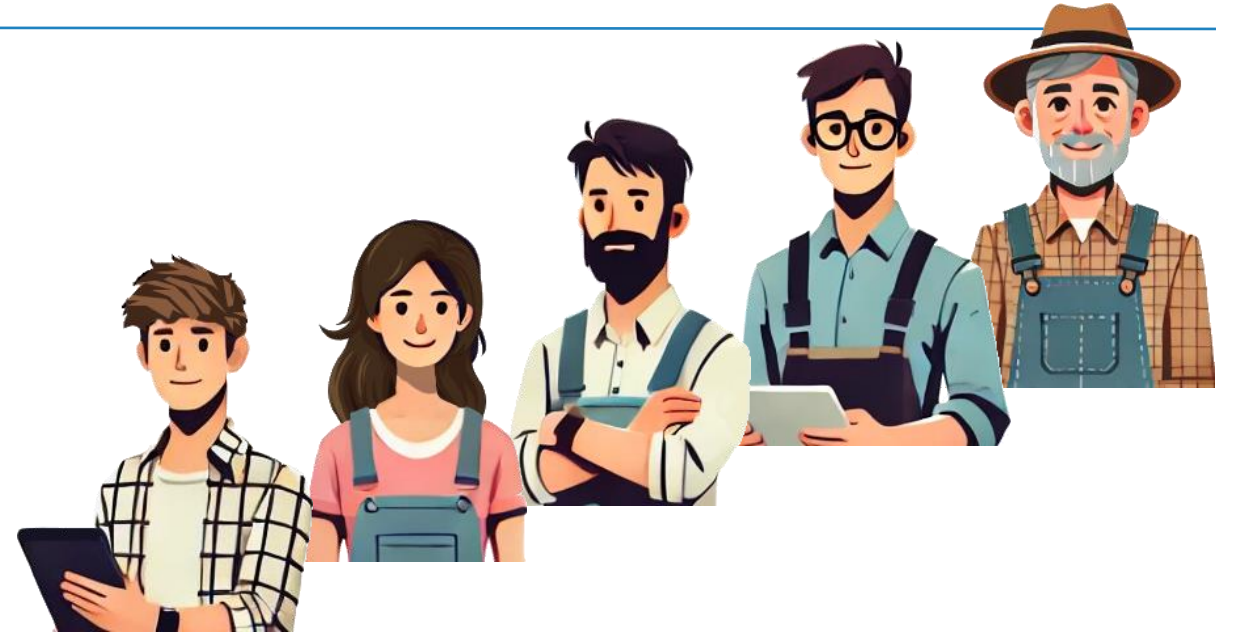

User-Centered Explainable AI for Decision Support Systems in Dairy Farming

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MOTIVATION: DIGITALIZATION AND ITS CHALLENGES



Digitalization promises many benefits

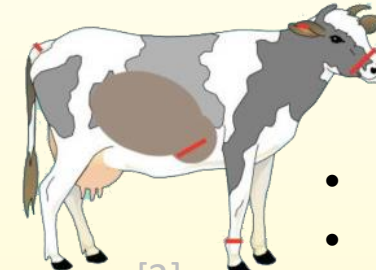
- Automation
- Reduce manual labor
- Increased animal welfare
- AI-based decision support

Challenges in adoption

- Black box
- Privacy concerns
- Complexity



- Heat detection
- Calving period
- Identity
- Activity
- Rumination

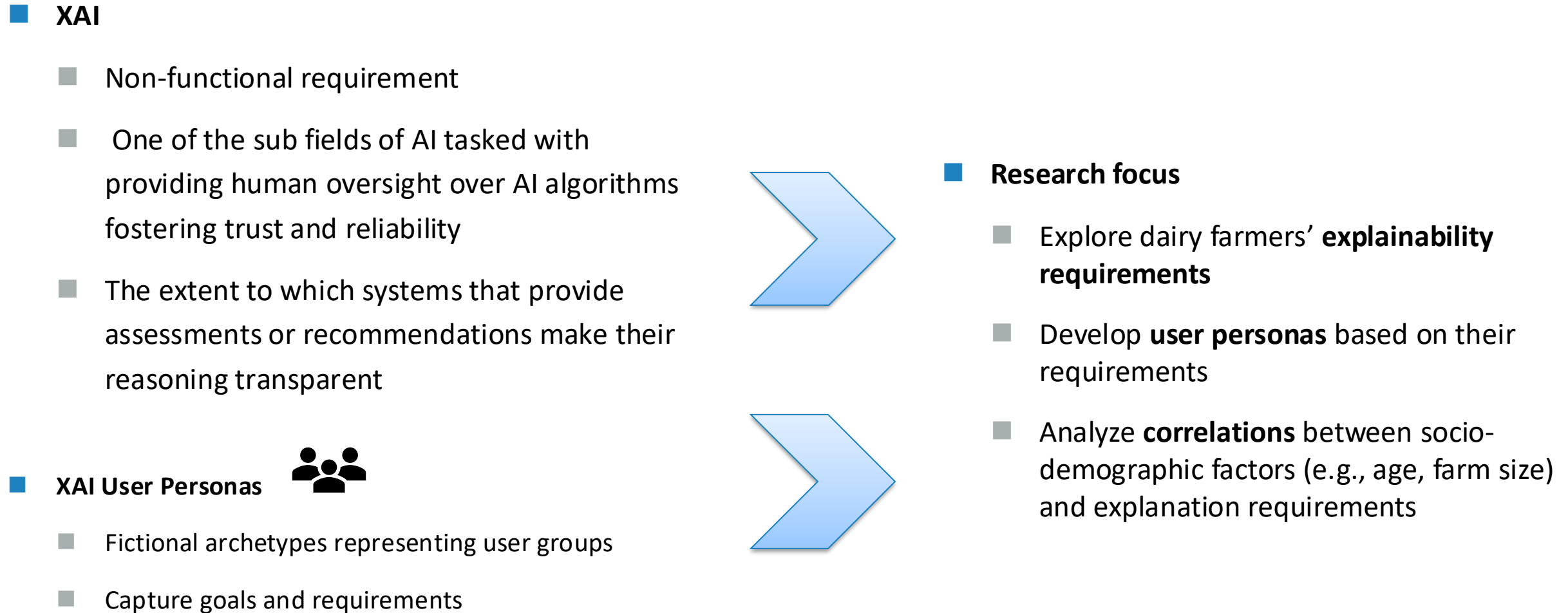


- Temperature
- pH
- Activity, lameness
- Standing + lying time

Sources:
[1] DeLaval Group, <https://corporate.delaval.com>

[2] Džermeikaitė et al., <https://europepmc.org/article/pmc/pmc10000156> (edited)

BACKGROUND AND RESEARCH FOCUS



SURVEY OVERVIEW

PREFERRED EXPLAINABILITY DETAIL

Two explainability dimensions

Technical

How detailed should the system justify its recommendations for you to trust it?



Privacy

How precisely do you want to know how the system or the provider processes your data to trust it?

[1] Creazilla, <https://creazilla.com/media/icon/3505806/201409-cow>

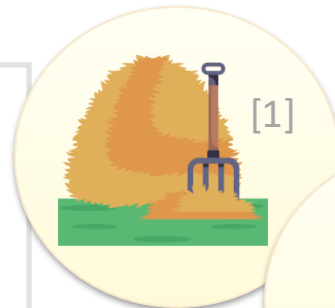
SURVEY OVERVIEW

PREFERRED EXPLAINABILITY DETAIL

Three scenarios

Scenario 1: Feeding

System advises adjusting the herd's feed to +10% protein and -5% fiber to enhance milk quality



[2]



Scenario 2: Breeding

System monitors activity data and detects heat in cow No. 23 + recommends insemination

Scenario 3: Health

System analyzes sensor data (e.g., body temperature, somatic cell count) and indicates that cow No. 23 is likely infected with mastitis

SURVEY OVERVIEW

PREFERRED EXPLAINABILITY DETAIL: EXAMPLE (1)

Technical



Scenario 2:
Breeding



Which of the following explanations has the right level of detail for you to trust the system's assessment (cow in heat)?

1. The system explains that the assessment is based on increased walking activity over the last 24 hours.
2. The system explains that the assessment is based on increased walking activity over the last 24 hours, which indicates restlessness and matches known patterns for heat.
3. The system reports that the cow's movement activity has increased by 40% compared to normally observed values, and lying time has decreased, which are strong indicators of heat.
4. The system only indicates that the cow is assessed as being in heat.
5. The system explains that the cow's movement behavior suggests heat.

SURVEY OVERVIEW

PREFERRED EXPLAINABILITY DETAIL: EXAMPLE (2)

Privacy



Scenario 3:
Health



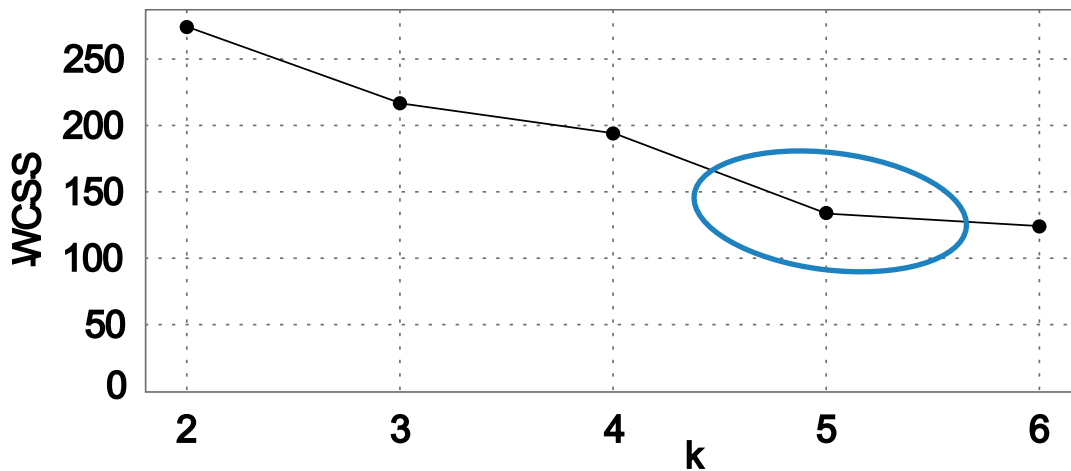
How precisely do you want to know how the system (or provider) processes the collected animal data (body temperature, somatic cell count, ...) to trust it?

1. I generally trust that providers handle my data responsibly.
2. I mostly trust providers, but I would like some basic explanations about how my data is handled.
3. I would feel better if I received some explanations about how my data is handled.
4. Without comprehensive explanations of where and how my data is stored and processed, I do not trust providers
5. I have concerns about data privacy and need detailed explanations to trust the system.

DATA ANALYSIS

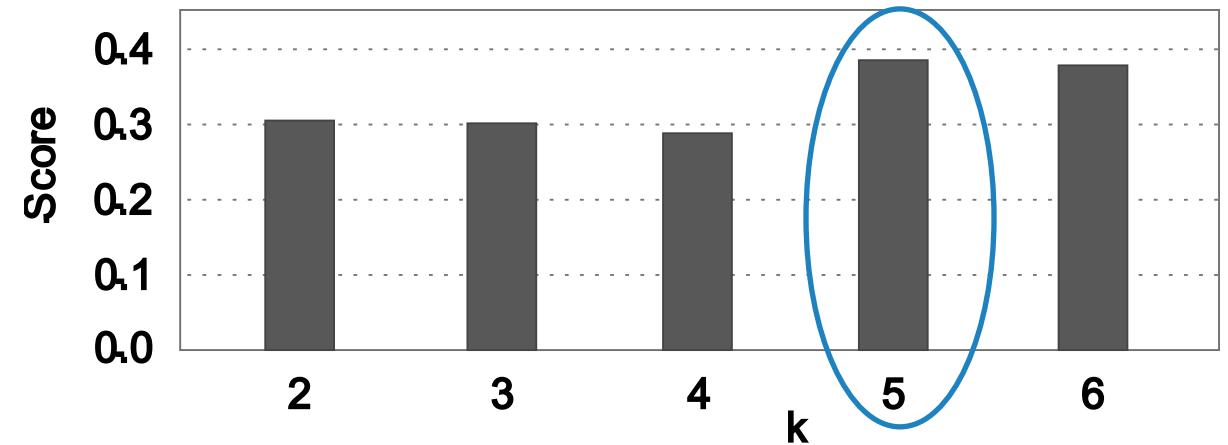
PREPROCESSING + CLUSTERING

- Principal Component Analysis (PCA): complexity reduction
- Retained enough components to capture 95% variance
- Determined $k = 5$ (using Elbow + Silhouette scores)



K-means Clustering

- Unsupervised learning for grouping data
- Divides data into k clusters based on similarity
- Useful for finding patterns in large datasets



PERSONAS OVERVIEW



*The Carefree
Power-User*

Tobias Meyer

Technical details



Privacy details



12.5%



*The Detail-Oriented
Privacy-Skeptic*

Anna Weber

Technical details



Privacy details



25.0%



The Minimalist

Lukas Beck

Technical details



Privacy details



17.5%



The Pragmatist

Michael Fischer

Technical details



Privacy details



20.0%



*The Selective
Privacy-Skeptic*

Johann Braun

Technical details



Privacy details



25.0%

EXAMPLE PERSONA (1)



*The Detail-Oriented
Privacy-Skeptic*

Anna Weber

Technical details



Privacy details



I find these systems useful, but I need to know what happens to my data. If a system recommends something, I want to understand why and verify it.

- **Age:** 39 years
- **Dairy farm:** 50 cows, 15 years experience
- **Education:** Higher agricultural school
- **Digital system use:** Almost daily, for 5 years
- **Challenges:** Some functions not intuitive, wants detailed technical explanations
- **Concerns:** Strong focus on data privacy & transparency

EXAMPLE PERSONA (2)

If I lack experience in something, explanations help. But for feeding, I know my routine in and out and don't need guidance. In other areas, I want to understand why the system suggests something.

- **Age:** 62 years
- **Dairy farm:** 70 cows, 20 years experience
- **Education:** Agricultural master
- **Digital system use:** Weekly, for 4 years
- **Challenges:** Varying explanation needs (detailed in some areas, minimal in others)
- **Concerns:** Expects full transparency, worries about unauthorized access to his data



*The Selective
Privacy-Skeptic*

Johann Braun

Technical details



Privacy details



CORRELATION ANALYSIS RESULTS

Finding	Variable 1	Variable 2	r-value or z-value	p-value
F1	dGender	eFeedTech	$z = -2.668$	$p = 0.008$
F2	dAge	eBreedPriv	$r = 0.453$	$p = 0.003$
F3	dAge	eFeedTech	$r = -0.340$	$p = 0.032$
F4	dSysConf	eBreedPriv	$r = 0.403$	$p = 0.010$
F5	dSysConf	eFeedTech	$r = -0.451$	$p = 0.003$
F6	dSysFreq	eFeedTech	$r = 0.415$	$p = 0.008$
F7	dSysDur	eFeedTech	$r = 0.339$	$p = 0.032$

dGender	Gender (female, male, other)
dAge	Age group (≤ 25 , 26 to 40, 41 to 60, ≥ 61)
dSysConf	Confidence in using digital systems (low to high)
dSysFreq	Frequency of digital system use (not at all to almost daily)
dSysDur	Years of digital system use (≤ 1 to > 5 years)
eFeedTech	Desired detail level for feeding-related technical explanations
eBreedPriv	Desired detail level for breeding-related privacy explanations

CORRELATION ANALYSIS FINDINGS

- F₁: **Female** farmers want **more detailed technical explanations** on **feeding** than male farmers.
- F₂: **Older** farmers seek **more detailed explanations** on **data privacy** in **breeding** than younger farmers.
- F₃: **Older** farmers want **more detailed technical explanations** on **feeding** than younger farmers.
- F₄: Farmers **confident** with digital systems demand **more detail** on **data privacy** in **breeding**.
- F₅: Farmers **confident** with digital systems need **less technical detail** on **feeding**.
- F₆: **Frequent** system users want **more detailed technical explanations** on **feeding**.
- F₇: **Long-term** system users desire **more detailed technical explanations** on **feeding**.

SUMMARY

■ Summary

- Developed five user personas capturing dairy farmers' explainability requirements
- Identified how socio-demographic factors correlate with explanation requirements
- Highlighted the need for user-centered requirements analysis
- Data transparency is part of explainability, not an afterthought. Farmers need to know where data goes
- AI systems are powerful but opaque by default. Explainability must be designed in from the start

Thank you

