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Analysis of single particle diffusion with transient binding using particle filtering. (English)

Zbl 1343.92143
J. Theor. Biol. 401, 109-121 (2016).

Summary: Diffusion with transient binding occurs in a variety of biophysical processes, including movement of transmembrane proteins, T cell adhesion, and caging in colloidal fluids. We model diffusion with transient binding as a Brownian particle undergoing Markovian switching between free diffusion when unbound and diffusion in a quadratic potential centered around a binding site when bound. Assuming the binding site is the last position of the particle in the unbound state and Gaussian observational error obscures the true position of the particle, we use particle filtering to predict when the particle is bound and to locate the binding sites. Maximum likelihood estimators of diffusion coefficients, state transition probabilities, and the spring constant in the bound state are computed with a stochastic expectation-maximization (EM) algorithm.

MSC:

92C40 Biochemistry, molecular biology
92C05 Biophysics
60J70 Applications of Brownian motions and diffusion theory (population genetics, absorption problems, etc.)

Keywords:

switching model; particle tracking; particle filter

Software:

astsa

Full Text: DOI

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