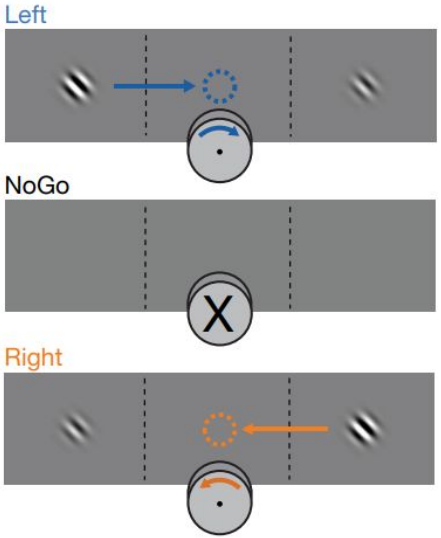
Inside of a Mouse's Brain

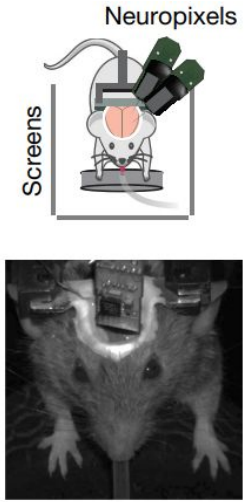
Reducing Dimensions of Neural Recordings using Seq-to-Seq Modeling

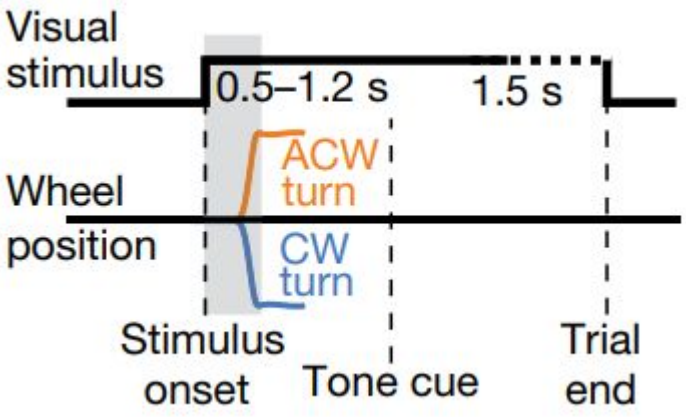
Dimensional Data Diggers

The experiment set-up

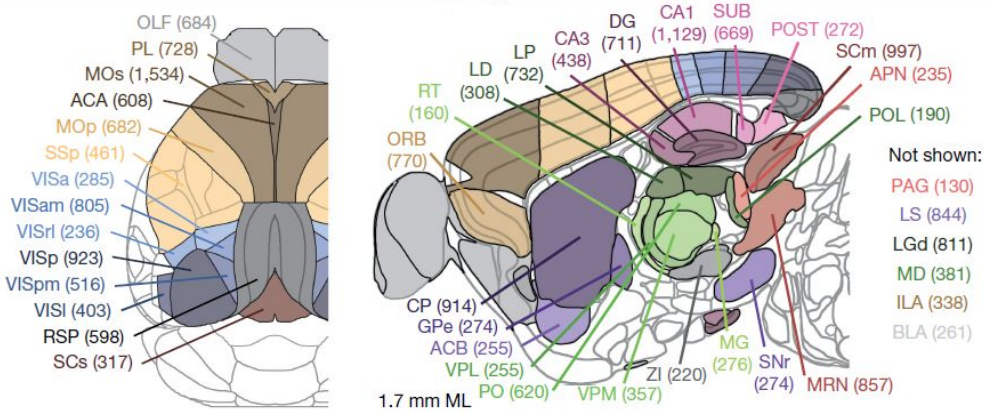
Neuropixels probes recorded approximately 30,000 neurons in 42 brain regions while performing a visual discrimination task.

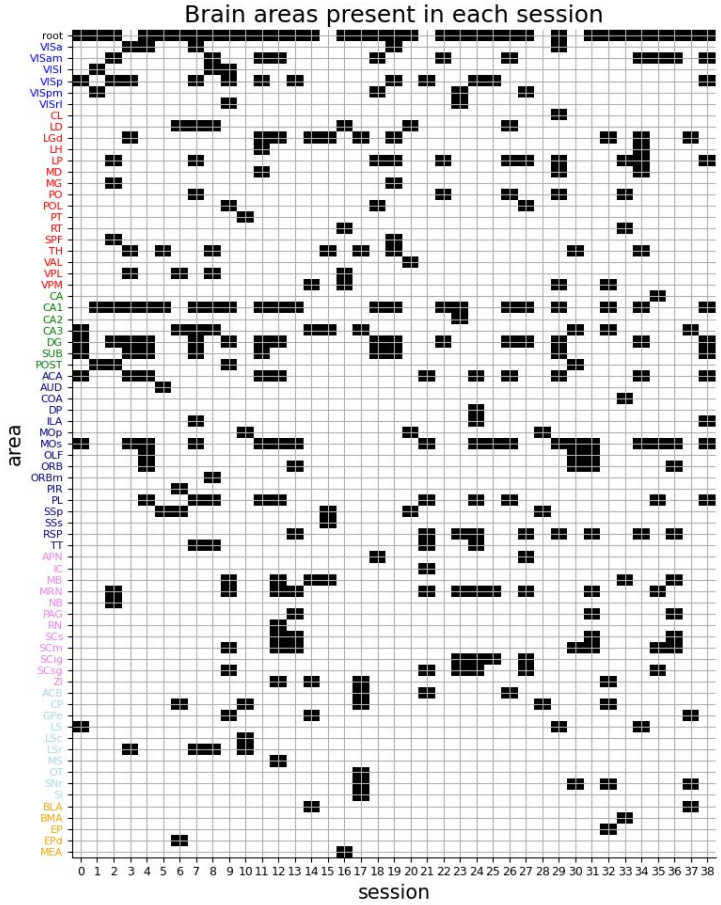






Recorded brain regions





Question

- Can we find similarities in activities in different brain areas during a certain process?
- Can activity of one area of the brain be predicted from activity of other areas?
- Can activity of a subset of neurons be predicted by another subset in the same region?

Goal

Learning about brain connectivity;

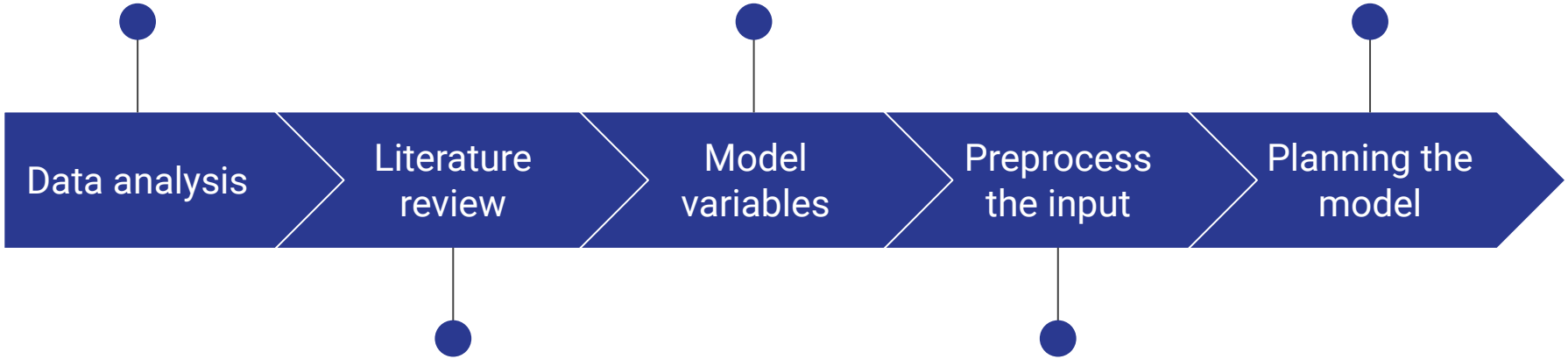
Shedding light on how information from one brain area can be used to predict activity of another region

Project steps

What information does the dataset include?

Which variables should be modelled and considered?

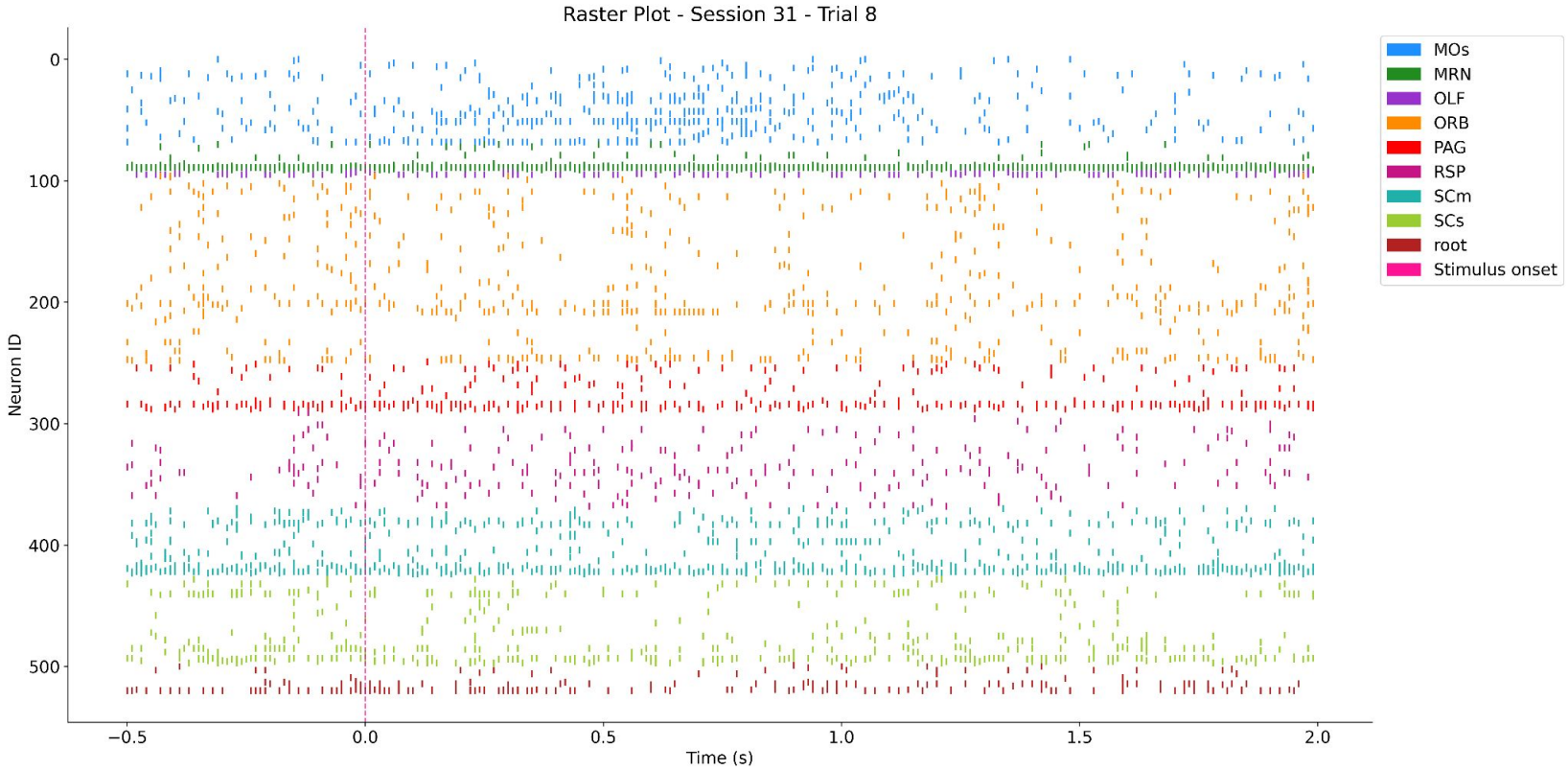
ML network selection



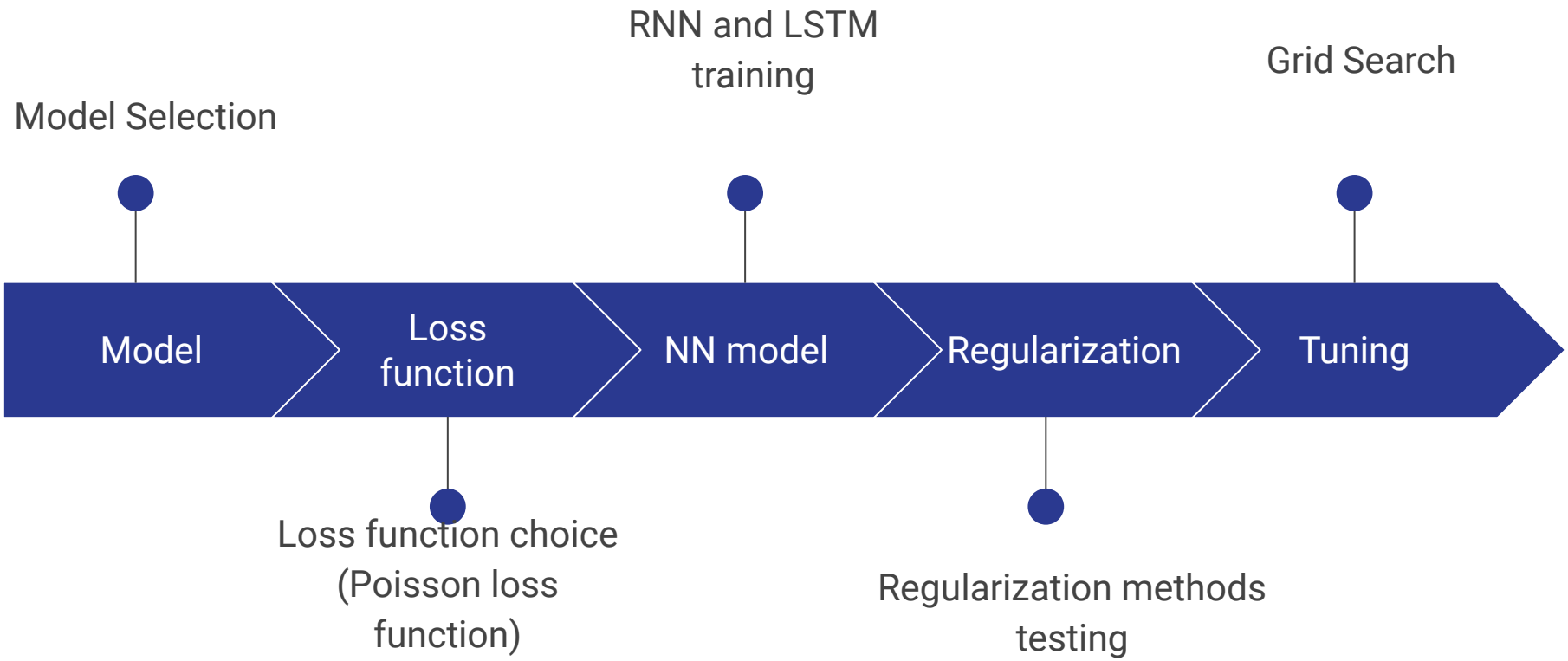
How others approach similar questions/goals?

Make the input ready for modelling

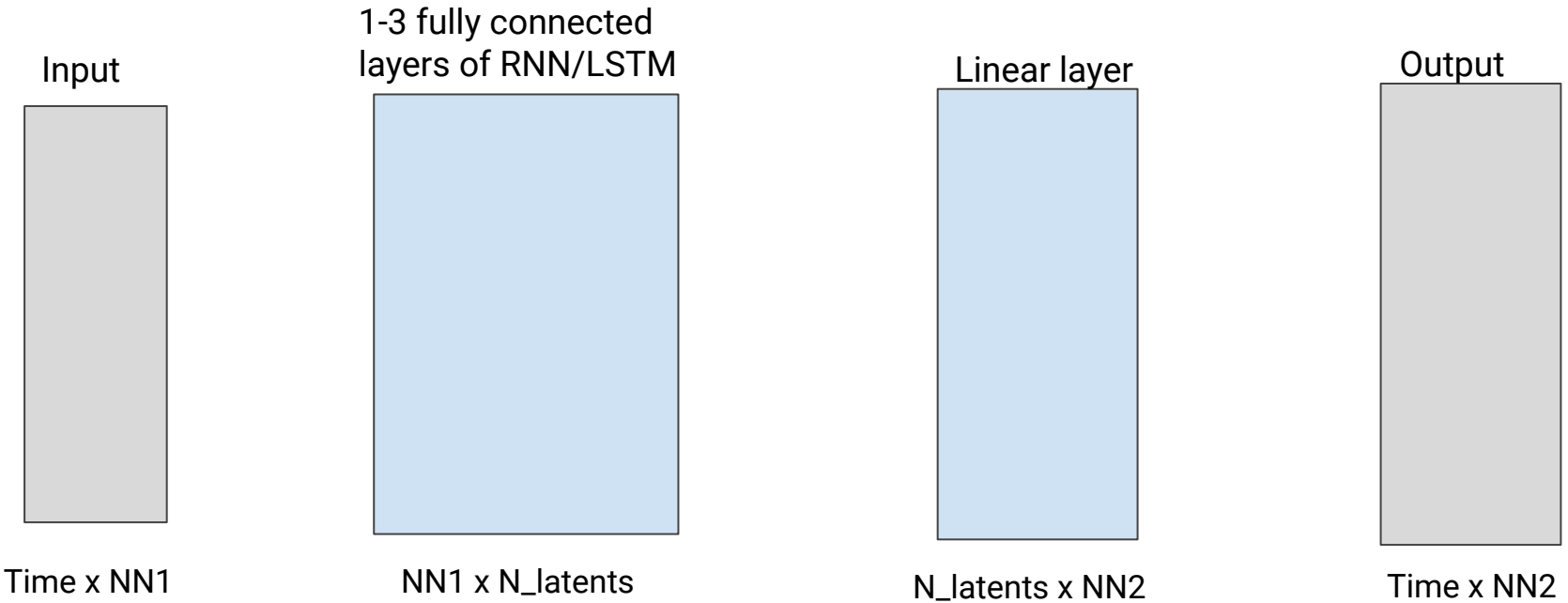
Raster plot for all neurons in session 31



Implementation Steps



Model architecture



Time: 250 time point, binned by 10 ms

NN1, NN2: number of neurons

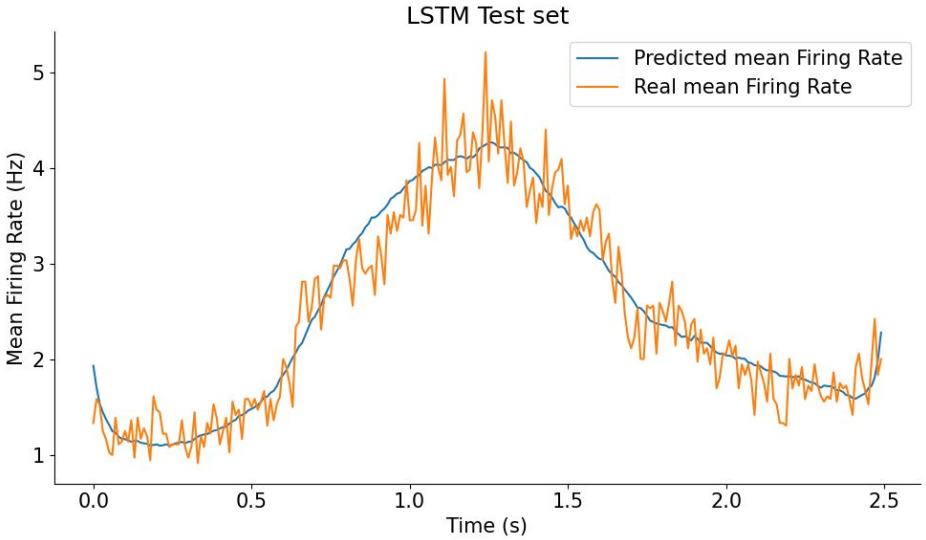
Predicting motor cortex based on other areas

Input: 453 other area neurons

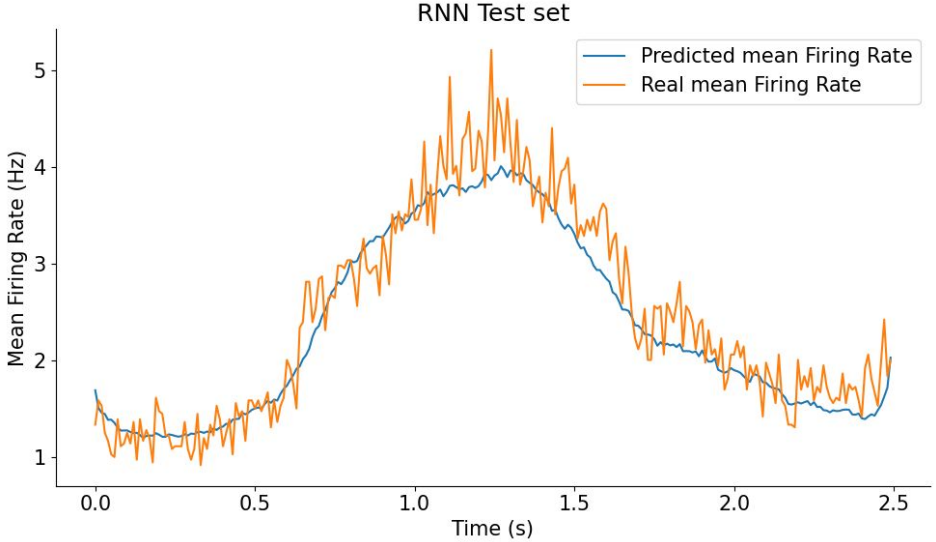
Output: 69 motor cortex neurons

15 neurons in fully connected layer, tested on 20% of data
Learning rate 0.001; weight decay 0.0001

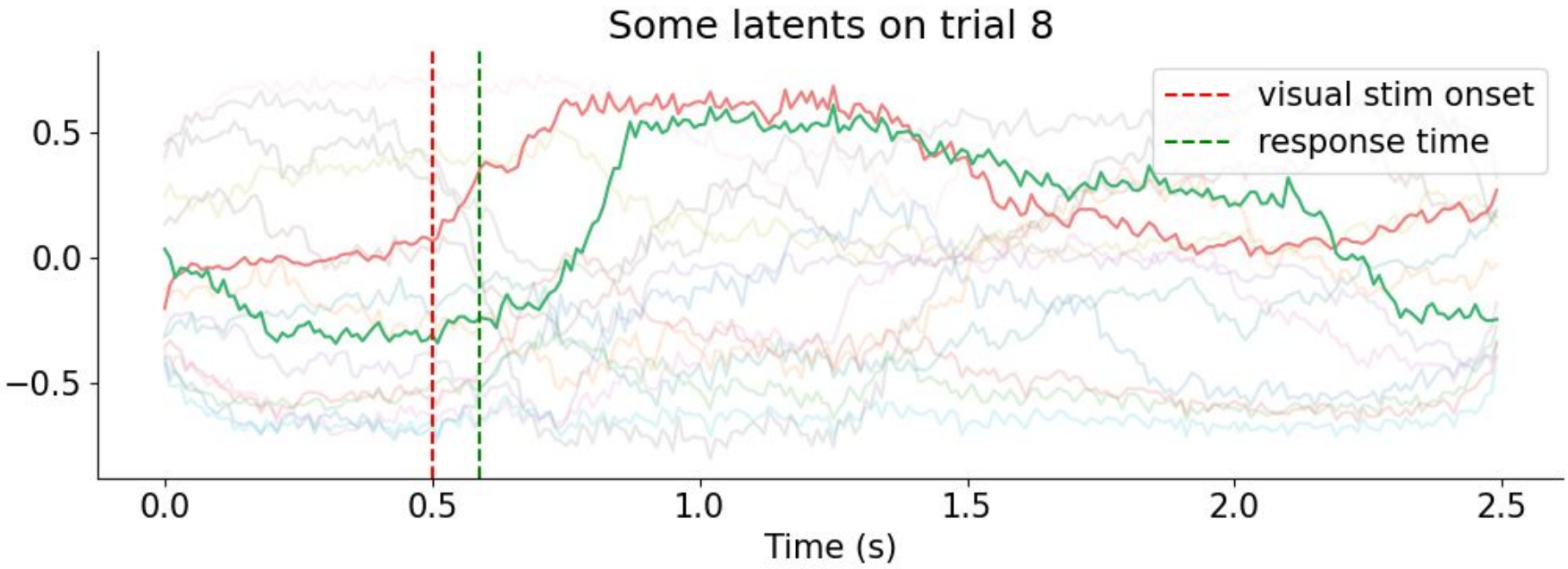
Poisson loss function value 0.0873



Poisson loss function value 0.0914



Plotting some latents of LSTM (2/15 latents)

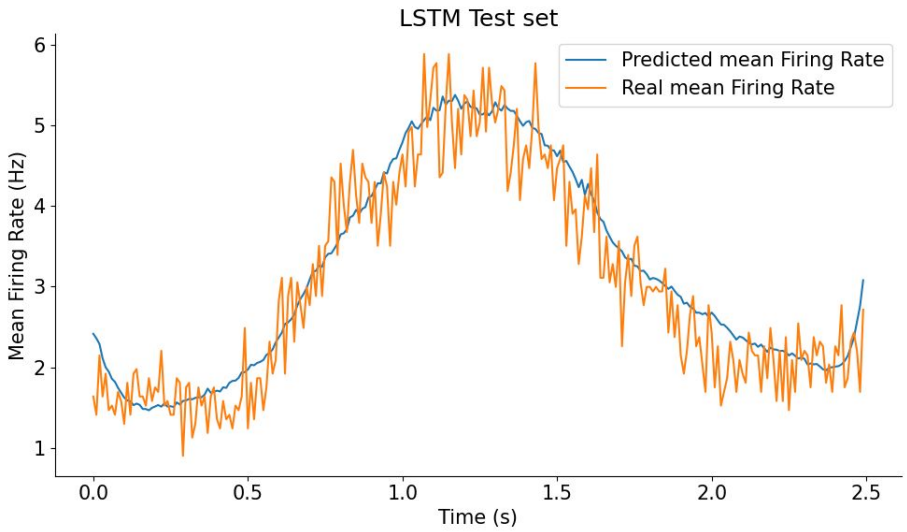


Predicting activity of MOs within 1 brain area

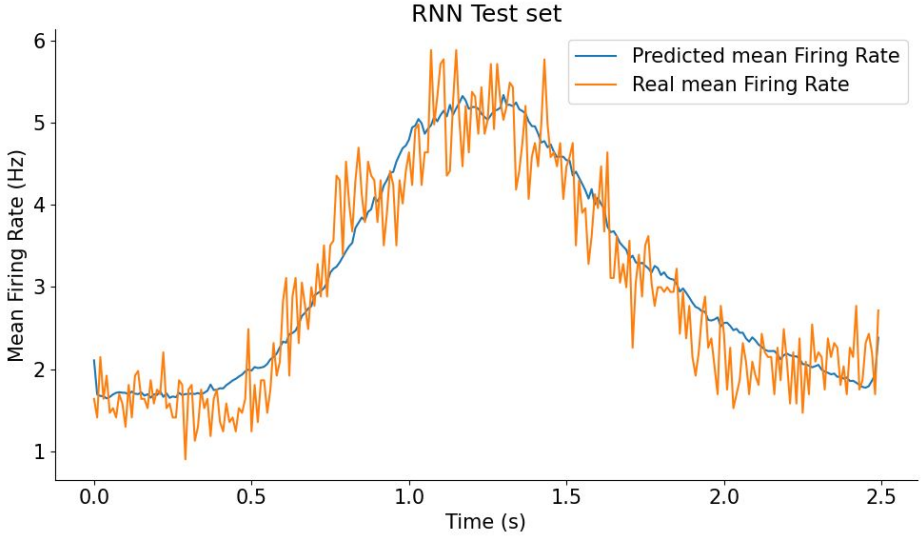
Input: 34 motor cortex neurons

Output: 34 motor cortex neurons

Poisson loss function value 0.1019

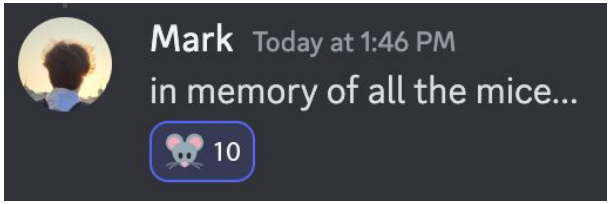


Poisson loss function value 0.1024



Conclusion

- By employing DL methods it is possible to receive an embedding for a set of neurons which would contain information about their spiking activity in different trials, with different actions being performed. This basis of their spiking activity contains less noise and can more easily be used to analysis activity.



References

Steinmetz, N. A., Zatka-Haas, P., Carandini, M., & Harris, K. D. (2019). Distributed coding of choice, action and engagement across the mouse brain. *Nature*, *576*(7786), 266-273.

Thank you for your attention

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