

Computer Vision

My PhD Research Work
Research work of our group:

BS Students

MS Students

PhD Student

Research work :

BSF21:

Shoplifting Detection
Health Monitoring and Diagnostic (fall detection)
Segmentation Strategies for Enhancing System Automation
Virtual Fashion Fit Smart
Sign Language Detection and Text Translation
AI-Powered Student Engagement Monitoring System
AI-Powered Image Segregation System

MSAIF22:

CAR Image
Alignment
Anomaly Detection
Cataract Detection
Depth Estimation

MSDSF23:

Pneumonia Detection Using Multi-Modality Dataset
Leaf Area Estimation using deep learning
Waste Detection

MSCSF23:

Signature Verification
MRI Image Alignment
Gesture Recognition
Child kidnapping
Super-Resolution
Facial Expression Recognition

MSAIF23:

Text to Sign Language Generation
Weapon Detection
Anomaly Detection
Face Recognition (attendance system + age invariance)
Student Involvement Monitoring

PhD:

Explainable system for mammograms images

Course outline : Classical CV + DL for CV

- Introduction of Computer Vision
- Mathematical Preliminaries: Linear algebra review
- Review important libraries of python for computer vision
- Image filtering: Image enhancement, Edge detection, Corner detection, Feature extraction (SIFT- Describe the image)
- Basics of Neural Networks (Youtube videos)
- PyTorch Tutorial
- Convolutional neural networks (CNNs)
- Image Classification (Binary, multiple, multi label)
- Object Detection
- Segmentation: Instance and semantic segmentation
- Optical flow: (Image alignment and tracking)
- Action Recognition: (video classification/action detection) RNN/LSTM
- Generative modeling: GANs

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ARY Qtv

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Disney Jr.

Cartoon Network...

Generative Adversarial

Variational Autoencoder

Machine Learning

Muhammad Farooq, Ph.D.

@FarooqComputerVision • 522 subscribers • 126 videos

I currently hold the position of Assistant Professor in the Department of Information Tech ...more

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51 videos

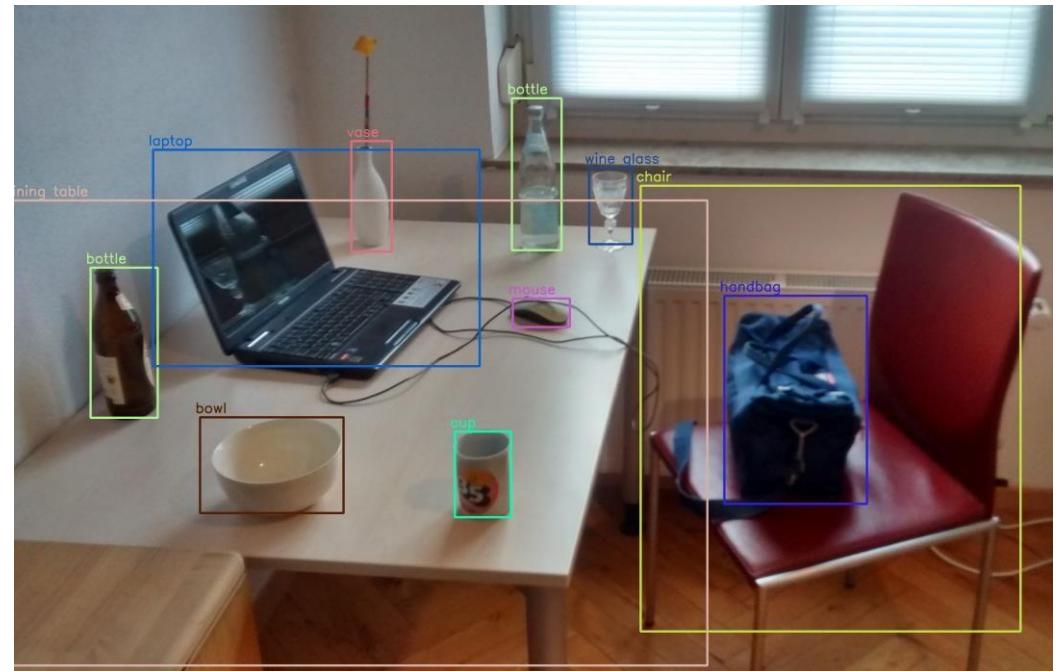
Course sources

- Dr Yogesh S Rawat, Assistant Professor, Center of Research in University of Central Florida.
<https://www.crcv.ucf.edu/courses/cap5415-fall-2021/>
- Dr Shree Nayar : Professor of Computer Science at Columbia University: <https://fpcv.cs.columbia.edu/>
- Dr Nazar
- Ms Adeela

Introduction to Computer Vision

What is computer vision?

- Automatically extracting meaningful information from images and videos.
- Ability of computers
 - To understand visual data
 - For example, images, videos...
- Automate tasks
 - Which human visual system can perform



Need of CV course





Autonomous Navigation: Driverless Car

Face Recognition



What is Vision Used For?



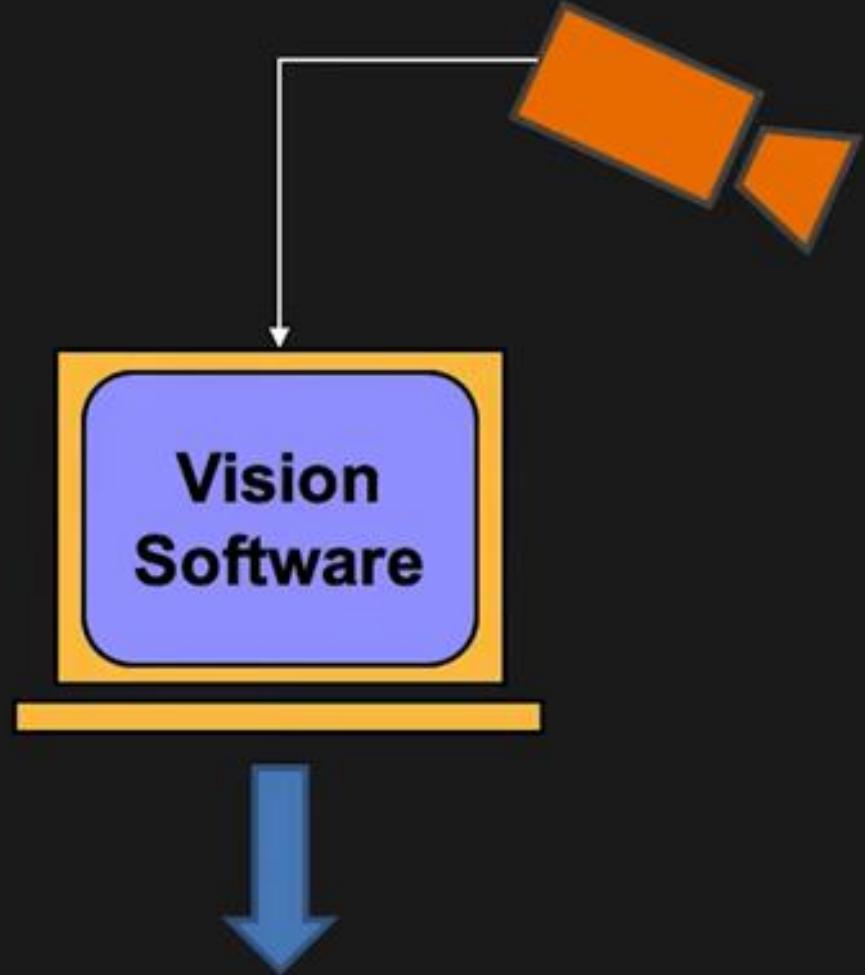
Factory Automation: Visual Inspection

Basic Elements of vision system

Camera

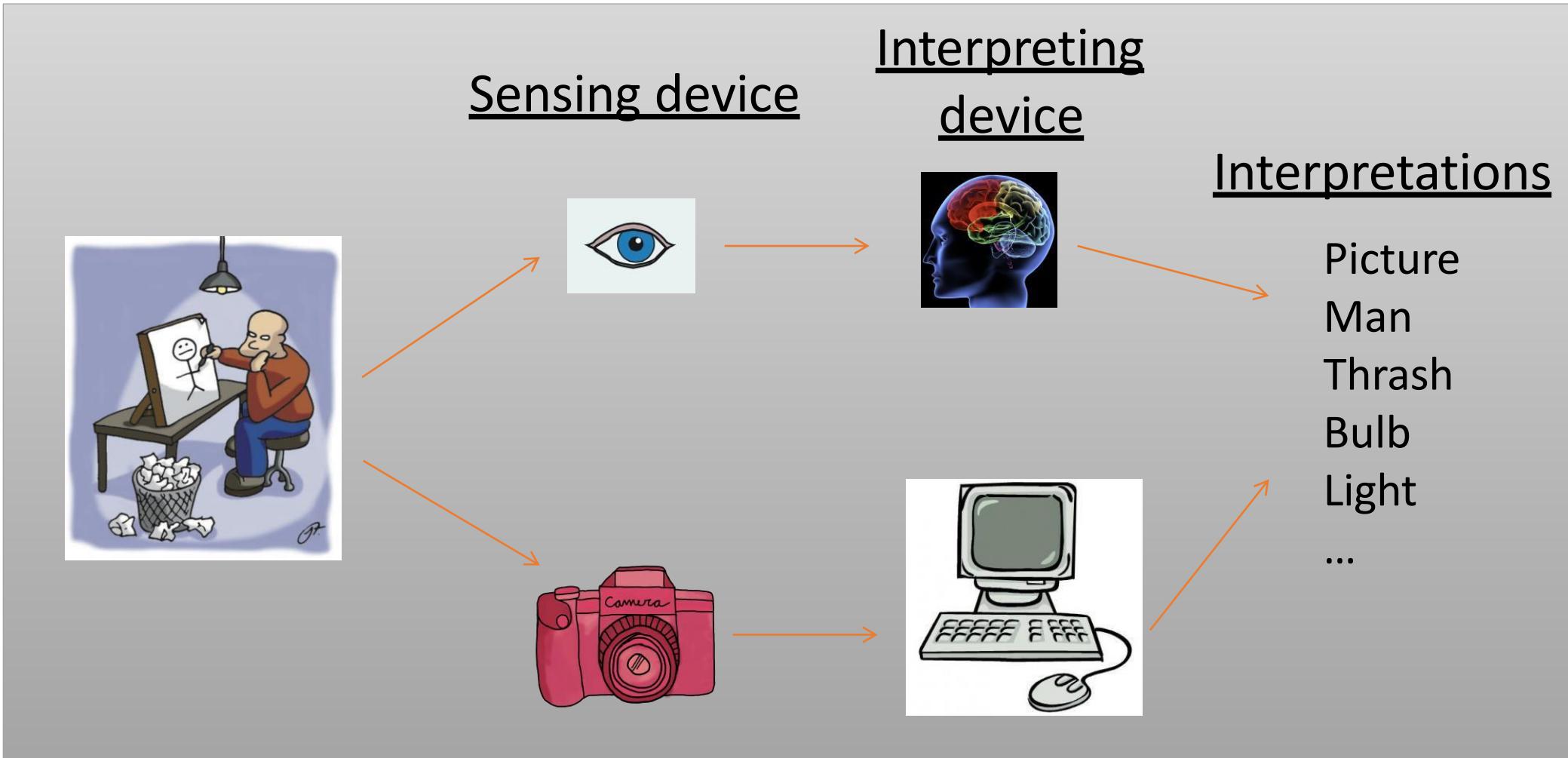


Lighting



Scene

Vision vs. Computer Vision?

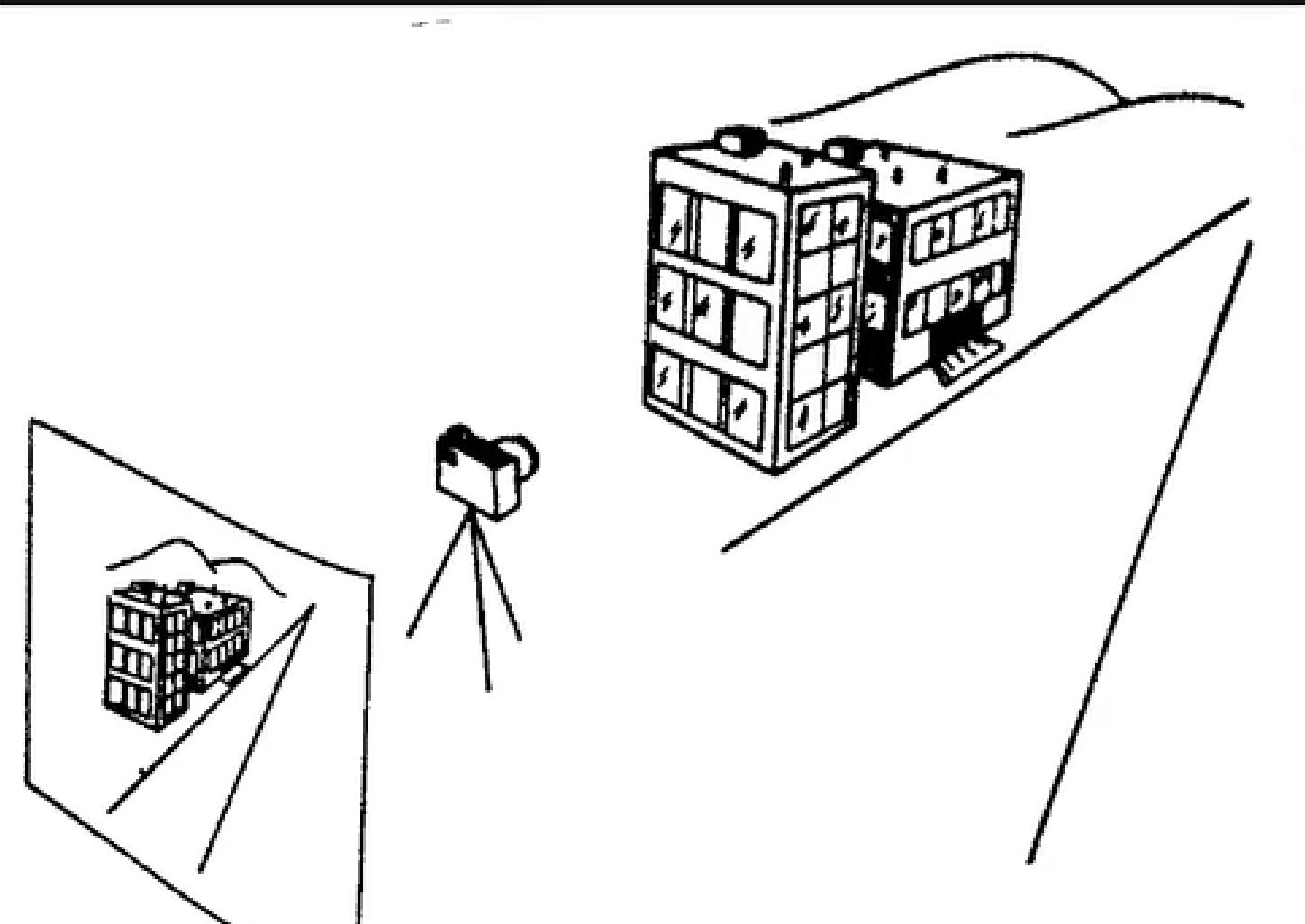


Vision Deals with Images

An Image is an **Array of Pixels**

A Pixel has Values:

- Brightness
- Color
- Distance
- Material
- ...



Images Are Interesting



But When You Look Close...

157	159	159	104	104	115	128	131	133	133	132	131	132	130	129	118	132	158	156	153	190	144	117	126	120	81
159	165	153	101	103	113	126	129	130	130	126	124	127	128	127	120	122	158	159	154	160	190	121	118	67	47
162	154	154	98	101	114	124	127	130	132	144	159	155	132	123	119	119	148	154	150	140	185	161	60	48	45
141	132	158	93	98	110	121	125	122	129	143	172	191	188	143	105	117	148	140	145	142	153	105	44	49	71
100	130	157	93	99	110	120	116	116	129	138	163	191	205	211	130	107	153	98	133	147	107	44	47	81	151
87	130	157	92	97	109	124	111	123	134	139	175	194	201	207	205	126	151	74	114	160	57	49	63	141	163
93	131	159	92	98	112	132	108	123	133	162	180	183	192	196	205	184	151	138	199	195	54	47	119	161	156
96	134	164	95	97	113	147	108	125	142	156	171	173	178	184	181	186	191	206	203	161	44	84	158	159	155
95	137	165	95	95	111	168	122	130	137	145	139	144	139	145	179	193	203	194	158	95	49	135	160	157	155
101	139	166	94	96	104	172	130	126	130	108	77	85	80	153	191	188	161	144	113	48	83	161	160	156	153
101	133	167	94	96	100	154	137	123	92	67	57	72	153	182	184	175	101	116	53	48	119	166	163	159	152
99	130	169	97	99	109	131	128	84	55	60	75	149	176	170	194	209	99	79	51	67	150	158	155	154	151
97	129	170	97	98	118	122	94	66	56	56	140	161	114	136	187	163	81	85	52	98	161	159	154	148	137
92	123	173	101	98	129	95	74	74	45	94	174	106	115	126	168	108	60	92	55	128	157	153	148	145	157
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71	119	172	106	91	78	97	70	99	104	59	116	142	153	141	165	123	55	84	132	154	146	148	199	209	210
61	126	175	112	83	74	92	123	130	53	61	108	137	132	138	154	77	58	82	150	152	143	155	210	211	213
53	128	175	105	71	82	109	127	75	50	57	74	115	139	151	117	47	67	89	154	154	143	159	218	214	199
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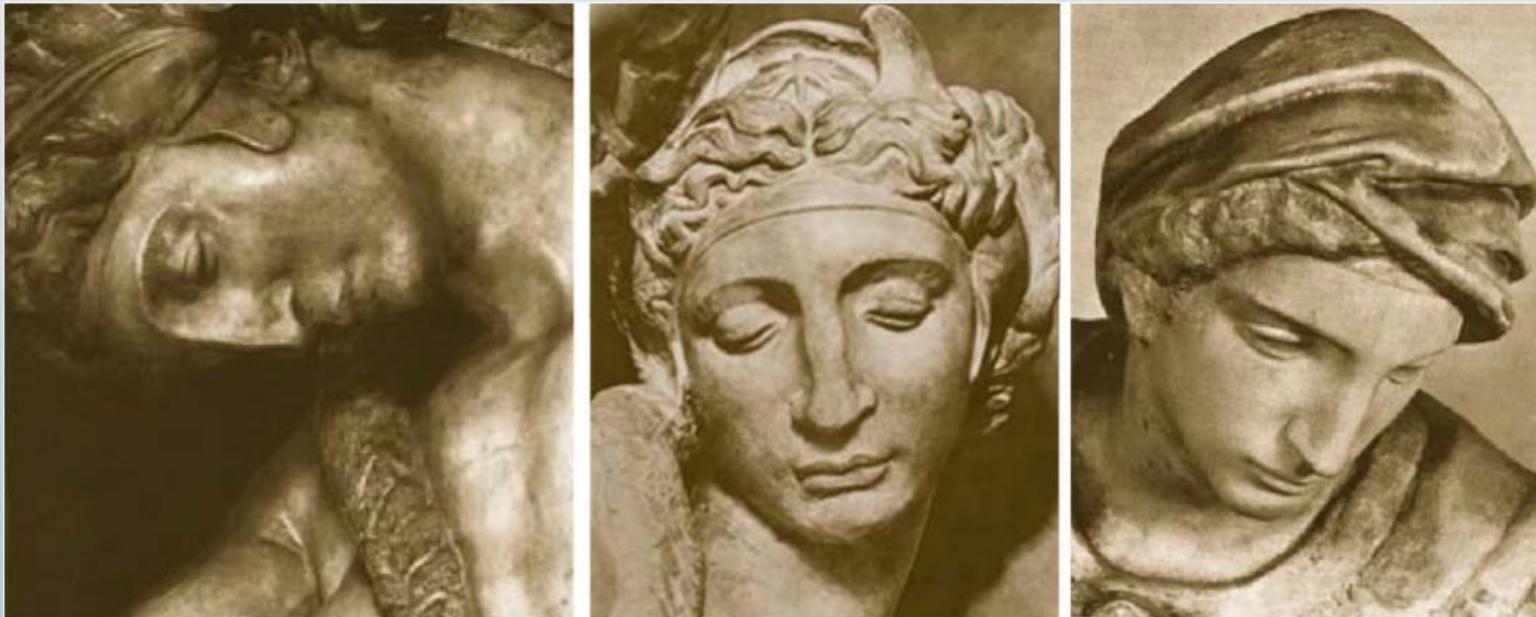
Why is Visual Perception hard?

Intra Class Variation



Why is Visual Perception hard?

Viewpoint Variation



Michelangelo (1475-1564)

Why is Visual Perception hard?

Occlusion



Rene Magritte (1957)

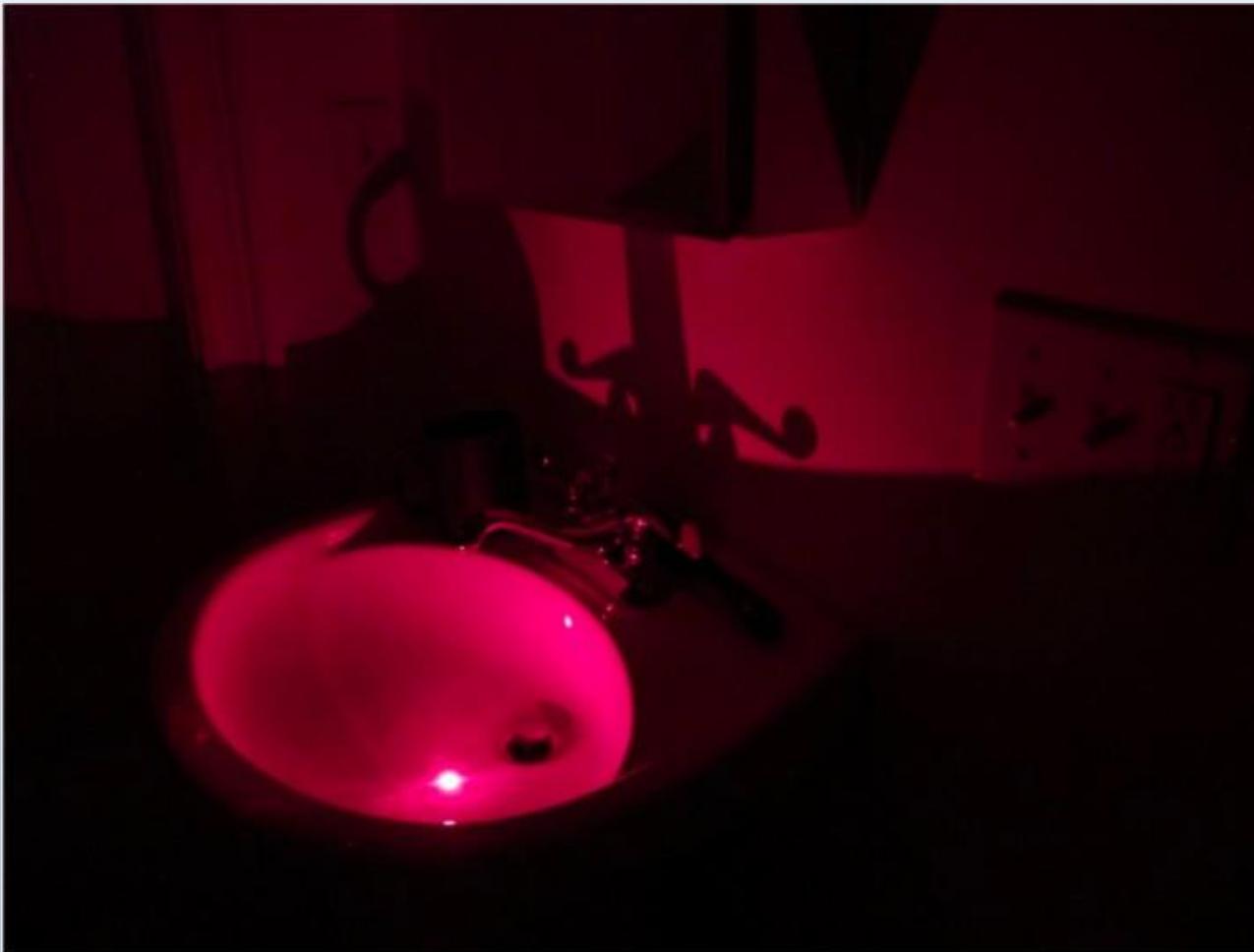
Why is Visual Perception hard?

Illumination



Why is Visual Perception hard?

Illumination



Why is Visual Perception hard?

Illumination



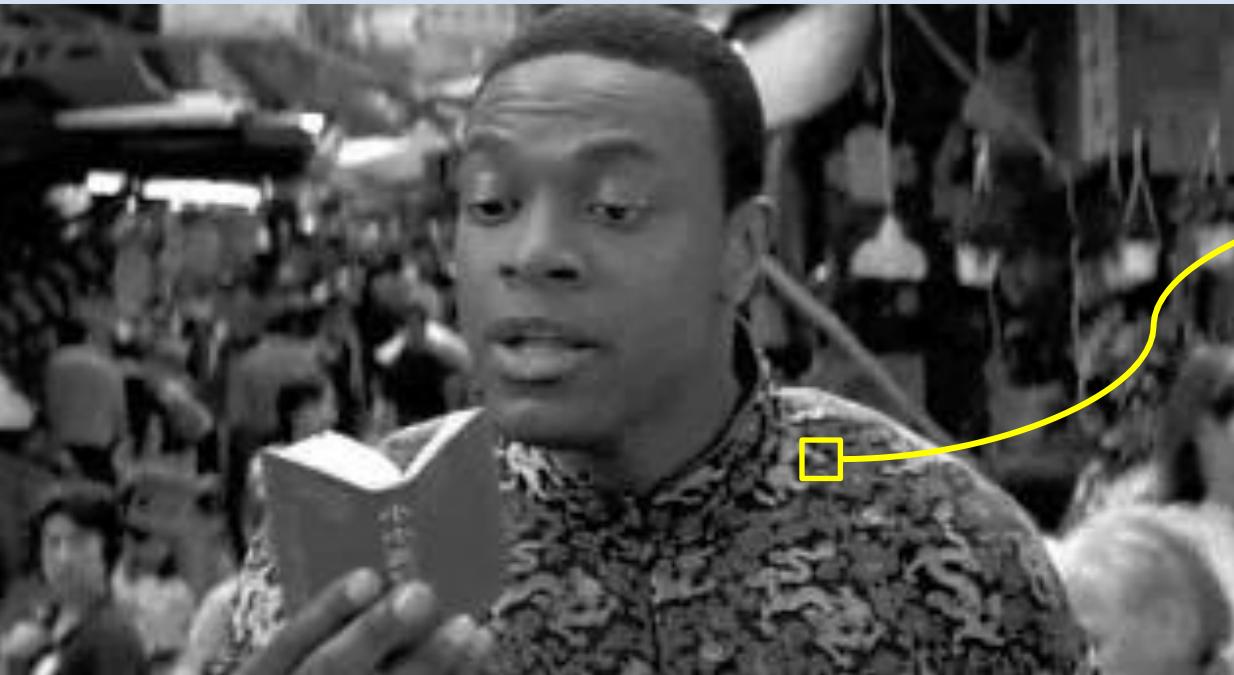
Why is Visual Perception hard?

Motion

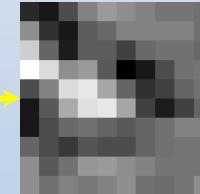


Goal of Computer Vision?

- To bridge the gap between
 - image pixels and “meaning” (semantic)!



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 computer sees!

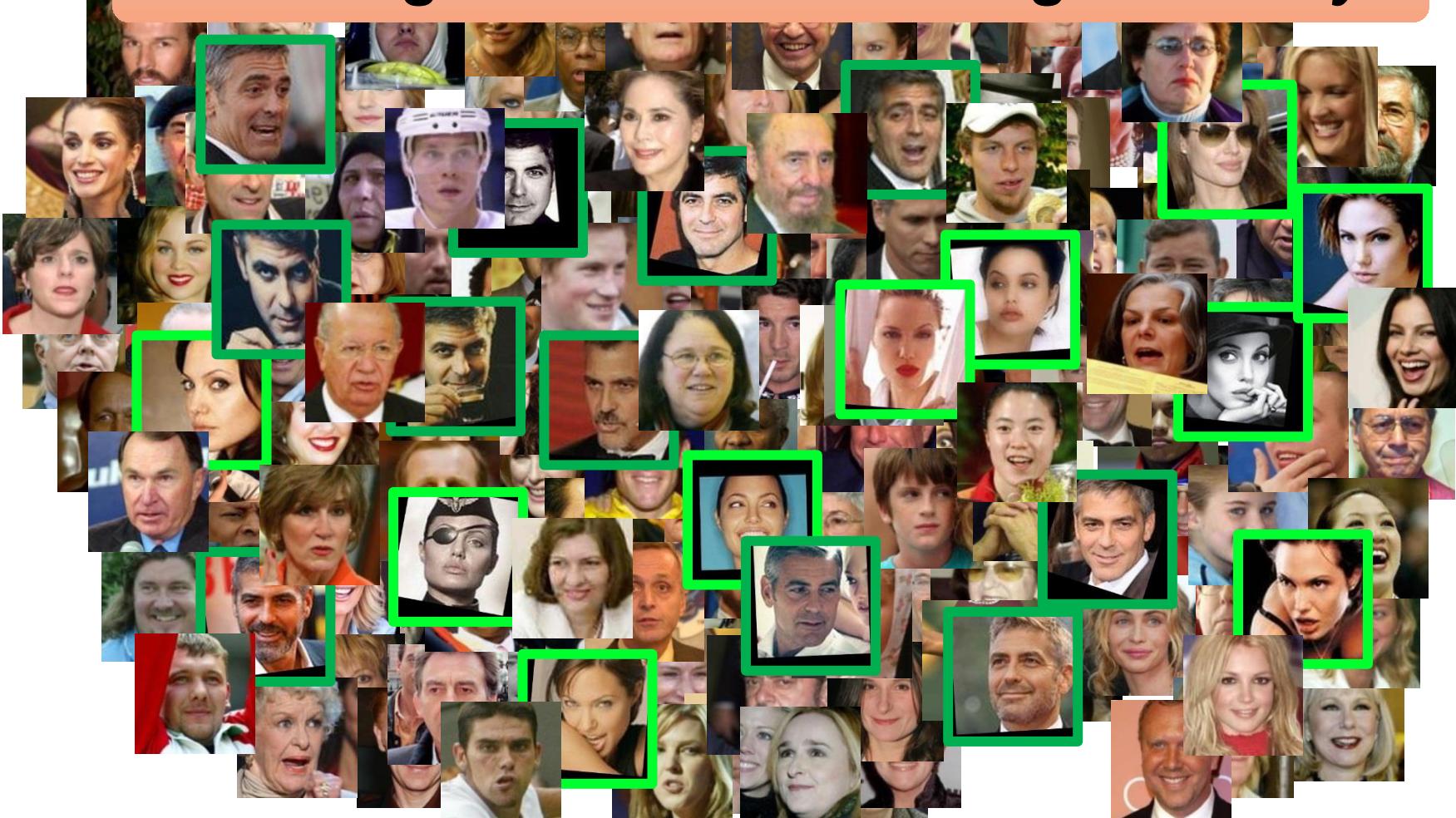
Applications of Computer vision

Face Recognition



Open-Universe Face Identification

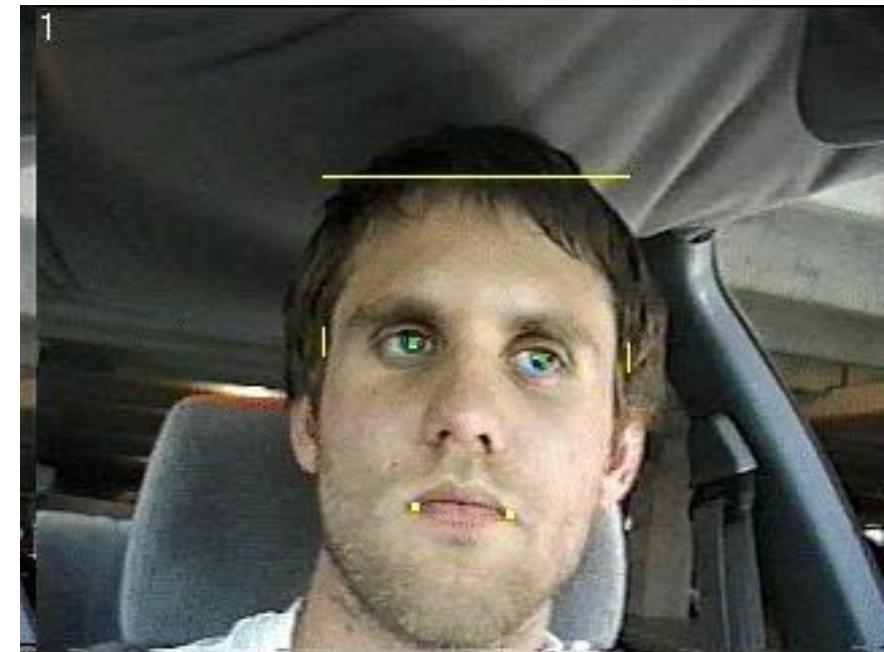
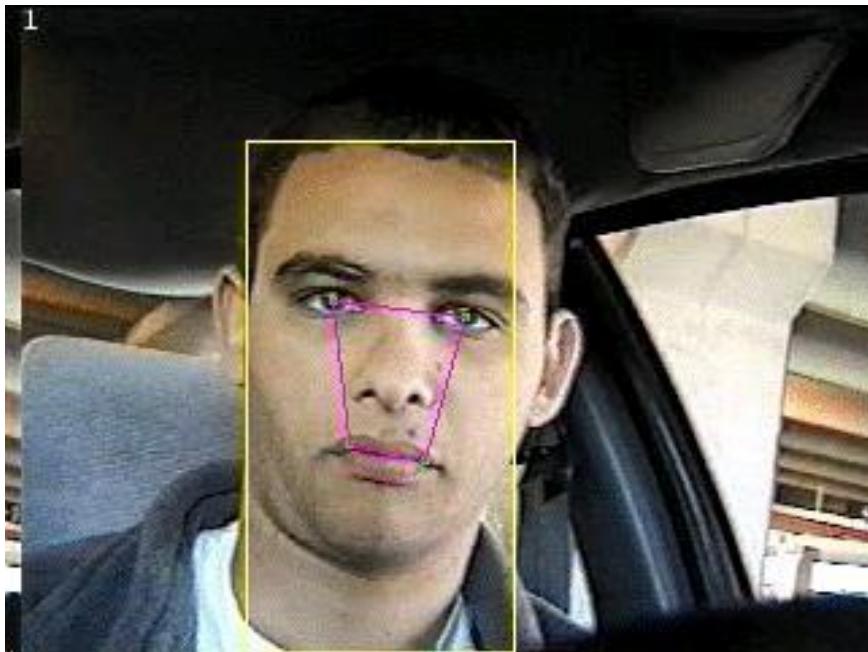
Find Angelina Jolie and George Clooney



Facial expression recognition and generation



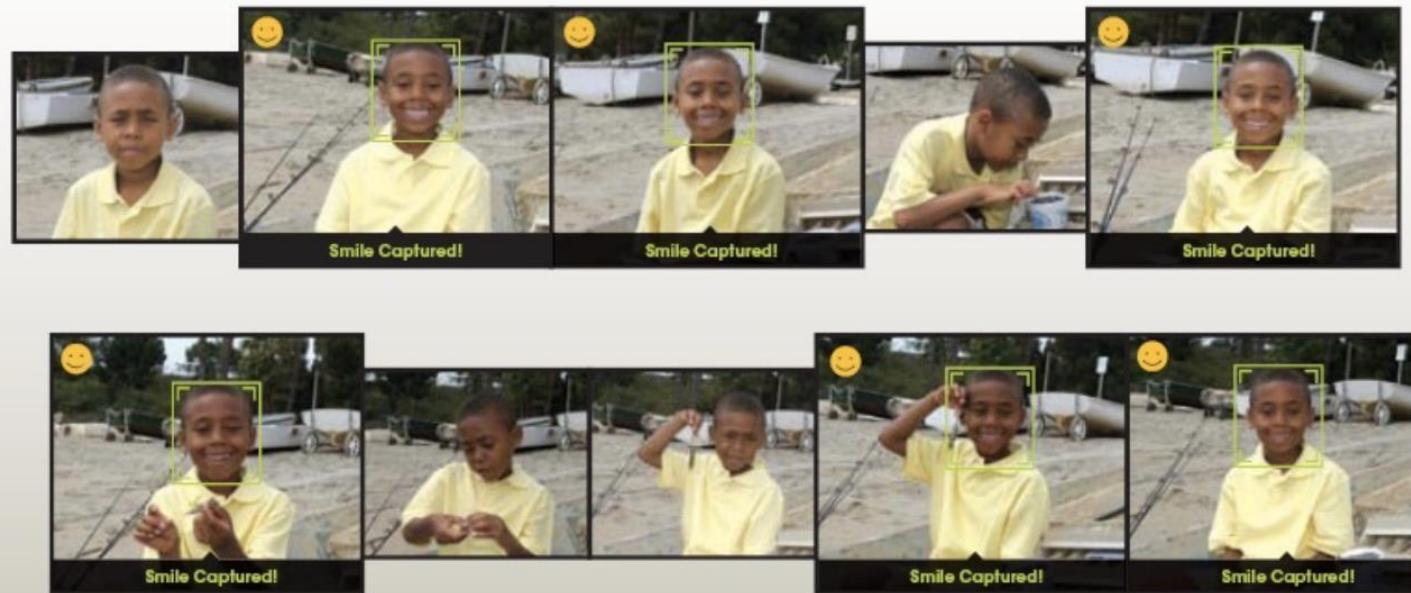
Fatigue detection => Fit for driving or not



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.



Lip-reading



High Density Crowded Scenes



Political Rallies



Religious Festivals

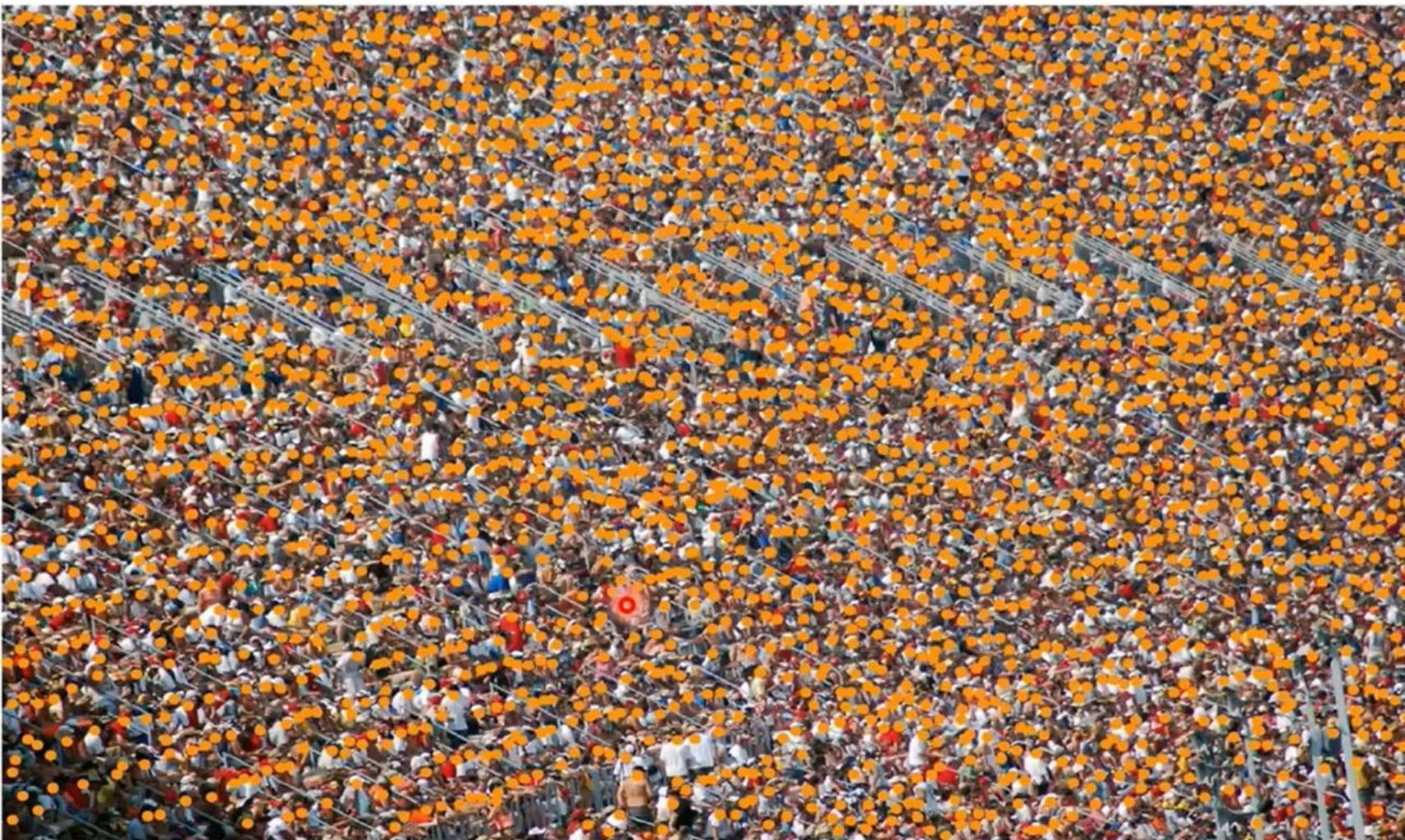


Marathons



High Density
Moving Objects

Counting



Ground truth=2319

Lecture 1 - Introduction

Proposed Method=2496

Biometrics



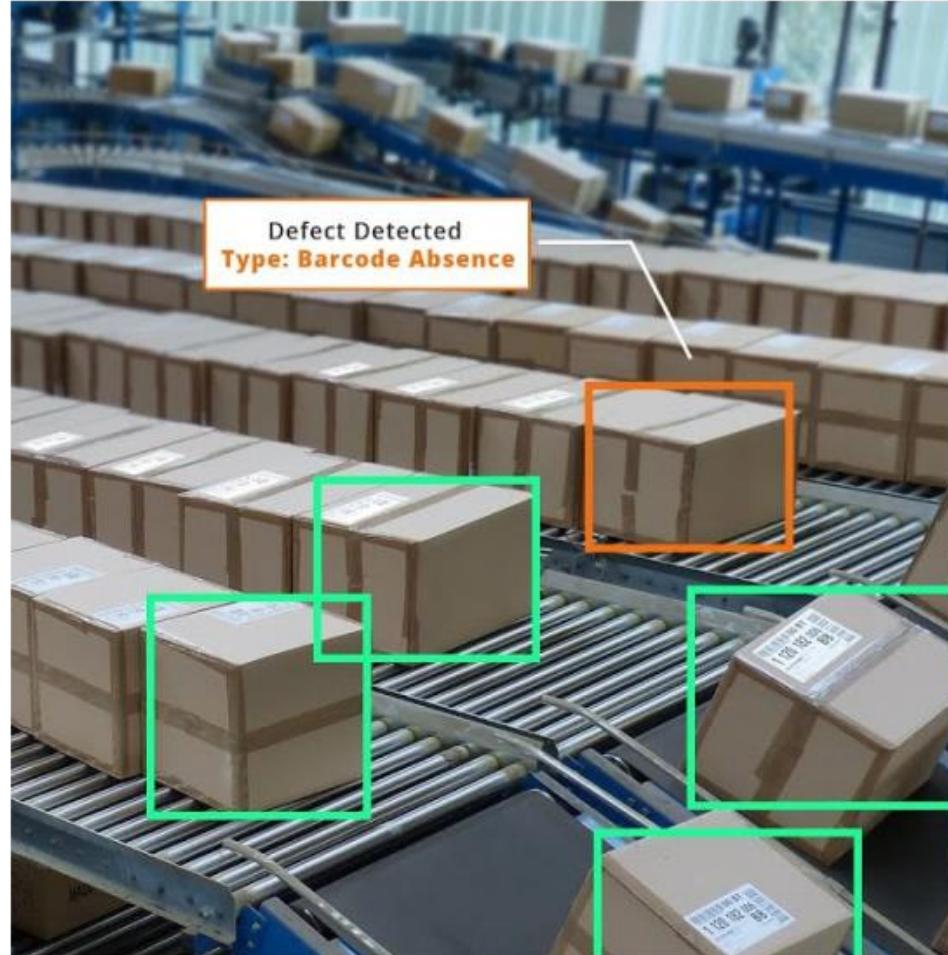
Fingerprint scanners on
many new laptops,
other devices

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



Biometrics: Iris Recognition

Industrial Inspection, Monitoring and Control



What is Vision Used For?



Factory Automation: Vision-Guided Robotics

What is Vision Used For?



Factory Automation: Visual Inspection



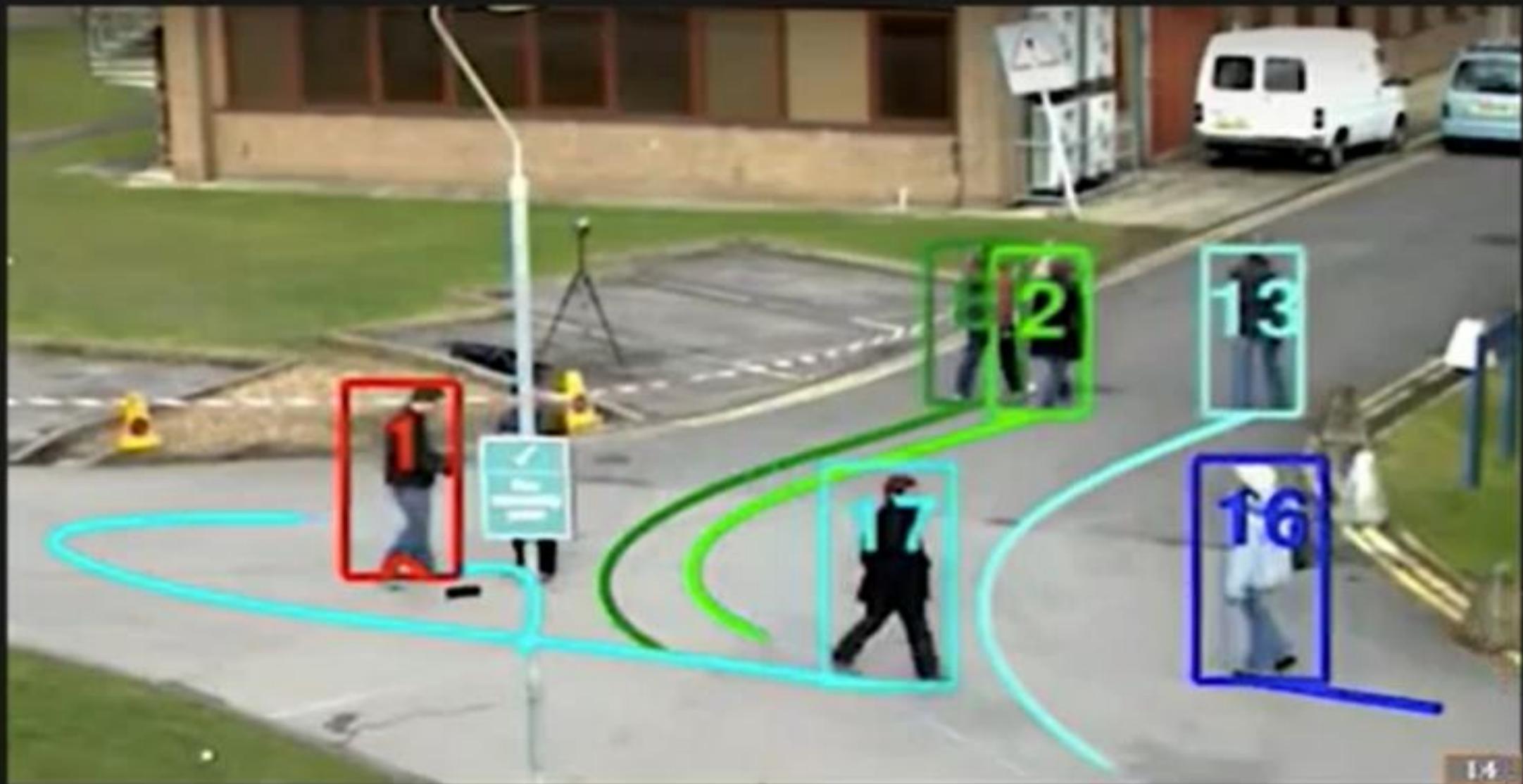
ATA 010

Optical Character Recognition (OCR): Reading License Plates

What is Vision Used For?



Intelligent Marketing: Vending Machine with Face Detection



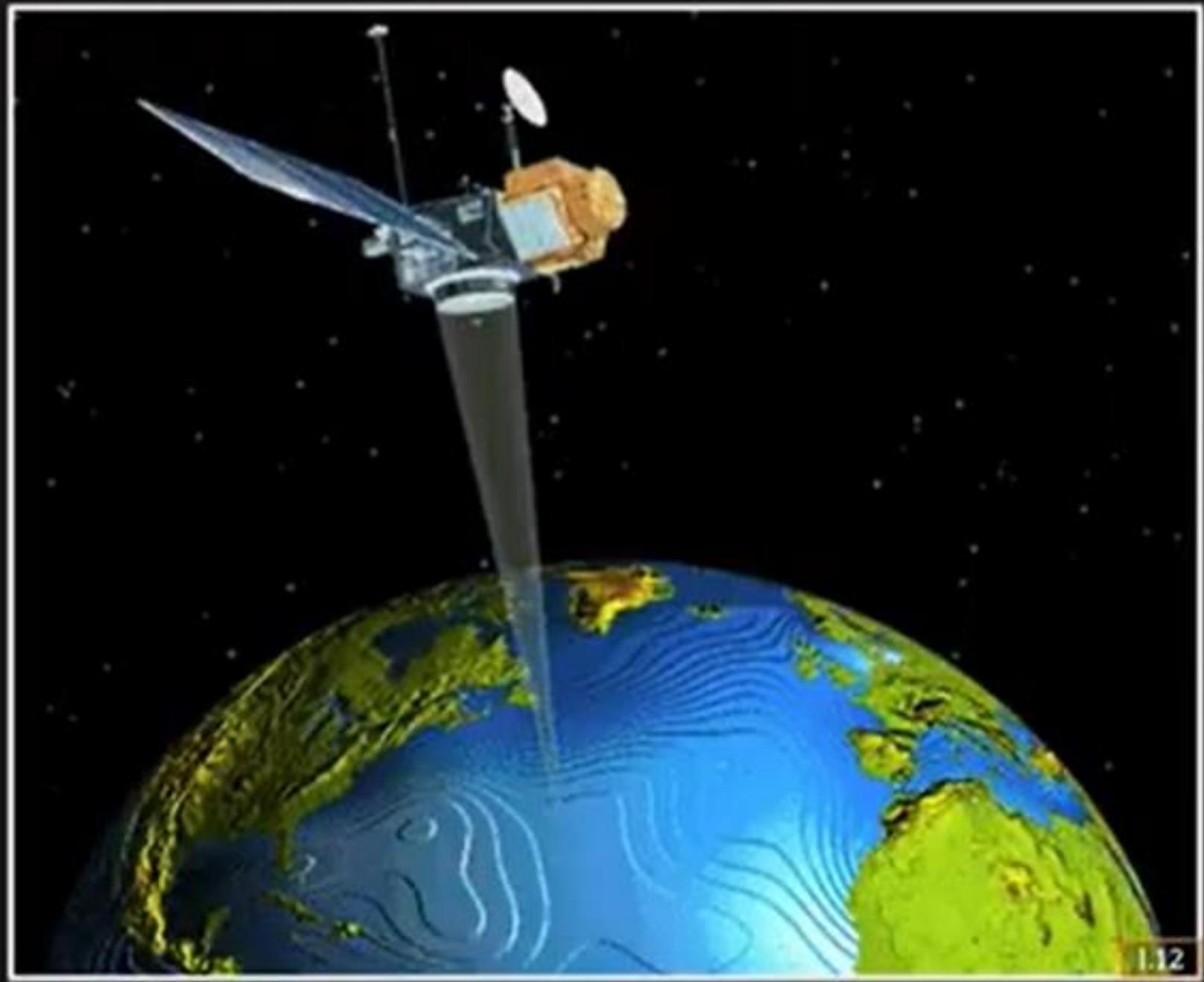
Security: Object Detection and Tracking



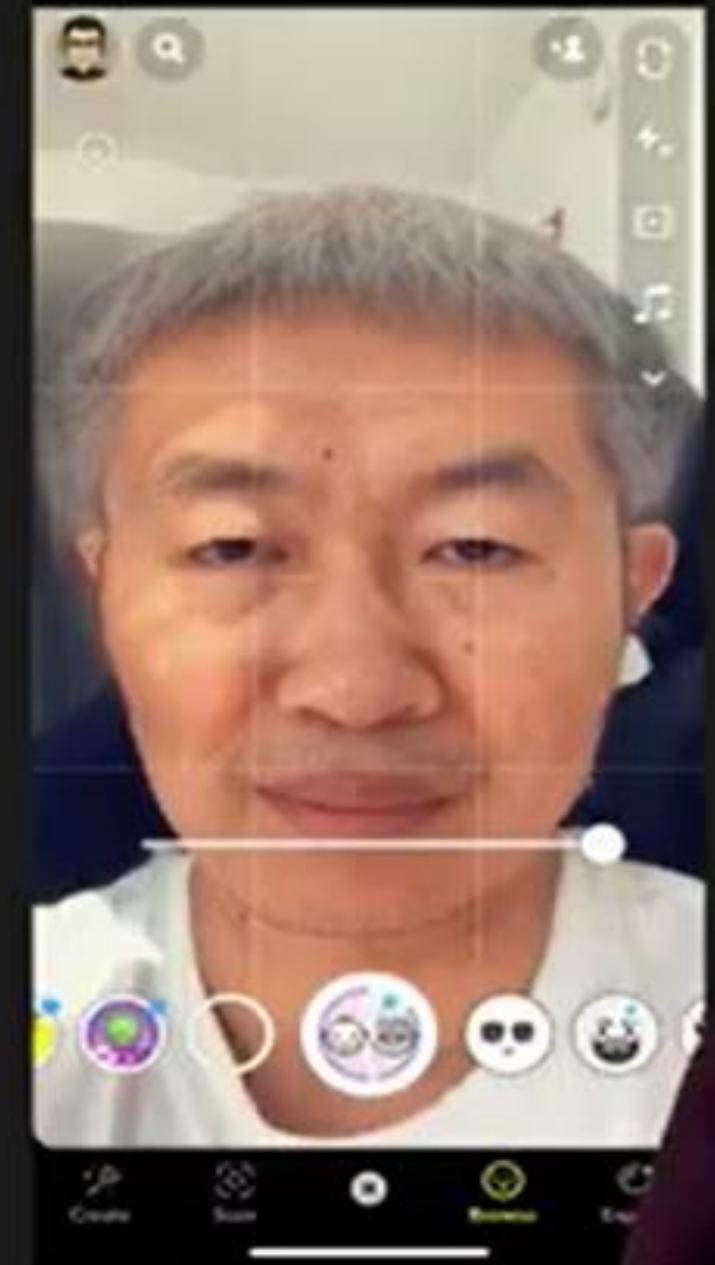
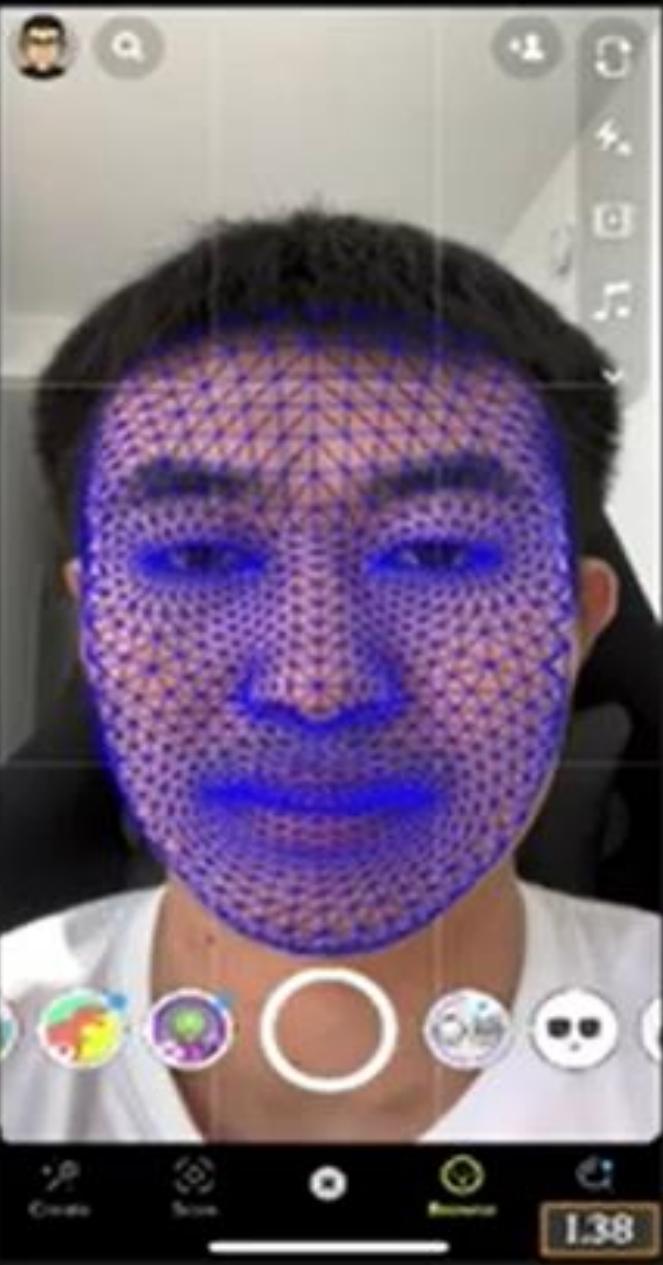
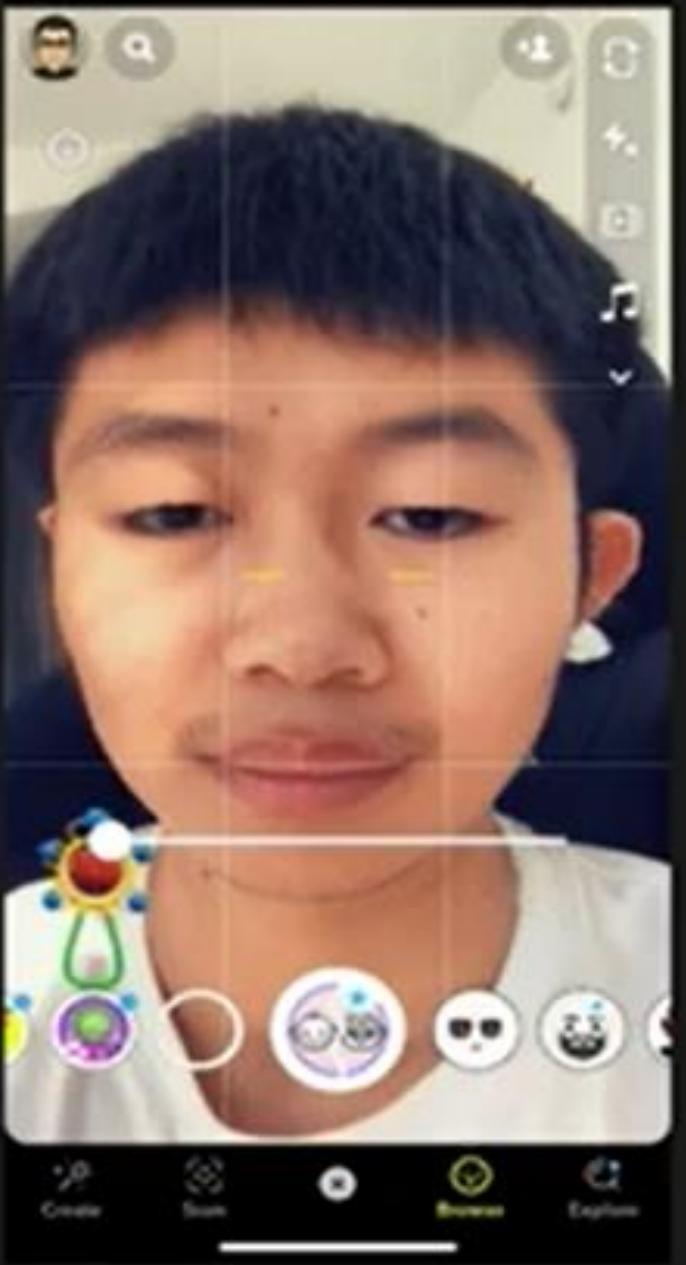
Autonomous Navigation: Driverless Car

MRI image





Remote Sensing



Augmented Reality: Face Manipulation

Computer vision tasks

Object Recognition/ classification

- **Problem:** Given an image A, does A contain an image of a person?

Object Recognition/ Classification

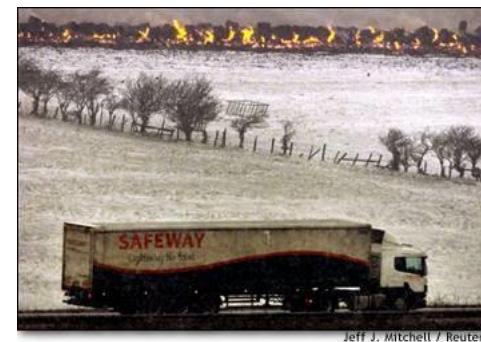
- **Problem:** Given an image A, does A contain an image of a person?



YES

Object Recognition/ Classification

- **Problem:** Given an image A, does A contain an image of a person?



NO

Object localization and Object detection



Mike Hewitt / Allsport



Patrick Gardin / AP



Andy Barron / Reno Gazette-Journal

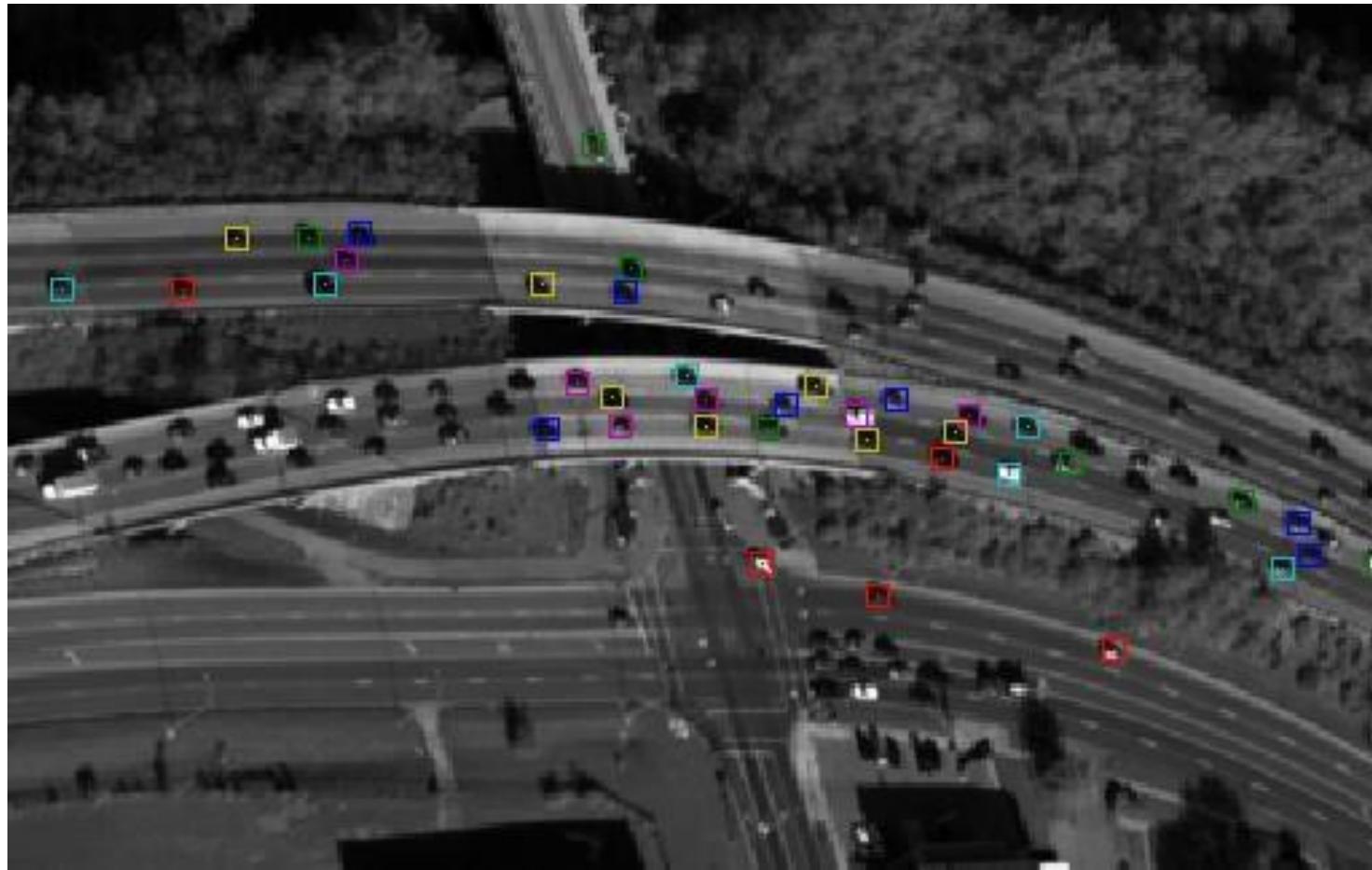


Sydney Morning Herald

Human Detection



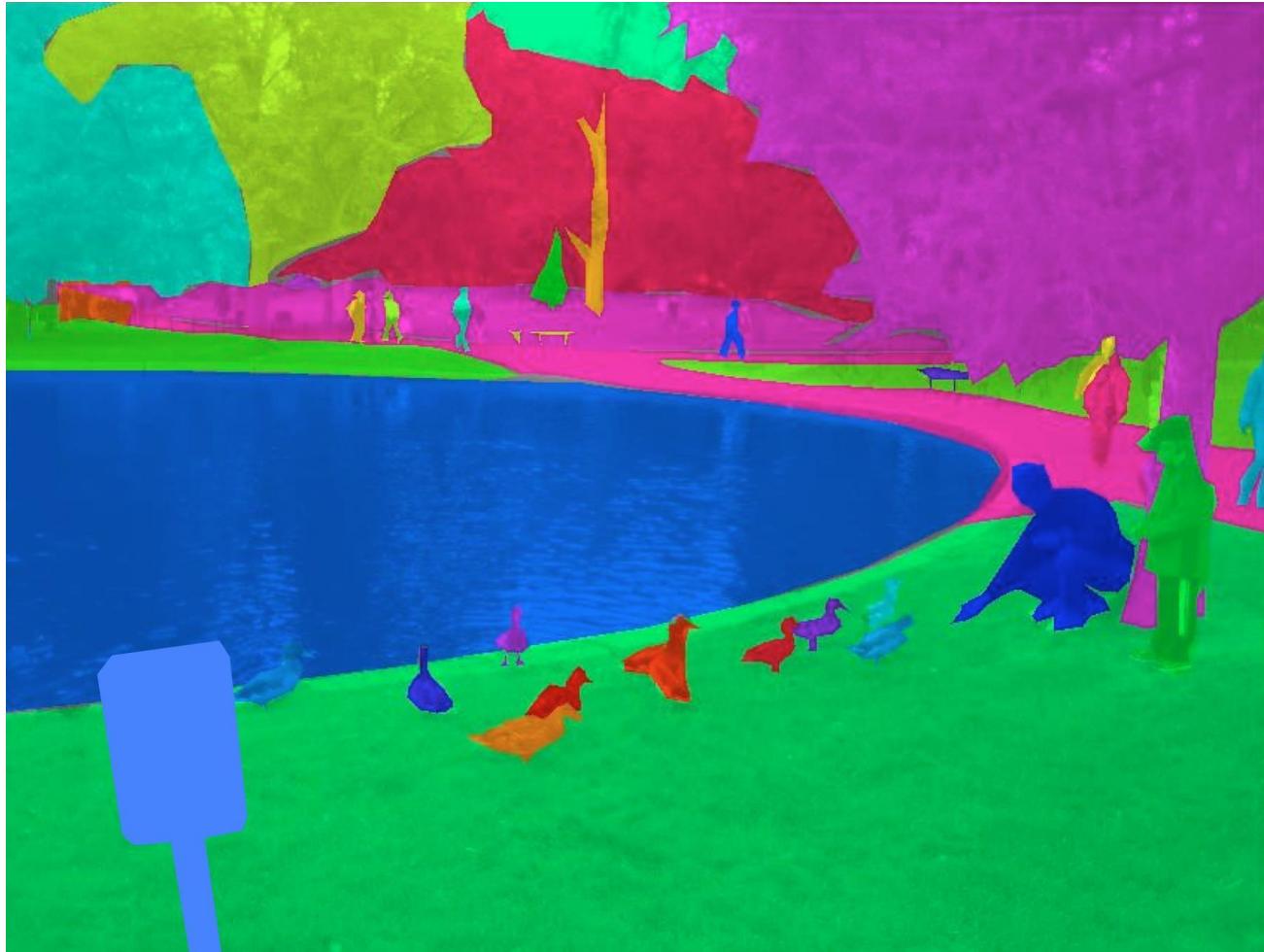
Tracking (multi-object)



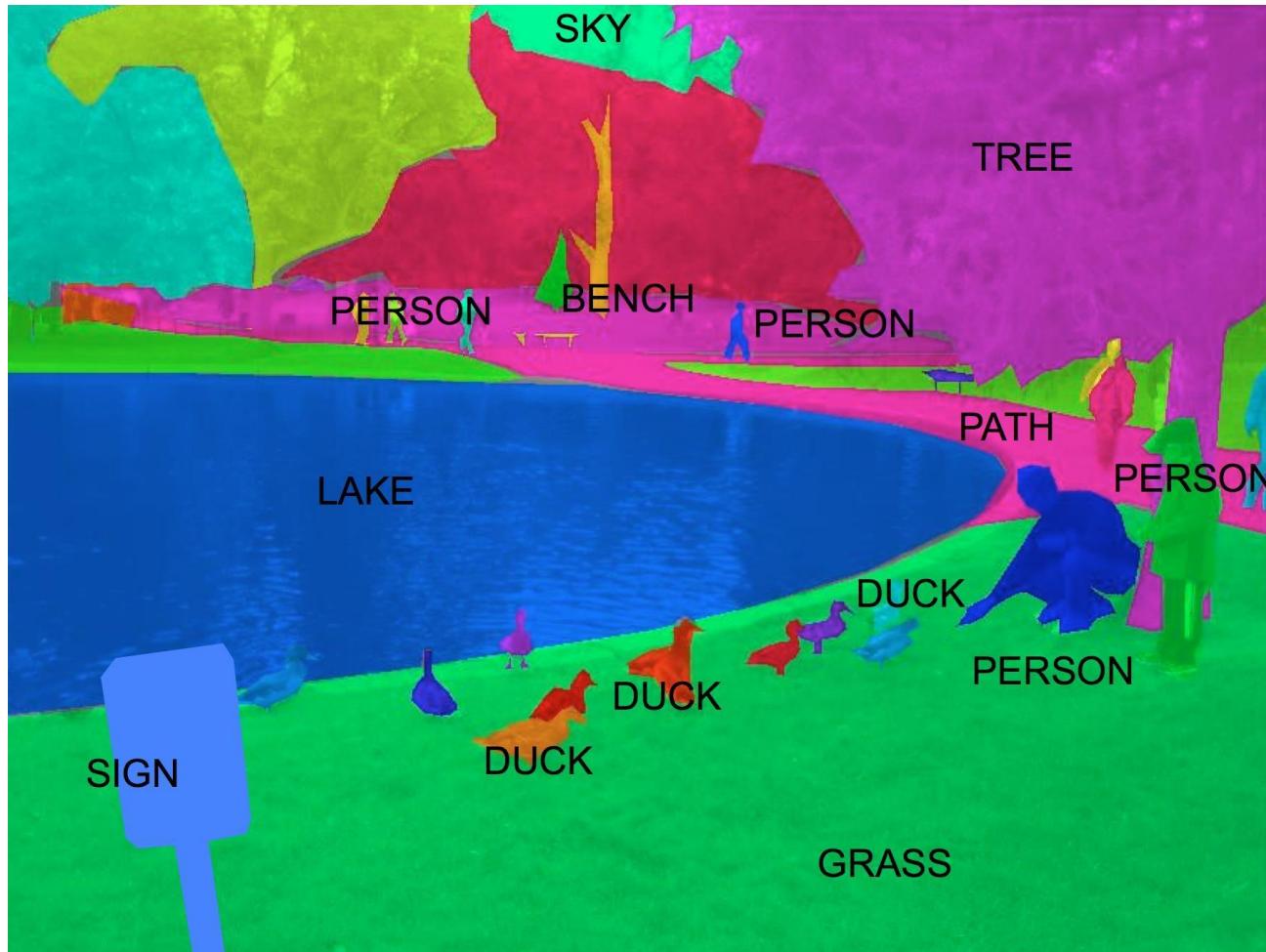
Semantic Segmentation



Segmentation



Segmentation



Segmentation



Video Clip

- Sequences of frames
- 30 frames per second



Sequences of Images



Action recognition – UCF101



Cycling



Diving



Golf Swinging



Riding



Volleyball



Basketball Shooting

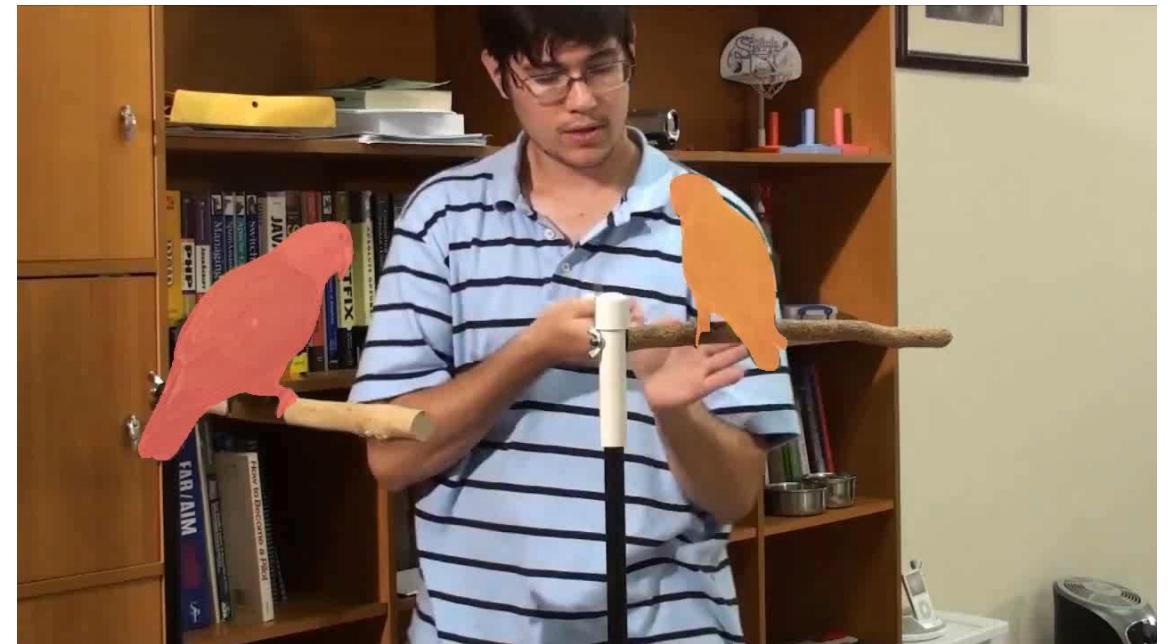


Swinging



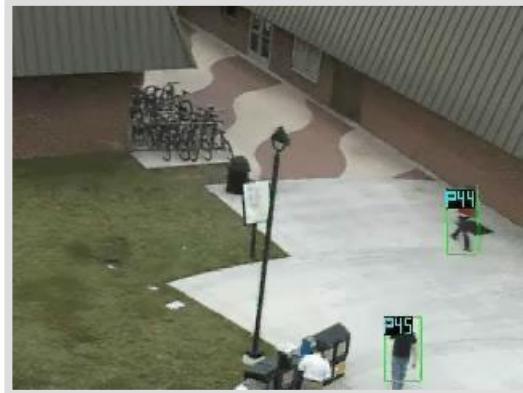
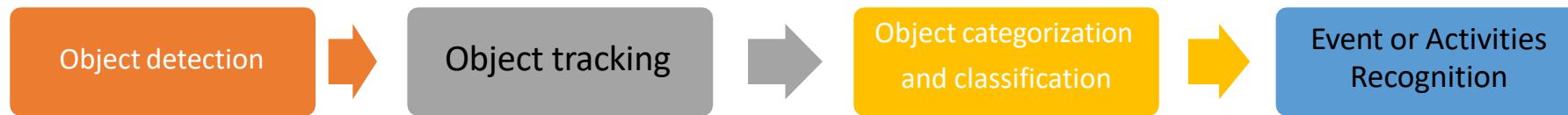
Tennis Swinging

Video segmentation



Duarte, Rawat, Shah, ICCV 2019

Video Surveillance and Monitoring



So.... How do we detect an object in an
Image?

Naïve approach: Template Matching with sliding window

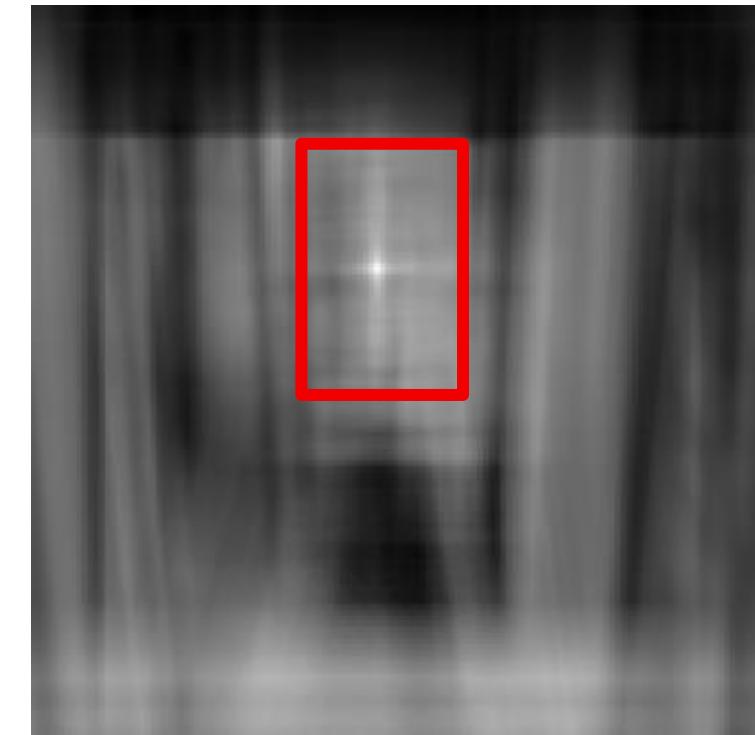
This is a chair



Find the chair in this image



Output of correlation



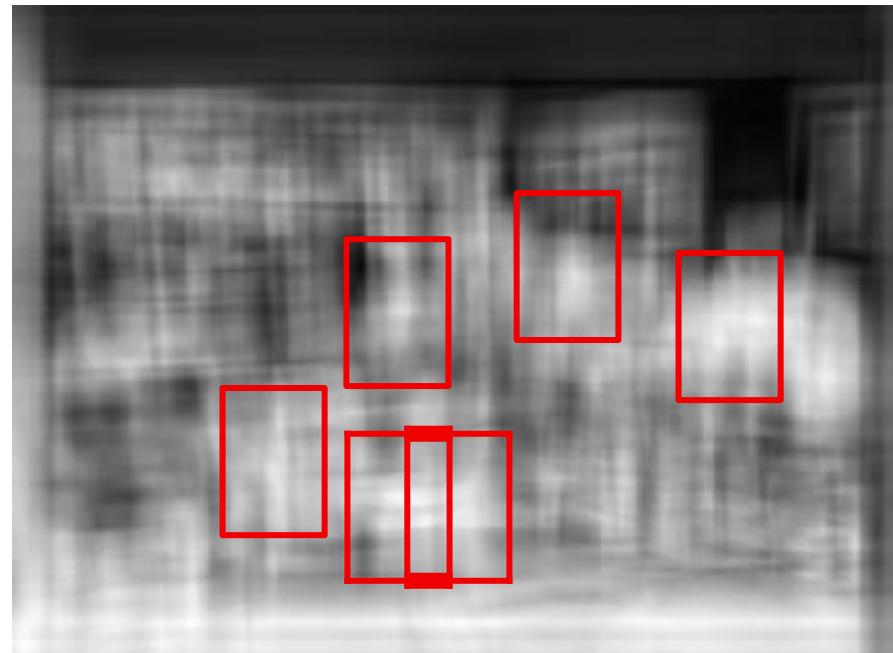
Template Matching

Find the chair in this image



Template Matching

Find the chair in this image



Epic fail!

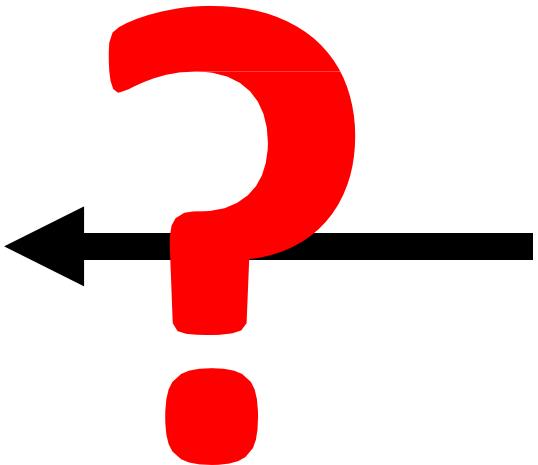
Simple template matching is not going to make it

Idea: Use patches with features (Not a SOTA)

- Instead of comparing raw image pixels:
 1. Extract multiple patches from the image of a specific category.
 2. Transform the pixels in these patches into a more robust representation, known as features.
 3. Compute the histogram of these features.
 4. For a new image, follow the same process: extract patches, find features, and calculate the histogram.
 5. Compare the histogram of the new image with the stored histogram. If the distance between them is small, the objects belong to the same class

- Features, examples:
 - compute edges
 - compute color histograms
 - gradients

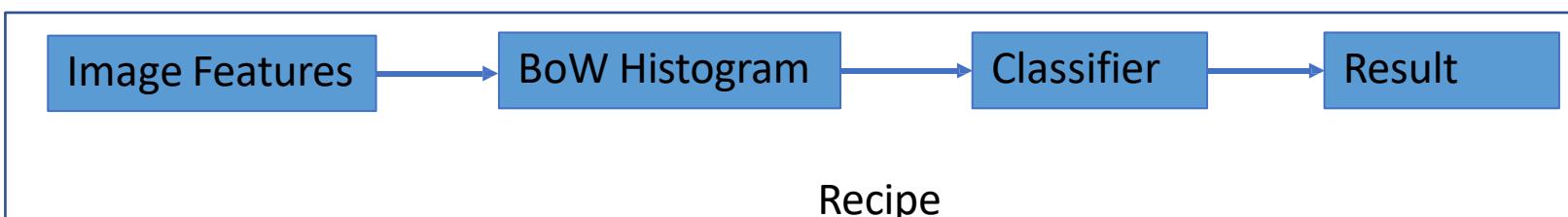
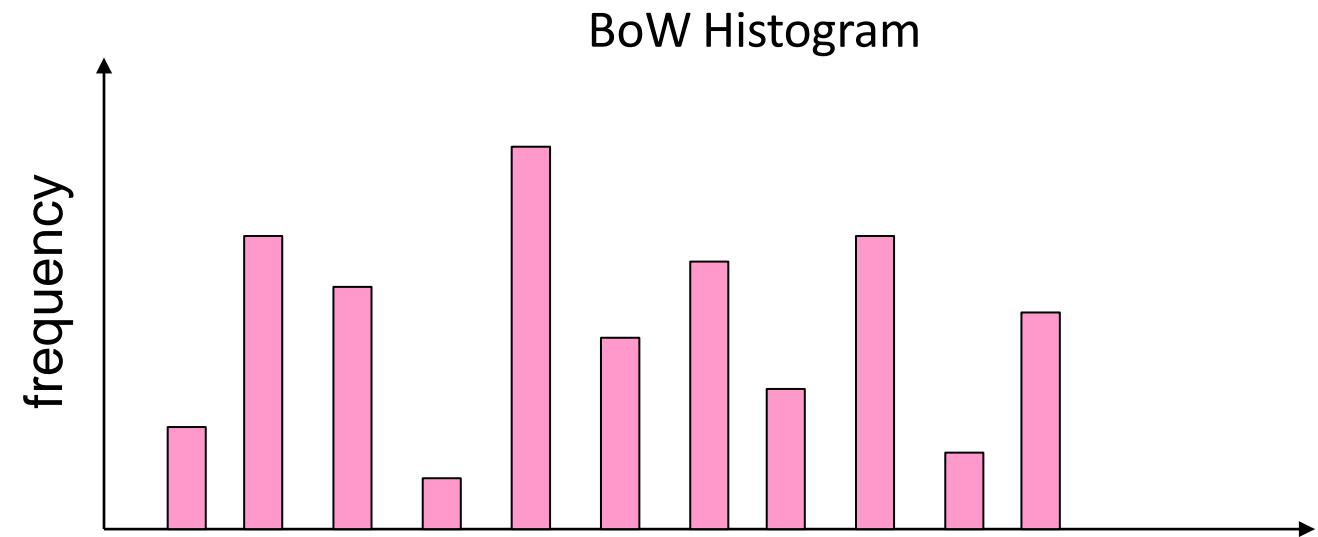
“Bag-of-feature/
Bag-of-histogram/ bag-of
words” Representation



“Bag-of-Words” (BoW) Histograms



Image



Some more applications

Retail – Amazon Go

<https://youtu.be/NrmMk1Myrxc>



Retail - Clothing

<https://youtu.be/Mr71jrkzWq8>



Self-driving - Waymo

<https://youtu.be/TsaES--OTzM>

