The Intelligent Pig Barn

Anders Ringgaard Kristensen
University of Copenhagen

Who am I?

Anders Ringgaard Kristensen: Born 1958
Grew up on a farm in Western Jutland

Degrees:
1982: Animal Scientist
1985: PhD Statistics/Animal Science
1993: Dr. agro. Herd Management
2003: Master of Information Technology

Professor of Animal Husbandry, pigs, since 2005.

Research in:
- Model based production monitoring
- Model based decision support

} Precision Livestock Farming

Project manager of the PigIT alliance

Improving pig welfare – what are the ways forward?

The aim of this presentation is to discuss use of information technology (including sensors) as *one* of the ways forward.

- Many welfare problems also have a negative impact on production (e.g. diarrhea, tail biting, fouling, respiratory diseases).
- Welfare problems often result in behavioral changes.
- Sensors and vision technology can be used to detect behavioral changes.
- Early detection of behavioral changes means early detection of welfare problems.

Example: The PigIT project

- www.pigit.net

Previous Danish projects

The Farm*Watch* project (University of Copenhagen and the Danish Pig Research Centre):

- Monitoring the condition of young pigs by their drinking behavior.

The PigVision project (Aarhus University, University of Copenhagen and the Danish Pig Research Centre):

- Weight assessment by use of vision technolgy.

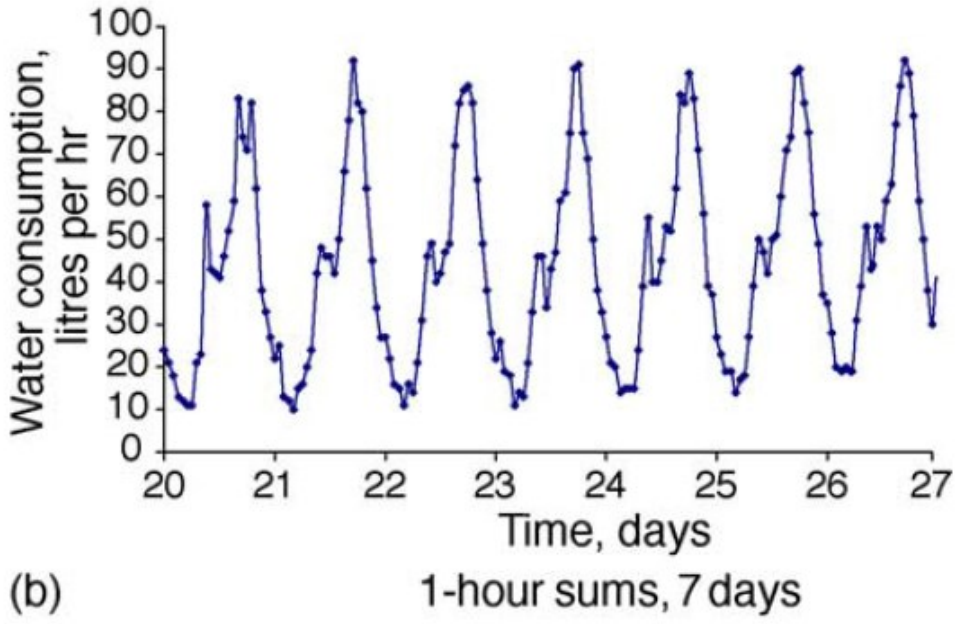
The Hogthrob projects (University of Copenhagen and the Danish Pig Research Centre):

- Monitoring sow behavior by use of 3D accelerometers.

The Intelligent Farrowing pen (Aarhus University and the Danish Pig Research Centre):

- Monitoring sow behavior in the farrowing pen by use of multiple sensors.

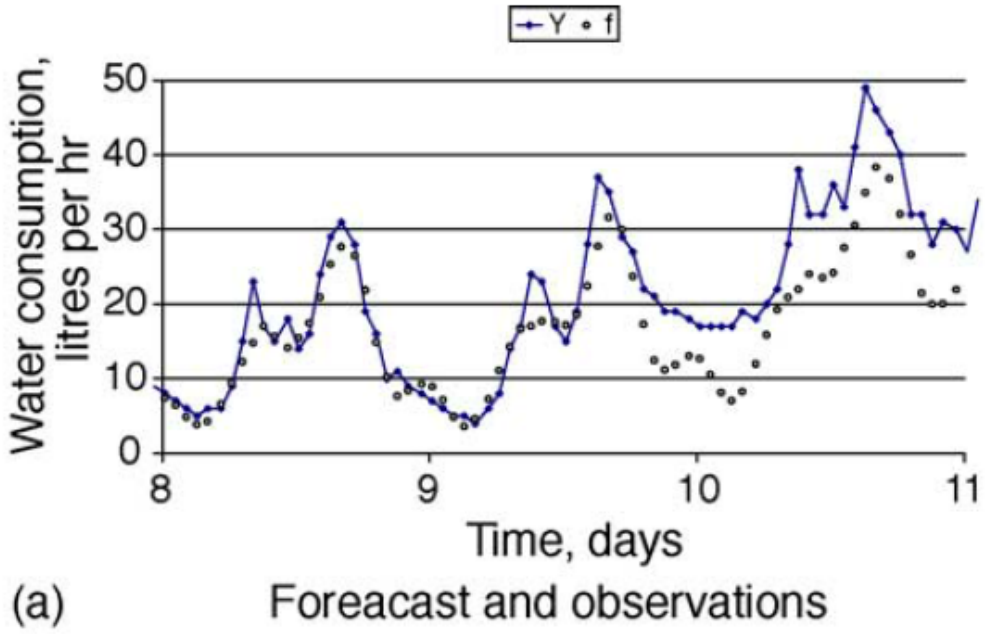
Normal drinking pattern for weaners



Madsen, T.N. & A.R. Kristensen. 2005. A model for monitoring the condition of young pigs by their drinking behavior. *Computers and Electronics in Agriculture 48,* 138-154.

Detecting changes in drinking pattern

1. Build a model describing the drinking pattern
2. Let the model calibrate itself to the normal pattern
3. Use the model to forecast the water intake:
    1. "Good forecasts": The pattern has not changed
    2. Systematic over (or under) estimation: The pattern has changed.



Observation
Forecast

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Sow activity (accelerometer) two days before farrowing

Fig. 1. (a) 24 h time series of acceleration measurements (10 s average) for sow 1 of group S, two days before farrowing. (b) Output results (2 min intervals) from the MPKF. HA: high active; MA: medium active; L1: lying side 1; L2: lying side 2; LS: lying sternally.

Cornou, C., S. Lundbye-Christensen & A.R. Kristensen. 2011. Modeling and monitoring sows' activity types in farrowing house using acceleration data. *Computers and Electronics in Agriculture 76*, 316-324.

Sow activity (accelerometer) day of farrowing

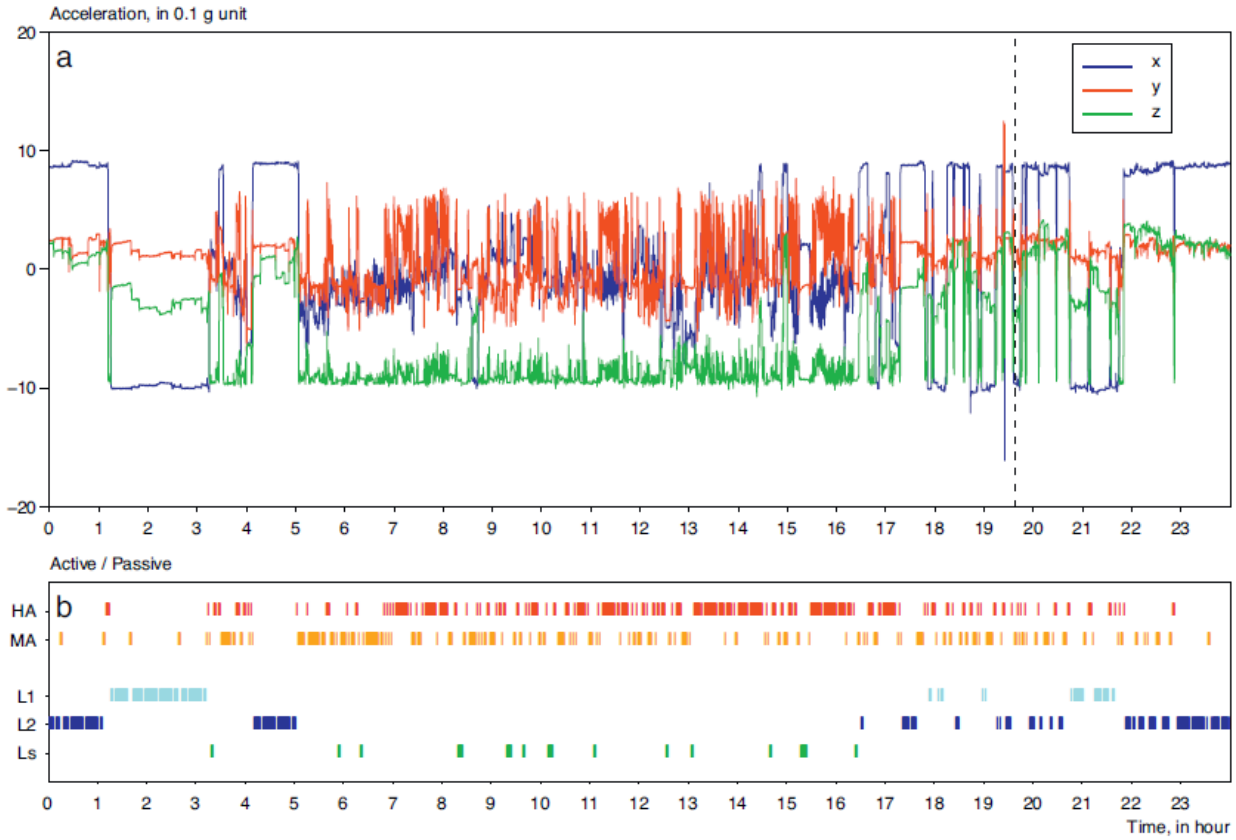


Fig. 2. (a) 24 h time series of acceleration measurements (10 s average) for sow 1 of group S, the day of farrowing. (b) Output results (2 min intervals) from the MPKF. HA: high active; MA: medium active; L1: lying side 1; L2: lying side 2; LS: lying sternally. The vertical dotted line indicates the onset of farrowing.

Cornou, C., S. Lundbye-Christensen & A.R. Kristensen. 2011. Modeling and monitoring sows' activity types in farrowing house using acceleration data. *Computers and Electronics in Agriculture 76*, 316-324.

Current activity: The PigIT project

Improving welfare and productivity in growing pigs using advanced ICT methods.

- Societal objective is to contribute significantly to the competitiveness of the Danish slaughter pig industry while still ensuring a satisfactory level of animal welfare.
- This will provide a basis for future commercial products with an international market perspective.

Partners:

- University of Copenhagen
- Aarhus University
- The Danish Pig Research Centre

International partner (parallel project):

- Utrecht University

Affiliated partners:

- TNM A/S
- Skov A/S
- AgroSoft A/S

Overall hypothesis of PigIT

Through

- systematic placement of cheap sensors in the pen (no sensors on the pigs)
- data integration, modeling, data filtering, pattern recognition

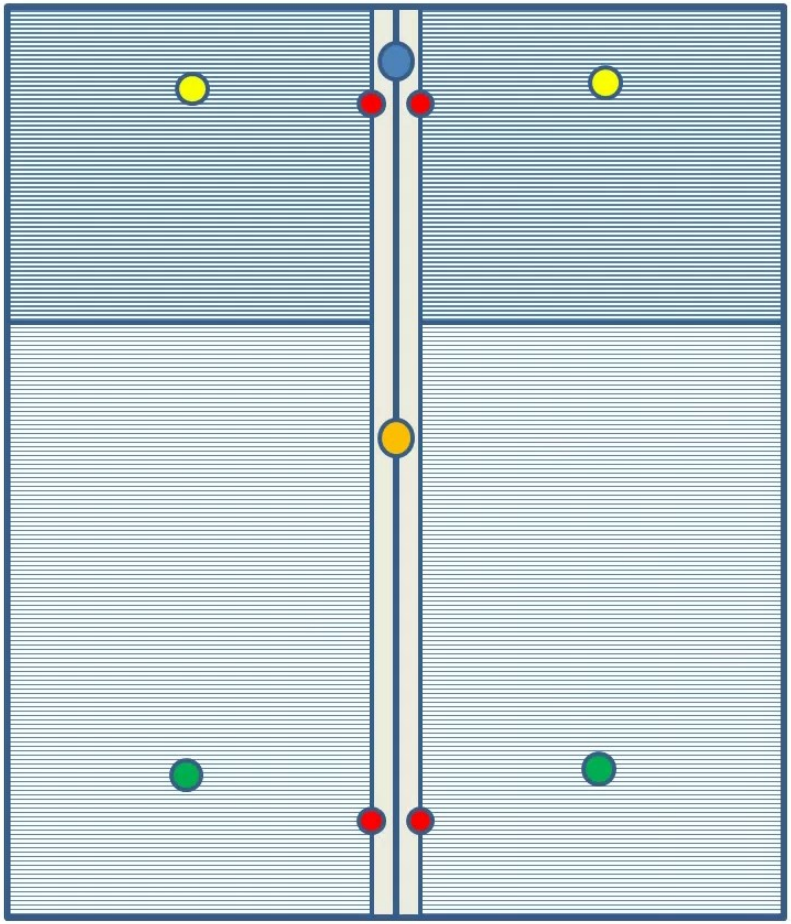
we will be able to detect behavioral changes reflecting

- impaired welfare
- impaired productivity

Welfare problems considered:

- Diarrhea
- Tail biting
- Fouling

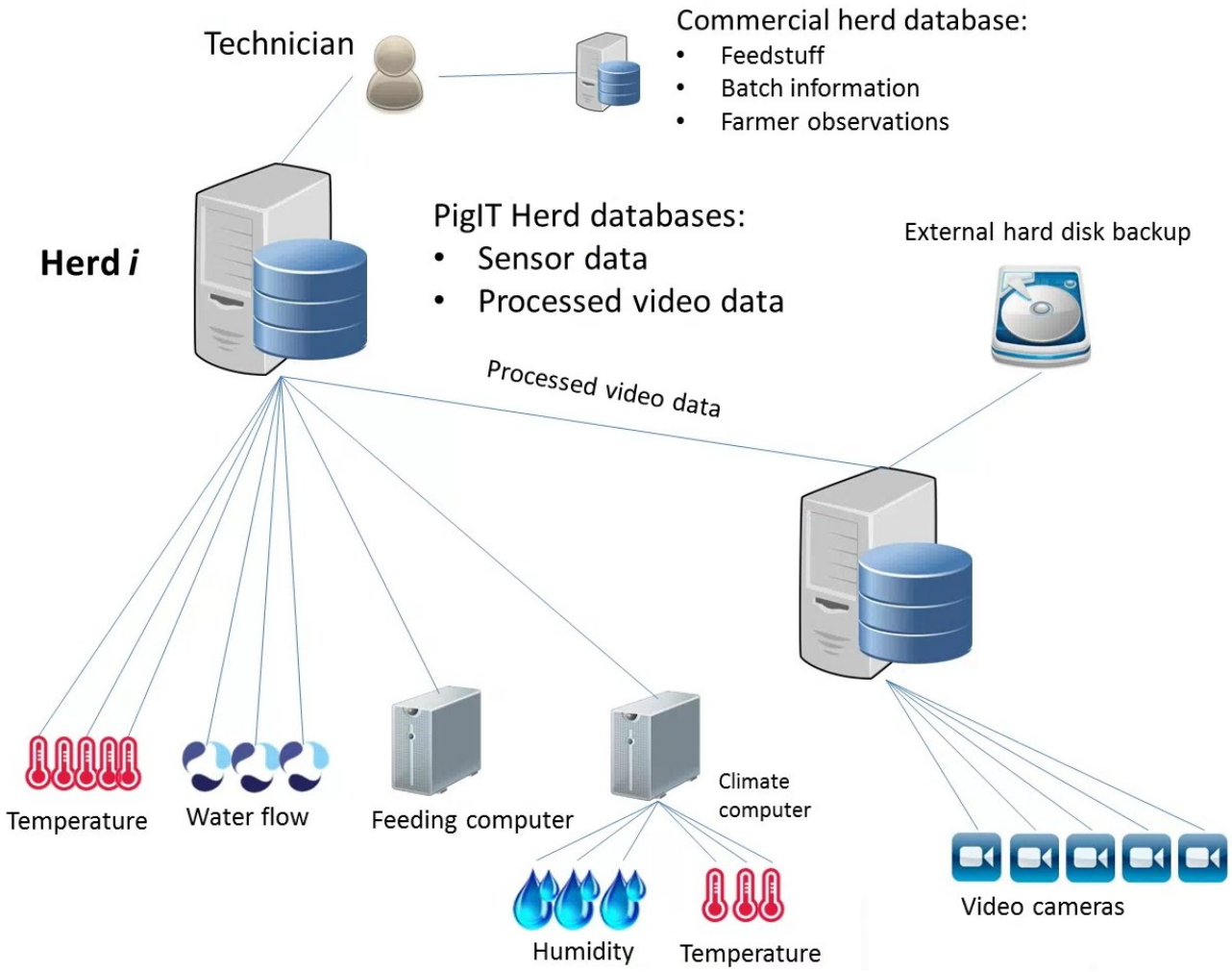
Sensors as installed in two experimental pens



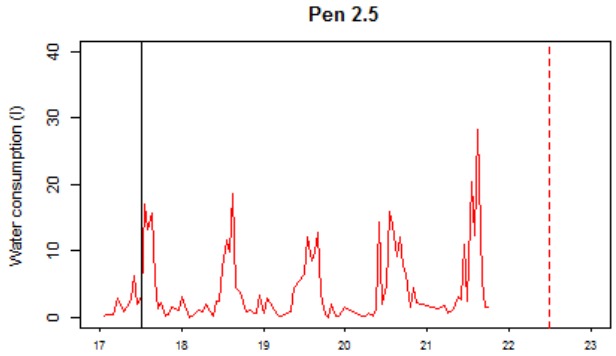
- Drained floor
- Slatted floor
- Feeding trough
- Feed dispenser
- Drinking nipple
- Camera for live weight
- Camera for activity
- Temperature sensor

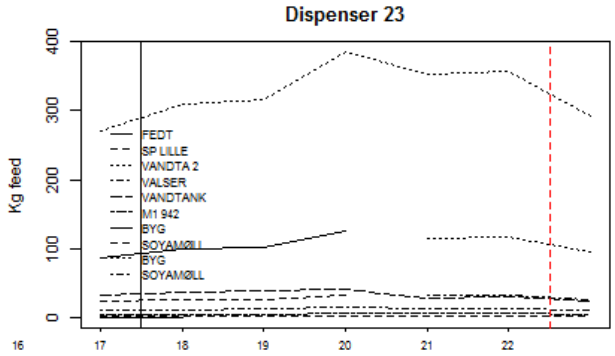
16 pens in 4 sections are monitored by sensors and cameras

Data infrastructure in a herd

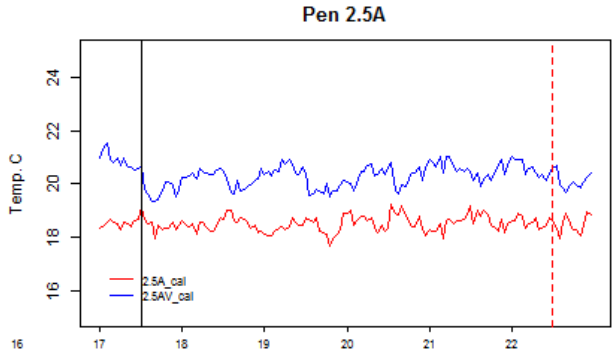


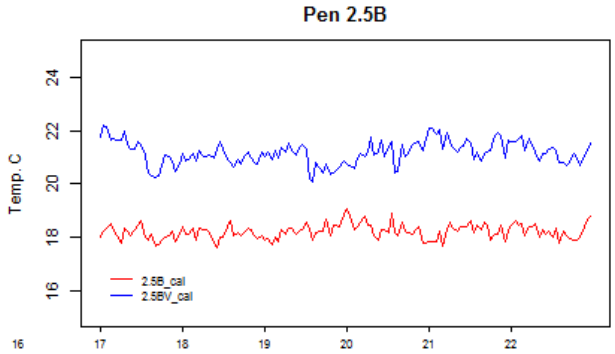
Sensor data – what does it look like?



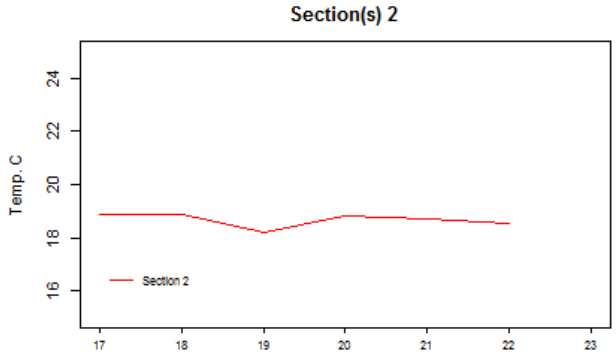


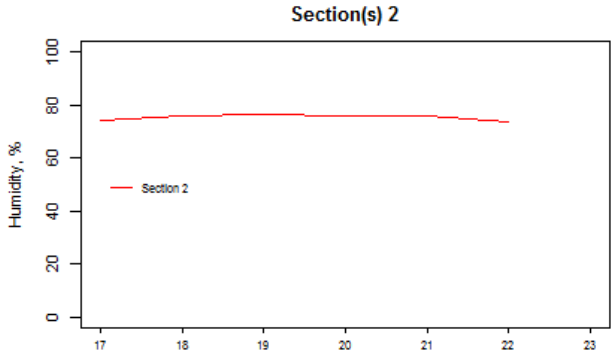
Water, Feed





Local temp.





Section: Temp. Humidity

A pilot example of data analysis for early warning

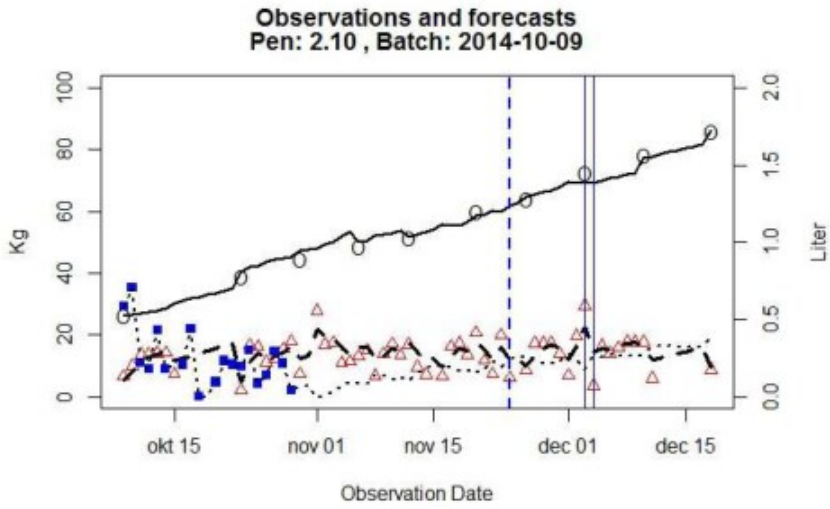
Multivariate observations:

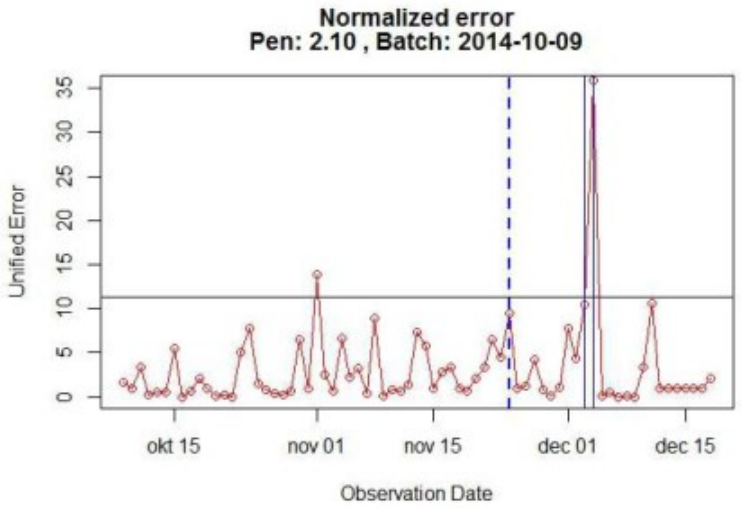
- Weekly weighings
- Daily feed allocation
- Daily water consumption

Data analyzed by multivariate state space models:

1. Build a model describing the multivariate data
2. Let the model calibrate itself to the normal pattern
3. Use the model to forecast the observations:
    1. "Good forecasts": The pattern has not changed
    2. Big deviations: The pattern has changed

Early warning





Sensor observations:

- Live weight
- Feed allocation
- Water consumption

Filtered values:

- Live weight
- Feed allocation
- Water consumption

Farmer observations:

- Diarrhea
- Fouling

Warning system:

- Warning threshold
- Forecast error

Is information technology one of the ways forward?

Yes, probably, but there are still many issues to resolve.

Challenges:

- Consistent combination of information from multiple sources
- Lack of "golden standard" for verification
- Prioritization of warnings:
  - False positives are a constant inconvenience
  - When is it *really* serious?
- Investment costs – installing sensors is expensive
- Robustness – the sensors and computers must be running 24/7

Acknowledgements

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The entire PigIT research group has contributed to the ideas presented.

The title of this presentation and article is inspired by a project known as "The Intelligent Farrowing Pen" at Aarhus University.

PhD student Dan Børge Jensen has contributed to this presentation and the associated article.