Java : Design Goals

A general-purpose concurrent
object-oriented language
for the Internet

Framework-Oriented Programming

- Familiar
  - C/C++ syntax
- Simple
- Portable
  - Platform-independent
  - Architecture-neutral
- Object-oriented
- Reliable
- Robust
- Interpreted
  - Efficient
- Secure
- Concurrent
  - Interactive
- Distributed
  - For Internet

Simplicity

- Programmer perspective
  - Automatic garbage collection
    - Avoids memory leaks.
    - Avoids dangling pointers
  - No C++ structure/union.
    - Only "pointer" to structure.
  - "Unconstrained" array type
- Implementer perspective
  - No multiple inheritance of code.
    - Only single inheritance of classes.
  - Restricted overloading.

Garbage Collection : Perspectives

- Garbage Collection is necessary for fully modular programming, to avoid introducing unnecessary intermodular dependencies.
  - *"Uniprocessor Garbage Collection Techniques" by Paul R. Wilson et al*
- Two of the most powerful tools available to the software engineer are abstraction and modularity. ... Automatic memory management gives increased abstraction to the programmer.
  - *"Garbage Collection" by Jones and Lin*

Portability

- Architecture-neutral
  - Size of *integer*, *char*, etc. and the meaning of floating point operations fixed by the language.
- All "behavioral" aspects of a Java program defined by the Java language specification, rather then left to the implementation.
  - Order of evaluation of operands fixed.
  - Error and Exception handling
    - Imposes a degree of uniformity on the outcome of running a program.

Non-portability : *gotcha.c*

```
main()   {
    int i  = 5;
    printf("%d \n",  i);
    printf("%d   %d   %d  \n",
             i, i/++i, i);
}
```

- *Intuitively??*
  - **5 0 6**


```
class PortJava {
 public static void main(String[] args){
     int i = 5;
     System.out.println("\t i = " + i
                 + "\t i/++i = " + i/++i
                 +  "\t i = " + i);
  }
}
```

- Output:: `i = 5 i/++i = 0 i = 6`


```
class PortableJava {
 public static void printOrder(int i,int j,int k)
  {
      System.out.print("\t i-> " + i);
      System.out.print("\t j-> " + j);
      System.out.println("\t k-> " + k);
  }
 public static void main(String[] args)
  {
      int i = 5;
      printOrder(i, i/++i, i);
  }
}
```

- Output:: `i-> 5  j-> 0  k-> 6`

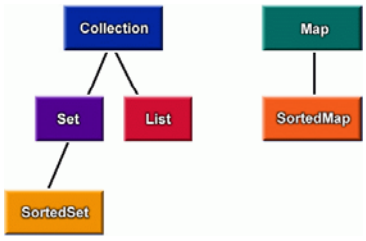
Possible Outcomes

- SPARC : `cc/gcc gotcha.c -ldl; a.out`
  - **6 1 6**
- Alpha, MIPS : `cc/gcc gotcha.c; a.out`
  - **5 1 6**
- SUN-3 : `cc gotcha.c ; a.out`
  - **6 1 5**

Object-oriented programming

- Programming with Data Types
  - Data Abstraction
    - Modularity
    - Encapsulation (*information hiding*)
- Reuse and Sharing
  - Inheritance
    - Reusing code
  - Polymorphism and Dynamic binding
    - Sharing behavior; Frameworks

Java Collections : *Interfaces*



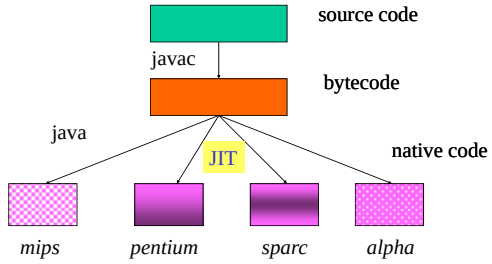
Java Collections : *Implementations*

		Implementations			
		Hash Table	Resizable Array	Balanced Tree	Linked List
Interfaces	Set	HashSet		TreeSet	
	List		ArrayList		LinkedList
	Map	HashMap		TreeMap	

Reliability and Robustness

- Reliability
  - Degree of Confidence in "error-free" execution of a program after a clean compile.
  - Strong typing
- Robustness
  - "Graceful degradation" behavior of a program when presented with an input that violates preconditions. (Cf. **correctness**)
  - Exception handling

Java : Compiler and Interpreter



Interpreted, Efficient, Secure

- A Java program is compiled into *bytecode* that is *interpreted* by the Java Virtual m/c.
- *Just-In-Time compilers* convert bytecode into native code for *efficiency*.
- JVM performs various *security* checks while executing bytecode.
  - JVM enforces severe access restrictions while running applets downloaded from a remote site.

Evolution of Sun's JDK

- Java 1.0: Interpreter
- Java 1.1: Interpreter + JIT Compiler
- Java 2 : Hotspot
  - Profiling and Adaptive Dynamic Compilation of "*hot*" code
  - Method in-lining and other aggressive optimizations, and Decompilation
  - Improved Memory Management for long-running (server) programs
  - Fast Thread Synchronization

Improvements : Java *vs* C++

"Java is better than C++, more because of what it does not have, than for what it has."

- No global vars.
  - Typos detected, not misinterpreted.
- No *goto*s.
  - Disciplined uses *abstracted* (exceptions, labeled breaks).
- No pointers.
  - Array-index out-of-bounds detected.
  - In Java, pointers cannot be manipulated *explicitly*. However, they serve as *object handles*.
- No *explicit* memory management.
  - No memory leaks and no illegal access of freed storage.
  - Improves readability.

Concurrent Programming

- Threads can share address space. In Java, threads are modeled after Hoare's *monitors*.
- Java is a ***multi-threaded*** system, which is very convenient for coding *interactive*, *multi-media* applications.
  - Doing I/O *concurrently* with reading a document. (*downloading via browser*)
  - Periodic updating of the screen with *data* acquired in real-time. (*sports/stocks ticker*)

Distributed Processing

- WWW (URL+HTTP+HTML) contributed immensely to the sharing of (distributed) *static* data.
  - URL encodes description of a protocol, service, server name, location of a resource on the server, etc. succinctly.
    - `http://www.cs.wright.edu/~tkprasad`
    - `ftp://user@host:port/path`
    - `mailto:user@host`
  - URL facilitated access to remote resources by integrating access to various protocols/services such as FTP, telnet, mail, http, etc in a browser.
- Java contributed immensely to the sharing of dynamic/executable content.

(cont'd)

- CGI scripts enabled dynamic customization of responses based on user input (using FORMS).
  - However, this also requires a centralized, powerful server to run scripts to process client requests.
- Java applets enabled moving code to a client machine in response to a client request (rather than the final data).
  - Computations distributed to client machines (providing an alternative to the traditional client-server model).
  - More responsive interaction, and emphasis on portability .
    - Required support for *GUIs, network programming, virtual machine, etc.*