Recreation

vided by 9 when a certain one of its digits is deleted,
g number is again divisible by 9.

ctually dividing the resulting number by 9 results in
ther digit.

ers satisfying the conditions of this problem.

Announcements

tograder has been running. Check the Scores tab for

resubmit. See the Course Info tab.

, *many* people need to do style fixes! Use `make style`
`galaxy/*.java` to check before submission.

Project Ethics

: All major submitted non-skeleton code should be writ-
one.

ss or Share Code: Before a project deadline, you should
possession of solution code that you did not write, nor
ur own code to others in the class.

urces: When you receive significant assistance on a
someone else (other than the staff), cite that assis-
here in your source code.

Ethical Collaboration

f approaches for solving a problem.

r receiving significant ideas towards a problem solution,

f specific syntax issues and bugs in your code.

snippets of code that you find online for solving tiny
. googling "uppercase string java" may lead you to some
that you copy and paste. Cite these.

Caution:

meone else's project code to assist with debugging.

omeone else's project code to understand a particular
f a project. Generally unwise though, due to the danger
.

Unethical Collaborations

nother student's project code in any form before a final
distributing your own.

roject solution code that you did not write yourself be-
deadline (e.g., from github, or from staff solution code
here). Likewise, distributing such code.

ure #11: Examples: Comparable & Reader

Comparable

provides an interface to describe Objects that have
der on them, such as String, Integer, BigInteger and

```
erface Comparable { // For now, the Java 1.4 version
rns value <0, == 0, or > 0 depending on whether THIS is
=, or > OBJ.  Exception if OBJ not of compatible type. */
areTo(Object obj);
```

a general-purpose max function:

```
rgest value in array A, or null if A empty. */
tic Comparable max(Comparable[] A) {
ngth == 0) return null;
le result; result = A[0];
 i = 1; i < A.length; i += 1)
sult.compareTo(A[i]) < 0) result = A[i];
esult;
```

will return maximum value in S if S is an array of Strings,
kind of Object that implements Comparable.

amples: Implementing Comparable

```
presenting a sequence of ints. */
nce implements Comparable {
t[] myValues;
t myCount;

 get(int k) { return myValues[k]; }


 compareTo(Object obj) {
ence x = (IntSequence) obj; // Blows up if obj not an IntSequence
t i = 0; i < myCount && i < x.myCount; i += 1) {
 (myValues[i] < x.myValues[i]) {
 return -1;
lse if (myValues[i] > x.myValues[i]) {
 return 1;

 myCount - x.myCount;  // <0 iff myCount < x.myCount
```

Implementing Comparable II

to add an interface retroactively.

nce did *not* implement Comparable, but did implement
without @Override), we could write

```
arableIntSequence extends IntSequence implements Comparable {
```

hen "match up" the compareTo in IntSequence with that
e.

Java Generics (I)

you the old Java 1.4 Comparable. The current version
feature: Java generic types:

```
terface Comparable<T> {
ompareTo(T x);
```

ike a formal parameter in a method, except that its
ype.

equence (no casting needed):

```
equence implements Comparable<IntSequence> {

ide
 int compareTo(IntSequence x) {
 (int i = 0; i < myCount && i < x.myCount; i += 1) {
 if (myValues[i] < x.myValues[i]) ...

urn myCount - x.myCount;
```

Example: Readers

ava.io.Reader abstracts *sources of characters*.

sent a revisionist version (not the real thing):

```
erface Reader {  // Real java.io.Reader is abstract class
ase this stream: further reads are illegal */
se();

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

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

 and return single character, or -1 at end-of-stream. */
();
```

ew Reader(); it's abstract. So what good is it?

Generic Partial Implementation

their specifications, some of Reader's methods are re-

this with a *partial implementation,* which leaves key
nplemented and provides default bodies for others.

bstract: can't use **new** on it.

```
ial implementation of Reader. Concrete
entations MUST override close and read(,,).
AY override the other read methods for speed. */
tract class AbstractReader implements Reader {
two lines are redundant.
bstract void close();
bstract int read(char[] buf, int off, int len);

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

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

char[] buf1 = new char[1];
```

ementation of Reader: StringReader

gReader reads characters from a String:

```
tringReader extends AbstractReader {
ng str;
k;
 that delivers the characters in STR. */
gReader(String s) {
 k = 0;


close() {
ll;


ead(char[] buf, int off, int len) {
 str.length())
rn -1;
th.min(len, str.length() - k);
hars(k, k+len, buf, off);
;
en;
```

Using Reader

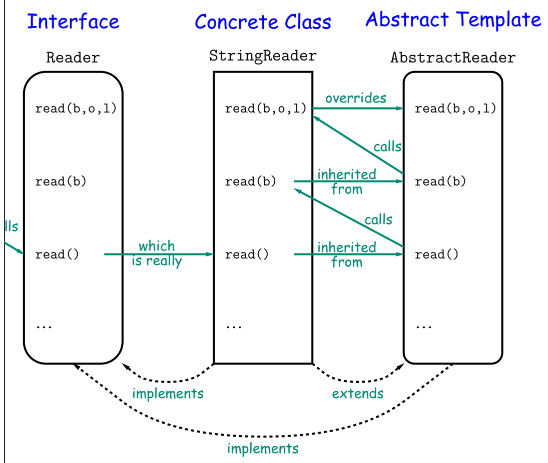
ethod, which counts words:

```
umber of words in R, where a "word" is
sequence of non-whitespace characters. */
) {
t;
unt = 0;
 {
r.read();
 -1) return count;
acter.isWhitespace((char) c0)
Character.isWhitespace((char) c))
t += 1;
```

rks for *any* Reader:

```
Reader(someText))          // # words in someText
treamReader(System.in))    // # words in standard input
ader("foo.txt"))           // # words in file foo.txt.
```

How It Fits Together



Lessons

nterface class served as a *specification* for a whole set

t client methods that deal with Readers, like wc, will Reader for the formal parameters, not a specific kind nus assuming as little as possible.

n a client creates a new Reader will it get specific about e of Reader it needs.

ent's methods are as *widely applicable* as possible.

ractReader is a tool for implementors of non-abstract es, and not used by clients.

brary is not pure. E.g., AbstractReader is really just r and there is no interface. In this example, we saw *ould* have done!

ble interface allows definition of functions that de- a limited subset of the properties (methods) of their uch as "must have a compareTo method").