Supervised HSMM to study the behavioral trajectories of wildlife in nature from accelerometer data.

Sandra Plancade, Nicolas Morellet, Nathan Ranc, Nathalie Peyrard

Accelerometers are devices that allow for the high-frequency recording of an animal's movements over long durations and in conditions that are not directly observable, with the goal of inferring its behavior phases (feeding, running, immobility, etc.). In the so-called supervised context, both accelerometer measurements and behavioral sequences are recorded for a portion of the data (training set), with the aim of predicting unknown behavioral sequences from the accelerometer measurements. In this context, classical analysis focuses on the proportion of time spent on each behavior (namely the time budget), ignoring the temporal aspect of the data. However, behavioral trajectories characterized by the durations of behaviors and transitions could potentially provide richer information.
Hidden Markov or Semi-Markov Models (H(S)MM) provide a natural framework for modeling behavioral dynamics from accelerometer measurements. Yet, despite their potential for trajectory analysis, these models are rarely used or are mostly applied as simple smoothing methods in traditional analyses focused on prediction error. The study of trajectories using Markov models is the subject of rare works in HMM (Leos-Barajas, 2017), possibly inhomogeneous (Koslik, 2024). For the analysis of data on roe deer, we developed an approach combining random forest and supervised HSMM for behavioral trajectory inference. In this presentation, we will discuss the various challenges of implementing this approach, both applied and methodological.