

# HIDDEN MARKOV MODELS IN R

There are many packages for HMMs in R, including:

- ▶ depmixS4
- ▶ HiddenMarkov
- ▶ msm
- ▶ MSwM


They all differ in flexibility, amount of documentation, application focus, etc.

We will talk about two packages that focus on movement (and other ecological) data:

- ▶ moveHMM
- ▶ momentuHMM


## 2015 – moveHMM

Small package to analyse animal movement data (step lengths and turning angles)

-  Michelot, Langrock, & Patterson (2016). “moveHMM: an R package for the statistical modelling of animal movement data using hidden Markov models”. *MEE*.

## 2017 – momentuHMM

Much larger package with more modelling options

-  McClintock & Michelot (2018). “momentuHMM: R package for generalized hidden Markov models of animal movement”. *MEE*.

Both packages have vignettes, which are a good place to start.

**moveHMM: an R package for the analysis of animal movement data**

Théo Michelot, Roland Langrock & Toby Patterson

May 13, 2022

**moveHMM workflow: wild haggis analysis**

Théo Michelot

2022-05-13

**A short guide to choosing initial parameter values for the estimation in moveHMM**

Théo Michelot & Roland Langrock

May 13, 2022

**momentuHMM: R package for analysis of telemetry data using generalized multivariate hidden Markov models of animal movement**

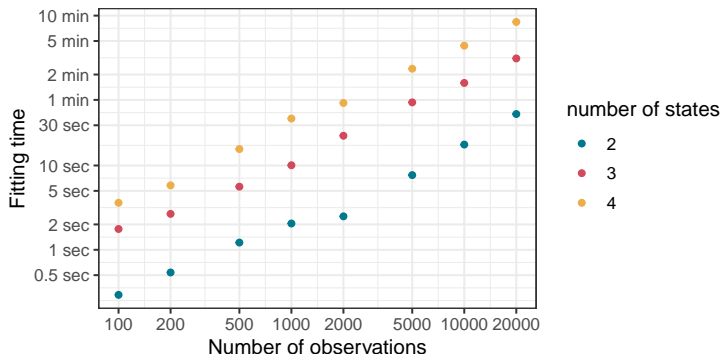
Brett T. McClintock<sup>1</sup> and Théo Michelot<sup>2</sup>

# Computational speed

moveHMM and momentuHMM were written with computational speed in mind.

- ▶ model fitting usually between a few seconds and a few minutes
- ▶ might still be prohibitive for “big data” (millions of observations)

Example runtimes on my laptop:



## **SOME CONCLUSION**

# Things we didn't mention

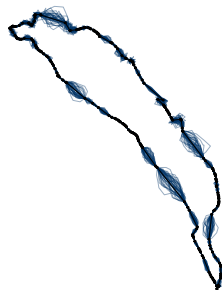
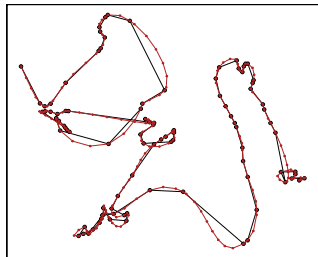
Two key requirements to apply HMMs:

- ▶ no measurement error
- ▶ observations at regular time intervals

When these are not met, there are a couple of options:

- ▶ filter and/or regularise tracks (state-space models<sup>1</sup>)
- ▶ multiple imputation

These options are available through `crawlWrap()` and `MIfitHMM()` in `momentuHMM`.



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<sup>1</sup>e.g., see packages `foieGras` and `crawl` in R

New R package for HMMs, under development: [github.com/TheoMichelot/hmmTMB](https://github.com/TheoMichelot/hmmTMB)

Main new features:

- ▶ random effects
- ▶ non-parametric relationships between parameters and covariates
- ▶ integration with Stan for Bayesian inference

