

# The Impact of Negative Sampling on Contrastive Structured World Models

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## BACKGROUND:

The Contrastive Structured World Model (C-SWM, Kipf et al.) can model the dynamics of environments that are

- deterministic,
- fully-observable, and
- decompose into several objects.

In order to minimize C-SWM's contrastive loss, the learned encoding of the current state should be predictive of the encoding of the next state. At the same time, the encoding of the current (**positive**) state should be sufficiently different from some other (**negative**) state.

## METHODS

We experiment with three negative sampling strategies:

**Baseline negatives:** permute positive example in a mini-batch to create negative examples.

**Time-aligned negatives:** a negative example is sampled from a different episode but the same timestep as the positive example.

**Episodic and out-of-episode negatives:** mix negative example from the same and different episodes as positive counterparts with a ratio  $\beta$ .

## RESULTS

**#1:** Time-aligned negatives can double C-SWM's 10 step prediction score (main panel) and perform similarly to a recent improvement on C-SWM (right panel, 3rd and 4th row).

**#2:** Mixing of in- and out-of-episode negatives can both help and hurt depending on how we evaluate the model (right panel, 1st and 2nd row).

# Carefully chosen negative examples in the Contrastive Structured World Model greatly improve predictions.

