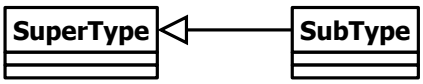
UML Class Relationships

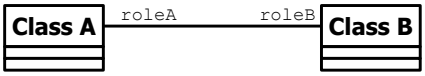
The following is a brief description of the relationship types used in UML class diagrams.

Inheritance (aka generalization)



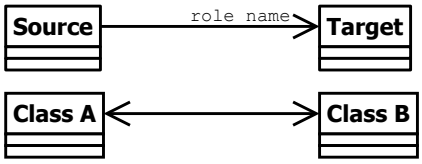
- A parent-child relationship.
- A **SubType** class inherits behavior from a **SuperType** class. A **SuperType** is a more general concept than a **SubType**. The **SuperType** is the parent class and the **SubType** is the child class.
- ***Example***: SuperType is ***Car*** and SubType is ***HybridCar***. A HybridCar is a Car. A HybridCar has all of the behaviors of a Car, and has additional behaviors not found in a Car.

Association



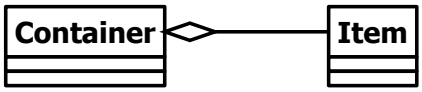
- Two classes are associated with each other via object reference(s).
- First diagram shows no navigation between the two classes.

Association with Navigation



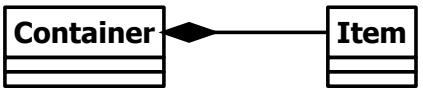
- Second diagram shows navigation from Source to Target.
- ***Example***: Source is ***Purchase-Order*** and Target is ***Customer***. A Purchase-Order *has* a Customer that is making the purchase. The Purchase-Order class would have an attribute that stores a Customer object.
- Third diagram shows navigation in either direction.
- ***Example***: Class A is ***Purchase-Order*** and Class B is ***Customer***. A Purchase-Order *has* a Customer that is making the purchase. A Customer may have many Purchase-Orders. The Purchase-Order class would have an attribute that stores a Customer object. The Customer class would have an attribute that stores many Purchase-Order objects.

Aggregation



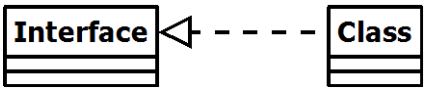
- A whole-part relationship between an aggregate (the whole or container) and a constituent part (i.e., Item). Typically used in one-to-many relationships.
- Aggregation is a special type of association relationship.
- ***Example***: Container is ***Car*** and Item is ***Brake***. A Car has Brakes. The Car class would have an attribute that allows it to store many Brake objects.

Composition



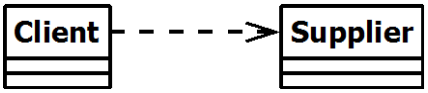
- Similar to aggregation, with an additional constraint that Item cannot exist without the Container. Like aggregation, composition is a special type of association relationship.
- ***Example***: Container is ***Invoice*** and Item is ***Purchase-Item***. An Invoice contains Purchase-Items. The Invoice class would have an attribute that allows it to store many Purchase-item objects. The Purchase-Item objects do not exist unless their Invoice object exists.

Realizes



- Implements an interface.
- The **Class** must implement the behavior of the **Interface**.
- ***Example***: Interface is ***Door*** and Class is ***Car***. A Car must include behavior for a Door.

Dependency



- A Client class is dependent on a Supplier class. That is, a change to the Supplier may affect or supply information needed by the Client.
- ***Example***: Client is ***Employee-GUI*** and Supplier is ***Employee***. The Employee-GUI is dependent on the Employee. When the Employee class changes, it's likely the Employee-GUI class must be changed. When the Employee-GUI class changes, no changes are necessary in the Employee class.

Additional UML Class Diagram Notation

The following is a brief description of other notations used in a UML class diagram.

Association Multiplicities

Exactly one

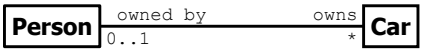
Many (zero or more)

Optional (zero or one)

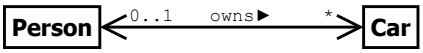
Modifiers for Multivalued (*) Multiplicity Sets

{ordered}	The objects in the set can be retrieved in a sort order.
{unordered}	Default.
{unique}	Each object in the set can be uniquely identified.
{nonunique}	Default

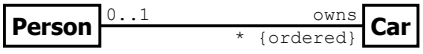
Association Multiplicity Examples



A Car is owned by zero or one Person.
A Person owns zero or more Cars.



A Person owns zero or more Cars.

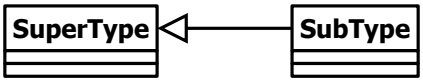


A Person owns zero or more Cars, ordered by the date purchased.

Java Examples of UML Class Relationships

Inheritance (aka generalization)

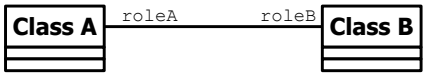
- ***Example***: SuperType is ***Car*** and SubType is ***HybridCar***.
- A HybridCar is a Car.




```
public class Car
{
  private String engineType;
  public Car(String engineType)
  {
    this.engineType = engineType;
  }
}
```

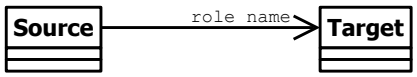
```
public class HybridCar extends Car
{
  private String electricEngineSize;
  public HybridCar(String engineType,
                   String electricEngineSize)
  {
    super(engineType); //call SuperType constructor
    this.electricEngineSize = electricEngineSize;
  }
}
```

Association

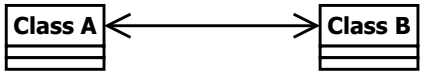


- Class A and Class B have a connection that involves their instances.

Association with Navigation



- ***First Example***: Source is ***Purchase-Order*** and Target is ***Customer***.
- A Purchase-Order *has* a Customer that is making the purchase. The Purchase-Order class would have an attribute that stores a Customer object.



- ***Second Example***: Class A is ***Purchase-Order*** and Class B is ***Customer***.
- A Purchase-Order *has* a Customer that is making the purchase. A Customer may have many Purchase-Orders. The Purchase-Order class would have an attribute that stores a Customer object. The Customer class would have an attribute that stores many Purchase-Order objects.

First Example

```
public class Customer
{
  //attributes and methods for a customer.
}
```

```
public class Purchase_Order
{
  Customer cust;
  public Purchase_Order(Customer cust)
  {
    this.cust = cust;
  }
}
```

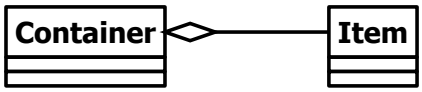
Second Example

```
public class Customer
{
  //Customer may have many
  //purchase orders.
  private ArrayList<Purchase_Order> poList;
  public Customer()
  {
    poList = new
        ArrayList<Purchase_Order>();
  }
  public void addPO(Purchase_Order po)
  {
    poList.add(po);
  }
}
```

```
public class Purchase_Order
{
  //A purchase order is for one customer.
  Customer cust;
  Public Purchase_Order(Customer cust)
  {
    this.cust = cust;
  }
}
```

Aggregation

- ***Example***: Container is ***Car*** and Item is ***Brake***.
- A Car has Brakes. The Car class would have an attribute that allows it to store many Brake objects.

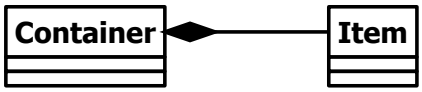



```
public class Brake
{
  private String type;
  public Brake(String type)
  {
    this.type = type;
  }
}
```

```
public class Car
{
  private Brake[] brakes; //contains Brake objects
  public Car()
  {
    //create array and individual Brake objects
    brakes = new Brake[2];
    brakes[0] = new Brake("front disc");
    brakes[1] = new Brake("rear drum");
    //Note: Many cars have disc and/or drum brakes.
    //This is why this is aggregation.
  }
}
```

Composition

- ***Example***: Container is ***Invoice*** and Item is ***Purchase-Item***.
- An Invoice lists Purchase-Items. The Invoice class would have an attribute that allows it to store many Purchase-item objects.

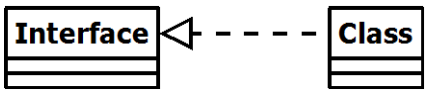



```
public class Purchase_Item
{
  private String itemDesc;
  private int count;
  public Purchase_Item(String desc,
                       int count)
  {
    itemDesc = desc;
    this.count = count;
  }
}
```

```
public class Invoice
{
  private ArrayList<Purchase_Item> items;
  public Invoice()
  {
    //create ArrayList
    items = new ArrayList<Purchase_Item>();
  }
  public addItem(String desc, int count)
  {
    //create unique Purchase_Item;
    //store in ArrayList
    Purchase_Item item =
        new Purchase_Item(desc, count);
    items.add(item);
  }
}
```

Realizes

- ***Example***: Class is ***Car*** and Interface is ***Door***.
- A Car must include behavior for a Door.

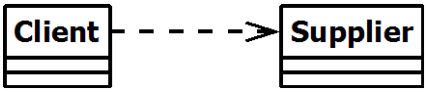



```
public interface Door
{
  // method signatures
  public void openDoor();
  public void closeDoor();
}
```

```
public class Car implements Door
{
  private String engineType;
  public Car(String engineType)
  {
    this.engineType = engineType;
  }
  //must implement each Door method signature
  public void openDoor()
  {
    //code that mimics behavior of opening a door
  }
  public void closeDoor()
  {
    //code that mimics behavior of closing a door
  }
}
```

Dependency

- ***Example***: Client is ***Employee-GUI***; Supplier is ***Employee***.
- The Employee-GUI is dependent on the Employee. When the Employee class changes, it's likely the Employee-GUI class must be changed. When the Employee-GUI class changes, no changes are necessary in the Employee class.




```
public class Employee
{
  //Attributes and methods to
  //represent an Employee.
}
```

```
public class EmployeeGUI
{
  //Note: no attribute of type Employee!
  //Instead: Employee object passed to methods that
  //    need access to Employee data.
  public EmployeeGUI(Employee empl)
  {
    //create GUI to display empl data.
  }
  public void changeDisplay(Employee empl)
  {
    //change info displayed in GUI
    //based on empl obj.
  }
}
```