Introduction

Why stochastic transitions?

Probabilistic models of cognition (see e.g. [1])
- Enable stochastic simulations, such as tracking noisy movements of objects [2] or reasoning with uncertainty about sequences of events [3].
- Allow for statistical inference using MCMC methods.
- Model observed processes in birdsong etc. [4]

In a Markov chain, the future depends only on the present; this captures many natural applications.

Why attractor networks?

- A Hopfield network [5] is a fully connected network of \( N \) neurons with update rule:
  \[
  x_i \leftarrow \text{sign} \left( \sum_{j=1}^{n} J_{ij} x_j \right)
  \]
- For appropriate \( J_{ij} \), the network state will fall into one of several chosen attractor states, robust to noise.
- Attractor states are a common model for memories.

How to go from deterministic to stochastic?

Network design

Structure of the network

Mixed state \( x^Q \)

Memory state \( x^M \)

Noise state \( x^N \)

Structure of noise states

Stochastic transitions

Deterministic transitions

Acknowledgments

We would like to thank the Center for Brains, Minds, and Machines and the Marine Biological Laboratory at Woods Hole for their support during this research. D.R. is additionally supported by NSF grant no. 1122374.

References