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Kálmán filters for continuous-time movement models

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Abstract

We introduce fast implementations for the likelihood functions, telemetry error filters, probabilistic trajectory and velocity reconstructions, and movement-path simulations for a large class of continuous-time movement models. This class of models includes all of the basic continuous-time models that have been applied to animal movement. A diverse array of movement behaviors can be modeled from within this framework, including range residence, persistence of motion, migration, range shifting, and territorial patrol. The fast algorithms presented here, based upon the Kálmán filter, are critical for applying movement analyses to the evergrowing number of modern datasets that feature thousands or more observed animal locations, and they are key to the continuous-time movement modeling (ctmm) R package.

Keywords: animal tracking, conditional simulation, Kálmán filter, Kálmán smoother, Kriging, maximum likelihood.

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