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# A Software System for the Discovery of Situations Involving Drivers in Storms

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# Introduction

- ▶ Situation is a structured part of reality<sup>[1]</sup>
- ▶ Formalized in situation theory
- ▶ Useful abstraction in environmental software systems
  - ▶ In particular those that utilize sensor networks
  - ▶ To collect data and extract knowledge about reality
- ▶ Present a system that
  - ▶ Acquires and represents situational knowledge for
    - ▶ Storms from radar data for rainfall intensity
    - ▶ Drivers from user input and computed directions
  - ▶ Supports discovery of new situations
    - ▶ In which drivers are within storms
- ▶ In systems, situations are information objects

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# Model situations

- ▶ Situation  $s$  is said to support ( $\models$ ) infons
- ▶ Infon  $\sigma$  is a tuple consisting of
  - ▶ Relation  $R$
  - ▶ Objects  $a_1, \dots, a_m$
  - ▶ Polarity 0/1
- ▶ Objects stand in the relation  $R$  (polarity 1)
- ▶ Objects can be physical entities in the environment, or ...
- ▶ Temporal and spatial locations, values, situations

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# Example

$$s \models \ll \text{storm-at}, \dot{s}, \dot{l}, \dot{t}, 1 \gg$$

- ▶  $\dot{s}, \dot{l}, \dot{t}$  are parameters
- ▶ Parameters may anchor ( $\rightsquigarrow$ ) concrete instances
- ▶  $\dot{s} \rightsquigarrow$  Storm instance with attributes (e.g. area)
- ▶  $\dot{l} \rightsquigarrow$  POLYGON (...)
- ▶  $\dot{t} \rightsquigarrow$  2015-06-02T16:05+02:00

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# Acquire situations

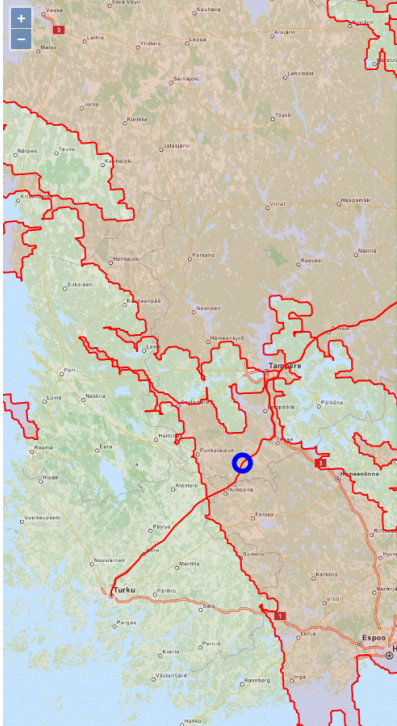
- ▶ Collect and process data, possibly sensor data
- ▶ Run processed data through computational model(s)
- ▶ Result are bits of information (e.g. class label)
- ▶ Map information to entities of a conceptual model
- ▶ Compose entities to situations
- ▶ Situations are structured entities of a conceptual model

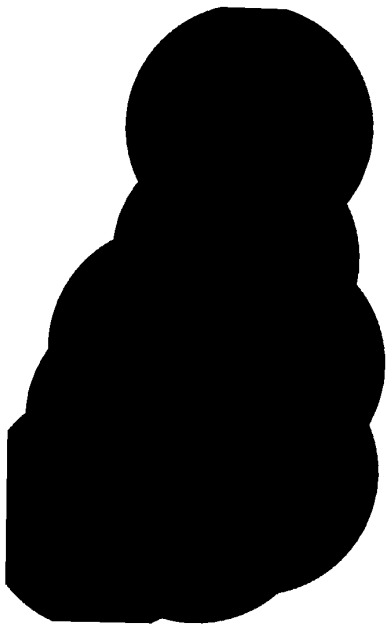
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# Represent and query situations

- ▶ Using semantic web technologies
- ▶ Resource Description Framework (RDF)
- ▶ Web Ontology Language (OWL)
- ▶ Situation theory ontology (STO)
  - ▶ Extended with domain knowledge
  - ▶ The conceptual model
- ▶ Profium Sense RDF database (or other triple stores)
- ▶ Given a situation with infons, relation, objects, ...
  - ▶ Process it to RDF statements
  - ▶ RDF conformant with STO vocabulary
  - ▶ Stream RDF to Profium Sense for management
- ▶ Retrieve situations (RDF) using SPARQL

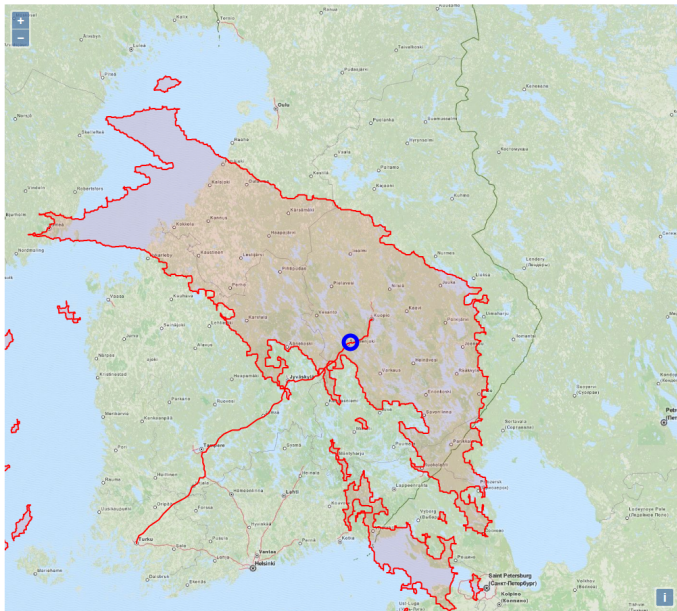
# Application











## New Direction

Origin

Destination

Departure time

add

clear

Demo

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## Discover situations

```
a Situation [  
  storm-at ;  
  [ asWKT ?polygon ] ;  
  [ inXSDDateTime ?time ] ;  
]  
a Situation [  
  driver-at ;  
  [ asWKT ?point ] ;  
  [ inXSDDateTime ?time ] ;  
]  
filter (inside(?point, ?polygon))
```

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# Situation projection

- ▶ Project storms into future
- ▶ Forecast storm path by some hours
- ▶ Project storm spatial extent along the path
- ▶ Anticipate situations in which drivers are in storms
- ▶ System can suggest alternative routes and/or schedule

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## Related work

- ▶ Route planning<sup>[2]</sup>
  - ▶ Cost of travelling through grid cells
  - ▶ Weather conditions can influence the cost
- ▶ Road trip planning online services
  - ▶ May include weather information (e.g. AccuWeather)
  - ▶ Show forecast weather at selected locations along route
- ▶ Main difference
  - ▶ Situational knowledge is represented explicitly
  - ▶ Can be processed automatically, shared, integrated

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# Take aways

- ▶ Data is not where the story ends
- ▶ Knowledge about monitored environment needed
- ▶ Knowledge extraction necessary
  - ▶ Manually with visualization, statistical analysis
  - ▶ Automatically with machine learning, other models
- ▶ Situation as key abstraction for extracted knowledge
- ▶ Representation of situational knowledge
- ▶ Let systems manage and process situational knowledge
- ▶ Systems can obtain and maintain situation awareness

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# References

- [1] Devlin, K.: Logic and Information. Cambridge University Press (1991)
- [2] 14. Szczerba, R., Galkowski, P., Glicktein, I., Ternullo, N.: Robust algorithm for real-time route planning. Aerospace and Electronic Systems, IEEE Transactions on 36(3), 869-878 (Jul 2000)