INFO1113 Object-Oriented Programming

Week 6A: Abstract Classes and Interfaces

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Topics

- Abstract Classes (s. 4)
- Abstract Classes UML (s. 24)
- Interfaces (s. 27)
- Interfaces and UML (s. 47)

Inheritance

As noted last week, we are able to extend a class to a subclass. We will be visiting how we are able to define **abstract** classes, how they are used and when to use them.

We will also be visiting **interfaces** and discussing about the different perspectives between class and inheritance based relationships.

Refer to Chapter 8.4, pages 684-688, (Java, An Introduction to Problem Solving & Programming, Savitch & Mock)

What is an abstract class?

Although similar to a **concrete class**, an **abstract** class cannot be instantiated. It can define methods and attributes which can be inherited, inherit from super types and can be inherited from.

However, abstract classes can also enforce a method implementation for subtypes.

Refer to Chapter 8.4, pages 684-688, (Java, An Introduction to Problem Solving & Programming, Savitch & Mock)

Why would we use abstract?

The main case for **abstract** is that we have some **type** that we do not want instantiated but is a generalisation of many other types.

Example:

- **Shape** is a generalisation of **Triangle, Square, Circle** but we don't have a **concrete** instance of **Shape**

- **Furniture** is a generalisation of **Chair, Sofa, Table** and **Desk**.

Refer to Chapter 8.4, pages 684-688, (Java, An Introduction to Problem Solving & Programming, Savitch & Mock)

Sounds like abstract classes are quite different from classes!

What can we still do?

We still are able to specify:

- Constructors
- Define methods (static and instance)
- Attributes
- Use all the access modifiers
- … everything a regular class can do *except!*

We cannot instantiate the class *but* we can specify methods subtypes must define.

~~**AbstractClass a = new AbstractClass();**~~

Refer to Chapter 8.4, pages 684-688, (Java, An Introduction to Problem Solving & Programming, Savitch & Mock)

Declaration of an abstract class

Simply we are able to define an **abstract** class by using the **abstract keyword**. This immediately marks the class as abstract and we do not need anything more.

Syntax:

```
[modifier] abstract class ClassName
```

Declaration of an abstract class

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Syntax:

```
[modifier] abstract class ClassName
```

Example:

```
public abstract class Furniture
```

What if we try to instantiate it?

Since it is marked as abstract, the compiler will refuse to allow this type of instantiation.

But there is a little more at work here when we mark something as **abstract**.

This is because we can mark methods as being abstract as well.

```
public abstract void stack(Furniture f);
```

```
> javac FurnitureStore.java
FurnitureStore.java:22: error: Furniture
is abstract; cannot be instantiated
        Furniture f = new
Furniture("Table");
                          ^
1 error
<program end>
```

Abstract methods

We are able to declare an **abstract** method in **only abstract classes**.

When we declare an abstract method we do not **define** a method body (the logic of the method).

```
public abstract void stack(Furniture f);
```

The class should not be instantiated and behaviour is defined by the subtypes and not the super type.

Declaration of an abstract class

We have an **abstract** class specified.

```
import java.util.List;
import java.util.ArrayList;

public abstract class Furniture {

    private String name;
    private List<Part> parts;

    public Furniture(String name) {
        this.name = name;
        this.parts = new ArrayList<Part>();
    }

    public void addPart(Part p) {
        parts.add(p);
    }

    public abstract void stack(Furniture f);
}
```

Declaration of an abstract class

We have an **abstract** class specified.

```
import java.util.List;
import java.util.ArrayList;

public abstract class Furniture {

    private String name;
    private List<Part> parts;

    public Furniture(String name) {
        this.name = name;
        this.parts = new ArrayList<Part>();
    }

    public void addPart(Part p) {
        parts.add(p);
    }

    public abstract void stack(Furniture f);
}
```

Notice we have declared an **abstract** method.

Declaration of an abstract class

We have an **abstract** class specified.

```java
import java.util.List;
import java.util.ArrayList;

public abstract class Furniture {

    private String name;
    private List<Part> parts;

    public Furniture(String name) {
        this.name = name;
        this.parts = new ArrayList<Part>();
    }

    public void addPart(Part p) {
        parts.add(p);
    }

    public abstract void stack(Furniture f);
}
```

```java
public class WoodChair extends Furniture {

    public WoodChair() {
        super("WoodChair");
    }

}
```

However, in this class we have not defined the method **stack**.

```java
public class FurnitureStore {
    public static void main(String[] args) {
        WoodChair f = new WoodChair();
        f.stack(new WoodChair());
    }
}
```

```
> javac FurnitureStore.java
WoodChair.java:1: error: WoodChair is not abstract
and does not override abstract method
stack(Furniture) in Furniture
public class WoodChair extends Furniture {
           ^
1 error
```

Declaration of an abstract class

We have an **abstract** class specified.

```
import java.util.List;
import java.util.ArrayList;

public abstract class Furniture {

    private String name;
    private List<Part> parts;

    public Furniture(String name) {
        this.name = name;
        this.parts = new ArrayList<Part>();
    }

    public void addPart(Part p) {
        parts.add(p);
    }

    public abstract void stack(Furniture f);
}
```

```
public class WoodChair extends Furniture {

    public WoodChair() {
        super("WoodChair");
    }

    public void stack(Furniture f) {
        System.out.println("Don't put
          furniture on chairs!");
    }
```

Now we have defined the method **stack** in the subclass.

```
public class FurnitureStore {
    public static void main(String[] args) {
        WoodChair f = new WoodChair();
        f.stack(new WoodChair());
    }
}
```

```
> javac FurnitureStore.java
WoodChair.java:1: error: WoodChair is not abstract
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stack(Furniture) in Furniture
public class WoodChair extends Furniture {
           ^
1 error
```

Declaration of an abstract class

We have an **abstract** class specified.

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import java.util.List;
import java.util.ArrayList;

public abstract class Furniture {

    private String name;
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    public Furniture(String name) {
        this.name = name;
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    }

    public void addPart(Part p) {
        parts.add(p);
    }

    public abstract void stack(Furniture
}
```

```
public class WoodChair extends Furniture {

    public WoodChair() {
        super("WoodChair");
    }

    public void stack(Furniture f) {
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          furniture on chairs!");
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Now we have defined the method **stack** in the subclass.

```
public class FurnitureStore {
    public static void main(String[] args) {
        WoodChair f = new WoodChair();
        f.stack(new WoodChair());
    }
}
```

```
> javac FurnitureStore.java
>
```

Declaration of an abstract class

We have an **abstract** class specified.

```java
import java.util.List;
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public abstract class Furniture {

    private String name;
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```java
public class WoodChair extends Furniture {

    public WoodChair() {
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    }

    public void stack(Furniture f) {
        System.out.println("Don't put
          furniture on chairs!");
    }
```

Now we have defined the method **stack** in the

```java
public class FurnitureStore {

    public static void main(String[] args) {
        WoodChair f = new WoodChair();
        f.stack(new WoodChair());
    }
}
```

We can now declare and invoke stack through **WoodChair** class.

```
> java FurnitureStore
Don't put furniture on chairs!
```

Declaration of an abstract class

We have an **abstract** class specified.

```java
import java.util.List;
import java.util.ArrayList;

public abstract class Furniture {

    private String name;
    private List<Part> parts;

    public Furniture(String name) {
        this.name = name;
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    }
```

```java
public class WoodChair extends Furniture {

    public WoodChair() {
        super("WoodChair");
    }

    public void stack(Furniture f) {
        System.out.println("Don't put
          furniture on chairs!");
    }
```

Now we have defined the method **stack** in the

```java
public class FurnitureStore {

    public static void main(String[] args) {
        Furniture f = new WoodChair();
        f.stack(new WoodChair());
    }
}
```

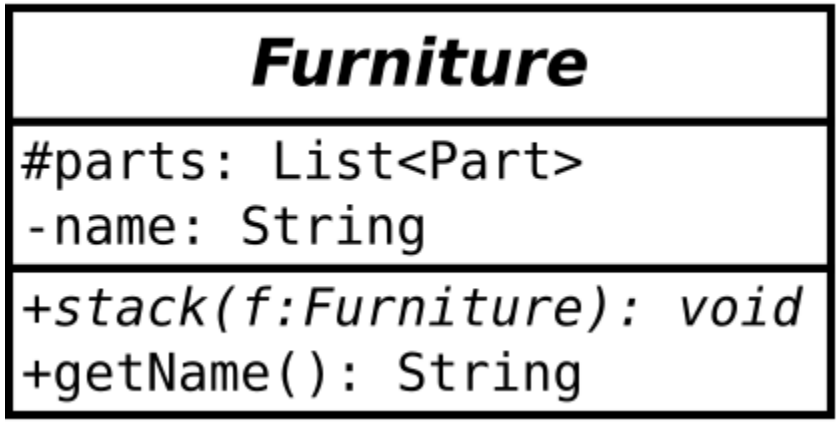
We can even bind it to **Furniture** type and **invoke** stack which will call the subtype's method

```
> java FurnitureStore
Don't put furniture on chairs!
```

Neat! Let’s play around with it and see what other types we can create

Abstract Classes and UML

Within a UML class diagram, we can illustrate abstract classes with the following.



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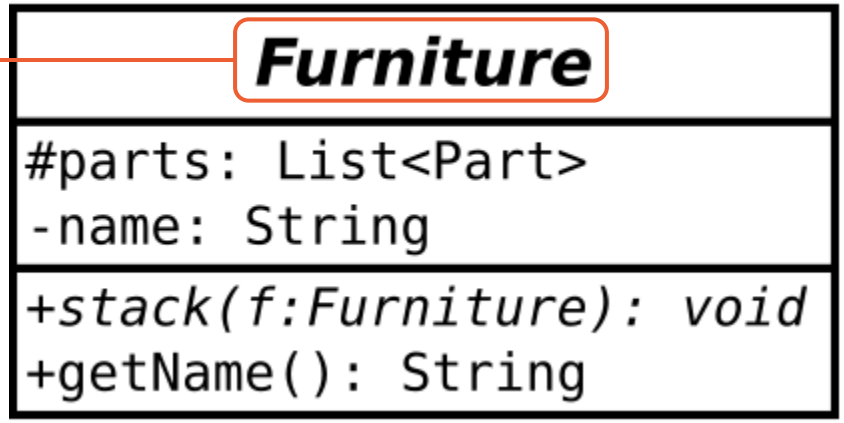
Within a UML class diagram, we can illustrate abstract classes with the following.

Italicised font shows that it is an abstract class.



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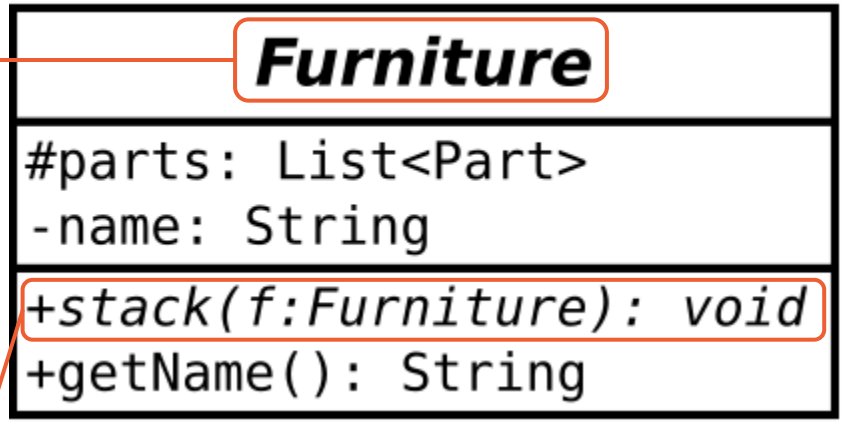

We also show **polymorphic** method as italicised.

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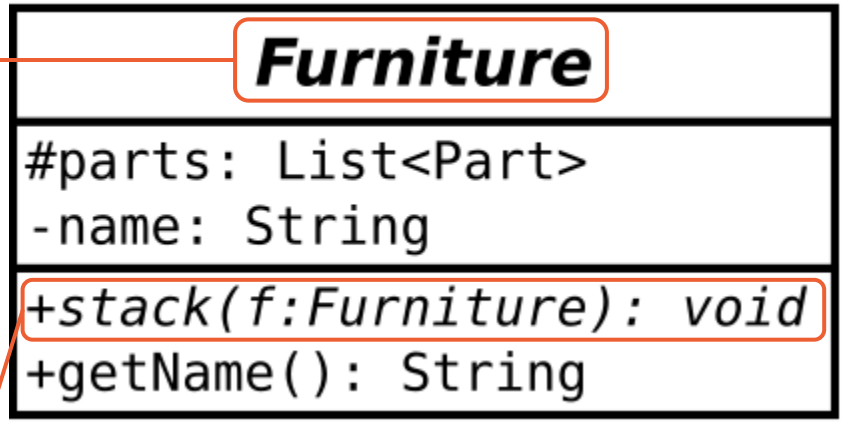

We also show **polymorphic** method as italicised.

This is convention for UML 2.

Interfaces

We will now look at **interfaces.**

We will be introducing a new keyword **`implements`**.

Interfaces share a similarity with **Abstract Classes** in that they declare methods that a class must **implement** and **they cannot be instantiated.** However, unlike classes, they can be **implemented by classes** as many times as they like.

We are not bound to implementing a single interface, we can implement multiple interfaces.

Refer to Chapter 8.4, pages 659-669, (Java, An Introduction to Problem Solving & Programming, Savitch & Mock)

Interfaces

Maybe it might be best to ask **Why would we want to do that?**

Interfaces

- **Cannot specify any attributes only methods**
- **Do not (typically) provide a method definition**
- **Cannot instantiate them**
- **Can be implemented multiple times**

From an application design perspective we need to consider how we can use interfaces and where they are appropriate.

Refer to Chapter 8.4, pages 659-669, (Java, An Introduction to Problem Solving & Programming, Savitch & Mock)

Declaration of an interfaces

Simply we are able to define an **interface** by using the **interface keyword**.

Syntax:

```
[modifier] interface InterfaceName
```

Example:

```
public interface Swim
```

Declaration of an interfaces

Simply we are able to define an **interface** by using the **interface keyword**.

Syntax:

```
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```

To be clear, an **interface** is **not a class.**

Example:

```
public interface Swim
```

Declaration of an interfaces

Simply we are able to define an **interface** by using the **interface keyword**.

Syntax:

```
[modifier] interface InterfaceName
```

Example:

```
public interface Swim {
    public void swim();
    public void dive();
}
```

To be clear, an **interface** is **not a class.** It defines a group a methods for implementers to define.

Declaration of an interfaces

Simply we are able to define an **interface** by using the **interface keyword**.

Syntax:

```
[modifier] interface InterfaceName
```

Example:

```
public interface Swim {
    public void swim();
    public void dive();
}
```

To be clear, an **interface** is **not a class.** It defines a group a methods for implementers to define.

Since a **Dog** class **implements** the **Swim** interface it will need to define the methods for **Swim.**

```
public class Dog implements Swim
```

Interfaces

So let's take a look at the following example

```
public interface Move {
    public void move(double hours);
}
```

```
public class Dog implements Move {
    private String region; //Water or Land
    private final double LAND_MOVEMENT_SPEED_KMH = 50.0;
    private final double WATER_MOVEMENT_SPEED_KMH = 8.0;
    private double kmTravelled = 0.0;

    public Dog(String region) {
        this.region = region;
    }

    public void move(double hours) {
        if(region.equals("water")) {
            kmTravelled += (WATER_MOVEMENT_SPEED_KMH *hours);
        } else if(region.equals("land")) {
            kmTravelled += (LAND_MOVEMENT_SPEED_KMH * hours);
        }
    }

    public double getKMTravelled() {
        return kmTravelled;
    }
}
```

```
public class Dolphin implements Move {
    private String region; //Water or Land
    private final double LAND_MOVEMENT_SPEED_KMH = 1.0;
    private final double WATER_MOVEMENT_SPEED_KMH = 60.0;
    private double kmTravelled = 0.0;

    public Dolphin(String region) {
        this.region = region;
    }

    public void move(double hours) {
        if(region.equals("water")) {
            kmTravelled += (WATER_MOVEMENT_SPEED_KMH * hours);
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            kmTravelled += (LAND_MOVEMENT_SPEED_KMH * hours);
        }
    }

    public double getKMTravelled() {
        return kmTravelled;
    }
}
```

Okay! It’s a lot, but let’s try and distill it

Interfaces

So let's take a look at the following example (WHOA!)

```
public interface Move {
    public void move(double hours);
}
```

We have defined our **Interface Move** that will be implemented by **Dog** and **Dolphin**.

```
public class Dog implements Move {
    private String region; //Water or Land
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        }
    }

    public double getKMTravelled() {
        return kmTravelled;
    }
}
```

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public class Dolphin implements Move {
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            kmTravelled += (LAND_MOVEMENT_SPEED_KMH * hours);
        }
    }

    public double getKMTravelled() {
        return kmTravelled;
    }
}
```

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        }
    }

KMTravelled() {
elled;
```

They both have a similar implementation but **their** land and water movement speed is different. We could change it completely between the two implementations.

Interfaces

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```

We have defined our **Interface Move** that will be implemented by **Dog** and **Dolphin**.

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    private double kmTravelled = 0.0;

    public Dog(String region) {
        this.region = region;
    }

    public void move(double hours) {
        if(region.equals("water")) {
            kmTravelled += (WATER_MOVEMENT_SPEED_KMH *hours);
        } else if(region.equals("land")) {
            kmTravelled += (LAND_MOVEMENT_SPEED_KMH * hours);
        }
    }

    public double getKMTravelled() {
        return kmTravelled;
    }
}
```

Since they both implement **Move** interface, we can treat them as a **Move type.**

```
public class Dolphin implements Move {
    private String region; //Water or Land
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    public Dog(String region) {
```

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public class Dolphin implements Move {
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    private double kmTravelled = 0.0;

    public Dolphin(String region) {
```

Since they both implement **Move** interface, we can treat them as a **Move type.**

```
public class MovingAnimals {
    public static void main(String[] args) {
        Dog dog = new Dog("land");
        Dolphin dolphin = new Dolphin("land");
        Move[] movingAnimals = {dog, dolphin};

        for(Move m : movingAnimals) {
            m.move(1.0);
        }

        System.out.println(dog.getKMTravelled());
        System.out.println(dolphin.getKMTravelled());
    }
}
```

We can create an **Move[]** array and add both **dog** and **dolphin** types to it.
Why?

Interfaces

So let's take a look at the following example (WHOA!)

```
public interface Move {
    public void move(double hours);
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```

We have defined our **Interface Move** that will be implemented by **Dog** and **Dolphin**.

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public class Dolphin implements Move {
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    private double kmTravelled = 0.0;

    public Dolphin(String region) {
```

Since they both implement **Move** interface, we can treat them as a **Move type.**

```
public class MovingAnimals {
    public static void main(String[] args) {
        Dog dog = new Dog("land");
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        Move[] movingAnimals = {dog, dolphin};

        for(Move m : movingAnimals) {
            m.move(1.0);
        }

        System.out.println(dog.getKMTravelled());
        System.out.println(dolphin.getKMTravelled());
    }
}
```

We can create an **Move[]** array and add both **dog** and **dolphin** types to it.
Because they are of type Move.

Interfaces

So let's take a look at the following example (WHOA!)

```
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    public void move(double hours);
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```

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Since they both implement **Move** interface, we can treat them as a **Move type.**

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            m.move(1.0);
        }

        System.out.println(dog.getKMTravelled());
        System.out.println(dolphin.getKMTravelled());
    }
}
```

If they of **type Move** we are guaranteed to be able to use **move()** method.

Interfaces

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        System.out.println(dog.getKMTravelled());
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    }
}
```

We can see the updated variables that have been applied to both objects.

Interfaces

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    public void move(double hours);
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```

We have defined our **Interface Move** that will be implemented by **Dog** and **Dolphin**.

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    public Dog(String region) {
```

```
public class Dolphin implements Move {
    private String region; //Water or Land
    rivate final double LAND_MOVEMENT_SPEED_KMH = 1.0;
    rivate final double WATER_MOVEMENT_SPEED_KMH = 60.0;
    rivate double kmTravelled = 0.0;

    blic Dolphin(String region) {
```

Since they both implement **Move** interface, we can treat them as a **Move type.**

```
public class MovingAnimals {
    public static void main(String[] args) {
        Dog dog = new Dog("land");
        Dolphin dolphin = new Dolphin("land");
        Move[] movingAnimals = {dog, dolphin};

        for(Move m : movingAnimals) {
            m.move(1.0);
        }

        System.out.println(dog.getKMTravelled());
        System.out.println(dolphin.getKMTravelled());
    }
}
```

```
> java MovingAnimals
50.0
1.0
<program end>
```

We can then see that **move()** has changed an **internal** travelled variable.

Using interfaces!

Note: Interfaces

Okay, I lied a little, we can have variables in an interface.

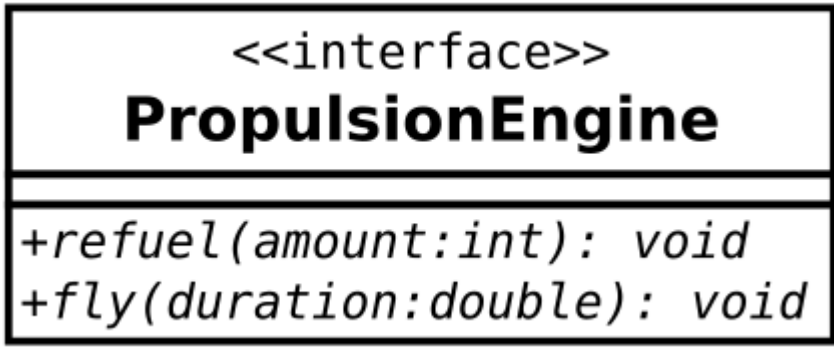
However! The variables are:

- Static (They belong to the interface)
- Constant (have the **final** modifier applied to them)

Therefore we cannot use them for instances.

Abstract Classes and UML

Just like **abstract** classes we can represent an interface within UML however it is slightly different than others.



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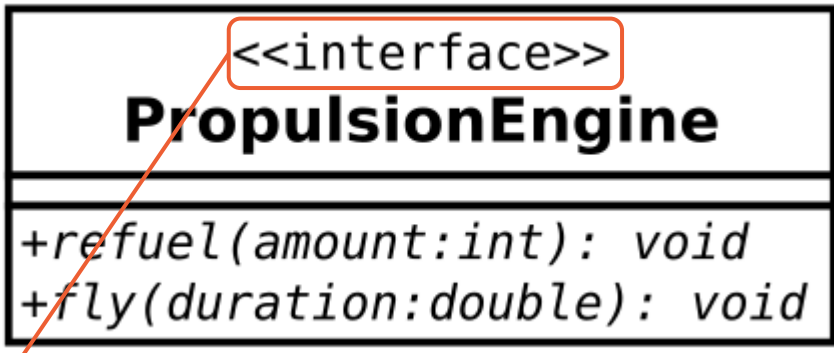

We specify the stereotype in UML to be interface and this gives us specificity of language constructs.

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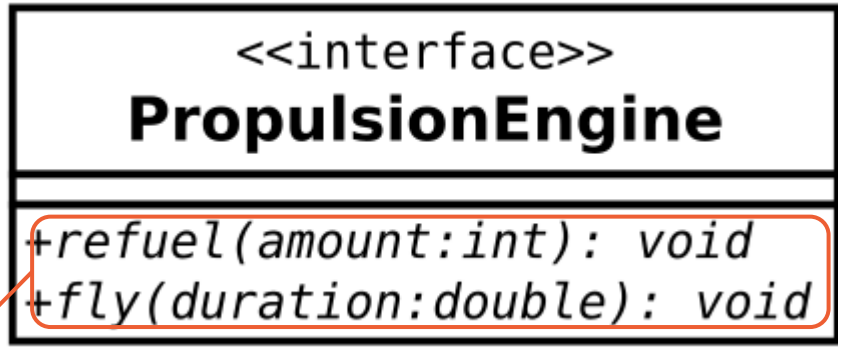

Italicised font shows that it is a polymorphic method

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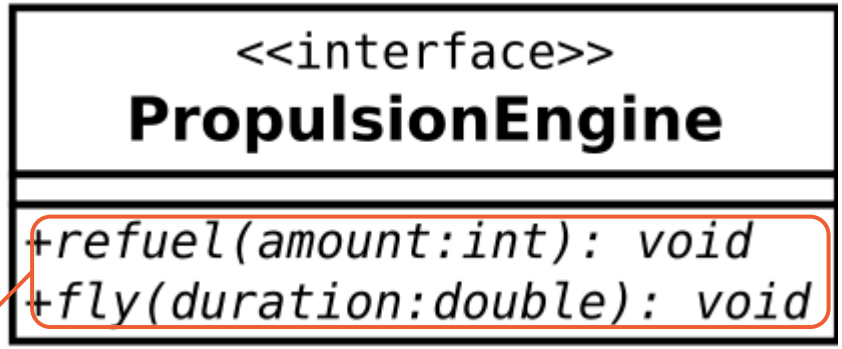

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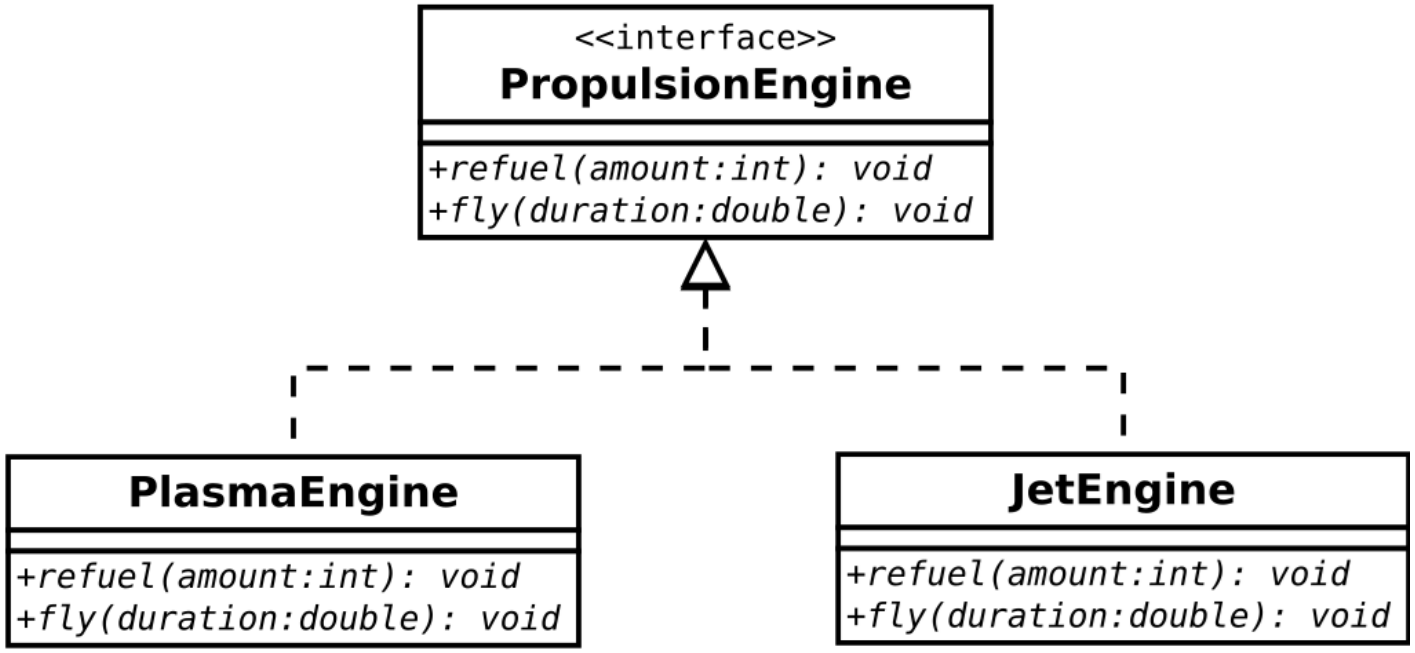

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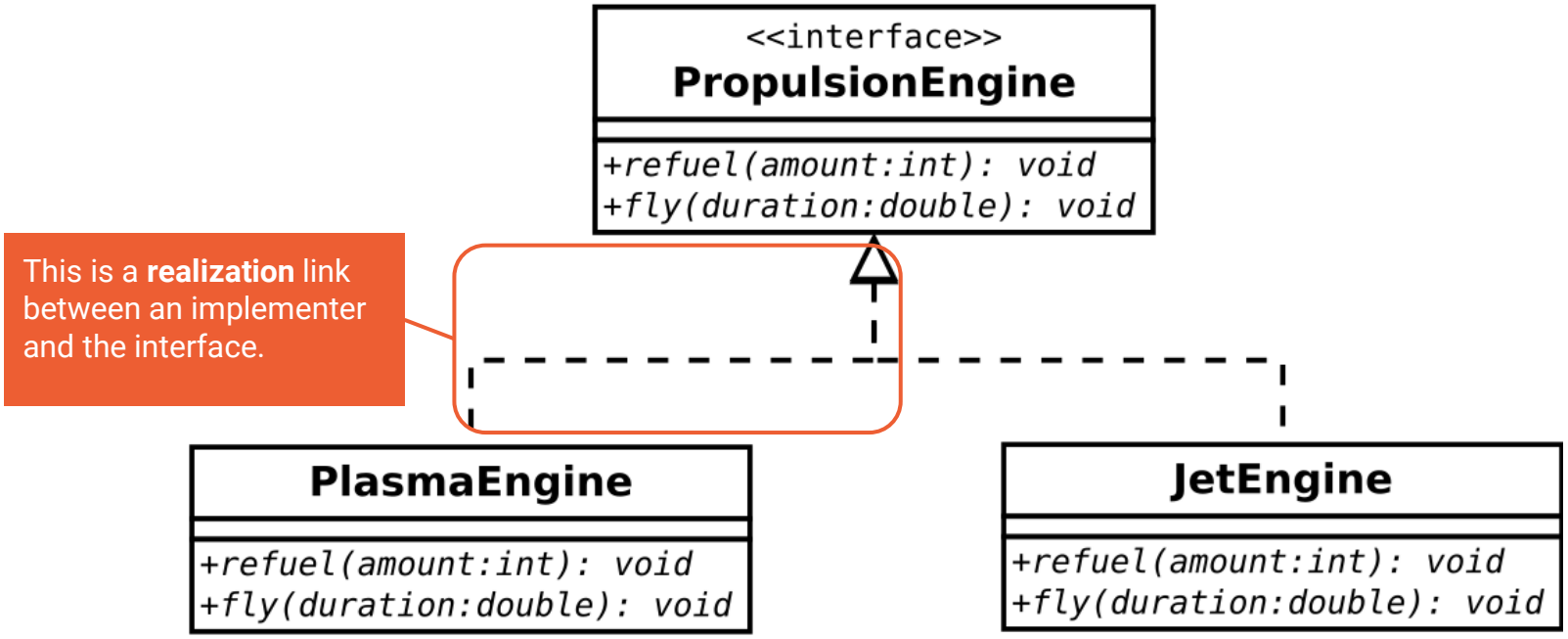

See you next time!