# New insights into pig social interactions from AI-assisted digital phenotypes

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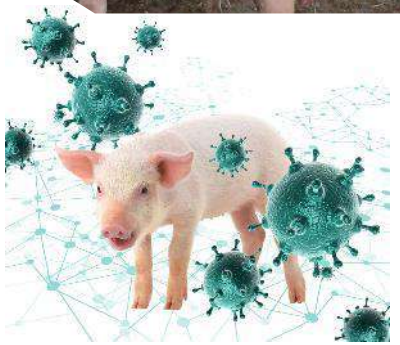
# Social interactions play a crucial role in animal performance, health & welfare

Feeding behaviour
Growth rate

Aggression

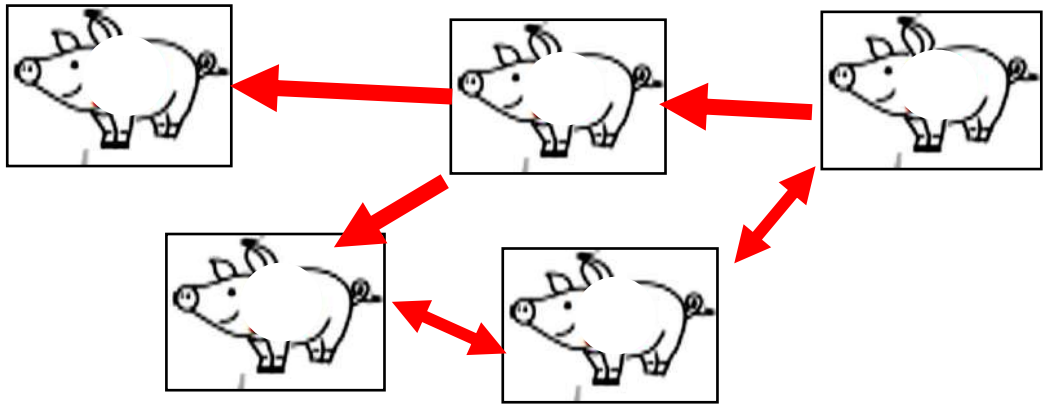


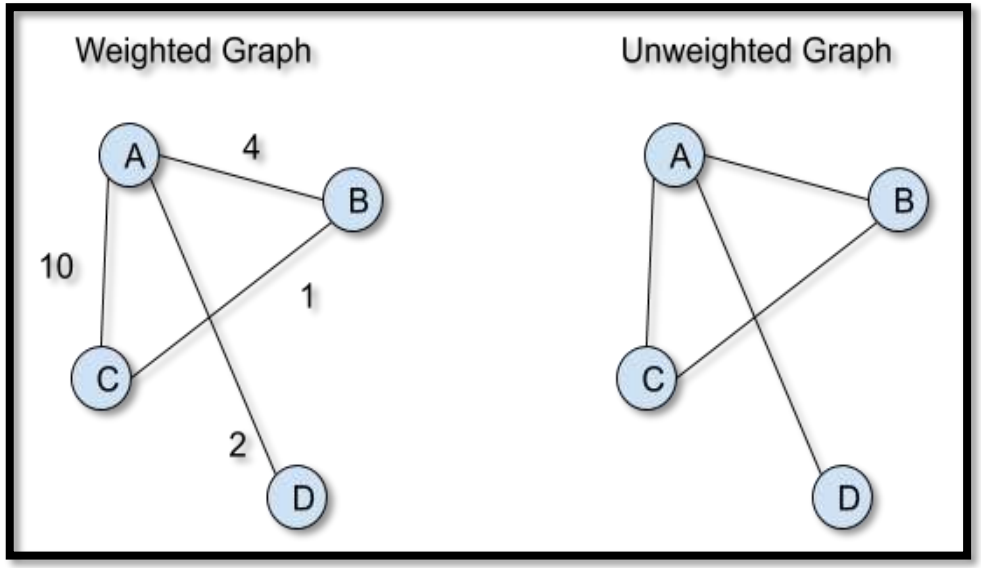
Disease transmission

**Measuring social interactions & their impact is challenging**

# Social Network Analysis (SNA)

An approach that quantifies the pattern of relationships among interacting individuals.



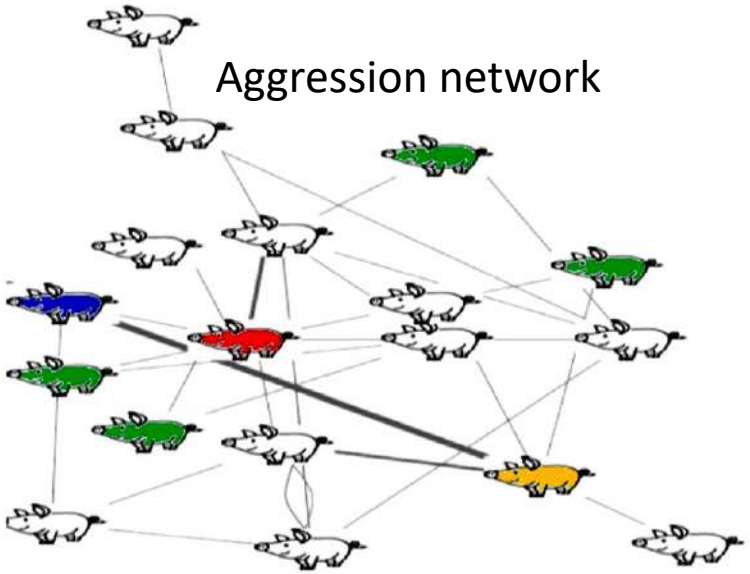



Behaviour data → **SNA** → Novel behaviour traits →

- Insights into the social structure of a group
- Identify the direct and indirect role of each animal

# SNA of aggressive behaviour in pigs

Photo by Lucy Oldham



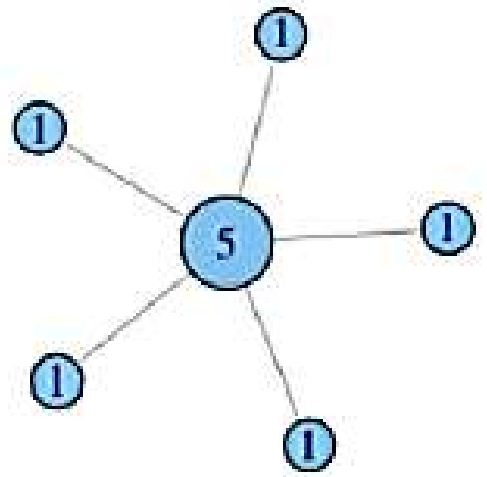
Aggression network

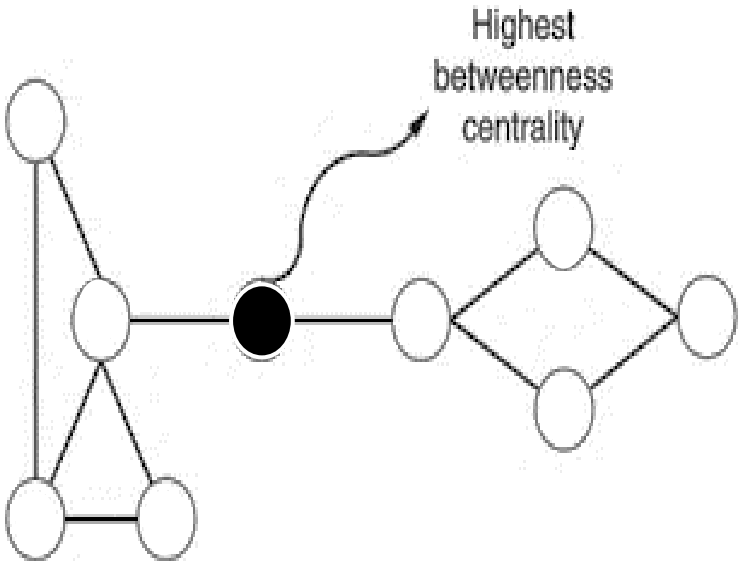
- Aggression is a major unresolved welfare issue
- Previous analyses using **data from manually extracted from video recordings** have shown that
  - Social network structures predictive of chronic aggression
  - Central individuals play key role in pen level aggression
  - Centrality is partly genetically determined
    - ➢ potential to breed for low aggression
- But time consuming & unfeasible to implement on scale

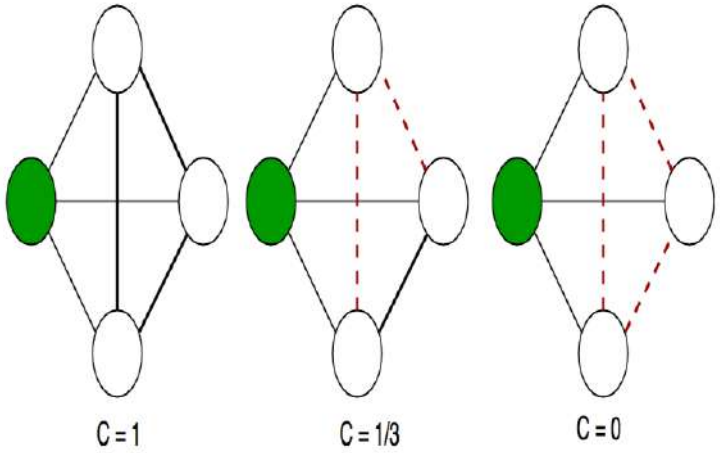
*Foister et al., Plos One 2018; Buttner et al., Animal 2020; Agha et al., Genes 2022a&b; Oldham et al. Sci Rep. 2025*

# SNA individual traits

| Degree centrality | Betweenness centrality | Clustering coefficient |
| --- | --- | --- |
| The number of edges connected to a node. | It measures the number of shortest social paths that pass through a particular individual. | Proportion of an animal's connections that are also connected with each other. |

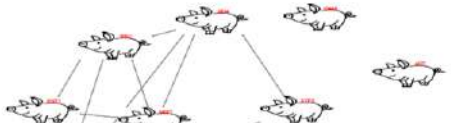


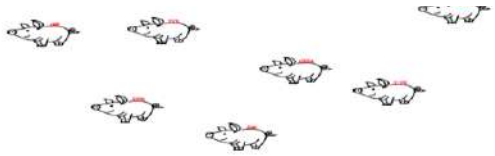



# Our vision

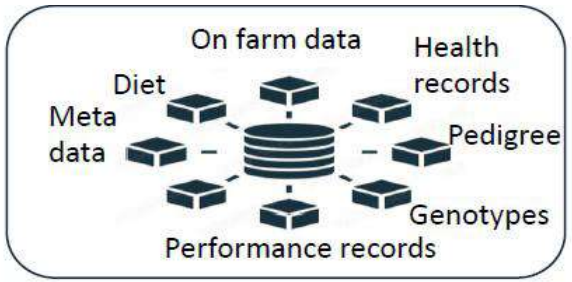


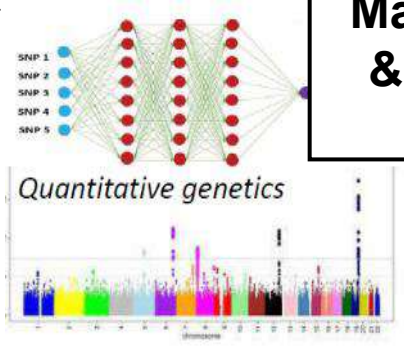


**Social Network Analyses**

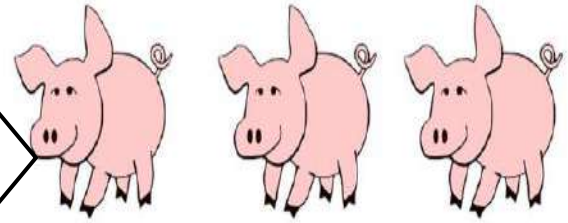


**AI-assisted digital behavioural phenotypes**




**Next gen Management & Breeding**



Highly productive, healthy pigs & high welfare standards for a range of environments


# Objectives

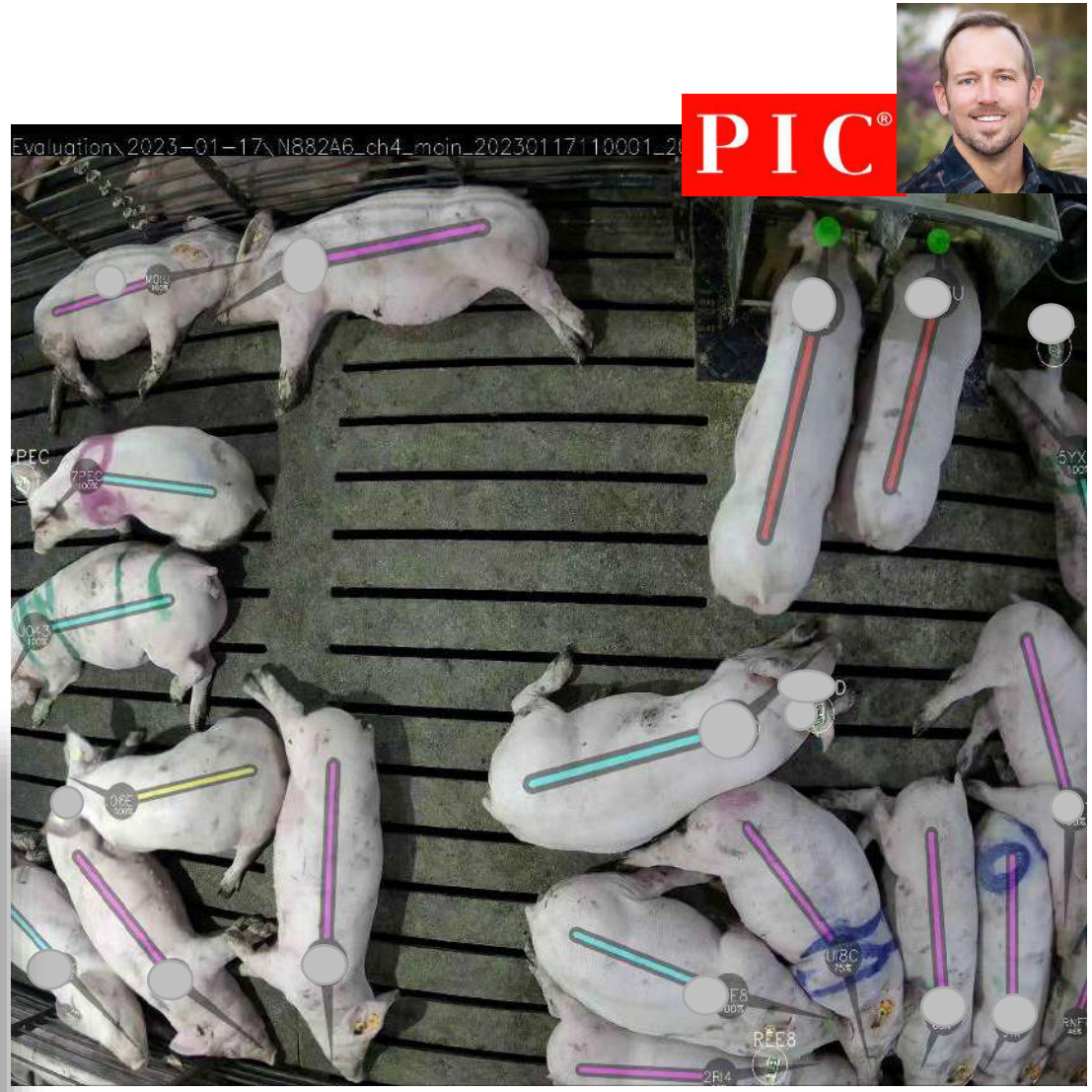
Explore the feasibility to use automated data from commercial pigs & SNA to

- Construct social interaction networks
- Gain new insights into the social structure and its dynamic changes within pens
- Identify the role of individual animals in the social structure
- Identify aggressive behaviour

# Automated (pilot) data

- Video footage of 6 pens (16-19pigs)
  - 70 recording days; 14 hour per day.
- Multi-object DL tracking algorithm to extract **individuals' posture, activity & position in real time**

| Animal | Time | Activity | | Posture | Position of shoulder & tail | | | |
|---|---|---|---|---|---|---|---|---|
| B | C | D | E | F | N | O | P | Q |
| ID | Second | Eat | Drink | Posture | ShoulderX | ShoulderY | TailX | TailY |
| 2RI | 3227.455322 | 0 | 0 | 3 | 2.36 | 1.47 | 3.12 | 1.36 |
| ATI | 1937.396729 | 0 | 0 | 3 | 5.09 | 1.55 | 4.55 | 1.39 |
| ATI | 1937.797119 | 0 | 0 | 3 | 5.17 | 1.53 | 4.65 | 1.41 |
| ATI | 1937.997314 | 0 | 0 | 3 | 5.18 | 1.52 | 4.69 | 1.43 |
| ATI | 1938.19751 | 0 | 0 | 3 | 5.28 | 1.46 | 4.71 | 1.46 |
| ATI | 1951.810791 | 0 | 0 | 3 | 5.6 | 1.11 | 5.09 | 1.38 |
| ATI | 1952.010986 | 0 | 0 | 3 | 5.58 | 1.13 | 5.06 | 1.38 |



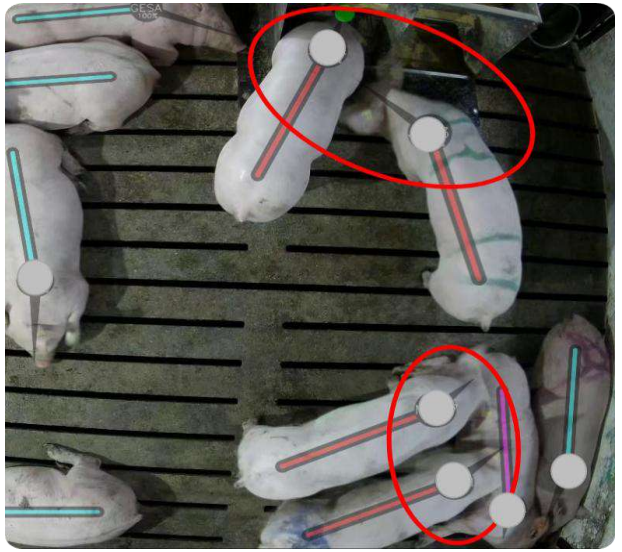

ed line = Standing, Yellow line = Sitting, Cyan line = Lying Sternal, Magenta line = Lying Lateral, Green Dot Snout = Eating, Blue Dot Snout = Drinking

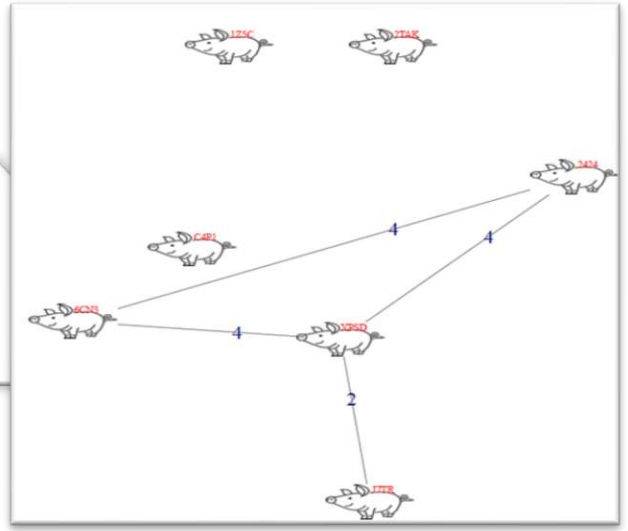
- Video recordings and camera snapshots for validation

*Agha et al., Revealing the hidden social structure of pigs with AI-assisted automated monitoring data and SNA, Animals 2025*


# Constructing Social Contact Networks

- **Choose a time period** of interest (e.g. 3 days)
- **Define contact:** animals **standing** for **prolonged** time (>2 minutes) **in proximity (**< 0.5-meter distance based on Shoulder X & Y coordinates)**.**
- **Develop computational SNA pipeline to construct and characterise weighted contact networks**
  - **For different pens**
  - **For different time periods**

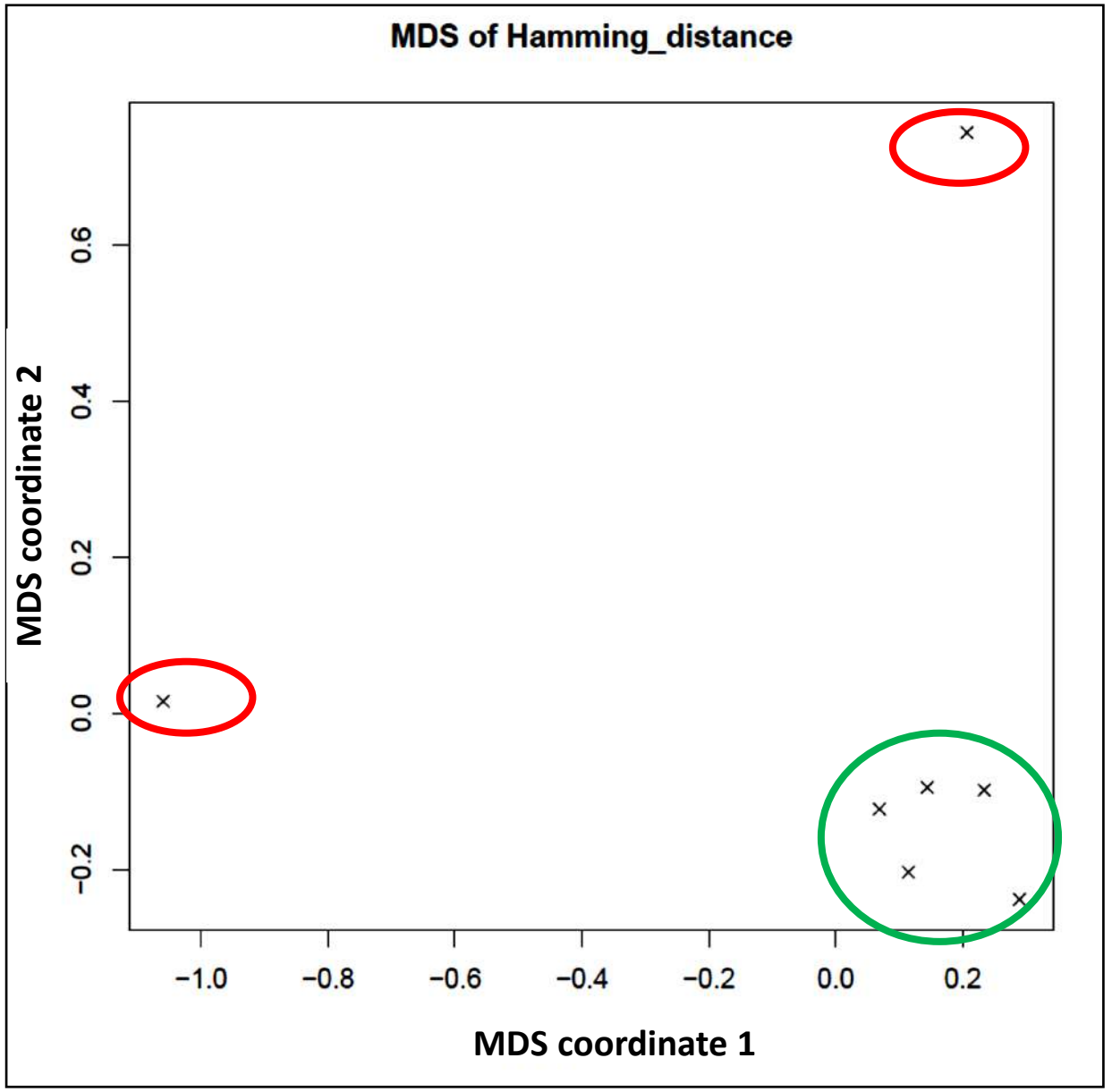


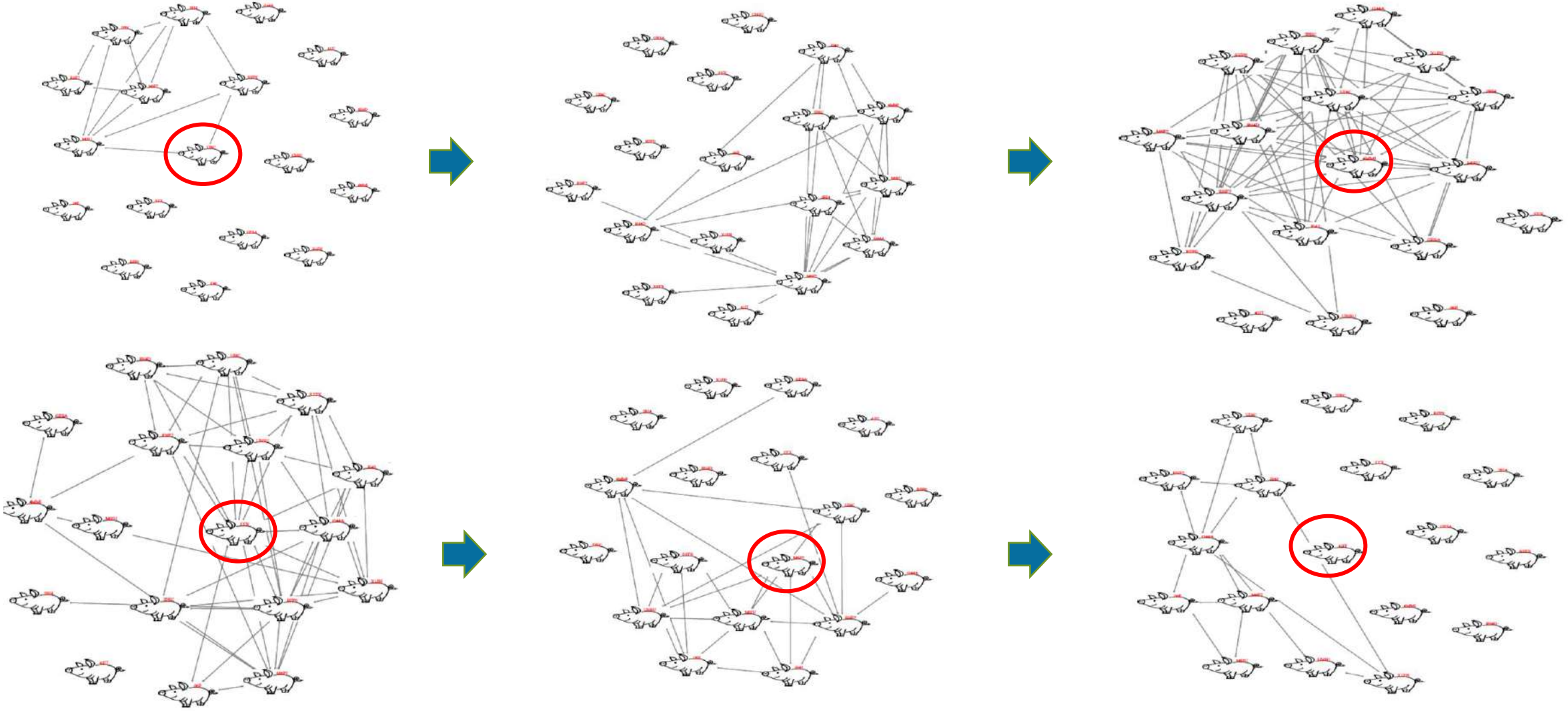
# Social contact structures can differ substantially between pens

**The Hamming distance** is equal to the number of addition/deletion operations needed to transform the edge set of a network into that of the other.

Closer networks e.g., points have similar social interaction patterns

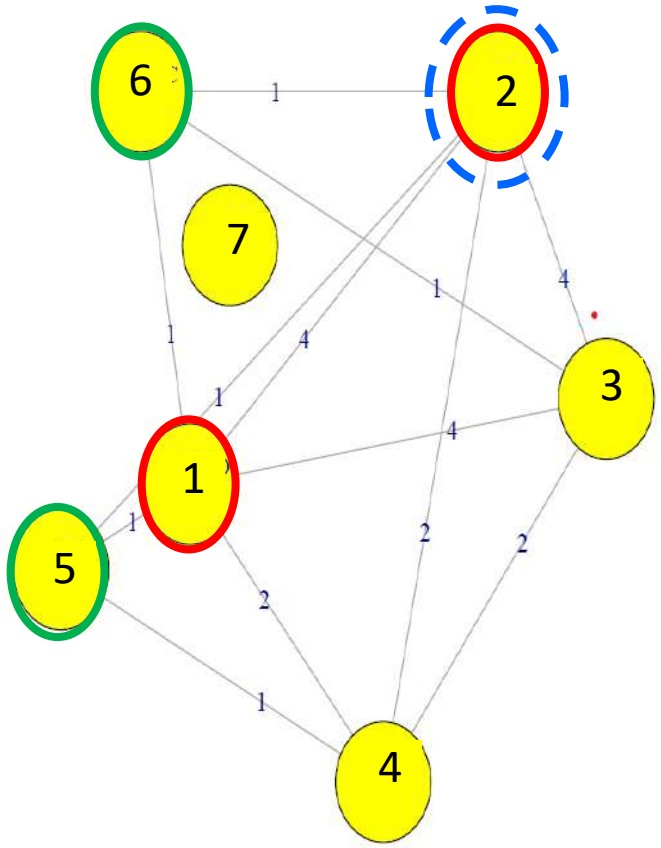


# Social pen structures can change significantly over time, but some individuals may have a stable role



*Turner et al., Sci Rep. 2020; Agha et al., Animals 2025; Oldham et al., Sci Rep. 2025*

# Animals differ in their direct and indirect role in a pen's social structure

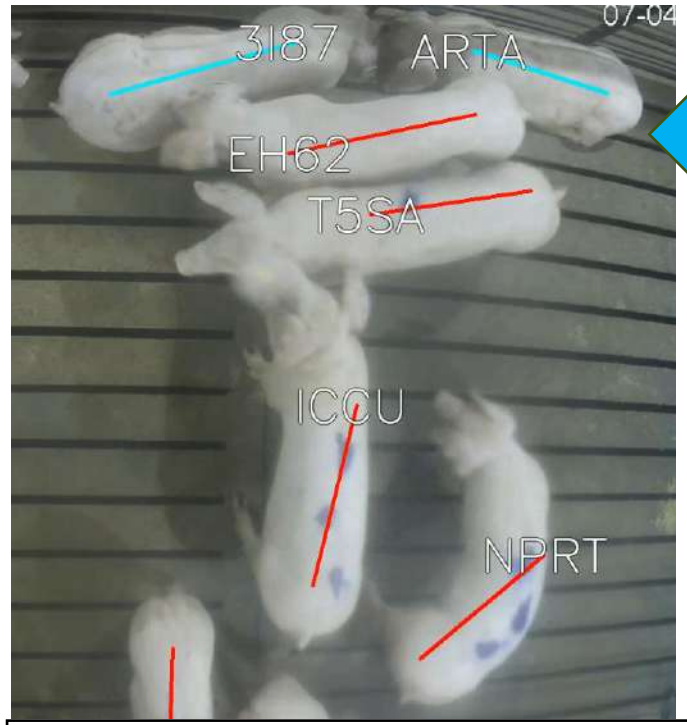



| ID | Degree centrality | Betweenness centrality | Clustering coefficient |
|---|---|---|---|
| 1 | 0.83 | 0.97 | 0.70 |
| 2 | 0.83 | 1.00 | 0.70 |
| 3 | 0.67 | 0.98 | 0.83 |
| 4 | 0.67 | 0.67 | 0.83 |
| 5 | 0.50 | 0.28 | 1.00 |
| 6 | 0.50 | 0.32 | 1.00 |
| 7 | 0.00 | 0.00 | 0.00 |

*Agha et al., Revealing the hidden social structure of pigs with AI-assisted automated monitoring data and SNA, Animals 2025*

# Is proximity a good indicator of fighting?


- 113 video clips (time censored) containing **one fighting dyad** + 113 control clips matched by time and age of pigs
- Proximity measures from corresponding automated position data of these pens

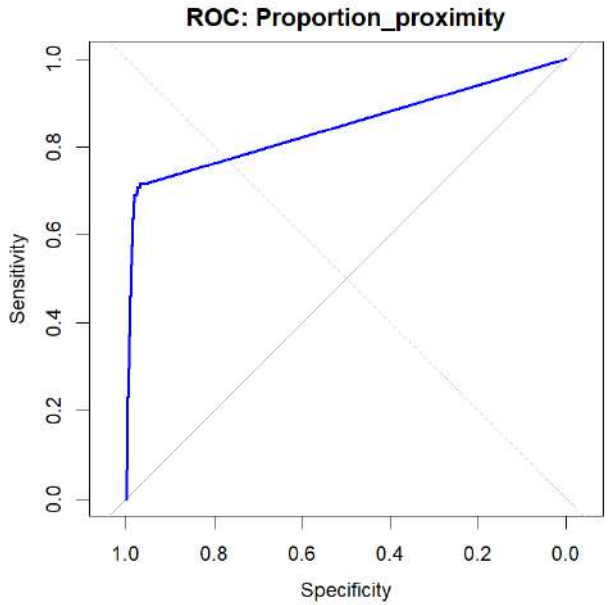



Still image including two pigs fighting (PIC annotated video)

Fighting dyads identified by watching videos (ground truth)

Relative time spent in close proximity as indicator of fighting

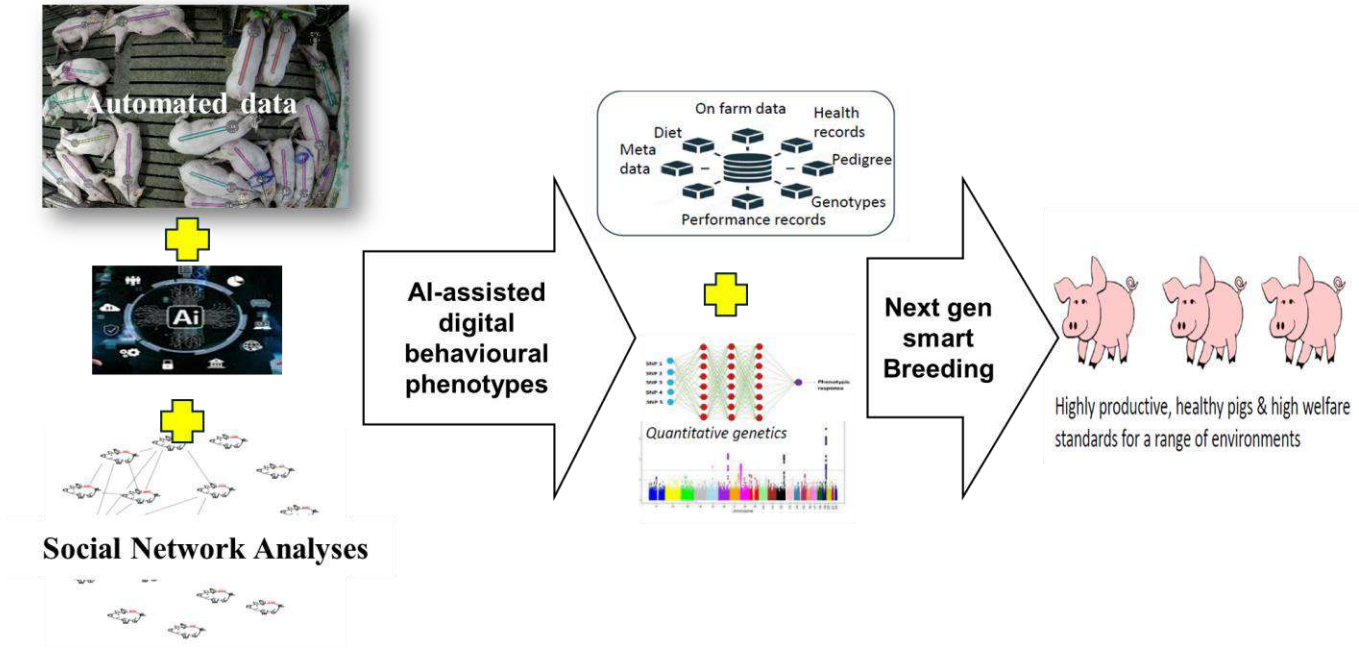
| ROC_AUC | Specificity | Sensitivity | Positive predictive value |
|---|---|---|---|
| **0.846** | 0.98 | 0.76 | 0.09 |




- Relative time spent in proximity is a valuable indicator for fighting
- But not a reliable predictor of fighting on its own

# Conclusions

- Automated recording systems coupled with AI & SNA offer promising data for real-time study of social interactions in farmed animals
- Scope to tackle unresolved health, welfare & economic challenges in animal production
- Urgent need for further research to facilitate impactful implementation



# Data Validation

~1800 data point was validated

(300 annotated images each included 6 randomly selected and marked pigs)

- **Validation of the posture and activities**

Accuracy of > 97%

- **Validation of the coordinates**

Compare the order of the animals in the data file with images.