Knowledge Graph for Enhancing Food Assistance Information Systems

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Abstract

In 2021, the United States Department of Agriculture (USDA) reported that **33.8 million** people lived in **food-insecure households** [1]. The prevalence of child food insufficiency for Hispanic households with children peaked in April 2022 at 29.7 percent. The government and some private organizations provide help facilitating access to net-related services; however, underrepresented communities (i.e., Hispanics) are less prone to use information systems that provide food assistance. The scope of this work focuses on identifying FAIS elements relevant to the Hispanic community and creating a knowledge graph to connect data meaningfully. The knowledge graph will facilitate the reuse of this information for the development of Software Engineering best practices and training materials for developing systems that consider cultural and structural competencies.

Introduction

Food security refers to the ability of a population having access to food by all people at all times for an active, healthy [1]. We believe that technology, in particular, Information Systems (IS) can be used to better disseminate food security resources to those in need. However, previous work indicates that Information Systems are underused by underrepresented groups such as Hispanics due to cultural and linguistic factors [2]. In this work, we refer to **food insecurity** as the condition in which individuals or households have limited access to the food supply, due to multiple factors including financial constraints, lack of resources, living cost, or job security.

Background

The Information Systems meets CUltural COmpetencies (IS-CUCO) is an NSF-funded project seeking to incorporate cultural and structural competencies in the development cycle of IS, in particular **Food Assistance Information Systems (FAIS),** to increase their use by underrepresented communities (e.g., Hispanic communities). FAIS are IS that support the management and distribution of food assistance programs and resources to individuals and families in need.

Knowledge Graphs (KG) provide a powerful framework for organizing and connecting data and revolutionized the area of data science when promoted by Google in 2012. Knowledge graphs are critical to many enterprises today and provide the structured data and factual knowledge that drive products and make them more intelligent [3].

Competency Questions

1. What types of information systems are available for food security?

2. What are the types of FAIS available in the cities studied, the type of facilities, the services provided and the requirements to access these services?

Problem Statement/Hypothesis

The first purpose of the FAIS KG is to enable the interdisciplinary and interinstitutional IS-CUCO team to reach a consensus on key terms related to FAIS, Food Security, Cultural Competencies, and Structural Competencies. In this work, we present the FAIS subgraph of the IS-CUCO knowledge graph.

The second and main purpose of the FAIS knowledge graph is to provide a high-level data model for the integration of data related to FAIS elements relevant to the Hispanic community. The goal is to utilize the KG to retrieve information needed to analyze and understand barriers that prevent Hispanics from using FAIS.

Methods and Materials

For the creation of the FAIS knowledge graph, the research team identified relevant data, resources, and information on FAIS from Chicago, Los Angeles, El Paso, and New York. This work leveraged a previous analysis created by members of the IS-CUCO research group.

An initial concept map illustrated in Fig. 1 was created as a graphical representation of the knowledge graph and was refined through multiple iterations with members of the IS-CUCO research team. Our current concept map has fifty concepts such as "Nutrition Assistance Program" and "Food Bank". Concepts in this concept map were linked using standard relationships such as "is-a" and domain-specific relationships such as "supports" that link a specific program to the targeted population they support.

In parallel, the team developed a glossary to capture the vocabulary and guidelines of each keyword in the knowledge graph by providing their data provenance, e.g., a definition and its source.
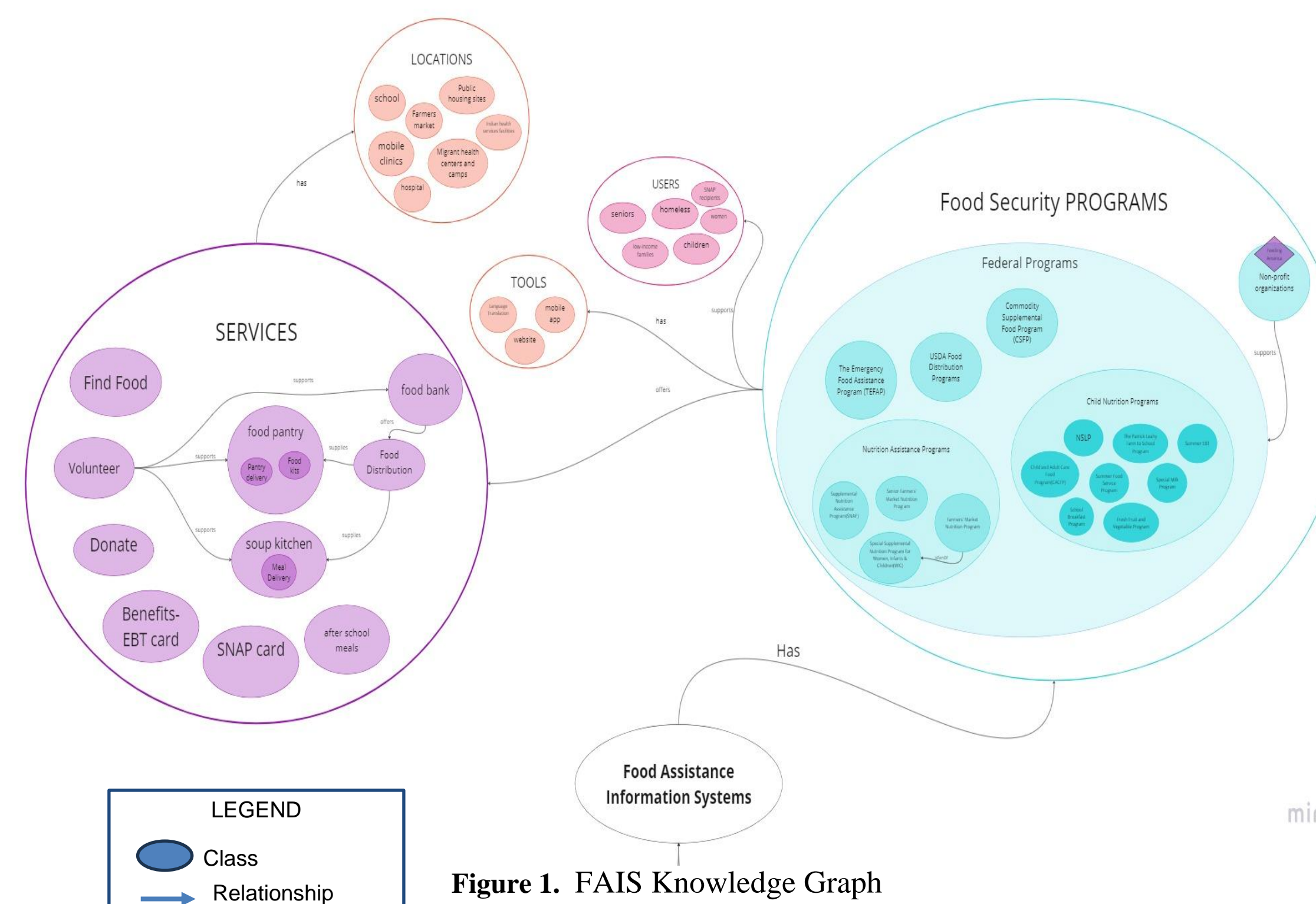

Figure 1. FAIS Knowledge Graph

Results

➢ An initial concept map was created as a graphical representation of the knowledge graph and was refined through multiple iterations with members of the IS-CUCO research team. The knowledge graph, currently in development, served to reach consensus about key terms related to FAIS across the different research team members, that come from different disciplines and organizations.

➢ A glossary is currently in development, to capture the vocabulary and guidelines of each concept in the knowledge graph and provide their data provenance, e.g., a definition and its source.

➢ The knowledge graph was implemented using Protégé and the Web Ontology Language (OWL), shown in Fig. 2.

➢ The knowledge graph can answer competency questions such as the types of FAIS available in the cities studied, the type of facilities, the services provided, and the requirements to access these services, see Fig. 3.
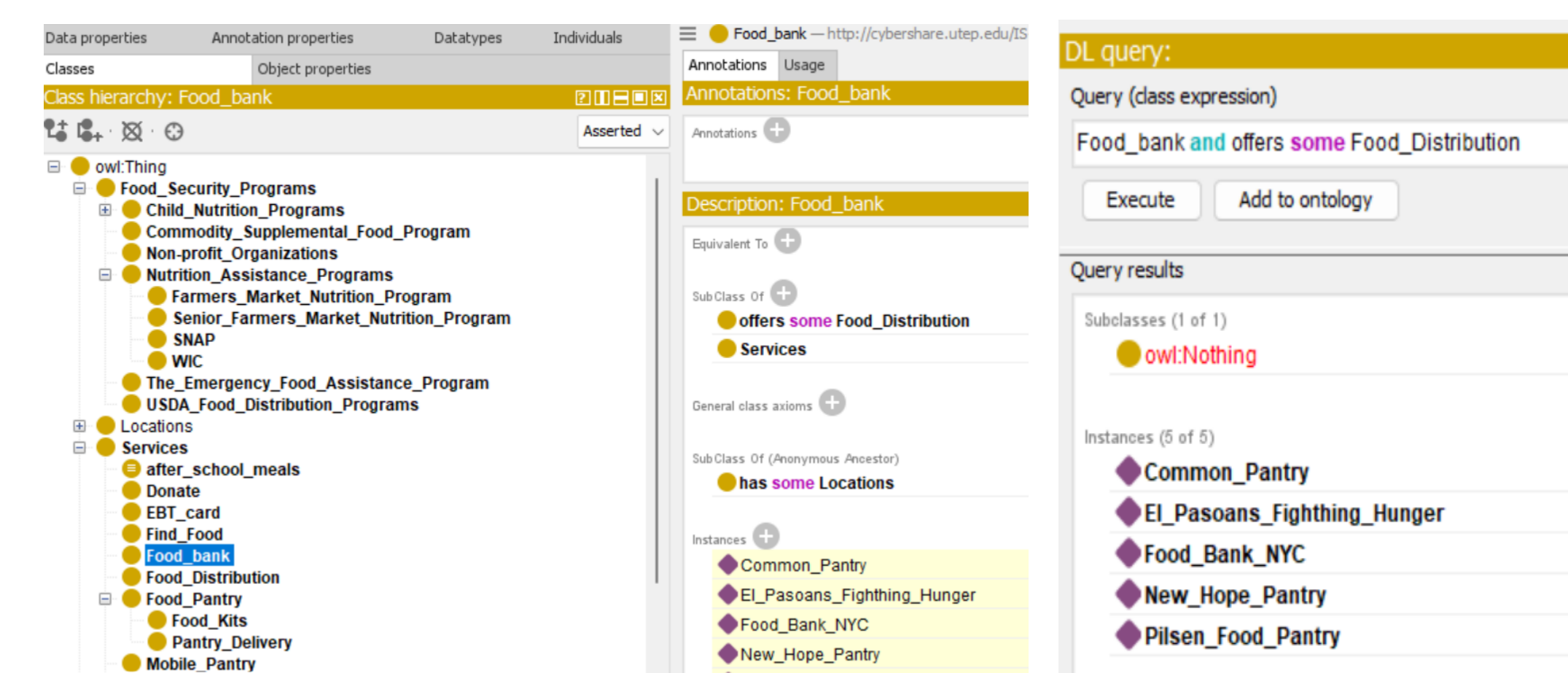

Figure 2. Ontology Class Hierarchy

Figure 3. Query Results

Conclusion

The FAIS knowledge graph enables the connection of relevant concepts and data sources relevant to analyze and understand motivations or barriers that impact the use of FAIS by Hispanics. This work can be extended to other cities, services, and populations to provide useful data to create inclusive and diverse systems. The use of knowledge graphs is important in projects that integrate data and resources from heterogeneous sources, different disciplines, organizations, and locations. Since they are based on semantic descriptions beyond the syntactic representation, knowledge graphs also offer a solution to bridge resources that are available in different languages, e.g., English and Spanish to support FAIS systems that consider cultural differences.

References

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