

Switching Linear Dynamics for Variational Bayes Filtering

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Overview

Problem

System identification of physical simulations.

Contributions

Learning of meaningful latent space including linear encoding of unobserved velocities and interactions.

Improved simulation accuracy due to proposed inference structure.

Highlighting of existing problems with the Concrete relaxation and susceptibility to time discretization.

Model

Recurrent hierarchical VAE transitioned by switching linear dynamics.

Approximate Bayesian inference via stochastic gradient variational Bayes.

observations

$$x_{1:T} \in \mathbb{R}^{T \times n_x}$$

controls

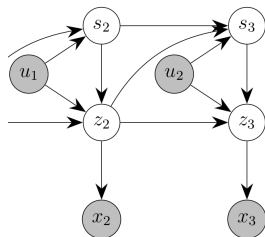
$$u_{1:T} \in \mathbb{R}^{T \times n_u}$$

latent variables

$$z_{1:T} \in \mathbb{R}^{T \times n_z}$$

switching variables

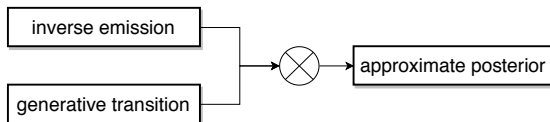
$$s_{2:T} \in \mathbb{R}^{T \times n_s}$$



Inference Model

Split into two components which allows reuse of generative transition.

Enables the reconstruction error to be backpropagated through the transition.



Multi-agent Maze Experiment

- ▶ Learned on observed (x,y) -coordinates of agents.
- ▶ Extraction of linear encoding of velocities.
- ▶ Encoding of interaction with walls.

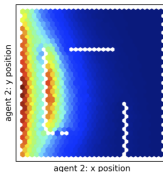
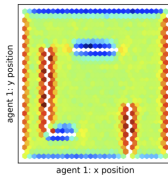
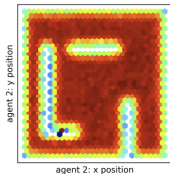
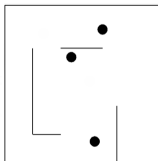
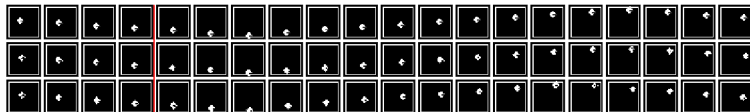


Image Bouncing Ball in a Box Experiment



Time Discretization

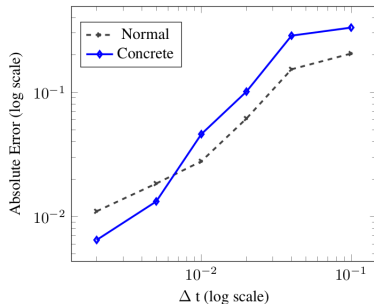


Figure: Modelling switching variables as Concrete random variables scales less favourably with increasing time discretization intervals.

Summary

Stochastic treatment of variables whose exclusive role is determining the transition is vital for feature extraction.

Those features lead to improved simulation accuracy.

Predefined time discretization can be crucial for a model's performance, especially for rigidly chosen locally linear transitions.