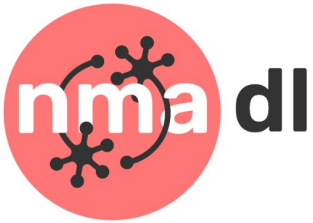
Pod: Salteñas



Neuromatch Academy:
Deep Learning

July 2022

Group 1:

Evan Cesanek

Daan Wesselink

Akhilesh Kumar

Pasha Zamani

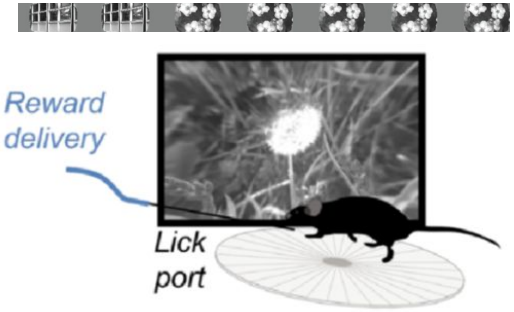
Erjun Zhang

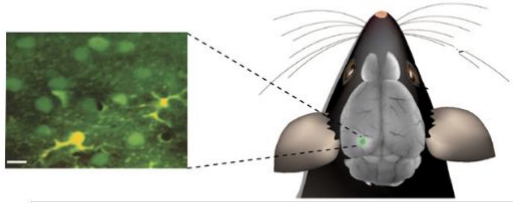
Baby Kumari

TA: Charles I.Saidu
Mentor: Naoki Hiratani
Project TA: Farrokh Karimi

Phenomenon

(**8** natural scene images)

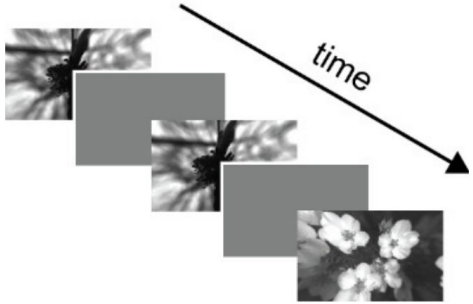


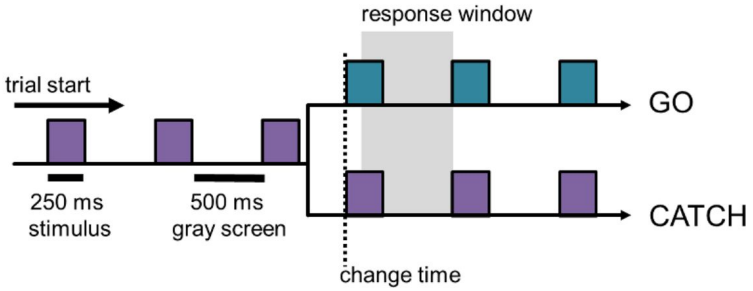


2-photon
Ca^{+2} imaging

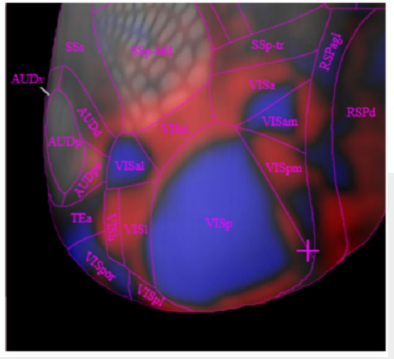
Mouse
visual
cortex

Visual change detection task





Question



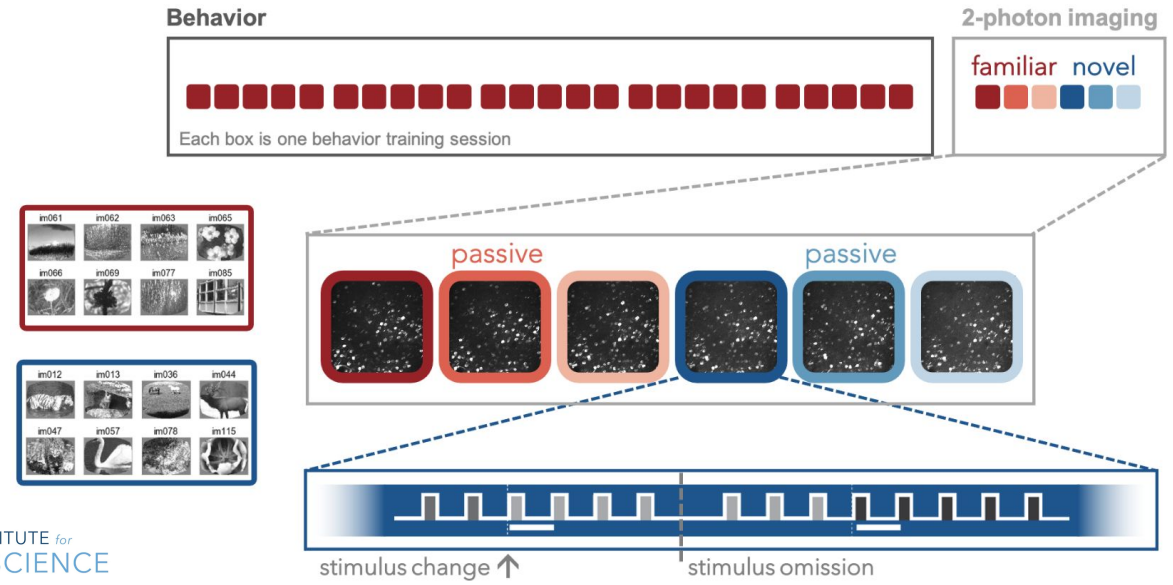
It is shown that excitatory **SLC** cells in the visual cortex are image selective.
(Garrett, Manavi, et al, 2020)

- **Do inhibitory neurons of visual cortex (VIP and SST) carry information about the identity of visual stimuli ?**

- **Which neurons encode visual change ?**

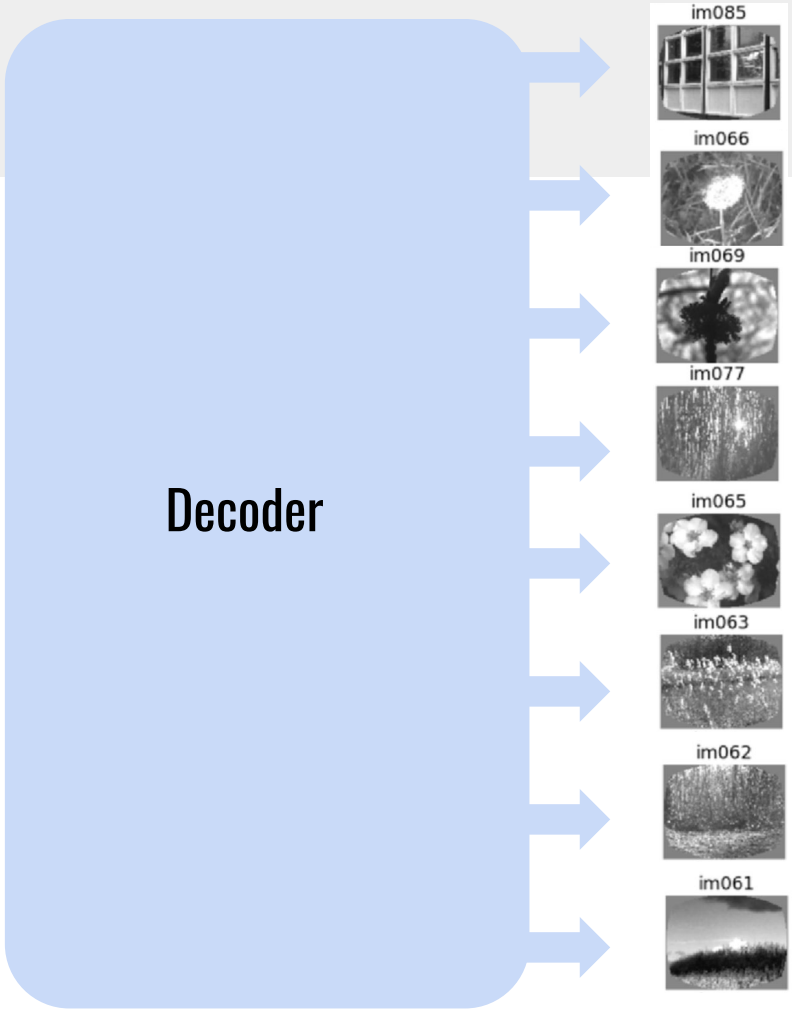
Data

- **Three visual cell types:** SST inhibitory (N=7), VIP inhibitory (N=5), SLC excitatory (N=5)
- **Two-photon calcium imaging** (neural activity = fluorescence change, dF/F)
  - Mean baseline-corrected activity
  - Full time-series [-150, 750] ms
- **Familiar images only**
- **Active and passive viewing**

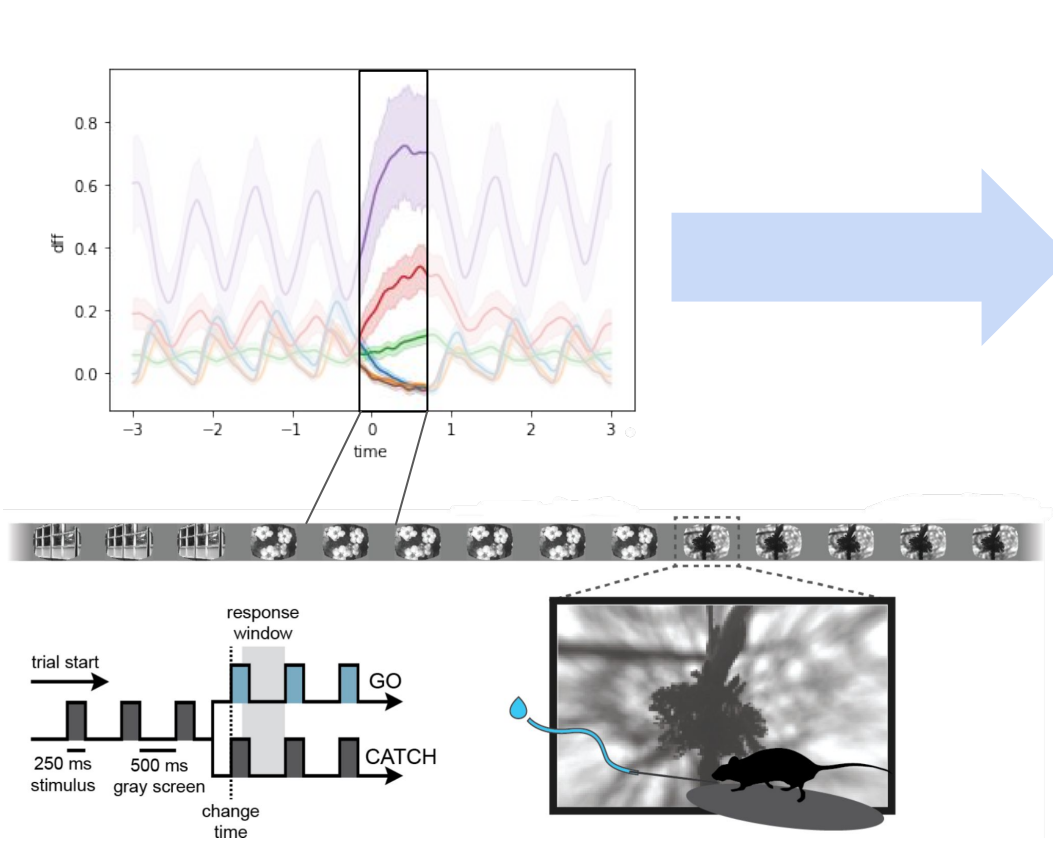


ALLEN INSTITUTE for BRAIN SCIENCE

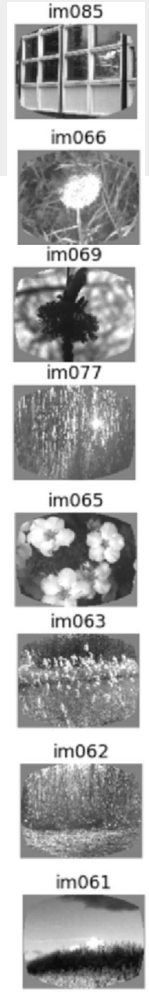
Decoding image identity



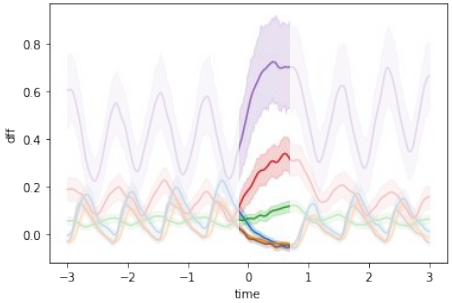
Decoding image identity

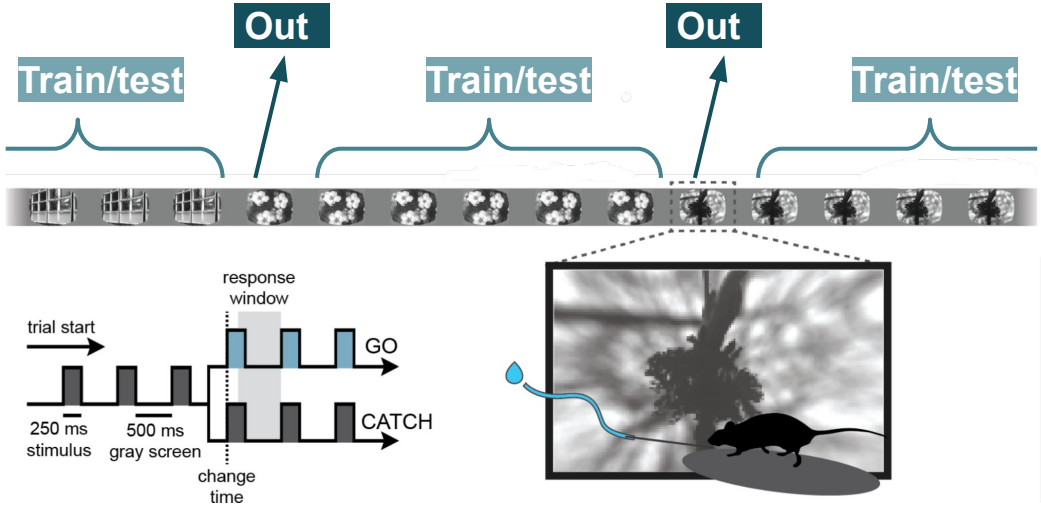


Decoder



Decoding image identity

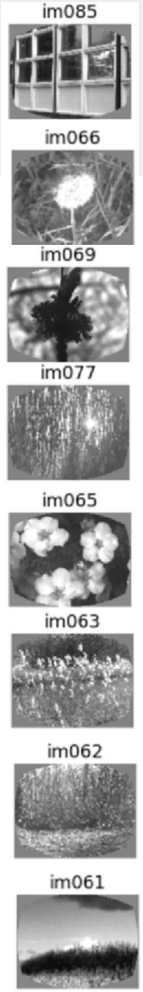




SVM (baseline)

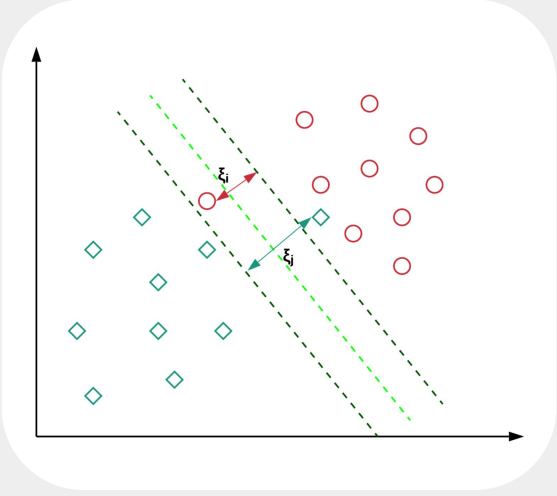
ANN

CNN

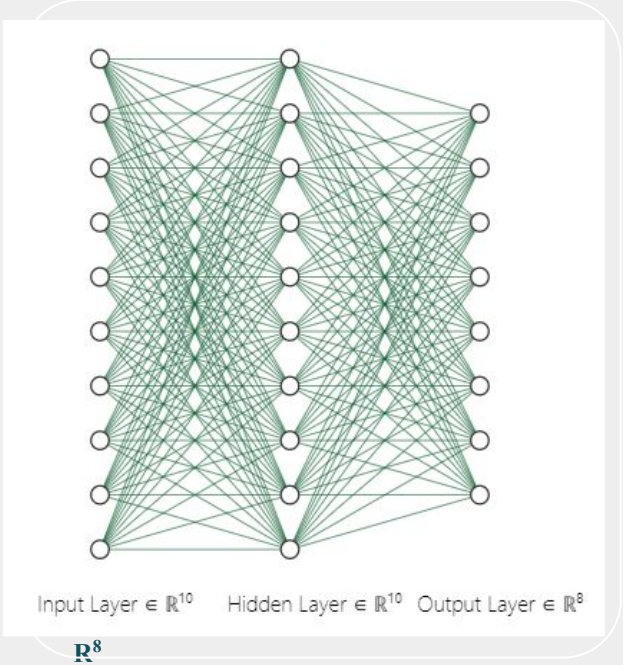


Network architectures

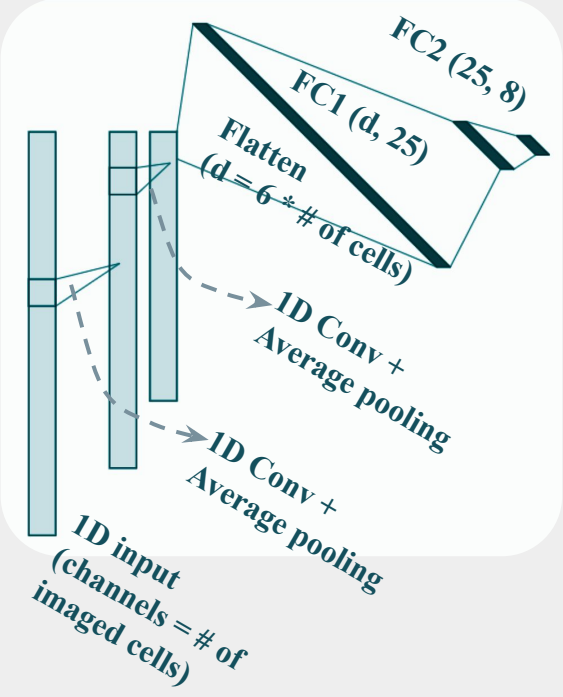
SVM (baseline)



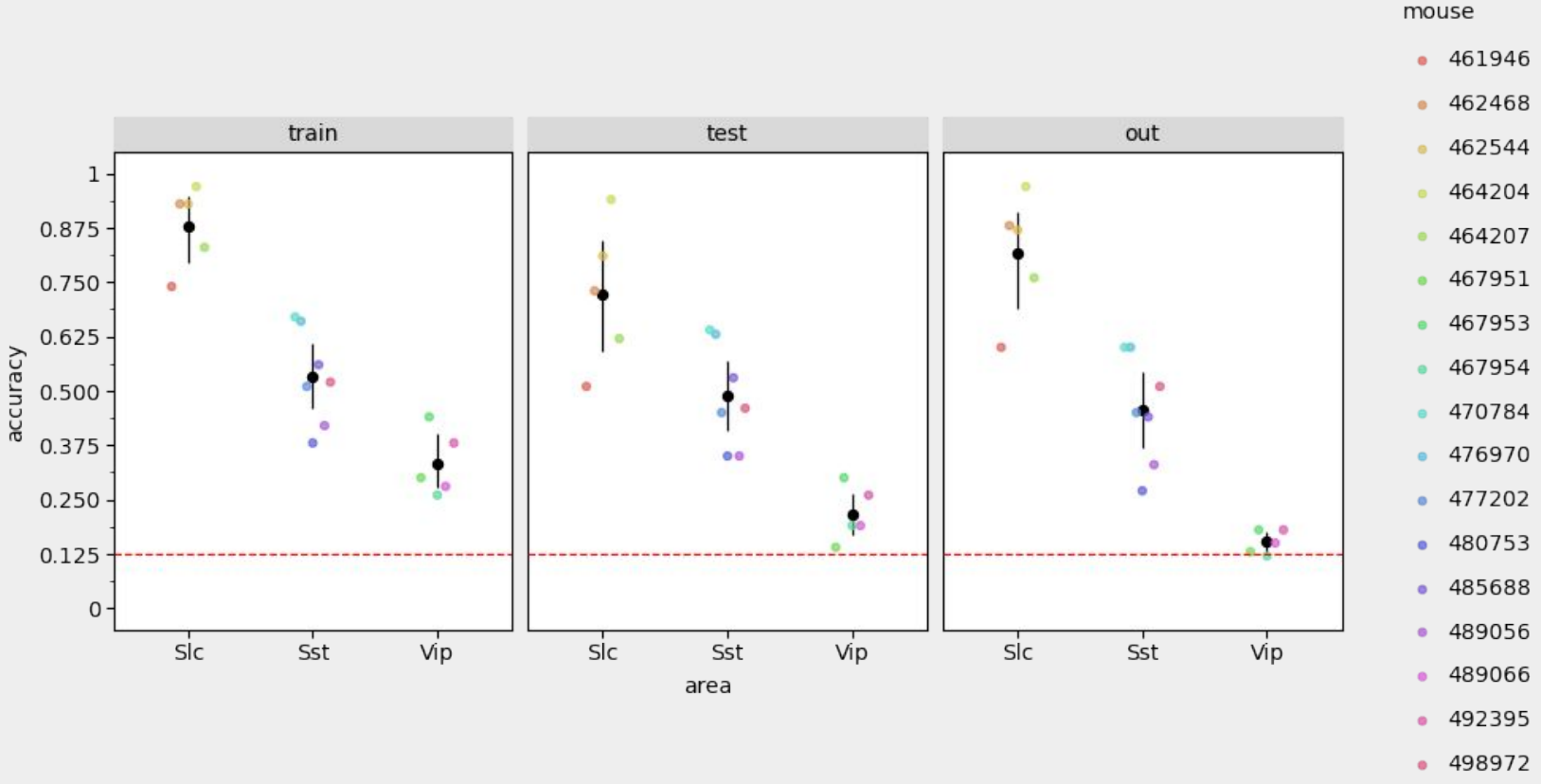
ANN



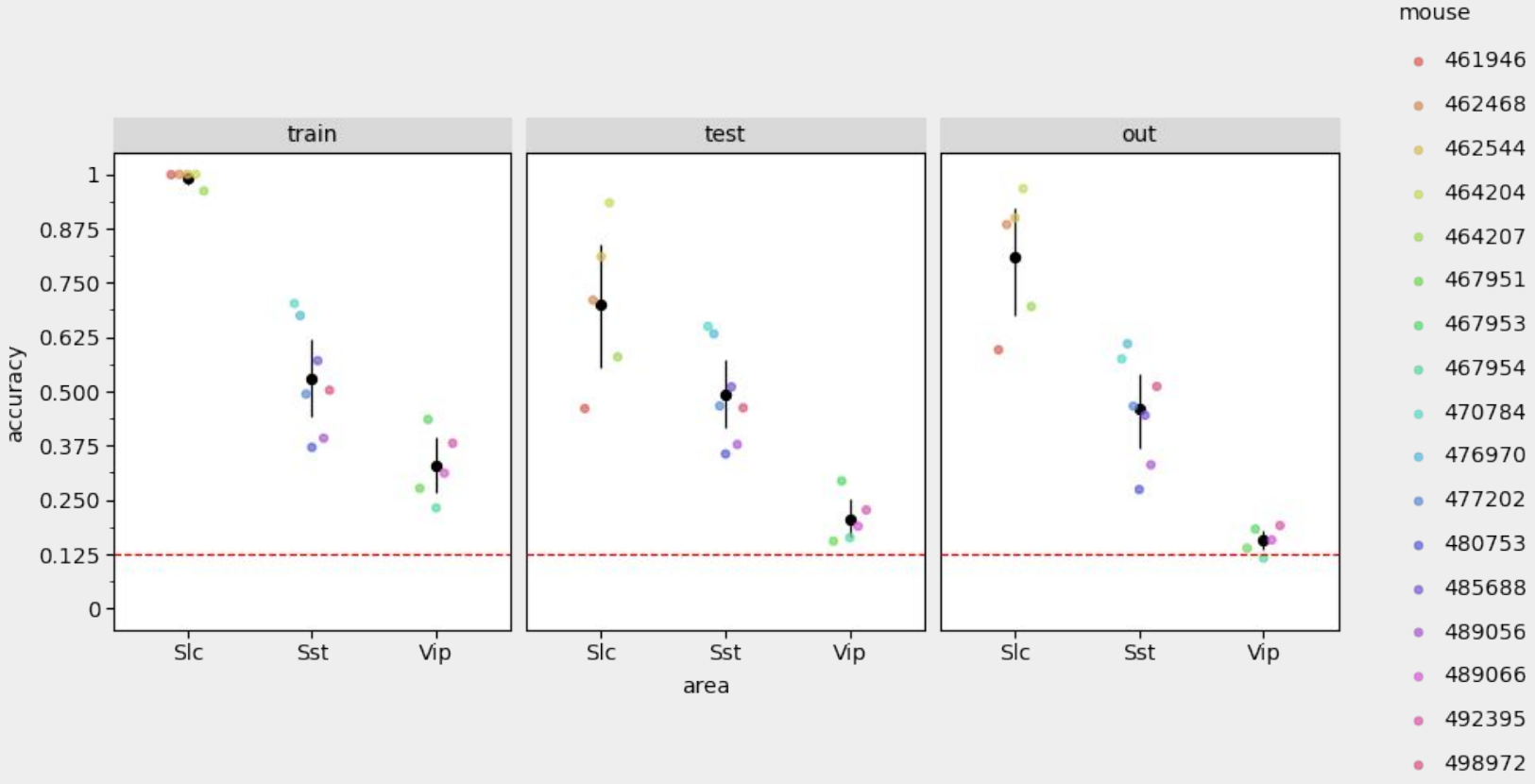
CNN



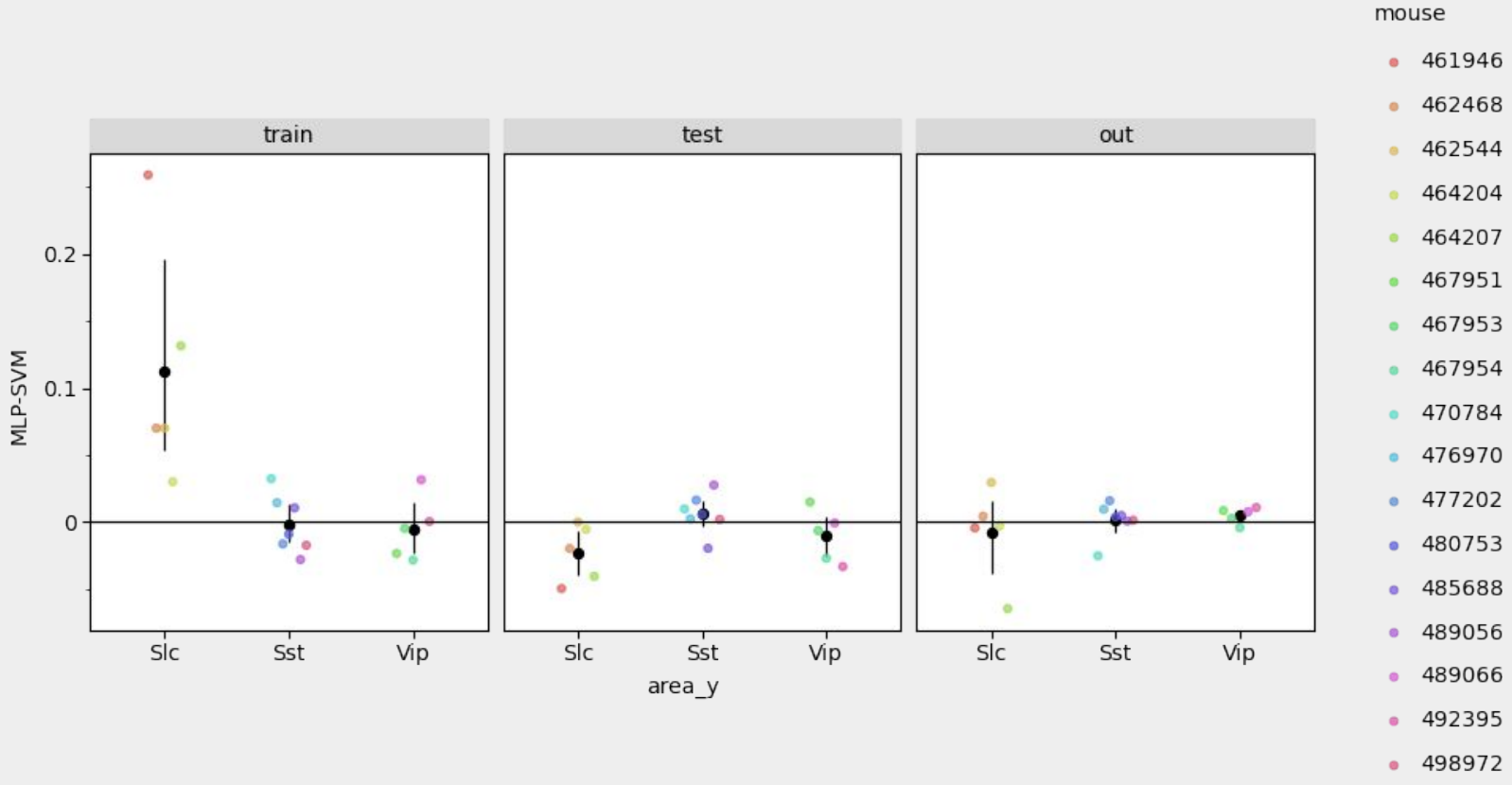
SVM (mean firing rates)



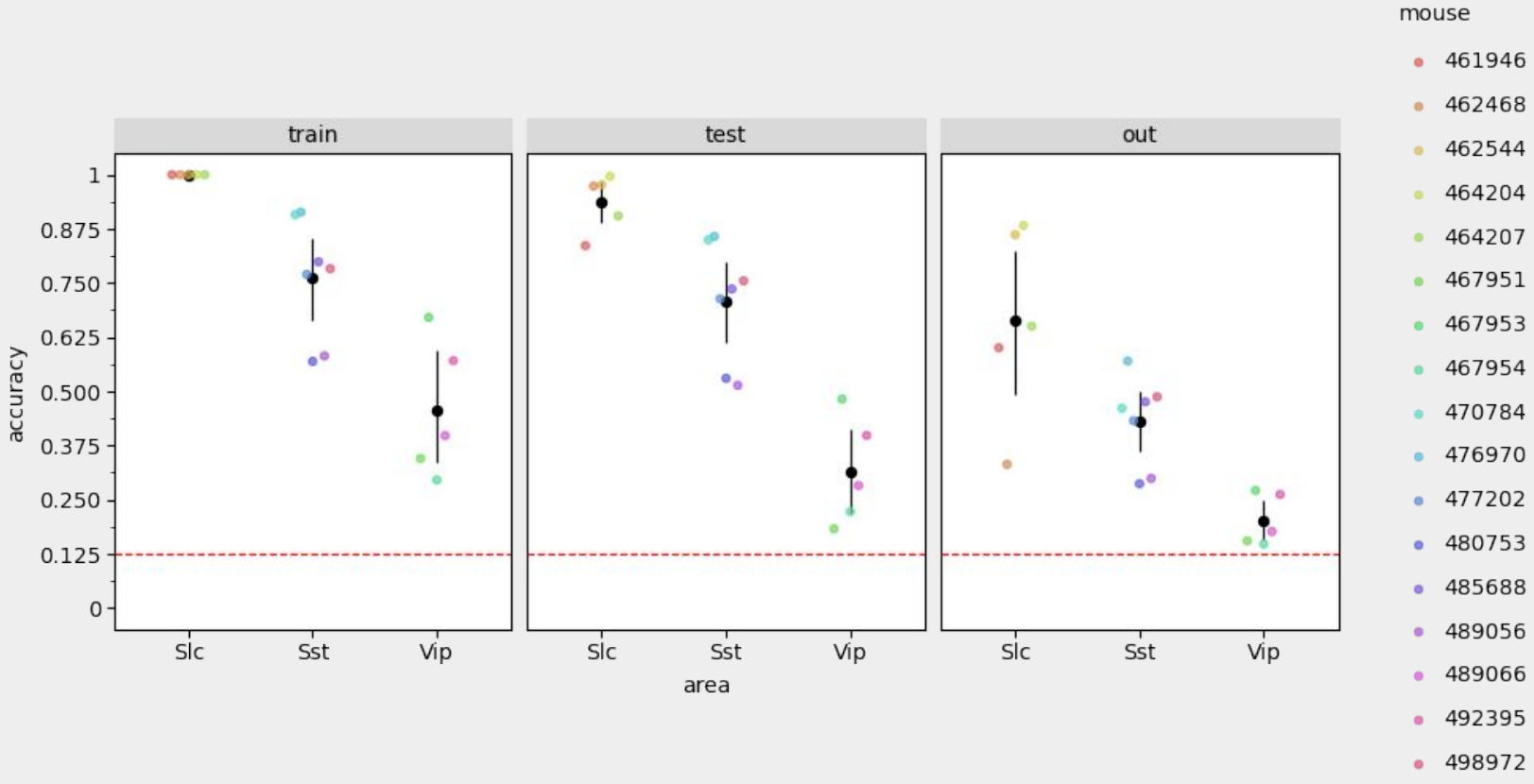
ANN (mean firing rates)



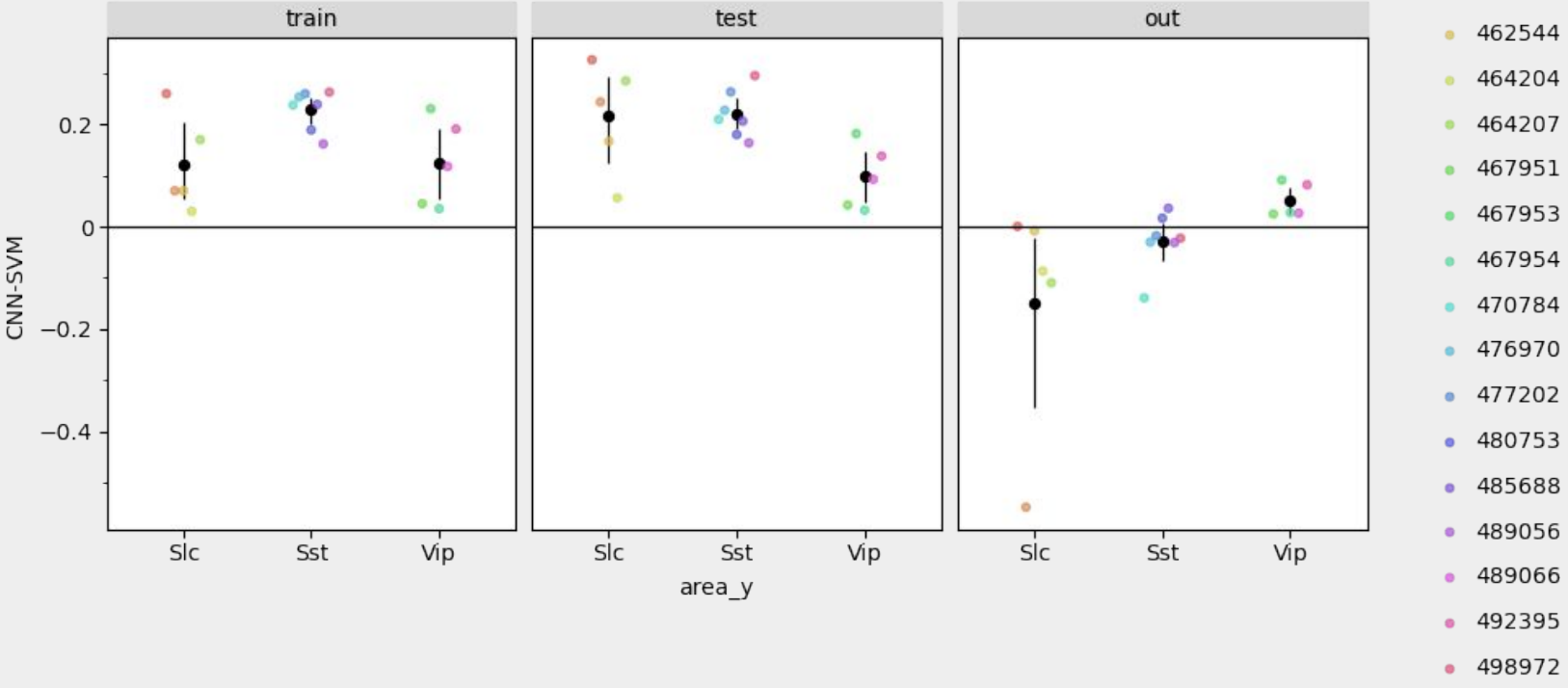
ANN does not outperform SVM



CNN (full time series)



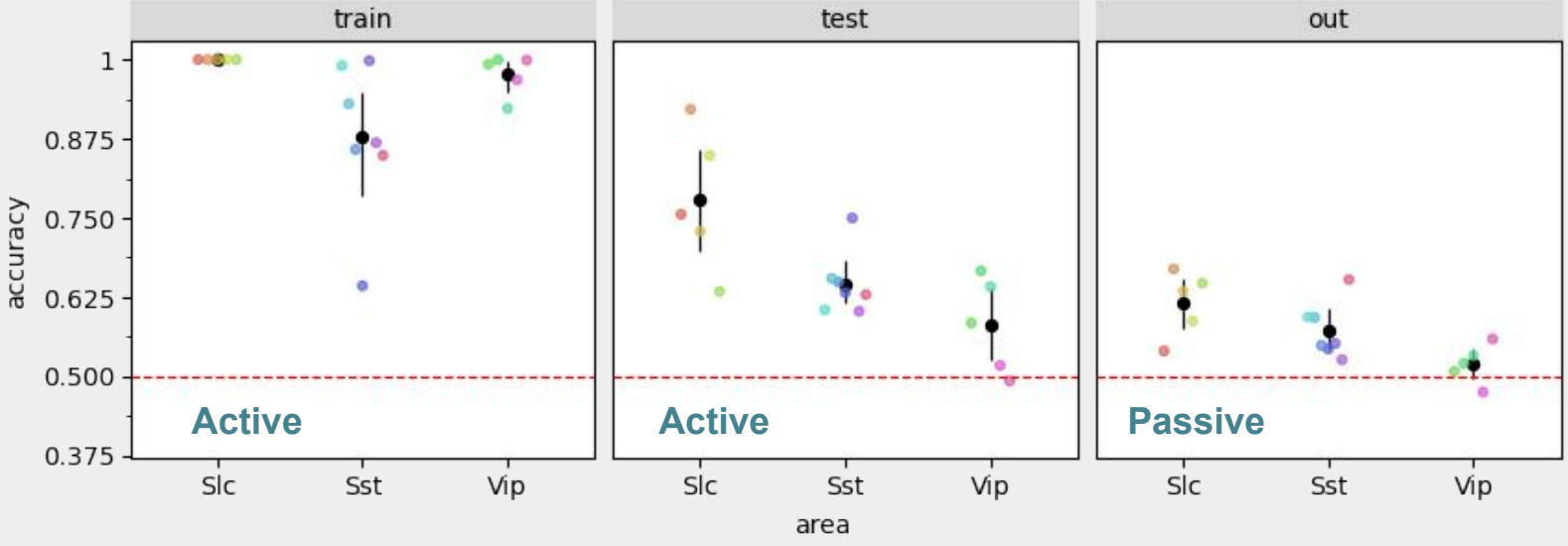
CNN outperforms SVM
(but uses full time series)



Decoding image-change

ANN
(mean firing rates)

1st vs. 2nd presentation



SVM, MLP And CNN (PCA)

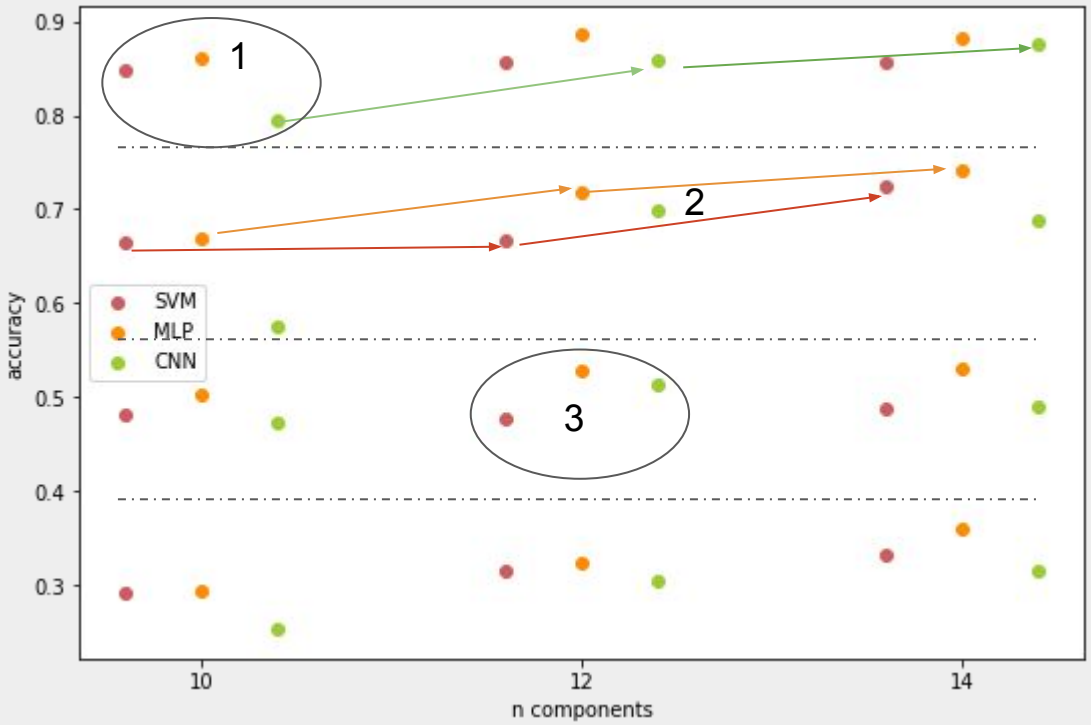
Drop constant feature

Normalization

PCA (n=10~15)

Split data (0.8/0.2)

SVM, MLP, and CNN



Mouse 1

Mouse 2

Mouse 3

Mouse 4

Conclusions

- Image identity information is encoded in SLC and SST inhibitory neurons (but not in VIP)
- CNNs are an effective approach for neural decoding using time-series activity of multiple neurons, where high feature dimensionality can thwart standard machine learning methods
- SST decoding performance drops considerably when tested on initial image presentations, suggesting that these neurons may respond differently to image change versus repeated-image recognition
- Follow-up analysis shows that SST neurons also encode whether it is the first or second presentation of an image