

Embracing Interference in Wireless Systems

Shyamnath Gollakota



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L Darling-Hammond



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Embracing Interference in Wireless Systems Shyamnath Gollakota, 2014-06-01 The wireless medium is a shared resource. If nearby devices transmit at the same time their signals interfere resulting in a collision. In traditional networks collisions cause the loss of the transmitted information. For this reason wireless networks have been designed with the assumption that interference is intrinsically harmful and must be avoided. This book, a revised version of the author's award-winning Ph.D. dissertation, takes an alternate approach. Instead of viewing interference as an inherently counterproductive phenomenon that should be avoided, we design practical systems that transform interference into a harmless and even a beneficial phenomenon. To achieve this goal, we consider how wireless signals interact when they interfere and use this understanding in our system designs. Specifically, when interference occurs, the signals get mixed on the wireless medium. By understanding the parameters of this mixing, we can invert the mixing and decode the interfered packets, thus making interference harmless. Furthermore, we can control this mixing process to create strategic interference that allows decodability at a particular receiver of interest but prevents decodability at unintended receivers and adversaries. Hence, we can transform interference into a beneficial phenomenon that provides security. Building on this approach, we make four main contributions. We present the first WiFi receiver that can successfully reconstruct the transmitted information in the presence of packet collisions. Next, we introduce a WiFi receiver design that can decode in the presence of high power cross technology interference from devices like baby monitors, cordless phones, microwave ovens, or even unknown technologies. We then show how we can harness interference to improve security. In particular, we develop the first system that secures an insecure medical implant without any modification to the implant itself. Finally, we present a solution that establishes secure connections between any two WiFi devices without having users enter passwords or use pre-shared secret keys.

Computational Prediction of Protein Complexes from Protein Interaction Networks Sriganesh Srihari, Chern Han Yong, Limsoon Wong, 2017-05-30 Complexes of physically interacting proteins constitute fundamental functional units that drive almost all biological processes within cells. A faithful reconstruction of the entire set of protein complexes, the complexome, is therefore important not only to understand the composition of complexes but also the higher level functional organization within cells. Advances over the last several years, particularly through the use of high throughput proteomics techniques, have made it possible to map substantial fractions of protein interactions, the interactomes, from model organisms including *Arabidopsis thaliana*, a flowering plant; *Caenorhabditis elegans*, a nematode; *Drosophila melanogaster*, fruit fly; and *Saccharomyces cerevisiae*, budding yeast. These interaction datasets have enabled systematic inquiry into the identification and study of protein complexes from organisms. Computational methods have played a significant role in this context by contributing accurate, efficient, and exhaustive ways to analyze the enormous amounts of data. These methods have helped to compensate for some of the limitations in experimental datasets, including the presence of biological and technical

noise and the relative paucity of credible interactions In this book we systematically walk through computational methods devised to date approximately between 2000 and 2016 for identifying protein complexes from the network of protein interactions the protein protein interaction PPI network We present a detailed taxonomy of these methods and comprehensively evaluate them for protein complex identification across a variety of scenarios including the absence of many true interactions and the presence of false positive interactions noise in PPI networks Based on this evaluation we highlight challenges faced by the methods for instance in identifying sparse sub or small complexes and in discerning overlapping complexes and reveal how a combination of strategies is necessary to accurately reconstruct the entire complexosome

Declarative Logic Programming Michael Kifer, Yanhong Annie Liu, 2018-09-19 The idea of this book grew out of a symposium that was held at Stony Brook in September 2012 in celebration of David S Warren s fundamental contributions to Computer Science and the area of Logic Programming in particular Logic Programming LP is at the nexus of Knowledge Representation Artificial Intelligence Mathematical Logic Databases and Programming Languages It is fascinating and intellectually stimulating due to the fundamental interplay among theory systems and applications brought about by logic Logic programs are more declarative in the sense that they strive to be logical specifications of what to do rather than how to do it and thus they are high level and easier to understand and maintain Yet without being given an actual algorithm LP systems implement the logical specifications automatically Several books cover the basics of LP but focus mostly on the Prolog language with its incomplete control strategy and non logical features At the same time there is generally a lack of accessible yet comprehensive collections of articles covering the key aspects in declarative LP These aspects include among others well founded vs stable model semantics for negation constraints object oriented LP updates probabilistic LP and evaluation methods including top down vs bottom up and tabling For systems the situation is even less satisfactory lacking accessible literature that can help train the new crop of developers practitioners and researchers There are a few guides on Warren s Abstract Machine WAM which underlies most implementations of Prolog but very little exists on what is needed for constructing a state of the art declarative LP inference engine Contrast this with the literature on say Compilers where one can first study a book on the general principles and algorithms and then dive in the particulars of a specific compiler Such resources greatly facilitate the ability to start making meaningful contributions quickly There is also a dearth of articles about systems that support truly declarative languages especially those that tie into first order logic mathematical programming and constraint solving LP helps solve challenging problems in a wide range of application areas but in depth analysis of their connection with LP language abstractions and LP implementation methods is lacking Also rare are surveys of challenging application areas of LP such as Bioinformatics Natural Language Processing Verification and Planning The goal of this book is to help fill in the previously mentioned void in the LP literature It offers a number of overviews on key aspects of LP that are suitable for researchers and practitioners as well as graduate students The following chapters in theory

systems and applications of LP are included

Verified Functional Programming in Agda Aaron Stump, 2016-02-01
 Agda is an advanced programming language based on Type Theory Agda's type system is expressive enough to support full functional verification of programs in two styles In external verification we write pure functional programs and then write proofs of properties about them The proofs are separate external artifacts typically using structural induction In internal verification we specify properties of programs through rich types for the programs themselves This often necessitates including proofs inside code to show the type checker that the specified properties hold The power to prove properties of programs in these two styles is a profound addition to the practice of programming giving programmers the power to guarantee the absence of bugs and thus improve the quality of software more than previously possible *Verified Functional Programming in Agda* is the first book to provide a systematic exposition of external and internal verification in Agda suitable for undergraduate students of Computer Science No familiarity with functional programming or computer checked proofs is presupposed The book begins with an introduction to functional programming through familiar examples like booleans natural numbers and lists and techniques for external verification Internal verification is considered through the examples of vectors binary search trees and Braun trees More advanced material on type level computation explicit reasoning about termination and normalization by evaluation is also included The book also includes a medium sized case study on Huffman encoding and decoding

Heterogeneous Computing Mohamed Zahran, 2019-05-29 If you look around you will find that all computer systems from your portable devices to the strongest supercomputers are heterogeneous in nature The most obvious heterogeneity is the existence of computing nodes of different capabilities e.g. multicore GPUs FPGAs But there are also other heterogeneity factors that exist in computing systems like the memory system components interconnection etc The main reason for these different types of heterogeneity is to have good performance with power efficiency Heterogeneous computing results in both challenges and opportunities This book discusses both It shows that we need to deal with these challenges at all levels of the computing stack from algorithms all the way to process technology We discuss the topic of heterogeneous computing from different angles hardware challenges current hardware state of the art software issues how to make the best use of the current heterogeneous systems and what lies ahead The aim of this book is to introduce the big picture of heterogeneous computing Whether you are a hardware designer or a software developer you need to know how the pieces of the puzzle fit together The main goal is to bring researchers and engineers to the forefront of the research frontier in the new era that started a few years ago and is expected to continue for decades We believe that academics researchers practitioners and students will benefit from this book and will be prepared to tackle the big wave of heterogeneous computing that is here to stay

Shared-Memory Parallelism Can be Simple, Fast, and Scalable Julian Shun, 2017-06-01 Parallelism is the key to achieving high performance in computing However writing efficient and scalable parallel programs is notoriously difficult and often requires significant expertise To address this challenge it is crucial to

provide programmers with high level tools to enable them to develop solutions easily and at the same time emphasize the theoretical and practical aspects of algorithm design to allow the solutions developed to run efficiently under many different settings This thesis addresses this challenge using a three pronged approach consisting of the design of shared memory programming techniques frameworks and algorithms for important problems in computing The thesis provides evidence that with appropriate programming techniques frameworks and algorithms shared memory programs can be simple fast and scalable both in theory and in practice The results developed in this thesis serve to ease the transition into the multicore era The first part of this thesis introduces tools and techniques for deterministic parallel programming including means for encapsulating nondeterminism via powerful commutative building blocks as well as a novel framework for executing sequential iterative loops in parallel which lead to deterministic parallel algorithms that are efficient both in theory and in practice The second part of this thesis introduces Ligra the first high level shared memory framework for parallel graph traversal algorithms The framework allows programmers to express graph traversal algorithms using very short and concise code delivers performance competitive with that of highly optimized code and is up to orders of magnitude faster than existing systems designed for distributed memory This part of the thesis also introduces Ligra which extends Ligra with graph compression techniques to reduce space usage and improve parallel performance at the same time and is also the first graph processing system to support in memory graph compression The third and fourth parts of this thesis bridge the gap between theory and practice in parallel algorithm design by introducing the first algorithms for a variety of important problems on graphs and strings that are efficient both in theory and in practice For example the thesis develops the first linear work and polylogarithmic depth algorithms for suffix tree construction and graph connectivity that are also practical as well as a work efficient polylogarithmic depth and cache efficient shared memory algorithm for triangle computations that achieves a 2.5x speedup over the best existing algorithms on 40 cores This is a revised version of the thesis that won the 2015 ACM Doctoral Dissertation Award

Code Nation Michael J. Halvorson, 2020-04-22 *Code Nation* explores the rise of software development as a social cultural and technical phenomenon in American history The movement germinated in government and university labs during the 1950s gained momentum through corporate and counterculture experiments in the 1960s and 1970s and became a broad based computer literacy movement in the 1980s As personal computing came to the fore learning to program was transformed by a groundswell of popular enthusiasm exciting new platforms and an array of commercial practices that have been further amplified by distributed computing and the Internet The resulting society can be depicted as a Code Nation a globally connected world that is saturated with computer technology and enchanted by software and its creation Code Nation is a new history of personal computing that emphasizes the technical and business challenges that software developers faced when building applications for CP M MS DOS UNIX Microsoft Windows the Apple Macintosh and other emerging platforms It is a popular history of computing that explores the experiences of novice computer users

tinkerers hackers and power users as well as the ideals and aspirations of leading computer scientists engineers educators and entrepreneurs Computer book and magazine publishers also played important if overlooked roles in the diffusion of new technical skills and this book highlights their creative work and influence Code Nation offers a behind the scenes look at application and operating system programming practices the diversity of historic computer languages the rise of user communities early attempts to market PC software and the origins of enterprise computing systems Code samples and over 80 historic photographs support the text The book concludes with an assessment of contemporary efforts to teach computational thinking to young people

Hardness of Approximation Between P and NP Aviad Rubinstein, 2019-06-07

Nash equilibrium is the central solution concept in Game Theory Since Nash's original paper in 1951 it has found countless applications in modeling strategic behavior of traders in markets human drivers and electronic routers in congested networks nations in nuclear disarmament negotiations and more A decade ago the relevance of this solution concept was called into question by computer scientists who proved under appropriate complexity assumptions that computing a Nash equilibrium is an intractable problem And if centralized specially designed algorithms cannot find Nash equilibria why should we expect distributed selfish agents to converge to one The remaining hope was that at least approximate Nash equilibria can be efficiently computed Understanding whether there is an efficient algorithm for approximate Nash equilibrium has been the central open problem in this field for the past decade In this book we provide strong evidence that even finding an approximate Nash equilibrium is intractable We prove several intractability theorems for different settings two player games and many player games and models computational complexity query complexity and communication complexity In particular our main result is that under a plausible and natural complexity assumption Exponential Time Hypothesis for PPAD there is no polynomial time algorithm for finding an approximate Nash equilibrium in two player games The problem of approximate Nash equilibrium in a two player game poses a unique technical challenge it is a member of the class PPAD which captures the complexity of several fundamental total problems i.e. problems that always have a solution and it also admits a quasipolynomial time algorithm Either property alone is believed to place this problem far below NP hard problems in the complexity hierarchy having both simultaneously places it just above P at what can be called the frontier of intractability Indeed the tools we develop in this book to advance on this frontier are useful for proving hardness of approximation of several other important problems whose complexity lies between P and NP Brouwer's fixed point market equilibrium CourseMatch A CEEI densest k subgraph community detection VC dimension and Littlestone dimension and signaling in zero sum games

On Monotonicity Testing and the 2-to-2 Games Conjecture Dor Minzer, 2022-12-06 This book discusses two questions in Complexity Theory the Monotonicity Testing problem and the 2 to 2 Games Conjecture Monotonicity testing is a problem from the field of property testing first considered by Goldreich et al in 2000 The input of the algorithm is a function and the goal is to design a tester that makes as few queries to the function as possible accepts monotone functions and

rejects far from monotone functions with a probability close to 1 The first result of this book is an essentially optimal algorithm for this problem The analysis of the algorithm heavily relies on a novel directed and robust analogue of a Boolean isoperimetric inequality of Talagrand from 1993 The probabilistically checkable proofs PCP theorem is one of the cornerstones of modern theoretical computer science One area in which PCPs are essential is the area of hardness of approximation Therein the goal is to prove that some optimization problems are hard to solve even approximately Many hardness of approximation results were proved using the PCP theorem however for some problems optimal results were not obtained This book touches on some of these problems and in particular the 2 to 2 games problem and the vertex cover problem The second result of this book is a proof of the 2 to 2 games conjecture with imperfect completeness which implies new hardness of approximation results for problems such as vertex cover and independent set It also serves as strong evidence towards the unique games conjecture a notorious related open problem in theoretical computer science At the core of the proof is a characterization of small sets of vertices in Grassmann graphs whose edge expansion is bounded away from

1 **Semantic Web for the Working Ontologist** James Hendler, Fabien Gandon, Dean Allemang, 2020-08-03 Enterprises have made amazing advances by taking advantage of data about their business to provide predictions and understanding of their customers markets and products But as the world of business becomes more interconnected and global enterprise data is no long a monolith it is just a part of a vast web of data Managing data on a world wide scale is a key capability for any business today The Semantic Web treats data as a distributed resource on the scale of the World Wide Web and incorporates features to address the challenges of massive data distribution as part of its basic design The aim of the first two editions was to motivate the Semantic Web technology stack from end to end to describe not only what the Semantic Web standards are and how they work but also what their goals are and why they were designed as they are It tells a coherent story from beginning to end of how the standards work to manage a world wide distributed web of knowledge in a meaningful way The third edition builds on this foundation to bring Semantic Web practice to enterprise Fabien Gandon joins Dean Allemang and Jim Hendler bringing with him years of experience in global linked data to open up the story to a modern view of global linked data While the overall story is the same the examples have been brought up to date and applied in a modern setting where enterprise and global data come together as a living linked network of data Also included with the third edition all of the data sets and queries are available online for study and experimentation at data world swwo

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