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An Ontological Approach to Representing and Reasoning about Events in the Sensor Web

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While observations are fed into the Sensor Web through a growing number of environmental sensors, the challenge is to infer information about geographic events they reflect. For example, we may ask what the measurements mean when a service compiles hourly wind speeds from different providers. The service should perhaps include meaningful descriptions than just the measurements; for instance, whether the wind occurring at a particular site is nearly calm or reflects a windstorm. Similarly, we may want to know the intensity of a snowfall occurrence from a series of visibility measurements supplied by a visibility sensor.

A systematic approach representing domain knowledge is vital when reasoning about events at the conceptual level. A description of how one gets from observations to inferred events must be expressed. Environmental models usually capture such information. Nonetheless, they jeopardize transparency; the information contained within these models is implicit, limited to domain experts, and hard to acquire or manipulate. The formal specifications in the Semantic Sensor Web primarily describe sensors and observations; they do not describe information concerning geographic events. Existing event-oriented ontologies represent common concepts concerning events, e.g., participant, time, location and relations between events. Nevertheless, the event-of-interest is not explicitly associated with sensing concepts such as observation event, sensor and result.

This paper delivers an ontology to formally capture the relations between observations and geographic events. The ontology constitutes common building blocks for constructing application ontologies that account for inferences of the former from the latter. The formal vocabularies are exploited with a rule-based mechanism to support inferences of events from in-situ observations. The paper also demonstrates how these vocabularies are used to formulate symbolic spatio-temporal queries in the Sensor Web. A use case for reasoning about blizzards and their temporal parts from time series supplied by the Environment Canada illustrates the ontological approach.