A Critique of Neocognitron by Fukushima

Fukushima has made an attempt to mimic the functioning neural cells and their structuring. I shall briefly describe the architecture of Neocognitron presented here.

As mentioned by Fukushima, in an earlier work by Hubel and Wiesel which describes the possible functioning of the biological neural system, and also as studied in our earlier paper *Perceptron*, the neural system is a hierarchical architecture with the deep layers encoding more information within each cell. Another point to be noted with respect to neural cells exhibiting plasticity or their ability to learn and relearn different functions of which the functions can be vision, hearing etc. I shall discuss more about how these have been implemented with respect to the work presented here.

First, the cells are organized in layers, with each layer containing two planes of cells. The first plane consists of *simple* cells which are similar to the lower order hypercomplex in our brain and the second plane consists of *complex* cells which are again similar to the higher order hypercomplex. The "C-cells" are more invariant to the small distortions or positional variations as compared to the "S-cells". Hence, irrespective of the displacement within the region connected to the C-cells, the pattern projected is invariant. The S-planes and C-planes are placed alternatively. It must be inferred that while the connections of S-cells are modifiable, the connections for C-cells are fixed.

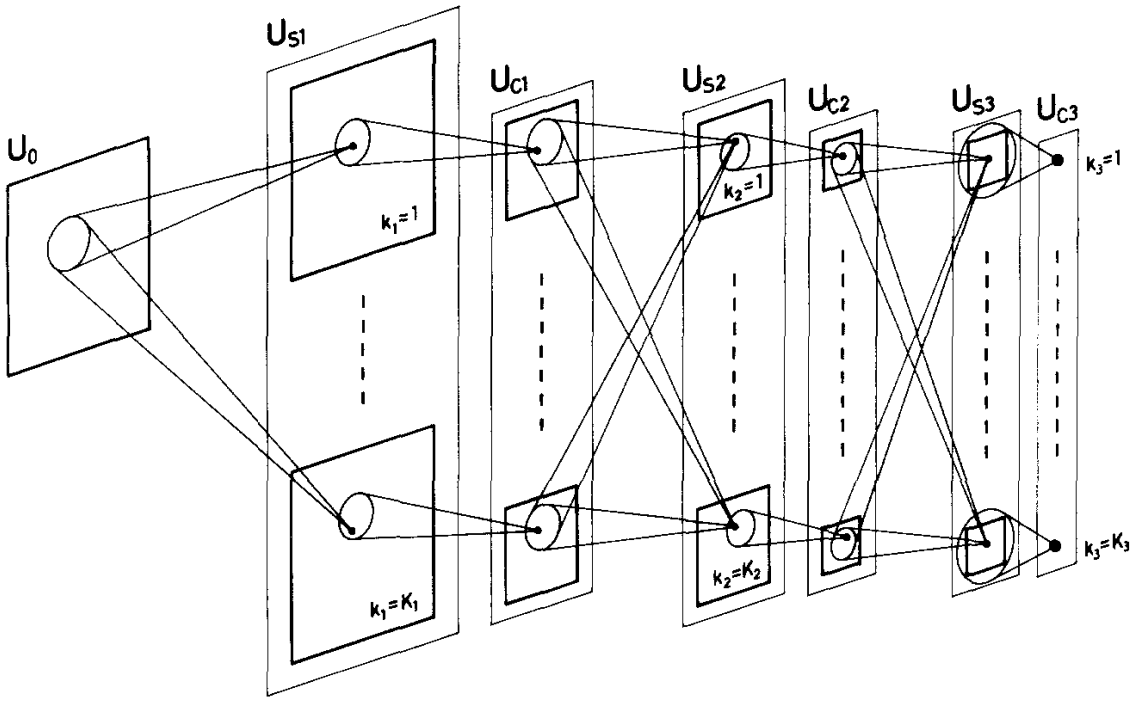

Figure 1: S and C layers are alternating.

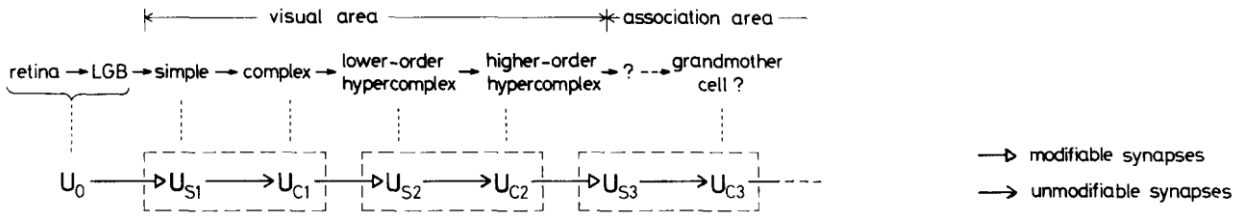

Figure 2: Arrangement of the layers of cells

The S-cell which has the highest value within that plane, is propagated to the next S-layer. This explains the concept of S-columns, where the dominant cells generate stimuli that are propagated to the further regions.

Now let us about the self-organizing part. From Fig. 2, it is clear that the S-cells are modifiable while the C-cells aren't as they are connected to their specific regions of S-cells. But the S-cells can be presented with similar patterns again and again by which these cells get reinforced and some of the cells get strongly biased towards a feature and thereby propagate the signal to further layers. This way the cells are trained with different set of patterns for which different set of cells become sensitive to. It must be observed that different patterns might contain similar sub-patterns. Hence, the cells that get stimulated need not be totally different for different patterns.

The research work presented here has provided a stable ground for establishment for modern Neural Network architectures. Although this implementation does not yet include backpropagation, the ability of the network to recognize patterns and also account for positional variations and a bit of distortions is just intriguing!

References:

1. https://www.youtube.com/playlist?list=PL13DA69CB569CE1E6