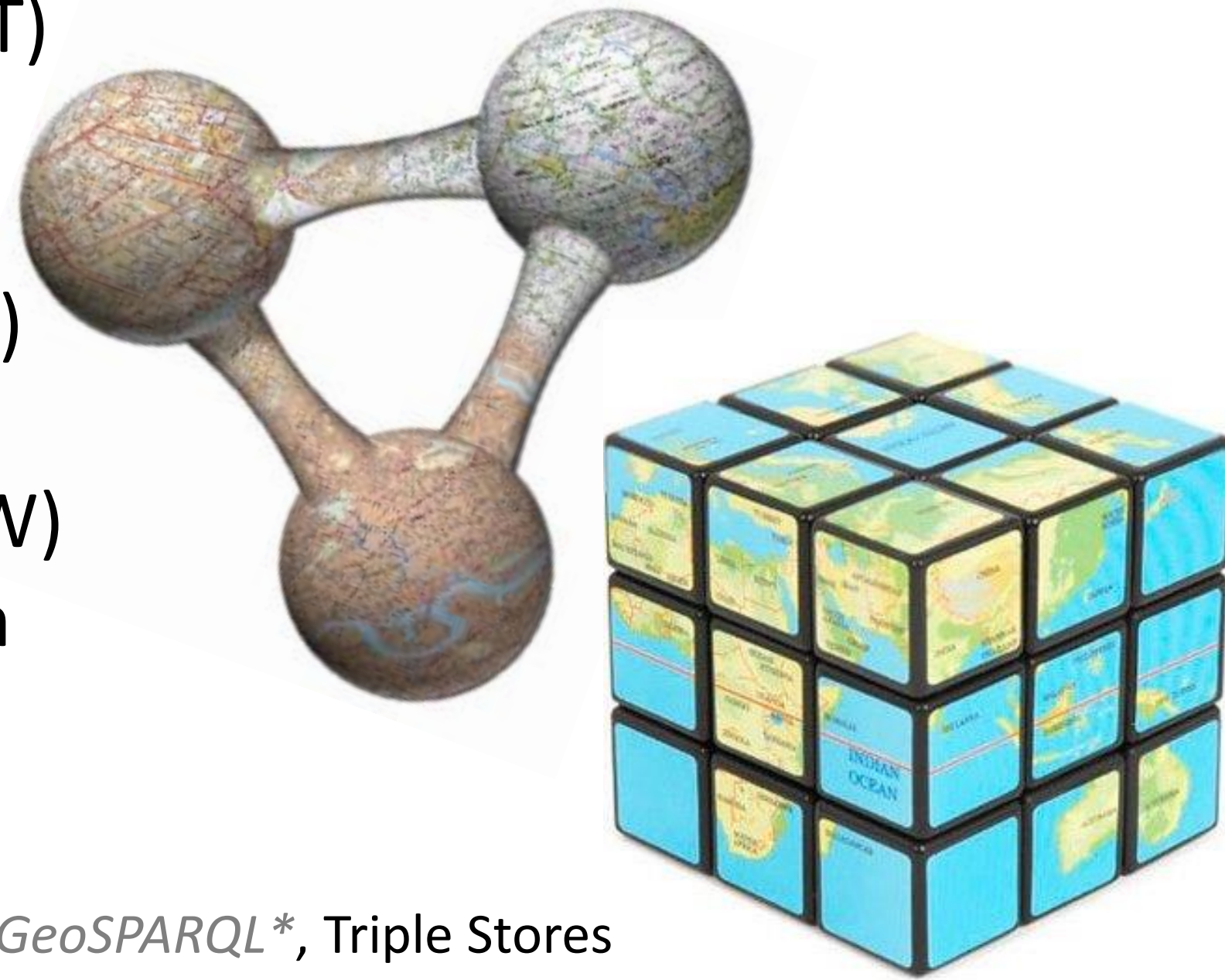


## What is My Research About

- Semantic Spatio-Temporal (ST) Warehouses
- RDF Data Warehousing (DW) with Business Intelligence (BI) technologies
- Geospatial Semantic Web (SW)
- Spatio-Temporal Linked Open Data (LOD).



### Tools and Approaches :

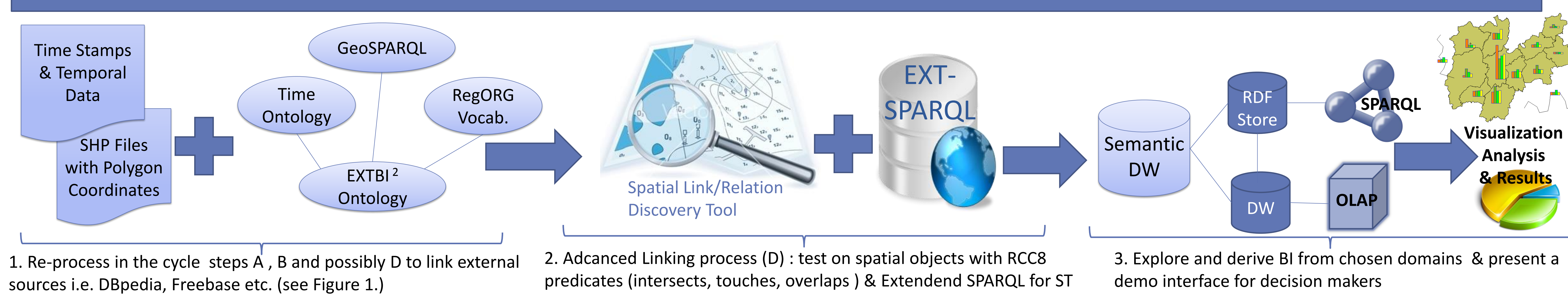
- ✦ SW Tools: RDF Data Model, SPARQL 1.1, *GeoSPARQL\**, Triple Stores
- ✦ BI Tools: *Spatial Data Warehouses, OLAP Cubes, MDX*
- ✦ Query Processing approaches : *Parallel, Federated over Distributed RDF Stores*

\*Note that possible future direction of tools and use case data written in italic grey fonts

## Overall Objectives & Expected Outcomes

- To represent data with multi-dimensional, enhanced ontologies and integrate it into a knowledge base linked with relevant data.
  - To support advanced link discovery for spatial objects and to develop advanced query techniques for multi-dimensional RDF data.
  - To extend query processing capabilities over distributed RDF data sources and test the applicability with OLAP queries
- Proof-of-concept RDF Data Model and Ontology Design Pattern (ODP) for ST data
  - Spatial Link/Relation Discovery Tool based on Region Connection Calculus (RCC8)+ ST Query Language
  - OLAP Queries and results over distributed RDF data sources

## Work Flow



## Process Cycle

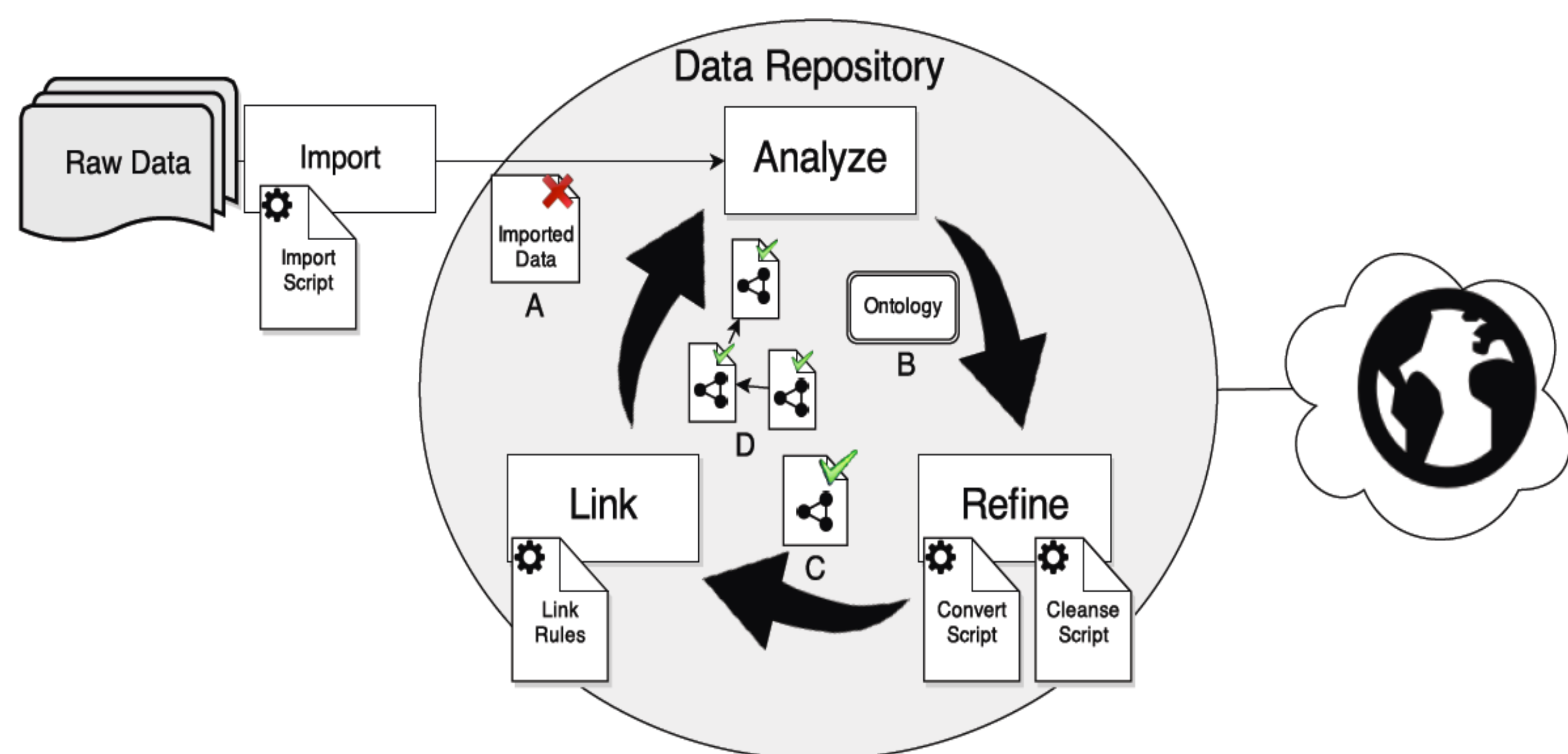


Figure 1: Process Overview

## Use Case

- **Agricultural Domain**
  - Field
  - Organic Field
  - Field Block
  - *Livestock Farming*
  - *Seasonal Farming*
  - *Annual Expenditures*
- **Climate Sensor Data**
  - *Precipitation sensors*
  - *Wind Turbine sensors*
- **Business Domain**
  - Company Registry Data (CVR)
  - Production units & addresses
  - Fully responsible participant data
- **Geographical data**
  - Municipalities
  - Fields
  - *Water bodies*

## Queries

```
SELECT ?crop COUNT (*) AS ?cnt
FROM <http://extbi.lab.aau.dk/resource/agriculture>
WHERE {
  ? field agri:produces ?crop .
  ? field wgs:long ?long .
  ? field wgs:lat ?lat .
  FILTER (?long > [x - 0.5] && ?long < [x + 0.5]
    && ?lat > [y - 0.5] && ?lat < [y + 0.5]) .
} GROUP BY ?crop
```

Query 1 : AQT\* – Counts fields based on the crop they produce

```
SELECT ?name ?address
FROM <http://extbi.cs.aau.dk/resource/agriculture>
FROM <http://extbi.cs.aau.dk/resource/business>
WHERE {
  ?company bus:owns ?organicField.
  ?company bus:name ?name.
  ?company bus:officialAddress ?address
} GROUP BY ?name ?address
```

Query 2: SQT\* – Finds the company address that owns organic fields

## Evaluation

Step	Virtual	Materialized	Native
Data	74.92	603.35	603.35
Cleansing			
Load	1.01	1.01	1.01
Ontology			
Load	8.76	12.35	12.35
Mappings			
Dump RDF	0.00	0.00	4684.82
Load RDF	0.00	0.00	840.04
<b>Total</b>	<b>84.68</b>	<b>616.70</b>	<b>6141.56</b>

Table 1: Load times in seconds

Query	Virtual	Materialized	Native
AQT 1	5.92	3.39	1.04
AQT 2	13.32	7.00	0.23
AQT 3	10.81	7.70	0.05
AQT 4	-	-	0.14
AQT 5	-	20.37	0.86
SQT 1	-	-	2.35
SQT 2	0.09	0.12	0.10
SQT 3	2188.85	1.81	0.40
SQT 4	6.57	2.35	1.63
SQT 5	-	23.79	3.29
<b>Average</b>	<b>370.93</b>	<b>8.31</b>	<b>1.01</b>

Table 2: Runtimes in seconds

\*AQT : Aggregated Query Template / SQT: Simple Query Template

## References

- <sup>1</sup> M3 - [https://it4bi-dc.ulb.ac.be/Modeling\\_and\\_Semantics](https://it4bi-dc.ulb.ac.be/Modeling_and_Semantics)
- <sup>2</sup> Extended BI- EXTBI Project page: <http://extbi.lab.aau.dk/>