Lecture: Introduction to Computer Vision

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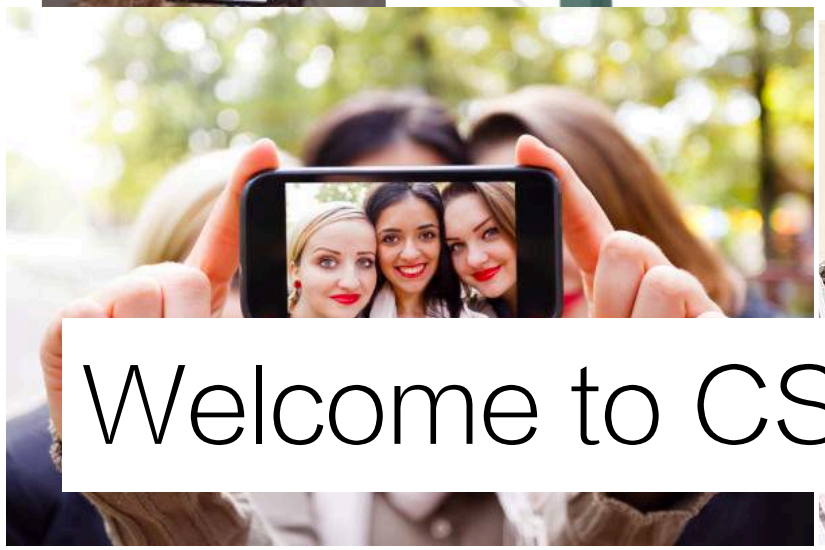
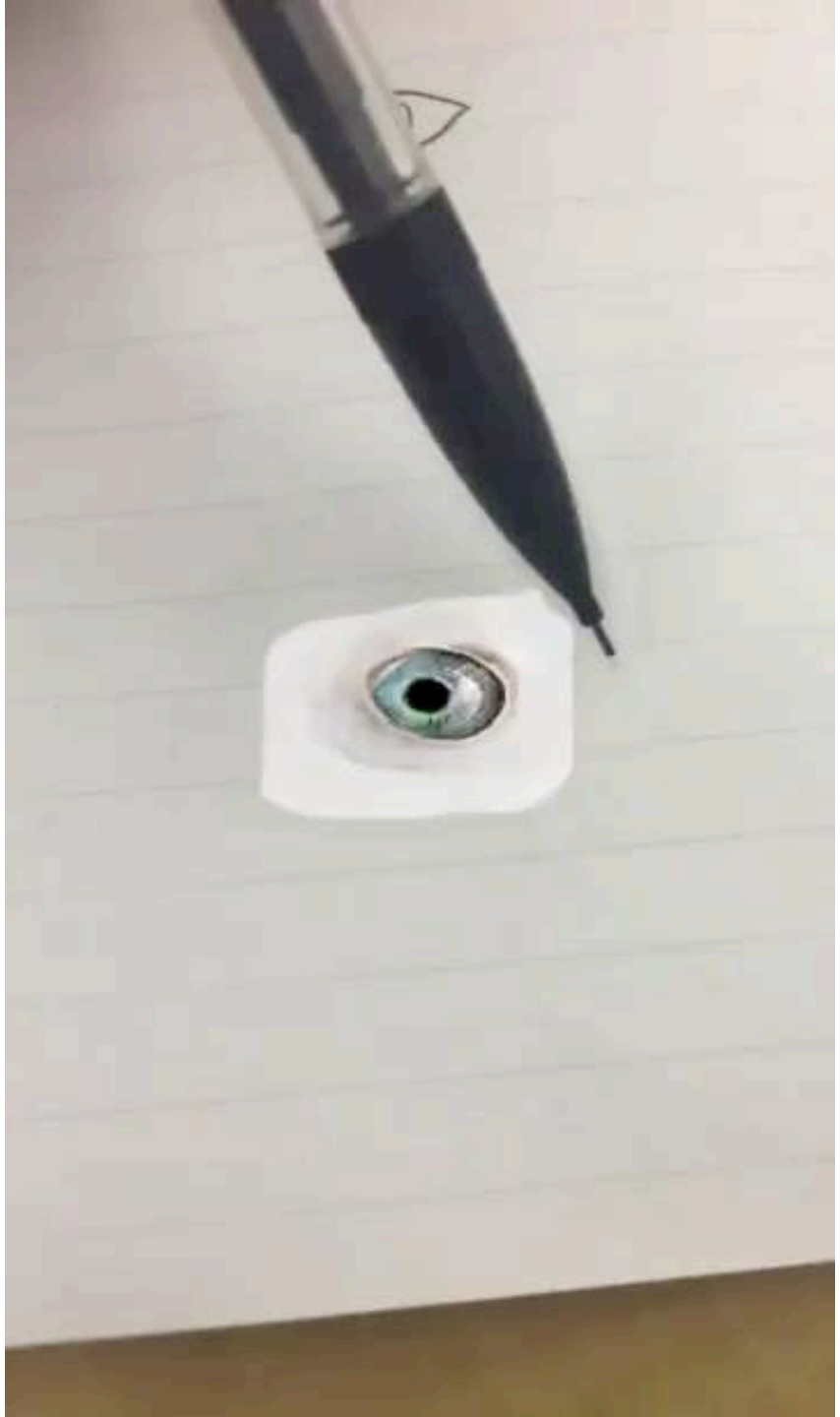
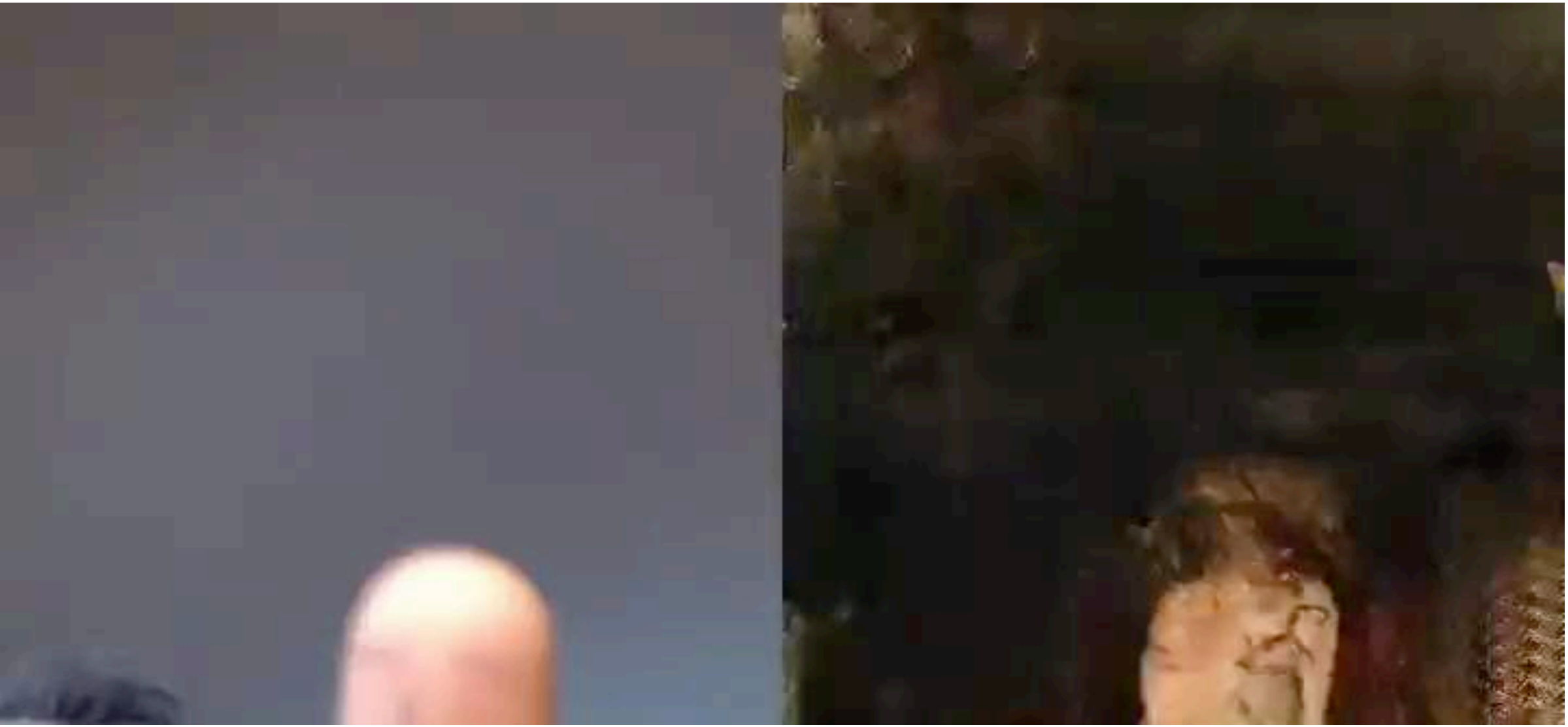
Stanford Vision and Learning Lab



Welcome to CS131

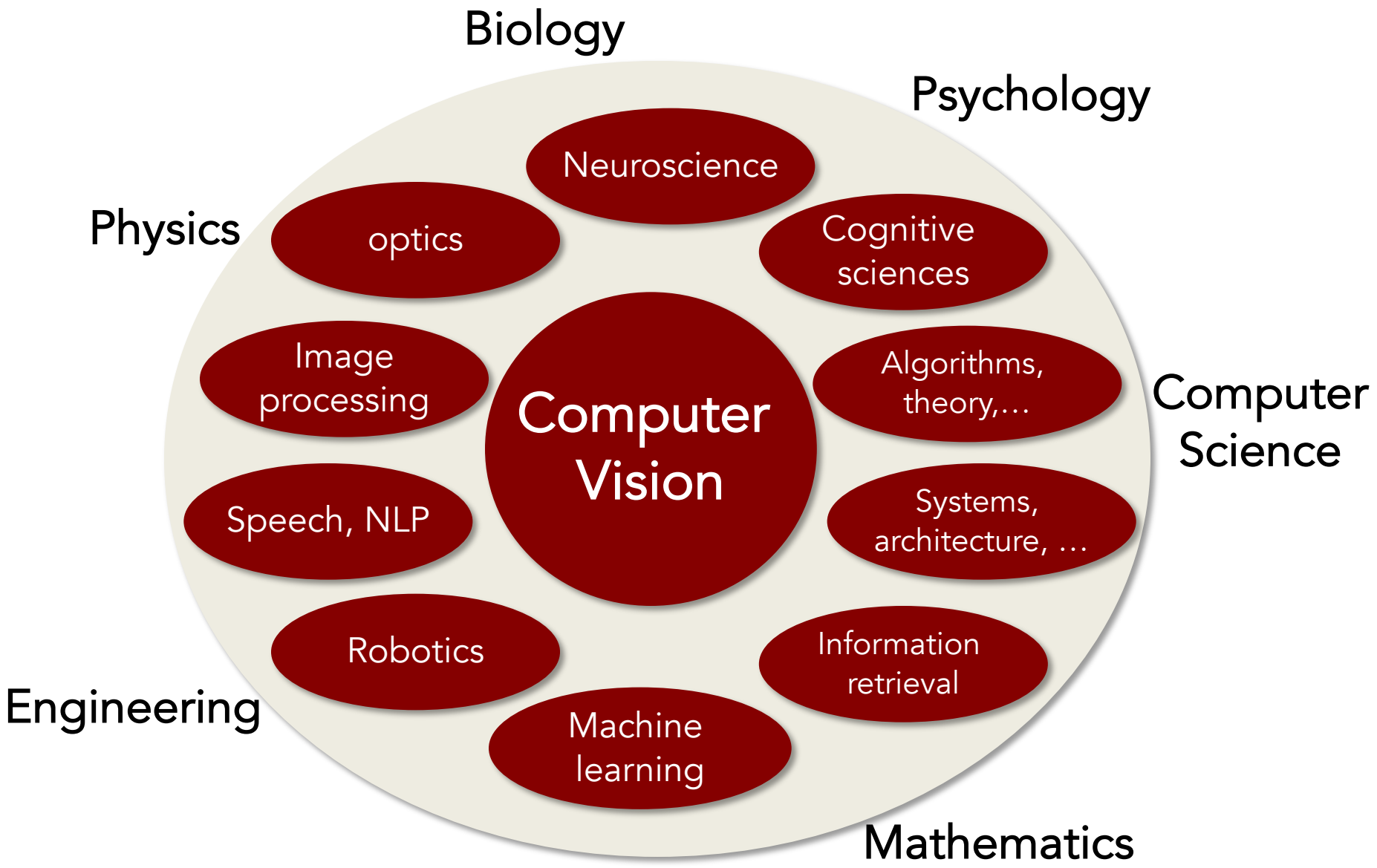


Jason Salavon
GAN experiment on Twitter



Mario Klingemann, GAN experiment on Twitter

Main device 0


Biology
Psychology
Physics
Computer Science
Engineering
Mathematics
Computer Vision
Neuroscience
Cognitive sciences
optics
Image processing
Algorithms, theory,…
Speech, NLP
Systems, architecture, …
Robotics
Information retrieval
Machine learning

Today's agenda

- Introduction to computer vision
- Course overview

Quiz?

What about this?

3D Reconstruction

Michaelangelo's David

Recognizing chairs

What is (computer) vision?

Image (or video)

Sensing device

Interpreting device

Interpretations

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

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)

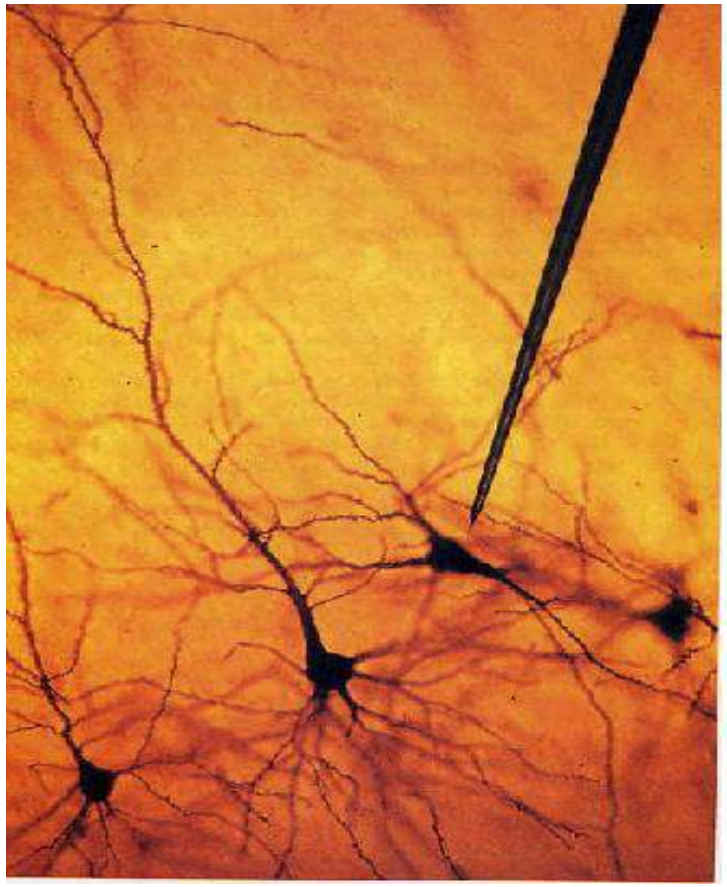
Sensing device

Interpreting device

Interpretations

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

1981: Nobel Prize in medicine

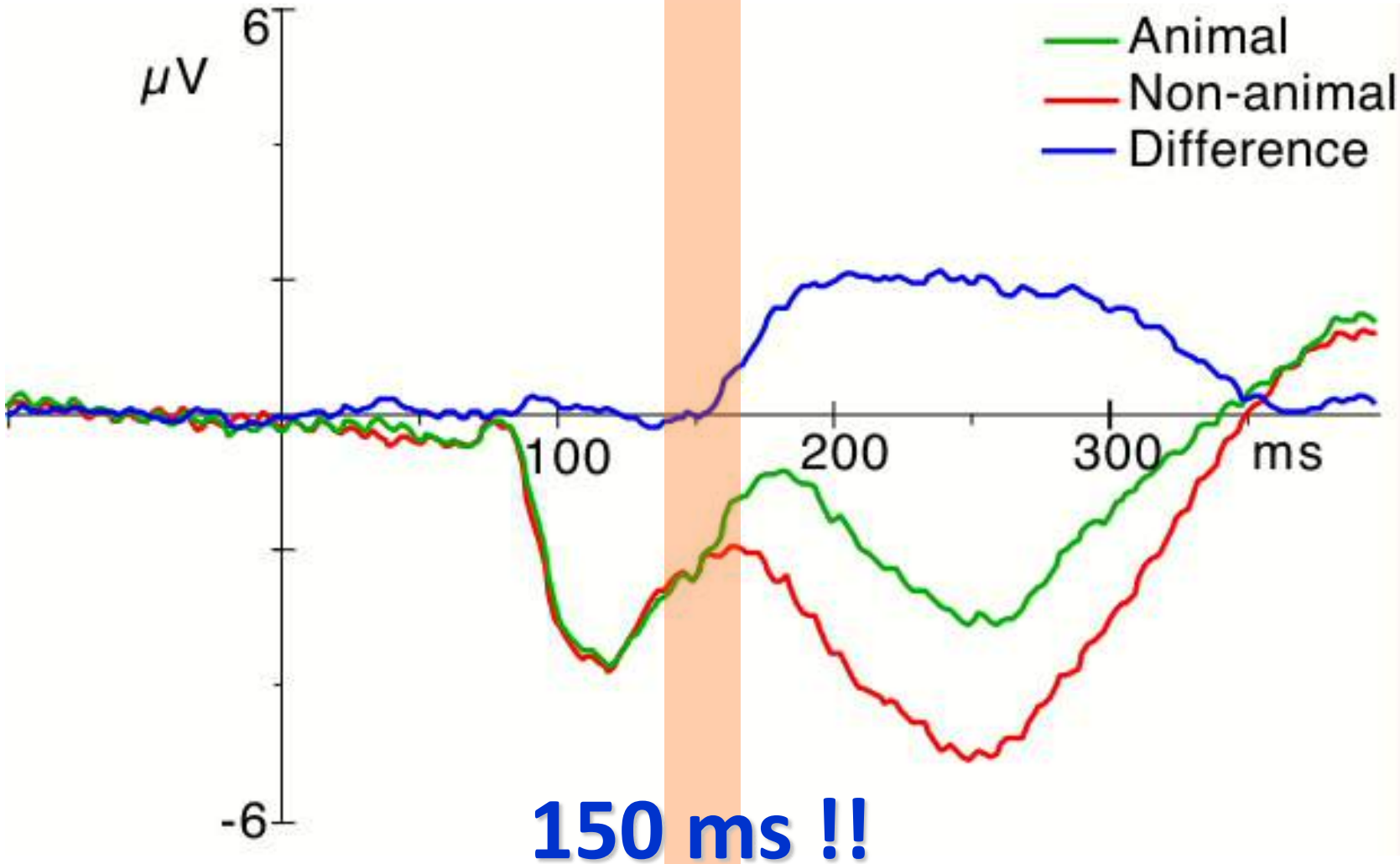


Hubel & Wiesel

Human vision is superbly efficient

Potter, Biederman, etc. 1970s

Thorpe, et al. *Nature,* 1996



150 ms !!

Thorpe, et al. *Nature,* 1996

Change Blindness

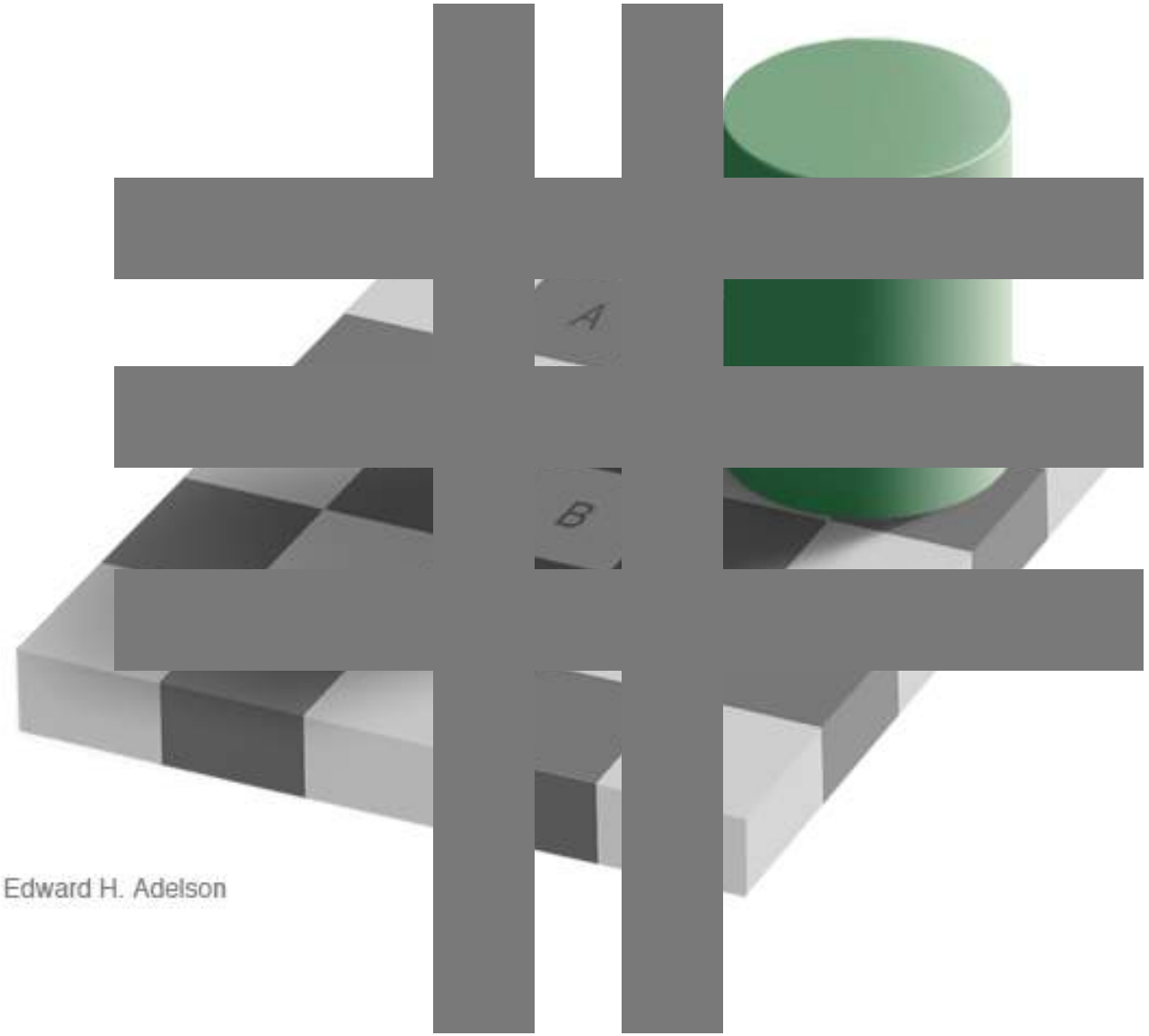
Rensink, O’regan, Simon, etc.

Change Blindness

Rensink, O’regan, Simon, etc.

Segmentation

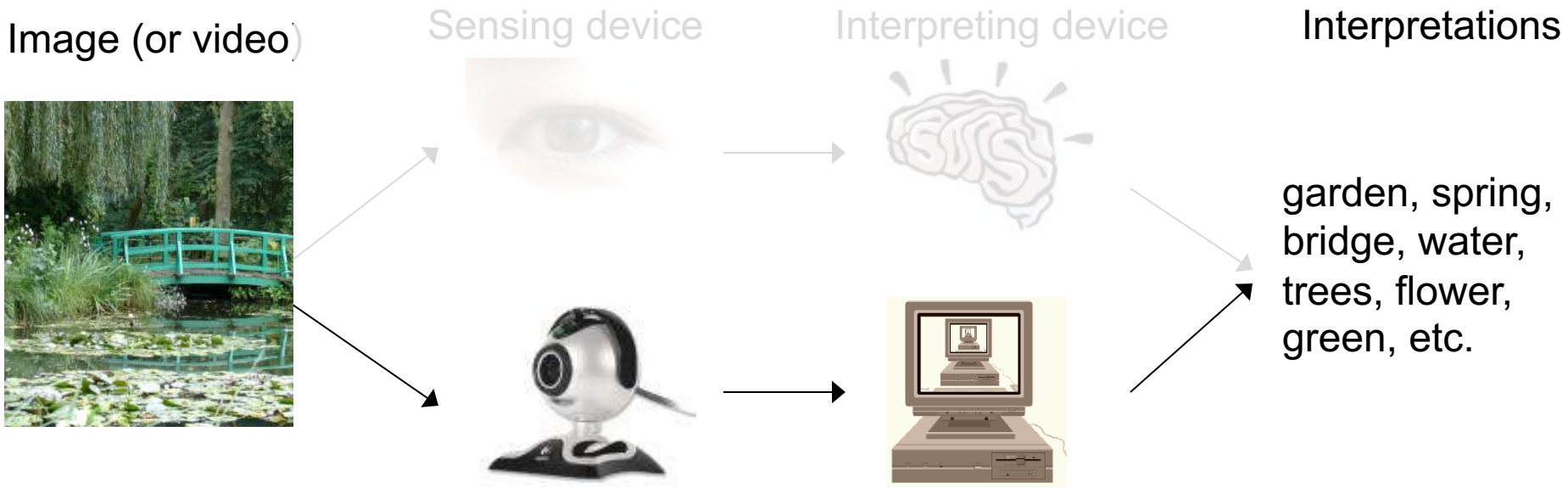
Perception



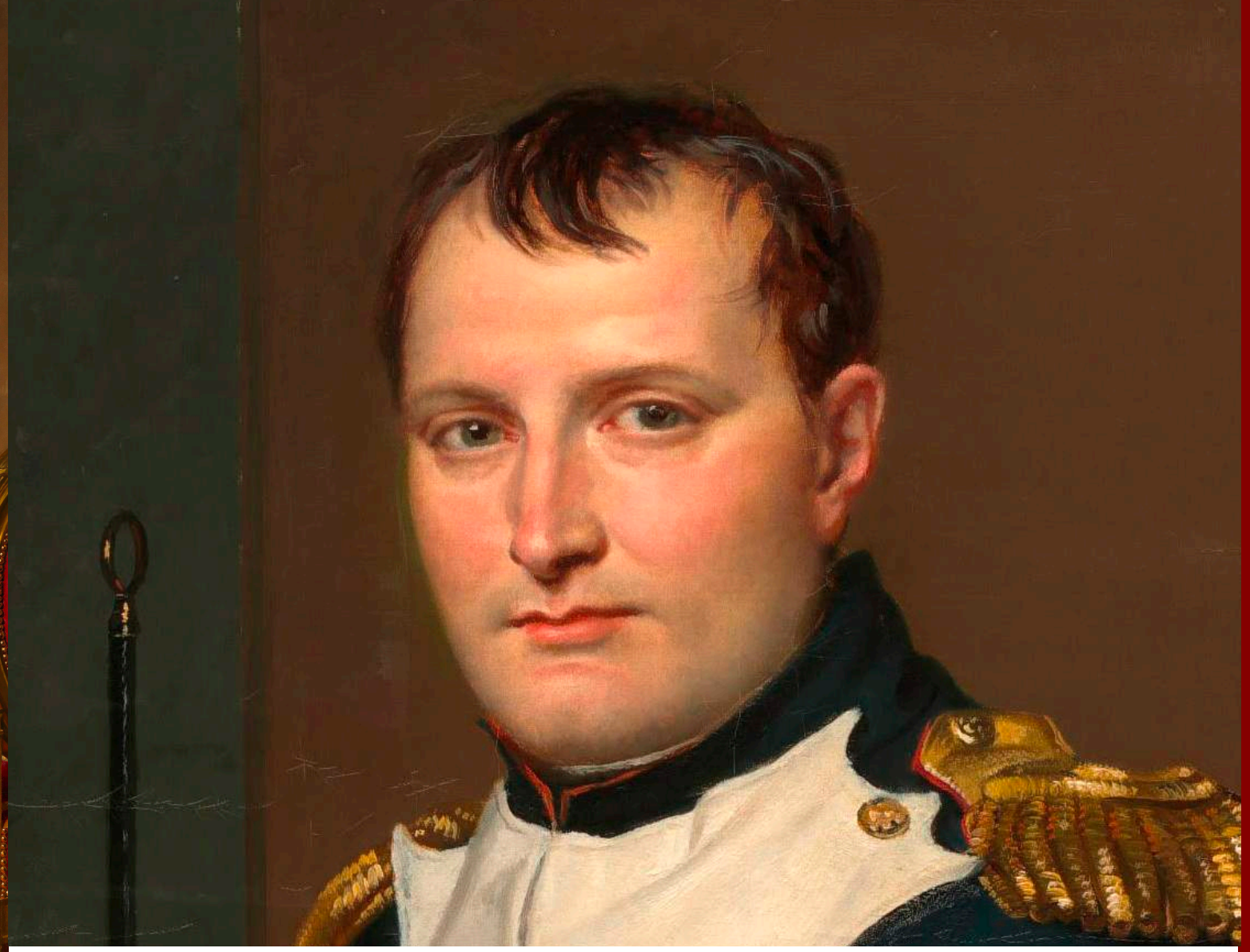
Edward H. Adelson

Motion without movement

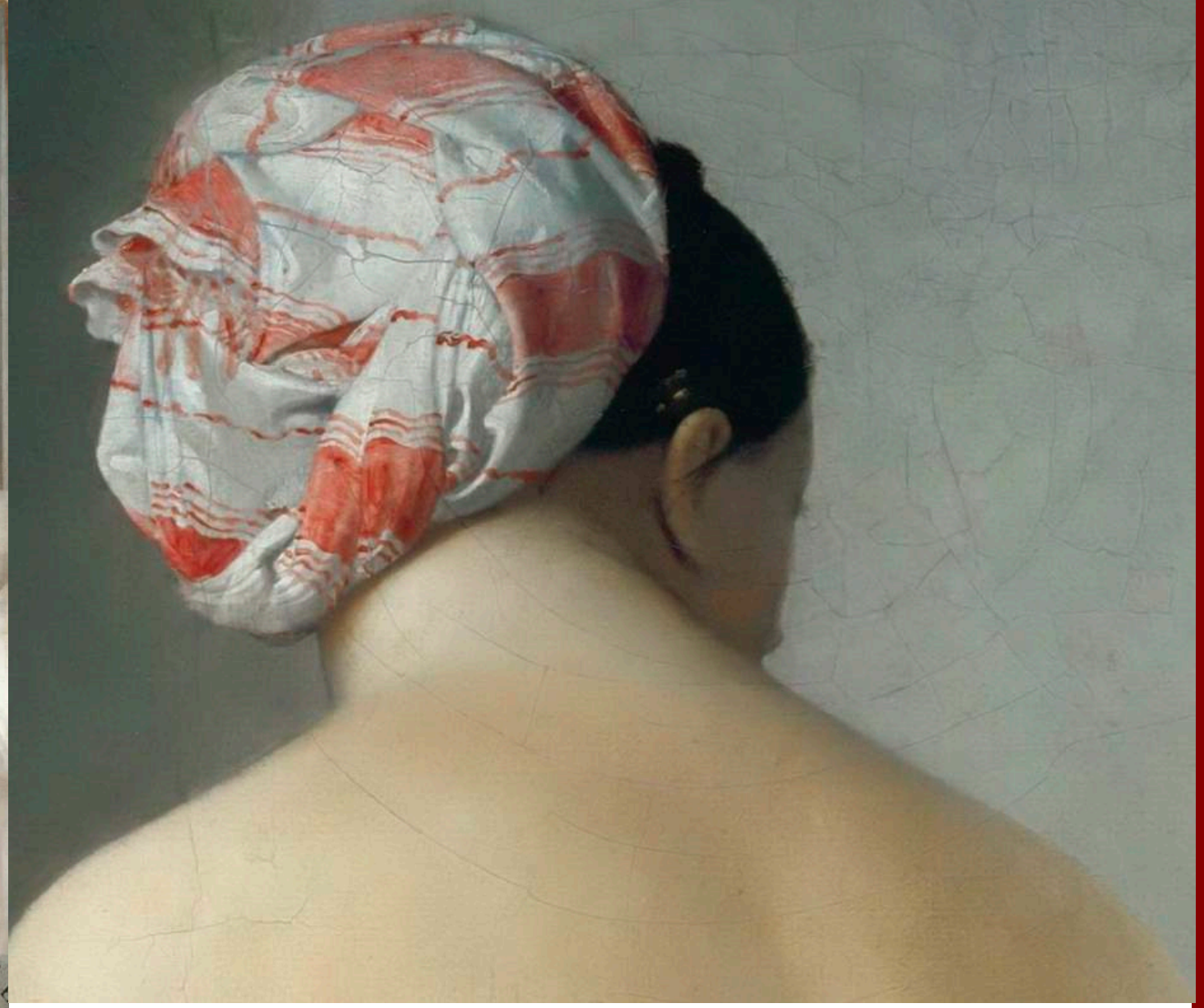
What is (computer) vision?



Paintings in 1838



1812: Jacques-Louis-David
The Emperor Napoleon at his Study at the Tuileries



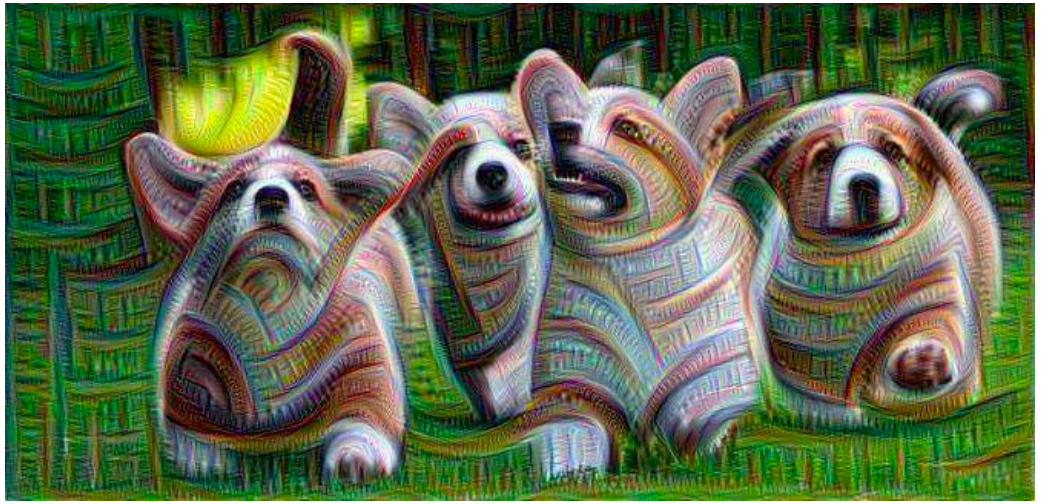
1808: Ingres, La grande baigneuse

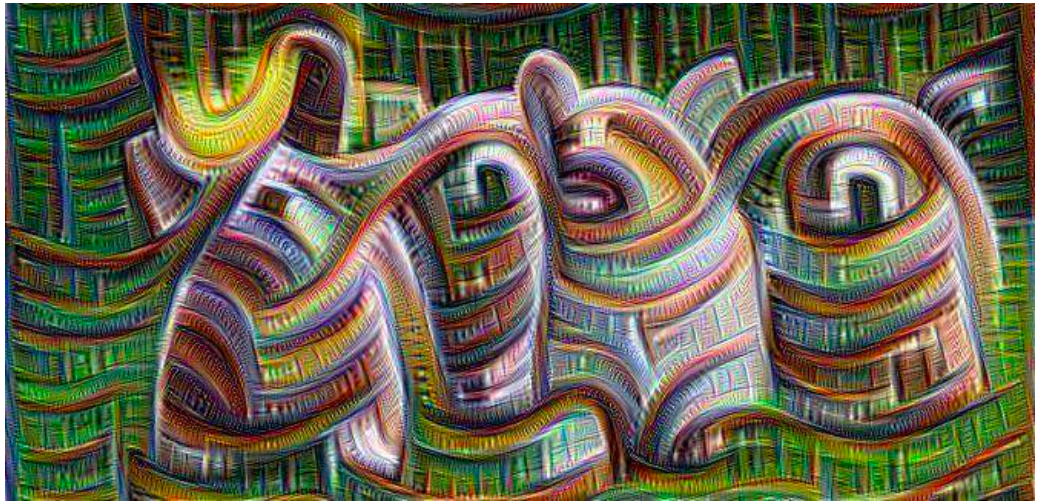
“From today, painting is dead”
— painter Paul Delaroche
at a demonstration of the Daguerreotype,
1839

1837: Niépce, First photo of one’s meal

1838: Boulevard du Temple, Daguerre

1838: First selfie, Robert Cornelius

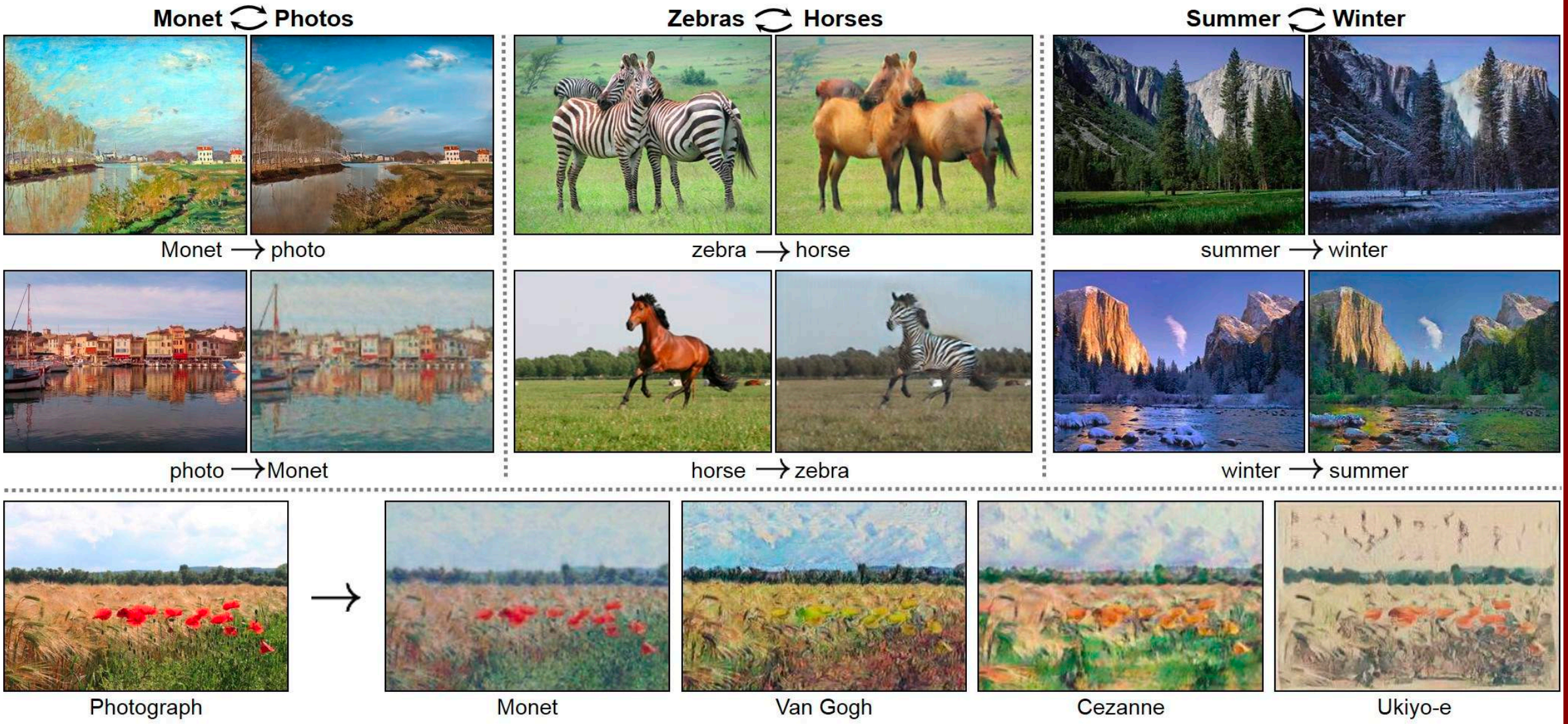




DeepDreams
[Mordvintsev et al. 2015]

Neural Style Transfer
[Gatys et al. 2015]

Neural Style Transfer
[Gatys et al. 2015]



CycleGAN [Zhu et al. 2017]

The goal of computer vision

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6	5	4	3	2	1	0	3	2
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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

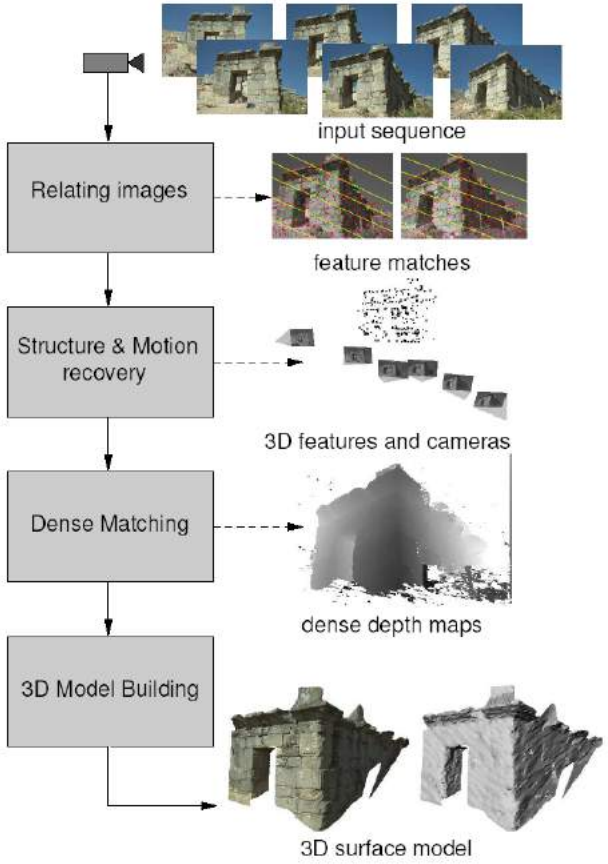
Seymour Papert

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".

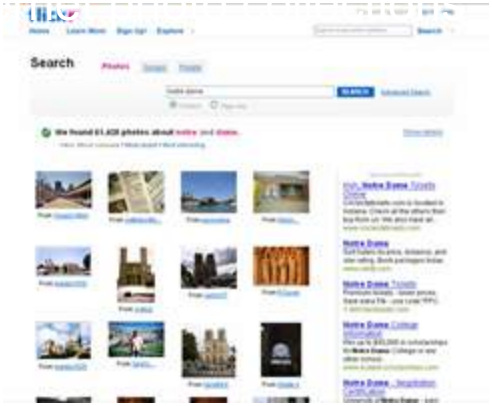
What kind of information can we extract from an image?

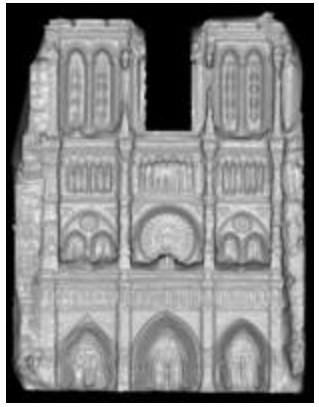
- Metric 3D information
- Semantic information

Vision as measurement device



Pollefeys et al.

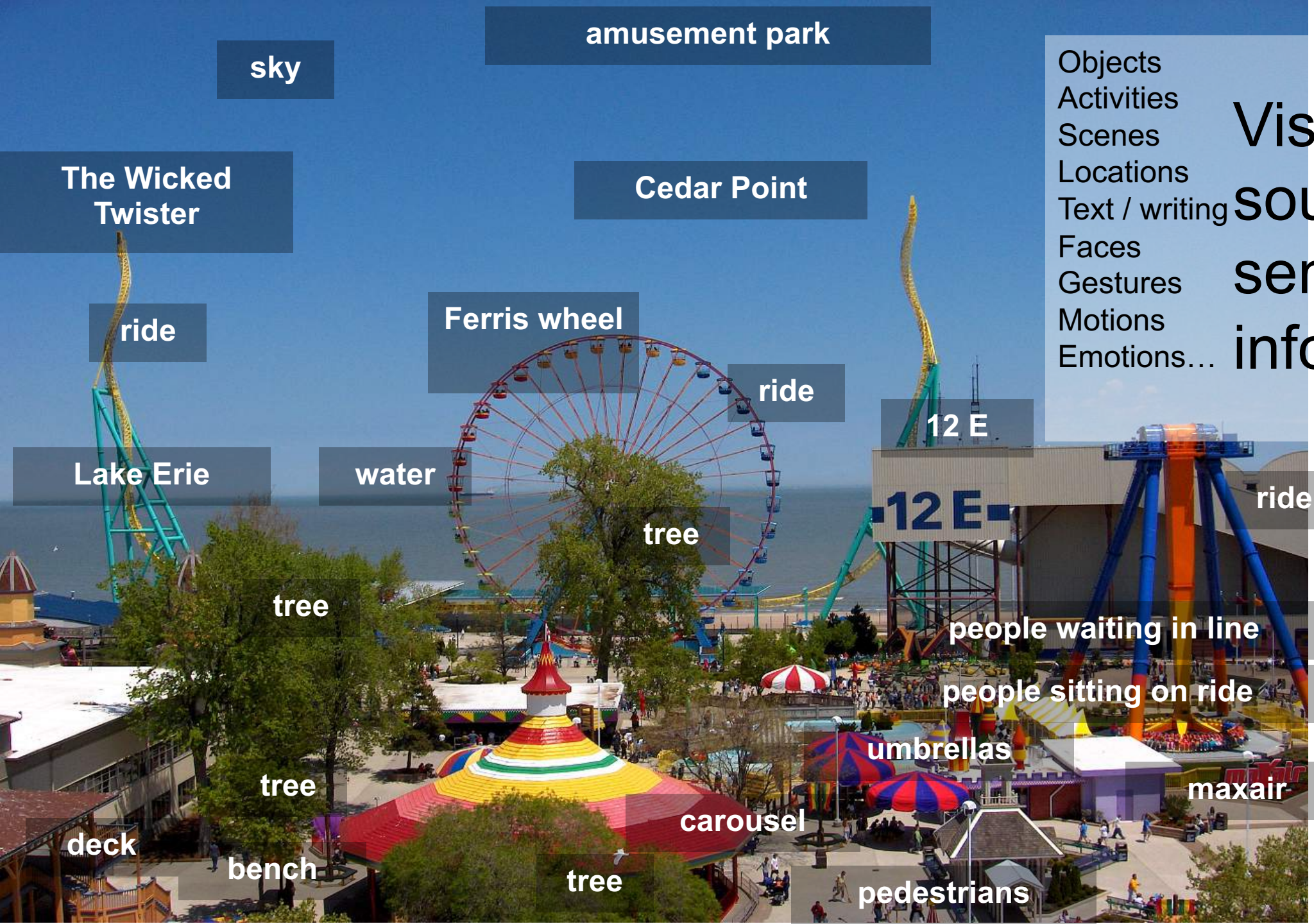




Goesele et al.

Vision as a source of semantic information

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



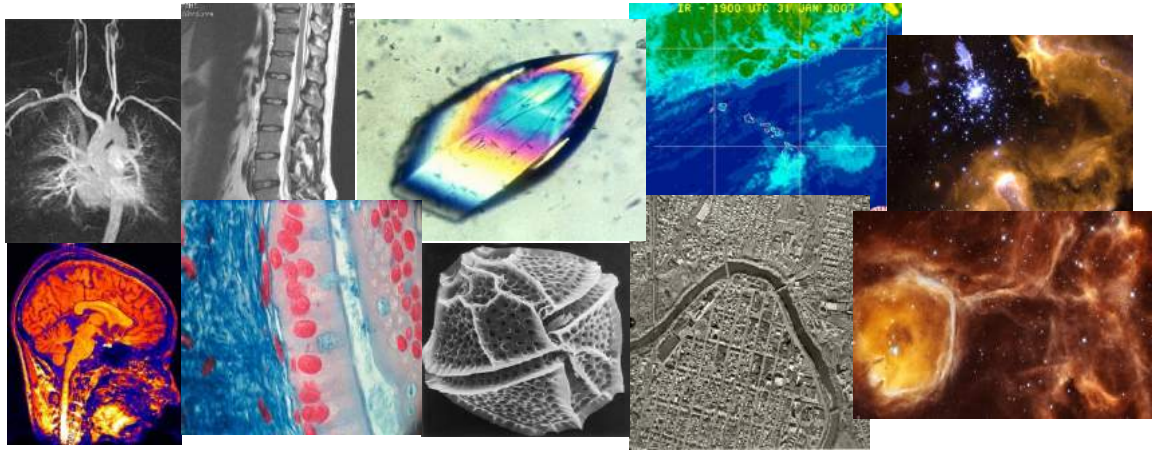
Slide credit: Kristen Grauman

Why study computer vision?

- Vision is useful: Images and video are

Google Image Search | Google Photos | flickr | webshots | picsearch | YouTube Broadcast Yourself

Surveillance and security



Medical and scientific images

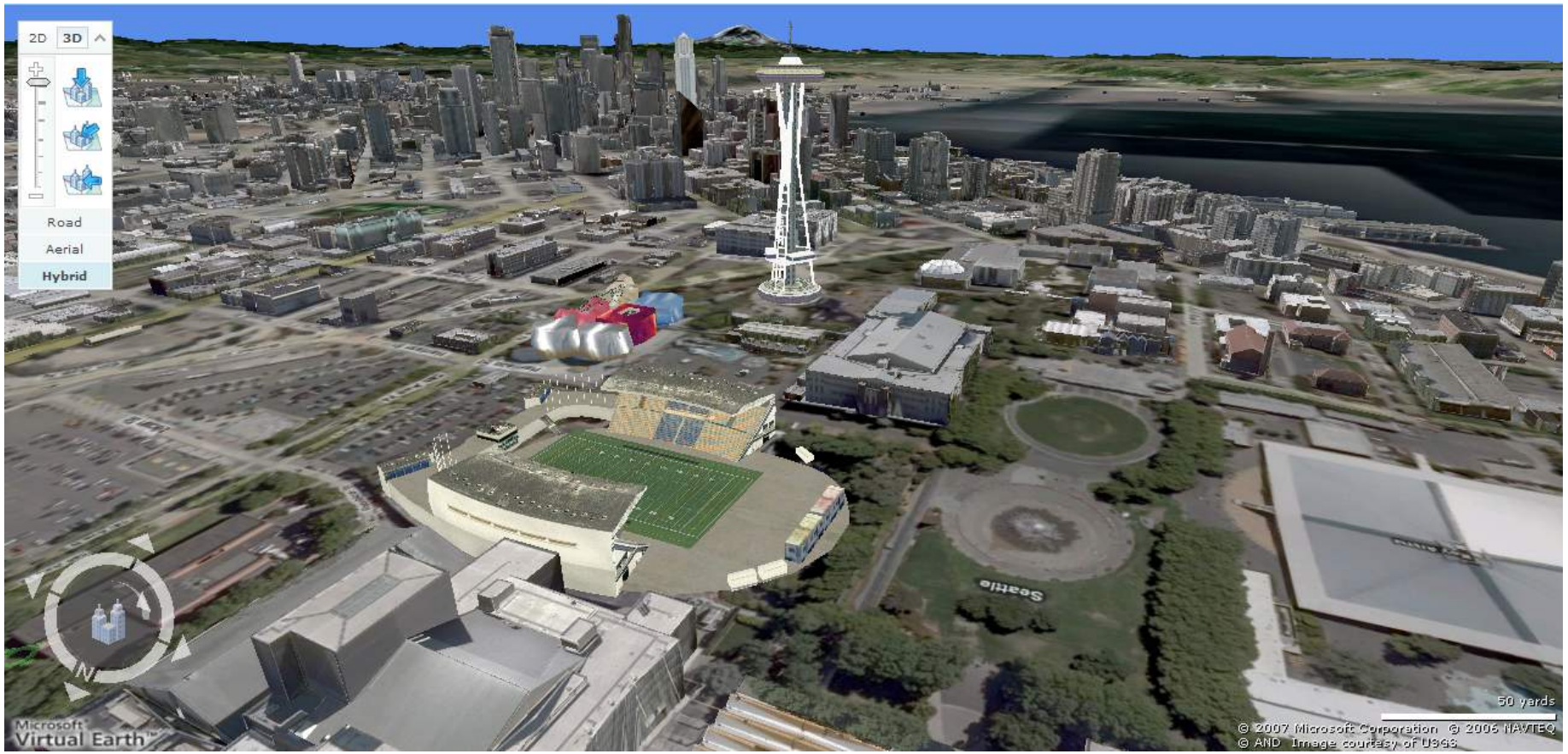
80% of all web traffic is images and videos

Majority of the internet is dark matter without computer vision

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

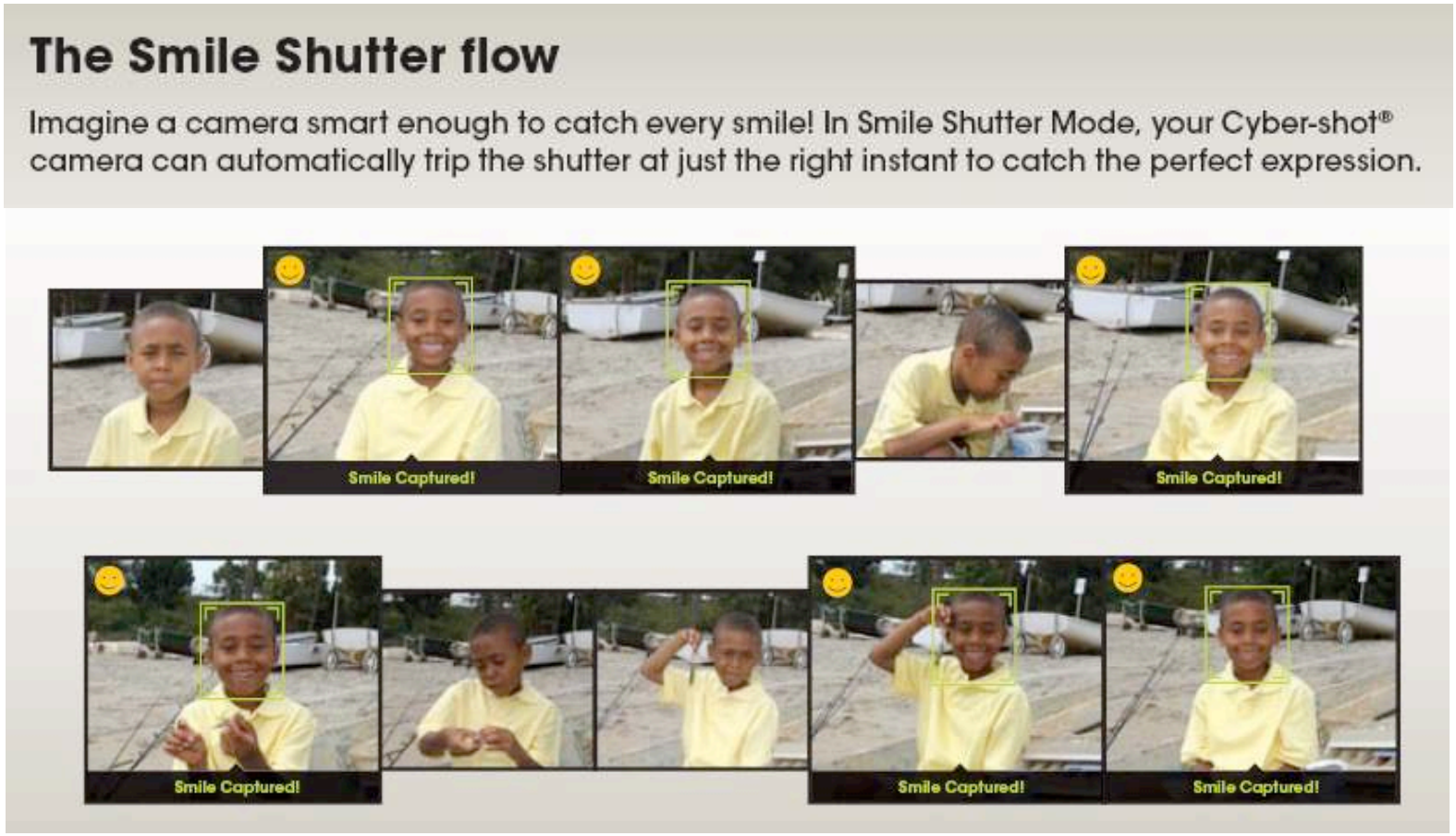
Source: S. Seitz

Face detection

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

Source: S. Seitz

Smile detection



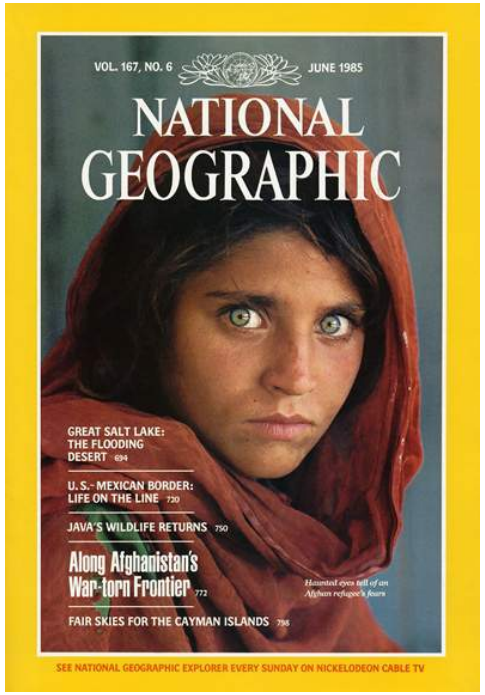
Sony Cyber-shot® T70 Digital Still Camera

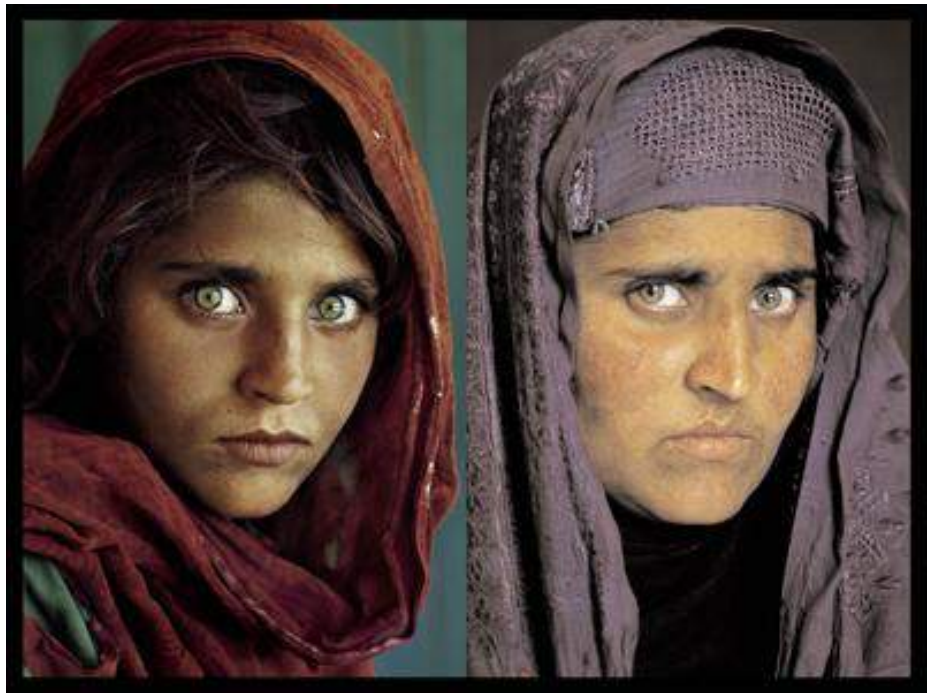
Source: S. Seitz

Face recognition: Apple iPhoto software

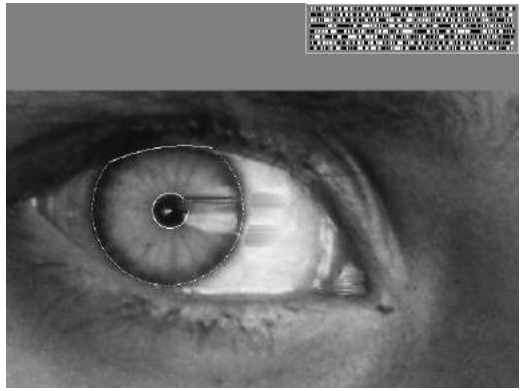
http://www.apple.com/ilife/iphoto/

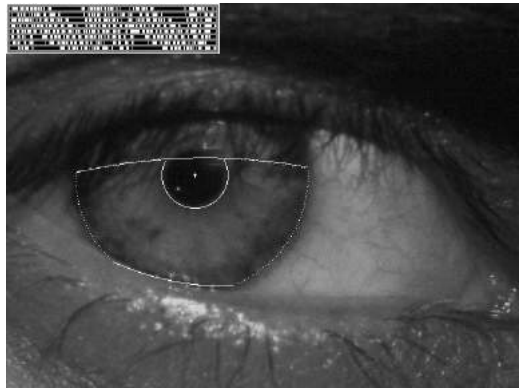
Biometrics





[How the Afghan Girl was Identified by Her Iris Patterns]

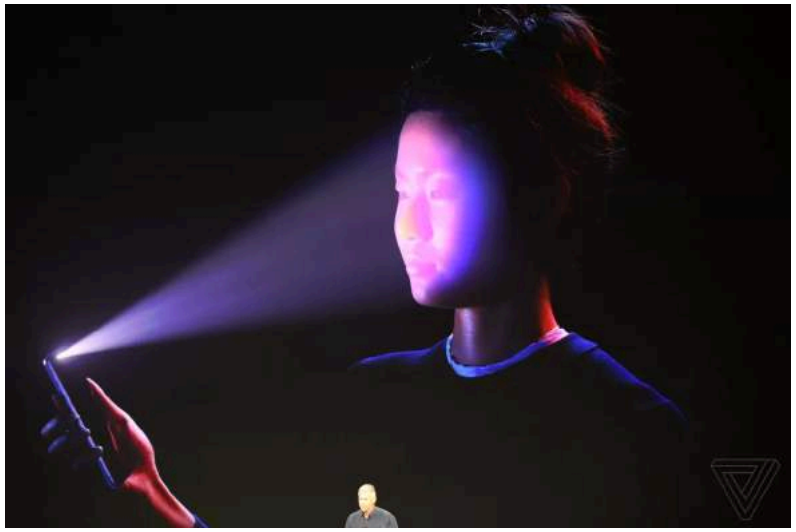




Source: S. Seitz

Biometrics

Fingerprint scanners on many new laptops, other devices



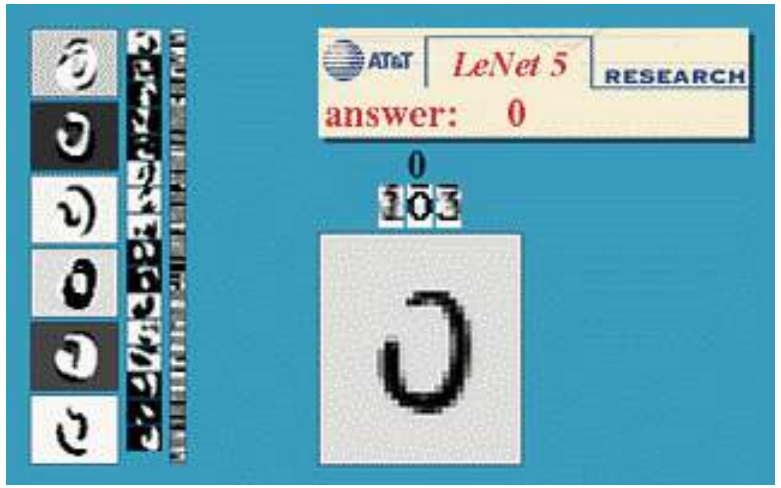
Face recognition systems now beginning to appear more widely

iphone X just introduced face recognition

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

Google maps: Annotate all houses and streets

Avenue des Sapins

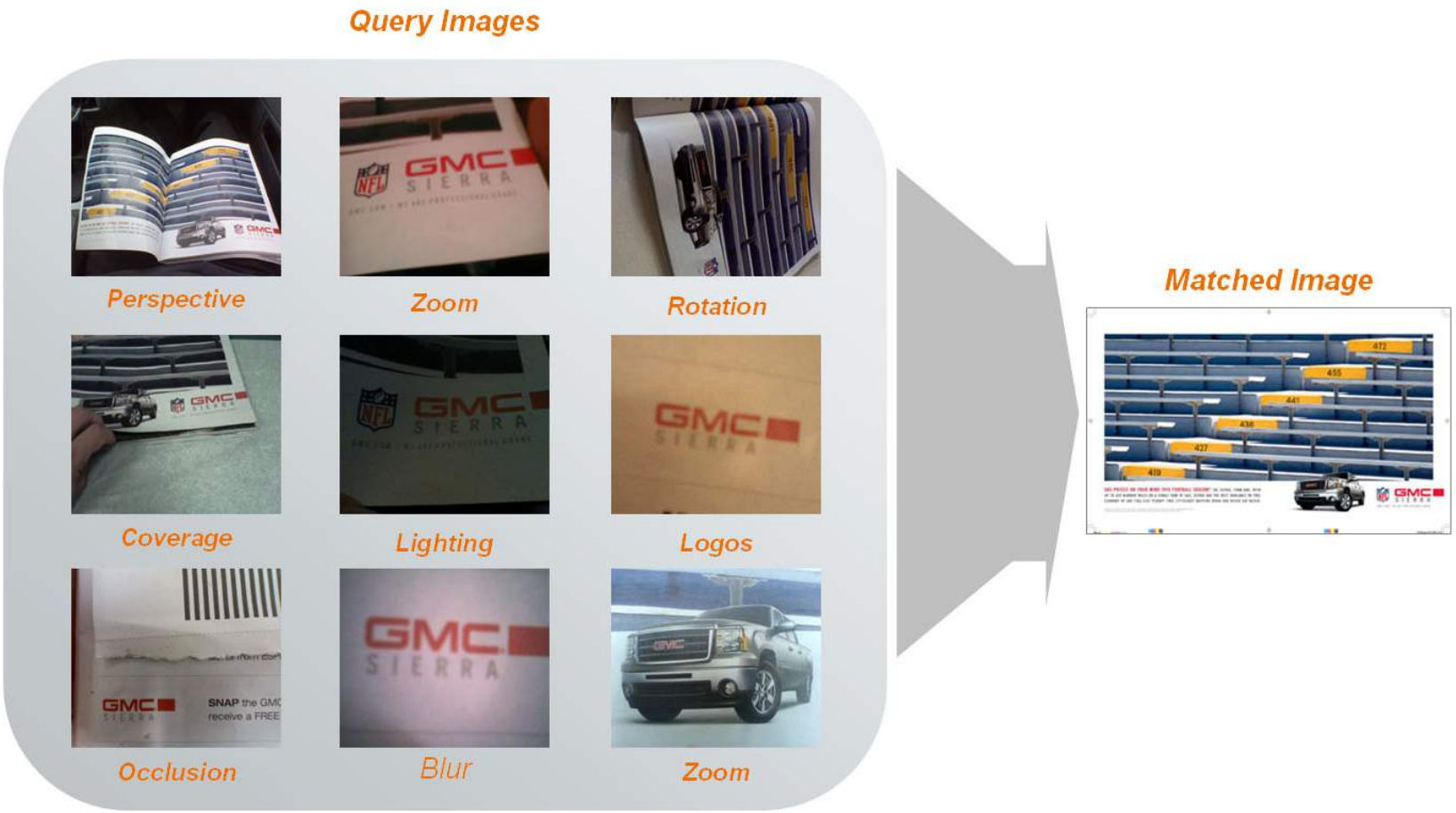
Goodfellow et al. 2014

Toys and Robots

Mobile visual search: iPhone Apps

snaptell

kooaba



syte

Solutions Marketplace Pricing Resources Case Studies Company

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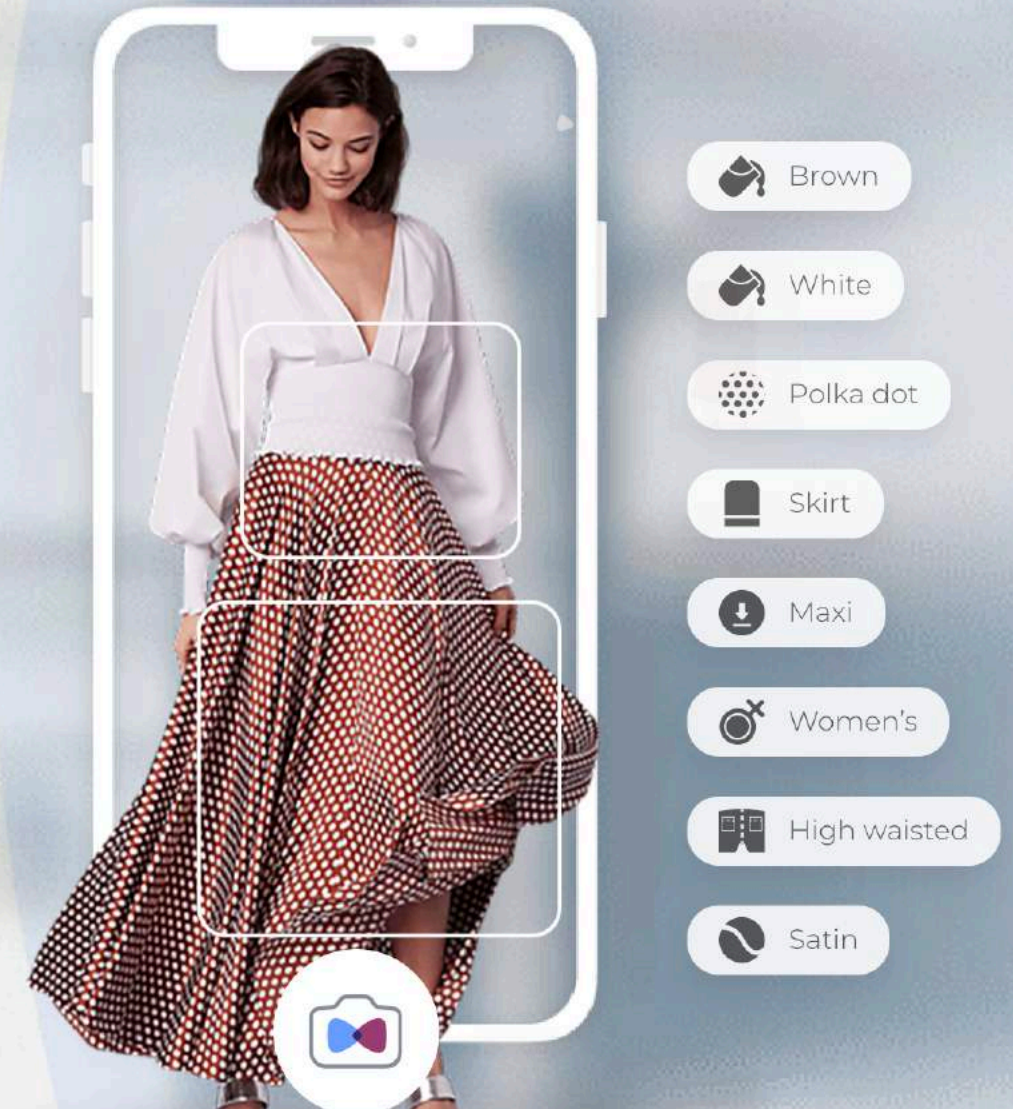
The Leader in Visual AI for Retail

Syte changes the way retailers connect shoppers with the products that inspire them by delivering the best Visual AI technology for retail. Discover our solutions that empower retailers to increase customer engagement, and boost conversion and sales.

Enter Business Email | See Syte in Action! | Watch Video

TOMMY HILFIGER FARFETCH bon prix SHOPSTYLE



Snapstacles and Google glasses

- That's Ranjay in undergrad ->

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

Amazon Go

Vision-based interaction (and games)

Microsoft's Kinect

Sony EyeToy

Assistive technologies

Source: S. Seitz

Augmented Reality

Virtual Reality

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

Machine Bias

There's software used across the country to predict future criminals. And it's biased against blacks.

MGMT, "When You Die"