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Application of Semantic Ontology for Observation of L'Aquila Toads, to Forecast Earthquakes'

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Abstract

Natural disasters have been always referred to as Mother Nature's blow to today's unconventional way of living. Once there is Tsunami and on the other hand earthquakes which are termed mass exodus of life. One of the key instance of proposing the paper are that we cannot challenge mother nature but at least come to know when she really might throw a blow on this earth. Mother Nature might provide us the clues which are far more difficult for us as human beings to interpret. One of the key features of this paper is how animals might not help us overcoming Natural disaster but to safeguard over selves from the onslaught of Mother Nature if there were any possibilities. The history of artificial intelligence shows that knowledge is very critical for intelligent systems to be optimized. In many cases, better knowledge can be more important for solving a task than better algorithms. To have truly intelligent systems, knowledge needs to be captured, processed, reused, and communicated. Ontologies support all these tasks which enable us to take critical decisions at time of need.

Keywords: Semantics, Ontology, Intelligent systems, Toads, Knowledge base.

1. Introduction (*Natural Disasters*)

"Nature is a man's' biggest Laboratory", not concluding that everyone has to experiment on it but have the privilege to learn that most of the solutions for any big problem do exist in its continuous fight towards its existence.
This paper emphasizes the fact that the basic things which occur in Nature on its own without any interference are absolute solutions which can be life changing. There has been extensive work on the measurement of seismic activities so that natural disasters can be tackled without any kind of major setbacks. Animals have significantly showcased a lot behavioral changes before a natural disaster is bound to occur the behavioral changes include overreacting to certain events such in dogs may include excessive barking, biting. Based on the above instances which were recorded earlier by many researchers' in respective fields the decision to whether animals can foresee these occurrences are always debatable and not conclusive. But the L'Aquila toads were an example of strange animal behavior before a major seismic event when they exhibited very strange behavior at a particular time when they had to adhere to certain concrete rules. The reports of reptiles, amphibians behaving uniquely have been recorded at various instances. For an instance in 1975, in Haicheng, China, for example, many people spotted snakes emerging from their burrows a month before the city was hit by a large earthquake. This was particularly odd, because it occurred during the winter. The snakes were in the middle of their annual hibernation, and with temperatures well below freezing, venturing outside was suicide for the cold-blooded reptiles. But each of these cases - of waking reptiles, fleeing amphibians or deep-sea fish rising to the surface - has been an individual anecdote. And major earthquakes are so rare that the events surrounding them are almost impossible to study in detail.
This is where the case of the L'Aquila toads was different. Ms Grant, a biologist from the Open University, was monitoring the toad colony as part of her PhD project. "It was very dramatic," she recalled. "It went from 96 toads to almost zero over three days. So how toads and earth-

quakes are related? Is one prominent question which runs in our mind but the answer is the habitat of its existence which in turn is a pond. Scientists have been studying the chemical changes that occur when rocks are under extreme stress. Their laboratory-based tests have now revealed, not only that these changes could be connected, but that the Earth's crust could directly affect the chemistry of the pond that the toads were living and breeding in at the time. When rocks are under very high levels of stress - for example by the "gargantuan tectonic forces" just before an earthquake, they release charged particles. These charged particles can flow out into the surrounding rocks, and when they arrive at the Earth's surface they react with the air converting air molecules into charged particles known as ions. "Positive airborne ions are known in the medical community to cause headaches and nausea in humans and to increase the level of serotonin, a stress hormone, in the blood of animals," They can also react with water, turning it into hydrogen peroxide. This chemical chain of events could affect the organic material dissolved in the pond water - turning harmless organic material into substances that are toxic to aquatic animals.

2. Materials And Method's

The term "ontology" can be defined as an explicit specification of conceptualization. Ontologies capture the structure of the domain, i.e. conceptualization. Here the domain what ontology excessively applied for will be the pond which is the toad's primary habitat. [1, 6] The conceptualization describes knowledge about the domain, not about the particular state of affairs in the domain. Usually the toad being an amphibian can resort both in outside the pond. Hence the movement of the toad is keenly observed using a high definition camera. In other words, the conceptualization is not changing, or is changing very rarely. Ontology is then specification of this conceptualization - the conceptualization is specified by using particular modeling language and particular terms [4, 7]. Formal specification is required in order to be able to process ontologies and operate on ontologies automatically.

Ontology describes a domain, while a knowledge base (based on ontology) describes particular state of affairs [2, 6]. Each knowledge based system or agent has its own knowledge base, and only what can be expressed using ontology can be stored and used in the knowledge base. Hence the first primary goal is to build the knowledge base. The knowledge base can be built on various simple features what are exhibited by toads. When an agent wants to communicate to another agent, he uses the constructs from some ontology. In order to understand in communication, ontologies must be shared between agents.

Sometimes, ontology is defined as a body of knowledge describing some domain, typically a common sense knowledge domain, using a representation vocabulary as described above [5, 6]. In this case, an ontology is not only the vocabulary, but the whole ``upper" knowledge base (including the vocabulary that is used to describe this knowledge base).An earthquake is ground shaking caused by a sudden movement of rock in the Earth's crust. Such movements occur along faults, which are thin zones of crushed rock separating blocks of crust. When one block suddenly slips and moves relative to the other along a fault, the energy released creates vibrations called seismic waves that radiate up through the crust to the Earth's surface, causing the ground to shake.

Earthquakes may last only a few seconds or may continue for up to several minutes. They can occur at any time of the day or night and at any time of the year. They are caused by stress that builds up over time as blocks of crust attempt to move but are held in place by friction along a fault. (The Earth's crust is divided into large plates that continually move over, under, alongside, or apart from one another atop the partly molten outer layer of the Earth's core.) When the pressure to move becomes stronger than the friction holding them together, adjoining blocks of crust can suddenly slip, rupturing the fault and creating an earthquake.

3. Experiments

3.1. Case Study

In the case study we use the point which will be our domain or conceptualization which will be extensively watched over. As we all know are aware that semantic network is a graph which is made up of vertices and edges, where vertices indicate concepts and edges relationship between concepts. There are two primary things which are responsible to help us take a decision that is movement of toad outside the pond and the decision to be taken that is alarm indication.

Usually in the breeding season the toads tend to me more in the aquatic state than the land at this particular juncture we tend to be more keenly observant wherein if the movement of toads are at an more alarming rate from the aquatic state the decision of some seismic activity at the earth's crust are of more possible occurrence. Hence we make use of the concept called as Topic Maps which are (syntactically) standardized form of semantic networks. They allow using topics (concepts), associations (rela-

tions) between concepts (including specifying role of topic in the association), and occurrences (resources relevant to topic, in fact instances of topic). Topics, associations and occurrences are used to create ontology of a domain, and a particular topic map then uses them to expresses state of affairs in the domain. In our particular concern towards decision making the occurrences play a very pivotal role.

When the movement of toads are more from the aquatic state to land state that is considered as an unnatural occurrence, this occurrence can be instantiated by using various relations between concepts that are used in semantic networks which are as follows:

- synonym - concept A expresses the same thing as concept B
- antonym - concept A expresses the opposite of concept B
- metonym, homonym – part of and has-part relation between concepts
- hyponym, hyponym - inclusion of semantic range between concepts in both directions [4]

Using ontology we can define the meaning how a toad is different from any other object coming out from a pond and later for various concepts of toads relationship can be instantiated and recorded so that there is more number of toads coming out from the pond and later using this as our primary result a decision can be instantiated.

3.2. Need for Ontology

In recent years ontologies have become common on the World Wide Web and have been moving from the realm of Artificial Intelligence to the desktops of domain experts. The World Wide Web consortium have been constantly on the verge of developing Resource Description Framework which is a language for encoding knowledge on WebPages to make it more understandable to electronic agents which search for information. Ontology development is quite different from creating classes and relations in Object Oriented Programming. In Object Oriented Programming primary concern is methods on classes wherein the programmer makes his decisions based on operational properties of a class, whereas in ontology the designer makes these decisions based on structural properties of the class. Ontology along with a set of individual instances of a class constitutes a knowledge base. But in reality there always lies a thin line which separates, where ontology ends and knowledge base begins.

Focuses of most ontology are classes which describes the concepts in the domain. For example with relevant to the problem in this paper a class of toads represents all Toads, and specific toads (L. Aquila) are instances of this class. A class can have subclasses that represent concepts that are more specific than the super class. Slots describe properties of classes and instances. L. Aquila toad has a rough skin and does not jump but hops around or walks in the habitat. In a pond there might be more than one instances of the class called Toads. At the class level we could say that the instances of class Toads will have slots describing their skin color, skin type, legs, and eyes and so on.

In practical terms, developing an ontology includes,

- To define classes in ontology.
- Taxonomic arrangements of classes (Subclass – Super class) hierarchy.
- Definition of slots and describing allowed values for these slots.
- Filling in the values for slots for instances.

Once finished we can create a knowledge base by defining individual instances of these classes by filling in specific slot value information and additional slot restrictions.

As observed in Figure 2 we used black for classes and red for instances. Ontologies once defined can be reused if required by our system to interact with other applications that have already committed to particular ontologies or controlled vocabularies. Whenever we develop ontology for a specific domain and scope there can be plenty of questions which might rise such as, for what are we going to use the ontology? Who will use and maintain the ontology? These questions are better answered during the ontology design process.

3.3. Figures and Tables

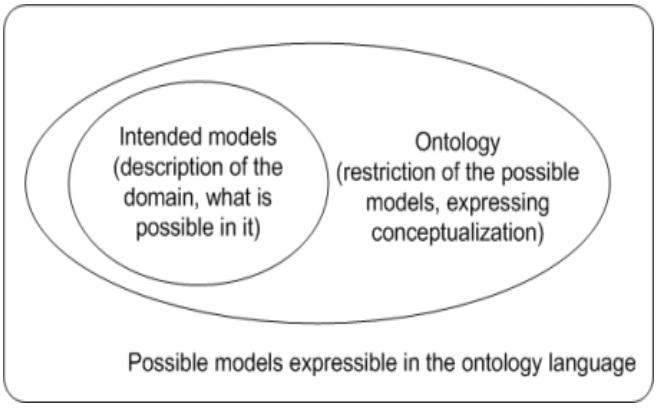

Figure 1: Models in expressing ontology.

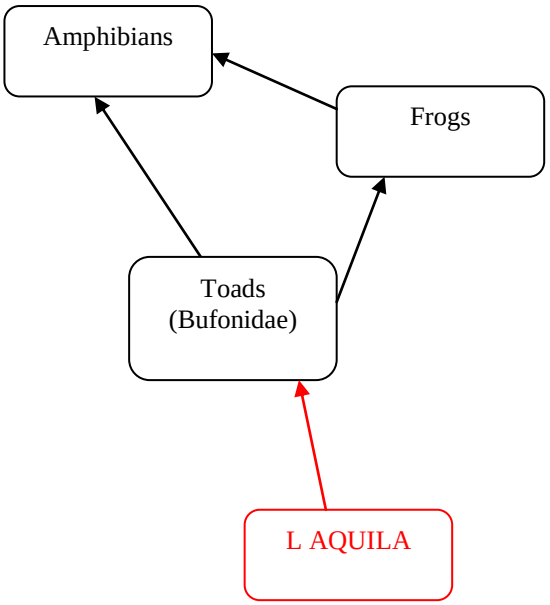

Figure 2: Some classes, instances and relations among them in toad domain

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