Chapter 13

Other Interesting JAVA Classes

What is in This Chapter?

This chapter discusses some interesting JAVA classes such as String, Date, GregorianCalendar and others. This chapter can be viewed as an explanation of the tool-like classes available in JAVA to make your life easier.
13.1 The String Class

Strings are one of the most commonly used concepts in all programming languages. They are used to represent text characters and are fundamental in allowing a user to interact with the program. In JAVA, Strings are actually objects, not primitives and any text between double quotes represents a literal String in our programs:

```java
String name = "Stan Dupp";
String empty = "";
```

However, since Strings are also objects, we can create one by using one of many available constructors. Here are two examples:

```java
String nothing = new String(); // makes an empty String
String copy = new String(name); // makes copy of the name String
```

A String has a length corresponding to the number of characters in the String. We can ask a String for its length by using the length() method:

```java
String name = "Stan Dupp";
String empty = "";
name.length(); // returns 9
empty.length(); // returns 0
```

This length remains unchanged for the string at all times. That is, once a string has been created we cannot change the size of the string, nor can we append to the string.

Even though we cannot append to a String, we can still make use of the + operator to join two of them together. Recall, for example, the use of the + operator within the toString() method for the Person class:

```java
public String toString() {
    return (this.age + " year old Person named " + 
            this.firstName + " " + this.lastName);
}
```

Here, we are actually combining 5 String objects to form a new String object containing the result … the original 5 String objects remain unaltered.

Each character in a String is assigned an imaginary integer index that represents its order in the sequence. The first character in the String has an index of 0, the second character has
an index of 1, and so on. We can access any character from a `String` by using the `charAt()` method which requires us to specify the index of the character that we want to get:

```java
String name = "Hank Urchif";
name.charAt(0); // returns character 'H'
name.charAt(1); // returns character 'a'
name.charAt(name.length() - 1); // causes StringIndexOutOfBoundsException
name.charAt(name.length()); // causes StringIndexOutOfBoundsException
name.charAt(100); // returns empty string ""
```

There are also some methods in the `String` class that allow us to extract a sequence (or range) of characters from the `String`. The `substring(s,e)` method does just that. It takes two parameters `s` and `e`, where `s` specifies the starting character index and `e` specifies one more than the ending character index:

```java
String name = "Hank Urchif";
name.substring(0, 4); // returns character "Hank"
name.substring(5, 11); // returns character "Urchif"
name.substring(1, name.length()); // returns character "ank Urchif"
name.substring(3, 6); // returns character "k U"
```

In all cases above, the resulting `String` is a new object, the original `name` object remaining unchanged.

There is also a very useful method for eliminating unwanted leading and trailing characters (e.g., spaces, tabs, newlines and carriage returns). This can be useful when writing programs that get `String` input (e.g., name, address, email etc..) from the user through text fields on windows. The `trim()` method returns a new `String` object that represents the original string object but with no leading and trailing space, tab, newline or carriage return characters.

```java
String s1 = " I need a shave ";
String s2 = " ";
s1.trim(); // returns "I need a shave"
s2.trim(); // returns empty string ""
```

Also, sometimes when getting input from the user we would like to force the information to be formatted as either uppercase or lowercase characters. Two useful methods called `toUpperCase()` and `toLowerCase()` will generate a copy of the string but with all alphabetic characters converted to uppercase or lowercase, respectively. The methods only affect the alphabetic characters ... all other characters remain the same.
A final important topic that we will discuss regarding strings is that of comparing strings with one another. String comparison is a fundamental tool used in many programs. For example, whenever we want to search for a person’s name in a list, we must compare the name of the person (i.e., a String) with all of the names in a list of some sort.

JAVA has two useful methods for comparing Strings. The equals(s) method compares one String with another String, s, and then returns true if the two strings have the exact same characters in them and false otherwise. A similar comparison method called equalsIgnoreCase(s) is used to compare the two strings but in a way such that lowercase and uppercase characters are considered equal.

In regards to sorting strings, the compareTo(s) method will compare one string with another (i.e., parameter s) and return information about their respective alphabetical ordering. The method returns an integer which is:

- negative if the first string is alphabetically before s
- positive if the first string is alphabetically after s, or
- zero if the first string equals s

You may notice, in the last two cases, that uppercase characters always come alphabetically before lowercase characters. You should always take this into account when sorting data.
To avoid sorting problems, it may be best to use `toUpperCase()` on each `String` before comparing them:

```java
if (s1.toUpperCase().compareTo(s2.toUpperCase()) < 0)
    // s1 comes first
else
    // s2 comes first
```

Another very useful method in the `String` class is the `split()` method because it allows you to break up a `String` into individual substrings (called `tokens`) based on some separation criteria. For example, we can extract

- words from a sentence, one by one
- fields from a database or text file, separated by commas or other chars

The term *delimiter* is used to indicate the character(s) that separate the tokens (i.e., individual words or data elements).

Consider for example, the following `String` data which has been read in from a file:

"Mark,Lanthier,49,M,false"

Perhaps this is data for a particular person and we want to extract the information from the string in a way that we can use it. If we consider the comma ',' character as the only delimiter, then we can use the `split` method to obtain an array of `Strings` which we can then parse one by one to extract the needed data:

```java
String   s1 = "Mark,Lanthier,49,M,false";
String[] tokens = s1.split(",");
for (String token: tokens)
    System.out.println(token);
```

The code above will produce the following output:

```
Mark
Lanthier
49
M
false
```

Each token is an individual `String` that can be used afterwards. If, for example, we wanted to have just the 3rd piece of data (i.e., 49) and use it in a math expression, we could split the string and access just that piece of data, converting it to an integer as necessary ...

```java
Mark
Lanthier
49
M
false
```
String   s1 = "Mark,Lanthier,49,M,false";
String[]  tokens;
int        age;

   tokens = s1.split(",");
   age = Integer.parseInt(tokens[2]);
   if (age > 21) ...

The "," parameter to the split() method above indicates that the ',' character is the delimiter.
If we had the following String, however, we may want to include the ':' character as a delimiter as well:

"Mark,Lanthier:49:M,false"

We cannot simply use the parameter string ",:" because that will only consider consecutive comma colon characters as delimiters (i.e., a 2-char delimiter). We want to allow the comma OR the colon to be delimiters, but not necessarily together. To accomplish this, the expression in the string becomes more complex. We basically have to indicate that we want all non-alphanumeric characters to be part of the tokens and everything else to be delimiters. So the following code would do what we want:

String   s1 = "Mark,Lanthier:49:'M',false";

String[]  tokens = s1.split("[^a-zA-Z0-9]");
for(String token: tokens)
   System.out.println(token);

Notice the square brackets [] in the parameter string. This indicates that we are about to list a sequence of characters to be the delimiters. The ^ character negates the list of characters to indicate that we are about to list all the non-delimiter characters (i.e., the token characters). Then we list the alphanumeric ranges a-z, A-Z and 0-9 to indicate that any alphanumeric character is part of a token, while everything else is to be considered a delimiter.

The parameter string is considered to be a regular expression (not discussed here) and can be quite complex. You may look in JAVA's API for more information. In some cases, the token strings will be of size 0. For example, consider the following code:

String   s1 = "Mark, Lanthier , 49 ,,, M , false";

String[]  tokens = s1.split("[, ]");  // comma or space delimiter
for(String token: tokens)
   System.out.println(token);

The following output would be obtained ...
Notice that there are many spaces in between. These spaces are empty strings. We should check for the empty strings in our code:

```java
String s1 = "Mark, Lanthier, 49,, M, false";
String[] tokens = s1.split("[ , ]"); // comma or space delimiter
for (String token : tokens)
    if (token.length() > 0)
        System.out.println(token);
```

Then we obtain the output as before:

```
Mark
Lanthier
49
M
false
```

**Supplemental Information (StringTokenizers)**

There is another (perhaps simpler) way of extracting tokens from a String through use of the StringTokenizer class (imported from the java.util package). However, for some reason, the JAVA guys "suggest" that you use the split() method instead.

```java
String s = "Mark, Lanthier , 49 ,,, M , false";
StringTokenizer tokens = new StringTokenizer(s,", ");
System.out.println("The string has " + tokens.countTokens() + " tokens");
```
This code will produce the same result as above, but with an extra line of output indicating the number of tokens in total, which is 5 in this example.

Interestingly, the \texttt{Scanner} class that we used for getting keyboard input can also be used to get tokens from a \texttt{String}. The list of delimiters however is actually a pattern sequence, not a list of separate delimiter characters. That means, whatever is listed as the delimiter string must match exactly (i.e., in the example below, a single comma must be followed by a single space character):

```java
String sentence = "Banks, Rob, 34, Ottawa, 12.67";
Scanner s = new Scanner(sentence).useDelimiter("\, \, ");
System.out.println(s.next());
System.out.println(s.next());
System.out.println(s.nextInt());
System.out.println(s.next());
System.out.println(s.nextFloat());
s.close();
```

Notice that the \texttt{Scanner} should be closed, we did not do this earlier but it is common practice.

13.2 The \texttt{StringBuilder} \& Character Classes

Strings cannot be changed once created. Instead, when we try to manipulate them, we always get back a "brand new" \texttt{String} object. This is not normally a problem in most cases when programming, however, sometimes we would like to be able to modify a \texttt{String} by inserting/removing characters. For example, when we open a file in a text editor or word processor, we usually append, cut and insert text “on the fly”. It would be memory-inefficient and time-inefficient to continually create new strings and copy over characters from an old string to a new one.

The \texttt{StringBuilder} class in JAVA is useful for such a purpose. You may think of it simply as a \texttt{String} that can be modified. The \texttt{StringBuilder} methods run a little slower that their \texttt{String} equivalent methods, so if you plan to create strings that will not need to change, use \texttt{String} objects instead.

Here are two constructors for the \texttt{StringBuilder} class:

```java
new StringBuilder();
new StringBuilder(s);   // s is a String
```
The first creates a StringBuilder with no characters to begin with and the second creates one with the characters equal to the ones in the given String s.

As with Strings, the length() method can be used to return the number of characters in the StringBuilder as follows:

```java
StringBuilder sb1, sb2;

sb1 = new StringBuilder();
sb2 = new StringBuilder("hello there");
sb1.length();  // returns 0
sb2.length();  // returns 11
```

Unlike Strings, you can actually modify the length of the StringBuilder to any particular length by using a setLength(int newLength) method. If the newLength is less than the current length, the characters at the end of the StringBuilder are truncated. If the size is greater, null characters are used to fill in the extra places at the end as follows:

```java
StringBuilder sb;

sb = new StringBuilder("hello there");
sb.setLength(9);
System.out.println(sb);  // displays "hello the"
```

As with Strings, the charAt(int index) method is used to access particular characters based on their index position (which starts at position 0). Unlike Strings though, a setCharAt(int index, char c) method is also available which allows you to change the character at the given index to become the specified character c. Here is how these methods work …

```java
StringBuilder name;

name = new StringBuilder("Chip Electronic");
name.charAt(3);    // returns 'p'
name.setCharAt(4, '+');
System.out.println(name);  // displays "Chip+Electronic"
```

However, a more commonly used method in the StringBuilder class is the append(Object x) method which allows you to append a bunch of characters to the end of the StringBuilder. If x is a String object, the entire string is appended to the end. If x is any other object, JAVA will call the toString() method for that object and append the resulting String to the end of the StringBuilder:

```java
StringBuilder sb = new StringBuilder();
sb.append("Mark has ");
sb.append(new BankAccount("Mark"));
System.out.println(sb);  // displays "Mark has Account #10000 with $0.0"
```
The resulting output may differ, of course, depending on the BankAccount’s toString() method. Similar methods also exist for appending an int, long, float, double, boolean or char as follows:

    append(int x), append(long x), append(float x),
    append(double x), append(boolean x), append(char x)

The final two methods that we will mention allow you to remove characters from the StringBuilder. The deleteCharAt(int index) method will remove the character at the given index while the delete(int start, int end) method will delete all the characters within the indices ranging from start to end-1 as follows:

```java
StringBuilder sb;
sb = new StringBuilder("Miles Perlyter");
sb.delete(3, 11); // changes sb to "Milter"
sb.deleteCharAt(sb.length()-1); // changes sb to "Milte"
sb.deleteCharAt(sb.length()-1); // changes sb to "Milt"
```

Sometimes, it is useful to use a StringBuilder to go through a String and make changes to it. For example, consider using a StringBuilder to remove all the non-alphabetic characters from a String as follows (of course the result would have to be a new String, since the original cannot be modified) …

```java
String original, result = "";
StringBuilder sb;
Character c;

original = "Hello, my lst name ... is Mark !!";
sb = new StringBuilder();
for (int i=0; i<original.length(); i++) {
    c = original.charAt(i);
    if (Character.isLetter(c))
        sb.append(c);
}
result = new String(sb);
System.out.println(result);
```

Notice a couple of things from this code. First, the StringBuilder is used as a temporary object for creating the result string but is no longer useful after the method has completed. We use one of the String class’ constructors to create the new String ... passing in the StringBuilder. Second, we are checking for non-alphabetic characters by using Character.isLetter(). Here, isLetter() is a static function in the Character class that determines whether or not the given character is alphabetic or not.

**Side note:** Character is a class in JAVA known as a wrapper class because it is an object wrapper for the char primitive. Essentially, the class can be used to “convert” (i.e., wrap up) a char into an object that can then be used as a regular object. There is a wrapper class for each of the primitives in JAVA (i.e., Integer, Long, Float, Double, Character, Boolean, Short and Byte). Since JAVA 1.5, primitives are automatically wrapped into objects, and so we need not worry about this.
There are other useful methods in the `Character` class. Here are just a few:

- `Character.isLetter(c)`  // checks if c is a letter in the alphabet
- `Character.isDigit(c)`   // checks if c is a digit (i.e., '0' - '9')
- `Character.isLetterOrDigit(c)`  // ... this one is obvious ...
- `Character.isWhiteSpace(c)`  // checks if c is the space character
- `Character.isLowerCase(c)`   // checks if c is lowercase (e.g., 'a')
- `Character.isUpperCase(c)`   // checks if c is uppercase (e.g., 'A')
- `Character.toLowerCase(c)`  // returns lowercase equivalent of c
- `Character.toUpperCase(c)`  // returns uppercase equivalent of C

Here are some examples of how they are used:

- `Character.isLetter('A')`  // returns true
- `Character.isDigit('6')`   // returns true
- `Character.isLetterOrDigit('@')`  // returns false
- `Character.isWhiteSpace(' ')`  // returns true
- `Character.isLowerCase('a')`  // returns true
- `Character.isUpperCase('A')`  // returns true
- `Character.toLowerCase('A')`  // returns 'a'
- `Character.toUpperCase('a')`  // returns 'A'

Note that none of these methods require you to make an instance of a `Character` object. They are all `static/class` methods that take a `char` as a parameter (int in some cases) and return another primitive.

## 13.3 The Date and Calendar Classes

It is often necessary to use dates and times when programming. Let us take a look at the `Date` class provided in the `java.util` package. The `Date` class allows us to make data objects that incorporate time as well. The `java.util.Date` class is used to represent BOTH date and time. Dates are stored simply as a number, which happens to be the number of milliseconds since January 1, 1970, 00:00:00 GMT.

New dates are created with a call to a constructor as follows:

```java
Date today = new Date();
```

The result is an object that represents the current date and time and it looks something like this when displayed (of course it will vary depending on the day you run your code):

```
Thu Mar 26 14:39:17 EDT 2009
```

Notice that it shows the `day`, `month`, `day-of-month`, `hours`, `minutes`, `seconds`, `timezone` and `year` of the `Date` object. This is default behavior for this class. There are only three other useful methods in the `Date` class:

- `getTime()` - Returns a `long` representing this time in milliseconds.
• **after**(*Date d*) - Returns whether or not receiver date comes after the given date d.
• **before**(*Date d*) - Returns whether or not receiver date comes before the given date d.

Most other methods have been **deprecated** (which means they should not be used anymore).

In the class **Date** itself, there is no easy way to create a specific date (e.g., Feb. 13, 1992). Instead, we must use a different class to do this. In the current version of JAVA, **Calendar** objects are used to represent dates, instead of **Date** objects. **Calendar** is an abstract base class for converting between a **Date** object and a set of integer fields such as YEAR, MONTH, DAY, HOUR, and so on.

Although this **Calendar** class has many useful constants and methods (as you will soon see), we cannot make instances of it (i.e., we cannot say new **Calendar**()). Instead, the more specific kind of calendar called a **GregorianCalendar** is used.

The **java.util.GregorianCalendar** class is used to query and manipulate dates. Here are some of the available constructors …

```java
new GregorianCalendar() // today’s date
new GregorianCalendar(1999, 11, 31) // year,month,day
new GregorianCalendar(1968, 0, 8, 11, 55) // year, month, day, hours, mins
```

Notice that:

- the year is specified as 4-digits (e.g., 1968)
- months are specified from 0 to 11 (January being 0)
- days must be from 1 to 31
- hours and minutes are at the end of the constructor

Calendars do not display well.

Here is what you would see if you tried displaying a **GregorianCalendar**:

```java
java.util.GregorianCalendar[time=1178909251343,areFieldsSet=true, areAllFieldsSet=true,lenient=true,zone=sun.util.calendar.ZoneInfo[id= "America/New_York",offset=-18000000,dstSavings=3600000,useDaylight=true, transitions=235,lastRule=java.util.SimpleTimeZone[id=America/New_York, offset=-18000000,dstSavings=3600000,useDaylight=true,startYear=0, startMode=3,startMonth=3,startDay=1,startDayOfWeek=1,startTime=7200000, startMode=0,endMode=2,endMonth=9,endDay=-1,endDayOfWeek=1,endTime= 7200000,endTimeMode=0]],firstDayOfWeek=1,minimalDaysInFirstWeek=1,ERA=1, YEAR=2007,MONTH=4,WEEK_OF_YEAR=19,WEEK_OF_MONTH=2,DAY_OF_MONTH=11, DAY_OF_YEAR=131,DAY_OF_WEEK=6,DAY_OF_WEEK_IN_MONTH=2,AM_PM=1,HOUR=2, HOUR_OF_DAY=14,MINUTE=47,SECOND=31,MILLISECOND=343,ZONE_OFFSET= -18000000,DST_OFFSET=3600000]
```

Obviously, this is not pleasant. To display a **Calendar** in a friendlier manner, we can use the **getTime()** method, which actually returns a **Date** object (… not very intuitive  … I know).

Consider these examples:
System.out.println(new GregorianCalendar().getTime()); // today
System.out.println(new GregorianCalendar(1999,11,31).getTime());
System.out.println(new GregorianCalendar(1968,0,8,11,55).getTime());

Here is the output (which of course varies with the current date):

Thu Mar 26 14:48:40 EDT 2009
Fri Dec 31 00:00:00 EST 1999
Mon Jan 08 11:55:00 EST 1968

The isLeapYear(int year) method returns whether or not the given year is a leap year for this calendar:

    new GregorianCalendar().isLeapYear(2008)); // returns true
    new GregorianCalendar().isLeapYear(2009)); // returns false

There are many other methods that we can use to query or alter the date which are inherited from the Calendar class.

For example, the get(int field) method is used along with some static constants to access information about the particular calendar date. For example, at the time of updating these notes the date was:

    Thu Mar 26 15:05:35 EDT 2009

Consider the results (shown to the right) of each get method call in the code below. You should use import java.util.Calendar at the top of your code so that you can use these constants:

    Calendar today = Calendar.getInstance();

    today.get(Calendar.YEAR);                     // 2009
    today.get(Calendar.MONTH);                     // 2
    today.get(Calendar.DAY_OF_MONTH);             // 26
    today.get(Calendar.DAY_OF_WEEK);              // 5
    today.get(Calendar.DAY_OF_WEEK_IN_MONTH);     // 4
    today.get(Calendar.DAY_OF_YEAR);              // 85
    today.get(Calendar.WEEK_OF_MONTH);            // 4
    today.get(Calendar.WEEK_OF_YEAR);             // 13
    today.get(Calendar.HOUR);                     // 3
    today.get(Calendar.AM_PM);                    // 1
    today.get(Calendar.HOUR_OF_DAY);              // 15
    today.get(Calendar.MINUTE);                   // 5
    today.get(Calendar.SECOND);                   // 35

The value returned from the get(int field) method can be compared with other Calendar constants. For example,

    if (aCalendar.get(Calendar.MONTH) == Calendar.APRIL) {...}
    if (aCalendar.get(Calendar.DAY_OF_WEEK) == Calendar.SATURDAY) {...}

Here are some of the useful constants:
There is also a `set(int field, int value)` method that can be used to set the values for certain date fields:

```java
daCalendar.set(Calendar.MONTH, Calendar.JANUARY);
daCalendar.set(Calendar.YEAR, 1999);
daCalendar.set(Calendar.AM_PM, Calendar.AM);
```

Other set methods allow the date and time to be changed ...

```java
daCalendar.set(1999, Calendar.AUGUST, 15);
daCalendar.set(1999, Calendar.AUGUST, 15, 6, 45);
```

We can also format dates when we want to print them nicely. There is a `SimpleDateFormat` class (in the `java.text` package) that formats a `Date` object using one of many predefined formats. It does this by generating a `String` representation of the date. The constructor takes a `String` which indicates the desired format:

```java
new SimpleDateFormat("MMM dd,yyyy");
```

The parameter in the method is a format string that specifies “how you want the date to look” when it is printed. By using different characters in the format string, you get different output for the date. The `format(Date d)` method in the `SimpleDateFormat` class is then used to actually do the work by applying the format to the given date. Here is an example:

```java
import java.text.SimpleDateFormat;
...
SimpleDateFormat dateFormatter = new SimpleDateFormat("MMM dd,yyyy");
Date today = new Date();
String result = dateFormatter.format(today);
System.out.println(result);
```

Here is the result (which would vary, depending on the date):

```java
Apr 4,2017
```

Here are examples of format Strings and their effect on the date April 30th 2001 at 12:08 PM:
**Format String** | **Resulting output**
--- | ---
without formatting | Tue Apr 30 12:08:52 EDT 2001
"yyyy/MM/dd" | 2001/04/30
"yy/MM/dd" | 01/04/30
"MM/dd" | 04/30
"MMM dd,yyyy" | Apr 30, 2001
"MMMM dd,yyyy" | April 30, 2001
"EEE. MMMM dd, yyyy" | Mon. April 30, 2001
"EEEE, MMMM dd, yyyy" | Monday, April 30, 2001
"h:mm a" | 12:08 PM
"MMMM dd, yyyy (hh:mma)" | April 30, 2001 (12:08PM)

For additional formatting information, check out the JAVA API specification. Here is a simple example that creates two dates. One representing today, the other representing a future date:

```java
import java.util.*;
import java.text.SimpleDateFormat;

public class DateTestProgram {
    public static void main (String[] args) {
        Calendar today = Calendar.getInstance();
        Calendar future;
        int difference;

        // Display Information about today's date and time
        System.out.println("Here is today:");
        System.out.println(today.getTime());
        System.out.println(today.get(Calendar.YEAR));
        System.out.println(today.get(Calendar.MONTH));
        System.out.println(today.get(Calendar.DAY_OF_MONTH));

        // Display Information about a future day's date and time
        future = Calendar.getInstance();
        future.set(2010, Calendar.MARCH, 5);
        System.out.println("Here is the future:");
        System.out.println(future.getTime());
        System.out.println(future.get(Calendar.YEAR));
        System.out.println(future.get(Calendar.MONTH));
        System.out.println(future.get(Calendar.DAY_OF_MONTH));

        // Test the formatting
        Date aDate = new Date();
        System.out.println(aDate);
        System.out.println(new SimpleDateFormat("yyyy/MM/dd").format(aDate));
        System.out.println(new SimpleDateFormat("yy/MM/dd").format(aDate));
        System.out.println(new SimpleDateFormat("MM/dd").format(aDate));
        System.out.println(new SimpleDateFormat("MMM dd,yyyy").format(aDate));
        System.out.println(new SimpleDateFormat("MMMM dd,yyyy").format(aDate));
    }
}
```
Here is the output from running this code on Mar 30th, 2017:

Here is today:
Thu Mar 30 16:17:49 EDT 2017
2017
2
30
Here is the future:
Mon Mar 05 16:17:49 EST 2040
2040
2
5
Thu Mar 30 16:17:49 EDT 2017
2017/03/30
17/03/30
03/30
Mar 30, 2017
March 30, 2017

Notice that the months start at 0, and so March is month #2.

Although we can create and display simple dates, we have not done any manipulation at all. For instance, we may want to know how many working days there are between two dates. There are many more functions in the Calendar and Date classes, but we will not discuss them any further here. You would have to look at the API for the Date, Calendar, GregorianCalendar and SimpleDateFormat classes.

Supplemental Information (Formatting Dates with Strings)

We can also use the String.format() method to format dates and times. There are many flags that can be used (see the API for details) but here are some commonly used ones for displaying dates and times:

```java
Date aDate = new Date();
System.out.println(String.format("%tc", aDate));
System.out.println(String.format("%tF", aDate));
System.out.println(String.format("%tR", aDate));
System.out.println(String.format("%tR", aDate));
System.out.println(String.format("%tR", aDate));
```

Here was the output when it was ran on March 30, 2017 at 4:19pm:

Thu Mar 30 16:19:09 EDT 2017
2017-03-30
16:19
04:19:09 PM
03/30/17