Machine learning methods for path analysis in behavioural neuroscience

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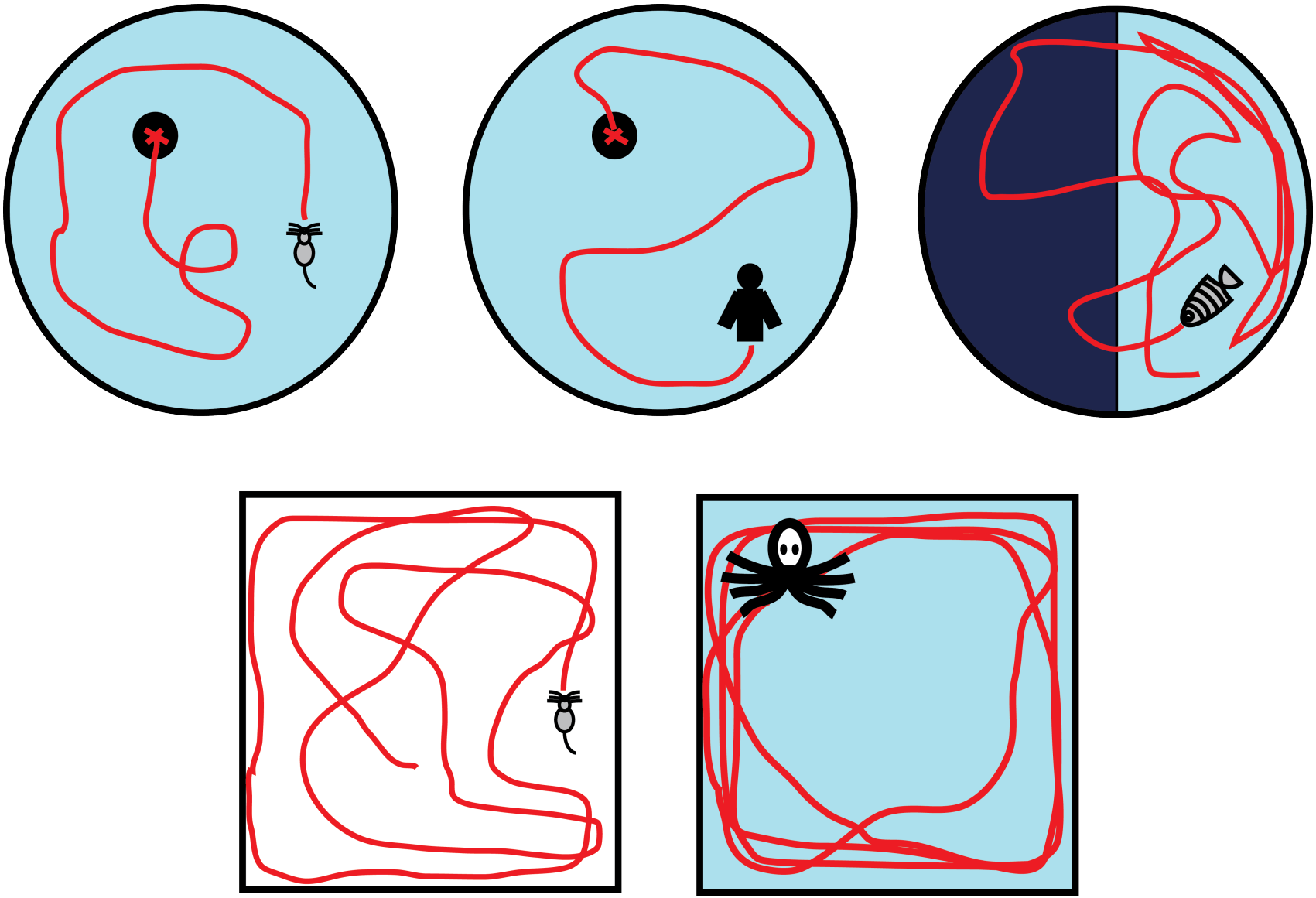
Supervised by Prof Eleni Vasilaki

The University Of Sheffield.

Behavioural experiments



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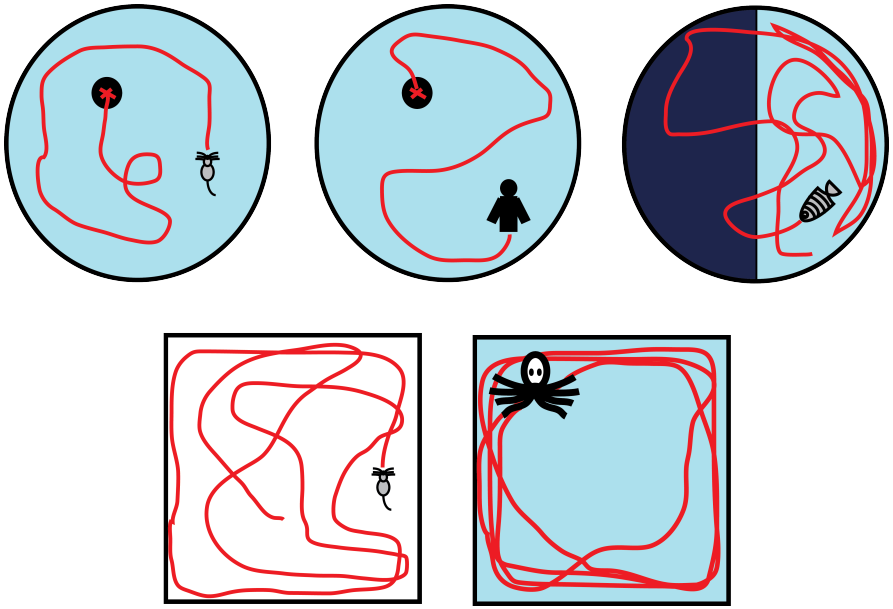

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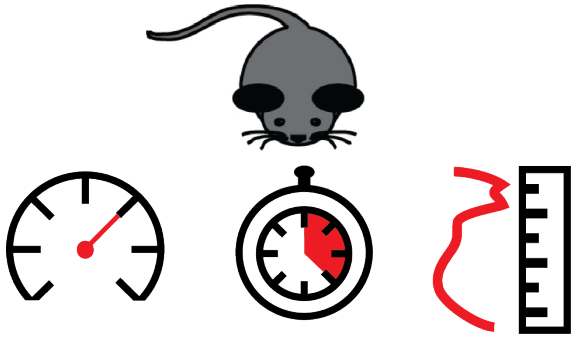
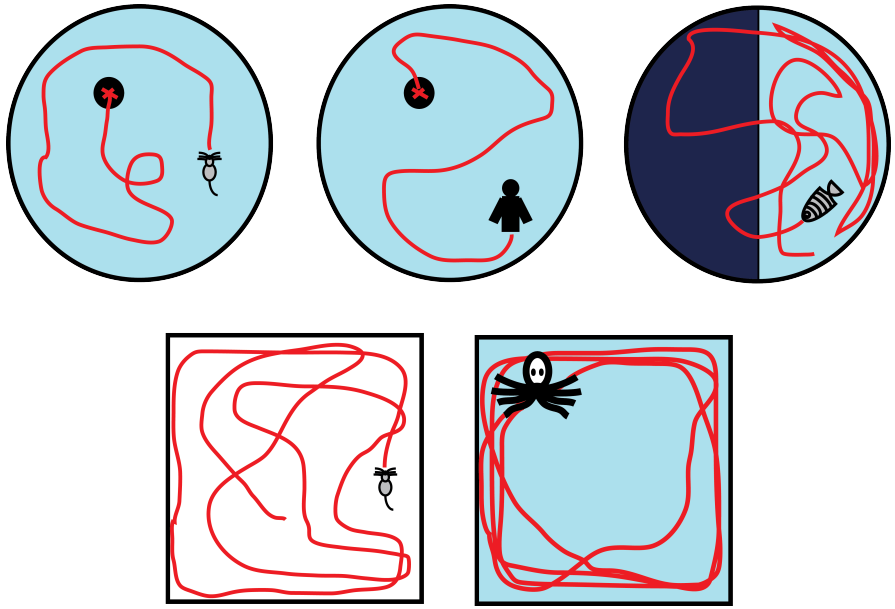
- Collect trajectory/path data.
- Compute various performance measurements.





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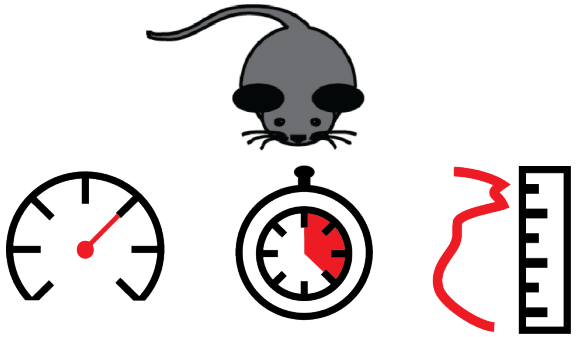

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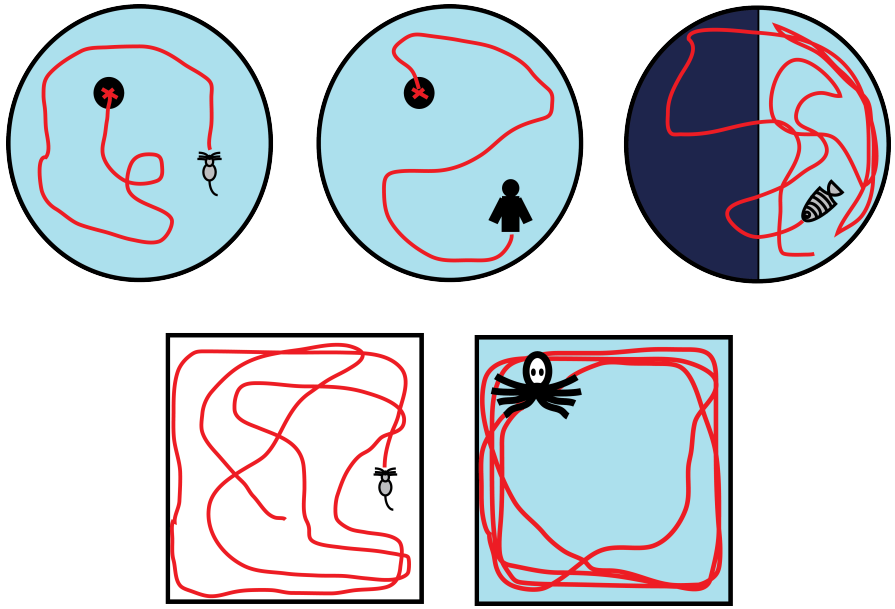

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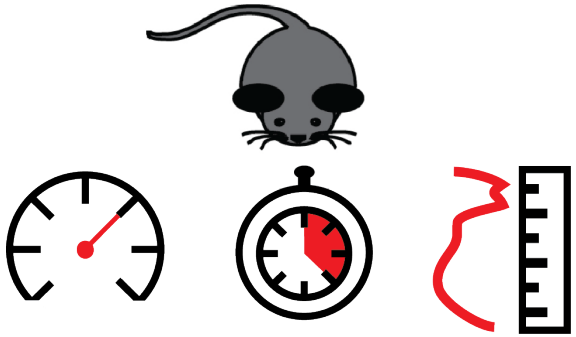

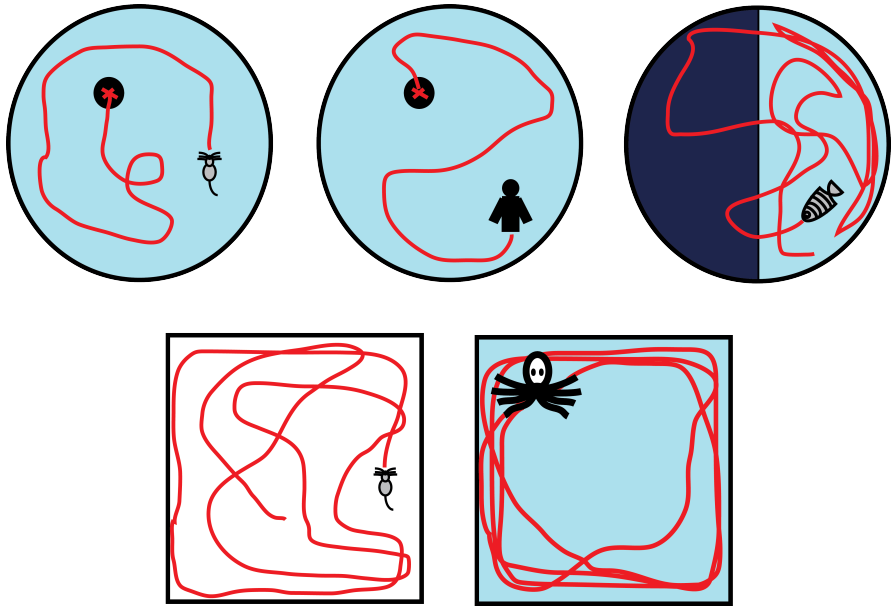

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  - Machine learning frameworks.
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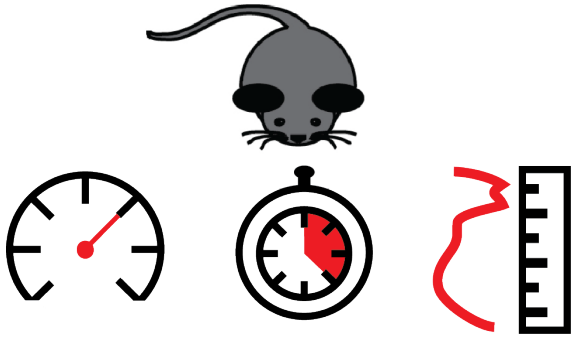

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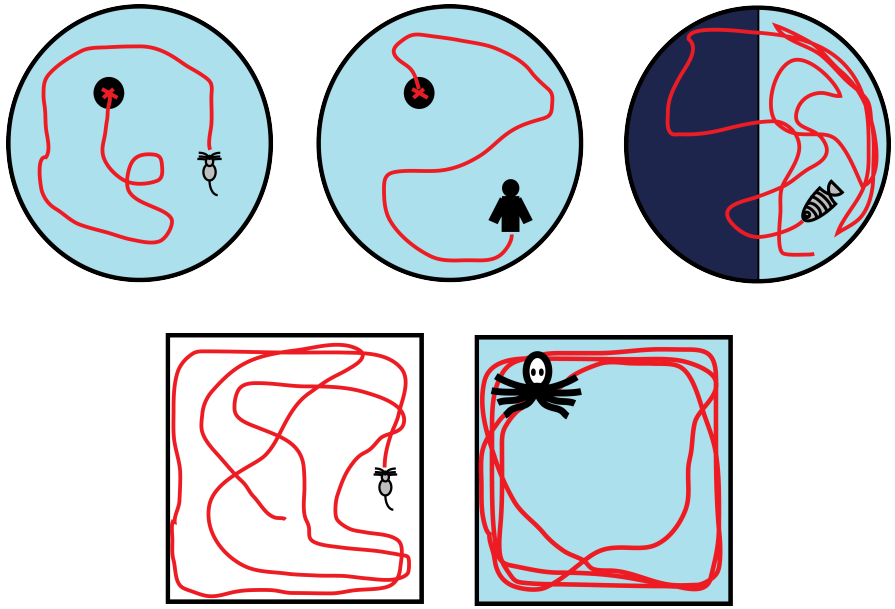
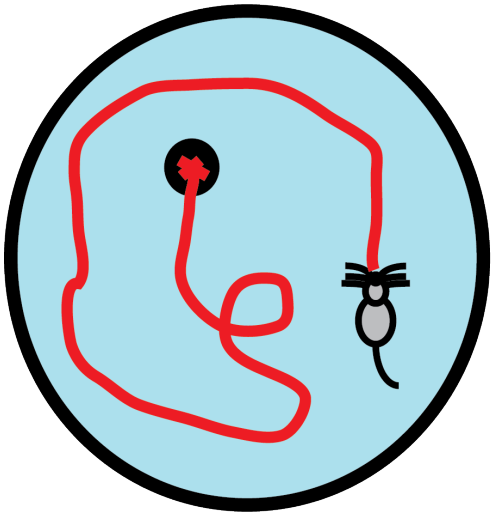
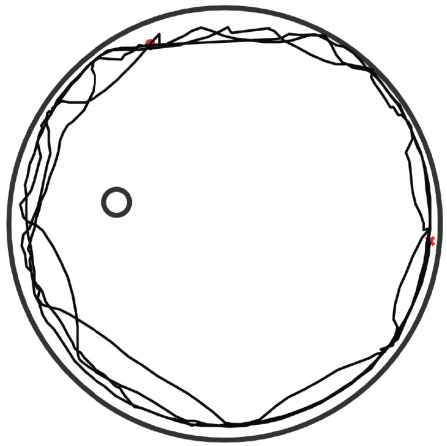


- Limited to specific experiments.
- Require meta-parameter tuning.
- Crucial behavioural information might be lost.

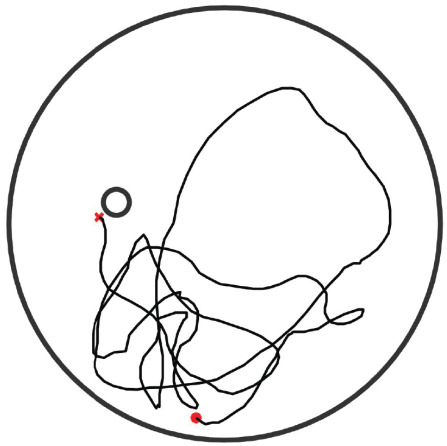
The Morris Water Maze



Full Trajectories Classification



Thigmotaxis

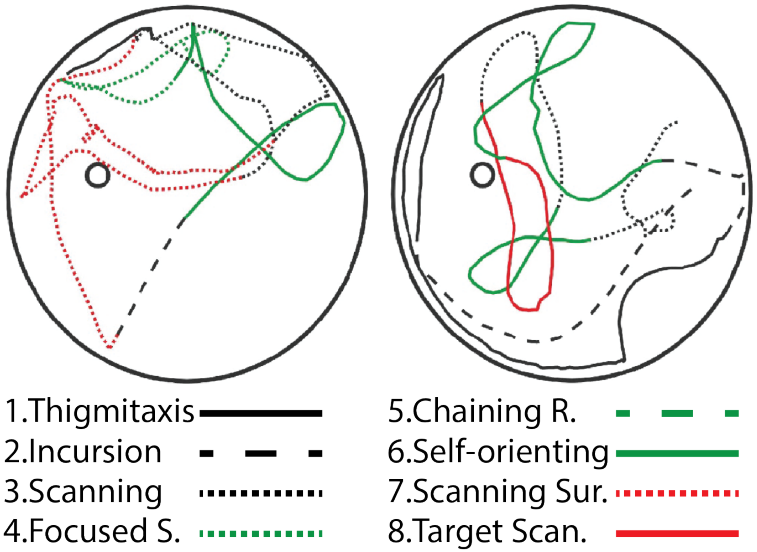


Focused Search

- Dalm, S., Grootendorst, J., De Kloet, E. R. (2000).
- Wolfer, D. P. & Lipp, H.-P. (2000).
- Wolfer, D. P., Madani, R., Valenti, P. & Lipp, H.-P. (2001).
- Graziano, A., Petrosini, L. & Bartoletti, A. (2003)
- Illouz, T., Madar, R., Louzon, Y., Griffioen, K. J. & Okun, E. (2016).
- Rogers, Jake, et al. (2017).
- Higaki, Akinori, et al. (2018).

The Morris Water Maze

Gehring, T. V., Luksys, G., Sandi, C., & Vasilaki, E. (2015).



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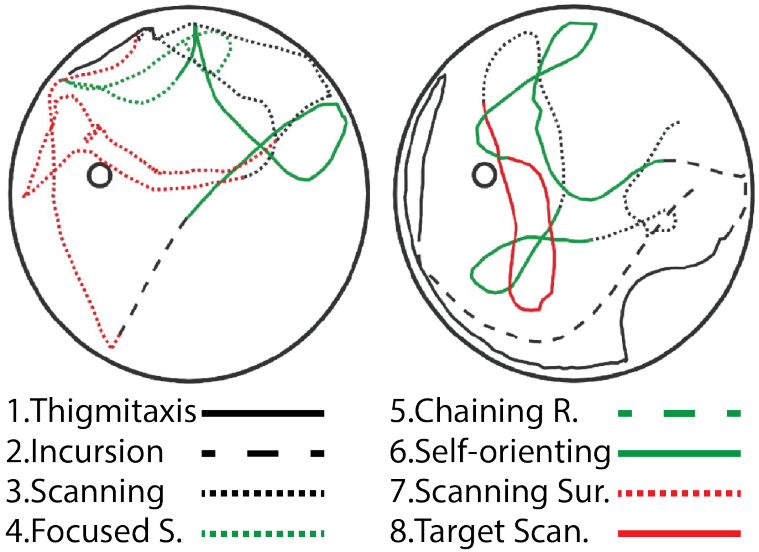
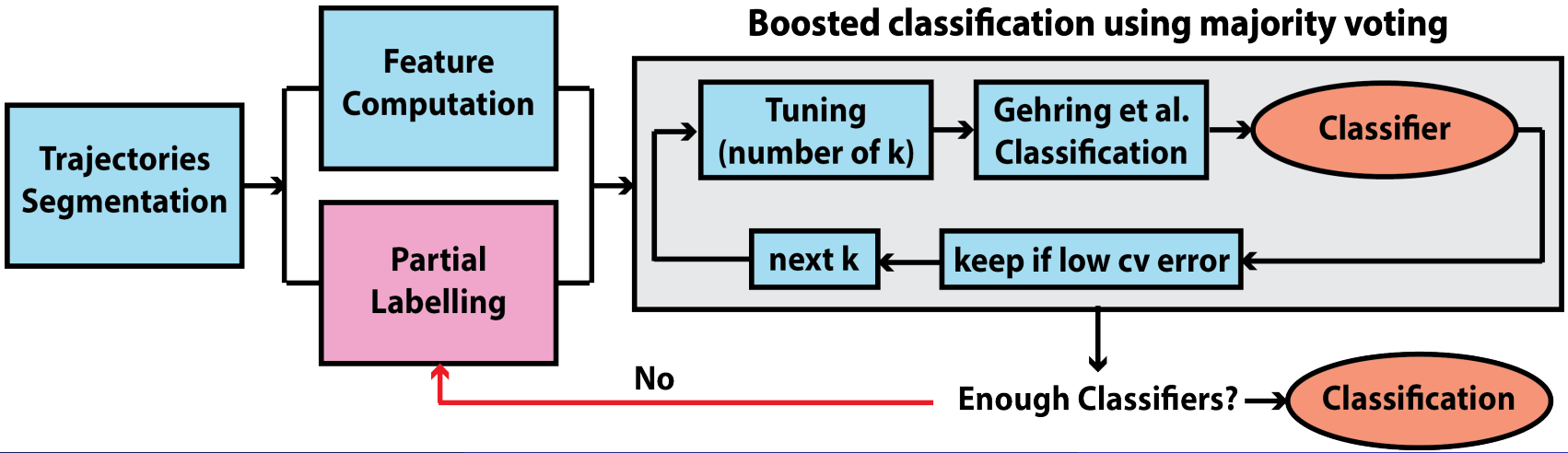




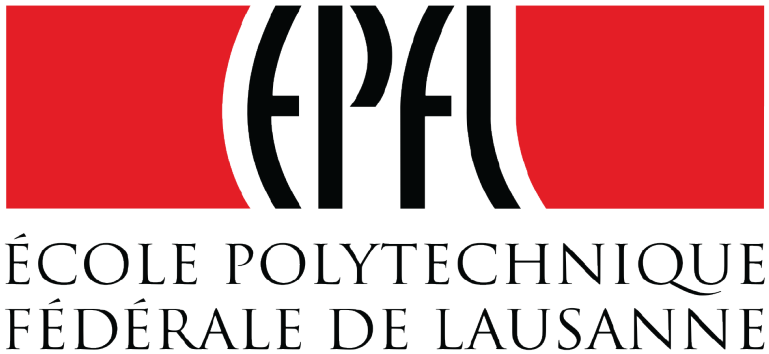
RODA collaborations

ROdent Data Analytics (RODA)

https://github.com/RodentDataAnalytics

Avgoustinos Vouros, Tiago V. Gehring, Mike Croucher, & Eleni Vasilaki. (2017, December 18). RodentDataAnalytics/mwm-ml-gen: Version 4.0.3-beta (Version v4.0.3). Zenodo. http://doi.org/10.5281/zenodo.1117837

RODA collaborations



Huzard, D., Vouros, A., Monari, S., Astori, S., Vasilaki, E., & Sandi, C. (2019).

RODA collaborations

nencki institute of experimental biology

ÉCOLE POLYTECHNIQUE FÉDÉRALE DE LAUSANNE

MOTE MARINE LABORATORY

KING'S College LONDON

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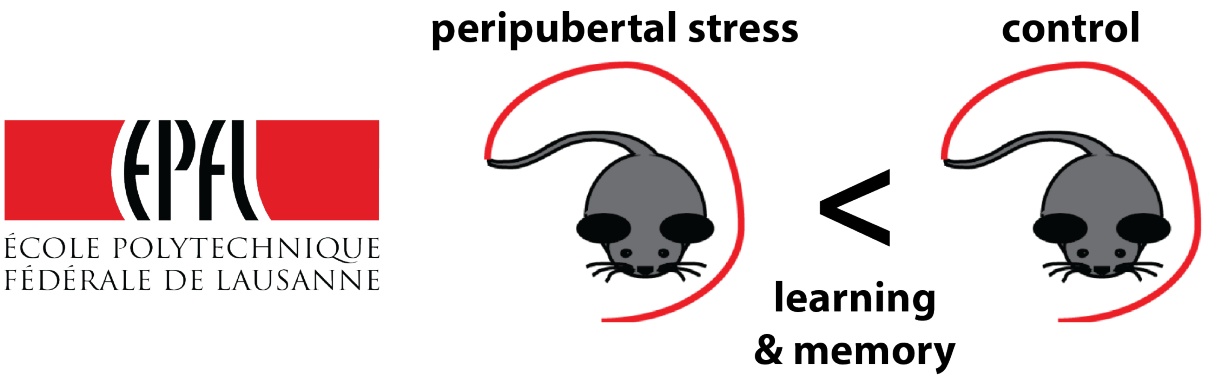

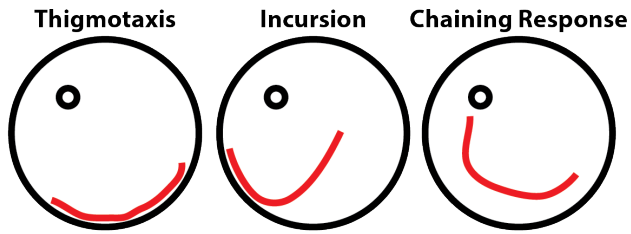

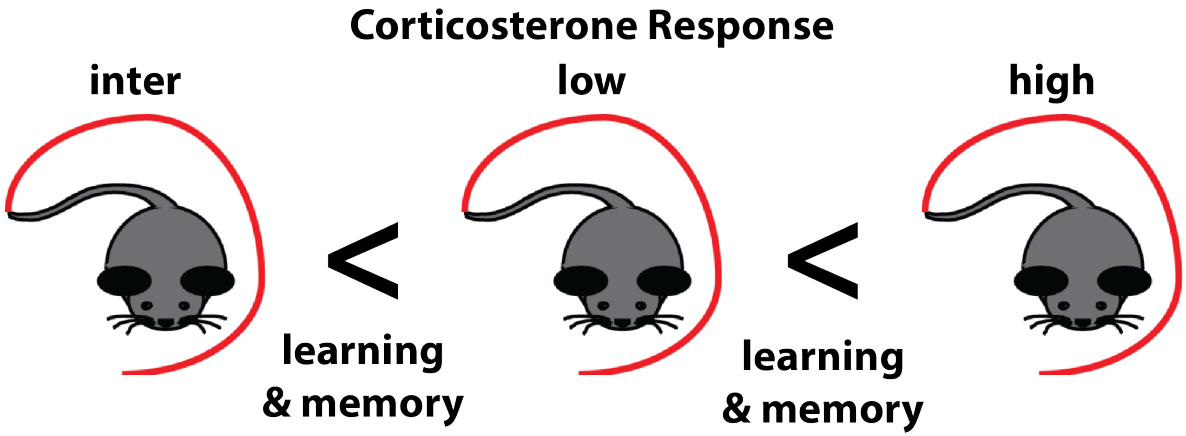

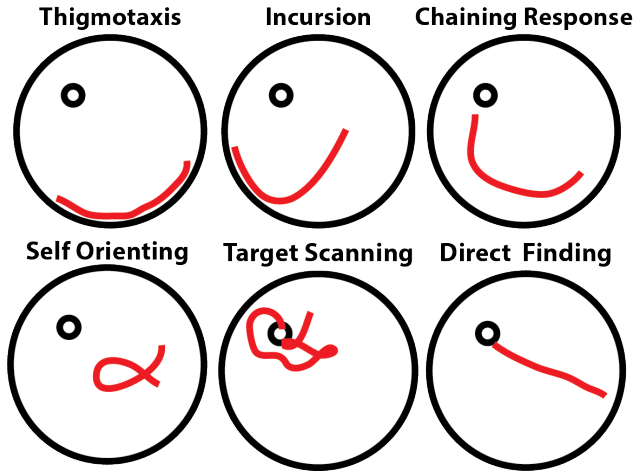

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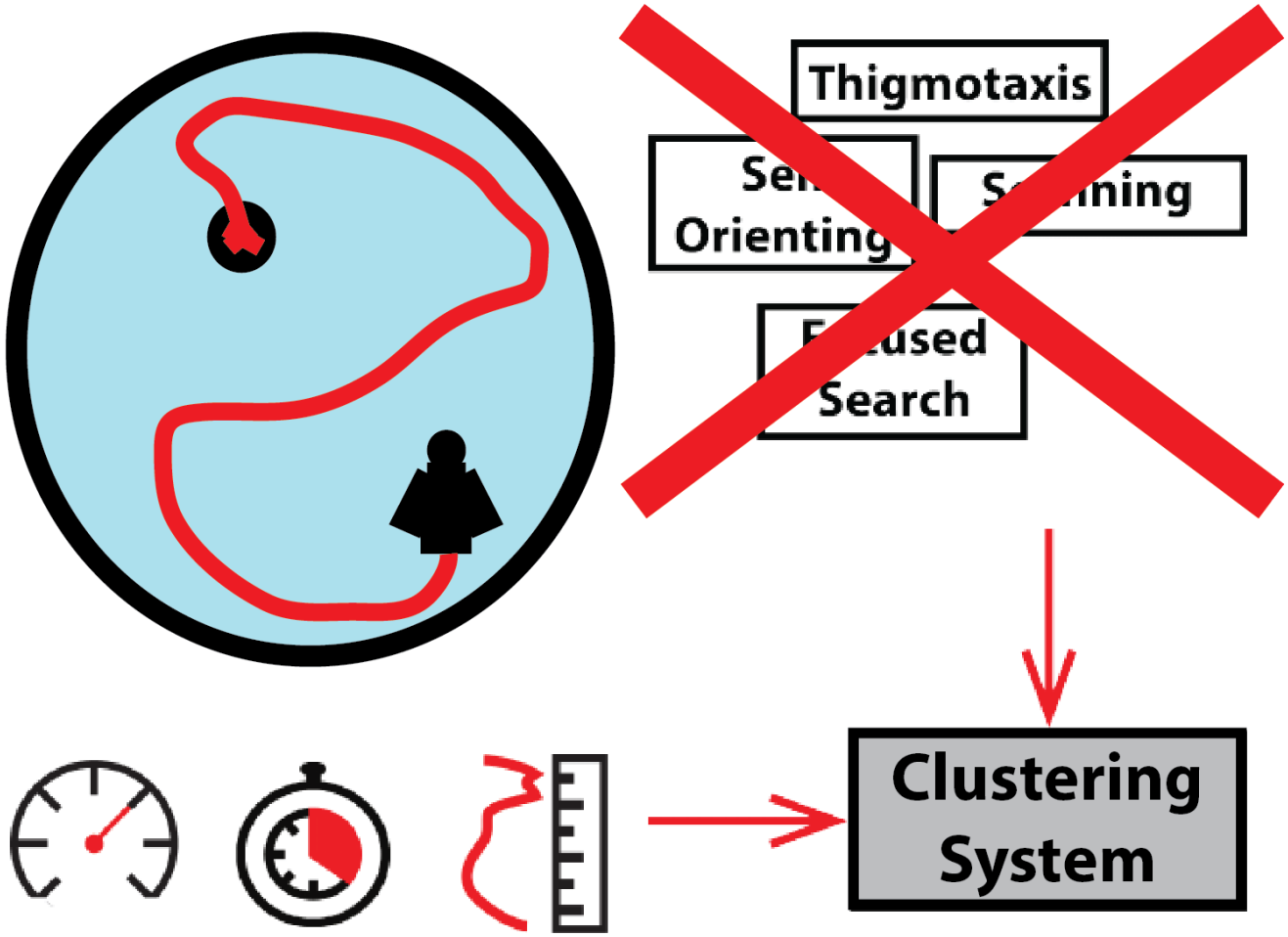
Unsupervised detection of behavioural motifs



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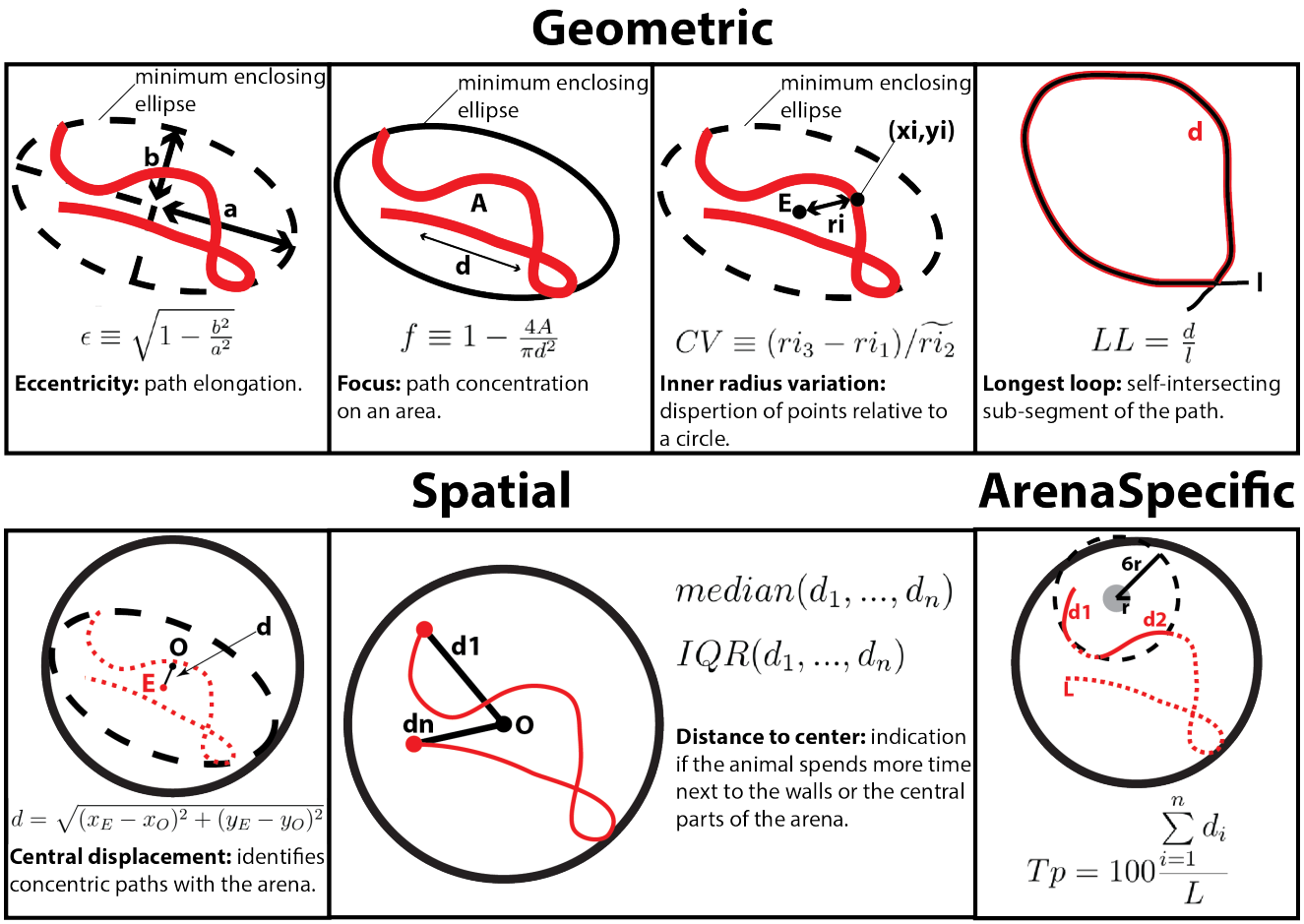

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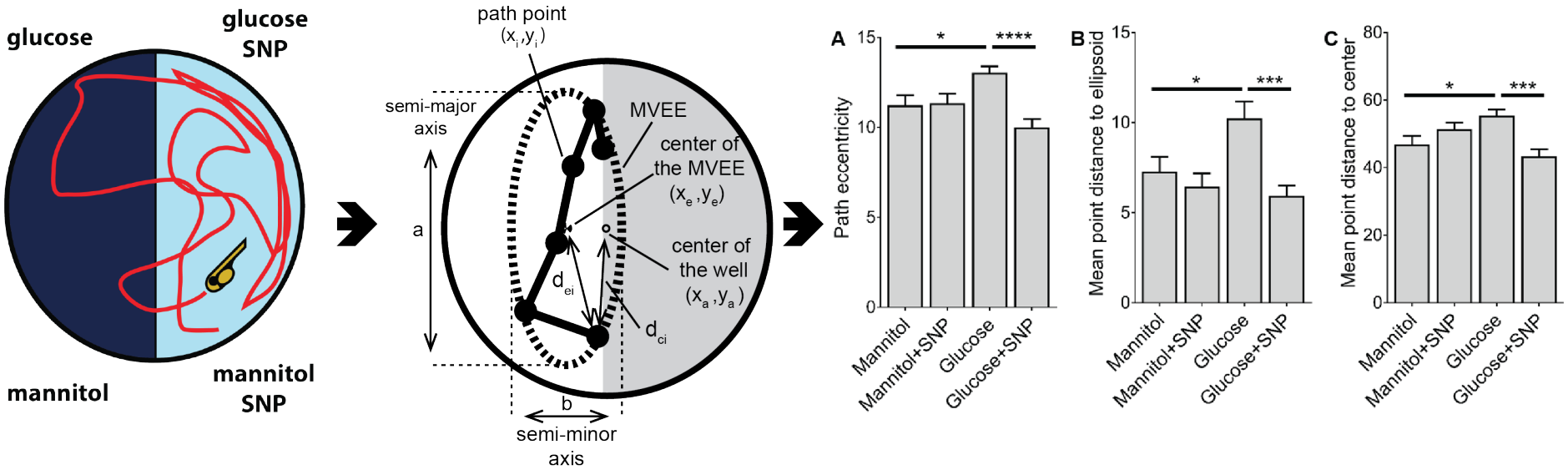

Chhabria, K., Vouros, A., Gray, C., MacDonald, R. B., Jiang, Z., Wilkinson, R. N., ... & Chico, T. (2019). Sodium nitroprusside prevents the detrimental effects of glucose on the neurovascular unit and behaviour in zebrafish. bioRxiv, 576942.
Corrections @ Journal of Physiology.

Unsupervised detection of behavioural motifs

The K-Means Algorithm (Lloyd's)

Advantages:

- Simple and easy to implement.
- Versatile.
- Guaranteed to converge.
- Invariant to data ordering.

Disadvantages:

- Detects only spherical and well-separated clusters.
- Sensitive to noise and outliers (Euclidean).
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In general:

- Non-deterministic.
- Sensitive to initial centroids location.
- Sensitive to features (variables/attributes).

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Current work

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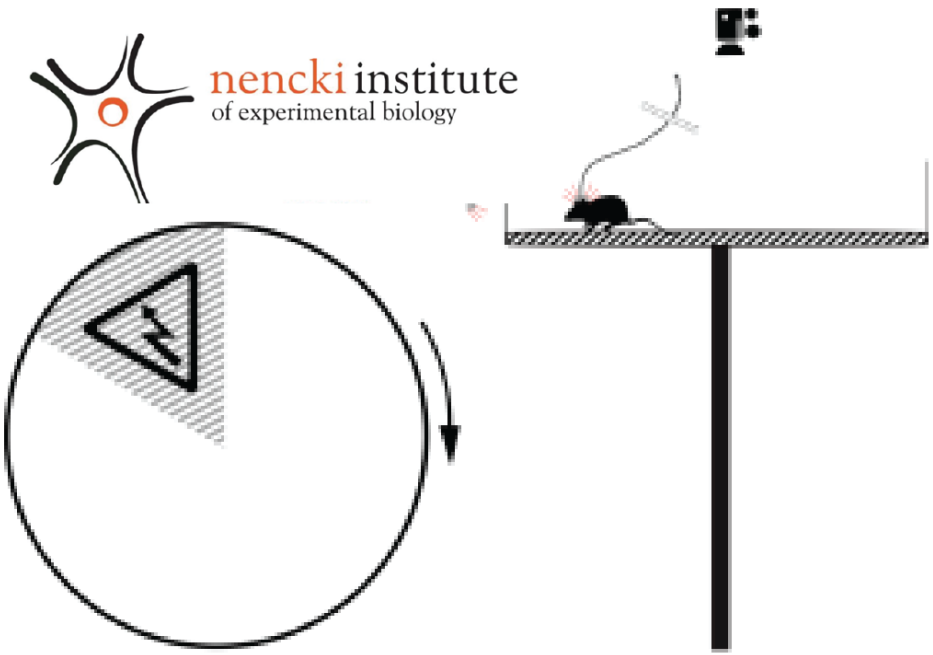
Future research

Active Allothetic Place Avoidance task:
The effects of silver nanoparticles on learning and memory.



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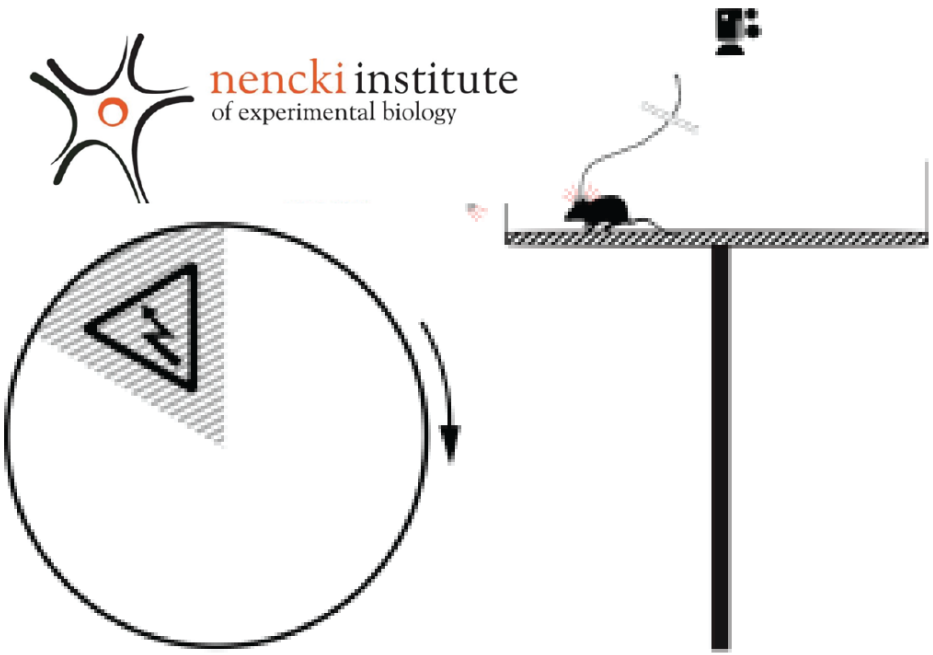

- Detect and categorize animal behavioural motifs.
- Link behavioural motifs to different stages of learning and memory.
- Detect the dominant features of each motif.

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Thank you for your attention!

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