Ontology-based approach in a conversational system: a multidisciplinary research proposal for assisting informal caregivers

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Abstract
This research proposal aims to address a current gap in the literature regarding informal carers and their support needs. Specifically, it focuses on their need for assistance in identifying and understanding their rights and responsibilities within the context of Italian law. The regulatory context's fragmented nature and lexical complexity necessitate the development of technical proposals to effectively address them. This research proposal aims to utilise the combined knowledge of labour law and computer science to develop an ontology-based system that might be embedded thereafter in a conversational agent to create a user-friendly and intuitive conversational interface that can help informal caregivers to find information about the regulatory protections provided to them under Italian laws.

Keywords
informal caregiver, ontology, labour law, conversational system, artificial intelligence

1. Introduction

The global population of adults aged 60 and above is expected to reach 2.1 billion by 2050 with a significant rise from the 962 million recorded in 2017 [1]. Italy is predicted to have a significant increase in its demographic shift, with estimates indicating that the proportion of persons aged 65 or above would reach 27.9% by 2050 [1]. The growing proportion of elderly individuals in the population, along with higher life expectancy and the high frequency of chronic diseases, has resulted in a greater need for care [2]. The financial capacity of health systems seems insufficient to meet this demand [3], leading to a greater reliance on informal care provided by family members, friends, or neighbours [4, 3]. Indeed, informal care has been found to have

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a favourable cost-effectiveness ratio [5], as it can save costs by reducing the need for formal care [6] and avoiding or postponing the placement of individuals requiring care or assistance in institutions, enabling them to stay in their own homes [7]. In this regard, it is crucial to analyse whether the legal frameworks regarding care and treatment adequately address the realities of informal caregiving, as the number of individuals being cared for by relatives continues to increase [8]. It becomes increasingly crucial when considering that informal carers may not always acknowledge their role as carers, often perceiving the assistance they offer as a natural aspect of their social and familial surroundings [9].

The concept of informal care lacks scientific stability and its application in public policies is complex, mostly due to its inability to differentiate what is intended to be changing in terms of its informality [10]. Policy measures vary across different countries, particularly in terms of the definition of informal carers, which may be limited to individuals with family connections in some countries (Spain, Portugal, Denmark), while including other relationships in others (Australia, France, Germany, UK, Finland), in the duration of unpaid leave, the availability of paid leave, and the types of support equipment provided [10]. In Italy, the authors (MTA and LC) are presently engaged in a labour law study concerning informal or unpaid caregiving [1]. The study emphasises the presence of a significant grey area (which consists primarily of foreign female workers) in the care sector [2] that is especially vulnerable to irregular work and is not protected by the law [3]. Currently, a reconstructive analysis of the regulatory framework is being conducted to determine the safeguards afforded to informal carers, placing particular emphasis on the enabling act n. 33/2023 [4], in order to restore the complexity of the subject and to highlight the insufficient presence and inadequacy of policies and legislative measures dedicated to informal caregivers.

In recent decades, AI has increasingly become a significant factor in the legal field and is expected to significantly impact legal practices in the coming years [11]. Tasks such as information retrieval, contract review, case prediction, classification and translation of legal documents, and translation and summarizing of such documents have attracted significant attention from the research community [12]. Using ontologies to characterise legal knowledge is a current approach to its organisation [13]. Ontologies serve as semantic data models, outlining the entities within a specific domain and the corresponding attributes used for their description [14]. Ontologies

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[1]The International Labour Organization prefers to distinguish between unpaid care work and paid care work. From the labour market perspective, the term "informal care work" refers to care work provided in the informal economy or to irregular care work.International Labour Office, Care work and care jobs for the future of decent work, Ginevra, 2018, p. 34 (note 8).

[2]Domina, Osservatorio sul lavoro domestico, 4° Rapporto annuale sul lavoro domestico, 2022, p. 93; A. Zini, La manodopera straniera nel settore domestico: tra nuove programmazioni dei flussi e stime dei fabbisogni reali, in Centro Studi e Ricerche IDOS (a cura di), Dossier Statistico Immigrazione, 2023, p. 302 ss.

[3]S. Borelli, Who cares? Il lavoro nell'ambito dei servizi di cura alla persona, Jovene, 2020; ID, Le diverse forme di sfruttamento nel lavoro domestico di cura, in LD, 2021; ID, Il sistema low-cost di assistenza di lunga durata, in B. Guastaferro, L. Tebano (a cura di), Cura, lavoro, diritti. L'Unione europea e le sfide della contemporaneità, Quaderno della Rivista Diritti, Lavori, Mercati, Editoriale Scientifica, 2022, pp. 151 ss.; A. Brambilla, P. Degani, M. Paggi, N. Zorzella (a cura di), Donne straniere, diritti umani, questioni di genere. Riflessioni su legislazioni e prassi, Cleup, Padova, 2022; M.G. Giammarinaro, F. Cocchi, C. Lavanna, F. Carchedi, P. Gulia, Donne gravemente sfruttate, Seconda Parte: Lo sfruttamento nel lavoro domestico e accenni in altri comparti, Roma, 2022, pp. 57 ss.

[4]Patto per un nuovo welfare sulla non autosufficienza, I decreti attuativi: un'occasione irripetibile, Il manifesto del patto, Rome, December 2023

are interconnected concepts that are related semantically [15] and frequently employed as the foundation for systems that facilitate knowledge modelling, information extraction, and question answering [16]. Artificial intelligence employs ontologies as a fundamental structure for representing knowledge [17] as their application facilitates the establishment of a shared vocabulary for describing a particular domain of interest, unifies and exchanges knowledge pertaining to that domain, and establishes connections with other domains [18]. In various contexts, ontologies have found extensive application among legal professionals, academics, and individuals, serving purposes like simulating legal actions, facilitating semantic search and indexing, and staying informed about the dynamic nature of laws and regulations [19]. As an example, Leone et al [16] proposed a tool called InvestigatiOnt to assist non-legal developers and end-users in selecting the legal ontology that most closely corresponds to the modelling demands of a particular legal domain of interest, facilitating their learning process by enhancing their comprehension of the unique characteristics that distinguish each ontology. Lame et al [15] conducted experimental research on automated techniques used to create legal ontologies from legislation and merge existing ontologies with new ones following the adoption of new laws. Similarly, Lenci et al [20] employed a comprehensive ontology learning system known as T2K, which integrates various tools for statistical text analysis, machine language learning, and Natural Language Processing (NLP), to extract ontological knowledge from Italian legislative documents pertaining to the environment in an autonomous manner.

To the best of our knowledge, there is currently a lack of research on ontology-based systems that aim to assist informal caregivers in understanding their rights and responsibilities within the framework of Italian law. The aim of this research proposal is to address this gap by utilising interdisciplinary expertise in labour law and computer science to create a new digital frontier that facilitates the understanding and portrayals of pertinent Italian laws for informal carers. The research proposal aims at creating an ontology-based system that might be embedded thereafter in a conversational agent to assist informal carers in understanding the regulatory protections that are accessible to them through a conversational interface that is both user-friendly and intuitive. This is consistent with the findings of a recent literature review conducted by Milella et al [21] which revealed that AI-based solutions have proven to be beneficial in equipping carers with valuable information to make well-informed decisions in their caregiving responsibilities, albeit there is a scarcity of studies that have delved into the utilisation of AI-based tools for addressing specific personal support needs (e.g, [22]), which could potentially enhance the empowerment of informal carers. Furthermore, a recent review conducted by the same authors [23] indicates that AI-based solutions show great potential for progress in various domains such as the improvement of the understanding of meta-information by refining semantics, as ontology plays a crucial role in developing comprehensive and coherent decision support systems for informal carers and the elderly they care for.

2. Method

This section outlines the essential methodological steps that will be involved in the development of the research proposal.

Firstly, ontology-based system design is typically entrusted to computer scientists who, apart

from possessing technical expertise, also require domain-specific knowledge in which the system will be applied [16]. Hence, legal experts will thoroughly analyse the current laws and regulations regarding informal carers within the framework of Italian legislation. This will lead to a thorough examination of the existing Italian legal framework regarding the topic, providing insights into any potential ambiguities, weaknesses, or gaps in the current legislation. It will also aid in getting insight into the legal data to identify key elements that are essential for the development of the digital tool for legal knowledge [13]. This step is currently in progress also to provide evidence of the feasibility of the present research proposal.

Secondly, the process of conceptualising an ontology-based system will be undertaken for the domain of interest. The structure of the reference ontology and its components will be derived from the most effective experiences of ontology-based systems implemented to enhance the comprehension and representation of legislation. As an example, de Oliveira and Parente de Oliveira [24] created a graph based on resource description framework (RFD) that generates a collection of terms that accurately describe the desired legal information to depict and retrieve certain sections of legal papers following a two-step procedure. Firstly, they started with the use of a basic formal ontology (BDO) to identify the structure of the legal system and the arrangement of its legal documents as well as to clarify their importance and the connections between them to be incorporated into the RDF graph [24]. Secondly, the process involved accessing the HTML version of legal documents from authorised repositories, converting them from HTML to RDF format, storing the resulting triples in a triple store, and then querying the stored triples using SPARQL to execute the proposed RDF graph [24]. In a similar vein, Kurtin and his colleagues [25] conceptualized a multilingual question-answering system that aims to provide responses to legal queries posed by users in natural language. The ontological modeling of the legal domain was based on the RDF model with a pattern-based linguistic approach to data extraction and then querying the stored triples using SPARQL to answer the question [25]. Both approaches may be a useful guideline in building our ontological model. Nevertheless, in their work Leone et al [26] presented a comprehensive overview of the legal ontologies that were utilised, categorising them into three distinct classes such as policies, licences, tenders and procurements, privacy, and cross-domains. As an example, the cross domain ontologies discussed in the papers offer rooms for expanding the scope of the present work. The multilingual thesaurus Eurovoc aimed at organizing and categorizing the documents released by European Union Institutions to make easier to find them sets the concepts representation by a set of terms, with one term being used for indexing and the others serving as synonyms, and additionally, translates all terms associated with a concept into the 23 languages spoken within the European Union [26]. Hence, key concepts within the legislation under consideration, including the rights, responsibilities, and regulatory constraints pertaining to informal carers, will be precisely delineated through the utilisation of potential classes and particular subclasses to represent conceptual hierarchies. In order to facilitate the understanding of legal terms utilised in the legislation by informal carers, an interactive glossary based on an ontology will be developed. This glossary would also include semantic annotations that contribute supplementary information and practical examples to place the concepts into context.

Thirdly, considering the goal of our multidisciplinary research, the development of a conversational interface that utilises ontology to provide answers to informal carers' inquiries regarding specific aspects of Italian legislation might be an additional option to evaluate for the

enrichment of the system. A conversational component might be carefully tailored to address the unique requirements of informal carers. This interface might offer detailed explanations, personalised guidance, and intuitive exploration of the relevant legislation. Additional possible implementations might include the integration of automatic notification systems into specialised mobile applications. These systems, utilising ontologies, would allow informal carers to easily stay informed about deadlines and any changes in their rights and responsibilities as outlined in the relevant legislation. The literature provides several possibilities for integrating conversational agents with ontologies, which might serve as a valuable framework for developing our study proposal. As an example, Amith et al. [27] integrate a question answering subsystem into the conversation interaction by utilising two methods: vector-based comparison and string matching. These methods are employed to identify matches between the key ideas of the questions and the triples of the ontology. Esfahani et al. [28] developed and evaluated the On2Cov tool, which generates a file containing information from the ontology. This file is used to provide input to both the chatbot-like interface and the JaCaMo agents, which handle reasoning and execute necessary actions.

3. Results

As this study is a research proposal in its early stage, some preliminary findings concern only the ongoing legal review conducted in the context of Italian law. Such findings indicate that the legislator's neglect of welfare measures to assist those who are not self-sufficient and the absence of measures that encourage employers to offer regular employment, have direct implications for undeclared work, particularly within the care sector. This situation poses a potential risk for both the employer and the employee, as they may find themselves lacking the necessary guarantees and protections. This may restrict the establishment of an ontology, necessitating a focus on the broad aspects of labour laws in the absence of specific references when it comes to informal caregiving. Nevertheless, the constraint can be alleviated by approaching the ontology model in a two-step process, as proposed by de Oliveira and Parente de Oliveira [24], which enables access to the legal safeguards for workers who also fulfil caregiving responsibilities for a family member, such as work-life balance measures (e.g, leave, expectations, permits, and part-time arrangements).

4. Conclusions

This research proposal aims to address a current gap in the literature regarding informal carers and their support needs. Specifically, it focuses on their need for assistance in identifying and understanding their rights and responsibilities within the context of Italian law. The regulatory context's fragmented nature and lexical complexity necessitate the development of technical proposals to effectively address them. This research proposal aims to utilise the combined knowledge of labour law and computer science to develop an ontology-based system that might be embedded thereafter in a conversational agent to create a user-friendly and intuitive conversational interface that can help informal caregivers to find information about the regulatory protections provided to them under Italian laws.

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