Convolutional Neural Networks

Deep Learning & Applications

Common Applications of CNNs

CNNs for Image Classification

Image Source:
twitter.com%2Fcats&psig=AOvVaw30_o-PCM-K21DiMAJQimQ4&ust=1553887775741551

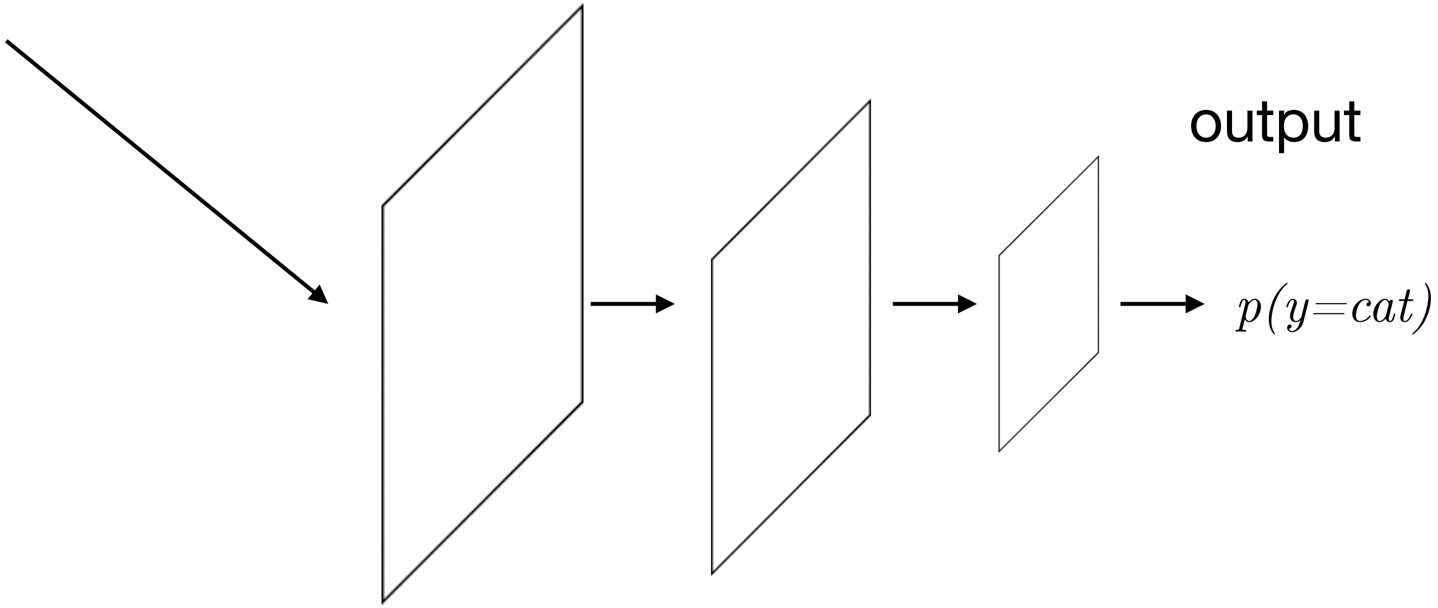
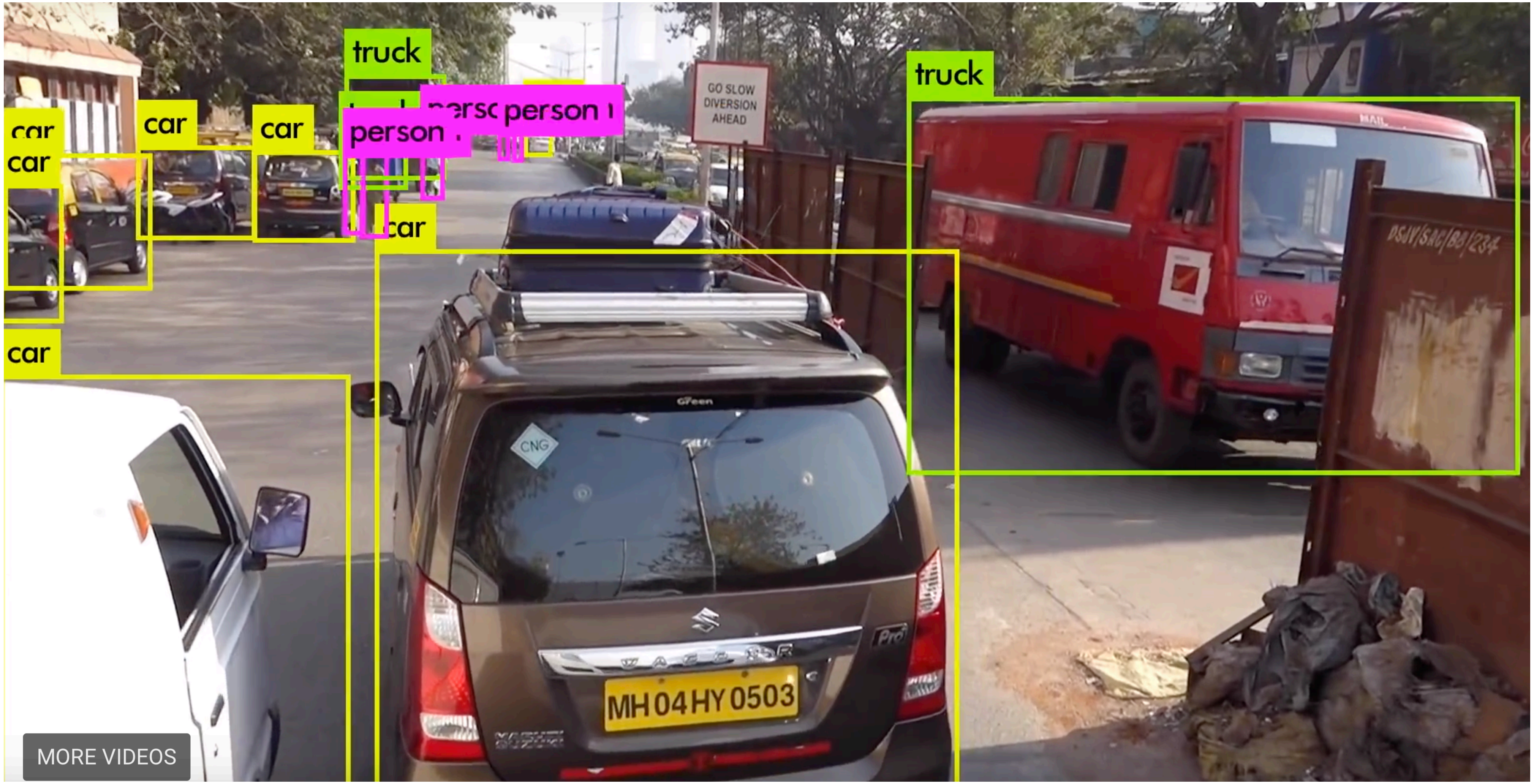


Image Source: https://www.pinterest.com/pin/244742560974520446

Object Detection



Redmon, J., Divvala, S., Girshick, R., & Farhadi, A. (2016). You only look once: Unified, real-time object detection. In *Proceedings of the IEEE Conference on Computer Vision and Pattern Recognition* (pp. 779-788).

Object Segmentation

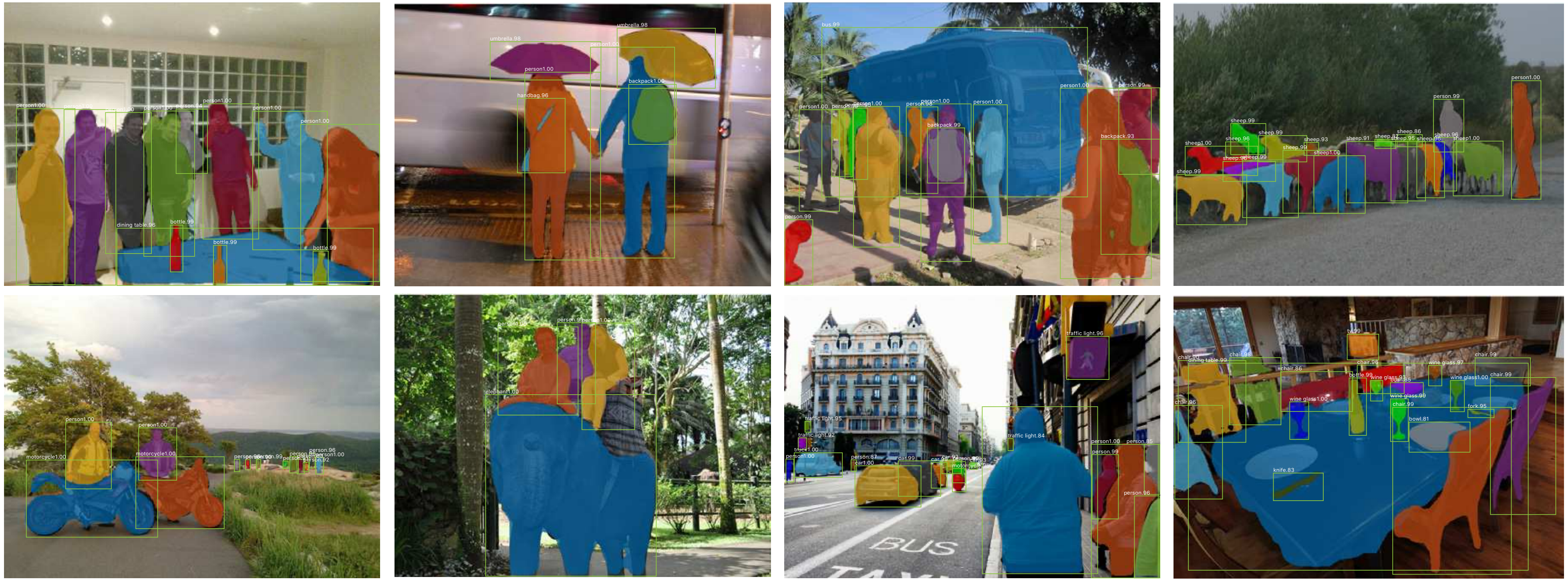
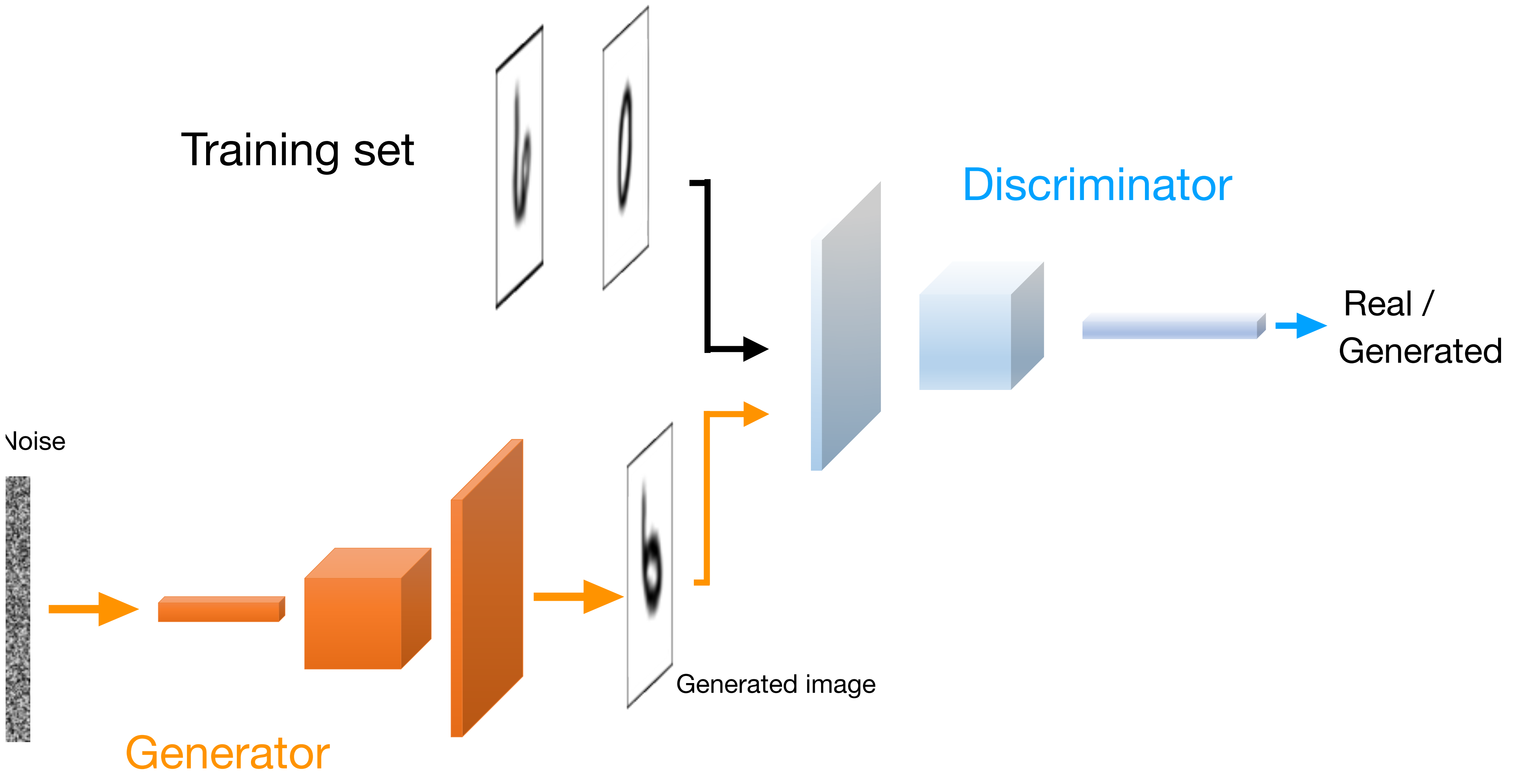


Figure 2. **Mask R-CNN** results on the COCO test set. These results are based on ResNet-101 [15], achieving a *mask* AP of 35.7 and running at 5 fps. Masks are shown in color, and bounding box, category, and confidences are also shown.

He, Kaiming, Georgia Gkioxari, Piotr Dollár, and Ross Girshick. "Mask R-CNN." In *Proceedings of the IEEE International Conference on Computer Vision*, pp. 2961-2969. 2017.

Image Synthesis



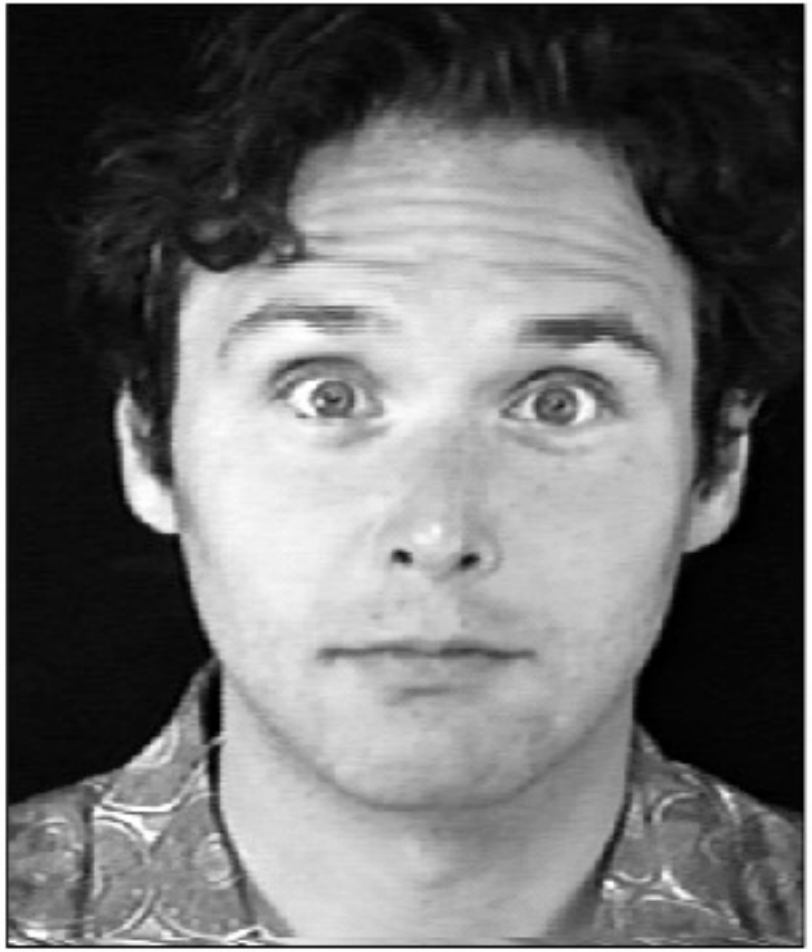
Human Detection

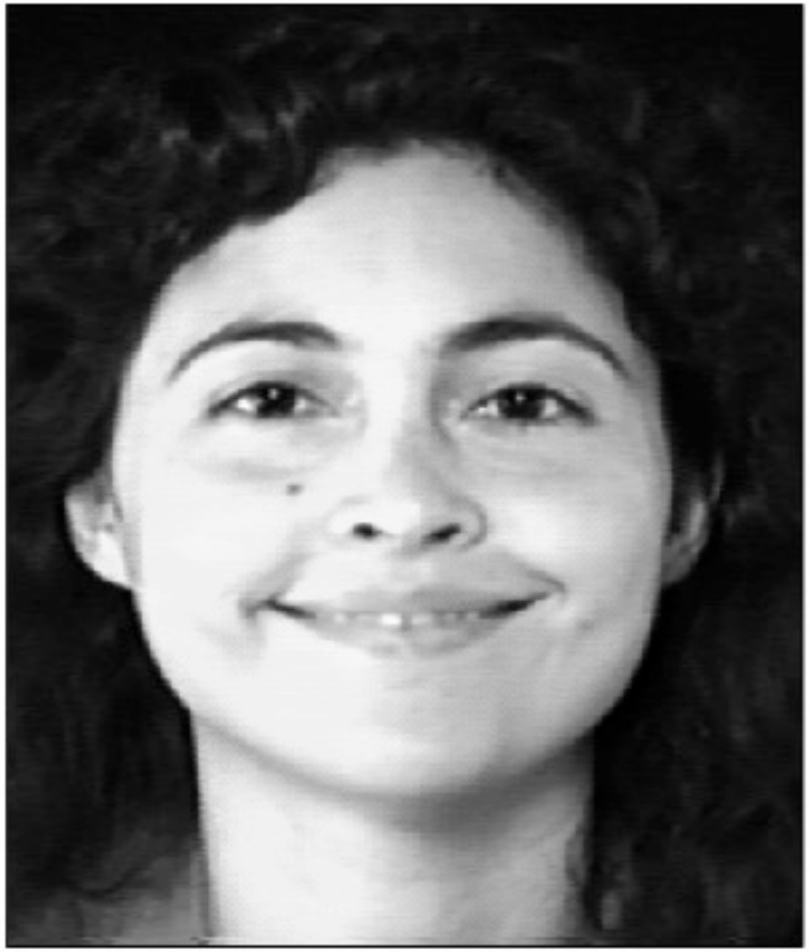
Face Recognition

Open-Universe Face Identification

Open-Universe Face Identification

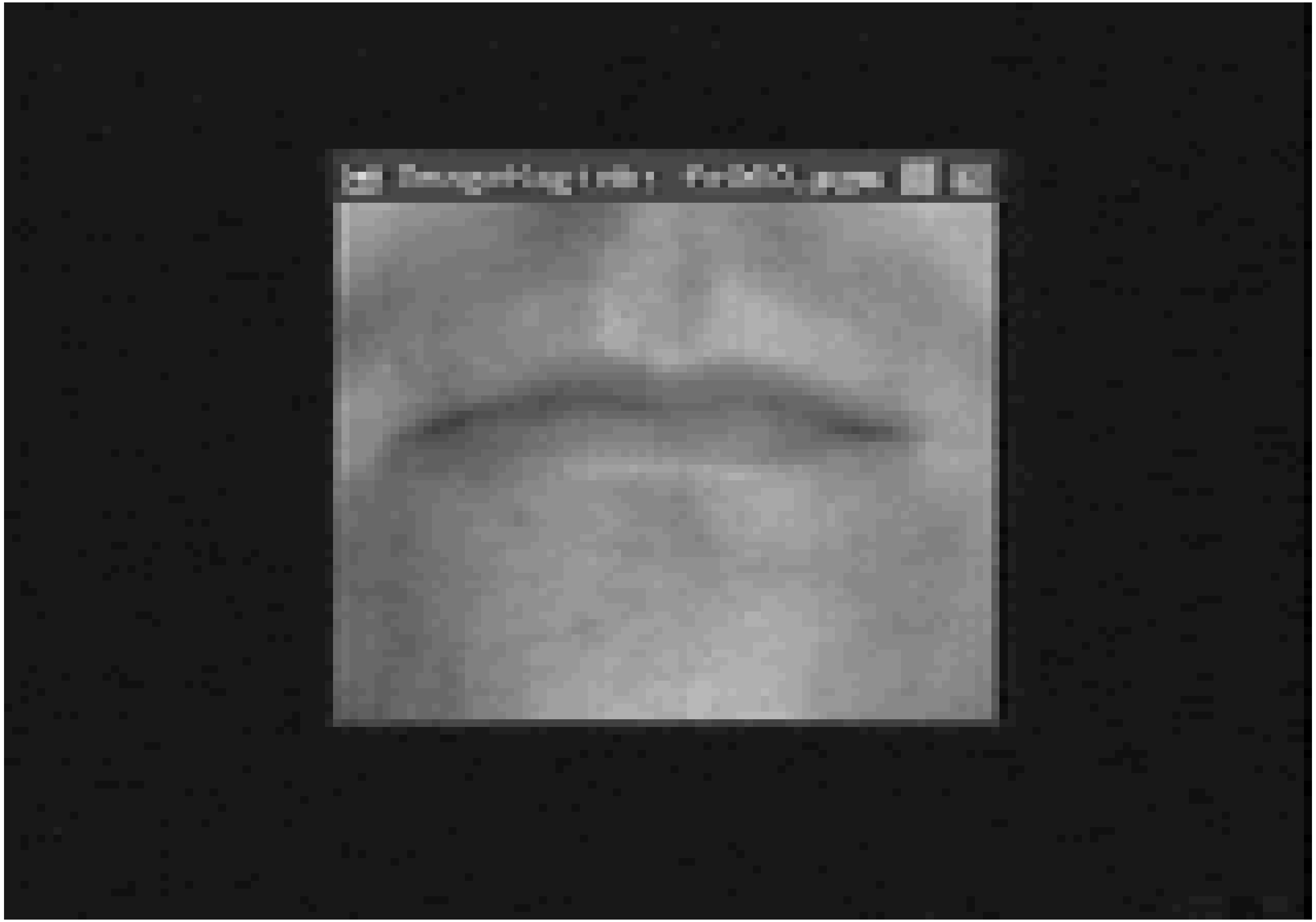
Facial expression



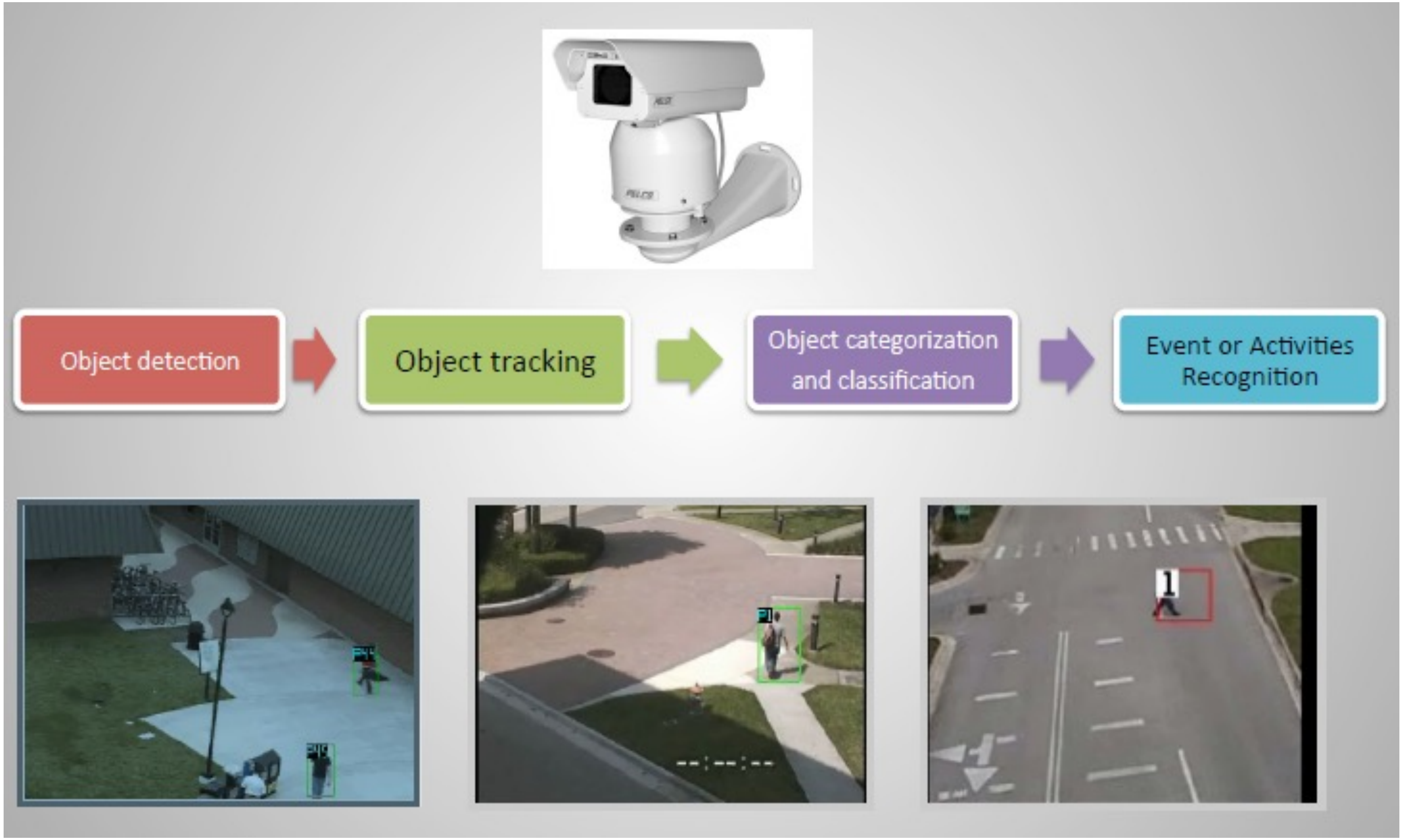


Fatigue detection

Lip-reading

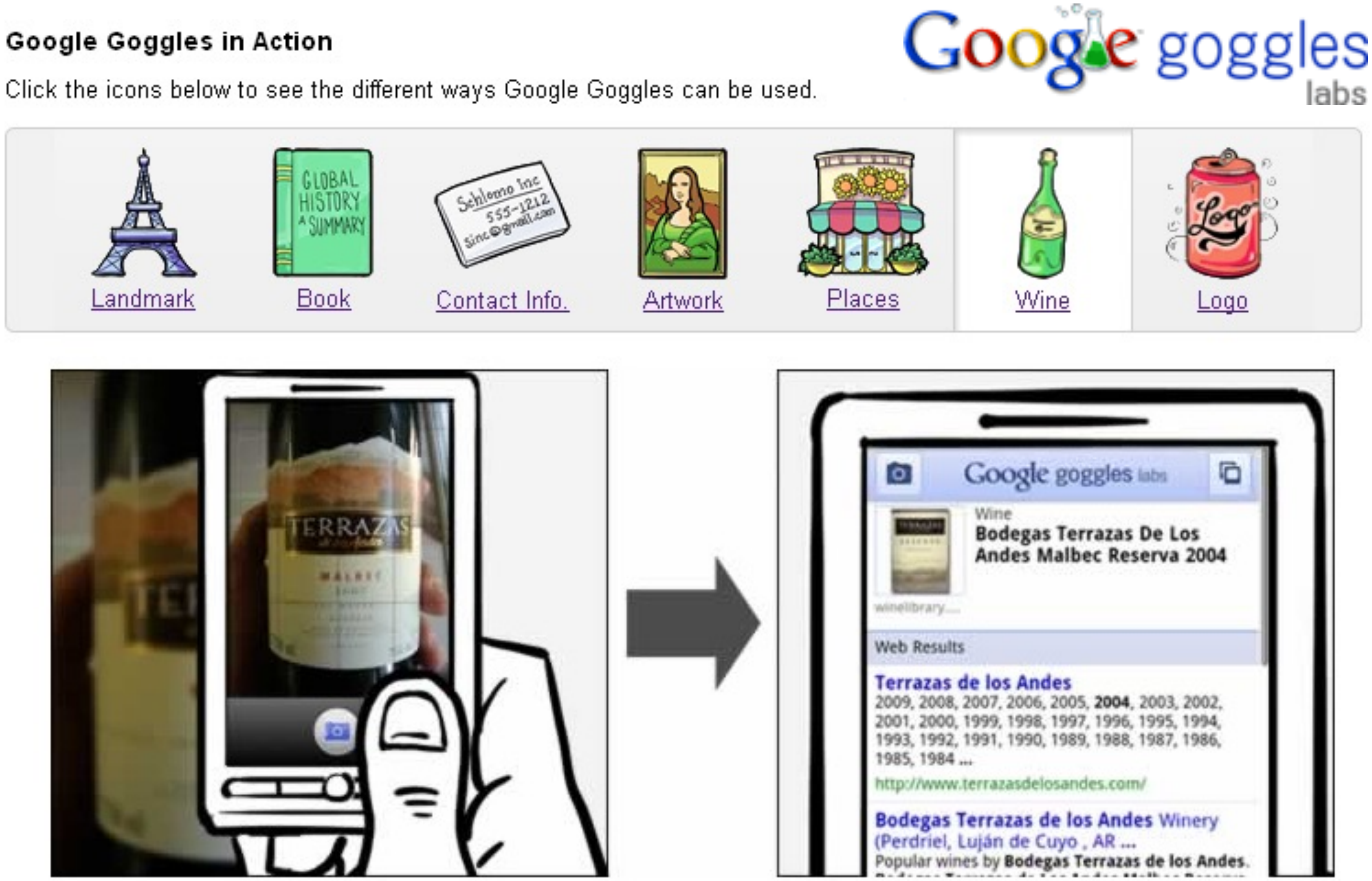


Video Surveillance and Monitoring

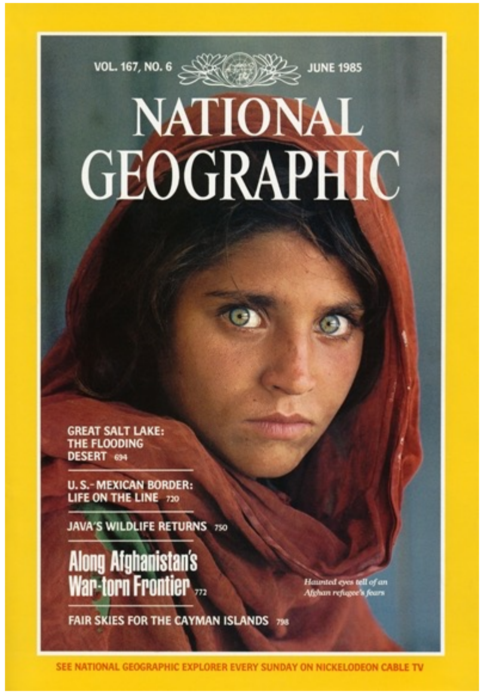


Unmanned Aerial Vehicles (drones)

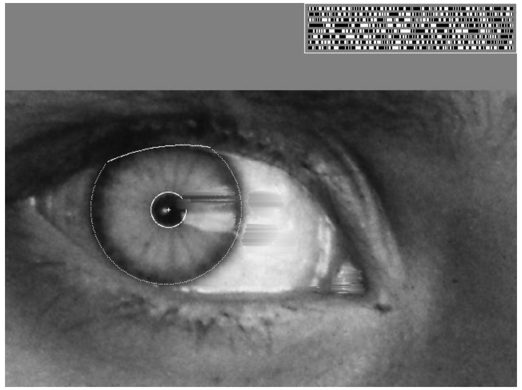
Mobile visual search: Google Goggles

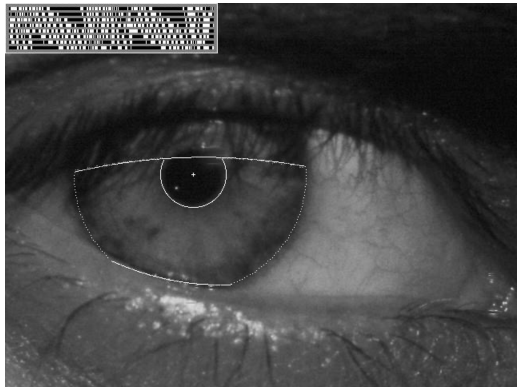


Biometrics



How the Afghan Girl was Identified by Her Iris Patterns



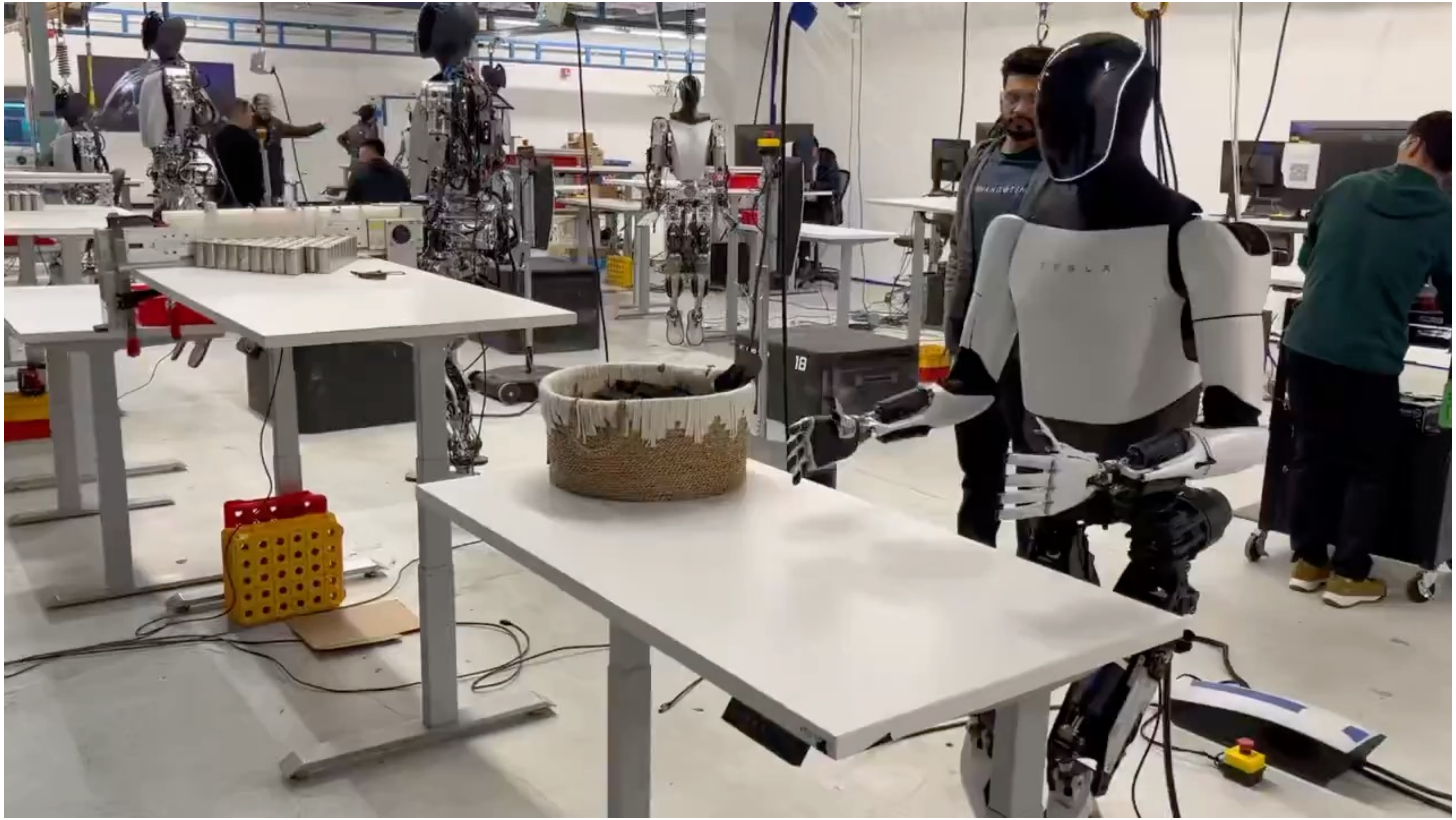


Automotive safety

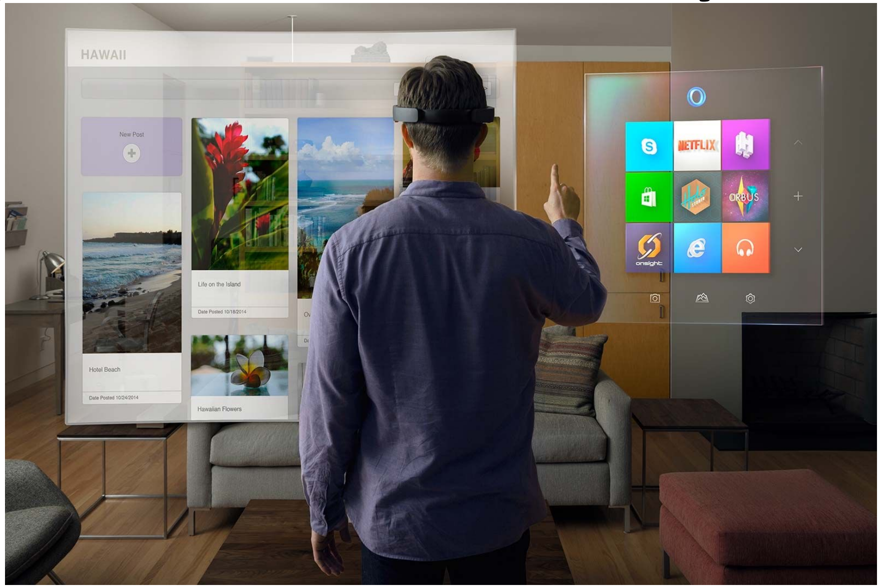
- [Mobileye](): Vision systems in high-end BMW, GM, Volvo models
  - Pedestrian collision warning
  - Forward collision warning
  - Lane departure warning
  - Headway monitoring and warning

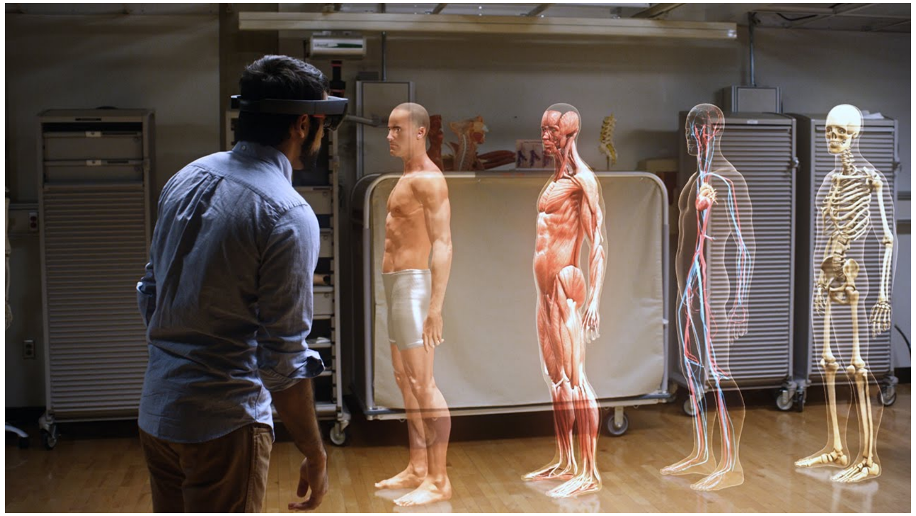
AutoCars - Uber

Mobile robots



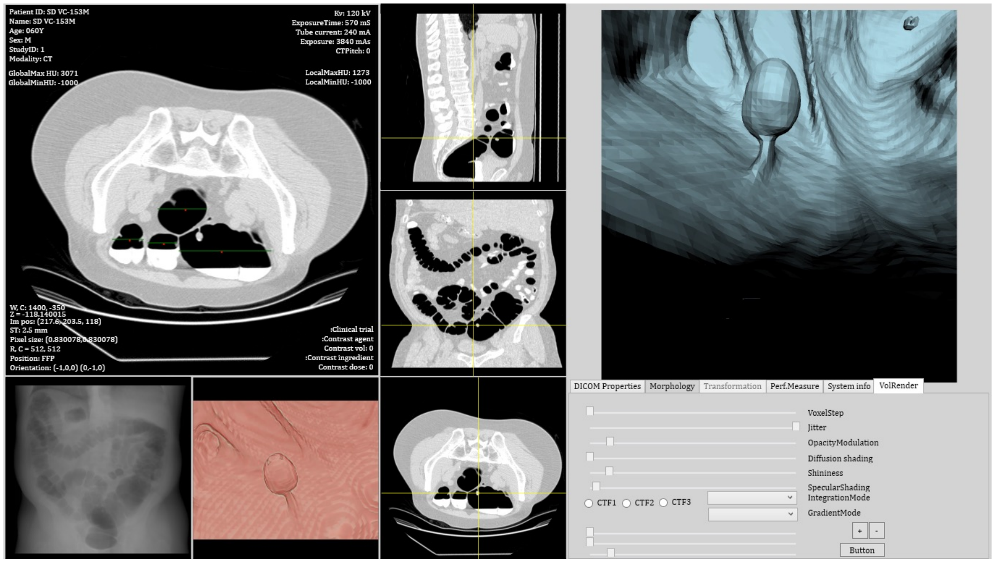
Augmented Reality and Virtual Reality

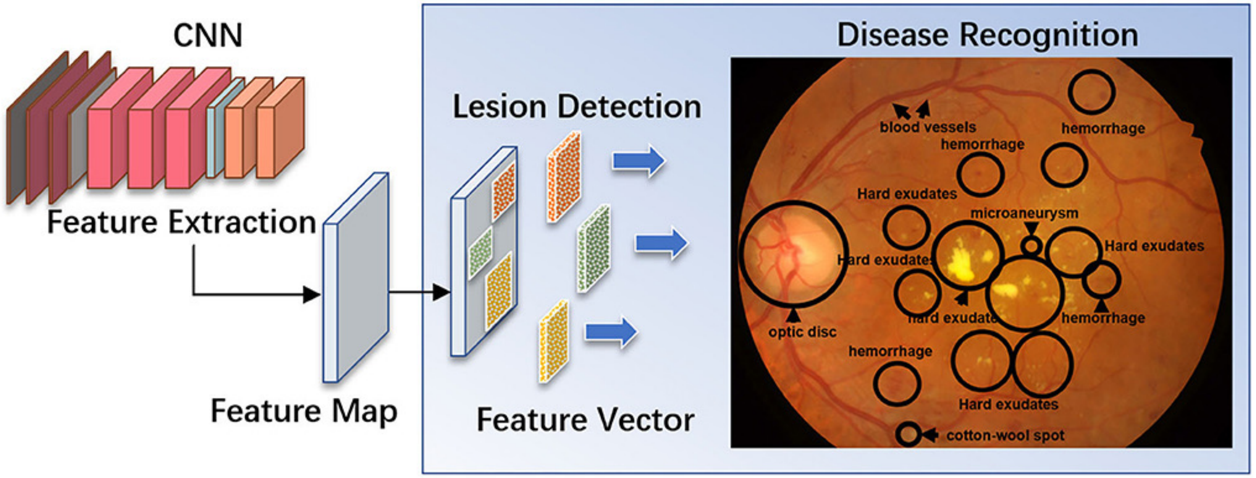




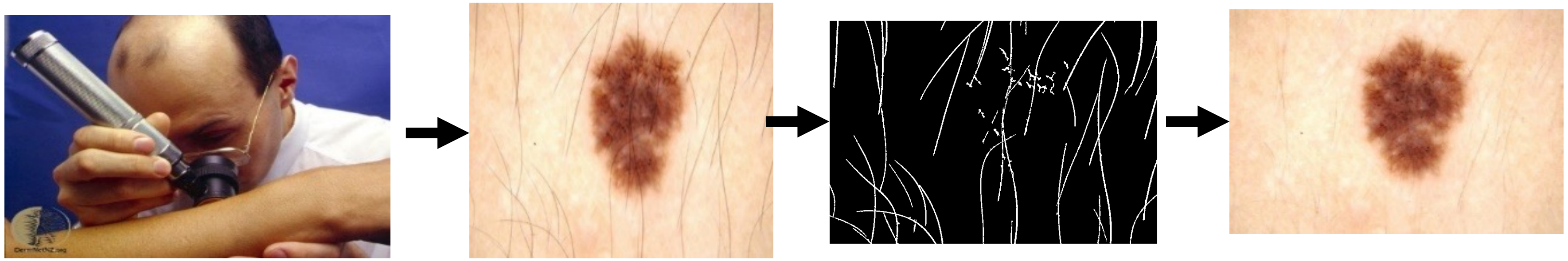
MS HoloLens, Oculus, Magic Leap,

Computer Aided Diagnosis

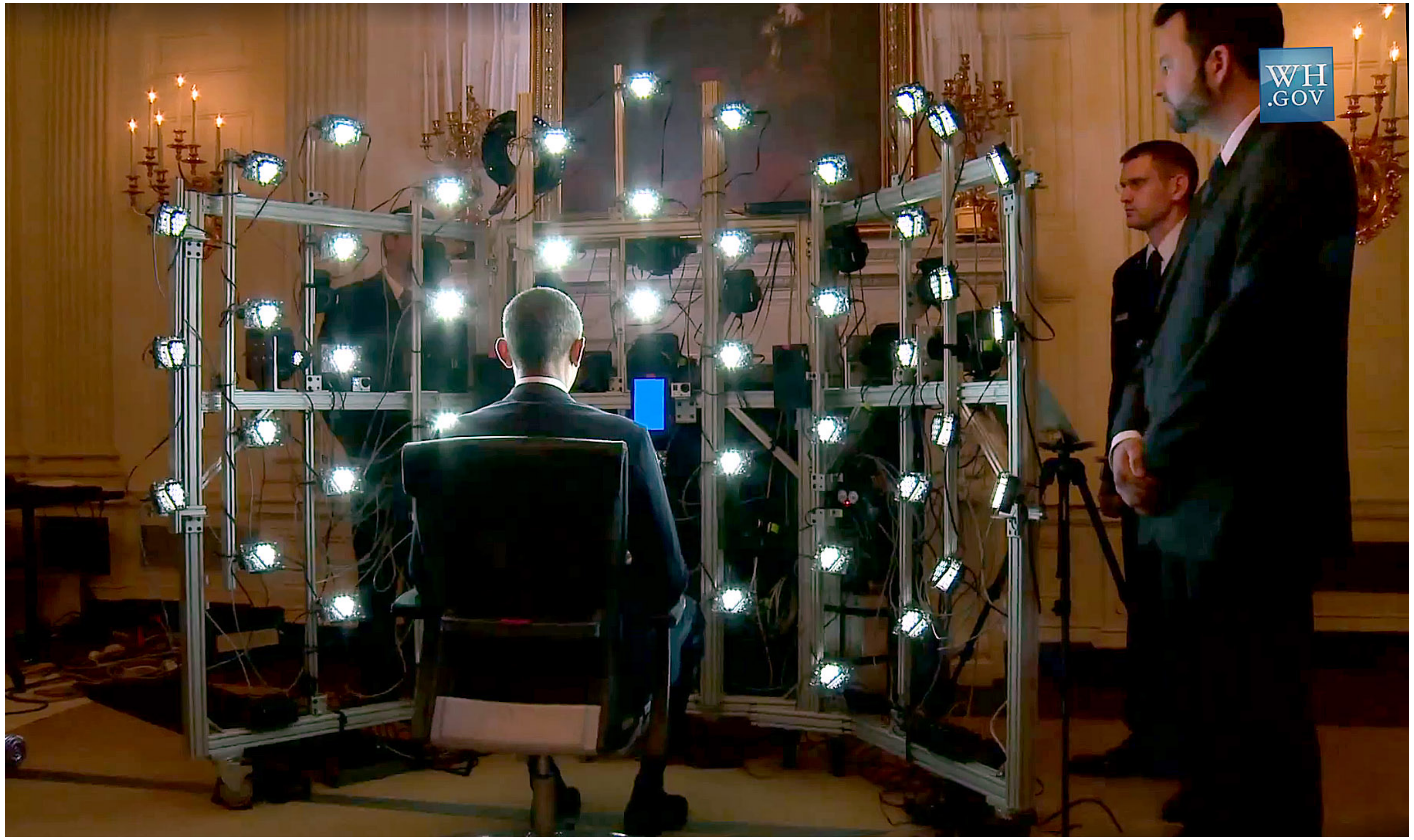




Fast RCNN Architecture

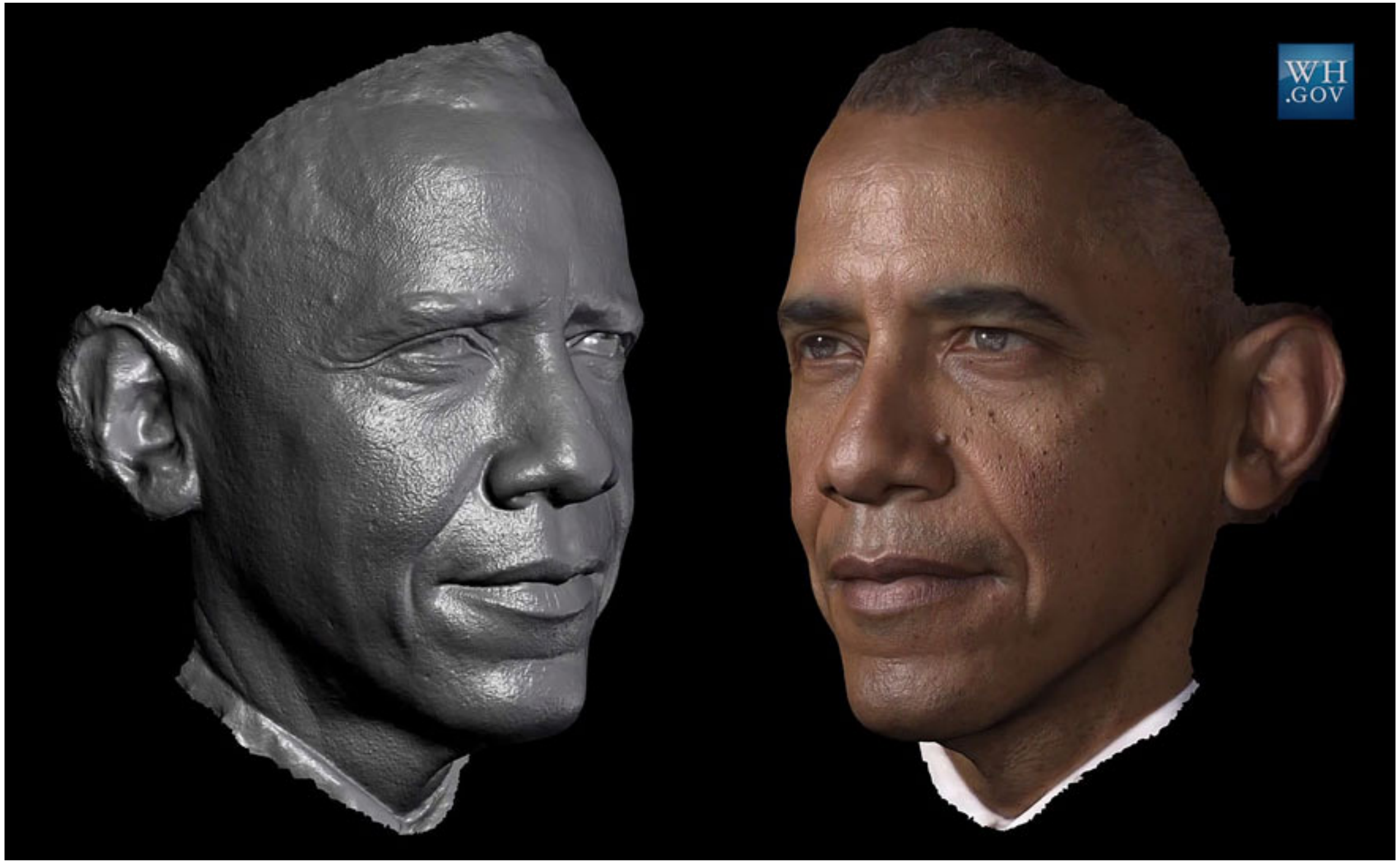


Human shape capture



Human shape capture

Human shape capture



Few Questions!

Can we build hardware as complex as the brain?

- How complicated is our brain?
  - a neuron, or nerve cell, is the basic information processing unit
  - estimated to be on the order of 10^{12} neurons in a human brain
  - many more synapses (10^{14}) connecting these neurons

- Conclusion
  - YES: in the near future we can have computers with as many basic processing elements as our brain, but with
    - far fewer interconnections (wires or synapses) than the brain
    - much faster updates than the brain

Can Computers Talk?

- This is known as “speech synthesis”

- Difficulties
  - sounds made by this “lookup” approach sound unnatural
  - a harder problem is emphasis, emotion, etc
    - humans understand what they are saying
    - machines don’t: so they sound unnatural

- Conclusion:
  - NO, for complete sentences with emotion
  - YES, for individual words

Can Computers Recognize Speech?

- Speech Recognition:
  - mapping sounds from a microphone into a list of words
  - classic problem in AI, very difficult
- Recognizing normal speech is much more difficult
  - speech is continuous: where are the boundaries between words?
  - large vocabularies
  - background noise, other speakers, accents, cold, etc
- Conclusion:
  - NO, normal speech is too complex to accurately recognize
  - YES, for restricted problems (small vocabulary, single speaker)

Can Computers Understand speech?

- Understanding is different to recognition:
  - “Time flies like an arrow”
    - assume the computer can recognize all the words
    - how many different interpretations are there?
      1. time passes quickly like an arrow?
      2. command: time the flies the way an arrow times the flies
      3. command: only time those flies which are like an arrow
      4. “time-flies” are fond of arrows

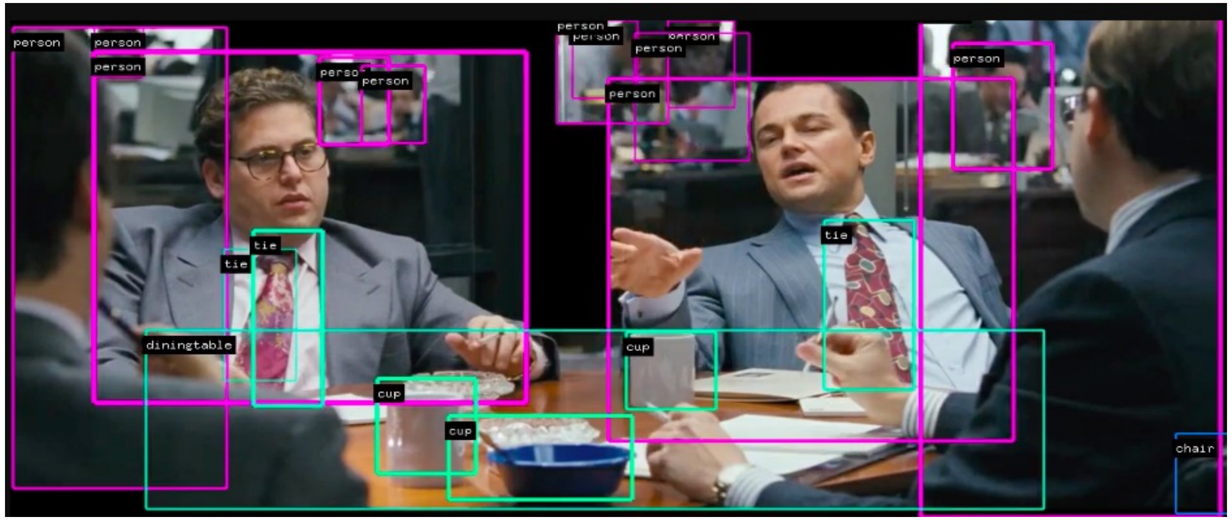
    - only 1. makes any sense,
      - but how could a computer figure this out?
      - clearly humans use a lot of implicit commonsense knowledge in communication
- Conclusion: NO, much of what we say is beyond the capabilities of a computer to understand at present

Can Computers Learn and Adapt ?

- Learning and Adaptation
  - **Machine learning** allows computers to learn to do things without explicit programming
  - many successful applications:
- Conclusion: YES, computers can learn and adapt, when presented with information in the appropriate way

Can Computers "see"?

- Recognition v. Understanding
  - Recognition and Understanding of Objects in a scene

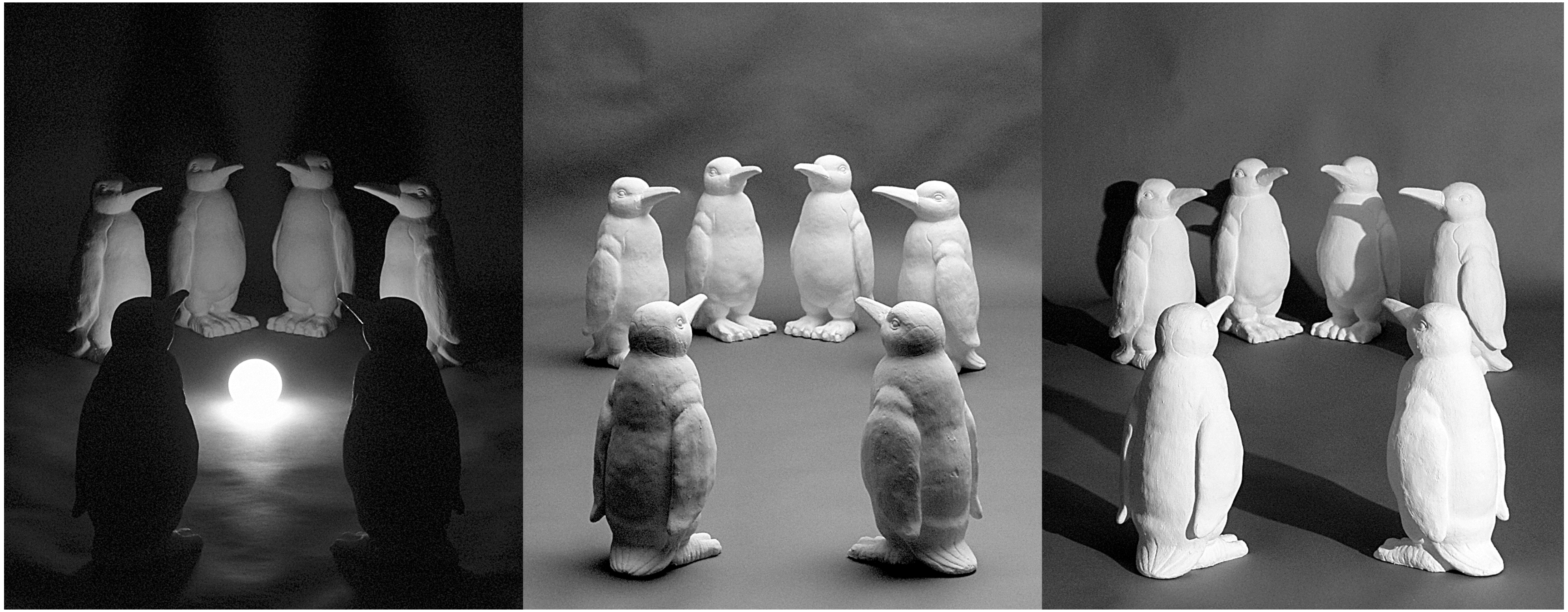


- Why is visual recognition a hard problem?

Challenges: viewpoint variation

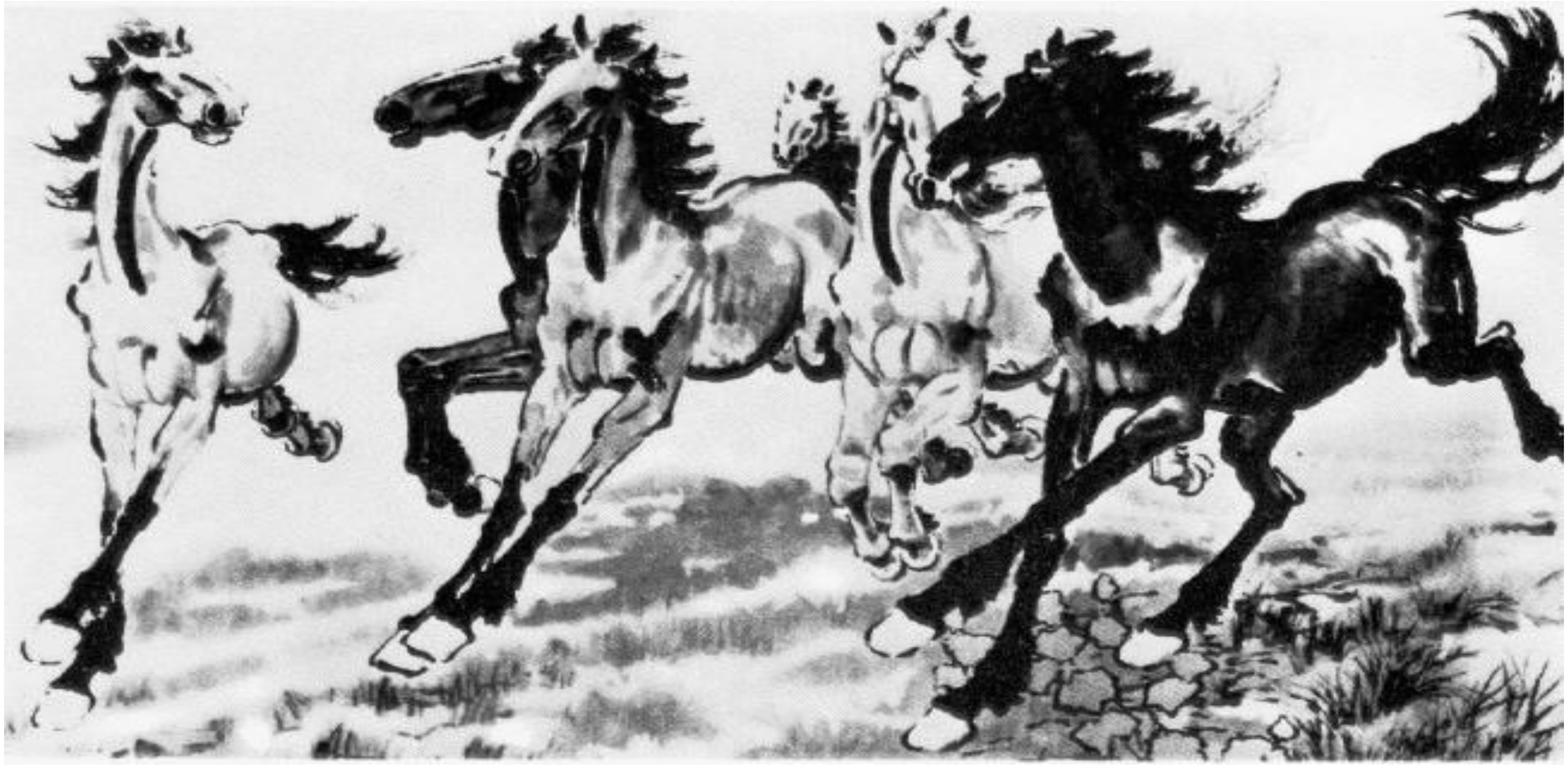
Michelangelo 1475-1564

Challenges: illumination



Challenges: scale

Challenges: deformation



Challenges: occlusion

Magritte, 1957

Challenges: background clutter

Challenges: Motion

Challenges: object intra-class variation






slide credit: Fei-Fei, Fergus & Torralba