Self-organized criticality in a neural network with the Watts-Strogatz topology

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The concept of complex networks describes a set of systems that exist in nature and have non-trivial topological properties. So relationships between states, people in a group (social network (sociology)), climate networks, epydemy networks, relationships between firms, computer networks, the Web, technological networks, relationships between genes in DNA are all examples of complex networks. Various phenomena arising in such networks are of great interest. One of these interesting phenomena is the phenomenon of self-organized criticality.

Self-organized criticality (hereinafter referred to as SOC) describes processes, ranging from snow avalanches and earthquakes to forest fires. The dependence of the size of events of these phenomena on the number of events matches a power law [1]. If we imagine systems that allow us to observe the above phenomena as mathematical models, then we can see that the SOC manifests itself at a certain (critical) value of a certain parameter, called the control one. Moreover, the critical value of the control parameter may depend on some other parameters of the system.

A phenomenological Integrate-and-Fire neural network with short-term plasticity and a "Small world" topology (the Watts-Strogatz model) is taken as a model for such a system [2]. The structure is determined by parameters that reflect the number of neighbors and the probability of a random connection.

The phenomenon of self-organized criticality in a neural network with short-term plasticity has been studied. It was found that this phenomenon is affected by the parameter of the bond strength. The value of the critical parameter is studied for different number of neighbors in the Watts-Strogatz topology. It seems that the dependence of the critical value of the parameter on the number of neighbors obeys the power law.

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