IA 301 Logics and Symbolic AI: Ontology Report

An ontology to help city planners make cities greener

Yazid Mouline and Jérémy Perez

https://github.com/yazidmouline/OntologyProject

https://github.com/jeremyperez1/TreePlannerOntology

Source: https://www.sustainability-times.com/clean-cities/lots-of-trees-can-help-keep-cities-cooler-in-summer/

Introduction 2

What is the problem tackled ? 2

Description of the ontology 2

Structure of the ontology 2

Object properties 3

Inferred classes 4

Asserted ontology 4

Inferred ontology 4

Ontology graph 5

Ontology metrics 5

Possible extensions 6

Conclusion 6

References 6

Introduction

When one thinks of a city, it does not evoke at all trees or vegetation. Indeed, human settlements have often come at the price of nature. Fortunately, city planners increasingly think of greenery for modern urban landscapes. Not only, it makes the city more beautiful and soothing, vegetation and especially trees help cities become better habitats for humans and wildlife. Indeed, trees help fight air pollution and cool temperatures by providing shades and releasing water through photosynthesis. Cities from all over the world such as Paris, Beijing or London are planning to include vegetation in their urban planning in order to adapt to climate change and improve the air quality. However, the problem does not solely rely on the quantity of trees. Species of trees have traits and characteristics and are more adapted to different types of environment: and that is essential in order to plant trees effectively. We built our ontology as a guide for city planners to know which species of trees should be planted in a given environment, described in a range of attributes. The first part of our report describes briefly what is the problem tackled (UN SDG problem).In the second part, we describe the ontology built. In the third part, we report the work did on Protégé.

1. What is the problem tackled ?

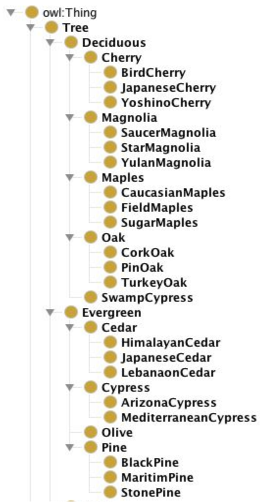
With more than half the global population living in urban areas, a ratio expected to go beyond two thirds by 2050, it is essential to make cities more sustainable. We tried to contribute with our work to the *United Nations Sustainable Development Goal n°11: Make cities and human settlements inclusive, safe and sustainabl*e. One key aspect to answer to this goal is *promoting sustainable land-use planning and management*. Including trees and vegetation in urban planning should be essential to provide a better, more soothing and cleaner environment. Our work aims to help urban planners to choose the right trees in the urban landscapes.

2. Description of the ontology

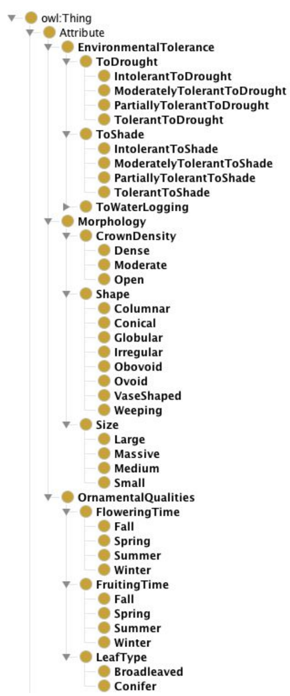
The ontology designed serves as a guide for city planners for tree planting, relying on different characteristics of trees, and giving the potential use of a tree species.

Structure of the ontology

Our ontology is composed of three main classes: **Tree**, **Attribute**, **PotentialUse.**



First, we listed a certain number of species of trees in the class **Tree,** and are classified into subclasses. For example, the class ***JapaneseCedar*** is a subclass of ***Cedar*** which is a subclass of ***Evergreen*** which is a subclass of **Tree**.



To define the properties of the tree species, we created the class Attribute that gathers main properties to characterize a tree. These attributes are also separated into subclasses. For example, the class ***IntolerantToDrought*** is a subclass of ***ToDrought*** which is a subclass of ***EnvironmentalTolerance*** which is a subclass of **Attribute**.

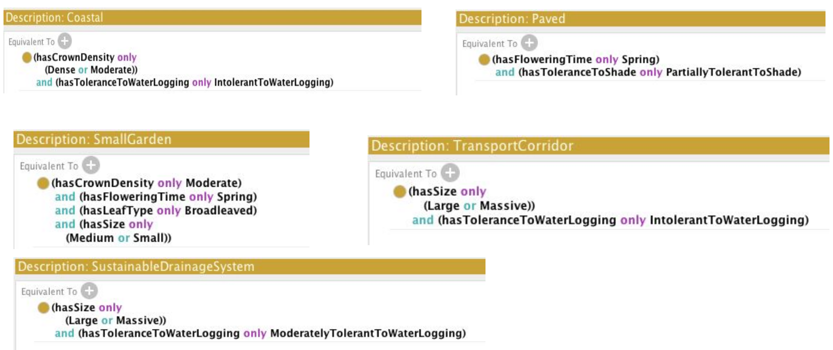
The third class PotentialUse lists the potential uses for a tree (***Park***, ***Coastal***, ***Paved…***) and we will detail it in the part *Inferred classes.*

Object properties

The object properties were established in order to characterize trees using the different attributes. These properties are modeled on the third level of subclasses of Attribute.

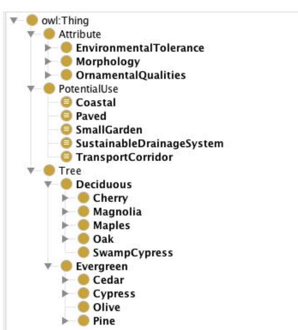
Inferred classes

We defined 6 classes that correspond to the potential ways to use a given tree. It can for example be planted in a Park, or used as a Sustainable Drainage System.



We associated particular attributes to those classes to be able to determine which trees belong to which classes. We did so by looking for attributes that were common to all species associated with a given potential use in Barwise & Kumar's work **[4]**

Asserted ontology

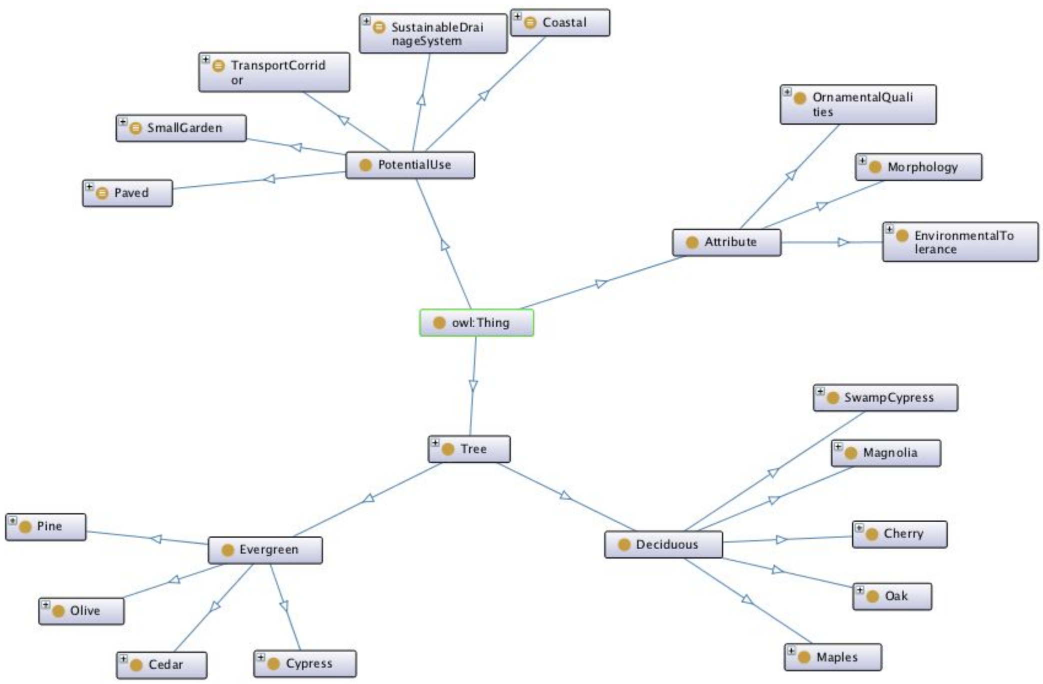


Before using the Reasoner, the subclasses of PotentialUse are empty.

Inferred ontology

In the inferred ontology, the subclasses of PotentialUse are filled with trees that are suited for the corresponding use. For example, a ***MaritimePine*** is suited for ***Coastal***.

Ontology graph



Ontology metrics

Metrics

Axiom	445
Logical axiom count	351
Declaration axioms count	94
Class count	85
Object property count	10
Data property count	0
Individual count	0
Annotation Property count	1

Class axioms

SubClassOf	286
EquivalentClasses	5
DisjointClasses	15
GCI count	0
Hidden GCI Count	5

Object property axioms

SubObjectPropertyOf	9
EquivalentObjectProperties	0
InverseObjectProperties	0
DisjointObjectProperties	0
FunctionalObjectProperty	9
InverseFunctionalObjectProperty	0
TransitiveObjectProperty	0
SymmetricObjectProperty	0
AsymmetricObjectProperty	0
ReflexiveObjectProperty	0
IrrefexiveObjectProperty	9
ObjectPropertyDomain	9
ObjectPropertyRange	9
SubPropertyChainOf	0

3. Possible extensions

The ontology can be extended for more precise and detailed results. Here are some ideas:

- Improving the taxonomy of the class **Tree** by adding more species of trees and more subclasses.
- Adding more metadata into classes to point to detailed information.
- Adding more attributes that would allow a more accurate classification
- Including more environmental metrics to better take into account the effect a species of tree could have on the city
- Narrowing the subclasses of **PotentialUse** to deal more precisely on the notion of location and climate
- Including the notion of fuzziness in order to have more flexible relations between potential uses and trees, to have a suitability degree instead of a hard constraint.

Conclusion

The ontology we built can be used to tackle the UN SDG goal n°11 by *promoting sustainable land-use planning and management.* Indeed, it serves as a guide for city planners to choose between a range of trees for a given use. However, as detailed in the part *Possible extensions,* for this ontology to be effective, it still needs many improvements. Hopefully, it will serve to make cities around the world more beautiful and less polluted.

References

[1] Hirons, A.D. and Sjöman, H. (2019) Tree Species Selection for Green Infrastructure: A Guide for Specifiers, Issue 1.3. Trees & Design Action Group.

[2]Vox: Why cities should plant more trees https://www.youtube.com/watch?v=aKyvGHycngM

[3] BBC: The best trees to reduce air pollution https://www.bbc.com/future/article/20200504-which-trees-reduce-air-pollution-best

[4] Yendle Barwise and Prashant Kumar (2020) Designing vegetation barriers for urban air pollution abatement: a practical review for appropriate plant species selection