Ontology-Driven Modelling of Personal data for Professional Social Media Platforms (PSMPs)

Bahadır Aktaş[1,2,*,†], Luís Ferreira Pires[1,†], Rodrigo Calhau[1,3,†] and Adem Akbıyık[2,†]

[1]University of Twente, Semantics, Cybersecurity and Services group, Enschede, the Netherlands
[2]Sakarya University, Management Information Systems Department, Business Faculty, Serdivan, Sakarya, Turkiye
[3]Federal Institute of Espírito Santo, Vitória, Brazil

Abstract

Professional Social Media Platforms (PSMPs), of which LinkedIn is the most prominent example, are web-based social networks oriented towards professional networking and career development. PSMPs enable individuals to showcase their work, share content, explore job opportunities, and connect with fellow professionals and colleagues. Workers looking for opportunities can use PSMPs to display their capabilities by publishing digital resumes, while companies looking for employees can use PSMPs to make them known to a broader audience and eventually to post job openings. Although PSMPs can play an important role in the recruitment process, this potential is not fully exploited because the data they hold lack precise semantics and are not machine-actionable. For this purpose, this paper describes the development of an ontology for personal data that aims to give formal semantics to PSMP personal data. This ontology has been developed based on the Unified Foundational Ontology (UFO) and is defined in OntoUML. The paper also describes how this ontology has been beneficially used in the development of a software system that advises job seekers on the skills and competences that they have to acquire to become a better match for a job position.

Keywords

Professional Social Network Platforms, career-related personal data, Unified Foundational Ontology, ontology engineering

1. Introduction

With the increasing popularity of social media, *Professional Social Media Platforms* (PSMPs), like LinkedIn, Xing and ResearchGate, became useful instruments for professional networking and career development. PSMP is a web-based social network oriented to companies and industry professionals looking to make new business contacts or keep in touch with coworkers, affiliates, and clients [1]. According to Statista[1], the number of PSMP users has increased in the last four years, confirming the growing popularity of these platforms. This increase can also be associated with the vast career-related data PSMPs possess and the career opportunities they offer for networking and visibility.

For workers looking for opportunities, PSMPs serve as platforms for publishing digital resumes. For companies looking for employees, they serve as platforms to make the companies known to a wider audience and, more specifically, to post job openings. This means that these platforms contain a wealth of career information, ranging from an individual's educational background, work experience, skills, and professional competences to available jobs and their requirements [1, 2]. Career opportunities that used to be communicated only through face-to-face meetings or newspaper ads can now reach a

Proceedings of FOIS 2025 Satellite events co-located with the 15th International Conference on Formal Ontology in Information Systems (FOIS 2025), September 10-12, 2025, Catania, Italy
*Corresponding author.
†These authors contributed equally.
bahadiraktas@sakarya.edu.tr (B. Aktaş); l.ferreirapires@utwente.nl (L. Ferreira Pires); calhau@ifes.edu.br (R. Calhau); adema@sakarya.edu.tr (A. Akbıyık)
https://www.linkedin.com/in/bahadir-aktas-0065b8a0/ (B. Aktaş); https://www.linkedin.com/in/lferreirapires (L. Ferreira Pires); https://integra.ifes.edu.br/p/rodrigo-fernandes-calhau (R. Calhau); https://adema.sakarya.edu.tr (A. Akbıyık)
0000-0002-3650-6471 (B. Aktaş); 0000-0001-7432-7653 (L. Ferreira Pires); 0009-0006-6051-2165 (R. Calhau); 0000-0001-7634-4545 (A. Akbıyık)
© 2025 Copyright © 2025 for this paper by its authors. Use permitted under Creative Commons License Attribution 4.0 International (CC BY 4.0).

[1]https://www.statista.com/forecasts/1147197/linkedin-users-in-the-world

CEUR-WS.org/Vol-4111/SC_Paper_4.pdf

CEUR Workshop Proceedings ceur-ws.org ISSN 1613-0073
published 2025-11-30

wider audience and are more accessible due to the visibility offered by PSMPs. However, digitization of career data brings along some challenges. Although PSMPs, such as LinkedIn, may maintain internal knowledge models, these are proprietary and not publicly accessible, making them unsuitable for open reuse or evaluation. As a result, publicly available PSMP data are not machine-actionable and lack precise semantics. Without precise semantic definitions, data can be misinterpreted, relations between data may not be revealed, and valuable nuances in career-related data can be missed.

To address this issue, *Ontology-Driven Conceptual Modeling* (ODCM) stands out as a promising tool. ODCM allows the definition of ontological models that give formal semantics to data, enhancing data comprehension and facilitating their understanding [3]. The *Unified Foundational Ontology* (UFO) is a foundation ontology that enables a precise definition of data semantics [4], and OntoUML is a UFO based modeling language defined as a UML profile that can be used to represent ontologies [5]. UFO and OntoUML have been successfully applied to perform *ontological unpacking*, namely exposing and analysing the ontological commitments of models, languages and tools for the purpose of evaluation and improvement in many different domains [6].

In this paper, we show how ontological unpacking can enable the extraction of semantic details from professional data from PSMPs, revealing their layers and uncovering relations between data elements that might otherwise go unnoticed. We defined an ontology of individual career-related data found on PSMPs, using the LinkedIn example as a case study, in an *ontologically well-founded* manner using ODCM, aiming at making the data machine-actionable. Through this ontology, professional data become grounded in ontological foundations, and connections between data elements are clearly articulated.

This paper is further structured as follows. Section 2 discusses career-related data in PSMPs and justifies the use of ontologies to give proper semantics to these data. Section 3 outlines the methodology based on SABiO [7] that we used to develop our reference ontology for online professional data. Section 4 discusses our reference ontology, our key modeling decisions and how the ontology was verified. Section 5 discusses some practical implications of using our ontology. Section 6 discusses related work. Finally, Section 7 gives our final remarks.

2. Career-Related Data in PSMPs

Professional Social Media Platforms (PSMP) are social networking platforms focused on professional networking [8], supporting social networks where relationships move beyond just friendships or casual connections. They have been specifically designed for business or academic purposes, aiming to of support professional networking and people interaction [2, 1]. PSMP users often utilize these networks to showcase their professional credentials, primarily for the purpose of self-promotion often aiming to tap the platform's resources for potential employment opportunities and the acquisition of professional information [9].

2.1. Usage and Functionality

Networking is considered a major factor in career success in workplaces [10]. Studies show that job hunters use PSMPs to grow their professional networks [11], and PSMP usage is motivated by the need for career advancement [12]. Users' profiles in PSMPs are similar to online resumes and can help users extend their professional network by establishing a common ground for professional self-promotion. In addition, active or passive participation in PSMP and disclosure of personal profiles have significant positive effects on the perceived social connectedness of PSMP users [13]. Another perspective on PSMP usage is from employers, as research shows that evaluating social media profiles is becoming an integral part of organizational hiring procedures [14]. Employers increasingly rely on social media profiles, especially those on PSMS platforms, to screen candidates and distinguish their professional attributes and job fit. Applicants are advised to manage their profiles proactively on these platforms to clearly demonstrate and present their skills and suitability for potential job opportunities [15]. Figure 1 summarizes the main uses of PSMPs for general, business and academic users [2].

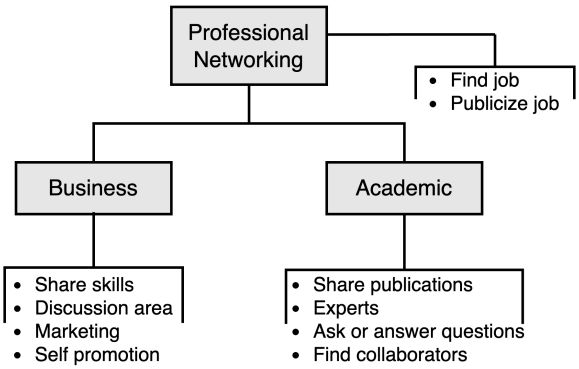

Figure 1: Professional networking hierarchy and main uses, adapted from [2]

PSMPs serve as platforms for professional networking and career advancement and host a rich array of user-generated data, which holds potential for career development, organizational decision-making, and data-driven insights.

2.2. User's Career Data

Career-related data plays an important role in career planning and can be used to enable individuals and organizations to make informed decisions about career paths and professional growth. By analyzing career data, an alignment can be achieved between individual aspirations and organizational goals. It improves human resources management and career development outcomes [16].

These data can also uncover patterns and insights, which enables many different applications in professional settings. For example, a LinkedIn user can create profiles with their employment history, professional achievements, skills and expertise. Additionally, users can join groups focused on job opportunities and recruitment, enabling them to build connections, explore job openings, and engage in discussions [1]. To better understand the data architecture of LinkedIn, Figure 2 visualizes a part of their data warehouse schema focusing on user and group related data. In this schema, the user information is structured in three main types: (1) personal information, (2) professional information, and (3) educational information [1].

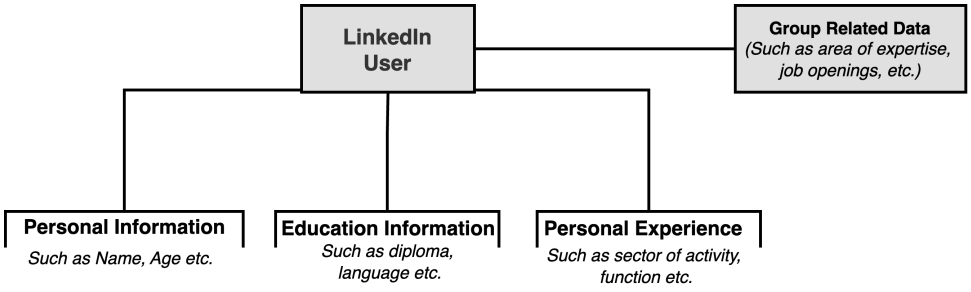

Figure 2: LinkedIn Warehouse Schema, adapted from [1]

However, this schema does not show an important aspect of user information present in LinkedIn, namely skills, certificates, publications and others. To address these missing components, we studied LinkedIn's user profile page to identify data elements that go beyond the schema, enabling a more comprehensive view of user profiles. LinkedIn offers various features that can be accessed through publicly available profile pages of a user. These include a profile summary (user's biography), skills (individual's skill set), and position-related details such as position summary (overview of current and past roles), position title (the specific job role), company name, and work location. Education

information can be also retrieved if available, including the name of the educational institutions, degree details, and field of study (user's academic area) [17].

2.3. Motivation for Ontologies

Career-related data in PSMPs suffer from ambiguity. Job titles, skills, and competences can have different meanings depending on the industry, organization, and region. The lack of commonly understood definitions makes it challenging to interpret and compare professional qualifications, which leads to inconsistencies. Traditional approaches fail to address the dynamism and complexity of individuals' competences and skills since these methods lack the ability to provide a rigorous representation of career data, which includes skills, experiences, and qualifications [18]. These shortcomings led to a limited and incomplete understanding of an individual's capabilities and limit the effectiveness of career planning and development strategies [19]. Initiatives such as HR-XML (Human Resource Extensible Markup Language) [20], O*Net (Occupation Information Network) [21] or ESCO (European Skills, Competences, Qualifications, and Occupations) [22] aim to address this issue by providing a structured classification system that links occupations to skills and knowledge.

O*Net is a US-based database focused on occupational classifications, skills, and work activities. It aims to improve consistency in job descriptions, and supports workforce planning by defining key knowledge areas, skills, and abilities for each role. However, O*Net remains a structured database and lacks the formal rigor of an ontology. It establishes links between occupations and required competences, however, it does not consider contextual variations, dynamic job requirements, or interdependencies [21]. HR-XML provides a standard format for exchanging HR-related data, improving interoperability in talent management systems. However, it does not define competences nor establish relationships between skills and occupations. While HR-XML enables data sharing across HR applications, it does not resolve ambiguity in competence definitions nor support dynamic job requirement updates [20]. ESCO improves consistency in job descriptions and facilitates workforce alignment by defining essential and optional competences for each role. However, ESCO remains a taxonomical system rather than an ontology, which means that it does not fully resolve ambiguity. Although it establishes links between occupations and skills, it does not account for contextual variations, evolving job requirements, or dependencies between competences. An ontology-driven approach can overcome these limitations by providing precise conceptual definitions, modeling contextual relationships, and enabling a structured, machine-actionable representation of career-related data in PSMPs [23].

This study aims to model the data represented in professional profiles of individuals shared publicly on PSMPs (Professional Social Media Platforms) using the Ontology-Driven Conceptual Modeling (ODCM) approach, the Unified Foundational Ontology (UFO) and OntoUML, ensuring semantic rigor and fostering semantic interoperability.

3. Methodology

The ontology we developed serves two main purposes: (1) as a *conceptual common model* that provides clearly defined concepts and relationships to facilitate understanding and communication among researchers and practitioners: (2) as a *domain model* that supports the development of consistent applications and algorithms, ensuring that PSMP data can be interpreted, processed, and reasoned upon effectively. Given this dual role, the ontology was developed following SABiO (Systematic Approach for Building Ontologies) [7], which is an ontology engineering methodology inspired by software development practices. SABiO structures ontology development into five phases: purpose identification and requirement elicitation, ontology capture, design, implementation, and test. These phases are briefly discussed below.

3.1. Purpose and Requirements

In the first step of the SABiO methodology, the objectives of the ontology are defined by engaging stakeholders, establishing a common vocabulary, specifying functional requirements through competency questions, identifying non-functional requirements, and structuring the ontology, *potentially decomposing it into sub-ontologies*. In this step, we identified the primary purpose of our ontology, which is to provide a structured representation of skill, competence and job position relevant to career planning and complex job placements based on online career-related data.

Competences, skills, and certifications are critical for career development, workforce planning, and education. Competences, as a combination of skills, knowledge, and behaviors, evolve over time through experience and learning [24]. An individual's competences continuously change in relation with their career development and through ongoing learning processes and this dynamism makes it difficult to establish clear relationships between competences, job roles, education, and professional growth. Effectively modeling these relationships is essential for both individuals managing their careers and organizations developing workforce acquisition strategies.

Increasing emphasis on lifelong learning and professional development has motivated the need for a structured representation of career-related data. Traditional career data representations fail to capture how competences change over time and how they interconnect across different professional and educational contexts [19, 25]. The lack of a rigorous structure in the approach leads to fragmented understanding of skills, qualifications and experience which in turn limits their value in career planning and decision-making. Career-related data shows inconsistent representation of competences although they remain crucial for professional development. Existing frameworks offer structured classifications [22], but lack the semantic rigor needed to capture contextual dependencies, evolving expertise, and the interplay between job roles and required qualifications. This limits their effectiveness in supporting career planning, job matching, and workforce development.

An ontology-driven approach provides a structured, semantically rigorous model that can formally define competences, skills, and their interrelations [26, 19, 27] . By representing career-related data with clear conceptual distinctions and relationships, an ontology enables consistent interpretation, semantic interoperability, and automated reasoning, which can benefit various applications, including AI-driven career guidance and adaptive workforce planning.

SABiO prescribes that competency questions should be defined to determine the purpose and the scope of the ontology. Guided by insights gathered through several one-to-one interviews with practitioners and academic experts, we formulated the following competency questions for our ontology:

- C1 - What are the structural components of individual competences and how do they relate to job positions and industry-recognized certifications?
- C2 - What are the distinctions and relationships between a person and their educational background?
- C3 - What are the conceptual elements that define the relationship between a person and their job experience in PSMPs?
- C4 - What are the distinctions between competences, skills and certifications in career-related data?
- C5 - What are the relationships between competence, job position, and required qualifications in the context of career planning?

These competency questions could unfold into more detailed inquiries. However, in this paper we limit our focus to these questions due to space limitations. Our ontology aims to establish a well-defined, machine-actionable model for structuring career-related data, to ensure semantic precision and interoperability in PSMP environments.

3.2. Ontology Capture

The objective of this step is to capture the domain conceptualization. In this step, concepts and relations in a reference domain are analyzed with the consideration of a foundational ontology. Therefore, this

step requires a selection of a foundational ontology. Relevant concepts and relations are also identified and organized, and a graphical modeling language is a key to support this. To accomplish this, we defined our ontology in OntoUML.

The ontology capture step has been structured around the key concepts of online career-related data, namely (1) a person's current employment and past job experiences, (2) a person's active education enrollment and graduation information, (3) skills and competences that are declared by a person and certifications that they acquired to prove these.

3.3. Design

The design step aims to bridge the gap between conceptual modeling of reference ontologies and operational ontology language. After a reference ontology is created, it can be transformed into an *operational ontology*, which is an artifact suitable for use in computer applications. This requires the use of a machine-readable ontology language like OWL to design and implement the ontology. In this study, we automatically generated an OWL model from the OntoUML model using gUFO [28]. The resulting OWL model was used in the verification phase (Section 4.4). Unlike reference ontologies, operational ontologies prioritize computational properties above accurate representation.

The remaining steps of SABiO methodology are not discussed in separate sections in the sequel for the sake of simplification, and clarity, and due to space limitations, but are discussed together with other issues. Implementation is discussed in Section 4, while test and the validation are discussed in Section **??** and Section 5.

4. Reference Ontology for Online Professional Data

In this section, we discuss the ontology aspects that have been identified previously. The discussion is separated into these aspects in order to make it more understandable. In addition, we rely on UFO concepts and properties. We provide a brief introduction and explanation to the foundational entities in our ontology as we introduce our modeling decisions and the UFO concepts used in these models. Although this paper presents only graphical representations, all underlying axioms, definitions, and types are retained and inherited as specified in UFO and implemented in OntoUML. For a more in-depth discussion of UFO and OntoUML, we refer to [4] and related literature on OntoUML modeling principles.

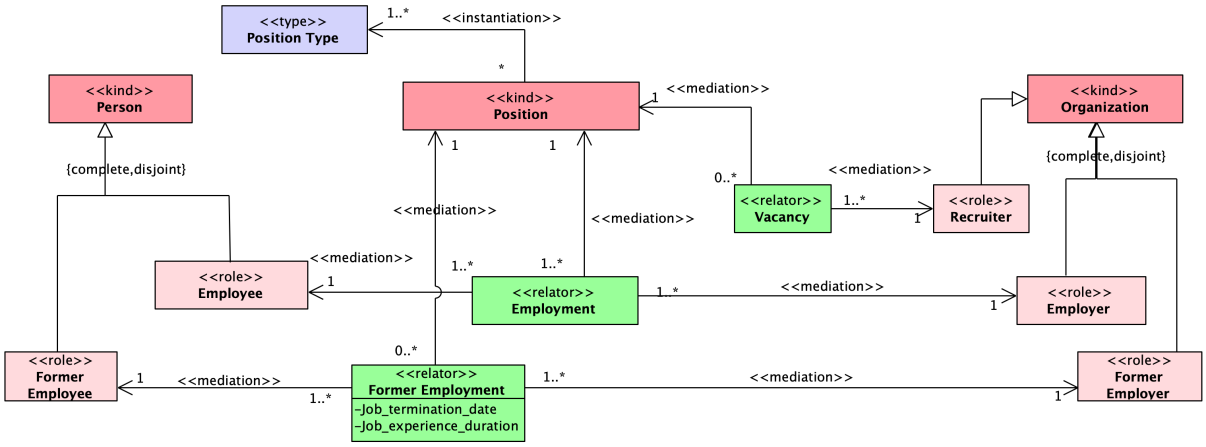

Figure 3: Employment View

4.1. Employment and Job Experience

Figure 3 shows the part of the ontology that defines a person's job experience and models the relationships between a person, a job position, and an employer. A person is modeled in this model as ***a kind,***

which means that it exists on its own and maintains its identity in various contexts and time. A solid conceptual foundation is ensured by defining a person as a kind, which captures fundamental, immutable properties.

A person can take on the ***roles*** of employee (currently employed by the organization) and former employee (employed in the past, no longer employed by the organization), depending on their work status. ***Roles are context-dependent and dynamic, meaning they exist only under specific conditions and can change over time.*** A person can be an employee and a former employee simultaneously, meaning they can be actively employed in one position while having left another, reflecting real-world career trajectories.

Similarly, an organization is also defined as ***a kind*** and can adopt the ***roles*** of employer or former employer, depending on whether the position in question is currently active. A position is ***a kind***, representing a specific job in a company (Jack's position as a Front End Developer in an organization called SmartSys), while a position type, categorized as ***a type***, a higher-level classification that exists exceeding individual organizations (Front End Developer position itself).

Three ***relators*** structure the employment relationships: (1) employment, representing the relationship in which an employee holds a job position within an organization that employs them, (2) former employment, representing a past relationship in which a person previously held a job position within an organization, and (3) vacancy, representing an open job position within an organization that is actively recruiting someone for the role. ***Relators encapsulate relationships between entities, offering a structured way to model employment interactions.*** Relators are linked to the relating concepts and entities with a mediation association. Unlike approaches such as RDF properties that model information with simple subject–predicate statements, UFO relators explicitly state multiplicity constraints, allowing complex n-ary relationships to be specified more precisely. ***Mediation is a special kind of dependency relationship connecting relators and entities that ensures the relationship depends on the existence of its participants.***

This model also represents a snapshot of a person's employment status. For example, after the person move to another job, then that would become a former employment since the source of existence of that relation changed. The new job will be the current employment since a new relationship is formed with a new employer (and possibly a new position).

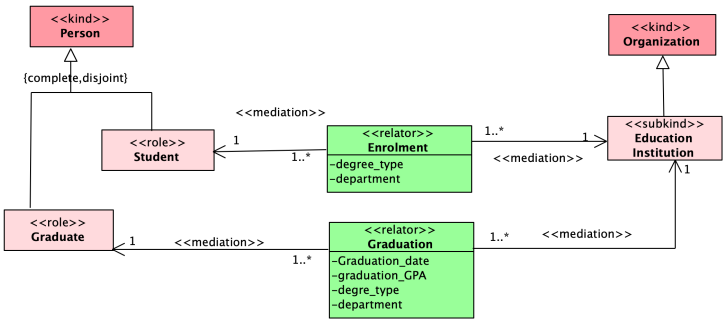

Figure 4: Enrolment and Education View

4.2. Education and Graduation

Figure 4 shows the part of the ontology that focuses on a person's education and defines the relationships between a person, the educational institution, and the academic status. A person can assume the ***roles*** of student (currently enrolled in an educational institution) and graduate (having completed a program). These ***roles*** can coexist, meaning a person can be a student in one institution while being a graduate of another (or even the same) institution. The educational institution is classified as a ***sub-kind*** of organization, distinguishing it as a specialized type of institution within the broader organizational category.

The relationships within this part of the ontology are structured through two ***relators***: (1) active enrollment, representing a current relationship in which a student is enrolled in an educational institution, and (2) graduation, representing an educational relationship in which a person has earned a qualification from an educational institution. This model allows for a clear differentiation between active enrollment and completed education.

4.3. Skills, Competence and Certification

Figure 5 shows the part of the ontology that models skills, competence, and certification, focusing on how a person's professional abilities are structured. Competence and skill are both ***modes, meaning they are intrinsic and dispositional properties that inhere in a person***. A characterization relationship connects a person to their competence and skill, ensuring that these attributes are systematically captured. (*Characterization shows that a feature (like a skill, quality, or state) is intrinsically part of something else and needs it to exist.*) When competence and skill are formally recognized through certification, they take on the ***roles*** of certified competence and certified skill, respectively. Additionally, a certification provider is defined as a ***role***, which is assumed by an organization that issues certifications. Certification ***relator*** represents a formal qualification granted to a person by a certification provider, recognizing specific competencies and skills.

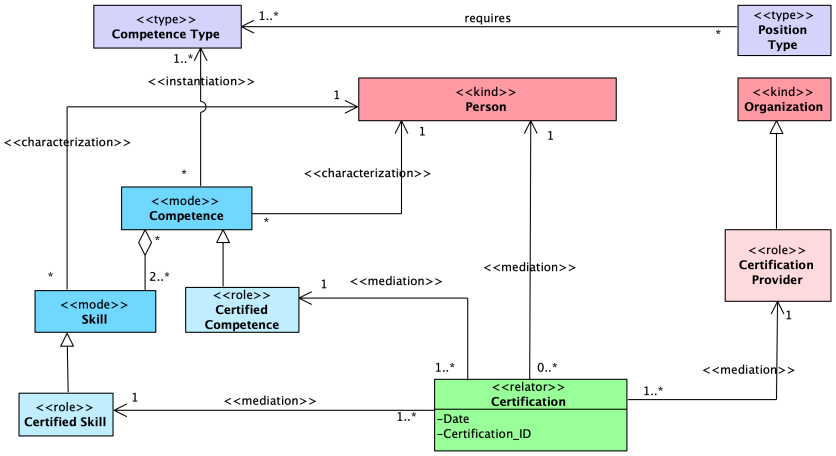

Figure 5: Skill, competence and certification

The distinction between competence, as a mode, and competence type is also critical: a competence mode inheres in a specific person (e.g., "Bahadir's competence in Android App Development"), whereas a competence type represents a higher-level classification that is independent of any individual (e.g., "Android App Development" as a general domain of competence). This explicit modeling of certifications, skills, and competences provides a nuanced understanding of professional expertise, addressing gaps in previous data models.

Moreover, the ontology establishes a link between competence types and position types, defining how professional roles are associated with required skills. A position type is connected to one or more competence types, ensuring that job roles can be analyzed based on the competences required to perform them. Similarly, competence types are characterized by their instantiations in individuals, meaning that a higher-level competence category is defined through its presence in people's actual skills. This structure enables a more systematic way to identify job roles and competences, offering a semantically rich and structured approach to career modeling.

4.4. Ontology Verification

To demonstrate the application of the proposed ontology and verify it through instantiation, we present a practical scenario, illustrated in Figure 6. This example highlights how the ontology supports the

representation of real-world professional scenarios by connecting individuals, their competences, roles, and institutional affiliations. John and Mary are professional aspiring the Frontend Developer career. John has already taken a step forward in his career: he recently earned a position as a Frontend Developer at the tech company SmartSys. In contrast, Mary is currently exploring opportunities and is applying for a similar position at the same company. Their educational paths reflect their efforts to the field. John holds a degree in Computer Science from a renowned university, while Mary is currently pursuing a degree in Information Systems at another renowned university.

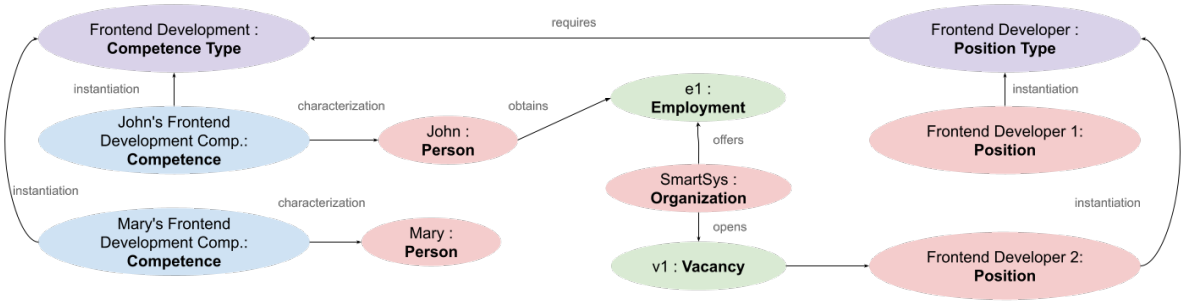

Figure 6: Instantiation of our proposed ontology

In the context of this scenario, the position of Frontend Developer at SmartSys requires a specific type of competence: *Frontend Development*. So, for anyone who need to perform this position must have competences that instantiate this competence type. As illustrated, both John and Mary possess competences that instantiate this competence type. These shared competences qualify them to perform the role, regardless of their current employment status. Importantly, the competences held by John and Mary are not only aligned with the requirements of the position but are also formally recognized, since they are certified by a Certification Provider (not depicted in 6 due to space constraints). This certification further reinforces their suitability for the Frontend Developer role.

5. Practical implications

We demonstrate the practical implications of the ontology by showcasing its use in a functional software prototype based on [16] that supports the career planning process of employees and job seekers in the IT field. The system calculates the suitability of individuals to a certain position using AI models successfully (accuracy, precision and recall all greater than 0.90), provides recommendations to increase the suitability and shows the possible effectiveness of the recommendation with a recalculated suitability score. Its AI component employs an ensemble learning approach, initially testing nine different classification algorithms. For each case, the three best performing models were selected to ensure optimal predictive accuracy and precision. These models were trained on a self-collected dataset comprising anonymized career information, scraped with a self-developed Python program, from publicly available PSMP profiles. For this study, only records related to information technology and information systems positions were retained.

The integration of the ontology was performed manually and guided the development process, including data collection, data preparation, feature engineering, and model training. Some examples of this are as follows.

To begin with, distinction of position kind and position type inspired the job requirements to be inferred by aggregating the shared attributes of individuals who already held that position in the real world. This bottom-up approach of extracting requirements, rather than being defined directly or through job postings, aims to ensure that system outputs reflect the industry realities and responds to evidence that job postings do not always align with the actual requirements of a job position [29, 30] (C1, C5).

Next, raw data were cleaned and normalized with ontology models and look-up lists so that job titles, skills and competencies matched the reference vocabulary. This was partly possible by integrating the IT skills classification framework proposed by [31] in addition to the ontology into the training data during feature engineering and into the structure of the recommendations. The clear definition of skill (actionable ability such as Python programming), and competence (a broader functional ability such as data analysis), allowed AI models to be trained with consistent and structure data (C4).

In addition, the modeling of education with explicit attributes (degree level, field of study, institution, etc.) allowed us to process education data systematically rather than relying on unstructured textual data available on PSMPs. The data was also normalized and categorized with reference to ontology model and reference tables for consistency. Also, the distinction between enrolled student and a graduate was revealed with the ontology-aligned representation. Based on this, only graduation data was used to train AI models, since enrolled student status is an ongoing process and not considered as a qualification indicator yet (C2).

Finally, the distinct separation of current and former employment revealed that the former is the target variable and the latter is one of the variables used to predict in the AI model development (C3).

Consequently, by manual integration and mapping ontology decisions to data schemas, data cleaning scripts, feature rules, and AI model inputs, the ontology became a bridge between raw PSMP data and the career planning system prototype. This demonstrates the ontology's real-world applicability beyond theoretical soundness. This process guided critical design decisions about data structure, system logic and interface elements, thereby validating its value in the development of intelligent career planning systems.

6. Related Work

Many available ontologies address the concepts of competence and skill. In the context of this work, we focus on competence ontologies that consider concepts related to the reporters (certification, employment) and positions (student, employee, employer) defined in this ontology. Similarly to this work, some competence ontologies also consider roles related to competences, like the ontologies proposed in [32, 33]. However, these ontologies consider generic roles related to competence, without taking into account specific roles from the PSMP context, such as student, employer, etc. Some ontologies address such distinctions in a way similar to this work. The ontology proposed by [34] considers the role of employee, as well as other related concepts such as organizations (organizational entity) and instructional entities. Acompora's ontology [35] also considers competences (skills) related to the employee role. However, these ontologies do not delve into such distinctions to the level realized in this work, nor do they consider other important distinctions for PSMP. An important distinction in this work concerns certifications that attest to competences and skills. Among the competence ontologies considered, this distinction is not explicitly addressed. It is indirectly approached through the concept of evidence of competence [36, 37].

Most of the cited ontologies are not grounded in an ontological foundation as our work, which is grounded in UFO. An exception in this regard is the ontology of occupations proposed in [38]. In addition to considering concepts such as capability, ability, and skill, the authors of this ontology also include concepts related to roles, such as occupation holder and occupation role. Nevertheless, important concepts in the PSMP context are not considered, such as, for instance, the very concept of competence itself. In this context, the most relevant ontology as a related work is Core-O [37], since it also aims to propose a competence ontology by considering ontological distinctions. The ontology proposed by [37] delves deeper into distinctions related to competence, such as skill, knowledge, attitude, capabilities, etc. In contrast, our proposed ontology focuses more on concepts related to competence in the professional and educational context related to PSMP, considering distinctions such as certification, employment, enrollment, educational institution, organizations, and others, which are not considered in Core-O.

7. Final remarks

This study proposes an ontological model for career-related personal data on PSMPs, thus enabling semantic clarity and machine-actionable representation. The grounding of the model in the Unified Foundational Ontology (UFO) and the implementation with OntoUML enabled this work to address some of the main limitations and shortcomings of career-oriented data, such as the lack of conceptual clarity, semantic interoperability, and contextual richness. In alignment with the FAIR principles (Findability, Accessibility, Interoperability, and Reusability) [39] , we have made our ontology (psmp-ontology) openly accessible under the permissive license via a Git repository (https://github.com/baha-aktas/psmp-ontology), which hosts the complete ontology.

The ontology captures critical distinctions related to employment and employment history, education, graduation, skills, competences, and certifications, and integrates them in a way that supports understandability and reasoning. A discussion of other competence ontologies showed that our model introduces a more nuanced representation of roles in the context of PSMP and distinguishes between certified and uncertified competences and skills.

The practical value of ontology is also demonstrated through an example of an integration into an AI-based career planning system. The ontology has affected key design decisions during system development, providing the rich semantic foundation for data structuring, supporting the training of AI models, and informing the design of the application logic (job fit calculation and recommendation generation). By bridging the ontological modeling, PSMP data modeling and practical system design, this work offers a robust foundation for future applications.

A potential limitation is that, although the competency questions were inspired and derived from stakeholder interviews, they were authored by the ontologists.

Acknowledgments

This study was supported in part by The Scientific and Technological Research Council of Türkiye (TÜBİTAK) through International Postdoctoral Research Fellowship Program.

Declaration on Generative AI

During the revision of this work the author(s) used Grammarly to check for spelling or grammatical errors.

References

[1] E. B. Ahmed, A. Nabli, G. Faiez, Group extraction from professional social network using a new semi-supervised hierarchical clustering, Knowledge and Information Systems 40 (2014) 29–47. doi:https://doi.org/10.1007/s10115-013-0634-x.

[2] M. A. Brandão, M. M. Moro, Social professional networks: A survey and taxonomy, Computer Communications 100 (2017) 20–31. URL: https://www.sciencedirect.com/science/article/pii/S014036641630696X. doi:https://doi.org/10.1016/j.comcom.2016.12.011.

[3] G. Guizzardi, N. Guarino, Explanation, semantics, and ontology, Data & Knowledge Engineering 153 (2024) 102325. URL: https://www.sciencedirect.com/science/article/pii/S0169023X24000491. doi:https://doi.org/10.1016/j.datak.2024.102325.

[4] G. Guizzardi, A. B. Benevides, C. M. Fonseca, D. Porello, J. P. A. Almeida, T. P. Sales, Ufo: Unified foundational ontology, Applied Ontology 17 (2022) 167–210. URL: https://journals.sagepub.com/doi/abs/10.3233/AO-210256. doi:10.3233/AO-210256. arXiv:https://journals.sagepub.com/doi/pdf/10.3233/AO-210256.

[5] G. Guizzardi, Ontological foundations for structural conceptual models, Phd thesis - research ut, graduation ut, University of Twente, 2005.

[6] A. García S., A. Bernasconi, G. Guizzardi, O. Pastor, V. C. Storey, I. Panach, Assessing the value of ontologically unpacking a conceptual model for human genomics, Information Systems 118 (2023) 102242. URL: https://www.sciencedirect.com/science/article/pii/S0306437923000789. doi:https://doi.org/10.1016/j.is.2023.102242.

[7] R. de Almeida Falbo, SABiO: Systematic Approach for Building Ontologies, in: G. Guizzardi, O. Pastor, Y. Wand, S. de Cesare, F. Gailly, M. Lycett, C. Partridge (Eds.), Proceedings of the 1st Joint Workshop ONTO.COM / ODISE on Ontologies in Conceptual Modeling and Information Systems Engineering co-located with 8th International Conference on Formal Ontology in Information Systems, ONTO.COM/ODISE@FOIS 2014, Rio de Janeiro, Brazil, September 21, 2014, volume 1301 of *CEUR Workshop Proceedings*, CEUR-WS.org, 2014. URL: https://ceur-ws.org/Vol-1301/ontocomodise2014_2.pdf.

[8] R. Caers, V. Castelyns, Linkedin and facebook in belgium: The influences and biases of social network sites in recruitment and selection procedures, Social Science Computer Review 29 (2011) 437–448. URL: https://doi.org/10.1177/0894439310386567. doi:10.1177/0894439310386567. arXiv:https://doi.org/10.1177/0894439310386567.

[9] J. van Dijck, You have one identity: performing the self on facebook and linkedin, Media, Culture & Society 35 (2013) 199–215. URL: https://doi.org/10.1177/0163443712468605. doi:10.1177/0163443712468605. arXiv:https://doi.org/10.1177/0163443712468605.

[10] M. L. Forret, Networking as a job-search behavior and career management strategy, in: The Oxford Handbook of Job Loss and Job Search, Oxford University Press, 2018. URL: https://doi.org/10.1093/oxfordhb/9780199764921.013.022. doi:10.1093/oxfordhb/9780199764921.013.022. arXiv:https://academic.oup.com/book/0/chapter/211794513/chapter-ag-pdf/44598212/book_28012_section_211794513.ag.pdf.

[11] W. Kim, K. Malek, Social networking sites versus professional networking sites: Perceptions of hospitality students, Journal of Human Resources in Hospitality & Tourism 17 (2018) 200–221. URL: https://doi.org/10.1080/15332845.2017.1340763. doi:10.1080/15332845.2017.1340763. arXiv:https://doi.org/10.1080/15332845.2017.1340763.

[12] D. Gursoy, C. G.-Q. Chi, E. Karadag, Generational differences in work values and attitudes among frontline and service contact employees, International Journal of Hospitality Management 32 (2013) 40–48. URL: https://www.sciencedirect.com/science/article/pii/S0278431912000552. doi:https://doi.org/10.1016/j.ijhm.2012.04.002.

[13] B. Aktaş, A. Akbıyık, Social connectedness in professionally-oriented social network sites and its effects on social network value, in: International Management Information Systems Conference "Connectedness and Cybersecurity", 2019.

[14] D. H. Kluemper, P. A. Rosen, Future employment selection methods: evaluating social networking web sites, Journal of managerial Psychology 24 (2009) 567–580.

[15] J. Hoek, P. O'Kane, M. McCracken, Publishing personal information online: How employers' access, observe and utilise social networking sites within selection procedures, Personnel Review 45 (2016) 67–83.

[16] B. Aktaş, Ontology Driven, Artificial Intelligence Based Career Planning System For Individuals, Phd thesis, Sakarya University, Sakarya, TURKIYE, 2024. Available at https://enstituois.sakarya.edu.tr/TezDosyalari/1350_TamMetin.pdf.

[17] R. C, M. M. Kodabagi, Connecting user profiles of social networks using proximity-based clustering, Malaysian Journal of Computer Science (2022) 1–15. URL: https://ejournal.um.edu.my/index.php/MJCS/article/view/40401. doi:10.22452/mjcs.sp2022no2.1.

[18] Z. Altan, An ontology model oriented to the career planning of university students, in: 2022 International Congress on Human-Computer Interaction, Optimization and Robotic Applications (HORA), 2022, pp. 1–7. doi:10.1109/HORA55278.2022.9799963.

[19] S. Miranda, F. Orciuoli, V. Loia, D. Sampson, An ontology-based model for competence management, Data & Knowledge Engineering 107 (2017) 51–66. URL: https://www.sciencedirect.com/science/article/pii/S0169023X16303640. doi:https://doi.org/10.1016/j.datak.2016.12.001.

[20] H. O. Standards, Hr open standards, 2025. URL: https://www.hropenstandards.org/

standards-downloads, last accessed on 2025-03-17.
[21] O. Online, O*net online, 2025. URL: https://www.onetonline.org, last accessed on 2025-03-17.
[22] European Commision, European skills, competences, qualifications and occupations (esco), 2024. https://esco.ec.europa.eu/en/about-esco/what-esco, Last accessed on 2025-02-20.
[23] O. Corcho, M. Fernández-López, A. Gómez-Pérez, Ontological Engineering: Principles, Methods, Tools and Languages, Springer Berlin Heidelberg, Berlin, Heidelberg, 2006, pp. 1–48. URL: https://doi.org/10.1007/3-540-34518-3_1. doi:10.1007/3-540-34518-3_1.
[24] G. Bergenhenegouwen, Competence development - a challenge for hrm professionals: core competences of organizations as guidelines for the development of employees, Journal of European Industrial Training 20 (1996) 29–35. URL: https://www.emerald.com/insight/content/doi/10.1108/03090599610150282/full/html. doi:10.1108/03090599610150282.
[25] F. D. L. Deist, J. Winterton, What is competence?, Human Resource Development International 8 (2005) 27–46. URL: https://doi.org/10.1080/1367886042000338227. doi:10.1080/1367886042000338227.
[26] M. Fazel-Zarandi, M. S. Fox, An Ontology for Skill and Competency Management, iOS Press, Amsterdam, The Netherlands, 2012, pp. 89 – 102. URL: https://ebooks.iospress.nl/publication/6871. doi:10.3233/978-1-61499-084-0-89.
[27] R. F. Calhau, C. L. B. Azevedo, J. P. A. Almeida, Towards ontology-based competence modeling in enterprise architecture, in: 2021 IEEE 25th International Enterprise Distributed Object Computing Conference (EDOC), 2021, pp. 71–81. doi:10.1109/EDOC52215.2021.00018.
[28] J. P. A. Almeida, G. Guizzardi, T. P. Sales, R. A. Falbo, gufo: A lightweight implementation of the unified foundational ontology (ufo), 2019. http://purl.org/nemo/doc/gufo.
[29] A. E. Barber, M. V. Roehling, Job postings and the decision to interview: A verbal protocol analysis, Journal of Applied Psychology 78 (1993) 845–856. doi:https://doi.org/10.1037/0021-9010.78.5.845.
[30] A. Felstead, D. Gallie, F. Green, H. Inanc, Fits, misfits and interactions: learning at work, job satisfaction and job-related well-being, Human Resource Management Journal 25 (2015) 294–310. doi:https://doi.org/10.1111/1748-8583.12071.
[31] B. Aktaş, N. Baz Aktaş, A. Akbıyık, İşgücü piyasalarinda yönetim bilişim sistemleri programlarinin farkindaliği: Abd ve türkiye'deki İş İlanlari Üzerinden bir değerlendirme, Journal of Research in Business 7 (2022) 60–79. doi:10.54452/jrb.1024997.
[32] V. Tarasov, Ontology-based approach to competence profile management, Journal of universal computer science (Online) 18 (2012) 2893–2919.
[33] W. Zaouga, L. B. A. Rabai, W. R. Alalyani, Towards an ontology based-approach for human resource management, Procedia Computer Science 151 (2019) 417–424.
[34] A. Schmidt, C. Kunzmann, Sustainable competency-oriented human resource development with ontology-based competency catalogs, Expanding the Knowledge Economy: Issues, Applications, Case Studies. Proceedings of E-Challenges (2007).
[35] G. Acampora, M. Gaeta, F. Orciuoli, P. Ritrovato, Exploiting semantic and social technologies for competency management, in: 2010 10th IEEE International Conference on Advanced Learning Technologies, IEEE, 2010, pp. 297–301.
[36] G. Paquette, O. Marino, R. Bejaoui, A new competency ontology for learning environments personalization, Smart Learning Environments 8 (2021) 16.
[37] R. F. Calhau, J. P. A. Almeida, T. P. Sales, P. P. F. Barcelos, G. Guizzardi, Core-o: A competence reference ontology for professional and learning ecosystems, in: Volume 394: Formal Ontology in Information Systems, 2024. doi:10.3233/FAIA241289.
[38] S. Smith, D. Dooley, Y. He, Foundational development of an occupation ontology, in: Joint Ontology Workshops, Episode VIII: The Svear Sommar of Ontology, volume 3, 2022.
[39] M. D. Wilkinson, M. Dumontier, I. J. Aalbersberg, G. Appleton, M. Axton, A. Baak, N. Blomberg, J.-W. Boiten, L. B. da Silva Santos, P. E. Bourne, J. Bouwman, A. J. Brookes, T. Clark, M. Crosas, I. Dillo, O. Dumon, S. Edmunds, C. T. Evelo, R. Finkers, A. Gonzalez-Beltran, A. J. Gray, P. Groth, C. Goble, J. S. Grethe, J. Heringa, P. A. 't Hoen, R. Hooft, T. Kuhn, R. Kok, J. Kok, S. J. Lusher, M. E.

Martone, A. Mons, A. L. Packer, B. Persson, P. Rocca-Serra, M. Roos, R. van Schaik, S.-A. Sansone, E. Schultes, T. Sengstag, T. Slater, G. Strawn, M. A. Swertz, M. Thompson, J. van der Lei, E. van Mulligen, J. Velterop, A. Waagmeester, P. Wittenburg, K. Wolstencroft, J. Zhao, B. Mons, The fair guiding principles for scientific data management and stewardship, Scientific Data 3 (2016) 160018. URL: https://doi.org/10.1038/sdata.2016.18. doi:10.1038/sdata.2016.18.