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RESEARCH ARTICLE

EXPLORING PAKISTAN'S RICH CULTURAL HERITAGE THROUGH ONTOLOGICAL MAPPING

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ABSTRACT

Despite Pakistan's rich and varied cultural past, individuals frequently have trouble locating reliable and timely information online. An all-encompassing and methodical approach to information representation is necessary due to the intricate and ever-changing character of Pakistani culture, which includes customs, dialects, food, and geographic variety. The Pakistan Culture Ontology seeks to provide comprehensive knowledge regarding diverse facets of Pakistani culture, fostering comprehension and mitigating cultural disparities and inter-provincial disputes. This ontology supports national pride and education by promoting positive conversations and communication, which in turn supports global heritage preservation and cultural diplomacy. Utilizing RDF (Resource Description Framework) and OWL (Web Ontology Language), the ontology makes use of Semantic Web 3.0 technologies and is created with the Protege tool. Classes, sub classes, object and data properties, annotations, and schema imports are used to organize knowledge in large-scale complex ontologies using the adaptable Neon methodology. Following a thorough representation of the knowledge, the ontology is assessed using pitfall checks and verified using user-submitted SPARQL queries pertaining to cultural subjects. The requirement for an authentic and systematic depiction of Pakistani culture is addressed by the first of its kind, the Pakistan Culture Ontology. Supporting several languages (Urdu, Sindhi, Pashto, and English) and attaining worldwide integration with other cultural, historical, and geographical ontologies are among the upcoming improvements. Plans call for applying AI and machine learning to cultural trend analysis, recommendation systems, and building large language models (LLMs) to respond to culturally sensitive queries. The ontology also envisions sophisticated data analytic tools, crowd sourcing for data validation, and immersive VR and AR experiences. Furthering curriculum development, cultural preservation, and growth into domains including cultural economics, governance, and tourism will be made possible by partnerships with museums, archives, educational institutions, researchers, and organizations.

KEYWORDS

Pakistan Culture Ontology, Cultural Heritage Preservation, Semantic Web Technologies, SPARQL Queries, Intercultural Communication.

1. INTRODUCTION

Culture represents the collective values, beliefs, practices, traditions, arts, and behaviors of groups of people, serving as a framework for social interaction and identity formation within communities. It encompasses various elements, including language, religion, customs, norms, and social structures, which are shaped by historical, geographical, and social contexts. The concept of culture extends beyond mere traditions; it is a way of life that defines the essence of a people and their interaction with the world. For instance, Pakistan's cultural diversity is a reflection of its historical, geographical, and ethnic multiplicity, with distinct regional cultures such as Punjabi, Sindhi, Balochi, Pashtun, and Gilgiti traditions, each contributing unique customs, language, clothing, food, and social norms to the country's collective identity.

While culture is often passed down through generations, much of this knowledge remains fragmented or hidden in unstructured formats, making it difficult to fully appreciate and understand. To bridge this gap, ontologies have emerged as powerful tools for formalizing and representing knowledge in a machine-readable format. Cultural ontology,

in particular, provides a structured framework to describe and categorize cultural elements, facilitating knowledge exchange and enabling automated reasoning. By applying ontologies, we can preserve cultural knowledge, ensure its accessibility, and foster global understanding. In the context of Pakistan, a Cultural Ontology could serve as a systematic repository, capturing the intricate details of the country's diverse cultural practices, beliefs, and values, organized in a way that makes it accessible for both human understanding and machine processing.

The advent of the Semantic Web, with technologies like RDF (Resource Description Framework) and OWL (Web Ontology Language), further enhances the potential of cultural ontologies. These frameworks enable the creation of interconnected, context-aware data that allows machines to interpret, reason, and respond to complex cultural queries. By structuring cultural information using these technologies, we can create a robust foundation for representing the knowledge embedded in Pakistan's rich cultural heritage. Furthermore, this ontology can play a significant role in bridging communication gaps, promoting national pride, and fostering mutual respect among diverse communities, both within Pakistan and globally.

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The goal of this paper is to develop and present a comprehensive Pakistan cultural ontology that systematically captures and represents the diverse cultural elements of Pakistan. We will define the key concepts, relationships, and attributes that make up the cultural fabric of the country, such as regional customs, language, food, clothing, festivals, traditions, and social structures. By using Semantic Web technologies like RDF and OWL, we will design an ontology that not only organizes this cultural knowledge in a structured, machine-readable format but also allows for reasoning and automated data retrieval. This paper will detail the methodology used to create this ontology, the process of structuring cultural data, and the benefits of such a representation for both human understanding and machine interpretation. Ultimately, our work aims to provide a valuable resource for researchers, educators, and anyone interested in exploring the rich cultural heritage of Pakistan, fostering cross-cultural understanding, and enabling further research and development in the field of cultural knowledge management.

2. LITERATURE REVIEW

The Pakistan Culture Ontology project aims to establish a comprehensive ontology to preserve and promote Pakistani culture on a global scale. Despite the rich, diverse, and multidimensional nature of Pakistani culture, no dedicated ontology has yet been developed for this purpose. Due to the complexity and variety of Pakistan's cultural heritage, it remains challenging to fully comprehend and share its legacy. This project seeks to bridge this gap by illustrating various facets of Pakistani culture, thus facilitating global awareness and appreciation of its richness. The cultural ontology we develop will serve as an authoritative resource, emphasizing Pakistan's distinctive traditions, customs, and heritage, while fostering broader international understanding and respect for Pakistani culture.

Currently, no ontology exists to preserve and promote Pakistani culture on a worldwide level, which underscores the importance of this initiative. Pakistani culture is multifaceted, with diverse influences from South Asia, Central Asia, and the Middle East. Yet, there is no definitive structure to comprehend or share all aspects of this heritage. The goal of this project is to create an organized framework that will make the vast cultural knowledge of Pakistan more accessible, shareable, and easier to learn about. As Venkatesan (University of Manchester) suggests, ontology can be seen as a tool for cultural objectification, where language evolves to represent concepts in a more structured and universal manner, eliminating provisional or ambiguous definitions in cultural contexts (Venkatesan, 2007). This aligns with the notion that real ontologies involve achieving the perfection of language and representation in a cultural context.

The field of cultural heritage management has increasingly relied on information systems to manage digital copies of real artifacts. Institutions involved in the preservation of cultural artifacts are under growing political pressure to make their holdings publicly accessible (Doerr, 2013). However, the challenge of organizing and expressing cultural knowledge is intensified by the diversity of disciplines involved, such as archaeology, ethnography, and history (Shang, 2017). This interdisciplinarity underscores the complexity of constructing a unified ontology that can adequately represent cultural heritage. Doerr highlights that ontologies in cultural heritage are critical for organizing and preserving cultural knowledge in a way that is both comprehensive and universally accessible (Doerr, 2013). In this context, ontology-based methods have proven essential for cultural knowledge preservation and dissemination (Shang, 2017).

Further complicating the development of cultural ontologies is the diversity of cultures themselves. Guarino critically examines the challenges involved in defining, representing, and handling the complexity of cultural diversity in ontological frameworks (Guarino, 2016). His analysis points to issues such as inadequate definitions and unclear relationships between cultural concepts, suggesting that interdisciplinary collaboration is necessary for refining cultural ontologies (Guarino, 2016). Shang also discusses the construction of traditional culture ontologies, which organize cultural elements based on their roles and representations (Shang, 2018). These ontologies serve to facilitate the preservation and diffusion of cultural knowledge, specifically in digital formats (Shang,

2018).

In the realm of traditional dance preservation, some researcher explore the application of ontologies to safeguard the cultural knowledge embedded in traditional dance forms (Kalita and Deka, 2019). Their work demonstrates how ontologies can effectively organize and preserve the movements, cultural significance, and historical context of dance, ensuring its accessibility for future generations (Kalita and Deka, 2019). Similarly, in a study they discusses the use of ontologies in digitizing and preserving Iranian folklore, illustrating how ontological structures can be applied to facilitate the digitization of extensive cultural archives (Emadi, 2020).

Other scholars, author have explored the representation of intangible cultural heritage through ontologies (Brecoulaki et al., 2018). In their work on Vallenato music, they demonstrate how ontologies can be used in context-aware systems to preserve the cultural significance of music (Brecoulaki et al., 2018). This approach has inspired similar efforts in the field of intangible cultural heritage preservation, where ontology-based methods help structure and document cultural practices, customs, and behaviors (Chantas et al., 2017). These efforts reflect the growing recognition of the value of ontologies in preserving not only tangible artifacts but also the intangible aspects of culture. The application of ontological frameworks extends to the study of folk taxonomies in archaeological records, as explored (VanPool and VanPool, 2015). Their research emphasizes the importance of ethnosemantics in understanding how ancient cultures categorized and interacted with their environment, a process that can inform modern efforts in digital heritage preservation (VanPool and VanPool, 2015).

Additionally, researcher and others reveals the need for more sophisticated approaches to cultural ontologies, highlighting the role of language, art, and cultural artifacts in shaping the ontology of culture (Guarino, 2016). By synthesizing these diverse approaches to cultural ontologies, this paper aims to create a comprehensive framework for documenting and preserving the vast and varied cultural heritage of Pakistan. This will not only contribute to the academic understanding of Pakistan's cultural legacy but also provide a valuable tool for cultural practitioners, researchers, and global audiences interested in engaging with Pakistan's diverse traditions.

3. PROPOSED METHODOLOGY

In the realm of cultural heritage preservation, there is an urgent need for structured knowledge representation. This goal is addressed by the suggested technique for constructing the Pakistan Culture Ontology. With the use of this methodology, Pakistani cultural concepts, entities, and relationships will be methodically organized and formalized into a machine-readable ontology, facilitating the more effective and efficient preservation and promotion of Pakistani culture. This project is important because it has the potential to completely change how cultural heritage is shared and kept, which could result in Preserving Pakistan's rich cultural legacy for upcoming generations; Creating a bridge between Pakistani culture and the international community to foster mutual understanding and interaction between cultures Establishing a tranquil and harmonious atmosphere, encouraging international collaboration.

4. METHODOLOGIES

4.1 Sabio Methodology

The Semi-Automatic Business Integration Ontology, or SABIO, technique is centered on integrating data and business processes inside a company. It places a strong emphasis on using ontologies to promote smooth communication and departmental and system-to-system interoperability. To guarantee effective integration, SABIO uses a semi-automatic strategy that combines human intervention with automated procedures.

4.2 Methontology

Methontology is a technique created especially for ontology construction. It offers a methodical approach to ontology construction, putting a focus on precise definitions, knowledge formalization, and modularization. Methontology promotes the use of tried-and-true methods from

knowledge engineering and software engineering to guarantee the usability and quality of ontologies.

4.3 Onto Knowledge

The ONTO Knowledge Methodology is centered on the methodical creation and administration of knowledge inside businesses. Processes for acquiring, representing, storing, retrieving, and using knowledge are included. The goal of ONTO Knowledge Methodology is to efficiently use knowledge assets to facilitate innovation, organizational learning, and decision-making.

4.4 Diligent Methodology

The goal of the DILIGENT (Distributed and Large-scale Information Gathering from the Environment for Networked Threats) Methodology is to collect and analyze data from large-scale and distributed environments, with a focus on VOLUME 11, 2023 5 Author et al.: Preparation of Papers for IEEE TRANSACTIONS and JOURNALS network threat identification. It includes methods for gathering, analyzing, and visualizing data with an emphasis on efficiency and scalability. The application of DILIGENT Methodology is especially pertinent in threat intelligence and cybersecurity settings.

4.5 Neon Methodology

The creation and implementation of ontologies in networked settings is the main emphasis of the NEON (Network Environment for Ontologies) Methodology. It tackles issues with distributed systems scalability, evolution, and ontology integration. In networked contexts, the NEON Methodology places a strong emphasis on the use of common protocols and technologies to provide smooth interoperability between disparate ontologies and systems.

5. METHODOLOGIES EMPLOYED IN RESEARCH

5.1 Neon Methodology

The creation and implementation of ontologies in networked settings is the main emphasis of the NEON (Network Environment for Ontologies) Methodology. It tackles issues with distributed systems scalability, evolution, and ontology integration. In networked contexts, the NEON Methodology places a strong emphasis on the use of common protocols and technologies to provide smooth interoperability between disparate ontologies and systems. Nine Scenarios for Building Ontology Networks Nine adaptable scenarios for cooperatively creating ontologies and ontology networks are included in the Neon Methodology framework, with a focus on knowledge resource reuse and re-engineering (ontological and ontological ones have been recognized).

5.1.1 Scenario 1

From definition until execution the ontology network for the Pakistan Culture Ontology was built completely from scratch, without the use of any pre-existing knowledge resources. This required a careful examination of Pakistani-specific customs, beliefs, and practices. The ontology was painstakingly created to encompass every aspect of Pakistani culture, including language, food, holidays, clothes, and social mores.

5.1.2 Scenario 2

Reusing and re-engineering non-ontological resources is the second scenario. Non-ontological materials like literary works, historical records, cultural studies, and anthropological research were examined during the creation of the Pakistan Culture Ontology. While adhering to the ontology's standards, pertinent data was retrieved and reengineered into ontological structures to guarantee thorough coverage of Pakistani cultural knowledge.

5.1.3 Scenario 3

We used Scenario 3 (Reusing ontological Resources) of the NEON Methodology, which uses pre-existing ontological data, to develop the Pakistan Culture Ontology. We found comparable ontologies in fields like sociology, anthropology, and cultural heritage, despite the fact that there

were no ontologies that particularly addressed Pakistani culture. We developed a new ontology that incorporates Pakistani culture by utilizing ideas, connections, and axioms from preexisting ontologies. By using the available knowledge resources, this method enabled us to make sure the ontology adhered to established conceptual frameworks.

5.1.4 Scenario 4

Reusing and re-engineering ontological resources - Similar to Scenario 3, this scenario did not apply as there were no pre-existing ontological resources related to Pakistani culture that could be reused or re-engineered in the development of the Pakistan Culture Ontology.

5.1.5 Scenario 5

Reusing and merging ontological Resources: As there were no existing ontologies on Pakistani culture, this scenario was not relevant to the development process. The ontology was built from scratch, integrating various aspects of Pakistani

5.1.6 Scenario 6

Reusing, merging, and re-engineering ontological Resources: Since no ontological resources existed for Pakistani culture, this scenario did not apply to the development of the Pakistan Culture Ontology. All ontology development efforts focused on creating original ontological structures tailored specifically to Pakistani cultural knowledge.

5.1.7 Scenario 7

Reusing ontology design patterns (ODPs): Given the absence of pre-existing ontologies, there were no ontology design patterns available for reuse in the development of the Pakistan Culture Ontology. Ontology developers relied on established methodologies and domain expertise to design and structure the ontology effectively.

5.1.8 Scenario 8

Restructuring Ontological Resources: Since the Pakistan Culture Ontology was developed from scratch, restructuring existing ontological resources was not applicable in this scenario. However, modularization and extension techniques were employed internally to organize and expand the ontology network as needed.

5.1.9 Scenario 9

Localizing ontological Resources: In the context of Pakistan's Culture Ontology, localization involves adapting the ontology to accommodate various languages and cultural communities within Pakistan. This ensured that the ontology was accessible and relevant to diverse linguistic and cultural groups across the country.

5.2 Knowledge Organization

This methodology helps to structure the diverse data into structured form such as in the form of classes and sub-classes, like language, tradition, and social structures. This methodology is designed in a protege tool that will be used to preserve the complex and unstructured data of Pakistani Culture.

5.3 Cultural Understanding

The purpose of the Pakistan Culture Ontology is to improve the interpretability and retrieval of cultural knowledge by offering an organized and thorough representation of many facets of Pakistani culture. Through the use of object and data attributes, the ontology formalizes the semantics of Pakistani cultural concepts and their relationships, facilitating more precise indexing, ranking, and retrieval of cultural information. Better search results and a greater comprehension of Pakistani culture follow from this Data properties are used in the Pakistan Culture Ontology project to specify particular aspects of cultural concepts. This provides detailed information that improves the ontology's accuracy and richness. These characteristics adequately convey a variety of elements that are essential to a thorough understanding of Pakistani culture, including socioeconomic class, gender roles, and aesthetic standards.

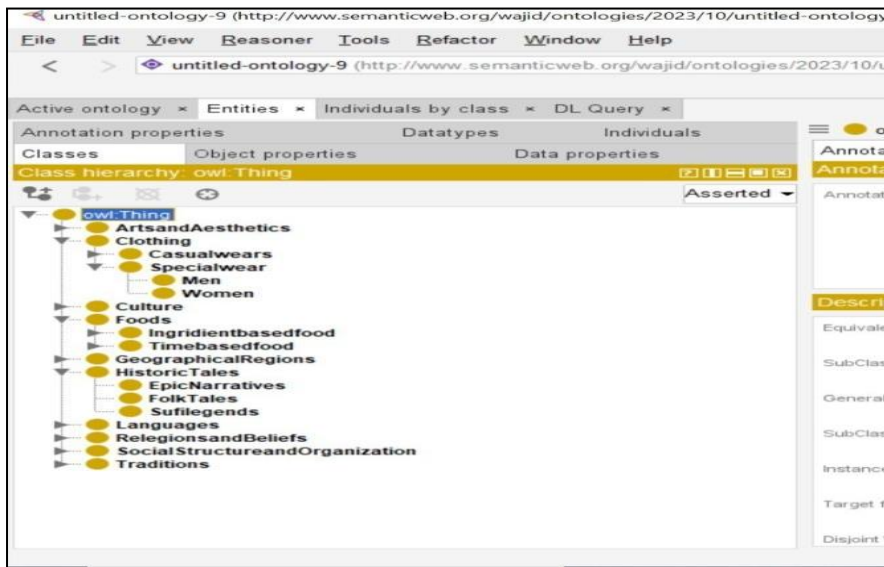


Figure 1: Class Hierarchy

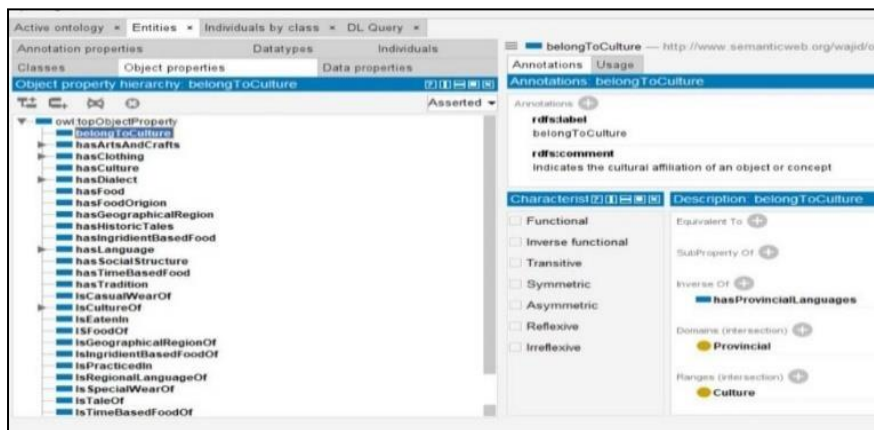


Figure 2: Object Properties

For instance, the socioeconomic class might represent the regional differences in societal stratification, gender role can define cultural expectations within family structures, and aesthetic principles can

characterize the artistic qualities connected to traditional needlework. Through the integration of various features of data, the ontology provides a comprehensive and intricate portrayal of Pakistan's rich cultural legacy

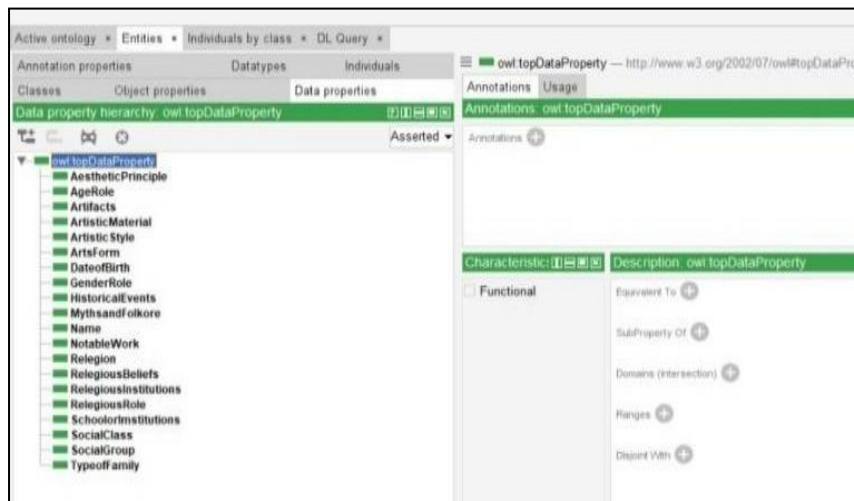


Figure 3: Data Properties

5.4 Improving Comprehensibility With Annotation Properties:

The Protege tool's annotation properties are essential for improving the readability of our Pakistan Culture Ontology since they offer contextual and semantic clarification for the elements inside the ontology. The owl: backward-compatible with attribute makes sure that changes don't break existing data by indicating if a newer or older version of an ontology is compatible with it. The owl: deprecated attribute directs users toward more modern substitutes by marking items that are out-of-date and

should not be utilized. The owl: not suited to avoid confusion and conflicts, the with property lists items that are incompatible with particular versions. An ontology element's prior version is stored in the owl: prior Version attribute, which makes version tracking and historical referencing easier. Understanding an element's evolution and modifications over time is made easier with the use of the owl: version Info property, which gives information about the version of an element. Explanatory notes and explanations can be included.

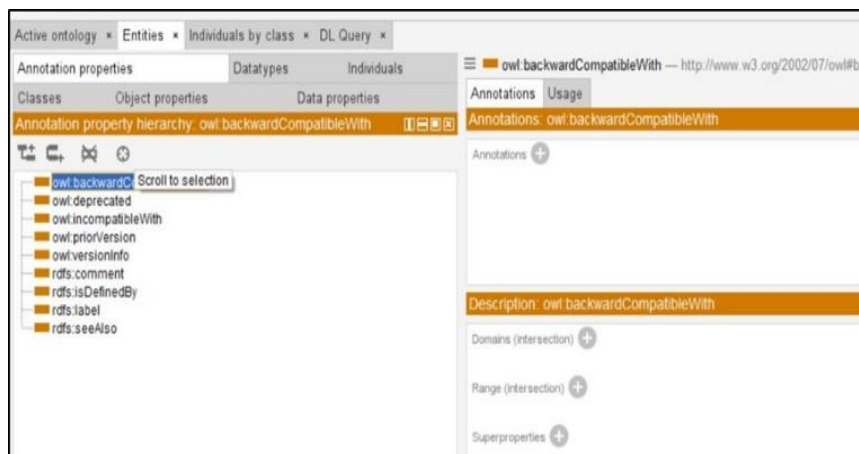


Figure 4: Annotations-Properties

With ontology items using the `rdfs:comment` attribute, which helps users better comprehend the functions and applications of certain ontology elements. An element's connection to its defining ontology is ensured via the `rdfs:isDefinedBy` attribute, which also provides context and attribution clarity. The `rdfs:label` attribute gives ontology elements human-readable names, which facilitates their interpretation and increases their accessibility. The `rdfs:seeAlso` feature, which provides further context and information to aid users in gaining a more thorough understanding, concludes by linking to similar sites. The Pakistan Culture Ontology may provide comprehensive, relevant, and user-friendly metadata by utilizing these annotation features. This improves the ontology's general clarity, usefulness, and efficacy and makes it easier for users to traverse and comprehend the complex nuances of Pakistani culture.

5.5 Individuals

The Pakistan Culture Ontology encompasses a wide range of people who represent Pakistan's rich and varied past. Traditional clothing, such as the

Achkan and Dhoti Kurta, exemplifies regional fashion, whilst Gharara displays bridal apparel. Notable individuals like Baba Bulleh Shah draw attention to the literary and spiritual heritage. Complex social structures are seen in groups like the Banjara Community and ideas like the Biraderi and Caste System. Festivals like as Eid al-Fitr and Eid al-Adha, as well as Barelvi and Deobandi denominations, serve as symbols of religious rituals. Bright kite festival Basant captures cultural celebrations. Entries such as Beef, Chicken, Daal, Dried Fish, Fresh Water Fish, Crab, Dairy, Eggs, and Fruits highlight the diversity of cuisine. Buddhist art from Gandhara and Basohli paintings represent artistic traditions. Dera Sufiana, Chenab Valley, Doaba Region, and Colonial Influence all depict the historical and geographical essence. Traditions in dance and folklore are essential components of this cultural fabric. The Sikh community's sacred writings are represented by the Guru Granth Sahib, while Growing Interest emphasizes contemporary cultural advancements. All in all, these people add to a thorough portrayal of Pakistan's cultural identity, highlighting the country's rich historical background, social cohesion, and dynamic customs.

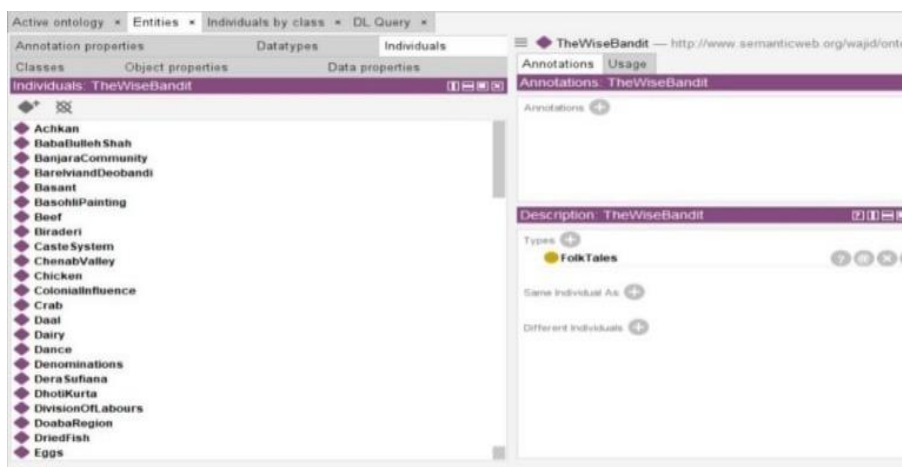


Figure 5: Individuals

5.6 Use Cases

Google Scholar Integration: Ontology Mapping for Cultural Heritage Preservation Module In this use case, we want to employ ontology mapping to improve cultural heritage preservation with a particular focus on clothes, food, and languages. Initially, we included Google Scholar in our system to have access to an extensive collection of scholarly literature. We connect sub-classes of the Clothing ontology class, like Men/Women, Casual wear, and Special wear, to pertinent academic papers about traditional dress, fashion history, and cultural importance. Examples of traditional Indian/Pakistani clothes include ghagra, sherwani, and shalwar suits with dupatta, which are mapped to relevant articles. Comparably, under Foods, we link items like chicken and beef to articles about meat-based cuisines, and we link desserts like halwa and lassi to studies about local dessert customs.

Lastly, under Languages, examples such as Malvi and Punjabi are linked to linguistic research on local vernaculars and cultural manifestations. By employing an ontology mapping technique, we establish an extensive

knowledge base that connects cultural items to academic research, so promoting a more profound comprehension and conservation of intangible cultural assets. Subclasses of Casualwear, Women, Men, and Specialwear are included in the ontology of clothing, with examples such as ghagra, sherwani, and shalwar kameez. Mapping categories of clothing and examples of traditional clothing worn by men and women, such as ghagra and sherwani, improves the preservation of cultural heritage in the Pakistan Culture Ontology project.

The ontology of foods includes subclasses such as Ingredient-based food, Meat-based food, and Time-based food, containing items like halwa, chicken, and beef. The mapping of traditional foods like halwa and chicken is made easier by the integration of the Foods ontology into the Pakistan Culture Ontology project, which helps with the documentation and preservation of cultural heritage. Punjab's cultural identity in Pakistan is mostly shaped by Punjabi, with its diverse range of dialects. In addition to being a vital component of everyday communication, this language is also essential to the expression of culture in genres including literature, folk music, and traditional storytelling.

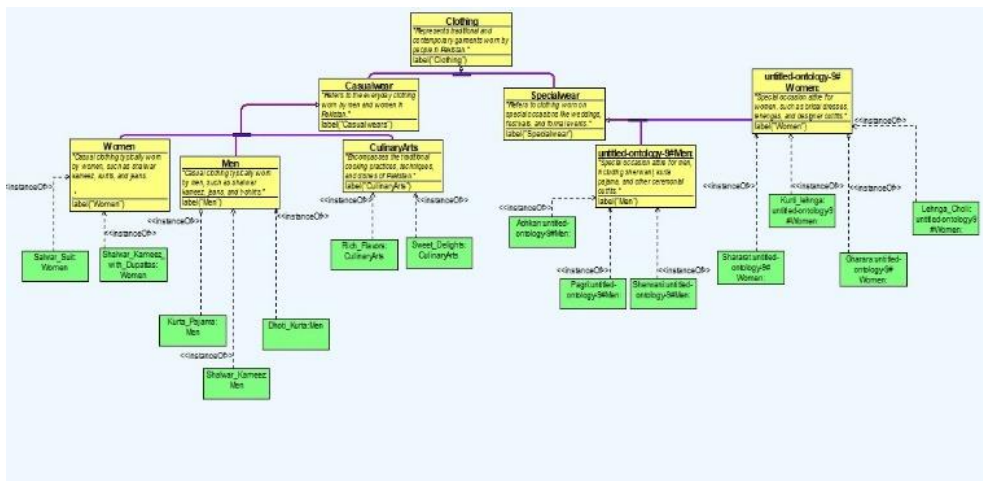


Figure 6: Clothing

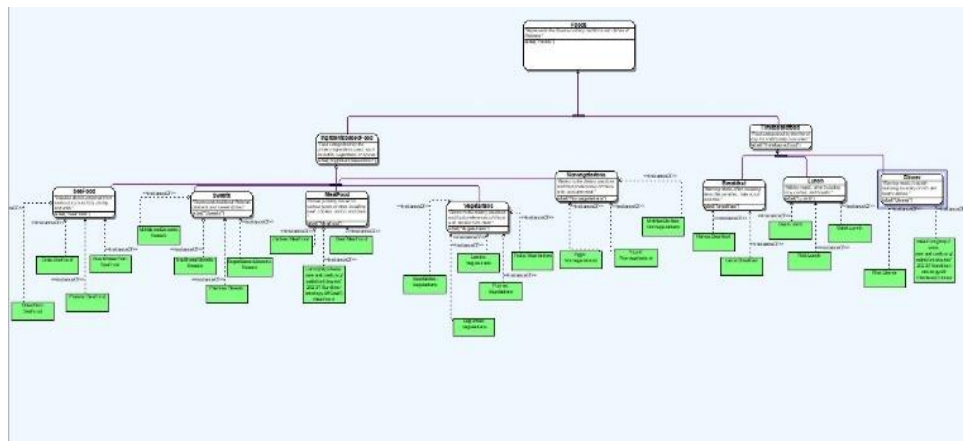


Figure 7: Food

5.7 Diversity in Linguistics and Cultural Abundance Local Speeches

Saraiki: With its unique phonetic and syntactic traits, Saraiki, which is primarily spoken in Punjab’s southern regions, adds to the diversity of cultures. It frequently appears in folk ballads and Sufi poetry, capturing the pastoral and spiritual essence of the area. Pothwari: Native to the Pothohar Plateau, this language is full of colloquial idioms and is often utilized in regional plays and folklore. Majhi: Spoken in Punjab’s central districts, this dialect is regarded as the mainstream version of the language. It is frequently employed in literary and formal settings. Hindko: Adding to the linguistic mosaic, Hindko speakers can also be found in Punjab, despite the language being mainly spoken in Khyber Pakhtunkhwa. Expressions of Culture: Literature: The rich literary legacy of Punjabi language is exemplified by epic stories such as "Heer Ranjha" and the poetry of Waris Shah and Baba Bulleh Shah.

These pieces frequently include romantic, mystic, and social justice themes. Music and Dance: The language is essential to performing the traditional Punjabi dances, Bhangra and Gidha. Punjabi songs frequently honor romantic tales, historical occurrences, and agricultural life. The ontology of languages has subclasses called Provincial and Regional, with examples such as Malvi, Punjabi, and Hindko." "Mapping regional languages such as Punjabi and Hindko in the Pakistan Culture Ontology enriches cultural heritage documentation." "By categorizing languages into Provincial and Regional subclasses, the ontology facilitates comprehensive representation of Pakistan’s linguistic diversity."

Mapping of several regional languages, such as Punjabi and Malvi, is made possible by the Languages ontology’s integration with the Pakistan Culture Ontology project."

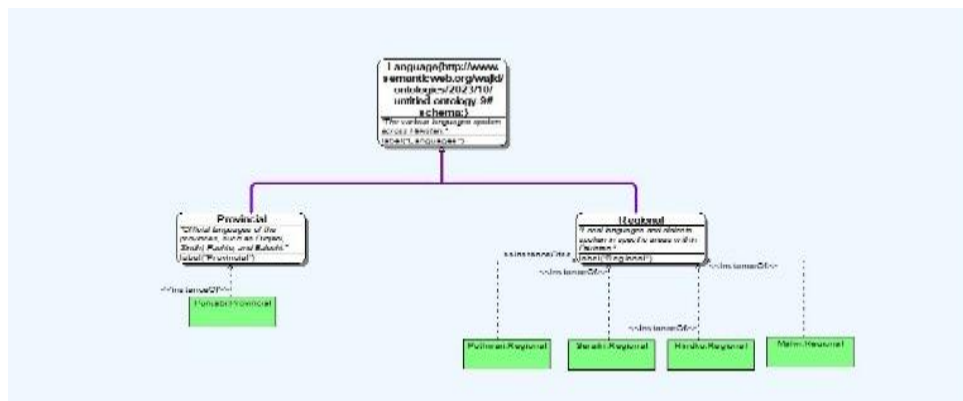


Figure 8: Languages

"By incorporating linguistic data, the ontology enhances cultural heritage preservation efforts by capturing the linguistic richness of Pakistan." Pakistan’s linguistic legacy can be documented and studied in an organized manner by mapping regional languages inside the ontology.

5.8 Challenges

Pakistani culture is rich and diverse, inspired by civilizations such as the Indus Valley, Persian, Mughal, and British, and its preservation depends

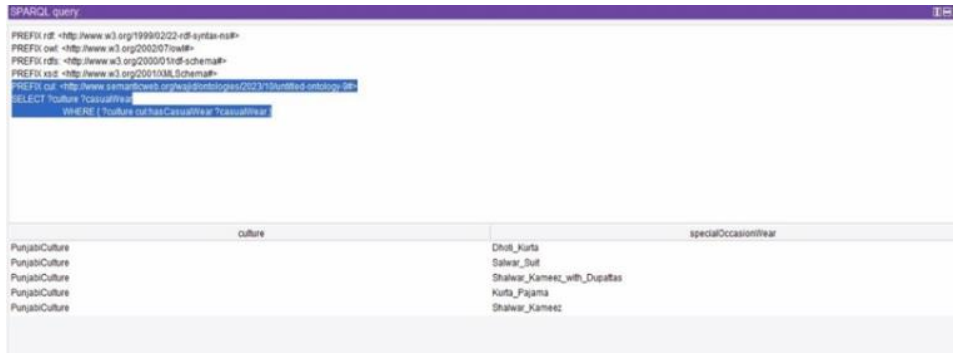


Figure 11: Casual-Wears

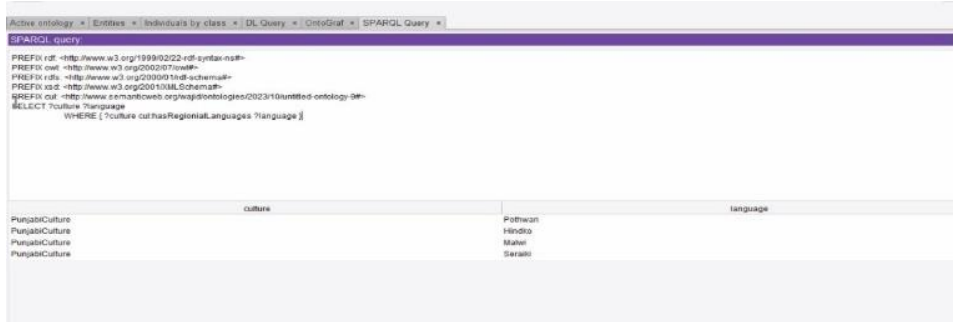


Figure 12: Regional-Languages

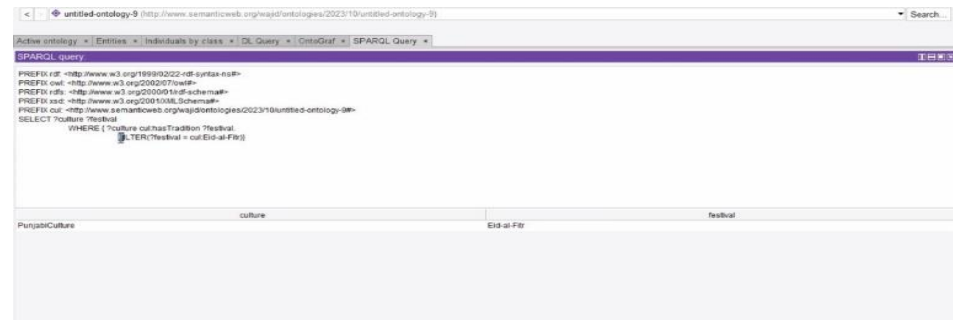


Figure 13: Festivals

Table 1: Ontology Metrics

Metrics	
Axiom	850
Logical axiom count	412
Declaration axioms count	221
Class count	54
Object property count	35
Data property count	20
individual count	112
Annotation property count	3
Class Axioms	
Subclass of	54
Object Property Axioms	
Object Property Domain	35
Object Property Range	35
Data Property Axioms	
Data Property Domain	20
Data Property Range	20
Individual Axioms	
ClassAssertion	114
Object Property Assertions	103
Data Property Assertions	2
Annotations Axioms	
AnnotationAssertion	217

7. ORSD OF PAKISTAN CULTURAL ONTOLOGY

Purpose: The purpose of Pakistan Ontology is to provide a structured framework for organizing and categorizing cultural data of Pakistan, facilitating communication gaps and preserve Pakistan rich cultural heritage.

Scope: The Pakistan Culture Ontology's purview includes organizing and categorizing cultural components such as dialects, customs, cuisine, and attire. Through the establishment of semantic linkages between these pieces, it seeks to preserve cultural heritage by improving documentation, interpretation, and accessibility for future generations across digital platforms.

7.1 Implementation Language

The Pakistan cultural ontology will be implemented in OWL language.

7.2 Intended Uses

Use 1 : Arranging cultural components for thorough recording and conservation.

Use 2: Categorizing cultural material per customs and geographical differences.

Use 3: Examining cultural data to determine opportunities and requirements for preservation.

Use 4: Monitoring the evolution of cultural customs and historical sites. textbf6. Ontology Requirements:

7.3 Non-Functional Requirements

NFR1. The ontology must be consistent and should be able to successfully address and answer all the competency questions.

NFR2. The ontology must satisfy the FAIR (Findable, Accessible, Interoperable, Reusable) principle. b. Functional Requirements: Groups of Competency Questions based on Modules

7.4 Competency Questions

Group 1: Arts and Aesthetics

CQ1.1. What are the different forms of visual arts in Pakistan? (CHO)

CQ1.2. what are performing arts across Punjab regions in Pakistan? (TI)

CQ1.3. Which types of handicrafts are specific to the Punjabi culture?(CHO)

CQ1.4. what are the arts and aesthetics of punjabi culture?(SR)

Group 2: Foods

CQ2.1. What are the famous time based foods of Punjab? (PTI)

CQ2.2. What are the most famous Punjabi foods? (PTI) CQ2.3. What are non-vegetarian Pakistani foods? (TI)

Group 3: Clothing

CQ3.1. What are the casual wears of Pakistani Culture for men and women?(CHO)

CQ3.2. What are the special wears of Pakistani Culture for men and women? (CHO)

CQ3.3. What are Punjabi wedding traditional dresses?(SR)

Group 4: Languages

CQ4.1. What are the languages spoken in Punjab?(CHO) CQ4.2. What is the provincial language of Punjab?(PTI) CQ4.3. What are the dialects of the Punjabi language?(SR)

Group 5: Traditions

Q5.1. What are famous traditions of Punjabi culture?(CHO) CQ5.2. What are some Punjabi religious traditions?(TI) CQ5.3. What are the main cultural festivals held in the Punjab region?(TI)

Group 6: Historic Tales

CQ6.1. What are the famous historical tales of Punjab? (CHO) CQ6.2. What are the famous Sufi legends of Punjab?(SR) CQ6.3. What are famous Sufi legends of Punjabi culture? (CHO)

Summary of the Ontology Requirements Specification Document for Pakistan Cultural Ontology

8. CONCLUSION

The evaluation and enhancement of the Pakistan Culture Ontology through systematic methods like pitfall checks and version control has significantly improved its quality and reliability. By utilizing tools like OOPS! for identifying common design flaws and implementing corrections in Protege, the ontology now adheres to best practices, ensuring its structural integrity and usability. Additionally, the integration of SPARQL queries has confirmed the ontology's accuracy and functionality, making it capable of answering competency questions that reflect real-world cultural data. With its well-structured framework and semantic linkages, the Pakistan Culture Ontology serves as a valuable tool for organizing, preserving, and sharing Pakistan's diverse cultural heritage across digital platforms. The ontology not only supports future research and preservation efforts but also enables accessible, consistent, and comprehensive cultural knowledge retrieval for users worldwide.

Adding support for Urdu, Sindhi, Pashto, and English to the ontology will make it more inclusive and appeal to a wider range of users [?]. Raising the profile of this ontology to a global level can be achieved by aligning and integrating it with other cultural, historical, and geographical ontologies to form a more complete and interconnected knowledge network. We can evaluate and produce insights from the ontology data by utilizing machine learning and artificial intelligence techniques. This opens up possibilities for applications like recommendation systems, chatbots, and cultural trend analysis. The Pakistan culture ontology can be used to train large language models (LLMs), which would enable them to offer more precise and culturally sensitive replies. This integration can also be extended to dealing with LLMs. By integrating VR and AR technologies, developers can create immersive experiences that let consumers explore Pakistani. Furthermore, in order to ensure the correctness and completeness of ontology data, a crowdsourcing platform can be built to include researchers, cultural specialists, and members of the public in the validation process. Creating data analytics tools will enable decision-making, policy formulation, and cultural preservation by allowing the extraction of insightful patterns and insights from the ontological data.

Investigating knowledge network embedding methods will provide improved querying, grouping, and visualization capabilities by representing the ontology data in a dense vector space. Pakistani cultural history can be preserved for a long time by working with museums, archives, and other cultural organizations to integrate ontology into their digital preservation initiatives. Students and teachers will be encouraged to think critically, be culturally aware, and be digitally literate by creating instructional materials and curricula that make use of ontology. By cultivating collaborations with scholars, establishments, and associations, the ontology will broaden its Purview and delve into novel fields and uses, including cultural economics, governance, and travel and tourism. Our Pakistani culture ontology can become a global ontology with rich, interrelated cultural insights and applications in a variety of disciplines by spreading its name and working with other cultural ontologies.

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