BETTER
BIG DATA EARTH OBSERVATION TECHNOLOGY

Semantic Analytics In BETTER

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BETTER Hackathon
08th November 2019
Frascati, Rome

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This project has received funding from the European Union's Horizon 2020 Research and Innovation Programme under grant agreement no 776280

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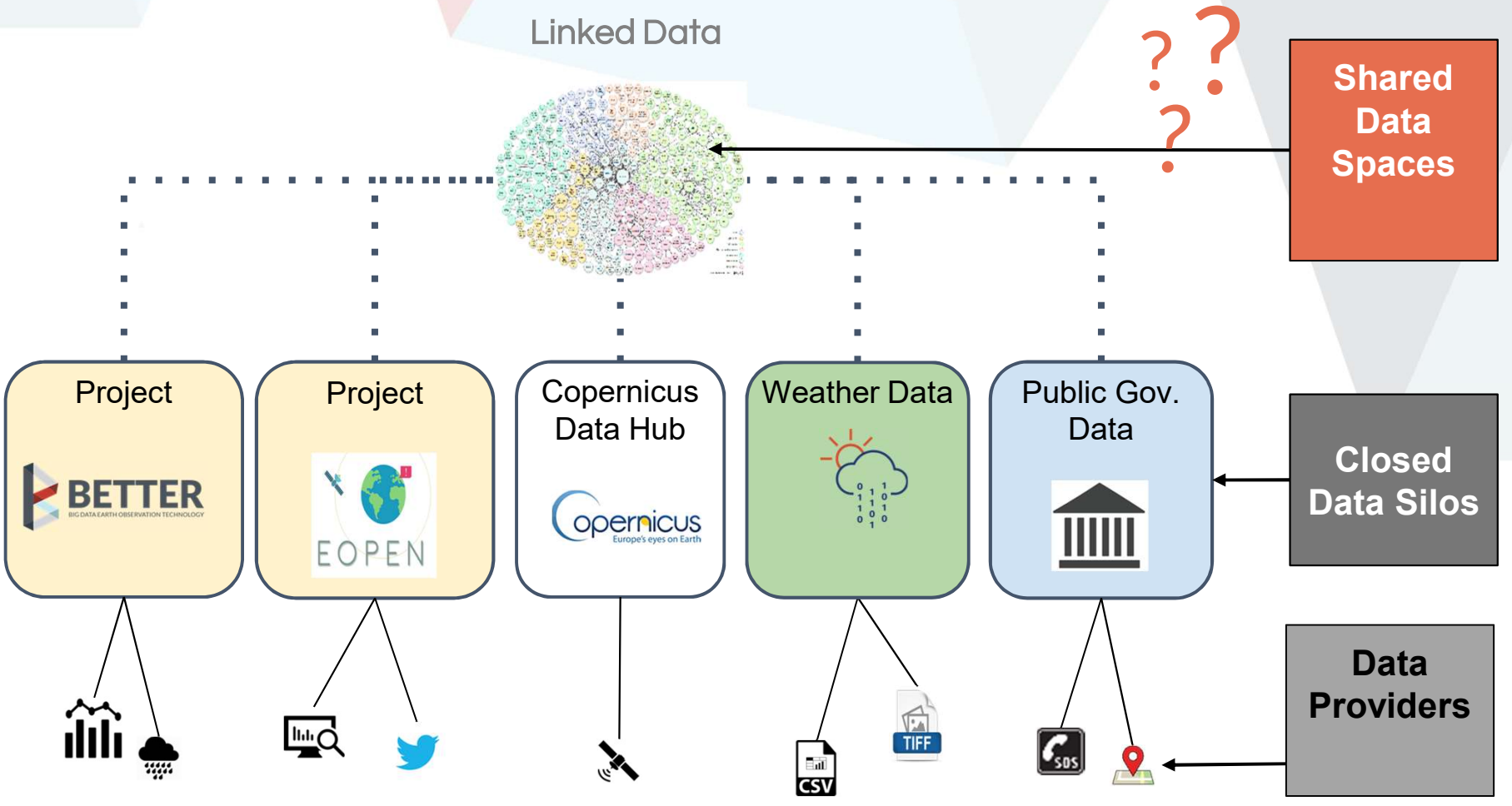
Data Heterogeneity: Limiting the Potential!



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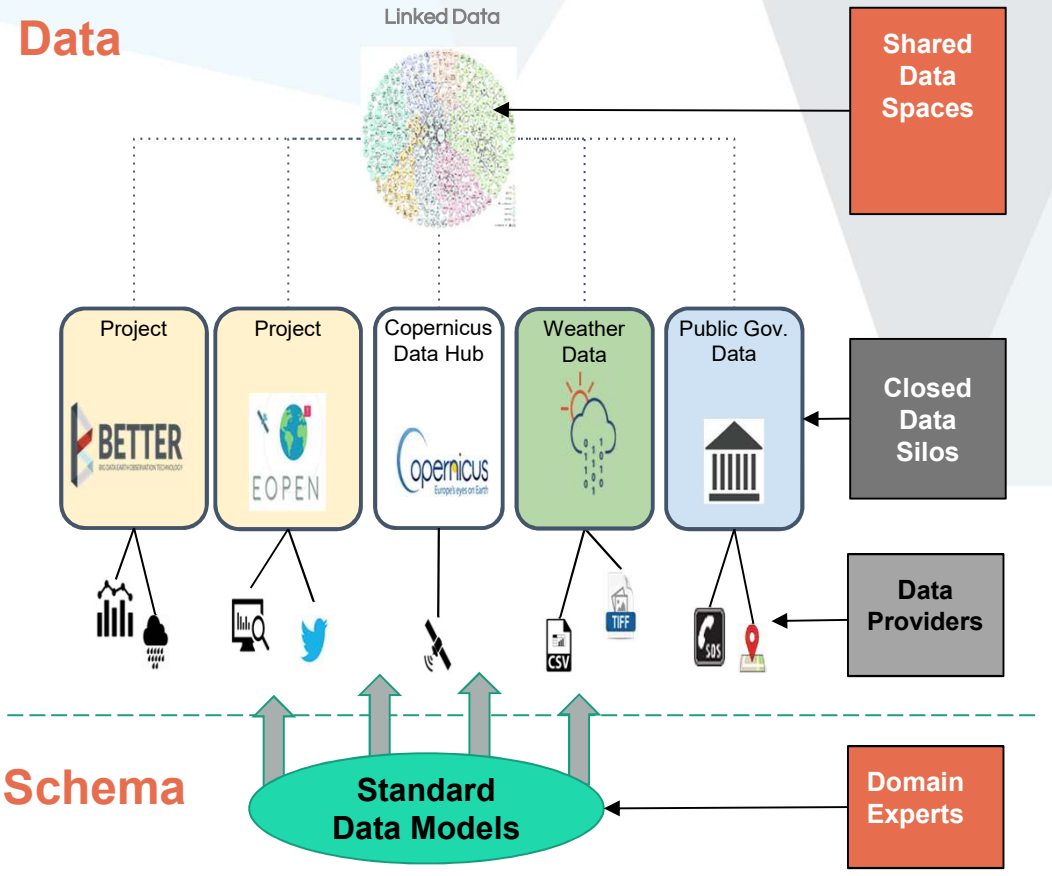
What is needed to Enable Linking and Maximise Re-use?

- Highly-structured Data Format
- Using Common Domain Models
- Porting existing data onto highly-structure format
- Using Universal Identifiers for Things



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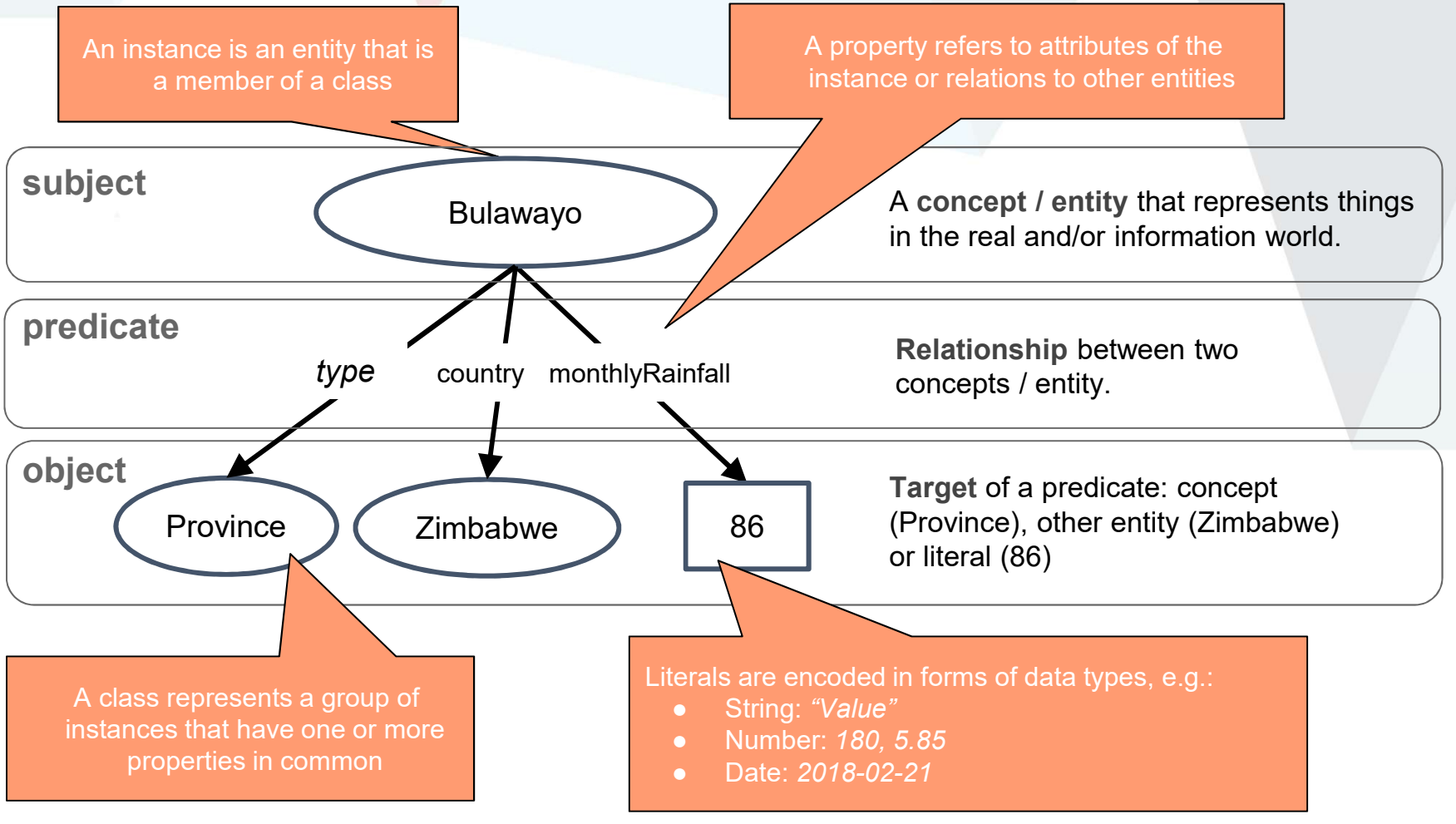
Encoding Knowledge with RDF



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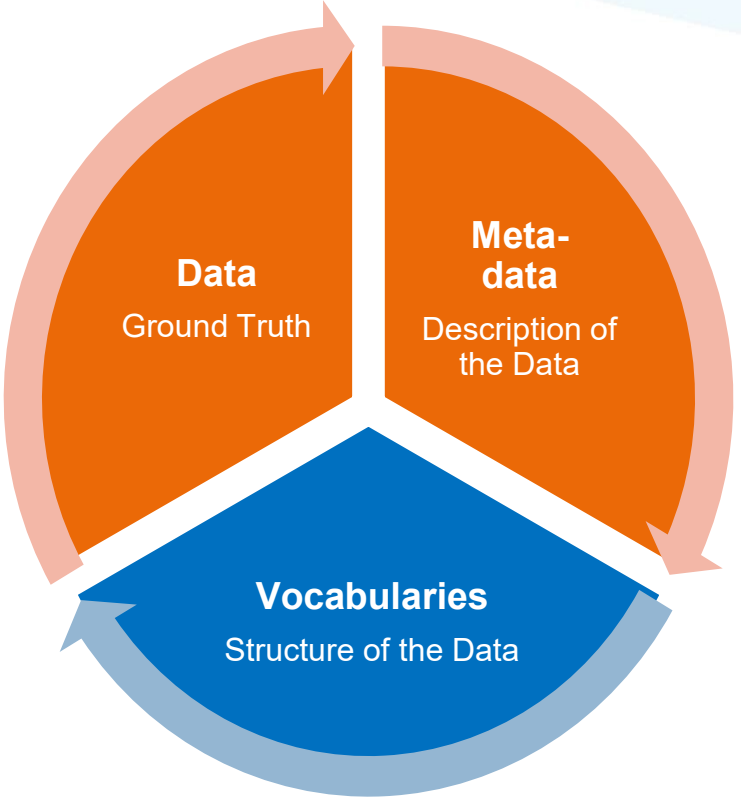
Ontologies: Enabling a common ‘Language’



- **Raw data / ground truth**
  - People, Places, Organisations, Sensor data, Production data, etc.
- **Metadata**
  - License information, Provenance, Versioning, Documentation, etc.
- **Vocabularies**
  - Domain Models: Definitions of Class and Property(-hierarchies)
  - Define Metadata that describes Raw Data (entities) using
  - T-box enabling Knowledge Representation

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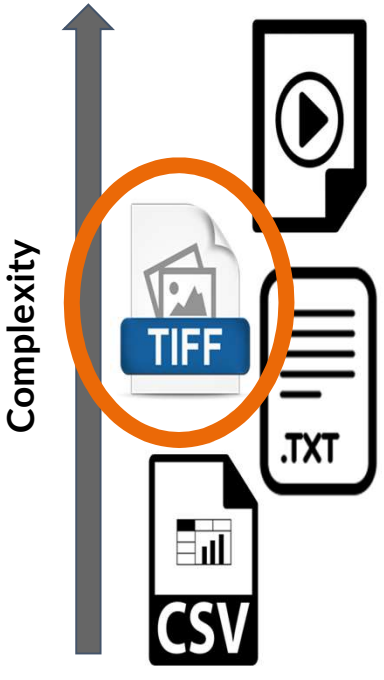
Transformation tools: Un/Semi/Structured data to RDF

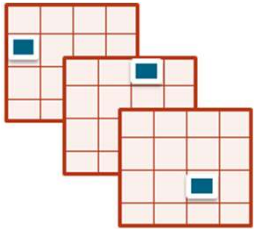
Un/Structured Text, Media, etc.

Relational data models

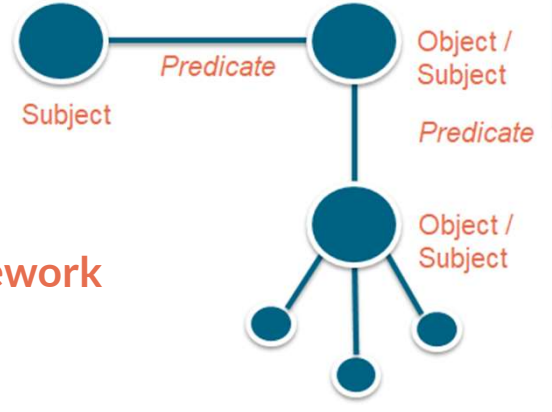
Graph based data model



?



R2RML
SILK Framework
....



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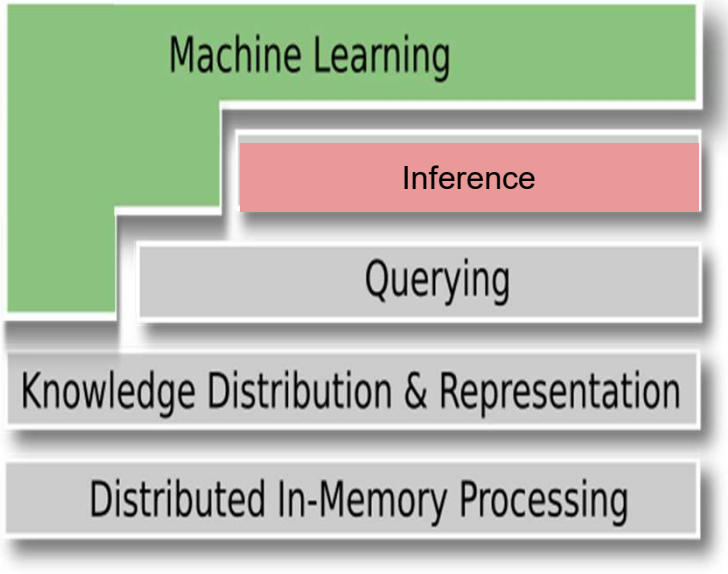
SANSA: Innovative KG-based Inference & ML

- **Machine Learning Distributed algorithms**
  - KG embeddings for KB completion, link prediction
  - Graph Clustering
  - Association Rule Mining
  - Semantic Decision Trees



- **Inference**
  - In-memory via **rule-based forward chaining**
  - Dynamically build **Rule dependency graphs**
  - Based on RDF/OWL fragments

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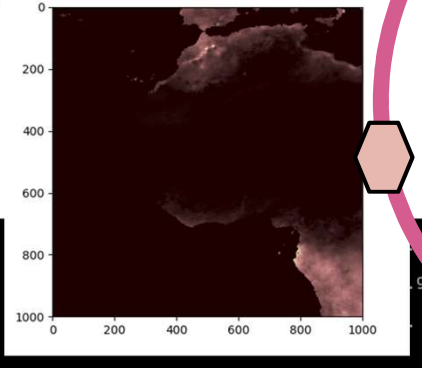
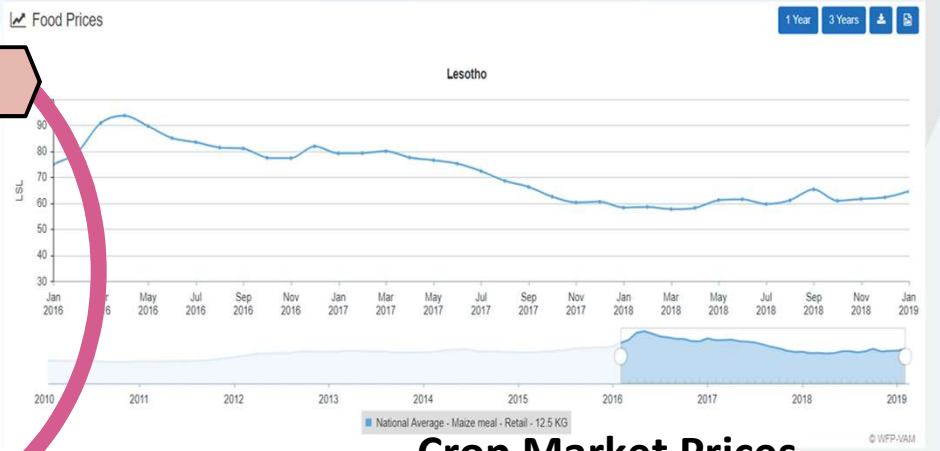
Today's Exercise!
Rainfall to Market Price Correlation Detection

CHIRPS Rainfall aggregates




```
>>> array
array([[  0.      ,
        134.87132],
       [  0.      ,
        114.61279],
       [  0.      ,
        101.95908],
       ...,
       [  0.      ,   0.      ,   0.      , ..., 167.36545, 170.28468,
        176.22345],
       [  0.      ,   0.      ,   0.      , ..., 163.13359, 166.25623,
        173.71649],
       [  0.      ,   0.      ,   0.      , ..., 161.90408, 167.51051,
        168.20584]], dtype=float32)
>>> array[989,934]
171.32156
>>>
```



Crop Market Prices

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CHIRPS Knowledge Graph Linking & Pattern Discovery

- **Ingestion of CHIRPS-derived Knowledge Graphs/RDF**
  - Ontology Mapping for semi-automatic RDF transformation
- **Interlinking with relevant open data**
  - Crop Market Prices from WFP
- **Implicit Discovery of Patterns**
  - Identify *correlations* between Rainfall and Crop (Maize) Market prices

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Required Libraries

- Python 3+
  - Particular packages requirement: GDAL, Shapely
- Java 7+
- Maven
- Apache Spark 2+
- Linux OS

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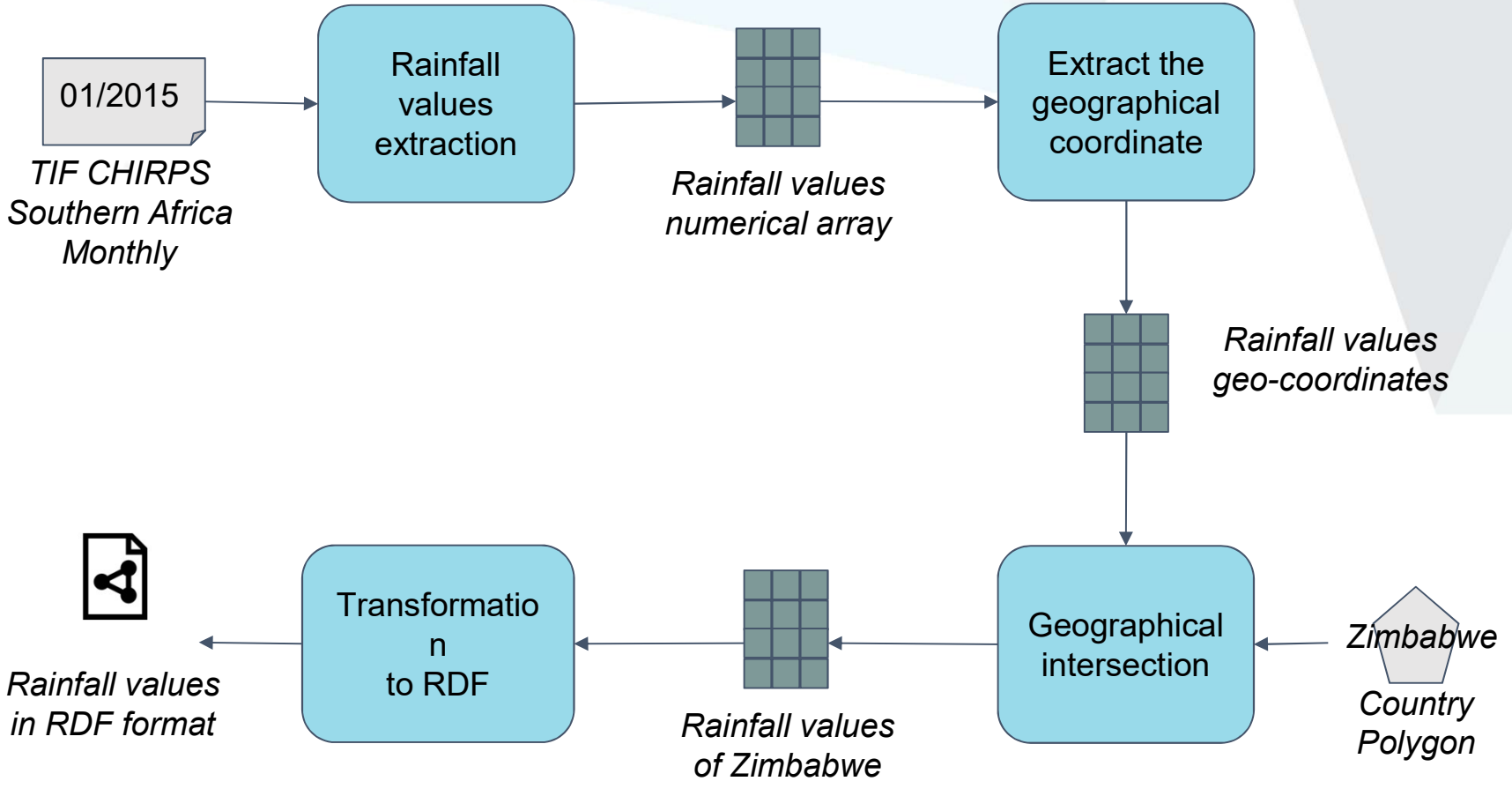
Task 1: From CHIRPS TIF to RDF



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Task 1: From CHIRPS TIF to RDF

- **Required Libraries:** Python 3 + GDAL and Shapely packages
- **Material Location:** App > 1_Rainfall_TIF_to_RDF
- **Application Execution:** run the command

```
python3 Main.py ../../Data/CHIRPSv2_SouthernAfrica_N30_daystotal_2015-01-01_2015-01-31.tif tif-rainfall-output.ttl
```

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Task 1: From CHIRPS TIF to RDF

- **Output:** RDF multidimensional data (aka Data Cube Vocabulary)

```
@prefix qb: <http://purl.org/linked-data/cube#> .
@prefix eg: <http://example.org/ns#> .
@prefix dbpedia: <http://dbpedia.org/ontology/> .
@prefix cf-feature: <http://purl.oclc.org/NET/ssnx/cf/cf-feature#> .

eg:obs1 a qb:Observation ;
    qb:dataSet eg:dataset-prices ;
     dbpedia:month "1" ;
     dbpedia:year "2015" ;
     cf-feature:rainfall_amount "789587" ;
.
```

Namespaces (domains)

An Observation

A DataSet

Dimensions

The Measure

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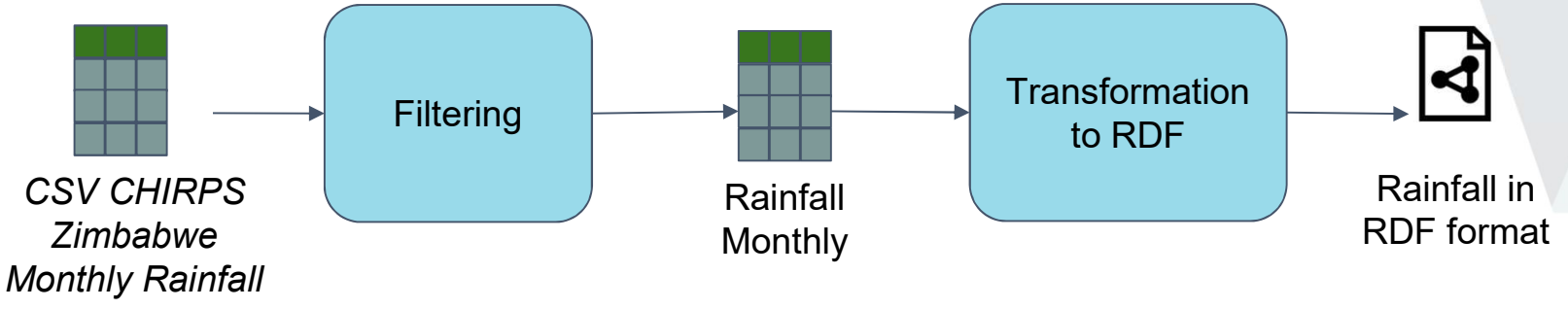
Task 2: From CHIRPS CSV to RDF



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Task 2: From CHIRPS CSV to RDF

- **Required libraries:** Python 3
- **Material location:** App > 2_Rainfall_CSV_to_RDF
- **Application Execution:** run the command

```
python3 Main.py ../../Data/Zimbabwe_Rainfall.csv rainfall-output.ttl
```

Task 2: From CHIRPS CSV to RDF

- **Output:** RDF multidimensional data (aka Data Cube Vocabulary)

```
@prefix qb: <http://purl.org/linked-data/cube#> .
@prefix eg: <http://example.org/ns#> .
@prefix dbpedia: <http://dbpedia.org/ontology/> .
@prefix cf-feature: <http://purl.oclc.org/NET/ssnx/cf/cf-feature#> .

eg:obs1 a qb:Observation ;
    qb:dataSet eg:dataset-prices ;
     dbpedia:month "1" ;
     dbpedia:year "2015" ;
     cf-feature:rainfall_amount "789587" ;
.
```

Namespaces (domains)

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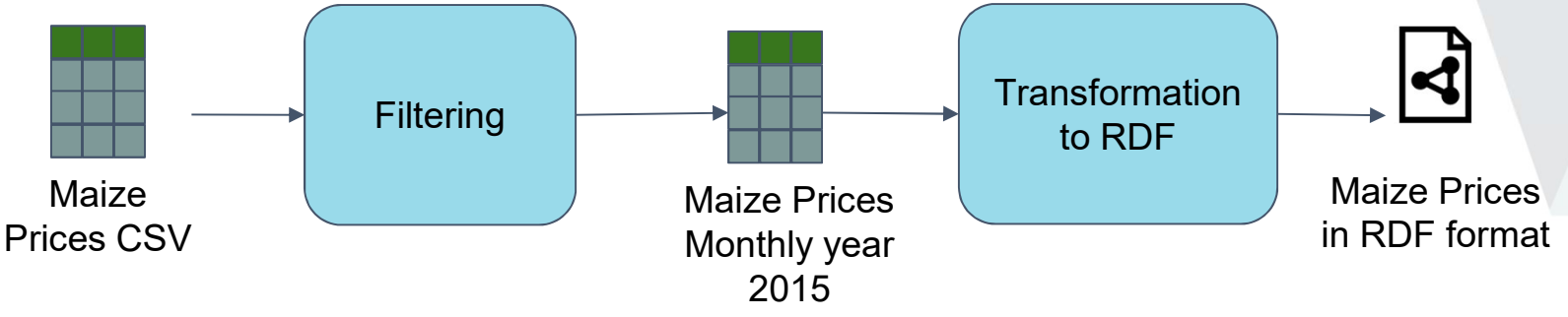
Task 3: From WFP Maize prices to RDF



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Task 3: From WFP Maize prices to RDF

- **Required Libraries:** Python 3
- **Material Location:** App > 3_Prices_CSV_to_RDF
- **Application Execution:** run the command

```
python3 Main.py ../../Data/Zimbabwe_Maize_Prices-2015.csv prices-output.ttl
```

Task 3: From WFP Maize prices to RDF

- **Output:** RDF multidimensional data (aka Data Cube Vocabulary)

```
@prefix qb: <http://purl.org/linked-data/cube#> .
@prefix eg: <http://example.org/ns#> .
@prefix dbpedia: <http://dbpedia.org/ontology/> .
@prefix cbo: <http://comicmeta.org/cbo/> .

eg:obs1 a qb:Observation ;
    qb:dataSet eg:dataset-prices ;
     dbpedia:month "1" ;
     dbpedia:year "2015" ;
     cbo:price "789587" ;
.
```

Namespaces (domains)

An Observation

A DataSet

Dimensions

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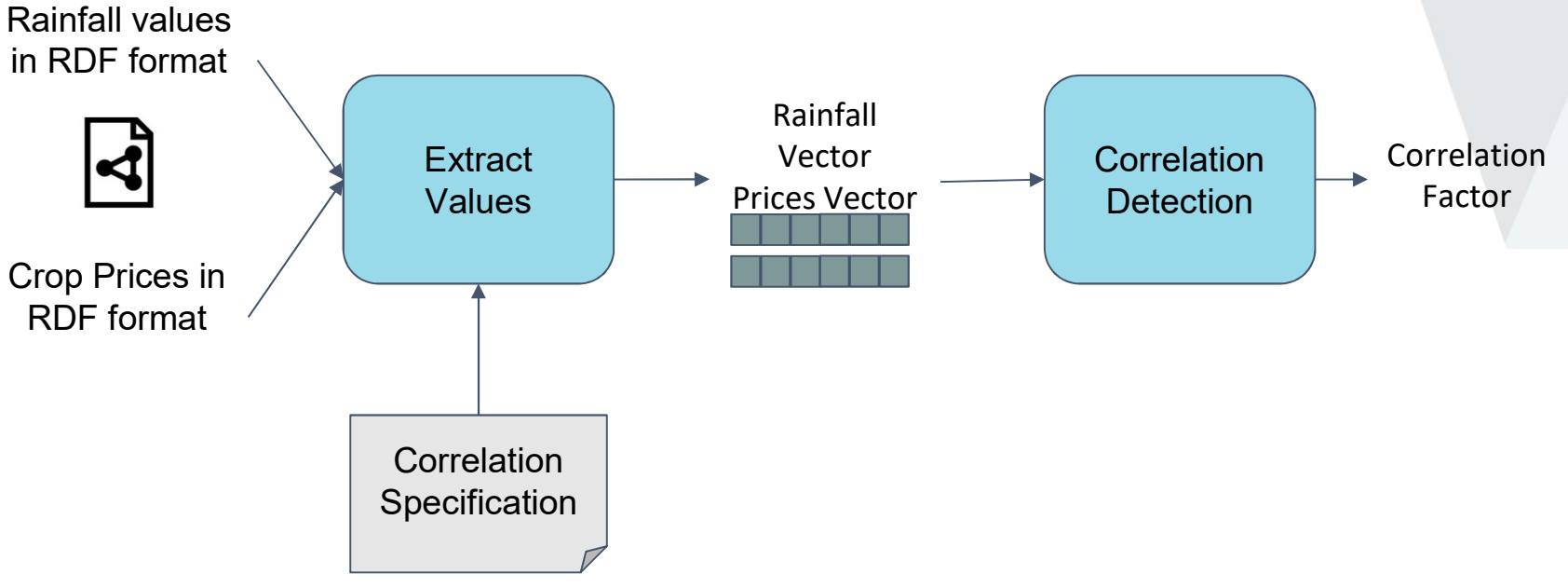
Task 4: Correlation Detection



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Task 4: Correlation Detection

```
{
  "properties": [
    {
      "source": "/home/user/.../Apps/2_Rainfall_CSV_to_RDF/rainfall-output.ttl",
      "target": "<http://purl.oclc.org/NET/ssnx/cf/cf-feature#rainfall_amount>",
      "filters": {
        "<http://dbpedia.org/ontology/year>": "2015",
        "<http://dbpedia.org/ontology/month>": "1,2,3,4"
      }
    },
    {
      "source": "/home/user/.../Apps/3_Prices_CSV_to_RDF/prices-output.ttl",
      "target": "<http://comicmeta.org/cbo/price>",
      "filters": {
        "<http://dbpedia.org/ontology/month>": "{02,03,04}{03,04,05}{04,05,06}{05,06,07};sum",
        "<http://dbpedia.org/ontology/year>": "2015"
      }
    }
  ]
}
```

Filter based on other properties

The two properties to correlated

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Task 4: Correlation Detection

- **Required Libraries:** Python 3, Maven, Apache Spark
- **Material Location:** App > 4_SANSA_Correlation_Detection
- **Application Execution:**
  - Run the command `mvn package` to package the App
  - Run the command (if SPARK_HOME not set, navigate to Spark folder)

```
spark-submit --class org.ml.test.App --master local[*] --executor-memory 5G
target/correlation-1.0-SNAPSHOT.jar ../../Data/correlation.conf local[*]
```

Task 4: Correlation Detection

- **Output:** Correlation Value using *Pearson* method
  - Value range between -1 and 1
  - The closer to 1 = positive correlation
    - When rainfalls change, prices change in the same direction (up/down)
  - The closer to -1 = negative correlation
    - When rainfalls change, prices change in the opposite direction (up/down)

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