



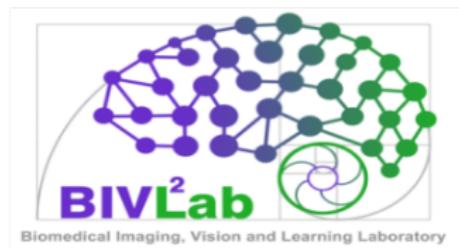
Computer vision: An introduction

Visual learning and understanding

Fabio Martínez, Ph.D

Escuela de ingeniería de sistemas e informática
BivL²ab and **MACV**
Universidad Industrial de Santander

2019



Información del profesor

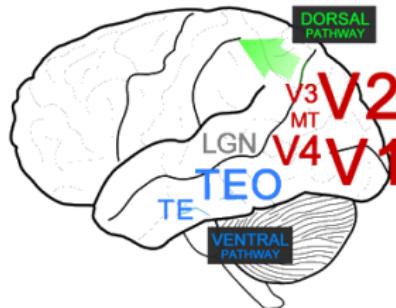
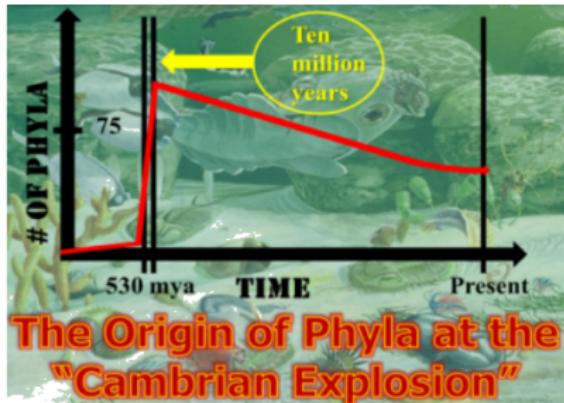
- ▶ Nombre: Fabio Martínez Carrillo
- ▶ Correo (contacto y comunicación):
famarcar@saber.uis.edu.co
- ▶ Página Web: contenido del curso
[curso GITHUB](#)

Why Vision ? ... ¹

¹Mainly inspired (copied):

- ▶ Challenges and Future of Visual intelligence
- ▶ visual intelligence in computers

Why vision ?



- ▶ During millions of years of evolution looks like **vision** was the **key**
 - ▶ “Sudden evolution of vision”
- ▶ Almost **half brain** is dedicated only to process **visual information**

The magic and power of human vision

Fast forward: 540 million years later...



min 4:55...27 ms

- ▶ Challenges and Future of Visual intelligence

Image Perception: Why is this hard?

Origins of computer vision: an MIT undergraduate summer project

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 sub-problems which will allow individuals to work independently and yet participate in the construction of a system complex enough to be a real landmark in the development of "pattern recognition".

The idea was to solve computer vision on a summer undergraduate school

Image Perception: Why is this hard?

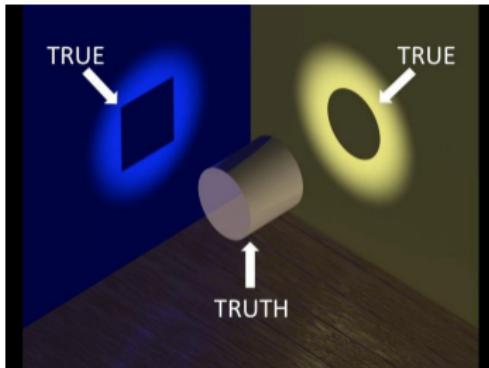
- To bridge the gap between pixels and “meaning”



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

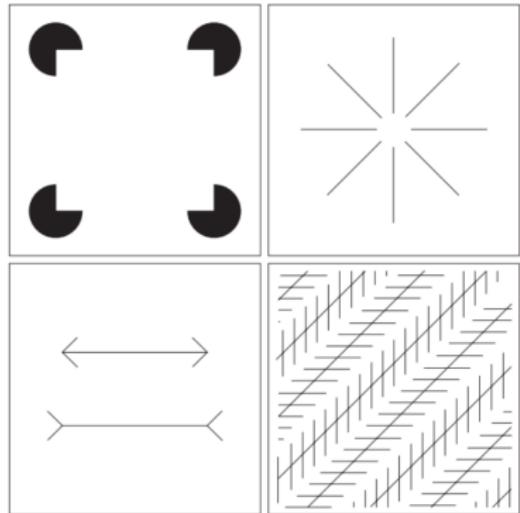


Vision is a mathematically ill posed problem

We should reconstruct 3D scene from 2D information.

- Different objects, geometries, different perspectives result in different information
- It is computationally expensive

Image Perception: Why is this hard?



It is more than measuring pixels . . .

Image Perception: Why is this hard?

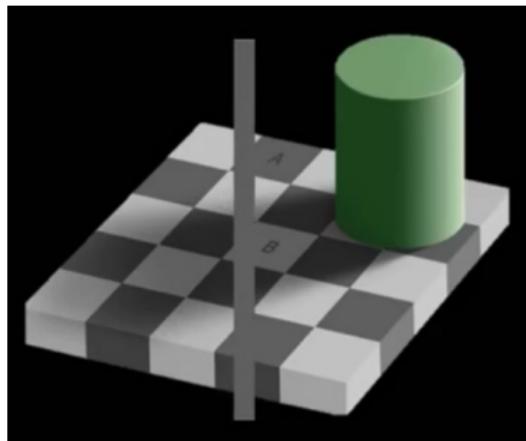
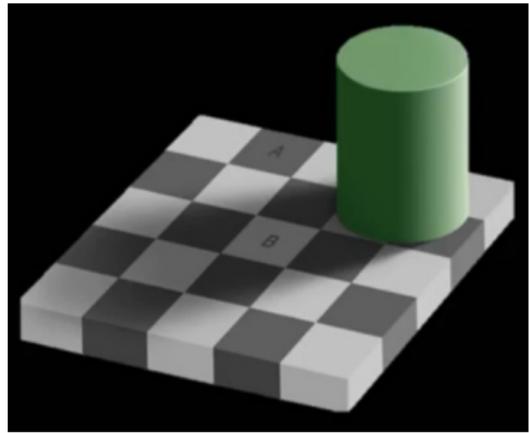
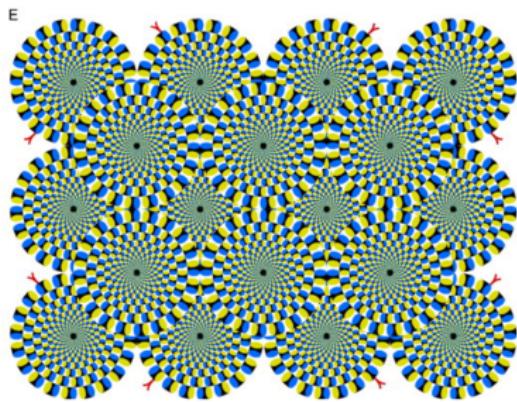
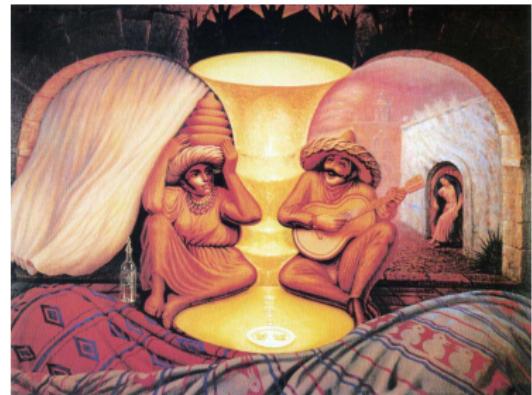


Image Perception: Why is this hard?



Vision also consist to learn to see



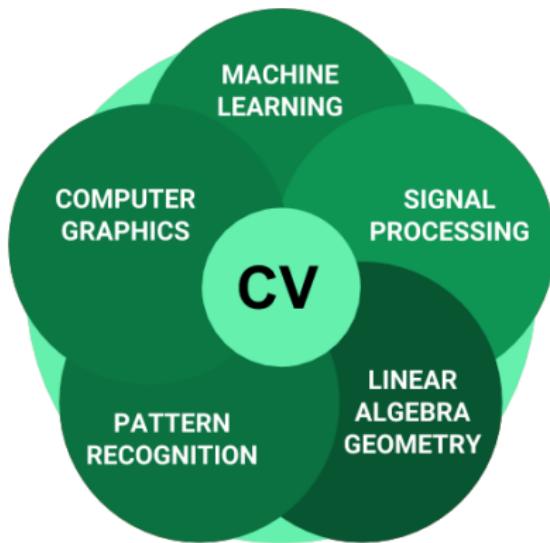
min 14:31

The Kitten experiments

- ▶ Challenges and Future of Visual intelligence
- ▶ “Learning is the path to visual intelligence”

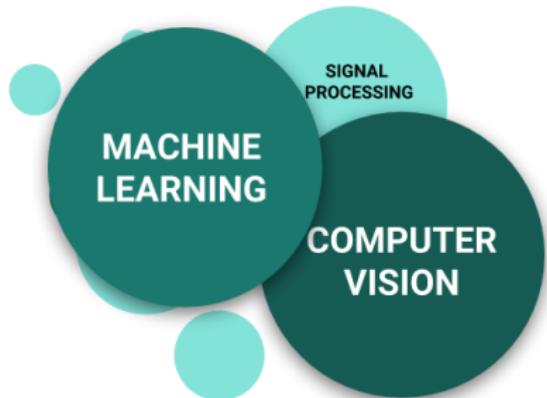
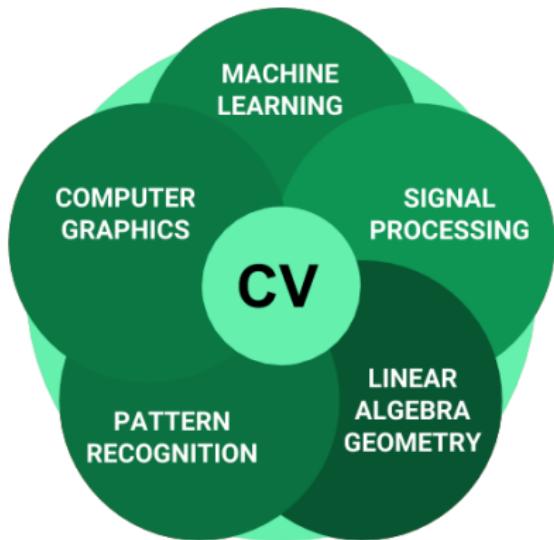
What is Computer vision ? ...

What is Computer vision ?



A set of computer methods and techniques aimed at interpreting images and videos to replicate human visual abilities

What is Computer vision ?



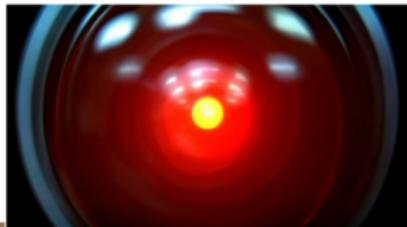
In this course we mainly study C.V + M.L for Visual learning and understanding

It is not image processing



But image processing is really important into computer vision

Why study CV?: everywhere²



²taken from stanford course

Why study CV?: ..so many applications³

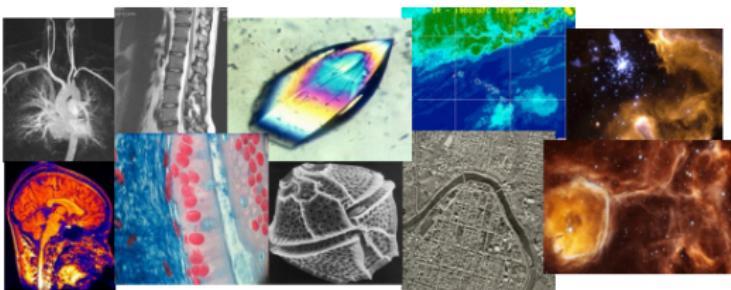


Google™
Image Search Picasa™

flickr™ GAMMA webshots™ picsearch™ YouTube
Broadcast Yourself™



Surveillance and security



Medical and scientific images

³taken from standford course

C.V. course outline ...

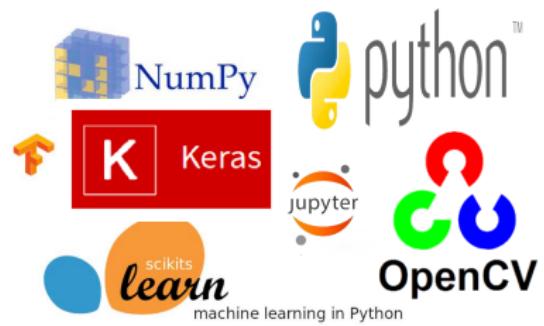
Course outline



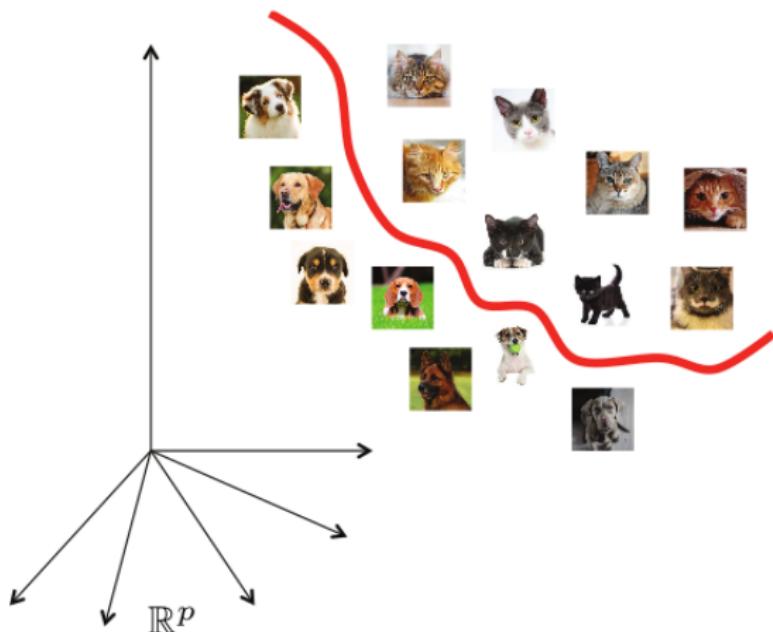
- ▶ The course is mainly based on the **coding of C.V concepts** and the **develop of small and real applications**
- ▶ The course is focus on the analysis and study of **C.V. algorithms**

First Module: Computer vision tools

- ▶ opencv
- ▶ classification of images
- ▶ convolution and preprocessing



At the end of first module

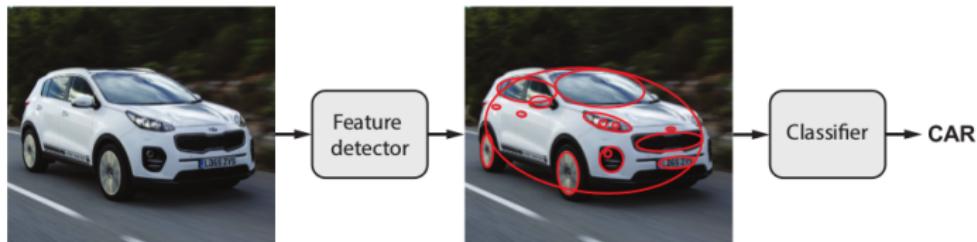


Second Module: Image and video descriptors

- ▶ image descriptor
- ▶ video descriptors
- ▶ Representations

At the end of second module

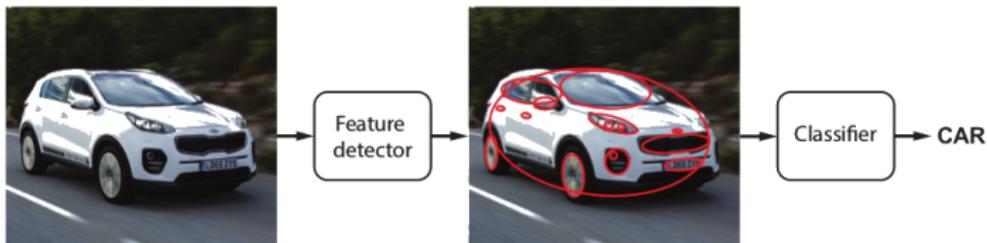
Handcrafted vs Learned features



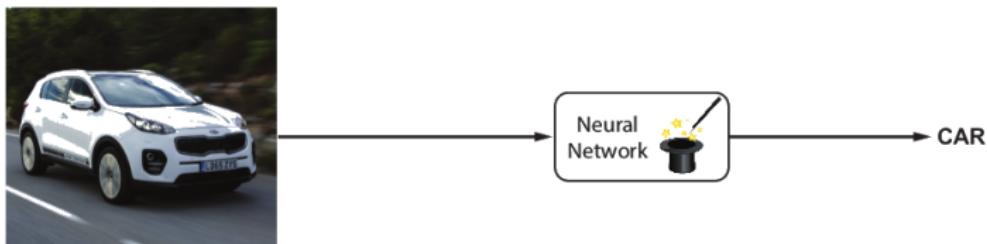
Classical computer vision: hand-crafted features (e.g. SIFT)
+ simple classifier (e.g. SVM)

... but there exist other way to do the same!

Handcrafted vs Learned features



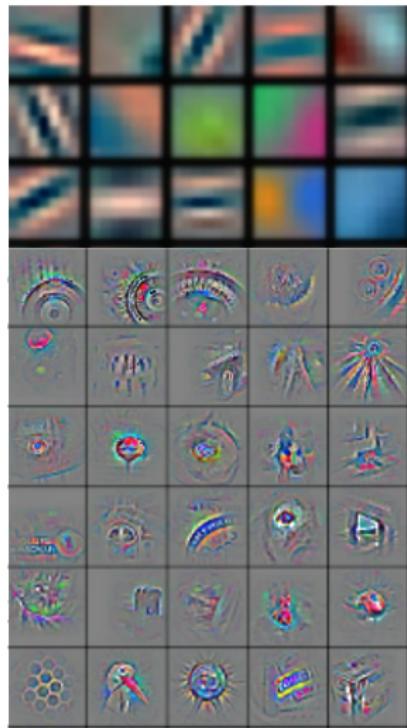
Classical computer vision: hand-crafted features (e.g. SIFT)
+ simple classifier (e.g. SVM)



Modern computer vision: data-driven end-to-end systems

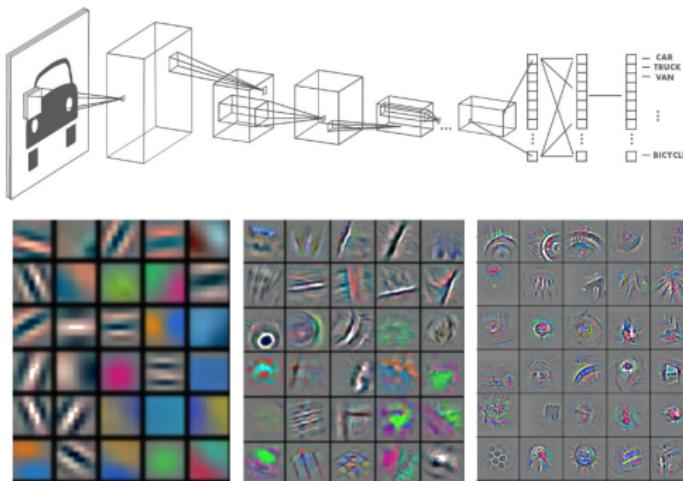
Third module: Deep learning on CV

- ▶ DNN
- ▶ CNN
- ▶ Deep features
- ▶ Dropout



At the end of third module

Key properties of CNNs



OJO! . . . no hay que matar una pulga con una bomba atómica



How to obtain an A+

Some applications and challenges

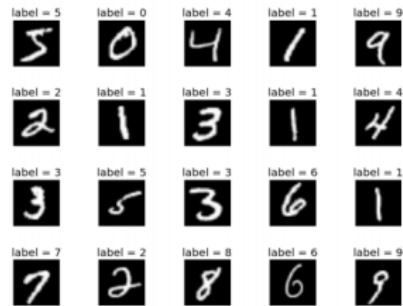
...

Face detection



Character recognition

Optical Character Recognition
(Hand Written Digits)

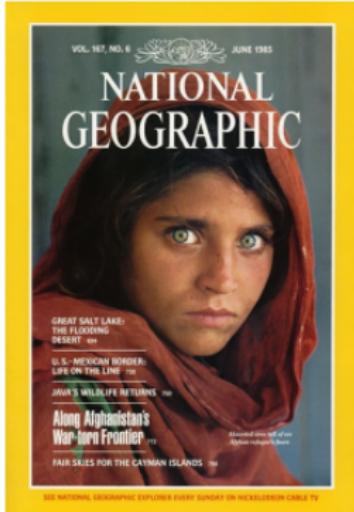


MNIST Data Set

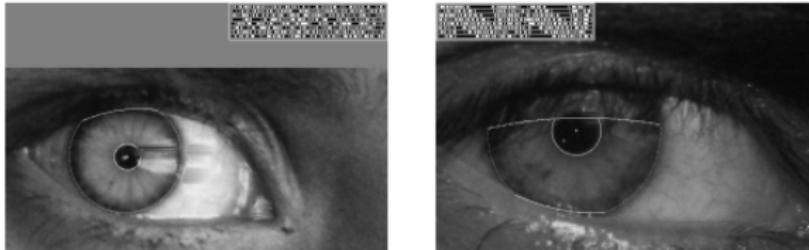
Surveillance



Biometrics



How the Afghan Girl was Identified by Her Iris Patterns

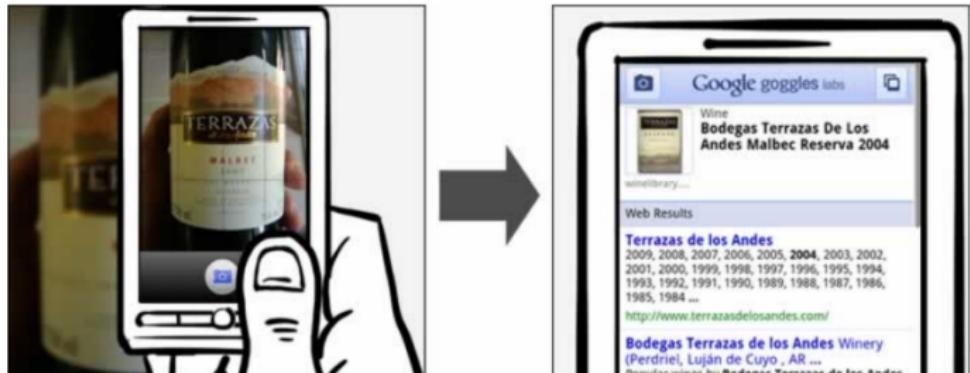


visual search

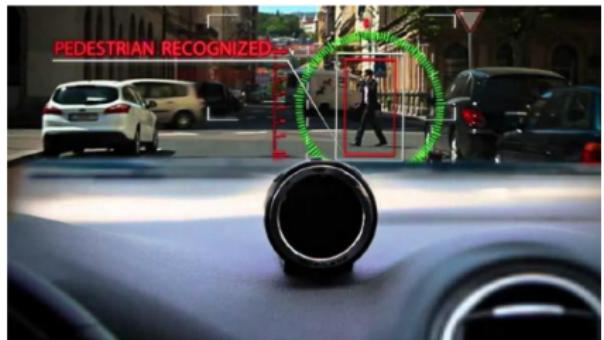
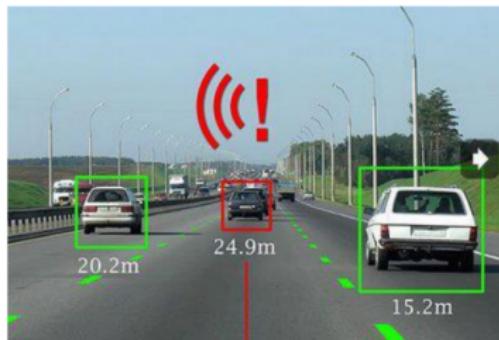
Mobile visual search: Google Goggles

Google Goggles in Action

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



Autonomous vehicle



Vision interaction



Microsoft's Kinect



Sony EyeToy

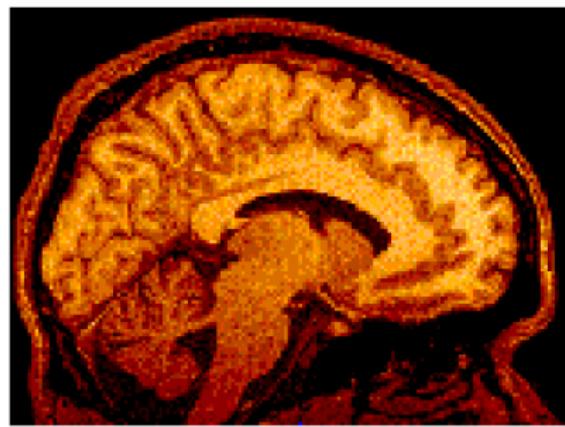


Assistive technologies

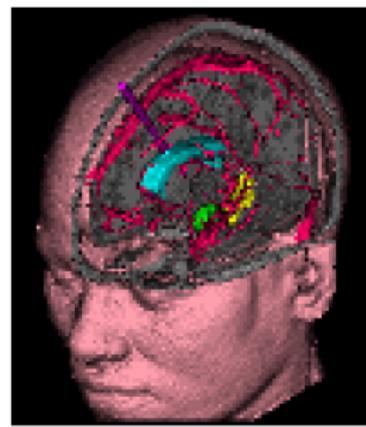
Source: S. Saito

We have kinects!

Medicine

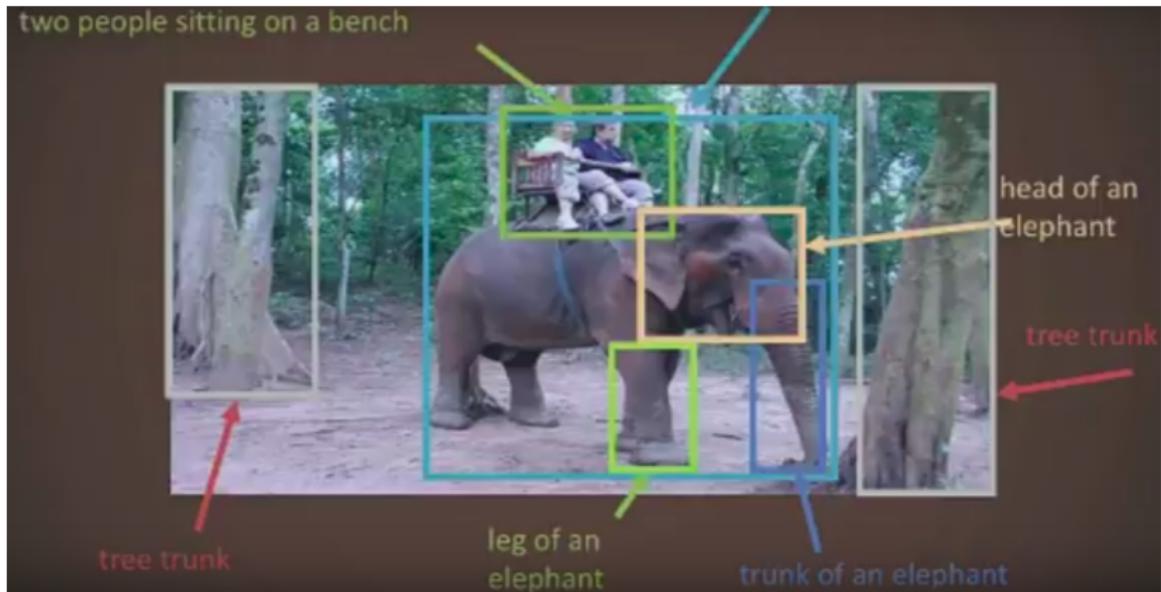


Brain Imaging MRI



Vital Images Inc.

Scene understanding

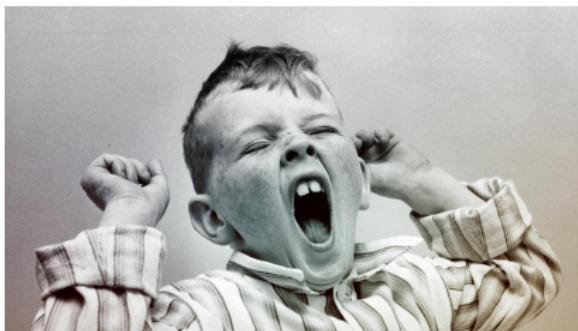


Some conclusions ⁴

- ▶ Computer Vision is a challenging and exciting field
- ▶ Applied to many real world situations
- ▶ Tremendous progress in the last two decades thanks to the combination with machine learning
- ▶ **There is still work to be done... the scene understanding is almost primitive!!**



Thank you for your attention ...



... It's time to wake up



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MACV 
Motion Analysis and Computer Vision

