Parallel Programming

Q: So lets just all use multicore from now on!

A: Software must be written as parallel program

Multicore difficulties

- Partitioning work
- **Coordination & synchronization**
- Communications overhead HW
- How do you write parallel programs?

  ... without knowing exact underlying architecture?

SW
Your
career...

Synchronization Of Parallel Programs

András Vajda

Synchronization Of Parallel Programs:

Cas075 Françoise André,Daniel Herman,J.-P. Verjus,1985 This book proposes a method for expressing typical cooperation and competition problems as well as different synchronization and communication methods for implementing them   Distributed Synchronization of Parallel Programs Patrice Quinton,Jean-Pierre Verjus,1986   Distributed Synchronization of Parallel Programs: why and How? Institut National de Recherche en Informatique et en Automatique,P. Quinton,Jean-Pierre Verjus,1986   **Compiler Analysis to Implement Point-to-point Synchronization in Parallel Programs** John Nguyen,1993 Abstract The shared memory data parallel model presents an attractive interface for programming multiprocessors by allowing for easy management of parallel tasks while hiding details of the underlying machine architecture Unfortunately the shared memory abstraction requires synchronization in order to maintain data consistency Present compilers provide consistency between parallel code sections by enforcing a global point of synchrony with a barrier synchronization Such a simple mechanism possesses several disadvantages First the required global collection of information generates significant overhead which leads machine designers to employ special hardware to support barriers Second global synchronization reduces parallelism by requiring needless serialization of independent tasks This work aims to reduce the costs associated with these disadvantages by generating pairwise point to point synchronization between specific tasks Implementation of point to point synchronization demands extensive analysis of program dependences A compiler must perform flow analysis and dependence testing in order to compute lexical dependences between program statements In addition dynamic dependences between processors must be computed by examining array reference and statement contexts The final synchronization scheme must support any dependences that arise in the program while ensuring that no deadlock scenarios can occur This work proposes algorithms that satisfy such requirements and presents some encouraging results from a preliminary implementation   Reducing Synchronization in Distributed Parallel Programs Philip B. Miller,2016

On Synchronization Patterns in Parallel Programs Jean-Loup Baer,Richard N. Zucker,1991 Abstract Efficient synchronization is a key element in obtaining good speed up from parallel programs The overhead introduced by synchronization especially lock manipulation can sometimes remove any benefit from parallelizing programs Techniques to efficiently obtain locks under high contention have been studied in the literature using artificial programs We consider the impact of these techniques in a more realistic framework using a sample of real parallel programs running on a shared bus multiprocessor system Cycles lost to lock contention and the number of processors waiting to acquire a lock are the two principal metrics that we use Trace driven simulation experiments are performed for sequentially consistent and weakly consistent architectural models   *Synchronization Costs in Parallel Programs and Concurrent Data Structures* Vitalii Aksenov,2018 To use the computational power of modern computing machines we have to deal with concurrent programs Writing efficient concurrent programs is notoriously difficult primarily due to the need of harnessing synchronization costs In

this thesis we focus on synchronization costs in parallel programs and concurrent data structures First we present a novel granularity control technique for parallel programs designed for the dynamic multithreading environment Then in the context of concurrent data structures we consider the notion of concurrency optimality and propose the first implementation of a concurrency optimal binary search tree that intuitively accepts a concurrent schedule if and only if the schedule is correct Also we propose parallel combining a technique that enables efficient implementations of concurrent data structures from their parallel batched counterparts We validate the proposed techniques via experimental evaluations showing superior or comparable performance with respect to state of the art algorithms From a more formal perspective we consider the phenomenon of helping in concurrent data structures Intuitively helping is observed when the order of some operation in a linearization is fixed by a step of another process We show that no wait free linearizable implementation of stack using read write compare swap and fetch add primitives can be help free correcting a mistake in an earlier proof by Censor Hillel et al Finally we propose a simple way to analytically predict the throughput of data structures based on coarse grained locking

Static Analyses and Optimizations for Parallel Programs with Synchronization Yuan Zhang,2008 As parallel systems become dominant in computer architectures parallel programs that take the advantage of multiple threads of control are taking the place of conventional sequential programs Yet parallel programs have introduced new challenges to compiler static analyses and optimizations On one hand classical compiler analyses and optimizations need to be enhanced to handle the inter thread interference and synchronization enforced dependence relation in a parallel program On the other hand new analyses and optimizations need to be designed for new programming language features In this dissertation we propose the following compiler static analyses and optimizations for parallel programs with synchronization 1 An interprocedural multi valued expressions analysis for both distributed and shared memory programs based on program slicing An expression is multi valued if it evaluates differently in different threads For Single Program Multiple Data style programs multi valued expressions analysis is a key component to determine the concurrent paths which are executed by different threads concurrently 2 An interprocedural barrier matching technique for both distributed and shared memory programs to detect synchronization errors caused by the misplacement of barriers or if the program is validated to determine the set of barrier statements that synchronize together 3 The first interprocedural concurrency analysis algorithm that can handle shared memory programs with textually unaligned barriers 4 A new framework of flow sensitive and synchronization sensitive data flow analyses for shared memory programs Pointer analysis is used as an example to demonstrate the effectiveness of this framework The most significant advantage of this framework is that inter thread interference and synchronization enforced dependence are modeled as concurrency relation thus it is easily extensible to new language features and compatible with different memory models 5 A lock assignment algorithm to optimize shared memory programs with atomic sections a high productivity synchronization construct that enforces atomicity and mutual exclusion Taking a program annotated with atomic

sections the compiler automatically infers an assignment of the minimum number of locks to atomic sections so as to exploit the parallelism among atomic sections without violating their semantics Two additional lock optimization problems that are closely related to the lock assignment problem are presented **Pro .NET 4 Parallel Programming in C#** Adam Freeman,2011-01-11 Parallel programming has been revolutionised in NET 4 providing for the first time a standardised and simplified method for creating robust scalable and reliable multi threaded applications The Parallel programming features of NET 4 allow the programmer to create applications that harness the power of multi core and multi processor machines Simpler to use and more powerful than classic NET threads parallel programming allows the developer to remain focused on the work an application needs to perform In Pro NET 4 Parallel Programming in C Adam Freeman presents expert advice that guides you through the process of creating concurrent C applications from the ground up You ll be introduced to NET s parallel programming features both old and new discover the key functionality that has been introduced in NET 4 and learn how you can take advantage of the power of multi core and multi processor machines with ease Pro NET4 Parallel Programming in C is a reliable companion that will remain with you as you explore the parallel programming universe elegantly and comprehensively explaining all aspects of parallel programming guiding you around potential pitfalls and providing clear cut solutions to the common problems that you will encounter **A New Construct for Synchronization of Parallel Logic Programs** University of Maryland at College Park. Computer Science Center,S. Kasif,1985 Verification of Sequential and Concurrent Programs Krzysztof R. Apt,Ernst-Rüdiger Olderog,2013-03-09 This book provides a structured introduction to the verification of sequen tial and concurrent programs It thus belongs to the area of programming languages but at the same time it is firmly based on mathematical logic In logic one usually studies fixed syntactic or semantic objects This is not necessarily the case in the area of program verification The objects studied here namely programs do not have a standard syntax their semantics can be defined in many different ways and several approaches to their verification can be contemplated These differences lead to various difficult design decisions Even though we restrict our attention here to one programming style imperative pro gramming we are still confronted with a veritable cornucopia of pro gramming constructs from which an appropriate selection has to be made Having studied some of these constructs separately does not yet imply that we understand their combined effect **Analysis of Synchronization in a Parallel Programming Environment** Rice University. Dept. of Computer Science,J. S. Subhlok,1990 Modelling Communication and Synchronization in Parallel Programming Languages Dennis Harold Freidel,1984 **OpenMP Shared Memory Parallel Programming** Rudolf Eigenmann,Michael J. Voss,2003-05-15 This book contains the presentations given at the Workshop on OpenMP App cations and Tools WOMPAT 2001 The workshop was held on July 30 and 31 2001 at Purdue University West Lafayette Indiana USA It brought together designers users and researchers of the OpenMP application programming int face OpenMP has emerged as the standard for shared memory parallel progr ming For the rst time it is

possible to write parallel programs that are portable across the majority of shared memory parallel computers WOMPAT 2001 s ved as a forum for all those interested in OpenMP and allowed them to meet share ideas and experiences and discuss the latest developments of OpenMP and its applications WOMPAT 2001 was co sponsored by the OpenMP Architecture Review Board ARB It followed a series of workshops on OpenMP including WOMPAT 2000 EWOMP 2000 and WOMPEI 2000 For WOMPAT 2001 we solicited papers formally and published them in the form of this book The authors submitted extended abstracts which were reviewed by the program committee All submitted papers were accepted The authors were asked to prepare a nal paper in which they addressed the reviewers comments The proceedings in the form of this book were created in time to be available at the workshop In this way we hope to have brought out a timely report of ongoing OpenMP related research and development e orts as well as ideas for future improvements **Scientific and Technical Aerospace Reports** ,1991 **Transactional Memory. Foundations, Algorithms, Tools, and Applications** Rachid Guerraoui,Paolo Romano,2014-12-29 The advent of multi core architectures and cloud computing has brought parallel programming into the mainstream of software development Unfortunately writing scalable parallel programs using traditional lock based synchronization primitives is well known to be a hard time consuming and error prone task mastered by only a minority of specialized programmers Building on the familiar abstraction of atomic transactions Transactional Memory TM promises to free programmers from the complexity of conventional synchronization schemes simplifying the development and verification of concurrent programs enhancing code reliability and boosting productivity Over the last decade TM has been subject to intense research on a broad range of aspects including hardware and operating systems support language integration as well as algorithms and theoretical foundations On the industrial side the major players of the software and hardware markets have been up front in the research and development of prototypal products providing support for TM systems This has recently led to the introduction of hardware TM implementations on mainstream commercial microprocessors and to the integration of TM support for the world s leading open source compiler In such a vast inter disciplinary domain the Euro TM COST Action IC1001 has served as a catalyzer and a bridge for the various research communities looking at disparate yet subtly interconnected aspects of TM This book emerged from the idea having Euro TM experts compile recent results in the TM area in a single and consistent volume Contributions have been carefully selected and revised to provide a broad coverage of several fundamental issues associated with the design and implementation of TM systems including their theoretical underpinnings and algorithmic foundations programming language integration and verification tools hardware supports distributed TM systems self tuning mechanisms as well as lessons learnt from building complex TM based applications **Programming Many-Core Chips** András Vajda,2011-06-10 This book presents new concepts techniques and promising programming models for designing software for chips with many hundreds to thousands processor cores Given the scale of parallelism inherent to these chips software designers face new challenges in terms of operating systems

middleware and applications This will serve as an invaluable single source reference to the state of the art in programming many core chips Coverage includes many core architectures operating systems middleware and programming models

Synchronization Architecture in Parallel Programming Models Arturo González Escribano,2003 **Parallel Programming Simulation** Zhuohua Zhou,1999 Describes a parallel computing program that was implemented with a single processor in Windows 98 in Microsoft Visual C 5 0 by using multiple threads synchronizaton and asynchronous parallel processing and MS message management technologies Presents two examples of matrix multiplication and solving linear equations in parallel to show this application *Studies on Memory Consistency and Synchronization Failure Detection in Parallel Programs* ,1998

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