THE USE OF MULTIVARIABLE SENSOR DATA TO EARLY DETECT LAMENESS IN SHEEP

SENSORS IN FOOD AND AGRICULTURE CONFERENCE 2016

MOLLER CENTRE – CAMBRIDGE

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OUTLINES

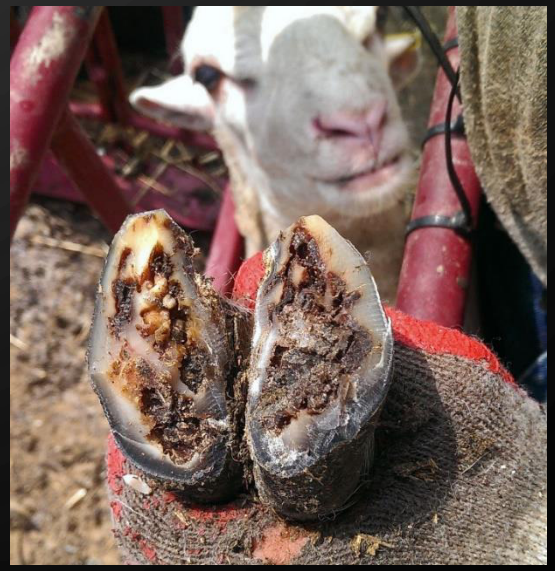
- Problem definition.
- Research aim.
- Related works.
- Sensor prototype.
- Data Collection/Data collection obstacles.
- Lame & Sound Sheep data examples.
- Data analysis and machine learning.
- Research Methodology.
- Preliminary results.
- What is next?

PROBLEM DEFINITION

- Lameness is a clinical symptom referring to locomotion changes, resulting in impair and erratic movements that widely differ from normal gait or posture (Van Nuffel, et al. , 2015).
- Lameness represents a serious cost problem in sheep industry and farming productivity in the UK.
- The cost of the footrot disease (one of the common causes of lameness) to British sheep industry per year was estimated by £24 million (Nieuwohf and Bishop, 2005), and around £10 for each ewe (AHDB, 2014).
- It varies from mildly lame to severely lame.

RESEARCH AIM

- To develop an automated model to early detect lameness in sheep by analysing the data that will be retrieved from a mounted sensor on sheep neck collar.
- Minimize sensor power consumption by eliminating the sensor data which have less effect on decision making to identify lameness.
- This model will help the shepherd to early detect the lame sheep to prevent the worse situation of trimming or even culling the sheep.

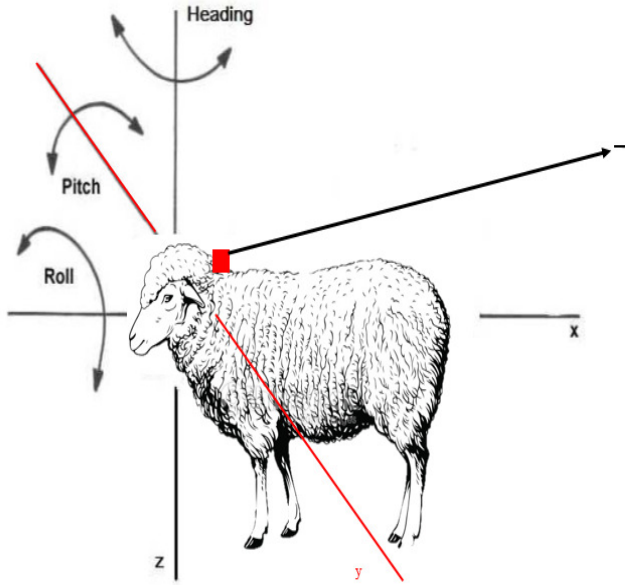


RELATED WORKS

- Very divergent because of the ***multidisciplinary*** feature of this research study.

Data Collection Methods	Data Analysis Methods	Analysis Purpose	Species Type
Human Observation	LS /GS Scoring system techniques/done by trained observer)	Detect animal illness (mastitis, lameness, ketosis)	Cattle
Video Cameras	Statistical Techniques	Classification (lying, standing, grazing, ruminating)	sheep
Sensor data (GPS, Accelerometer, head movements, ...)	Computerized techniques (Data mining use Machine Learning techniques)		Other species

SENSOR PROTOTYPE



- **Longitude**
- **latitude**

- **Time Accuracy** (one reading every 40 mS)
- 25 readings/ S (1000/40)
- 25*60=1500 reading/Min.
- 1500*60= 90000 / Hr.

Acceleration M/S²

X Accelerometer
Y Accelerometer
Z Accelerometer

Angular velocity (Rad/s)

X Angular velocity
Y Angular velocity
Z Angular velocity

Orientation (clockwise/anticlockwise)

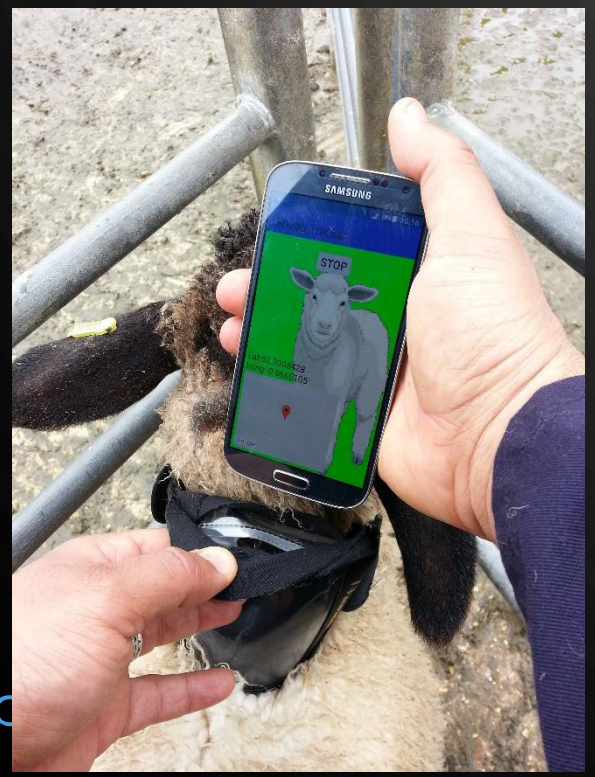
Roll angle (Deg around X axis)
Pitch angle (Deg around Y axis)
Head angle (Deg around Z axis)

Sensor data is an Excel file like this :

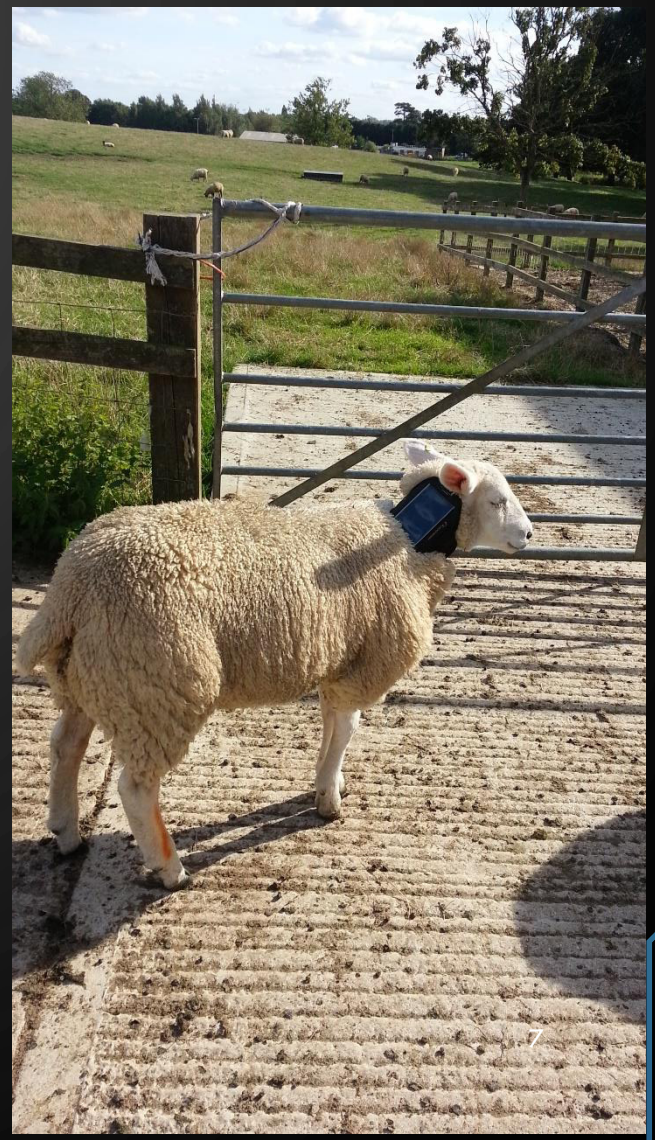
	Acc_X	Acc_Y	Acc_Z	Gyr_X	Gyr_Y	Gyr_Z	Orien_Pitch	Orien_Roll	Orien_Yaw	Latitude	Longitude	Date	Time
2	-0.69917	-1.57198	-1.14897	-0.45509	-0.39951	-0.26145	-16.410892	2.927611	75.95117	52.300834	-0.86594	13-06-2016	15:04:47
3	-2.76453	-1.36522	0.78649	-0.55283	-0.20067	0.251066	-14.242001	3.1945748	73.359406	52.300834	-0.86594	13-06-2016	15:04:47
4	-0.95646	-1.19815	-0.21115	-0.08033	-0.09071	-0.24343	-13.774706	2.3488736	75.299736	52.300834	-0.86594	13-06-2016	15:04:47
5	-1.14872	-0.60101	-0.36716	-0.42669	-0.15119	-0.74342	-6.0657816	1.5303112	90.65416	52.300834	-0.86594	13-06-2016	15:04:47
6	-1.45992	-4.33668	0.618028	0.744645	0.880562	-1.60291	-8.57852	-2.707409	91.072586	52.300834	-0.86594	13-06-2016	15:04:47
7	-0.00584	0.333444	0.185181	-0.00611	-0.18479	1.080926	-7.839893	-3.7475405	92.44334	52.300834	-0.86594	13-06-2016	15:04:47
8	-2.39968	-0.60565	2.878337	0.600481	-0.3259	0.713491	-14.070807	-4.9930644	83.81161	52.300834	-0.86594	13-06-2016	15:04:47
9	3.209546	0.406241	-0.55731	-0.22297	0.030543	0.849408	-15.288356	-6.806	76.803215	52.300834	-0.86594	13-06-2016	15:04:47
10	1.868029	1.495727	-0.17706	0.316734	0.903164	-0.01833	-19.162153	-14.495595	60.624344	52.300834	-0.86594	13-06-2016	15:04:47
11	-0.15216	-0.55541	-2.16829	-0.15577	-0.21777	0.347888	-15.965284	-14.442375	49.610886	52.300843	-0.86594	13-06-2016	15:04:49
12	-0.37969	-0.39115	0.385308	-0.82436	-0.0281	0.521374	-13.751822	-8.83548	25.22552	52.300843	-0.86594	13-06-2016	15:04:49
13	1.208119	1.036239	-0.97474	-0.13439	-0.74678	0.201891	-9.466216	-5.3669314	21.053997	52.300843	-0.86594	13-06-2016	15:04:49
14	0.267904	-0.10811	1.804601	-0.24343	0.042455	0.03207	-17.090143	-5.230672	18.19053	52.300843	-0.86594	13-06-2016	15:04:49
15	-0.59035	0.096449	-0.12529	1.123687	0.327118	2.199115	-14.938739	-12.819288	35.574986	52.300843	-0.86594	13-06-2016	15:04:49
16	-5.5238	-1.28483	0.293481	-1.29778	0.470977	0.824974	-15.480663	-17.33137	27.172062	52.300843	-0.86594	13-06-2016	15:04:49
17	0.051884	-0.44479	0.577173	-0.75564	-0.01588	1.610852	-21.341005	5.629398	350.13882	52.300843	-0.86594	13-06-2016	15:04:49
18	0.499812	1.316553	-0.85172	1.085202	-1.15759	1.432784	-19.636309	10.83776	344.17938	52.300843	-0.86594	13-06-2016	15:04:49
19	0.70479	-1.21495	1.169003	-0.29138	-0.22358	0.486554	-18.986576	14.896962	341.23053	52.300843	-0.86594	13-06-2016	15:04:49
20	1.025396	-0.15471	-0.56558	-0.01863	-0.40684	0.14508	-16.08978	36.314705	336.2743	52.300843	-0.86594	13-06-2016	15:04:49
21	-0.39316	-2.65021	-2.239	-0.04398	-0.34728	0.109345	-7.351151	50.030014	340.88007	52.300843	-0.86594	13-06-2016	15:04:49
22	0.320116	1.691304	-0.24202	-0.46914	0.207694	1.742188	-6.053575	53.55163	347.09537	52.300843	-0.86594	13-06-2016	15:04:49
23	1.091949	1.345643	2.967357	-0.16005	-0.40806	-1.22998	-16.894253	52.730118	352.22086	52.30085	-0.86593	13-06-2016	15:04:51

DATA COLLECTION

- Data were collected from Lodge farm at Moulton College on 13 June 2016 (9 sheep) and on 23 Sept. 2016 (22 sheep).



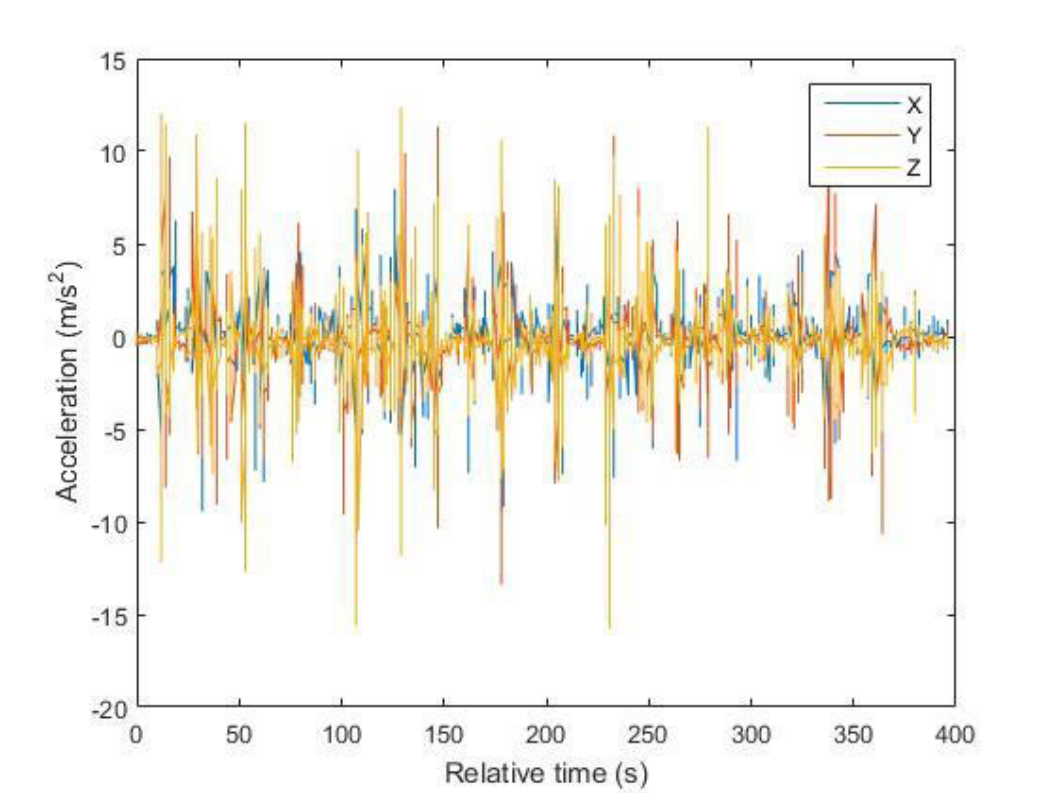
Video Footage example



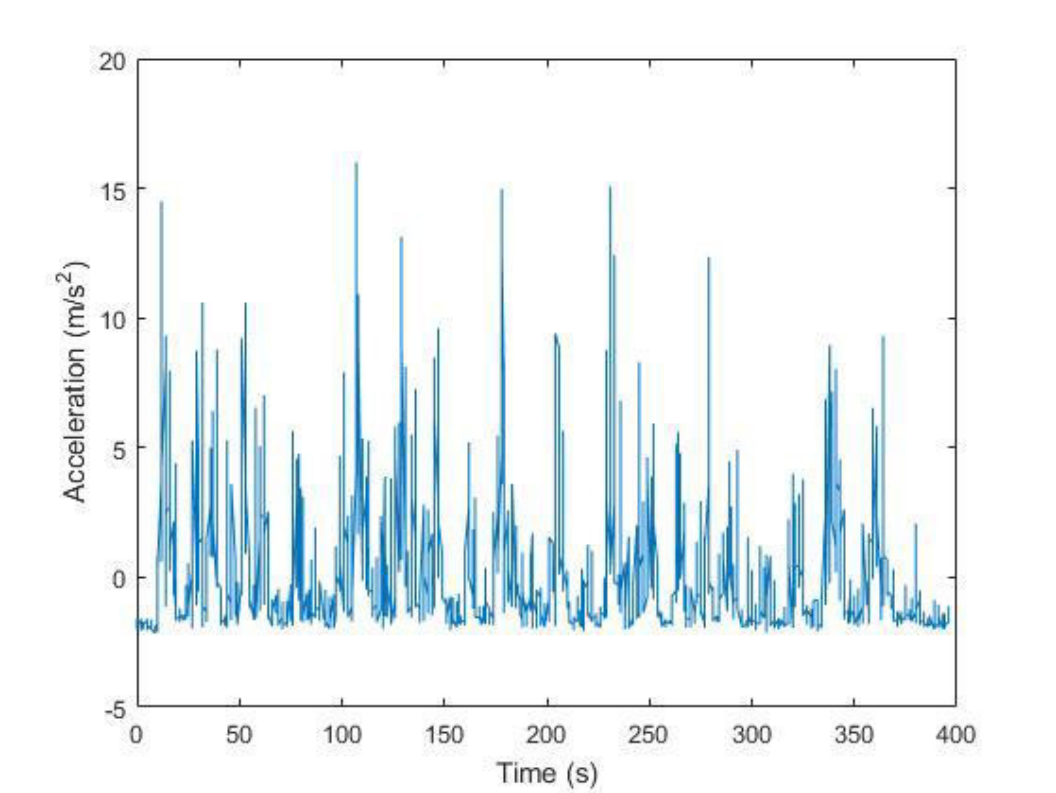
DATA COLLECTION OBSTACLES

- Catching the sheep not and easy work, help is always needed. DBS check.
- Muddy soil in rainy weather.
- Sensor collar need to be fixed with clips.
- Sheep do not move. Need to walk to simulate them for continuous waling which is important for readings.

LAME SHEEP EXAMPLE

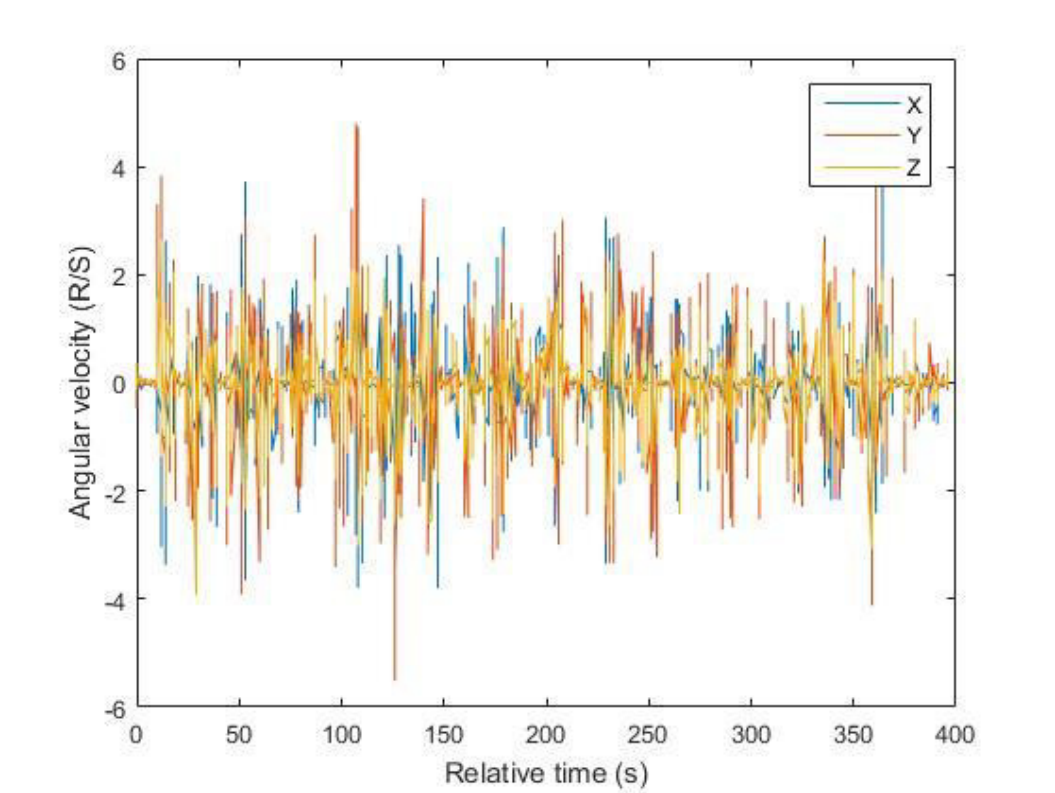


Acceleration data for lame sheep

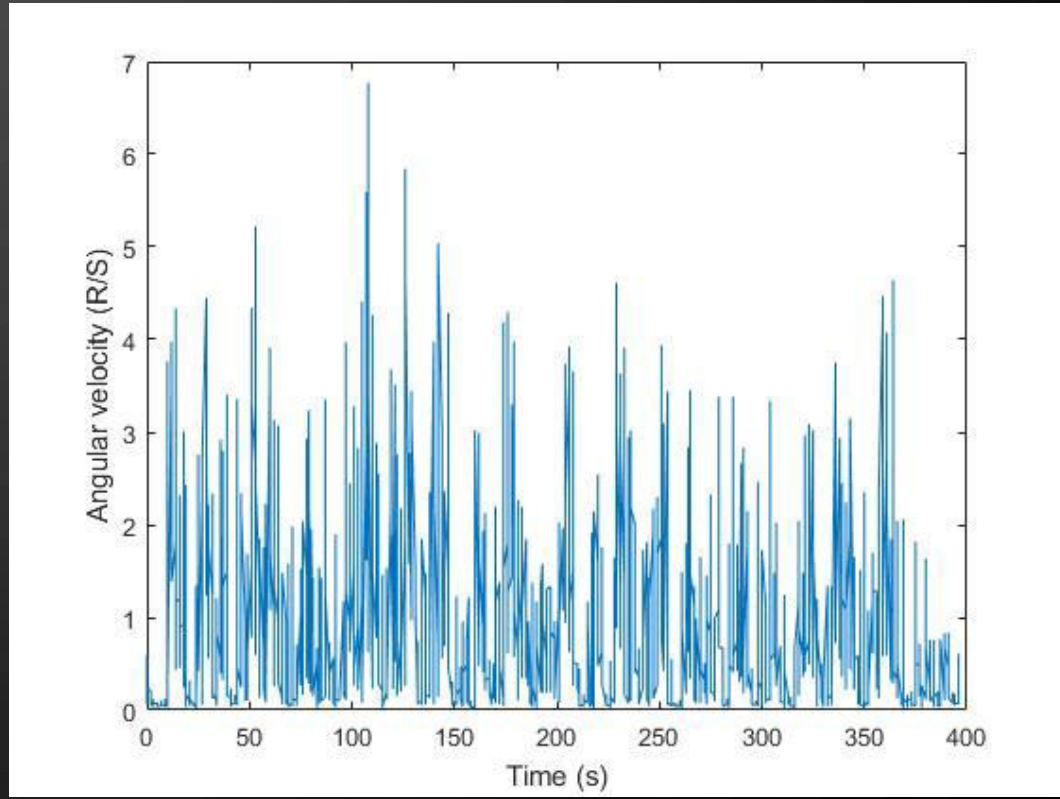


Acceleration magnitude for lame sheep

LAME SHEEP EXAMPLE CONT.

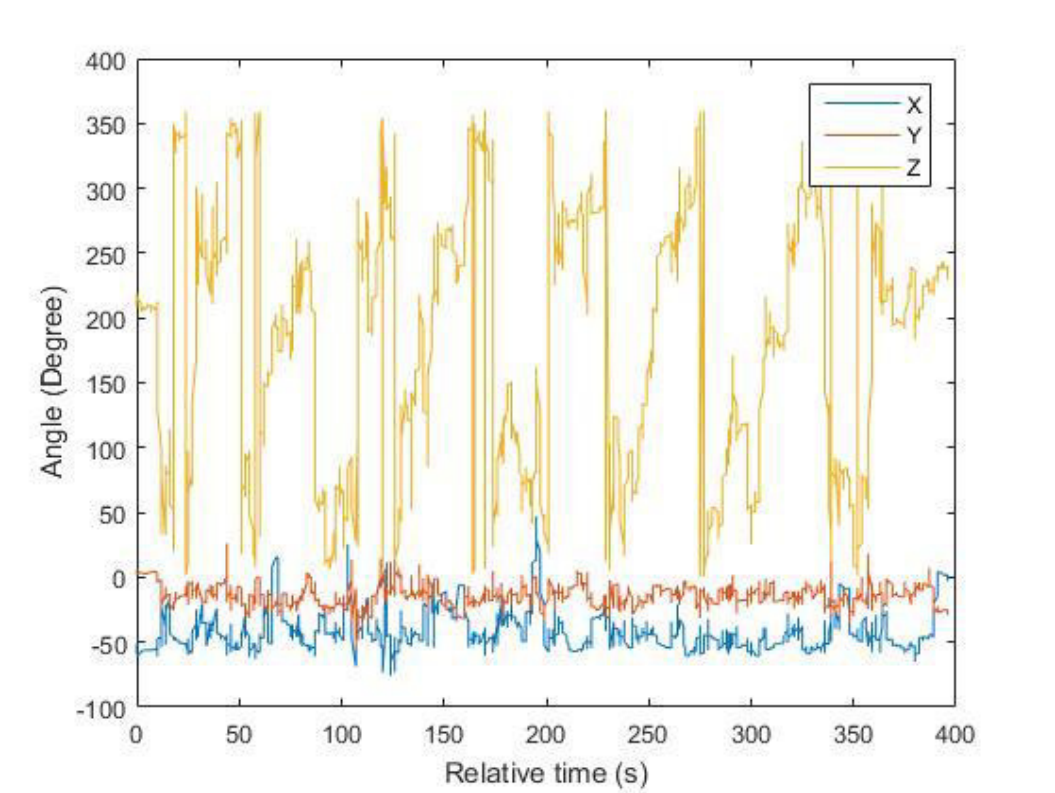


Gyroscope data for lame sheep

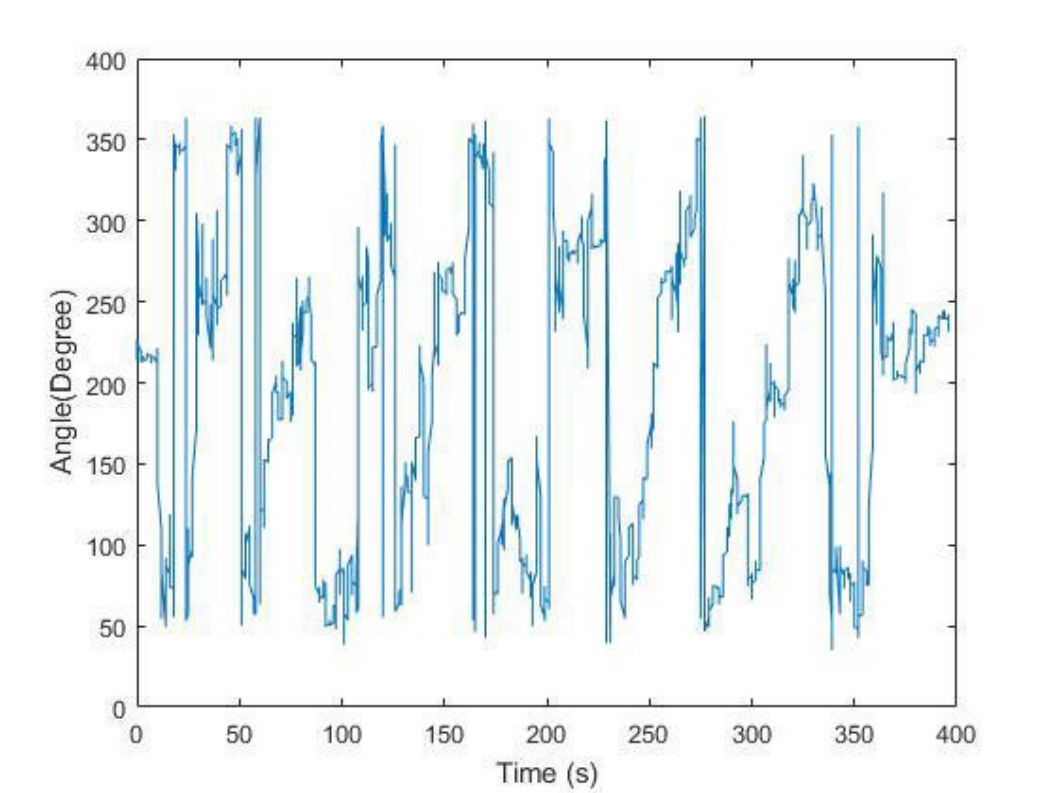


Gyroscope magnitude for lame sheep

LAME SHEEP EXAMPLE CONT.

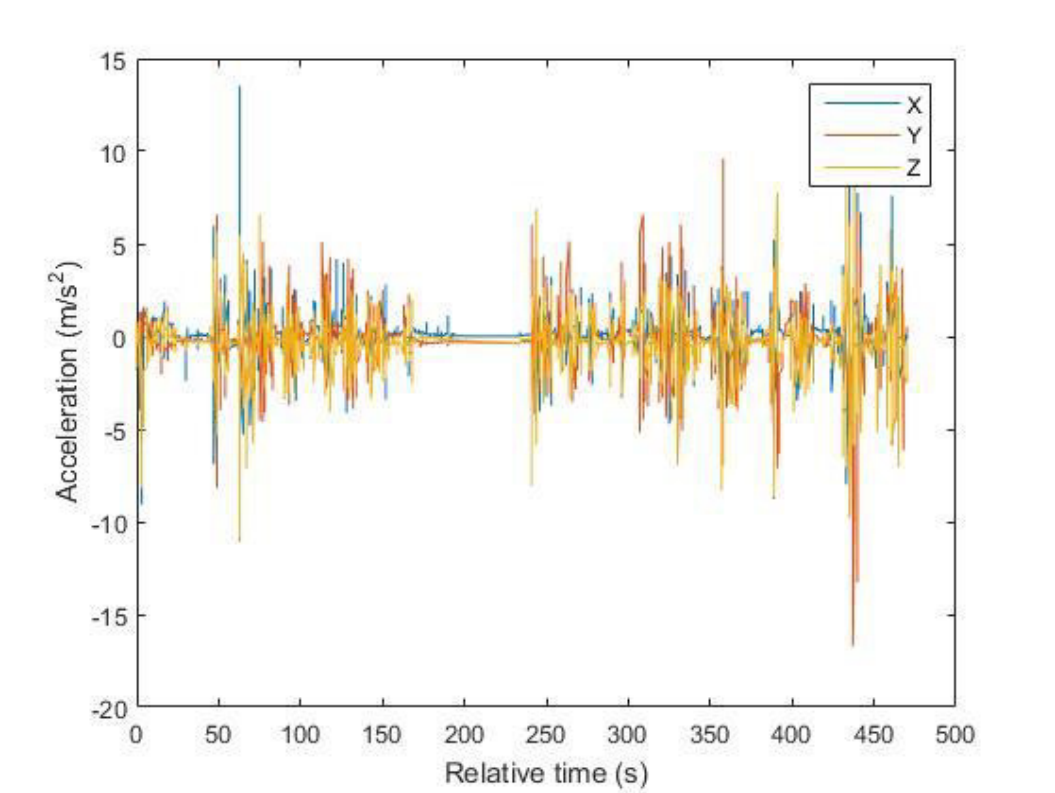


Angle data for lame sheep

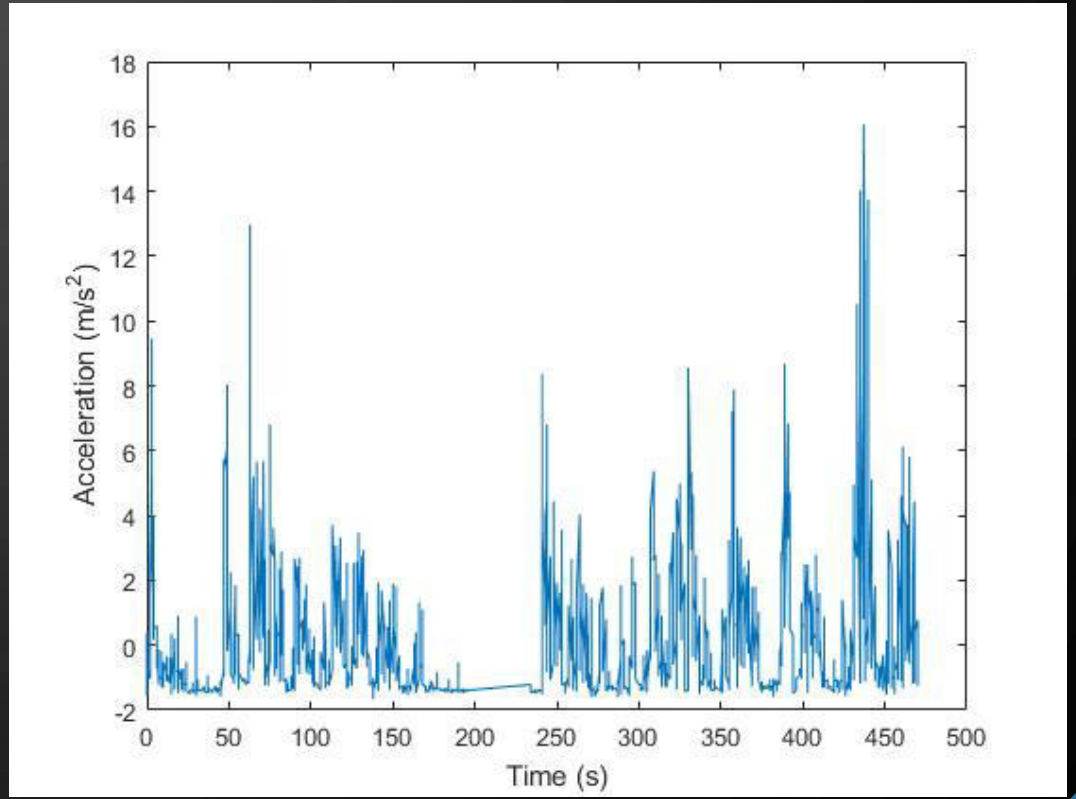


Angle magnitude for lame sheep

SOUND SHEEP EXAMPLE

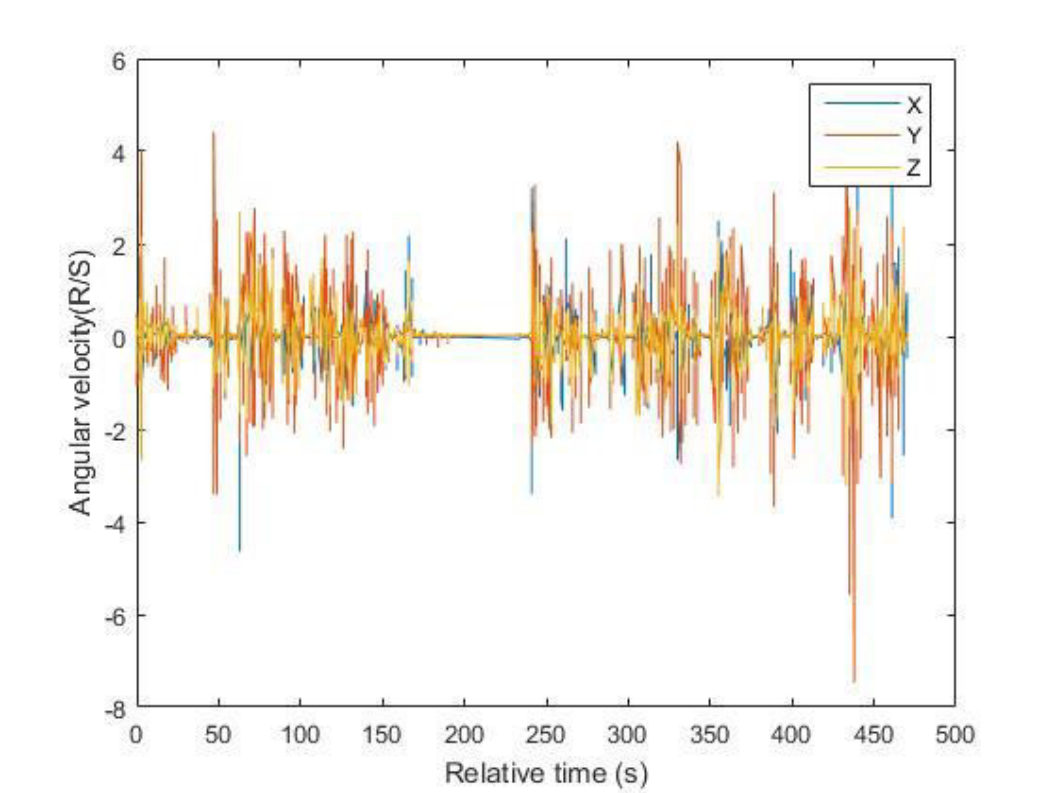


Acceleration data for sound sheep

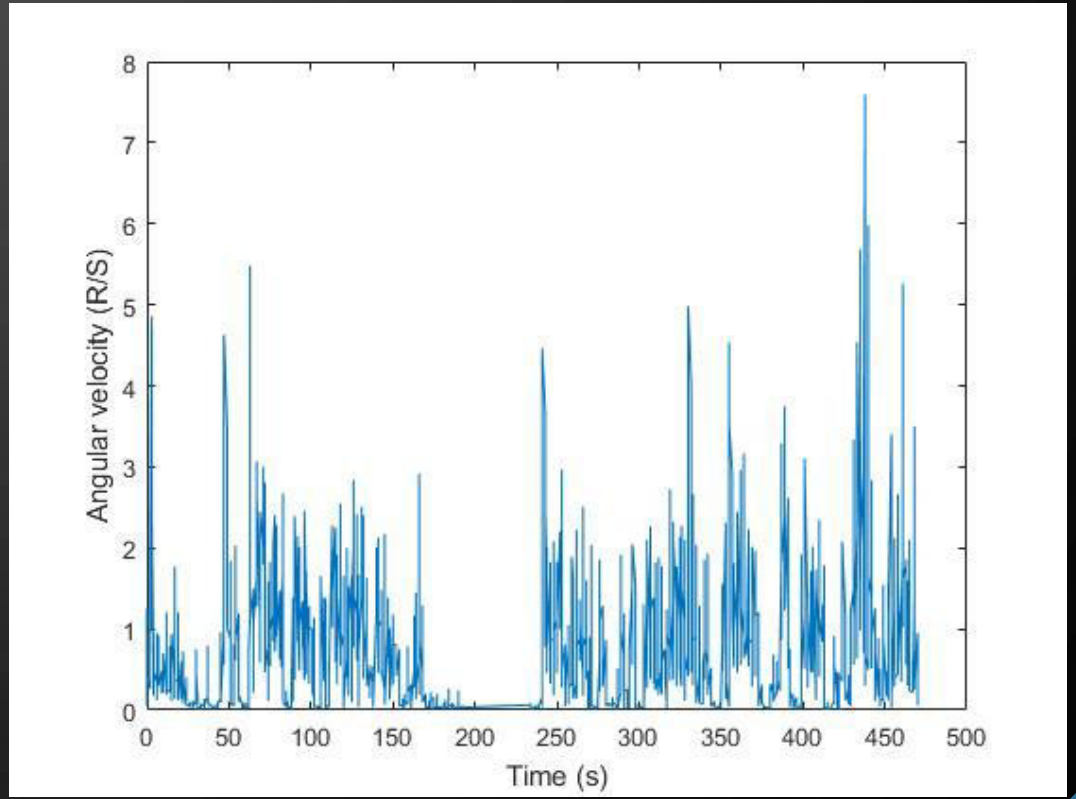


Acceleration magnitude for sound sheep

SOUND SHEEP EXAMPLE CONT.

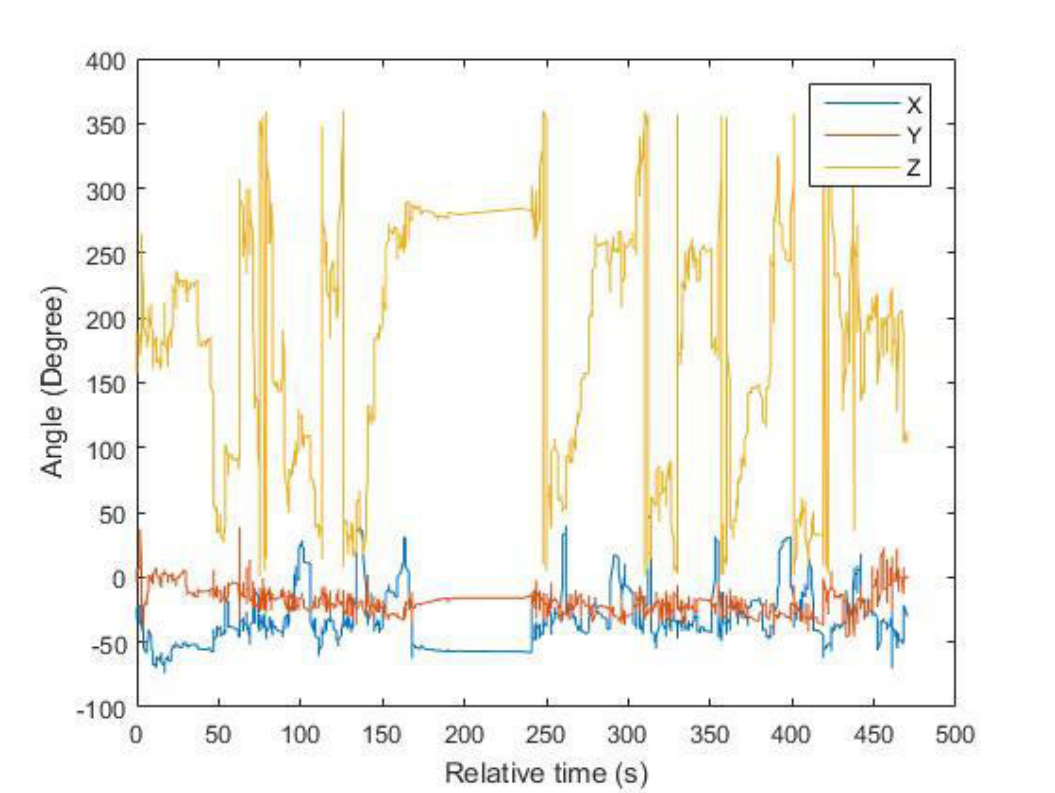


Gyroscope data for sound sheep

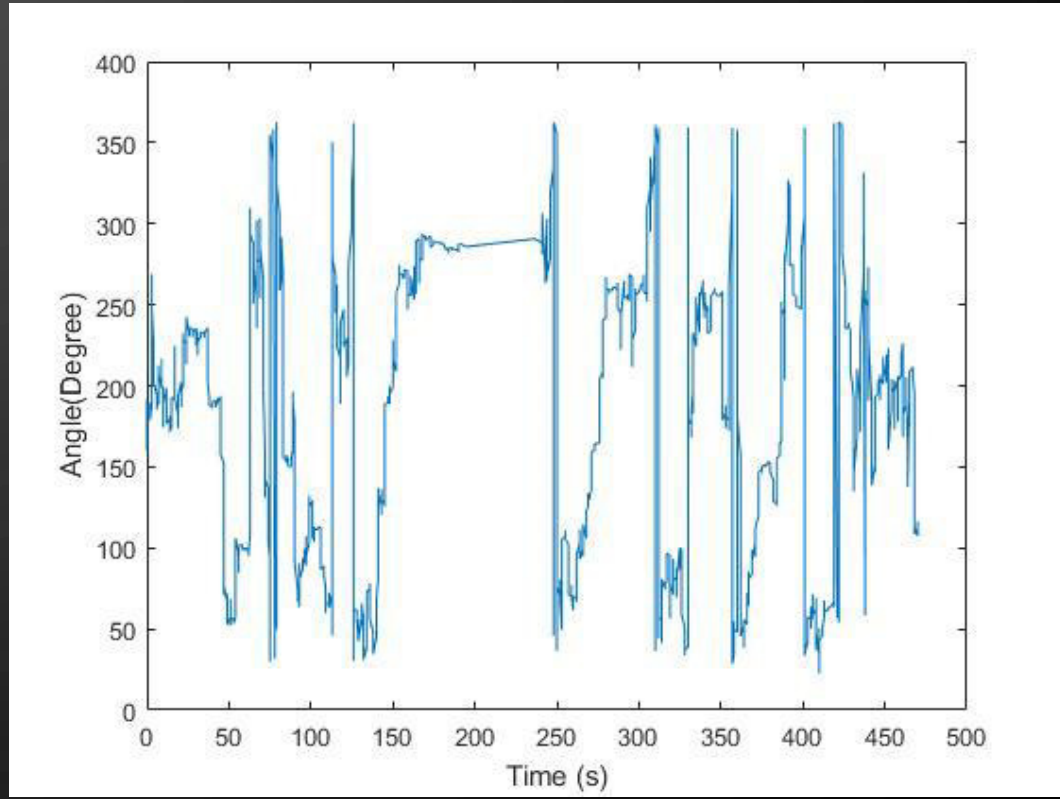


Gyroscope magnitude for sound sheep

SOUND SHEEP EXAMPLE CONT.



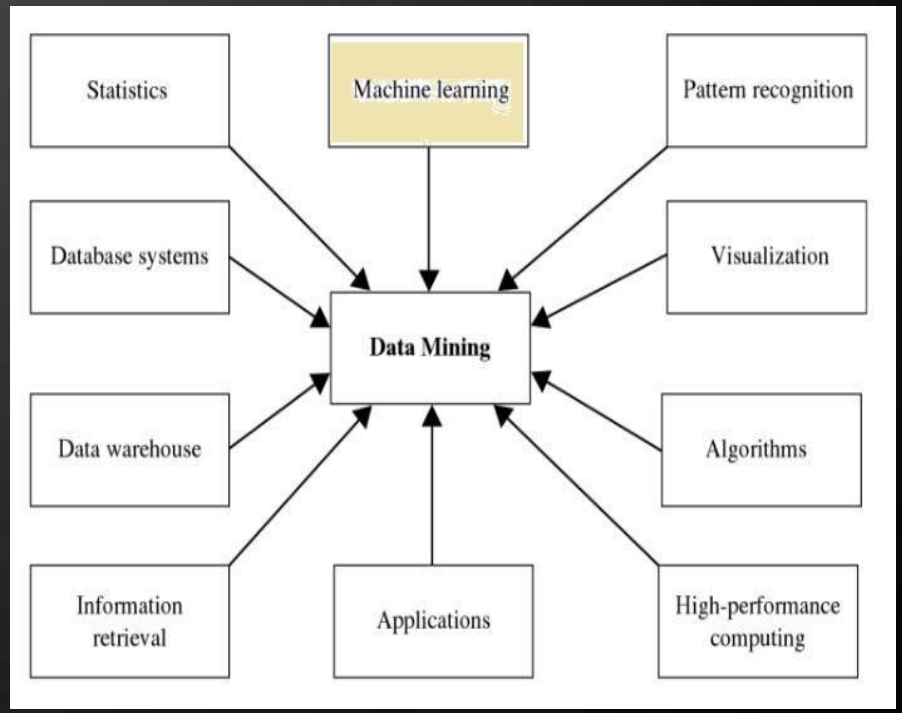
Angle data for sound sheep



Angle magnitude for sound sheep

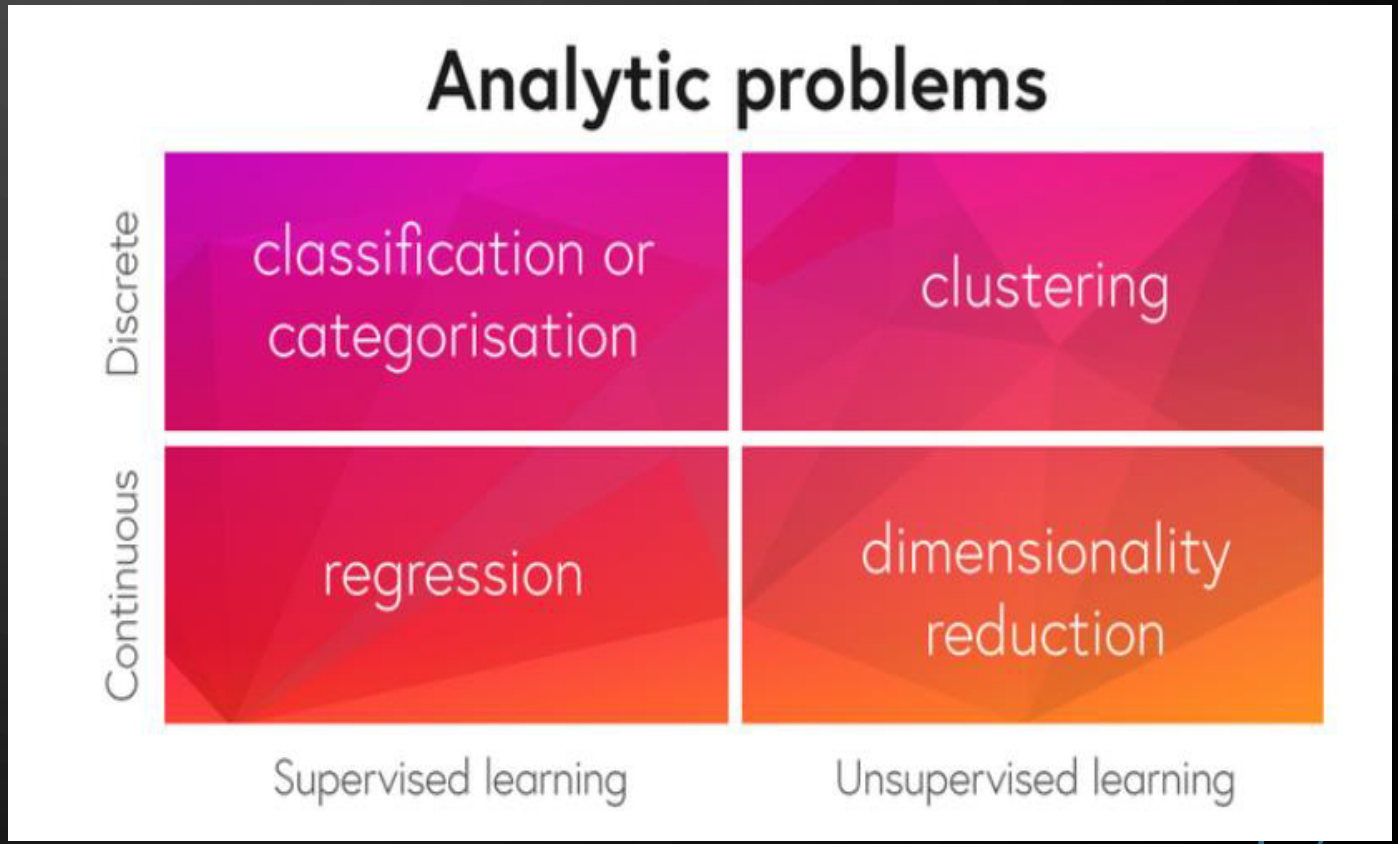
DATA ANALYSIS

- Analysis of the data includes simple query and reporting, statistical analysis, more complex multidimensional analysis, and ***data mining***.
- Data mining is the process of automatically retrieving useful information from huge data repository by predicting the results of future observations.
- Data mining incorporates with various techniques from different domains.

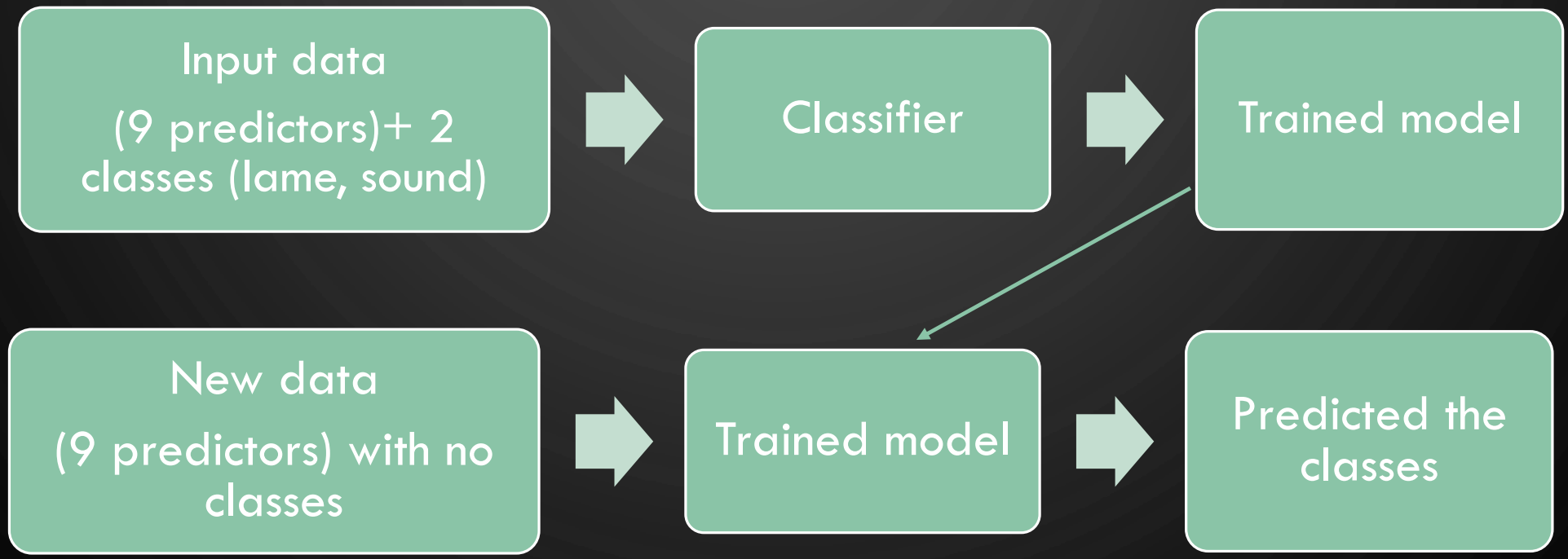


MACHINE LEARNING

- **M**achine **L**earning (ML) is a method of data analysis that automates analytical model building.
- ML investigate how the computers automatically learn from data to identify the output (class) based on the data attributes to predict an intelligent decision for unseen data.

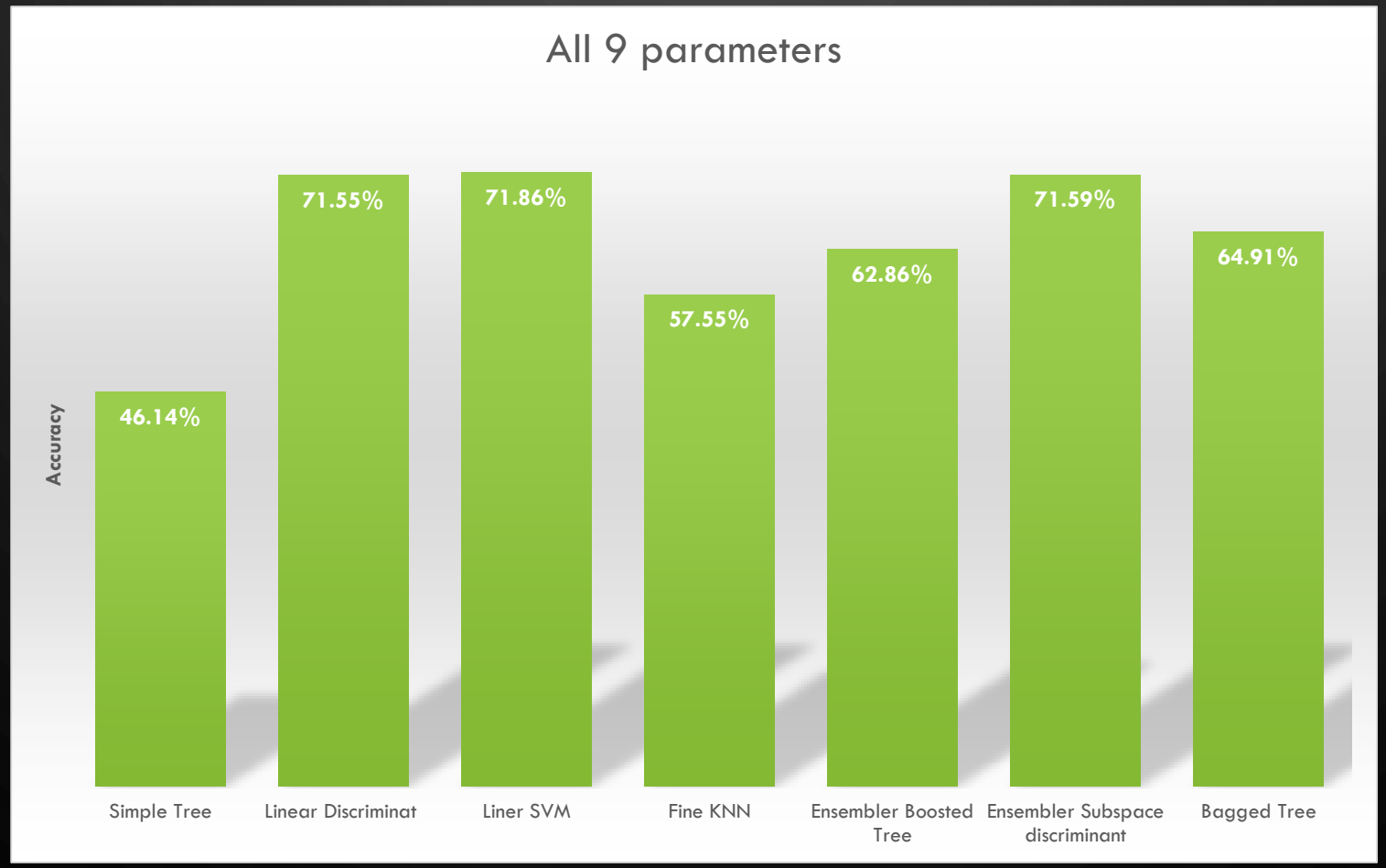


RESEARCH METHODOLOGY



PRELIMINARY RESULTS

- Preliminary results with Classifier



WHAT IS NEXT?

- Eliminate the variable data sensor that have less effect on making a decision (identify lameness class).
- Data preprocessing (normalization).
- Feature extraction (Apply window size scenario)
- Implementation:

The Sensor gives the lameness alarm

- The developed Algorithm will built in the sensor itself.

The Base Station gives the lameness alarm

- The develop algorithm will be in a remote base station (communication part may be need)

REFERENCES

- AHDB Beef & Lamb, Agriculture & Horticulture Development Board. 2014. Manual 7 - Reducing lameness for better returns. [ONLINE] Available at: http://beefandlamb.ahdb.org.uk/returns/health-and-fertility/. [Accessed 01 March 16]

- Van Nuffel, A., Zwertvaegher, I., Pluym, L., et al., 2015. Lameness Detection in Dairy Cows: Part 1. How to Distinguish between Non-Lame and Lame Cows Based on Differences in Locomotion or Behavior. *Animals*, *5*(3), pp.838–860. Available at: http://www.mdpi.com/2076-2615/5/3/0387/.

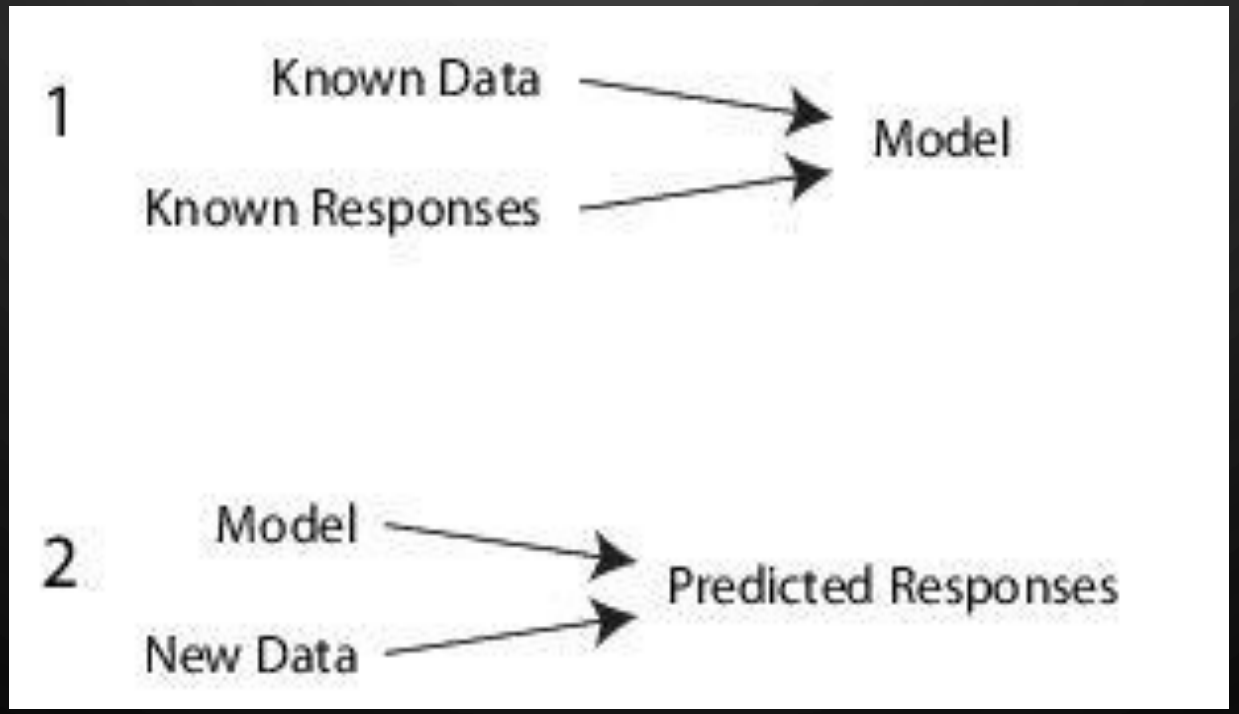
- Nieuwhof, G.J. and Bishop, S.C., 2005. Costs of the major endemic diseases of sheep in Great Britain and the potential benefits of reduction in disease impact. *Animal Science*, 81(01), pp.23-29.

- Lynn Greiner . 2011. *DataBase Trends and Applications*. [ONLINE] Available at: http://www.dbta.com/Editorial/Trends-and-Applications/What-is-Data-Analysis-and-Data-Mining-73503.aspx. [Accessed 01 March 16].

THANK YOU FOR LISTING

CLASSIFICATION

- To predict the new classes in test data set based on the attributes of previously known classes in a training data set.



MATLAB CLASSIFIERS

Classifier	Prediction Speed	Memory Usage	Interpretability
Decision Trees 	Fast	Small	Easy
Discriminant Analysis 	Fast	Small for linear, large for quadratic	Easy
Support Vector Machines 	Medium for linear. Slow for others.	Medium for linear. All others: medium for multiclass, large for binary.	Easy for Linear SVM. Hard for all other kernel types.
Nearest Neighbor Classifiers 	Slow for cubic. Medium for others.	Medium	Hard
Ensemble Classifiers 	Fast to medium depending on choice of algorithm	Low to high depending on choice of algorithm.	Hard

- Speed: fast 0.01 Sec, medium1 sec., slow 100 sec.
- Memory: small 1MB, medium 4MB, large 100 MB.