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Coupled Systems, Synchronization, Neural Networks, Neuronal Dynamics, Flocking Problems and Traffic Flow Models

Our research interests are centered around the real world problems that can be modeled by coupled networks. Among the problems under considerations are as follows: **(i) Coupled chaotic oscillators; Coupled maps lattices.** Our group has been studying synchronization phenomena in coupled systems for the last few years. We develop some analytical theorems to ensure the emerge of synchronization. These results can be applied to the realistic design of electronic circuit system and secure communication (Figure 1). **(ii) Biological neural networks; Neural pathways:** In the last few decades, the study of the neuronal dynamical behaviors has shifted to a network of neurons from a single neuron. Our group focuses on the study of synchronization phenomena in the neural network and probes the distinct neuronal dynamical behaviors under coupled neural networks (Figure 2). **(iii) Flocking behavior; Collective animal behavior exhibited by many living beings such as birds, fish, bacteria and insects:** Recently, we consider the flocking behaviors of living beings and discuss the mechanism of avoiding collision between them (Figure 3). **(iv) Epidemic models; Disease transmission models :** We are also interested in considering the impact of the individual contact networks, awareness and vectors on the disease spreading. **(v) Microscopic and macroscopic traffic flow models :** The traffic flow problem is one of our research interests. We wish to study some well-known traffic models to explain the traffic flow and the occur of traffic jams. In the future, we aim to use our model to predict and control the traffic flow in freeways of Taiwan.

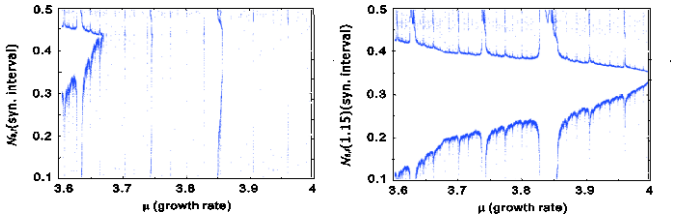

Figure 1: The wavelet transform method on the logistic map to increase the interval of synchronization.

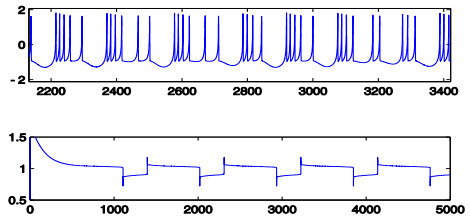

Figure 2: Neuron exhibits different firing dynamics without or with coupling.

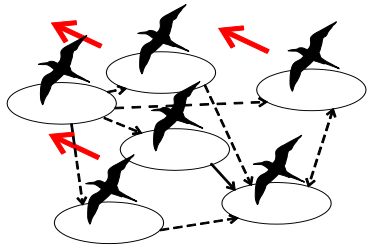

Figure 3: A flock of birds reaching the consensus fly with the same velocity and preserve their flying formation.