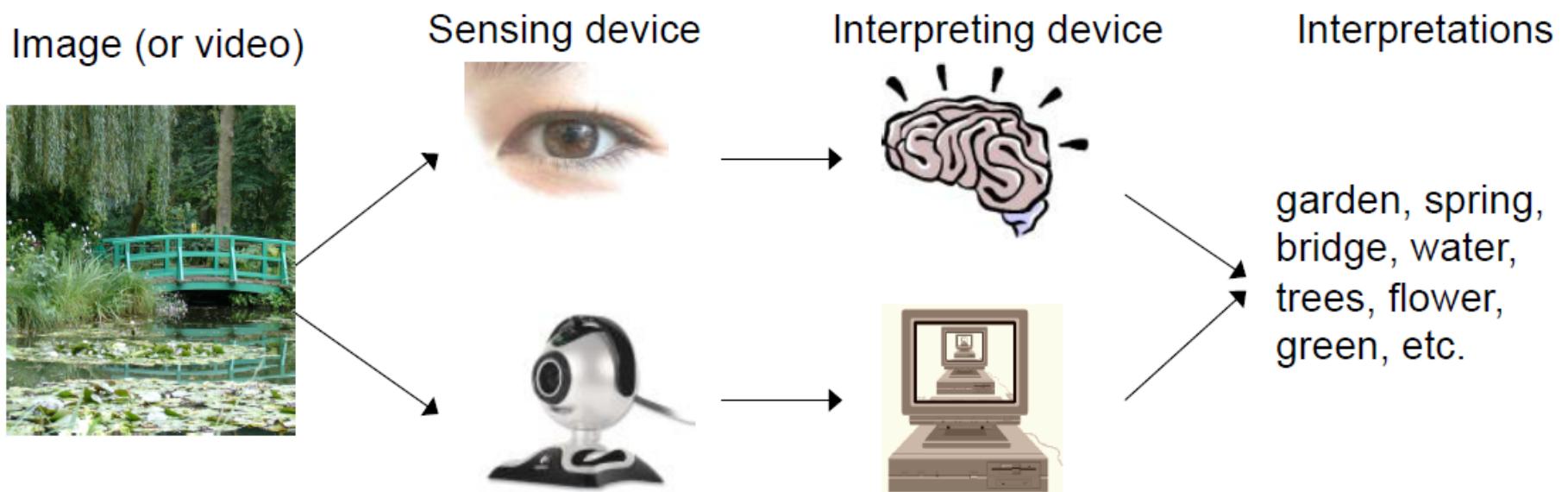


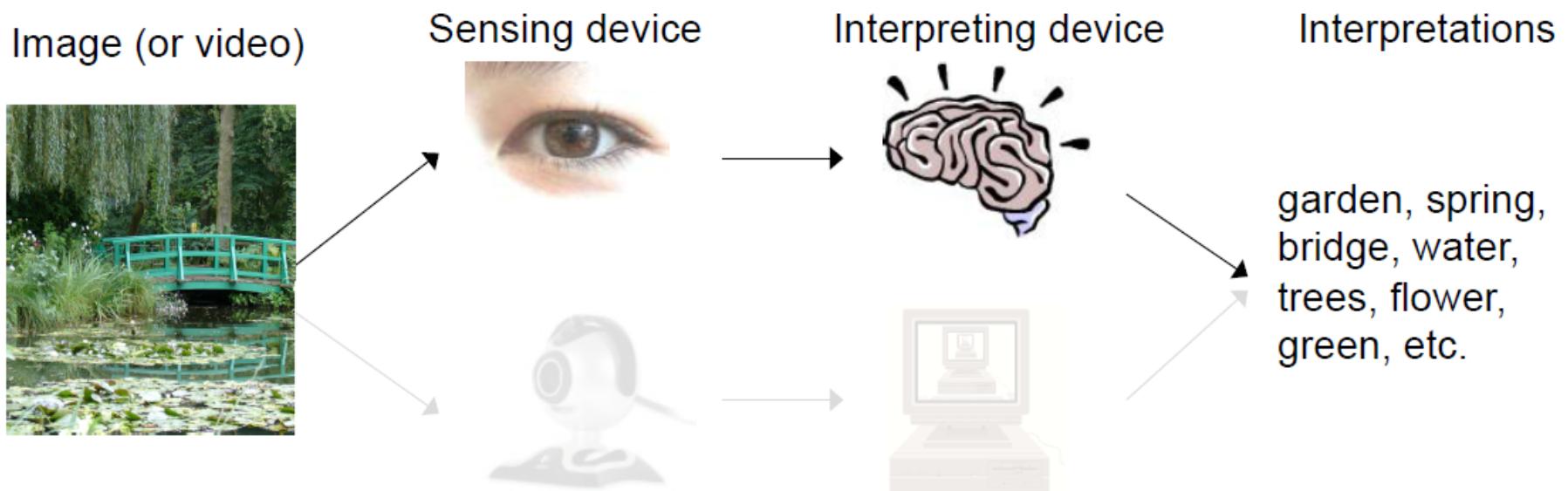
BBM416 – Fundamentals of Computer Vision

Dr. Nazlı İkizler Cinbiş

What is (computer) vision?



What is (computer) vision?



Human vision is superbly efficient



Potter, Biederman, etc. 1970s

Change blindness



Rensink, O'regan, Simon, etc.

5

Change blindness



Rensink, O'regan, Simon, etc.

6

The goal of computer vision

- To extract meaning from pixels



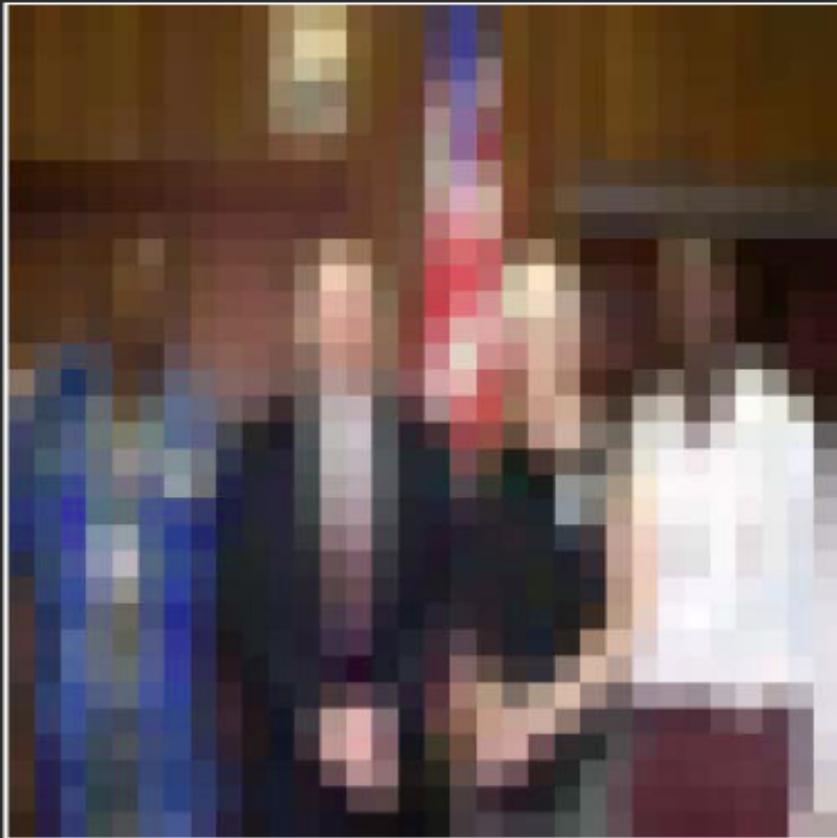
What we see

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

The goal of computer vision

- To extract meaning from pixels



Humans are remarkably good at this...

A little story about Computer Vision

In 1966, Marvin Minsky at MIT asked his undergraduate student Gerald Jay Sussman to “spend the summer linking a camera to a computer and getting the computer to describe what it saw”. We now know that the problem is slightly more difficult than that.

(*Szeliski 2009, Computer Vision*)

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

PROJECT MAC

Artificial Intelligence Group
Vision Memo. No. 100.

July 7, 1966

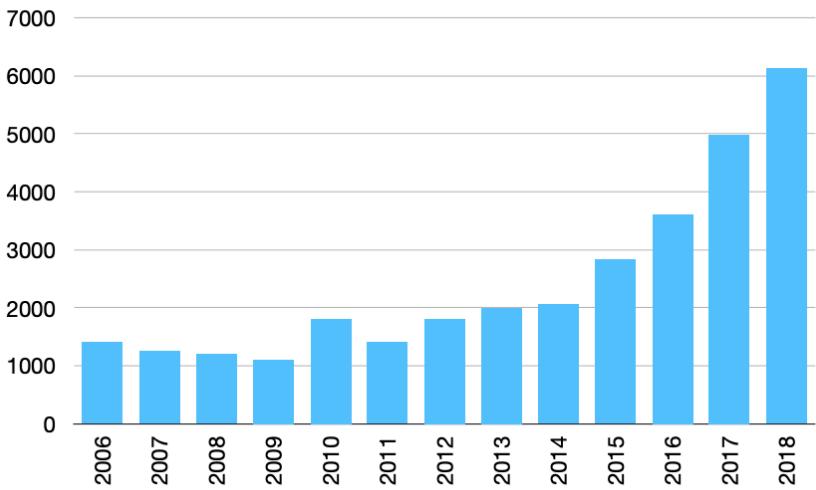
THE SUMMER VISION PROJECT

Seymour Papert

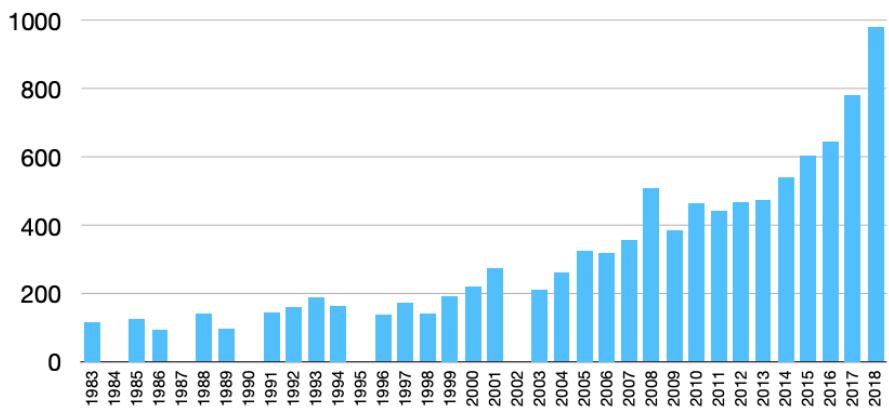
The summer vision project is an attempt to use our summer workers effectively in the construction of a significant part of a visual system.
The particular task was chosen partly because it can be segmented into

Growth of the field

CVPR Attendance



CVPR Papers



[Source](#)

The computer vision industry

- Corporate sponsors of CVPR 2015:



The computer vision industry

- Corporate sponsors of CVPR 2018:

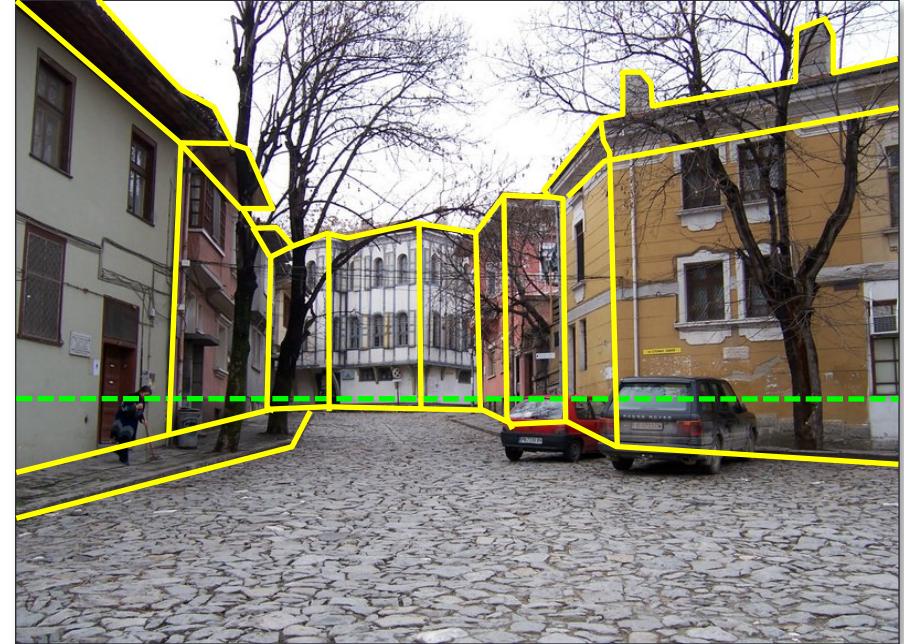
<http://cvpr2018.thecvf.com/sponsors>



What kind of information can be extracted from an image?

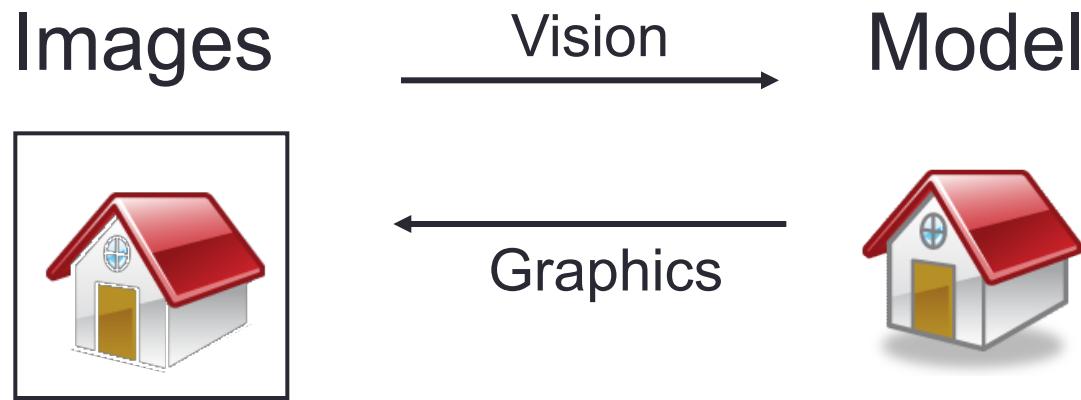


Semantic information



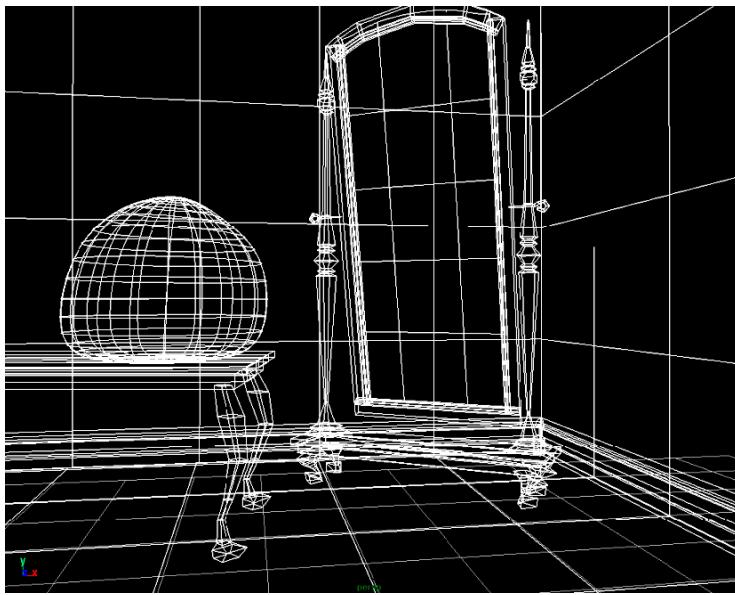
Geometric information

Vision and Graphics

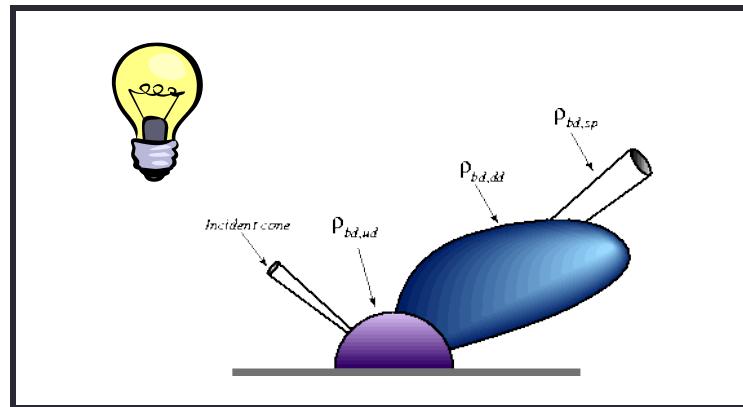


Inverse problems: analysis and synthesis.

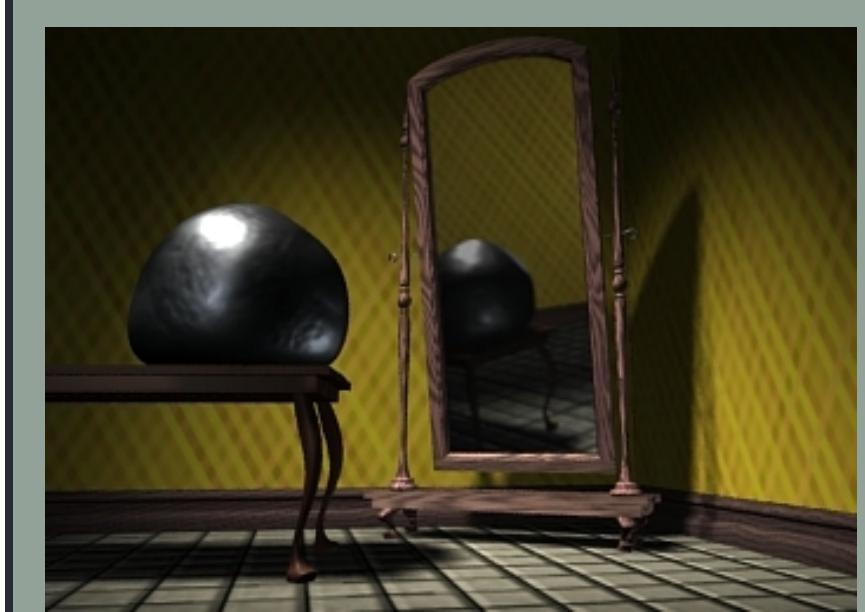
What is computer graphics? (3D->2D)



3D geometry



physics

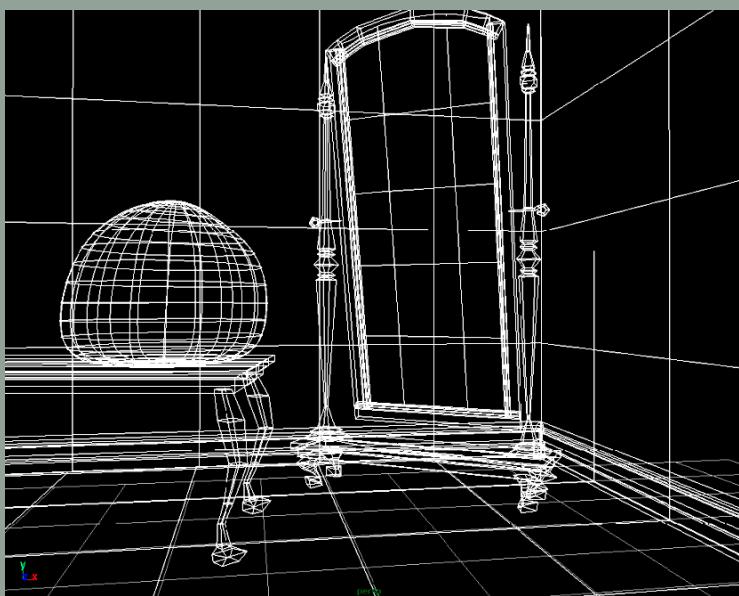


projection

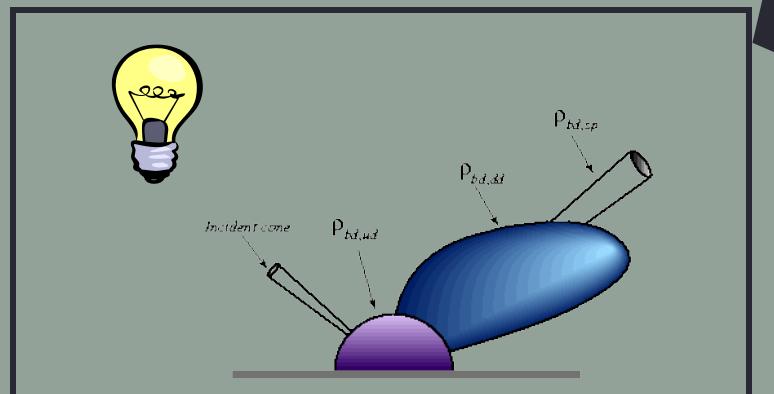
Simulation

GRAPHICS

What is computer vision? (2D->3D)



3D geometry



physics



Why vision?

- Images and video are everywhere!



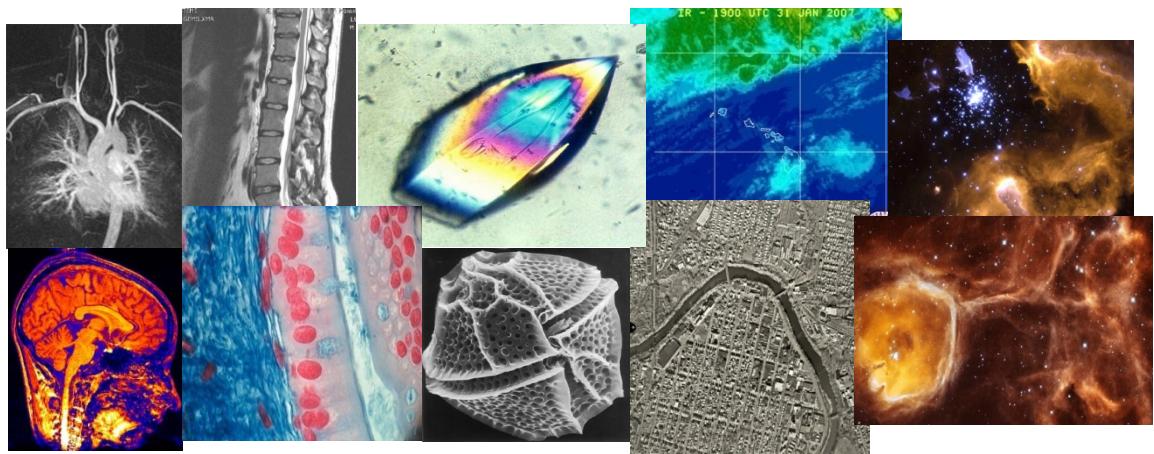
Personal photo albums



Movies, news, sports



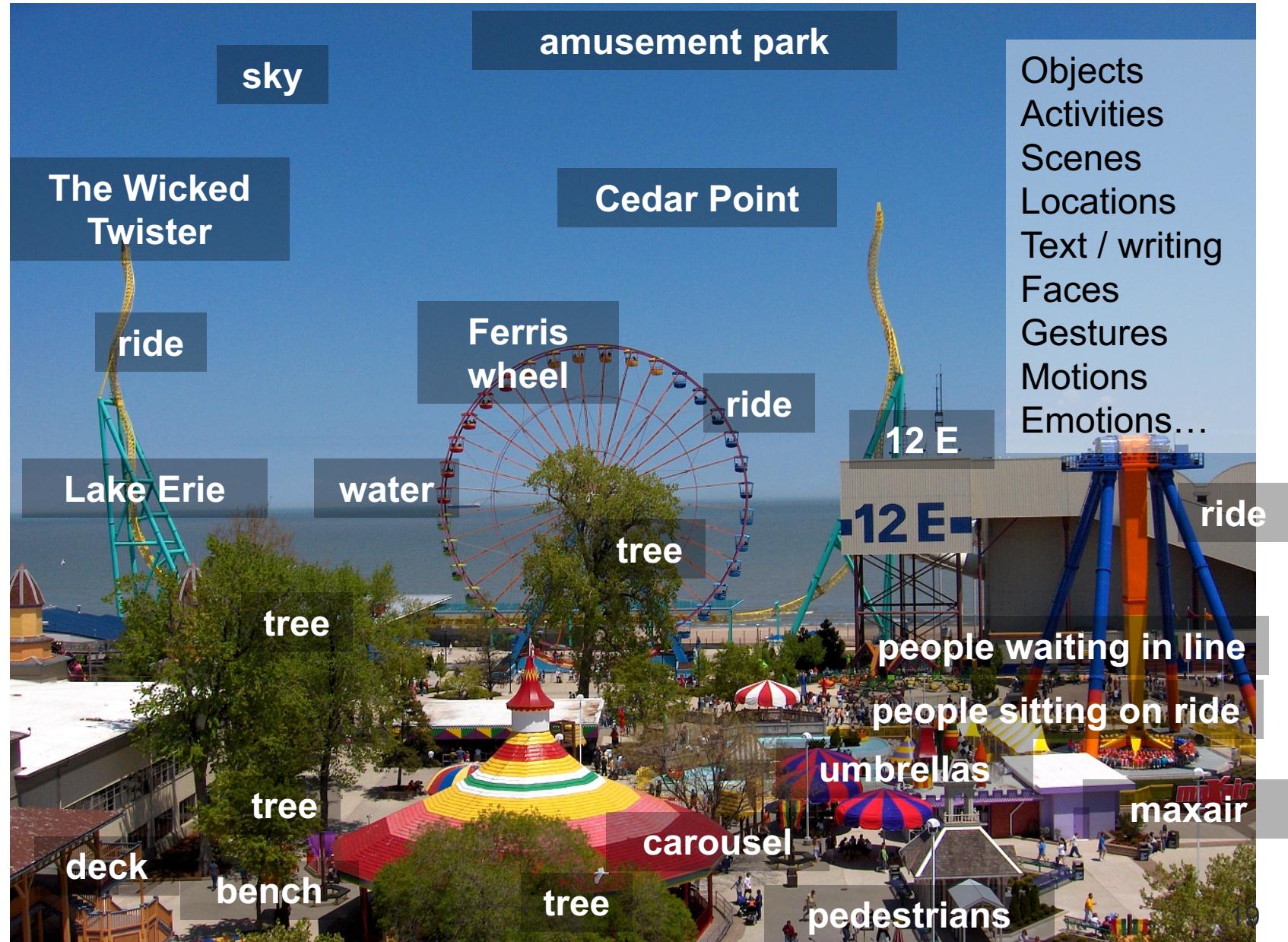
Surveillance and security



Medical and scientific images

**What kind of topics does vision
deal with?**

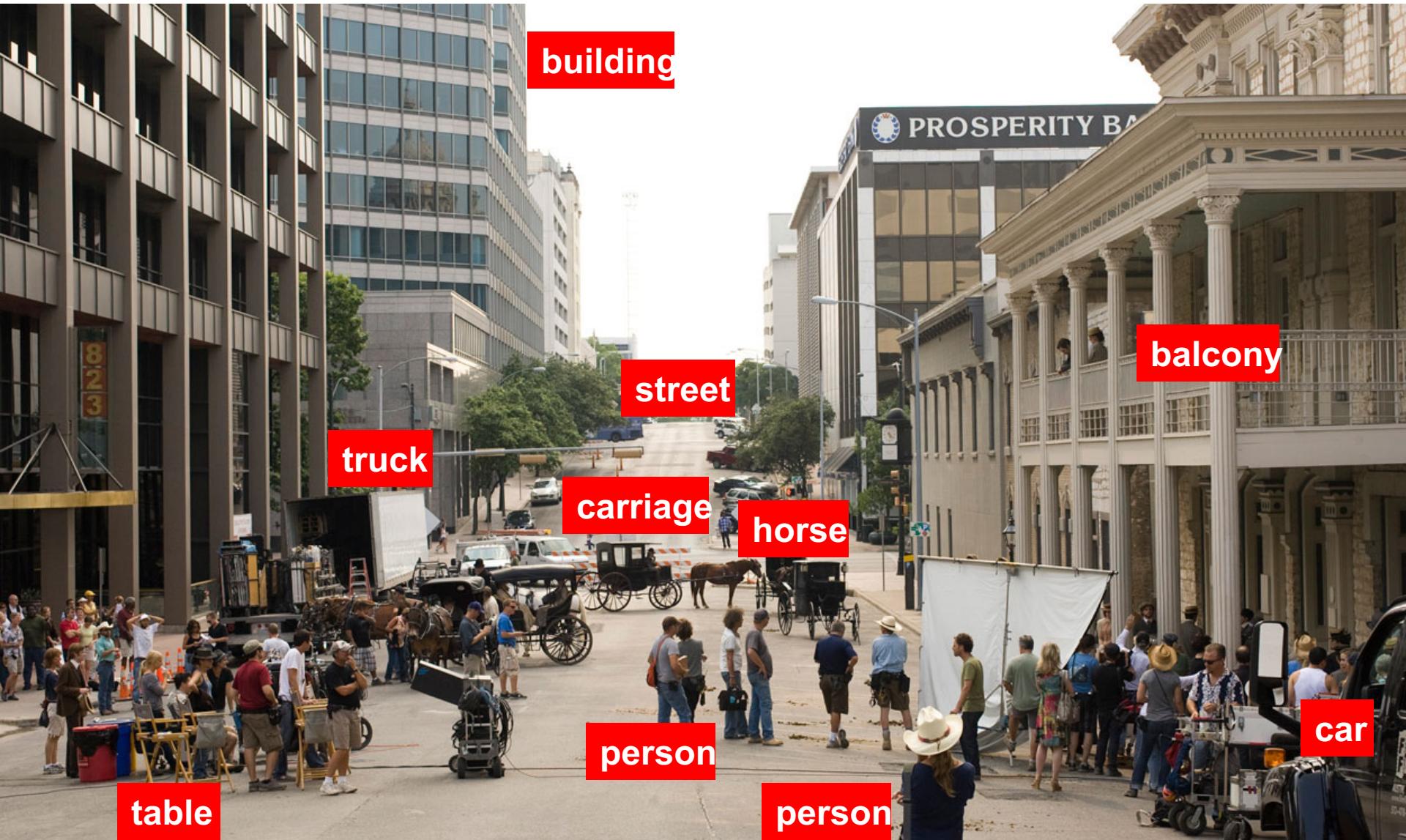
Vision as a source of semantic information



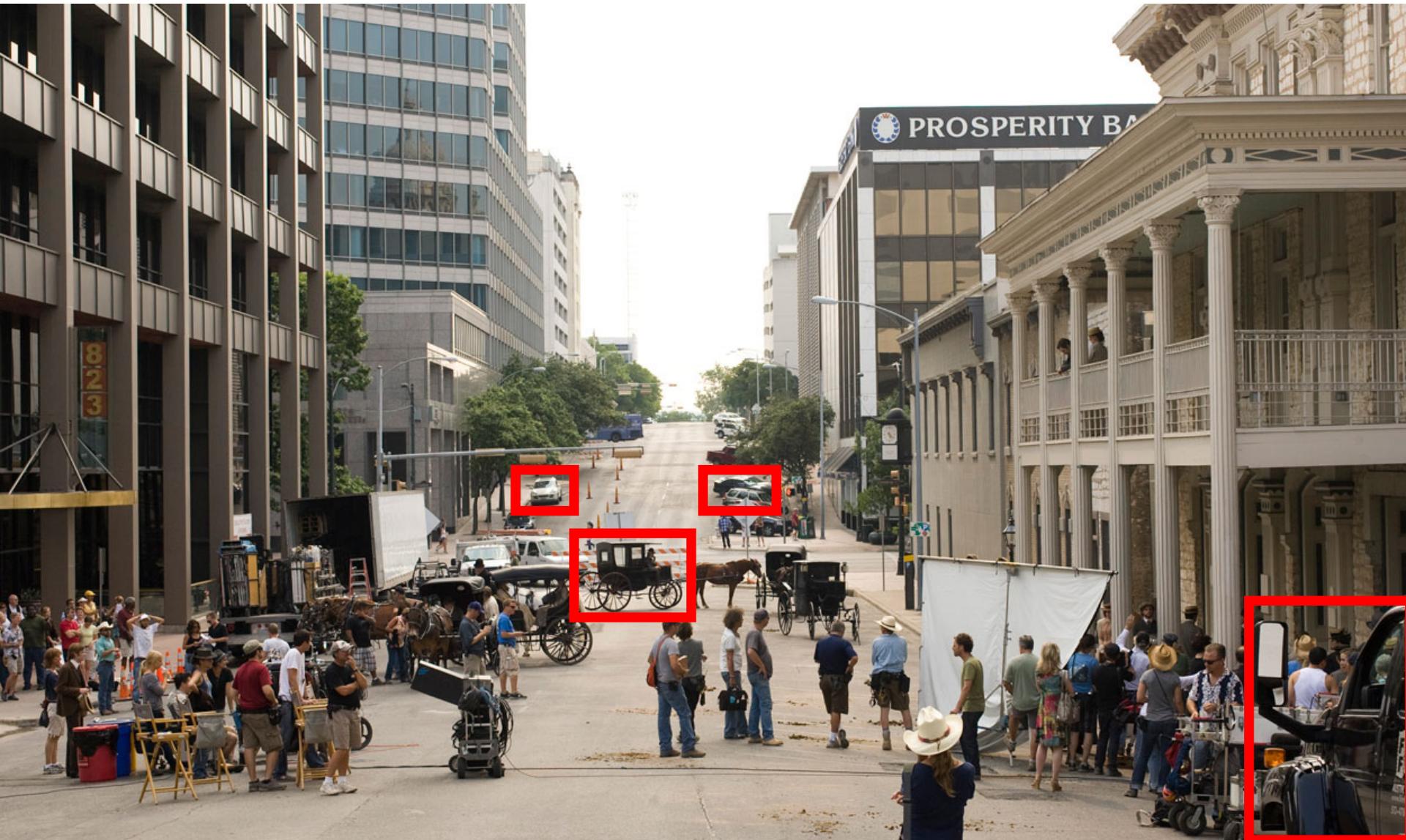
Some Visual Recognition Problems: Why are they challenging?



Recognition: What objects do you see?



Detection: Where are the cars?



Activity: What is this person doing?



Scene: Is this an indoor scene?



Instance: Which city? Which building?



Visual question answering: Why is there a carriage in the street?

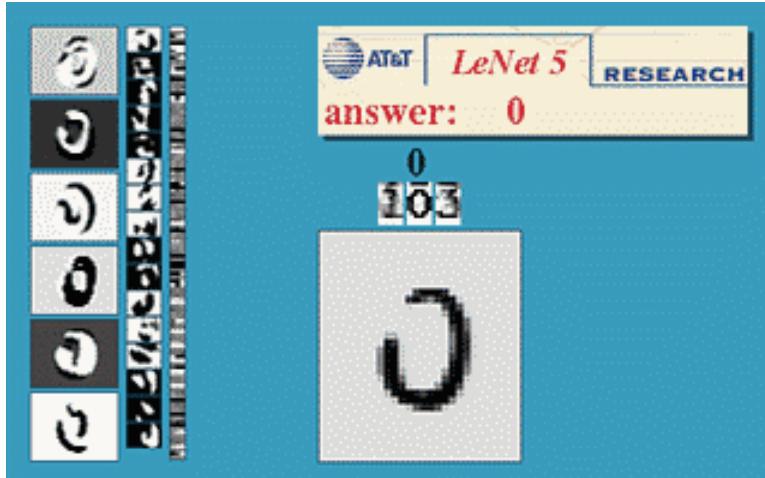


Successes of Computer Vision to date

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

<http://www.research.att.com/~yann/>



License plate readers

http://en.wikipedia.org/wiki/Automatic_number_plate_recognition

Biometrics



Fingerprint scanners on many new laptops, other devices



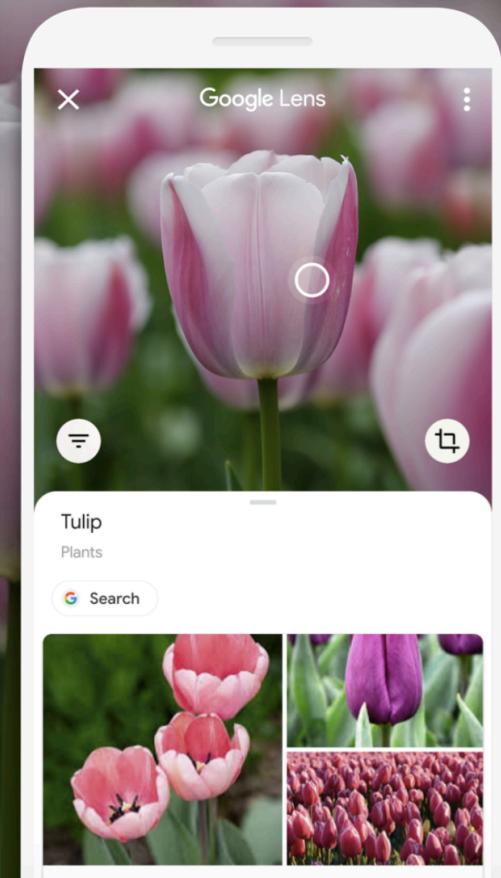
Face recognition systems now beginning to appear more widely
iphone X just introduced face recognition

Google Lens



Search what you see

Explore what's around you in an entirely new way.



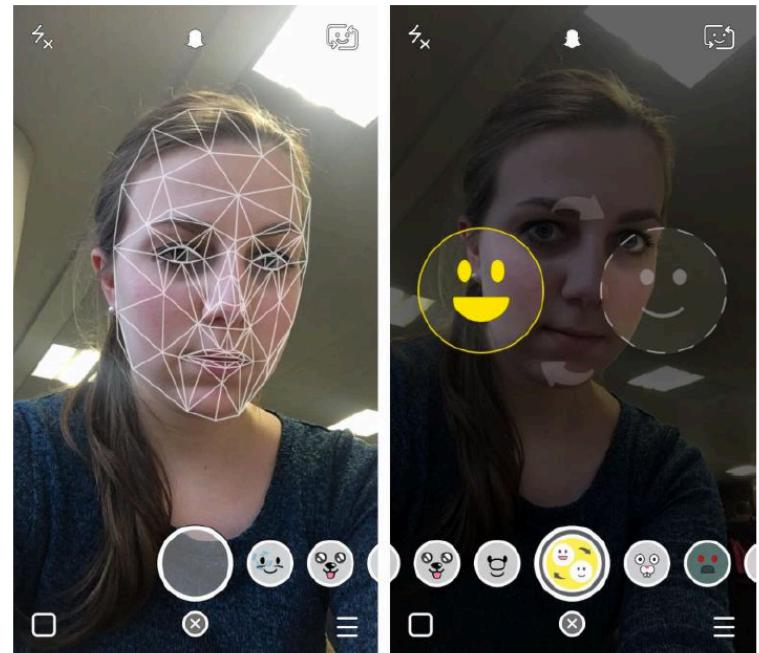
Photosynth



For the interested: More recent work

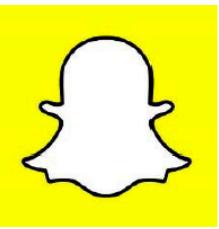
<https://mspoweruser.com/googles-nerf-microsoft-photosynth-on-steroids/>

Face detection



- Almost all digital cameras detect faces
- Snapchat face filters

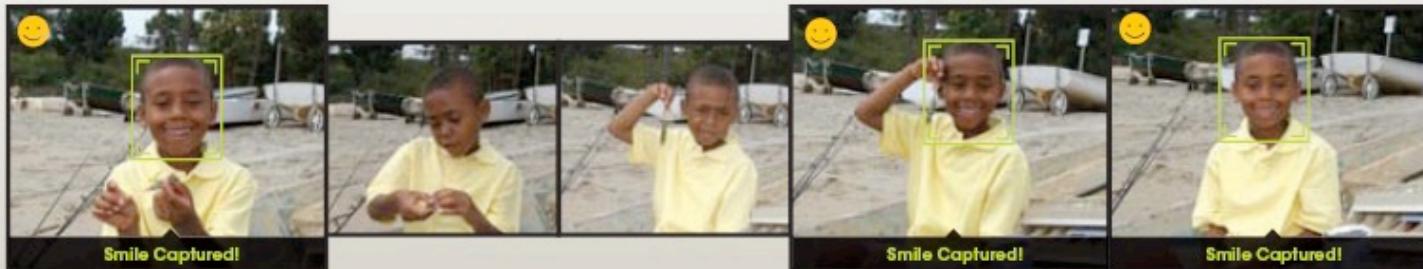
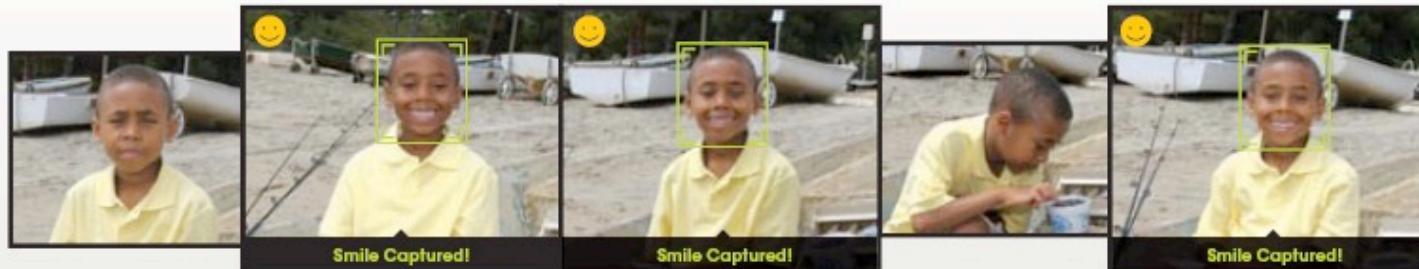




Smile detection

The Smile Shutter flow

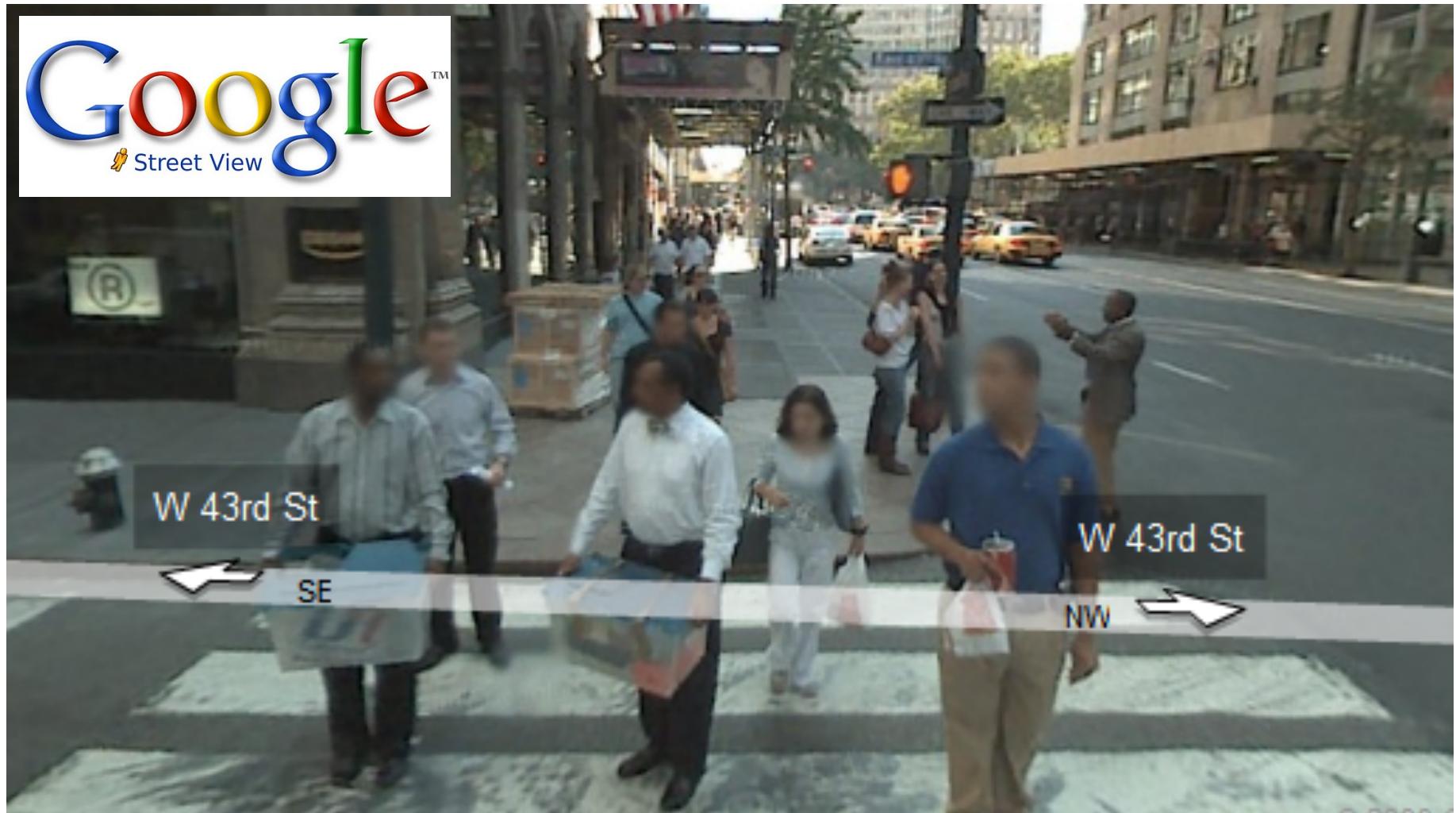
Imagine a camera smart enough to catch every smile! In Smile Shutter Mode, your Cyber-shot® camera can automatically trip the shutter at just the right instant to catch the perfect expression.



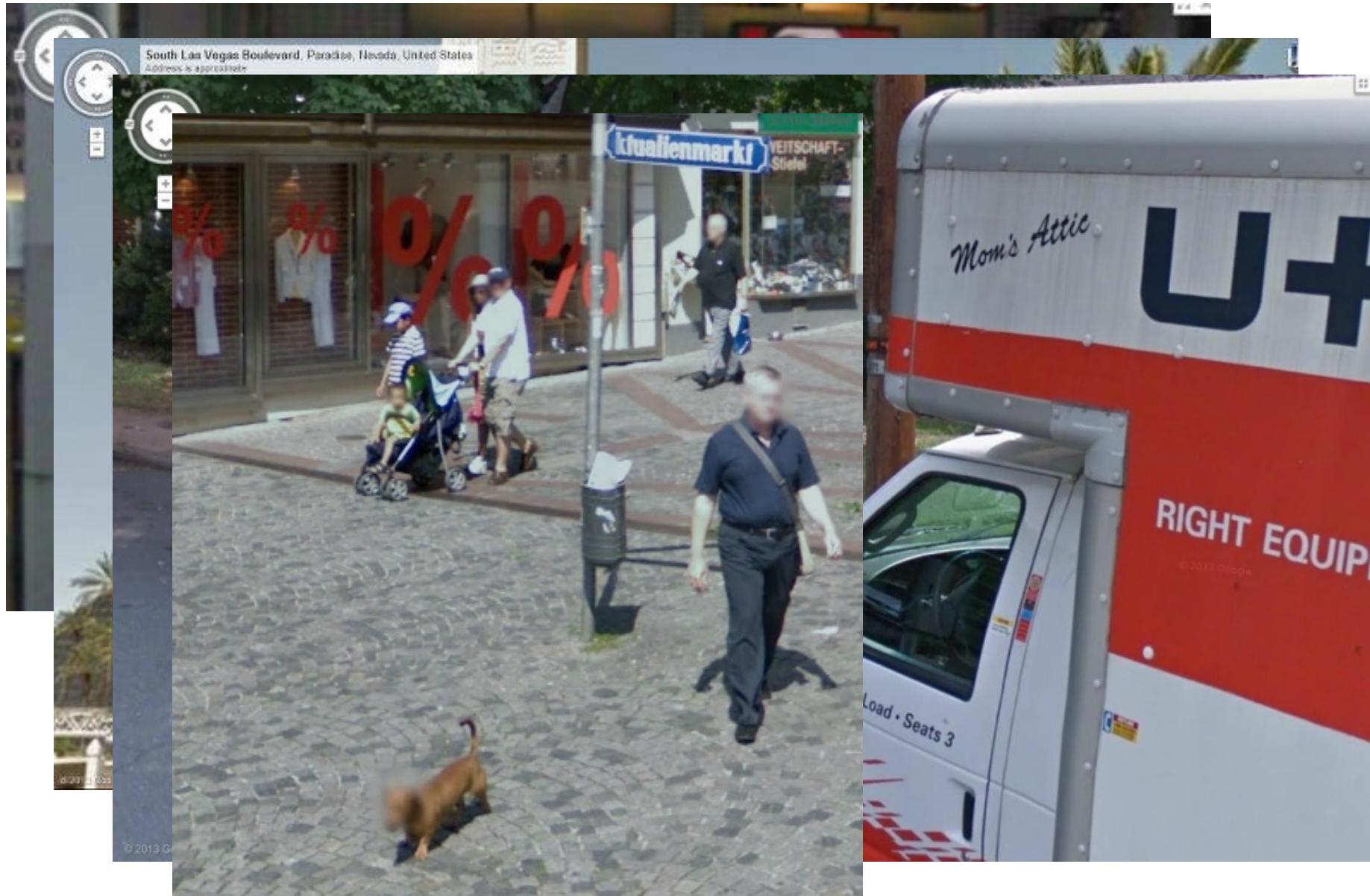
Sony Cyber-shot® T70 Digital Still Camera

Canon to display its cutting-edge digital camera technologies, such as the ability to track all the faces in a group photo and take the photo as soon as everyone smiles.

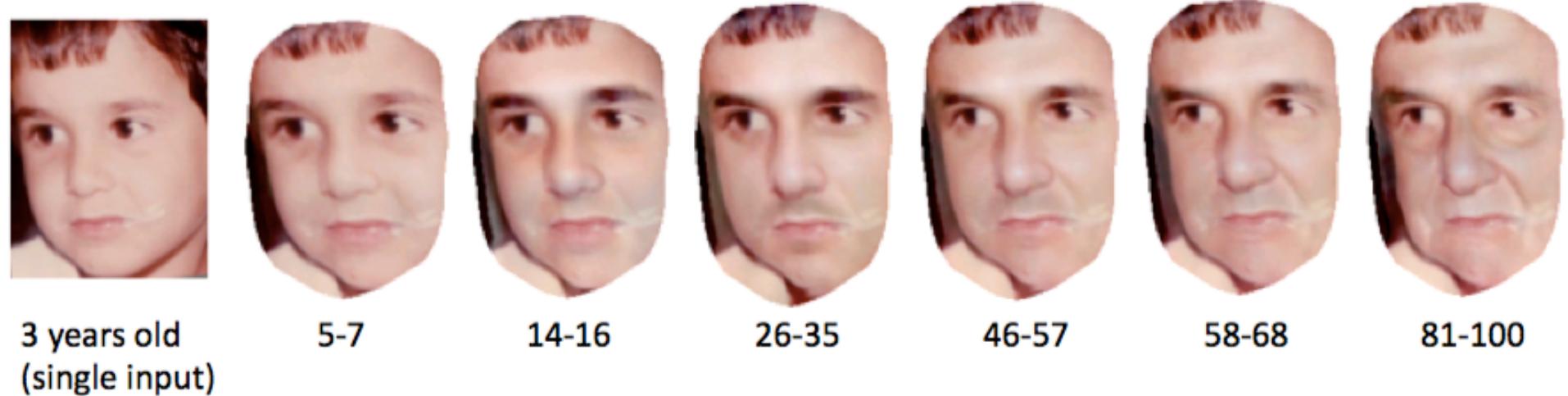
Face detection for privacy protection



Technology gone wild...



Automatic age progression



3 years old
(single input)

5-7

14-16

26-35

46-57

58-68

81-100

I. Kemelmacher-Shlizerman, S. Suwajanakorn, and S. Seitz, [Illumination-Aware Age Progression](#), CVPR 2014

[YouTube Video](#)

Recognition



- [Computer Eyesight Gets a Lot More Accurate](#), NY Times Bits blog, August 18, 2014
- [Building A Deeper Understanding of Images](#), Google Research Blog, September 5, 2014
- [Baidu caught gaming recent supercomputer performance test](#), Engadget, June 3, 2015

[Solutions](#)[Marketplace](#)[Pricing](#)[Resources](#)[Case Studies](#)[Company](#)[See Syte in Action!](#)

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.

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[See Syte in Action!](#)[Watch Video](#) **FARFETCH****bon
PRIX****SHOPSTYLE**

Brown

White

Polka dot

Skirt

Maxi

Women's

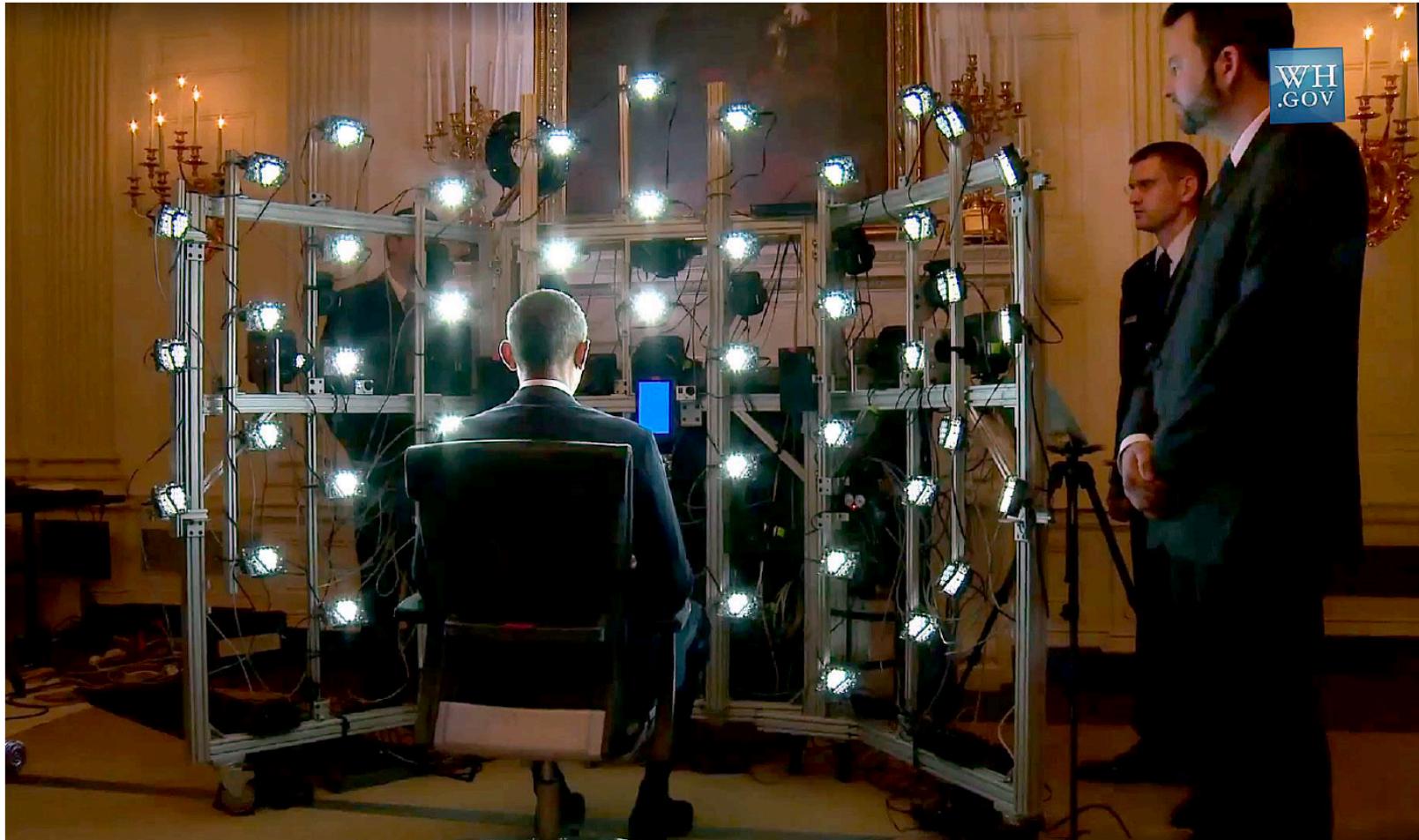
High waisted

Satin

Human shape capture

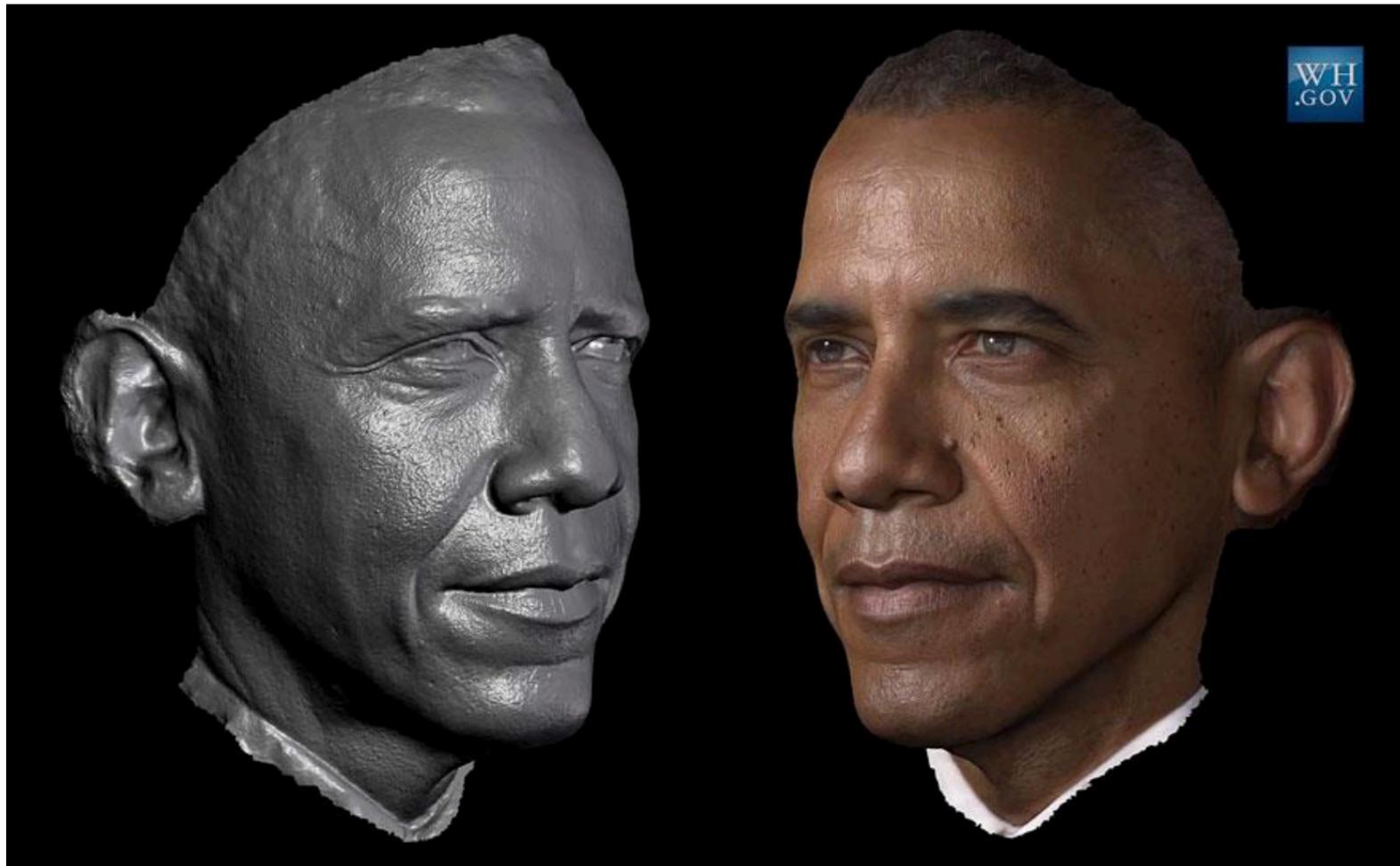


Human shape capture

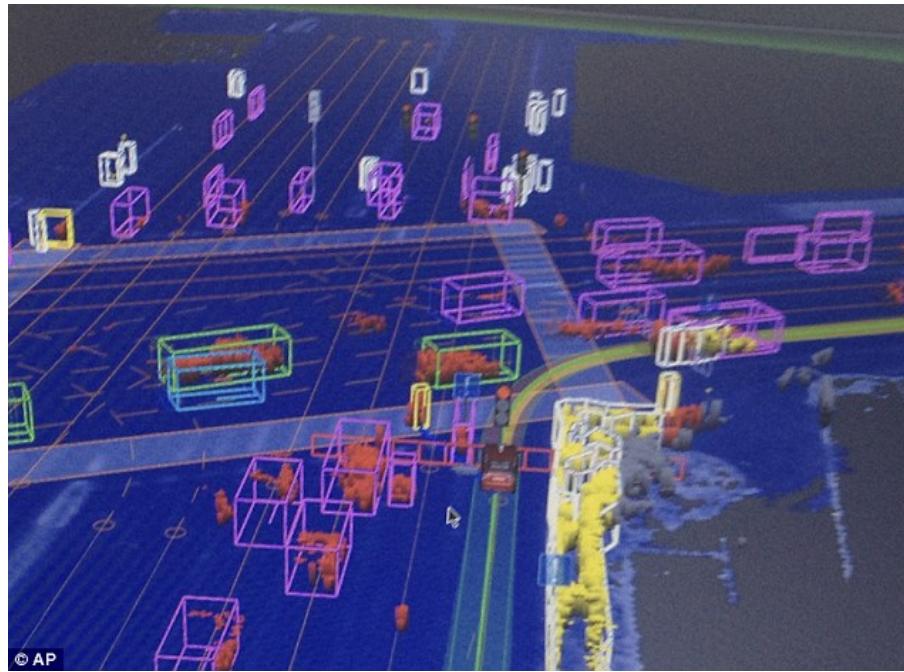


Human shape capture

<http://gl.ict.usc.edu/Research/PresidentialPortrait/>



Google self-driving cars



- [Google's self-driving car passes 300,000 miles \(Forbes, 8/15/2012\)](#)
- [Nissan pledges affordable self-driving car models by 2020 \(CNET, 8/27/2013\)](#)

Self-Driving Cars

- Many other companies:
 - Uber
 - Tesla
 - GM
 - Toyota
- More than just vision
 - LIDAR
 - Planning
 - Mapping
 - Anticipating behavior of other drivers

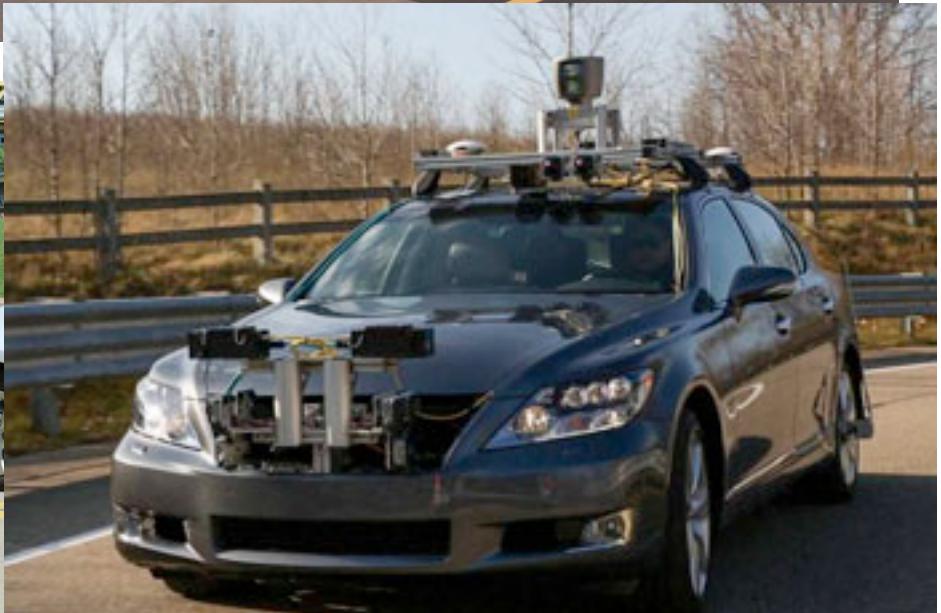


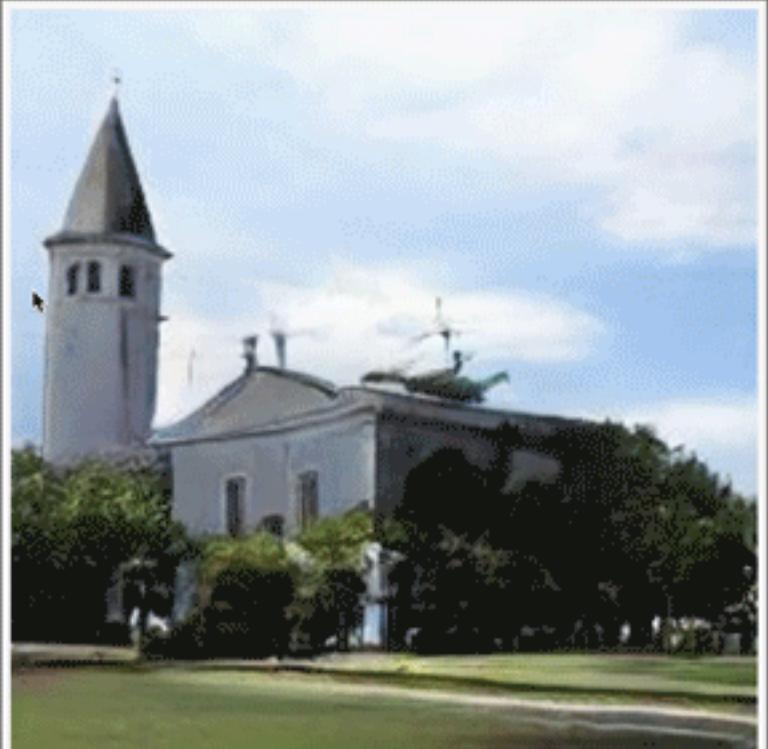
Image editing with GANs

Select a feature brush & strength and enjoy painting:

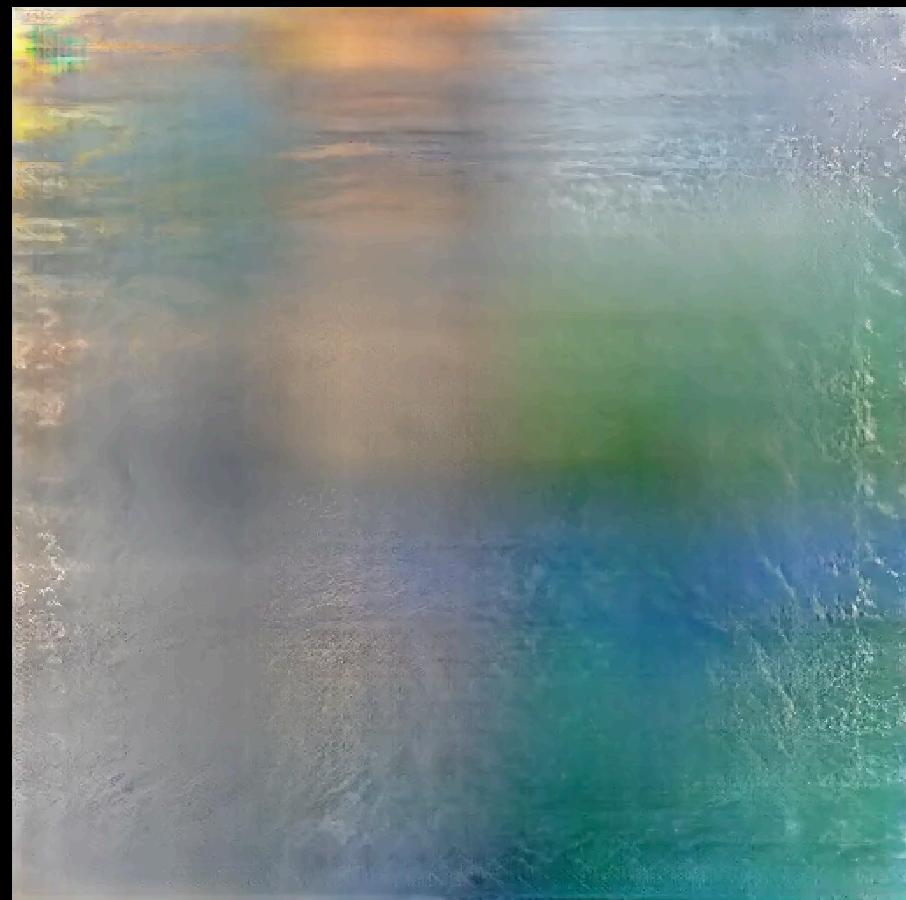
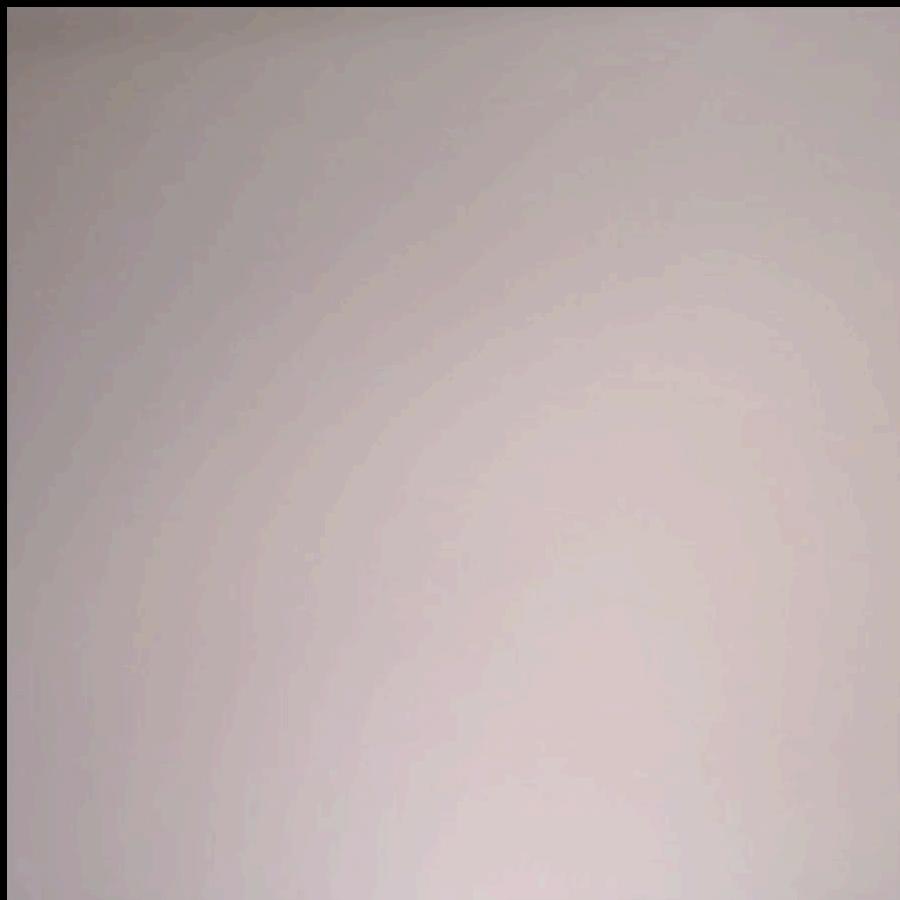
- tree
- grass
- door
- sky
- cloud
- brick
- dome**

draw **remove**

undo **reset**

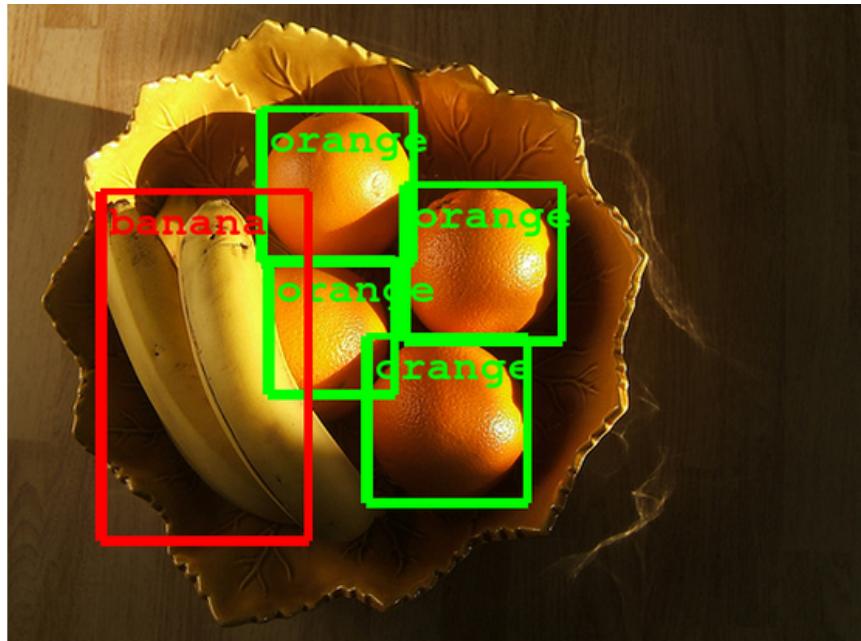
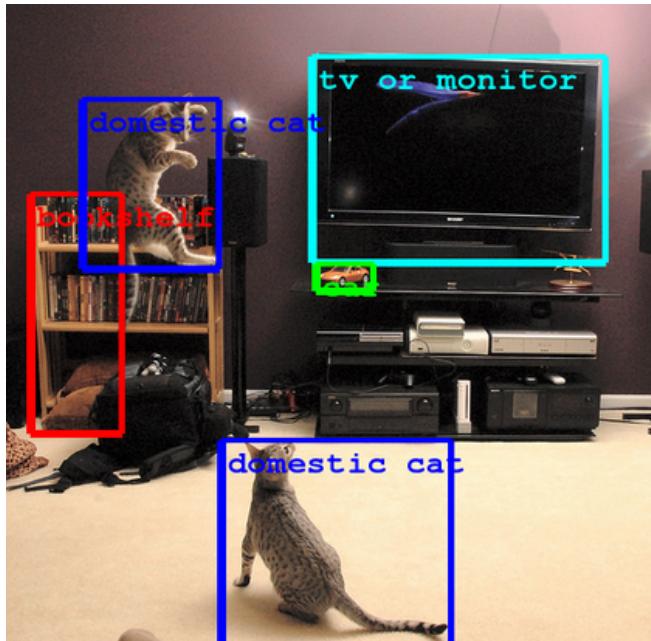


Main device 0

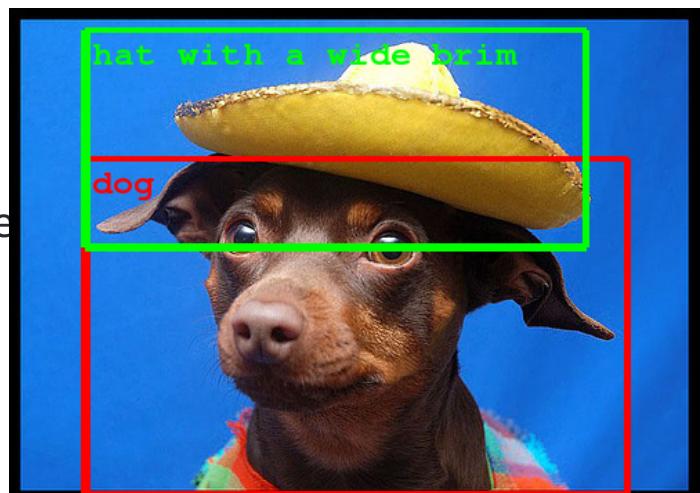


Memo Akten

Recognition

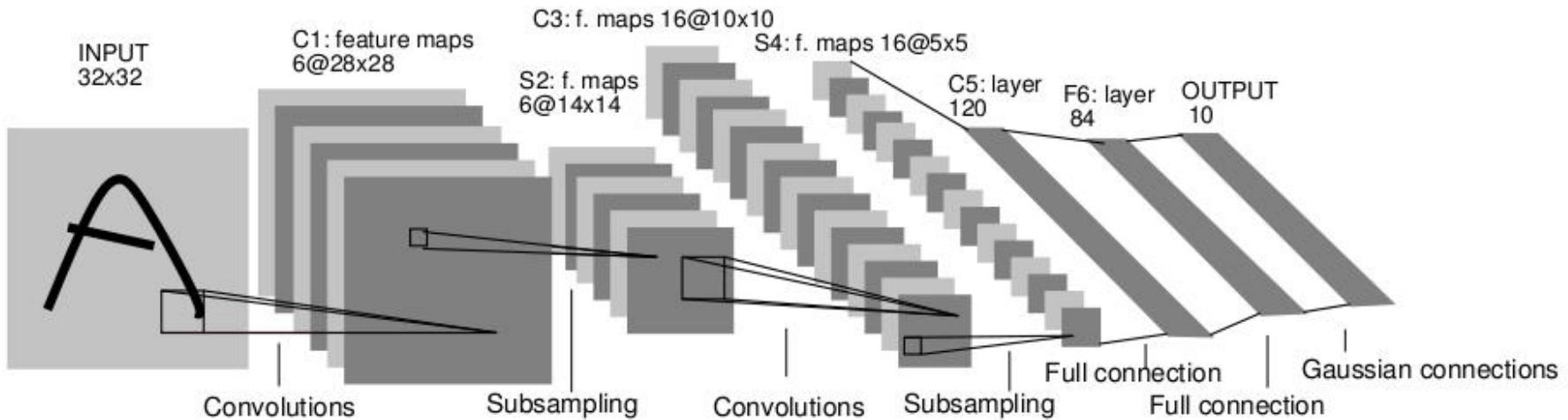


- [Computer Eyesight Gets a Lot More Accurate](#), NY Times Bits blog, August 18, 2014
- [Building A Deeper Understanding of Images](#), Google Research Blog, September 5, 2014
- [Baidu caught gaming recent supercomputer performance test](#), Engadget, June 3, 2015

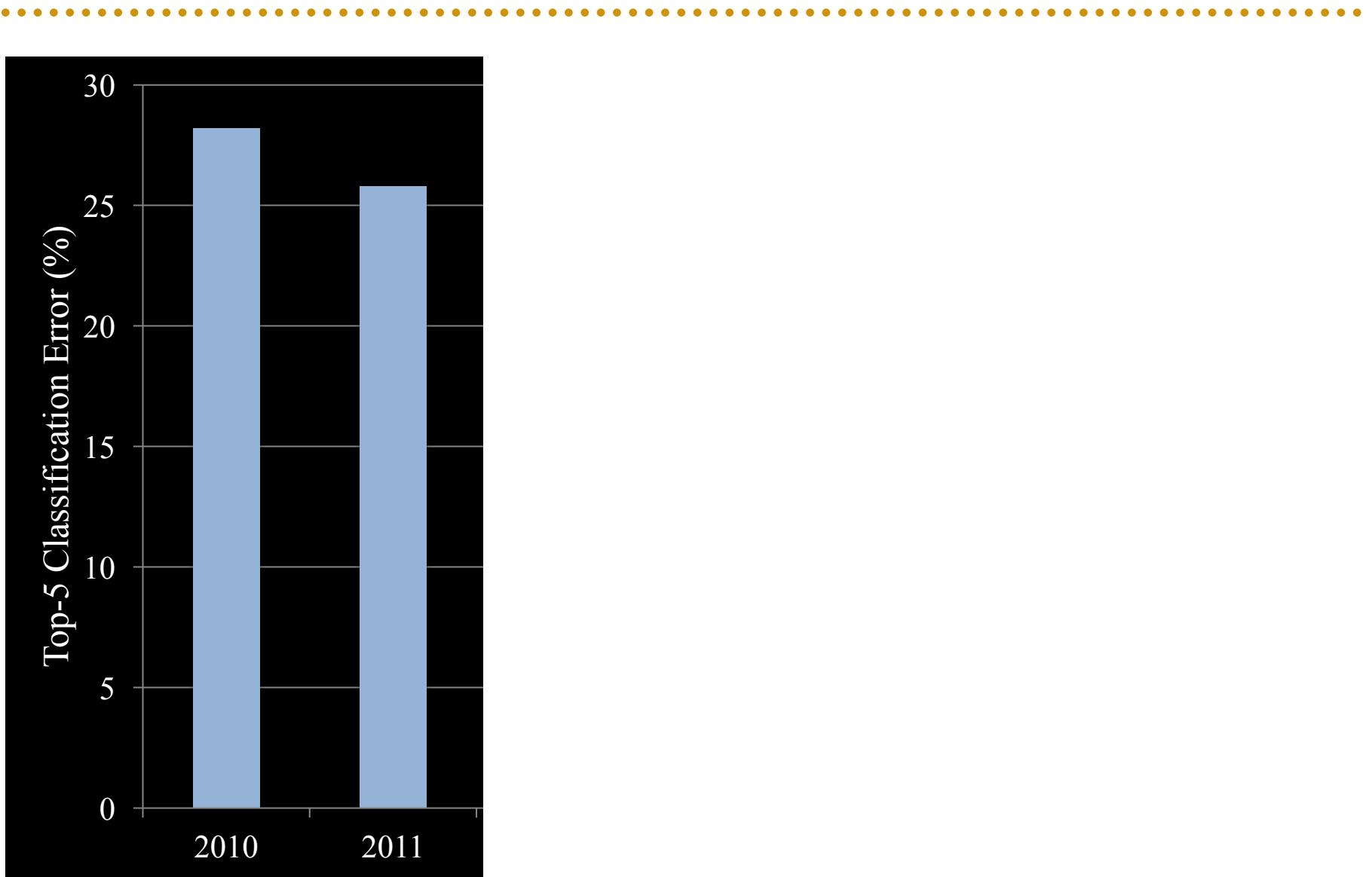


Convolutional Neural Networks

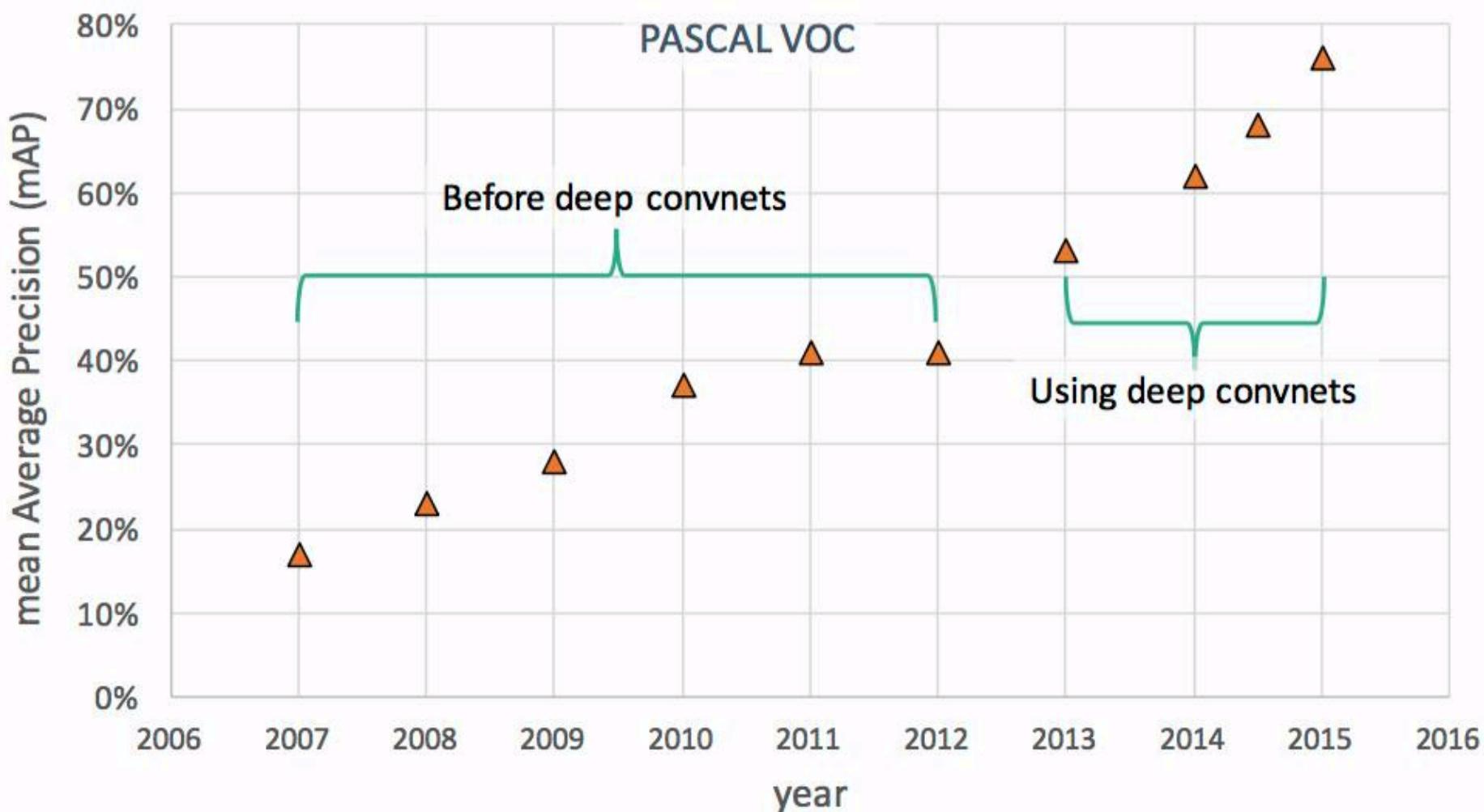
- LeCun et al. 1989
- Neural network with specialized connectivity structure
- Huge revival in 2012

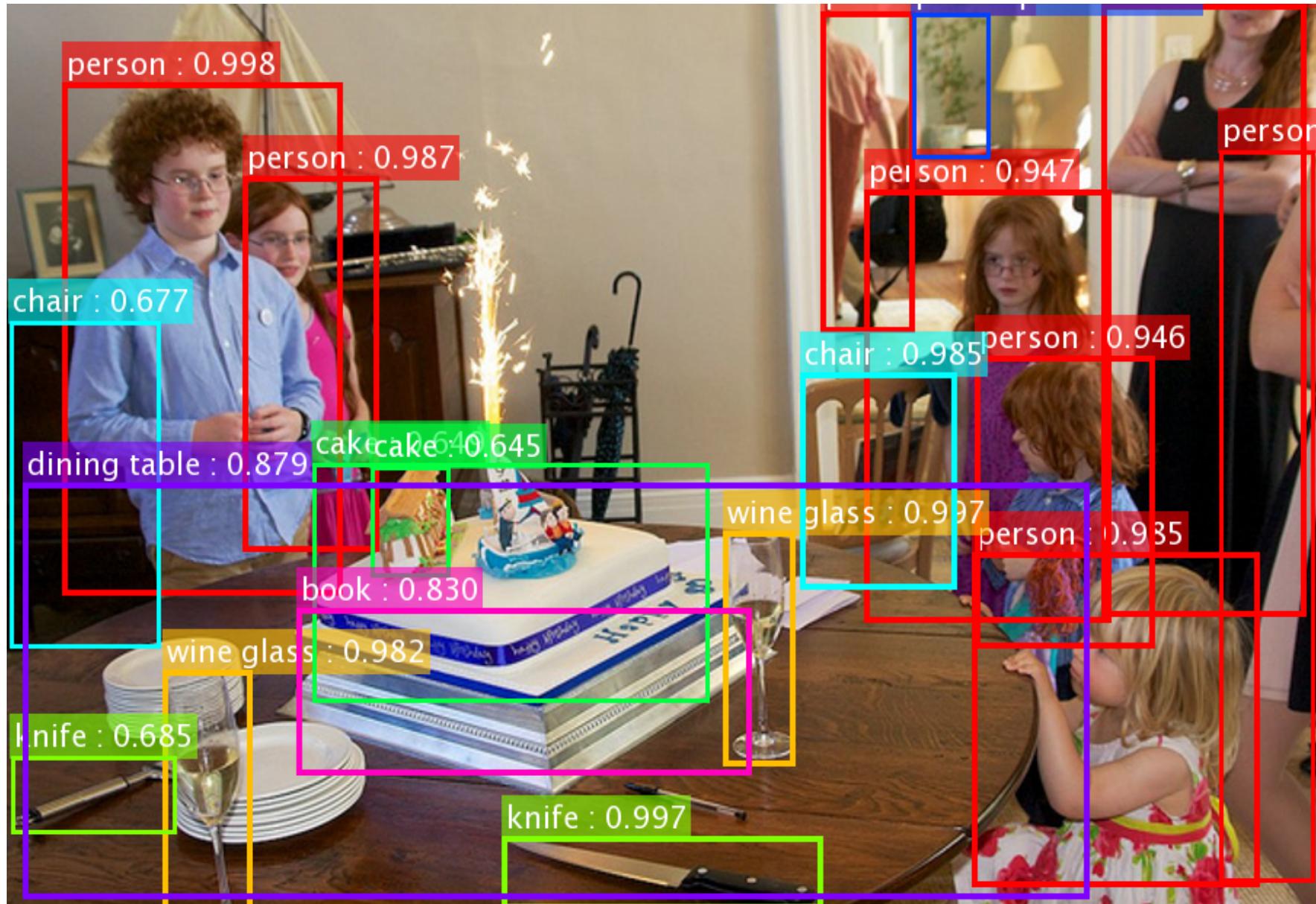


ImageNet Classification (2010 – 2015)

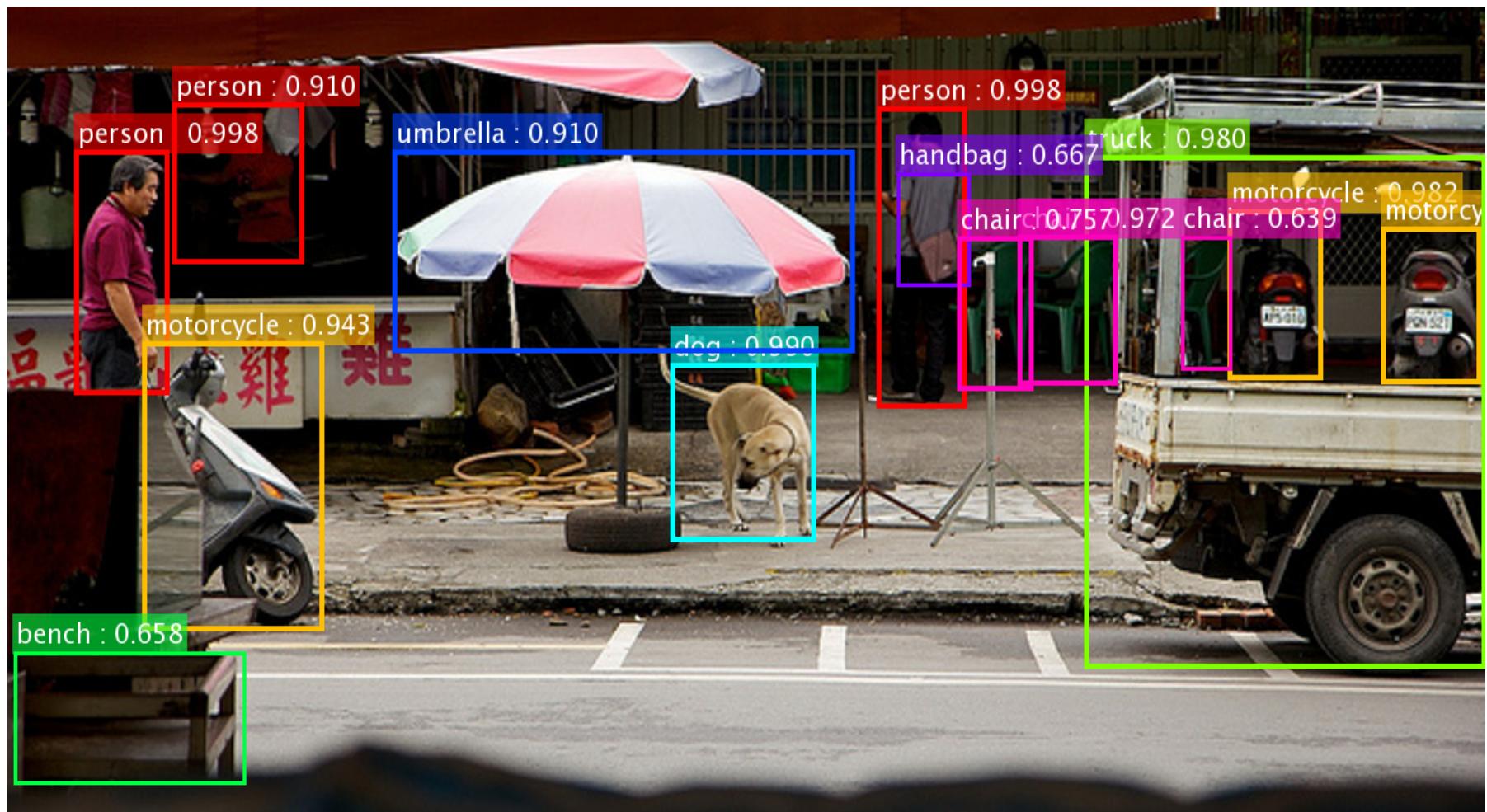


Object Detection Progress





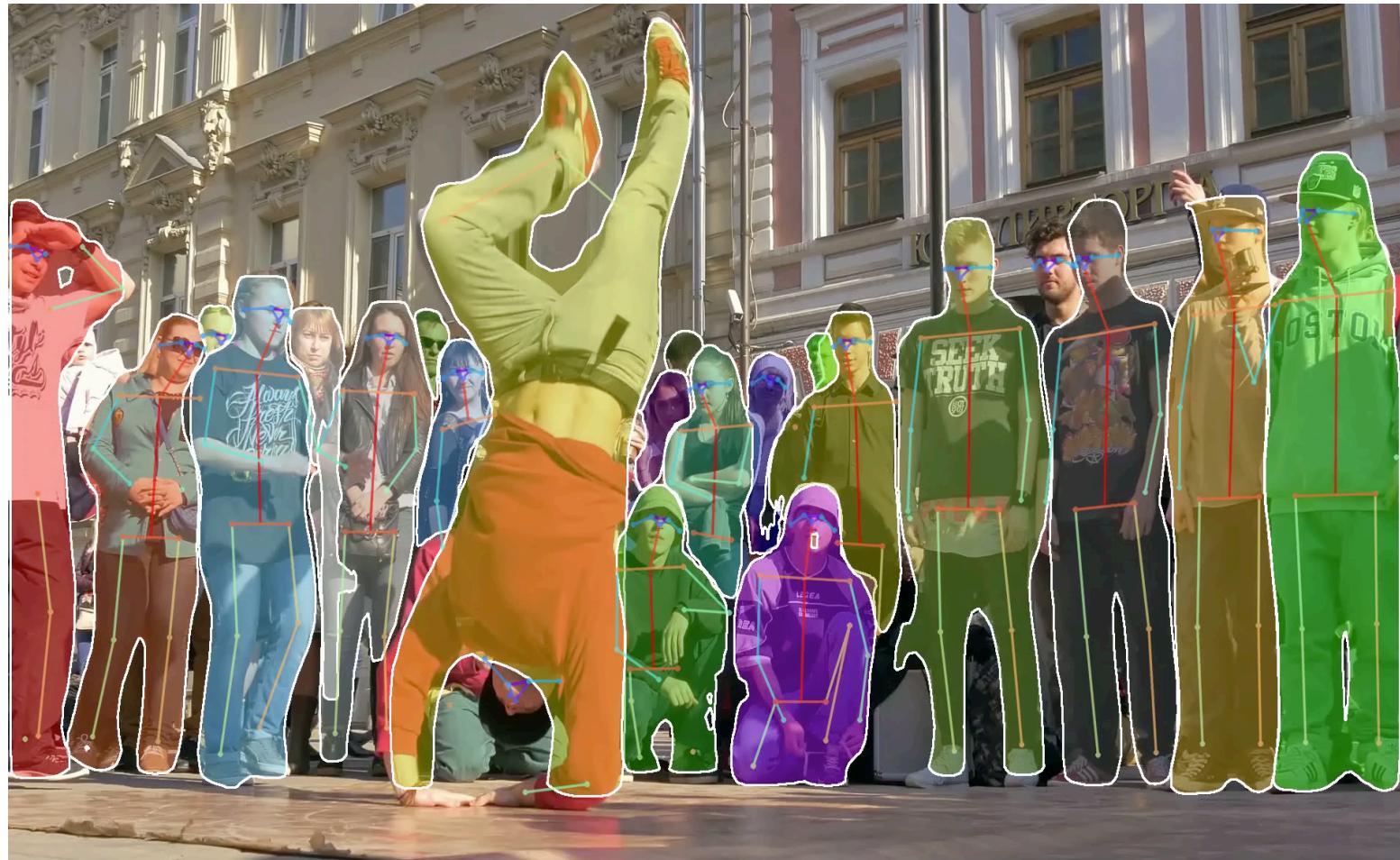
He, Zhang, Ren, & Sun. "Deep Residual Learning for Image Recognition". ICCV 2015.



He, Zhang, Ren, & Sun. “Deep Residual Learning for Image Recognition”. ICCV 2015.



Mask R-CNN [He et al. 2017]



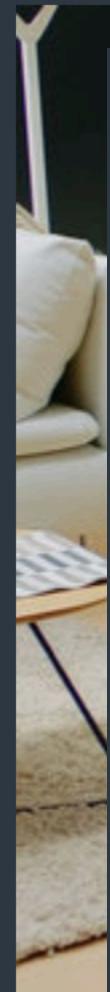
Mask R-CNN [He et al. 2017]

Mobile robots



MOLEY ROBOTICS

Mobile robots



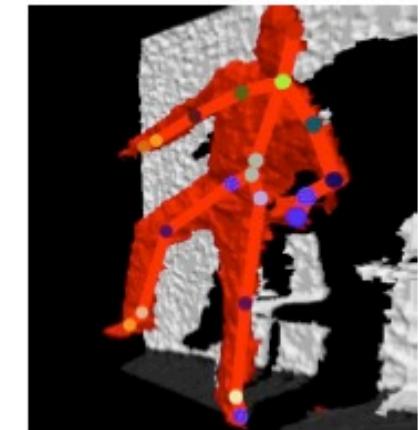
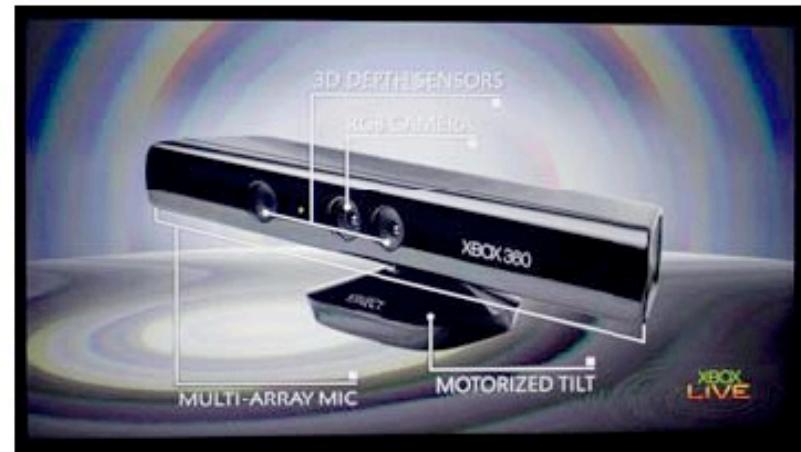
AEOLUS ROBOTICS



PAL-ROBOTICS.COM



Vision-based interaction: Xbox Kinect



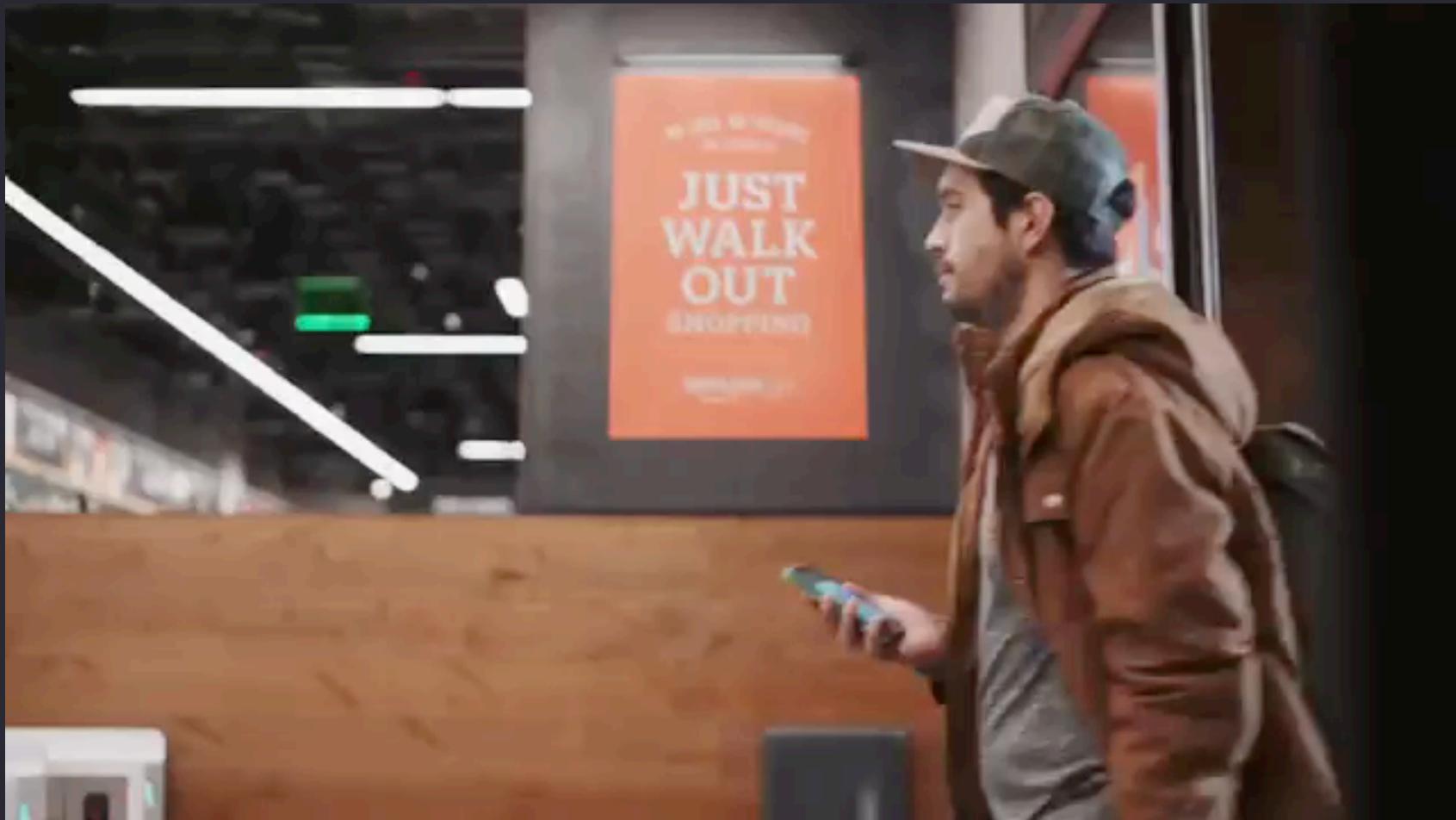
<http://blogs.howstuffworks.com/2010/11/05/how-microsoft-kinect-works-an-amazing-use-of-infrared-light/>

<http://electronics.howstuffworks.com/microsoft-kinect.htm>

<http://www.xbox.com/en-US/Live/EngineeringBlog/122910-HowYouBecometheController>

<http://www.ismashphone.com/2010/12/kinect-hacks-more-interesting-than-the-devices-original-intention.html>

Amazon Go



Amazon plans to nearly triple number of 'grab and go' stores



Save 3



Amazon is planning to expand its 'grab and go' stores to two new US cities CREDIT: ELAINE THOMPSON/AP

Follow ▾

By **Olivia Feld**, SENIOR US TECHNOLOGY REPORTER, SAN FRANCISCO

25 FEBRUARY 2019 • 7:50AM

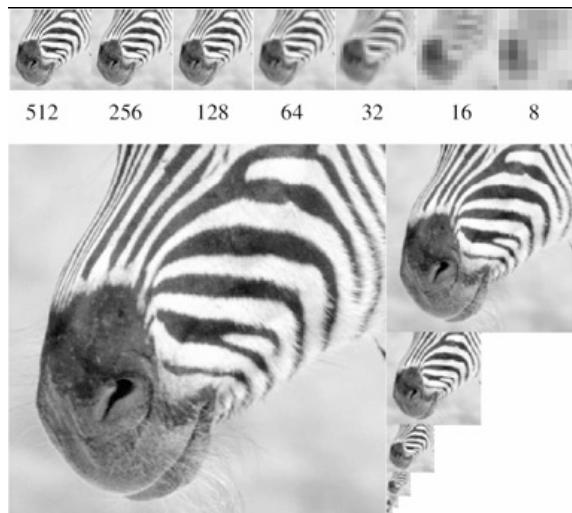
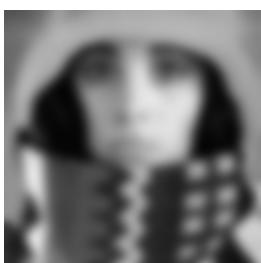
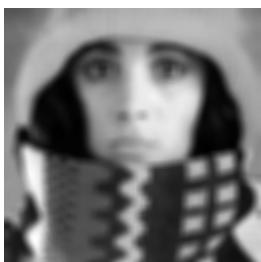
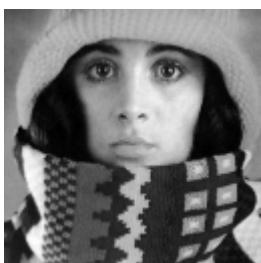
Amazon plans to continue its assault on the high street by almost trebling its cashier-free "grab and go" stores in the US.

The tech giant is opening 17 new Amazon Go stores in the coming months, The Telegraph understands, including its first locations in New York City and Philadelphia.

Course overview

- 1) Early vision: Image formation and processing
- 2) Mid-level vision: Grouping and fitting
- 3) Deep Learning - Convolutional Architectures
- 4) Recognition
- 5) Detection and Segmentation
- 6) Basic Video Processing

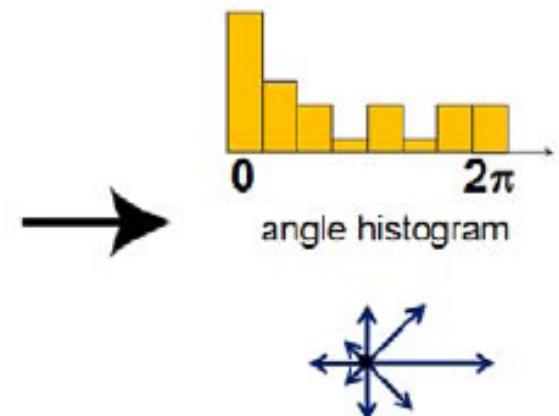
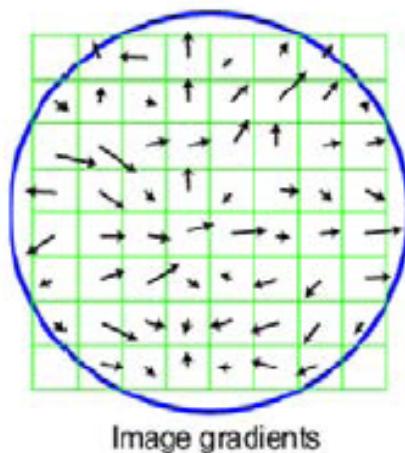
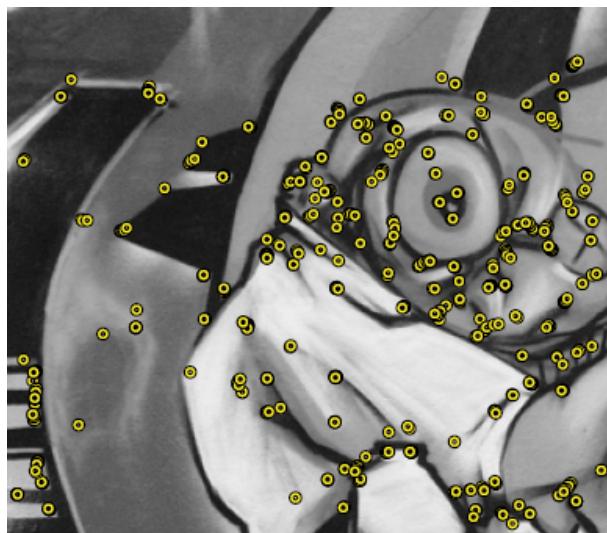
Features and filters



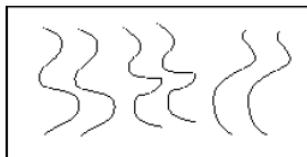
- Transforming and describing images; textures, colors, edges

Features and filters

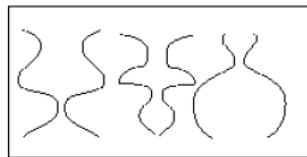
- Detecting distinctive + repeatable features
- Describing images with local statistics



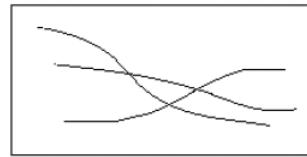
Grouping and fitting



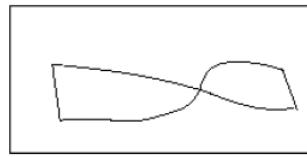
Parallelism



Symmetry



Continuity



Closure



[fig from Shi et al]

- Clustering, segmentation, fitting; what parts belong together?

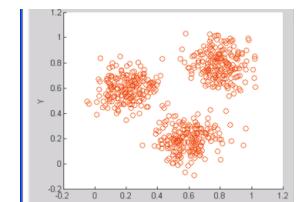
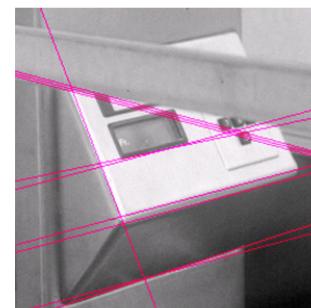
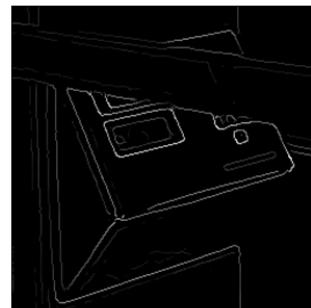


Image categorization

- Fine-grained recognition

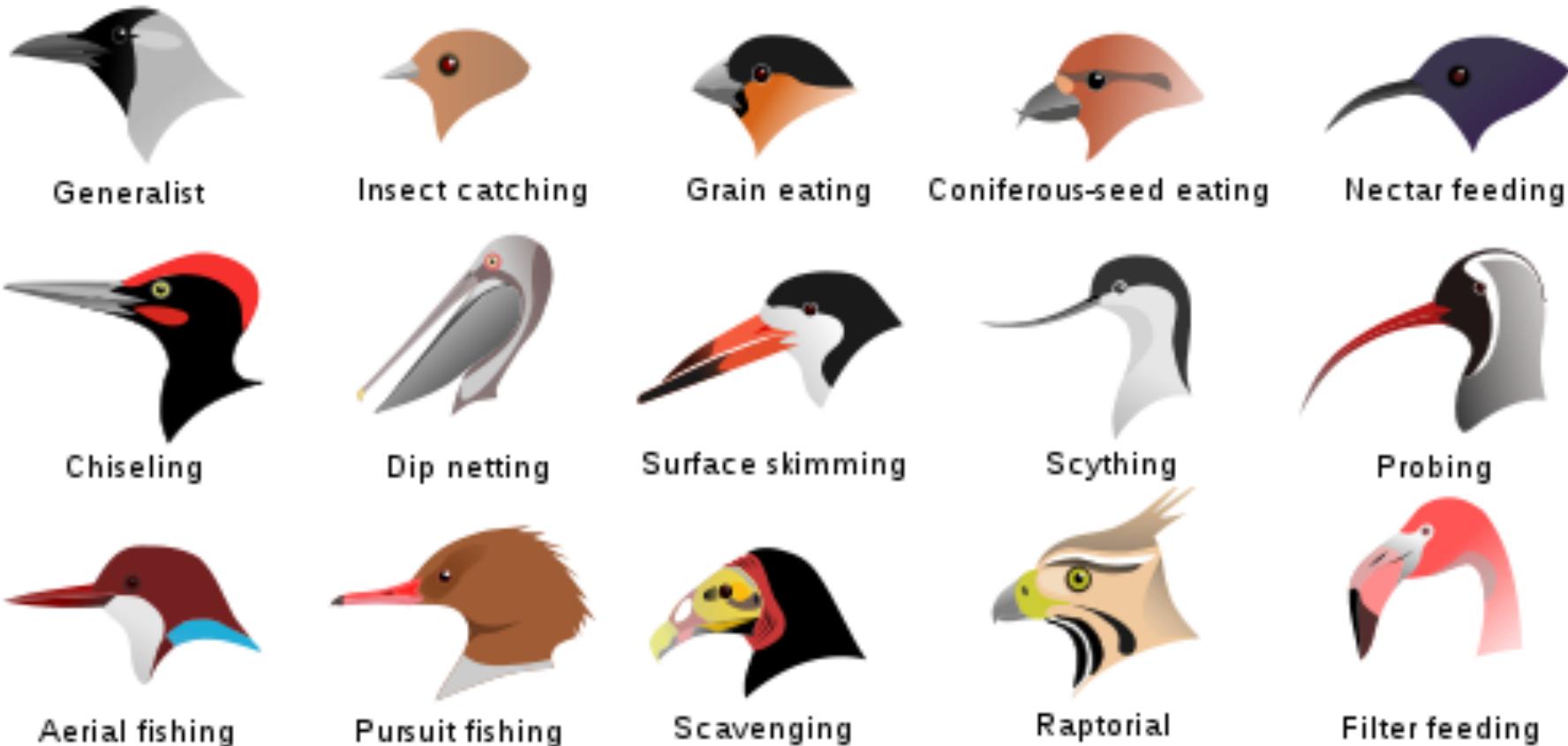


Image categorization

- Image style recognition



HDR



Macro



Baroque



Rococo



Vintage



Noir



Northern Renaissance



Cubism



Minimal



Hazy



Impressionism



Post-Impressionism



Long Exposure



Romantic



Abs. Expressionism

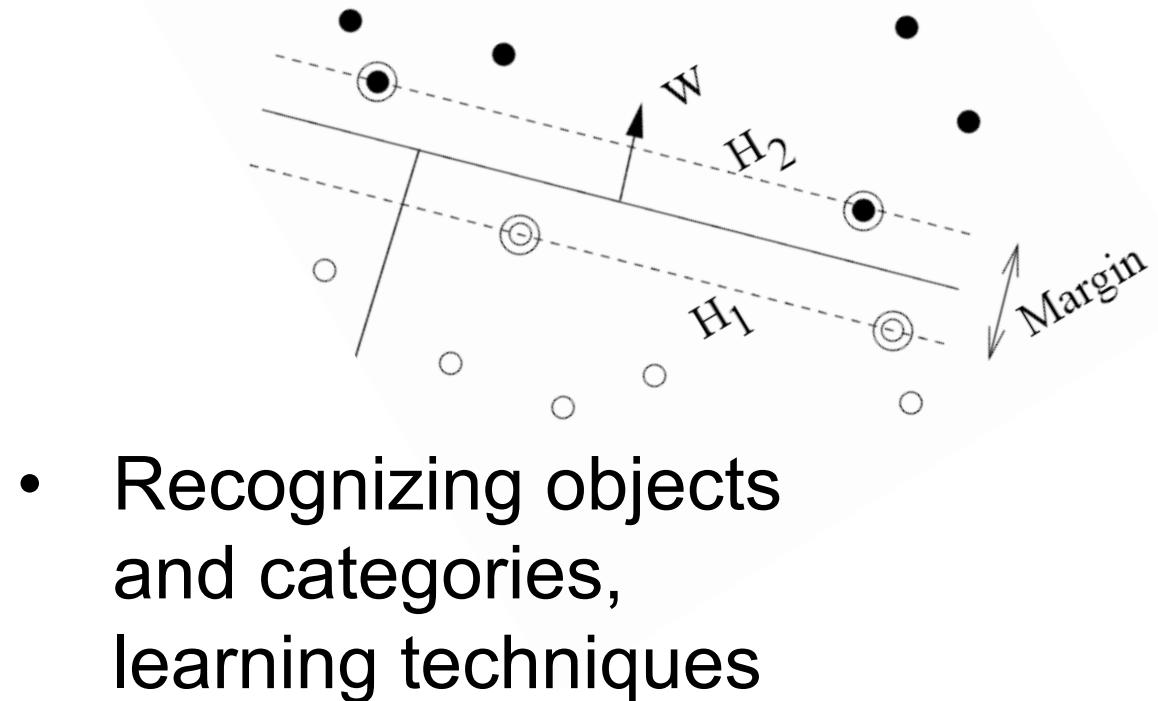
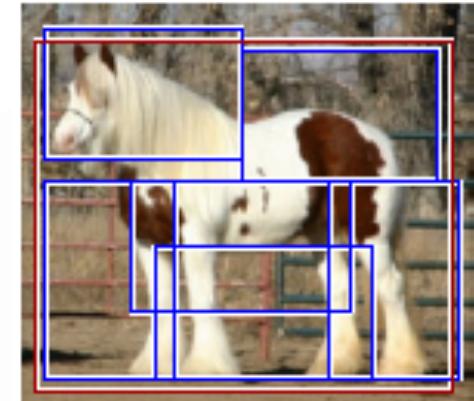
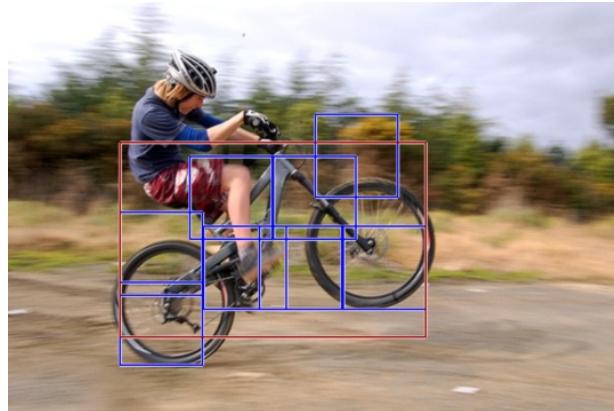
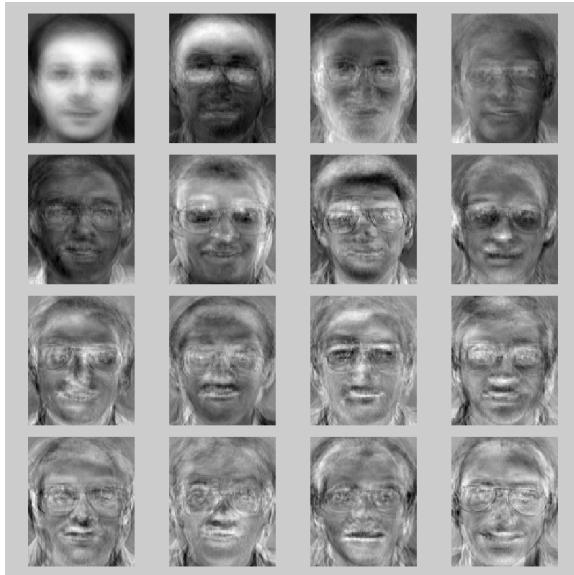


Color Field Painting

Flickr Style: 80K images covering 20 styles.

Wikipaintings: 85K images for 25 art genres.

Visual recognition and SVMs

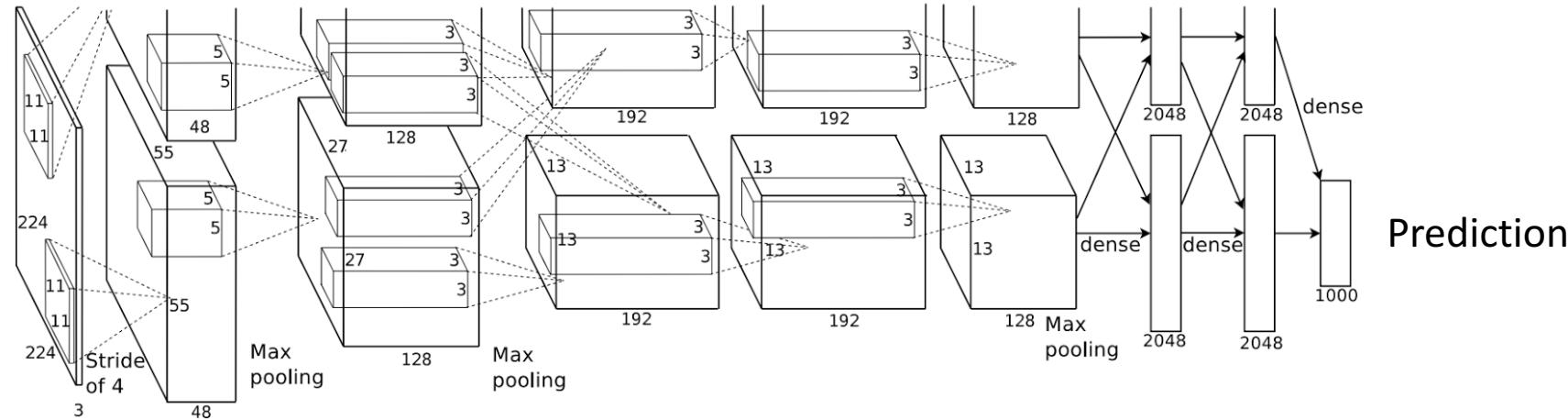


- Recognizing objects and categories, learning techniques

Convolutional neural networks (CNNs)

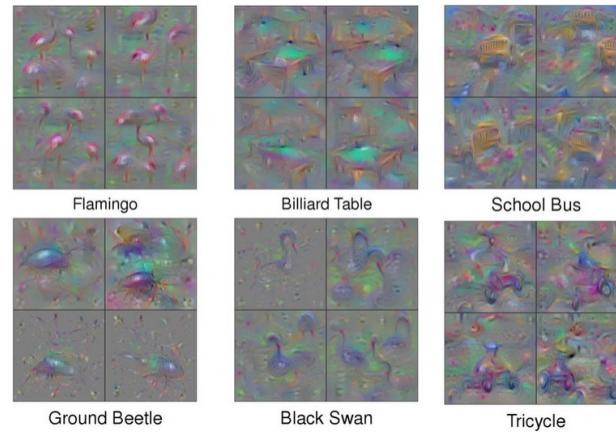
- State-of-the-art on many recognition tasks

Image



Prediction

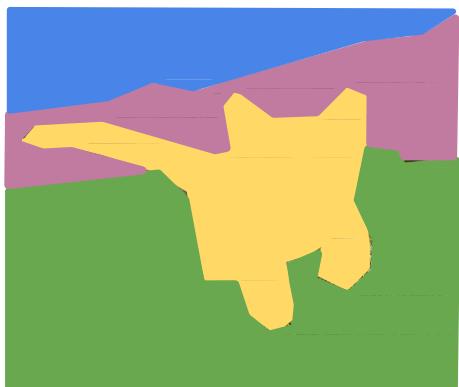
Krizhevsky et al., NIPS 2012



Yosinski et al., ICML DL workshop 2015

Different Flavors of Object Recognition

Semantic Segmentation



GRASS, CAT,
TREE, SKY

No objects, just pixels

Classification + Localization



CAT

Single Object

Object Detection



DOG, DOG, CAT

Multiple Object

Instance Segmentation



DOG, DOG, CAT

Motion and tracking

- Tracking objects, video analysis



Tomas Izo

Course Information

- Mondays 13:00-15:45 via zoom
- Office Hours:
 - by appointment
- For communications
 - <https://piazza.com/hacettepe.edu.tr/spring2021/bbm416/>

Course Information

- References:
 - [Computer Vision: Algorithms and Applications](#), by Richard Szeliski, Springer, 2010. (Available free online)
 - [Deep Learning](#), Ian Goodfellow and Yoshua Bengio and Aaron Courville, 2016.
 - [Computer Vision: A Modern Approach \(2nd edition\)](#), by D.A. Forsyth and J. Ponce, Prentice Hall, 2011.
 - Computer Vision: Models, Learning, and Inference, by Simon J.D. Prince, 2012.
 - Lecture slides and notes.

Course Information

- Grading
 - Midterm Exam (30%)
 - Project (30%)
 - Done in groups of two or three
 - Progress report + Final report + presentation
 - Final exam (40%)

Project Information

- This semester's Theme:

"Computer Vision in everyday life"

Start thinking about your projects

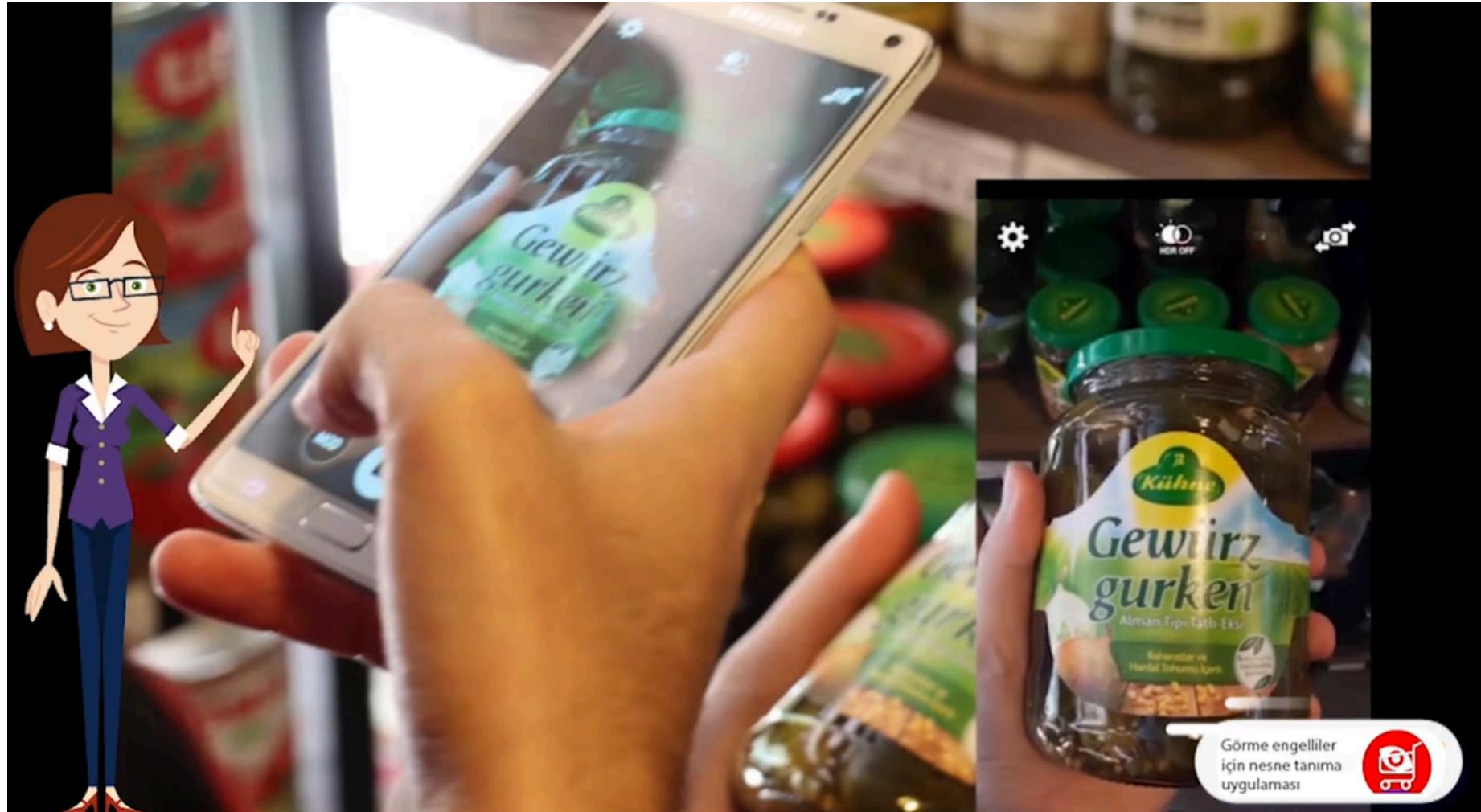
Proposals will be due in March 15.

HUSee: Görme Zorluğu Yaşayan Bireyler İçin Derin Öğrenme ile Detaylı Nesne Tanıyan Mobil Uygulama

Berk Gülay, Tarık Yılıkoğlu, Ümit Ese, Nazlı İkizler Cinbiş



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2019



Our students Berk Gülay, Ümit Ese, Tarık Yılıkoğlu came in first place in TUBITAK 2242 University Students Research Project Competition at Information and Communication Category.

Our students Berk Gülay, Ümit Ese, Tarık Yılıkoğlu came in first place in the Final Competition of TUBITAK 2242 University Students Research Project Competition at Information and Communication Category held between September 17-22, 2019 with their projects titled "Mobile Application Defining Detailed Object for Visually Impaired Individuals with Deep Learning".

Healthy Area

Erhan Kabaoğlu, Gökay Berkem Turan, Zafer Can Yücel, Nazlı İkizler Cinbiş

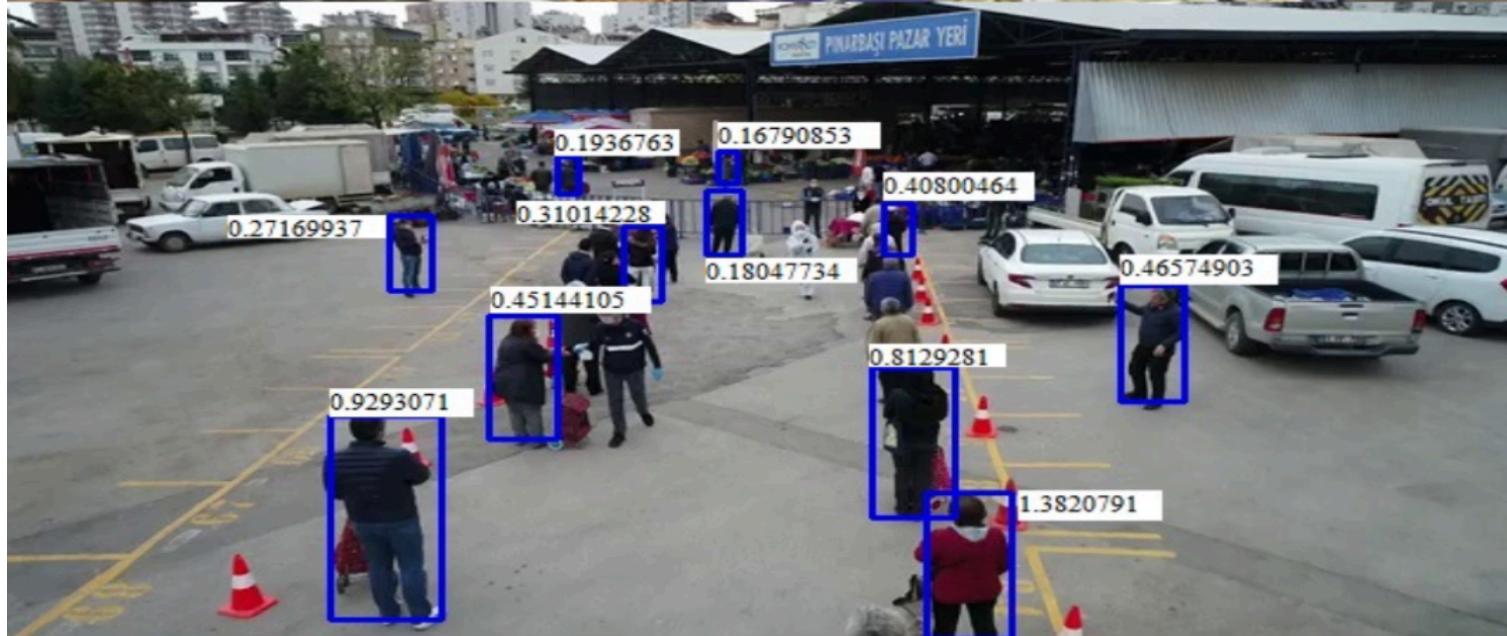


Healthy Area

Erhan Kabaoğlu, Gökay Berkem Turan, Zafer Can Yücel, Nazlı İkizler Cinbiş

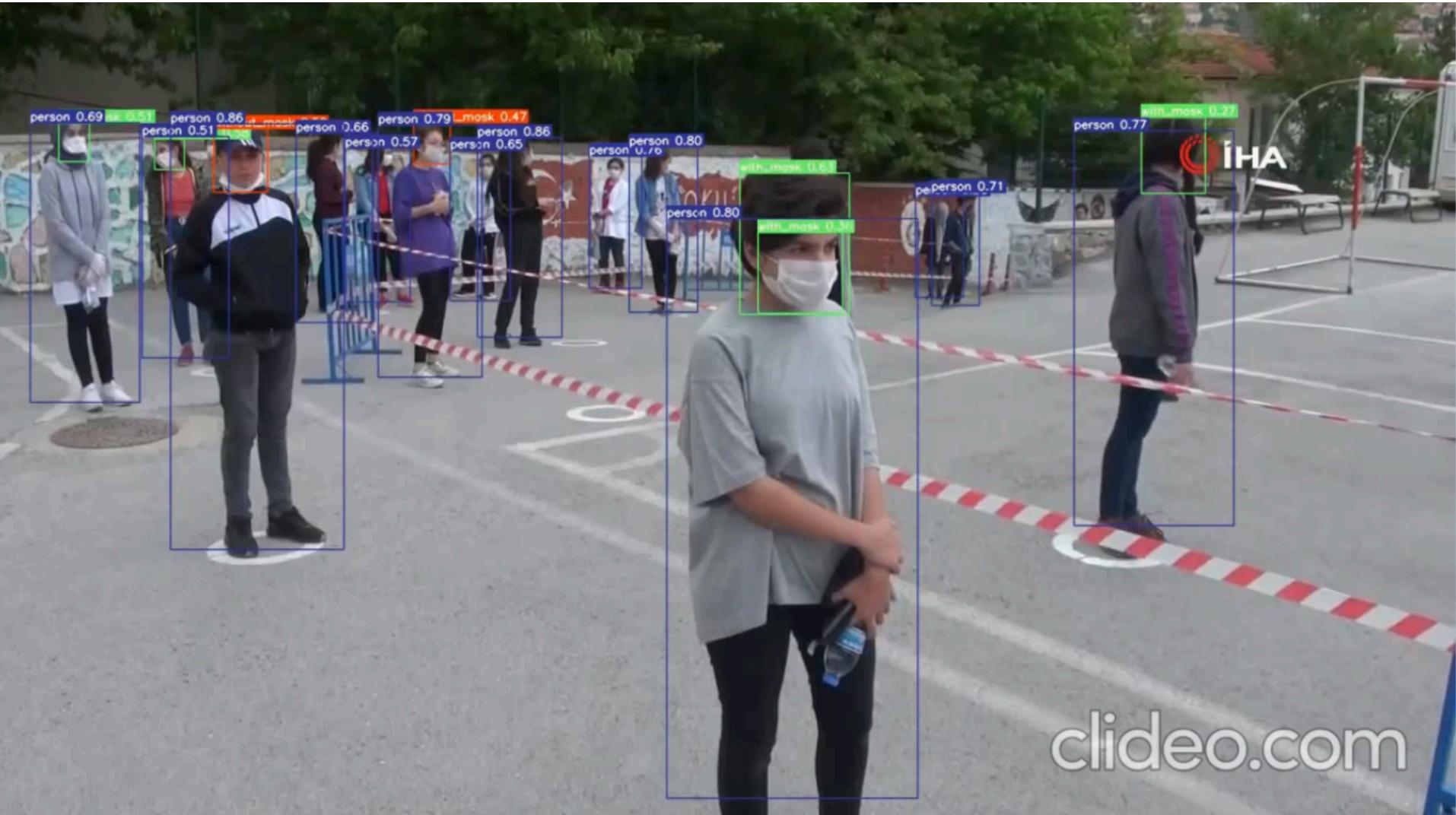


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Healthy Area

Erhan Kabaoğlu, Gökay Berkem Turan, Zafer Can Yücel, Nazlı İkizler Cinbiş



BBM 418

- Teaching Assistant
 - Yunus Can Bilge
- Four programming experiments (%20 + %25 + %25 + %30)
 - Programming in Python and PyTorch
- Recitation and Tutorial Hours

Course Ethics

Academic Integrity:

The students are expected to strictly adhere to the academic integrity policy of the Department, act honestly and respect the rights of the others in carrying out all academic assignments. Academic dishonesty, including cheating, fabrication and plagiarism will not be tolerated. Unless stated otherwise, all the work on the assignments must be carried out individually. While the discussions over the general concepts about the course are allowed, discussions related to a particular solution to a specific problem, (actual or pseudo) code sharing are strictly forbidden. Using assistance from the internet without providing proper citation is also considered as violation of the academic integrity. Note that, all the aforementioned violations to academic integrity policy are subject to disciplinary action.