an ordered collection of elements with duplicates allowed. |
| 11. | qualified association |  | Qualification increases the precision of a model. It is used to avoid many to many multiplicities and it converts into one to one multiplicity. |

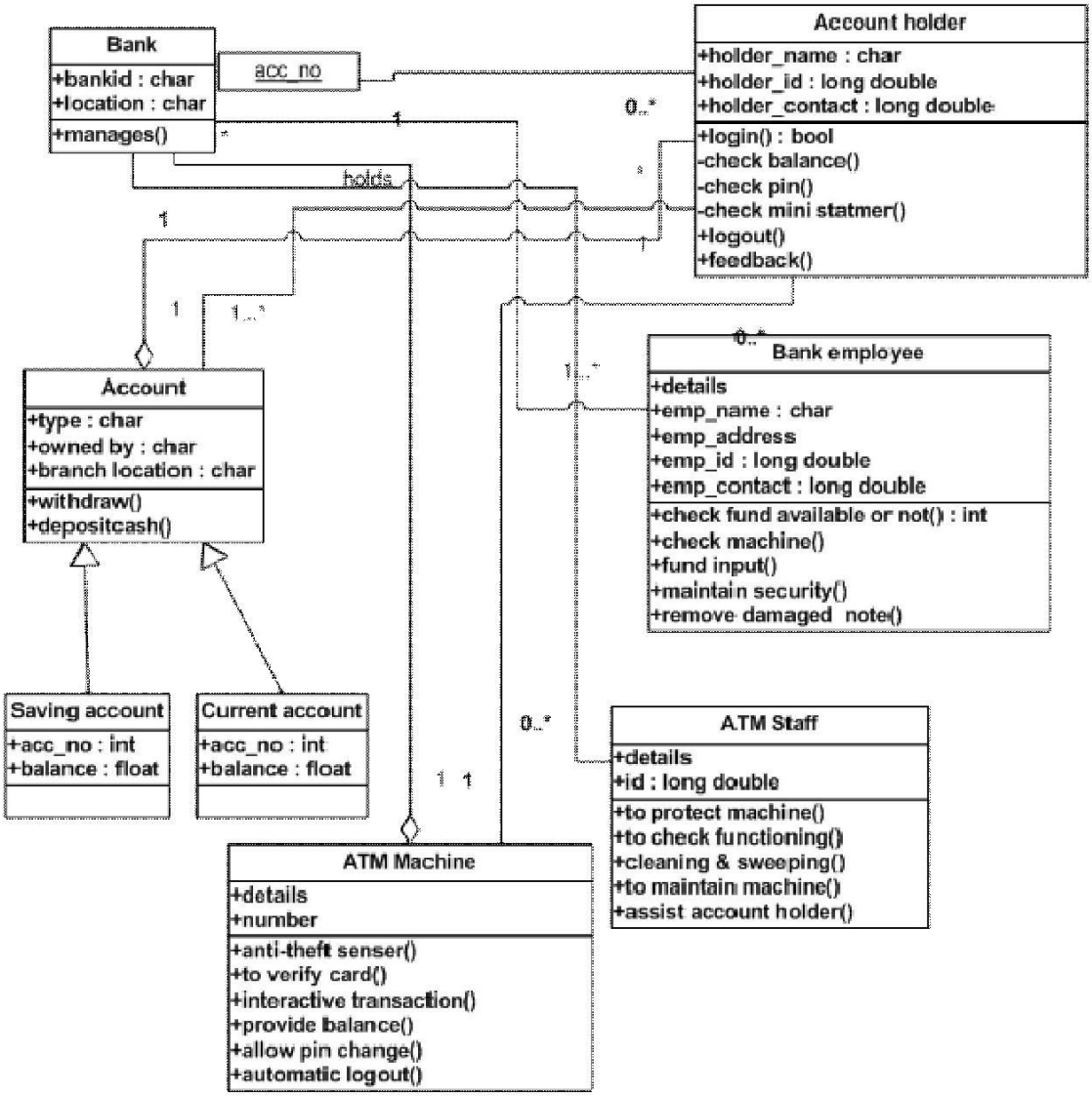
| | | | |
|---|---|---|---|
| 12. | generalization |  | Generalization organizes classes by their super-class and sub-class relationship. |
| 13. | enumeration |  | An enumeration is a data type that has a finite set of values. |
| 14. | aggregation |  | It is a strong form of association in which an aggregate object is made of constituent parts. |
| 15. | composition |  | It is a form of aggregation. Composition implies ownership of the parts by the whole. |
| 16. | Abstract class |  | It is a class that has no direct instances. |
| 17. | Concrete class |  | It is a class that is intangible; it can have direct instances. Class-2 is example of concrete class |
| 18. | package |  | A package is a group of elements with common theme. |

**Examples:**

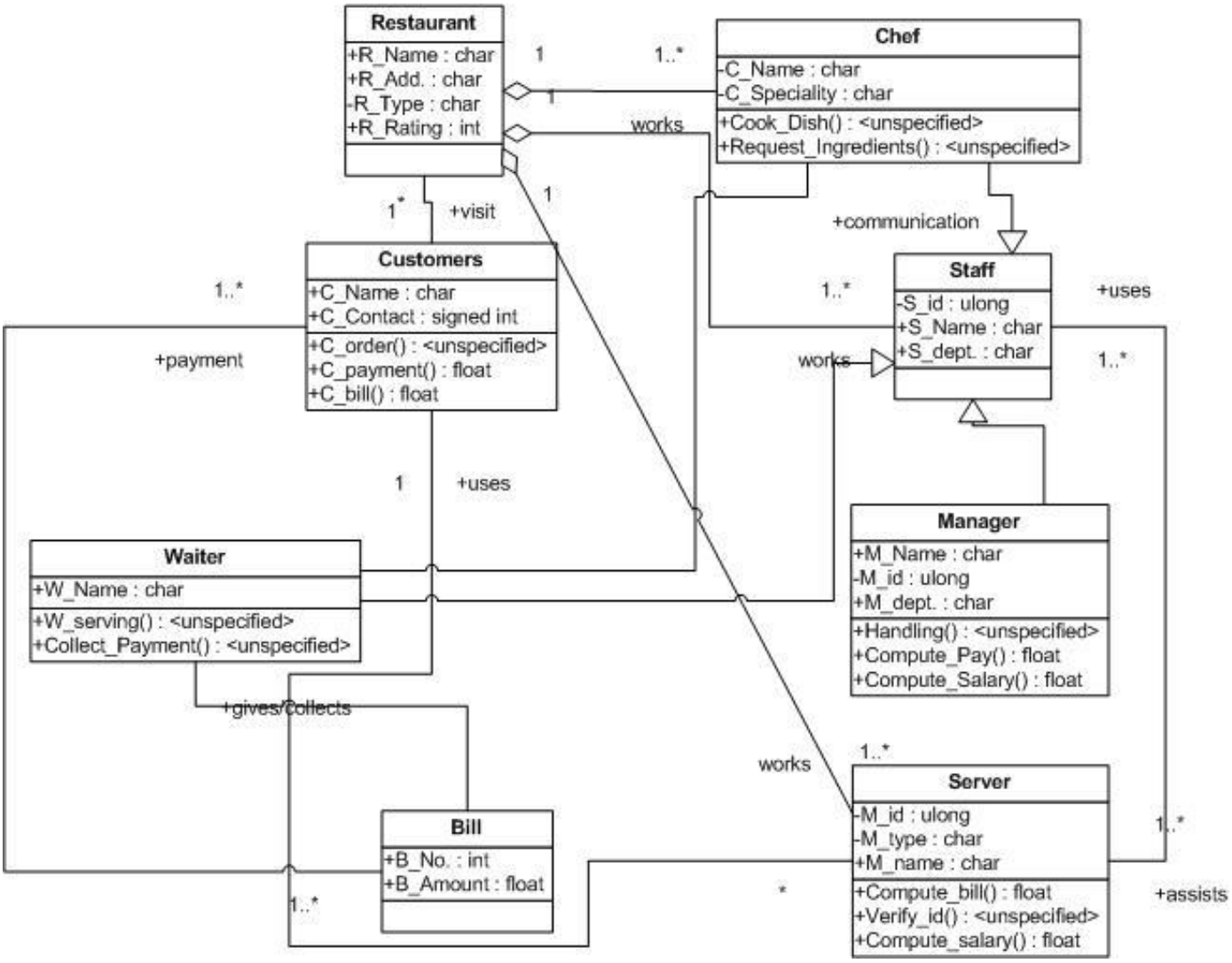
**Class Diagram for Library Management System**



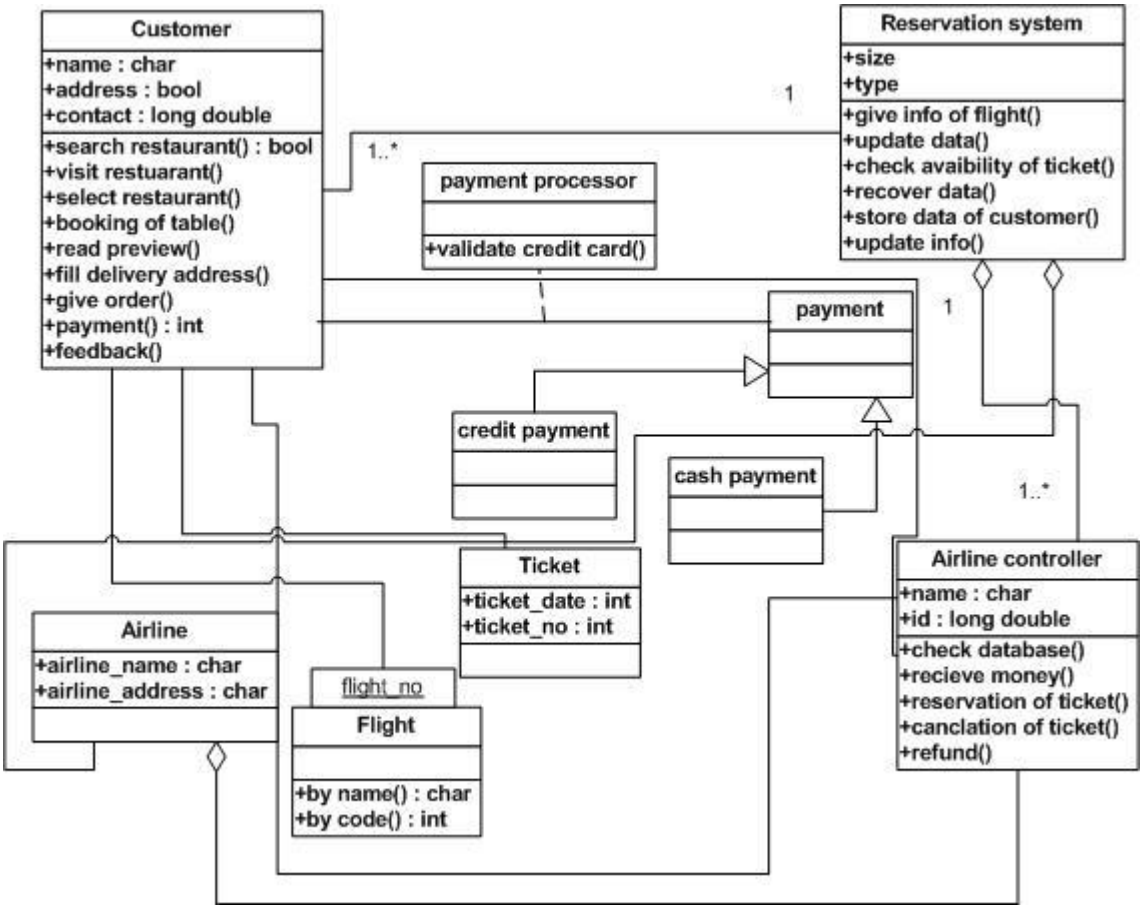
**Class Diagram for ATM**



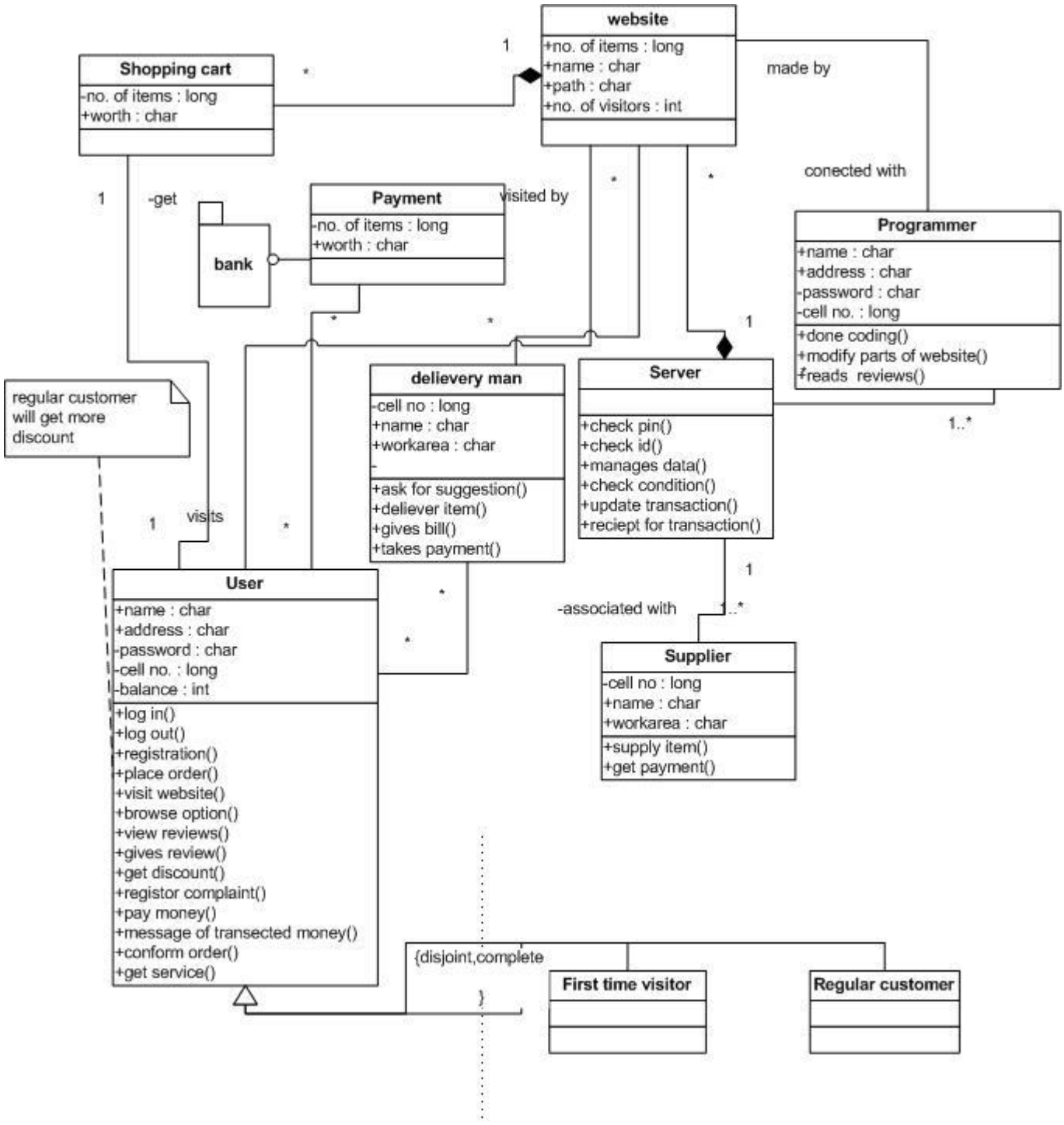
**Class Diagram for Online Restaurant System**



**Class Diagram for Online Reservation System**

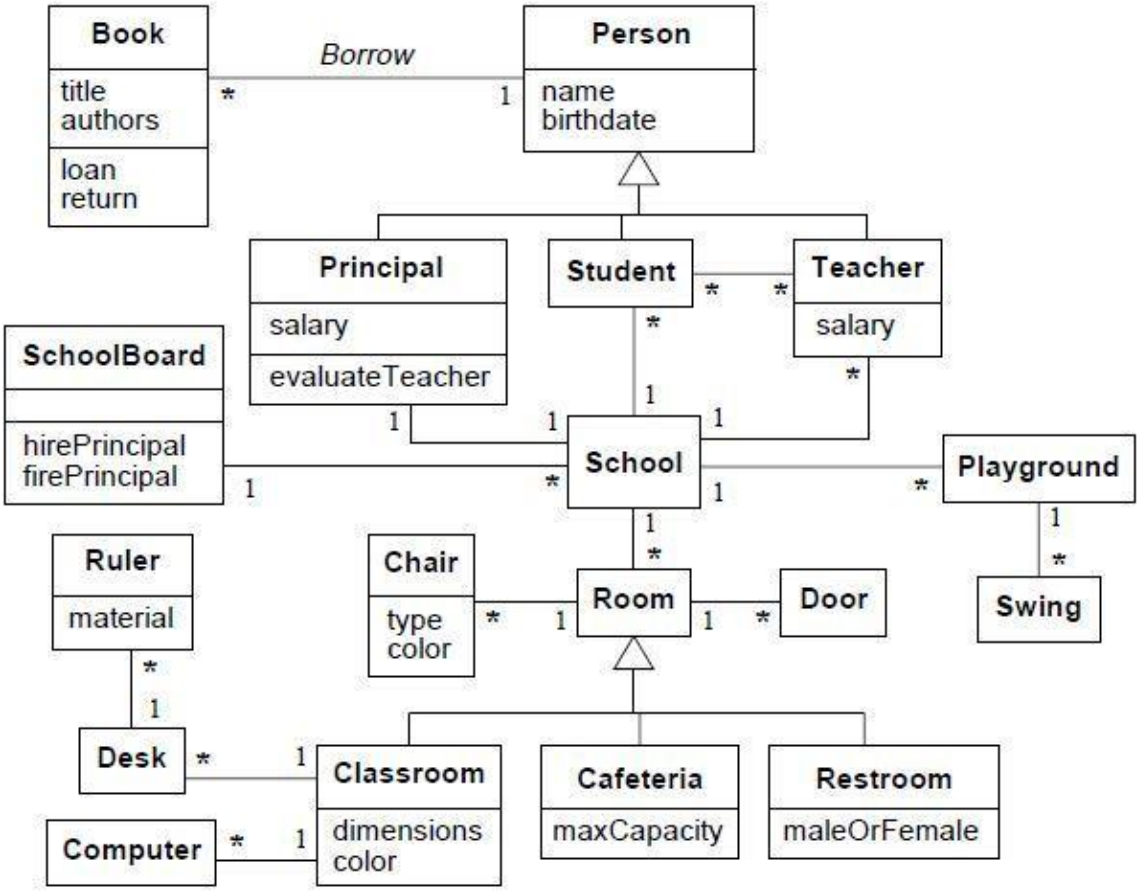


**Class Diagram for Online Shopping System**

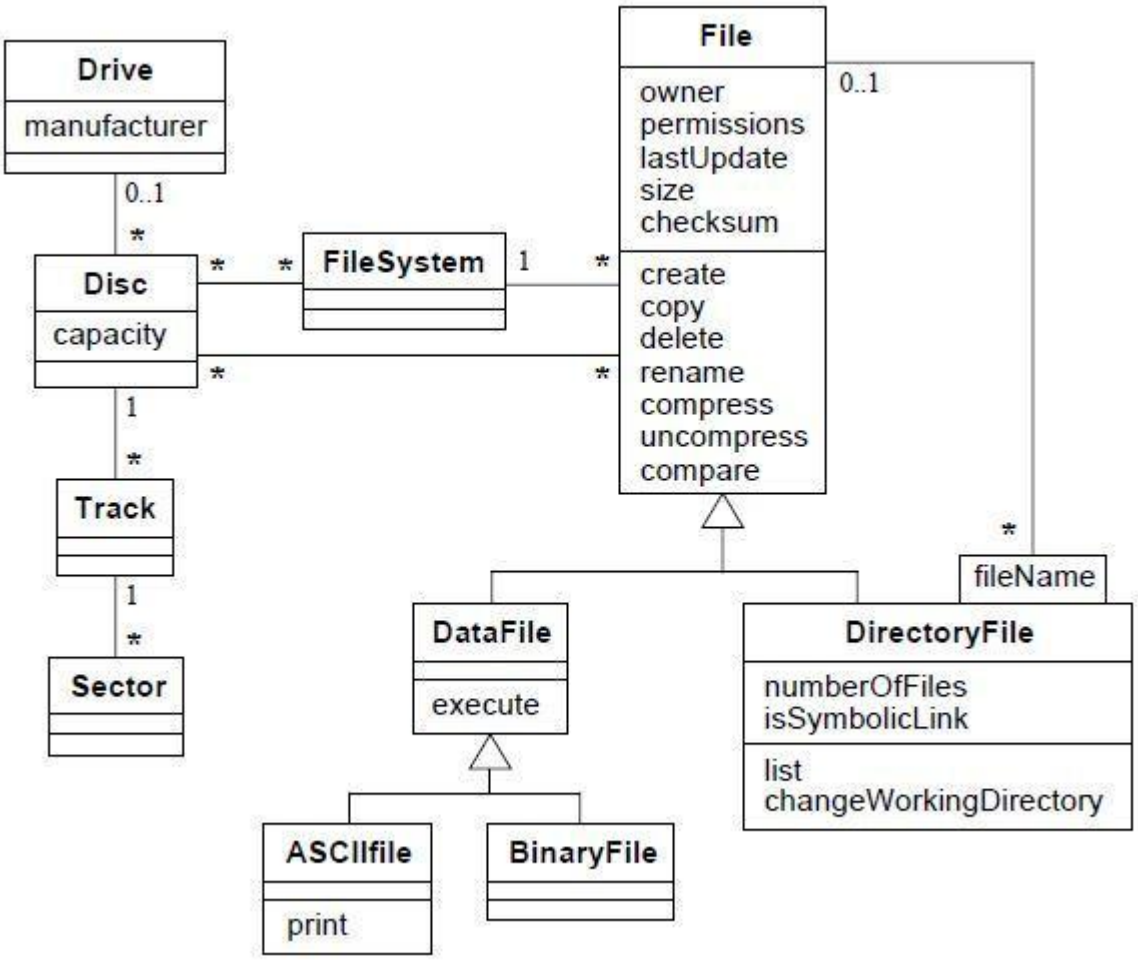


# Additional Diagram : Class Diagram

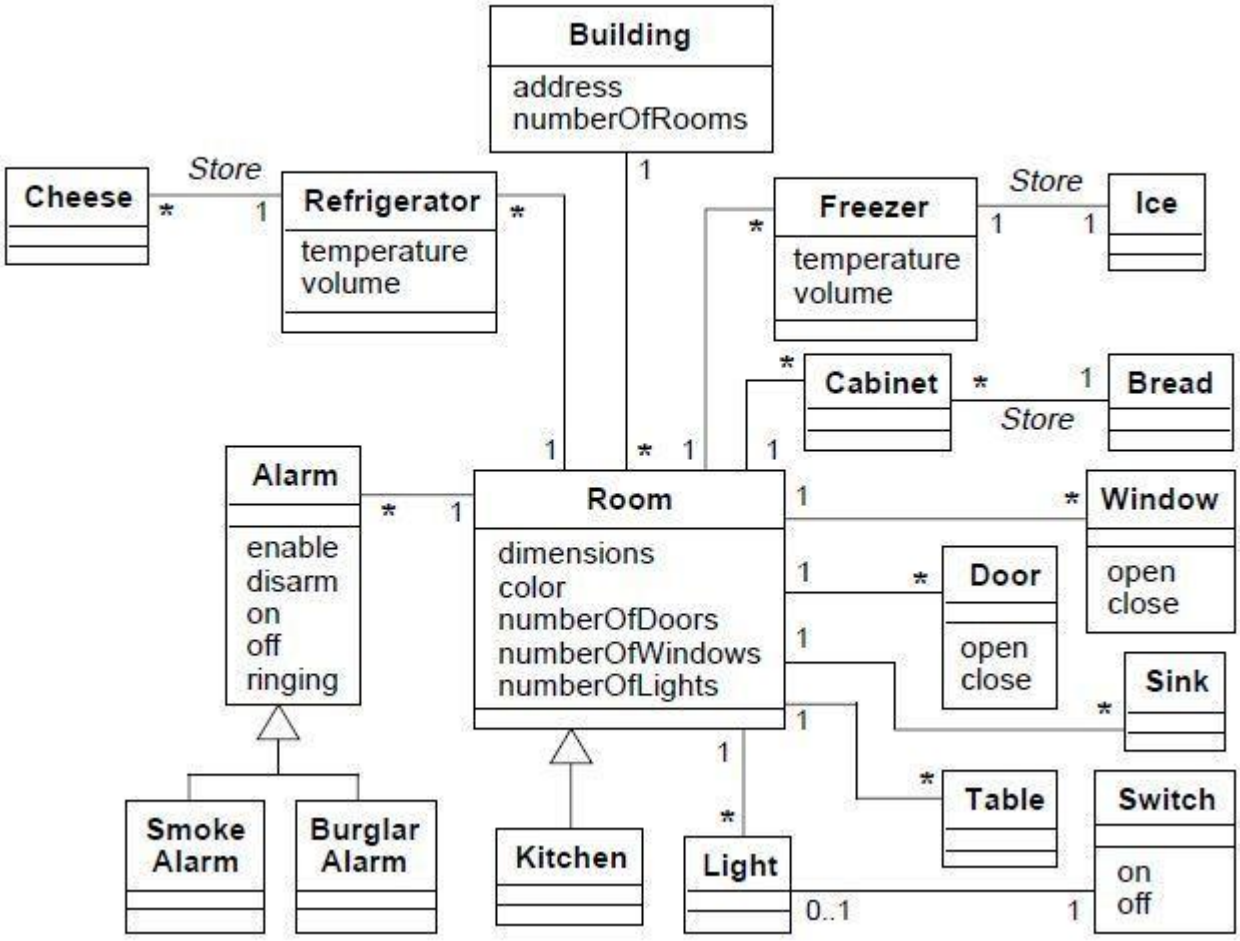
**1 Prepare Class diagram showing at least 10 relationships among the following object classes. Include associations and qualified associations, aggregations, generalizations, and multiplicity. You may add additional objects. Also show attributes and operations. School, playground, principal, school board, classroom, book, student, teacher, canteen, restroom, computer, desk, chair.**



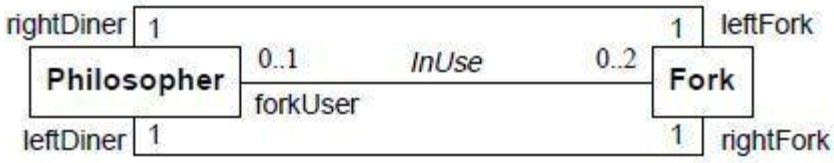
**2 Prepare a class diagram for each group of classes. Add at least 10 relationships (associations and generalizations) to each diagram. File system, file, ASCII file, binary file, directory file, disc, drive, track, and sector.**



**3 Prepare a class diagram for group of classes. Sink, freezer, refrigerator, table, light, switch, window, smoke alarm, burglar alarm, cabinet, bread, cheese, ice, door, kitchen**




**4 Prepare a class diagram for the dining philosopher problem. There are 5 philosophers and 5 forks around a circular table. Each philosopher has access to 2 forks, one on either side. Each fork is shared by 2 philosophers. Each fork may be either on the table or in use by one philosopher. A philosopher must have 2 forks to eat.**



**5 Categorize the following relationships into generalization, aggregation or association. Justify your answer.**

**i. A country has a capital city.**

Association. A capital city and a country are distinct things so generalization certainly does not apply. You could argue that a capital city is a part of a country and thus they are related by aggregation.

**ii. A file is an ordinary file or a directory file.**

Generalization. The word "or" often is an indicator of generalization. *File* is the super class and *Ordinary File* and *Directory File* are subclasses.

**iii. Files contain records.**

Aggregation. The word "contain" is a clue that the relationship may be aggregation. A record is a part of a file. Some attributes and operations on files propagate to their constituent records.

**iv. A polygon is composed of an ordered set of points.**

Aggregation or Composition. The phrase "is composed of" should immediately make you suspicious that there is an aggregation. An ordered set of points is a part of a polygon. Some attributes and operations on a polygon propagate to the corresponding set of points.

**v. A drawing object is text, a geometrical object, or a group.**

Generalization. Once again, the word "or" should prompt you to think of generalization. *DrawingObject* is the super class. *Text*, *Geometrical Object*, and *Group* are subclasses.

**vi. A route connects two cities.**

Association. Either *Route* is a class associated with the *City* class, or *Route* is the name of the association from *City* to *City*.

**vii. A student takes a course from a professor.**

Ternary association. *Student*, *Course*, and *Professor* are distinct classes of equal stature.

**viii. A person uses a computer language on a project**.

Ternary association. *Person*, *Computer Language*, and *Project* are all classes of equal stature. The association cannot be reduced to binary associations. None of these classes are a-kind-of or a-part-of another class. Thus generalization and aggregation do not apply.

**ix. Modems and keyboards are input / output devices.**

Generalization. The keyword "are" is the clue. Modem and Keyboard are the subclasses; InputOutputDevice is the super class.

**x. Classes may have several attributes.**

Association or aggregation. It depends on your perspective and the purpose of the model whether aggregation applies.

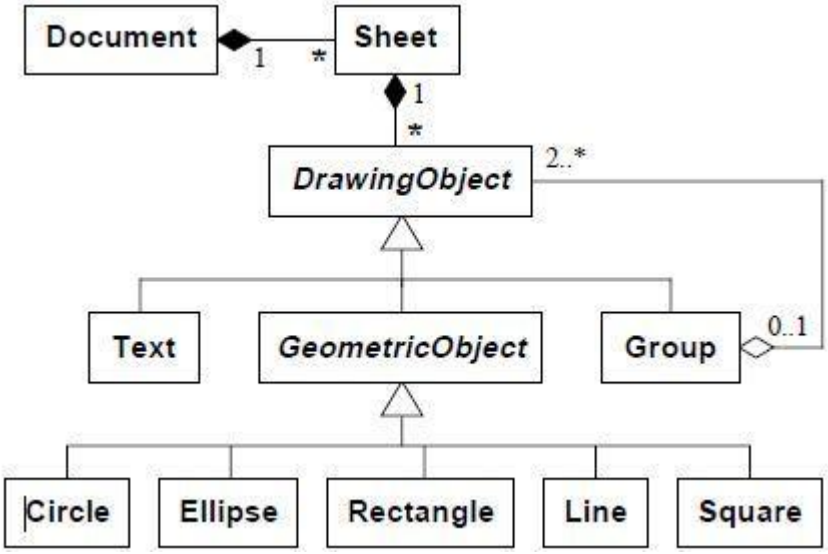
**xi. A person plays for a team in a certain year.**

Ternary association. *Person*, *Team*, and *Year* are distinct classes of equal stature.

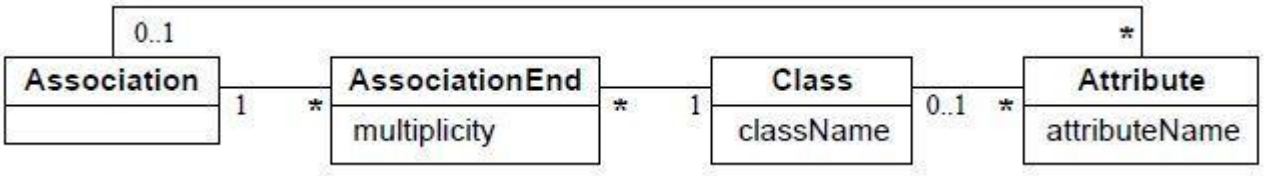
**xii. A dining philosopher uses a fork.**

Association. Dining philosophers and forks are completely distinct things and are therefore not in a generalization relationship. Similarly, neither object is a part of the other nor the relationship is not aggregation.

**5 Prepare a class diagram for a graphical document editor that supports grouping. Assume that a document consists of several sheets. Each sheet contains drawing objects, including text, geometrical objects and groups. A group is simply a set of drawing objects, possibly including other groups. A group must contain at least two drawing objects. A drawing object can be a direct member of at most one group. Geometrical objects include circles, ellipses, rectangles, lines and squares.**




**6 Prepare a meta-model that supports only the following UML concepts: class, attribute, association, association end, multiplicity, class name, and attribute name. Use only these constructs to build meta-model.**



# State Diagram

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**Introduction**

- *A **state diagram** is a graph in which nodes correspond to states and directed arcs correspond to transitions labeled with event names.*
- A state diagram combines states and events in the form of a network to model all possible object states during its life cycle, helping to visualize how an object responds to different stimuli.
- A state diagram is a graph whose nodes are states and whose directed arcs are transitions between states.
- A state diagram specifies the state sequence caused by event sequence.
- State names must be unique within the scope of a state diagram.
- All objects in a class execute the state diagram for that class, which models their common behavior.
- We can implement state diagrams by direct interpretation or by converting the semantics into equivalent programming code.

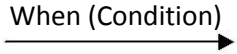
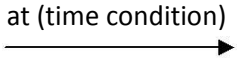
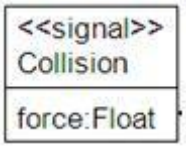
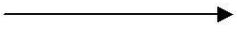
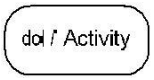
**Purpose**

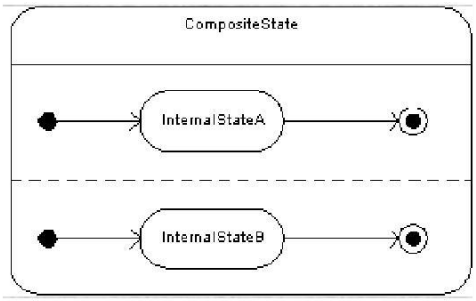
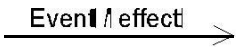
- The state model describes those aspects of objects concerned with time and the sequencing of operations events that mark changes, states that define the context for events, and the organization of events and states.
- They are used to give an abstract description of the behavior of a system.
- It provides direction and guidance to the individual counties within the states.
- It specifies the possible states, what transitions are allowed between states.
- It describes the common behavior for the objects in a class and each object changes its behavior from one state to another.
- It is used to describe the dependence of the functionality on the state of the system that is how the functionality of an object depends on its state and how its state changes as a result of the events that it receives.
- It describes dynamic behavior of the objects of the system.

**When to use: State Diagram**

- They are perfectly useful to model behavior in real time system.
- Each state represents a named condition during the life of an object during which it satisfies some condition or waits for some event.
- It determines how objects of that class react to events.
- For each object state, it determines what actions the object will perform when it receives an event.

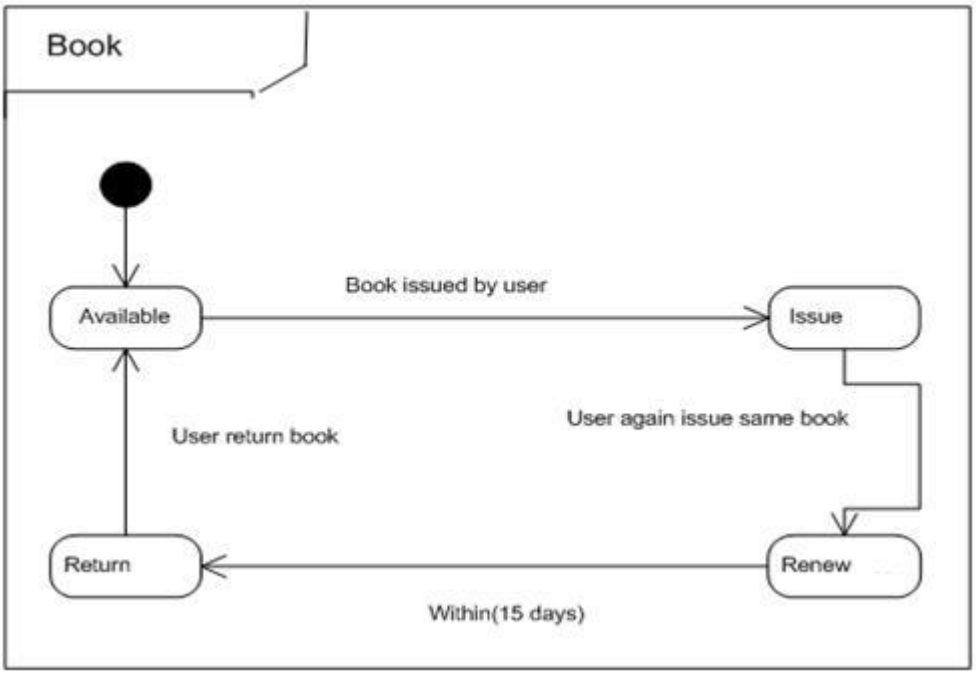
**State Diagram Notations**

| No. | Name | Notation | Description |
|---|---|---|---|
| 1 | State |   | A state is an abstraction of the values and links of an object. State models a situation during which some (usually implicit) invariant condition holds. |
| 2 | Transition |  | A transition is a directed relationship between a source state and a target state. It may be part of a compound transition, which takes the state machine from one state configuration to another |
| 3 | Event |   | A transition is an instantaneous change from one to another state |
| 4 | Change Event |   | A change in value of a Boolean expression |
| 5 | Time Event |   | The arrival of an absolute time or the passage of a relative amount of time |
| 6 | Signal Event |   | Receipt of an explicit, named, asynchronous communication among objects. |
| 7 | Guarded transition |   | A guard condition is a Boolean expression that must be true in order for a transition to occur. |
| 8 | Do activity |   | A do activity an activity that continuous for extended time within state. |

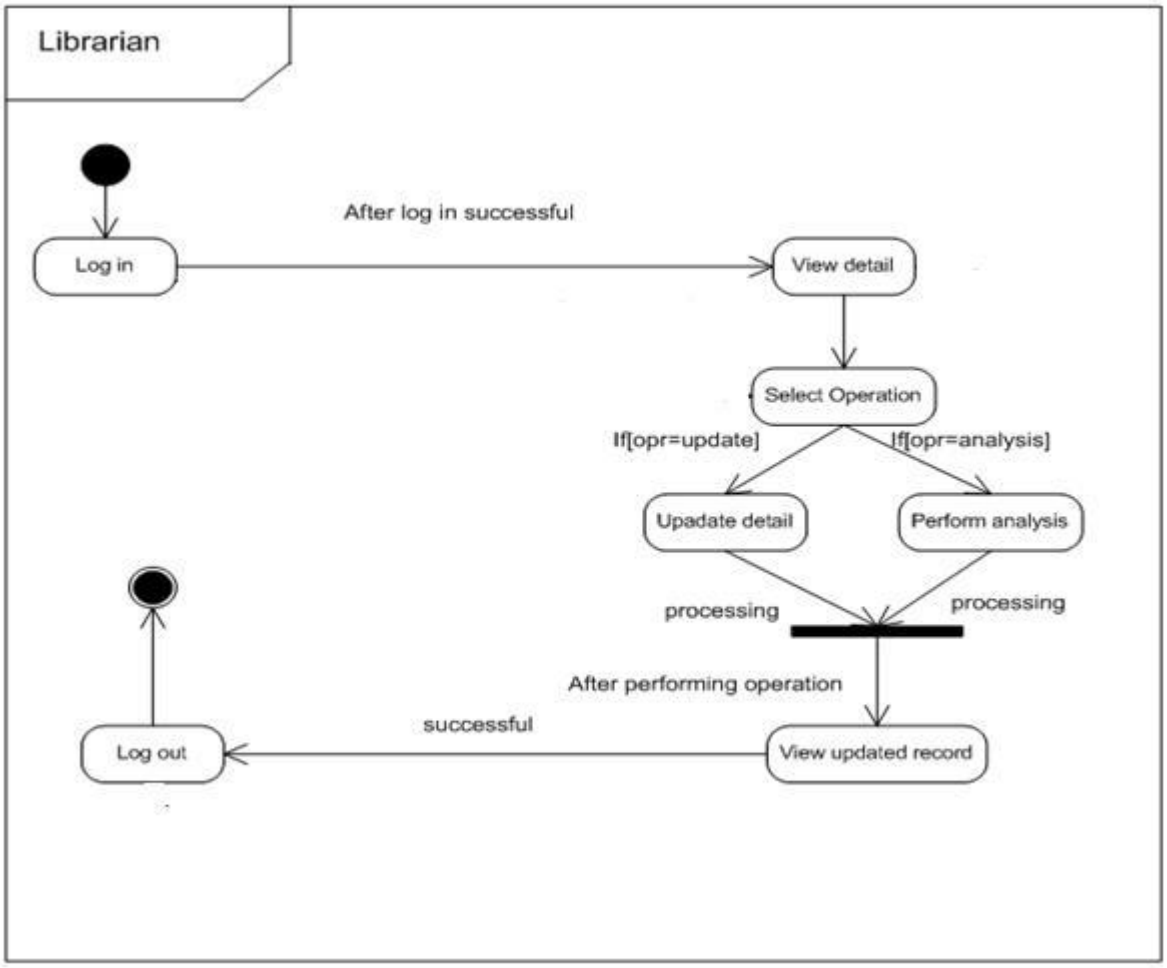
| | | | |
|---|---|---|---|
| 9 | Entry activity | | An state is entered by any incoming transition the entry activity is performed |
| 10 | Exit activity | | When the state is exited by any outgoing transition the exit activity is performed |
| 11 | Nested State Diagram<br><br>Sub machine Diagram |  | A submachine state specifies the insertion of the specification of a submachine. The state machine that contains the submachine state is called the containing state machine. |
| 12 | Composite State |  | A state can be refined hierarchically by composite states. |
| 13 | Activity effect |  | An activity is actual behavior that can be invoked by any number of effects |
| 14 | Initial state point |  | It shows the starting state of object. |
| 15 | Final state point |  | It shows the terminating state of object. |

**Examples:**

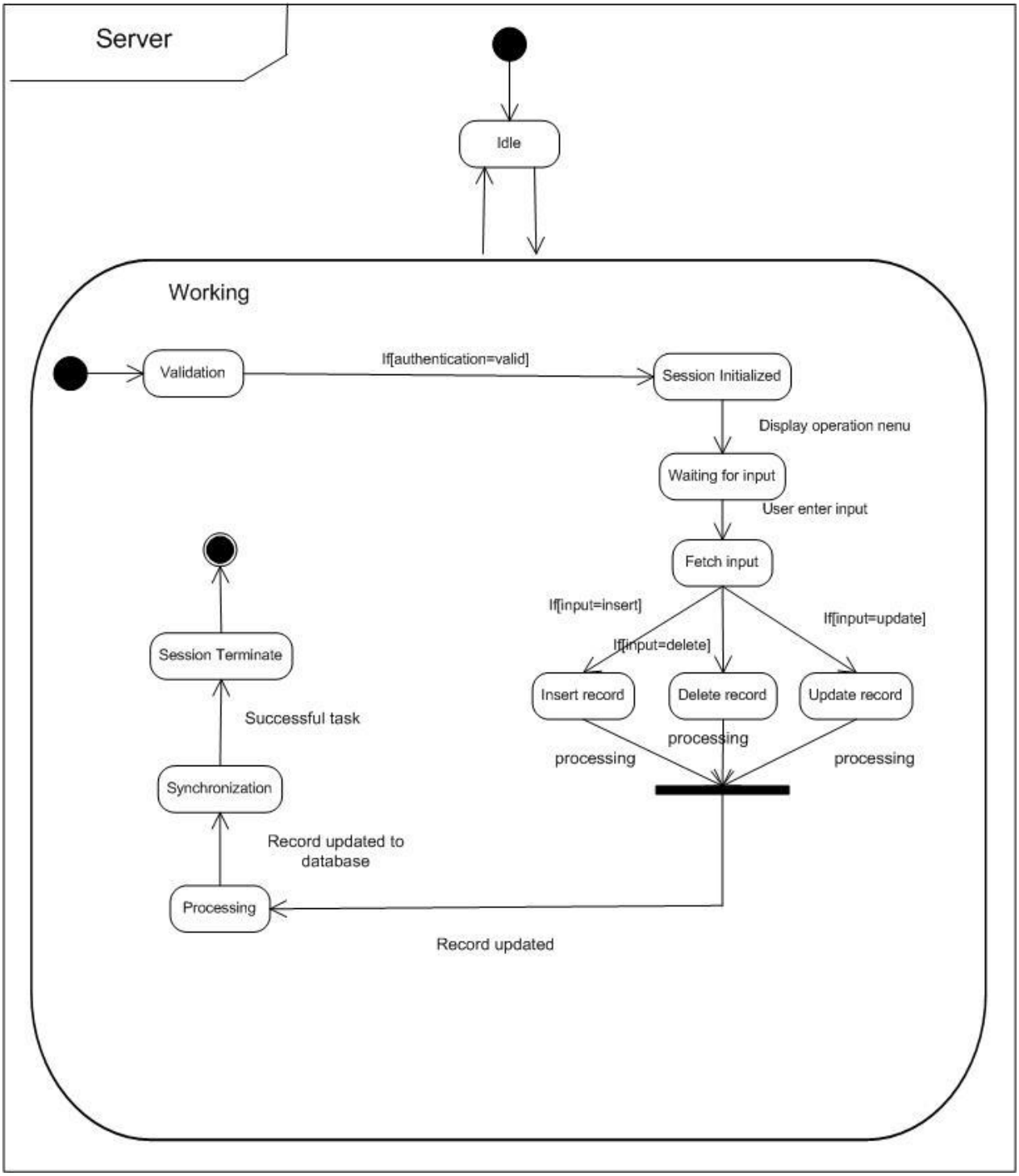
**State diagram for library management system**



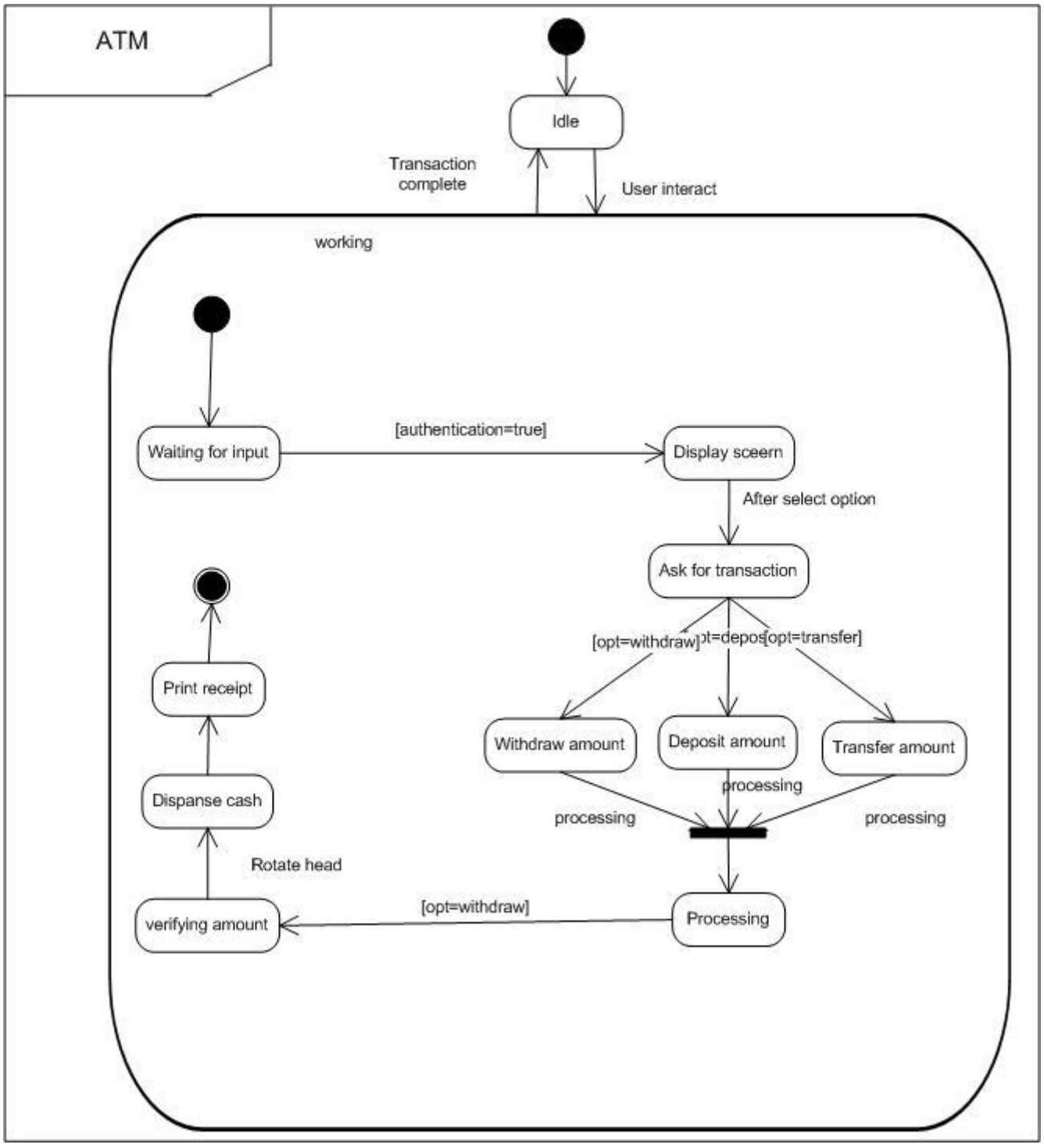
**State diagram for library management system**



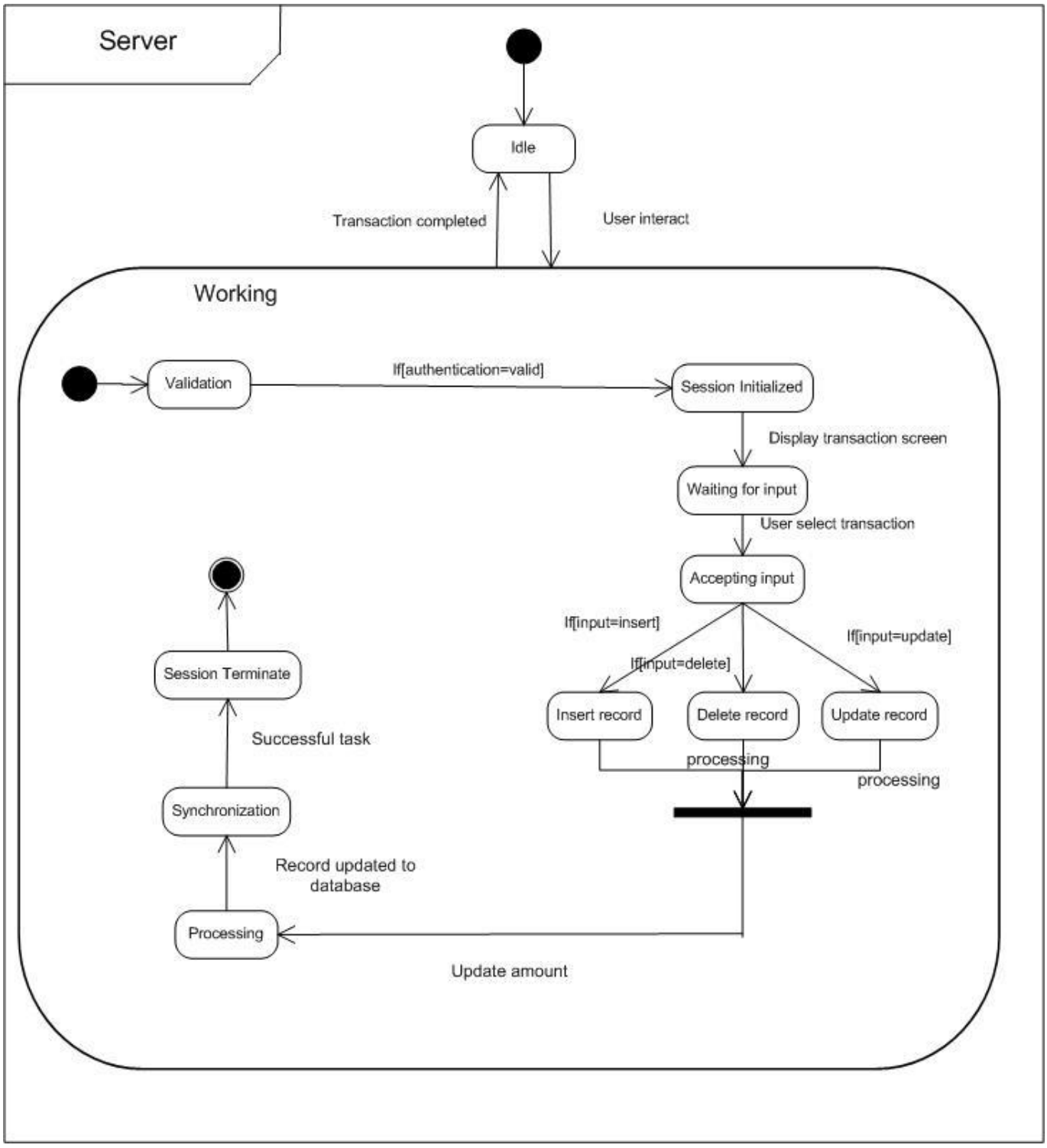
**State diagram for library management system**



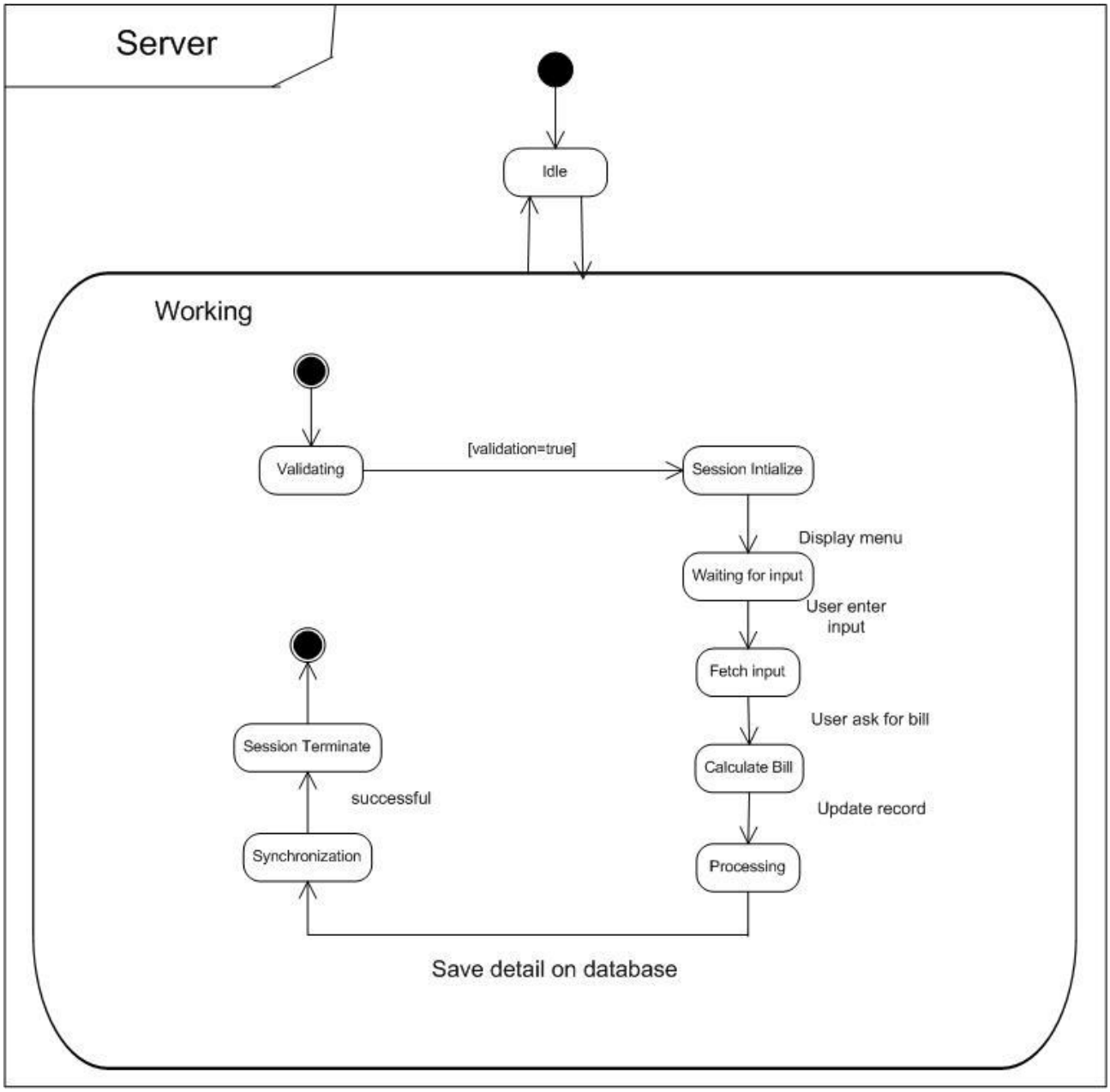
**State diagram for ATM Management System**



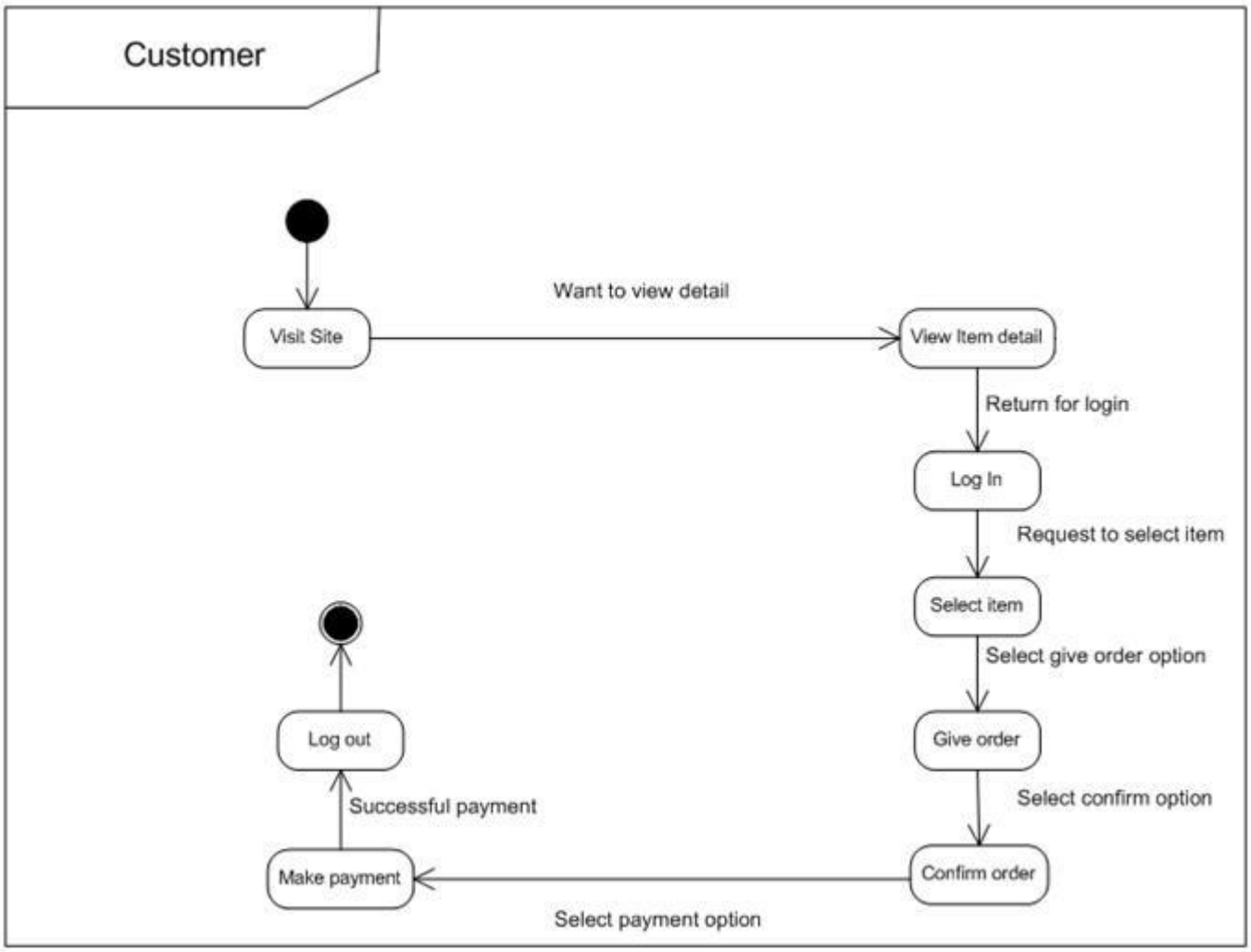
**State diagram for ATM Management System**



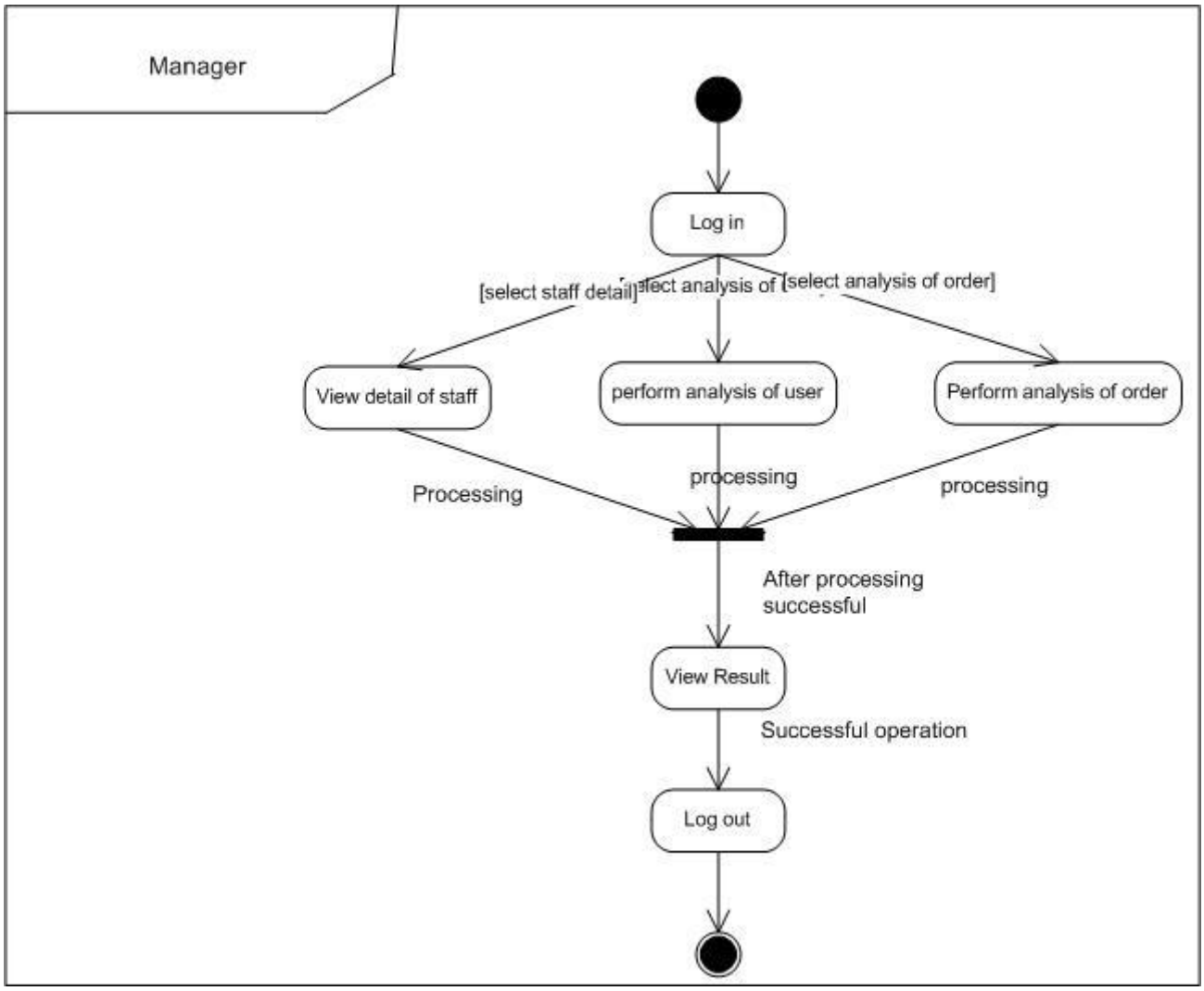
**State diagram for Online Restaurant management**



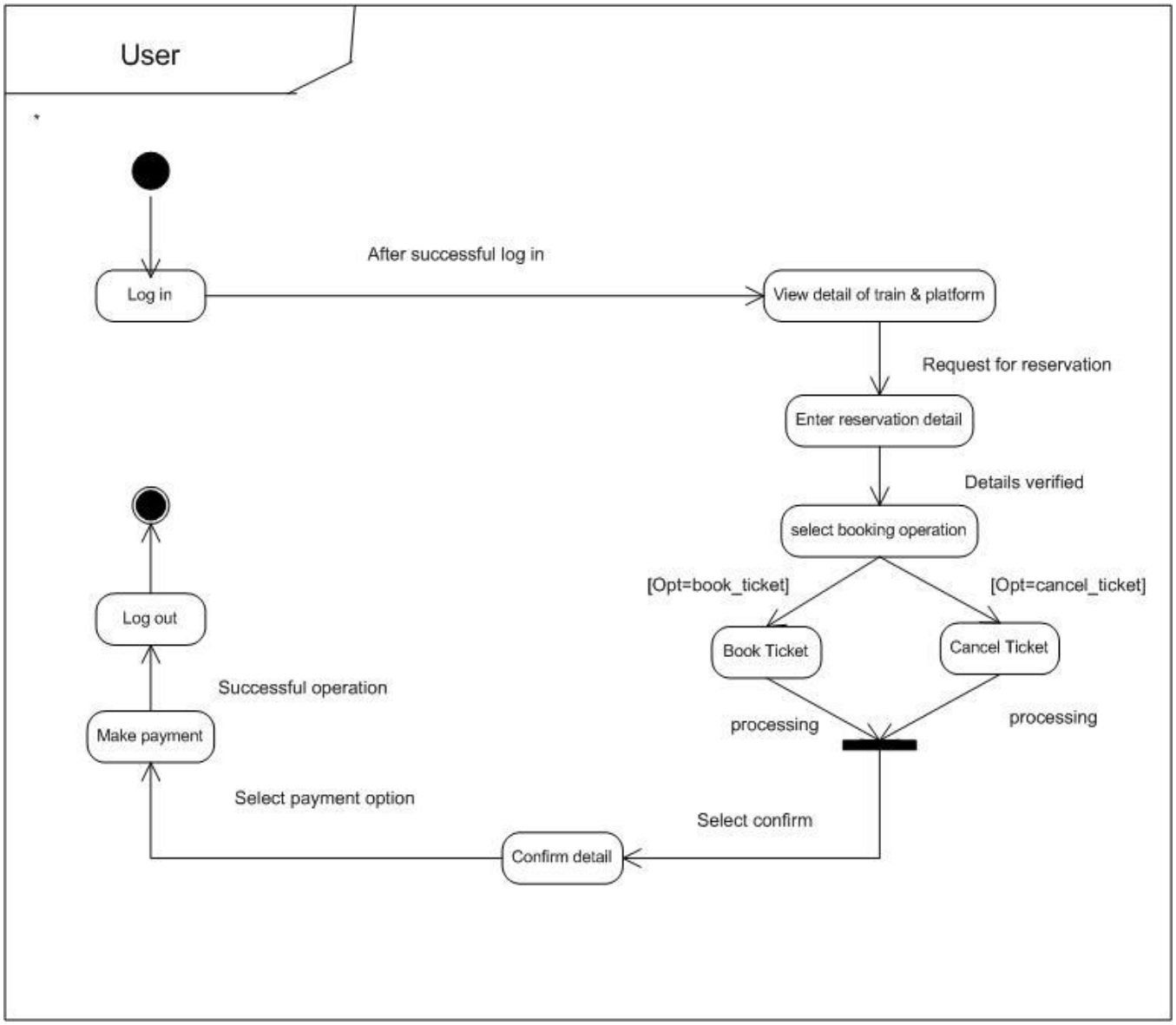
**State diagram for Online Restaurant Management System**



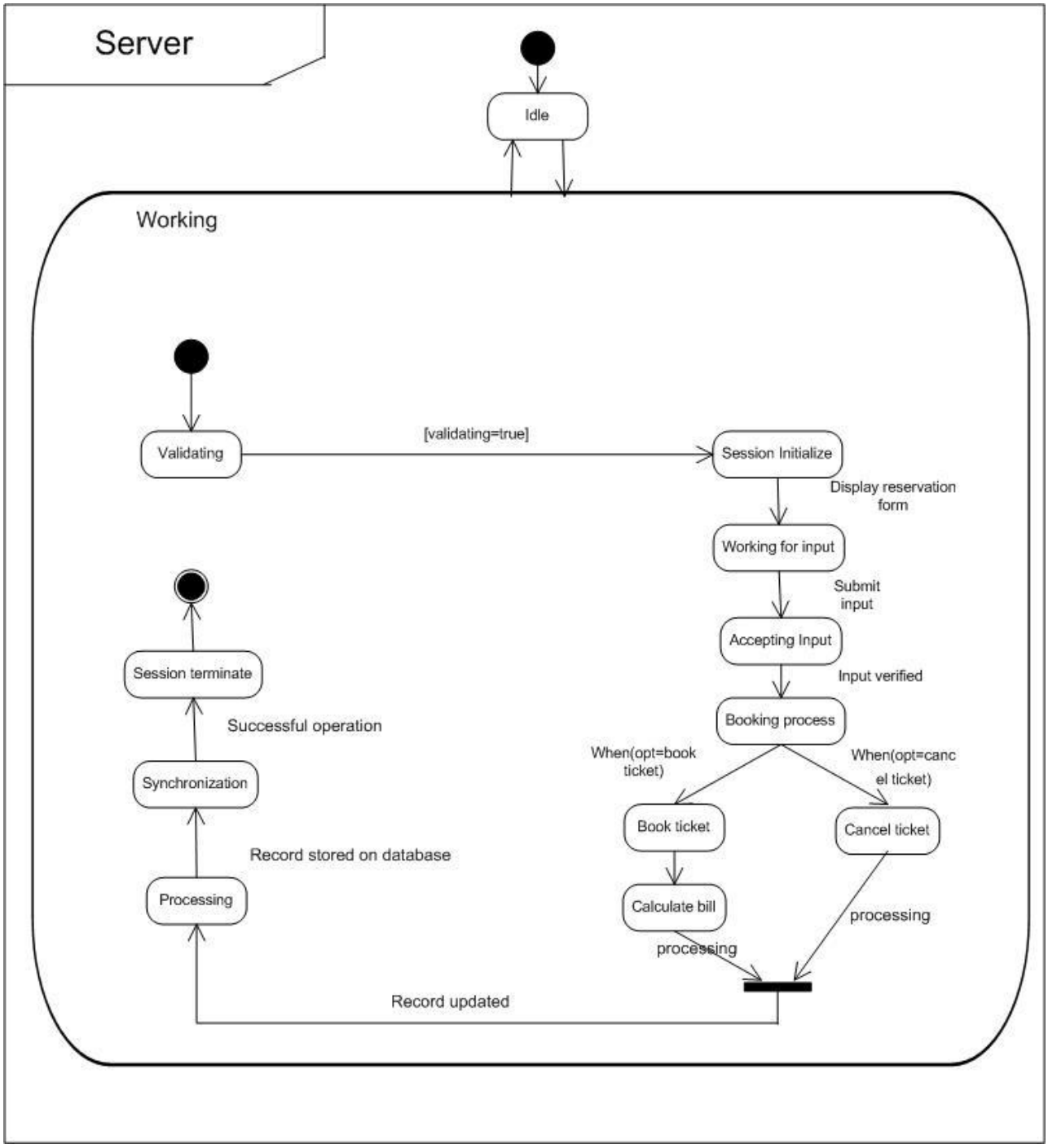
**State diagram for Online Restaurant management**



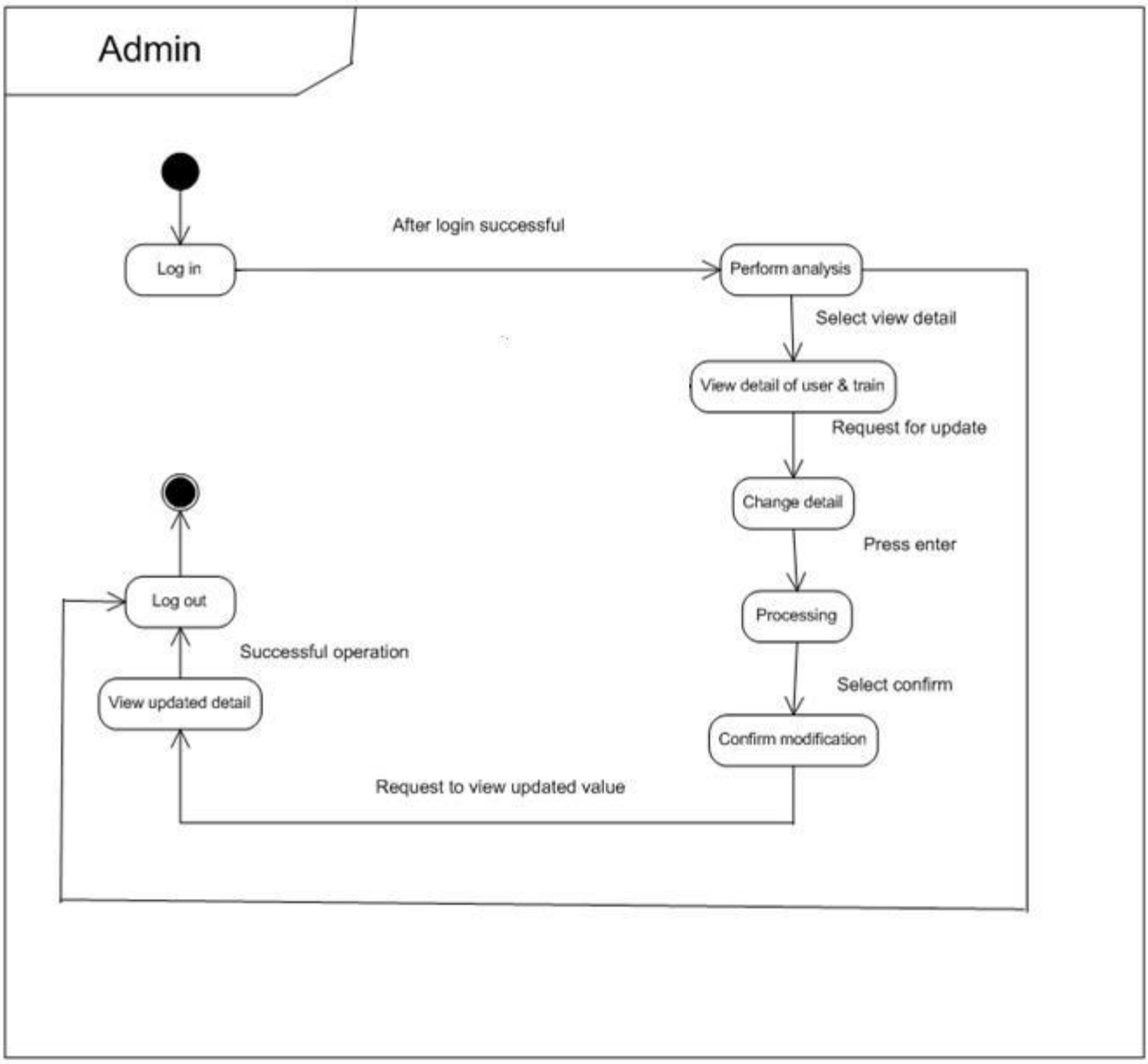
**State diagram for online reservation system**



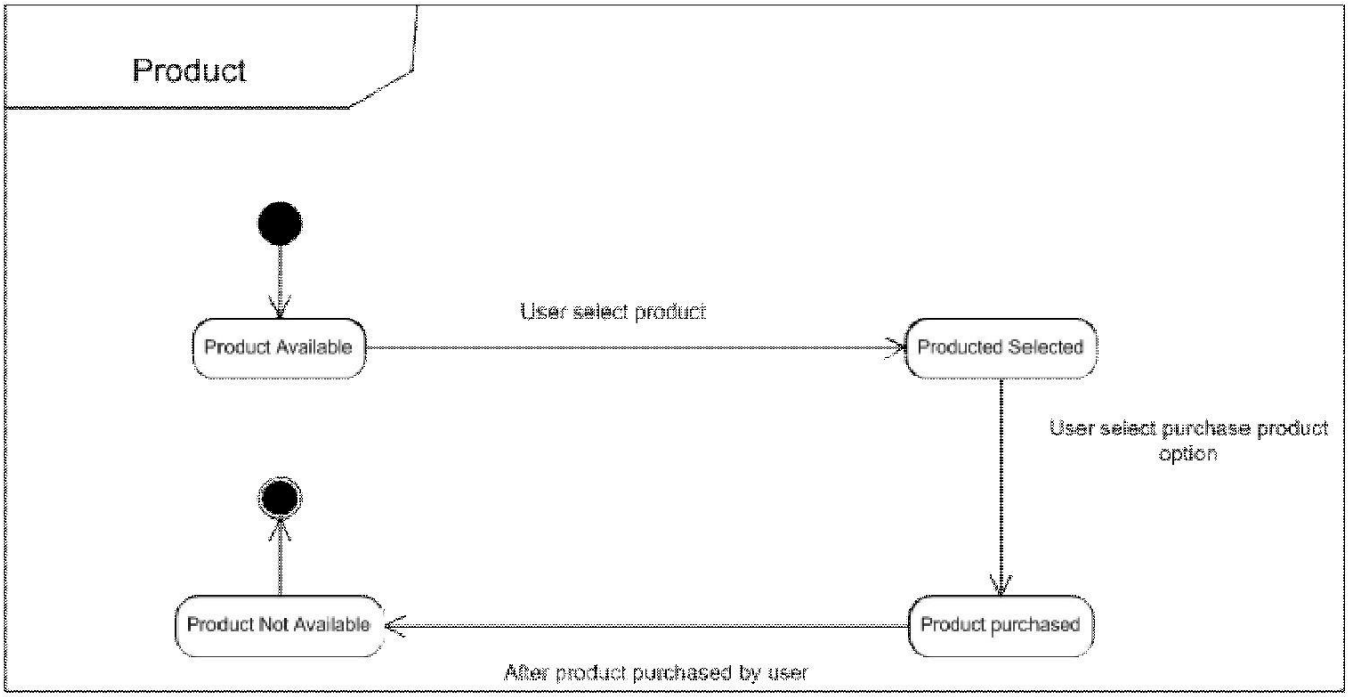
**State diagram for online reservation system**



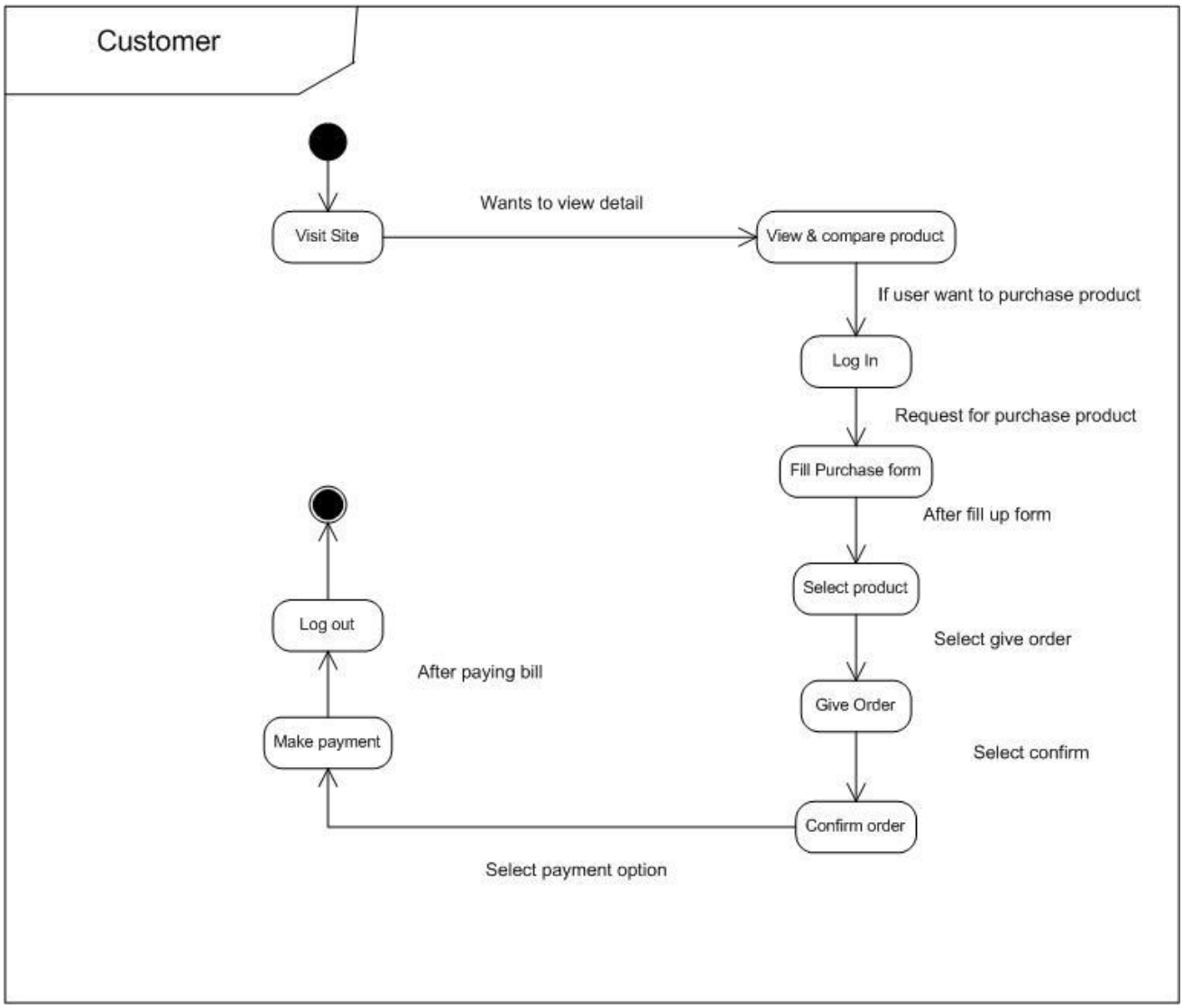
**State diagram for online reservation system**



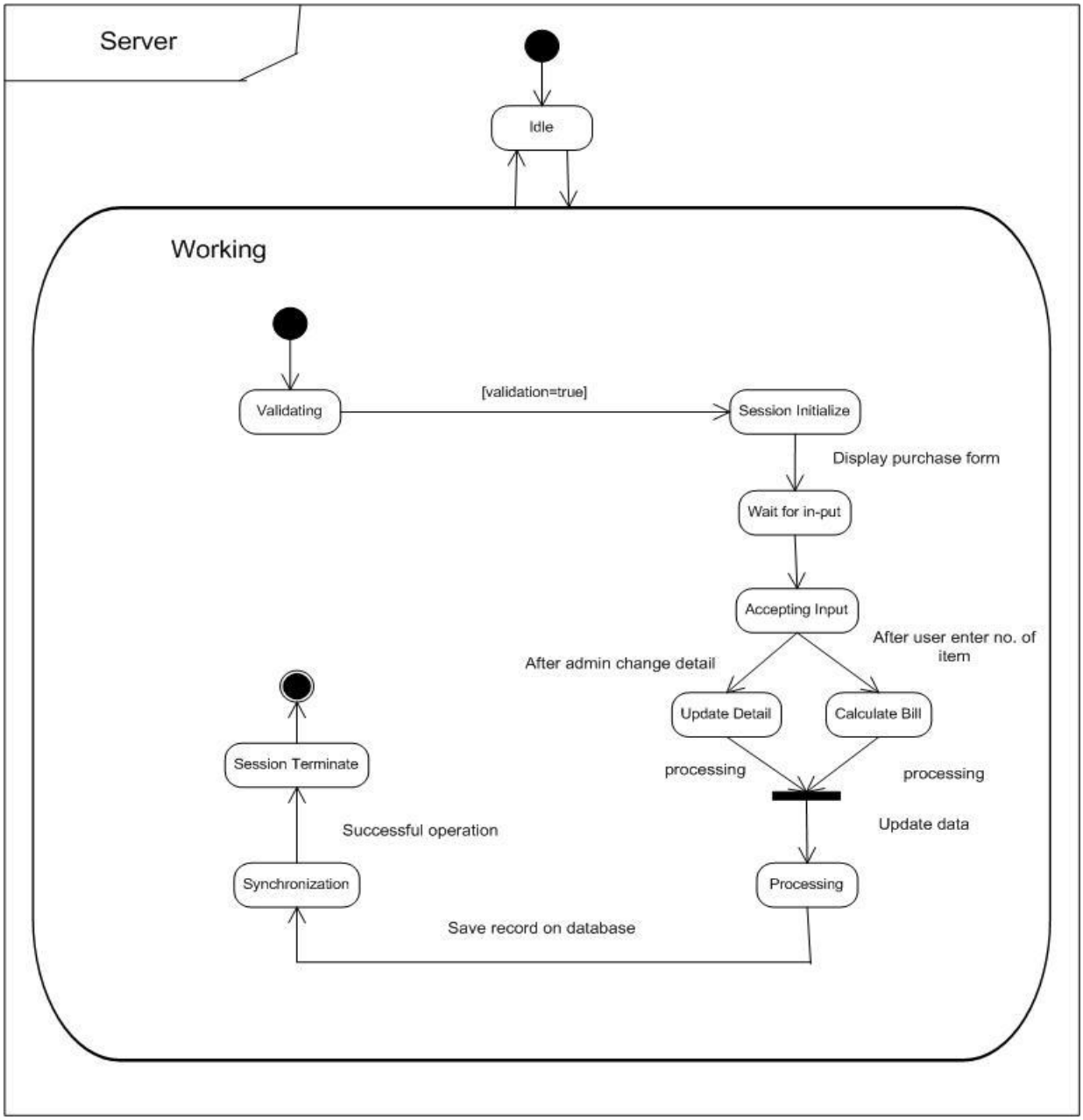
**State diagram for online shopping system**



**State diagram for online shopping system**

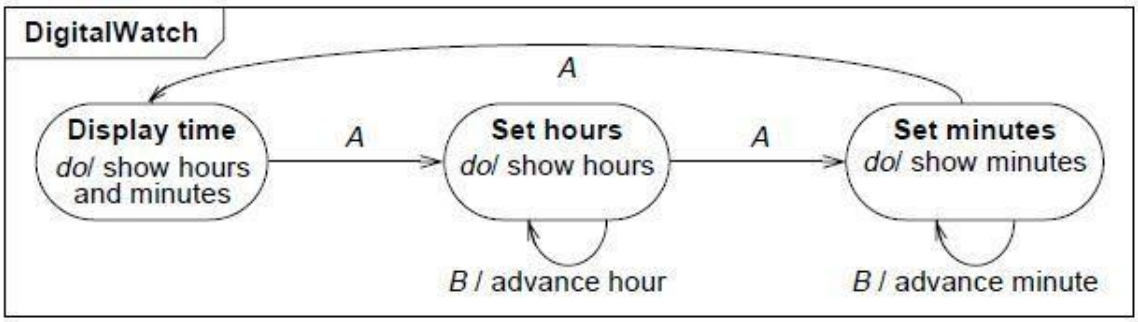


**State diagram for online shopping system**

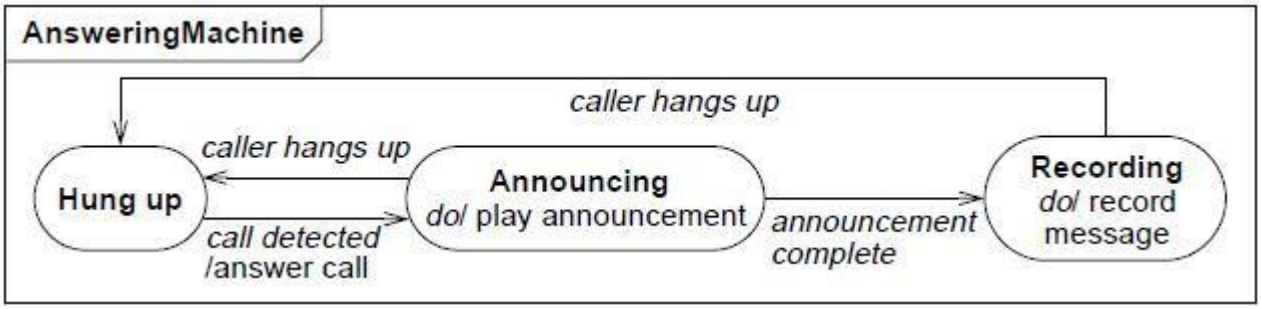


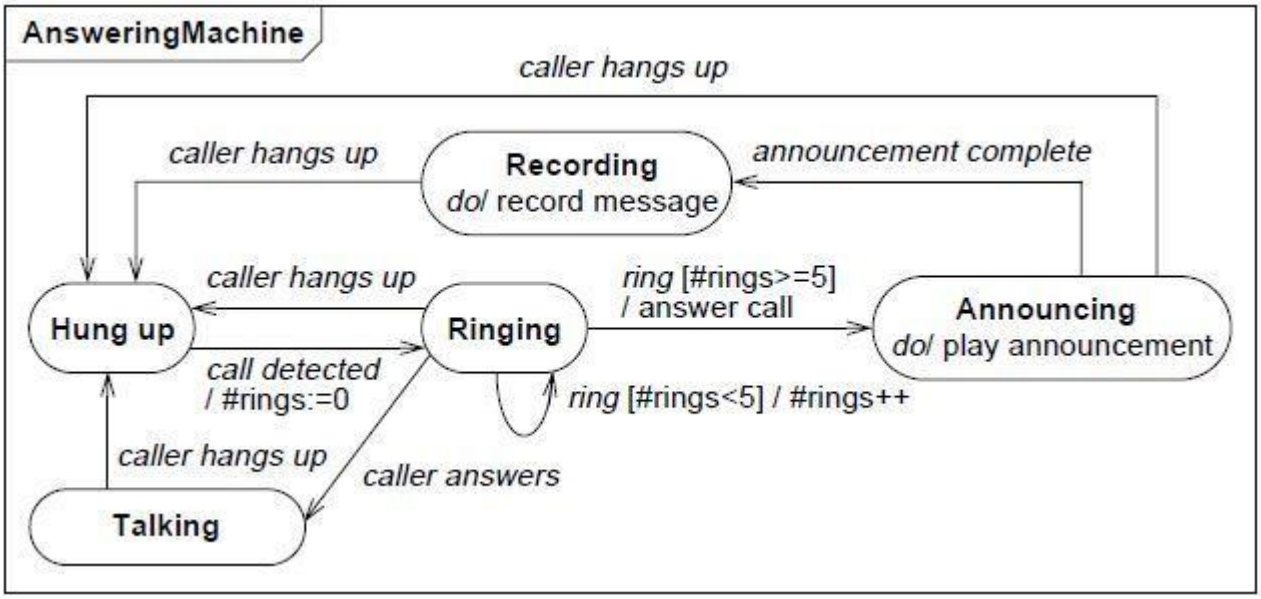
## Additional Diagram: State Diagram

1. **A simple digital watch has a display and two buttons to set it, the A button and the B button. The watch has two modes of operation, display time and set time. In the display time mode, the watch displays hours and minutes, separated by a flashing colon. The set time mode has two sub modes, set hours and set minutes. The A button selects modes. Each time it is pressed, the mode advances in the sequence: display, set hour, set minutes, display, etc. Within the sub modes, the B button advances the hours or minutes once each time it is pressed. Buttons must be released before they can generate another event. Prepare a State diagram of the watch.**

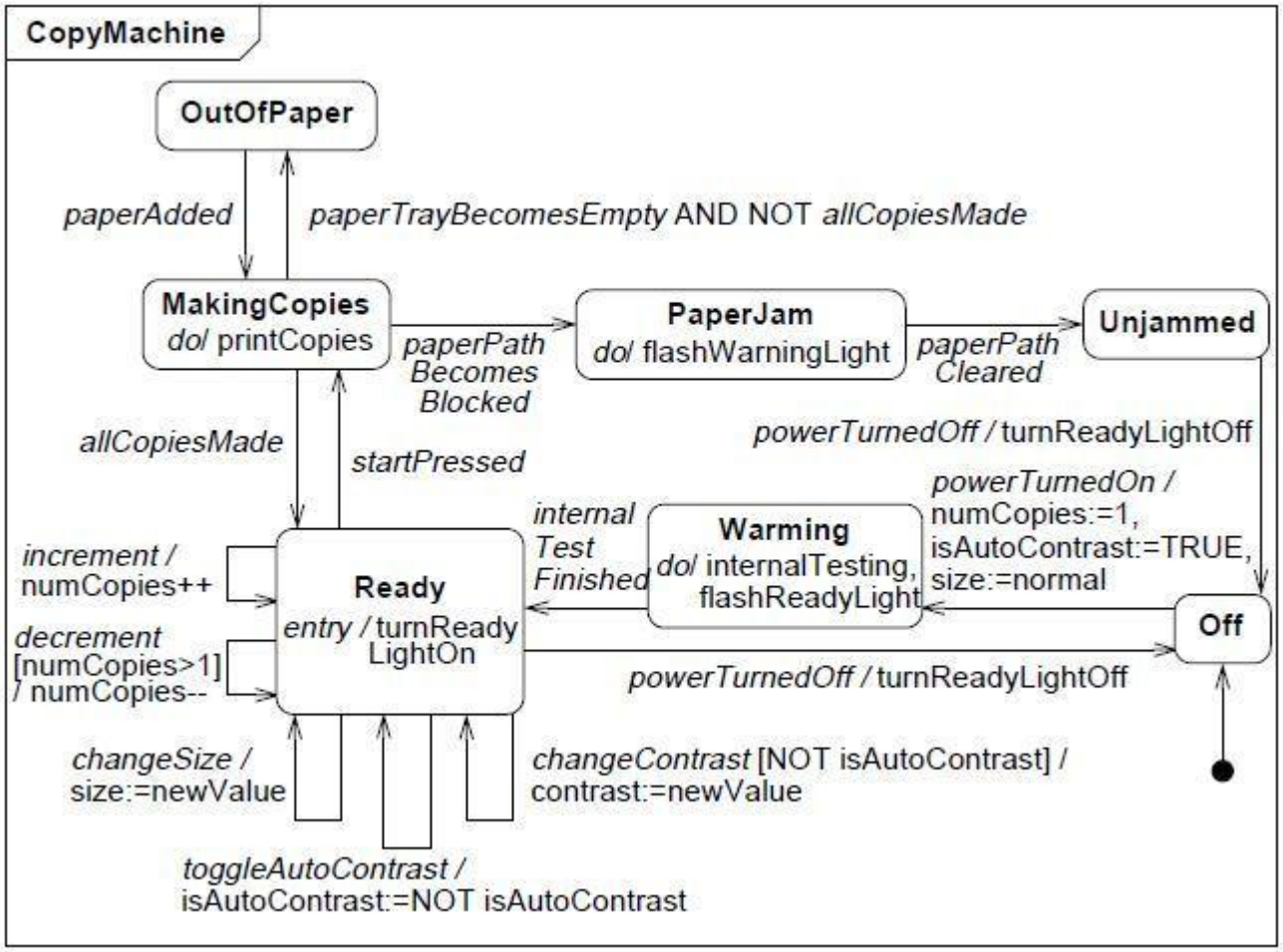


**2. Draw state diagram for the control of a telephone answering machine. The machine detects an incoming call on the first ring and answers the call with a prerecorded announcement. When the announcement is complete, the machine records the caller's message. When the caller hands up, the machine hangs up and shuts off. Place the following in the diagram: call detected, answer call, play announcement, record message, caller hangs up, announcement complete.**



**4. Differentiate state and event. List different types of events. Identify states and events for a Photocopier (Zerox) machine from the description given below and draw the state diagram for the same. Initially the machine is off. When the operator switches on the machine, it first warms up during which it performs some internal tests. Once the tests are over, machine is ready for making copies. When operator loads a page to be photocopied and press 'start' button, machine starts making copies according to the number of copies selected. While machine is making copies, machine may go out of paper. Once operator loads sufficient pages, it can start making copies again. During the photocopy process, if paper jam occurs in the machine, operator may need to clean the path by removing the jammed paper to make the machine ready.**



# Sequence Diagram

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**Introduction**

- Sequence diagrams model the dynamic aspects of a software system.
- The emphasis is on the “sequence” of messages rather than relationship between objects.
- A sequence diagram maps the flow of logic or flow of control within a usage scenario into a visual diagram enabling the software architect to both document and validate the logic during the analysis and design stages.
- Sequence diagrams provide more detail and show the message exchanged among a set of objects over time.
- Sequence diagrams are good for showing the behavior sequences seen by users of a diagram shows only the sequence of messages not their exact timing.
- Sequence diagrams can show concurrent signals.

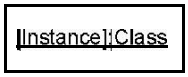
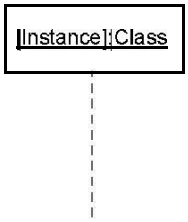
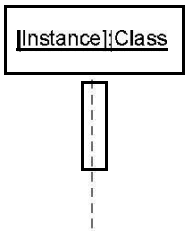
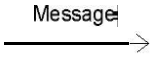
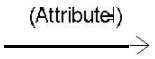
**Purpose**

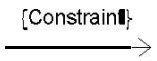
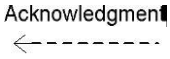
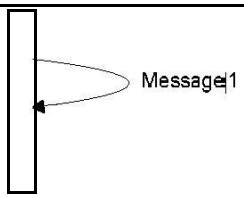
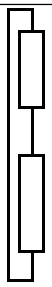
- The main purpose of this diagram is to represent how different business objects interact.
- A sequence diagram shows object interactions arranged in time sequence.
- It depicts the objects and classes involved in the scenario and the sequence of messages exchanged between the objects needed to carry out the functionality of the scenario.

**When to use : Sequence Diagram**

- Sequence diagram can be a helpful modeling tool when the dynamic behavior of objects needs to be observed in a particular use case or when there is a need for visualizing the “big picture of message flow”.
- A company’s technical staff could utilize sequence diagrams in order to document the behavior of a future system.
- It is during the design period that developers and architects utilize the diagram to showcase the system’s object interactions, thereby putting out a more fleshed out overall system design.

**Sequence Diagram Notations**

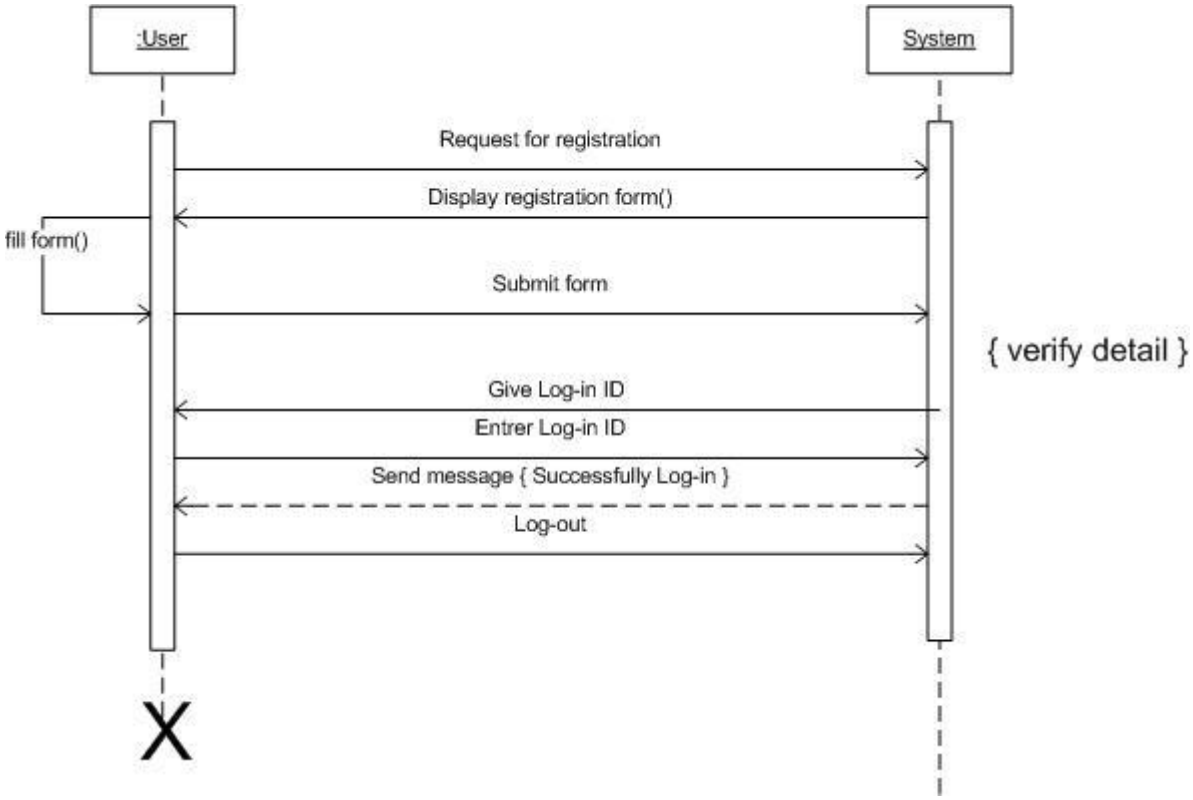
| Sr. No. | Name | Notation | Desription |
|---|---|---|---|
| 1 | Object |  | It represents the existence of an object of a particular time. |
| 2 | Life line |  | Lifeline represents the duration during which an object is alive and interacting with other objects in the system. It is represented by dashed lines. |
| 3 | Scope |  | It shows the time period during which an object or actor is performing an action. |
| 4 | Message<br><br>transition |  | To send message from one object to another. |
| 5 | Message with attribute |  | To send message with some particular attribute |

| | | | |
|---|---|---|---|
| 6 | Message with constraint |  | To send message from one object to other vy some constraint. |
| 7 | Acknowledgement |  | It represent communication between objects conveys acknowledgement. |
| 8 | Self message |  | Self message occurs when an object sends a message to itself. |
| 9 | Recursive message |  | Self message occurs when an object sends a message to itself within recursive scope. |

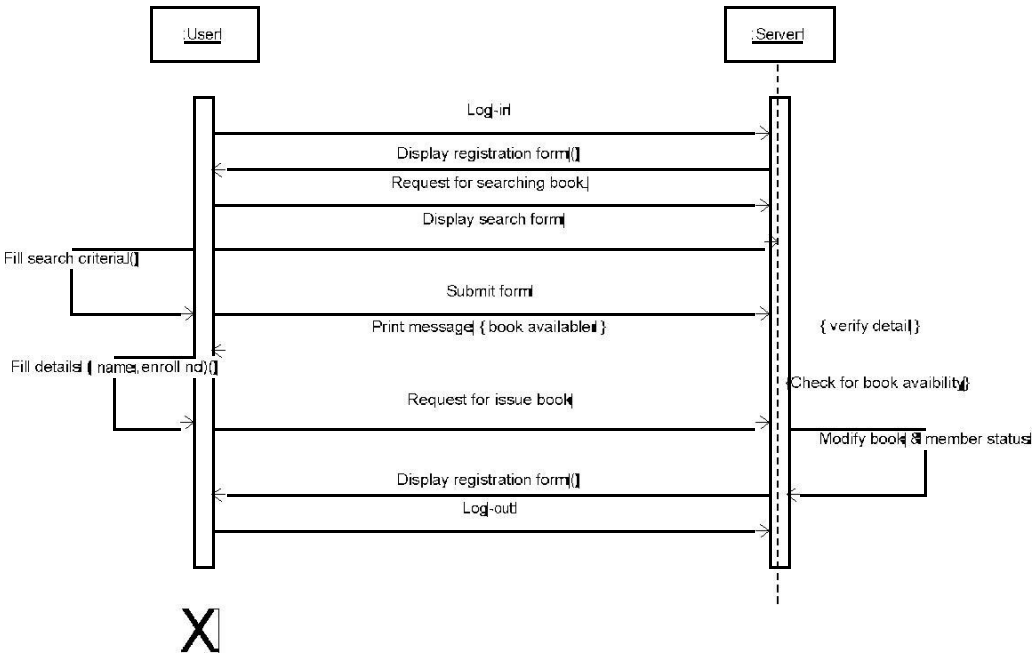
**Examples:**

**Sequence Diagram for library management system:-**

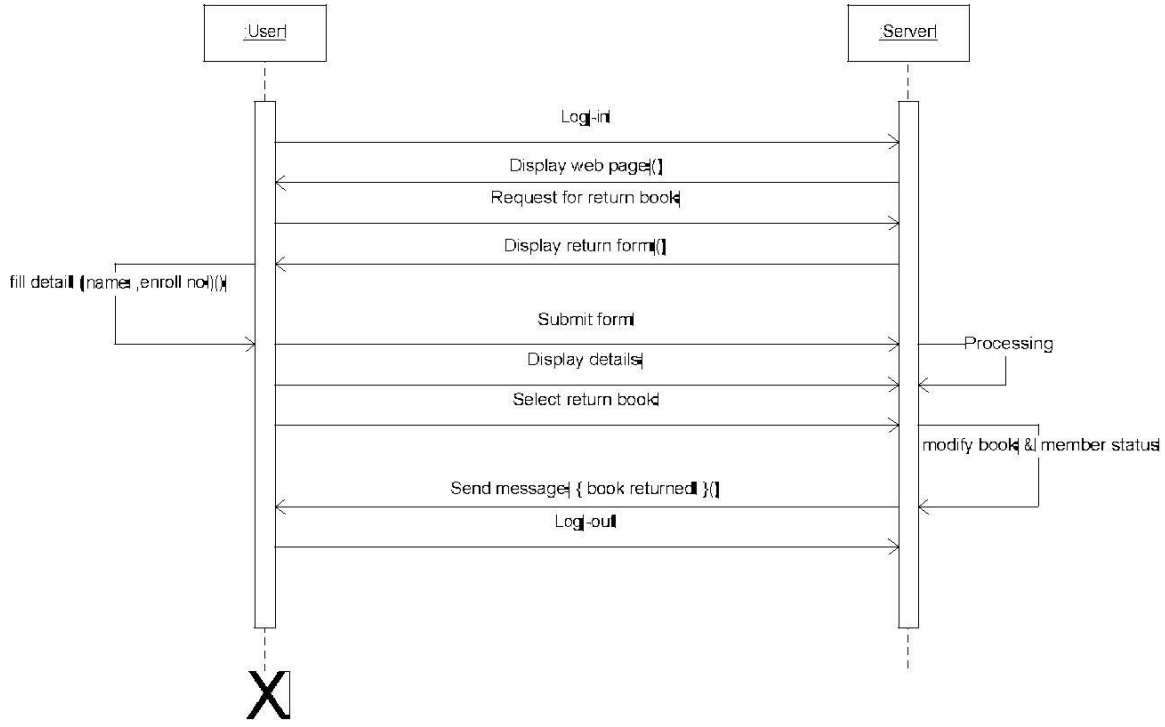
**Registration**



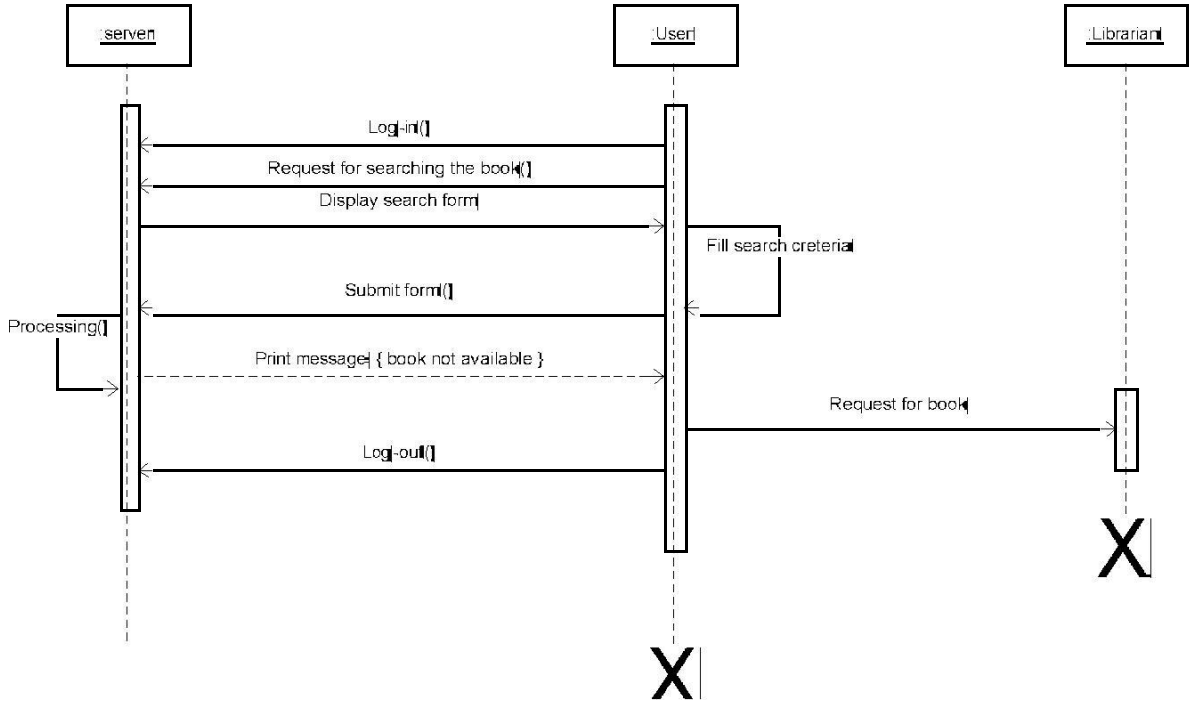

**Issue book**



**Return book**

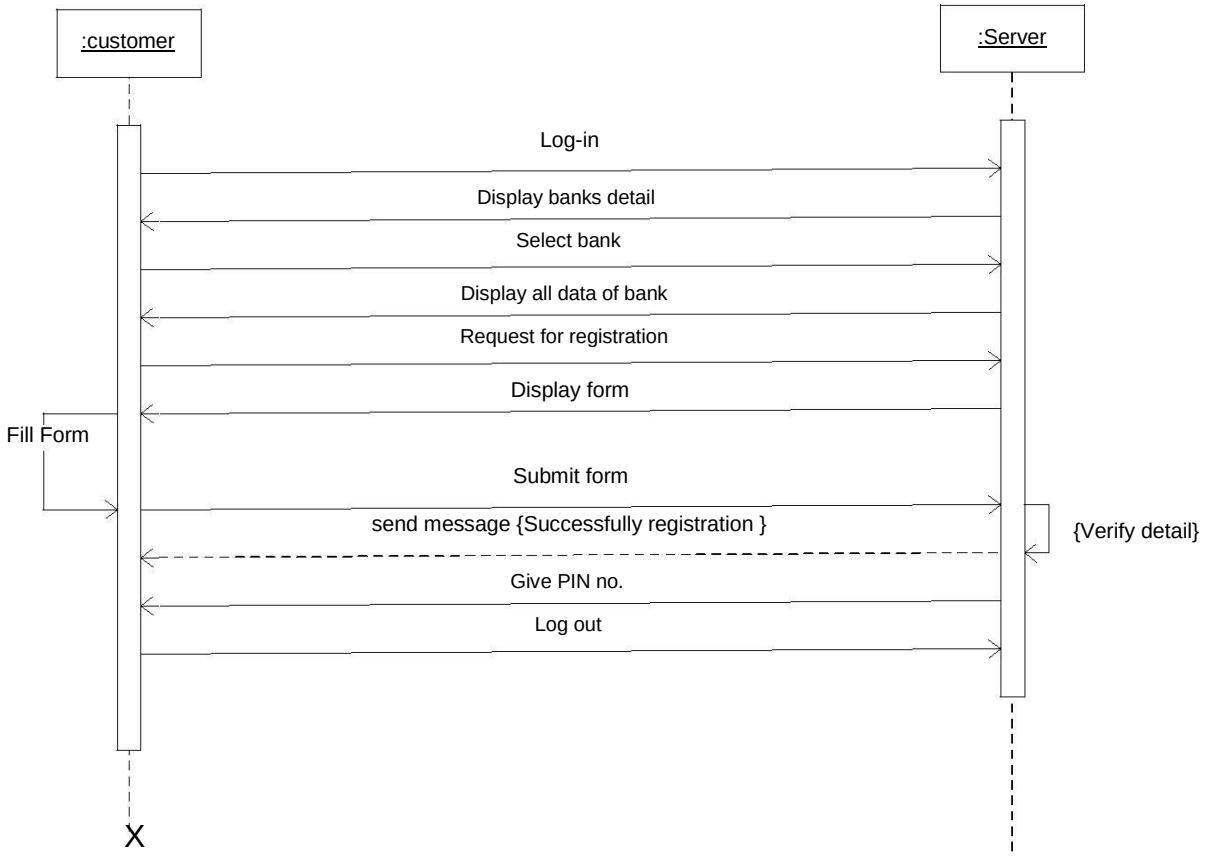



**Book not available**

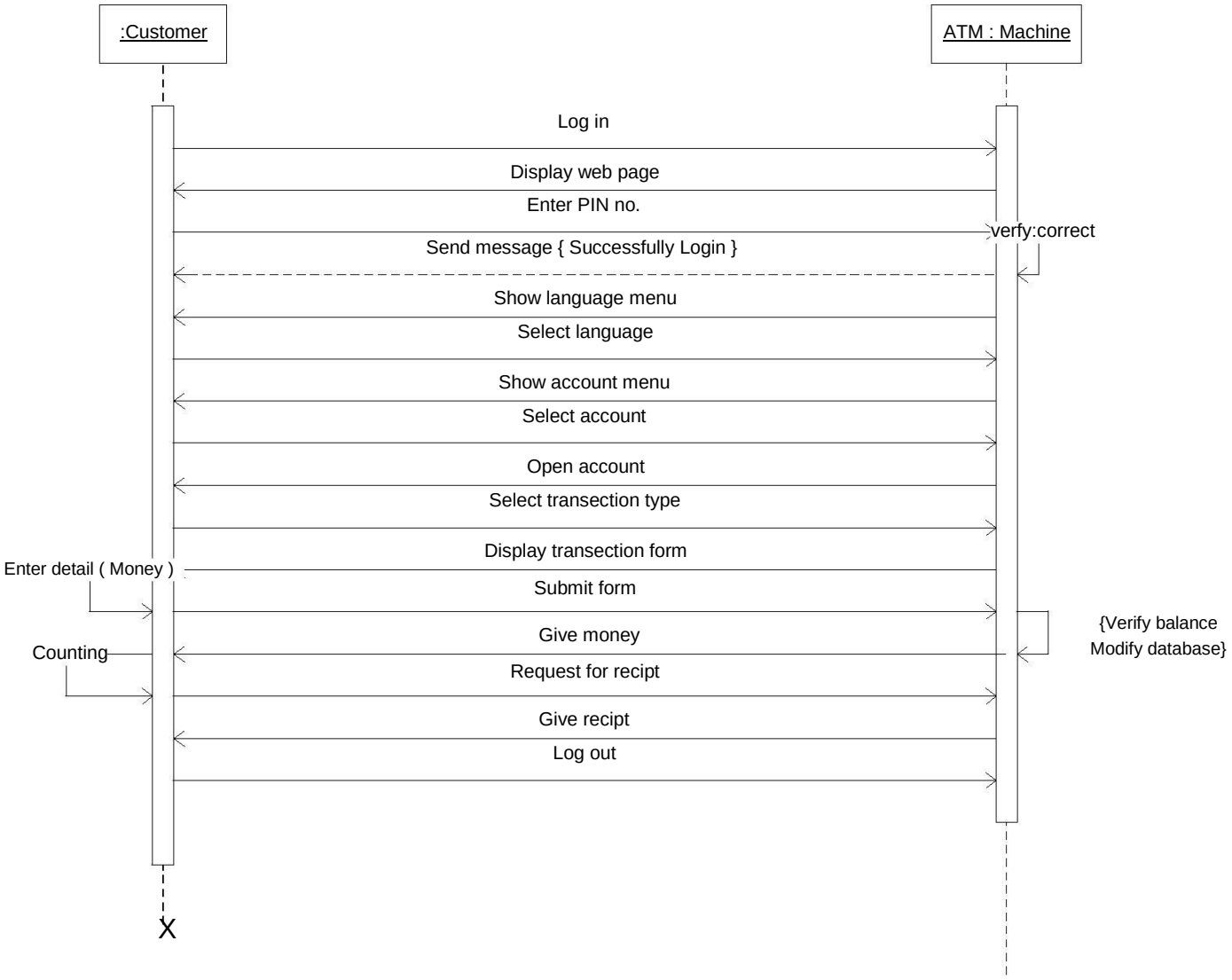


## Sequence Diagram For ATM Management System:-

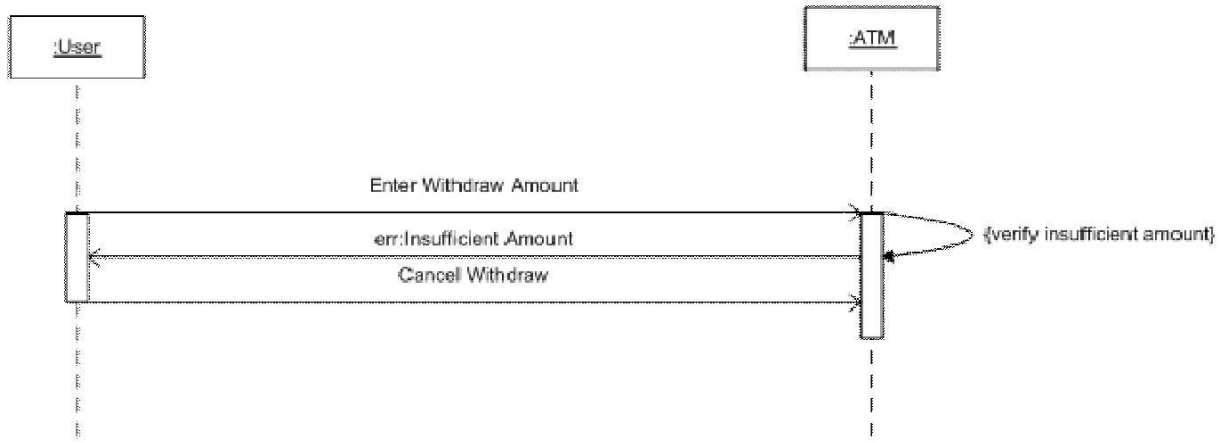
### Create account



**Transaction**

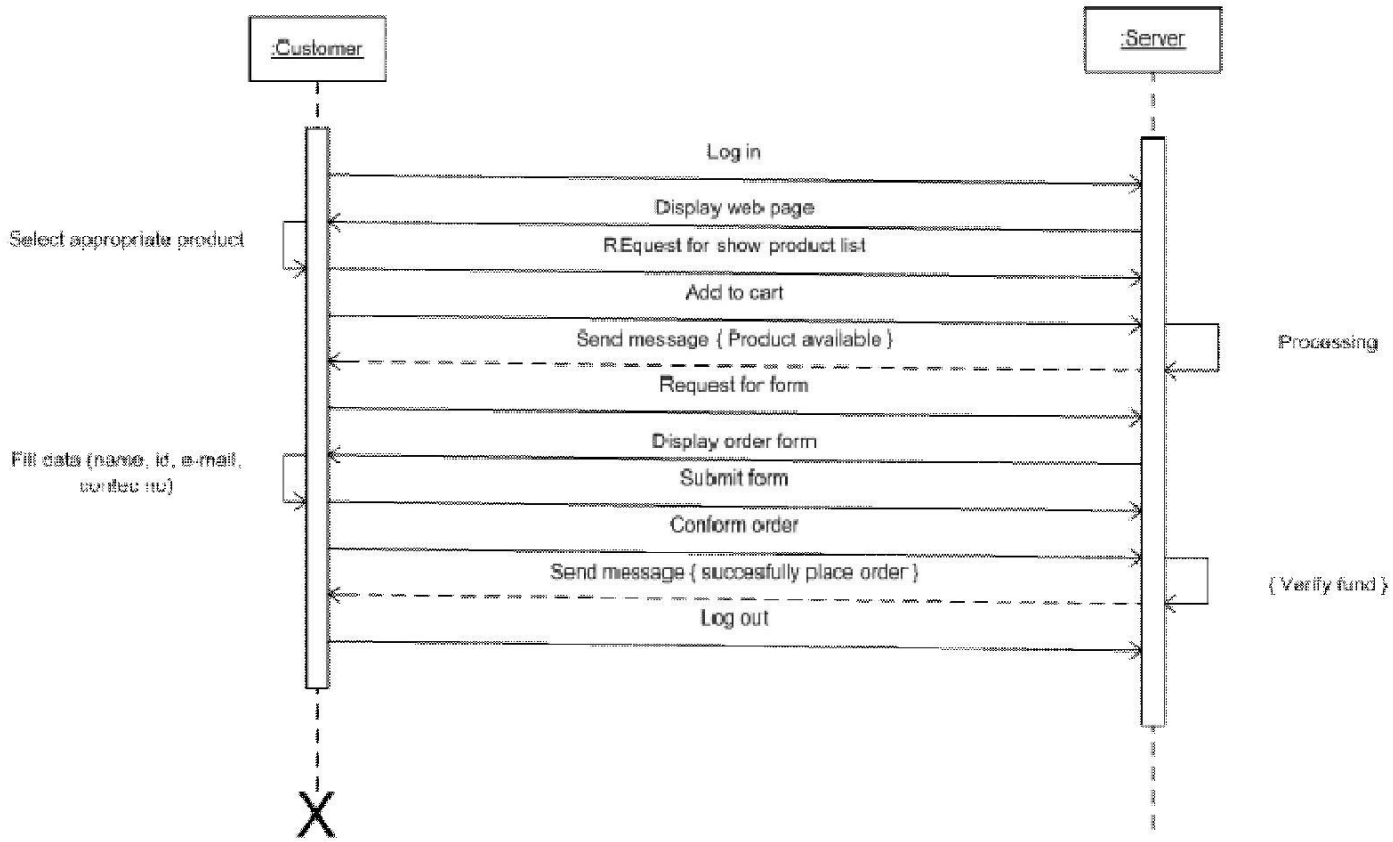


**Exceptional case**

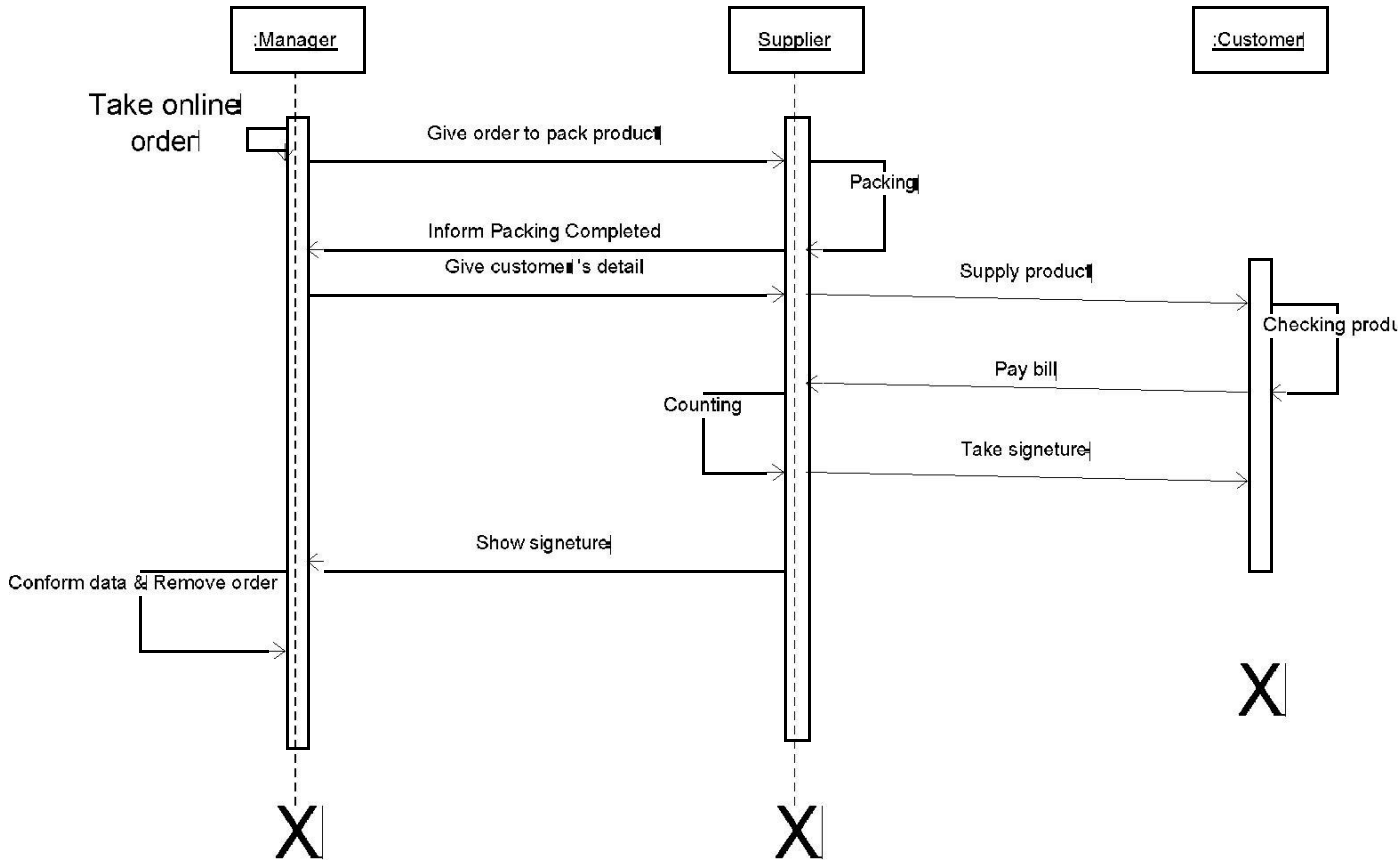



**Sequence diagram for Online shopping system:-**

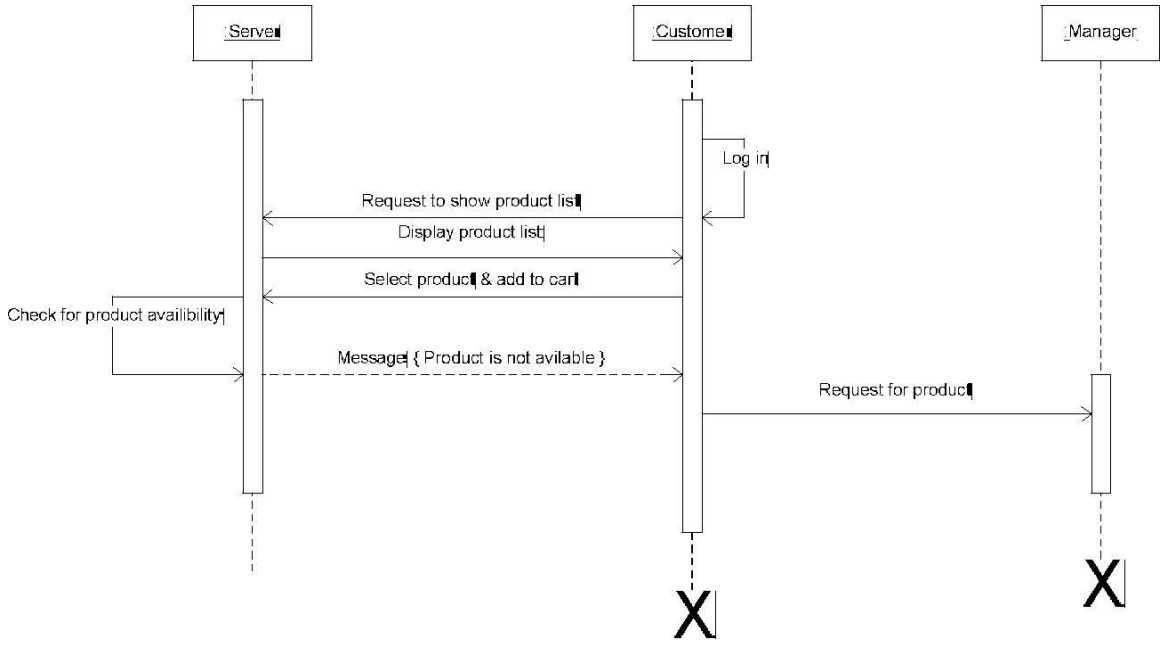
**Place order**



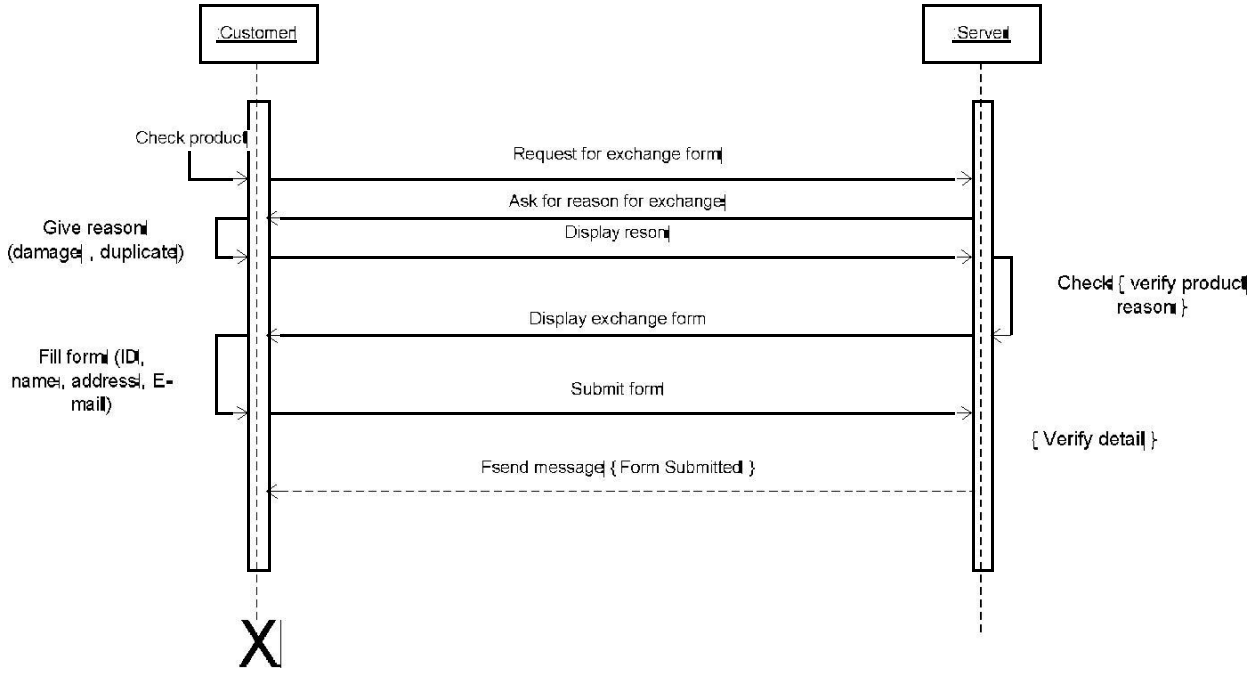
**Supply order**



**Product not available**

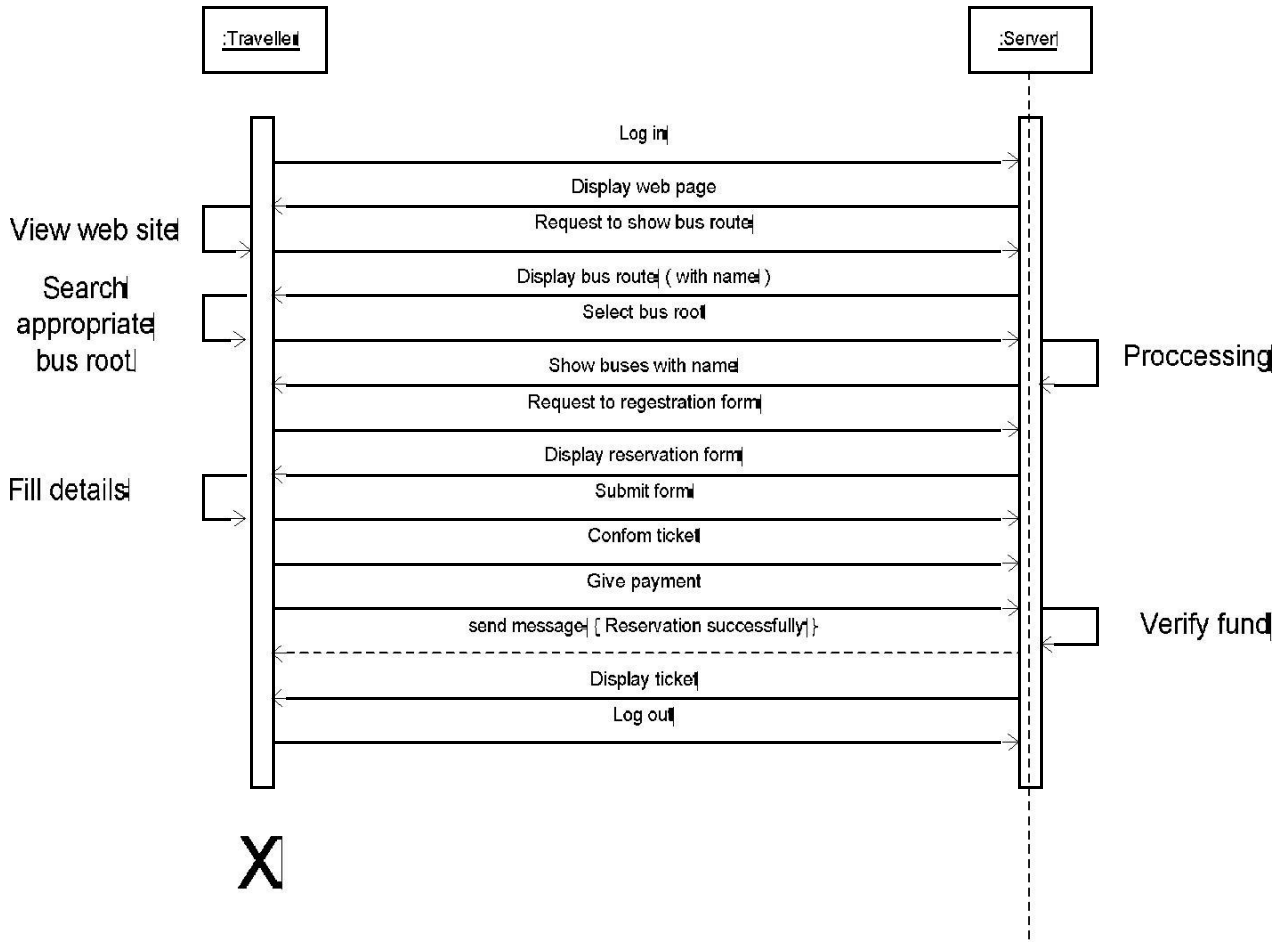



**Product Exchange**

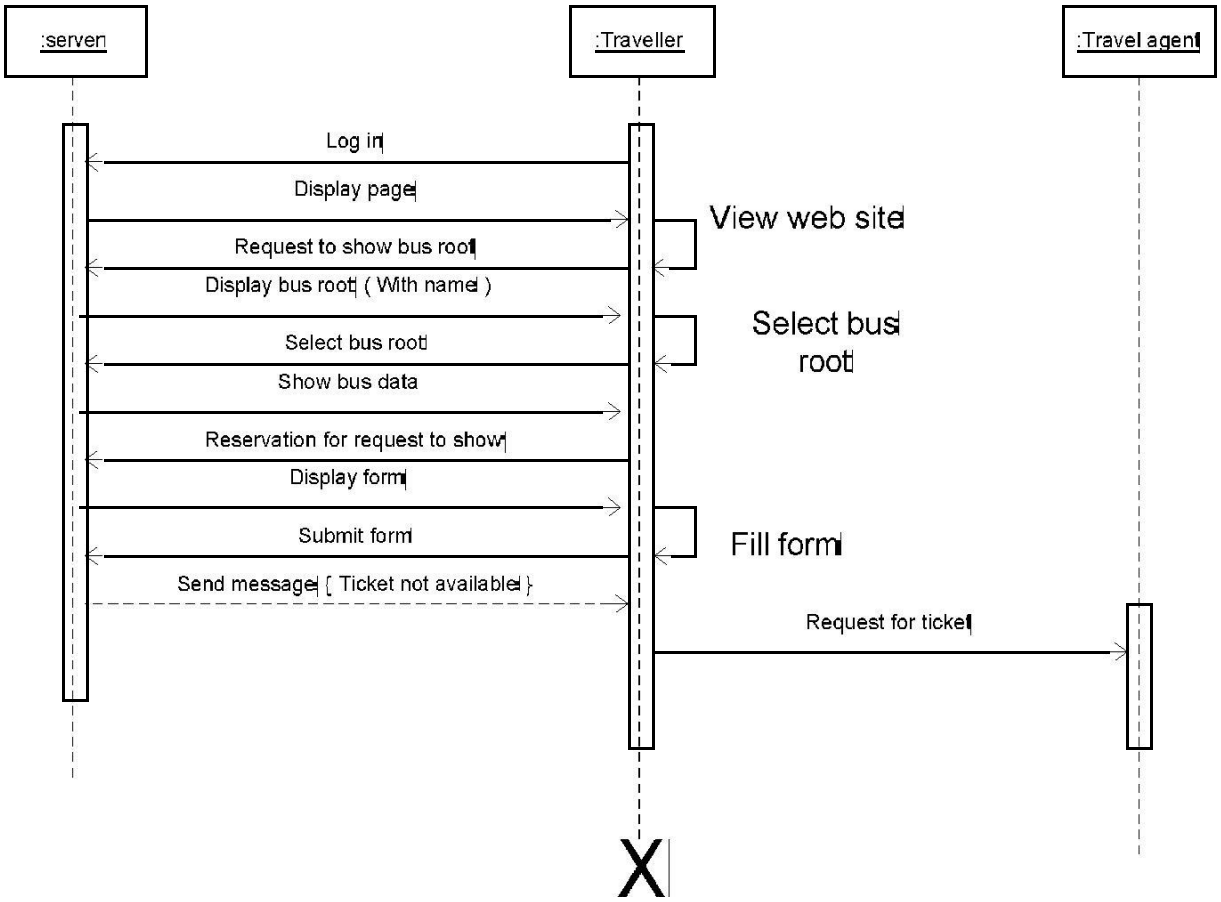


**Sequence diagram for Bus reservation system:-**

**Reservation**

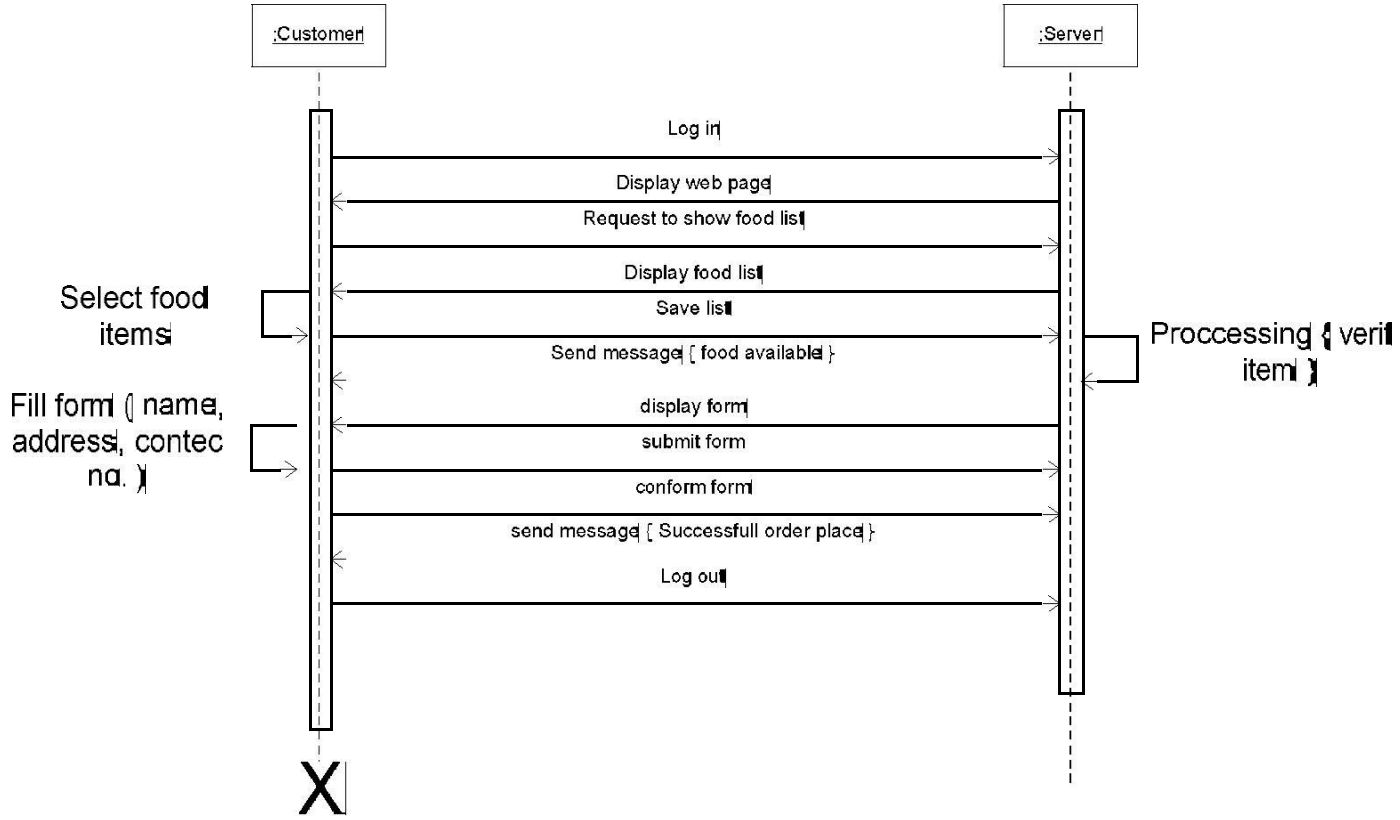


**Ticket not available**

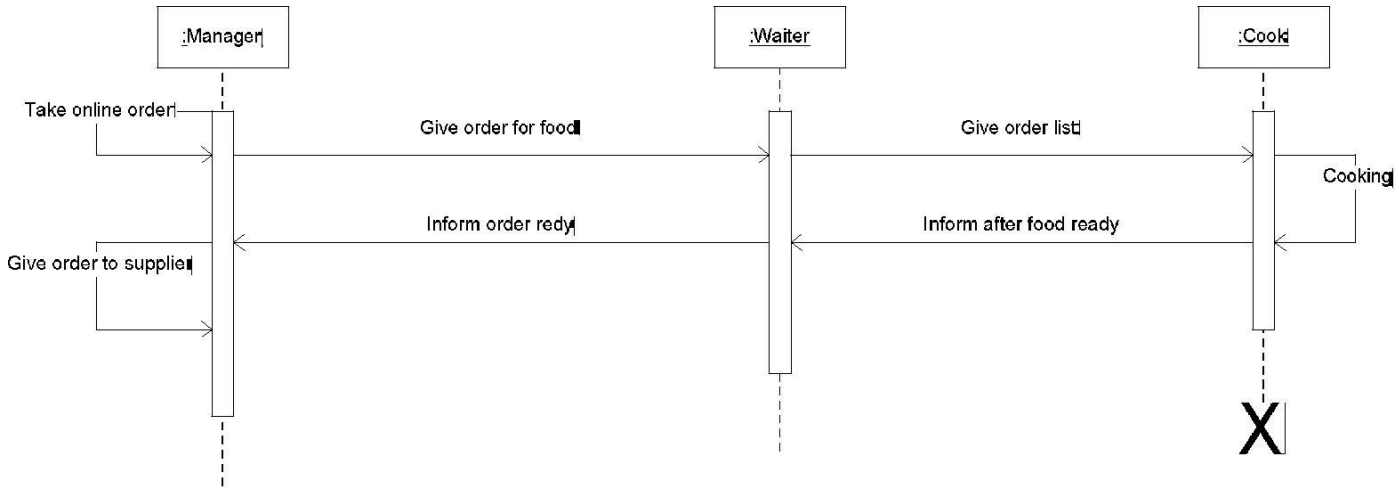


**Sequence diagram for Online Restaurant Management System:-**

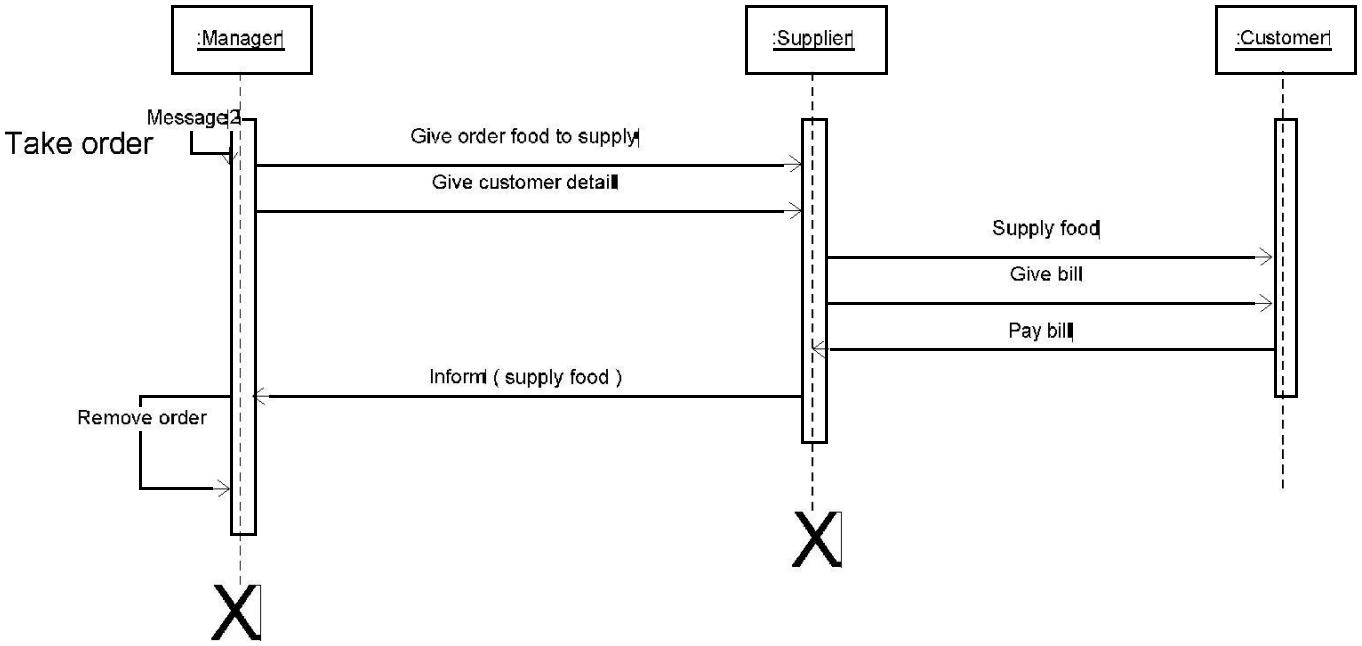
**Place online order**



**Prepare food**




**Supply food**



# Activity Diagram

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**Introduction**

- An activity diagram is a type of flow chart with additional support for parallel behavior.
- This diagram explains overall flow of control.
- Activity diagram is another important diagram in UML to describe dynamic aspects of the system.
- Activity diagram is basically a flow chart to represent the flow from one activity to another activity
- The activity can be described as an operation of the system.
- The control flow is drawn from one operation to another. This flow can be sequential, branched or concurrent. This distinction is important for a distributed system.
- Activity diagrams deals with all type of flow control by using different elements like fork, join etc.

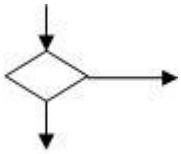
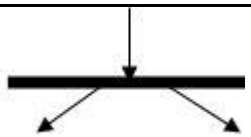
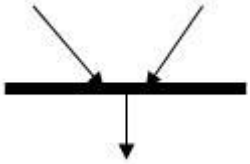
**Purpose**

- Contrary to use case diagrams, in activity diagrams it is obvious whether actors can perform business use cases together or independently from one another.
- Activity diagrams allow you to think functionally.

**When to use : Activity Diagrams**

- Activity diagrams are most useful when modeling the parallel behavior of a multithreaded system or when documenting the logic of a business process.
- Because it is possible to explicitly describe parallel events, the activity diagram is well suited for the illustration of business processes, since business processes rarely occur in a linear manner and often exhibit parallelisms.
- This diagram is useful to investigate business requirements at a later stage.
- An activity diagram is drawn from a very high level. So it gives high level view of a system. This high level view is mainly for business users or any other person who is not a technical person.
- This diagram is used to model the activities which are nothing but business requirements.
- So the diagram has more impact on business understanding rather *implementation details*.

**Activity Diagram Notations**

| No. | Name | Symbol | Description |
|---|---|---|---|
| 1. | Activity |   | Represent individual activity of system. |
| 2. | Transition |  | Represents flow of data from one activity to another. |
| 3. | Decision |  | Decision node is a control node that accepts tokens on one or more incoming edges and selects outgoing edge from two or more outgoing flows. The notation for a decision node is a diamond-shaped symbol. |
| 4. | Initial activity |  | Initial node is a control node at which flow starts when the activity is invoked. Activity may have more than one initial node. Initial nodes are shown as a small solid circle. |
| 5. | Final activity |  | Final node is a control final node that stops all flows in an activity. Activity final nodes are shown as a solid circle with a hollow circle inside. It can be thought of as a goal notated as "bull's eye," or target. |
| 6. | Fork |  | A fork in the activity diagram has a single incoming transition and multiple outgoing transitions exhibiting parallel behavior.The incoming transition triggers the parallel outgoing transitions. |
| 7. | Join |  | A join in the activity diagram synchronizes the parallel behavior started at a fork. Join ascertains that all the parallel sets of activities (irrespective of the order) are completed before the next activity starts. It is a synchronization point in the diagram. Each fork in an activity diagram has a corresponding join where the parallel behavior terminates. |

**Examples**

**Activity Diagram for Library Management System**

**Issue and return book**

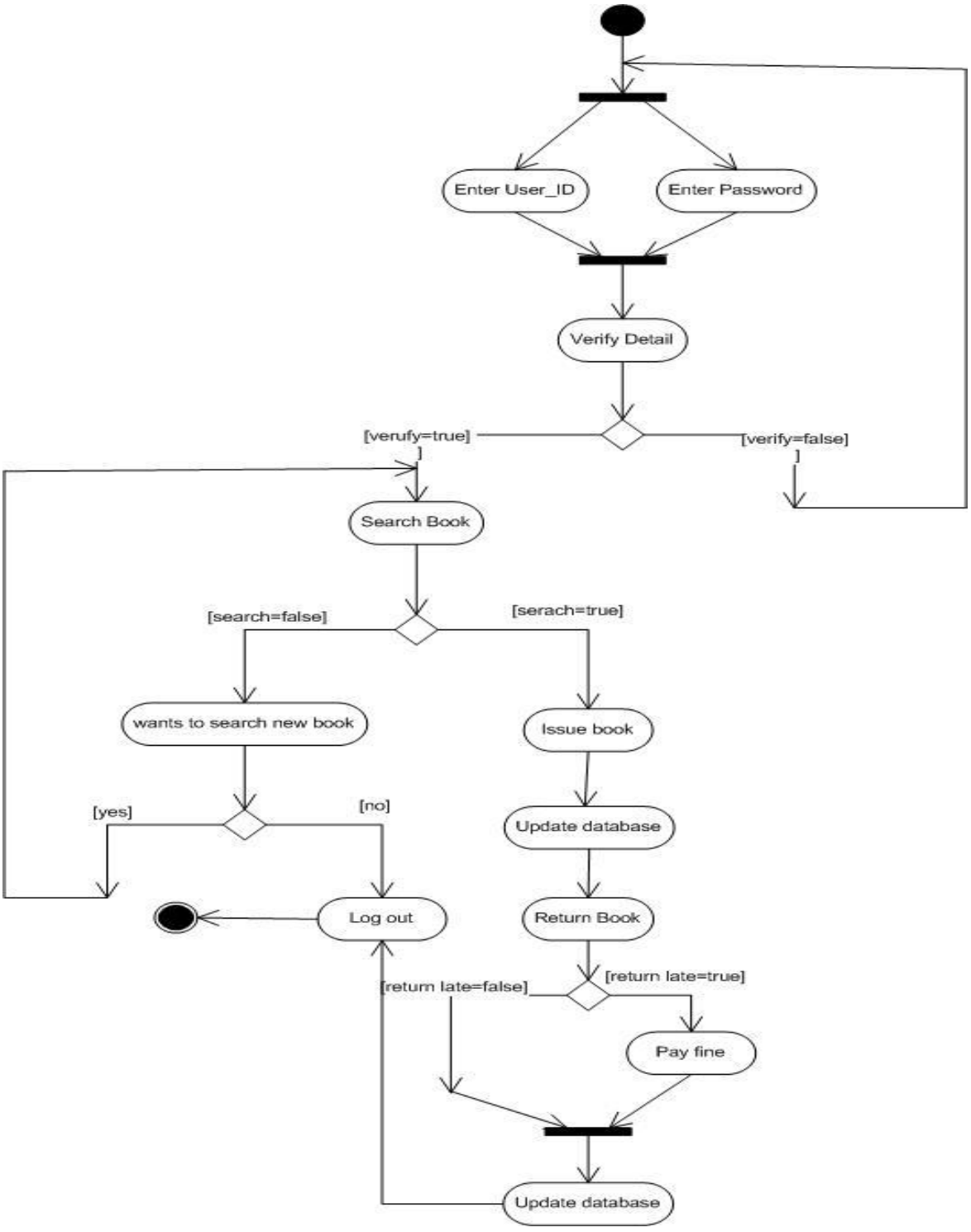
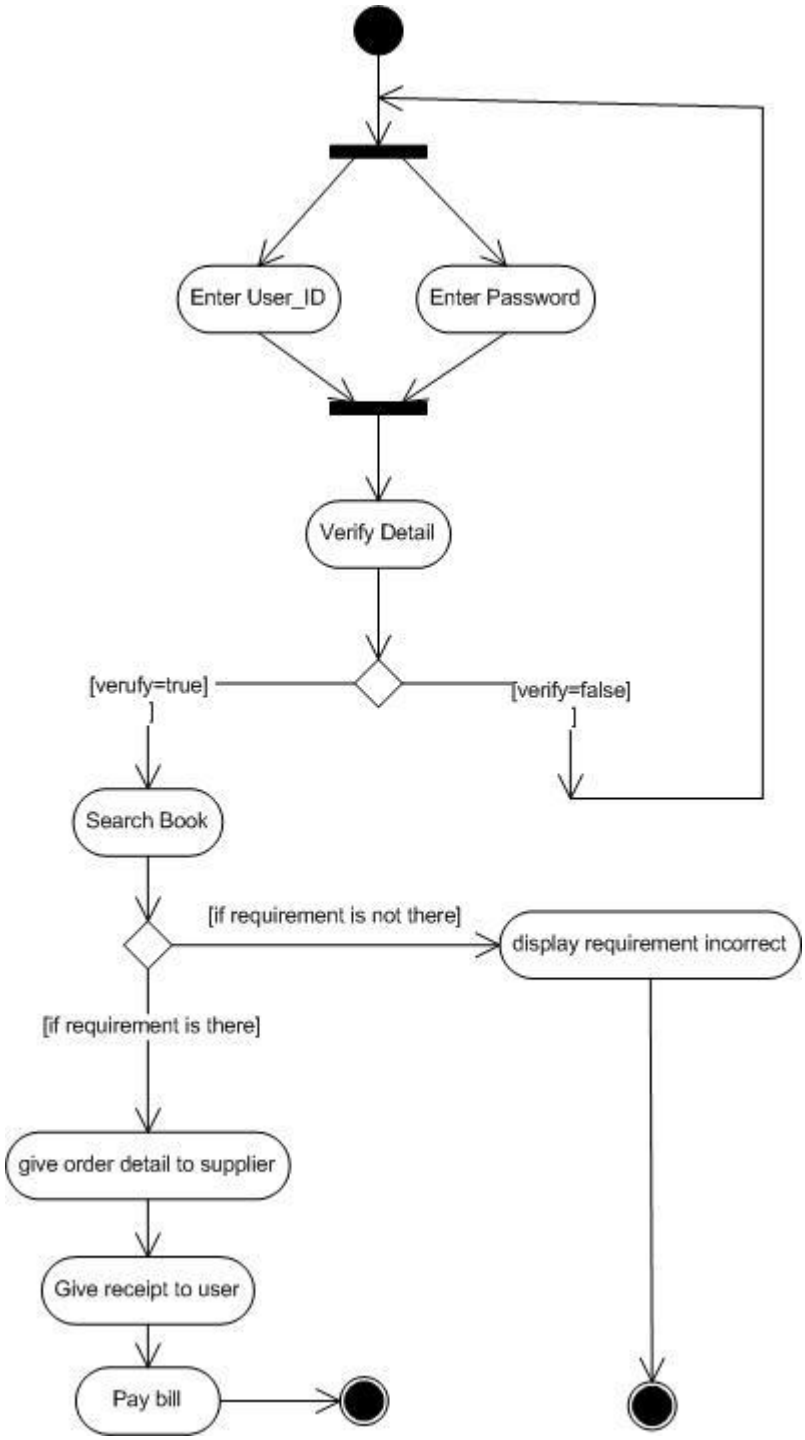
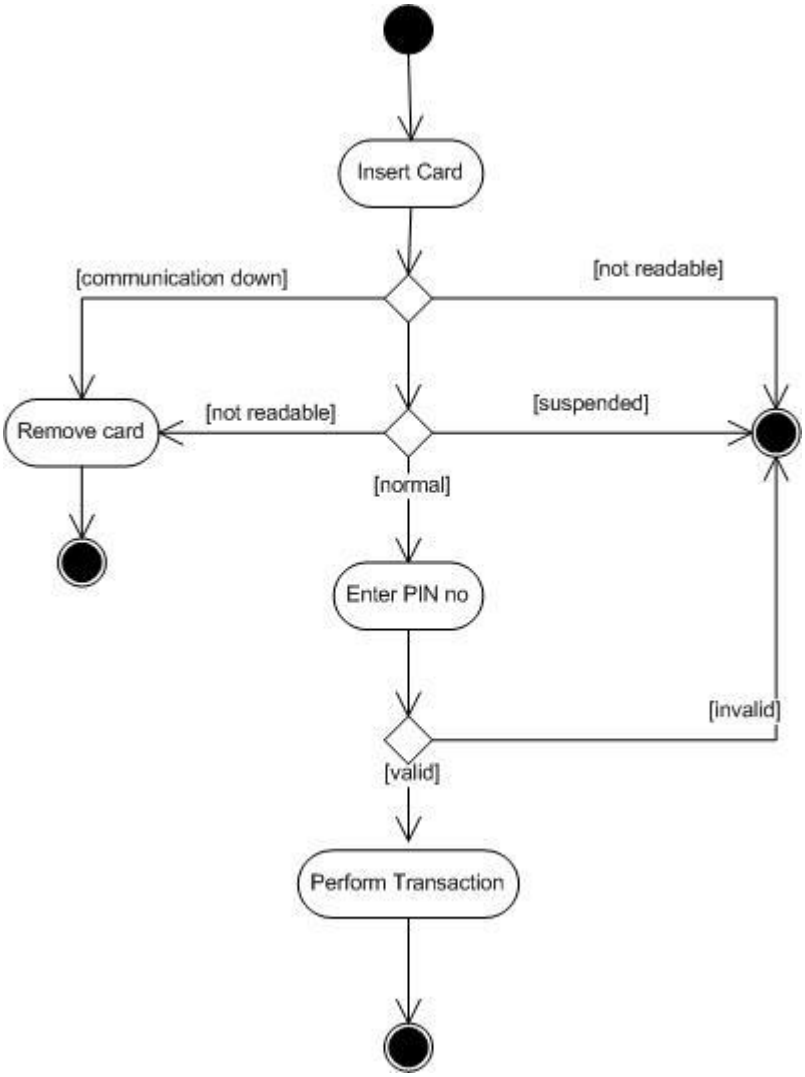


**Diagram for ordering new book**

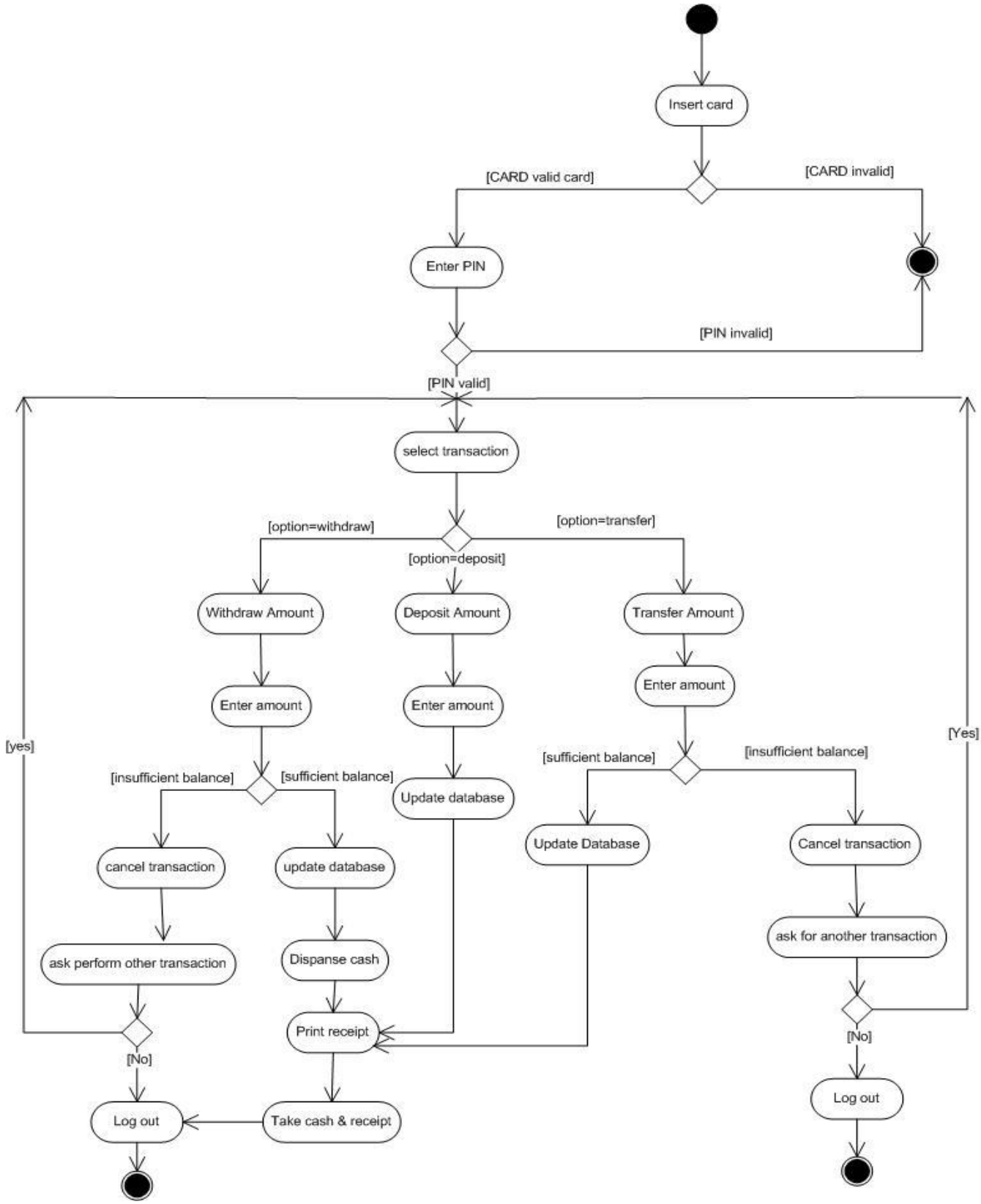


**Activity diagram for ATM**

**Verify PIN number**

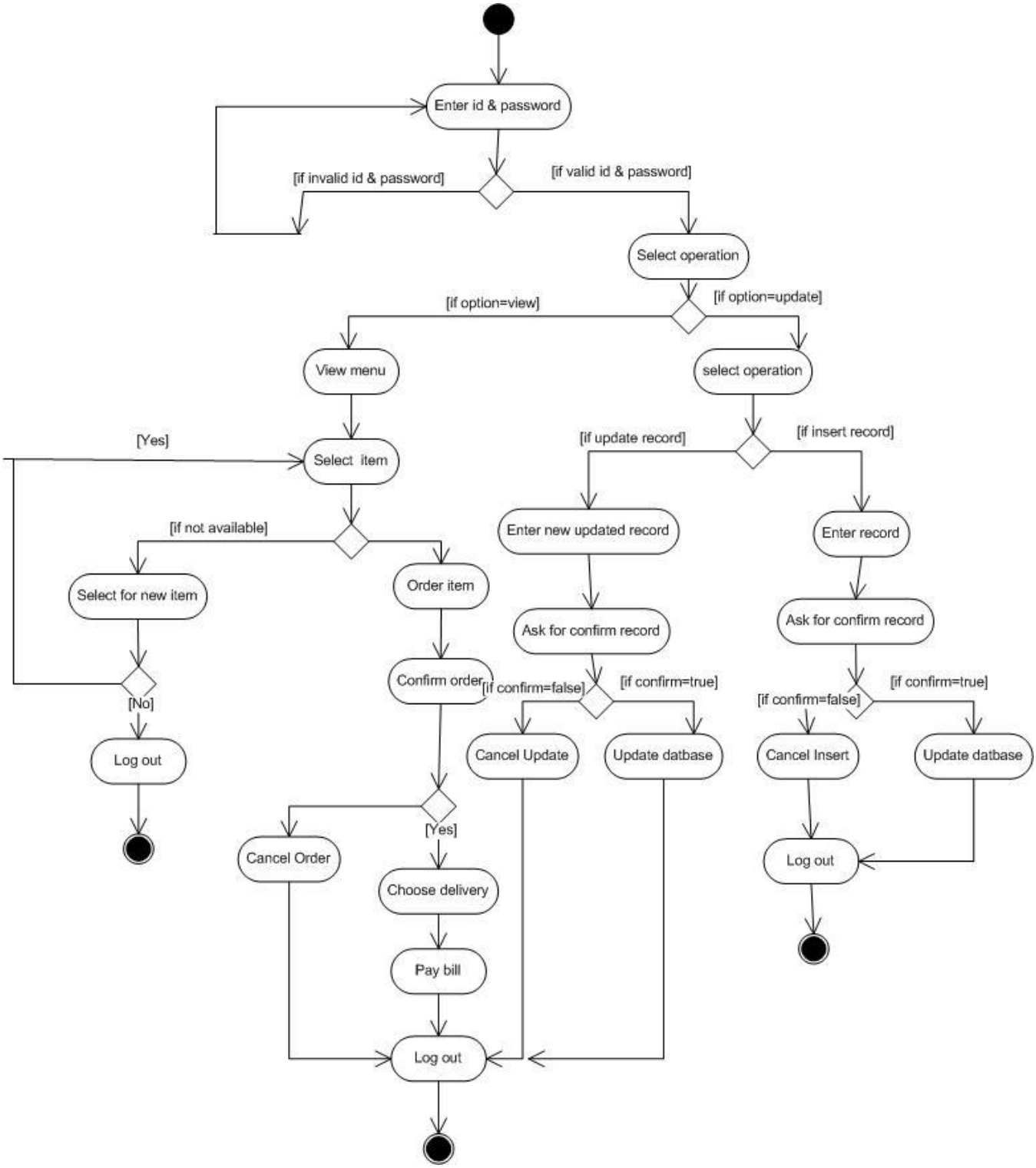


**Transaction**

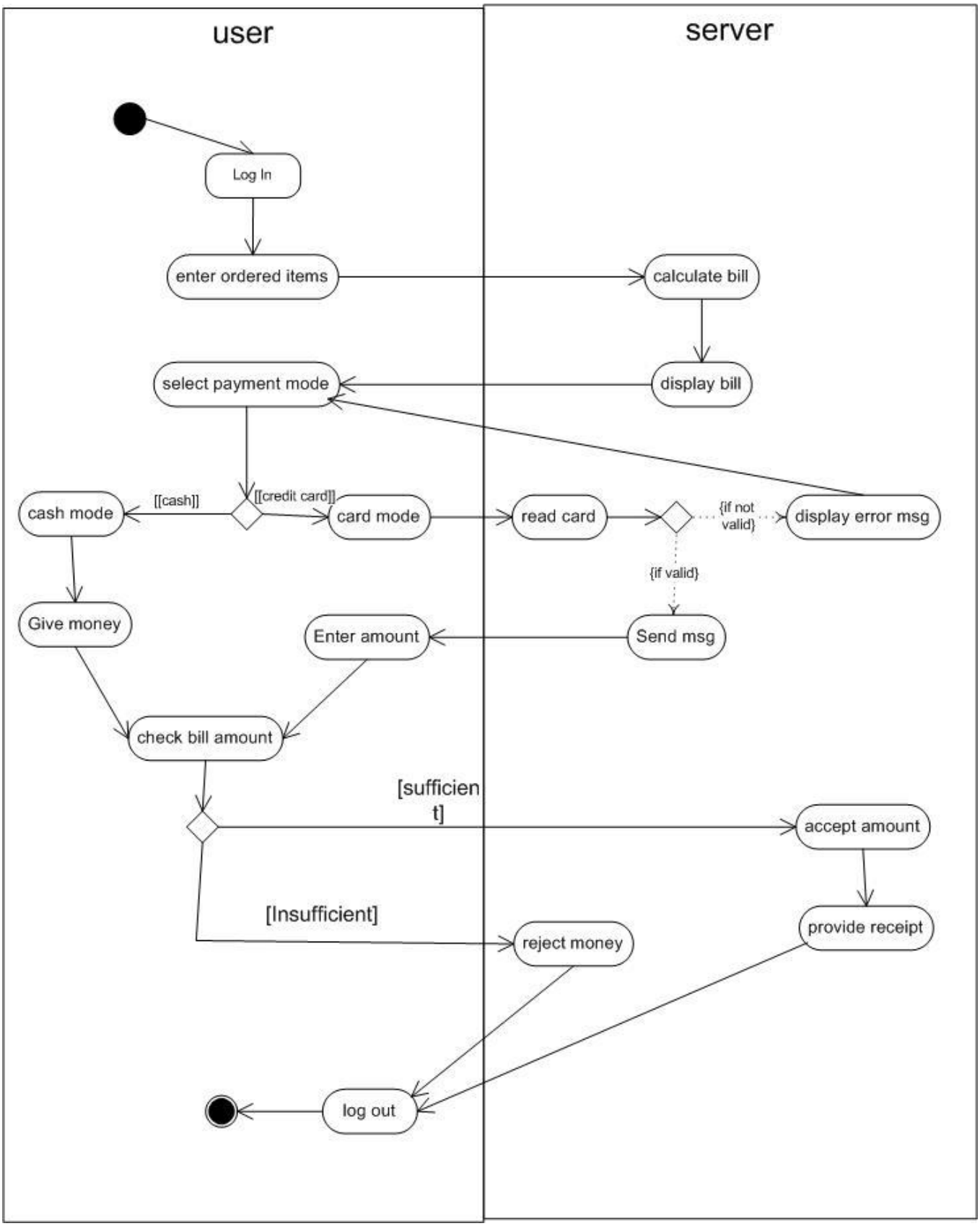


**Activity Diagram for Online Restaurant Management System**

**Place order**

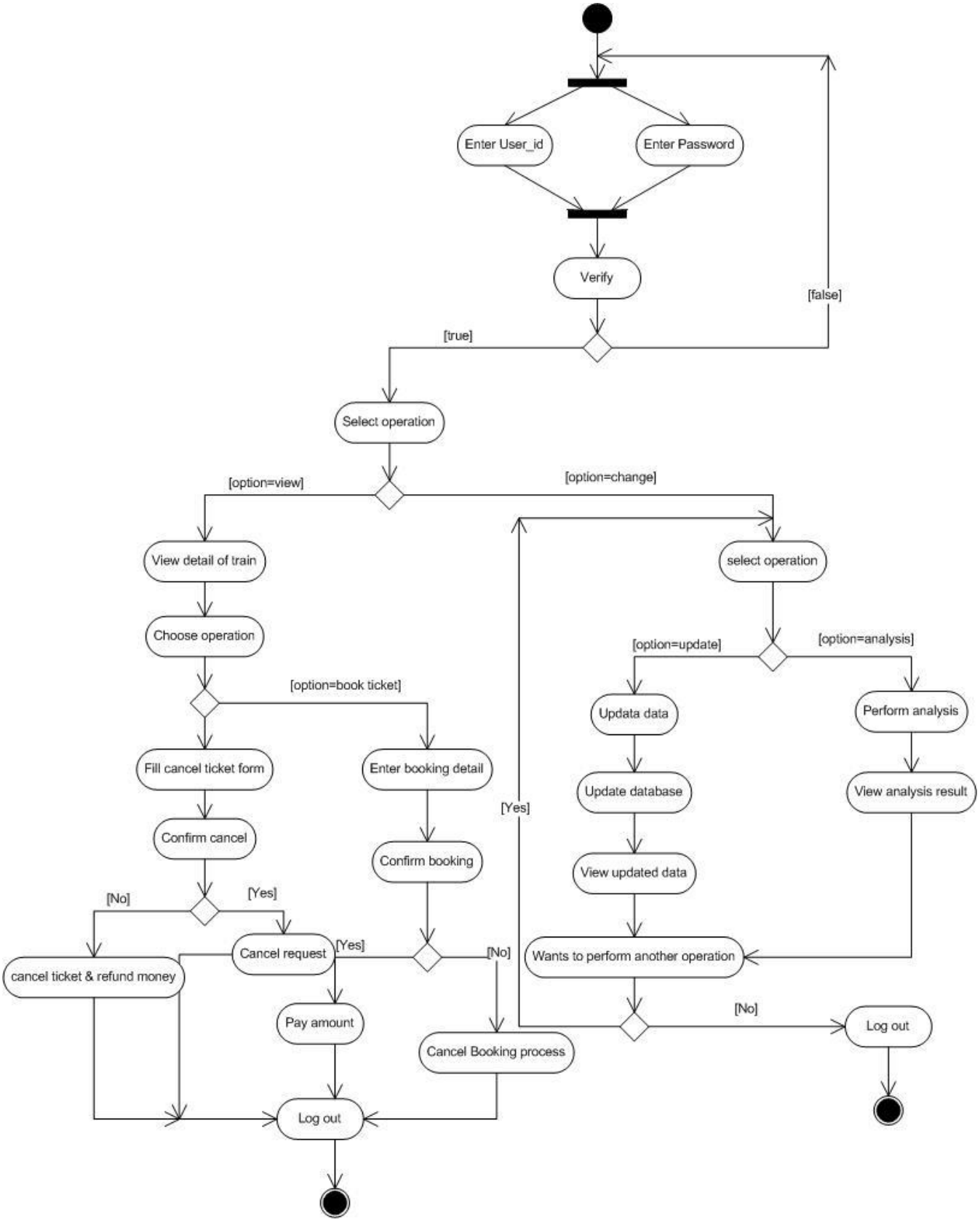


**Payment**

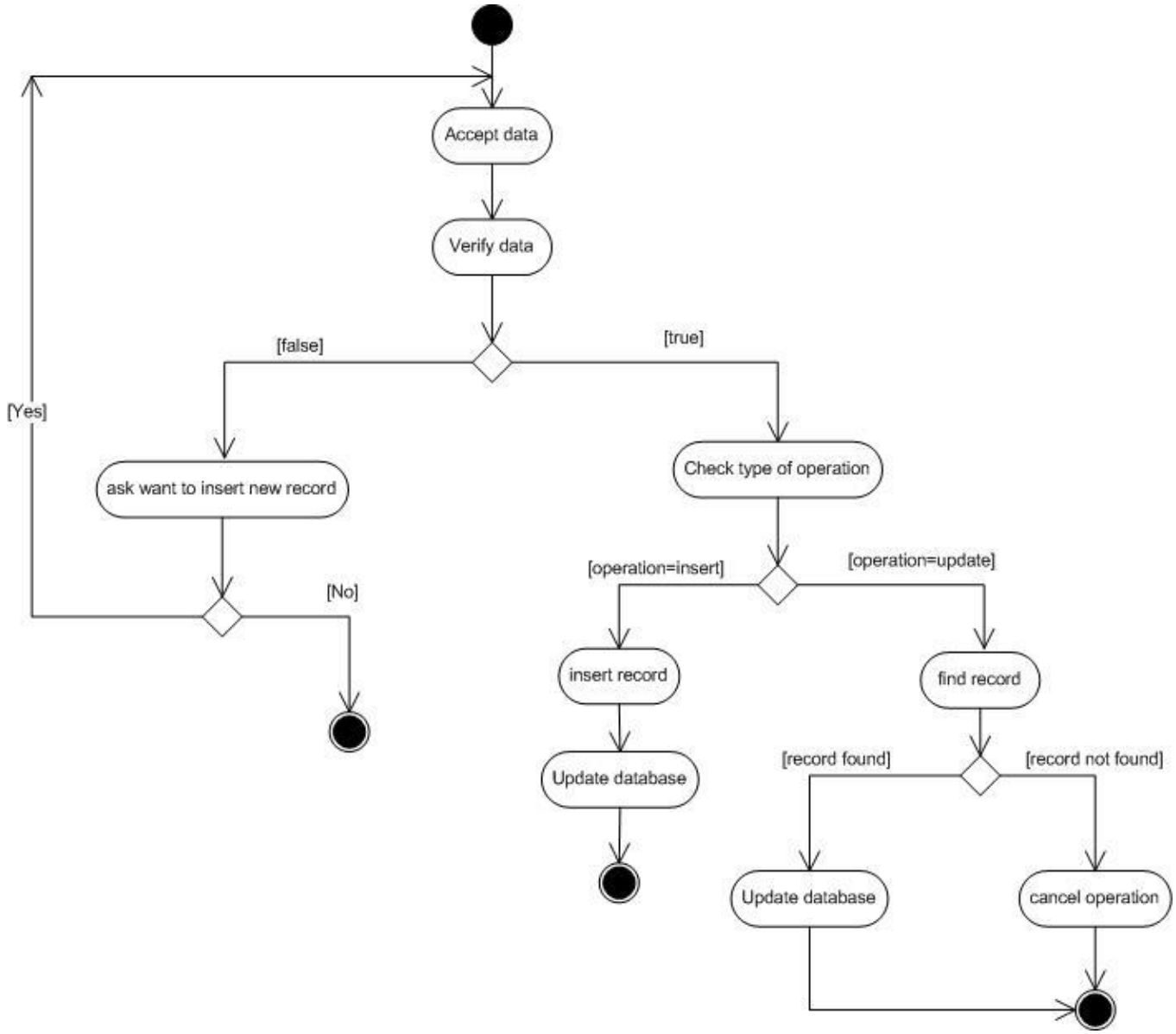

user
server
Log In
enter ordered items
calculate bill
select payment mode
display bill
cash mode
[[cash]]
[[credit card]]
card mode
read card
{if not valid}
display error msg
{if valid}
Give money
Enter amount
Send msg
check bill amount
[sufficien t]
accept amount
[Insufficient]
reject money
provide receipt
log out

## Activity Diagram for Online Reservation System

### Booking Process

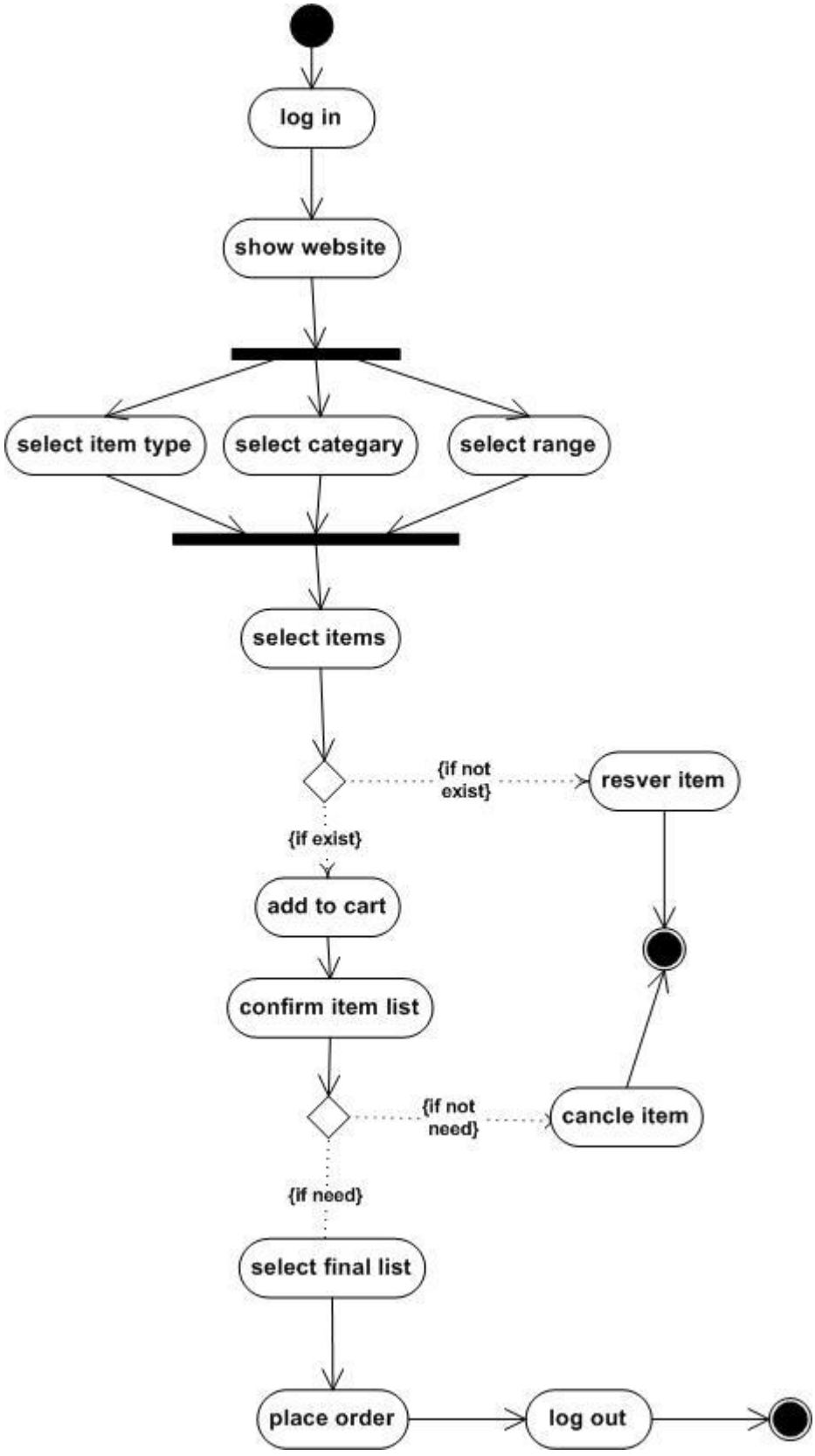


**Server Operation**



**Activity diagram for Online Shopping**

**Purchase Product**



# Additional Diagram: Activity Diagram

1. **Prepare an activity diagram for computing a restaurant bill. There should be a charge for each delivered item. The total amount should be subject to tax and a service charge of 18% for groups of six of more. For smaller groups, there should be a blank entry for a gratuity according to the customer's discretion. Any coupons or gift certificates submitted by the customer should be subtracted.**