Grab the Tiger by the Tail!
Java 5 New Features

Presented to

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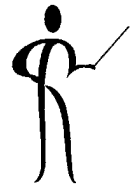
Session Objectives

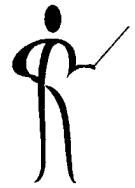
- Know how Java 5 differs from previous releases
- Understand how to use improved syntax features
- Be able to use new features to simplify existing programs

Introduction to Java 5.0



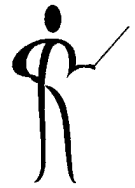
- Java has become the dominant development language for web-based systems.
- Since its release to the public in 1995 (Java 1.0) Java has matured improving functionality and performance with each new release.
- In September 2004 Sun released Java 5.0 (code-name "Tiger").
- This session discusses and demonstrates what's new in Java syntax as well as some internal improvements that make this the best release of Java ever.
- Specific topics include: generics, enhanced for loop iteration, autoboxing/unboxing, typesafe enumerations, static imports, annotations, formatted (ala printf) output, variable argument lists, input scanner, and other features.

Numbering change



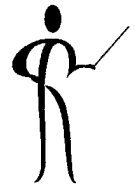
- The current release's actual name is Java 2 Standard Edition 5.0, commonly referred to by Sun as Java 5.
- Sun changed version numbering scheme; J2SE 1.5 is now J2SE 5.0 (the leading "1" was dropped).
- Code name during product development was "Tiger" hence the name of this paper (Tiger was a pretty popular product code name in 2005 with other vendors too).
- Most Sun documentation including Javadoc references 1.5 rather than 5.0 when specifying the new version.
- Java 2 Version 5.0 (1.5) still uses "Java 2" to denote the second generation of Java and to illustrate the family nature of J2SE, J2EE, and J2ME.
- The "1.5" version numbering will show up in some other places you might notice:
  - Java 1.5 shows up when using the java and javac executables:
    - **java -version (returns java version "1.5.0")**
    - **java -fullversion (returns java full version "1.5.0-b64")**
    - **javac -source 1.5 (javac -source 5 also works)**
  - Java 1.5 shows up in the sytem properties java.version and java.vm.version as well as in the "@since" Javadoc entries for new classes and members.
  - Installation directories for JDK and JRE are "jdk1.5.0" and "jre1.5.0" respectively.

JDK/SDK nomenclature



- Sun has resurrected the name "JDK" as in "Java 2 JDK" rather than using the "SDK" moniker adopted by Java 1.2, 1.3, and 1.4.
- Sun has also returned to calling the runtime environment "JRE" rather than "J2RE".
- Here are the "official" names from Sun:
  - Java™ 2 Platform Standard Edition 5.0 J2SE™ 5.0
  - J2SE™ Development Kit 5.0 JDK™ 5.0
  - J2SE™ Runtime Environment 5.0 JRE 5.0

Java Grows Over Time

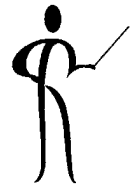


- Here is a comparison of Java library size from version to version:
  - Java 1.2 — 1500+ Classes and Interfaces
  - Java 1.3.1 — 1800+ Classes and Interfaces
  - Java 1.4 — 2700+ Classes and Interfaces
  - Java 5 (Java 1.5) — 3200+ Classes and Interfaces

New Java Syntax

- Java's syntax has had several improvements.
- Topics covered specifically in this paper include:
  - generics
  - enhanced for loop
  - auto boxing/unboxing
  - typesafe enumerations
  - static import
  - metadata via annotations
  - formatted output
  - variable argument lists
  - simplified input processing via scanner
  - improved synchronization
  - More…

Need for Generics

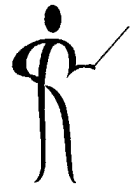


- At first glance Java's Generics feels familiar to those of us who have used C++ templates, but Java Generics are so much more.
- Java provides many opportunities for manipulating objects where the actual object type is stripped and must be re-supplied using a cast when the object is used later.
- For instance, look at the code below:

```
ArrayList oldStyle = new ArrayList();
oldStyle.add(new String("Hello"));
oldStyle.add(new String("there"));
oldStyle.add(new Integer(12));  // ok the old way
oldStyle.add(new String("whoops"));
// following loop raise runtime error
for (Iterator i = oldStyle.iterator();i.hasNext();) {
      System.out.println("Entry = "
                         + (String) i.next());
}
```

- This code generates the runtime error "ClassCastException" since the third item being retrieved from the ArrayList is not the expected data type.

Generics Example



- Using Generics allows specification of the allowable data type for a Java object so that the compiler will catch data type errors.
- Generic syntax specifies the data type inside less-than "<" and greater-than ">" symbols as follows:

```
ArrayList<String> newStyle = new ArrayList<String>();
```

- The example below show the String class but the class may be any class available in your CLASSPATH.
- The compiler uses the data type specified to restrict what may be placed into the object at compile time.
- The rewritten example looks something like this:

```
ArrayList<String> newStyle = new ArrayList<String>();
newStyle.add(new String("Hello"));
newStyle.add(new String("there"));
// following line raises compile error so it is commented
//newStyle.add(new Integer(12)); // compile error
newStyle.add(new String("whoops"));
for (Iterator<String> i = newStyle.iterator();i.hasNext();) {
        System.out.println("Entry = " + (String) i.next());
}
```

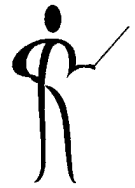
Lint is not just in your navel!

- The "lint" command has long been used in the Unix world to verify C program syntax, data type use, and portability of code.
- Java 5 (1.5) compiler adds "-Xlint" switch allowing compiler to flag potential:

```
javac UsingGenerics.java -Xlint:unchecked -deprecation
```

- Options for Xlint include:
  - all — Get all lint warnings
  - deprecation — Warns about deprecated API use (similar to -deprecation)
  - fallthrough — Flags cases in a switch statement that "fall through" to the next case
  - finally — Indicates an "finally" block that cannot reach completion
  - path — Warns of path directories specified on command line that do not exist
  - serial — Indicates that one or more Serializable classes do not have serialVersionUID defined
  - unchecked — Warns about unchecked use of generic types

Lint Warnings



- Here's what Lint warnings look like:

```
C:\JavaTiger\src\samples\UsingGenerics.java:30:
  warning: [unchecked] unchecked call to add(E) as a
  member of the raw type java.util.ArrayList
      oldStyle.add(new Integer(12));
                           ^
C:\JavaTiger\src\samples\UsingGenerics.java:31:
  warning: [unchecked] unchecked call to add(E) as a
  member of the raw type java.util.ArrayList
      oldStyle.add(new String("whoops"));
```

Additions to Arrays

- java.util.Arrays class has new additions including a toString() method to prints the contents of any array/collection.

```
int[] anArray = { 1, 3, 5, 7, 9, 11, 13, 15, 16, 20 };
System.out.println(Arrays.toString(anArray));
```

  - Generates the following output:

```
[1, 3, 5, 7, 9, 11, 13, 15, 16, 20]
```

- Another method Arrays.deepToString() displays the contents of a multi-dimensional array. Given the following array:

```
int[][] apartment = new int[5][4];
```

  - The results of using Arrays.toString() and Arrays.deepToString() are illustrated below.
  - First, using Arrays.toString() the contents of the first level show as addresses (Windows PC used for example):

```
[[I@10b62c9, [I@82ba41, [I@923e30, [I@130c19b, [I@1f6a7b9]
```

  - Next, using Arrays.deepToString() the contents of the array are listed:

```
[[0, 0, 0, 0], [0, 1, 2, 3], [0, 4, 5, 6], [0, 7, 8, 9], [0, 10,
11, 12]]
```

- Arrays also added new Arrays.deepEquals(array1,array1), Arrays.hashCode() and Arrays.deepHashCode() methods

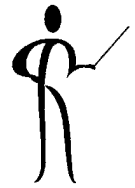
Enhanced for loop

- Beginning with Java 5 (Java 1.5) a new style of “for” loop
- The new for loops are sometimes called "for-in" loops

```
public class ForEachLoop {
    public static void main ( String[] args ) {
           String[] lastName = new String[5];
           lastName[0] = "Winklemann";
           lastName[1] = "Ruiz";
           lastName[2] = "Gandhi";
           lastName[3] = "Yakazuki";
           lastName[4] = "Jones";
           for (String thisName : lastName) {
               System.out.println("Name is " + thisName);
           }
    } // end main
}  // end ForEachLoop class
```

  - **This code loops through each entry in an array or collection object returning one value at a time for processing. In other words an Iterator is used without an Iterator being defined!**

For-In Syntax



- The new "for" construct is equally at home with either a traditional array or an object of some collection type:

```
for (String thisName : lastName) {
    System.out.println("Name is " + thisName);
}
```

  - Data type of one item in array/collection (String above)
  - Local name used for returned item in for loop (thisName above)
  - : (colon, think of it as the word “in”)
  - Name of array or collection object that implements the new java.lang.Iterable interface (lastName above)

Autoboxing and Unboxing

- Java 5 (Java 1.5) and later automatically “box” and ”unbox” values

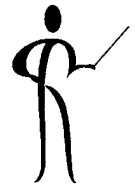
```
Integer intObject = new Integer(123);
int intPrimitive = intObject;      // pre-Java 5 error
double doublePrimitive = 123.45;
Double doubleObject  = doublePrimitive;   // pre-Java 5 error
```

- In Java 1.4 (or earlier releases), properly moving data between wrapper class objects and primitives required more work:

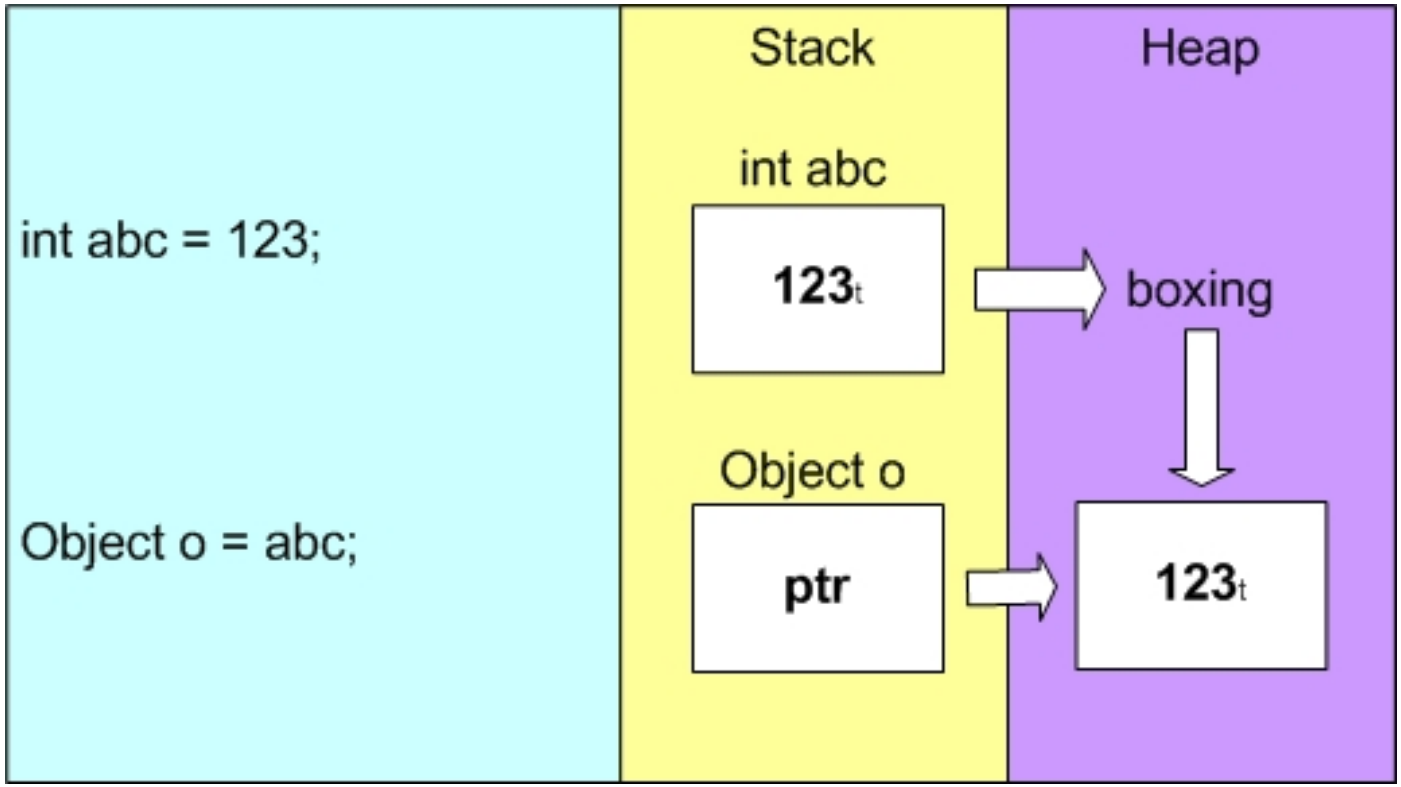
```
Integer intObject = new Integer(123);
int intPrimitive = intObject.intValue();
double doublePrimitive = 123.45;
Double doubleObject = new Double(doublePrimitive);
```

- The advent of automatic Boxing and automatic Unboxing greatly simplifies code when using Collection and other types of objects.
- Boxing and Unboxing is also important since Primitive data and Reference Type data are stored in different places.
- Primitives representing local variables are stored on the stack while objects are stored in heap memory.

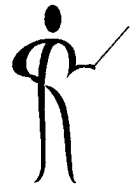
Boxing



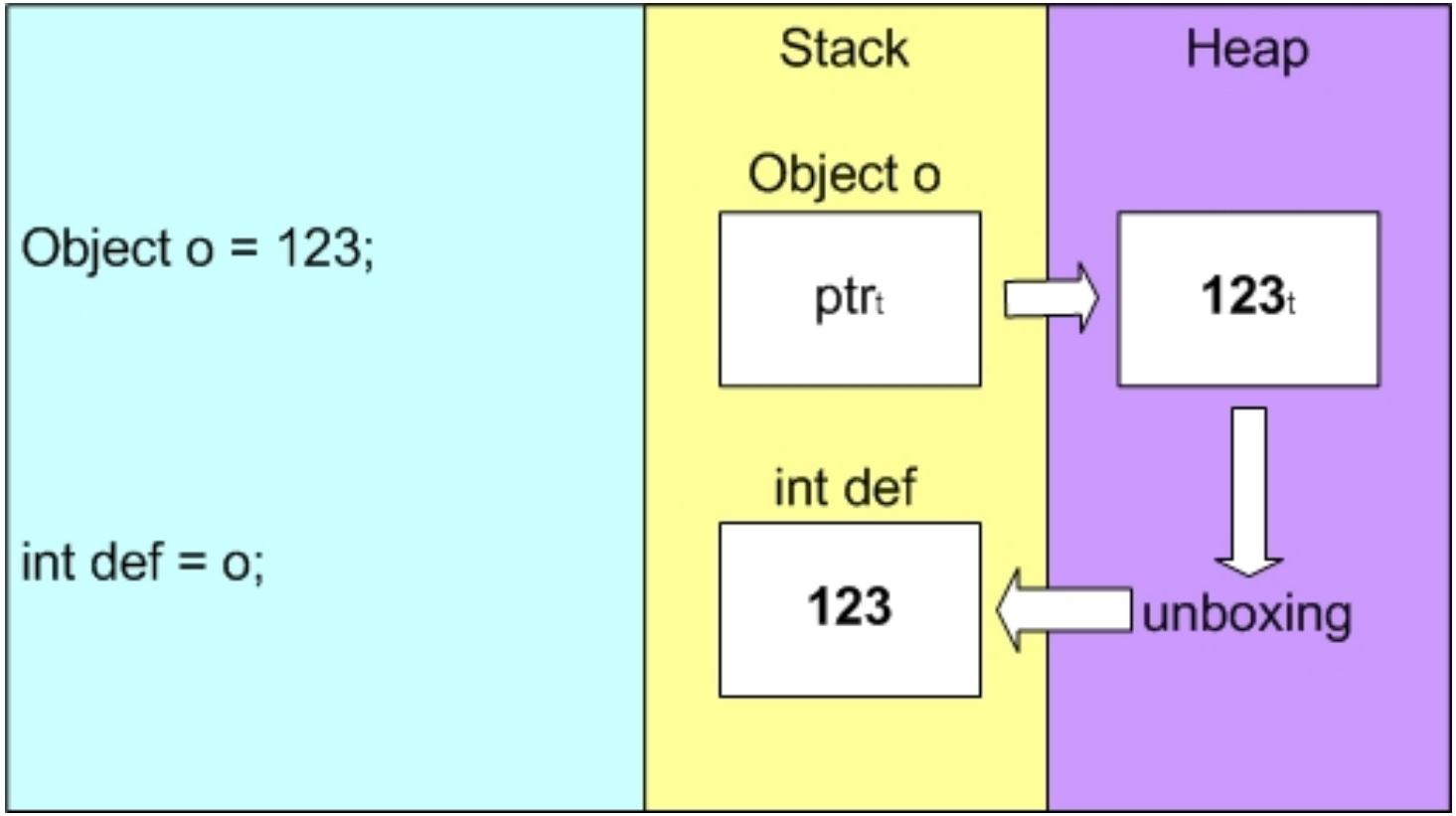
- When an integer is assigned to an object, the system, “boxing” makes a copy of the value on the heap and points the object to the new value.



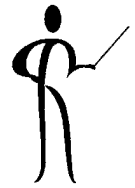
UnBoxing



- When an object assigned to an integer, “unboxing” copies the value from the heap into the variable's storage in the stack



Enum



- Another new Java 5 feature that will look familiar to C programmers is the "Enum" data type.
- Enum allows assignment of a specific set of values to associated

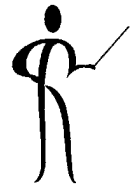
```
package samples;
public class UsingEnums {
     public enum Weekdays {
            Monday, Tuesday, Wednesday, Thursday, Friday,
            Saturday, Sunday
     };
     public UsingEnums() {
            Weekdays weekDays;
     }
     public static void main(String[] args) {
            UsingEnums myUE = new UsingEnums();
     }
}
```

Static import

- Java 5 (Java 1.5) allows import of static items
- Useful when same methods or variables used repeatedly

```
import static java.lang.Double.parseDouble;
import static java.lang.Integer.parseInt;
public class StaticImportDemo {
   public static void main(String[] args) {
               String intValue = "123";
               String dblValue = "567.89";
               double resultValue = 0;
               try {
                      resultValue = parseInt(intValue)
                       + parseDouble(dblValue);
                      System.out.println("resultValue is "
                       + resultValue);
               }
               catch (NumberFormatException e) {
                      System.out.println("Either intValue or"
                                    " dblValue not numeric");
               }
               return;
   }
}
```

Metadata via Annotations



- Java 5 introduced a method for adding metadata to package and type declarations, methods, constructors, parameters, fields, and variables.
- java.lang.Override, indicates method overrides a superclass method

```
@Override
public String accountHtml() {
        // overriding code goes here
}
```

  - Compiler error if the method above does not match the signature of a superclass method

```
java.lang.Deprecated, flags method or element as deprecated
        @Deprecated public class Y2Ktools (
                        // deprecated code
        }
```

  - Compiler warning if code extends this class
- java.lang.SuppressWarnings, turns off compiler warnings

```
@SupressWarnings({"unchecked","fallthrough"})
```

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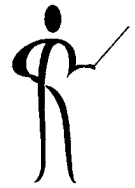
Formatted Output

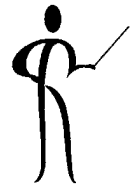
- Even though Java offers the excellent java.text package classes and methods for formatting of data, people with C backgrounds still miss "printf" and its functionality.
- Java 5 adds java.util.Formatter with new capabilities to all of Java's output methods.
- Formatting may be applied using the locale and may be directed to a "sink" (often a file).
- The methods "format()" and "printf()" (C programmers say "hooray!") are synonymous.
- The PrintStream class now includes methods for "format()" and "printf()" using the same formatting characters.

Format Characters



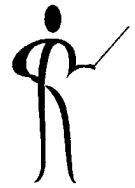
- '%b', '%B' If the argument is null, the result is "false", if it is boolean or Boolean the result is the string returned by String.valueOf(), if it is not null or Boolean the result is "true".
- '%h', '%H' Formats boolean output as "true"/"TRUE" ("%h"/"%H"), "false"/"FALSE" ("%h"/"%H"), or "null"
- '%s', '%S' Formats output as String data using argument's formatTo() method (if available) or toString()
- '%c', '%C' Formats Byte, Short, Character, or Integer as a single character
- '%d' Formats Byte, Short, Integer, Long, or BigInteger as an integer
  '%o' Formats Byte, Short, Integer, Long, or BigInteger as octal
- '%x', '%X' Value (or its hashcode) formatted as hexadecimal integer
- '%e', '%E' Formats Float, Double, or BigDecimal value (exp. notation)
- '%f' Formats Float, Double, or BigDecimal value as floating-point
- '%g', '%G' Formats Float, Double, or BigDecimal value with less than six significant digits using floating-point notation
- '%a', '%A' Formats Float, Double, or BigDecimal value with less than six significant digits using floating-point notation with base-16 values for the decimal part and base-10 values for the exponent
- '%t', '%T' Prefix used for date/time conversions (see below)
- '%%' Used to print a literal '%'
- '%n' Platform-specific line separator

Time Characters



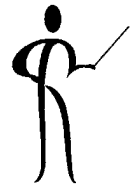
- 'H' 2-digit hour using 24-hour clock (leading zero)
- 'I' 2-digit hour using 12-hour clock (leading zero)
- 'k' Hour using 24 hour clock (0-23)
- 'l' Hour using 12-hour clock (1-12)
- 'M' 2-digit minute within hour (leading zero)
- 'S' 2-digit seconds within minute (leading zero)
- 'L' 3-digit millisecond within second (leading zeros)
- 'N' 9-digit nanosecond within second (leading zeros)
- 'p' Locale-specific morning or afternoon marker in lower
- case for "%tp" (am/pm) upper case for "%Tp" (AM/PM)
- 'z' RFC 822 time zone offset from GMT, e.g. -0800
- 'Z' String representing timezone abbreviation
- 's' Seconds since the beginning of the epoch starting 1 January 1970 00:00:00 UTC (Long value)
- 'Q' Milliseconds since the beginning of the epoch starting 1 January 1970 00:00:00 UTC (Long value)

Date Characters



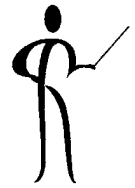
- 'B' Locale-specific full month name ("January")
- 'b' Locale-specific abbreviated month name ("Jan")
- 'h' Same as 'b'.
- 'A' Locale-specific full name of the day of the week ("Sunday")
- 'a' Locale-specific short name of the day of the week ("Sun")
- 'C' 2-digit year (00-99), four-digit year divided by 100 (leading zero)
- 'Y' 4-digit year (0000-9999)
- 'y' Last two digits of the year (leading zeros)
- 'j' 3-digit (Julian) day of year (001-366, leading zeros)
- 'm' 2-digit month (leading zero)
- 'd' 2-digit day of month (leading zero)
- 'e' 2-digit day of month (1-31)

Date/Time Characters



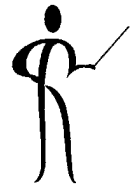
- 'R' Time formatted for the 24-hour clock as "%tH:%tM"
- 'T' Time formatted for the 24-hour clock as "%tH:%tM:%tS"
- 'r' Time formatted for the 12-hour clock as "%tI:%tM:%tS %Tp" (morning/afternoon marker ('%Tp') location may be locale-dependent)
- 'D' Date formatted as "%tm/%td/%ty"
- 'F' ISO 8601 complete date formatted as "%tY-%tm-%td".
- 'c' Date and time formatted as "%ta %tb %td %tT %tZ %tY", e.g. "Sun Jul 20 16:17:00 EDT 1969"

Special Characters



- Formatting also uses special flags to control print-related functionality like justification, signs, and zero padding.
  - '-' Right-justified output (all data types)
  - '#' Left-justified output (numeric data only)
  - '+' Output includes sign (numeric data only)
  - ' ' Output includes leading-space for positive values (numeric data only)
  - '0' Output is zero-padded (numeric data only)
  - ',' Output uses group locale-specific group separators (numeric data only)
  - '(' Output surrounds negative numbers with parentheses (numeric data only)

System.out.format Examples



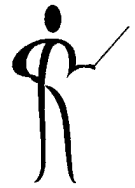
- Here is an example of a numeric value being formatted using System.out.format(), System.out.printf() works identically:

```
double balance = 1234.56;
System.out.format("Balance is $%,6.2f",balance);
    Output:
                    Balance is $1,234.56
```

- Here is an example of a date being formatted using System.out.format():

```
Date today = new Date();
System.out.format("\nToday is %TF %TT",
today,today);
    Output:
          Today is 2005-06-09 20:15:26
```

Formatter Examples



- The Formatter class may also be used to format String data anytime, the following example shows the use of the Formatter object and locales:

```
Formatter myUSformat = new Formatter();
Formatter myFRformat = new Formatter();
String balUS = myUSformat.format("Balance is $%,6.2f",
                                 balance).toString();
String balFR = myFRformat.format(Locale.FRANCE,
           "Balance is $%,6.2f",balance).toString();
System.out.println("US " + balUS);
System.out.println("FRANCE " + balFR);
    Output:
           US Balance is $1,234.56
           FRANCE Balance is $1 234,56
```

Variable argument lists

- Java 5's new variable argument lists (VarArgs) allow specification of a method that can accept a final parameter of the same time with the number of values to be determined at runtime.
  - Only one variable argument list is allowed per method
  - Variable list must be the last argument defined for the method.
  - The ellipsis "…" is used to indicate that an argument might appear a variable number of times.
- In the class below, the constructor is designed to expect a variable number of options for the specified automobile:

```
public Auto (String year, String make, String model, String... options) { … )
```

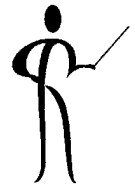
- The variable argument list allows specification of multiple cars with varying lists of options as shown below. Though this example is illustrated using String data type, any data/object type may be used.

```
Auto johnsToy = new Auto("1969","Fiat","124 Spider", "5-speed", "disk brakes");
Auto myTruck = new Auto("1997","Ford","Expedition", "Automatic",
                  "Four-wheel drive","power windows","power locks",
                  "air-conditioning","stereo with cd changer","tinted glass");
```

Scanner Input

- Console input is not common in production programs, but it is very useful when learning Java or creating test modules.
- Before Java 5 we frequently used System.in and its "readLine()" method to access the keyboard.
- Java 5 introduces the java.util.Scanner class designed specifically for this purpose greatly reducing the amount of code needed to communicate with the keyboard.

Keyboard Input – Old Style



```
String firstName;
InputStreamReader inStream = new
InputStreamReader(System.in);
BufferedReader inBuf = new BufferedReader(inStream);
System.out.print("Please enter your first name => ");
try {
       firstName = inBuf.readLine();
} // end of first try block
catch (IOException e) {
  System.out.println("Problem reading first name");
  return;
} // end catch block
```

Keyboard Input – New Style

```
String lastName;
System.out.print("Please enter your last name => ");
Scanner fromkeyboard = new Scanner(System.in);
lastName = fromkeyboard.next();
```

- Scanner objects have several input methods:
  - next() returns the next String token from the input buffer
  - next(comparePattern) or next(compareString) where the next String matching a given pattern is returned.
  - Numeric variations include:
    - nextBigDecimal()
    - nextBigInteger()
    - nextBoolean()
    - nextByte()
    - nextDouble()
    - nextFloat()
    - nextInt()
    - nextLine()
    - nextLong()
    - nextShort()

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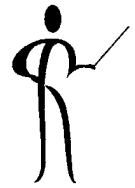
Synchronization

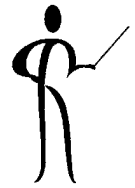
- Beginning with Java 5 (Java 1.5) the java.util.concurrent.locks, java.util.concurrent, and java.util.concurrent.atomic packages are available providing better locking support than provided by the "synchronized" modifier.
- All existing code still works as before.
- The java.util.concurrent.locks.Lock interface has several methods including:
  - lock() to obtain a lock (blocking if the lock cannot be obtained)
  - unlock() to release a lock
  - lockInterruptibility() obtains a lock but allows interruptions
  - tryLock() attempts to obtain a lock without a wait.
- The java.util.concurrent.locks.ReentrantLock class behaves very much like using synchronized does today.
- The java.util.concurrent.locks.Condition interface allows complex and multiple conditional waits.
- The java.util.concurrent.locks.ReadWriteLock interface allows separate locks for reading and writing.

StringBuilder class



- New with Java 5.0 (Java 1.5) the java.lang.StringBuilder class provides a faster alternative to StringBuffer.
- In most ways StringBuilder works exactly the same as StringBuffer.
- StringBuilder is faster than StringBuffer because it is not ThreadSafe and multiple threads should not access StringBuilder objects without Synchronizing.
- Developers should use StringBuilder when speed is important in a single-thread environment and use StringBuffer if multiple threads might require access.
- Strings are very useful but immutable, if applications are constantly changing the value of a String, memory is being allocated and reallocated in an inefficient manner.
- The StringBuilder (java.lang.StringBuilder) class by contrast is mutable and should be used for strings that will change in size or value frequently. The efficiency difference is significant for applications that “build” output lines by concatenating strings.

StringBuilder Example



```
/** StringBuilderTest.java */
public class StringBuilderTest {
   public static void main(String[] args) {

      String myString = "How";
      StringBuilder myStrBldr = new StringBuilder("How");

      myString += " now";
      myString += " Brown";
      myString += " Cow?";

      myStrBldr.append(" now");
      myStrBldr.append(" Brown");
      myStrBldr.append(" Cow?");

      System.out.println("String = " + myString);
      System.out.println("StringBuilder = " + myStrBldr);
   }
}
```

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Conclusion

- Java 5 or Java 1.5 (whatever the name is) provides many features to make the life of developer richer allowing creation of better and more interesting programs.
- Generics and the new for loop are probably exciting enough in their own right, but the other features all work together to make this new release the best Java ever.

Training Days 2006

Mark your calendar for:

February 15-16, 2006!

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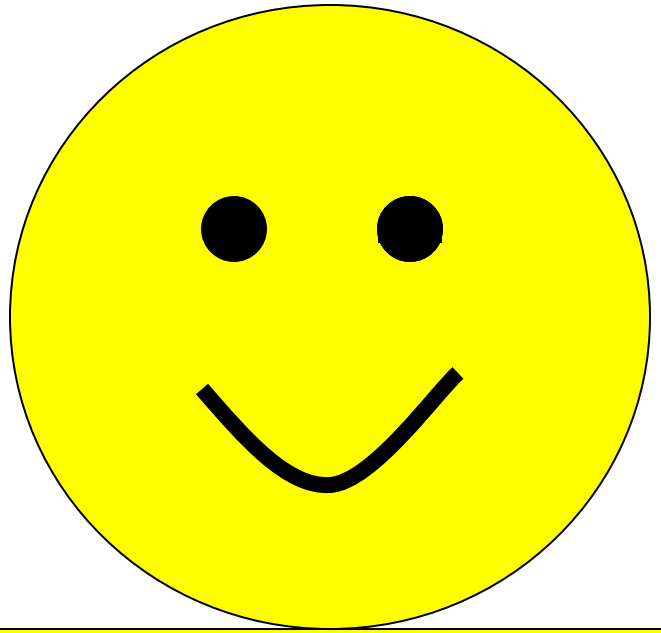

Thanks for your attention!

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