JIT Compilation for VA Smalltalk

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VA Smalltalk VM
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› Performance-critical parts powered by LLVM
› CMake-based build system
› FFI powered by libffi
› True headless optional VM
› VA Smalltalk is IoT ready!
VA Smalltalk VM Update

› New interpreter for ARM
› Improved interpreter for x86
› Return struct by value for FFI
› New JIT compiler for x86 (ARM-ready)
New JIT Compiler
New JIT Compiler

› Template-based
› Powered by LLVM
› Very fast
Templates

› Generated by LLVM at build-time
› Minimum platform-specific parts
› Maximum code reuse with interpreter
› Templates as a standard object file
A Typical Template

TPpushLiteral:

movabsq $FXMethodLiteralOp0, %rax
movq %rax, -8(%r15)
addq $-8, %r15
Compiling

› Copy templates
  › Do optimisations
 › Perform relocations fixup
Optimisations

› Super-instructions
› Avoid stack usage where possible
› Inline caches
Inline caches

› Monomorphic inline cache
› Polymorphic inline cache
› Megamorphic inline cache
A Send Template

TPsendArgs0:
  movq %rdx, 88(%rbp)
  movabsq $FXReturnAddress, %rsi
  movq %rsi, 96(%rbp)
  movl $768, 224(%rbp)
  movabsq $FXSendArgsReturnTo, %rax
  xorl %edx, %edx
  rex64 jmpq *%rax
  [ inline cache data ]
Decompilation

› PC is native in a stack frame
› No additional memory footprint
› Frame is marked if it is running native code
Benchmarks
Integer Arithmetic

Seconds (Less is Better)
Factorial

Seconds (Less is Better)
Prime Summing

Seconds (Less is Better)
Pi Digits

Seconds (Less is Better)

arbitrary-precision arithmetic
Mandelbrot

Seconds (Less is Better)

- 8.x_JIT
- 8.x_INTERP
- 9.x_JIT
- 9.x_INTERP
Spectral Normalization

- The spectral norm of an infinite matrix $A$, with entries $a_{11}=1$, $a_{12}=1/2$, $a_{21}=1/3$, $a_{13}=1/4$, $a_{22}=1/5$, $a_{31}=1/6$, etc.
- Fraction arithm & arrays
Binary Trees

Allocate-walk-deallocate binary trees

Seconds (Less is Better)
N-Body

Models planet orbits, lots of floating-point operations

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Seconds (Less is Better)
Fasta

DNA chains. Integer & arrays

Seconds (Less is Better)
Creatures of different colors. Process switching

Chameneos-redux

Seconds (Less is Better)
Customers Feedback

We did some testing with x86 and got good results:

In a typical use case we have execution times e.g.

VA8.0.2x86       17.5 sec
VA9.0.1x86       21.5 sec
VA9.2x86_JIT    12.8 sec

— An Instantiations VA Smalltalk Customer
Conclusion
VA Smalltalk 9.2

› Available now under Early Customer Access Program (ECAP) at instantiations.com/ecap
› v.9.2 Release later this year
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Questions?