Extracting urban forests in GEOBIA framework using AGROVOC and WorldView-2 imagery

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Abstract: In GEOBIA, segmentation is a very first task in creating image objects from very high spatial resolution (VHSR) imagery. In general, the extracted image objects are readily be used in the GIS - ready vector format. However further investigations, developments and testing of methods in extracting accurate image objects are needed. In this paper, we have developed thematic and spatial semantics using AGROVOC Ontologies for extracting agricultural objects in particular urban forests. AGROVOC is a multilingual structured vocabulary for the agricultural domain, which is owned and maintained by an international community of Agricultural Research Information Institutions and the Food and Agriculture Organization (FAO) of the United Nations. This has been published as Linked Open Data so that information can be used automatically. In this case study example, we aim to develop a proof-of-concept for classes like tree, tree types, plantation and forest in multiple scales. The preliminary results showed that in GEOBIA framework, objects can be characterised with semantic meaning and their relationship with the real world. This was tested for a Worldview-2 imagery of Hobart, Tasmania, Australia in depicting urban trees and other agricultural objects.
Keywords: Agriculture, AGROVOC, GEOBIA, Geographic, Ontology, WorldView-2

1. Introduction

In GEOBIA, extracting accurate image objects using segmentation is a building block of thematic map preparation. Generating image objects and labelling them is a knowledge-driven approach which considers space, time and theme. Therefore, it requires development of spatial, temporal and thematic semantics. These semantics can be better engineered under an umbrella of an integrative Ontology (Arvor et al., 2013). Developing such Ontology for the advancement of GEOBIA is an essential (Blaschke et al., 2014) and a challenging task (Andres et al., 2012; Belgiu et al., 2014). Taking this methodological challenge as a broader horizon, in this study, we develop a proof-of-concept object classification system for classes like tree, tree types, plantation and urban forest in multiple scales in an urban setting. In delineating the trees/gardens in a city environment in a hierarchy we use property (cadastral layer) as a thematic control. Further, thematic knowledge on trees, tree types, plantation and urban forests are used from AGROVOC ontology. The spatial semantics governed by the object properties and controlled by cadastral layer and the thematic semantics developed with the aid of AGROVOC Ontology make feasible to accurately extract the trees/gardens in an urban setting. This proof-of-concept is tested for a VHRS WorldView-2 imagery of Hobart City, Tasmania, Australia. The preliminary results proved that in GEOBIA framework, objects can be characterised with semantic meaning (Spatial and thematic semantics) and their relationship with the real world.

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2. AGROVOC Ontology and tree/agricultural object detection

AGROVOC is a vocabulary covering all areas of interest of the Food and Agricultural Organization (FAO) of the United Nations, including food, nutrition, agriculture, fisheries, forestry, environment etc. (URL 1) and is controlled and edited by a community of experts. The AGROVOC is used all over the world by researchers, librarians, information managers and others, for sharing and accessing the information. It currently consists of over 32,000 concepts available in up to 20 languages and published as Linked Open Data so that information can be used automatically. For example, forest and all information about and related plants including urban forests (trees) can be extracted (Fig. 1).

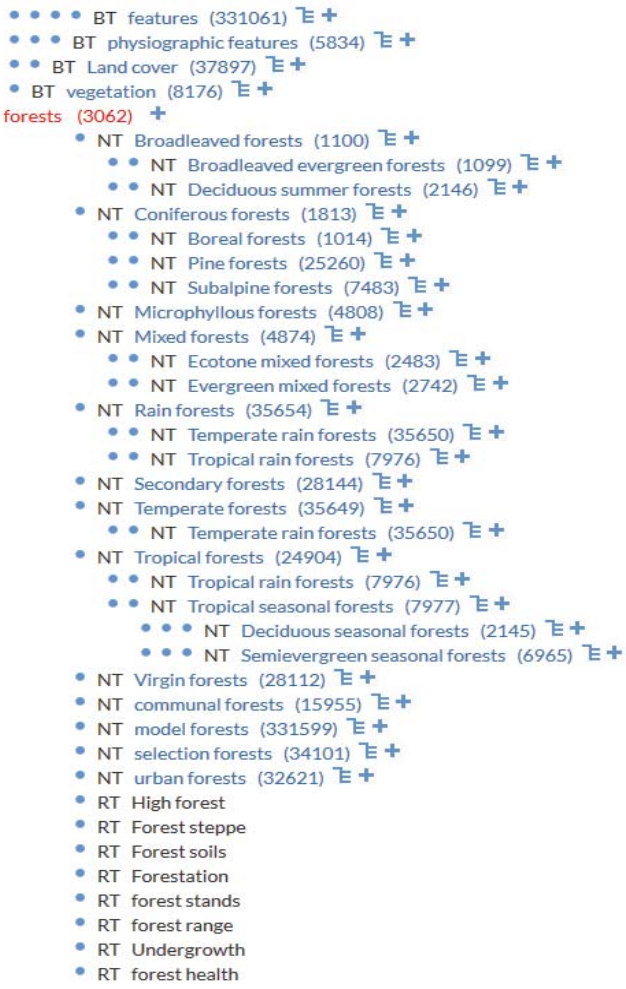

Figure 1. Urban Forest Object information from AGROVOC Ontology.

Furthermore, AGROVOC is connected with different data sources and hence it is possible that the information can also be augmented.

3. Data and proposed methodology

The data used in this study are WorldView-2 imagery of Hobart City from 2012 and cadastral layer from 2009. WorldView-2 imagery is acquired from a commercial Earth Observation Satellite owned by Digital Globe (Fig. 2a). The cadastral layer is provided by The Land Information System Tasmania (The LIST). The imageries are segmented in multiple levels (3

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different scales) with a focus to extract vegetation in particular trees / gardens controlled by cadastral layer as a thematic layer in GEOBIA framework (Fig. 2b). The representative segmentation is presented in (Fig. 2c). The first step in realising the AGROVOC definition in the local context which is carried out with thorough check-up to the bibliography and the object of interest to be extracted. We have checked the definition to tress and other agricultural objects and adapted them to local context. Our focus here is to extract tress with the use of AGROVOC ontology controlled by cadastral data in multiple scales in a GEOBIA environment.

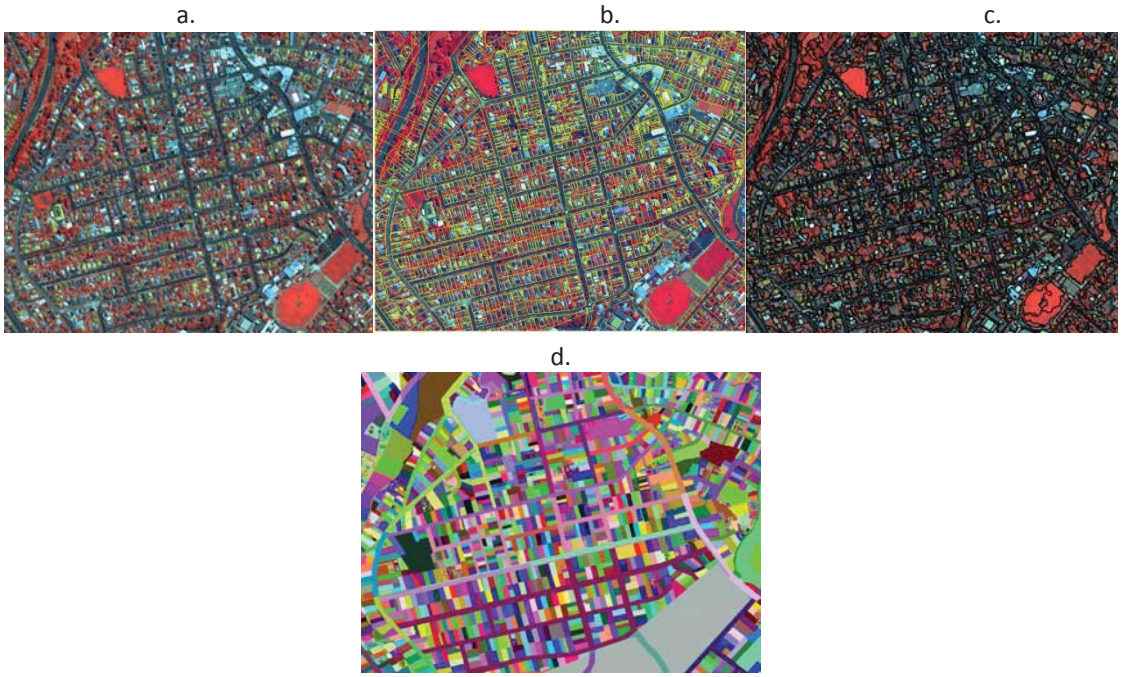

Figure 2. From left to right a. WorldView-2 imagery in false colour composite, b. Imagery overlaid by cadastral layer, c. segmented imagery using multi-resolution segmentation with the inclusion of cadastral layer and d. lower centre showing the property layer as a thematic layer in GEOBIA environment.

4. Refining the segmentation and classification using adapted definition

The process description as shown in Figure 3 starts with an image processing in this case a VHSR WorldView-2 imagery coupled with a cadastral data as thematic layer.

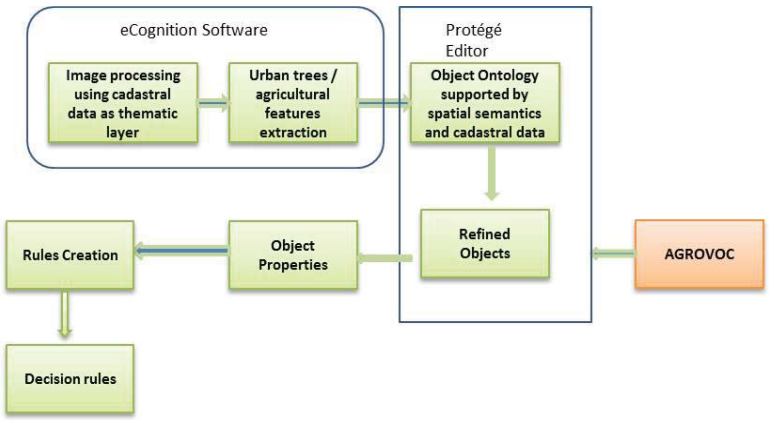

Figure 3. Process description of extracting trees/agricultural features in an urban setting by developing an integrated object ontology considering spatial and thematic semantics and AGROVOC.

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The resulted segmentations in different hierarchies for urban trees/agricultural features are used to develop object ontology supported by spatial semantics and cadastral data. These lead to refined objects with the help of AGROVOC Ontology where we can create rules to make decision on extractions of features.

5. Discussions and Conclusions

In this paper, we developed an integrated ontology based on spatial and thematic semantics. The spatial semantics is a result of multi-resolution segmentation controlled by thematic layer – the parcel data in a hierarchy. The thematic semantics is adopted from AGROVOC ontology which later used in refining the spatial semantics from hierarchical segmentation as shown in the Figure 3. This approach could be useful in delineating trees in urban setting, considering an ontological perspective.

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Useful links (accessed April 2014):

URL1: http://aims.fao.org/standards/agrovoc/about