FIS2005 http:/www.mdpi.org/fis2005/

Extended Pain as Margin to Paste up to Future

Yukio-Pegio Gunji[1,2], Taichi Haruna[2] and Igor Balaz[3]

[1]: Department of Earth and Planetary Sciences, Faculty of Science, Kobe University, Nada, Kobe 657-8501, Japan
[2]: Graduate School of Natural Sciences, Kobe University
[3]: Faculty of Natural Sciences, University of Novi Sad, 21000 Novi Sad, Serbia and Motenegro

E-mail: yukio@kobe-u.ac.jp

Abstract:
Through some topics on knowing something, empirical temperature and robot's recognition, we make the interface between parts and whole manifesting, and express it as "extended pain". By formalizing wholeness as a weaken co-limit, we describe dynamical negotiation between making parts and making whole in a lattice theory as a model for differentiation under a constraint of unity.

Keywords: self-0rganization; negotiation; sheaf; co-limit; empirical world

1. Introduction

Since a self-organizing system consists of parts or subsystems autonomously constructed, it contains differentiation process. In most cases, proliferation does not entail to explosion or collapse of a system and generated parts can interact with each other subsequently, under a particular constraint such as a system unity. Although it looks as if generating parts through differentiation was consistent with keeping a unity as a whole, the perfect consistency between existence of parts and the unity never allows development and/or proliferation of a system. Making parts can be dynamically balanced with making a unity, and that is the negotiation between parts and whole.

How can we describe that negotiation? The notion of wholeness of a system is expressed as a (co-) limit in terms of category theory, in a system theoretical approach including M-R system, [1,2] autopoiesis [3] and evolvable hierarchical system [4]. Individualizing context or making a co-limit is expressed as a co-limit functor that can constitute higher order in a hierarchical system [4,5,6]. A co-limit functor constitutes adjunction with a diagonal functor, and that implies making wholeness is consistent with making parts without negotiation. Making a higher order in those models is implemented as external driving force, not as self-organizing force, since there is neither indefiniteness nor choice. We have to weaken the notion of co-limit and implement dynamical negotiation for a self-organizing system [7,8].

The negotiation between parts and whole is not a feature specialized only to living systems. When one talks about the connection between formal and empirical world, one is always faced with the problem on individualizing indefinite context (from empirical to formal world) and on applying a formal statement (or value) to an empirical world, and that is measurement problem. We here manifest the measurement problem through the aspect of knowing something, measuring body temperature, pain in a robot, and positively express it by the dynamical negotiation in a discrepancy between parts and wholeness, called “extended pain”. Because such an aspect is re-found in living systems or materials, it is nothing but internal measurement [9]. Finally we propose a formal model for the dynamical negotiation in differentiation process by using a lattice theory [10]. In that model, co-limit is so weaken that it contains indefiniteness and choice resulting from discrepancy between making whole and making parts.

2. Naked king

A Japanese advertising film on TV shows us what knowing something is, through conversation on “Apeos” among three presidents. Two presidents A and B who know what Apeos is talk about Apeos, and ask the third one, C, “Apeos is nice, isn’t it?” He does not know what Apeos is and imagines that Apeos is a car, and replies, “An Apeos can be driven smoothly.” The president A laughs, “Apeos can be driven?” and asks B, “You can’t drive Apeos, can you?” In laughing by A and B, the sentence, “What is Apeos?” is finally shown.

The reason why that film is interesting is that the president A, in spite of having knowledge on Apeos, asks to B. Imagine that Apeos is a kind of machine and that A was originally not an engineer but a business man. He is confirmed that he knows Apeos, but he might not know the internal structure of Apeos. Therefore, when the president C talks to A by the unexpected sentence, the president A doubts his own knowledge and thinks that he may be a naked king. That is why he asks the President B, and only after that he can laugh.

What is to know? On the one hand one can choose one important attribute and can ignore any other attributes, as if any other attributes could be induced from a chosen one. A chosen attribute is regarded as a representative of all attributes. Any other parts (attributes) are constructed as something neglected from the representative that is regarded as whole. We call it the procedure from whole to parts, or Intent of the knowledge. On the other hand, knowing one thing is regarded as possession of a collection of all attributes on that thing. One has to distinguish an attribute (part) from each other, and collects all attributes. It results in appearance of whole. We call it the procedure from parts to whole, or Extent of the knowledge. In an ideal world the former procedure (from whole to parts) is equivalent to the latter (from parts to whole). It is assumed that knowing is based on the equivalence between Intent and Extent, but actually it is impossible. Recall Apeos. The president A was confirmed that he knows Apeos, based on Intent of the Knowledge, and was not aware of the discrepancy between Intent and Extent of Apeos till the President C talks to him a strange thing. Knowing always inherits the discrepancy between Intent and Extent of the knowledge. While we all might be naked kings in principle, we can say that we know it.

Knowing that holds in the first person perspective contains discrepancy between Intent and Extent in the third person perspective. In other words, discrepancy between the first and third person perspective is nothing but a way of the second person perspective, and/or ontology that cannot be separated from epistemology.

3. Temperature in empirical world

We here consider measuring body temperature in every day life. Temperature is defined only for an equilibrium system. In a theory, the statement, “if a system is equilibrium, then the temperature of the system can be defined” is significant. By contrast, in an empirical world, one has to check whether a given system is equilibrium or not, and simultaneously the temperature has to be measured. What is measuring temperature? One local point is chosen such that it represents a given system and then the measuring apparatus is put into that point. A whole system consisting of a given system and the measuring apparatus becomes non-equilibrium, and then a whole system changes to be an equilibrium system. In other words, at a local point a particular work is made to make a whole system be an equilibrium system. Since measuring temperature is based on the choice of a local point, it can be compared to Intent of the knowledge mentioned before. What is checking whether a system is equilibrium or not? One has to distinguish all local points and check whether they are the same in a term of concentration. In other words he has to construct whole of a given system by collecting all local points. It can be compared to Extent of the knowledge.

Measuring body temperature in an empirical world contains both Intent (from a local point representing a whole system to an assumed whole system) and Extent (from all points to wholeness as the summing up). There is discrepancy between Intent and Extent in measuring body temperature, as well as in the case of knowing. It is impossible to operate both procedures simultaneously. In other words, measuring temperature is done in keeping that discrepancy. The next question arises whether the temperature in an empirical world does not matter with that in a theory, since a body is not confirmed as an equilibrium system. Although it sounds as if they are separated from each other, one of hopeful interpretations is considering that an equilibrium system is not a priori but appears just after the temperature is measured. The equilibrium system is assumed to appear such that it corresponds to the measured temperature, a posteriori.

The equilibrium system a posteriori that we introduced in empirically measuring temperature is different from equilibrium in a theory, since the equilibrium a posteriori contains discrepancy between Intent and Extent of a system. Intent implies the operation from the concept of wholeness (representative, W1) to parts (P1) that can be induced from representative, and Extent implies the operation from parts (P2) to wholeness (W2) that is a collection of parts. Discrepancy between them, therefore, contains perpetual change such as from W1 to W2 via P1 and P2. In other words, the equilibrium system appeared a posteriori must be “changeable equilibrium system”. Although it is nonsense in a theory, it makes sense in an empirical world. It yields, however, the reason why one can detect illness by measuring body temperature. If one accepts that the body carries changeable equilibrium system with respect to temperature, body temperature can be changed without observing explicit heat change. The change of body temperature without explicit reason, or fever, is always regarded as a sign of illness. That is why it can be justified that one can detect illness by measuring body temperature. The essential structure is changeable equilibrium containing discrepancy between Intent and Extent, or between two dynamical operations from W1 to P1 and one from P2 to W2.

4. Pain of a robot

We extend the idea of changeable equilibrium in the form of extended pain. We here consider how a robot can recognize a series of tasks as an individual one job. Consider a job of catching a ball. It is divided into three tasks, tracking a ball movement, striking a ball by a grab, and pulling a grab to absorb the shock. We can say that if any other tasks are embedded in each individual task, a robot can always see a whole of tasks in doing a task. In such a sense we say that a robot can recognize a series of tasks as one job.

To estimate intrinsic embedded structure, we here focus on the second task, striking a ball by a grab. If a robot has to prepare the subsequent task that is pulling a grab to absorb the shock, it has to measure the shock of the striking ball. Correct measurement is possible only if the measurement apparatus that is a robot itself is not broken. Therefore, measuring the shock of the ball simultaneously requires checking whether all local areas of a robot body are damaged or not. The situation is as same as that in measuring body temperature. On one hand, all local points of a robot (a body in measuring temperature, respectively) have to be examined, and it corresponds to the procedure from P2 to W2. On the other hand, one point striking a ball is chosen and the event of striking a ball is individualized (measuring body temperature, respectively), and it corresponds to the procedure from W1 to P1. As well as in the case of measuring body temperature, it is impossible to process two procedures simultaneously. In other words, there is discrepancy between two procedures co-existing. A whole process inheriting that discrepancy results in measuring the shock of a ball.

If it is possible to check all points of measuring apparatus in measuring the shock of a ball, the subsequent task is independently separated from the task of striking a ball. The correct measured value requires how to process the measured value since measuring apparatus itself is not changed through measurement and there is no hint for the subsequent task. Under that condition it is necessary for a robot to paste up all tasks by additional knowledge. In general such a pasting is programmed a priori. By contrast, if a robot contains the discrepancy, and i.e., it is impossible to measure the shock correctly, the measured value results from both the shock of the ball and the damage of a robot. In the measured value, the estimation of the shock of a ball cannot be separated from the damage of measurement apparatus. We call that measured value, the mixture of the incorrect measurement with the damage, extended pain. When a child receives a ball, he feels not only the shock of a ball but also the damage of his own hand, and that is his own pain. Due to the pain, a child can pull a grab without explicit calculation of the shock. In other words, due to the pain a child can anticipate the subsequent task.

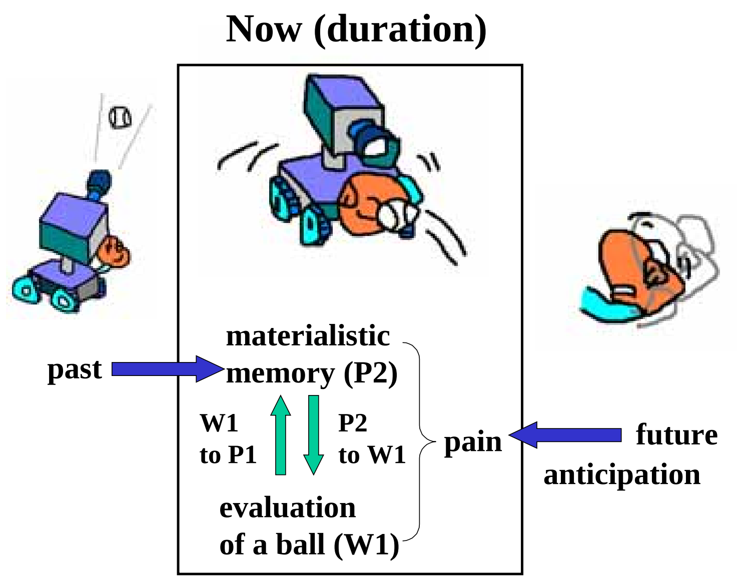

Fig. 1. Extended pain inhering two kinds of operations, from W1 to P1, and that from P2 to W2. Only P2 and W1 can be explicitly recognized, and discrepancy (= negotiation) between two operations constitutes the extended pain in a task of striking a ball.

In introducing the notion of extended pain, the moment of striking a ball is replaced by the duration at which both preceding and subsequent tasks are embedded in the form of extended pain (Fig. 1). The possibly damaged measurement apparatus always carry the past, and the extended pain always contains the future in the form of anticipation. Since the measurement inherits the discrepancy between Intent (from W1 to P1) and Extent (from P2 to W2), Extent carries the past and a whole process inhering discrepancy plays a role in anticipation. That is why both the past and future are embedded in that duration, and a series of tasks is regarded as one job in a robot, thanks for the extended pain. In other words, the extended pain inhering the past is the margin to paste up the future.

5. Differentiation and structured unity

In biological system, each moment of proliferation can be replaced by the duration, the extended pain. On one hand, proliferation or differentiation implies the process from a unity to parts. On the other hand, differentiated parts are not independently separated from each other and are structured under an individual unity. In the terminology we mentioned before, differentiation corresponds to the process of Intent, from W1 to P1, and remaining unity corresponds to the process of Extent, from P2 to W2. The external observer does not see whether unity such as global property really exists or not. The notion of unity can be induced from the limit of external perspective, and results in the process inhering discrepancy between Intent and Extent.

In the external perspective structure can be separated from function, although they cannot be separated in a real living system. If one describes a living system as a programmable system, structure and function can be expressed as data and programs, respectively, and there is a gap between a formal expression and a real living system. That gap derives both program-like and data-like attributes even in data (or program). Although differentiation is expressed as the process giving some parts as some data structures, the gap between the real system and its expression can give rise to program-like attributes in each data structure. It can be found as the duality of which data-structure implies not only data but also program to make data. However in a living system any differentiated part has its own boundary (data), each part is maintained by perpetual process to make its boundary. In this sense, program-like attribute or function can be found in each part (structure). A structure as a part cannot be separated from a particular function by which the structure is chosen, and that leads to existence of domain of candidates to be chosen, that is wholeness.

Given wholeness (W1), proliferation can lead to parts (P1), and simultaneously generated parts (P2) are maintained by wholeness (W2), and vice versa. The process of differentiation can inherit discrepancy between the process from W1 to P1 and that from P2 to W2. As far as a living system is kept as the living, discrepancy always imply negotiation between them. The situation is as same as that in measuring body temperature and as the extended pain. The differentiation always carries the margin to paste up the future and a system can anticipate the subsequent environmental changes.

6. Discrepancy and negotiation between two operations

We here propose the metaphoric model for differentiation as the margin to paste up the future. The process is expressed as a pair of operation from W1 to P1 and that from P2 to W2. Structure of a system or structured parts is expressed as a lattice that is a partially ordered set closed under join and meet. First we assume that all materials are elements of a lattice $\boldsymbol{L}$. Given $\boldsymbol{L}$, the proliferation (from W1 to P2) is expressed as the process to construct K such that

$$K = \cup_{x \in L'} f^{-1}(x) \cup \{0\}$$

for a sub-lattice $L \subseteq \boldsymbol{L}$, where 0 is the least element of $\boldsymbol{L}$ and $f^{-1}(x)$ is defined by

$$f^{-1}(x) = \mathrm{Sub}\{y \in \boldsymbol{L} \mid \exists z \in S\ (y \vee z = x)\},$$

where Sub$M$ is a subset of M, $f^{-1}(x)$ is chosen as disjoint, and S is chosen as $L' \subseteq S \subseteq \boldsymbol{L}$, $L' \cong L$, that is a sub-lattice of $\boldsymbol{L}$. It is easy to verify that K is a lattice, and that $f^{-1}(x)$ is an equivalent class where $R = \cup_{x \in L'} R(x)$ with $R(x) = f^{-1}(x) \times f^{-1}(x)$ is an equivalent relation. Especially, it can be verified that $K/R \cong L$, if R is a congruence such that, if $<x, y> \in R$ then $<x \vee z, y \vee z>$ and $<x \wedge z, y \wedge z> \in R$ for $\forall z \in K$. At that case a map $K \rightarrow K/R$ is well defined.

By that operation, a structure expressed as a lattice, L, can give rise to a lattice K in which each element of L can be divided into some elements, to conserve the structure of L in the sense that $K/R \cong L$. It means that given a structured wholeness (W1), proliferation can lead to parts (P1) constituting equivalent class.

Next, we define the inverse operation from P2 to W2, from a collection of parts to a structured whole. Given L, choose an ideal of L, J, that is a down-set closed under $\vee$. The binary relation such that

$$\theta_J = \{<x, y> \in L \mid \exists z \in J\ (x \vee z = y \vee z)\}.$$

It can be verified that θ_J is an equivalent relation since J is closed under $\vee$ and then transitive law holds. From θ_J one can obtain structured wholeness as L/θ_J, a quotient lattice [6,10]. It can be verified that L is distributive if and only if θ_J is congruence. At that case, $L \rightarrow L/\theta_J$ is well-defined.

Wholeness is expressed as a limit (co-limit in a term of category theory) in an abstract sense [4,5,6]. In a perspective drawing, a vanishing point is a part of whole drawing, but is a limit of part (some figures in a perspective drawing). Any part is well-defined in a perspective through a vanishing point. In this sense, we call vanishing point wholeness. If $L \rightarrow L/\theta_J$ is well-defined, L/θ_J is a co-limit for elements of an equivalent class of θ_J. Therefore, construction of L/θ_J for L is construction of structured wholeness, and construction of K satisfying $K/R \cong L$ is construction of parts satisfying another structured wholeness.

Fig. 2 shows the abstract extended pain in differentiation process, consisting of two operations, that from W1 to P1 and that from P2 to W2. Here, $\boldsymbol{L}$ is defined as the power-set of $\{a, b, c\}$. Given L (corresponding to P2) and an ideal J of L as shown as a loop of L in Fig. 2, an equivalent relation is derived from J, and the structured wholeness expressed as a quotient lattice, L/θ_J (corresponding to W2) is obtained. Choice of J implies choice of a particular function, and then L/θ_J is a structure with respect to a particular function. Each equivalent class is shown as a loop in L. After that, L' (corresponding to W1) that is isomorphic to L/θ_J is obtained, and S is chosen such that $L' \subseteq S \subseteq \boldsymbol{L}$. Since $f^{-1}(x)$ for each x in L' is an equivalent class of equivalence relation, $R = \cup_{x \in L'} R(x)$ with $R(x) = f^{-1}(x) \times f^{-1}(x)$, new lattice K (corresponding to P1) is obtained such that satisfies $K/R \cong L$. Equivalence class $f^{-1}(x)$ is shown as a loop in K.

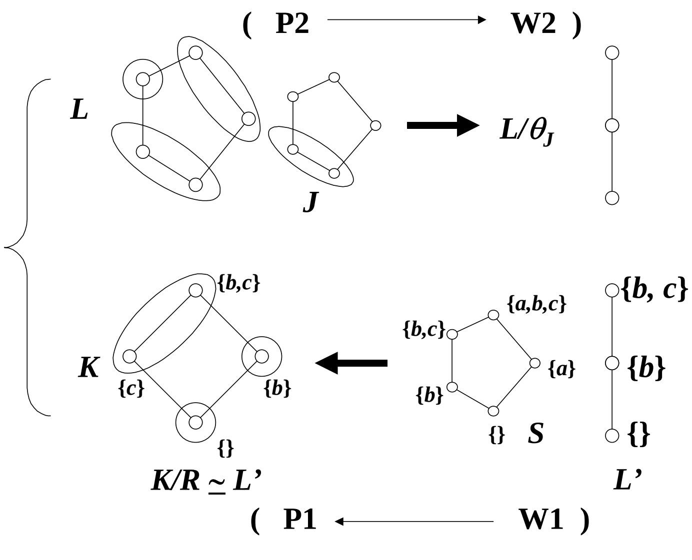

Fig. 2. An example of a pair of proliferation (from W1 to P1) and construction of structured wholeness (from P2 to W2). Such a pair constitutes the process of differentiation.

If both equivalent relations, θ_J and R are congruence relations, both L and K are distributive lattices, and they are isomorphic to each other. It means that the structure of a system is invariant through development, and (co-) limit is well defined. By contrast, in general, the structure of a system, expressed as a lattice is perpetually changed though two operations from P2 to W2 and from W1 to P1, where (co-) limit is weakly constructed. In other words, weakly constructed, $L \rightarrow L/\theta_J$ and $K \rightarrow K/R$ can constitute the margin to paste up the future and makes a system, itself, develop.

Since congruence for equivalence relation, θ_J and R, does not hold in general, co-limit is not well-defined in a strict sense. That is an essential engine for indefiniteness and choice. Given L, a quotient lattice, L/θ_J is obtained. Co-limit is so weak that it is impossible to indicate co-limit without ambiguity (i.e., impossible to wholeness objectively), and then a quotient lattice including weaken co-limit can be invalidated with respect to elements and then it can be replaced by L'. Because of ambiguity in indicating a lattice L' self-consistently, it allows growing wholeness. It results in choice of S such that $L' \subseteq S \subseteq \boldsymbol{L}$, and a lattice K is obtained. Discrepancy between making structured wholeness and making structured parts still remains and dynamical negotiation perpetually proceeds. That is “extended pain” inheriting anticipation.

In our talk we will introduce more adequate tool that negotiates between parts and whole, called indefinite skeleton by which $f^{-1}(x)$ is “locally” defined.

7. Conclusion

Whenever one talks about empirical things in a formal world, the interface problem between formal and empirical world arises. In other words, if one defines an empirical thing in a formal world, he also has to care about how the definition is appropriate in understanding the empirical. It implies that he has to care both a particular definition and the context in which the definition is adequate. That is measurement problem.

Although the measurement problem is not usually cared and is ignored, if one focuses on indicating and/or individualizing context, he is explicitly faced with that problem. Through some topics about what knowing is and measuring temperature, the problem is manifesting and is expressed as “extended pain” inheriting dynamical negotiation between parts and whole. Especially when one talks about self-organizing process, that dynamical structure is explicitly obtained.

We finally propose an abstract model of self-organizing process such as differentiation, featured with a pair of operations, proliferation and making unity as a whole (i.e., making co-limit). If a structured system is expressed as a lattice, co-limit is expressed as an equivalent class derived from congruence relation, and then making unity as a whole or structured wholeness is expressed as a quotient lattice. We here weaken co-limit by an equivalent class derived just from equivalent relation. It leads to growing wholeness or replacing co-limit by another elements, and that allows proliferation or substituting a structure into an element of a lattice. Due to weaken co-limit, the negotiation between making unity and proliferation can perpetually proceeds in keeping structural change. It is a formal expression of anticipation inherited in a system or the extended pain as a margin to paste up the future.

References

[1] Rosen, R (ed). *Theoretical Biology and Complexity: Three Essays on the Natural Philosophy of Complex Systems*. Academic Press, 1985.

[2] Rosen, R. *Life Itself: A Comprehensive Inquiry into the Nature, Origin, and Fabrication of Life.* Columbia University Press, 1991.

[3] Maturana, H. and Varela, F.J. *Autopoiesis and Cognition: The Realization of the Living.* D. Reidel, 1980.

[4] Ehresmann, A.C. and Vanbremeersch, J.P. Information processing and symmetry-breaking in memory evolutive systems. *BioSystems*, **43**(1), 25-40 (1997).

[5] Fontana, W., Wagner, G. and Buss, L.W. Beyond digital naturalism. In *Artificial Life: The Proceedings of an Interdisciplinary Workshop on the Synthesis and Simulation of Living Systems* (Langton, C. ed.) pp. 211-227, 1990.

[6] Zaletzky, A.N. Review: The algebraic relational theory and its applications. *Journal of Biological Systems* **8**(3), 279-317 (2000).

[7] Gunji, Y.-P., Takahashi, T. and Aono, M., Dynamical infomorphism: form of endo-perspective. *Chaos, Solitons & Fractals* **22**, 1077-1101 (2004).

[8] Gunji, Y.-P. and Kamiura, M. Observational heterarchy enhancing active coupling. *Physica D* **198**, 74-105 (2004).

[9] Matsuno, K. *Protobiology: Physical Basis for Biology.* CRC Press, 1987.

[10] Davey, B.A. and Priestley, H.A. *Introduction to Lattices and Order,* Cambridge University Press, 2002 (2nd ed.).