neuromatch

Comparing Trained Models on Motor Control Tasks

Joyful Catmint

Neuromatch Workshop in the NeuroAI course,
Slot 4, Pod: Joyful Catmint, Megapod: Aspen
Project TA: Paolo Muratore, Course TA: Pravish Sainath

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Introduction

Backgrounds		Research Questions
Generalization (W1D1)	→	What makes a neural net generalize?
Comparing Tasks (W1D2)	→	How to compare different models trained in different environments with different perturbations?
Latent Dynamics (W1D3)	→	What happens as we progress from simple to more physiologically constrained models?

Here we look at Motor Control

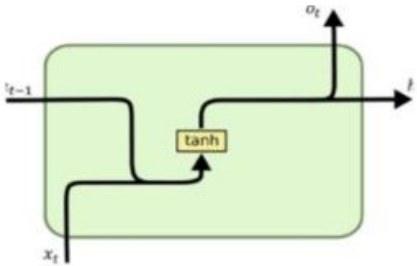
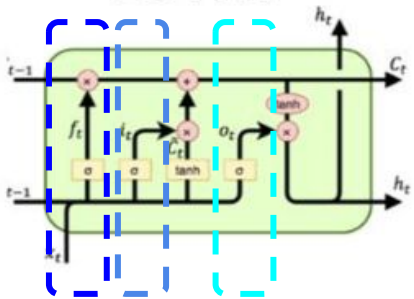
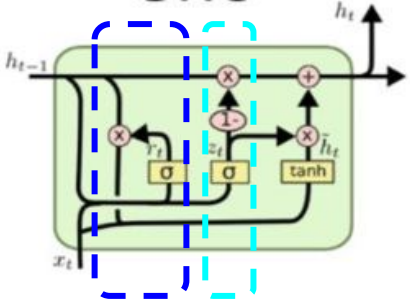
Our Goals - Testing Model Generalizability and Interpretability

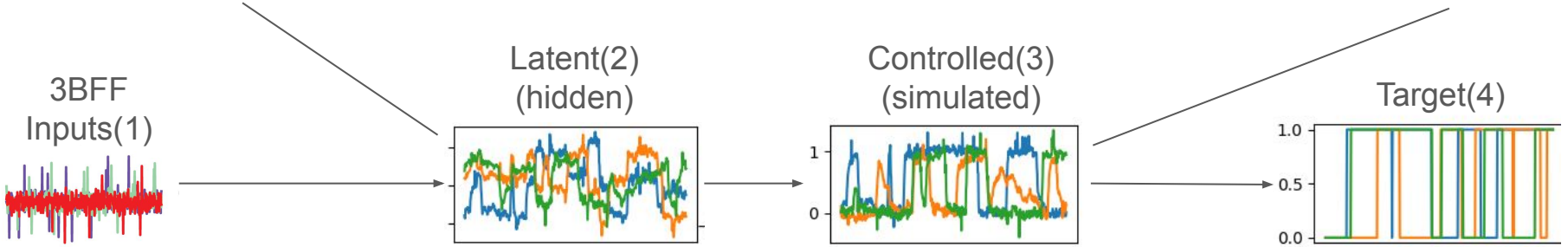
Computation-Through-Dynamics Benchmark*

Task-trained Models	Task Envs	Analysis
NODE, LSTM, GRU	3BFF vs Random Task Non-noisy vs Noisy environment	Train and validation Latent Dynamics

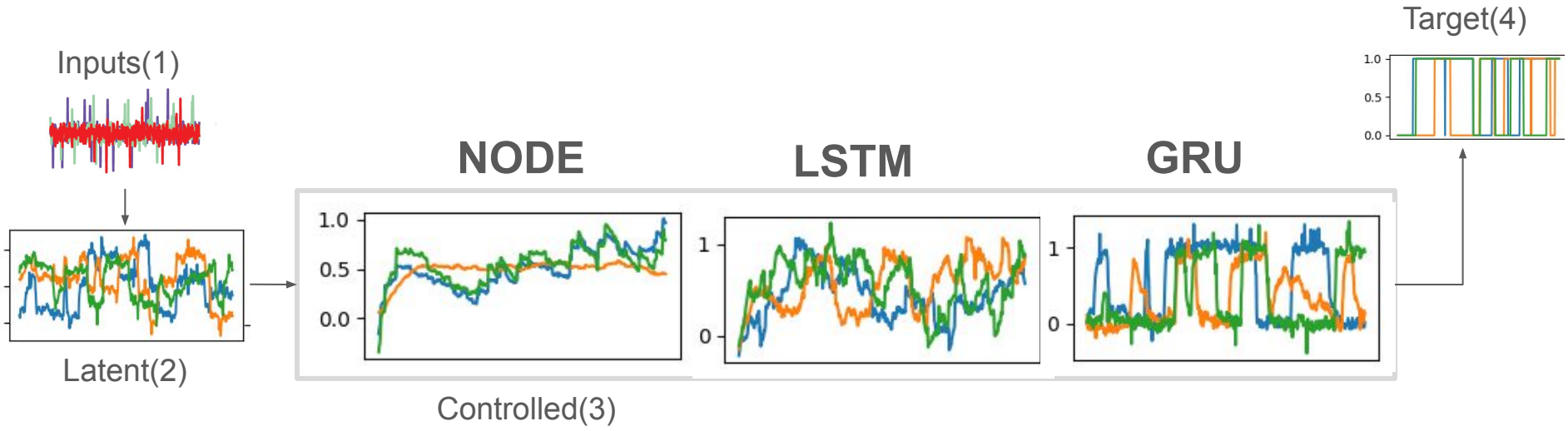
*https://snel.ai/resources/ctdbench/

Result 1 - How different models learn a task?

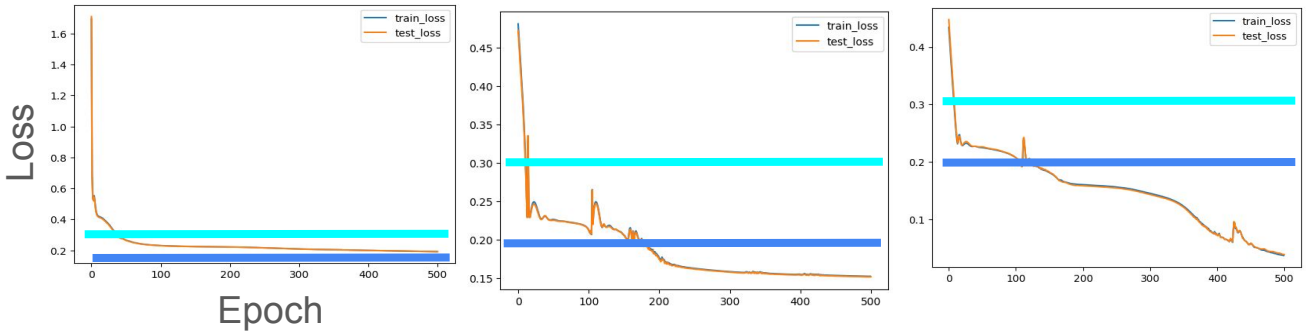
	NODE	LSTM	GRU
			
Trainable Params	4.8k	68.7k	51.6k



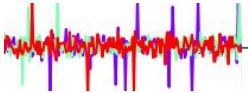
Result 1 - How different models learn a task?



500 epochs



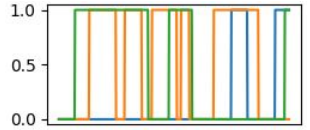
Result 2 - Effect of noise on generalization



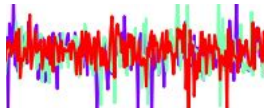
noise= 0.15 (default)

NODE LSTM GRU

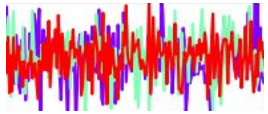
Target(4)



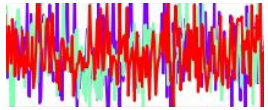
Inputs(1)



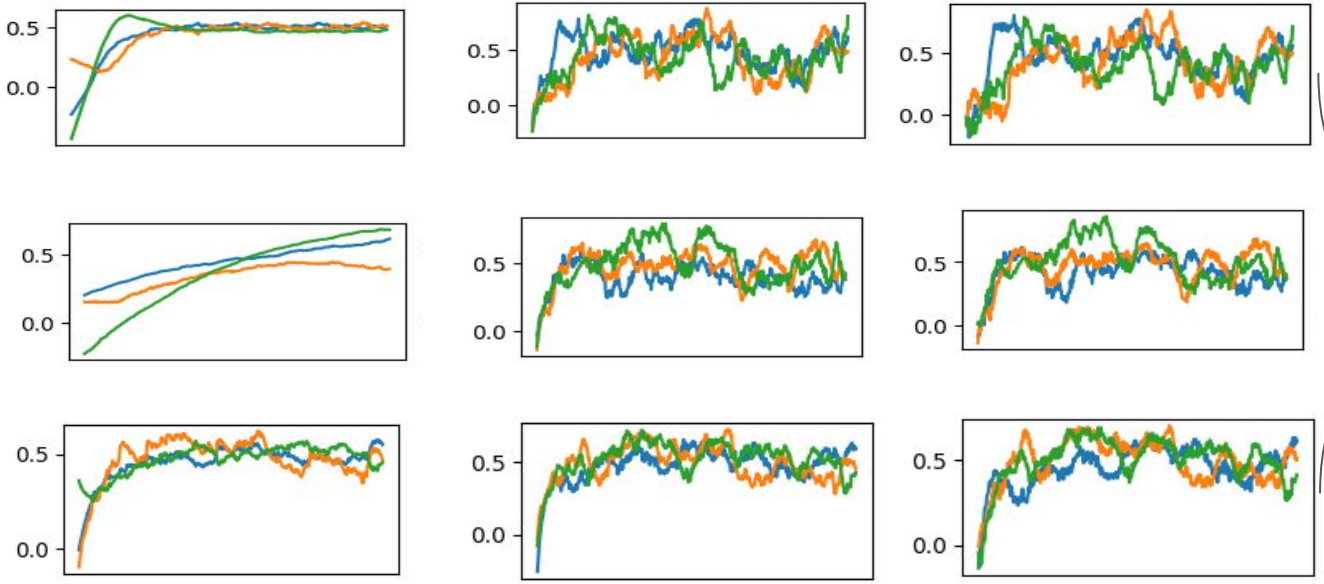
noise= 0.3



noise= 0.45



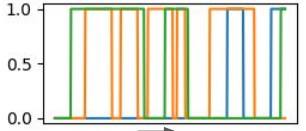
noise= 0.6

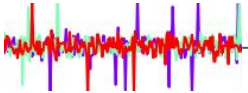


CONTROLLED (3)

250 epochs

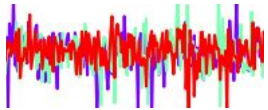
Models- Effect of noise on Loss Graphs



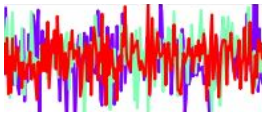


noise= 0.15 (default)

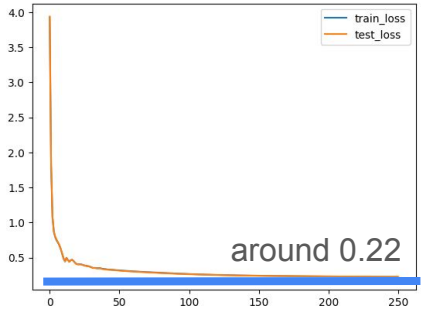
NODE **LSTM** **GRU**

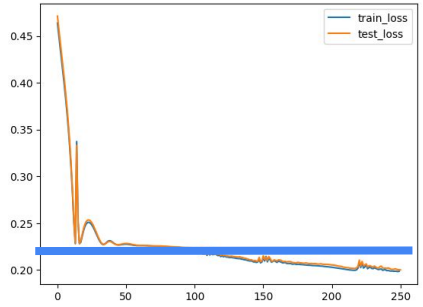


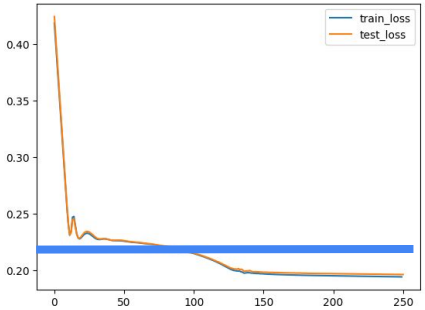
noise= 0.3

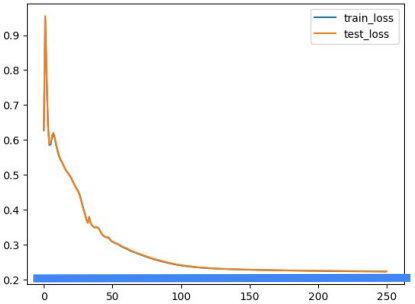


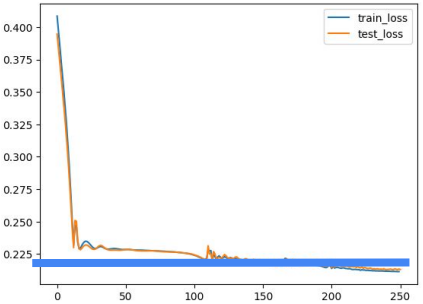
noise= 0.45

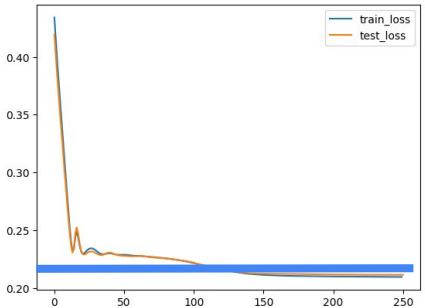






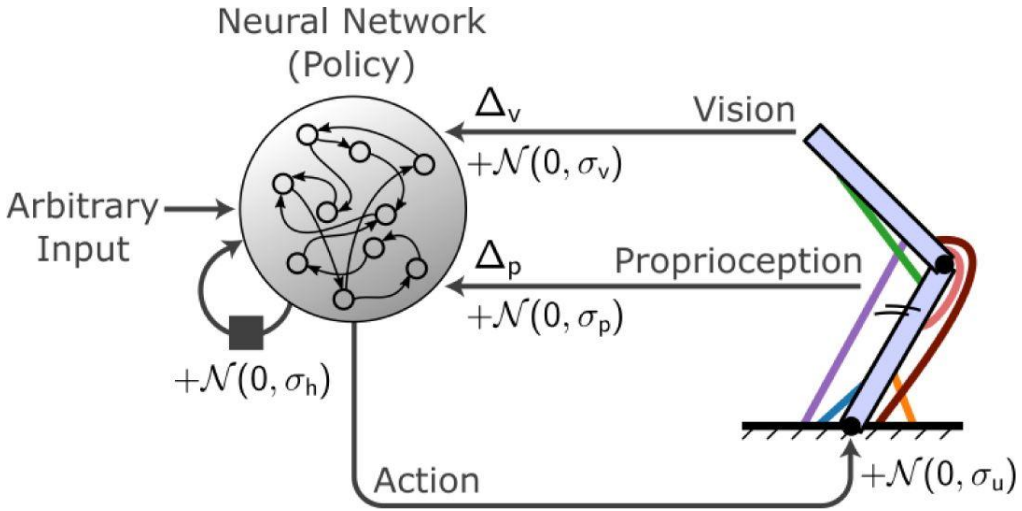






250 epochs

Result 3 - Physiologically constrained environment



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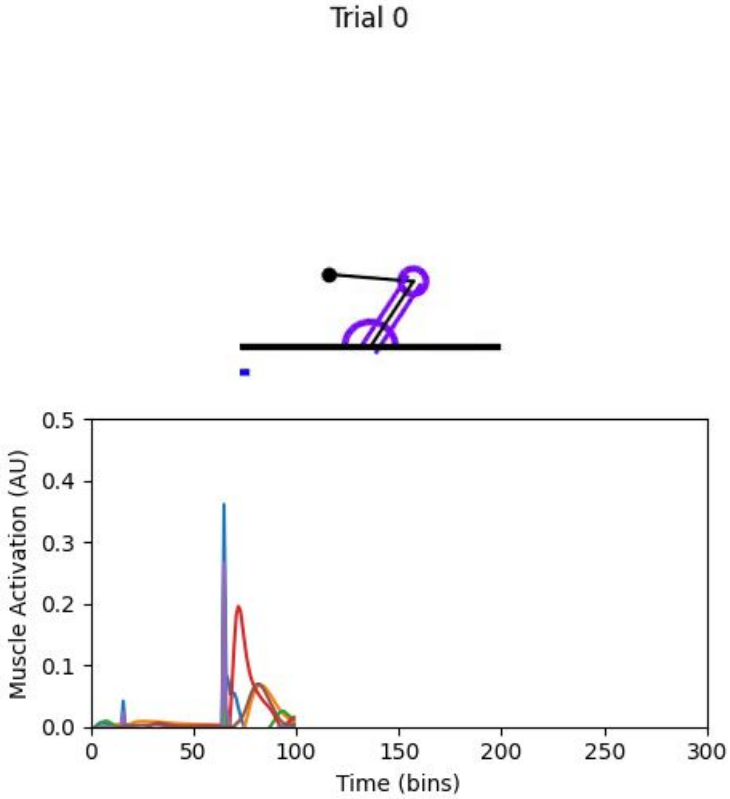
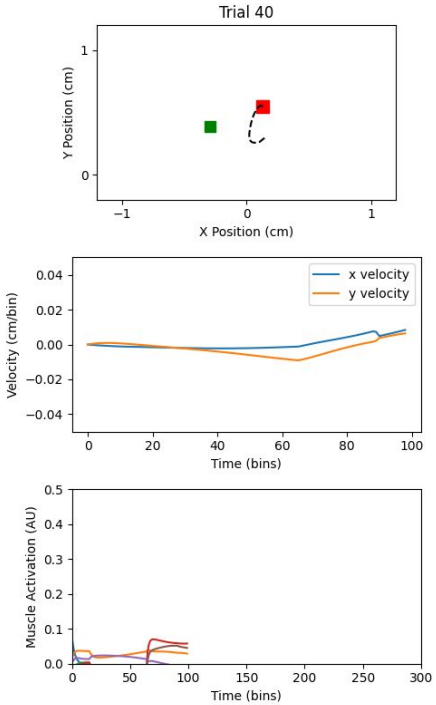
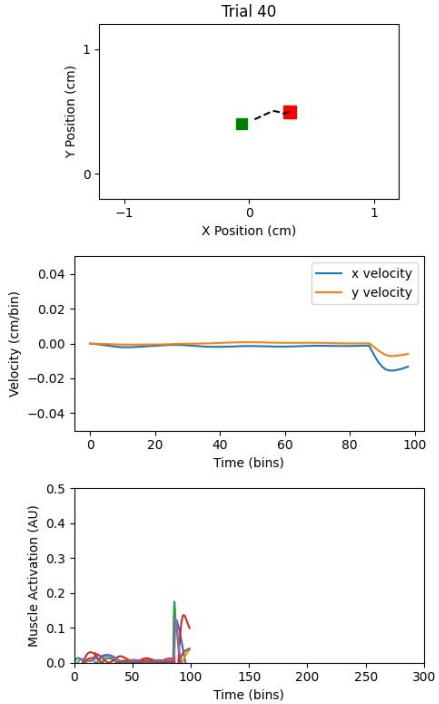


Result 3 - Physiologically constrained environment

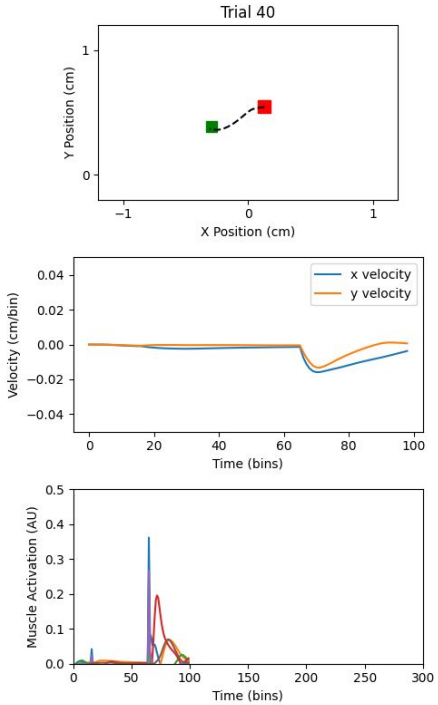
20 epochs



250 epochs



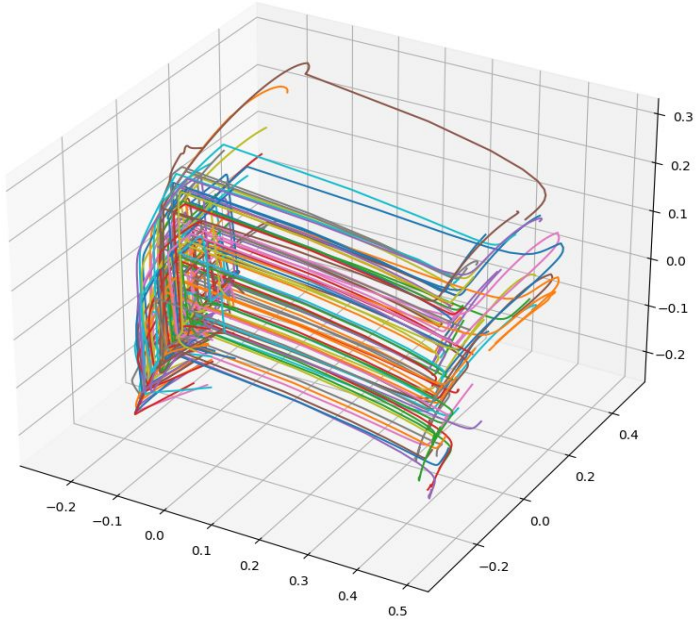
500 epochs



Result 3 - Physiologically constrained environment

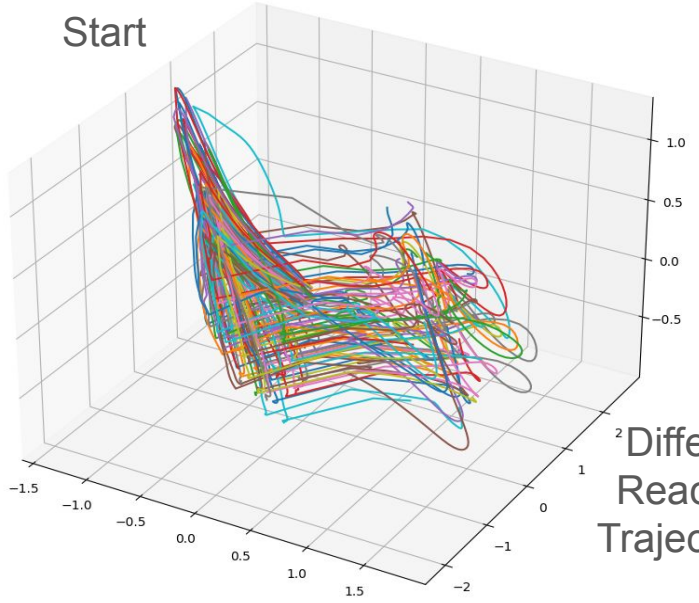
Task-Trained Latent Dynamics

1 epoch



500 epochs

Start



Different Reaching Trajectories

Conclusion

Simple models internal dynamics correlate with output, but physiologically constrained models show interesting latent representations.

A GRU model is easy to physiologically interpret. However, NODE and LSTM models are robust to noises while maintaining similar performance.

Also, noises disrupt interpretability of models in general.

Still an area of research!

Q?