Association, Aggregation, and Composition

(CS 217)

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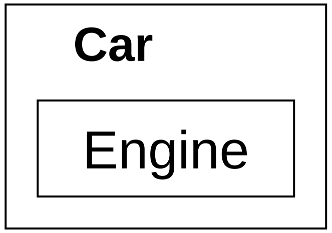
Engine is a part-of Car (Example)

```
class Car
{
    public:
        Car(char* e_No){
            cout << "Car created" << endl;
            ptr_engine = new Engine(e_No); //Engine created
        }
        void disp(){
            cout << ptr_engine->getEngineNumber() << endl;
        }
        ~Car() {
            cout << "\nCar destroyed" << endl;
            delete ptr_engine; //engine destroyed/deleted
        }
    private:
        Engine* ptr_engine;
};
```

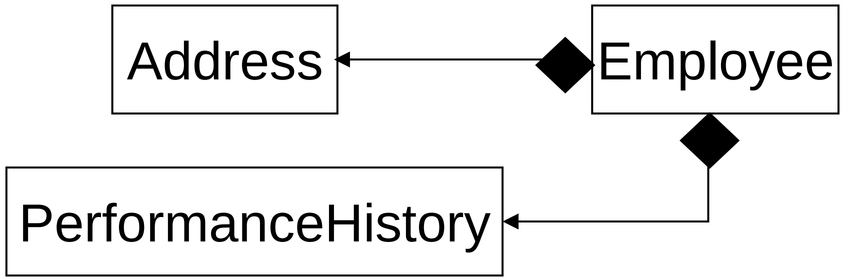


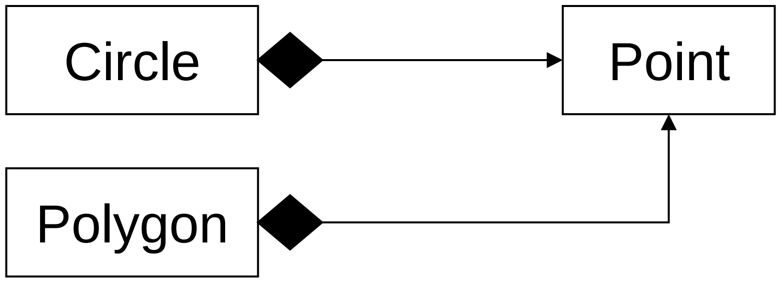
Composition variants

- Whole **creates** the parts and **destroy** them **BUT** it can do it **indirectly** as well
  - **Deferring creation** of parts For example, a string class may not create a dynamic array of characters
  - Instead of creating part, whole can opt to **use a part** that has been **given to it as input**
  - Whole can **delegate destruction** of its parts (e.g. to a garbage collection routine).
- The key point here is that the composition should manage its parts.

Composition and subclasses

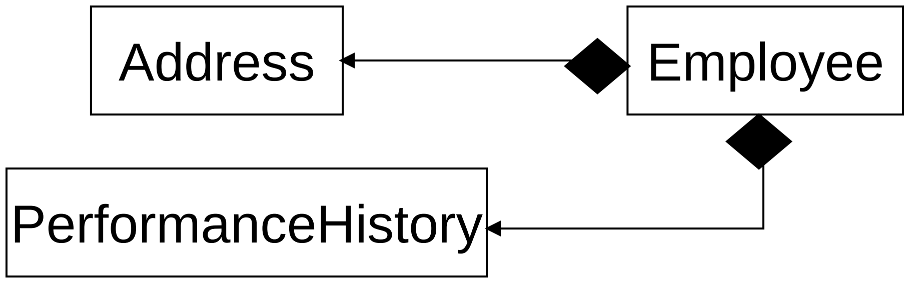
- When/why create a subclass instead of direct implementation of a feature?
  - Car (whole) Engine (part) example
- Composition → subclass
  - **Each individual class** should be focused on performing **one task** (simple and straight forward)
  - Each subclass can be **self-contained**, which makes them **reusable**.
  - The **parent class** can focus only on **coordinating the data flow** between the subclasses.





Composition and subclasses

- **Subclass** or **direct implementation**?
  - One class one task
  - Task can be
    - storage and manipulation
    - coordination



Composition - recap

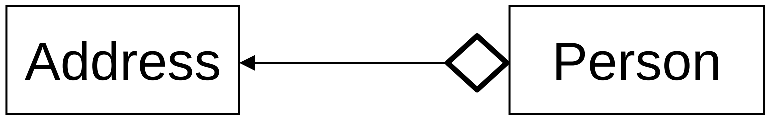
- Relationship between objects
  - Association
  - Object composition (**Composition** and **Aggregation**)
- **Object composition** is the process of **creating complex objects** from **simpler one**.
- Composition (models **part-of** relationship)
  - Whole is responsible for **existence** of part

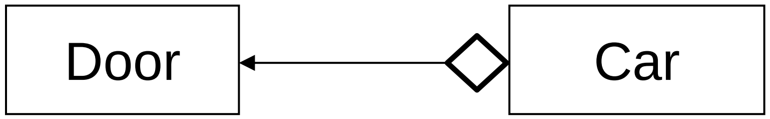
Part 3
Aggregation

Aggregation

- An **aggregation** is also a **part-whole** relationship
- It models **has-a** relationship
- Similar to composition
  - The **parts** are **contained** within the **whole**
  - It is also a **unidirectional** relationship
- Unlike composition
  - Parts **can belong to more than one** object at a time
  - Whole **is not responsible for the existence** and lifespan of the parts

Aggregation





Singular part

- Every person has an address.
- One address can belong to more than one person at a time
- Address existed before the person starting living at the address
- Whole knows of existence (person knows)
- Part doesn't know about the whole

Multiplicative parts

- A car door is part of the car.
- Door belongs to the car,
- It can belong to other things as well, like the body of the car.
- The car is not responsible for the creation or destruction of the door.
- Whole knows about existence
- Part doesn't know about the whole

Aggregation tests

- The part (member) **is part of** the object (class)
- The part (member) **can belong to more than one object** (class) at a time
- The part (member) **does not** have its **existence** managed by the object (class)
- The part (member) **does not know** about the existence of the object (class)

Implementing aggregation VS composition

- Aggregation
  - **Parts** are **added** as **references** or **pointers**
  - **Whole** is **not responsible** for creation and deletion
  - Whole takes the objects it is going to point to as: 1) **constructor parameters**; 2) **parts are added later via access functions**
  - Parts exists **outside the scope** of whole

- Composition
  - **Parts** are **added** as **normal variables** (or pointers)
  - **Whole** is **responsible** for **creation** and **deletion**

Examples

Composition

```
class Part{
    //class implementation
};

class Whole {
    private:
        Part* p; //can be normal variable
    public:
        Whole() {
            this->p = new Part();
        }
        ~Whole(){
            delete p;
        }
};

int main()
{
    Whole w;
}
```

Aggregation

```
class Part{
    //class implementation
};

class Whole {
    private:
        Part* p;
    public:
        Whole(Part *p) {
            this->p = p;
        }
};

int main()
{
    Part* p = new Part();
    Whole w(p);
}
```

Person has an Address - Example

```
class Address
{
    private:
        int h_No; //house no
        int st_No;  //street no
        string sector; //sector
        string city; //store city
    public:
        //parameterized constructor
        Address(int h, int s, const string& sec, const string& c)
        { }

};
```

Person has an Address - Example

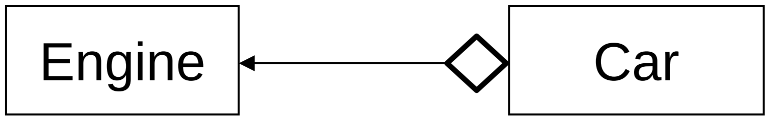
```
class Person
{
    private:
        string p_name; //person name

        //it will get reference to address object (part)
        const Address& p_address; // A person can live at only one address (here)

    public:
        //parameterized constructor
        Person(const string& s, const Address& address) : p_name{s}, p_address{ address }
        { }

        //display person details
        void disp_Person() const{
            cout << "Name: " << p_name << "; ";
            p_address.disp_Address();
        }
};
```

Person has an Address - Example

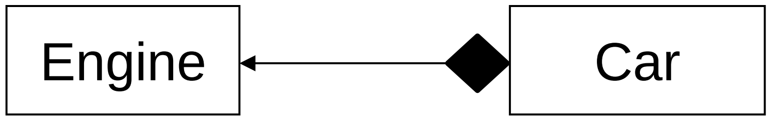
```
int main()
{
    //part object created
    Address part_Object( 12, 3, "G-20", "Islamabad" );

    //whole object created
    Person whole_Object("Random person", part_Object );

    whole_Object.disp_Person();


    return 0;
}
```

Aggregation or Composition

- When to do what?



Repair shop software



Car performance software

Implement the simplest relationship that meets your needs!!!

Not the one that seems like it would fit best in a real-life context.

Aggregation/Composition - recap

- Object composition
  - Composition
  - Aggregation
- Used to model relationships where a whole is built from one or more parts