GPU Programming and Architecture: Course Overview

Patrick Cozzi
University of Pennsylvania
CIS 565 - Fall 2012

Lectures

- Monday and Wednesday
- 6-7:30pm
- Moore 212

- Lectures are recorded
- Attendance is required for guest lectures

Image from http://pinoytutorial.com/techtorial/geforce-gtx-580-vs-amd-radeon-hd-6870-review-and-comparison-conclusion/

Instructor

- Patrick Cozzi







If you are curious, see http://www.seas.upenn.edu/~pcozzi/

Instructor

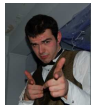
- Email
  - pjcozzi+cis565@gmail.com
- Office Hours
  - After class
  - Generally, I'm here as long as you're here

Teaching Assistant

- Karl Li: yiningli@seas.upenn.edu
- Office Hours
  - SIG Lab
  - Tuesday, TBA
  - Friday, TBA

If you are curious, see http://www.yiningkarlli.com/

CIS 565 Hall of Fame


Jon McCaffrey


Krishnan Ramachandran


Varun Sampath


Sean Lilley


Ian Lilley

- Are you next?

Prerequisites

- Passion for computer graphics
- CIS 460/560. Preferably received an A
- Strong C or C++
- Also useful: CIS 371 or CIS 501

Course Website

- http://www.seas.upenn.edu/~cis565/
- Schedule, reading, slides, audio, projects, etc.

Piazza

- https://piazza.com/upenn/fall2012/cis565/
- Be active; let's build a course community

GitHub

- Used for course materials, projects, and the final project
- Create an account:
  - https://github.com/signup/free
- Join our GitHub organization:
  - https://github.com/CIS565-Fall-2012
- Who is new to source control?

Recommended Books

Real-Time Rendering

2008, Tomas Akenine-Möller, Eric Haines, and Naty Hoffman

OpenGL Insights

2012, Patrick Cozzi and Christophe Riccio, Editors

Readings handed out in class

Programming Massively Parallel Processors

2010, David Kirk and Wen-mei Hwu

Old draft: http://courses.engr.illinois.edu/ece498/al/Syllabus.html

Course Contents

- *GPU* – *G*raphics *P*rocessing *U*nit
- Is it still just for graphics?

Images from http://www.ngohq.com/news/18784-nvidia-launches-geforce-gtx-580-a.html and http://gs7.blogspot.com/2011/09/amd-radeon-hd-6990-worlds-fastest.html

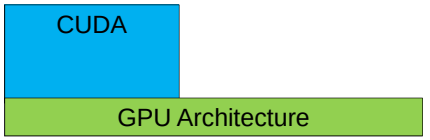
Course Contents

- Start with GPU architecture

Not to scale

Course Contents

- *CUDA* programming model for *GPU Compute*



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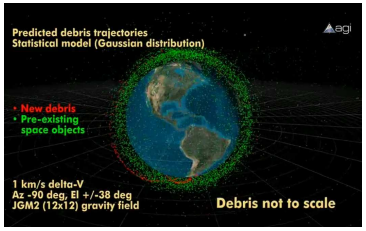
Course Contents

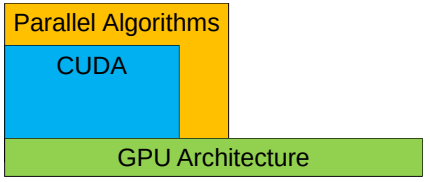
- GPU Compute example: conjunction analysis



http://www.youtube.com/watch?v=dtT3pTh_g-8

Course Contents

- Parallel algorithms that form building blocks



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Course Contents

- Parallel Algorithms example: *Scan*
  - Given:

3	1	7	0	4	1	6	3

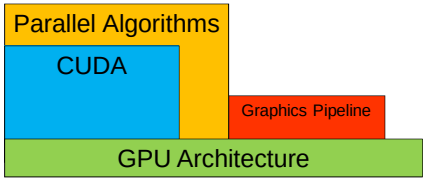
  - Compute:

0	3	4	11	11	15	16	22

  - In parallel!

Course Contents

- Historical and modern graphics pipeline



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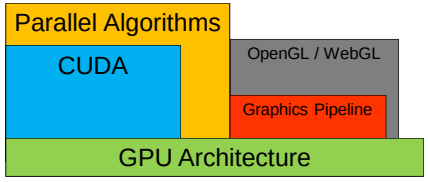
Course Contents

- WebGL



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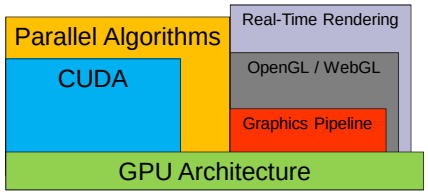
Turbulenz

http://www.youtube.com/watch?v=AJg_BmY9-8o

Course Contents

- Real-Time Rendering



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AMD Toyshop Demo

http://www.youtube.com/watch?v=LtxvpS5AYHQ

AMD Leo Demo

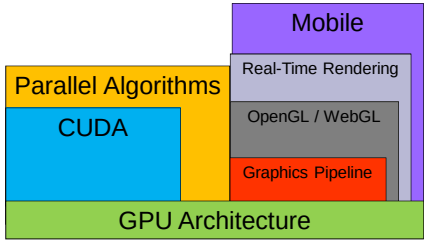
http://www.youtube.com/watch?v=zYweEn6DFcU

GPU Compute + Rendering

http://www.nvidia.com/object/GTX_400_games_demos.html

Course Contents

- Mobile



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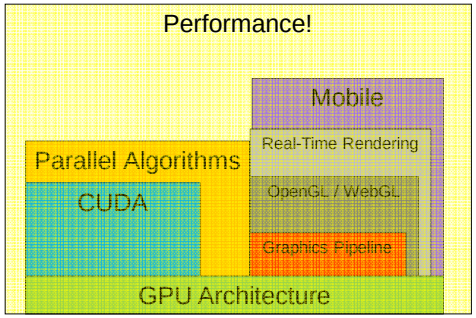
Course Contents



To scale!

Grading

- Projects 60%
- Final Project 40%
- Final 0%

Projects

- Intense. Usually one week.
- Significantly more work than previous semesters.

Projects

- Each project has
  - Coding
    - Pick *x* of *n*, e.g., 3 of 5, plus open-ended parts
  - Written performance analysis
  - A blog post with screenshots and a video/demo
  - Random in-class demos. Show, don't tell.

Projects

- One or two projects will be replaced with four-hour hackathons
- Class will be canceled that day

Projects

- Due anytime on the due date
- Submitted using GitHub
- Late Policy
  - 1 second to 1 week late: 50% deduction

Projects

- Grade yourself. Seriously
- We reserve 30% of the grade as a sanity check

Projects

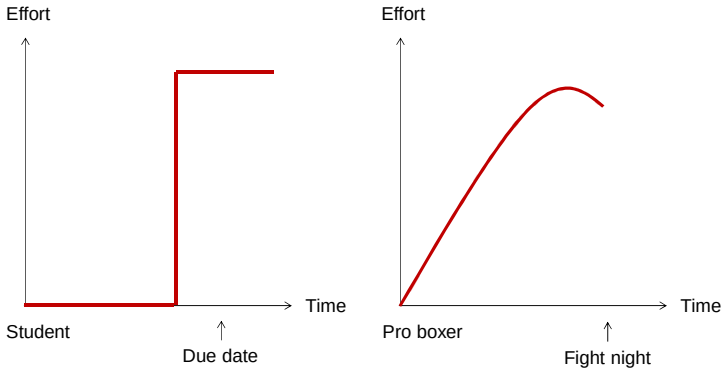
- Can be done as open source
  - Build your code portfolio
- Want to use private repos? Get a free edu account
  - https://github.com/edu

On Interviews…

"Send me your code and then we'll talk"

- Christophe Riccio

Intensity



Academic Integrity

- http://www.upenn.edu/academicintegrity/
- An academic integrity violation will result in the student receiving an F in this course
- Get approval for all code you didn't write yourself with the TA in advance

GPU Requirements

- Most projects require an *NVIDIA GeForce 8* series or higher
- Update your drivers:
  - http://www.nvidia.com/Download/index.aspx
- What GPU do I have?
- What OpenGL/OpenCL/CUDA version:
  - http://www.ozone3d.net/gpu_caps_viewer/

GPU Requirements

- Lab Resources
  - *Moore 100b* - NVIDIA GeForce 9800s
  - *SIG Lab* - Most systems have at least NVIDIA GeForce 8800s. Two systems have a GeForce 480, three have Fermi Quadros, one has a Fermi Tesla, and one has an AMD card
- Contact Karl

CPU and GPU Trends

- *FLOPS* – *FL*oating-point *OP*erations per *S*econd
- *GFLOPS* - One billion (10^9) FLOPS
- *TFLOPS* – 1,000 GFLOPS

CPU and GPU Trends

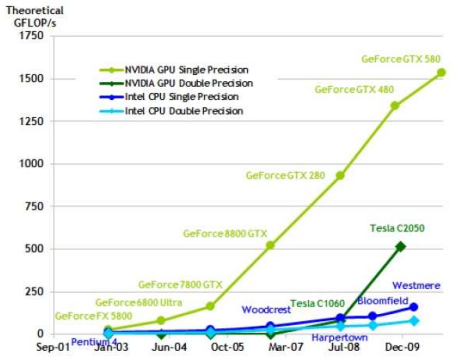


Chart from: http://proteneer.com/blog/?p=263

CPU and GPU Trends

- Compute
  - Intel Core i7 – 4 cores – 100 GFLOP
  - NVIDIA GTX280 – 240 cores – 1 TFLOP
- Memory Bandwidth
  - System Memory – 60 GB/s
  - NVIDIA GT200 – 150 GB/s
- Install Base
  - Over 200 million NVIDIA G80s shipped

Class Exercise

- Graphics Pipeline

Reminders

- Piazza
  - Signup: https://piazza.com/upenn/fall2012/cis565/
- GitHub
  - Create an account: https://github.com/signup/free
  - Change it to an edu account: https://github.com/edu
  - Join our organization: https://github.com/CIS565-Fall-2012
- No class Wednesday, 09/12