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Inferring collective dynamics in groups of social mice

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Social interactions are a crucial aspect of behavior in human society and many animal species. Nonetheless, it is often difficult to distinguish the effect of interactions from independent animal behavior (e.g. non-Markovian dynamics, response to environmental cues, etc.). I will address this question in social mice, where we infer statistical physics models for the collective dynamics for groups of mice, housed and location-tracked over multiple days in a controlled yet ecologically-relevant environment. We reproduce the distribution for the co-localization patterns using pairwise maximum entropy models. The inferred interaction strength is biologically meaningful, and can be used to characterize sociability for different mice strains. Moreover, these models can distinguish the effect of change of prefrontal cortex plasticity due to social-impairment drugs, and useful to study autism in the mice model. The equilibrium dynamics on the resulting model can successfully predict the transition rates, but not the waiting time distribution. Inspired by the observed long-tailed waiting time distributions in the mice, we have developed a novel inference method that can tune the dynamics while keeping the steady state distribution fixed. Constructed through a non-Markovian fluctuation-dissipation theorem, this new inference method, termed the "generalized Glauber dynamics", addresses an important question in statistical inference, for which I will derive the expression, demonstrate its power, and show how to infer the model using examples of Ising and Potts spins. Finally, we will apply the generalized Glauber dynamics to the social mice data, and show how memory is important in collective animal behavior.

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