**Adaptive modeling of neural spike count data with non-Poisson variability**

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**Abstract:**

In many areas of the brain, neural spiking activity covaries with features of the external world, such as sensory stimuli or an animal’s movement. Experimental findings suggest that the variability of neural activity changes over time and may provide information about the external world beyond the information provided by the average neural activity. To flexibly track time-varying neural response properties, here we developed a dynamic, adaptive filter model with Conway-Maxwell-Poisson (COM-Poisson) observations. The COM-Poisson model can flexibly describe firing patters that are both under- and over-dispersed relative to the Poisson distribution. Here we track parameters of the COM-Poisson distribution as they vary over time. Using simulations, we show that a Normal approximation can accurately track dynamics in state vectors for both the mean and dispersion parameters. We then fit our model to neural data from “place cells” in the hippocampus and neurons in V1 area. We find that this method out-performs previous adaptive methods based on the Poisson distribution. This model provides a flexible framework for tracking time-varying non-Poisson count data and may also have applications beyond neuroscience.