Lecture 42: Conclusions
Announcements

• Exam review: Sunday 1-3pm, location: TBA
• Exam topics
  – Lec 18 (Cameras, Mar 9)-lec 39 (ConvNets, May 4)
• Grading: any unresolved issues drop me a note
• Final: Sunday 2pm, May 22
  – BTN100WEST, Barton Hall 100 West-Main Floor
• Course evaluation
  – Replace your lowest quiz grade with your highest one
Grading

• Rough grade breakdown:
  – Quizzes + class evaluation: 5%
  – Midterm, final exam: 15% each
  – Homeworks: 10% each
  – Programming projects: 45%
ConvNets

Applications

Google Image Search

Search by Image

Best guess for this image: cats and kittens

Funny Cats and Kittens MeowingCompilation 2013 - YouTube
www.youtube.com/watch?v=DXUyRlk6K -
Nov 9, 2013 - Cats Meowing | Cat Meowing | Kittens Meowing | Kitten Meowing | Meowing Cat | Funny Cat | Meowing Kittens | Cat Meowing Non Stop | Cats ...

mama cat comes to rescue her little kitten - YouTube
www.youtube.com/watch?v=S-S-Df6nH5Q -

Visually similar images
ConvNets

Applications - Photo Search
ConvNets

YouTube

Google Shopping

Advertising

StreetView / Maps

Self-Driving Cars

Robotics

Much more...
Video Classification

Two-Stream Convolutional Networks for Action Recognition in Videos [Simonyan et al.], 2014

Long-term Recurrent Convolutional Networks for Visual Recognition and Description [Donahue et al.], 2014

Large-scale Video Classification with Convolutional Neural Networks [Karpathy et al.], 2014
Image Captioning

*man in black shirt is playing guitar.*
*construction worker in orange safety vest is working on road.*
two young girls are playing with lego toy.*
*boy is doing backflip on wakeboard.*
girl in pink dress is jumping in air.
black and white dog jumps over bar.
young girl in pink shirt is swimming on swima.
man in blue wetsuit is surfing on wave.*
CNNs

The Deep and now Deeper Hammer

Deep learning infrastructure by the Google Brain team

“ImageNet Classification with Deep Convolutional Neural Networks”,
Krizhevsky, Sutskever, Hinton, NIPS 2012
• Lightstage
Science in Art

- Joe and Pauline Degenfelder ‘60
  - Degenfelder jade collection

“Mutton” jade

White jade inkwell
What makes jade look like jade?
Why are translucent materials so beautiful?

Shiny materials: light bounces off the surface.

Translucent materials: light goes into the surface.
What makes white jade look like white jade?

Current graphics models
  + Diffusive
  - Glassy

Answer
  Phase function
Phase function: direction of light scatter

Simple models cannot produce glassy, only diffusive

Ours: expand phase fns to 2 perceptual dimensions

Setup

Soap

Wax

Captured

Old

Ours

glassy
diffusive
Answer:

- how
- lasers
- mustard
- whole milk shampoo
- hand cream
- robitussin
- olive oil
- curacao
- mixed soap
- milk soap
- liquid clay
- reduced milk
- Adelson, Gkioulekas, Xiao, Zhao, Zickler
Femto photography Project
Vision and Graphics

- **Computer Graphics**: Models to Images
- **Computer Vision**: Images to Models
- **Comp. Photography**: Images to Images
Creating Realistic Imagery

Computer Graphics
- + great creative possibilities
- + easy to manipulate objects/viewpoint
- - Tremendous expertise and effort to obtain realism

Computational Photography
- Realism
- Manipulation
- Ease of capture

Photography
- + instantly realistic
- + easy to acquire
- - very hard to manipulate objects/viewpoint
Aside: Image Manipulation

Figure 3: The 1860 portrait of President Abraham Lincoln and Southern politician John Calhoun.
Fig. 1. Our algorithm finds that the shadows in this 1969 moon landing photo are physically consistent with a single light source. The solid lines correspond to constraints from cast shadows and dashed lines correspond to constraints from attached shadows. The region outlined in black, which extends beyond the figure boundary, contains the projected light locations that satisfy all of these constraints.
The ultimate camera

• Infinite resolution
• Infinite zoom control
• Desired object(s) are in focus
• No noise
• No motion blur
• Infinite dynamic range (can see dark and bright things)
• ...

Light field camera [Ng et al., 2005]
Light field camera
Refocusing images
Conventional vs. light field camera

Conventional camera

Light field camera
Inside the Lytro

The Lytro camera is the first consumer “light field camera.” It uses a new technology to create photos that can have their focus changed after they have been taken. Because of this, there is no need to auto-focus, resulting in virtually no shutter delay. Here’s how it works.

Camera Overview
A Lytro camera is made up of two sections. An anodized aluminum shell contains the lens assembly, while the electronics are housed within a silicone rubber grip.

Light Field Sensor
Consists of a standard digital camera CMOS sensor coupled with a micro-lens array. The array contains thousands of miniature lenses.

Micro-Lens Array
Tiny lenses divide the CMOS sensor’s pixels into multiple areas, each showing the image at a slightly different angle. Software uses this data to triangulate the image in 3-D space.

Capturing Light
Lytro’s light field sensor captures not only the color, intensity and position of the light, but also its direction, which is lost in traditional cameras.

Changing Focus
Because all the directional information of the entering light is captured, software can change the focal plane. Clicking any point on the image brings that area into focus, whether raindrops on the surface of a window or buildings beyond.

Source: Lytro Inc.

https://www.lytro.com/camera/
Computational Photography

Gigapixels
Hyperlapse
Timelapse
Motion Magnification, video
Sound
Where to?

- Lots of companies doing vision
  - Big and small
- Robotics
- Self-driving cars
- Image applications
- Languages and images

- Masters and PhD
Questions?

• Good luck!