UNIVERSITÀ DEGLI STUDI DI SASSARI
DIPARTIMENTO DI AGRARIA

PREDICTION OF BEHAVIOR ACTIVITY OF DONKEYS AT PASTURE USING DATA FROM A TRI-AXIAL ACCELEROMETER

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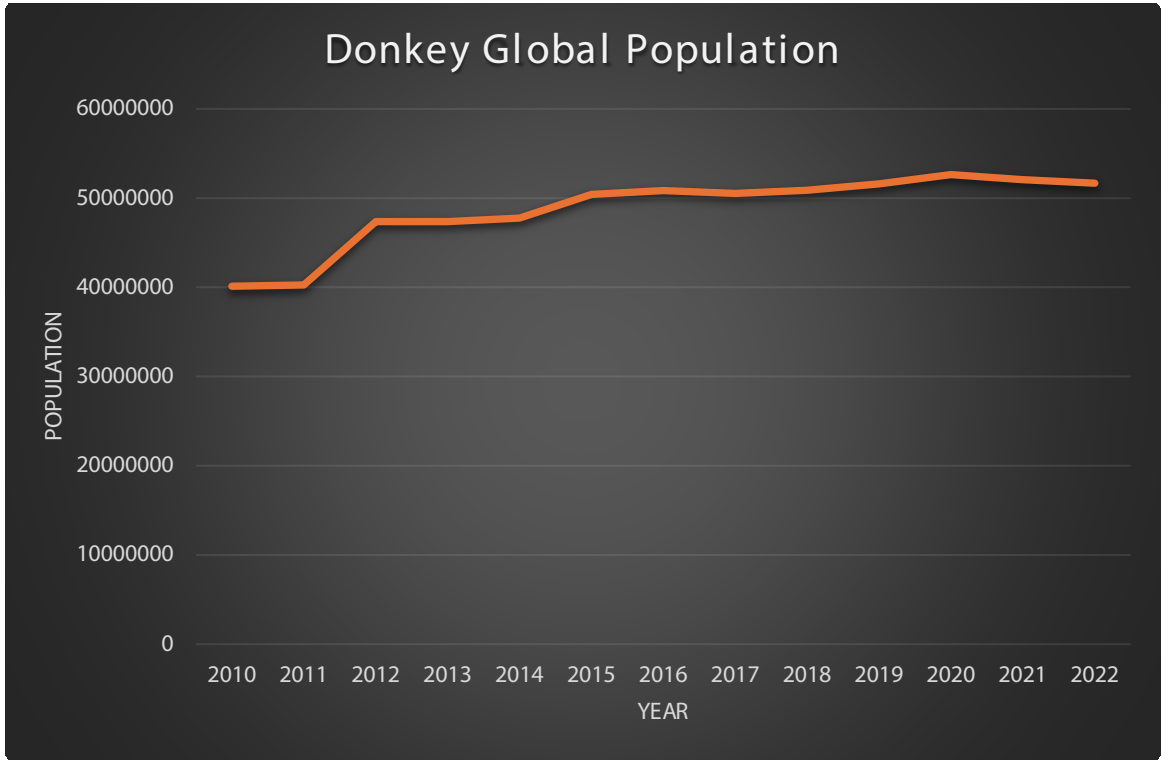
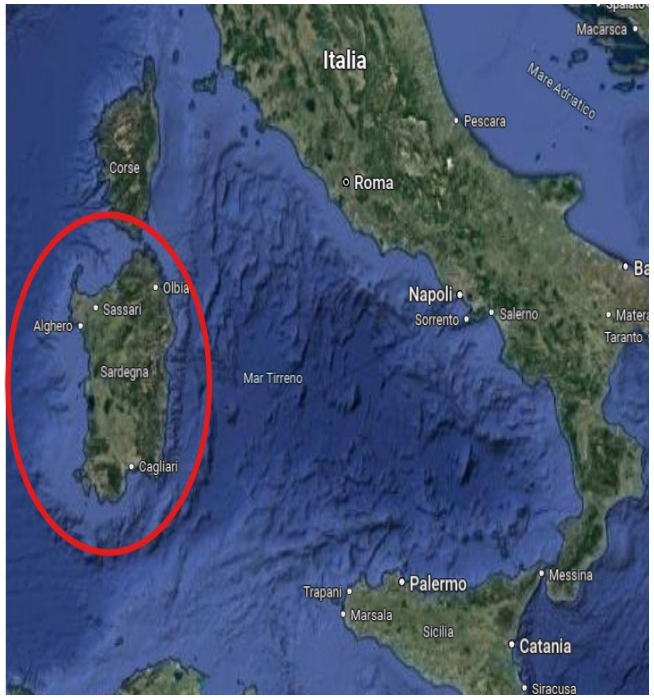
INTRODUCTION

- In the last ten years the world donkey population has increased (FAO, 2022)
- Most of the population raised in least developed countries
- Increasing of interest in developed countries
- Meat, milk, recreational, and hippo-theraphy
- Similarity between Donkey and human Milk



INTRODUCTION

- In Sardinia more than 8,000 donkeys are farmed (BDN, 2023)
- Sardo donkey is a Sardinia native breed
- Milk production and pet therapy
- Extensive farming system



INTRODUCTION

- Precision livestock farming includes several tracking tools

- Tri-axial accelerometers has been widely used in animal's behavior studies:
  - Cattle (Brennan et al., 2021)
  - Sheep (Giovanetti et al., 2017)
  - Goats (Moreau et al., 2009)
  - Horses (Keller et al., 2022)

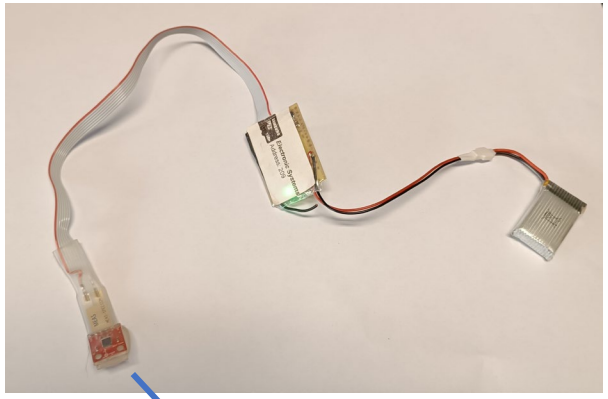
- No studies on donkeys at pasture using accelerometers

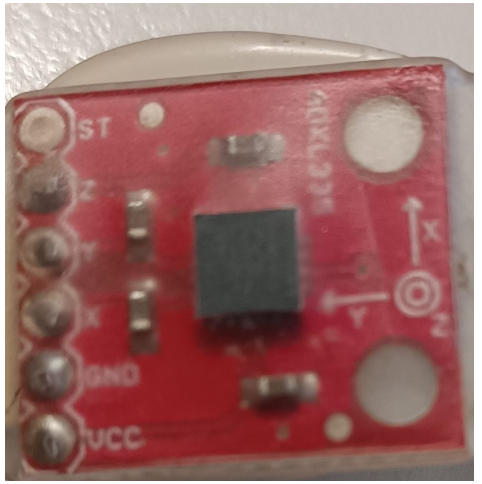
AIM

Aim of this research was to develop a statistical procedure to discriminate activities (grazing, walking, and resting) of donkeys at pasture using raw data derived from accelerometer devices

MATERIALS AND METHODS

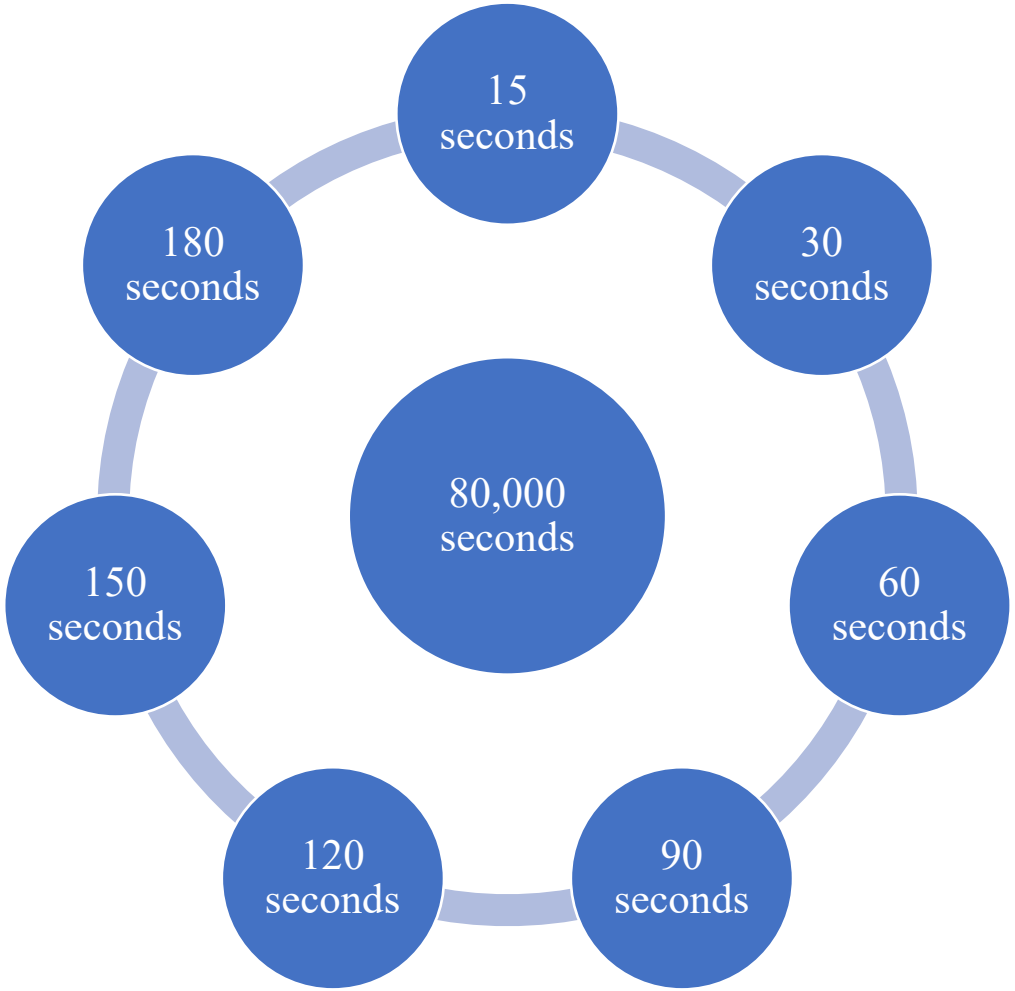
- Farm “Asinamento” Berchidda (SS)
  - Natural pasture area of 530 m2
  - 11 days experimental trial
  - 11 Donkeys
- Tri-axial accelerometer sensor in a collar bell
  - X Longitudinal
  - Y horizontal
  - Z vertical
  - Three peaks for each axis each second
  - Data storage in a Micro SD memory
- Behavior recording
  - Video recording (2-3 h/day)





DATA PROCESSING

- Video elaboration to assign activity for each second of record
- Grouped data into time interval with predominant activity



Mean
- Mx; My; Mz

Variance
- Vx; Vy; Vz

Inverse coefficient of variation
- ICVx; ICVy; ICVz

Resultant Axes Value
- Mr; Vr; ICVr

STATISTICAL ANALYSIS

- **ANOVA**

$$y = \mu + B + \varepsilon$$

- Y = one of the 12 variables
- μ = overall mean
- B = Behavior (grazing, walking, resting)
- ε = random residual

- **CANONICAL DISCRIMINANT ANALYSIS**

$$CAN = C_1X_1 + C_2X_2 + \ldots\ldots\ldots + C_nX_n$$

- **Model Evaluation**
  - Bootstrap procedure
  - Error rate and Accuracy
  - F-score

RESULTS

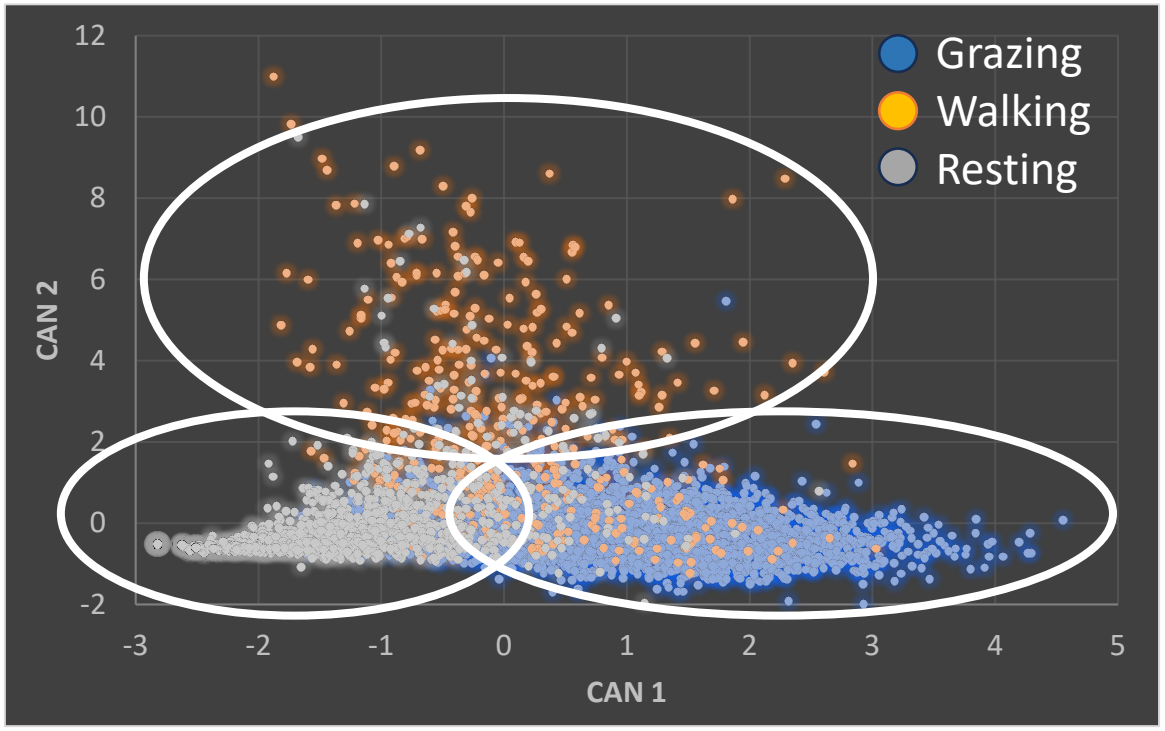
- Behaviors Frequency
  - 57% Grazing
  - 9% Walking
  - 34% Resting

- ANOVA
  - At least one of three behavior was significantly different in all epochs ($p < 0.01$)
  - All Behaviors were significantly different in all epochs for M values
  - No differences were found between Grazing and Walking for ICV variables

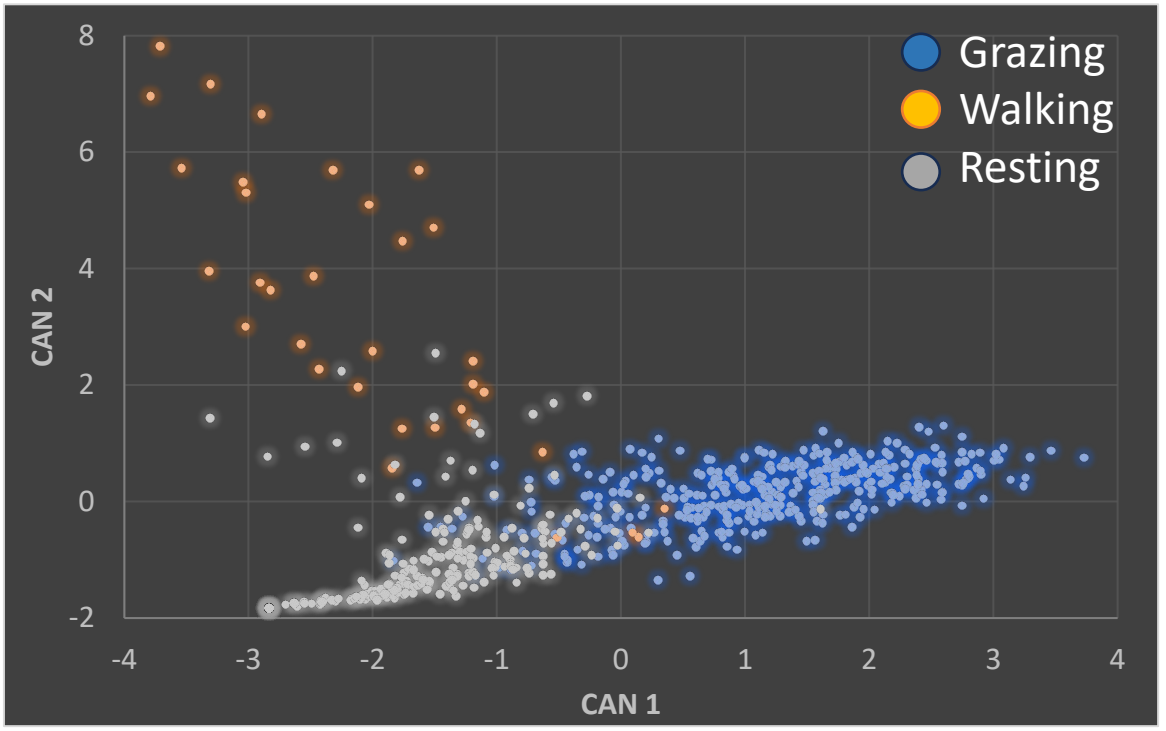
RESULTS

- M_r was discarded due to high multicollinearity
- The three behaviors were significantly discriminated
- CAN1 separated Grazing from Resting
- CAN2 separated Walking from the other activities

CDA15s epoch

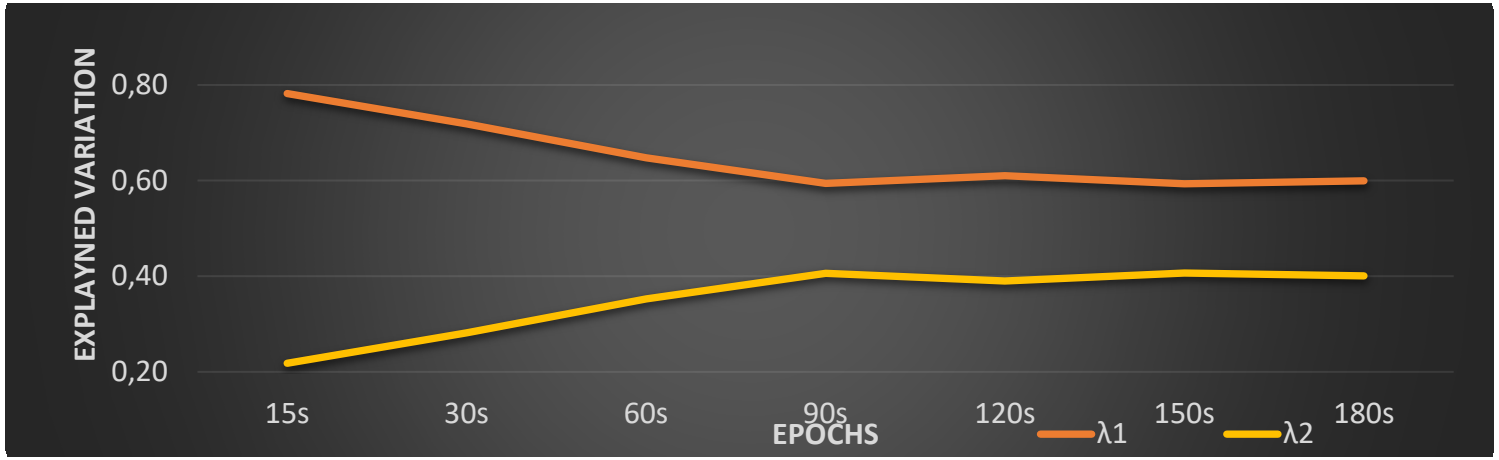


CDA 120s epoch



RESULTS

- Trends of variance explained by the CANs among all epochs
  - λ1 Decreased from 0.80 to 0.60
  - λ2 increased from 0.20 to 0.40
  - Plateau around 60% (CAN1) and 40% (CAN2)
- Euclidean distance in the space of CAN
  - Short and stable distance between Resting to Grazing
  - Increasing distance between walking and the others

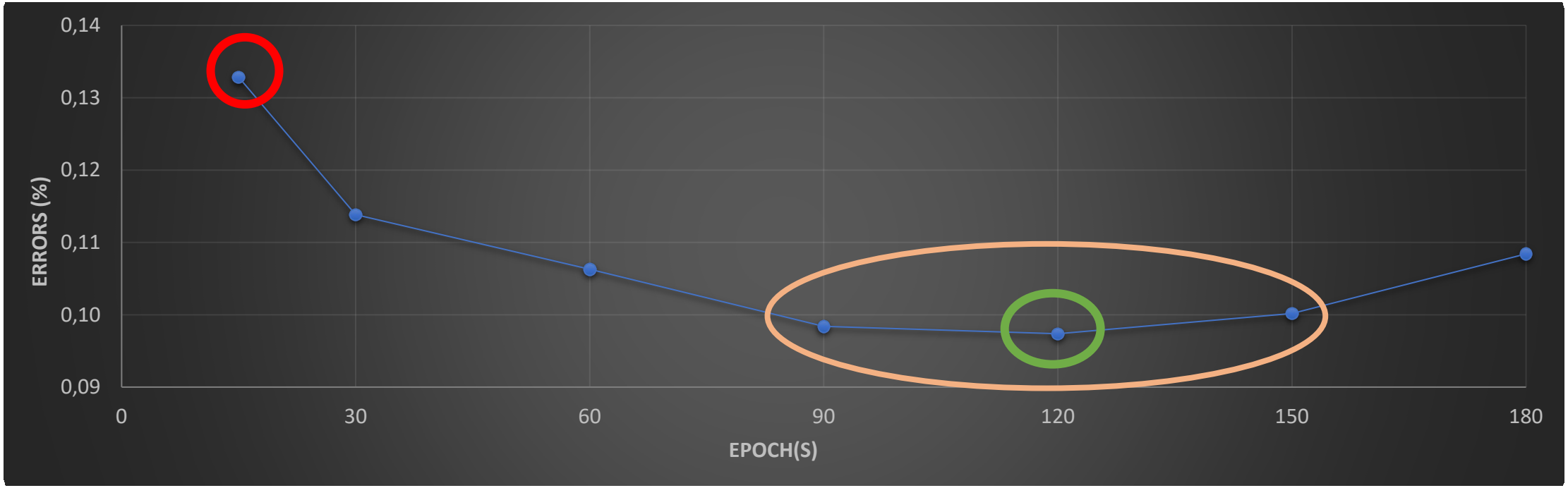


Time epoch		Euclidean Distance	
		Grazing	Resting
15 s	**Walking**	**7.2**	**9.3**
	Resting	**7.7**	
30 s	**Walking**	**10.4**	**12.9**
	Resting	**8.7**	
60 s	**Walking**	**18.5**	**18.6**
	Resting	**8.3**	
90 s	**Walking**	**25.9**	**25.3**
	Resting	**9.1**	
120 s	**Walking**	**28.4**	**25.4**
	Resting	**8.7**	
150 s	**Walking**	**32.8**	**29.5**
	Resting	**8.6**	
180 s	**Walking**	**30.3**	**26.9**
	Resting	**8.3**	

RESULTS

- Overall error rate of assignment
- 13.3% highest error rate 15 s
- 9.7% lowest error rate 120 s
- Similar results for 90, 120, and 150 epochs

Epochs	Accuracy	F-Score
15s	86.7	78.1
30s	88.9	82.2
60s	90.0	84.0
90s	90.4	86.8
120 s	90.9	87.2
150 s	91.0	87.1
180s	89.9	87.6



CONCLUSIONS

- Accelerometer data are suitable to detect behavior of donkeys at pasture which can be useful to improve management of donkeys raised in marginal areas
- The Canonical Discriminant Analysis was able to significantly separate the three behaviors
- The division of the whole dataset in time-epochs allowed to find the best setting to improve the accuracy of model
- 120s epochs showed highest accuracy, whereas 90s and 150s showed close results

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