

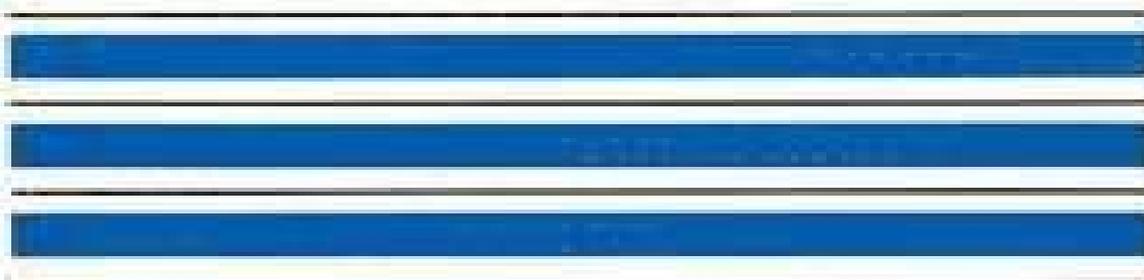
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# **A Systolic Array Optimizing Compiler**

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**Monica S. Lam**

**foreword by H.T. Kung**



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# Systolic Array Optimizing Compiler

**D. Arnold**



## **Systolic Array Optimizing Compiler:**

**A Systolic Array Optimizing Compiler** Monica S. Lam, 2012-12-06 This book is a revision of my Ph D thesis dissertation submitted to Carnegie Mellon University in 1987 It documents the research and results of the compiler technology developed for the Warp machine Warp is a systolic array built out of custom high performance processors each of which can execute up to 10 million floating point operations per second 10 MFLOPS Under the direction of H T Kung the Warp machine matured from an academic experimental prototype to a commercial product of General Electric The Warp machine demonstrated that the scalable architecture of high performance programmable systolic arrays represents a practical cost effective solution to the present and future computation intensive applications The success of Warp led to the follow on iWarp project a joint project with Intel to develop a single chip 20 MFLOPS processor The availability of the highly integrated iWarp processor will have a significant impact on parallel computing One of the major challenges in the development of Warp was to build an optimizing compiler for the machine First the processors in the xx A Systolic Array Optimizing Compiler array cooperate at a fine granularity of parallelism interaction between processors must be considered in the generation of code for individual processors Second the individual processors themselves derive their performance from a VLIW Very Long Instruction Word instruction set and a high degree of internal pipelining and parallelism The compiler contains optimizations pertaining to the array level of parallelism as well as optimizations for the individual VLIW processors *A Systolic Array Optimizing Compiler*

Monica S. Lam, 2011-10-17 This book is a revision of my Ph D thesis dissertation submitted to Carnegie Mellon University in 1987 It documents the research and results of the compiler technology developed for the Warp machine Warp is a systolic array built out of custom high performance processors each of which can execute up to 10 million floating point operations per second 10 MFLOPS Under the direction of H T Kung the Warp machine matured from an academic experimental prototype to a commercial product of General Electric The Warp machine demonstrated that the scalable architecture of high performance programmable systolic arrays represents a practical cost effective solution to the present and future computation intensive applications The success of Warp led to the follow on iWarp project a joint project with Intel to develop a single chip 20 MFLOPS processor The availability of the highly integrated iWarp processor will have a significant impact on parallel computing One of the major challenges in the development of Warp was to build an optimizing compiler for the machine First the processors in the xx A Systolic Array Optimizing Compiler array cooperate at a fine granularity of parallelism interaction between processors must be considered in the generation of code for individual processors Second the individual processors themselves derive their performance from a VLIW Very Long Instruction Word instruction set and a high degree of internal pipelining and parallelism The compiler contains optimizations pertaining to the array level of parallelism as well as optimizations for the individual VLIW processors *A Systolic Array Optimizing Compiler*

M. S.-L. Lam, 1987 **A Systolic Array Parallelizing Compiler** Ping-Sheng Tseng, 1990-08-31 Widespread use of

parallel processing will become a reality only if the process of porting applications to parallel computers can be largely automated. Usually it is straightforward for a user to determine how an application can be mapped onto a parallel machine; however, the actual development of parallel code if done by hand is typically difficult and time consuming. Parallelizing compilers which can generate parallel code automatically are therefore a key technology for parallel processing. In this book Ping Sheng Tseng describes a parallelizing compiler for systolic arrays called AL. Although parallelizing compilers are quite common for shared memory parallel machines, the AL compiler is one of the first working parallelizing compilers for distributed memory machines, of which systolic arrays are a special case. The AL compiler takes advantage of the fine grain and high bandwidth interprocessor communication capabilities in a systolic architecture to generate efficient parallel code. xii

Foreword While capable of handling an important class of applications, AL is not intended to be a general purpose parallelizing compiler.

**Parallel Supercomputing in MIMD Architectures** R. Michael Hord, 2018-02-01 Parallel Supercomputing in MIMD Architectures is devoted to supercomputing on a wide variety of Multiple Instruction Multiple Data (MIMD) class parallel machines. This book describes architectural concepts, commercial and research hardware implementations, major programming concepts, algorithmic methods, representative applications, and benefits and drawbacks. Commercial machines described include Connection Machine 5, NCUBE, Butterfly, Meiko, Intel iPSC, iPSC 2, and iWarp, DSP3, Multimax, Sequent, and Teradata. Research machines covered include the J Machine, PAX, Concert, and ASP. Operating systems, languages, translating sequential programs to parallel, and semiautomatic parallelizing are aspects of MIMD software addressed in Parallel Supercomputing in MIMD Architectures. MIMD issues such as scalability, partitioning, processor utilization, and heterogeneous networks are discussed as well. This book is packed with important information and richly illustrated with diagrams and tables. Parallel Supercomputing in MIMD Architectures is an essential reference for computer professionals, program managers, applications system designers, scientists, engineers, and students in the computer sciences.

*Parallel Computing and Transputers* D. Arnold, 1994 The broadening of interest in parallel computing and transputers is reflected in this text. Topics covered include concurrent programming, graphics and image processing, and robotics and control. It is based on the proceedings of the 6th Australian Transputer and Occam User Group Conference Record of the Fifteenth Annual ACM Symposium on Principles of Programming Languages, 1988

**Encyclopedia of Parallel Computing** David Padua, 2014-07-08 Containing over 300 entries in an A-Z format, the Encyclopedia of Parallel Computing provides easy, intuitive access to relevant information for professionals and researchers seeking access to any aspect within the broad field of parallel computing. Topics for this comprehensive reference were selected, written, and peer reviewed by an international pool of distinguished researchers in the field. The Encyclopedia is broad in scope, covering machine organization, programming languages, algorithms, and applications. Within each area, concepts, designs, and specific implementations are presented. The highly structured essays in this work comprise a synonym, a definition, and a discussion of the topic.

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**Systolic Array Processors** J. V. McCanny,John McWhirter,Earl E. Swartzlander,1989 *Languages and Compilers for Parallel Computing* ,1995 *Languages and Compilers for Parallel Computing* David Hillel Gelernter,Alexandru Nicolau,David A. Padua,1990 A collection of papers examining the languages and compilers for parallel computing It covers a wide variety of topics ranging from improving parallel program performance using critical path analysis to software engineering of parallel programs in the computation orientated display environment

**Proceedings of the International Conference on Application Specific Array Processors** Sun Yuan Kung,1990 *Proceedings* ,1991

[20 Years of the ACM SIGPLAN Conference on Programming Language Design and Implementation](#) Kathryn S. McKinley,2004 Special volume of 50 selected papers with retrospectives from the original authors *Parallel Architectures and Compilation Techniques* Michel Cosnard,Guang R. Gao,Gabriel M. Silberman,1994 Fine and medium grain parallelism continues to hold its own as a vital vibrant research topic Within the area new developments in superscalar and VLIW architectures and their associated compilation techniques have provided exciting new avenues to extract performance from a

slowing technology curve Comprising 28 full length papers and a number of short poster papers this publication offers a high quality exploration of the current state of the art in the field It will be of particular interest to those involved in control structures and microprogramming processor architectures computer system implementation programming techniques and software engineering *Supercomputing 88: Technology assessment, industrial supercomputer outlooks, European supercomputing accomplishments, and performance & computations* ,1988 Parallel Functional Languages and Compilers Bolesław Szymański,1991

## Reviewing **Systolic Array Optimizing Compiler**: Unlocking the Spellbinding Force of Linguistics

In a fast-paced world fueled by information and interconnectivity, the spellbinding force of linguistics has acquired newfound prominence. Its capacity to evoke emotions, stimulate contemplation, and stimulate metamorphosis is actually astonishing. Within the pages of "**Systolic Array Optimizing Compiler**," an enthralling opus penned by a highly acclaimed wordsmith, readers set about an immersive expedition to unravel the intricate significance of language and its indelible imprint on our lives. Throughout this assessment, we shall delve in to the book is central motifs, appraise its distinctive narrative style, and gauge its overarching influence on the minds of its readers.

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