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Software Design Patterns

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Pattern types

Creational Patterns

Behavioural Patterns

Structural Patterns

Creational Patterns

Creational design patterns deal with object creation mechanisms, trying to create objects in a manner suitable to the situation.

Behavioural Patterns

Behavioral design patterns identify and realise common communication patterns among objects. By doing so, these patterns increase flexibility in carrying out this communication.

Structural Patterns

Structural design patterns ease the design by identifying a simple way to realise relationships among entities.

Pattern types

Creational Patterns

Behavioural Patterns

Structural Patterns

Abstract Factory

Singleton

Factory Method

Prototype

Builder

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The *abstract factory pattern* provides a way to encapsulate a group of individual factories with a common theme without specifying their concrete classes

If you want to create cars of ***different models*** from the ***same brand***

you need ***Mercedes Factory***

If you want ***another brand*** with ***different models***

You need additional ***Audi Factory***

Abstract Factory

Two factories have the same available public API for:

Creating a new car

Delivering it to customer

Developing new models

some other…

Mercedes Factory

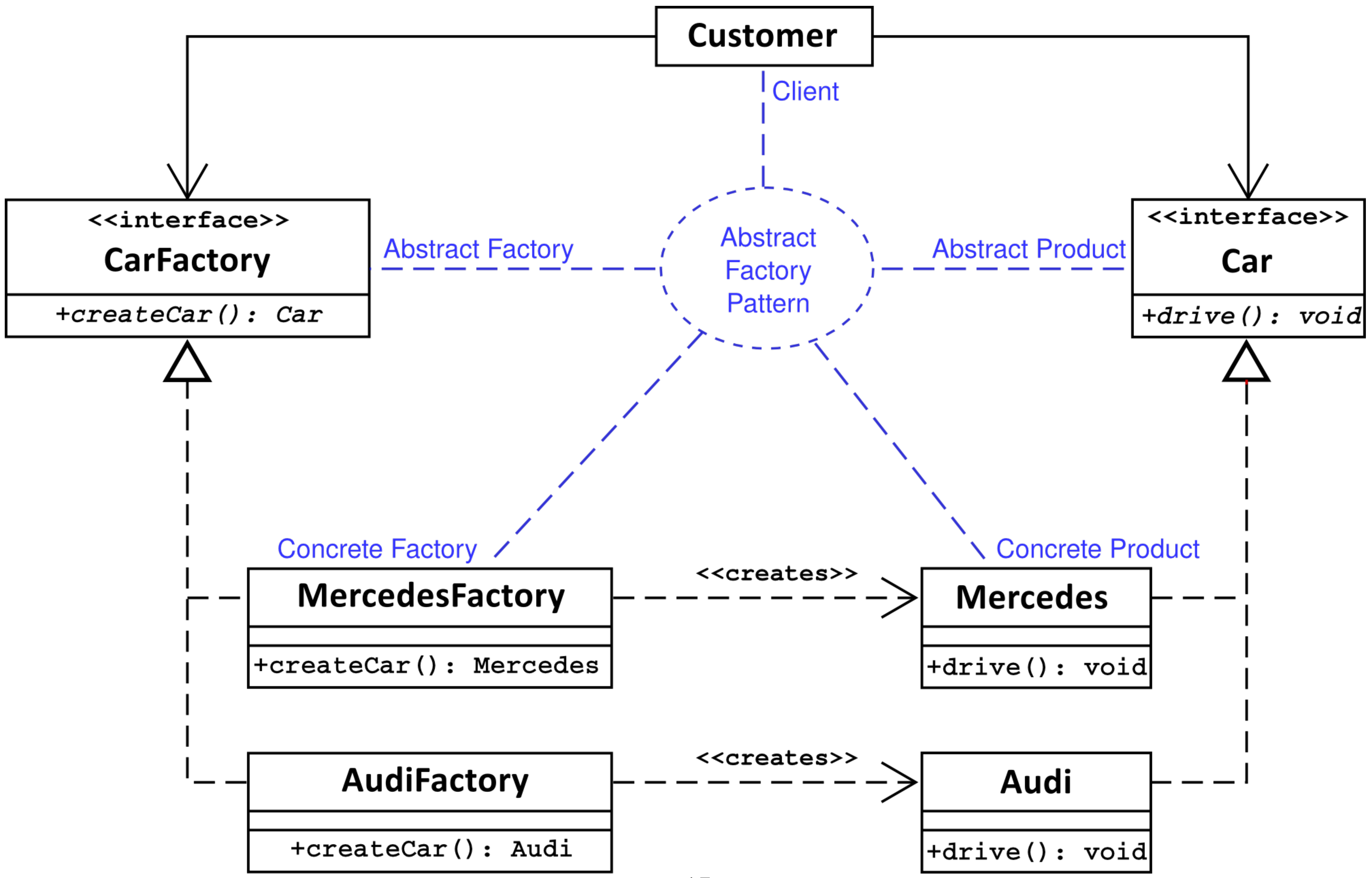
Audi Factory

Abstract Factory

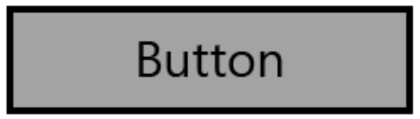
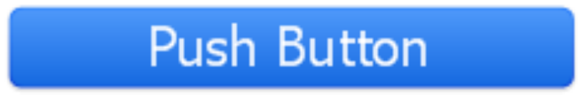
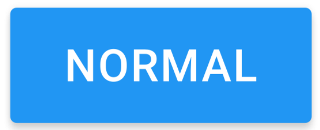
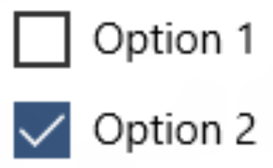
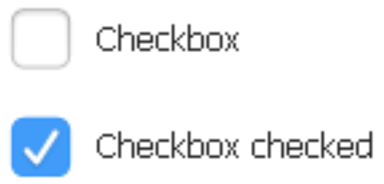
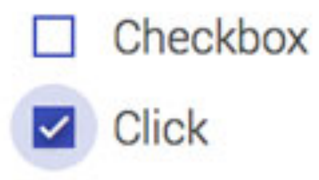
API can be extracted to an Interface

$$\begin{tikzcd}
 & \text{CarFactory <<Interface>>} \arrow[dl] \arrow[dr] & \\
\text{Mercedes Factory} & & \text{Audi Factory}
\end{tikzcd}$$

Abstract Factory



Crossplatform
GUI library for *native* widgets

	Windows	OSX	Android
Button			
Checkbox			

```
public interface Button {

}


public class WindowsButton implements Button {

}

public class OsxButton implements Button {

}

public class AndroidButton implements Button {

}
```

```java
public interface Checkbox {

}


public class WindowsCheckbox implements Checkbox {

}

public class OsxCheckbox implements Checkbox {

}

public class AndroidCheckbox implements Checkbox {

}
```

<u>Button</u>

- WindowsButton
- OsxButton
- AndroidButton

<u>Checkbox</u>

- WindowsCheckbox
- OsxCheckbox
- AndroidCheckbox

```java
public interface WidgetFactory {
   public Button createButton();
   public Checkbox createCheckbox();
}
```

```
public interface WidgetFactory {
   public Button createButton();
   public Checkbox createCheckbox();
}
```

```
public class WindowsWidgetFactory implements WidgetFactory {
   @Override
   public Button createButton() {
      return new WindowsButton();
   }

   @Override
   public Checkbox createCheckbox() {
      return new WindowsCheckbox();
   }
}
```

```java
public interface WidgetFactory {
  public Button createButton();
  public Checkbox createCheckbox();
}
```

```java
public class OsxWidgetFactory implements WidgetFactory {
  @Override
  public Button createButton() {
    return new OsxButton();
  }

  @Override
  public Checkbox createCheckbox() {
    return new OsxCheckbox();
  }
}
```

```java
public interface WidgetFactory {
  public Button createButton();
  public Checkbox createCheckbox();
}
```

```java
public class AndroidWidgetFactory implements WidgetFactory {
  @Override
  public Button createButton() {
    return new AndroidButton();
  }

  @Override
  public Checkbox createCheckbox() {
    return new AndroidCheckbox();
  }
}
```

<u>Button</u>
- WindowsButton
- OsxButton
- AndroidButton

<u>Checkbox</u>
- WindowsCheckbox
- OsxCheckbox
- AndroidCheckbox

<u>WidgetFactory</u>
- WindowsWidgetFactory
- OsxWidgetFactory
- AndroidWidgetFactory

```
WidgetFactory widgetFactory;
WidgetFactory widgetFactory;

// “pseudocode” //
switch(System.getProperty("os.name")) {
   case "Windows":
      widgetFactory = new WindowsWidgetFactory();
      break;
   }
```

```
WidgetFactory widgetFactory;

// “pseudocode” //
switch(System.getProperty("os.name")) {
   case "Windows":
      widgetFactory = new WindowsWidgetFactory();
      break;
   case "OSX":
      widgetFactory = new OsxWidgetFactory();
      break;
   case "Android":
      widgetFactory = new AndroidWidgetFactory();
      break;
   default:
      widgetFactory = null;
      throw new Exception("Unsupported OS");
}
```

```java
WidgetFactory widgetFactory;

// “pseudocode” //
switch(System.getProperty("os.name")) {


   // ........ //


}


Button button = widgetFactory.createButton();
Checkbox checkbox = widgetFactory.createCheckbox();
```

```
WidgetFactory widgetFactory;

// “pseudocode” //
switch(System.getProperty("os.name")) {
   case "Windows":
      widgetFactory = new WindowsWidgetFactory();
      break;
   case "OSX":
      widgetFactory = new OsxWidgetFactory();
      break;
   case "Android":
      widgetFactory = new AndroidWidgetFactory();
      break;
   default:
      widgetFactory = null;
      throw new Exception("Unsupported OS");
}


Button button = widgetFactory.createButton();
Checkbox checkbox = widgetFactory.createCheckbox();
```

Pattern types

Creational Patterns

Behavioural Patterns

Structural Patterns

→

Abstract Factory

Singleton

Factory Method

Prototype

Builder

```java
public class Game {
    private final String name;
    private final Player player;
    private final Level level;
    private final Board board;
    private final Renderer renderer;

    public Game(String name, Player player, Level level, Board board, Renderer renderer) {
        this.name = name;
        this.player = player;
        this.level = level;
        this.board = board;
        this.renderer = renderer;
    }

    public Game(String name, Player player, Level level, Board board) {
        this(name, player, level, board, new Renderer());
    }

    public Game(String name, Player player, Level level) {
        this(name, player, level, new Board());
    }

    public Game(String name, Player player) {
        this(name, player, new Level());
    }

    public Game(String name) {
        this(name, new Player());
    }

    public Game() {
        this("Default game");
    }
}
```

```
public class Game {
    private final String name;
    private final Player player;
    private final Level level;
    private final Board board;
    private final Renderer renderer;

    public Game(String name, Player player, Level level, Board board, Renderer renderer) {
        this.name = name;
        this.player = player;
        this.level = level;
        this.board = board;
        this.renderer = renderer;
    }

    public Game(String name, Player player, Level level, Board board) {
        this(name, player, level, board, new Renderer());
    }

    public Game(String name, Player player, Level level) {
        this(name, player, level, new Board());
    }

    public Game(String name, Player player) {
        this(name, player, new Level());
    }

    public Game(String name) {
        this(name, new Player());
    }

    public Game() {
        this("Default game");
    }
}
```

The ***telescoping constructor anti-pattern*** occurs when the increase of object constructor parameter combinations leads to an exponential list of constructors

The intent of ***the Builder design pattern*** is to separate the construction of a complex object from its representation

```java
public class Game {
  private final Player player;
  private final Level level;

  public Game(Player player, Level level) {
    this.player = player;
    this.level = level;
  }
}
```

Static builder class

```
public class Game {
  private final Player player;
  private final Level level;

  public Game(Player player, Level level) {
    this.player = player;
    this.level = level;
  }

  public static Builder builder() {
      return new Builder();
  }

  public static class Builder {

  }
}
```

Static builder class

```
public class Game {
   private final Player player;
   private final Level level;

   public Game(Player player, Level level) {
      this.player = player;
      this.level = level;
   }

   public static class Builder {
      private Player player;
      private Level level;

      public Game build() {
         return new Game(player, level);
      }
   }
}
```

Static builder class

```
public class Game {
    private final Player player;
    private final Level level;

    public Game(Player player, Level level) {
        this.player = player;
        this.level = level;
    }

    public static class Builder {
        private Player player;
        private Level level;

        public Builder setPlayer(Player player) {
            this.player = player;
            return this;
        }
        public Builder setLevel(Level level) {
            this.level = level;
            return this;
        }
        public Game build() {
            return new Game(player, level);
        }
    }
}
```

Usage:

```java
public static void main(String[] args) {
  Game game = Game.builder()
        .setLevel(new Level())
        .setPlayer(new Player())
        .build();
}
```

Static builder class

```java
public class Game {
    private final Player player;
    private final Level level;

    public Game(Player player, Level level) {
        this.player = player;
        this.level = level;
    }

    public static class Builder {
        private Player player;
        private Level level;

        public Builder setPlayer(Player player) {
            this.player = player;
            return this;
        }
        public Builder setLevel(Level level) {
            this.level = level;
            return this;
        }
        public Game build() {
            return new Game(player, level);
        }
    }
}
```

Duplication

Inner builder class

```
public class Game {
   private ~~final~~ Player player;
   private ~~final~~ Level level;

   private Game() {}
}
```

Inner builder class

```
public class Game {
  private Player player;
  private Level level;

  private Game() {}

  public static Builder builder() {
      return new Game().new Builder();
  }

  public class Builder {

  }
}
```

Inner builder class

```
public class Game {
    private Player player;
    private Level level;
    private Game() {}

    public static Builder builder() {
         return new Game().new Builder();
     }

    public class Builder {
        private Builder() {}

        public Builder setPlayer(Player player) {
            Game.this.player = player;
            return this;
        }

        public Builder setLevel(Level level) {
            Game.this.level = level;
            return this;
        }

        public Game build() {
            return Game.this;
        }
    }
}
```

Inner builder class

```java
public class Game {
    private Player player;
    private Level level;
    private Game() {}

    public static Builder builder() {
         return new Game().new Builder();
     }

    public class Builder {
        private Builder() {}

        public Builder setPlayer(Player player) {
            Game.this.player = player;
            return this;
        }

        public Builder setLevel(Level level) {
            Game.this.level = level;
            return this;
        }

        public Game build() {
            return Game.this;
        }
    }
}
```

Does not create new object on each build() call

Inner builder class + Cloneable

```
public class Game implements Cloneable {

  private Game() {}

  public Game clone() {
    Game game;
    try {
      game = (Game) super.clone();
      // clone mutable instance fields if needed
    } catch (CloneNotSupportedException e) {
      e.printStackTrace();
      throw new RuntimeException();
    }
    return game;
  }
}
```

Inner builder class + Cloneable

Before

```java
public Game build() {
  return Game.this;
}
```

After

```java
public Game build() {
  return Game.this.clone();
}
```

Usage:

```
public static void main(String[] args) {
   Game game = Game.builder()
         .setLevel(new Level())
         .setPlayer(new Player())
         .build();
}
```

VS.

```
public static void main(String[] args) {
   Game game = new Game(new Player(), new Level());
}
```

VS.

```
public static void main(String[] args) {
   Game game = new Game();
   game.setPlayer(new Player());
   game.setLevel(new Level());
}
```

Pattern types

Creational Patterns

Behavioural Patterns

Structural Patterns

- Chain of responsibility
- Command
- Interpreter
- Iterator
- Mediator
- Memento
- Observer
- State
- Strategy
- Template Method
- Visitor

Pattern types

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Structural Patterns

Chain of responsibility
Command
Interpreter
Iterator
Mediator
Memento
Observer
State
Strategy
Template Method
Visitor

Chain of responsibility

The chain-of-responsibility is a design pattern consisting of a source of command objects and a series of processing objects. Each processing object contains logic that defines the types of command objects that it can handle; the rest are passed to the next processing object in the chain. A mechanism also exists for adding new processing objects to the end of this chain

Chain of responsibility

The idea is to *process the message by yourself or to redirect it to someone else.*

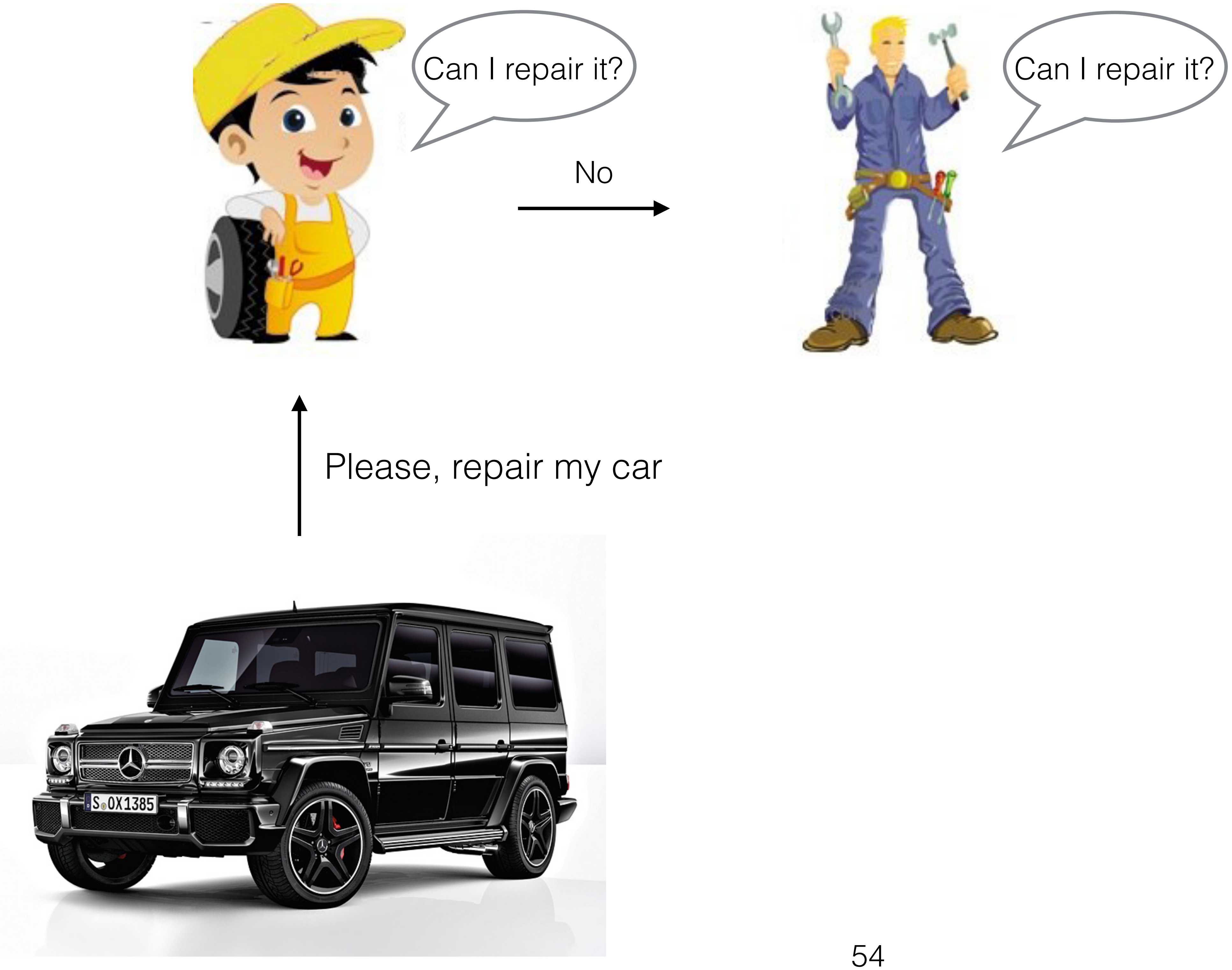
Chain of responsibility

You need to repair a car

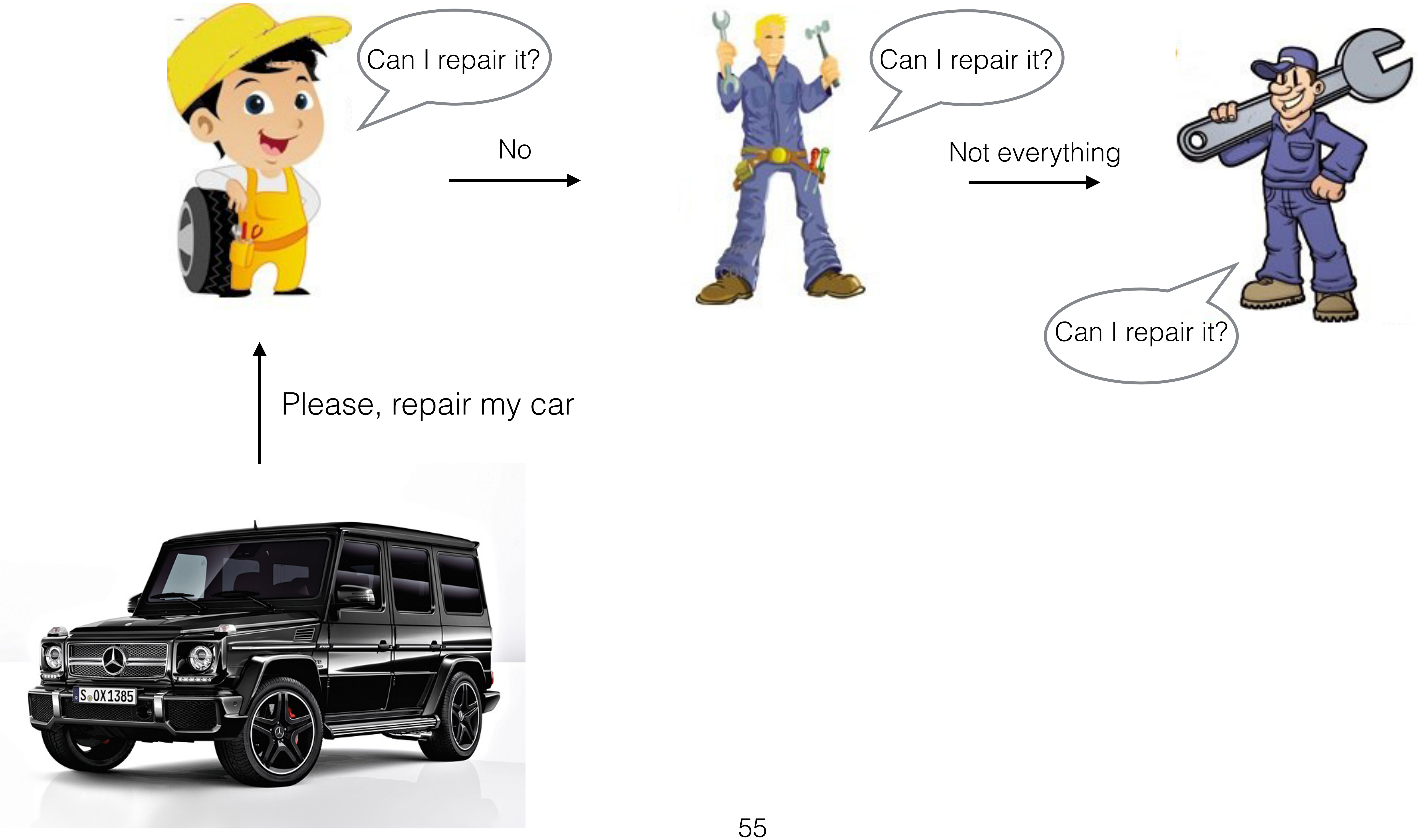
Chain of responsibility

Please, repair my car

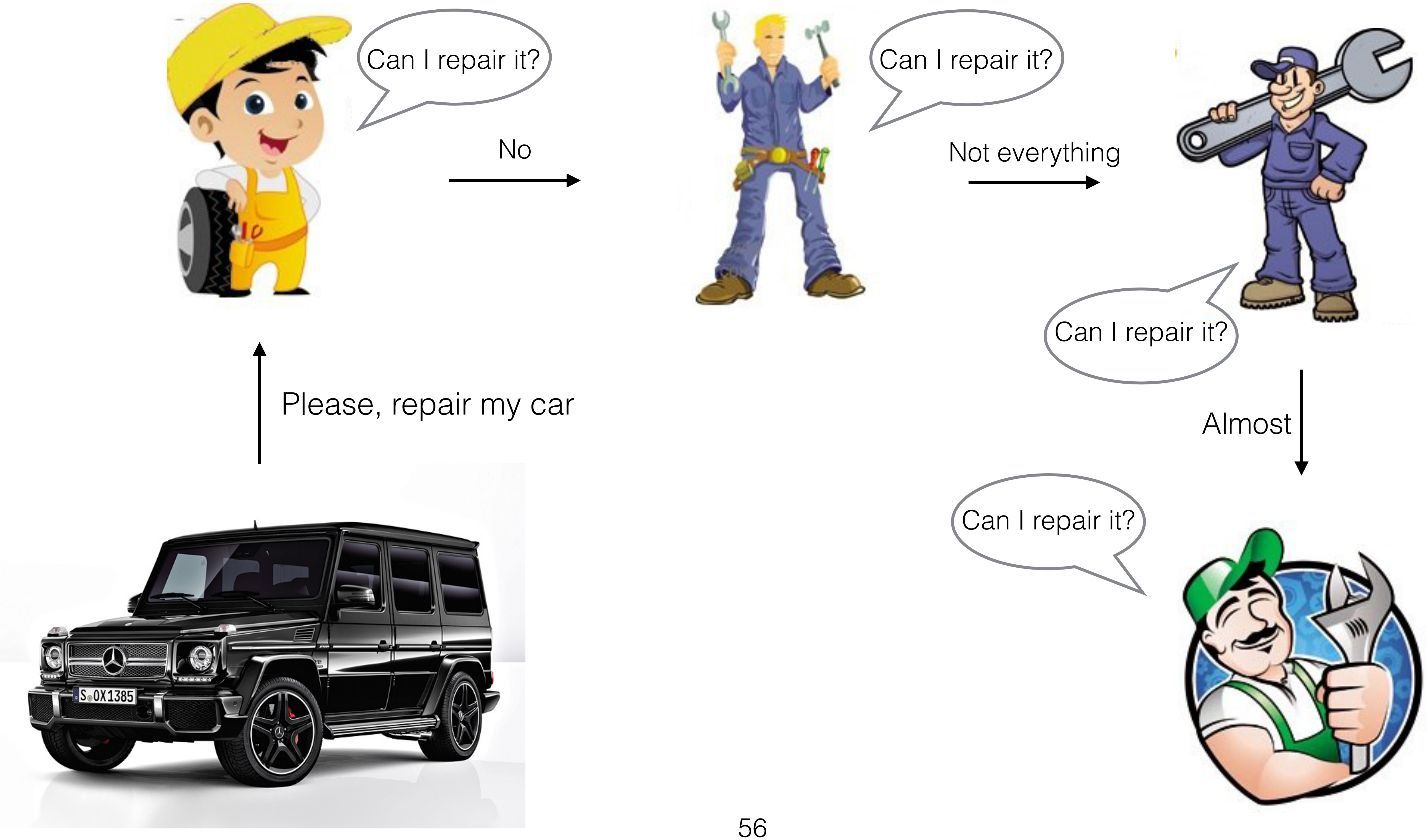
Chain of responsibility



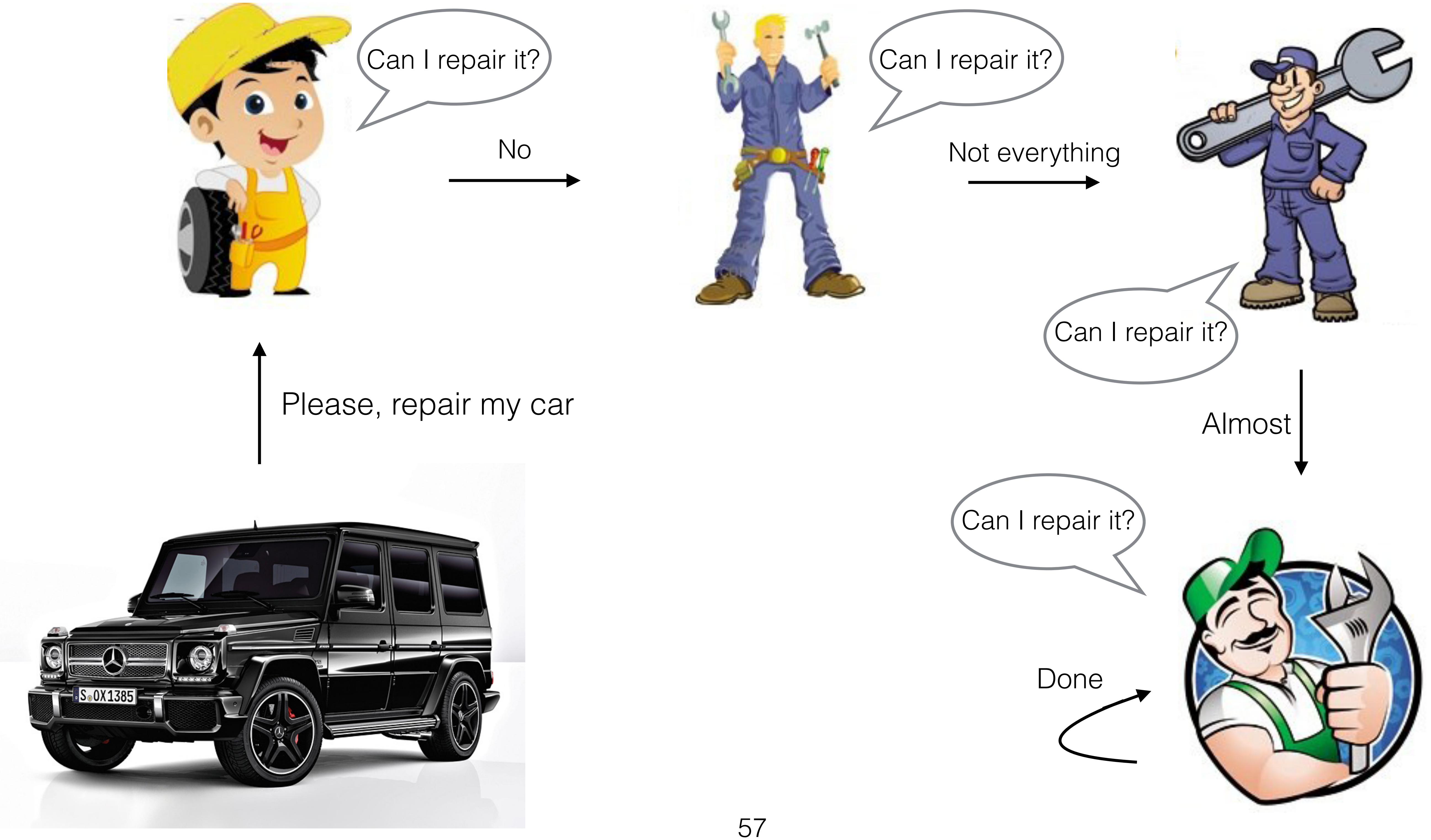
Chain of responsibility



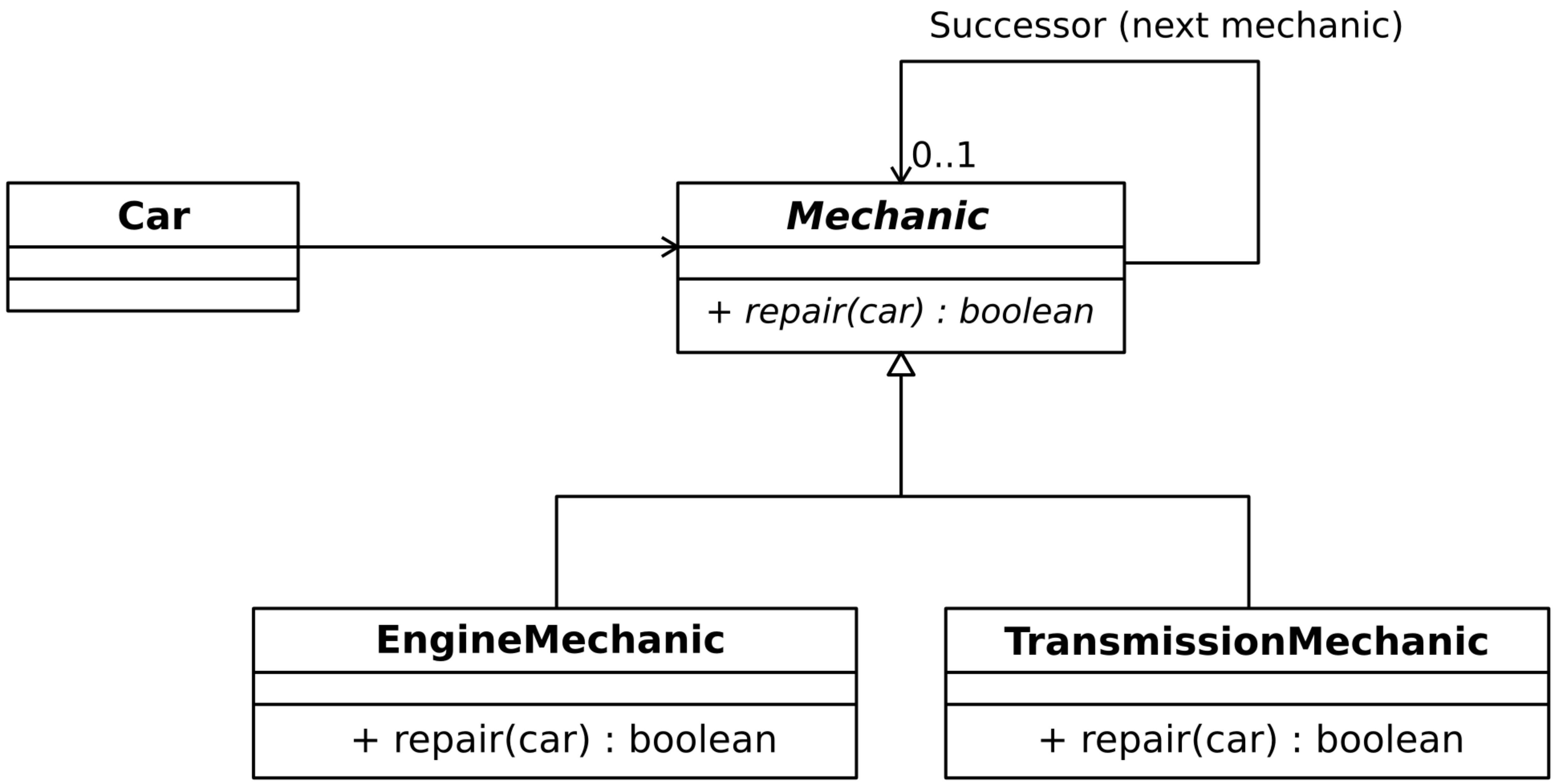
Chain of responsibility



Chain of responsibility



Chain of responsibility



Pattern types

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- Observer
- State
- Strategy
- Template Method
- Visitor

The ***visitor pattern*** provides an ability to add new operations to existing object structures without modifying those structures

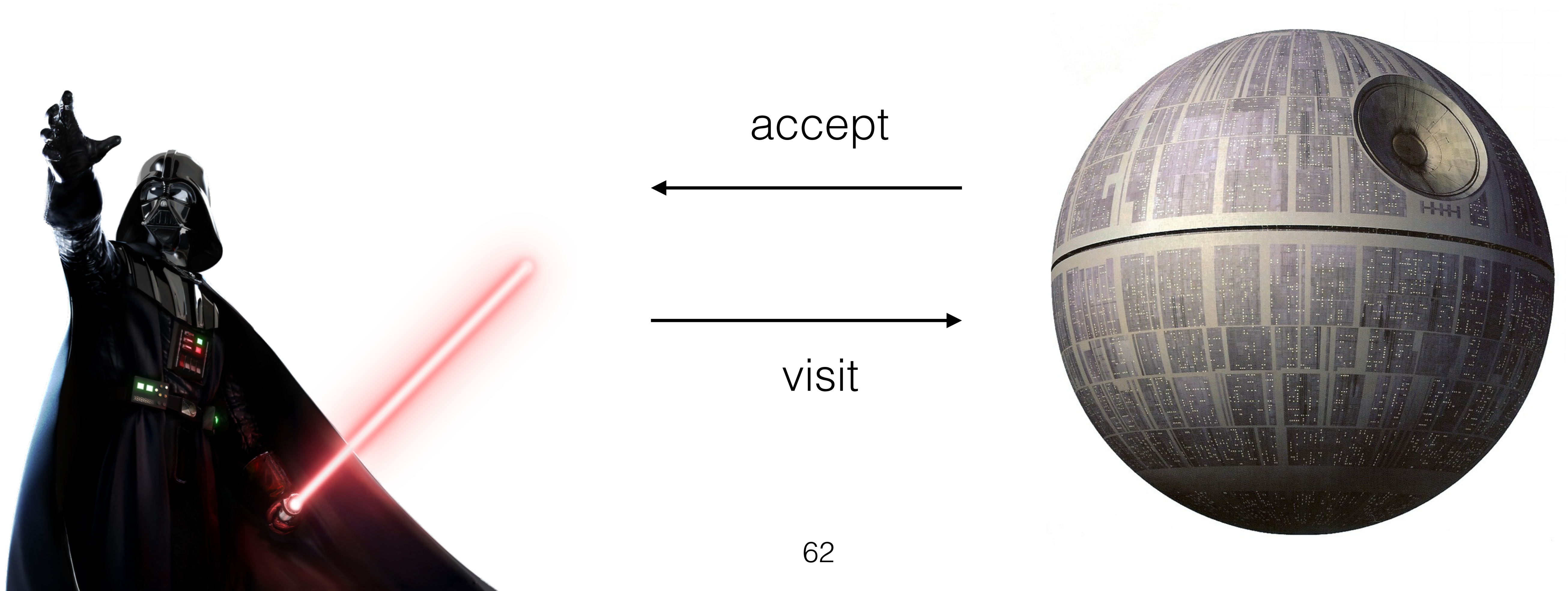
Visitor

Help Darth Vader to check the dislocation of his forces.

Visitor

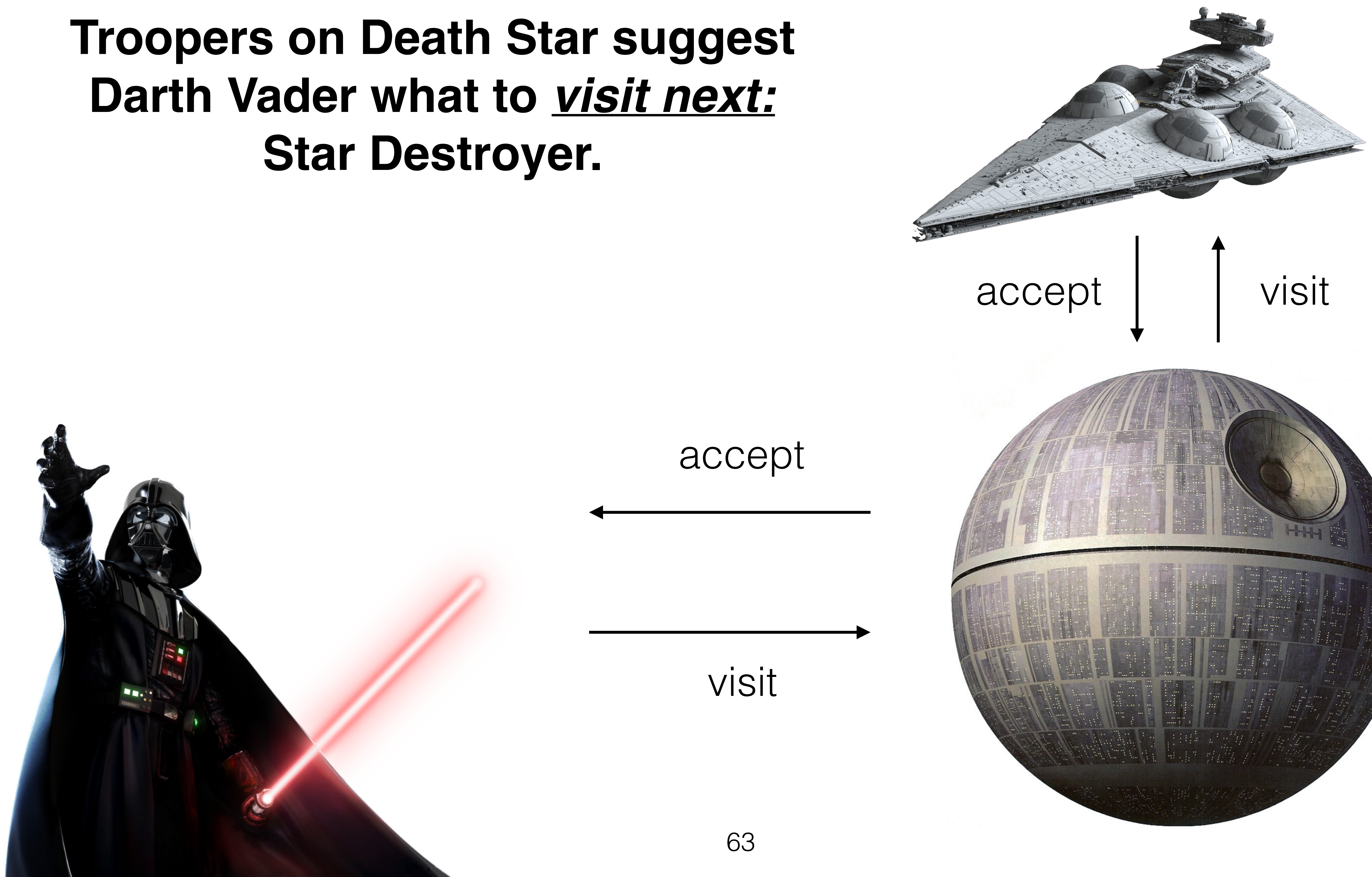
!!!

1. **Death Star *accepts* Darth Vader.**
2. **Darth Vader *visits* Death Star.**



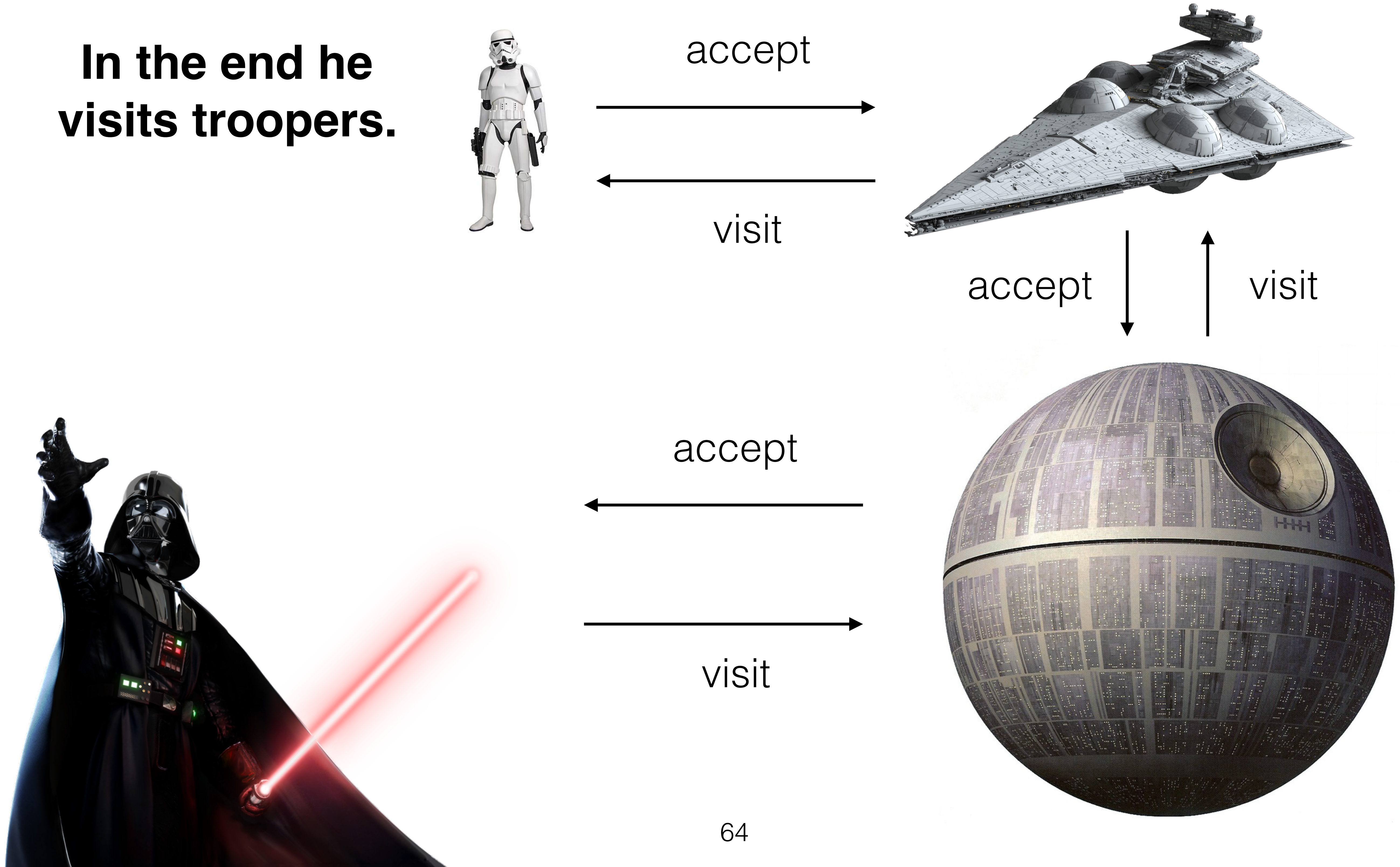
Visitor

Troopers on Death Star suggest Darth Vader what to *visit next:* Star Destroyer.

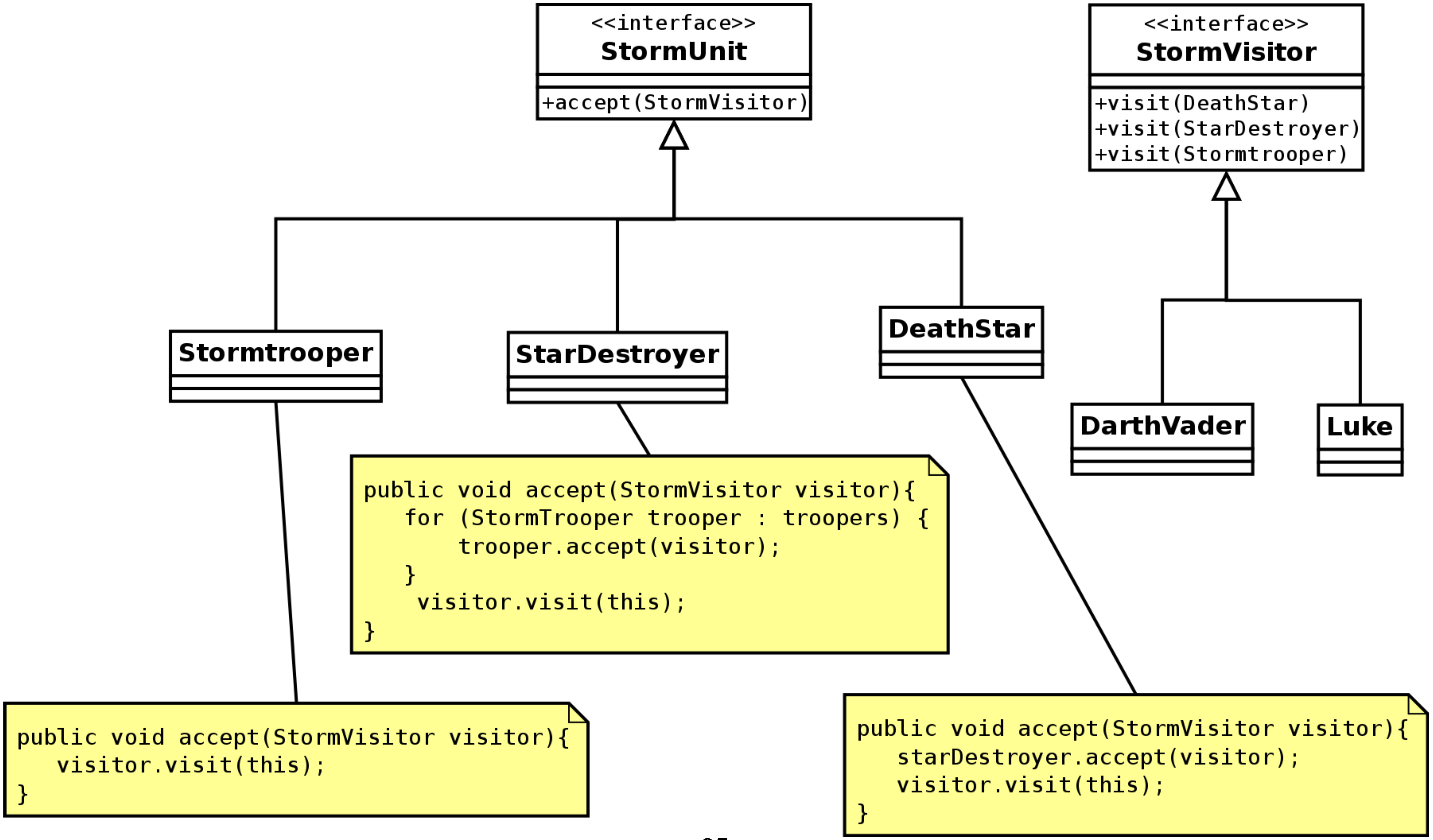


Visitor

In the end he visits troopers.



Visitor



```
public void accept(StormVisitor visitor){
   for (StormTrooper trooper : troopers) {
       trooper.accept(visitor);
   }
    visitor.visit(this);
}
```

```
public void accept(StormVisitor visitor){
   visitor.visit(this);
}
```

```
public void accept(StormVisitor visitor){
   starDestroyer.accept(visitor);
   visitor.visit(this);
}
```

Pattern types

Creational Patterns

Behavioural Patterns

Structural Patterns

- Adapter
- Bridge
- Composite
- Decorator
- Facade
- Flyweight
- Proxy

Pattern types

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- Flyweight
- Proxy

The composite pattern lets a client to treat a group or a single instance uniformly.

(to have the same interface)

Composite

Darth Vader wants to control one trooper or a group of troopers *in the same way*

Composite

… or even groups of groups of troopers

Composite

Darth Vader doesn't care how many troopers to control - one or many

```
public interface StormUnit {
  public void fight();
}
```

```java
public interface StormUnit {
   public void fight();
}
```

```java
public class Stormtrooper implements StormUnit {




}
```

```java
public interface StormUnit {
   public void fight();
}
```

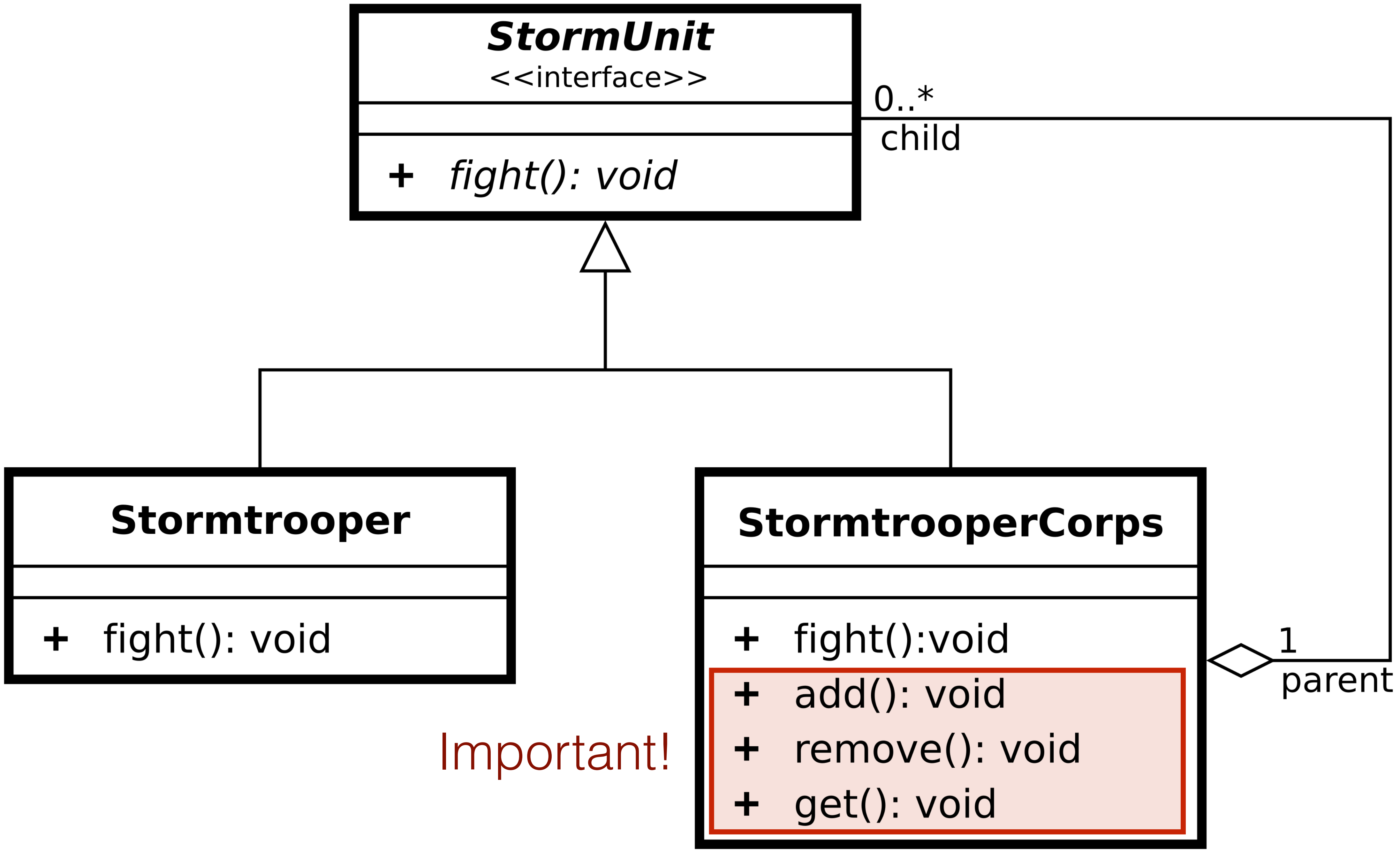
```java
public class Stormtrooper implements StormUnit {
   @Override
   public void fight() {
      System.out.println("Yes, sir!");
   }
}
```

```java
public class StormGroup implements StormUnit {
  private ArrayList<StormUnit> stormUnits = new ArrayList<>();









}
```

```java
public class StormGroup implements StormUnit {
   private ArrayList<StormUnit> stormUnits = new ArrayList<>();

   @Override
   public void fight() {
      System.out.println("Group is ready, sir!");
      for (StormUnit stormUnit : stormUnits) {
         stormUnit.fight();
      }
   }









}
```

```java
public class StormGroup implements StormUnit {
   private ArrayList<StormUnit> stormUnits = new ArrayList<>();

   @Override
   public void fight() {
      System.out.println("Group is ready, sir!");
      for (StormUnit stormUnit : stormUnits) {
         stormUnit.fight();
      }
   }

   public void addStormUnit(StormUnit aStormUnit) {
      stormUnits.add(aStormUnit);
   }

   public void removeStormUnit(StormUnit aStormUnit) {
      stormUnits.remove(aStormUnit);
   }

   public void getStormUnit(int index) {
      stormUnits.get(index);
   }
}
```

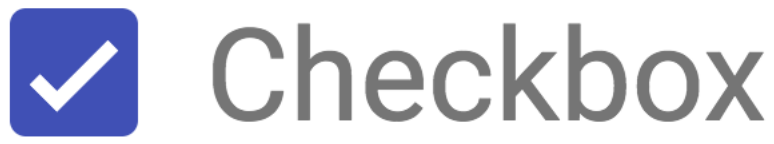
Composite



StormUnit
<<interface>>
+ fight(): void
0..*
child
Stormtrooper
+ fight(): void
StormtrooperCorps
+ fight():void
+ add(): void
+ remove(): void
+ get(): void
1
parent
Important!

UI Components (Checkbox)

Material Design Light for Web
(getmdl.io)



UI Components (Checkbox)

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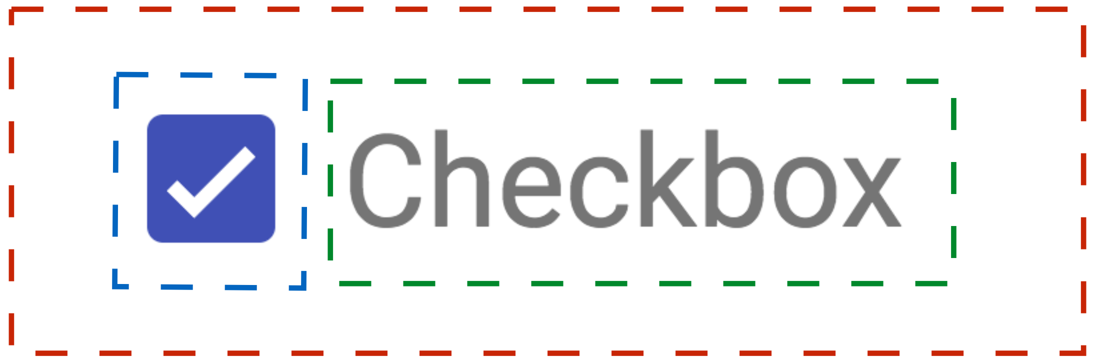
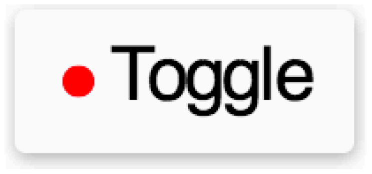


```
<label for="chkbox1">
  <input type="checkbox" id="chkbox1">
  <span>Checkbox</span>
</label>
```

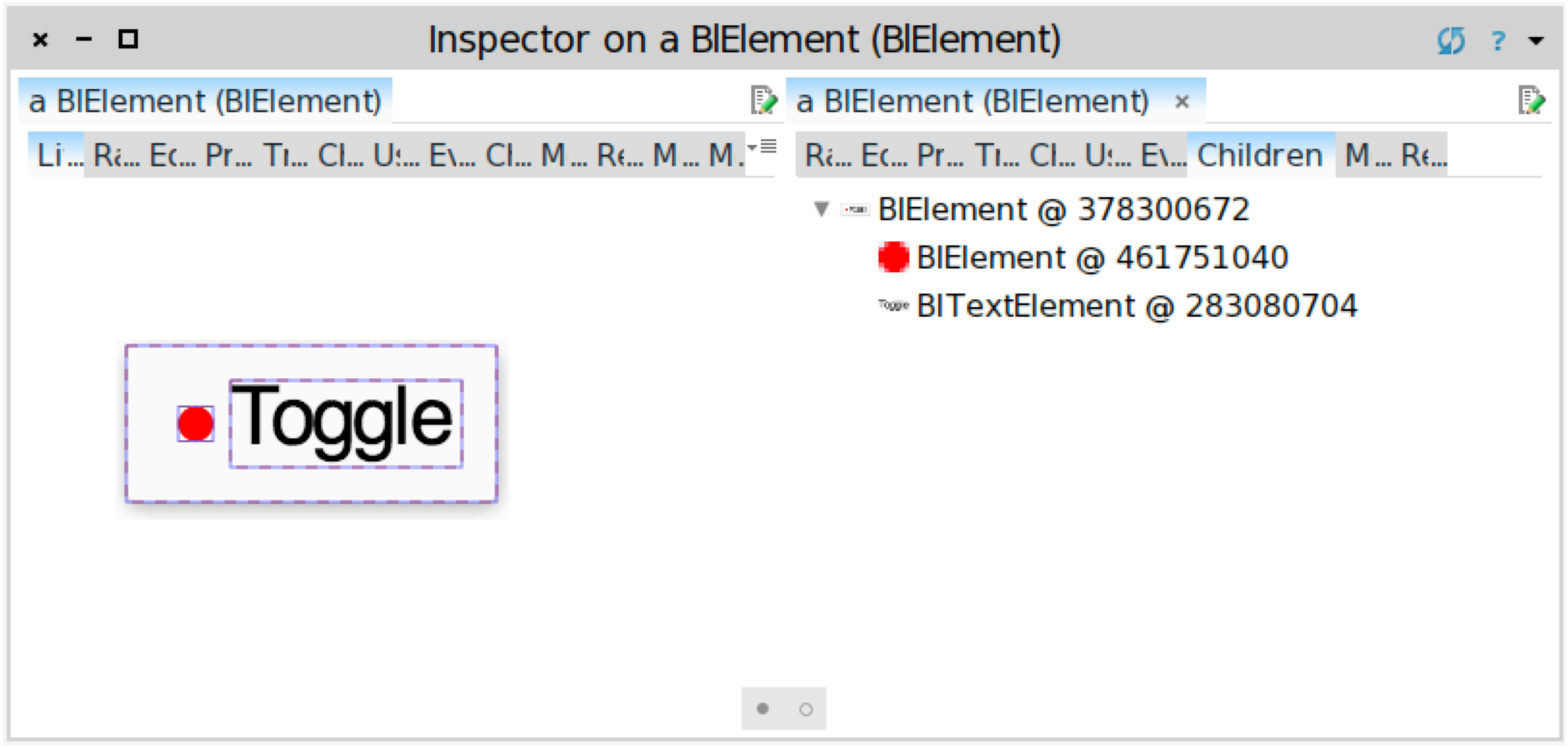
UI Components (Toggle)

Bloc for Pharo
(pharo.org)



UI Components (Checkbox)

Bloc for Pharo
(pharo.org)


Inspector on a BlElement (BlElement)
a BlElement (BlElement)
a BlElement (BlElement)
Li... Ra... Ec... Pr... Tr... Cl... Us... Ev... Cl... M... Re... M... M...
Ra... Ec... Pr... Tr... Cl... Us... Ev... Children M... Re...
BlElement @ 378300672
BlElement @ 461751040
BlTextElement @ 283080704
Toggle

The End.