

Ontologies in a data-driven world: Finding the middle ground

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- Large, well-thought-out ontologies (foundational/domain/etc).
- Networked, interlinked ontologies
- “You just have to get your formal definitions right, and a lot of the rest will just fall into place.”

- **“You just have to get your formal definitions right, and a lot of the rest will just fall into place.”**
 - **This does not even work for**
 - **scientists**
 - **wanting to share and reuse scientific data**
 - **through well-kept data repositories**
 - **So how is this supposed to work for the web at large?**

$a:\text{flowsInto} \sqsubseteq a:\text{IsConnected}$ (1)

$a:\text{IrrigationCanal} \sqsubseteq a:\text{Canal}$ (2)

$\exists a:\text{flowsInto}.a:\text{AgriculturalField} \sqsubseteq a:\text{IrrigationCanal}$ (3)

$a:\text{Waterbody} \sqcap a:\text{Land} \sqsubseteq \perp$ (4)

$a:\text{AgriculturalField} \sqsubseteq a:\text{Land}$ (5)

$b:\text{flowsInto} \sqsubseteq b:\text{IsConnected}$ (6)

$b:\text{Canal} \sqsubseteq (\geq 2 b:\text{IsConnected}.b:\text{Waterbody})$ (7)

$b:\text{IrrigationCanal} \equiv (=1 b:\text{IsConnected}.b:\text{Waterbody})$

$\sqcap (=1 b:\text{flowsInto}.b:\text{AgriculturalField})$ (8)

Two ontologies.

Left: transportation domain

Right: agriculture domain

We cannot simply equate $a:\text{Canal}$ and $b:\text{Canal}$!

- **Try to find a universal definition for**
 - **Forest**
 - **Mountain**
 - **City**
 - **River**

 - **Etc.**

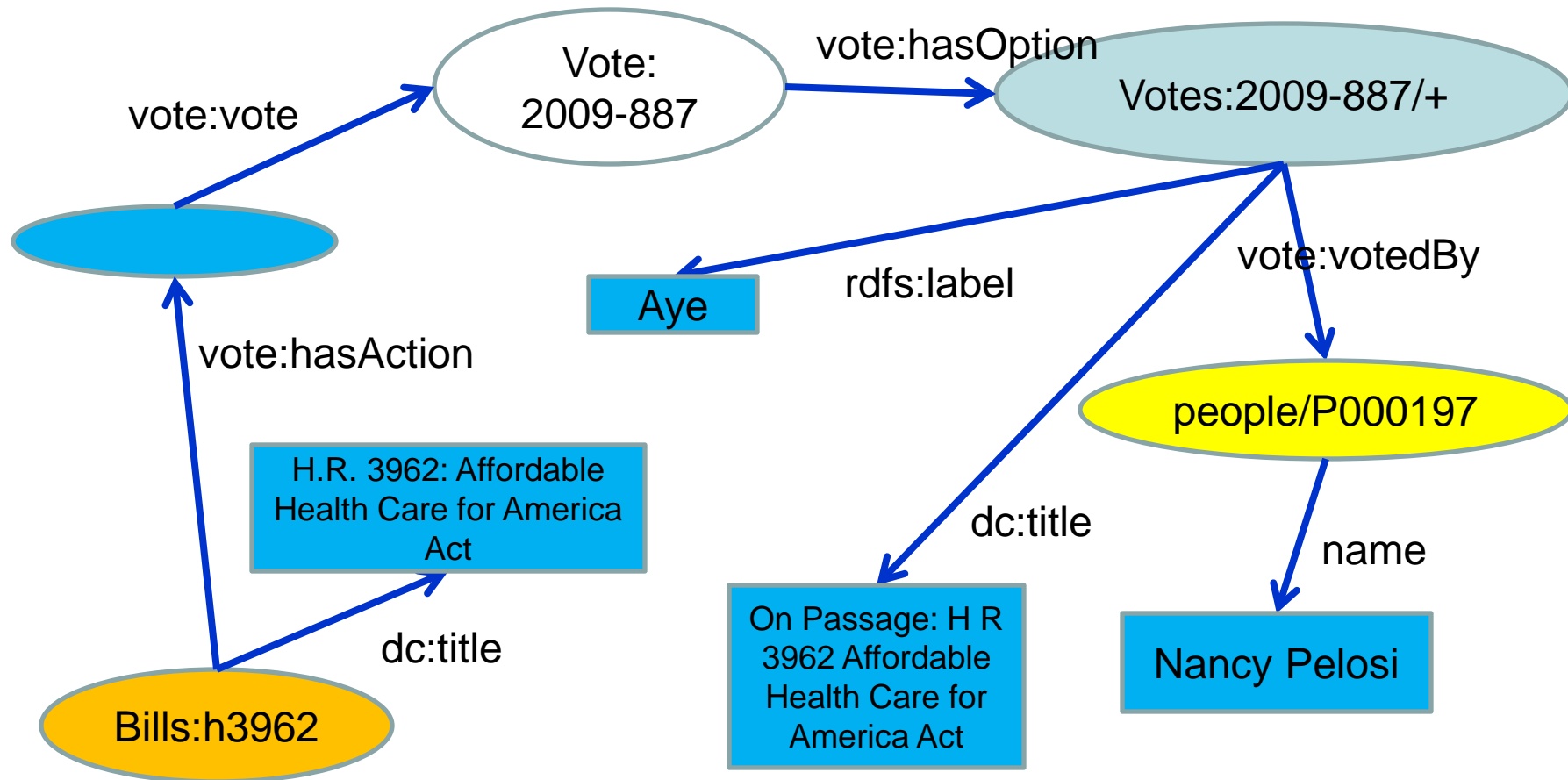
- **The stronger our ontological commitments, the more we lose reusability.**

- **We need to accept that conceptualizations are often very local, resulting in “micro-ontologies”.**

- Where are they used on the web?
 - Brittle
 - Expensive
 - Sometimes unintuitive
 - Unwieldy
 - Difficult to reuse
-
- Work in some contexts.
 - Work if a lot of central control is imposed.
 - Take a lot of manpower.

- “Ontologies don’t work, let’s just link data”
- “Okay, with a little bit of ontologies on top.”
- But then we don’t even know how to effectively query over multiple linked datasets (without using a lot of manpower to manually integrate them).
- It seems rather obvious that we need to get ontologies into the picture, but how to do it while avoiding the drawbacks of strong ontological commitments?

“Nancy Pelosi voted in favor of the Health Care Bill.”



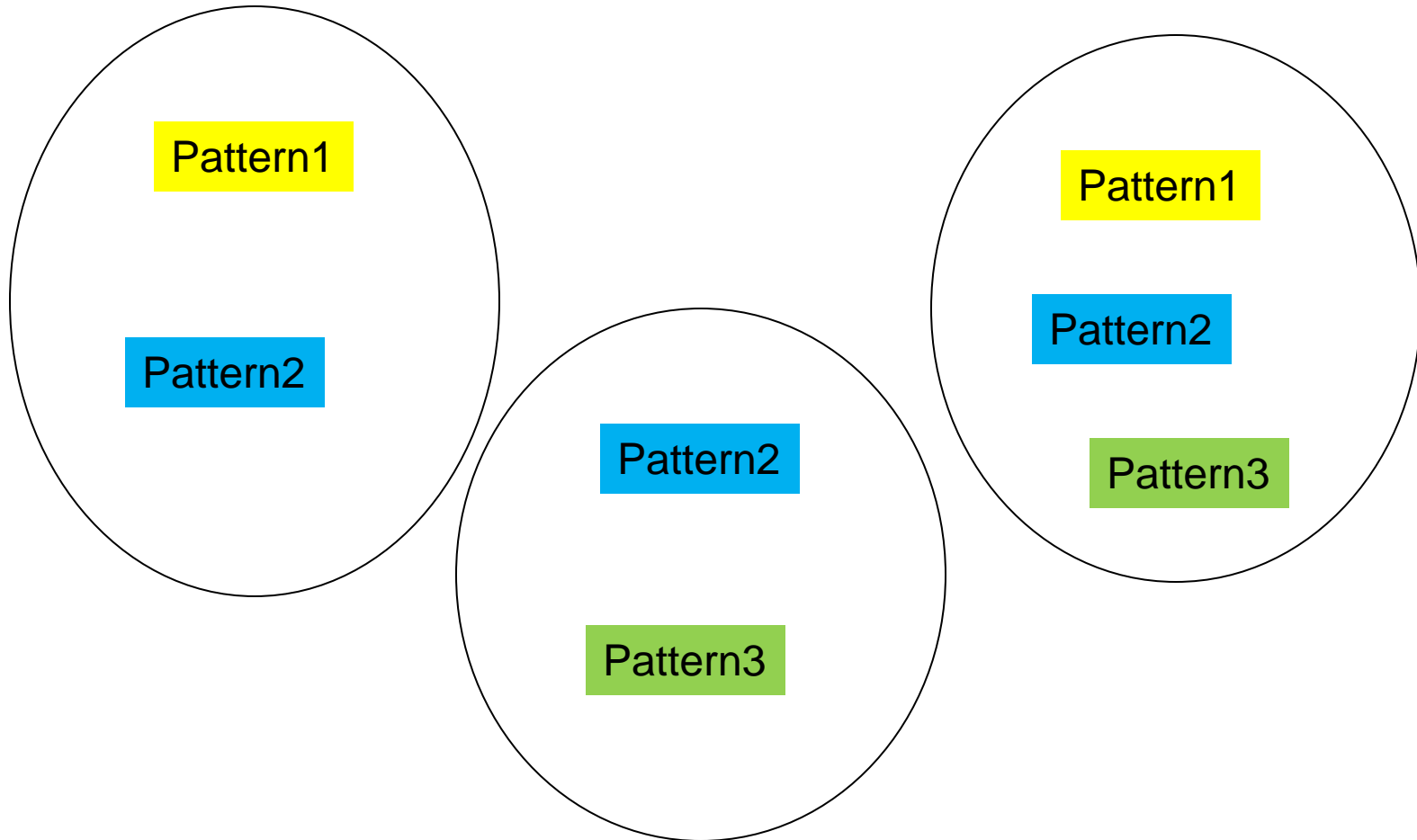
- **Identify, which logical or conceptual depth of modeling is suitable for which purpose.**

But even more importantly.

- **Establish a flexible conceptual architecture using data and ontological modeling.**

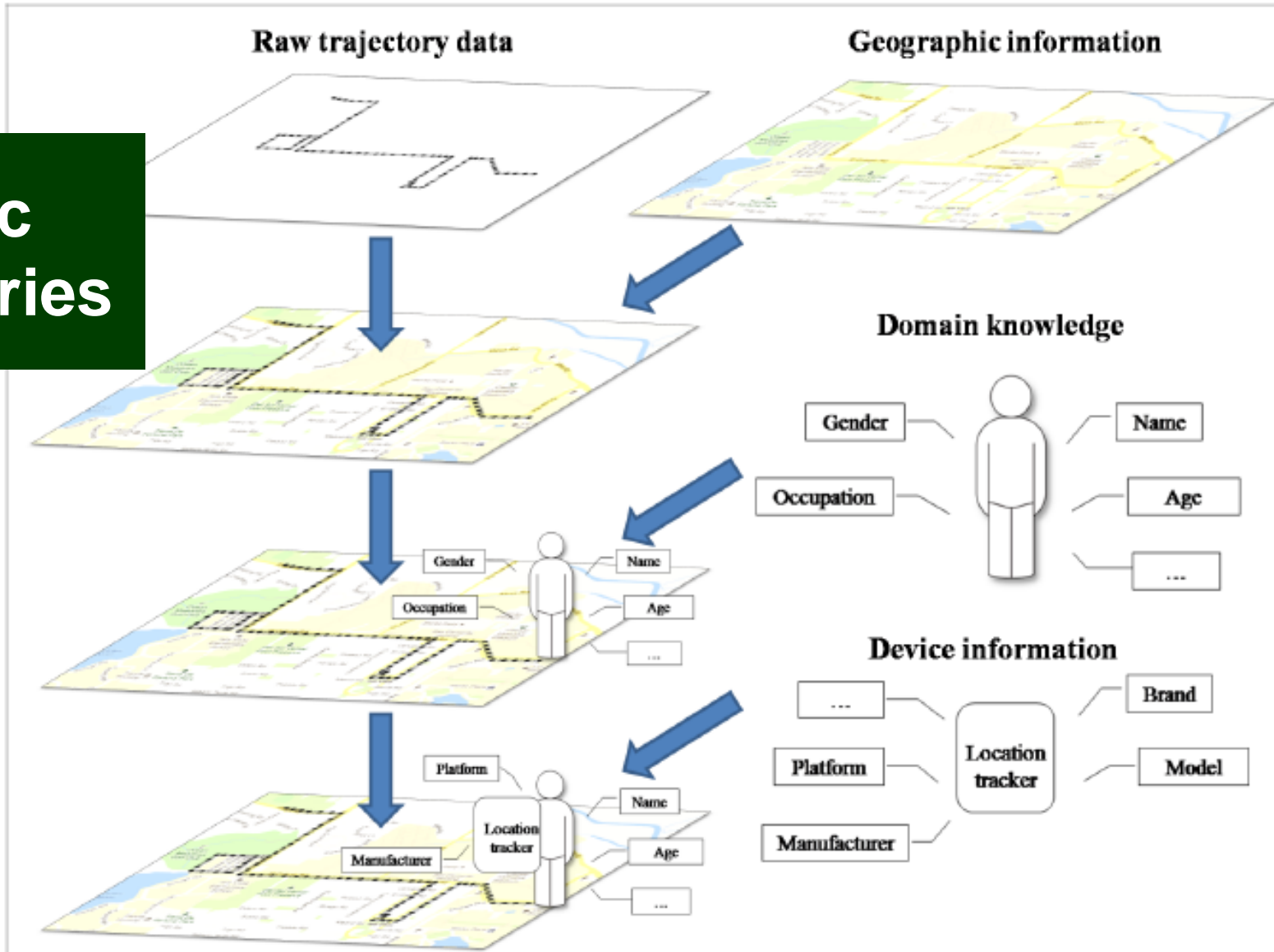
- **Bottom-up homogenization of data representation.**
- **Avoidance of strong ontological commitments.**
- **Avoidance of standardization of specific modeling details.**
- **Well thought-out patterns can be very strong and versatile, thus serve many needs.**

We are currently establishing many geo-patterns in a series of hands-on workshops, the GeoVoCamps, see <http://vocamp.org/>

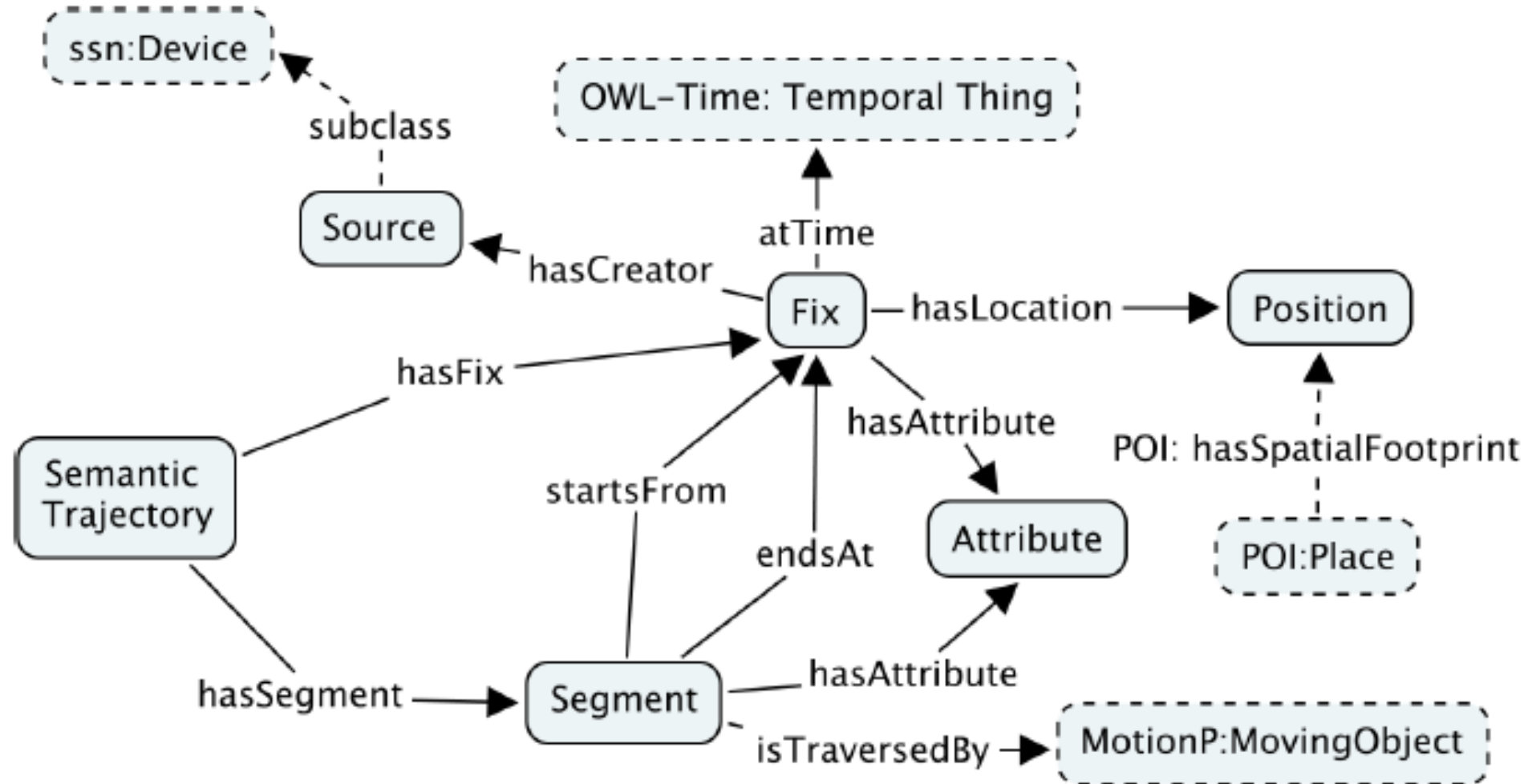


“Horizontal” alignment via patterns

Semantic Trajectories



[Hu, Janowicz, Carral, Scheider, Kuhn, Berg-Cross, Hitzler, Dean, COSIT2013]



$$\begin{aligned} \textit{Fix} \sqsubseteq & \exists \textit{atTime} . \textit{OWL-Time:Temporal Thing} \sqcap \exists \textit{hasLocation} . \textit{Position} \\ & \sqcap \exists \textit{hasFix}^- . \textit{SemanticTrajectory} \end{aligned} \quad (1)$$

$$\textit{Segment} \sqsubseteq \exists \textit{startsFrom} . \textit{Fix} \sqcap \exists \textit{endsAt} . \textit{Fix} \quad (2)$$

$$\top \sqsubseteq \leq 1 \textit{startsFrom} . \top \quad (3)$$

$$\top \sqsubseteq \leq 1 \textit{endsAt} . \top \quad (4)$$

$$\textit{Segment} \sqsubseteq \exists \textit{hasSegment}^- . \textit{SemanticTrajectory} \quad (5)$$

$$\textit{startsFrom}^- \circ \textit{endsAt} \sqsubseteq \textit{hasNext} \quad (6)$$

$$\textit{hasNext} \sqsubseteq \textit{hasSuccessor} \quad (7)$$

$$\textit{hasSuccessor} \circ \textit{hasSuccessor} \sqsubseteq \textit{hasSuccessor} \quad (8)$$

$$\textit{hasNext}^- \sqsubseteq \textit{hasPrevious} \quad (9)$$

$$\textit{hasSuccessor}^- \sqsubseteq \textit{hasPredecessor} \quad (10)$$

$$Fix \sqcap \neg \exists endsAt.Segment \sqsubseteq StartingFix \quad (11)$$

$$Fix \sqcap \neg \exists startsFrom.Segment \sqsubseteq EndingFix \quad (12)$$

$$Segment \sqcap \exists startsFrom.StartingFix \sqsubseteq StartingSegment \quad (13)$$

$$Segment \sqcap \exists endsAt.EndingFix \sqsubseteq EndingSegment \quad (14)$$

$$SemanticTrajectory \sqsubseteq \exists hasSegment.Segment \quad (15)$$

$$hasSegment \circ startsFrom \sqsubseteq hasFix \quad (16)$$

$$hasSegment \circ endsAt \sqsubseteq hasFix \quad (17)$$

$$\exists hasSegment.Segment \sqsubseteq SemanticTrajectory \quad (18)$$

$$\exists hasSegment^- .SemanticTrajectory \sqsubseteq Segment \quad (19)$$

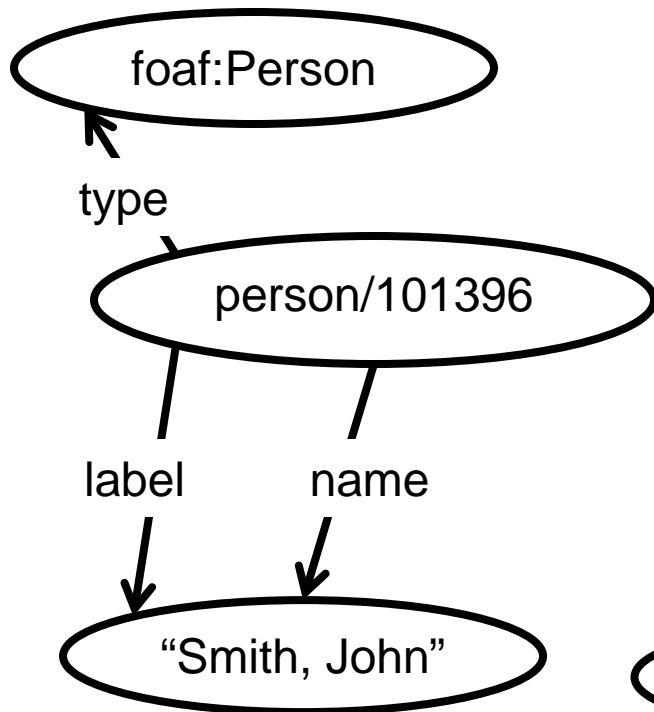
$$\exists hasFix.Segment \sqsubseteq SemanticTrajectory \quad (20)$$

$$\exists hasFix^- .SemanticTrajectory \sqsubseteq Fix \quad (21)$$

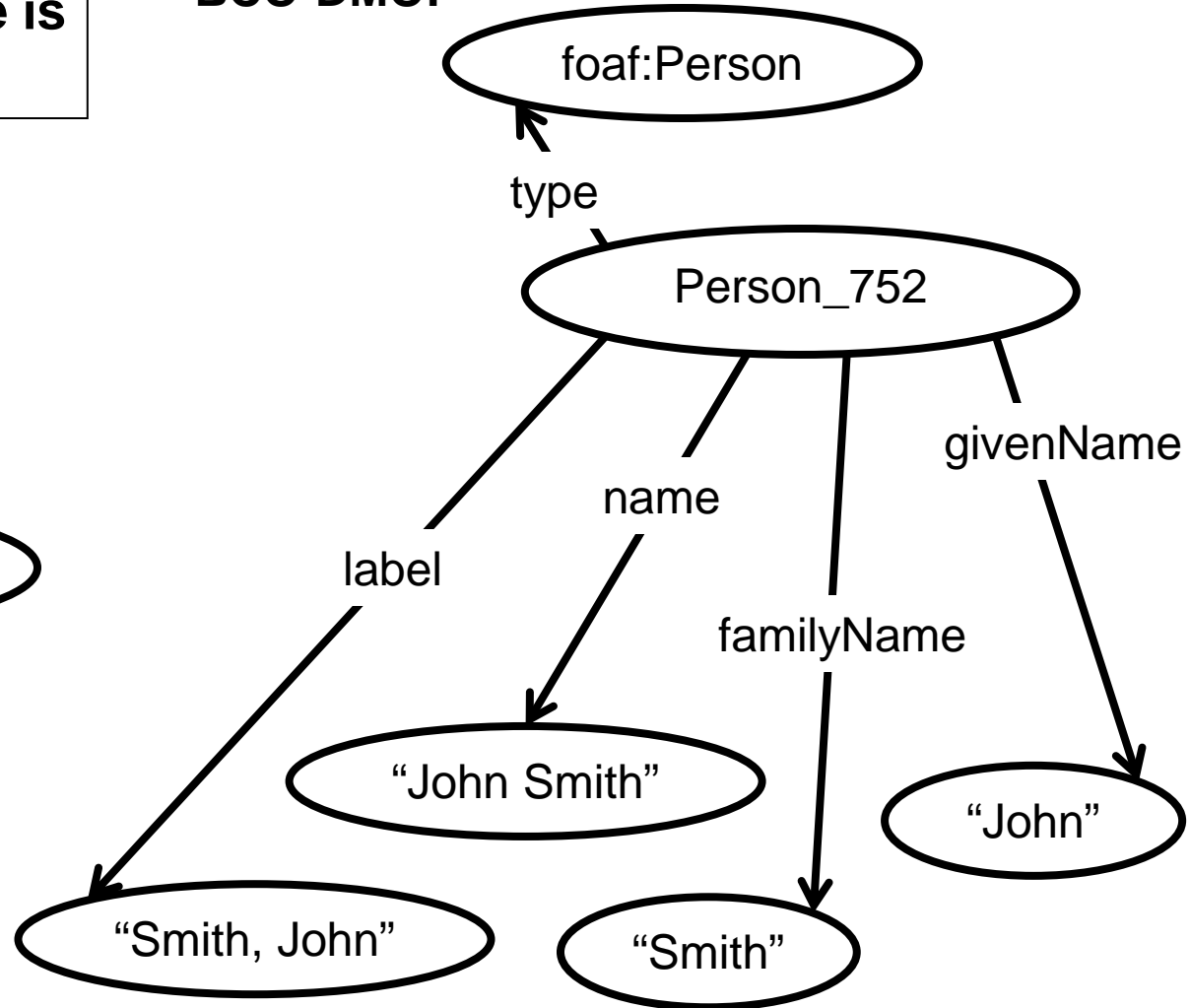
Helpfulness of patterns

Even minimalistic reuse is helpful:

R2R:



BCO-DMO:



- **Help to focus when modeling (one key notion at a time).**
- **Good ontology modeling implicitly employs the patterns idea anyway. It's just that you expose the patterns.**
- **An ontology composed of patterns exposes its internal conceptual structure (as a composition of formal vocabulary pieces).**
- **Well-designed patterns are widely reusable and adaptable.**
- **You don't have to buy a whole ontology when you adopt a few patterns from it.**
- **You can easily modify a pattern without giving up on a lot of similarity to the original pattern (which can be leveraged for data integration).**
- **You can separate the patterns from specific (application-driven) modifications.**
- **You can separate the patterns from specific axiomatically defined "views".**

- **Identify, which logical or conceptual depth of modeling is suitable for which purpose.**

But even more importantly.

- **Establish a flexible conceptual architecture using data and ontological modeling.**
- **A principled use of patterns, including**
 - **the development of a theory of patterns and**
 - **the provision of a critical amount of central patterns may provide a primary path forward.**

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