A Geographic Standards based Metamodel to formalize Spatio-Temporal Knowledge in Remote Sensing Applications

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Outline

1. Introduction

2. Spatio-Temporal Metamodel

3. How to use this metamodel ?

4. Conclusions and Perspectives

Context of study
Satellite Image Interpretation
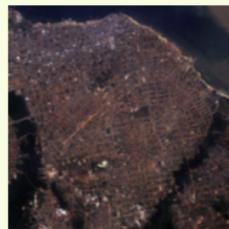
By diverse experts
Remote Sensing
Ecologist,
Geographer,

. . .

In various thematics
Cartography,
Urban planning,
Environment monitoring,

. . .

Image Interpretation Process

Image properties

e.g. wavelength, texture

Experts

Image Interpretation Process

Image properties

e.g. wavelength, texture

Experts

Field knowledge

e.g. Salinity, Leaf type

Issues

Image properties

e.g. wavelength, texture

Experts

Field knowledge

e.g. Salinity, Leaf type
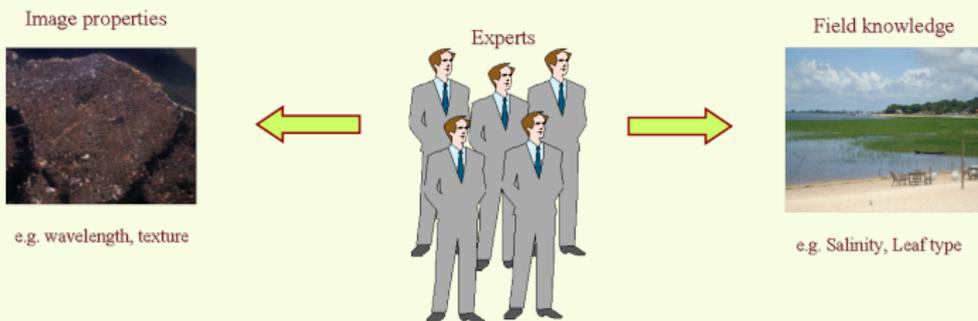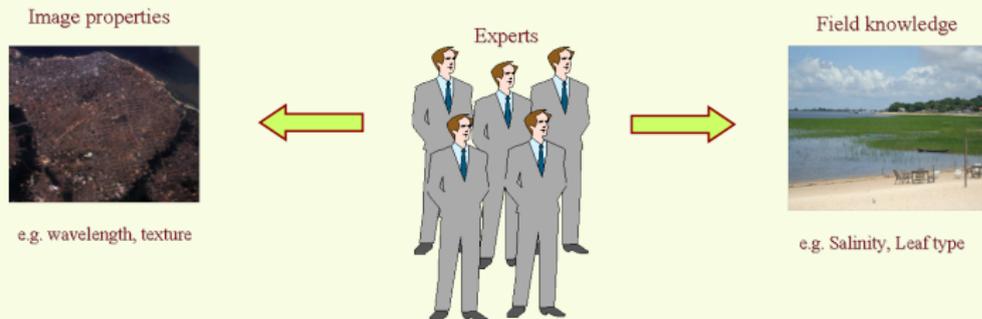
→Different knowledge
→Heterogeneous interpretations   ⟹   **Semantic Gap**
→Non consensual results

Proposal to reduce the semantic gap

1) Define Image and Field ViewPoints

Image Viewpoint

Field Viewpoint

$\rightarrow$ Same features according to different perspectives

Proposal

2) Take into account Spatio-temporality in both viewpoints

$\rightarrow$ Spatio-temporal concepts are commonly used
to define features

Proposal

3) Formalize Knowledge into ontologies
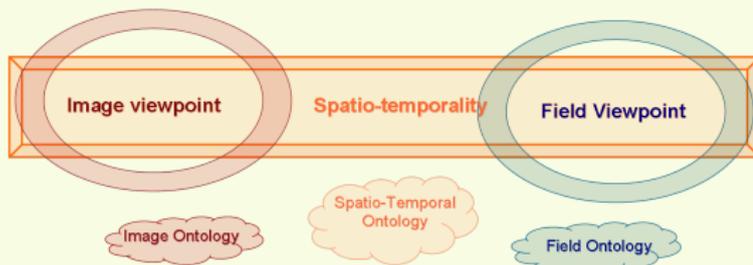
$\rightarrow$ Represent knowledge in a common formalism

$\rightarrow$ Harmonize definitions

Proposal

4) Formalize commonsense knowledge into a framework
ontology
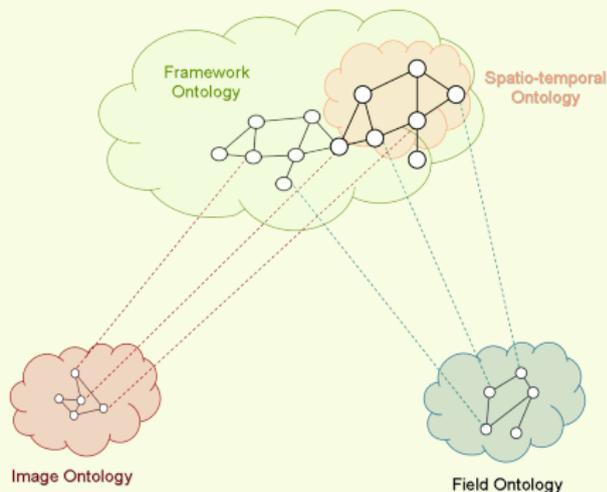
$\rightarrow$ Give a common basis to describe the viewpoints

$\rightarrow$ Reuse concepts that appear redundantly

$\rightarrow$ Facilitate matching between concepts

Proposal

5) Matching and Reasoning
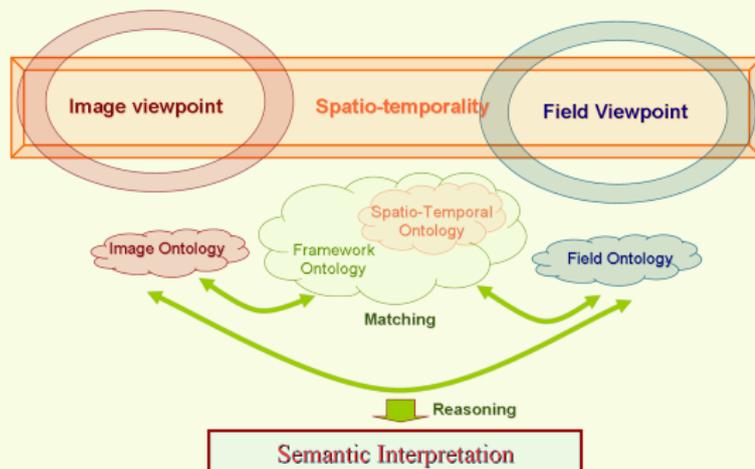
$\rightarrow$ Ensure Semantic Interpretation

Focus on step 2 : Modeling Spatio-temporal Knowledge

$\rightarrow$ Favour integration of ST concepts in both viewpoints

$\rightarrow$ Make easier ST matching between viewpoints

A Spatio-Temporal Metamodel

$\rightarrow$ High level conceptual framework

$\rightarrow$ Based on spatio-temporal expertise and geographic standards

$\rightarrow$ Providing a standardized semantic description of ST Knowledge

$\rightarrow$ First step of the framework ontology formalization

Spatio-Temporal Metamodel Structure

Organized into 8 Packages
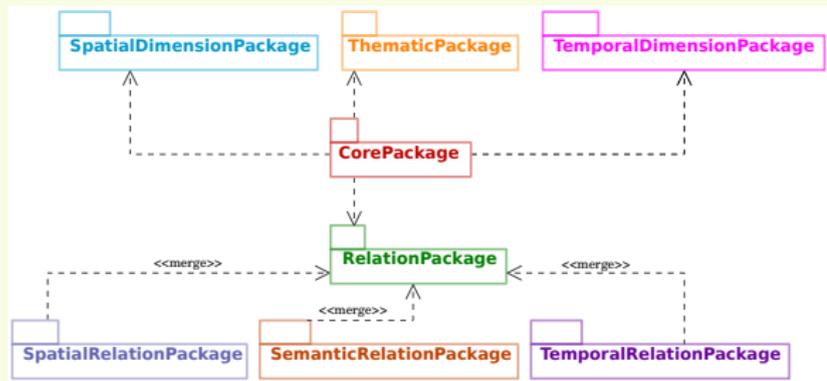
$\rightarrow$ Aggregate information semantically close

$\rightarrow$ Ensure modularity

The Core Package

- Used to characterize the geographical feature as a whole
- Have a direct or indirect dependency on the other packages
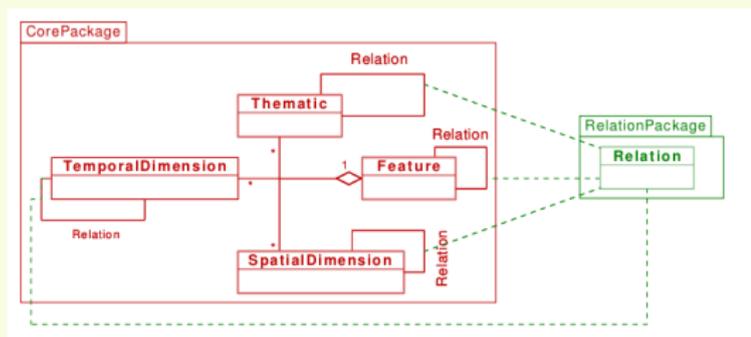
A geographic feature is an aggregation of spatial, temporal and thematic dimensions, with which different kinds of relations can be specified.

The SpatialDimension Package

- Directly linked to the CorePackage by the *SpatialDimension* class
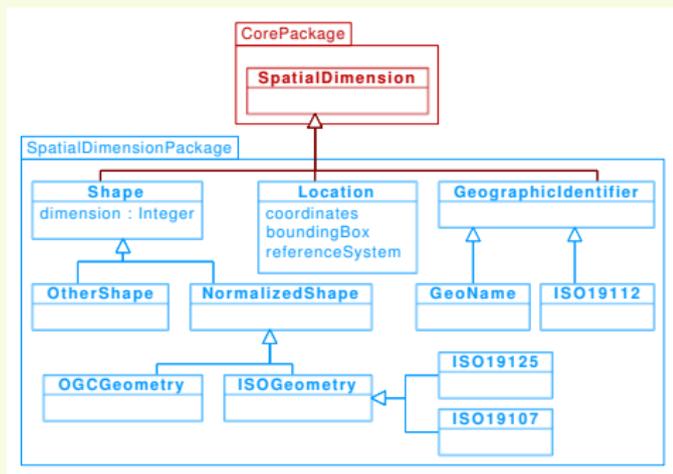
$\rightarrow$ 3 classes : *geometric shape*, *location* and *geographic identifier*

$\rightarrow$ Most elements are derived from standards

The Relation Package

- Directly linked to the CorePackage by the *Relation association class*
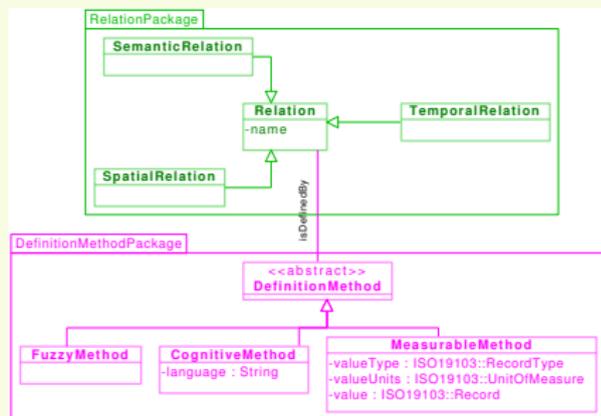
$\rightarrow$ Specialized into 3 sub-classes

$\rightarrow$ Associated with a definition method

The Spatial Relation Package

- 3 sub-classes defined by E.Clementini
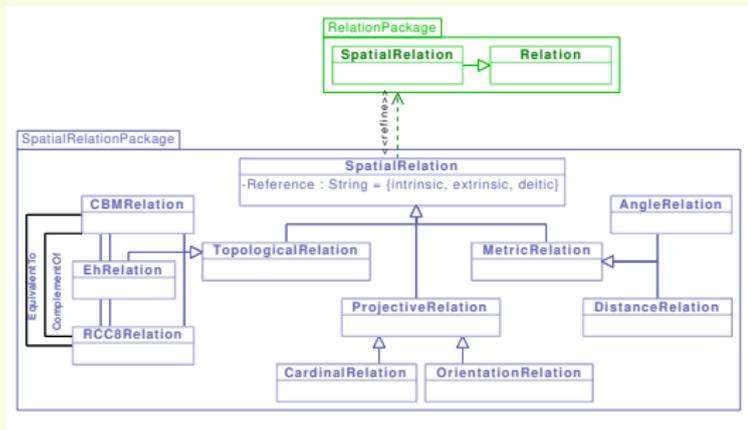
$\rightarrow$ Most elements are derived from previous works

Egenhofer, RCC8, Frank, . . .

How to use this metamodel ?

1) For each viewpoints, create a model derived from the metamodel

    a) Define Spatio-Temporal features

    b) Add Thematic, Spatial and Temporal Characteristics

    c) Add Semantic, Spatial and Temporal Relationships
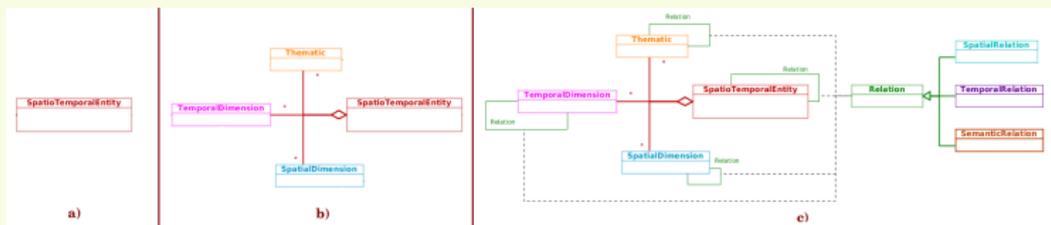
$\rightarrow$ Spatio-Temporal concepts and Relations

    are derived from the Metamodel

$\rightarrow$ Thematic Properties and Semantic Relations

    are specified by the model

How to use this metamodel ?

2) Make matching between viewpoints
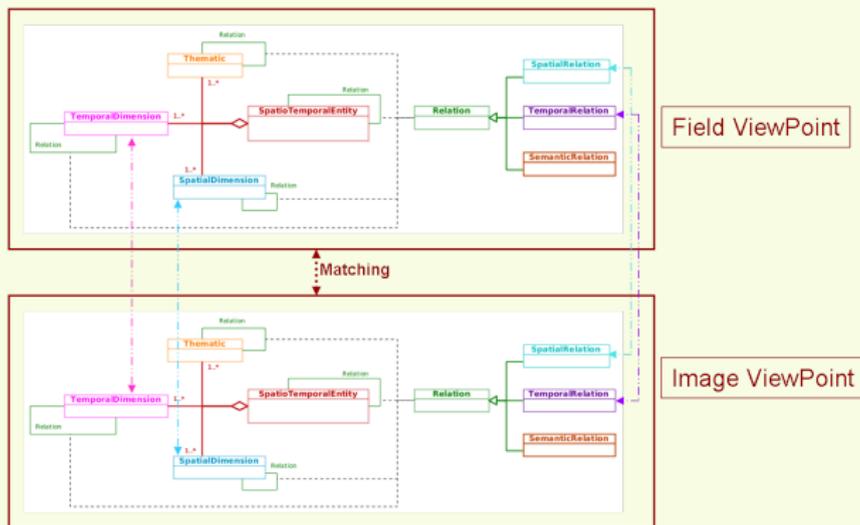
$\rightarrow$ Some correspondances are obvious (e.g spatial relations)

$\rightarrow$ Others must be explicitly defined (e.g. thematic dimensions)

Field Point of View Model
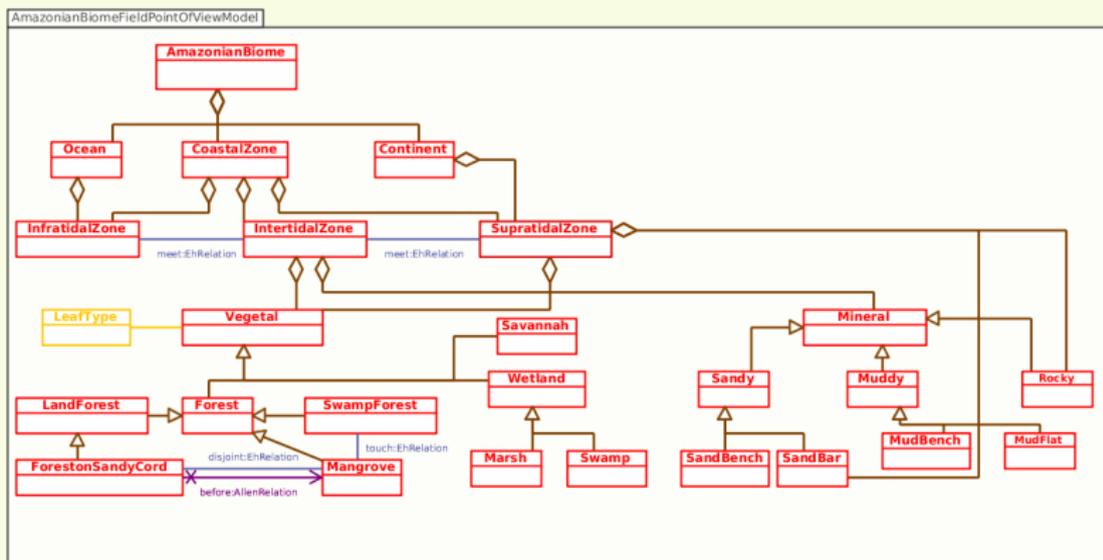
$\rightarrow$ Features classification with spatial and temporal relations

Image Point of View Model
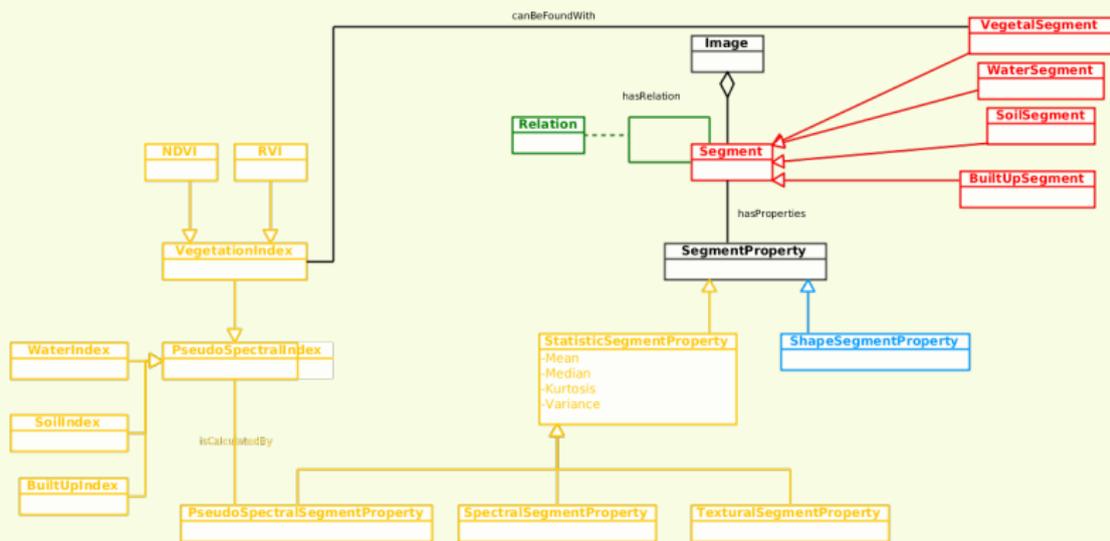
$\rightarrow$ Image segment thematic characteristics

Preliminary Results

Calibrated Image

Vegetation

Mangrove

Beach

$\rightarrow$ For details, please contact *samuel.andres@ird.fr*

Conclusions

Modular conceptual ST metamodel based on normalized approaches

Support image interpretation according to the associated point of view

Easy to use by remote sensing and thematic experts

Preliminary interesting results

Perspectives

Formalize all concepts into framework and domain ontologies

Define more accurate matching

Use description logics to enable complex reasoning

Refine preliminary results

Thank you for your attention

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