PANSYSTEMS METHODOLOGY AND ITS APPLICATIONS: CYBERNETICS, EPISTEMOLOGY, SHENGKEOLOGY AND SOCIOLOGY

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Abstract: New Formulation of PM, PM Logic, Observocontrol Relativity, Panweight Fuzziness, Generalized Composition, Modelling, Decisions, Games, Social Shengke.

1. Introduction

Pansystems methodology (PM) is also called pansystems theory or pansystems analysis,it is a kind of transfield and methodology research on general thing-laws and generalized systems (2F:two field) with the emphasis on relation, relation-transformation,pansymmetry (generalized symmetry) and sufficiently observocontrollable modelling (4E:4 respects of emphasis).

PM was presented first in 1976.There are about five respects (5B) concerning the history background or promoting causes for the presentation, research and development of PM: (1) transfield and methodological generalization or summary of certain work of transtopical researches in mathematics,physics, systems science and other branches, specially including the so-called approximation-transforming theory (ATT) tapped in China in 1950's. In the research of ATT we got many hundreds of new mathematical propositions from the viewpoint of pansystems, namely from the viewpoint of 4E. (2) Exposition and scientification of certain pansystems outlook hidden in Chinese traditional culture and its combination with modern science and technology. (3) The main stream of modern science: integration, co-development, dialectical synthesis, interdisciplinary-transdisciplinary-metadisciplinary tendency, combination of division and union of discipline development. (4) Information society, situation of knowledge explosion, and the demand of scientification, systematization, mathematization and computerization of methodology. (5) Great demand of new concepts, principles and methods to treat large scale supercomplex dynamical systems with damaged information, fuzzy factors and shengke (synergy-conflict) relations.

An important part of PM is certain researches on the so-called PM concepts (7C),specially including their logic and mathematics: Generalized Systems (G), Transformations (T), Pansymmetry (P), PM Relations (R), PM Frameworks (F), PM Extractions (E), PM Strengthening (S) (see below). Consequently, sometimes an epitome description of PM can be expressed in images as PM = 5B·4E·(2F / 7C...) or PM = 5427.

The meaning of the term pansystems in PM is generalized and of technical terms. Generally speaking, it means a sort of standpoint or inclination of researches, or a class of PM concepts and methods developed in PM, sometimes it means also certain topic-community developed within PM frameworks.

From the presentation of PM onwards, we got diversified development combined with many tens of topics, and complemented or generalized certain fundamental concepts, principles, methods or results of mathematics, natural sciences, systems sciences, cognitive sciences, biomedicine and social sciences, and now a nationwide PM research network (PMAN), including more than twenty network-nodes, is established in China.

In this paper we are concerned with introduction of certain new formulation of PM, special attention is devoted to the research on MDG (Modelling-Decisions-Games) logic and related applications to cybernetics, epistemology, shengkeology and sociology, etc.

2. PM Concepts

PM concepts are quite universal and transdisciplinary, and their definitions are somewhat recurrent (by using a

Backus-Naur-like Form): (1) $C ::= G|T|P|R|F|E|S$. (2) $R ::= R_1 | R_2 | \cdots | R_{12}|$Compositions of R. Where R_i are 12 typical generalized relations of G: Macromicroscopy (R_1), Motion-Rest (R_2), Whole-Parts (R_3), Body-Shadow (R_4), Causality (R_5), Observocontrol (R_6), Shengke (Synergy-Conflict, etc.) (R_7), Panorder (Generalized Order)(R_8), Series-Parallel (R_9), Simulation (Modelling)(R_{10}), Clustering-Discoupling (R_{11}), Difference-Identity (R_{12}). (3) $G ::= (A,B)$. Where A (called hardware): certain given set, B (called software) $\in St(A)$, and $St(A) ::=$ Panweighted Relations (PR) of A | R of St(A) | PR of St(A). (4) $T ::=$ PR of G | G with Parameters. (5) $F ::=$ Epitomes or Transformations of C-Networks as Conceptual Referencial Systems in Description, Modelling, Analysis, Connection or Operation of Things and G. (6) $E ::=$ Relatively Optimizational or Satisfactory Exposition, Selection, Extraction or Formation of Certain C in MDG and Operations. (7) $S ::=$ Use Certain C to Strengthen Thinking and Operations. (8) $P ::=$ Relative, Approximate, Generalized Symmetry | R or T of G with Parameters of Different Dimensions and Scopes | Relative Invarience or Tolerance of G| Complexity-Simplicity Relations | $R_2 | R_{10} | R_{12}$.

3. Panlanguage and Set-like Pansystems

A sort of typical generalized system called panlanguage is described in the form $U = (A,B)$, $B \subset P(A^* \times W)$, where $A^* = \cup A \uparrow I_k$, $\{I_k\}$ —certain given family of sets, W—panweight set, P( )—power set operator. Examples:

(1) Panweighted Network (PN): $B \subset A^2 \times W$. (2) Panweighted Field (PF): $B \subset P(A^* \times W_1) \cup A \times W_2 \times W_3$. (3) Panweighted Field-Network (PFN): $B \subset P(A^* \times W_1) \cup A^2 \times W_2 \times W_3 \cup A^2 \times W_4$. (4) Simplified PFN: $B: A \cup A^2 \longrightarrow W$. (5) PR: $B \subset A^* \times W$. (6) n-ary PR: $B \subset A^n \times W$. (7) Division-Product PR: $A = \cup A_i$, $B \subset (\prod A_i) \times W$.

The PFN family is enough for ordinary practice, including applications to simplified social systems. Automata, I/O models, mathematical structures or knowledge representation which the modern computers treat practically for both numerical and non-numerical computations , all these are of simplified PFN family.

A more extensive typical generalized system is the so-called set-like pansystem which possesses certain main properties or behaviors like sets for R, specially for R_3 and R_4, including necessary associativity and commutativity. Naturally, it is necessary to introduce certain definitions or axioms of R_3, R_4 and their composition for these generalized systems. It is proved that panlanguage is of set-like pansystems, provided R_3, R_4 and composition are difined in a certain natural form.

4. Composition and Panderivative

Let $f \subset \prod F(i)$, $g \subset \prod G(j)$, $D(lm) \subset F(l) \cap G(m)$, then we define the composition $f \circ g$ or $f \circ g(cD(lm)) \subset H = (\prod F(i)) \times (\prod G(j))(i \neq l,\ j \neq m)$ as the set $\{(x_i, y_j \mid i \neq l,\ j \neq m) \mid \exists t \in D(lm),\ (x_i \mid x_l = t) \in f,\ (y_j \mid y_m = t) \in g\}$. Clearly, f and g induce two mappings by this co-this composition (continue to use the original symbols) $f\colon P(\prod G(j)) \longrightarrow P(H)$, $g\colon P(\prod F(i)) \longrightarrow P(H)$.

If $f \in P(C^2)$, let $f^{-1} = \{(x,y) \mid (y,x) \in f\}$ and $f^{(2)} = f \circ f$, $f^{(n+1)} = f^{(n)} \circ f$, $f^t = f \cup f^{(2)} \cup f^{(3)} \cup \cdots$ (transitive closure of f).

The concept panderivative is a unified generalization of many ones such as derivative, differential, integral, various variations, gradient, difference, ratio, sum, accumulation, various integral transformations, and Taylor remainder expression, etc. It can be defined as certain transformation of some G-classes or software classes induced from given hardware transformation. A typical panderivative of discrete type is defined as follows. Let $f \subset C \times D$, $K \subset St(C)$, $m \in M(C,D,K) = (St(D)\uparrow K)\uparrow P(C \times D)$, then $f' = f \circ m : K \longrightarrow St(D)$, is called (K,m) panderivative of f. Let $f(i) \subset C(i) \times D(i)$, then $\prod f(i) \subset \prod (C(i) \times D(i))$, define the 1-1 mapping by changing product-order as $h\colon \prod(C(i) \times D(i)) \longrightarrow (\prod C(i)) \times (\prod D(i))$

, then we have $h(\prod f(i)) \subset (\prod C(i)) \times (\prod D(i))$. Specially, for $f \subset C \times D$, we can define in a similar manner $h(f\uparrow I) \subset (C\uparrow I) \times (D\uparrow I)$, $h(f^*) \subset C^* \times D^*$, and their inductions: $f' = h(f\uparrow I): P(C\uparrow I) \longrightarrow P(D\uparrow I)$, $f' = h(f^*): P(C^*) \longrightarrow P(D^*)$, which are called panderivatives of panlanguage type or panratios. An importain cace is for $a \in P(C^2)$, $f'(a) = a \circ f' = f^{-1} \circ a \circ f \in P(D^2)$.

If $U = (A,B)$, $V = (C,D)$ are two given generalized systems, $g \subset A \times C$, $m \in M(A,C,B)$, $g' = g \circ m$, then $(g,g'): U \longrightarrow (C, g'(B))$.

5. PM Logic, PM Clustering and Modelling

PM logic is a sort of research on combination of PM and logic or cognition psychology, including metadisciplinary and logical studies of PM concepts. In them the PM R_i-logic ($i = 5,6,7,8,10,12$) are connected closely with certian PM exploration to problems concerning MDG and social systems.

Various branches of modern mathematics are based on set theory whose fundamental predicate is the membership, it can be considered as a special case of generalized R_3. The main work of operations or axiomatic system of set theory is to use membership to generate several R_3 , R_4 . Consequently, modern mathematical stuctures all can be considered to be generated from R_3 and R_4, naturally including the generation of the mathematical structures for various PM concepts, specially for various R_i . By introducing certain so-called ordered combination of relations (denoted by $*$) and the fundamental R_4 and R_3: projections, embodiments, confinements, extensions, then we can axiomatically define various R_i . For example, bird's-eye view ::= extensions * projections, microscopy ::= confinements * embodiments, epitome ::= confinements *projections , extended embodiments (or panembodiments)::= extensions * embodiments, explicit simulations::= projections * embodiments, implicit simulations:: = embodiments *projections, synergy simulations:: = extensions *implicit simulations * confinements, etc. These PM relations, transformations or simulations (provided they are defined for sets or hardware) can be extended to generalized systems or software, and we have naturally the concepts such as subsystems, extended systems, shadow systems, body systems, explicit models, implicit models, synergy models, bird's-eye view models (macromodels), microscopic models (micromodels), epitomes for given generalized systems, for example having the aid of the concepts of panlanguage, set -like pansystems and panderivatives, etc. Furthermore, the relations of explicit, implicit and synergy simulations correspond to that of body-body, shadow-shadow and epitome -epitome respectively. In a macrosense the simulation or modelling can be defined as certain transformation of generalized systems which conserves some properties, structures, relations or sofwares in a certain tolerant class, consequently, the transformations or relations presented can be considered sometimes as certain simulations. Generally speaking, softwares can be considered as hardware or other generalized systems, so the concepts of simulations defined for general hardwares can be extended to certain softwares. This leads the concept of soft simulations which can be considered as a PM generalization of the so-called function simulations in the sense of modern cybernetics, and the corresponding concepts of primitive simulations are called hard ones. A PM generalization of the important concept of black box can be described as a certain bird's-eye view model of given generalized system in which the system is reduced to hardware-software point. The concepts of structure, function and their interrelations are very important and useful in methodologies and varios disciplines, and a PM model of the concept of structure is naturally the software of system, and the concept of functions corresponds to certain softwares of some black box-reducing macromodels. In PM modelling logic, the concept of PM extractions of pansymmetries, specially by using the concept of panderivatives, is of an important and methodological one which is briefly called PDEP principle.

An important, fundamental and universal model of R_{12} is to use tolerance and tolerance-complement to simulate the identity-seeking and difference-seeking respectively. We use $E_5[A)$ to denote the class of tolerant relations in A. If $a \in E_5[A)$, we use $A = \cup A_i(da)$ to describe the tolerant clustering with respect to a, where A_i are corresponding tolerant classes. Define quotient system $A/a = \{A_i\}$, quotient simulation $f_a = \{(x, A_i) \mid x \in A_i\} \subset A \times (A/a)$. The inversion of it is called product simulation, and the composition of them is just the tolerance a. The quotient simulation is of implicit one, and the composition of any implicit simulation and its inversion is a tolerant relation. If the tolerance is reduced to equivalence, then the clustering corresponds to an exact partition, and the quotient simulation to a projection or mapping. Conversely, the composition of any projection and its inversion is an equivalence. These interrelations of concepts presented can be extended to generalized systems and these laws are called correspondence principle. By using these laws we can define the so-called tolerance-multiplication and tolerance-division. In PM there is a law called R_{12} pansymmetry theorem which asserts that the tolerance is closed or conservative under following operations or transformations: union (disjunction), intersection (conjunction), inversion, commutative composition, transitive closure, direct product, tolerance-multiplication, tolerance-division, confinement, embodiment, microscopy , explicit simulation, implicit simulation, projection. PM has already developed similar theorems for equivalence, semiordered relation, invariant subsets, suddenly variant subsets, associativity, commutativity, optimality, connectedness, discoupling, complement,etc. Generally speaking, the implicit simulation conserves R_9 , identity-seeking, clustering, connectedness, inversion and certain PM operators (certain transformations from generalized system, structures, software into R, specially into R_8, R_{10}, R_{12}); and the embodiment goes a step further to conserve equivalence, difference-seeking, discoupling, complement. Furthermore, the direct product conserves great majority of mathematical structures such as topologicity, lattice, linearity, convexity, semigroup, semiring, Boolean property, soft algebra, disjunction, conjunction, complement, composition, and many R, etc.

We can extend the concept of composition to the case of PR as follows. Let $f:\prod F(i) \longrightarrow W$, $g:\prod G(j) \longrightarrow W$, $D \subset F(l) \cap G(m)$, $\theta_1 : W \uparrow D \longrightarrow W$, $\theta_2 : W^2 \longrightarrow W$, $\theta = (\theta_1, \theta_2)$, then define $f\theta g$ or $f\theta g(cD)$ by using $f\theta g(x_i \mid i \neq l; y_j \mid j \neq m) =: \theta_1(f(x_i \mid x_l = t)\, \theta_2\, g(y_j \mid y_m = t) \mid t \in D)$. The panweight can be considered as a shadow system of PR, and for PR, specially for PFN, there are certain embodiment conservative structures (under certain natural conditions), for example: distributivity, commutativity, associativity and the so-called panoptimality. This proposition called the 4-laws conservation principle leads to certain extension of the famous Bellman's principle in dynamic programming.

In the definitions of related transformations, if we replace the role of projection by quotient simulation, the corresponding concepts obtained are named by adding modifier "quotient" (sometimes perhaps drop this modifier), for example we have the concepts such as quotient macromodel, quotient epitome, implicit quotient simulation, etc. We define panproduct ::= (direct product | embodiment) * (epitome | quotient epitome | synergy simulation). The concept of panproduct is an important extension of ultraproduct which is a very useful tool of theoretic modelling in the model theory of mathematical logic. We discovered the establishment and development of various new generalized number-systems and various mathematical structures is mainly based on the concept of panproduct.

PM Discoupling Princile. This is the concept that the operators of equivalence-reducing and strongly connected equivalence-reducing make the related relations black box and unidirectional in the correspoding quotient systems respectively.

PM Simulation Principle. This is the concept that to use certain PR, PR of PR, or panproduct to realize generalized quantization or to simulate various R, including composite, fuzzy causality and observocontrol relations.

PM Simplification Principle. It means the methods of simplification, reduction, dimension-decreasing by using the concepts such as projection, epitome, quotient simulation, quotient epitome, epitome of various models, composition, bird's-eye view, PM discoupling principle, PM simulation principle, etc. This principle is very useful for the description, modelling, analysis, treatment and operations of large scale supercomplex dynamical systems (LSSDS), including the MDG of ecosystems, social shengke , artificial intelligence, pattern recognition, management, economy, politics, education and intelligence exploitation, etc.

Clustering Panweightedness (CW Principle). About this there are several respects of meaning. First, tolerance clustering is usually reduced from certain panweighted relations, systems or PFN according to PM simplication. Secondly, the tolerance itself is usually panweighted. Thirdly, under the perturbation, hybridization, disjunction/conjunction-tolerance-reducing of other relations or actions, the tolerance with its panweight is correspondingly changed.

Implicit Variables of Clustering Criterion (IVCC Principle). This is the concept that the clustering criterion contains usually certain implicit parameters, and the clustering is changed correspondingly and implicitly.

$\mathbf{R}_{12}$-Transforming Principle. Let $f \subset A \times C$, $a_i, b_j \in \mathbf{E}_S[A)$, $c_k \in \mathbf{E}_S[C)$, $I(C) = \{ (x,x) | x \in C \}$. If $f'(a_i) \subset c_k$, then f realizes (a_i, c_k)-identical modelling; if $f'(\bar{a}_i) \subset \bar{c}_k$, then f realizes a modelling of (a_i, c_k)-difference-

seeking, where $\bar{a}$ means the complement of a; if $f'(a_i) \subset \bar{c}_k$, then f realizes a modelling which transforms a_i-identity-seeking into c_k-difference-seeking; if $f'(\bar{a}_i) \subset c_k$, then f is a modelling reforming a_i-difference-seeking to c_k-identity-seeking; if $f'(\bar{a}_i) \subset \overline{I(C)}$, $f'(b_j) \subset I(C)$, then f is a modelling making a_i-difference distinct and b_j-identity identical.

Duality Principle. This is the concept that the PM operator defined as the tolerance-reducing of complement of relation realizes certain dual transformations for R_{11}, connection-disconnection, R_{12}, far-nearness, etc.

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