PSG

Cow Calving Ease Project

The aim of this project is to predict Calving Ease Score (CES) of cow based upon cow behaviour data. The CES is a score that indicates how easy it was for the cow to calve, on a scale from 1 to 5:

- 1 means quick, easy birth without assistance,
- 2 means more than two hours of labour, but no assistance,
- 3 means minimal assistance, but no difficulty in calving,
- 4 means an obstetrical chain was used,
- 5 means an extremely difficult birth requiring mechanical assistance.

Introduction

What is calving ease and why is it important?

01 Nutritional Source

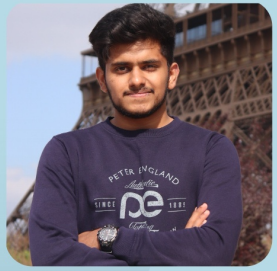
Milk is a vital source of nutrition globally, and its production heavily depends on healthy cows and successful calving. Calving is crucial because it initiates lactation; without it, milk production doesn't occur, making calving ease essential for both animal welfare and dairy farm efficiency.

02 Machine Learning Benefits

Machine learning can help predict calving ease by analyzing patterns in historical data such as cow breed, age, and previous calving outcomes. This allows farmers to make more informed breeding and management decisions, improving both animal welfare and productivity.

Project Goals

Team members:



Shashank

Designation

Suyash

Designation

Sriram

Designation

Feature Description

01 CalvDate

The actual date the cow gave birth — helps align behavior patterns with calving.

02 AvgTotalMotion

Average physical movement — increased motion may indicate restlessness pre-calving.

03 TotalMotion

Total accumulated motion data in a period — reflects activity level.

04 AvgTotalSteps

Average number of steps — spikes can hint at discomfort or upcoming labor.

05 TotalSteps

Full step count — supports trends seen in average step analysis.

06 Cow

Cow identifier — allows tracking and group-wise splitting to prevent data leakage.

07 AvgRumination

Average time spent chewing cud — typically drops just before calving.

08 Rumination

Point-in-time rumination reading — often used in combination with motion data.

09 Parity

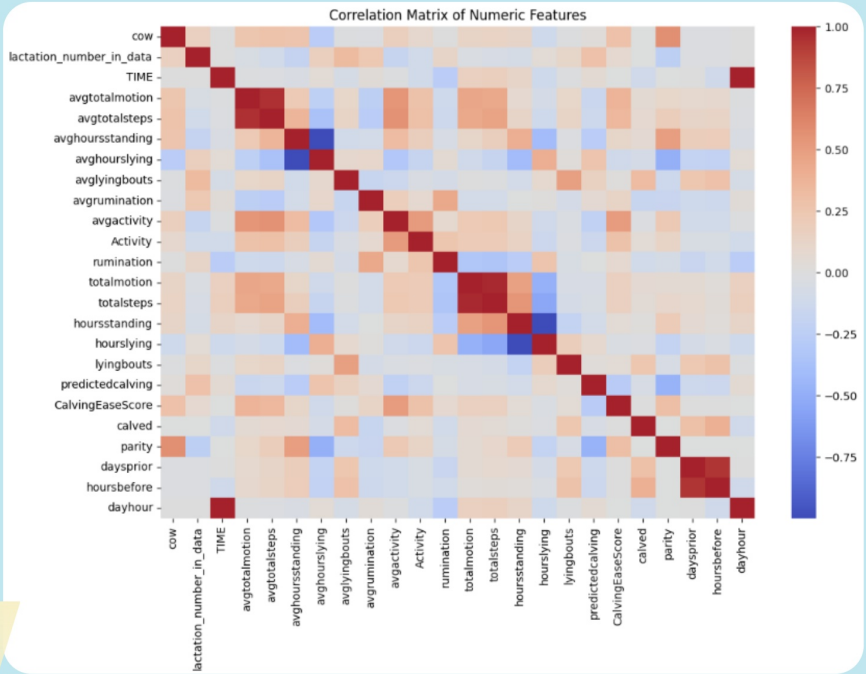
Number of previous calvings — first-time mothers often have harder births.

10 Days_Since_Last_Calving

Time gap between calvings — longer gaps may indicate risk or recovery factors.

Data Description

Correlation Matrix for all Numeric Features



1,837 records

Total records available

This dataset contains a substantial amount of data for analysis.

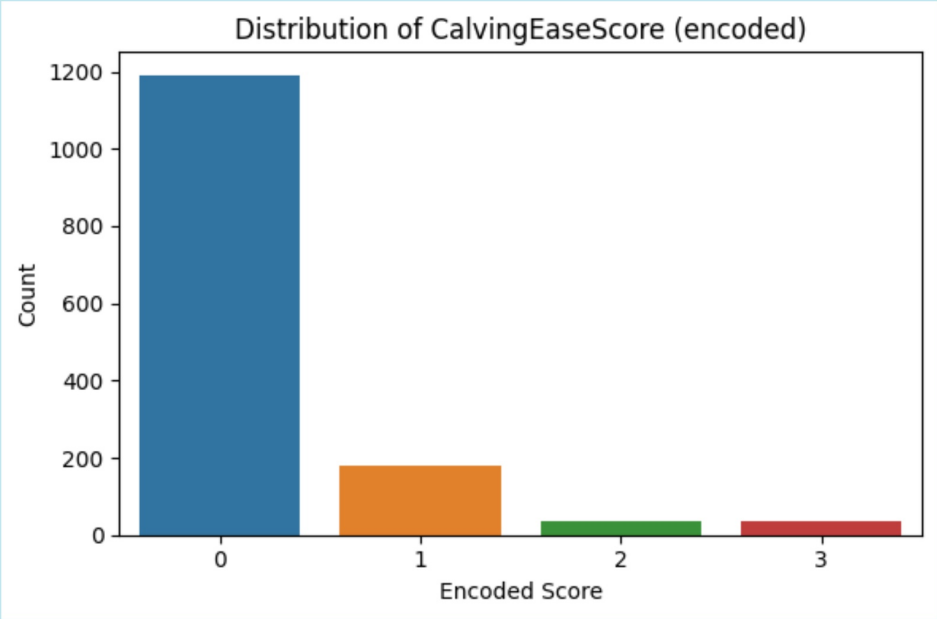
28 features

Total features included

The dataset includes various metrics relevant to cow monitoring.

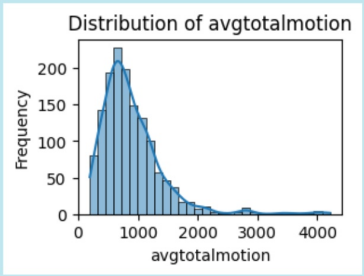
Label Distribution

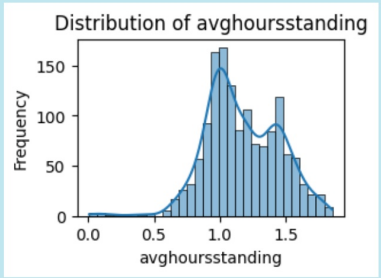
The image shows how the CES scores are labelled in the data.

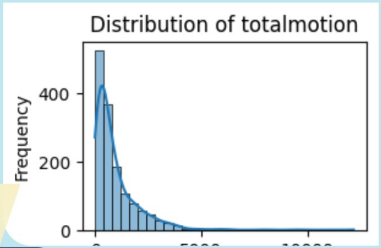


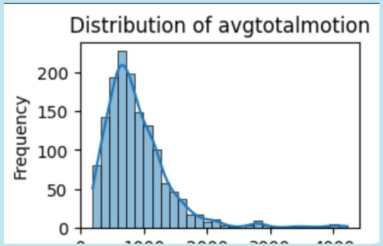
Pre processing and data cleaning steps

Distributions of Few Important Numerical Features









01

Standard Scaler

Used to standardize the dataset features.

02

Removed Columns

Columns with only one unique value (no variability) were removed.

03

Filled Missing Values

Filled missing values in numeric columns with their mean.

04

Label Encoder

Converted text/object columns into numeric values.

05

Removed Date Columns

Removed date columns (date, calvdate) and redundant columns (CES).

06

Deleted Rows

Deleted rows where all values are missing.

07

Captured Non-linear Relationships

Used new features like lying_steps_interaction.

Model Development

01 **Logistic Regression CV Accuracy**

87.43 ± 0.74% Accuracy

02 **Random Forest CV Accuracy**

98.27 ± 0.99% Accuracy

03 **XGBoost CV Accuracy**

99.57 ± 0.27% Accuracy

Hyperparameter-Tuned XGBoost

We used GridSearchCV to find the best XGBoost settings for predicting calving ease. This boosted model accuracy while avoiding overfitting.

Best Model Performance

Our tuned XGBoost model achieved **98.96%** test accuracy, accurately predicting calving difficulty based on cow behavior.

Weighted F1 Scores

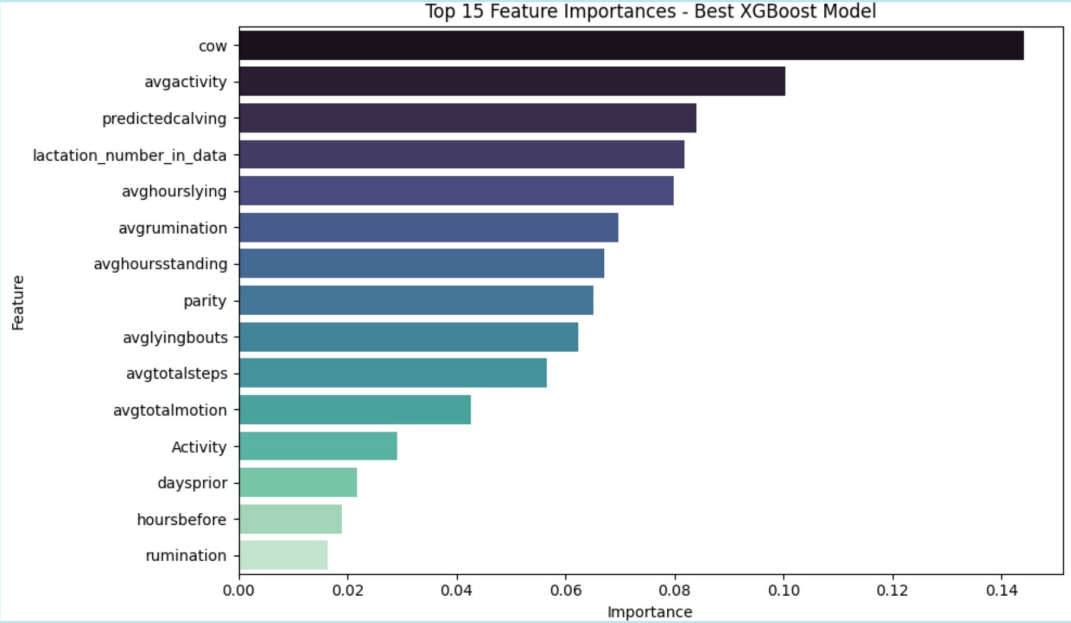
The model achieved **98.941%** weighted F1 score, which is a criteria used to judge the accuracy of the model

Results

Test performance Accuracy based on F1 score

Important Features

The bar plot shows the important of the top 15 features based on the gain each features brings to the model



Ethical Considerations

- **Machine Learning Model Potential**

  Our machine learning model demonstrates strong potential to predict calving ease using behavioral and health data, helping farmers anticipate and manage difficult births.

- **Improving Productivity**

  This approach not only improves productivity and farm efficiency, but also emphasizes animal welfare and ethical care.

- **Individualized Management**

  By focusing on real-time activity data over breed assumptions, the model shifts farmers' perspectives toward individualized, compassionate management.

- **Core Ethical Considerations**

  Ethical considerations—like fairness, transparency, and responsible use—are at the core of our project, ensuring AI supports human judgment, not replaces it.

- **Automation vs. Human judgment**

  AI predictions should support—not replace—farmers' experience. Overreliance may lead to missed contextual cues or poor decisions.

Ethical Considerations

Farmer/Cow Interactions:

AI Support

The use of AI can support farmers by reducing physical and emotional stress during calving periods, allowing them to make more informed decisions.

Model Design

We designed the model to support farmers, not replace them with AI.

Early Warnings

By providing early warnings through Calving Ease Scores (CES), it allows farmers to prepare and respond in a timely, informed way during the critical calving period.

Human-Animal Connection

This enhances the farmer's ability to care for the animal without diminishing the human-animal connection.

Ethical Considerations

- **Breed-based assumptions**

  Many farmers rely heavily on breed-based assumptions to predict how easily a cow will give birth.

- **Machine learning model**

  Our machine learning model reveals that physical and physiological factors are often more accurate predictors of calving ease than breed alone.

- **Reframing cows**

  It helps reframe cows not as tools for milk production, but as individuals with needs that can be understood and supported through smart technologies.

- **Animal welfare concerns**

  Using behavior data to intervene earlier can improve outcomes—but only if it's used humanely and not to push productivity at the cost of comfort.

Conclusion

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- **AI's impact on agriculture**

  We believe AI can improve the agriculture market and prevent any fluctuations which can alter people's lives (possibly preventing any famines or shortage of milk throughout the world).

- **Wellbeing of cows**

  Additionally, this will also ensure the wellbeing of cows which can improve the ecosystem especially at the root level.

- **Supporting informed decisions**

  AI-powered predictions give farmers valuable insights ahead of time, helping them make better, faster decisions during critical calving periods.

- **Scalability for small farms**

  Affordable AI solutions can empower small and medium farms to access the same precision tools as large-scale operations, promoting equity in agriculture.