ICOS Carbon Portal
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Situation awareness in environmental monitoring

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Introduction

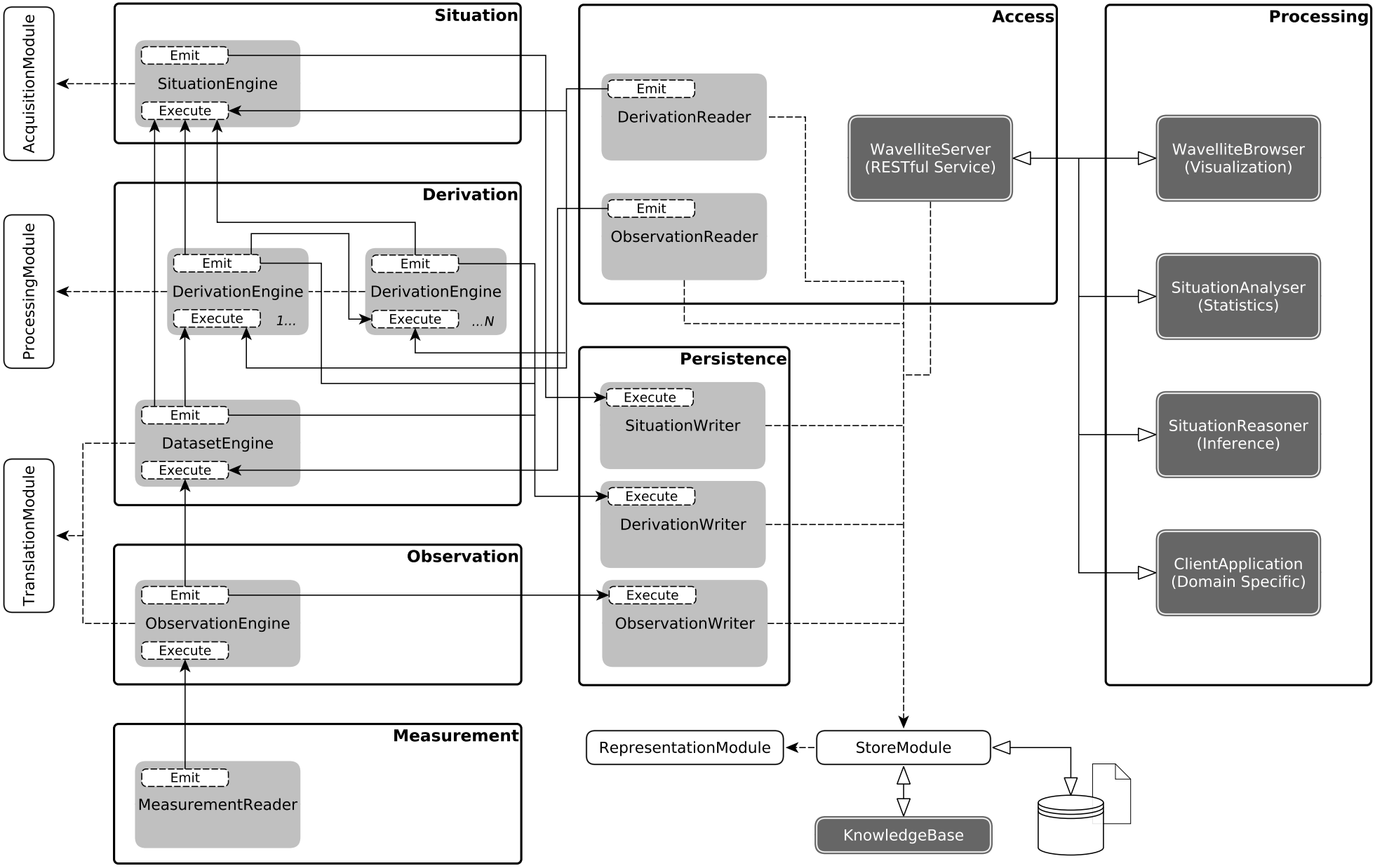
- Environmental monitoring
  - Manual and automated sampling
  - Sensor have increased data volumes
  - Manual data processing difficult (or impossible)
  - Real-time requirements in, e.g.
    - Intelligent transportation systems
    - Smart homes (ambient intelligence)
    - Disaster management systems
- Situation awareness (SA)
  - Perception, comprehension, projection
  - Obtaining and maintaining SA is situation *assessment*
  - Cognitive model for information processing in agents
  - Applied predominantly in aviation/military applications

Problem

- Interpreting sensor data generally tedious
  - Heterogeneous devices, data, formats, protocols, ...
  - Complex data processing
  - Complex information extraction
  - Yet, it is a recurrent task
- Unfortunately,
  - Lots of sensor data does not translate trivially into lots of information about the monitored environment

Idea

- Develop a software framework that
  - Supports implementing situation assessment
  - Formalizes and structures the process in software
  - Takes care of common program logic
- Demonstrate the framework
- Environmental monitoring applications

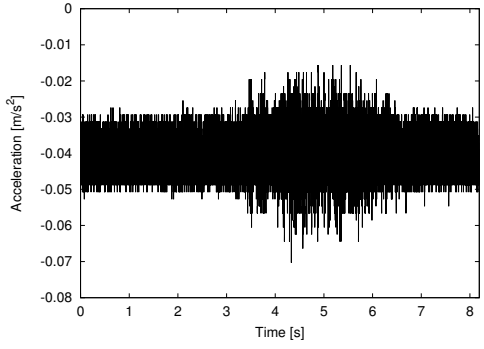

AcquisitionModule
ProcessingModule
TranslationModule
Situation
Emit
SituationEngine
Execute
Derivation
Emit
DerivationEngine
Execute
1...
Emit
DerivationEngine
Execute
...N
Emit
DatasetEngine
Execute
Observation
Emit
ObservationEngine
Execute
Measurement
Emit
MeasurementReader
Access
Emit
DerivationReader
Emit
ObservationReader
WavelliteServer
(RESTful Service)
Persistence
Execute
SituationWriter
Execute
DerivationWriter
Execute
ObservationWriter
Processing
WavelliteBrowser
(Visualization)
SituationAnalyser
(Statistics)
SituationReasoner
(Inference)
ClientApplication
(Domain Specific)
RepresentationModule
StoreModule
KnowledgeBase

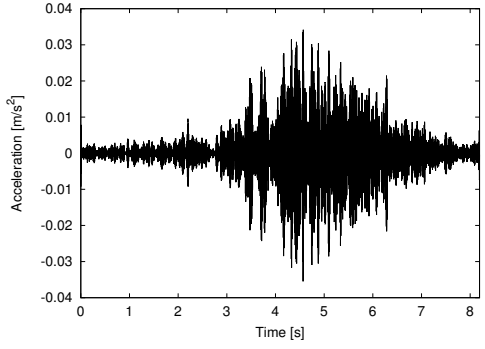
Situations

- Structured parts of reality
- Formalized in situation theory
- Situation s is said to support ($\models$) infons
- Infon σ is a tuple consisting of
- Relation R; Objects $a_1, \ldots, a_m$; Polarity $1/0$
- Objects can be physical entities in the environment, or ...
- Temporal and spatial locations, values, situations
- Objects stand in the relation R (polarity 1)
- Example
  - $s \models \ll \text{storm-at}, \dot{s}, \dot{t}, 1 \gg$
  - $\dot{s} \rightsquigarrow$ Storm individual with attributes (e.g. spatial extent)
  - $\dot{t} \rightsquigarrow$ February 6, 2015 at 16:05

Applications


CARPOOL
2 OR MORE
PERSONS
PER
VEHICLE


Acceleration [m/s^2]
Time [s]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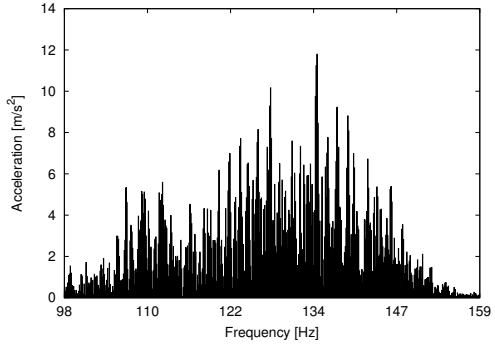
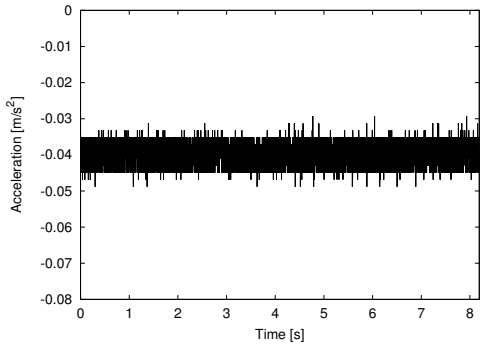
Time [s]


Acceleration [m/s^2]
Frequency [Hz]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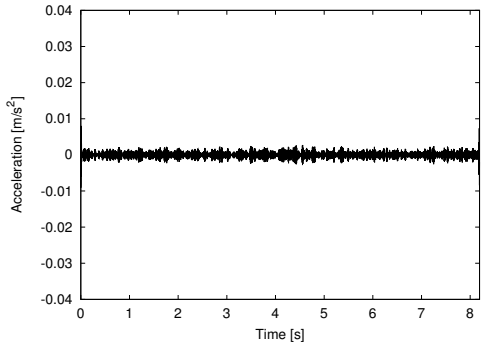
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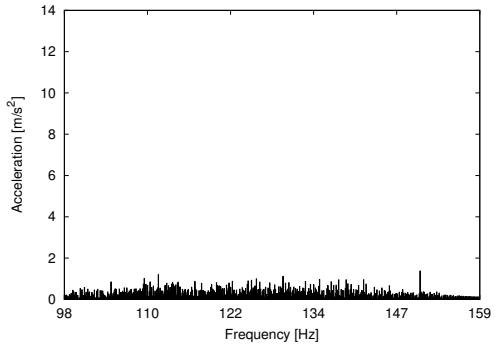
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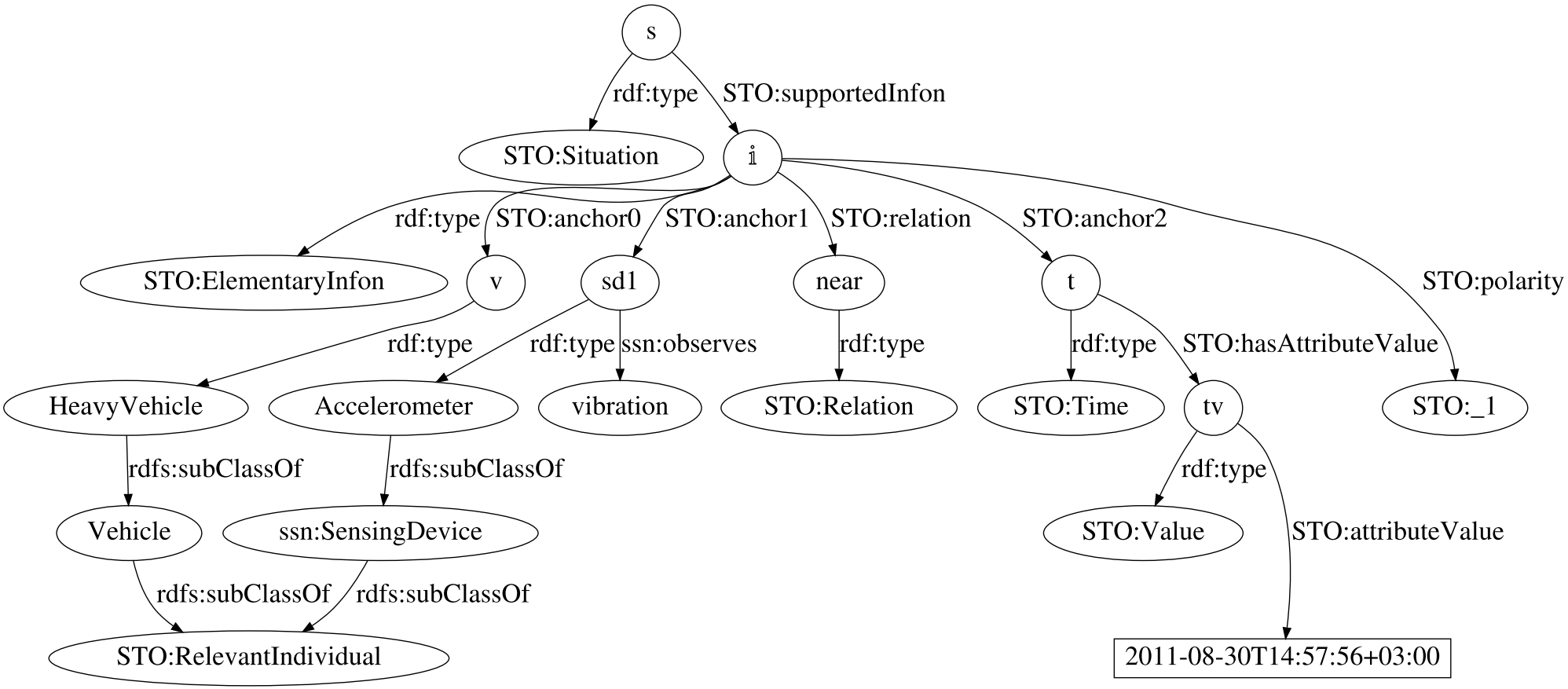

s
rdf:type
STO:supportedInfon
STO:Situation
i
rdf:type
STO:anchor0
STO:anchor1
STO:relation
STO:anchor2
STO:polarity
STO:ElementaryInfon
v
sd1
near
t
STO:_1
rdf:type
rdf:type
ssn:observes
rdf:type
rdf:type
STO:hasAttributeValue
HeavyVehicle
Accelerometer
vibration
STO:Relation
STO:Time
tv
rdfs:subClassOf
rdfs:subClassOf
rdf:type
Vehicle
ssn:SensingDevice
STO:Value
STO:attributeValue
rdfs:subClassOf
rdfs:subClassOf
STO:RelevantIndividual
2011-08-30T14:57:56+03:00

Relation

Outbreak
Acute outbreak
Pest protection

Start date

____-__-__ __:__

End date

____-__-__ __:__

filter

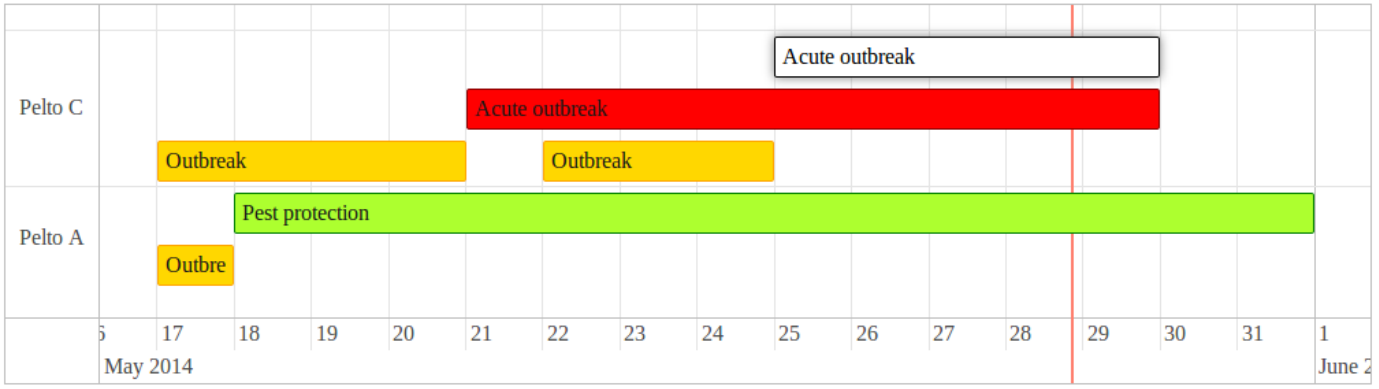
Relation
Acute outbreak

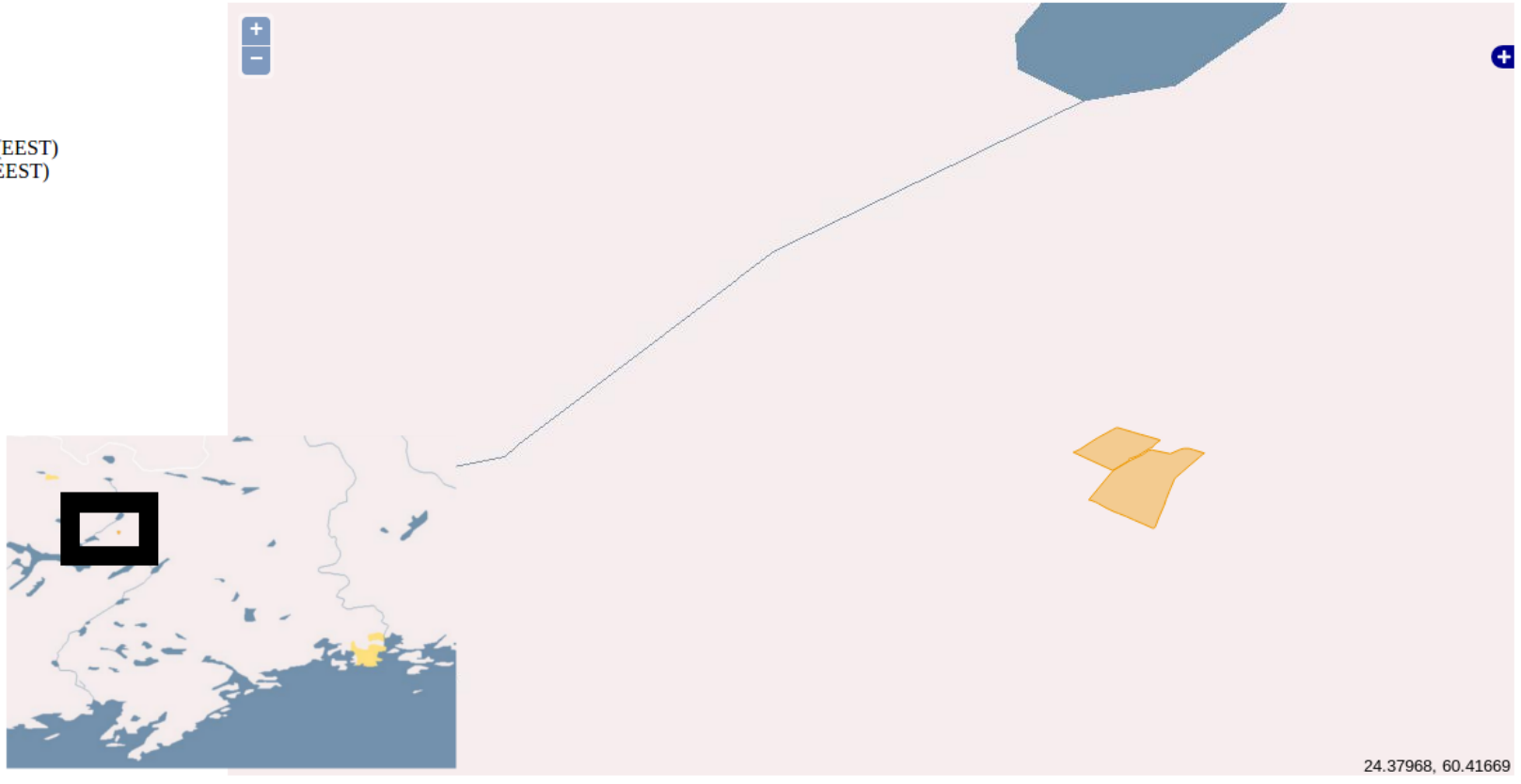
Relevant individual
Drechslera tritici-repentis

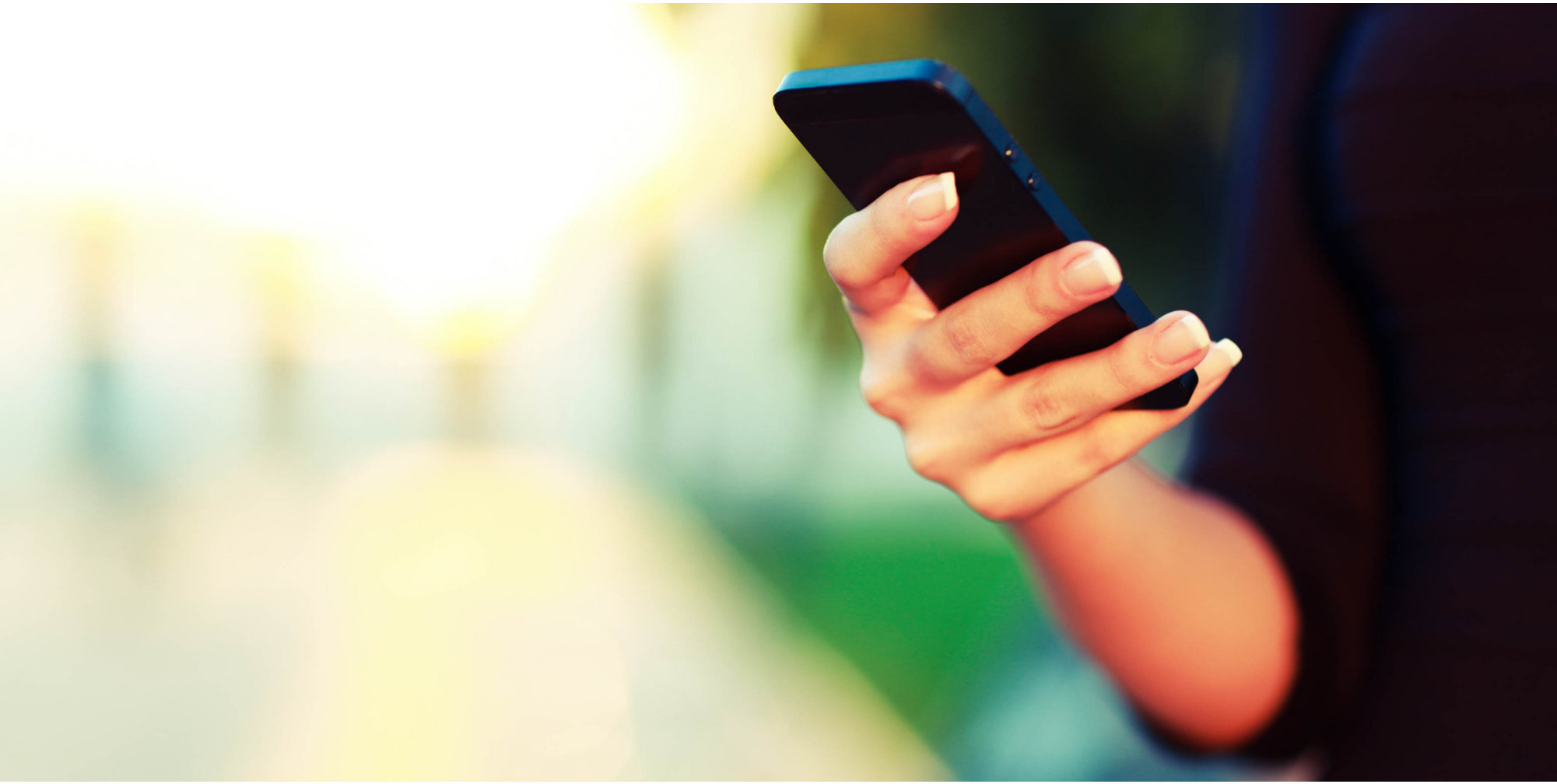
Temporal location
Sun May 25 2014 00:00:00 GMT+0300 (EEST)
Fri May 30 2014 00:00:00 GMT+0300 (EEST)

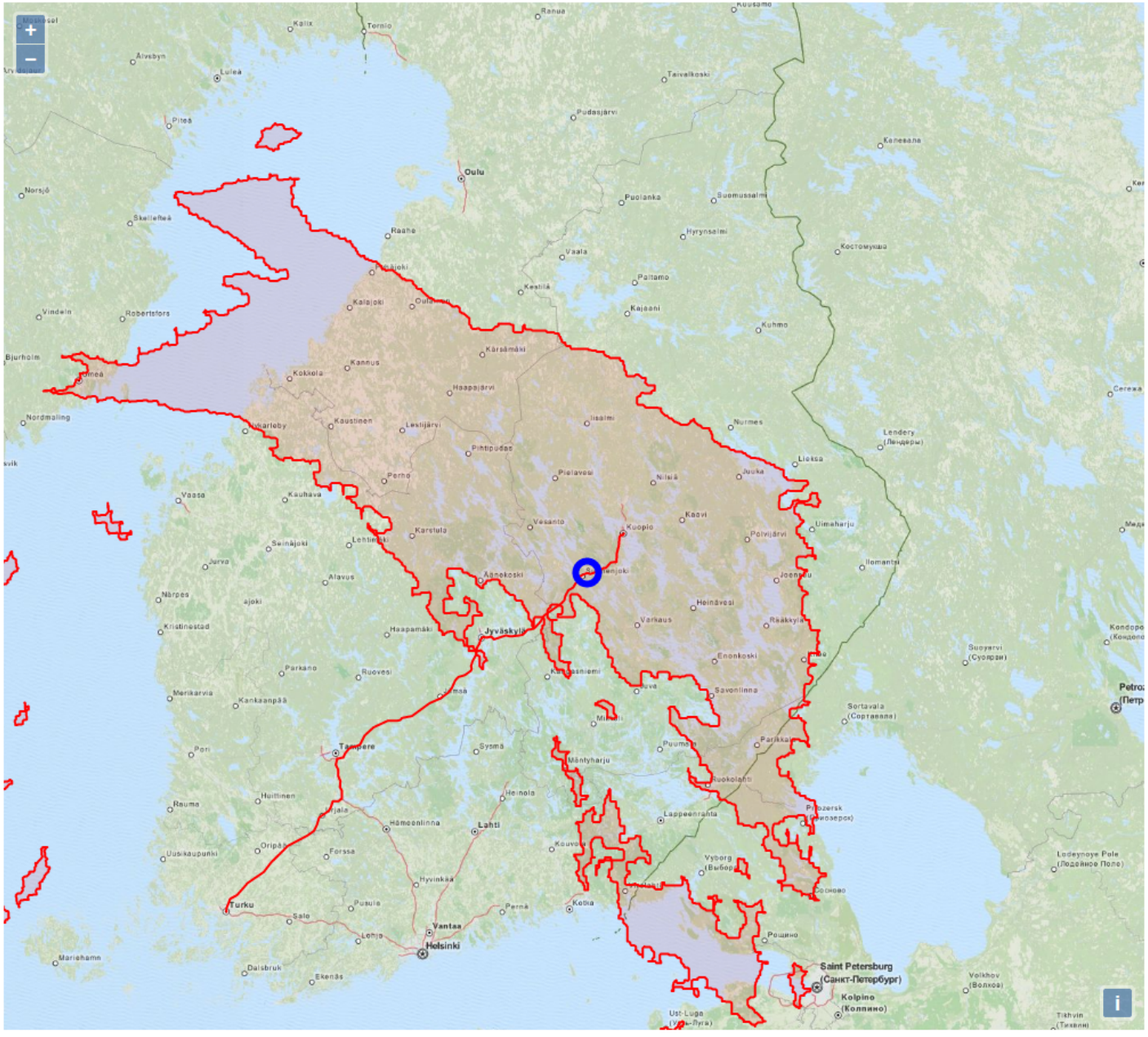
Spatial location
Pelto C

Polarity
True









New Direction

Origin

Destination

Departure time

add clear

Demo

Situation discovery

```
a Situation [
storm-at ;
[ location ?location1 ] ;
[ inXSDDateTime ?time ]
]
a Situation [
driver-at ;
[ location ?location2 ] ;
[ inXSDDateTime ?time ]
]
filter (inside(?location2, ?location1))
```

Take aways

- Data is not where the story ends
- Information about monitored environment needed
- Information extraction necessary intermediate step
  - Manually with visualization, statistical analysis, ...
  - Automatically with machine learning, data mining, ...
- Situation as key abstraction for extracted information
- Explicit representation of information about situations
- Use techniques in knowledge-based systems
- Systems can obtain and maintain situation awareness