An Event-Oriented Data Modeling Technique Based on the Cognitive Semantics Theory

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ABSTRACT

The Resource-Event-Agent (REA) model has been proposed as a data modeling approach for representing accounting transactions. However, most business events are not transactions; thus, the REA formulation is incomplete. Based on the Conceptual Semantics theory, this paper discusses the entity-relationship event network (EREN) model, which extends the REA model and provides a comprehensive data template for a business event. Specifically, the notions of resource, event, and agent in the REA model are extended to include more discriminating entity types. The EREN technique can be used to identify events, sketch a network of events, and develop a data model of a business application by applying the EREN template to each event. Most extant techniques facilitate only the descriptive role whereas the EREN technique facilitates both the design and descriptive role of data modeling.

Keywords: Cognitive Semantics, Data Model, Database, Entity Relationship, Event, Pattern, Process, Relational

INTRODUCTION

The process of designing, constructing, and adapting information modeling methods for information systems (IS) development is known as method engineering (Siau, 1999; 2004). A technique or a modeling method is a procedure with a prescribed notation to perform a development activity (Brinkkemper, 1996) and, thus, provides the knowhow required for method engineering. Most modeling methods are designed based on common sense and intuition of the method designers rather than on theoretical foundations (Siau & Rossi, 2007). Cognitive psychology can provide a foundation for developing theory-based systems analysis and design techniques (Davern, Shaft, & Te’eni, 2012; Pitts & Browne, 2007; Siau, 1999). This paper builds on the resource-event-agent (REA) framework (Geerts & McCarthy, 2002; Poels, 2011) and provides a data modeling technique that is based on cognitive semantics theory proposed by (Jackendoff, 1985).

Several decades have passed since the entity-relationship (ER) data model (Chen, 1976) and the relational model (Codd, 1970) were proposed. Conceptual data modeling based on the ER model and logical data modeling
based on the relational model are popular textbook methods (Gillenson, 2004; Teorey, 1999). These methods represent entities, attributes, and degree and cardinality of relationships in an ER diagram (Batini, Ceri, & Navathe, 1992; Hoffer, Ramesh, & Topi, 2010) and translate the resulting ER diagram into a relational representation (An, Hu, & Song, 2010; Ram, 1995). The translation from the ER diagram to the relational representation is governed by rules and can be automated. Thus, the ER model not only provides a conceptual role for capturing data requirements but also serves as an anchor for the logical model, which sets up the design stage (Teorey, Yang, & Fry, 1986). Consequently, the function of the ER model goes beyond providing graphical notations to document data requirements; the ER model also provides a framework for design.

Simson (2007) debates whether data modeling is better characterized as a descriptive or a design activity. The objective of a descriptive activity is to document some aspect of the real world, whereas the objective of a design activity is to create data structures for meeting a set of requirements. Although description and design activities are both important, literature has focused too much on the descriptive role and too little on the design role of data modeling (Simson, 2007). Most ER-based techniques are geared to mechanically translate and document stated user requirements and do not evoke the design thinking required to facilitate accurate modeling. For example, it is common knowledge that the stated requirement “a customer buys a product” does not result in a direct link between the entities Customer and Product. Nevertheless, there are no textbook guidelines that prohibit the Customer-Product relationship; instead, the correct solution is shown without discussing why the alternative would be wrong or why the designer needs to mediate the relationship between the entities Customer and Product by creating an entity corresponding to the event “buys.”

Techniques based on the ER-based model typically rely on examples that show exercises and resulting solutions but rarely explain the problem-solving process. According to Scheer (1998), many publications merely interpret preexisting entity relationship models. Most laboratory experiment studies that evaluate the effectiveness of the ER model, such as those by Batra, Hoffer, and Bostrom (1990) and Bock and Ryan (1993) provide model-ready user requirements as exercises for testing. Thus, the modeling exercise is reduced to a mere translation of the natural language into the data modeling representation. When model-ready user requirements are not provided, this literal translation can result in data modeling errors (Batra & Antony, 1994). Therefore, data modeling techniques should prevent the pitfalls in literal translation and be geared to deal with user requirements that entail deliberation.

A pattern-based approach can help in designing a data model even when the complete description of user requirements is not provided (Purao, Storey, & Han, 2003). Some publications (Coad, North, & Mayfield, 1997; Silverston, Inmon, & Graziano, 1997) provide a large number of patterns for several business domains. However, designers still need to commit cognitive resources to search for and apply the most relevant pattern for a given scenario, and it is possible that the usefulness and relevance of the pattern obtained may not compensate for the cognitive effort exerted in finding it. Other publications (Batra, 2005) provide a limited number of patterns, but some of these patterns, such as the hierarchy pattern, might be too simple to be useful. A unified pattern that can address the core data modeling difficulties may be more useful.

The REA ontology provides a simple pattern for modeling business transactions (Geerts & McCarthy, 2002; McCarthy, 2003; Poels, 2011). The REA pattern is based on three elements: resource, event, and agent. Because the “event” in REA pertains to transactions, the use of the REA model is likely to be limited to accounting applications and may be inapplicable when applied to other organizational events and applications. For example, the REA model is not geared to handle nontransaction events such as in social media or incident management.
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