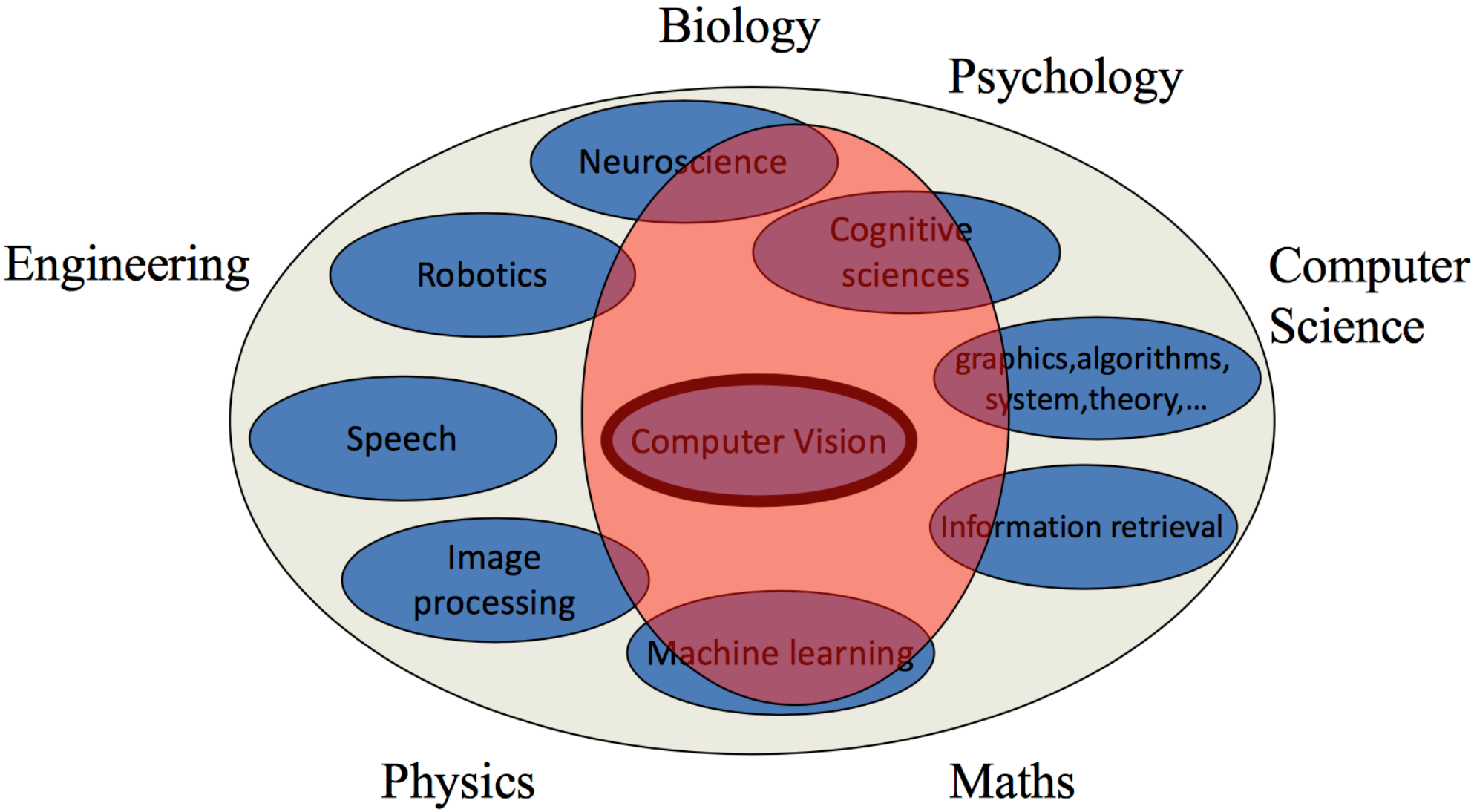
What is it related to?



Computer Vision

Applications

Ex. Object Recognition

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

Ex. Object Recognition

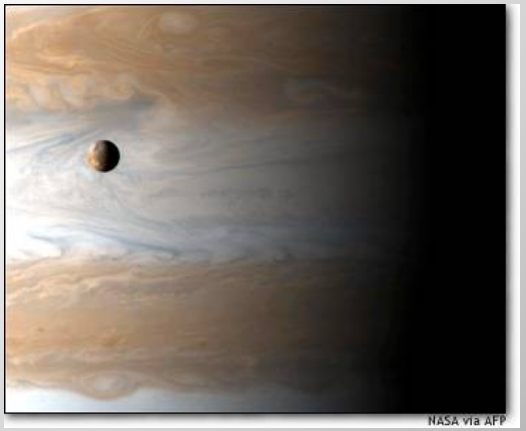
- Problem: Given an image A, does A contain an image of a person?

YES

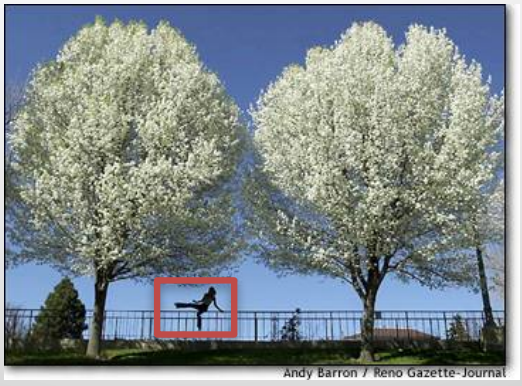
Ex. Object Recognition

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

NO



Ex. Object localization



Ex. Human Detection

Ex. Face Recognition

Ex. Image Search

Tons of applications, Big market, …

facebook

350 million photos uploaded daily

flickr

Picasa

YouTube

100 hours of movies uploaded per hour

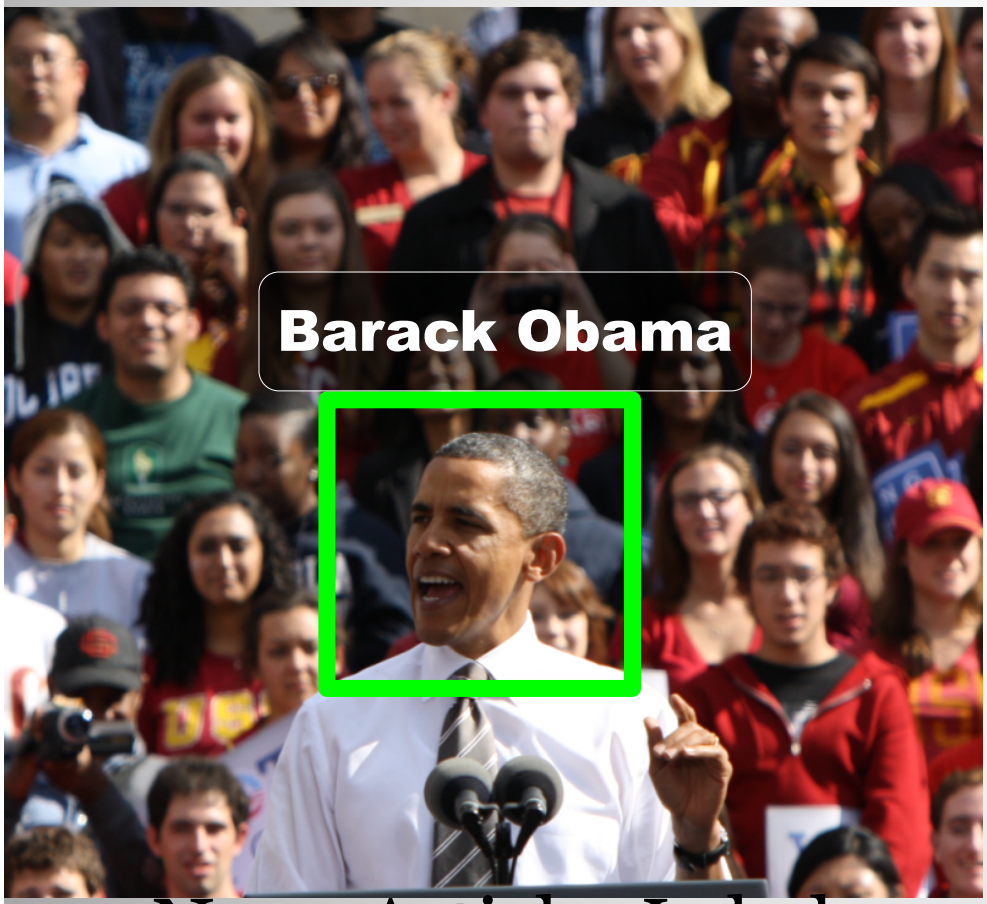
amazon instant video

Google play

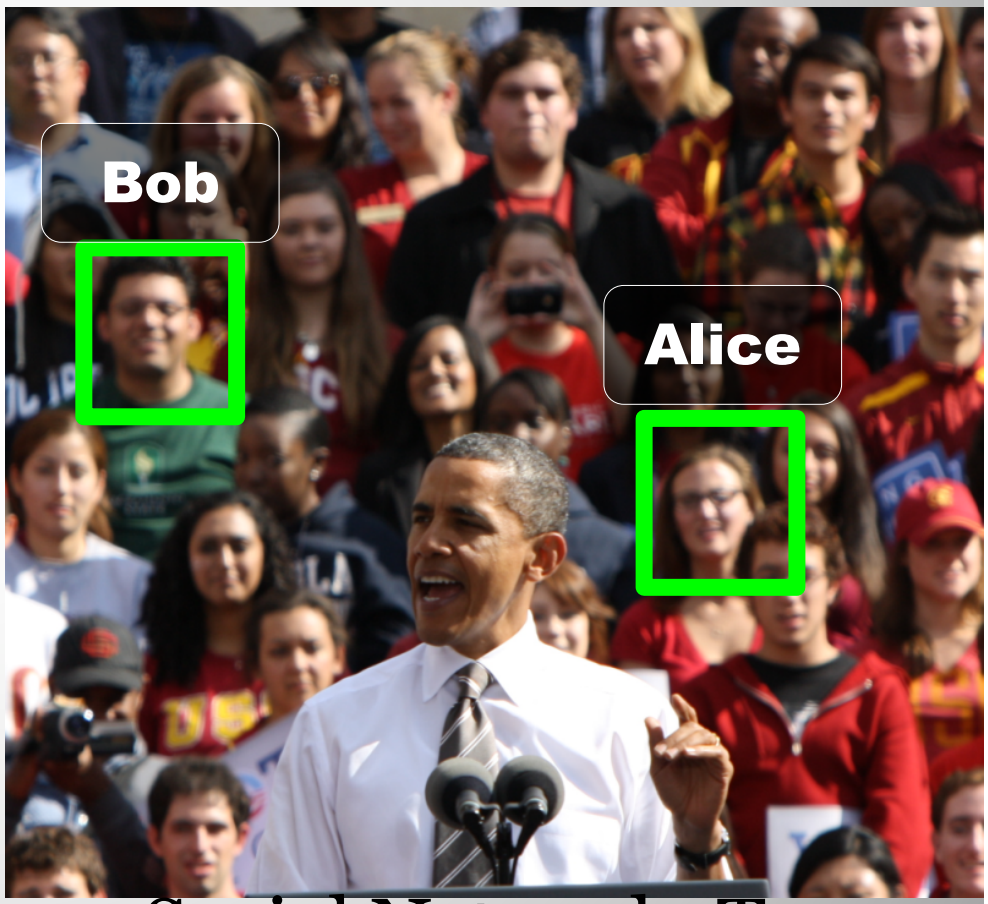
iTunes

60,000 movies

Open-Universe Face Identification



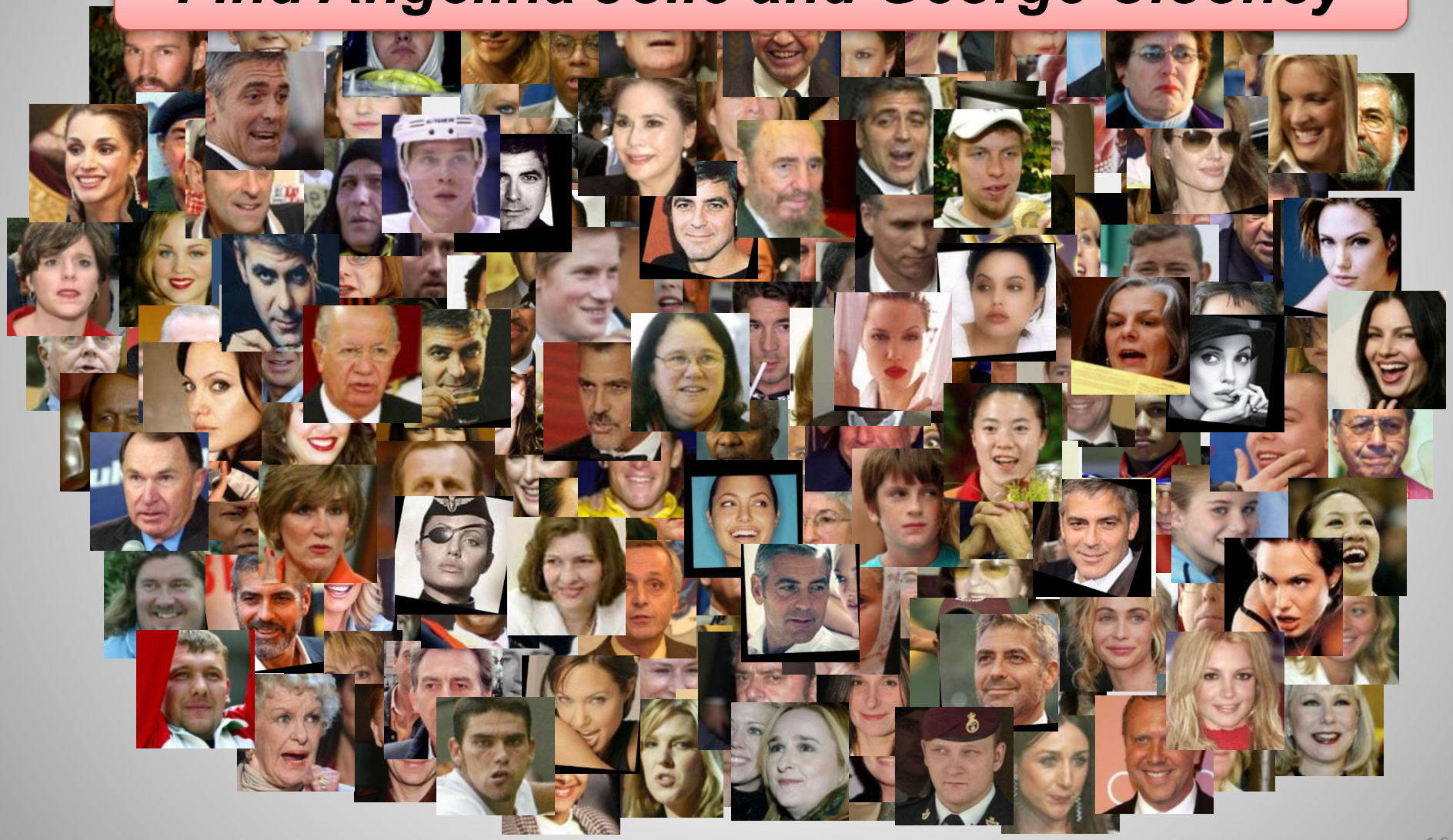
News Article: Label Important Figures



Social Network: Tag Facebook Friends

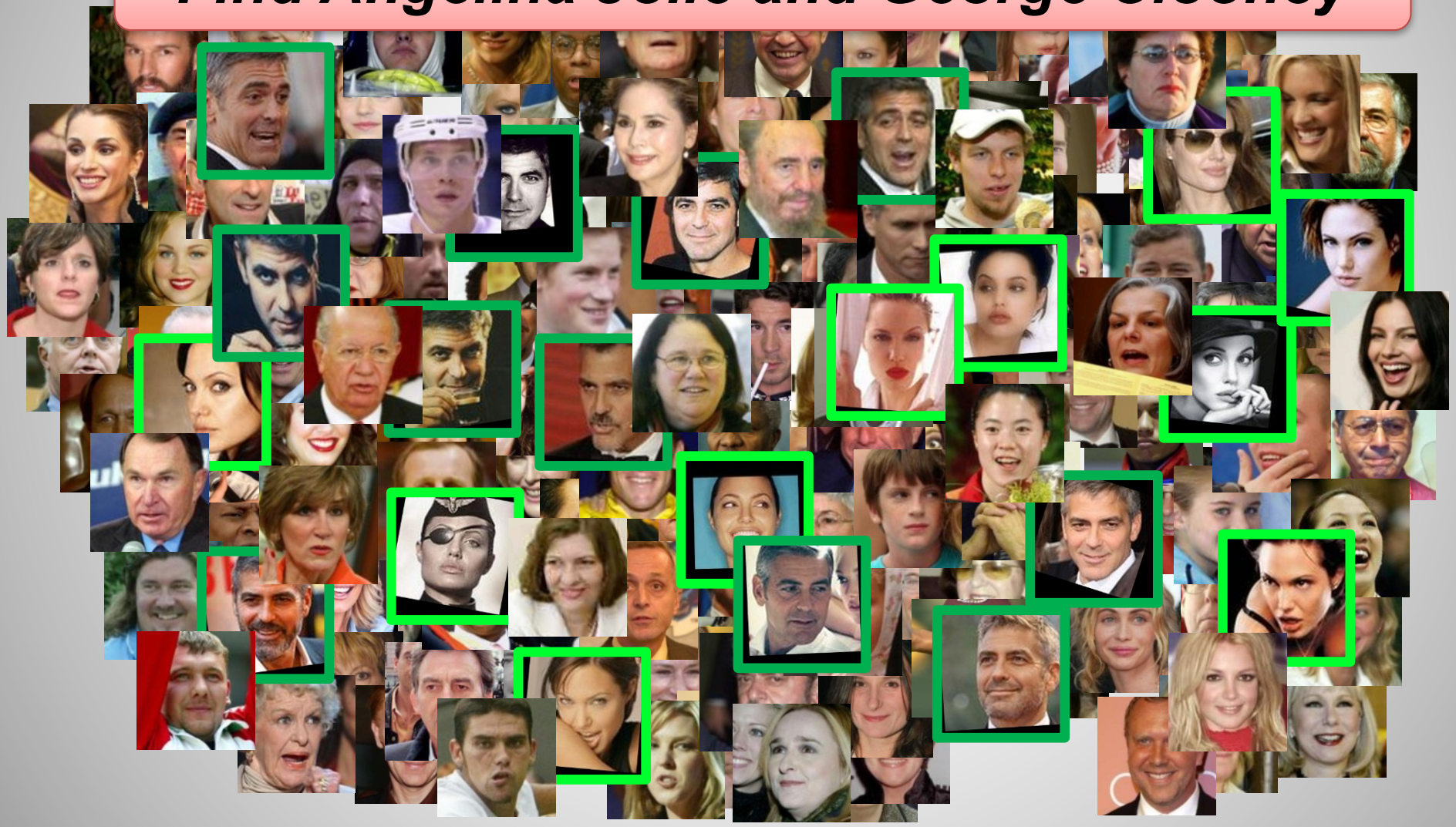
Open-Universe Face Identification

Find Angelina Jolie and George Clooney

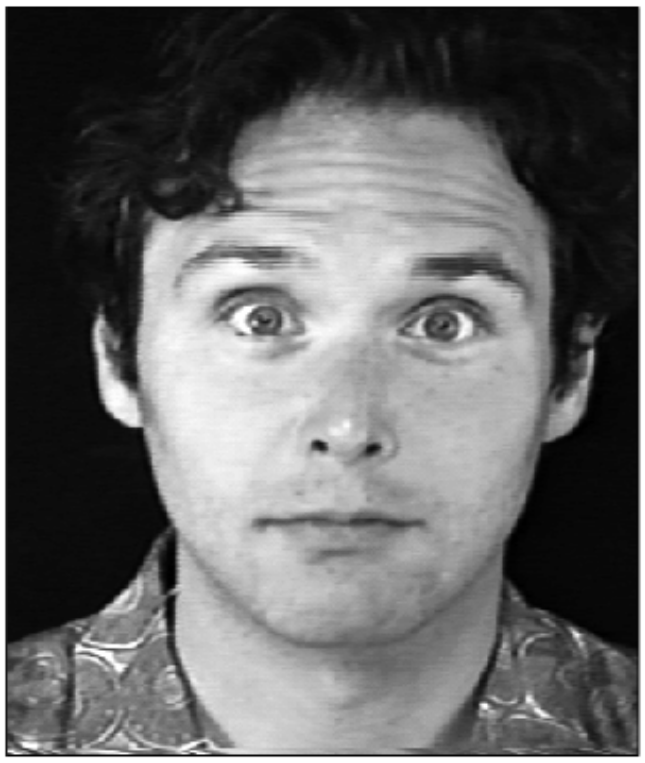


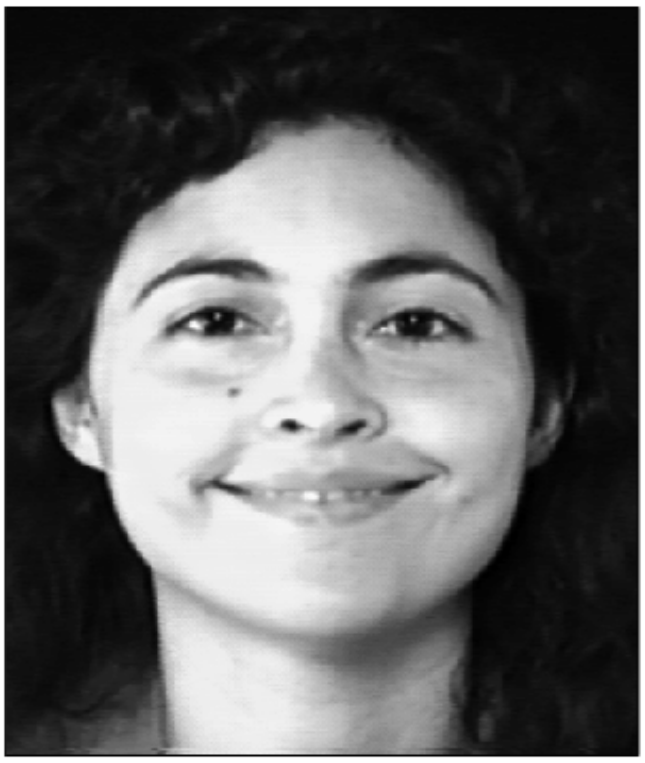
Open-Universe Face Identification

Find Angelina Jolie and George Clooney

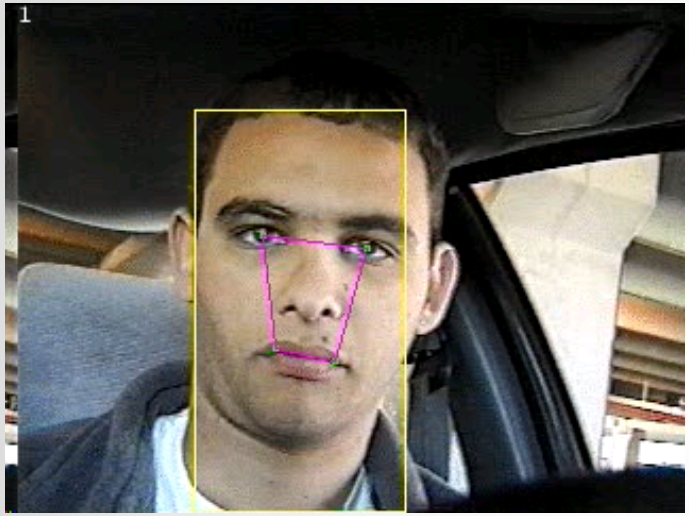


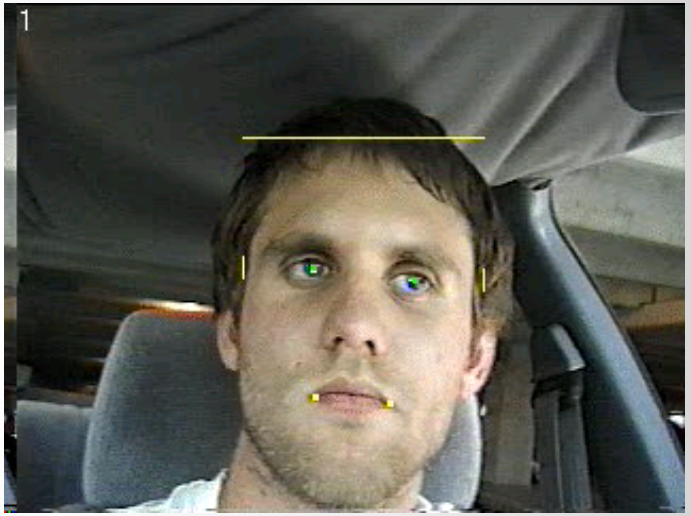
Ex. Facial expression



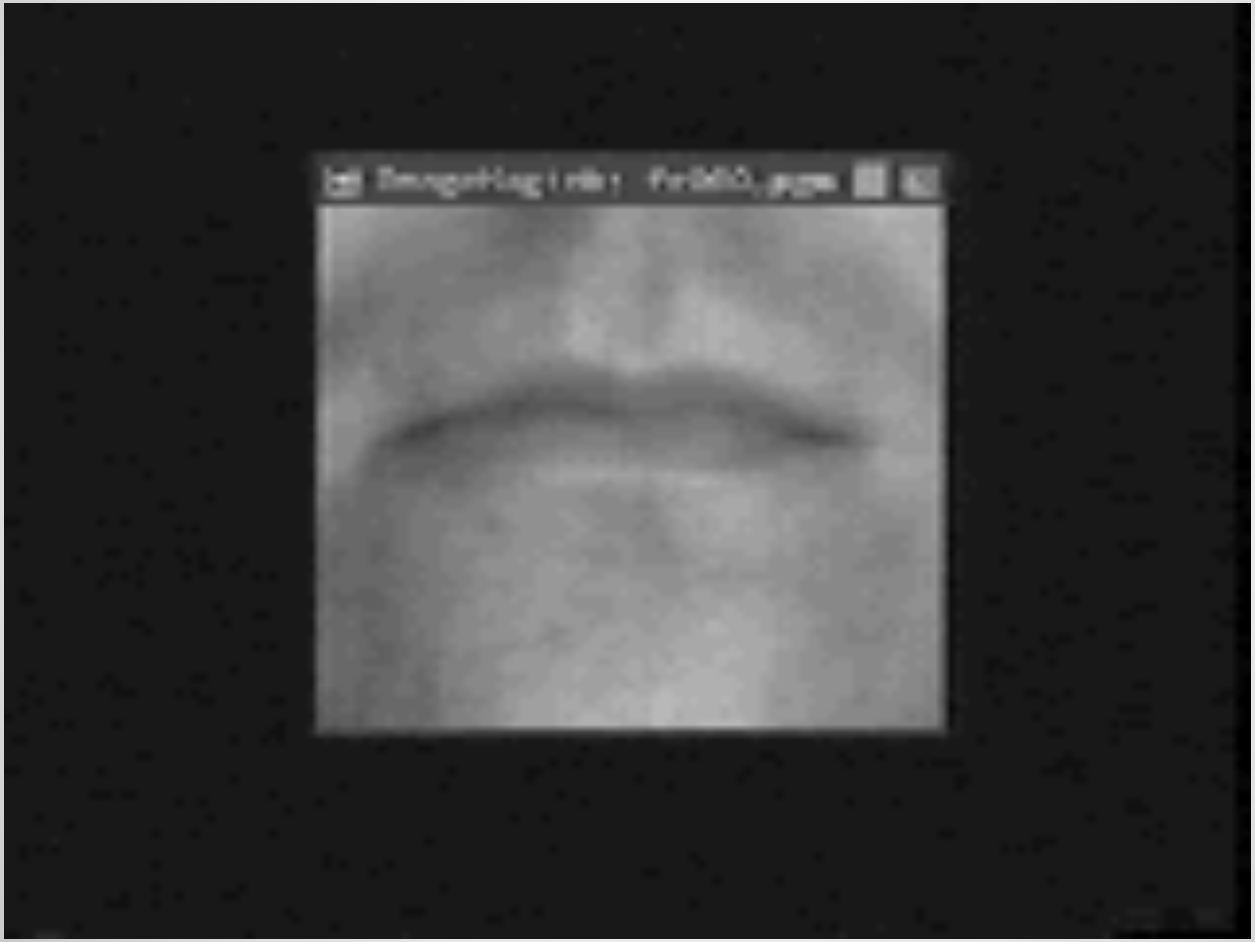


Ex. Fatigue detection



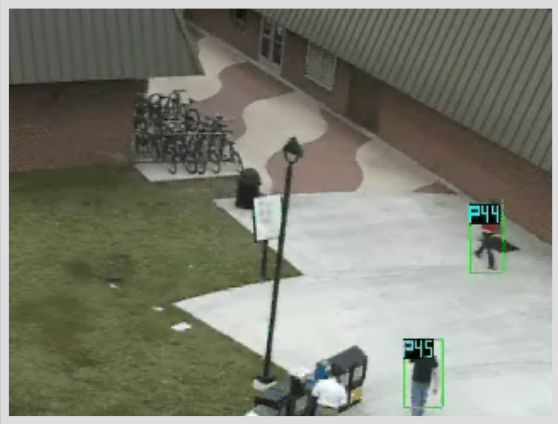


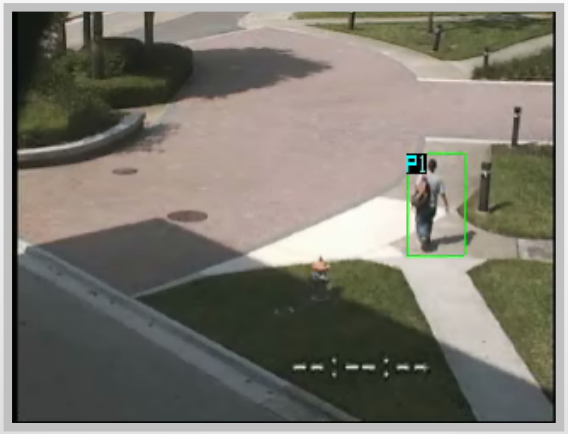
Ex. Lip-reading

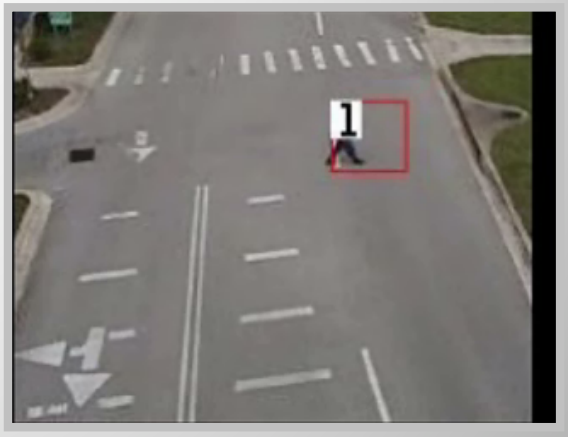


Video Surveillance and Monitoring

Object detection → Object tracking → Object categorization and classification → Event or Activities Recognition







UAVs: Unmanned Aerial Vehicles (drones)

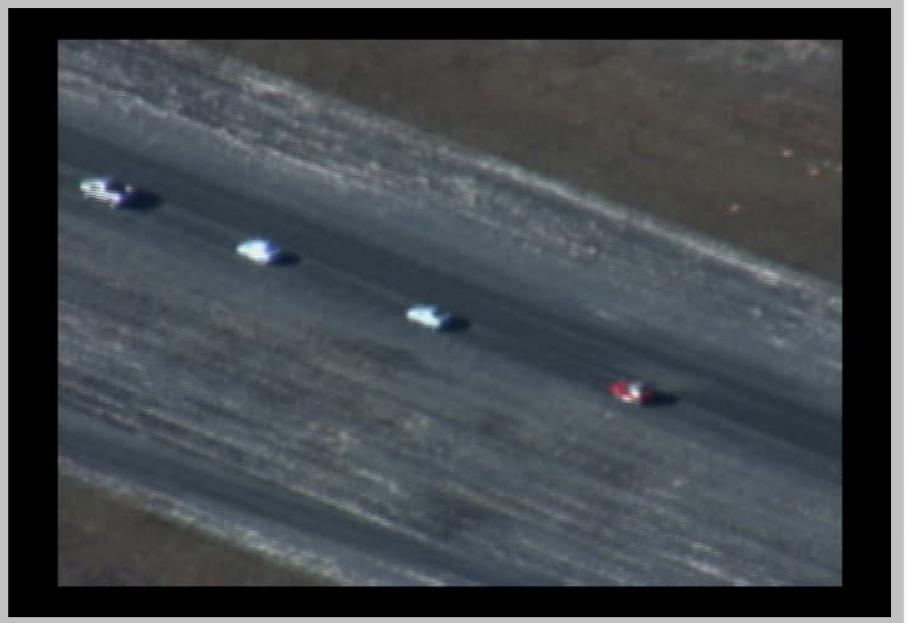
Global Hawk

Predator

Microdrone

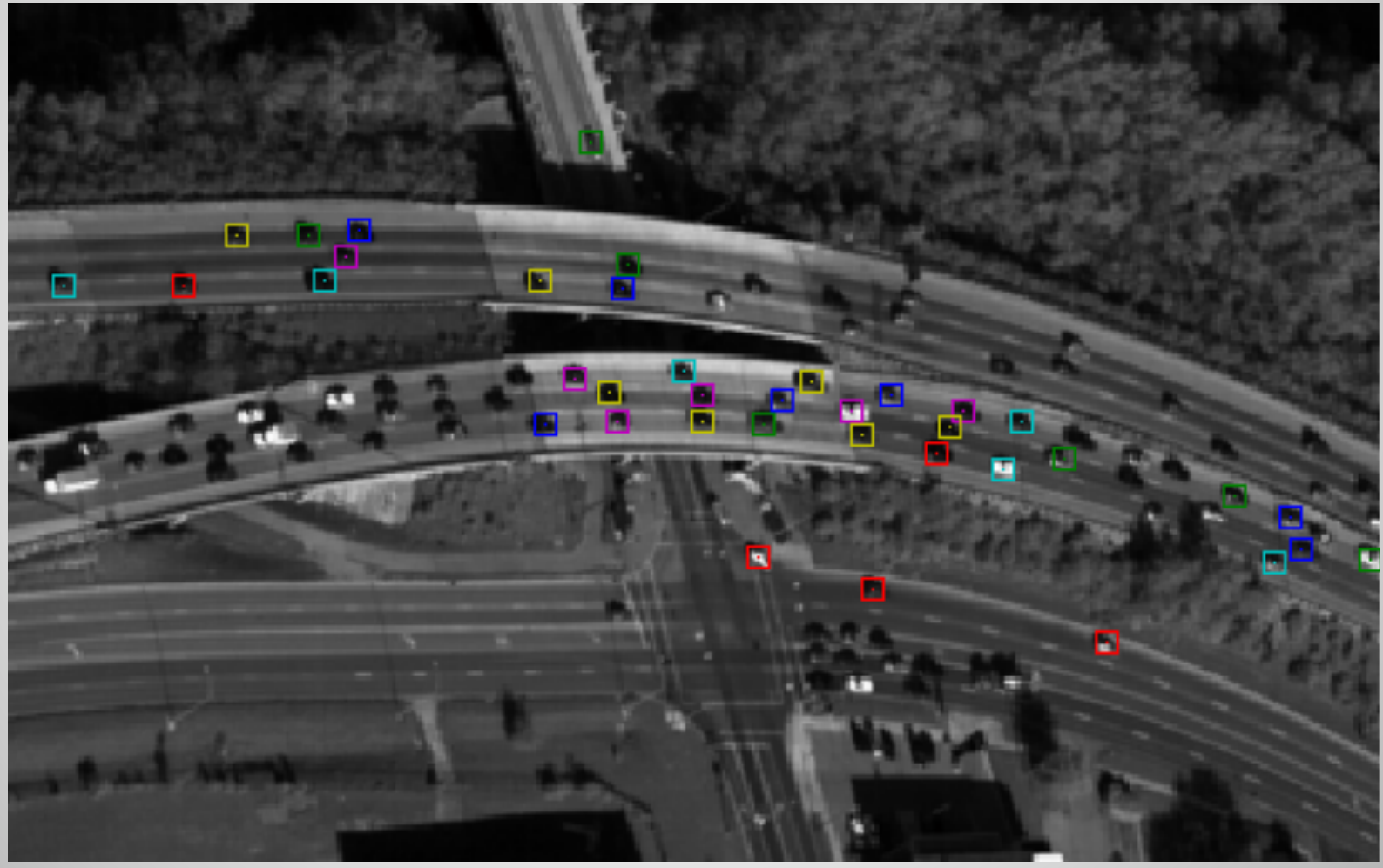
Ex. Detection in Videos

Ex. Object Tracking



Ex. Wide Area Surveillance

Ex. Tracking (multi-object)



Ex. Human Action Recognition

9 actions, 142 videos (UCF database, Shah).

Bench Swing

Dive

Swing

Run

Kick

Lift

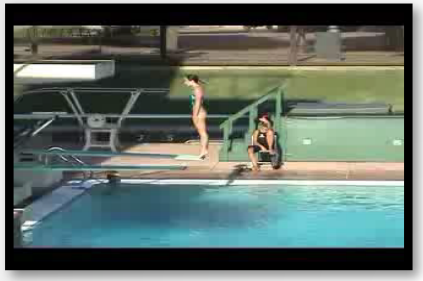
Ride

Golf Swing

Skate

Ex. UCF YouTube Action Dataset

Cycling



Diving

Golf Swinging

Riding

Juggling

Basketball Shooting

Swinging

Tennis Swinging

Volleyball Spiking

Trampoline Jumping

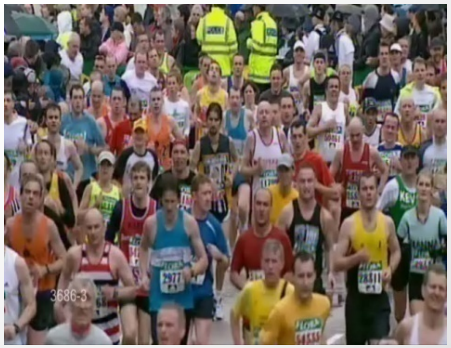
Walking Dog

Ex. High Density Crowded Scenes

Political Rallies

Religious Festivals

Marathons



High Density
Moving Objects

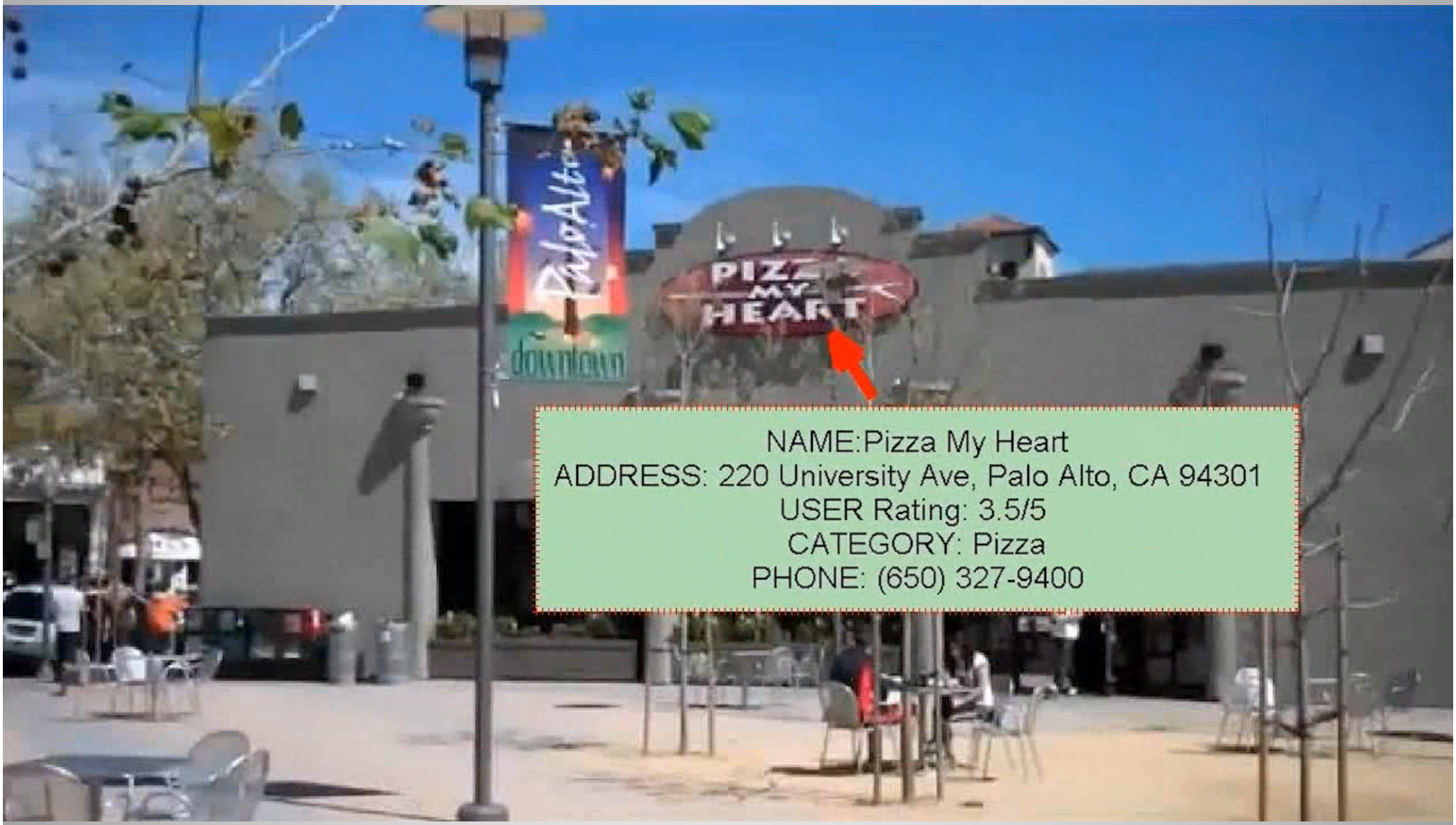
Ex. Counting in Extremely Dense Crowd Images

Ground truth=634 Proposed Method by Idrees and Shah=640

Ground truth=1428 Proposed Method=1468

Ground truth=2319 Proposed Method=2496

Ex. Visual Business Recognition



Ex. Medical Computer Vision

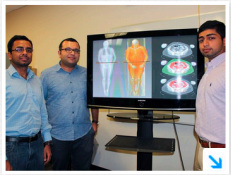
Central Florida Future
A GANNETT COMPANY

Search

HOME | NEWS | SPORTS | OPINION | ENTERTAINMENT | USA TODAY

UCF computer scientist creates program to analyze fat

Amelia Truong, Central Florida Future 3:48 p.m. EDT August 4, 2015



(Photo: Courtesy of UCF College of Engineering & Computer Science)

126 CONNECT | 18 TWEET | LINKEDIN | COMMENT | EMAIL | MORE

A computer scientist at UCF has created software to help doctors locate white fat tissues in th allowing them to start treatment faster ar accurately.

Ulas Bagci, an assistant professor for the Research in Computer Vision in the Colle Engineering & Computer Science, started research for his software after le brown fat cells and their benefits, according to a release.

Credit Details

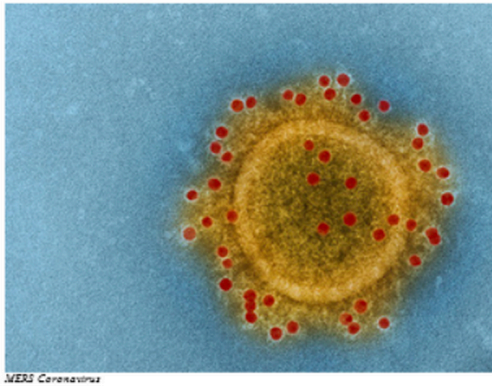
UCFTODAY Arts Business Colleges Community Health Opinions Science & Tech

UCF-Developed Software Analyzes Fat in Seconds

NIH National Institute of Allergy and Infectious Diseases

Tuesday July 28, 2015

Experimental MERS Vaccine Sh Promise in Animal Studies

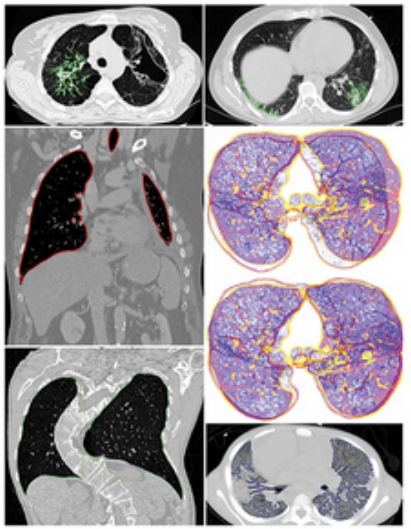


MERS Coronavirus

NIAID researchers designed an experimental vaccine against Middle East respiratory syndrome (MERS) and tested it in mice and monkeys. Vaccinated mice developed broadly neutralizing antibodies against multiple strains of the virus that causes MERS, while vaccinated macaque monkeys were protected from severe lung damage after exposure to the virus.

RadioGraphics
The journal of continuing medical education in radiology

July-August 2015
Volume 35 • Number 4
radiographics.rsna.org



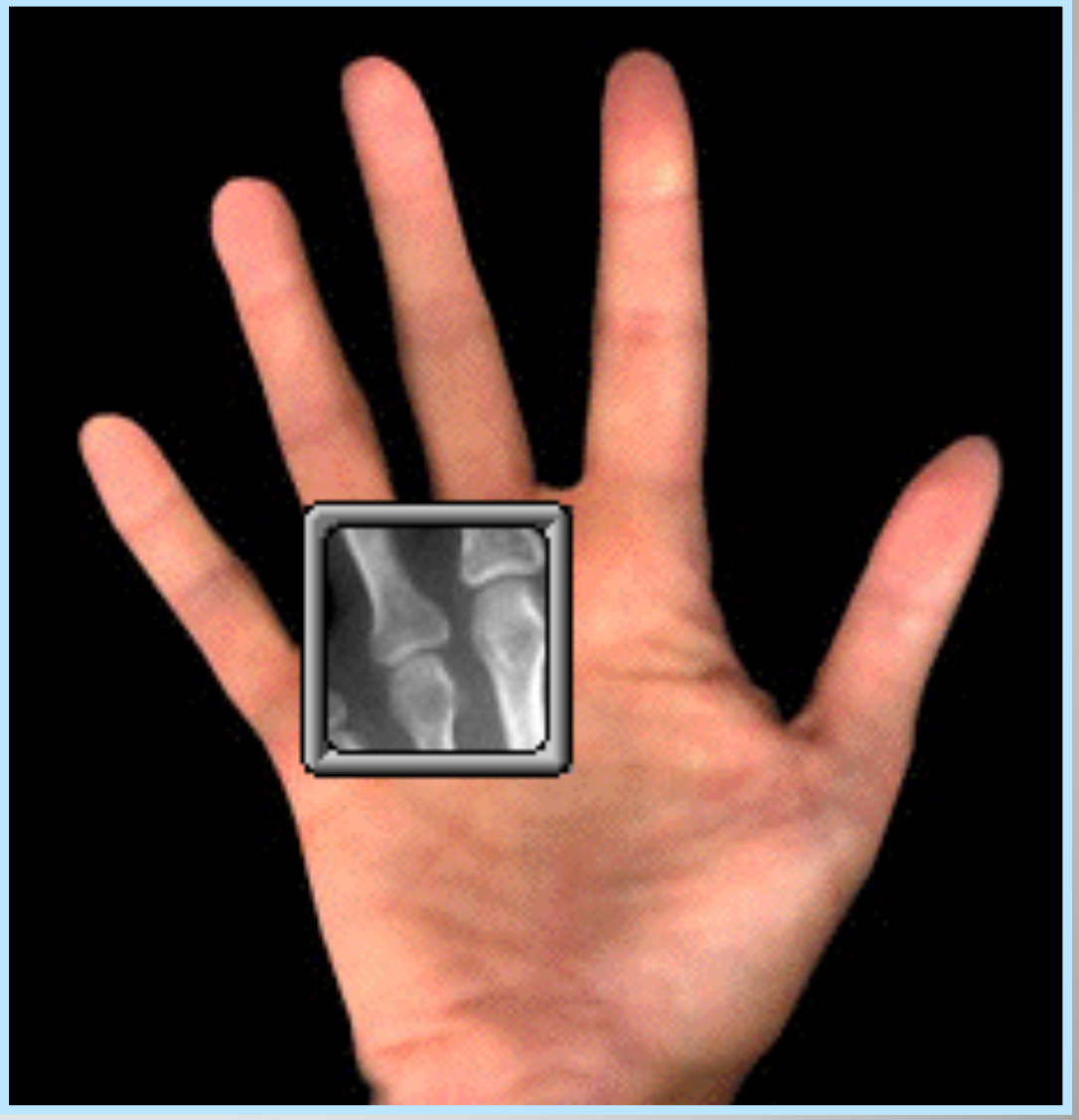
975 Digital Breast Tomosynthesis in the Diagnostic Setting: Indications and Clinical Applications
1077 High-Resolution Micro-copy-Coil MR Imaging of Skin Tumors: Techniques and Novel Clinical Applications
1141 From the Radiologic Pathology Archives
1245 RSNA Centennial Article

100 YEARS RSNA

Ex. X-Ray Imaging/Radiography

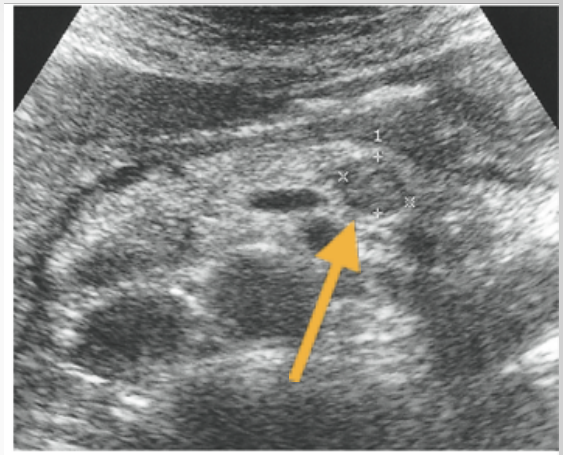
The first published medical image was a radiograph of the hand of Wilhelm Conrad Roentgen's wife in 1895.

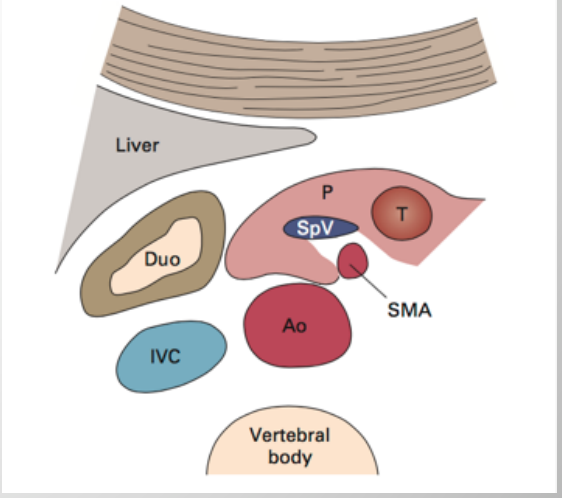
Nobel Prize in Physics 1901.



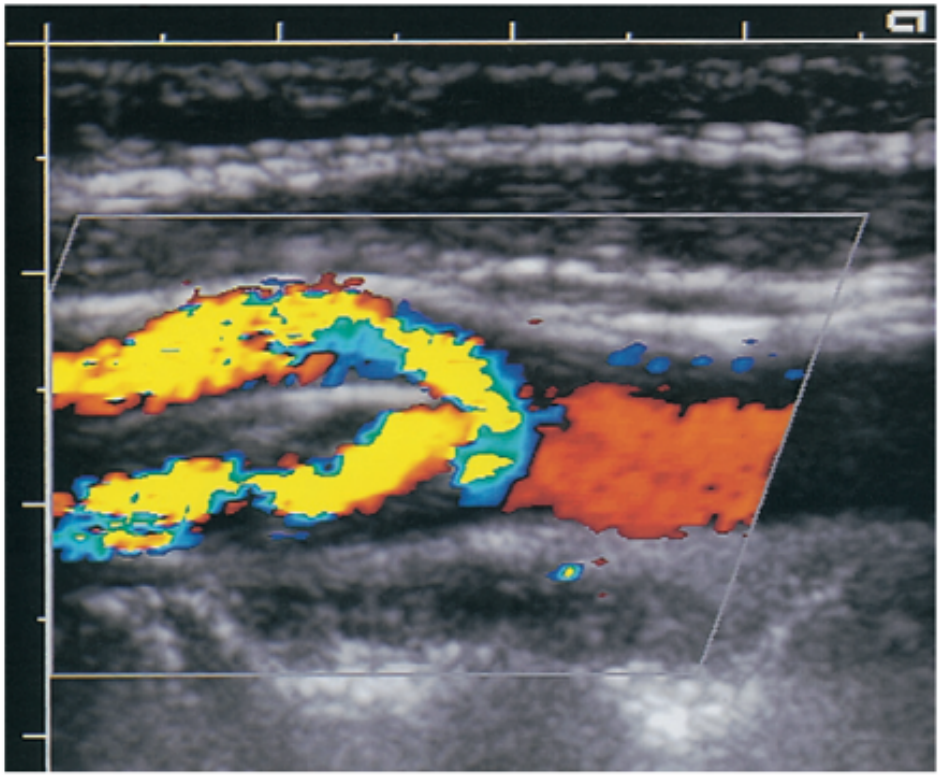
Ex. Ultrasound imaging and Analysis

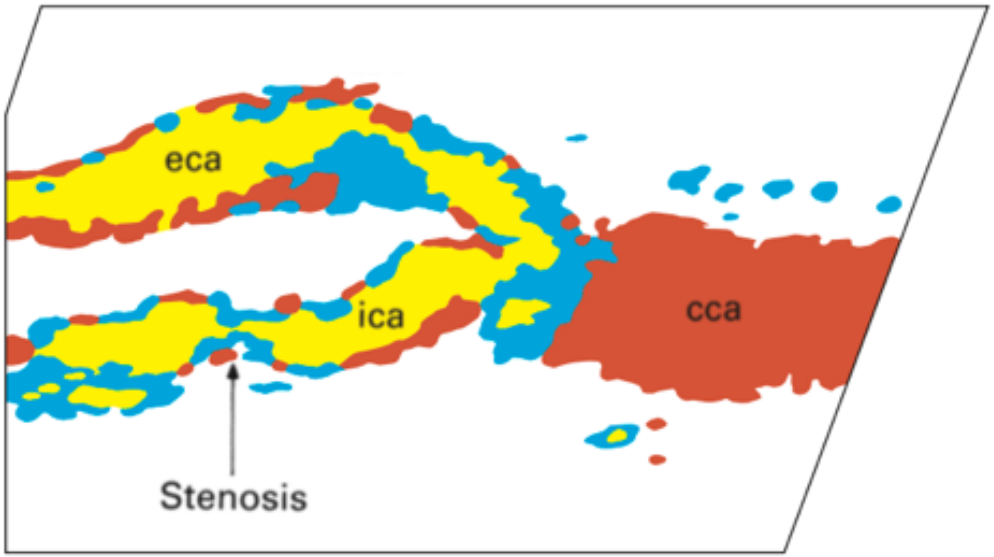
pancreas tumor (1cm)





Ex. Renal Artery Blood Flow Estimation by Computer Vision Techniques





CV methods can help calculating
All blood flow and identify
Automatically the abnormal regions.

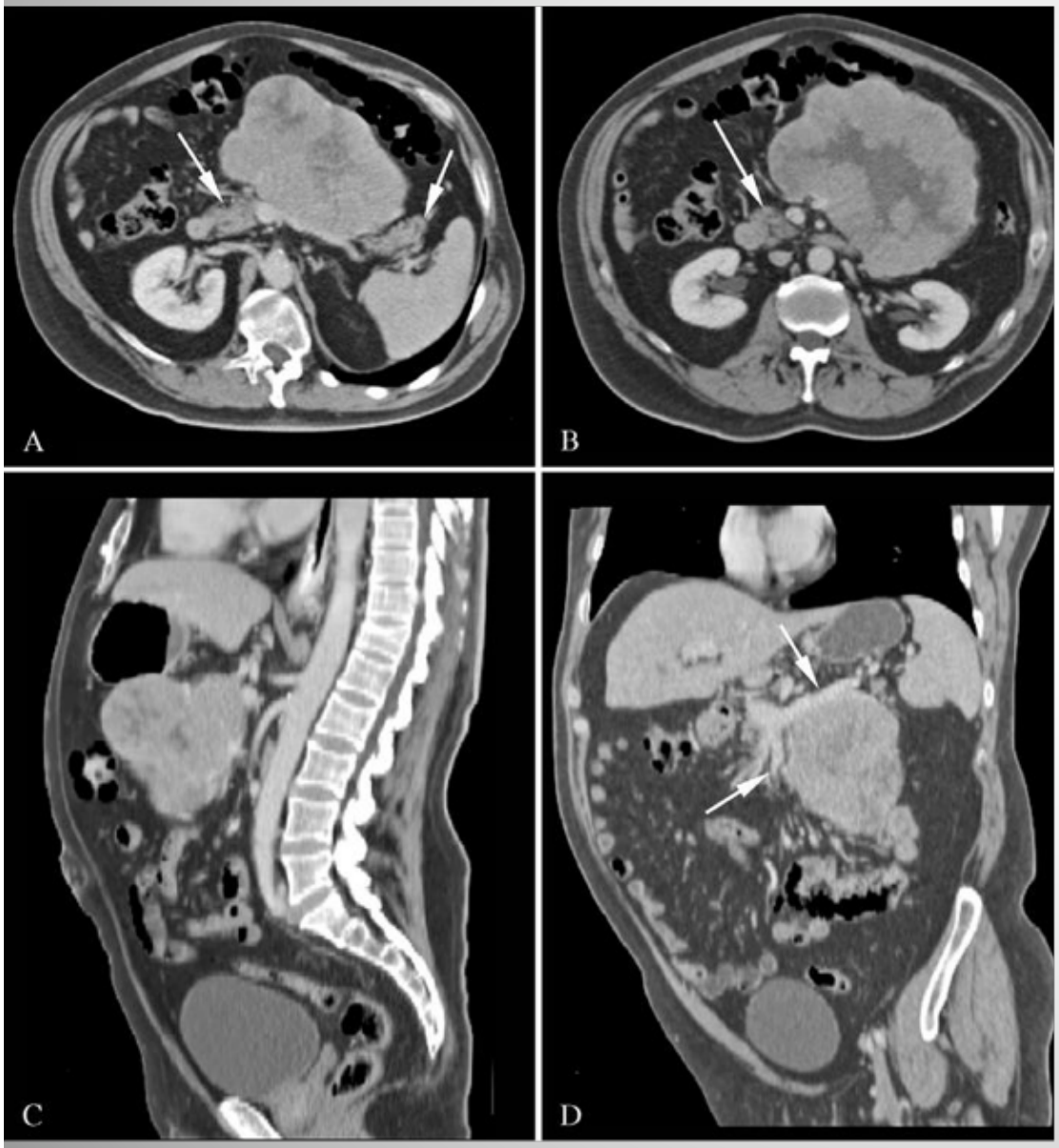
stenosis is seen

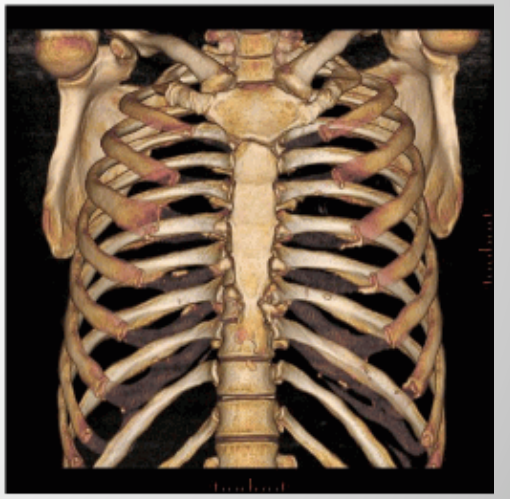
eca: external carotid artery

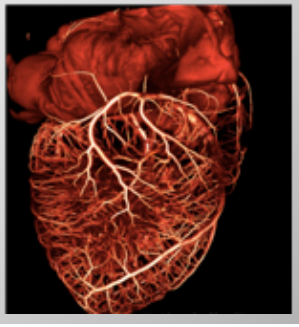
cca: common carotid artery

ica: internal carotid artery

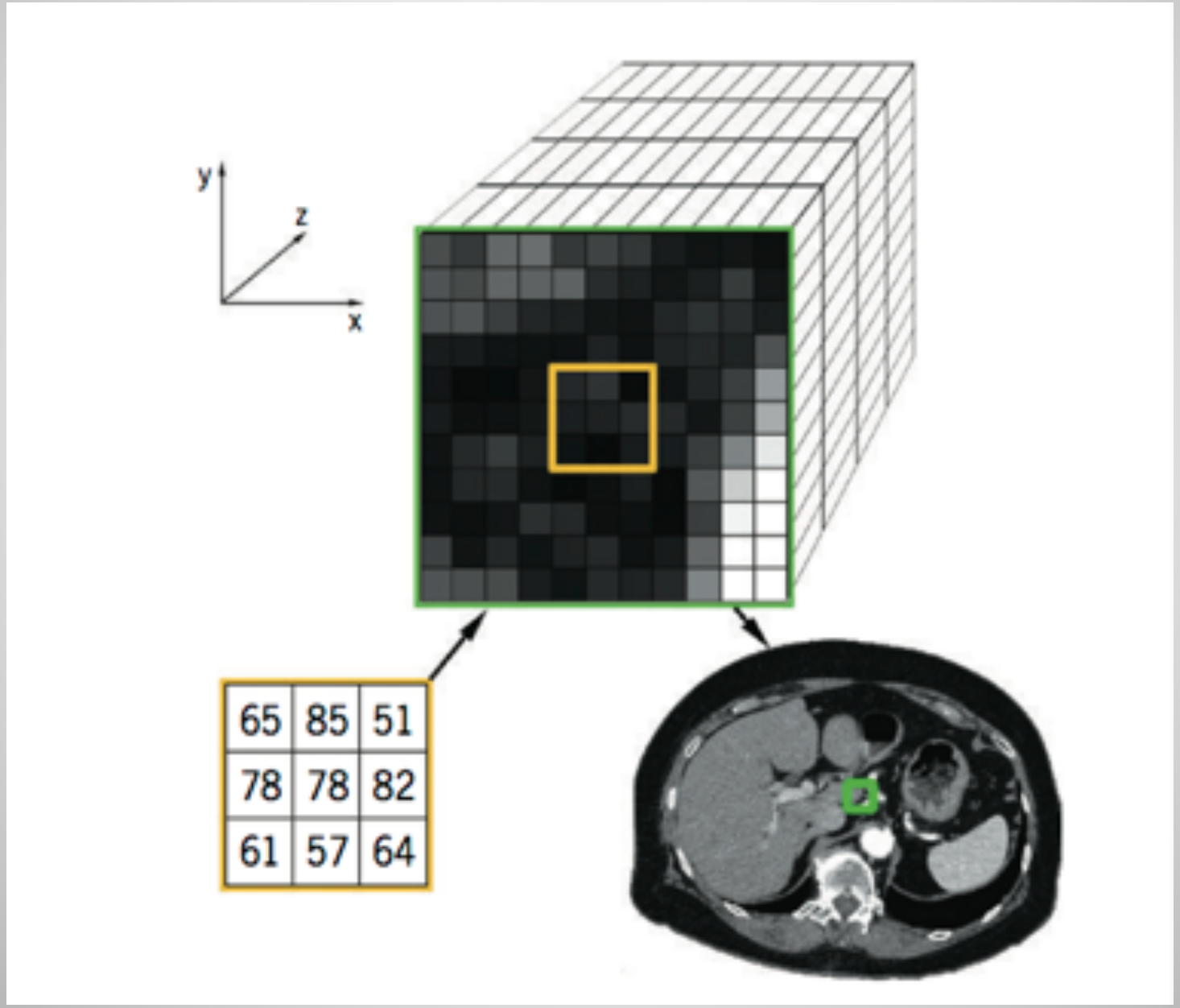
Ex. Computer Vision for Graphics







Computed Tomography / Auto-detection of tumors

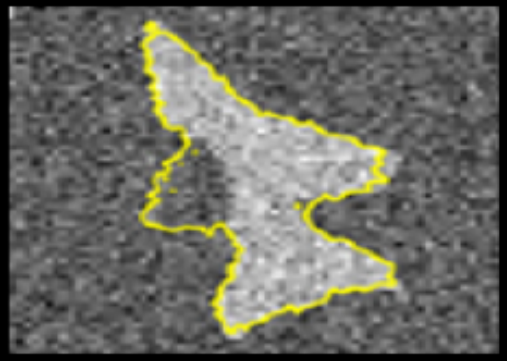


Computer vs. Human Vision?

- In which task computers are superior to humans?
- In which task humans are superior to computers?

Human > Computer

Recognition, detection, etc …global tasks



Computer > Human

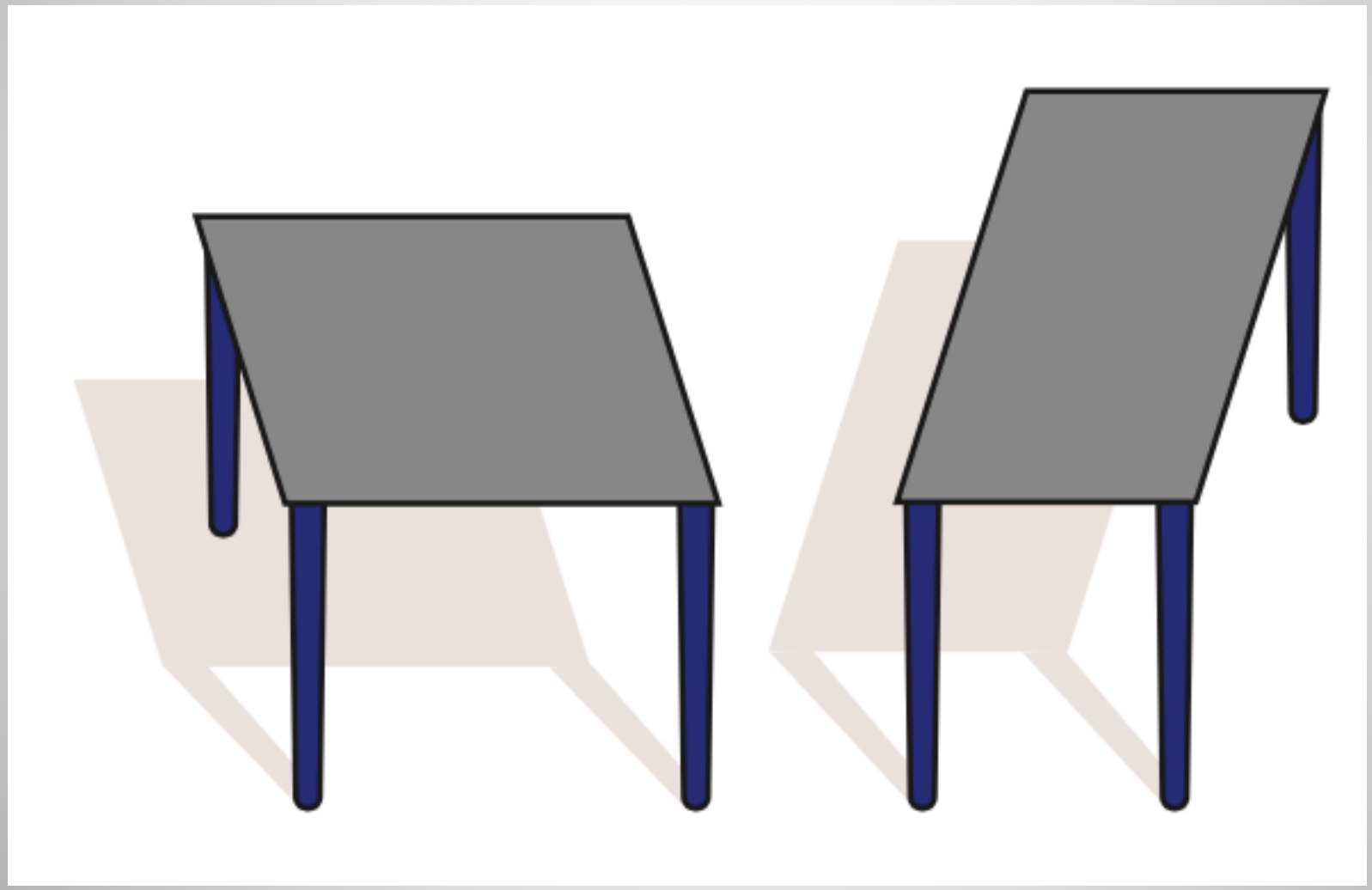
Delineation, local analysis, etc …local tasks

What can you see in this picture?

Now can you see what the picture is?

Credit: Thompson, Basic Vision, Oxford Press, 2012.

Do they look the same?



Visual Perception

- How do we know that the objects that we see are for?

Visual Perception

- How do we know that the objects that we see are for?
- Can people “see” without being aware of what they see?

Visual Perception

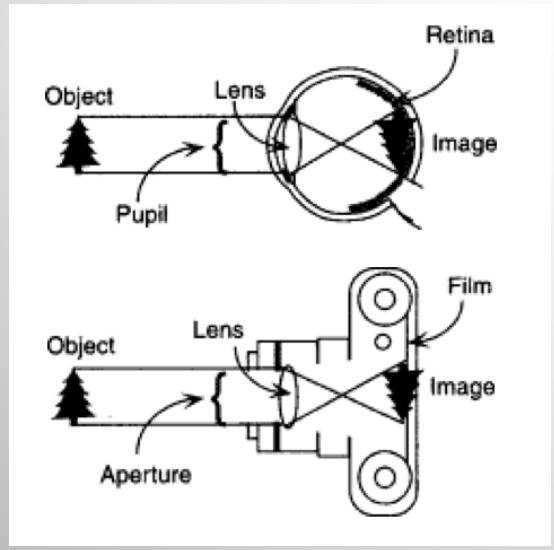
- How do we know that the objects that we see are for?
- Can people “see” without being *aware* of what they see?
- Why do objects appear colored?

Visual Perception

- Definition: *Process of acquiring knowledge about environmental objects and events by extracting information from the light they emit or reflect [Palmer, 2012].*

Visual Perception

- Definition: *Process of acquiring knowledge about environmental objects and events by extracting information from the light they emit or reflect [Palmer, 2012].*



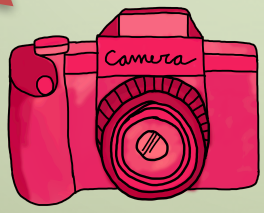
Perception is analogous to taking a picture!
(credit: Palmer, 2012)

Visual Perception

Vision is a process in which temporally changing intensity and color values in the image plane have to be interpreted as processes in the real world that happen in 3D space over time

Vision vs. Computer Vision ?

Sensing device

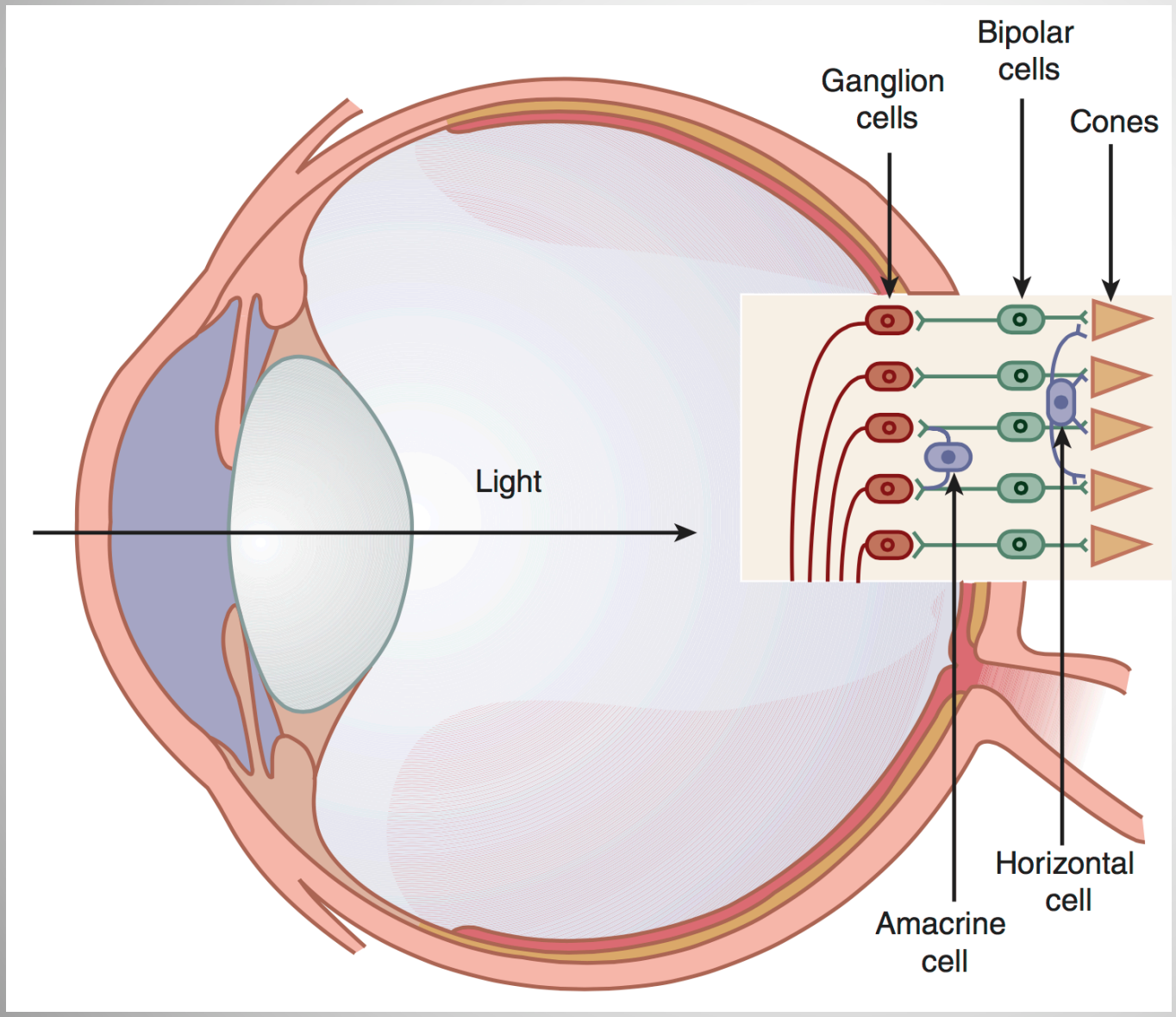


Interpreting device

Interpretations

Picture
Man
Thrash
Bulb
Light
…

Vision-Eye-Light



Retinal Processing:

Photoreceptors absorb Light quanta and convert This radiant energy into Electrical activity.

They synapse on bipolar cells, which in turn, can stimulate ganglion cells, thereby sending action potentials along the optic nerve to the LGN(lateral Geniculte nucleus).

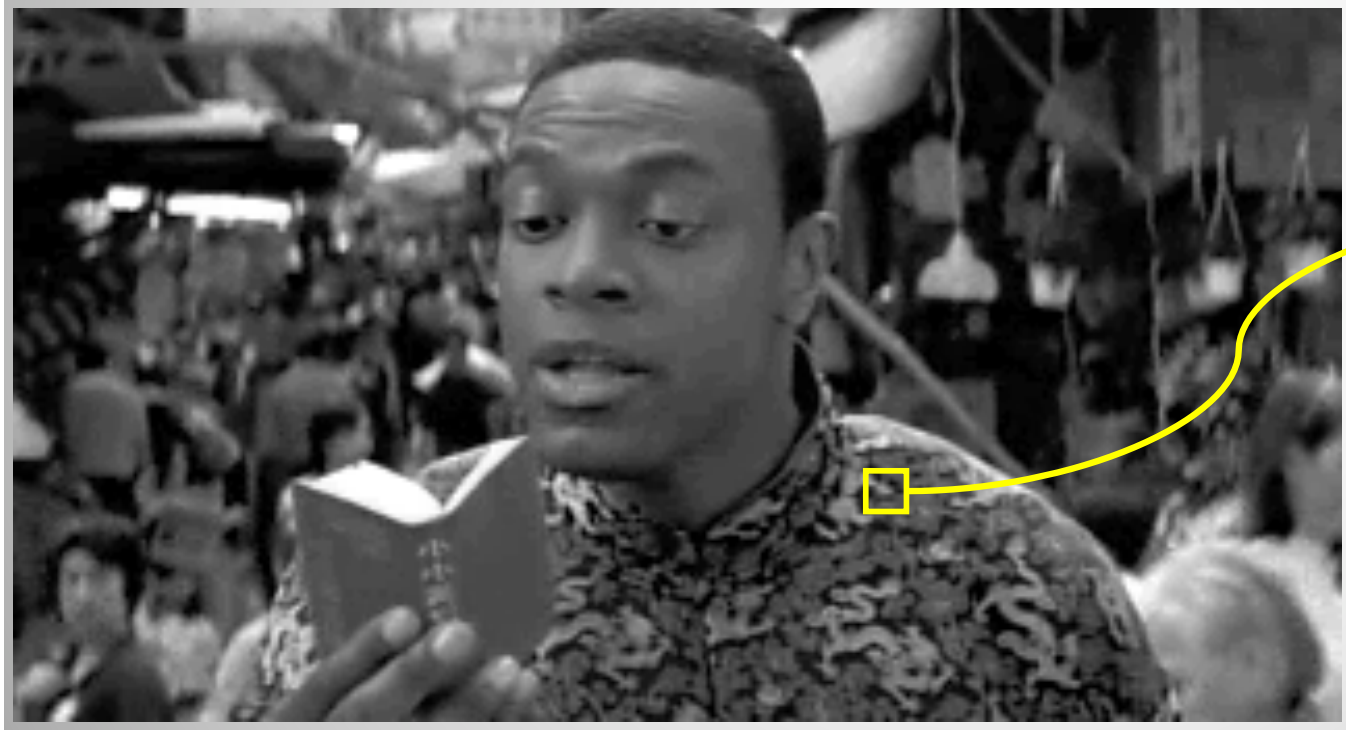
Credit: Schwarts, 2009.

Vision and Image Understanding

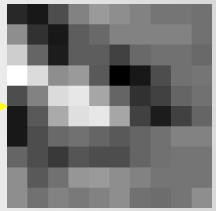
- Visual tasks: We use vision to interact with environments and survive – to navigate and avoid obstacles, to recognize and pick up objects, to identify food and danger, friends and enemies, …

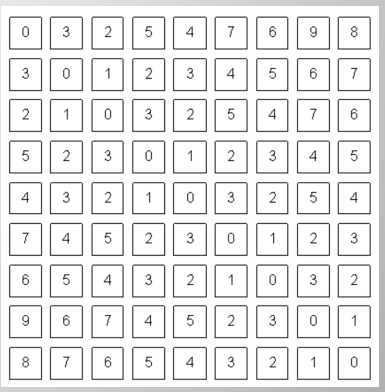
Goal of Computer Vision?

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



What we see!

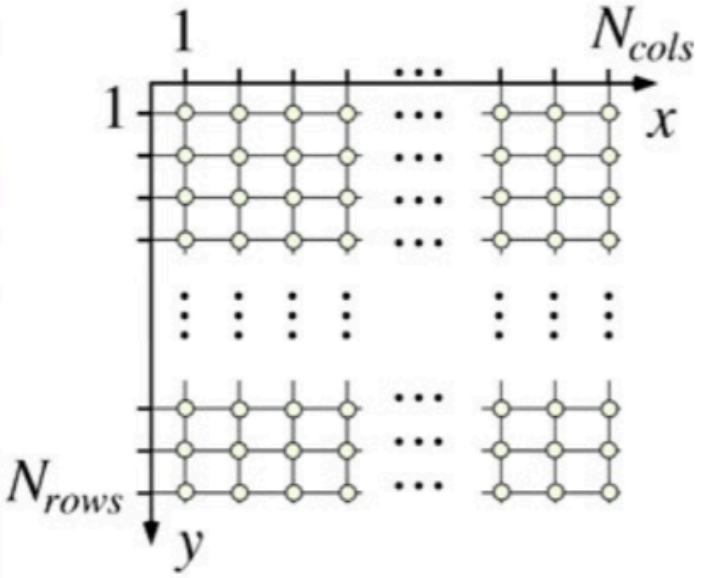




What computer sees!

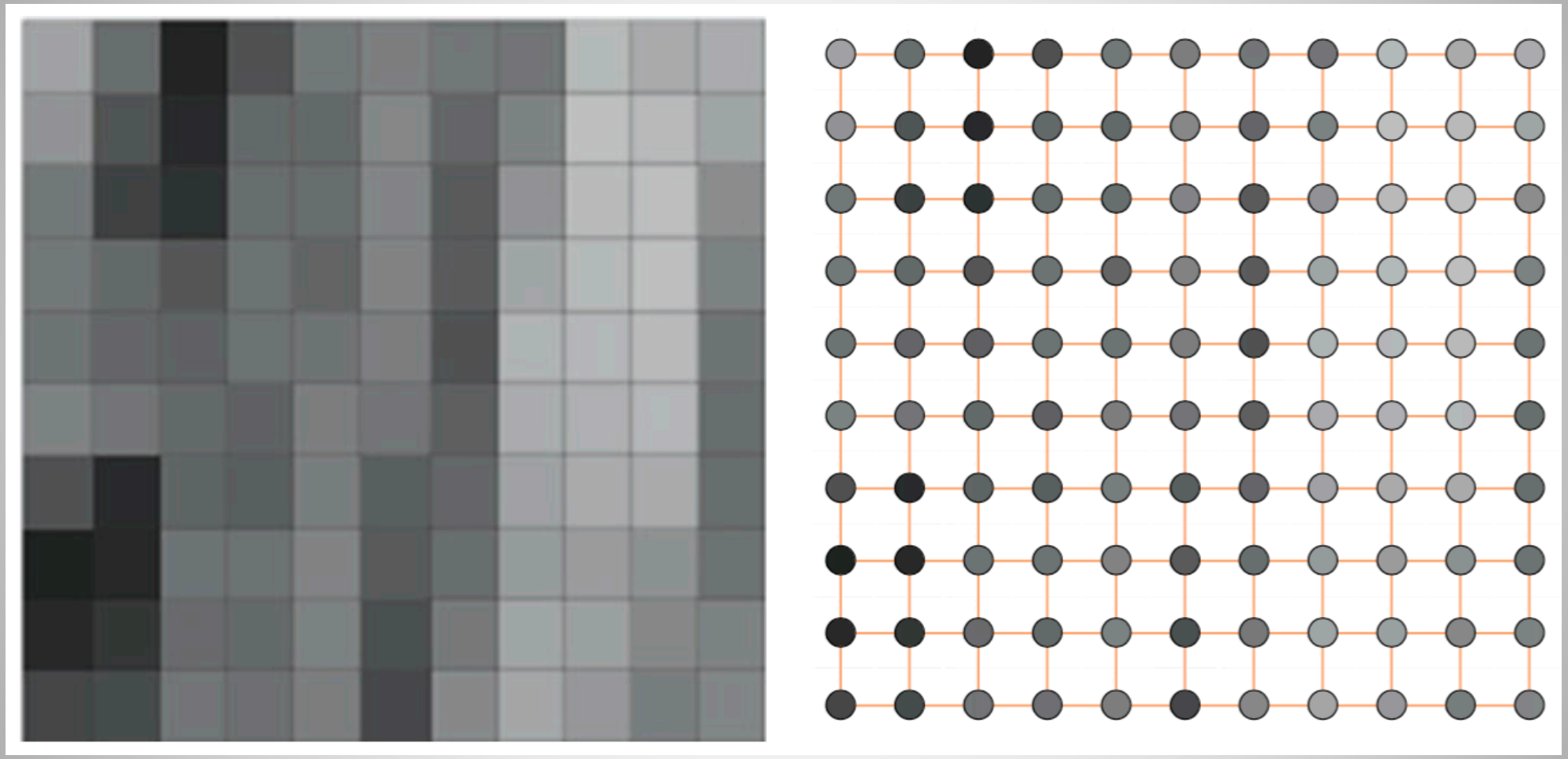
What is a (digital) Image?

- Definition: A digital image is defined by *integrating* and *sampling* continuous (analog) data in a spatial domain [Klette, 2014].



Left hand coordinate system

Picture Elements - PIXEL



PIXELS are ATOMIC ELEMENTS of an image.
In late 1960s, terminology ‘pixel’ was introduced by a group of scientist at JPL in California!

Image Types: Scalar and Binary

- A scalar image has integer values

$$u \in \{0, 1, ..., 2^a - 1\}$$

a: level (bit)

Ex. If 8 bit (a=8), image spans from 0 to 255

0 black

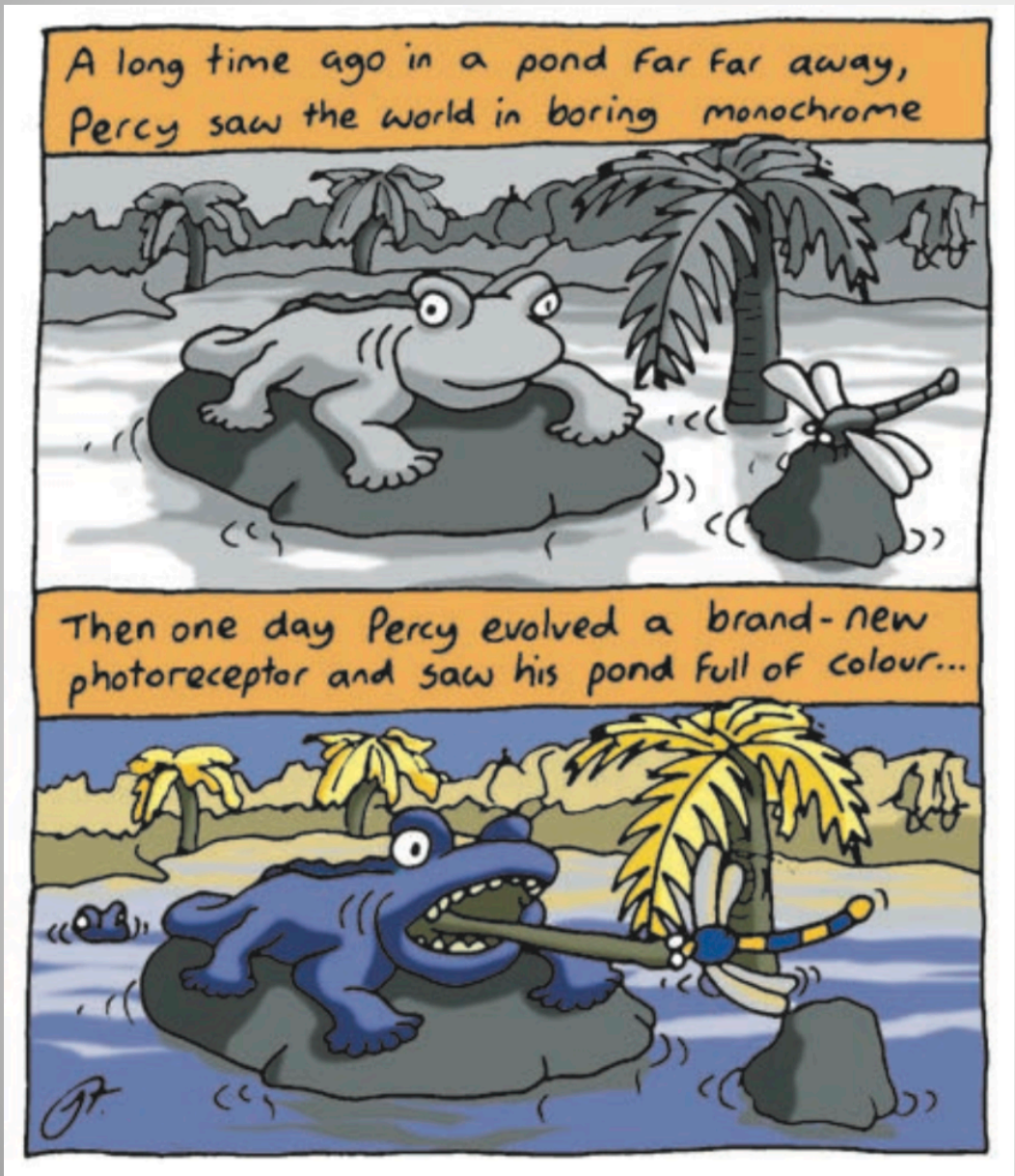
255 white

Ex. If 1 bit (a=1), it is binary image, 0 and 1 only.

Image Type: RGB (red, green, blue)

- Image has three channels (bands), each channel spans a-bit values.

Image Type: RGB (red, green, blue)



- Image has three channels (bands), each channel spans a-bit values.

Image Format

- Some formats: TIF, PGM, PBM, GIF, JPEG, PNG, RAW,…
- Medical Images: DICOM, Analyze, NIFTI,…

HEADER: contains image information, image size, pixel size, …

DATA: integer, double, float, unsigned integer, char,…

Practice: Image Format/Read/Show

```
from scipy import misc
l = misc.lena()
misc.imsave('lena.png', l) # uses the Image module (PIL)

import matplotlib.pyplot as plt
plt.imshow(l)
plt.show()
```

PIL: Python Imaging Library

from PIL import Image
Img = Image.open('empire.jpg')

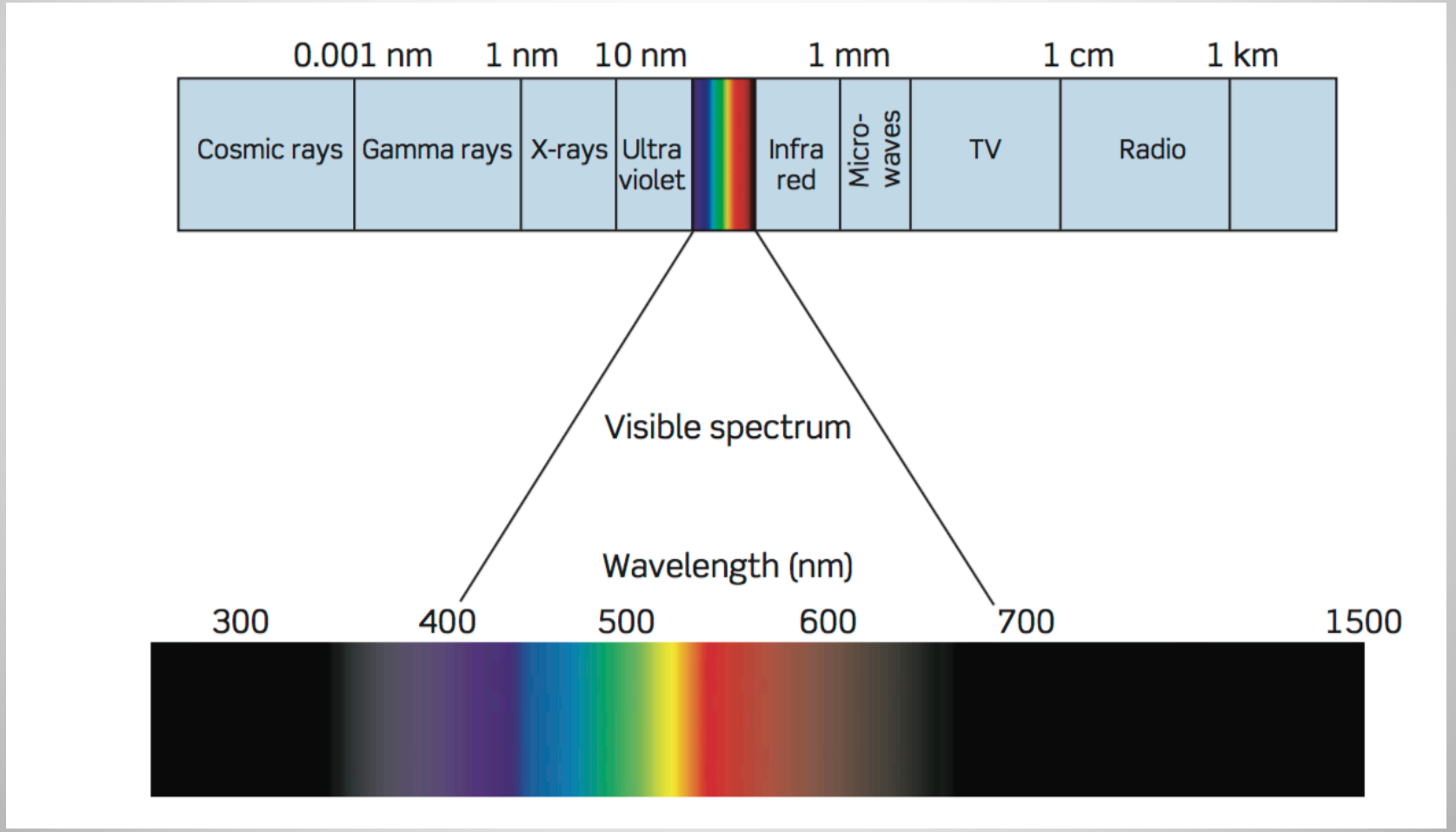
Matplotlib is a good graphics library with much
More powerful features than the
Plotting available in PIL

Color

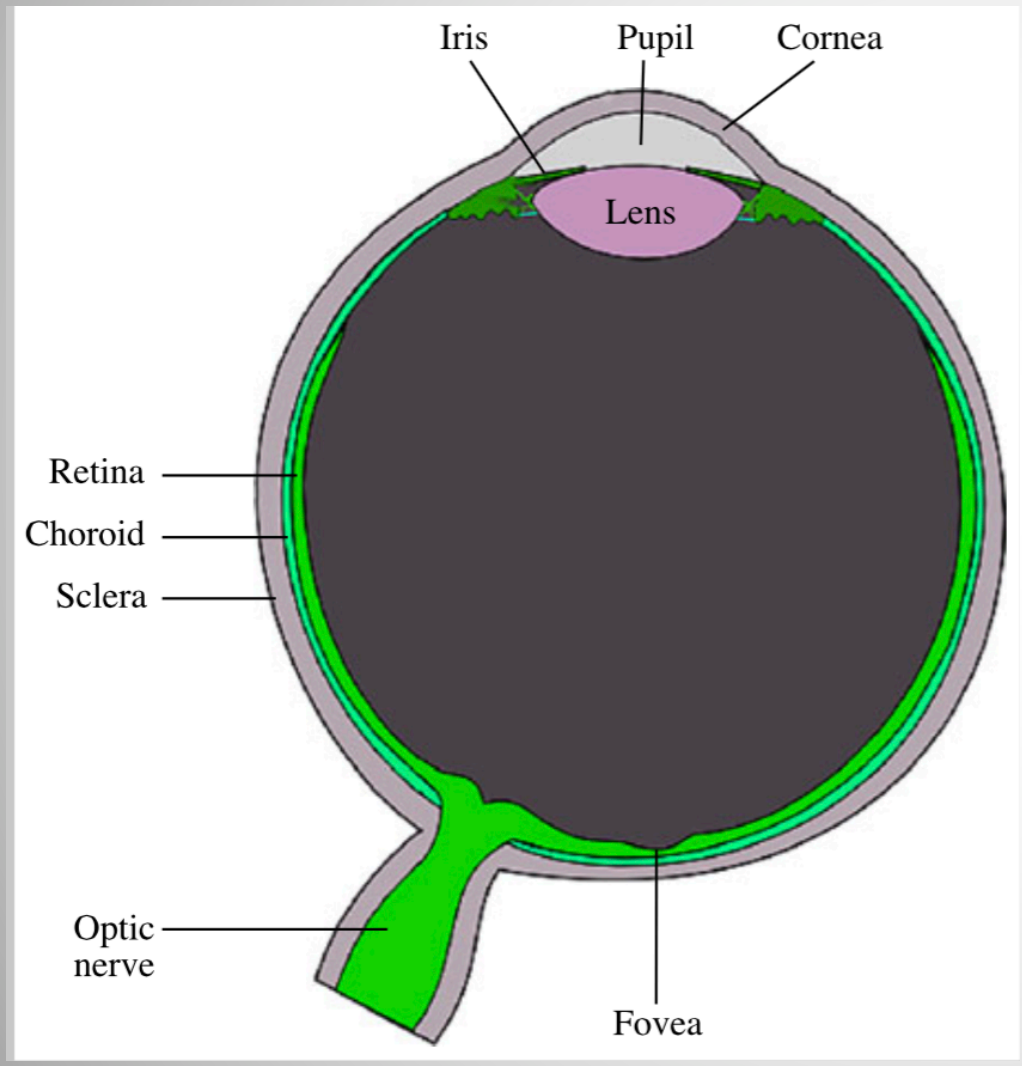
- If there is no light, there is no color!
- Human vision can only discriminate a few dozens of grey levels on a screen, but hundreds of thousands of different colors.
  - RED -> ~625 to 780 nm [long wavelength]
  - ORANGE -> ~ 590 to 625 nm [long wavelength]
  - YELLOW -> ~565 to 590 nm [middle range wavelength]
  - GREEN -> ~ 500 to 565 nm [middle range wavelength]
  - CYAN -> ~485 to 500 nm [middle range wavelength]
  - BLUE -> ~440 to 485 nm [short wavelength]
  - VIOLET -> ~330 to 440 nm [very short wavelength]

COLOR

- Color vision has evolved over millions of years.



Retina of Human Eye



There are three different types of color-sensitive cones corresponding to (roughly) RED (64% of the cones), GREEN (about 32%), and BLUE (about 2%).

6-7 million cones
120 million rods

Credit: Klette, 2012.

Video Clip

- Sequences of frames
- 30 frames per second

Sequences of Images

Vision in supermarkets

[LaneHawk by EvolutionRobotics]

"A smart camera is flush-mounted in the checkout lane, continuously watching for items. When an item is detected and recognized, the cashier verifies the quantity of items that were found under the basket, and continues to close the transaction. The item can remain under the basket, and with LaneHawk, you are assured to get paid for it… "

Source: S. Seitz

Automotive safety

- Mobileye: Vision systems in high-end BMW, GM, Volvo models
  - "In mid 2010 Mobileye will launch a world's first application of full emergency braking for collision mitigation for pedestrians where vision is the key technology for detecting pedestrians."

Source: A. Shashua, S. Seitz

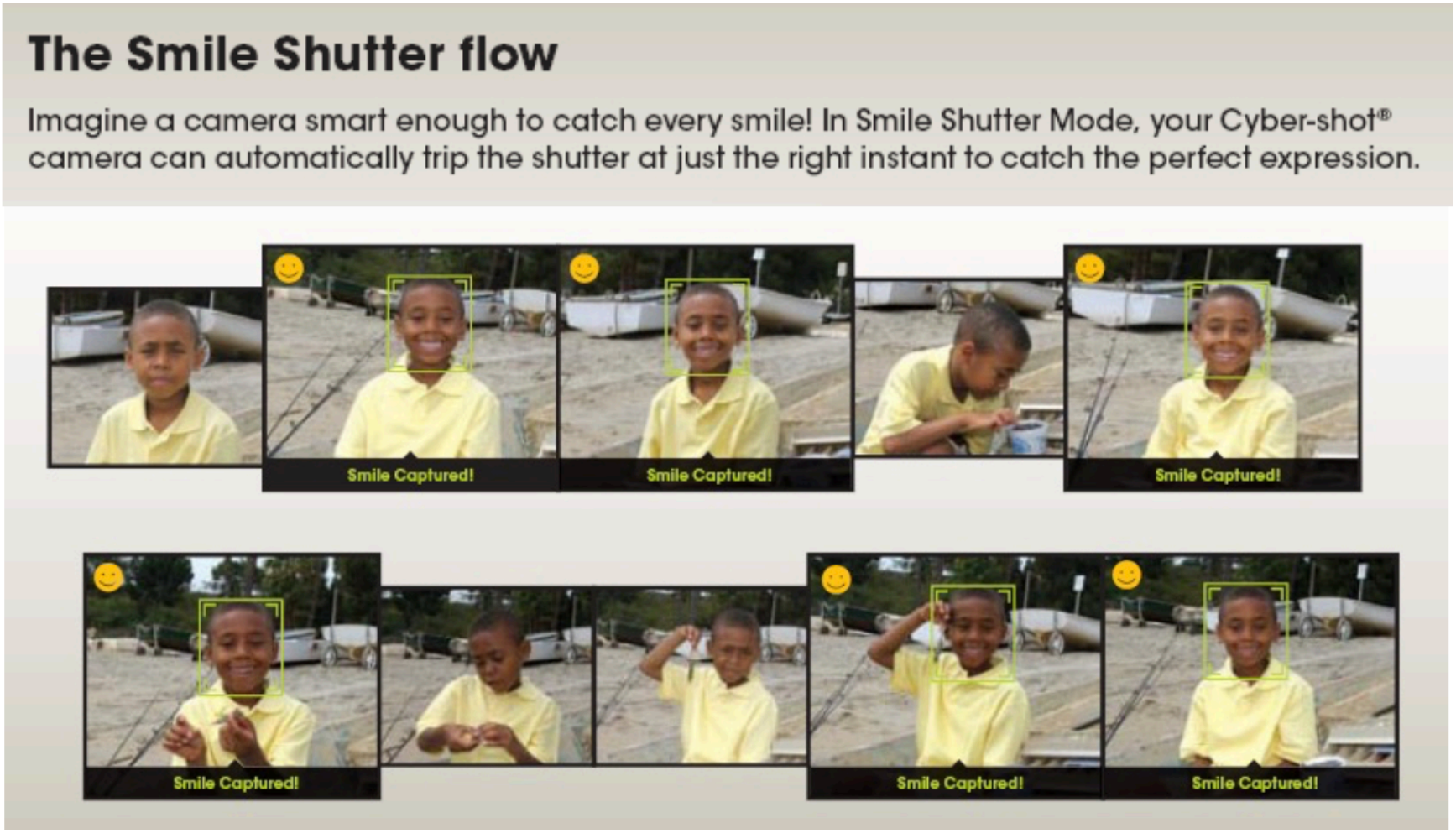
Biometrics

Fingerprint scanners on many new laptops, other devices

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

Source: S. Seitz

Smile detection



Sony Cyber-shot® T70 Digital Still Camera

Source: S. Seitz

Vision-based interaction (and games)

Microsoft's Kinect

Sony EyeToy

Assistive technologies

Source: S. Seitz