


GPU Programming and Architecture: Course Overview

Patrick Cozzi
University of Pennsylvania
CIS 565 - Fall 2013

Lectures

- Monday and Wednesday
- 6-7:30pm
- Towne 307

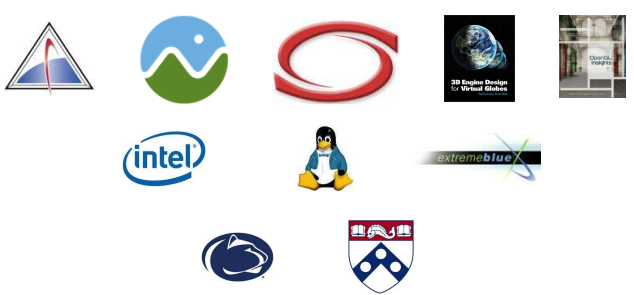


- [Fall](#) and [Spring](#) 2012 lectures were recorded
- Attendance is required for guest lectures

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

About Me

- Patrick Cozzi



See <http://www.seas.upenn.edu/~pcozzi/>

About Me

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

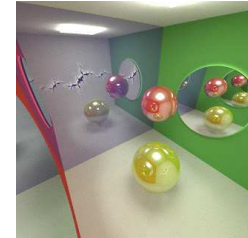
About Me

- Not “Professor”, “Dr.”, “Mr.”, or “Sir”
- Not even “instructor”
- Perhaps “coach”, “catalyst”, or “enabler”

- CIS 565 is a series of *projects* with supporting lectures.

Teaching Assistant

- Liam Boone:
wboone@seas.upenn.edu
- Office Hours
 - SIG Lab
 - TBA



See <http://liamboone.blogspot.com/>

CIS 565 Hall of Fame



Jon
McCaffrey



Krishnan
Ramachandran



Varun
Sampath



Sean
Lilley



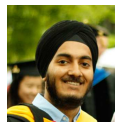
Ian
Lilley



Tiju
Thomas



Zakiuddin
Shehzan
Mohammed



Gundeep
Singh



Seunghoon
Park

- 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

- I don't check prereqs

Course Website

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

Google Group

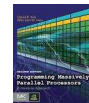
- <https://groups.google.com/forum/#!forum/cis-565-fall-2013>
- Send email to cis-565-fall-2013@googlegroups.com
- Be active; let's build a course community

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-2013>
- Who is new to source control?

Recommended Books



Programming Massively Parallel Processors

2012, David Kirk and Wen-mei Hwu

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



Real-Time Rendering

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



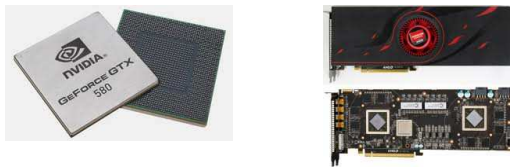
OpenGL Insights

2012, Patrick Cozzi and Christophe Riccio, Editors

Readings handed out in class

Course Topics

- GPU – Graphics Processing Unit
- Is it still just for graphics?



Images from <http://www.nvidia.com/news/18784-nvidia-launches-geforce-gtx-580-a.html> and <http://ig7.blogspot.com/2011/09/amd-radeon-hd-6990-worlds-fastest.html>

Course Topics

- Start with GPU architecture

GPU Architecture

Not to scale

Course Topics

- CUDA programming model for GPU Compute



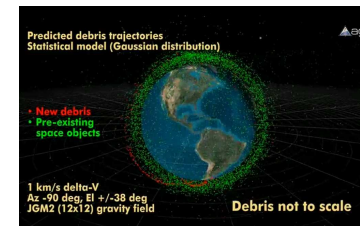
CUDA

GPU Architecture

Not to scale

Course Topics

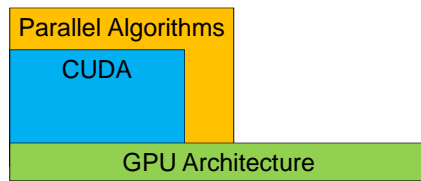
- GPU Compute example: conjunction analysis



http://www.youtube.com/watch?v=dT3pTh_q-8

Course Topics

- Parallel algorithms that form building blocks



Not to scale

Course Topics

- Parallel Algorithms example: *Scan*

□ Given:

3 1 7 0 4 1 6 3

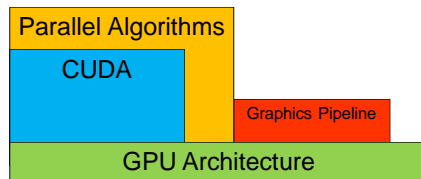
□ Compute:

0 3 4 11 11 15 16 22

□ In parallel!

Course Topics

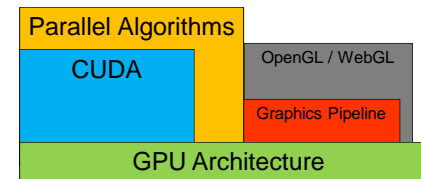
- Historical and modern graphics pipeline



Not to scale

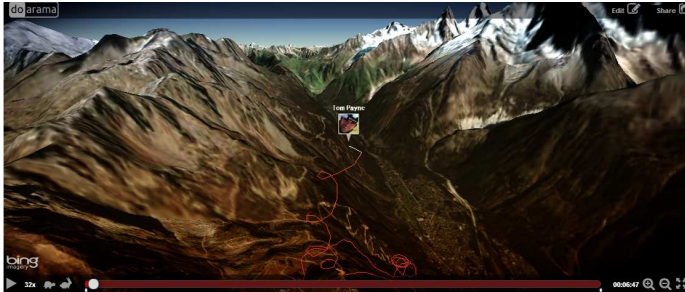
Course Topics

- OpenGL and WebGL



Not to scale

Doarama



<http://www.doarama.com/>

Turbulenz



http://www.youtube.com/watch?v=AJq_BmY9-8o

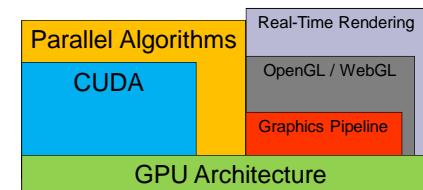
Unreal 3



<https://blog.mozilla.org/blog/2013/03/27/mozilla-is-unlocking-the-power-of-the-web-as-a-platform-for-gaming/>

Course Topics

- Real-Time Rendering



Not to scale

AMD Toyshop Demo



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

AMD Leo Demo



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

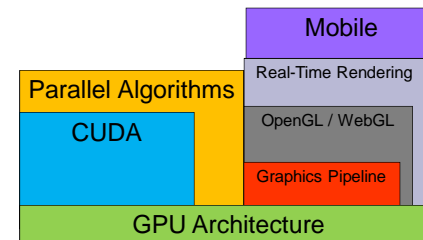
GPU Compute + Rendering



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

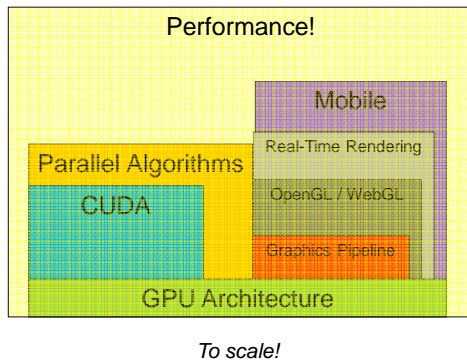
Course Topics

- Mobile



Not to scale

Course Topics



Course Topics

- Topics are as time permits
- We constantly adjust the schedule during the semester

Guest Lectures

- Shehzan Mohammed
- Tim Kaldewey
- Eric Haines
- Eric Lengyel
- Kevin Ring
- ...

<http://cis565-fall-2013.github.io/schedule.html>

Hackathons

- Cancel class, and code for prizes instead



Grading

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

Projects

- Intense.
- Significantly more work than other courses.

Course Quality	Instructor Quality	Difficulty
3.90	3.60	3.70
2.94	3.41	3.27
3.36	3.73	3.20

Projects

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

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>

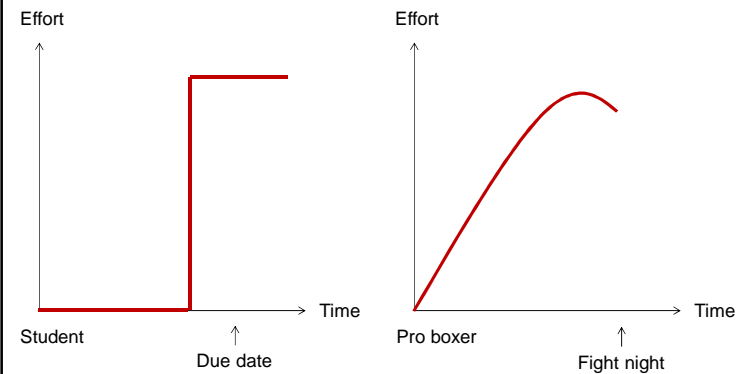
On Interviews...

“Send me your code
and then we’ll talk”

- Christophe Riccio



Intensity



Last Semester's Projects



7 Non-Photorealistic Toon Rendering by Kong Ma

<http://cis565-fall-2012.github.io/index.html>

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

CPU and GPU Trends

- **FLOPS** – *F*Lloating-point *O*Perations per *S*econd
- **GFLOPS** - One billion (10^9) FLOPS
- **TFLOPS** – 1,000 GFLOPS

CPU and GPU Trends

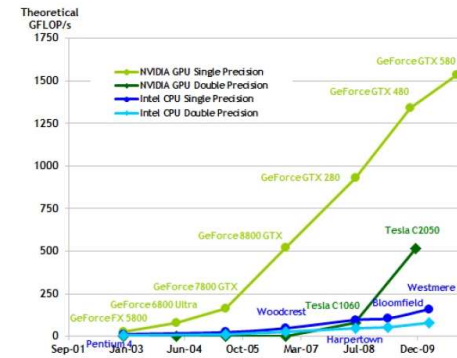


Chart from: <http://proteneer.com/blog/?p=263>

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 375 million CUDA-capable GPUs

Class Exercise

- Graphics Pipeline

Reminders

■ Google Group

- Signup: <https://groups.google.com/forum#!forum/cis-565-fall-2013>

■ 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-2013>