The Ptolemy C Code Generator

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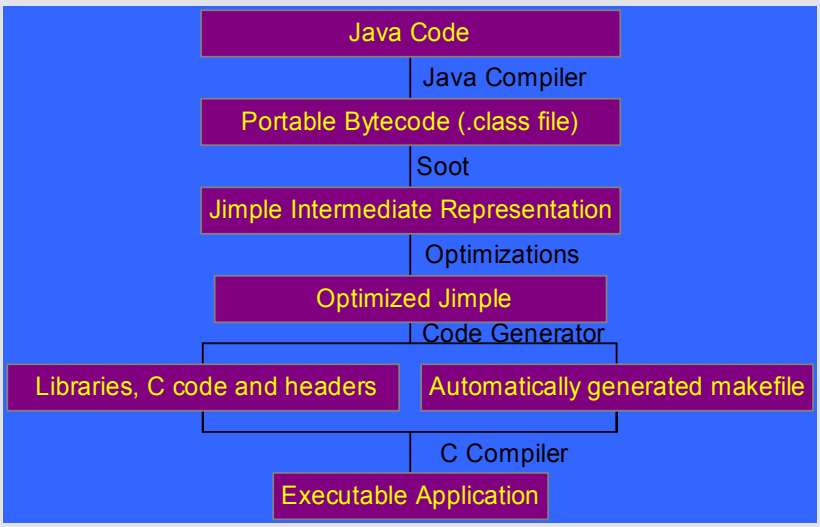
Why C?

- Fast
  - fewer runtime checks.
  - no JVM overhead.
- Small
  - full library not needed.
- Retargetability
  - ANSI C source code is portable.
  - No JVM needed.
  - Can run on embedded systems with no JVM and no OS.
- More optimized
  - C compilers have highly configurable, well-studied optimizations.

Cracking the Code

- *Problem*: Java Bytecode is stack-based. C uses local variables.
  - Use Soot to unroll the stack into local variables while transforming it into intermediate representation.
- *Problem*: Java is Object-Oriented. C is not.
  - Use hashing to give each method/field a different name.
  - Use structures for Objects/Classes.
  - Dare to use indirect function pointers (scary, but it works).
- *Problem*: Java relies heavily on exceptions. C has no support for exceptions.
  - Build support for exceptions in C using setjmp-longjmp.
- *Problem*: Java has automatic garbage collection, C does not
  - Use a C-based GC as a plugin.
- *Problem*: Java relies on JVM or OS for some functionality
  - Build a runtime library to provide the required functionality.

The Dark Art of Java-to-C Compilation



Trimming the Tree

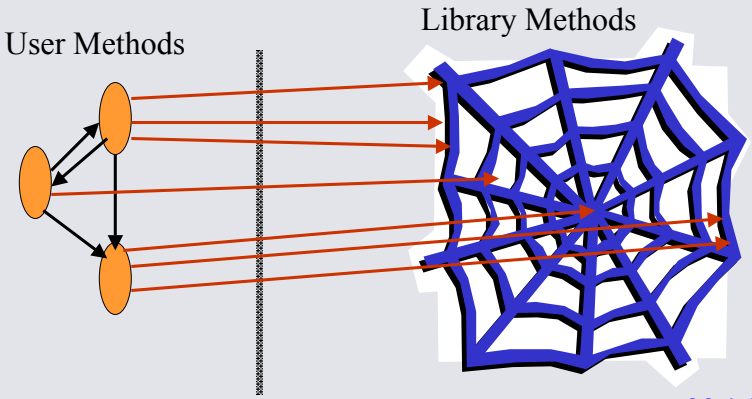
- Set up MethodCallGraph
- Start with main class and all its methods as required.
- Start worklist-based algorithm
  - If you see a class:
    - look at its initialization methods.
    - look at its superclasses.
  - If you see a field:
    - look at the class declaring it.
    - look at the class of its type.
  - If you see a method:
    - look at all fields it references.
    - look at all methods it calls.
    - look at its class.
    - look at the classes of exceptions it throws/catches.

Strategies for Speeding Up Compilation

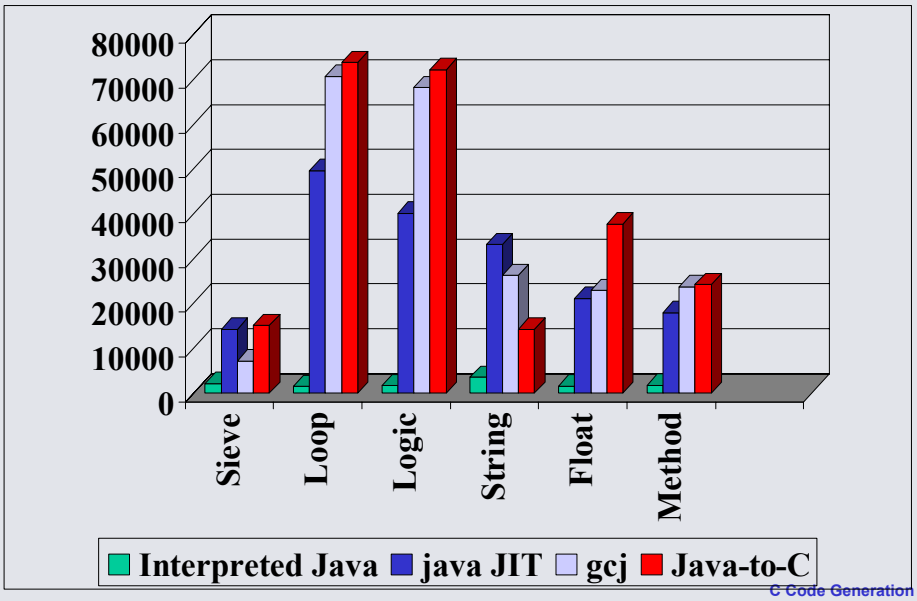
- Create single untrimmed shared static library
  - too simplistic.
  - generating library takes too long.
  - code bloat.
- Generate separate library trimmed for each application
  - still takes a long time.
  - mostly spending time figuring out polymorphic method calls within library classes.

Strategies for Speeding Up Compilation (continued)

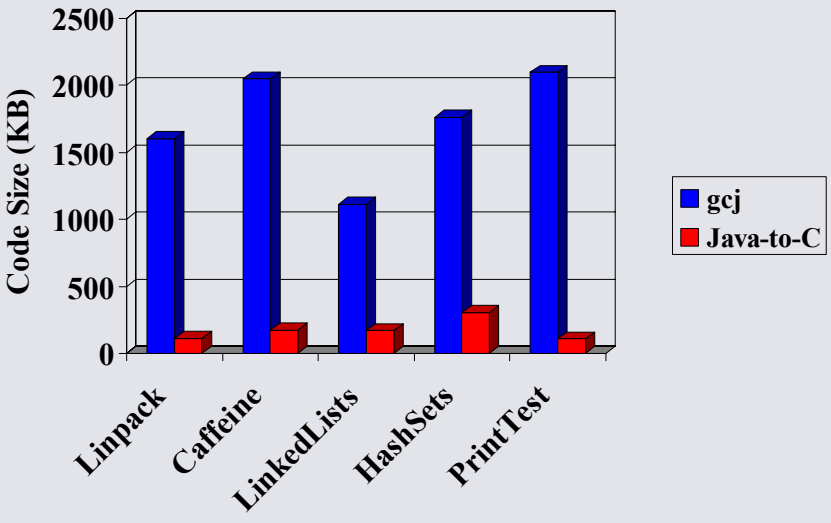
- Divide code into application and library classes:
  - cache library method targets in a disk file.
  - compile-time analysis is simplified.
  - extensible to any library classes (Ptolemy?)



Faster …



… and much, much smaller.



Roadmap

- Automatic makefile generation.
- Generated fully ANSI-compliant C.
- Inheritance.
- Exceptions.
- Multidimensional arrays.
- Interfaces.
- Automatic Garbage Collection.
- Plugging in to ptolemy.
- Further generic optimizations.
- Further ptolemy-specific optimizations.
- Run java code on a DSP.