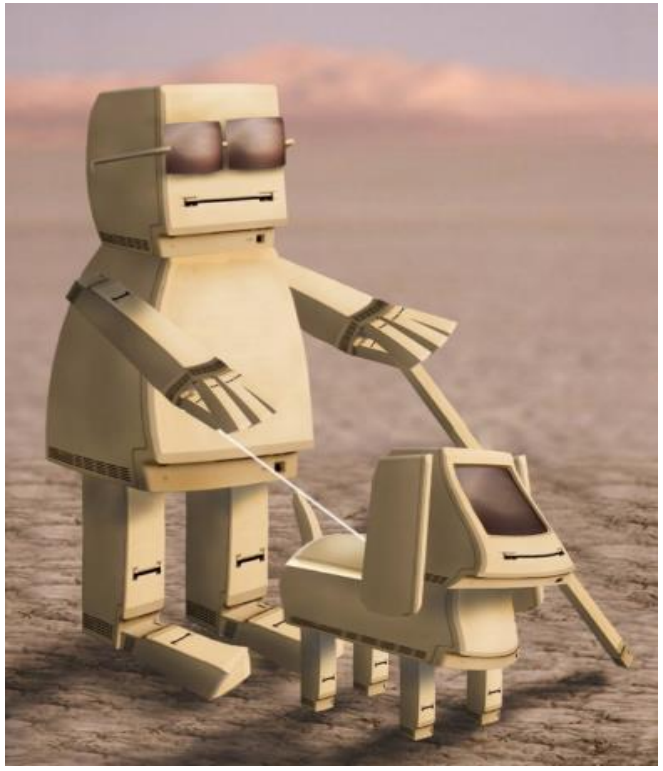
EBU7240
Computer Vision
- Introduction -

Semester 1, 2021

Changjae Oh

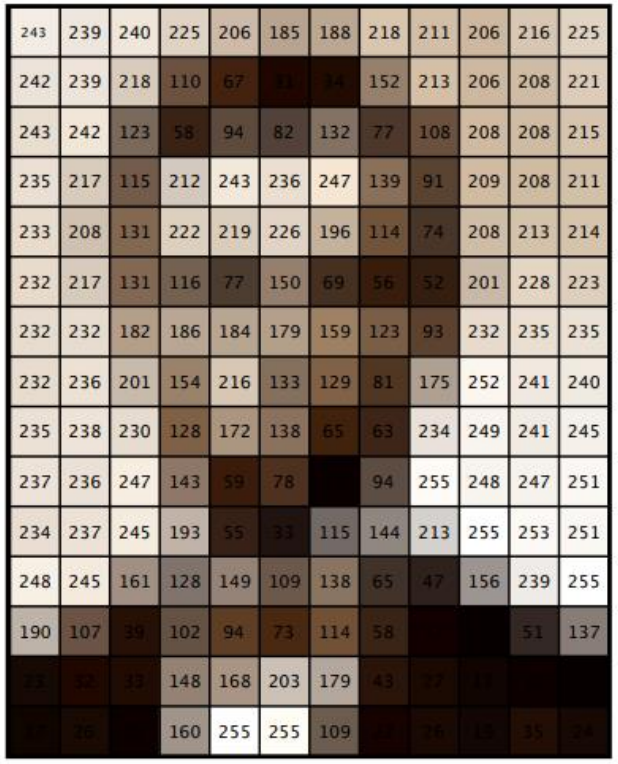
What is coming?

What is missing?



Machines are blind

243	239	240	225	206	185	188	218	211	206	216	225
242	239	218	110	67	31	34	152	213	206	208	221
243	242	123	58	94	82	132	77	108	208	208	215
235	217	115	212	243	236	247	139	91	209	208	211
233	208	131	222	219	226	196	114	74	208	213	214
232	217	131	116	77	150	69	56	52	201	228	223
232	232	182	186	184	179	159	123	93	232	235	235
232	236	201	154	216	133	129	81	175	252	241	240
235	238	230	128	172	138	65	63	234	249	241	245
237	236	247	143	59	78	10	94	255	248	247	251
234	237	245	193	55	33	115	144	213	255	253	251
248	245	161	128	149	109	138	65	47	156	239	255
190	107	39	102	94	73	114	58	17	7	51	137
23	32	33	148	168	203	179	43	27	17	12	8
17	26	12	160	255	255	109	22	26	19	35	24



Machine vs Human

Computer Vision in Four Words?

Making computers understand images

How simple is that?

华人民共和国万岁
世界人民大团结万

Computer Vision in Four Words?

:: Making computers understand images

- How many **people** are here?
- Who is a **person in the portrait**?
- What is this **building**?
- How is the **weather**?
- Where is **this city**?
- What is **written**?
- Is there any **gate**?

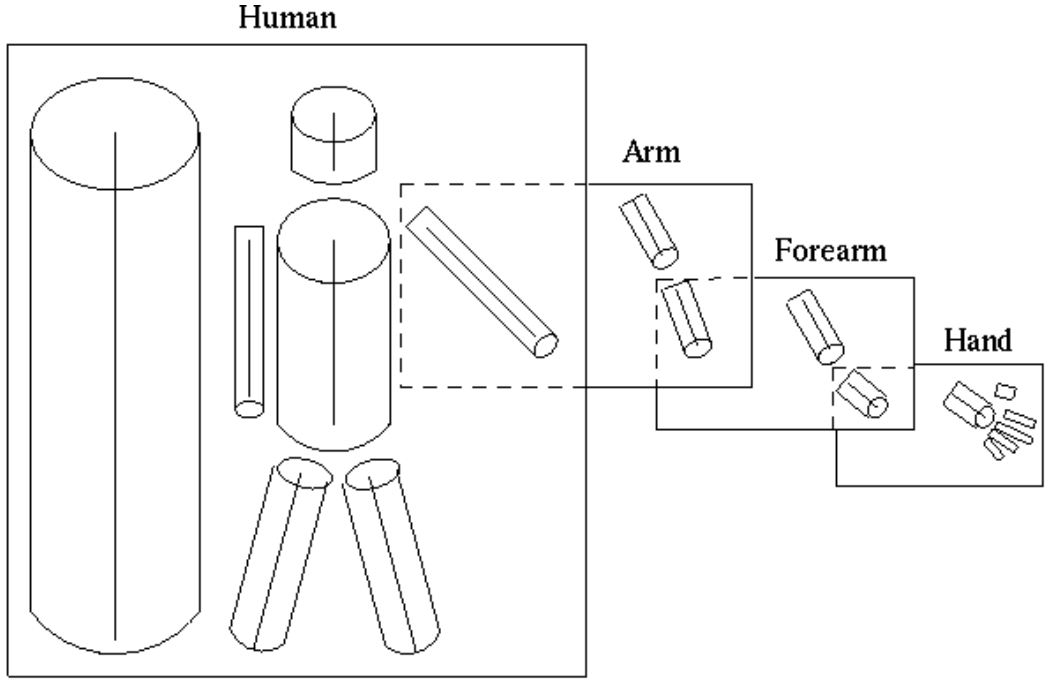
Computer Vision in Four Words?

:: Making computers understand images

- How many **people** are here? → **Object detection**
- Who is a **person in the portrait**? → **Face detection/recognition**
- What is this **building**? → **Object recognition**
- How is the **weather**? → **Scene recognition**
- Where is **this city**? → **Place recognition**
- What is **written**? → **Character recognition**
- Is there any **gate**? → **Object detection**

What is vision?

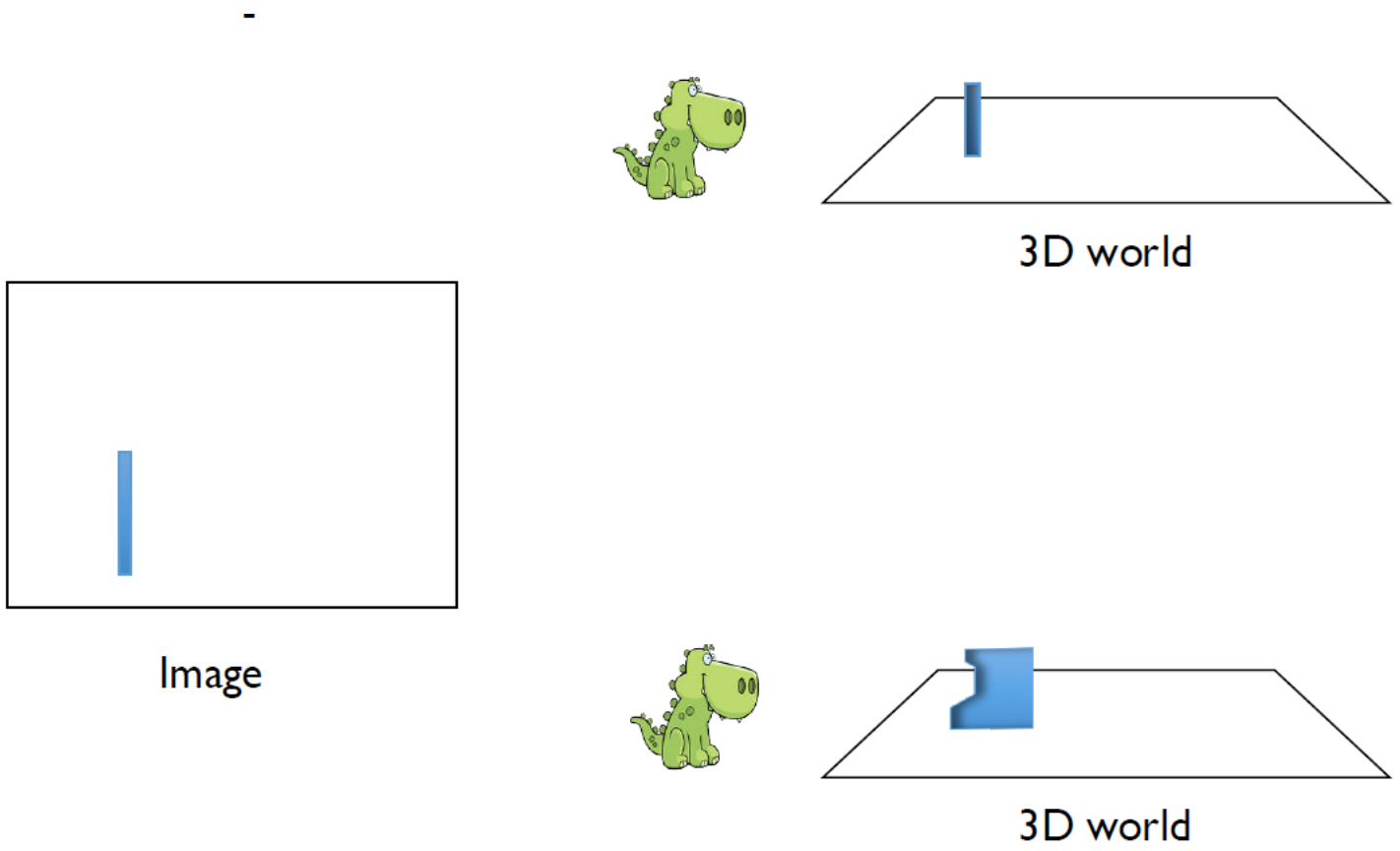
- What does it mean, to see? "*to know what is where by looking*".
- How to discover from images what is present in the world, where things are, what actio ns are taking place.
- "Vision can be understood as an information processing task which converts a numerical image representation into a symbolic shape-oriented representation."



Credit: Marr, 1982

Why is vision so hard?

- 3D: Viewpoint

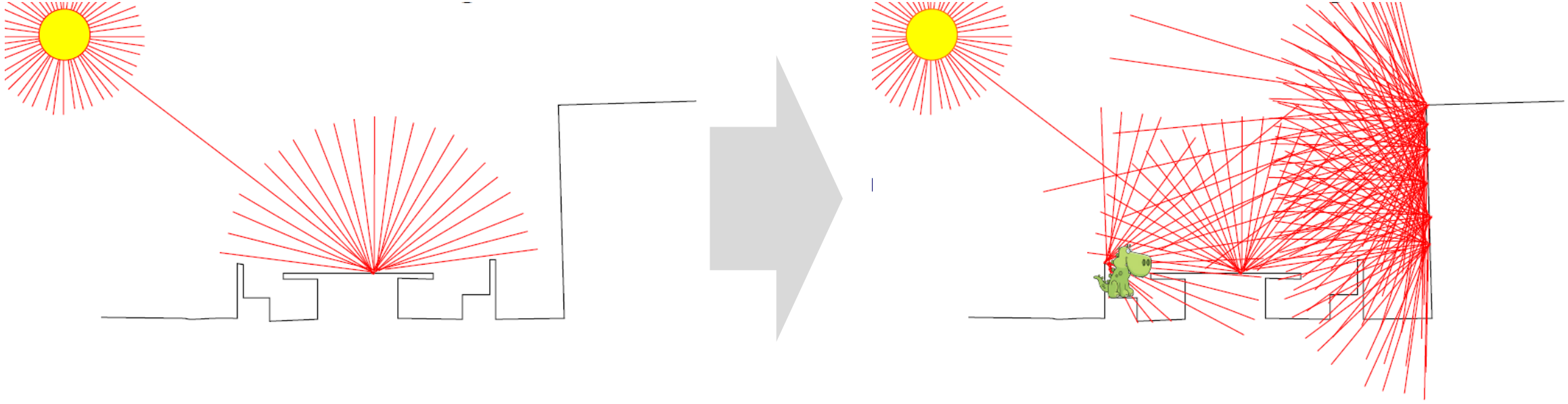


Why is vision so hard?

- 3D: Viewpoint

Why is vision so hard?

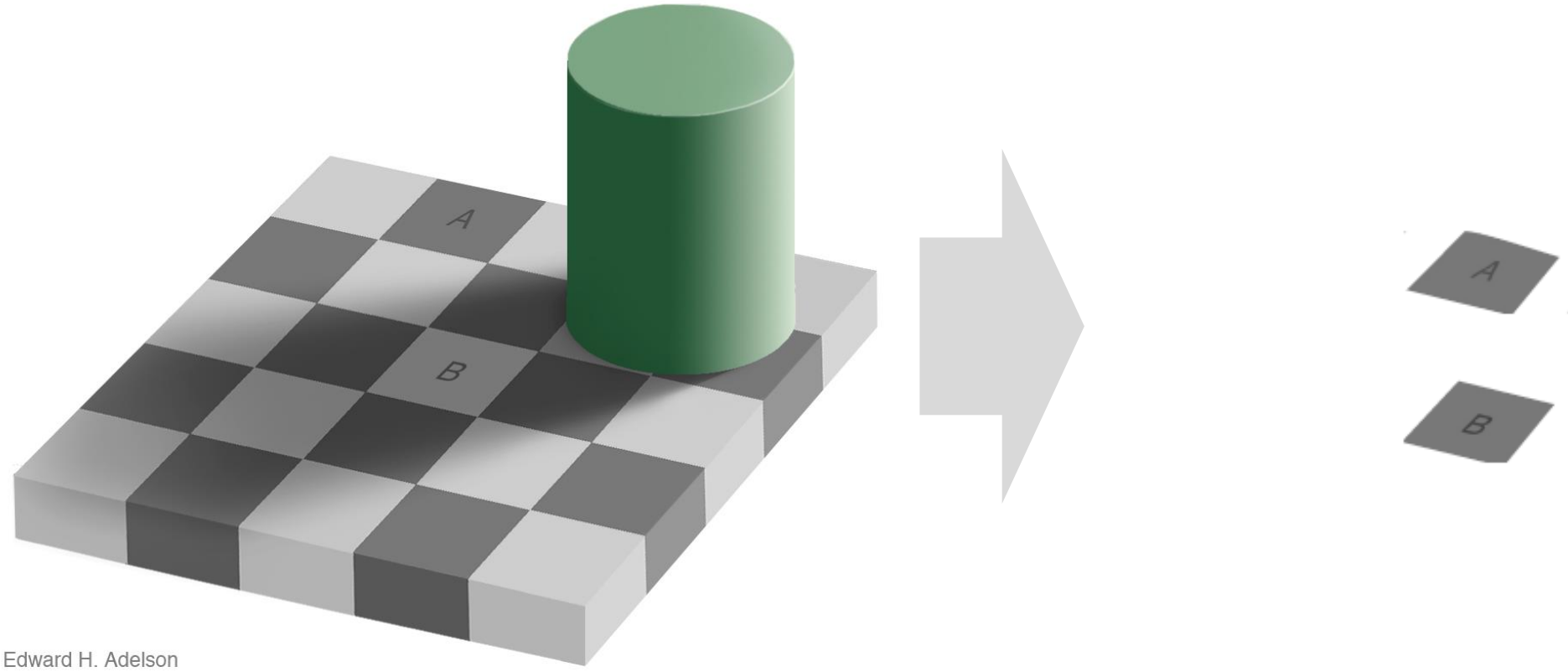
- Light



Credit: A. Torralba

Why is vision so hard?

- **Shadow**

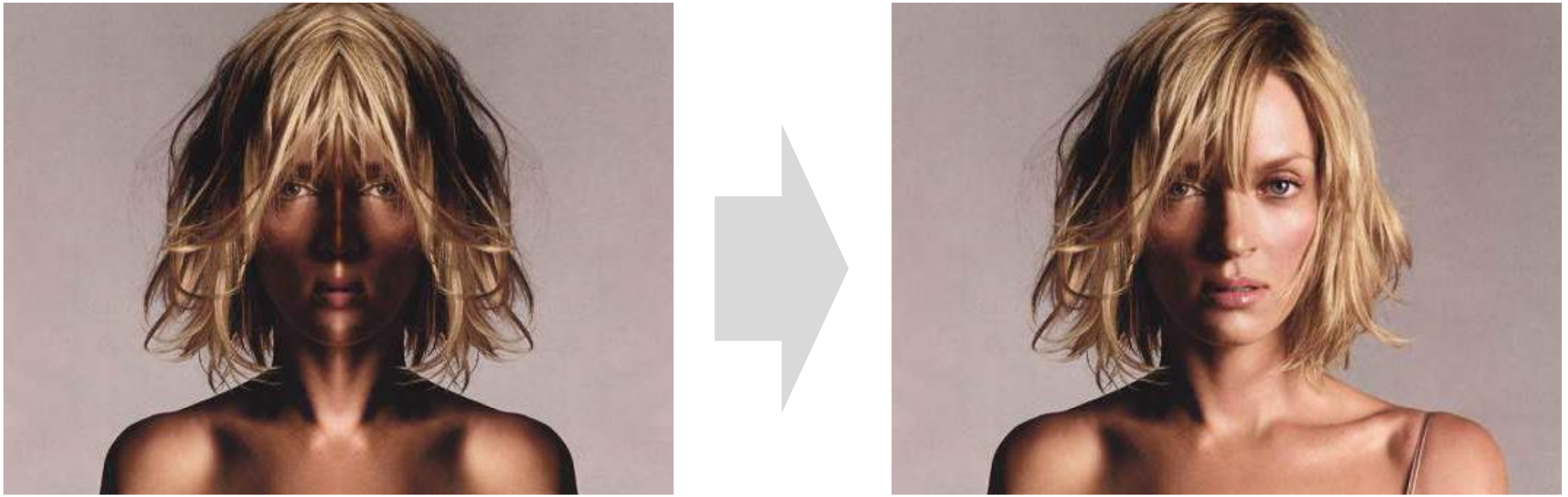


Edward H. Adelson

Credit: A. Torralba

Why is vision so hard?

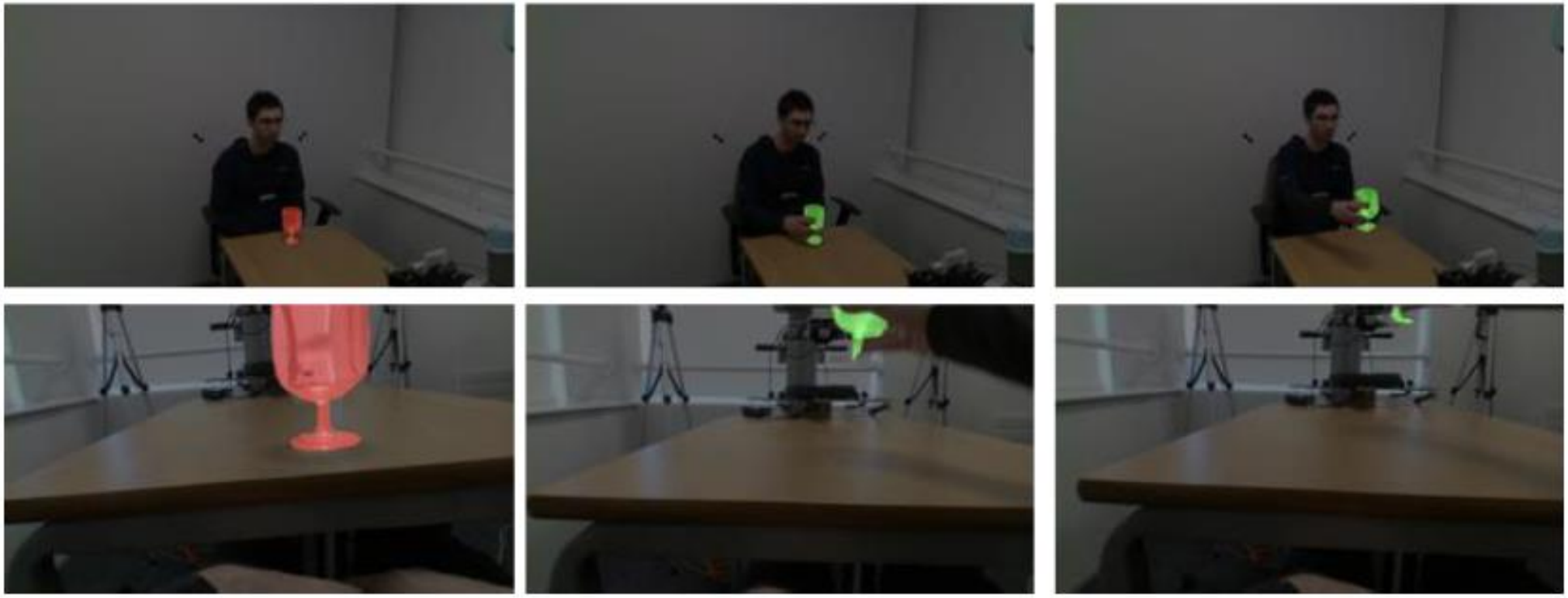
- **Shadow**



Credit: Mike Webster

Why is vision so hard?

- Transparent objects



Credit: Hengyi Wang (JP Final project 2021)
http://corsmal.eecs.qmul.ac.uk/

Why is vision so hard?

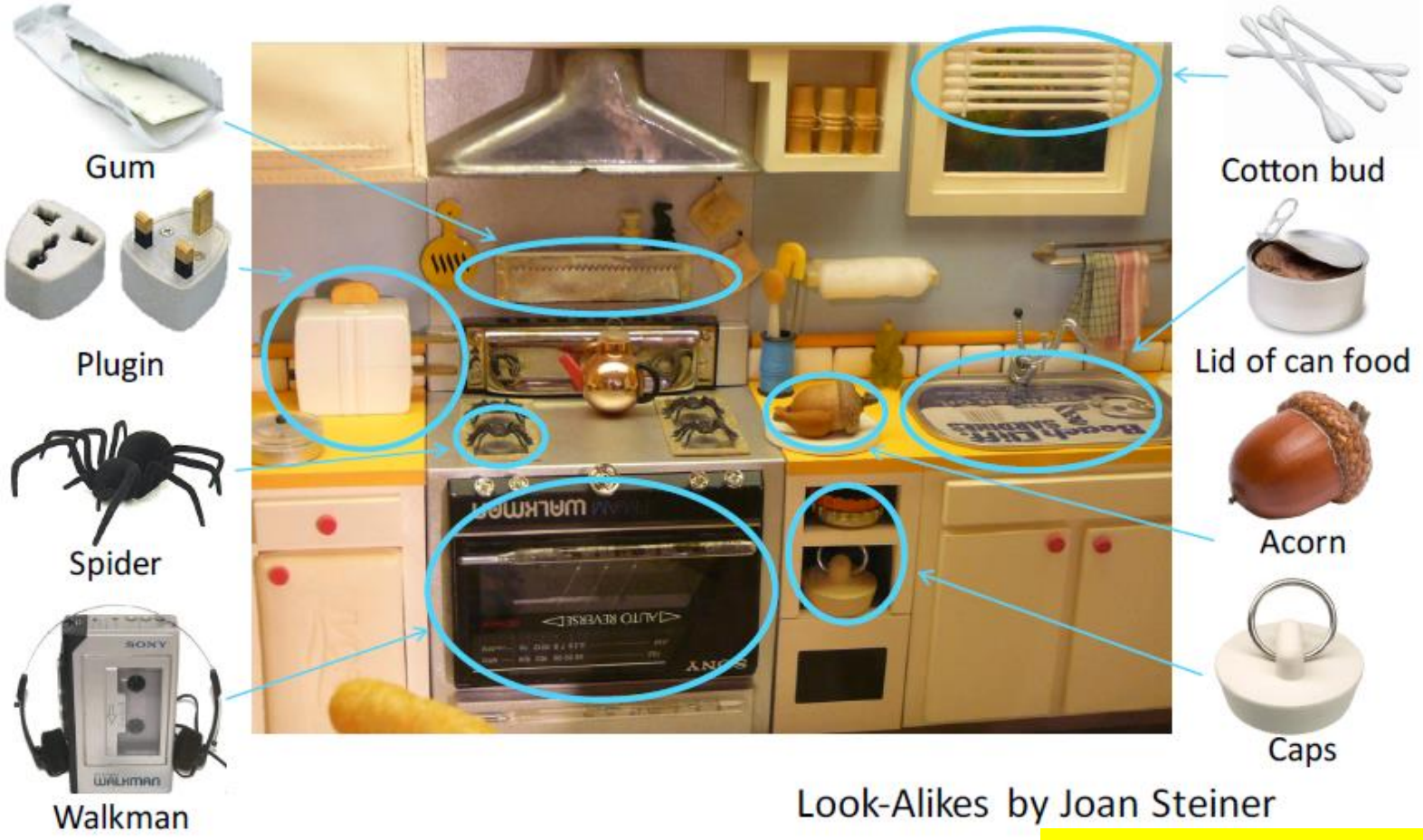
- What is this object?

Why is vision so hard?

- What is this object?

Why is vision so hard?

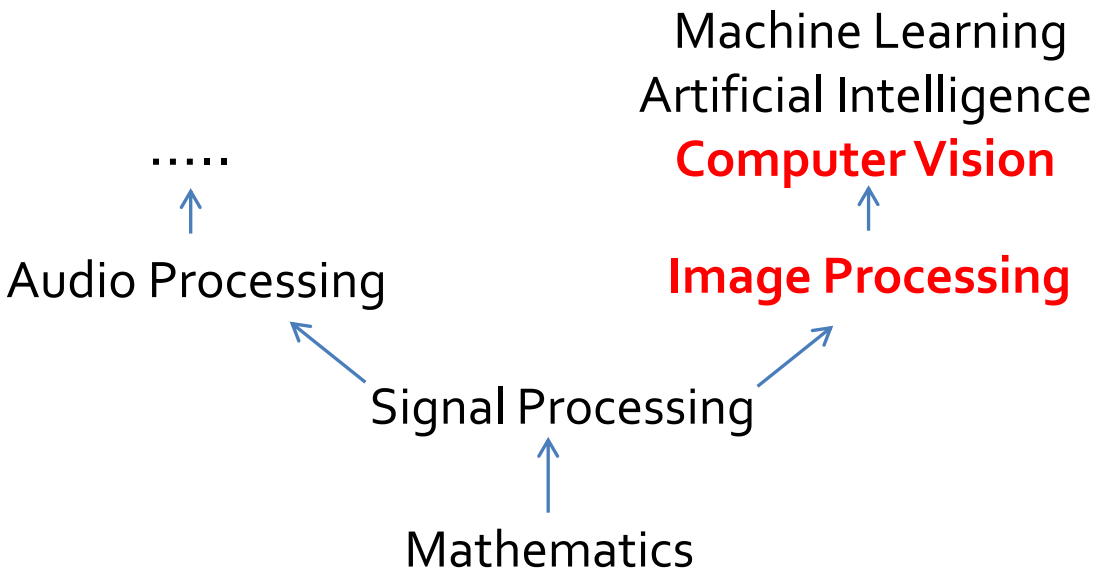
- What is this object?



It is not just about pixels!

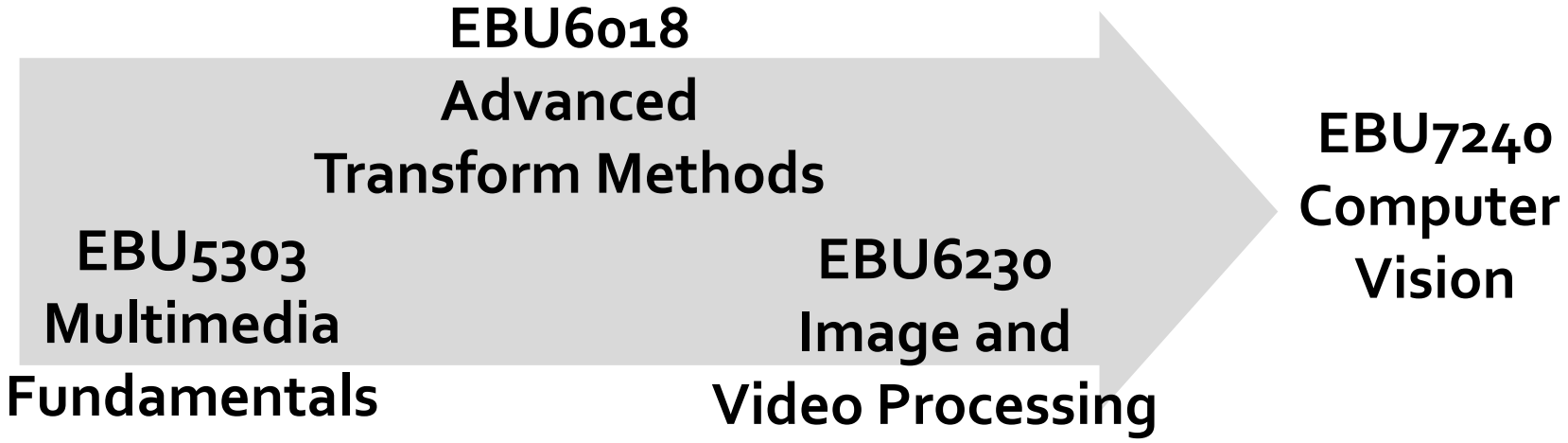
Computer Vision and Image Processing?

- **Computer Vision begins with Image Processing!**



- **Computer Vision**: techniques for enabling a computer to see a real-world using **images** as the human being does.
- **Image Processing**: fundamental techniques for image acquisition, processing, analysis

Computer Vision and EBUxxxx?



Computer Vision: Low-level Vision

Low-level vision

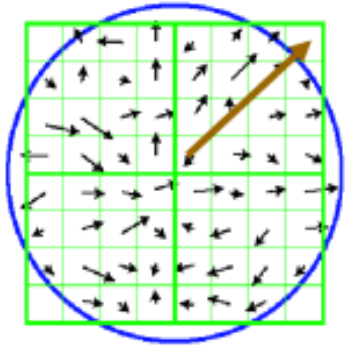
- Enhancement
- Restoration
- Filtering
- Feature extraction

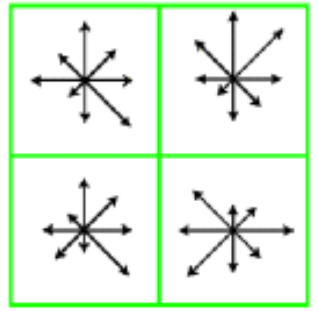
Mid-level vision

- Fitting
- Grouping
- 3D geometry
- 3D reconstruction
- Tracking

High-level vision

- Classification
- Detection
- Tracking
- Action & Pose





Computer Vision: Mid-level Vision

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- Enhancement
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Mid-level vision

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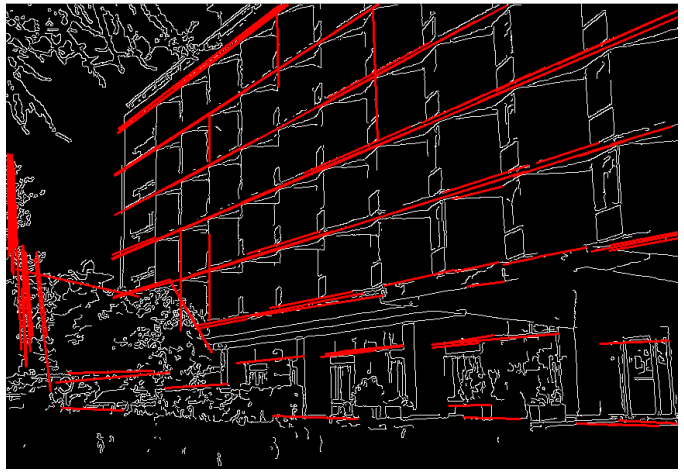
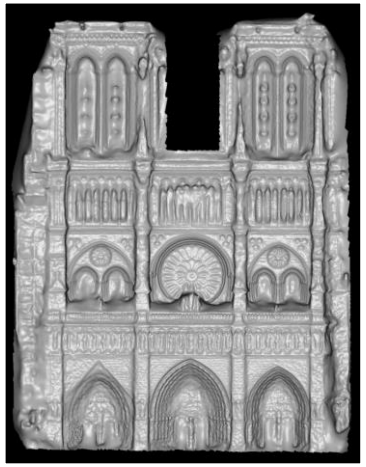
- Tracking

High-level vision

- Classification
- Detection
- Tracking
- Action & Pose





Computer Vision: High-level Vision

Low-level vision

- Enhancement
- Restoration
- Filtering
- Feature extraction

Mid-level vision

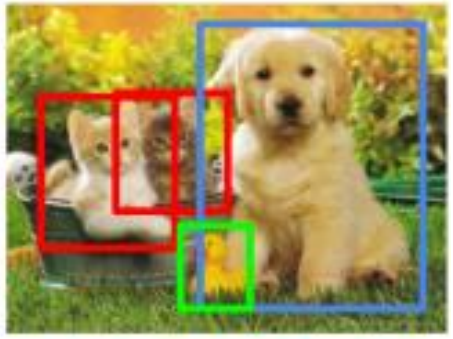
- Fitting
- Grouping
- 3D geometry
- 3D reconstruction
- Tracking

High-level vision

- Classification
- Detection
- Tracking
- Action & Pose

CAT

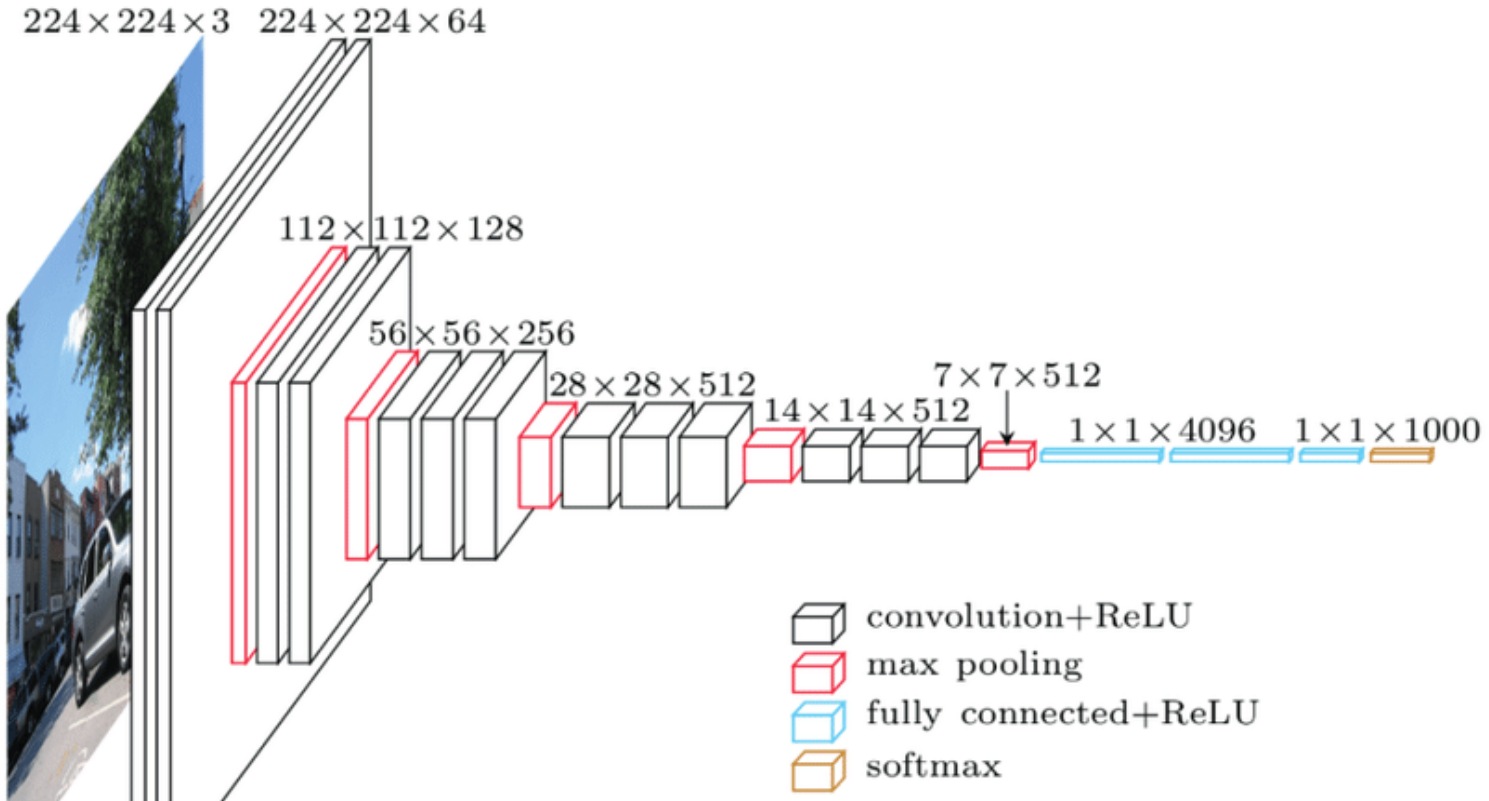
CAT



CAT, DOG, DUCK

Computer Vision: Deep learning approach

- **Multiple levels of (learned) representation**



EBU7240

Computer Vision

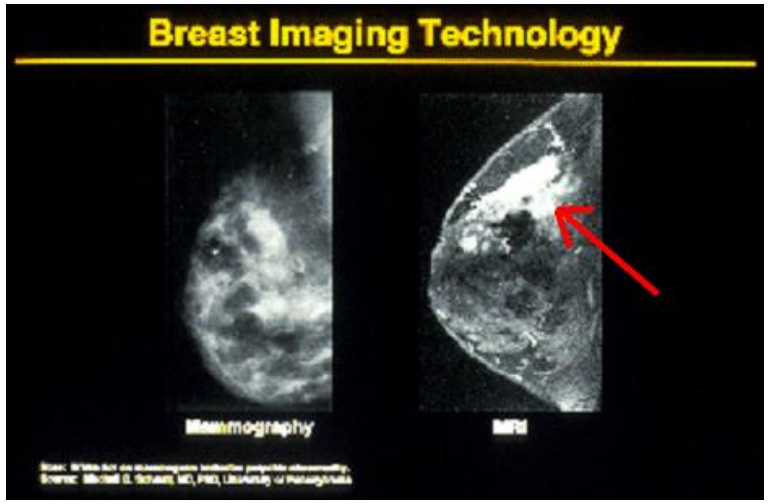
- Applications -

Semester 1, 2020

Changjae Oh

Why computer vision matters?

Safety

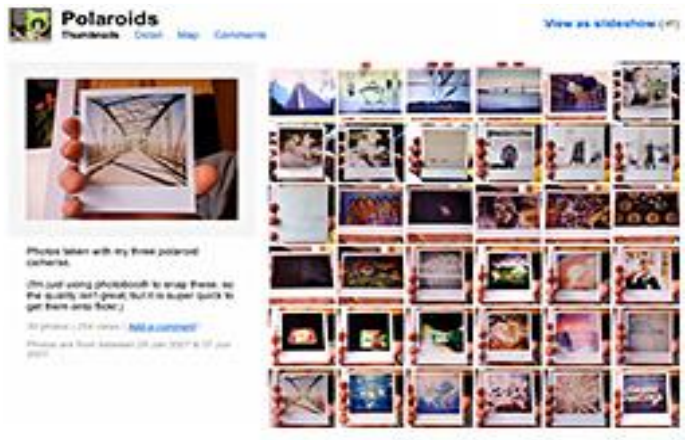


Health

Security

Comfort

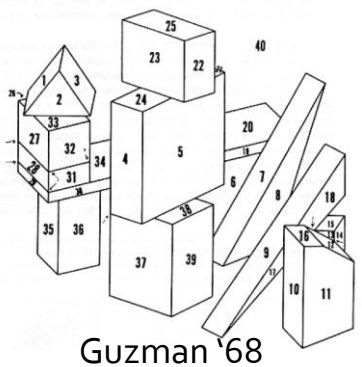
Fun



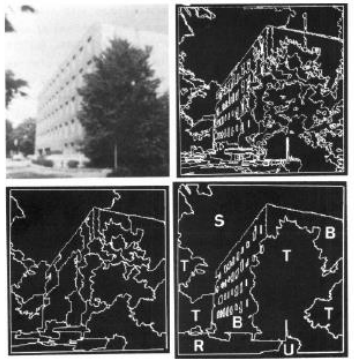
Access

Ridiculously brief history of computer vision

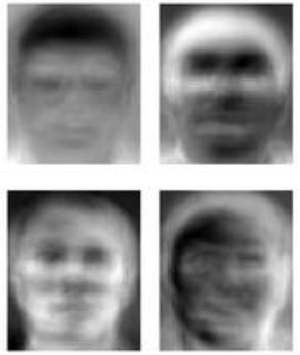
- 1966: Minsky assigns computer vision as an undergrad summer project
- 1960's: interpretation of synthetic worlds
- 1970's: some progress on interpreting selected images
- 1980's: ANNs come and go; shift toward geometry and increased mathematical rigor
- 1990's: face recognition; statistical analysis in vogue
- 2000's: broader recognition; large annotated datasets available; video processing starts
- 2010's: Deep learning with ConvNets
- 2020's: Widespread autonomous vehicles?
- 2030's: robot uprising?



Guzman '68



Ohta Kanade '78



Turk and Pentland '91

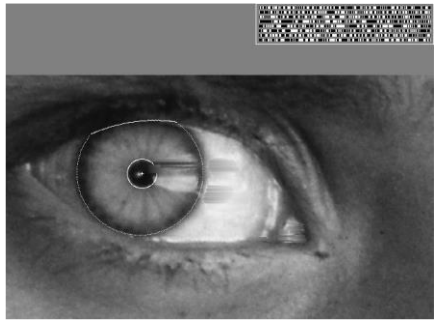
Slide credit: J. Hays

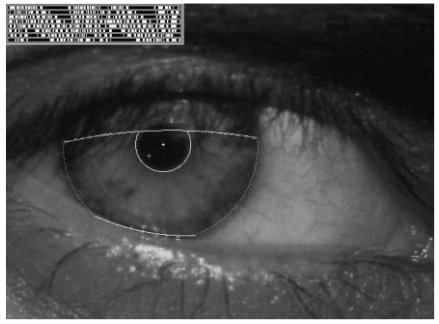
Applications – Motion capture

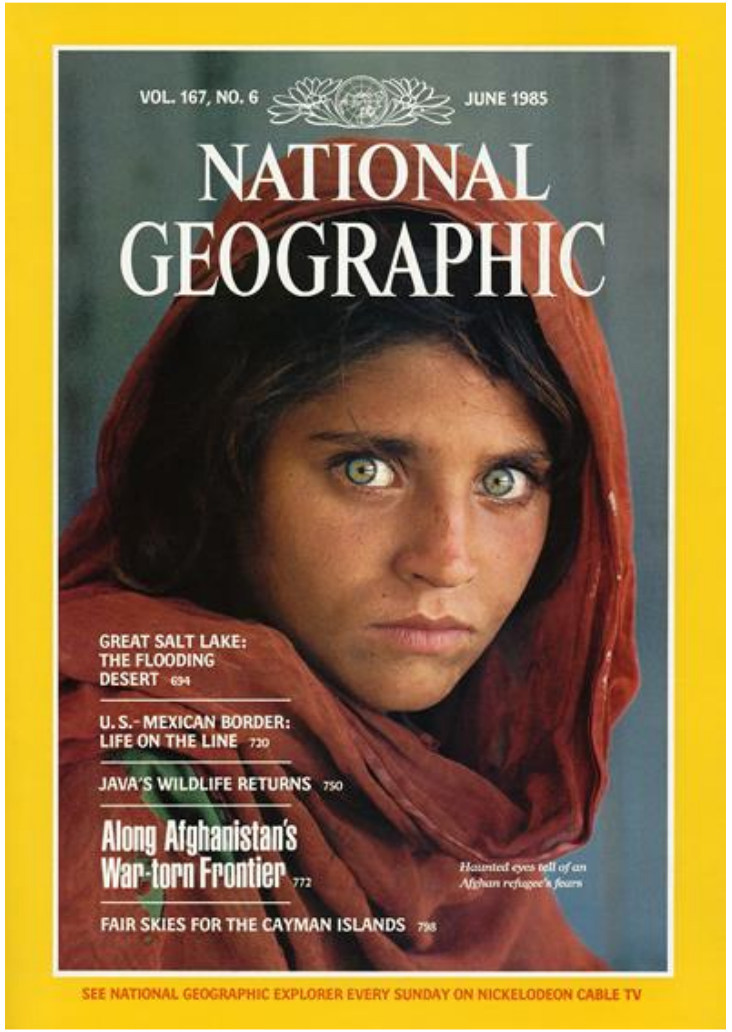
Microsoft XBox Kinect

Applications – Face recognition

How the Afghan Girl was Identified by Her Iris Patterns







https://www.cl.cam.ac.uk/~jgd1000/afghan.html

Applications – Face Alignment

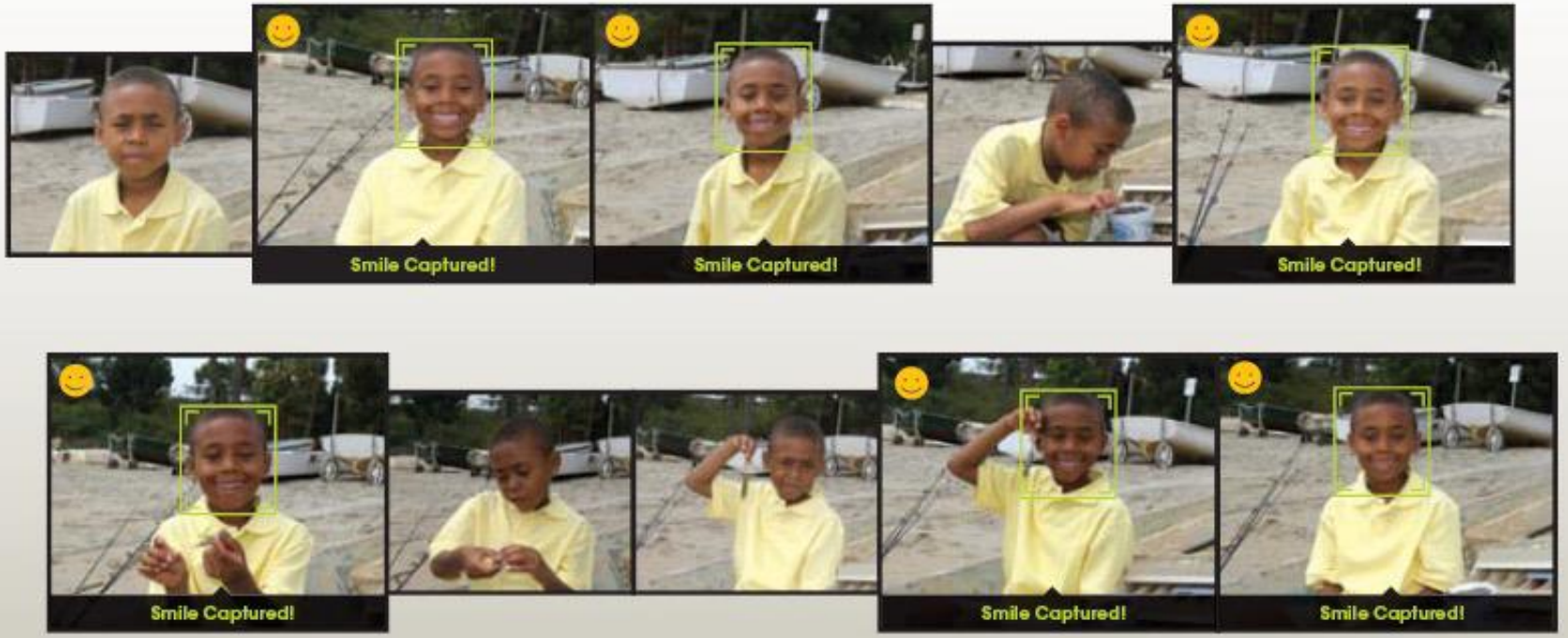
https://www.maccosmetics.co.uk/virtual-try-on

http://jbhuang0604.blogspot.com/2013/04/miss-korea-2013-contestants-face.html

Applications – Smile detection

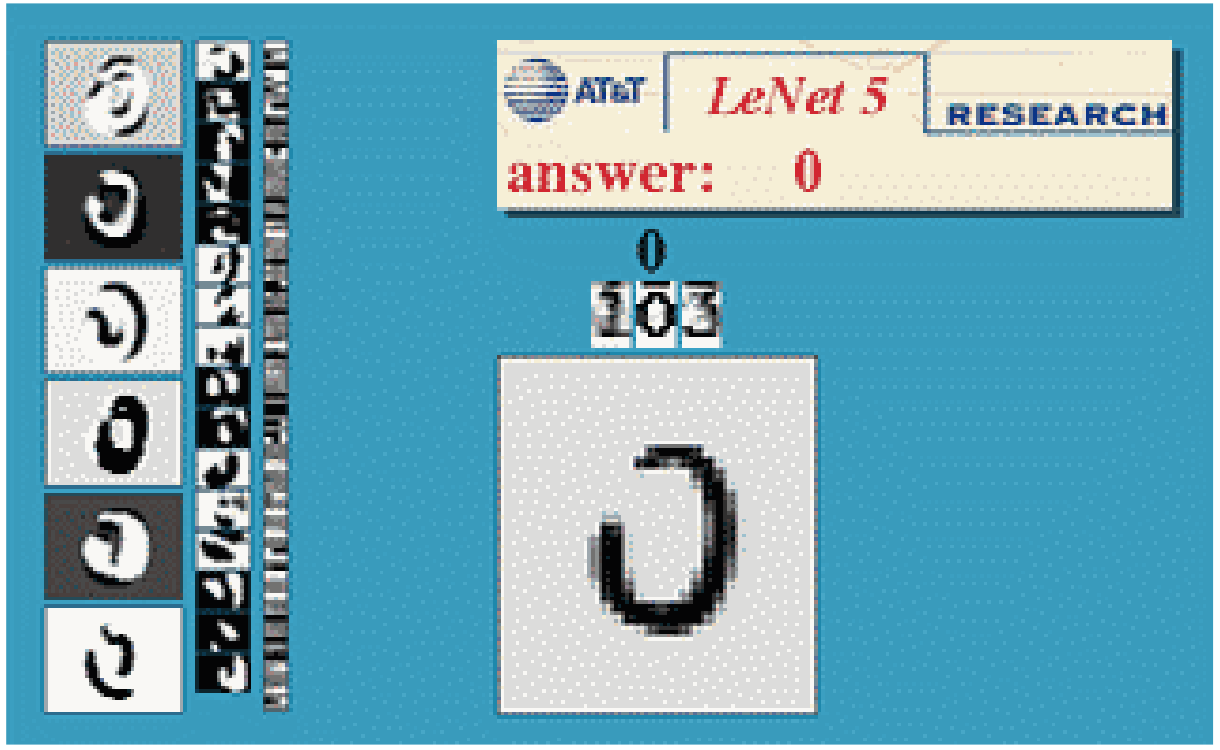
The Smile Shutter flow

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.



Slide credit: Steve Seitz

Applications – Optical character recognition (OCR)



Slide credit: Steve Seitz

Applications – Defect detection

https://deepsystems.ai/solutions/road-defects-detection

Applications – Cleaning robot

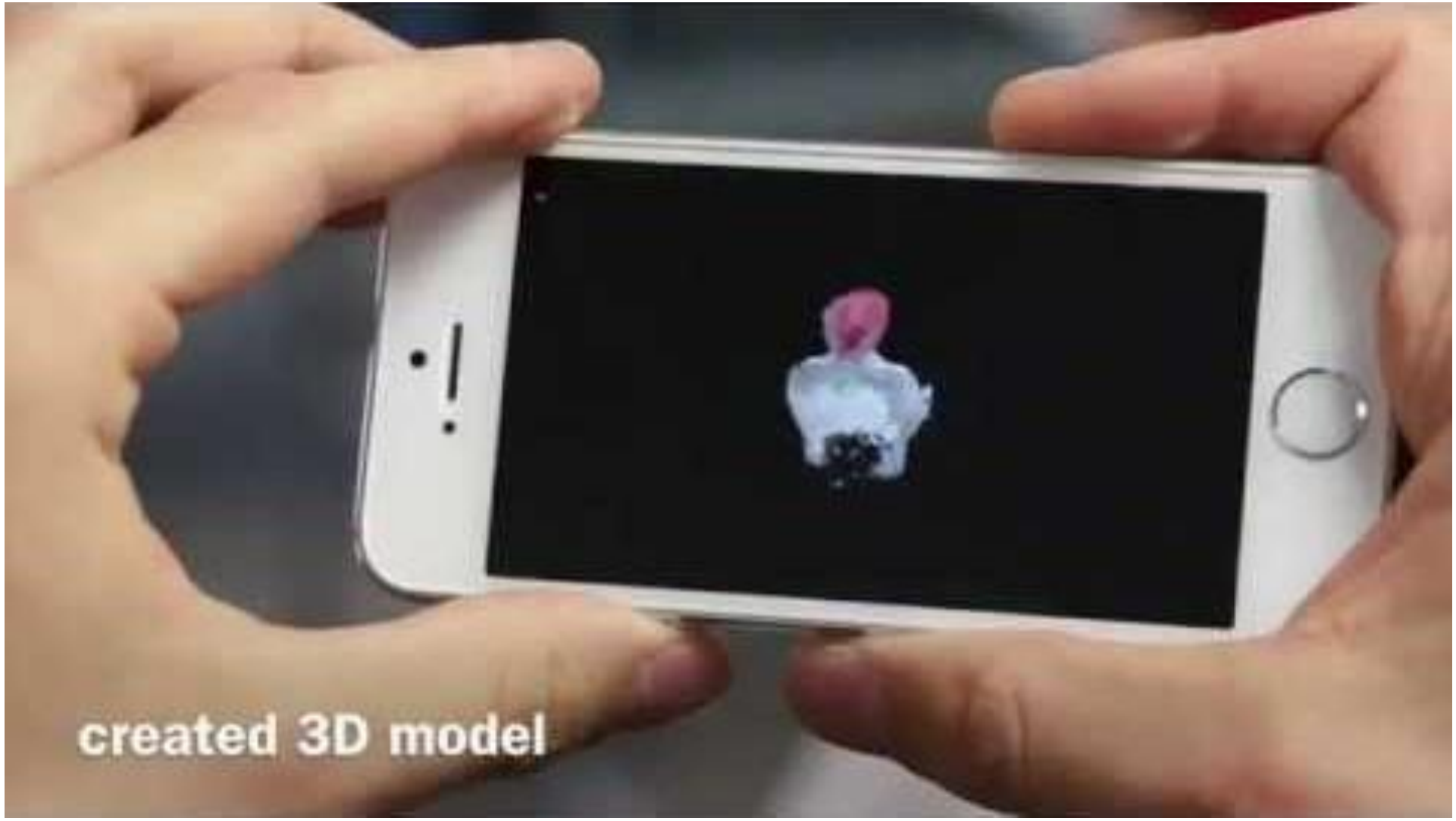
https://www.popsci.com/new-roomba-knows-location/

Applications – Sports

https://newsroom.intel.com/chip-shots/intel-replay-technology-delivers-all-star-experience-for-mlb-fans/#gs.fi3kzq

Applications – Object recognition

Applications – 3D from mobile phone



https://youtu.be/8M_-lSYqACo

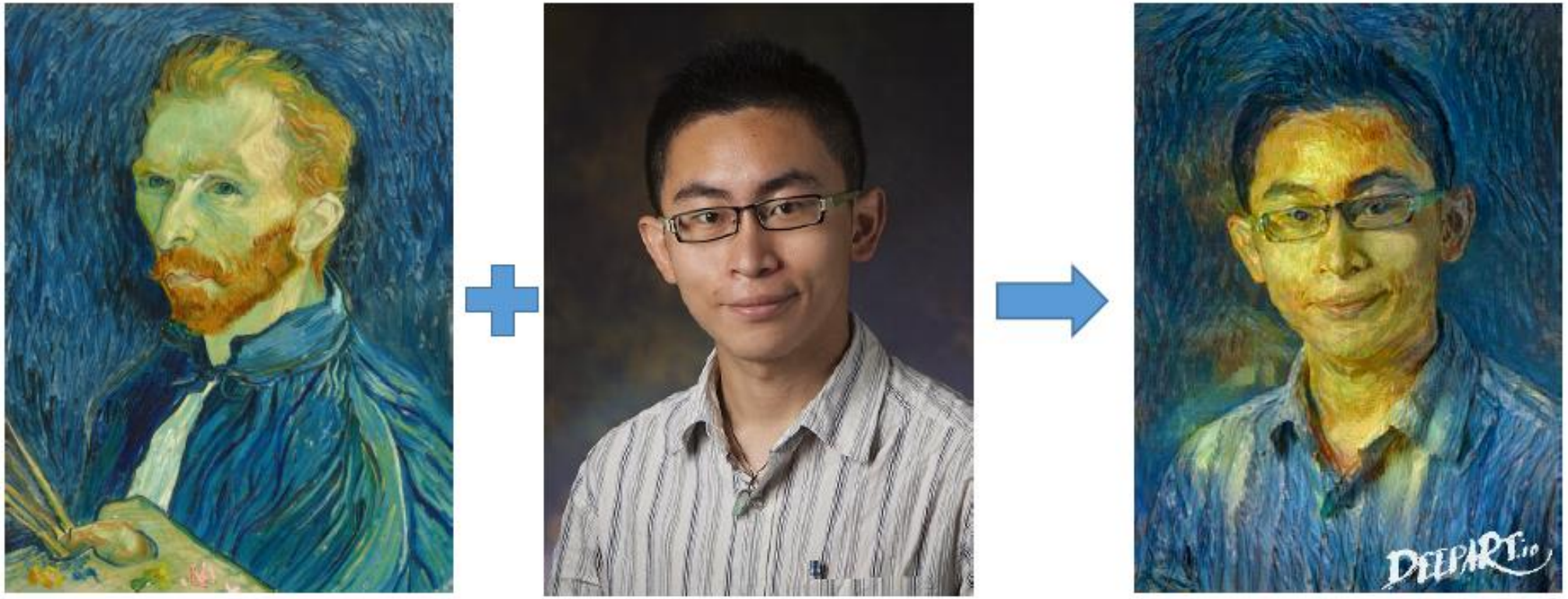
Applications – Indoor scene reconstruction

https://youtu.be/Ebyz8xxoK1w

Applications – Video Matting/Composition

https://youtu.be/63vqob-MljQ

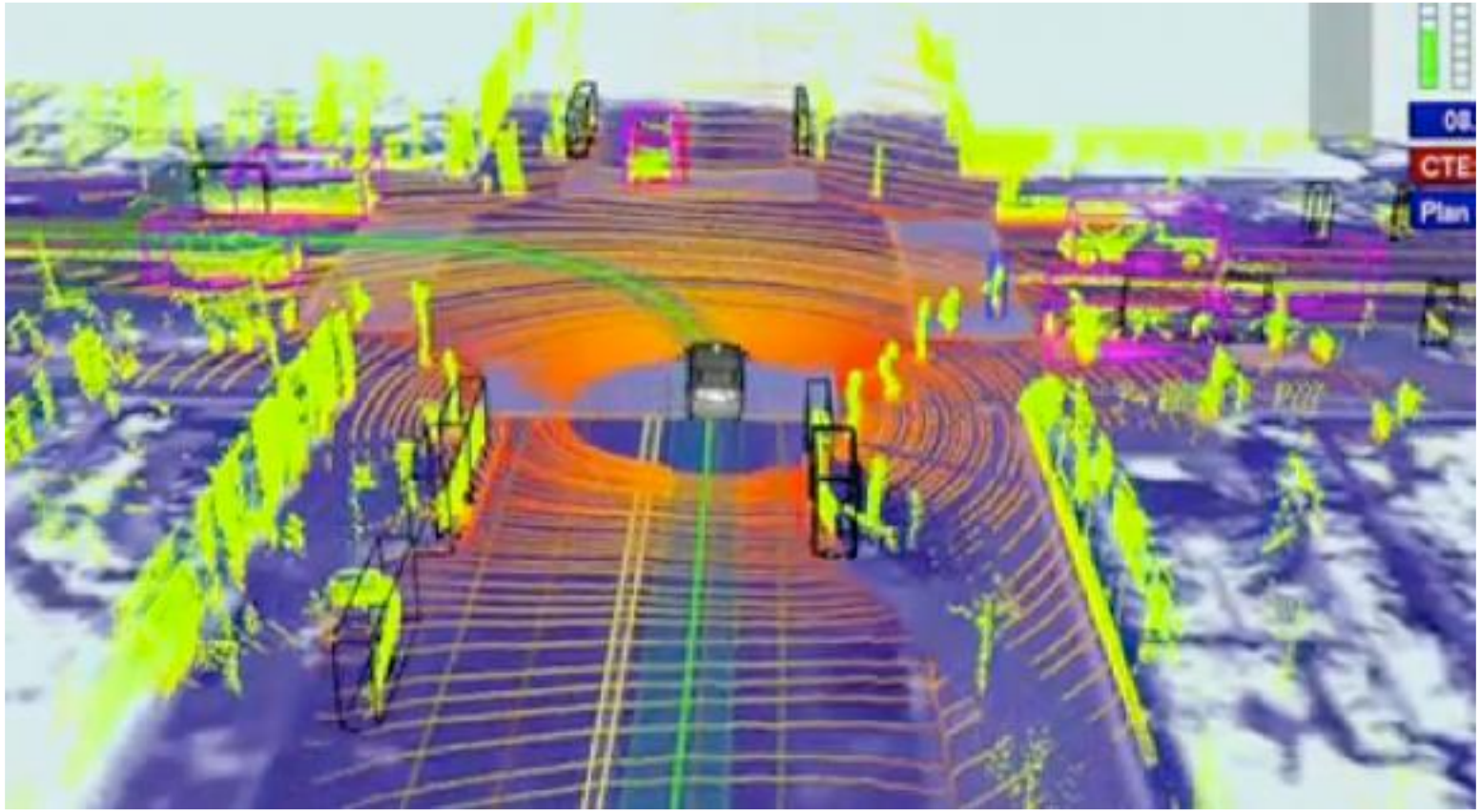
Applications – Style Transfer



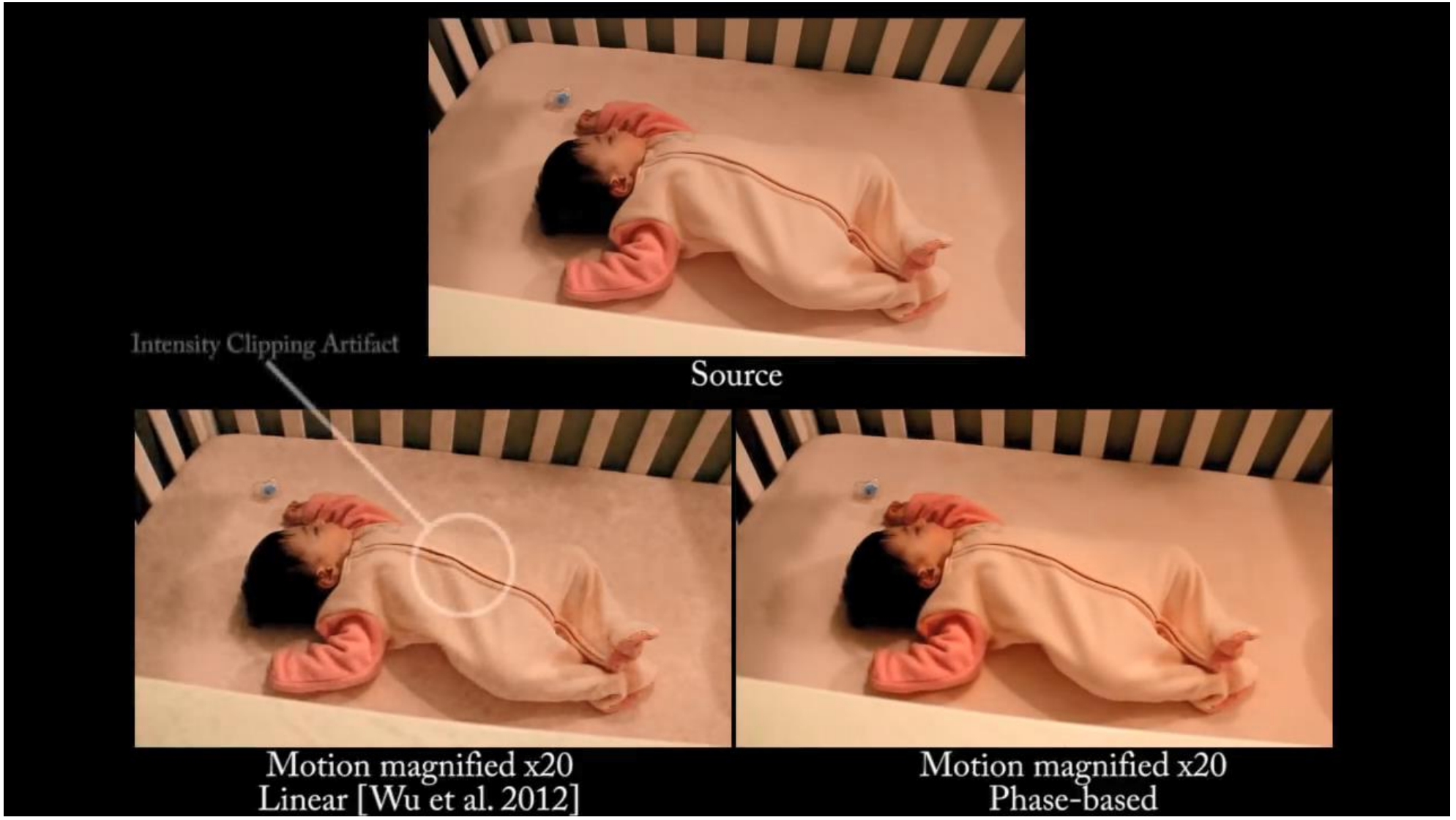
Source image (**Style**) Target image (**Content**) Output (deepart)

A Neural Algorithm of Artistic Style [Gatys et al. 2015]

Applications – Self-driving cars



Applications – Healthcare



Why is computer vision timely?

- Lots of image data is being collected

Why is computer vision timely?

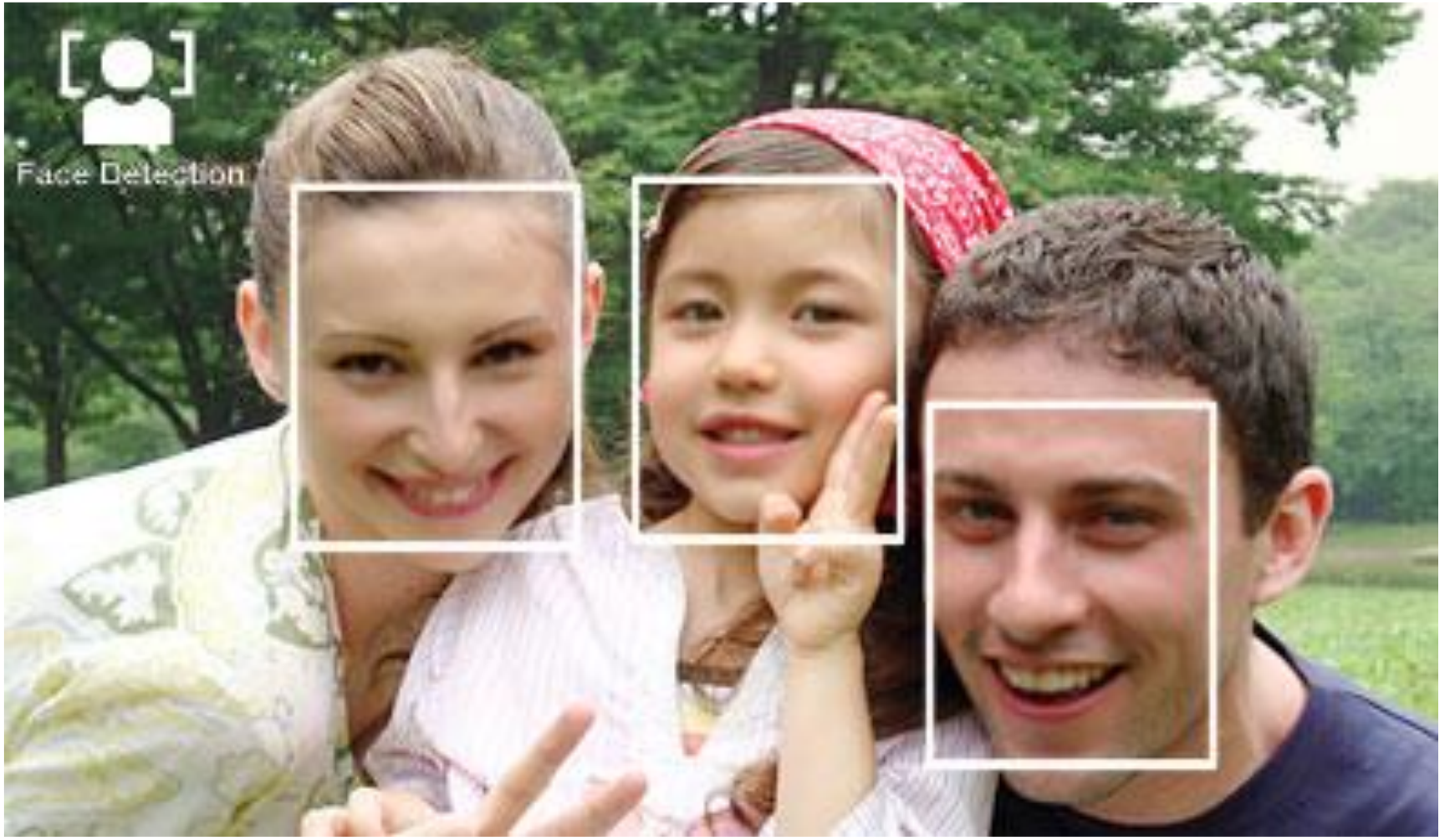
- **Lots of image data is being collected**
  - Bigger data is coming

Why is computer vision timely?

- There is a lot of information in images

Why is computer vision timely?

- Computer vision is starting to work …



http://www.sony-asia.com/article/271940/section/product/product/dsc-wx1

50 years ago

Slide credit: A. Torralba

10 years ago…

Slide credit: A. Torralba

Next topic

- **Let's talk about a computer's eye (a.k.a. camera)**
  - Prerequisite
    - Review EBU6230 Image/Video Processing - Week2: Image Transformations