JAVA
An overview for C++ programmers

Wagner Truppel
wagner@cs.ucr.edu

March 1st, 2004

The early history

- James Gosling, Sun Microsystems
- Not the usual start for a prog. language
  - Consumer electronics, 1991
  - *Mosaic* and the Internet, 1994
  - The revolution: *applets*, 1995
- Since then, many improvements and additions have been made to the language
- http://java.sun.com/features/1998/05/birthday.html

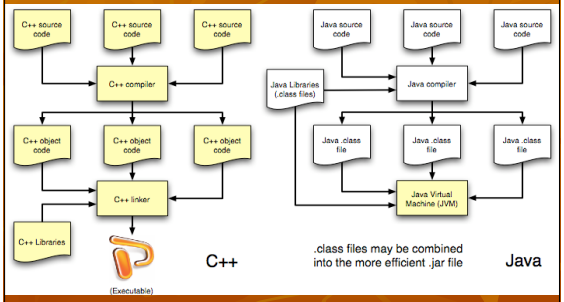
Why is Java so appealing ?

- Platform independent
- Safe
- Easy to learn
- Powerful, well-documented, and easy-to-use libraries to perform many complicated tasks
- During this presentation, we'll look into each of these qualities, and more
  - Comparison to C++
  - Hands-on activities

Platform independence

- Sun's motto for Java:
  write once, run anywhere
- It's a great idea, but…
  - how's it done ?
  - what are the drawbacks ?

Platform independence



Platform independence

- Wait… so does it mean that Java is an *interpreted* language ? Yes, source is compiled into *bytecodes*.
- Aren't interpreted languages inherently slower than compiled ones ? Yes.
- Why you should not care so much, though:
  - Java trades speed for
    - platform independence
    - safety (more on this later)
  - Java compilers are pretty darn good anyway
- Still, if you're *really* worried about speed, you may always use the so-called *just-in-time* (JIT) compilers.

Safe and easy to learn

- The first thing to note here is that these are *relative* terms
- In this talk, we'll compare Java and C++
- The general consensus is that Java is easier to learn and use than C++, but I'll let *you* be the judge of that.
- Is Java saf*er* than C++ ?

Saf*er* than C++ ?

- What do we mean by "safe" anyway ?
  Less prone to programmer mistakes
- Java achieves better safety than C++ by
  - providing *sandboxes* (won't talk much about them here)
  - checking *every* array access for out-of-bounds errors
  - eliminating direct access to pointer operations
  - automatically reclaiming any (heap) memory space not in use (*automatic garbage collection*)
  - having a less fragile approach to multiple inheritance
  - making *every* function *virtual*
  - providing, generally speaking, a simpler syntax than C++

No pointers ?

- Some people claim that Java has no pointers… Not true!
  - All objects are accessed through *references*, which are automatically de-referenced pointers
  - However, the pointer nature of these references is hidden from the programmer. Why ?
    - Reduced number of pointer-related errors

Automatic garbage collection

- Objects are *always* allocated in the *heap*, using *new*, as in `Foo f = new Foo();`
  - `f` itself is always allocated in the *stack*
  - the *object* referenced by `f` is allocated in the *heap*
  - recall that memory allocation in C++ is not so simple
- Java keeps track of how many valid references exist for each object – when an object has no more references to it, the memory space it occupies in the heap gets reclaimed
- No, it doesn't mean that you may be sloppy
- Automatic garbage collection has pros and cons
  - Pro: prevents many common memory allocation bugs
  - Con: has a negative impact on your program's efficiency

No multiple inheritance ?

- C++ inheritance forces the inheritance of both data and behavior (code)
  - That's a very fragile approach – in order to inherit some behavior your class may have to gain some data as well, even if it's not really needed
- Java solves that problem and at the same time eliminates the need for multiple inheritance by defining something called an *interface*
  - Interfaces only define the expected behavior of a set of functions, like a *contract* – no data and no implementation
  - A class may implement as many interfaces as needed
- Of course, regular inheritance between classes is still allowed, but a class may inherit from only one other class - no multiple *class* inheritance in Java

Functions are *always virtual*

- All (non-static) functions in Java follow a late-binding process
  - Which function code is actually executed depends on the actual run-time type of the object on which the function is being called, not on the object's declared type at compile time
- In C++, unless one declares a function to be virtual, the code to be executed is decided at compile time
- Thus, in Java, all (non-static) functions are virtual
- Late-binding is a little slower but prevents common hard-to-find bugs

Other differences between Java & C++

- (Almost) everything is an object
  - Only primitive types (*boolean*, *char*, *int*, *long*, *float*, *double*) are *not* objects
- Function arguments are *always* passed by *value*
  - Objects are *not* copied – only their references are
- Neat solution to name collisions (*package*s)
- No separation between header and implementation
- No operator overloading
- No *struct*s
- No generics (*templates*) and no *enum*s (constant enumerations) until Java 2, 1.5

A few other nice things about Java

- Inherently multi-threaded
  - Threads are supported at the language level and are also objects
- Much nicer compiler and run-time error messages than C++
- Exception handling is idiomatic – every Sun-written library uses it and does so consistently
- Powerful and easy-to-use libraries for data structures, multi-threading, networking, I/O, graphics, GUI

Other cool stuff

- *Javadoc*
  - Auto-documenting your code
    - Your comments are nicely formatted into a set of HTML pages
  - C++ has something similar: *Doxygen*
- *Swing*
  - Dynamically pluggable look-and-feel (plaf)
  - Powerful, easy-to-use GUI toolkit

Examples, please !

Hot from the Sun…

- Current release version: Java 2, 1.4.2
- Java 2, version 1.5 beta is out
  - Support for generics (*templates*)
  - Autoboxing
  - Enhanced `for` loop
  - Enumerated types
  - Static import
  - C-style formatted input/output
  - Variable arguments
  - and more…
- http://java.sun.com/developer/technicalArticles/releases/j2se15/

References – online

- The creators of Java
  - http://www.java.sun.com/
- The Java Developer Connection is a must. In particular, their Tech Tips free mailing list is awesome
  - http://developer.java.sun.com/
- A cool site to keep in touch with Java news
  - http://www.ibiblio.org/javafaq/index.shtml
- This site's free subscription mailing lists are excellent
  - http://www.javaworld.com/

References – books I (basics)

- The Java Tutorial: A Short Course on the Basics
- Thinking in Java (http://www.mindview.net/Books/TIJ/)
- The JFC Swing Tutorial
- Java in a Nutshell
- Java Cookbook
- The Elements of Java Style

References – books II (intermediate)

- Practical Java Programming Language Guide
- Effective Java Programming Language Guide
- Java Pitfalls: Time-Saving Solutions and Workarounds to Improve Programs
- Design Patterns Java Workbook
- *GoF*'s Design Patterns (C++)

Questions ?

I'd like to thank

- all of *you* for coming (and staying !)
- *Titus Winters* and *Dan Berger*, for organizing these talks and for inviting me to give this one