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Binarization of Spontaneous Neural Activities for Neural Ring Analysis

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Typical electrophysiological experiments in neuroscience examine the neural responses to sensory stimuli. That is, within the stimulus-response framework, how accurately the neural responses reflect the sensory stimuli has been characterized information theoretically. However, it is not necessarily clear if the neural responses actually responded only to the sensory stimuli the experimenters presented. For example, the neurons can actually respond to some hidden variables of which the experimenters are unaware. So, it is desirable to know in advance how much dimensions the "hidden stimulus space" for a neuron spans.

For that purpose, the systematic method of neural ring was proposed recently [1-3]. This novel, algebraic geometry-based method could uncover the information which conventional methods neglected. Meanwhile, the method of neural ring can be, in some sense, regarded as the distribution-free or nonparametric method and, therefore, the know-how for the application to noisy real data is lacking with few previous works.

Here we attempted to apply the neural ring method to the spontaneous neural activities in rat hippocampus [4-8]. The issues here can be that the real data is considerably noisy and that there are many possible ways to binarize the data so that the neural ring is applicable. By trying different styles of binarization, we discovered that some aspects of results are stable and did not change significantly. This suggests that, with the appropriate use, the neural ring can be a reliable data analysis method for obtaining stable biological conclusions.

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