Asymmetry in Genetic Code and the Role of Parrondo's Paradox in Nature

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I. INTRODUCTION

Genetic code table summarizes how the basic unit of protein – amino acid is encoded from sequences of three nucleotide triplet known as codon. Based on a set of simple rules, codons can be translated into amino acids and thus protein.

Standard genetic code table, as shown in Fig. (1), is arranged in a way that provides insight into physicochemical and biological properties of amino acid that are generated from the DNA/RNA codons. However, the standard genetic code table is oriented in such a manner that overlook the big picture that nature wish to convey to us – symmetry and asymmetry of life and the potential implication of asymmetry. Standard genetic code table can be put under mapping to result in a reconstructed genetic code table that show more clearly the symmetry and asymmetry of life code.

The reconstructed genetic code table, as shown in Fig. (2), shows slight asymmetry embedded in general symmetry, a pattern happens too many a time in nature. Human is a good example – mirror symmetry outside but internally, some of the organs are arranged in an asymmetrical manner. Total symmetry signifies stability, stagnant and eventual death while asymmetry means instability, constant movement and eventual breakthrough to life.

The reconstructed genetic code table shows mirror symmetry except for the small highlighted region in the center. The asymmetrical region is highlighted in Fig. (3). The reconstructed genetic code table is symmetrical around U – C and A – G of the third letter of codon except the above mentioned region, with U and A at the left column while G and C at the right column. Left and right column are symmetrical except for the highlighted region, giving a binary outcome – "left" versus "right".

Codons in the asymmetrical region encode for three amino acids – Tryptophan, Isoleucine, Methionine and one termination codon. The focus here is Methionine. Several studies have found out that restricting Methionine consumption extends lifespans of some animals and affect their fecundity[1, 2].

It is believed that asymmetry in genetic code table might have something to do with 3rd order path-dependent Parrondo's paradox. Parrondo's paradox is a counter-intuitive phenomenon whereby two individually losing games – game A and game B, can be mixed to produce a winning combine game.

In this case, noise can be seen as game A – a random process, while protein translation process can be seen as game B. Wobble base pair or the surrounding environment can serve to provide the noise component. The translation process can be biased into depressing methionine codon expression or promoting methionine codon expression. Parrondo's paradox will get in depending on whether noise is present or not.

In the scenario where the translation process is designed to promote the expression of methionine, introduction of noise has the paradoxical effect of decreasing the expression of methionine. Perhaps this is the design of nature, that in stable time, when there is no noise or less noise, the normal process of promoting expression of methionine take place, where individual reduce their life span in exchange for reproducing more rapidly.

On the other hand, in turbulent period where the situation is unsuitable for raising offspring, it would be better to increase individual survivability at the expense of reproduction capability. During unstable period, there will be an increase in the amount of noise and as a result of noise introduction, Parrondo effect will come in. The normal translation process (game B) will couple with noise (game A) and result in the outcome of suppressing the expression of methionine (Combine game), thus increasing the lifespan and survivability of individual while restricting reproduction.

In conclusion, 3rd order path dependent Parrondo's paradox and asymmetry in life code have both been independently developed. The study proposes a possible linkage between Parrondo's paradox and life code but the exact mechanism has yet to be firmly established. Evidence has been pointing towards that direction but the mystery remains determined not to be unraveled.

II. RESULT

3rd order path-dependent Parrondo's paradox can be seen as an extension of history dependent Parrondo's paradox[3]. Game A and game B both has binary outcome – "Win" and "loss". Game A has winning probability of p and losing probability of $(1 - p)$ while game B has winning probability p_k and losing probability of $(1 - p_k)$ depending on the result of previous three games.

The winning probabilities of game B can be summarized in the table below.
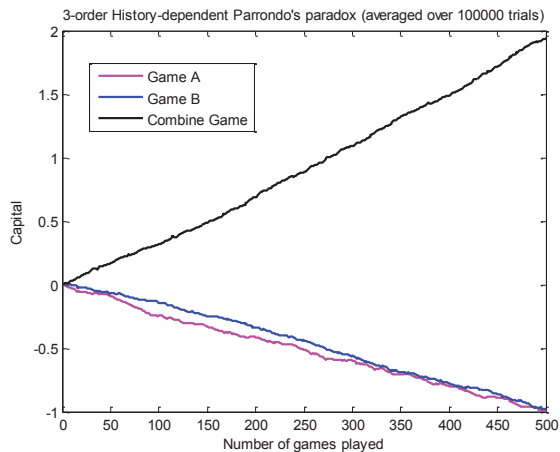
State k	Result of game at $(t-3)$	Result of game at $(t-2)$	Result of game at $(t-1)$	Winning Probability, p_k, at time t
1	Loss	Loss	Loss	p_1
2	Loss	Loss	Win	p_2
3	Loss	Win	Loss	p_3
4	Loss	Win	Win	p_4
5	Win	Loss	Loss	p_5
6	Win	Loss	Win	p_6
7	Win	Win	Loss	p_7
8	Win	Win	Win	p_8

One of the many possible sets of winning probabilities used in game A and game B are as shown:

Game A	Winning Probability	Game B	Winning Probability
p	0.499	p_1	0.899
		p_2	0.499
		p_3	0.499
		p_4	0.249
		p_5	0.249
		p_6	0.499
		p_7	0.499
		p_8	0.699

*Note: Losing probability = 1 – winning probability

The result of two individually losing game A and game B with a winning combine game, using the set of probabilities above, is as shown below:

III. FIGURES

FIG. 1. Standard Genetic Code Table.

FIG. 2. Reconstructed Genetic Code Table

FIG. 3. Asymmetrical region in genetic code table

[1] Grandison. R.C., Piper. M.D.W. and Partridge. L., Nature **462**, pp. 1061-1064 (2009).
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[3] Parrondo. J.M.R., Harmer. G.P. and Abbott. D., Physical Review Letters **85**, pp. 5226-5229 (2000).