# Sparse Encoding Promotes Synchronous Firings

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Synfire chain is a simple neural network model which can generate stable synchronous firings called a pulse packet. The existence of synfire chain has been implied by some experiments[1,2] and synchronous firing is thought to play key role in information processing in the brain[3]. Therefore synfire chain is widely studied by many researchers. However how synfire chains coexist in one network remains to be elucidated. We have previously reported the activity of a layered network in which we embed memory patterns by the Hebbian Learning[4]. In our previous report, a half of neurons belongs to each memory pattern, i.e., the firing rate of memory pattern $F = 0.5$, and then a memory pattern is activated synchronously. Therefore at first sight memory patterns seemed to be synfire chains. However under some input condition, synchrony of a memory pattern broken to groups (sublattices), and then the sublattices fire independently and synchronously with a time lag. This result suggests that in the $F = 0.5$ network synfire chain is each sublattice rather than memory pattern.

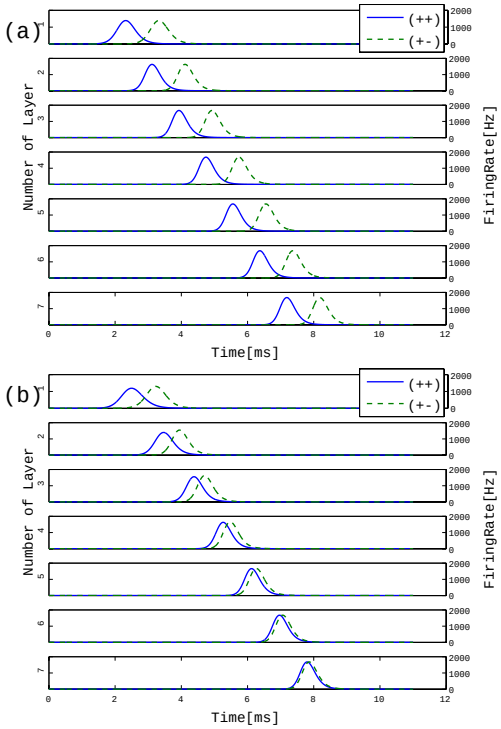


Figure 1: (a)$F = 0.5$, (b)$F = 0.4$. These figures show firing rates of $(++)$ sublattice (solid blue line) and $(+-)$ sublattice (dashed green line) in each layer.

In this study, we show that when firing rate of memory pattern $F$ is smaller than 0.5, the stability of memory pattern as synfire chain seems to be promoted compared to the $F = 0.5$ network. Here we pay attention to two memory patterns embedded in the network and two groups of neurons. One group belongs to both of the two memory patterns. The other group belongs to only one of the two memory patterns and become silent when the other memory pattern is activated. We call the former group as $(++)$ sublattice, and the latter as $(+-)$ sublattice. Now we activate $(++)$ sublattice, and after 1 millisecond we activate $(+-)$ sublattice at the first layer. When $F = 0.5$, the firing of the two groups independently propagates (Fig. 1(a)). When $F = 0.4$, on the other hand, the time lag between the two group firings approaches to zero through layers and at last the firing of the two groups becomes synchronous (Fig. 1(b)). This result means that in the $F = 0.4$ network synchronous firings between different sublattices become more stable than in the $F = 0.5$ network. This result also implies that the sparse encoding makes memory patterns more robust synfire chains. At the Cosyne meeting I will show the details of this robustness with other data and the mechanism behind it.

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**References**

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