Introduction

16-385 Computer Vision
Fall 2023, Lecture 1

Overview of today's lecture

- Teaching staff introductions
- What is computer vision?
- Course fast-forward and logistics

Teaching staff introductions

Hi!

Matthew O’Toole (Instructor)

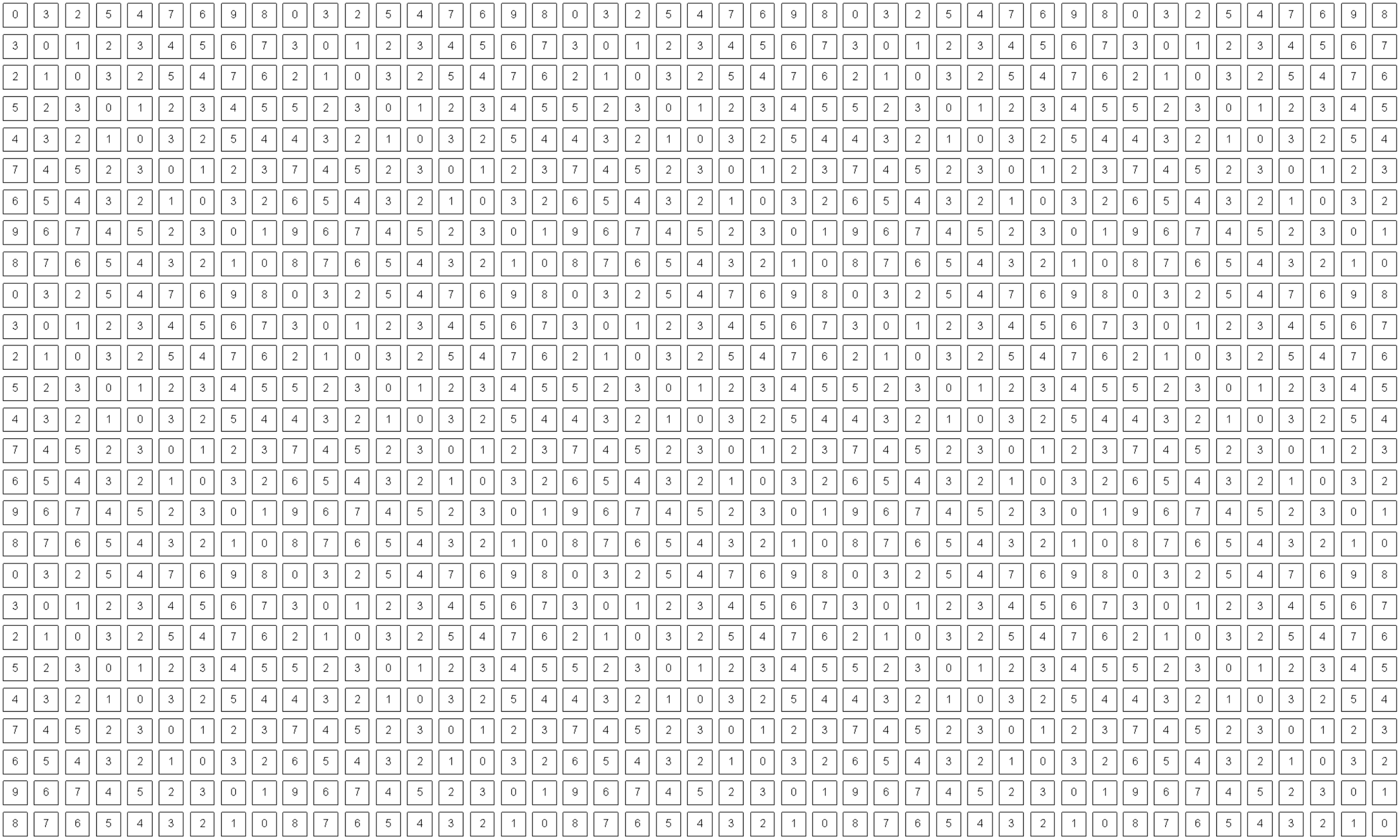
Jinhyung (David) Park

Tianyi Zhang

Minh Tran

What is computer vision?

What a person sees



What a computer sees

Why are we able to interpret this image?

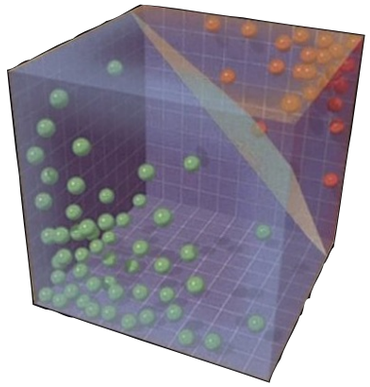
The goal of computer vision is

to give computers

(super) human-level perception

typical perception pipeline

representation

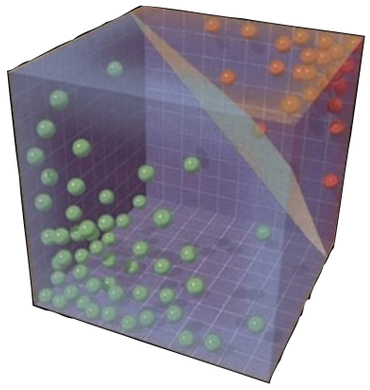


‘fancy math’

output

typical perception pipeline

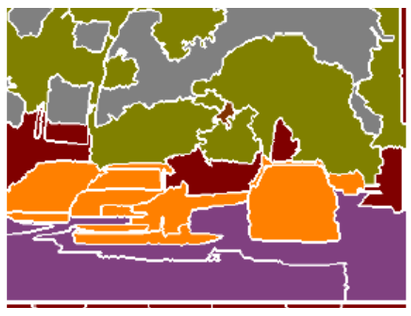
representation



‘fancy math’

what should we look at?
(image features)

output



what can we understand?
(semantic segmentation)

Important note:

In general, computer vision does not work

Important note:

In general, computer vision does not work

(except in certain situations/conditions)

Applications of computer vision

Object Recognition

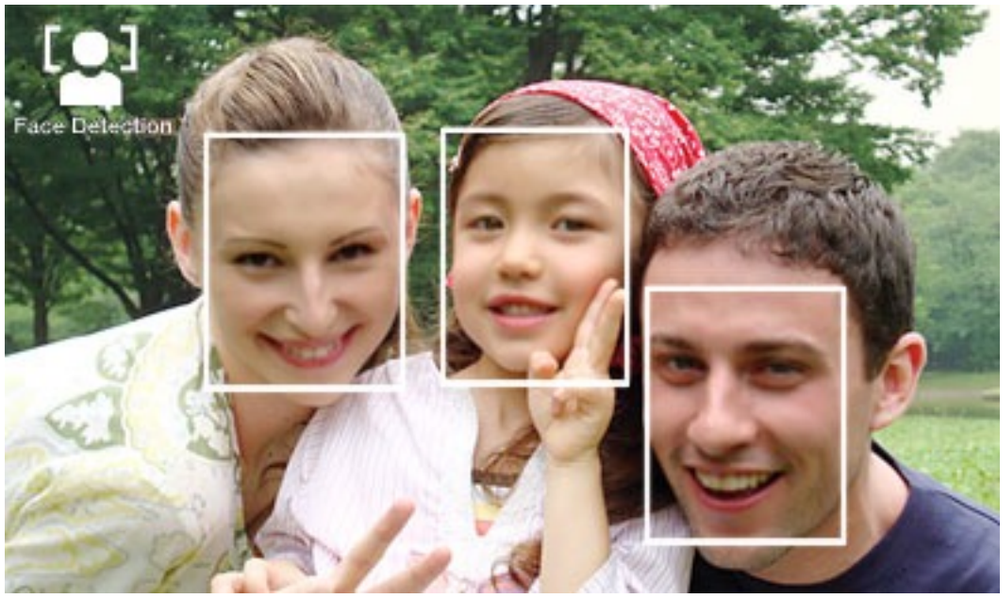


Toshiba Tech IS-910T 2013

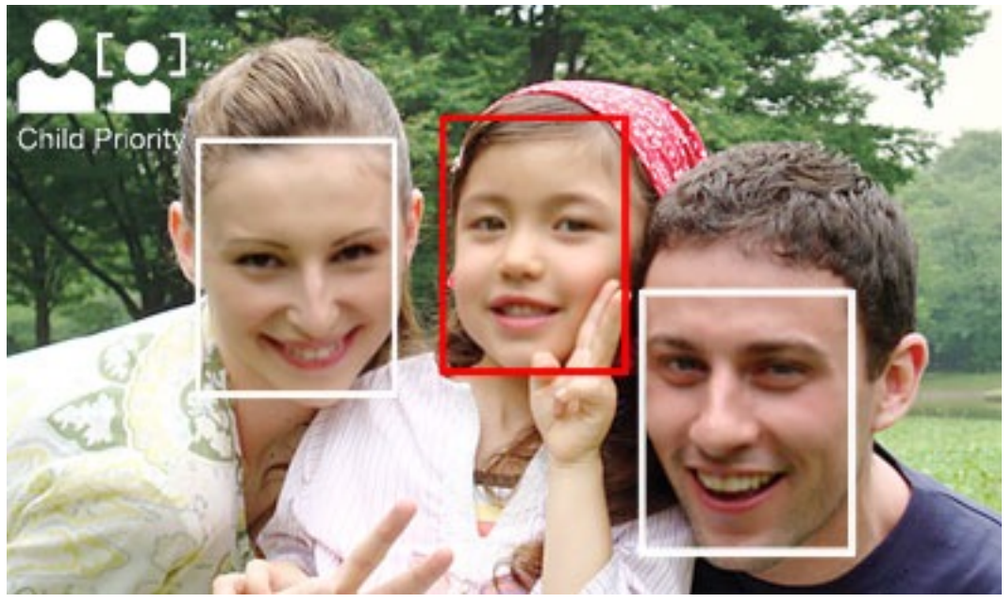

DataLogic LaneHawk LH4000 2012

Object Recognition

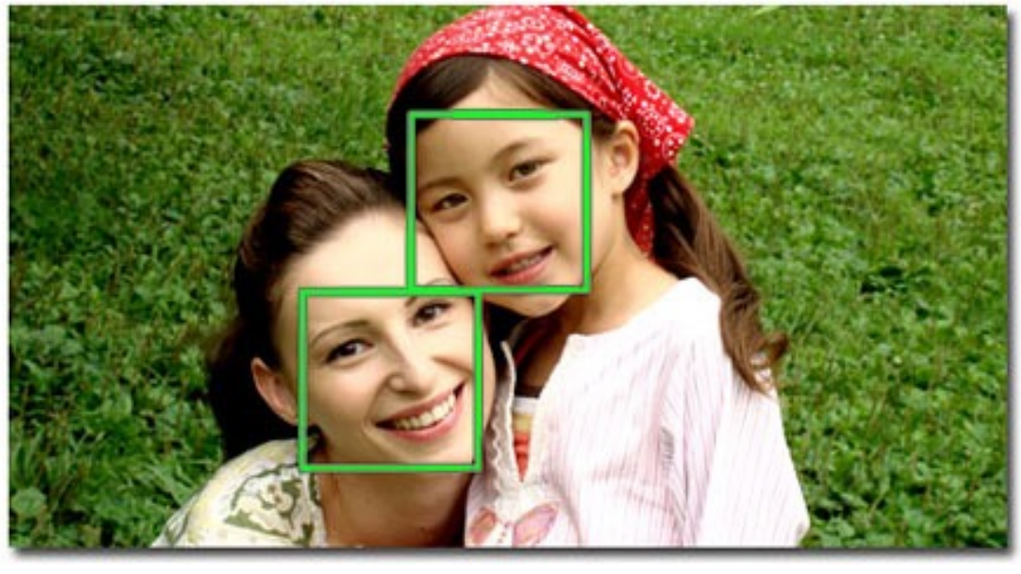
Face detection



Sony Cyber-shot

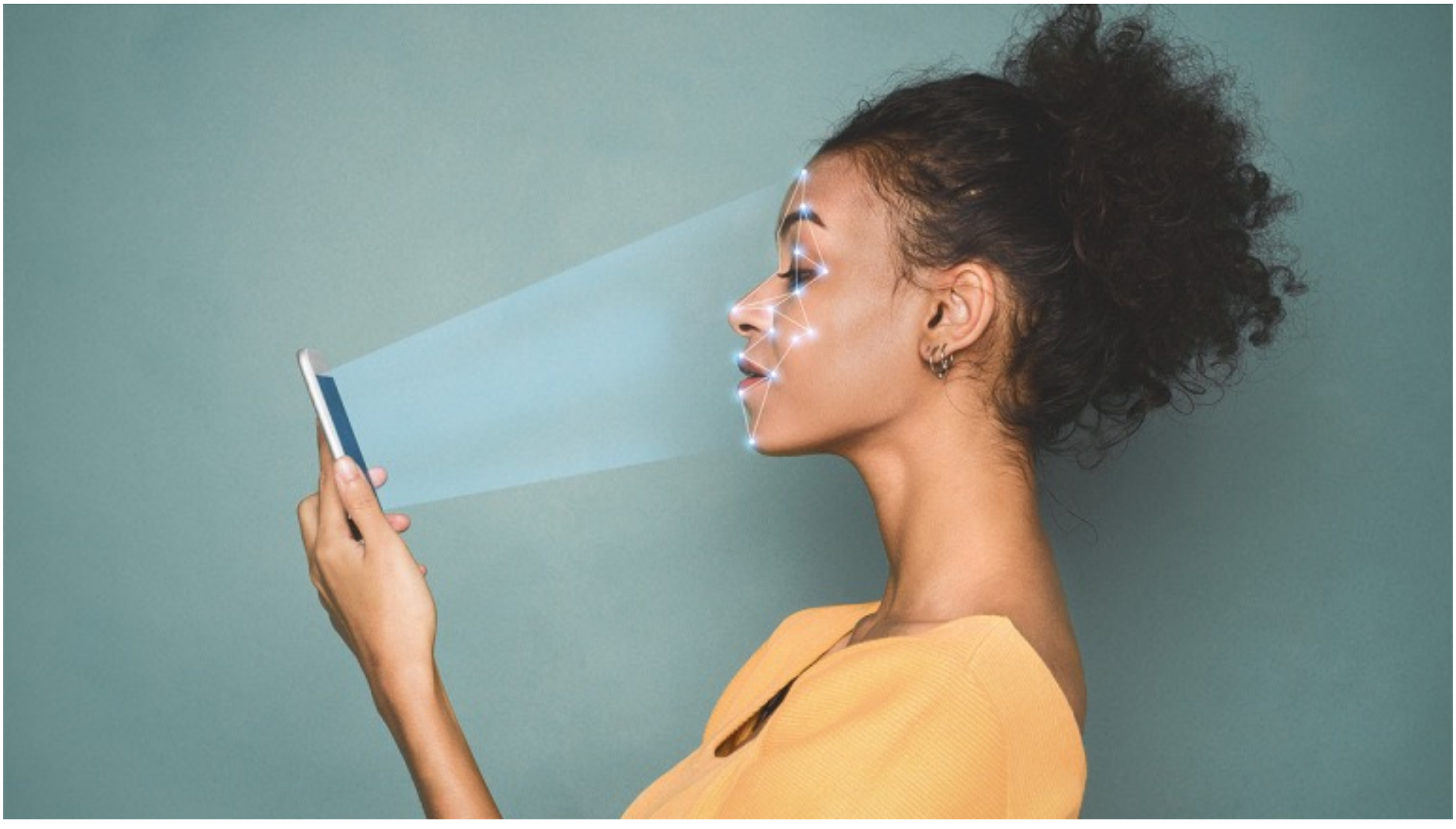


Age recognition



Smile recognition

Face ID

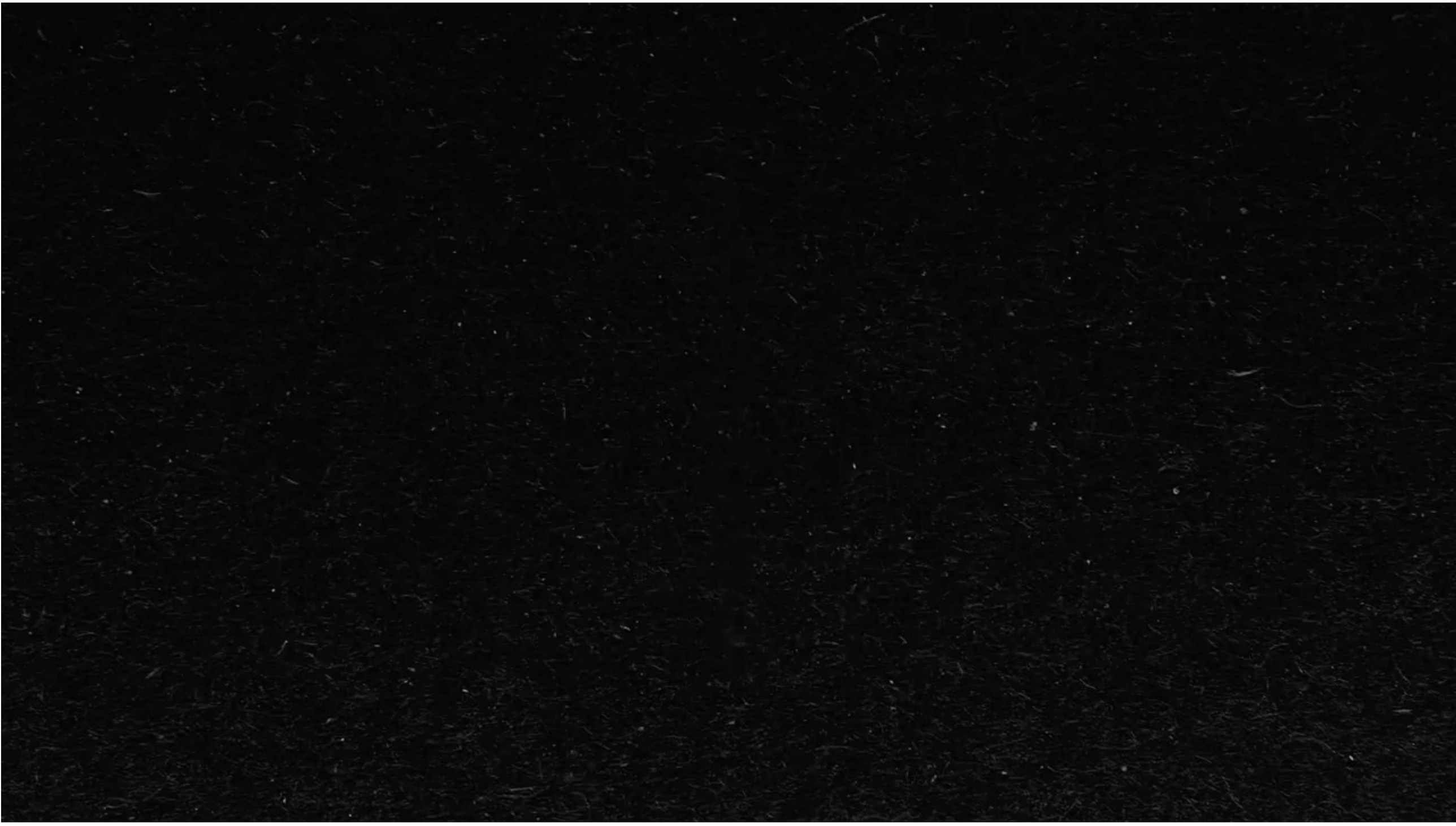


Face ID

Identifying plants

Google translate

First-down line



Vision in Cars

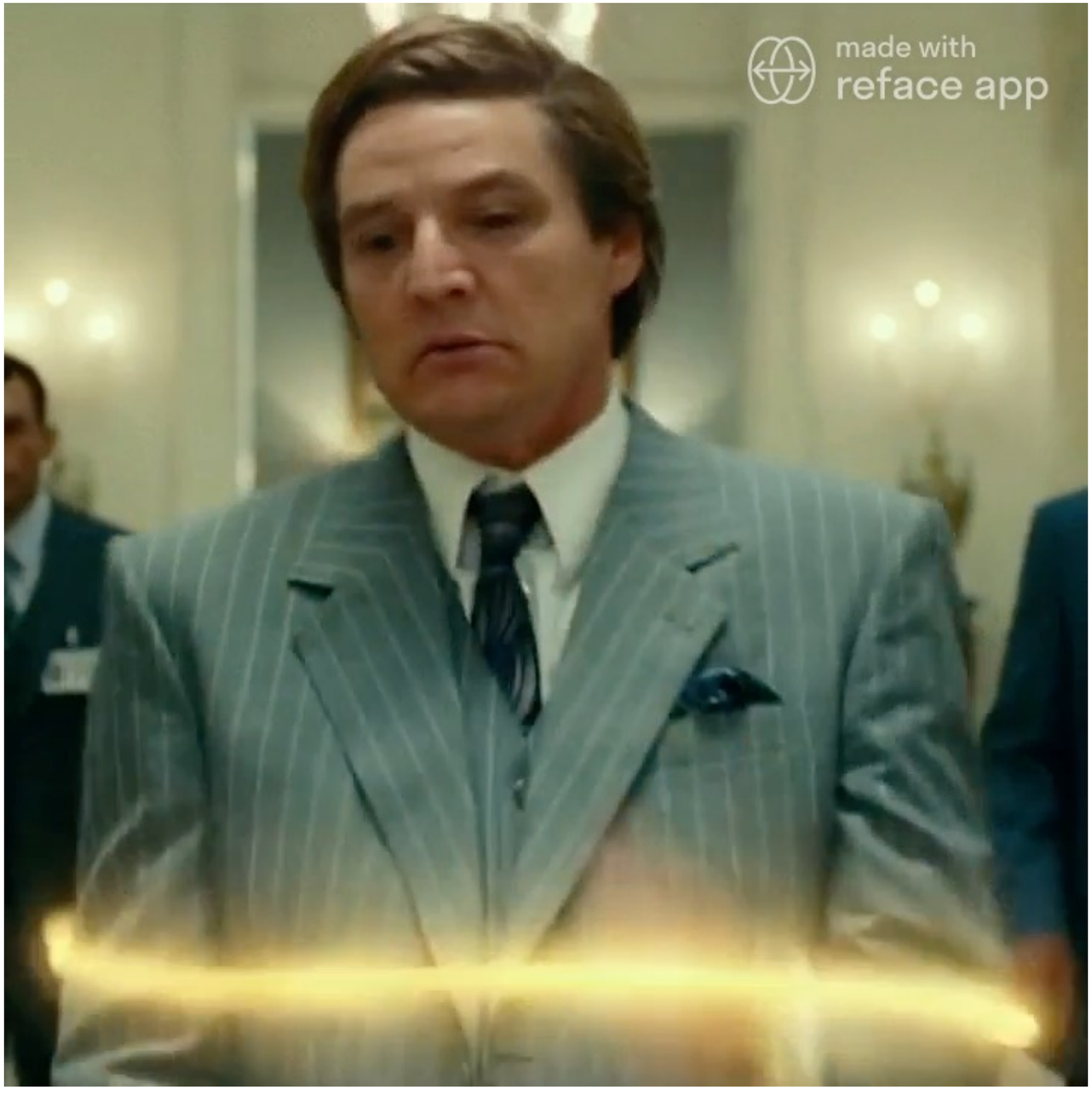
Image stitching

3D Scanning

Style Transfer

Deep Fake

Deep Fake



It’s a good time to do computer vision

Industry aggressively hiring CV faculty from universities

UW

Berkeley

CMU

Toronto

UBER

UCLA

USC

Dropbox

UCSD

Columbia

NYU

CMU CMU

NVIDIA

Toronto

amazon.com

CalTech UW

Stanford

CMU

Stanford

NYU

GTech

GTech

UT Austin

NYU

Google

Zillow

Oculus VR

ARGO AI

CMU

IBM

SFU

CMU

CMU CMU GTech

CMU

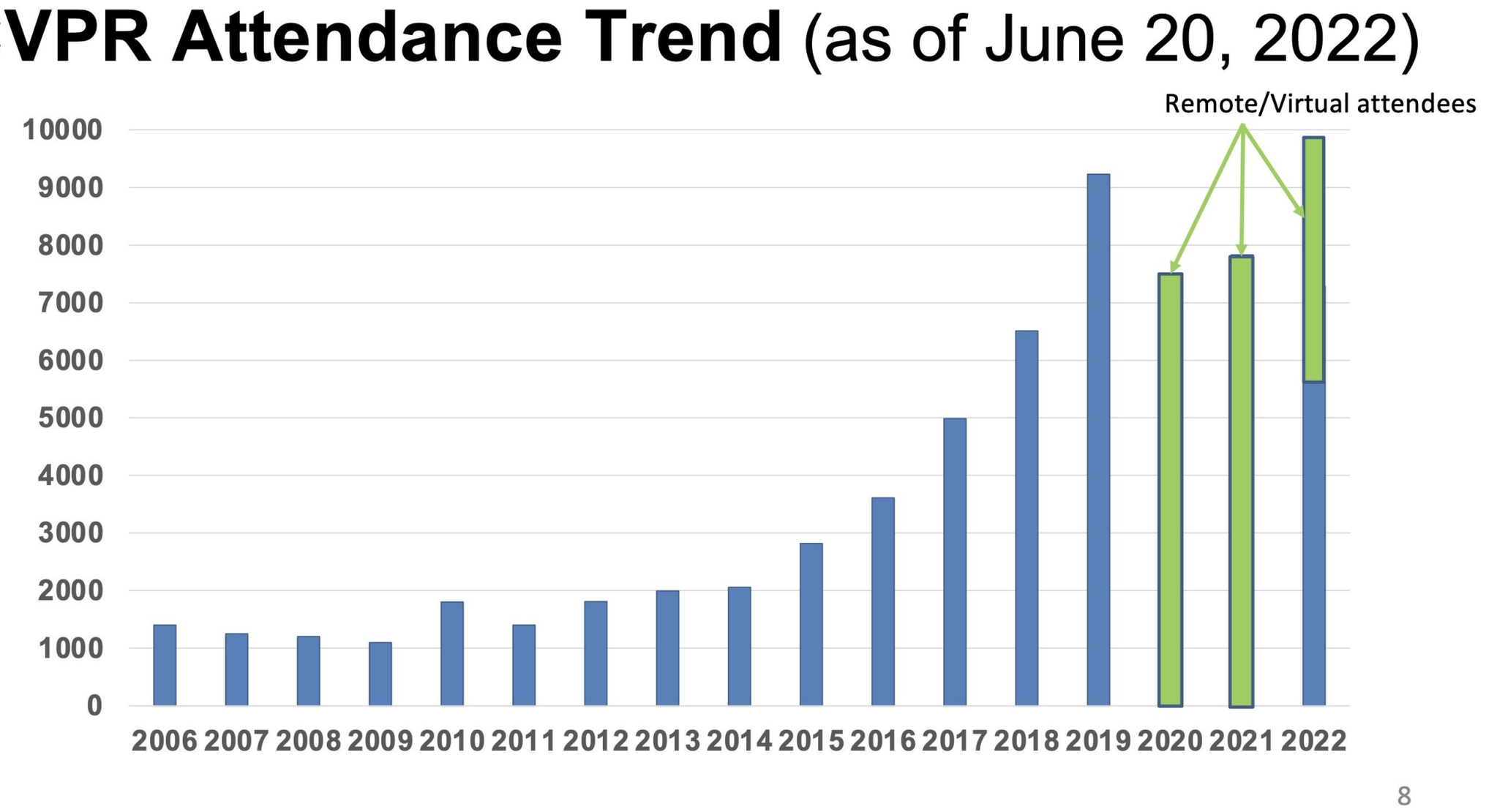
MIT

MIT Toronto UW

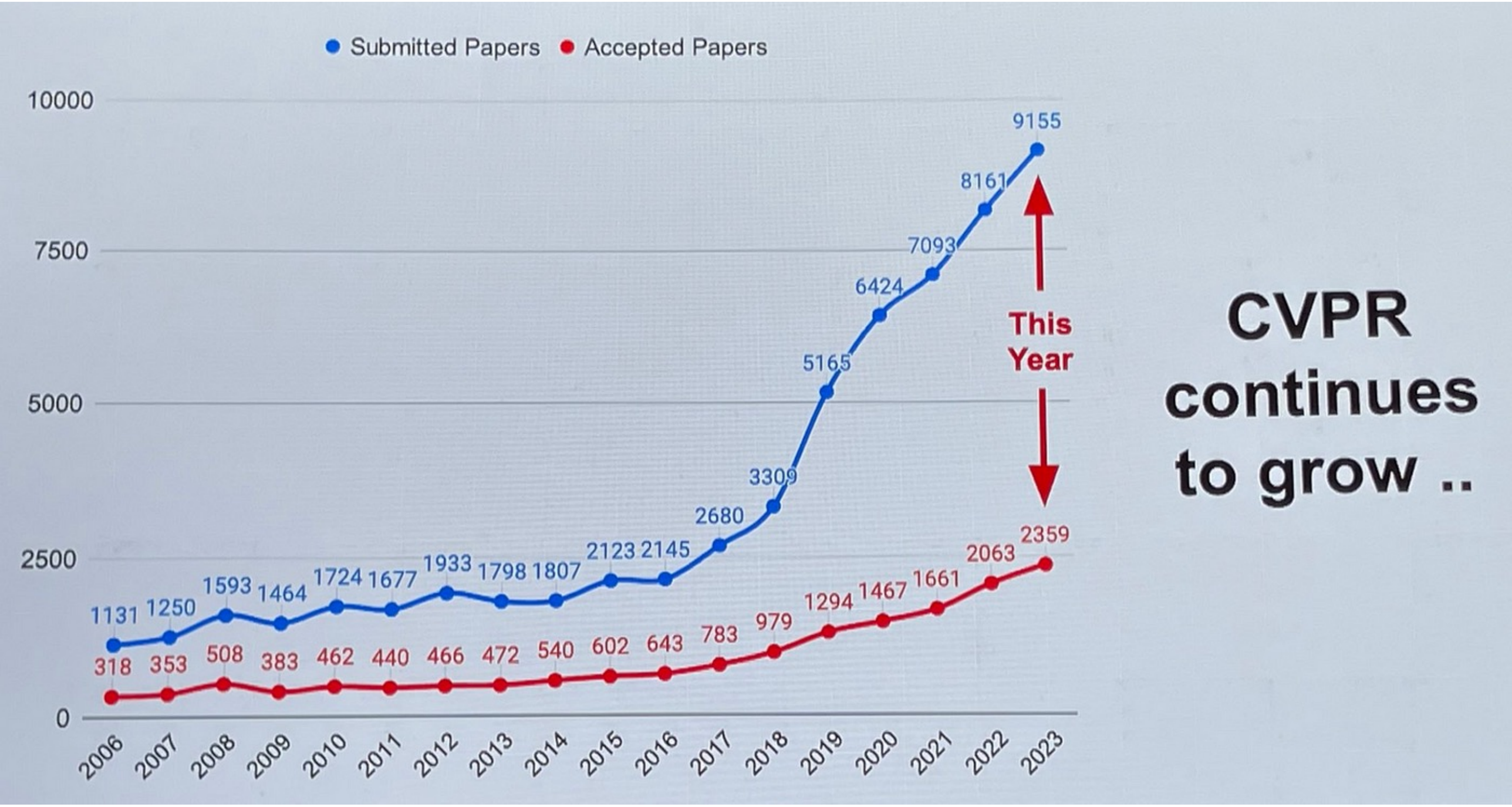
Industry aggressively hiring CV graduates, or even students!

(~~strong~~ dominant industrial presence at conferences for recruitment)

Stats for CVPR (Computer Vision and Pattern Recognition)



Stats for CVPR (Computer Vision and Pattern Recognition)



1	3D from multi-view and sensors	1,090	246
2	Image and video synthesis and generation	889	185
3	Humans: Face, body, pose, gesture, movement	813	166
4	Transfer, meta, low-shot, continual, or long-tail learning	688	153
5	Recognition: Categorization, detection, retrieval	673	139
6	Vision, language, and reasoning	631	118
7	Low-level vision	553	126
8	Segmentation, grouping and shape analysis	524	113
9	Deep learning architectures and techniques	485	92
10	Multi-modal learning	450	89
11	3D from single images	431	91
12	Medical and biological vision, cell microscopy	420	53
13	Video: Action and event understanding	373	83
14	Autonomous driving	359	69
15	Self-supervised or unsupervised representation learning	349	71
16	Datasets and evaluation	344	54
17	Scene analysis and understanding	276	54
18	Adversarial attack and defense	274	61
19	Efficient and scalable vision	252	48
20	Computational imaging	226	53
21	Video: Low-level analysis, motion, and tracking	215	46
22	Vision applications and systems	171	35
23	Vision + graphics	155	32
24	Robotics	141	23
25	Transparency, fairness, accountability, privacy, ethics in vision	129	30
26	Explainable computer vision	107	24
27	Embodied vision: Active agents, simulation	80	14
28	Document analysis and understanding	72	12
29	Machine learning (other than deep learning)	65	14
30	Physics-based vision and shape-from-X	55	12
31	Biometrics	51	11
32	Others	47	12
33	Optimization methods (other than deep learning)	46	12
34	Photogrammetry and remote sensing	38	8
35	Computer vision theory	33	5
36	Computer vision for social good	25	5

Computer vision at CMU

Dedicated courses for each subject we cover in this class:

- Physics-based Methods in Vision
- Geometry-based Methods in Computer Vision
- Computational Photography
- Visual Learning and Recognition
- Statistical Techniques in Robotics
- Sensors and sensing

… plus an entire department's worth of ML courses.

Master in Computer Vision at CMU

Course logistics

Website

http://16385.courses.cs.cmu.edu/

(includes links to Canvas and Piazza)

Assignments Canvas

https://canvas.cmu.edu/courses/37379

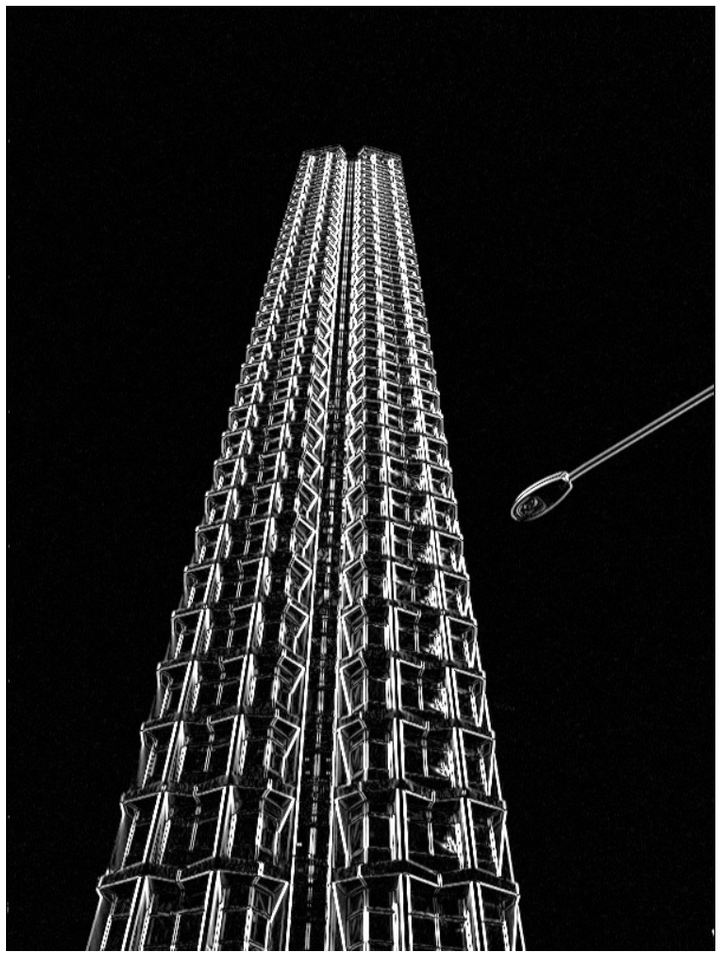
Discussion & Notes piazza

https://piazza.com/class/lluyey2bprp44v

Topics to be covered

Image processing:

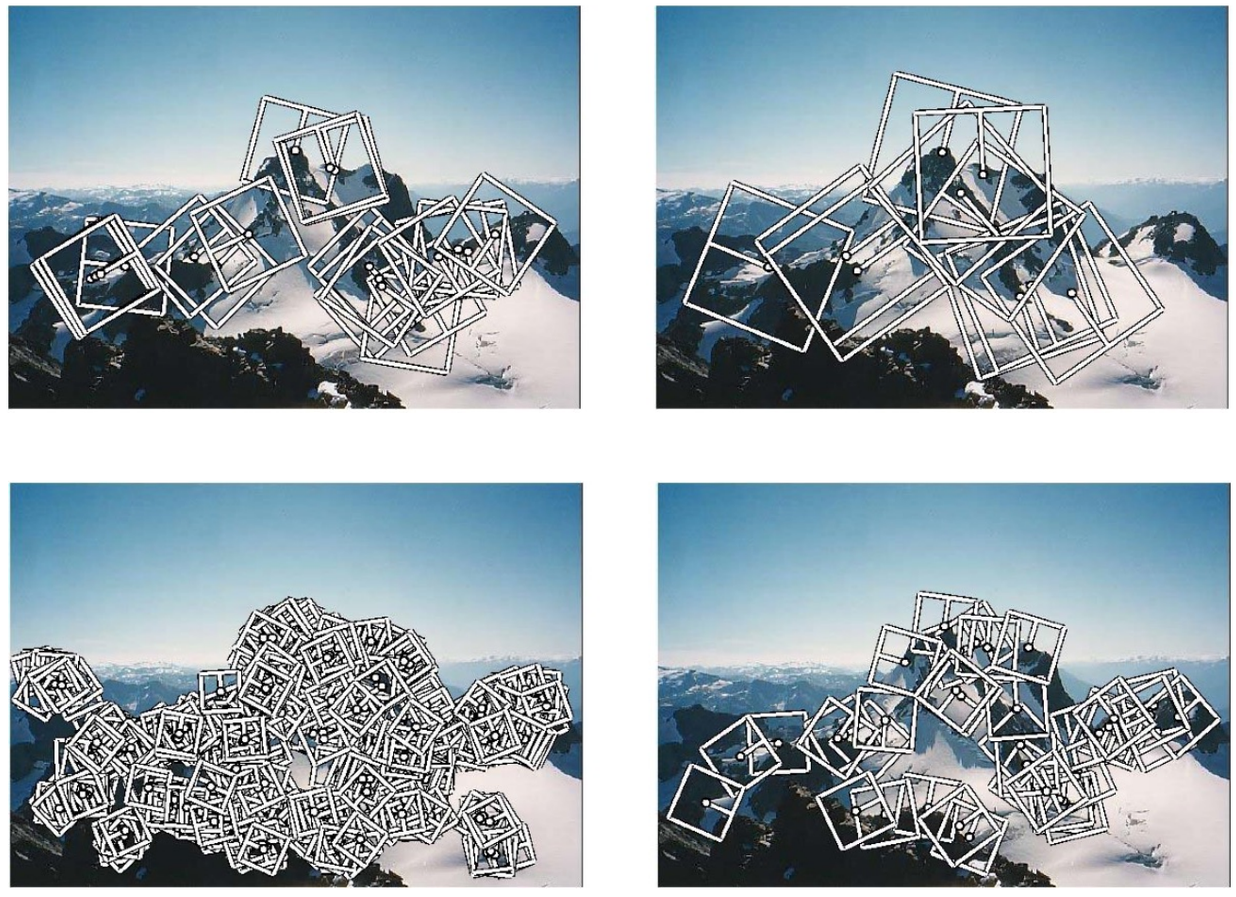
- Basics of filtering.
- Image pyramids.
- Gradients and lines.
- Hough transforms.



Topics to be covered

Feature detection and correspondences:

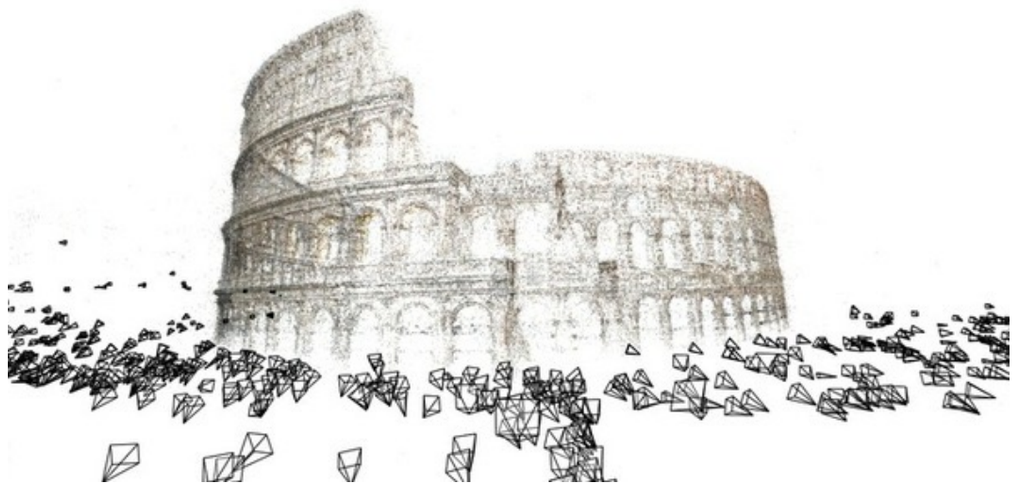
- Corner detection.
- SIFT et al.
- Feature descriptors.
- RANSAC.



Topics to be covered

Transformations and geometry:

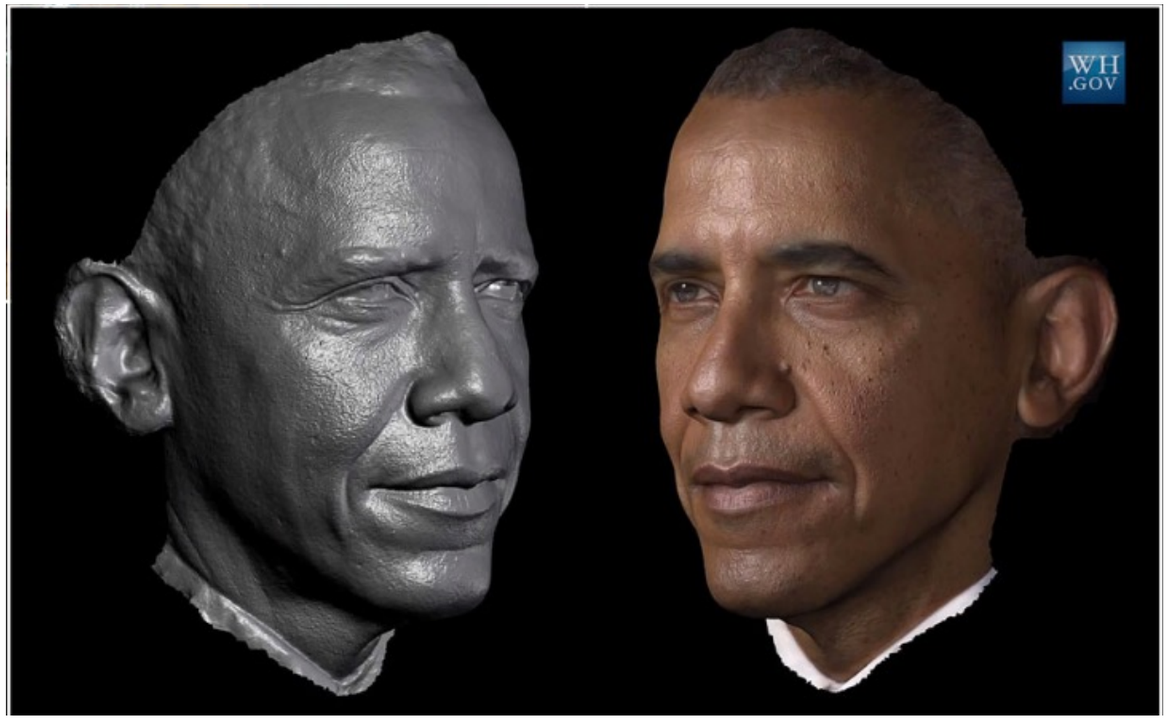
- Homographies and image alignment.
- Camera models.
- Fundamental matrix.
- Epipolar geometry and stereo.
- Structure from motion.



Topics to be covered

Physics-based vision:

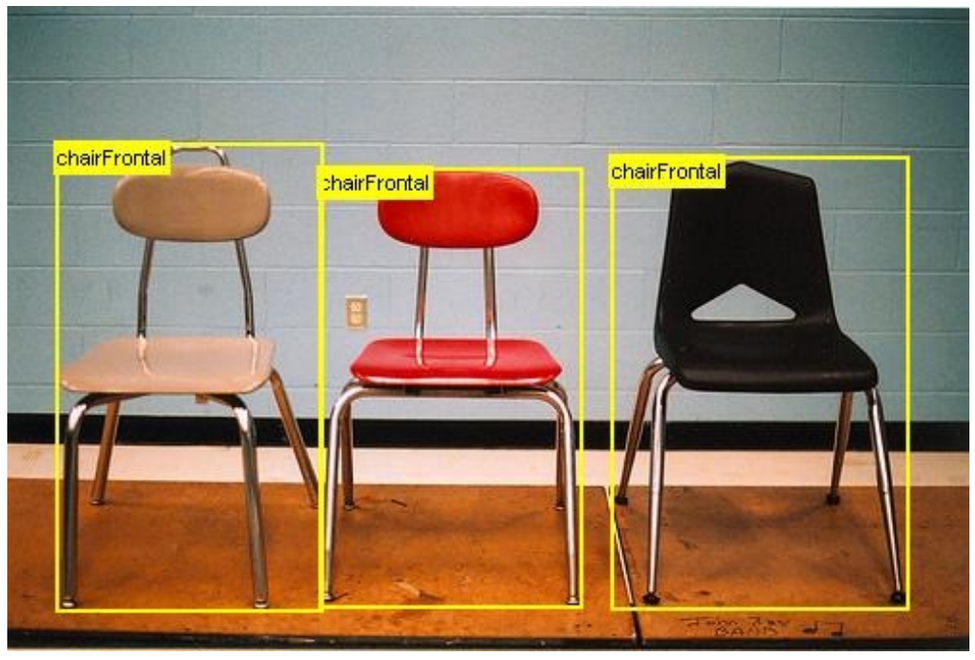
- Reflectance and image formation.
- Radiometry.
- Shape from shading.
- Photometric stereo.
- Color.



Topics to be covered

Objects, faces, and learning:

- Basics of probability.
- K-means, KNN, PCA, SVM.
- Bag of words.
- Viola-Jones face detection.
- Perceptron, backpropagation.
- Convolutional neural networks.



Topics to be covered

Dealing with motion:

- Optical flow (LK, HS).
- Image registration.
- Kalman Filtering.
- Tracking (KLT, Mean-Shift).

Grading

- Six two-week programming assignments: 97%
- Class, Website, and Piazza participation: 3%

Participation:

- Be active! Ask questions.
- Post on Piazza and course website.

Programming Assignments

- a lot of programming in Python
- hours and hours of programming
- days and days of debugging
- generous grading policy
- take advantage of extra credit

Assignment 1 Hough Transform
Assignment 2 Homography
Assignment 3 Stereo
Assignment 4 Bag of Words
Assignment 5 Convolutional Neural Nets
Assignment 6 Image Alignment

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Assignment 6 Image Alignment

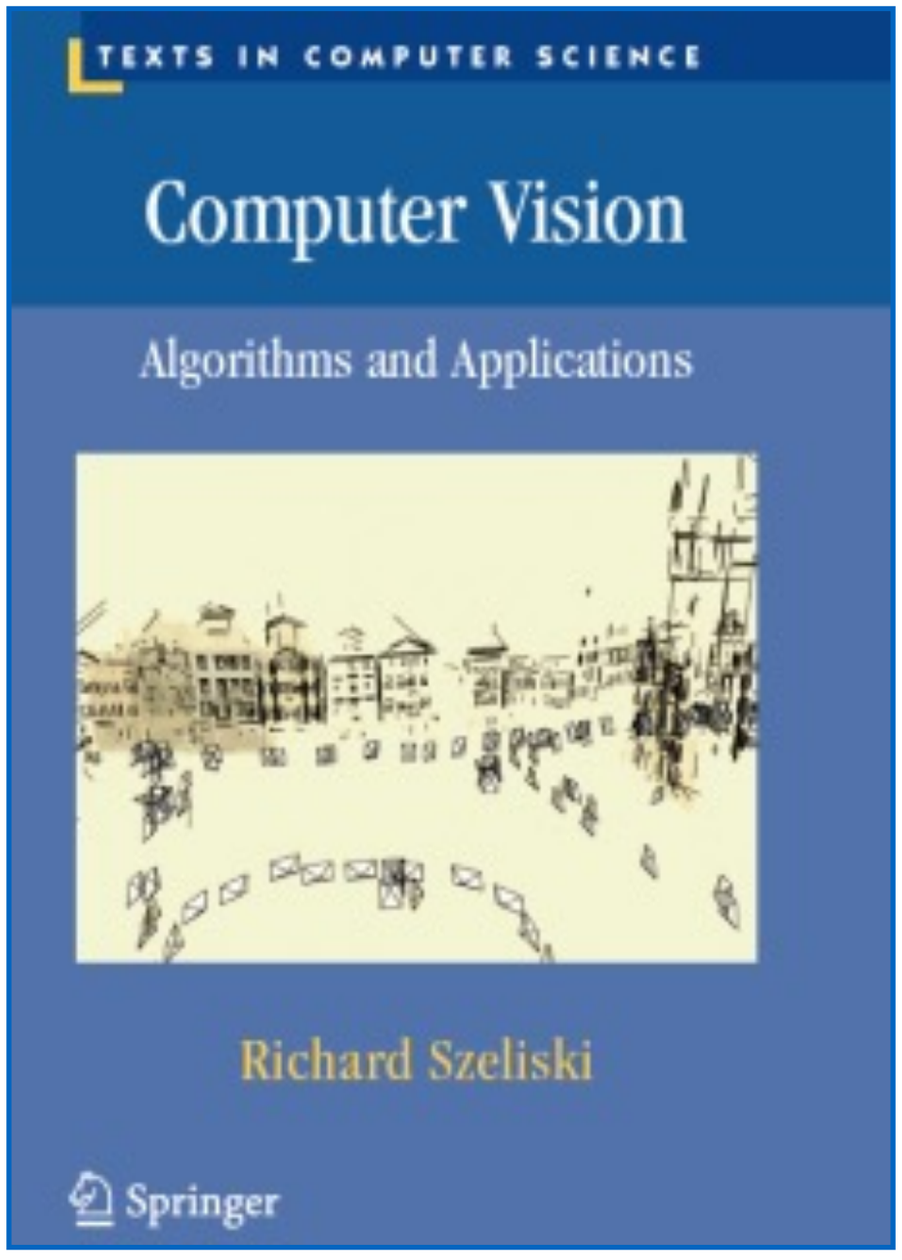
Seriously.. a lot of programming, so start early!

Leniency

Late days for programming assignments:

- 10% reduction of points per late day
- 6 free late days total
- use them wisely… save for later (harder) assignments!

Book



PDF online

http://szeliski.org/Book/

Contact information

- Feel free to email us about administrative questions.
  - please use [16385] in email title!
- Lecture questions should be asked on course website (or in lecture), and assignment/logistic questions should be asked on Piazza.
  - we won't answer technical questions through email.
  - you can post anonymously if you prefer.
- Office hours will be determined by poll.
  - feel free to email me about additional office hours.