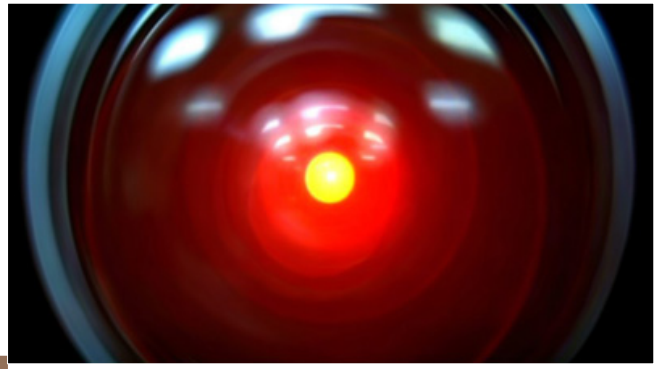
Lecture 1:
Introduction to “Computer Vision”

Dr. Juan Carlos Niebles
Stanford AI Lab

Prof. Fei-Fei Li
Stanford Vision Lab

Welcome to CS131



Slide adapted from Svetlana Lazebnik

CS131 is the introductory course for computer vision

- CS131 (fall, 2015):
  - Enthusiastic undergrads
  - Want to get to know this exciting technology
  - Pre-req to more advanced vision classes
- CS231a (spring, 2016, Prof. Silvio Savarese)
  - Similar to existing CS231a
  - Seniors, masters, and PhDs
- CS231b (spring, 2016): Cutting Edge Computer Vision

Today's agenda

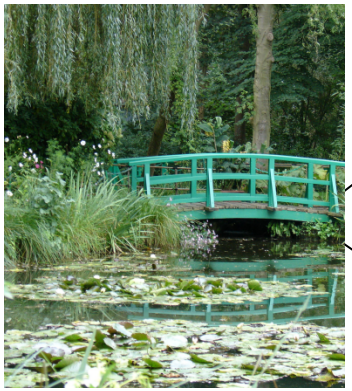
- Introduction to computer vision
- Course overview

Quiz?

What about this?

What is (computer) vision?

Image (or video)



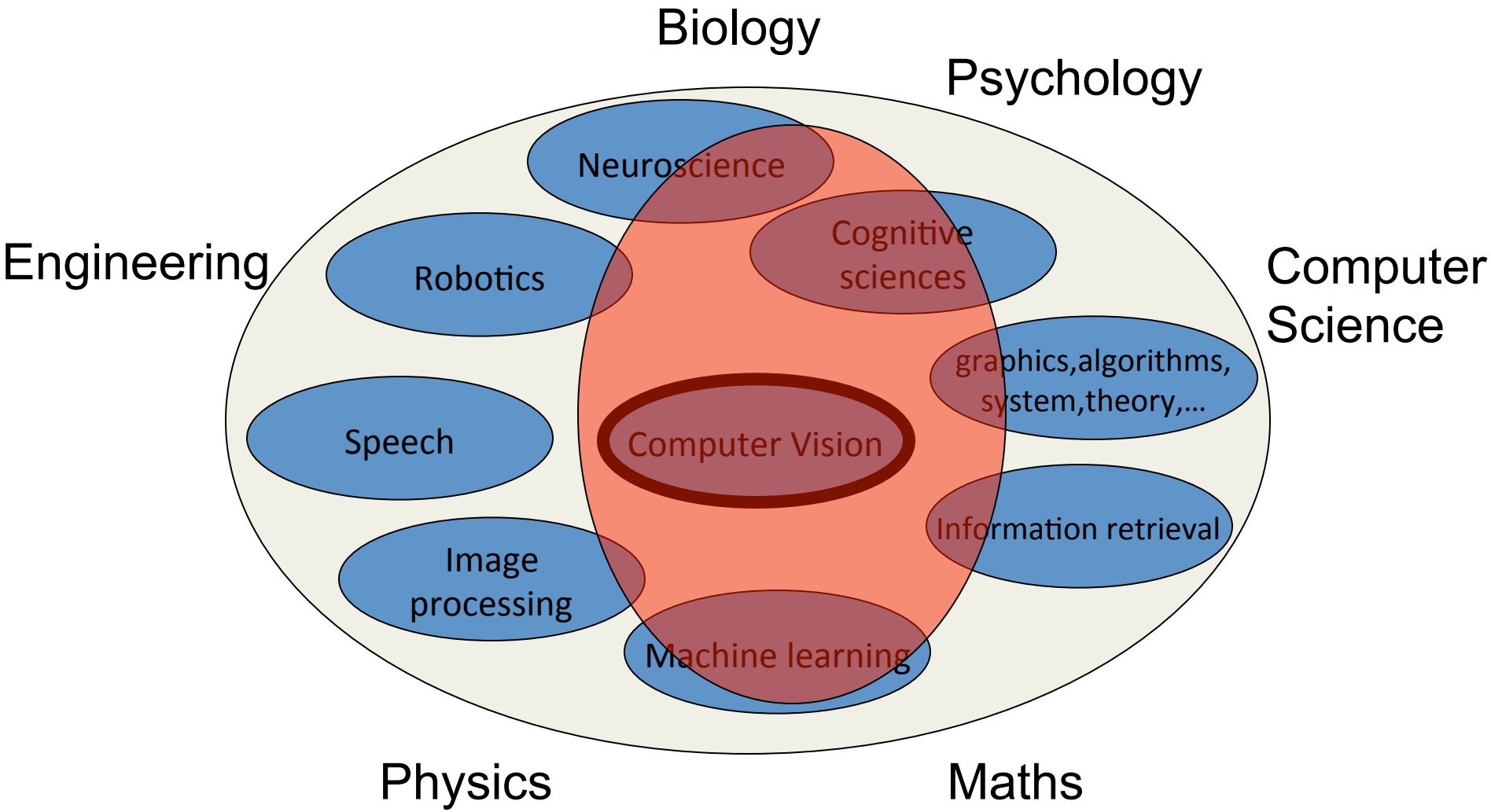
Sensing device

Interpreting device

Interpretations

garden, spring, bridge, water, trees, flower, green, etc.

What is it related to?



The goal of computer vision

- To bridge the gap between pixels and “meaning”

What we see

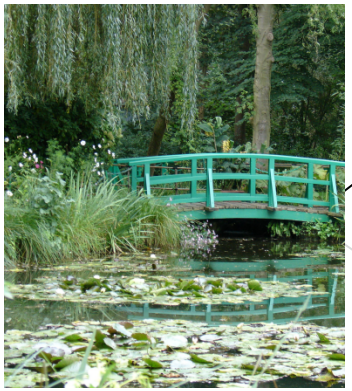
0	3	2	5	4	7	6	9	8
3	0	1	2	3	4	5	6	7
2	1	0	3	2	5	4	7	6
5	2	3	0	1	2	3	4	5
4	3	2	1	0	3	2	5	4
7	4	5	2	3	0	1	2	3
6	5	4	3	2	1	0	3	2
9	6	7	4	5	2	3	0	1
8	7	6	5	4	3	2	1	0

What a computer sees

Source: S. Narasimhan

What is (computer) vision?

Image (or video)



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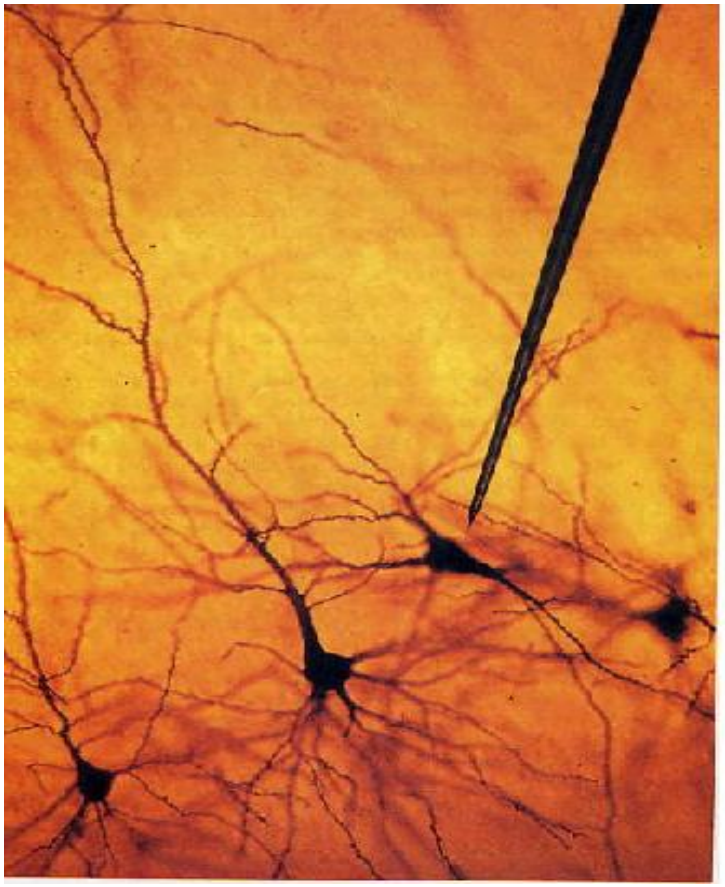
1981: Nobel Prize in medicine

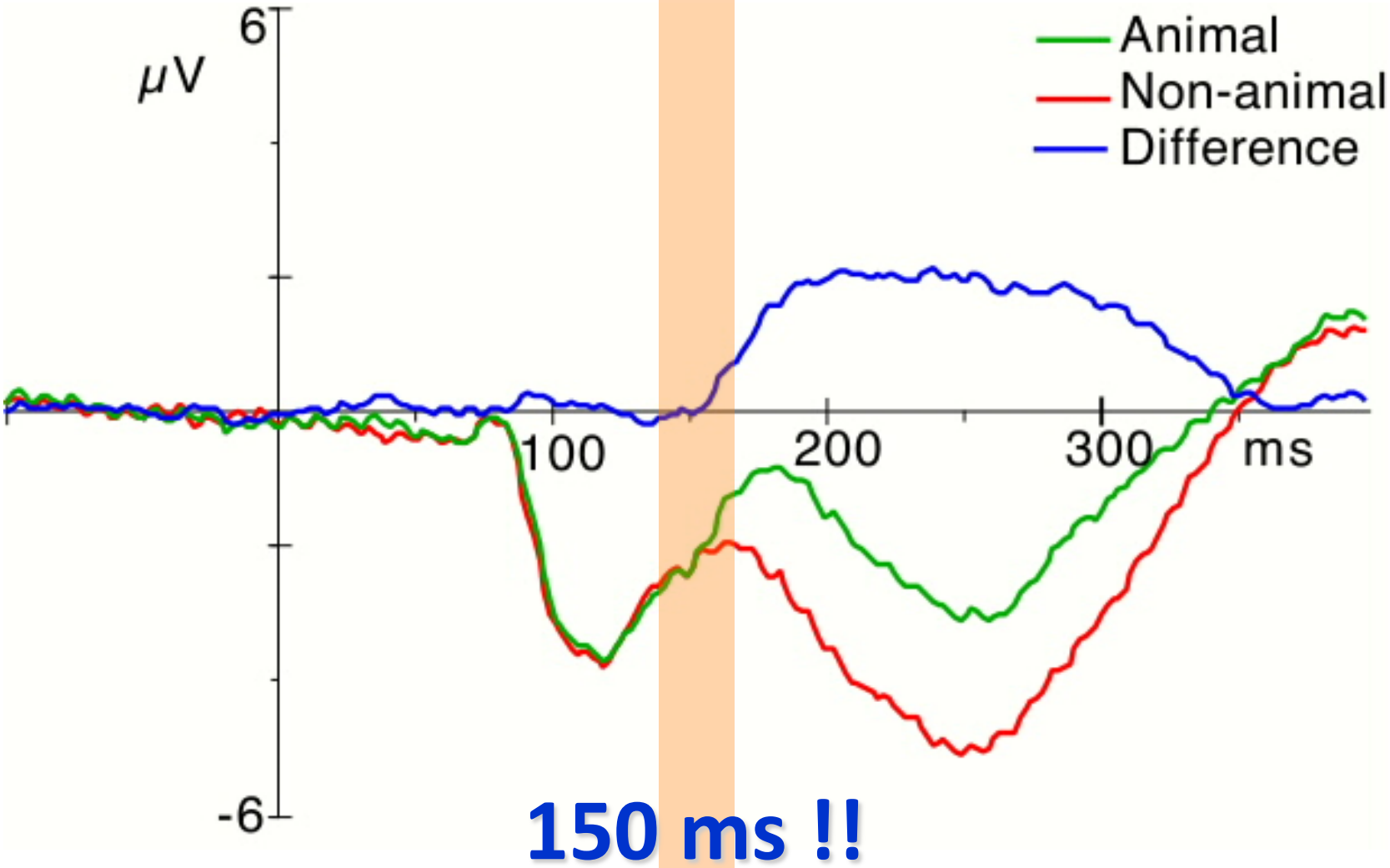


Hubel & Wiesel

Human vision is superbly efficient

Potter, Biederman, etc. 1970s

Thorpe, et al. *Nature,* 1996



150 ms !!

Thorpe, et al. *Nature,* 1996

Change blindness

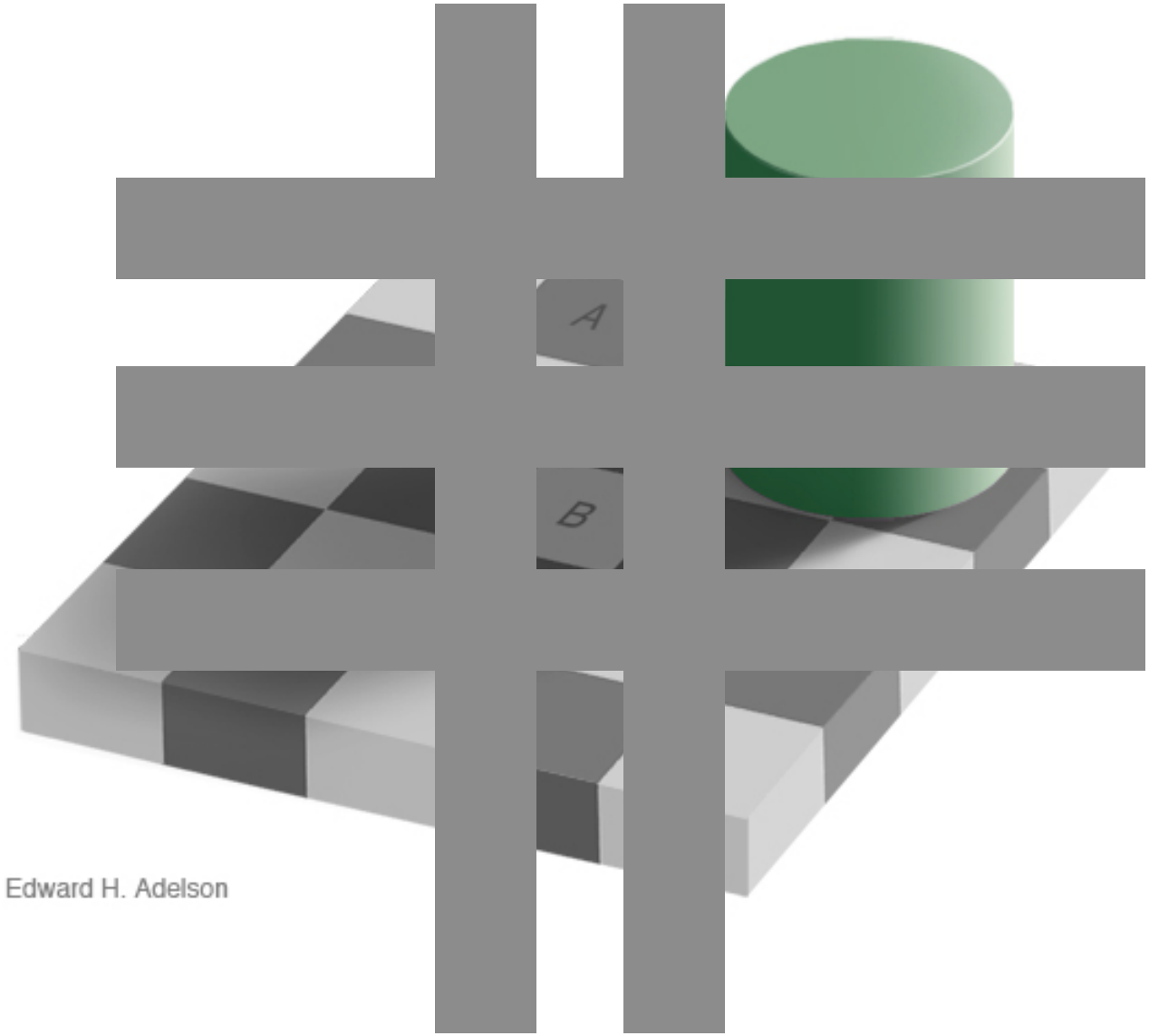
Rensink, O'regan, Simon, etc.

Change blindess

Rensink, O'regan, Simon, etc.

segmentation

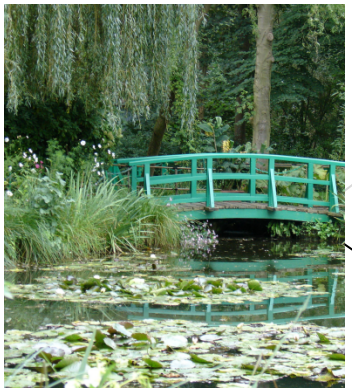
Perception



Edward H. Adelson

What is (computer) vision?

Image (or video)



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What a computer sees

Source: S. Narasimhan

Origins of computer vision: an MIT undergraduate summer project

MASSACHUSETTS INSTITUTE OF TECHNOLOGY
PROJECT MAC

Artificial Intelligence Group
Vision Memo. No. 100.

July 7, 1966

THE SUMMER VISION PROJECT

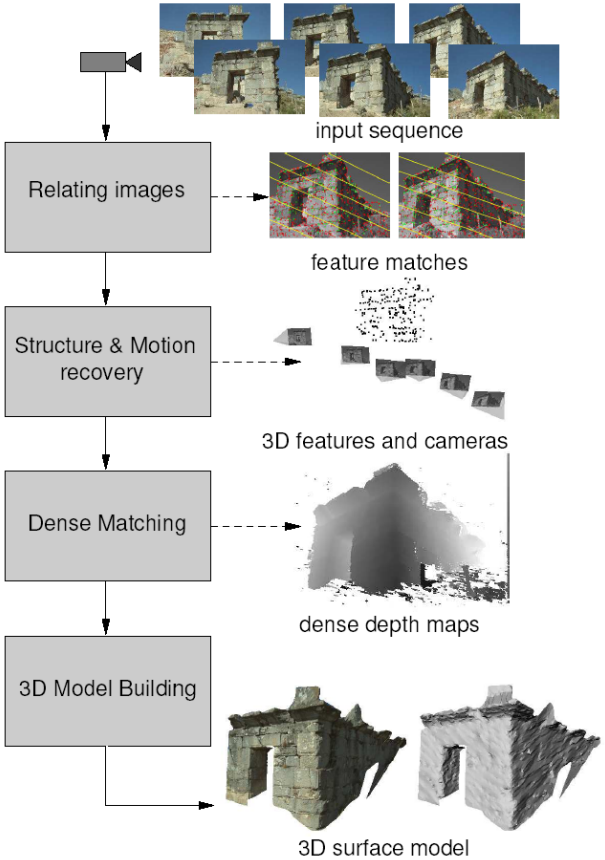
Seymour Papert

The summer vision project is an attempt to use our summer workers effectively in the construction of a significant part of a visual system. The particular task was chosen partly because it can be segmented into sub-problems which will allow individuals to work independently and yet participate in the construction of a system complex enough to be a real landmark in the development of "pattern recognition".

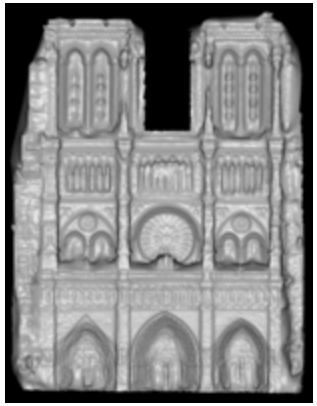
What kind of information can we extract from an image?

- Metric 3D information
- Semantic information

Vision as measurement device

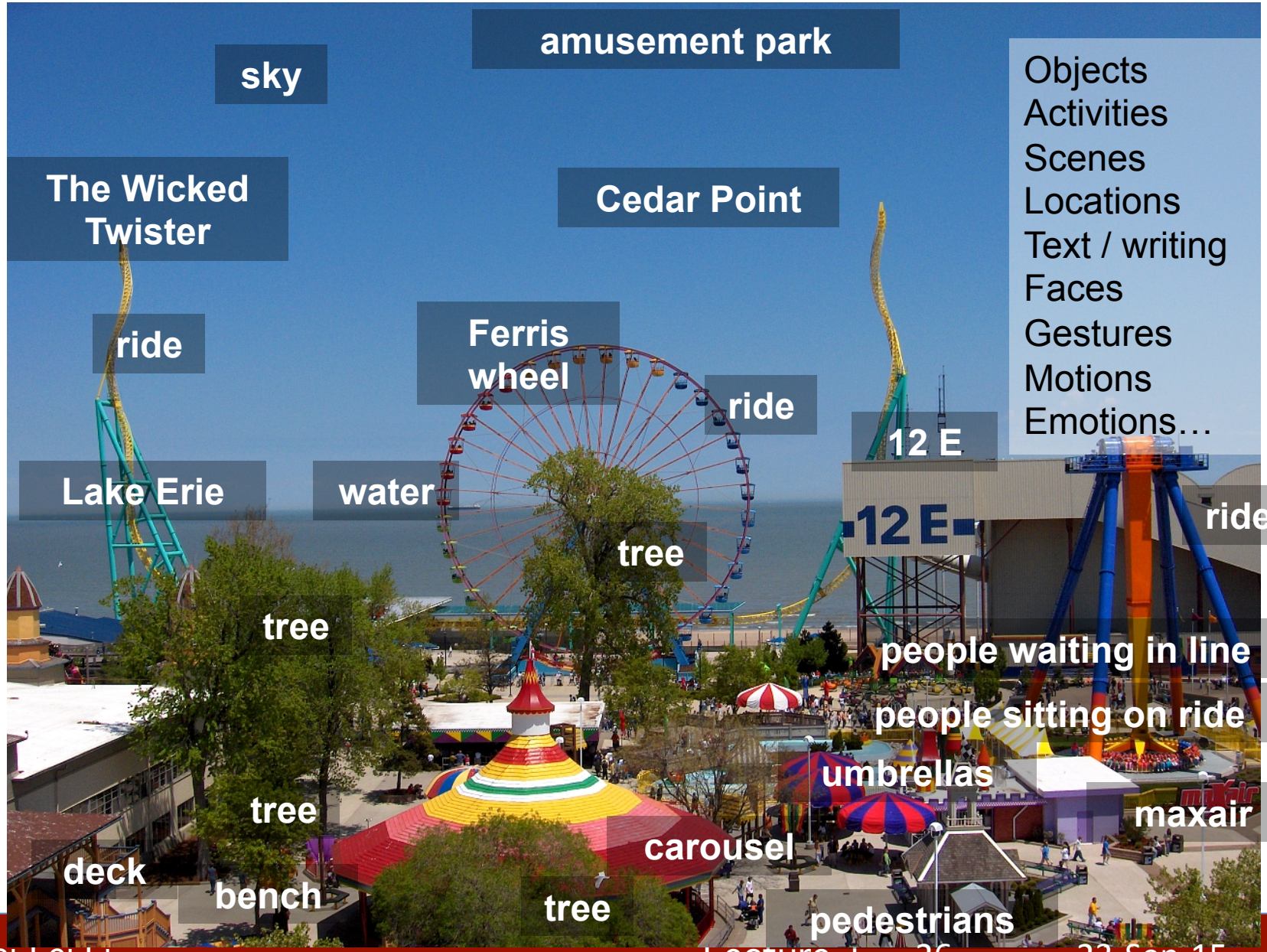


Pollefeys et al.



Goesele et al.

Vision as a source of semantic information

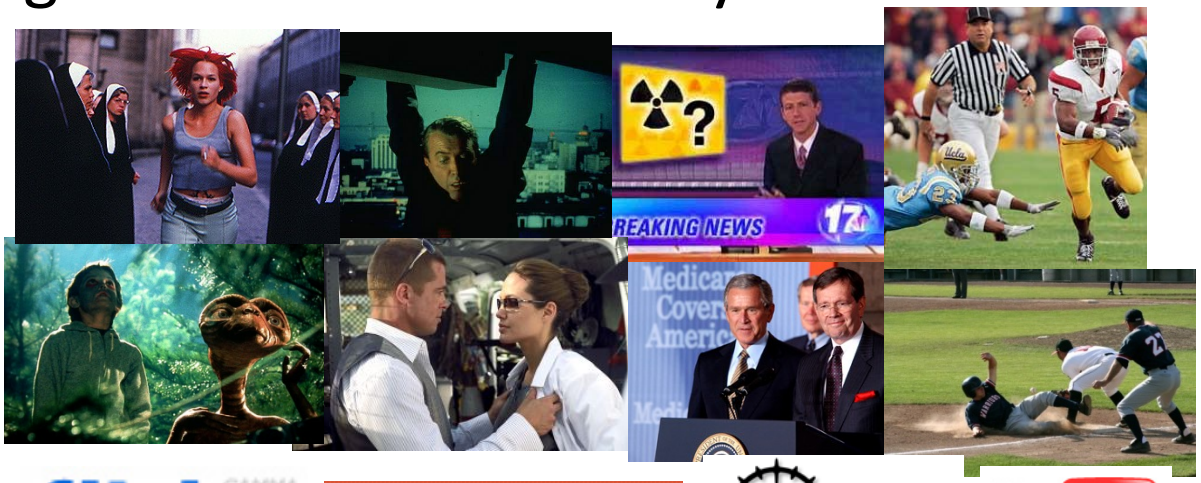


Objects
Activities
Scenes
Locations
Text / writing
Faces
Gestures
Motions
Emotions…

Slide credit: Kristen Grauman

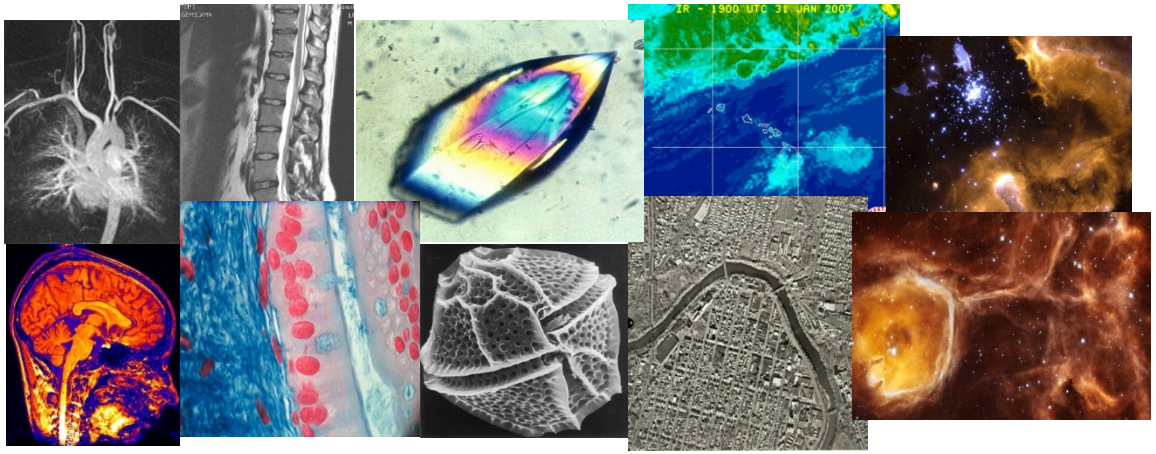
Why study computer vision?

- Vision is useful: Images and video are everywhere!



Google Image Search · Picasa · flickr · webshots · picsearch · YouTube Broadcast Yourself

Surveillance and security

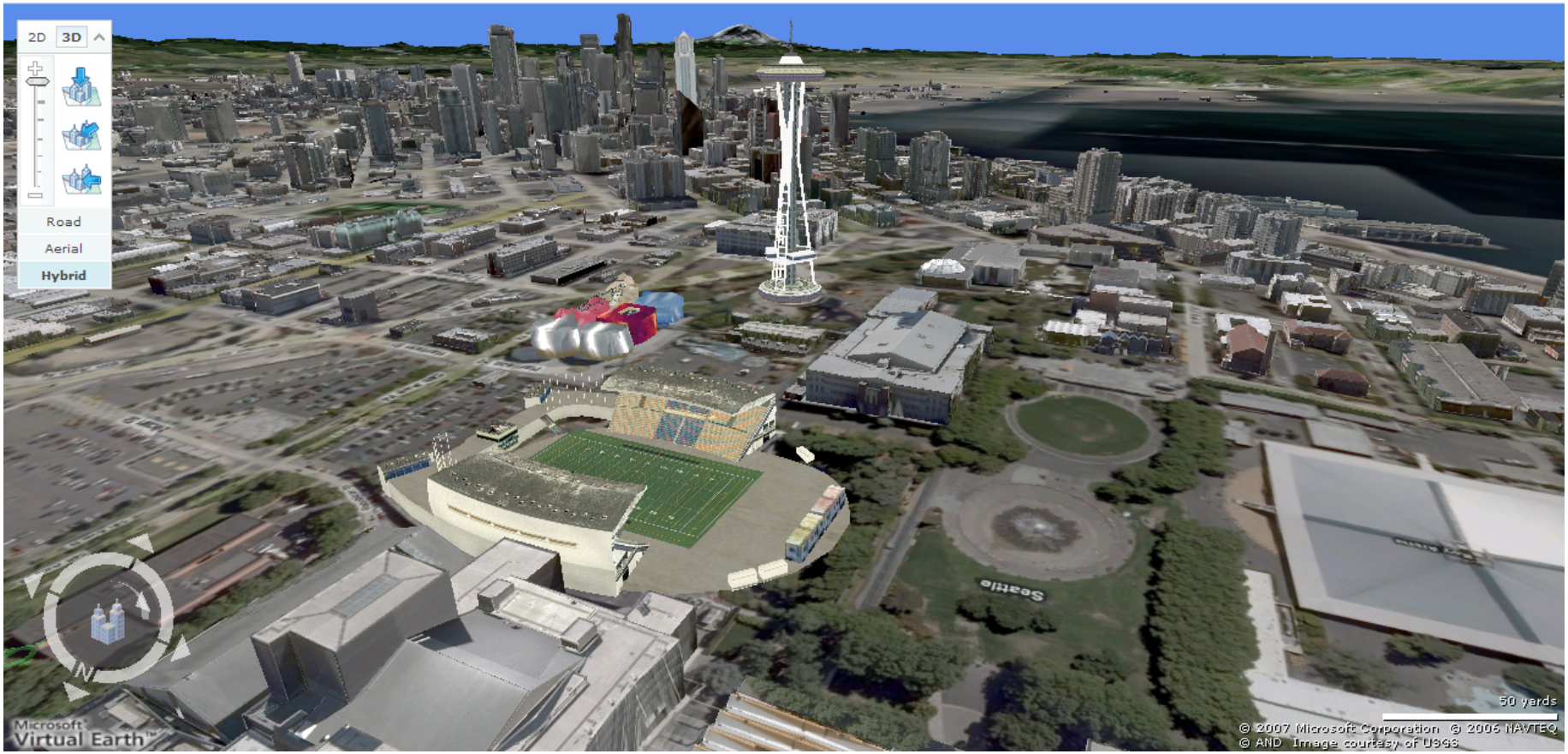


Medical and scientific images

Special effects: shape and motion capture

Source: S. Seitz

3D urban modeling



Bing maps, Google Streetview

Source: S. Seitz

3D urban modeling: Microsoft Photosynth

http://photosynth.net

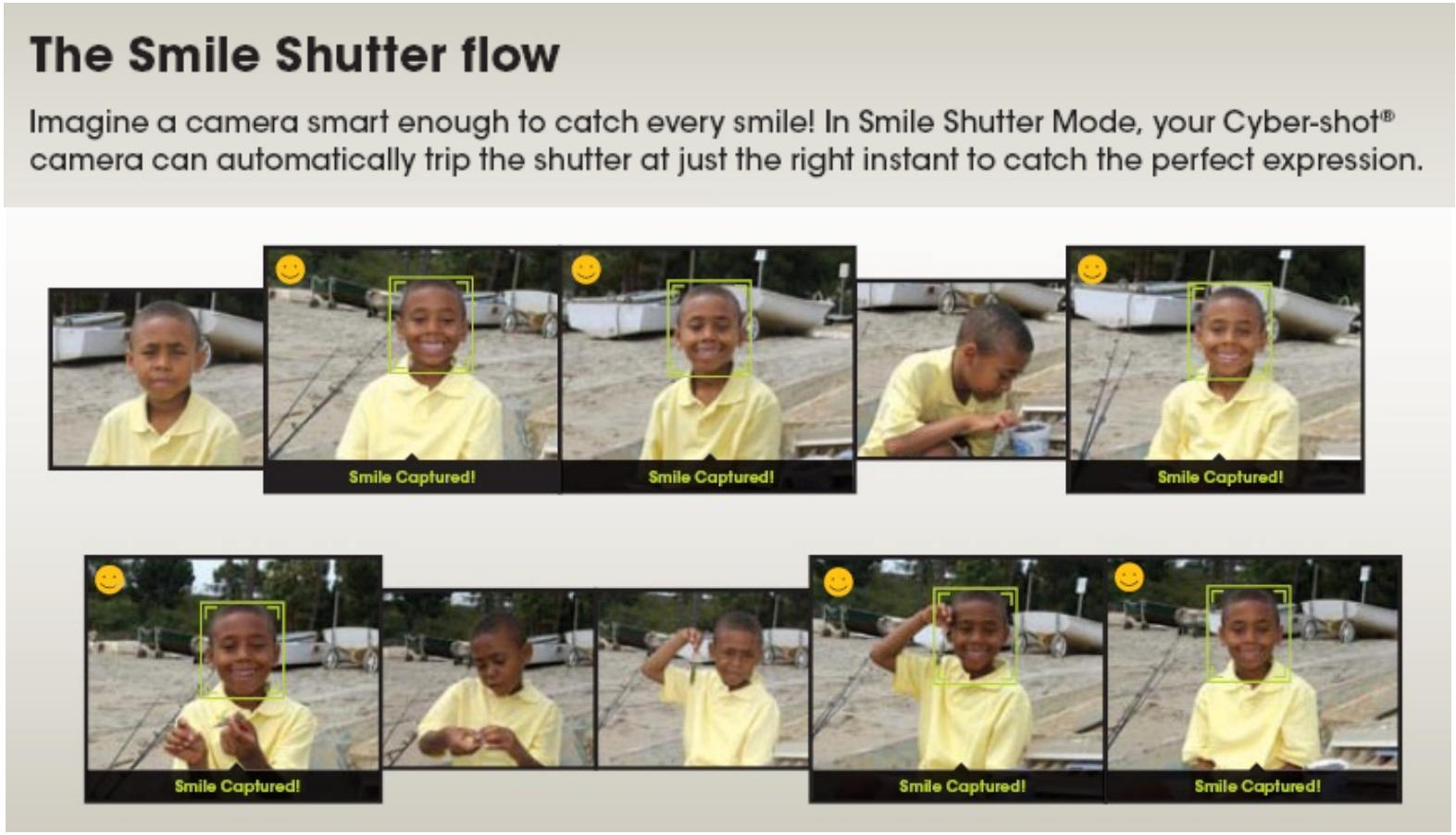
Source: S. Seitz

Face detection

- Many digital cameras now detect faces
  - Canon, Sony, Fuji, …

Source: S. Seitz

Smile detection



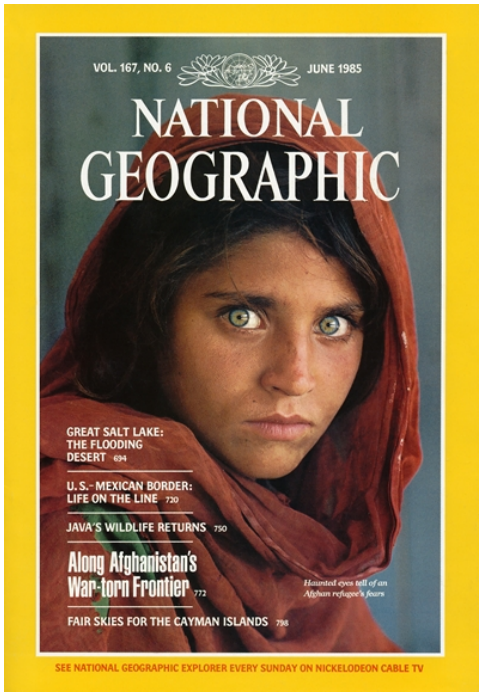
Sony Cyber-shot® T70 Digital Still Camera

Source: S. Seitz

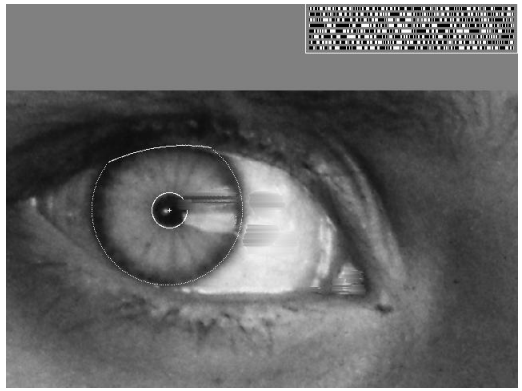
Face recognition: Apple iPhoto software

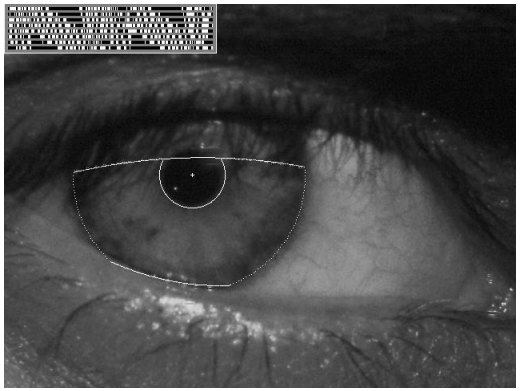
http://www.apple.com/ilife/iphoto/

Biometrics



How the Afghan Girl was Identified by Her Iris Patterns





Source: S. Seitz

Biometrics

Fingerprint scanners on many new laptops, other devices

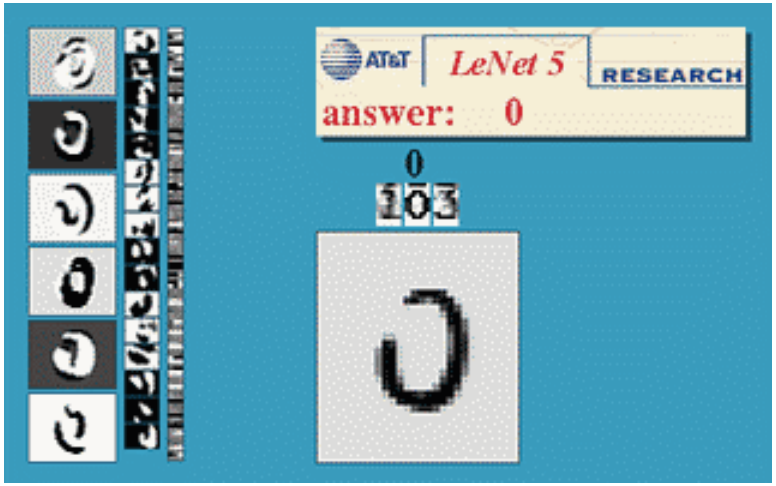
Face recognition systems now beginning to appear more widely
http://www.sensiblevision.com/

Source: S. Seitz

Optical character recognition (OCR)

Technology to convert scanned docs to text

- If you have a scanner, it probably came with OCR software



Digit recognition, AT&T labs

License plate readers
http://en.wikipedia.org/wiki/Automatic_number_plate_recognition

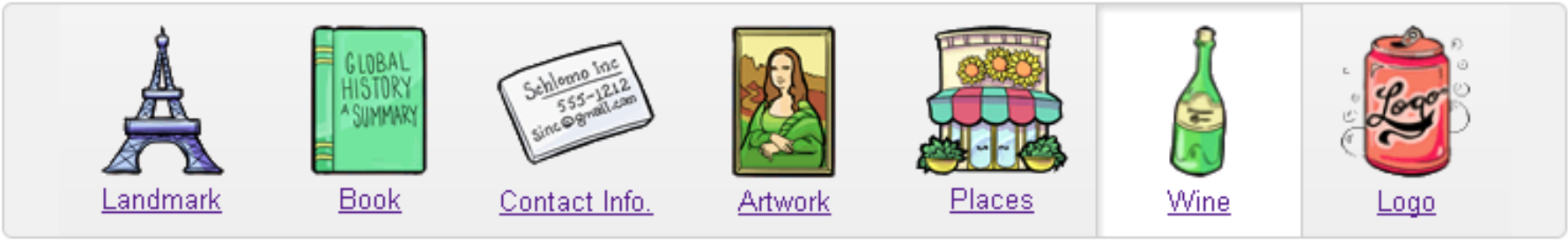
Source: S. Seitz

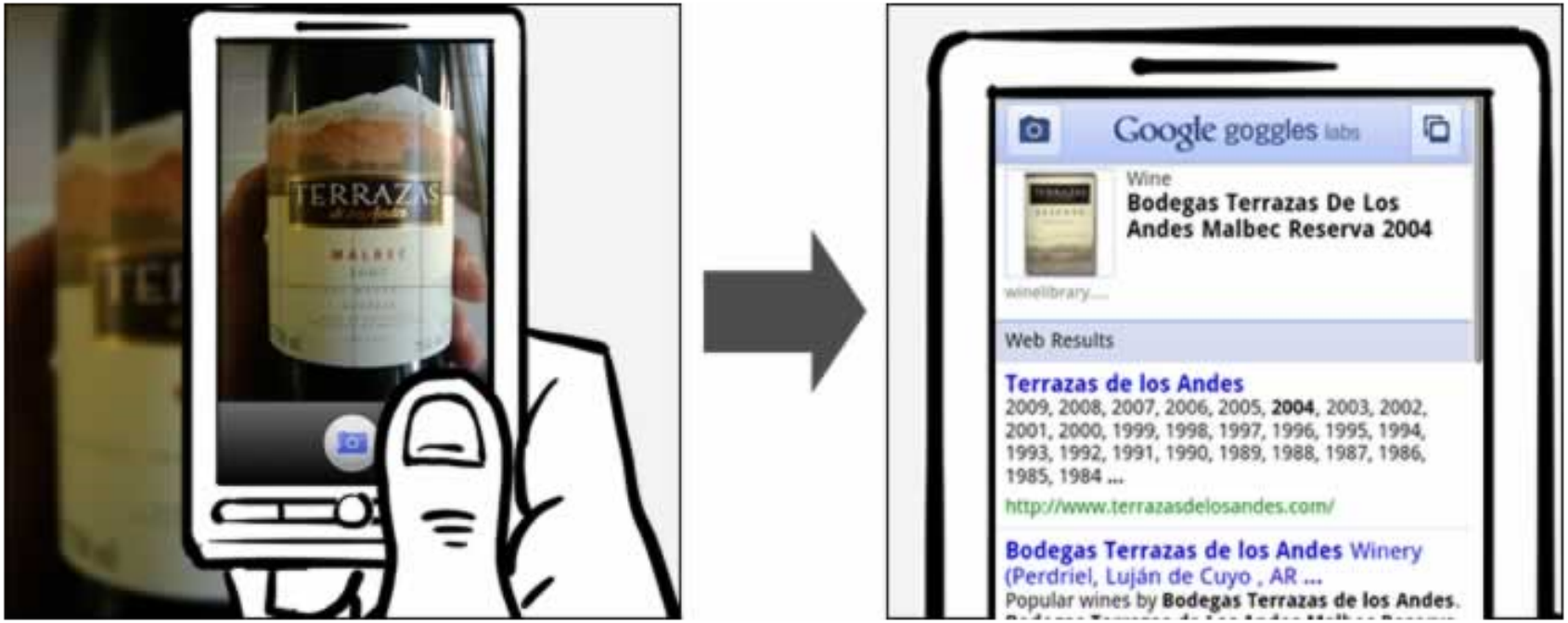
Toys and Robots

Mobile visual search: Google Goggles

Google Goggles in Action

Click the icons below to see the different ways Google Goggles can be used.

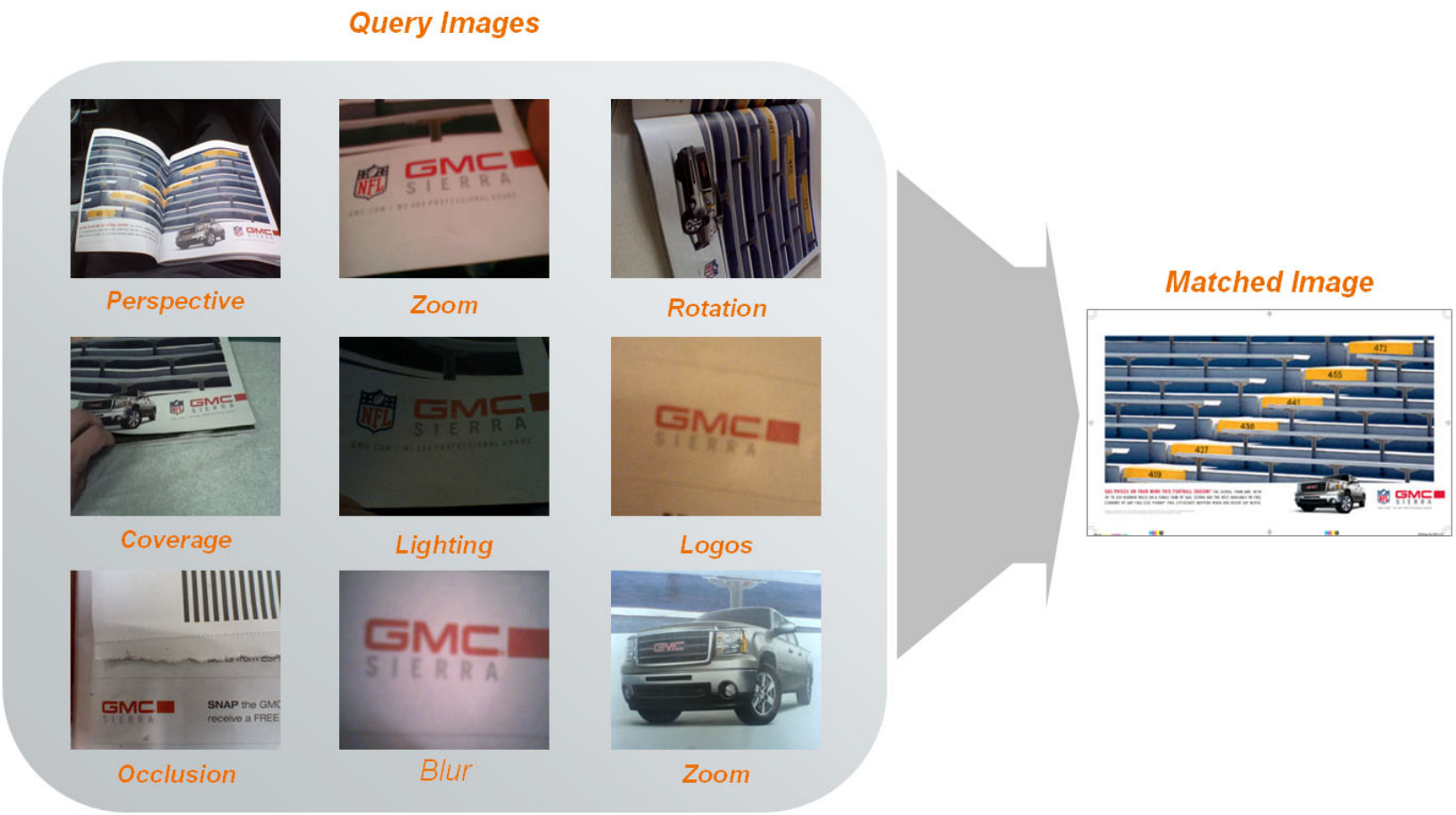




Mobile visual search: iPhone Apps

snaptell

kooaba



Automotive safety

- Mobileye: Vision systems in high-end BMW, GM, Volvo models
  - "In mid 2010 Mobileye will launch a world's first application of full emergency braking for collision mitigation for pedestrians where vision is the key technology for detecting pedestrians."

Source: A. Shashua, S. Seitz

Vision in supermarkets

LaneHawk by EvolutionRobotics

"A smart camera is flush-mounted in the checkout lane, continuously watching for items. When an item is detected and recognized, the cashier verifies the quantity of items that were found under the basket, and continues to close the transaction. The item can remain under the basket, and with LaneHawk, you are assured to get paid for it… "

Source: S. Seitz

Vision-based interaction (and games)

Microsoft's Kinect

Sony EyeToy

Assistive technologies

Source: S. Seitz

Vision for robotics, space exploration

NASA'S Mars Exploration Rover Spirit captured this westward view from atop a low plateau where Spirit spent the closing months of 2007.

Vision systems (JPL) used for several tasks

- Panorama stitching
- 3D terrain modeling
- Obstacle detection, position tracking
- For more, read "Computer Vision on Mars" by Matthies et al.

Source: S. Seitz

Today's agenda

- Introduction to computer vision
- Course overview

Contacting instructor and TAs

- Instructors:
  - Dr. Juan Carlos Niebles
  - Prof. Fei-Fei Li
- Teaching Assistants
  - Ranjay Krishna, Masters, CS
  - Zelun (Alan) Luo, Masters, CS
  - TBD

Contacting instructor and TAs

- All announcements, Q&A in Piazza
  - **http://piazza.com/stanford/fall2015/cs131**

- ALL EMAIL CORRESPONDENCES TO ANYONE OF US:
  - **cs131-fall1516-staff@lists.stanford.edu**

Overall philosophy

- Breadth
  - Computer vision is a huge field
  - It can impact every aspect of life and society
  - It will drive the next information and AI revolution
  - Pixels are everywhere in our lives and cyber space
  - CS131 is meant as an introductory course, we will not cover all topics of CV
  - Lectures are mixture of details techniques and high level ideas
  - Speak our "language"
- Depth
  - Computer vision is a highly technical field, i.e. know your math!
  - Master bread-and-butter techniques: face recognition, corners, lines, features, optical flows, clustering and segmentation
  - Programming assignments: be a good coder AND a good writer
  - Theoretical problem sets: know your math!
  - Final Exam: your chance to shine!

Syllabus

- Go to website… http://vision.stanford.edu/teaching/cs131_fall1516

Grading policy

- Program Set 0: 8%
  - Normalizing background knowledge
- 3 theoretical Problem Sets: 12% x 3 = 36%
- 3 programming assignments: 12% x 3 = 36%
- Final Exam: 20%
- Late policy
  - 5 free late days – use them in your ways
  - Afterwards, 25% off per day late
  - Not accepted after 3 late days per PS
- Collaboration policy
  - Read the student code book, understand what is 'collaboration' and what is 'academic infraction'

Homeworks

- All homework must be submitted on Gradescope (http://gradescope.com) as PDF.
- All code must be submitted via email to cs131.submissions@gmail.com
- PS0 is live, you can start working on it immediately.