Context Knowledge Discovery in Ubiquitous Computing

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Abstract. This article introduces the concept of context knowledge discovery process, and presents a middleware architecture which eases the task of ubiquitous computing developers, while supporting data mining and machine learning techniques.

1 Introduction

Many current Ubiquitous systems, such as Gaia [1], are using reasoning engines to infer high-level information from the low-level context data. However, the performance is limited due to the complications in composing rules for the rule-based reasoners, or calculating the uncertainty in probabilistic reasoners. In this paper we introduce context knowledge discovery process (CKDD) which was realized in CAMUS - our middleware architecture for context-aware systems. We also illustrate CKDD by explain the rule learning mechanism of CAMUS.

2 Context Knowledge Discovery in CAMUS Middleware

Context knowledge discovery (CKDD) differs from original knowledge discovery (KDD) in several aspects. While KDD works with transactional data in business and commercial systems, CKDD deals with context data in context-aware systems. While KDD normally discovers the interesting patterns of customers and sales, CKDD tries to model the users and their behavior, also tries to "understand" the needs of user so that a context-aware system can satisfy those needs in a ubiquitous manner.

CKDD is the core function of Learning and reasoning modules in CAMUS [2], a unified middleware framework for context-aware ubiquitous computing. The CKDD process includes 4 main steps: i) Context data preprocessing, which includes ontology mapping, context summary [3] or aggregation operations; ii) User identification (using RFID, user tag, badge, PDA, PC login...) and context recognition (using neural network, Bayesian network...); iii) Context data mining, which mines association rules, classification rule sets and clusters, to provide input to learning step; iv) Learning, which is illustrated by the rule learning algorithm and mechanism in Fig. 2.

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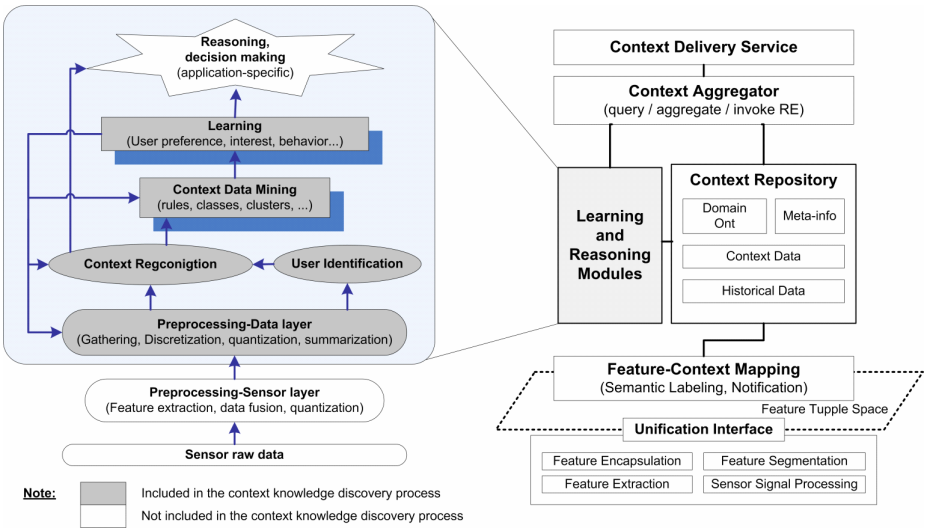

Fig. 1. CKDD, its position in the ubiquitous data inquiry and knowledge management process, and its correlation to CAMUS architecture

i/ *Learning the best rule*, each rule is assigned a utility function.

ii/ *Removal of covered example.s*

iii) Iterations: Repeat step i) and ii) until the number of attributes in a frequent set, or the number of examples covered by a new rule reach a limit.

iv) *Iteratively updating the rule set*: update the Utility of each rule based on application's reponse, remove low-utility rules and learn new rules from the updated training data.

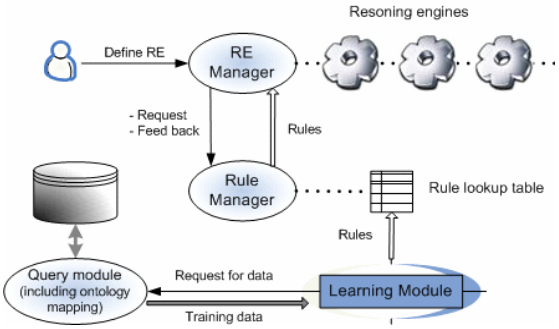

Fig. 2. Rule learning algorithm and mechanism in CAMUS

References

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[3] Faraz Rasheed, Yong-Koo Lee, Sungyoung Lee, "Context Summarization and Garbage Collecting Context", Ubiquitous Web Systems and Intelligence 2005.