Home range methods on indoor data

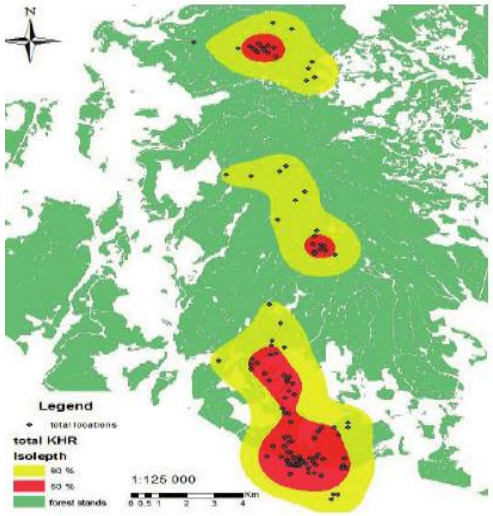
Hector Marina

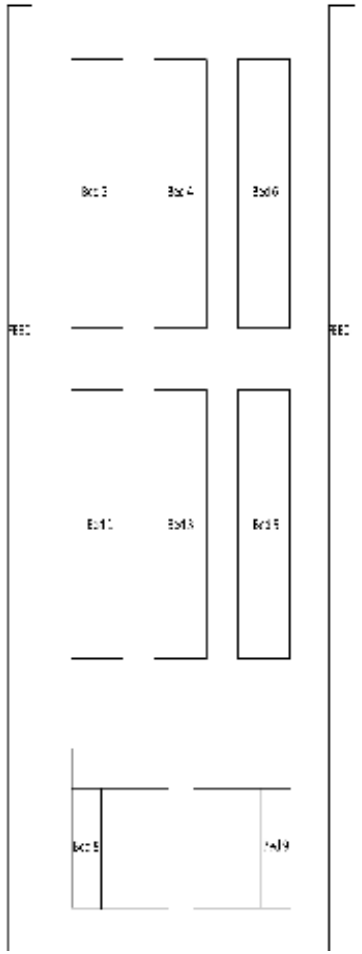
Brief introduction

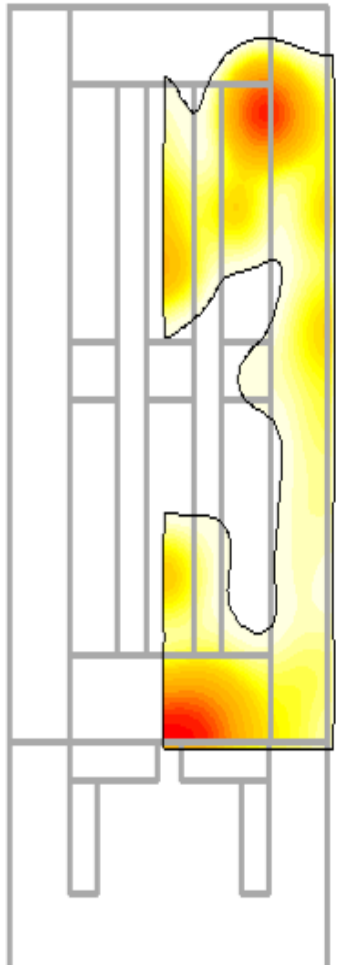
Home range:

- Area where it spends its time
- Encompasses all the resources the animal requires to survive and reproduce

(Burt, 1943)







Different methods

First-generation estimators

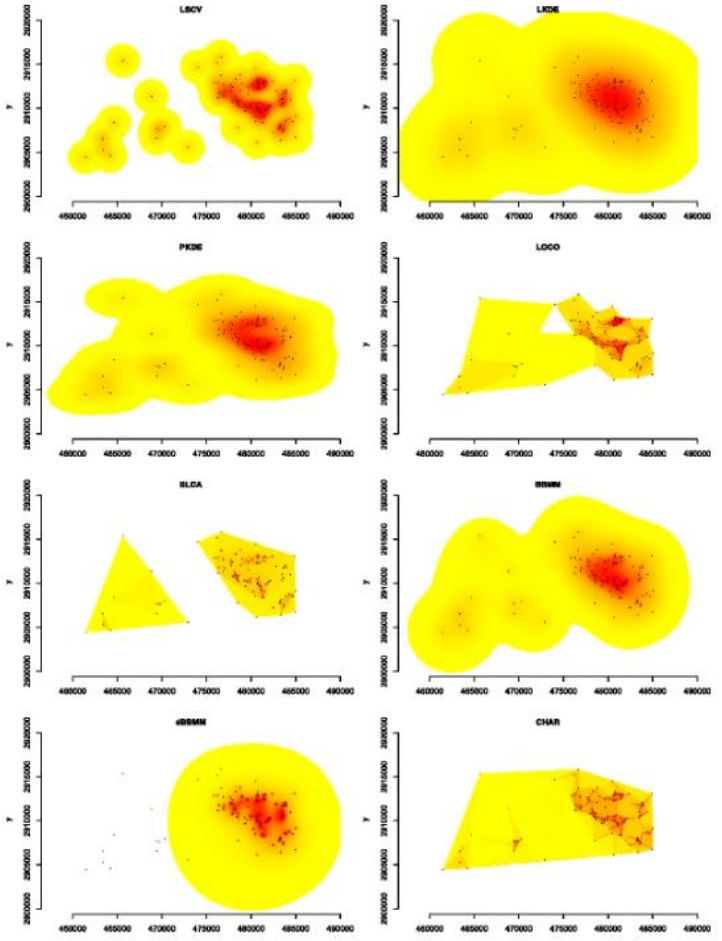
- Local convex hull
- Fixed kernel home range

Second-generation estimators

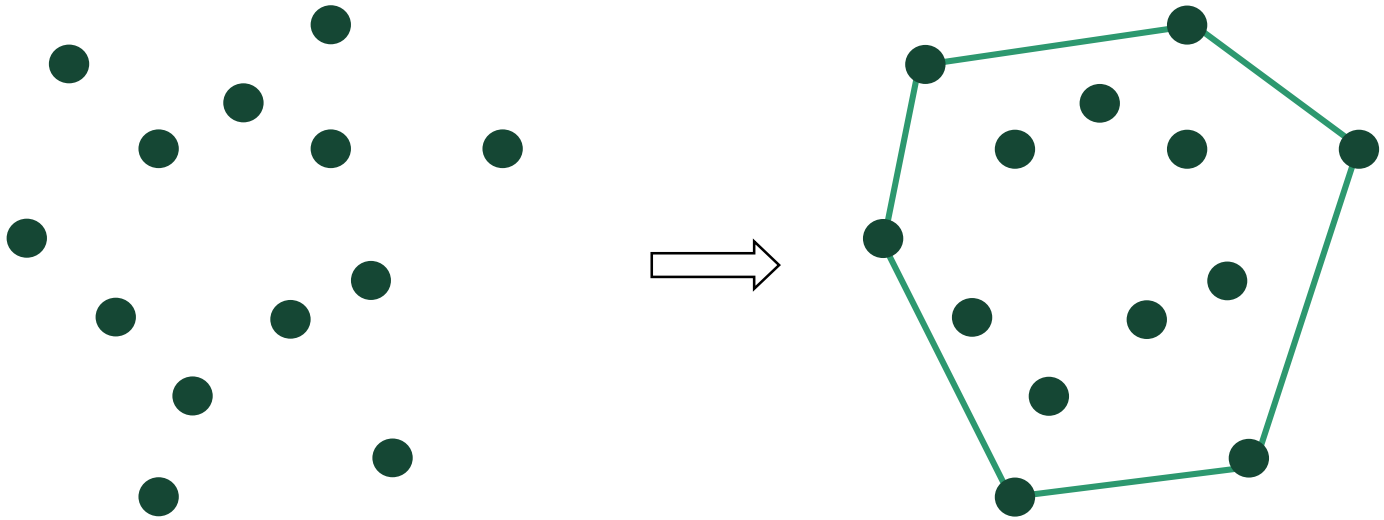
- Plug-in Kernel home range

Third generation estimators

- Movement-based kernel density estimator
- Brownian bridge movement model

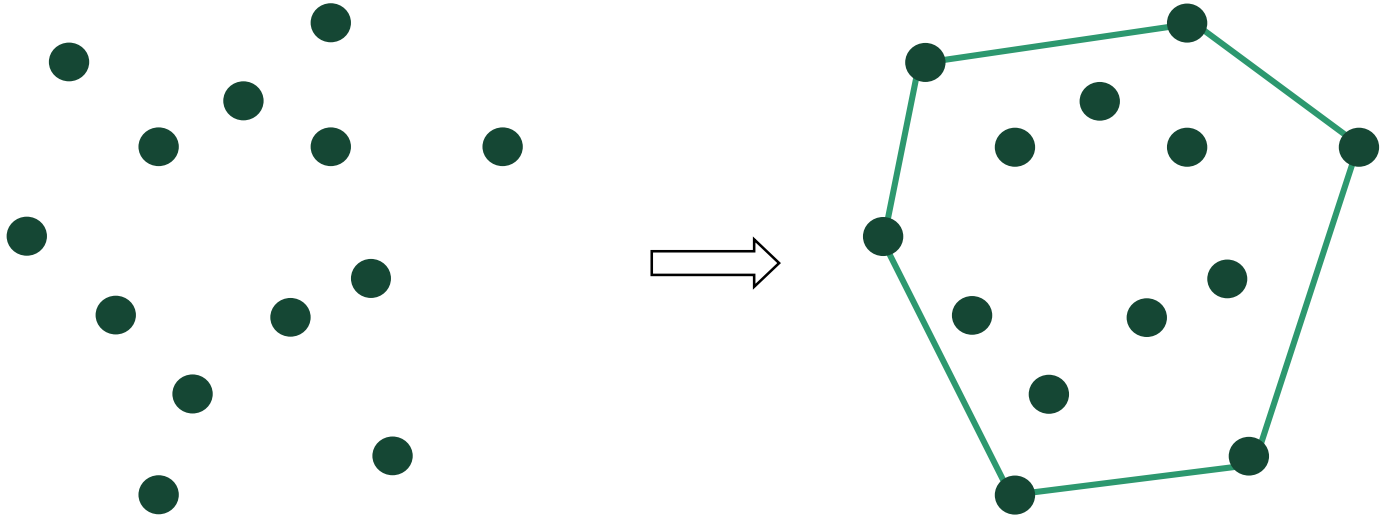


(Walter, 2015)



Minimum Convex Polygon

- Convex hull or convex envelope or convex closure



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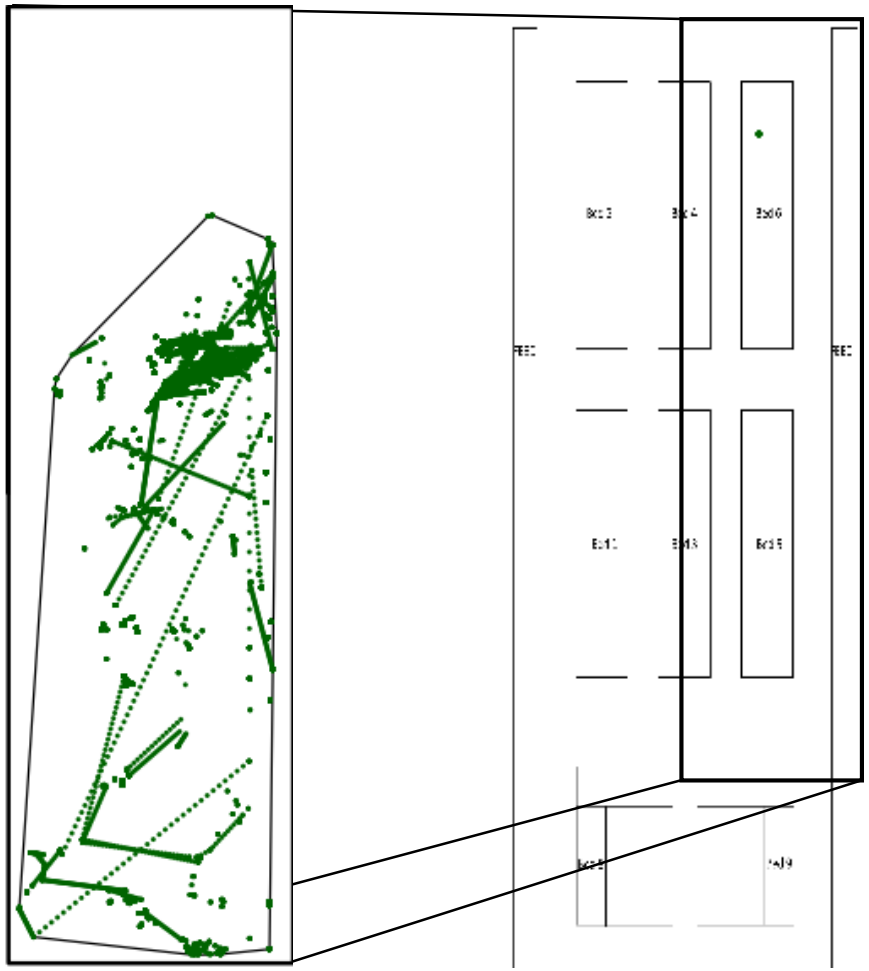

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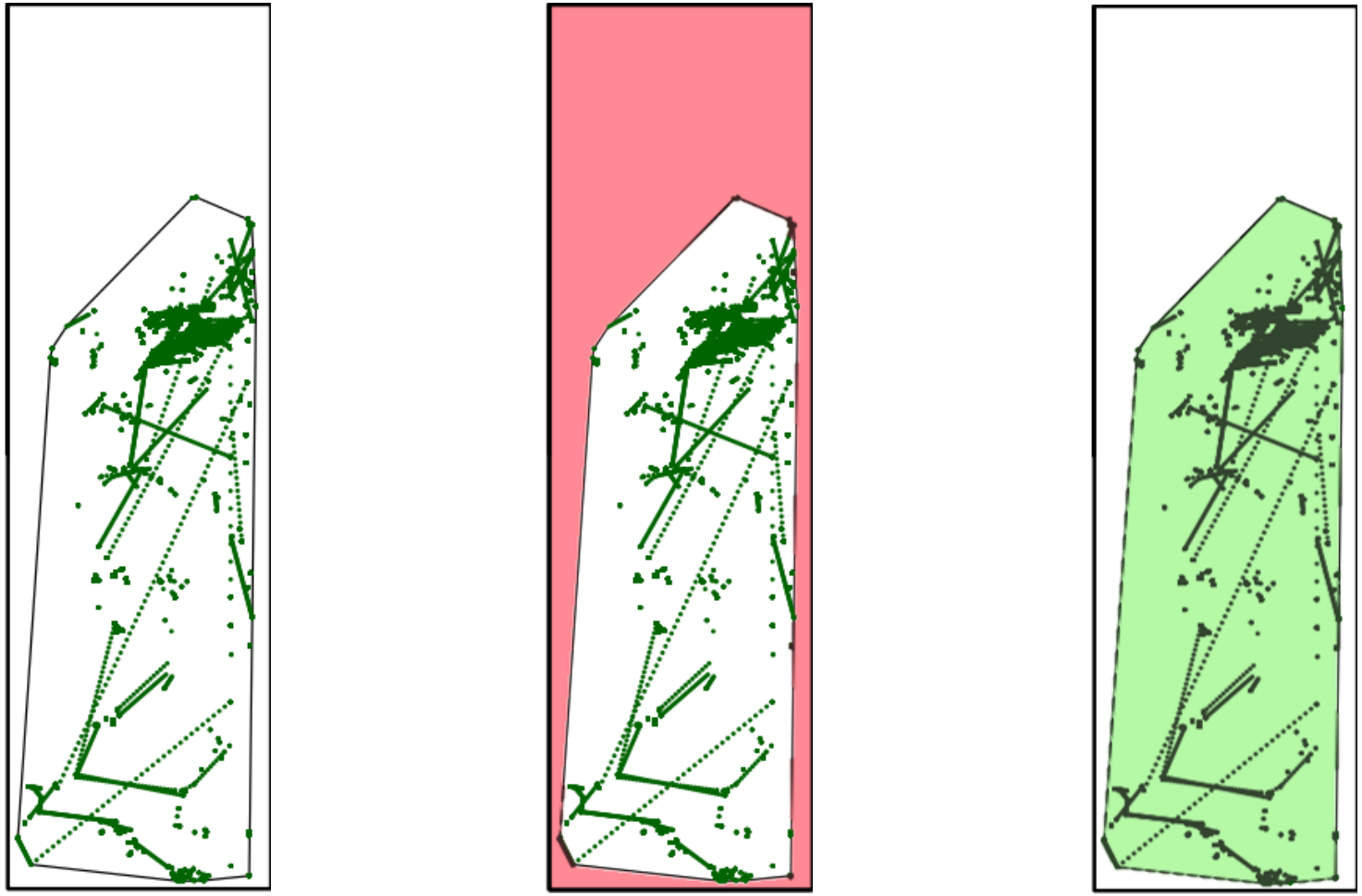
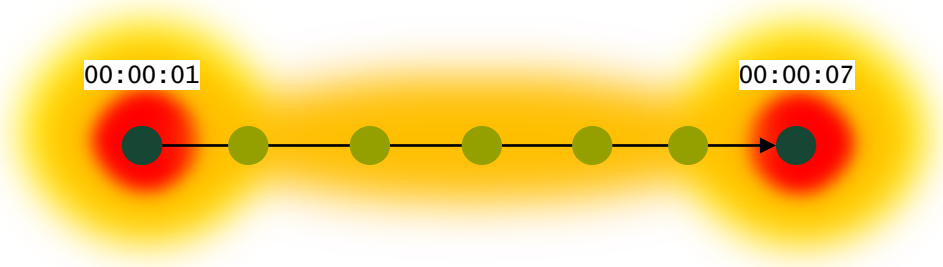


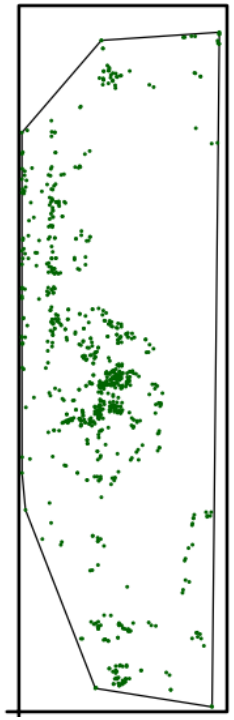
Utilization Distributions

- Brownian bridge movement model
  1. Sequential location data
  2. Estimated error
  3. Grid-cell size for utilization distribution

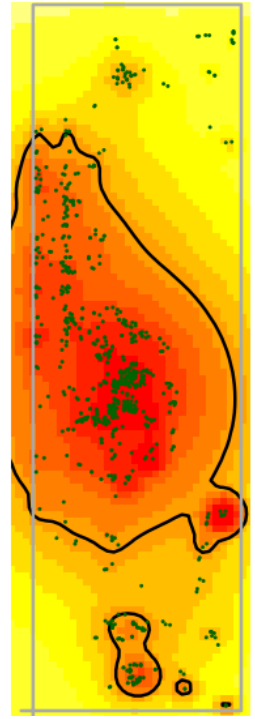
  – Paired locations becomes less realistic as the time interval increases



Convex hulls



Brownian bridge



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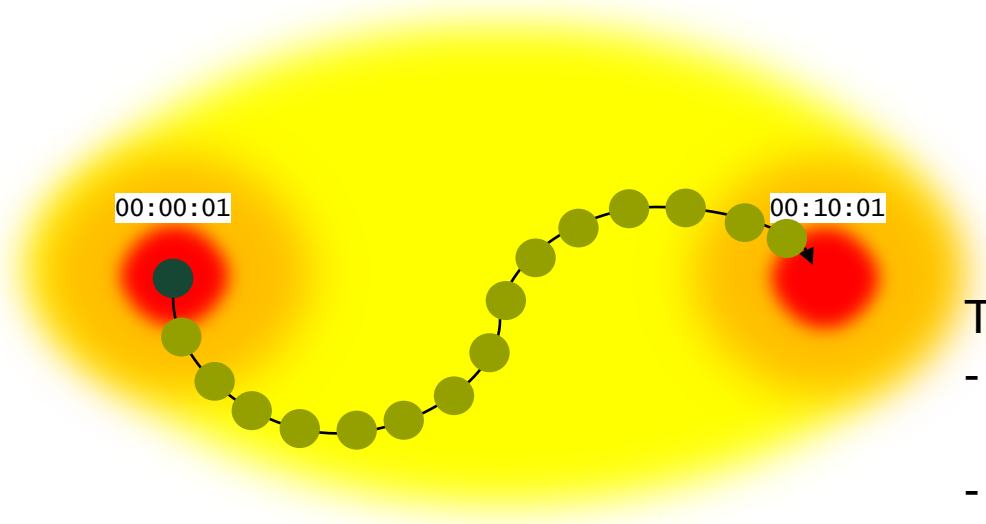

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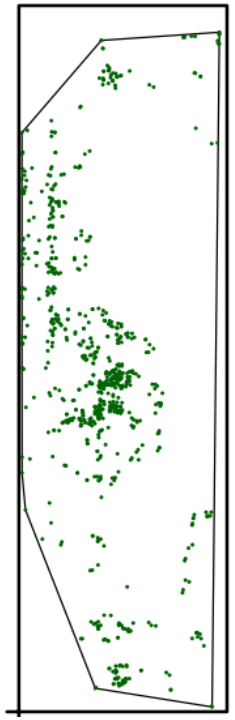
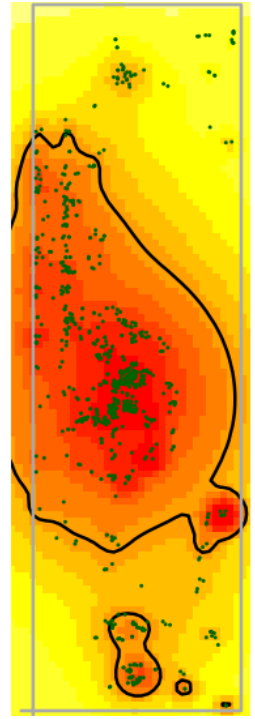
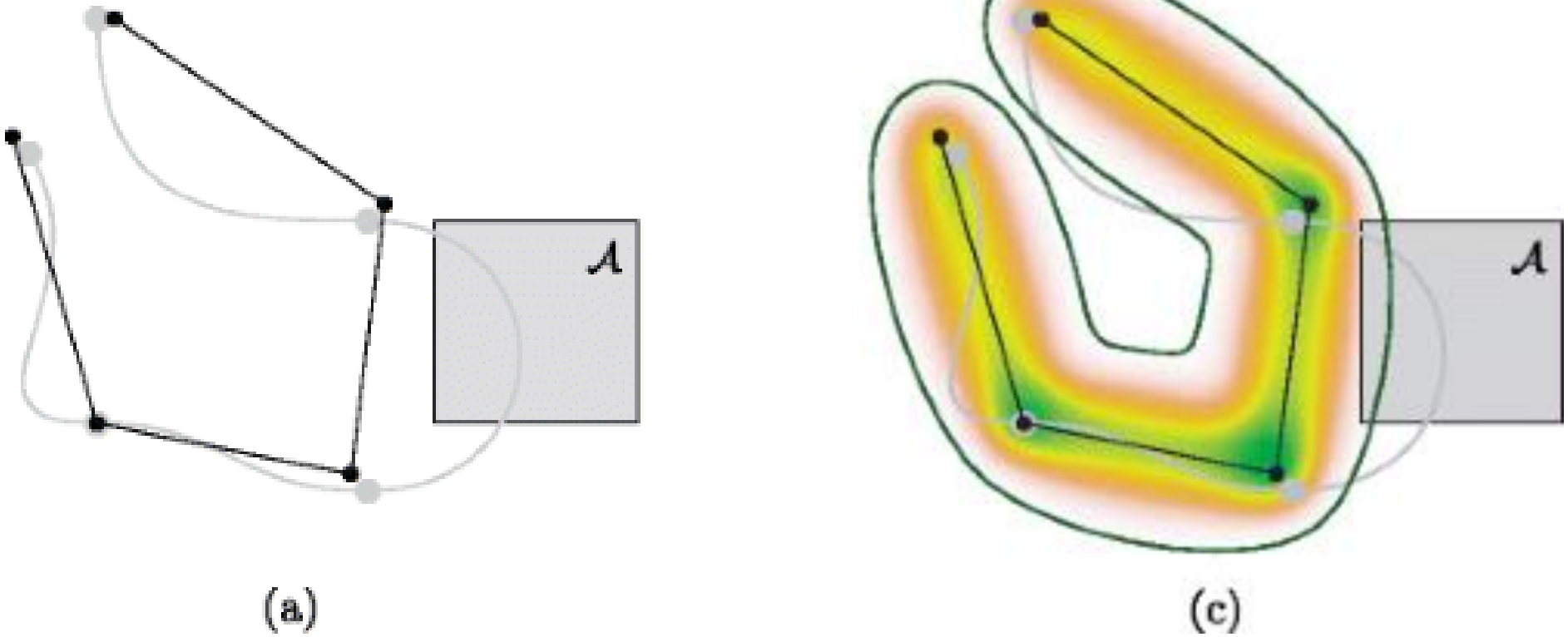


Brownian bridge



Two assumptions:

- Location errors correspond to a bivariate normal distribution
- Movement between successive locations is random



Buchin et al., (2015). Deriving movement properties and the effect of the environment from the Brownian bridge movement model in monkeys and birds. *Movement Ecology*.

Utilization Distributions

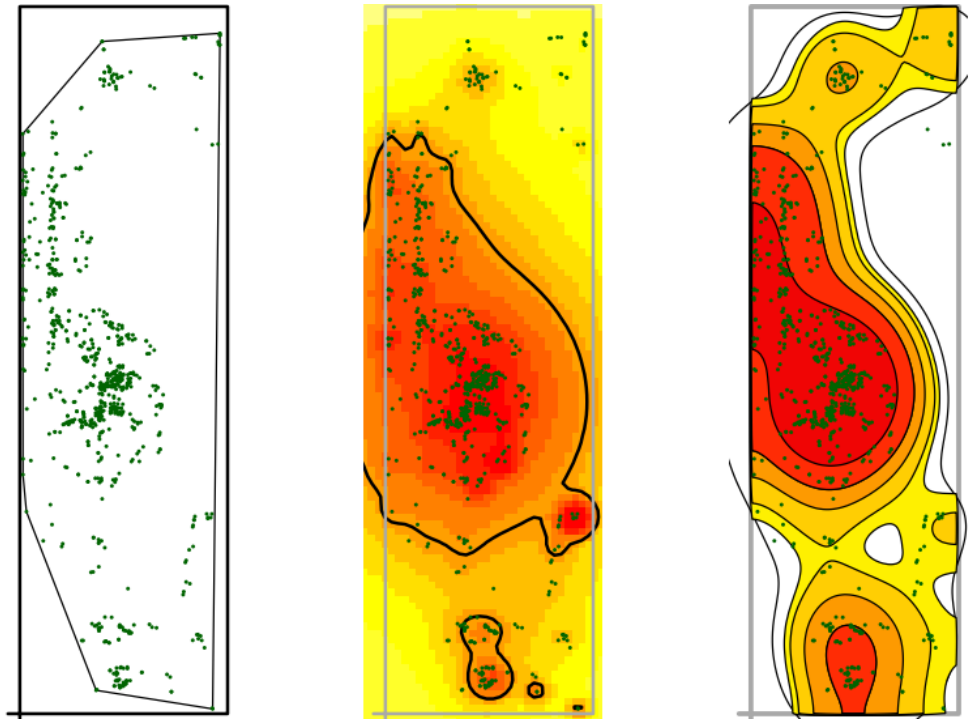
- Kernel density estimators
  - One of the most popular methods for measuring home ranges.
  - Several types of kernels
  - Similar results
  - Smoothing bandwidth (*ad hoc* method)

Number of data points

$$h = \sigma * n^{-1/6}$$

$$(0.5 * (sd_x + sd_y))$$

Convex hulls | Brownian bridge | Kernel



Krysten et al., (2014):
"*Examine the point distribution; justify the choice of smoothing parameter based on the objectives of the study*."

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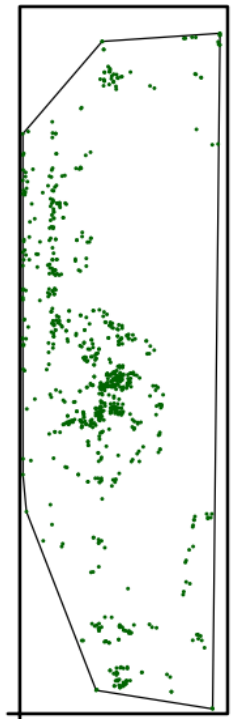
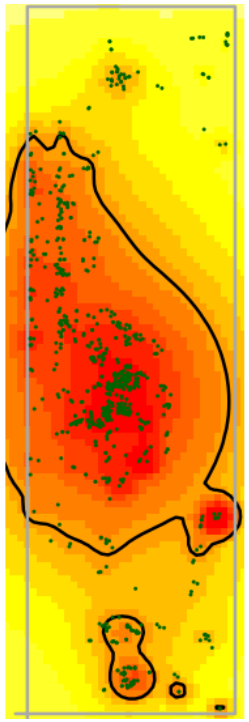
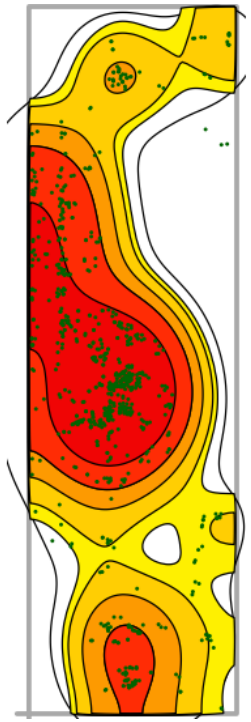


Brownian bridge



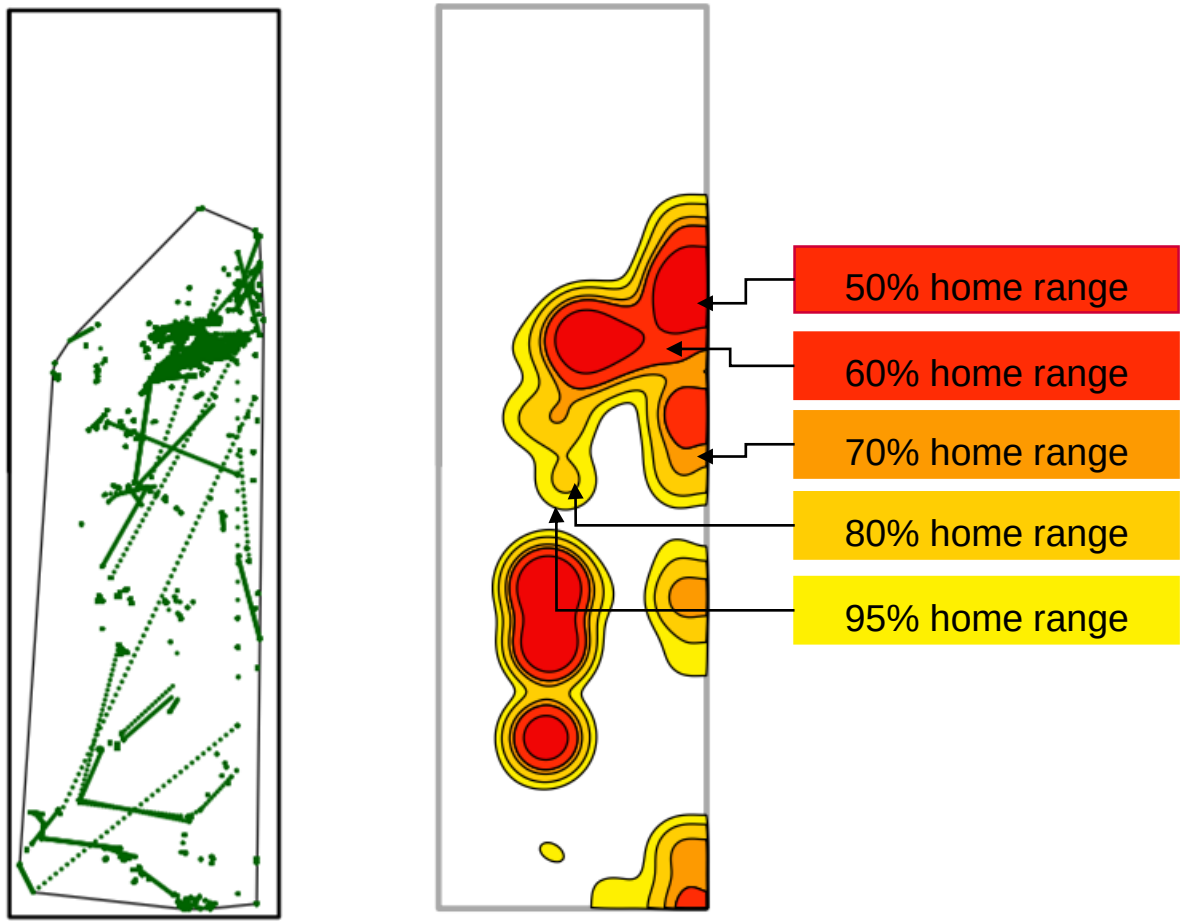
Kernel



```
HomeRangeBound <- kernelUD(FA_data[,"Tag"], h =  as.list(HomeRange)[[1]]@h$h, grid = 1000, boundary = bound)
```

Utilization Distributions

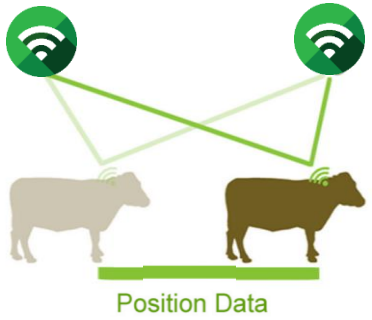
- Kernel density estimators

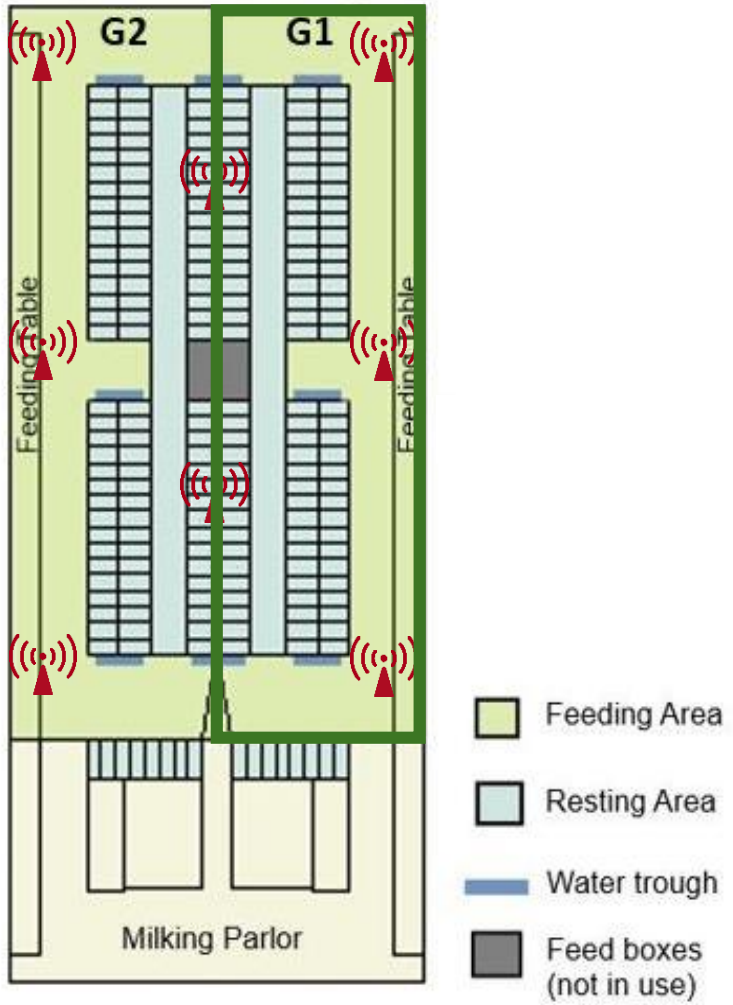


Data manipulation

Data manipulation

Real-time Location System

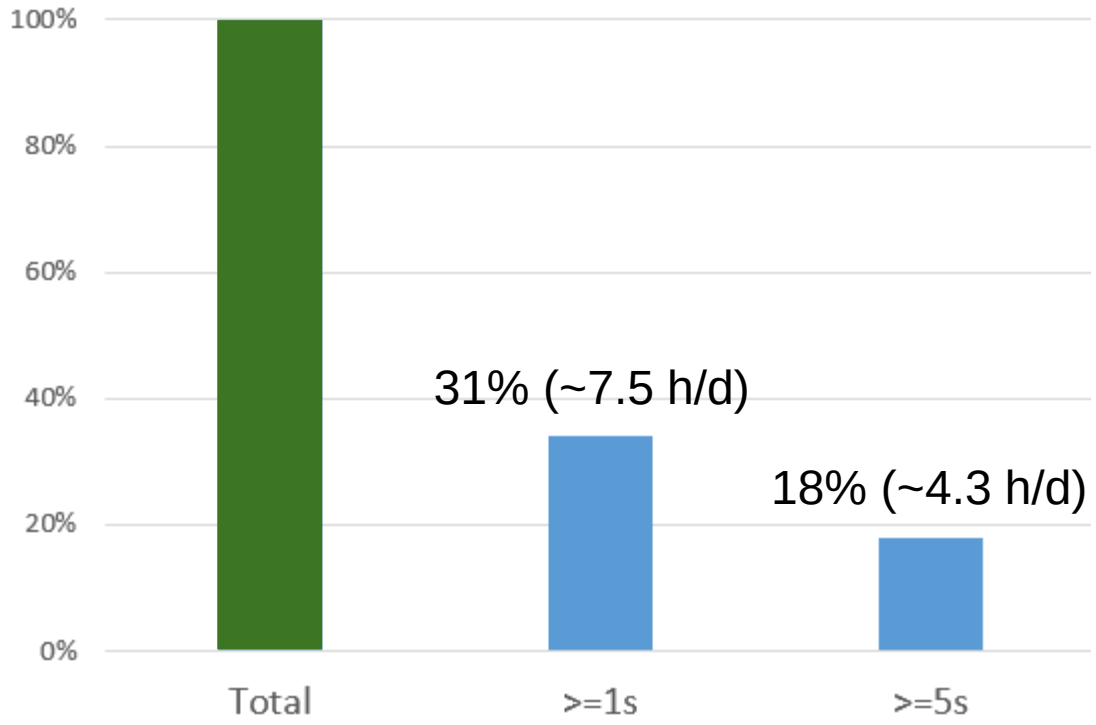




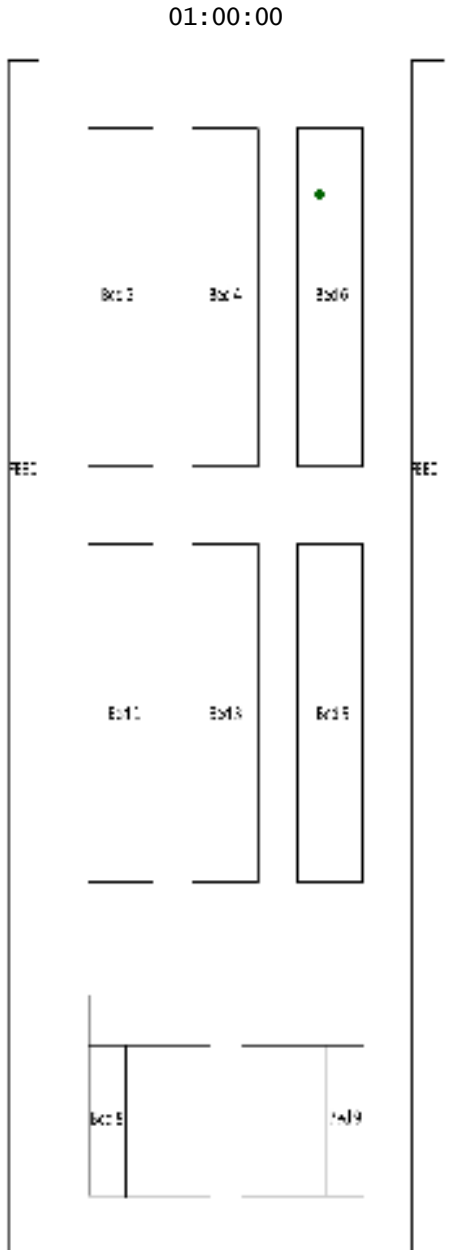
(Hansson et al., 2023)

Data manipulation

Interpolation methods



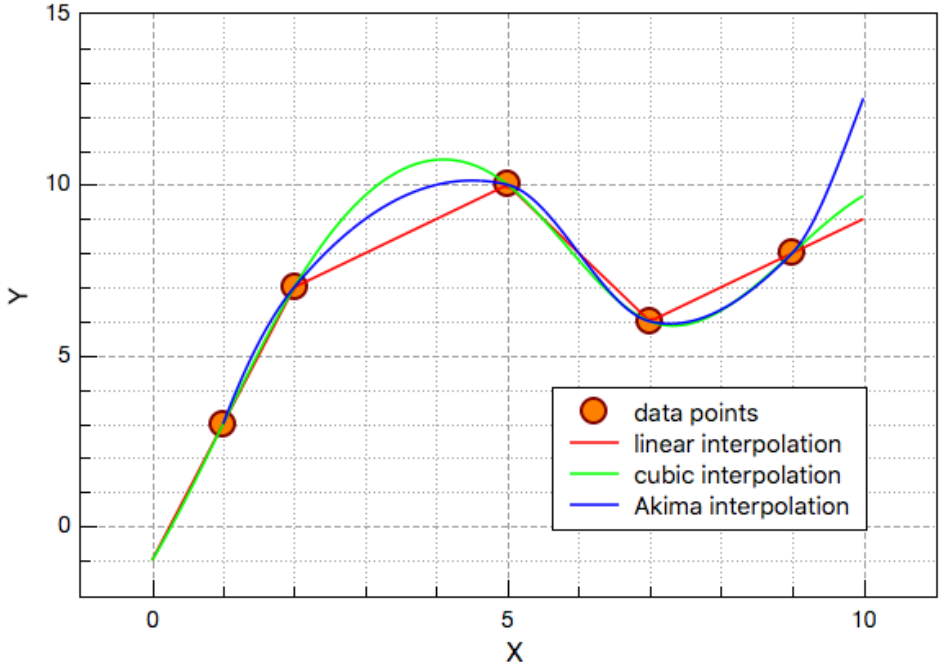
(Ren et al., 2021)



Data manipulation

Interpolation methods

- Maximising the information



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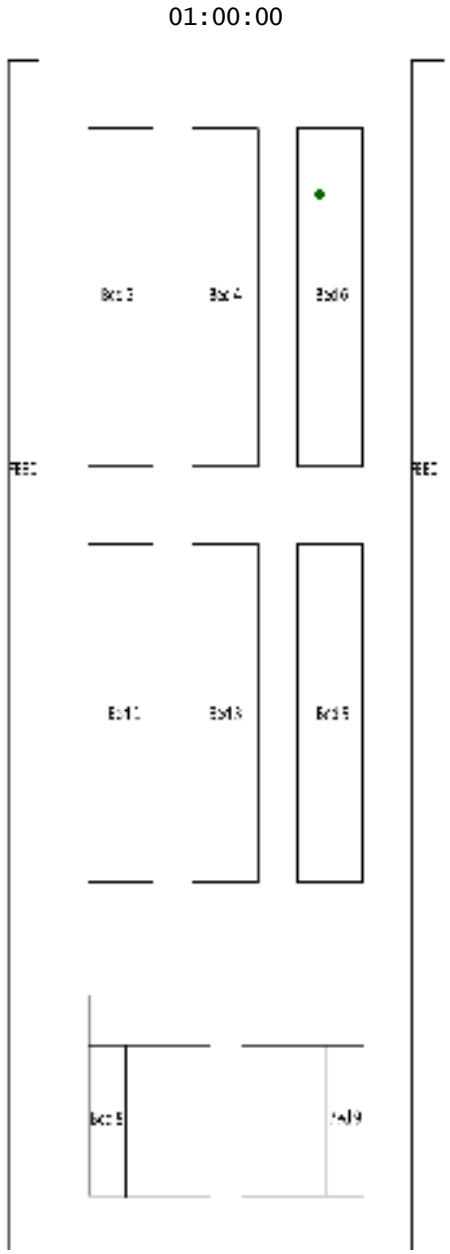
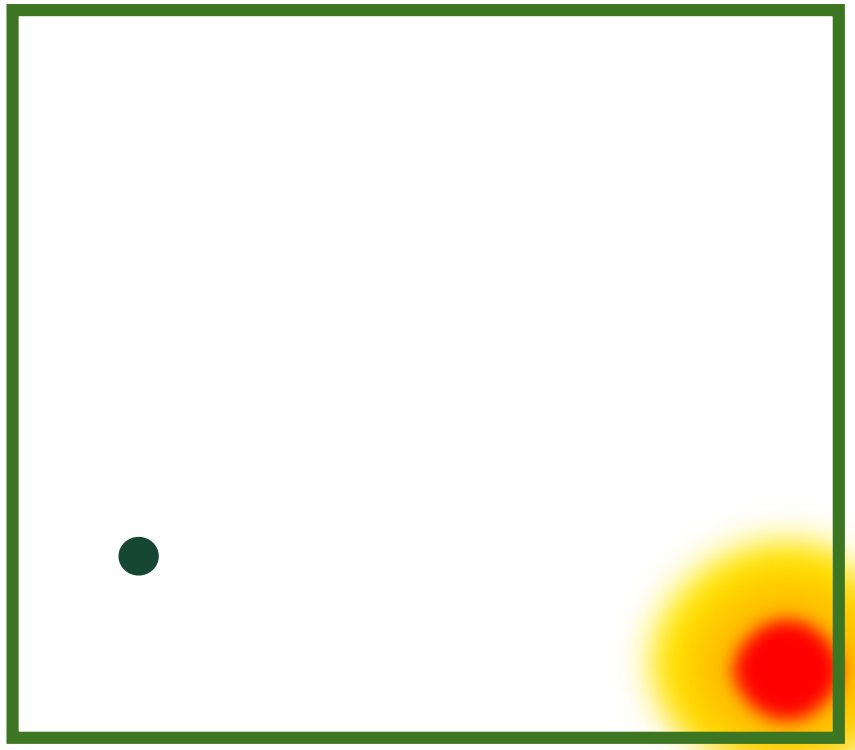
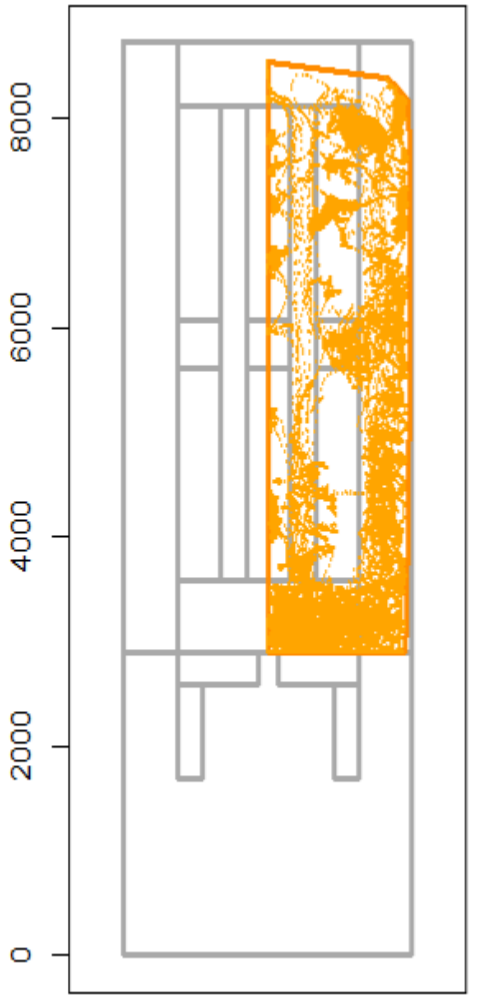
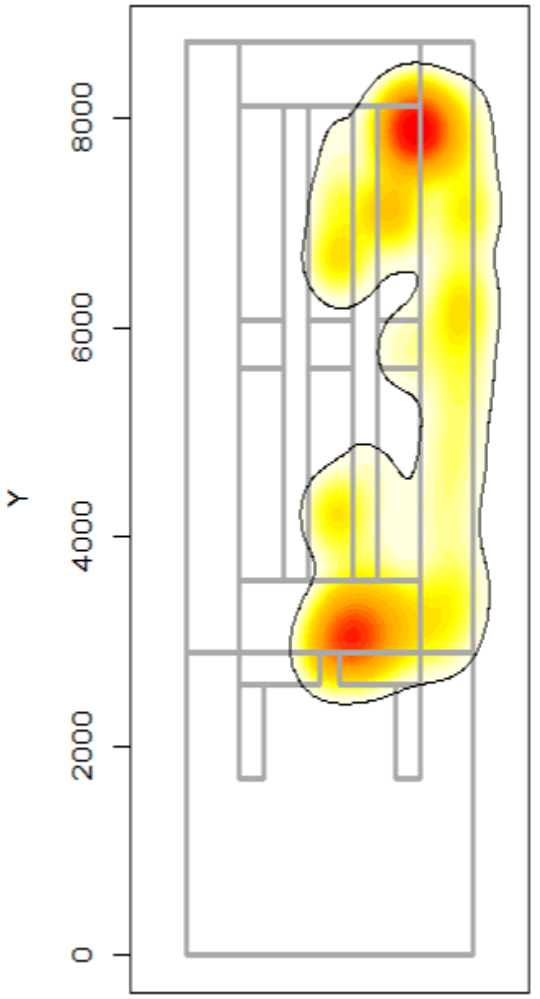


Data manipulation

Boundaries







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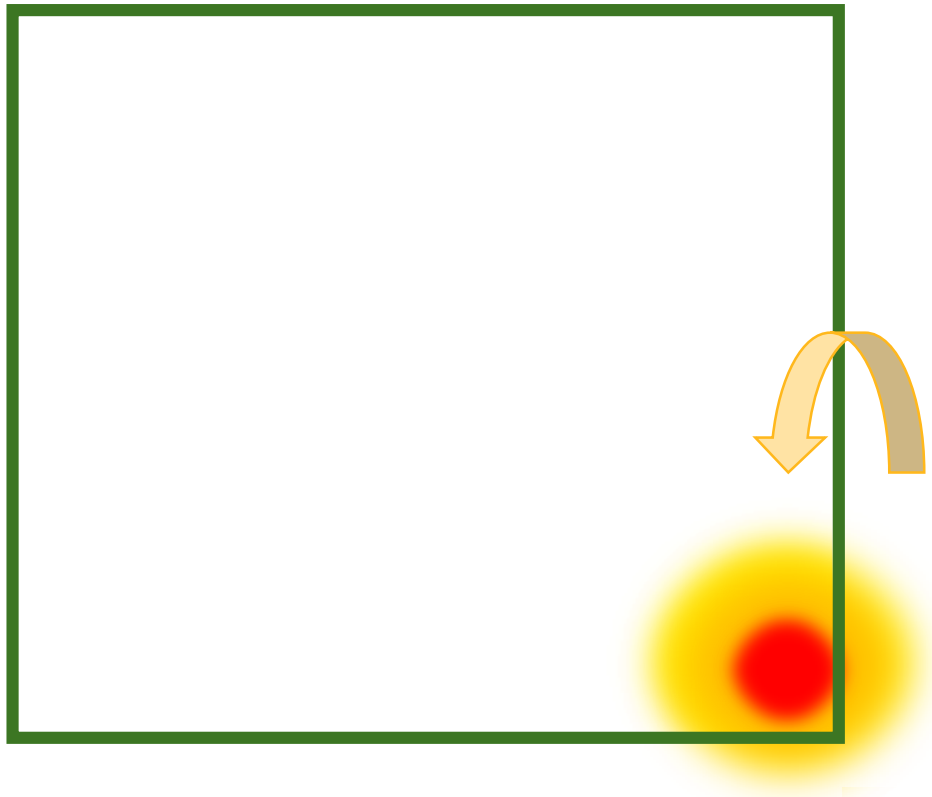
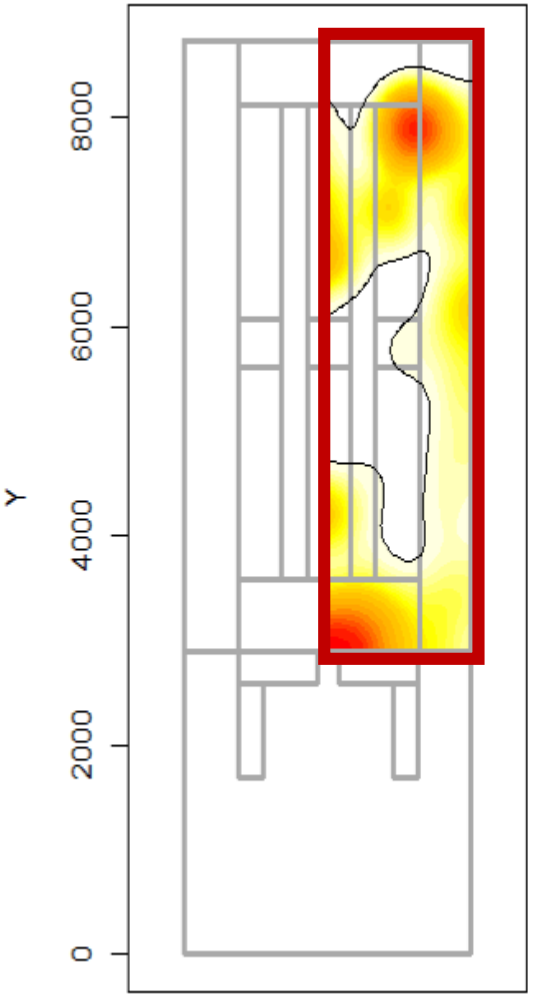
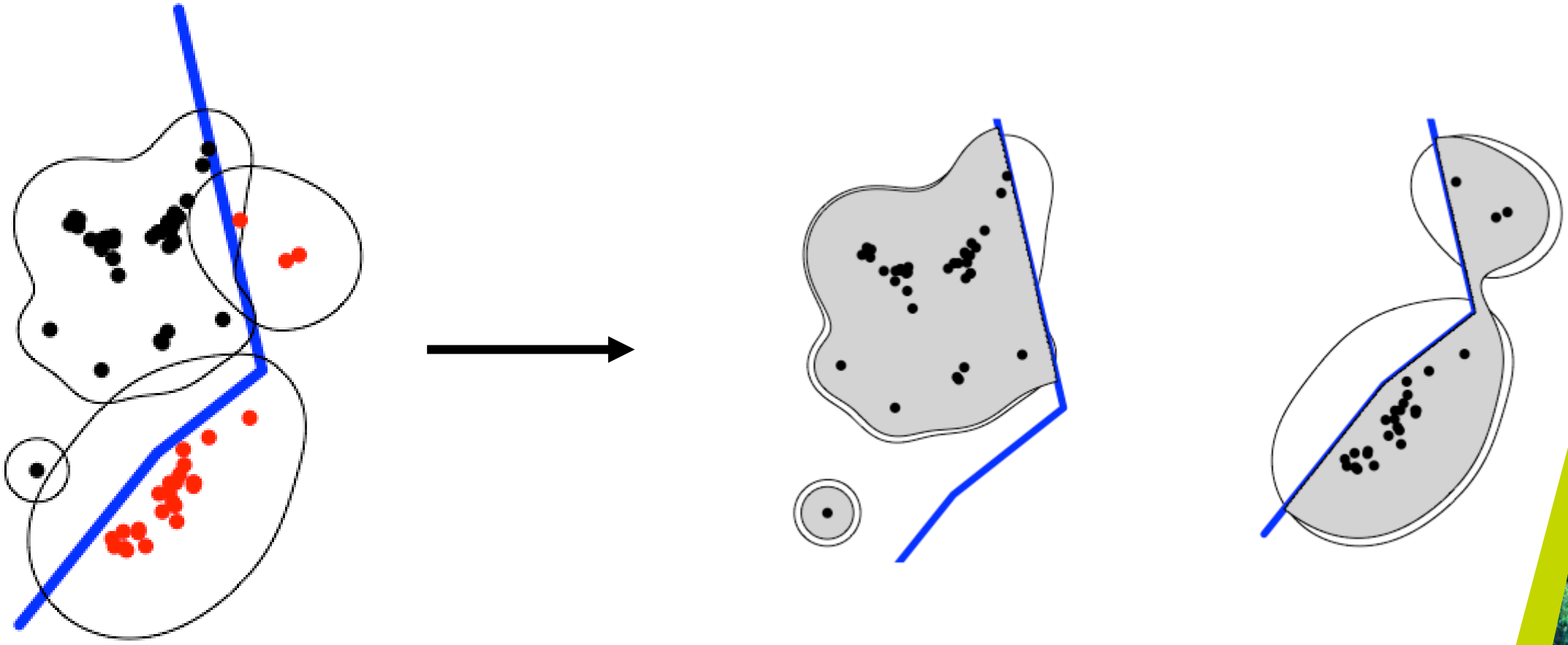


(Benhamou and Cornélis, 2010)



Data manipulation

Open boundaries



James E Paterson - Blog

Indoor home ranges applications

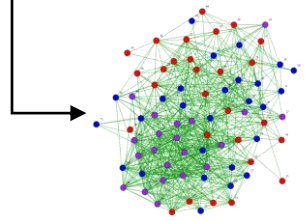
Applications of indoor home ranges

- Area usage of the animals
  - Cubical preference
  - Feed bunk preference
- Locate high density areas

Applications of indoor home ranges

- Barn area preference

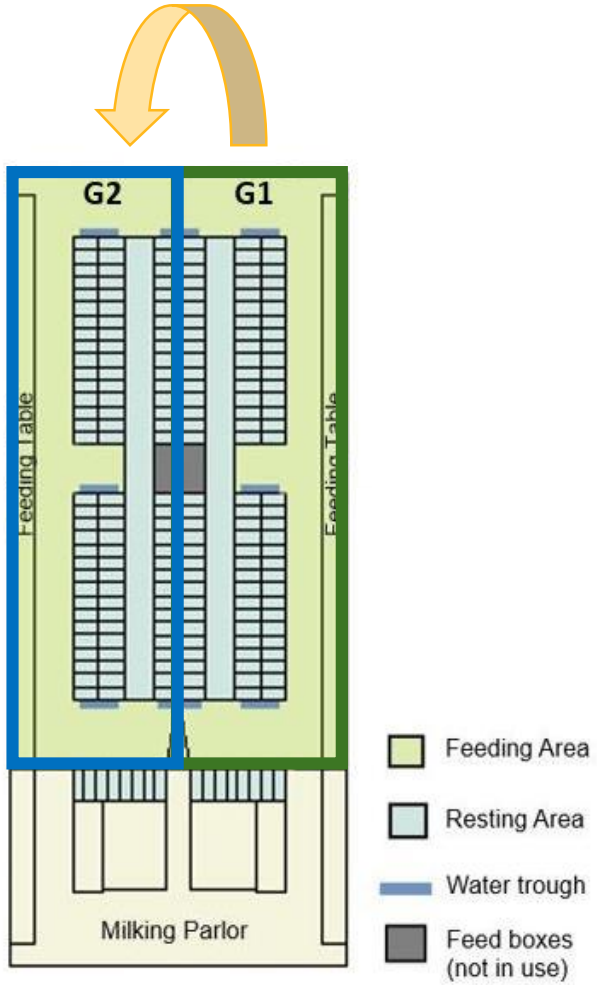
- Detect changes in behaviour

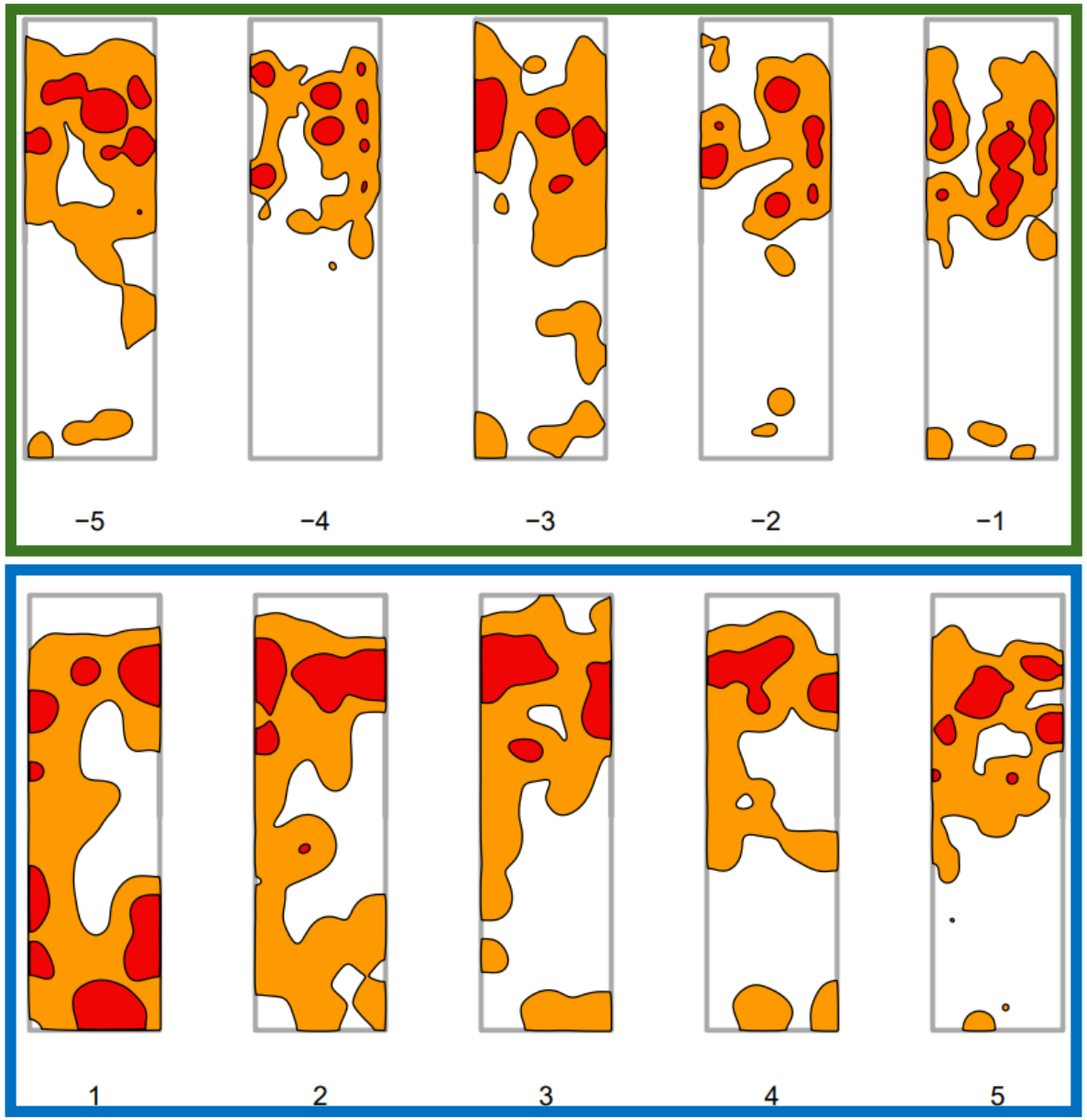


Social networks

Applications of indoor home ranges

(Gussman et al., 2025)





Recommended literature

1. Burt, W. H. (1943). Territoriality and home range concepts as applied to mammals. *Journal of Mammalogy*, 24, 346–352.
2. Roger A. Powell , Michael S. Mitchell, What is a home range?, *Journal of Mammalogy*, Volume 93, Issue 4, 14 September 2012, Pages 948–958, https://doi.org/10.1644/11-MAMM-S-177.1
3. Broekman, M. J. E., Hoeks, S., Freriks, R., Langendoen, M. M., Runge, K. M., Savenco, E., ter Harmsel, R., Huijbregts, M. A. J., & Tucker, M. A. (2023). *HomeRange*: A global database of mammalian home ranges. *Global Ecology and Biogeography*, 32, 198–205. https://doi.org/10.1111/geb.13625
4. Walter, W.D., Onorato, D.P. & Fischer, J.W. Is there a single best estimator? Selection of home range estimators using area-under-the-curve. *Mov Ecol* 3, 10 (2015). https://doi.org/10.1186/s40462-015-0039-4
5. Krysten L. Schuler, Greg M. Schroeder, Jonathan A. Jenks, and John G. Kie "Ad hoc smoothing parameter performance in kernel estimates of GPS-derived home ranges," Wildlife Biology 20(5), 259-266, (1 October 2014). https://doi.org/10.2981/wlb.12117
6. Ren, K., Nielsen, P.P., Alam, M., Rönnegård, L., 2021. Where do we find missing data in a commercial real-time location system? Evidence from 2 dairy farms. JDS Commun. 2, 345–350. https://doi.org/10.3168/JDSC.2020-0064
7. Ren, K., Alam, M., Nielsen, P.P., Gussmann, M., Rönnegård, L., 2022. Interpolation Methods to Improve Data Quality of Indoor Positioning Data for Dairy Cattle. Front. Anim. Sci. 0, 53. https://doi.org/10.3389/FANIM.2022.896666
8. Churakov, M., Silvera, A.M., Gussmann, M., Nielsen, P.P., 2021. Parity and days in milk affect cubicle occupancy in dairy cows. Appl. Anim. Behav. Sci. 244, 105494. https://doi.org/10.1016/J.APPLANIM.2021.105494
9. Benhamou, S., Cornélis, D., 2010. Incorporating Movement Behavior and Barriers to Improve Kernel Home Range Space Use Estimates. J. Wildl. Manage. 74, 1353–1360. https://doi.org/10.1111/J.1937-2817.2010.TB01257.X
10. Hansson, I., Silvera, A., Ren, K., Woudstra, S., Skarin, A., Fikse, W.F., Nielsen, P.P., Rönnegård, L., 2023. Cow characteristics associated with the variation in number of contacts between dairy cows. J. Dairy Sci. 106, 2685–2699. https://doi.org/10.3168/JDS.2022-21915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6th PLE workshop / seminar

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hector.marina@slu.se

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