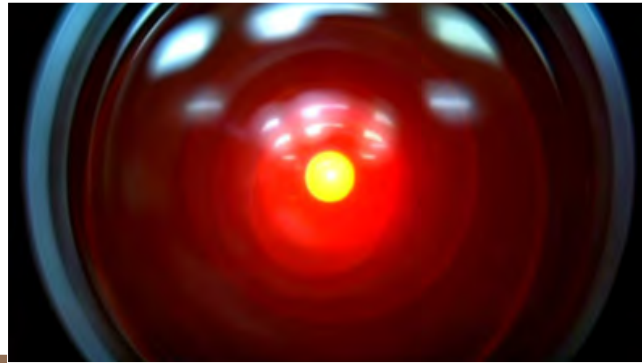
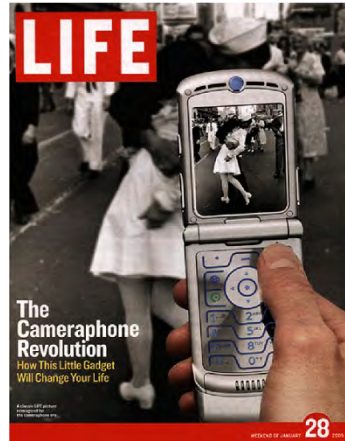


Lecture 1: Introduction to “Computer Vision”

Professor Fei-Fei Li
Stanford Vision Lab

Welcome to CS131



Fei-Fei Li



CS131 is a brand new class!

- CS131 (fall, 2013):
 - Enthusiastic undergrads
 - Want to get to know this exciting technology
- CS231a (winter, 2014, Prof. Silvio Savarese)
 - Similar to existing CS231a
 - Seniors, masters, and PhDs
- CS231b: Cutting Edge Computer Vision
- CS331 (fall, 2013, Prof. Silvio Savarese)
 - Advanced 3D reconstruction & recognition

Today's agenda

- Introduction to computer vision
- Course overview

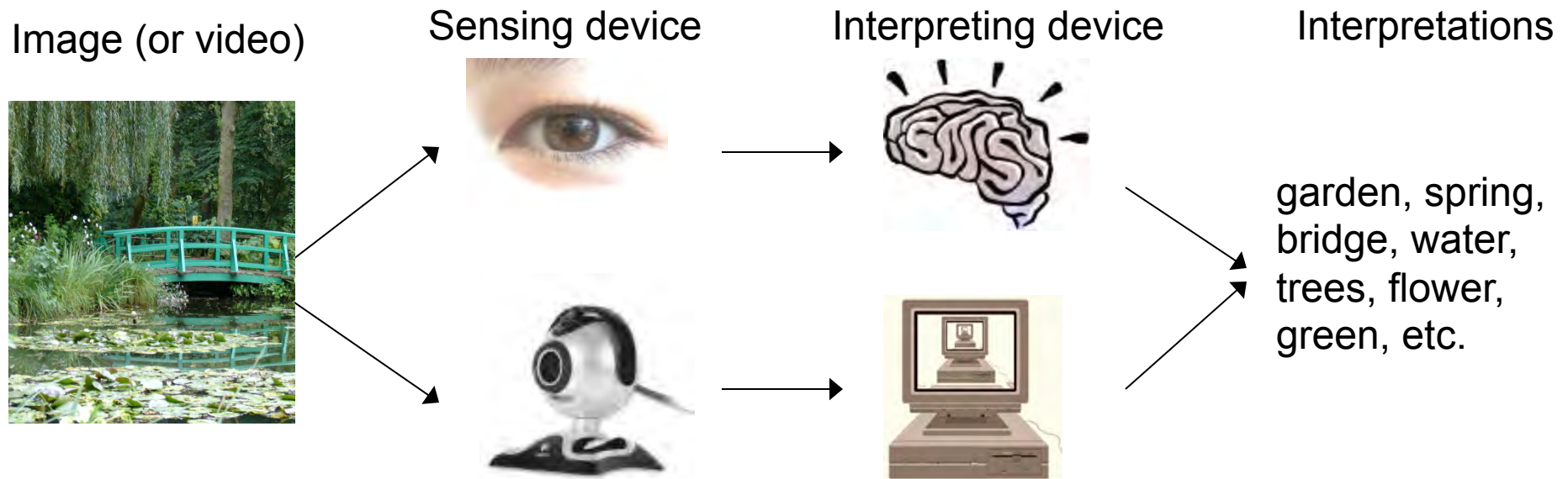
Quiz?



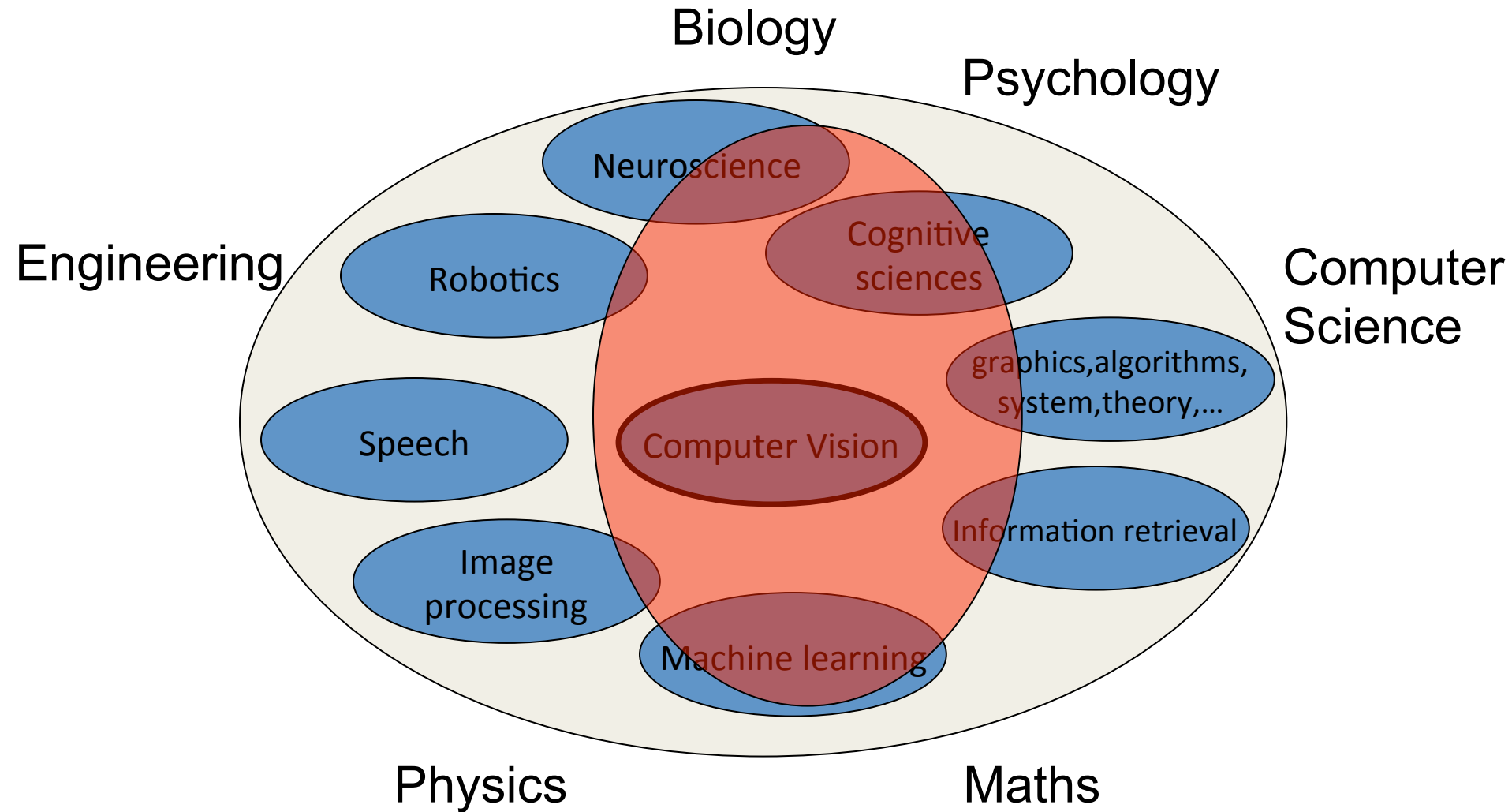
What about this?



What is (computer) vision?



What is it related to?



The goal of computer vision

- To bridge the gap between pixels and “meaning”

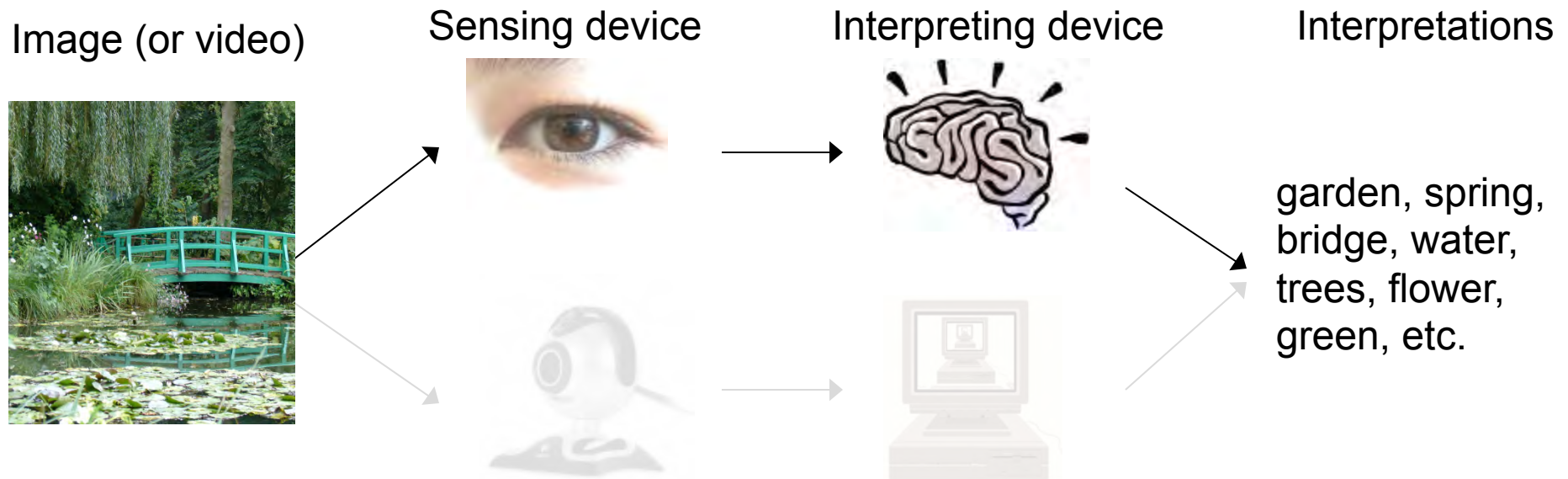


What we see

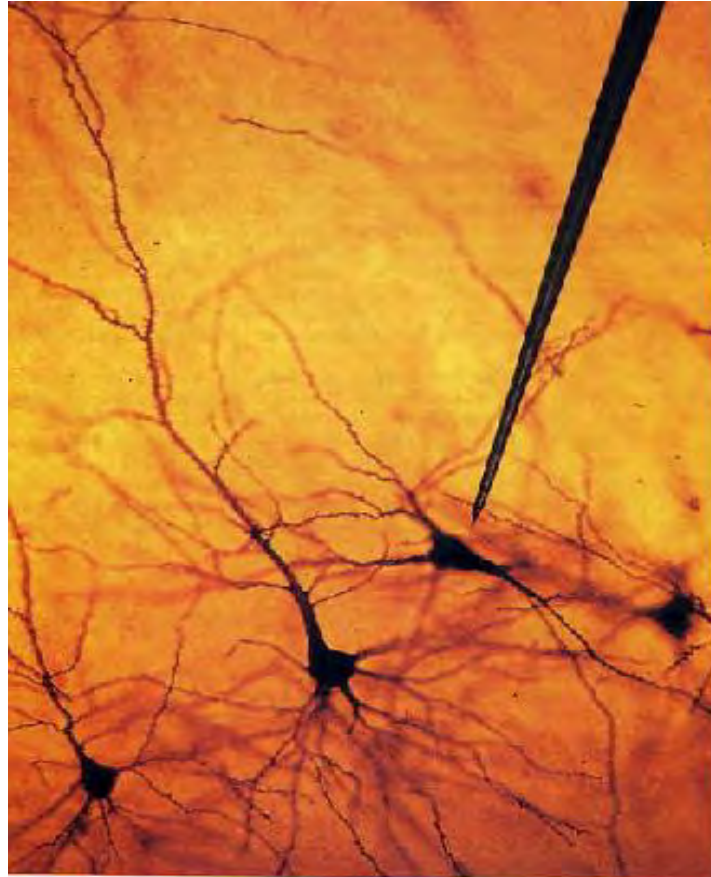
0	3	2	5	4	7	6	9	8
3	0	1	2	3	4	5	6	7
2	1	0	3	2	5	4	7	6
5	2	3	0	1	2	3	4	5
4	3	2	1	0	3	2	5	4
7	4	5	2	3	0	1	2	3
6	5	4	3	2	1	0	3	2
9	6	7	4	5	2	3	0	1
8	7	6	5	4	3	2	1	0

What a computer sees

What is (computer) vision?



1981: Nobel Prize in medicine

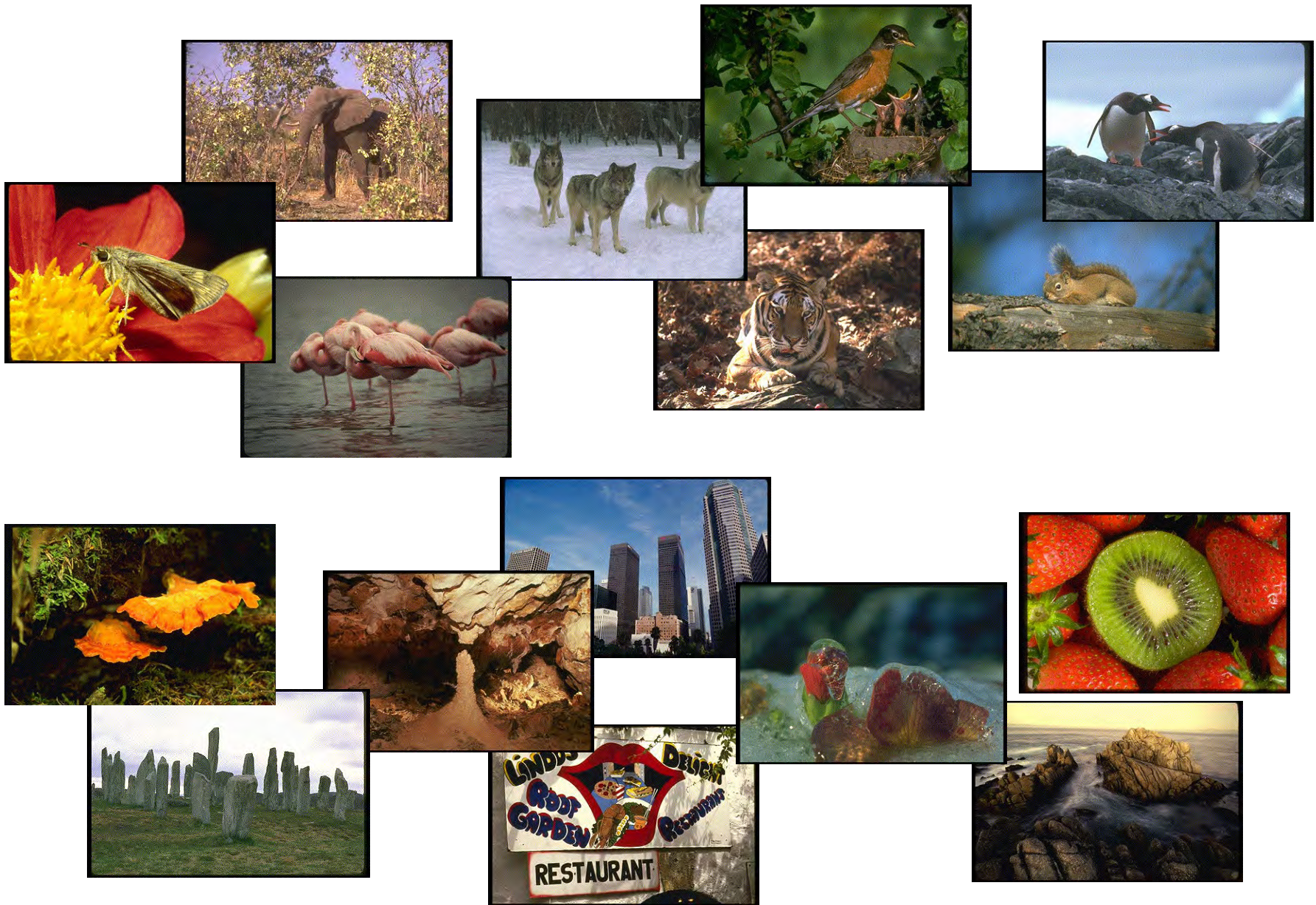


Hubel & Wiesel

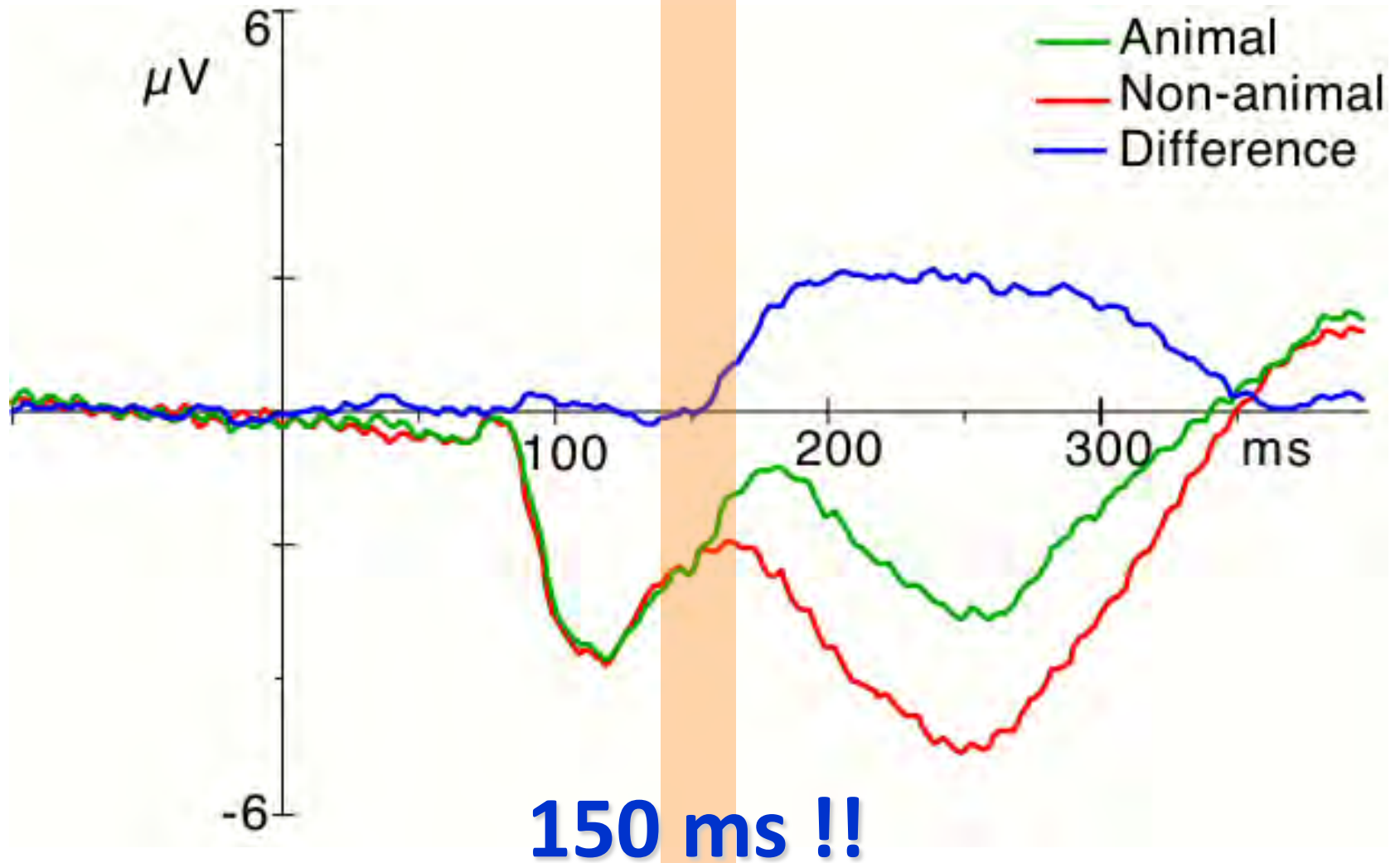
Human vision is superbly efficient



Potter, Biederman, etc. 1970s



Thorpe, et al. *Nature*, 1996



Thorpe, et al. *Nature*, 1996

Change blindness



Rensink, O'regan, Simon, etc.

Change blindness



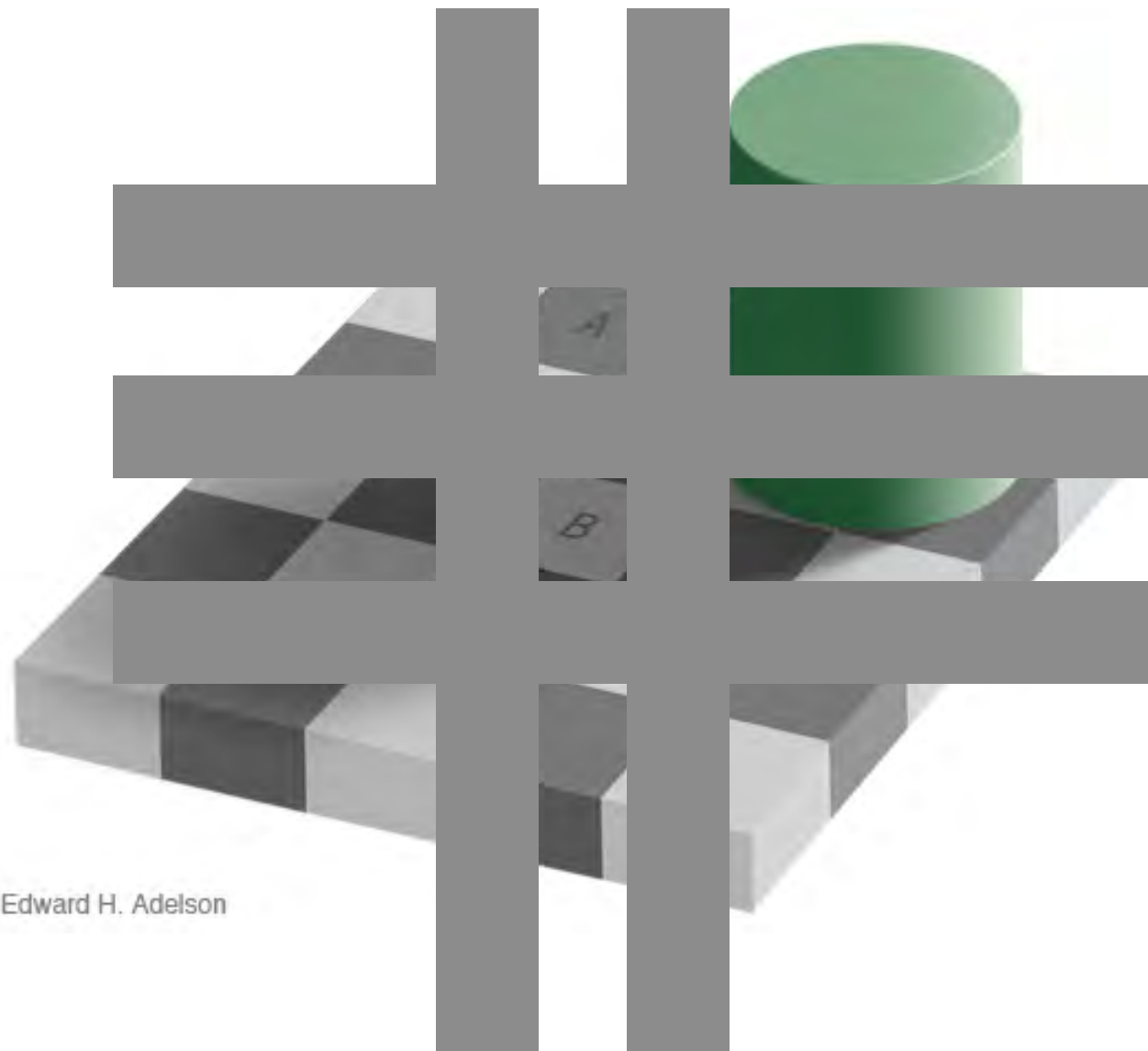
Rensink, O'regan, Simon, etc.

segmentation



Perception

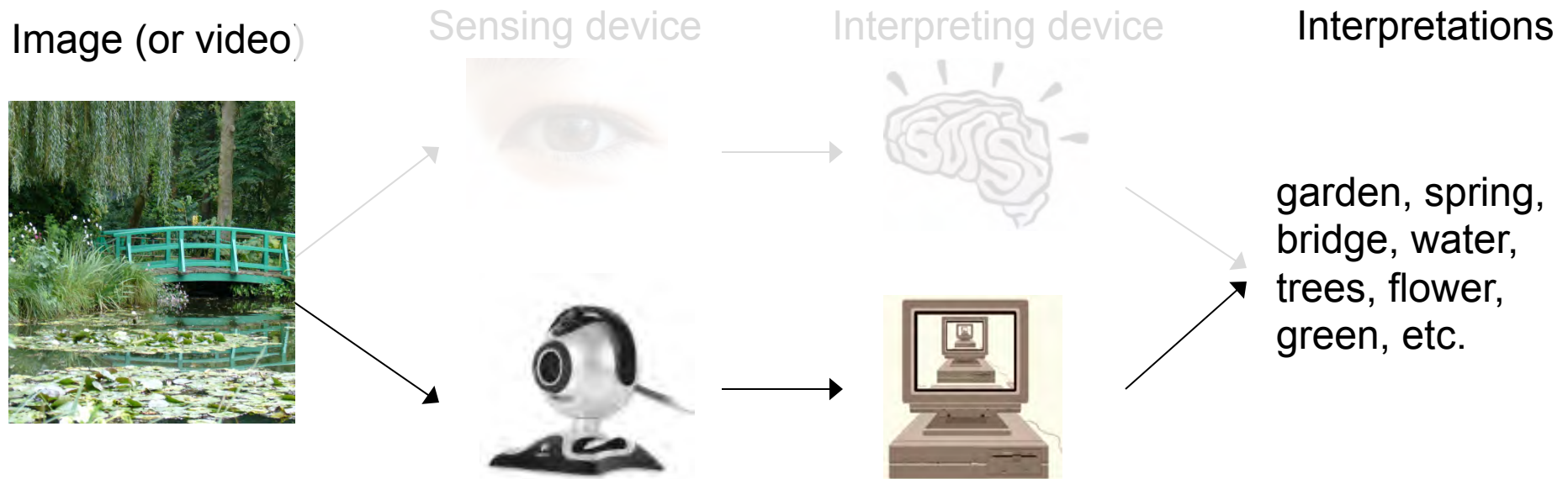




Edward H. Adelson



What is (computer) vision?



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

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".

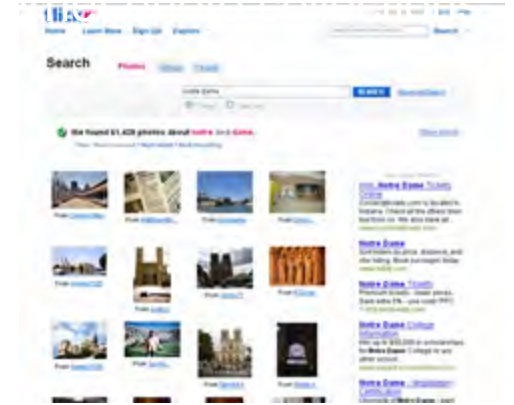
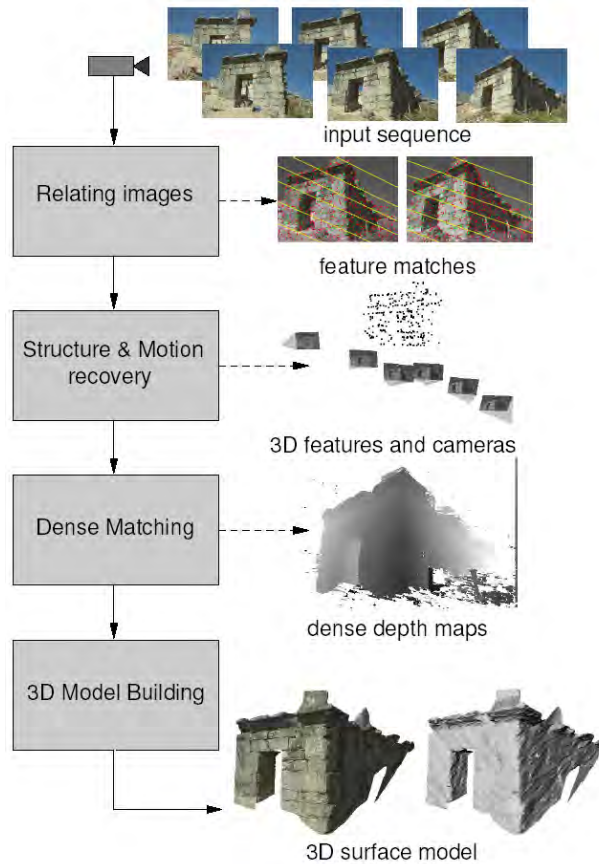
What kind of information can we extract from an image?

- Metric 3D information
- Semantic information

Vision as measurement device

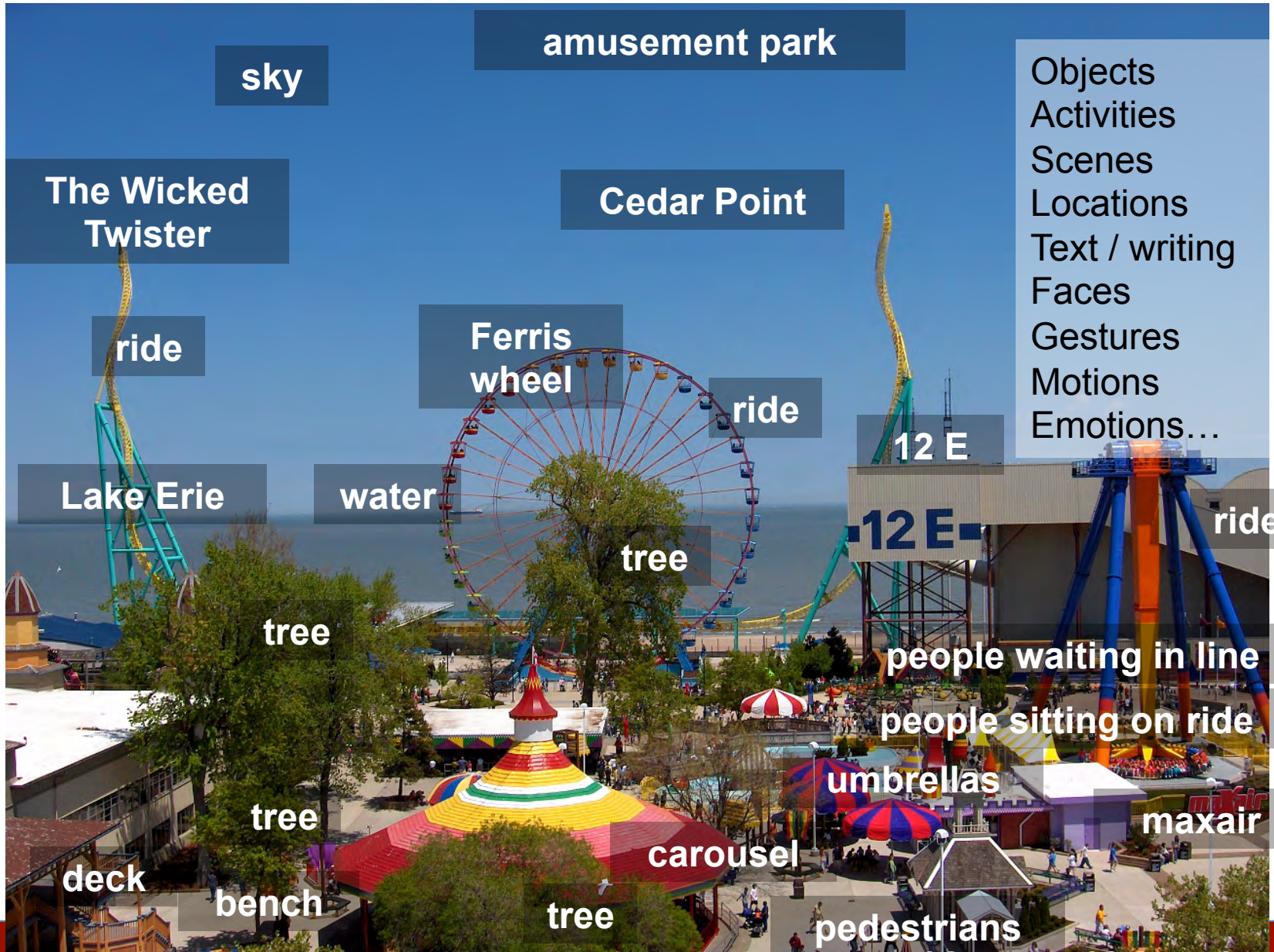


Pollefeys et al.



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™

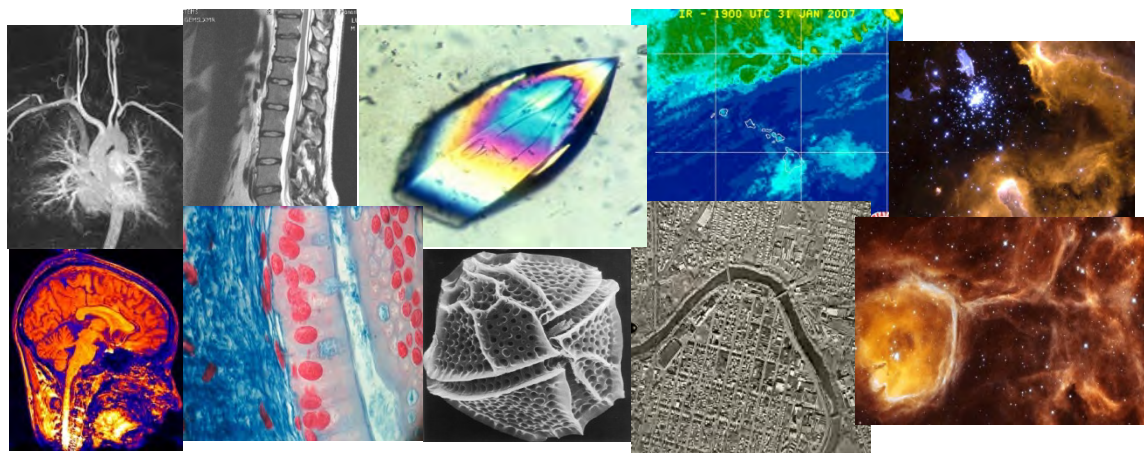
webshots™

picsearch™

YouTube™
Broadcast Yourself™



Surveillance and security



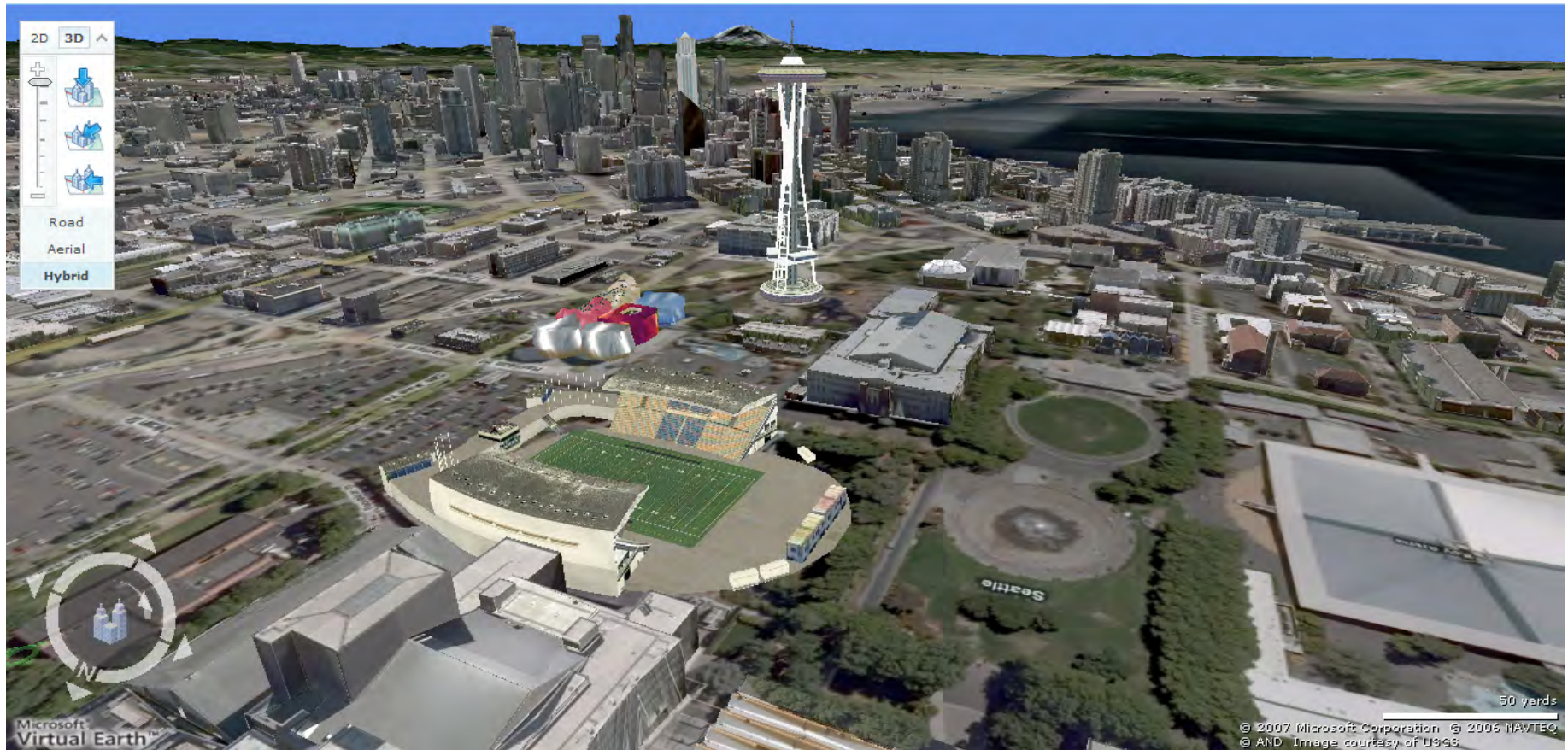
Medical and scientific images

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://labs.live.com/photosynth/>

Source: S. Seitz

Face detection



- Many new digital cameras now detect faces
 - Canon, Sony, Fuji, ...

Source: S. Seitz

Smile detection

The Smile Shutter flow

Imagine a camera smart enough to catch every smile! In Smile Shutter Mode, your Cyber-shot™ camera can automatically trip the shutter at just the right instant to catch the perfect expression.



[Sony Cyber-shot® T70 Digital Still Camera](#)

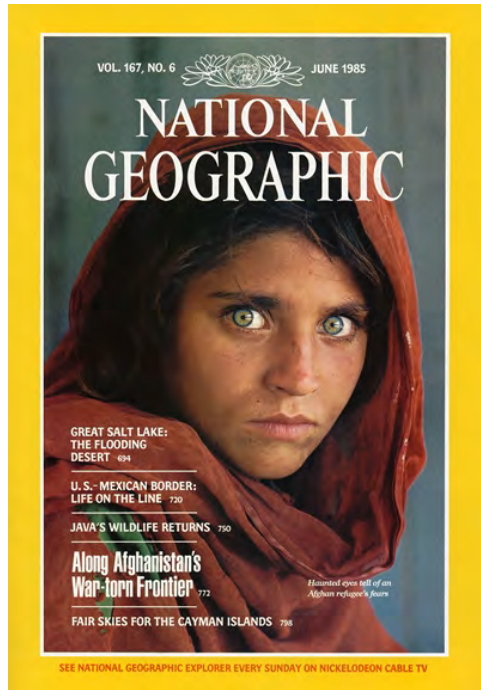
Source: S. Seitz

Face recognition: Apple iPhoto software

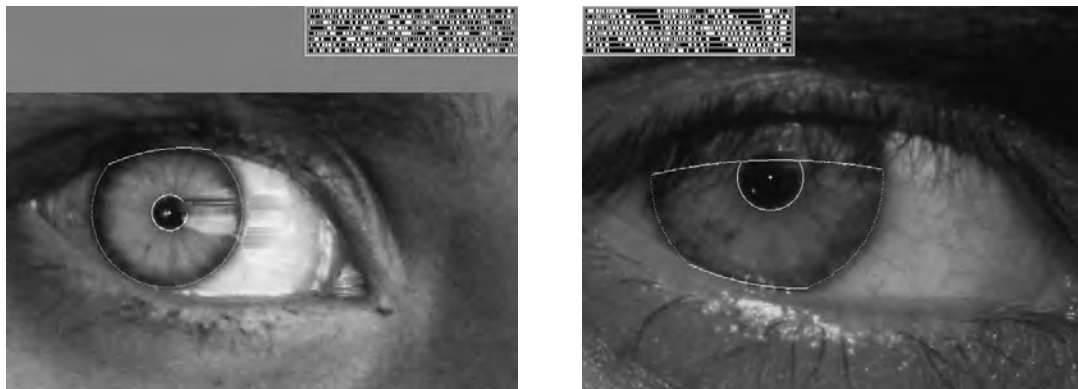


<http://www.apple.com/ilife/iphoto/>

Biometrics



How the Afghan Girl was Identified by Her Iris Patterns

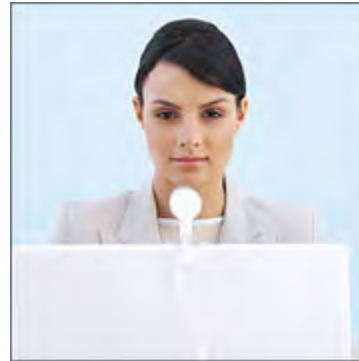


Source: S. Seitz

Biometrics



Fingerprint scanners on many new laptops, other devices



Face recognition systems now beginning to appear more widely

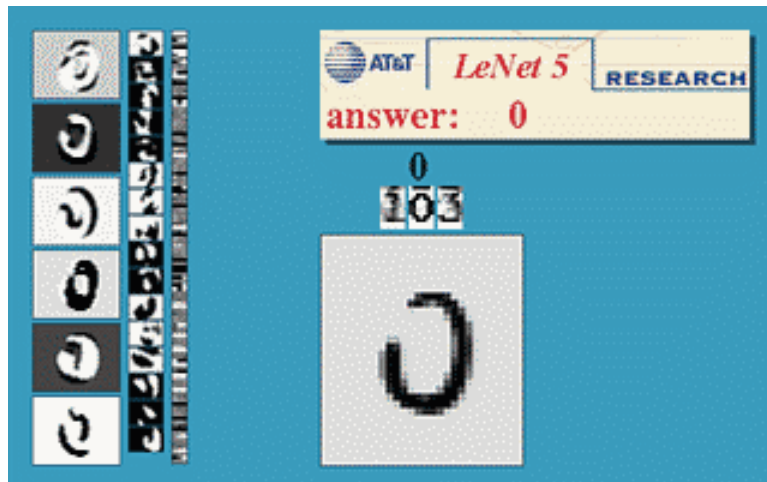
<http://www.sensiblevision.com/>

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

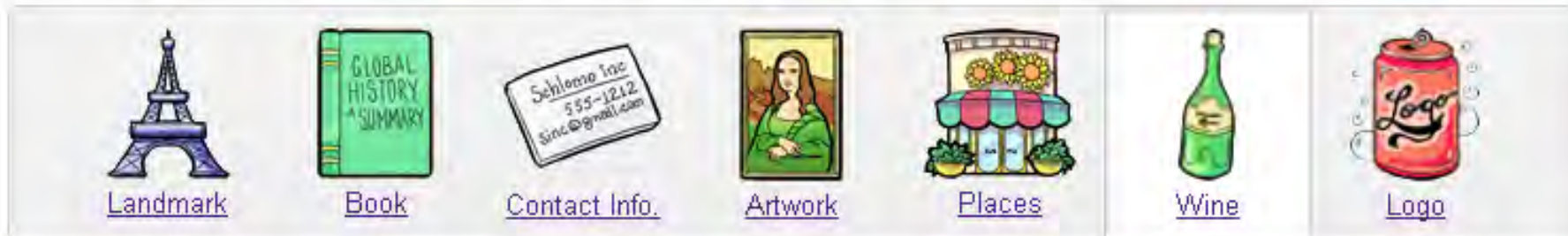
Toys and Robots



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



Query Images



Perspective



Zoom



Rotation



Coverage



Lighting



Logos



Occlusion



Blur



Zoom

Matched Image



Automotive safety

▶ manufacturer products consumer products ◀◀

Our Vision. Your Safety.

rear looking camera forward looking camera

side looking camera

▶ **EyeQ** Vision on a Chip

▶ **Vision Applications**
Road, Vehicle, Pedestrian Protection and more

▶ **AWS** Advance Warning System

News

▶ Mobileye Advanced Technologies Power Volvo Cars World First Collision Warning With Auto Brake System

▶ Volvo: New Collision Warning with Auto Brake Helps Prevent Rear-end

> all news

Events

▶ [Mobileye at Equip Auto, Paris, France](#)

▶ [Mobileye at SEMA, Las Vegas, NV](#)

> read more

- [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

- ALL EMAIL CORRESPONDENCES TO ANYONE OF US:
 - cs131-fall1314-staff@lists.stanford.edu
- Instructor: Prof. Fei-Fei Li
- Teaching Assistants
 - Luke Allen, Master candidate
 - Johnson, Ph.D. candidate, CS
 - Jiayuan Ma, master candidate, CS

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...

Grading policy

- Program Set 0: 8%
 - Normalizing background knowledge
- 3 theoretical Problem Sets: $12\% \times 3 = 36\%$
- 3 programming assignments: $12\% \times 3 = 36\%$
- 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’