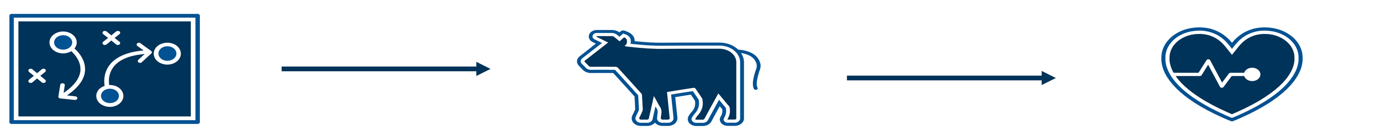
Advancing Precision Livestock Agriculture

Harnessing **Generative AI** for Enhanced Animal Behaviour Recognition

Regina Eckhardt[1], Reza Arablouei[2], Kieren McCosker[3], Heinz Bernhardt[1]

PROPOSED PROCEDURE

- **Idea**: Develop generative AI models to synthesize realistic data, simulating effects of various factors on cattle health and welfare
- **Importance**: Enable proactive assessment of future challenges in livestock farming



REASONS TO CHOOSE GENAI

- **Efficiently** process **large** amounts of **data:**
  - Accelerometer data is available with around 50 measurements per second
- **Generating** data for unseen **scenarios:**
  - Generative models learn relationships and important characteristics **without complex parameter tuning**
  - Simultaneously generate realistic data
- **Effective adaptation** of the **transformer** architecture:
  - **Utilize existing** models & structures
  - Easily adapt models to our data

DERIVE CATTLE BEHAVIOUR

- Deep Learning models enable **precise insights** into cattle **welfare**
- Detected behavioural changes detected through these models can **indicate health issues**, enhancing early intervention strategies
- **Deep Learning** models **outperform traditional** models in accuracy despite their computational demands

SENSOR DATA - KEY FEATURES & COLLECTION

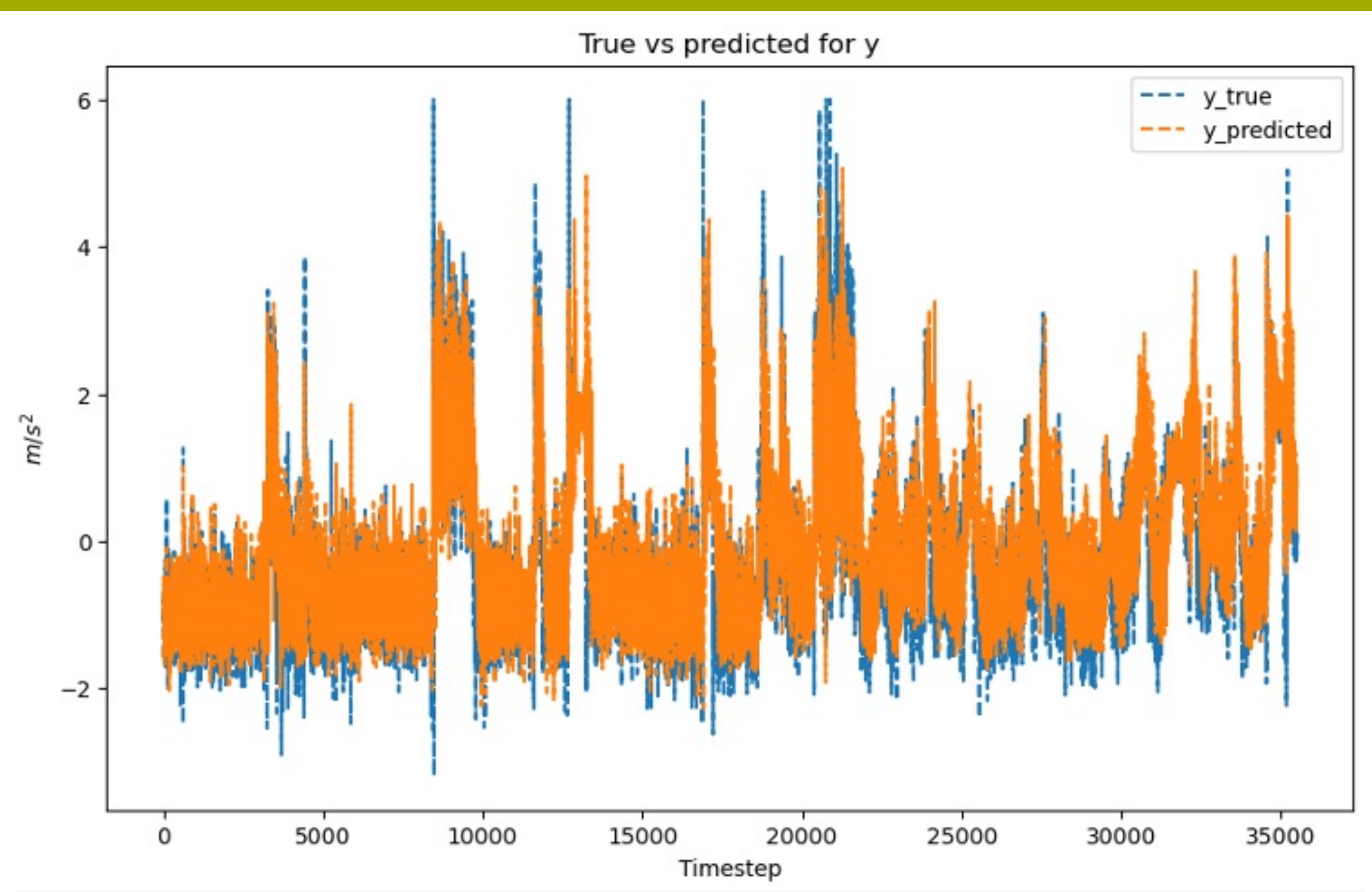
- Data from an experiment conducted at the **University of Queensland's Darbalara Farm**
- Data obtained using a **3-axis accelerometer** on a smart collar tag called **eGrazor**
- **eGrazor** is specifically designed for monitoring livestock
- 23 cattle were fitted with eGrazor collar tags
- eGrazor captured 50 measurements per second over a span of **30 days**

INNOVATE WITH EXISTING MODELS

- Leverage already **existing Transformer** models designed for time series data
  - Utilize accelerometer data as **time series data**
    - Apply established Transformer models tailored for time series analysis:
      - Effectively manage **seasonal patterns** in the data
      - Identify and learn **trends** within the data
    - Chosen model for initial implementation: **Autoformer**
    - **Autoformer model:**
      - Transformer-based model
      - Specific to time series forecasting
      - Capable of learning **temporal patterns**, **seasonalities** and **trends**

RESULTS

- **Promising initial results:**
  - Autoformer demonstrates **effectiveness** in capturing underlying patterns
  - Predicted values (orange) generally align well with actual values (blue), indicating **high accuracy** in **trend prediction**
- **Performance metrics:**
  - RMSE of 0.503 and MedAE of 0.239, both indicating **high accuracy**
  - Each training iteration took approximately 0.5 seconds on an Intel Xeon CPU
  - **Training** on one hour of data (~180,000 points) took around **six hours**
- **Challenges identified:**
  - **Discrepancies at peaks** where predicted values diverge from actual values indicating difficulty in handling abrupt changes
  - Sensitivity to data fluctuations, accurately predicting smaller peaks but **struggling with larger spikes**



CONCLUSIONS

- **Promising results:**
  - Initial implementation of the Autoformer model shows promise, despite limited data
- **Current challenges:**
  - Difficulty in predicting **extreme values**, especially at higher data ranges
- **Planned improvements:**
  - Adjust model architecture and fine-tune hyperparameters to improve performance in capturing rapid changes and high-magnitude values
- **Dataset and feature expansion:**
  - Extend dataset to cover longer periods for deeper insights (seasonal patterns and routine cattle behaviours)
  - Integrate **additional features** for enhanced analysis and predictive power
- **Future research:**
  - Explore alternative solutions to reduce computational costs
  - **Enable more efficient training** of larger datasets over extended periods

1. Chair of Agricultural Systems Engineering, TUM School of Life Sciences, Technical University of Munich, Freising, Germany
2. CSIRO's Data61, Pullenvale QLD, Australia
3. Queensland Alliance for Agriculture and Food Innovation, University of Queensland, St Lucia QLD, Australia