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On semantics-contingent syntax for conceptual modeling

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Conceptual modeling specifies the kinds of objects to be represented in an information system (IS). It involves documenting knowledge about a domain, defining its scope, and outlining constraints: making it a key element of IS. Conceptual models typically represent classes (categories, kinds) of objects rather than concrete specific individuals. Classes are central constructs in most conceptual modeling grammars (e.g., entity relationship diagrams, ERD, unified modeling language, UML). While representation of classes may differ between grammars, a common design principle (DP)[1] is what we term *different semantics same syntax (D3S)*. Under this DP all classes are depicted using the same syntactic symbol (e.g., box in ERD, see, Fig 1) despite these classes potentially representing very different kinds of entities in the world (e.g., natural kinds, social entities, artificial entities, see below).

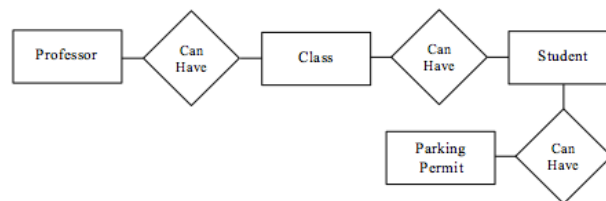


Fig. 1: Entity-relationship diagram adapted from [2]

Despite the wide diversity of approaches and grammars developed since 1970s, the D3S is the prevailing DP in conceptual modeling theory and practice. Recent developments in conceptual modeling's reference disciplines of psychology and philosophy and, however, doubt the theoretical justification of the D3S. Medin et al. [3], for example, distinguish classes based on structural differences, processing differences, and contexts of use. For example, in Fig 1., Professor, Student could have different structure and behavior than Parking Permit (e.g., organizations may not be able to influence some *attribute values* for humans in the roles of professors and students, but can create and manipulate attribute values for parking permits; real-world objects belonging to the professors and students classes may be naturally extremely diverse and not share many *attributes*, while one could force all parking permits to have exactly the same attribute). Some of this information may be valuable to capture graphically, as it affects how one

understand the models and develops IS objects (e.g., database schema). Following recent findings in psychology, we introduce a novel DP – **semantics-contingent syntax (SCS)** whereby syntactic representations of classes in conceptual models *may* differ based on their meaning.

To establish specific DPs by which semantics becomes dependent on syntax, we identify theory-grounded patterns along which classes can be grouped, and represented differently in conceptual models. These include distinctions based on isolated and interrelated concepts, physical and mental events, artifacts and natural concepts, concrete and abstract concepts, ad hoc and stable concepts, basic versus subordinate and superordinate level concepts, cross classifications versus taxonomies, bottom-up and top-down classes, naïve, folk and expert taxonomies [3–5]. We then show how each distinction motivates syntax sensitive to particularities of each pattern.

We believe, SCS carries profound implications for theory and practice of IS that we hope to explore in future work. First, it suggests the use of prevailing modeling approaches and grammars may require modifications to be more consistent with the SCS DP (even if it simply means making a comment next to a class). Also, the identification and modeling of classes is a central task of conceptual modeling and research has acknowledged the need for more theory-grounded design [6]. At the same time, more research is needed on the specific benefits and possible negative consequences (e.g., due to increased complexity) of this principle in conceptual modeling grammars. Second, it is important to become aware of the consequences of the SCS DP on database designs. For example, storing ad hoc concepts (e.g., things to take on vacation; that may not share many common attributes) may require flexible, noSQL databases rather than relational ones. Third, SCS can better inform studies on conceptual modeling as it suggests that differences in previous study results *may* be attributed to different kinds of classes [e.g., see 7].

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