Towards an Ontology to Structure Data on Women's Leadership in Computing in Brazil

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ABSTRACT. This paper proposes an ontology to structure data on female leadership in computer science in Brazil, with the goal of building an open and collaborative platform where data can be collected, organized and classified in order to construct a folksonomy of the domain. The ontology aims to address questions of competency in the domain, such as the contextual factors that motivate Brazilian women to pursue leadership positions in computer science as well as the policies that promote such opportunities. The proposed ontology may benefit different users, including female computer science professionals, leaders, researchers and policymakers.

KEYWORDS: women in computing / ontology / gender data.

HACIA UNA ONTOLOGÍA PARA ESTRUCTURAR DATOS SOBRE EL LIDERAZGO DE LAS MUJERES EN LA INFORMÁTICA EN BRASIL

RESUMEN. Este artículo propone una ontología para estructurar datos sobre el liderazgo femenino en la informática en Brasil, con el objetivo de construir una plataforma abierta y colaborativa donde los datos puedan ser recogidos, organizados y clasificados para construir una folcsonomía del dominio. La ontología pretende abordar cuestiones de competencia en el dominio, como los factores contextuales que motivan a las mujeres brasileñas a buscar posiciones de liderazgo en informática, y las políticas que promueven tales oportunidades. La ontología propuesta puede beneficiar

a varios usuarios, entre ellos profesionales femeninas de la informática, líderes, investigadores y responsables políticos.

PALABRAS CLAVE: mujeres en la informática / ontología / datos de género

RUMO A UMA ONTOLOGIA PARA ESTRUTURAR DADOS SOBRE A LIDERANÇA FEMININA NA COMPUTAÇÃO NO BRASIL

RESUMO. Este artigo propõe uma ontologia para estruturar dados sobre a liderança feminina na computação no Brasil, com o objetivo de construir uma plataforma aberta e colaborativa onde os dados possam ser coletados, organizados e classificados para construir uma folksonomia do domínio. A ontologia pretende abordar questões de competência no domínio, como os fatores contextuais que motivam as mulheres brasileiras a buscar posições de liderança em computação, e as políticas que promovem tais oportunidades. A ontologia proposta pode beneficiar vários usuários, incluindo profissionais femininas da computação, líderes, pesquisadores e responsáveis políticos.

PALAVRAS-CHAVE: mulheres na computação / ontologia / dados de gênero

1. INTRODUCTION

The low representation of women leaders in the fields of computing or information technology (IT) is a persistent problem in Brazil and the world. Many are the consequences of this inequality, from the perpetuation of gender stereotypes and the lack of role models to the loss of potential innovation driven by women leaders through their diverse perspectives and unique experiences (Rogers, 2015). Thus, it is crucial that industry and academia work together to change this reality and promote gender equity at all levels of corporate and academic hierarchies.

With the aim of improving this scenario, it is necessary to expand the availability of gender data in the IT workforce domain, since this kind of data is barely existent in Brazil[1]. The lack of gender data can undermine the creation and even the effectiveness of policies and programs designed to address gender equity in IT leadership.

Considering that ontology is a formal and explicit representation of a set of concepts and their relationships, which can be employed to share knowledge and integrate data from various sources (Noy and McGuinness, 2001), the development of an ontology of female leadership in computing in Brazil could substantially contribute to generating gender-related data within this domain. This endeavor could assist people in identifying and categorizing the experiences, contextual factors and opportunities related to women professionals in the field. Furthermore, the creation of an ontology has the potential to stimulate the debate concerning the leadership of women in IT, thereby contributing to the empowerment and expansion of the entire IT female community.

Thus, this paper aims to present an ontology for structuring data on women's leadership in the field of Computing in Brazil. This ontology could subsequently serve as the foundation for the development of an open and collaborative platform where data about the IT female workforce could be collectively collected, organized and classified to construct a domain-specific folksonomy.

A folksonomy is a decentralized classification system that is primarily shaped by a community of users who assign descriptive tags to online content (Guy and Tonkin, 2006). It represents a valuable addition to conventional knowledge organization methods, fostering active user engagement, encouraging the use of informal language and ensuring up-to-date relevance (Weller et al., 2010). Consequently, the proposed folksonomy will enable a large number of individuals to collaborate in organizing and classifying the information, as opposed to relying on a single individual or group for such tasks. This collaborative approach ensures that data is structured from the perspective of the users, considering their specific needs and interests regarding the domain (Allam et al., 2020).

1 At the time of this research, the Gender Data Portal (https://genderdata.worldbank.org/data-availability/) gave a data availability of 60.77% for gender-related data in Brazil, with very limited set of indicators. There are no leadership indicators. In the computing field, only indicators related to female enrollment in undergraduate STEM courses are available.

Moving on, Section 2 introduces the methodology employed in creating the ontology, Section 3 presents the ontology of female leadership in computing in Brazil, Section 4 discusses the next steps for the research and Section 5 provides some closing remarks.

2. METHODOLOGY

In order to create our ontology, we adopted the methodology of Noy and McGuinness (2001), a reference widely employed for this purpose in the field, which outlines seven steps for the creation of an ontology. These steps include: "*Step 1) Determine the domain and scope of the ontology; Step 2) Consider reusing existing ontologies; Step 3) Enumerate important terms in the ontology; Step 4) Define the classes and the class hierarchy; Step 5) Define the properties of classes—slots; Step 6) Define the facets of the slots; and Step 7) Create instances*".

For steps 3 to 7, we used theoretical references such as (Kohl and Prikladnicki, 2021; Batista and Mattos, 2019; Hamilton et al., 2016), technical reports on leadership such as (Grant Thornton, 2022; PretaLab, 2022; Michael Page, 2021; PretaLab, 2019) and domain-related news data[2] as a basis for defining ontology classes and properties. More details are shown in the following section.

3. ONTOLOGY RESULTS

In accordance to step 1 of the Noy and McGuinness (2001) methodology, the ontology presented in this paper intends to cover the domain of female leadership in computing in Brazil. Our main goal is to use this ontology as the basis to start an open and collaborative platform where data from this domain can be collected, organized and classified collectively for the creation of a domain folksonomy.

The ontology is expected to be able to answer competency questions about the domain, such as:

- What contextual factors motivate Brazilian women to take up leadership positions in the field of computing/IT?
- What policies promote opportunities related to leadership roles in the computing/IT field in Brazil?
- What contextual factors motivate Brazilian women to accept leadership opportunities within the computing/IT field?
- What organizations have policies that promote leadership opportunities in the computing/IT field?

2 *E.g.* www.generonumero.media/reportagens/mulheres-reprogramam-o-genero-dos-cursos-superiores-de -tecnologia-no-brasil

Therefore, the ontology could be employed by a diverse audience with different goals. For instance:

1. Women working in computing/IT, whether leaders or not, could provide data for the creation of real instances of the ontology classes;
2. Leaders and managers from different sectors could employ it in decision making and policy creation;
3. Researchers could use it as a source of new research hypotheses or even propose the maintenance and extension of the ontology.

The initial version of the ontology is illustrated in Figure 1. It has 19 domain classes and subclasses, 36 object properties (relationships) and 2 data properties. We propose that some classes, such as "*Organization*" and "*Contextual Factor*," could be linked to existing ontologies (step 2 of the Noy and McGuinness (2001) methodology), such as Reynolds (2014) and Ribeiro and Maciel (2020), accordingly.

Figure 1

The Women's Leadership in Brazilian Computing Ontology

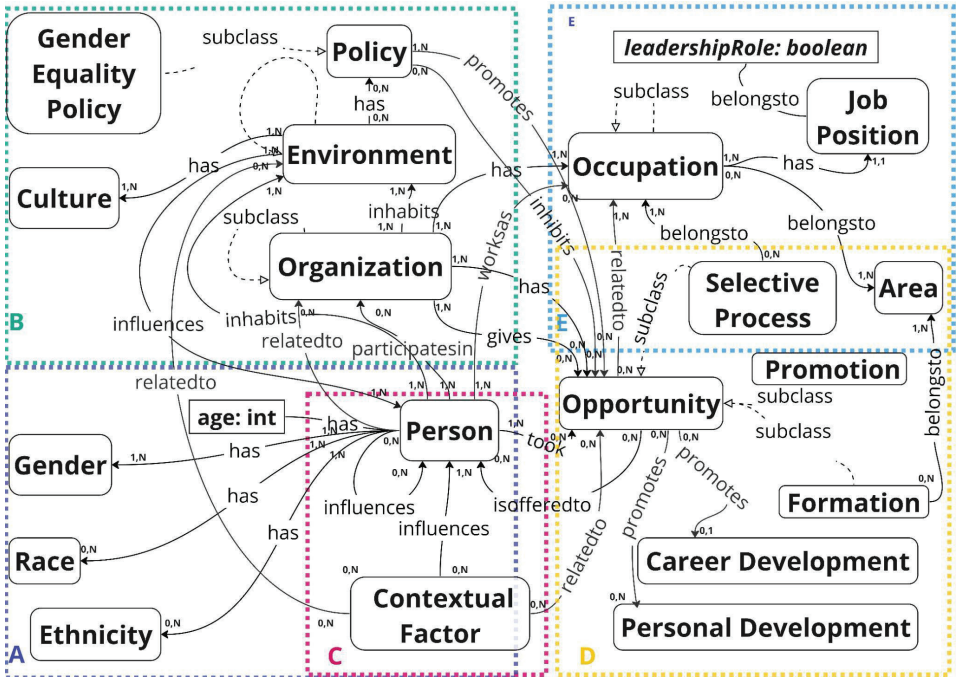


Figure 1 divides the ontology into five topics (items A to E) as an illustrative resource representing the main concepts of the ontology. These concepts are the following:

A) Classes and properties representing women and their social characteristics, which may influence the formation of subprofiles within women's groups, e.g., black women;

B) Classes and properties representing environments and organizations that women are or have been a part of along with their cultures, policies and internal structures, which could either promote or inhibit opportunities for women;

C) Classes and properties representing contextual factors that influence women across the various contexts they are situated in, e.g., educational factors;

D) Classes and properties representing different opportunities available to women, which they could accept (or not). These are opportunities that foster career development and personal growth for women;

E) Classes and properties representing women's professional lives, such as job roles, job positions, and leadership roles within organizations.

4. NEXT STEPS

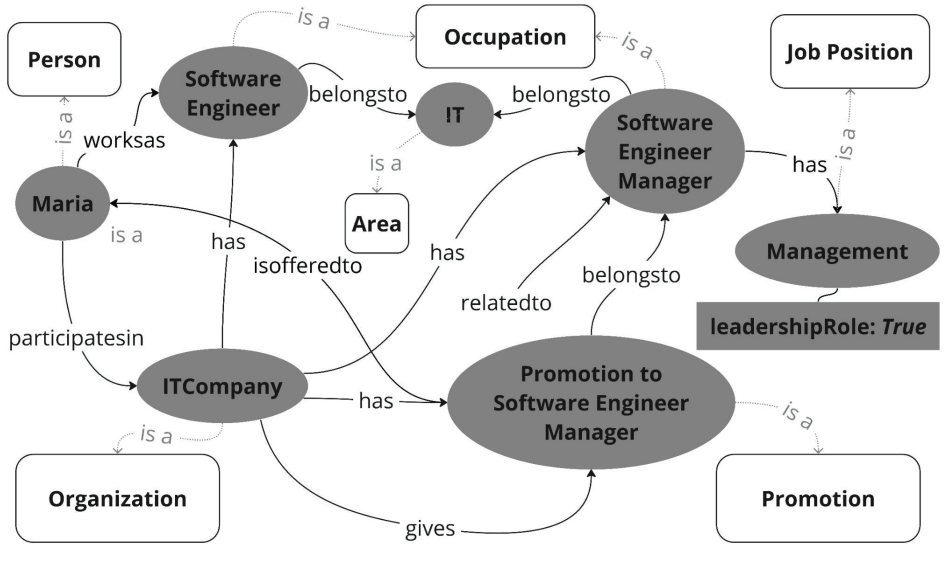
The ontology proposed in this paper is the preliminary result of a two-year project. This ontology will serve as the basis for building a folksonomy for the collection, organization, and classification of data related to female leadership in computing/IT in Brazil. This folksonomy will be made available on an open data platform linked to the Equality in Leadership for Latin American STEM (ELLAS) network[3] (Maciel et al., 2023).

By using the platform, individuals who identify as female, including students and professionals in computing/IT fields, could input their individual data to generate real world instances. Aggregated data could then be accessed by the platform's target audience, which includes researchers, managers, policymakers, as well as the general community.

3 https://ellas.ufmt.br/

Figure 2

Knowledge graph representing instances of Ontology



The ontology evaluation will be conducted by the collaborative construction of the folksonomy within the platform. When individuals input their individual data, they will be able to visualize their information represented by an instance graph as per the ontology. This will allow them to validate, modify or suggest changes to their data graph, as shown in Figure 2.

Figure 2 illustrates the knowledge graph of instances created from the following mini-scenario: *Maria* works in the field of Information Technology (*IT*) as a Software Engineer (*Occupation*) at *ITCompany* (*Organization*), where she has been offered to be promoted to Software Engineer Manager (*Promotion Opportunity*), a management-level role (*Job Position*) with a leadership function in the Software Engineering department (*Organization*). Having more instances like the one in Figure 2 would make it possible to determine, for example, whether the *ITCompany* organization has policies to promote leadership opportunities in computing/IT for women.

5. CONCLUSIONS

This paper presents the preliminary version of an ontology designed for structuring data about female leadership in computing/IT in Brazil. This version encompasses 19 classes and subclasses within the domain, along with 38 properties that were identified by conducting a survey of academic literature, technical reports and news articles about the domain. Prior to its 2022 edition, which specifically addresses ontologies within the domain of women in

computing, there were no publications found on the subject in the Women in Information Technology (WIT) archive[4], the largest Brazilian academic conference on the topic.

The proposed ontology is expected to contribute to the organization, dissemination and advancement of knowledge in the domain of female leadership in Brazilian computing. This contribution will enable a deeper understanding and exploration of the relationship between domain concepts, it will facilitate sharing information by way of a common vocabulary in order to generate gender-related data within the domain and it will facilitate the development of novel tools, research endeavors and policies aimed at fostering women inclusion and achieving gender equity in the field of computing.

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