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Inclusive Conceptual Modeling: Diversity, Equity, Involvement, and Belonging in Conceptual Modeling

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Abstract

We propose a vision for inclusive conceptual modeling. The urgency to address inclusiveness comes from two converging trends: the deepening reliance on information technology; and broader engagement of the members of the public in IT development and use, including conceptual modeling. In this paper, we propose inclusive conceptual modeling as a critical direction for conceptual modeling research, explain its basic tenets and illustrate corresponding research opportunities.

Keywords

Inclusive conceptual modeling, Inclusion, Diversity, Equity, Involvement, Belonging [1]

Introduction

As reliance on information technology (IT) deepens, ensuring everyone has an opportunity to benefit from IT is critical and urgent. Because conceptual modeling plays a key role in shaping the design and use of IT, inclusion in conceptual modeling is vital to ensure inclusive IT.

Conceptual modeling faces its own, unique inclusion challenges. For example, conceptual modeling languages and methods have been criticized for the insufficient support of non-IT experts and people with disabilities, despite increased involvement of novices in modeling [1], [2]. In addition, the medium of conceptual modeling is nearly exclusively visual, excluding people with visual impairments [1], [3], [4].

Some efforts to make conceptual modeling more inclusive exist. These include a proposal for disability-aware conceptual modeling [1], principles for universal conceptual modeling [3], gender-inclusive requirements engineering [5], modeling to support empowered users [2], among others. More broadly, conceptual modeling is often conducted within the context of such inclusive approaches as Agile, DevOps, and participatory design [6].

However, no conception of inclusive conceptual modeling exists and apart from a few recent efforts, the modeling community has generally ignored this issue [1]. Furthermore, as a recent study on gender inclusion in requirements elicitation suggests, many challenges to inclusion persist [5]. The IT systems continue to discriminate against users whose characteristics are underrepresented in the development process [7]. By becoming more inclusive, conceptual modeling can both increase its value for broader audiences and promote greater inclusion in IT development and use. This vision paper aims to catalyze these efforts by outlining a vision and a framework for inclusive conceptual modeling.

Inclusive Conceptual Modeling Framework

Consistent with on-going efforts within society, we propose that inclusiveness is a critical matter for conceptual modeling to remain relevant. Inclusive conceptual modeling is based on social, economic, and moral imperatives.

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Studies demonstrate that diverse teams produce more novel and higher-impact ideas (e.g. [8]). In 2016, the US President Barack Obama [9] summarized research findings and their implications as: "[r]esearch has shown that diverse groups are more effective at problem solving than homogeneous groups, and policies that promote diversity and inclusion will enhance our ability to draw from the broadest possible pool of talent, [and] solve our toughest challenges." The benefits of inclusion are also found in software development contexts [5]. Beyond the economic imperative, there is an overshadowing moral one. Caring, collaborating, and supporting each other, no matter the differences, is a hallmark of humanity.

To motivate specific research directions, we formulate the Inclusive Conceptual Modeling Framework derived from prior research on inclusion [9]–[11]. We define inclusion as the *culture* and *activities* that allow and encourage people with multiple backgrounds, beliefs, mindsets, and abilities to realize their potential in some activity. Commonly, inclusive culture is understood as a multifaceted environment and the concerted efforts to build and maintain such an environment [12]. Inclusive environments are characterized by *diversity*, *involvement, equity*, and *belonging* [10], [12]. These should serve as key considerations of inclusive conceptual modeling.

According to the World Bank, social inclusion is the process of improving the ability, opportunity, and worthiness of people, disadvantaged based on their identity, to take part in society [13]. Diversity is concerned with representation, but representation alone does not guarantee all voices are heard and considered. As Vernā Myers of LinkedIn, remarked: "Diversity is being invited to the party; inclusion is being asked to dance" [14]. Hence, access to key opportunities to promote active *involvement* of people, no matter their differences (including in opinions and beliefs), is necessary. *Equity* is fair and just treatment for all, while striving to identify and eliminate inequities and barriers. Finally, inclusive environments cultivate a sense of *belonging*. They draw people in and ensure those who voluntarily choose to engage feel they are full members of the community where they are comfortable, appreciated, and where they can self-realize and thrive [10], [12].

We now adapt these ideas to conceptual modeling. ***Inclusive conceptual modeling*** is ensuring and promoting diversity, equity, involvement, and belonging of people with different backgrounds, beliefs, and abilities so they can realize their full potential in conceptual modeling and its related activities. This definition provides the foundations of the Inclusive Conceptual Modeling Framework.

Given that conceptual modeling is part of broader IT development and use, however, we suggest distinct but partially overlapping ways inclusive conceptual modeling research can be conducted: *inward* and *outward inclusive activities*. ***Inward inclusive conceptual modeling*** is an objective to ensure the principal practices of conceptual modeling are inclusive with respect to the facets of inclusion (diversity, involvement, equity, and belonging). Inward inclusive modeling focuses on ensuring modeling artifacts and processes are designed to be accessible to as many people as possible. For example, using a conceptual modeling language that many different people can use because it has a simple and accessible notation is more inwardly inclusive than using a conceptual modeling language with complex notation that requires specialized training. Hence, a language that is primarily expressed using visual symbols or that uses advanced vocabulary may systematically exclude specific segments of the population.

An important research topic arising from this view is understanding the requirements different people have for modeling. It is critical to move beyond the traditional constituency of modeling – IT professions – as increasingly members of the public are becoming model users and designers. Additionally, conceptual modeling symbols that originate in one culture might not be easily understood by those from another culture. An open research area is developing languages and methods that are inclusive, including but not limited to disability, gender, and culture considerations. Assessments of inclusion quality of models and modeling languages are also needed. These assessments can establish the boundary conditions for when a particular conceptual modeling solution is appropriate, and how it can be made more inclusive.

Tools of conceptual modeling may also exclude or discourage users [1]. For example, as Nunes et al. [5] suggest, learning and engaging with tools "through tinkering" may discourage female users. As conceptual modeling activities are increasingly being automated, not only do the rules

and constructs of modeling need to be accessible, but also how they are introduced and manipulated by the tools.

To cultivate inclusive conceptual modeling, the language in which conceptual modeling activities is couched must be sensitive to the needs of diverse people. For example, the language of conceptual modeling must be invariant to genders and identities. Presently, little guidance for language inclusiveness is provided during the design of conceptual modeling languages, such as names of entity types, relationship types or roles (cf. [15]). Prior research mainly considered semantic and ontological parameters [16]. Conceptual modeling research can consider the recommendations from diversity and inclusion leaders, such as the American Psychological Association on inclusive concepts and language (e.g., "they" to refer to individuals) [11].

Outward inclusive conceptual modeling is the aim of broader, more "ambassadorial" activities undertaken by the conceptual modeling community as part of IT development and use. The conceptual modeling community has an important role to play in encouraging greater inclusivity in IT development and use. This can be "leading by example" but also actively collaborating with the relevant IT development and use communities to address common inclusion challenges.

A new area of research is artificial intelligence (AI)-supported conceptual modeling, focusing on topics such as mining models from process data and creating AI-supported learning and modeling tools. The coupling of conceptual modeling with AI creates opportunities for conceptual modeling researchers to collaborate with the AI research community, which is grappling with issues of inclusion, fairness, and algorithmic bias.

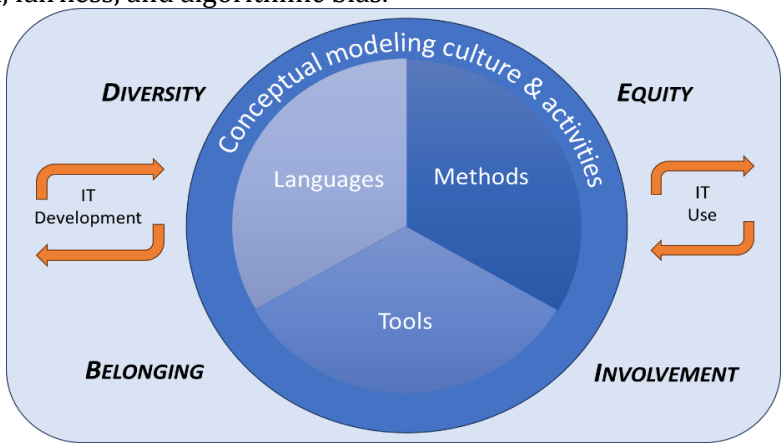

Figure 1. Inclusive Conceptual Modeling Framework

One way to develop inclusive software is to make it more modular, flexible, and personalized. Traditional conceptual modeling may be a bottleneck for these initiatives. While conceptual modeling methods are participative, and often elicit individual requirements, these are commonly reconciled into "unified" models. More research on *federated conceptual models* (analogous to federated schemas and data lakes) is needed. Such models may preserve the individual views of the users, without reconciling them, and seek to analyze and capture the differences, rather than similarities (as in unified models) more systematically. These differences can inform the development of more adaptive and personalized IT.

Broadly, conceptual modeling, through its inherent human focus, is well-positioned to facilitate involvement of underrepresented people with IT, reduce or remove participation barriers, and increase the sense of belonging. Often these benefits of modeling were implicit; more explicit research attention to how conceptual modeling can contribute to inclusive IT stands to uncover unrealized opportunities. The ideas of the Inclusive Conceptual Modeling Framework are visually captured in Figure 1.

Conclusion and Outlook for Future

Conceptual modeling continues to be an important part of IT development. Consistent with efforts within society, we propose that inclusiveness is critical for conceptual modeling. Inclusive

conceptual modeling seeks to ensure that the artifacts and activities of conceptual modeling are accessible to the broadest audience possible and that barriers to participation in conceptual modeling are removed or minimized. In this vision paper, we establish the need for inclusive conceptual modeling. To this end, we hope to spark awareness to this important objective, and thereby steer research toward improving inward and outward inclusiveness in conceptual modeling.

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