Context Semantic representation for pervasive interaction in a Smart city paradigm

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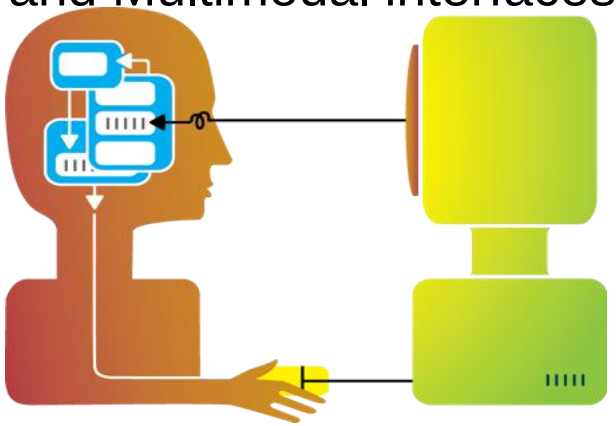
Talk Outline

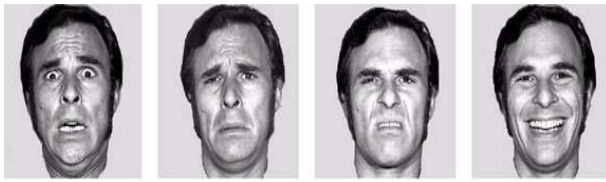
- Motivation
- Context in Ubiquitous Interaction
- Semantic Representation
- Experimental Validation
- Conclusions - Future Work

Application Domains

Human computer interaction and Multimodal interfaces



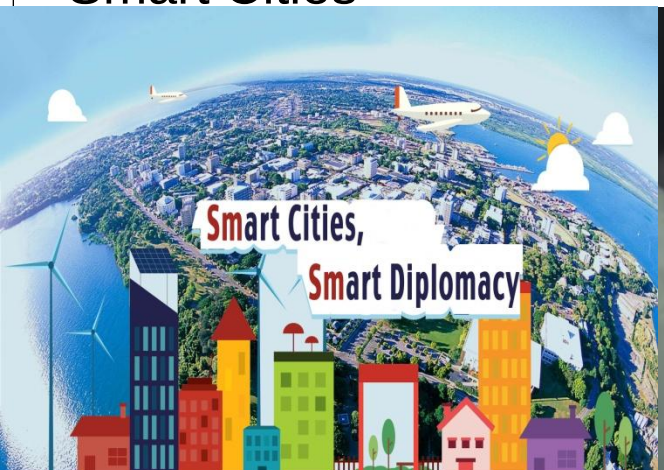
Emotion Recognition



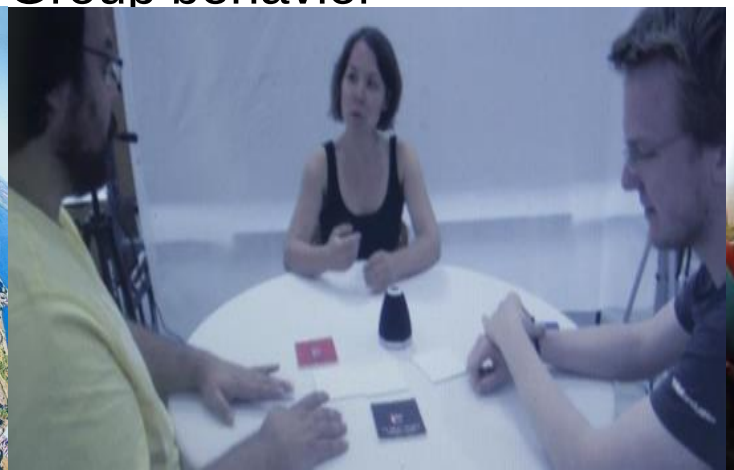
Ubiquitous Interaction

Education

Smart Cities



Group behavior



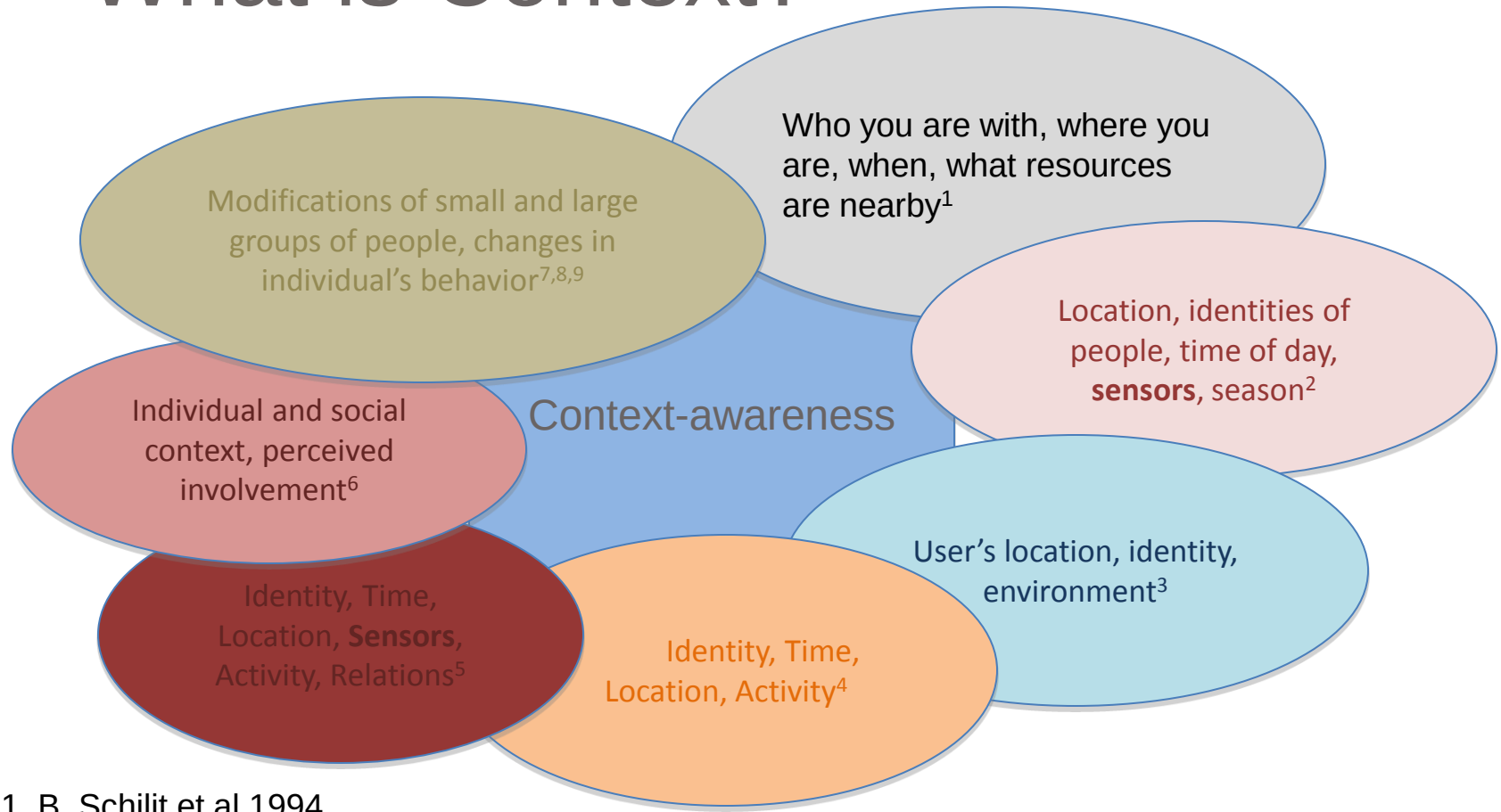
Entertainment

Research Areas

Ubiquitous Computing

- multimodal signal processing, machine learning, statistical modeling, human-centered computing
- Human-centered computing
  - Recognition and analysis of emotional expression
  - Modeling and fusion of multimodal affective signals
- General social behavior under diverse contextual settings
  - From emotions to general human states, e.g. frustration, engagement
  - Analysis of individuals, dyad and multiparty behavior within smart homes
  - Incorporating context into multiparty multimodal interaction
- Applications
  - Personalized interfaces, smart sensing environments

What is Context?



1. B. Schilit et al,1994.
2. P. J. Brown et al, 1997.
3. N. S. Ryan et al, 1998.
4. G. D. Abowd et al, 1999.
5. A. Zimmermann et al, 2007.
6. F. Bonin et al, 2012.
7. T. Choudhury and A. Pentland, 2003.
8. D. Gatica-Perez, 2009.
9. M. Wollmer et al, 2012.

Sensors

Sensors are divided to:

- In house sensors:
  - Sensors that are located in the houses,
  - Sensors can be to different rooms (e.g. bathroom bedroom, kitchen).
- City sensors
  - SmartSantander sensors are used.

Type of Sensors

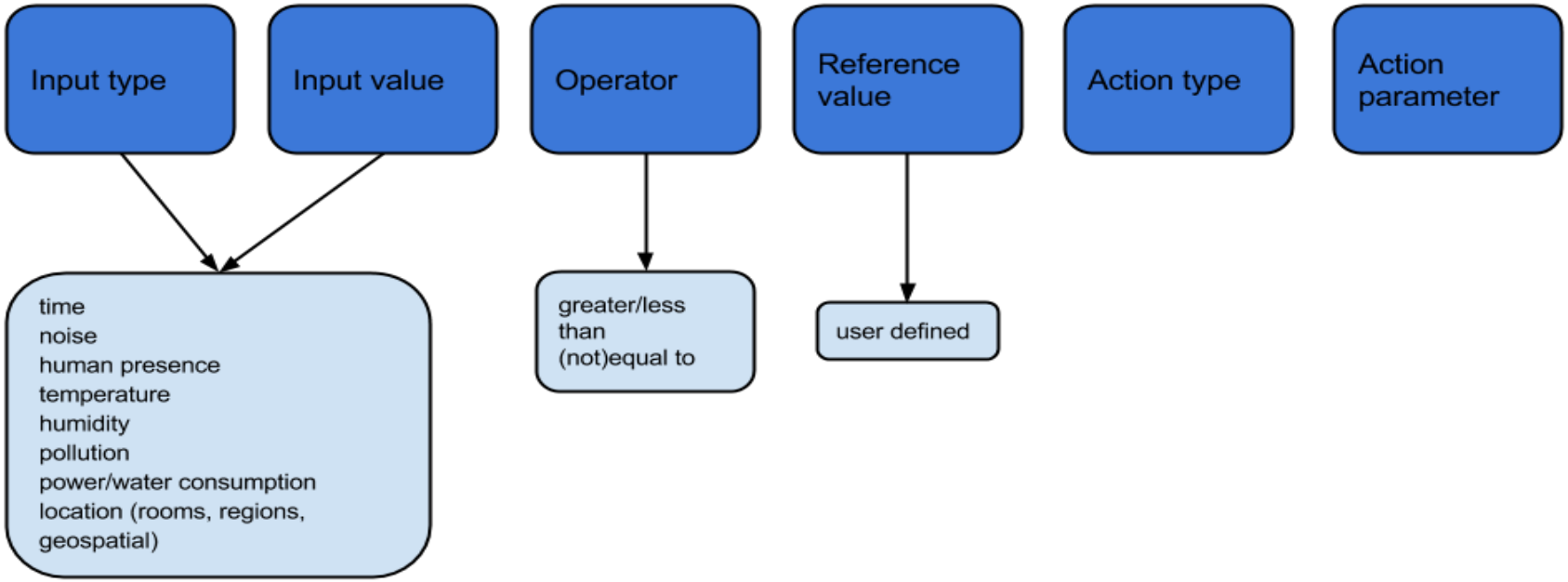
- In house sensors can be:
  - **Temperature**,
  - Humidity,
  - **Luminosity**,
  - Water and Power consumption levels,
  - **Human presence,**
  - Noise
- City Sensors can be:
  - Mobility sensors,
  - Traffic and parking sensors,
  - Environmental sensors
  - Park and garden irrigation sensors.

Smart Santander Sensors

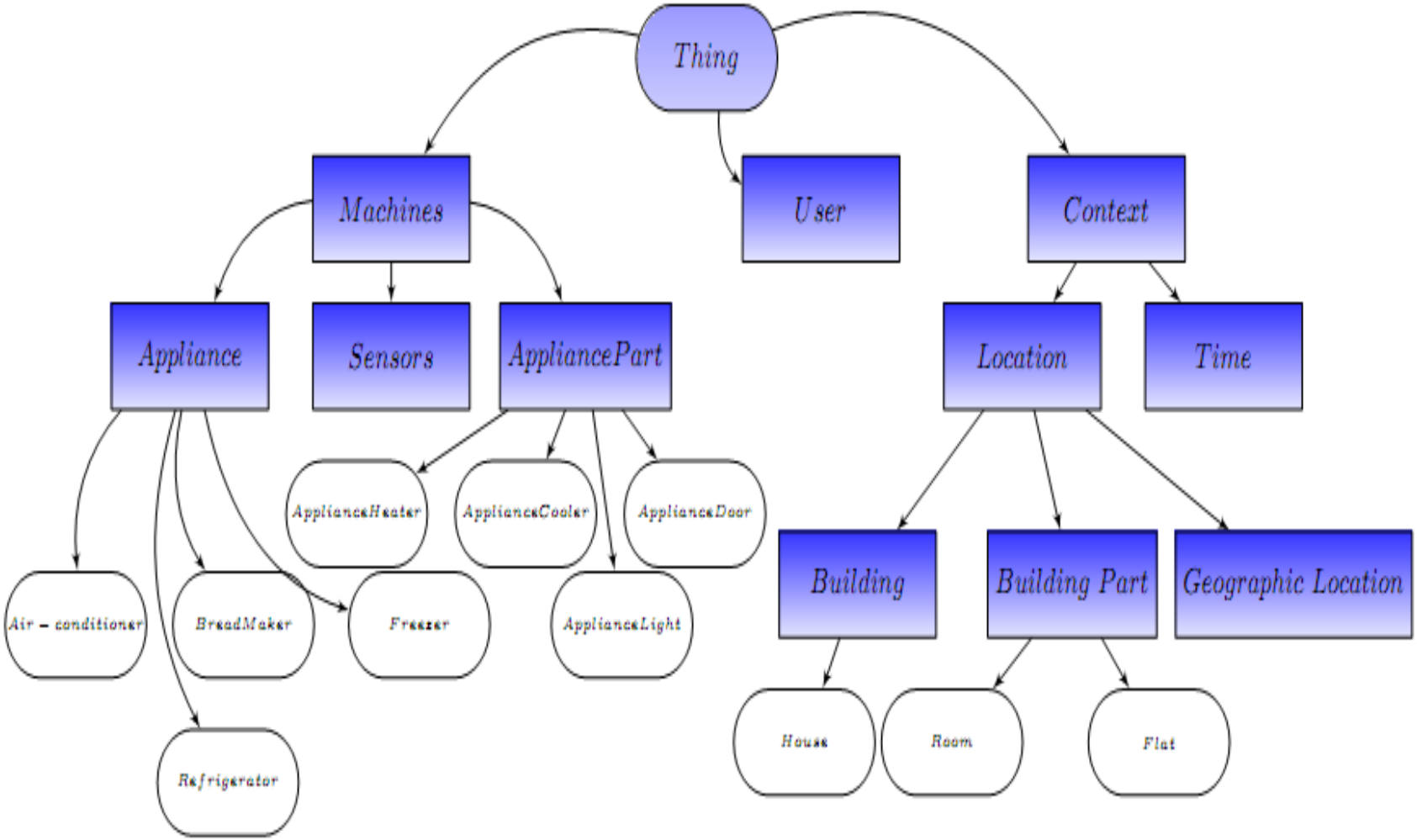
Semantic Representation

“Home Rules”

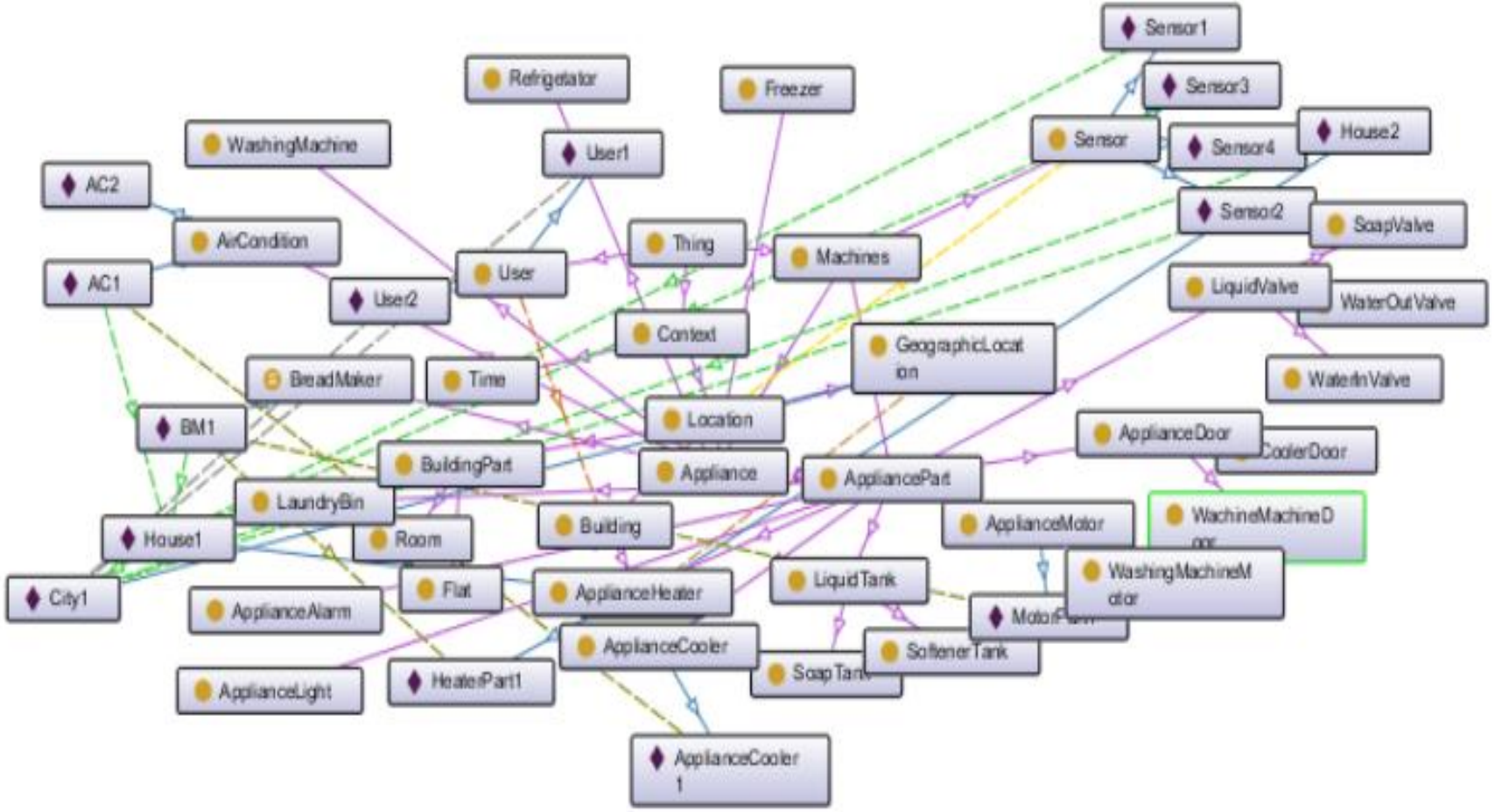
- Representational approach of the home rules can be created in the ecosystem



Semantic Representation of the Ecosystem using Hierarchical Ontologies



Semantic Representation of the Ecosystem using Ontology structure



Semantic Representation of the Home rules in Ontologies

- Things are needed to trigger a home rule are:
  - SWRLs:

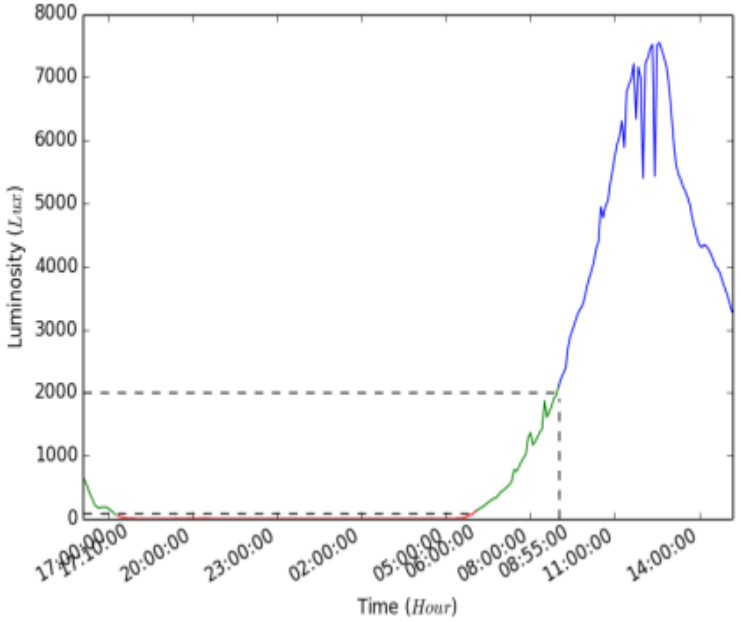
Rules
House(?house)∧Sensor(?sens)∧hasSensor(?house, ?sens)∧hasPowerConsumption(?sens, ?power)∧WashingMachine(?wm)∧isLocatedIn(?wm, ?house) ∧isOn(?wm, true)∧greaterThan(?power, 1000)→restriction(?wm, true)
City(?city)∧House(?house)∧builtIn(?house, ?city)∧Sensor(?sens)∧hasSensor(?city, ?sens)∧Air-conditioner(?air)∧isLocatedIn(?air, ?house) ∧hasTemperature(?sens, ?temp)∧isOn(?air, true)∧greaterThan(?temp, 15)→restriction(?air, true)
City(?city)∧House(?house)∧builtIn(?house, ?city)∧Sensor(?sens)∧hasSensor(?city, ?sens)∧Air-conditioner(?air)∧isLocatedIn(?air, ?house) ∧hasLuminosity(?sens, ?lum)∧isOn(?air, true)∧lessThan(?lum, 100)→restriction(?air, true)
House(?house)∧Sensor(?sens)∧hasSensor(?house, ?sens)∧Air-conditioner(?air)∧isLocatedIn(?air, ?house) ∧humanPresence(?sens, ?hum)∧isOn(?air, true)∧notEqual(?hum, 1)→restriction(?air, true)

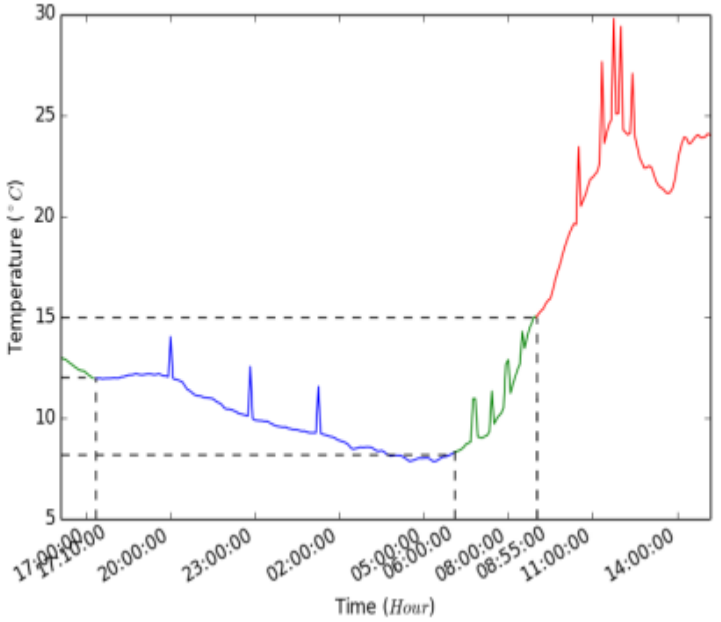
  - Restriction property:

Experiment

"Triggering a Home Rule"

- Home rule:
  - the Air-conditioner should not be switched on, when the temperature is higher than 15°C, the luminosity is lower than 100 lux and no human presence is detected in the house.
- Luminosity and Temperature levels of the





Conclusions – Future Work (1)

- Novel formalization to capture the semantics of Smart Home environments
- Experts ensure semantic interoperability
- Formal machine - processable representation defines, extracts and uses a set of concepts and their fuzzy semantic relations
- High level semantic representation language to define complex home rules

Conclusions – Future Work (2)

- Exploration of other rule based paradigms (e.g. OWL 2 RL ontology with the SPIN rule based reasoner)
- Incorporation of the user, usage and the context information through a unified semantic representation, for personalized services and optimization
- Exploration of the computational cost and the scaling of SandS to a wider user group

Thank you !

Any Questions ?