NEURAL POPULATION CODING
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1. Introduction	• Organization of class • Basics of population recordings • Basic population coding model
2. Simple encoding models	**Tolhurst, D., J. Movshon, et al. (1983). The statistical reliability of signals in single neurons in cat and monkey visual cortex. Vision Research 23: 775-785.** **Shadlen, M., K. Britten, et al. (1996). A computational analysis of the relationship between neuronal and behavioral responses to visual motion. Journal of Neuroscience 16(4): 1486-1510.**
3. Population decoding	**Georgopoulos, Apostolos P., Andrew B. Schwartz, and Ronald E. Kettner. Neuronal population coding of movement direction. *Science* 233.4771 (1986): 1416-1419.** **Graf, A. B. A., A. Kohn, et al. (2011). Decoding the activity of neuronal populations in macaque primary visual cortex. Nat Neurosci 14(2): 239-245.** Berens, P., A. S. Ecker, et al. (2012). A fast and simple population code for orientation in primate V1. J Neurosci 32(31): 10618-10626.
4. Fisher information and maximum-likelihood estimation	**Paradiso, M. (1988). A theory of the use of visual orientation information which exploits the columnar structure of striate cortex. Biological Cybernetics 58: 35-49.** **Dayan and Abbott, *Theoretical Neuroscience* (2001), Section 3.3** Seung, H. S. and H. Sompolinsky (1993). Simple models for reading neuronal population codes. Proc Natl Acad Sci U S A 90(22): 10749-10753. Abbott, L. and P. Dayan (1999). The effect of correlated variability on the accuracy of a population code. Neural Computation 11: 91-101.
5. Noise correlations in encoding and decoding	**Averbeck, B. B., P. E. Latham, et al. (2006). Neural correlations, population coding, and computation. Nat Rev Neurosci 7(5): 358-366.** **Ecker, Alexander S., et al. Decorrelated neuronal firing in cortical microcircuits. *Science* 327.5965 (2010): 584-587.**

	Hansen BJ, Chelaru M, and Dragoi V (2012). Correlated variability in laminar cortical circuits. *Neuron*, 76, 590-602 Wu, S., H. Nakahara, et al. (2001). Population coding with correlation and an unfaithful model. Neural Computation 13(4): 775-797.
6. Structure from response and response from structure	**Pillow, Jonathan W., et al. Spatio-temporal correlations and visual signalling in a complete neuronal population. *Nature* 454.7207 (2008): 995-999.** **Ganmor E, Segev R, Schneidman E. (2011) The architecture of functional interaction networks in the retina. J Neurosci. 31(8): 3044-54** Hu Y, Trousdale J, Josic K, Shea-Brown E. (2013) Motif statistics and spike correlations in neuronal networks. J. Stat. Mech. Trousdale J, Hu Y, Shea-Brown E, Josić K. (2012) Impact of network structure and cellular response on spike time correlations. PLoS Comput Biol. 8(3):e1002408
7. Representation of probability and uncertainty	**Ma WJ and Jazayeri M, Neural coding of probability and uncertainty, in press.** Foldiak, P. (1993). The 'ideal homunculus': statistical inference from neural population responses. Computation and Neural Systems. F. Eeckman and J. Bower. Norwell, MA, Kluwer Academic Publishers: 55-60. Sanger, T. (1996). Probability density estimation for the interpretation c neural population codes. Journal of Neurophysiology 76(4): 2790-2793 Kiani R, Shadlen MN. (2009). Representation of confidence associated with a decision by neurons in the parietal cortex. Science. 8;324(5928):759-64 Berkes, P., G. Orban, et al. (2011). Spontaneous cortical activity reveals hallmarks of an optimal internal model of the environment. Science 331(6013): 83-87.
8. Neural implementation of Bayesian computation	**Ma, W. J., J. M. Beck, et al. (2006). Bayesian inference with probabilistic population codes. Nat Neurosci 9(11): 1432-1438.** Jazayeri, M. and J. A. Movshon (2006). Optimal representation of sensory information by neural populations. Nat Neurosci 9(5): 690-696

	Beck, J. M., P. E. Latham, et al. (2011). Marginalization in neural circuits with divisive normalization. J Neurosci 31 (43): 15310-15319. Fischer, Brian J., and José Luis Peña. Owl's behavior and neural representation predicted by Bayesian inference. Nature neuroscience 14.8 (2011): 1061-1066.
9. Mixed selectivity	**Mante V, Sussillo D, Shenoy KV, Newsome WT. (2013) Context-dependent computation by recurrent dynamics in prefrontal cortex. Nature. 7;503 (7474):78-84** **Rigotti M, Barak O, Warden MR, Wang XJ, Daw ND, Miller EK, Fusi S. (2013) The importance of mixed selectivity in complex cognitive tasks. Nature. 30;497 (7451):585-90.** Machens CK, Romo R, Brody CD (2010) Functional, but not anatomical, separation of what and when in prefrontal cortex. J Neurosci. 6;30(1):350-60.
10. Natural grouping of stimuli or task based on neural responses	**Kiani R, Esteky H, Mirpour K, Tanaka K. (2007) Object category structure in response patterns of neuronal population in monkey inferior temporal cortex. J Neurophysiol. 97 (6):4296-309.** **Kriegeskorte N, Mur M, Ruff DA, Kiani R, Bodurka J, Esteky H, Tanaka K, Bandettini PA. (2008) Matching categorical object representations in inferior temporal cortex of man and monkey. Neuron. 26;60 (6):1126-41.**
11. Invariance through population codes	**Hung CP, Kreiman G, Poggio T, DiCarlo JJ. (2005) Fast readout of object identity from macaque inferior temporal cortex. Science. 4;310 (5749):863-6.** **DiCarlo JJ, Cox DD. (2007) Untangling invariant object recognition. Trends Cogn Sci. 11 (8):333-41.**
12. Parcellation of cortex by response properties	Kiani et al, in preparation, subnet paper
13. Extension to imaging	**Chen, Yuzhi, Wilson S. Geisler, and Eyal Seidemann. Optimal decoding of correlated neural population responses in the primate visual cortex. *Nature neuroscience* 9.11 (2006): 1412-1420.** **Harvey CD, Coen P, Tank DW. (2012) Choice-specific sequences in parietal cortex during a virtual-navigation decision**

	task. Nature. 14;484 (7392):62-8. Marshel JH, Garrett ME, Nauhaus I, Callaway EM. (2011) Functional specialization of seven mouse visual cortical areas. Neuron. 22;72 (6):1040-54. Harrison, S. A. and F. Tong (2009). Decoding reveals the contents of working memory in early visual areas. Nature 458 (7238): 632-635. Brouwer, G. J. and D. J. Heeger (2009). Decoding and reconstructing color from responses in human visual cortex. J Neurosci 29 (44): 13992-14003.
14. Dynamical system approach	Churchland & Shenoy 2012 Afshar & Shenoy 2009 Sahani & Shenoy
15. General discussion	