4 Tour of the *java.lang* Package

Topics

- The *Math* Class
- The *String* and the *StringBuffer* Class
- The *Wrapper* Classes
- The *Process* and the *Runtime* Class
- The *System* Class

The *Math* Class

- Provides predefined constants and methods for performing different mathematical operations

- Methods:

Math Methods
`public static double abs(double a)`
Returns the positive value of the parameter. An overloaded method. Can also take in a float or an integer or a long integer as a parameter, in which case the return type is either a float or an integer or a long integer, respectively.
`public static double random()`
Returns a random postive value greater than or equal to 0.0 but less than 1.0.
`public static double max(double a, double b)`
Returns the larger value between two *double* values, *a* and *b*. An overloaded method. Can also take in float or integer or long integer values as parameters, in which case the return type is either a float or an integer or a long integer, respectively.
`public static double min(double a, double b)`
Returns the smaller value between two *double* values, *a* and *b*. An overloaded method. Can also take in float or integer or long integer values as parameters, in which case the return type is either a float or an integer or a long integer, respectively.
`public static double ceil(double a)`
Returns the smallest integer that is greater than or equal to the specified parameter *a*.
`public static double floor(double a)`
Returns the largest integer that is lesser than or equal to the specified parameter *a*.

The *Math* Class: Methods

Math Methods
`public static double exp(double a)`
Returns Euler's number *e* raised to the power of the passed argument *a*.
`public static double log(double a)`
Returns the natural logarithm (base e) of *a*, the *double* value parameter.
`public static double pow(double a, double b)`
Returns the *double* value of *a* raised to the *double* value of *b*.
`public static long round(double a)`
Returns the nearest *long* to the given argument. An overloaded method. Can also take in a *float* as an argument and returns the nearest *int* in this case.
`public static double sqrt(double a)`
Returns the square root of the argument *a*.
`public static double sin(double a)`
Returns the trigonometric sine of the given angle *a*.
`public static double toDegrees(double angrad)`
Returns the degree value approximately equivalent to the given radian value.
`public static double toRadians(double angdeg)`
Returns the radian value approximately equivalent to the given degree value.

The *Math* Class: Example

```
1  class MathDemo {
2     public static void main(St ring args[]) {
3        System.out.println("absolute value of -5: " +
                                          Math.abs(-5));
4        System.out.println("absolute value of 5: " +
                                          Math.abs(-5));
5        System.out.println("random number(max is 10): " +
6                                           Math.random()*10);
7        System.out.println("max of 3.5 and 1.2: " +
8                                         Math.max(3.5,1.2));
9        System.out.println("min of 3.5 and 1.2: " +
10                                        Math.min(3.5,1.2));
11 //continued...
```

The *Math* Class: Example

```
12        System.out.println("ceiling of 3.5: " +
13                                          Math.ceil(3.5));
14        System.out.println("floor of 3.5: " +
15                                          Math.floor(3.5));
16        System.out.println("e raised to 1: " +
17                                          Math.exp(1));
18        System.out.println("log 10: " + Math.log(10));
19        System.out.println("10 raised to 3: " +
20                                          Math.pow(10,3));
21  //continued...
```

The *Math* Class: Example

```
22          System.out.println("rounded off value of pi: " +
23                                          Math.round(Math.PI));
24          System.out.println("square root of 5 = " +
25                                          Math.sqrt(5));
26          System.out.println("10 radian = " +
27                                  Math.toDegrees(10) + " degrees");
28          System.out.println("sin(90): " +
29                                  Math.sin(Math.toRadians(90)));
30      }
31  }
```

The *String* Class

- Definition:
  - Represents combinations of character literals
  - Using Java, strings can be represented using:
    - Array of characters
    - The *String* class
  - Note: A *String* object is different from an array of characters!

- String constructors
  - 11 constructors

The *String* Class: Constructors

```
1  class StringConstructorsDemo {
2     public static void main(String args[]) {
3        String s1 = new String();          //empty string
4        char chars[] = { 'h', 'e', 'l', 'l', 'o'};
5        String s2 = new String(chars);    //s2="hello";
6        byte bytes[] = { 'w', 'o', 'r', 'l', 'd' };
7        String s3 = new String(bytes);    //s3="world"
8        String s4 = new String(chars, 1, 3);
9        String s5 = new String(s2);
10       String s6 = s2;
11 //continued
```

The *String* Class: Constructors

```
12          System.out.println(s1);
13          System.out.println(s2);
14          System.out.println(s3);
15          System.out.println(s4);
16          System.out.println(s5);
17          System.out.println(s6);
18      }
19  }
```

The *String* Class: Methods

String Methods
`public char charAt(int index)`
Returns the character located in the specified *index*.
`public int compareTo(String anotherString)`
Compares this string with the specified parameter. Returns a negative value if this string comes lexicographically before the other string, 0 if both of the strings have the same value and a postive value if this string comes after the other string lexicographically.
`public int compareToIgnoreCase(String str)`
Like compareTo but ignores the case used in this string and the specified string.
`public boolean equals(Object anObject)`
Returns true if this string has the same sequence of characters as that of the *Object* specified, which should be a *String* object. Otherwise, if the specified parameter is not a *String* object or if it doesn't match the sequence of symbols in this string, the method will return false.
`public boolean equalsIgnoreCase(String anotherString)`
Like equals but ignores the case used in this string and the specified string.
`public void getChars(int srcBegin, int srcEnd, char[] dst, int dstBegin)`
Gets the characters from this string starting at the *srcBegin* index up to the *srcEnd* index and copies these characters to the *dst* array starting at the *dstBegin* index.

The *String* Class: Methods

String Methods
`public int length()`
Returns the length of this string.
`public String replace(char oldChar, char newChar)`
Returns the string wherein all occurrences of the *oldChar* in this string is replaced with *newChar*.
`public String substring(int beginIndex, int endIndex)`
Returns the substring of this string starting at the specified *beginIndex* index up to the *endIndex* index.
`public char[] toCharArray()`
Returns the character array equivalent of this string.
`public String trim()`
Returns a modified copy of this string wherein the leading and trailing white space are removed.
`public static String valueOf(-)`
Takes in a simple data type such as boolean, integer or character, or it takes in an object as a parameter and returns the *String* equivalent of the specified parameter.

The *String* Class: Example

```
1  class StringDemo {
2     public static void main(String args[]) {
3        String name = "Jonathan";
4        System.out.println("name: " + name);
5        System.out.println("3rd character of name: " +
6                           name.charAt(2));
7        /* character that first appears alphabetically
8           has lower unicode value */
9        System.out.println("Jonathan compared to Solomon: "
10                          + name.compareTo("Solomon"));
11       System.out.println("Solomon compared to Jonathan: "
12                         + "Solomon".compareTo("Jonathan"));
13 //continued...
```

The *String* Class: Example

```
14        /* 'J' has lower unicode value compared to 'j' */
15        System.out.println("Jonathan compared to jonathan: " +
16                                        name.compareTo("jonathan"));
17        System.out.println("Jonathan compared to jonathan
18     (ignore case): " + name.compareToIgnoreCase("jonathan"));
19        System.out.println("Is Jonathan equal to Jonathan? " +
20                                        name.equals("Jonathan"));
21        System.out.println("Is Jonathan equal to jonathan? " +
22                                        name.equals("jonathan"));
23        System.out.println("Is Jonathan equal to jonathan
24        (ignore case)? " + name.equalsIgnoreCase("jonathan"));
25  //continued...
```

The *String* Class: Example

```
26        char charArr[] = "Hi XX".toCharArray();
27        /* Need to add 1 to the endSrc index of getChars */
28        "Jonathan".getChars(0, 2, charArr, 3);
29        System.out.print("getChars method: ");
30        System.out.println(charArr);
31        System.out.println("Length of name: " +
32                           name.length());
33        System.out.println("Replace a's with e's in name: " +
34                           name.replace('a', 'e'));
35        /* Need to add 1 to the endIndex parameter of
36           substring*/
37        System.out.println("A substring of name: " +
38                           name.substring(0, 2));
39    //continued...
```

The *String* Class: Example

```
40        System.out.println("Trim \"  a b c d e f   \": \"" +
41                           "  a b c d e f   ".trim() + "\"");
42        System.out.println("String representation of boolean
43                  expression 10>10: " + String.valueOf(10>10));
44        /* toString method is implicitly called in the println
45           method*/
46        System.out.println("String representation of boolean
47                     expression 10<10: " + (10<10));
48        /* Note there's no change in the String object name
49           even after applying all these methods. */
50        System.out.println("name: " + name);
51    }
52 }
```

The *StringBuffer* Class

- Problem with *String* objects:
  - Once created, can no longer be modified
- A StringBuffer object
  - Similar to a String object
  - But, mutable or can be modified
    - Unlike *String* in this aspect
    - Length and content may changed through some method calls

The *StringBuffer* Class: Methods

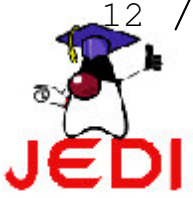
StringBuffer Methods
`public int capacity()`
Returns the current capacity of this *StringBuffer* object.
`public StringBuffer append(-)`
Appends the string representation of the argument to this *StringBuffer* object. Takes in a single parameter which may be of these data types: *boolean, char, char [], double, float, int, long, Object, String and StringBuffer*. Still has another overloaded version.
`public char charAt(int index)`
Returns the character located in the specified *index*.
`public void getChars(int srcBegin, int srcEnd, char[] dst, int dstBegin)`
Gets the characters from this object starting at the *srcBegin* index up to the *srcEnd* index and copies these characters to the *dst* array starting at the *dstBegin* index.
`public StringBuffer delete(int start, int end)`
Deletes the characters within the specified range.
`public StringBuffer insert(int offset, -)`
Inserts the string representation of the second argument at the specified offset. An overloaded method. Possible data types for the second argument: *boolean, char, char [], double, float, int, long, Object and String*. Still has another overloaded version.

The *StringBuffer* Class: Methods

StringBuffer Methods
`public int length()`
Returns the number of characters in this *StringBuffer* object.
`public StringBuffer replace(int start, int end, String str)`
Replaces part of this object, as specified by the first two arguments, with the specified string *str*.
`public String substring(int start, int end)`
Returns the substring of this string starting at the specified *start* index up to the *end* index.
`public String toString()`
Converts this object to its string representation.

The *StringBuffer* Class: Example

```
1  class StringBufferDemo {
2     public static void main(String args[]) {
3        StringBuffer sb = new StringBuffer("Jonathan");
4        System.out.println("sb = " + sb);
5        /* initial capacity is 16 */
6        System.out.println("capacity of sb: "+sb.capacity());
7        System.out.println("append \'O\' to sb: " +
8                                 sb.append("O"));
9        System.out.println("sb = " + sb);
10       System.out.println("3rd character of sb: " +
11                                sb.charAt(2));
12 //continued...
```



The *StringBuffer* Class: Example

```
13        char charArr[] = "Hi XX".toCharArray();
14        /* Need to add 1 to the endSrc index of getChars */
15        sb.getChars(0, 2, charArr, 3);
16        System.out.print("getChars method: ");
17        System.out.println(charArr);
18        System.out.println("Insert \'jo\' at the 3rd cell: "
19                           + sb.insert(2, "jo"));
20        System.out.println("Delete \'jo\' at the 3rd cell: "
21                           + sb.delete(2,4));
22        System.out.println("length of sb: " + sb.length());
23  //continued
```

The *StringBuffer* Class: Example

```
24          System.out.println("replace: " +
25                             sb.replace(3, 9, " Ong"));
26          /* Need to add 1 to the endIndex parameter of
27             substring*/
28          System.out.println("substring (1st two characters): "
29                             + sb.substring(0, 3));
30          System.out.println("implicit toString(): " + sb);
31      }
32  }
```

The Wrapper Classes

- Some Facts:
  - Primitive data types are not objects
    - Cannot access methods of the *Object* class
  - Only actual objects can access methods of the *Object* class
  - Why wrapper classes?
    - Need an object representation for the primitive type variables to use Java built-in methods
- Definition:
  - Object representations of simple non-object variables

The Wrapper Classes

- Primitive Data Types and their Corresponding Wrapper Classes

Primitive Data Type	*Corresponding Wrapper Class*
boolean	Boolean
char	Character
byte	Byte
short	Short
int	Integer
long	Long
float	Float
double	Double

- Wrapper classes are very similar to their primitive equivalents.
  - Capitalized
  - Spelled out versions of the primitive data types

The Wrapper Classes: Boolean Example

```
1  class BooleanWrapper {
2     public static void main(String args[]) {
3        boolean booleanVar = 1>2;
4        Boolean booleanObj = new Boolean("TRue");
5        /* primitive to object; can also use valueOf
6           method */
7        Boolean booleanObj2 = new Boolean(booleanVar);
8        System.out.println("booleanVar = " + booleanVar);
9        System.out.println("booleanObj = " + booleanObj);
10       System.out.println("booleanObj2 = " +
11                                booleanObj2);
12 //continued...
```

The Wrapper Classes: Boolean Example

```
13          System.out.println("compare 2 wrapper objects: "
14                             + booleanObj.equals(booleanObj2));
15          /* object to primitive */
16          booleanVar = booleanObj.booleanValue();
17          System.out.println("booleanVar = " + booleanVar);
18      }
19  }
```

The *Process* Class

- Definition:
  - Provides methods for manipulating processes
    - Killing the process
    - Running the process
    - Checking the status of the process
  - Represents running programs

- Methods:

Process Methods
`public abstract void destroy()`
Kills the current process.
`public abstract int waitFor() throws InterruptedException`
Does not exit until this process terminates.

The *Runtime* Class

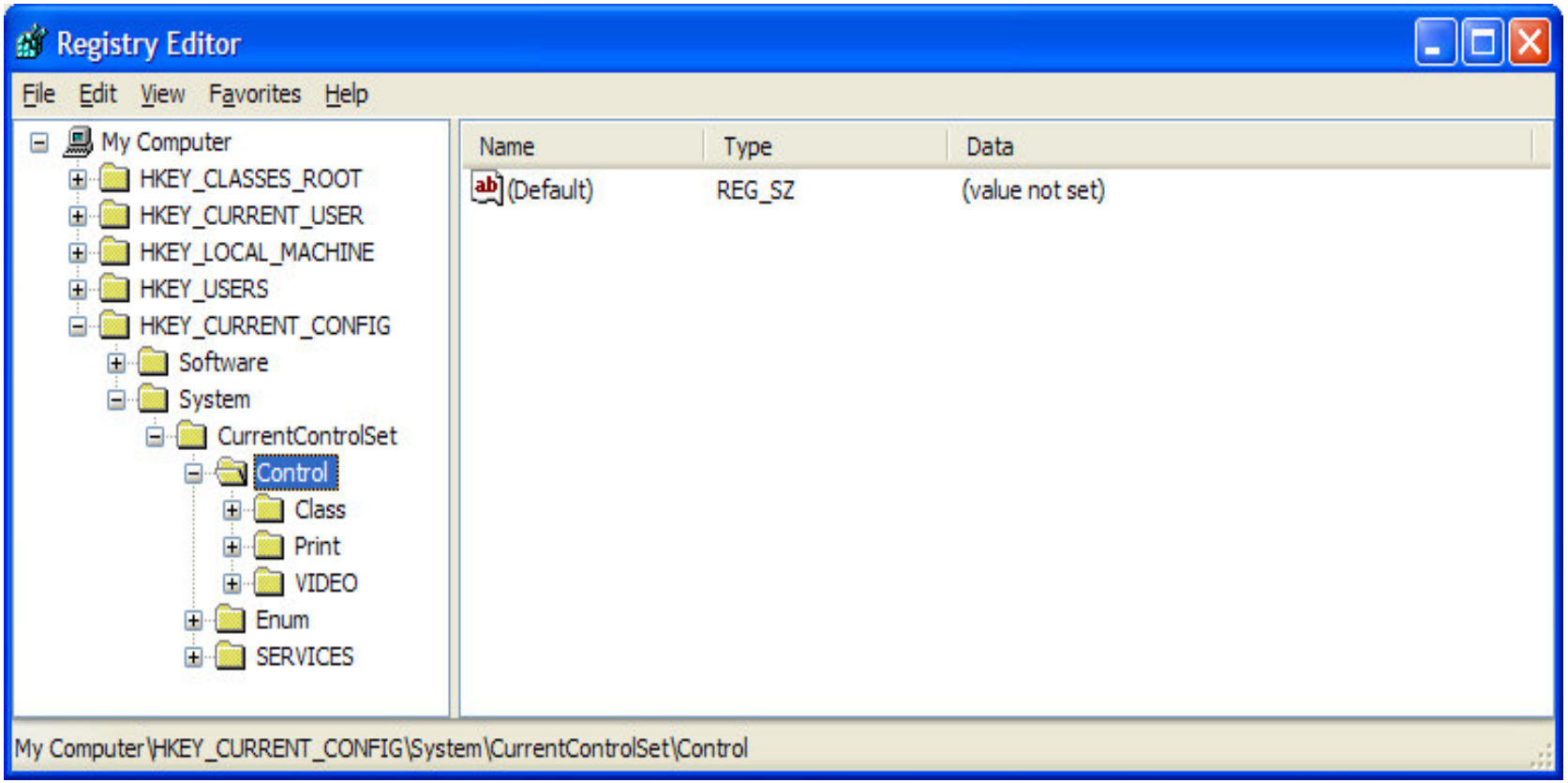
- Represents the runtime environment

- Has two important methods:

Runtime Methods
`public static Runtime getRuntime()`
Returns the runtime environment associated with the current Java application.
`public Process exec(String command) throws IOException`
Causes the specified *command* to be executed. Allows you to execute new processes.

The *Process* and *Runtime* Class: Example

- Opening the Registry Editor



The *Process* and *Runtime* Class: Example

```
1  class RuntimeDemo {
2     public static void main(String args[]) {
3        Runtime rt = Runtime.getRuntime();
4        Process proc;
5        try {
6           proc = rt.exec("regedit");
7           proc.waitFor();   //try removing this line
8        } catch (Exception e) {
9           System.out.println("regedit is an unknown
10                                 command.");
11       }
12    }
13 }
```

The *System* Class

- Provides many useful fields and methods
  - Standard input
  - Standard output
  - Utility method for fast copying of a part of an array

The *System* Class: Methods

System Methods
`public static void arraycopy(Object src, int srcPos, Object dest, int destPos, int length)`
Copies *length* items from the source array *src* starting at *srcPos* to *dest* starting at index *destPos*. Faster than manually programming the code for this yourself.
`public static long currentTimeMillis()`
Returns the difference between the current time and January 1, 1970 UTC. Time returned is measured in milliseconds.
`public static void exit(int status)`
Kills the Java Virtual Machine (JVM) running currently. A non-zero value for status by convention indicates an abnormal exit.
`public static void gc()`
Runs the garbage collector, which reclaims unused memory space for recycling.
`public static void setIn(InputStream in)`
Changes the stream associated with *System.in*, which by default refers to the keyboard.
`public static void setOut(PrintStream out)`
Changes the stream associated with *System.out*, which by default refers to the console.

The *System* Class: Example

```
1  import java.io.*;
2  class SystemDemo {
3     public static void main(String args[])
4                                  throws IOException {
5        int arr1[] = new int[1050000];
6        int arr2[] = new int[1050000];
7        long startTime, endTime;
8        /* initialize arr1 */
9        for (int i = 0; i < arr1.length; i++) {
10          arr1[i] = i + 1;
11       }
12 //continued...
```

The *System* Class: Example

```
13          /* copying manually */
14          startTime = System.currentTimeMillis();
15          for (int i = 0; i < arr1.length; i++) {
16             arr2[i] = arr1[i];
17          }
18          endTime = System.currentTimeMillis();
19          System.out.println("Time for manual copy: " +
20                                (endTime-startTime) + " ms.");
21  //continued...
```

The *System* Class: Example

```
22          /* using the copy utility provided by java */
23          startTime = System.currentTimeMillis();
24          System.arraycopy(arr1, 0, arr2, 0, arr1.length);
25          endTime = System.currentTimeMillis();
26          System.out.println("Time for manual copy: " +
27                                  (endTime-startTime) + " ms.");
28          System.gc();   //force garbage collector to work
29          System.setIn(new FileInputStream("temp.txt"));
30          System.exit(0);
31      }
32  }
```

Summary

- The Math Class
- The String and the StringBuffer Class
  - String Constructors
  - String and StringBuffer Methods
- The Wrapper Classes
- The Process and the Runtime Class
- The System Class