Processing automatic tracking data to identify interactions between Holstein-Friesian cows
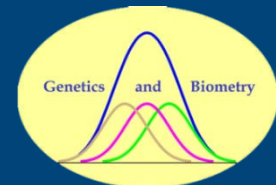
Shivateja Medisetti[1], Borbala Foris[1], Silke Trißl[1], Jan Langbein[2], Nina Melzer[1]

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Genetics and Biometry

Motivation

Detecting association and interaction in groups of cows

Association (Closeness, Avoidance)
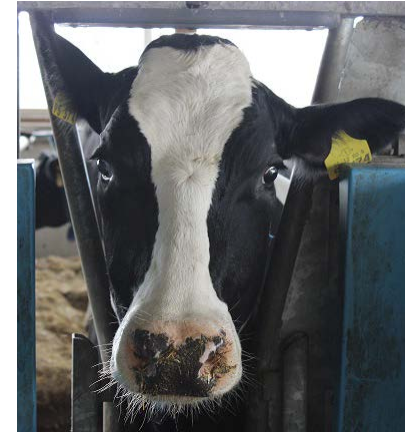- Undirected
- A is close to B and vice versa

Interaction (Positive, Negative)
- Directed
- A is actor and B is receiver

Background

	Association	Interaction
Video Capture	−	✓
Proximity Tracker	✓	✗
Automatic Tracking	✓	?

Is it possible to use such tracking data to detect interactions between cows?

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Experimental Data

Group of 15 Holstein-Friesian cows (free-stall barn at the FBN, Dummerstorf)

Observation period: 3 x 24 h on successive days

Video data
- Two video cameras for group coverage

Location data
- Ubisense (detection) and TrackLab (storage and export)
- 35 measurements per minute per tag (50,400 measurements per day)

Feeder data
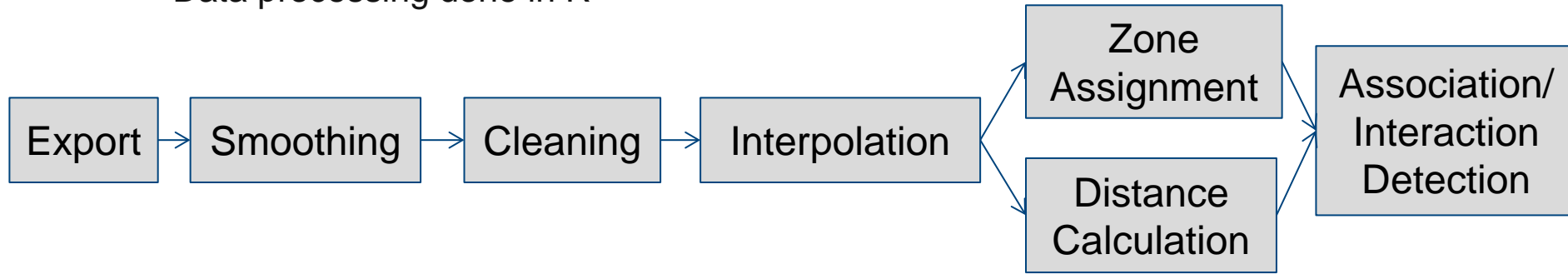- Ten feeding weight scale bins and two waterers with Roughage Intake Control (RIC)

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Data Processing

Video data – used as "Gold standard"

- Video analysis using Mangold Interact
    1. Interactions (e.g., grooming, displacement) in defined zones for 3 days
    2. Barn location (predefined zone membership) of each cow for one day

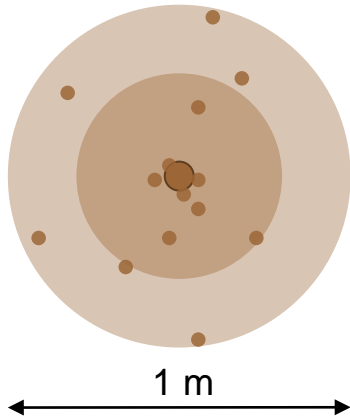**TrackLab data – Workflow**

- Data processing done in R

Export → Smoothing → Cleaning → Interpolation → Zone Assignment / Distance Calculation → Association/ Interaction Detection

Data Export

Data export from TrackLab

- Copy and paste as no built-in data export functionality in TrackLab software

Overview of raw data

1 m

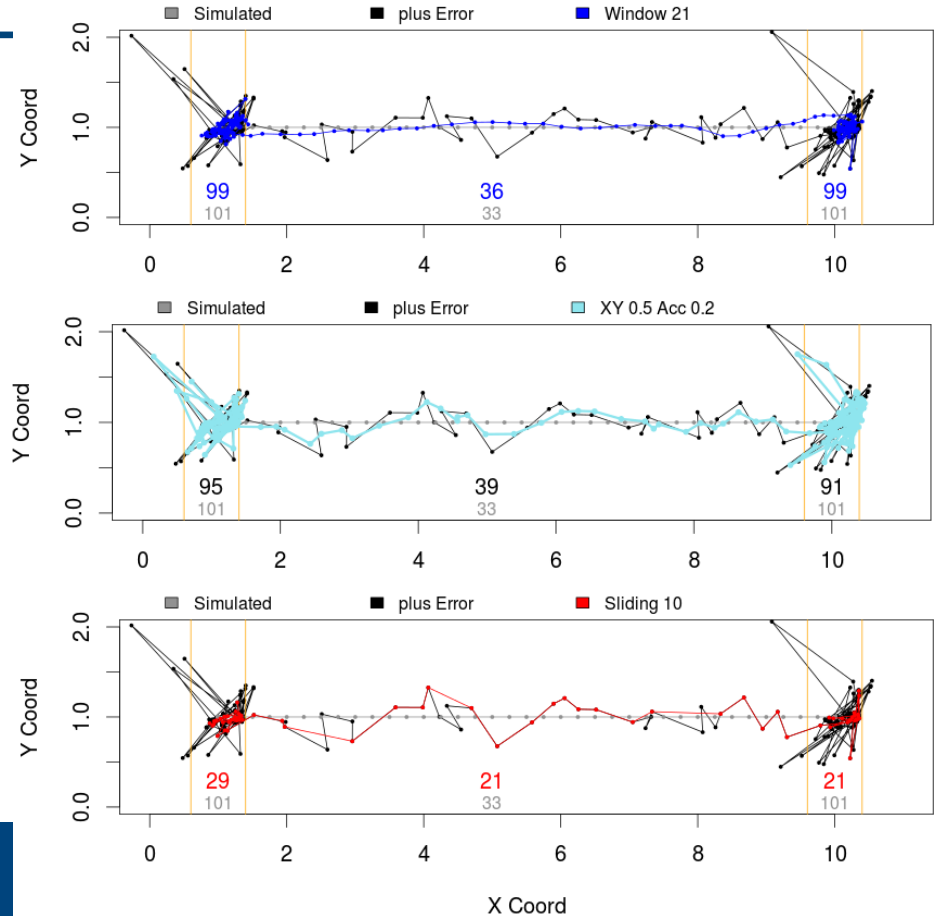# Data Smoothing – 3 Methods

Weighted Least Squares (WLS)

- TrackLab parameter: n=21 *measurements*
- Good for stationary measurements
- Strong effect on movement

Kalman Filter

- Smoothes movement well
- Little effect on stationary measurements

Sliding Window Approach

- Parameter: n=10 *seconds*
- Strong effect on stationary measurements
- Little effect on movement

Data Cleaning and Data Interpolation

Data Cleaning

− Remove time periods (approx. 4h per day): milking time, barn cleaning (cows absent)
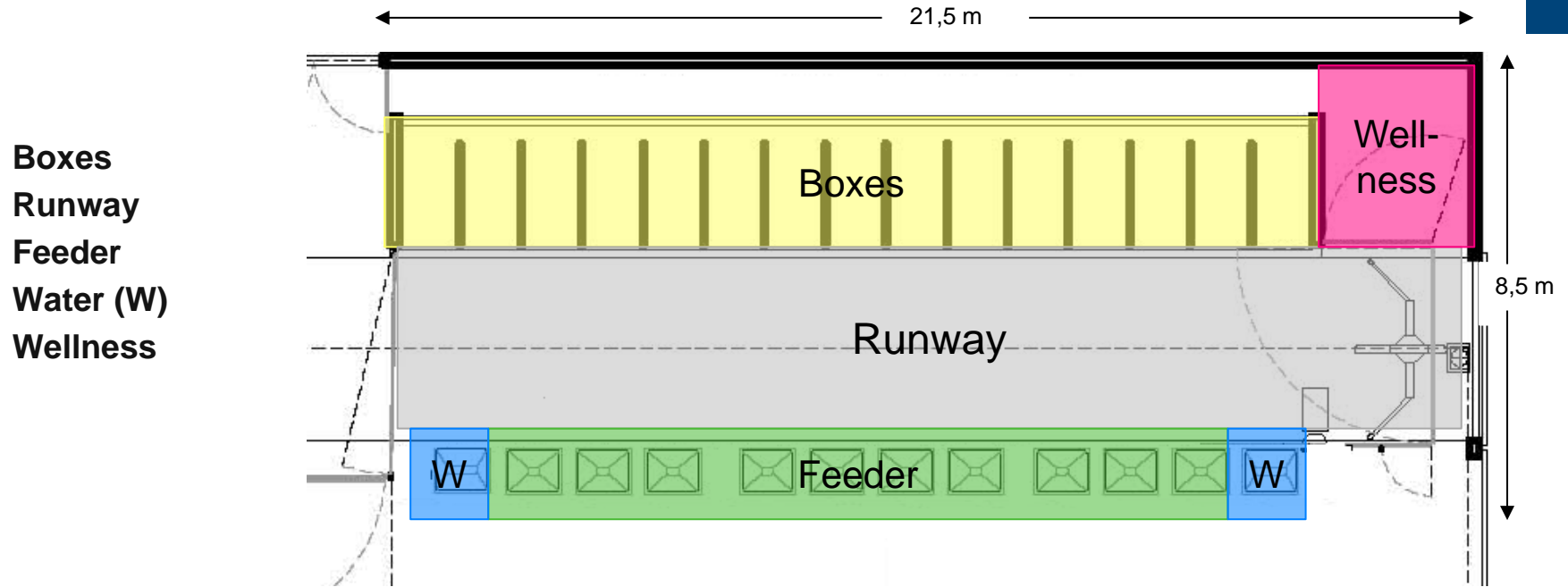feeder locked (cows present)

Data Interpolation

− Tags are measured at different timepoints
− Interpolate X and Y coordinates to each full second

	Day 1	Day 2	Day 3
No. of measurements	72,889	75,424	70,981

− Both steps were also applied on the raw data termed as Original

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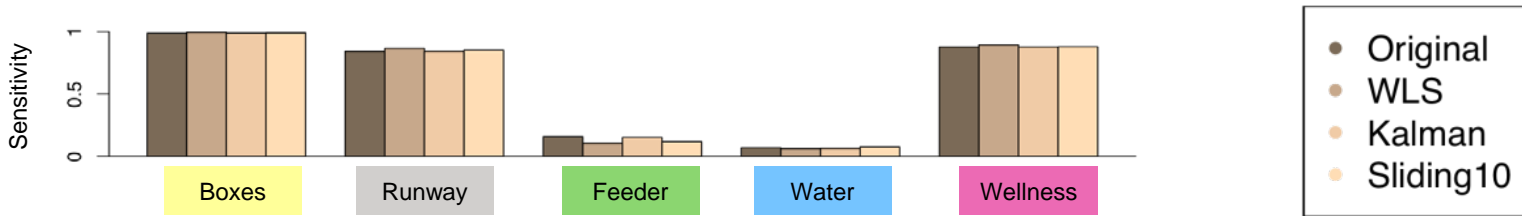# Zone Assignment

Boxes
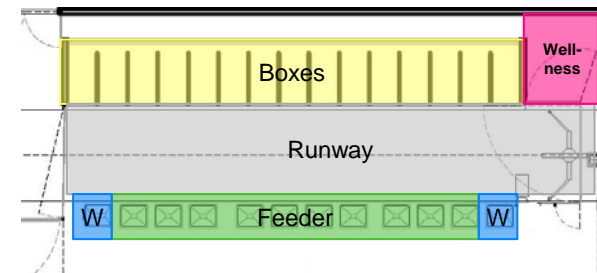**Runway**
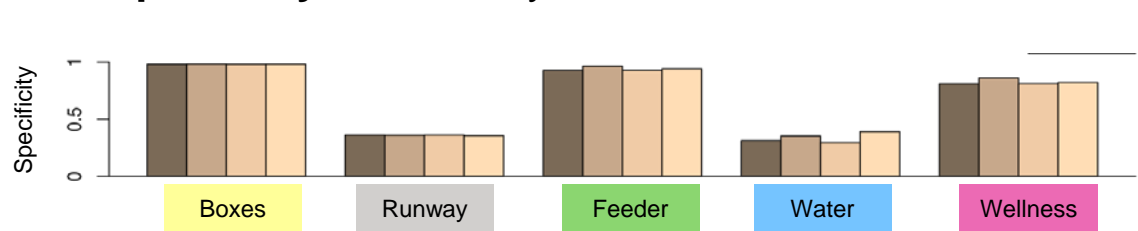**Feeder**
Water (W)
Wellness

Zone Assignment - X,Y-Coordinates

Compared to "Gold standard": Annotated video data of day 1

Sensitivity: How many measurements of the Gold standard are detected correctly?
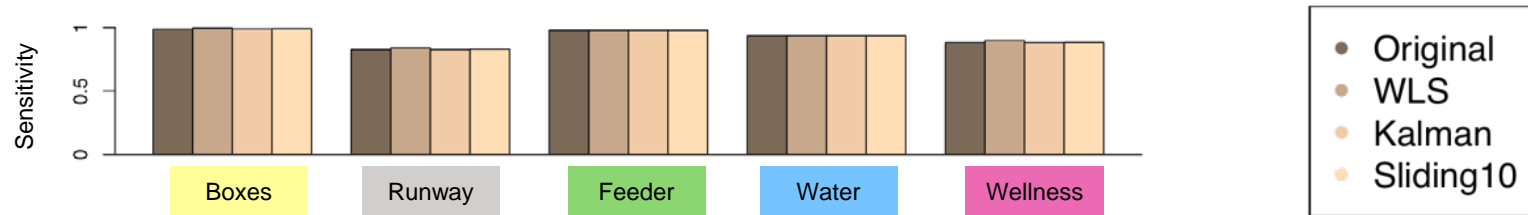

Specificity: How many of the detected measurements are correct?

Zone Assignment – Add Feeder Information

Compared to "Gold standard": Annotated video data of day 1

Sensitivity: How many measurements of the Gold standard are detected correctly?

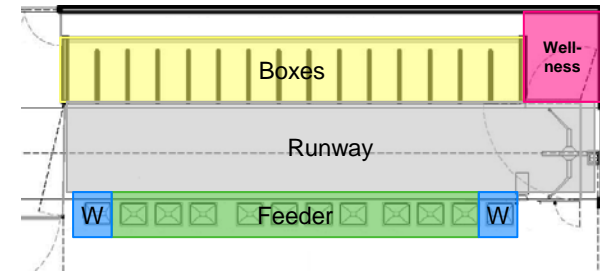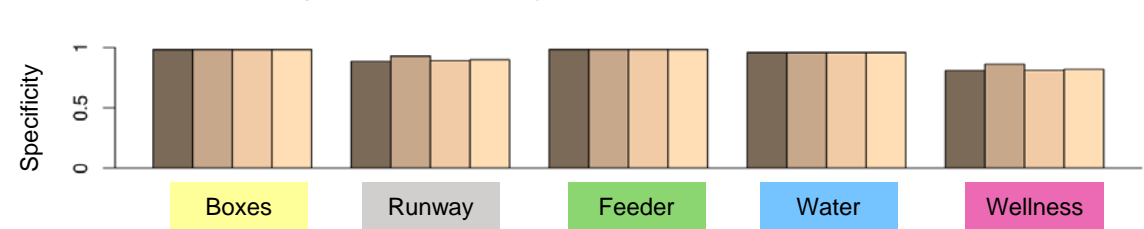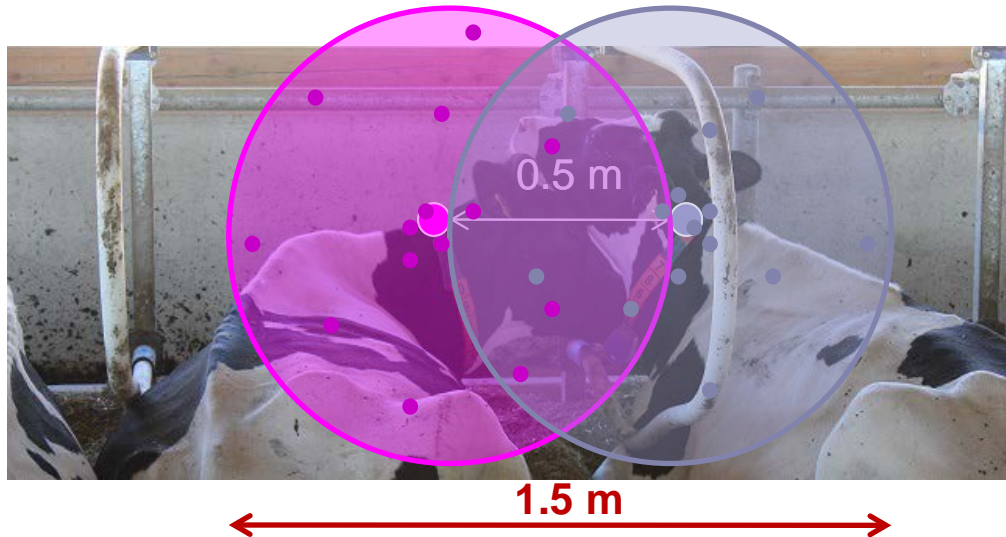**Specificity:** How many of the detected measurements are correct?
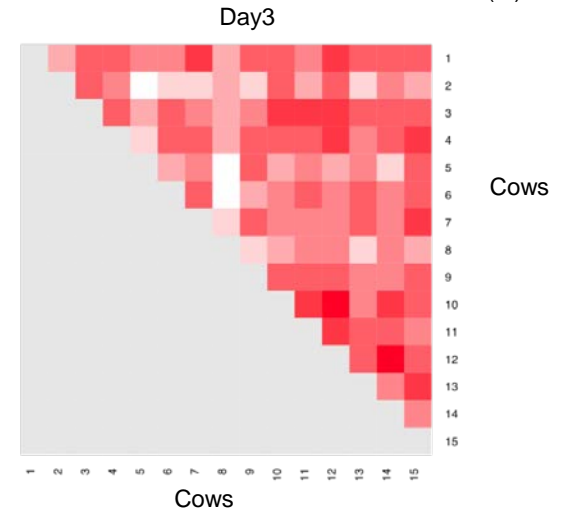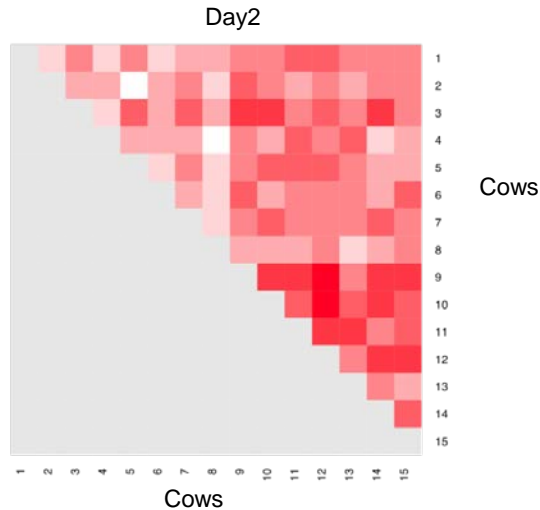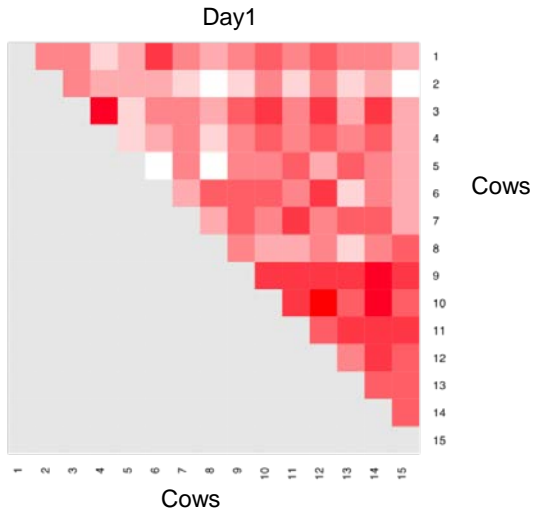
Distance Calculation

Euclidean distance between any two tags at any timepoint

Which distance is close?

Association

Calculate the average distance for each of the three days for each pair of cows (exemplary shown for Original measurements)

Interaction Detection

100 interactions at Feeder/Water (excluding milking time and time where feeder locked; Observer1)

Displacements mainly classified into:

1. **Replacements:** cow A displaces cow B → to eat/drink at the same specific Feeder/Water
   → **n=70** detectable
   → **n= 6** not detectable (special cases and technical problems)
2. **Pushing:** cow A pushes cow B away from the Feeder/Water
   → **n=20** (not searched)

Day 1	Observer1	Original	Kalman	Sliding 10	WLS
True detected	70	66	67	51	47
False detected		5	5	6	5
Newly revealed		30	30	28	28

Newly revealed interactions verified by Observer2

Additional 2 replacements were found by Observer2

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Interaction Detection – Validation

	Replacements				
	Total	Detectable	Not detectable	Pushings	False observed
Observer1 - Day2	111	**49**	11	39	12
Observer1 - Day3	109	**79**	3	18	9

		Observer1	Original	Kalman	Sliding 10	WLS
Day2	True detected	49	44	46	37	34
	False detected	-	5	3	4	5
	Newly revealed	-	17	19	18	17
Day3	True detected	79	69	69	60	51
	False detected	-	9	7	9	8
	Newly revealed	-	15	14	11	11

How good is the "Gold standard" created by only one observer?

Conclusion

Interaction detection using automatic tracking data is possible
- Good data quality is needed, includes careful data preparation
- Additional information like feeder data are useful

Smoothing has some effects
- To determine association between cows by averaging distances over a whole day smoothing is not necessary
- For zone assignment smoothing is advantageous
- Depending on the research aim other methods may be useful

Automatic tracking data holds many hidden treasures
- 24 hour monitoring of groups of cattle

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Thank You For Your Attention

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