Rule-based Context Assessment in Smart Cities

Beibei Hu, Theodore Patkos, Abdelghani Chibani, and Yacine Amirat

Université Paris-Est Créteil (UPEC), LISSI, France

beibei.hu@gmail.com

① Introduction

Motivations:

- In urban environments, people affected by unexpected incidents act in different roles (e.g., citizens and first responders), and they need to receive relevant information at real-time.
- Urban ecosystems are required to exploit the semantics of events and create urban-specific Linked Data.

Objectives:

- In the context of the European PEOPLE smart cities project, our research focuses on reasoning and assessing the relevancy of information for users involved in critical urban situations.

Contributions:

- Designed an architecture for the provision of information relevant to the current situation of users acting in specific roles.
- Proposed a rule-based approach for information relevance assessment given context by the specification of declarative rules.

② Motivating Scenario

Assumption:

- In an intelligent urban space, bus stations and streets can be equipped with sensors to track the physical context of each unit in real-time. To handle the incidents, the command center operators use a context-aware system that connects to sensors and standard databases.

Citizen Rescue Scenario:

- At the Paul Armangot bus stop around 5pm, an old man has suddenly fallen down and remains unconscious. The incident occurs near the UPEC university around closing time. First responders are sent to rescue this citizen.

Requirements:

- The situations in which users perform their activities in urban spaces are characterized by various types of context.
- The same piece of information may have different levels of significance for people acting in specific roles.

People in specific situations	Relevant Information
The ambulance approaching to the incident spot	An traffic alert
The ambulance engaged in the rescue activities	A heart attack record of the patient
The police unit engaged in providing a free passage for the ambulance	Nearby traffic situations

③ A Rule-Based Architecture

Contextualized Information Delivery Architecture (CIDA)

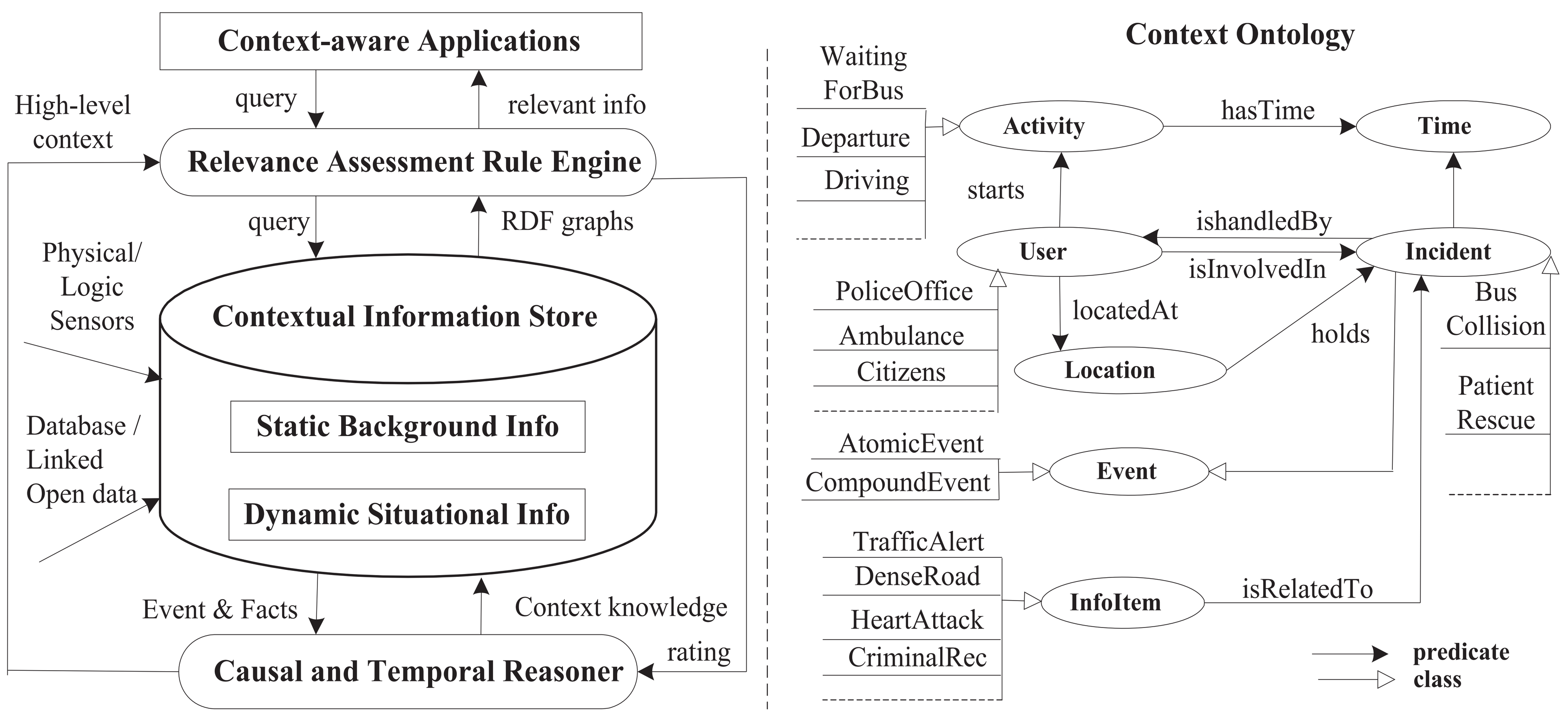

Fig.1: The Contextualized Information Delivery Architecture

- Contextual Information Store. All information is represented in an ontology-based context model, which consists of a generic ontology and a domain-specific ontology.
- Causal and Temporal Reasoner (CTR). CTR decides which emergency entities to contact, and derives high-level context knowledge given available urban-related data.

CTR Rule examples:

(1) ¬ HoldsAt(PublicHoliday($?day$),$?t$) ⇒ Initiates(UniversityEnd(IUT,$?day$),DenseRoadActivity(RoadSegmentX),$?t$)

(2) Happens(Incident($?e$),$?t1$) ∧ HoldsAt(LocatedAt($?e$,Loc1),$?t1$) ∧ HoldsAt(DenseRoadActivity(Loc2),$?t2$) ∧ ($?t1$-$?t2$ ≤ 15min)∧ HoldsAt(Near(Loc1,Loc2),$?t1$) ⇒ Happens(InformativeEvent(Traffic,Loc2),$?t1$)

- Relevance Assessment Rule Engine (RARE). RARE assesses the relevance of information by taking into account the contextual situations that are described in ConAD. For each rule defined in our Context Rating Rule Language (CRRL), RARE translates the rule body into a SPARQL query, and computes the relevance rating indicated in the rule head.

CRRL Rule examples:

R1: **infoType**($?info$, TrafficAlert) & **happens**($?info$, $?aleloc$) & **nearBy** ($?aleloc$, $?eveloc$) & **holds**($?eveloc$, $?event$) & **isHandledBy**($?event$, $?user$) & **starts**($?user$, DepartureActivity) & **hasRole**($?user$, Ambulance)
⇒ ***updateRating*** $(+5.0)$

R2: **type**($?info$, TrafficAlert) & **hasRole**($?user$,?role)& **hasRole**($?user$, Citizen)
⇒ ***updateRating*** (-1.0)

④ Evaluation Methodology

Data Sets definition

- Datasets are engineered corresponding to our scenarios, consisting of a set of information items and other contextual information in the citizen rescue scenario.
- Rule sets are engineered in an incremental way.

$$
\begin{aligned}
Rul_{i+1} &= Rul_i \cup AddRul_{i+1} (i > 0)\\
Rul_1 &= InitialRul\\
InitialRul &= \textit{A set of initial rules.}\\
AddRul_{i+1} &= \textit{An additional set of rules.}
\end{aligned}
$$

Configurations

- The effectiveness of the system is evaluated by applying rule sets on corresponding datasets.
- The performance of the current rule sets are evaluated on forward use cases, to investigate whether the current rules can provide a base performance.
- The extended rule sets are applied to the backward datasets to assess the influence of additional rules.

Evaluation Measures

$P@k = \frac{|Top-k \cap GS|}{k}$; $R@k = \frac{|Top-k \cap GS|}{|GS|}$.

⑤ Conclusion and Future Work

Conclusion

- Presented a rule-based architecture for contextualized information provision in a smart city.
- Defined an evaluation methodology to assess the behavior of systems.

Future Work

- Define a mechanism which allows the relevance ratings generated by RARE to influence the weight of context knowledge inferred by CTR.
- Perform evaluation studies based on large and realistic datasets for further improvements.

Reasoning Web 2012, Summer School, September 3-8, Vienna, Austria.