

GEOSPATIAL ONTOLOGY OF AGRICULTURAL REGIONS:
AN EXCERSIZE IN KNOWLEDGE ENGINEERING

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Abstract

This research project attempts to construct a geospatial ontology of global agricultural regions.

A geospatial ontology is a formal conceptualization of the spatial relationships of geographic phenomenon. The purpose of a geospatial ontology is to increase the understanding of the semantics in a domain for computers and to increased interoperability between data sets.

This research project explores the challenges of creating a ‘universal’ conceptualization of a social geographic phenomenon as it pertains to GIScience. This ontology of agricultural regions aims to answer questions like what is a farm? How is a farm differentiated from other landscapes on the Earth’s surface? What is the typology of farming systems? The ontology in this study takes a top-down approach using semantics identified from Derwent Whittlesey’s agricultural region classification scheme. Ultimately this ontology may be useful for governing bodies in environmental monitoring or environmental decision-making on a national scale.

Introduction

As the world’s population continues to grow there is increasing pressure on our agricultural food systems. In order to optimize the land available for farming and to farm sustainably and efficiently there is a need for the collection, organization, and exchange of agricultural data. For this project I will build a geospatial ontology of globally distributed agricultural regions. By doing so I hope to outline the relationships of the defining characteristics of each farming system for increased geospatial data interoperability amongst agricultural stakeholders. This holds significance for the precision farming and best-practice agricultural management as well as the development of a slightly more abstract geospatial concept—that is to say the majority of

geospatial ontologies in existence now are for physical sciences like geology or hydrology. This research project aims to build a functioning geospatial ontology for global agricultural regions.

I perform a literature review of agricultural region classifications to identify one that I believe is the most comprehensive and then select the relationships and vocabulary associated to the typology. Then using Stanford's Protégé 5, I build the ontology in the standard web ontology language (OWL). Due to time constraints I only defined the classes within the classification by spatial characteristics, though economic aspects are important to consider. In the following section, I review the necessary terminology and concepts of ontologies in GIScience.

Geospatial Ontology Literature Review

History and Definition

The study of ontology is rooted in philosophy and is defined as the study of the nature of being, coming to existence, or reality in addition to the study of categories and their relations. Upon the introduction of Artificial Intelligence (AI) ontologies have been discovered as a useful foundation for information sharing because of their potential to explicitly identify and define both concrete and abstract ideas. Ontology has since been appropriated to the fields of computer science, knowledge engineering, and GIScience to name a few (F. T. Fonseca, Egenhofer, Davis Jr, & Borges, 2000). Geo-ontologies, geospatial ontologies, and ontologies for information sharing have been a growing topic of research in GIScience beginning around the 1990's. Thomas Gruber (1992), one of the first researchers to define ontology as it pertains to GIScience, defines it as "an explicit specification of a conceptualization". This popular definition has been further refined by Guarino (1998) as to distinguish between ontology and

conceptualizations such that an ontology is a logical theory accounting for the intended meaning of a formal vocabulary (i.e. its ontological commitment to a particular conceptualization of the world); whereas a conceptualization is the formal structure of reality as perceived and organized by an agent, independent of the vocabulary used (Frederico T. Fonseca, Egenhofer, & Aqouris, 2002; F. T. Fonseca et al., 2000). Geospatial ontologies are the intersection of the regular functions of ontologies (richer semantics) with feature components and relations to the standard GIS feature representations of coordinates, topology, and attributes.

Interoperability and Knowledge Sharing

There is a geospatial information community (GIC) consensus that the key inhibiting factor for sharing geographic data is semantic non-interoperability (Pundt & Bishr, 2002). This problem is central to the appropriation of ontologies to GIScience as the demand for knowledge sharing increases. Interoperability refers to the ability to utilize a range of data formats from a range of programs and applications (Zhang, Zhao, & Li, 2015). Geospatial ontologies are used to increase semantic interoperability on three levels—search, querying, and integration—and encompasses the processes of semantic enrichment (reconciling semantic heterogeneity by adding semantic information to a data set) and mapping discovery (ontology matching) (Buccella, Cechich, & Fillottrani, 2009). There is also often a distinction between approaches that call for ontology engineering and approaches that specify semantics and develop transformation mechanisms between domains, though both are functions of ontology (Hong & Kuo, 2015). Another aspect of interoperability special to ontologies is the increased communication between different types of users (both man and software). The future of interoperability in GIS is in standardization and semantic translation (Visser, Stuckenschmidt, Schuster, & Vögele, 2002).

Though ontologies are used to standardize metadata exchange they, ironically, do not have a standardized methodology for their own construction.

Ontological Engineering and Architecture

Perhaps one of the largest misconceptions of geospatial ontologies is that they replace numerical and statistical modeling (Janowicz, 2012). Ontologies, instead, are better thought of in terms of the metadata organization for a communication or exchange layer (Buccella et al., 2009). How we choose to organize the metadata is the foundation of ontological engineering and ontology architecture. The most common approach for geospatial ontology architecture is to use multiple top-down structured authoritative global ontologies (also known as top-level ontologies) that connect to specified domain ontologies and application ontologies (Janowicz, 2012). The domain ontology is used to define semantics specific to the area of interest (Klien & Probst, 2005) and works with the application ontology to report back to the global ontology (Baglioni, Masserotti, Renso, & Spinsanti, 2007). The application ontology represents, through a combination of concepts and relations, the structure of the database where spatial properties between objects are explicitly represented (Baglioni et al., 2007).

Kolas, Hebel, and Dean (2005) identify 5 distinct ontologies they believe are pivotal to building an enhanced geospatial semantic web. These are (1) a base geospatial ontology providing core geospatial knowledge vocabulary and structure; (2) a feature data source ontology that provides an ontological view of Web Feature Service (WFS) data; (3) a geospatial service ontology that supports knowledgebase discovery and execution of all registered geospatial services; (4) a geospatial filter ontology that integrates geospatial relationships to queries; and

(5) a domain ontology providing a knowledge representation that is organized, customized, and aligned with a specific domain and/or user (Kolas et al., 2005). This offers an organized framework, however, there is no specified standard to the geospatial semantic web.

There are limitations to the traditional description logic top-down architecture, one of which is semantic accuracy. Janowicz (2012) argues that GIS provides marginal and abstract information on logical consistency, which is often reduced to topological relations and attribute accuracy.

There is very little focus on semantic accuracy and for this reason he proposes using an observation driven engineering approach¹. This approach utilizes a bottom up methodology with many local ontologies and aims to preserve semantic diversity and local, application-centric conceptualizations without giving up interoperability and enable users to become active knowledge engineers (Janowicz, 2012). A second issue with conventional geospatial ontologies is discussed by Sen (2008) in his paper “Framework for Probabilistic Geospatial Ontologies”. He argues that conventional geospatial ontologies are not equipped to deal with probabilistic systems. This is problematic when a user is trying to specify something that is ‘most similar’ or ‘least similar’, which realistically, is very useful information. Sen (2008) proposes using a Bayesian Networks for the expression of probabilistic geospatial ontologies, as opposed to the Boolean method.

¹ For detailed methodology please refer to “Observation-Driven Geo-Ontology Engineering” by Janowicz (2012)

Geospatial Ontologies in GIScience

The implications of geospatial ontologies to GIScience can be seen most clearly in software development. Ontology-driven geographic information integration offers a backbone for the development of specialized software. Ontologies in general have developed an individual computing language (OWL) and geospatial ontologies have also driven the creation of the Geospatial Semantic Web, two very important technological advancements. The use of geospatial ontologies also has implications to GISystems—many ontologies are engineered directly from geographic databases, specifically changing the way data is shared. Initially, ontology seems to have been introduced to GIScience as an organizational tool but with time geospatial ontology has realized its scientific nature and implications to GIScience studies. We saw this first in the types of problems surrounding ontologies, many of them are inherent to GIScience. Secondly, this is due to its intersection with other pillars of GIScience such as spatial cognition, uncertainty, big data, and open data. Thirdly, in order for ontology to be built there must agreement on the definition of the concepts involved. Ontologies, then, are a way to identify geographic concepts that are poorly understood or problematic, and offer a chance to better formally conceptualize them.

Agriculture Regions Literature Review

History

Agriculture is the cultivation of plants, fungi, fibers, or animals and is generally referred to as the practice of farming. Farming developed independently in various places and at various times globally, each region pioneering farming methods specific to the environmental conditions of

that place (Ponting, 2007, p. 23). One of the most widely accepted theories of agricultural development is by the agricultural economist Ester Boserup stating that agriculture is the result of both increasing frequency of land use and population density (Reed, 2011, p. 24). As population density increased, more food was necessary to sustain the settlements and so more land was cultivated until it became increasingly scarcer. Once less and less land was available for farming, various farming technologies arise in an effort to increase yields at a lower cost in terms of energy at first and now both energy and money. These yields are heavily dependent on the type of crops one is able to grow in their climate, depending on various exogenous factors like soil moisture and type, sun, and seasonality (Ponting, 2007, pp. 46-52).

Following the early stages of agriculture we see the second revolution commonly referred to as the green revolution. Beginning in the 1960's this revolution changed an already diverse field into even more diverse farming techniques. The green revolution was propelled by human's selection of species, chemically precise inputs, and mass mechanization of labor (Evenson & Gollin, 2003, pp. 758-760). This revolution was the result of a drastic population boom and an immediate need for higher output of food production. It is from the green revolution that most of our foods today is a part of. The green revolution developed the crop-management practice of precision agriculture, defined as matching the resource application and agronomic practices with soil and crop requirements as they vary in space and time within a field (Whelan & McBratney, 2000, p. 265).

Today we see a variety of types of agriculture with definitions that vary country to country, however, there is a set of features commonly used to distinguish farming types. These are the (1) size of the farm, usually measured in economic output rather than spatial extent; (2) the

farming practices; (3) crops cultivated; (4) proximity to urban centers or transport routes; (5) mobility; (6) type of labor; (7) the socio-economic status of the owner/manager (FAO). The most widely accepted global farm typology comes from an updated version of Whittlesey's classification from 1939 (Helburn, 1957, p. 2). The crop and livestock association; methods used to grow crops and produce the stock; intensity of application to the land of labor; capital and organization, and the outturn of product that results; the disposal of the products for consumption; the ensemble of structures used to house and facilitate the farming operations (Helburn, 1957, p. 2).

Classification methods are not globally standardized and vary by country, the Whittlesey region classification scheme was the first to focus not only on climate but farming practices. It is the most applicable typology to farming worldwide and is broken down into 12 farming systems (Whittlesey, 1936, p. 200). In Derwent Whittlesey (1936) seminal paper *Major Agricultural Regions of the Earth*, he determined that these regions are broadly divided into 4 greater groups: dominant animal rearing in regions too arid, rugged, or remote for successful crop raising; dominant production of crops, with animals minor or absent, but with crops varied due to a growing season never checked by cold; dominant production of crops, with animals minor, and with the number of crops strictly limited either by natural environment or by market; and roughly equal production of crops and animals (p. 210). These groups, though well defined, are not precise enough as they lump together farming systems with various intensities of labor.

For this reason, Whittlesey decided to include the intensiveness of application and quantity of return to point the differences between the world which uses machinery, the world which uses much hand labor and still is able to create high yields, and regions where less advanced hand tool

are used and produce a significantly smaller return (p. 211). Lastly, he notes it is important to consider the destination of the production. The differences in farming operations between subsistence and commercial farming are drastic and should not be equated by the type of produce or climactic limitations (p.211).

The classification is as follows. Nomadic Herding (p. 214-215), known as the aboriginal form livestock business, is largely determined by the natural environment. Occurring on natural grasslands and steppes, people travel with their herds following vegetation and water. In this subsistence farming the animals provide the owners with nearly all their goods. The temporary settlements are widely scattered and continuously encroached on by expanding livestock ranching.

Livestock ranching (p. 215-217) is a sedentary operation where owners have fixed places of residence. They operate for the benefit of an individual rather than a community like in nomadic herding. Ranchers raise their livestock for the market and on a large scale with vast regions of land fenced off for grazing. It is typical to North America, Latin America, and Australia on grasslands, prairies, and steppes.

Shifting cultivation (p. 218) occurs within a tropical forest and is dependent on the slash and burn farming for soil fertility. This type of farming system utilizes intertillage, where multiple crops are cultivated in one field in order to provide shelter to weaker varieties. Shifting cultivation is subsistence based and requires communities to move every few years to cultivate

new, fertile soils. There are sometimes instances of livestock rearing, however, this is a secondary source of subsistence.

Paddy rice farming (p. 221), sometimes referred to as intensive subsistence tillage with rice dominant. The defining feature of this mode of farming is the paddy-irrigable deltas, floodplains, coastal plains, and terraces. Paddy farming is both commercial and subsistence based and yields more grain per acre than any other crop. Livestock is present as a means of labor for plowing and all other work is done by hand.

Peasant grain, root, and livestock farming (p. 222-223) or intensive subsistence tillage without paddy rice, occurs in low latitude oases scattered across the desert of Inner Asia and North Africa. This farming system is less intensive than paddy rice and mostly for subsistence. It is a sedentary operation that produced lower yields and operates at a smaller scale.

Mediterranean agriculture (p. 227) is a subsistence system based on grain cultivation in the wet season and drought-resistant vine crops in the dry seasons. Livestock is present but rarely integrated into farming labor and fields are let to lay fallow to regain fertility after a few years of crop production. It occurs in the high and lowlands of the Mediterranean.

Plantation Agriculture (p. 224-225) is strictly for commercial purposes occurring in tropical and subtropical areas. It is reliant on large amounts of hand labor and is located close to shipping lanes. This farming system is dedicated to one type of crop, usually a cash crop, and is cultivated over extensive land areas.

Market Gardening (p. 236), or specialized horticulture, occurs on a large scale. It focuses on a select few crops for the commercial market appearing mostly in industrialized countries. They are located along transit routes and they raise no livestock. These occur in various subtropical regions and are characterized by a single house amongst a large field or orchard.

Commercial Livestock fattening (p. 231) or sometimes referred to as commercial livestock and crop farming, is the cultivation of grains to feed livestock for commercial purposes. These systems take place on a large scale and are characterized by fenced off fields on grasslands and prairies. They are located closer to cities to facilitate rapid consumption of animals post slaughter. Livestock fattening is machine intensive and great care is placed in selecting the appropriate variety of grain to grow.

Commercial dairying (p. 234) produces dairy products for the market. They operate on a large scale on grasslands, prairies, and steppes. All of the products must reach their market destination quickly to avoid spoiling so these farms are often located on the outskirts of suburban areas. The dairy business is highly mechanized and characterized by barns and grazing areas for the livestock.

Commercial grain farming (p. 229) is strictly for commercial purposes and employs no livestock. Farms are operated by one person or corporations and are located near large transport route on grasslands, steppes, or prairies. These are very large scale and input intensive. They rely mostly

on machine labor as a product of the green revolution and most of the seeds have been genetically engineered for higher yields.

Lastly, urban agriculture was originally part of Whittlesey's classification but it has become an important form of agriculture for many urban areas with food scarcity. These farming systems are small scale and subsistence based; many function as community gardens or green houses.

Methods

The methodologies for this ontology construction can be broken down into 4 distinct parts: vocabulary collection; organization, class construction, and relationships; property class restrictions; and query testing and visualization. Ontology building is necessarily an iterative process, so though these parts were generally followed in succession, I did revisit each step numerous times. As a general guideline I referred to two ontology construction tutorials, *Ontology Development 101; A Guide to Creating Your First Ontology* by Noy and McGuinness and *A Practical Guide to Building OWL Ontologies Using Protégé 4 and CO-ODE Tools* by Horridge (2011). Additionally, I followed the best practice guidelines outlined by the semantic web and I chose to use a top-down approach because I felt it would be simpler to identify the broader concepts first (Bergman, 2010).

Vocabulary Collection

In order to collect the vocabulary I needed for this ontology I first had to develop a set of questions to define the scope and domain of this ontology. These involved considering the end

user and the purpose I want my ontology to serve. I determined these questions to be: *What is a farm? Where do different farming systems occur globally? How is a farm differentiated from other landscapes on the Earth's surface?* As part of the best practice guidelines, I searched for an existing ontology and discovered the Agricultural Ontology Service (AOS) constructed from the AGROVOC, a thesaurus dedicated to agricultural vocabulary. I looked into this ontology to see if there was any specific vocabulary I should use to increase the interoperability between ontologies concerned with agriculture. The goal of the AOS is an extension of the FAO's effort to create a tool to help structure and standardize agricultural terminology in multiple languages for use by any number of different systems around the world (Lauser, Sini, Liang, Keizer, & Katz, p. 1). Upon further inspection, however, the FAO wished to use the AOS as merely an enhanced thesaurus and it did not have any geospatial concerns. This prompted my decision to try and build a geospatial ontology for a global agricultural classification scheme separate from the AOS. I decided on an updated version of Whittlesey classification scheme, as described earlier. The FAO determined that this classification was incomplete and somewhat selective (FAO, pp. 6,8), however, it had 11 concise categories that spanned globally and took into account both livestock and crop cultivation variations so I deemed it most appropriate. The other classifications were too broad, too limited, or didn't deal with both livestock and crops, which by definition are both included in agriculture. With my classification scheme selected, I then went through and pulled out vocabulary specific to each classification. Looking for things such as, but not limited to, farming techniques; or whether they happened in developing countries; or if it needed to be in a city landscape or forested area.

Organization, Class Construction, and Relationships

From my vocabulary list, the next stage is to organize this list into a hierarchy with classes and subclasses in Protégé 5. Starting with the superclass farm I worked down the vocabulary list grouping like concepts. For example the concept of the location of a farm could be subdivided into urban, rural, and suburban. I will define the relationships between classes later on, but in building a hierarchy it is important that every subclass can theoretically be an ‘is-a’ relation to its superclass as the relationships between classes are only applied to instances of that class. For example, we can reason that a *tropical forest* is a *landscape*. For any class that cannot have instances belonging to a specific class other than its own, I made sure to identify it as disjoint from those classes—this applies to the 11 different agricultural regions.

As I organized the vocabulary into classes I thought about what types of relationships I would like to represent in the ontology. Where applicable, each relationship is assigned a domain and range. The domain and range define what class has the specified relationship to what other class; for example, farm (domain) has type of (relationship) Whittlesey Region (range). According to the best practice recommendations it is not always ideal to restrict relationships to classes as this decreases interoperability (Bergman, 2010). I only added domains and ranges to the relationships representative of a superclass and its subclasses, not relationships that applied across classes at the same level in the hierarchy. Additionally each relationship should be assigned a type from functional, inverse functional, transitive, symmetric, asymmetric, reflexive, or irreflexive. These decide how the relationships will work between instances. The relationships I focused on were the ones that I found inherently spatial, as opposed to descriptive characteristics, which I did include in my original hierarchy.

Property Class Restrictions

Once the relationships have been identified I can use them to give my classes meaning beyond simply a typology. To do this I went to the Whittlesey Regions class and gave all of the agricultural regions their necessary conditions following the semantic subject-predicate-object type definition (Hong & Kuo, 2015, p. 2230). Necessary conditions are the criteria that an instance of that class must have in order to belong in the class. For these I entered all of spatial information to each farming region. Each one was given a location, a size, a country, a landscape, and a mobility. These relationships are entered in the Subclass section of the classes tab. When building these I had to assign one of three main categories of restrictions—quantifier, cardinality, or has value restrictions. I only used quantifier restrictions because I did not have associated values or instances to create meaning with the other two restriction types. From the quantifier restrictions I must decide if they are universal or existential. If the relationship is universal I use the word ‘only’ meaning that only the listed values are capable of placing the instance in this class. And if the relationship is existential I use the word ‘some’ to tell the computer that at least one of the values from this class is required. By this stage all of my Whittlesey Regions are primitive classes, meaning they lack sufficient conditions.

Without sufficient conditions my ontology is still technically a typology as it is unable to do any reasoning on it’s own, so I must enter the sufficient conditions to create defined classes. The sufficient conditions are where a query search looks to identify potential returns, and these are entered in the equivalent class section of the classes tab. A sufficient condition is used to tell the system that if an instance has a set of values it must belong to a class. With both sufficient and

necessary conditions, the reasoning works two ways so that a named class is defined by its restricting conditions and a list of conditions can be used to identify a class. I entered all the corresponding spatial values (subclasses in this case) into the equivalent class tab using the Boolean operators and/or. All separate class values were connected by and, any class that had more than one potential subclass listed the potential subclasses connected by or within parentheses.

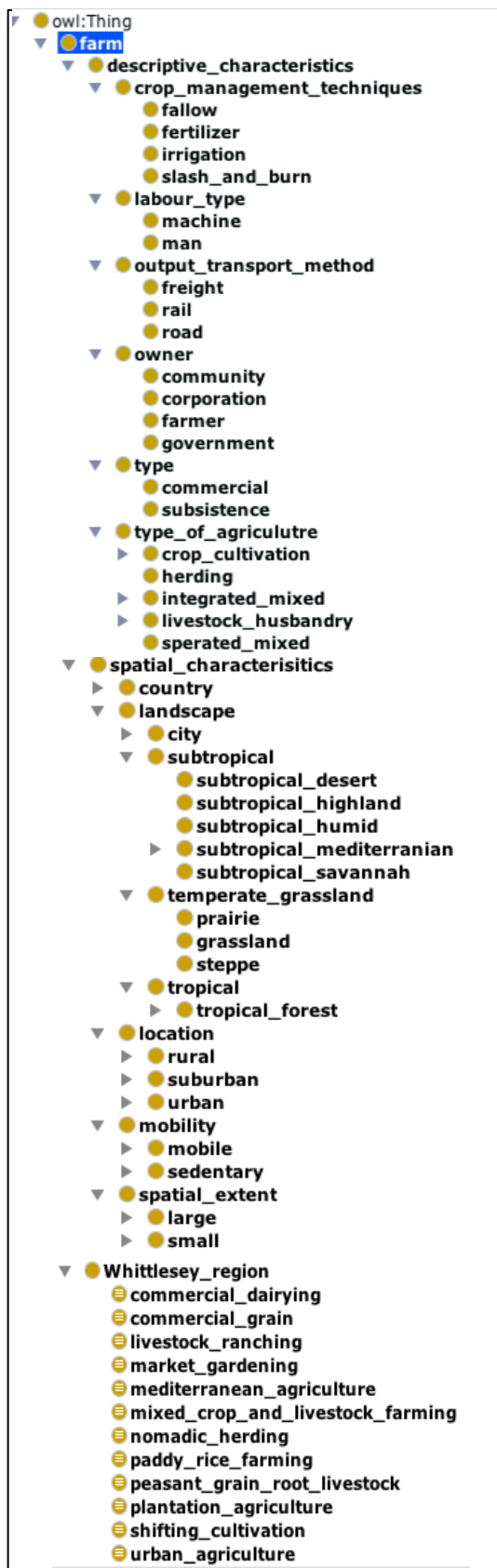
It is important to note that the reasoner plug in should be invoked at this time, though I synchronized it with each input to be clear that my inputs were logical. If the reasoner returns any errors, now is the time to go back and figure this out. I can open the inferences the reasoner makes for any class highlighted in red to see where the logic is faulty. In this case a few Whittlesey regions are highlighted because the spatial characteristics alone were not enough to differentiate them and I declared them disjoint. So I added one or two descriptive values to these classes in both the necessary and sufficient criteria.

Query Testing and Visualization

Finally, as a test to see that the ontology is capable of reasoning on its own I ran some test queries. I tested all 11 Whittlesey Region sufficient criteria to be sure that I had input those correctly and also some random short combinations like 'rural and sedentary and grassland'. This seemed to be working, so I moved on to visualization. First I had to set up the OwlViz plug-in so that it worked in the protégé environment. Then I opened all classes and subclasses to see how they are organized, this wasn't showing relationships besides is-a because I did not

include any instances. Instead, I set up the OntoGraf tool to visualize the classes, subclasses, and the object properties between them.

Figure 1: Screenshot Protégé 5 Class Hierarchy



Results

The resulting ontology is the skeleton for a comprehensive geospatial ontology of agricultural regions. This ontology has a total of 71 classes and 15 object properties, 216 logical axioms, 0 data properties, and 0 individuals. My ontology starts with the superclass farm and breaks down into 3 subclasses; descriptive characteristics, spatial characteristics, and Whittlesey regions. The further breakdown of classes can be seen in the Figure 1.

Looking under the Whittlesey_region class in Figure 1, note that the yellow circles have 3 white lines in them, this is an indication that they are defined classes. All other classes are primitive. All relationships concerning spatial characteristics are under the owl object property head and then a subhead exists for relations concerned with descriptive characteristics to organize the object properties. Each property has a corresponding class and the values used to give the Whittlesey regions exist as subclass of these classes. This is the pattern between the object properties and class that is the foundation for the ontology

Figure 2: Object Property Screenshot

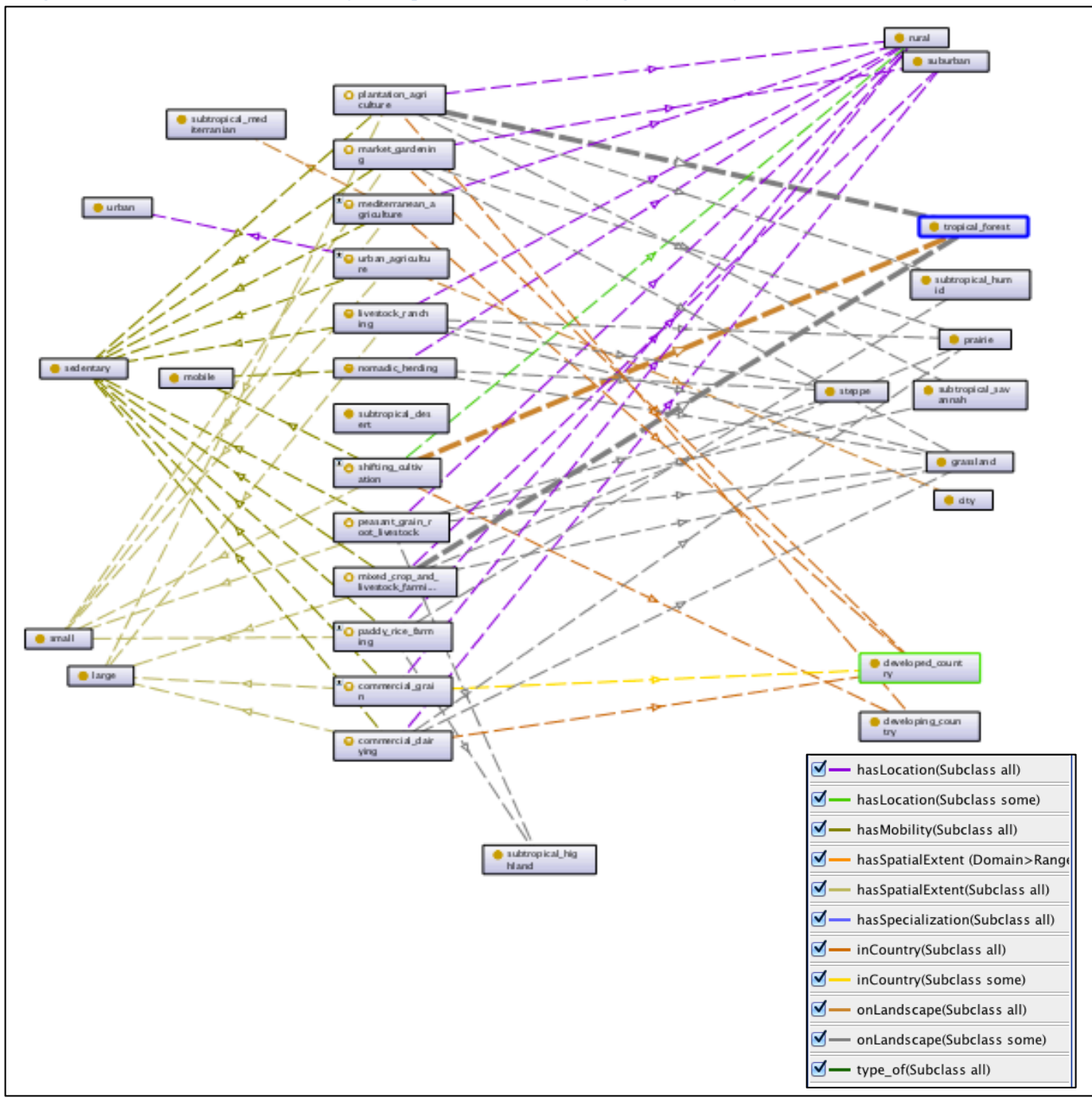


architecture. A figure of the hierarchy of object properties can be seen in Figure 2. All object properties except the subproperties of Modifier_Properties and type_of have domains and ranges corresponding to the classes they influence. Properties type_of and has_type are inverses and defined as such. All of these properties are transitive or functional and none of

them are disjoint from the others.

The relationships are successfully visualized between the Whittlesey regions and their spatial characteristics as Figures 3 and 4 show. Each region has an assigned location, mobility, spatial extent, country, and landscape value. Some of these relationships are repeated in the key (see figure 4) with the clause ‘subclass all’ or ‘subclass some’ following them. This is the result of using both existential and universal quantifying object properties.

Figure 3: OntoGraf Visualization of Object Properties and Whittlesey Regions with Key



Discussion

The original goal of this ontology was to facilitate in answering the three questions asked at the beginning of the methodologies. The ontology I was able to build only partially addresses the first two questions. This is the result of undertaking a very large and very conceptual project. Though I have some knowledge of agricultural food systems, I am not an expert nor am I in touch with my indented end users. My ontology, therefore, is not universal but rather my conception of the defining spatial characteristics of varying types of farms. I made design decisions that, as the creator of the ontology, seemed logical but others may think differently. Now I will discuss some of the decisions I made and their consequences.

Firstly, I chose to differentiate between spatial and descriptive characteristics. I justified this decision on the basis that I am building a geospatial ontology and incorporating non spatial characteristics was necessary to distinguish farming types but not the focus of the ontology. Farming systems have a variety of different features that are not all inherently spatial. To keep the ontology on track I tried to focus strictly on characteristics determined in space like whether or not the farm moved, and what kind of landscape it occurred on. I originally planned on building an ontology of just a farm, but quickly realized that a farm was indeed many different things. The characteristics between a North American dairy farm and a North American grain farm alone are quite different. Inspired by Sinha et al. (2014, p. 197) surface water ontology, I wanted to design a minimalist ontology not designed to represent all aspects of farming.

A second decision worth discussion is the choice of using a top-down approach. Though the literature on ontology engineering is undecided whether or not a bottom-up or top-down

approach is best, I felt this way would be the most clear. It did, however, bias my thinking. I noticed that instead of reworking the intended structure I spend a great deal of time trying to fit concepts in where they might not have made the most sense. It is also the reason why the only defined classes I have are the Whittlesey regions. Other ontologies may more defined classes, but I was most concerned with defining the top parts of the ontology with the subclasses, which I focused much less on. Additionally, I did not include any instances. This is partially a result of the top-down approach but also I didn't see any time instances would be helpful. This ontology is to function as an upper-level ontology, and to give it specific instances would be restrictive. By not defining instances, I leave the option to integrate dataset features as instances to the ontology and thus increase its interoperability (Sinha et al., 2014, p. 198).

Because this ontology was designed to integrate databases it also has no data properties. Any sort of numerical spatial data I was able to find, from the FAO or US Census, does not follow any type of standardization. There are no agreed upon values for what is a large farm globally. There do exist measures for this on a regional level but to input definitive values to my global scale ontology would be limiting. Ideally, a geospatial ontology should be operable on multi-scales, however, when considering something like farming this proved to be very difficult as any relationships I defined did not seem to hold across scales especially when their defining features are scale dependent. All the relationships I included are either transitive or functional and I believe this is due to the mereological approach.

Looking at the subclass property restrictions, you will notice there are only quantifier restrictions. Again, because there is no associated database I did not assign any has value

relationships or cardinality. Had I been able to include relationships such as nearby or far from then cardinality would have been used but the Whittlesey region classification did not incorporate these relationships into the classification scheme. Within the quantifier relationships I used both the types universal and existential. I decided these on my best judgment and did not have any system in place to aid these decisions therefore there may be some inconsistencies between classes. These inconsistencies did not make themselves evident with query testing or the reasoner.

The necessary property restrictions were input with relationships and values while the sufficient property restrictions were just all the necessary values connected with the Boolean operation 'and'. I was unable to confirm if this is incorrect and decided to structure it this way for the users simplicity. People searching for a specific type of farm will not necessarily understand the relationships used to determine which values define the whole but they may have one or two values in mind of what they are searching. So by just requiring the values, I believe I created a slightly more user-friendly ontology. My intended end-user is not an agricultural expert, this is also part of the reason why I did not include the crops farmed by each region. I considered including these features because the FAO's AOS is based largely on the various types of crops farmed. Including this would have made it much simpler to connect the two ontologies, however, there is no definitive list including which farming region produces which crops. I also felt that this would detract from the fact that this is a geospatial ontology. The AOS did not include many spatial features and that is why this became my focus.

Lastly, One of the greatest challenges of constructing this ontology is critically thinking about the placement of each thing you wish to represent. Ideally, an ontology should have no repeating inputs as this can become confusing for the reasoner. I succeeded in organizing the features I wished to include without repetitions however I had now way to test its interoperability with other systems. I did not have access to any of the work from the AOS nor were there available agriculture related ontologies on the WebProtégé interface. Many ontologies are constructed on a by-demand basis. When the need for one is identified they are constructed by teams of ‘experts’ to facilitate the utmost interoperability and then built into the semantic web. I would like to emphasize that I am not an expert in neither agriculture nor computer sciences, and as such, my ontology is very much an exercise in knowledge engineering.

Recommendations

I would recommend future ontology engineers explore multiple options in their architecture and construction. Thought the top-down approach seemed best at first, a more observation driven approach certainly has its advantages. Especially when building formal domain level ontologies, which are modeling rather abstract entities like farming systems, focused on the parts and wholes, the theory of dependence and of boundary, and continuity and contact (Agarwal, 2005, p. 512). Because observations are necessarily discrete and are made at discrete times or time intervals over discrete regions of space, they may facilitate the construction of better geospatial ontological systems which are built on a discrete framework of space and time (Couclelis, 2010, p. 1789).

To help tackle the challenge of keeping consistent design decisions I would recommend setting a strict question guide. Though any description-logic reasoner is designed to catch these inconsistencies, they may not always be made evident (Alcaraz Calero et al., 2010, p. 1127). These questions could function as a kind of checklist to keep the ontology on track and should be modeled after the ontology that the one in construction will ideally be integrated to.

Future geospatial ontologies would be most beneficial if they were interoperable with the FAO ontology of soils for remotely sensed data and included spatial characteristic definitions identifiable in remote sensing (Frederico T. Fonseca et al., 2002, p. 13). Such that a dataset with spectral profiles of soils or plants in addition to the spatial information of the clustering may provide advanced decision making processes for farmers (Walisadeera, Wikramanayake, & Ginige, 2013, p. 230). This would also require a comprehensive ontology of agricultural practice associated to spatial data and could greatly increase world wide more sustainable farm management (Huang, Cui, Zhang, & Deng, 2012, p. 872).

Conclusion

This project was an exercise in geospatial ontology engineering for global agricultural regions. It focused on the spatial characteristics used to define the 11 different types of Whittlesey Regions identified within historical agricultural classification literature. Using Protégé 5 and the semantic web's best practice guidelines, I constructed a query returning geospatial ontology. The ontology took a mereotopological approach to define these regions by their topological parts, divided into spatial characteristics and when necessary descriptive characteristics.

Bibliography

- Agarwal, P. (2005). Ontological considerations in GIScience. *International Journal of Geographical Information Science*, 19(5), 501-536.
doi:10.1080/13658810500032321
- Alcaraz Calero, J. M., Marín Pérez, J. M., Bernal Bernabé, J., Garcia Clemente, F. J., Martínez Pérez, G., & Gómez Skarmeta, A. F. (2010). Detection of semantic conflicts in ontology and rule-based information systems. *Data & Knowledge Engineering*, 69(11), 1117-1137. doi:<http://dx.doi.org/10.1016/j.datak.2010.07.004>
- Baglioni, M., Masserotti, M., Renso, C., & Spinsanti, L. (2007). Building Geospatial Ontologies from Geographical Databases. In F. Fonseca, M. A. Rodríguez, & S. Levashkin (Eds.), *GeoSpatial Semantics* (Vol. 4853, pp. 195-209): Springer Berlin Heidelberg.
- Bergman, M. (2010). A Reference Guide to Ontology Best Practices. Retrieved from <http://www.mkbergman.com/911/a-reference-guide-to-ontology-best-practices/>
- Buccella, A., Cechich, A., & Fillostrani, P. (2009). Ontology-driven geographic information integration: A survey of current approaches. *Computers & Geosciences*, 35(4), 710-723. doi:<http://dx.doi.org/10.1016/j.cageo.2008.02.033>
- Couclelis, H. (2010). Ontologies of geographic information. *International Journal of Geographical Information Science*, 24(12), 1785-1809.
doi:10.1080/13658816.2010.484392
- Evenson, R. E., & Gollin, D. (2003). Assessing the Impact of the Green Revolution, 1960 to 2000. *Science*, 300(5620), 758-762. Retrieved from <http://www.jstor.org/stable/3834249>
<http://www.sciencemag.org/content/300/5620/758.full.pdf>
- FAO. Agricultural systems classifications (pp. 5-11): FAO. Retrieved from <http://www.fao.org/docrep/014/i2414e/i2414e02.pdf>. Retrieved from <http://www.fao.org/docrep/014/i2414e/i2414e02.pdf>
- Fonseca, F. T., Egenhofer, M., & Aqouris, P. (2002). Using Ontologies for Integrated Geographic Information Systems. *Transactions in GIS*, 6(3).
- Fonseca, F. T., Egenhofer, M. J., Davis Jr, C. A., & Borges, K. A. V. (2000). Ontologies and knowledge sharing in urban GIS. *Computers, Environment and Urban Systems*, 24(3), 251-272. doi:[http://dx.doi.org/10.1016/S0198-9715\(00\)00004-1](http://dx.doi.org/10.1016/S0198-9715(00)00004-1)

- Gruber, T. (1992). *A translation approach to portable ontology specification (Technical Report KSL 92-71)*. Retrieved from Stanford, CA:
- Guarino, N. (1998). Formal ontology and information systems *Amsterdam, IOS Press*, 3-15.
- Helburn, N. (1957). The Bases For A Classification Of World Agriculture. *The Professional Geographer*, 9(2), 2-7. doi:10.1111/j.0033-0124.1957.092_2.x
- Hong, J.-H., & Kuo, C.-L. (2015). A semi-automatic lightweight ontology bridging for the semantic integration of cross-domain geospatial information. *International Journal of Geographical Information Science*, 29(12), 2223-2247. doi:10.1080/13658816.2015.1072200
- Horridge, M. (2011). *A Practicle Guide To Building OWL Ontologies Using Protege 4 and CO_ODE Tools*.
- Huang, Y.-q., Cui, W.-h., Zhang, Y.-j., & Deng, G.-y. (2012). Research on Development of Agricultural Geographic Information Ontology. *Journal of Integrative Agriculture*, 11(5), 865-877. doi:[http://dx.doi.org/10.1016/S2095-3119\(12\)60077-X](http://dx.doi.org/10.1016/S2095-3119(12)60077-X)
- Janowicz, K. (2012). Observation-Driven Geo-Ontology Engineering. *Transactions in GIS*, 16(3), 351-374. doi:10.1111/j.1467-9671.2012.01342.x
- Klien, E., & Probst, F. (2005). *Requirements for Geospatial Ontology Engineering* Paper presented at the Institute for Geoinformatics, Münster, Germany.
- Kolas, D., Hebler, J., & Dean, M. (2005). Geospatial Semantic Web: Architecture of Ontologies. In M. A. Rodríguez, I. Cruz, S. Levashkin, & M. Egenhofer (Eds.), *GeoSpatial Semantics* (Vol. 3799, pp. 183-194): Springer Berlin Heidelberg.
- Lauser, B., Sini, M., Liang, A., Keizer, J., & Katz, S. From AGROVOC to the Agicultural Ontology Service / Concept Server An OWL model for creating ontologies in the agricultural domain. Retrieved from Food and Agriculture Organization website: <http://www.fao.org/3/a-ah801e.pdf> Retrieved from <http://www.fao.org/3/a-ah801e.pdf>
- Noy, N. F., & McGuinness, D. L. *Ontology Development 101: A Guide to Creating Your First Ontology*. 1-25. http://protege.stanford.edu/publications/ontology_development/ontology101.pdf Retrieved from http://protege.stanford.edu/publications/ontology_development/ontology101.pdf
- Ponting, C. (2007). *A New Green History of the World*: Penguin Books Ltd.
- Pundt, H., & Bishr, Y. (2002). Domain ontologies for data sharing—an example from environmental monitoring using field GIS. *Computers & Geosciences*, 28(1), 95-102. doi:[http://dx.doi.org/10.1016/S0098-3004\(01\)00018-8](http://dx.doi.org/10.1016/S0098-3004(01)00018-8)

- Reed, C. (2011). *World Anthropology : Origins of Agriculture*. Tubingen, DEU: Walter de Gruyter.
- Sen, S. (2008). Framework for probabilistic geospatial ontologies. *International Journal of Geographical Information Science*, 22(7), 825-846.
doi:10.1080/13658810701694853
- Sinha, G., Mark, D., Kolas, D., Varanka, D., Romero, B. E., Feng, C.-C., . . . Sorokine, A. (2014). An Ontology Design Pattern for Surface Water Features. In M. Duckham, E. Pebesma, K. Stewart, & A. U. Frank (Eds.), *Geographic Information Science* (pp. 187-203): Springer International Publishing.
- Visser, U., Stuckenschmidt, H., Schuster, G., & Vögele, T. (2002). Ontologies for geographic information processing. *Computers & Geosciences*, 28(1), 103-117.
doi:[http://dx.doi.org/10.1016/S0098-3004\(01\)00019-X](http://dx.doi.org/10.1016/S0098-3004(01)00019-X)
- Walisadeera, A. I., Wikramanayake, G. N., & Ginige, a. A. (2013). An Ontological Approach to Meet Information Needs of Farmers in Sri Lanka. *Springer-Aerlag*, 228-240.
- Whelan, B. M., & McBratney, A. B. (2000). The "Null Hypothesis" of Precision Agriculture Management. *Precision Agriculture*, 2(3), 265-279.
doi:<http://dx.doi.org/10.1023/A:1011838806489>
- Whittlesey, D. (1936). Major Agricultural Regions of the Earth. *Annals of the Association of American Geographers*, 26(4), 199-240.
- Zhang, C., Zhao, T., & Li, W. (2015). *Geospatial Semantic Web* (1 ed.): Springer International Publishing.

Appendix.

I. OWL Code generated by Protégé 5 .

```
Prefix(owl:<http://www.w3.org/2002/07/owl#>)
Prefix(rdf:<http://www.w3.org/1999/02/22-rdf-syntax-ns#>)
Prefix(xml:<http://www.w3.org/XML/1998/namespace>)
Prefix(xsd:<http://www.w3.org/2001/XMLSchema#>)
Prefix(rdfs:<http://www.w3.org/2000/01/rdf-schema#>)
```

```
Ontology(<http://www.semanticweb.org/oliviadavies/ontologies/2015/11/untitled-ontology-11>
```

```
Declaration(Class(<http://www.semanticweb.org/oliviadavies/ontologies/2015/11/untitled-ontology-11#Whittlesey_region>))
Declaration(Class(<http://www.semanticweb.org/oliviadavies/ontologies/2015/11/untitled-ontology-11#city>))
Declaration(Class(<http://www.semanticweb.org/oliviadavies/ontologies/2015/11/untitled-ontology-11#commercial>))
Declaration(Class(<http://www.semanticweb.org/oliviadavies/ontologies/2015/11/untitled-ontology-11#commercial_dairying>))
Declaration(Class(<http://www.semanticweb.org/oliviadavies/ontologies/2015/11/untitled-ontology-11#commercial_grain>))
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Declaration(Class(<http://www.semanticweb.org/oliviadavies/ontologies/2015/11/untitled-ontology-11#grassland>))
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<http://www.semanticweb.org/oliviadavies/ontologies/2015/11/untitled-ontology-11#farm>
<http://www.semanticweb.org/oliviadavies/ontologies/2015/11/untitled-ontology-11#grassland>
<http://www.semanticweb.org/oliviadavies/ontologies/2015/11/untitled-ontology-11#large>
<http://www.semanticweb.org/oliviadavies/ontologies/2015/11/untitled-ontology-11#livestock_husbandry>
<http://www.semanticweb.org/oliviadavies/ontologies/2015/11/untitled-ontology-11#prairie>
<http://www.semanticweb.org/oliviadavies/ontologies/2015/11/untitled-ontology-11#sedentary>

```

```

<http://www.semanticweb.org/oliviadavies/ontologies/2015/11/untitled-ontology-11#suburban>))
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<http://www.semanticweb.org/oliviadavies/ontologies/2015/11/untitled-ontology-11#Whittlesey_region>)
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<http://www.semanticweb.org/oliviadavies/ontologies/2015/11/untitled-ontology-11#prairie>))
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<http://www.semanticweb.org/oliviadavies/ontologies/2015/11/untitled-ontology-11#sedentary>))
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<http://www.semanticweb.org/oliviadavies/ontologies/2015/11/untitled-ontology-11#large>))
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