

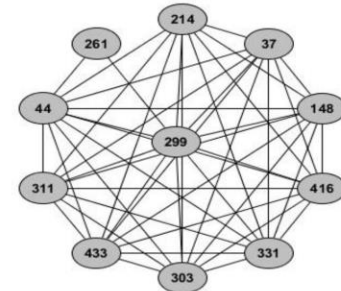
# Automated assessing of social networks and daily barn activities of dairy cows from video surveillance

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Institute of Animal Breeding & Husbandry, CAU Kiel

70th Annual Meeting of the European Federation of Animal Science  
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Session 25, Abstract number 31118, [jsalau@tierzucht.uni-kiel.de](mailto:jsalau@tierzucht.uni-kiel.de)





# Introduction & motivation

**AIM:** Analysis of daily barn activities





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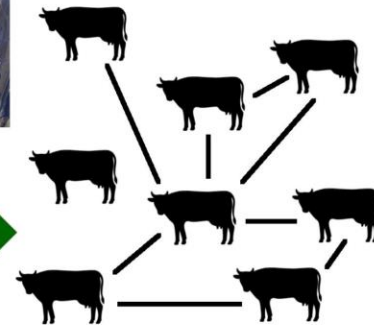


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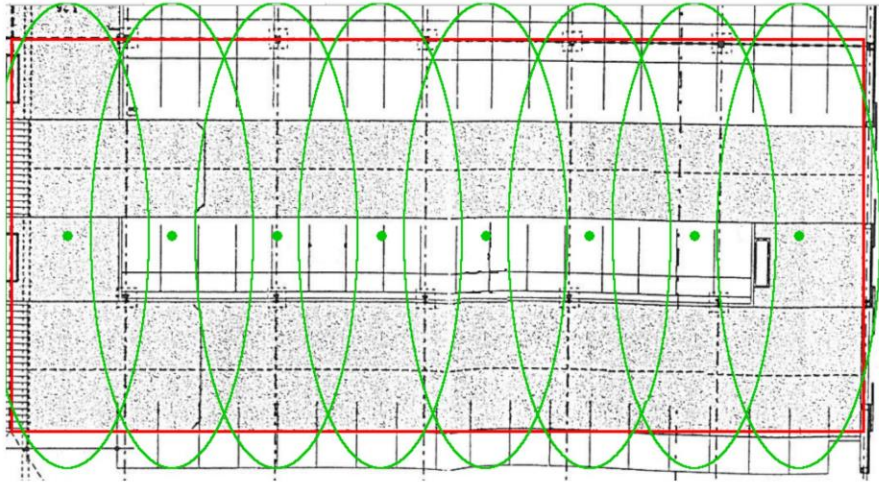
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Using network analysis



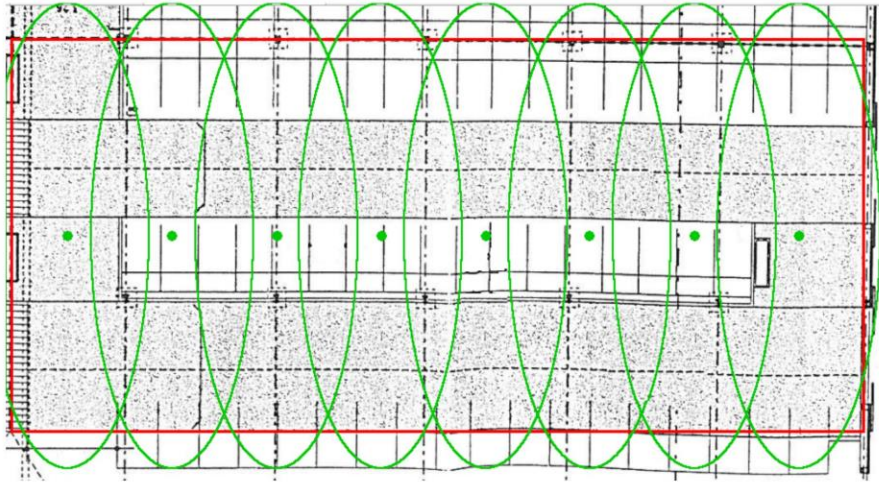
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Chamber of Agriculture, Schleswig-Holstein, Futterkamp

- Rectangular barn area, 12 m x 26 m

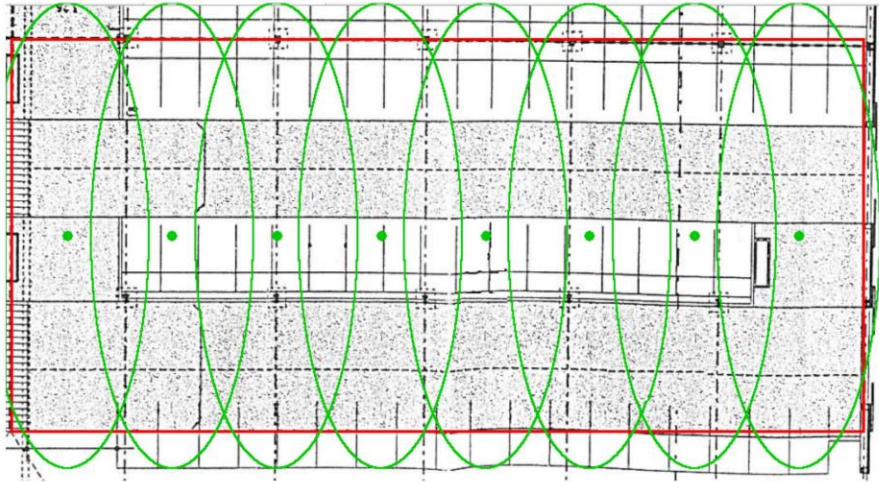
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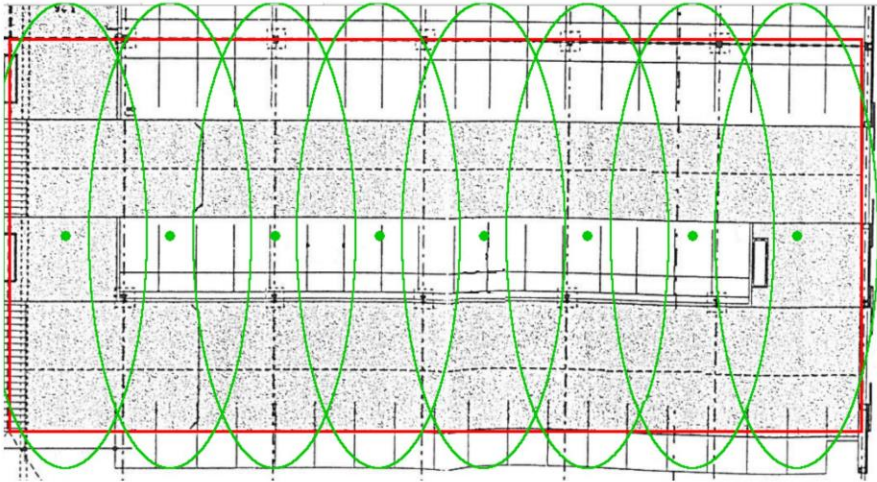


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- Recording between morning and afternoon milking





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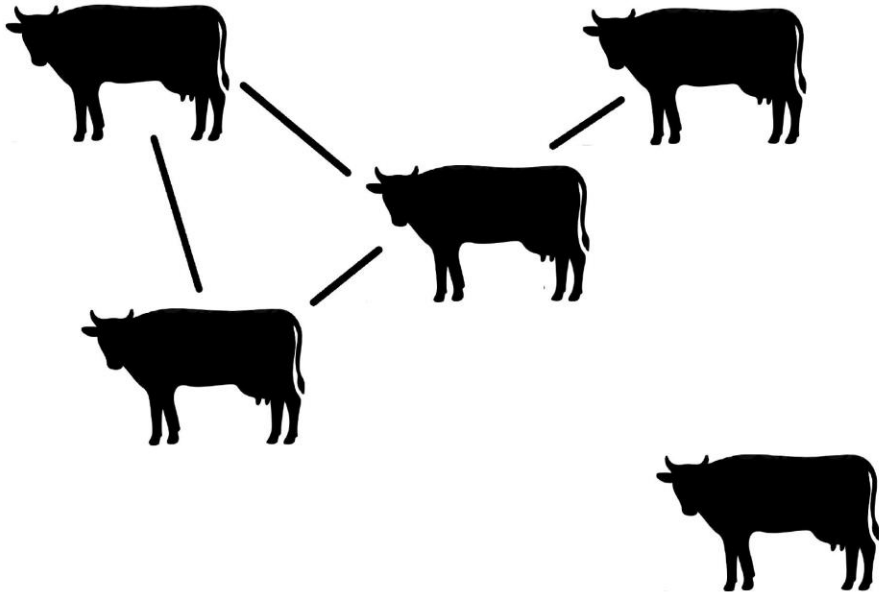




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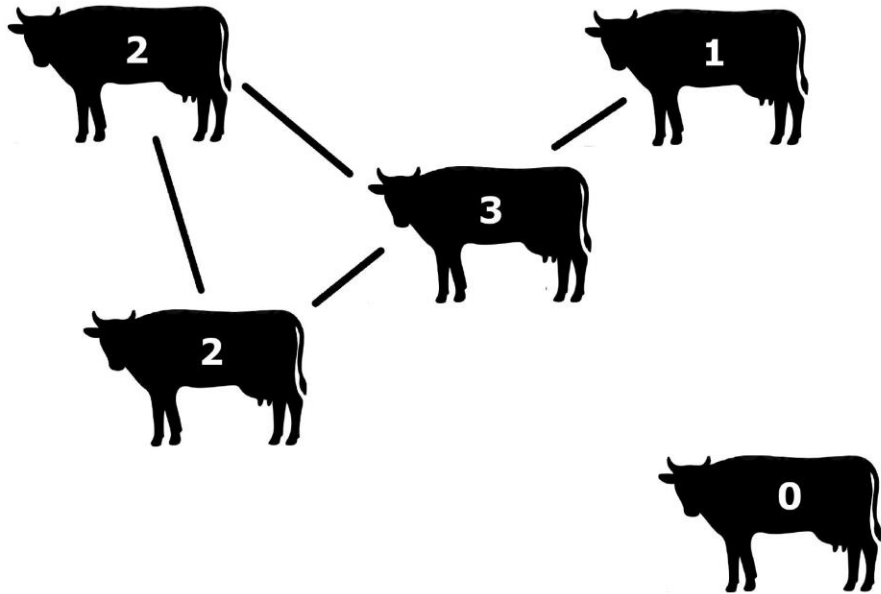
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  - Contact definition:  
Cows positioned with their heads within approx. one head's length

# Material & methods - Network parameter: Degree



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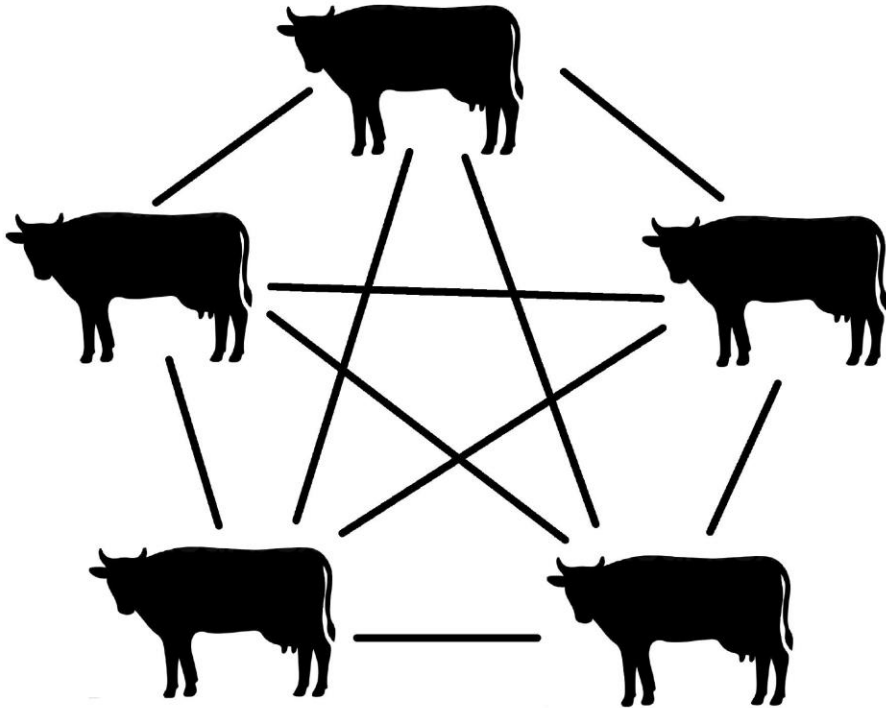


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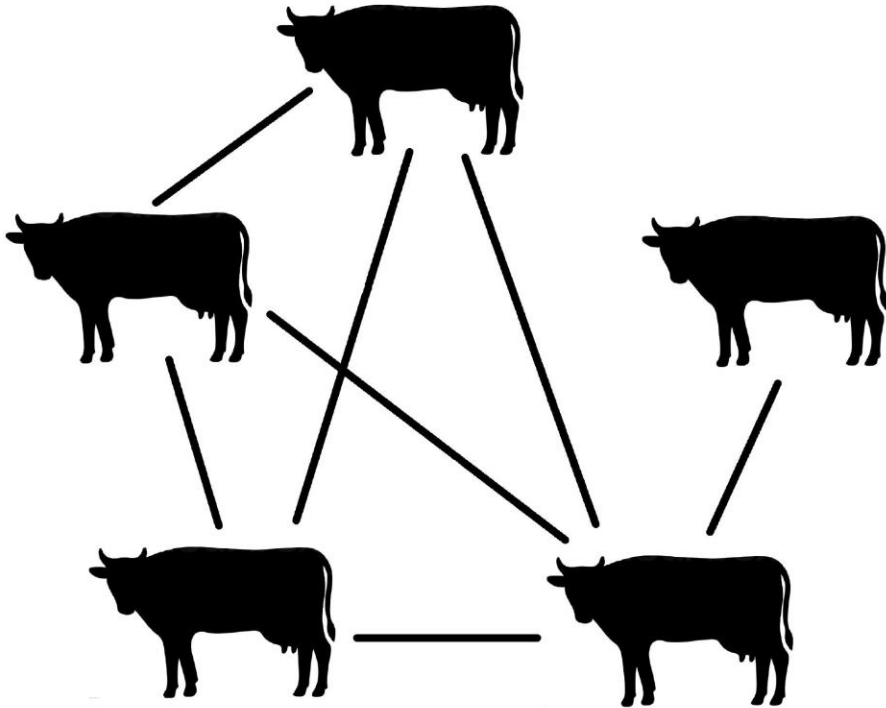
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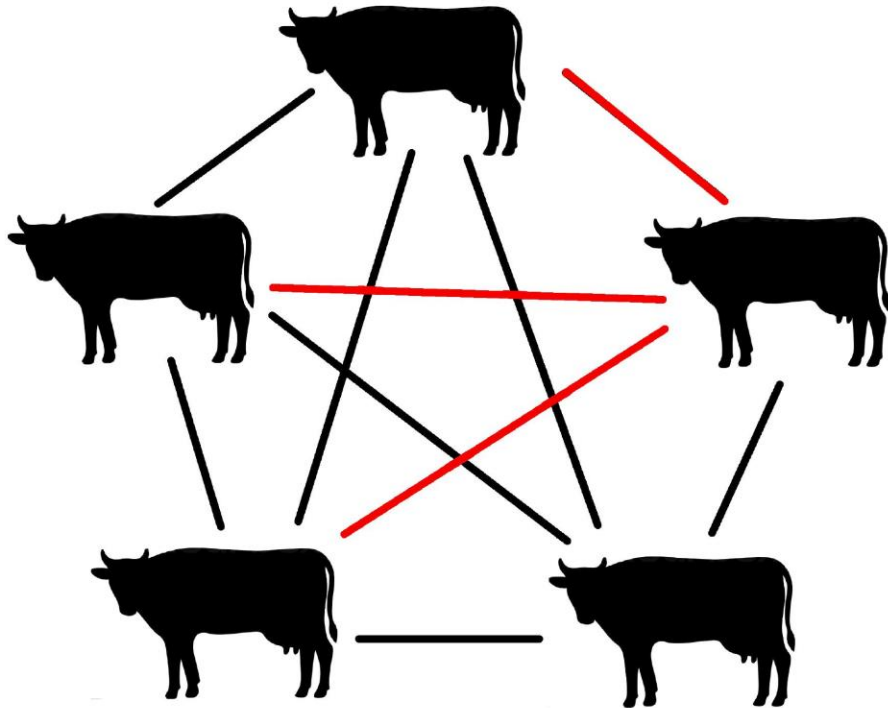
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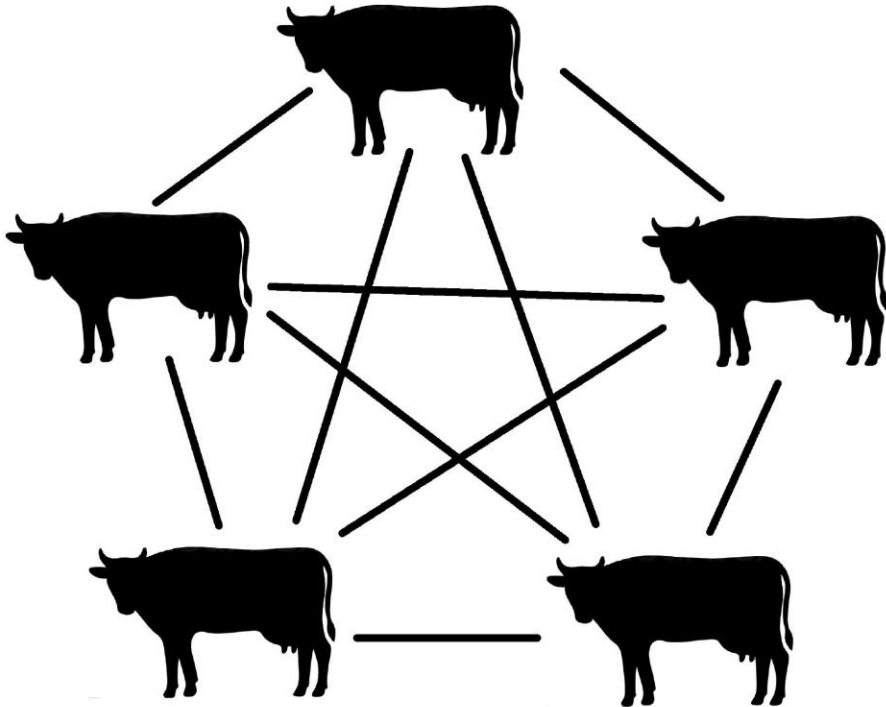


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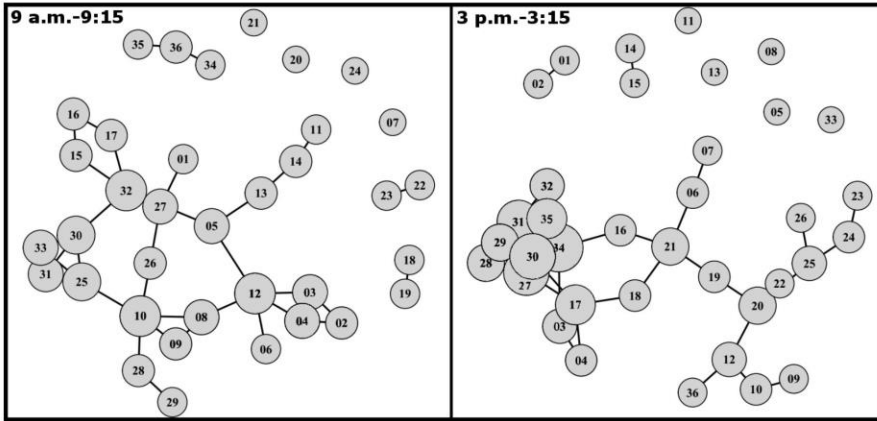
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- Clique: **Fully** connected component
- Difference to connected component
  - No edges missing
  - Every node is connected to every other node
- Parameters to analyse the clique structure
  - Size of largest clique
  - Number of cliques  $\geq 3$  cows



# Analysis of contact networks

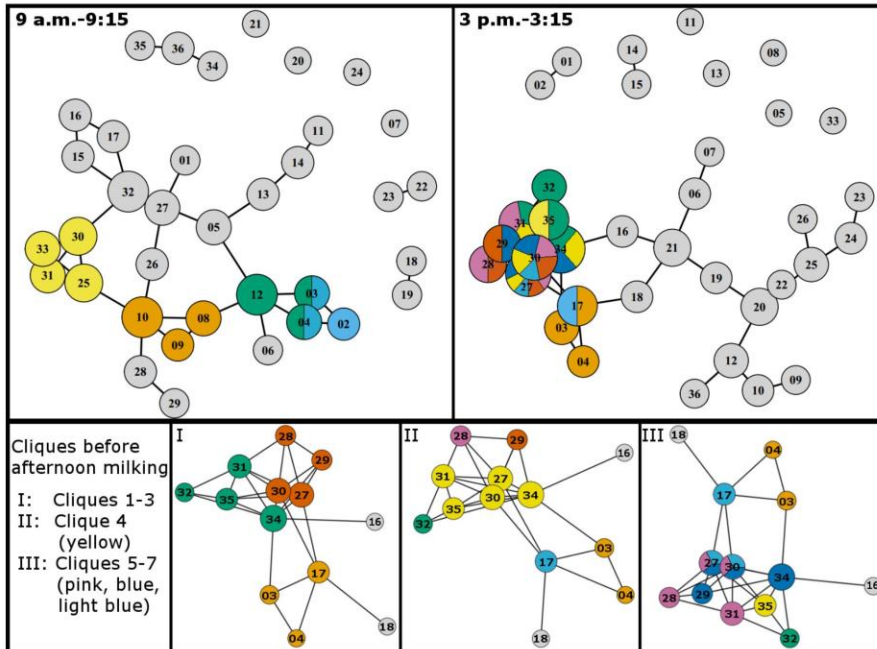


- Degree

- Ranging from 0 to 5 ( $2.1 \pm 1.4$ )
- Ranging from 0 to 8 ( $2.5 \pm 2.1$ )



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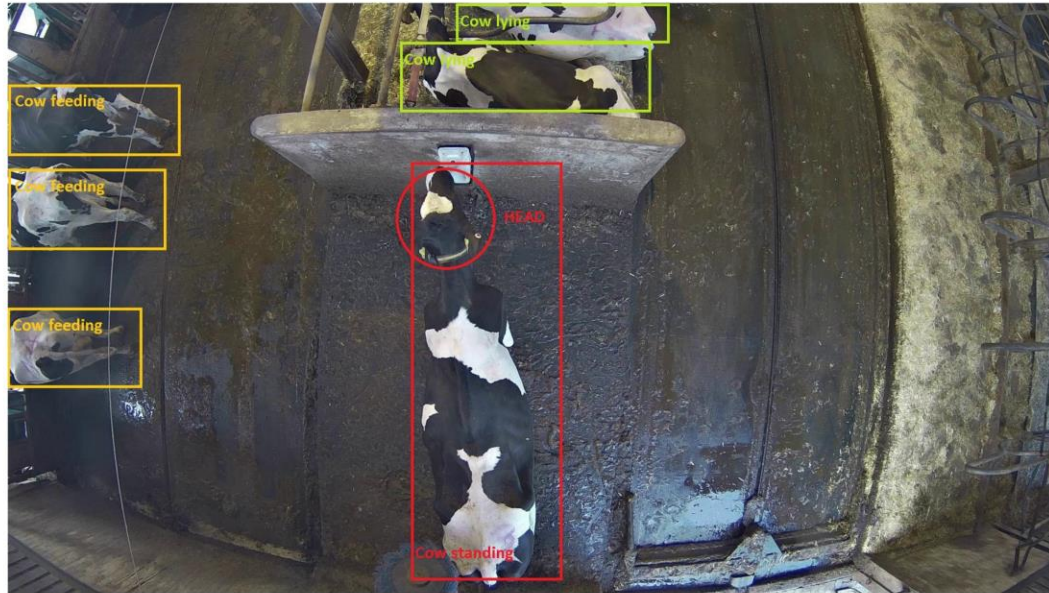


- Degree
  - Ranging from 0 to 5 ( $2.1 \pm 1.4$ )
  - Ranging from 0 to 8 ( $2.5 \pm 2.1$ )
  
- Cliques
  - Number of cliques  $\geq 3$  cows: 4  
 Size of largest clique: 4
  
  - Number of cliques  $\geq 3$  cows: 7  
 Size of largest clique: 5



# Automated object recognition

A reliable automated cow recognition is needed:



⇒ As a start: Detection of moving objects



# Motion detection

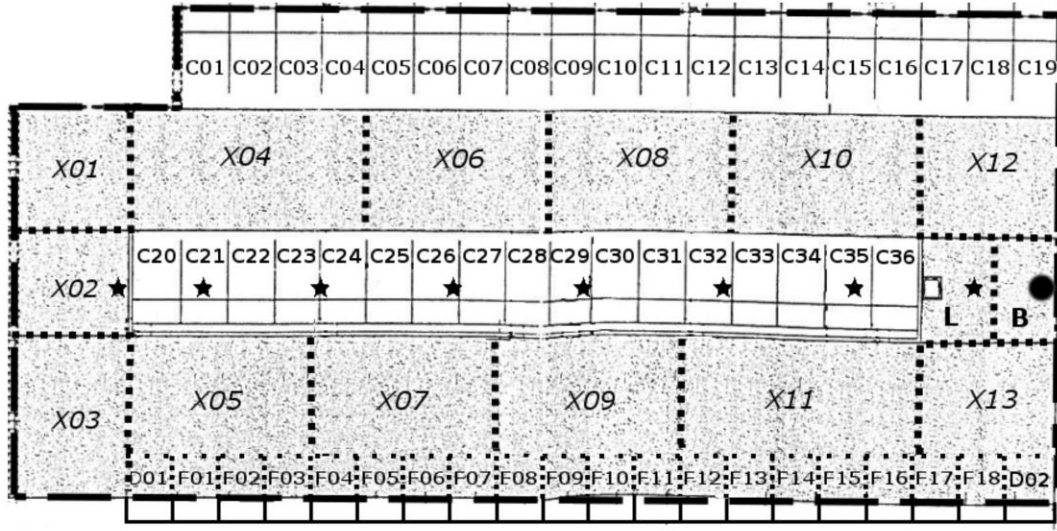


- Modelling image background from the first images
- Subtraction of background model
  - ⇒ Moving objects remain as image foreground
- Keep only moving objects of a predefined size





# Motion detection – Partition of the barn



- Barn was divided into areas
  - Lying cubicles
  - Feeding-/Drinking places
  - Running area partitioned into rectangles

# Motion detection – Space-Usage-Pattern



- Transfer partition to field of view (FOV) of the cameras
  - Avoiding contradictory results of motion detection
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Apply motion detection to detect the areas with cow activity  
⇒ Space-Usage-Pattern



# Analysis of Space-Usage-Pattern

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	12 am-1 pm	0.013	0.004	...
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4th of April	8 am-9 am	0.008	0.013	...
	9 am-10 am	0.004	0.007	...
	10 am-11 am	0.008	0.003	...
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- Motion detection applied to recordings
  - 3rd to 7th of April, 8 am to 2 pm
  - 26th to 30th of June, 8 am to 2 pm
- Data set organised by day and hour

Space-Usage-Pattern of each hour:  
Proportionate usage of total barn per area





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between hours

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  - Compare pairs of hours **within each day**



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Pearson correlations between hours

P. correlations between hours

- Calculation of Pearson correlations between Space-Usage-Pattern:
  - Compare pairs of hours **within each day**
  - Compare the same hours **between days**



# Analysis of Space-Usage-Pattern - Correlations

Day	Hour	X01	X02	...
3rd of April	8 am-9 am	0.008	0.011	...
	9 am-10 am	0.006	0.010	...
	10 am-11 am	0.009	0.011	...
	11 am-12 am	0.008	0.010	...
	12 am-1 pm	0.013	0.004	...
	1 pm-2 pm	0.010	0.004	...
4th of April	8 am-9 am	0.008	0.013	...
	9 am-10 am	0.004	0.007	...
	10 am-11 am	0.008	0.003	...
	11 am-12 am	0.006	0.001	...
	12 am-1 pm	0.002	0.003	...
	1 pm-2 pm	0.002	0.003	...
5th of April	8 am-9 am	0.005	0.007	...
...	...	...	...	...
30th of June	11 am-12 am	0.011	0.014	...
	12 am-1 pm	0.002	0.009	...
	1 pm-2 pm	0.004	0.003	...

Pearson correlations between days

Pearson correlations between hours

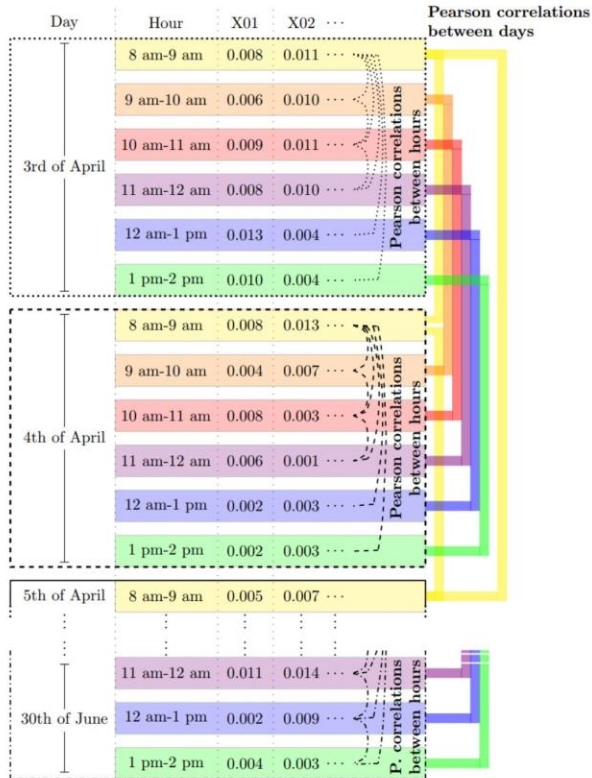
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# Analysis of Space-Usage-Pattern - Correlations

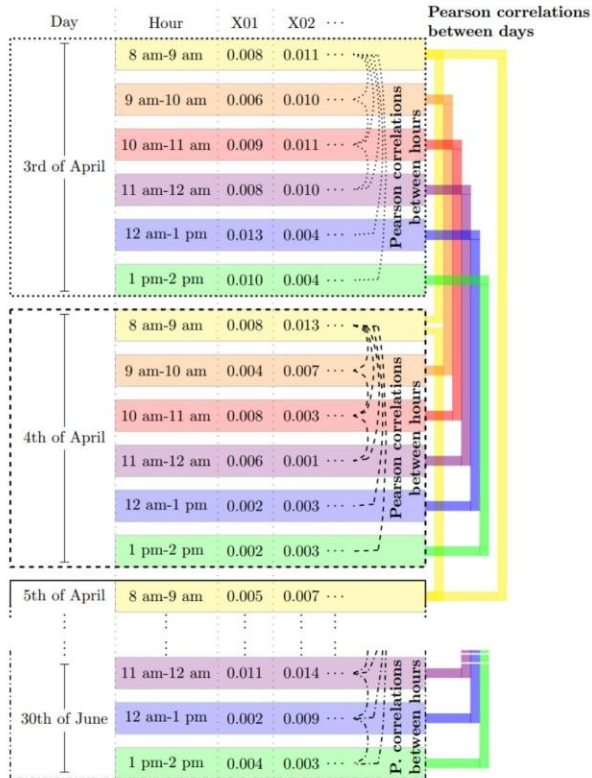


- Calculation of Pearson correlations between Space-Usage-Pattern:
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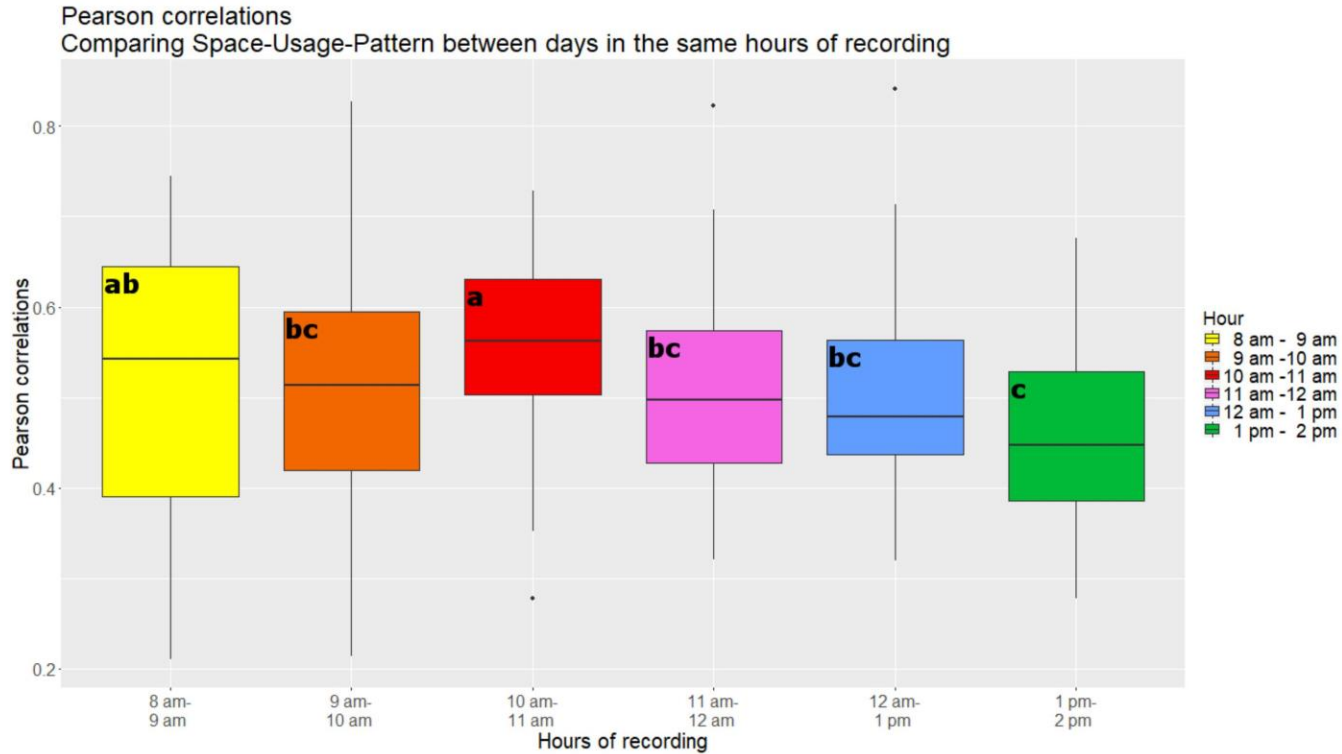
# Analysis of Space-Usage-Pattern - Correlations



- Calculation of Pearson correlations between Space-Usage-Pattern:
  - Compare pairs of hours **within each day**
  - Compare the same hours **between days**
- Kruskal-Wallis tests reveal significant ( $p=0.05$ ) differences between days/hours

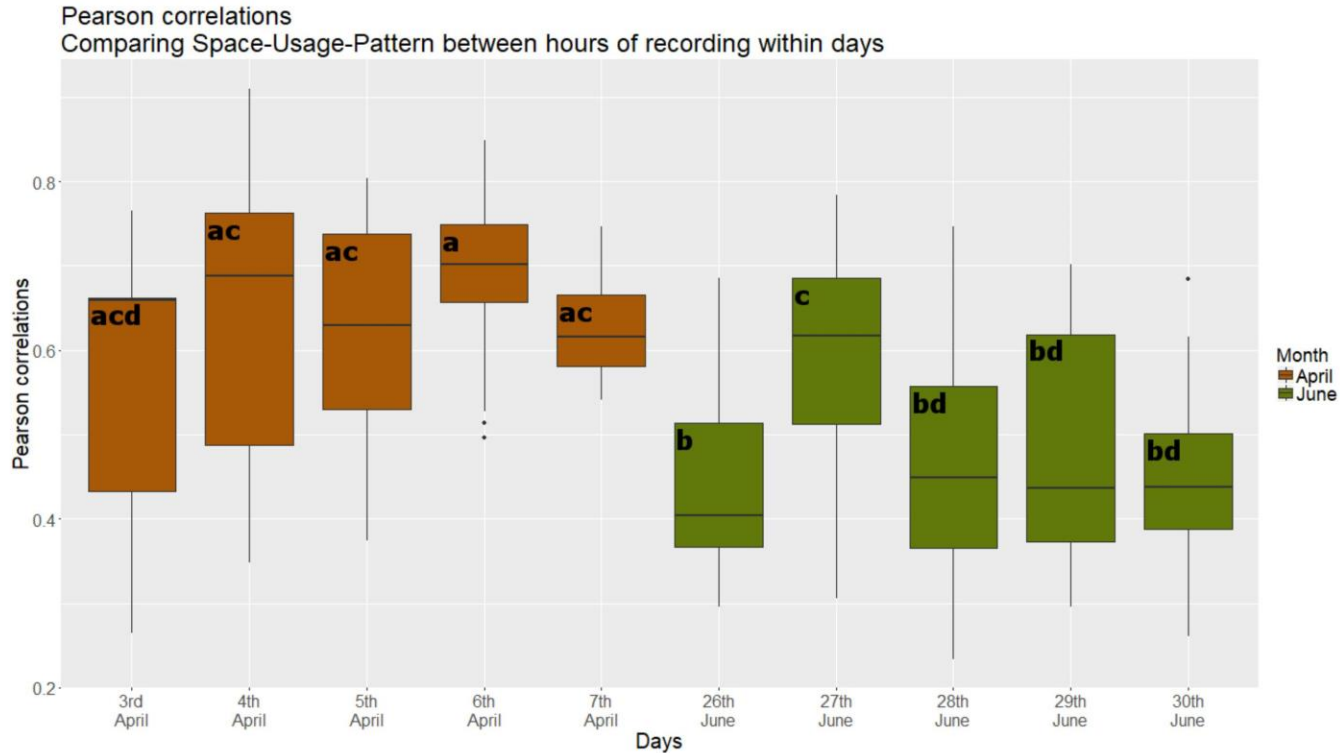


# Comparison of Space-Usage-Pattern between days





# Comparison of Space-Usage-Pattern within days





# Visualization of Space-Usage-Pattern

Areas visited more in April

Areas visited more in June





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- For a full analysis of contact networks automation is necessary  
⇒ Machine learning techniques are needed
- Automated detection of moving objects was implemented successfully
- Motion detection in predefined barn areas gives insight about space usage
- Animal preferences and daily activities can be revealed

# Thank you for your attention!

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