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Neuronal Spatiotemporal Pattern Discrimination: The Dynamical Evolution of Seizures

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We developed a modern numerical approach to the multivariate linear discrimination of Fisher from 1936 based upon singular value decomposition that is sufficiently stable to permit widespread application to spatiotemporal neuronal patterns. We demonstrate this approach on an old problem in neuroscience – whether seizures have distinct dynamical states as they evolve with time. A practical result was the first demonstration that human seizures have distinct initiation and termination dynamics, an important characterization as we seek to better understand how seizures start and stop. Such strategies are also useful in defining the onset of a seizure dynamically, and whether there is a dynamically distinct preseizure state. A proper orthogonal decomposition helps illustrate the changing coherent structures that underlie such activities. Our approach is broadly applicable to a wide variety of spatiotemporal dynamical data, from multichannel EEG or MEG, to sequentially acquired optical imaging data or fMRI.