SCO Development Protocol

Aim

This document describes the process of development of the Sustainability Core Ontology (SCO).

SCO Description

SCO is an open-source middle-level ontology that provides the terminology pertaining to the three major theoretical challenges of sustainability (Ubbiali et al., 2024):

1. The polysemy of the term sustainability.
2. The relationship between sustainability and sustainable development.
3. The complexity underlying sustainability.

SCO seeks to establish a pivotal basis for harmonizing and integrating top-level and domain ontologies within a family of interoperable ontologies addressing sustainability. (Ubbiali et al., 2024). Currently, SCO employs Basic Formal Ontology (BFO) as the upper-level ontology. SCO envisions aligning with and mapping to other top-level ontologies, such as the Unified Foundational Ontology (UFO) and the Descriptive Ontology for Linguistic and Cognitive Engineering (DOLCE), in the near future.

SCO conforms to OBO-Foundry principles. To date, this ontology is formalized in Web Ontology Language (OWL) and covers three natural languages, English, French, and Italian. SCO includes 80 classes, 84 object properties, 65 annotation properties, and 2 individuals. SCO is licensed under the CC BY 4.0.

The most recent version of SCO is available on GitHub at the following link: https://github.com/gioUbbiali/Sustainability-Core-Ontology.git. The person responsible for SCO is Giorgio A. Ubbiali.

Methods and Materials

We created SCO on the basis of the SCO Structured Vocabulary (SCO-SV). This resource provides a core set of terms and relational expressions pertaining to the three major theoretical challenges of sustainability. We extended and deepened SCO-SV by defining additional terms and relational expressions. We proceeded as such by referring to the literature assessed in Ubbiali et al. (2024) and following the recommendations of Arp et al. (2015) and Smith (2013). We formulated the SCO vocabulary and related definitions in English and further translated them into French and Italian. Native speakers revised and validated our translations.

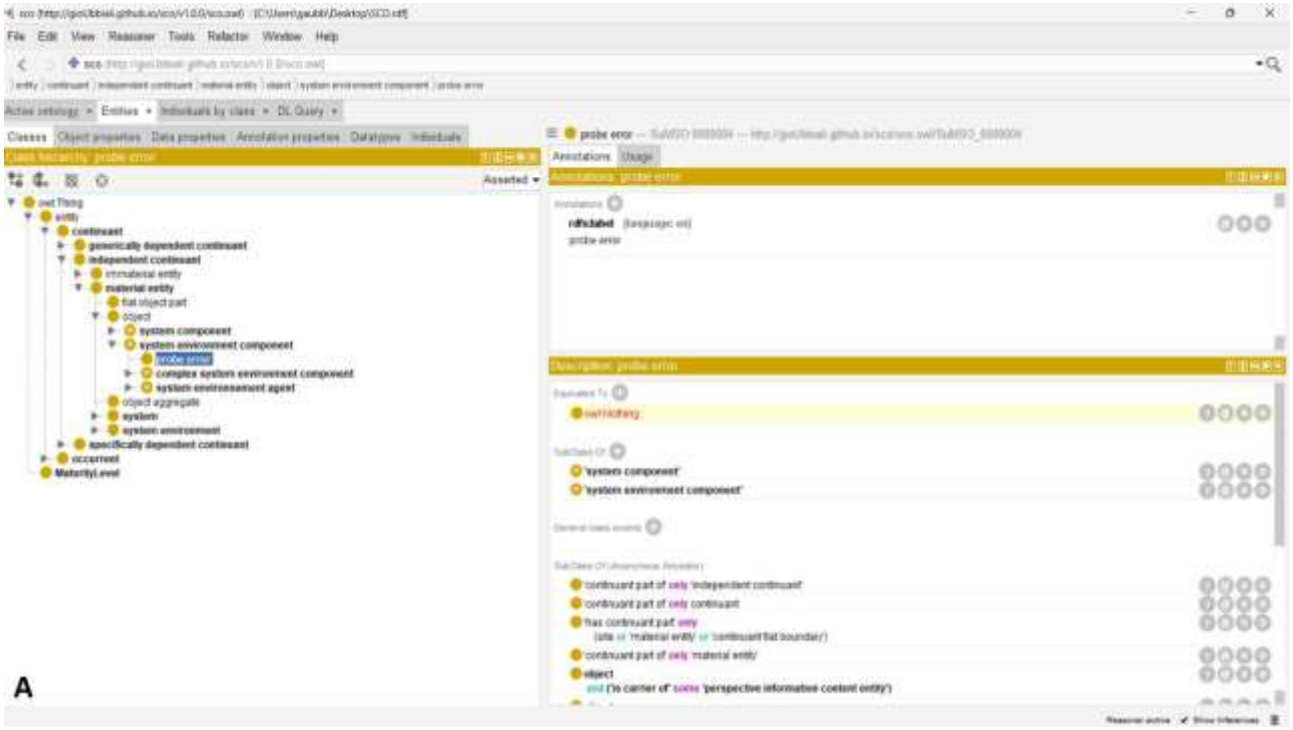
We hierarchically organized and formalized SCO vocabulary in OWL using Protégé. We created corresponding classes and properties, extending BFO from the top down. We proceeded as such following the

recommendations of Arp et al. (2015) and Horridge (2009). When possible, we reused classes and properties from existing ontologies. We manually imported those classes and properties into SCO (for now; see the README description for import files). Table 1 presents resources reused or pointed to by SCO.

We validate SCO employing Protégé automatic reasoners ELK 0.5.0 and HermiT 1.4.3.456 to detect possible logic inconsistencies. We included the use of a probe error class as a control text Fig.1 (Horridge, 2009, p. 49). Reasoner validation detected no logic inconsistencies in SCO. We equally engaged in discussions with ontology specialists and made revisions in line with their recommendations.

Ontology	Ontology Acronym	Repository/Homepage
SCO Structured Vocabulary	SCO-SV	https://github.com/gioUbbiali/Sustainability-Core-Ontology/tree/66b8585ba588d784725f5255104b8970e315bc09/SCO%20SV
Basic Formal Ontology	BFO	https://basic-formal-ontology.org/
Industry Ontology Foundry	IOF	https://ontocommons.eu/initiatives/industry-ontology-foundry
Common Core Ontologies	CCO	https://www.ontologyrepository.com/
Interaction Network Ontology	INO	https://github.com/INO-ontology/ino
Relation Ontology	RO	https://oborel.github.io/
Gene Ontology	GO	https://geneontology.org/
Sustainable Development Goal Interface Ontology	SDGIO	https://github.com/SDG-InterfaceOntology

Table 1. *Ontologies to which SCO points or reuse.*



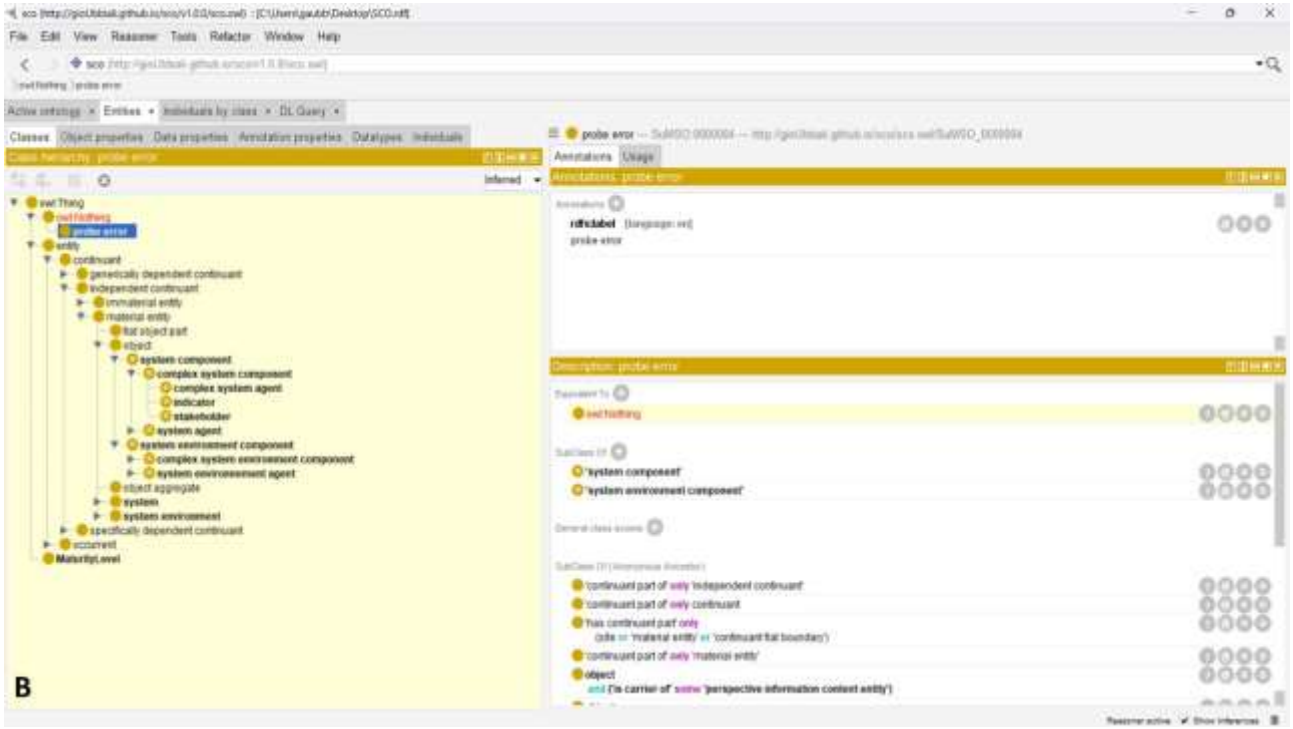


Fig.1. HermiT 1.4.3.456 detection of logic inconsistency for the "probe error" class. This class has been constructed as a subclass of both the "system component" and "system environment component" classes, two disjointed classes. Fig.1A asserted SCO hierarchy; Fig.1B inferred SCO hierarchy.

Future Implementations

To date, we envision the following implementations for SCO. SCO will align with and map to other top-level ontologies, such as the UFO and DOLCE. SCO will cover definitions in other natural languages as well as formal and semi-formal definitions in First Order Logics (FOLs) and Description Logics (DLs). SCO will equally deepen the representation of challenges to sustainability, including classes and object properties that will account for systems granularity, system scales, and levels as well as system change and behaviors. Further implementations and a constant update of SCO and its development process will follow.

Get In Touch

Tracks for contributions and open issues can be found here. Please contact Giorgio A. Ubbiali in case you wish to get involved and participate in the development of SCO.

Bibliography

Arp, R., Smith, B., & Spear, S. A. 2015. *Building Ontologies with Basic Formal Ontology*. Cambridge, Massachusetts: Massachusetts Institute of Technology.

Horridge, M. 2009. "A Practical Guide to Building OWL Ontologies Using Protégé 4 and CO-DE Tools." *The University of Manchester*.

Smith, B. 2013. "Introduction to the Logic of Definitions." https://philarchive.org/rec/SMIITT-4.

Ubbiali, G. A.,Borghini, A., & Lange, M. C. 2024. “Ontologies for Sustainability: Theoretical Challenges.” https://doi.org/10.31219/osf.io/z8uqr.