Animal migration modelling: an analytical description of the two-dimensional time-integrated Brownian bridge

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Abstract: Both monitoring and modelling help to gain insight into the dynamics of animal migration. The delineation of important regions for the studied species is one possible goal of a monitoring campaign. This can be achieved by determining the probability distribution function (PDF) or the probability density that an animal is located at a certain location at an arbitrary point in time. In order to account for the relative amounts of time the animal has spent in various regions and for the chronological order of the data points, continuous trajectories should be used instead of discrete measured locations. The construction of such trajectories can be achieved by assuming random movement between the data points. The process of random movement restricted by a starting and ending location is called a Brownian bridge (BB) and is used in the Brownian Bridge Movement Model [1, 2]. More specifically, the latter constructs the PDFs of the BBs at several time instances between every two consecutive observations. The resulting PDFs are then integrated over time in order to determine the PDF of the time-integrated BB. This PDF describes the probability density that an animal is located at a certain location at an arbitrary time instant in the considered time interval and thus delineates important regions. To the best of our knowledge, the integral is always computed numerically. Therefore, an analytical description is derived since this would be more accurate and speed up the calculations.

References

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