Utilization of sensors, production data, and machine learning models in decision-making processes in commercial pig production

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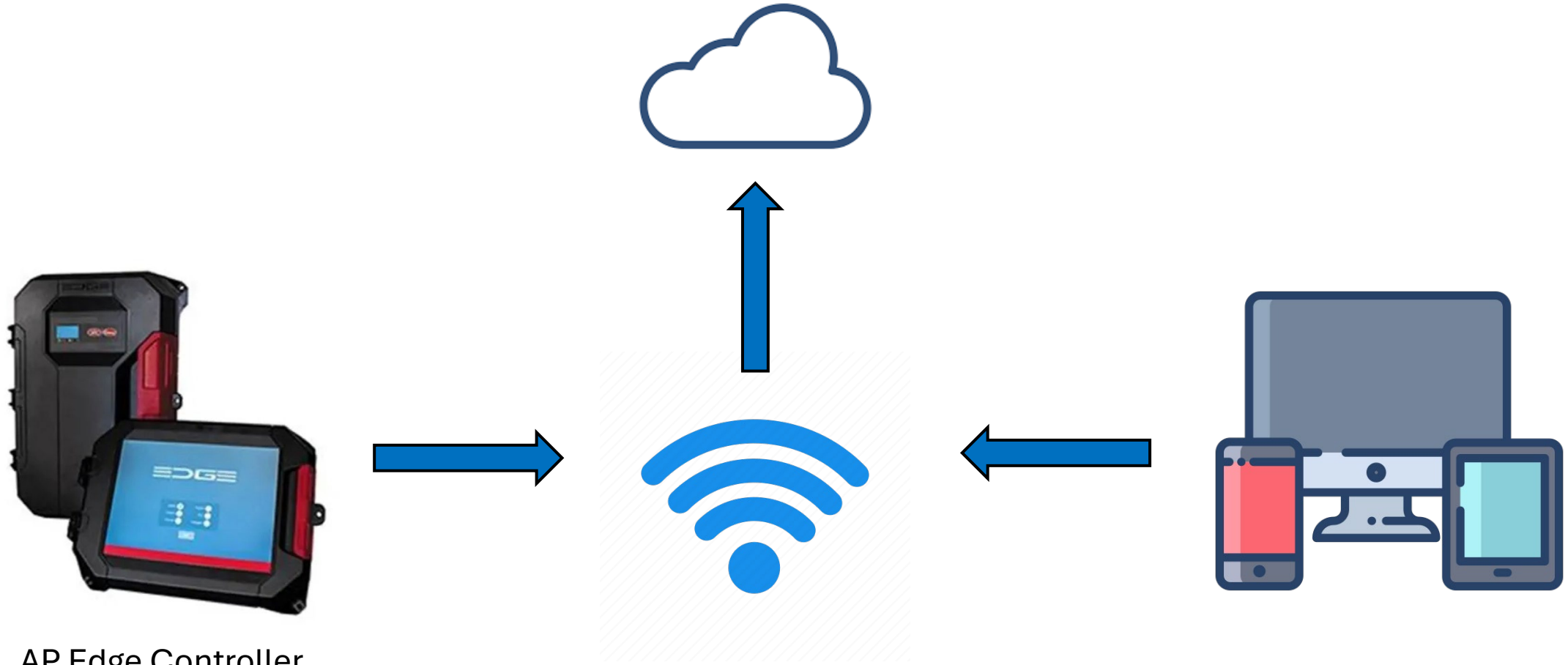
BACKGROUND: You can't manage what you don't measure – *often and accurately!*

Example: A farmer experiencing short-term increases in mortality cannot effectively intervene without recording mortality daily



AP Edge Controller

BACKGROUND: Advances in technology have enabled a rapid increase in the amount of data available to commercial pig producers

Group Level Production Data

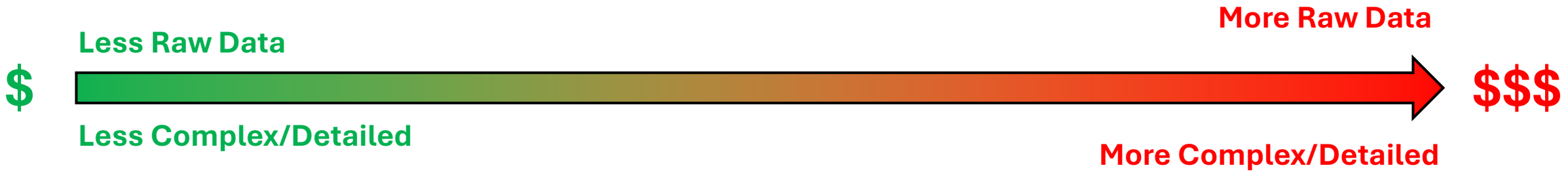
- Inventory
- Movements
- Entry and exit weights
- Feed deliveries
- Market sales
- Mortality
- Treatments

Sensor Data

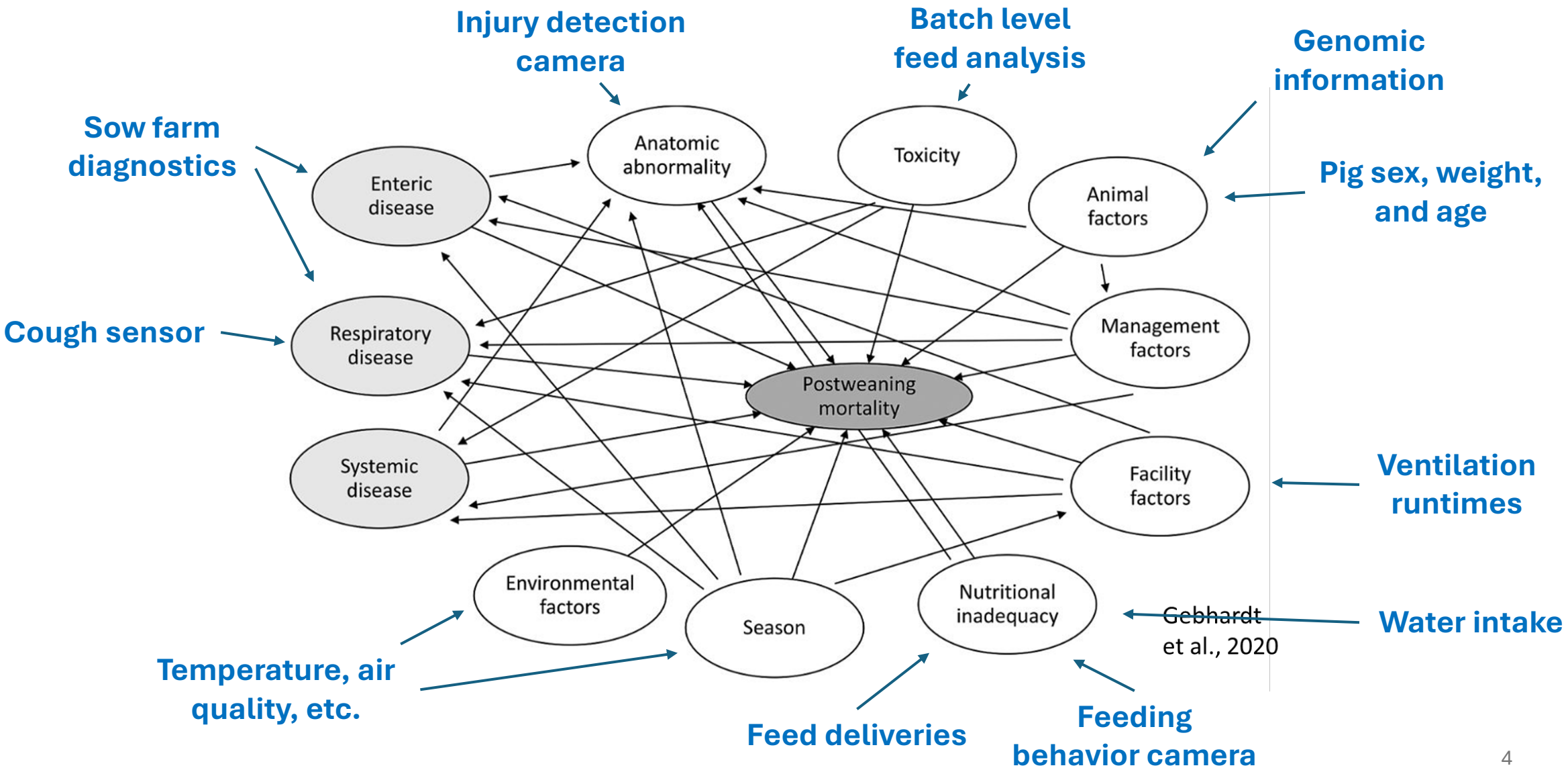
- Temperature
- Water disappearance
- Cough monitors
- Air quality measurements
- Fan runtimes
- Feed bin levels
- Feed line runtimes

Camera Data

- Feeding activity
- Drinking activity
- Injury detection
- Aggression detection
- Weight estimation
- Body temperature monitoring
- Social interaction



Drivers of profitability on pig farms, such as mortality rate, are influenced by complex webs of causal factors



As the number of data streams from sensors, cameras, and production data increases, daily decision processes could become more difficult

Problems

- For each sensor or camera deployed, the number of daily ***decisions*** multiplies by a factor of 2
- Example: 2 sensors (A and B)
  - A: Good, B: Good
  - A: Bad, B: Good
  - A: Good, B: Bad
  - A: Bad, B: Bad
- ***How*** do farmers prioritize ***where*** and ***when*** to act upon information relayed from the sensors?
- ***What*** are the optimal operating procedures in the event of a sensor or camera warning?

A Potential Solution

- Machine learning models take data from hundreds of sources and provide a single prediction
- Automatically accounts for complex interactions and nonlinearities (previous slide)
- Learns future outcomes from patterns in past data streams
- Can be tailored to predict key drivers of profitability (mortality, feed conversion, etc.)
- Continuously monitor data streams and their impact on economic drivers

Definition of the target variable is integral to successful application of machine learning models in smart farms (think like a producer!)

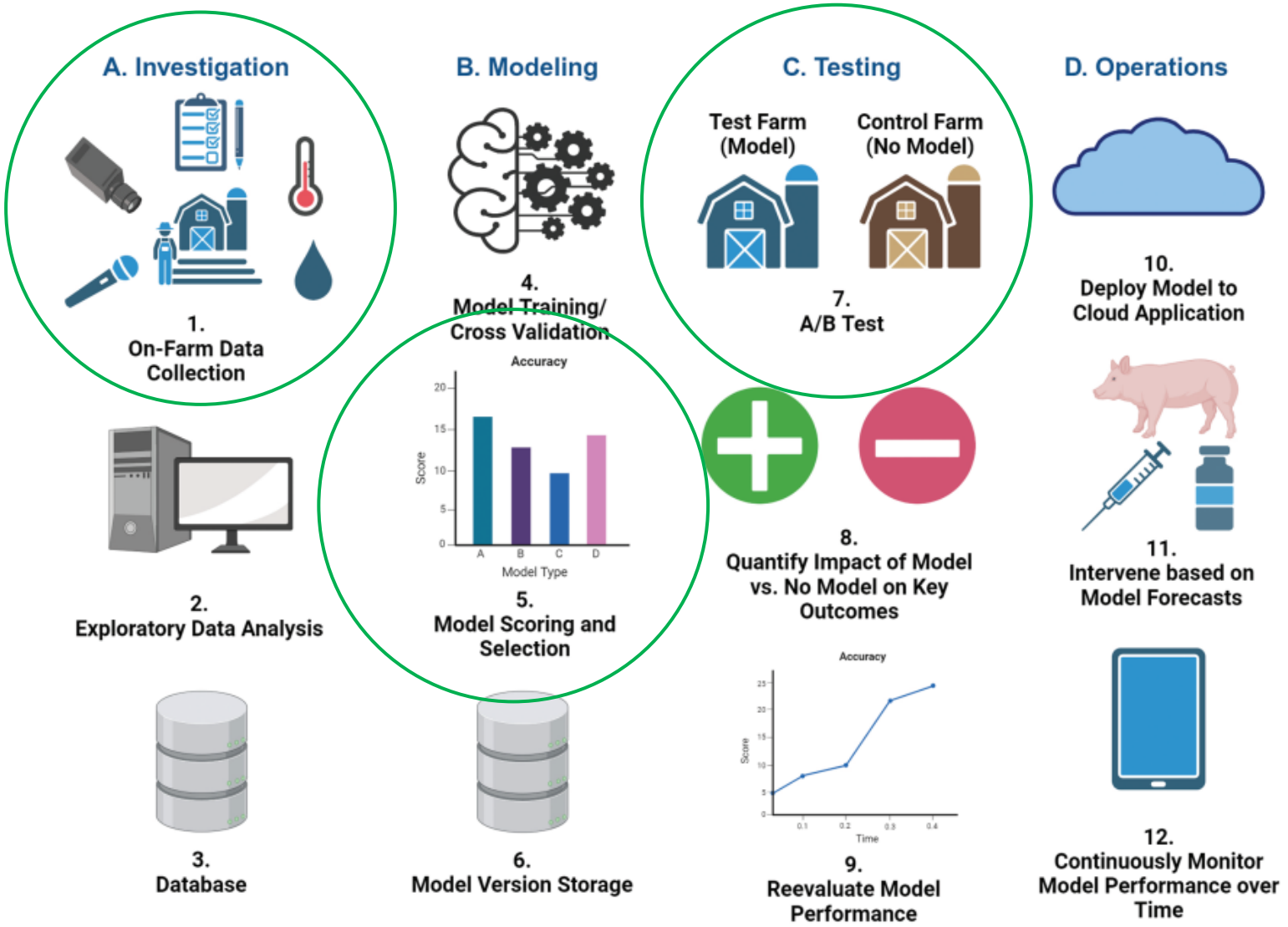
1. Magnitude of the target variable required to trigger action
   - Example: X% increase in mortality rate, three consecutive days with increases in the number of mortalities, etc.
2. Cost of intervening in the event of a trigger
   - Medication, labor, veterinary, consulting costs, etc.
3. Cost of the sensors/cameras required to predict the target variable

Finding the threshold where…

Cost to fix the economic driver

Impact of the economic driver

A comprehensive framework for successful application of machine learning models in commercial pig production



- Identification of leading indicators for target variable
- Cost/benefit analysis

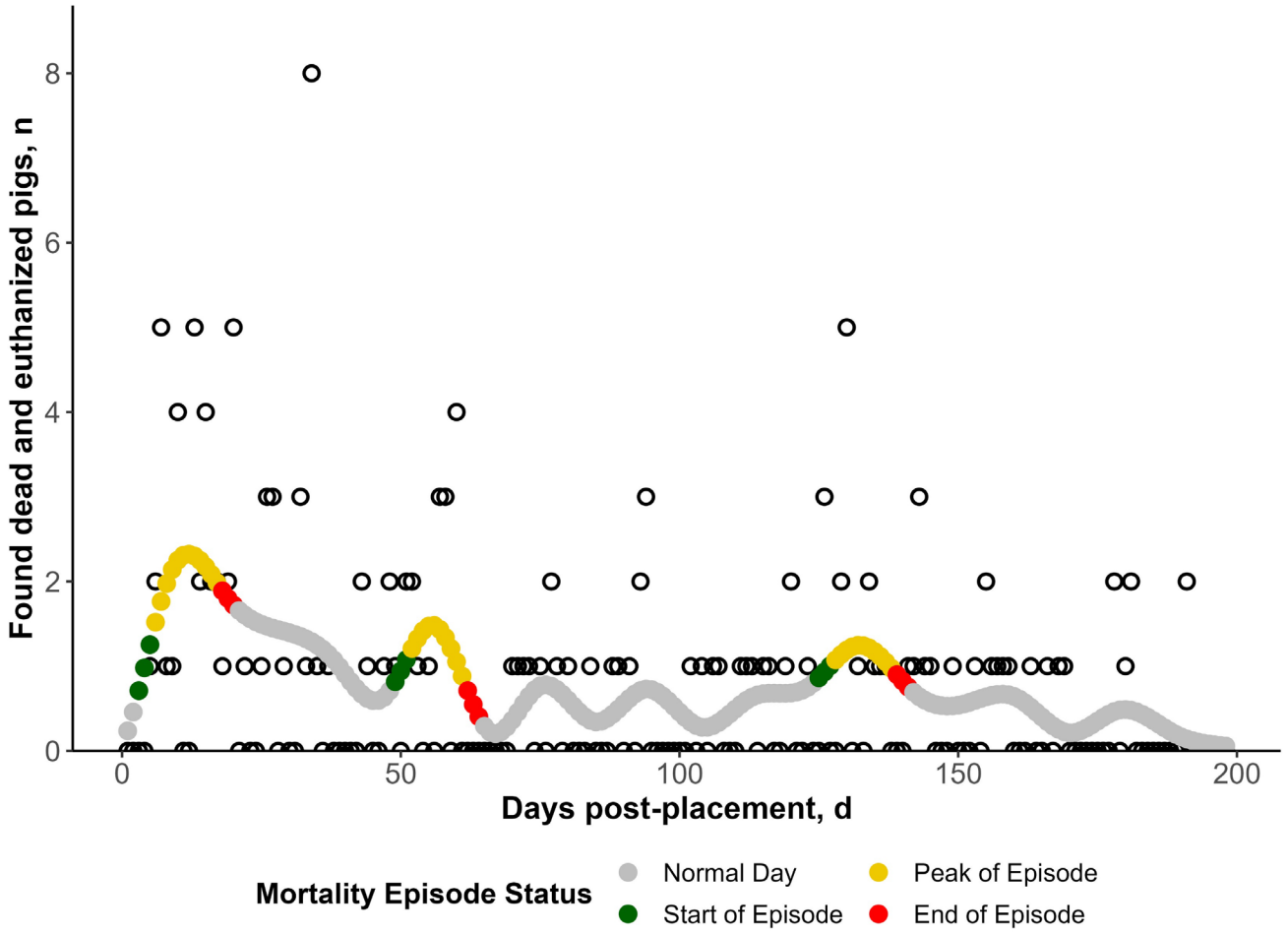
- Impact of accuracy on intervention
- Sunk cost of intervention for false positives
- True positive detection ability compared to baseline

- Do we observe a measurable positive impact on the target variable?
- How does model use impact employee/user behavior?

Grohmann and Decker, 2025

A simplified example to predict mortality episode occurrence in wean-to-finish barns

Target Variable Definition using Historical Data



Encode Target Variable:

- Normal Day = 0
- All Other Days = 1

A simplified example to predict mortality episode occurrence in wean-to-finish barns (cont.)

Age
- Days post placement
- Growth period

Water Disappearance
- Real gal/hd/d
- Detrended gal/hd/d

Temperature
- High and low set point deviations
- High – low temperature range

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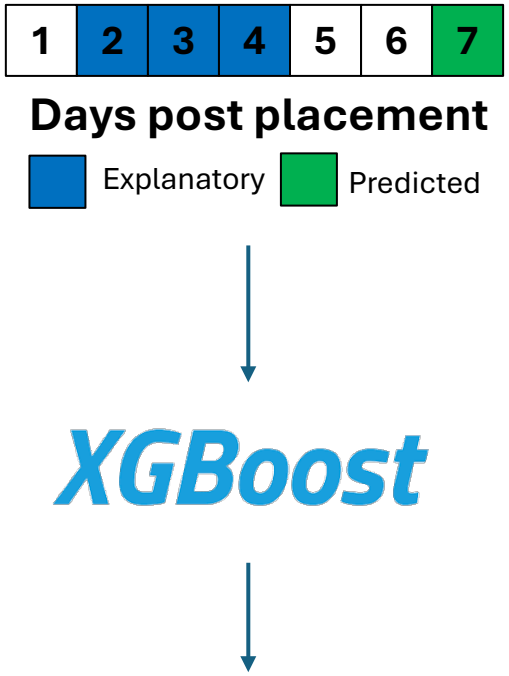
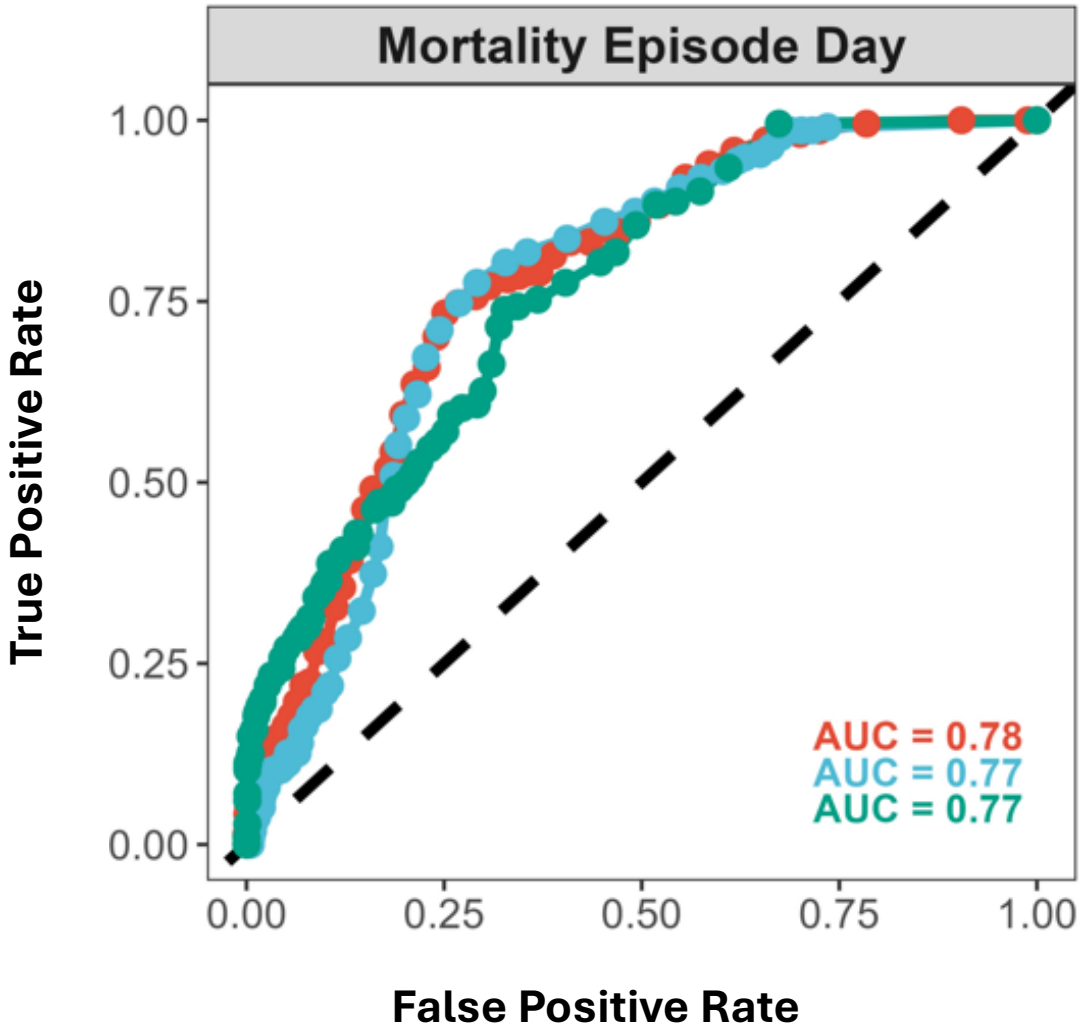
- Respiratory Health Status
  - 1 (high cough) to 99 (low cough) numerical indicator of cough incidence

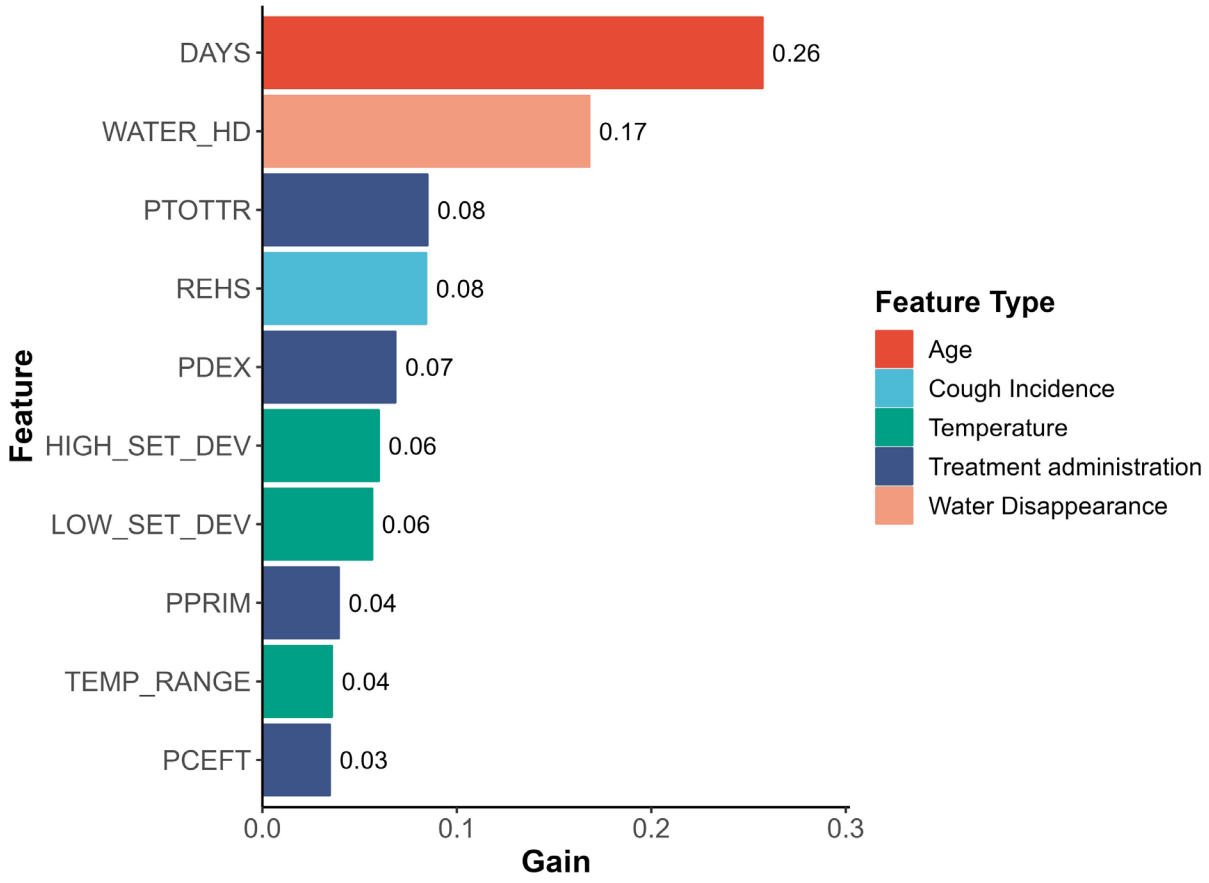


Predicted probability of a mortality episode 3 days from today

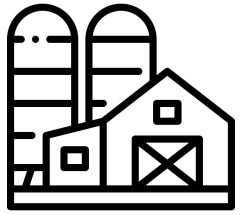
Antibiotic Administration
- Proportion of inventory
  - Ceftiofur
  - Dexamethasone
  - Enrofloxacin
  - Lincomycin
  - Penicillin
  - Tetracycline
  - Primary Respiratory
  - Secondary Respiratory
  - Total injected
- Water Medications (0 = none/1 = administered)

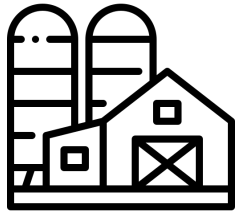
A simplified example to predict mortality episode occurrence in wean-to-finish barns (cont.)





A simplified example to predict mortality episode occurrence in wean-to-finish barns (cont.)





XGBoost

Prediction

75% chance for a mortality episode in 3 days

10% chance for a mortality episode in 3 days

XGBoost

Feature Contributions

- Cough increased likelihood by **25%**
- Temperature deviations increased likelihood by **20%**
- Water intake decreased likelihood by **5%**

Intervention Checklist

1. Run diagnostics
2. Water medications?
3. Check controllers, heaters, fans, set points, etc.

Closing Thoughts…

- Establish a baseline
  - How good are we at managing an opportunity outcome?
- Don’t let ***perfect*** be the enemy of ***better***
  - 100% accuracy is not required to make improvements or more profitable decisions
- Start small…
  - Evaluate what data streams are currently available and how they can be leveraged further
- Adopt a proactive instead of reactive mindset
  - Machine learning, assisted by sensors, cameras, and other technology can help detect problems before it’s too late

Carthage Analytics: turning data into information, information into knowledge, and knowledge into action

- **What we do:** provide clients with Power BI reporting and predictive analytics across a variety of data integrations
  - Sow (PigKnows and Porcitec), Wean-to-Finish (MetaFarms and PigKnows)
- Current and Future Projects incorporating Machine Learning
  - Automated market weight optimization, down to the pig group-level
  - Market plan optimization: scheduling first cuts, mid-cuts, and final cuts
    - First Cut Predictor (next slide)
  - Automated wean-to-finish mortality monitoring
  - Prediction of farrowing success based on historical sow records
  - Wean pig forecasting for optimization of supply ordering at sow farms
- Always open to collaboration!
  - Feel free to reach out: cgrohmann@hogvet.com

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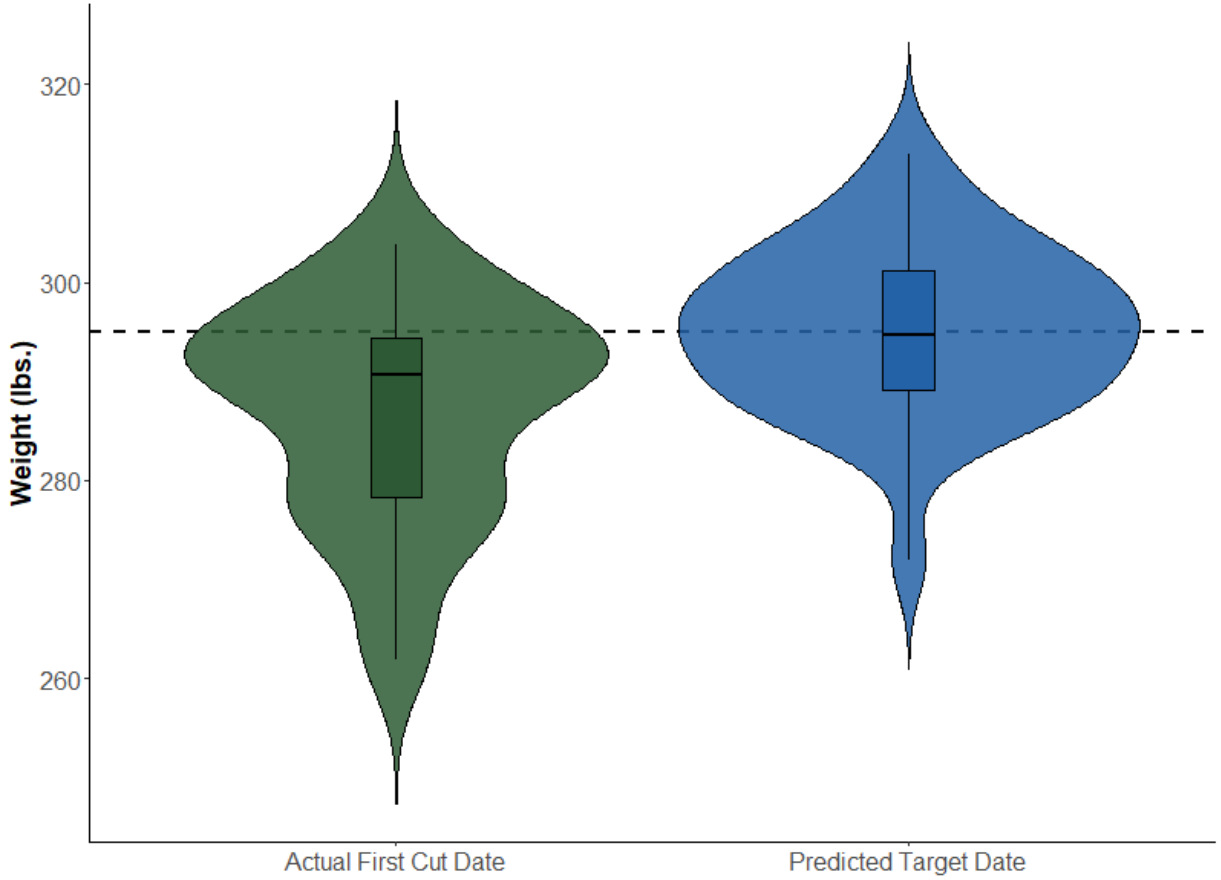
Carthage Analytics: *First Cut Predictor* model has shown promising results in reducing load weight variation and increasing target weight accuracy

Producer A
Target Weight = 295
Error, d = 2.05



Producer B
Target Weight = 280
Error, d = 2.27