Introduction to Patterns & Modules

Cogan Shimizu
cogan.shimizu@wright.edu
coganshimizu.com

Knowledge and Semantic Technologies Lab
Wright State University
Cogan Shimizu
Assistant Professor
Department of Computer Science & Engineering
Wright State University

Knowledge Engineering
Broadly Defined

Open Science
Linking Artifacts, Workflows, and Assisting Research

Effective Pedagogy
Methods for Individualized Teaching and Examination
Motivation

Modular Ontology Modeling

Examples

Tools & Resources
Example: The KnowWhereGraph

The KnowWhereGraph
Funded by NSF, as part of the convergence accelerator program, worth $6M, over 50 collaborators

Incorporates over 30+ thematic and “placial” datasets into a knowledge graph with over 13.5 billion triples

We can integrate data over different geospatial representations to derive key insights and summarize them into area briefings

<table>
<thead>
<tr>
<th>Thematic Datasets</th>
<th>Place-Centric Datasets</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Dataset Name/Theme</strong></td>
<td><strong>Source Agency</strong></td>
</tr>
<tr>
<td>Soil Properties</td>
<td>USDA</td>
</tr>
<tr>
<td>Wildfires</td>
<td>USGS, USDA, USFS, NRC</td>
</tr>
<tr>
<td>Earthquakes</td>
<td>USGS</td>
</tr>
<tr>
<td>Expert - Covid-19 Mobility</td>
<td>Direct Relief (DR)</td>
</tr>
<tr>
<td>Expert - General</td>
<td>KGW, UC System, DR</td>
</tr>
<tr>
<td>Cropwell Types</td>
<td>USDA</td>
</tr>
<tr>
<td>Smoke Plumes</td>
<td>NOAA</td>
</tr>
<tr>
<td>Climate Observations</td>
<td>NOAA</td>
</tr>
</tbody>
</table>
Isolate instantiated patterns into modules, and then interconnect them.

Different datasets are given their own modules, as well as conceptually distinct notions, such as Event, which occurs across nearly every dataset.
Evolution and Maintenance of the graph by replacing modules in the schema. To be explained :)
The Enslaved Hub

- Funded by the Andrew W. Mellon Foundation
- Integrates historical data on enslaved peoples in order to form coherent histories
- The Enslaved Ontology guides the design of a customized Wikibase installation, as well as a data interchange format between historians
- ~1 Million Records
Knowledge Engineering  Now with Patterns

Enhancing the field with so-called “pattern-mediated methods” for improved reusability

Patterns + Schemas = Modularity

Modular KG Schemas closely tie human conceptualization to a machine-parseable constraint language. A plug and play mentality allows for the rapid, iterative assembly of schemas using peer-reviewed resources and best practices.

Metadata Scaffolding

A schema imposes structure on data, encoding knowledge. This metadata scaffolding can be used to inform other methods as background knowledge, improving alignment and learning tasks, and provide a mechanism for improved reusability.
The scaffolding allows us to quickly:
- assemble modules into an initial schema (like puzzle pieces);
- maintain, evolve, and extend the schema; and
- improve discoverability and navigation of the data

We use OPLa to formalize this scaffolding.
The language formerly known as “OPLa”

It is an annotation ontology which models how patterns are related to each other – as well as alternative specifications for the pattern (e.g., perspectives, shapes)

New specification forthcoming
Modular Ontology Modeling

Modular Ontology can act as a bridge between human conceptualization and data.

- We have designed the modular ontology modeling methodology (right)
  - Focuses on empirical reality (i.e., which data actually exists)
  - Is a pattern based method
  - Limits exposure to formal logics

1. Define the use case
2. Make competency questions
3. Identify key notions
4. Match patterns to key notions
5. Instantiate the patterns
6. Systematic axiomatization
7. Assemble the modules
8. Review final product
9. Produce the OWL artifacts

Pascal Hitzler, Cogan Shimizu: Modular Ontologies as a Bridge Between Human Conceptualization and Data. ICCS 2018: 3-6.
Outline & Objectives

Motivation

Modular Ontology Modeling

Examples

Tools & Resources
An Example Pattern

A Pattern for Depicting Causal Relationships between Events
An Example Pattern

A Pattern for Aligning Vocabularies & Taxonomies
An Example Pattern

A Pattern for Depicting Features of Cells in a Hierarchical Grid
Template Based Instantiation

KWG Core

SOSA/SSN Kernel

FeatureOfInterest

USClimateDivision

SpatialObject

Agent

ClimateObservation

ClimateObservableProperty

TemporalEntity

Result

Observation

ObservationCollection

Phenomenon

Region

hasTemporalExtent

spatialRelations

hasFeatureOfInterest

hasFeatureOfInterest

hasResult

hasIssuingAuthority

observedProperty

phenomenonTime

xsd:literal

xsd:literal

hasSimpleResult
Outline & Objectives

Motivation

Modular Ontology Modeling

Examples

Tools & Resources
MODL: The Modular Ontology Design Library

- MODL is also an OPaL Ontology
- Contains 13 patterns in V1.
- Contains 32 patterns in V2 (forthcoming).
- Not just an artifact, but also a template – make your own MODL!
- Encodes many inter-pattern relationships – interfaces, specializations/generalizations, and categories

<table>
<thead>
<tr>
<th>Category</th>
<th>Patterns</th>
</tr>
</thead>
<tbody>
<tr>
<td>Metapatterns</td>
<td>Explicit Typing Property Reification Stubs</td>
</tr>
<tr>
<td>Organization of Data</td>
<td>Aggregation, Bag, Collection Sequence, List Tree</td>
</tr>
<tr>
<td>Space, Time, and Movement</td>
<td>Spatiotemporal Extent Spatial Extent Temporal Extent Trajectory Event</td>
</tr>
<tr>
<td>Agents and Roles</td>
<td>AgentRole ParticipantRole Name Stub</td>
</tr>
<tr>
<td>Description and Details</td>
<td>Quantities and Units Partonomy/Meronomy Provenance Identifier</td>
</tr>
</tbody>
</table>

https://github.com/kastle-lab/modular-ontology-design-library/
The Ontology Design Patterns Portal

https://ontologydesignpatterns.org/

https://github.com/odpa/patterns-repository
The Comprehensive Modular Ontology IDE

1. A Graphical Paradigm
2. A Pattern Library
3. Customizable Semantics

www.comodide.com
The Comprehensive Modular Ontology IDE
THANKS!

Cogan Shimizu
cogan.shimizu@wright.edu
coganshimizu.com

Knowledge and Semantic Technologies Laboratory
Wright State University