Collaborative Research Center for Innovative Mathematical Modelling (CRCIMM)

[Innovative Mathematical Modelling and Its Applications]

Institute of Industrial Science

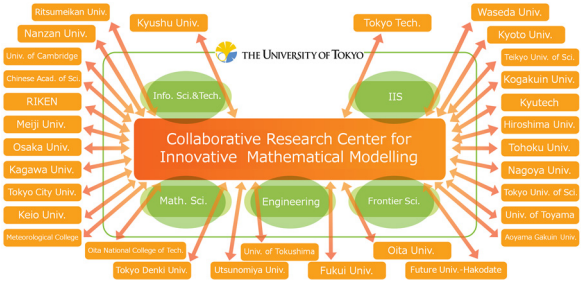
http://www.sat.t.u-tokyo.ac.jp/center/en

Special Field of Study: Complex Systems Modelling

Innovative Mathematical Modelling and Its Applications

Mathematical modelling is to describe a system or a phenomenon using mathematical language. We are studying innovative mathematical modelling and its applications in order to resolve complex issues in science and technology.

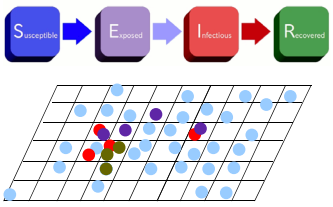
We are promoting the development of this research field based on the project "Mathematical Theory for Modelling Complex Systems and Its Transdisciplinary Applications in Science and Technology" (Core-Researcher: Kazuyuki AIHARA), which was supported by Funding Program for World-Leading Innovative R&D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



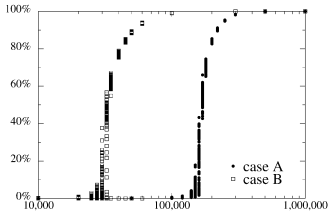
Project Organization Chart

Mathematical modelling for infectious disease containment

We are investigating effective measures for the containment of infectious diseases such as influenza. For this purpose, we use SEIR model in which four types of individuals are considered: susceptible (S), exposed (E), infectious (I), and recovered (R).



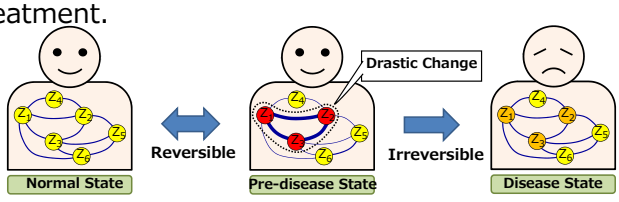
Simulation of spread of infectious diseases using SEIR model



Effects of movement restrictions and latent period on the spread of infectious diseases

Early Detection of Complex Diseases by Dynamical Network Biomarkers

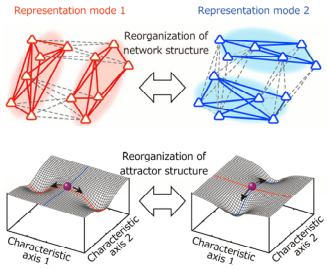
A biomarker is a substance used as an indicator to distinguish between disease and normal states. In contrast, we theoretically derive a new method, dynamical network biomarker (DNB), that distinguishes between pre-disease and normal states. This method serves for very early diagnosis and treatment.



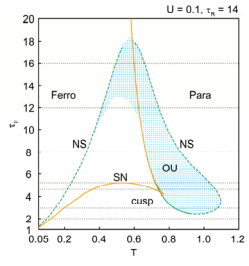
Mathematical modelling of disease progression and DNB

Models of neural networks

The flexible information processing in the brain is realized by communication among many neurons through electrical signals. We have constructed mathematical models of neural networks with dynamic synapses and investigated their dynamical properties and functions.



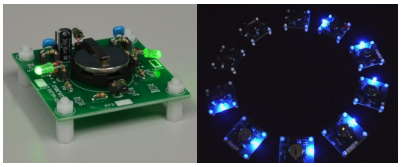
Model of dynamical reorganization of neural network



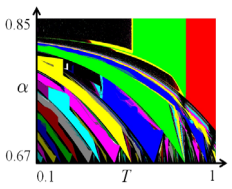
Bifurcation analysis of neural network with dynamic synapses

Optically Coupled Oscillators: Sync. + Bifurc. = Rhythm of Light

An LED firefly is a square-wave oscillator controlled by light. A group of LED fireflies (Optically Coupled Oscillators, OCOs), generates a huge variety of rhythms and synchronous patterns.



LED firefly and optically coupled oscillators



Bifurcation Diagram