In recent years there has been significant interests in population coding by the correlations between the responses of neurons . In many neural systems, it has been showed that the correlations between the spike trains of neurons might convey additional information about external stimuli.

While the correlation has a great impact on the encoding of information, it shows various effects on the population coding according to the features of neural systems or external stimuli. Panzeri et al showed the relationship between noise correlation and signal correlation for synergy. Wilke et al also showed that the features of neural systems and noise play important roles in the representational accuracy of neural populations.

In this paper, we use mutual information to analyze the encoding of information in neural populations. Mutual information has found as a powerful tool in the analysis of neural coding. It is possible to quantify information transfer by neural responses of both a single neuron and neural systems with correlation, and we study how much information can be conveyed with neural populations according to the different levels of correlation and the features of neural systems.

We find the factors determining the efficiency of neural population coding, and study their effects from several examples. The information encoding of neural populations with the same noise correlations might show synergistic or redundant effects according to their characteristics. Here, we find that the inhomogeneity parameter α and the product of SNR's β play significant roles in the information transfer of neural populations. We also show that neural populations convey more information if the sign of noise correlation is opposite to that of signal correlation, as shown by Panzeri et al.

As the inhomogeneity parameter α increases, the neural population conveys more information. This means that population coding is efficient if neural responses are inhomogeneous. Thus the neural population with different receptive fields is more favorable than that with the same receptive fields. In fact, the receptive field of many neural systems in a brain is divided into small overlapping parts assigned to single neurons.

A single neuron conveys insufficient information in the cases that the neuron is insensitive to external stimuli or the neural response is very noisy.
In the case of fine tuning that the range of external stimuli is very small, the information transfer of a single neuron is also low.
The neural population, however, can convey sufficient information since the efficiency of population coding increases, as the product of SNR's β decreases.

To understand the encoding of neural systems, it is necessary to analyze the experimental results with hypotheses introduced here. In this work, we consider an additive noise model and assume that information is transferred by the mean firing rate of spike trains. It would be interesting to apply these results to diverse neural systems with different models of noise and coding strategies.