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Dedicated to Author's Wife
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BINARY AND TERNARY STRUCTURES IN THE EVOLUTIONS IN THE UNIVERSE ($2 \times 3 \times 2 \times 2 \times \cdots$ -WORLD)

THE DESCRIPTION OF FURTHER STAGES OF THE EVOLUTIONS (POLYMERS, MOLECULAR BIOLOGY AND NATURAL LANGUAGE)

Summary

In this paper we continue our considerations and describe the further stages of the evolution. We can construct the evolution theory for polymer physics, molecular biology and natural language.

Keywords and phrases: polymer, molecular biology, natural language, binary physical structure, ternary physical structure, polymer, evolution, universe, binary extension, ternary extension, noncommutative Galois extension

Introduction

In the first part of our paper [24] we proposed a definition of evolution that might uniformly describe evolution from the level of atom physics to cosmology and molecular biology. Introducing the concepts of binary and ternary extensions we described the hierarchy structure (BTBB-structure) and the complexity systems of the evolution of the universe in a unified manner. We also constructed evolutional tree and discussed basic problems concerning the evolutions. Based on the scheme given in Figure 5 of [24] we described the evolutions of the space-time, atoms, stars and galaxies. In this paper we continue our considerations and describe the further stages of the evolution.

1. The description of the evolutions in the universe (IV) and (V), (VI). Polymer physics and molecular biology.

In our paper [24] we gave the definition of evolution in terms of entropy based on Boltzman formula:

$$S(X) = k \log(\#(X_j)),$$

where k is a positive constant, and $\#(X_j)$ is the total number of the states $\{X_j\}$ of the system X and described evolutions.

We will describe the evolution of polymer physics and molecular biology. We follow the notations in Part I.

1. Polymer physics. The processes (1)-(4) are those of atom physics. The processes (5)-(∞): Choosing monomers we can give polymers of linear type by successive binary extensions. Monomers make simple random walks and polymers make self avoiding random walks respectively. Hence we see that the distributions of polymers are of power law type [8]. We show that we can realize some of planer polymers by the complex analytic method [15] as can be seen in Fig. 1.

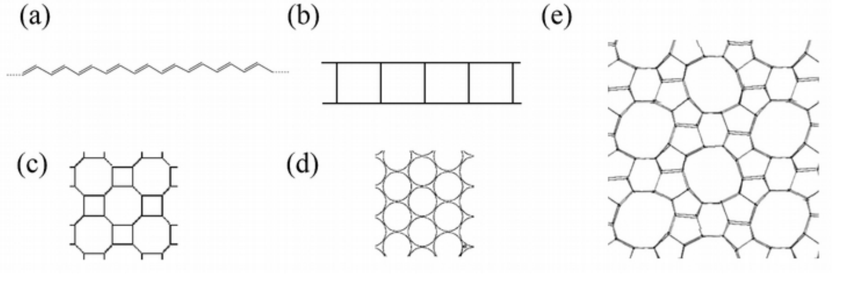


Fig. 1. (a) Polyacetylene, (b) Magnetic body, (c) Graphite, (d) Zeolite, (e) Zeolite.

The separation of the universe and polymer. Although their characters are quite difficult, they have the same seed. We should know how the separation is created.

Next we will treat the evolutions in molecular biology in the following two steps separately:

2. The chemical evolution of RNA, DNA and proteins [9]. The evolution is quite similar to that of polymers. The difference is the bond structure. They have peptide bands. We choose the RNA world and describe the evolution.

(1) They make a neutral evolution. Hence they make a simple random walk.

(2) The first binary extension generates DNA sequences from RNA sequences. Here we notice that there is the duality: A $\Longleftrightarrow$ T, C $\Longleftrightarrow$ G.

(3) The ternary extension generates proteins by the transcription mechanism following the codon table [9, 17].

(4)-(∞) These processes produce construction of cells.

Whether the construction of cells can be performed by successive binary extensions or not is not known. Typical self organization is self replication. This might be a binary extension [16].

3. The biological evolution [4, 17].

(1) The origin of the life surely exists but is unclear. We put the origin as élan vital by H. Bergson [3].

(2) The first binary extension is the duplication caused by EF1a and EF2, (Fig. 2 (a)).

(3) The ternary extension generates the 3-domains of animals (Fig. 2 (b)) [11].

(4)-(∞) These processes produce the body construction. It is unknown whether the body construction of a living being can be performed by successive binary extensions or not. The tool-kit operation might be a binary extension [4].

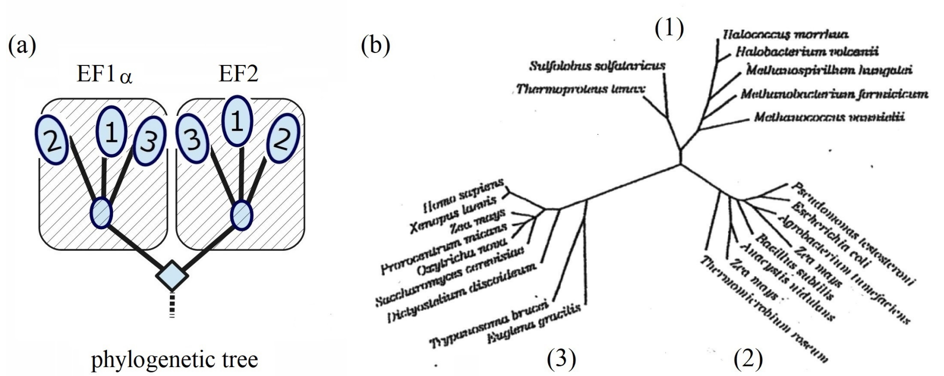


Fig. 2. (a) Genes duplication of $EF1_{\alpha}$ and EF2; (b) Three domains of biological evolution ((1) Archae bacteria (2) Eubacteria (3) Eukaryota).

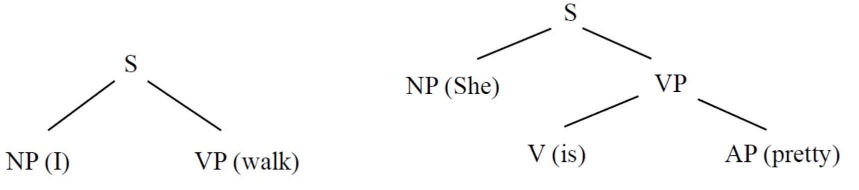
Some remarks on Astrobiology. Recently more and more often biology is studied in the framework of astronomy. We expect that our theory shall contribute to these studies, because we can discuss the evolution theory finding the binary and ternary extension structures without any knowledge on living beings on other planets.

2. The description of the evolutions in the universe (VI). Natural languages

Here we consider the Shannon entropy [24]. It measures how much non-determined information remains in the process. Following Chomskys old syntactic theory (1975) we construct the evolution [5].

(1) The origin of the creation of language is also unclear. The language begins with sequences of words. The language is called regular language. When we ignore the sense of the words, we may assume that they make simple random walks.

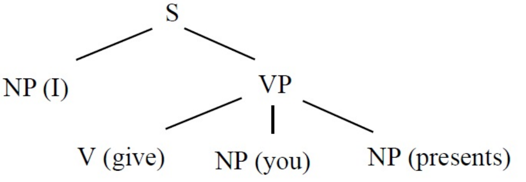
(2) The first binary extension classifies the words of the regular language into the ending part and non-ending parts and produces the context free sentences [14]. Example, I walk or She is pretty (Fig. 3).



[h]

Figure 3.

(3) The ternary extension appears in more complicated sentences: Example: I give you presents. This can be realized by the successive binary and ternary extensions:

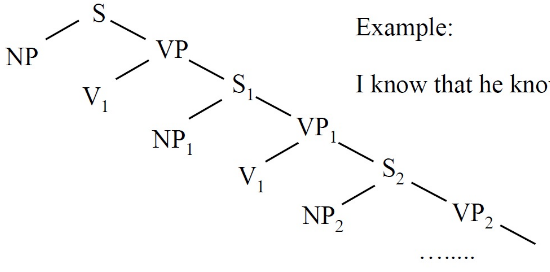


[h]

Figure 4.

(4) We can list up all the possible sentences in our scheme. We omit it. The realizable sentences in (∞) are a certain class of sentences which are not the total sentences.

Summary: We know that our scheme is not enough to describe all the sentences in this real world, although it can describe simple daily conversation sentences. Here we give an example of sentence which can be acceptable by grammar, but not practical in use:



Example:

I know that he knows that he knows...

[h]

Figure 5.

The new phase of the evolution in formal and natural languages. In order to include all sentences, we have to extend our scheme to Turring machine. This is the conclusion from the classification of the formal languages:
(1) Regular sequences $\Longrightarrow$ (2) Context free sentences $\Longrightarrow$ (3) Context sensitive sentences $\Longrightarrow$ (4) General (Type 0) sentences [14].

Our evolution theory can cover only the stages (1), (2) and (3) in this category. Hence in order to cover all sentences, we have to extend our evolution theory to the Turring machine (4). By this we have encountered a new phase in the evolution. We may imagine easily that we have encountered the appearance of intelligence at this stage.

Remark. In Part III we will develop the non-commutative Galois theory of language and realize the Chomsky's universal grammar in this theory and discuss basic problems in a rigorous manner.

Conclusions. Our observations show that we can analyze the evolution and construct the evolution tree when a seed of the evolution is given. Hence the final question might be to make clear the seed of the evolution. We may expect that the book with the title The Origin of Seeds" (not "species" [6]) should be written.

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STRUKTURY BINARNE I TERNARNE W EWOLUCJACH WSZECHŚWIATA (ŚWIAT $2 \times 3 \times 2 \times 2 \times \cdots$)

OPIS DALSZYCH FAZ EWOLUCJI (POLIMERY, BIOLOGIA MOLEKULARNA I JĘZYK NATURALNY)

S t r e s z c z e n i e

Po sformułowaniu definicji ewolucji w Części I tej pracy [24] i opisie pierwszych faz ewolucji, kontynuujemy ten opis uwzględniając fizykę polimerów, biologię molekularną oraz języki naturalne.

Słowa kluczowe: polimer, biologia molekularna, język naturalny, binarne struktury fizyczne, ternarne struktury fizyczne, kwinarne struktury fizyczne, senarne struktury fizyczne, pentacen, polimer, ewolucja, wszechświat, rozszerzenie binarne, rozszerzenie ternarne, nieprzemienne rozszerzenie Galois