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Educawood: a Socio-Semantic Annotation System for Environmental Education

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Abstract. Educawood is a socio-semantic annotation system intended for environmental learning in Secondary and Higher Education. It can be used to socially annotate trees and other ecosystem structures such as dead wood. Furthermore, Educawood allows the exploration of existing semantic datasets of land cover maps and forestry inventories as well as social tree annotations (all released as Linked Open Data). Teachers can browse these data to propose contextualized environmental education activities, e.g. finding and annotating singular trees. Students can go on a field trip and use Educawood with their mobile devices to submit tree annotations. Follow-up activities can exploit socially-created tree annotations, for example in virtual field trips.

Keywords: Environmental education · Forestry datasets · Linked Open Data · Semantic annotations · Virtual field trips.

1 Introduction

Environmental education is critical to better understand Earth's ecosystems and promote more responsible attitudes towards the conservation and conscious and sustainable use of our planet. Multiple investigations suggest a deeper and better understanding of environmental science through active learning experiences grounded on real-life settings [3,2]. For example, field trips can be organized to identify tree species and analyze biodiversity; the impact of climate change can be assessed using biomass equations to estimate ecosystem carbon stocks grounded on forest data. To support such kinds of environmental learning activities we propose the software system Educawood.

Educawood can be used to support learning activities based on the social annotation of trees and other ecosystem structures; it also allows the exploration

of the forestry information available in an area of interest. Educawood exploits existing semantic datasets of land cover maps and forestry inventories that were released as Linked Open Data for the Iberian peninsula in our previous work [1]. Teachers can check such information to propose contextualized activities for environmental education, e.g. finding a holm oak in a nearby dehesa and annotate it. Students can go on a field trip and perform the proposed activities, using Educawood with their mobile phones to annotate trees (locations, species, dendrologic measures, photos...) as required. These annotations are published as Linked Open Data and can thus be reused for performing new learning activities such as virtual field trips.

2 Activity catalogue and supported annotations

We aim to support learning activities in environmental education such as the following:

A1 Find and annotate a typical tree of a patch
A2 Find and annotate a singular tree (rare species, big size...) of a patch
A3 Identify the species of an annotated tree by checking its images
A4 Given a tree annotated by other students, estimate how many trees like it are necessary to compensate car carbon emissions in a 1,000 km journey
A5 Follow a specific track and annotate all the dead wood you find
A6 Follow a specific track and annotate all the microhabitats (nests, cavities) you find

These activities have been proposed by forestry academics, requiring land cover maps and forestry inventories of the zone of interest. A land cover map such as the Spanish one provides information of the geometries and main species of homogeneous areas (called patches). A forestry inventory provides tree annotations of a territory using a sampling strategy, e.g. the Spanish inventory uses a grid of 1 km^2 cells. In our previous work we have proposed the tool Forest Explorer [4] for browsing those datasets.

Tree annotation is an important activity in the forestry domain and in environmental education. We have thus developed the Simple Tree Annotation ontology (STA –namespace `sta`). It supports typical tree annotations –namely, location, height, width, and species identification– plus image annotation and creator metadata. We borrow terms from WGS84 Geo[3] and Dublin Core[4] vocabularies when appropriate. Note that STA supports multiple and probably inconsistent annotations from multiple users –the ontology includes primary properties, e.g. `hasPrimaryPosition` that can be used for conflict resolution. We have finished a working (and tested) version of STA for tree annotation. A future release will support annotations of dead wood and microhabitats. Listing 1 includes a sample annotation of a tree in RDF with STA.

[3] https://www.w3.org/2003/01/geo/wgs84_pos
[4] https://dublincore.org/specifications/dublin-core/dcmi-terms/

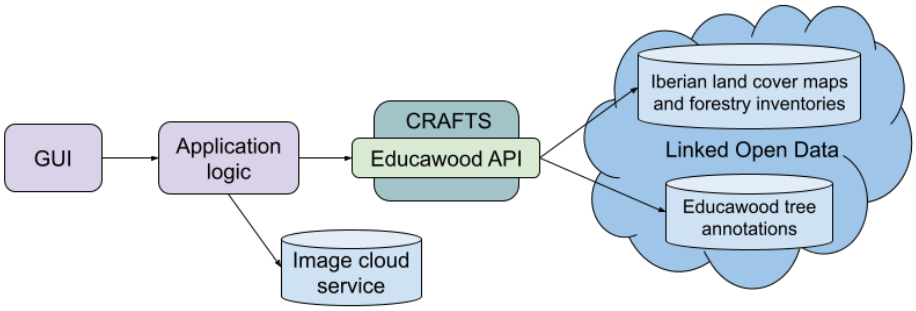

Fig. 1. Logical architecture of Educawood.

Listing 1. Annotation of a tree with a position and an image of its general view in RDF using Turtle syntax.

```
:tree0 a sta:Tree ;
   dc:creator :jimand ;
   sta:hasPositionAnnotation :posann0 ;
   sta:hasPrimaryPosition :posann0 ;
   sta:hasImageAnnotation :imgann0 .
:posann0 a sta:PositionAnnotation, sta:PrimaryPosition ;
   dc:creator :jimand ;
   geo:lat 41.012 ;
   geo:long -4.967 .
:imgann0 a sta:ImageAnnotation ;
   dc:creator :jimand ;
   sta:hasImage :alcornoque.jpg .
:alcornoque.jpg a sta:Image, sta:GeneralView .
```

3 Architecture of Educawood

Educawood is a socio-semantic system for the annotation of trees and other ecosystem structures. The logical architecture is graphically depicted in Fig. 1. Users access the system through the `GUI`; this component exposes an interactive map for exploring forestry data coming from land cover maps, forest inventories, and social tree annotations. The `GUI` also includes a form for creating annotations such as the one in Listing 1. User actions performed through the `GUI` are forwarded to the `Application logic` component that provides the system's core functionalities: user management, tree annotation, forestry data retrieval, and image upload (which relies on an external `Image cloud service`).

Tree annotations created with the system are stored in the `Educawood tree annotations` dataset. `Iberian land cover maps and forestry inventories` are also employed to retrieve forestry data from an area of interest. Since these sources are available as Linked Open Data, we use `CRAFTS`[5] (Configurable REST-

[5] https://crafts.gsic.uva.es

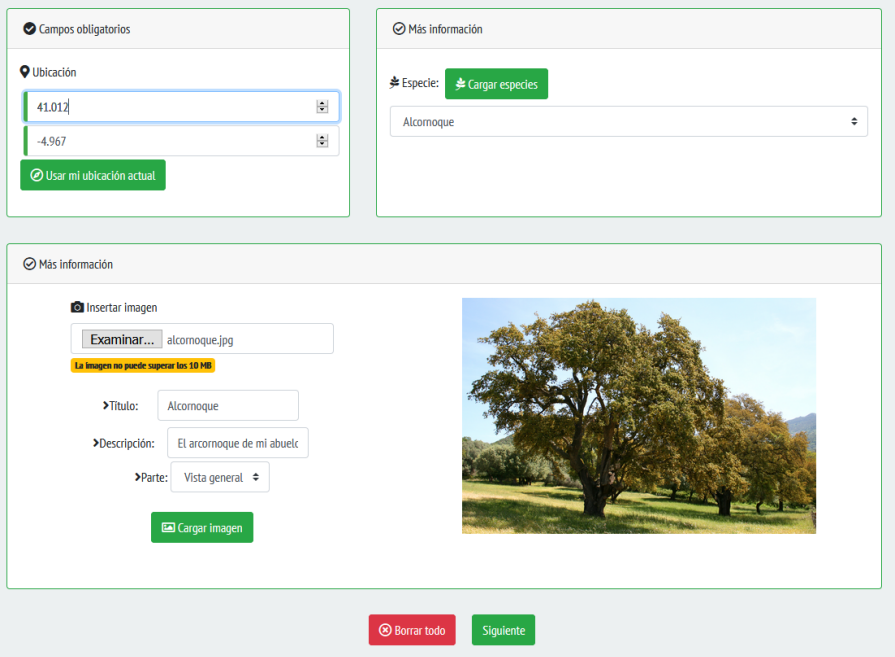

Fig. 2. Tree annotation example with Educawood corresponding to Listing 1.

ful APIs For Triple Stores). More specifically, the `Educawood API` exposes a regular RESTful API that greatly simplifies the access to the data sources –note that the alternative involves the usage of Semantic Web technologies such as SPARQL, OWL, and RDF.

We have developed a preliminary working prototype of Educawood. The source datasets are already deployed in distinct SPARQL endpoints, while the `Educawood API` is deployed at https://crafts.gsic.uva.es/apis/educawood. The `Application logic` is based on Express[6] –a popular Node.js web application framework. We have employed Angular[7] to develop the `GUI`. This prototype is web-based and can thus be used with any device with a modern web browser (to run the `GUI` –see Fig. 2). This facilitates the use of Educawood with mobiles in field trips, as well as with computers in the classroom or at home.

4 Sample learning scenario

Educawood is intended to be used in blended learning settings in Secondary and Higher Education. The proposed activities can be carried out in field trips, computer-mediated, and face-to-face classroom practices. We present below a learning scenario intended for a Nature Sciences course in Secondary school:

[6] https://expressjs.com/
[7] https://angular.io/

1. The teacher uses Educawood (or Forest Explorer) to prepare a field trip, finding a suitable patch with a mixture of Scots pines and Black pines with Holly trees in the under-story.
2. The teacher proposes several activities for their students: (i) identify singular trees (rare species, big size...), (ii) identify tree microhabitats (nests and cavities), and (iii) measure trees (diameter and height). Focusing on the target patch, students can search for common tree species of pines and distinguish between them, and look for Holly trees.
3. (Field trip) Students complete the proposed activities. They use Educawood with their mobile devices to annotate trees and tree microhabitats –see Fig. 2 for an annotation example with Educawood.
4. (Classroom) Students can estimate carbon stock of the measured trees by fractions (branches, stem, roots, and leaves) using appropriate equations in the classroom.
5. (Home) More follow-up activities like forest virtual visits[8] to identify main species and locate tree microhabitats that can lead to new annotations with Educawood. This can be used as a basis to gain insight on concepts like intertree competition, structural and specific diversity and sustainable management by guessing the trees to harvest in order to promote bioeconomy while enhancing diversity.

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[8] http://sostenible.palencia.uva.es/content/virtual-forest-tours