Moving forward: Advances in modeling and visualizing movement data

OTN 4.8: Data Modelling and Visualization

Kim Whoriskey, Marie Auger-Méthé, Stuart Carson, Duncan Murdoch, and Joanna Mills Flemming
Modelling Marine Animal Tracks with TMB

**first-Difference Correlated Random Walk**

\[ d_t = x_t - x_{t-1} \quad d_t \sim \gamma T d_{t-1} + \mathcal{N}_2(0, \Sigma) \]

\[ T(\theta) = \begin{pmatrix} \cos(\theta) & -\sin(\theta) \\ \sin(\theta) & \cos(\theta) \end{pmatrix} \quad \Sigma = \begin{pmatrix} \sigma^2_{\text{lon}} & \rho \sigma_{\text{lon}} \sigma_{\text{lat}} \\ \rho \sigma_{\text{lon}} \sigma_{\text{lat}} & \sigma^2_{\text{lat}} \end{pmatrix} \]

\[ y_{t,i} = (1 - j_i)x_{t-1} + j_i x_t + \epsilon_t \]
Modelling Individual Marine Animal Tracks

Albertsen et al. 2015

Auger-Méthée et al. 2016

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Estimating discrete behavioural states

Behaviour Equation

\[ b_i = \{0, 1\} \]

\[ b_i \sim \text{Bernoulli}(\alpha_{b_{i-1}}) \]

\[ \gamma_{b_i} = \{\gamma_0, \gamma_1\} \]

Movement Equation

\[ d_i = x_i - x_{i-1} \]

\[ d_i = \gamma_{b_{i-1}} T d_{i-1} + \epsilon_i \]
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SHMMM/SHaMM

Great Lakes Acoustic Telemetry Observation System

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swim

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Estimating continuous behavioural states

**Behaviour Equation**

\[ \gamma_i = \gamma_{i-1} + \nu_i \]

**Movement Equation**

\[ d_i = x_i - x_{i-1} \]

\[ d_i = \gamma_i \frac{\Delta t_i}{\Delta t_{i-1}} (d_{i-1}) + \epsilon_i \]
Estimating continuous behavioural states
Estimating grey seal space use - INLA

Gaussian Random Field

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Estimating grey seal space use over time - INLA

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Relating grey seal space use to prey distribution

Cod Abundance

Bottom Time

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Visualizing aquatic telemetry data

rgl is ...

- an R package (Adler and Murdoch 2015)
- a link between R and WebGL (JavaScript API)

We use rgl to ...

- visualize groups of movement patterns
- visualize animals moving through time
- visualize animals moving in 3D

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Other visualization tools:

- Co-op students (Alex Nunes)
- OTN Trackathon

OTN Workshop:

- Thursday (tomorrow)
- 8:30 AM - NOON
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Thank you

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