Chapter II

Ternary Relationships: Semantic Requirements and Logically Correct Alternatives

Trevor H. Jones
Duquesne University, USA

Il-Yeol Song
Drexel University, USA

INTRODUCTION

Conceptual data modeling is a backbone of most major systems development projects. Within this arena, one of the most widely used techniques is the entity-relationship (ER) or extended entity-relationship model (EER, henceforth also referred to as ER), introduced by Chen (1976). However, there are multiple competing models and notations, each having distinct strengths and weaknesses. Many of the model definitions and underpinnings continue to undergo practical and theoretical development. The abilities of each of the model structures and notations to fully represent the semantics of any given situation are constantly compared, with many issues open to argument. More specifically, certain arguments revolve around the inclusion of binary or N-ary representation of relationships in ER models. A central argument stems from the superior ability of N-ary modeling to reflect the true semantics of any given situation, whereas a binary model provides the simplest constructs for expressing information systems' logical design and is equivalently represented in a relational database management system (DBMS) (McKee & Rodgers, 1992).

The purpose of conceptual models is twofold: to provide a semantically correct, conceptual representation of the organizational data, as well as to provide a platform from which to develop a logical implementation schema. Consequently, the superior methodology for model construction is to adopt the semantically superior form and provide some

heuristic set to allow transformation to a result, which can be implemented in the more desired format. This course of action has been widely recognized and well researched in the form of developing relational schema from ER diagrams; rule sets as well as automated tools have been developed that offer to guide the process of translation (e.g., Jajodia, Ng & Song, 1983; Ling, 1985; Markowitz & Shoshani, 1992; Elmasri & Navathe, 2000).

Within these methodologies, one area continues to be formally investigated. N-ary relationships in ER models continue to be constructs that are misunderstood by educators, difficult to apply for practitioners, and problematic in their interpretation to relational schemas. These problems are due to causes ranging from a difficulty in identifying legitimate ternary relationships in practical situations to the lack of understanding of the construct in relation to the basis of normalization upon which the relational model is grounded. Song, Evan, and Park (1995) provide a comparative analysis of conceptual modeling notations. While all of the notations had some allowance for ternary modeling, *none* of the CASE tools included in the study allowed for the use and translation of ternary relationships. This indicates the recognition of ternary relationships as having semantic significance, but a practical difficulty of implementing them beyond the equivalent logical level. Very little research has been completed on the theoretical underpinnings of N-ary relationships, and that which exists is generally created as passing references in search of other research solutions (Krippendorf and Song, 1997; Song, Rowan, Medsker & Ewens, 2001).

N-ary relationships are substantially different from binary, in that they create a particular set of dynamics *inherent* to the relationship, which do not exist otherwise. With binary relationships, the construct is concerned with the cardinality between two participating entities. However, with relationships of a higher order, we encounter the problem of subsets within the original relationship, which may affect the logical derivation of the database structure subsequently (Dullea and Song, 1998). This complexity accounts for differing notations to address the relationships (Song et al., 1995) and other problems associated with these constructs. McAllister (1996, pp. 257) states, "…different approaches for modeling n-ary relationships differ not only in terms of *appearance* and *placement*, but also in terms of *meaning*."

This chapter serves to provide insight to these problems. It seeks to formally analyze the dynamics of having three entities participating in a relationship simultaneously. This is done from two perspectives:
1.   The theoretical approach to understanding this type of conceptual construct and the subsequent analysis of logical and relational models founded on these theories.
2.   The practical aspects of using these constructs in entity-relationship modeling and how the various construct combinations can be mapped to the logical/physical model.
      The second aspect is partly founded on the first, because the potential decomposition of N-ary constructs and their final representations can be derived from theoretical analysis of the implicit relationships.

There will, therefore, be a particular effort to explain the simultaneous existence of N-ary and binary relationships that share the same participating entities and are semantically related; this viewpoint has never been raised in previous research and leaves several questions unanswered. It is possible that an N-ary relationship may contain, or have imposed on it, a binary relationship between two of its participating entities that is semantically *related* to, and therefore potentially constrains, the ternary. Jones and Song (1996) have previously analyzed the question of which semantically related N-ary and binary relationship combinations can logically co-exist simultaneously. In their work, they have shown that only certain combinations of ternary/binary

15 more pages are available in the full version of this document, which may be purchased using the "Add to Cart" button on the publisher's webpage: www.igi-global.com/chapter/ternary-relationships-semantic-requirements-logically/4320

Related Content

Adversarial Training for Predicting the Trend of the COVID-19 Pandemic
Haishuai Wang, Jiali Ma, Ziping Zhao, Zhenyi Jia, Zhenyan Jiand Jun Wu (2022). *Journal of Database Management (pp. 1-16).*
www.irma-international.org/article/adversarial-training-for-predicting-the-trend-of-the-covid-19-pandemic/299560

Internet Map Services and Weather Data
Maurie Caitlin Kelly, Bernd J. Hauptand Ryan E. Baxter (2009). *Handbook of Research on Innovations in Database Technologies and Applications: Current and Future Trends (pp. 300-306).*
www.irma-international.org/chapter/internet-map-services-weather-data/20714

Reengineering Probabilistic Relational Databases with Fuzzy Probability Measures into XML Model
Zongmin Ma, Chengwei Liand Li Yan (2017). *Journal of Database Management (pp. 26-47).*
www.irma-international.org/article/reengineering-probabilistic-relational-databases-with-fuzzy-probability-measures-into-xml-model/189137

A Link-Based Ranking Algorithm for Semantic Web Resources: A Class-Oriented Approach Independent of Link Direction
Hyunjung Park, Sangkyu Rhoand Jinsoo Park (2011). *Journal of Database Management (pp. 1-25).*
www.irma-international.org/article/link-based-ranking-algorithm-semantic/49721

Using Ontology and Rule-Based Reasoning for Conceptual Data Models Synonyms Detection: A Case Study
Ljubica Kaziand Zoltan Kazi (2019). *Journal of Database Management (pp. 1-21).*
www.irma-international.org/article/using-ontology-and-rule-based-reasoning-for-conceptual-data-models-synonyms-detection/230292