CYBELE

Statistical Challenges Towards a Semantic Model for Precision Agriculture and Precision Livestock Farming

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SemStats 2019

This project has received funding from the European Union’s Horizon 2020 research and innovation programme under grant agreement No. 825355.

The CYBELE project

- Agriculture is a high volume, huge business with low operational efficiency
- Precision Agriculture and Livestock Farming use **intensive data collection and processing** to drive operational decisions
  - Drones patrol fields and alert farmers for crop ripeness or potential problems
  - Sensors on fields provide granular data points on soil conditions
  - GPS units on tractors can help determine optimal usage of heavy equipment
  - Satellite images can help computing useful field overview indicators e.g. Normalized Difference Vegetation Index
- The CYBELE project aims at demonstrating how Precision Agriculture and Livestock Farming can revolutionise the agrifood sector using the power of high performance computing

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Farming data

- Farming data come from diverse heterogeneous sources
- Structured data
  - Sensor data e.g. measure the soil's electrical conductivity at a specific location and time
  - Forecasts e.g. for weather, prices, production
- Unstructured data
  - Earth observations e.g. satellite/drone images
  - Video e.g. video data from pig pens to monitor pigs behaviour
  - Maps can be combined with other data to provide easily interpretable results
- Data lakes are required to store farming data

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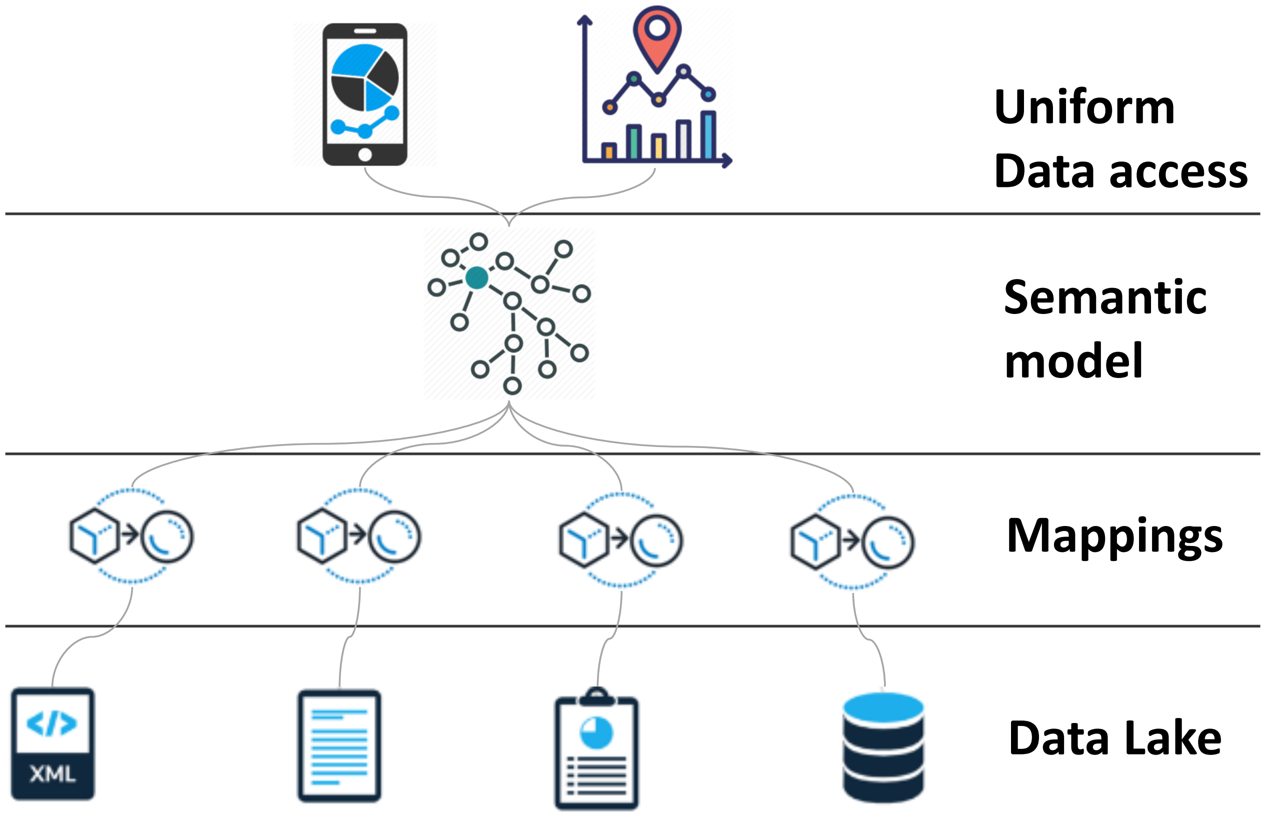
Uniform access to data lakes



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Role of the Semantic Model

- Represent domain knowledge related to the content of a data lake e.g. agriculture, farming, weather
- The semantic model can express:
  - Metadata:
    - Structural e.g. dimensions, measures
    - non-structural e.g. publisher, issuing date, license
  - Data:
    - values of dimensions e.g. geo dimension → Greece, New Zealand

V1 of the model

- Enables the uniform access of heterogeneous data
  - Facilitate data **discovery** → require metadata
  - Facilitate data **querying** → require data and metadata
  - Facilitate data **integration** → require data and metadata

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Semantic model development

- The methodology followed comprises the steps:
  - Study the scope of the model and the relevant data
  - Identify the user roles regarding data exploitation and their requirements
  - Extract the main concepts of the model from the requirements
  - Define the model by matching the concepts to existing standards and vocabularies

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Scope of the Semantic Model

- The semantic model focuses on the agri-food domain
  - Agriculture data e.g. protein content, soil electrical conductivity
  - Livestock farming data e.g. animal weight, livestock feed
  - Fishing data e.g. fish behavior data, landing data of fish stocks
  - Aquaculture data e.g. water temperature, current speed
  - Climate and weather data e.g. temperature, humidity
  - Satellite & aerial image data

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User roles

- End user (e.g. farmer and livestock manager)
  - exploit big data applications that produce easy to consume and interpret visualizations
- Modeler and developer
  - produce big data application &models for the end users
- Data analyst and farming consultant
  - exploit data-driven decision making to support end users
- Statistician
  - exploit big agricultural and livestock farming data to deliver official statistics

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Semantic Model User Requirements

- Search for datasets:
  - Regarding a specific cultivation e.g. soya, grapes
  - Created as a result of an activity e.g. sensoring, forecasting
  - That are updated e.g. monthly, daily, nearly real-time
  - Published/created/owned by a specific organization
  - Issued/modified after/before a specific point in time
  - That have a specific dimension e.g. geo, time
  - That have a specific measure e.g. NDVI
  - That have a specific unit of measure e.g. prices in euro
  - That have specific temporal coverage e.g. [2017- 2019]
  - Distributed in a specific format e.g. CSV, XML, JSON
  - Distributed under a specific license e.g. Creative Commons

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Vocabularies used

- DCAT
  - describe datasets metadata
- Stat-DCAT
  - describe datasets statistical metadata
- PROV-O
  - describe provenance information
- QB vocabulary
  - describe statistical data and metadata

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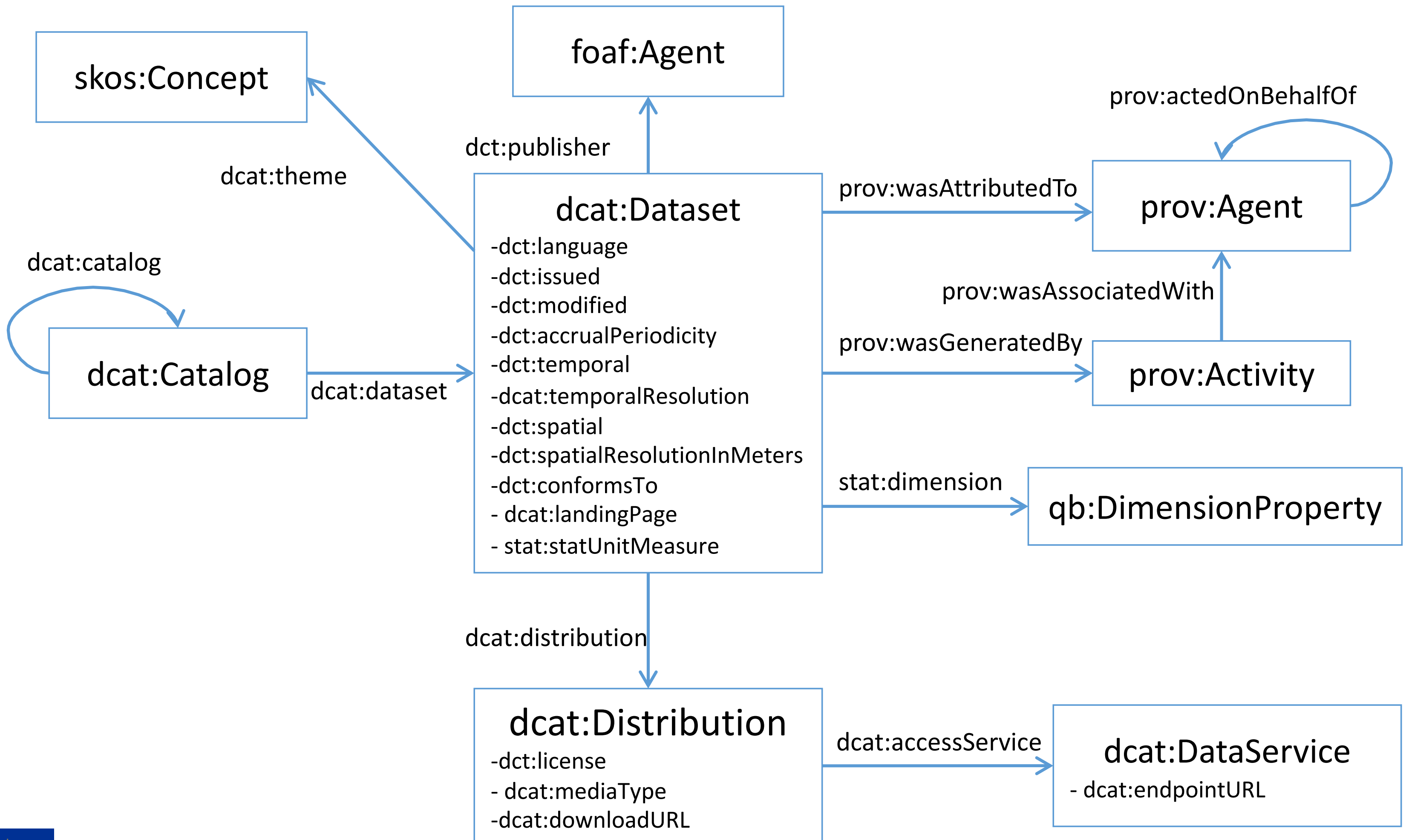
The model



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Statistical challenges

- Aggregated data are needed to support decision making
  - Sensors produce measurements regularly e.g. every 1 minute
  - Aggregated data are needed e.g. at day level
- Unstructured data need to be processed to calculate indexes
  - Satellites produce multispectral images
  - Indicators are needed e.g. Normalized Difference Vegetation Index (NDVI)
- Join of different datasets is required
  - Dataset 1: NDVI calculated from satellite images
  - Dataset 2: soil compression calculated from sensors at field
  - The join can use as an ID the field location

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Towards v2 of the model

Requirements:

- Requirement 1: query data
  - I want data of area X for the time [2018 - 2019] that measure the NDVI
  - Result: set of observations from one dataset
- Requirement 2: integrate data
  - I want data of area X for the time [2018 - 2019] that measure the NDVI AND the soil compression
  - Join observations from two datasets

Next steps:

- Define ontologies and code lists for:
  - Structural metadata: dimensions, measures, units
  - No-structural metadata: data format, theme, language, frequency update
  - Data values: time values, geo values, ...

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Thank you

https://www.cybele-project.eu

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