Lecture 20:

Course Summary + Graphics at Stanford Today

Interactive Computer Graphics
Stanford CS248, Winter 2020
FLATTEN THE CURVE

NUMBER OF CASES

HEALTHCARE SYSTEM CAPACITY

TIME SINCE FIRST CASE

@SIOUXSIEW @XTOTL @THESPINOFFTV

'ADAPTED FROM @DREWAHARRIS, THOMAS SPLETTSTÖBER (@SPLETT) AND THE CDC'
Flatten the Curve

- Number of cases
- Time since first case
- Healthcare system capacity

Don't panic but be careful.
- Washing hands
- Not touching face
- Stay home when sick

@siouxsiEW @xtotl @thespinofftv

'Adapted from @drewaharris, Thomas Splettstoesser (@splette) and the CDC'
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As accomplished CS248 students you’ve now learned the basics of drawing shapes, representing surfaces/light/materials/motion, and manipulating images, etc...

(and have been introduced to core graphics ideas like sampling, anti-aliasing, acceleration data structures, etc.)

What’s Next?
More graphics classes at Stanford

SPRING

CS348B: “Image Synthesis Techniques”, theory and practice of realistic, physically-based rendering (Hanrahan, T/Th 1:30-2:50)
CS348K: “Visual Computing Systems”, principles of creating efficient parallel systems for computational photography, 3D graphics, and deep learning for vision (Fatahalian, T/Th 3-4:20)
CS348E: Character Animation: Modeling, Simulation, and Control of Human Motion (Liu, M/W 1:30-2:50)
CS448V: “Computational Video Manipulation,” recent research results related to manipulating video (Agrawala, M/W 3-4:20)
EE267: “Virtual Reality”, focuses on display and tracking hardware for VR (Wetzstein, M/W 3-4:20)

WINTER

CS348C: “Animation and Simulation”, deep dive into animation and simulation techniques (James)
EE367/CS448i: “Computational Imaging and Display”, advanced course on display design (Wetzstein)
CS205L: “Continuous Mathematical Methods with an Emphasis on Machine Learning” (Fedkiw)

OTHER

CS146: “Computer Game Design”, make your own games in Unity (James)
CS348B (Spring, Hanrahan)

- Rendering realistic images by modeling the physical process of light interacting with materials
- With ray tracing as the mechanism to simulate these phenomenon
Graphics Research at Stanford Today
Ron Fedkiw

- Simulation techniques (often) targeted at film production
- Now exploring use of machine learning to augment or improve physical simulations
Ron Fedkiw

Segmentation Masks of Stereo Footage

Left Camera

Right Camera
Maneesh Agrawala

- Many current projects on video editing and manipulation

Visual Rhythm and Beat [Davis et al.]
Many current projects on video editing and manipulation

fluffles

**STACY**
I am not buying that kid a Christmas gift.

**RYAN**
Stacy.

**STACY**
He is a bad kid.

**RYAN**
He's family.

**STACY**
Are you certain that your cousin is his real father? Because I'm pretty sure that kid is the spawn of Satan.

**RYAN**
Come on now, that's a bit dramatic.

**STACY**
Oh really?

**RYAN**
Yea. You're going to make me regret saying that, aren't you?
Doug James

- Physically based simulation

Example: Pouring Faucet

Frequency-domain radiation
[Langlois et al. 2016]

Time-domain radiation
[Our approach]
Doug James

- Physically based simulation
Doug James

- Physically based simulation
Leo Guibas

- Geometry processing and analysis

PointNet: Deep Learning on Point Clouds

Shape Similarity and Correspondence
Front Wheel Pivot
(BMX Bike)
Gordon Wetzstein

- Computational imaging and computational displays

Seeing around corners
“Confocal non-line-of-sight imaging based on the light cone transform”
Gordon Wetzstein

- Computational imaging and computational displays

“Hybrid Optical-Electronic Convolutional Neural Networks”

Using carefully designed optics to compute the early layers of a CNN prior to digital processing
Karen Liu

Interests in animation, simulation, and control
Platforms for scaling modern video processing applications to hundreds of GPUs or thousands of CPUs.
Kayvon Fatahalian (me)

A completely computer generated Wimbledon point.
Can we design a ray tracer that can boot up 10,000 cores in the cloud in a few seconds and render a massive film-quality scene?
Can we redesign a game engine to more efficiently support RL-based training?

And distribute simulation processing across many machines in the cloud?
Detecting domain-specific video events

Cable TV news: political interviews, commercial segments

Feature film analysis: action shots, conversations, close-ups

Vehicular video: open parking spots, vehicle maneuvers of interest
Challenge:
Training detectors for new events can be expensive:

Collecting training data is labor-intensive, and training accurate models requires compute, time, and skill
Approach:
Specify novel events in video as queries that programmatically compose the outputs of existing, pre-trained models.
Unlabeled Video Collection
Unlabeled Video Collection

Annotations produced by pre-existing models

Face Detections

3:15–3:16: BERNIE...
5:18–5:20: THANK YOU...
9:15–9:17: TODAY IN...

Captions

def bernie_and_jake(faces):
    bernie = faces.filter(face.name == "Bernie")
    jake = faces.filter(face.name == "Jake")
    bernie_and_jake = bernie.join(jake,
        predicate = time_overlaps,
        merge_op = span)
    return bernie_and_jake
def bernie_and_jake(faces):
    bernie = faces
    .filter(face.name == "Bernie")
    jake = faces
    .filter(face.name == "Jake")

    bernie_and_jake = bernie
    .join(jake,
          predicate = time_overlaps,
          merge_op = span)

    return bernie_and_jake
def bernie_and_jake(faces):
    bernie = faces
    .filter(face.name == "Bernie")
    jake = faces
    .filter(face.name == "Jake")
    bernie_and_jake = bernie
    .join(jake,
         predicate = time_overlaps,
         merge_op = span)
    return bernie_and_jake
Analyzing video to curate content

All interviews on TV news
Other popular research topics in computer graphics...
Creating physically plausible models

- Via 3D printing, fabrication
- Creatures that locomotes, furniture that stands, etc.

Fabricate models that are balanced to stand

Fabricate robots that can balance and move
Computational photography

- Using computation (and increasingly machine learning) to make more aesthetic photographs, simulate behavior of more complex lenses, etc.

Computational photography

- Using computation (and increasingly machine learning) to make more aesthetic photographs, simulate behavior of more complex lenses, etc.

High Dynamic Range Imaging (HDR)
Advanced geometry processing

Fundamental questions about alignment, similarly, symmetry, etc…
Advanced displays/rendering for VR/AR

Near eye light field display
Content creation and capture

Manipulating actors by performance capture

Audio input to mesh animation
The other direction: graphics helping machine learning

Grand Theft Auto Screenshots | Synthesized “photorealistic” image

Pix2pixHD
Carla autonomous driving simulator
A fun resource

Ke-sen Huang’s famous site with all the SIGGRAPH papers!
http://kesen.realtimerendering.com/

SIGGRAPH 2018 papers on the web

Page maintained by Ke-Sen Huang. If you have additions or changes, send an e-mail.

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Note that when possible I link to the page containing the link to the actual PDF or PS of the preprint. I prefer this as it gives some context to the paper and avoids possible copyright problems with direct linking. Thus you may need to search on the page to find the actual document.


Changelog

(01) A Race to the Bottom (of the Geometric Energy Plot)

Blended Cured Quasi-Newton for Distortion Optimization  
Yufeng Zhu (The University of British Columbia and Adobe Research), Robert Bridson (The University of British Columbia and Autodesk), Danny Kaufman (Adobe Research)

Progressive Parameterizations  
Ligang Liu, Chunyaoye, Ruiqi Ni, Xiao-Ming Fu (University of Science and Technology of China)

Anderson Acceleration for Geometry Optimization and Physics Simulation  
Yue Peng (University of Science and Technology of China), Bailin Deng (Cardiff University), Juyong Zhang, Fanyu Geng, Wenjie Qin, Ligang Liu (University of Science and Technology of China)

Opt: A Domain Specific Language for Non-linear Least Squares Optimization in Graphics and Imaging  
Zachary DeVito (Facebook Research), Michael Mara (Stanford University), Michael Zollhofer (MPI Informatics), Gilbert Bernstein (Stanford University), Jonathan Ragan-Kelley (UC Berkeley), Christian Theobalt (MPI Informatics), Pat Hanrahan (Stanford University), Matthew Fisher (Adobe Research), Matthias Niessner (Technical University of Munich)  
(TOG Paper)

Active Animations of Reduced Deformable Models with Environment Interactions  
Zherong Pan, Dinesh Manocha (University of North Carolina at Chapel Hill)
How to get involved

- Email your graphics professors and ask to talk to them about independent study
  - Although to be honest... the best intro line is ("I took and loved your 300-level class and did well and want to keep going)

- A common way to get started
  - Hack code to contribute to a Ph.D. student’s research project
Why research (or independent study)?

- You will learn way more about a topic than in any class.

- You think your undergrad friends are very smart? Come hang out with Stanford Ph.D. students! (you get to work side-by-side with them and with faculty). Imagine what level you might rise to.

- It’s way more fun to be on the cutting edge. Industry might not even know about what you are working on. (imagine how much more valuable you are if you can teach them)

- It widens your mind as to what is possible.
Maybe you might like research and decide you want to go to grad school

Pragmatic comment: Without question, the number one way to get into a top grad school is to receive a strong letter of recommendation from faculty members. You get that letter only from being part of a research team for an extended period of time.

DWIC letter: (“did well in class” letter) What you get when you ask for a letter from a faculty member who you didn’t do research with, but got an ‘A’ in their class. This letter is essentially thrown out by the Ph.D. admissions committee at good schools.
A very good reference

CMU Professor Mor Harchol-Balter’s writeup:
“Applying to Ph.D. Programs in Computer Science”

http://www.cs.cmu.edu/~harchol/gradschooltalk.pdf
Why not start your own project?

Interested in applying computer science to a problem that excites you? Give it a shot!

Like a topic enough to be your own boss? Consider starting your own company.

Why go work for Google or Facebook when you can start a company that beats them? (yes, those are great jobs too!)
Thanks for being a great class!

Good luck on projects! Make sure you have fun, that’s the point!

And, above all else, do your best to stay healthy, and keep others healthy.