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FPGA-Accelerated Simulation of Computer System

Fpga Accelerated Simulation Of Computer Systems

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Fpga Accelerated Simulation Of Computer Systems Derek Chiou:

FPGA-Accelerated Simulation of Computer Systems Hari Angepat,Derek Chiou,Eric S. Chung,James C. Hoe,2014-07-01

To date the most common form of simulators of computer systems are software based running on standard computers One promising approach to improve simulation performance is to apply hardware specifically reconfigurable hardware in the form of field programmable gate arrays FPGAs This manuscript describes various approaches of using FPGAs to accelerate software implemented simulation of computer systems and selected simulators that incorporate those techniques More precisely we describe a simulation architecture taxonomy that incorporates a simulation architecture specifically designed for FPGA accelerated simulation survey the state of the art in FPGA accelerated simulation and describe in detail selected instances of the described techniques Table of Contents Preface Acknowledgments Introduction Simulator Background Accelerating Computer System Simulators with FPGAs Simulation Virtualization Categorizing FPGA based Simulators Conclusion Bibliography Authors Biographies

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Chiou,Eric S. Chung,James C. Hoe,2022-05-31 To date the most common form of simulators of computer systems are software based running on standard computers One promising approach to improve simulation performance is to apply hardware specifically reconfigurable hardware in the form of field programmable gate arrays FPGAs This manuscript describes various approaches of using FPGAs to accelerate software implemented simulation of computer systems and selected simulators that incorporate those techniques More precisely we describe a simulation architecture taxonomy that incorporates a simulation architecture specifically designed for FPGA accelerated simulation survey the state of the art in FPGA accelerated simulation and describe in detail selected instances of the described techniques Table of Contents Preface Acknowledgments Introduction Simulator Background Accelerating Computer System Simulators with FPGAs Simulation Virtualization Categorizing FPGA based Simulators Conclusion Bibliography Authors Biographies

Quantum Computer Systems Yongshan Ding,Frederic T. Chong,2022-05-31 This book targets computer scientists and engineers who are familiar with concepts in classical computer systems but are curious to learn the general architecture of quantum computing systems It gives a concise presentation of this new paradigm of computing from a computer systems point of view without assuming any background in quantum mechanics As such it is divided into two parts The first part of the book provides a gentle overview on the fundamental principles of the quantum theory and their implications for computing The second part is devoted to state of the art research in designing practical quantum programs building a scalable software systems stack and controlling quantum hardware components Most chapters end with a summary and an outlook for future directions This book celebrates the remarkable progress that scientists across disciplines have made in the past decades and reveals what roles computer scientists and engineers can play to enable practical scale quantum computing

[Customizable Computing](#) Yu-Ting Chen,Jason Cong,Michael Gill,Glenn Reinman,Bingjun Xiao,2022-05-31 Since the end of Dennard scaling in the early

2000s improving the energy efficiency of computation has been the main concern of the research community and industry. The large energy efficiency gap between general purpose processors and application specific integrated circuits (ASICs) motivates the exploration of customizable architectures where one can adapt the architecture to the workload. In this Synthesis lecture we present an overview and introduction of the recent developments on energy efficient customizable architectures including customizable cores and accelerators on chip memory customization and interconnect optimization. In addition to a discussion of the general techniques and classification of different approaches used in each area we also highlight and illustrate some of the most successful design examples in each category and discuss their impact on performance and energy efficiency. We hope that this work captures the state of the art research and development on customizable architectures and serves as a useful reference basis for further research design and implementation for large scale deployment in future computing systems.

Robotic Computing on FPGAs Shaoshan Liu, Zishen Wan, Bo Yu, Yu Wang, 2022-05-31 This book provides a thorough overview of the state of the art field programmable gate array (FPGA) based robotic computing accelerator designs and summarizes their adopted optimized techniques. This book consists of ten chapters delving into the details of how FPGAs have been utilized in robotic perception, localization, planning and multi robot collaboration tasks. In addition to individual robotic tasks, this book provides detailed descriptions of how FPGAs have been used in robotic products including commercial autonomous vehicles and space exploration robots.

Space-Time Computing with Temporal Neural Networks James E. Smith, 2022-05-31 Understanding and implementing the brain's computational paradigm is the one true grand challenge facing computer researchers. Not only are the brain's computational capabilities far beyond those of conventional computers, its energy efficiency is truly remarkable. This book, written from the perspective of a computer designer and targeted at computer researchers, is intended to give both background and lay out a course of action for studying the brain's computational paradigm. It contains a mix of concepts and ideas drawn from computational neuroscience combined with those of the author. As background relevant biological features are described in terms of their computational and communication properties, the brain's neocortex is constructed of massively interconnected neurons that compute and communicate via voltage spikes and a strong argument can be made that precise spike timing is an essential element of the paradigm. Drawing from the biological features, a mathematics based computational paradigm is constructed. The key feature is spiking neurons that perform communication and processing in space-time with emphasis on time. In these paradigms, time is used as a freely available resource for both communication and computation. Neuron models are first discussed in general and one is chosen for detailed development. Using the model, single neuron computation is first explored. Neuron inputs are encoded as spike patterns and the neuron is trained to identify input pattern similarities. Individual neurons are building blocks for constructing larger ensembles referred to as columns. These columns are trained in an unsupervised manner and operate collectively to perform the basic cognitive function of pattern clustering. Similar input

patterns are mapped to a much smaller set of similar output patterns thereby dividing the input patterns into identifiable clusters Larger cognitive systems are formed by combining columns into a hierarchical architecture These higher level architectures are the subject of ongoing study and progress to date is described in detail in later chapters Simulation plays a major role in model development and the simulation infrastructure developed by the author is described

In-/Near-Memory Computing Daichi Fujiki,Xiaowei Wang,Arun Subramaniyan,Reetuparna Das,2022-05-31 This book provides a structured introduction of the key concepts and techniques that enable in near memory computing For decades processing in memory or near memory computing has been attracting growing interest due to its potential to break the memory wall Near memory computing moves compute logic near the memory and thereby reduces data movement Recent work has also shown that certain memories can morph themselves into compute units by exploiting the physical properties of the memory cells enabling in situ computing in the memory array While in and near memory computing can circumvent overheads related to data movement it comes at the cost of restricted flexibility of data representation and computation design challenges of compute capable memories and difficulty in system and software integration Therefore wide deployment of in near memory computing cannot be accomplished without techniques that enable efficient mapping of data intensive applications to such devices without sacrificing accuracy or increasing hardware costs excessively This book describes various memory substrates amenable to in and near memory computing architectural approaches for designing efficient and reliable computing devices and opportunities for in near memory acceleration of different classes of applications

Deep Learning Systems Andres Rodriguez,2022-05-31 This book describes deep learning systems the algorithms compilers and processor components to efficiently train and deploy deep learning models for commercial applications The exponential growth in computational power is slowing at a time when the amount of compute consumed by state of the art deep learning DL workloads is rapidly growing Model size serving latency and power constraints are a significant challenge in the deployment of DL models for many applications Therefore it is imperative to codesign algorithms compilers and hardware to accelerate advances in this field with holistic system level and algorithm solutions that improve performance power and efficiency Advancing DL systems generally involves three types of engineers 1 data scientists that utilize and develop DL algorithms in partnership with domain experts such as medical economic or climate scientists 2 hardware designers that develop specialized hardware to accelerate the components in the DL models and 3 performance and compiler engineers that optimize software to run more efficiently on a given hardware Hardware engineers should be aware of the characteristics and components of production and academic models likely to be adopted by industry to guide design decisions impacting future hardware Data scientists should be aware of deployment platform constraints when designing models Performance engineers should support optimizations across diverse models libraries and hardware targets The purpose of this book is to provide a solid understanding of 1 the design training and applications of DL algorithms in industry 2 the compiler

techniques to map deep learning code to hardware targets and 3 the critical hardware features that accelerate DL systems This book aims to facilitate co innovation for the advancement of DL systems It is written for engineers working in one or more of these areas who seek to understand the entire system stack in order to better collaborate with engineers working in other parts of the system stack The book details advancements and adoption of DL models in industry explains the training and deployment process describes the essential hardware architectural features needed for today s and future models and details advances in DL compilers to efficiently execute algorithms across various hardware targets Unique in this book is the holistic exposition of the entire DL system stack the emphasis on commercial applications and the practical techniques to design models and accelerate their performance The author is fortunate to work with hardware software data scientist and research teams across many high technology companies with hyperscale data centers These companies employ many of the examples and methods provided throughout the book

Compiling Algorithms for Heterogeneous Systems Steven Bell, Jing Pu, James Hegarty, Mark Horowitz, 2022-05-31 Most emerging applications in imaging and machine learning must perform immense amounts of computation while holding to strict limits on energy and power To meet these goals architects are building increasingly specialized compute engines tailored for these specific tasks The resulting computer systems are heterogeneous containing multiple processing cores with wildly different execution models Unfortunately the cost of producing this specialized hardware and the software to control it is astronomical Moreover the task of porting algorithms to these heterogeneous machines typically requires that the algorithm be partitioned across the machine and rewritten for each specific architecture which is time consuming and prone to error Over the last several years the authors have approached this problem using domain specific languages DSLs high level programming languages customized for specific domains such as database manipulation machine learning or image processing By giving up generality these languages are able to provide high level abstractions to the developer while producing high performance output The purpose of this book is to spur the adoption and the creation of domain specific languages especially for the task of creating hardware designs In the first chapter a short historical journey explains the forces driving computer architecture today Chapter 2 describes the various methods for producing designs for accelerators outlining the push for more abstraction and the tools that enable designers to work at a higher conceptual level From there Chapter 3 provides a brief introduction to image processing algorithms and hardware design patterns for implementing them Chapters 4 and 5 describe and compare Darkroom and Halide two domain specific languages created for image processing that produce high performance designs for both FPGAs and CPUs from the same source code enabling rapid design cycles and quick porting of algorithms The final section describes how the DSL approach also simplifies the problem of interfacing between application code and the accelerator by generating the driver stack in addition to the accelerator configuration This book should serve as a useful introduction to domain specialized computing for computer architecture students and as a primer on domain specific languages and image processing hardware

for those with more experience in the field Innovations in the Memory System Rajeev Balasubramonian, 2022-05-31 The memory system has the potential to be a hub for future innovation While conventional memory systems focused primarily on high density other memory system metrics like energy security and reliability are grabbing modern research headlines With processor performance stagnating it is also time to consider new programming models that move some application computations into the memory system This in turn will lead to feature rich memory systems with new interfaces The past decade has seen a number of memory system innovations that point to this future where the memory system will be much more than dense rows of unintelligent bits This book takes a tour through recent and prominent research works touching upon new DRAM chip designs and technologies near data processing approaches new memory channel architectures techniques to tolerate the overheads of refresh and fault tolerance security attacks and mitigations and memory scheduling

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