Context Inconsistency Management Using Partial Constraint Checking

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Abstract—Thanks to the pervasive computing paradigm more and more computer systems in utility buildings and industry are context-aware. They use a representation of the world they operate in to reduce the human-computer interaction necessary for this operation. Unfortunately reasoning based on contexts is not without flaws and context inconsistencies are the main reason for context-aware applications' incongruous behavior. Detecting context inconsistencies using traditional context modeling is very computer intensive, making timely conflict resolution unfeasible in most settings.
In this paper we present two complementary approaches for improving the mitigation of context inconsistencies. First we extend the traditional ontology based context modeling approach with context lifecycles to more accurately represent the world surrounding the application. Many of the conflicts in context reasoning can simply be resolved using information about the lifecycle state of a set of specific contexts [2]. Secondly we propose partial constraint checking for more efficiently identifying and timely resolving context inconsistencies at runtime. By adding an extra constraint layer to the traditional ontology model, conflicts can be resolved by checking constraints or partial constraints only locally in the ontology. This dramatically improves performance compared to iterative evaluation of an entire ontology [1]. Apart from resolving conflicting contexts it is also possible to represent them into the ontology model. In our paper we explore the possibilities of incorporating inconsitencies into ontologies using fuzzy OWL and discuss the consequences of this approach on standard reasoning methods [3].

Index Terms—Pervasive Computing, Ontology Model, Context Lifecycle, Inconsistency Resolution.

1 Introduction

- WHAT
Conflict detection
Conflict resolution
Inconsistent ontologies

- WHY
Performance
Automate resolution
Better model context

- HOW
PCC
CIR
HMM - Fuzzy set theory

2 Related Work

Pervasive or ubiquitous computing is a fast-developing discipline that has been receiving increasing attention from both researchers and software developers [1]. In the past decade, many context-aware systems have been developed, ranging from smart room environments to warehouse and supply chain management systems. Lots of effort has been put into building middleware infrastructures that handle vast amounts of sensory data and extract the context information relevant for pervasive applications. Examples of such systems are CoBrA and CORTEX [2]. Various modeling approaches have been proposed for capturing context information, of which the ontology based context model appears to be most promising for most pervasive applications [2].

Context management for consistency however has not been adequately studied in the existing literature. None of the studies on context-awareness discusses a way for detecting context inconsistencies for reliable pervasive computing [1, 2]. Even though there has been related research going on in other disciplines as artificial intelligence and software engineering, it doesn't provide adequate support for context inconsistency detection in ubuquitous computing. In addition the strategies proposed in literature for resolving context conflicts are not suited for pervasive computing. Some are based on assumptions that may not apply to general pervasive environments. Other require human participation for conflict resolution, which is usually expensive and slow for pervasive computing [1]. Finally no research has been done on the potential of fuzzy ontologies for representing context inconsistencies in the environment instead of trying to resolve them [3].

In this article we aim at putting a milestone for context management by proposing an efficient inconsistency detection algorithm based on a constraint language extending the traditional ontology based context model. In addition we put forward a conflict resolution algorithm which is based on a context reliability heuristic. Finally the use of fuzzy ontologies representing context inconsistencies as a promising alternative to conflict resolution is explored.

3 Partial Constraint Checking

4 Context Inconsistency Resolution

5 Fuzzy Ontologies

better modeling training required maybe slower extensive research necessary

HMM Forward-backward algorithm

6 Discussion

7 Conclusion

References

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