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Fact-Orientation and Conceptual Logic

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***Abstract*—Fact-orientation is a conceptual approach to modeling information systems that captures the facts of interest in natural sentence structures without forcing some aspects to be modeled as attributes of other structures. Its graphical notation for data modeling enables a vast variety of business constraints to be depicted visually, while its formal basis in logic enables models to be transformed into implementation targets for execution. This paper provides a state-of-the-art overview of fact-orientation in general and second-generation Object-Role Modeling (ORM) in particular, highlighting its conceptual and visual support for logic-based modeling, and contrasting it with other data modeling approaches.**

Keywords-Object-Role Modeling, fact-orientation, conceptual schema, information modeling, business rules, data modeling.

I. INTRODUCTION

Typically, analysis and modeling of an enterprise or business domain is a collaborative process between the business expert, who best understands the business rules and requirements, and the modeler whose main task is to elicit this understanding and capture it in a formal model that can be executed (directly or indirectly via transformation) by an information system. Ideally, the formal model (including its representation of the business rules) should be validated by the business experts. Since business experts are often non-technical, the model needs to be conceptual in nature, cast in language that is intelligible to the business expert while still being formal. Fact-orientation aims to address this communication need in an optimal way, using a highly expressive graphical notation together with readable textual formulations that can be automatically transformed to implementation targets.

This address provides a state-of-the-art overview of fact-orientation in general and second-generation Object-Role Modeling (ORM) in particular, highlighting its conceptual and visual support for logic-based modeling. It identifies ORM's underlying principles and logical foundations, outlines recent improvements to the methodology and associated tool support, and contrasts fact-orientation with other data modeling and logic-based approaches. The rest of this paper is structured as follows. Section II provides a quick overview of fact-orientation, sketching its history and main principles, and introducing its graphical notation. Section III conveys some of the expressive power of ORM's graphical and textual languages for data modeling, as compared with Entity Relationship (ER) diagramming [[6]] and class diagramming in the Unified Modeling Language (UML) [[21]]. Section IV briefly surveys some active research areas within fact-orientation, including connections between ORM and two other logic-based languages, and. Section V concludes with some recommendations and a list of references for further reading.

II. HISTORY AND PRINCIPLES OF FACT-ORIENTATION

Fact-oriented modeling approaches were initially developed in the 1970s as a way to model, query, and transform facts using *attribute-free* structures based on *controlled natural language sentences*. For example, features that would be modeled in ER or UML as attributes, such as Person.birthdate and Person.isSmoker, are instead modelled by *fact types* such as Person was born on Date and Person smokes. *Objects* are classified as either entities (e.g. persons) or values (e.g. person names), and all facts are encoded as relationships over one or more objects. The term "*role*" is used for a part played by an object in a fact.

The first widely used approach to fact-orientation was Natural Information Analysis Method (NIAM) [[26]]. This introduced a "circle-box" graphical notation to depict fact types, using boxes for roles, with lines connecting them to named circles depicting the object types, and also introduced a "cookbook" procedure for building models, that made heavy use of concrete examples and natural verbalization. The approach had significant impact on early standardization work for conceptual schemas [[25]], and formalizations of the approach soon followed (e.g. [[9]], [[24]]). More than thirty years afterward, a family of fact-oriented approaches now exists, with many improvements and extensions to the original notation and modelling process, but the encoding of facts in terms of objects and roles, and the use of concrete examples with verbalization still lie at the heart of all these approaches, where the process of creating a data model begins by verbalizing facts from *data use cases* (e.g. reports, forms, or queries) that exemplify the data requirements.

The main versions of fact-orientation in current use include ORM, Cognition enhanced NIAM (CogNIAM), and Fully Communication Oriented Information Modeling (FCO-IM) [[2]]. These are supported by a variety of industrial and academic software tools [[15]], further details of which may be found on www.orm.net, www.ORMFoundation.org, and www.factbasedmodelling.org. The Semantics of Business Vocabulary and Business Rules (SBVR) [[23]] and Object-oriented Systems Modeling (OSM) [[8]] initiatives are also close relatives to fact-orientation with their attribute-free

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