Supplemental Methods

This supplemental section provides methodological details, including generative model specifications, mathematical derivations, and implementation algorithms.

Generative Model Specifications

Matrix A: Observation Likelihoods

The observation likelihood matrix defines the probabilistic mapping from hidden states to observations:

$$A = \begin{pmatrix} P(o_1 \mid s_1) & P(o_1 \mid s_2) & \cdots & P(o_1 \mid s_n) \\ P(o_2 \mid s_1) & P(o_2 \mid s_2) & \cdots & P(o_2 \mid s_n) \\ \vdots & \vdots & \ddots & \vdots \\ P(o_m \mid s_1) & P(o_m \mid s_2) & \cdots & P(o_m \mid s_n) \end{pmatrix}$$

Normalization: Each column sums to 1, representing a valid probability distribution over observations for each state.
Interpretation: - Rows correspond to observation modalities - Columns correspond to hidden state conditions - Entry (A[i,j]) represents the probability of observing (o_i) given state (s_j)