Java library provides an interface to describe Objects that have a natural order on them, such as String, Integer, BigInteger and BigDecimal:

```java
public interface Comparable {
    // For now, the Java 1.4 version
    /** Returns value <0, == 0, or > 0 depending on whether
    * THIS is <, ==, or > OBJ. Exception if OBJ not of compatible type. */
    int compareTo(Object obj);
}
```

Might use in a general-purpose max function:

```java
/** The largest value in array A, or null if A empty. */
public static Comparable max(Comparable[] A) {
    if (A.length == 0) return null;
    Comparable result; result = A[0];
    for (int i = 1; i < A.length; i += 1)
        if (result.compareTo(A[i]) < 0) result = A[i];
    return result;
}
```

Now `max(S)` will return maximum value in S if S is an array of Strings, or any other kind of Object that implements Comparable.
Examples: Implementing Comparable

/** A class representing a sequence of ints. */
class IntSequence implements Comparable {
    private int[] myValues;
    private int myCount;
    ...
    public int get(int k) { return myValues[k]; }

    @Override
    public int compareTo(Object obj) {
        IntSequence x = (IntSequence) obj; // Blows up if incomparable
        for (int i = 0; i < myCount && i < x.myCount; i += 1)
            if (myValues[i] < x.myValues[i])
                return -1;
            else if (myValues[i] > x.myValues[i])
                return 1;
        return myCount - x.myCount; // Umm. A bit tricky
    }
}
Implementing Comparable II

• Also possible to add an interface retroactively.

• If IntSequence did not implement Comparable, but did implement compareTo (without @Override), we could write

    class ComparableIntSequence extends IntSequence implements Comparable {
    }

• Java would then “match up” the compareTo in IntSequence with that in Comparable.
Example: Readers

- **Java class** `java.io.Reader` abstracts *sources of characters*.

- Here, we present a revisionist version (not the real thing):

  ```java
  public interface Reader { // Real java.io.Reader is abstract class
    /** Release this stream: further reads are illegal */
    void close();

    /** Read as many characters as possible, up to LEN,
     * into BUF[OFF], BUF[OFF+1],..., and return the
     * number read, or -1 if at end-of-stream. */
    int read(char[] buf, int off, int len);

    /** Short for read(BUF, 0, BUF.length). */
    int read(char[] buf);

    /** Read and return single character, or -1 at end-of-stream. */
    int read();
  }
  
  Can't write new Reader(); it's abstract. So what good is it?
Generic Partial Implementation

- According to their specifications, some of Reader's methods are related.

- Can express this with a partial implementation, which leaves key methods unimplemented and provides default bodies for others.

- Result still abstract: can't use new on it.

```java
/** A partial implementation of Reader. Complete implementations MUST override close and read(,,). They MAY override the other read methods for speed. */
public abstract class AbstractReader implements Reader {
  public abstract void close();
  public abstract int read(char[] buf, int off, int len);

  public int read(char[] buf) { return read(buf,0,buf.length); }

  public int read() { return (read(buf1) == -1) ? -1 : buf1[0]; }

  private char[] buf1 = new char[1];
}
```
Implementation of Reader: StringReader

The class StringReader reads characters from a String:

```java
public class StringReader extends AbstractReader {
    private String str;
    private int k;
    /** A Reader delivering the characters in STR. */
    public StringReader(String str)
    { this.str = str; k = 0; }

    public void close() { str = null; }

    public int read(char[] buf, int off, int len) {
        if (k == str.length())
            return -1;
        len = Math.min(len, str.length() - k);
        str.getChars(k, k+len, buf, off);
        k += len;
        return len;
    }
}
```

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Using Reader

Consider this method, which counts words:

```java
/** The total number of words in R, where a "word" is
 * a maximal sequence of non-whitespace characters. */
int wc(Reader r) {
    int c0, count;
    c0 = ' '; cnt = 0;
    while (true) {
        int c = r.read();
        if (c == -1) return count;
        if (Character.isWhitespace((char) c0) && ! Character.isWhitespace((char) c))
            count += 1;
        c0 = c;
    }
}
```

This method works for any Reader:

```java
// Number of words in the String someText:
wc(new StringReader(someText))
// Number of words in standard input.
w(new InputStreamReader(System.in))
// Number of words in file named fileName:
w(new FileReader(fileName))
```

other implementations of Reader
How It Fits Together

Client

Interface

Concrete Class

Abstract Template

Reader

StringReader

AbstractReader

wc method

... read() ...

read(b)

read(b, o, l)

read(b)

read(b, o, l)

read(b)

read(b, o, l)

... read() ...

... read() ...

... read() ...

which is really

inherited from

overrides

calls

inherited from

implies

extends

implies
Lessons

• The Reader interface class served as a specification for a whole set of readers.

• Ideally, most client methods that deal with Readers, like wc, will specify type Reader for the formal parameters, not a specific kind of Reader, thus assuming as little as possible.

• And only when a client creates a new Reader will it get specific about what subtype of Reader it needs.

• That way, client’s methods are as widely applicable as possible.

• Finally, AbstractReader is a tool for implementors of non-abstract Reader classes, and not used by clients.

• Alas, Java library is not pure. E.g., AbstractReader is really just called Reader and there is no interface. In this example, we saw what they should have done!

• The Comparable interface allows definition of functions that depend only on a limited subset of the properties (methods) of their arguments (such as “must have a compareTo method”).

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