Construction and Presentation of the Ontology: Vegetables and their Enemies

Georgios Gelastopoulos[1], Nikolaos Papaioannou[1], Georgios C. Makris[1]
[1]Inter-Faculty Master Program on Networks and Complexity of Aristotle University of Thessaloniki

ABSTRACT:*An agriculture ontology describing vegetables as well as their enemies and their diseases would be very beneficial to agriculture science. It has the potential of providing aid to scientists that are trying to identify diseases, or even the ones that are trying to improve agriculture drugs. This ontology aims to describe some common vegetables which are classified by their basic characteristics and also the main enemies of them. It also presents the parts that these enemies attack to, as well as the vulnerability of each plant to temperature.*
KEYWORDS –*agriculture, insects, ontology, plants*

I. INTRODUCTION

In computer science, ontology is defined as the representation of knowledge, describing concepts and the relationships between them using a specific notation and dictionary. Ontologies are used in making logical conclusions about the properties of these concepts as well as to describe them. According to Gruger (1993) "An ontology is a formal, explicit specification of a shared conceptualization" [3]. As a result, ontologies are trying to answer questions like, what is a thing, into what categories can we sort the things, what is the meaning of these things, etc.

In order to represent ontologies in computer applications the language OWL is the most common. OWL (W3C Web Ontology Language) is a semantic language for the description data, designed to represent complicated relationships of ontologies. So, with OWL, someone can build a knowledge model and this model provides description for the data, usually in the form of a knowledge graph [1].

The structure of an ontology consists of three basic components.

Individuals are the fundamentals objects in which we are interested in. These objects may include distinctive objects like people, cars, animals, countries etc. Example of objects could be Bob, England, Brazil etc.

Classes are the sets (or collections) that contain individuals. For example the class Countries could contain individuals such as USA, Brazil, England. Classes can also have various subclasses for example, European Countries which contains individuals like England, Denmark, etc.[7]

Properties are the relations that connect individuals among each other. For example Bob lives in England. The property here is the phrase lives in which connects individuals Bob and England. The phrase "lives in" in OWL notation would be livesIn. Individuals from different classes can be related with a property [2][4].
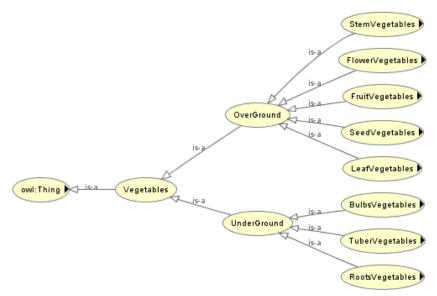
Nowadays there is a plethora of publications and bibliography about ontologies in many complicated and different fields. In this attempt we focus in plant diseases, which is a very complicated field as well, and there is still a lot to cover.
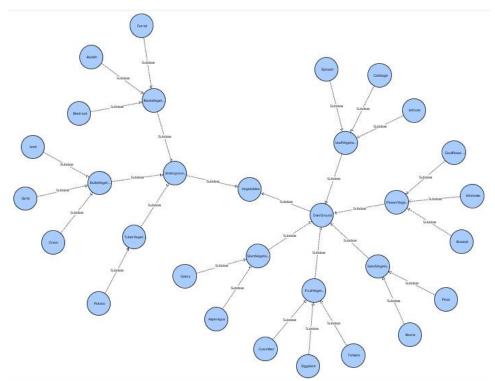
II. DESCRIPTION

The goal of this ontology is to classify common vegetables and describe relationships between them and their enemies (insects). It was written in Protégé environment. Protégé is a free, open-source ontology editor. The main classes are four and the description of these classes is following.

The first class of the ontology is Vegetables [5][6][8]. This class is divided in two main sub-categories: vegetables that grow underground and vegetables that grow above ground. The above ground vegetables are classified based on the part that can be eaten in these categories: Flowers, Fruits, Leafs, Seeds and Stems. Broccoli, cauliflower and artichoke belong to the flower class. In fruit class belong the cucumber, eggplant and tomato. In the leaf category belong the cabbage, lettuce and spinach. In seed class belong beans and peas. In stems class belong the asparagus and celery.

Vegetables that grow underground are classified based on the part that can be eaten in three classes: Bulbs, Tuber and Root Vegetables. In bulbs belong the garlic, onion and leek. In Roots class belong the beetroot, carrot and radish. Lastly, in Tuber class belongs the potato.
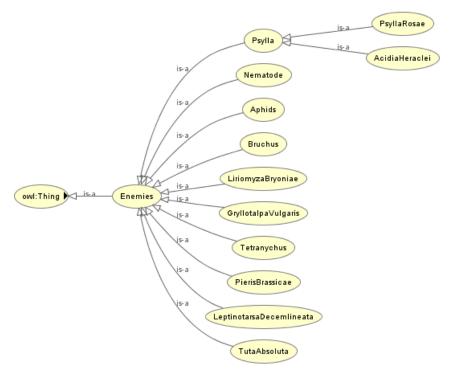
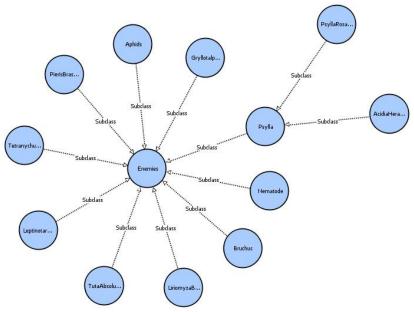**Picture 1.** Vegetables subclasses visualized with Protege OWLViz.

Picture 2. Classes of vegetables visualized withVOWL.

The second main class is Enemies. As enemies are included some of the most known insect-enemies of vegetables, such as: Aphis, Bruchus, Psylla, Nematode, LiriomyzaBryoniae (commonly known as leaf miner), Gryllotalpa Vulgaris (commonly known as mole cricket),Tetranychus, Pieris brassicae (commonly known as cabbage moth), Leptinotarsa Decemlineata (commonly known as potato beetle) and TutaAbsoluta. Each name of enemies is written in their Latin scientific name.
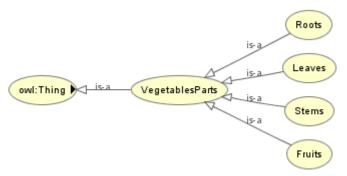
Picture 3. Representation of Enemies classes by Protégé OWLViz environment.
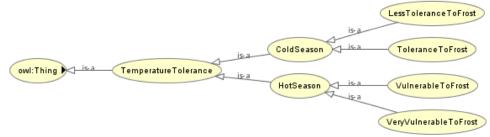

Picture 4. Representation of Subclasses of Enemies with VOWL.

The third main class is the parts of vegetables that are being attacked by insects. These parts are Roots, Leaves, Stems and Fruits.
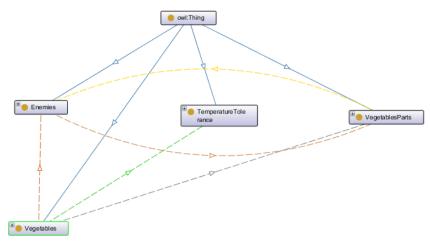
Picture 5. Representation of Vegetable Parts Class by Protege OWLViz.
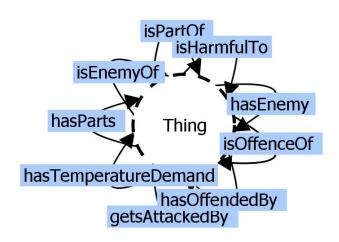
The last main class is Temperature Tolerance. Each vegetable has a specific temperature tolerance. At first level there are 2 classes, the cold season vegetables and hot season vegetables. Cold season vegetables are divided into two classes, tolerance to frost and less tolerance to frost, while hot season vegetables are divided into vulnerable to frost and very vulnerable to frost.

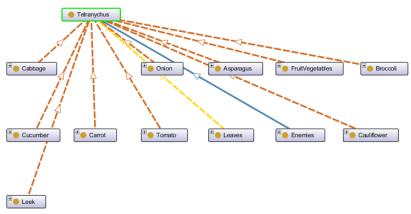**Picture 6.** Representation of Temperature Tolerance by Protege OWLViz environment.

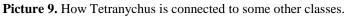**Picture 7.** Representation of main classes using OntoGraf.

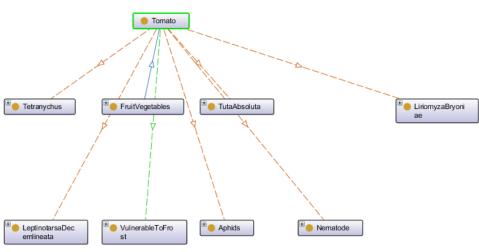**Picture 8**. Representation of Properties of classes by VOWL.

III.   EXAMPLES

Some indicative visual examples of how the classes are connected are following.
Example 1

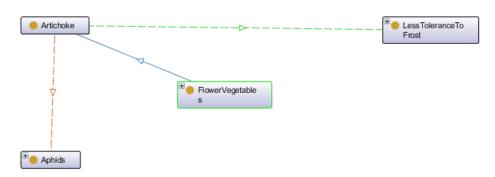**Picture 9.** How Tetranychus is connected to some other classes.

It is easily seen from the representation above, which are the vegetables that it attacks to, which part of the plant it attacks to, and in which class it belongs to.
Example 2

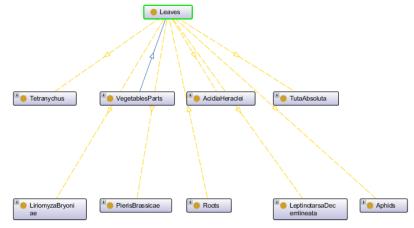**Picture 10.** How tomato is connected to some other classes.

A second example for the tomato plant. It can be seen who are the enemies of the plant, in which class it belongs to, and that it is vulnerable to frost.

Example 3

Picture 11. How artichoke is connected to the other classes.

Artichoke's enemy is aphids, it belongs to flower class and it is less tolerant to frost.

Example 4

Picture 12. How leaves are connected to the other classes.

An example for the class leaves. We can see that it is being attacked by many insects.

IV. CONCLUSION

This ontology classifies some of the most common vegetables and presents their insect enemies, the parts of which these enemies attack to, as well as the tolerance each vegetable has to temperature. The ontology could be enriched with more vegetables and more plants in general and also more enemies/diseases like fungus can be added. It can be developed as a useful tool for studying the pathology of the plants, the diagnosis of a plant's disease and problem solving in the agriculture sector.

IRI: urn:absolute:www.vegetables.com/ontology/le.owl

REFERENCES

[1]. K. Breitman, M. A. Casanova, W. Truszkowski , Semantic Web: Concepts, Technologies and Applications (London: Springer, 2007).

[2]. K. Dopfer, J. Potts, Why evolutionary realism underpins evolutionary economic analysis and theory: A reply to Runde's critique, Journal of Institutional Economics, 6(3), 2010, 401-413.

[3]. T. Gruber, A translation approach to portable ontology specifications, Knowledge acquisition, 5(2), 1993, 199-220.

[4]. T. C. Jepsen, Just What Is an Ontology, Anyway?, IT Professional, 11(5), 2009, 22-27.

[5]. C. Lee, M. Wang, H. Hagras, A Type-2 Fuzzy Ontology and Its Application to Personal Diabetic-Diet Recommendation, IEEE Transactions on Fuzzy Systems, 18(2), 2010, 374-395.

[6]. C. Snae, M. Bruckner, FOODS: A Food-Oriented Ontology-Driven System, 2nd IEEE International Conference on Digital Ecosystems and Technologies, Phitsanulok, 2008, 168-176.

[7]. Alexandros Z. Spyropoulos, NikoletaKissoudi, Alexandros Samalis, Georgios C. Makris. Representation in the Semantic Web of the Structure and Functions of a Police Department in Greece. International Journal of Engineering Science Invention (IJESI), Vol. 09(11), 2020, PP 01-06. Journal DOI- 10.35629/6734

[8]. Teng-Yang Tao, Ming Zhao, An Ontology-Based Information Retrieval Model for Vegetables E-Commerce, Journal of Integrative Agriculture , 11(5), 2012, 800-807.