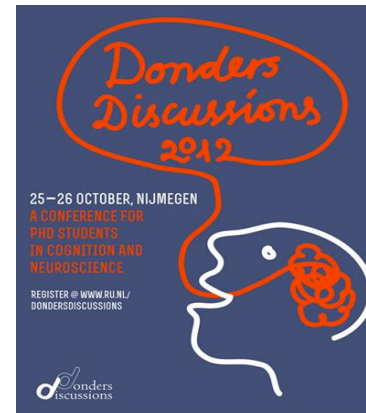# Automatic Behaviour Analysis for supporting ADHD Diagnose

Miguel Ángel Bautista[1,2], Antonio-Hernández Vela[1,2], Oriol Pujol [1,2], Laura Igual [1,2], Verónica Violant[4], Josep Moya[3], Sergio Escalera[1,2]

[1]*Dept. Applied Mathematics and Analysis, Universitat de Barcelona*
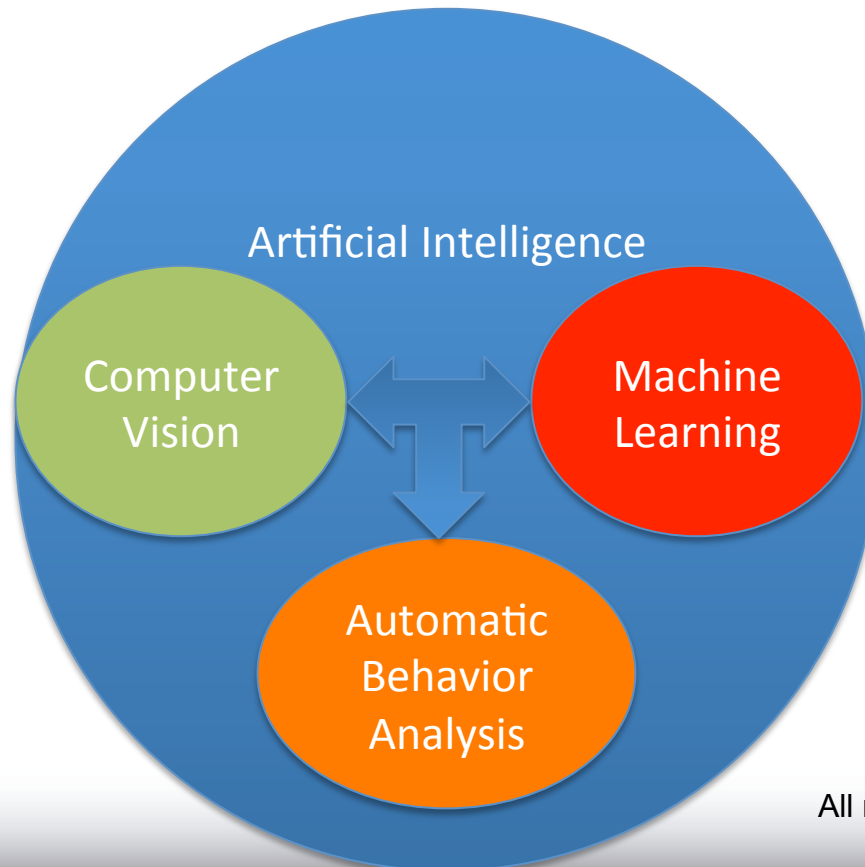[2]*Computer Vision Center*
[3]*Corporació Parc Taulí*
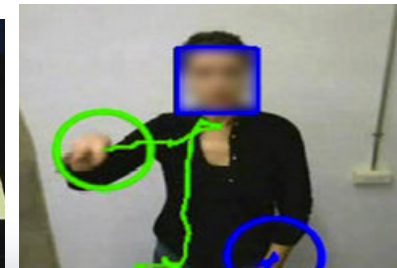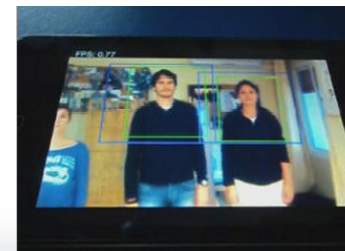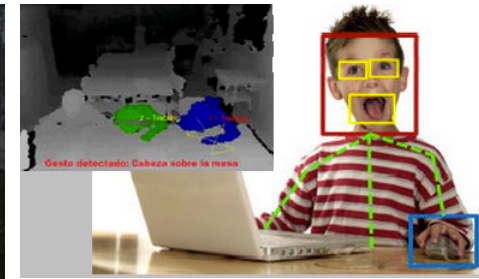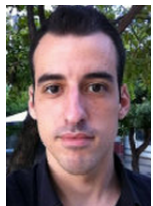[4]*Dept. Neonatal Psychology, Universitat de Barcelona*

Outline

- **A global perspective of Automatic Human Behavior Analysis.**
  - How is Human Behavior Analysis applicable to ADHD?

- **Automatic Behavior Analysis methodology for ADHD diagnose support:**
  - Video sequences.
  - Indicator symptoms (DSM IV & CIE-X).
  - ADHD indicator symptoms database.
  - Feature extraction from data (Bag of Visual and Depth Words).
  - Learning to detect indicators (Multi-instance Dynamic Time Warping).

- **Experiments and preliminary results:**
  - Experimental Settings.
  - Visual results

- **Conclusions and Future work**

A global perspective of Automatic Human Behavior Analysis

- **Automatic Behavior Analysis** is a current hot topic in the Computer Vision and Machine Learning field.
- The primal goal is to develop a system that is able to **detect behavioral patterns from data (video stream)** and categorize those patterns within a certain behavioral class.

Artificial Intelligence

Computer Vision

Machine Learning

Automatic Behavior Analysis

HuPBA (Human Pose and Behavior Analysis Group)

- The **HupBA group** is composed by several Ph.D Students all in the field of **Computer Vision and Machine Learning**:

  - **Antonio Hernández- Vela** (Human Pose and Behavior Recognition)
  - **Miguel Reyes** (Human Pose Recognition for Physical recovery support)
  - **Victor Ponce** (Behavior Analysis Recognition for higher social analysis)
  - **Albert Clapés** (Human Behavior Recognition for Human-Computer Interaction)
  - **Xavier Pérez** (Human Behavior Recognition applied in Social Robotics)
  - **Miguel Ángel Bautista** (Multi-class classification and its application in Human Behaviour Recognition)
 - **Dr. Sergio Escalera** (The boss ☺)

- ADHD is a problem **with inattentiveness, over-activity, impulsivity, or a combination**. For these problems to be diagnosed as ADHD, they must be out of the normal range for a child's age and development.

Gesto detectado: Cabeza sobre la mesa

- **Lack of attention** (inattentiveness)
- **Hyperactivity**
- **Impulsive behavior** (impulsivity)

- Some problems are that a Doctor only has available a short period of time to diagnose the subject in-situ and diagnose is mainly perform by tests and questionnaires.

- We **provide support to the diagnose by automatically detecting (in video sequences) the symptoms** that fall in the major classes (inattentiveness, hyperactivity, impulsivity).

Automatic Behavior Analysis methodology for ADHD diagnose support
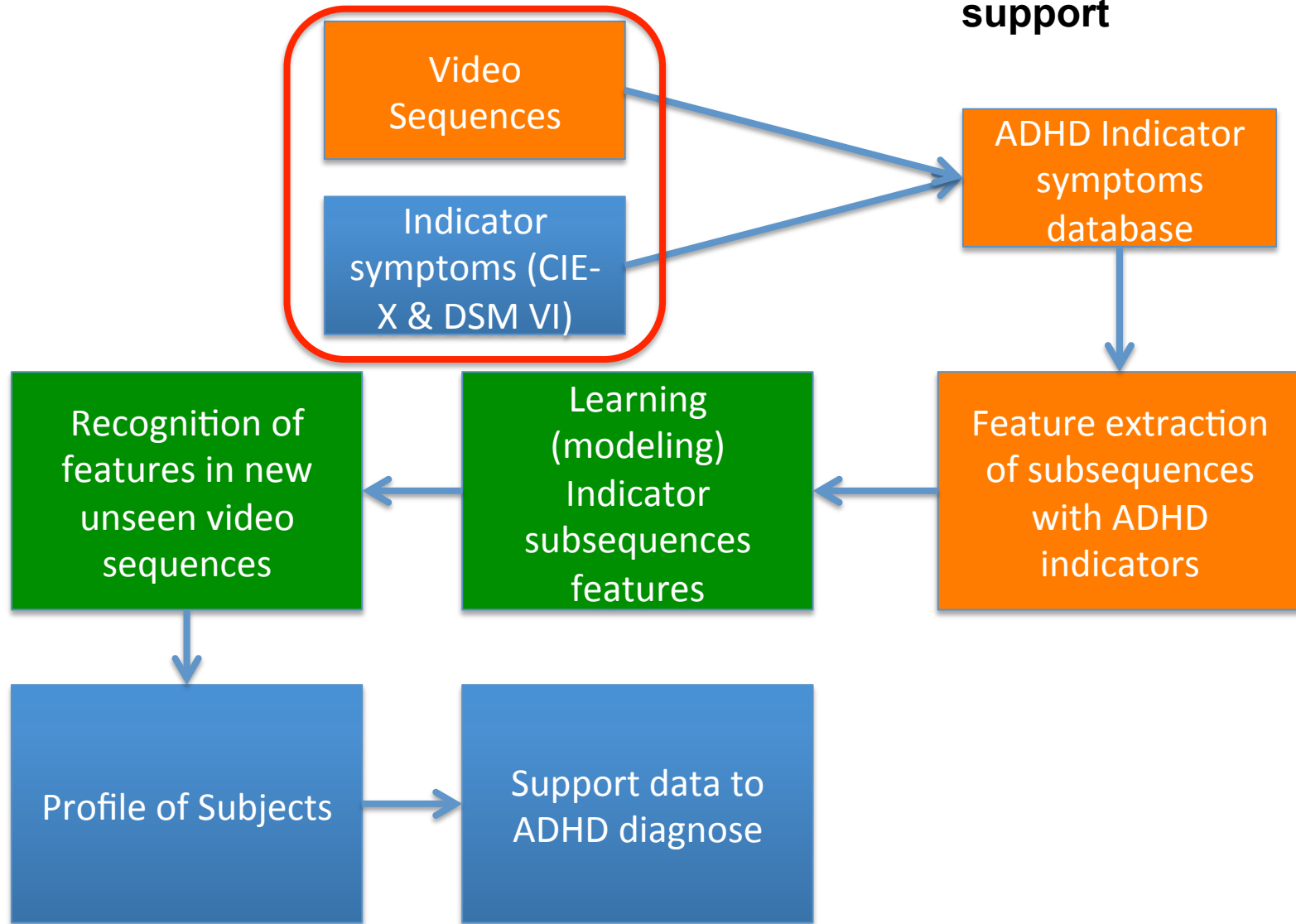
Video sequences

- The data collected is **a set of 17 video sequences** that are classified in two groups:
    - Video sequences of **subjects diagnosed with ADHD**.
    - Video sequences of **subjects not diagnose with ADHD**.
- Both types of subjects were recorded in **two diferent scenarios**:
    - **Playing a computer game**.
    - **Performing school work**.
- All subjects were recorded with a **Kinect® camera** that is able to obtain both a **RGB data and Depth information**.

Indicator symptoms (DSM-IV & CIE-X)

- A **selection of indicator symptoms** was performed in order to obtain an **objective and discriminative** selection of those symptoms that **could be automatically detected**.

- The final **indicator symptoms that are learned** by the system and its able to recognize are the following:

  - Turn Head
  - Torso in table
  - Classmate space invasion
  - Continuous activity change
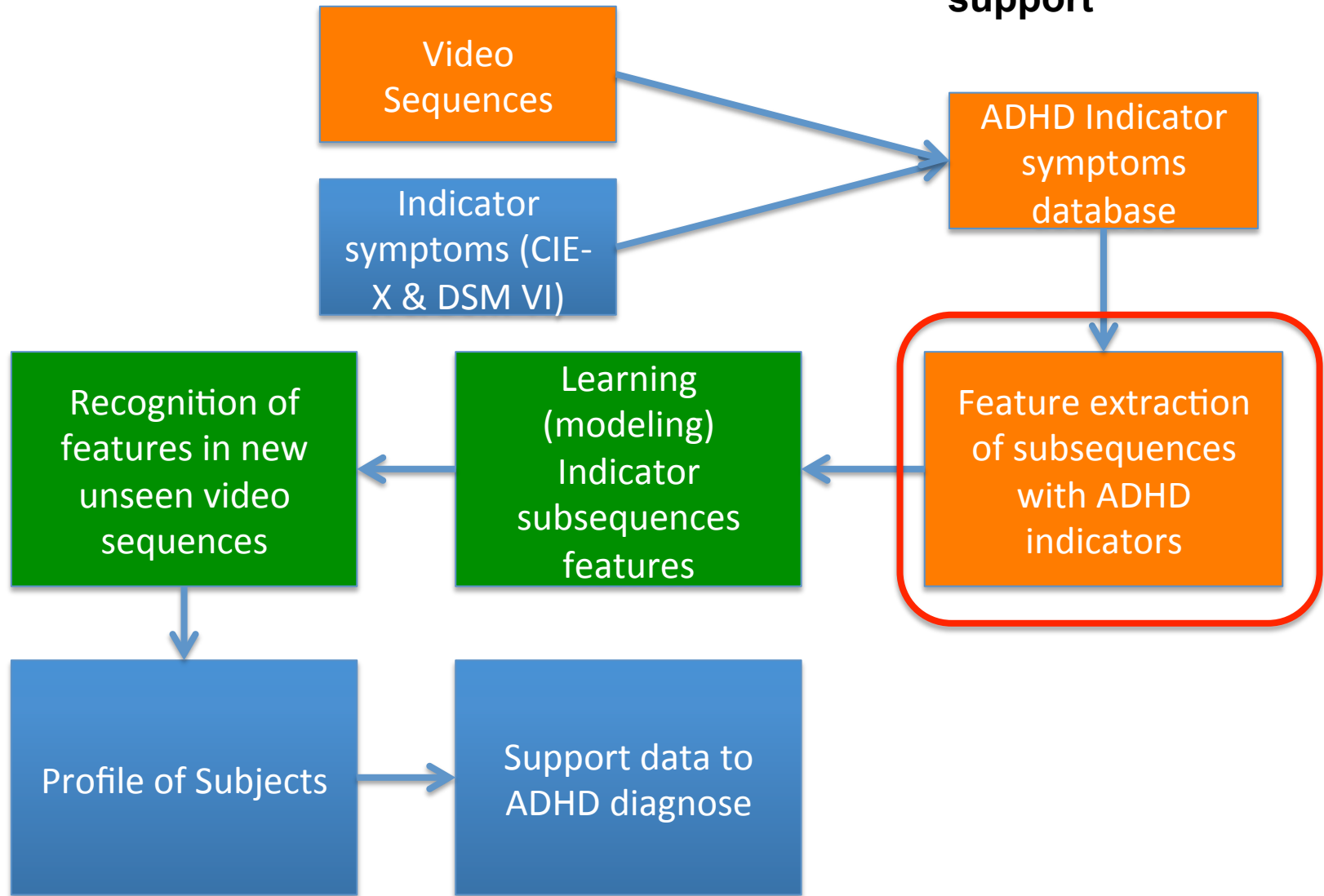 - Non repetitive movement
  - Movement in chair

Automatic Behavior Analysis methodology for ADHD diagnose support
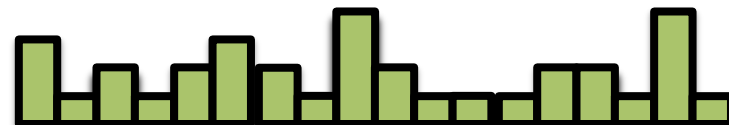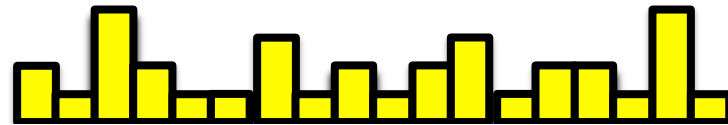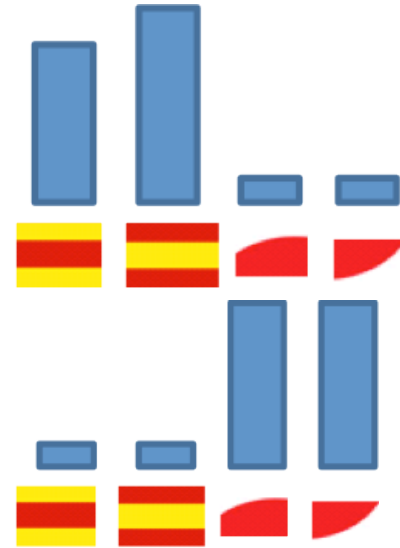
ADHD indicator symptoms database
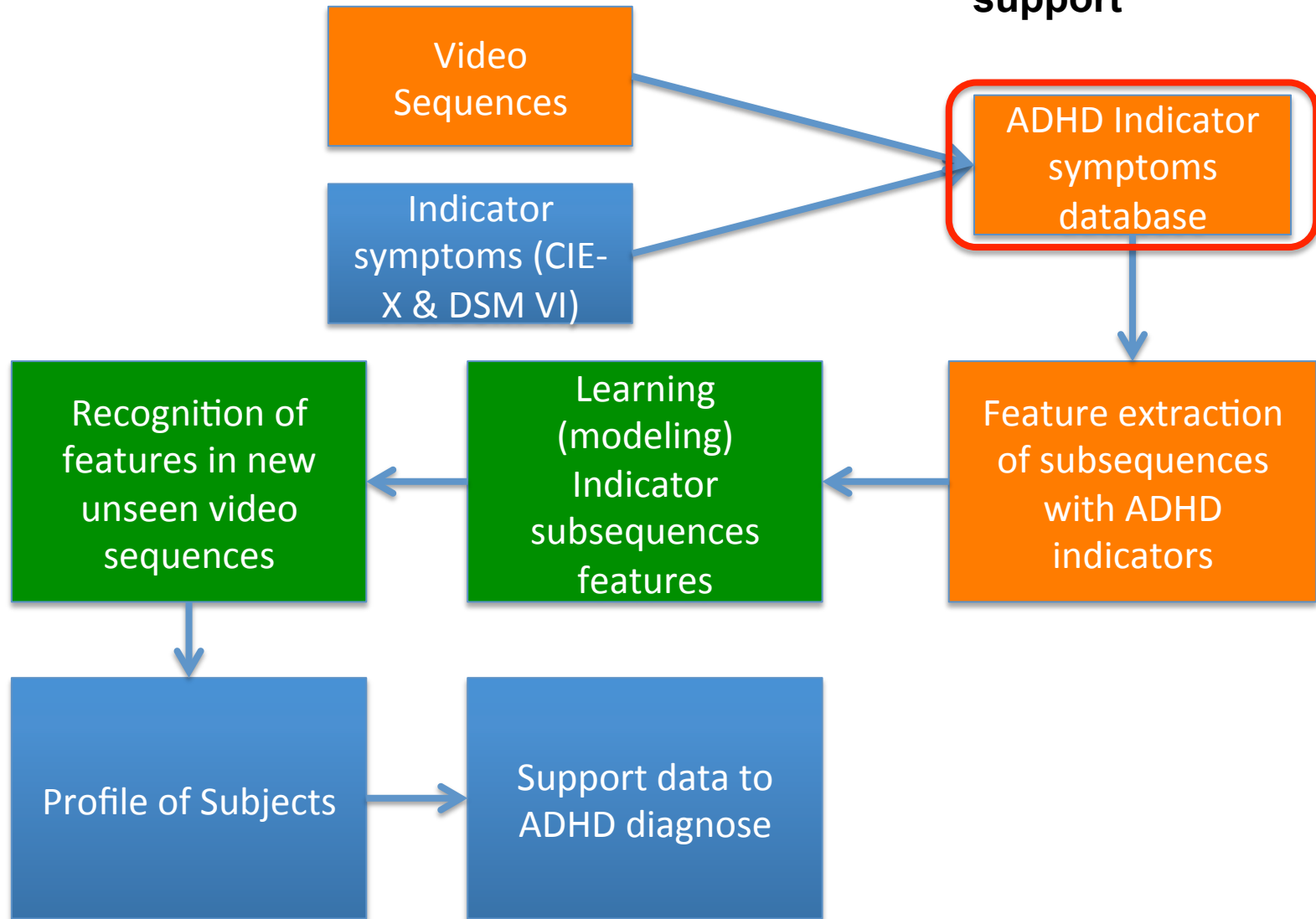
- The **17 video sequences were manually labelled** with the indicators symptoms previously shown.

- This task was performed by **two independent observers** obtaining a mean coefficient of agreement (Cohen's Kappa) of **0.93**.

- Each video sequence was labelled N times (one time per each subject appearing in the sequence).

- Time windows when **disturbing events took place were ignored** when labelling the sequences.
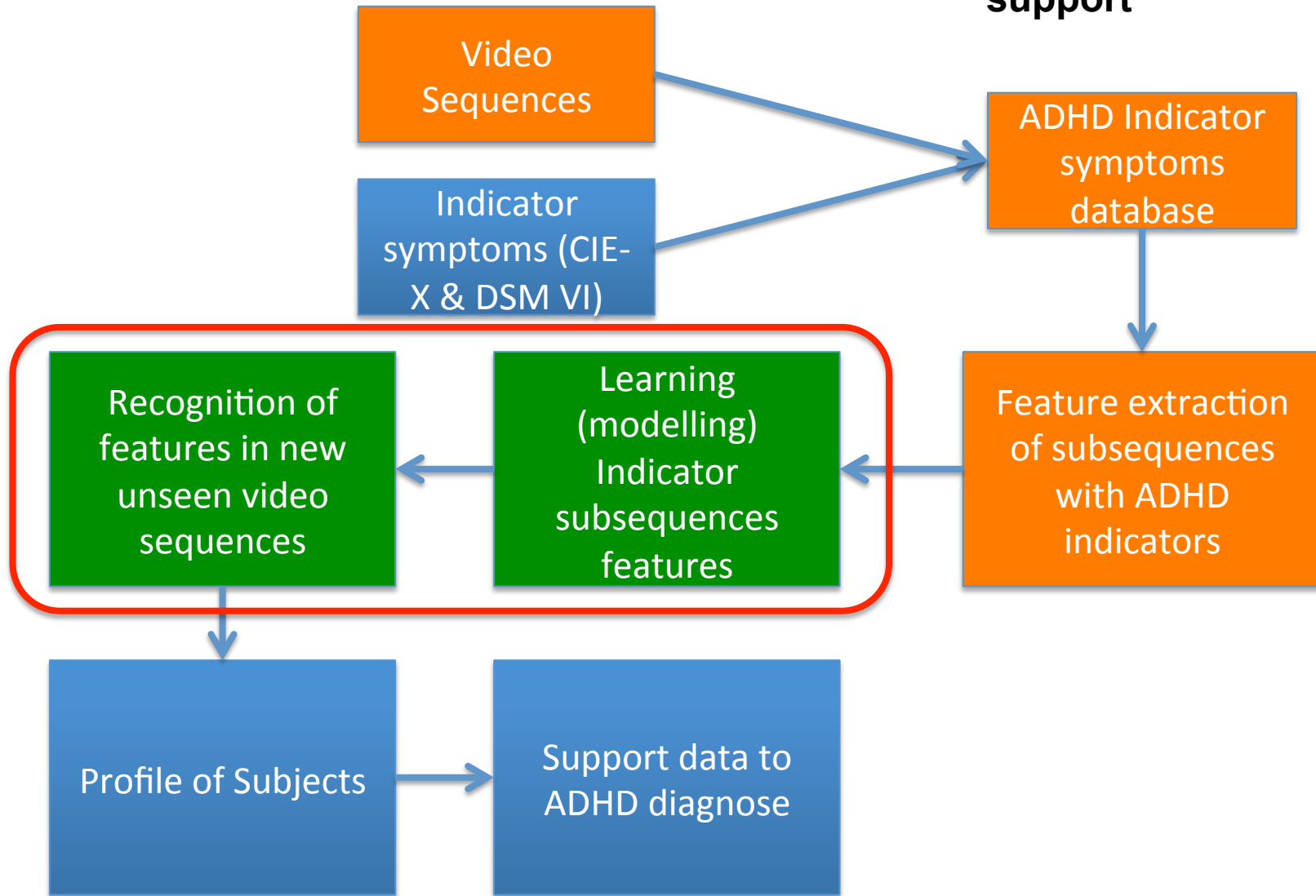
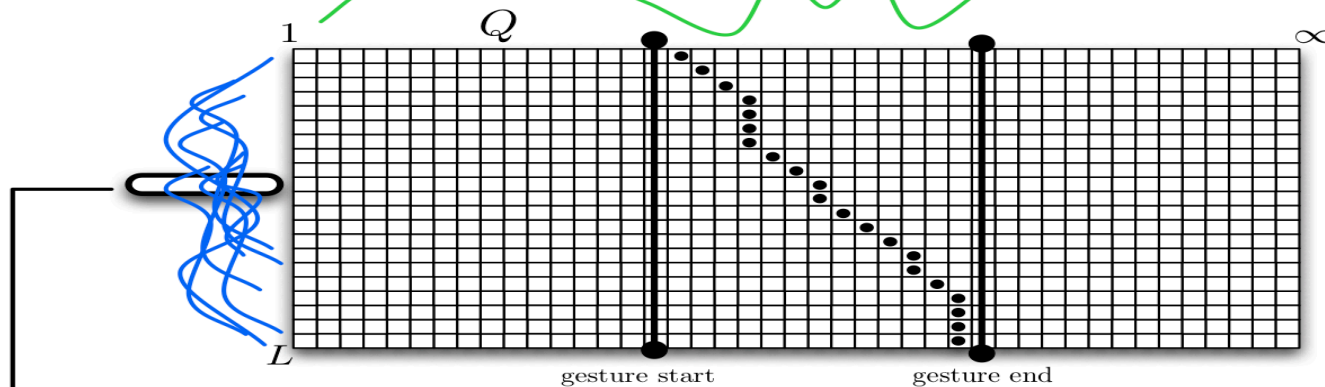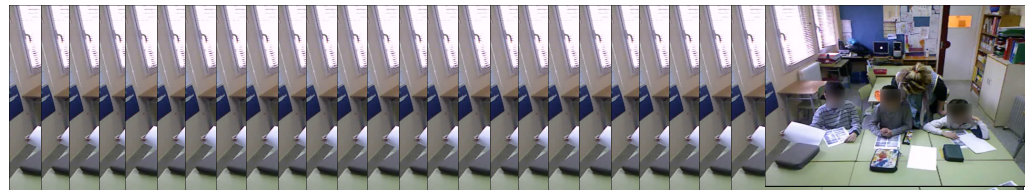# Automatic Behavior Analysis methodology for ADHD diagnose support

Video Sequences

Indicator symptoms (CIE-X & DSM VI)

ADHD Indicator symptoms database

Feature extraction of subsequences with ADHD indicators

Learning (modeling) Indicator subsequences features

Recognition of features in new unseen video sequences

Profile of Subjects

Support data to ADHD diagnose

Feature extraction from data (Bag of Visual and Depth Words - BoVDW)

Automatic Behavior Analysis methodology for ADHD diagnose support

Video Sequences

Indicator symptoms (CIE-X & DSM VI)

ADHD Indicator symptoms database

Feature extraction of subsequences with ADHD indicators

Learning (modelling) Indicator subsequences features

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Profile of Subjects

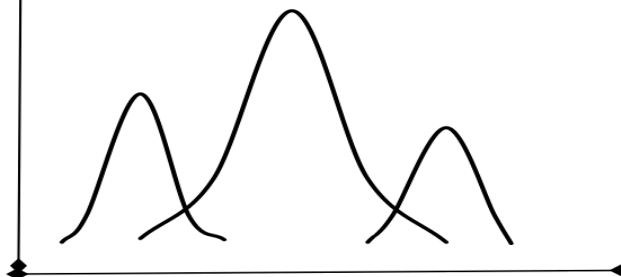**Support data to ADHD diagnose**

# Learning to detect indicators (Multi-instance Dynamic Time Warping)

$$\lambda_l$$
$$\{\omega_i^l, \mu_i^l, \Sigma_i^i\}, i \in [1, 2, 3]$$

- Our final goal is to test the **recognition rate** of our system in the 17 sequences that compose the database.

- The **indicators that the system learns** are the previously shown:

  - Turn Head
  - Torso in table
  - Classmate space invasion
  - Continuous activity change
  - Non repetitive movement
  - Movement in chair

- We use the **overlapping metric**:
  - Overlapping= predicted frames/(predicted frames + ground truth frames)

- For now, we can only provide with **preliminar results,** we shown examples on **Torso in table and Turn head** indicators.

- Example : Torso in table
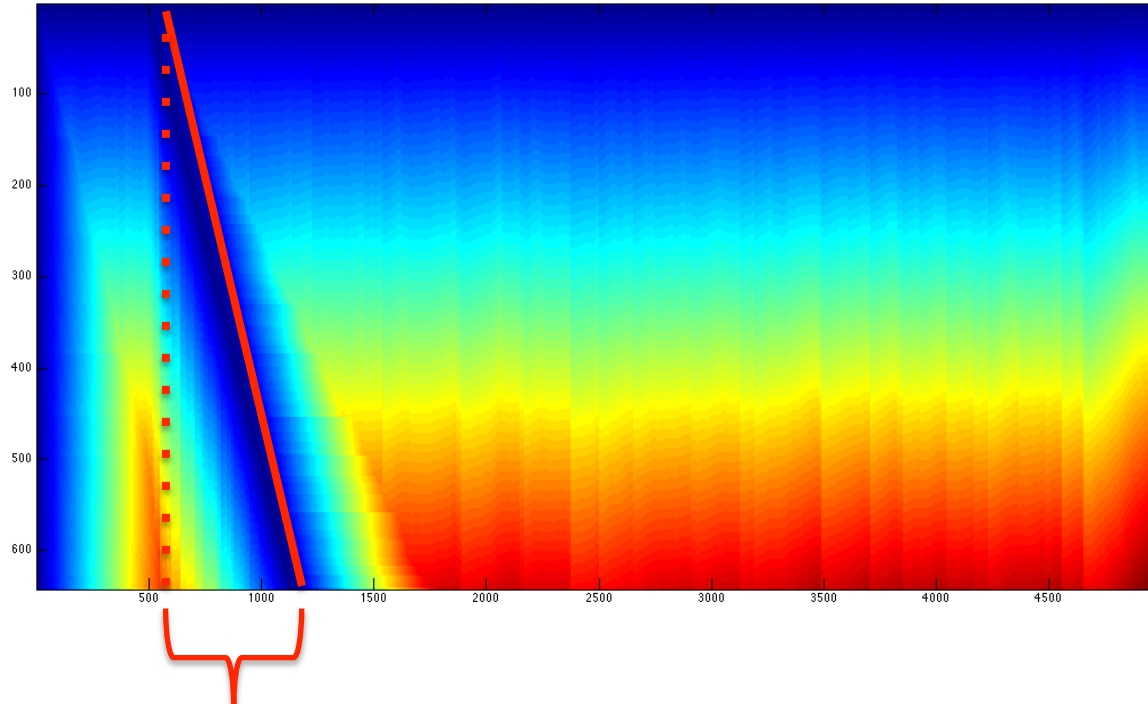
- Example : Turn Head
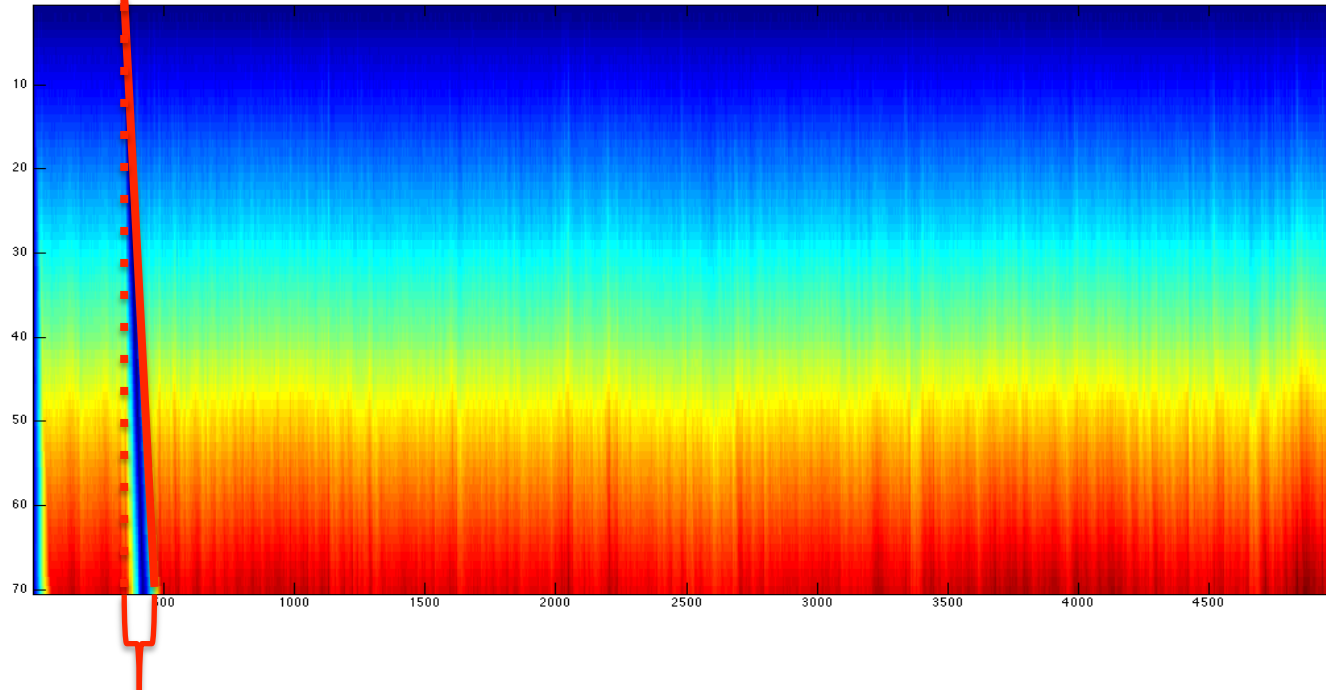
- We have presented a **novel methodology and a preliminar experiment** of Automatic Behavior Analysis for **ADHD diagnose support**.

- Results encourage the use of **BoVDW and DTW** to tackle the recognition of Indicator symptoms of ADHD in video sequences.

- Although this is only a preliminar study, at this very moment we are finishing the experiments of a final version that will soon be published.

- Future work lines deal with a multimodal diagnose procedure using **Multi-modal Human Behavior Analysis, MRI, Genetic factors, etc.**
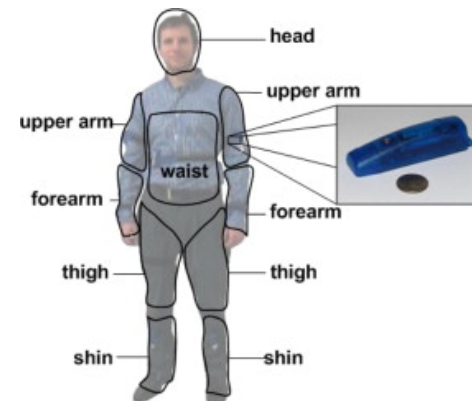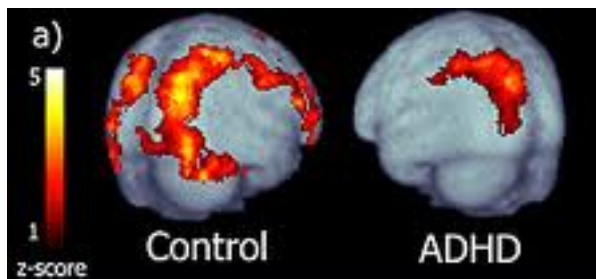
Automatic Behaviour Analysis for supporting ADHD Diagnose
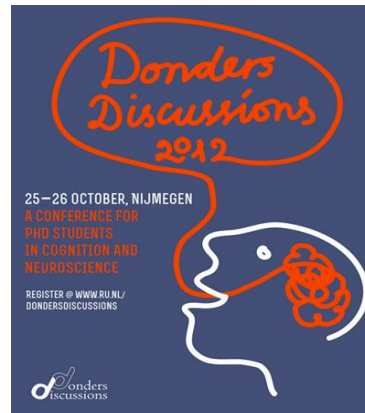
THANKS!!! ☺
QUESTIONS ?

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