Computational Photography
CS445

Instructor: Derek Hoiem

TAs: Jae Lee Yong, Yuan Shen, Wilfredo Torres Calderon

Today's Class

- A little about us
- 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

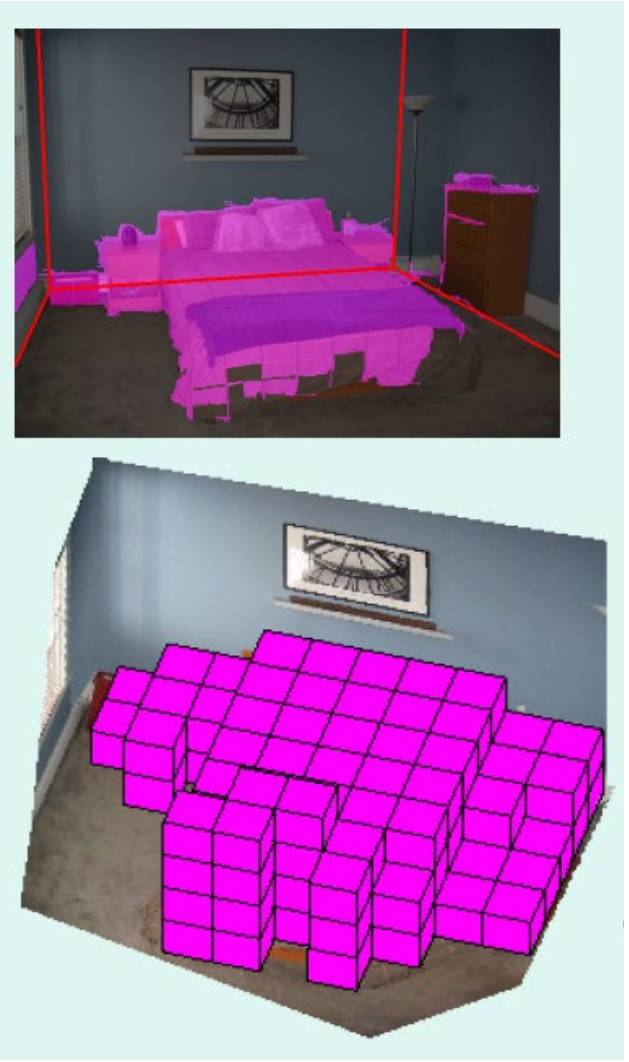
2007-2008
Postdoc at Beckman Institute

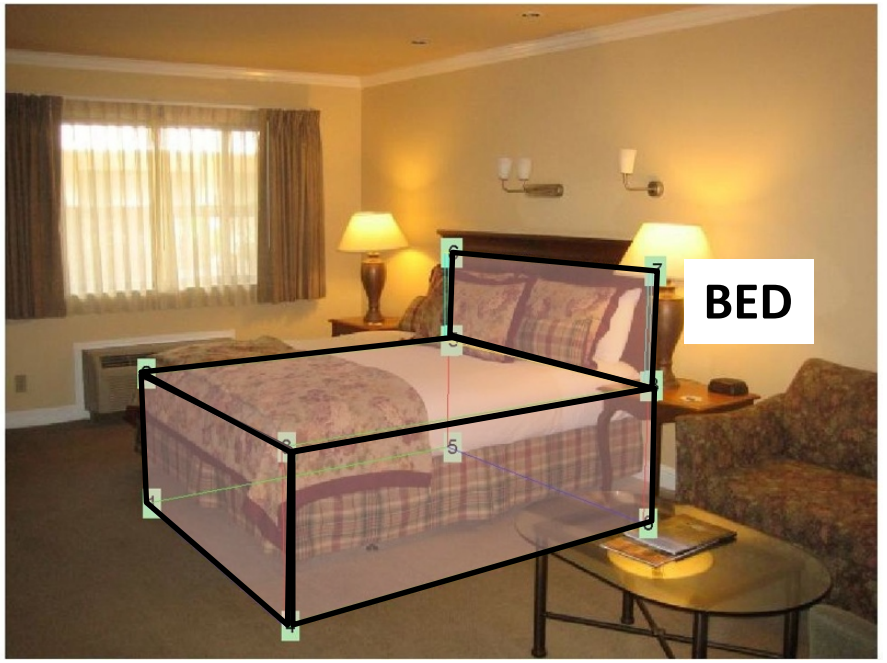
2009-
Asst/Assoc Prof in CS at UIUC

My research

My research

Recovering 3D layout and context



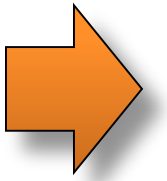


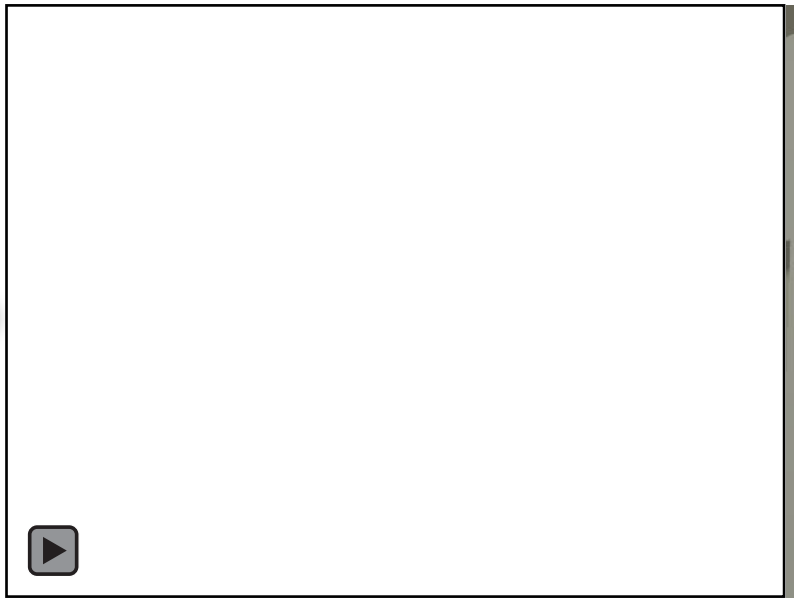
Hedau et al. 2009, 2010

My Research

3D scene model from RGB+D image

RGBD Image



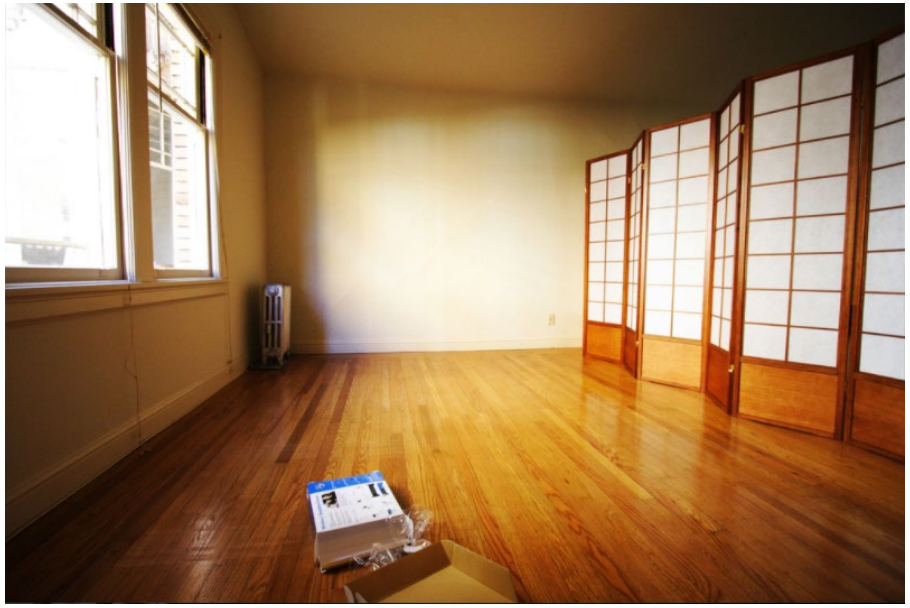


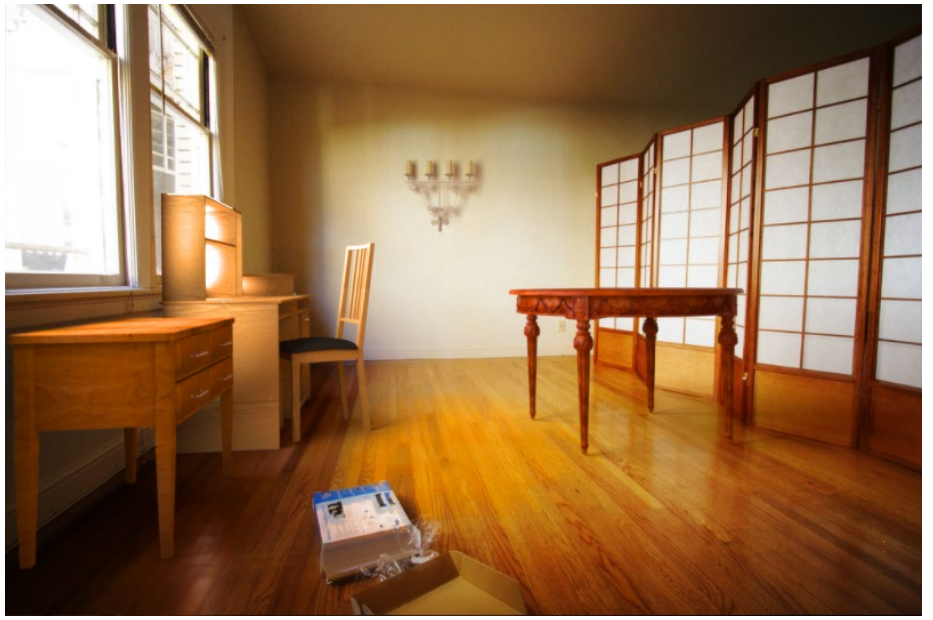
3D Model

Guo, Zou, Hoiem 2018

My Research

Editing images as if they were 3D scenes



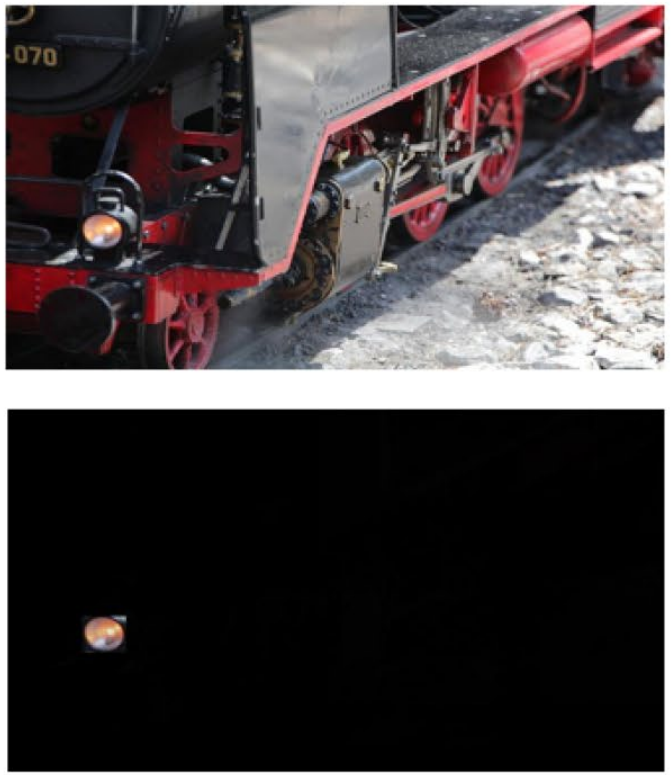


Karsch et al. 2011

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

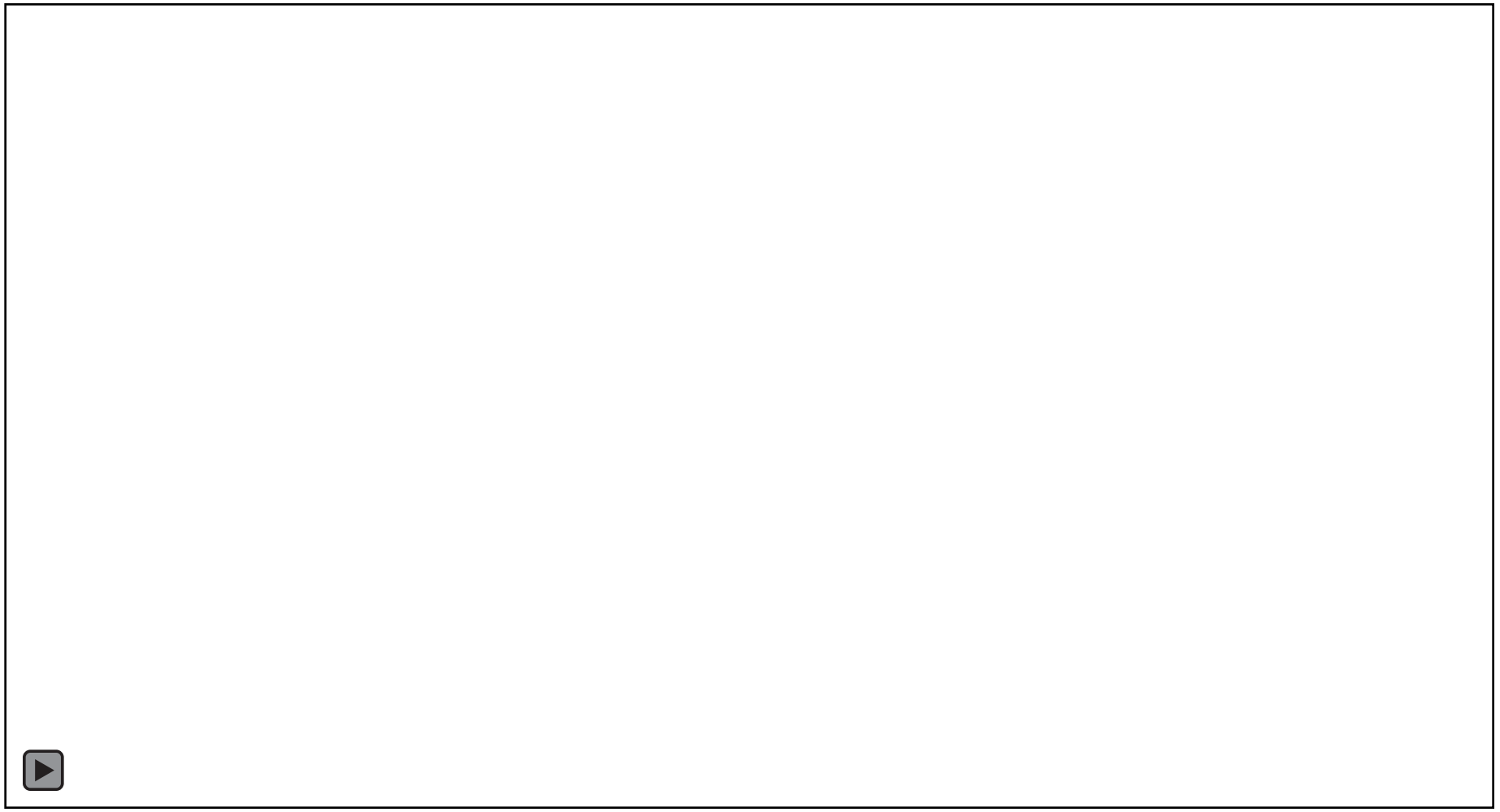
Generating comic videos

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

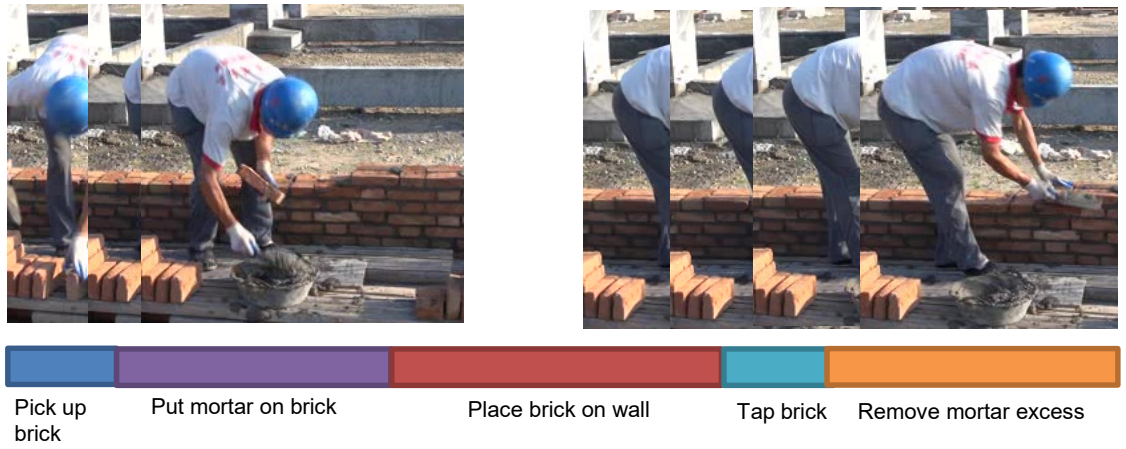
https://vimeo.com/242479887

https://www.reconstructinc.com/

Wilfredo Torres Calderon

Research: Productivity assessment on construction activities using visual data

Vision–based construction worker activity analysis informed by 2d pose



PhD student
(3rd Year)

Benchmarking methods for automated construction worker pose estimation and activity analysis [ICSIC'19]

Jae Yong Lee

Experience

RECONSTRUCT

Lead Visualization Engineer
& Project Manager (2015 –)

ILLINOIS

B.A Comp. Engr (2010 – 2016)
Ph.D Comp. Sci (2018 –)

Microsoft

Research Intern (2019 Summer)

대한민국공군
REPUBLIC OF KOREA AIR FORCE

Staff Sergeant (2011-2013)

Advisor

- Prof. Derek Hoiem

Research Interest

- Geometric Computer vision
- Machine Learning

Hobby

- Piano 🎹
- Biking 🚲
- Procrastinating _(:3」∠)_

Yuan Shen

- First Year Computer Science PhD student
- Fifth year at UIUC, (got BS in CS this spring)
- Interned at RECONSTRUCT this summer
- Research Interest: Entity grounding and Visual Question Answering

Undergrad

A Neural Network Regressor for Multi-modal Fashion Recommendations

With Professor Ranjitha Kumar (HCI)

Figure: A Neural Network Regressor for Multi-modal Fashion Recommendations by Kedan Li, Krishna Dusad, Yuan Shen, Ajaita Saini, Ranjitha Kumar and David Forsyth, Sept. 2018

Current Research

Phrase Grounding by Soft-Label Chain Conditional Random Field

With Professor Julia Hockenmaier (AI)

Figure: Phrase Grounding by Soft-Label Chain Conditional Random Field by Jiacheng Liu and Julia Hockenmaier, Jun. 2019

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

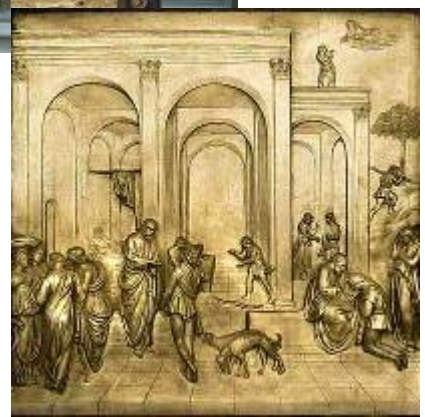
Nuns in Procession. French ms. ca. 1300.

Depicting Our World: Renaissance

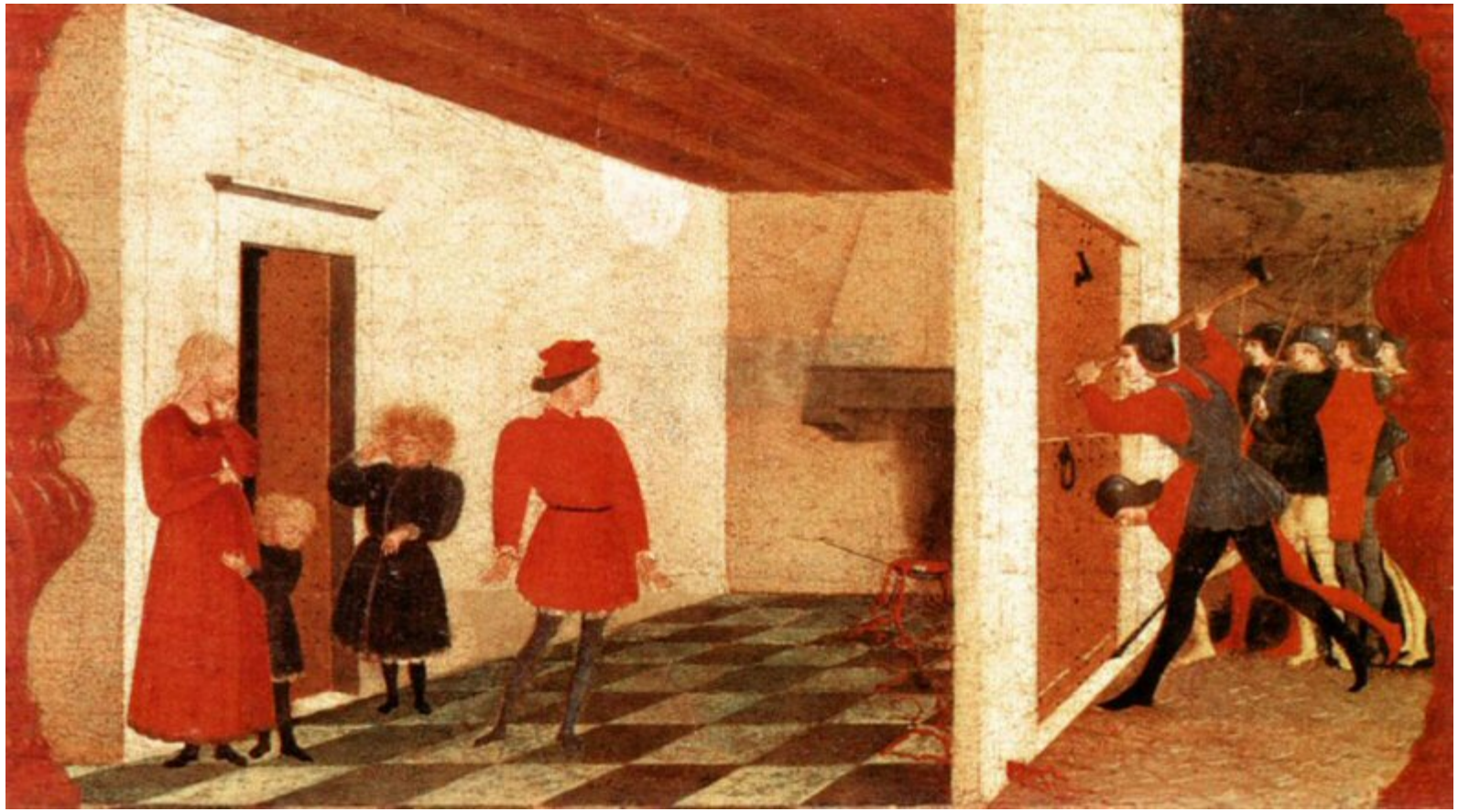
North Doors (1424)

Lorenzo Ghiberti (1378-1455)

East Doors (1452)



Depicting Our World: Renaissance

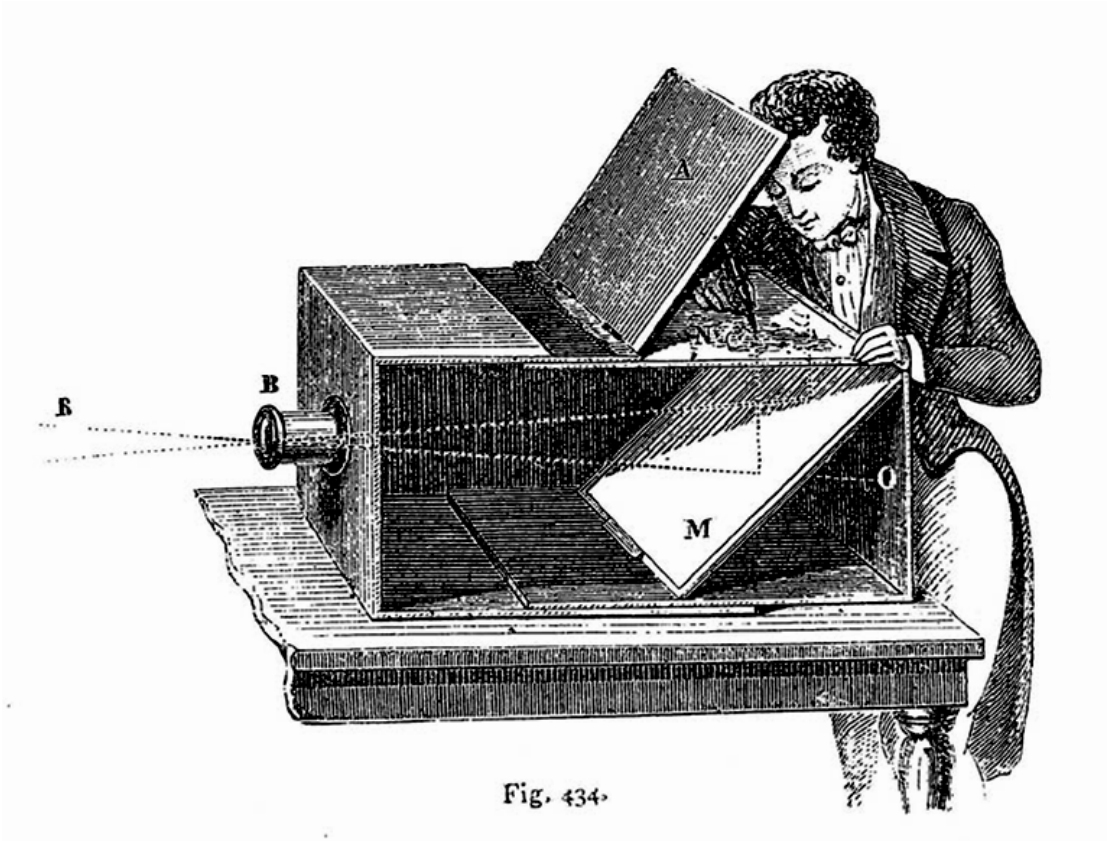


Paolo Uccello,
Miracle of the Profaned Host (c.1467-9)

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?

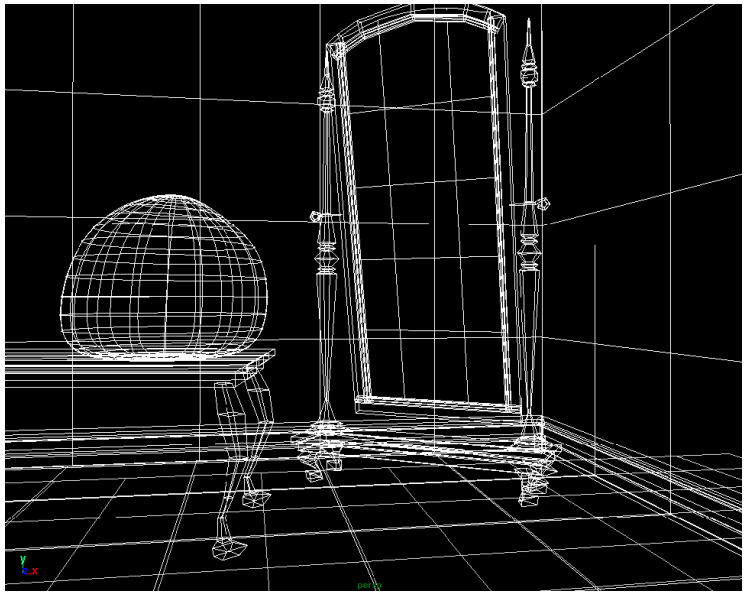
PAMELA ANDERSON -- WARTS AND ALL...

ALL TOUCHED UP AND READY TO GO!!!

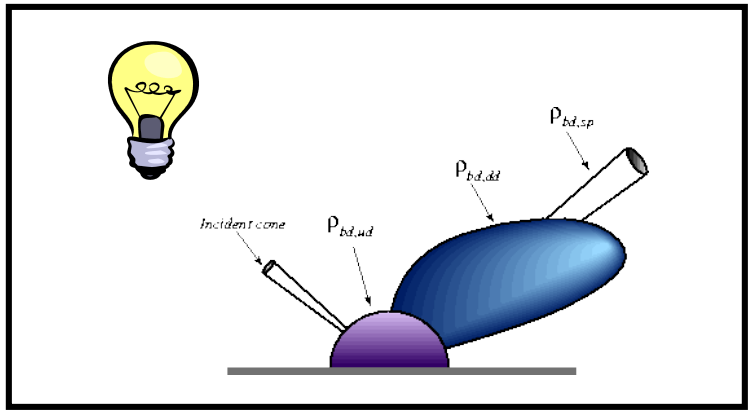
http://www.freephotoediting.com/samples/photo-glamourisation/020_celebrity-skin-retouching.htm

Enter Computer Graphics...

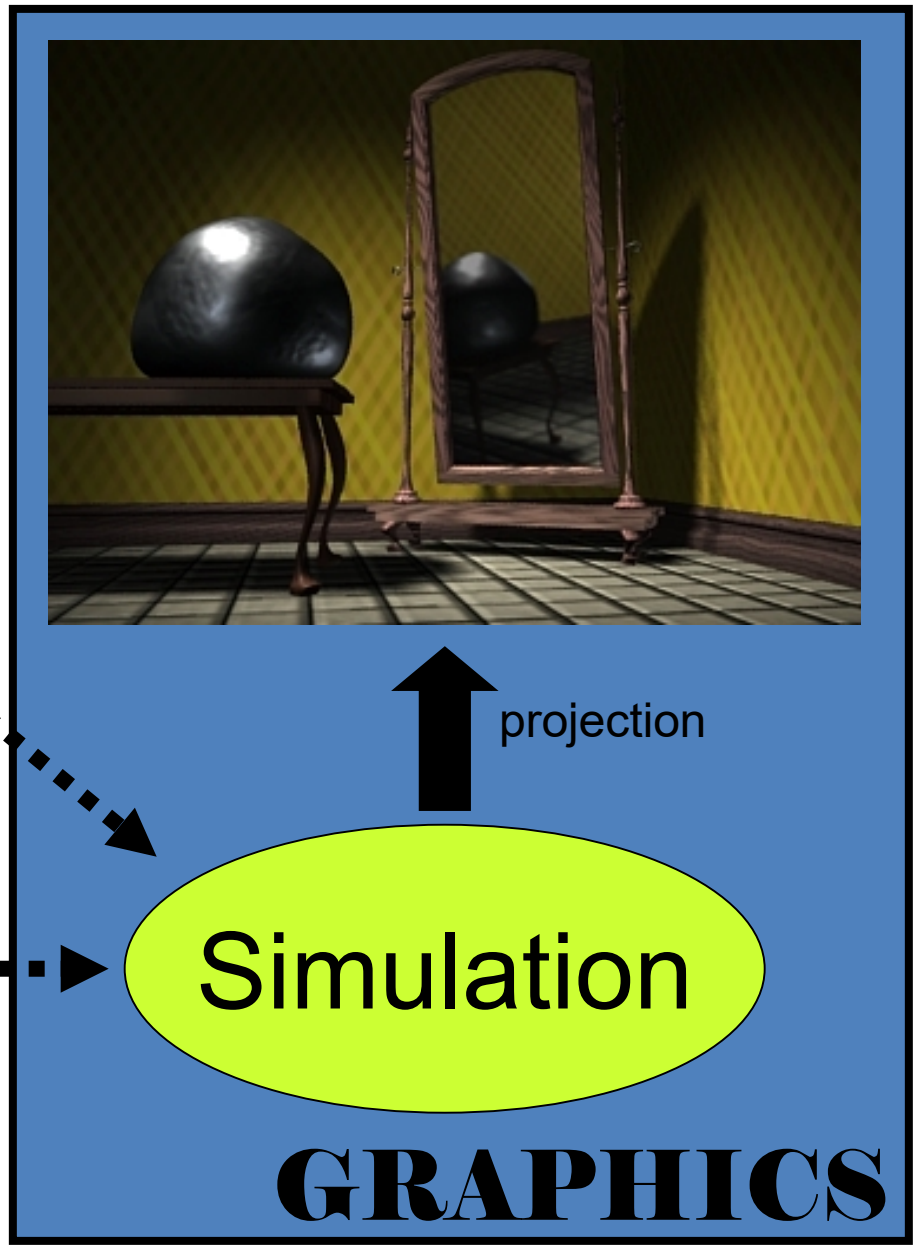
Traditional Computer Graphics



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

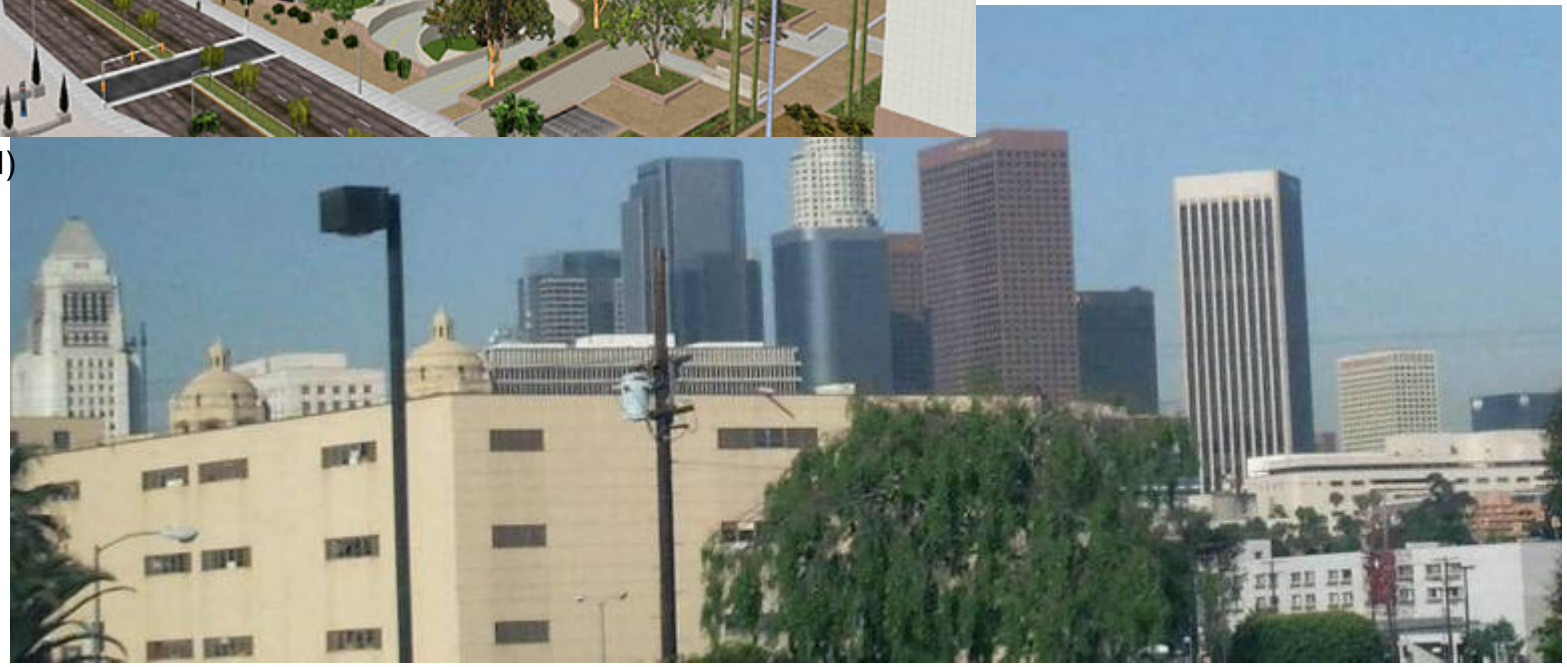
From “Final Fantasy”

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

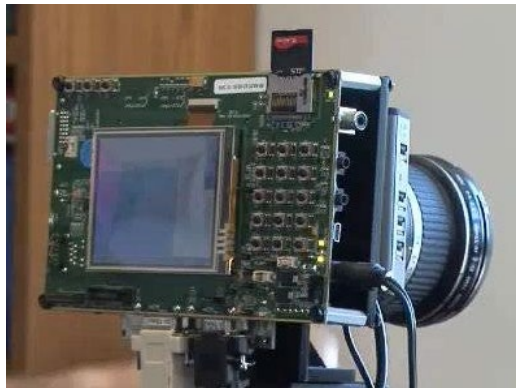
Photography

+ 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)

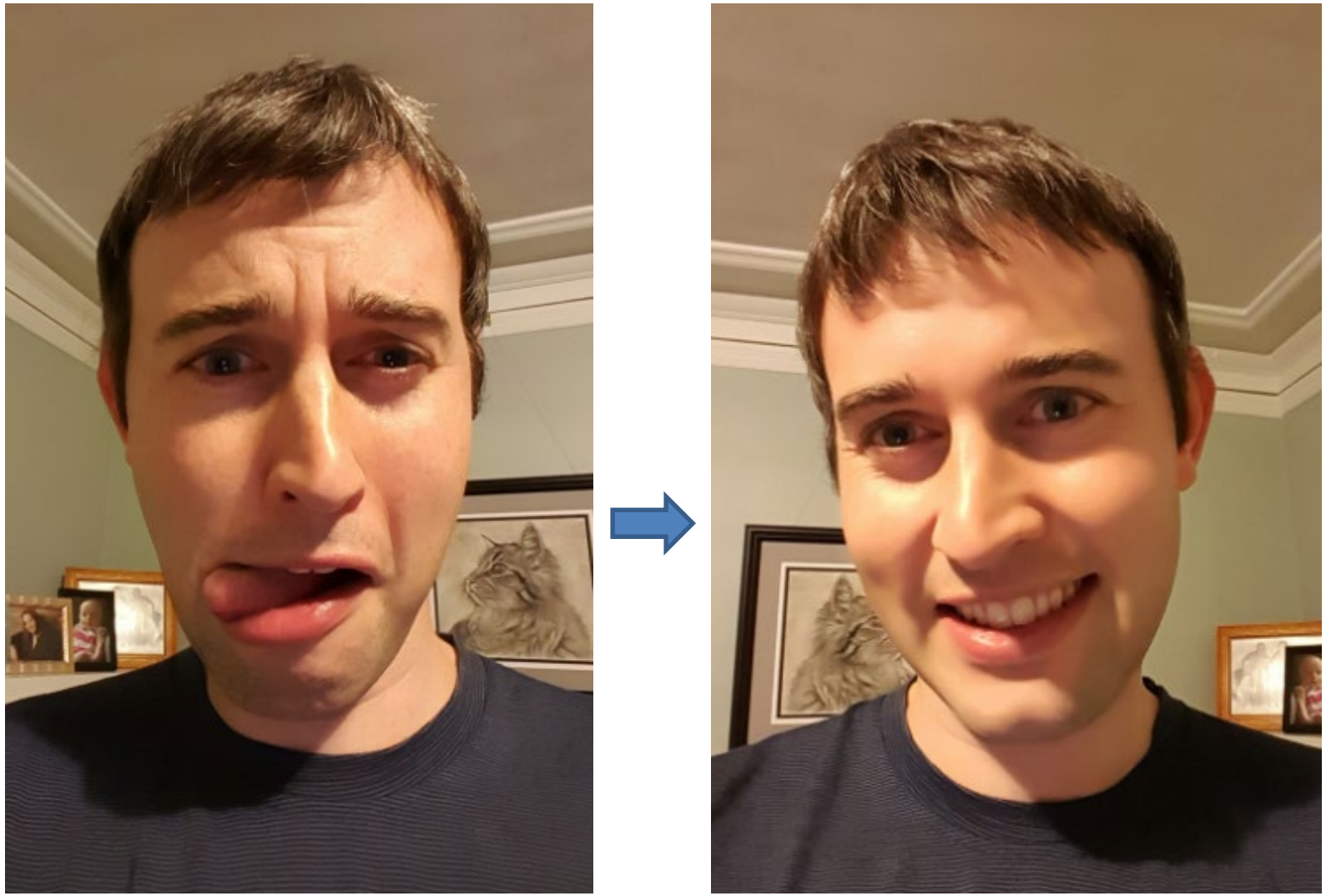
http://www.debevec.org/Campanile/

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 outline

Prof: Derek Hoiem (dhoiem@illlinois.edu), SC 3312
TAs: Wilfredo Torres Calderon (trrscld2@illinois.edu)
Jae Yong Lee (lee896@illinois.edu)
Yuan Shen (yshen47@illinois.edu)

Web page:

http://courses.engr.illinois.edu/cs445/

Course objectives

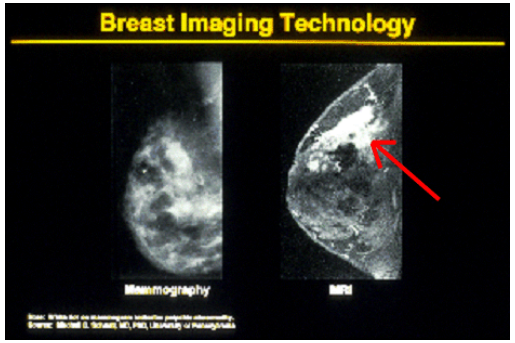
1. You will have new abilities for visual creation.

Graphic by James Hays

Course objectives

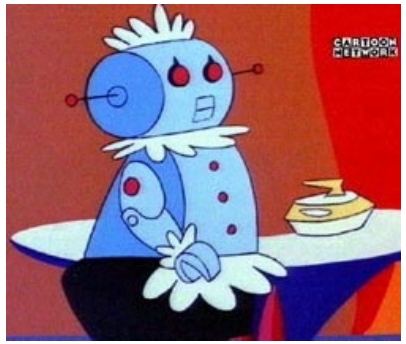
2. You will get a foundation in computer vision.

Safety



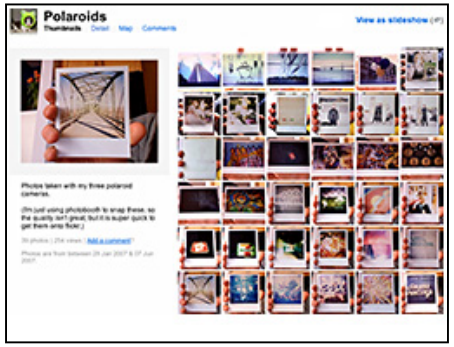
Health

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.

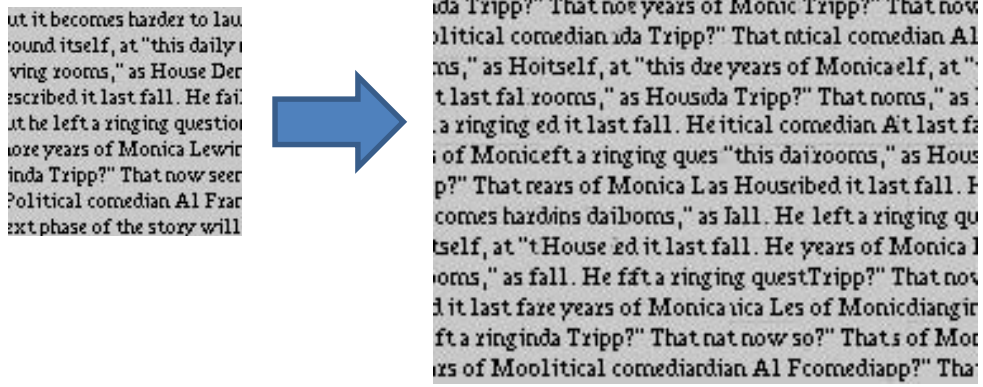
Course objectives

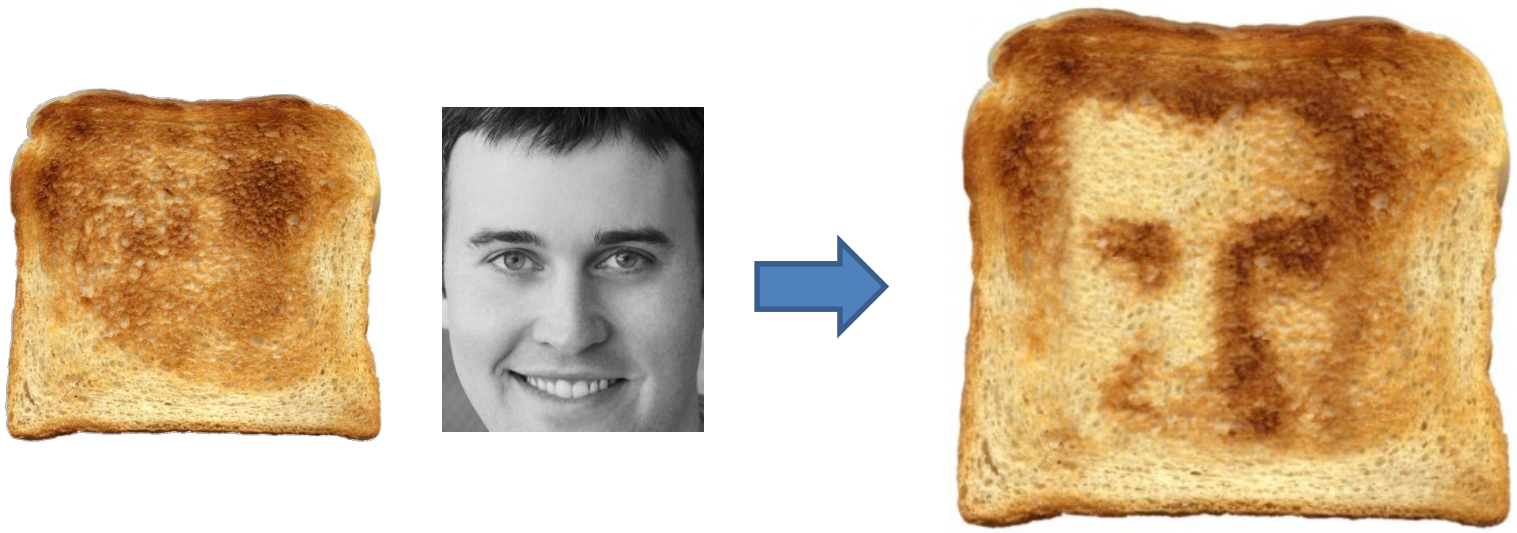
4. You'll have fun doing cool stuff!

Projects

Project 1: Hybrid Images

Project 2: Image Quilting for Texture Synthesis and Transfer

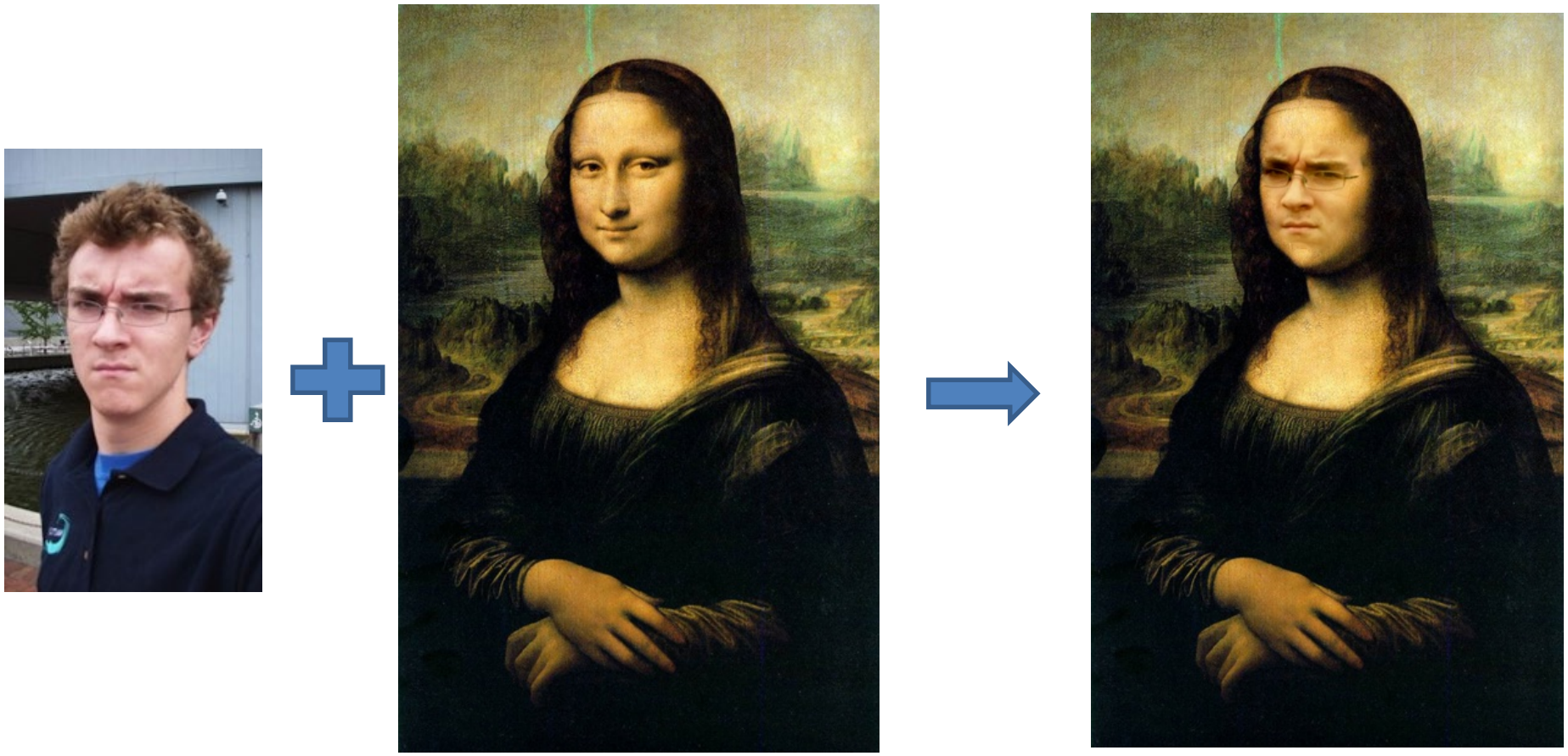




Project 3: Poisson Editing

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!

Project details

- Implement stuff from scratch and apply it to your own photos
- Reporting via web page (plus submit code)
- Software/hardware
  - Python
  - Machines available in EWS labs

Getting help outside of class

Office hours

- See website: https://courses.grainger.illinois.edu/cs445/fa2019/
- Let us know if you can't make any of those times

Linear algebra tutorial

- Thurs 9/5, 5pm

Discussion board: https://piazza.com/class/jzj8te0di3bjt

Readings/textbook

Grades

- Written and programming assignments (55%)
  - Core projects worth total of 500 points, “bells and whistles” for additional points
  - Undergrads graded out of 500, grads out of 600
- Exam (25%)
- Final Project (20%)
- Participation

Late policy

- Up to five free days total – use them wisely!
- 10 point penalty per day after that

Team Project Course (optional)

- To fulfill the “team project” undergraduate requirement register 1 credit for CS 497
- Form team of 3+
- Work throughout semester on final project with extra milestones
  - Sept 20: Team and topic proposal
  - Oct 18: Detailed project plan
  - Nov 18: First half of project complete
  - Final exam period: Complete project due

Academic Integrity

- Can discuss projects, but don’t show/share code
- Don’t look up code (even to get hints) or copy from a friend
- If you’re not sure if it’s allowed, ask
- Acknowledge any inspirations
- If you get stuck, come talk to me

Other comments

Prerequisites

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

Your own camera

- Strongly recommended
- Pro camera apps for smartphones

New for this semester

- Professional lecture recordings + green screen
- Projects in Python instead of Matlab
- Deep learning
  - Featured heavily in image generation and face understanding lectures, but *not* a focus of this class
- Travel / family
  - Out next Mon to Thurs (9/2-9/5) for grant meeting
  - Expecting new baby, due date Oct 24

Feedback is welcome

Final comments

- Resist the urge to start packing up on the last slide
- Reasons to not take the course…
- To do now
  - Any Q's or concerns, come talk to me!
- To do later
  - Look over syllabus, etc.
  - Sign up for Piazza
- Next class: pixels and basic filtering