Spatiotemporal Analysis of Sensor Logs Using Growth Ring Maps

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Outline

- Introduction
- Temporal analysis using hierarchical clustering
- Spatial analysis using transition matrices
- Spatiotemporal analysis using growth ring map
- Results
- Conclusions

Introduction

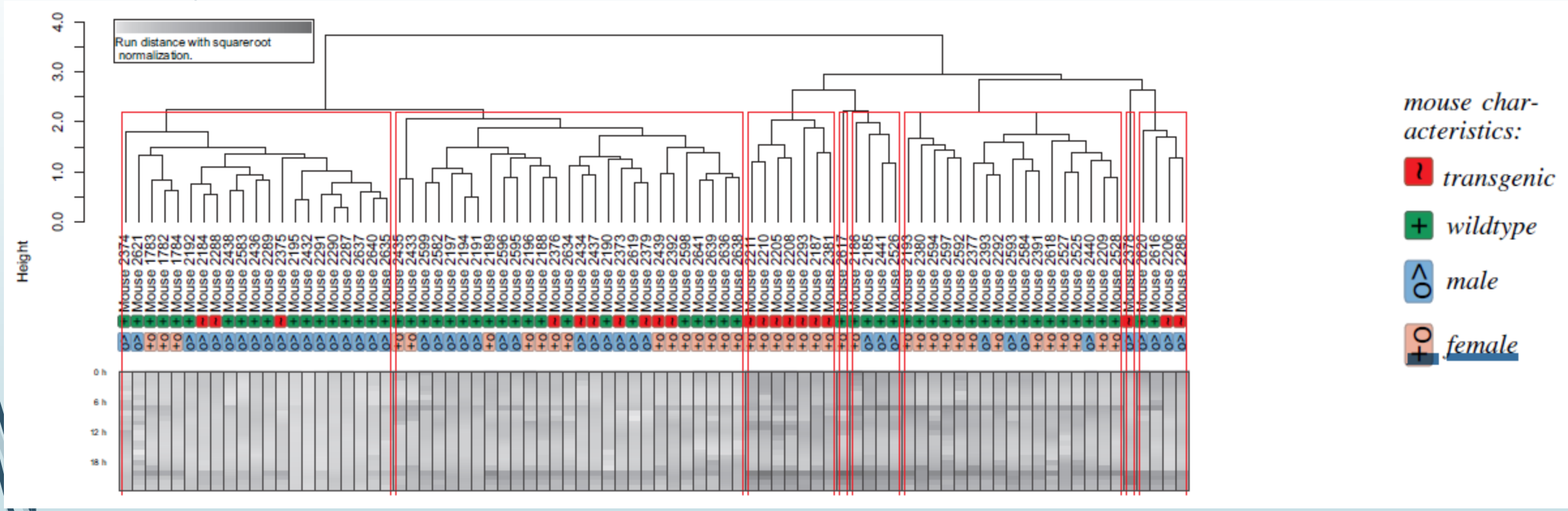
- Spatioten ging research field.
- Growth R
  - To repr tting non-overlapping pixels
  - Enable interest in spatiotemporal data
- Mice exp
  - There on.
  - Discon ate lower bound properties of actu

- Why it is insufficient to look merely at temporal or spatial data?

Temporal analysis using hierarchical clustering

- Hypothesis: whether it is possible to distinguish between Alzheimer-transgenic and wildtype mice based on the amount of movement hourly aggregated over the days.
- Movement lower bound estimation reflects the activity patterns of the mice.
- Using hierarchical clustering with average linkage clustering
- The cut-off point for the cluster definition is manually fine-tuned based on the cluster dendrogram resulting in eight clusters for the distance of 2.5.

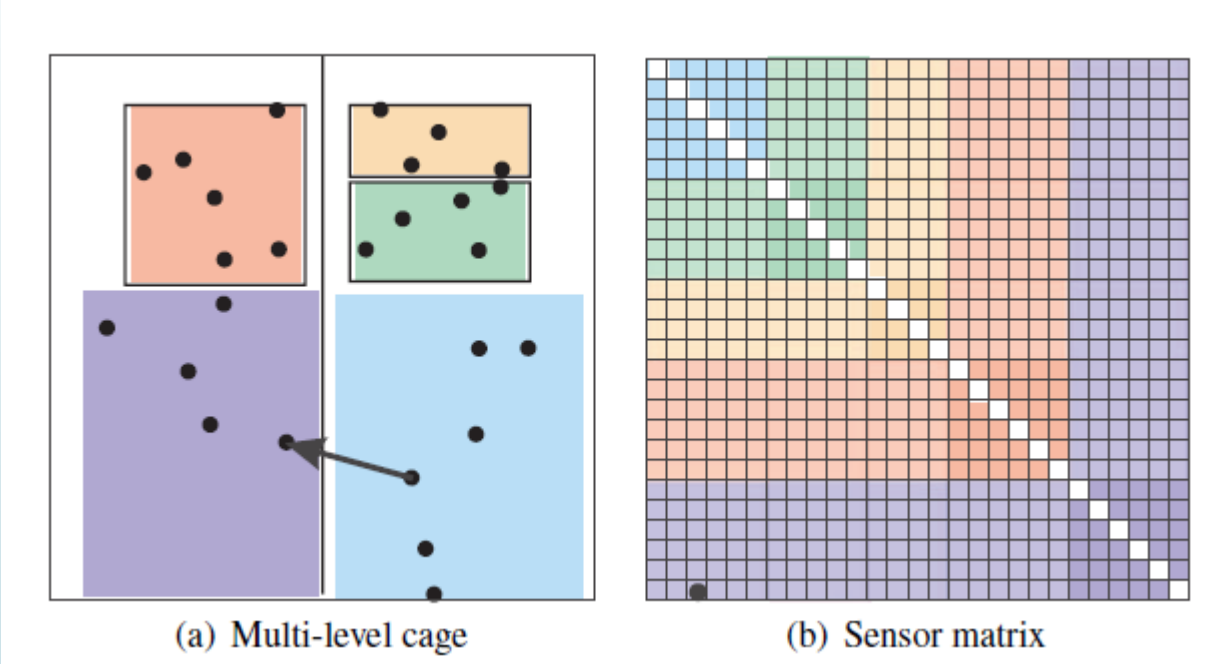
Temporal analysis using hierarchical clustering(cont'd)



Spatial analysis using transition matrices

- Aims to capture the territorial behavior of mice.
- Locations of the sensors and the direct sequence of moving from one sensor to the next one are used.
- Creating a sensor matrix:
  - 27 sensors are grouped into 5 compartment of the cage.
  - map the spatial location of the sensors to a linear representation.
  - multiple triggering of the same sensor was cleaned out from the data during preprocessing.
  - the number of occurrences of a movement pattern are mapped to the intensity of the grayscale color map.

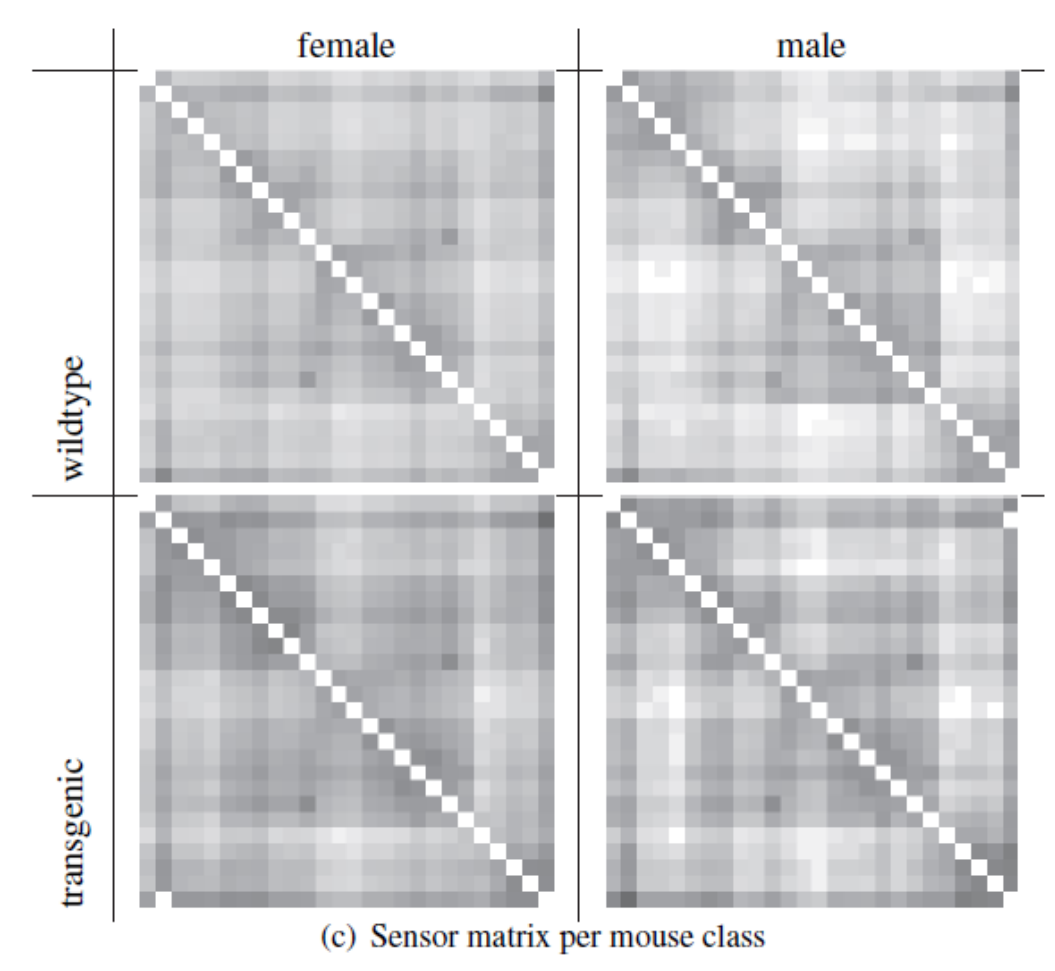
Spatial analysis using transition matrices(cont'd)



(a) Multi-level cage

(b) Sensor matrix

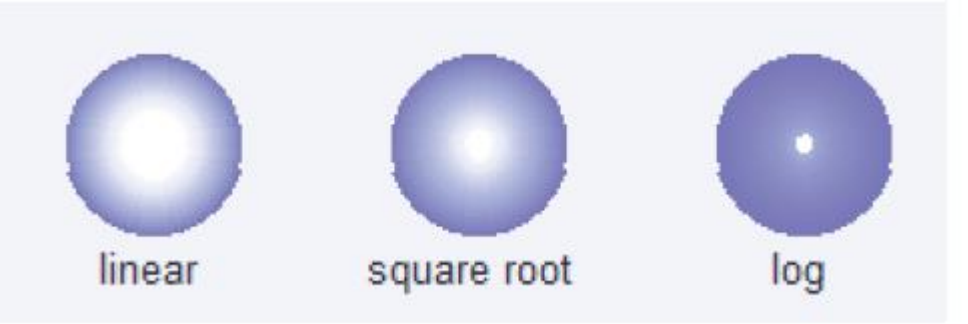
Spatial analysis using transition matrices(cont'd)



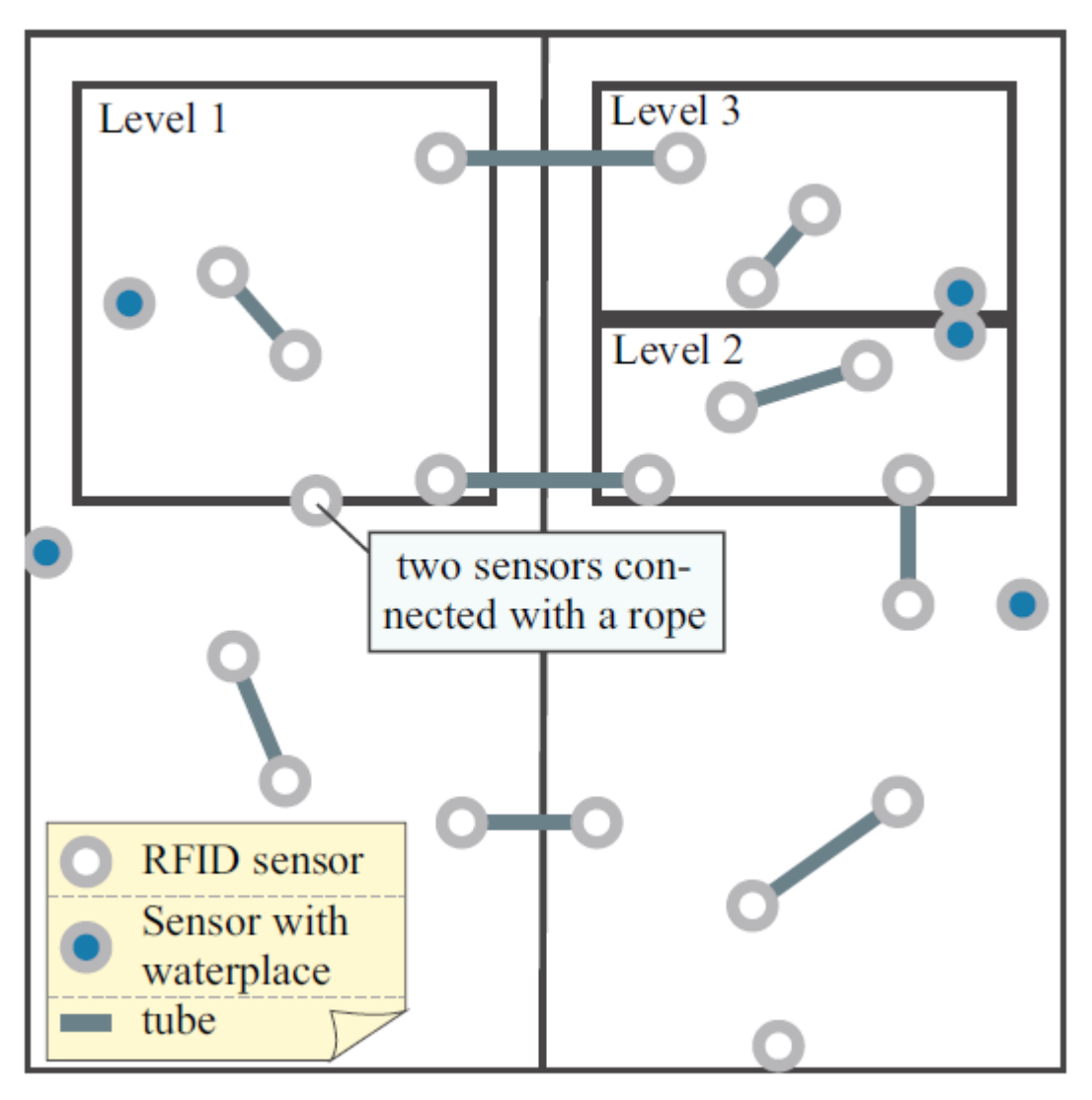
(c) Sensor matrix per mouse class

Spatiotemporal analysis

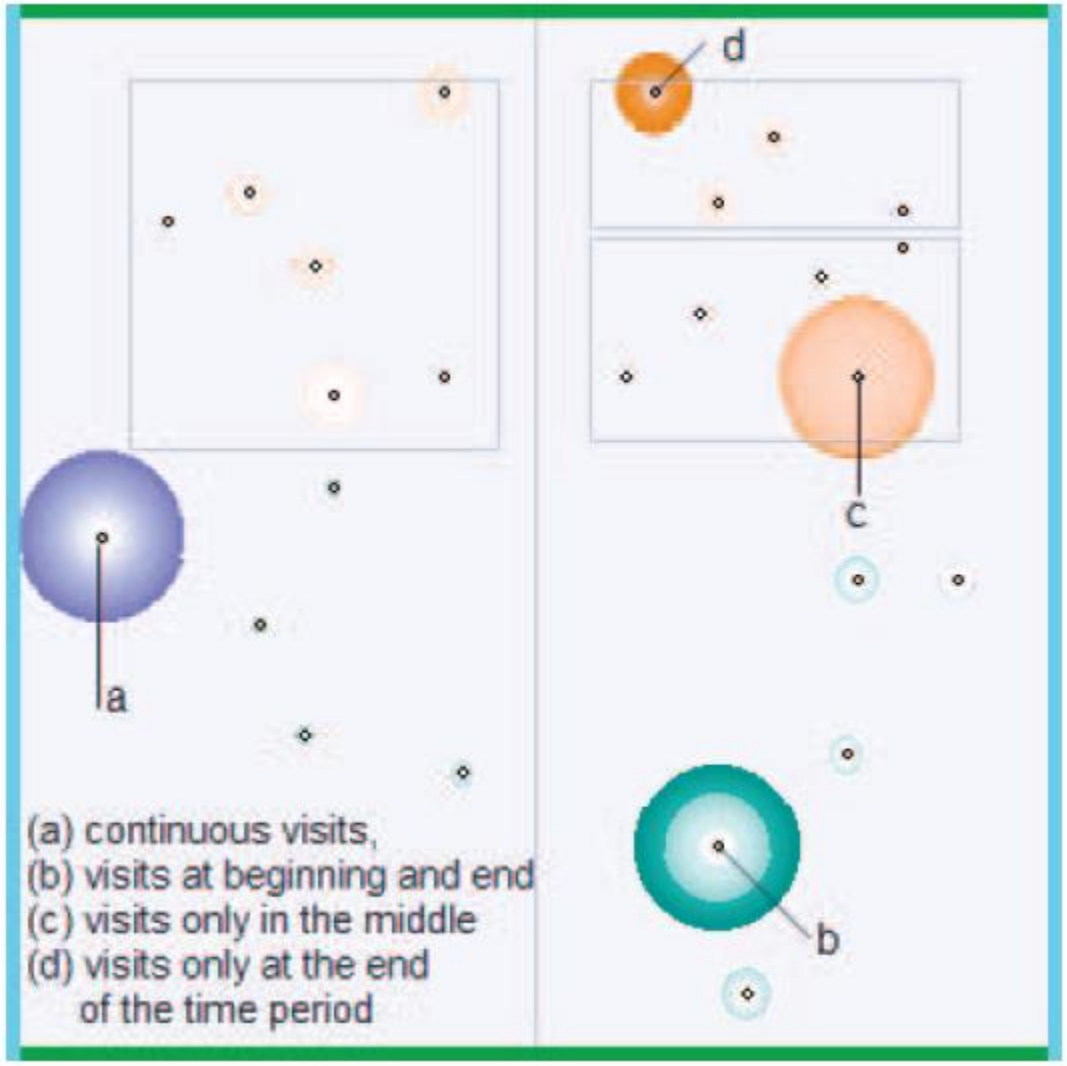
- The behavioral properties that have to be taken into account
  - the spatial information with different semantic type of sensors
  - the temporal aspects
  - number of visits at a sensor
- Scaling of the color gradient



Spatiotemporal analysis(cont'd)



Growth Ring Map

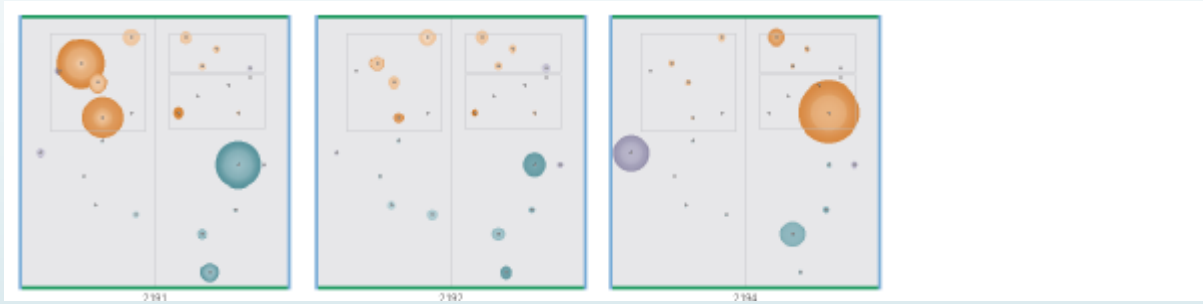


Results

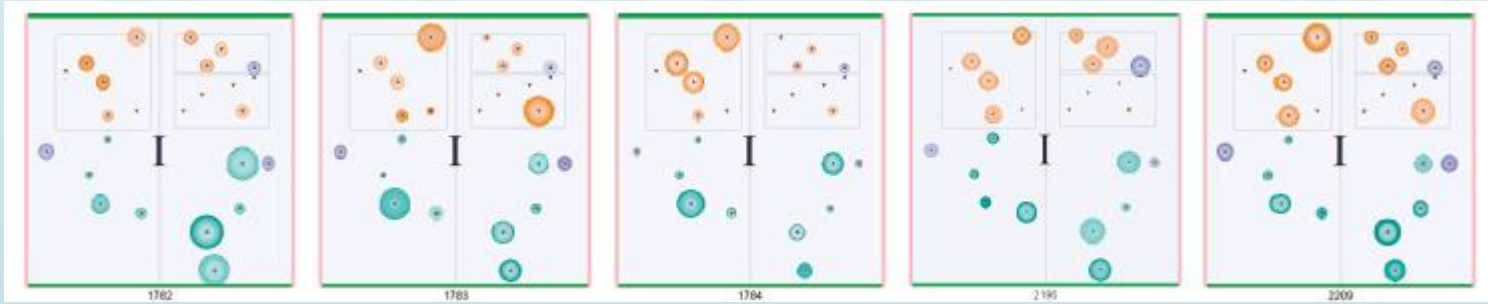
- Remove mice that have less than 3 months of sensor data
- There are four aspects to analyze:
  - Territoriality
  - Watering places
  - Temporal behavior of Alzheimer transgenic mice
  - Grouping of mice

Territoriality

- Male wildtype mice

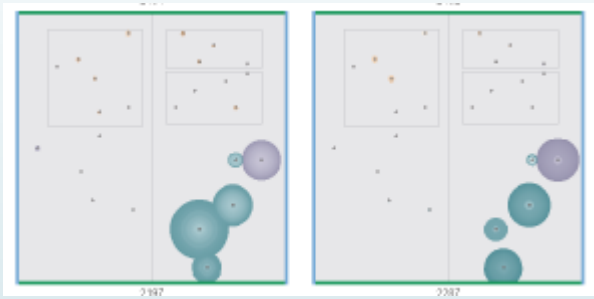


- Female mice

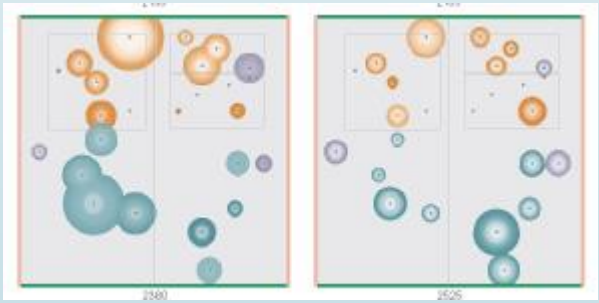


Watering Places

- Male mice



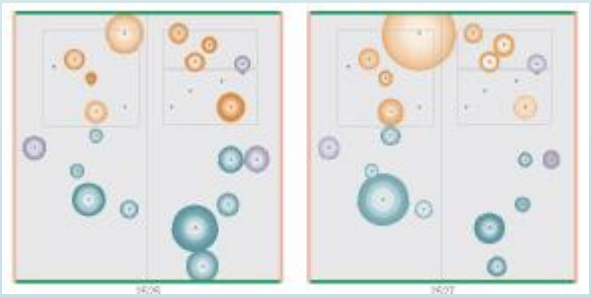
- Female mice



Temporal Behavior of Alzheimer Transgenic Mice

- Female transgenic mice

- Female healthy mice



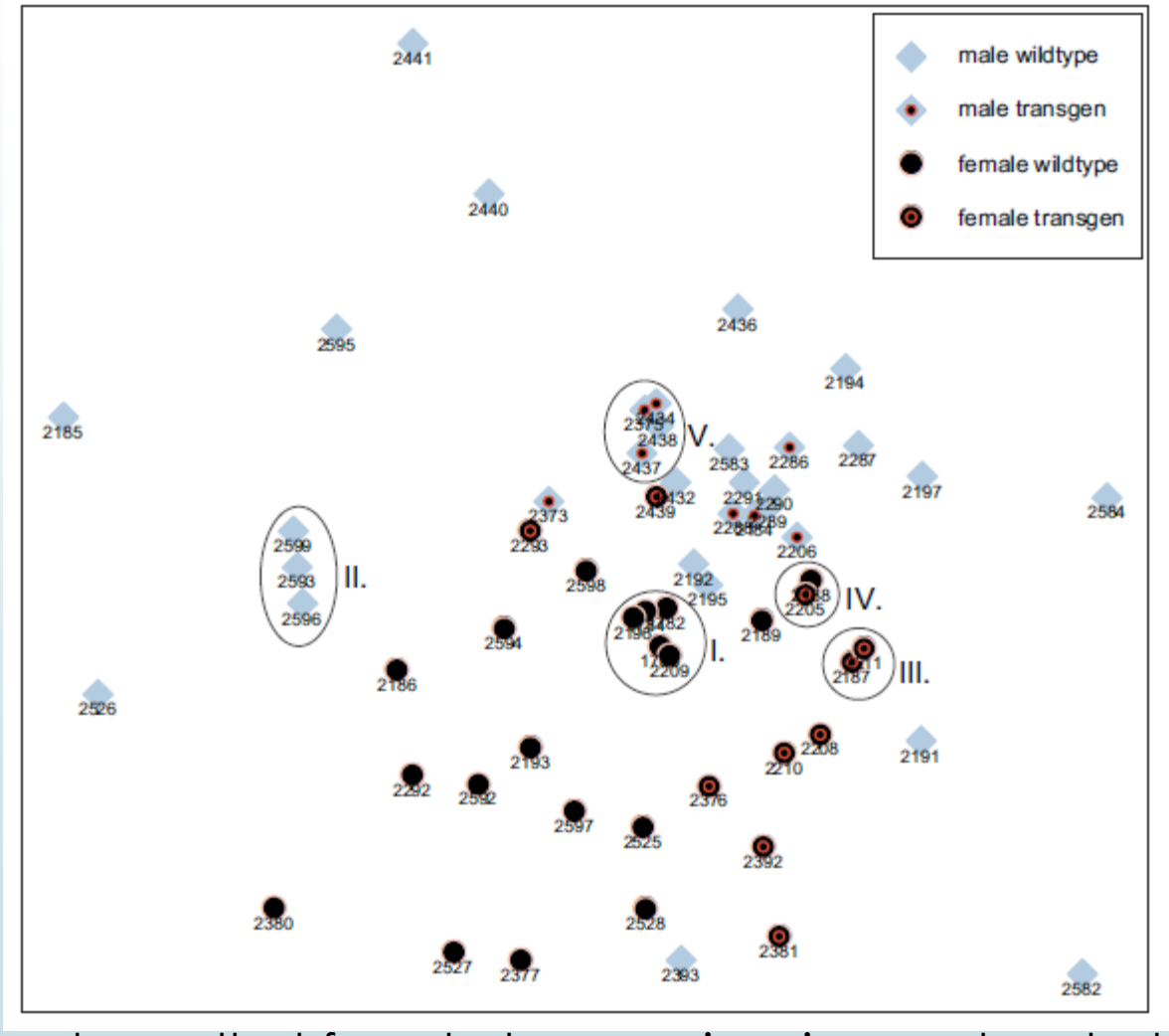
Grouping of Mice

- There are quite a large number of mice behave in a very similar way as shown by almost identical Growth Ring Maps.
  - The duration of the experiment was 8 months whereas most mice only spent a few months in the cage.
  - While female mice can move more freely in the cage, we explain the effect by the fact that they tend to prefer some locations, which might be linked to an alpha male.

Cross-Validation

- Multi-dimensional scaling
- To show that the results created by Growth Ring Maps technique are systematic and reproducible
- The output of the MDS is a two-dimensional point representation of the individual mice
- Mice having similarities in their territorial behavior would be positioned closer to each other

Cross-Validation



There is a tendency that female-transgenic mice are located further right of the plot than female-wildtype.

Conclusion

- A two-dimensional sensor map with plotting a number of non-overlapping pixels, which are colored according to temporal and level information, next to the sensor nodes.
- Growth Ring Maps are beneficial for certain types of tasks and data.
- Further research is needed to
  - improve the scalability of the number of objects investigated
  - evaluate the learnability of the representation
  - assess possibilities for interaction techniques especially in dimension reduction.

- Thanks for your listening ☺