An exploration of the principle of emerging interactions in spatiotemporal diversity

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ABSTRACT
We aim to construct an artificial system that produces functional differentiation via interactions with complex environment in order to adapt itself quickly to the environment. For this purpose, we develop a principle of self-organization with constraints which produces functional differentiation, and explore collective intelligence in humans and non-human primates. We conduct the research via analyses of interactions between brain areas, individuals and groups, respectively. The research results are expected to contribute to the development of order-made medical treatments, the design of interacting robots, in particular, with humans, and the creation of new format of community based on collective intelligence.

Author Keywords
Functional differentiation; complex environment; a principle of self-organization; constraints; collective intelligence; humans and non-human primates; interactions between brain areas, individuals and groups.

ACM Classification Keywords
H.5.3 Group and Organization Interfaces.

INTRODUCTION
As shown in Figure 1, our project consists of five teams: the emergence principle team (Tsuda), the inter brain regions and robot team (Kawai), the intra/inter individuals team (Kikuchi), the intra/inter groups team (Kameda), and the inter-individuals/groups team (Matsuda).

EMERGENCE PRINCIPLE TEAM (TSUDA G)
On We propose the principle of interaction emergence and clarifies its information structure. Express the target system as a network and confirm the dynamic transition of the network structure based on the norm of propagation information amount maximization among nodes. By introducing various constraints, optimization of the network structure occurs, visualization of the process of functional differentiation as a result, and clarify the mathematical structure of the principle of interaction emergence. We will verify and strengthen the principle by applying this principle to three different interaction levels between brain regions, intra and inter individuals and intra and inter groups.

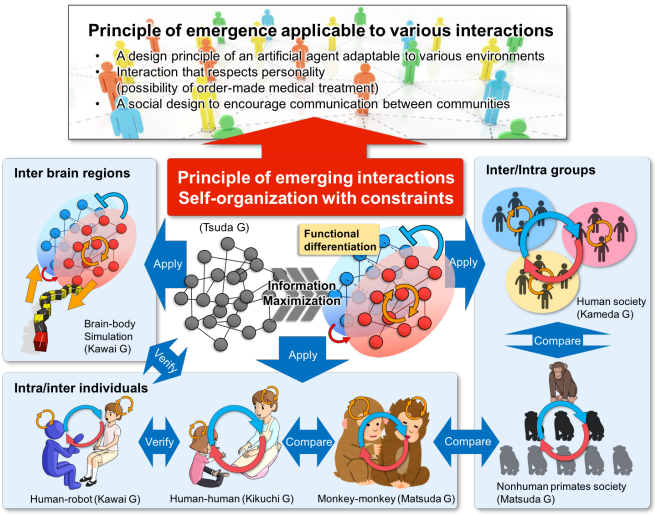

Figure 1: Team structure of the project on an exploration of the principle of emerging interactions in spatiotemporal diversity

INTER BRAIN REGIONS AND ROBOT TEAM (KAWAI G)
We cover the interaction between the brain and the environment as a typical example. We show that neural network structure is treated as interaction between regions of the brain and functional differentiation is promoted based on the principle of interaction emergence. The network structure to be constructed and its change are the foundation of various interactions.

INTRA/INTER INDIVIDUALS TEAM (KIKUCHI G)
We observe the human brain interaction using the hyperscanning MEG system. In particular, we focused on comparison between autistic spectrum children and their

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parents, and typical development children and their parents, tried to extract brain activity patterns unique to autistic spectrum children, and we will make it clear the difference in functional differentiation by examining the difference between functionalized networks of brain regions of typical development children and those of autistic spectrum children. Based on the obtained findings, we will explore the path to diagnosis and care.

INTRA/INTER GROUPS TEAM (KAMEDA G)

The attempts to model various interactions among groups, with human group as a unit. If it is on the Web, incorporate a virtual agent to promote the emergence of collective action. By setting cooperative/competitive tasks and applying the above principle model, dynamic change of group creation and division is regarded as group functional differentiation and the process is clarified. In experiments in real environments, we also clarify the dynamic process of group dynamics considering physical constraints of individuals. By doing this, guidelines for group behavior design at the time of disaster etc. are acquired.

INTER-INDIVIDUALS/GROUPS TEAM (MATSUDA G)

Please We observe social interactions among individuals and between groups in captive and free-ranging non-human primates, focusing on their multi-level social system that is one of the most complex primate society, in which two or more levels of organization are recognizable. We attempt modeling by applying the principle of interaction emergence, and aims to strengthen the demonstration of principle. By revealing the differences due to the different levels or species at the same level, the depth and the capability in representing the divergence of the principle of interaction emergence will be made clear. Applying this, we can propose a technique to design an environment that encourages the better social structure and to optimaize human behaviors. Throughout the topic data analysis that captures algebraically the phase structure embedded in the data is conducted by the emergent principle team (Tsuda G).

With the above team structure, we clarify the emergent principle of interaction between brain regions, individuals, and groups embedded in a complex networked environment. By clarifying the mechanism of differentiation, we develop a method to optimize human behavior in a networked society.

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