
On the Problem of Modeling Context for Embodied Interaction

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Abstract

Researchers have been investigating context-aware systems for various decades. Fields of research such as Ubiquitous Computing, Situated Computing or Embodied Interaction are strongly coupled to this basic thought of situating applications or objects in specific contexts. However, a context only considers the present and neglects the high dynamics of the situation, including the past and the future, it is embedded in. We argue that this leads to a fundamental context-modeling problem. Moreover, we propose a new model for describing highly dynamic environments with situations, contexts and circumstances. We show that a situation has a Gestalt and outline the importance of analyzing situations for future research challenges.

Keywords

Embodied interaction, context, situated computing, theoretical modeling

ACM Classification Keywords

H.1.m. Models and Principles: Miscellaneous.

General Terms

Theory

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Introduction

In recent research, terms like context, context-sensitivity or context-adaptation have characterized a change in computer science. Namely, behavior of applications should depend on the environment and particularly the context in which they are deployed. Fields of research like Ubiquitous Computing or Ambient Intelligence are strongly coupled to this basic thought. Also research conducted under the umbrella term *Embodied Interaction*¹ is based upon that very same presumption: objects are embodied within a specific context. However, most research typically focuses on detecting context elements (like temperature, geographical location or time), which are to describe the context. And the term context itself remains rather vague and fuzzy. In other words, if a set of features was set and recognized, those features would describe the context. We feel that this leads to a fundamental misunderstanding in modeling context.

In the present paper, we first identify the aforementioned, fundamental modeling problem. Based upon this, we then elaborate on the distinction between situation, context and circumstance. A more fine-grained and thorough distinction allows us to gain a deeper understanding of research challenges, which will conclude our paper.

Context Modeling

Context is typically modeled under the assumption that it is defined by various pieces of information [2]. Consequently, context awareness is the "property of

¹ We here refer to the definition of Paul Dourish [1], „Embodied phenomena are those that by their very nature occur in *real* time and *real* space“.

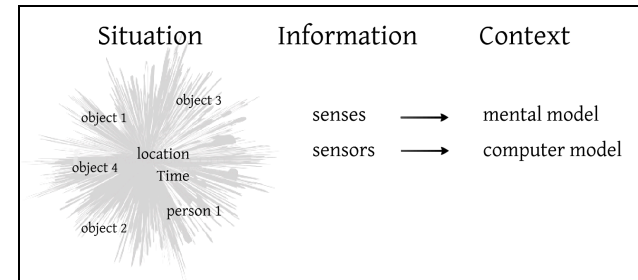


Figure 1. Context Modeling

computer programs to have *information* about circumstances under which they operate" [4]. "Information characterizing the *situation*" [5], as a modeling assumption, can be seen analogously to the real world: humans sense information through their senses. Using these pieces of information, humans assess the situation and form a mental model. Analogously, computer models are set up by describing a context utilizing sensor data (see Figure 1).

However, a situation is a much more complex structure and only a set of features (i.e. information) does not suffice to define it. This observation is also motivated by the context definition in textual sciences: "For natural (and informal) languages, the word context denotes the parts of a discourse that surround a word or passage and can throw light on its meaning." [4]. In this case, the context actually contributes to the meaning of the information or even, what the information is. Hence, information determines context on the one hand, but information is interpreted according to the context in which it is articulated on the other hand. Both arguments are valid, but circular. They therefore appear as an error.

However, there is more to it: this circle in the argumentation is particularly important in textual sciences, the so-called hermeneutic circle. As an example: the meaning of a paragraph can only be determined with an overall understanding. But an overall text understanding cannot exist without considering the meaning of each paragraph. Moreover, this circular dependency is not to be resolved, it is an interplay of moments: a preconception leads to an understanding of individual moments (e.g. the understanding of a particular paragraph), which in turn has an impact on the overall understanding, which moreover influences the understanding of particular moments. Situations in highly dynamic environments should be modeled on this very level of complexity. For this purpose, we define a situation as a composition of contexts and circumstances in the following section.

Situation, Context and Circumstance

In the following, we define a situation with respect to four aspects: a situation (1) has a *Gestalt*, (2) is comprised of circumstances and (3) is nested.

(1) Situations have a Gestalt

That objects can have a certain Gestalt is a well-known fact and has been discovered by Psychology and Philosophy in the early 20th century. Gestalt here means that the whole is not the sum of its parts. Moreover, the Gestalt determines the parts/elements and their meanings [8,9]. Consider for instance a melody: every tone can be transposed, but the melody remains the same. In contrast, when every tone remains the same but is played figuratively, the melody changes. Hence, the melody attributes a certain (musical) value to each tone. Here, the Gestalt determines its meaning. The relationship between

context and information can be expressed in a structurally similar way. Hence, situations share the attributes of a Gestalt: they are very much like musical tones not the sum of its parts [3,6]. Moreover, Gestalts can convey different internal structures. Consider for instance an orchestra. Soloists are basically musicians in the orchestra. Only by setting themselves apart from the rest, e.g. by raising their voice or playing a unique melody, they become soloists. Situations as Gestalts can have the same attributes: elements can emerge or take a back seat. Differences in their Gestalt are differences in their internal structure.

(2) Situations are comprised of circumstances

Situations can have a Gestalt structure such that they require a certain object to be present (e.g. a soloist). But these objects manifest themselves in terms of circumstances. Circumstances are the results of assertions (e.g. an object is present in a room).

(3) Situations are nested

In contrast to contexts, situations can be nested. Typically one argues that situations are defined by the present, the "here and now". However, the present is influenced by both past and future [7]. Consider for instance being on a shopping tour, while being aware of the fact that you have to take a test the next morning. This might lead you to procrastinating and shopping a little longer to avoid coming home and having to anticipate the tomorrow. In this example, the "now", the present, is influenced by a future event. Basically, this particular future event constitutes your "now". Existing approaches in computer science do not consider these emerging Gestalt boundaries. They assume a static "here and now" by e.g. evaluating GPS data, the current time and therefore define a context,

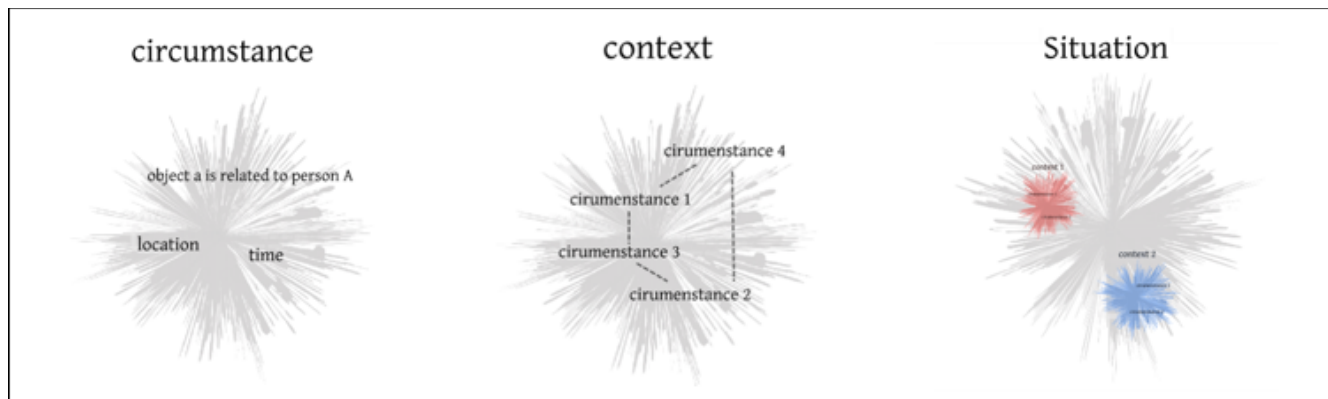


Figure 2. Situations as compositions of contexts and circumstances

comprising various circumstances in relation to a specific situation. A context cannot be nested.

Conclusion

Situations are highly dynamic. Their boundaries are not known a-priori (see Figure 2). They are nested and can span various contexts. Contexts on the contrary are not temporally nested. They are bound to the direct, spatial proximity. Circumstances are the elements of contexts (e.g. the spatial location of an object). These three terms lead to different research challenges. Existing research has mostly focused on the analysis of circumstances, less on context and only little on situations. Particularly for a field such as embodied interaction, the analysis of a situation plays an important role, since the embodiment takes place in a situation. Computers are embodied in situations and therefore not only dependent on the “here and now”, but also on the past and the future.

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