

# Home range methods on indoor data

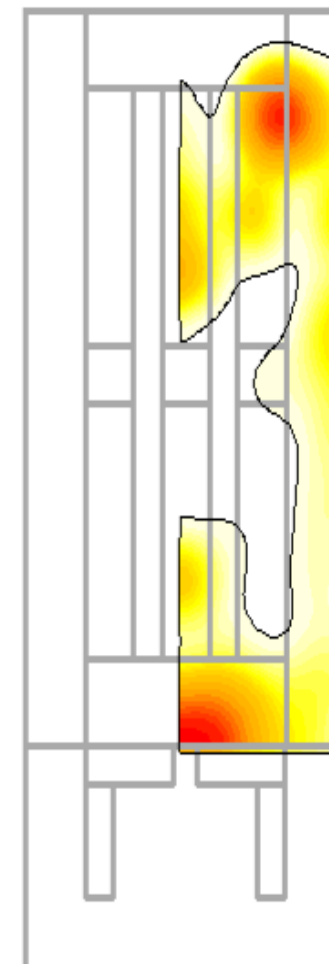
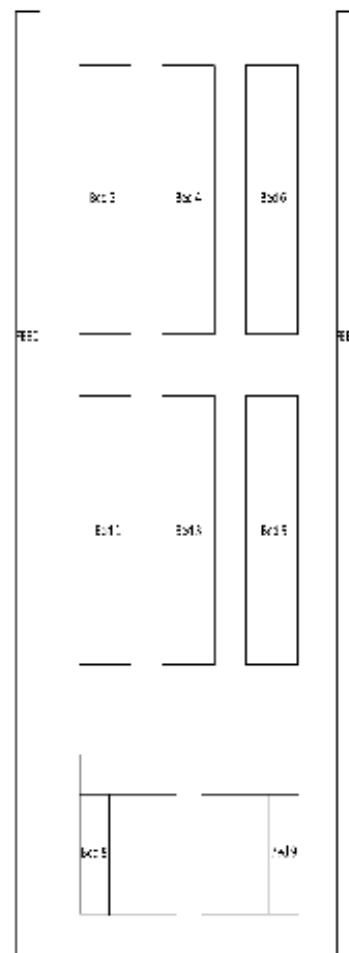
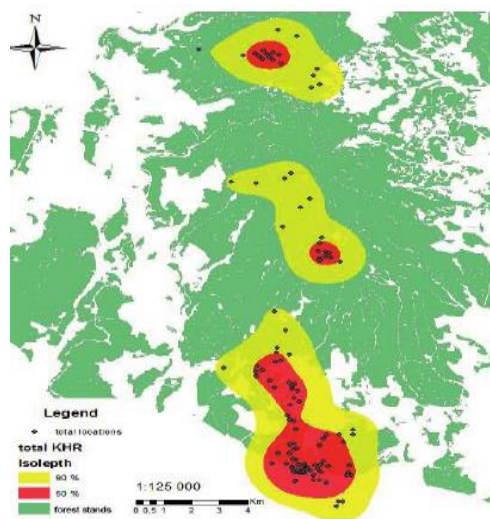
Hector Marina



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

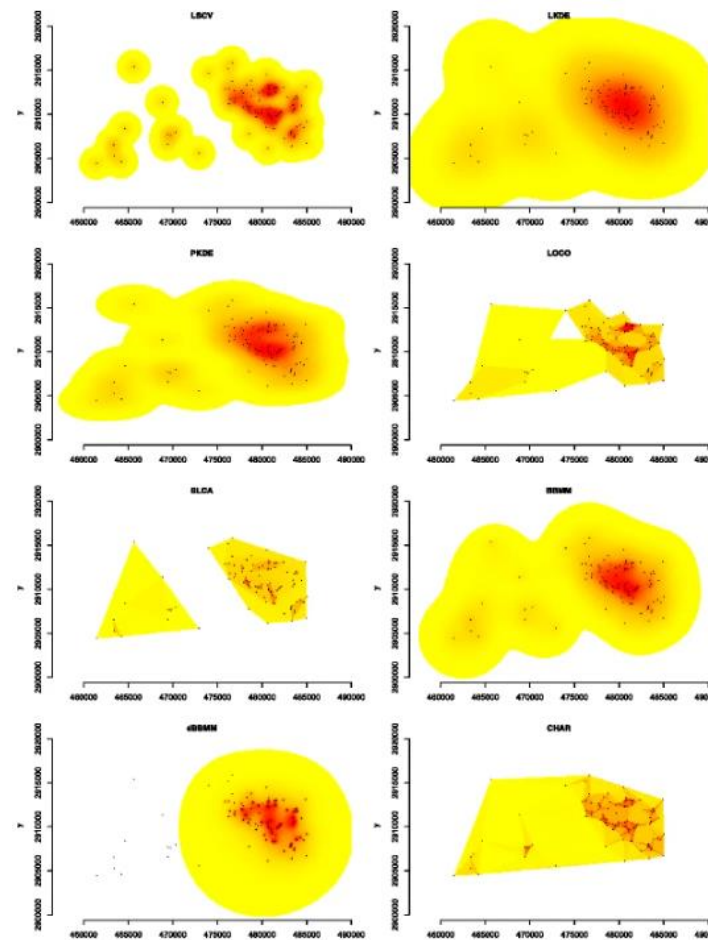
- Local convex hull
- Fixed kernel home range

## Second-generation estimators

- Plug-in Kernel home range

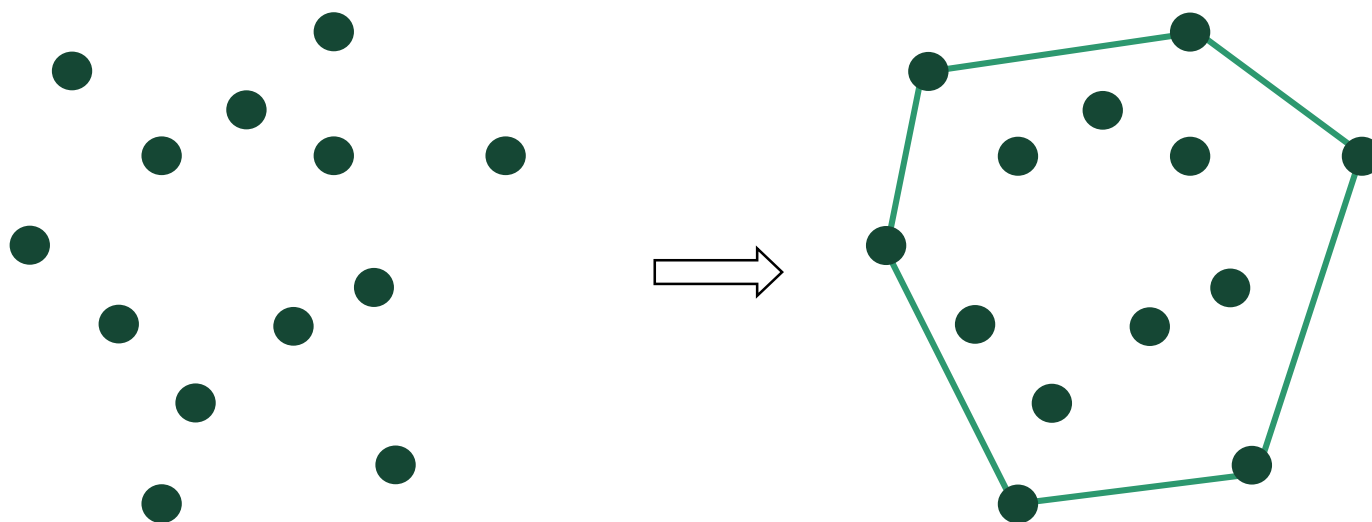
## Third generation estimators

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



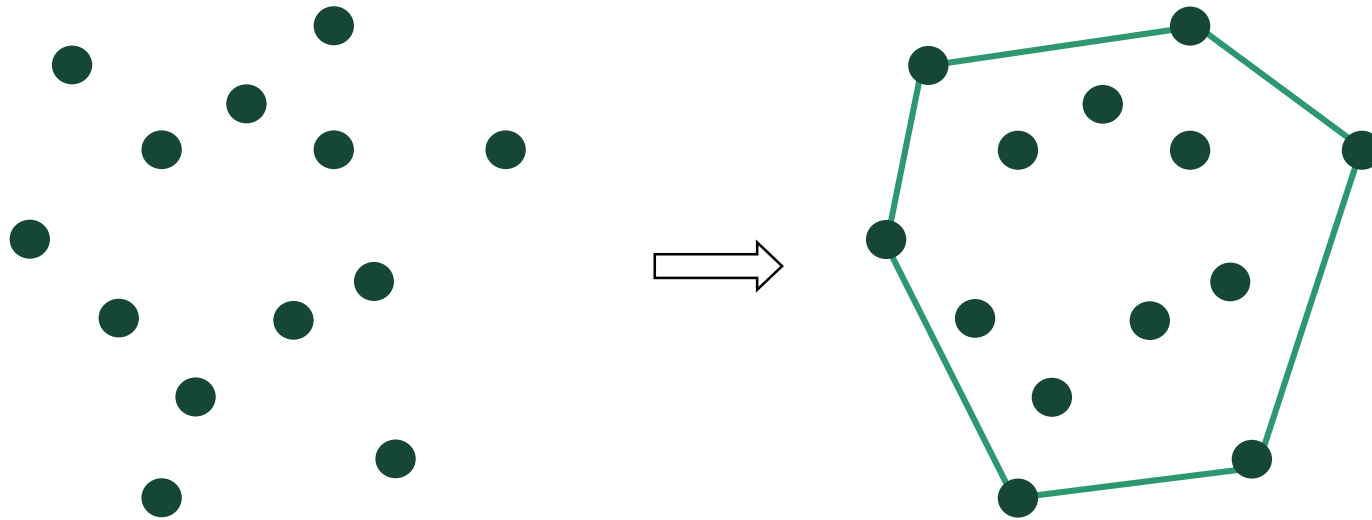
(Walter, 2015)





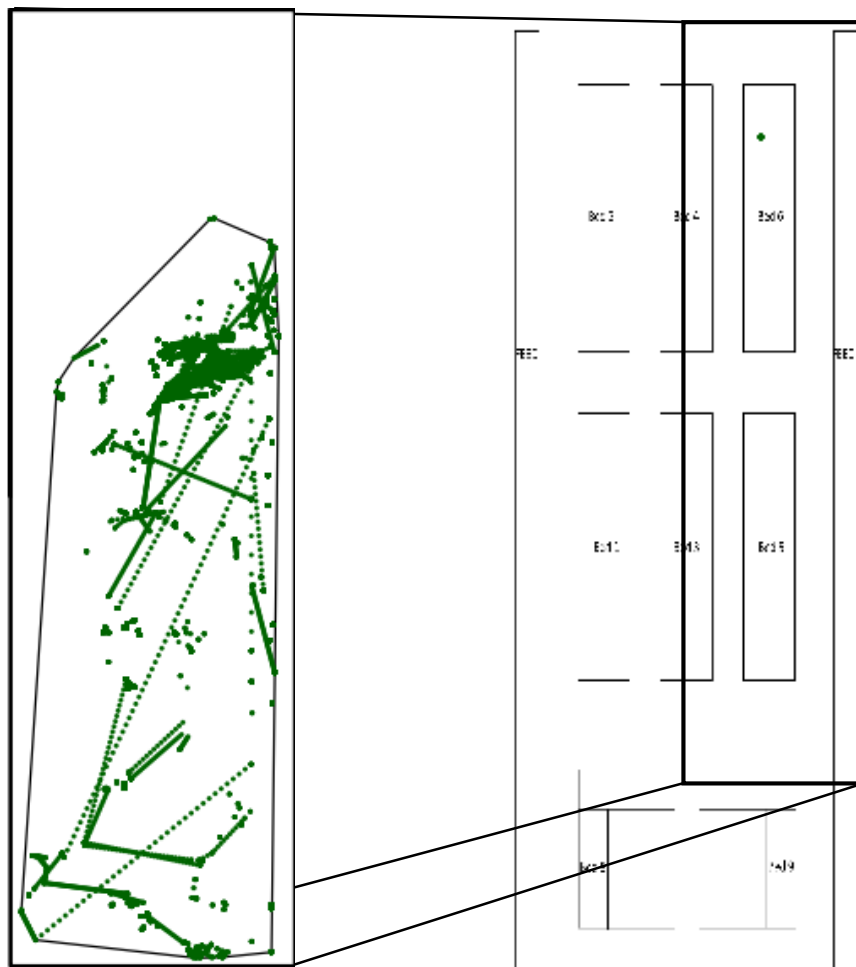
# Minimum Convex Polygon

- Convex hull or convex envelope or convex closure



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# Minimum Convex Polygon

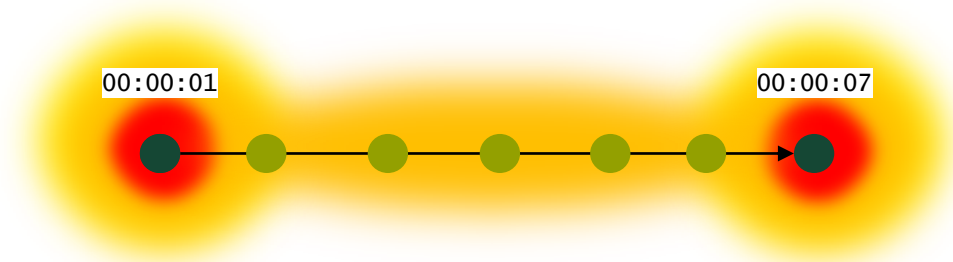
- Convex hull or convex envelope or convex closure



# Utilization Distributions



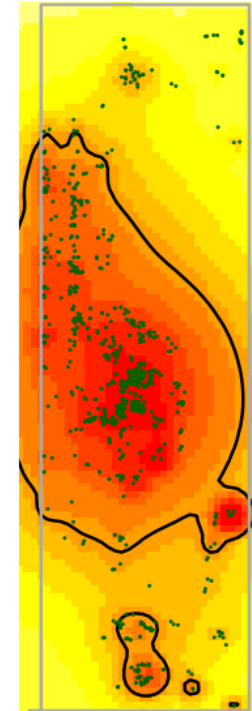
- Brownian bridge movement model
  1. Sequential location data
  2. Estimated error
  3. Grid-cell size for utilization distribution
  - Paired locations becomes less realistic as the time interval increases



Convex hulls

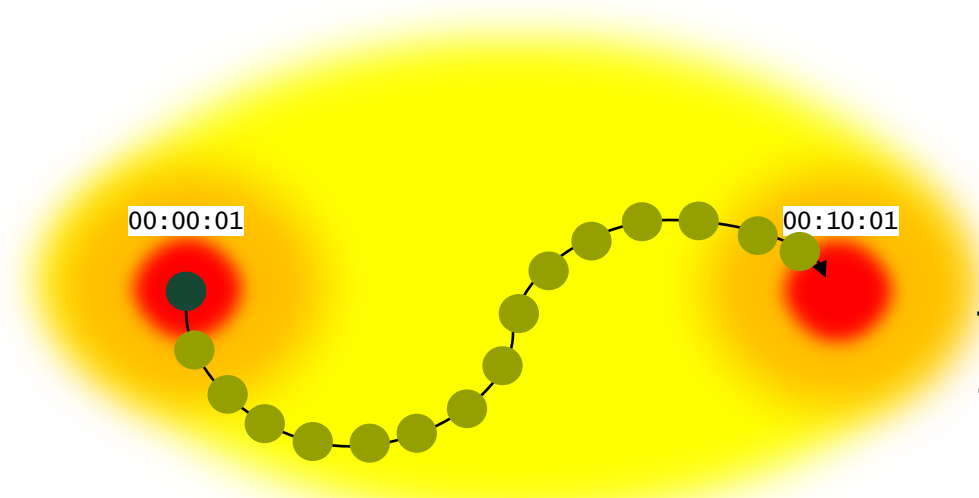


Brownian bridge

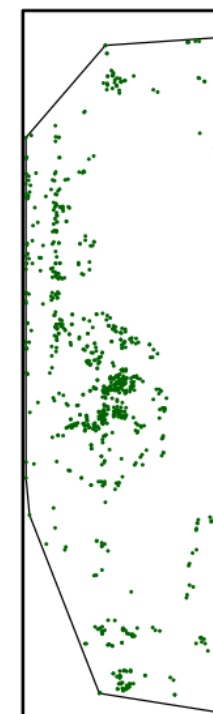




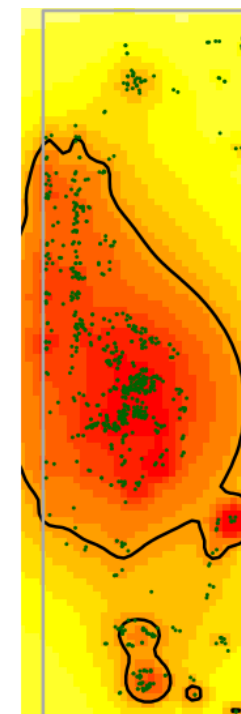
- Brownian bridge movement model
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Convex hulls

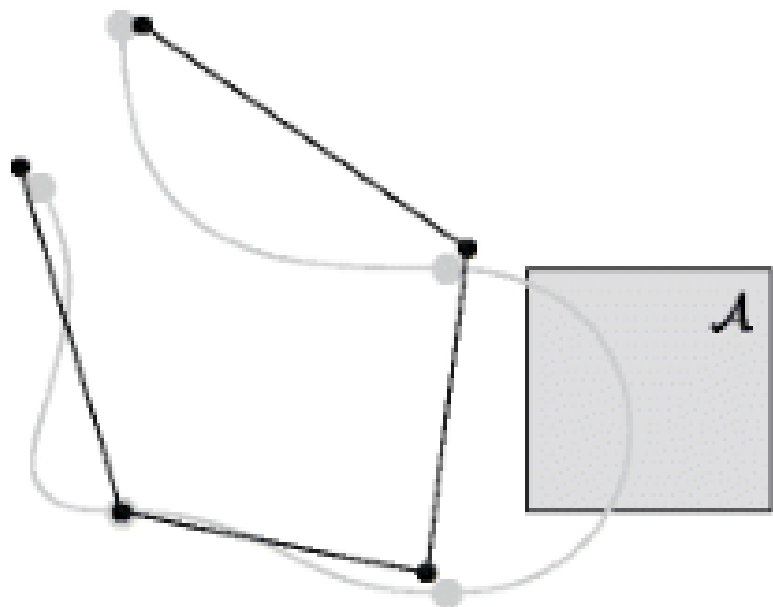


Brownian bridge

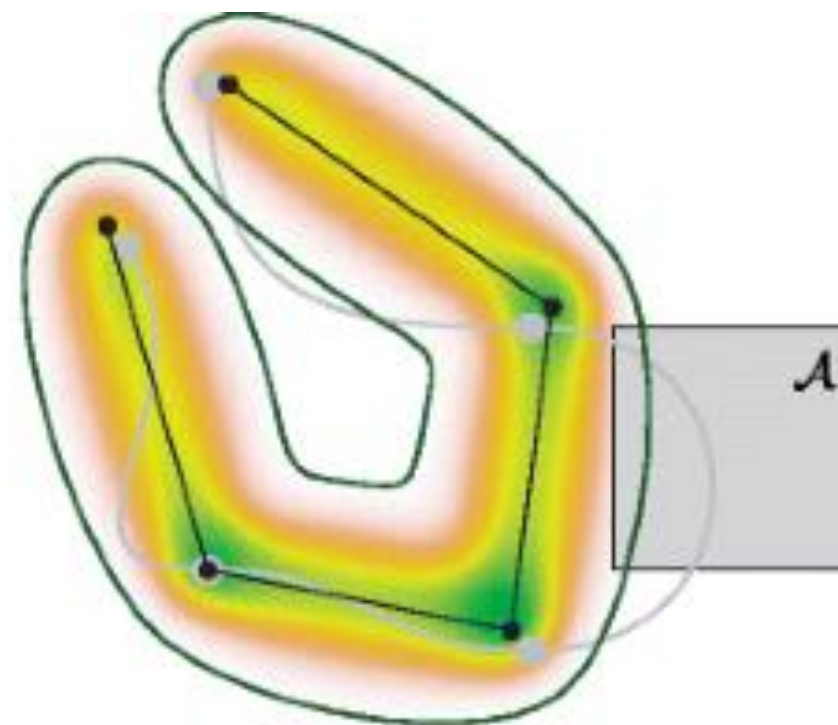


Two assumptions:

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



(a)



(c)

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*.

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

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

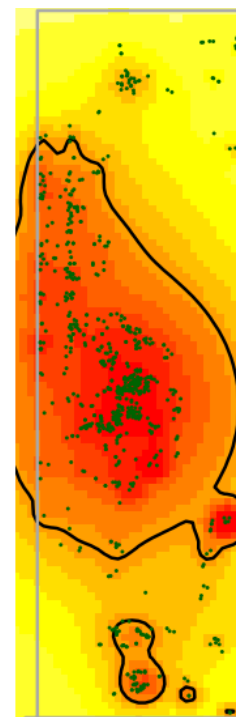
Number of data points

$(0.5 * (sd_x + sd_y))$

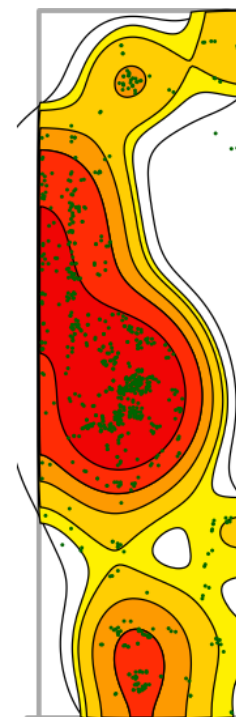
Convex hulls



Brownian bridge



Kernel



Krysten et al., (2014):

*“Examine the point distribution; justify the choice of smoothing parameter based on the objectives of the study.”*

- Kernel density estimators
  - One of the most popular methods for measuring home ranges.
  - Several types of kernels
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$$h = \sigma * n^{-1/6}$$

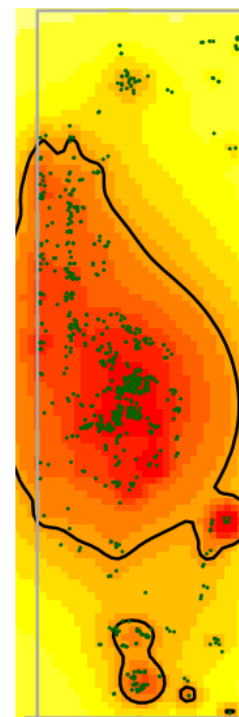
Number of data points

$(0.5 * (sd_x + sd_y))$

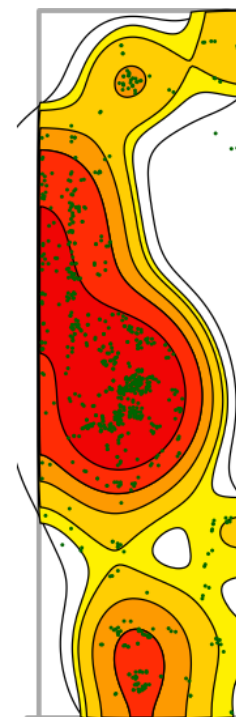
Convex hulls



Brownian bridge



Kernel

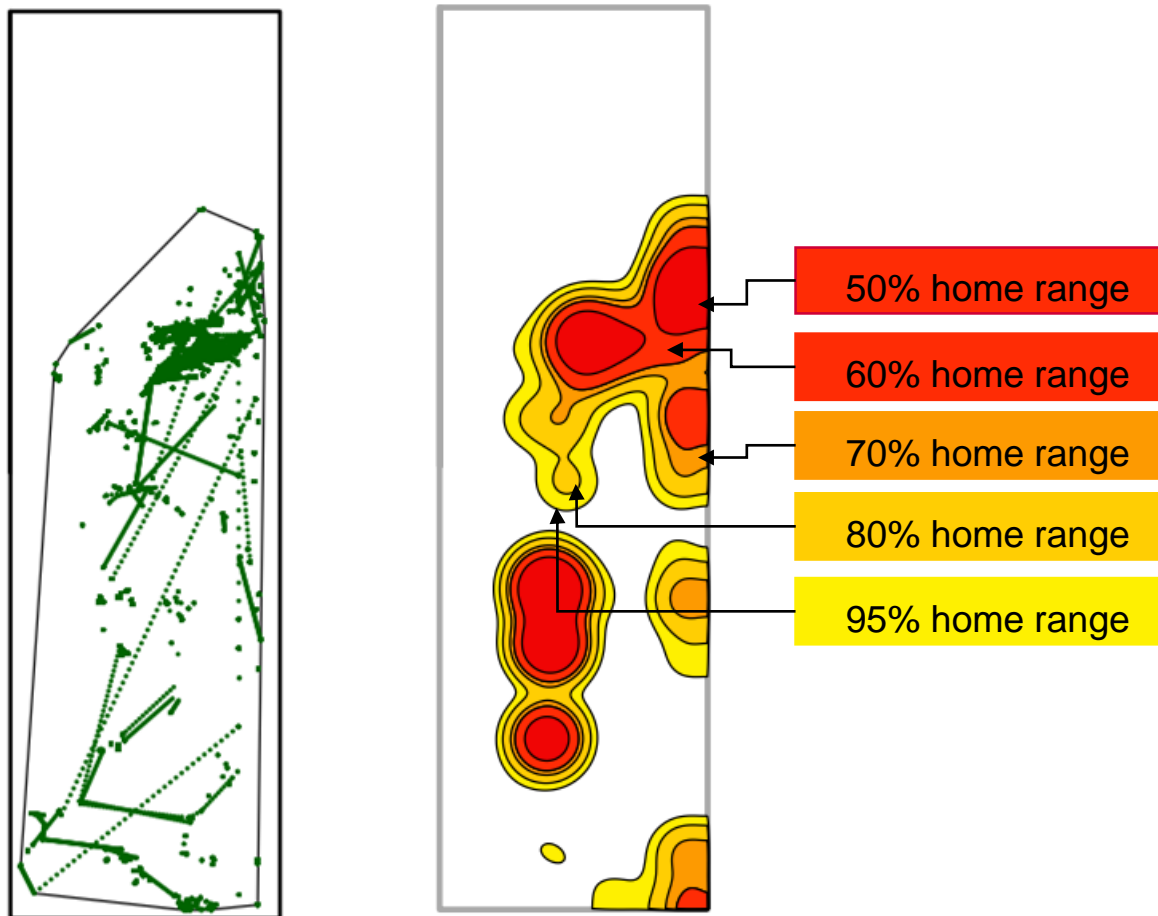


```
HomeRangeBound <- kernelUD(FA_data[, "Tag"], h = as.list(HomeRange)[[1]]@h$h, grid = 1000, boundary = bound)
```

# Utilization Distributions



- Kernel density estimators



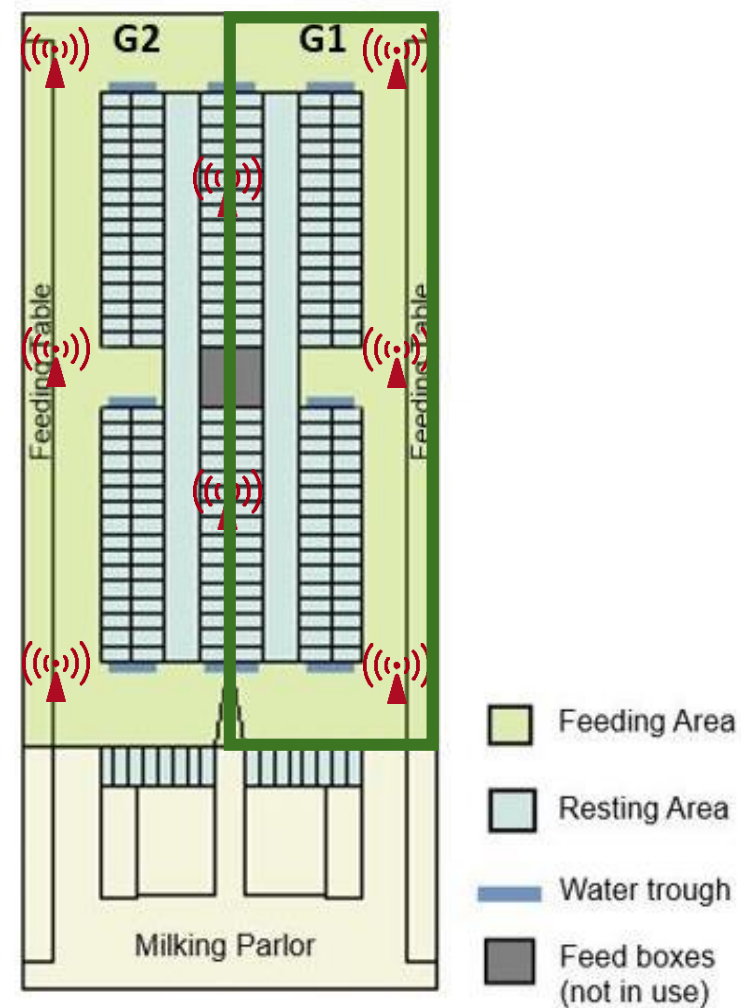
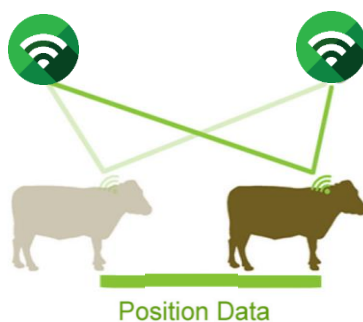
# Data manipulation



# Data manipulation

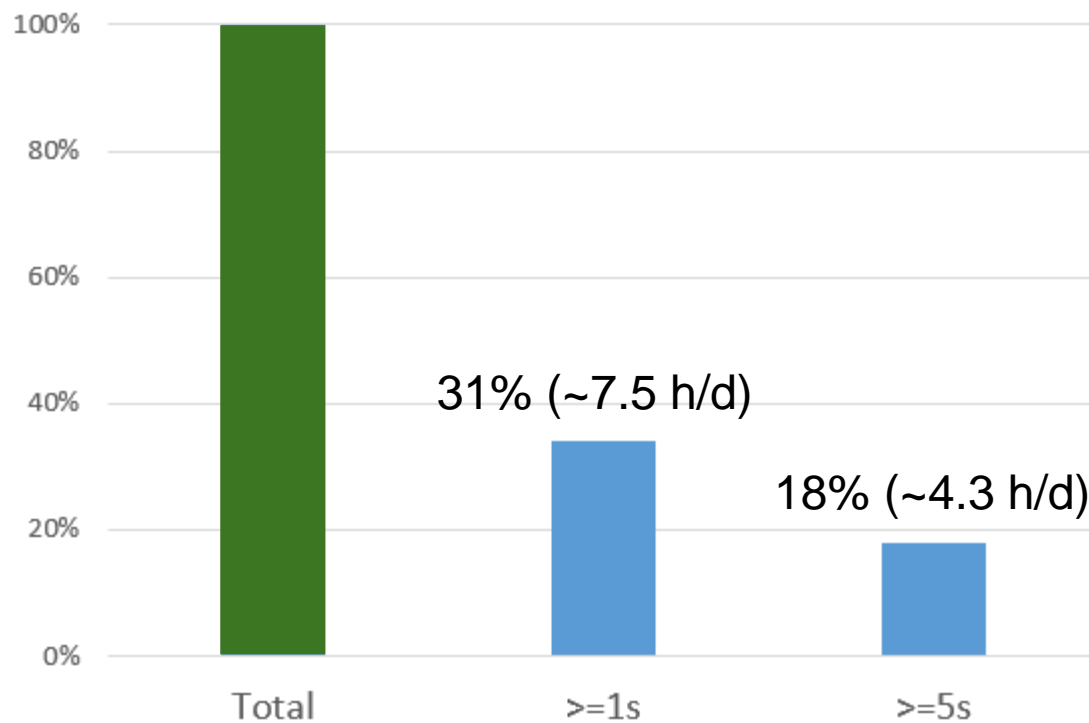


## Real-time Location System



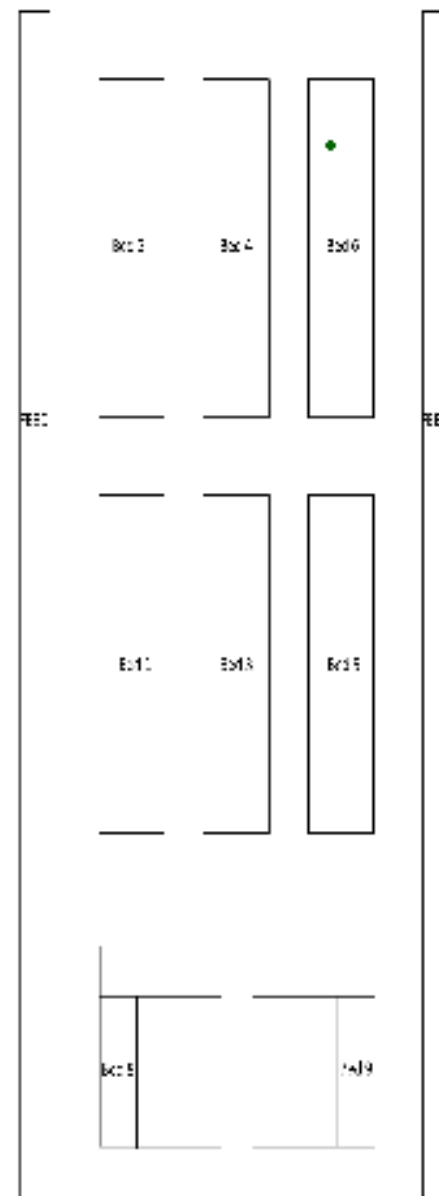
(Hansson et al., 2023)

## Interpolation methods



(Ren et al., 2021)

01:00:00

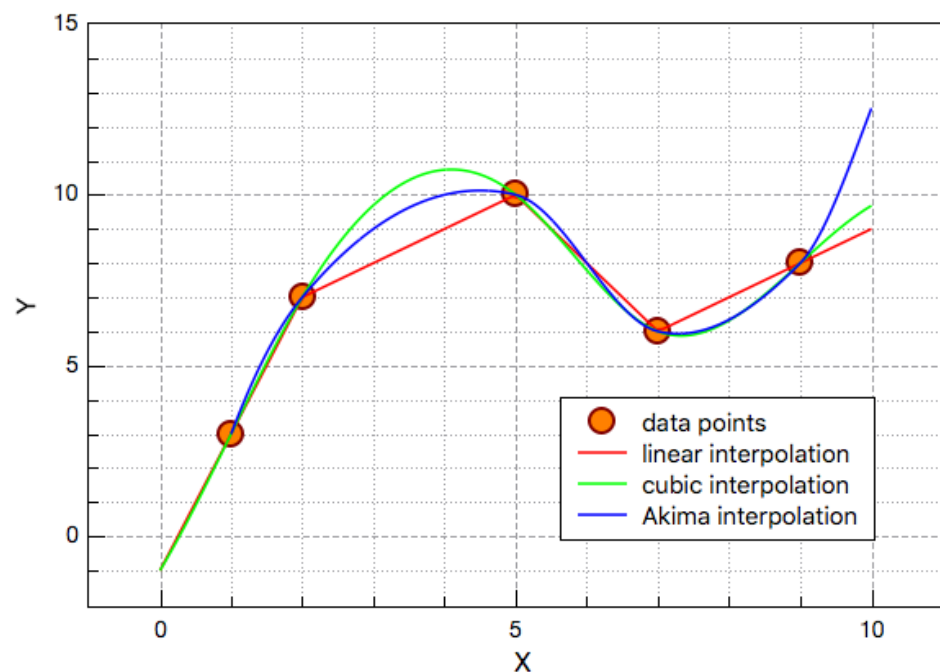


# Data manipulation



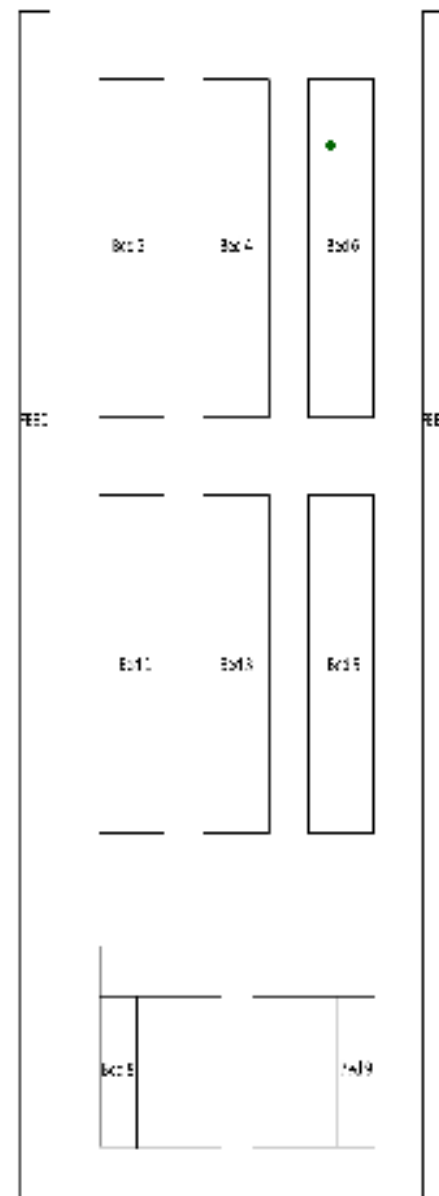
## Interpolation methods

- Maximising the information

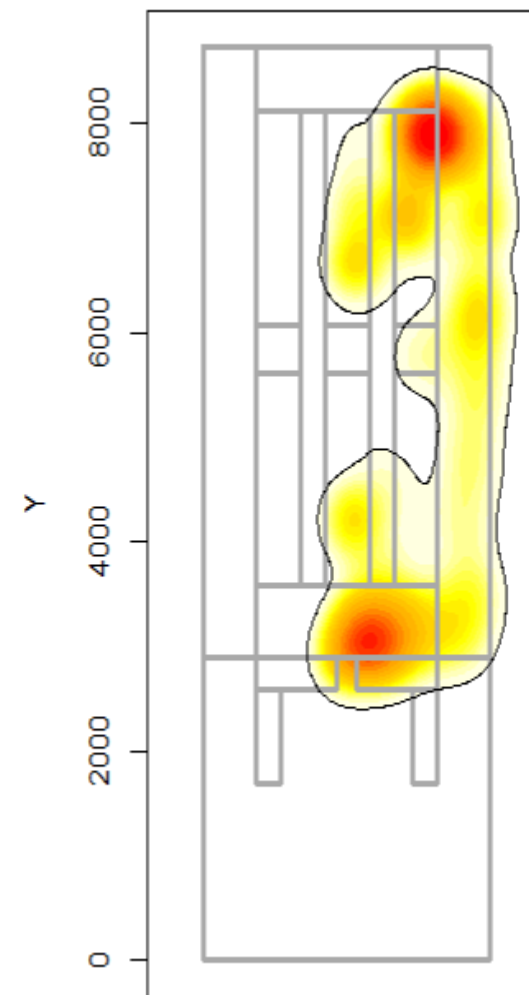
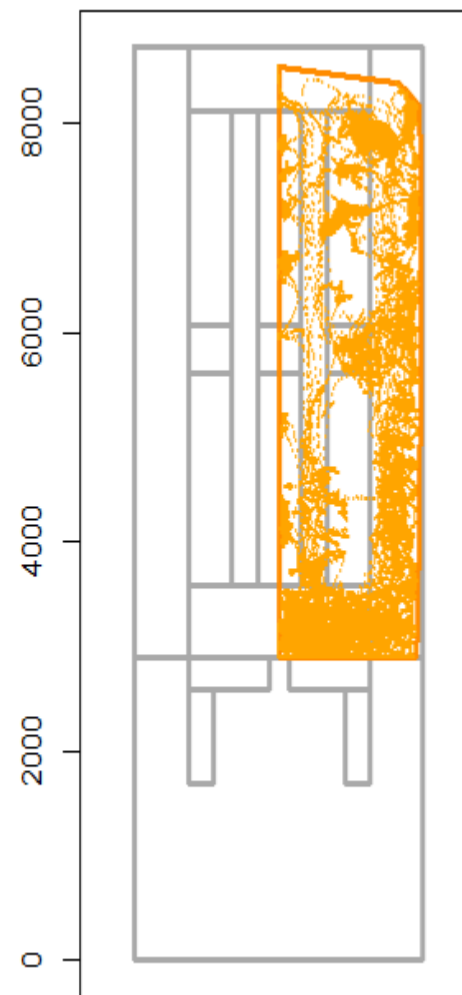
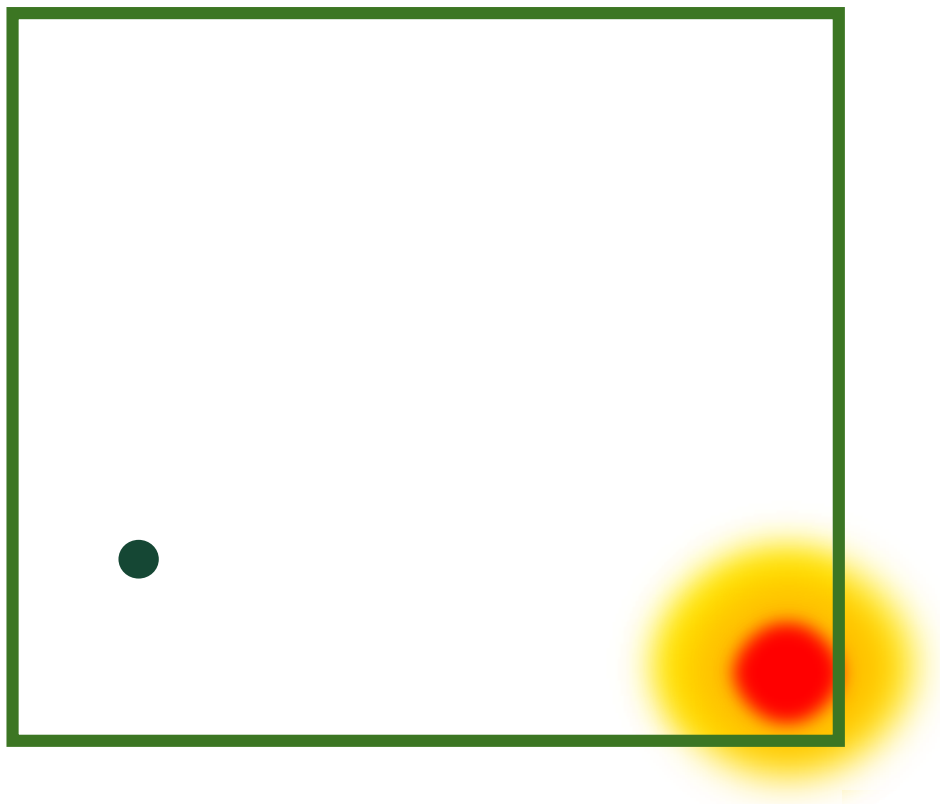


(Ren et al., 2022)

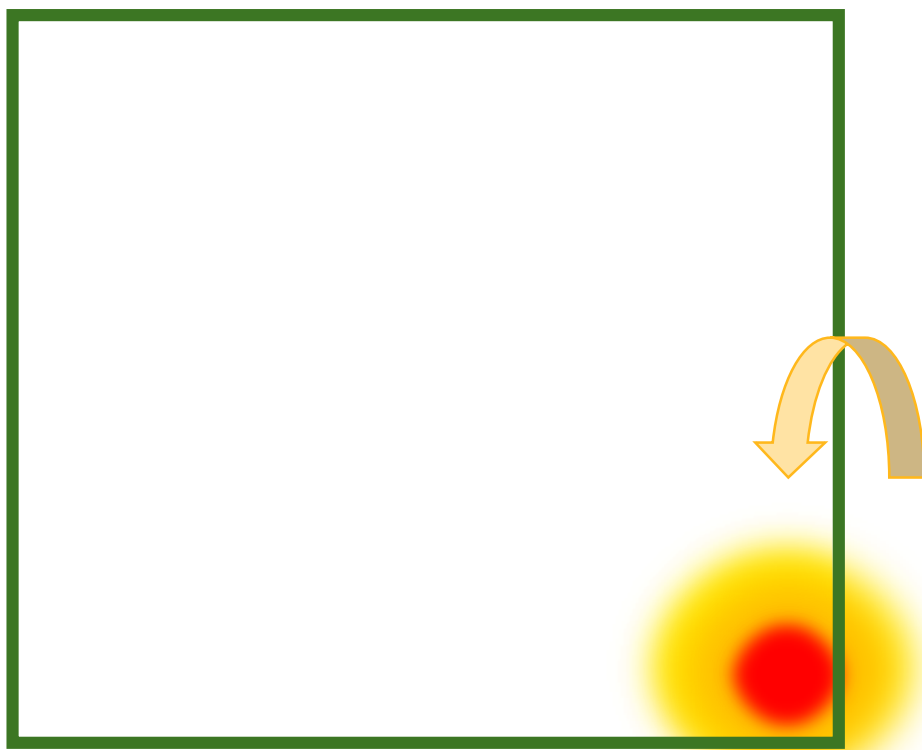
01:00:00



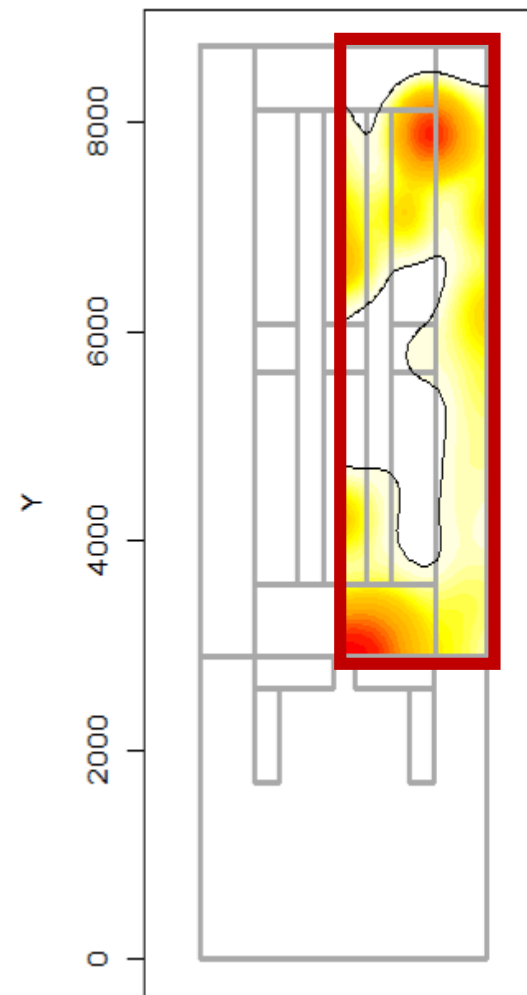
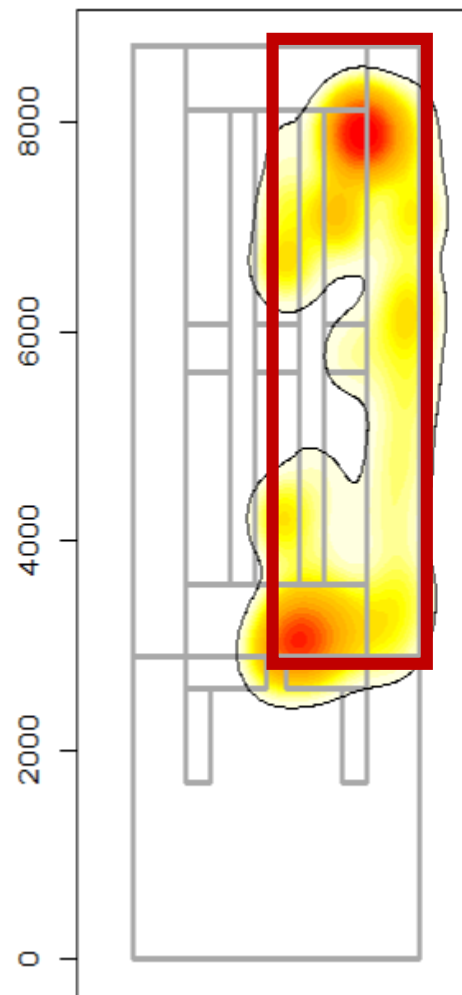
## Boundaries



## Boundaries



(Benhamou and Cornélis, 2010)



# **Indoor home ranges applications**

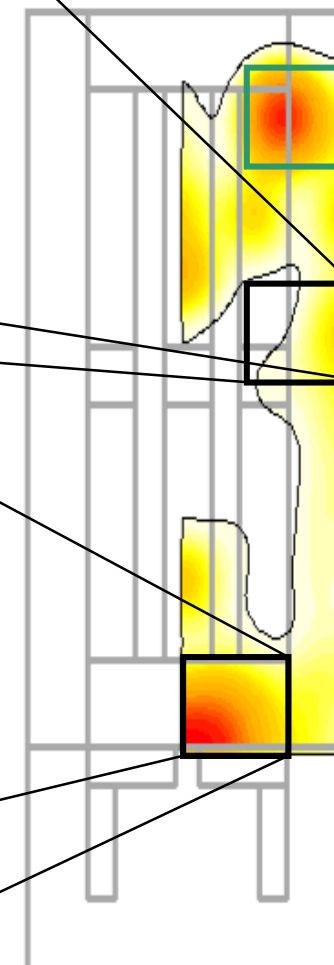
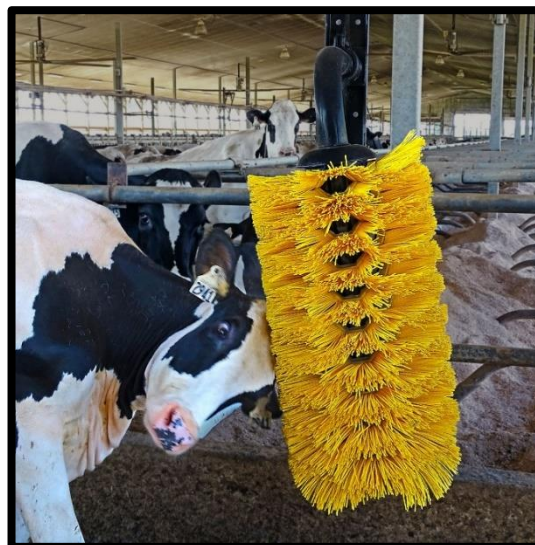


# Applications of indoor home ranges

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



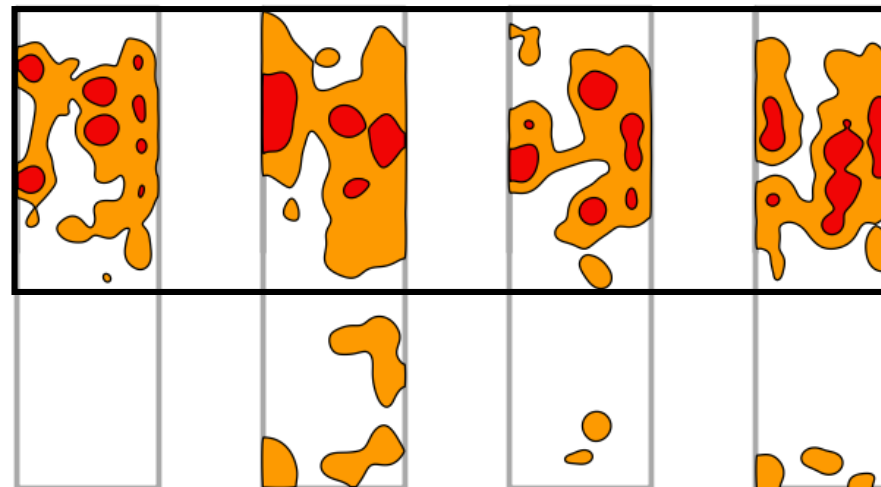
(Churakov et al., 2021)



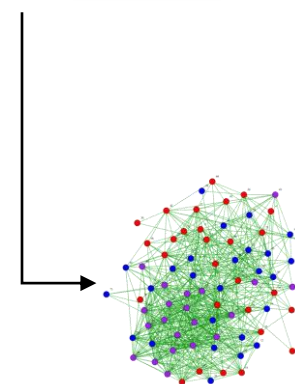
# Applications of indoor home ranges



- Barn area preference



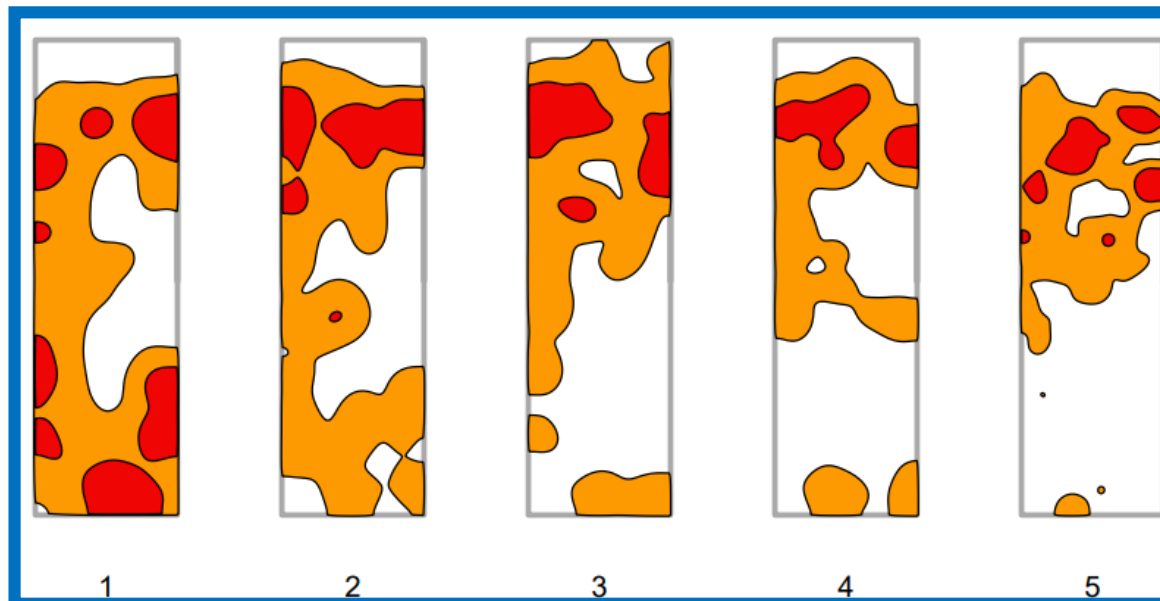
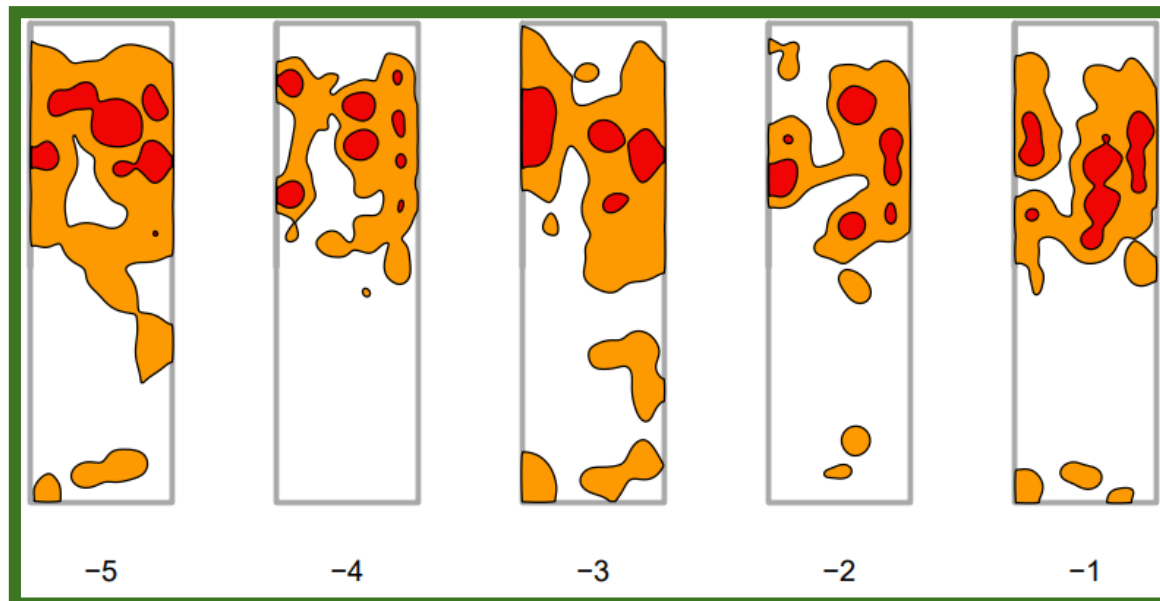
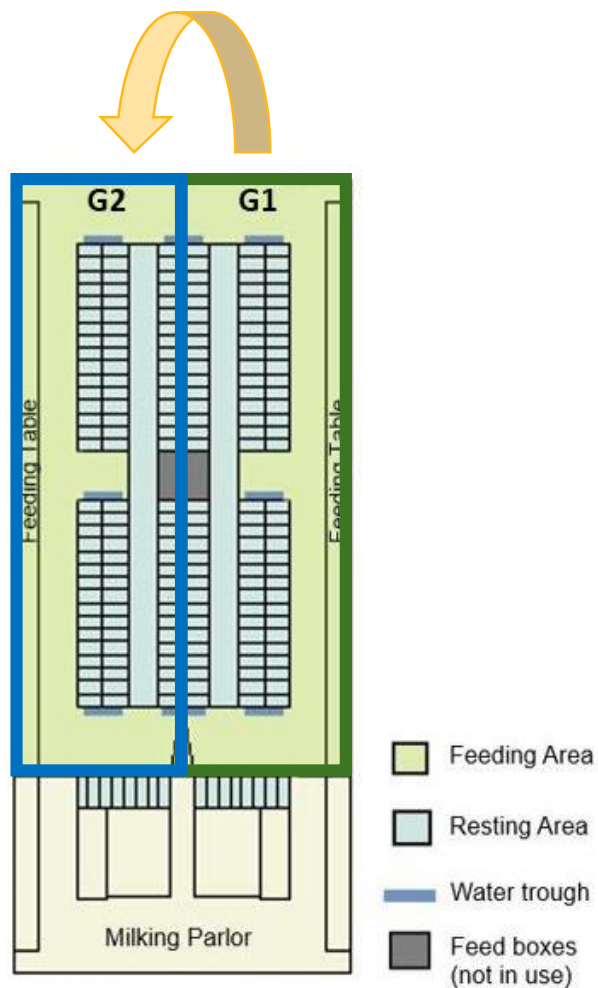
- Detect changes in behaviour



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., Rønnegård, 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., Rønnegård, 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., Rønnegård, 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>



hands  
on

The text "hands on" is centered on the page. The word "hands" is in a smaller, black, sans-serif font, and "on" is in a larger, bold, black, serif font. Behind the text are several blue handprints of varying sizes, some overlapping the letters.





GitHub



6th PLF  
workshop  
seminar

SCIENCE AND  
EDUCATION  
**FOR  
SUSTAINABLE  
LIFE**

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