Implementation Strategies for Language-Oriented Architectures

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Abstract

Each programming language has a corresponding virtual-machine (VM) architecture that can execute a program in that language (a fact language compilers can take advantage of). The instruction sets of these language-oriented architectures are much more often interpreted by software than by hardware.

To the extent that instructions/second is a meaningful measure of hardware power, VM instructions/second is a meaningful measure of interpreter power. Comparisons of performance between VM architectures are colored by the fact that speed depends on both the VM and underlying hardware architectures and the implementation of the interpreter. Nevertheless, comparisions are suggestive. For example, compare the instruction rates in the table below for the VM architectures of a set of A.I. languages.

Language	Encoding Method	Interpreter Implementation Language	Hardware	Clock (MHz.)	VM Instructions Per Second
Smalltalk[1]	byte code	microcode	Dorado	20.0	300,000
Smalltalk[2]	byte code	macrocode	68000	12.5	100,000
Prolog [3]	threaded code	Forth	NC4000	4.0	96,000
Prolog [3]	threaded code	Forth	NC4000	10.0	320,000 est
Prolog [4]	byte code	C	VAX 11/780	-	66,000
Scheme [5]	byte code	macrocode	68000	5.0	30,000 est

[1] Deutsch, L.P. (1982). The Dorado Smalltalk-80 Implementation: Hardware Architecture's Impact on Software Architecture In Smalltalk-80 Bits of History, Words of Advice. Addison Wesley.

[2] Deutsch, L.P. and Schiffman A.M. (1984). Efficient Implementation of the Smalltalk-80 System. In Conference Record of the Eleventh Annual ACM Symposium on Principles of Programming Languages. pp. 297-302

[3] Odette, L.L. and Wilkinson, W.. (1986). Prolog at 20,000 LIPS on the Novix? Proceedings FORML Conference

[4] Gabriel, J., Lindholm, T., Lusk, E L., and R.A. Overbeek (1985). A Tutorial on the Warren Abstract Machine for Computational Logic. Technical Report ANL-84-84. Argonne National Laboratory

[5] Schooler, R. and Stamos, J.W. (1984). Proposal for a Small Scheme Implementation. Technical Report MIT/LCS/TM-267. Massachusetts Institute of Technology

We argue that Forth provides marked advantages over conventional approaches to implementing VM interpreters.