Building ontology on-the-fly for the VGI and authority road networks to facilitate their integration

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Outline of the presentation:

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- Ontology
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- (Suggestion for) implementation
- Discussion
- Summary
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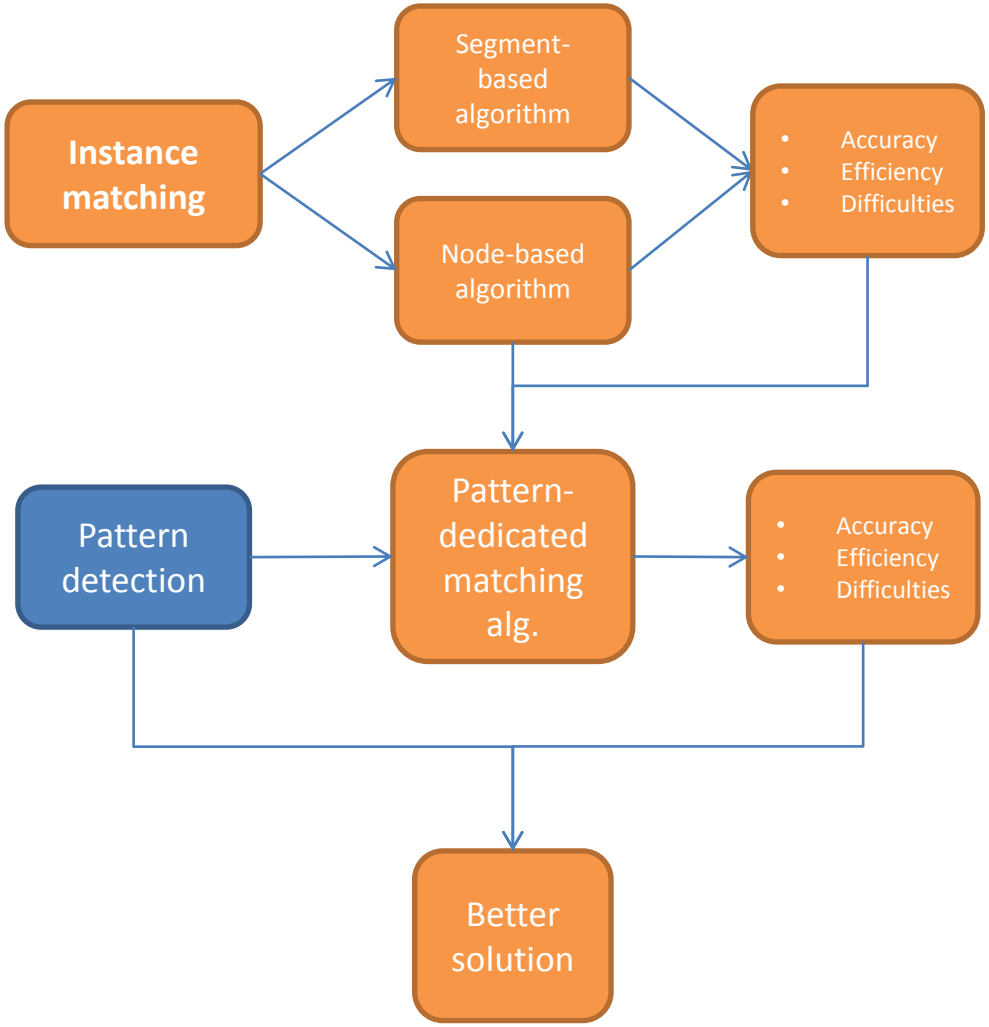
Problem statement



Problem statement

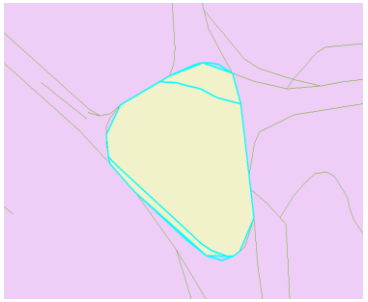
Patterns

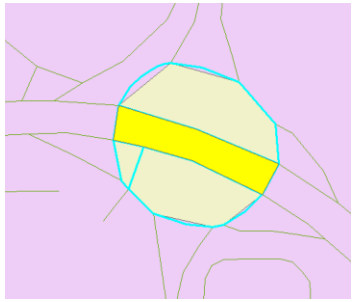
Pattern:

A set of related instances that makes a particular shape which defines a concept (e.g. roundabout) and has a specific functionality.

Difficulties of pattern detection:

- Patterns are not the same through a dataset especially in VGIs, but their concept and functionality are the same.
- Relations between different patterns make the issue more complex.



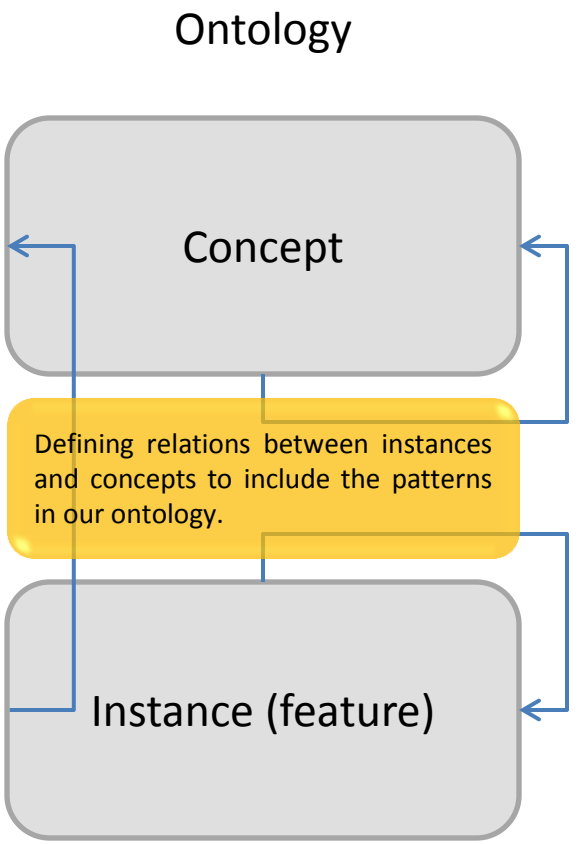


Ontology *(OWL 2.0)*

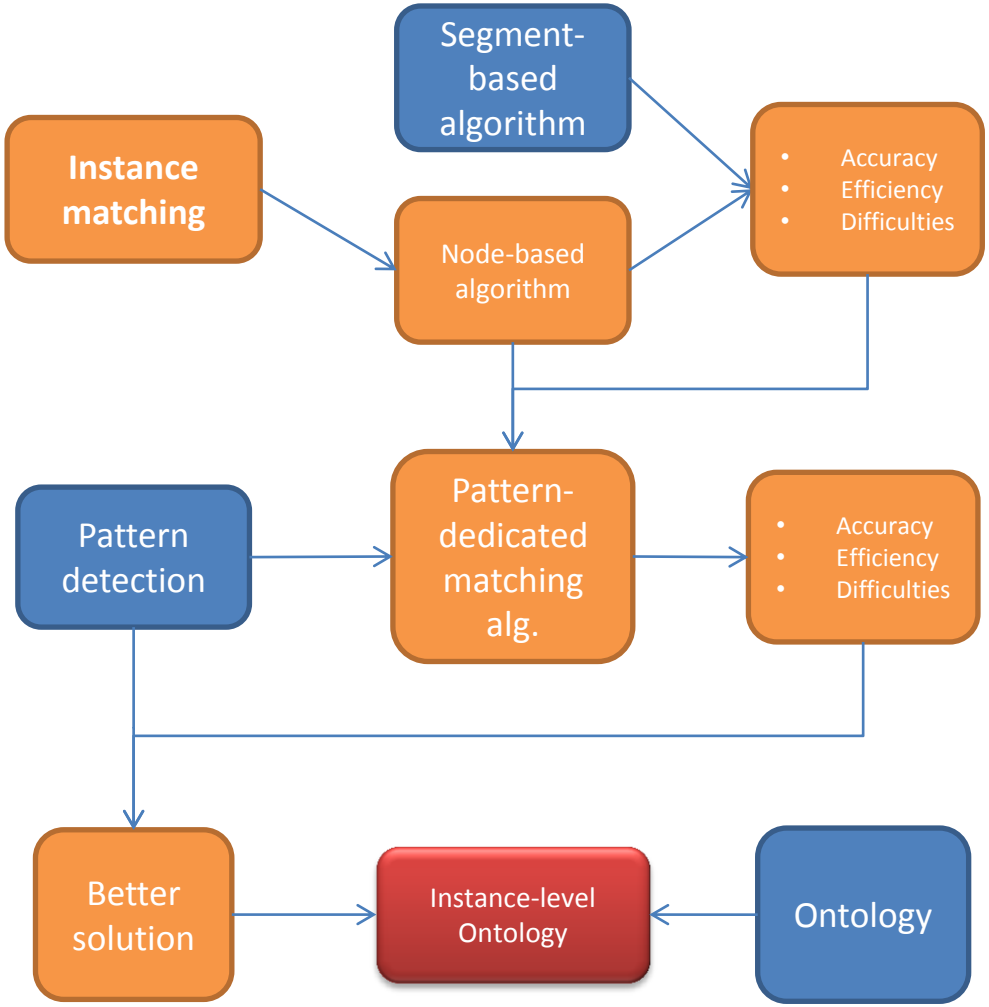
Explicitly defining the conceptualization used in a domain application.

Capabilities of ontologies:

- Introducing the concept-instance relations (patterns)
- Introducing the instance-instance relations (relation between patterns)
- The concept is independent of the representation (concept defines the patterns)



Our proposal



Related work

- Ontology in spatial data field:
  - Extracting ontology from relational databases: An et al. (2006), Baglioni et al. (2007)
  - Schema-level ontology:
    - LinkedGeodata (Auer et al., 2009), Ballatore and Bertolotto (2011),
    - Towntology (COST Action C21, 2005/2009)
    - Ontology-based GIS (Belhadef and Kholladi, 2009; Fonseca, et al. 2002)
    - OSMonto (Codescu, et al. 2011)
  - Including spatial dimension to ontology:
    - NeoGeo (GeoVocab.org)
    - GeoSPARQL (OGC)
    - PelletSpatial (Stocker and Sirin, 2009; Begetis, 2012)
    - Choros (Georg Christodoulou, 2011)
  - Road network ontology:
    - OTN (Ontology of Transportation Network) (REWERSE project)
    - Hierarchical ontology on multi-scale road model for cartographical applications (Mang and Weng, 2009)

Cases

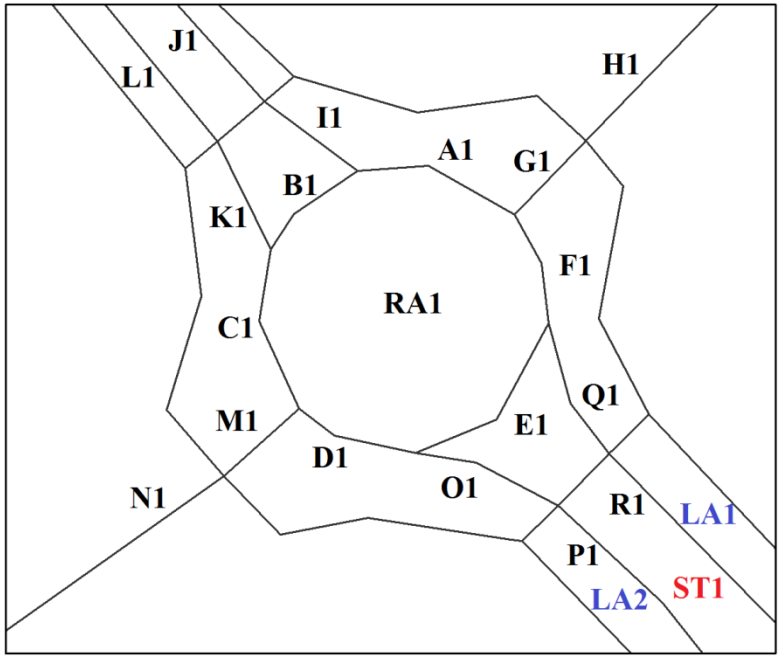
Instance-level ontology for a roundabout and street:

RA1 is a **Roundabout** (instance-concept)
{A1, B1, C1, D1, E1, F1} **build** RA1 (instance-instance)
A1 is a **Segment**
…

ST1 is a **Street**
{LA1, LA2} **Build** ST1
LA1 is a **Lane**
{R1, Q1} **build** LA1
R1 is a **Segment**
…
Q1 **intersects** {F1, E1}

Reasoning:

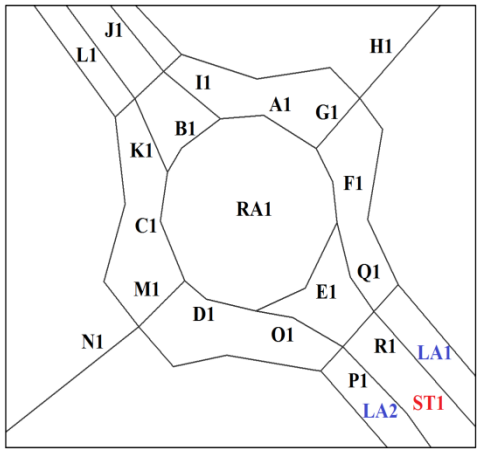
ST1 **is connected to** RA1 (instance-instance relation -> patterns relation)



Cases

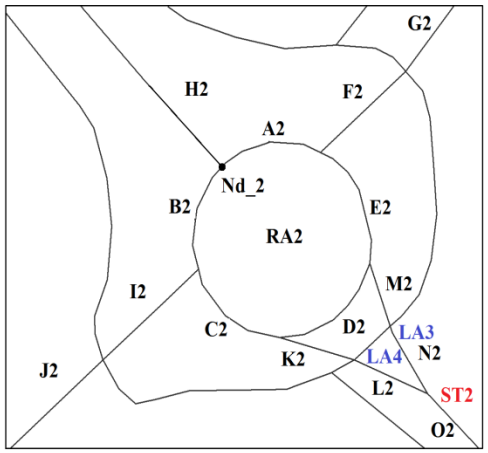
Instance-level ontology for integrating two datasets:

Dataset1



Using SWRL:
- {LA1, LA2} build **detailed_part1**
- **detailed_part1** is a **detailed_partition**
- **detailed_partition** is **subclass** of **street_partition**
- {detailed_part1} build ST1

Dataset2



Using SWRL:
- {LA3, LA4} build detailed_part2 **…**
- O2 build **generalized_part2**
- **generalized_part2** is a **generalized_partition**
- **generalized_partition** is **subclass** of **street_partition**
- {detailed_part2, generalized_part2} build ST2

Implementation

Instance-level ontology

- The instance-level ontology needs to be handled by the data-producers/users.
- creating Instance-level ontology while the data is being produced (On-the-fly) seems to be the best way.
- Methods for gathering information:
  - Questionnaire (Naïve)
  - Data mining and defining rules (SWRL) , still need to ask some questions (Aided)

Discussion

- **Benefits:**
  - The user has the best knowledge of what he is producing.
  - The accuracy of information is higher.
  - Independent from representation
  - The Instance-level ontology can be used:
    - Query answering
    - Generalization
    - Multi-scale databases

- **Difficulties:**
  - What is the best ontology design.
  - The questionnaire imposes the main work load on the data producers/users.
  - How to make an optimize questionnaire for gathering minimum information while enables us to produce required knowledge.
  - Automation using data mining and SWRL needs a complex implementation.

Summary

- Complex structures (patterns) make the data integration difficult.
- Pattern detection seems not efficient as the patterns vary through a dataset; however their concepts and functionalities remain the same.
- Ontology (OWL 2.0) can help us to embed the patterns in the ontology.
- Then concept defines the pattern in ontology, and it is representation independent.
- This introduces instance-level ontology which needs the users to produce it on-the-fly.
- The solution puts the main work load on the users but the results are more accurate and can be used in different applications.
- We believe the data should be collected in a cleverer way.

Future work

- developing an instance-level ontology which can meet our requirements and can help us in matching road networks.
- Integrating the instance-level ontology into our node-based algorithm and comparing the results with the former algorithms.
- Preparing an optimize questionnaire for a preliminary implementation of the ontology on-the-fly.
- Developing mechanisms as web services to aid the users for collecting information.