Division of Electrical Engineering and Computer Science	Research field	Brain-Like Information Processing	Lab. ID EC33
Laboratory web site			

Research subjects

Over the last decade, computational modeling of human neurons has been central not only to neurobiology but also to computer science and many other fields. Much of this work has focused on how particular tasks or computations are implemented by neural networks to generate a behavior. As a consequence, the contribution of single neurons and their dendrites has long been overlooked underestimated. More recently, it has become widely accepted that dendrites play a key role in the overall computation performed by a neuron. However, the modeling of nonlinearity in dendrites and the assignment of the right synapses to the right dendrite remain open problems in the field. Thus, we propose a new neuronal model that considers nonlinear interconnection and synaptic plasticity, and we use the Exclusive OR problems and directionally selective cells to demonstrate dendritic nonlinear computation and the neuron's ability to learn. If correct, this model offers fundamental new insight to the neuron's function and may help to predict cell morphology and the spatial distribution of synapses.

Master/Doctor course: Education policy, curriculum, typical activity in the laboratory

Master course: The first grade students will be given some papers, or conference papers on brain-like information processing and asked to read them. The students give presentations and discuss their topics in a weekly laboratory seminar. At the beginning of the second grade, the students decide their research subject for the Master thesis after consultation with staffs. The students are encouraged to go for outer activities, participating research workshops/meetings, international conferences, even foreign country institutes for months.

Doctor course: The Our laboratory has a weekly seminar to doctor course students. In the seminar, the doctor course students have a chance to present their works, discuss and find out solutions to their problems. The professors will give an individual weekly meeting with the doctor course students twice a month to see the progress of their researches. The doctor course students must publish at least a journal paper for her or his doctoral degree.

Daily life in the laboratory, etc.

Personal working desk with a personal computer is available for every student.
All relevant students of undergraduate, and Master share the laboratory rooms, and everyday free discussion on brain-like information processing or related topics are strongly encouraged.
Many laboratory activities are organized like, welcome party for new comers, excursion, etc.

Message or comments by the laboratory faculty staffs

The mission of the Brain-like Information Processing Laboratory is to conduct state-of-the-art research and teaching that translates ideas from the brain sciences into new ways to design new computers. Researches on brain are very hot and interesting. Recently, several experimental findings, such as directional selectivity in retinal neurons and coincidence detection in the auditory system, have provided strong circumstantial support for dendritic computation playing a key and possibly essential role in neuronal computation. However, no existing model captures the important characteristic of dendritic nonlinearity. We proposed a novel neuronal model that mimics the essence of known nonlinear interaction among inputs to the dendrites. We have also showed that the rich nonlinear dendritic response and the powerful nonlinear neural computational capability of the model neuron, as well as many known neurobiological phenomena of neurons and dendrites, may be understood and explained by this model.

Recent Master theses in these 3 years (+ more if appropriate)

year.month	Thesis title (including English translation of Japanese thesis title)
2021.3	Research on Motion Direction Detection by Convolution Neurons
2021.3	Sentimental Analysis with Short Time Voice Data Using Machine Learning
2020.3	Micro expression recognition based on deep learning
2020.3	A new nonlinear synaptic function for dendritic neuron model
2019.3	Studies on the Dimensionality Reduction of Multi-Directional Images by Variational AutoEncoder
2018.3	Studies on Directionally Selective Cell's Dendritic Morphology Prediction
2017.3	Studies on Dendritic Structure Prediction of Auditory Coincidence Detecting Cells
2016.3	Studies on Directionally Selective Cells' Dendritic Morphology Prediction
2015.3	A New Neuron Model and Its Learning Algorithm

Recent Doctoral theses in these 3 years (+ more if appropriate)

year.month	Thesis title (including English translation of Japanese thesis title)

Laboratory mail address	TODO YUKI <yktodo@se.kanazawa-u.ac.jp>