Non-locality in Cognition without Quantum Mechanics

Yukio-Pegio Gunji [1], *Taichi Haruna* [2]

(1) Waseda University, Shinjuku-ku, Tokyo, Japan, yukio@waseda.jp

(2) Tokyo Woman's Christian University, Suginami-ku, Tokyo, Japan

While cognitive illusion such as conjunction fallacy, guppy effect and border line contradiction, is recently explained by using quantum mechanics, there is no reason why one can introduce quantum mechanics. We here define cognition as a binary relation between a set of objects in the external world and a set of representations in a brain, and underlying algebraic structure as a rough set lattice [1]. We show that dealing a single item is expressed as a Boolean lattice, and that decision making using AND- and/or OR- operations can divide a binary relation into some contexts entailing generalized Orthomodular lattice (i.e. almost disjoint union of Boolean lattices). Because an Orthomodular lattice is regarded as quantum logic without Hilbert space, our approach verify why quantum-like mathematical structure can be arisen in macroscopic phenomena. We also define probability map from a lattice to [0.0, 1.0] which is monotonous. The change of a lattice entails the change of the probability space. Figure 1 shows the simplest case of the change of lattice from Boolean lattice to Chinese lantern (one of generalized Orthomodular lattice). Elements of a Chinese lantern derived from decision making is regarded as a contracted subset of corresponding Boolean lattice. In Figure 1 elements in Chinese lantern has the same color as a subset of Boolean lattice. Based on elements in the corresponding subset, the probability of elements in Chinese lantern is determined. In Figure 1, while $P(1001) = P(1010) = 0.5$ is determined in Boolean lattice, $P(1001 \text{ AND } 1010) = P(1000) = 0.57$ is determined in Chinese lantern. It shows that guppy effect since $P(A \text{ AND } B) > (P(A)+P(B))/2$. Finally, we show that macroscopic cognition has non-locality leading to quantum logic without Hilbert space and most of cognitive illusion can be explained in this perspective.

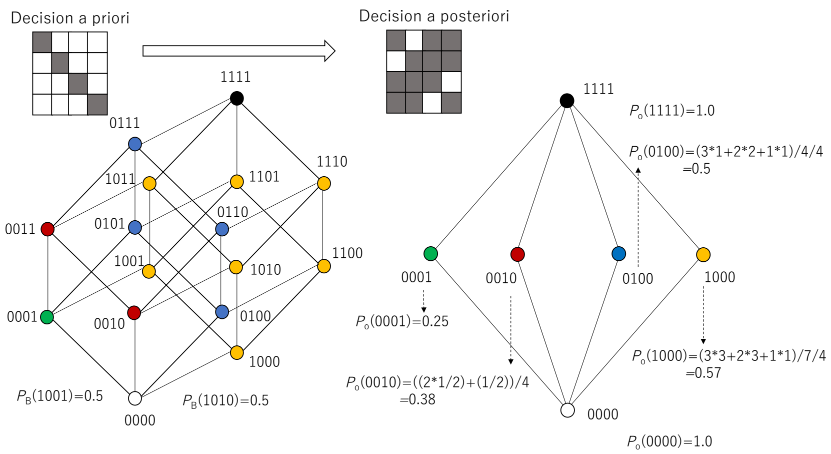

Figure 1: Boolean lattice (left) and Generalized Orthomodular lattice (right)

References

[1] Gunji, Y.-P. and Haruna, T. (2010) A Non-Boolean Lattice Derived by Double Indiscernibility. *Transactions on Rough Sets* XII, 211-225.