

# Multicore And Gpu Programming An Integrated Approach

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CUDA by Example  
Hands-On GPU Programming with CUDA  
GPU Parallel Program Development Using CUDA  
Cuda Handbook  
Mastering CUDA C++ Programming: From Fundamentals to Advanced GPU Computing  
Hands-On GPU Programming with Python and CUDA  
Professional CUDA C Programming  
GPU Programming in MATLAB  
CUDA Programming  
Hands-On GPU Computing with Python  
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Practical GPU Programming  
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General-Purpose Graphics Processor Architectures  
Directive-based General-purpose GPU Programming  
Gerassimos Barlas Jason Sanders  
Jaegeun Han Tolga Soyata Nicholas Wilt Toby Webber Dr. Brian Tuomanen John Cheng Nikolaos Ploskas Shane Cook  
Avimanyu Bandyopadhyay Tom Deakin Maris Fenlor Michael McCool Tolga Soyata Nicholas Wilt Ethan Cole Tor M. Aamodt Tian Yi David Han

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multicore and gpu programming offers broad coverage of the key parallel computing skillsets multicore cpu programming and manycore massively parallel computing using threads openmp mpi and cuda it teaches the design and development of software capable of taking advantage of today s computing platforms incorporating cpu and gpu hardware and explains how to transition from sequential programming to a parallel computing paradigm presenting material refined over more than a decade of teaching parallel computing author gerassimos barlas minimizes the challenge with multiple examples extensive case studies and full source code using this book you can develop programs that run over distributed memory machines using mpi create multi threaded applications with either libraries or directives write optimized applications that balance the workload between available computing resources and profile and debug programs targeting multicore machines comprehensive coverage of all major multicore programming tools including threads openmp mpi and cuda demonstrates parallel programming design patterns and examples of how different tools and paradigms can be integrated for superior performance particular focus on the emerging area of divisible load theory and its impact on load balancing and distributed systems download source code examples and instructor support materials on the book s companion website

cuda is a computing architecture designed to facilitate the development of parallel programs in conjunction with a comprehensive software platform the cuda architecture enables programmers to draw on the immense power of graphics processing units gpus when building high performance applications gpus of course have long been available for demanding graphics and game applications cuda now brings this valuable resource to programmers working on applications in other domains including science engineering and finance no knowledge of graphics programming is

required just the ability to program in a modestly extended version of c cuda by example written by two senior members of the cuda software platform team shows programmers how to employ this new technology the authors introduce each area of cuda development through working examples after a concise introduction to the cuda platform and architecture as well as a quick start guide to cuda c the book details the techniques and trade offs associated with each key cuda feature you ll discover when to use each cuda c extension and how to write cuda software that delivers truly outstanding performance major topics covered include parallel programming thread cooperation constant memory and events texture memory graphics interoperability atomics streams cuda c on multiple gpus advanced atomics additional cuda resources all the cuda software tools you ll need are freely available for download from nvidia developer [nvidia.com/object/cuda\\_by\\_example.html](http://nvidia.com/object/cuda_by_example.html)

explore different gpu programming methods using libraries and directives such as openacc with extension to languages such as c c and python key features learn parallel programming principles and practices and performance analysis in gpu computing get to grips with distributed multi gpu programming and other approaches to gpu programming understand how gpu acceleration in deep learning models can improve their performance book description compute unified device architecture cuda is nvidia s gpu computing platform and application programming interface it s designed to work with programming languages such as c c and python with cuda you can leverage a gpu s parallel computing power for a range of high performance computing applications in the fields of science healthcare and deep learning learn cuda programming will help you learn gpu parallel programming and understand its modern applications in this book you ll discover cuda programming approaches for modern gpu architectures you ll not only be guided through gpu features tools and apis you ll also learn how to analyze performance with sample parallel programming algorithms this book will help you optimize the performance of your apps by giving insights into cuda programming platforms with various libraries compiler directives openacc and other languages as you progress you ll learn how additional computing power can be generated using multiple gpus in a box or in multiple boxes finally

you'll explore how cuda accelerates deep learning algorithms including convolutional neural networks (cnn) and recurrent neural networks (rnn). By the end of this cuda book, you'll be equipped with the skills you need to integrate the power of gpu computing in your applications. What you will learn: understand general gpu operations and programming patterns in cuda; uncover the difference between gpu programming and cpu programming; analyze gpu application performance and implement optimization strategies; explore gpu programming profiling and debugging tools; grasp parallel programming algorithms and how to implement them; scale gpu accelerated applications with multi-gpu and multi-nodes; delve into gpu programming platforms with accelerated libraries (python and openacc); gain insights into deep learning accelerators in cnn and rnn using gpus. Who this book is for: this beginner-level book is for programmers who want to delve into parallel computing, become part of the high-performance computing community, and build modern applications. Basic C and C++ programming experience is assumed. For deep learning enthusiasts, this book covers python interops, DL libraries, and practical examples on performance estimation.

Gpu parallel program development using cuda teaches gpu programming by showing the differences among different families of gpus. This approach prepares the reader for the next generation and future generations of gpus. The book emphasizes concepts that will remain relevant for a long time rather than concepts that are platform-specific. At the same time, the book also provides platform-dependent explanations that are as valuable as generalized gpu concepts. The book consists of three separate parts. It starts by explaining parallelism using cpu multi-threading. In part I, a few simple programs are used to demonstrate the concept of dividing a large task into multiple parallel sub-tasks and mapping them to cpu threads. Multiple ways of parallelizing the same task are analyzed, and their pros and cons are studied in terms of both core and memory operation. Part II of the book introduces gpu massive parallelism. The same programs are parallelized on multiple nvidia gpu platforms, and the same performance analysis is repeated because the core and memory structures of cpus and gpus are different. The results differ in interesting ways. The end goal is to make programmers aware of all the good ideas as well as the bad ideas so readers can apply the good ideas and

avoid the bad ideas in their own programs part iii of the book provides pointer for readers who want to expand their horizons it provides a brief introduction to popular cuda libraries such as cublas cufft npp and thrust the opengl programming language an overview of gpu programming using other programming languages and api libraries such as python opencv opengl and apple s swift and metal and the deep learning library cudnn

gpus can be used for much more than graphics processing as opposed to a cpu which can only run four or five threads at once a gpu is made up of hundreds or even thousands of individual low powered cores allowing it to perform thousands of concurrent operations because of this gpu can tackle large complex problems on a much shorter time scale than cpus dive into parallel programming on nvidia hardware with cuda by chris rose and learn the basics of unlocking your graphics card this updated and expanded second edition of book provides a user friendly introduction to the subject taking a clear structural framework it guides the reader through the subject s core elements a flowing writing style combines with the use of illustrations and diagrams throughout the text to ensure the reader understands even the most complex of concepts this succinct and enlightening overview is a required reading for all those interested in the subject we hope you find this book useful in shaping your future career business

unleash the power of parallel processing with cuda c mastering cuda c programming dive into the world of gpu programming and accelerate your applications to new heights are you ready to harness the incredible power of parallel processing mastering cuda c programming is your comprehensive guide to unlocking the full potential of nvidia gpus for general purpose computing whether you re a curious beginner or a seasoned programmer this book will equip you with the knowledge and skills to write high performance cuda c applications what is cuda cuda compute unified device architecture is a parallel computing platform and programming model developed by nvidia it allows you to use gpus for general purpose processing accelerating applications in fields like artificial intelligence scientific computing and high performance data processing why choose this book crystal clear explanations complex concepts are broken down into

digestible chunks with plenty of examples and analogies to aid understanding even if you're new to gpu programming or parallel programming you'll grasp the fundamentals with ease hands on learning solidify your understanding with practical projects that guide you through building real world cuda applications you'll find cuda examples throughout the book illustrating key concepts and techniques optimization mastery master advanced techniques for cuda optimization including cuda streams shared memory and dynamic parallelism to achieve peak performance and efficiency in your code real world applications explore how cuda c is used in diverse fields from deep learning and machine learning to scientific computing and image processing we'll even delve into cutting edge applications in ai autonomous systems and robotics future proof your skills get a glimpse into the future of nvidia cuda and its role in emerging technologies like ai and quantum computing what you'll learn fundamentals of cuda programming understand the basics of cuda programming with cuda c including gpu architecture memory management and thread organization cuda libraries leverage powerful cuda libraries like cublas and cufft to accelerate linear algebra and signal processing tasks streamlining development with thrust explore the thrust library to simplify cuda development and write more concise and efficient code debugging and profiling master debugging techniques and profiling tools to identify and resolve issues in your cuda code advanced optimization dive deep into advanced optimization techniques including memory coalescing warp divergence and kernel fusion multi gpu programming learn how to harness the power of multiple gpus to tackle even larger and more demanding computational challenges a comprehensive guide for all levels this book serves as both a cuda tutorial for beginners and a comprehensive cuda guide for experienced programmers it's your one stop resource for mastering cuda c and unlocking the incredible power of parallel processing don't miss out on this opportunity to accelerate your applications and become a proficient cuda c programmer order your copy of mastering cuda c programming today and start your journey into the world of high performance computing

build real world applications with python 2.7 cuda 9 and cuda 10 we suggest the use of python 2.7 over python 3.x

since python 2.7 has stable support across all the libraries we use in this book key features expand your background in gpu programming pycuda scikit cuda and nsight effectively use cuda libraries such as cublas cufft and cusolver apply gpu programming to modern data science applications book description hands on gpu programming with python and cuda hits the ground running you'll start by learning how to apply amdahl's law use a code profiler to identify bottlenecks in your python code and set up an appropriate gpu programming environment you'll then see how to query the gpu's features and copy arrays of data to and from the gpu's own memory as you make your way through the book you'll launch code directly onto the gpu and write full blown gpu kernels and device functions in cuda c you'll get to grips with profiling gpu code effectively and fully test and debug your code using nsight ide next you'll explore some of the more well known nvidia libraries such as cufft and cublas with a solid background in place you will now apply your new found knowledge to develop your very own gpu based deep neural network from scratch you'll then explore advanced topics such as warp shuffling dynamic parallelism and ptx assembly in the final chapter you'll see some topics and applications related to gpu programming that you may wish to pursue including ai graphics and blockchain by the end of this book you will be able to apply gpu programming to problems related to data science and high performance computing what you will learn launch gpu code directly from python write effective and efficient gpu kernels and device functions use libraries such as cufft cublas and cusolver debug and profile your code with nsight and visual profiler apply gpu programming to data science problems build a gpu based deep neural network from scratch explore advanced gpu hardware features such as warp shuffling who this book is for hands on gpu programming with python and cuda is for developers and data scientists who want to learn the basics of effective gpu programming to improve performance using python code you should have an understanding of first year college or university level engineering mathematics and physics and have some experience with python as well as in any c based programming language such as c c++ go or java

break into the powerful world of parallel gpu programming with this down to earth practical guide designed for

professionals across multiple industrial sectors professional cuda c programming presents cuda a parallel computing platform and programming model designed to ease the development of gpu programming fundamentals in an easy to follow format and teaches readers how to think in parallel and implement parallel algorithms on gpus each chapter covers a specific topic and includes workable examples that demonstrate the development process allowing readers to explore both the hard and soft aspects of gpu programming computing architectures are experiencing a fundamental shift toward scalable parallel computing motivated by application requirements in industry and science this book demonstrates the challenges of efficiently utilizing compute resources at peak performance presents modern techniques for tackling these challenges while increasing accessibility for professionals who are not necessarily parallel programming experts the cuda programming model and tools empower developers to write high performance applications on a scalable parallel computing platform the gpu however cuda itself can be difficult to learn without extensive programming experience recognized cuda authorities john cheng max grossman and ty mckercher guide readers through essential gpu programming skills and best practices in professional cuda c programming including cuda programming model gpu execution model gpu memory model streams event and concurrency multi gpu programming cuda domain specific libraries profiling and performance tuning the book makes complex cuda concepts easy to understand for anyone with knowledge of basic software development with exercises designed to be both readable and high performance for the professional seeking entrance to parallel computing and the high performance computing community professional cuda c programming is an invaluable resource with the most current information available on the market

gpu programming in matlab is intended for scientists engineers or students who develop or maintain applications in matlab and would like to accelerate their codes using gpu programming without losing the many benefits of matlab the book starts with coverage of the parallel computing toolbox and other matlab toolboxes for gpu computing which allow applications to be ported straightforwardly onto gpus without extensive knowledge of gpu programming the next

part covers built in gpu enabled features of matlab including options to leverage gpus across multicore or different computer systems finally advanced material includes cuda code in matlab and optimizing existing gpu applications throughout the book examples and source codes illustrate every concept so that readers can immediately apply them to their own development provides in depth comprehensive coverage of gpus with matlab including the parallel computing toolbox and built in features for other matlab toolboxes explains how to accelerate computationally heavy applications in matlab without the need to re write them in another language presents case studies illustrating key concepts across multiple fields includes source code sample datasets and lecture slides

if you need to learn cuda but don t have experience with parallel computing cuda programming a developer s introduction offers a detailed guide to cuda with a grounding in parallel fundamentals it starts by introducing cuda and bringing you up to speed on gpu parallelism and hardware then delving into cuda installation chapters on core concepts including threads blocks grids and memory focus on both parallel and cuda specific issues later the book demonstrates cuda in practice for optimizing applications adjusting to new hardware and solving common problems comprehensive introduction to parallel programming with cuda for readers new to both detailed instructions help readers optimize the cuda software development kit practical techniques illustrate working with memory threads algorithms resources and more covers cuda on multiple hardware platforms mac linux and windows with several nvidia chipsets each chapter includes exercises to test reader knowledge

explore gpu enabled programmable environment for machine learning scientific applications and gaming using pycuda pyopengl and anaconda accelerate key features understand effective synchronization strategies for faster processing using gpus write parallel processing scripts with pycuda and pyopenclearn to use the cuda libraries like cudnn for deep learning on gpus book description gpus are proving to be excellent general purpose parallel computing solutions for high performance tasks such as deep learning and scientific computing this book will be your guide to getting started

with gpu computing it will start with introducing gpu computing and explain the architecture and programming models for gpus you will learn by example how to perform gpu programming with python and you ll look at using integrations such as pycuda pyopencl cupy and numba with anaconda for various tasks such as machine learning and data mining going further you will get to grips with gpu work flows management and deployment using modern containerization solutions toward the end of the book you will get familiar with the principles of distributed computing for training machine learning models and enhancing efficiency and performance by the end of this book you will be able to set up a gpu ecosystem for running complex applications and data models that demand great processing capabilities and be able to efficiently manage memory to compute your application effectively and quickly what you will learnutilize python libraries and frameworks for gpu accelerationset up a gpu enabled programmable machine learning environment on your system with anacondadeploy your machine learning system on cloud containers with illustrated examplesexplore pycuda and pyopencl and compare them with platforms such as cuda opencl and rocm perform data mining tasks with machine learning models on gpusextend your knowledge of gpu computing in scientific applicationswho this book is for data scientist machine learning enthusiasts and professionals who wants to get started with gpu computation and perform the complex tasks with low latency intermediate knowledge of python programming is assumed

the essential guide for writing portable parallel programs for gpus using the openmp programming model today s computers are complex multi architecture systems multiple cores in a shared address space graphics processing units gpus and specialized accelerators to get the most from these systems programs must use all these different processors in programming your gpu with openmp tom deakin and timothy mattson help everyone from beginners to advanced programmers learn how to use openmp to program a gpu using just a few directives and runtime functions then programmers can go further to maximize performance by using cpus and gpus in parallel true heterogeneous programming and since openmp is a portable api the programs will run on almost any system programming your gpu with openmp shares best practices for writing performance portable programs key features include the most up to

date apis for programming gpus with openmp with concepts that transfer to other approaches for gpu programming written in a tutorial style that embraces active learning so that readers can make immediate use of what they learn via provided source code builds the openmp gpu common core to get programmers to serious production level gpu programming as fast as possible additional features a reference guide at the end of the book covering all relevant parts of openmp 5.2 an online repository containing source code for the example programs from the book provided in all languages currently supported by openmp c, c++ and fortran tutorial videos and lecture slides

if you're a python pro looking to get the most out of your code with gpus then practical gpu programming is the right book for you this book will walk you through the basics of gpu architectures show you hands on parallel programming techniques and give you the know how to confidently speed up real workloads in data processing analytics and engineering the first thing you'll do is set up the environment install cuda and get a handle on using python libraries like pycuda and cupy you'll then dive into memory management kernel execution and parallel patterns like reductions and histogram computations then we'll dive into sorting and search techniques but with a focus on how gpu acceleration transforms business data processing we'll also put a strong emphasis on linear algebra to show you how to supercharge classic vector and matrix operations with cublas and cupy plus with batched computations efficient broadcasting custom kernels and mixed library workflows you can tackle both standard and advanced problems with ease throughout we evaluate numerical accuracy and performance side by side so you can understand both the strengths and limitations of gpu based solutions the book covers nearly every essential skill and modern toolkit for practical gpu programming but it's not going to turn you into a master overnight key learnings boost processing speed and efficiency for data intensive tasks use cupy and pycuda to write and execute custom cuda kernels maximize gpu occupancy and throughput efficiency by using optimal thread block and grid configuration reduce global memory bottlenecks in kernels by using shared memory and coalesced access patterns perform dynamic kernel compilation to ensure tailored performance use cupy to carry out custom high speed elementwise gpu operations and

expressions implement bitonic and radix sort algorithms for large or batch integer datasets execute parallel linear search kernels to detect patterns rapidly scale matrix operations using batched gemm and high level cublas routines table of content introduction to gpu fundamentals setting up gpu programming environment basic data transfers and memory types simple parallel patterns introduction to kernel optimization working with pycuda and cupy features practical sorting and search linear algebra essentials on gpu

this book is a high level overview of sh and its relationship to other realtime shading and graphics processing unit programming languages it is a reference manual and language specification and methodically and exhaustively presents details of the various features of sh

gpu parallel program development using cuda teaches gpu programming by showing the differences among different families of gpus this approach prepares the reader for the next generation and future generations of gpus the book emphasizes concepts that will remain relevant for a long time rather than concepts that are platform specific at the same time the book also provides platform dependent explanations that are as valuable as generalized gpu concepts the book consists of three separate parts it starts by explaining parallelism using cpu multi threading in part i a few simple programs are used to demonstrate the concept of dividing a large task into multiple parallel sub tasks and mapping them to cpu threads multiple ways of parallelizing the same task are analyzed and their pros cons are studied in terms of both core and memory operation part ii of the book introduces gpu massive parallelism the same programs are parallelized on multiple nvidia gpu platforms and the same performance analysis is repeated because the core and memory structures of cpus and gpus are different the results differ in interesting ways the end goal is to make programmers aware of all the good ideas as well as the bad ideas so readers can apply the good ideas and avoid the bad ideas in their own programs part iii of the book provides pointer for readers who want to expand their horizons it provides a brief introduction to popular cuda libraries such as cublas cufft npp and thrust the opengl

programming language an overview of gpu programming using other programming languages and api libraries such as python opencv opengl and apple s swift and metal and the deep learning library cudnn

gpu computing gems jade edition offers hands on proven techniques for general purpose gpu programming based on the successful application experiences of leading researchers and developers one of few resources available that distills the best practices of the community of cuda programmers this second edition contains 100 new material of interest across industry including finance medicine imaging engineering gaming environmental science and green computing it covers new tools and frameworks for productive gpu computing application development and provides immediate benefit to researchers developing improved programming environments for gpus divided into five sections this book explains how gpu execution is achieved with algorithm implementation techniques and approaches to data structure layout more specifically it considers three general requirements high level of parallelism coherent memory access by threads within warps and coherent control flow within warps chapters explore topics such as accelerating database searches how to leverage the fermi gpu architecture to further accelerate prefix operations and gpu implementation of hash tables there are also discussions on the state of gpu computing in interactive physics and artificial intelligence programming tools and techniques for gpu computing and the edge and node parallelism approach for computing graph centrality metrics in addition the book proposes an alternative approach that balances computation regardless of node degree variance software engineers programmers hardware engineers and advanced students will find this book extremely usefull for useful source codes discussed throughout the book the editors invite readers to the following website this second volume of gpu computing gems offers 100 new material of interest across industry including finance medicine imaging engineering gaming environmental science green computing and more covers new tools and frameworks for productive gpu computing application development and offers immediate benefit to researchers developing improved programming environments for gpus even more hands on proven techniques demonstrating how general purpose gpu computing is changing scientific research distills the best practices

of the community of cuda programmers each chapter provides insights and ideas as well as hands on skills applicable to a variety of fields

the cuda handbook begins where cuda by example leaves off discussing both cuda hardware and software in detail that will engage any cuda developer from the casual to the most hardcore newer cuda developers will see how the hardware processes commands and the driver checks progress hardcore cuda developers will appreciate topics such as the driver api context migration and how best to structure cpu gpu data interchange and synchronization the book is partly a reference resource and partly a cookbook

master the full power of gpu acceleration and take your c applications to performance levels that cpus alone simply can't reach mastering gpu programming with c and cuda is a practical modern and results driven guide for developers who want to build lightning fast parallel applications optimize cuda workloads and even deliver gpu powered libraries that can be used directly from python whether you're accelerating simulations processing massive datasets building real time applications or exploring high performance computing this book shows you exactly how to harness nvidia gpus with confidence and produce software that truly scales unlock the real performance potential of gpus starting from the core principles of parallelism and gpu architecture you'll learn how to think like a gpu programmer step by step you'll write your first kernels optimize memory usage scale across multiple gpus and leverage advanced features like cuda streams and asynchronous execution build skills that translate to real world impact through clear explanations hands on examples and professional optimization techniques you will learn how to develop high performance parallel applications in c and cuda optimize kernels memory transfers and gpu resource usage analyze and eliminate bottlenecks with profiling tools scale workloads using multi gpu and distributed models package gpu powered code into reusable c libraries expose cuda libraries to python using pybind11 for broader adoption go beyond tutorials build production ready solutions this isn't just a collection of code snippets you'll explore real engineering

practices modern c patterns for safer gpu resource management api design and modular gpu library architecture deployment strategies for research enterprise and cloud environments best practices for maintainability testing and cross platform builds expand your reach with python integration with python now dominating ai data science and research the book teaches you how to connect your gpu accelerated c code to python turning your work into reusable scalable and widely adoptable tools who this book is for c developers breaking into gpu computing engineers and researchers building high performance applications professionals working in ai simulation finance analytics robotics gaming and scientific computing anyone who wants to unlock more speed scalability and efficiency from their software no prior cuda experience is required just solid c fundamentals and the desire to push performance boundaries why this book stands out unlike generic cuda resources this book covers fundamentals and advanced optimization bridges c and python for maximum versatility focuses on reusable production grade techniques prepares you for the fast evolving gpu landscape cloud platforms and next gen hardware

originally developed to support video games graphics processor units gpus are now increasingly used for general purpose non graphics applications ranging from machine learning to mining of cryptographic currencies gpus can achieve improved performance and efficiency versus central processing units cpus by dedicating a larger fraction of hardware resources to computation in addition their general purpose programmability makes contemporary gpus appealing to software developers in comparison to domain specific accelerators this book provides an introduction to those interested in studying the architecture of gpus that support general purpose computing it collects together information currently only found among a wide range of disparate sources the authors led development of the gpgpu sim simulator widely used in academic research on gpu architectures the first chapter of this book describes the basic hardware structure of gpus and provides a brief overview of their history chapter 2 provides a summary of gpu programming models relevant to the rest of the book chapter 3 explores the architecture of gpu compute cores chapter 4 explores the architecture of the gpu memory system after describing the architecture of existing systems

chapters ref ch03 and ref ch04 provide an overview of related research chapter 5 summarizes cross cutting research impacting both the compute core and memory system this book should provide a valuable resource for those wishing to understand the architecture of graphics processor units gpus used for acceleration of general purpose applications and to those who want to obtain an introduction to the rapidly growing body of research exploring how to improve the architecture of these gpus

graphics processing units gpus have become a competitive accelerator for non graphics applications mainly driven by the improvements in gpu programmability although the compute unified device architecture cuda is a simple c like interface for programming nvidia gpus porting applications to cuda remains a challenge to average programmers in particular cuda places on the programmer the burden of packaging gpu code in separate functions of explicitly managing data transfer between the host and gpu memories and of manually optimizing the utilization of the gpu memory we have designed hicuda a high level directive based language for cuda programming it allows programmers to perform these tedious tasks in a simpler manner and directly to the sequential code we have also prototyped a compiler that translates a hicuda program to a cuda program and can handle real world applications experiments using seven standard cuda benchmarks show that the simplicity hicuda provides comes at no expense to performance

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