Interfaces in Java 8

- *Functional interface*: a special type of interface that has a single ***abstract*** (or empty) method.
  - *Non-static* and *non-default* method
- Before Java 8, all methods defined in an interface were abstract.
  - `public interface Foo{ public void Boo() }`
  - `public interface Comparator<T>{ public int compare(T o1, T o2) }`
  - No methods could have their bodies (ipmls) in an interface.
- Java 8
  - Introduces ***2 extra types*** of methods to interfaces: ***static*** *methods* and ***default*** *methods*.
  - Calls traditional abstract/empty methods as *abstract methods*.
- `Comparator<T>` in Java 8 has…
  - one abstract method (`compare()`)
  - many *static* and *default* methods.

Abstract Interface Methods

- Java 8 introduces the keyword `abstract`.
  - ```
    public interface Foo{
        public abstract void Boo()
    }
    ```
  - `abstract` can be omitted.
    - ```
      public interface Comparator<T>{
          public int compare(T o1, T o2)
      }
      ```
    - ```
      public interface Comparator<T>{
          public abstract int compare(T o1, T o2)
      }
      ```


Static Interface Methods

- ```
  public interface I1{
      public static int getValue(){ return 123; } }
  ```
- `I1.getValue();` // Returns 123.
- `public interface I2 extends I1{}`
- `I2.getValue();` // I2 does not inherit getValue(). Compilation error.
- ```
  public interface I2 extends I1{}
      public static int getValue(){ return 987; } }
  ```
- `I2.getValue();` // I2 can override getValue(). Returns 987.
- `public class C1 implements I1{}`
- `C1.getValue();` // Results in a compilation error.

- Can call a static method of an interface without a class that implements the interface.
  - Classes never implement/have static interface methods.

Default Interface Methods

- ```
  public interface I1{
      public default int getValue(){ return 123; } }
  ```
- `I1.getValue();` // Cannot call it like a static method. Compilation error.
- `public class C1 implements I1{}`
- ```
  C1 c = new C1();
  c.getValue();   // Returns 123.
  ```
- ```
  public interface I2 extends I1{}
  public class C2 implements I2{}
  C2 c = new C2();
  c.getValue();   // I2 inherits getValue(). Returns 123.
  ```
- ```
  public interface I2 extends I1{
      public default int getValue(){ return 987; } }
  public class C2 implements I2{}
  C2 c = new C2();
  c.getValue();   // I2 can override getValue(). Returns 987.
  ```
- ```
  public class C1 implements I1{
      public int getValue(){ return 987; } }
  C1 c = new C1();
  c.getValue();   // C1 can override getValue(). Returns 987.
  ```

- ```
  public interface I1{
      public default int getValue(){ return 123; } }
  public class C1{
      public int getValue(){ return 987; } }
  public class C2 extends C1 implements I1{}
  ```
- ```
  C2 c = new C2();
  c.getValue();     // Returns 987.
  ```

- **Precedence rule:** The super class's method precedes an interface's default method.

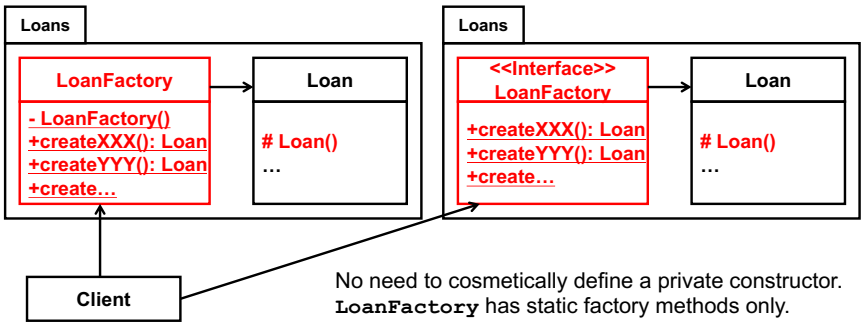
- ```
  public class C2 extends C1 implements I1{
      public int getValue(){
          return I1.super.getValue(); } }
  ```
- ```
  C2 c = new C2();
  c.getValue(); // Returns 123.
  ```
  – You can call an interface's default method.

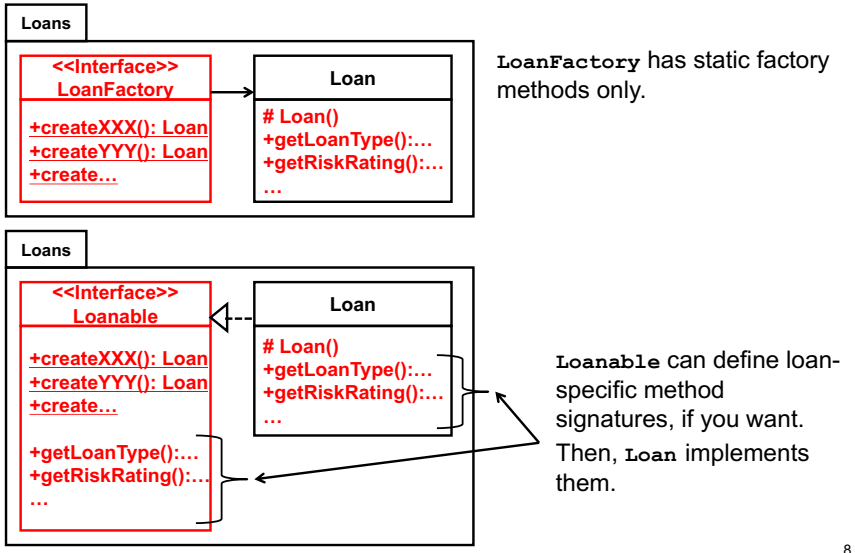

- ```
  public interface I1{
      public default int getValue(){ return 123; } }
  public interface I2 {
      public default int getValue(){ return 987; } }
  public class C1 implements I1, I2{}     // Compilation error.
  ```
  – Default methods from different interfaces conflict.

- ```
  public class C1 implements I1, I2{
      public int getValue(){
          return I1.super.getValue(); } }    // Returns 123.
  ```


Examples: Static Interface Methods

- Static factory methods to create an object that implements an interface.
- They can be implemented as static interface methods.





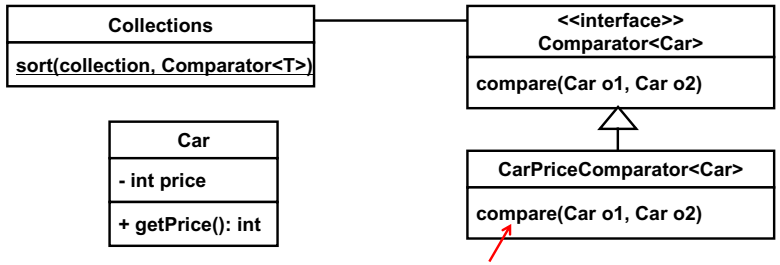
Static Methods in Comparator

- `java.util.Comparator<T>` has…
  - one abstract method (`compare()`) and
  - many *static* and default methods.
  - `static Comparator<T> comparing(Function<T, R> keyExtractor)`
    - Accepts a function that extracts a `Comparable` sort key from `T`
      - Sort key (`R`): data/value to be used in ordering/sorting
      - `Function<T, R>`
        - » Represents a function (LE) that accepts a parameter (T) and returns a result (R).
        - » A functional interface whose abstract method is: `R apply(T t)`.
    - Returns a `Comparator<T>`

```
class Car{ private int getPrice(); }
Collections.sort(carList, Comparator.comparing(
                              (Car car)-> car.getPrice() );
                          //comparing() returns a Comparator<Car>
```

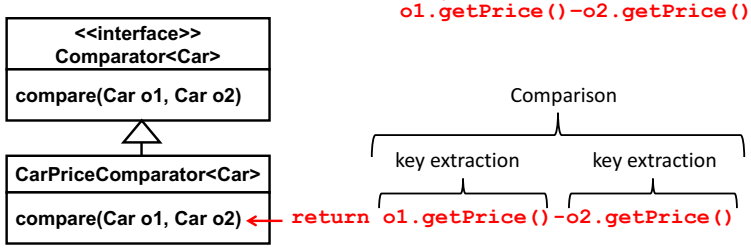


```
class Car{
  private int getPrice(); }
Collections.sort(carList,
                 Comparator.comparing(
                     (Car car)-> car.getPrice() );
Collections.sort(carList,
                 (Car o1, Car o2)->
                     o1.getPrice()-o2.getPrice())
```



- What `Comparator.comparing()` does is to
  - Transform a *key extraction function* to a *comparison function*
- *Higher-order function*
  - Accepts a function as a parameter and produces/returns another function as a result

```
class Car{ private int price;
           public int getPrice();}
Collections.sort(carList,
                 Comparator.comparing(
                     (Car car)-> car.getPrice() );
Collections.sort(carList,
                 (Car o1, Car o2)->
                     o1.getPrice()-o2.getPrice());
```



Benefits of Using Lambda Expressions

- Can make your code more concise (less repetitive)
  - This may or may not mean "easier to understand" depending on how much you are used to lambda expressions.
- Can enjoy the power of functional programming
  - e.g., higher-order functions
- Can gain a new way to access collections
  - "Internal" iteration as opposed to traditional "external" iteration
    - Enables Map-Reduce data processing (a topic in CS681)
- Can simplify concurrent programming (multi-threading) in Java
  - A topic in CS681

A Bit More about Comparator

- `class Car{ public int getPrice();}`
  `Collections.sort(carList,`
  `Comparator.comparing(`
  `(Car car)-> car.getPrice() );`
- `Collections.sort(carList,`
  `Comparator.comparing( Car::getPrice ) );`

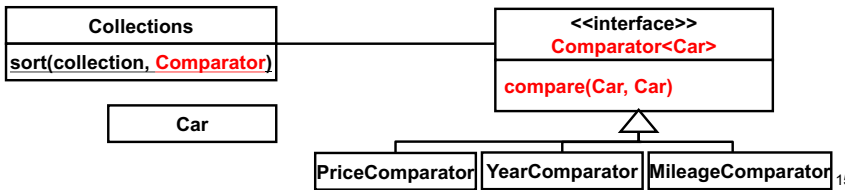
- *Method references* in lambda expressions
  - *object::method*
    - `System.out::println`
      - `System.out` contains an instance of PrintStream.
    - `(int x) -> System.out.println(x)`
  - *Class::staticMethod*
    - `Math::max`
    - `(double x, double y) -> Math.max(x, y)`
  - *Class::method*
    - `Car::getPrice`
    - `(Car car)-> car.getPrice()`
    - `Car::setPrice`
    - `(Car car, int price)-> car.setPrice(price)`

- `class Car{ public int getPrice();}`
  `Collections.sort(carList,`
  `Comparator.comparing(`
  `(Car car)-> car.getPrice() );`
- `Collections.sort(carList,`
  `Comparator.comparing( Car::getPrice ) );`
- `Collections.sort(carList,`
  `(Car o1, Car o2)->`
  `o1.getPrice()-o2.getPrice());`
  - Ascending order (natural order) by default

- What if you want *descending ordering* with `comparing()`?
  - `Collections.sort(carList,`
    `Comparator.comparing(Car::getPrice,`
    `Comparator.reverseOrder() );`
  - `Collections.sort(carList,`
    `Comparator.comparing(Car::getPrice,`
    `Comparator.naturalOrder() );`
  - `Collections.sort(carList,`
    `Comparator.comparing(Car::getPrice).reversed() );`

HW 12 (Optional)

- Work on HW 6 with lambda expressions, NOT with 3 classes that implement `Comparator`.
  - Implement the Car class
    - `class Car{`
      `public int getPrice();`
      `public int getYear();`
      `public float getMileage(); }`
  - Instead of defining 3 classes, define the body of each `compare()` method as a lambda expression and pass it to `Collections.sort()`.



- Pass 3 different lambda expressions to `Collections.sort()`
  - `Collections.sort(carList,`
    `(Car car1, Car car2)->{ ... } );`
    `Collections.sort(carList,`
    `(Car car1, Car car2)->{ ... } );`
  - `Collections.sort(carList,`
    `(Car car1, Car car2)->{ ... } );`
  - Use `Comparator.comparing()`, if you like. You will get an extra point.

- Create several `Car` instances and sort them with each lambda expression.
  - Minimum requirement: ascending order (natural order)
  - [Optional] Do descending ordering as well with `reverseOrder()` or `reserved()` of `Comparator`.
  - [Optional] Implement Pareto comparison with a lambda exp.

- Due: December 24 midnight