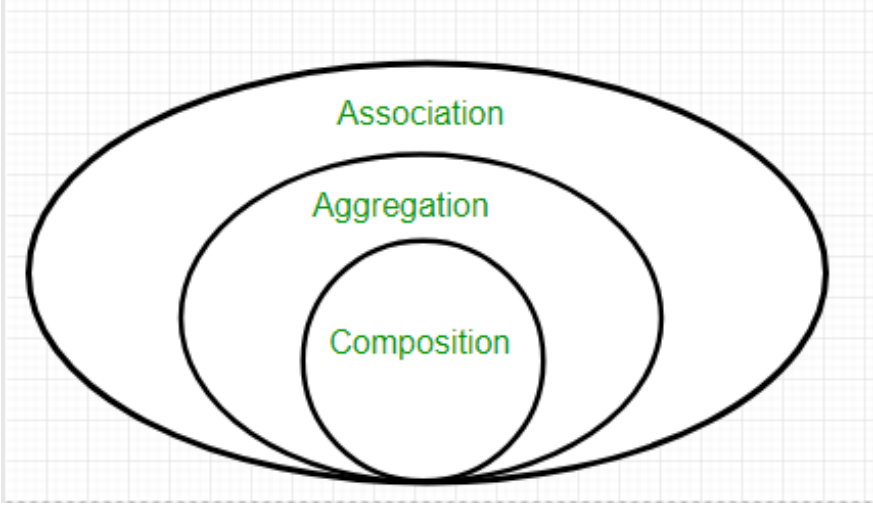
A owns B => Composition.
A uses B => Aggregation.
A "belongs/have" => Association.

Association and aggregation are weak relationships while composition is a strong relationship.

Association, Composition and Aggregation in Java

Association is a relation between two separate classes which establishes through their Objects. Association can be one-to-one, one-to-many, many-to-one, many-to-many. In Object-Oriented programming, an Object communicates to another object to use functionality and services provided by that object. **Composition** and **Aggregation** are the two forms of association.



Note that is-a relation is tightly coupled, that means if a class has some changes on demand of a client then the classes connected to it must have to be changed.
But the association is not tightly-coupled means that if there is any change in one class then no change in others. That's why association is preferred over inheritance.

NOTE: Is-a relationship is completely inheritance.

Example:

Java

```
// Java Program to illustrate the
// Concept of Association

// Importing required classes
import java.io.*;
import java.util.*;

// Class 1
// Bank class
class Bank {

    // Attributes of bank
    private String name;
```

```
    private Set<Employee> employees;
    // Constructor of this class
    Bank(String name)
    {
        // this keyword refers to current instance itself
        this.name = name;
    }

    // Method of Bank class
    public String getBankName()
    {
        // Returning name of bank
        return this.name;
    }

    public void setEmployees(Set<Employee> employees)
    {
        this.employees = employees;
    }
    public Set<Employee>
    getEmployees(Set<Employee> employees)
    {
        return this.employees;
    }
}

// Class 2
// Employee class
class Employee {
    // Attributes of employee
    private String name;
    // Employee name
    Employee(String name)
    {
        // This keyword refers to current instance itself
        this.name = name;
    }

    // Method of Employee class
    public String getEmployeeName()
    {
        // returning the name of employee
        return this.name;
    }
}

// Class 3
// Association between both the
// classes in main method
class GFG {

    // Main driver method
    public static void main(String[] args)
    {
```

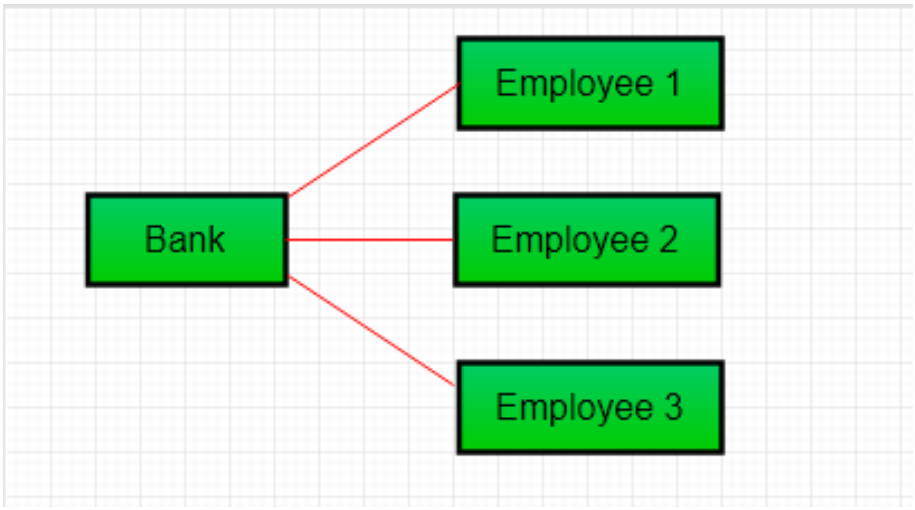
```
        // Creating objects of bank and Employee class
        Bank bank = new Bank("ICICI");
        Employee emp = new Employee("Ridhi");

        Set<Employee> employees = new HashSet<>();
        employees.add(emp);

        bank.setEmployees(employees);

        System.out.println(emp.getEmployeeName()
                           + " belongs to bank "
                           + bank.getBankName());
    }
}
```

Output


```
Ridhi belongs to bank ICICI
```

Output Explanation: In the above example, two separate classes Bank and Employee are associated through their Objects. Bank can have many employees, So it is a one-to-many relationship.

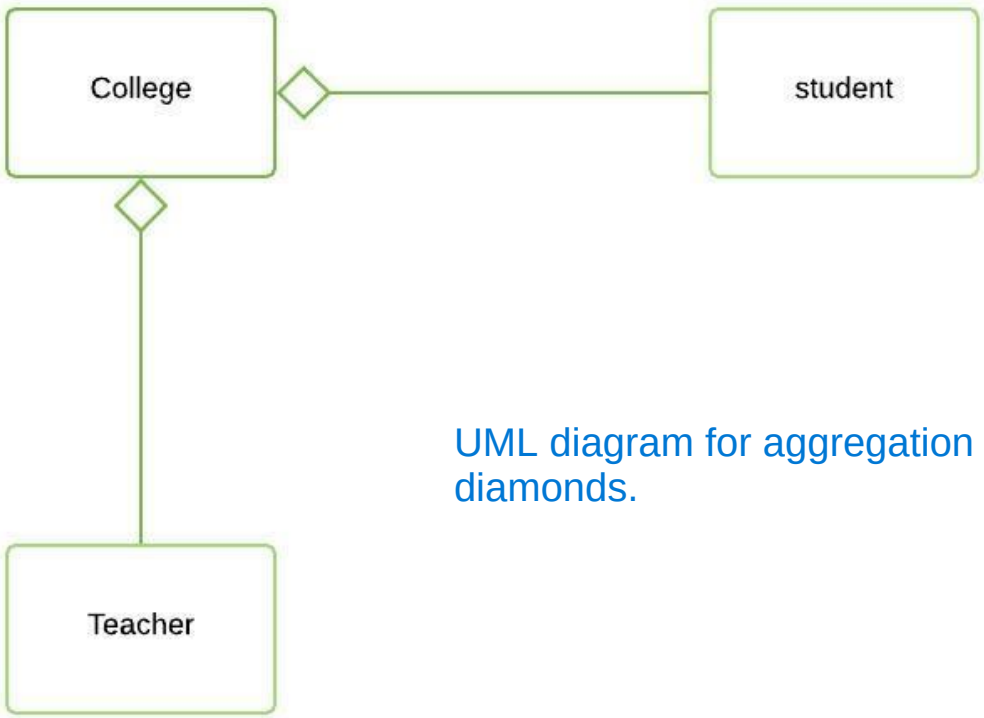
UML for association: Bank->Employee



Aggregation

It is a special form of Association where:

- It represents Has-A's relationship.
- It is a **unidirectional association** i.e. a one-way relationship. For example, a department can have students but vice versa is not possible and thus unidirectional in nature.
- In Aggregation, **both entries can survive individually** which means ending one entity will not affect the other entity.



UML diagram for aggregation contains empty diamonds.

Aggregation

Example

Java

```java
// Java program to illustrate Concept of Aggregation

// Importing required classes
import java.io.*;
import java.util.*;

// Class 1
// Student class
class Student {

    // Attributes of student
    String name;
    int id;
    String dept;

    // Constructor of student class
    Student(String name, int id, String dept)
    {

        // This keyword refers to current instance itself
        this.name = name;
        this.id = id;
        this.dept = dept;
    }
}

// Class 2
// Department class contains list of student objects
// It is associated with student class through its Objects
class Department {
    // Attributes of Department class
    String name;
    private List<Student> students;
    Department(String name, List<Student> students)
    {
        // this keyword refers to current instance itself
        this.name = name;
        this.students = students;
    }

    // Method of Department class
    public List<Student> getStudents()
    {
        // Returning list of user defined type
        // Student type
        return students;
    }
}

// Class 3
```

```java
//  Institute class contains list of Department
// Objects. It is associated with Department
// class through its Objects
class Institute {

    // Attributes of Institute
    String instituteName;
    private List<Department> departments;

    // Constructor of institute class
    Institute(String instituteName,List<Department> departments)
    {
        // This keyword refers to current instance itself
        this.instituteName = instituteName;
        this.departments = departments;
    }

    // Method of Institute class
    // Counting total students of all departments
    // in a given institute
    public int getTotalStudentsInInstitute()
    {
        int noOfStudents = 0;
        List<Student> students;

        for (Department dept : departments) {
            students = dept.getStudents();

            for (Student s : students) {
                noOfStudents++;
            }
        }

        return noOfStudents;
    }
}

// Class 4
// main class
class GFG {

    // main driver method
    public static void main(String[] args)
    {
        // Creating object of Student class inside main()
        Student s1 = new Student("Mia", 1, "CSE");
        Student s2 = new Student("Priya", 2, "CSE");
        Student s3 = new Student("John", 1, "EE");
        Student s4 = new Student("Rahul", 2, "EE");

        // Creating a List of CSE Students
        List<Student> cse_students = new ArrayList<Student>();

        // Adding CSE students
        cse_students.add(s1);
```

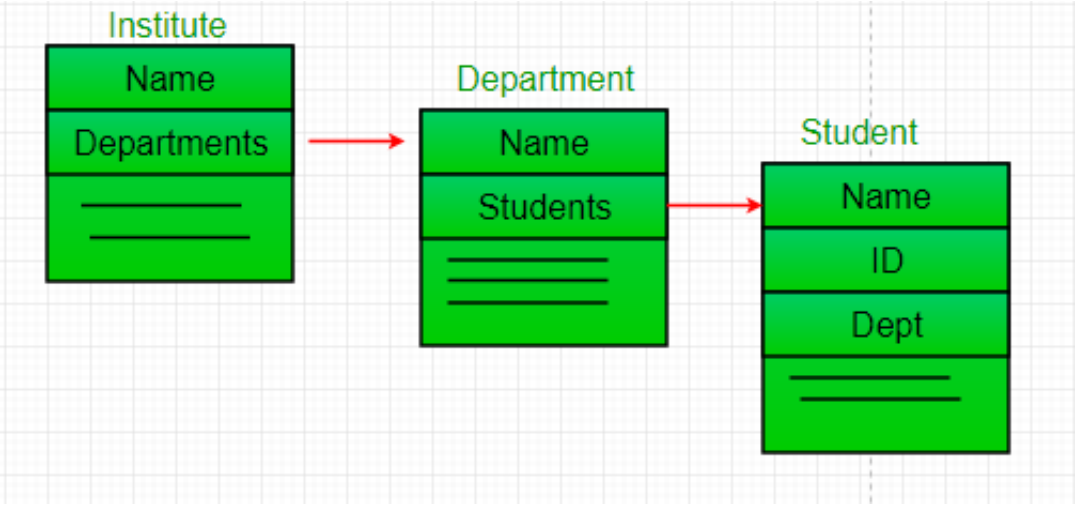
```
        cse_students.add(s2);

        // Creating a List of EE Students
        List<Student> ee_students
            = new ArrayList<Student>();

        // Adding EE students
        ee_students.add(s3);
        ee_students.add(s4);

        // Creating objects of EE and CSE class inside
        // main()
        Department CSE = new Department("CSE", cse_students);
        Department EE = new Department("EE", ee_students);

        List<Department> departments = new ArrayList<Department>();
        departments.add(CSE);
        departments.add(EE);

        // Lastly creating an instance of Institute
        Institute institute = new Institute("BITS", departments);

        // Display message for better readability
        System.out.print("Total students in institute: ");

        // Calling method to get total number of students
        // in institute and printing on console
        System.out.print(institute.getTotalStudentsInInstitute());
    }
}
```

Output

```
Total students in institute: 4
```

Output Explanation: In this example, there is an Institute which has no. of departments like CSE, EE. Every department has no. of students. So, we make an Institute class that has a reference to Object or no. of Objects (i.e. List of Objects) of the Department class. That means Institute class is associated with Department class through its Object(s). And Department class has also a reference to Object or Objects (i.e. List of Objects) of the Student class means it is associated with the Student class through its Object(s).

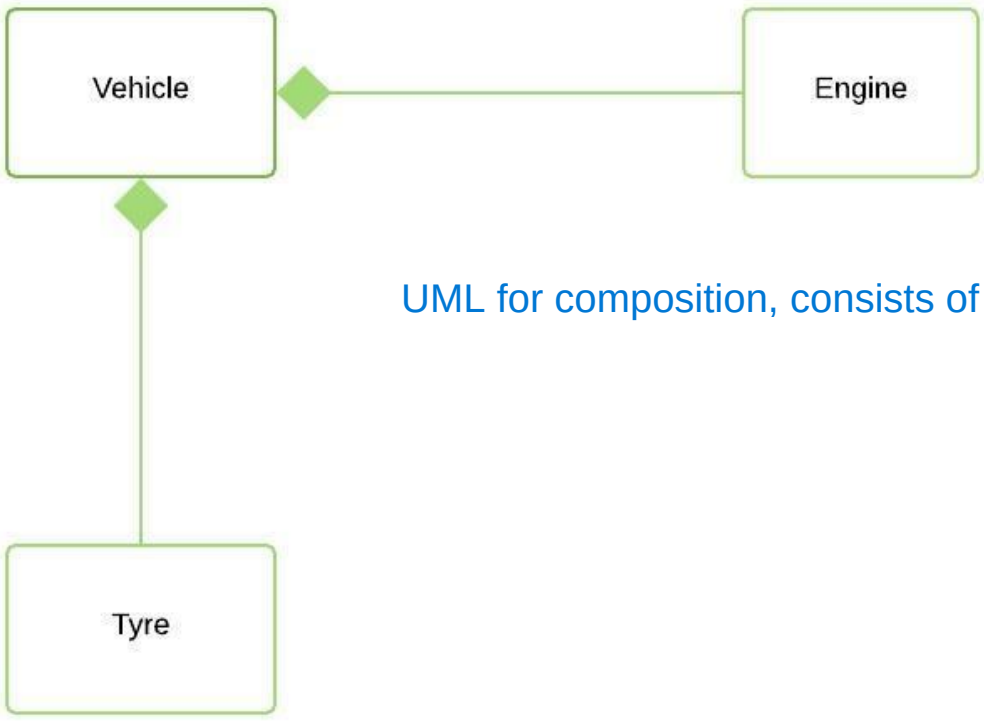
It represents a **Has-A** relationship. In the above example: Student **Has-A** name. Student **Has-A** ID. Student **Has-A** Dept. Department **Has-A** Students as depicted from the below media.



When do we use Aggregation ??

Code reuse is best achieved by aggregation.

Concept 3: **Composition**



UML for composition, consists of filled diamond.

Composition

Composition is a restricted form of Aggregation in which two entities are highly dependent on each other.

- It represents **part-of** relationship.
- In composition, both entities are dependent on each other.
- When there is a composition between two entities, the composed object **cannot exist** without the other entity.

Example Library

Java

```
// Java program to illustrate
// the concept of Composition

// Importing required classes
import java.io.*;
import java.util.*;

// Class 1
//  Book
class Book {

    // Attributes of book
    public String title;
    public String author;

    // Constructor of Book class
    Book(String title, String author)
    {

        // This keyword refers to current instance itself
        this.title = title;
        this.author = author;
    }
}

// Class 2
class Library {

    // Reference to refer to list of books
    private final List<Book> books;

    // Library class contains list of books
    Library(List<Book> books)
    {

        // Referring to same book as
        // this keyword refers to same instance itself
        this.books = books;
    }

    // Method
    // To get total number of books in library
    public List<Book> getTotalBooksInLibrary()
```

```
    {

        return books;
    }
}

// Class 3
// Main class
class GFG {

    // Main driver method
    public static void main(String[] args)
    {

        // Creating objects of Book class inside main()
        // method Custom inputs
        Book b1
            = new Book("EffectiveJ Java", "Joshua Bloch");
        Book b2
            = new Book("Thinking in Java", "Bruce Eckel");
        Book b3 = new Book("Java: The Complete Reference",
                           "Herbert Schildt");

        // Creating the list which contains number of books
        List<Book> books = new ArrayList<Book>();

        // Adding books
        // using add() method
        books.add(b1);
        books.add(b2);
        books.add(b3);

        Library library = new Library(books);

        // Calling method to get total books in library
        // and storing it in list of user0defined type -
        // Books
        List<Book> bks = library.getTotalBooksInLibrary();

        // Iterating over books using for each loop
        for (Book bk : bks) {

            // Printing the title and author name of book on
            // console
            System.out.println("Title : " + bk.title
                               + " and "
                               + " Author : " + bk.author);
        }
    }
}
```

Output

```
Title : EffectiveJ Java and  Author : Joshua Bloch
Title : Thinking in Java and  Author : Bruce Eckel
Title : Java: The Complete Reference and  Author : Herbert Schildt
```

Output explanation: In the above example, a library can have no. of **books** on the same or different subjects. So, If Library gets destroyed then All books within that particular library will be destroyed. i.e. books can not exist without libraries. That's why it is composition. Book is **Part-of** Library.

Aggregation vs Composition

1. Dependency: Aggregation implies a relationship where the child **can exist independently** of the parent. For example, Bank and Employee, delete the Bank and the Employee still exist. whereas Composition implies a relationship where the child **cannot exist independent** of the parent. Example: Human and heart, heart don't exist separate to a Human

2. Type of Relationship: Aggregation relation is **"has-a"** and composition is **"part-of"** relation.

3. Type of association: Composition is a **strong** Association whereas Aggregation is a **weak** Association.

Example:

Java

```java
// Java Program to Illustrate Difference between
// Aggregation and Composition

// Importing I/O classes
import java.io.*;

// Class 1
// Engine class which will
// be used by car. so 'Car'
// class will have a field
// of Engine type.
class Engine {

    // Method to starting an engine
    public void work()
    {

        // Print statement whenever this method is called
        System.out.println(
            "Engine of car has been started ");
    }
}
```

In composition, we have to declare the contained references as private final, so that no other can change the object requirement. But in aggregation, it may be non-final, it can be removed from the container class, but not in case of composition.

Example: Car, music player, and engine.
Music players have independent use despite the existence of cars. Also, the car can move without a music player. Hence, there is a weak association called aggregation between them.

The car cannot run without an engine. Also, the engine has no significant use without the car. Hence they have a strong association called composition between them.

```
// Class 2
// Engine class
final class Car {

    // For a car to move,
    // it needs to have an engine.

    // Composition
    private final Engine engine;

    // Note: Uncommented part refers to Aggregation
    // private Engine engine;

    // Constructor of this class
    Car(Engine engine)
    {

        // This keywords refers to same instance
        this.engine = engine;
    }

    // Method
    // Car start moving by starting engine
    public void move()
    {

        // if(engine != null)
        {
            // Calling method for working of engine
            engine.work();

            // Print statement
            System.out.println("Car is moving ");
        }
    }
}

// Class 3
// Main class
class GFG {

    // Main driver method
    public static void main(String[] args)
    {

        // Making an engine by creating
        // an instance of Engine class.
        Engine engine = new Engine();

        // Making a car with engine so we are
        // passing a engine instance as an argument
        // while creating instance of Car
        Car car = new Car(engine);
```

```
        // Making car to move by calling
        // move() method inside main()
        car.move();
    }
}
```

Output

```
Engine of car has been started
Car is moving
```

In case of aggregation, the Car also performs its functions through an Engine. but the Engine is not always an internal part of the Car. An engine can be swapped out or even can be removed from the car. That's why we make The Engine type field non-final.

This article is contributed by **Nitsdheerendra**. If you like GeeksforGeeks and would like to contribute, you can also write an article using write.geeksforgeeks.org or mail your article to review-team@geeksforgeeks.org. See your article appearing on the GeeksforGeeks main page and help other Geeks. Please write comments if you find anything incorrect, or you want to share more information about the topic discussed above.

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