

# Gait Recognition with Wii Balance Board

Biometric Systems Course

Professor De Marsico Maria



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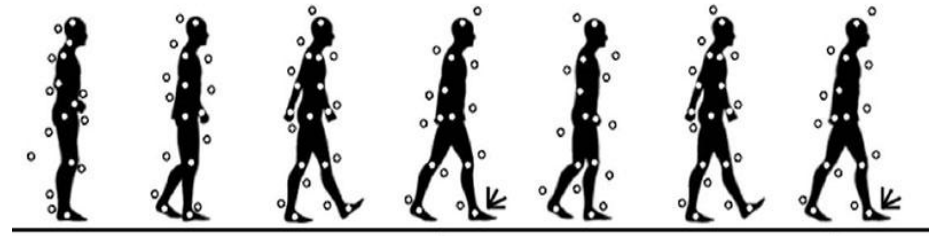
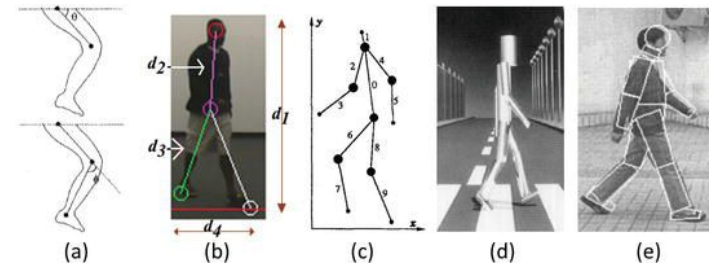
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## Introduction

- Why Gait Recognition?
  - Soft biometric trait
  - Lack of permanence
  - High uniqueness
  - Both genotypic and behavioral
  
- Approaches
  - Floor sensor-based
  - Wearable sensor-based
  - Machine Vision-based
  - One more approach: *Wii Balance Board*





## Objective

- Use cheap and reliable hardware
- Hard to spoof system
- Build accurate gait recognition system

## Wii Balance Board and focus on the Hardware Sensors

- Videogame Wii Fit
  - Yoga, sport, games etc...
- Reliable sensors
  - Center of Pressure
- Cheap and Portable





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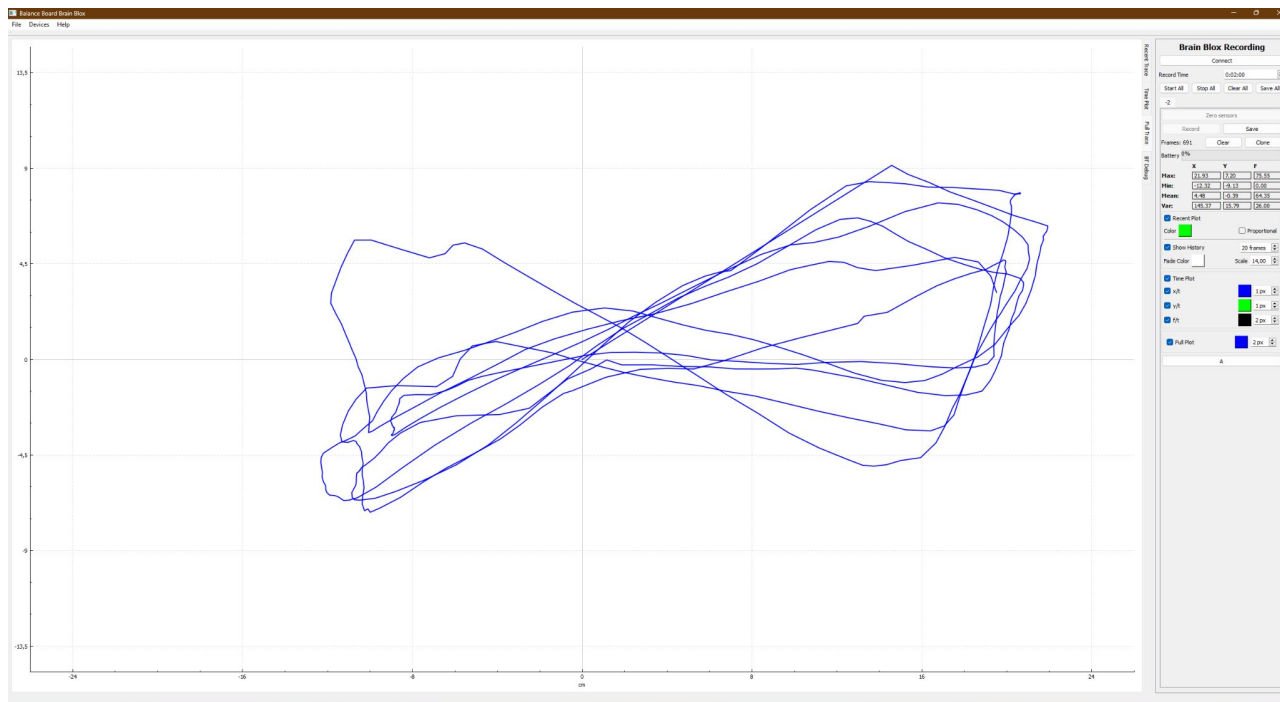
## Sampling





## Software and Acquisition Interface

- Sample acquisition interface: Brainblox
- Libraries: Scikit-learn, TsFresh

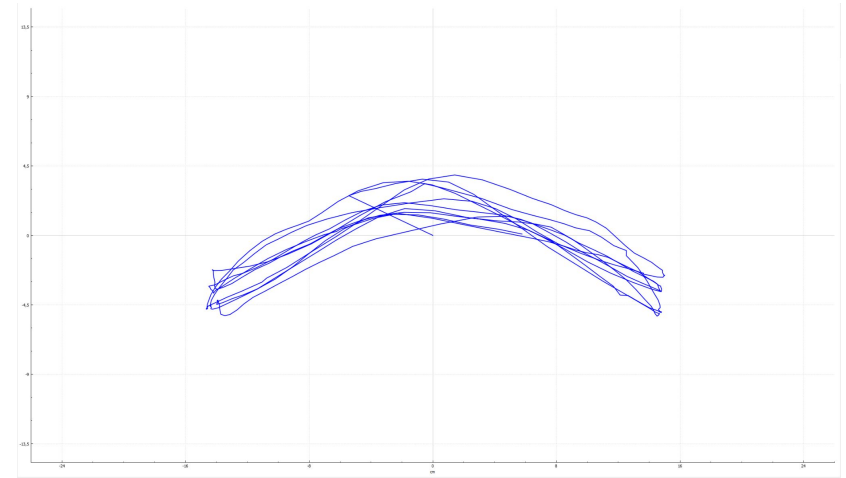


Gait from 66 years old woman



## Building the Dataset

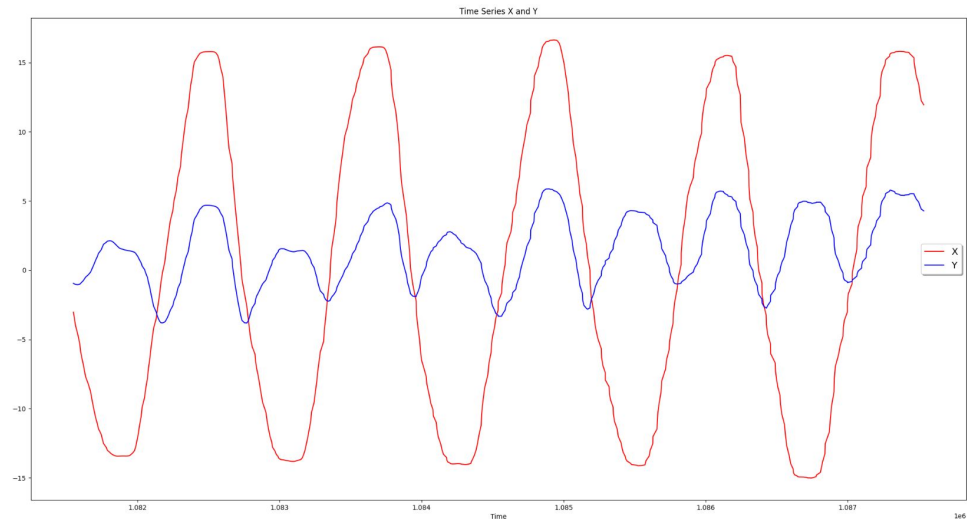
- Attended and controlled settings
- Ten footsteps starting with right foot
- 24 identities collected
  - 30 samples each
  - 720 templates
- Wide age range
  - 11 to 66 years old
- Different physical conditions
  - Workers, athletes, sedentaries people
  - Resting, average tired, tired



Gait from 26 years old gymnast

## Working with Time Series

- Computationally inexpensive
  - About 1 minute to extract features from 720 samples using parallelization
- Template size
  - About 30 Kb



Gait from 26 years old gymnast

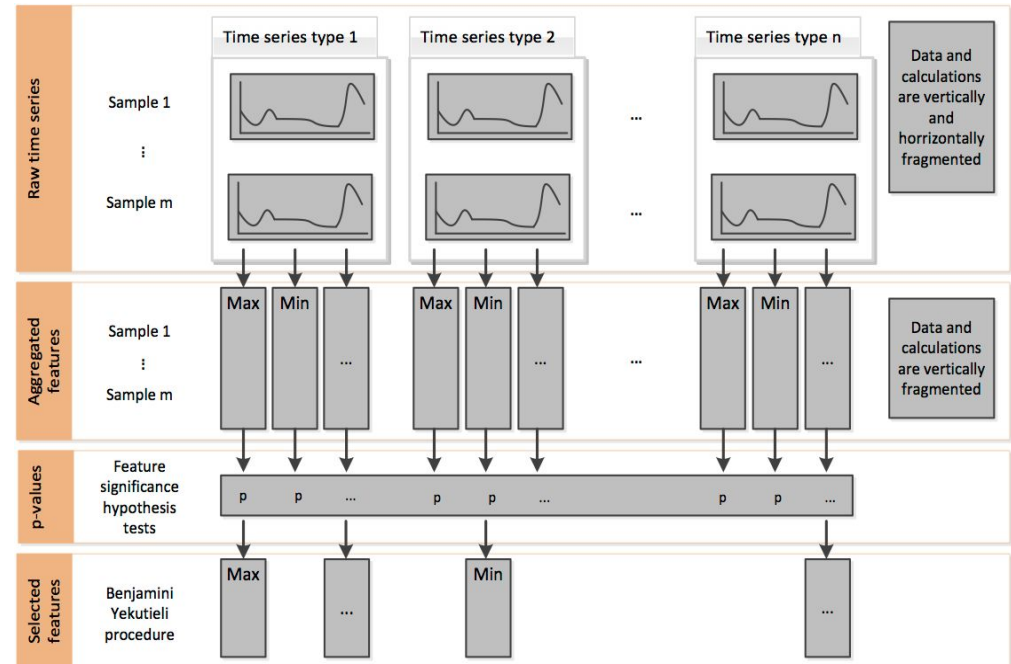


## Feature Extraction, Normalization and Filtering

- Feature Extraction
  - Provided by TsFresh
- MinMax features scaling
  - Provided by Scikit-learn

$$s'_k = \frac{s_k - \min}{\max - \min}$$

- Feature Selection
  - Provided by TsFresh



- Relevance Table
  - Provided by TsFresh
  - Selecting the k most relevant features



## Different Approaches

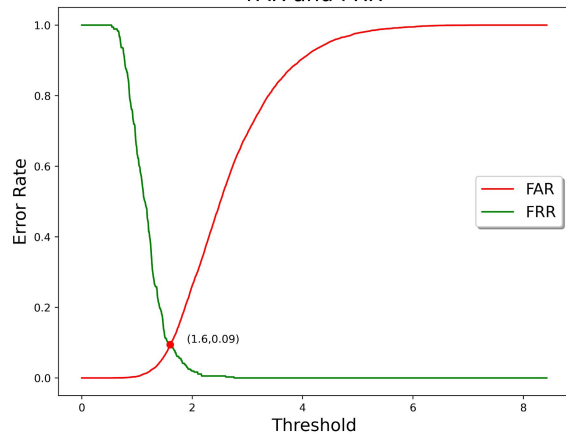
- Feature similarities
  - Pairwise feature vectors euclidean distance
  - Distance matrix
- Classification model training
  - SVM, Logistic Regression, KNN
  - Requires lots of data



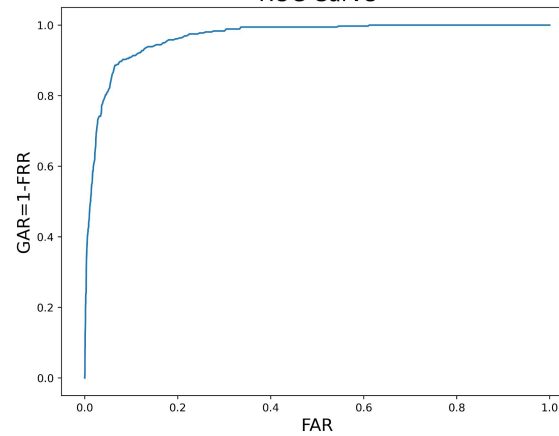
## Verification Performance Evaluation

- ALL-Against-ALL

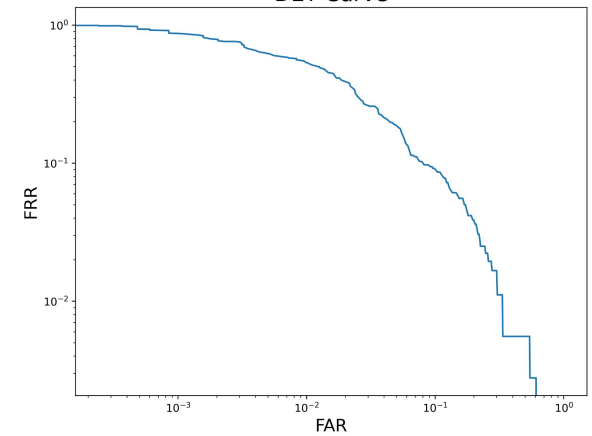
FAR and FRR



ROC Curve



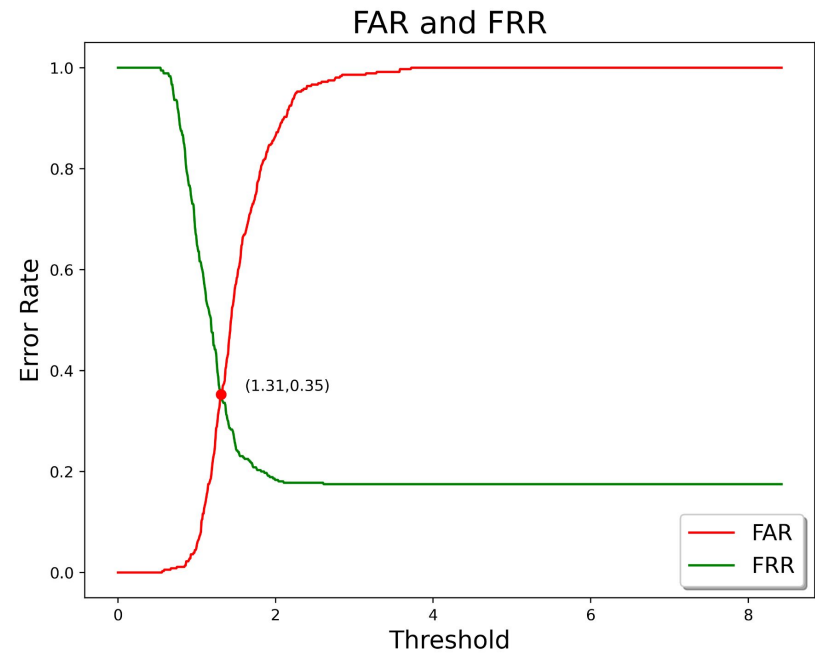
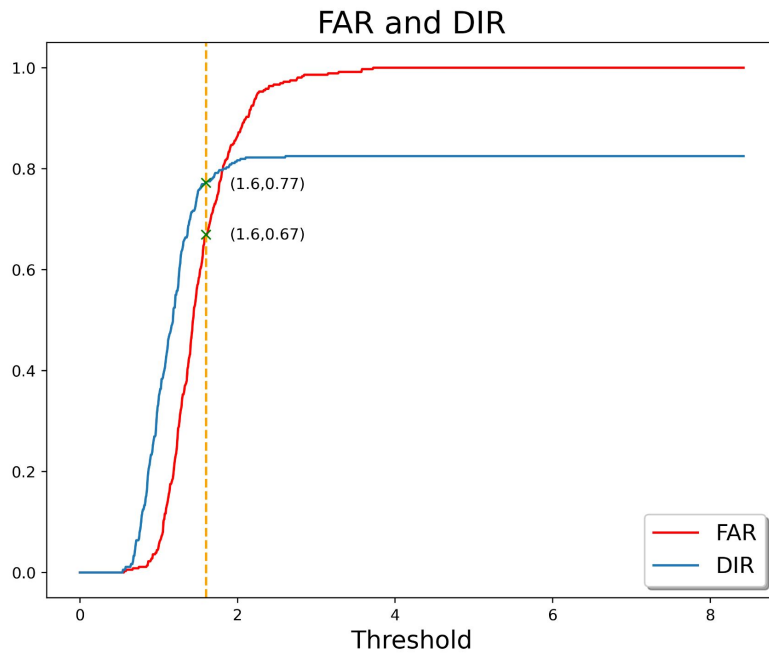
DET Curve





## Identification Performance Evaluation (1/3)

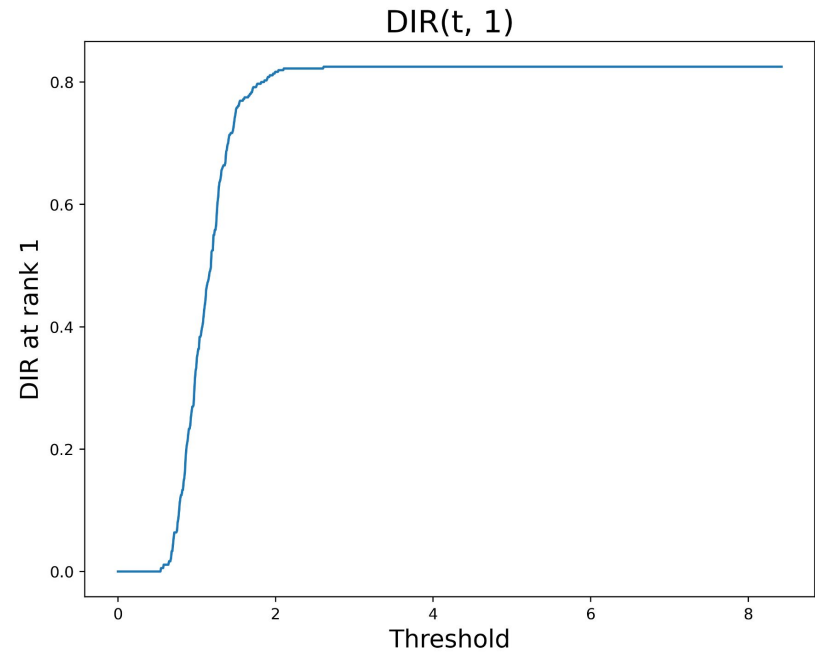
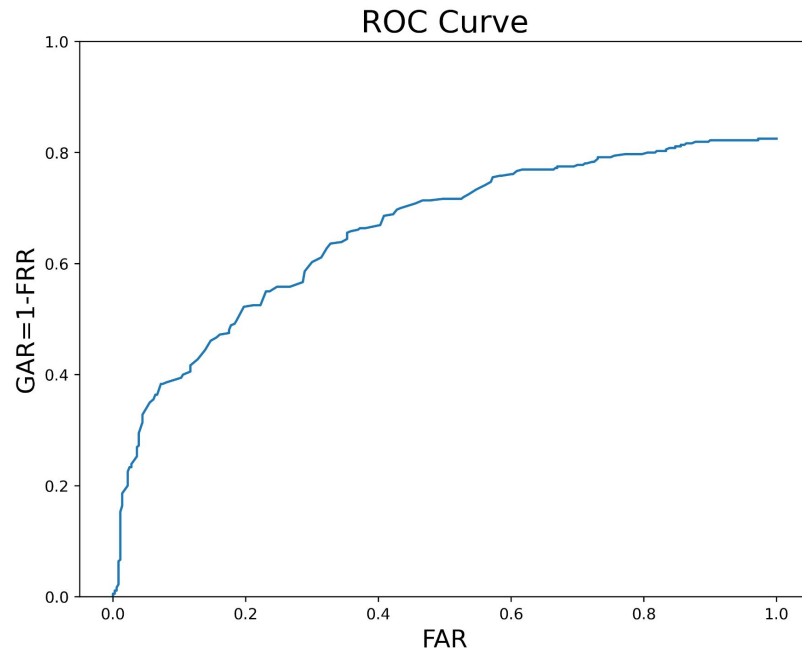
- ALL-Against-ALL
  - Open-set





## Identification Performance Evaluation (2/3)

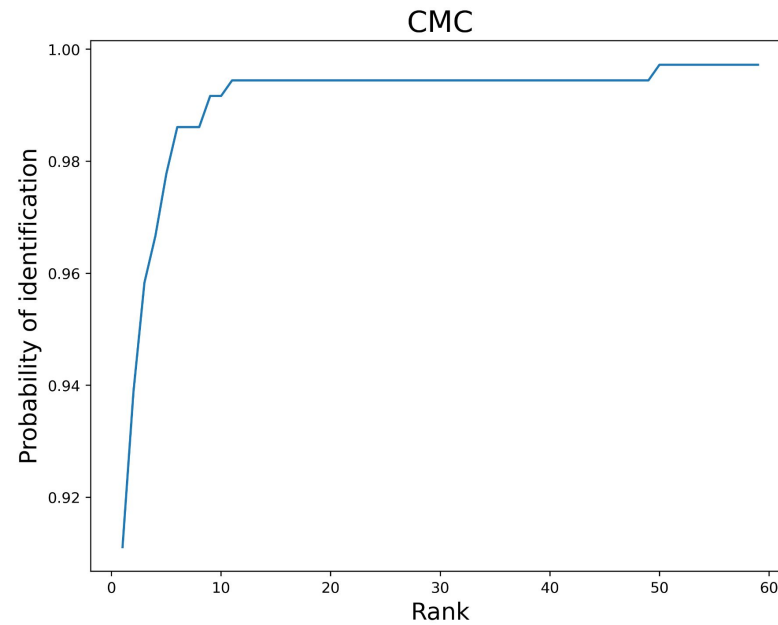
- ALL-Against-ALL
  - Open-set





## Identification Performance Evaluation (3/3)

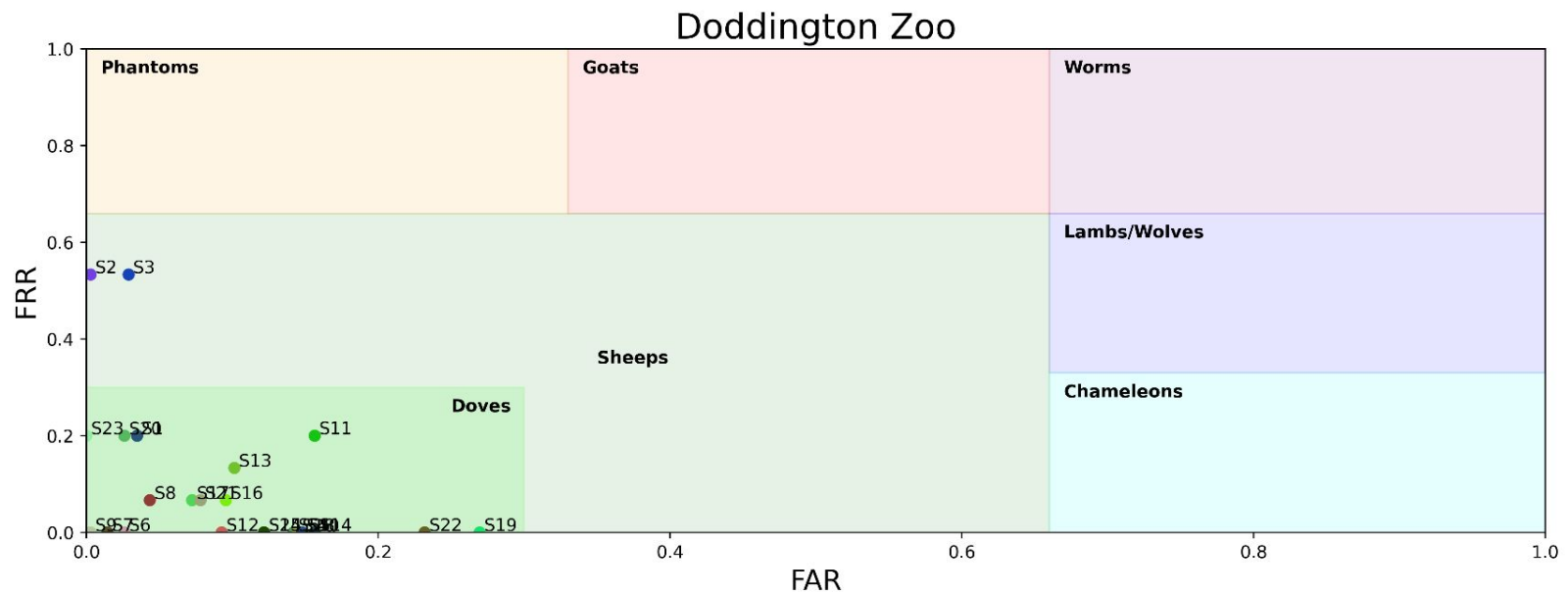
- ALL-Against-ALL
  - Closed-set





## Doddington Zoo

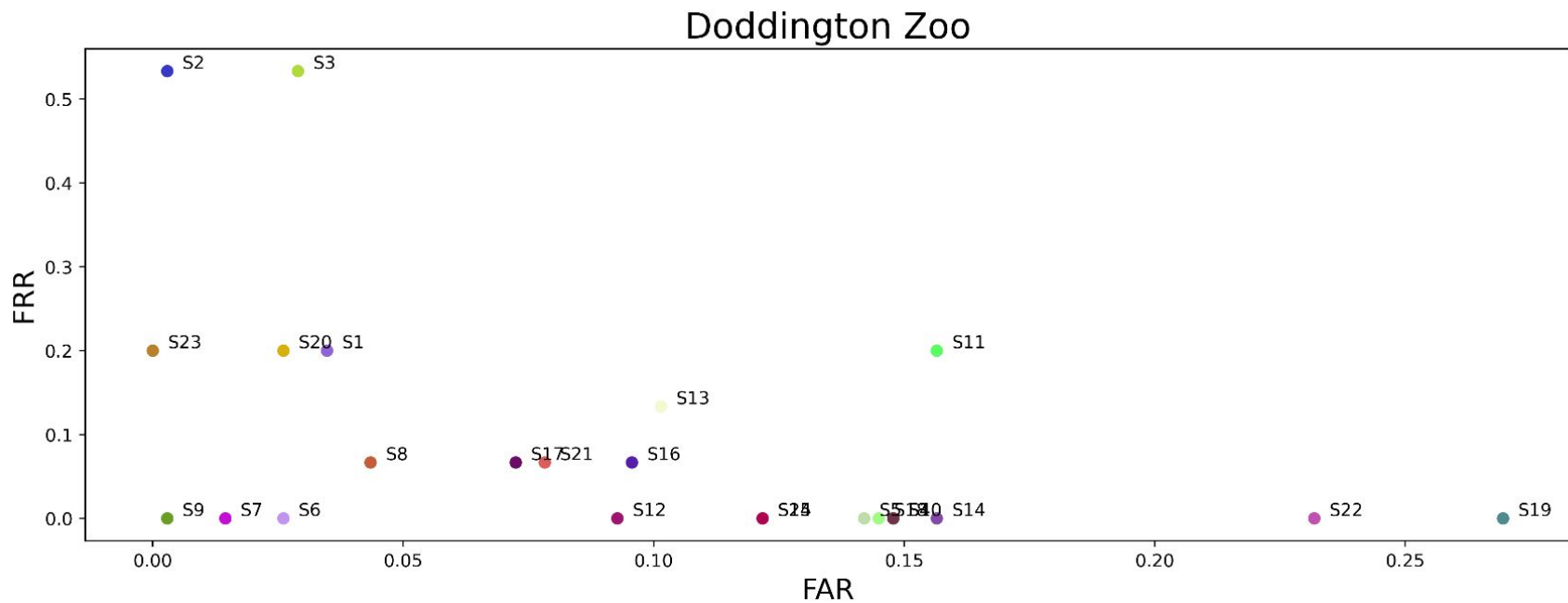
- Computed in verification





## Doddington Zoo (close up)

- Computed in verification







## Conclusion

- Pros
  - Hard to spoof
  - Computationally inexpensive
- Cons
  - Easy to camouflage
  - Attended and controlled settings
- Future Works:
  - Continuous samples acquisition via integrated WBB driver
  - Possible sensor addition and integration (Wiimote controllers)
  - Possible medical and sport use
  - “Smart Carpet”, a system that grants access to a public building, private office or home



Thank you for the attention!



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\*Thanks to the sample data volunteers

