Stochastic resetting with limited information

Verónica Sanz-Arque[1], Francisco Javier Cao-García[1,2]

[1]Universidad Complutense De Madrid, Madrid, Spain, [2]IMDEA Nanoscience, Madrid, Spain

Stochastic resetting refers to the random reinitialization of the position of a random movement, and to the overall resulting kinematics [1,2]. The typical case is a Brownian motion that is instantly reinitialized to the starting position at exponentially distributed time rates, given by a resetting rate. Several variations such as finite-time resetting [3], partial resetting [4] and random amplitude resetting have been studied [5]. However, generally these studies assume that the position is precisely known.

Here, we address the case where position precision is finite, and therefore the position information is limited. We choose for our computations a discrete realization. We consider a jump process over a lattice with an exponential stochastic resetting. But where the position information for resetting is only known at a coarse-grained level. The problem is addressed from a probability density and an agent-based perspective. The latter allows us to study the sequences of resetting actions and its correlations.

We have found the different scaling of several characteristic magnitudes with the spatial position precision. These magnitudes include the gathered information, the entropy reduction by information, the entropy change at resetting, the entropy of the sequence of resetting actions, and the conditional probabilities between resetting actions, all of them as a function of the resetting rate to jump rate ratio. Analytical results for the scaling are found in the slow and fast resetting limits.

These results provide a relevant insight into real world applications of stochastic resetting, where the position precision is finite.

References:

[1] M. R. Evans, S. N. Majumdar, and G. Schehr, Stochastic Resetting and Applications, J. Phys. A Math. Theor. 53, (2020). https://doi.org/10.1088/1751-8121/ab7cfe

[2] S. Gupta and A. M. Jayannavar, Stochastic Resetting: A (Very) Brief Review, Front. Phys. 10, 1 (2022). https://doi.org/10.3389/fphy.2022.789097

[3] D. Gupta, A. Pal, and A. Kundu, Resetting with Stochastic Return through Linear Confining Potential, J. Stat. Mech. Theory Exp. 2021, (2021). https://doi.org/10.1088/1742-5468/abefdf

[4] O. Tal-Friedman, Y. Roichman, and S. Reuveni, Diffusion with Partial Resetting, Phys. Rev. E 106, (2022). https://doi.org/10.1103/PhysRevE.106.054116

[5] M. Dahlenburg, A. V. Chechkin, R. Schumer, and R. Metzler, Stochastic Resetting by a Random Amplitude, Phys. Rev. E 103, (2021). https://doi.org/10.1103/PhysRevE.103.052123