Modeling Of Odor Information Processing In The Human Brain
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The question of how brain-like networks behave dynamically and in particular, how they might store and retrieve information has become a focus of many mathematicians and physical scientists interested in building devices with pattern recognition abilities. We attempt to relate the parallel endeavors of biologists and theorist in the context of the mammalian olfactory bulb, which we believe to be a particularly good model system for study of the neural substrate for learned pattern recognition and association. Olfactory system deals with the analysis and processing of odor molecule’s information. It is one of the oldest systems present in mammals. The olfactory bulb helps in discriminating and identifying different odors. The anatomy and physiology of the olfactory bulb are well studied. Efforts have been made to model its information processing function, which is still unclear. Since the olfactory bulb is located close to the brain, studying the functionality of it would help us understand how other parts of the brain work.

In the brain, fast oscillations of local field potentials, which are thought to arise from the coherent and rhythmic activity of large numbers of neurons, were observed first in the olfactory system and have since been described in many neocortical areas. Oscillations and chaos has been the subject of extensive studies in many chemical, physical, and biological systems. Oscillations can occur in neural system due to properties of single neurons and properties connectivity among neurons. The studies on oscillations in neural networks further investigate special geometries of neural network architecture that promote oscillation. The model, which we consider, is based on oscillatory type of neural nets given the biophysiological evidence, which places a strong emphasis on this particular type of dynamics in the cortical circuits. It will be important to determine the sequence of events in the olfactory bulb circuitry during odor stimulation in order to understand the generation of odor-induced responses of mitral/tufted cells and signals from the output neurons of the olfactory bulb.

We model and simulate the problem of how the olfactory neural system processes the odorant molecular information for constructing the olfactory image of each object. The brain simulator is based on oscillatory neural networks and uses coupled oscillators because the cell structures act like coupled oscillators. In order to implement this in the model, we use nonlinear differential equations with matrices to represent a system of mitral and granule cells.

Our approach to this problem is to faithfully model the olfactory neural system and simulate its outputs. The input to the model is assumed to be composed of true odor signal and a sum of the receptor background and the central inputs to the mitral cell dendrites in the input layer.