NLB 2021 Winning Submission

Approach and Methods

AE.STUDIO

AE Studio in 60 seconds...

- AE = Agency Enterprise (as in human agency)

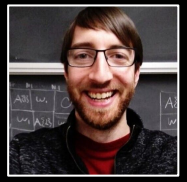
> *"We believe that technology should increase rather than decrease human agency."*

- Product Development and Data Science Consulting Firm

- Working to build software to support BCI research

BCI Team

Darin Sleiter



Mike Vaiana

Joshua Schoenfield

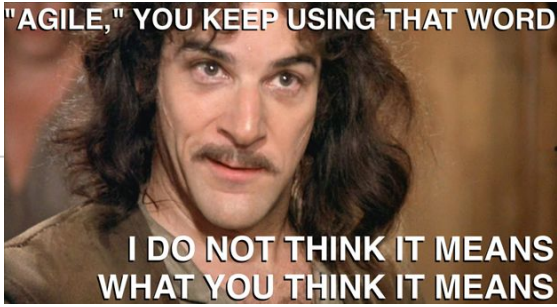
Sumner Norman

Diogo de Lucena

Acknowledgments

- Joel Ye and Chethan Pandarinath
  - Authored the paper our work is based on:
    - *Representation learning for neural population activity with Neural Data Transformers*
  - Open sourced an implementation of the NDT model which we forked
    - https://github.com/snel-repo/neural-data-transformers

Approach and Process



Agile Software Development

- What can we achieve in the time we have?
  - ~~Novel ML algorithm~~
  - ~~Implement paper from scratch~~
  - **Adapt open source code from paper**

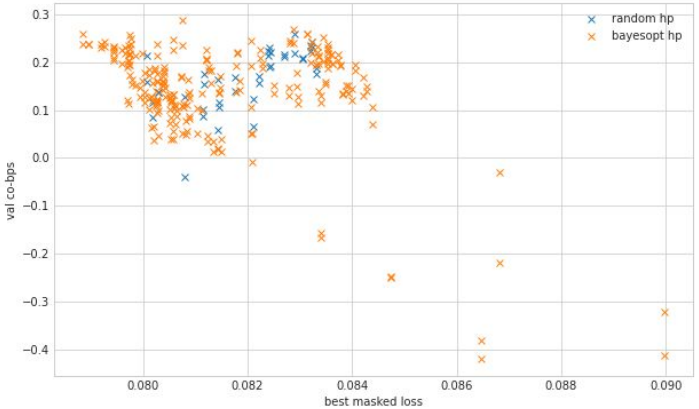
Data Science

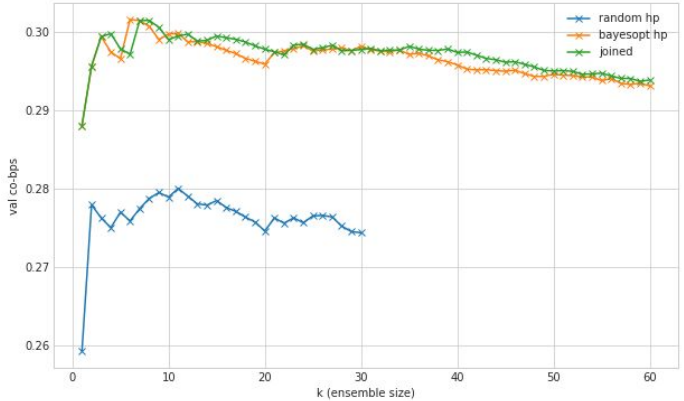
- We used best practices for delivering an ML *product*
- Enumerated possible improvements
  - Picked the ones with the best trade-off between speed and expected improvement

Methods

Neural Data Transformer [1] Ensemble

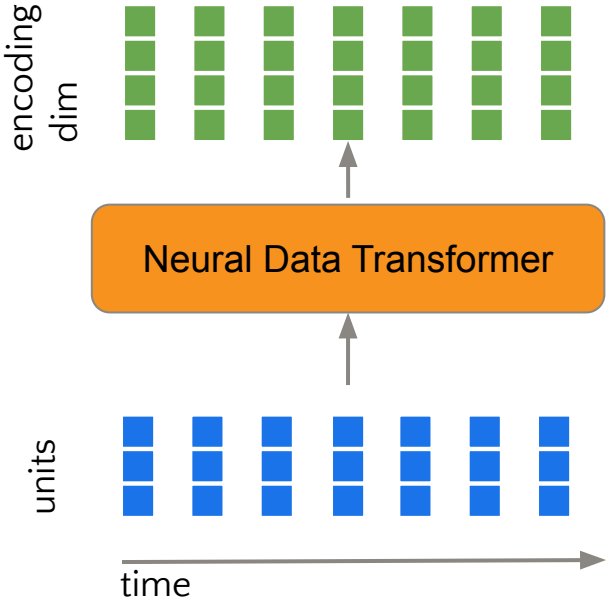
- Used the open source implementation of Neural Data Transform (Ye & Pandarinath 2021)
  - Implementation also from Ye & Pandarinath: github.com/snel-repo/neural-data-transform
- For each dataset we ensembled 7-21 NDT models
- Candidates for ensembling were created by training 100+ NDT models with Bayesian hyperparameter optimization on each dataset





[1] Representation learning for neural population activity with Neural Data Transformers
Joel Ye, Chethan Pandarinath
bioRxiv 2021.01.16.426955; doi: https://doi.org/10.1101/2021.01.16.426955

NDT in 60 seconds...

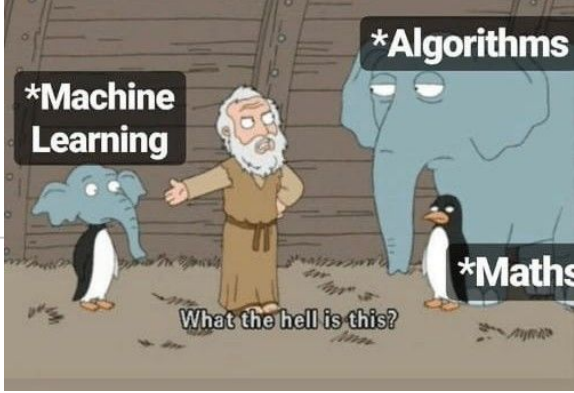


W x =

Final rate predictions* (yellow) are a learned matrix (W) times the encoded vector (green).

*technically these are log(rates)

What didn't work for us...



- AutoLFADS[1] / LFADS [2]
  - We weren't able to reproduce or beat the AutoLFADS leaderboard results with our own implementation.
- Stacking
- Per-neuron ensembles

[1] A large-scale neural network training framework for generalized estimation of single-trial population dynamics
Mohammad Reza Keshtkaran, Andrew R. Sedler, Raeed H. Chowdhury, Raghav Tandon, Diya Basrai, Sarah L. Nguyen, Hansem Sohn, Mehrdad Jazayeri, Lee E. Miller, Chethan Pandarinath
bioRxiv 2021.01.13.426570; doi: https://doi.org/10.1101/2021.01.13.426570

[2] Pandarinath, C., O'Shea, D.J., Collins, J. *et al.* Inferring single-trial neural population dynamics using sequential auto-encoders. *Nat Methods* 15, 805–815 (2018). https://doi.org/10.1038/s41592-018-0109-9

Join Us! ae.studio/join-us

- **Join our heady team. We're looking for:**
  - BCI Data Engineers
  - BCI Data Scientists
  - and more.

- **The AE Studio BCI Team is currently exploring a range of academic collaborations...let's partner!**
  - **Contact Diogo:** diogo@ae.studio

Links

- AE.Studio
  - https://github.com/agencyenterprise/ae-nlb-2021/blob/master/approach.md
  - https://github.com/agencyenterprise/ae-nlb-2021
  - https://ae.studio/brain-computer-interface
  - https://ae.studio/join-us
- Neural Data Transformers
  - https://doi.org/10.51628/001c.27358
  - https://github.com/snel-repo/neural-data-transformers
- AutoLFADS/LFADS
  - https://doi.org/10.1101/2021.01.13.426570
  - https://snel-repo.github.io/autolfads/
  - https://github.com/lyprince/hierarchical_lfads