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Presentation Abstract

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Abstract:	Our recent work has shown that the activity of tens to hundreds of neurons can be succinctly summarized by a smaller number of population activity patterns, which are extracted using dimensionality reduction methods such as Gaussian-process factor analysis (GPFA; Yu et al., 2009, Churchland et al., 2010). The population activity can then be viewed as a neural trajectory, where each of its dimensions describes the time-evolution of one pattern. Although this approach is valuable for exploratory data analysis and for studying neural population activity on the level of a single experimental trial, it has two limitations. First, we would like to visualize the neural trajectory at its optimal dimensionality (i.e., the number of patterns needed to describe the population activity), which is determined from the data and is typically greater than three. However, direct plotting can only provide a 2D or 3D view. Second, it is often difficult to intuit the relationship between a neural trajectory and the activity of individual neurons from which the trajectory was extracted, even if the relationship is linear. To address these limitations, we developed a Matlab graphical user interface (GUI) that allows the user to i) quickly navigate through a large number of different 2D projections of the neural trajectories, and ii) perturb the neural

trajectory and immediately see how the constituent firing rates of individual neurons could have produced this trajectory. For i), the user can continuously rotate a 2D projection within the higher-dimensional space and is guided by thumbnail previews for each rotation direction. All possible 2D projections of the neural trajectories can be achieved. For ii), the user can click and drag the neural trajectory, then see the predicted firing rate profile for each neuron corresponding to the perturbed trajectory. To demonstrate the utility of this GUI, we applied it to visualize neural population activity on single trials from a decision-making maze task (Kaufman et al., 2011, this volume). Because internal decision processes can vary considerably from trial to trial, the use of GPFA is crucial for studying single-trial neural phenomena in this task. Based on 101 neurons recorded simultaneously in premotor and motor cortices, GPFA identified ~12 dimensions (or patterns). We then visualized the neural trajectories in the GUI and identified features that would have easily been missed had we simply projected them into a static 2D or 3D space. In sum, the use of statistical methods like GPFA, in tandem with visualization tools like the GUI developed here, has the potential to further our understanding of neural population activity on individual trials.

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