Halter Project
Predict Cow Sickness Using MLs

161.777: Practical Data Mining
Massey University

CONTENTS

Part One
INTRODUCTION

Halter Project

- Halter is a pioneering company leveraging technology for dairy farmers and operates farms throughout New Zealand.
- Halter provides collars with a specialised app to collect sensor data from cows on farms.
- Sensor data is transformed into valuable behavioural insights through advanced modelling.
- The combined analysis of sensor and behaviour data enables effective monitoring and detection of cows' health conditions.
- Train dataset: 10,181 cows from 150 farms, 5 metadata, 12 sensor and 12 behaviour fs
- Test dataset: 409 cows from 25 farms, 12 sensor variables and 12 behaviour variables in both datasets.

Project Purpose

Objectives

- identify significant correlations within the variables
- explore seasonal sickness
- characterise the recovery process of cows following sickness
- establish patterns to estimate duration of a cow's sickness

Benefits to Farmers

- managing the health of their cows
- preventing mild conditions from worsening and
- minimising the spread of sickness to other cows
- safeguarding the well-being of cows, restoring full productivity and preserving valuable assets


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Part Two
DATA WRANGLING & EDA

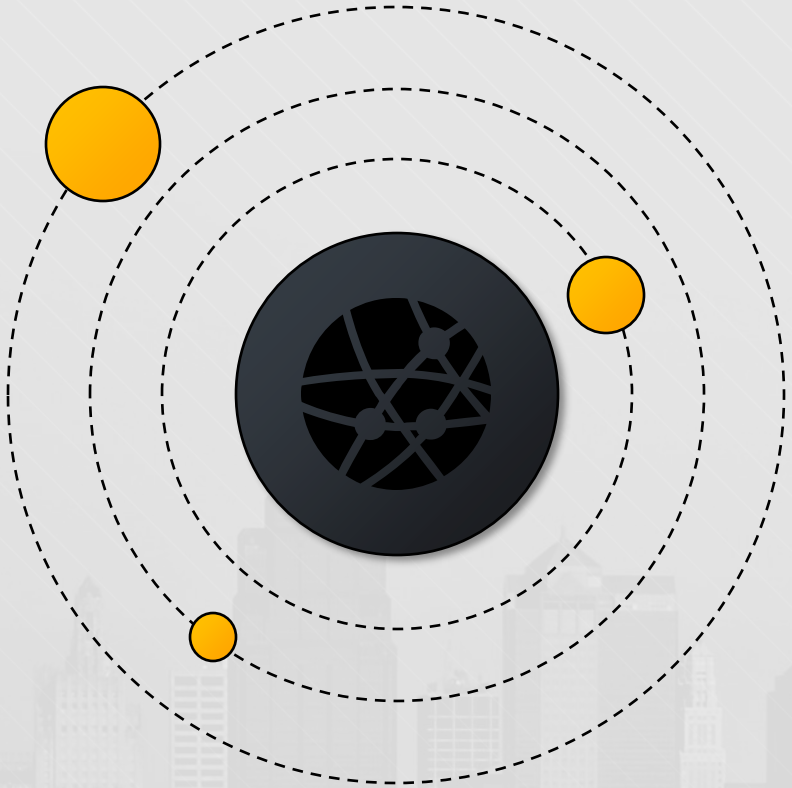
Train Dataset

Metadata
UTC Timestamp
Cattle ID
Farm ID
Sickness Type
Hours Since Sickness

Behaviour Features
Grazing
Mob Median Grazing
Mob Std Grazing
Farm Average Grazing
Resting
Mob Median Resting
Mob Std Resting
Farm Average Resting
Rumination
Mob Median Rumination
Mob Std Rumination
Farm Average Rumination

Sensor Features
ODBA Average
ODBA Std
Farm Average ODBA Average
Farm Average ODBA Std
Pitch Average
Pitch Std
Farm Average Pitch Average
Farm Average Pitch Std
Roll Average
Roll Std
Farm Average Roll Average
Farm Average Roll Std

Data Wrangling



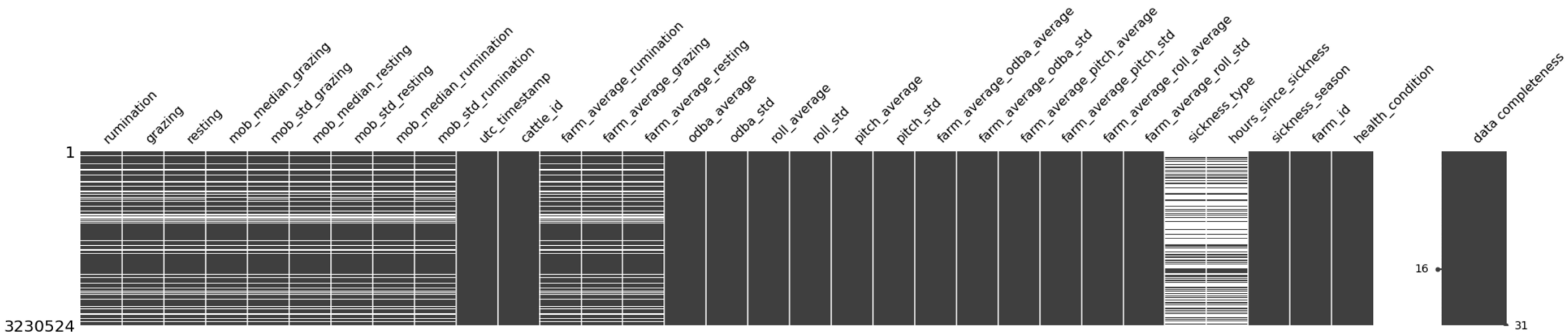
Focus on up to 14 days of pre- and post-health/sickness

Find a target timestamp to select up to 14 days of pre- and post-health/sickness

Look at the hours since sickness column per cow:

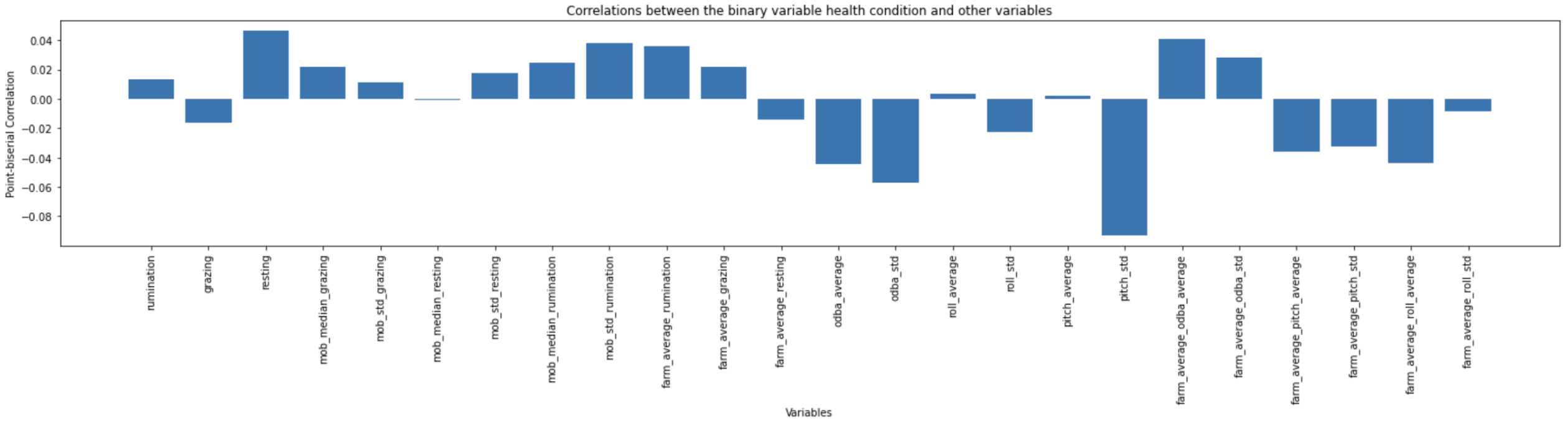
- if all blanks: target timestamp=the earliest timestamp
- at least one value, find 0 or the absolute value closest to 0 :
  - hours since sickness=0, target timestamp on the same row;
  - hours since sickness>0, target timestamp-(hours since sickness);
  - hours since sickness<0, target timestamp+(-hours since sickness).

Missing Data



- 31 columns with 3230524 rows
- Full data: 17 columns
- Missing data: 14 columns, may be caused by sickness type and hours since sickness, which means healthy cows

Point-biserial Correlation



- **Highly positively correlated to health condition**: resting, mob std rumination, farm average rumination, mob median rumination
- **Highly negatively correlated to health condition**: pitch std, odba std, farm average roll average, odba average

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PART THREE

Analysis

Process Flow

Feature Engineering

Method ologies

Model Performance

Key Variables

Prediction Score

Feature Engineering

1 Adding Health Condition

Health_Condition

- 0=health
- 1=sick

2 Adding Seasonal Variable

Sickness_Season

- Spring = Sep-Nov
- Summer= Dec-Feb
- Autumn= Mar-May
- Winter = Jun-Aug

3 Adjusting Relative to Farm/Mob

Adding 18 new variables

Behavior Features Relative to Farm/Mob (9)

- Grazing - Farm_Avg
- Grazing - Mob_Med
- Grazing - Mob_Std
- Resting - Farm_Avg
- Resting - Mob_Med
- Resting - Mob_Std
- Rumitating - Farm_Avg
- Rumitating -Mob_Med
- Rumitating - Mob_Std

Sensor Features Relative to Farm/Mob (6)

- OBDA - Farm_Avg
- OBDA - Farm_Std
- Pitch - Farm_Avg
- Pitch - Farm_Std
- Roll - Farm_Avg
- Roll - Farm_Std

Mob Relative to Farm (3)

- Graze: Mob_med - Farm_Avg
- Resting: Mob_med - Farm_Avg
- Rumitate: Mob_med - Farm_Avg

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Methodologies

	Decision Tree	Gradient Boosting	Logistic Regression	Neural Network
Description	• a simple yet powerful supervised learning model used for classification and regression tasks	• an ensemble learning technique that combines multiple decision trees	• a widely-used statistical model to evaluate the relationship between input features and the probability of an event	• particularly deep learning model, excels at identifying complex patterns and relationships within the data
Advantages	• Highly interpretable	• Highly accurate	• Efficient • Interpretable	• Highly flexible
Disadvantages	• Prone to overfitting	• Less interpretable	• May not perform well with high-dimensional or highly correlated features	• Less interpretable • Computationally intensive

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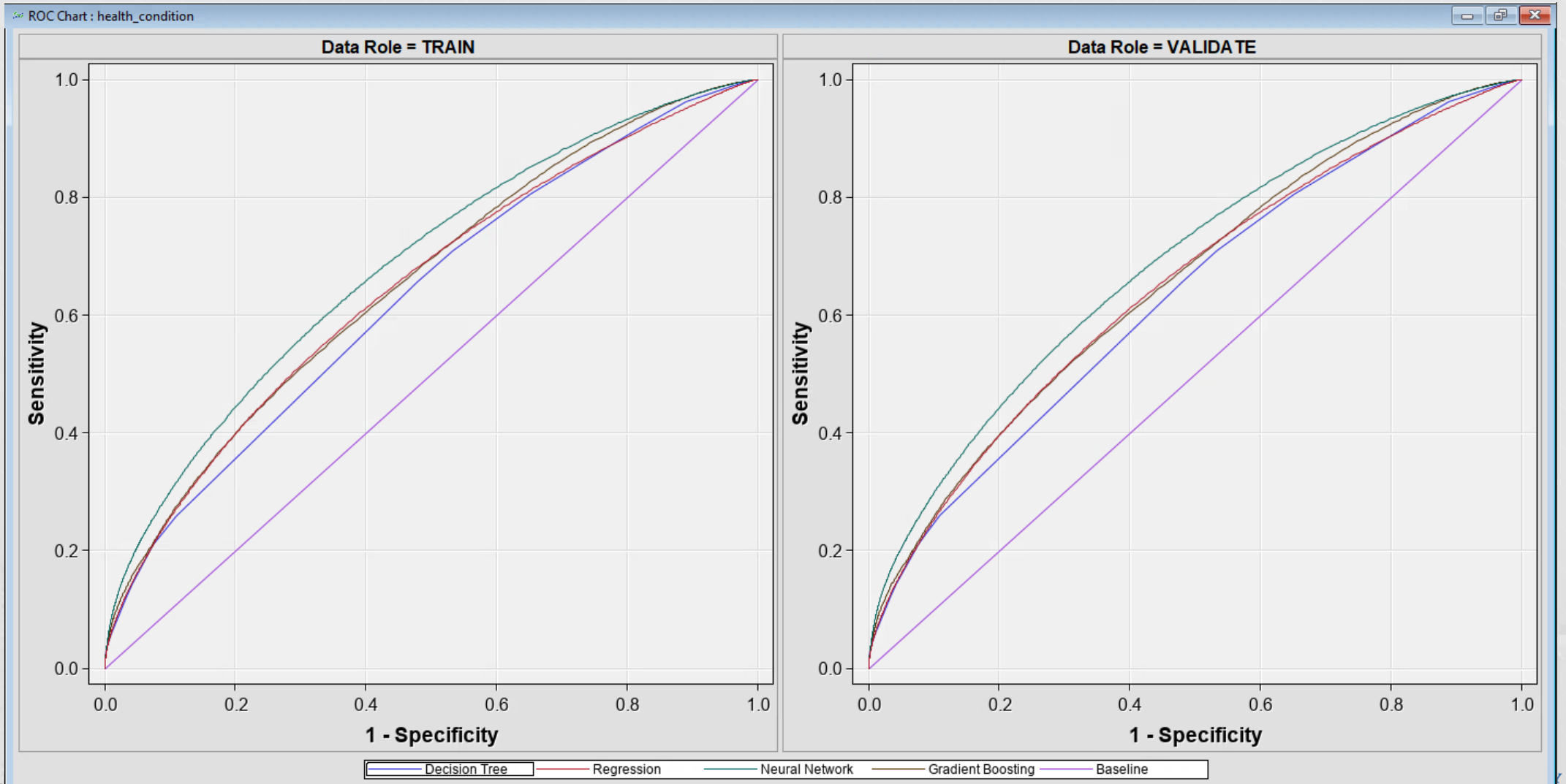
Model Performance



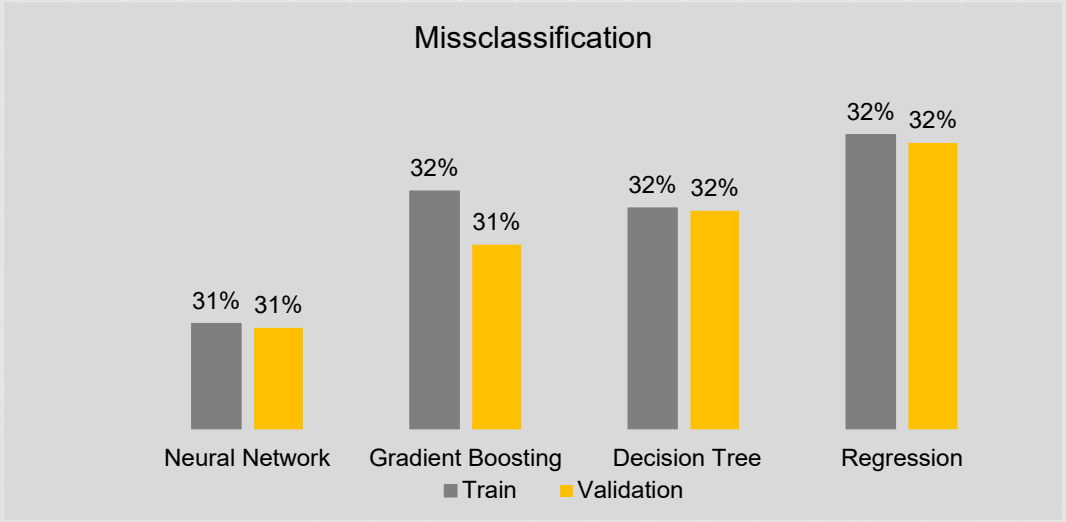
Evaluation Metrics

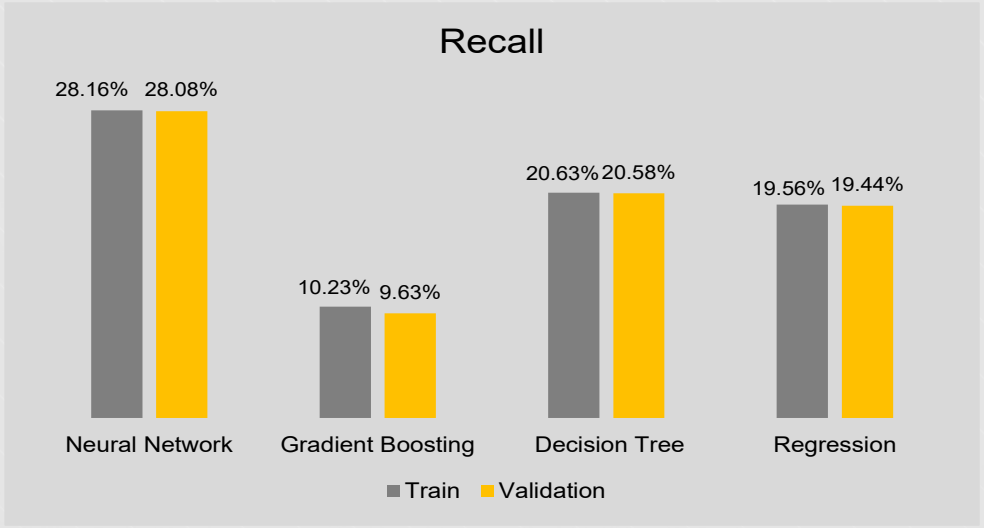
Recall

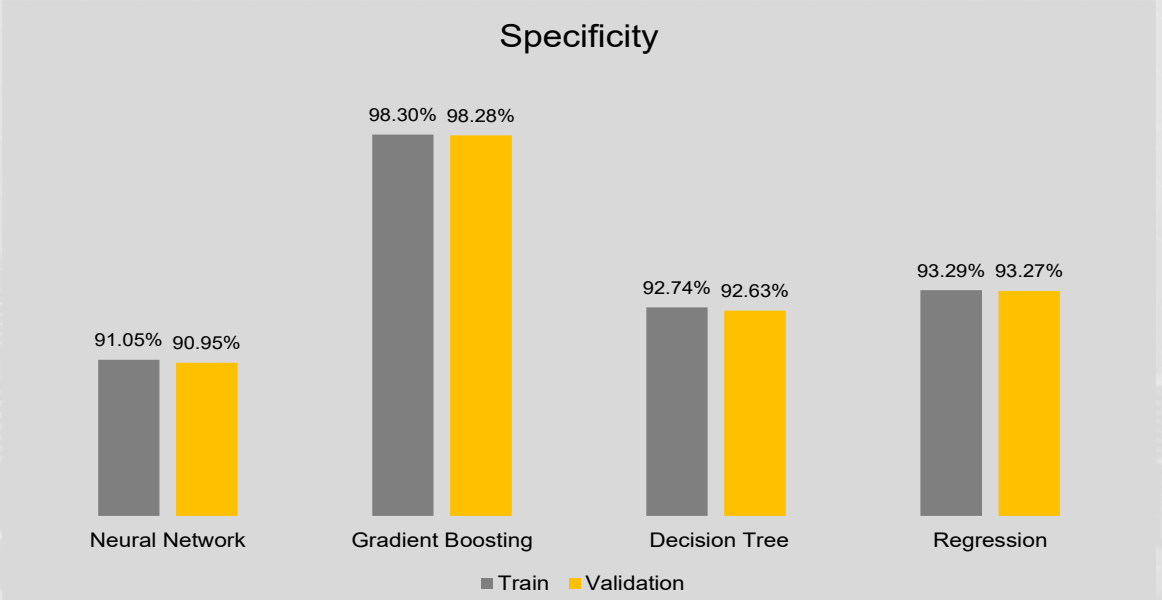
Specificity

$$= \frac{\text{Sick Cows Detected}}{\text{Total Sick Cows}} \qquad \frac{\text{Health Cows Not Alerted}}{\text{Total Healthy Cows}}$$

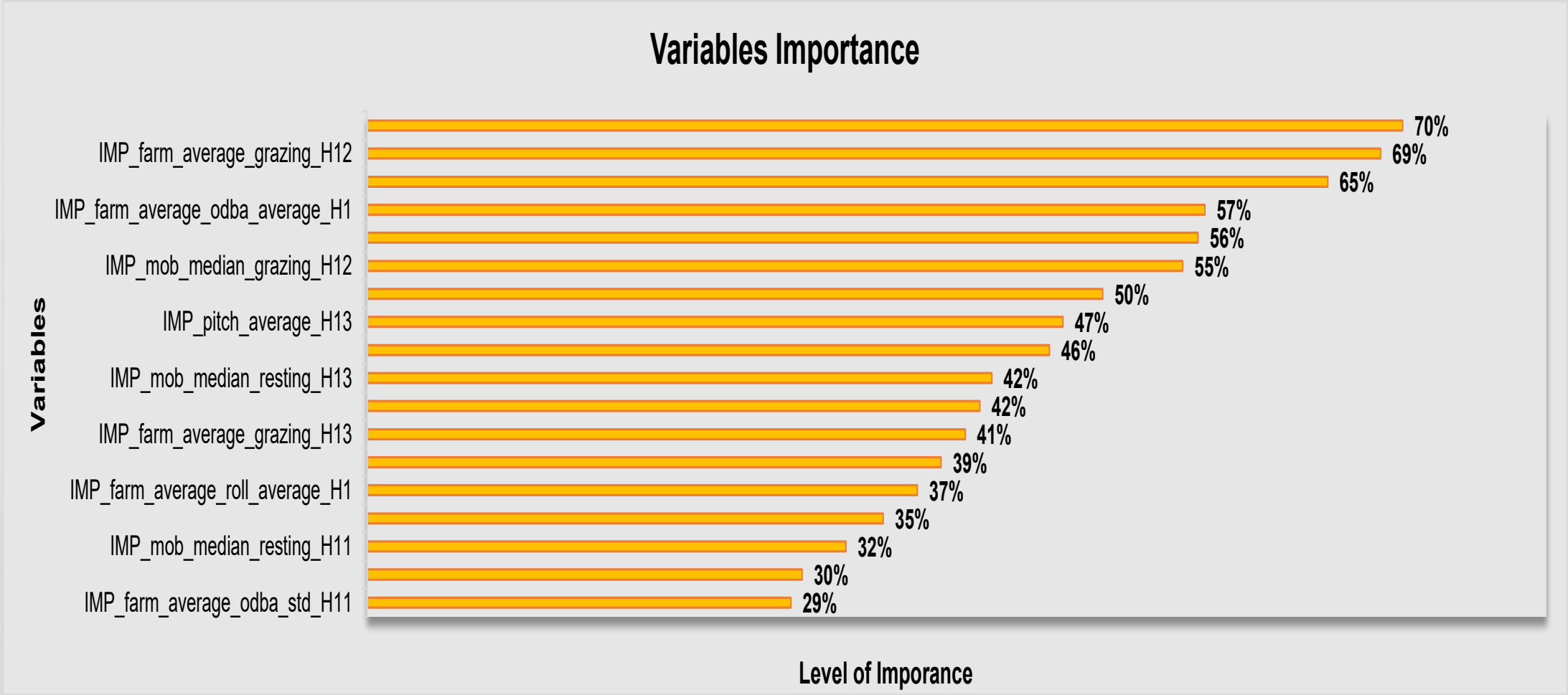
Model Performance







Key Variables of Neural Network



Prediction Score of Neural Network

Recall (percent of sick cows detected, relative to when it was recorded):

2 weeks before / after:	79%
2 weeks before only:	77%

Precision:

Alerted cows which were sick:	98%
Alerts within 2 weeks of a sickness:	59%

PART FOUR

Conclusion

Conclusion

Decision Tree

Gradient Boosting

Neural Network

Logistic Regression

Further Study

- **Adding new variables:** 18 variables adjusting relatives to farm or mob
- **Recovery from sickness**: health condition turn from 1 (sick) to 0 (healthy)
- **Sickness duration:** from the time when cow's health condition is 1 to the time when cow's health condition is 0

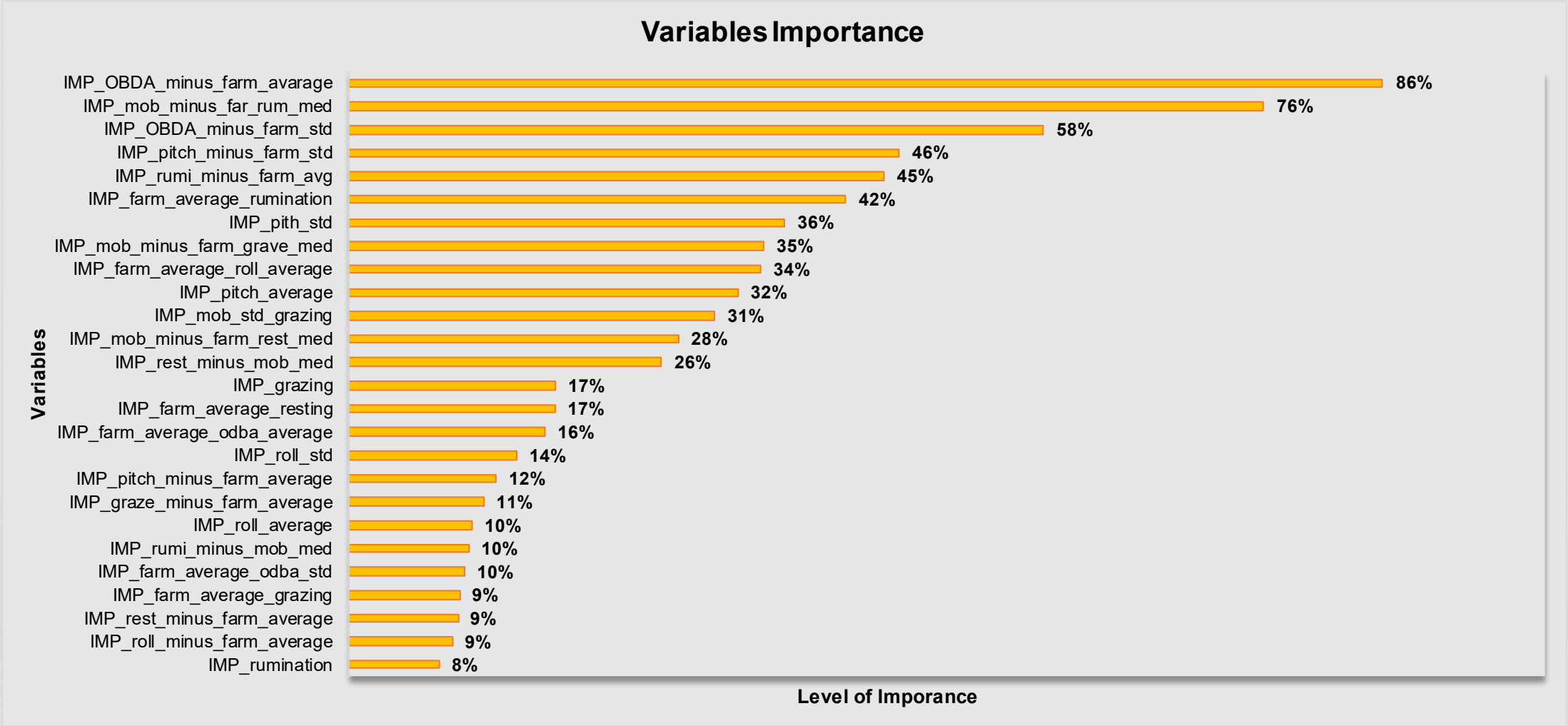
Model improvement

For further study:

- health condition as a binary variable, **long short-term memory networks**
- sickness type as a categorical variable, **naïve baye and nominal model**

Key Variables

(Adding new variables)




THANK YOU