Conceptual Modeling Foundations
The Notion of a Model in Conceptual Modeling

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SYNONYMS

Modeling, Model

DEFINITION

A model is a well-formed, adequate, and dependable artifact that represents other origin artifacts. Its criteria of well-formedness, adequacy, and dependability must be commonly accepted by its community of practice within some context and correspond to the functions that a model fulfills in utilization scenarios and use spectra. As an artifact, a model is grounded in its community's sub-discipline and is based on elements chosen from the sub-discipline. A conceptual model is based on abstract concepts and their inter-relationships. A conceptual database model represents the structure and the integrity constraints of a database within the given utilization scenario.

MAIN TEXT

The conceptual modeling community widely uses models for constructing information systems. Conceptual modeling is a widely applied practice and its application has led to a large body of useful constructs and methods for creating artifacts that describe some abstraction of reality and serve as a prescription for the development of a database system.

Science and technology widely uses models in a variety of in utilization scenarios. Models function as an instrument in those utilization scenarios. The main function of a conceptual database model is description-prescription. In this case, a conceptual model is used as a mediator between a reality and an abstract reality that developers of a database system intend to build. Other functions of a model, besides the description-prescription function, are the explanation, the optimization-variation, the validation-verification-testing, the reflection-optimization, the explorative, the hypothetical, and the documentation-visualization functions. The functions of a model determine the purposes of the deployment of the model.

Models have several *essential properties*:

- A model's artifact is *well-formed* if it satisfies a well-formedness criterion. Typically, conceptual models have predicate calculus as their formal foundation. Concepts are predicates and relationships among concepts are n-ary predicates ($n \geq 2$). Constraints are well-formed formulas expressing constraints with cardinality constraints and generalization/specialization constraints being the most common. For ease of understanding the underlying predicate calculus is usually rendered as a conceptual-model diagram. In typical conceptual-model diagrams, named boxes represent sets of objects, lines connecting boxes represent relationships among objects, and embellishments associated with lines such as cardinality-constraint notes, arrowheads, and generalization/specialization triangles denote constraints over the objects and their relationships.
- Well-formedness enables an artifact to be *adequate* for a collection of origin artifacts if (i) it is analogous to the origin artifacts to be represented according to some analogy criterion, (ii) it is more focused (e.g. simpler, truncated, more abstract or reduced) than the origin artifacts being modeled, and (iii) it is sufficient to satisfy its purpose.
- Well-formedness also enables an artifact to be *justified*: (i) by an empirical corroboration according to its objectives, supported by some argument calculus, (ii) by rational coherence and conformity explicitly stated through formulas, (iii) by falsifiability that can be given by an abductive or inductive logic, and (iv) by stability and plasticity explicitly given through formulas. An artifact is *sufficient* as measured by a *quality* characterization for internal quality, for external quality and for quality in use through quality characteristics

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that support correctness, generality, usefulness, comprehensibility, parsimony, robustness, novelty, etc. Sufficiency is typically combined with some assurance evaluation (tolerance, modality, confidence, and restrictions). A well-formed artifact is *dependable* if it is justified and sufficient.

- A *model* is a well-formed, adequate and dependable artifact by adherence to its underlying formalisms if it is commonly accepted by its community of practice within some context and if it fulfills the functions in utilization scenario and use spectra. Adequacy and dependability characterize the utility of a model for deployment, reliability, and degree of precision efficiency for satisfying the use necessities.

Not only should a model faithfully represent a collection of origin artifacts by being well-formed, adequate, and dependable, it should also provide facilities or methods for its use. A model is *functional* if there are methods for utilization of the artifact to achieve the objectives for which an artifact might serve. Typical task objectives include defining, constructing, evolving, migrating, exploring, communicating, understanding, replacing, substituting, documenting, negotiating, replacing, optimizing, validating, verifying, testing, reporting, and accounting. We call a model *effective* if it can be deployed according to its objectives.
Models satisfy several properties that make them functional and effective:

- *Mapping* property: the model can be defined through a mapping from the origin artifacts that it represents.
- *Analogy* property: the model is analogous to the origin artifact based on some analogy criterion.
- *Truncation* property: the model lacks some of the ascriptions made to the origin artifacts and thus functions by abstraction by disregarding the irrelevant.
- *Pragmatic* property: the model use is only justified for particular model users, the tools of investigation, and the period of time.
- *Amplification* property: models use specific extensions which are not observed in the origin artifacts.
- *Idealization* property: modeling abstracts from reality by scoping the model to the ideal state of affairs.
- *Utilization* property: the model functions well within its intended scenarios of usage according to its capacity and potential.
- *Divergence* property: models deliberately diverge from reality in order to simplify salient properties of interest, transforming them into artifacts that are easier to work with.
- *Added value* property: models provide a value or benefit based on their utility, capability and quality characteristics.
- *Purpose* property: models and conceptual models are governed by the purpose. The model preserves the purpose.

CROSS REFERENCE

I. Data Model
   a. Semantic Data Model
   b. Conceptual Modeling
   c. Entity-Relationship Model
   d. Conceptual Data Model

II. Database Design
   a. Conceptual Schema Design
   b. Schema Deployment

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