Democratizing Parallelism, Democratizing Education

Teaching a MOOC about GPU Computing

David Luebke
NVIDIA Research
The “New” Moore’s Law

Computers no longer get faster, just wider

You must re-think your algorithms to be parallel!

Data-parallel computing is most scalable solution
An Unlikely Hero

Battlefield 3 by DICE (Electronic Arts)
Power is the Problem

And fetching operands costs more than computing on them:

- 64-bit DP 20pJ
- 256-bit access 8 kB SRAM
- 256-bit buses
- 28nm
- Efficient off-chip link
- 500 pJ
- 50 pJ
- 256 pJ
- 26 pJ
- 16 nJ
- 1 nJ

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How do you add up a list of numbers?

```cpp
int sum = 0;
for (int i=0; i<N; ++i) sum += x[i];
```

Parallel reduction builds a summation tree

N threads need log N steps

Different order $\Rightarrow$ different answer!
Computers Now Get Wider, Not Faster

How do you sort a list of items?

Insertion Sort  Heap Sort  Merge Sort

Which goes faster on large data?

ALL Students need to understand this!  Early!
Why Are We Here Again?

The World’s Programmers
Where Are We Going?

Processor Market Share

Processor Shipments (Billions)

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Source: Mercury Research, ARM, Internal estimates
Democratizing Parallelism

Parallel computing isn’t just a good idea...it’s the law!

Power is the problem ... and communication is power.

Today’s parallel supercomputers have a day job.

Mobile computing will have a huge influence.

We need to prepare students for this world!
My Story

Taught computer science for 8 years @ University of Virginia

*Got interested in GPGPU because it was graphics*

Moved to NVIDIA

*Stayed interested in GPGPU because it could save the world*

Did lots of CUDA evangelism

*Grew deeply concerned about parallel computing education*

Met with Prof Dave Evans, UVA & Udacity

*Did something about it*
What’s a MOOC?

Massively Online Open Course

Video-based, automated grading, peer learning

Vibrant self-organized communities

Free & massively popular

Rampant excitement, hype, and backlash

The Course

CS 344: Intro to Parallel Computing

27,000 students and counting
Introduction to Parallel Programming

Class Summary
Learn the fundamentals of parallel computing with the GPU and the CUDA programming environment! In this class, you'll learn about parallel programming by coding a series of image processing.

What Should I Know?
We expect students to have a solid experience with the C programming language and basic knowledge of data structures and algorithms.

What Will I Learn?
You'll master the fundamentals of massively parallel computing by using CUDA C/C++ to program modern GPUs. You'll learn the GPU programming model and architecture, key algorithms and application development best practices.

Course Instructors
John Owens
Instructor
Format

Strong Udacity style

7 units, each about 90 minutes of lecture

Frequent quizzes & programming exercises

Programming assignments after each unit

NVIDIA-sponsored contest
Design decisions

1. CUDA C? OpenCL? Something else?
2. Why GPUs and not a broader definition of “parallel”?
3. Who is the audience and what prerequisites?
4. How can any student program GPUs?
5. Why image processing as a basis for the assignments?
6. Why (and why not) do a contest?
So, what's it like to teach a MOOC?

Your audience, energy!

Notes, tablet, microphone, camera, bell
What’s it like to teach a MOOC?

- Exhilarating
- Exhausting
- Humbling
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Exhaustive

Forums

Managing

Projects

Training

Instructors

Testers

Assistant Instructor

Video Editors

Made many of these slides
“It takes an immense amount of work to produce an adequate MOOC, and a staggering amount of work to produce a really good one.”

—Armando Fox, Berkeley

Software Engineering for Software as a Service
(50,000 registered)
Humbling

https://www.udacity.com/course/viewer#!/c-cs344/l-77202674/e-78522765/m-78805279
Where Next?

Taking the course new places, keeping it up to date

Beyond videos, quizzes, and programming exercises
(e.g. www.udacity.com/course/cs291)

Beyond lectures, grades, and linear pedagogy


Recruiting & cultivating the workforce
Stray Thoughts

On MOOC vendors

On dropout rates

On contests and free giveaways

On MOOCs and the media

On MOOCs and the future of higher education
Thank You

Let’s discuss!

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