The case for a standardised CRS ontology

GeoLD Workshop
2024-05-26

Timo Homburg, Frans Knibbe2, Ghislain Atemezing, Nathalie Abadie and Luís Moreira de Sousa

Contents

1. Introduction

Coordinate Reference Systems and the Semantic Web

- Coordinate Reference Systems (CRS)
  - the means to correctly interpret coordinates;
  - provide high precision positioning.
- Hundreds of CRSs have been created through history.
  - Many remain in use today
- **Gazetters** are the most common resource used in Linked Open Data (LOD).
  - Dictionaries of place names.
  - At best provide rough locations.
- No standard was ever issued for the provision and exchange of CRSs as Linked Data.

2. Definitions

Definitions (I)

- **Spatial Reference System (SRS)**
  - a system for establishing spatial position.
  - can use :
    - geographic identifiers (e.g. place names)
    - Identifiers with structured geometry (e.g. Discrete Global Grid System - DGGS)
    - coordinates (thus being a **Coordinate Reference System**).
- **Coordinate System**
  - a set of mathematical rules specifying coordinates are to be assigned to points.

Definitions (II)

- **Datum**:
  - a parameter, or set of parameters, defining:
    - position of the origin,
    - scale,
    - orientation.

Definitions (III)

- **Coordinate Reference System (CRS)**:
  - is related to an object by a datum.
  - defines:
    - type of space in which coordinates are recorded
    - units of distance used
    - spatial and temporal limits to applicability
    - projection parameters
- **CRS registry**:
  - a collection of CRS descriptions.

3. Motivation

Motivation

- A standardised CRS vocabolary for LOD is missing.
- A single CRS referenced in GeoSPARQL,
  - Often the only one supported by triple stores.
- Users largely on their own:
  - How to represent CRSs with RDF?
  - Where to record CRS definitions?
  - With which derreferencing mechanism?
  - How to interpret such definitions?

4. Related Work

OGC/ISO conceptual schema

- Framework for the description of CRS parameters
  - ISO 19111
  - OGC abstract specification “Referencing by coordinates”
- Expressed in UML
  - Used in GML and Well-Known Text
- Guarantees interoperoberability
  - Should be considered by any additional CRS specifications/encodings.

ISO 19111 ontologies

- Set of ontologies automatically derived from XML schemas.
- Quality issues:
  - URIs do not have the right data type
  - Language tags for text literals are missing
  - Content negotiation is not supported
  - Separation in multiple ontologies seems unnecessary
  - UML constraints are not translated (to SHACL, for example)
  - Notes are not separate resources (and are not preceded by a space)
  - Not all terms have definitions
  - Blank nodes with an unclear meaning were generated
  - Existing applicable web ontologies are not used (e.g. OWL Time, GeoSPARQL)

CRS identifiers and registries

Registry	URI	RDF
EPSG Geodetic Parameter Registry		
• EPSG.io		
• European Reference Coordinate System Service		
• SpatialReference.org		
• French national mapping agency (IGN France) registry		

IGN CRS ontology

- http://data.ign.fr/def/ignf/20160628.en.htm
- Extension to GeoSPARQL, based on ISO 19111.
- Re-uses existing ontologies (e.g. QUDT).
- **`ignf:CRS`** class.
- IGN's CRS registry published as RDF:
  - http://data.ign.fr/id/sparql
- URIs based on legal CRS names, e.g.:
  - http://data.ign.fr/id/ignf/crs/RGF93LAMB93

Proj4RDF

- https://github.com/situx/proj4rdf
- Attempt to **convert the EPSG database to RDF**
- Extraction of CRS data from the PROJ library
- Mapping of CRS attributes to a **custom vocabulary**
- Attempt to infer a class structure and properties out of the implementation specifics
- Classes, where applicable, have been linked to the OGC standard for SRS
- Addition of more than 1000 spheroid definitions
- Addition of custom projection classes
- By no means perfect, should be considered a **working draft**
- Verification, standardisation and consultation by experts necessary

5. Benefits and Use Cases

Provision of CRS semantics on the Web

1. Provide human readable definitions of CRS elements directly from geometry instances.
2. Seamless link between geometries and CRS interpretation.
3. Enable reasoning on CRS elements.
4. Enable expression of custom CRSs.
5. CRS definitions usable by both humans and machines/algorithms.
6. Simply extensions to ISO 19111, e.g. extraterrestrial CRSs
7. CRS specifications used in metadata
8. CRS elements used in (federated) SPARQL queries
9. CRS recommendations based on dataset extent and/or coordinate precision

Publication of CRS registries

1. An official CRS registry in RDF can be published (e.g. by the OGC).
2. Data stores no longer need to replicate and update CRS parameters.
3. Well-known official URIs can be used to match CRSs in web searches and federated searches.
4. Official national grids can be published by national agencies.
5. Enable validation of coordinate data, e.g. via SHACL.
6. CRS specifications can be used in metadata standards, e.g. GeoDCAT-AP25.
7. Stand-alone systems can rely on the Web to remain up-to-date.
8. Provision of JSON-LD contexts for established JSON-based CRS schemes.

Complement to GeoSPARQL

1. A new property in the `Geometry` class can target instances in CRS registries.
2. Strenghtened definition of geometries:
   - Coordinates and CRSs defined natively in RDF.
3. (Federated) GeoSPARQL queries become feasible with geometries that use a custom CRS

Increased interoperability

1. Geographic geometry and other types of geometry can use the same CRS semantics.
2. Facilitate georeferencing with local CRSs.
3. Make coordinate transformations possible with Linked Data tools.
4. CRS semantics can be made available to knowledge domains outside of Geoinformatics,
   - e.g. in the cultural heritage domain.
5. Historical CRSs can be published using the same semantics as modern CRSs.

6. Future Work

Moving forwards

- An ontology framed by and compatible with existing standards
- Re-use of existing UML-base models
- A proof-of-concept