EARTHQUAKE ONTOLOGY AND RESEARCHES ON EARTHQUAKE PREDICTION

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ABSTRACT

This paper describes the method and development of earthquake prediction ontology. In my previous work, I developed ontologies for earthquake. I extend that work to construct the earthquake prediction ontology. The aim is to build the ontology as complete and correct as possible from freely available databases or textbooks on the top of an existing middle layer ontologies SWEET. The current status of the project and a preliminary result of the model are presented.

1. INTRODUCTION

Ontologies can be defined as machine interpretable definitions of domain concepts and the interrelation between those concepts representing domain knowledge.

I am following the ontology methodology called V-model and the ontology building life-cycle (Stevens 2001 [1]) to build the ontologies.

The domain studied in this paper concerns the *earthquakes* (EQs) and their *prediction* knowledge. The purpose is to acquire the best knowledge by analyzing available expert research publications and web data.

The earthquake ontology I developed was constructed semi-autonomously using text mining techniques and natural language processing [2].

2. APPROACH

In this paper, I present the earthquake prediction ontology construction based on SWEET ontologies (http://sweet.jpl.nasa.gov/ontology/) (Raskin and Pen, 2005 [3]) and web data mining.

2.1. Methods of ontologies development

a) Find ontologies concerning the domains faults, earthquakes, earth, astronomy, tectonic plates
b) Encode the prediction part within those ontologies
c) Conceptualize terms within earthquake prediction research publications
d) Validate the ontology
e) Share to the community

I also follow the method developed by the Ontologist Prof. Barry Smith [5] such that every node in the ontology should represent both universals (terms used in a plurality of sciences to designate entities) and the corresponding instances in reality and the Ontology Development 101 [6].

3. EARTHQUAKE PREDICTION ONTOLOGY

EQ Predictions can be classified into three categories: *long-term prediction, medium-term prediction* and *imminent/short term prediction*.

Long and medium term predictions are based on geological data and motions of tectonic plates. Imminent predictions are focusing on the cloud patterns, animal behaviors, P-waves and weather anomalies [4]. The following is an example of the ontology:

Disjoint classes:Long-term prediction/Medium-term prediction/Imminent prediction
EQ Prediction has_a latitude, longitude, time, magnitude range, number of EQ in the given range, depth range, focal mechanism, percentage of success rate, heuristics
New Slots for subclasses: Time-frame, fault type, geological data, recurrence time, foreshocks, aftershocks, possible_intensity,...
Long-term prediction has_a { Time_frame = [2years~100+years], recurrence_time = 150years, fault_type = active, foreshocks =..., geological_data=Interplates, possible_intensity=M>8.0,..}
Medium-term prediction has_a { Time_frame = [month~2years], fault_type = active, foreshocks=..., geological_data=high strained rock strata,...}
Imminent prediction has_a { Time_frame = [seconds~month], fault_type = active, foreshocks =..., P_waves, clouds formation, wheater anomalies, animals behavior anomalies,...}

Other terms used on EQ predictions are *'elastic rebound theory'*, *'slow strain monitoring'*, *co-seismic changes*, *slip predictable*, *non-Poissonians*, and *'seismic gap hypothesis'*, *GPS-monitoring*, *Lithosphere*, *Ionosphere*, *tides by Moon phases*, *Sun CME*, *volcanic activity* .

4. DISCUSSION

Concepts in SWEET2.3 cover partially the EQ ontology and slots in EQ Prediction ontology. I used phenGeoSeismicity.owl, phenGeolTectonic.owl, phenVolcanic.owl, phenStar.owl and phenGeolFault.owl.

Earthquake hazard maps created by the www.usgs.org or www.aist.go.jp indicate the location of the active faults and their percentage of chance to generate a megaquake or great earthquake M6+.

The most reliable parameter for predicting the earthquakes used by the experts and validated is the foreshocks. However, every foreshock did not induce the big one. Experts are still investigating the phenomena.

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