AIHARA LAB.

[Mathematical Modeling for Solving Complex Problems]

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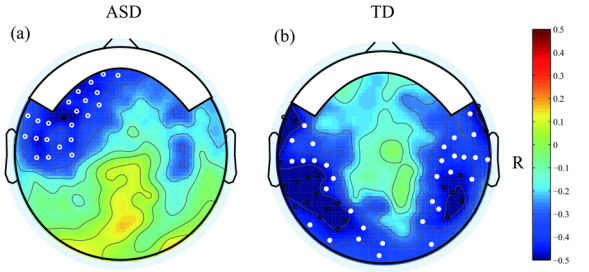
Special Field of Study: Biological Information Systems

Mathematical Modeling for Solving Complex Problems

We study a variety of complex systems and problems—biological systems, social systems, economic systems, diseases, energy problems, natural disasters, and so on—through mathematical modeling and data analyses. We also try to establish fundamental theories and methods for analyzing those specific systems. We advance researches based on the joint works with the Collaborative Research Center for Innovative Mathematical Modelling.

Brain: Neuroimaging

Magnetoencephalography (MEG) is a non-invasive neuroimaging method. We analyze MEG data by using graph theory to characterize the functional brain networks of autism spectrum disorder (ASD) children and typically developing (TD) children.



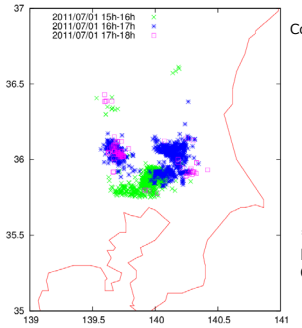
Courtesy of Fang Duan (D3)

The correlation coefficient maps between nodal efficiency and achievement scale by group.

An example of MEG data analysis of ASD and TD children

Lightning: Analysis of Lightning Data

It is important to evaluate a risk of damage from lightning for infrastructures (e.g., power grids, communication networks, tall buildings, and wind turbines). We are studying the relationship among the lightning parameters (location, time, peak value of current, polarity, etc.) and other factors (season, region, climate conditions, etc.) through observation data analysis and mathematical modeling.



Courtesy of Fumiyuki Fujii (Technical Associate)

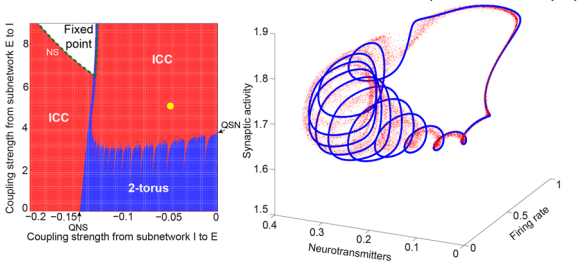
*Japan Lightning Detection Network of Franklin Japan Cooperation

Lightning occurrence map of Kantō region based on JLDN* data

Brain: Neural Network Model

We are studying complex dynamics of neural network models to understand the mechanism of flexible information processing in the brain. For example, we have clarified the conditions for different types of neuronal activities (fixed point, oscillation, chaos, cross-frequency coupling, etc).

Courtesy of Takumi Sase (D3)



(left) Bifurcation analysis and (right) an example of complex dynamics