Recreation

An integer is divided by 9 when a certain one of its digits is deleted, and the resulting number is again divisible by 9.

a. Prove that actually dividing the resulting number by 9 results in deleting another digit.

b. Find all integers satisfying the conditions of this problem.

Announcements

- Miniproj0 autograder has been running. Check the Scores tab for results.
- Yes, you can resubmit. See the Course Info tab.
- In particular, *many* people need to do style fixes! Use `make style` or `style61b *.java` to check before submission.

Project Ethics

Basic Rules:

1. By You Alone: All major submitted non-skeleton code should be written by you alone.
2. Do Not Possess or Share Code: Before a project deadline, you should never be in possession of solution code that you did not write, nor distribute your own code to others in the class.
3. Cite Your Sources: When you receive significant assistance on a project from someone else (other than the staff), cite that assistance somewhere in your source code.

Ethical Collaboration

Unproblematic

- Discussion of approaches for solving a problem.
- Giving away or receiving significant ideas towards a problem solution, if cited.
- Discussion of specific syntax issues and bugs in your code.
- Using small snippets of code that you find online for solving tiny problems (e.g. googling "uppercase string java" may lead you to some sample code that you copy and paste. Cite these.

Requiring Great Caution:

- Looking at someone else's project code to assist with debugging.
- Looking at someone else's project code to understand a particular idea or part of a project. Generally unwise though, due to the danger of plagiarism.

Unethical Collaborations

- Possessing another student's project code in any form before a final deadline, or distributing your own.
- Possessing project solution code that you did not write yourself before a final deadline (e.g., from github, or from staff solution code found somewhere). Likewise, distributing such code.

CS61B Lecture #11: Examples: Comparable & Reader

Comparable

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

```
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:

```
/** 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;  // <0 iff myCount < x.myCount
    }
}
```

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`.

Java Generics (I)

- We've shown you the old Java 1.4 `Comparable`. The current version uses a newer feature: Java gemeric types:

```
public interface Comparable<T> {
    int compareTo(T x);
}
```

- Here, `T` is like a formal parameter in a method, except that its "value" is a *type*.
- Revised `IntSequence`:

```
class IntSequence implements Comparable<IntSequence> {
    ...
    @Override
    public int compareTo(IntSequence x) {
       for (int i = 0; i < myCount && i < x.myCount; i += 1)
           if (myValues[i] < x.myValues[i])
               ...
       return myCount - x.myCount;
    }
}
```

Example: Readers

- Java class `java.io.Reader` abstracts *sources of characters*.
- Here, we present a revisionist version (not the real thing):

```
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.

```
/** A partial implementation of Reader. Concrete
 *  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:

```
public class StringReader extends AbstractReader {
  private String str;
  private int k;
  /** A Reader that delivers the characters in STR. */
  public StringReader(String s)
    { str = s; 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;
  }
}
```

Using Reader

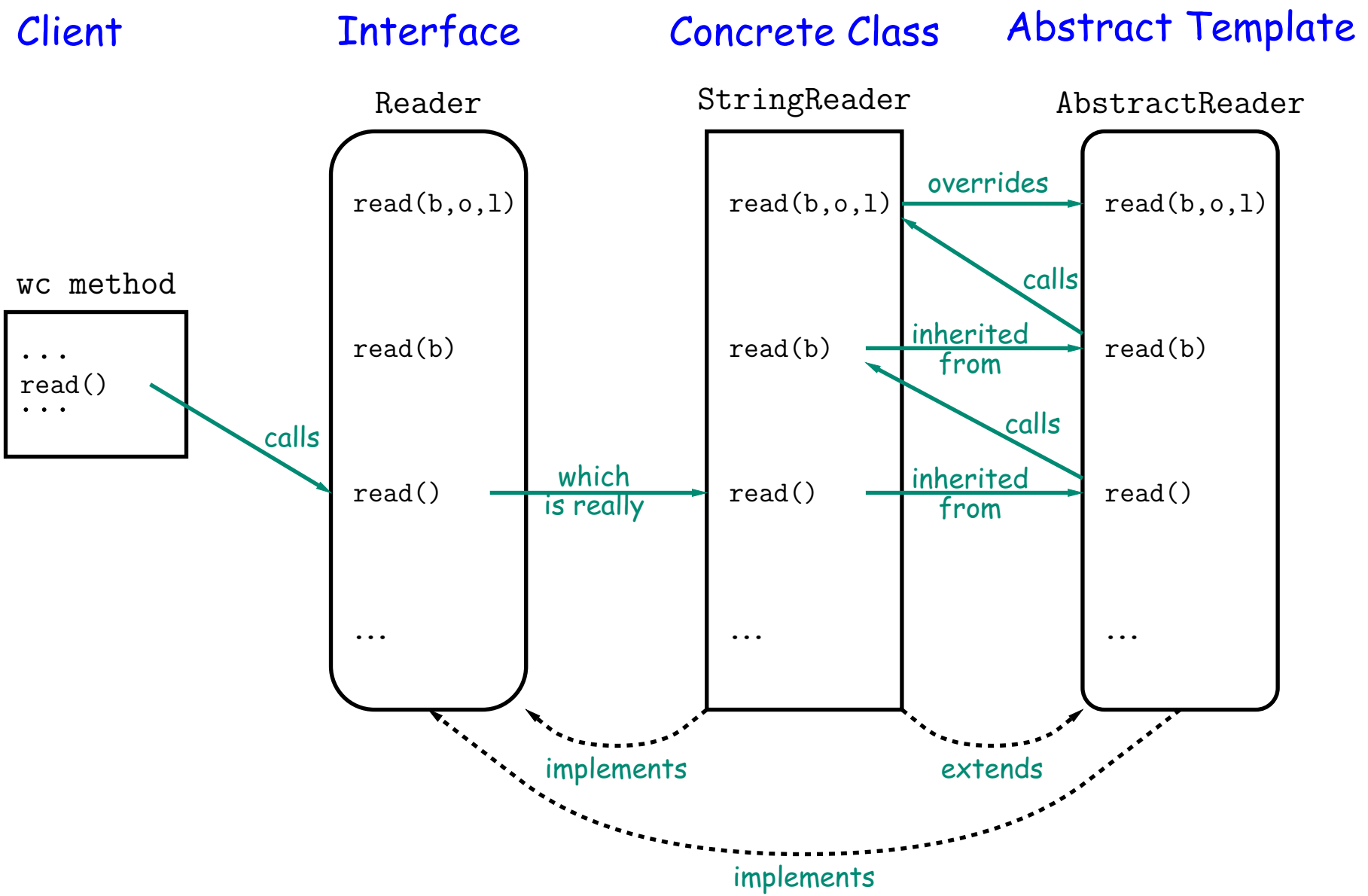
Consider this method, which counts words:

```
/** 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 = ' '; count = 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`:

```
wc(new StringReader(someText))          // # words in someText
wc(new InputStreamReader(System.in))    // # words in standard input
wc(new FileReader("foo.txt"))           // # words in file foo.txt.
```

How It Fits Together



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").