Collaborative Research Center for Innovative Mathematical Modelling

[Innovative Mathematical Modelling to Solve Complex Problems in Our World]

Institute of Industrial Science

http://www.sat.t.u-tokyo.ac.jp/center/

Complex Systems Modelling

Innovative Mathematical Modelling

Mathematical modelling is a way to describe a system of phenomena using mathematical language. We are studying mathematical theory for innovative mathematical modelling and its applications in order to resolve complex issues in science and technology.

We are promoting the project "Mathematical Theory for Modelling Complex Systems and Its Transdisciplinary Applications in Science and Technology" (Core-Researcher: Kazuyuki AIHARA), which is supported by Funding Program for World-Leading Innovative R&D on Science and Technology (FIRST Program).
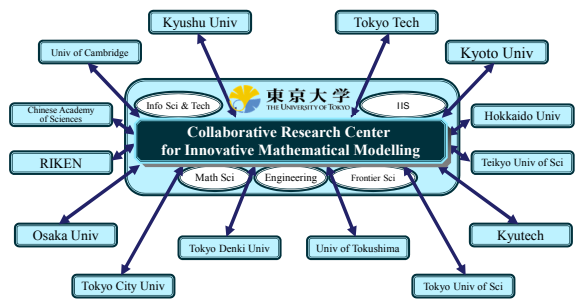

Project Organization Chart

Mathematical modelling for infectious disease containment

For spread of infectious diseases like influenza, we are researching effective measures for the infectious disease containment through simulations of SEIR model in which there are four kinds of populations: susceptible individuals (S), exposed individuals (E), infectious individuals (I), and recovered individuals (R).
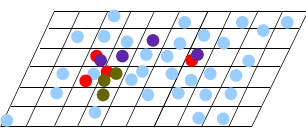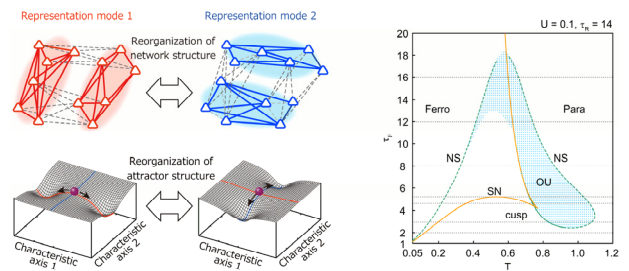

Spread of a infectious disease using SEIR model
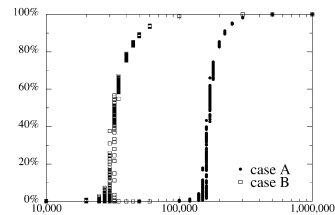
Dependence of fraction of I on movement restrictions and latent period

Early Detection of Complex Diseases by Dynamical Network Biomarkers

A biomarker is a substance used as an indicator for distinguish diseased from normal patients. In contrast, we theoretically derive an index based on a dynamical network biomarker (DNB) that serves as an early-warning signal to distinguish pre-diseased from normal patients.

Mathematical modeling of disease progression and DNB

Models of neural networks

Flexible mechanism of information processing in the brain is realized by communication among many neurons with transmitting electric signals. We have constructed mathematical models of neural network including dynamic synapses and investigated its dynamical properties and functions.
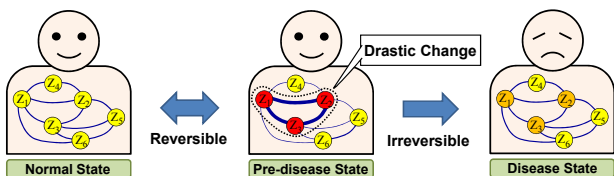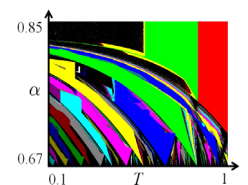

Model of dynamical reorganization of neural network

Bifurcation analysis of neural network with dynamic synapses

Optically Coupled Oscillators
～ Sync + Bifur = Rhythm of Light ～

An LED firefly is a square-wave oscillator controlled by LED light. A group of LED fireflies forms an Optically Coupled Oscillator (OCO), and OCOs generate a huge variety of synchronous patterns.
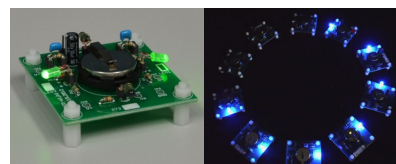
LED firefly and optically coupled oscillators

Bifurcation Diagram