Chapter VI

What Organizes the World: N-Relational Entities

Introduction

Relationship as a primary constituent of reality setting a mutual order of things in the world commonly involves a large number of the terms or components or arguments that it interrelates. Realistic, actual, factual, existent, or real relationships consist of a multitude of elements, or parts, or terms, thus being polyadic, N-term connections. This implies that a true modeling of N-relational entities should consider their real nature, types, and properties (ontology) as well as the meanings of their correlatives (semantics) and formal attributes (mathematics). The first considers the reality of relations, telling us:

- How they exist, intrinsically and inherently (in the very nature of things) or extrinsically and extraneously (as connections among things)
- What kinds of relational species are there
- How relationships are classified

The second one indicates the primary meanings (definition or intension) with the connotative senses (extension) of the relations, or how they draw their meanings, from the correlative terms or from the relation itself. The third expresses the relationships in terms of mathematical sets, quantities, variables, functions, arguments, and values.

As with a binary relationship, the basic meaning of an N-ary relation consists in the way of ordering of correlative things, while the extension in the number of the things it connects. As it was discussed, the SW ontology languages have a poor expressivity for an adequate representation of real objects, states, changes, and relations. The same observation goes for a recent W3C project on modeling N-ary relations (Hayes & Welty, 2006), analyzed only

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with respect to the number of terms they connect, disregarding both their reality and such inherent properties as cardinality, symmetry, transitivity, reflexivity. Such a trivial reduction of relations to their correlative terms is rooted in a set theoretical axiom of choice, where a relation is defined as a mathematical function, the set of ordered pairs of individuals, members of two disjoint sets (the domain and range parts). This conception underpins the property construct of the RDF Schema, defined as relationships between resources, viewed as representing everything in the universe of discourse. Instead of defining a class in terms of its properties, the class/property distinction is solved to the benefit of the properties determined in terms of the classes of resource connected as the domains and ranges of properties (RDF Schema, 2004). In other words, relations as properties are simply reduced to the sets of ordered pairs of subsets, exemplified by common attribute-value pairs.

A deeper view comes from a relational logic based on the relations as denuded of their terms, an alternative to the subject-predicate logic based instead on the terms related, and considering properties (predicates) as inhering in substances (subjects). It is as old as Kant's shift from objects (substances) to the relations of substance and accident. Russell further generalized this relational approach as that "it is neither in space nor in time, neither material nor mental; yet it is something" and that "every proposition should be regarded as expressing a relation between two or more things" (Russell, 1990, pp. 272-273). Symbolically, it is written in the from R(a, b, c,...), where the arguments or terms are unknown constants, or as the relational variables that are neither individual variables nor classes, but just objects.

In fact, relationships should be considered with respect to the nature and meanings of its components; for it is a real entity (like interactive causality and space-time relations) rather than an idea, although linguistically expressed by special relational verbs, propositions, common nouns, and relational adjectives. Not all verbs indicate just connections, but they also show *existence* ("be," "exist"), *state* ("have," "possess," "know"), *action* ("do," "change"), as well as *relationships* ("relate," "cause," "represent").

Proposed as another W3C standard, the SW N-relational modeling appears as a trivial approximation of real relationships; for the real Semantic Web grounded to complex nonlinear reality asks for the N-relational ontology of things. As a matter of fact, relations are marked not only by the number of terms they connect but rather by the nature of relationships (or ordering) and the types of the terms related. Therefore, we speak of connections of diverse ontological types: substantial relations (identity and part-whole relationships), quantitative relations (equality or inequality), qualitative relations (similarity or dissimilarity), causal connections, space-time relations; natural relationships, mental associations, logical connections, semantic relations, social links, or cultural ties, and so forth.

Now, the statements (factual sentences) actually express some types of relationship among the terms associated by the agency of verbs, which show also existence, states, and actions. It clearly is fancied wrong to represent the proposition "'man created God and angels in his own likeness"' just by the symbolic form R (a, b, c). Organized by nonlinear relationships, this ever-changing dynamic complex world is more mysterious and enigmatic than the notional world peddled by formal logicians. Besides, we again confirm the golden ontological rule (Aristotle, 1990, Topics, book I, ch. 9): *to be related to real world domains, a core set of predicable relations of "definition," "class," "property," "inheritance," "difference," "sameness," and "statement,", a base of Web ontologies, should be reified in terms of the ontological predicates: the entity classes of reality ordered by real relationships*.

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