Adaptive Presentation of Linked Data on Mobile

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ABSTRACT

We present PRISSMA, a context-aware presentation layer for Linked Data. PRISSMA extends the Fresnel vocabulary with the notion of mobile context. Besides, it includes an algorithm that determines whether the sensed context is compatible with some context declarations.

Categories and Subject Descriptors

H.5.2 [**Information Interfaces and Presentation**]: User Interfaces

Keywords

Linked Data; Context Awareness

1. INTRODUCTION

The paper addresses context-aware adaptation of Linked Data. We split up the problem in two sub-questions: i) *how to model context for Linked Data presentation* and ii) *how to deal with context imprecision to select proper presentation metadata at runtime.* Presentation metadata selection is riddled by context imprecision and ambiguity: we need an error-tolerant strategy that takes into account possible discrepancies between context descriptions and actual context. This error-tolerant mechanism must support heterogeneous context dimensions (e.g. location, time, strings), and run on the client-side, to avoid disclosing sensitive context data.

Other presentation frameworks for Linked Data have been proposed, such as LESS [1], or the Linked Data Visualization Model [3]. Nevertheless, none of these works adapts RDF to mobile context. On the other hand, there exist adaptation frameworks with context-aware features, but none of those support Linked Data.

2. OUR PROPOSAL

PRISSMA is a Fresnel-based [5] RDF rendering engine that selects the most appropriate presentation of RDF triples according to mobile context. The Fresnel vocabulary is built on the separation between *data selection* and *formatting*. Data selection (including filtering) is implemented by Fresnel *Lenses*, while *Formats* define how to present data (Figure 1). In our solution, presentation-level metadata is modelled by the PRISSMA vocabulary[1], an ontology designed as an extension of Fresnel. The vocabulary introduces the concept of *Prism*, an RDF graph that describes the context conditions under which a given set of Fresnel presentation metadata must be selected (Figure 1).

```
# Prism to style a dbpedia:Museum when user is walking in Paris
:museumPrism a prissma:Prism ;
             a fresnel:Group ;
  fresnel:purpose :walkingInParis ;
  fresnel:stylesheetLink <http://example.org/example.css> .

# Fresnel presentation-level triples
:museumlens a fresnel:Lens;
  fresnel:group :museumPrism;
  fresnel:classLensDomain dbpedia:Museum;
  fresnel:showProperties ( dbpprop:location
                           dbpprop:publictransit
                           example:telephone
                           example:openingHours
                           example:ticketPrice ) .

:addressFormat a fresnel:Format ;
  fresnel:group :museumPrism ;
  fresnel:propertyFormatDomain dbpprop:location ;
  fresnel:label "Address" ;
  fresnel:labelStyle "label-address"^^fresnel:styleClass ;
  fresnel:valueStyle "value-address"^^fresnel:styleClass .

# [...]

# PRISSMA context description
:walkingInParis a prissma:Context ;
  prissma:user :artLover ;
  prissma:environment :parisWalking .

:artLover a prissma:User ;
  foaf:interest "art".

:parisWalking a prissma:Environment ;
  prissma:poi :paris ;
  prissma:motion "walking" .

:paris geo:lat "48.8567" ;
  geo:long "2.3508" ;
  prissma:radius "5000" .
```

Figure 1: A sample Prism (prefixes are omitted)

Prism selection is performed at runtime by an error-tolerant subgraph matching algorithm based on the notion of graph edit distance. The algorithm takes into account the dis-

[1] http://ns.inria.fr/prissma

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http://dx.doi.org/10.1145/2567948.2577314.

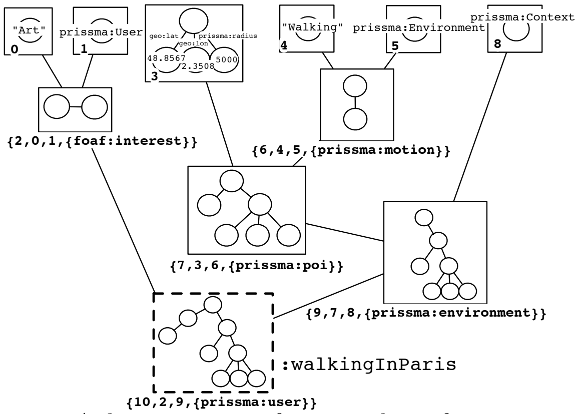
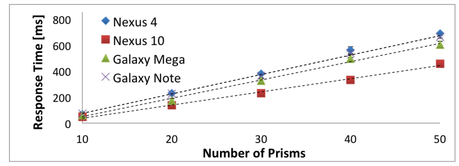


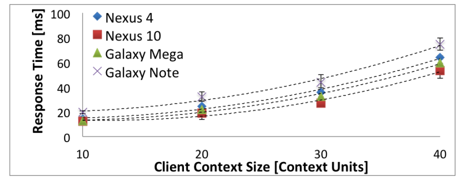
Figure 2: A decomposition of context data of `:museumPrism` showed in Figure 1.

crepancies between Prisms and the sensed context, supports heterogeneous context dimensions, and runs on the client-side - to avoid disclosing sensitive context information. The Prism selection algorithm is an extended and RDF-adapted version of the Messmer and Bunke error-tolerant algorithm for finding *optimal* subgraph isomorphisms in labelled, directed graphs [4]. The strategy relies on the fact that the optimal error-tolerant subgraph isomorphism problem can be reduced to the computation of *graph edit distance* [2]: retrieving the optimal error-tolerant subgraph isomorphism problem is therefore solved by determining the least expensive sequence of edit operations. More precisely, each graph is decomposed recursively in two subgraphs, until the remaining subgraphs consist in single nodes. Every subgraph is stored in a tree-like structure, called *decomposition* (Figure 2), a common storage for all decomposed model graphs. The advantage of this approach is that subgraphs that are repeated in different graphs are collapsed in the decomposition and represented only once, thus providing a compact representation of model graphs. This feature is important in a memory-constrained mobile scenario, especially when the stored graph structures share the same background ontology (thus having a high chance of common triple patterns). Furthermore, such approach supports runtime updates of RDF graphs: context descriptions are added to the decomposition in an incremental manner, and the structure does not have to be re-built from scratch. Given an input graph, an online search algorithm searches in the decomposition for the error-tolerant subgraph isomorphisms with the lowest edit costs, starting from smaller subgraphs. The chosen subgraphs are recursively combined to find *optimal* (i.e. least expensive) error-tolerant subgraph isomorphisms from the model graphs to the input graphs. Since common subgraphs are stored only once, the strategy guarantees sublinear complexity with respect to the number of model graphs in the system, an important feature when their number can be potentially high. Each graph edit operation δ computed by the Prism selection algorithm is associated to a cost $C(\delta) \in [0, 1]$. The computation of this cost has been customized to a series of context dimensions (e.g. location, time, strings, missing nodes).

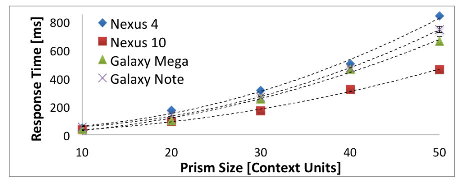
Response time test campaign confirms the theoretical complexity analysis of the selection algorithm, and shows the sublinear dependence on the number of Prisms in the system (Figure 3a).



(a)



(b)



(c)

Figure 3: Search algorithm response time evaluation

3. LIMITATIONS AND FUTURE WORK

The main limitation of PRISSMA is the need for a proper parametrization of the selection algorithm, i.e. tuning the cost functions and choosing the most appropriate threshold for determining when graphs match. This is a well-known issue of strategies based on graph edit distance. Future work will deal with a series of activities: first, machine learning techniques will be adopted to fine tune the algorithm parameters. Second, other cost functions, such as semantic distance between URIs will be added. Furthermore, Prisms distribution has not been examined, although Prisms might be distributed according to Linked Data principles, thus creating *Linked Presentation-level Metadata*. Response time comparison with cited state-of-the-art solutions is envisaged, although experimental conditions vary, making the comparison tricky. User acceptability evaluation needs to be performed with proof-of-concept applications adopting PRISSMA.

4. REFERENCES

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