

# Context Inference Engine (CiE): Inferring Context

*Umar Mahmud, Department of Computer Software Engineering, Military College of Signals,  
National University of Sciences & Technology (NUST), Islamabad, Pakistan*

*Mohammed Younus Javed, Dean of Faculty of Engineering, College of Electrical &  
Mechanical Engineering, National University of Sciences & Technology (NUST), Islamabad,  
Pakistan*

---

## ABSTRACT

*Context Awareness is the task of inferring contextual data acquired through sensors present in the environment. 'Context' encompasses all knowledge bounded by a scope and includes attributes of machines and users. A general context aware system is composed of context gathering and context inference modules. This paper proposes a Context Inference Engine (CiE) that classifies the current context as one of several recorded context activities. The engine follows a distance measure based classification approach with standard deviation based ranks to identify likely activities. The paper presents the algorithm and some the results of the context classification process.*

*Keywords:* Context Aware Inference, Context Awareness, Context Inference Engine (CiE), Distance Measure Based Context Classification, Knowledge

---

## 1. INTRODUCTION

Context Aware Systems provide smart service adaptation based on the state of the devices as well as the human users present in the environment. The core of the context aware system is an inference engine. The task of this engine is to recognize activity and situations based on the supplied contextual data. The context is viewed as a state composed of variables at this level. A state is a description of an activity. An activity may be composed of a number of distinct states describing the same activity.

CiE is designed to identify which activity does the current state belong to? A number of

approaches have been proposed in the literature including Rule Based Approaches (RBA) and Classification Based Approaches (CBA) as a means to implement context inference engine.

Section 2 covers the inference issues in context aware systems. Section 3 presents the CiE Algorithm and Section 4 evaluates the proposed algorithm and shows the test results. The paper concludes in Section 5.

## 2. CONTEXT INFERENCE APPROACHES IN LITERATURE

The first generation context aware systems were designed as applications that considered spatial and temporal factors as the context of the system (Schilit, Hilbert, & Trevor, 2002; Want, Hopper,

DOI: 10.4018/japuc.2012070102

Falcao, & Gibbons, 1992; Cheverst, Mitchell, & Davies, 1999; Abowd, Atkinson, Hong, Long, Kooper, & Pinkerton, 1997; Román, Hess, Cerqueira, Campbell, & Nahrstedt, 2002; Hofer, Pichler, Leonhartsberger, Altmann, & Werner, 2002; Wang, 2004; de Deugd, Carroll, Kelly, Millett, & Ricker, 2006; Dey & Abowd, 1999; Riaz, Kiani, Lee, Han, & Lee, 2005). These first generation systems lacked the inference support based on classification techniques and were primarily RBA. Many researchers have identified RBA as a promising technique due to its efficiency in computation (Chen, Finin, & Joshi, 2003; Mahmud, Iltaf, Rehman, & Kamran, 2007; Gu, Pung, & Zhang, 2004; Fahy & Clarke, 2004; Guo, Gao, Ma, Li, & Huang, 2008). Use of context matching (Samulowitz, Michahelles, & Linnhoff-Popien, 2001) has provided an improvement on RBA. The design of a context aware system following a rule based technique though considered efficient lacks flexibility in terms of learning new rules and situations. Moreover, the strain on the developer to introduce new rules and modify them in different software engineering phases is high. Context aware systems are thus restricted to the quantity of the rules developed by the engineer.

To provide learning capability in the context aware system, some researchers have proposed context recognition processing as the alternative to the inference task (Korpiä, Mäntylä, Kela, Keränen, & Malm, 2003; Mayrhofer, 2004; Blum, 2005; Brdiczka, Crowley, & Reignier, 2007; Yuan & Wu, 2008). The context aware system recognizes the current situation and proposes appropriate actions as suggested by the developer. Use of supervised learning has provided encouraging results in context recognition (Korpiä, Mäntylä, Kela, Keränen, & Malm, 2003; Brdiczka, Crowley, & Reignier, 2007). The researchers following the context recognition generally agree on the distance being the criterion for similarity among different contextual situations (Mayrhofer, 2004; Brdiczka, Crowley, & Reignier, 2007; Yuan & Wu, 2008). The similarities in context highlight the importance of contextual conflicts that may

arise in dynamic situations. Priorities have been proposed as a general remedy to resolve conflicts (Mayrhofer, 2004; Shin & Woo, 2005).

## 2.1. RBA

Most of the systems have a rule based context inference component (Chen, Finin, & Joshi, 2003; Mahmud, Iltaf, Rehman, & Kamran, 2007; Gu, Pung, & Zhang, 2004; Fahy & Clarke, 2004; Loke, 2010; Guo, Gao, Ma, Li, & Huang, 2008; Lee, Choi, & Elmarsri, 2009; Cao, Lamma, Hou, & Jarke, 2008; Riboni & Bettini, 2011; Bernini, Micucci, & Tisato, 2010; Barbosa & Andrade, 2009; Ye, Stevenson, & Dobson, 2011). These systems are simple to construct and allow the developer to create first order logic based rules that are fired when activated. RBA provides a fast mapping between perception and its action. They are also suitably represented in the form of set theory, state machines and ambient calculus (Ranganathan & Campbell, 2008). RBA have fast response time but exhibit slower performance for large rule sets (Wei & Chan, in press; Pansar-Syväniemi, Simula, & Ovaska, 2010). Moreover, uncertainty cannot be addressed through rules unless fuzzy rules are employed (Korpiä, Mäntylä, Kela, Keränen, & Malm, 2003; Ghadiri, Baraani-dastjerdi, Ghasem-aghazadeh, & Nematbakhsh, 2011). Though RBA has been a widely adopted inference technique, it still lacks the learning factor that is the basis of classification based algorithms. RBA can support probabilistic techniques in addition to rule (Bulfony et al., 2008; Feng, Teng, & Tan, 2009).

## 2.2. CBA

In classification based inference the problem of context awareness is reduced to the problem of identifying which situation or activity the current context belongs to (Mayrhofer (2004), Blum (2005), Brdiczka, Crowley, and Reignier (2007), Yuan and Wu (2008), Dargie (2009), Vladiu and Constantinescu (2011), Perttunen, Kleek, Lassila, and Riekkä (2009), and Könönen, Mäntylä, Similä, Pärkkä, and Hermes (2010). Current context is gathered from the sensors

27 more pages are available in the full version of this document, which may be purchased using the "Add to Cart" button on the product's webpage:

[www.igi-global.com/article/context-inference-engine-cie/73650](http://www.igi-global.com/article/context-inference-engine-cie/73650)

## Related Content

---

### Towards Ambient Business: Enabling Open Innovation in a World of Ubiquitous Computing

Christian Schmitt, Detlef Schoder, Kai Fischbach and Steffen Muhle (2008). *Advances in Ubiquitous Computing: Future Paradigms and Directions* (pp. 251-279).  
[www.igi-global.com/chapter/towards-ambient-business/4925](http://www.igi-global.com/chapter/towards-ambient-business/4925)

### Managing Context Uncertainty in Smart Pervasive Environments

Nirmalya Roy and Sajal K. Das (2010). *Designing Solutions-Based Ubiquitous and Pervasive Computing: New Issues and Trends* (pp. 1-23).  
[www.igi-global.com/chapter/managing-context-uncertainty-smart-pervasive/42501](http://www.igi-global.com/chapter/managing-context-uncertainty-smart-pervasive/42501)

### A Choreographed Approach to Ubiquitous and Pervasive Learning

Sinuhé Arroyo and Reto Krummenacher (2007). *Ubiquitous and Pervasive Knowledge and Learning Management: Semantics, Social Networking and New Media to Their Full Potential* (pp. 216-235).  
[www.igi-global.com/chapter/choreographed-approach-ubiquitous-pervasive-learning/30481](http://www.igi-global.com/chapter/choreographed-approach-ubiquitous-pervasive-learning/30481)

### Mobile Novelty Mining

Agus T. Kwee and Flora S. Tsai (2009). *International Journal of Advanced Pervasive and Ubiquitous Computing* (pp. 43-68).  
[www.igi-global.com/article/mobile-novelty-mining/41704](http://www.igi-global.com/article/mobile-novelty-mining/41704)