Computational Photography
CS445

Instructor: Derek Hoiem

Today’s Class

- A little about me
- Intro to Computational Photography
- Course outline and logistics

About me

Raised in “upstate” NY

About me

1998-2002
Undergrad at SUNY Buffalo
B.S., EE and CSE

2002-2007
Grad at Carnegie Mellon
Ph.D. in Robotics

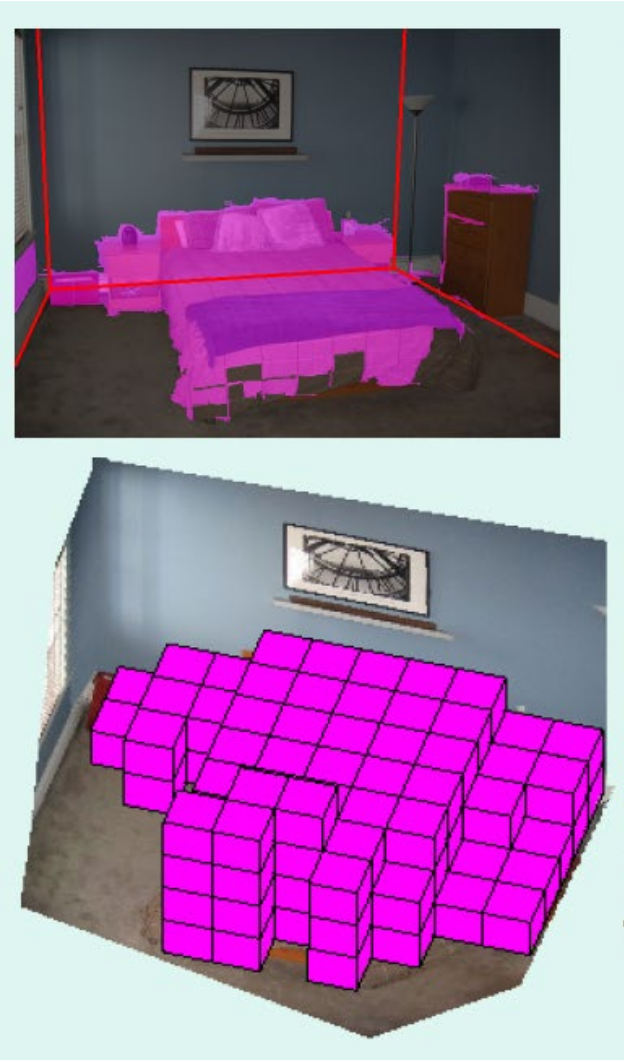
2007-2008
Postdoc at Beckman Institute

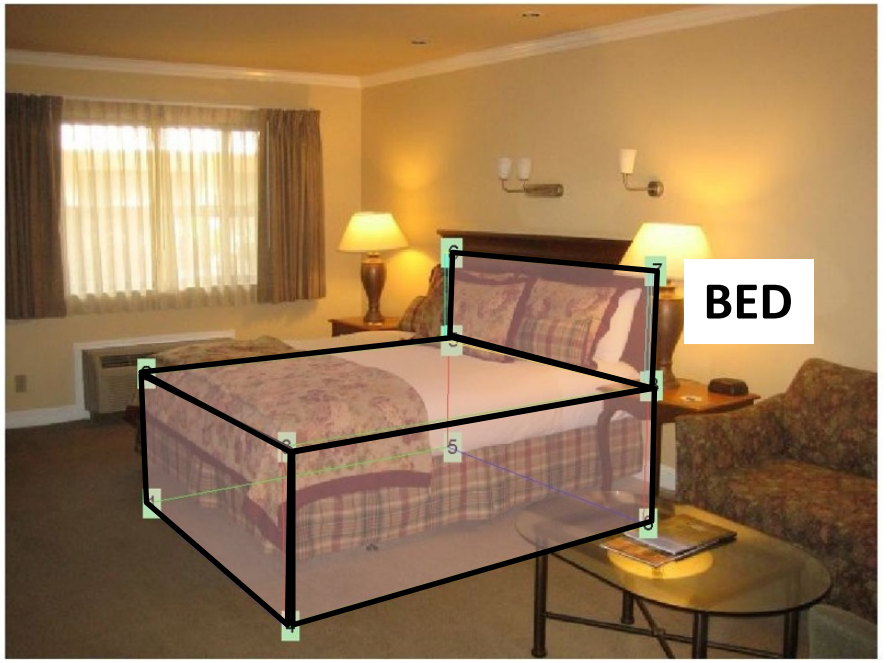
2009-
Asst/Assoc Prof in CS at UIUC

My research

My research

Recovering 3D layout and context



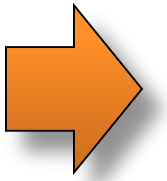


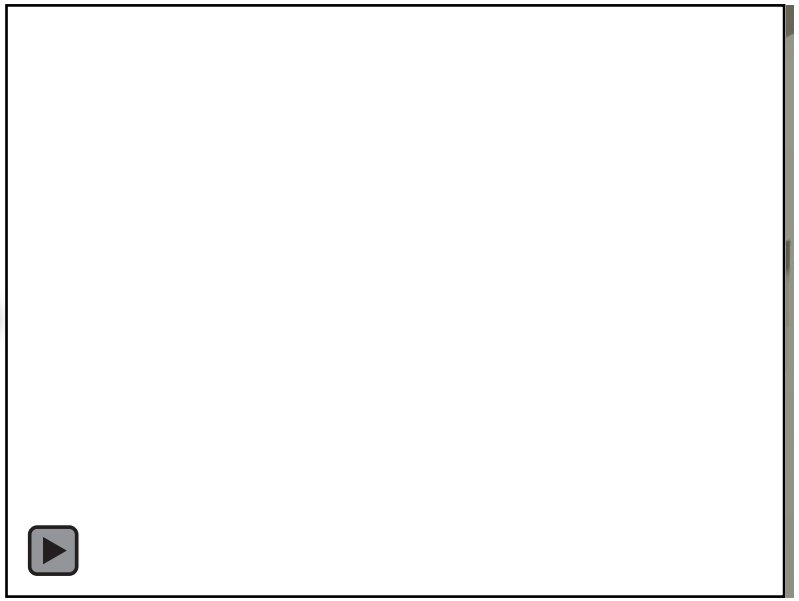
Hedau et al. 2009, 2010

My Research

3D scene model from RGB+D image

RGBD Image



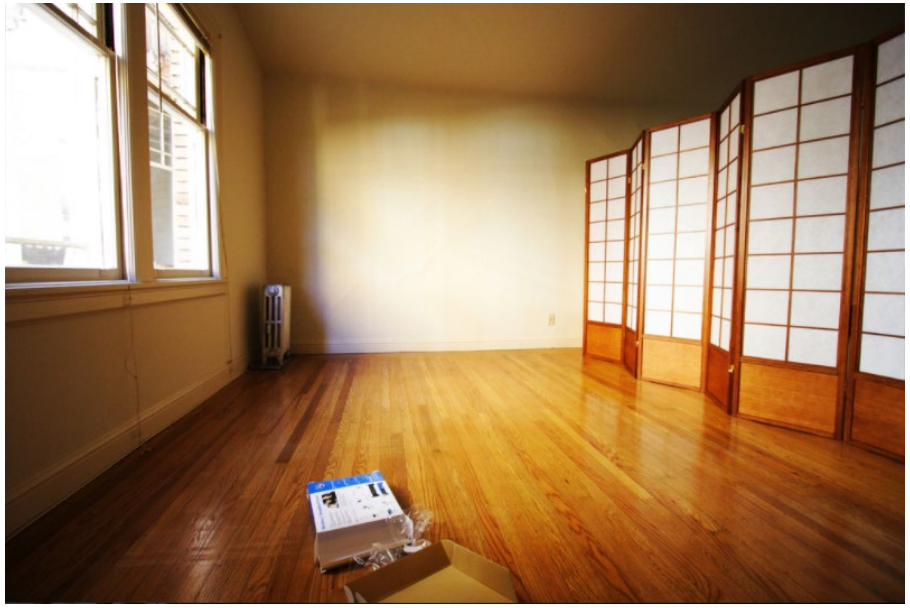


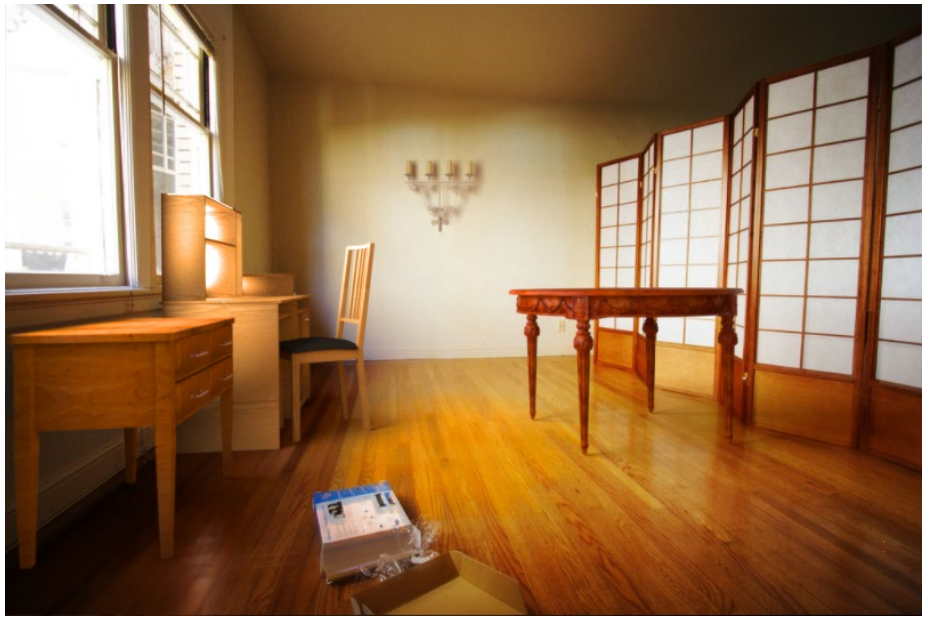
3D Model

Guo, Zou, Hoiem 2018

My Research

Editing images as if they were 3D scenes



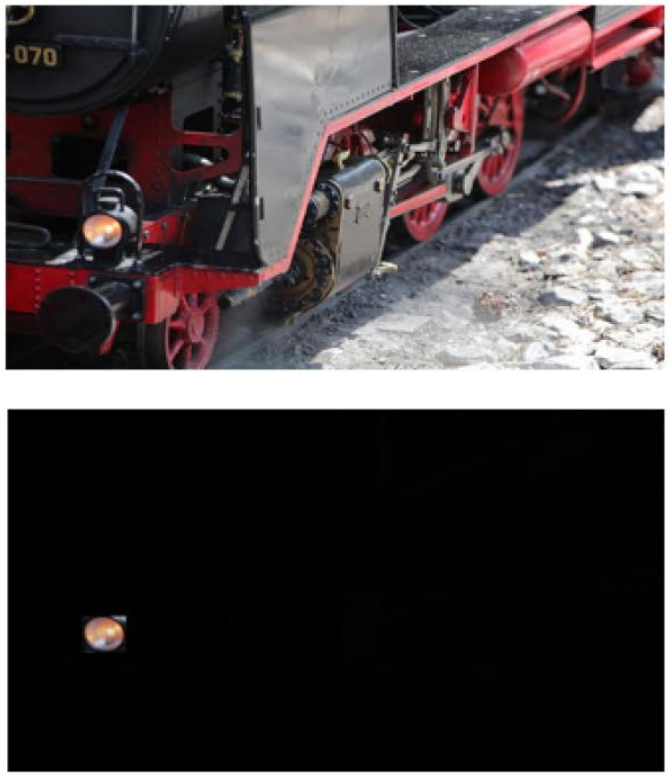


Karsch et al. 2011

GOLFER

My Research

Question: Is the light on the train lit?
Answer: yes



Objects: light, signal, traffic light, eye, wheel
Attributes: lit, illuminated, round, glowing, lighted

Question: What is the yellow object in the street?
Answer: hydrant

Objects: hydrant, fire hydrant, post, container, device
Attributes: yellow, different, bright yellow, banana, cold

Gupta et al. 2017

My Research

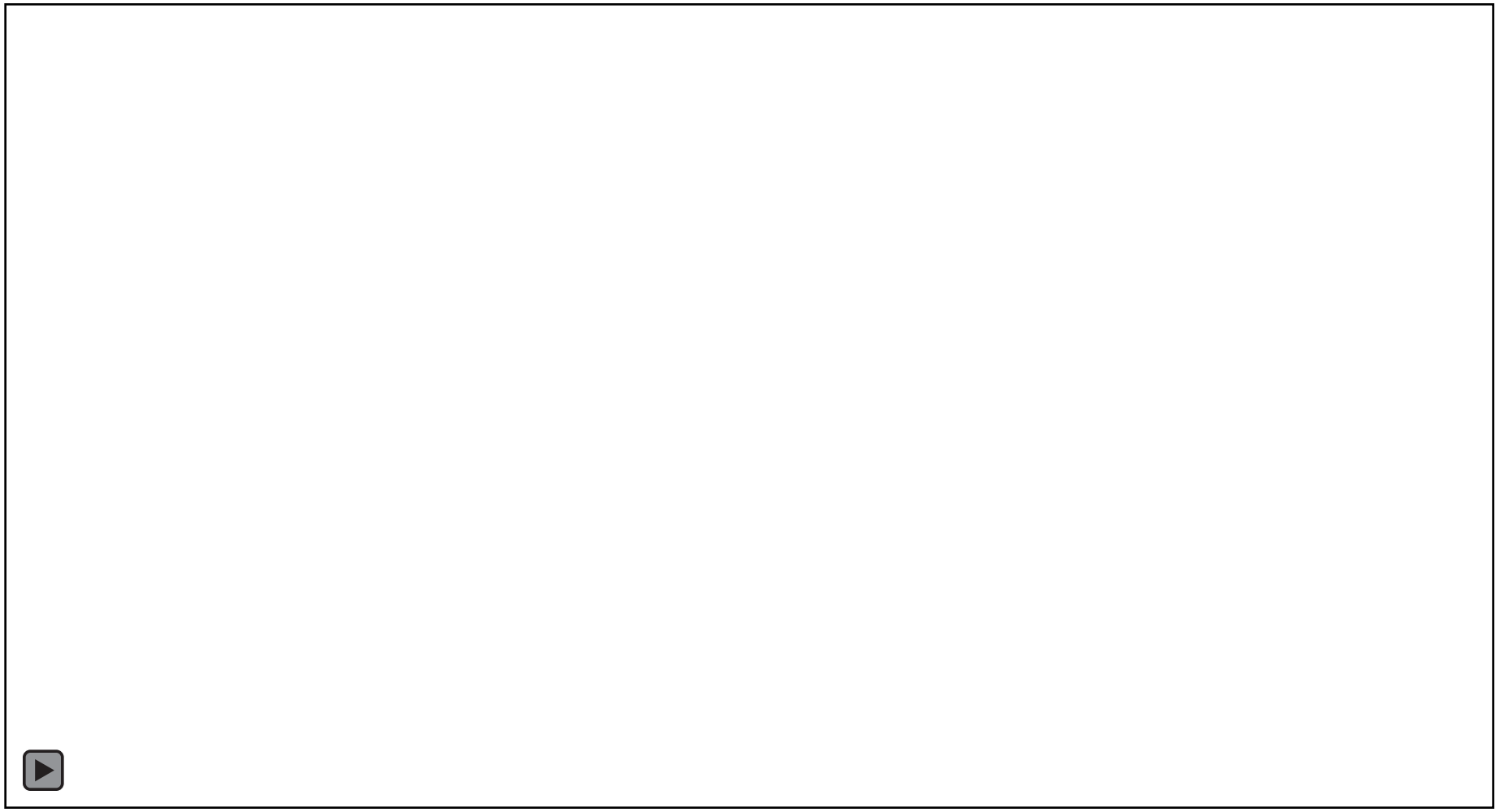
Generating comic videos

Fred wearing a red hat is walking in the living room

Wilma and Betty are seated at a table in the kitchen

Gupta et al. 2018

Reconstruct: vision for construction



Crunchbase top 50 global startups

https://vimeo.com/242479887

https://www.reconstructinc.com/

Some background to computational photography and …

The Pursuit of Realism

Several of following slides from Alyosha Efros

Depicting Our World: The Beginning

Prehistoric Painting, Lascaux Cave, France
~ 15,000 B.C.

Depicting Our World: Middle Ages

The Empress Theodora with her court.
Ravenna, St. Vitale 6th c.

Depicting Our World: Middle Ages

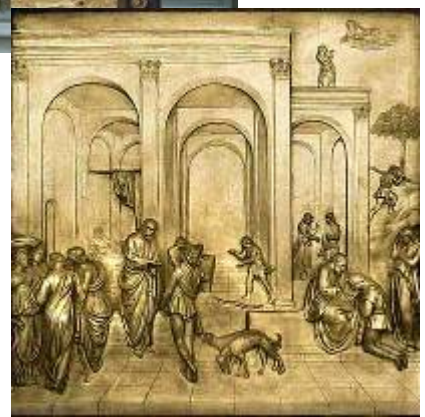
Nuns in Procession. French ms. ca. 1300.

Depicting Our World: Renaissance

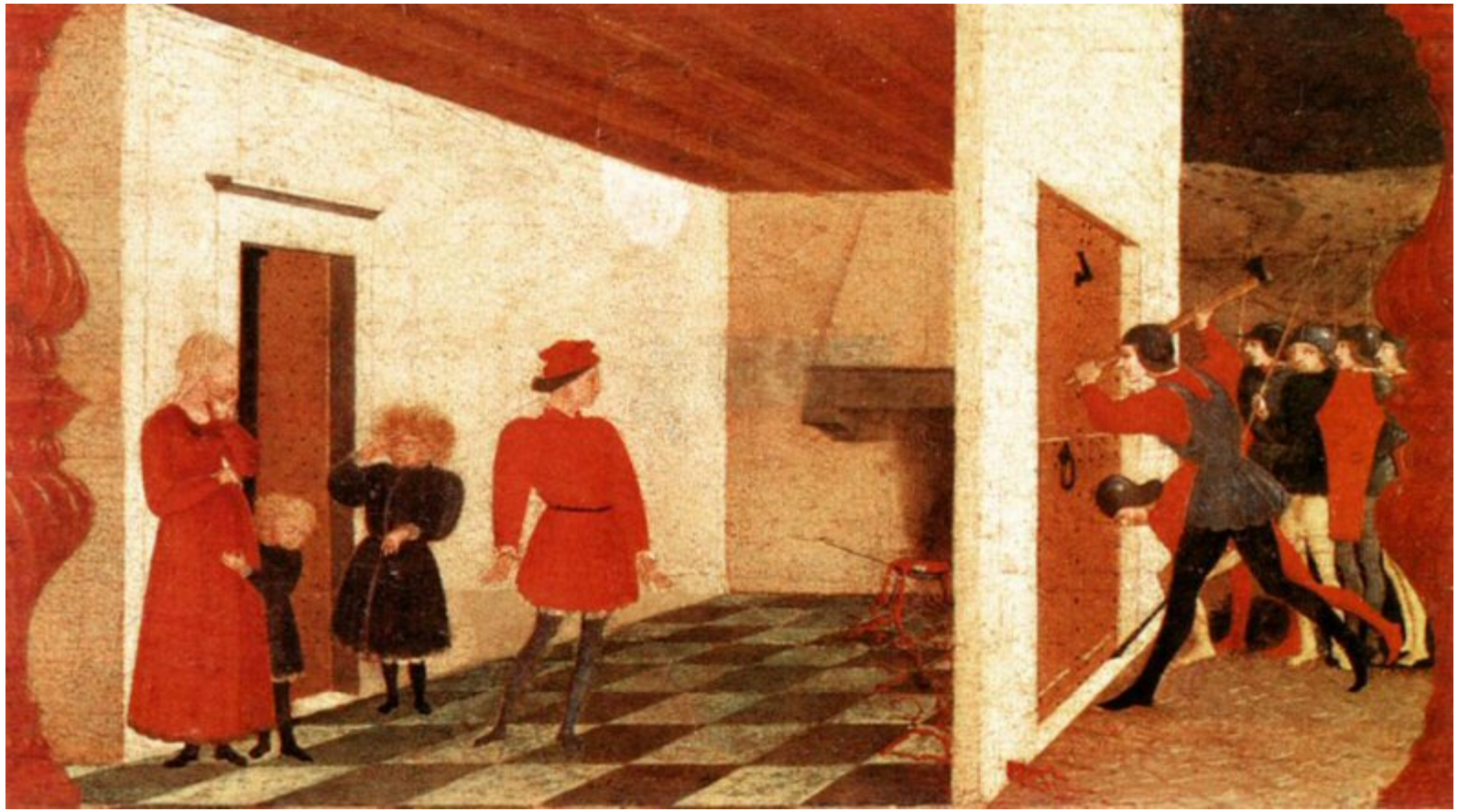
North Doors (1424)

Lorenzo Ghiberti (1378-1455)

East Doors (1452)



Depicting Our World: Renaissance

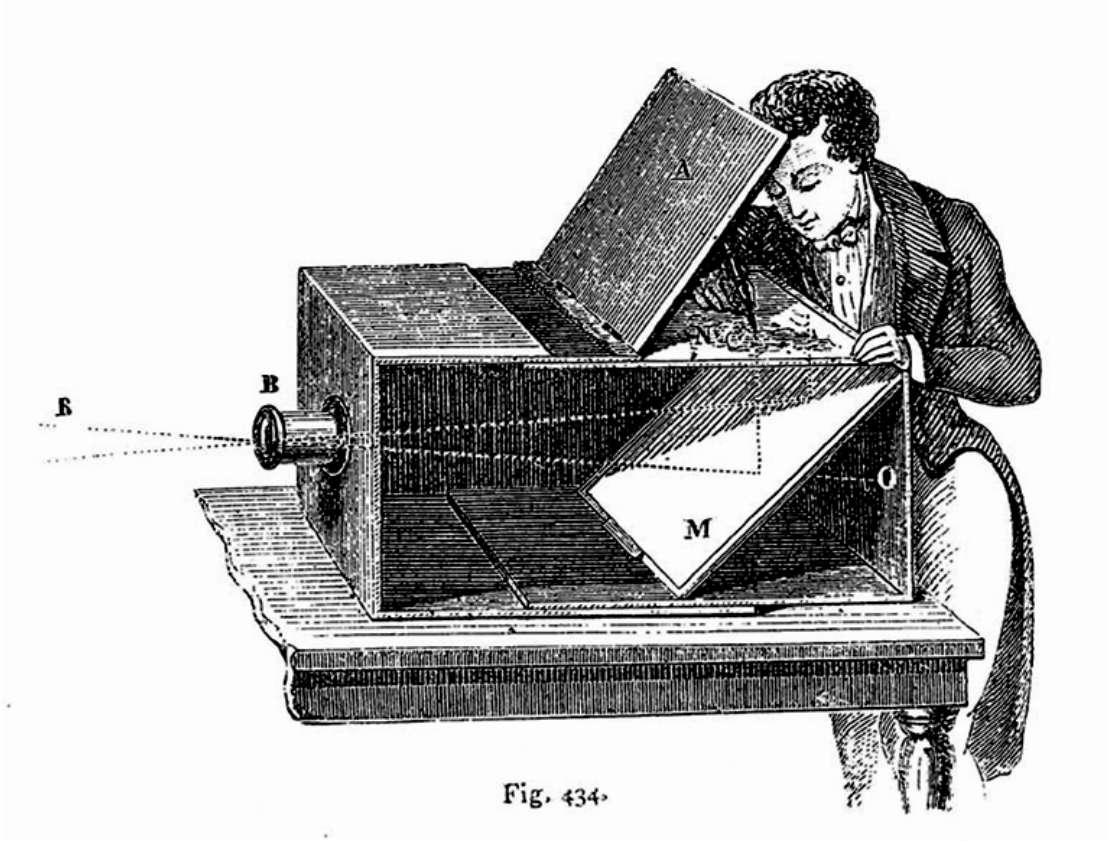


Paolo Uccello,
Miracle of the Profaned Host (c.1467-9)

Depicting Our World: Toward Perfection

Jan van Eyck, *The Arnolfini Portrait (1426-1434)*

Depicting Our World: Toward Perfection



Lens Based Camera Obscura, 1568

Depicting Our World: Perfection!

Still Life, Louis Jaques Mande Daguerre, 1837

But is a photo really realistic?

Related story: https://www.propublica.org/article/the-toppling-saddam-statue-firdos-square-baghdad

Is reality what we want?

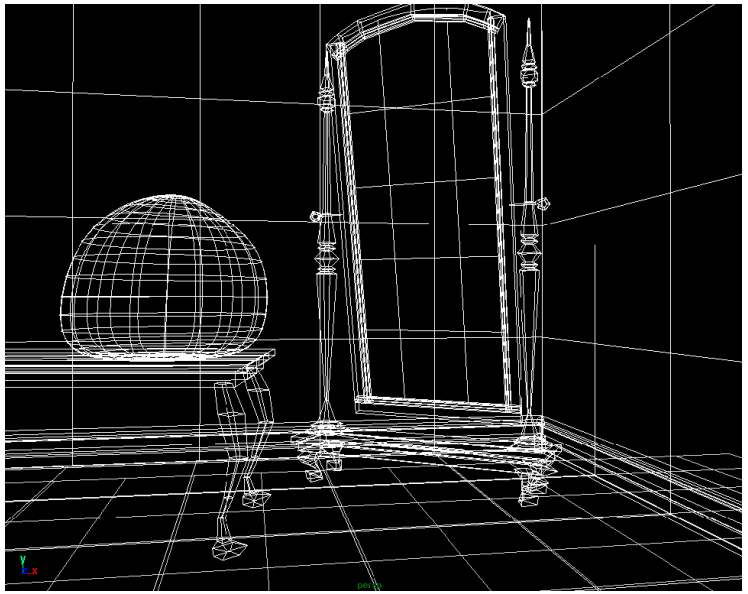
PAMELA ANDERSON -- WARTS AND ALL...

ALL TOUCHED UP AND READY TO GO!!!

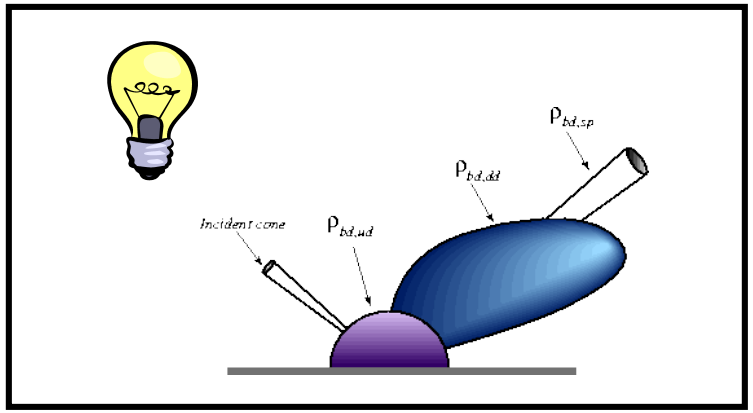
http://www.freephotoediting.com/samples/photo-glamourisation/020_celebrity-skin-retouching.htm

Enter Computer Graphics...

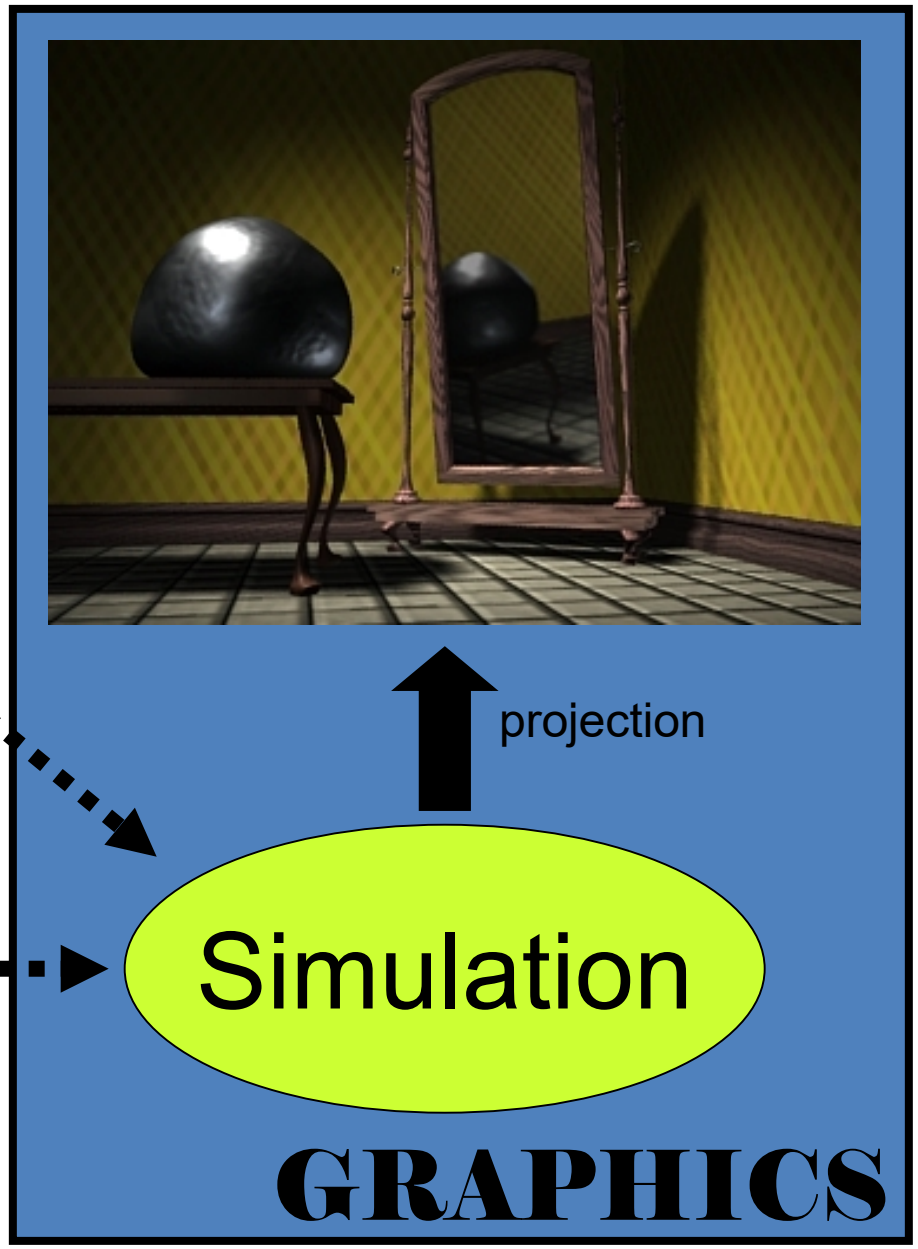
Traditional Computer Graphics



3D geometry



physics



Computer graphics

What's wrong?

The richness of our everyday world

Photo by Svetlana Lazebnik

Which parts are hard to model?

Photo by Svetlana Lazebnik

People

From “Final Fantasy”

Alyosha Efros - On the Tube, London

Faces / Hair

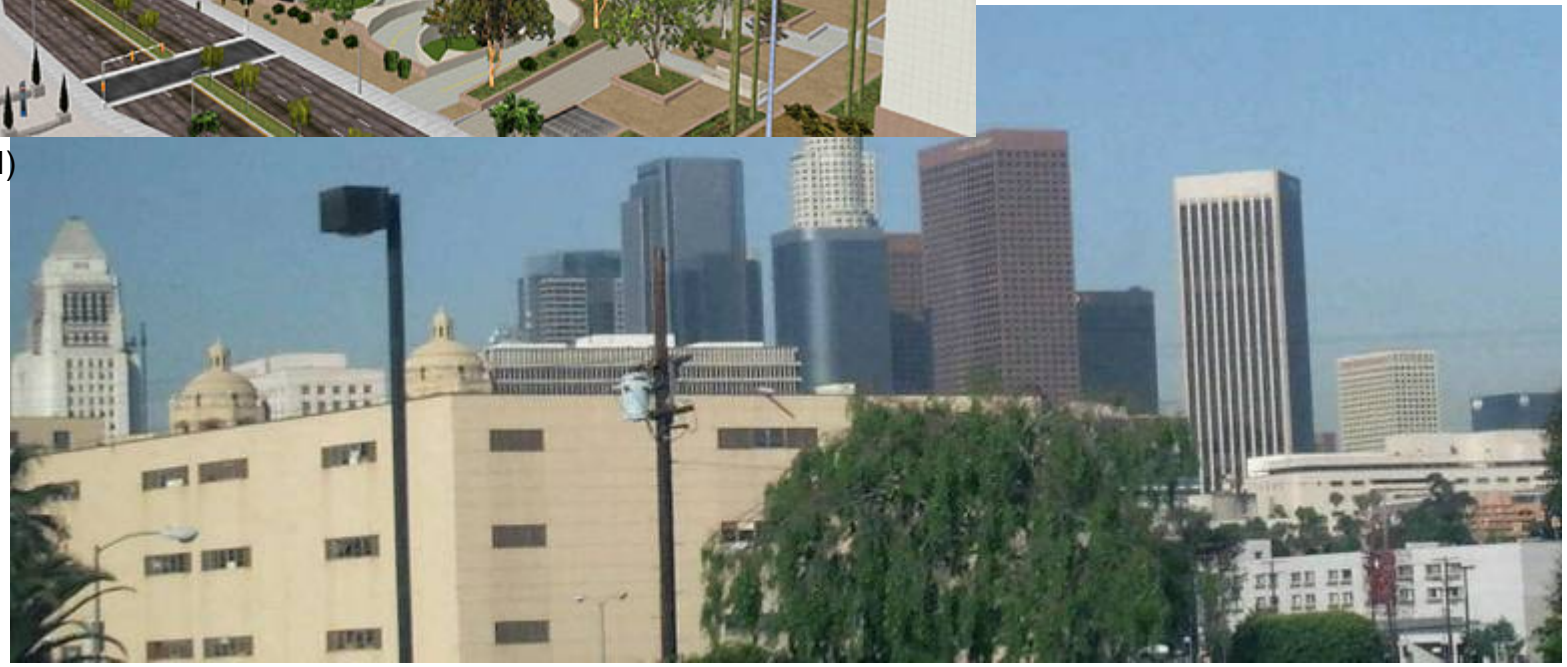
From “Final Fantasy”

Photo by Joaquin Rosales Gomez

Urban Scenes

Virtual LA (SGI)

Photo of I LA



Nature

River Cherwell, Oxford

The Realism Spectrum

Computer Graphics

+ easy to create new worlds

+ easy to manipulate objects/viewpoint

- very hard to look realistic

Computational Photography

Realism
Manipulation
Ease of capture

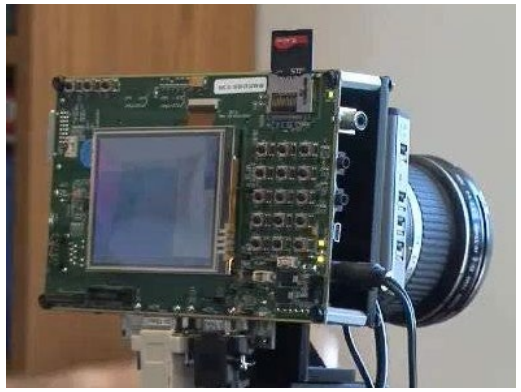
Photography

+ instantly realistic

+ easy to aquire

- very hard to manipulate objects/viewpoint

Computational Photography



How can I use computational techniques to capture light in new ways?

How can I use computational techniques to breathe new life into the photograph?

How can I use computational techniques to synthesize and organize photo collections?

Virtual Real World

Campanile Movie (1997)

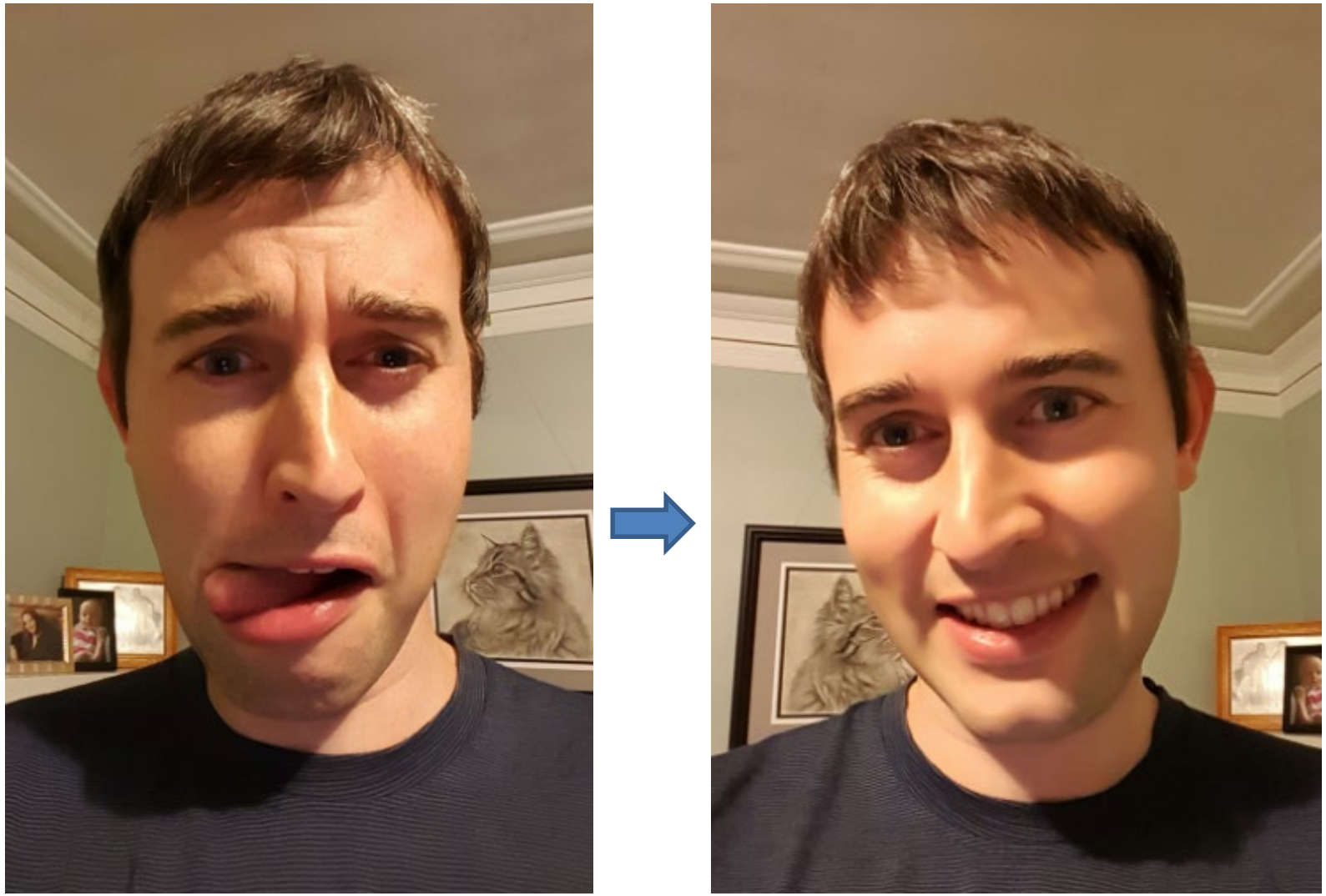
http://www.debevec.org/Campanile/

Going beyond reality…

Benjamin Button (2008)

http://www.digitaldomain.com/work/the-curious-case-of-benjamin-button/

Another example of blending reality with fantasy



Samsung Galaxy S6 regular and “beauty” selfie

FaceApp

Course objectives

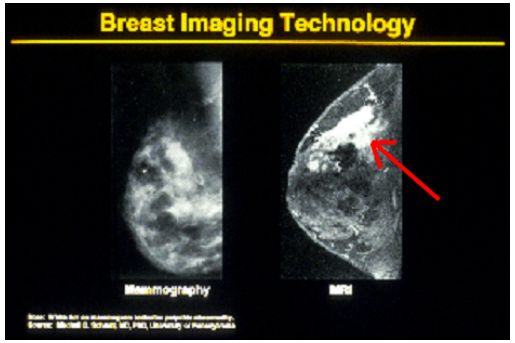
1. You will have new abilities for visual creation.

Graphic by James Hays

Course objectives

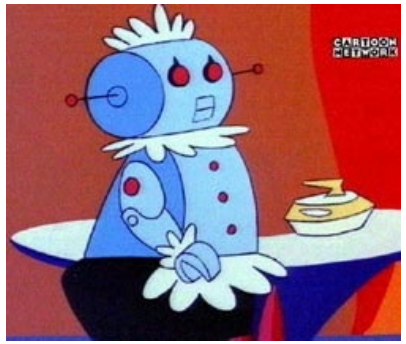
2. You will get a foundation in computer vision.

Safety



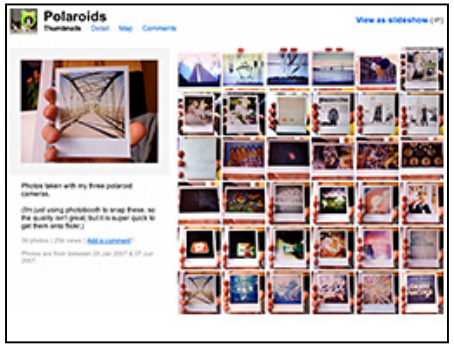
Health

Security



Comfort

Fun



Access

Got job?

- Google, Facebook, Microsoft, Sony, iRobot, Amazon, Snapchat, Ebay, tons of startups, etc.

- http://www.cs.ubc.ca/~lowe/vision.html

Course objectives

3. You'll better appreciate your own visual ability.

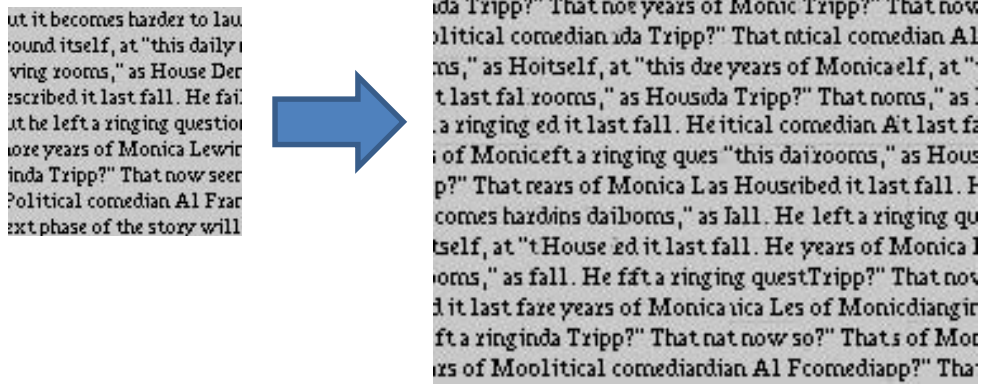
Course objectives

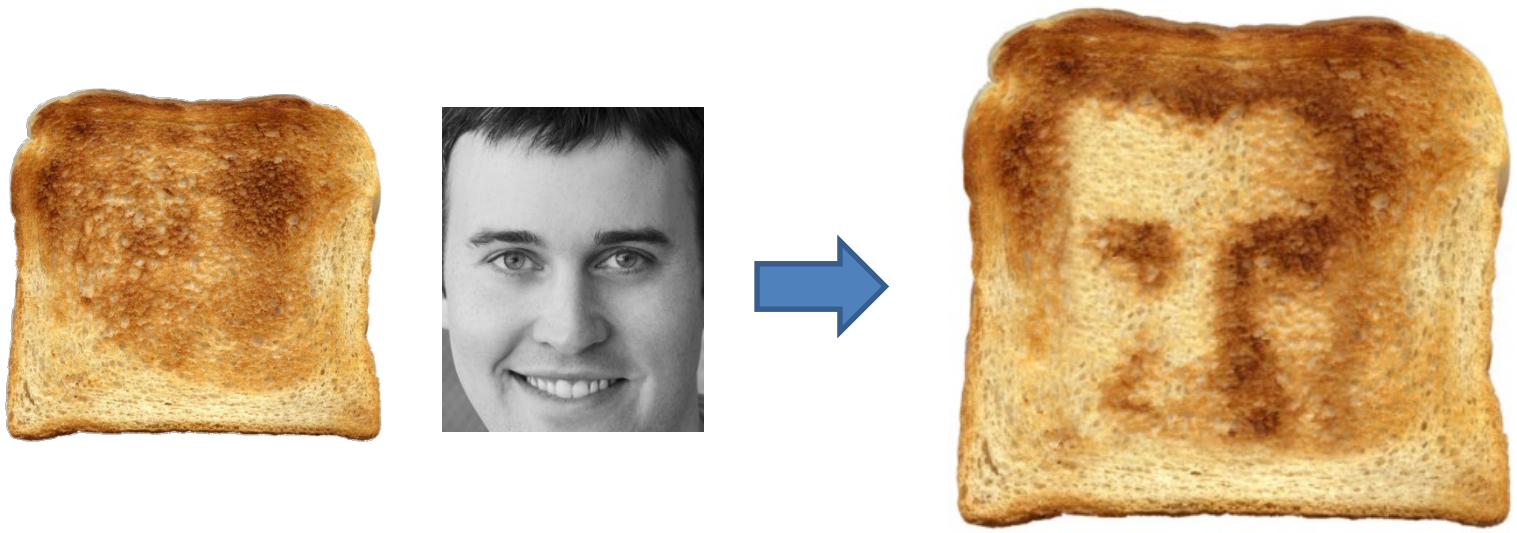
4. You'll have fun doing cool stuff!

Projects

Project 1: Hybrid Images

Project 2: Image Quilting for Texture Synthesis and Transfer

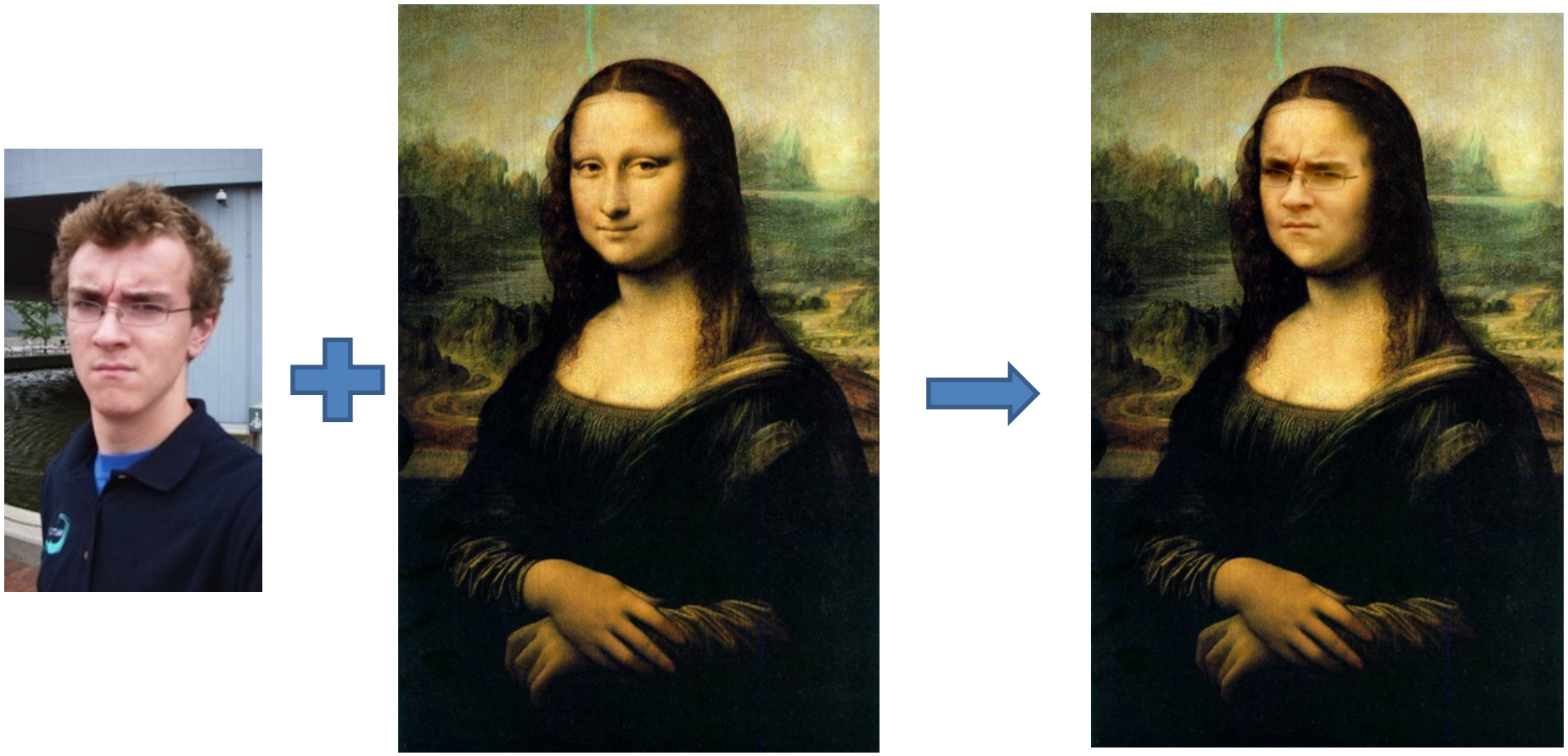




Project 3: Poisson Editing

Photos from James Hays

Project 3: Poisson Editing



Photos from Evan Wallace

Project 4: Image-Based Lighting

Project 5: video alignment, stitching, and editing

Final Project

Something cool!

Course outline

Prof: Derek Hoiem dhoiem@illlinois.edu

TAs

Zhi Chen zhic4@illinois.edu

Shengyu Fen shengyu8@illinois.edu

Eric Lee kylee5@illinois.edu

Dominic Roberts djrbrts2@illinois.edu

Yuan Shen yshen47@illinois.edu

Grades

- Projects (55%)
  - 5 projects: each with 100 core points with more optional “bells and whistles”
  - 3 credit (ugrad): graded out of 425 points
  - 4 credit (grad): graded out of 500 points
  - Can early 25 additional points for extra credit
- Exams (30%)
  - Midterm 15%: covers first half
  - Final 15%: covers entire semester
- Final Project (15%)
  - 1% for proposal, 14% for final submission
  - 2 page abstract

Late policy

- Up to ten free days total – use them wisely!
- 5 point penalty per day after that
- Project must be submitted within two weeks of due date to receive any points

Project details

- Implement stuff from scratch and apply it to your own photos

- Submit PDF, Jupyter notebook, and Python code

Learning resources

Lectures

- Lecture modules on Coursera
- Original full-length recordings: https://ensemble.illinois.edu/Playlist/CS445_Hoiem_FA19
  - Search by lecture date, e.g. 9.06 for Sept 6, based on schedule here: https://courses.engr.illinois.edu/cs445/fa2019/

Slides

- On Coursera

Office hours

- Will be updated on the Coursera page

Discussion board: https://piazza.com/class/kdszesldhqd74g

Readings/textbook: for depth and details not covered in lecture

Academic Integrity

These are OK

- Discuss projects with classmates (don’t show each other code)
- Use Stack Overflow to learn how to use a Python module
- Get images from online (make sure to attribute the source)

Not OK

- Copying or looking at project-specific code (i.e. so that you claim credit for part of an assignment based on code that you didn’t write)
- Using external resources (code, images) without acknowledging them

Remember

- Ask if you’re not sure if it’s ok
- You are safe as long as you acknowledge all of your sources of inspiration, images, code, etc. in your write-up

Other comments

Prerequisites

- **Linear algebra**, plus some basic calculus and probability
- Experience with graphics, image processing, or Python will help but is not necessary

Equipment

- Your own camera, but a smartphone is probably good enough
- A mirrored sphere for project 4 (12 cm or bigger) e.g. https://www.amazon.com/Stainless-Mirror-Polished-Sphere-Ornament/dp/B01ING7L4U

Feedback is welcome