Ontology Design Patterns in GeoLink

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EarthCube:

NSF Program, multiple projects, long run-time

Goal: Developing a Community-Driven Data and Knowledge Environment for the Geosciences

“concepts and approaches to create integrated data management infrastructures across the Geosciences.”

“EarthCube aims to create a well-connected and facile environment to share data and knowledge in an open, transparent, and inclusive manner, thus accelerating our ability to understand and predict the Earth system.”
Ontological Commitments

a.k.a.

modeling choices you may regret later
Ontological Commitments

Whenever you decide on how to make your metadata

• keyword annotation
• controlled vocabularies
• light-weight taxonomy
• full-blown ontology

You always have to make specific modeling decisions.

You can either make detailed specifications (ontological commitments) which will often hinder reuse for new purposes.

Or you can avoid the commitments, resulting in ambiguity which cannot really be resolved later, thus also hindering reuse.
Soft Spot Search

cost of data integration and reuse

few/no ontological commitments

many/strong ontological commitments

strength of schema/metadata

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Soft Spot Search

cost of data integration and reuse

few/no ontological commitments

perhaps: a flexible, plug- and playable metadata architecture

many/strong ontological commitments

strength of schema/metadata
OceanLink and GeoLink

OceanLink: NSF 2013-2014, $300k
GeoLink: NSF 2014-2016, $1.9M
Building Blocks in the NSF EarthCube program

LDEO: Robert Arko, Suzanne Carbotte, Kerstin Lehnert
WHOI: Cynthia Chandler, Peter Wiebe, Lisa Raymond, Adam Shepherd
UCSB: Krzysztof Janowicz, Yingjie Hu
NCEAS: Mark Schildhauer, Matt Jones
Ocean Leadership: Douglas Fils
Marymount Univ: Thomas Narock
WSU: Pascal Hitzler, Michelle Cheatham, Adila Krisnadhi, Nazifa Karima
UMBC: Tim Finin
Rationales for using patterns

- Strongly supportive of collaborative, inter-disciplinary modeling (focus on one central notion at a time)
- Keeping overview of a large continuously evolving ontology
- Open-ended use case: maximal flexibility of the modular approach for efficient adjustability
- Disruptive vision: plug- and playable ontology virtualization
Roles (Cruise as Event)
Cruise Trajectories

- Cruise
  - hasTrajectory
  - isUndertakenBy Vessel
- Trajectory
  - hasSegment
  - hasFix
- Position
  - hasLocation
  - hasSpatialFootprint
- Segment
  - startsFrom
  - endsAt
- Fix
  - hasAttribute
- Place
  - nextFix
- Port
  - rdfs:subClassOf
- Attribute
  - time:TemporalEntity
  - rdf:type port_stop_departure
  - rdf:type port_stop_arrival
Information Objects
Axiomatization (selection)

\[
\begin{align*}
\text{Cruise} & \sqsubset (=1 \text{ hasTrajectory.Trajectory}) \quad (13.1) \\
\text{Cruise} & \sqsubset (=1 \text{ isUndertakenBy.Vessel}) \quad (13.2) \\
\text{Cruise} & \sqsubset (=1 \text{ isDescribedBy.InformationObject}) \quad (13.3) \\
\text{InformationObject} & \sqsubset (=1 \text{ isDescribedBy}\neg .\text{Cruise}) \quad (13.4) \\
\text{hasTrajectory}\neg \circ \text{isUndertakenBy} & \sqsubset \text{isTraveledBy} \quad (13.5) \\
\exists \text{hasTrajectory.Trajectory} & \sqsubset \text{Cruise} \quad (13.6) \\
\text{Cruise} & \sqsubset \forall \text{hasTrajectory.Trajectory} \quad (13.7) \\
\exists \text{isUndertakenBy.Vessel} & \sqsubset \text{Cruise} \quad (13.8) \\
\text{Cruise} & \sqsubset \forall \text{isUndertakenBy.Vessel} \quad (13.9) \\
\exists \text{isDescribedBy.InformationObject} & \sqsubset \text{Cruise} \quad (13.10) \\
\text{Cruise} & \sqsubset \forall \text{isDescribedBy.InformationObject} \quad (13.11) \\
\exists \text{isTraveledBy.Vessel} & \sqsubset \text{Trajectory} \quad (13.12) \\
\text{Trajectory} & \sqsubset \forall \text{isTraveledBy.Vessel} \quad (13.13)
\end{align*}
\]
Axiomatization (selection)

If a trajectory is traveled by a vessel, then every segment is traversed by that vessel.

\[ \text{hasSegment} \circ \text{isTraveledBy} \sqsubseteq \text{isTraversedBy} \]  
(13.28)

Also, a fix cannot be followed by more than one other fix, and cannot follow itself. This gives a linear structure in the ordering of the fixes.

\[ \text{Fix} \sqsubseteq \exists \text{hasLocation}.\text{Position} \sqcap \exists \text{atTime}.\text{TimeEntity} \sqcap (=1 \text{hasFix} \circ \text{Trajectory}) \]  
(13.14)

\[ \text{Fix} \sqsubseteq (\leq 1 \text{nextFix}.\text{Fix}) \sqcap \neg \exists \text{nextFix}.\text{Self} \]  
(13.15)
GeoLink setup

User Interface

GeoLink Patterns

mappings

- R2R
- BCO-DMO
- LTER
- ...
- ...

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Thanks!

www.geolink.org
References

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