Annotating Diverse Scientific Data with HAScO

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HADatAc Framework

Motivations

Scientific Knowledge Representation in Support of Data Analysis

HAScO provides the foundation for developing domain ontologies used to semantically annotate scientific data.

"*The repeatability of data and computational intensive experiments is a key aspect in making their results more trustworthy, and thus also of higher relevance to other researchers in the community*"

– MAYER; MIKSA; RAUBER, 2014

Motivations

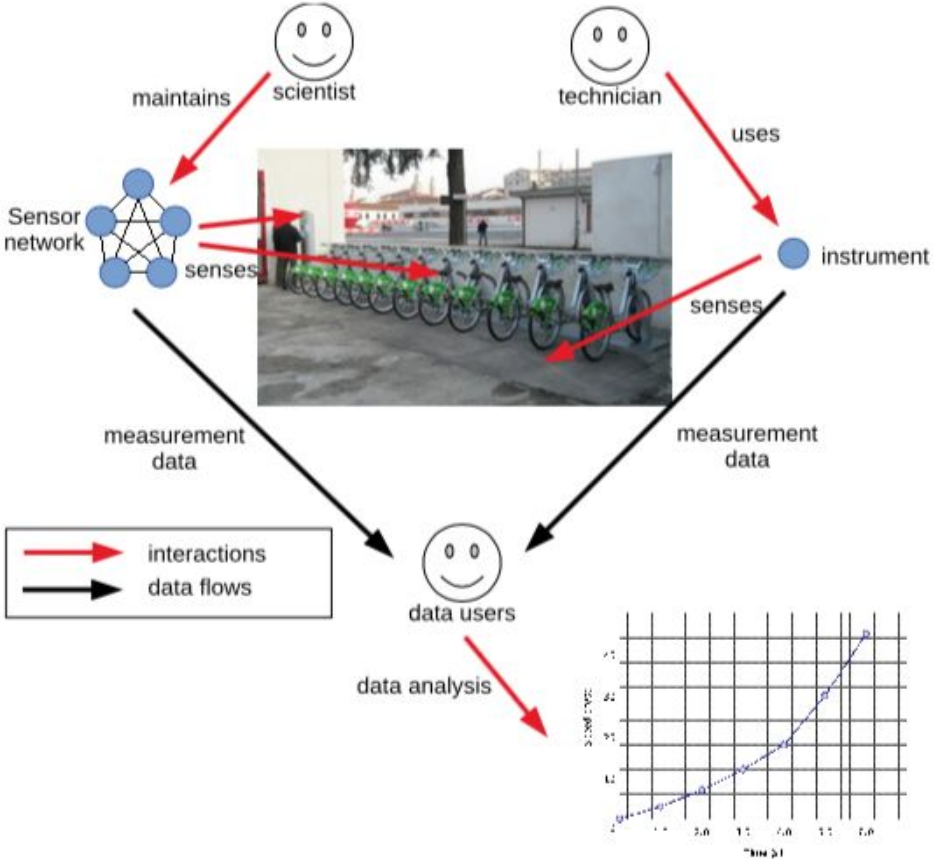
Scientific Knowledge Representation in Support of Data Analysis

- Ontologies are being widely used in science activities, most notably in roles related to **acquiring**, **preparing**, **integrating** and managing data resources.

- Data acquisition and preparation are often difficult to reuse since they tend to be **domain dependent**, as well as dependent on how data is acquired: through **measurement**, **subject-elicitation**, and/or **model-generation** activities.

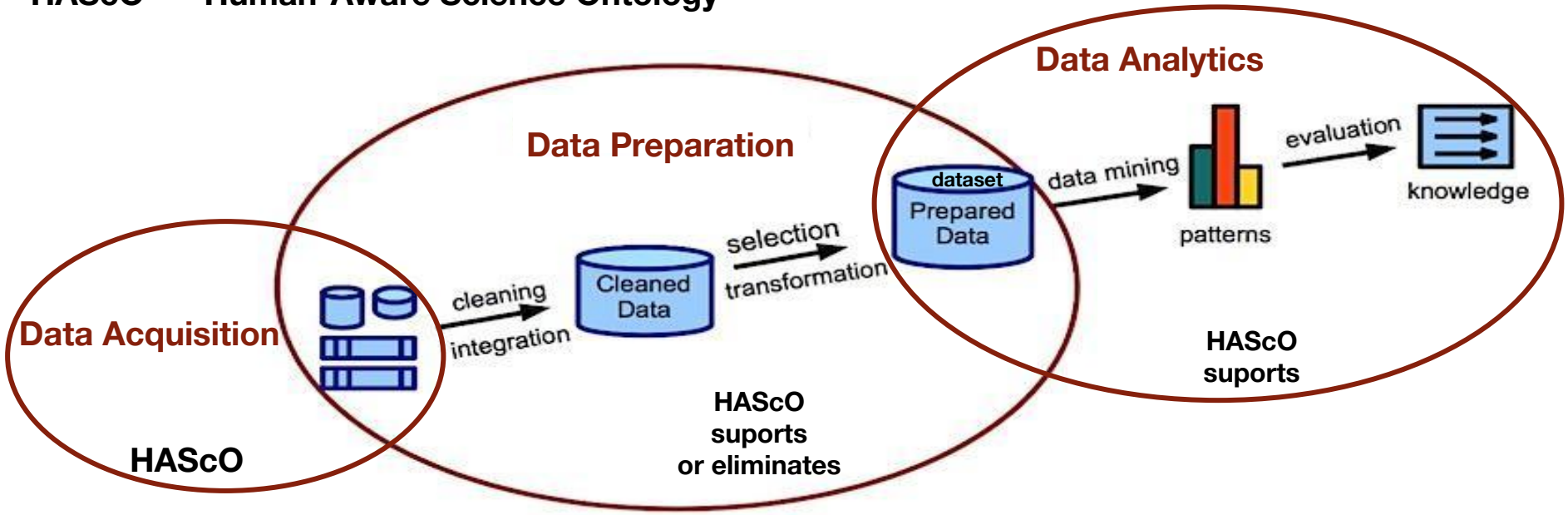
- Therefore, tools developed for preparing data from one scientific activity often cannot be adapted to prepare data from other scientific activities.

Typical data acquisition scenario (Santos, 2018)



Source: Santos, Henrique. *An Indicator-based Approach for Variable Alignment based on Knowledge Graphs*, 2018.

HAScO - Human-Aware Science Ontology

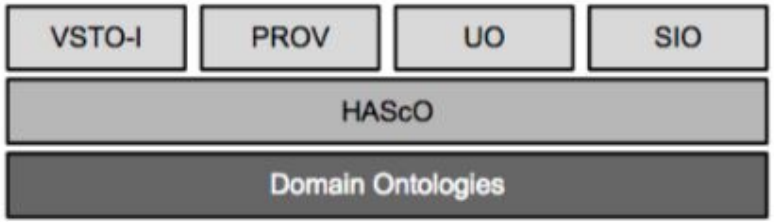


- It is a process that involves many different tasks and which **cannot be fully automated**.
- Many of the data preparation activities are **routine, tedious, and time consuming**.
- It has been estimated that data preparation **accounts for 60%-80% of the time** spent on a data mining project.
- **HAScO** is an ontology for **conceptually describing** the tasks of data preparation.

[1] https://www.datapreparator.com/what_is_data_preparation.html with adaptations

HAScO: Human-Aware Science Ontology

- HAScO integrates a collection of well-established science-related ontologies.



- Designed for encoding **metadata of scientific studies** in **large data ecosystem**, where data can come from diversified data sources including sensors, lab results, and questionnaires.

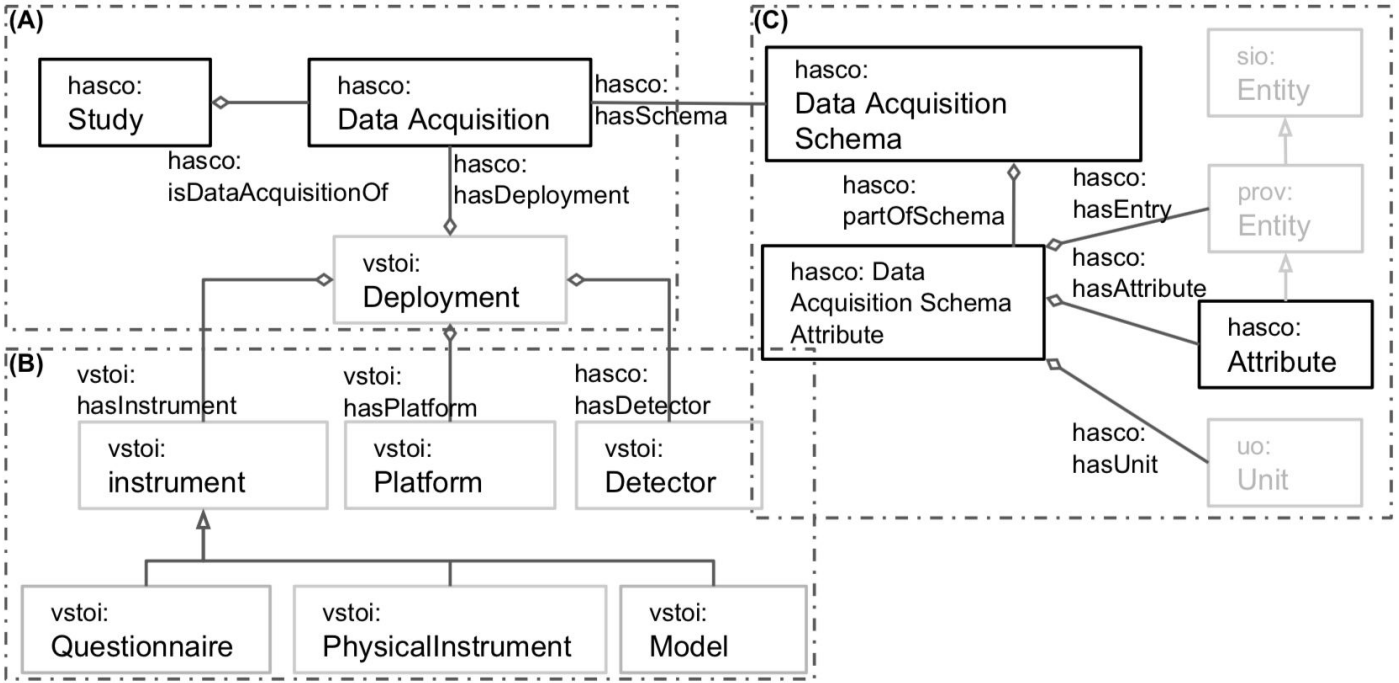
- The paper presents HAScO based on our experience applying it to annotate data, facilitating its exploration and analysis.

Using HAScO

- Data files produced by scientific studies are processed to identify and **annotate the objects** (a gene, for instance) with the appropriate ontological terms.
- Study > Object Collections > Objects > Attributes > Values
- Objects, Attributes, Values are typed based on HAScO
- HAScO is used for harmonizing data across studies since the meaning of and interrelationships between the data is explicit. Harmonization is achieved through the use of **data annotation**, semantically **rich query support**, and **data driven views** for specific user groups.
- One benefit is that software platforms can support scientists in their data **acquisition**, preparation and exploration activities for analysis .
- HAScO supports the design and implementation of the Human-Aware Data Acquisition Framework (HADatAc) [Pinheiro et al. 2018]
  => a platform to **support broad scientific data acquisition activities**.

Overview of HAScO

(A) scientific activities;
(B) instruments of data acquisition;
(C) scientific data schema.



Requirements for Scientific Data Representation

Data Acquisition Activity Metadata				HAScO's Use Cases (Research Projects)		
				Environmental Studies	Human Health Studies	Building Sciences Studies
Study Metadata	Study Type	Observations		X		X
		Experiments		X	X	X
	Study Description	Identification of objects and their inter-relations			X	X
		Data quality management at study level		X		X
		Temporal support for study description			X	X
		Spatial support for study description		X		X
Sensing Infrastructure Metadata	Instruments (Data Acquisition Methods)	Measurement Data	sensor networks	X		X
			lab controlled		X	
		Elicited Data	questionnaires		X	X
			documents as source			X
		Model Generated Data	simulation	X		
	Activities (Quality Control)	Uncertainty Provenance	lab managed		X	
			deployment managed	X		X

Conclusion

- To encode scientific findings in a structured, knowledge-enhanced way using ontologies, can support research exploration and potentially identify novel connections, thereby increasing the overall research impact [Brodaric/Gahegan 2010].

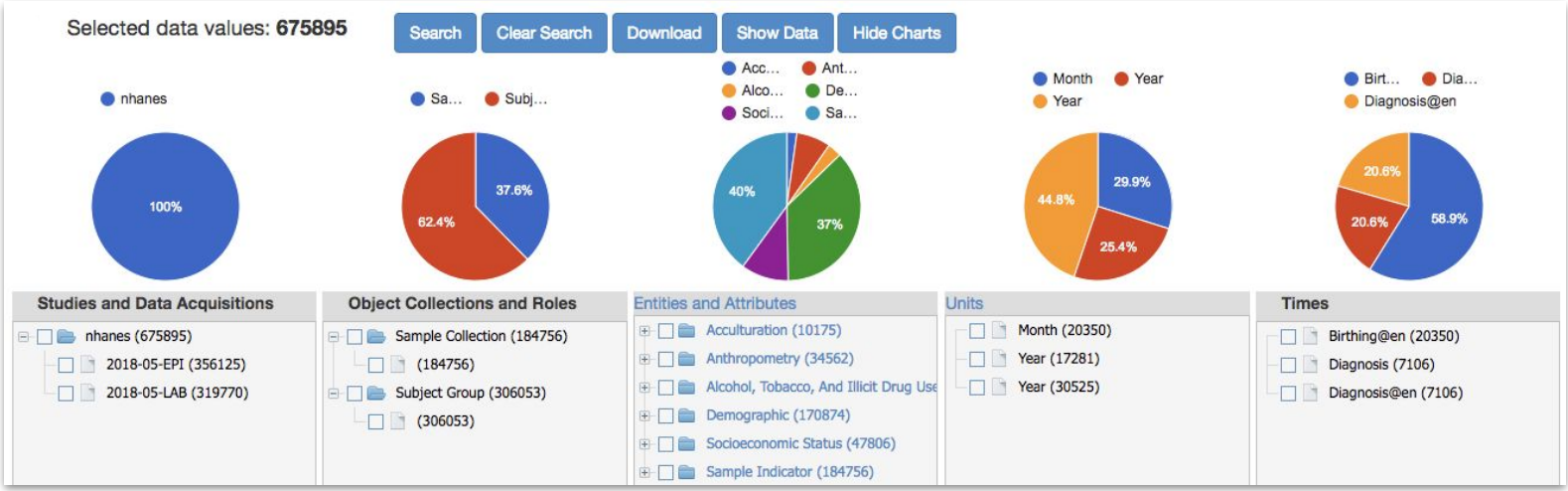
- HAScO was developed and applied to major scientific projects with the goal of helping scientists with data preparation (in support of data analysis).

- HAScO is domain-agnostic, and leverages a combination of well-established foundational ontologies including SIO, OBO Foundry's UO, W3C's PROV, and VSTO-I.

- In addition to supporting some high-level scientific concepts such as Studies, Subjects, Samples and others, HAScO provides a quality dimension of data based on a new generalizable concept called Data-Acquisition.

HAScO and HaDatAc

- The ontology is available under MIT license http://hadatac.org/ont/hasco/
- We are maintaining and evolving the ontology through its use in the HaDatAc infrastructure.
- To the extent that the HaDatAc framework is used as a basis for the implementation of new research projects, HAScO will evolve accordingly, guaranteeing the necessary support for the progress of the ontology.



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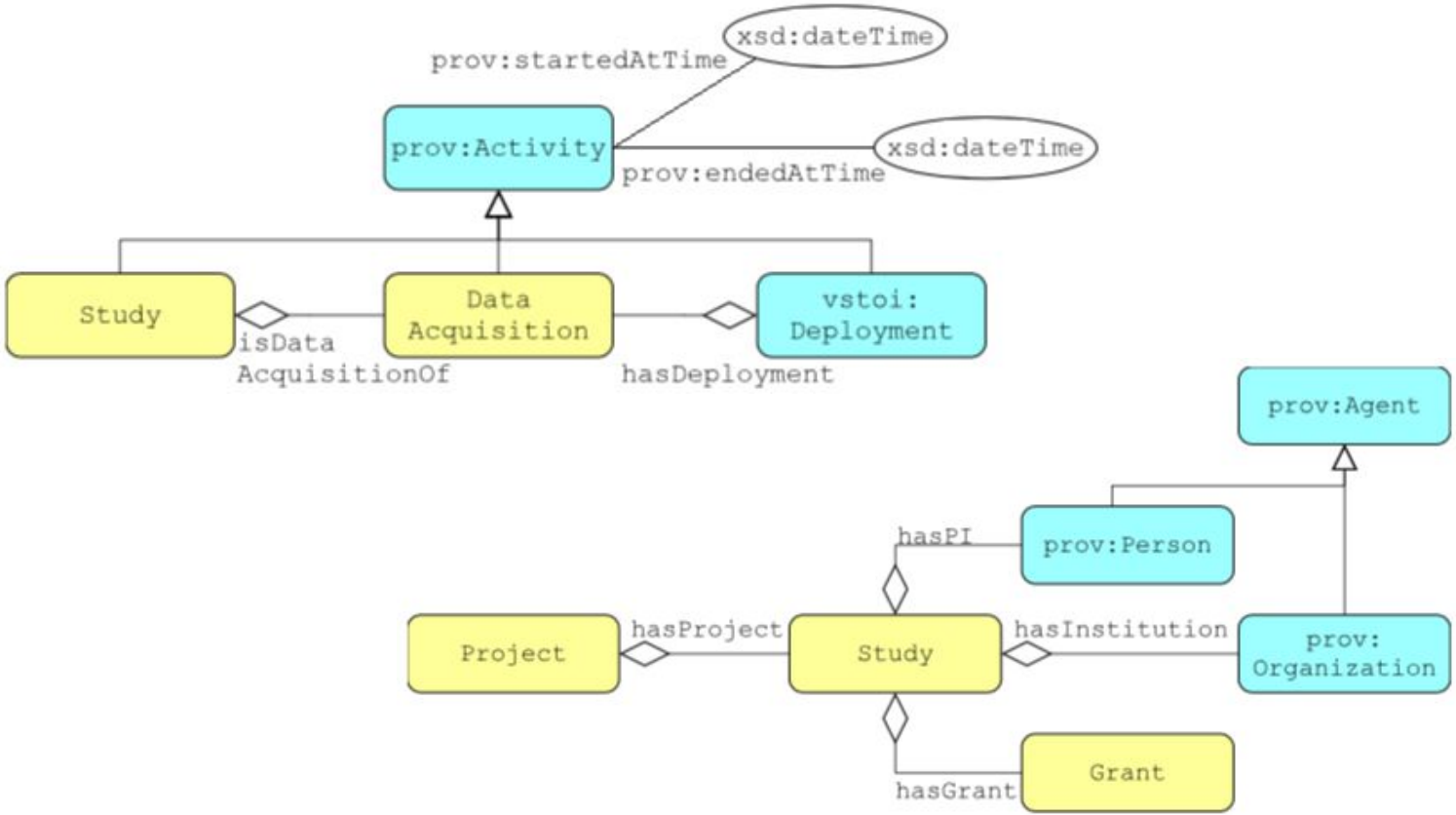
Studies and Data Acquisition activities



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Instruments