M2 Internship - Multidisciplinary Approaches to Fish Behavior Analysis at the Interface of Biology and Mathematics.

Fish health management/disease surveillance relies on field observations by human observers (WOAH report DOI: 10.20506/woah.3476), which strongly depends on their expertise and ability to recognize specific diseases excluding emergent diseases. Transition to digital aquaculture must provide expert tools for tracking fish and analyse their behaviour to foster disease prevention and control, diagnosis of fish diseases and evaluation of welfare of farmed fish.

Our project aims to develop tracking and AI analysis of label-free rainbow trout for the detection of fish diseases and the improvement of animal welfare. Based on video monitoring, the master student will be in charge of data analyses in collaboration with FBIAS[1] engineers to build long and accurate trajectories for every single fish within a group, without confusing them using AI-based tracking algorithms. In collaboration with INRAE/AgroParisTech, he/she will leverage clustering algorithms for functional/longitudinal data. In particular, state-of-the-art probabilistic methods have recently emerged by leveraging multi-task Gaussian process models for simultaneous modelling, forecasting, and clustering of individual trajectories [1]. The current context of position tracking multiple fish poses new mathematical challenges, as the 2D output dimension (position in the aquarium) continuously evolves over time, and analyses need to be robust to potential errors in the initial visual tracking of individual fish. The student will need to familiarise themselves with the MagmaClustR [2] R package that implements those algorithms, and propose pre-treatments adapted to this context. Further methodological developments could be considered to improve scaling to long-duration sequences and/or online predictions.

In parallel, he/she will analyse data obtained at the level of the group (fish location in the aquarium based on automated detection (YOLO) to check the dynamics of fish accumulation of these zones across time, investigate whether these dynamics can reveal behaviour changes and measure the mean distance to nearest neighbours as an output of social behaviour.

The interdisciplinary consortium will provide an optimal environment to work at the interface between biologist, data analyst and mathematicians. The developed tools (image analyses, statistics) will be of particular interest for applied perspectives in aquaculture withing an active field of research in the scientific community.

Profil : Master's degree/ engineering degree, with a solid background in biology and ethology, advanced data analysis and coding skills in R. Additional knowledge in statistics, especially time series and stochastic processes, is considered as an advantage. The candidate demonstrates reliability, autonomy, motivation, and adaptability, with a rigorous and collaborative approach to work.

References:

[1] Arthur Leroy, Pierre Latouche, Benjamin Guedj, Servane Gey (2023). Cluster-Specific Predictions with Multi-Task Gaussian Processes. Journal of Machine Learning Research.

[2] Arthur Leroy, Pierre Latouche (2025). MagmaClustR: Clustering and Prediction using Multi-Task Gaussian Processes with Common Mean. R package version 1.2.1, https://github.com/ArthurLeroy/MagmaClustR-

[1] https://france-bioimaging.org/service/fbias-open-desk/

To apply, please send a CV and a cover letter to
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