Introduction

Outline

- Course Information
- Definitions
- Connections to other disciplines
- Computer vision tasks and applications

Course Information

Course Title	Computer Vision
Course Number	ENCS 5343
Prerequisites	Artificial Intelligence, Computer Programming and Data Structures
Instructor	Aziz Qaroush
Email	aqaroush@birzeit.edu
Office	Masri119

Course Information

References	• Digital Image Processing, Rafael C. Gonzalez and Richard E. Woods, Pearson Education, Fourth Edition 2017 • Computer Vision: Algorithms and Applications, Richard Szeliski, Springer, second edition 2022. • Computer Vision: A Modern Approach, by D.A. Forsyth and J. Ponce, Prentice Hall, Second edition, 2012. • Lecture Notes.

Course Information

- **Course Contents**
  - Introduction to Computer Vision.
  - Digital Image Processing Fundamentals.
    - Digital Imaging Basics.
    - Contrast Enhancement.
    - Image Filtering.
    - Edge Detection
  - Intr. To Deep learning in Computer Vision.
    - Introduction to Deep Learning
    - Artificial Neural Networks
    - Convolutional Neural Networks
  - Features Extraction - Detection and Description
  - Image Classification
  - Object Detection
  - Image Segmentation
  - Optical Flow and Object Tracking.
  - Action Recognition

Course Information

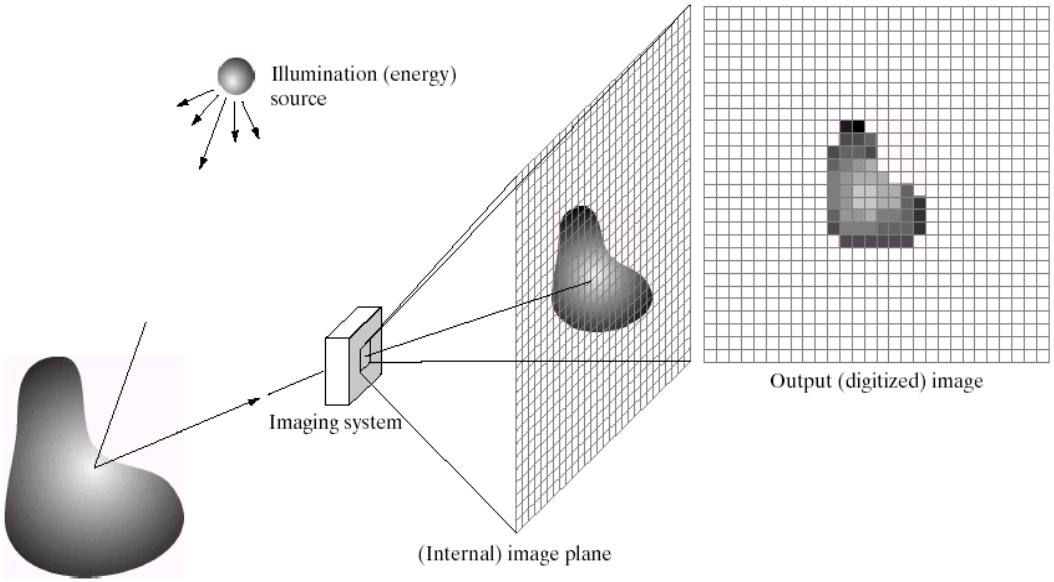
Assessment Policy		
Assessment Type	**Expected Due Date**	**Weight**
Midterm Exam	TBA	20%
Final Exam	TBA	40%
Two Assignments	TBA	20%
Project	TBA	20%

Course Information

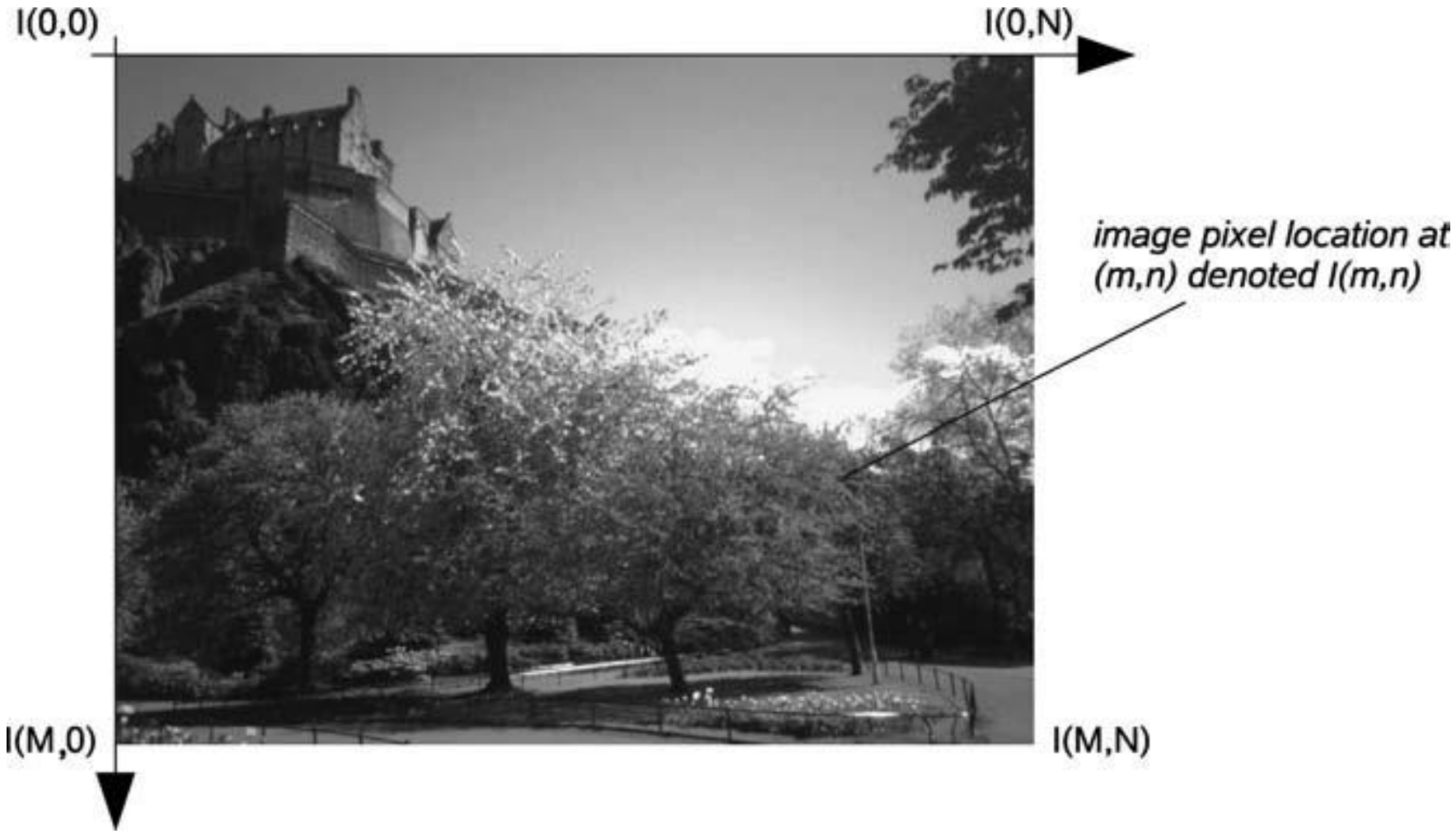
Additional Notes	
Assignments	No late assignments
Exams	Comprehensive exams
Makeup Exams	No makeup exam
Drop Date	TBA
Attendance	Your attendances is very important
Key to a good grade	Reading the TEXTBOOK and HANDOUT + DOING the PROJECTS

What is a Digital Image?

- A **digital image** is a representation of a two- dimensional image as a finite set of digital values, called picture elements or pixels.
  - An **image can be define as a two-dimensional function f(x,y) with x and y being the spatial coordinates and f is the amplitude**
  - A **digital image is the representation of an image using finite and discrete values for x,y, and f**
  - These values are called picture elements or pixels

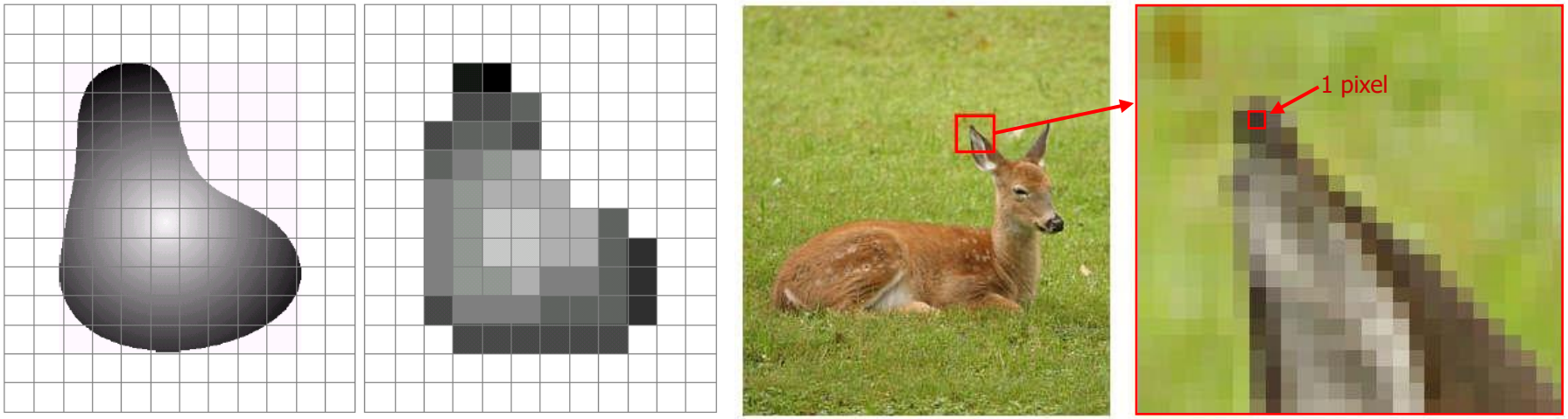


What is a Digital Image?



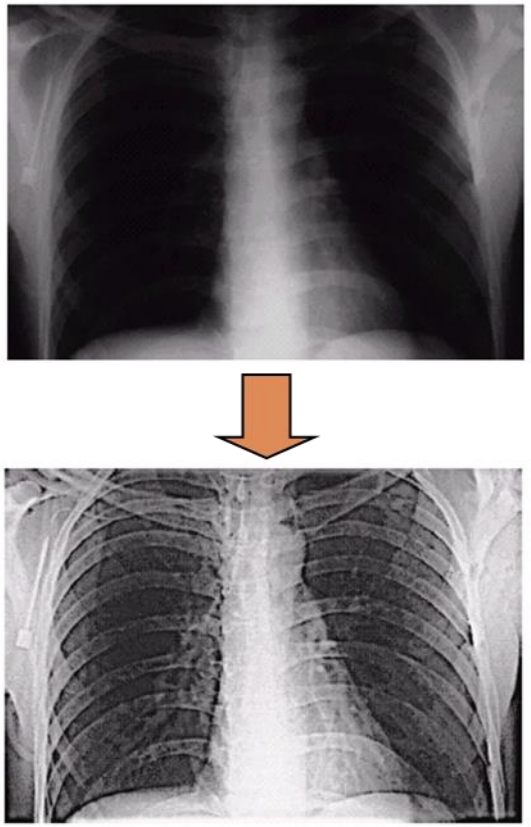
What is a Digital Image? (cont…)

- Pixel values typically represent gray levels, colors, heights, opacities etc
- **Remember** *digitization* implies that a digital image is an *approximation* of a real scene



What is Digital Image Processing?

- Digital image processing focuses on two major tasks
  - Improvement of pictorial information for human interpretation
  - Processing of image data for storage, transmission and representation for autonomous machine perception
- Some argument about where image processing ends and fields such as image analysis and computer vision start



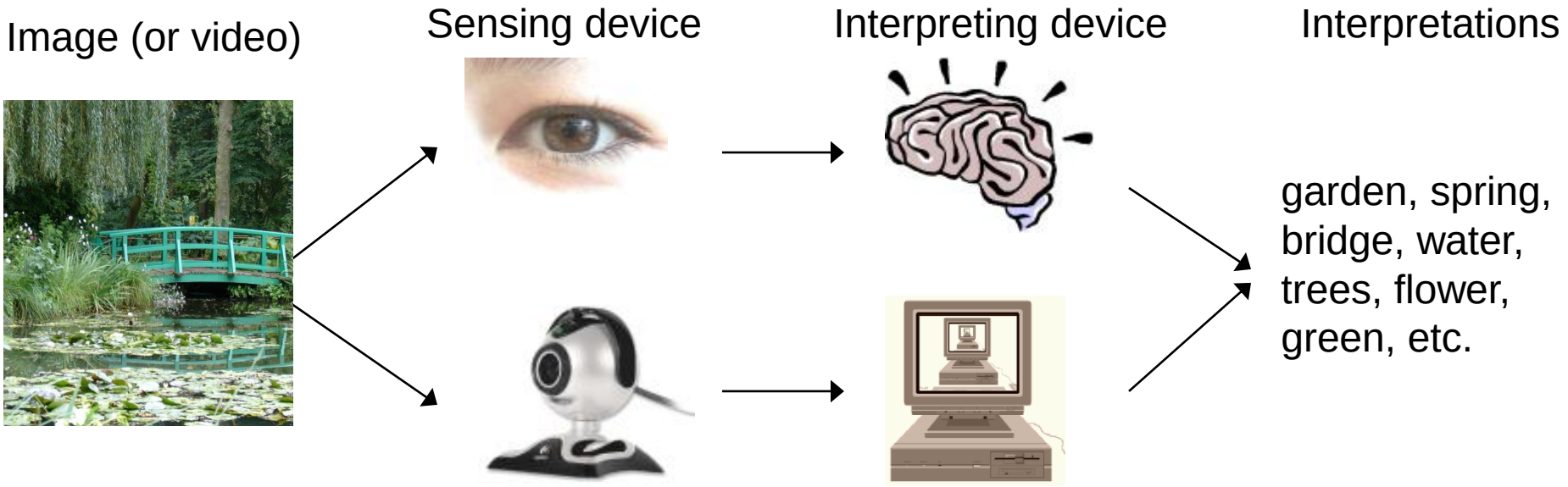
What is Computer Graphics

- Computer graphics refers to the field of computer science and technology that focuses on creating, manipulating, and displaying visual content using computers.
- It involves the generation, processing, and rendering of images, videos, and animations using digital techniques.
- Computer graphics play a crucial role in various applications, including entertainment, art, design, scientific visualization, virtual reality, user interfaces, and more.
- Some key aspects of computer graphics:
  - **Rendering:** Rendering is the process of generating a final image or animation from a 3D model, scene description, or other data.
  - **Virtual Reality (VR) and Augmented Reality (AR):** Computer graphics are fundamental to VR and AR technologies, which aim to create immersive and interactive virtual worlds or overlay digital information onto the real world.

What is Computer Vision

- Computer vision is a field of computer science that works on enabling computers to see, identify and process images in the same way that human vision does, and then provide appropriate output.
- Computer vision is concerned with the theory and technology for building artificial systems that obtain information from images or multi-dimensional data.
- **Computer vision** is concerned with the automatic extraction, analysis and understanding of useful information from a single image or a sequence of images.

Vision vs. Computer Vision?



The goal of computer vision

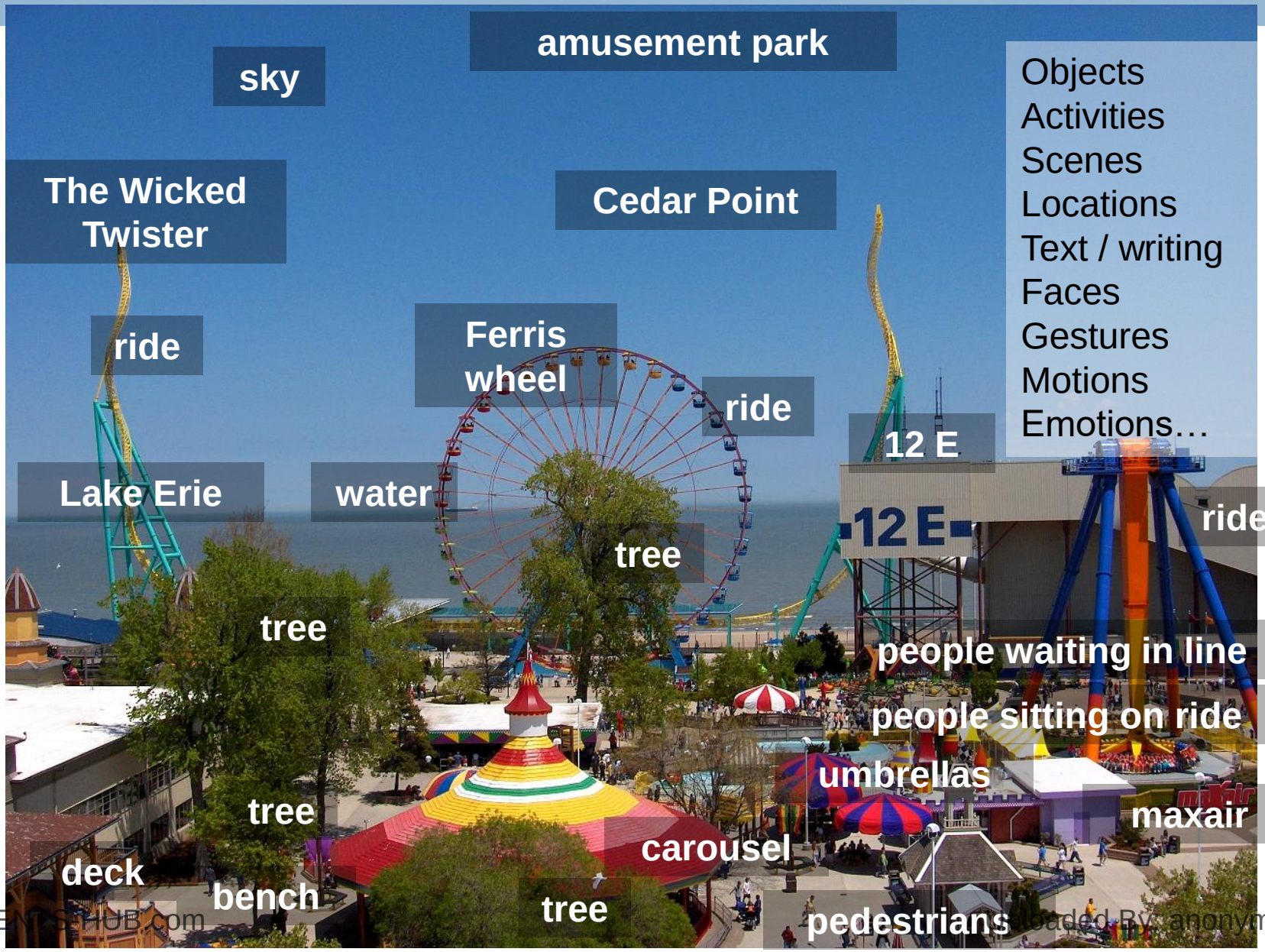
- The goal of computer vision is to give computers **(super) human-level perception**
  - bridge the gap between pixels and “meaning

What we see

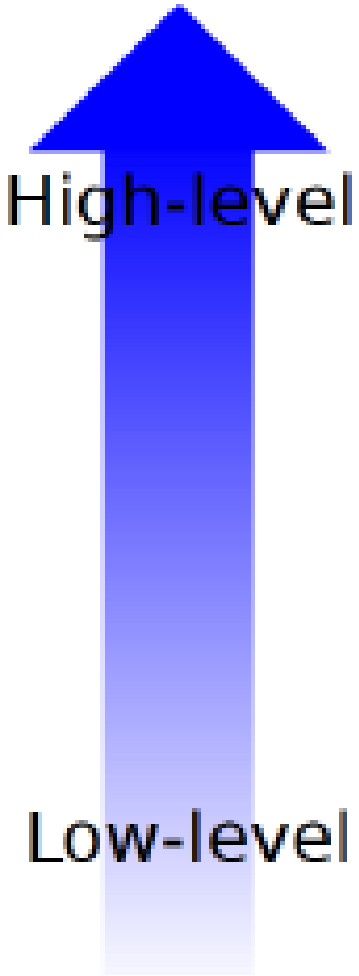
0	3	2	5	4	7	6	9	8
3	0	1	2	3	4	5	6	7
2	1	0	3	2	5	4	7	6
5	2	3	0	1	2	3	4	5
4	3	2	1	0	3	2	5	4
7	4	5	2	3	0	1	2	3
6	5	4	3	2	1	0	3	2
9	6	7	4	5	2	3	0	1
8	7	6	5	4	3	2	1	0

What a computer sees

Vision as a source of semantic information



Relationship with other Related Fields



Computer Vision

Object detection, recognition, shape analysis, tracking
Use of Artificial Intelligence and Machine Learning

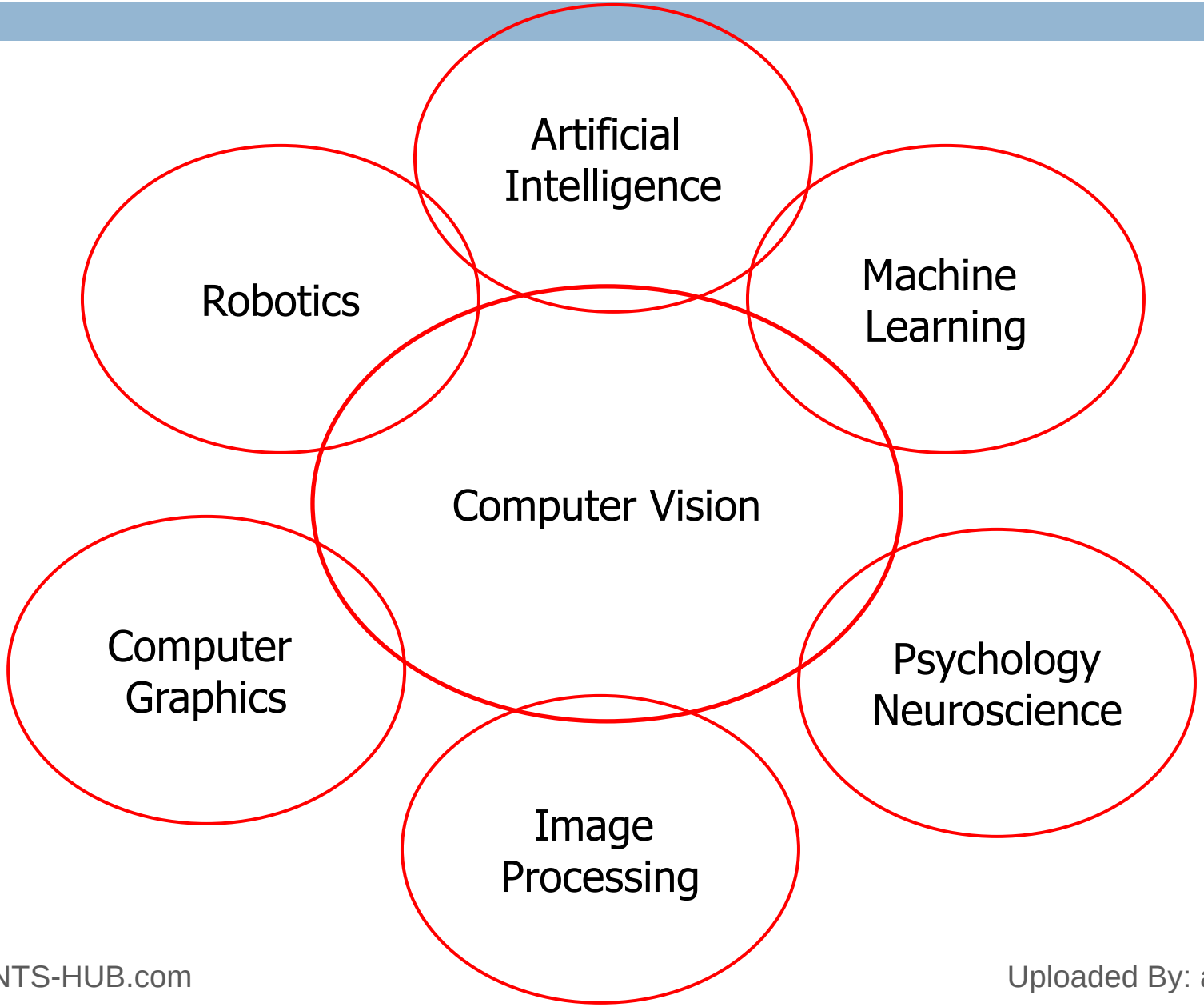
Image Analysis

Segmentation, image registration, matching

Image Processing

Image enhancement, noise removal, restoration,
feature detection, compression

Connections to other disciplines



Computer Vision Tasks and Applications

- Face Recognition
- Object Recognition
- Video Surveillance and Monitoring
- Object detection, tracking and behavior analysis
- Remote Sensing
- Robotics
- Computer Graphics

Content Aware Image Resizing

Traditional resizing uses and stretches the whole image.

Content-aware resizing uses important areas. Extends in horizontal direction and reduces in vertical.

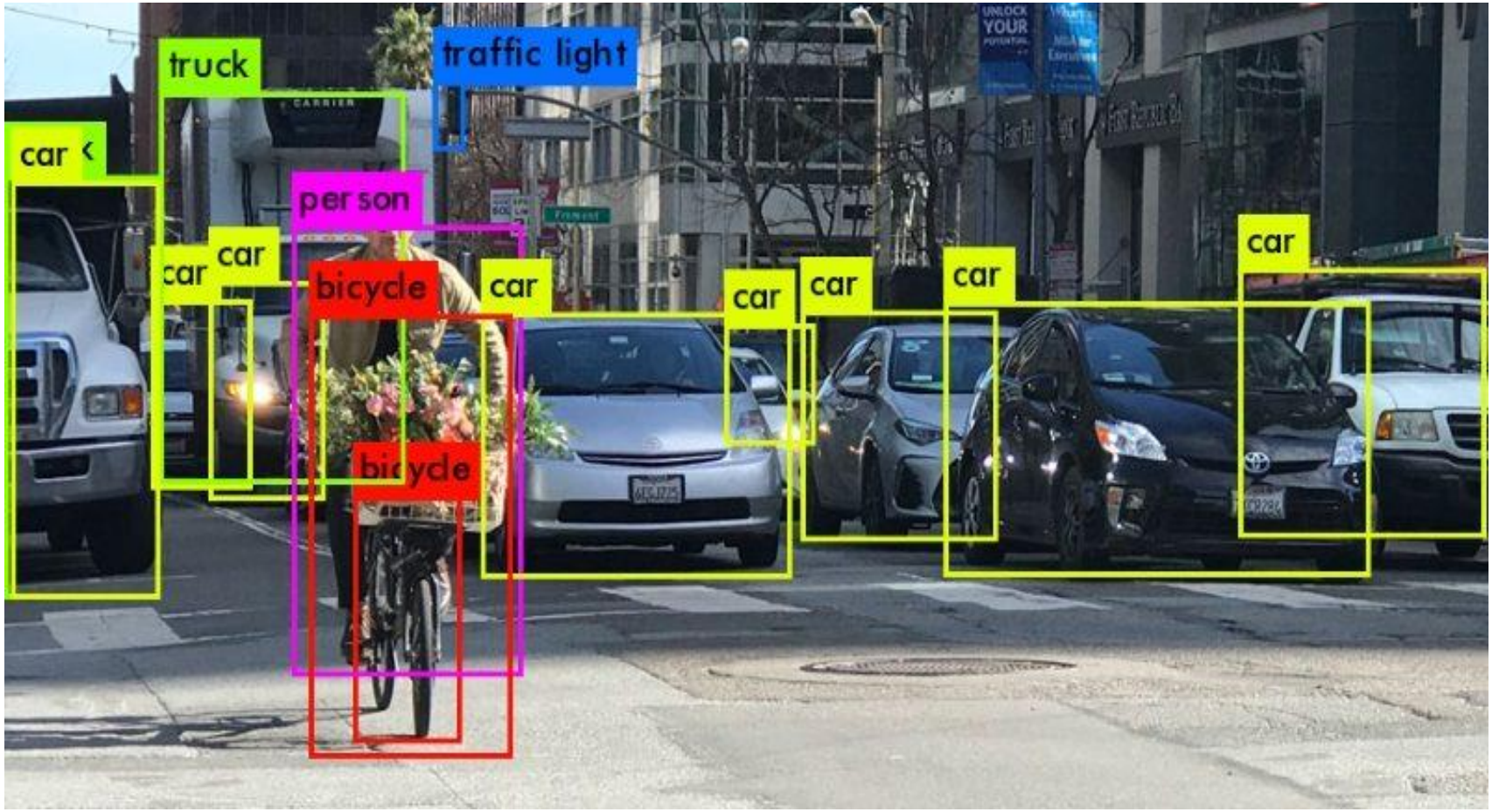
Object Recognition

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

YES

Face recognition: Apple iPhoto software

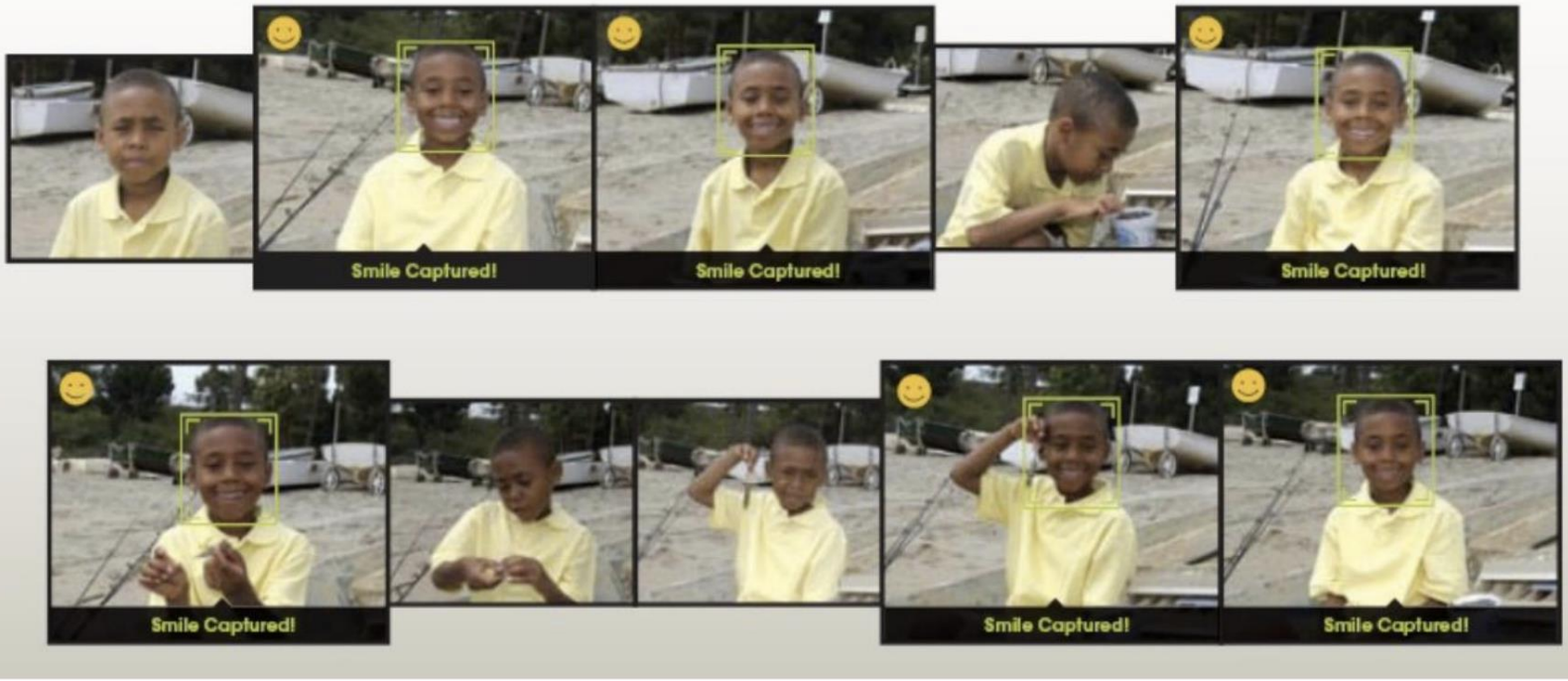
Object Detection and localization



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.



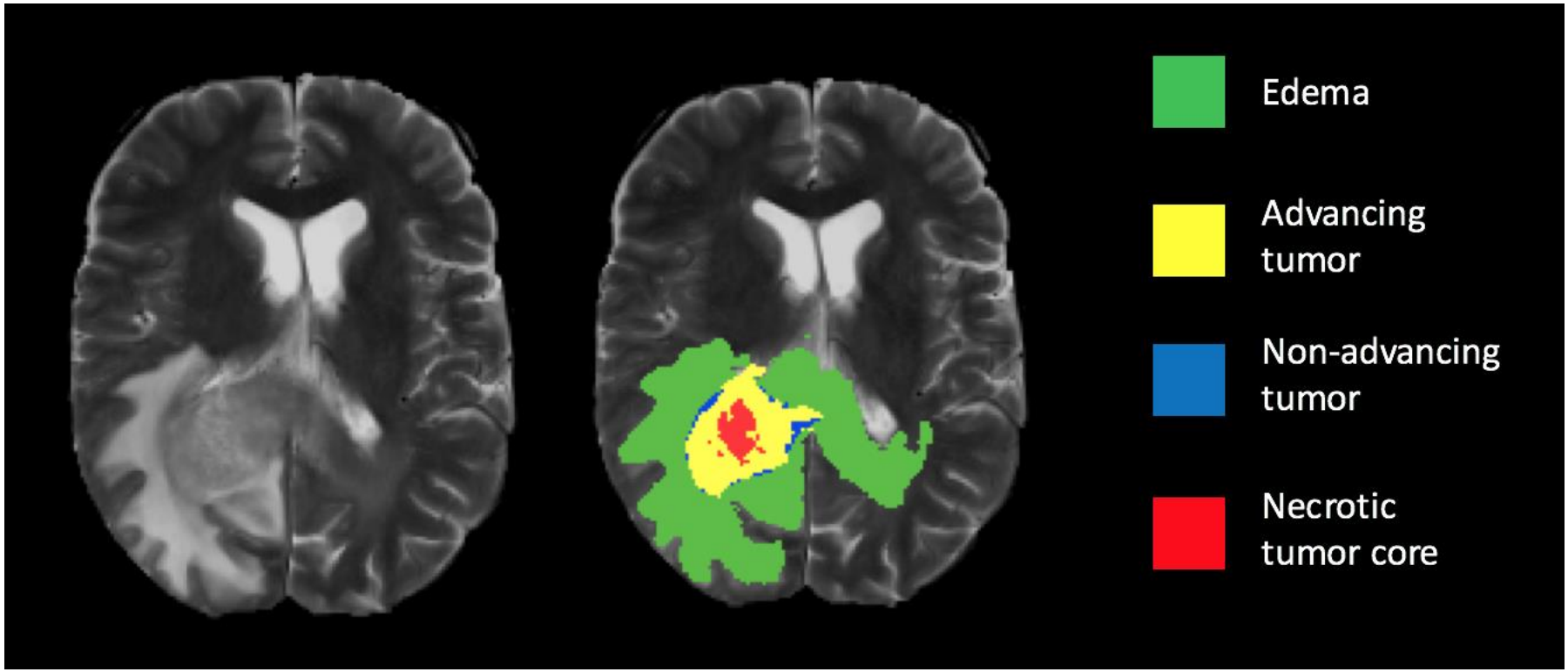
Sony Cyber-shot® T70 Digital Still Camera

Source: S. Seitz

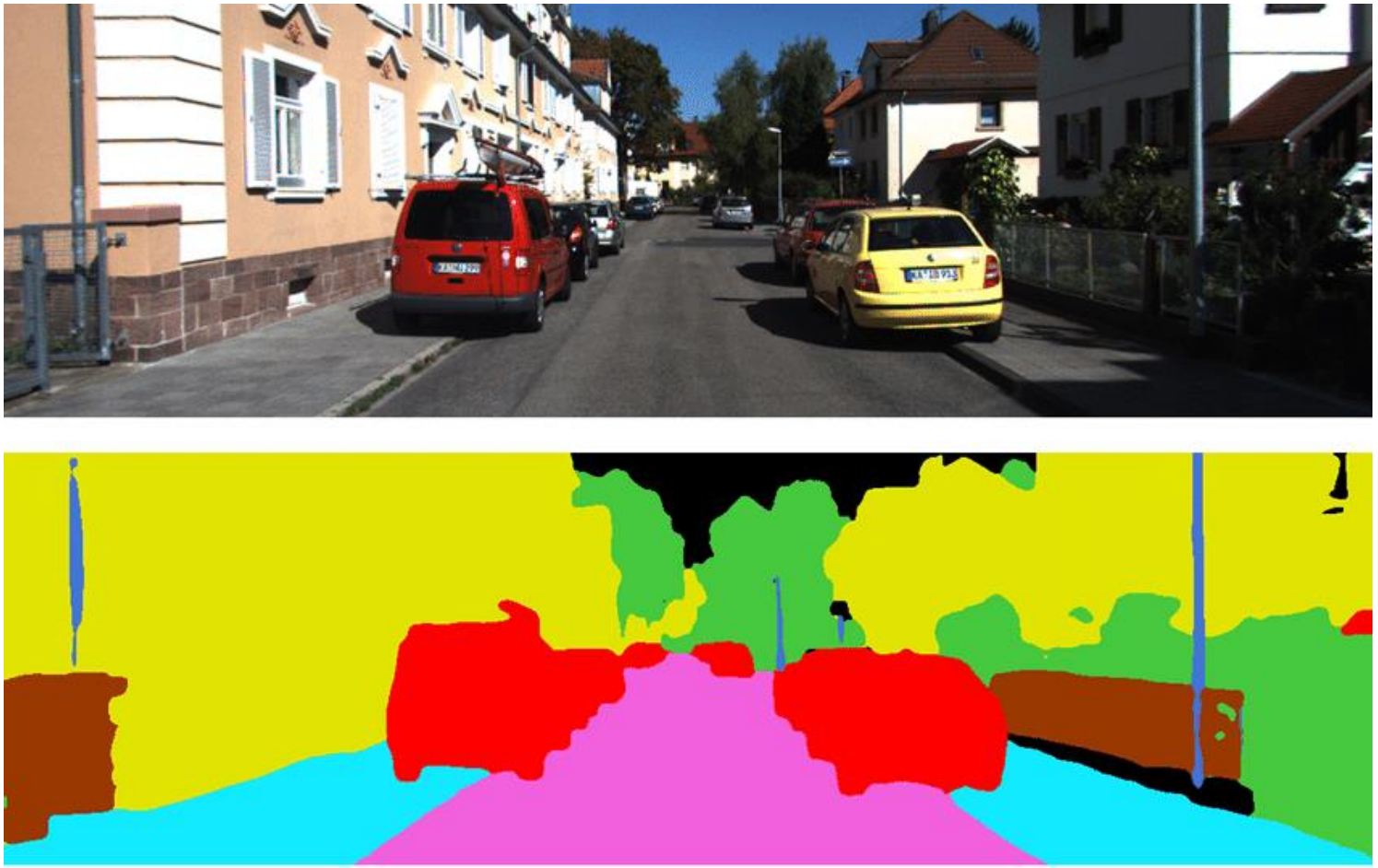
Object Counting

Image Segmentation

Brain Tumar Segmentation



Semantic Segmentation



Action recognition

Cycling

Diving

Golf Swinging

Riding

Volleyball

Basketball Shooting

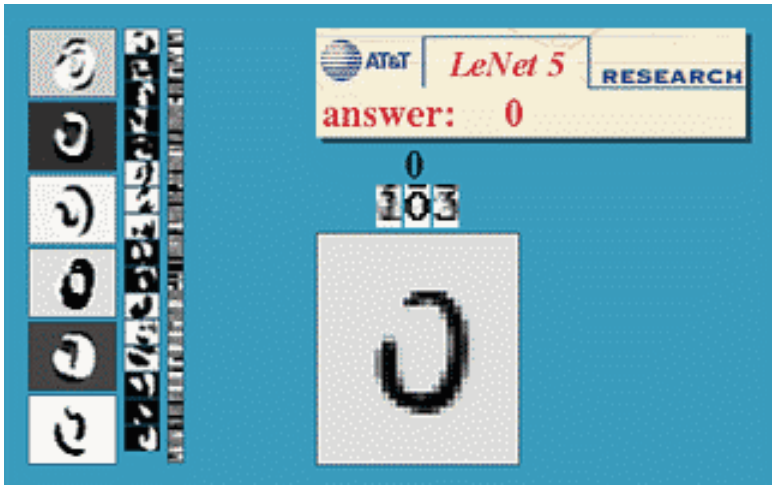
Swinging

Tennis Swinging

Optical character recognition (OCR)

Technology to convert scanned docs to text

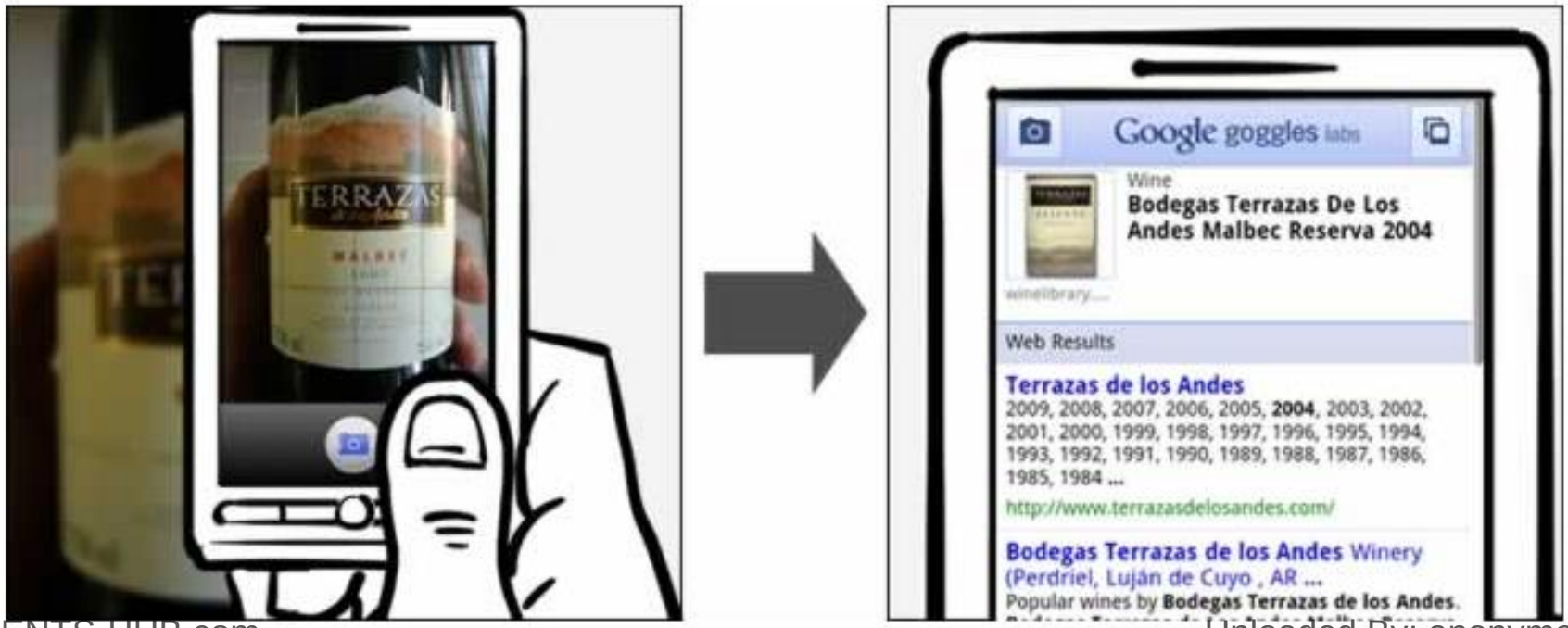
- If you have a scanner, it probably came with OCR software



Mobile visual search: Google Goggles

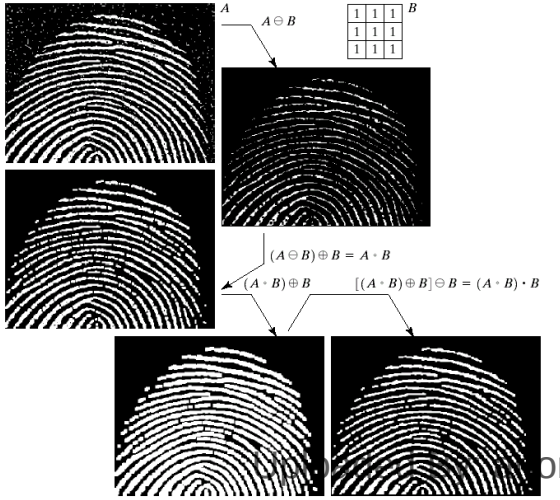
Google Goggles in Action

Click the icons below to see the different ways Google Goggles can be used.



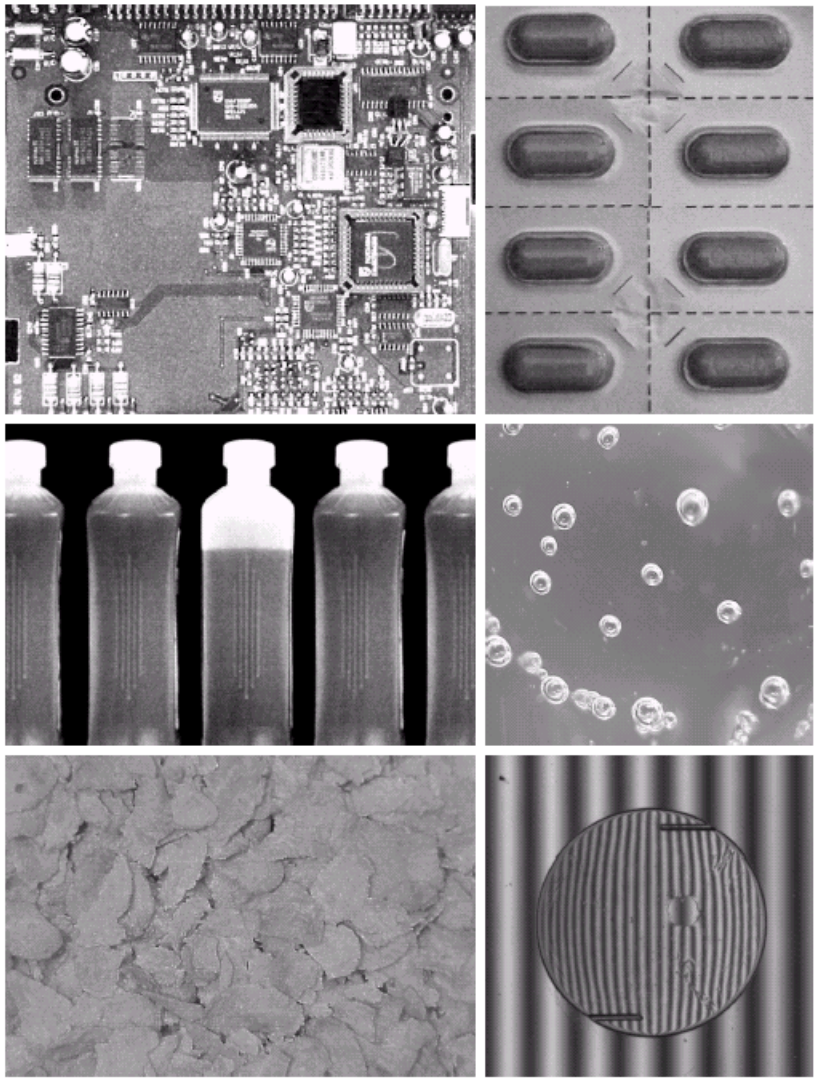
Examples: Law Enforcement

- Image processing techniques are used extensively by law enforcers
  - Number plate recognition for speed cameras/automated toll systems
  - Fingerprint recognition
  - Enhancement of CCTV images



Examples: Industrial Inspection

- Human operators are expensive, slow and unreliable
- Make machines do the job instead
- Industrial vision systems are used in all kinds of industries
- Can we trust them?

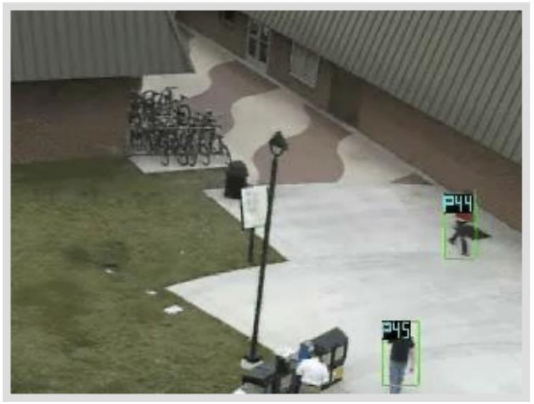


Automotive safety

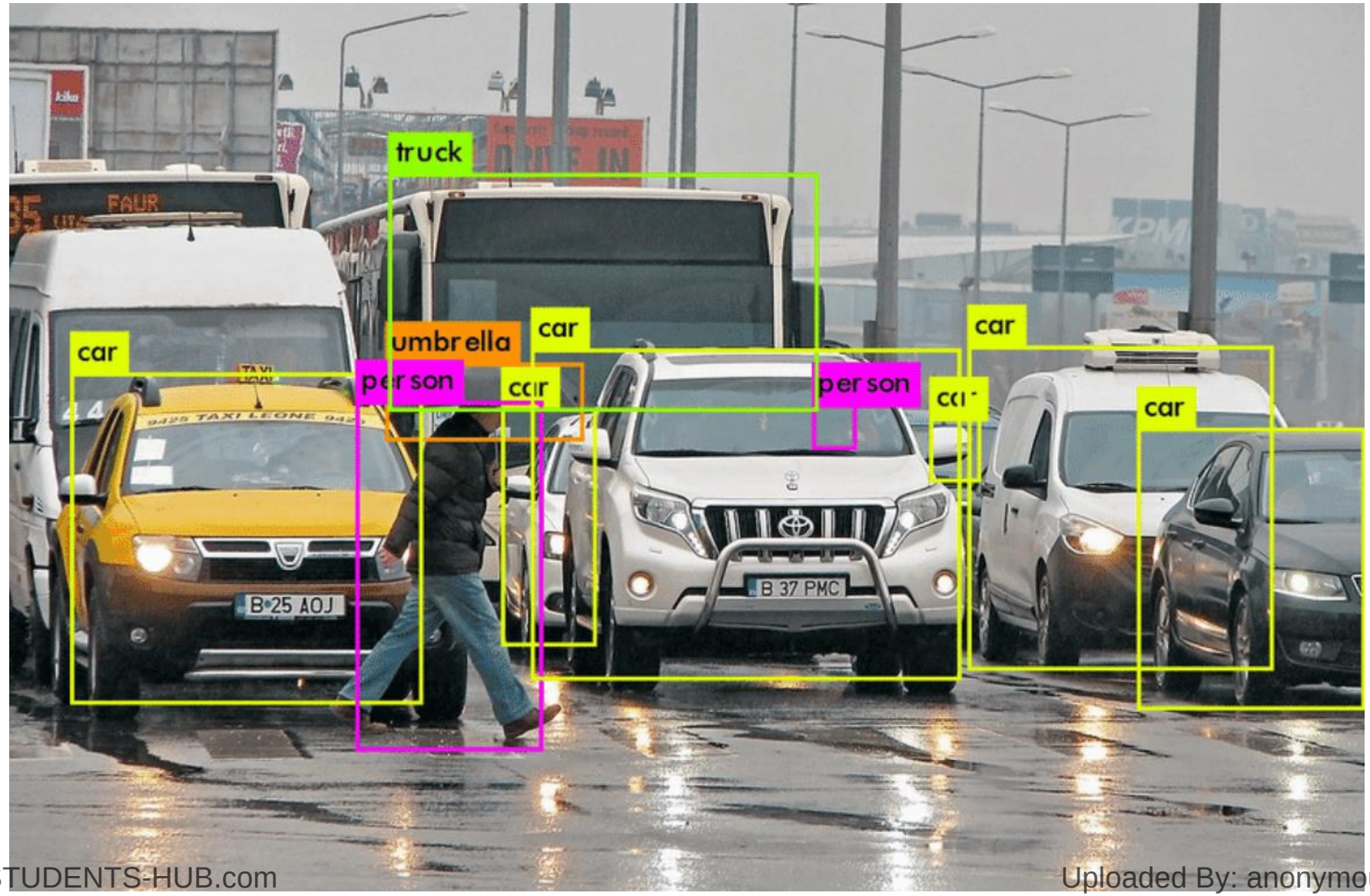
- Mobileye: Vision systems in high-end BMW, GM, Volvo models
  - "In mid 2010 Mobileye will launch a world's first application of full emergency braking for collision mitigation for pedestrians where vision is the key technology for detecting pedestrians."

Video Surveillance and Monitoring

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



Vehicle Tracking, Classification and Counting



Vision-based interaction (and games)

Microsoft's Kinect

Sony EyeToy

Assistive technologies

Text-to-image Generation

Acknowledgement

- The material in these slides are based on:
  - Digital Image Processing: Rafael C. Gonzalez, and Richard
  - Forsythe and Ponce: Computer Vision: A Modern Approach
  - Rick Szeliski's book: Computer Vision: Algorithms and Applications
  - cs131@ Stanford University
  - cs131n@ Stanford University
  - CS198-126@ University of California, Berkely
  - CAP5415@ University of Central Florida
  - CSW182 @ University of California, Berkely
  - 11-785@ Carnegie Mellon University
  - CSCI1430@ Brown University
  - Computer Vision@ Bonn University
  - ICS 505@ KFUPM
  - Digital Image Processing@ University of Jordan