Game Theoretic Analysis of Competition during Neural Development

Irit Nowik

Industrial Engineering and Management Department
SCE - Shamoon College of Engineering
Ashdod 77245 Israel,
E-mail: iritno@sce.ac.il

Key words: Stochastic processes, Game theory, Size principle, Synapse elimination

We offer a new game theoretic approach to analyze biological competitive processes. We analyze the developmental competition between neurons innervating the same muscle. We view the neurons as the players competing to innervate a maximal number of muscle fibers. When the competition period ends, neurons with successively higher activation-thresholds innervate successively more muscle fibers. This is called "the *size principle*". The size principle is thought to result from the competition between the neurons but it was not known how. As the size principle is thought of as one of the most fundamental principles in the organization of the motor system, it is important to understand how it evolves. Existing experimental data on this issue seemed contradictory and was referred to as "paradoxical". The analysis in this work is centered on two interconnected stochastic processes. We prove that the *time* of winning has competitive value, in the sense that it is advantageous to invest more in *later* competitions, in order to win *more* competitions. This enables us to resolve the paradox, explain the size principle, and provide testable predictions. These results have implications on non biological competitive systems as well.