An interface for Exploiting Spatio-temporal Heterogeneous Data (Environmental data, Ship Trajectory)

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Outline

1. Introduction
2. Semantic integration of spatio-temporal data
3. A geospatial-triplestore-based knowledge base
4. Exploiting heterogeneous spatio-temporal data through a Web interface
5. Application in two different use cases
   1. GEMINAT (Environment and landscape geo-knowledge)
   2. DéAIS (Detection of faked AIS messages)
6. Conclusion & perspectives & future work
Introduction

- Environmental data (spatio-temporal)
  - Data Integration
  - A semantic web approach (RDF, OWL)
  - A web interface
Semantic integration

Ontology of time & ontology of fluent

- OWL-Time
  - Formalized in OWL
  - Recommended by the W3C
  - Dedicated to the concepts and temporal relationships as defined in the theory of Allen
    - intervalBefore
    - intervalMeets
    - intervalDuring
    - inside
    - ...
Semantic integration

Ontology of time & ontology of fluent

Ontology of fluent

- Represents properties of an entity over time as fluents
- **4D-fluent:**
  - Introduces the TimeSlice class
  - Enables diachronic relations in the Semantic Web

An example of the 4D-fluent approach
A spatio-temporal ontology for environment

Based on the 4-D fluent approach
Inspired by the Continuum model
As a semantic mediator to integrate data sets
Generalizing the Interval class to the TemporalEntity class of OWL-Time
Spatio-temporal reasoning mechanism: temporal SWRL rules and spatial functions of the triplestore, sparql update
A spatio-temporal ontology for environment

Semantic integration

A spatio-temporal ontology for environment

![Ontology Diagram]

sige: http://gemina.univ-lr.fr/owlSigE#
geo: http://geovocab.org/spatial#
time: http://www.w3.org/2006/time#
strdf: http://strdf.di.uoa.gr/ontology#
Semantic integration

• **Mapping**
  • On-demand mapping
  • Materialization
  • Materialization best query performance / update
A geospatial-triplestore-based knowledge base

- Knowledge base (T-Box, A-Box)
- Geospatial triplestore (Strabon)
  - Sesame – PostgreSQL/Postgis
  - Web Interface
- SPARQL Construct or SPARQL Update are used to enrich data with expert knowledge
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Geospatial knowledge base

knowledge base

T-Box
- Time Ontology
- Space Ontology
- Environment Ontology
...

A-Box
- Mapping
- RDF Dump

Sparql
Update

Endpoint
Triplestore

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Exploiting heterogeneous spatio-temporal data

Web Interface

3 layers

- ETL (Extract, Transform, Load)
- Management layer
  - semantic query module
  - KB management module
- Application layer
  - Visualization module
  - Knowledge base enrichment module
  - Data analysis module
Heterogeneous spatio-temporal data

Application layer
- Data analysis
- Visualization
- KB enrichment

Management layer
- KB management
- Semantic query

ETL layer
- Data extraction & transformation

OpenStreetMap

Endpoint
Triplestore

OWL/RDFS
Schema
The framework consists of:

1. Data translation
2. Temporal relation inference
3. Triplestore load
4. Data preparation and visualization.
Application

• Application in two different use cases

• “GEMINAT” (Environment and landscape geo-knowledge)

• “DéAIS” (Detection of faked AIS messages)
The ”Plaine & Val de Sèvre” workshop observatory

- Established by the UMR Chizé in 1994
- Seeks for relationships between agricultural practices and ecological processes

Application—“GEMINAT”

- Search for correlations between crop rotations and biodiversity
- Changes of limits discovery
- Data anomalies detection

A search for correlation between the positions of Montagu's Harrier and grassland parcels in 2012

A search for fusion event between parcels in 2009
Application- “GEMINAT”

- Web Interface
  - An example of use
The goal of the project “DéAIS” is to detect whether ship’s AIS reports have been falsified (or spoofed) (Ecole Navale-IRENav, Mines ParisTech-CRC, CEREMA, Université de La Rochelle-l3i)

We have at the University – AIS Automatic identification system

We have in our knowledge base ship trajectory and some other data in La Rochelle Area (3 ports)

We have use our approach for data analysis

More on :
Application- “DéAIS”

- Web Interface
  - An example of use

```xml
PREFIX deais: <http://l3i.univ-lr.fr/deAIS#>
PREFIX strdf: <http://strdf.dl.oua.gr/ontology#>
PREFIX time: <http://www.w3.org/2006/time#>
WHERE {
  ?v a deais:Vessel.
  ?v deais:hasTrajectory ?traj.
  ?zone a deais:Zone.
  ?zone deais:name "Route Ecart Type".
  FILTER(strdf:intersects(?geomz, ?geom))
  ?traj deais:hasFix ?fix.
  ?v deais:hasTime ?dt.
  ?pos time:inXSDDateTime ?dt.
  FILTER(?pos="2017-01-17T00:00:00+01:00"^^http://www.w3.org/2001/XMLSchema#dateTime & ?pos="2017-01-17T00:00:00+01:00"^^http://www.w3.org/2001/XMLSchema#dateTime)
}
```

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Conclusion & perspectives

- **Conclusion**
  - A framework is introduced to exploit environmental data through semantic web technologies
  - The proposed ontology and framework can fulfill the need of spatio-temporal analysis of these heterogeneous data
  - The approach is used for 2 use cases
  - [https://gitlab.univ-lr.fr/abouju/STRDFMining](https://gitlab.univ-lr.fr/abouju/STRDFMining)

- **Perspectives**
  - Use this approach for other use case and integrate other datasets
  - Enrich and qualify the data sources through the framework
  - Publish a portion of these data as linked data
Future works

- An ANR Portic (2018-2022)
  The Digital Revolution: relationship to knowledge and culture
  PORTs & Information and Communication Sciences and Technology
  Querying and visualizing eighteenth-century shipping and trade dynamics in the digital era
- A local project DYPOMAR (Port Dynamics, Urban and Maritime Environments), a project funded through a French CPER/FEDER planning agreement between the French State and the Nouvelle-Aquitaine region (2014-2020).
Future works

• Unmanned surface vehicle
  – heterogeneous spatio-temporal data
Thank you!
References


