Topic:

UML

Unified Modelling Language

Software Engineering

Definition

- UML is a standard language for specifying, visualizing, constructing and documenting the artifacts of software systems.
- UML is different from the other programming languages like Java, C++ but tools can be used to generate code in various languages using UML diagrams.
- UML is a pictorial language used to make software blue prints.

Goals of UML

- ***A picture is worth a thousand words,*** this absolutely fits while discussing about UML.

- UML diagrams are not only for developers but also for business users, common people and anybody interested to understand the system. So it must be clear that UML is not a development method rather it accompanies with processes to make a successful system.

- The goal of UML can be defined as a simple modelling mechanism to model all possible practical systems in today's complex environment.

Building Blocks

This chapter describes all the UML building blocks. It can be defined as:

- **Things**
- **Relationships**
- **Diagrams**

1. Things

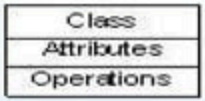
Things are the most important building blocks of UML. Things can be:

- Structural
- Behavioral
- Grouping
- Annotational

Structural Things

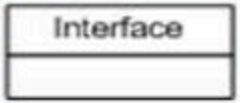
Class:

Class represents set of objects having similar responsibilities .



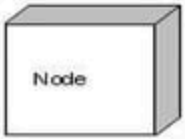
Interface:

Interface defines a set of operations which specify the responsibility of a class.



Node:

A node can be defined as a physical element that exists at run time.



Collaboration:

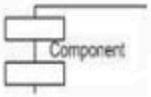
Collaboration defines interaction between elements.

Use case:

Use case represents a set of actions performed by a system for a specific goal.

Component:

Component describes physical part of a system.

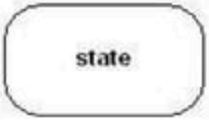


Behavioral things

A behavioral thing consists of the dynamic parts of UML models. Following are the behavioral things: _

Interaction:
Interaction is defined as a behavior that consists of a group of messages exchanged among elements to accomplish a specific task.

State machine:
State machine is useful when the state of an object in its life cycle is important. It defines the sequence of states an object goes through in response to events. Events are external factors responsible for state change.

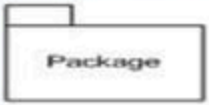


Grouping Things

Grouping things can be defined as a mechanism to group elements of a UML model together. There is only one grouping thing available:

Package:

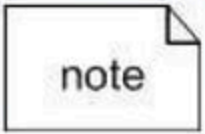
Package is the only one grouping thing available for gathering structural and behavioral things.



Annotational things

Annotational things can be defined as a mechanism to capture remarks, descriptions, and comments of UML model elements. **Note** is the only one Annotational thing available.

Note:
A note is used to render comments, constraints etc of an UML element.

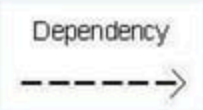


2. Relationship

Relationship is another most important building block of UML. It shows how elements are associated with each other and this association describes the functionality of an application. There are four kinds of relationships available.

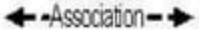
Dependency:

Dependency is a relationship between two things in which change in one element also affects the other one.



Association:

Association is basically a set of links that connects elements of an UML model. It also describes how many objects are taking part in that relationship.

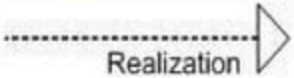


Generalization:

Generalization can be defined as a relationship which connects a specialized element with a generalized element. It basically describes inheritance relationship in the world of objects.

Realization:

Realization can be defined as a relationship in which two elements are connected. One element describes some responsibility which is not implemented and the other one implements them. This relationship exists in case of interfaces.



3. Diagrams

UML diagrams are the ultimate output of the entire discussion. All the elements, relationships are used to make a complete UML diagram and the diagram represents a system.

UML includes the following nine diagrams

Structural Diagrams:

1. Class diagram
2. Object diagram
3. Component diagram
4. Deployment diagram

Behavioral Diagrams:

5. Use case diagram
6. Sequence diagram
7. Collaboration diagram
8. State diagram
9. Activity diagram

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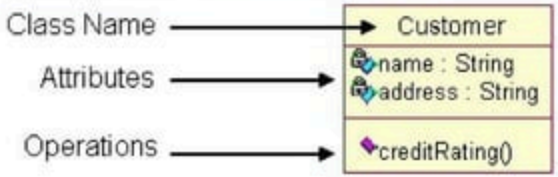
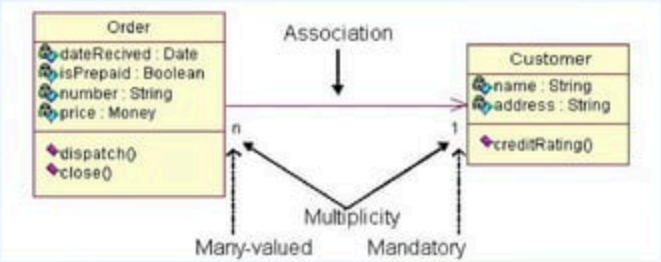
Class Diagram

Class diagrams are widely used to describe the types of objects in a system and their relationships. Class diagram consists of classes, interfaces, associations and collaboration.

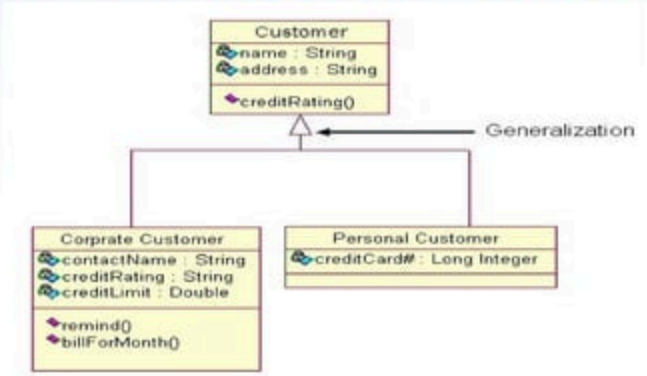
Classes are composed of three things: a name, attributes, and operations. Below is an example of a class.



Class diagrams also display relationships such as containment, inheritance, associations and others.



Another common relationship in class diagrams is a generalization. A generalization is used when two classes are similar, but have some differences. Look at the generalization below:



When to Use: Class Diagrams

Class diagrams are used in nearly all Object Oriented software designs. Use them to describe the Classes of the system and their relationships to each other.

How to Draw: Class Diagrams

Class diagrams are some of the most difficult UML diagrams to draw. To draw detailed and useful diagrams a person would have to study UML and Object Oriented principles for a long time. Therefore, this page will give a very high level overview of the process.

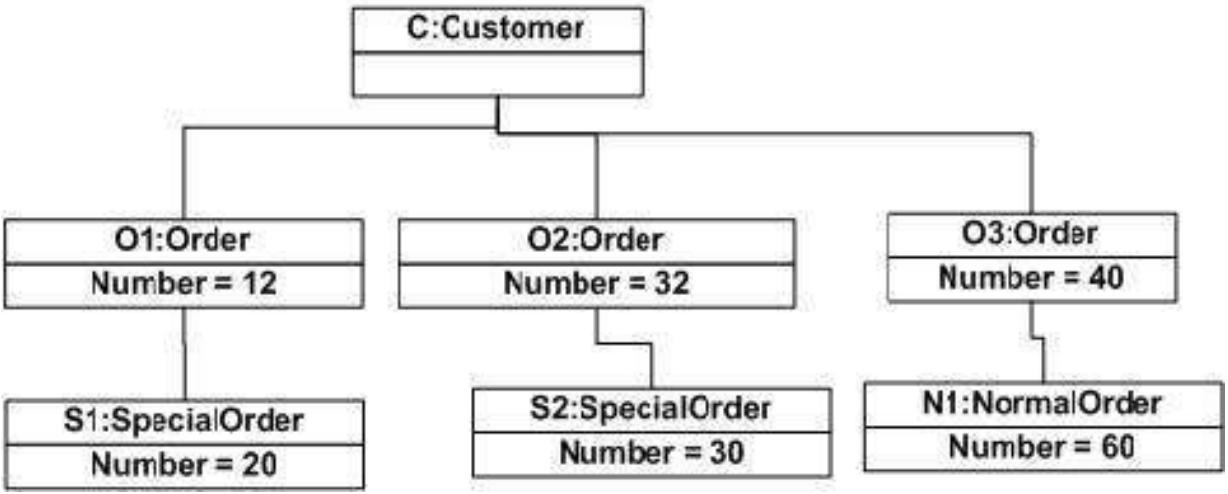
Object Diagram

Object diagrams can be described as an instance of class diagram. So these diagrams are more close to real life scenarios where we implement a system.

Object diagrams are a set of objects and their relationships just like class diagrams and also represent the static view of the system.

The usage of object diagrams is similar to class diagrams but they are used to build prototype of a system from practical perspective.

Object diagram of an order management system



Component Diagram

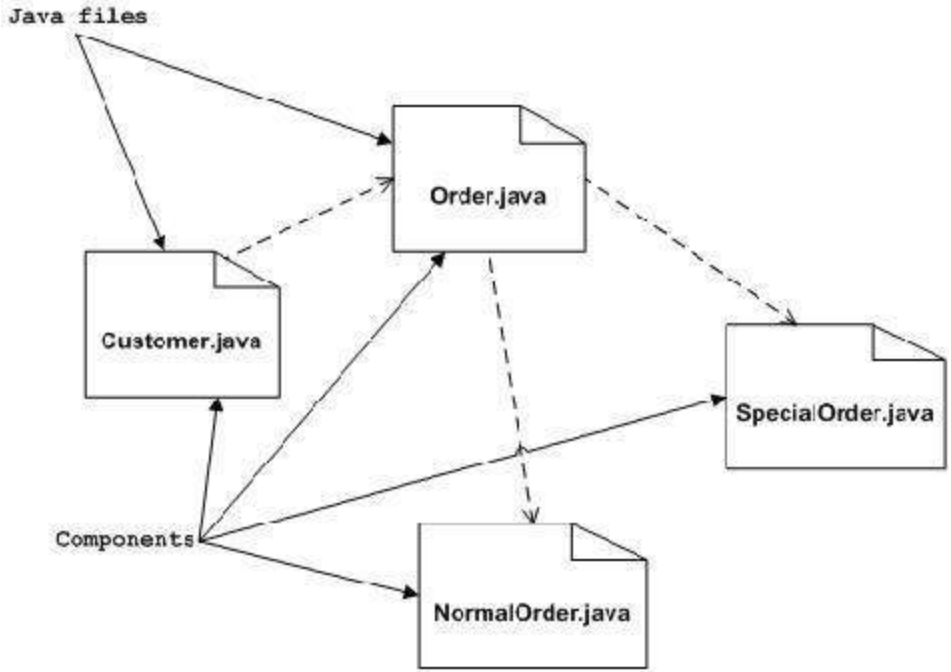
Component diagrams represent a set of components and their relationships. These components consist of classes, interfaces or collaborations.

So Component diagrams represent the implementation view of a system.

During design phase software artifacts (classes, interfaces etc) of a system are arranged in different groups depending upon their relationship. Now these groups are known as components.

Finally, component diagrams are used to visualize the implementation.

Component diagram of an order management system



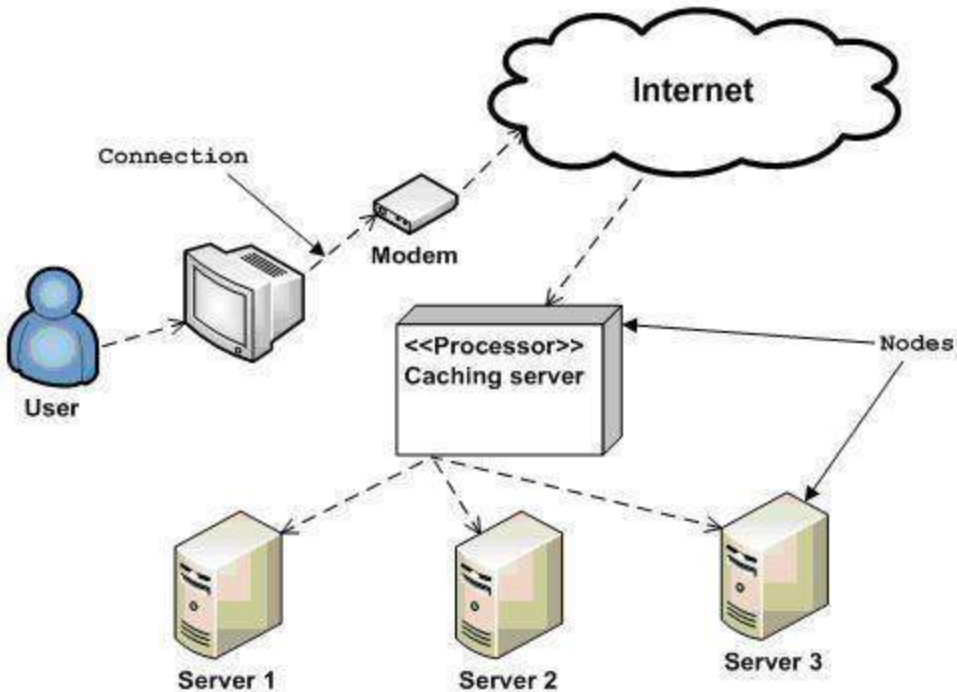
Deployment Diagram

Deployment diagrams are a set of nodes and their relationships. These nodes are physical entities where the components are deployed.

Deployment diagrams are used for visualizing deployment view of a system. This is generally used by the deployment team.

Note: *If the above descriptions and usages are observed carefully then it is very clear that all the diagrams are having some relationship with one another. Component diagrams are dependent upon the classes, interfaces etc which are part of class/object diagram. Again the deployment diagram is dependent upon the components which are used to make a component diagrams.*

Deployment diagram of an order management system



Use Case Diagrams

A use case is a set of scenarios that describing an interaction between a user and a system. A use case diagram displays the relationship among actors and use cases. The two main components of a use case diagram are use cases and actors.

An actor is represents a user or another system that will interact with the system you are modeling. A use case is an external view of the system that represents some action the user might perform in order to complete a task.

When to Use: Use Cases Diagrams

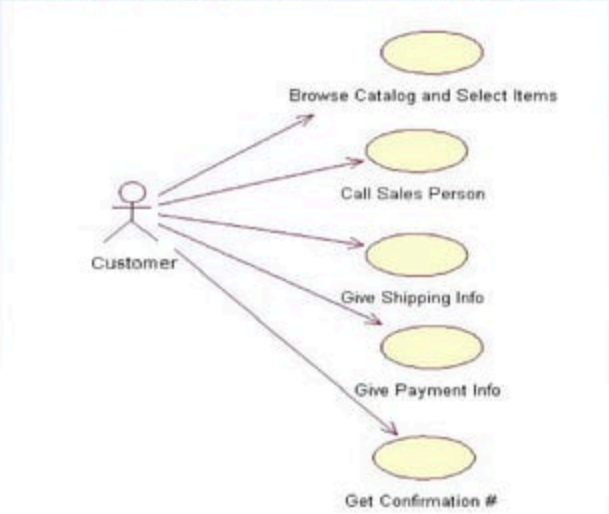
Use cases are used in almost every project. These are helpful in exposing requirements and planning the project. During the initial stage of a project most use cases should be defined, but as the project continues more might become visible.

How to Draw: Use Cases Diagrams

Use cases are a relatively easy UML diagram to draw, but this is a very simplified example. Start by listing a sequence of steps a user might take in order to complete an action.

1. Browse catalog and select items.
2. Call sales representative.
3. Supply shipping information.
4. Supply payment information.
5. Receive conformation number from salesperson.

These steps would generate this simple use case diagram:



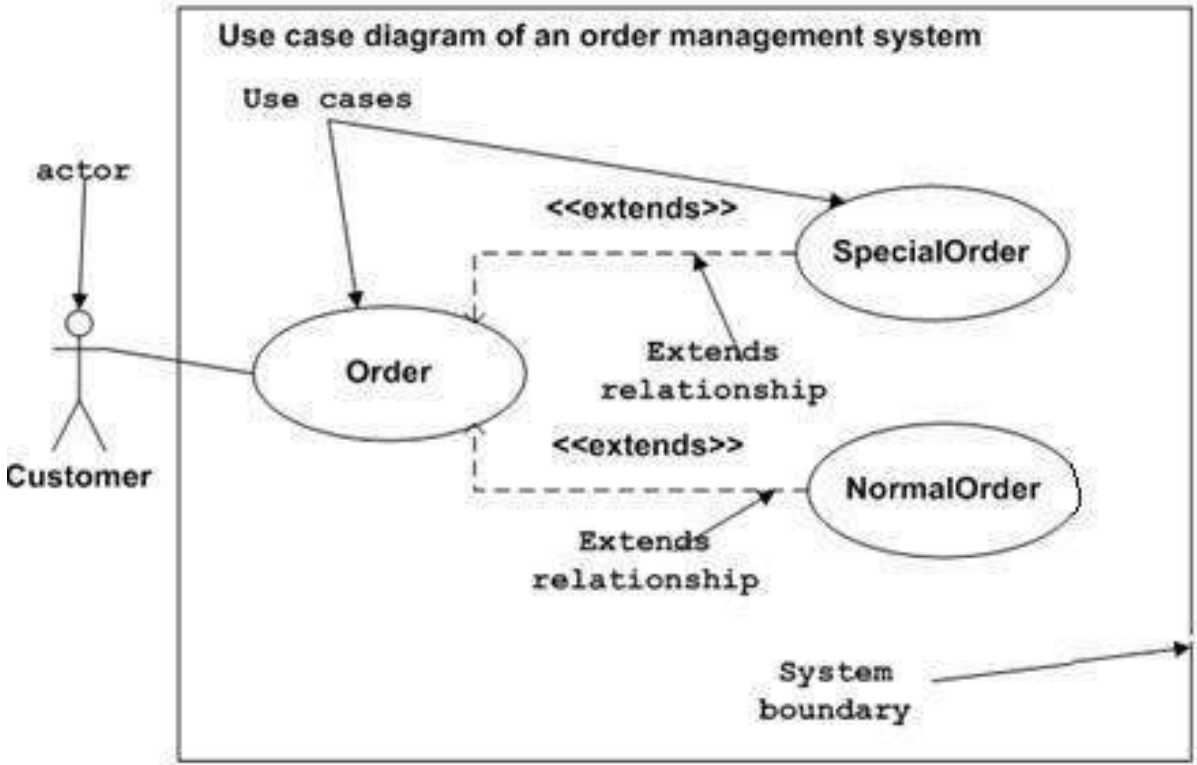


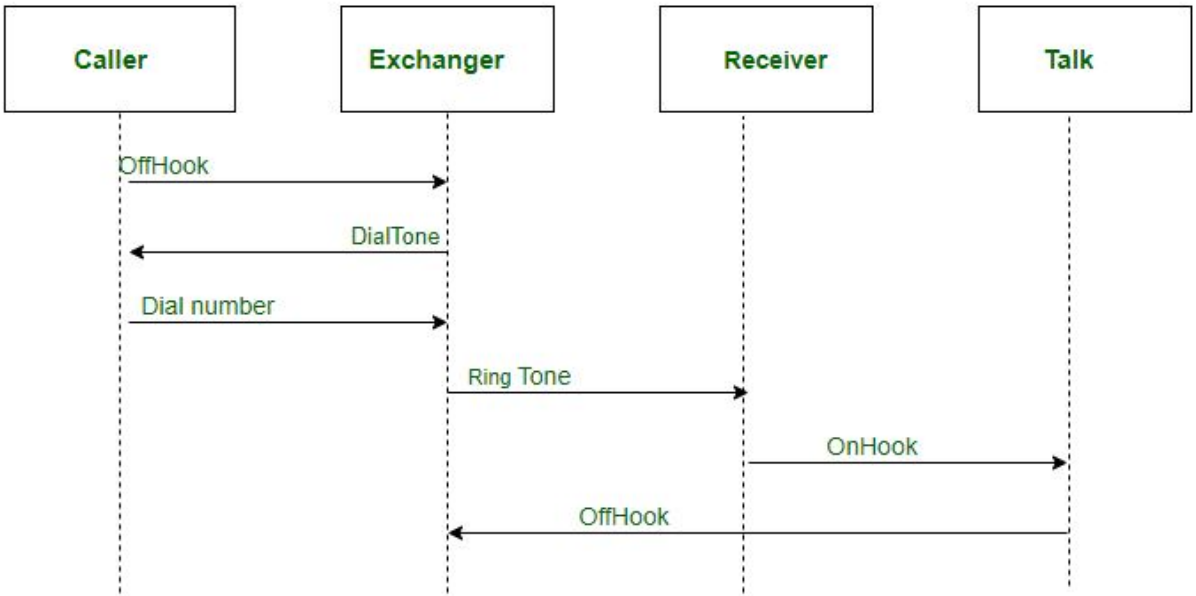
Figure: Sample Use Case diagram

Sequence Diagram

A sequence diagram is an interaction diagram. From the name it is clear that the diagram deals with some sequences, which are the sequence of messages flowing from one object to another.

Interaction among the components of a system is very important from implementation and execution perspective.

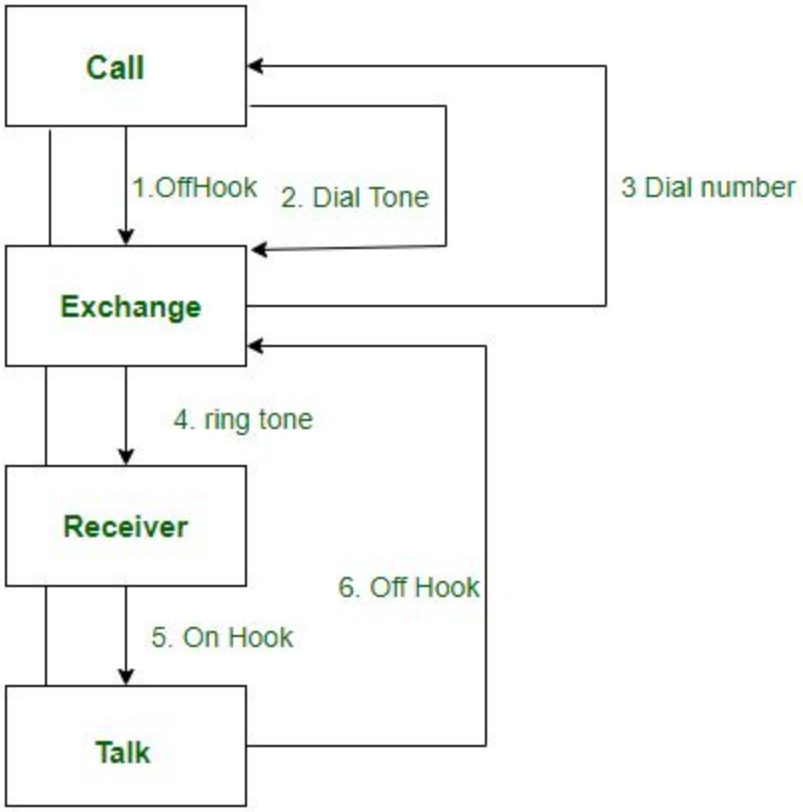
So Sequence diagram is used to visualize the sequence of calls in a system to perform a specific functionality.


Caller
Exchanger
Receiver
Talk
OffHook
DialTone
Dial number
Ring Tone
OnHook
OffHook

Collaboration Diagram

Collaboration diagram is another form of interaction diagram. It represents the structural organization of a system and the messages sent/received. Structural organization consists of objects and links.

The purpose of collaboration diagram is similar to sequence diagram. But the specific purpose of collaboration diagram is to visualize the organization of objects and their interaction.


Call
1.OffHook
2. Dial Tone
3 Dial number
Exchange
4. ring tone
Receiver
6. Off Hook
5. On Hook
Talk

State Diagram

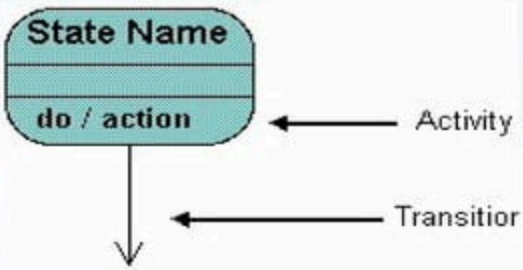
State diagrams are used to describe the behavior of a system. State diagrams describe all of the possible states of an object as events occur. Each diagram usually represents objects of a single class and track the different states of its objects through the system.

When to Use: State Diagrams

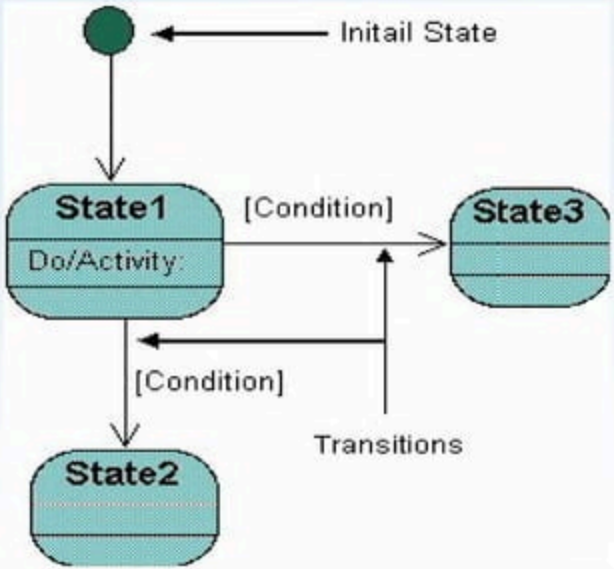
Use state diagrams to demonstrate the behavior of an object through many use cases of the system. Only use state diagrams for classes where it is necessary to understand the behavior of the object through the entire system. Not all classes will require a state diagram and state diagrams are not useful for describing the collaboration of all objects in a use case.

How to Draw: State Diagrams

State diagrams have very few elements. The basic elements are rounded boxes representing the state of the object and arrows indicting the transition to the next state. The activity section of the state symbol depicts what activities the object will be doing while it is in that state.



All state diagrams being with an initial state of the object. This is the state of the object when it is created. After the initial state the object begins changing states. Conditions based on the activities can determine what the next state the object transitions to.


Initail State
State1
Do/Activity:
[Condition]
State3
[Condition]
Transitions
State2

Activity Diagrams

Activity diagrams describe the workflow behavior of a system. Activity diagrams are similar to state diagrams because activities are the state of doing something. The diagrams describe the state of activities by showing the sequence of activities performed. Activity diagrams can show activities that are conditional or parallel.

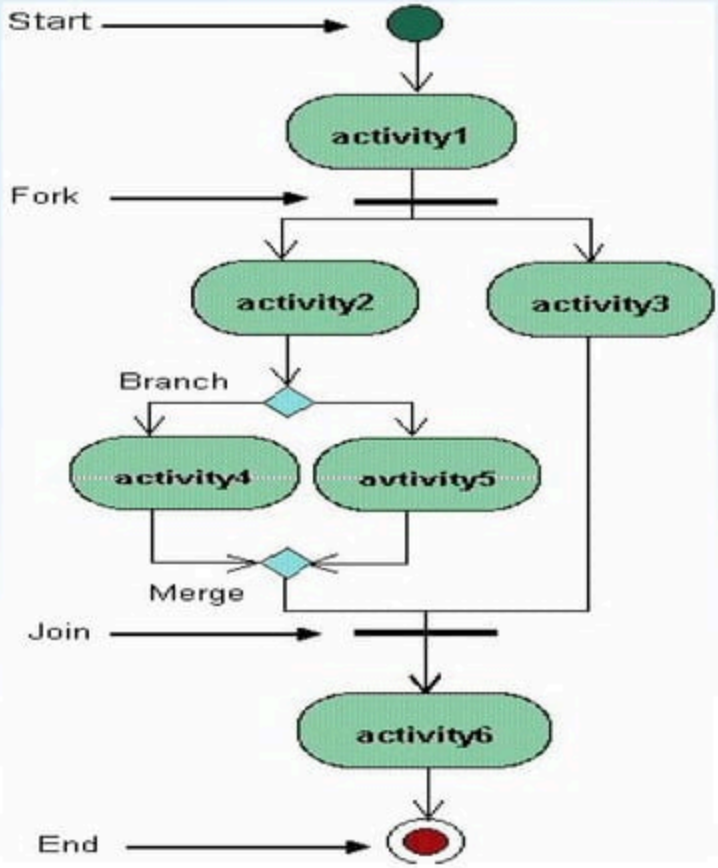
When to Use: Activity Diagrams

Activity diagrams should be used in conjunction with other modeling techniques such as interaction diagrams and state diagrams. The main reason to use activity diagrams is to model the workflow behind the system being designed. Activity Diagrams are also useful for: analyzing a use case by describing what actions need to take place and when they should occur; describing a complicated sequential algorithm; and modeling applications with parallel processes.

How to Draw: Activity Diagrams

Activity diagrams show the flow of activities through the system. Diagrams are read from top to bottom and have branches and forks to describe conditions and parallel activities. A fork is used when multiple activities are occurring at the same time.

The **diagram below** shows a fork after activity1. This indicates that both activity2 and activity3 are occurring at the same time. After activity2 there is a branch. The branch describes what activities will take place based on a set of conditions. All branches at some point are followed by a merge to indicate the end of the conditional behavior started by that branch. After the merge all of the parallel activities must be combined by a join before transitioning into the final activity state


Start
activity1
Fork
activity2
activity3
Branch
activity4
avtivity5
Merge
Join
activity6
End