CS102
Programming II

CLASS (PART - I)

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TOPICS

- Inheritance
  - **`extends`**
  - **`super`**
- Polymorphism

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INHERITANCE

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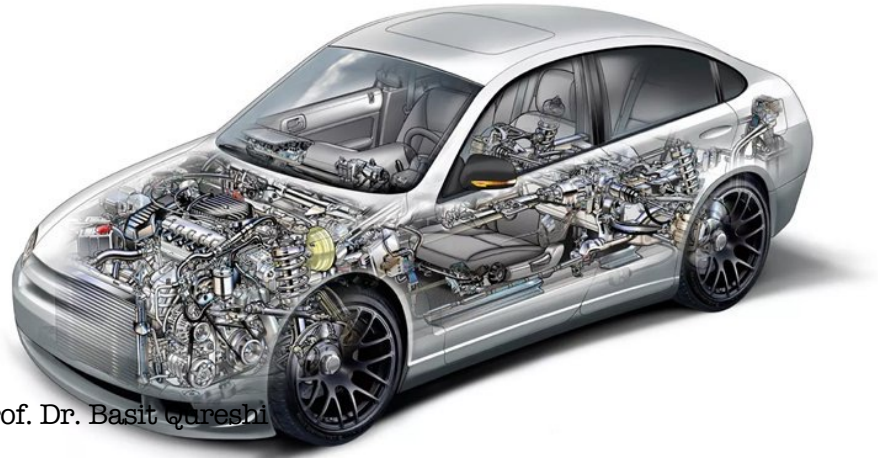
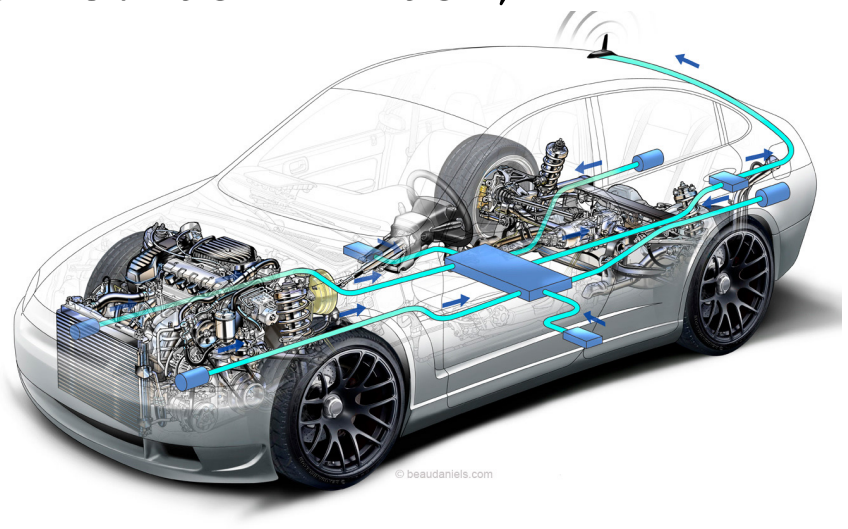
RECALL COMPOSITION

```
public class Car {
   int year;
   String model;
   Engine e;
   Car(){ //initialize attributes
   }
   Car(int year, String model){
      this.year = year;
      this.model = model;
   }
}
```



```
public class Engine {
   int hp;
   String fuel;
   Engine() {//initialize attributes


   }
   Engine(int hp, String fuel){
      this.hp = hp;
      this.fuel = fuel;
   }
}
```



RECALL COMPOSITION

```
public class Car {
   int year;
   String model;
   Engine e;
   Car(int year, String model){
      this.year = year;
      this.model = model;
   }
}
```

```
public class Engine {
   int hp;
   String fuel;
   Engine(int hp, String fuel){
      this.hp = hp;
      this.fuel = fuel;
   }
}
```

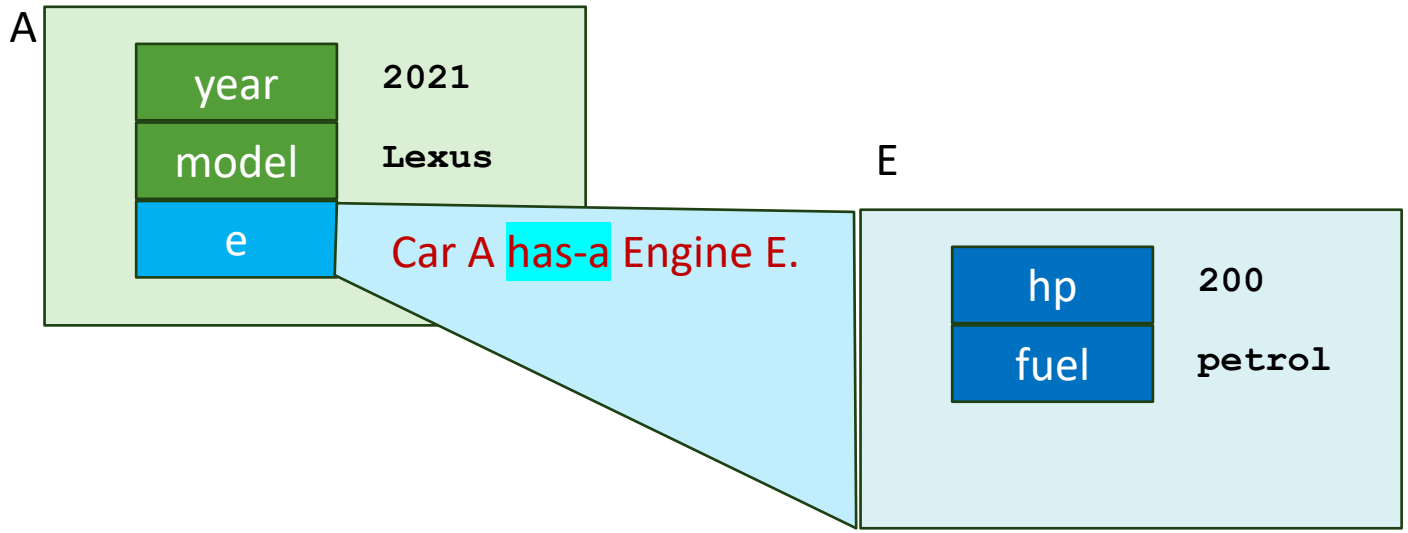
Every **Car** has-a **Engine**.

Engine is a class. **e** is object of class **Engine**, which is a attribute of class **Car**.

RECALL COMPOSITION

- Make a Car object and initialize the composed object of Engine class

```
public static void main(String [] args){
   Car A = new Car(2021, "Lexus");
   Engine E = new Engine(200, "petrol");
   A.e = E;
  }
```



Methods of class Engine can be available to object A.e

INHERITANCE

- Recall Composition:

Every **`Car`** has-a **`Engine`**

- Inheritance defines the is-a relationship between two classes

Examples:

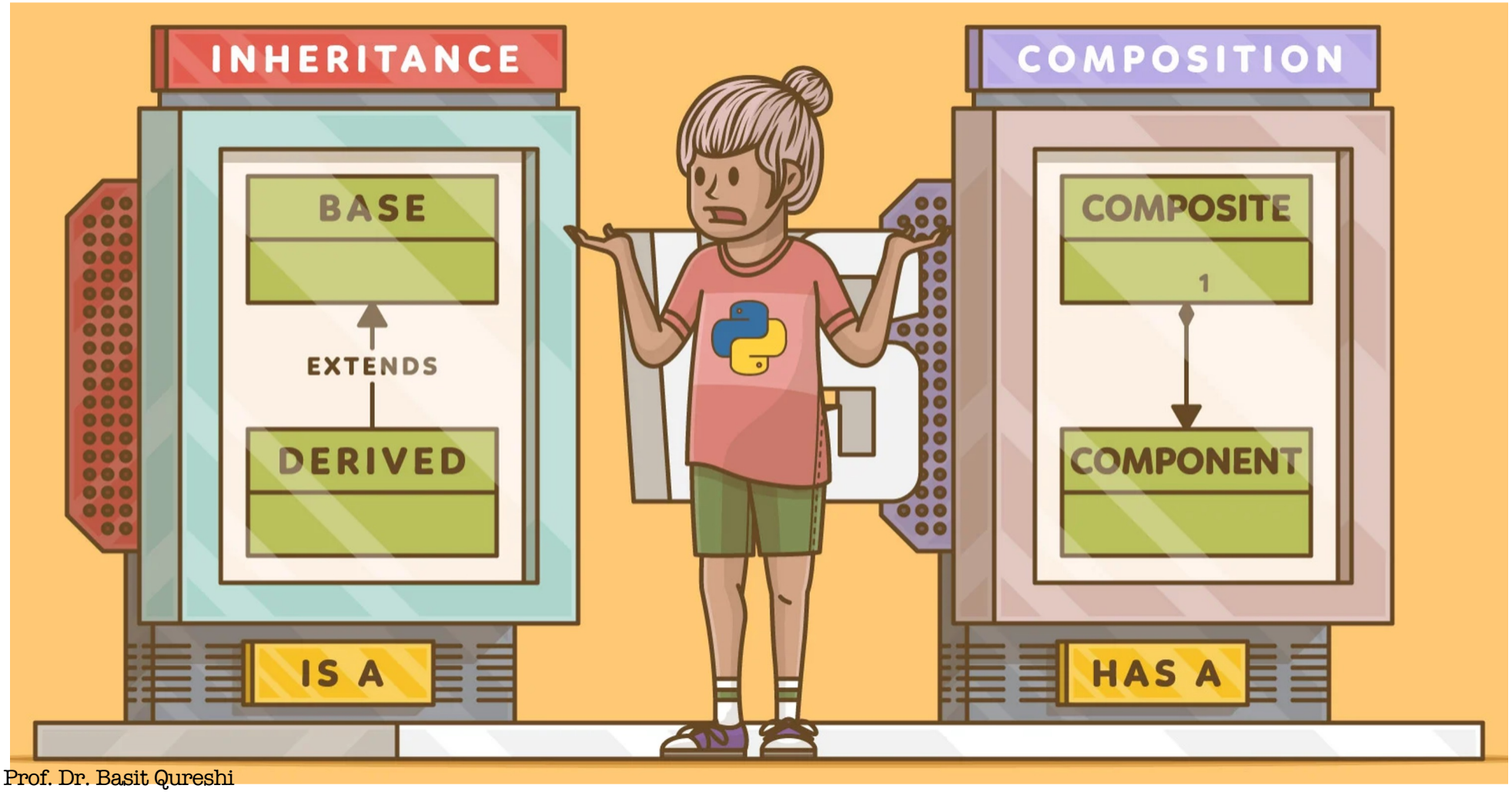
A **`Student`** is-a **`Person`**. A **`Professor`** is-a **`Person`**

A **`Car`** is-a **`Vehicle`**. A **`Bus`** is-a **`Vehicle`**

A **`Laptop`** is-a **`Device`**. A **`Tablet`** is-a **`Device`**

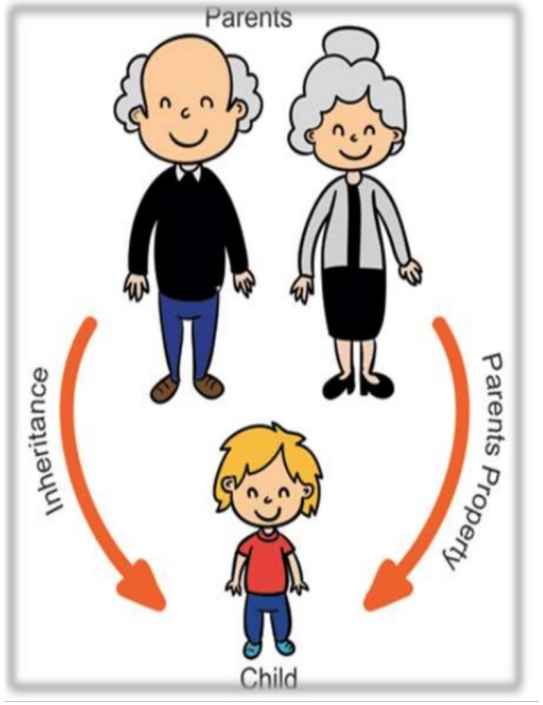
INHERITANCE

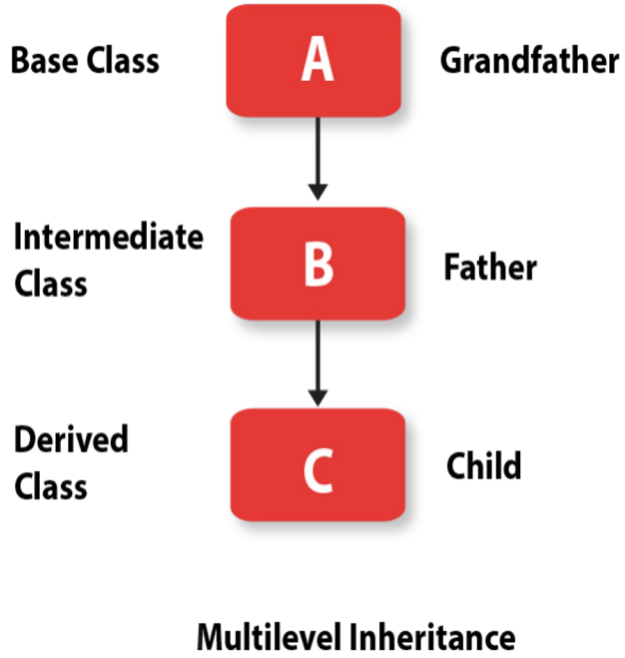
- We use **`extends`** to define the **is-a** relationship between classes.



INHERITANCE

- *Inheritance* allows a software developer to *derive* a new class from an existing one
- The existing class is called the ***parent*** *class,* or ***super****class*, or ***base****class*
- The derived class is called the ***child*** *class* or ***sub****class*
- The ***child*** inherits characteristics of the ***parent*** including methods and variables/attributes defined by the parent class





WHY INHERITANCE? REUSABILITY

- Save time: No need to implement the common methods/behaviors again.

  The child class can derived/reuse the parent methods/behaviors.

  No need to re-implement from the scratch.

- Save space: No need to declare the common attributes again.

  - The child class can derived the common attribute from the parent class.

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EXTENDS

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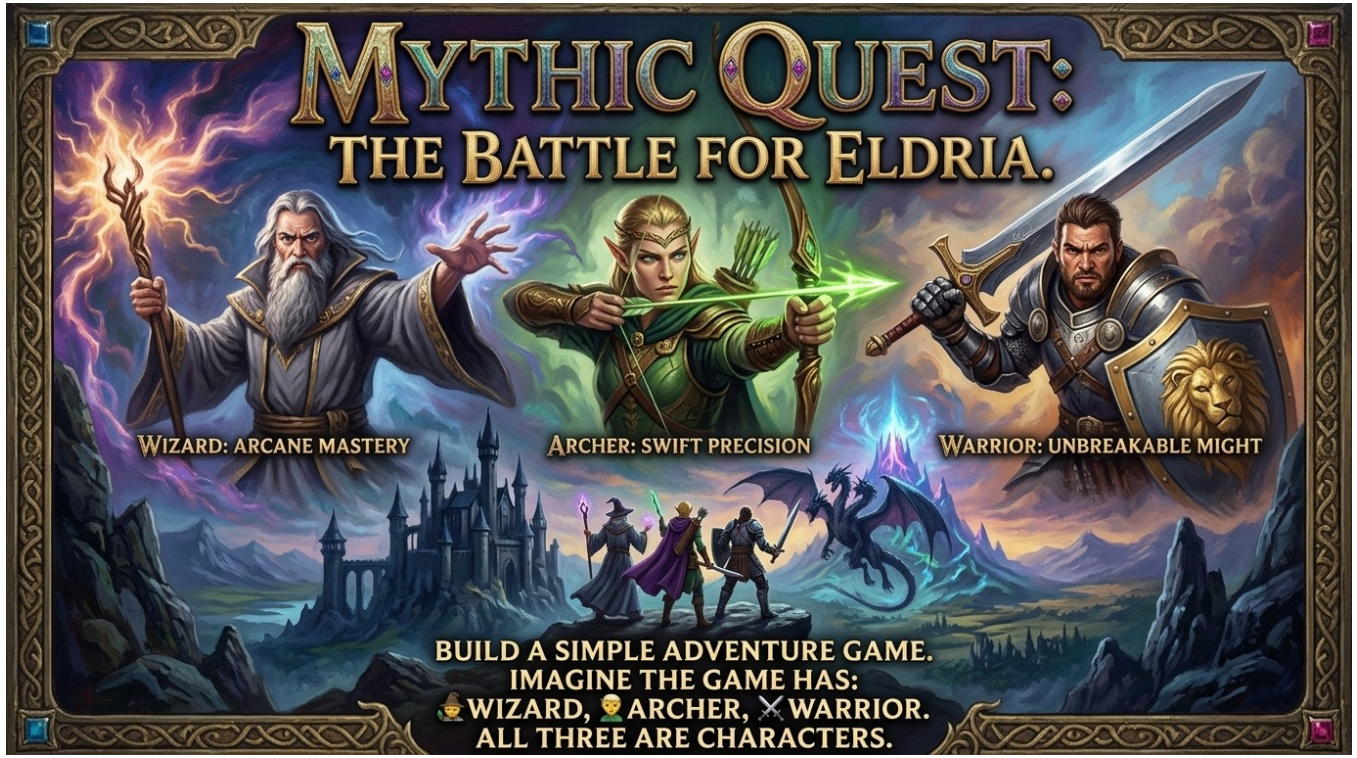
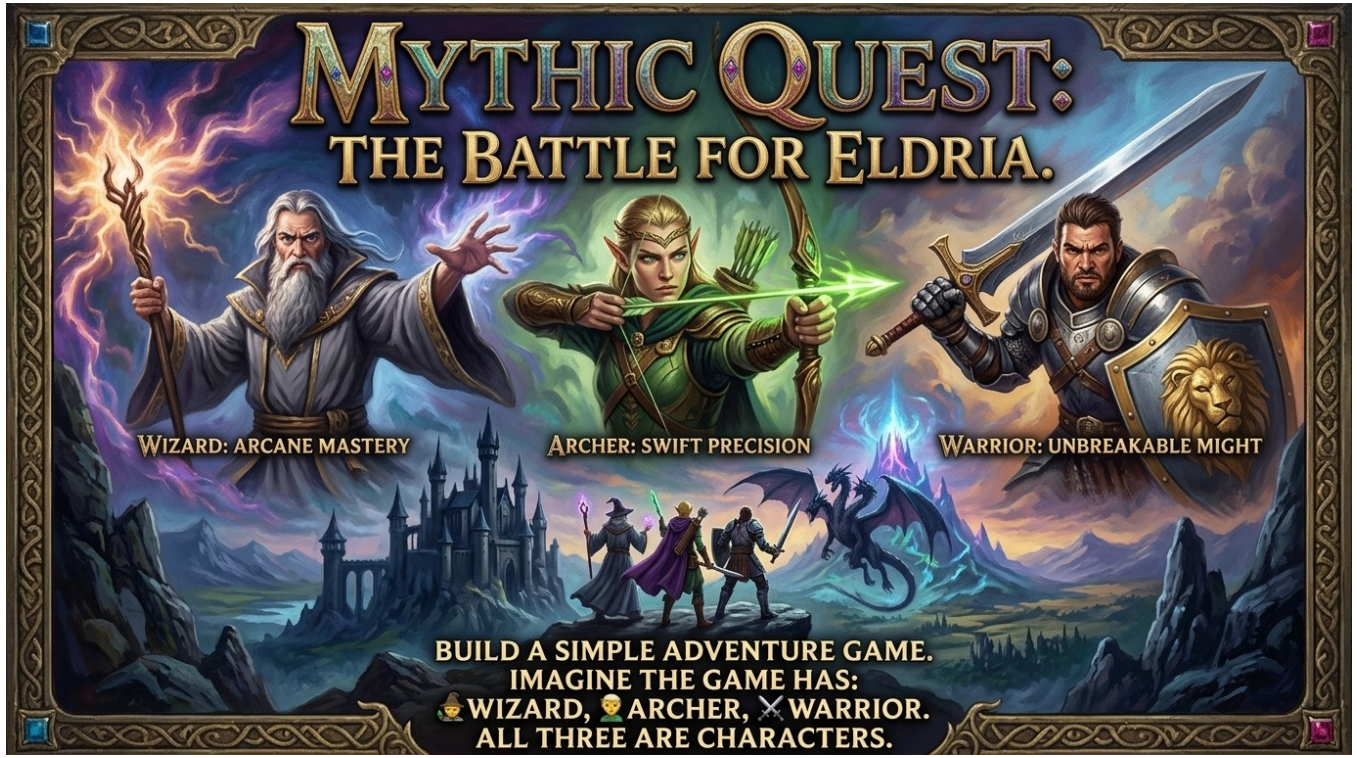
IDEATING INHERITANCE

- Let's build a **Adventure Game**.
- Imagine the game has:
- 🧙‍♂️ **Wizard**
- 🧝‍♂️ **Archer**
- ⚔️ **Warrior**
- All three are **characters**, so they share some common attributes and methods. But each character attacks differently. This is exactly what **inheritance** is designed for.



IDEATING INHERITANCE

- What things do all characters in a game have in common?
  - `Name`
  - `Health`
  - `Level`
  - `Position`
  - `Attack`
  - `Move`

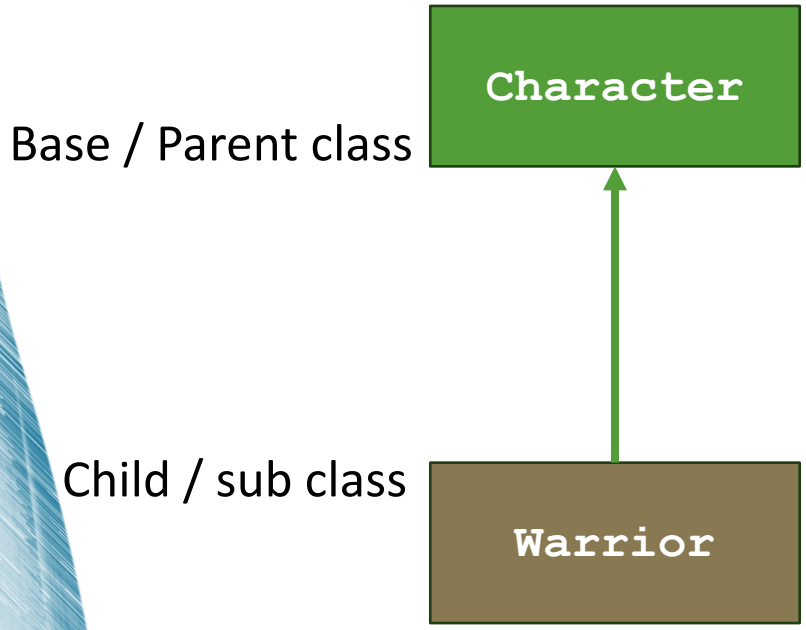


THE CHARACTER CLASS

```
class Character {
  int health;
  String name;
  void move(){
    System.out.println(name + " is moving");
  }
  void attack() {
    System.out.println(name + " is attacking");
  }
}
```

THE WARRIOR CLASS


```
class Warrior extends Character {
  void useSword() {
    System.out.println(name + " attacks with a sword!");
  }
}
```



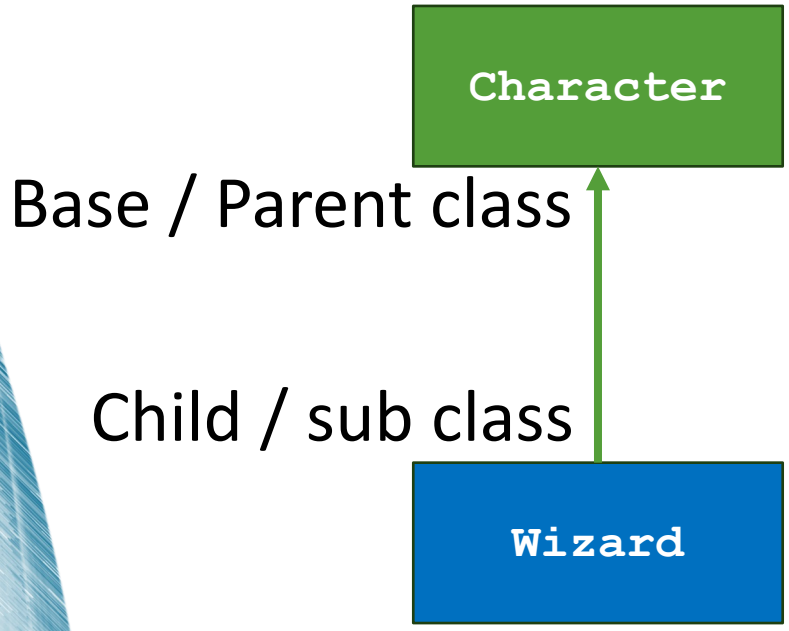
`Warrior` is ***inherited*** from **`Character`**.
Note the keyword **`extends`**

Warrior automatically get **health** and **name** variables from Character class.
It also gets the `move()` and `attack()` methods from Character class.

Warrior has its own `useSword()` method.

THE WIZARD CLASS


```
class Wizard extends Character {
  void fireBall() {
    System.out.println(name + " throws a fireball!");
  }
}
```

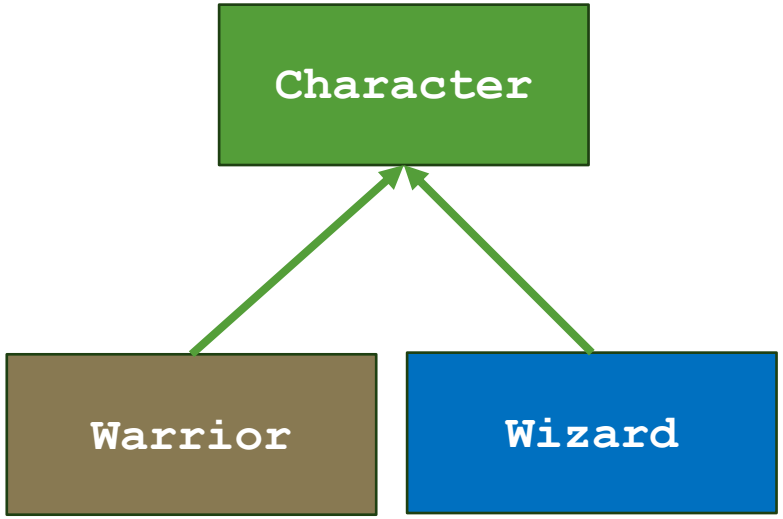


`Wizard` is ***inherited*** from **`Character`**.
Note the keyword **`extends`**

Wizard automatically get **health** and **name** variables from Character class.
It also gets the `move()` and `attack()` methods from Character class.

Wizard has its own `fireBall()` method.

INHERITANCE



Warrior is-a **Character**
Wizard is-a **Character**

Wizard is ***inherited*** from **Character**.
Warrior is ***inherited*** from **Character**.

Wizard and Warrior automatically get **health** and **name** variables from Character class. They also gets the `move()` and `attack()` methods from Character class.

Warrior has its own `useSword()` method.
Wizard has its own `fireBall()` method.

We can define variables/attributes/methods for each subclass.

TESTING THE GAME

```
class Character {
 public class Game {
   public static void main(String[] args) {
    Warrior w = new Warrior();
    w.name = "Thor";
    w.health = 100;
    w.move();
    w.attack(); //inherited from Character
    w.useSword();
    Wizard a = new Wizard();
    a.name = "Robin";
    a.health = 80;
    a.move();
    a.attack(); // inherited from Character
    a.fireBall();
   }
}
```

Output:

```
Thor is moving
Thor is attacking
Thor attacks with a sword!
Robin is moving
Robin is attacking
Robin throws a fireball!
```

THE WARRIOR CLASS


```
class Warrior extends Character {
  void useSword() {
    System.out.println(name + " attacks with a sword!");
  }
  @Override
  void attack() {
    System.out.println(name + " swings a sword!");
  }
}
```

```
class Character { ...attributes/methods...
void attack() {
    System.out.println(name + " is attacking");
  }
}
```

Warrior is ***inherited*** from **Character**.

Warrior defines `attack()` method.
Character already has `attack()` method.

We use the keyword `@Override`

THE WIZARD CLASS


```
class Wizard extends Character {
  void fireBall() {
    System.out.println(name + " throws a fireball!");
  }
 @Override
  void attack() {
    System.out.println(name + " throws fireBall!");
  }
}
```

```
class Character { ...attributes/methods...
void attack() {
    System.out.println(name + " is attacking");
  }
}
```

Wizard is ***inherited*** from **Character**.

Wizard defines `attack()` method.
Character already has `attack()` method.

We use the keyword `@Override`

TESTING THE GAME

```
class Character {
 public class Game {
   public static void main(String[] args) {
    Warrior w = new Warrior();
    w.name = "Thor";
    w.attack(); //using @override attack() from Warror
    Wizard a = new Wizard();
    a.name = "Robin";
    a.attack(); //using @override attack() from Wizard
  }
}
```

Expected output:

```
Thor is attacking
Robin is attacking
```

Actual output:

```
Thor swings a sword!
Robin throws fireball!
```

SUPER

- To call a parent class method or attribute in Java, we use **`super.`**
- **`super`** means go to my parent.

```
class Character {
void attack() {
    System.out.println(name + " is attacking");
  }
}

class Warrior extends Character {
@Override
  void attack() {
    System.out.println(name + " swings a sword!");
  }
}
```

```
//Tester program
Warrior w = new Warrior();
w.attack();

//should print
Warrior swings a sword!
```

SUPER

- To call a parent class method or attribute in Java, we use **`super.`**
- **`super`** means go to my parent.

```
class Character {
void attack() {
    System.out.println(name + " is attacking");
  }
}

class Warrior extends Character {
@Override
  void attack() {
    super.attack();
    System.out.println(name + " swings a sword!");
  }
}
```

```
//Tester program
Warrior w = new Warrior();
w.attack();

//would print
Warrior is attacking
Warrior swings a sword!
```

Note

`this.attack()` → call my (Warrior) method

`super.attack()` → call parent's (Character) method

`Super` can be used with attributes of parent class

SUPER

- Using **super** we can modify the attributes of the parent class.

```
class Character {
   int health;
   String name;
   void attack() {
     System.out.println(name + " is attacking");
   }
}
class Warrior extends Character {
@Override
   void attack() {
     super.name = "Alan";
     super.health = 99;
   }
}
```

Character
name = Alan
health = 99

Warrior
name = Thor
Health 85;

TYPES OF INHERITANCE IN JAVA

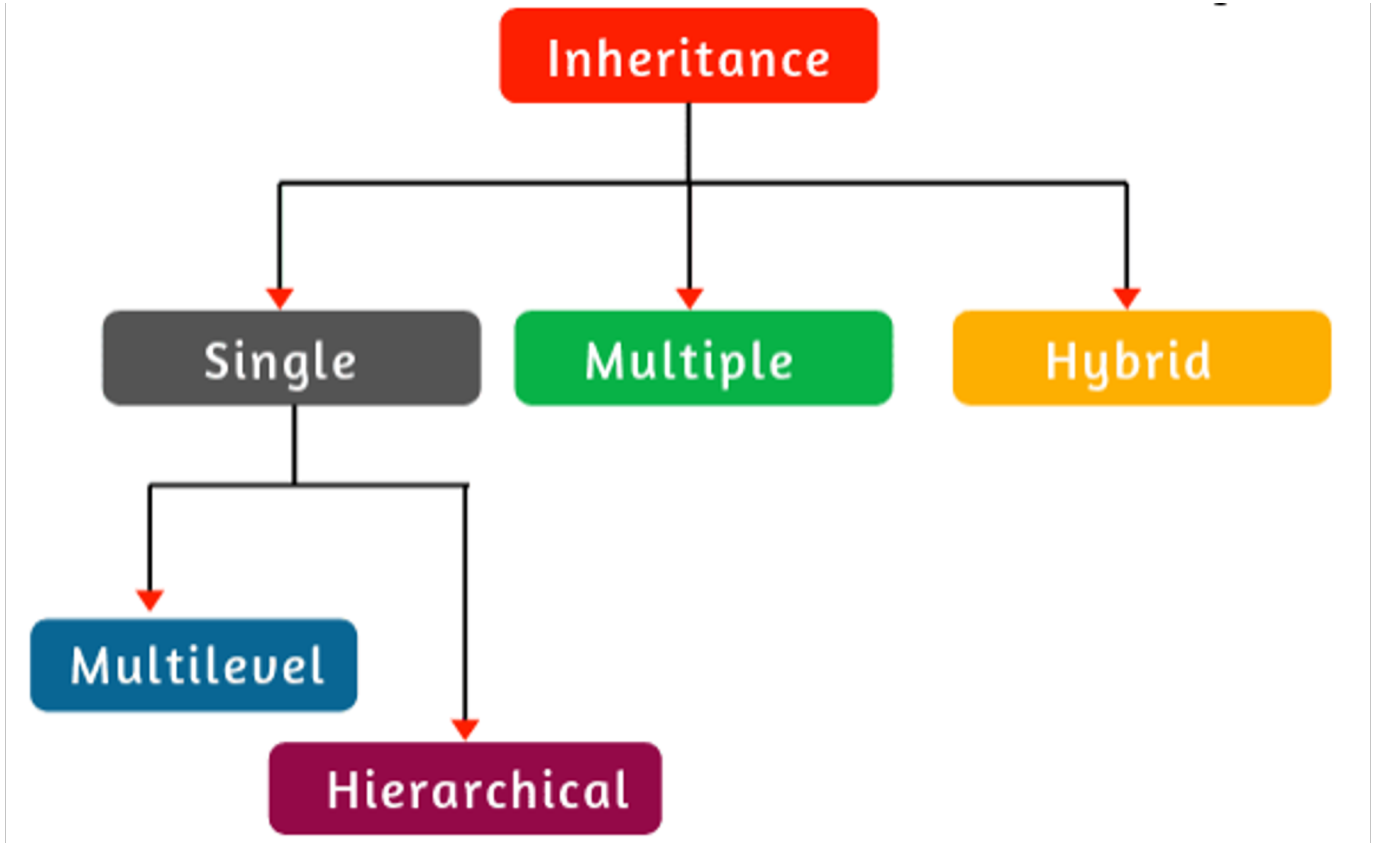
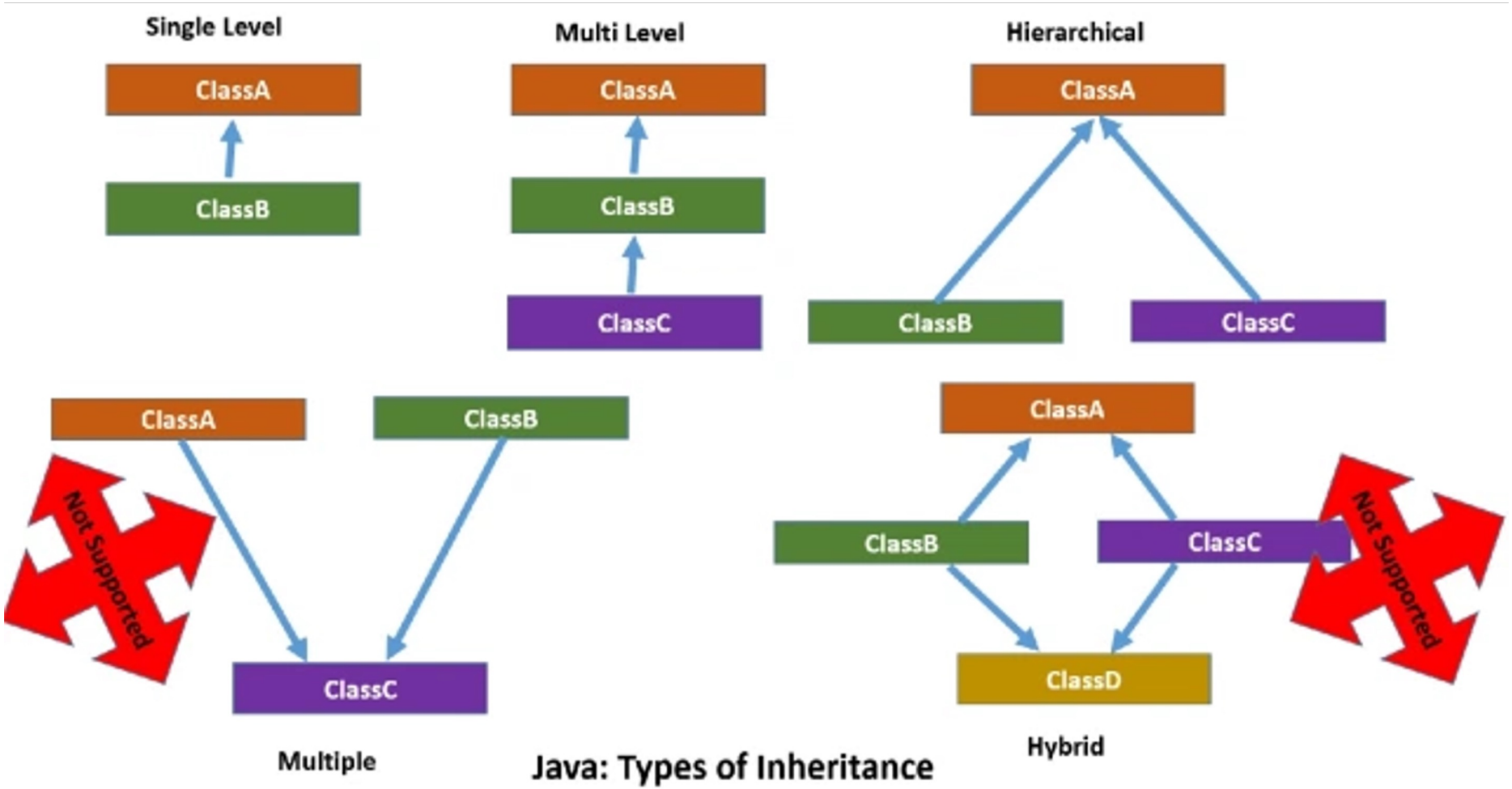


Fig: Classification of Inheritance in Java

TYPES OF INHERITANCE IN JAVA



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POLYMORPHISM

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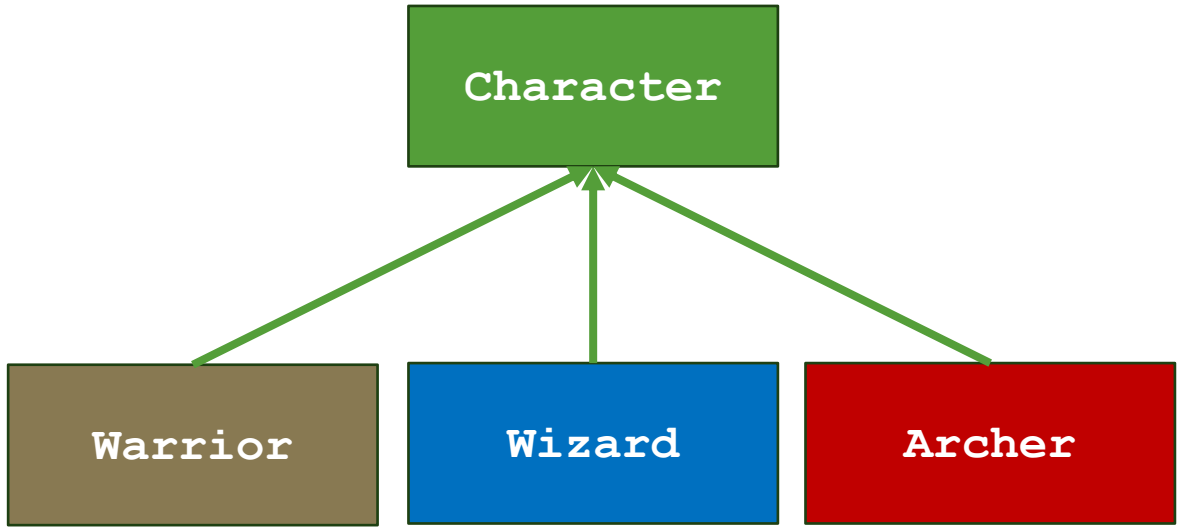
POLYMORPHISM

"One thing, many forms"

In Java, polymorphism allows a **parent-class reference** to refer to different child objects, and Java automatically calls the appropriate overridden method.



We can use the `Character` object to refer to child classes!

POLYMORPHISM

```
class Character {
  void attack() {
    System.out.println(”Character attacks”);
  }
}
```

```
class Warrior extends Character {
  @Override
  void attack() {
    System.out.println(”Warrior swings a sword!");
  }
}
```

POLYMORPHISM

```
Class Wizard extends Character {
  @Override
  void attack() {
    System.out.println(”Wizard throws a fireball!”);
  }
}
```


```
class Archer extends Character {
  @Override
  void attack() {
    System.out.println(”Archer shoots a arrow!");
  }
}
```

POLYMORPHISM

```
Class Tester {
  public static void main(String [] args){
    Character c1 = new Warrior();
    Character c2 = new Wizard();
    Character c3 = new Archer();
    c1.attack();
    c2.attack();
    c3.attack();
  }
}
```

Observe:

Warrior object is stored in c1

Wizard object is stored in c1

Archer object is stored in c1

```
//Output
Warrior swings a sword!
Wizard throws a fireball!
Archer shoots a arrow!
```

Java looks at the **actual object**, not just the reference type.

We wrote the **same code** three times; But each object performs the operation differently
That's **polymorphism**.

POLYMORPHISM

```
Class Tester {
  public static void main(String [] args){
    Character [] Players = { new Warrior(), new Wizard(), new Archer() };
    for(int i=0; i<Players.length; i++)
      Players[i].attack();
  }
}
```

Same Output!

We don't need to write:

```
if (player is Warrior)
    ...
else if (player is Archer)
    ...
else if (player is Wizard)
    ...
```

Java automatically chooses the correct attack()

Polymorphism allows us to use a common parent type to work with different child objects, while each child provides its own implementation of the same method.

POLYMORPHISM

- **Static Polymorphism**
  - Method Overloading
  - Compile-time
  - Same method name, different parameters
- **Dynamic Polymorphism**
  - Method Overriding
  - Runtime
  - Parent reference → Child object
  - Actual object's method is executed
- To note: **constructors cannot be overridden**, although they can be overloaded.

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POLYMORPHISM

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