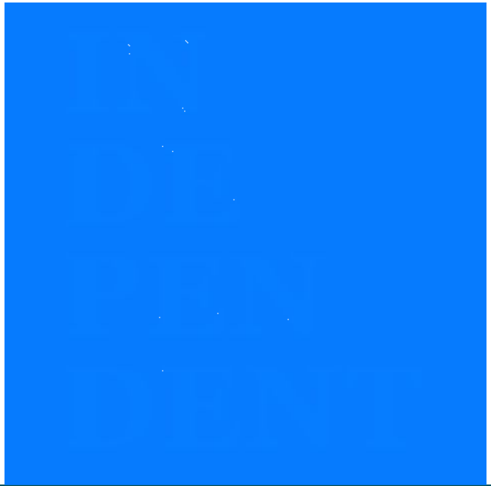
Aggregation and Composition

Problem Scenario

In Real World Scenarios, when objects communicate with each other. There could be **two modes** of the communications.

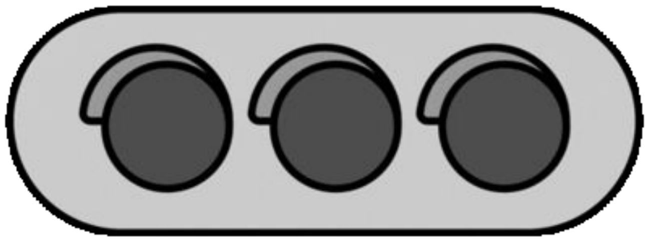
Problem Scenario 01

Sometimes two objects (instances) of two different classes exists on their own and the lifetime of an object does not depend on the lifetime of another object.



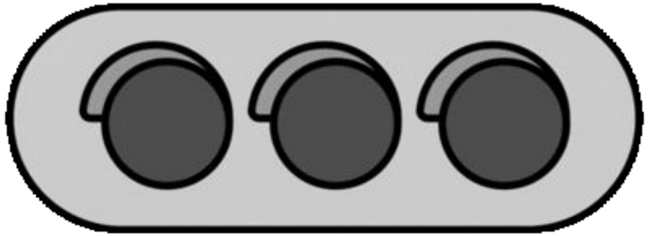
Problem Scenario 01: Example

For example, At Road, Traffic Signal and Car can be seen as two independent Classes.
Individual signals and cars can be represented through objects of these classes.



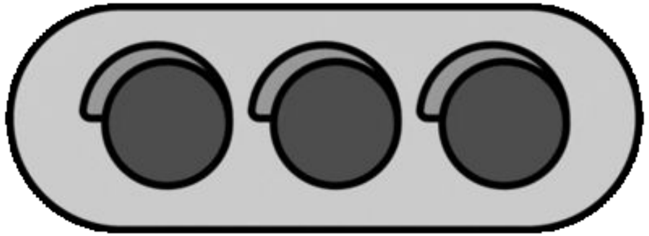
Problem Scenario 01: Example

These instances, Car and Traffic Signal need to communicate with each other but the life time of both instances can be different from each other.



Problem Scenario 01: Example

Existence of Car object does not depend on the existence of Traffic Signal object and Vice versa.



Problem Scenario 02

Similarly, sometimes in real life there are some objects those existence depends on the existence of other objects.

Problem Scenario 02: Example

For example, TableofContents and Book both have two different properties and qualified as for two different classes.

Problem Scenario 02: Example

An object of TableofContents class does not mean anything without its corresponding object of Book class.

Problem Scenario 02: Example

In other words, we can say the object lifetime of TableofContents class depends on the lifetime of the corresponding Book class

Problem Scenario

So when the classes collaborate with each other, there could be two possible scenarios

1. Lifetime of objects is independent of each other.

2. Lifetime of objects dependent on each other.

Types of Association

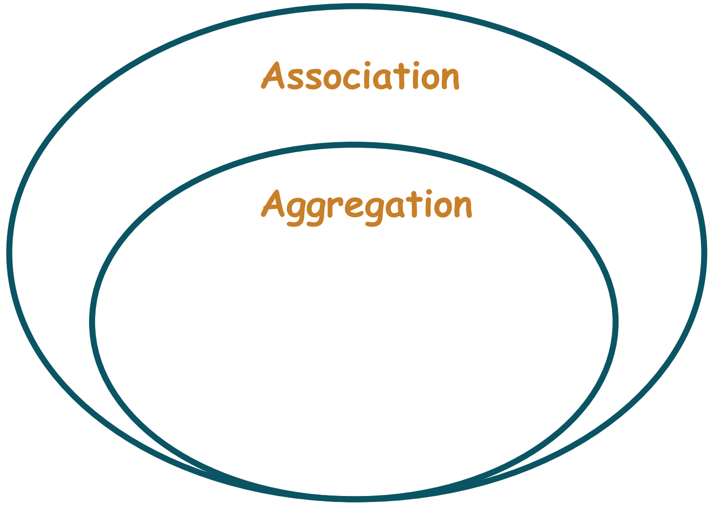
To handle these scenarios of Real Life, Object Oriented Programming offers two types of Associations.

1. Aggregation.

2. Composition.

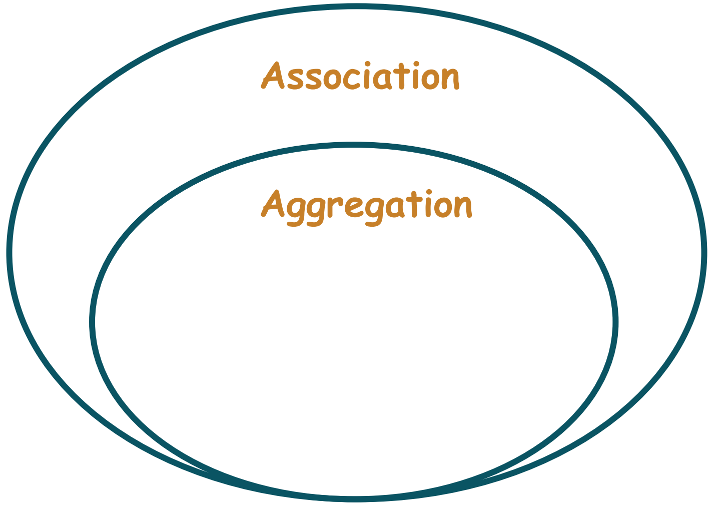
Types of Association: Aggregation

When two objects have independent lifetime but one object has an other object such type of association is called the Aggregation.



Types of Association: Aggregation

The relation between Car and Traffic Signal class is Aggregation relation because both object have their own lifetime and signal object contains the cars.



Aggregation: Working Example

The Car class provide one method that allow external world to communicate with it

```
class Car
{
   public string carName;                     //Data Member
   public Car(string name)                    //Parameterized Constructor
   {
       carName = name;
   }
   public void onSignalChange(string action)              //Member Function/Behaviour
   {
       Console.WriteLine("I am " + carName + " and I am in " + action + " state");
   }
}
```

Aggregation: Working Example

The TrafficSignal class contains cars in carList that are present on the signal and new cars can be added into the list using addCar Function

```
class TrafficSignal
{
    //Data Members
    string state;
    List<Car> carList = new List<Car>();

     //Member Functions/Behaviours
    public void addCar(Car c)
    {
        carList.Add(c);
    }
}
```

Aggregation: Working Example

TrafficSignal class also provides two methods to set it state Red and Green

```
class TrafficSignal
{
    //Data Members
    string state;
    List<Car> carList = new List<Car>();

    //Member Functions/Behaviours
    public void addCar(Car c)
    {
        carList.Add(c);
    }
    public void setRedState()
    {
        state = "Red";
        informCars();
    }
    public void setGreenState()
    {
        state = "Green";
        informCars();
    }
}
```

Aggregation:

Both of these methods, call informCars function to update the cars state.

```
class TrafficSignal
{
    //Data Members
    string state;
    List<Car> carList = new List<Car>();

    //Member Functions/Behaviours
    public void addCar(Car c)
    {
        carList.Add(c);
    }
    public void setRedState()
    {
        state = "Red";
        informCars();
    }
    public void setGreenState()
    {
        state = "Green";
        informCars();
    }
    public void informCars()
    {
        foreach (Car car in carList)
        {
            car.onSignalChange(state);
        }
    }
}
```

Aggregation:

Both of these methods, call informCars function to update the cars state. This function inform all cars through the available method of car that the signal has been changed.

```
class TrafficSignal
{
    //Data Members
    string state;
    List<Car> carList = new List<Car>();

    //Member Functions/Behaviours
    public void addCar(Car c)
    {
        carList.Add(c);
    }
    public void setRedState()
    {
        state = "Red";
        informCars();
    }
    public void setGreenState()
    {
        state = "Green";
        informCars();
    }
    public void informCars()
    {
        foreach (Car car in carList)
        {
            car.onSignalChange(state);
        }
    }
}
```

```
class TrafficSignal
{
    //Data Members
    string state;
    List<Car> carList = new List<Car>();

    //Member Functions/Behaviours
    public void addCar(Car c)
    {
        carList.Add(c);
    }
}
```

```
static void Main(string[] args)
{
     TrafficSignal signal1 = new TrafficSignal();
     Car car1 = new Car("Car1");
     Car car2 = new Car("Car2");
     signal1.addCar(car1);
     signal1.addCar(car2);
     signal1.setRedState();
     signal1.setGreenState();
     Console.ReadKey();
}
```

```
class TrafficSignal
{
    //Data Members
    string state;
    List<Car> carList = new List<Car>();

    //Member Functions/Behaviours
    public void addCar(Car c)
    {
        carList.Add(c);
    }
    public void setRedState()
    {
        state = "Red";
        informCars();
    }
    public void setGreenState()
    {
        state = "Green";
        informCars();
    }
    public void informCars()
    {
        foreach (Car car in carList)
        {
            car.onSignalChange(state);
        }
    }
}
```

```
class TrafficSignal
{
    //Data Members
    string state;
    List<Car> carList = new List<Car>();

    //Member Functions/Behaviours
    public void addCar(Car c)
    {
        carList.Add(c);
    }
}
```

```
I am Car1 and I am in Red state
I am Car2 and I am in Red state
I am Car1 and I am in Green state
I am Car2 and I am in Green state
```

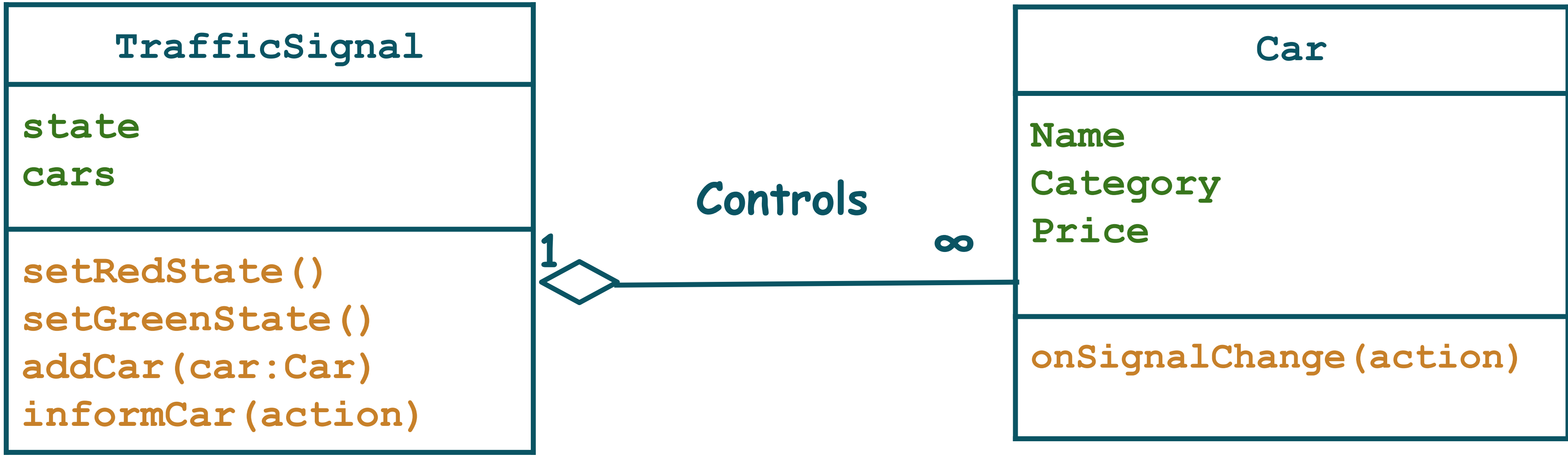
```
static void Main(string[] args)
{
     TrafficSignal signal1 = new TrafficSignal();
     Car car1 = new Car("Car1");
     Car car2 = new Car("Car2");
     signal1.addCar(car1);
     signal1.addCar(car2);
     signal1.setRedState();
     signal1.setGreenState();
     Console.ReadKey();
}
```

```
class TrafficSignal
{
    //Data Members
    string state;
    List<Car> carList = new List<Car>();

    //Member Functions/Behaviours
    public void addCar(Car c)
    {
        carList.Add(c);
    }
    public void setRedState()
    {
        state = "Red";
        informCars();
    }
    public void setGreenState()
    {
        state = "Green";
        informCars();
    }
    public void informCars()
    {
        foreach (Car car in carList)
        {
            car.onSignalChange(state);
        }
    }
}
```

Aggregation: Class Diagram

We use empty diamond symbol in class diagram to represent the Aggregation Relation between two classes.



Types of Association

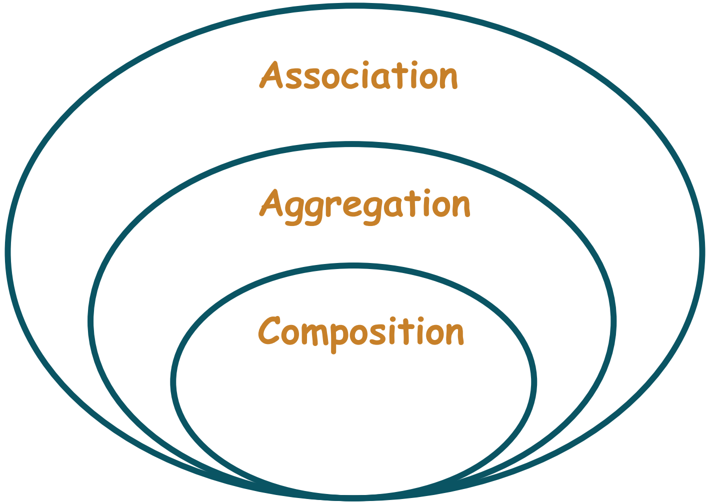
Too handle these scenarios of Real Life, Object Oriented Programming offers two types of Associations.

1. Aggregation.

2. Composition.

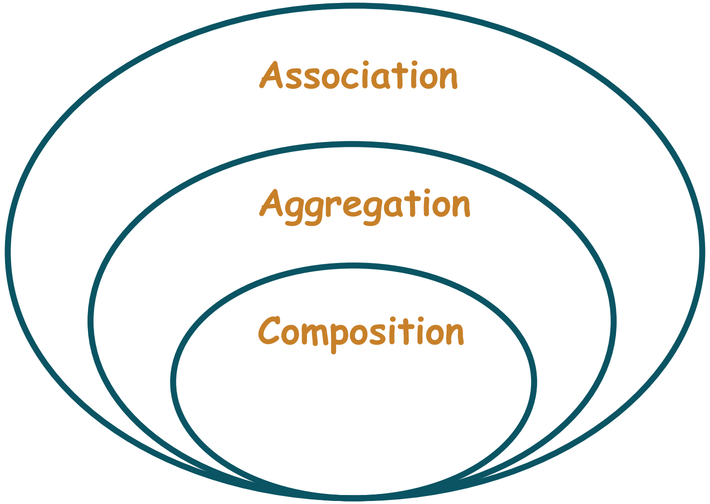
Types of Association: Composition

When life time of an object depends on the lifetime of another object this type of Association is called Composition.



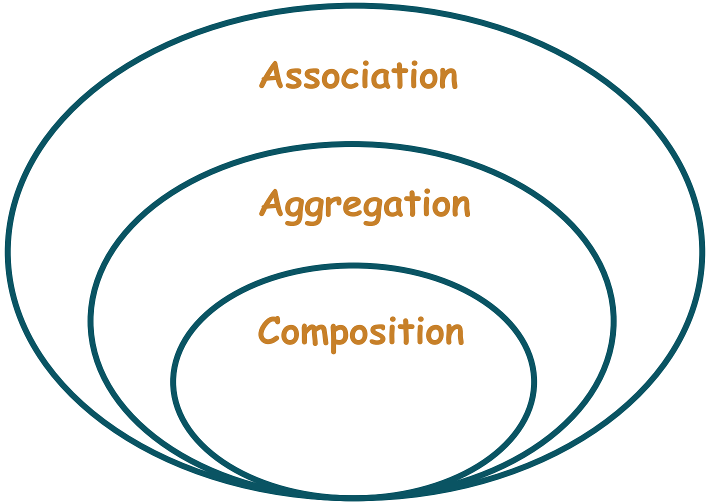
Types of Association: Composition

The Association between Book and TableofContents is type of composition.



Composition: Working Example

The Association between Book and TableofContents is type of composition.



Composition: Working Example

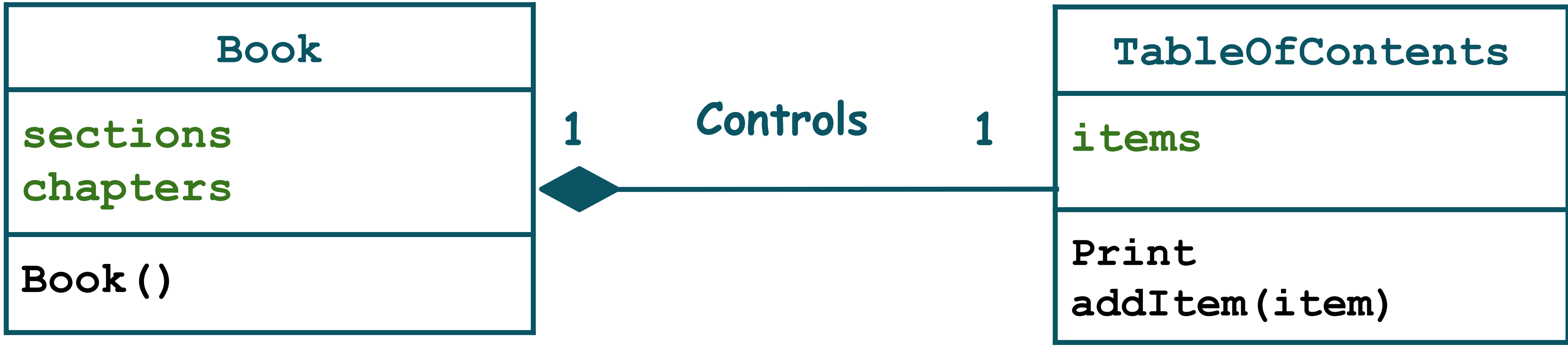
```
static void Main(string[] args)
{
     Book book1 = new Book();
     Console.ReadKey();
}
```

```
class TableofContents
{
    List<string> items;
    public void addItem(string item)
    {
        items.Add(item);
    }
}
```

```
class Book
{
    public Book()
    {
        toc = new TableofContents();
    }
    TableofContents toc;
    List<string> sections;
    List<string> chapters;
}
```

Composition: Working Example

We use filled diamond symbol in class diagram to represent the Composition Relation between two classes.



Conclusion

- Association has two types
  1) Aggregation
  2) Composition

- When life times of two separate objects are independent of each other, this type of association is called Aggregation
- When life time of two separate objects are dependent of each other, this type of association is called Composition.

Learning Objective

Identify and Write Code for Aggregation and Composition Scenarios.

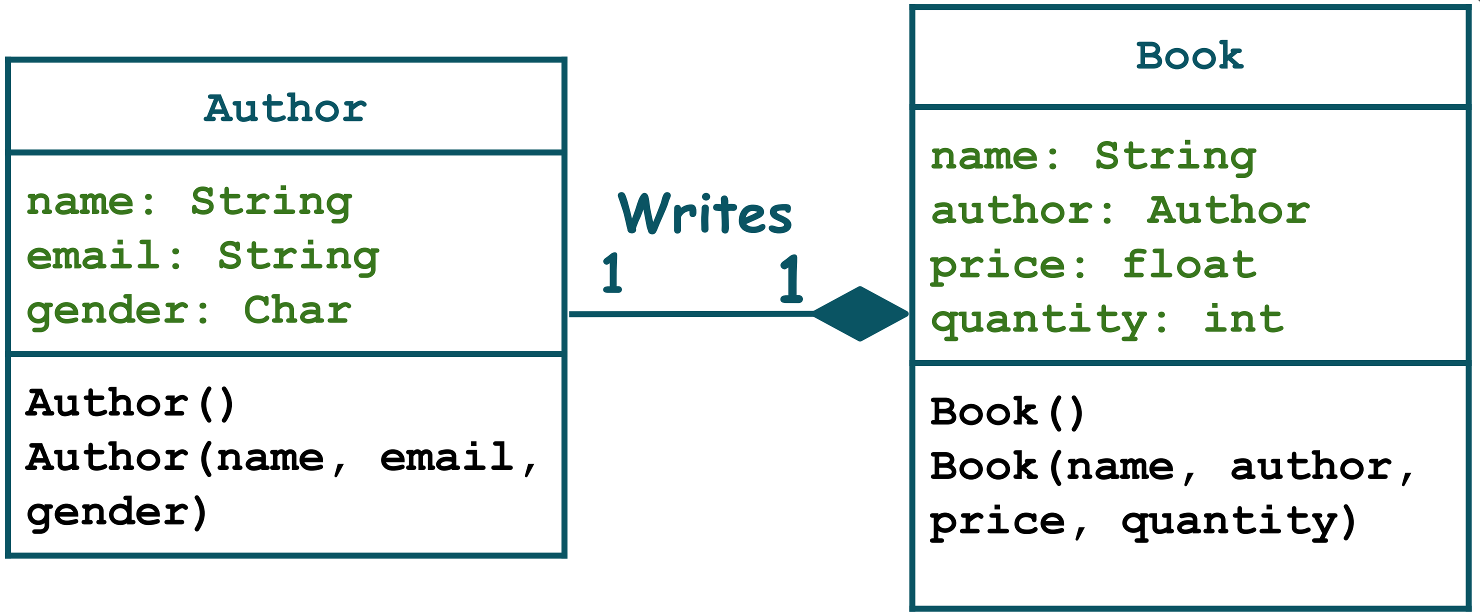
Self Assessment: Association

1. A Football player has a football. Write two classes.
    1. Football
    2. FootballPlayer

Football class has type, size and weight attributes. Write the default constructor as well as parameterized constructor of the class.
FootballPlayer has name and Football attributes. Write the default as well as parameterized constructor of the class.

Self Assessment: Association

2. Write the code in C# for the following domain model.



Author
name: String
email: String
gender: Char
Author()
Author(name, email, gender)
Writes
1
1
Book
name: String
author: Author
price: float
quantity: int
Book()
Book(name, author, price, quantity)