## Functional Stream Derivatives of Context-Awareness on P2P Networks

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**Abstract.** This paper will be both to give an in-depth analysis as well as to present the new material on the notion of context-awareness process on P2P networks, an idea that networking can both sense and react accordantly based on external actions. The paper formalizes context-awareness process using the notion of *functional stream derivative*, including P2P networks, context-awareness and the functional stream derivatives of context-awareness on P2P networks. A brief summary of this approach is also given.

**Keywords:** Context-awareness, Context-awareness process, Functional stream derivative, P2P networks.

## 1 Introduction

In development of P2P networks, one of the limitations of the current approaches is that when increasing (fully or partially) the context-awareness of networking, the semantics and understanding of the context-awareness process become difficult to capture for the development. As motivation, the context-awareness process on P2P networks should be carefully considered under a suitably rigorous mathematical structure to capture its semantics completely, and then support an automatic developing process, in particular, and applications of context-aware networking, generally.

Both initial algebras and final coalgebras are mathematical tools that can supply abstract representations to aspects of the context-awareness process on P2P networks. On the one hand, algebras can specify the operators and values. On the other hand, coalgebras, based on a collection of observers, are considered in this paper as a useful framework to model and reason about the contextawareness process on P2P networks. Both initiality and finality give rise to a basis for the development of context-awareness calculi on P2P networks directly based on and driven by the specifications. From a programming point of view,

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this paper provides coalgebraic structures to develop the applications in the area of context-aware computing on P2P networks.

A coalgebraic structure provides an expressive, powerful and uniform view of context-awareness, in which the observation of context-awareness processes on P2P networks plays a central role. The concepts of bisimulation and homomorphism of context-awareness are used to compute the context-awareness process on P2P networks.

## 2 Outline

The paper is a reference material for readers who already have a basic understanding of P2P networks and are now ready to know the novel approach for formalizing context-awareness process on such P2P networks using coalgebraic language.

Formalization is presented in a straightforward fashion by discussing in detail the necessary components and briefly touching on the more advanced components. The notion of functional stream derivatives, including justifications needed in order to achieve the particular results, is also presented.

The rest of this paper is organized as follows: Section 3 briefly describes related work and existing concepts. P2P networks and context-awareness are the subjects of Section 4. Section 5 presents functional stream derivatives of contextawareness. Finally, Section 6 is a brief summary.

## 3 Related Work and Existing Concepts

In our previous paper [15], we have rigorously approached to the notion of context-awareness in context-aware systems from which coalgebraic aspects of the context-awareness emerge. The coalgebraic model is used to formalize the unifying frameworks for context-awareness and evolution of the context-awareness processes, respectively.

Most notions and observations of this paper are instances of a theory called universal coalgebra [10,4]. In [9,11], some recent developments in coalgebra are presented.

The programming paradigm with functions called functional programming [1,5,2,3,7] treats computation as the evaluation of mathematical functions. Functional programming emphasizes the evaluation of functional expressions. The expressions are formed by using functions to combine basic values.

The notion of bisimulation is a categorical generalization that applies to many different instances of infinite data structures, various other types of automata, and dynamic systems [10,9,4]. In theoretical computer science, a bisimulation is an equivalence relation between abstract machines, also called the abstract computers or state transition systems (i.e., a theoretical model of a computer hardware or software system) used in the study of computation. Abstraction of computing is usually considered as discrete time processes. Two computing