Petrel movement model

Théo Michelot

April 9, 2025

Analysis of petrel movement data from `https://doi.org/10.5441/001/1.q4gn4q56`.

Observation model

Step length L_t is modelled as

$$L_t \mid \{S_t = j\} \sim \text{gamma}(\mu_j,\ \sigma_j)$$

for $j \in \{1, 2\}$. Observation parameters are shared across individuals.

Priors for observation parameters:

$$\begin{aligned}
\log(\mu_1) &\sim N(\log(2), 0.5^2) \\
\log(\mu_2) &\sim N(\log(10), 0.5^2) \\
\log(\sigma_1) &\sim N(\log(2), 0.5^2) \\
\log(\sigma_2) &\sim N(\log(10), 0.5^2)
\end{aligned}$$

Hidden state model

Transition probabilities for individual $k \in \{1, 2, \dots, 133\}$:

$$\Pr(S_{t+1}^{(k)} = j \mid S_t^{(k)} = i) = \text{inv.logit}(\beta_{ij0} + u_{ij}^{(k)})$$

for $i, j \in \{1, 2\}$, and where the $u_{ij}^{(k)}$ are random effects:

$$u_{ij}^{(k)} \sim N(0,\ 1/\lambda_{ij})$$

Priors for hidden state process parameters:

$$\begin{aligned}
\beta_{120} &\sim N(-2, 0.5^2) \\
\beta_{210} &\sim N(-2, 0.5^2) \\
\log(\lambda_{12}) &\sim N(\log(2), 0.5^2) \\
\log(\lambda_{21}) &\sim N(\log(250), 2^2)
\end{aligned}$$