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Using accelerometers for goat activity monitoring

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➤ Using Accelerometers for goat activity monitoring

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➤ Predicting behavior from acceleration signal

- **Objective:** study the link between behavior and parasitism
 - Does behavior changes during infestation to gastrointestinal intestinal nematodes?
 - Does behavior influences the risk of parasitism ingestion?
 - Need to collect individual behavioral information, on the long term:
 - + Accelerometers are well suited for individual data collection.
 - No universal method to predict behavior from acceleration.
- ➔ Development of :
1. A sharable dataset of annotated acceleration data.
 2. A hierarchical LSTM model to predict behavior.



➤ Dataset creation : experimental setup

1. Set up animals with accelerometers on the left horn.



- Accelerometers AX3 from Axivity.

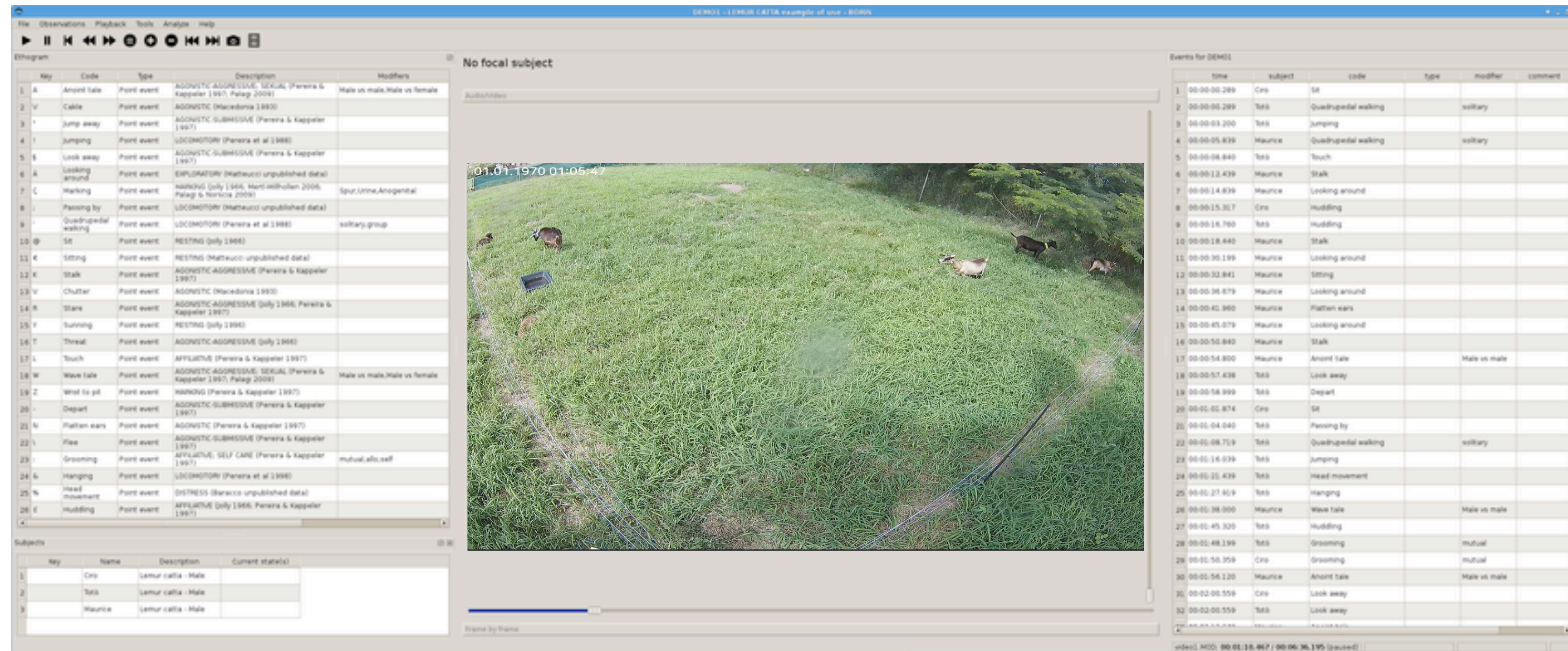
2. Record behavior with a camera



- Experimental paddock 20 x 10 m.
- 2 to 5 adult lactating or pregnant Creole goats.
- Free to graze for 6 to 8 hours.
- Animals are changed every day.

Dataset creation : experimental setup

3. Use Boris to watch the videos and record the associated behavior for each animal



- Five behaviors:
 - Grazing, Displacement, Ruminating/Chewing, Resting, Other (bleating, social, scratching...)
- Annotation only when possible:
 - Identification of the animal and behavior.



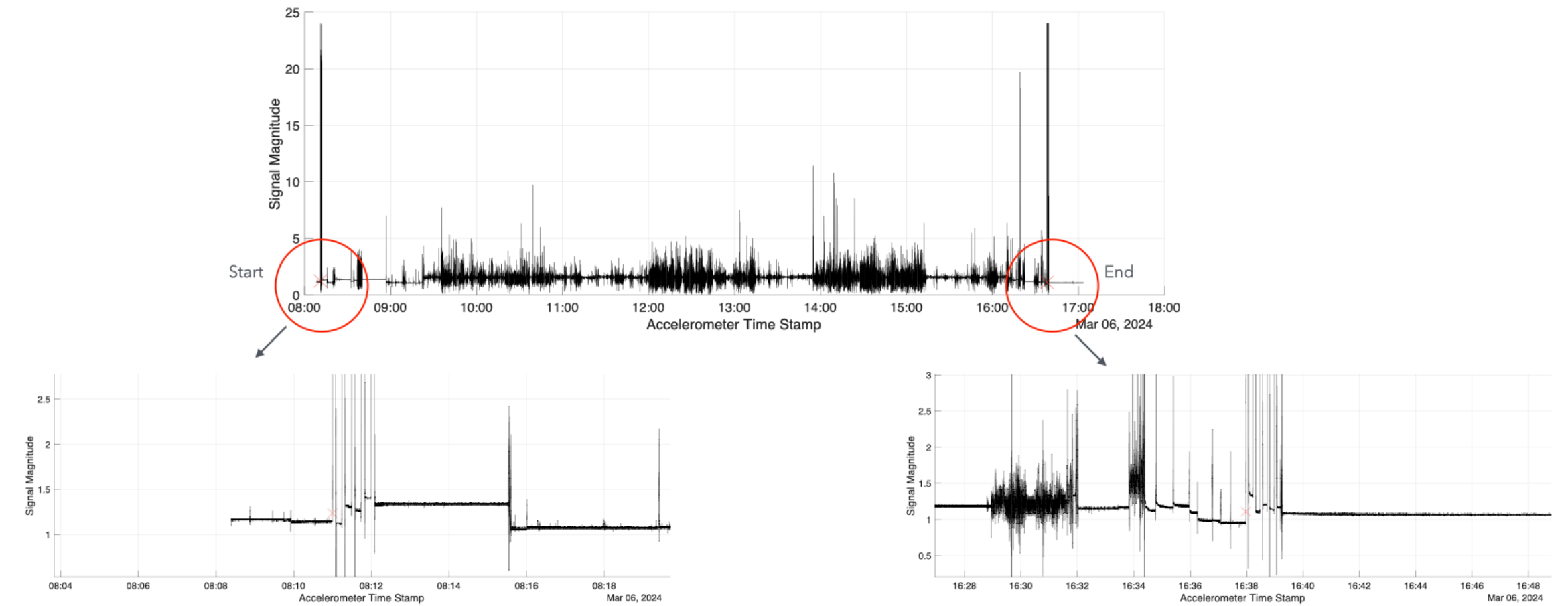
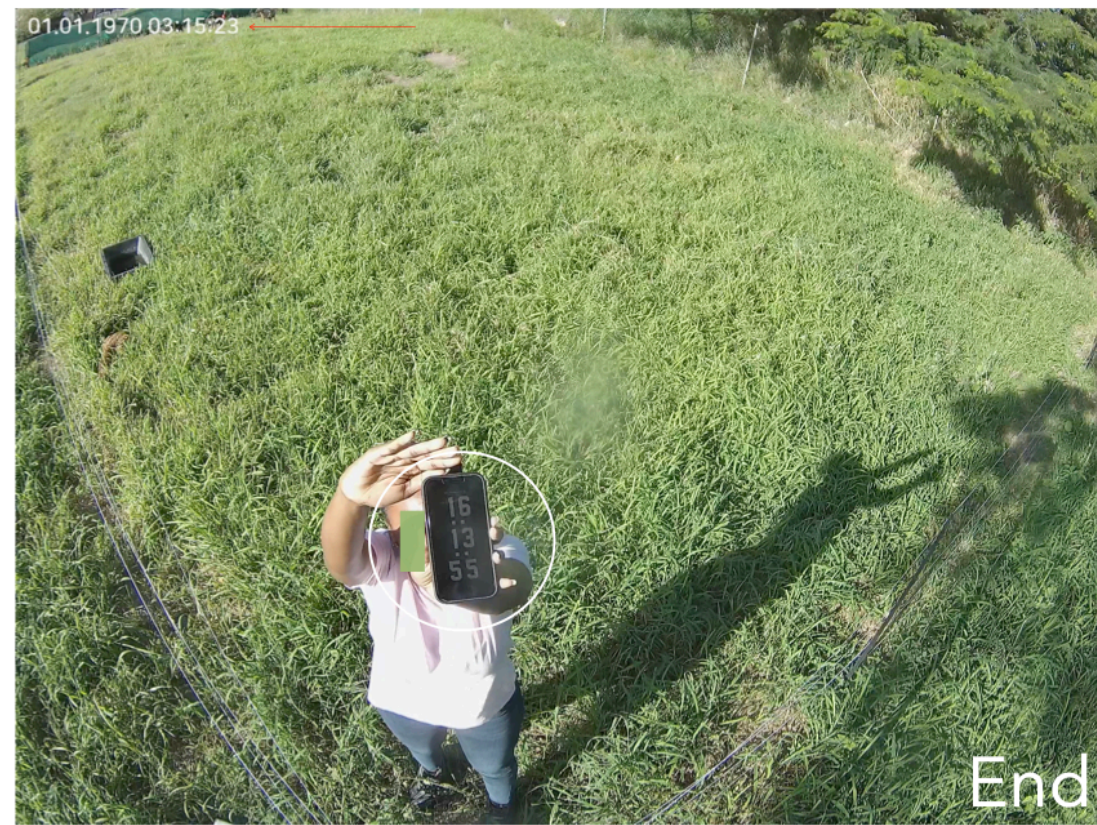
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➤ Dataset creation : experimental setup

4. Time synchronization between accelerometers and video frames



4.1 Synchronize camera to UTC time:

- Film smartphone time connected to internet.

4.2 Synchronize accelerometers to UTC time:

- Create a distinctive acceleration pattern.

4.3 Account for time drift:

- 1h of sensor records are not necessarily one hour in reality...
- Compute and add drift to the sensors time.



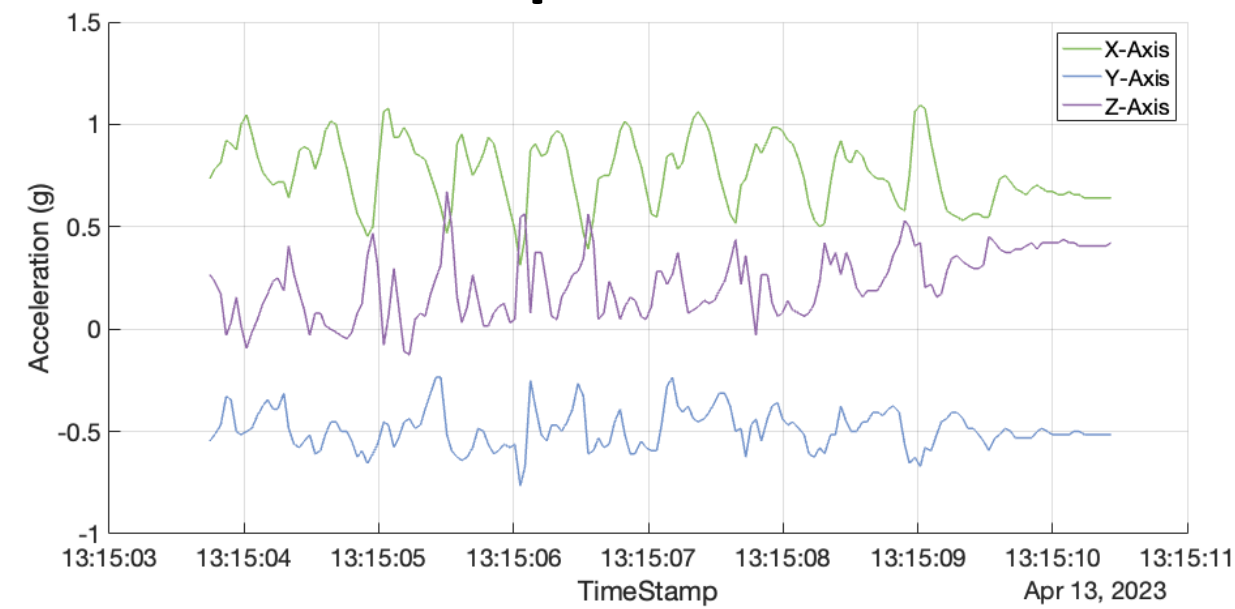
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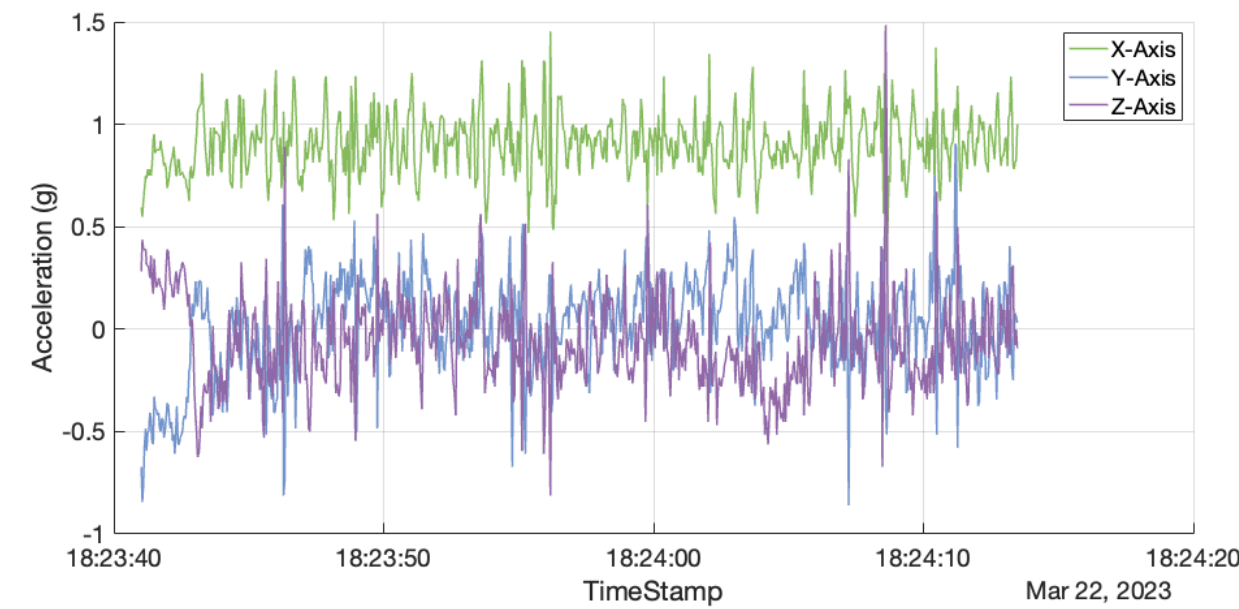
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Final dataset : some examples

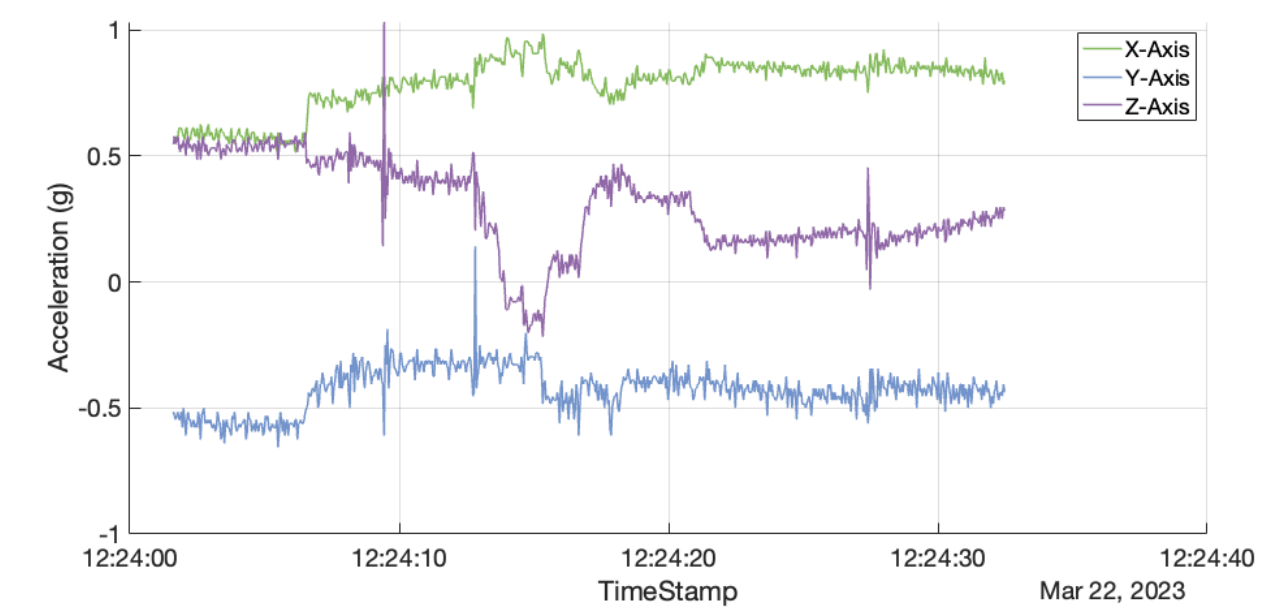
Displacement



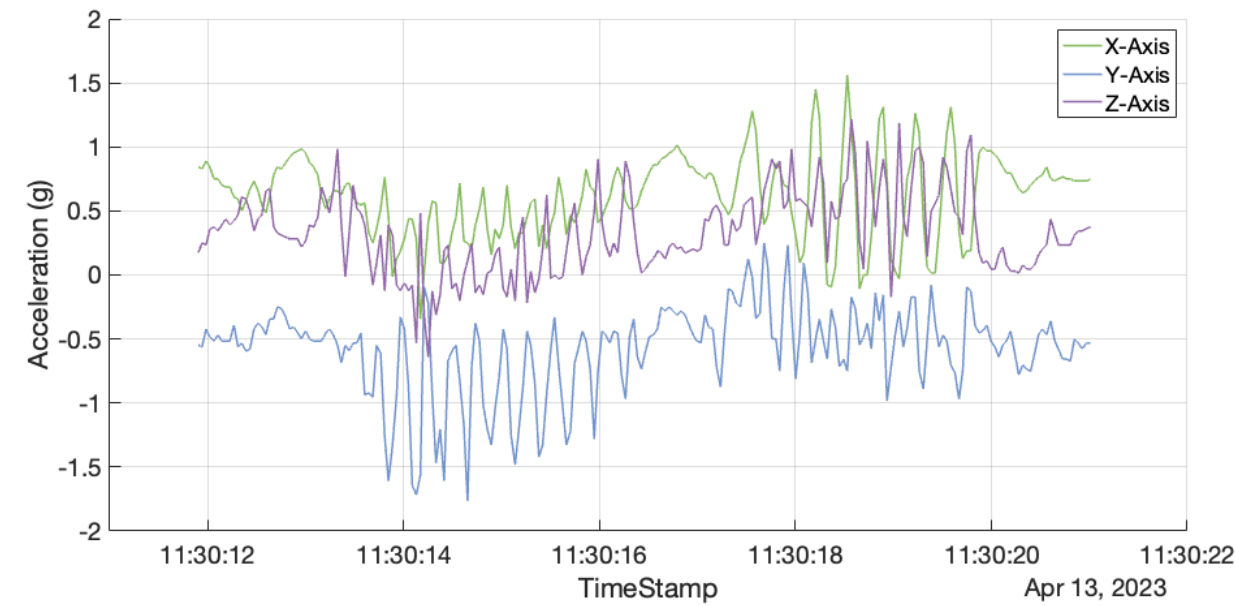
Grazing



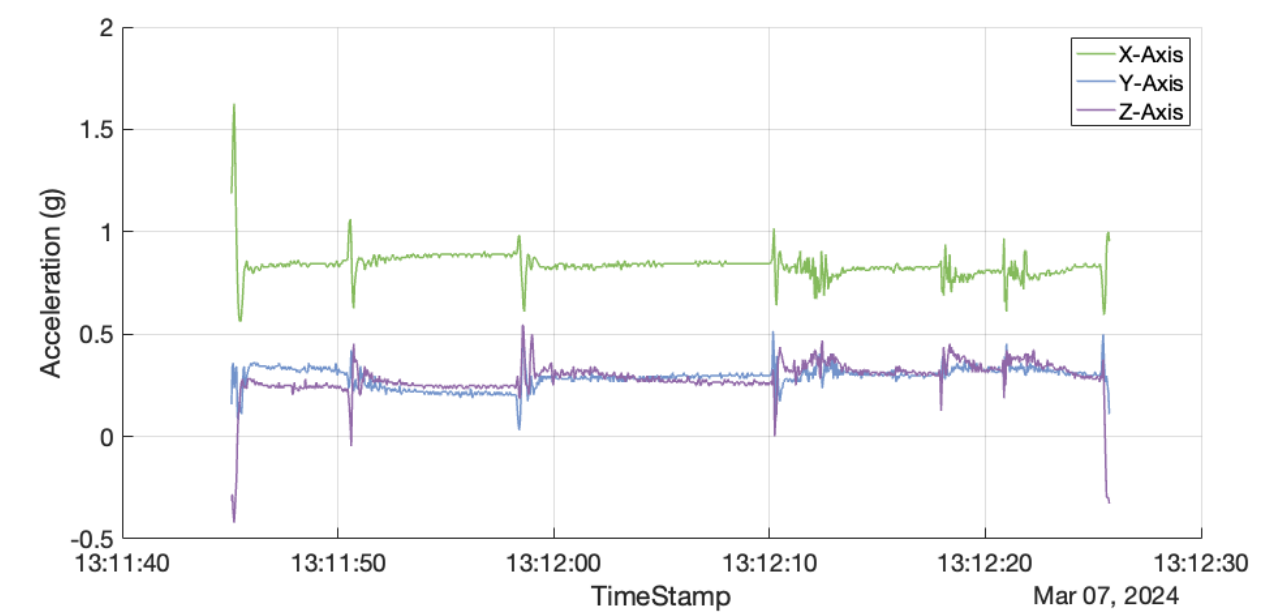
Ruminating/Chewing



Other



Resting



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➤ Final dataset

- 144 hours of annotated videos.
- 59 different animals.
- High heterogeneity of labelling time and sequence duration....
 - Had to be accounted for when designing the prediction method !

Behaviors	Cumulated time (h)	Mean sequences duration (s)
Displacement	0.61	7.03
Grazing	67.67	32.93
Ruminating / Chewing	10.58	29.73
Other	6.23	9.23
Resting	59.55	42.2

- Sharable dataset:
 - Data paper submitted to Data In Brief



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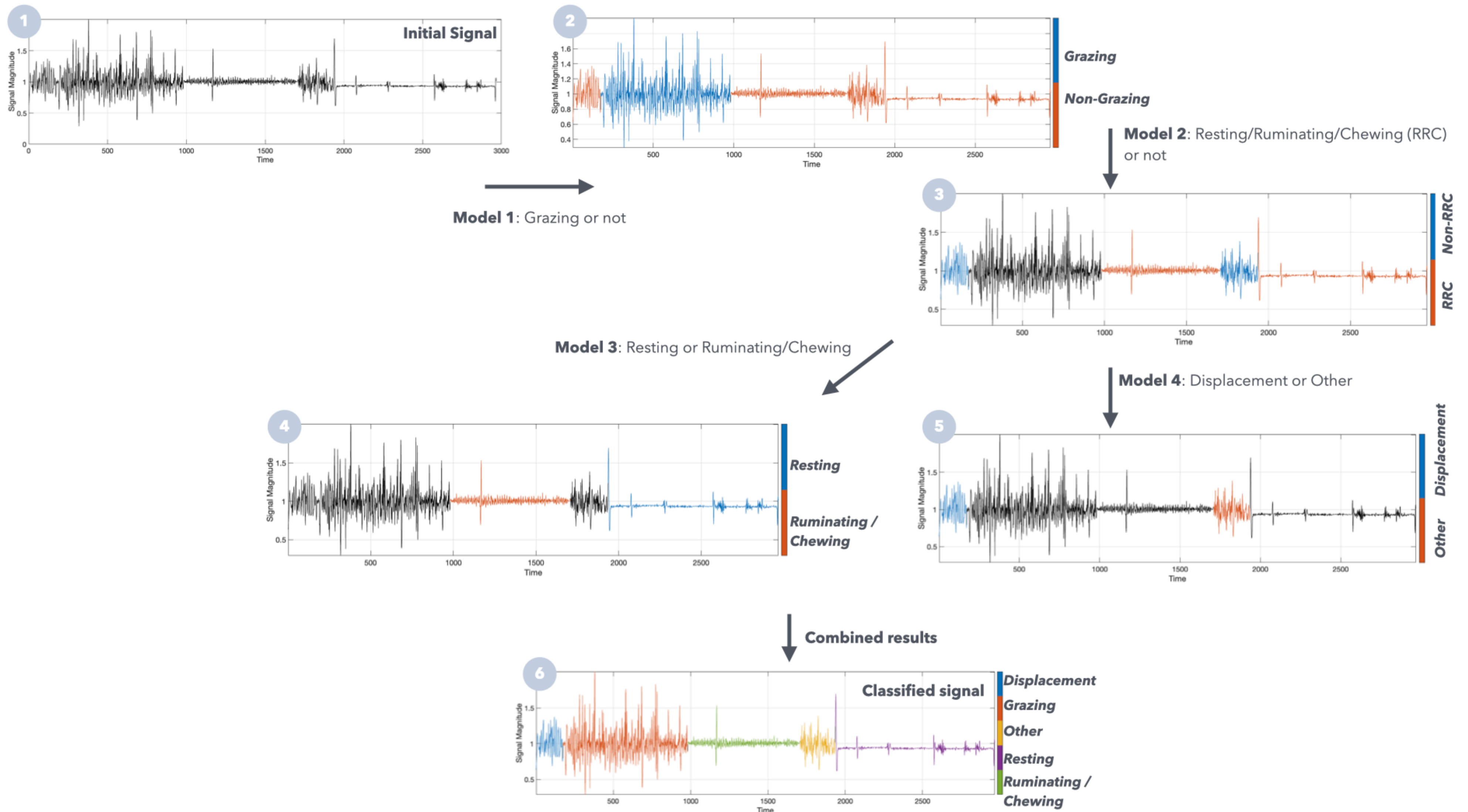
➤ Behavior prediction: Challenges

- Long Short Term Memory (LSTM) neural networks are well suited for prediction using time series.
- High heterogeneity of behavior sequences:
 - Difficult to use one model suited for all behavior type.
 - Development of a hierarchical model.

Behaviors	Cumulated time (h)	Mean sequences duration (s)
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➤ Hierarchical LSTM model for prediction



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➤ Hierarchical LSTM models for prediction

- 7 animals for test (21%).
- 52 animals for training (79%).

True Class		Confusion Matrix					Recall	
		Displacement	Grazing	Other	Resting	Ruminating/Chewing	Displacement	Grazing
Displacement	3397	65	748	903	1	66.4%	33.6%	
Grazing	152	1417200	4808	3781	98	99.4%	0.6%	
Other	242	5431	86668	4747	270	89.0%	11.0%	
Resting	1770	1738	3330	1005262	13801	98.0%	2.0%	
Ruminating/Chewing	30	266	238	4756	127384	96.0%	4.0%	

Precision		Mean Precision = 87.86%				
		Displacement	Grazing	Other	Resting	Ruminating/Chewing
Displacement	60.8%	99.5%	90.5%	98.6%	90.0%	
Grazing	39.2%	0.5%	9.5%	1.4%	10.0%	



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➤ Hierarchical LSTM models for goats behavior prediction

Thank you !

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