Chapter XIII
Towards a Context Definition for Multi-Agent Systems

Tarek Ben Mena
RIADI-ENSI, Tunisia GRIC-IRIT, France

Narjès Bellamine-Ben Saoud
RIADI-ENSI, Tunisia

Mohamed Ben Ahmed
RIADI-ENSI, Tunisia

Bernard Pavard
GRIC-IRIT, France

ABSTRACT
This chapter aims to define context notion for multi-agent systems (MAS). Starting from the state of the art on context in different disciplines, we present context as a generic and abstract notion. We argue that context depends on three characteristics: domain, entity, and problem. By specifying this definition with MAS, we initially consider context from an extensional point of view as three components—actant, role, and situation—and then from an intensional one, which represents the context model for agents in MAS which consist of information on environment, other objects, agents, and relations between them. Therefore, we underline a new way of representing agent knowledge, building context on this knowledge, and using it. Furthermore, we prove the applicability of contextual agent solution for other research fields, particularly in personalized information retrieval by taking into account as agents: crawlers and as objects: documents.

INTRODUCTION
The notion of context is a well-known concept in cognitive psychology, philosophy of language, and in linguistics as well. Nevertheless, it has emerged in the Artificial Intelligence field only since 1980 (Weyhrauch, 1980).

Indeed, it was during the 13th International Joint Conference on Artificial Intelligence that context came to be considered more significant
when Giunchiglia (1993) and McCarthy (1993) introduced contexts as formal objects.

The term “context” itself has always been ostensible in the English language, and the scrutiny of the concept which it represents has been the object of study in various fields and according to various points of view. However, the focus of the present study is on the field of Artificial Intelligence (AI), particularly on those studies that have been carried out to apply the results obtained in the field of the representation of knowledge.

There is no single definition of the notion of context. Each field has its own terminology to define a context according to various aims. On one dimension, Hirst (1997) shows that there is no theory of context, and that context in a natural language is not the same as context in the representation of knowledge. On another dimension, Hoffman (2004) states that the AI does not seek to define what the term context really stands, for but AI often describes context as being a local model representing a point of view on a field.

In this chapter, we aim to provide a definition of context with regard to multi-agent systems and then underline a new way of building on it as well as using it. Therefore, we progressively define context as an abstract and general notion, then we consider an extensional point of view, to end up with a specific definition for multi-agent system (MAS) from an intensional viewpoint presented as a context model. We apply this model in a case study for representing knowledge and reasoning at a context-aware agent.

**BACKGROUND: CONTEXT AND AI**

Theoretically, in artificial intelligence, contexts have been introduced as means of partitioning knowledge into manageable sets (Hendrix, 1997). A precursory idea of context can be traced back to Peirce’s existential graphs (Roberts, 1973). Existential graphs use a logical form of context called a cut which shows in a topological manner the scope of a negative context on a sheet of paper (the sheet of assertion). Context as a concept was first introduced in AI with Weyhrauch (1980) works on the mechanization of the logical theories in an interactive system of theorems demonstration. Sowa (1985) introduced conceptual graphs as an extension of the existential graphs and defined contexts as concepts whose referent contains one or more conceptual graphs (Sowa’s situations).

**Context and Logic**

In logic, the context mechanism was introduced into the CYC project (www.cyc.com) in 1990 to simplify the construction of the commonsense-knowledge base (Lenat, Sierra, & Guha, 1990). In 1991, CYC contained more than 1.5 million sentences and covered a wide range of phenomena (Guha, 1991). Contexts are considered as rich objects in a first-order framework, extending the logic as required (Lenat, 1993). Contexts have also been considered as logical constructs that facilitate reasoning activities. In 1993, McCarthy (1993) defines context as the generalization of a collection of assumptions. According to this definition, contexts are treated as formal objects and have been made first-class objects in first-order logic. The basic relation ist(c, p) proposed by McCarthy asserts that the proposition p is true in the context c, where c is meant to capture all that is not explicit in p that is required to make p a meaningful statement representing what it is intended to state. Such a basic relation is always given in a context. Buvač (1996; Buvač & Mason, 1993) treats ist as a modality. Brézillion (1999) proposed the consequences of the formula ist(c, p) presented by McCarthy:

1. A context is always related to another context.
2. Contexts have an infinite dimension.
3. Contexts cannot be completely described.