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Faculty of Informatics

Diplomarbeitspräsentation

AUTOMATION SYSTEMS GROUP

Masterstudium:
Software Engineering & Internet Computing

A Weather Ontology for Predictive Control in Smart Homes

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Smart homes and ontologies

Smart homes are dwellings that are equipped with some kind of intelligence to perform tasks on their own.

Some of their goals are:

- Support with routine tasks.
- Increase comfort.
- Reduce energy consumption.

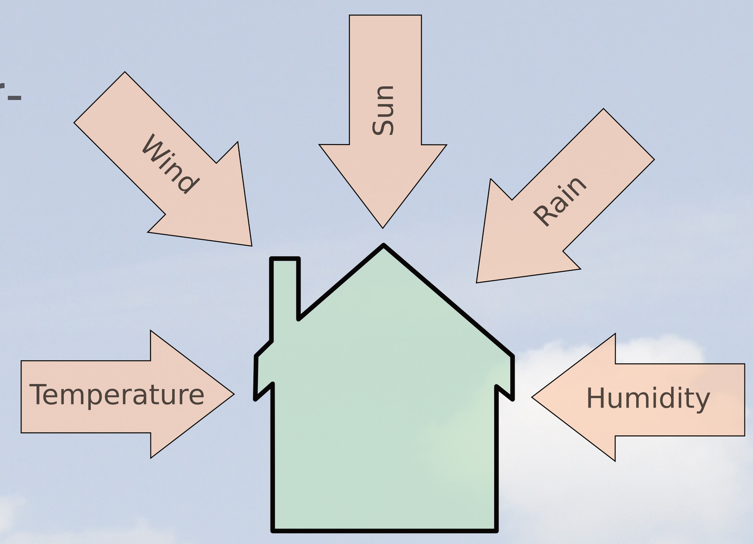
Common problems of many smart home systems:

- High complexity.
- Optimising and customising are difficult.
- Missing powerfulness and flexibility.

To overcome these problems, a knowledge base built upon *OWL* can be introduced. A smart home can use the knowledge from this model to make appropriate control decisions.

Why introduce a weather data model?

Weather has a wide influence on a dwelling. Examples for weather-related control decisions are:



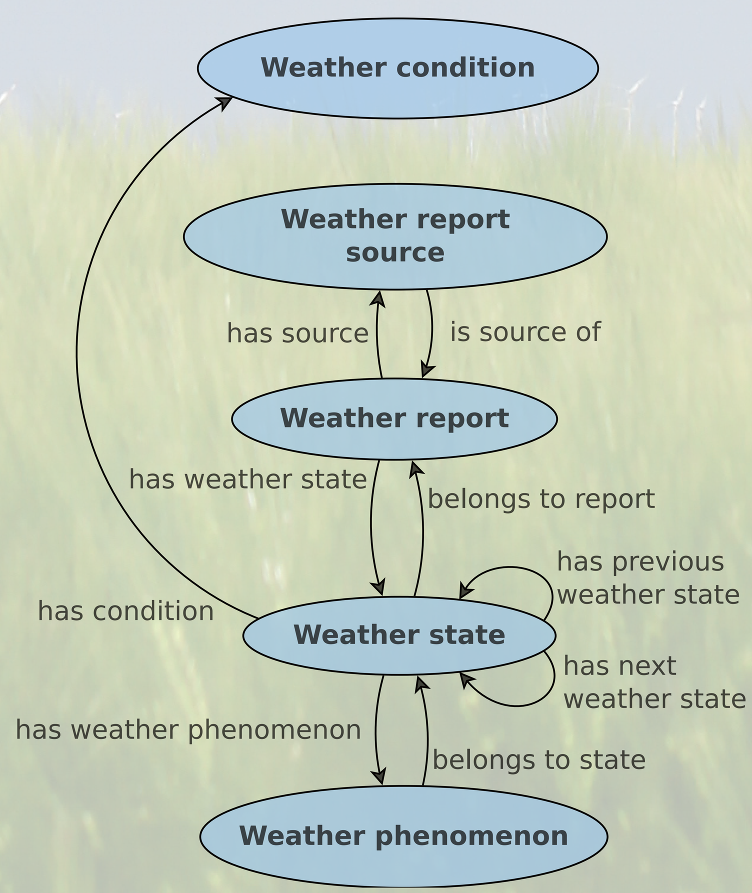
- Heating, ventilation, and air conditioning (*HVAC*).
- Irrigation.
- Utilisation of solar and wind power.
- Preparing for severe weather (e.g. close windows, retract awnings).

Methodological approach

- Evaluation of existing weather ontologies.
- Identification of uses cases for weather data in smart homes.
- Analysis of methodologies for ontology design.
- Examination of sources for weather data.
- Design of *SmartHomeWeather* using *METHONTOLOGY*.
- Development of *Weather Importer*.

The *SmartHomeWeather* ontology

- The *SmartHomeWeather* ontology is built around five top-level concepts.
- It supports current and future weather data.
- It allows weather-based control decisions within smart home systems.
- *SmartHomeWeather* uses *OWL* reasoning heavily.

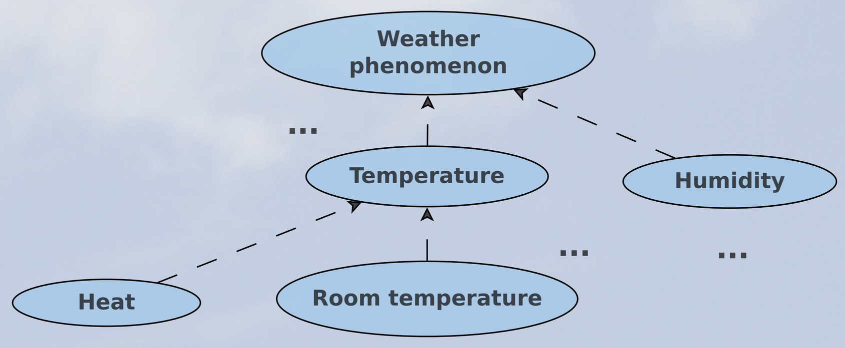


The *SmartHomeWeather* ontology (cont.)

The top-level concepts are:

- *Weather phenomenon*: A certain weather element: temperature, humidity, . . .
- *Weather condition*: A one-word description of the weather situation: "Sun", "Fog", . . .
- *Weather state*: The weather situation as a set of *Weather phenomena*.
- *Weather report*: All data about the weather for one point of time (location, source, weather situation).
- *Weather report source*: A source of weather data (sensor or Internet service)

Each concept is root of a concept hierarchy.



Querying the data model is done using *SWRL* rules and *SPARQL* queries.

```
hasWeatherPhenomenon(?s1, ?t1) ∧
  hasTemperatureValue(?t1, ?v1) ∧

  hasWeatherPhenomenon(?s2, ?t2) ∧
  hasTemperatureValue(?t2, ?v2) ∧

  greaterThan(?v2, ?v1) ∧
  hasNextWeatherState(?s1, ?s2) ⇒
    increasingTemperature(?s1, ?s2)
```

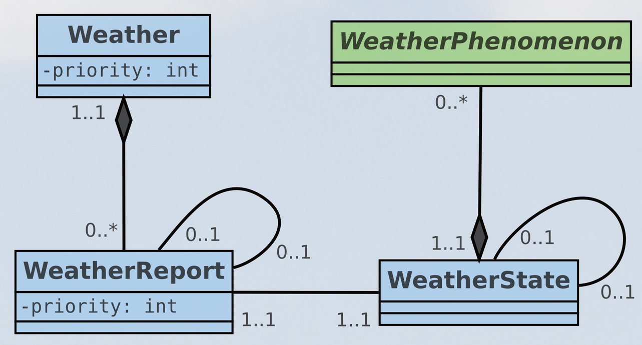
SWRL rule (simplified) to find consecutive *Weather states* that denote increasing temperature.

```
SELECT ?s2
WHERE {
    ?s1 weather:increasingTemperature ?s2.
    ?s1 weather:belongsToWeatherReport ?r.
    ?r a weather:ShortRangeForecastReport.
}
```

SPARQL query to obtain all *Weather states* for the upcoming three hours (`ShortRangeForecast-Report`) that denote increasing temperature (refer to the *SWRL* rule seen on the left).

The *Weather Importer*

The *Weather Importer*



- is implemented in Java.
- uses an object-oriented model resembling the structure of *SmartHomeWeather*.
- retrieves weather data from local sensors and Internet services.
- generates individuals based on weather data.
- provides unit tests for *SmartHomeWeather*.

Future work

Further use cases of *SmartHomeWeather* may be identified. Interoperation with other systems and data sources can be examined:

- Minimising costs for electrical power based on weather data and varying costs for electrical power over time.
- Improving decision making based on both weather data and the buildings' inhabitants' actions.
- Learning from weather situations and their influence on the dwelling.
- Mutual benefits of *Smart Cities* and smart homes utilising *SmartHomeWeather*.

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