INVESTIGATION AND APPLICATIONS OF PANSYSTEMS
RECOGNITION THEORY AND PANSYSTEMS-
OPERATIONS RESEARCH OF LARGE-
SCALE SYSTEMS (I)

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ABSTRACT
In this work, a sort of recognition theory and operations re-
search of large scale systems are developed within the framework
of pansystems methodology. We establish a series of theorems con-
cerning pansystems relations, which discuss some fundamental pro-
blems of interdisciplines from the viewpoint of generalized sys-
tem-transformation-symmetry in things mechanism, and are connect-
ed closely with mathematical physics systems thinking science
bioecological sciences and the methodological investigation of me-
chanical foundation. This paper offers 100 pansystems theorems.

I. Introduction: Pansystems Methodology and Its Development
Pansystems methodology is a transdisciplinary investigation and applications
of generalized system-transformation-symmetry in things mechanism which are closely
connected with mathematical physics science, systems science, biomedical ecology
science and thinking science. It emphasizes the mathematical research of pansys-
tems relations—some generalized relations and their inner/outer transformations,
macrocosm vs. microcosm, motion vs. rest, whole vs. parts, body vs. shadow, cause
vs. effect, observation vs. control, series vs. parallel, simulation, clustering vs.
separability, difference vs. identity, primary vs. secondary, "shengke".

Pansystems methodology was first presented in 1976 and from that time onwards
research workers have obtained a series of professional development which has been
forming some special investigations, such as: pansystems logic, pansystems network
analysis, pansystems ecology and pansystems medicine, etc. The related concrete
new results obtained concern cybernetics, dynamic programming, dynamic games, simu-
lation theory, clustering analysis, graph theory, automata, approximation transform-
ing theory, fuzzy sets theory, universal algebra, hypercomplex variables functions,
mathematical logic, network analysis, scientific methodology, economics bioeco-
logical medicine, etc.

The framework developed presents a new substructure for investigating the pattern
recognition and large-scale systems. The purpose of this work is just to develop
the related investigation and applications, within which we can not only talk about
a series of operations mechanism of recognition and large-scale systems, but also
derive many important mathematical theorems, which can help us to analyze and syn-
thetize certain models of mechanics and mathematical physics. The main subject of
pansystems recognition theory and pansystems-operations research of large-scale
systems is to establish the mathematical interrelations of related object-problems
and the inner/outer transformations of the pansystems-relations. Consequently, it
is rather different from the current related investigations.

II. Typical Binary Relations, \( \delta \)-Operations, Pansystems Simulations

Let \( G \) be a given set as a universe, denote the power set of \( G \) as \( P(G) \), and
define \( I=I(G) = \{(x,x) \mid x \in G \} \), which belongs to \( P(G^2) \). If \( f, g \in P(G) \), then
define \( \overline{f} \mathbin{\Delta} g = \overline{f \cup g}, \overline{f \cap g} = f \cap g, f^{-1} = \{(y, x) \mid (x, y) \in f \} \), \( f = G^1 - f, f \circ g = \{(x, y) \mid \exists t \in G, (x, t) \in f, (t, y) \in g \} \), and \( f \leq g \) means \( f \subseteq g \). Define \( f^{(n)} = I \), \( f^{(n+1)} = f \circ f^{(n)} \).

The typical binary relations of \( G \) are defined as follows:

- \( R(G) = \{f \mid f \in P(G^2), f \subseteq I \} \), \( S(G) = \{f \mid f \in P(G^2), f = f^{-1} \} \), \( S_2(G) = \{f \mid f \in P(G^2), f^{-1} \subseteq I \} \),
- \( T(G) = \{f \mid f \in P(G^2), f^{(3)} \subseteq I \} \), \( E_1(G) = R(G) \cap S(G) \), \( L_1(G) = R(G) \cap T(G) \), \( L_2(G) = S_2(G) \cap L_1(G) \).

\( E_1(G), E(G), L(G) \) are called the classes of semi-equivalence, equivalence and
semi-ordered relations of \( G \) respectively.

We shall adopt the notation \( (\cdot) \)\( \Pi f_i \) for \( f_1, f_2, \ldots \), provided it makes sense,
and let \( \overline{f}_i = (\overline{f}_i) \).

The \( \delta \)-operators are defined as the general items of the following various
\( \varepsilon \)-operators and \( \delta \)-operators.

\[ e_1(g) = g \mathbin{\Delta} g^{-1} \mathbin{\Delta} I, e_i(g) = e_i(g \mathbin{\Delta} g^{-1}), e_i(g) = e_i(g \mathbin{\Delta} g^{-1}), e_i(g) = e_i(g \mathbin{\Delta} g^{-1}) \]

\[ \max \{\delta \in E(G), \delta \leq g \} \] (provided it makes sense), \( \delta_1(g) = \delta_1(g) = \delta_1(g) \).

These operators depend on the universe \( G \), and clearly we have

Theorem 1. \( e_i(g) \in E_1(G), \delta_1(g) \in E(G) \).

Theorem 2. If \( e_i \in E_1(G) \), then \( \backslash e_i \vee e_i, e_i^{-1}, e_i^{(\cdot)} \in E(G) \), and when \( e_i \) are
commutative with respect to composition operation then also \( (\cdot) \Pi e_i \in E(G) \).

Theorem 3. If \( \delta_1 \in E(G) \), then \( \backslash \delta_1 \vee \delta_1, \delta_1^{-1}, \delta_1^{(\cdot)} \in E(G) \), and when \( \delta_1 \) are
commutative with respect to composition operation, then also \( (\cdot) \Pi \delta_1 \in E(G) \).

Theorem 4. \( \varepsilon \in E_1(G) \), then \( \varepsilon^{(n)} \in E(G), \varepsilon^{(n)} \in E_1(G) \).

Theorem 5. If \( g \in R(G) \), then for any integers \( m, n \geq 0 \), we have \( g^{(n)} \leq g^{(n+m)} \),
and \( g^{(n)} = \sqrt{g^{(n+m)}} \) (i.e. \( n = 1, 2, \ldots \)) for any integer \( k \geq 0 \).

Proof. Since \( l \leq g \), hence \( g^{(n)} \leq g^{(n+m)} \). Using this inequality continuously
leads to the proof of the theorem.

Comment 1. Intuitively, this theorem shows that for \( g \in R(G) \), \( g \) can be ap-