CS4495/6495
Introduction to Computer Vision

1A-L1 *Introduction*

Outline

- What is computer vision?
- State of the art
- Why is this hard?
- Course overview
- Software

Why study Computer Vision?

- Images (and movies) have become ubiquitous in both production and consumption.
- Therefore applications to manipulate images (movies) are becoming core.
- As are systems that *extract information* from imagery
  - Surveillance
  - Building 3D representations
  - Motion capture assisted

Why study Computer Vision?

- But most of all…

It is a really deep and cool set of problems!

Every picture tells a story

Goal of computer vision is to write computer programs that can interpret images

Steve Seitz

Making sense of a picture

- We want to extract meaning out of an image/sequence of images
- This is different from image processing, which is mainly concerned with transforming images
- Image processing operations such as blurring, thresholding etc. are often used as part of CV algorithms

Making sense of a picture

- Look at this scene carefully…

Making sense of a picture

- What items could you identify? How did you recognize them?
- What about other objects/spaces/time of day etc.?

Current state of the art

- Can computers match (or beat) human vision?
  - Yes and no (but mostly no!)
- Humans are much better at “hard” things
- Computers can be better at “easy” things
  - Though getting really good at labeling using machine learning techniques. Only a little on that in this course.

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Current state of the art

- The next slides show some examples of what current vision systems can do

Optical character recognition (OCR)

Technology to convert scanned docs to text

If you have a scanner, it probably came with OCR

License plate readers

http://en.wikipedia.org/wiki/Automatic_number_plate_recognition

Handwritten Digit recognition

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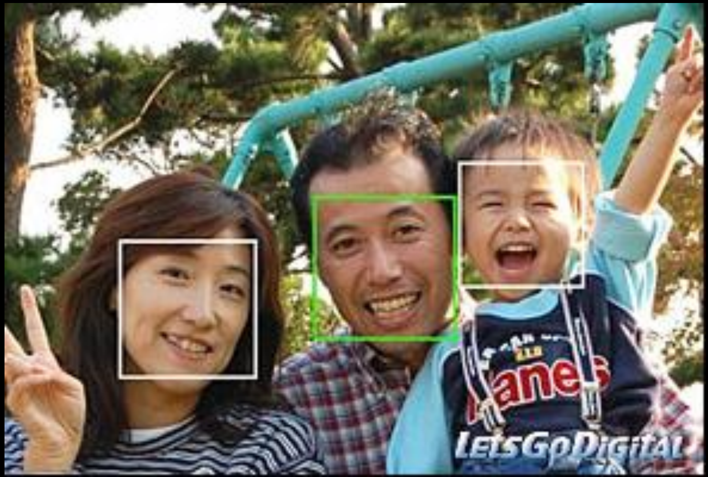
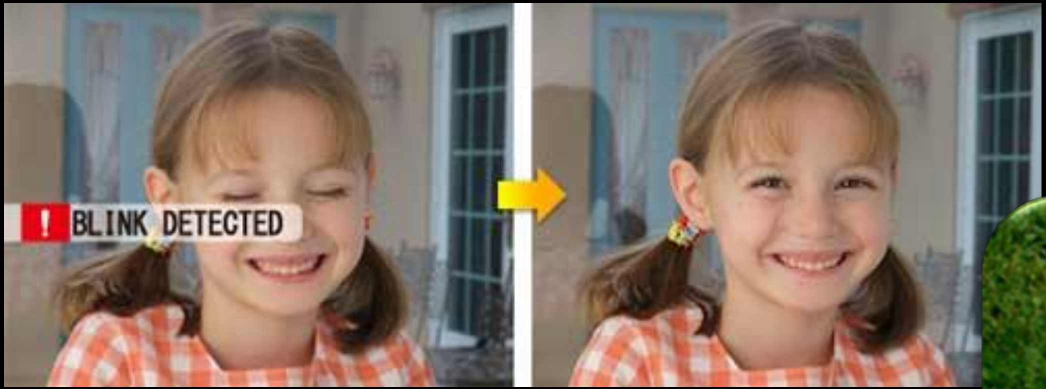
Face detection and more…

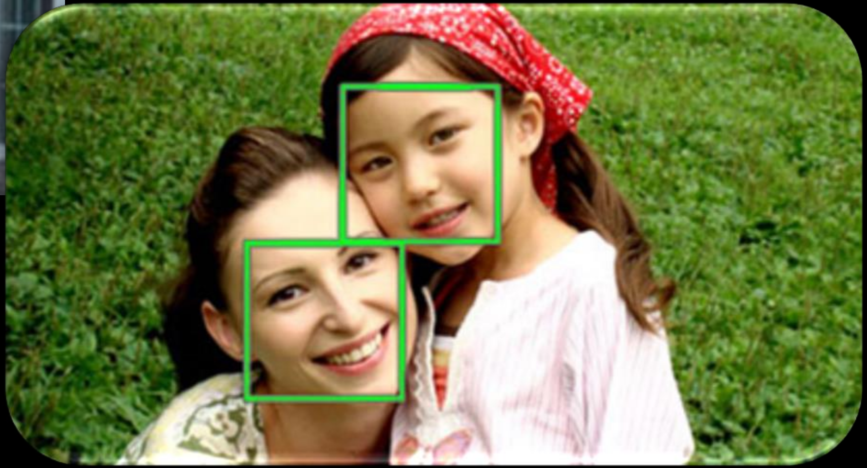


- Most digital cameras can detect faces…

Face detection and more…



SONY
“Smile Shutter”



- Some can detect blinking or smiling…

Face detection and more…

- And some can even recognize you!

Object recognition (in supermarkets)

- Evolution Robotics Retail developed LaneHawk™, a retail loss-prevention solution that helps turn bottom-of-basket (BOB) losses and in-cart losses into profits in real time.
- The company was acquired by Datalogic 5 years later!

Object recognition *(in mobile devices!)*

Special effects: shape capture

The Matrix movies, ESC Entertainment, XYZRGB, NRC

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Special effects: motion capture

Pirates of the Caribbean
Industrial Light and Magic
www.ilm.com

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Earth viewers (3D modeling)

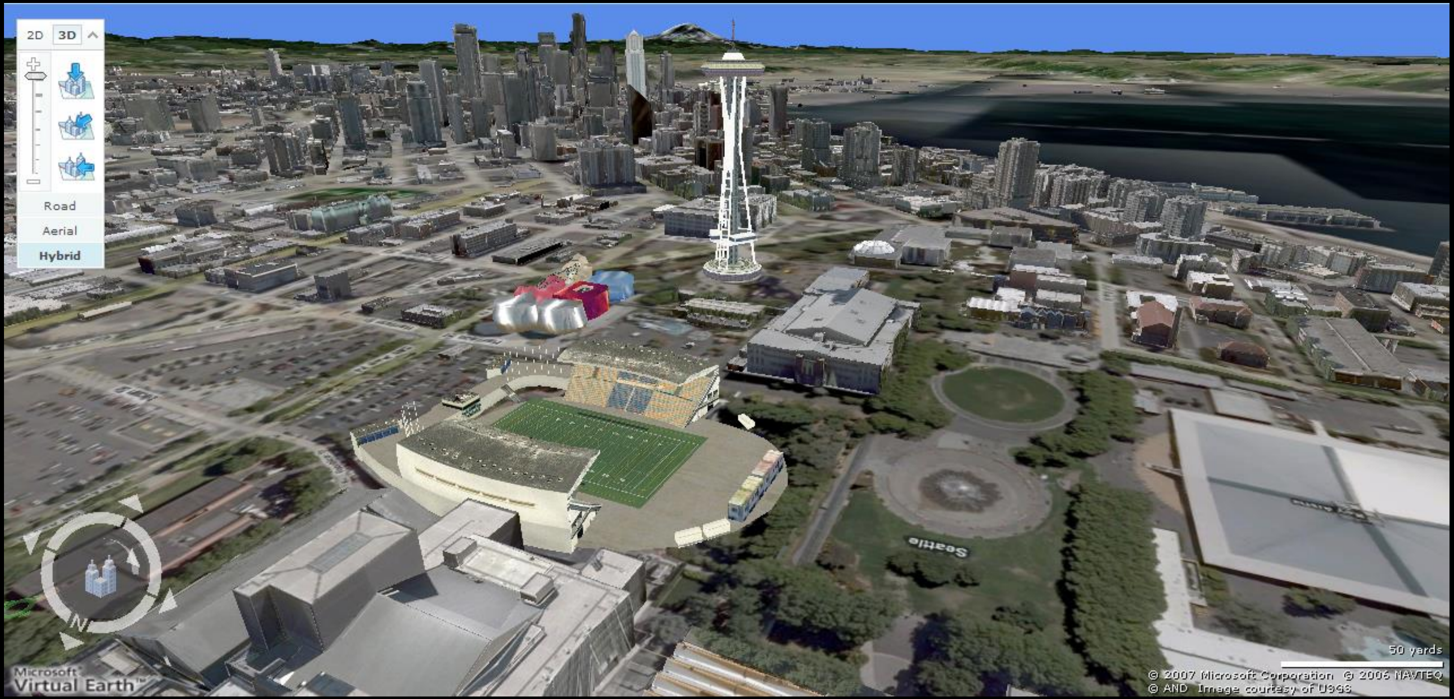

Image from Microsoft's Virtual Earth
(see also: Google Earth)

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Smart cars

Mobileye

Slide content courtesy of Amnon Shashua

Smart cars *are here!*

Nevada embraces the future, approves self-driving cars

By Bill Howard on February 20, 2012 at 9:00 am | 1 Comment

Sports

Sportvision first down line

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Vision-based interaction (and games)

Nintendo Wii has camera-based IR tracking built in.

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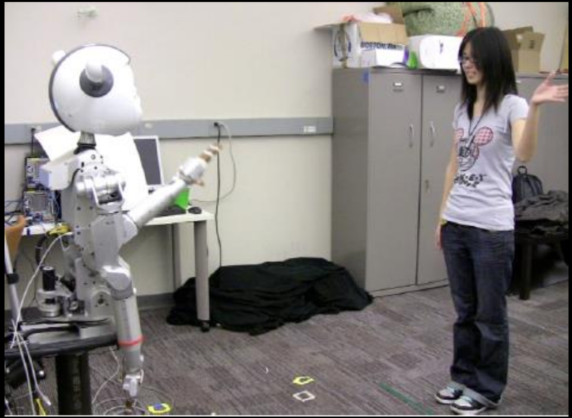
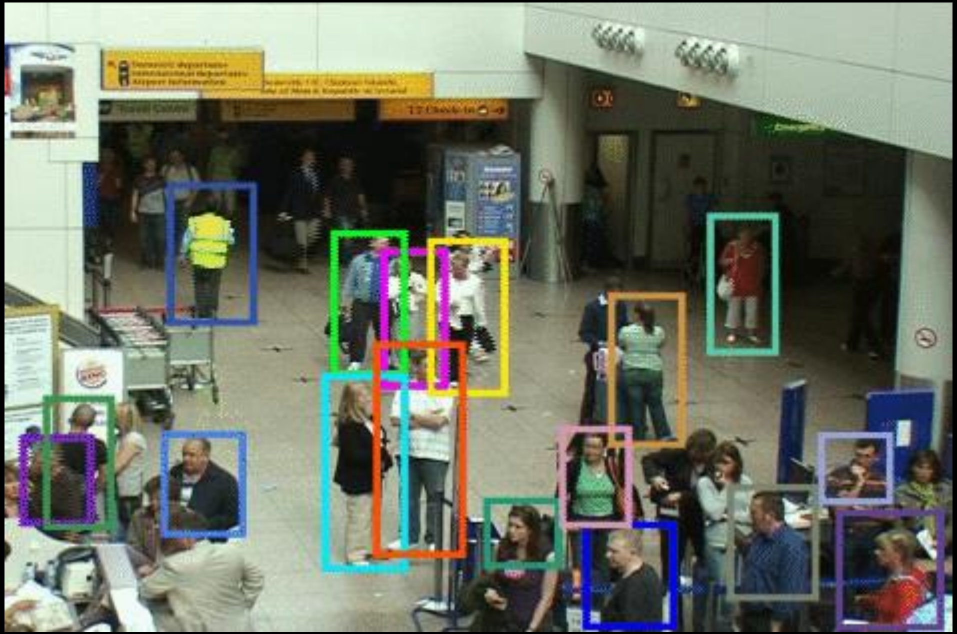
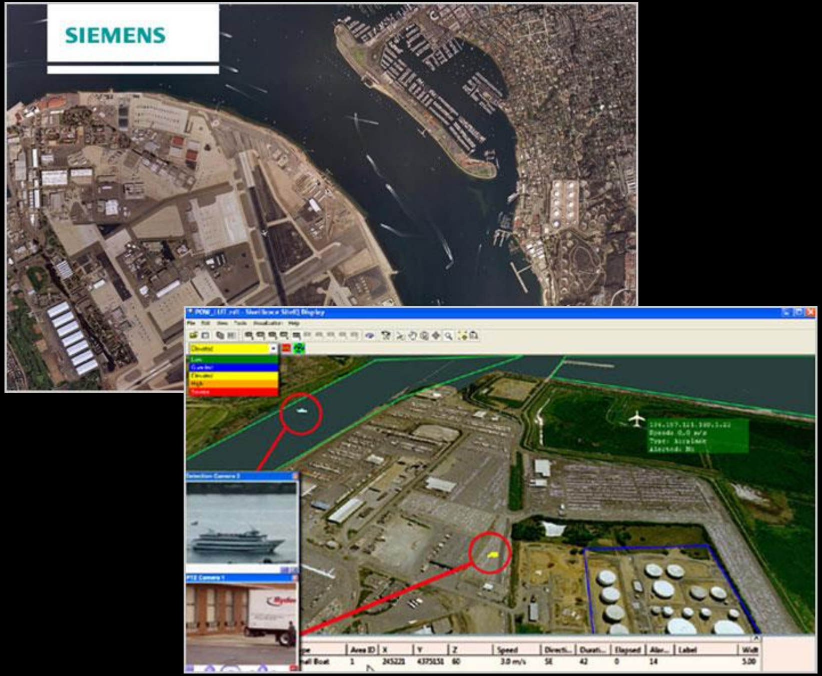
But the game changer:

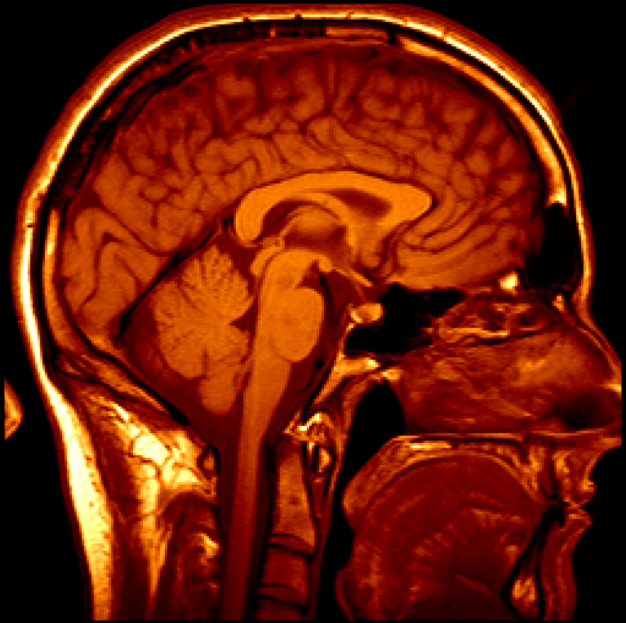


Security and surveillance





Medical imaging



3D imaging
MRI, CT

Image guided surgery
Grimson et al., MIT

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Current state of the art

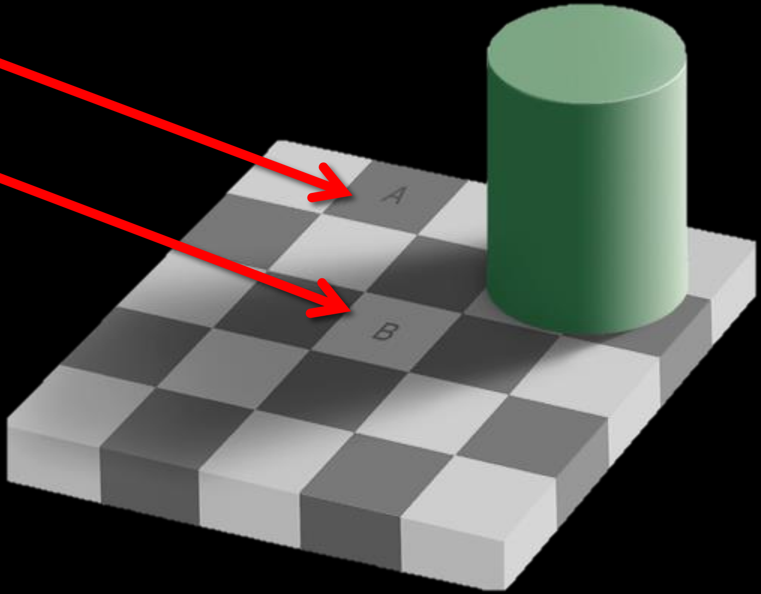
- This is just a taste of the state of the art.
- Some of these are less than 5 years old, most less than 10
- This is a very active research area, and rapidly changing
  - Many new apps in the next 5 years

Why is this hard?

Simple scene right?

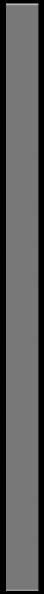
Dark square

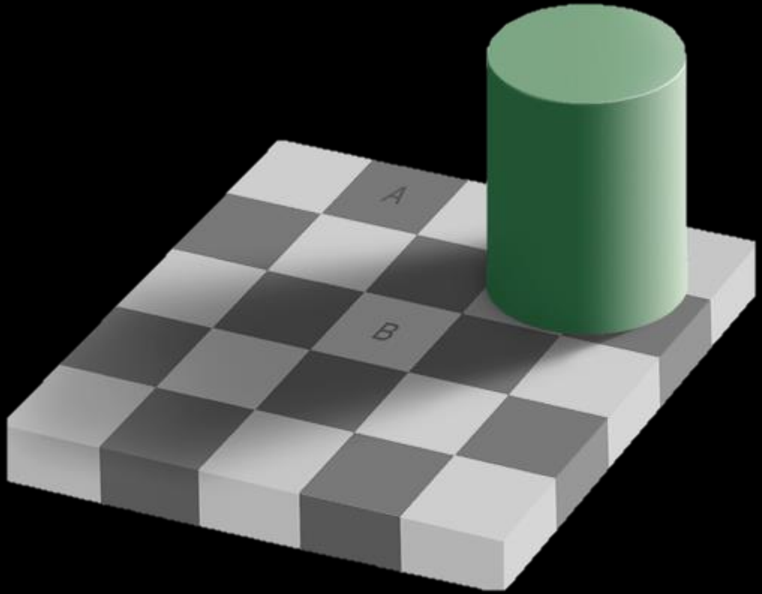
Light square



Edward Adelson

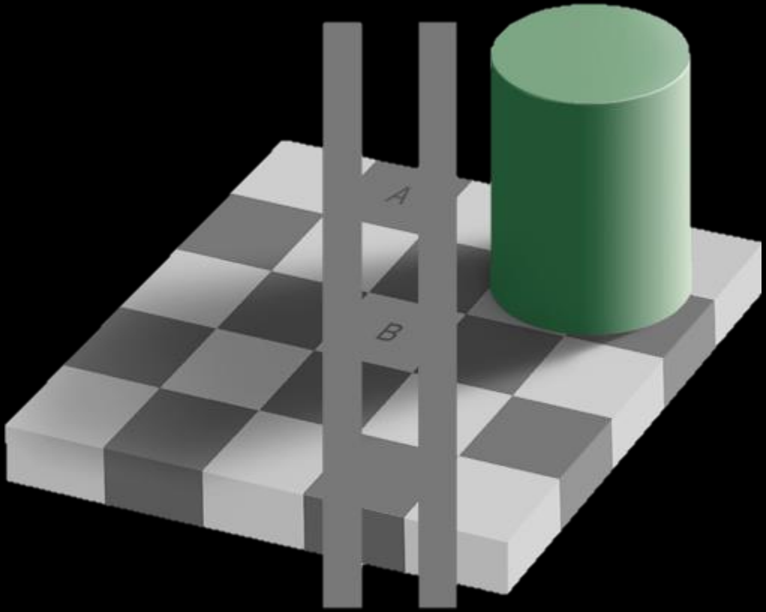
Really?





Edward Adelson

Really!



Edward Adelson

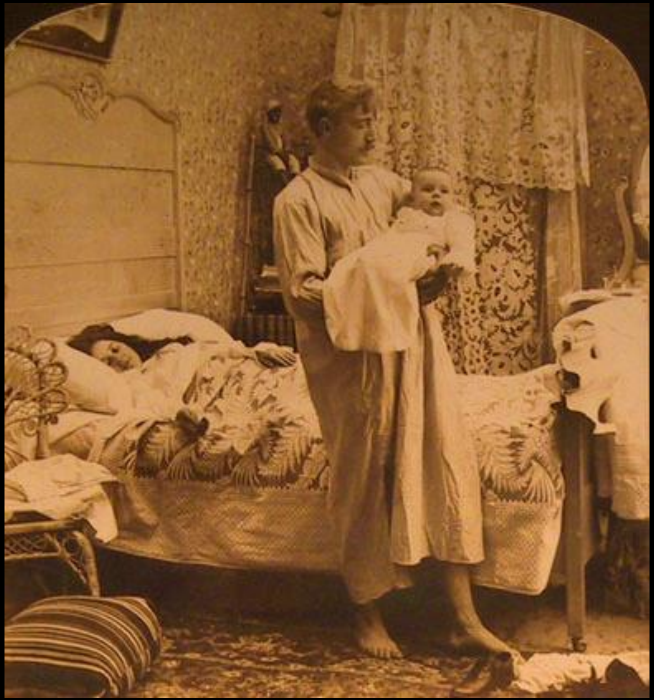
Vision is NOT Image Processing

- In the previous example, the two squares have exactly the same *measurement* of intensity.
- So, seeing is not the same as measuring properties in the image.
- Rather, "seeing" is building a *percept* of what is in the world based upon the measurements made by an imaging sensor.

Building models from change (1)

Michael Black

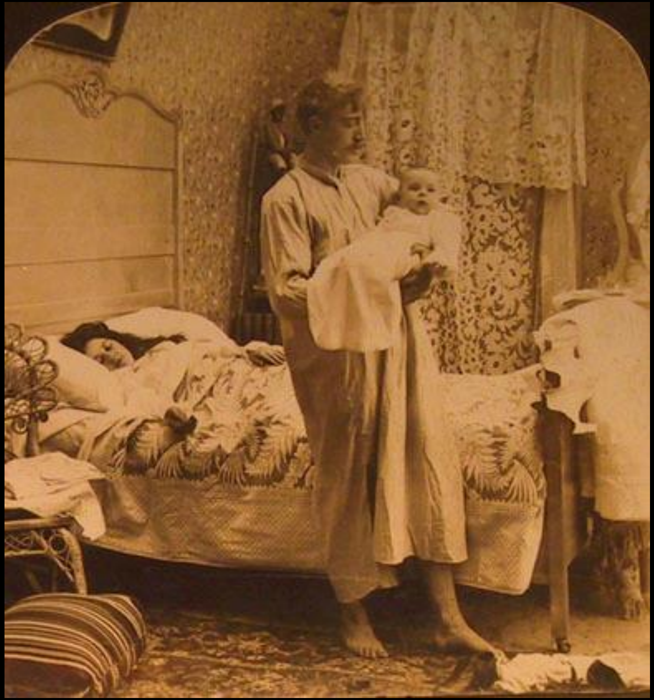
Building models from change (1)



Left Image

Michael Black

Building models from change (1)



Right Image

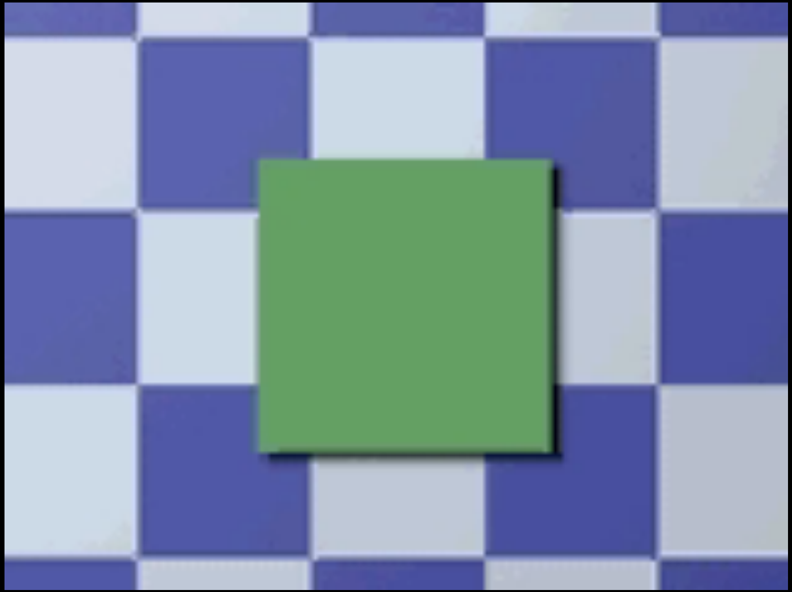
Michael Black

Building models from change (2)

Dan Kersten

http://vision.psych.umn.edu/users/kersten/kersten-lab/shadows.html

Building models from change (3)



Dan Kersten

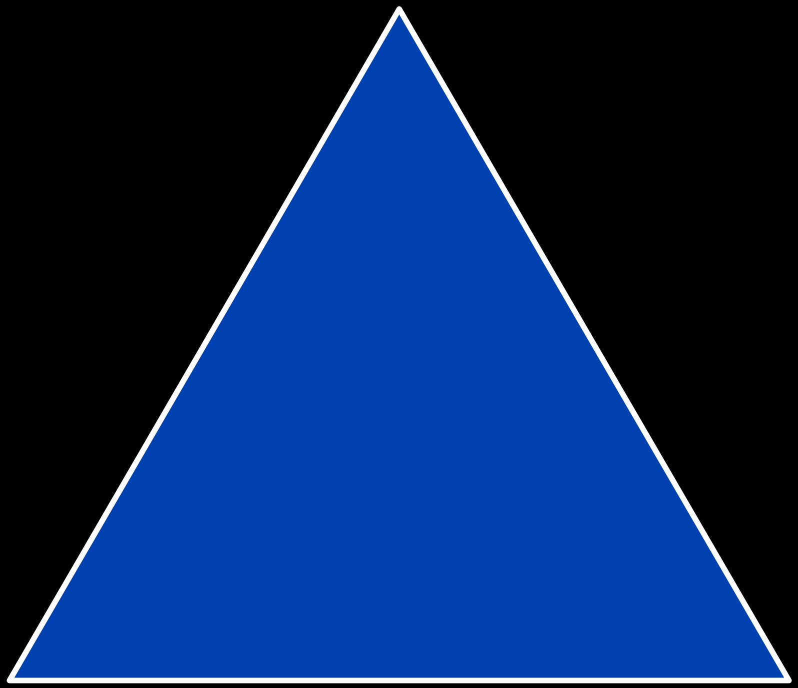
http://vision.psych.umn.edu/users/kersten/kersten-lab/shadows.html

Interpreting images

- The previous example is one where the human system is again "wrong" – nothing is moving upwards. But feels like the best interpretation.
- Our goal is to develop your understanding of some of what it takes to go from image to interpretation.

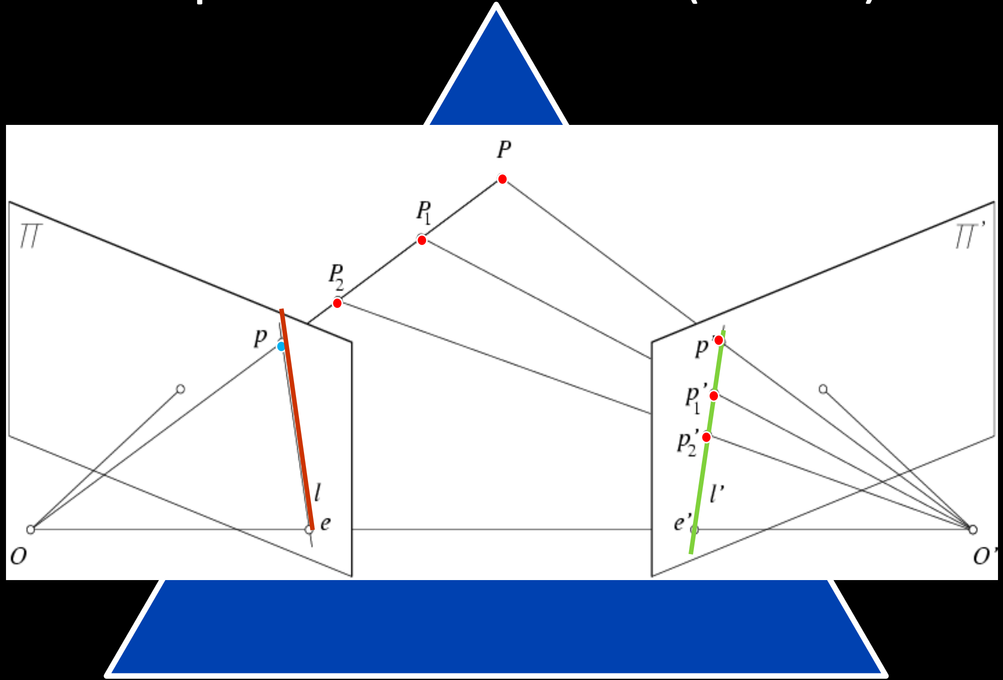
Course overview

A little bit of pedagogy...

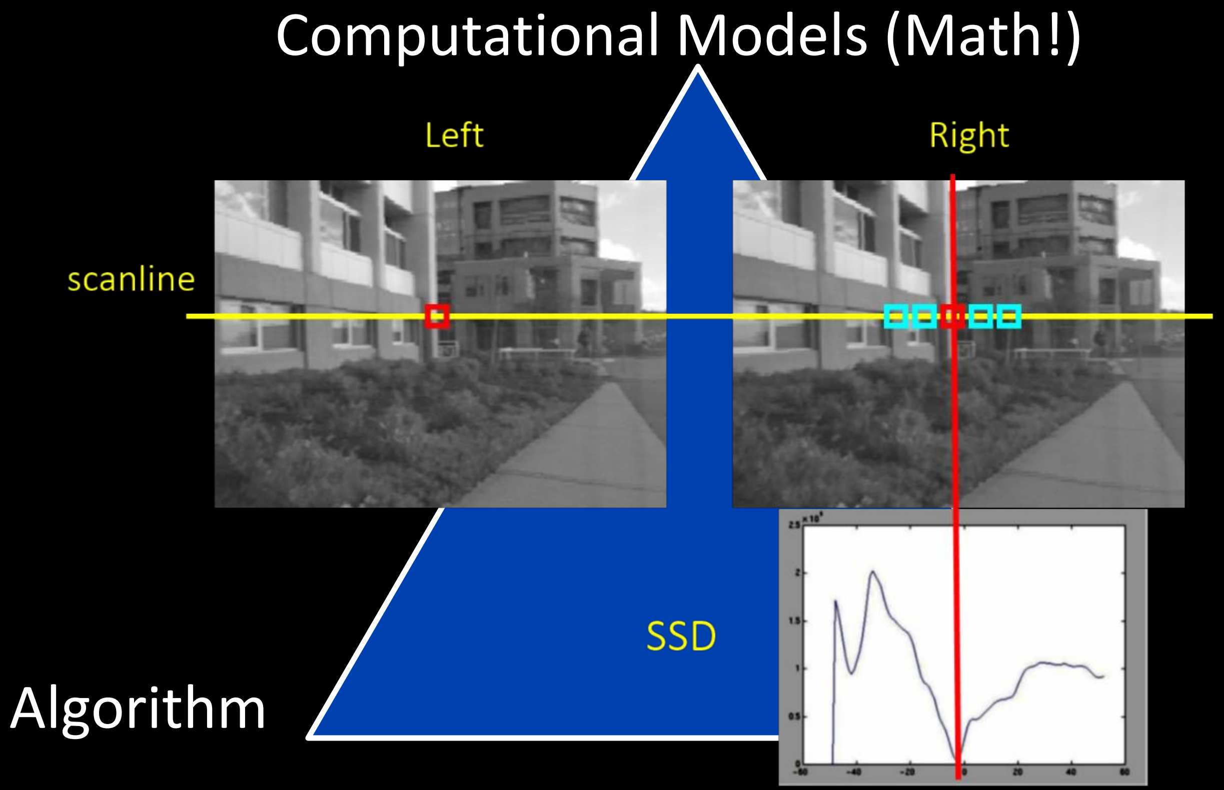


A little bit of pedagody...

Computational Models (Math!)



A little bit of pedagody…



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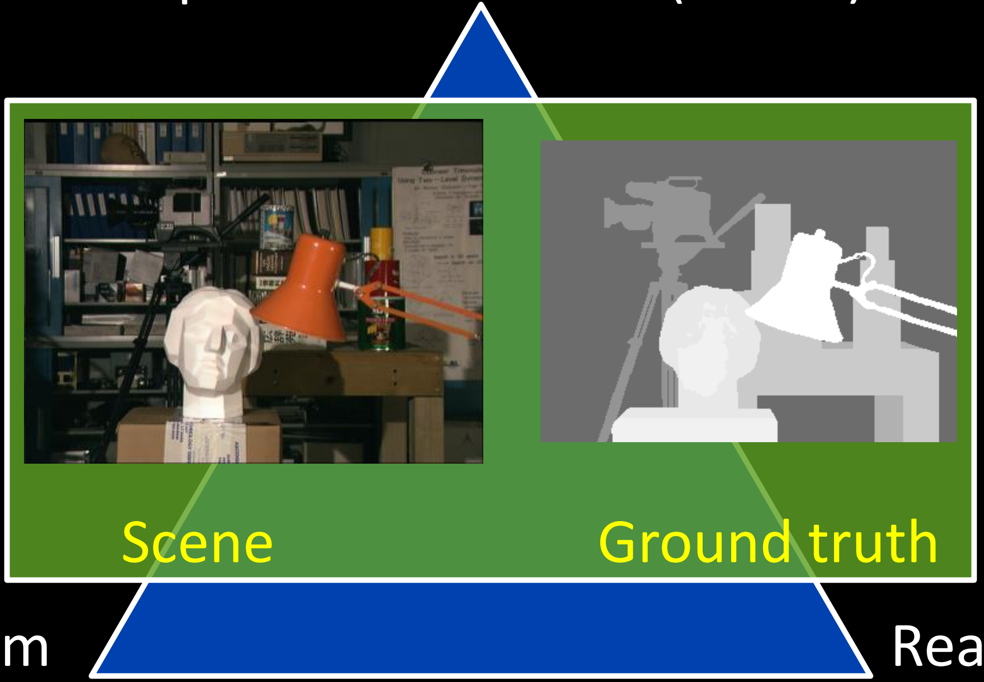

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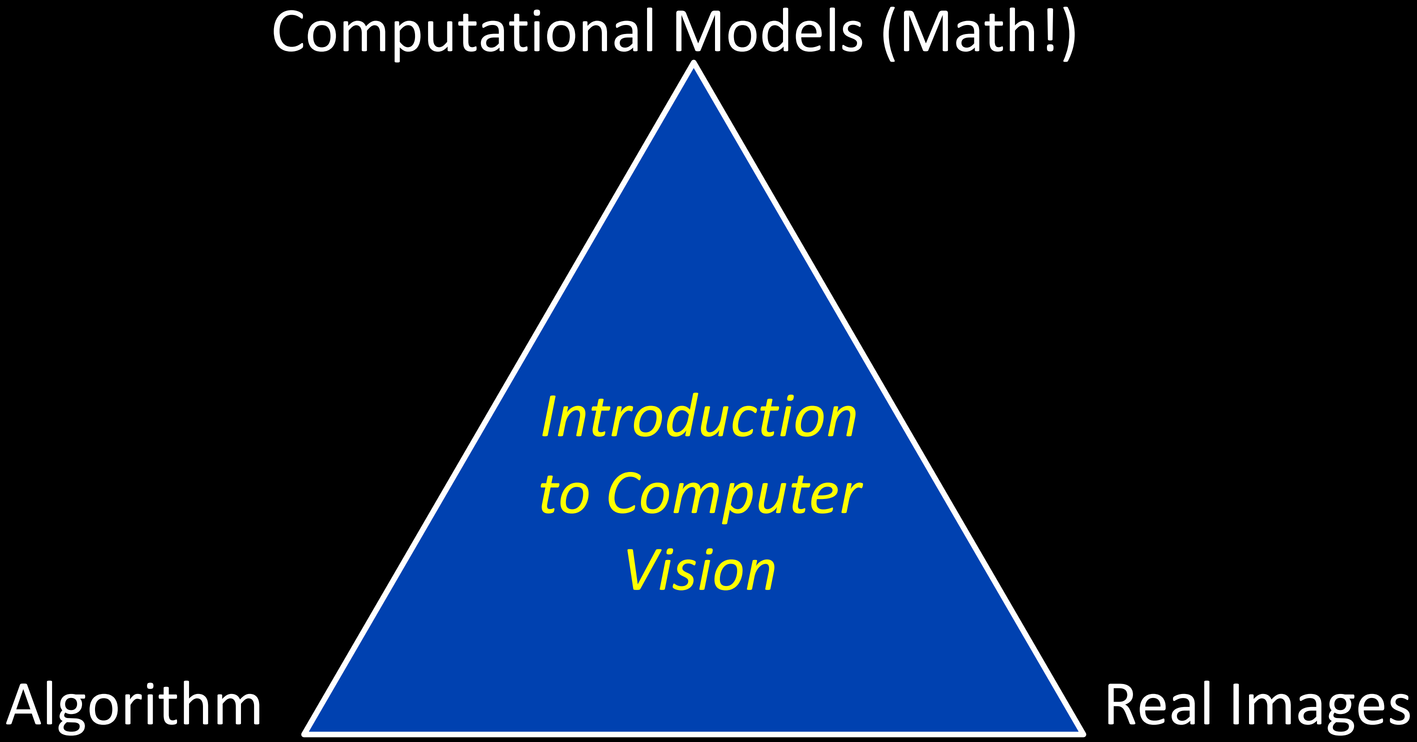

Topic outline

1. Introduction
2. Image Processing for Computer Vision
3. Camera models and views
4. Features and matching
5. Lightness and Brightness
6. Image motion
7. Motion and tracking
8. Classification and Recognition
9. Miscellaneous operations
10. Human Vision

Problem sets

- 8 problem sets (PS0 to PS7)

Policies

- Blackboard-level conversations OK, esp. on forums
- Write your own code
- Ask questions on forum first, then contact TA/instructor

Exam

- There will be a final exam.
- It’s not hard – it simply designed to require folks to go back over the slides (and text) and remember what we’ve learned.

Grading

- The general rubric is 85% of the final grade is based upon the problem sets.
- 15% is the final.

Software

- Embedded programming exercises (in Octave)
- Matlab/Octave: Primary platform for exercises, problem sets
- Python + NumPy + OpenCV: You can submit your problem set solutions in Python, but there will be very limited support

Learning goals

What do you expect to learn from this course?

- Note down somewhere and track your progress.
- In the end, you may not have learnt everything you expected.
- At the same time, you may have learnt some things you did not know about at all ☺