A neural net can serve as a biological example of a stochastic dynamical network. Generally, we consider a large collection of nonlinear units ("neurons") with dissipation, coupled to each other in a certain way. Each unit is subjected to an external perturbation, which has the features of a random signal, called "noise". In a real neural network a random-looking input to an individual neuron arises as a result of summation of inputs from many surrounding neurons.

In a single nonlinear unit noise can induce oscillations, which are impossible without external input, and their regularity depends on the level of applied noise in a highly counterintuitive way. Namely, there is an optimal, moderate, level of applied noise at which the oscillations are most regular, and this phenomenon is called coherence resonance.

Coupled within a network, individual units influence each others’ behavior, and depending on the coupling parameters, they can oscillate with various degrees of synchrony. Several kinds of collective behaviour will be demonstrated, including non-synchronous and synchronous oscillations (firings in terms of neurodynamics), and several stages in between the two extremes.

On the one hand, neural synchrony is believed to be helpful in information processing. On the other hand, a range of neural disorders, like Parkinson’s disease, essential tremor and epilepsy, are believed to be associated with synchronization in certain parts of the brain. To control such conditions, it is therefore necessary to get rid of unwanted synchronization. Of course, the best control tool in this situation would be non-invasive and easy to apply.

An overview of the existing approaches to the manipulation of the collective behavior of stochastic dynamical networks will be given. One approach will be considered in more detail, namely, the delayed feedback applied through the mean field. It will be shown how one can induce or destroy synchronous firing, or adjust the amount of synchrony in the network, depending on what the situation requires. The knowledge of the existing collective behavior can help one to predict the outcome of the delayed feedback application. It needs to be taken into account that the delay can introduce multistability. Namely, from different initial states the stochastic network can settle down at different types of collective oscillations, e.g. it can be either synchronous or non-synchronous at exactly the same parameters, depending on initial conditions.

A semi-analytical approach is discussed that can help to analyse and predict the behavior of a stochastic network, possibly with delays included. Namely, one can write down a system of cumulant equations and truncate it at certain stages. The accuracy of different approximations is illustrated by comparing with the numerical solutions of the full stochastic differential equations.