MODULE 07: INTERFACES AND COLLECTIONS

Professor : Dave Houtman

Office: T323

Office Hrs: Wednesday 14:15 – 15:30
Wednesday (after lecture*)

* confirm beforehand

Email: houtmad@algonquincollege.com

7.0 What is an interface?

Each reference type falls into one of three categories, shown below:

a) (arrays)
b) Classes
c) Interfaces

Simple *arrays* form the first type. They may be thought of as primitive versions of full-blown *classes*, which make up the second category of reference types.

In this module we explore the last of these three types, **interfaces**.

7.0 What is an interface?

Before addressing the question of what an interface *is*, recall the effect of the word `abstract` when used with classes and methods:

- *An abstract class is a class that cannot be instantiated*. You must inherit from it first using `extends`; the subclass can then be instantiated. An abstract class's *methods* may or may not be abstract, but a single abstract method will automatically make its class abstract.

  But the class can also be abstract *without* any of its methods being abstract. The concrete methods of an abstract class will be inherited by the subclass(es) and can be used the same as if inherited from a regular (concrete) superclass.

- *An abstract method must be overridden in its first concrete subclass*. In other words if the subclass is abstract, then you are *not* required to override abstract methods inherited from the superclass. But the first non-abstract class in a hierarchy of abstract subclasses must override the abstract methods it inherits.

7.0 What is an interface?

The two most important features of an interface are:

1. An interface is treated like a special kind of class in Java, one that consists *entirely of constants and abstract methods*. Therefore

    a) it cannot be instantiated. As with an abstract class, there's no such things as a `new` interface; and

    b) *all* of its methods must be overridden in the first concrete subclass

2. An interface acts like something of a contract; once you specify that a class **implements** an interface, you are guaranteeing that that class *must* contain concrete versions of every method specified in the interface. And then any instance of that class is guaranteed to have those features.

So the purpose of an interface is to declare a common set of behaviours for its derived classes, and therefore, any objects instantiated them. Any concrete class that implements an interface is guaranteed to fulfill a particular set of requirements, as specified by the interfaces methods. And if you code implements an interface, then *you* must overload all the interface's methods with your own.

7.0 What is an interface?

The form of an interface is thus:

```
[access modifier] interface interfaceName {

   public static final fieldIdentifier1;    // constant properties
   public static final fieldIdentifier2;
   ...
   public abstract returnType methodIdentifier1();   //methods
   public abstract returnType methodIdentifier2();
   ...
}
```

Example:

```
public interface Comparable<E> {
   public abstract int compareTo(E o); // one method only
}
```

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7.0 What is an interface?

When a class implements this interface, e.g.

```
public class MyNewClass implements Comparable<String>
```

then that class will need to implement the abstract method `compareTo()`, which is parameterized (in this case) with the `String` type. So `MyNewClass` will need to provide its own version of `compareTo()`:

```
@Override
public int compareTo(String str){
   … // insert comparison code here
}
```

7.1 Abstract Classes v. Interfaces

In almost every way, you can treat an interface like a class with abstract methods:

- As with abstract classes, you cannot instantiate a new object from an interface using the `new` operator;
- You must import interfaces the same way as you do for classes using, e.g. `import java.classname.*`
- You can use an interface as a data type in the declaration of identifiers, arrays, and parameters passed to functions
- Since *every* method in an interface is abstract, *every* method must be overridden in the derived class…unless the derived class is abstract
- You can use an interface for casting
- Just as classes inherit via *class inheritance*, interfaces inherit via *interface inheritance*. However, since the two are so similar, we often refer to both as just *inheritance*, thus inferring that this may involve either classes *or* interfaces. Rather than sub- and superclasses, we have subinterfaces and superinterfaces

7.1 Abstract Classes v. Interfaces

- Because an interface contains nothing but constants and abstract methods, you do not need to explicitly use the words `public static final` and `public abstract` in the declaration of your fields and methods; this is automatically assumed inside an interface. Thus you will see

```
public interface Comparable<E> {
    public int compareTo(E o);
}
```

rather than

```
public interface Comparable<E> {
    public abstract int compareTo(E o);
}
```

…since `abstract` is assumed

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7.1 Abstract Classes v. Interfaces

There are a few differences:

- Interfaces use the word `implements` rather than `extends`. For example, given `InterfaceA`, you can write:

```
public class MyNewClass implements InterfaceA {
    …
}
```

- You can both *implement* a class and *extend* an interface, e.g.

```
public class MyNewClass extends BaseClass
                              implements InterfaceA {
    …
}
```

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7.1 Abstract Classes v. Interfaces

If fact, note that the declaration

```
public class MyNewClass implements InterfaceA {
    …
}
```

is equivalent to

```
public class MyNewClass extends Object
                                  implements InterfaceA{
    …
}
```

- You can add multiple interfaces by separating each interface with a comma:

```
public class MyNewClass implements InterfaceA, InterfaceB {
    …
}
```

7.1 Abstract Classes v. Interfaces

- As noted in the previous example, while a derived class can only extend from *one* base class, it can have *multiple* interfaces. Thus the problem of multiple inheritance *does not apply to interfaces*

- While interfaces are 'implemented' rather than 'extended', nonetheless the form of a bounded generic type for an interface uses 'extends', just as it would for a class. Thus

```
public class MyClass<T extends MyInterface>{
    //...
}
```

- Unlike classes, which descend from `Object`, interfaces have no parent object. However, interfaces are implemented in such a way that they have access to `equals()`, `toString()`, `finalize()`, and `clone()`. See http://stackoverflow.com/questions/13776018/does-an-interface-by-default-extend-object for details

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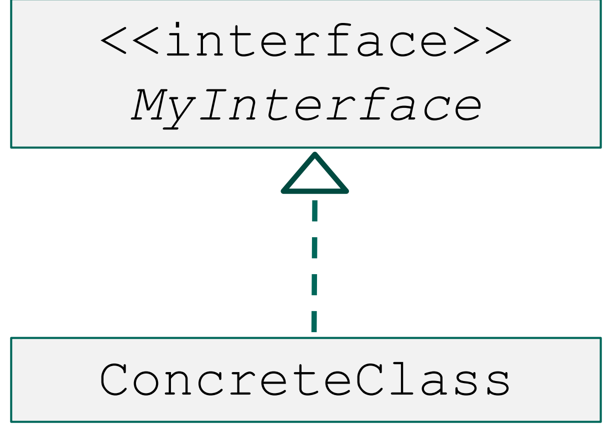
7.1 Abstract Classes v. Interfaces

- As with abstract classes, interface identifiers are italicized in UML. Unlike abstract classes, interface inheritance is symbolized using a dashed line



Note: the double angular brackets, << >> , known as *guimettes*, are sometimes used to signal additional information in UML diagrams. In this case, the notation `<<interface>>` reminds us that we are not dealing with a class.

7.1 Abstract Classes v. Interfaces

You can think of an interface as the purest expression of an abstract class—so pure, in fact, that it doesn't actually define any code itself, it only declares specifications for derived classes.

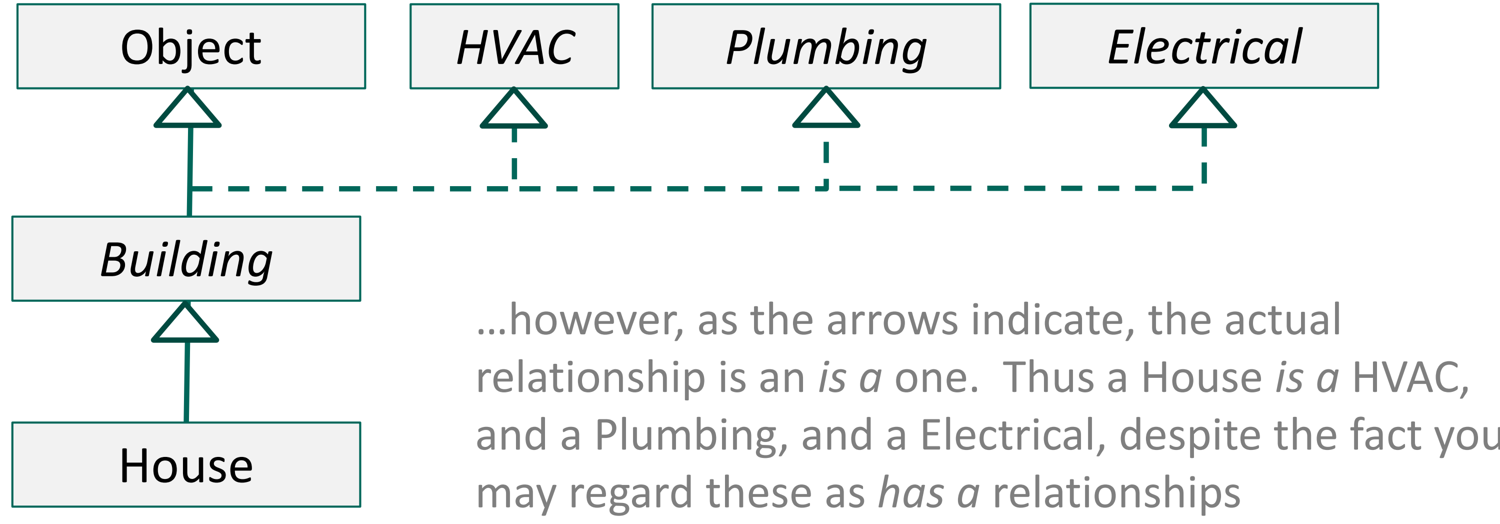
Supertype	Must implement/extend to a concrete class before object instantiation?	Must override *every* base class method in the derived class?
A concrete class	NO	NO
An abstract class with no abstract methods	YES	NO
A class with at least one abstract method	YES	NO only the abstract method(s) in the base class
An interface	YES	YES

7.1 Abstract Classes v. Interfaces

Since an interface looks just like a purely abstract class, a reasonable question to ask is: when should I use one and when should I use the other?

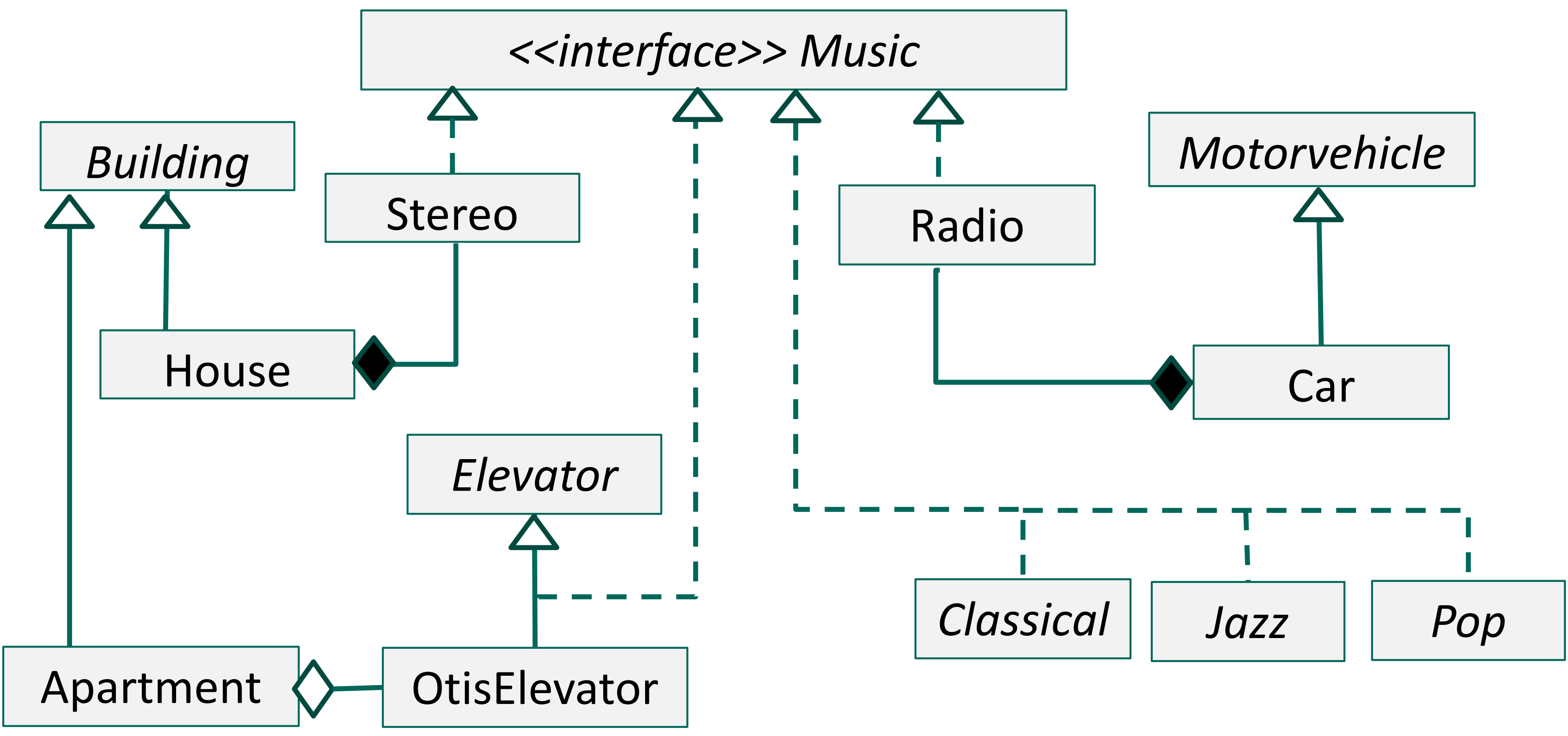
In general, use inheritance from a class when there is a strong *is a* relationship; a dog *is a* animal, a house *is a* building.

Interfaces should be used when there is a weak *is a* relationship, or even an abstract *has a* relationship, especially when a broad specification or behaviour is involved. For example…



7.1 Abstract Classes v. Interfaces

Interfaces are especially useful when one feature or standard can be applied to several different, unrelated classes. Consider the following (somewhat metaphorical) example: while nothing *extends* directly from the *Music* interface, it is an abstract feature that can be *implemented* in many other classes:



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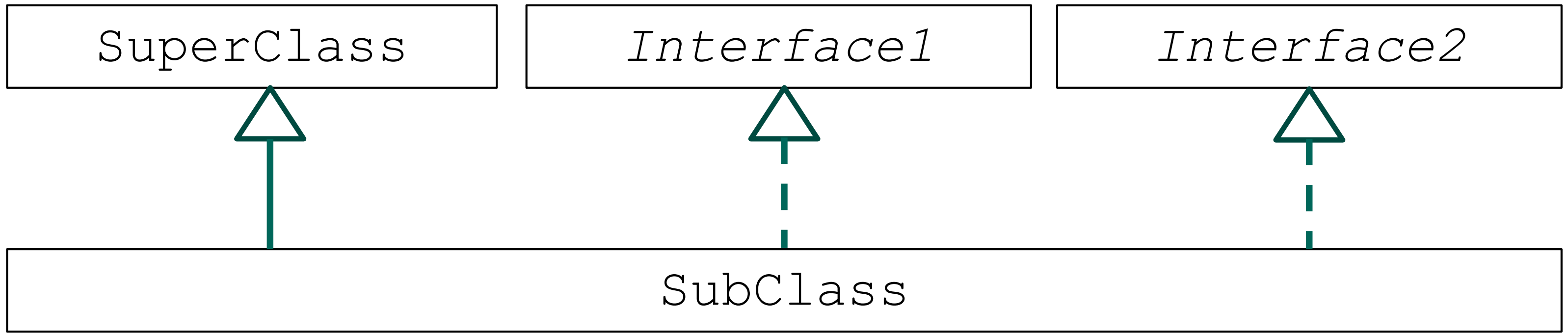
7.1 Abstract Classes v. Interfaces

Of course, it is possible to go overboard implementing interfaces in this way. Some basic features are better left as part of an abstract class, rather than separated into interfaces.

7.2 Implementing Interfaces

When a 'subclass extends a superclass and implements an interface' this means that the subclass has now added the methods specified in the interface to the methods that would normally be available via the parent class (i.e., `SuperClass`, in the case below):



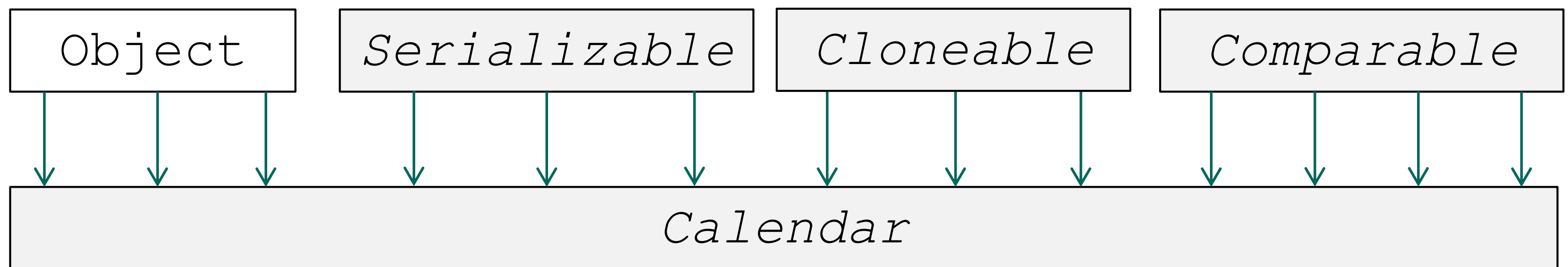
So `SubClass` offers the methods from the `Superclass`, *plus* the methods 'passed down' from the interfaces. If `SubClass` is a concrete class, then it *must* override all the abstract methods it 'inherits' from the interface(s) it implements. And so any instance of `SubClass` will have access to these concrete methods.

7.2 Implementing Interfaces

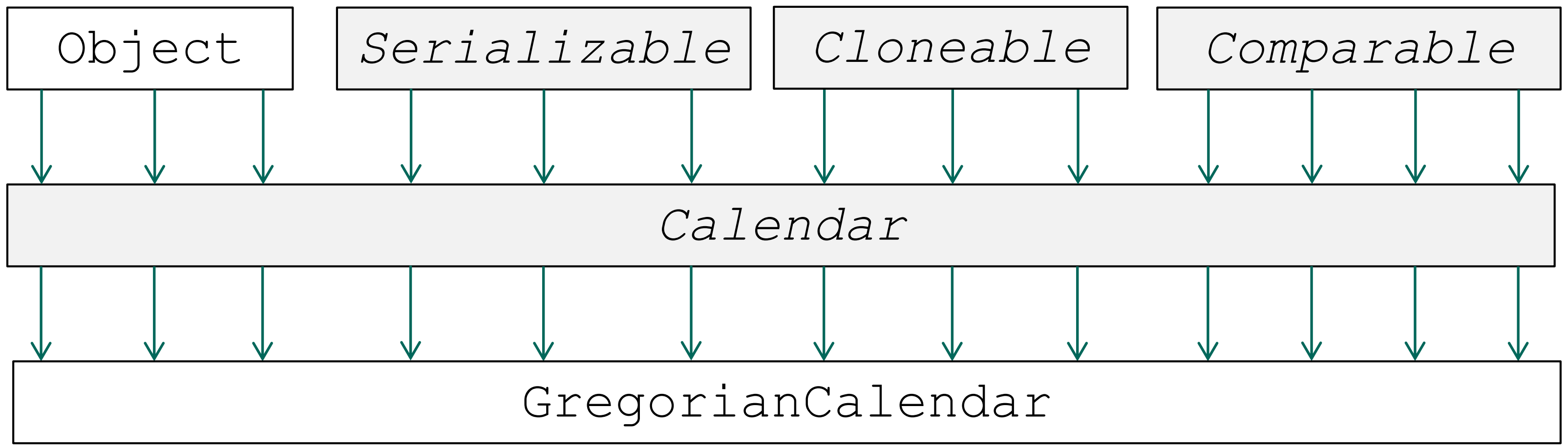
So, for example, in the case of the `Calendar` class

```
public abstract class Calendar
extends Object
implements Serializable, Cloneable, Comparable<Calendar>
```

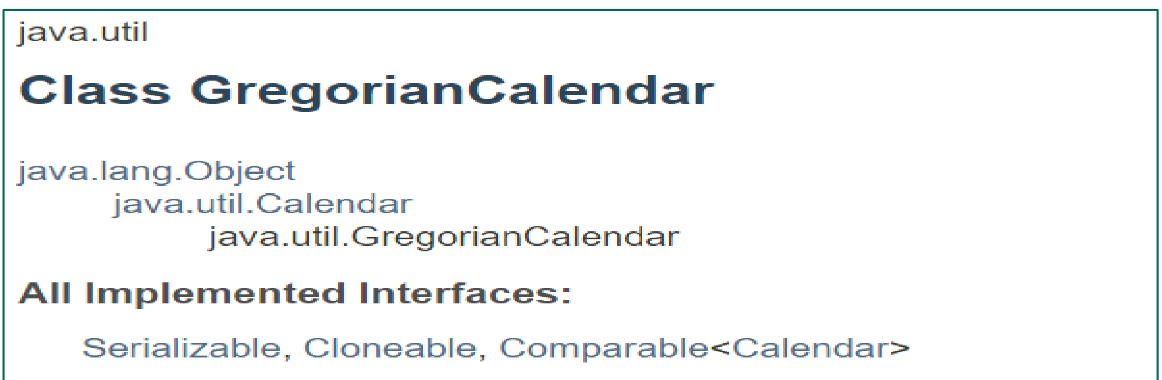
This means that `Calendar` has now added the methods in the `Serializable`, `Cloneable` and `Comparable` interfaces to the methods that would normally be available via `Object`:



7.2 Implementing Interfaces



Any class that extends `Calendar` will have the `Object` class's methods available to it (which may be overridden in `Calendar`), plus the methods of the three interfaces, which are all overridden in `Calendar`.



7.2 Implementing Interfaces

Since the `Calendar` class implements `Comparable`…

```
public abstract class Calendar
extends Object
implements Serializable, Cloneable, Comparable<Calendar>
```

…and `Comparable` contains a single abstract method (seen earlier)…

```
public int compareTo(E o){
    … // insert comparison code here
}
```

…then `Calendar` must perform its own implementation of the `compareTo()` method, designed to check to see if `this` Calendar's date is greater than the `Calendar` date passed as `(E o)`. This method is then made available to the user:

int	compareTo(Calendar anotherCalendar) Compares the time values (millisecond offsets from the Epoch) represented by two Calendar objects.

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7.2 Implementing Interfaces

Another example is `String`...

```
public final class String
extends Object
implements Serializable, Comparable<String>, CharSequence
```

...where again `Comparable` contains the same sole abstract method...

```
    public int compareTo(E o){
        … // insert comparison code here
    }
```

...which String *must* override. So `String` performs its own implementation of the `compareTo()` method, designed to check to see if `this String` object is greater than the `String` object passed as `(E o)`. This then is made available to the user:

int	compareTo(String anotherString) Compares two strings lexicographically.

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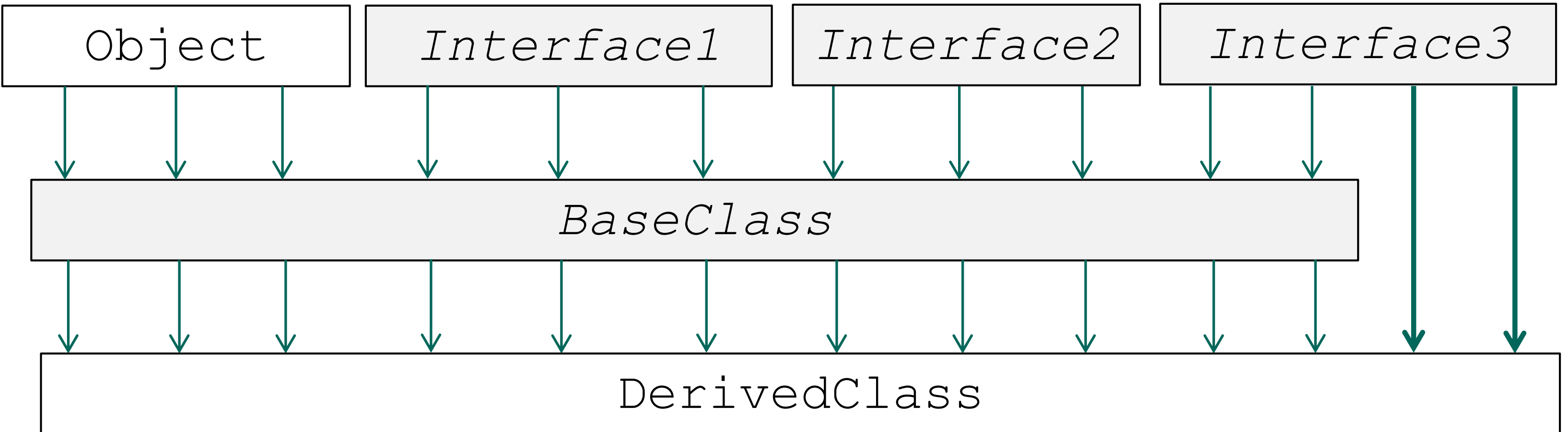
7.3 The `Comparable` and `Comparator` Interfaces

The previous slide, which diagramed the relationship between `Calendar` and `GeorgianCalendar`, reminds us that an `abstract` class is not *required* to override abstract methods supplied by its interfaces. Hence abstract methods may still need to be dealt with in a subclass, if the superclass did not deal with them itself.



7.3 The `Comparable` and `Comparator` Interfaces

Any concrete subclass that implements an interface, such as `Comparable`, will need to override it. So if you implement `Comparable`, *you* must supply your own version of the `compareTo()` method:

```
@Override
public int compareTo(E obj){
   // compare this object with obj here
}
```

...just as `Calendar` and `String` do *internally*, in their code.

7.3 The `Comparable` and `Comparator` Interfaces

Q. Why do I need `compareTo()`? What is it used for?

A. In order to sort objects into some kind of order (for example, in any kind of sortable array, like `Arrays`, or a list, like `ArrayList`), you need to be able to determine whether one object is greater than, less than, or equal to another. `compareTo()` performs this operation by comparing a particular property of two objects. The result of `compareTo()` *must* be:

- A negative value if one object's property is less than another's
- A zero if the two object's properties are equal
- A positive value if one object's property is greater than another's

This numerical value is used by the sorting method to order the contents of the array/list.

Note that different objects are sorted according to different features…

7.3 The `Comparable` and `Comparator` Interfaces

For example, when two `Calendar` objects are compared, the comparison is based on the time, in milliseconds, since Jan. 1, 1970 00:00:00.000 GMT. So the `compareTo()` method in `Calendar` will look something like this:

```
@Override
public int compareTo(E obj){
    return(this.getTimeInMillis() -
                                    obj.getTimeInMillis());
}
```

This returns an integer value less than, greater than, or equal to 0, depending on whether `this` time is less than, greater than, or equal to the `obj`'s time.

7.3 The `Comparable` and `Comparator` Interfaces

The integer returned by `compareTo()` is used to sort Calendar objects. For example, say we have an array of GeorgianCalendar objects:

```
Calendar[] arGC = new GregorianCalendar[10];
arGC[0] = new GregorianCalendar(); // Today's date
arGC[1] = new GregorianCalendar(1900, 1, 24);
arGC[2] = new GregorianCalendar(2042, 12, 31);
arGC[3] = new GregorianCalendar(1968, 11, 27);
// ...etc

Arrays.sort(arGC);  // use compareTo() to sort dates
```

7.3 The `Comparable` and `Comparator` Interfaces

Similarly, `String` has its own version of `compareTo()`, which probably looks something like this:

```
@Override
public int compareTo(E obj){
    int i = 0;
    do{
        c1 = this.charAt(i);
        c2 = obj.charAt(i++);
    } while (c1 == c2);
    return (c1 - c2);
}
```

The loop exits the first time the two characters are not equal. Again, this returns an integer value less than, greater than, or equal to 0, depending on whether `this` string's current character is less than, greater than, or equal to the `obj`' string's equivalent character.

7.3 The Comparable and Comparator Interfaces

So we can load an array Strings and sort them as follows

```
String[] cityNames = new String[]();
cityNames[0] = "Toronto, Canada";
cityNames[1] = "Sydney, Australia";
cityNames[2] = "Paris, France";
cityNames[3] = "Geneva, Switzerland";
// etc…

Arrays.sort(cityName);
```

The `compareTo()` method allows an array to be sorted by supplying an appropriate basis for comparisons to be made between objects. But since Strings, `Calendar`'s, `Integer`'s etc. are different objects, each needs to supply it's own `compareTo()` method, appropriate for the object itself.

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7.3 The `Comparable` and `Comparator` Interfaces

Thus any class that extends `Comparable` guarantees that it has implemented an appropriate `compareTo()` method. The following are all classes that implement `Comparable`, and so must implement its own `compareTo()` method:

```
public class Integer extends Number implements Comparable<Integer> {
   @Override
   public int compareTo(Integer o){
      // Uses the numerical value to return a number for sorting
   }
}
```

```
public class String extends Object implements Comparable<String> {
   @Override
   public int compareTo(String o){
      // Uses the character value to return a number for sorting
   }
}
```

```
public class Date extends Object implements Comparable<Date> {
   @Override
   public int compareTo(Date o){
      // Uses the elapsed time to return a number for sorting
   }
}
```

The above examples are derived from: Liang D. Y. (2014). *Introduction to Java Programming, Comprehensive Version, 10th Ed*. Toronto, ON: Pearson. pp. 509.

7.3 The `Comparable` and `Comparator` Interfaces

Q. What if you build your own classes, and need to be able to sort them?

A. Then your class must implement `Comparable`, and supply your own overridden `compareTo()` method appropriate to the object itself.

7.3 The `Comparable` and `Comparator` Interfaces

For example, assume you have created a `Complex` class designed to instantiate complex numbers. Assume that `Complex` has the method `modulus`, as follows:

```
public double modulus(){
    return Math.sqrt(getReal()*getReal() +
                                getImag()*getImag());
}
```

Say we wish to sort our complex numbers. One (mathematically contentious) way to do this is to compare their moduli, which is essentially a measure of the size of the complex number. Hence we could sort our complex numbers by implementing

```
public class Complex implements Comparable{

    @Override
    public int compareTo(E obj){
        return (this.modulus() - obj.modulus());
    }
    //etc.
```

7.3 The `Comparable` and `Comparator` Interfaces

In addition to Compar**able**, there is another interface that performs much the same function called (somewhat confusingly) Compar**ator**. The definition for Comparator is:

```
public interface Comparator<T>{
    public int compare(T obj1, T obj2);
}
```

So while Comparable allows comparisons between this object with T, Comparator allows for comparisons within the same class.

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7.3 The `Comparable` and `Comparator` Interfaces

Q. Why have two ways to compare objects?

A. As with `Array` and `Arrays`, `String` and `StringBuilder`, etc., there are practical reasons to use one comparison method or the other.

`Comparator` forces you to use the *natural order* of the object: you must compare a particular feature of one object against a feature of an object *of the same class, T*.

With `Comparable`, you can compare features between *two* different classes. You could compare, say, the length of a `String` with the length of a `StringBuilder`. You can't do that with `compare()`, since only one object type, `T`, is available for comparison.

Whether a class implements one or the other interface is up to the designers of that class.

7.3 The `Comparable` and `Comparator` Interfaces

A. (con't) Some classes implement `Comparable` and some `Comparator` (and some, apparently, both!). Thus you must override either `compareTo()` or `compare()`, depending on which class you are required to implement.

Notice that, regardless of which method you override, the mathematic result is always the same: return 0 if the two features of interest are equal, and a number greater or less than 0, if one feature is has greater or lesser priority than the other.

See: http://stackoverflow.com/questions/1440134/when-should-a-class-be-comparable-and-or-comparator, and http://www.javatpoint.com/difference-between-comparable-and-comparator

7.3 The `Comparable` and `Comparator` Interfaces

It's important at this point to recall what an interface is and why we use it:

The purpose of an interface is to declare
a common set of behaviours for its derived classes,
and therefore, any objects instantiated them

Thus when we implement `Comparable` or `Comparator` with a class, we are signaling that it has appropriate features that allow the class to be sorted, i.e. it has a valid `compareTo()` or `compare()` method.

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7.3 The Comparable and Comparator Interfaces

Comparators do not need to be implemented with the class itself; an interface's `compare()` or `compareTo()` method(s) can be passed directly into the sorting method

As an example, consider `ArrayList`. It's `sort()` method is declared as follows:

void	`sort(Comparator<? super E> c)` Sorts this list according to the order induced by the specified **Comparator**.

To sort an `ArrayList` you must pass a suitable `Comparator` object to the `sort()` method. But unlike our previous examples using `String` and `GregorianCalendar` (which sort by natural order, according to the `compareTo()` method supplied by Oracle), we can supply the Comparator object of our choosing, which sorts by whichever property we choose.

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7.3 The `Comparable` and `Comparator` Interfaces

As an example, consider the following class:

```
public class CityInfo {
  private Integer population;
  private String name;
  private Float averageIncome;
  private Integer rating;

  public CityInfo(String name, int pop, float inc,int rat){
      setPopulation(pop); setName(name);
      setAverageIncome(inc); setRating(rat);
  }

  public void setPopulation(int pop){this.population= pop;}
  public int getPopulation(){return this.population;}

  public void setName(String name) {this.name = name;}
  //all other setters and getters, etc…
}
```

7.3 The `Comparable` and `Comparator` Interfaces

In a separate class, we add various `CityInfo` objects to an `ArrayList`:

```
ArrayList<CityInfo> cities = new ArrayList<>();

 cities.add(new CityInfo("Vancouver, CA", 2313300, 67090.0f, 3));
 cities.add(new CityInfo("Melbourne, AU", 4087100, 65500.0f, 1));
 cities.add(new CityInfo("Vienna, AT", 1741200, 69200.0f, 2));
 cities.add(new CityInfo("Toronto, CA", 2615000, 68110.0f, 4));
```

We may wish to sort the list by any of it's properties: name, average income, population, or rating. Thus the object passed to sort will differ depending on our sorting criteria.

7.3 The `Comparable` and `Comparator` Interfaces

We can accommodate these different sorting methods by constructing different classes, each of which implements `compare()` in different ways. For example

```
public class ByPopulation implements Comparator<CityInfo>{
    @Override
    public int compare(CityInfo c1, CityInfo c2) {
        return (c1.getPopulation() - c2.getPopulation());
    }
}

public class ByIncome implements Comparator<CityInfo>{
    @Override
    public int compare(CityInfo c1, CityInfo c2) {
        return (c1.getIncome() - c2.getIncome());
    }
}

// etc…
```

7.3 The `Comparable` and `Comparator` Interfaces

We can then choose to sort based on which comparator object we wish to use. To sort the cities array by population, we'd use

```
cities.sort(new ByPopulation());
```

and to sort by average income, use instead:

```
cities.sort(new ByIncome());
```

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7.3 The `Comparable` and `Comparator` Interfaces

Note that our comparators can be implemented as inner classes. However, when using inner classes, we need to be careful to instantiate the outerclass first, before using the inner class comparator in the `sort()` method.

```
public class CitySort{
    public static void main(String [] args){
        ArrayList<CityInfo> cities = new ArrayList<>();
        cities.add(new CityInfo("Vancouver, Canada", 2313300,
            67090.0f, 3));
        cities.add(new CityInfo("Melbourne, Australia", 4087100,
            65500.0f, 1));
        CitySort cs = new CitySort();  // instantiate this object
        cities.sort(cs.new ByPopulation());
    }
    public class ByRating implements Comparator<CityInfo> {
        @Override
        public int compare(CityInfo c1, CityInfo c2) {
            return (c1.getRating() - c2.getRating());
        }
    } ...
```

7.3 The `Comparable` and `Comparator` Interf's ⌘

`void`	`sort(Comparator<? super E> c)` Sorts this list according to the order induced by the specified **`Comparator`**.

Finally, note the generic notation used with `sort()`. The Comparator can take an element `E` or any of its *superclasses*. (This notation may be considered the compliment to `<E extends SuperClass>` which says: "E or any of its *sub*classes").

Why limit the comparison to superclasses, and not subclasses? If subclasses were allowed, the method used in the comparison could potentially be overridden in one of the subclasses, and the sort wouldn't work correctly. By specifying 'this class or higher', we ensure that all classes can only call the latest (i.e. overridden in superclasses, but not below the current class) methods.

7.3 The `Comparable` and `Comparator` Interf's ⌘

void	`sort(Comparator<? super E> c)` Sorts this list according to the order induced by the specified `Comparator`.

As an example, say we wish to sort imaginary numbers using the `modulus()` method (as described above), and we *allow* subclasses of the current comparator to be used for the sort. But what if a rogue mathematician/programmer decided to override the `modulus()` method to return only the real component of the imaginary number, and not the actual modulus, as specified earlier? Then the sort would perform differently. The above notation prevents this problem by eliminating the possibility that an overridden subclass object can be used as the type of the comparator passed to `sort`() .

7.4 The `Cloneable` Interface

Two other interfaces are of particular interest to us: `Cloneable` and `Serializable`.

To be `Cloneable` means that a class can use `Object`'s `clone()` method. Not all classes can use `clone()` (perhaps it was overridden in the superclass) so `Cloneable` serves to indicate that `clone()` is still available.

As before, some methods demand that a class be `Cloneable` because they need to make a copy of the object. They will flag an error if the class is either not an `instanceof Cloneable`, or polymorphically incompatible.

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7.4 The `Cloneable` Interface

The `Cloneable` interface has the definition:

```
public interface Cloneable {}
```

In other words, it has *no* abstract methods to override. You may then well ask: of what use is `Cloneable`?

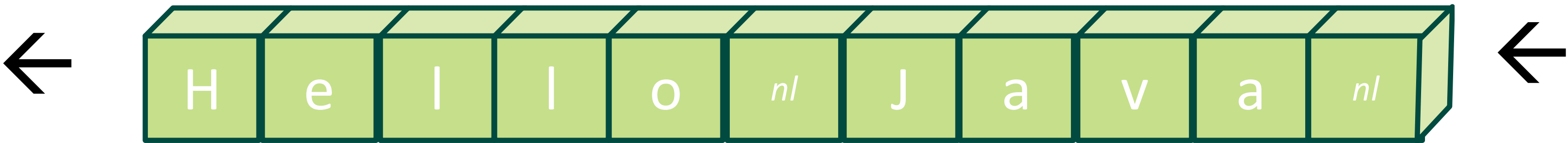
In this particular case, the fact that a class implements `Cloneable` is enough to indicate what the class is capable of. Interfaces used in this way, with no abstract methods, are called ***marker interfaces***. The `Cloneable` interface's very association with any object indicates that the object can be cloned.

(The alternative would be to have a `Cloneable` interface with a method that returned `true` or `false` to indicate if a class could be cloned or not. But why bother, when the very presence of the interface itself is enough to tag an object as cloneable? That's what marker interfaces do.)

This also means that, effectively, any concrete class that implements a marker interface is *not* required to override its methods—there aren't any!

7.5 The `Serializable` Interface

Recall from an earlier module that a *stream* is (essentially) a string of bytes 'flowing' through memory. Or more accurately, a *stream* is a data structure that keeps track of the start and end of a contiguous array of bytes in RAM. Special variables point to these locations and help keep track of which pieces of information are available to be read to or written to, whether they are 'flowing' in or out of the stream, whether the stream is buffered, etc.



7.5 The `Serializable` Interface

Streams are an extremely important concept in data I/O. They are available for bytes, characters and strings. And objects.

Objects present something of a problem. Whereas characters are always two bytes long, and strings are terminated by CR, how does one determine where an object starts and ends in a stream? If you ship a Java applet over the internet to a web site, how does the browser know how to unpackage the bytes it receives from the input stream into objects?

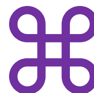
7.5 The `Serializable` Interface

In Java, in order to create an object stream, it must first be made ***serializable***. Or in other words, packaged in such a way as to be shipped in a stream. For this purpose, there is a `Serializable` interface. Any time objects need to be transported, for example to and from a file, they need to implement `Serializable` first. This is a way of signalling that the information can be transported reliably.

Most objects in the Java API implement `Serializable`, including `String`, `StringBuilder`, `Date`, and `ArrayList`. But when you wish to store a custom-built object stream to or from a file, you must make it `Serializable` first.

Like `Cloneable`, `Serializable` is a marker interface.

7.6 The Collection Interface



The `Collection` interface hierarchy forms a particularly rich family of interfaces. Here's a partial Java Collections Framework UML class diagram:

Collection Interface Family

<<interface>>
Collection

<<interface>>
Set

<<interface>>
List

<<interface>>
Queue

HashSet

<<interface>>
SortedSet

ArrayList

Vector

LinkedList

PriorityQueue

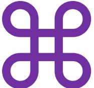
LinkedHashSet

<<interface>>
NavigableSet

TreeSet

From: http://www.marcus-biel.com/wp-content/uploads/2015/08/class-and-interface-hierarchy.png

7.6 The `Collection` Interface

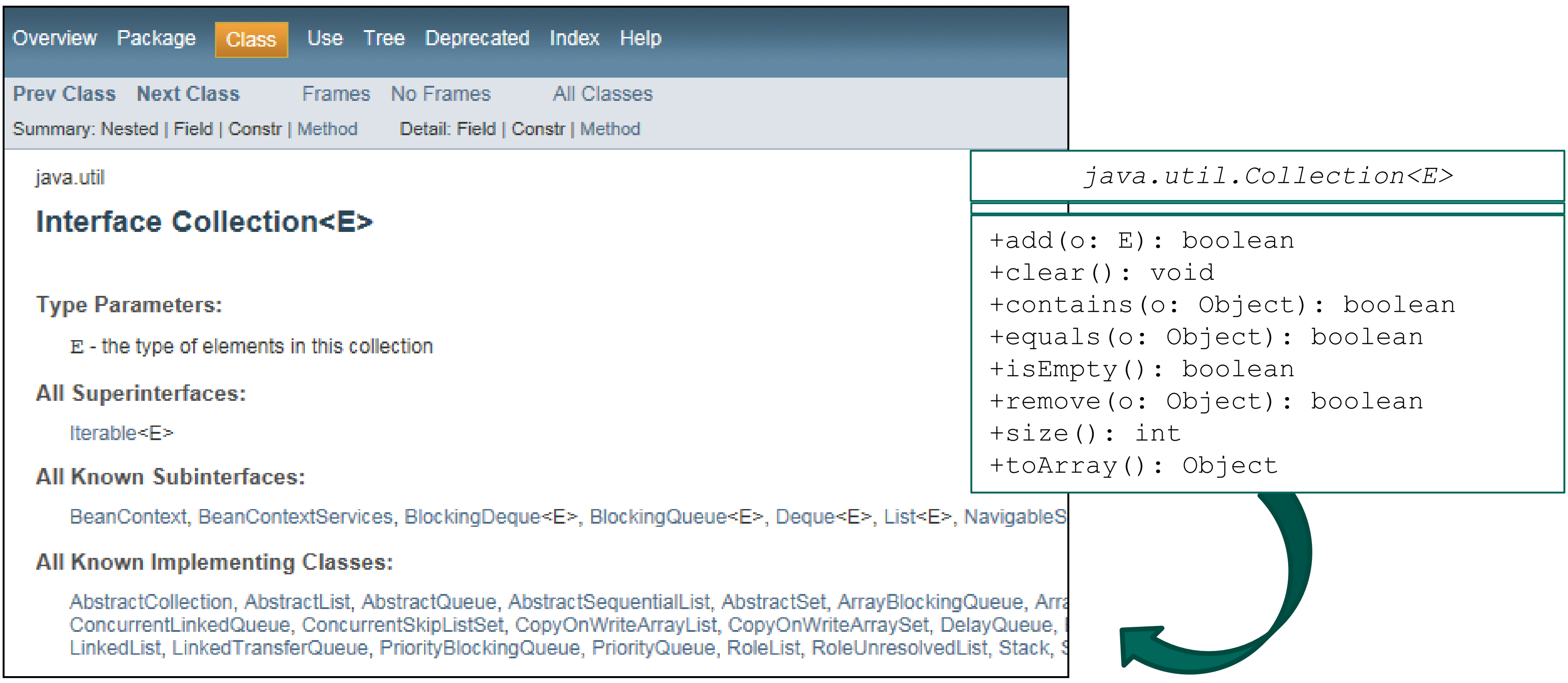


So any subclass or subinterface, like `ArrayList`, will inherit all of the Colllection interface's abstract methods. Being the first non-abstract class, ArrayList must provide concrete interpretations of all the abstract methods it inherits.

```
<<interface>>java.lang.Iterable

<<interface>>java.util.Collection<E>
+add(o: E): boolean
+clear(): void
+contains(o: Object): boolean
+equals(o: Object): boolean
+isEmpty(): boolean
+remove(o: Object): boolean
+size(): int
+toArray(): Object

<<interface>>List<E>

ArrayList<E>
```

7.6 The `Collection` Interface

Given the following information, from the Sun web page at
http://docs.oracle.com/javase/7/docs/api/java/util/Collection.html



each of the implementing classes (at the bottom) will provide access to the methods in the Collection interface, i.e. `add()`, `equals()`, `isEmpty()`…

7.6 The Collection Interface

Hence ArrayList() must inherit, via the List interface, all of the methods found in the Collection interface.

Indeed, *any* class that implements the Collection interface is effectively saying:

"I make available the standard Collection methods"

Hence the use of the term 'interface': an interface offers a standard set of behaviours or features to any client application.

Knowing that '*ArrayList implements Collection*' tells us ArrayList *must* have the same methods as any other class that implements Collection. Any class that extends from Collection will offer the same features. So if you need to ensure that the Collection object's methods will be available for use, you need to parameterize that method/class appropriately:

```
public static <T extends Collection> int myMethod(T obj1)…
```

7.6 The `Collection` Interface

So the various subinterfaces of `Collection` are each guaranteed to contain all of the `Collection` methods. But which of the *other* methods are passed down depends on which route we take through the inheritance hierarchy of the Collection Interface Family. And this depends on which features an object requires.

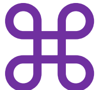
For example, an ArrayList has the following interfaces:

All Implemented Interfaces:

```
Serializable, Cloneable, Iterable<E>, Collection<E>, List<E>, RandomAccess
```

ALGONQUIN COLLEGE

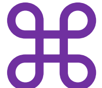
7.6 The `Collection` Interface



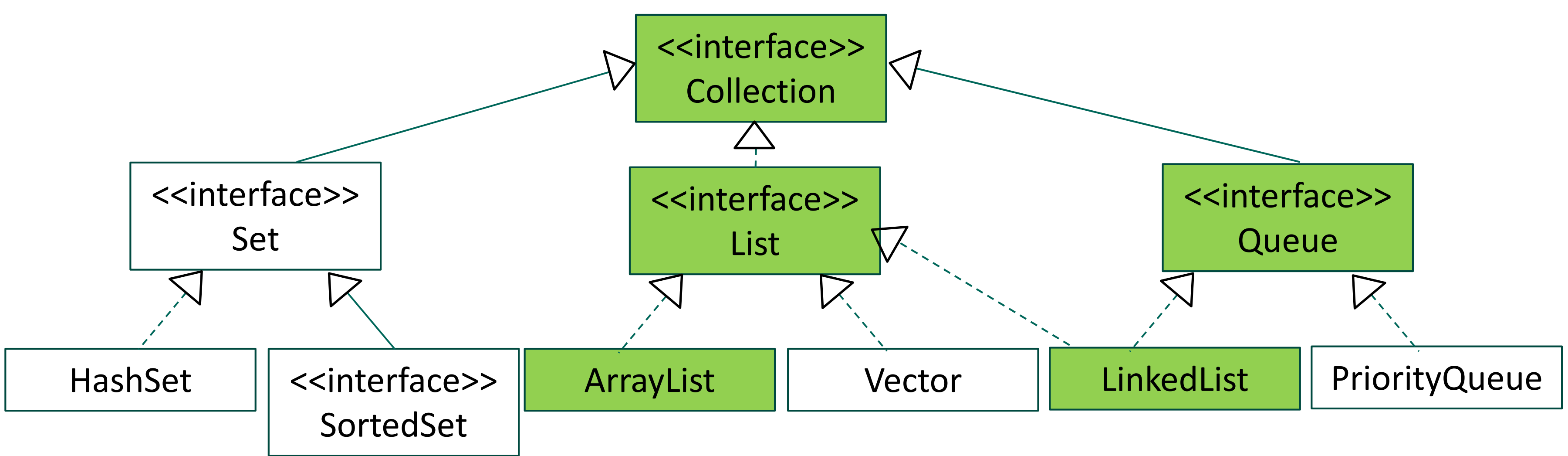
Why does `ArrayList` need all these interfaces? Consider all the features of an `ArrayList`, and you'll see that it needs to satisfy various requirements:

Interface	Reason
`Serializable`	marker interface used for serialization
`Cloneable`	marker interface used for cloning
`Iterable<E>`	allows a Collection of objects to be enumerated
`Collection<E>`	the root interface of the Collection hierarchy; it allows new elements to be added to the Collection
`List<E>`	adds additional methods needed to order the collection. (The `sort()` method is inherited from `List`.)
`RandomAccess`	another marker interface that indicates random access is allowed

7.6 The Collection Interface



Similarly a LinkedList—a type of data structure—implements both the Queue and List interfaces, which in turn implement the Collection interface.



7.6 The `Collection` Interface

So different interface specifications may be used to support alternate concrete implementations, i.e. different methods will be available in the *subinterfaces* according to the methods available in the *superinterfaces* . The presence of an interface in an object's family tree serves as a guarantee that specific public methods will be available to any calling method.

ALGONQUIN COLLEGE

7.6 The `Collection` Interface

As a final comment on the `Collection` interface, note that it is not to be confused with the `Collection`**s** class. The `Collections` class is an accessory class (like `Arrays`) that consists of nothing but static methods. Amongst the most useful of its methods is the `sort()` method, which is overloaded.

```
Collections.sort(List<T> list)
```

takes any `List` object (including `ArrayList`, a subclass, as just shown) and sorts it according to `T`'s `compare()` method. Additionally there is

```
Collections.sort(List<T> list, Comparator<? Super T> c)
```

Here, the second parameter is a comparator that can be used to override the natural order of the sort as indicated in the first parameter. So `Collections.sort()` provides the best features of both `Arrays.sort()` and the `ArrayList.sort()` in a single overloaded static method.