

Introduction



16-385 Computer Vision
Fall 2022, 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)



Benjamin Attal



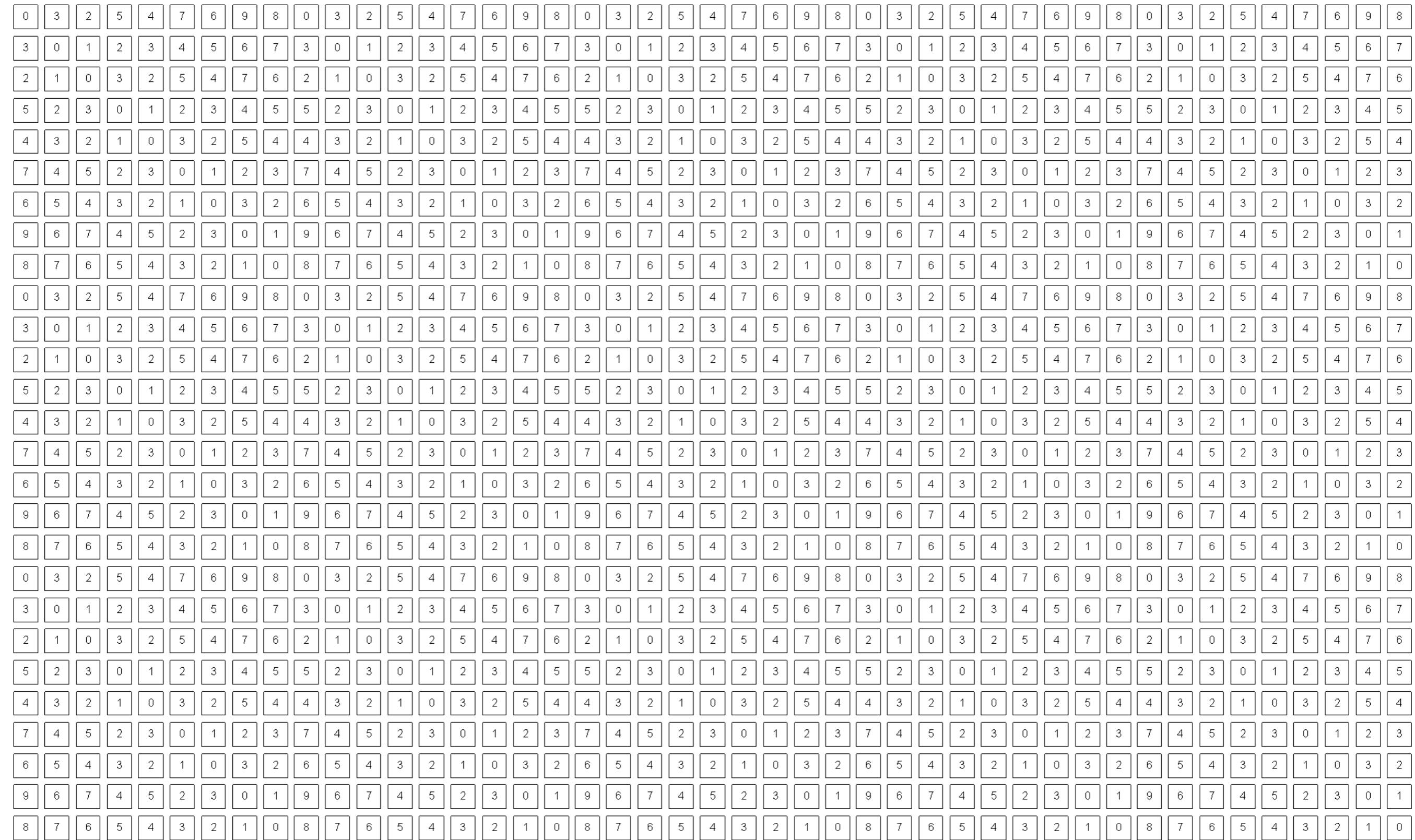
Emily Kim

What is
computer vision?



Photo by Svetlana Lazebnik

What a person sees



What a computer sees



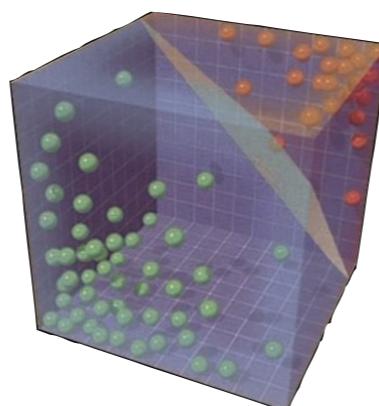
Photo by Svetlana Lazebnik

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



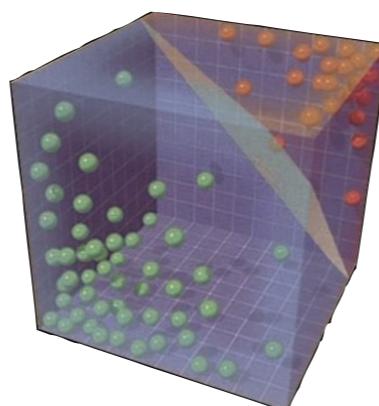
'fancy math'



output

typical perception pipeline

representation



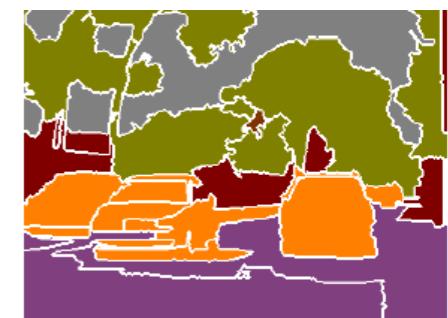
'fancy math'



output

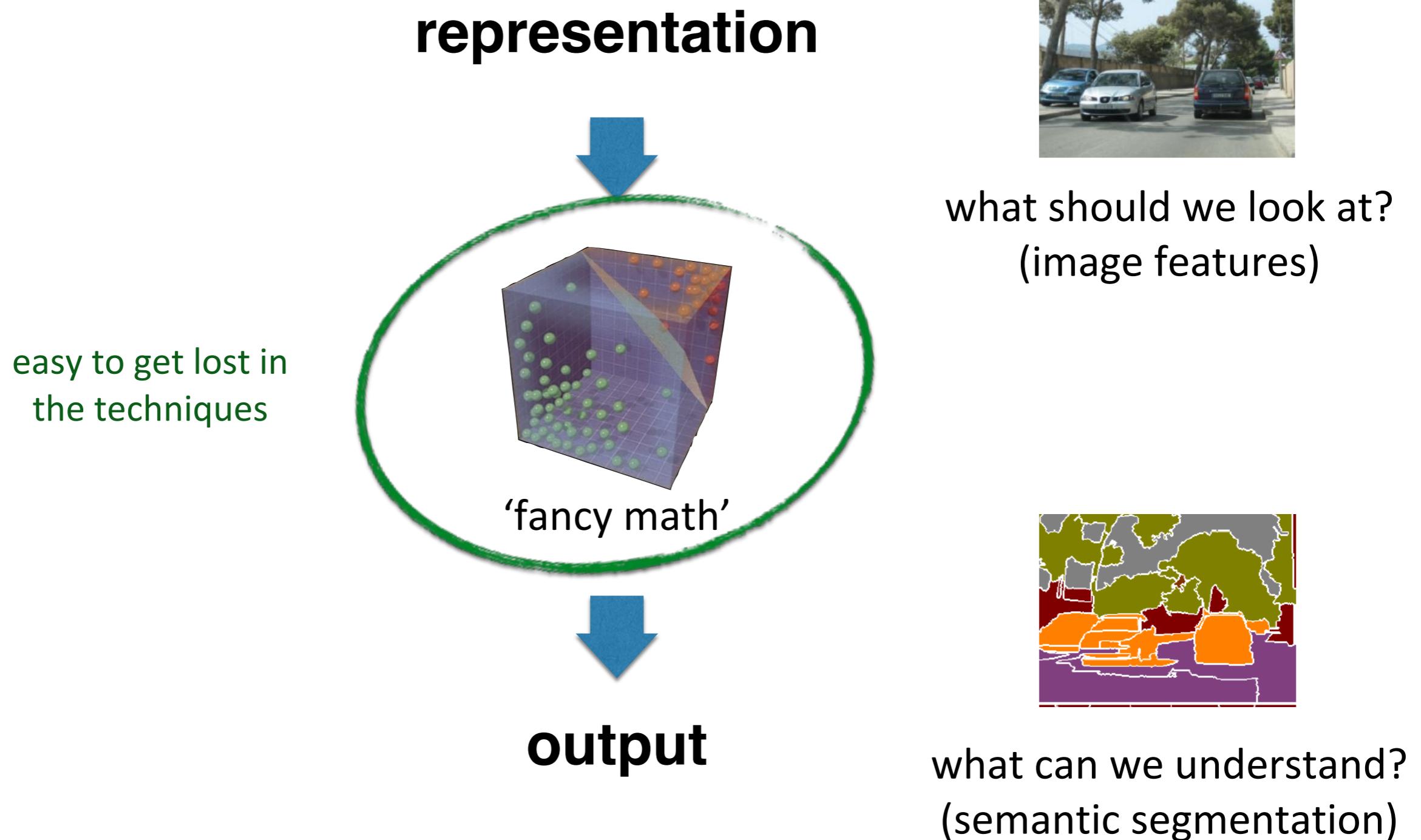


what should we look at?
(image features)

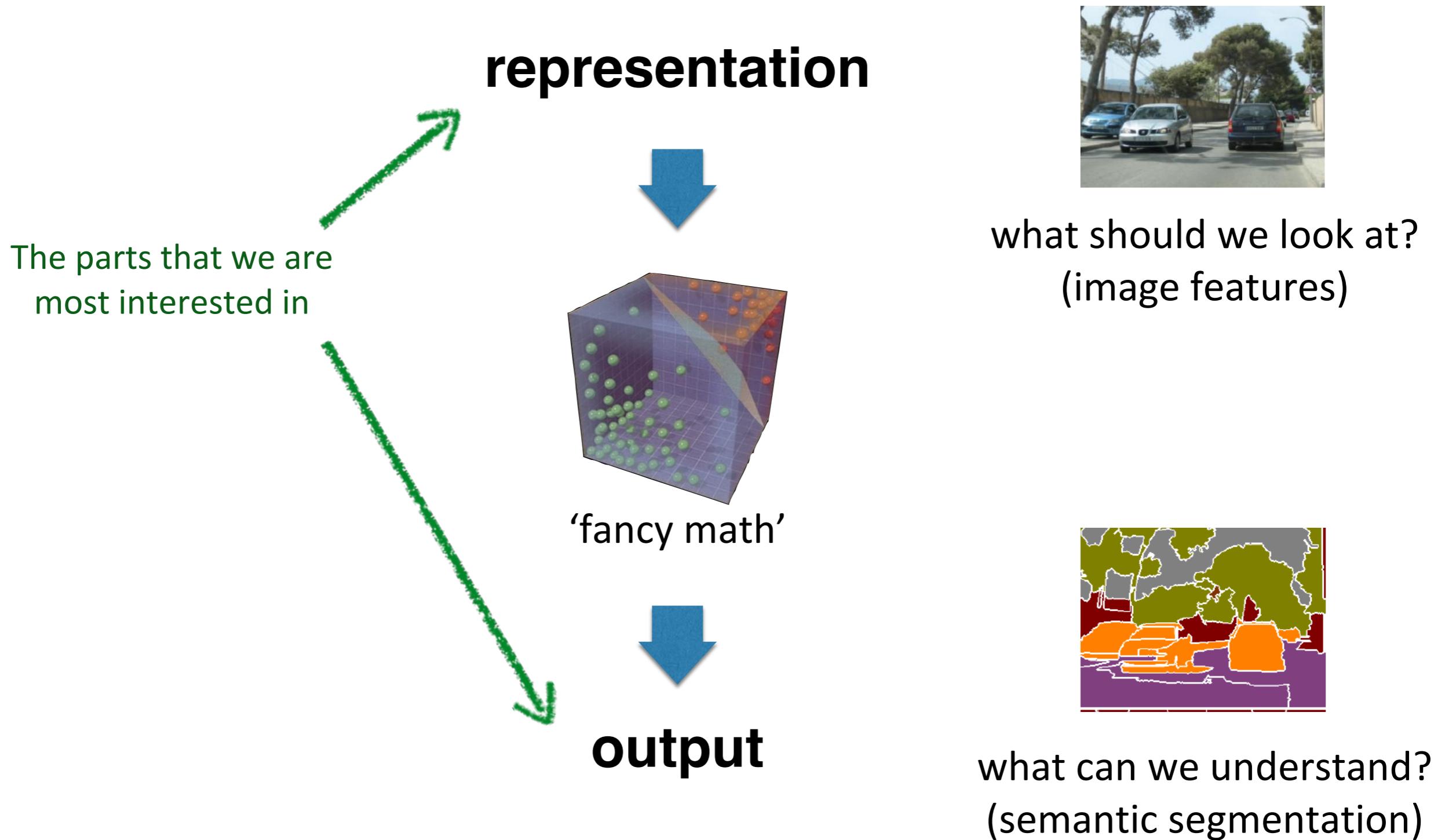


what can we understand?
(semantic segmentation)

typical perception pipeline



typical perception pipeline



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

Machine Vision



Automated visual inspection

Object Recognition



Toshiba Tech IS-910T

2013



DataLogic LaneHawk LH4000

2012

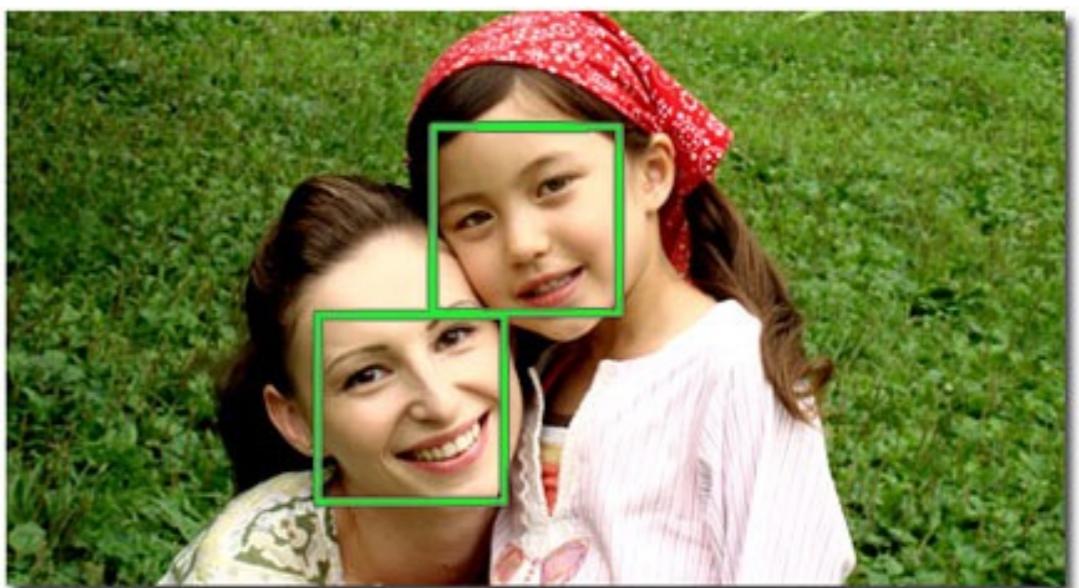
Face detection



Sony Cyber-shot



Age recognition



Smile recognition

Face ID



Face ID



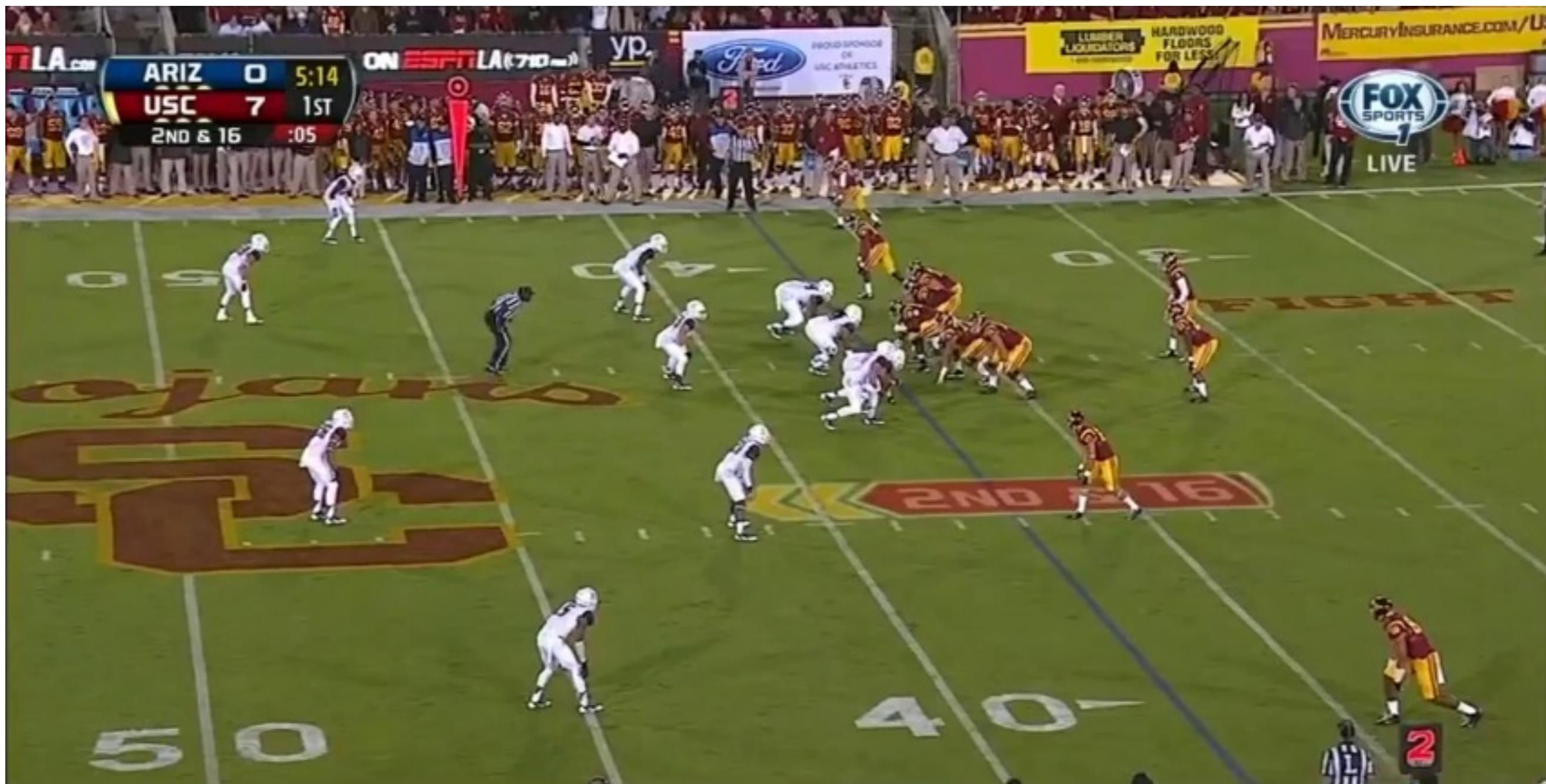
Identifying plants



Google translate



First-down line





BMW 5 series

BMW night vision



Vision in Cars



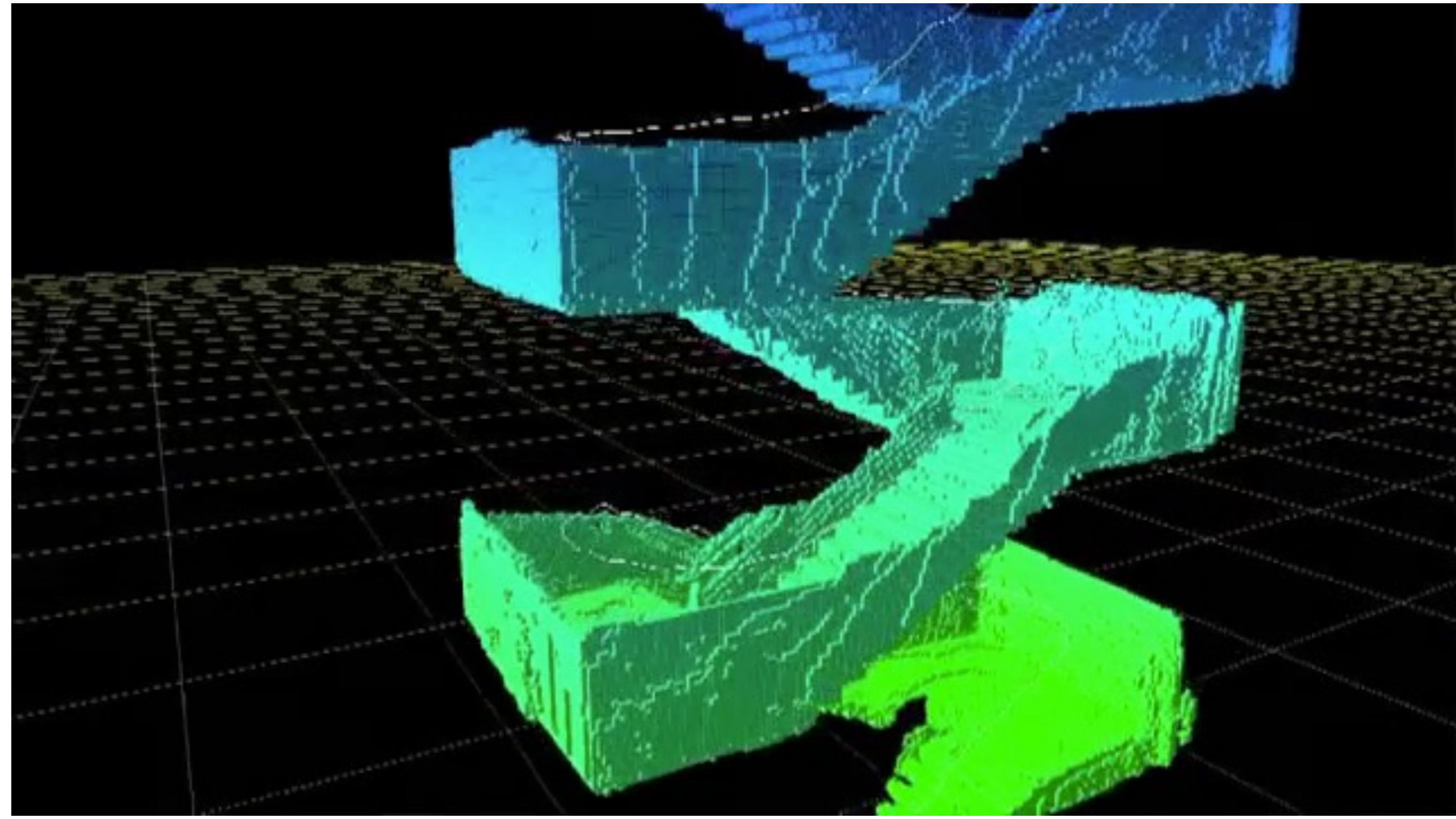
Image stitching



Photosynth



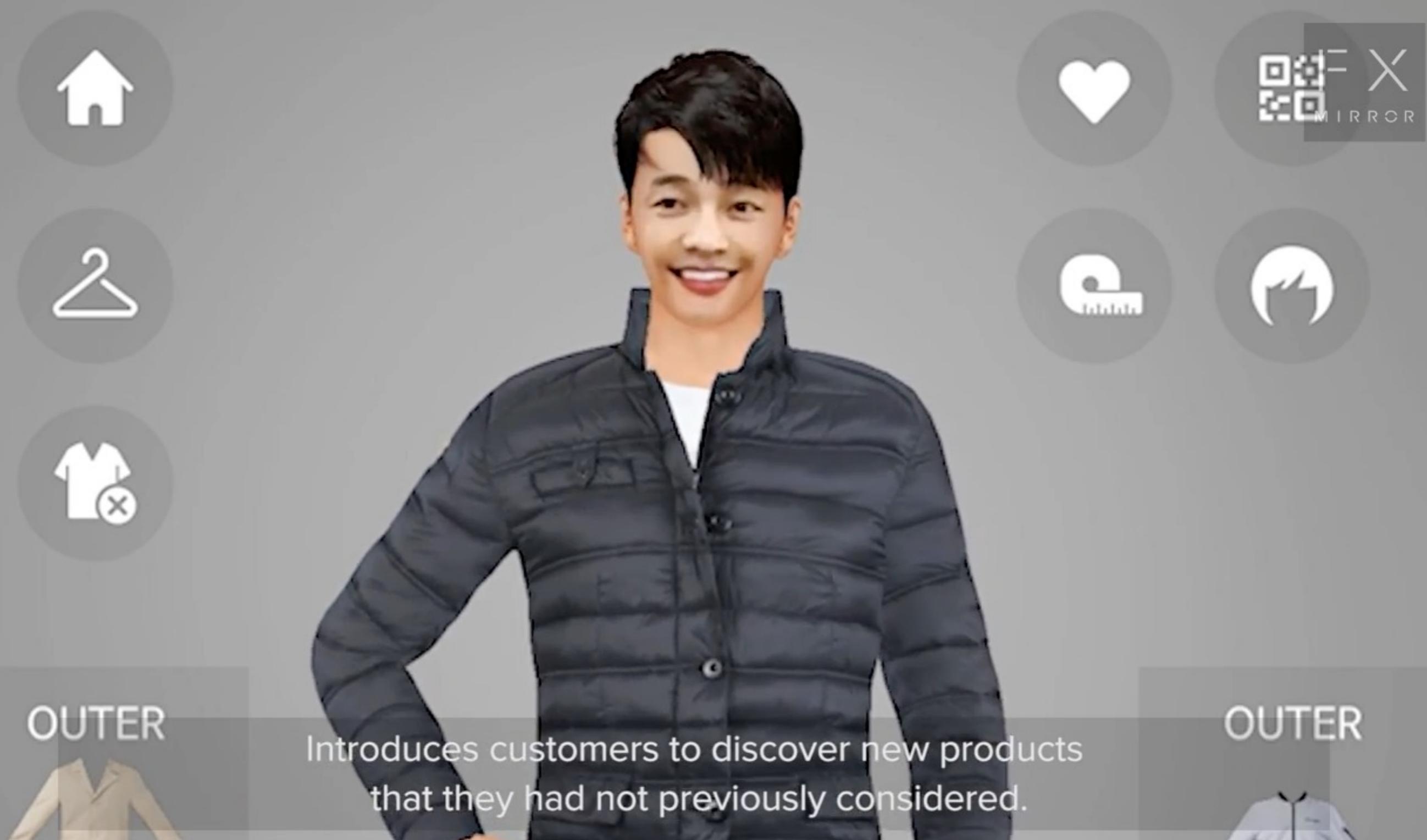
Tango



Computer Vision for VR



Virtual Fitting



Introduces customers to discover new products
that they had not previously considered.

Style Transfer



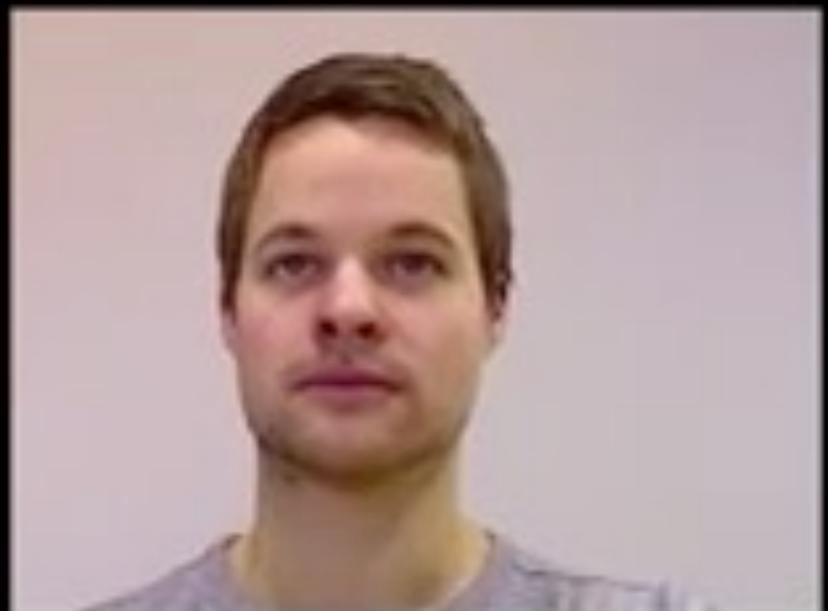
Reenactment Pipeline



Input Source



Tracking Source



Input Target



Tracking Target



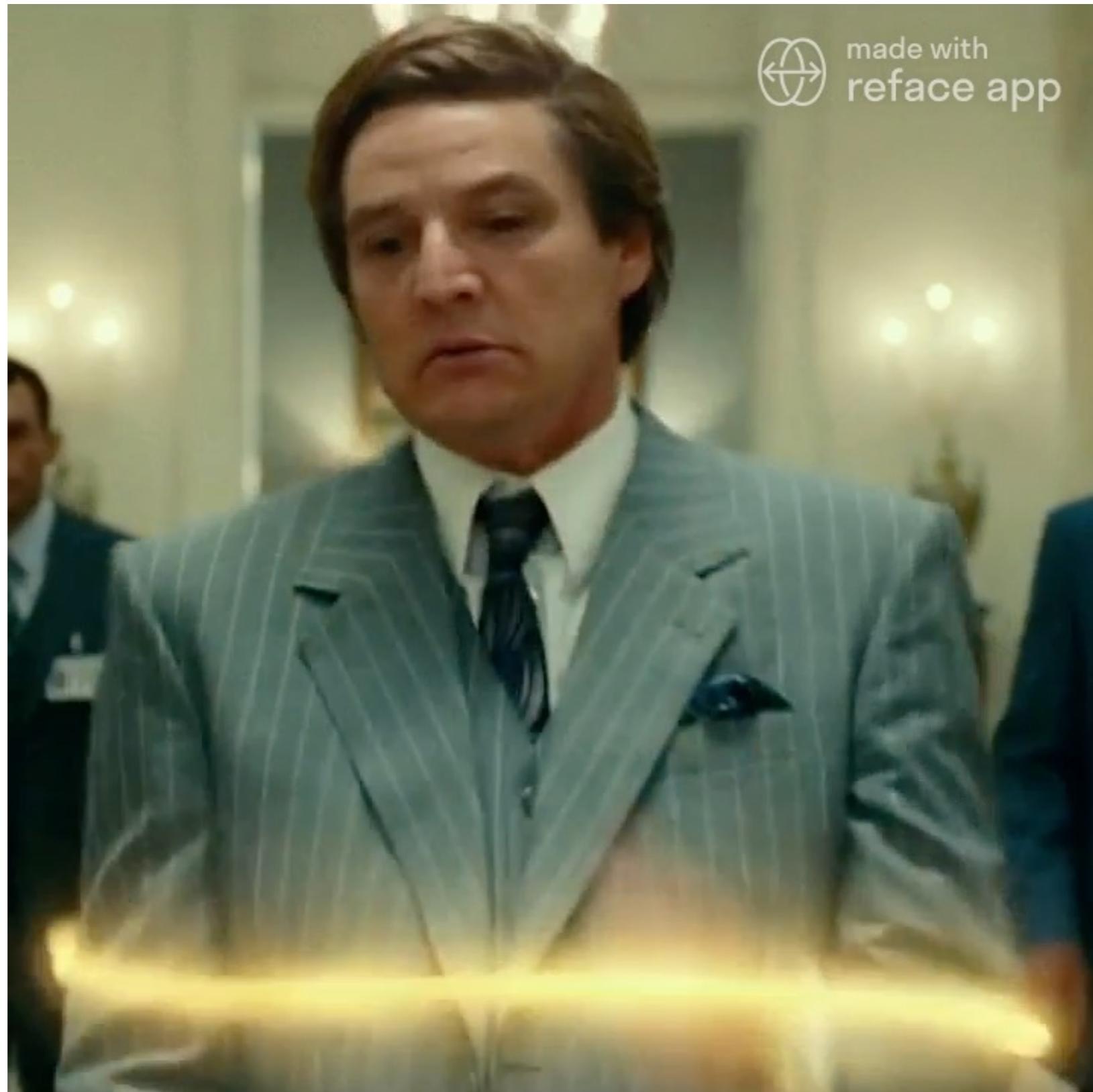
Expr. Transfer

Deep Fake

VFXCHRISUME



Deep Fake



It's a good time to do
computer vision

Industry aggressively hiring CV faculty from universities



UW



Berkeley



CMU



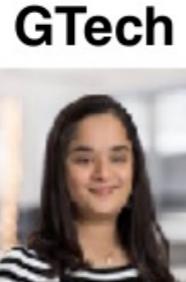
Toronto

UBER

NYU



NVIDIA



Toronto

UCLA



USC



UCSD



Columbia

Stanford CMU Stanford



Zillow

Oculus VR

ARGO.ai



IBM



Google

SFU



CMU



CMU CMU GTech



CMU



MIT



MIT



Toronto UW



Platinum Donors



Gold Donors



Silver Donors



Bronze Donors



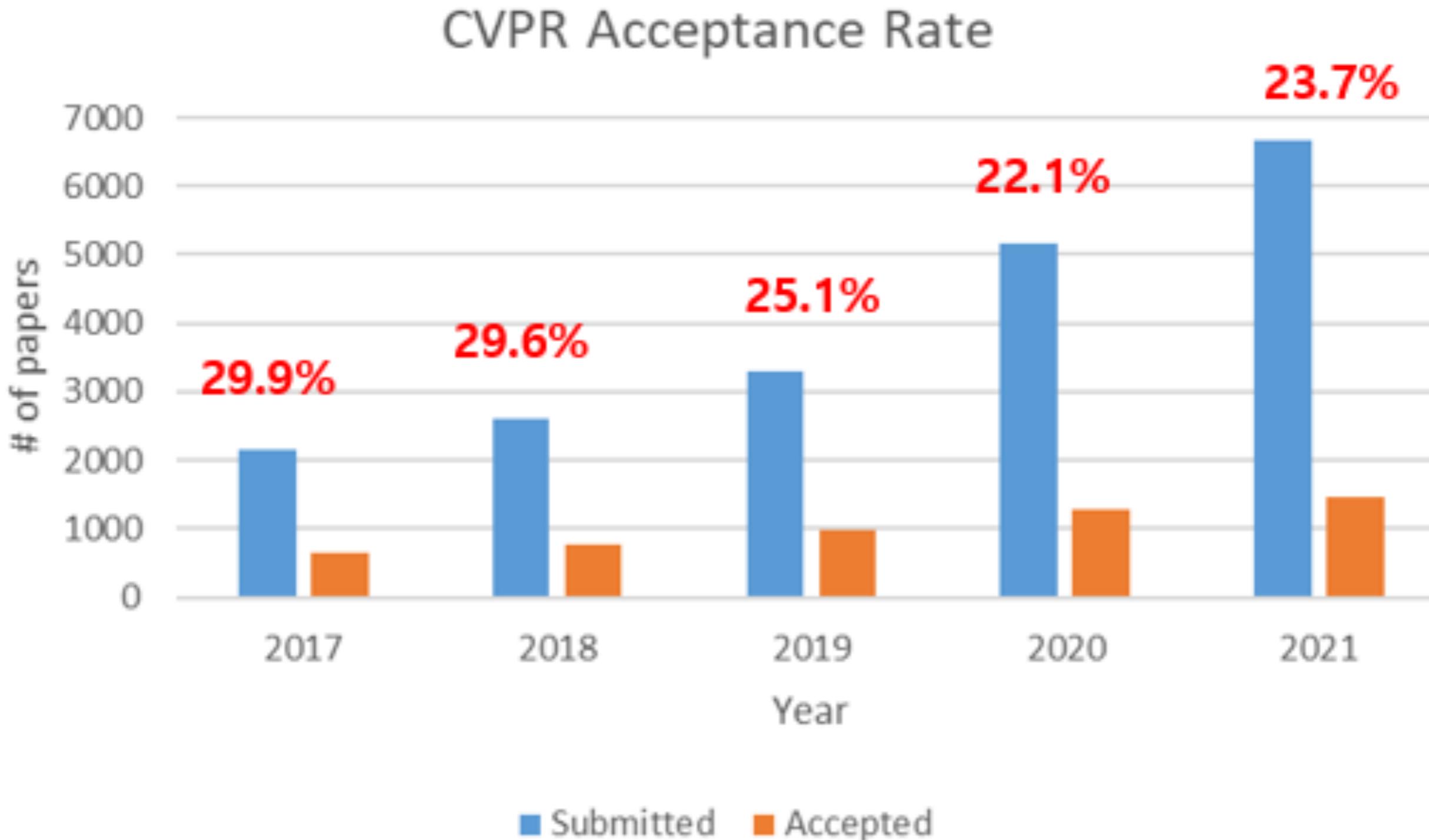
Startup Donors



Industry aggressively hiring
CV graduates, or even
students!

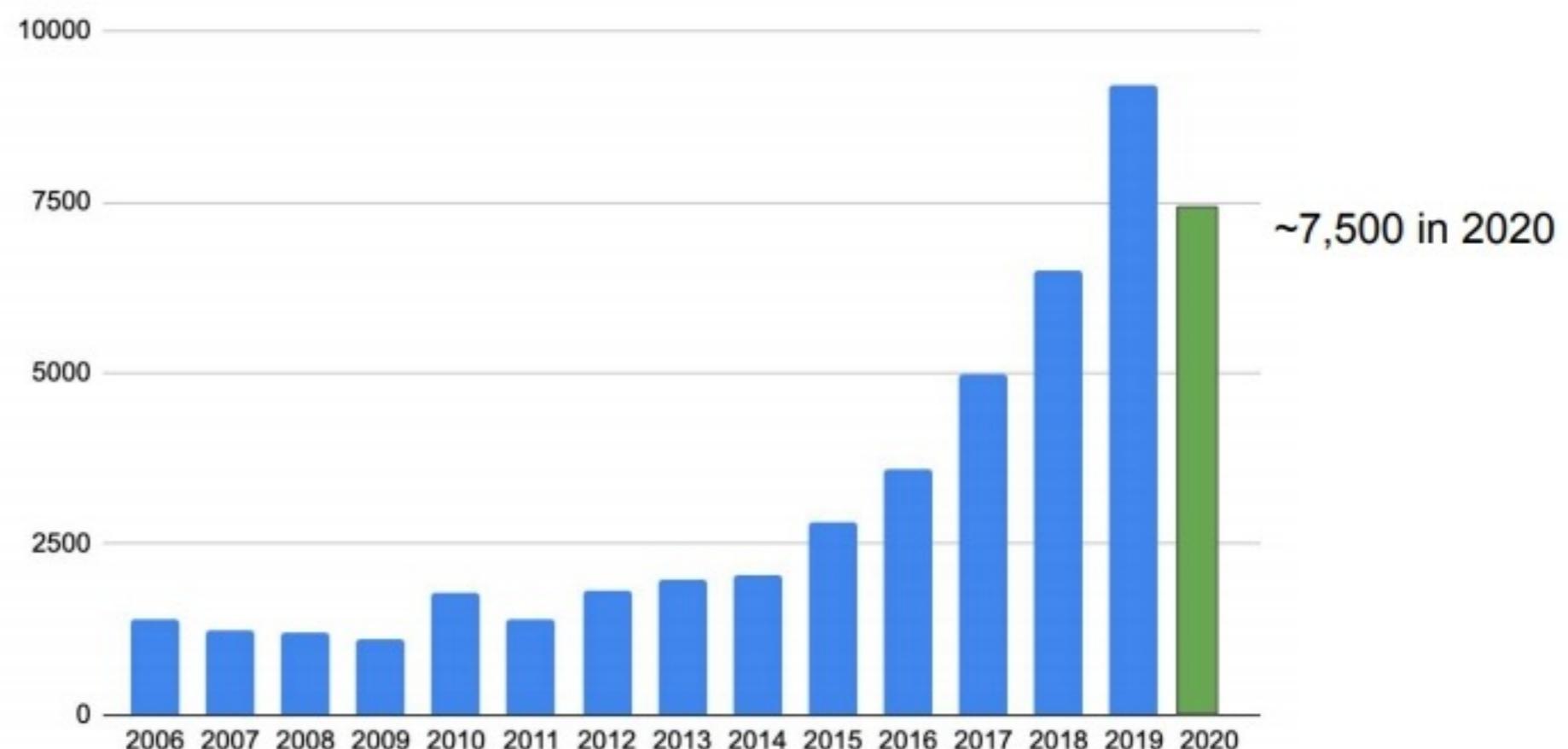
(~~strong~~ dominant industrial presence at
conferences for recruitment)

Stats for CVPR (Computer Vision and Pattern Recognition)



Stats for CVPR (Computer Vision and Pattern Recognition)

Attendees per year



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



Carnegie Mellon THE ROBOTICS INSTITUTE

Master of Science - Computer Vision MSCV

August 2016 - December 2017 (16-month program)

Computer vision is the study of acquiring and interpreting visual imagery. As computer vision shifts from research to development, there is a critical need for developers with expertise in this field.

GOALS

- Offer a comprehensive set of courses
- Facilitate hands-on research and development projects
 - Expose students to current and emerging state-of-the-art Computer Vision applications
 - Prepare students for careers in Computer Vision

COURSES

- Introduction to Computer Vision
- Introduction to Machine Learning
- Mathematical Fundamentals for Robotics
- Visual Learning and Recognition
- Geometry-based Methods in Computer Vision

Electives (choose 2)

- Human Communication and Multimodal Machine Learning
- The Visual World as seen by Neurons and Machines
- Comprehensive Sensing and Sparse Optimization
- Large Scale Learning using Images and Text
- Big Data approaches in Computer Vision
- Human Motion Modeling and Analysis
- Statistical Techniques in Robotics
- Physics-based Methods in Vision
- Probabilistic Graphical Models
- Statistical Machine Learning
- Convex Optimization
- Vision Sensors

Project and Seminar Courses

MSCV Seminar MSCV Project I MSCV Project II

ADMISSION AND APPLICATION

Requirements: Undergraduate (B.S. or equivalent) in engineering, computer science or applied mathematics

Application Materials

- Résumé • General GRE
- TOEFL / IELTS (Foreign Students only)
- Statement of Purpose (1 to 2 pages)
- Letters of Recommendation (3 Required)
- Undergraduate/Graduate (as applicable) Transcripts

Only online applications will be accepted.

Early application deadline: December 3, 2015

Final application deadline: December 15, 2015

FOR INDUSTRY SPONSORSHIPS PLEASE CONTACT
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Narasimhan
MSCV Program Director



Martial
Hebert
MSCV Spiritual Guru



J. Andrew (Drew)
Bagnell



Fernando
De la Torre Fraile



Abhinav
Gupta



Kris M.
Kitani



Simon
Lucey



Deva
Kannan Ramanan



Yaser Ajmal
Sheikh

Course logistics

Website



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

(includes links to Canvas and Piazza)

Assignments

Canvas

<https://canvas.cmu.edu/courses/31588>

Discussion & Notes

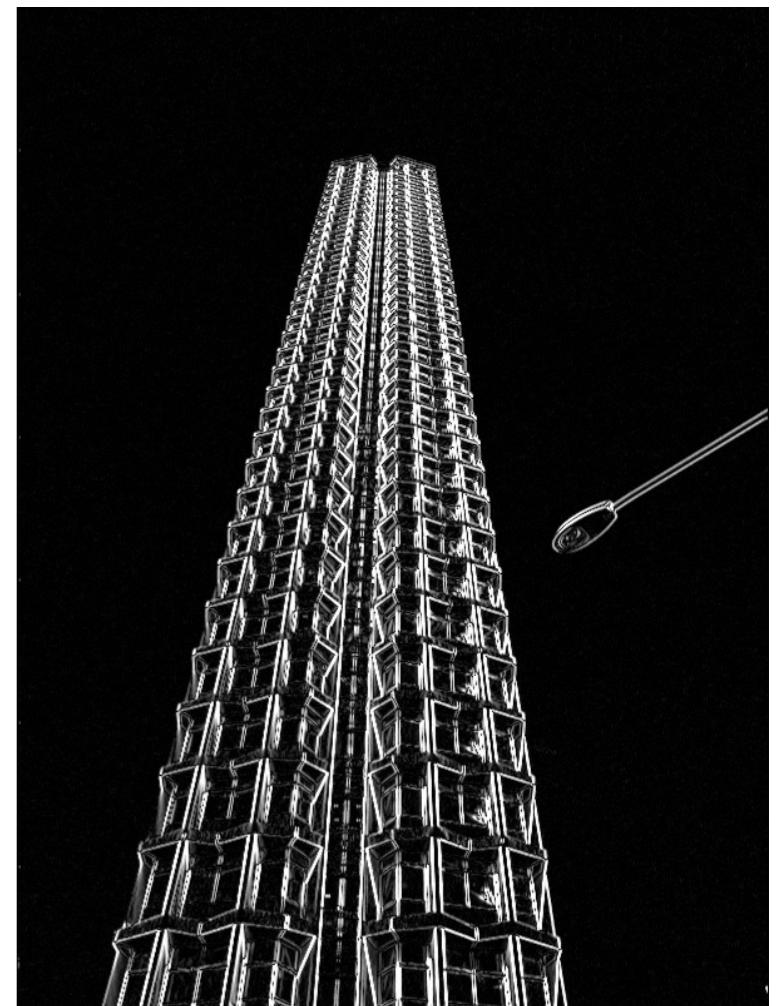
piazza

<https://piazza.com/cmu/fall2022/16385>

Topics to be covered

Image processing:

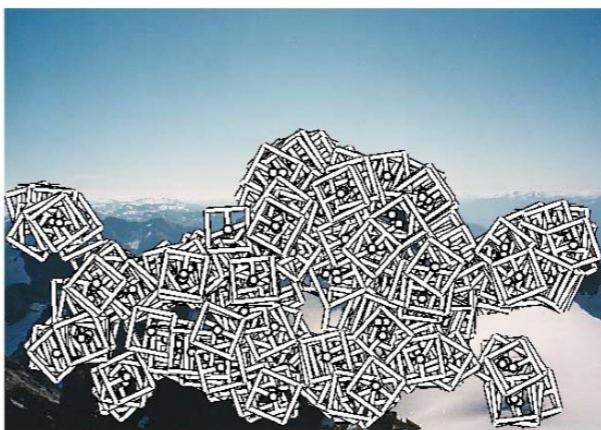
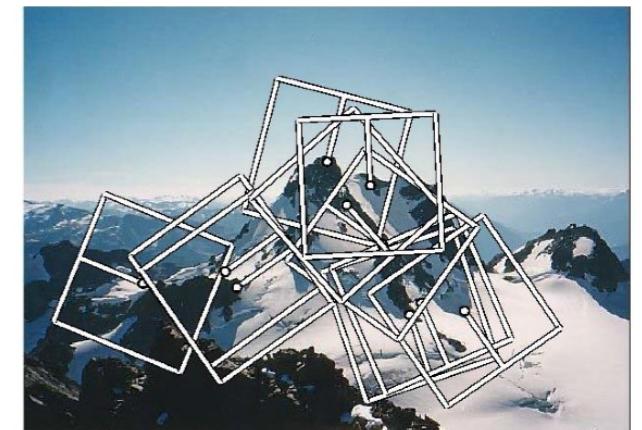
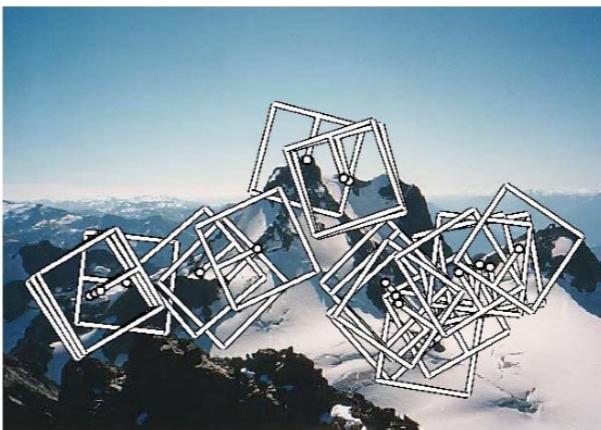
- Basics of filtering.
- Image pyramids.
- Gradients and lines.
- Hough transforms.



Topics to be covered

Feature detection and correspondences:

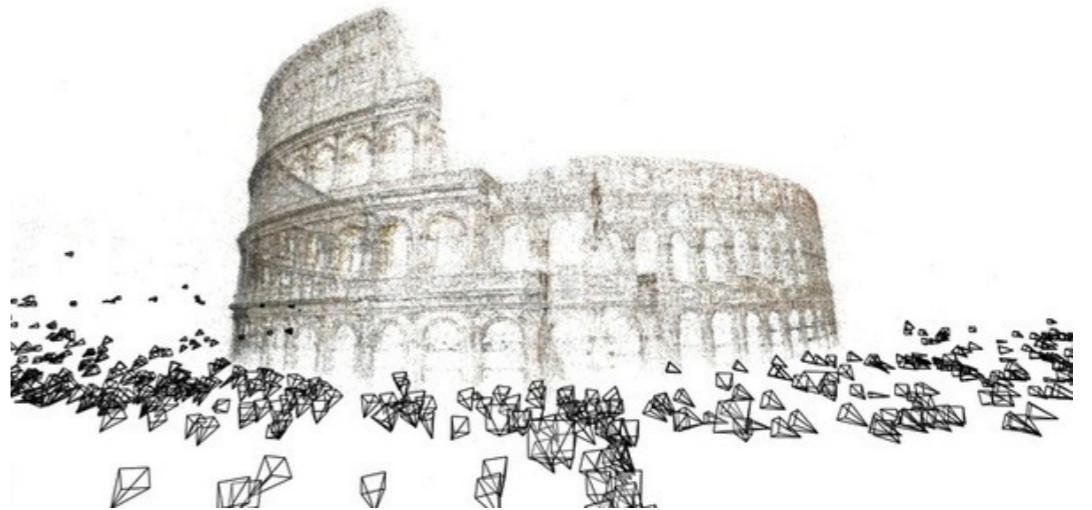
- Corner detection.
- SIFT et al.
- Feature descriptors.
- RANSAC.



Topics to be covered

Transformations and geometry:

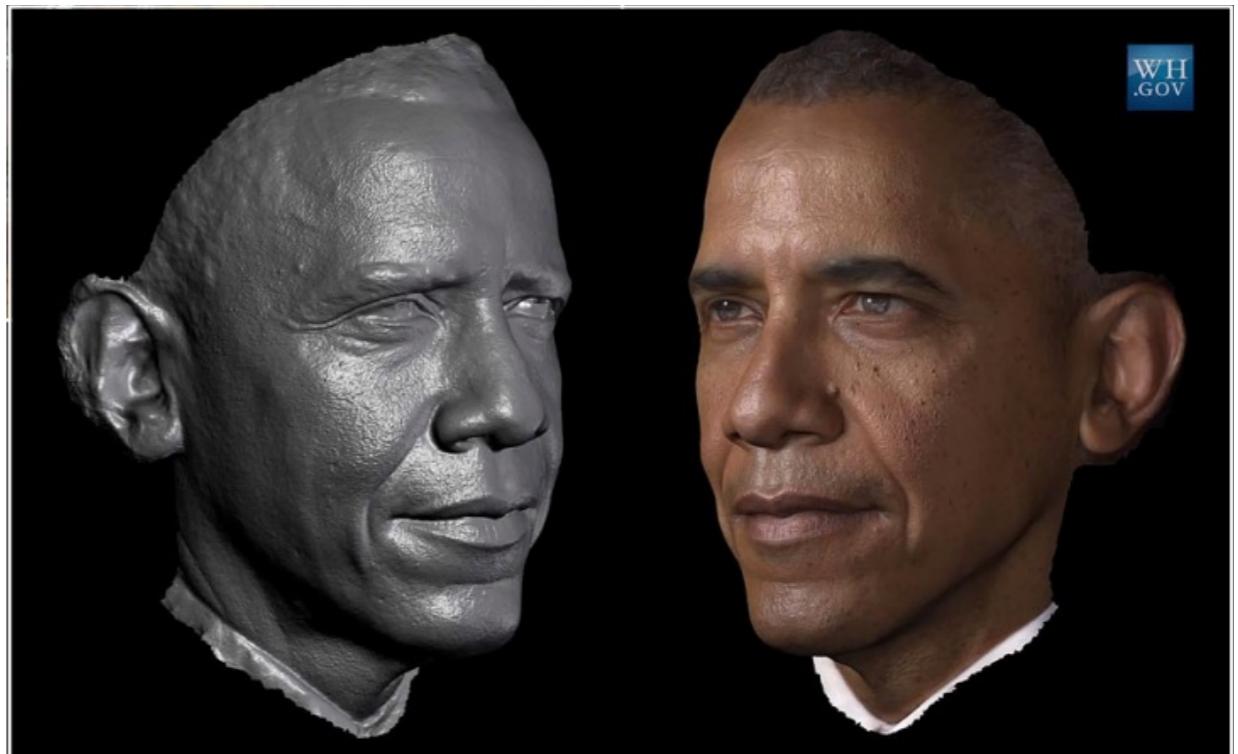
- Homographies and image alignment.
- Camera models.
- Fundamental matrix.
- Epipolar geometry and stereo.
- Structure from motion.



Topics to be covered

Physics-based vision:

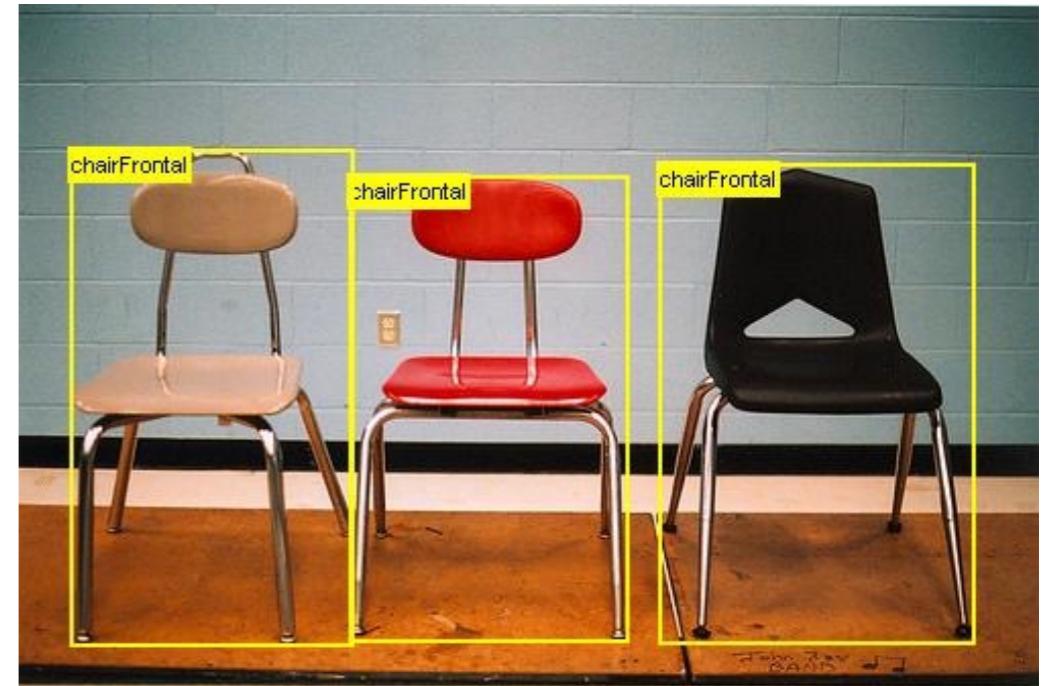
- Reflectance and image formation.
- Radiometry.
- Shape from shading.
- Photometric stereo.
- Color.



Topics to be covered

Objects, faces, and learning:

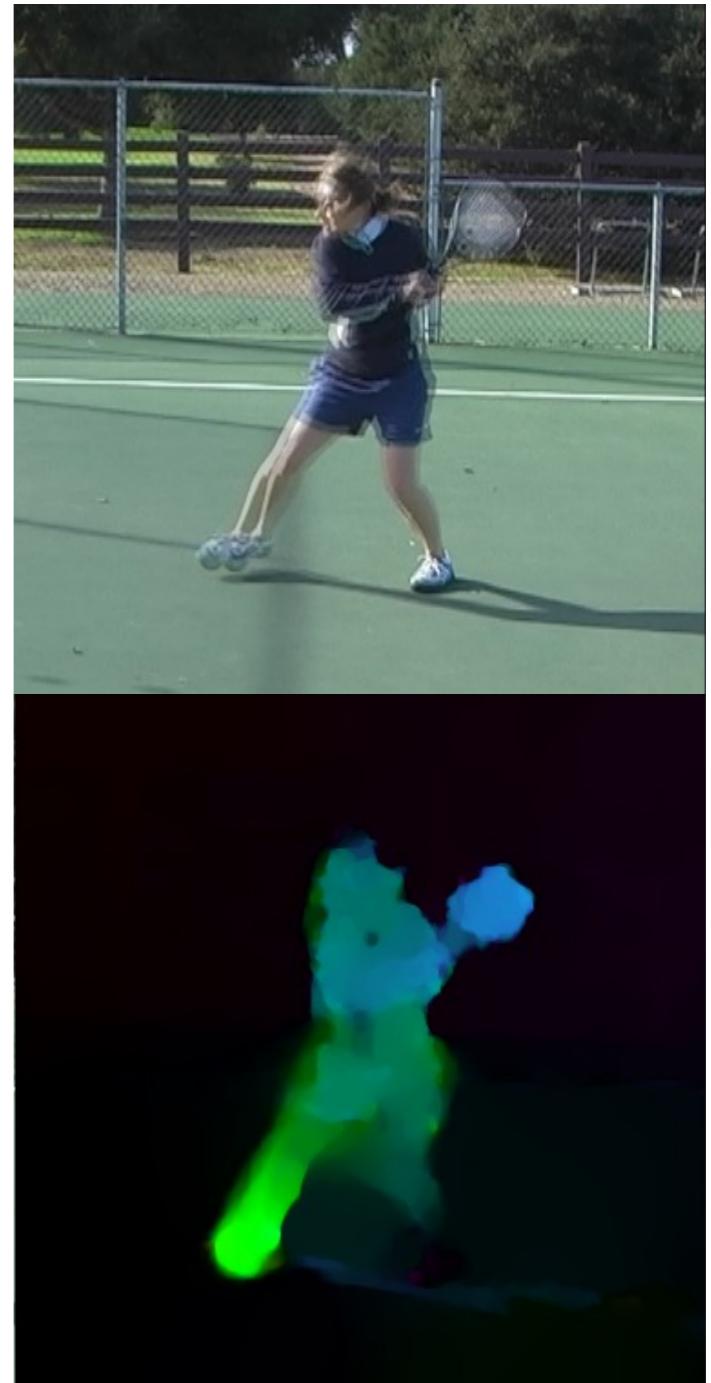
- Basics of probability.
- K-means, KNN, PCA, SVM.
- Bag of words.
- Viola-Jones face detection.
- Perceptron, backpropagation.
- Convolutional neural networks.



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: 70%
- Eleven weekly take-home quizzes: 27%
- 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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Seriously.. a lot of programming, so start early!

Leniency

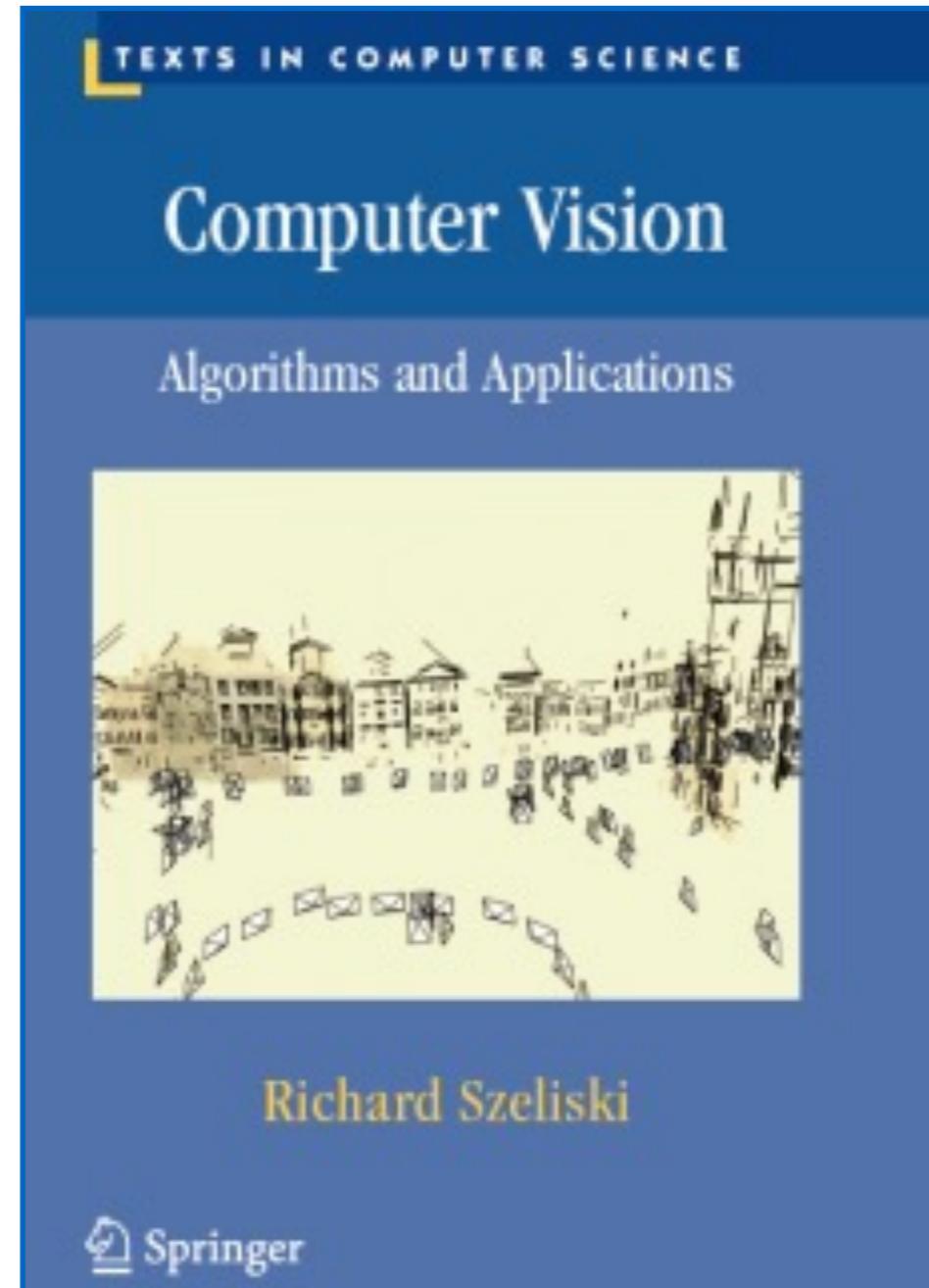
Late days for programming assignments:

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

Option to skip take-home quizzes:

- you only need to submit 8 out of 11 quizzes
- late quizzes will not be graded

Book



PDF online

<http://szeliski.org/Book/>

Prerequisites

We assume familiarity with calculus, linear algebra, basic probability, and programming.

Formal prerequisites:

- "Mathematical Foundations of Electrical Engineering" (18-202) and "Principles of Imperative Computation" (15-122)

OR

- "Matrix Algebra with Applications" (21-240) and "Matrices and Linear Transformations" (21-241) and "Calculus in Three Dimensions" (21-259) and "Principles of Imperative Computation" (15-122)

If you are missing a prerequisite but still want to enroll, let me know and we'll discuss it.

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/quiz/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.

I will announce office hours at the end of this week.