The StringTokenizer Class

In our demo programs thus far, input from the keyboard was processed one line at a time. Each line was converted to a String and operated on using available methods. However, it is often necessary to decompose a full line of input into tokens that are processed separately. Each token might be a word, for example. The StringTokenizer class in the java.util package provides services for this purpose.

By default, tokens are delimited by whitespace characters, but other delimiters are also possible. A whitespace is a space, return, tab, or newline character. The default delimiters are held in a string, " \r\t\n", which can be changed using methods of the StringTokenizer class.

Unlike the Math class, objects of the StringTokenizer class can be instantiated; thus, the StringTokenizer class includes constructor methods. The methods of the StringTokenizer class are summarized in Table 1.

<table>
<thead>
<tr>
<th>Method</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constructors</td>
<td></td>
</tr>
<tr>
<td>StringTokenizer(String str)</td>
<td>Constructs a string tokenizer for the specified string str; returns a reference the new object</td>
</tr>
<tr>
<td>StringTokenizer(String str, String delim)</td>
<td>Constructs a string tokenizer for the specified string str using delim as the delimiter set</td>
</tr>
<tr>
<td>StringTokenizer(String str, String delim, boolean returnTokens)</td>
<td>Constructs a string tokenizer for the specified string str using delim as the delimiter set; returns the tokens with the string if returnTokens is true</td>
</tr>
<tr>
<td>Instance Methods</td>
<td></td>
</tr>
<tr>
<td>countTokens()</td>
<td>returns an int equal to the number of times that this tokenizer's nextToken() method can be called before it generates an exception</td>
</tr>
<tr>
<td>.hasMoreTokens()</td>
<td>returns a boolean value: true if there are more tokens available from this tokenizer's string, false otherwise</td>
</tr>
<tr>
<td>nextToken()</td>
<td>returns a String equal to the next token from this string tokenizer</td>
</tr>
<tr>
<td>nextToken(String delim)</td>
<td>returns a String equal to the next token from this string tokenizer using delim as a new delimiter set</td>
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</tbody>
</table>

Count Words

Let's begin with a demo program. A basic tokenizing operation is to divide lines of input into words. The program CountWords demonstrates how this is done using methods of the StringTokenizer class (see Figure 1).
import java.io.*;
import java.util.*;

public class CountWords {
    public static void main(String[] args) throws IOException {
        BufferedReader stdin =
            new BufferedReader(new InputStreamReader(System.in), 1);

        String line;
        StringTokenizer words;
        int count = 0;

        // process lines until no more input
        while ((line = stdin.readLine()) != null) {
            // process words in line
            words = new StringTokenizer(line);
            while (words.hasMoreTokens()) {
                words.nextToken();
                count++;
            }
        }

        System.out.println("\n" + count + " words read");
    }
}

A sample dialogue with this program follows:

PROMPT> java CountWords
To be or not to be.
That is the question.
^Z
(\or ^D)
10 words read

In the sample dialogue, two lines of text containing 10 words were inputted via the keyboard. The third line of input shows "^Z" for "Control-Z". This is entered by depressing the control key while entering "z". When executing a Java program in a DOS window, Control-Z indicates an end-of-input or end-of-file condition. When Control-Z is detected, the readLine() method returns null. This condition signals that there is no more input available for processing. On systems running a unix-like operating system (e.g., linux or Solaris) an end-of-file condition is entered as Control-D.

In line 2, an import statement informs the compiler of the location of the StringTokenizer class. (It is in the java.util package.) Line 12 contains a declaration of an object variable named words of the StringTokenizer class. The while loop in lines 16-25 performs the task of inputting lines from the keyboard until a null (end-of-input) condition occurs. The relational expression in line 16 conveniently combines inputting a line of input with the relational test for null. Since assignment is of lower precedence than the "not equal to" (!=) relational operator, parentheses are required for the assignment expression.

Each line inputted is converted to a String object. A reference to the object is assigned to object variable line (lines 16). Line 19 instantiates a StringTokenizer object from the
string line and assigns a reference to it to the object variable words. This sets-up the conditions to begin processing the tokens — the words — in each line of text input. Two instance methods of the StringTokenizer class do all the work. The hasMoreTokens() method returns a boolean (true or false) indicating if there are more tokens to be processed. This method is called in line 20 via the instance variable words within the relational expression of an inner while loop. So, the outer while loop processes lines, the inner while loop processes the tokens in each line.

In the inner while loop, line 22 contains an expression to retrieve the next token in the StringTokenizer object words. Note that the token is retrieved, but is not assigned to anything. This is fine, because our task is simply to count words; we aren't interested in processing the words in any manner. The counting occurs in line 23, where the int variable count is incremented for each token retrieved. After both loops are finished the result is printed (line 26).¹

Count Alpha-only Words

For our next example, we'll make a small but interesting change to CountWords. Suppose we want to count words if they contain only letters of the alphabet. To count only "alpha" words, we must not only tokenize strings into words, but each token must be inspected character-by-character to determine if all characters are letters. The demo program CountWords2 shows the necessary modifications to perform this task (see Figure 2).

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¹ The presence of a leading newline character (“\n”) in the print statement is a fix for a quirk in Windows. If input arrives from the keyboard followed by Control-Z, the first line of subsequent output is overwritten by the operating system. The leading newline character ensures that the result printed is not overwritten.
import java.io.*;
import java.util.*;

public class CountWords2 {

    public static void main(String[] args) throws IOException {
        BufferedReader stdin = new BufferedReader(new InputStreamReader(System.in), 1);

        String line;
        StringTokenizer words;
        int count = 0;

        // process lines until no more input
        while ((line = stdin.readLine()) != null) {
            // process words in line
            words = new StringTokenizer(line);
            while (words.hasMoreTokens()) {
                String word = words.nextToken();
                boolean isAlphaWord = true;
                int i = 0;

                // process characters in word
                while (i < word.length() && isAlphaWord) {
                    String c = word.substring(i, i + 1).toUpperCase();
                    if (c.compareTo("A") < 0 || c.compareTo("Z") > 0)
                        isAlphaWord = false;
                    i++;
                }
                if (isAlphaWord)
                    count++;
            }
        }
        System.out.println("\n" + count + " alpha words read");
    }
}

Figure 2. CountWords2.java

A sample dialogue with this program follows:

PROMPT> java CountWords2
Maple Leafs 7 Flyers 1
^Z
3 alpha words read

Although the inputted line has five tokens, only three are alpha-only. Lines 22-35 perform the added task of determining if each token contains only letters. The first task is to retrieve a token as the String object word (line 22). Initially, we assume word contains only letters, so the boolean variable isAlphaWord is declared and set to true (line 23). Then, each character in word is tested (lines 27-33) using the compareTo() method of the String class. If a character is less than 'A' or greater than 'Z', it is not a letter and isAlphaWord is set false. This also causes an early termination of the inner while loop. If all characters are checked and isAlphaWord is still true, then the word is, indeed, alpha-only and count is incremented (line 35).
Determining if a word contains only letters, as in lines 27-33 of CountWords2, uses methods seen in earlier programs. In fact, this task can be simplified:

```java
for (int i = 0; i < word.length(); i++)
    if (!Character.isLetter(word.charAt(i)))
        isAlphaWord = false;
```

The work is now performed by the `isLetter()` method of the `Character` wrapper class (see Appendix C). The `isLetter()` method receives a `char` argument and returns a `boolean`: `true` if the character is a letter, `false` otherwise. The `char` argument is obtained via the `charAt()` method of the `String` class. It receives an integer argument specifying the character to extract from the string. Note that `isLetter()` is a class method, whereas `charAt()` is an instance method. Since we are using `isLetter()` to determine if a character is not a letter, the unary NOT (!) operator precedes the relational expression.

The technique above is not only shorter, it also allows the program to work with the Unicode definition of a letter. Thus, the program will work for non-ASCII interpretations of letters, such as occur in scripts other than English.

**Find Palindromes**

Now that we are comfortable with the `StringTokenizer` class, let’s look at another interesting example. A palindrome is a word that is spelled the same forwards as backwards, for example, "rotator". The program `Palindrome` reads lines of input from the keyboard until an end-of-file condition occurs. As each line is read, it is tokenized and each token is inspected to determine if it is a palindrome. If so, it is echoed to the standard output. The listing is given in Figure 3.
import java.io.*;
import java.util.*;

public class Palindrome {
    public static void main(String[] args) throws IOException {
        BufferedReader stdin =
            new BufferedReader(new InputStreamReader(System.in), 1);

        String line;
        StringTokenizer word s;
        String word;

        while ((line = stdin.readLine()) != null) {
            words = new StringTokenizer(line);
            while (words.hasMoreTokens()) {
                word = words.nextToken();
                if (word.length() > 2) // must be at least 3 characters long
                {
                    boolean isPalindrome = true;
                    int i = 0;
                    int j = word.length() - 1;
                    while (i < j && isPalindrome)
                    {
                        if (! (word.charAt(i) == word.charAt(j)) )
                        {
                            isPalindrome = false;
                            i++;
                            j--;
                        }
                    }
                    if (isPalindrome)
                        System.out.println(word);
                }
            }
        }
    }
}

Figure 3. Palindrome.java

A sample dialogue with this program follows:

PROMPT> java Palindrome
a deed worth doing
deed
rotator is a palindrome
rotator
^z

Two lines of input are entered and these contain two palindromes, "deed" and "rotator". The structure of the program is very similar to that of CountWords2. Instead of inspecting each
token to determine if it contains only letters, we check if characters are mirrored about an imaginary center point. The general idea is shown in Figure 4 for "rotator".

![Figure 4. Letter comparisons for palindrome test](image)

Lines 26-40 do the work. First, we set the boolean variable `isPalindrome` to true with an assumption that the token is a palindrome (line 29). Then, variables i and j are initialized with the index of the first and last character in the token, respectively (lines 30-31). The while loop in lines 32-38 processes pairs of characters starting at the outside, working toward the center. The loop continues only while i is less than j and `isPalindrome` remains true.

The crucial test is in line 34. The `charAt()` method in the `String` class extracts the characters at indices i and j from the token. These are compared using the "is equal to" relational operator (==). Note that `char` variables can be compared as though they were integers. The relational test is inverted with the NOT (!) operator. If the overall result is true, the characters are not equal and the token is not a palindrome. In this case, `isPalindrome` is set to false (line 35). After each test, i is incremented and j is decremented, thus moving the indices closer to the center of the token. Tokens with less than two characters are not checked in this program (line 27).

We will re-visit the Palindrome program later when we discuss recursion and debugging.