Implementing Usage Control Policies Using Reification with RDF-Star and SPARQL-Star

Ines Akaichi[1], Giorgos Flouris[2], Irini Fundulaki[2], Sabrina Kirrane[1]

[1]Institute for Complex Networks, WU, Vienna, Austria
[2]Institute of Computer Science, FORTH, Heraklion, Greece

WU

FORTH

Motivation

This work presents **GUCON-star,** an extension of **GUCON** [1]. While GUCON can express various data usage conditions using graph patterns, adding constraints like temporal ones can be cumbersome. To address this issue, we propose GUCON-star, which uses SPARQL-star and RDF-star for rule expression and compliance checking.

A GUCON Rule $cond \rightsquigarrow d\,a$

- $cond$ is a *graph pattern*
- $d\,a$ is a *deontic pattern*
  - $d \in \{\mathbf{A}, \mathbf{P}, \mathbf{O}, \mathbf{D}\}$, such as $\mathbf{A}$ (permission) $\mathbf{P}$ (prohibition), $\mathbf{O}$ (obligation), and $\mathbf{D}$ (dispensation)
  - $a = \{(s, p, o) \mid s \in E, p \in A, o \in R\}$, such as an (s, p, o) corresponds to a SPARQL triple pattern, E is the set of all **entities**; A is the set of all **actions**; and R is the set of all **resources**
- $\rightsquigarrow$ denotes if $cond$ is satisifed , then da may ($\mathbf{A}$)/must not ($\mathbf{P}$)/must ($\mathbf{O}$)/need not ($\mathbf{D}$) be satisfied.

A Serialization of GUCON using SPARQL

- $cond$ is a **SPARQL** graph pattern
- a is a **SPARQL** triple pattern

```
{?share rdf:type splog:SharingEvent ;
    rdf:subject ?x ;
    rdf:predicate eg:share ;
    rdf:object egmc:1.premierleague.com-2020-coverage ;
    splog:occurs  ?t .
?x  rdf:type eg:Person ;
    eg:position eg:Journalist .
FILTER (?t > "2021-02-25T21:00:00Z"^^xsd:dateTime)}
~ {A {?x  :share  egmc:1.premierleague.com-2020-coverage }}
```

A Serialization of GUCON using SPARQL-star

- $cond$ is a **SPARQL-star** graph pattern
- constraints are expressed using **quoted action patterns**
- a is a **SPARQL** triple pattern

```
{<<?x eg:share egmc:1.premierleague.com-2020-coverage>>
    splog:occurs  ?t .
?x  rdf:type eg:Person;
    eg:position eg:Journalist .
FILTER (?t > "2021-02-25T21:00:00Z"^^xsd:dateTime )}
~ {A {?x eg:share egmc:1.premierleague.com-2020-coverage }}
```

Architecture of the GUCON-star Engine

- Use **SELECT SPARQL-star** queries to identify **active** usage control rules by determining if the knowledge base has a match for the condition of the usage control rule.
- Employ **ASK SPARQL-star** queries on the knowledge base to evaluate compliance based on the active rules.
  - Active temporal **permissions** and **dispensations** are always considered valid.
  - In the case of active **obligations** and **prohibitions**, a match indicates compliance for obligations and non-compliance for prohibitions.
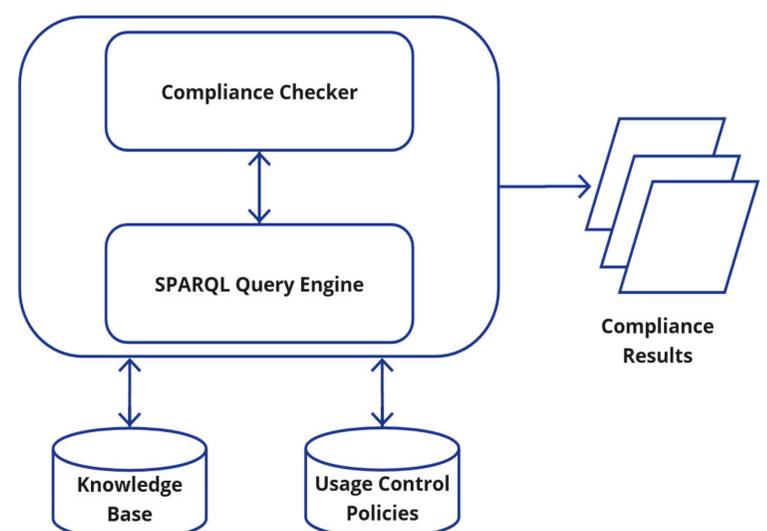
Future Work

- Implement the GUCON framework, incorporating **consistency** and **requirements** checking.
- Evaluate the **expressiveness** and **performance** of GUCON.
- Represent GUCON using various **serializations** such as Datalog, ASP, etc. This will allow us to compare the performance of different engines.

References

[1] Akaichi, I., Flouris, G., Fundulaki, I., Kirrane, S. (2023). GUCON: A Generic Graph Pattern Based Policy Framework for Usage Control Enforcement. In Rules and Reasoning. RuleML+RR 2023.

ines.akaichi@wu.ac.at

https://at.linkedin.com/in/akaichi-ines-87092312a