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Exploring the use of INLA in Modelling Animal Movement

Many models of animal movement fail to represent dynamic contextual information (such as spatiotemporal rasters of environmental variables) at the same fine temporal resolution as telemetry data, creating a mismatch between scales of behavioural and environmental information. However, representing large amounts of spatiotemporal data incurs a significant computational cost. Integrated Nested Laplace Approximation (INLA) methodology may provide a base framework for creating complex, context-aware models of animal movement in a computationally efficient way.

INLA is a method for fast, approximate Bayesian inference which can be used to fit a range of spatial and spatiotemporal models. The Bayesian nature of the method allows for the inclusion of prior knowledge, creating informed models for specialist systems, as well as emphasising uncertainty in inference and predictions; a vital feature for informing conservation and management strategies. In the R software packages associated with this method, INLA and inlabru, spatiotemporal data can be modelled as a function of environmental variables as well as other fixed and random effects in an additive linear predictor. Gaussian Markov Random Fields (GMRFs) are used to account for spatiotemporal correlation structures in a computationally efficient way – a feature vital to the handling of highly correlated telemetry data. The R package inlabru was developed with realistically complex ecological data structures and observation processes in mind, so may provide a suitable framework to model complicated animal movement data.

Here, I reconstruct the likelihoods of common movement modelling approaches within INLA, to assess the feasibility and benefits of using this method for movement modelling. I explore the use of continuous and discrete-time methods in 1 and 2 dimensions.

INLA presents an established framework for context-aware, spatiotemporal modelling that can easily be built up through joint modelling structures into a multi-level hierarchical model. Here, I aim to investigate whether the use of the INLA method provides an efficient framework for movement modelling as a basis for creating more complex movement models with improved predictive abilities.