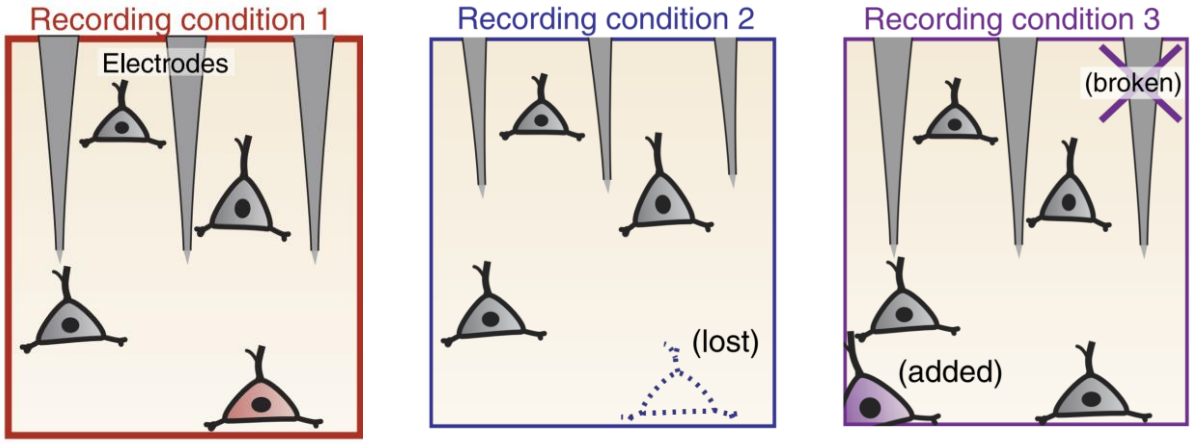
Making brain–machine interfaces robust to future neural variability (Sussillo et al. 2016) [1]

Joel Tokple | TU Berlin | BCI Seminar

Challenges in BMI systems

- Current neural decoders need frequent retraining, due to changes in neural recording conditions:
  - Changes of electrode positions relative to neurons
  - Variability in electrode properties (e.g. impedance)
  - Noise sources
  - Cognitive state

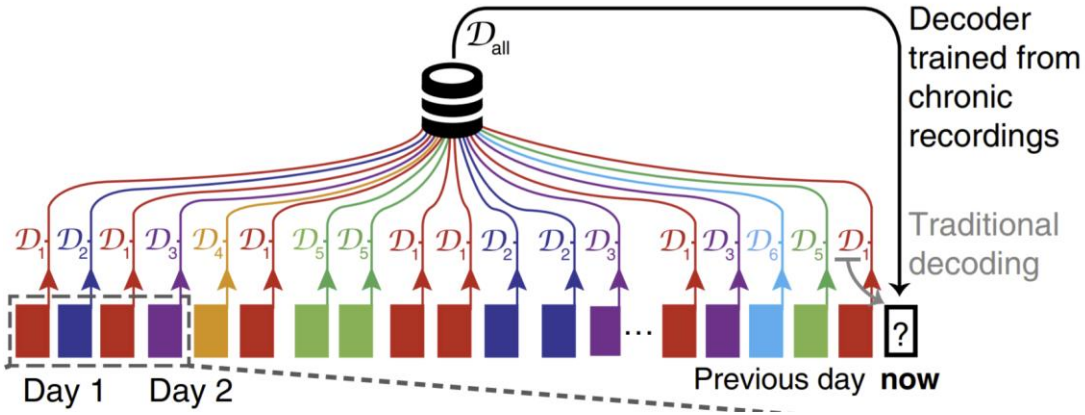


Source: [1]

Outline

1. Addressing the issue of neural variability
2. Experiments
3. Conclusion
4. References

Addressing the issue of neural variability



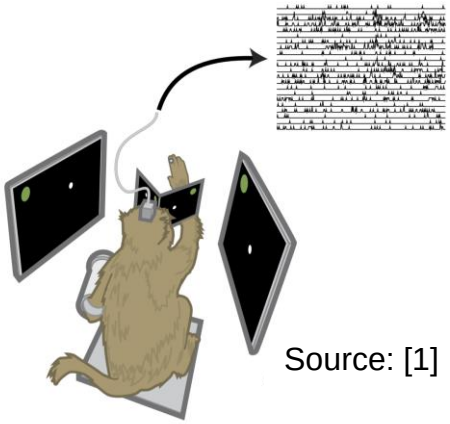
Source: [1]

- Multiplicative Recurrent Neural Network (MRNN)
- Trained on many days of previous data
- Using Training data augmentation, to further extend number of recording conditions

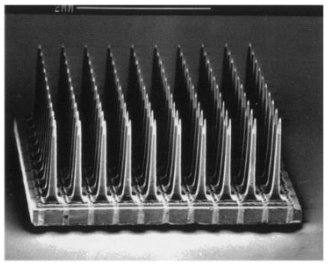
Experiments

Experimental Set Up

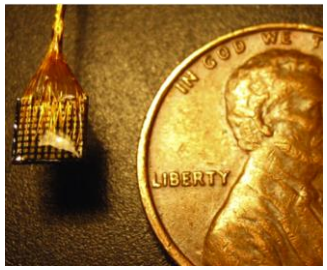
- Motor BMI experiments (cursor control)
- 2 rhesus macaque monkeys implanted w/ Utah arrays in motor cortex
- Training Data: neural activity (multiunit spikes) generated while performing point to point arm reaches
- Cursor Control performance evaluated on Radial 8 Task



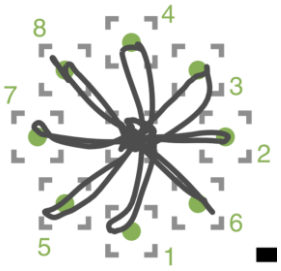
Source: [1]



Source: [2]



Source: [3]

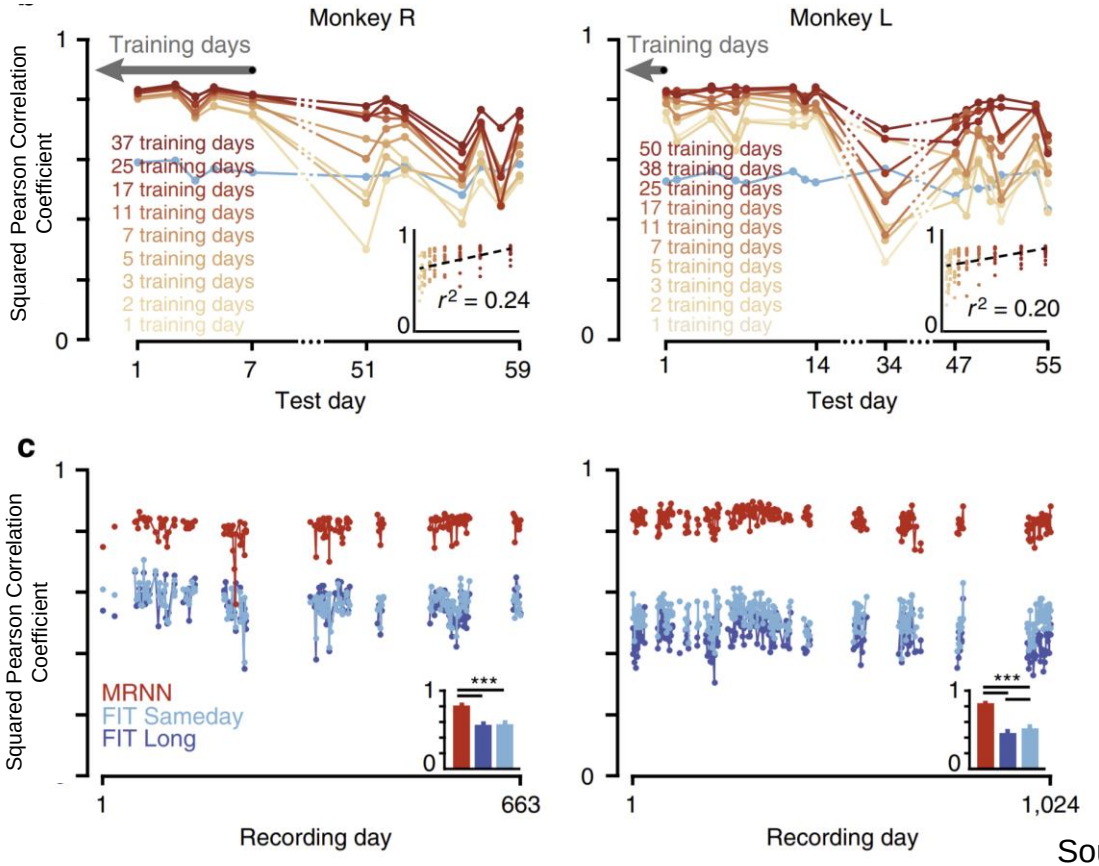


Source: [1]

Experiments

MRNN performance improves with more data

MRNN (yellow to red)
FIT Sameday

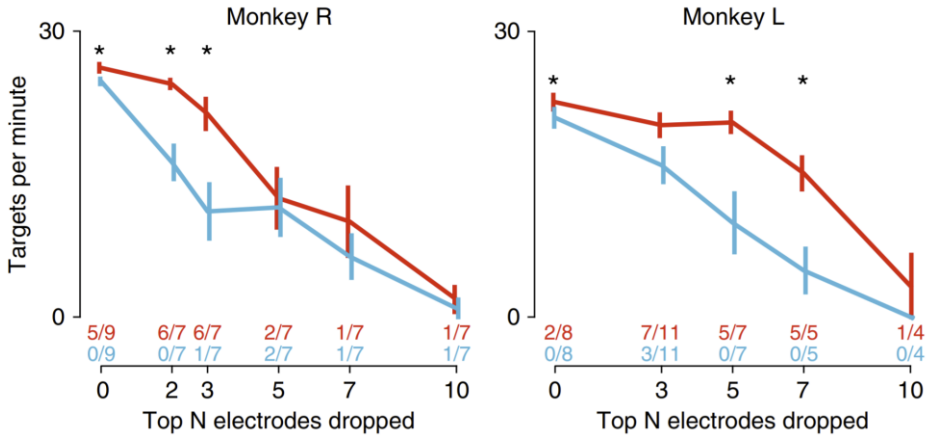


Source: Adapted from [1]

Experiments

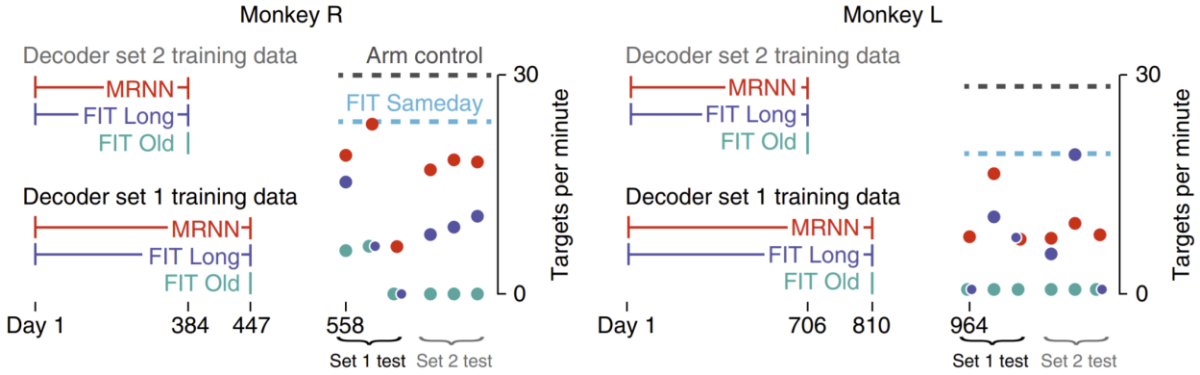
Robustness to unexpected loss of informative electrodes

MRNN
FIT Sameday



Source: [1]

Robustness to naturally sampled recording condition changes



Source: [1]

Conclusion

- MRNN copes much better with varying neural recording conditions
- But for neural recording conditions that don’t share any similarity not well suited
  - Should be used in conjunction with adaptive decoders
- Can benefit from other BMI research approaches as well
  - E.g. improved sensors
  - Different type of input signals (singleunit spikes, local field potentials)

References

[1] Sussillo, D., Stavisky, S.D., Kao, J.C., Ryu, S.I. and Shenoy, K.V., 2016. Making brain–machine interfaces robust to future neural variability. *Nature communications*, *7*(1), pp.1-13.

[2] Kelly, R.C., Smith, M.A., Samonds, J.M., Kohn, A., Bonds, A.B., Movshon, J.A. and Lee, T.S., 2007. Comparison of recordings from microelectrode arrays and single electrodes in the visual cortex. *Journal of Neuroscience*, *27*(2), pp.261-264.

[3] Normann, R.A., Maynard, E.M., Rousche, P.J. and Warren, D.J., 1999. A neural interface for a cortical vision prosthesis. *Vision research*, *39*(15), pp.2577-2587.