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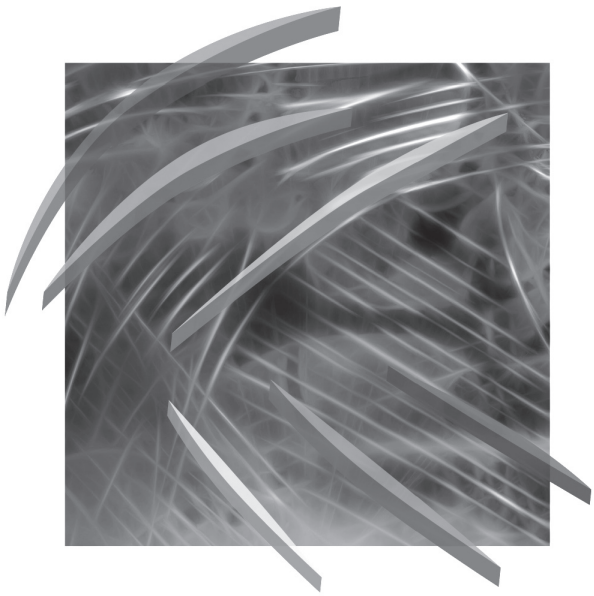

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APPROACHES TO CONTEXT REPRESENTATION IN CHOSEN INFORMATION TECHNOLOGIES

Abstract: Development of modern information technologies supporting business is strictly tied with assuring universal solutions used in different applications. One of the crucial factors in this area enabling the application of parameters in different situations is a context approach. The main goal of this paper is stressing the importance and selected solutions in respect of representation of contexts, taking into account several class applications representing different information technologies (databases, network systems and intelligent systems). Apart from discussion about the essence of representation of contexts (sorts of context and ways of its representation) the specialty of context usability in the mentioned areas is presented.

Key words: context representation, information technologies, software applications.

1. Introduction

Designing and the implementation of any software products are definitely connected with the environments where their functionalities are applied. Sometimes computer systems are prepared exactly for the specific conditions (especially in the case of building individualized software for a particular company or group of customers "package systems") but usually systems are created in a more universal way. This means there is a necessity to consider different methods of their usability in various conditions, or better, in more or less compound contexts. Therefore the context plays an essential role during the development phase of systems as well as during their implementation. The main question is how far context concepts are represented in different technologies because it can be certain confirmation of software flexibility if the context is included from the earliest stages of product development.

It is impossible to discuss real and complete impacts of context theories on solutions in different technologies but some of them are more open, while others are rather identified with non-(or very limited) contextual approaches. Both categories: **context** as well as **information technology** seem to be very important and represent different aspects and dimensions of its functionality. More and more often, context is considered as an essential concept embracing many aspects: philosophical, practical and many others [Benercetti, Bouquet, Ghidini 2001; Bouquet, Serafini 2001]. On the

other hand the ties between them are very strong, which means that any technology can be considered and implemented in more or less defined circumstances.

In this paper we present important and selected solutions in the respect of the usage of contexts taking into account applications representing different information technologies: databases, network systems and intelligent techniques. Basically, context plays different roles in the mentioned technologies and the available solutions confirm its usability in the creation of more flexible software.

2. Context interpretations and roles and its representation methods

In different situations we try to include environmental aspects of doing tasks or more generally performing any activities. At the very beginning a concept of **context** was strictly connected to the understanding of a text. Context was identified with this part of a text which is around a particular word or a sentence. In other words context determines the meaning of a phrase and can be considered not only as a linguistic category but also as a philosophical one. In his famous dissertation *Critique of Pure Reason* I. Kant defined a context "as environment of a particular event" [Kant 1998]. Therefore understanding of an informational aggregation requires contextual factors.

The first formal definition of context was proposed by J. McCarthy who stated that "**context** is a predicate **ist(*c*, *p*)** denotes the preposition ***p*** is true in context ***c***" [McCarthy 1993]. Nowadays, in modern approaches, authors stress the role of context in the interpretation of the particular concept. G. Hirst for example identifies context with "stressors having impact on different objects (personals, subjects or situations)" – [Hirst 1997]. Thus contexts are defined considering their effects on any system, thing or person. A slightly different interpretation is proposed by P. Brezillon and J.Ch. Pomerol who assumed that "context is that which constrains something without intervening in it explicitly" [Brezzillon, Pomerol 1999]. Summing up, one can say context is everything that enforces understanding and interpretation of a particular concept, some factor or situation with a different level of complexity [Jakubczyc, Owoc 2011].

One can define special goals to achieve using context. In some sense roles which can be assigned to context embrace different aspects of system (whatever that means) functionality. Identified roles of context are presented in Figure 1.

The first goal is to support understanding and interpretation of knowledge acquired via possible context. Different interpretations of the considered category lead to an extension of cognition scopes. That also means definition of boundaries of the investigated category embracing the core of an object as well as its environments.

Second, context allows for huge amount information reduction and in the same way for better information use. Context can be treated as a means for focusing on essential aspects of a particular situation and ignoring those not important. As a result better understanding of the phenomena is achieved.

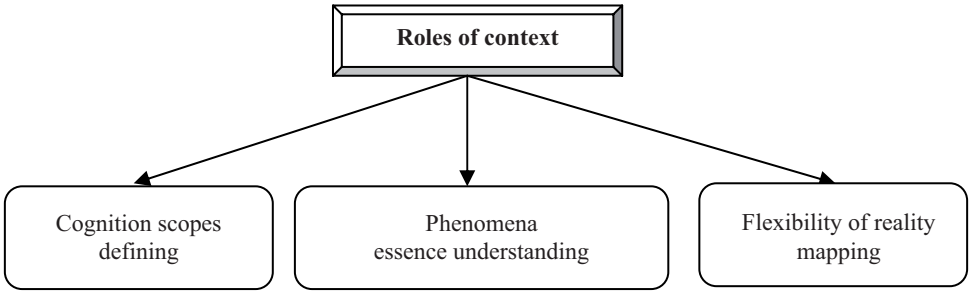

Figure 1. Aims of context usage

Source: own elaboration.

The third goal refers to the punctuality and flexibility of the reality mapping. Using different contexts allows for applying characteristics with more or less detailed descriptions necessary in complex phenomena and domains.

The roles defined above lead us to the problem of context representation. Basically forms of context representation are determined by its properties and especially include relationships to described phenomena. As a result we should be conscious of:

– relationships between context and domain knowledge,
– relationships among contexts.

This can be a base for defining methods of context representation, where these two relationships play the essential role in formulating approaches to solve a problem of including context in reality mapping.

Usually we try to consider different aspects of object or system functionality via delivering certain infrastructure allowing for a more flexible way of its behavior. Preparing a solution more systematically, we need special methods to represent context. To simplify, one can divide the following methods of context representation:

– ***context(s) separated*** from the domain knowledge (CS),
– ***independent contexts*** (IC),
– ***hierarchical contexts*** (HC);
– ***context(s) rooted*** in the domain knowledge (CR),

The first criterion describes a placement of context(s) which can be outside the particular system (or knowledge) – termed as separated context or located inside the system (or knowledge) – defined as context rooted. In both cases context can appear as a single entity (a problem is viewed using one perspective) or as a combination of several aspects (a problem considered using more perspectives).

The second criterion refers to consistency of separated contexts. Taking it into account, one can define – in some way – interrelated contexts (usually expressed as a hierarchy) or representing different aspects with no defined relationships.

All the mentioned options appear in solutions offered in different information technologies. There is not much research referring to the topic, some aspects of the problem were presented by E.P. Bontas [2004] and J.F. Sowa [1995]. In the next section, discussion about usability of forms context representation including selected business information technologies is presented.

3. Ways of context representation in different information technologies

Information technology (IT) as a category including all necessary components to manage information, in common understanding it embraces software, hardware and methods which can be used in acquisition, storing, processing and distributing. There are many classifications of IT where different criteria and groups of technologies are proposed. Usually the main phases of data processing allow for identification of technologies for gathering data, its storage and then technologies for different data processing and information delivering. Let us limit this potentially huge list of IT instances to the three most important and representative in information society: ***databases***, ***intelligent systems*** and ***network systems***. Apart from the great importance of the mentioned technologies it is worth stressing the long history of each of them and additionally, the strong impact and supportive role in many, more detailed, technologies. Let us remind ourselves of the main features of each of them.

Database technology plays an essential role in all identified phases of data processing and especially in data storing and processing. There are special data models proposed and the whole infrastructure to serve universal data files and its critical properties: non-redundancy, data integrity and privacy, data security and independence of data and programs. Database languages facilitate user communication with data resources served by database management systems.

Intelligent technologies, introduced gradually in many areas, focus on more sophisticated ways of knowledge processing. Therefore from the technological point of view we use more advanced data structures to perform tasks beyond typical processing: smart communication, automatic reasoning or explanation. Especially in this case we assume more flexible (more universal established) methods of computer processing.

Network systems and more globally – solutions for data interchange – in recent decades have become the world computer infrastructure for all data transmission processes. Information technology in this area denotes coupling of many hardware elements with specialized software managed in such a way (using special protocols and communication standards) that any data granules can be transferred between connected computer sites.

All the discussed technologies were created to support universal aims of data processing, thus it is a good point to analyze the specialty and usability of context. There are very many aspects of database, network and intelligence functioning in

different environments. First of all we should decide about context representation in applications that use separately, or in a more complex way, these technologies.

The initial version of potential usability of context representation forms in the discussed technologies is demonstrated in Table 1.

Table 1. Usability of context representation methods in selected information technologies

	Database Systems	Intelligent Systems	Network Systems
Separate context(s)	computer infrastructure	meta-knowledge representation	computer infrastructures
Rooted context(s)	components of database schema	components of knowledge representation	
Independent contexts	parameters of database properties	parameters of knowledge properties	parameters of network properties
Hierarchical contexts	mapped complex database objects	formalized complex knowledge granules	

Source: own elaboration.

In **database systems** (applications using this technology) we may apply all the defined methods of context representation. First, ***separate contexts*** can be used for establishing selected parameters of performing tasks in a particular environment where a database is implemented (for example constituting relationships to operation systems, used hardware etc.). Second, ***rooted context*** is frequently applied to mapping special features of objects modeling in database schema. In both methods we may assume many aspects which can be basically loosely coupled – therefore they represent ***independent contexts***. Following relationships between objects which are mapped in this schema but do not play a crucial role in the system – therefore they can be recognized as ***hierarchical contexts***.

Using any application as a **network system** we need to apply context including at least two methods. First, ***separate contexts*** can be used as before to express elements of computer infrastructure conditioning data transfer in computer networks. Second, selected (and no interrelated) parameters of network properties represent ***independent contexts.***

In the case of **intelligent technologies** we may implement all the discussed methods of context representation (similarly to databases). First, particular descriptors of knowledge contents in terms of meta-knowledge can be presented as ***separate contexts***. Elements of knowledge domain represented for example as presumptions of rules are typical for ***rooted contexts***. Representation of knowledge properties as specific parameters can be put as an example of ***independent contexts.*** Finally, certain external parts of knowledge granules are examples of ***hierarchical contexts***.

Summing up, there are broad areas of possible implementation of different context representation methods in information technologies. In reality, in technologies where

information structures and methods of processing are very complex and require flexible methods of its implementation, there are no limits for usability of all methods of context representation (database and intelligent technologies). In more standardized areas where parameters and protocols are strictly defined, (network technologies) the implementation of context representation methods is more limited.

4. Conclusions

The main findings of the research can be formulated in the following way:

1. Context concept was defined by many researchers basically as additional information that is *environment of a particular event or object*.

2. Context can play three basic roles (also in computer science): *defining scopes of cognition*, understanding *of phenomena essence and mapping of flexibility of reality*.

3. There are two main criteria to formulate methods of context representation: *relationships between context and domain knowledge and relationships among contexts*. Four methods of context representation are *separated context(s)*, *rooted context(s)*, *independent contexts* and *hierarchical contexts*.

4. All the mentioned methods can be applied in cases where information structures and methods of processing are very complex and require flexible methods (in our paper *databases* and *intelligent technologies*) while selected methods separate contexts and independent contexts are suggested in more standardized areas (*network technologies*).

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PODEJŚCIA DO REPREZENTACJI KONTEKSTU W WYBRANYCH TECHNOLOGIACH INFORMACYJNYCH

Streszczenie: Rozwój współczesnych technologii informacyjnych wspomagających biznes jest ściśle związany z zapewnieniem uniwersalnych rozwiązań w różnych zastosowaniach. Jednym z głównych czynników umożliwiających parametryzację w różnych sytuacjach jest podejście kontekstowe. Głównym celem artykułu jest podkreślenie znaczenia i wybranych rozwiązań z uwzględnieniem reprezentacji kontekstu w różnych klasach aplikacji reprezentujących różne technologie informacyjne (bazy danych, systemy sieciowe oraz systemy inteligentne). Oprócz rozważań o istocie reprezentowania kontekstu (rodzaje kontekstu i sposoby jego odwzorowania) zaprezentowano użyteczność kontekstu w wymienionych obszarach.

Słowa kluczowe: reprezentacja kontekstu, technologie informacyjne, aplikacje programowe.