Wrap-up and discussion
Course overview

Photographic optics and pipeline

• pinhole and lens cameras
• lenses and other optical elements
• paraxial optics
• aperture
• image processing pipeline
Exposure, HDR, and noise

- exposure control
- high-dynamic-range imaging
- radiometric calibration
- noise modeling
- noise calibration
Color and image editing

- tonemapping
- color processing
- color calibration
- edge-aware and bilateral filtering
- gradient-domain processing
- Poisson integration
Focus and coded photography

- focal stacks
- depth from (de)focus and confocal stereo
- lightfields and lightfield processing
- plenoptic camera
- deconvolution and motion deblurring
- coded aperture
- coded exposure
Radiometry and photometric stereo

- radiometry
- reflectance equation
- BRDF models
- illumination models
- calibrated photometric stereo
- uncalibrated photometric stereo
Geometry and stereo

- geometric camera models
- geometric camera calibration
- triangulation
- epipolar geometry
- stereo and disparity
- depth from lightfields
- structured light scanning
Computational light transport

- time-of-flight imaging
- direct and global illumination
- light transport matrices
- dual photography
- optical computing
- probing and epipolar imaging
Things you should know how to do

1. Build simple pinhole cameras, use DSLR cameras and modern lenses.

2. Write your own LDR and HDR image processing pipelines.

3. Calibrate the radiometric, color, noise, and geometric properties of a camera.

4. Fuse images and perform flash/no-flash photography.

5. Use bilateral and gradient-domain filtering for image editing tasks.

6. Capture and refocus your own lightfields and focal stacks.

7. Build three different types of depth and shape sensing systems: depth-from-defocus, photometric stereo, structured light.
Do you plan on taking any other vision/graphics courses?

If you are an undergraduate, check out the **graphics concentration**.

Background courses (ideally you should take both):
- 16-385/16-720 computer vision.

More advanced courses directly relevant for computational photography and imaging:
- **15-468** physics-based rendering – modeling, simulating, and inverting light transport. Spring 2024, offered by Yannis
- 15-458 discrete differential geometry – background for 3D geometry processing and geometric optics.
- 16-822 geometry-based methods in vision – all about epipolar geometry.
- 16-726 learning-based image synthesis – learning-based variants of computational photography algorithms.
- 16-722 sensing and sensors – background on vision and other sensors and noise modeling.
- 16-866 sensor systems – similar to above, background on vision and other sensors and noise modeling.
- 33-353 intermediate optics – wave optics, hands-on experience with optical components.

More general vision (left) and graphics (right):
- 16-824 visual learning and recognition
- 10-703 deep reinforcement learning
- 16-831 statistical techniques in robotics
- 16-833 robot localization and mapping
- 16-881 deep reinforcement learning for robotics
- 15-365 experimental animation
- 15-464 technical animation
- 15-465 animation art and technology
- 15-466 computer game programming
- 15-469 algorithmic textiles design
Interested in doing research in computational imaging or rendering? Talk to me!

Many, many possible projects, including:

• Projects on rendering and inverse rendering.
• Projects on theory of light transport.
• Projects on coherent imaging and optical coherence tomography.
• Projects on material inference (reflectance, scattering, refractive fields, particle sizing).
• Projects on tissue imaging.
• Projects on non-line-of-sight imaging.
• Projects on combining physics (rendering) and deep learning.
• Projects on data-driven optimization of imaging systems.
• Projects derived from your final project for a paper publication.

Many 15-463/663/862 alumni have worked on various research projects in my group.

Ideal background:
• Knowledge of (at least one of) graphics, vision, physics, numerical computing.
• If you’ve taken 15-463, you have the background.