UNIT-III-SOFTWARE ENGINEERING- UML

Introduction to UML:

The *Unified Modeling Language* (UML) is "a standard language for writing software blueprints. UML may be used to visualize, specify, construct, and document the artifacts of a software-intensive system".

In other words, just as building architects create blueprints to be used by a construction company, software architects create UML diagrams to help software developers build the software. If you understand the vocabulary of UML (the diagrams' pictorial elements and their meanings), you can much more easily understand and specify a system and explain the design of that system to others.

Grady Booch, Jim Rumbaugh, and Ivar Jacobson developed UML in the mid- 1990s with much feedback from the software development community.

UML 2.0 provides 13 different diagrams for use in software modeling.

Goals of UML

- Since it is a general-purpose modeling language, it can be utilized by all the modelers.
- UML came into existence after the introduction of object-oriented concepts to systemize and consolidate the object-oriented development, due to the absence of standard methods at that time.
- The UML diagrams are made for business users, developers, ordinary people, or anyone who is looking forward to understand the system, such that the system can be software or non-software.
- Thus it can be concluded that the UML is a simple modeling approach that is used to model all the practical systems.

Characteristics of UML

The UML has the following features:

- It is a generalized modeling language.
- It is distinct from other programming languages like C++, Python, etc.
- It is interrelated to object-oriented analysis and design.
- It is used to visualize the workflow of the system.
- It is a pictorial language, used to generate powerful modeling artifacts.

Do we really need UML?

- Complex applications need collaboration and planning from multiple teams and hence require a clear and concise way to communicate amongst them.
- Businessmen do not understand code. So UML becomes essential to communicate with non programmers essential requirements, functionalities and processes of the system.
- A lot of time is saved down the line when teams are able to visualize processes, user interactiostatechart diagram in umlns and static structure of the system.

UML is linked with **object oriented** design and analysis. UML makes the use of elements and forms associations between them to form diagrams.

Diagrams in UML can be broadly classified as:

1. **Structural Diagrams –** Capture static aspects or structure of a system. Structural Diagrams include: Component Diagrams, Object Diagrams, Class Diagrams and Deployment Diagrams.
2. **Behavior Diagrams –** Capture dynamic aspects or behavior of the system. Behavior diagrams include: Use Case Diagrams, State Diagrams, Activity Diagrams and Interaction Diagrams.

Object Oriented Concepts Used in UML –

1. **Class –** A class defines the blue print i.e. structure and functions of an object.
2. **Objects –** Objects help us to decompose large systems and help us to modularize our system. Modularity helps to divide our system into understandable components so that we can build our system piece by piece. An object is the fundamental unit (building block) of a system which is used to depict an entity.
3. **Inheritance –** Inheritance is a mechanism by which child classes inherit the properties of their parent classes.
4. **Abstraction –** Mechanism by which implementation details are hidden from user.statechart diagram in uml
5. **Encapsulation –** Binding data together and protecting it from the outer world is referred to as encapsulation.
6. **Polymorphism –** Mechanism by which functions or entities are able to exist in different forms.

Class Diagram:

The class diagram depicts a static view of an application. It represents the types of objects residing in the system and the relationships between them. A class consists of its objects, and also it may inherit from other classes. A class diagram is used to visualize, describe, document various different aspects of the system, and also construct executable software code.

It shows the attributes, classes, functions, and relationships to give an overview of the software system. It constitutes class names, attributes, and functions in a separate compartment that helps in software development. Since it is a collection of classes, interfaces, associations, collaborations, and constraints, it is termed as a structural diagram.

Purpose of Class Diagrams

The main purpose of class diagrams is to build a static view of an application. It is the only diagram that is widely used for construction, and it can be mapped with object-oriented languages. It is one of the most popular UML diagrams. Following are the purpose of class diagrams given below:

1. It analyses and designs a static view of an application.
2. It describes the major responsibilities of a system.
3. It is a base for component and deployment diagrams.
4. It incorporates forward and reverse engineering.

Benefits of Class Diagrams

1. It can represent the object model for complex systems.
2. It reduces the maintenance time by providing an overview of how an application is structured before coding.
3. It provides a general schematic of an application for better understanding.
4. It represents a detailed chart by highlighting the desired code, which is to be programmed.
5. It is helpful for the stakeholders and the developers.

Vital components of a Class Diagram

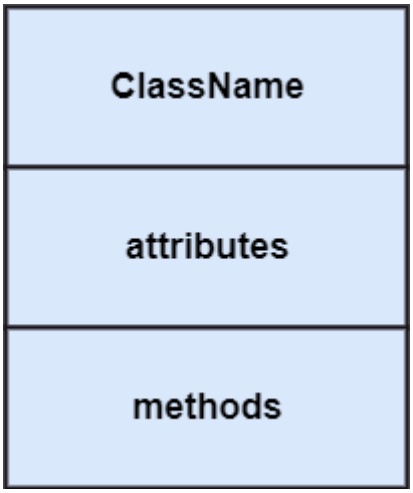
The class diagram is made up of three sections

- Upper Section: The upper section encompasses the name of the class. A class is a representation of similar objects that shares the same relationships, attributes,

operations, and semantics. Some of the following rules that should be taken into account while representing a class are given below:

- Capitalize the initial letter of the class name.
- Place the class name in the center of the upper section.
- A class name must be written in bold format.
- The name of the abstract class should be written in italics format.

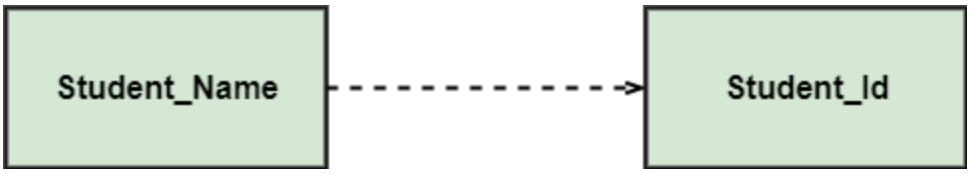
- Middle Section: The middle section constitutes the attributes, which describe the quality of the class. The attributes have the following characteristics:
  - The attributes are written along with its visibility factors, which are public (+), private (-), protected (#), and package (~).
  - The accessibility of an attribute class is illustrated by the visibility factors.
  - A meaningful name should be assigned to the attribute, which will explain its usage inside the class.
- Lower Section: The lower section contain methods or operations. The methods are represented in the form of a list, where each method is written in a single line. It demonstrates how a class interacts with data.



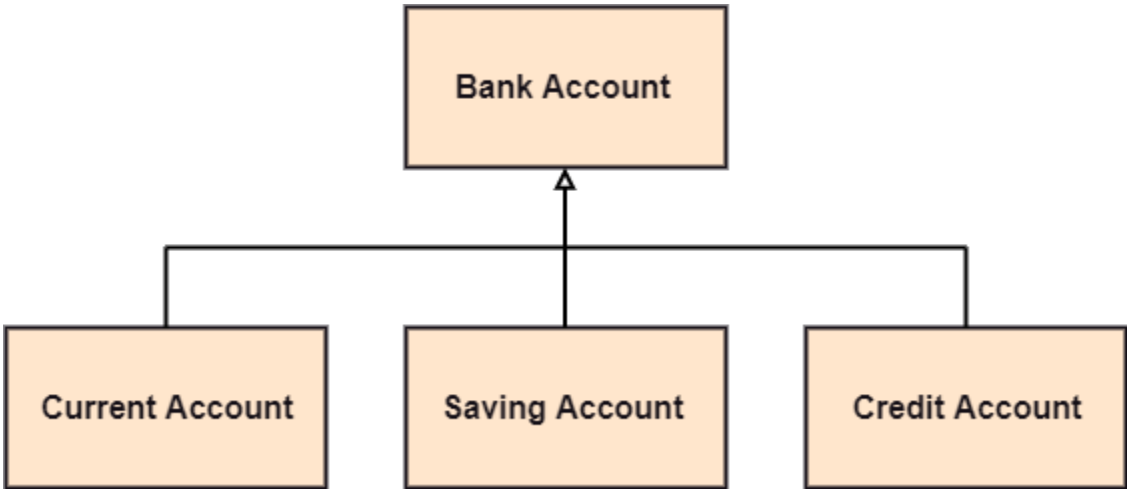
Relationships

In UML, relationships are of three types:

- Dependency: A dependency is a semantic relationship between two or more classes where a change in one class cause changes in another class. It forms a weaker relationship.
  In the following example, Student_Name is dependent on the Student_Id.



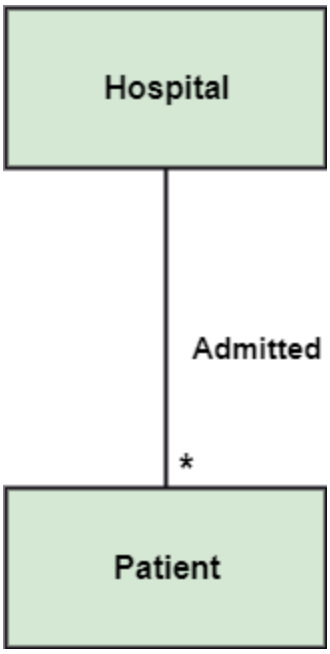
- Generalization: A generalization is a relationship between a parent class (superclass) and a child class (subclass). In this, the child class is inherited from the parent class. For example, The Current Account, Saving Account, and Credit Account are the generalized form of Bank Account.



- Association: It describes a static or physical connection between two or more objects. It depicts how many objects are there in the relationship. For example, a department is associated with the college.

Multiplicity: It defines a specific range of allowable instances of attributes. In case if a range is not specified, one is considered as a default multiplicity.

For example, multiple patients are admitted to one hospital.



Aggregation: An aggregation is a subset of association, which represents has a relationship. It is more specific then association. It defines a part-whole or part-of relationship. In this kind of relationship, the child class can exist independently of its parent class.

The company encompasses a number of employees, and even if one employee resigns, the company still exists.

Composition: The composition is a subset of aggregation. It portrays the dependency between the parent and its child, which means if one part is deleted, then the other part also gets discarded. It represents a whole-part relationship.

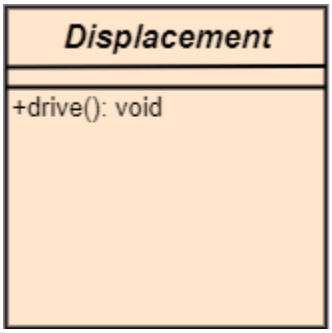
A contact book consists of multiple contacts, and if you delete the contact book, all the contacts will be lost.

Abstract Classes

In the abstract class, no objects can be a direct entity of the abstract class. The abstract class can neither be declared nor be instantiated. It is used to find the functionalities across the

classes. The notation of the abstract class is similar to that of class; the only difference is that the name of the class is written in italics. Since it does not involve any implementation for a given function, it is best to use the abstract class with multiple objects.

Let us assume that we have an abstract class named displacement with a method declared inside it, and that method will be called as a drive (). Now, this abstract class method can be implemented by any object, for example, car, bike, scooter, cycle, etc.



How to draw a Class Diagram?

The class diagram is used most widely to construct software applications. It not only represents a static view of the system but also all the major aspects of an application. A collection of class diagrams as a whole represents a system.

Some key points that are needed to keep in mind while drawing a class diagram are given below:

1. To describe a complete aspect of the system, it is suggested to give a meaningful name to the class diagram.
2. The objects and their relationships should be acknowledged in advance.
3. The attributes and methods (responsibilities) of each class must be known.
4. A minimum number of desired properties should be specified as more number of the unwanted property will lead to a complex diagram.
5. Notes can be used as and when required by the developer to describe the aspects of a diagram.
6. The diagrams should be redrawn and reworked as many times to make it correct before producing its final version.

Class Diagram Example

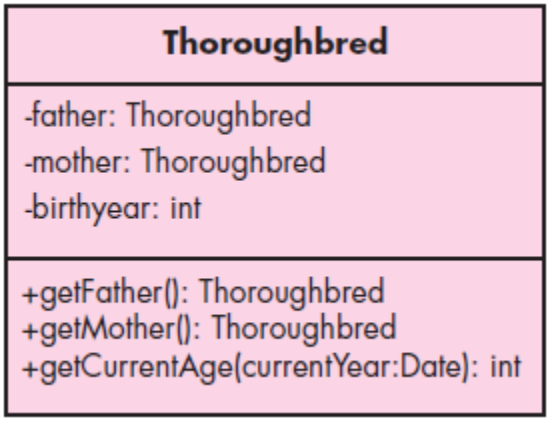
Ex:

It presents a simple example of a Thoroughbred class that models thoroughbred horses. It has three attributes displayed—mother, father, and birthyear.

The diagram also shows three operations: getCurrentAge(), getFather(), and getMother(). There may be other suppressed attributes and operations not shown in the diagram.

Each attribute can have a name, a type, and a level of visibility. The type and visibility

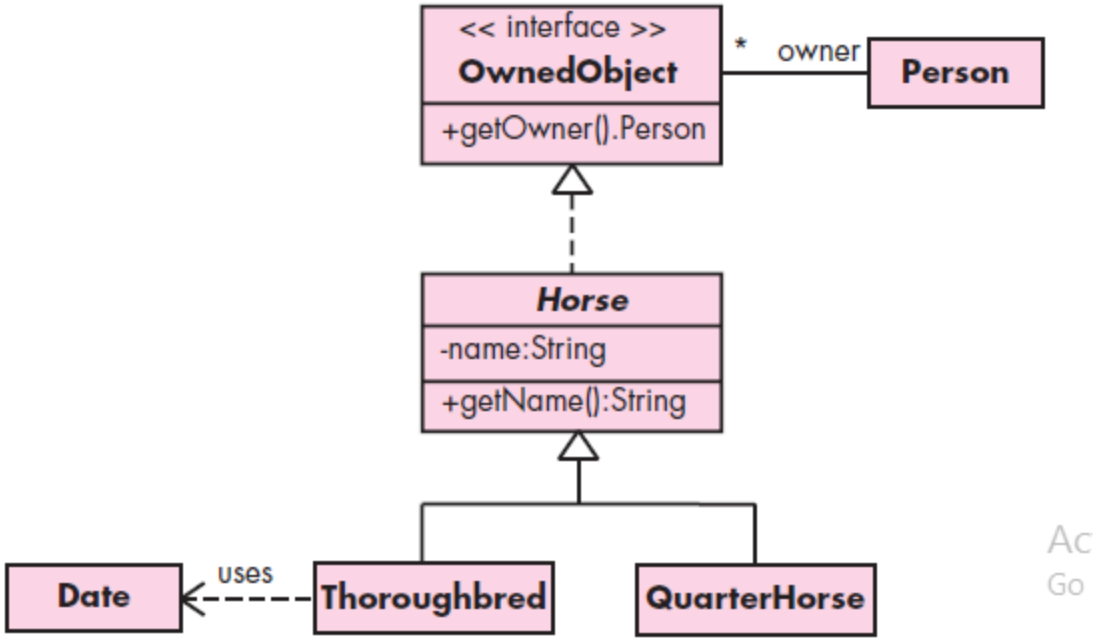
are optional. The type follows the name and is separated from the name by a Colon.



Ex:

Class diagrams can also show relationships between classes. A class that is a subclass of another class is connected to it by an arrow with a solid line for its shaft and with a triangular hollow arrowhead. The arrow points from the subclass to the superclass. In UML, such a relationship is called a *generalization*.

Ex: The **Thoroughbred** and **QuarterHorse** classes are shown to be subclasses of the **Horse** abstract class. An arrow with a dashed line for the arrow shaft indicates implementation of an interface. In UML, such a relationship is called a *realization*. For example, in Figure A1.2, the **Horse** class implements or realizes the **OwnedObject** interface.



Usage of Class diagrams

The class diagram is used to represent a static view of the system. It plays an essential role in the establishment of the component and deployment diagrams. It helps to construct an executable code to perform forward and backward engineering for any system, or we can say it is mainly used for construction. It represents the mapping with object-oriented languages that are C++, Java, etc. Class diagrams can be used for the following purposes:

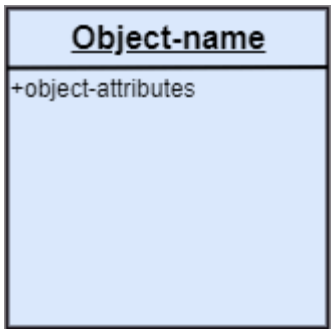
1. To describe the static view of a system.
2. To show the collaboration among every instance in the static view.
3. To describe the functionalities performed by the system.
4. To construct the software application using object-oriented languages.

Object Diagram

Object diagrams are dependent on the class diagram as they are derived from the class diagram. It represents an instance of a class diagram. The objects help in portraying a static view of an object-oriented system at a specific instant.

Both the object and class diagram are similar to some extent; the only difference is that the class diagram provides an abstract view of a system. It helps in visualizing a particular functionality of a system.

Notation of an Object Diagram



Purpose of Object Diagram

The object diagram holds the same purpose as that of a class diagram. The class diagram provides an abstract view which comprises of classes and their relationships, whereas the object diagram represents an instance at a particular point of time.

The object diagram is actually similar to the concrete (actual) system behavior. The main purpose is to depict a static view of a system.

Steps to draw an Object Diagram:

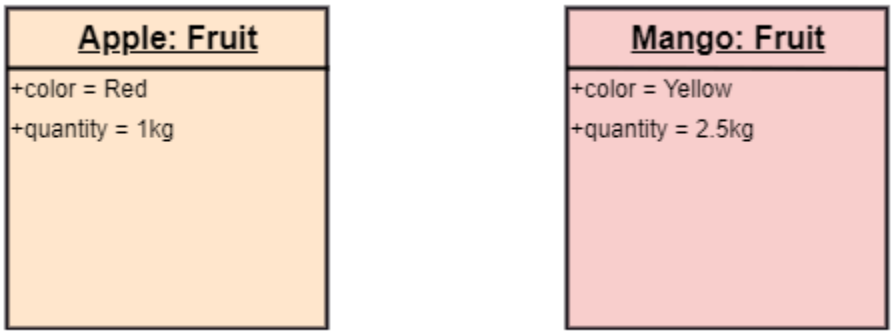
1. All the objects present in the system should be examined before start drawing the object diagram.
2. Before creating the object diagram, the relation between the objects must be acknowledged.
3. The association relationship among the entities must be cleared already.
4. To represent the functionality of an object, a proper meaningful name should be assigned.
5. The objects are to be examined to understand its functionality.

Applications of Object diagrams

The following are the application areas where the object diagrams can be used.

1. To build a prototype of a system.
2. To model complex data structures.
3. To perceive the system from a practical perspective.
4. Reverse engineering.

Ex:



Class vs. Object diagram

Serial No.	Class Diagram	Object Diagram
1.	It depicts the static view of a system.	It portrays the real-time behavior of a system.
2.	Dynamic changes are not included in the class diagram.	Dynamic changes are captured in the object diagram.
3.	The data values and attributes of an instance are not involved here.	It incorporates data values and attributes of an entity.
4.	The object behavior is manipulated in the class diagram.	Objects are the instances of a class.

Component Diagram:

The component diagrams have remarkable importance. It is used to depict the functionality and behavior of all the components present in the system, unlike other diagrams that are used to represent the architecture of the system, working of a system, or simply the system itself.

In UML, the component diagram portrays the behavior and organization of components at any instant of time. The system cannot be visualized by any individual component, but it can be by the collection of components.

Following are some reasons for the requirement of the component diagram:

1. It portrays the components of a system at the runtime.
2. It is helpful in testing a system.
3. It envisions the links between several connections.

It represents various physical components of a system at runtime. It is helpful in visualizing the structure and the organization of a system. It describes how individual components can together form a single system. Following are some reasons, which tells when to use component diagram:

1. To divide a single system into multiple components according to the functionality.
2. To represent the component organization of the system.

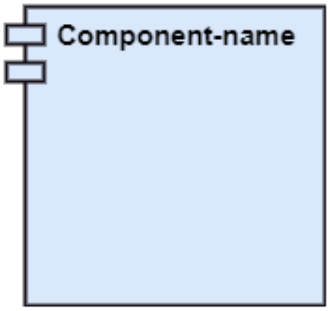
The component diagram is helpful in representing the physical aspects of a system, which are files, executables, libraries, etc. The main purpose of a component diagram is different from that of other diagrams. It is utilized in the implementation phase of any application.

Some of the artifacts that are needed to be identified before drawing a component diagram:

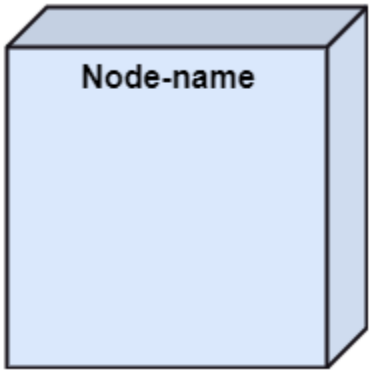
1. What files are used inside the system?
2. What is the application of relevant libraries and artifacts?
3. What is the relationship between the artifacts?

Notation of a Component Diagram

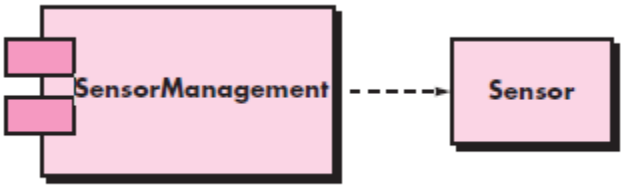
a) A component



b) A node



Ex:



In this figure, a component named **SensorManagement** (part of the *SafeHome* security function) is represented. A dashed arrow connects the component to a class named **Sensor** that is assigned to it. The **SensorManagement** component performs all functions associated with *SafeHome* sensors including monitoring and configuring them.

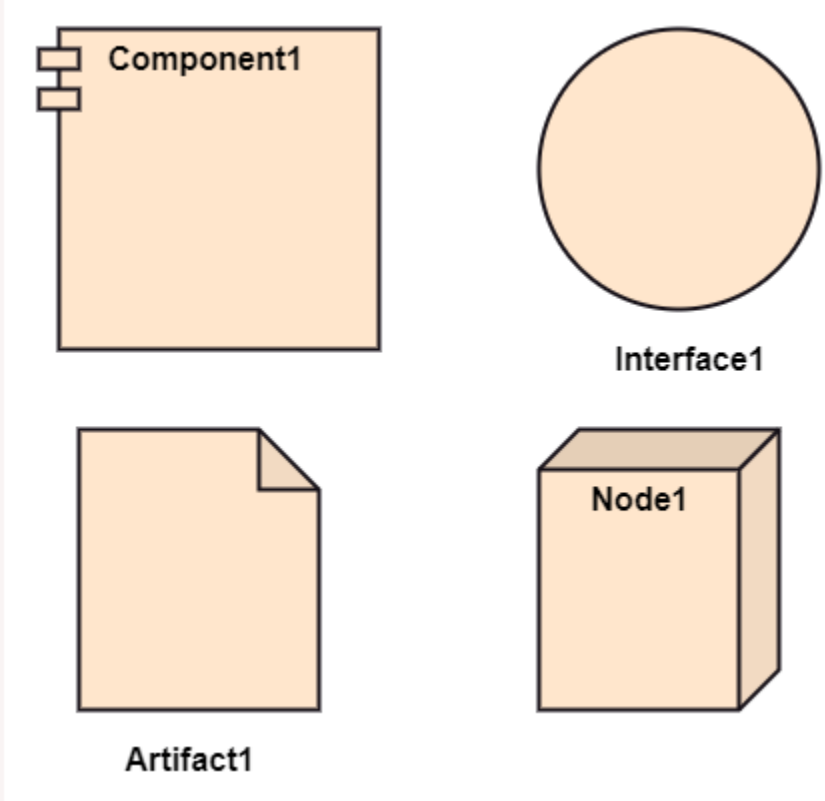
Deployment diagram:

The main purpose of the deployment diagram is to represent how software is installed on the hardware component. It depicts in what manner a software interacts with hardware to perform its execution.

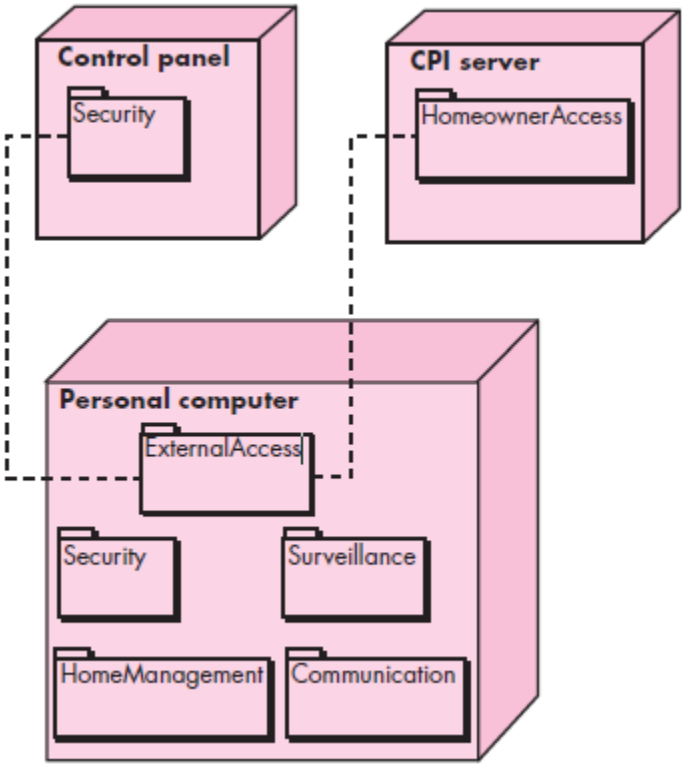
Both the deployment diagram and the component diagram are closely interrelated to each other as they focus on software and hardware components. The component diagram represents the components of a system, whereas the deployment diagram describes how they are actually deployed on the hardware.

The deployment diagram consist of the following notations:

1. A component
2. An artifact
3. An interface
4. A node



Ex:



In the figure, three computing environments are shown (in actuality, there would be more including sensors, cameras, and others). The subsystems (functionality) housed within each computing element are indicated. For example, the personal computer houses subsystems that implement security, surveillance, home management, and communications features. In addition, an external access subsystem has been designed to manage all attempts to access the *SafeHome* system from an external source. Each subsystem would be elaborated to indicate the components that it implements.

The diagram shown in Figure 8.7 is in *descriptor form*. This means that the deployment diagram shows the computing environment but does not explicitly indicate configuration details. For example, the "personal computer" is not further identified.

It could be a Mac or a Windows-based PC, a Sun workstation, or a Linux-box. These details are provided when the deployment diagram is revisited in *instance form* during the latter stages of design or as construction begins. Each instance of the deployment (a specific, named hardware configuration) is identified.

Deployment diagrams can be used for the followings:

1. To model the network and hardware topology of a system.
2. To model the distributed networks and systems.
3. Implement forwarding and reverse engineering processes.
4. To model the hardware details for a client/server system.
5. For modeling the embedded system.

Behavioural Diagrams:

Use case diagram:-

A use case diagram is used to represent the dynamic behavior of a system. It encapsulates the system's functionality by incorporating use cases, actors, and their relationships.

It models the tasks, services, and functions required by a system/subsystem of an application.

It depicts the high-level functionality of a system and also tells how the user handles a system.

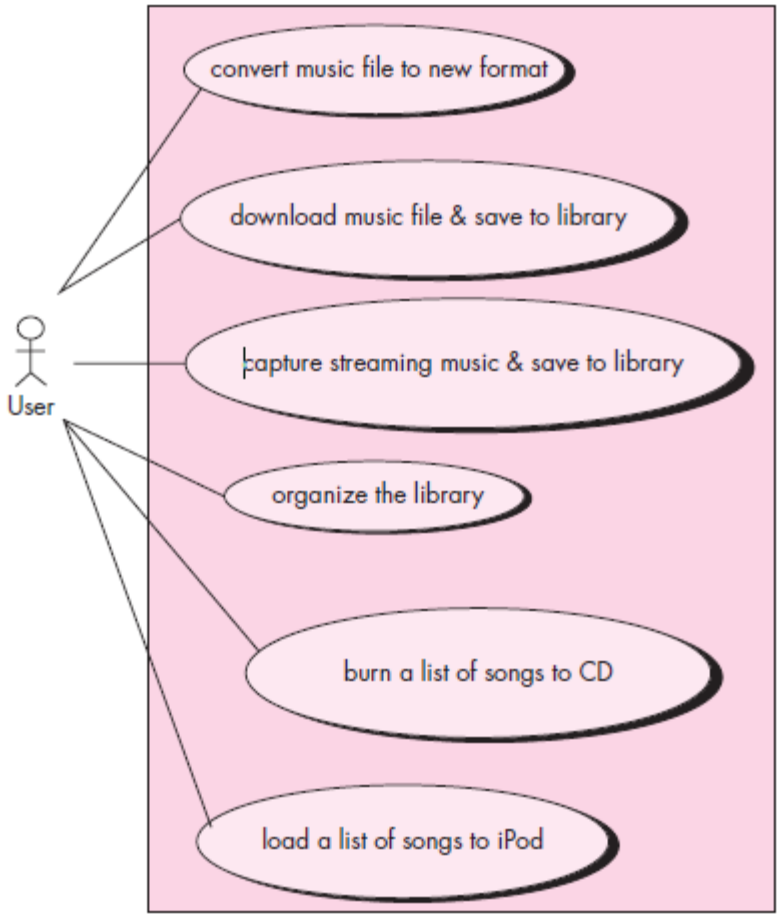
The main purpose of use case diagram is as follows.

1. It gathers the system's needs.
2. It depicts the external view of the system.
3. It recognizes the internal as well as external factors that influence the system.
4. It represents the interaction between the actors.

The actors are the person or a thing that invokes the functionality of a system. It may be a system or a private entity, such that it requires an entity to be pertinent to the functionalities of the system to which it is going to interact.

Once both the actors and use cases are enlisted, the relation between the actor and use case/ system is inspected. It identifies the no of times an actor communicates with the system. Basically, an actor can interact multiple times with a use case or system at a particular instance of time.

Ex: Use case diagram for the music system



Sequence Diagram

The sequence diagram represents the flow of messages in the system and is also termed as an event diagram. It helps in envisioning several dynamic scenarios. It portrays the communication between any two lifelines as a time-ordered sequence of events, such that these lifelines took part at the run time. In UML, the lifeline is represented by a vertical bar, whereas the message flow is represented by a vertical dotted line that extends across the bottom of the page. It incorporates the iterations as well as branching.

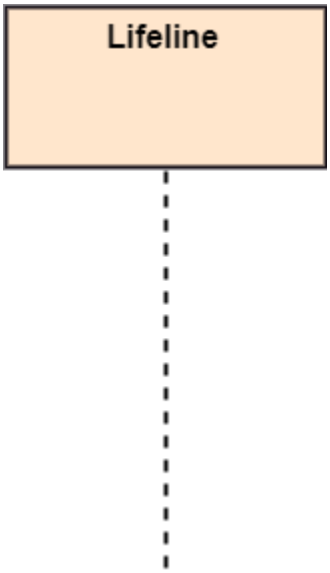
Purpose of a Sequence Diagram

1. To model high-level interaction among active objects within a system.
2. To model interaction among objects inside a collaboration realizing a use case.
3. It either models generic interactions or some certain instances of interaction.

Notations of a Sequence Diagram

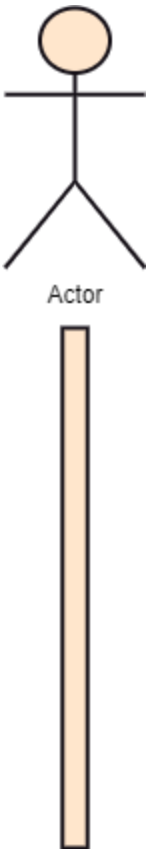
Lifeline

An individual participant in the sequence diagram is represented by a lifeline. It is positioned at the top of the diagram.



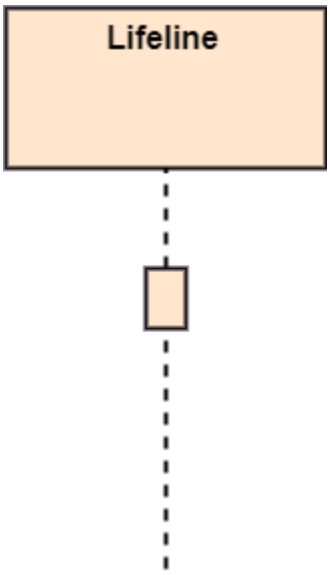
Actor

A role played by an entity that interacts with the subject is called as an actor. It is out of the scope of the system. It represents the role, which involves human users and external hardware or subjects. An actor may or may not represent a physical entity, but it purely depicts the role of an entity. Several distinct roles can be played by an actor or vice versa.



Activation

It is represented by a thin rectangle on the lifeline. It describes that time period in which an operation is performed by an element, such that the top and the bottom of the rectangle is associated with the initiation and the completion time, each respectively.

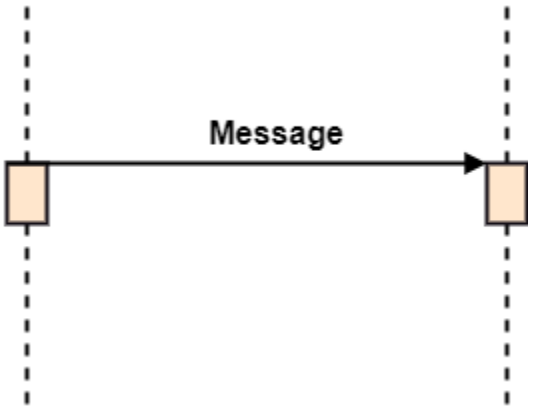


Messages

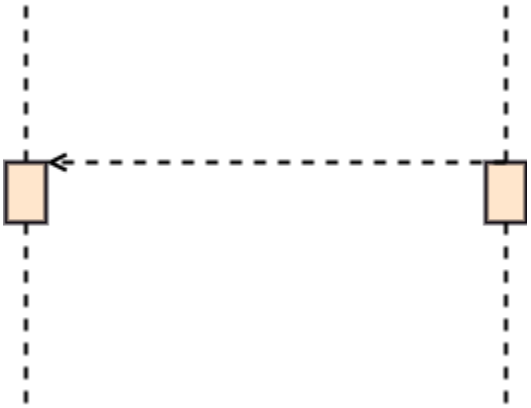
The messages depict the interaction between the objects and are represented by arrows. They are in the sequential order on the lifeline. The core of the sequence diagram is formed by messages and lifelines.

Following are types of messages enlisted below:

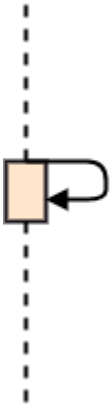
- **Call Message:** It defines a particular communication between the lifelines of an interaction, which represents that the target lifeline has invoked an operation.



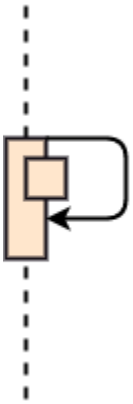
- **Return Message:** It defines a particular communication between the lifelines of interaction that represent the flow of information from the receiver of the corresponding caller message.



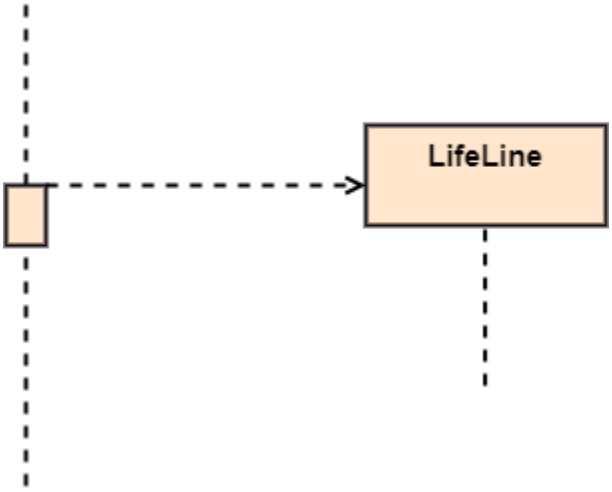
- **Self Message:** It describes a communication, particularly between the lifelines of an interaction that represents a message of the same lifeline, has been invoked.



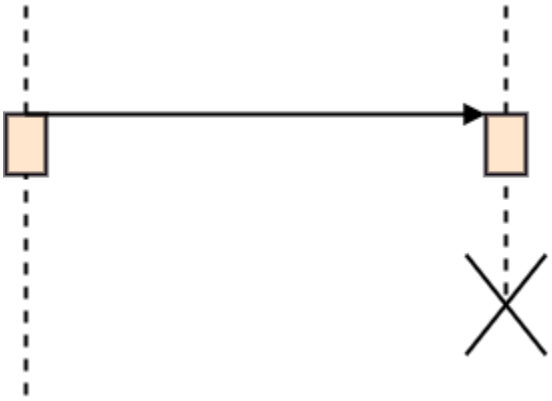
- **Recursive Message:** A self message sent for recursive purpose is called a recursive message. In other words, it can be said that the recursive message is a special case of the self message as it represents the recursive calls.



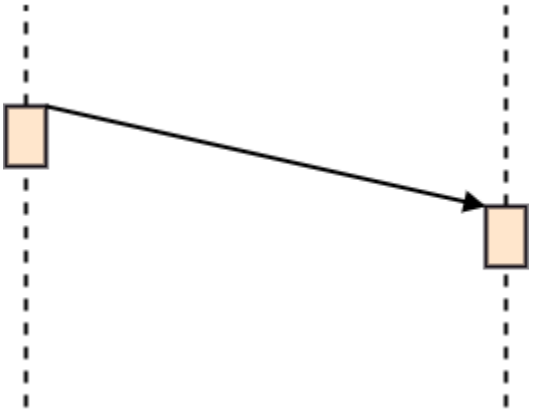
- **Create Message:** It describes a communication, particularly between the lifelines of an interaction describing that the target (lifeline) has been instantiated.



- **Destroy Message:** It describes a communication, particularly between the lifelines of an interaction that depicts a request to destroy the lifecycle of the target.

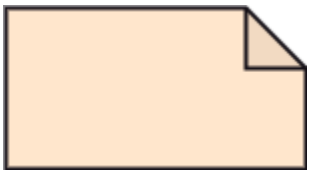


- **Duration Message:** It describes a communication particularly between the lifelines of an interaction, which portrays the time passage of the message while modeling a system.



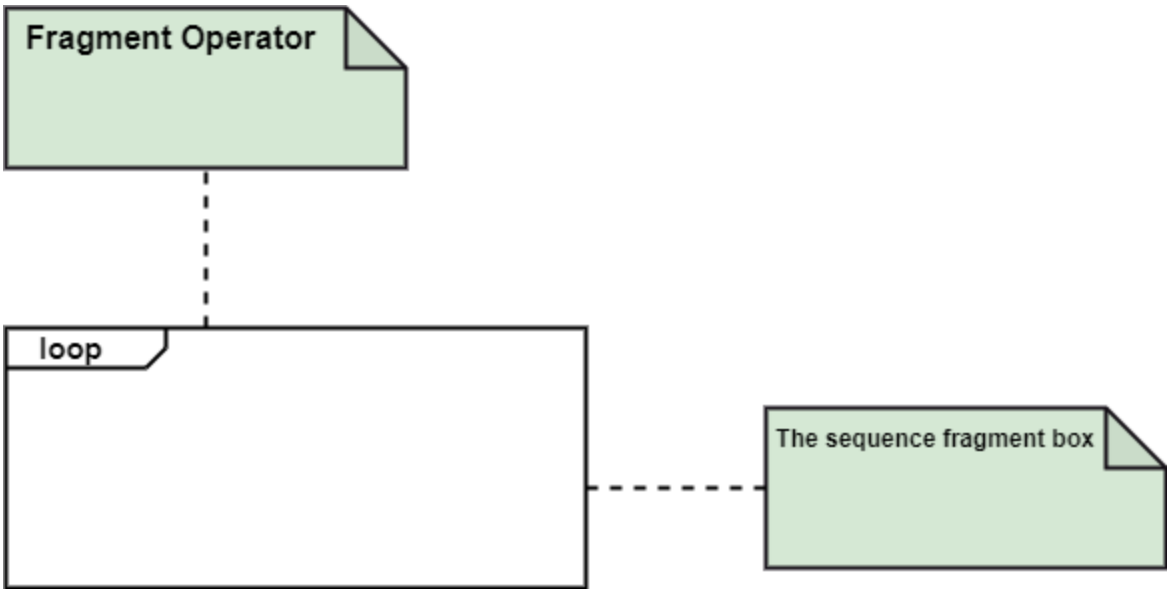
Note

A note is the capability of attaching several remarks to the element. It basically carries useful information for the modelers.



Sequence Fragments

1. Sequence fragments have been introduced by UML 2.0, which makes it quite easy for the creation and maintenance of an accurate sequence diagram.
2. It is represented by a box called a combined fragment, encloses a part of interaction inside a sequence diagram.
3. The type of fragment is shown by a fragment operator.



Types of fragments

Following are the types of fragments enlisted below;

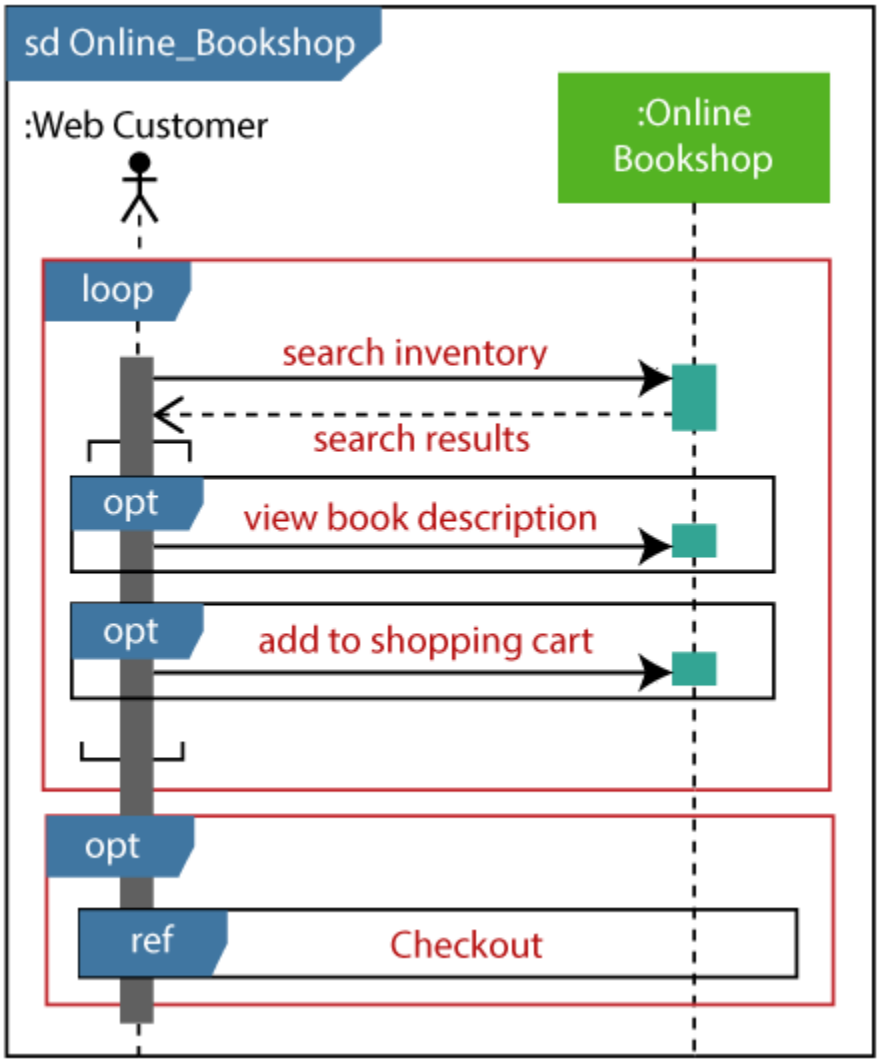
Operator	Fragment Type
Alt	Alternative multiple fragments: The only fragment for which the condition is true, will execute.
Opt	Optional: If the supplied condition is true, only then the fragments will execute. It is similar to alt with only one trace.
Par	Parallel: Parallel executes fragments.
Loop	Loop: Fragments are run multiple times, and the basis of interaction is shown by the guard.
Region	Critical region: Only one thread can execute a fragment at once.
Neg	Negative: A worthless communication is shown by the fragment.
Ref	Reference: An interaction portrayed in another diagram. In this, a frame is drawn so as to cover the lifelines involved in the communication. The parameter and return value

	can be explained.
Sd	Sequence Diagram: It is used to surround the whole sequence diagram.

Example of a Sequence Diagram

An example of a high-level sequence diagram for online bookshop is given below.

Any online customer can search for a book catalog, view a description of a particular book, add a book to its shopping cart, and do checkout.



Benefits of a Sequence Diagram

1. It explores the real-time application.
2. It depicts the message flow between the different objects.

3. It has easy maintenance.
4. It is easy to generate.
5. Implement both forward and reverse engineering.
6. It can easily update as per the new change in the system.

The drawback of a Sequence Diagram

1. In the case of too many lifelines, the sequence diagram can get more complex.
2. The incorrect result may be produced, if the order of the flow of messages changes.
3. Since each sequence needs distinct notations for its representation, it may make the diagram more complex.
4. The type of sequence is decided by the type of message.

Collaboration diagram:

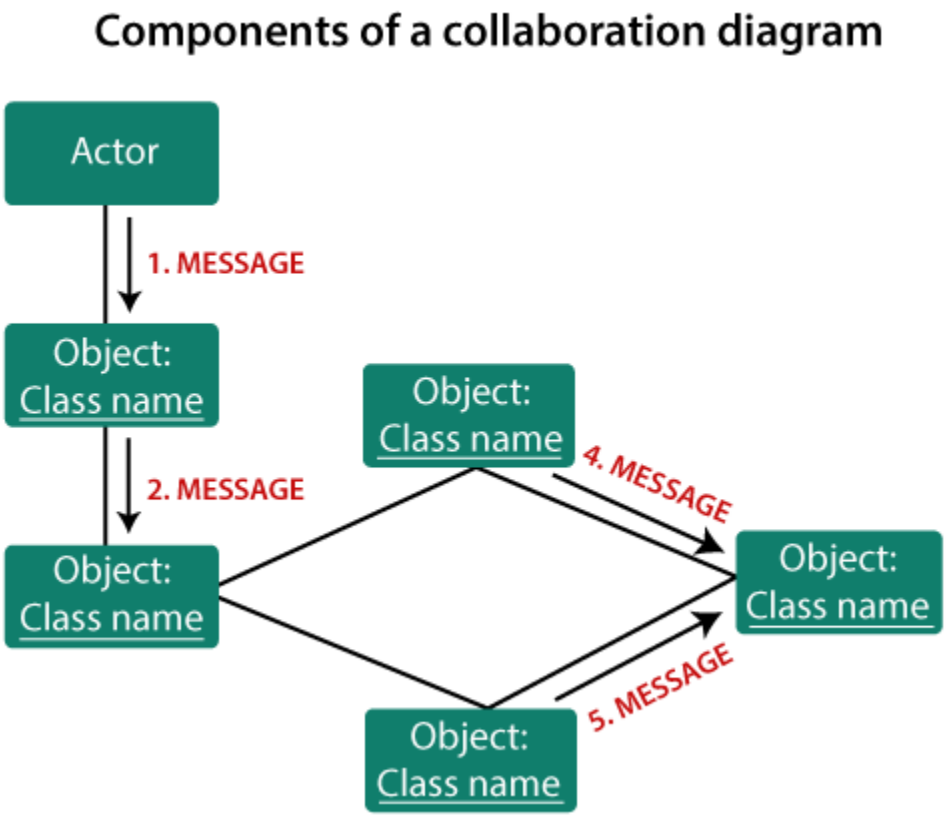
The collaboration diagram is used to show the relationship between the objects in a system. Both the sequence and the collaboration diagrams represent the same information but differently. Instead of showing the flow of messages, it depicts the architecture of the object residing in the system as it is based on object-oriented programming. An object consists of several features. Multiple objects present in the system are connected to each other. The collaboration diagram, which is also known as a communication diagram, is used to portray the object's architecture in the system.

Notations of a Collaboration Diagram

Following are the components of a component diagram that are enlisted below:

1. **Objects:** The representation of an object is done by an object symbol with its name and class underlined, separated by a colon.
   In the collaboration diagram, objects are utilized in the following ways:
   - The object is represented by specifying their name and class.
   - It is not mandatory for every class to appear.
   - A class may constitute more than one object.
   - In the collaboration diagram, firstly, the object is created, and then its class is specified.
   - To differentiate one object from another object, it is necessary to name them.

2. **Actors:** In the collaboration diagram, the actor plays the main role as it invokes the interaction. Each actor has its respective role and name. In this, one actor initiates the use case.
3. **Links:** The link is an instance of association, which associates the objects and actors. It portrays a relationship between the objects through which the messages are sent. It is represented by a solid line. The link helps an object to connect with or navigate to another object, such that the message flows are attached to links.
4. **Messages:** It is a communication between objects which carries information and includes a sequence number, so that the activity may take place. It is represented by a labeled arrow, which is placed near a link. The messages are sent from the sender to the receiver, and the direction must be navigable in that particular direction. The receiver must understand the message.



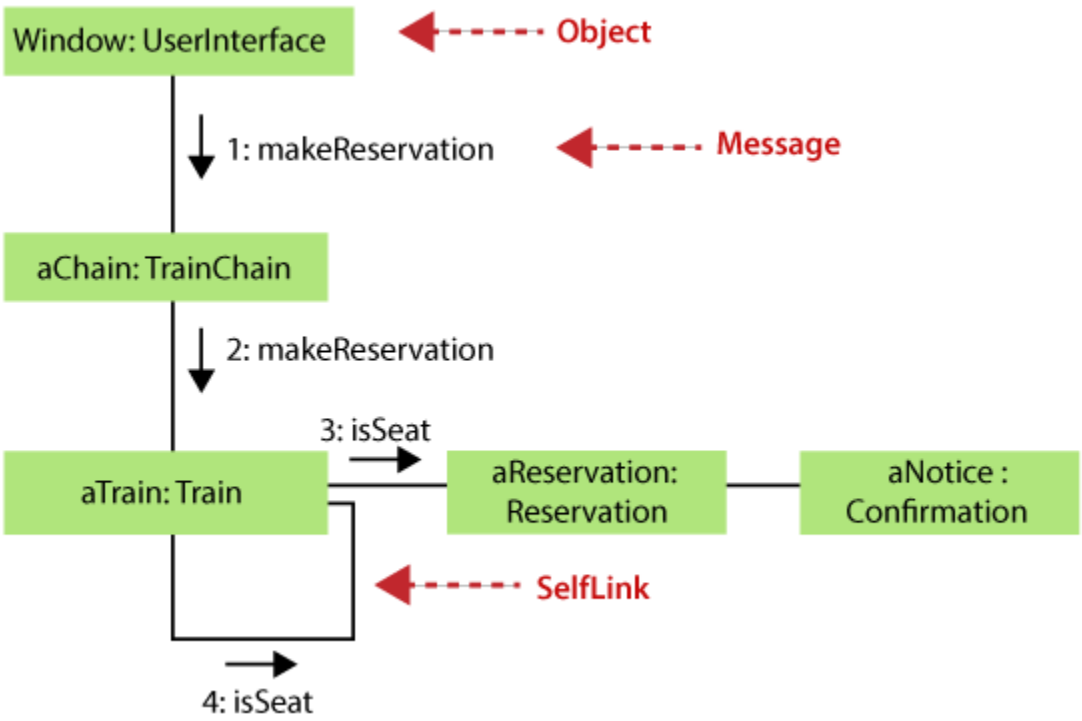
Steps for creating a Collaboration Diagram

1. Determine the behavior for which the realization and implementation are specified.
2. Discover the structural elements that are class roles, objects, and subsystems for performing the functionality of collaboration.

- Choose the context of an interaction: system, subsystem, use case, and operation.

3. Think through alternative situations that may be involved.
    - Implementation of a collaboration diagram at an instance level, if needed.
    - A specification level diagram may be made in the instance level sequence diagram for summarizing alternative situations.

Ex:



Benefits of a Collaboration Diagram

1. The collaboration diagram is also known as Communication Diagram.
2. It mainly puts emphasis on the structural aspect of an interaction diagram, i.e., how lifelines are connected.
3. The syntax of a collaboration diagram is similar to the sequence diagram; just the difference is that the lifeline does not consist of tails.
4. The messages transmitted over sequencing is represented by numbering each individual message.
5. The collaboration diagram is semantically weak in comparison to the sequence diagram

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State Chart Diagram:

The state machine diagram is also called the Statechart or State Transition diagram, which shows the order of states underwent by an object within the system. It captures the software system's behavior. It models the behavior of a class, a subsystem, a package, and a complete system.

It tends out to be an efficient way of modeling the interactions and collaborations in the external entities and the system. It models event-based systems to handle the state of an object. It also defines several distinct states of a component within the system. Each object/component has a specific state.

Following are the types of a state machine diagram that are given below:

1. **Behavioral state machine**

   The behavioral state machine diagram records the behavior of an object within the system. It depicts an implementation of a particular entity. It models the behavior of the system.

2. **Protocol state machine**

   It captures the behavior of the protocol. The protocol state machine depicts the change in the state of the protocol and parallel changes within the system. But it does not portray the implementation of a particular component.

Why State Machine Diagram?

Since it records the dynamic view of a system, it portrays the behavior of a software application. During a lifespan, an object underwent several states, such that the lifespan exist until the program is executing. Each state depicts some useful information about the object.

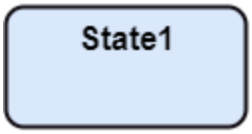
It blueprints an interactive system that response back to either the internal events or the external ones. The execution flow from one state to another is represented by a state machine diagram. It visualizes an object state from its creation to its termination.

The main purpose is to depict each state of an individual object. It represents an interactive system and the entities inside the system. It records the dynamic behavior of the system.

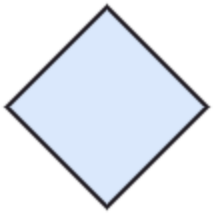
Notation of a State Machine Diagram

Following are the notations of a state machine diagram enlisted below:

Initial state



State-box



Decision-box

Final State

1.**Initial state:**It defines the initial state (beginning) of a system, and it is represented by a black filled circle.

2.**Final state:**It represents the final state (end) of a system. It is denoted by a filled circle present within a circle.

3.**Decision box:**It is of diamond shape that represents the decisions to be made on the basis of an evaluated guard.

4.**Transition:**A change of control from one state to another due to the occurrence of some event is termed as a transition. It is represented by an arrow labeled with an event due to which the change has ensued.

5.**State box:I**t depicts the conditions or circumstances of a particular object of a class at a specific point of time. A rectangle with round corners is used to represent the state box.

Ex:

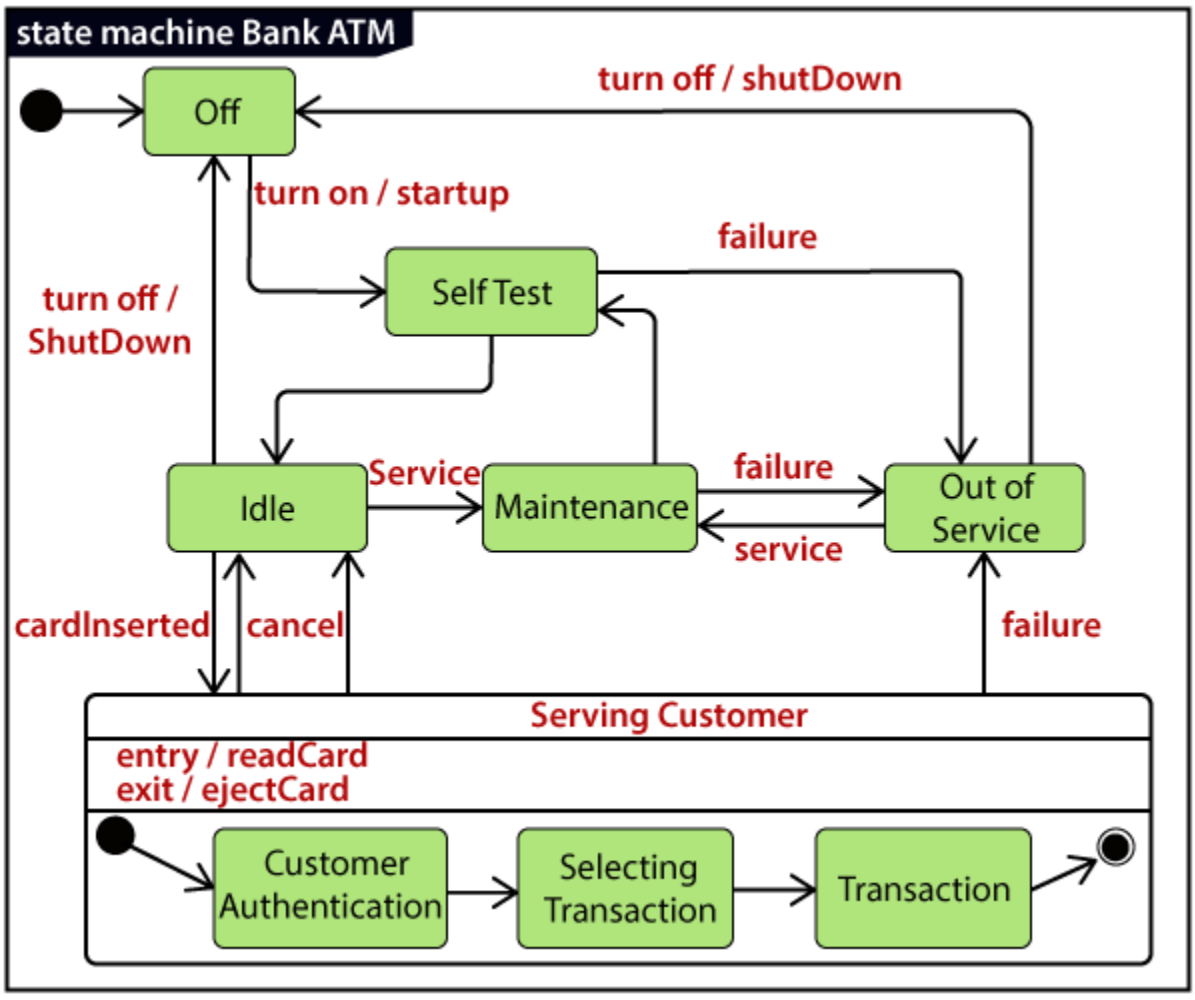
An example of a top-level state machine diagram showing Bank Automated Teller Machine (ATM) is given below.

Initially, the ATM is turned off. After the power supply is turned on, the ATM starts performing the startup action and enters into the**Self Test**state. If the test fails, the ATM will enter into the

Out Of Servicestate, or it will undergo**a triggerless transition**to the**Idle**state. This is the state where the customer waits for the interaction.

Whenever the customer inserts the bank or credit card in the ATM's card reader, the ATM state changes from**Idle**to**Serving Customer**, the entry action**readCard** is performed after entering into**Serving Customer**state. Since the customer can cancel the transaction at any instant, so the transition from **Serving Customer** state back to the**Idle**state could be

triggered by**cancel**event.



Activity diagram:

Activity diagram is another important diagram in UML to describe the dynamic aspects of the system.

Activity diagram is basically a flowchart 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. Activity diagrams deal with all type of flow control by using different elements such as fork, join, etc

Purpose of Activity Diagrams

The basic purposes of activity diagrams is similar to other four diagrams. It captures the dynamic behavior of the system. Other four diagrams are used to show the message flow from one object to another but activity diagram is used to show message flow from one activity to another.

Activity is a particular operation of the system. Activity diagrams are not only used for visualizing the dynamic nature of a system, but they are also used to construct the executable system by using forward and reverse engineering techniques. The only missing thing in the activity diagram is the message part.

It does not show any message flow from one activity to another. Activity diagram is sometimes considered as the flowchart. Although the diagrams look like a flowchart, they are not. It shows different flows such as parallel, branched, concurrent, and single.

The purpose of an activity diagram can be described as −

- Draw the activity flow of a system.
- Describe the sequence from one activity to another.
- Describe the parallel, branched and concurrent flow of the system.

How to Draw an Activity Diagram?

Activity diagrams are mainly used as a flowchart that consists of activities performed by the system. Activity diagrams are not exactly flowcharts as they have some additional capabilities. These additional capabilities include branching, parallel flow, swimlane, etc.

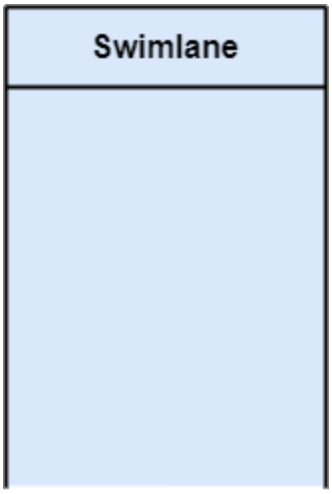
Activities

The categorization of behavior into one or more actions is termed as an activity. In other words, it can be said that an activity is a network of nodes that are connected by edges. The edges depict the flow of execution. It may contain action nodes, control nodes, or object nodes.

The control flow of activity is represented by control nodes and object nodes that illustrates the objects used within an activity. The activities are initiated at the initial node and are terminated at the final node.

Activity partition /swimlane

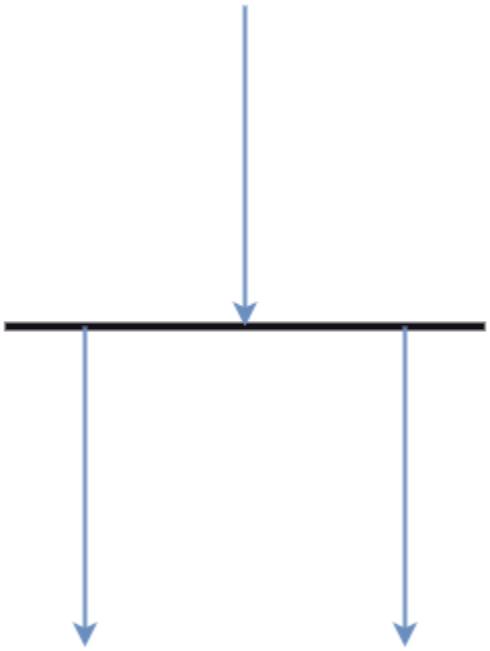
The swimlane is used to cluster all the related activities in one column or one row. It can be either vertical or horizontal. It used to add modularity to the activity diagram. It is not necessary to incorporate swimlane in the activity diagram. But it is used to add more transparency to the activity diagram.



Forks

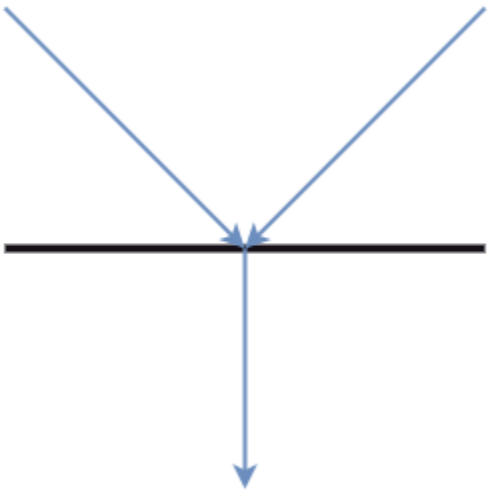
Forks and join nodes generate the concurrent flow inside the activity. A fork node consists of one inward edge and several outward edges. It is the same as that of various decision parameters.

Whenever a data is received at an inward edge, it gets copied and split crossways various outward edges. It split a single inward flow into multiple parallel flows.



Join Nodes

Join nodes are the opposite of fork nodes. A Logical AND operation is performed on all of the inward edges as it synchronizes the flow of input across one single output (outward) edge.



Pins

It is a small rectangle, which is attached to the action rectangle. It clears out all the messy and complicated thing to manage the execution flow of activities. It is an object node that precisely represents one input to or output from the action.

Before drawing an activity diagram, we must have a clear understanding about the elements used in activity diagram. The main element of an activity diagram is the activity itself. An activity is a function performed by the system. After identifying the activities, we need to understand how they are associated with constraints and conditions.

Before drawing an activity diagram, we should identify the following elements −

- Activities
- Association
- Conditions
- Constraints

Once the above-mentioned parameters are identified, we need to make a mental layout of the entire flow. This mental layout is then transformed into an activity diagram.

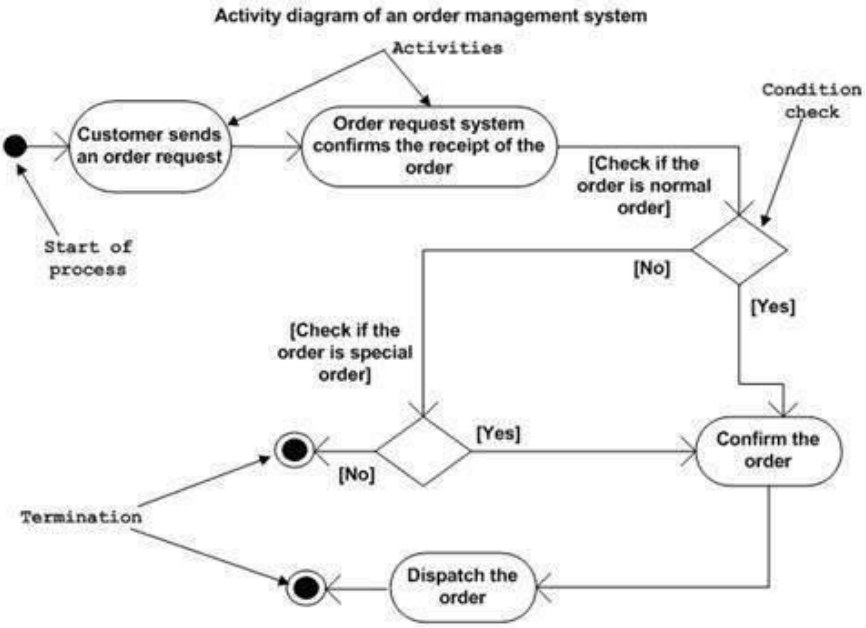
Following is an example of an activity diagram for order management system. In the diagram, four activities are identified which are associated with conditions. One important point should be clearly understood that an activity diagram cannot be exactly matched with the code. The activity diagram is made to understand the flow of activities and is mainly used by the business users

Following diagram is drawn with the four main activities −

- Send order by the customer
- Receipt of the order
- Confirm the order
- Dispatch the order

After receiving the order request, condition checks are performed to check if it is normal or special order. After the type of order is identified, dispatch activity is performed and that is marked as the termination of the process.

Ex: Order Management System


Activity diagram of an order management system
Activities
Condition check
Customer sends an order request
Order request system confirms the receipt of the order
[Check if the order is normal order]
Start of process
[No]
[Yes]
[Check if the order is special order]
[Yes]
[No]
Confirm the order
Termination
Dispatch the order
