



The role of data and AI in sustainable farming

June 3, 2026 | Claudia Kamphuis – researcher WLR Animal Breeding & Genomics

Coordinator Expertise Team Data Science

Acknowledgements

Funding, team members

Digital Future Farm (2021-2023)



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Knowledge Base (2020-2024; 2025-2028)

Next Level Animal Sciences (2020-2024)



Noldus Information Technology (2020-2024)



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Technology and digitization of the dairy domain

Larger Volumes, higher Velocity, and a Variety of data



RFID tags (1970)

Animal recognition

Technology and digitization of the dairy domain

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Activity meters (1980)

Heat detection

Technology and digitization of the dairy domain

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Lely (1992)

Automatic milking and
mastitis detection

Technology and digitization of the dairy domain

Larger Volumes, higher Velocity, and a Variety of data



RFID tags (1970)

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Automatic milking and
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Technology explosion

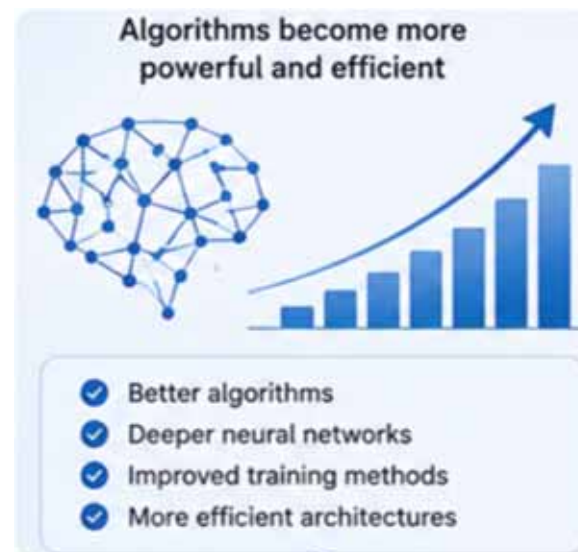
On/in the cow or her
environment

Technology and digitization of the dairy domain

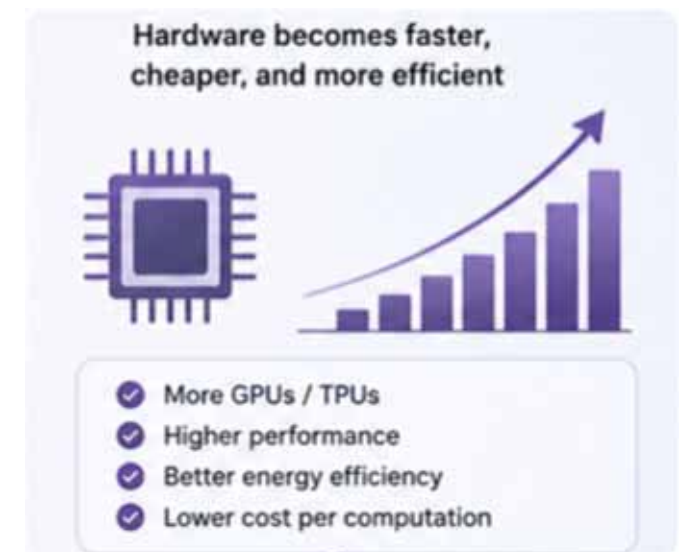
Larger Volumes, higher Velocity, and a Variety of data



Data grows



Other data-driven models including AI



Computer power increases

Developments in our domain

From detecting cow-individual (production related) health events to more complex approaches



Management-by-exception,
Increasingly complex management,



Governmental and societal
concerns around welfare
and environment

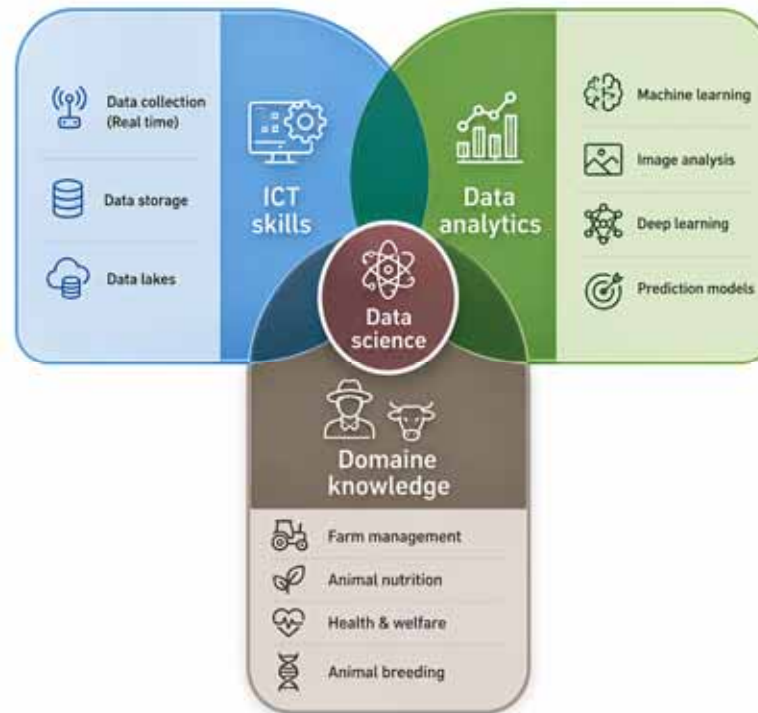


Sustainable farming

Data, AI and Sustainability

Connected through data science

Digitization



Sustainable dairy farming



A multicamera system for animal health & welfare

@ Dairy Campus

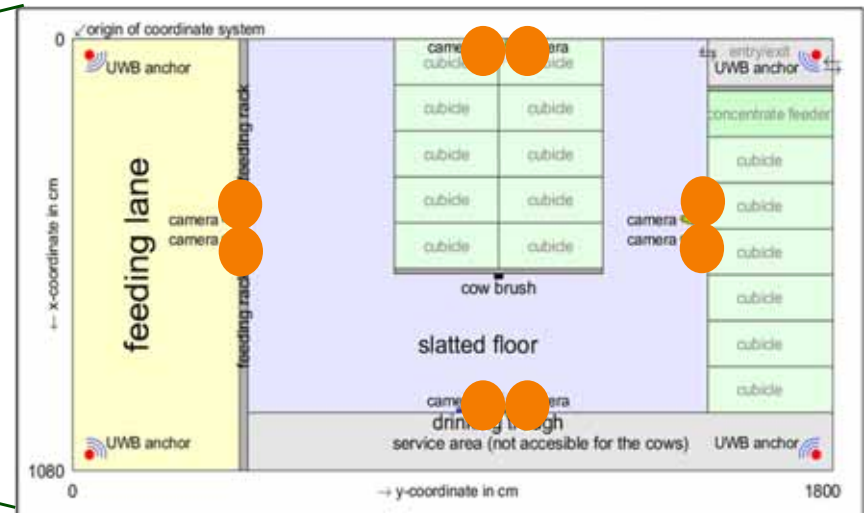
Objective

Longitudinal non-invasive monitoring of individual animals

One approach for multiple types of behavior, and motion

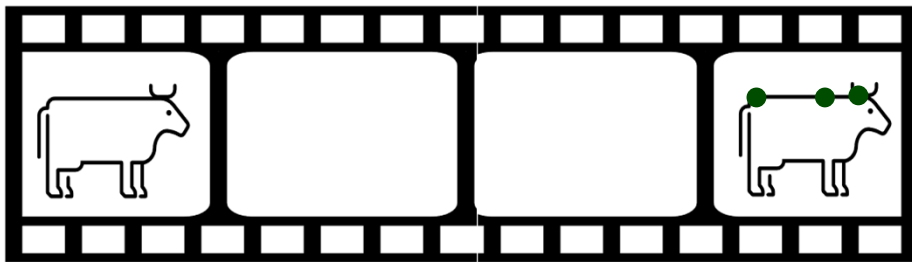


8 cameras (Viso, Noldus) in 1 unit (16 cows).

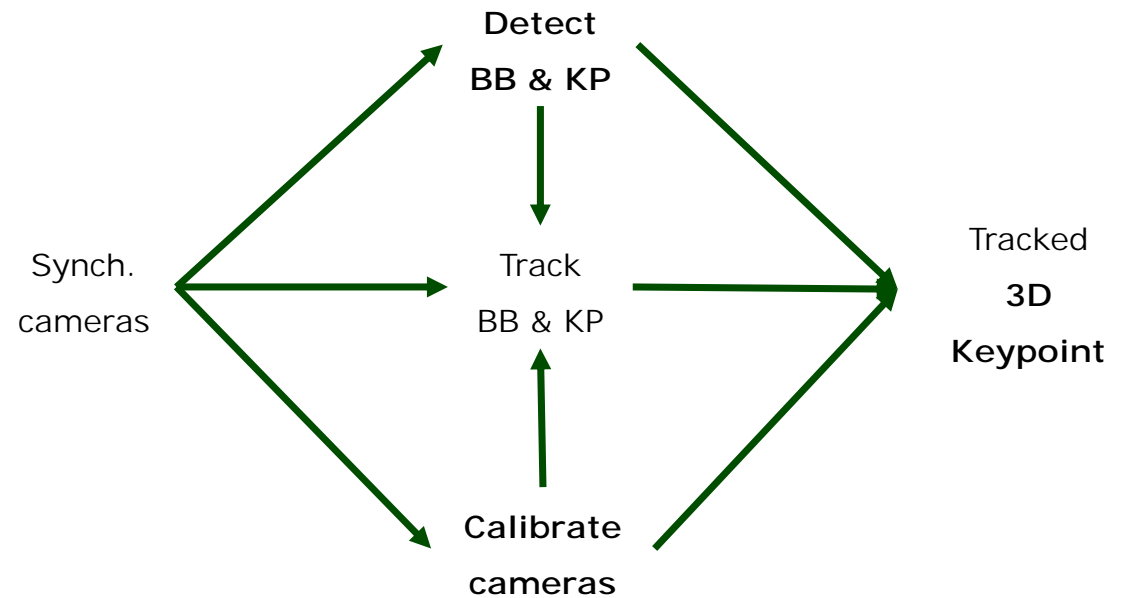


A multicamera system for animal health & welfare

@ Dairy Campus



Go from raw video footage to tracking 3D
key points through time and space
4 key points per cow





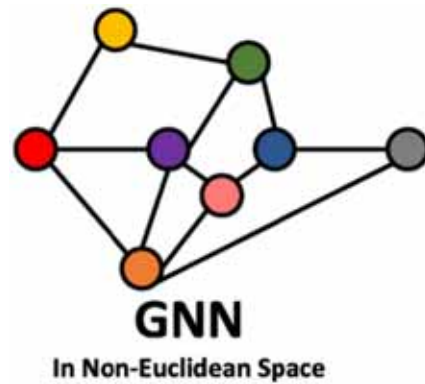
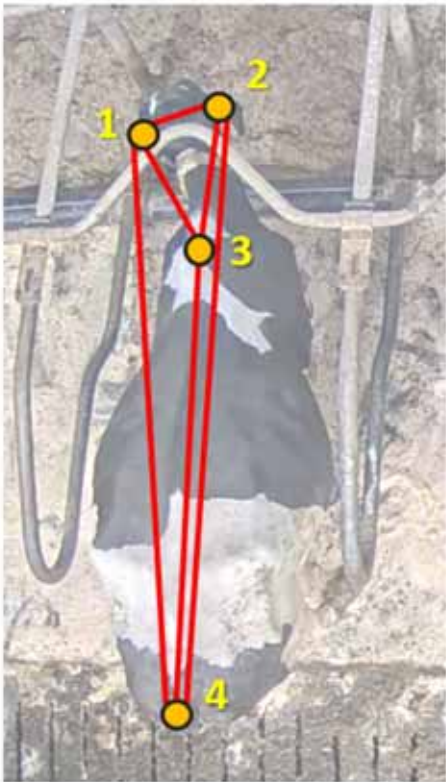
A multicamera system for animal health & welfare

Detail of pipeline, applied on unseen data (and cows)



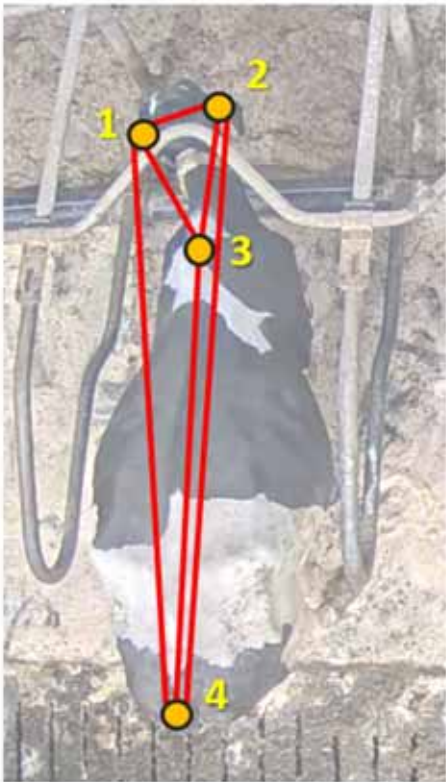
A multicamera system for animal health & welfare

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A multicamera system for animal health & welfare

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Next step(s)

Validate pipeline and action-recognition model

Add information as a new source for lameness detection models

Same set-up for new features related to health and welfare and sustainability

Implement in 3D simulation environment

Challenges

Technical aspects

Difficult to keep up: fast moving domain with new models entering quickly

Working together: understanding, expertise, explaining, expectations

A digital twin for environmental sustainability

@ De Marke

Nitrogen is a big problem in The Netherlands

The Dutch governments steers towards target-based governance

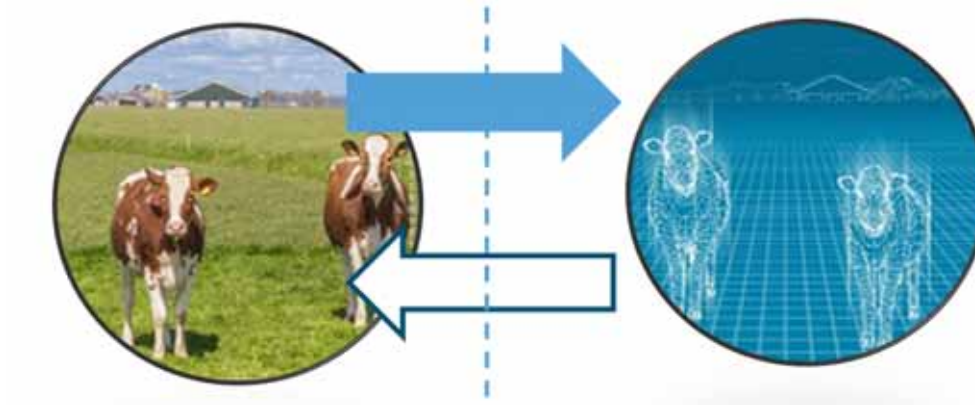
A digital twin can aid in **tactical** (day-to-day) farm management decisions by quantifying nitrogen flows using **real-time** farm and field specific **data**, dynamic **models**, and data **assimilation**



Migchels, G., et al. (2025). Technisch reductiepotentieel voor ammoniak, methaan en lachgas in de melkveehouderij. Report 1589, Wageningen Livestock Research

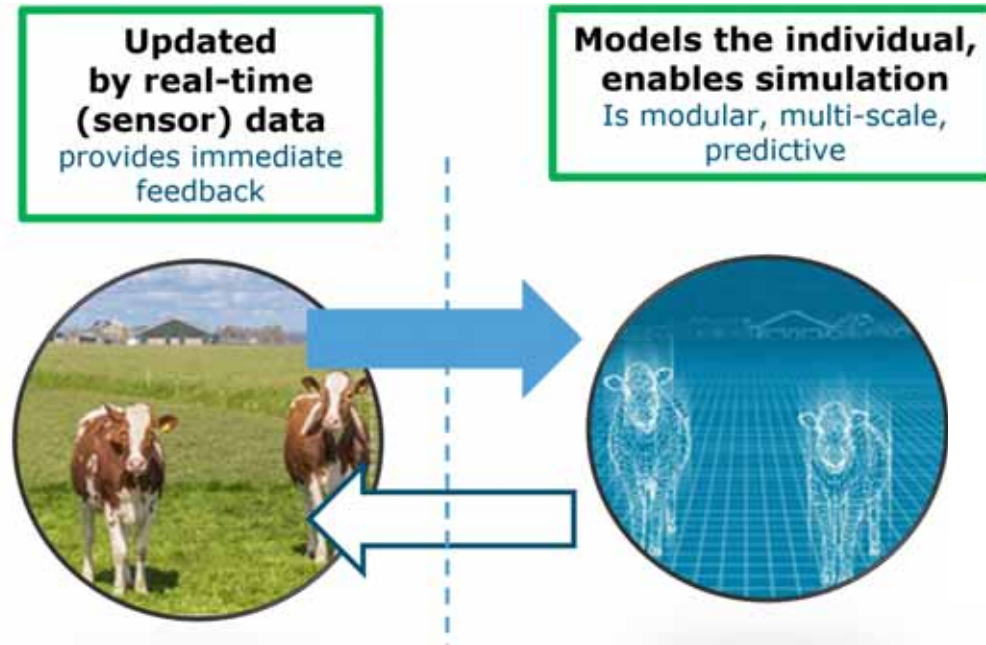
A digital twin for environmental sustainability

@ De Marke



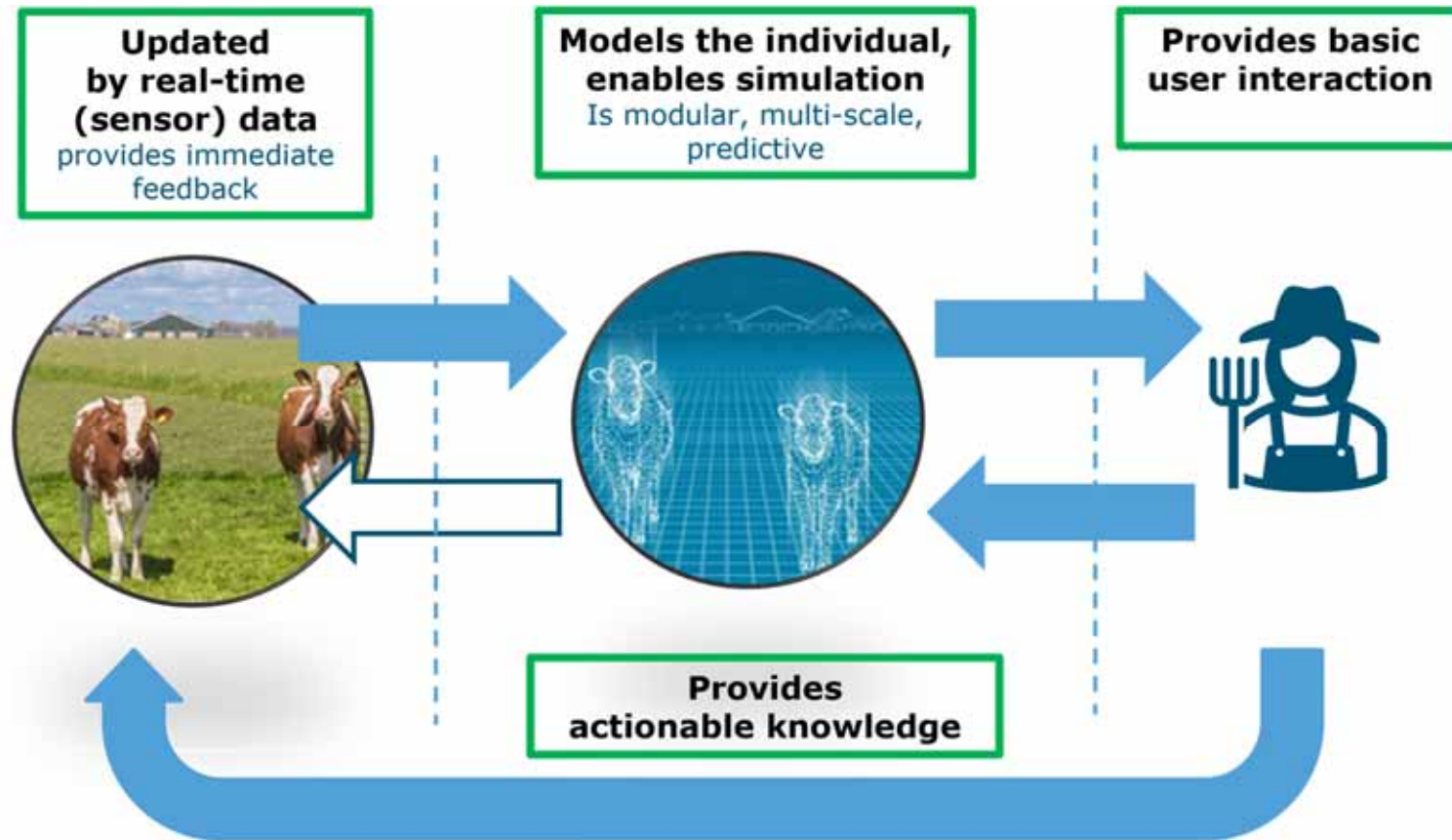
A digital twin for environmental sustainability

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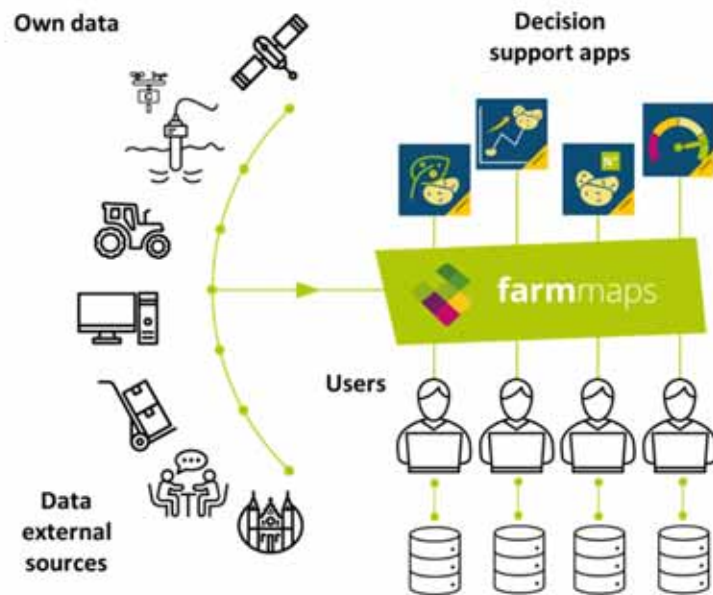


A digital twin for environmental sustainability

Main ingredients

A Data Platform

Farmmaps for real-time farm and field specific data

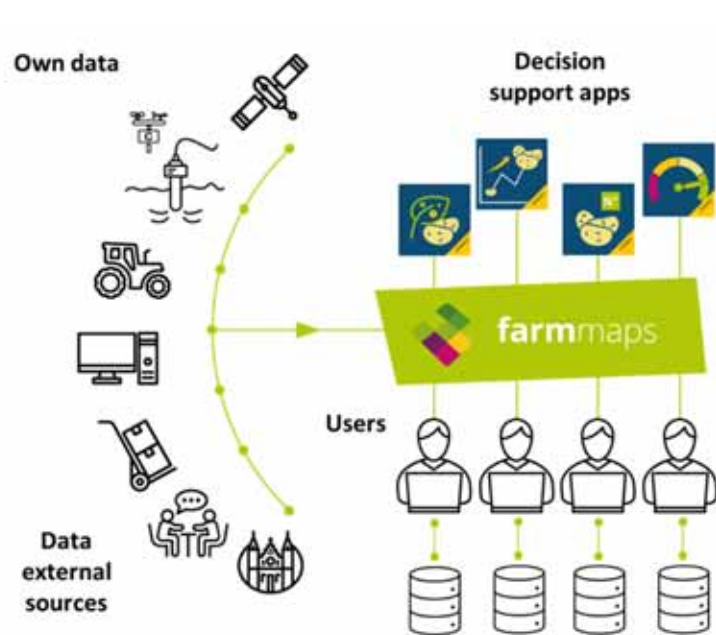


A digital twin for environmental sustainability

Main ingredients

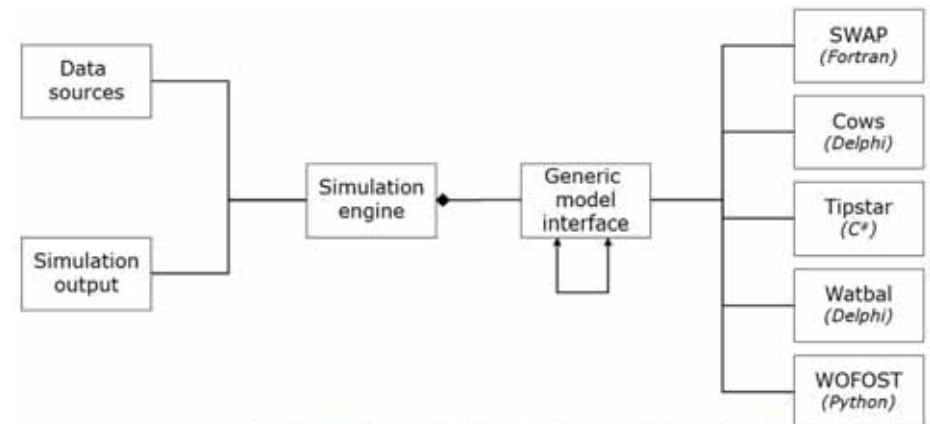
A Data Platform

Farmmaps for real-time farm and field specific data



A framework

A MODCOM framework to let models communicate

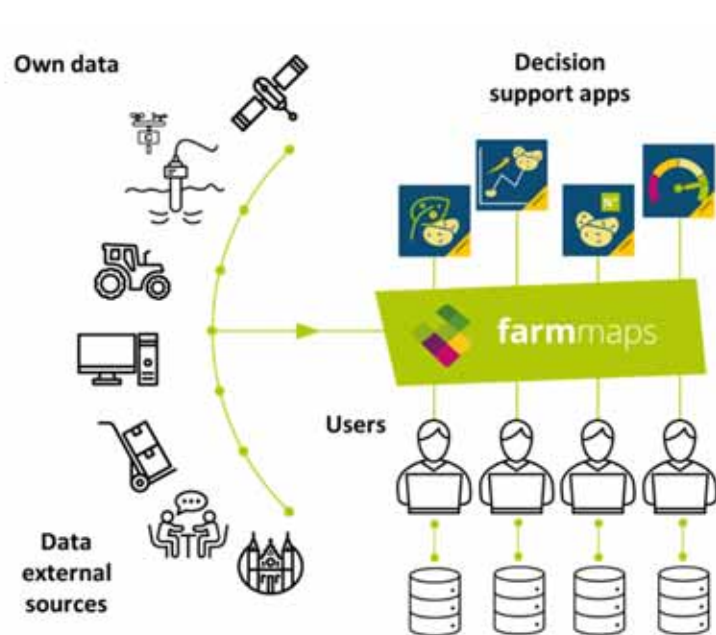


A digital twin for environmental sustainability

Main ingredients

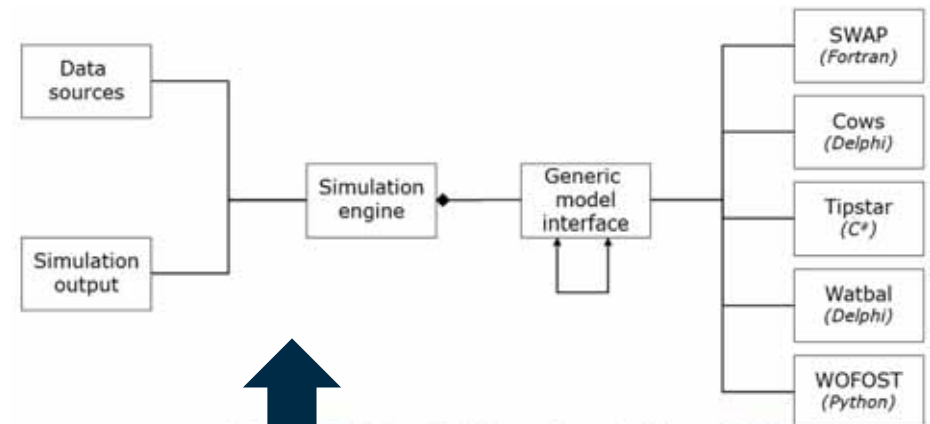
A Data Platform

Farmmaps for real-time farm and field specific data



A framework

A MODCOM framework to let models communicate



Data assimilation

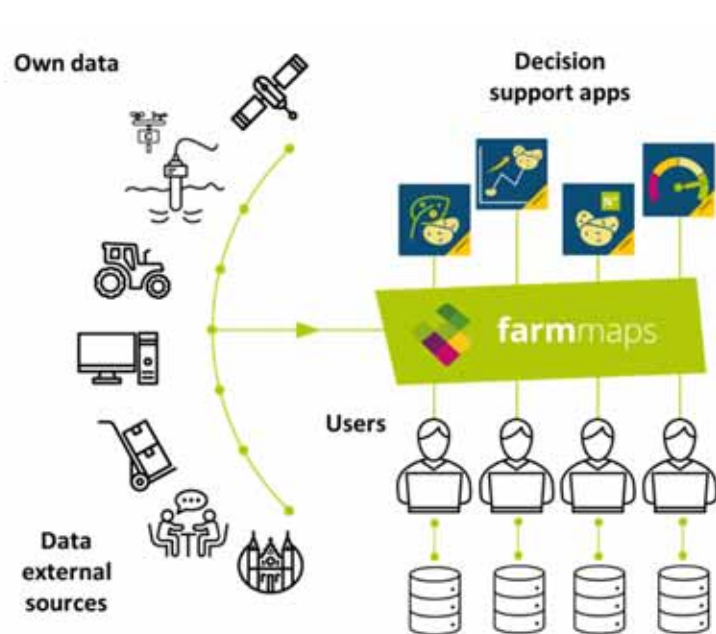
to get the digital twin in-synch with the physical object

A digital twin for environmental sustainability

Main ingredients

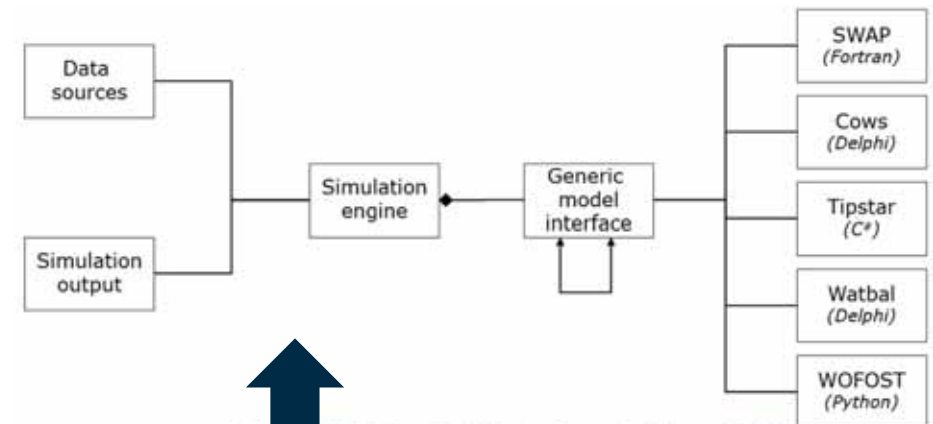
A Data Platform

Farmmaps for real-time farm and field specific data
And to visualize information



A framework

A MODCOM framework to let models communicate



Data assimilation

to get the digital twin in-synch with the physical object

A digital twin for environmental sustainability

Data assimilation

Models are 'just' models; they can deviate from reality

- Processes modelled imperfectly

- Processes are not included

- Calibration is imperfect

Use real-time data to adjust model predictions/simulations

- updating/forcing

- re-calibration

- filtering (Kalman filter)



NASA, Public domain, via Wikimedia Commons

A digital twin for environmental sustainability

Data assimilation



NASA, Public domain, via Wikimedia Commons



Jim Lovell locating a specific star during the Apollo 8 mission. NASA photo S-69-35099

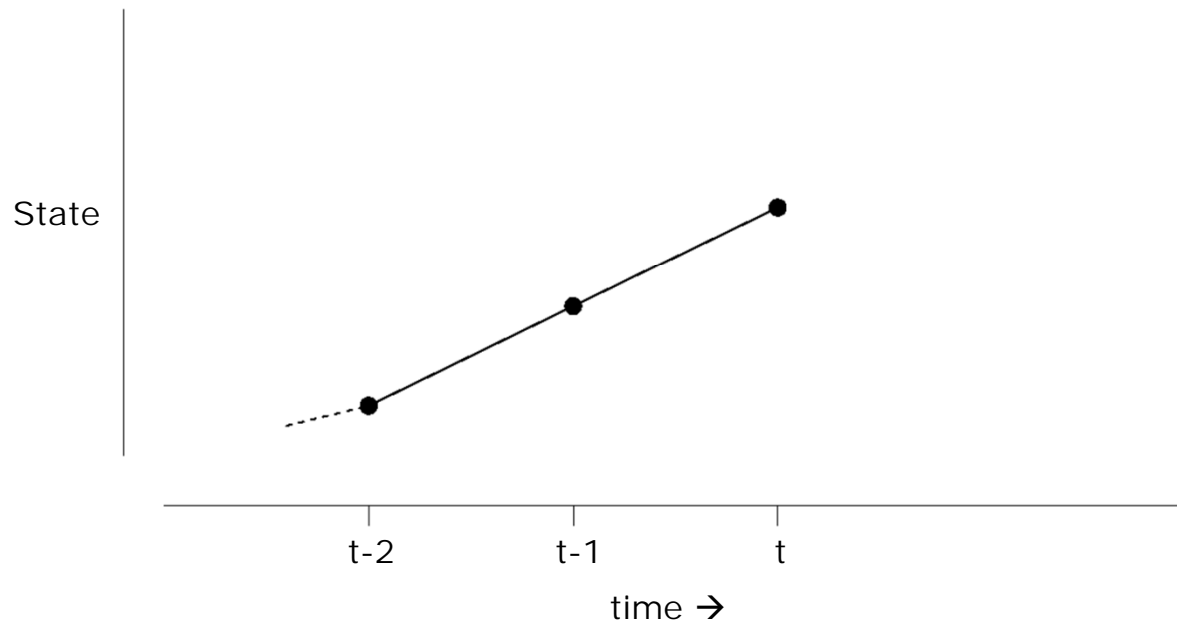


Neil A. Armstrong, Public domain, via Wikimedia Commons

Kalman (1960). A new approach to linear filtering and prediction problems. *ASME Trans., J. Basic Eng., ser. D.* **82**:35–45.
Kalman and Bucy (1961). New results in linear prediction and filtering theory. *ASME Trans., J. Basic Eng., ser. D.* **83**: 95–108
Grewal and Andrews (2010). Applications of Kalman Filtering in Aerospace 1960 to the Present. *IEEE Control Systems Magazine* **30**:69-78.

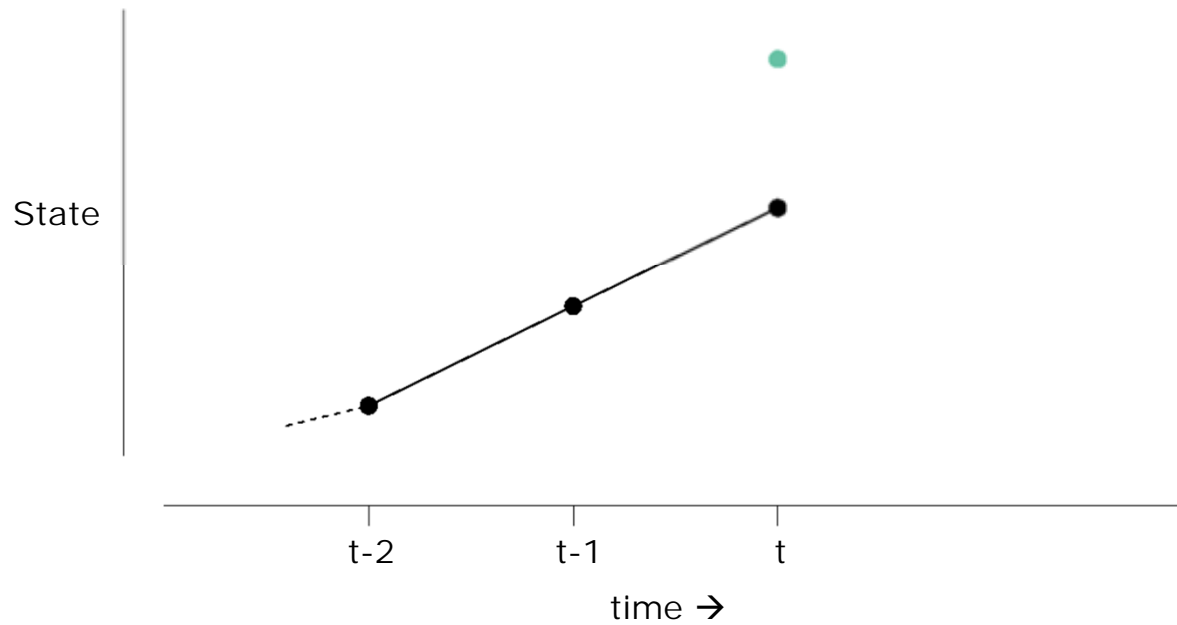
A digital twin for environmental sustainability

Data assimilation, (Kalman) filter



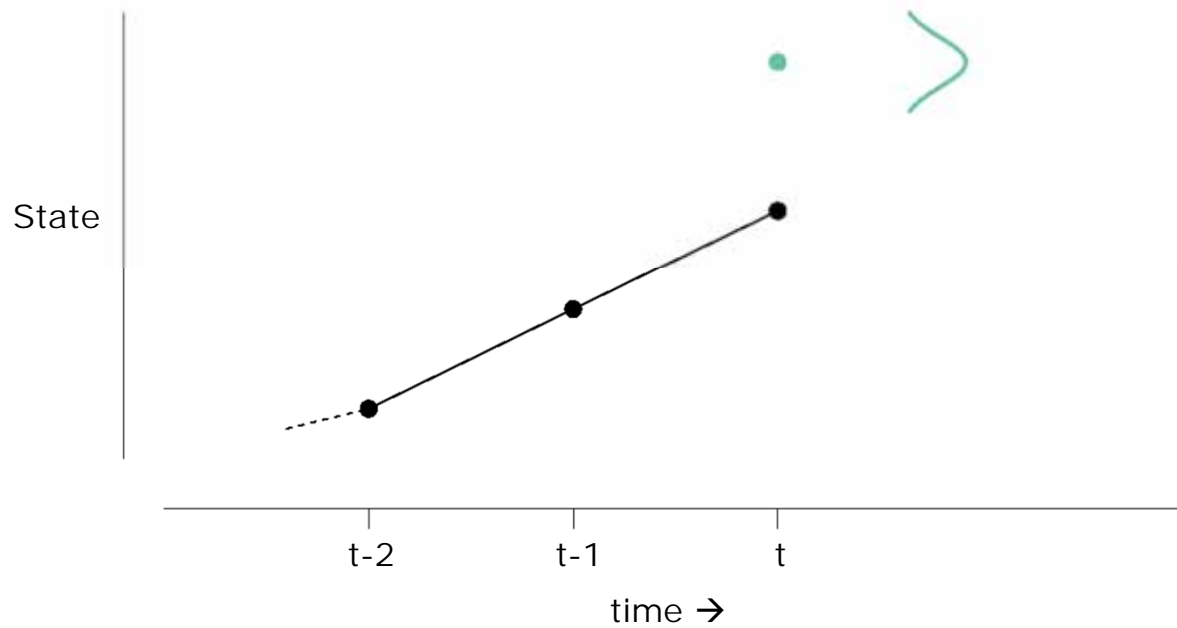
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Data assimilation, (Kalman) filter



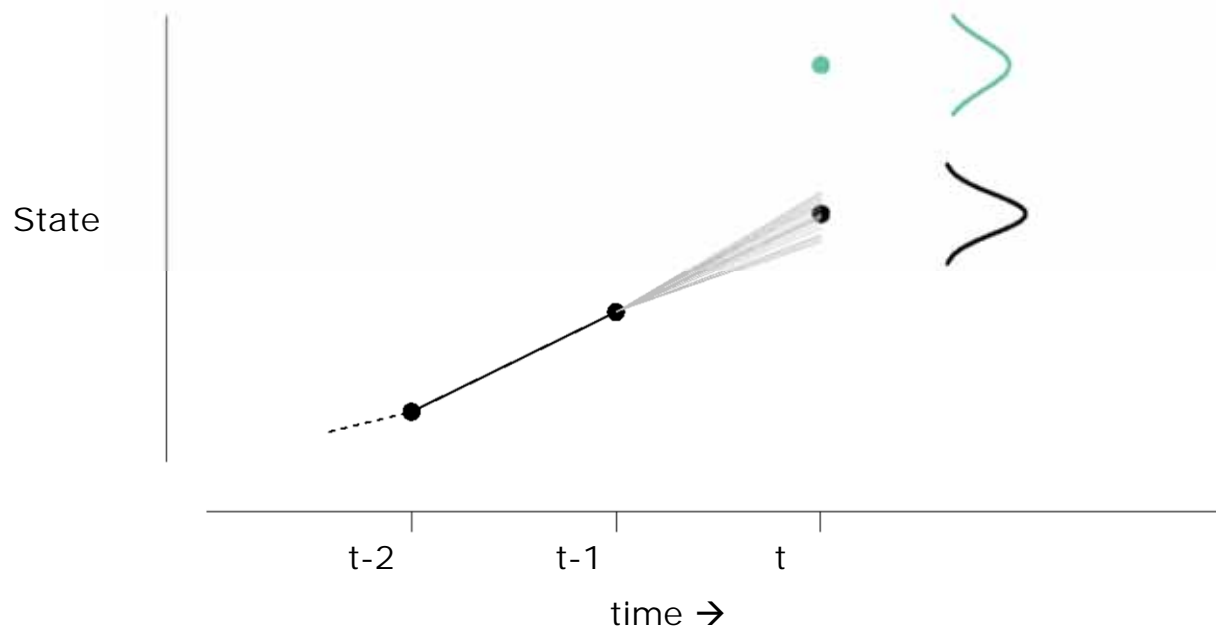
A digital twin for environmental sustainability

Data assimilation, (Kalman) filter



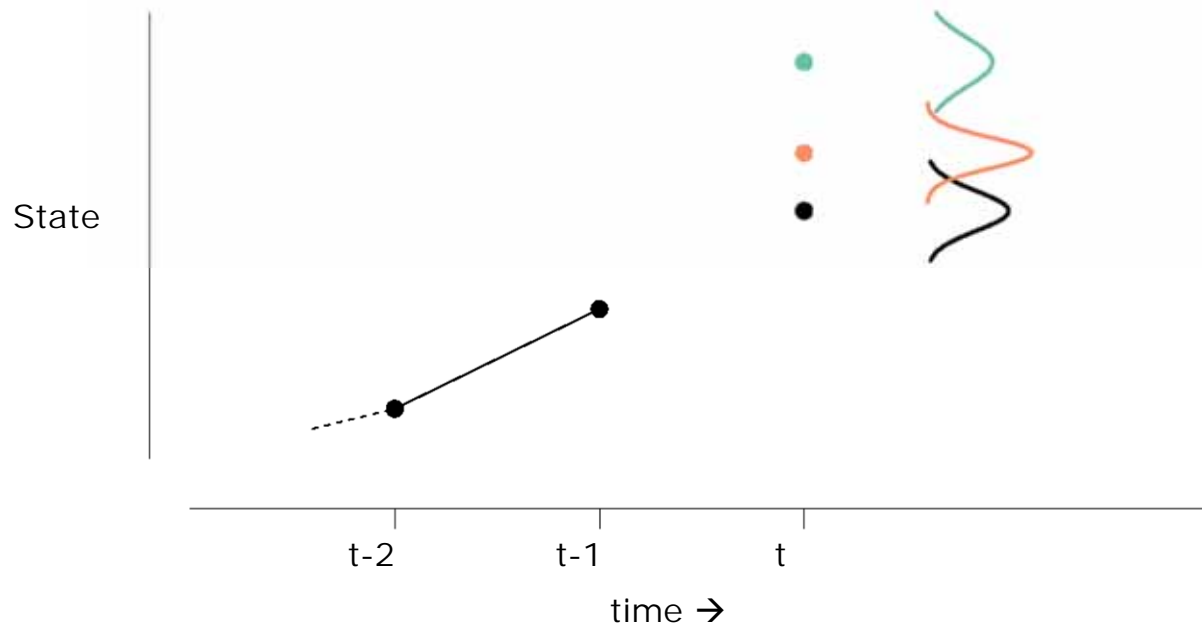
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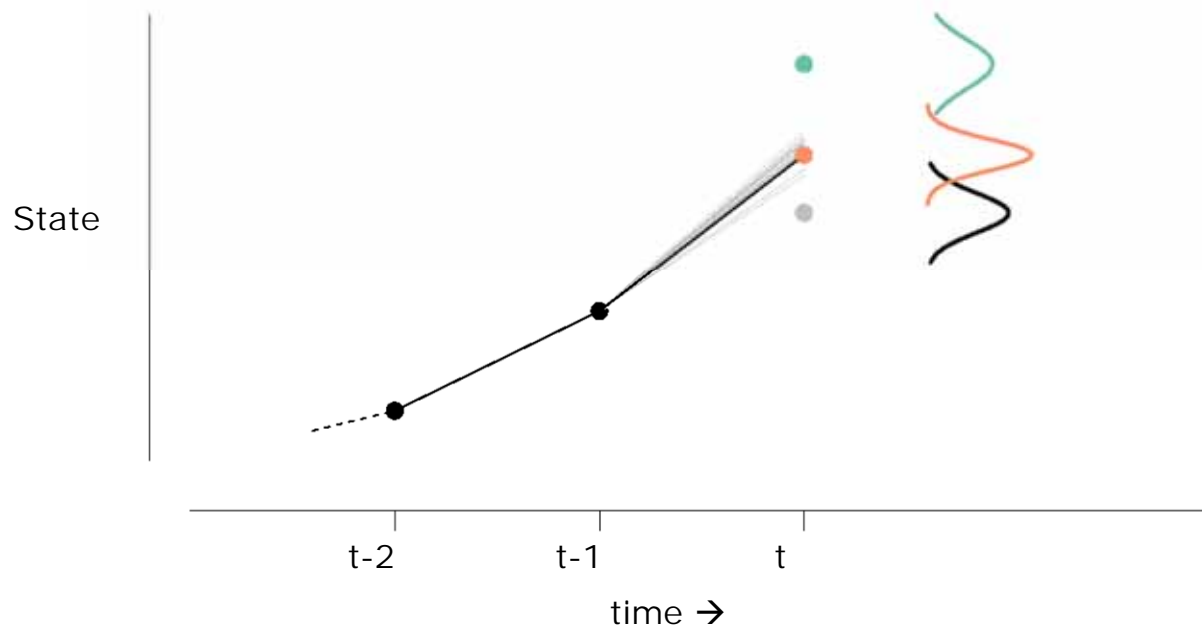
A digital twin for environmental sustainability

Data assimilation, (Kalman) filter



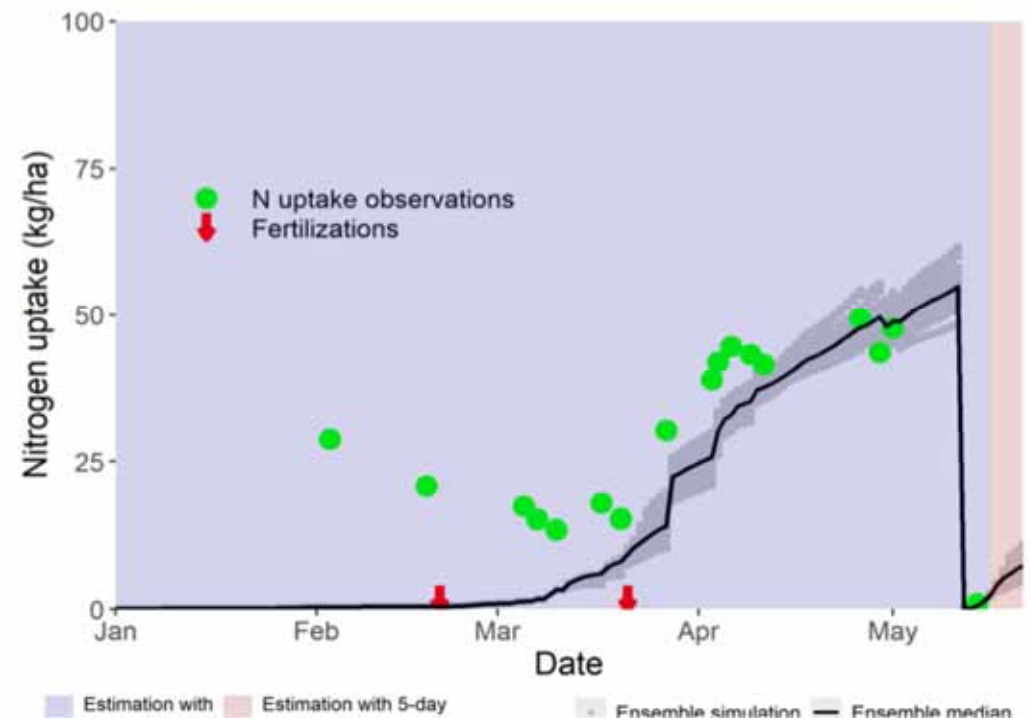
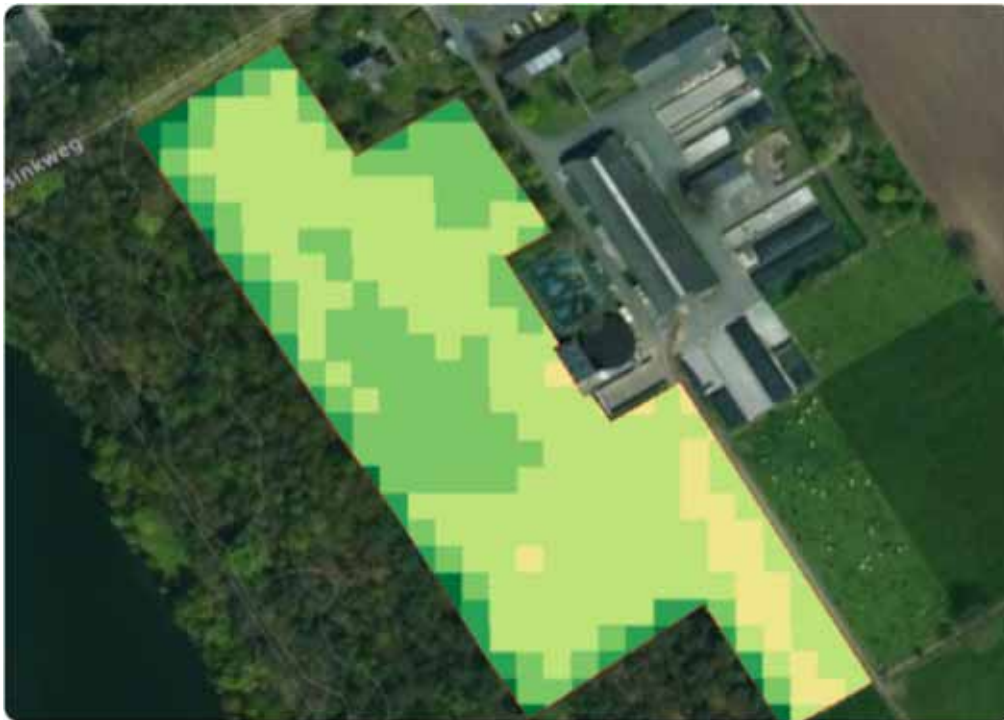
A digital twin for environmental sustainability

Data assimilation, (Kalman) filter



A digital twin for environmental sustainability

Twinning Nitrogen uptake @ the Marke using Data Assimilation



A digital twin for environmental sustainability

Twinning Nitrogen uptake @ the Marke using Data Assimilation



Compacted continuous grazing

A digital twin for environmental sustainability

De Marke

Next step(s)

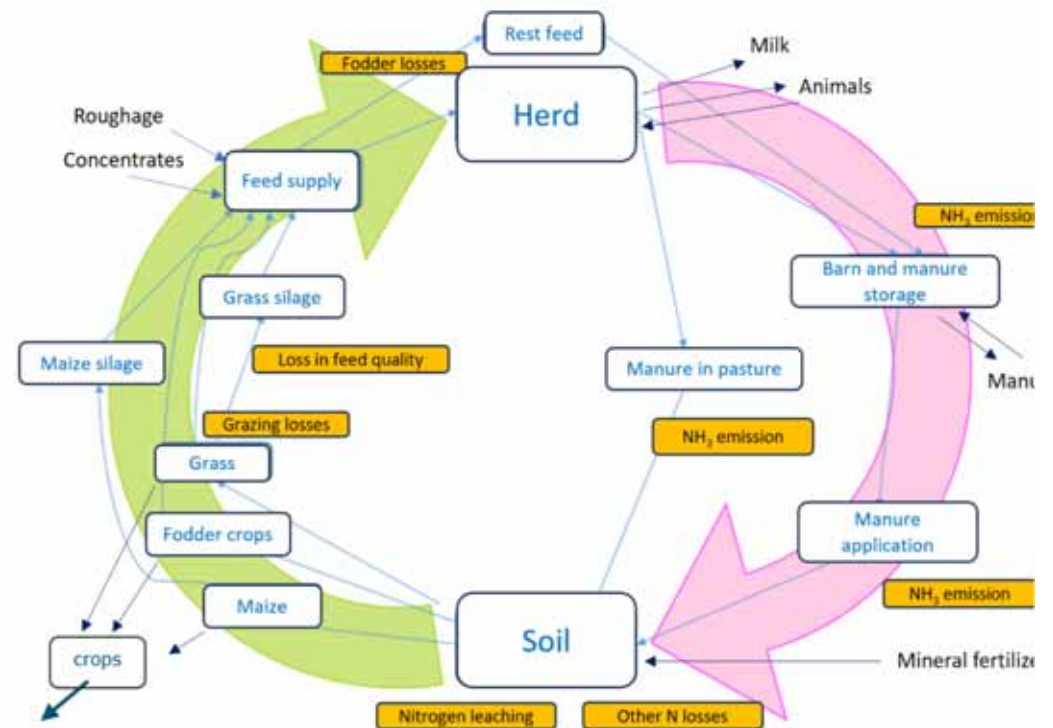
Now focused on pasture and herd

Adding other crops, and pink side of N cycle

Challenges PLENTY

Technical aspects

Organizational aspects: IP/business model, emotional ownership, collaborate at code level, software architecture, computer language, expertises



The role of data and AI in sustainability

Take home messages

Technology and digitization pushed data growth, data-driven models and computer power

Sustainable livestock production systems involves complex research questions

Data Science connects digitization with sustainable production systems

Combining domain, ICT and data analytics

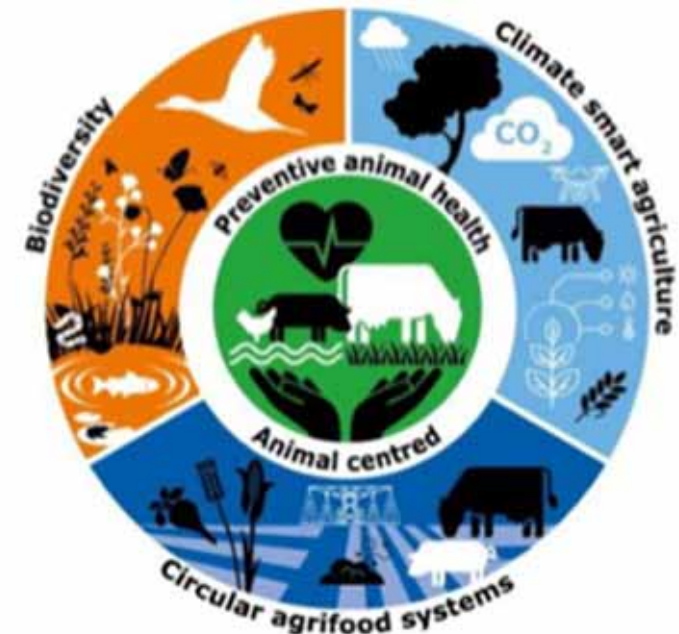
Multicamera system for animal health and welfare

Strong AI component to retrieve information from footage

Allows for continuous non-invasive monitoring

multiple behaviours using one system

potential for more detailed behavior and new traits



The role of data and AI in sustainability

Digital twins for environmental sustainability

strong real-time farm en field specific data and model component
allows for day-to-day management decisions
assimilation to synch model predictions with reality

A lot of challenges to tackle along the ways

Technical issues, IP, data and model ownership → easiest to tackle
Rapidly changing AI domain
People → hardest to tackle
 expertise, emotional ownership, language, expectations

Data and AI play a part in sustainable farming, people have to make it work



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