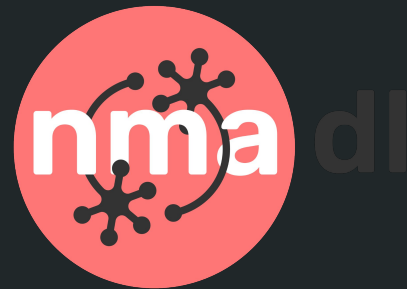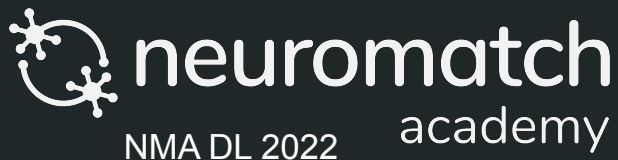# Neural Activity and Behavior Prediction using RNN

By: Amirreza Farbakhsh, Amirreza Bahramani, Keyvan Ghasemi, Narjes Soltani, Amir Khani, Ali Shamsnia

Cepelinai / LiveWired

neuromatch
academy

NMA DL 2022

# Who we are?

Sushrut Thorat

Mina Rezaei

Yara Bahram

Amirreza Farbakhsh

Amirreza Bahramani

Keyvan Ghasemi

Narjes

Amir Khani

ALi SHamsnia
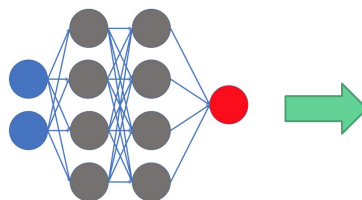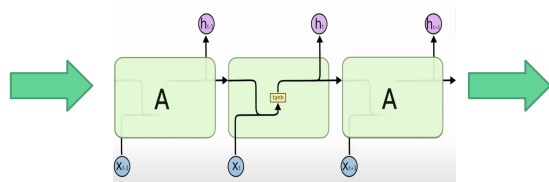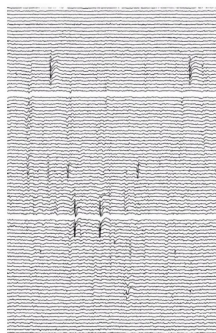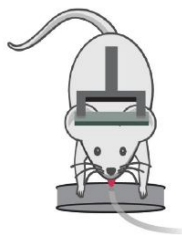
Introduction

- **Low dimensional latent representation → Making sense of data**
- **What we did?**
  - **Seq-to-seq RNN model to predict neural activity**
  - **Get latent states**
    - **Verify latents are actually relevant!**
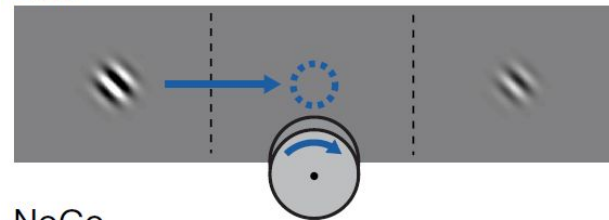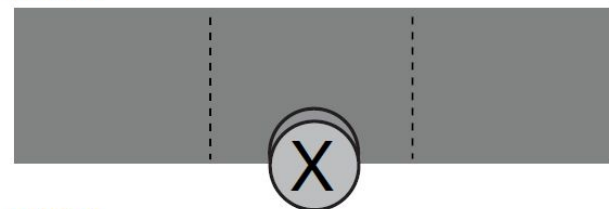   - **Analyze the latents**

Introduction
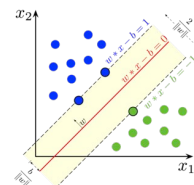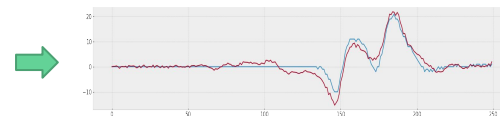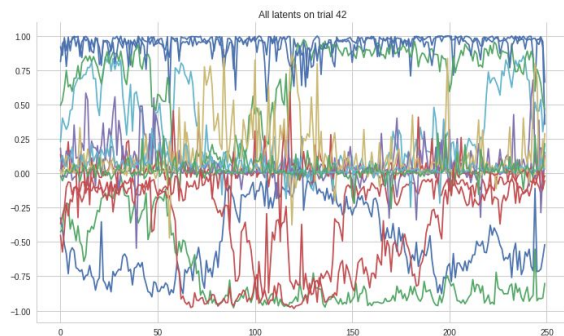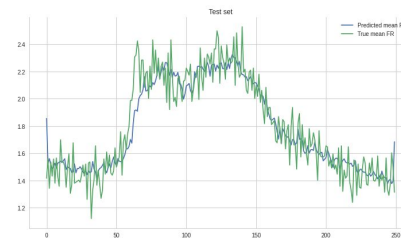
Steinmetz *et al* dataset

- **Recorded with Neuropixel**
- **29134 neurons across 39 sessions in 10 mice**
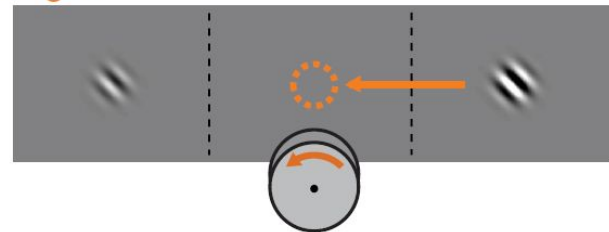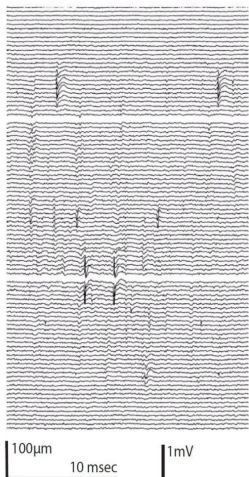
Steinmetz, N. A., Zatka-Haas, P., Carandini, M. & Harris, K. D. Distributed coding of choice, action and engagement across the mouse brain. *Nature* **576**, 266–273 (2019).

Left

NoGo

Right

Neural activity prediction

Recorded Neural activity
except for
Secondary Motor Cortex

Neural Network
seq-to-seq

Predicted Neural activity
Secondary Motor Cortex

Train data
80% trials
random
(189)

RNN

Linear

Test data
20% trials
random
(48)

Average activity
neurons/trial

100μm
10 msec
1mV

15 neurons
Bidirectional

15 inputs
281 outputs

696 neurons
237 trials
250 time bin
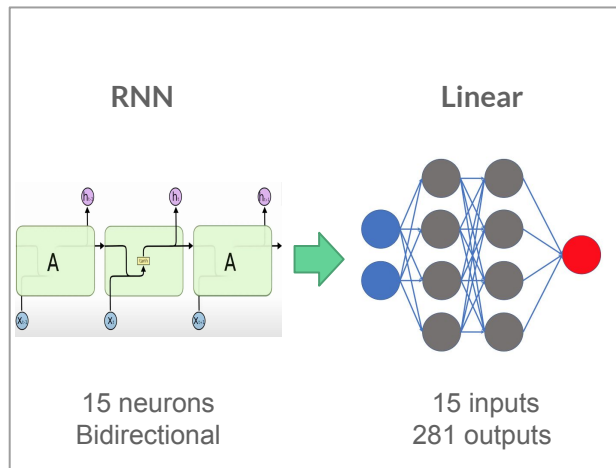
**Poisson log-likelihood loss
Adam, 0.005 lr optimizer
1000 iterations**

Training set
Predicted mean FR
True mean FR
Cost:0.071

Test set
Predicted mean FR
True mean FR
Cost:0.074

281 neurons
237 trials

Mouse decision prediction (SVM)

- **Kernel:** RBF

- **Total accuracy:** 96.6%

Rotation	Precision		Recall		F1-score		Support	
	Train	Test	Train	Test	Train	Test	Train	Test
Left	93%	100%	100%	93%	96%	97%	53%	15%
No-Go	98%	93%	100%	100%	99%	96%	49%	13%
Right	100%	90%	90%	90%	95%	90%	49%	10%

The timing of movement information flow

- **SVM on latents in 250 time bins**
- **Increase in flow of movement information after around 80 bins (300 ms after visual stimulus)**
- **Before the stimulus the accuracy of the model is higher than chance level**
- **Failed MLP model**

Result 5
Other methods (LFADS)

Result 1
Predicting Neural Activity

1

5

2

Conclusion

Result 2
Dimensionality Reduction on Big
Datasets.

Result 4
Inferring Emergent Activities
(Dynamics)

4

3

Result 3
The Flow of Information and
Causality
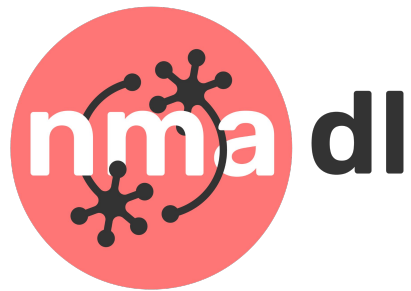
THANK YOU
FOR YOUR
CONSIDERATION

nma dl

GitHub