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Editor

Biological Functions for Information and Communication Technologies

Theory and Inspiration

Springer

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Prologue

In a sense, designing and constructing information communication systems inspired by life will establish a new paradigm in the history of science and technology. Given the 4 billion-years required to evolve intelligent life with the superb structures and functions of human and animal brains, it is clear we have much to gain by studying, with an open mind, the deep, sophisticated structures and functions of life forms, as well as the mechanisms of the evolution of life.

This book introduces trends in research on information and communications technologies inspired by life, current trends in research on molecular communication technologies, and future prospects for research in these areas. Chapter 1: "Reconsidering information and communications technologies from life", Chap. 2 : "Molecular communication as a Biological ICT", Chap. 3: "Artificial chemistry and molecular networks", Chap. 4: "Signal transduction in biological systems and its possible uses in computation and communication systems", and Chap. 5: "For deeper understanding". I will also present relevant research currently underway.

Chapter 1 aiming at the connections between life and ICT, focuses on information processing research modeled on the brain, on the various theories of evolution, on the early evolution of cells, or inspired by the evolution of life itself. Chapter 2 introduces molecular communication technologies as bio-ICTs and describes biosystem molecular communication, molecular communication architecture, and molecular communication design, which represent molecular communication technologies within the scope of biological information and communications technologies. Chapter 3 focuses on research on a network-type computing machine based on intermolecular interactions, describing control flow clusters as active machines, network connection switching rules based on energy minimization, self-organizing network configurations based on programming of active nodes, molecular agents, and program-flow computing, with the goal of creating new algorithms based on molecular theory. Chapter 4 discusses biosystem signal transmission and potential applications to computation and communication systems, drawing on cellular signal transmission networks and formal models, dynamic analysis of signal transmission networks, and error correction codes for cellular signaling pathways. Chapter 5, for deeper understanding, introduces

briefly the original thoughts aiming at and studying on life, and explains the solutions for real-world problems by complex networks which are currently attracting attention.

These topics will help present the argument that designing information processing models inspired by the superb design and function of life forms will lead to the design of various information processing systems and information communication systems capable of solving real-world problems. They also introduce the topic of using the functions of life forms at the molecular level to construct information communication systems based on molecules. Some of these technologies have already entered practical use, while others are expected to find practical applications in the near future.

Hidefumi Sawai

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