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Artificial
Vision
Applications

Applications of Computer Vision

Manuel J. Marín-Jiménez

University of Córdoba (Spain)

Department of Computing and Numerical Analysis

e-mail: mjmarin@uco.es

Where do I come from?

- University of Córdoba (Spain)

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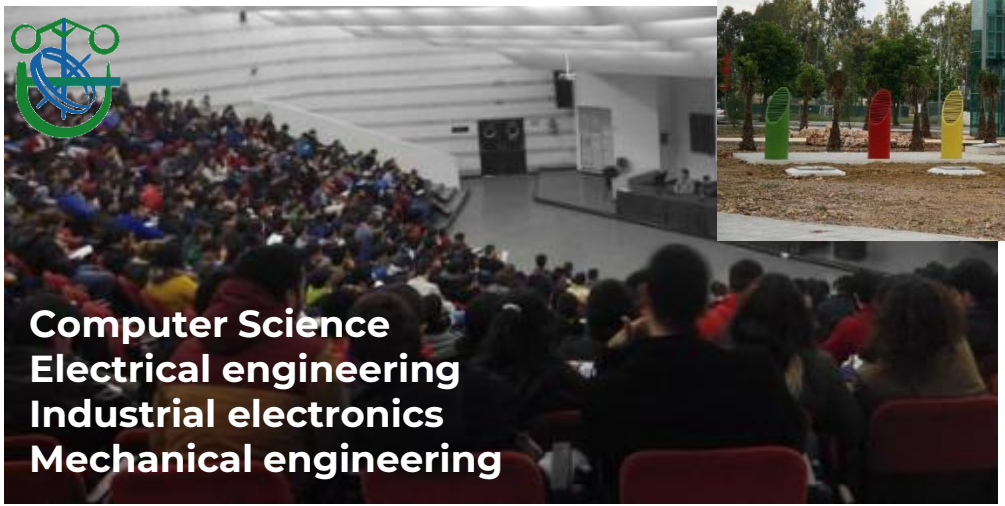
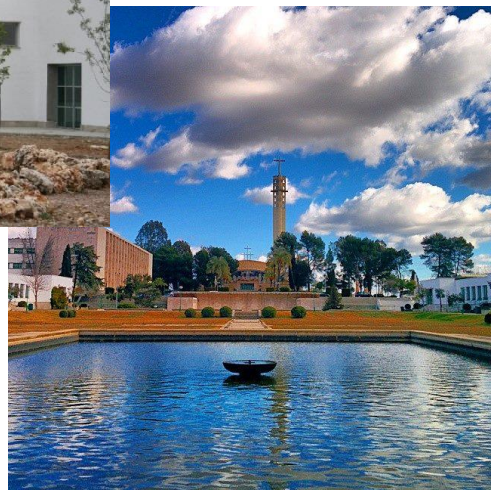
- **Polytechnic School** of the University of Córdoba (Spain)





Who am I?

- Research group: **Artificial Vision Applications (AVA)**
  - 7 permanent Professors
  - 6 PhD students
  - 1 Postdoc
  - +undergrad students

Overview

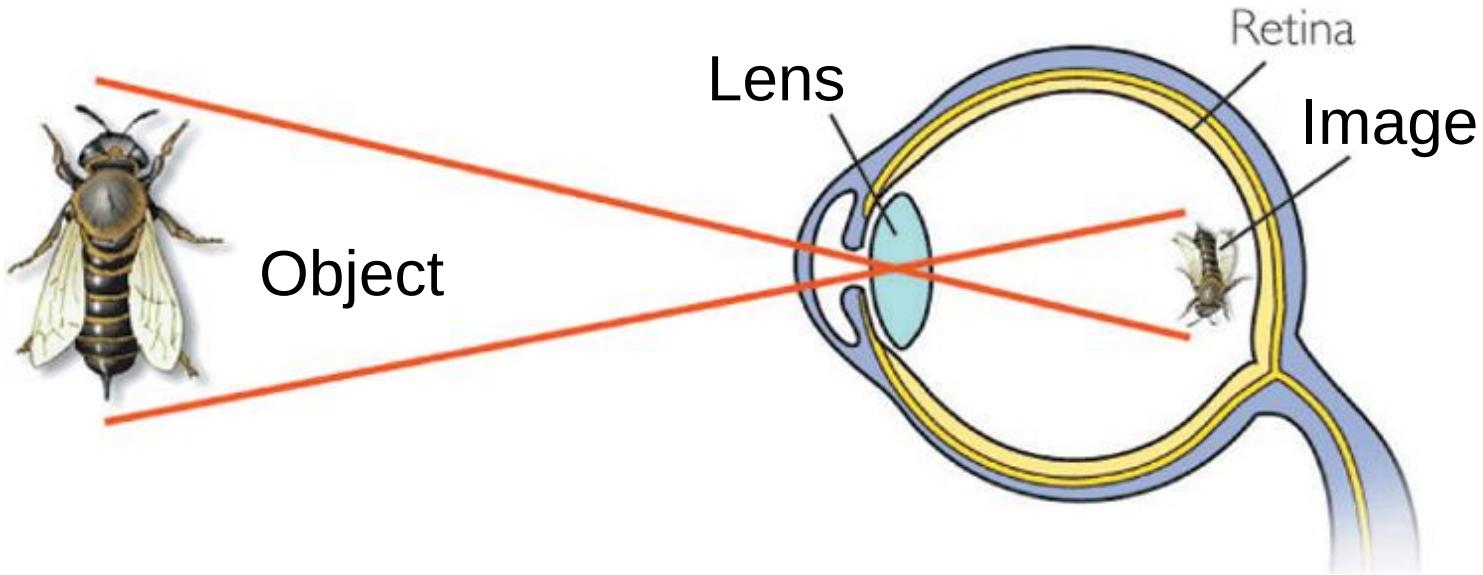
- ***Introduction to photography***
- **Digital Images**
- **Computer Vision concept**
- **Fields of applications**
- **Project RehApp**
- **Concluding remarks**

Introduction to photography

- **Photo**: visual representation (2D, flat) of a scene (3D)

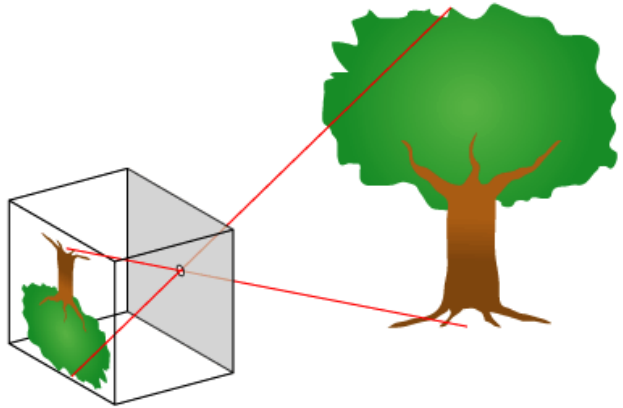
The human eye

- Our brain understands the inverted image



Camera projection: pinhole model

- From 3D world to 2D images: **light** enters through a **tiny hole** → inverted image



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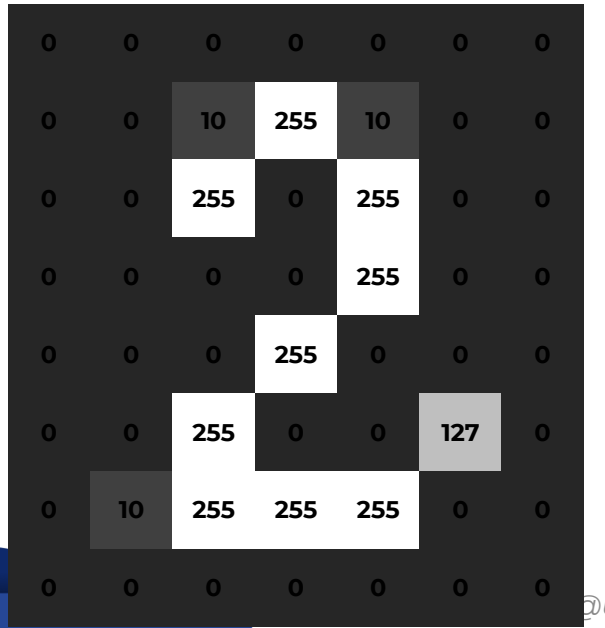
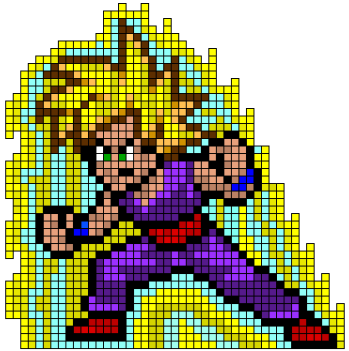
Digital images

- Image = matrix with integer values
  - Colour = tuple (**R**, **G**, **B**)



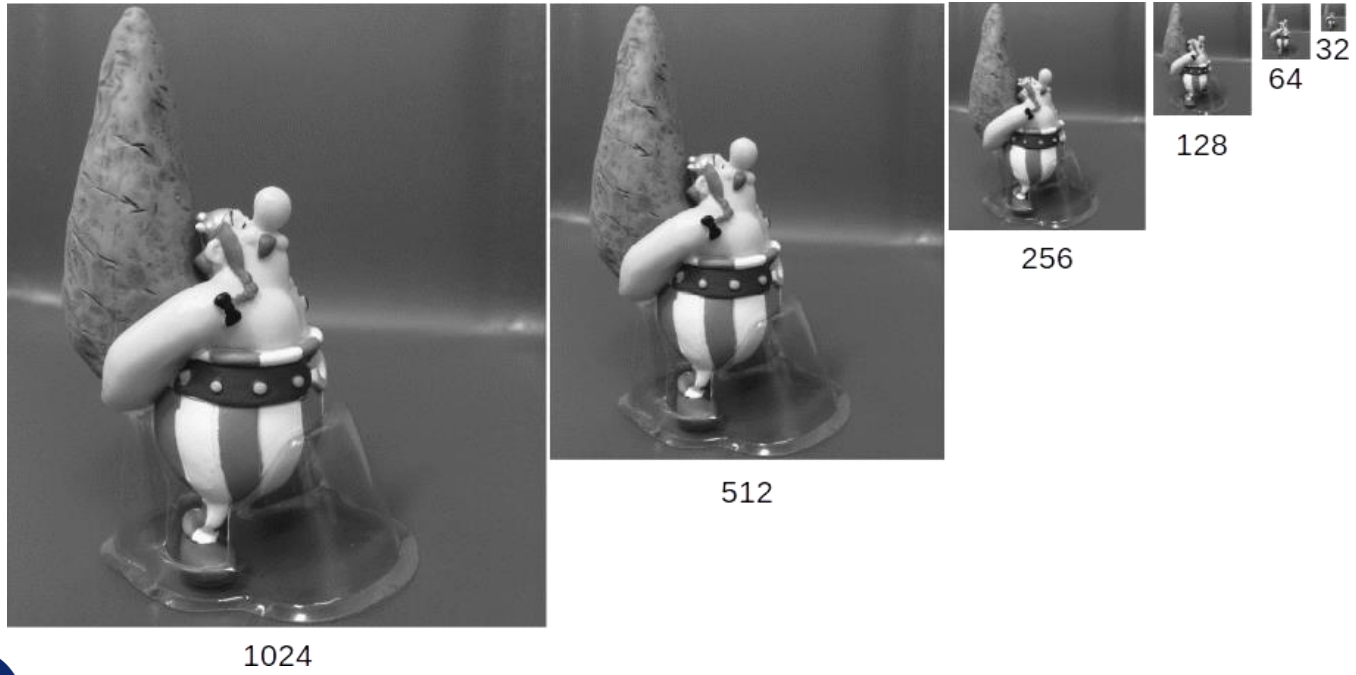
0	0	0	0	0	0	0
0	0	10	255	10	0	0
0	0	255	0	255	0	0
0	0	0	0	255	0	0
0	0	0	255	0	0	0
0	0	255	0	0	127	0
0	10	255	255	255	0	0
0	0	0	0	0	0	0



Pixel intensities

Image resolution

- How many pixels?



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Computer Vision

- Wikipedia says: **scientific discipline** that includes methods for acquiring, processing, analyzing and **understanding** real-world **images** [...] that **computers can perceive** and **understand** an image or sequence of images and act [...].

Computer Vision: is it easy?

- Humans spend much time with **eyes open**

- Human perception → **5 senses**
  - Sight (**Vision**)
  - Hearing (Audition)
  - Touch (Somatosensation)
  - Taste (Gustation)
  - Smell (Olfaction)

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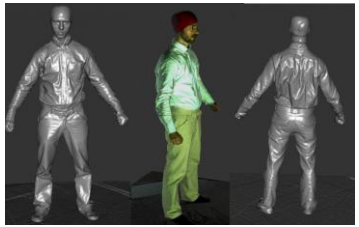
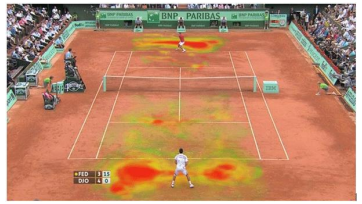
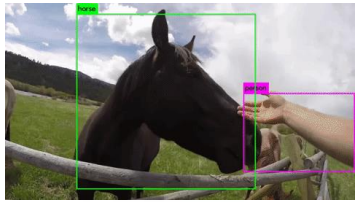
Applications

- Model objects or environments (robots)
- Recognizing actions and people (security)
- Sports
- Automatic industrial inspection
- Medicine
- Help to identify species/classes
- Organizing images and videos (search)
- Human-machine interaction (entertainment)
- Content generation

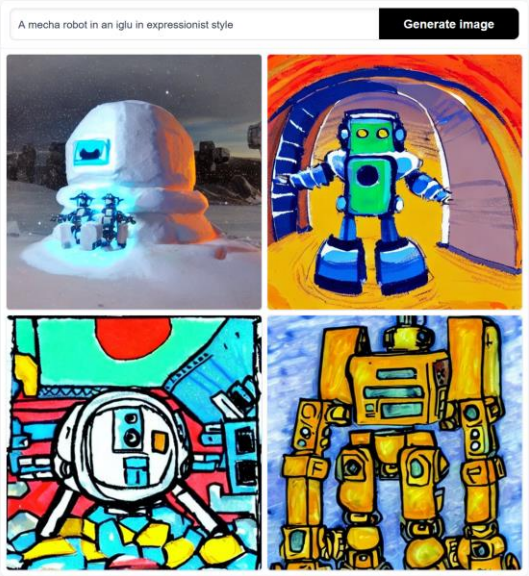






Trendy application: Vision and Language

- Dall-E, Stable Diffusion, Midjourney, ...



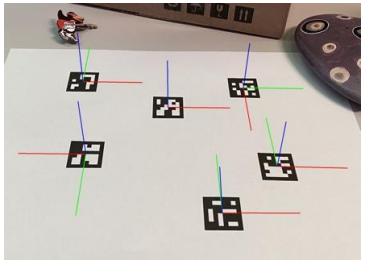
Trendy application: Vision and Language

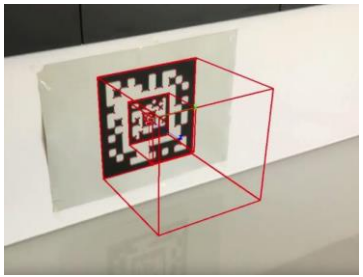
Apophenia

Made with Bing Image Creator

AVA Research lines: ArUco markers

- Camera pose estimation → e.g. Augmented Reality





AVA Research lines: human action analysis

- Actions and interactions


Image: Friends


Image: Stranger Things

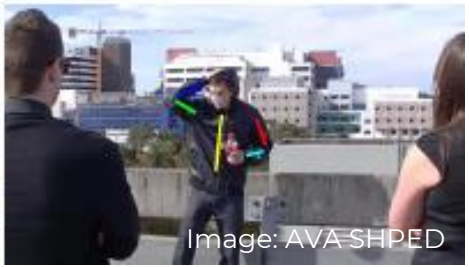


Image: AVA-SHPED

AVA Research lines: Biometrics (gait)

I'll identify you by the way you walk

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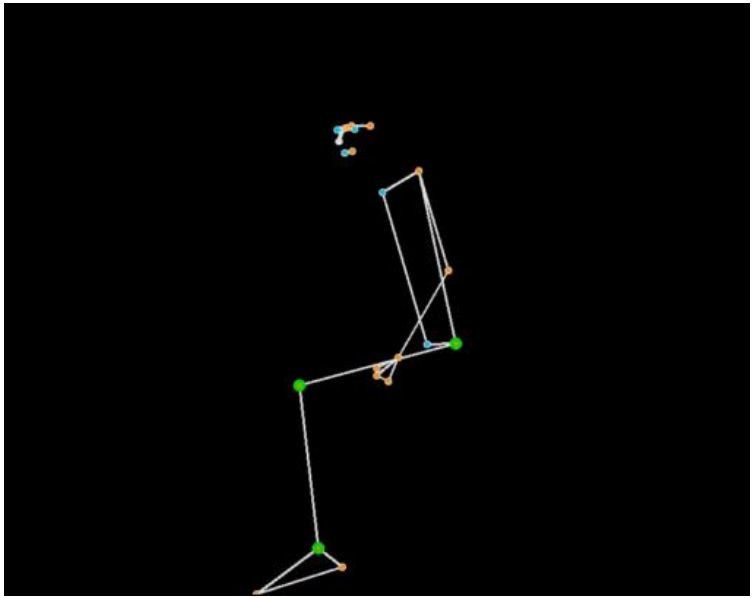
Project: RehApp

Total knee prosthesis implantation → common intervention in orthopedic surgery

- Home exercise plan
- Essential to recover mobility
- If not daily or incorrect exercises → possible problem
- Performing exercises → hard task, pain
- High number of intervened patients → difficult follow up

Project: RehApp

- Help to perform **rehabilitation** exercises **at home**



Project: RehApp

Objectives:

- **Personalized** analysis patient evolution → from home (no travel), own **smartphone**
- Quantify degree of **mobility** → mobile camera + AI
- Detect problems early during recovery → **early care**

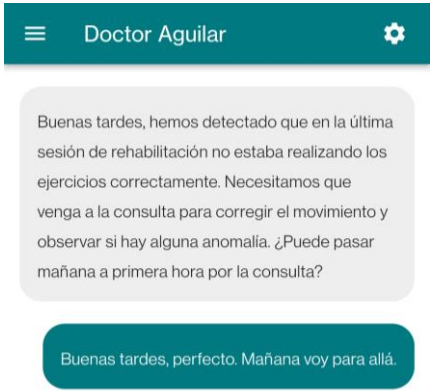
Project RehApp: solution

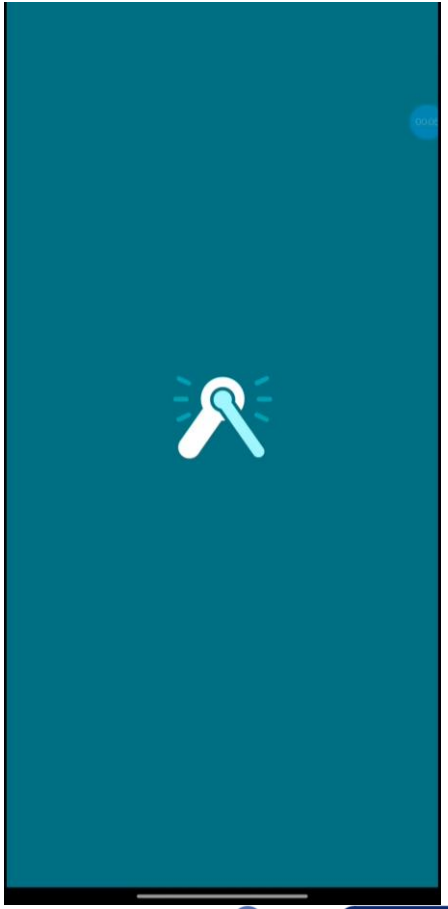
- ✓ **Web** receives and processes data → only access **medical doctor**

- ✓ **App** records videos → used by **patient**

Project RehApp: app

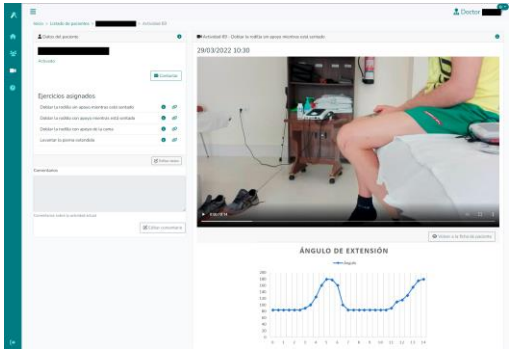
- ✓ List of exercises
- ✓ Videos and text for assistance
- ✓ Records and sends sessions
- ✓ Private chat with medical doctor

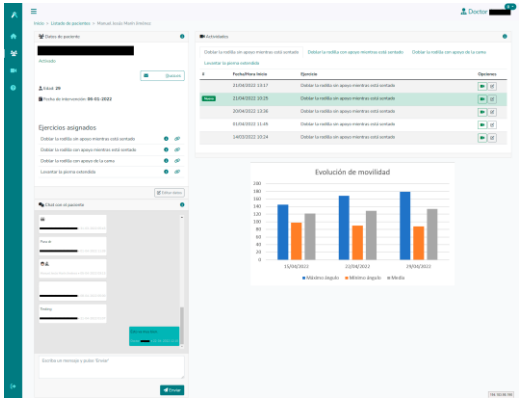




Project RehApp: website

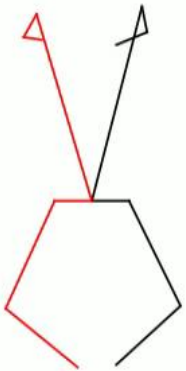
- ✓ Sign up of patients
- ✓ Customize exercises per patient
- ✓ Visualize videos and add private notes
- ✓ Send private messages to patients
- ✓ Tracking of mobility evolution

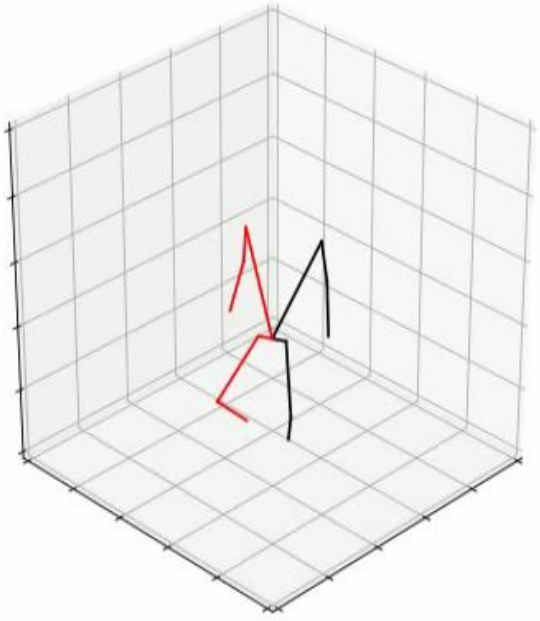




Project RehApp: skeletons 2D & 3D

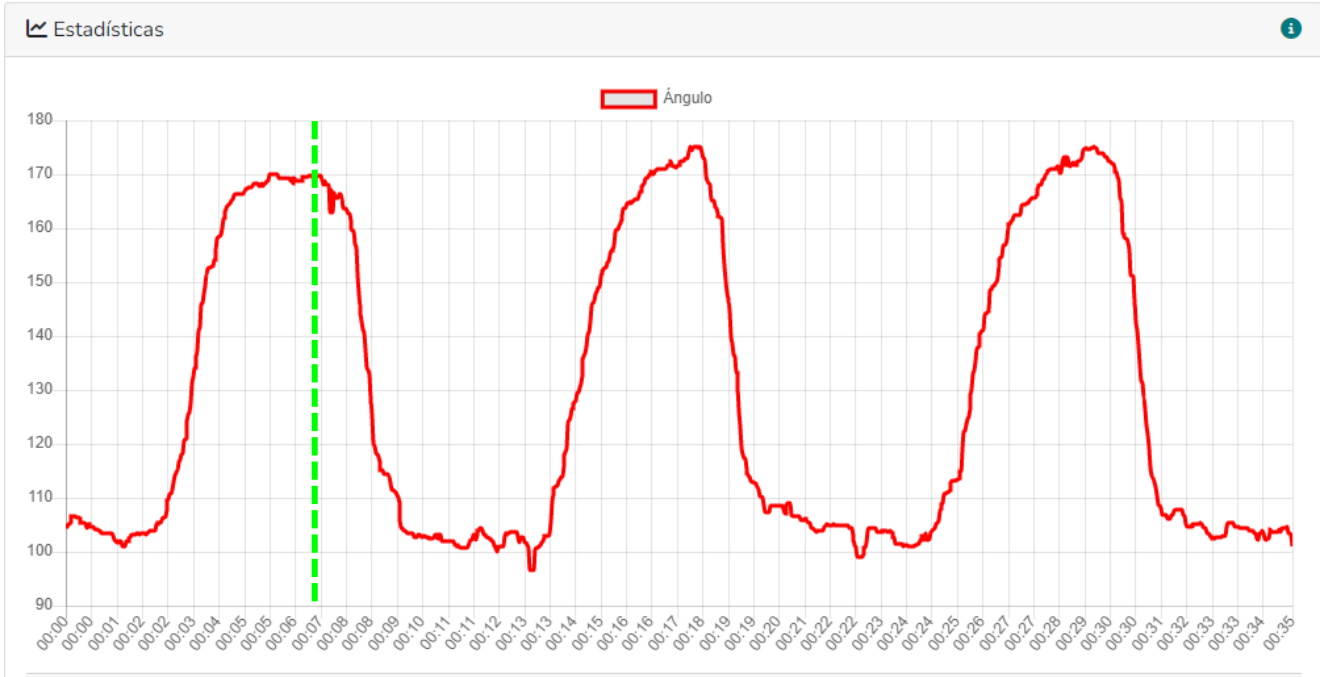
✓ Computer Vision → **H**uman **P**ose **E**stimation





Project RehApp: example

✓ Flexion angle → repetitions



Project RehApp: dataset

- ✓ Not limited to knees

(a) (b) (c) (d)

(e) (f) (g) (h)

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Take-home messages

- Computer Vision has arrived to help us
- Many applications benefit from Computer Vision
- Human-centric video analysis
- Aids physical rehabilitation

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e-mail: mjmarin@uco.es

Twitter: @ucoava