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Geomatics

Spatio-temporal reasoning in CIDOC CRM

An hybrid ontology with GeoSPARQL and OWL-Time

Nys Gilles-Antoine
Van Ruymbeke Muriel
Billen Roland

1

Background

▶ Cultural Heritage data modelling

▶ CIDOC CRM and extensions are ontologies dedicated to model Cultural Heritage data

▶ EPA extension proposal allows unperfected Cultural Heritage data modelling

Spatio-temporal management in CIDOC CRM and extensions
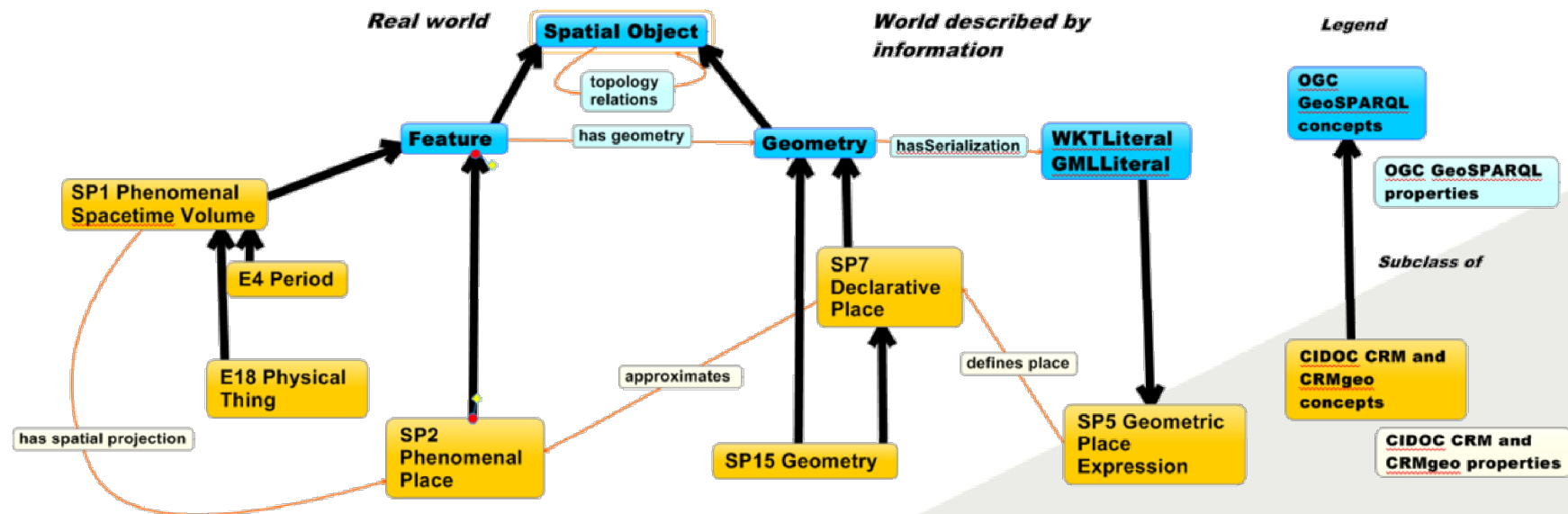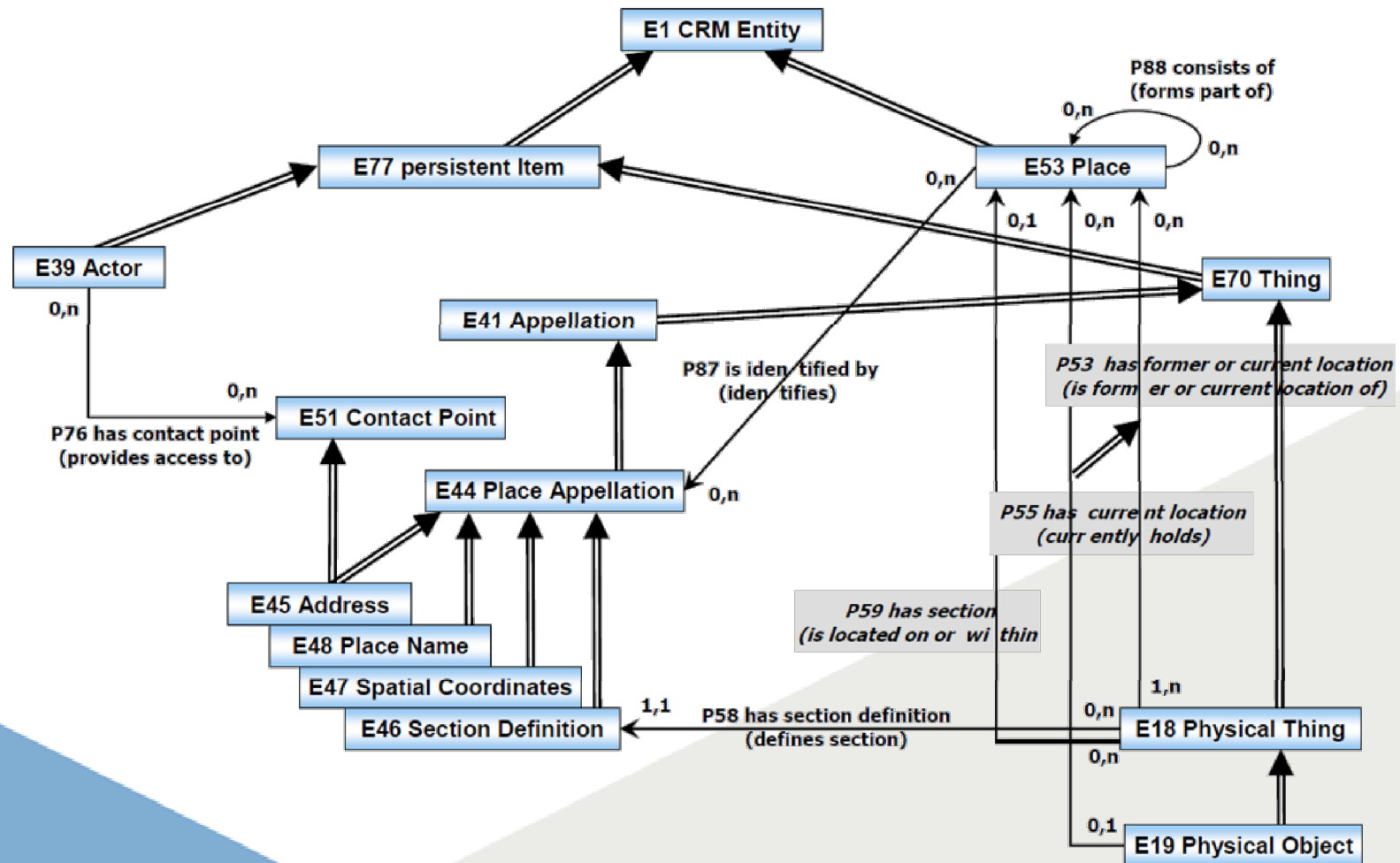
- CRMgeo entities and properties

fig. 1: CIDOC CRM and CRMgeo classes and their relations to GeoSPARQL classes
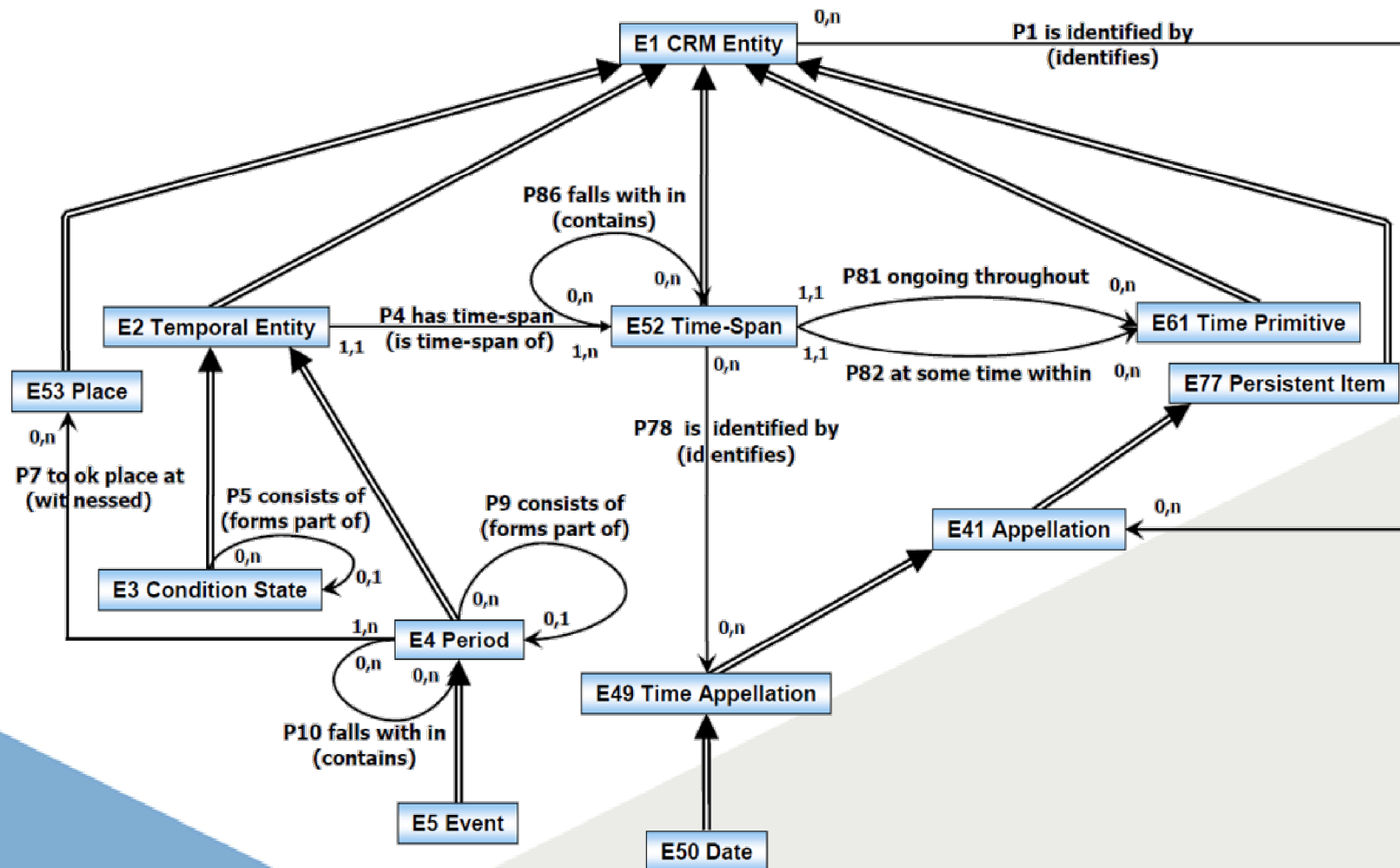
Spatio-temporal management in CIDOC CRM and extensions

- …

- CIDOC CRM entities and properties
  - CIDOC-CRM 6.2.3 (2018) :
    - Spatial information: fig. 2
    - Temporal information: fig. 3

CIDOC 2018 – Spatial information
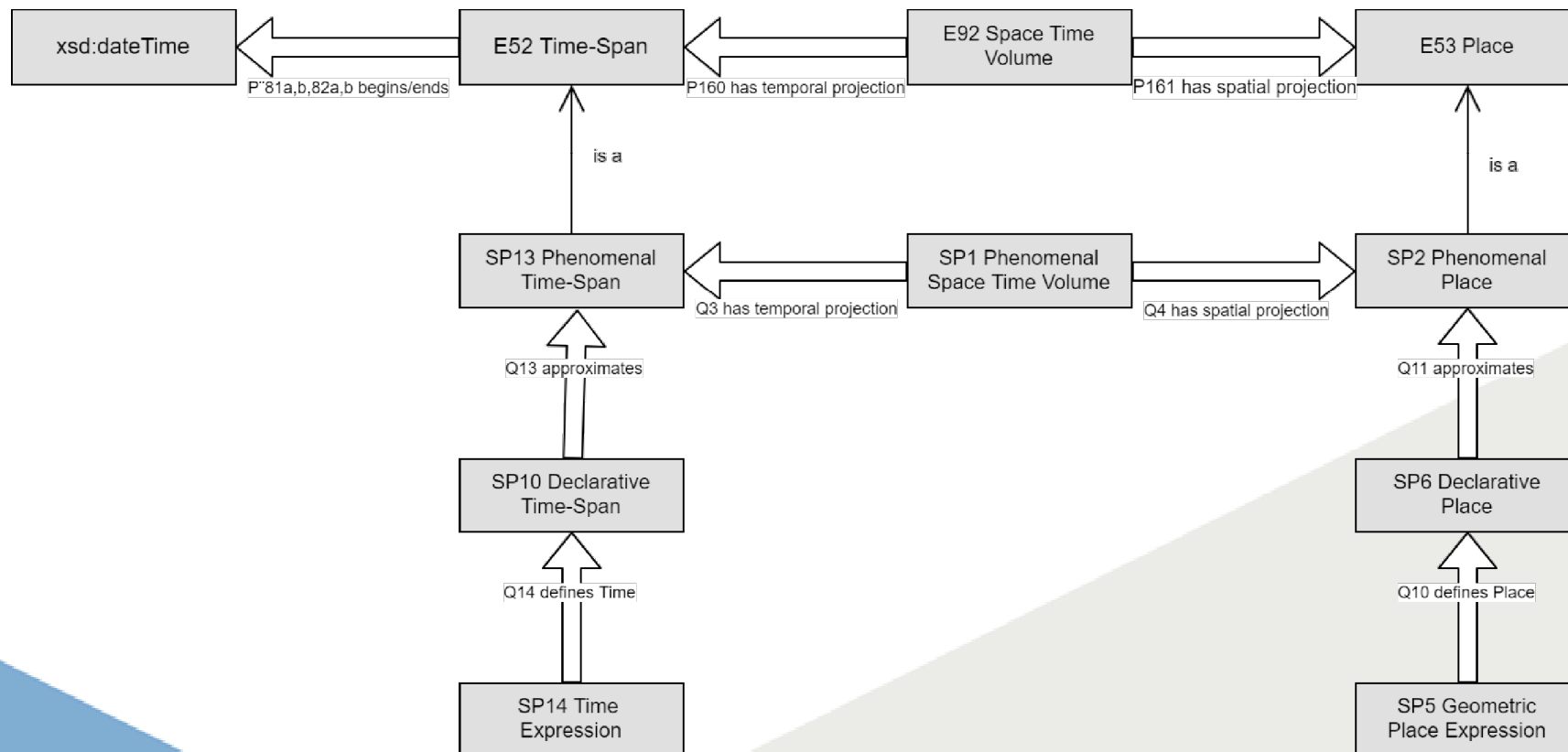
CIDOC 2018 – Temporal information

CIDOC 2018 – New classes

▶ …

▶ CIDOC CRM entities and properties
  ▶ CIDOC-CRM 6.2.3 (2018)
  ▶ Beforehand classes :
  New scopes of E61 Time Primitive or E94 Space primitive, or Temporal relations (P173 to P178 and P182 to P185).

CIDOC 2018 – Problems

- …

- CIDOC CRM entities and properties
  - …
  - Problem:
    - CIDOC CRM 6.2.3 : not implemented in RDF
    - No more links with GeoSPARQL

CIDOC 2018 - Problems

CIDOC - Lacks

- …

- Data types

  - Time: only xsd:dateTime or xsd:dateTimespan

  - Geo: No data

- Data properties

  - Time: Bag of properties

  - BUT:

    - No relative referencement

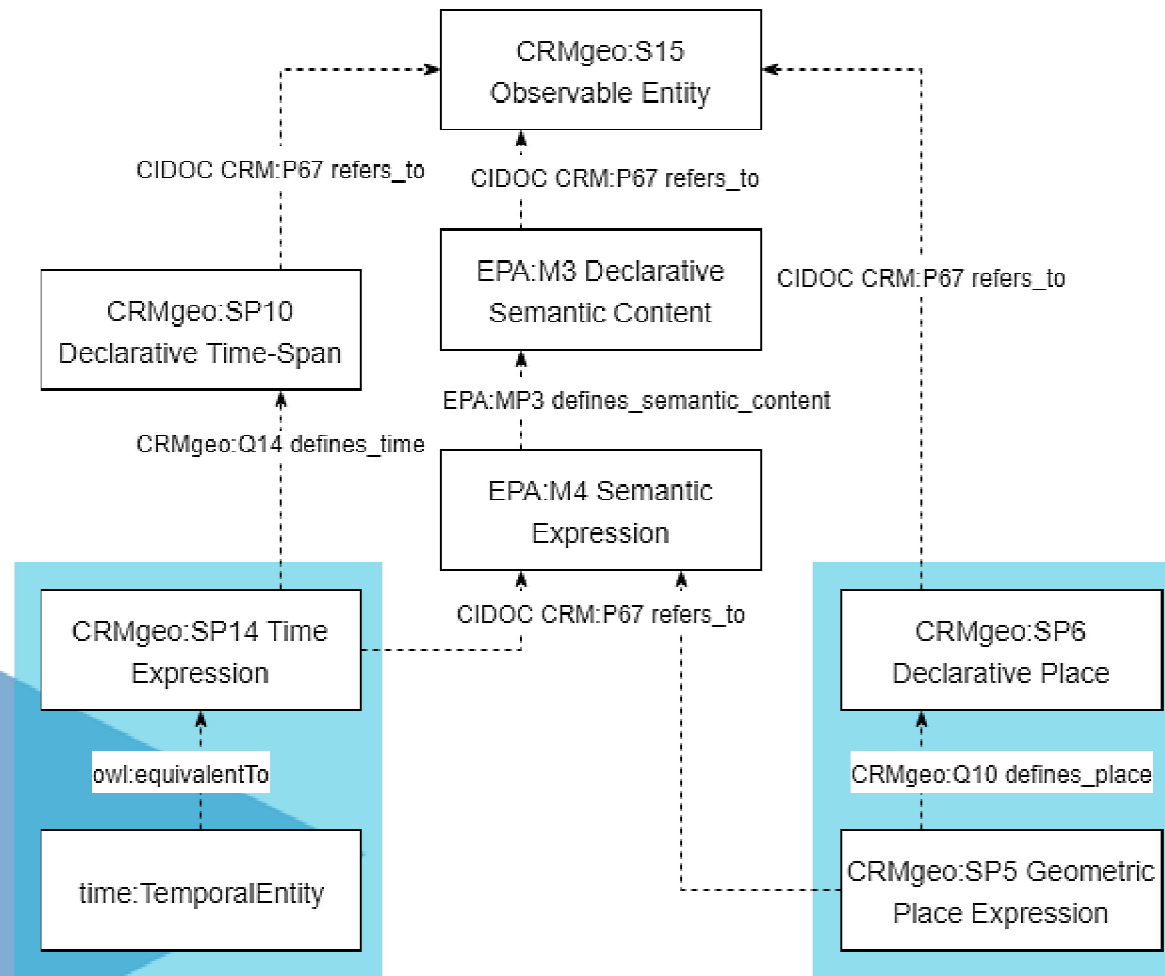   - Domain: E52 Time-Span thus unusable for instances of SP14 Time Expression

CIDOC - Lacks

▶ …

▶ Lack of workability

  ▶ No semantics means no reasoning.

Creating SWRL rules or using SPARQL endpoints to make them workable, we need specific data types like gmlLiteral, wktLiteral or xsd:gYear.
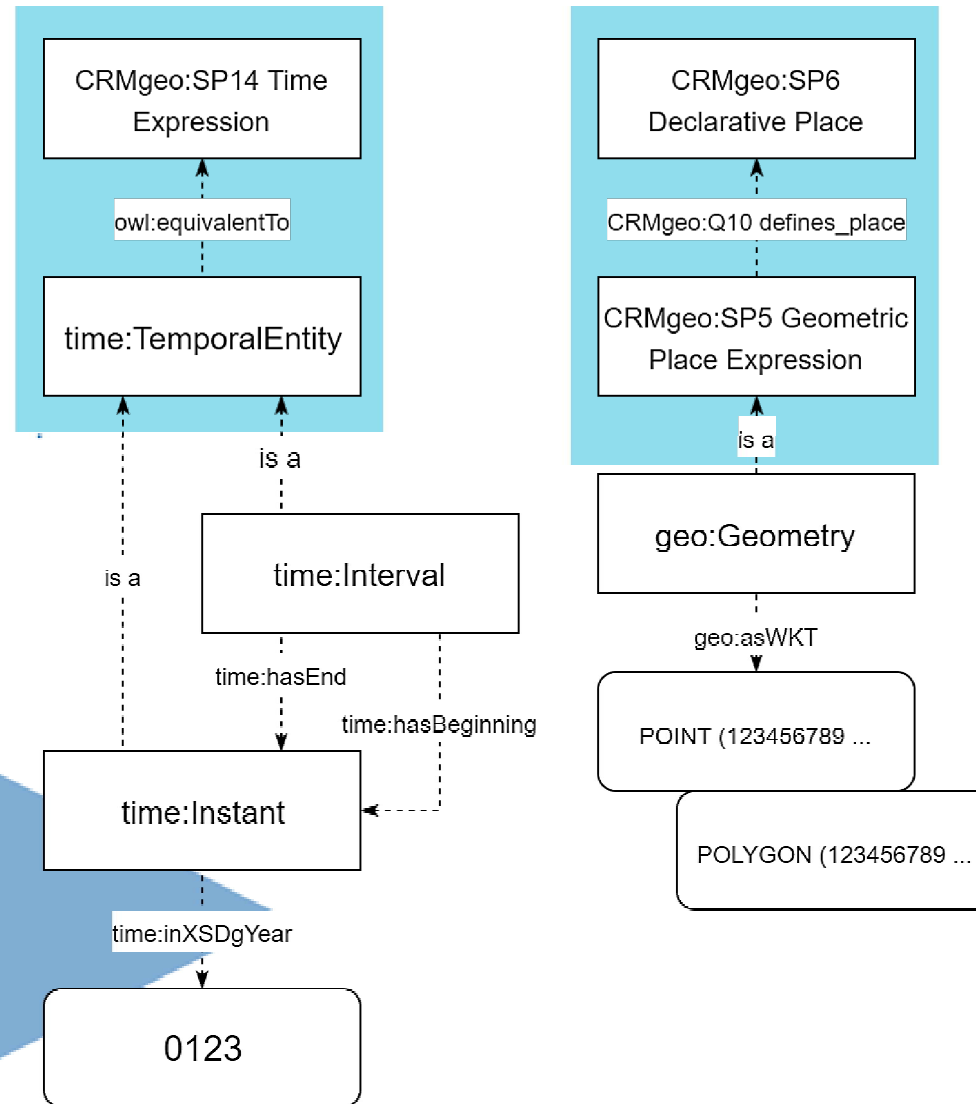
Need of an hybrid ontology

Use of GeoSPARQL and OWL-Time for spatio-temporal data to fullfil data types, data properties and workability

Hybrid ontology

Hybrid ontology

Spatial representation

▶ Properties are passive: not workable

▶ External tools : functions from GraphDB

Spatio query example

Which objects are in Wallonia?

```
SELECT ?DeclarativePlace WHERE {

    :Wallonia_geometry  CRMGeo:Q10_defines_place
    :Wallonia.

    :Wallonia_geometry geosparql:asWKT ?WalWKT.

    ?Geometry CRMGeo:Q10_defines_place
    ?DeclarativePlace.

    ?Geometry geosparql:asWKT ?GeomWKT.

    FILTER(geof:sfContains(?WalWKT,  ?GeomWKT)).

}
```

Temporal representation

▶ Properties are passive

▶ Reasoning on SWRL rules

▶ SOWL proposition

Temporal representation

Top Rule

```
time:inXSDgYear(?xTime, ?xXSD) ^ time:inXSDgYear(?yTime, ?yXSD) ^
swrlb:lessThan(?xXSD, ?yXSD) -> time:before(?xTime, ?yTime)
```

intervalBefore Rule

```
time:ProperInterval(?i) ^ time:ProperInterval(?j) ^ time:hasEnd(?i,
?iE) ^ time:hasBeginning(?j, ?jB) ^ time:before(?iE, ?jB) ->
time:intervalBefore(?i, ?j)
```
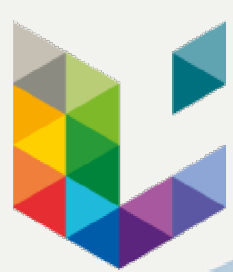
Temporal query example

What are the intervals that end after 750 and do not have a known beginning date?

```
SELECT * WHERE {

    ?interval time:hasEnd ?end .

    ?end time:inXSDgYear ?xsdE .

    FILTER(?xsdE > "0750"^^xsd:gYear) .

    FILTER ( !EXISTS{ ?interval time:hasBeginning
    ?beginning })

}
```

Spatio-temporal query example

What are the semantic expression that speak about an entity that existed after 1500 in Wallonia?

```
SELECT ?SemanticExpression ?DeclarativePlace WHERE {
        ?TimeExpression CRM:P67_refers_to ?SemanticExpression .
        ?Geometry CRM:P67_refers_to ?SemanticExpression .
        ?TimeExpression time:hasEnd ?end .
        ?end time:inXSDgYear ?xsdE .
        FILTER(?xsdE > "1500"^^xsd:gYear) .
        :Wallonia_geometry CRMGeo:Q10_defines_place :Wallonia .
        :Wallonia_geometry geosparql:asWKT ?WalWKT .
        ?Geometry CRMGeo:Q10_defines_place ?DeclarativePlace .
        ?Geometry geosparql:asWKT ?GeomWKT .
        FILTER(geof:sfContains(?WalWKT, ?GeomWKT)) .
    }
```

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Gilles-Antoine Nys

ganys@uliege.be

@GA_Nys

Muriel Van Ruymbeke

mvanruymbeke@uliege.be

@MvanRuymbeke

Roland Billen

rbillen@uliege.be

@RolandBillen

Feel free to contact us