

## A Dynamic Theory of Implicit Context

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### Abstract

Several distinctions between various concepts of context are discussed: internal vs. external, intrinsic vs. model-based, and implicit vs. explicit. Finally, a dynamic theory of implicit, intrinsic, internal context is briefly discussed and its application to a context-sensitive general cognitive architecture DUAL and a context-sensitive model of human reasoning, AMBR, are briefly outlined.

**Keywords:** implicit context, intrinsic context, internal context, dynamic approach

### CONTEXT EFFECTS

Psychologists have demonstrated context effects on virtually all cognitive processes. Thus, for example, context effects on perception have been demonstrated by Gestalt psychologists in various forms: different interpretations of ambiguous figures; visual illusions depending on the background elements or on the presence of other stimuli. In language comprehension context effects can be exemplified by lexical, syntax, semantic, inference, thematic and other types of context effects (Tiberghien, 1988). In memory studies various effects of context have been demonstrated – context-dependence of recall and even recognition, memory illusions in false recognition, context-based interference, priming effects, etc. (Davies & Thomson, 1988a, Levandowsky, Kirsner, & Bainbridge, 1989). In problem solving various forms of context effects have been demonstrated: functional fixedness (Maier, 1931, Dunker, 1945), set effects (Luchins, 1942), lack of transfer from previous problem solving experience (Gick & Holyoak, 1980), priming effects (Kokinov, 1990, Schunn & Dunbar, 1996), effects of casual elements of the environment (Maier, 1931, Kokinov & Yoveva, 1996). In decision-making various context effects have been demonstrated: framing effects – the effects of alternative descriptions, e.g. percentage died or saved; effects of alternative methods of elicitation; and effects of added alternatives (Shafir, Simonson, & Tversky, 1993). Barsalou (1993) demonstrated context effects on concepts characterisation.

Thus every change in the experimental conditions that proved to change the behaviour of the subject is called a context effect. In the case of perception, language comprehension, problem-solving, and decision-making most often context effects can be described as a change to the external environment which causes a change to the cognitive performance or subjects' response; in the case of learning, memory, and problem solving transfer (like in analogical problem solving) context effects typically demonstrated are due to the change of the external environment between the initial learning stage and the later memory or problem solving test.

According to the dynamic theory of context (Kokinov, 1995) *context is the set of all entities that influence human (or system's) behaviour on a particular occasion, i.e. the set of elements that produce context effects.*

### INTERNAL VS. EXTERNAL CONTEXT

Two different notions of context have been used in the literature which will be called here external and internal context. *External context* refers to the physical and social environment or the setting within which the subject's behaviour is generated (Davies & Thomson, 1988a, Roediger & Srinivas, 1993). *Internal context* refers to subject's current mental state (Sperber & Wilson, 1986, Kintsch, 1988, Giunchiglia & Bouquet, in press) within

which the subject's behaviour is generated.<sup>1</sup> Obviously there is a relation between the external and internal contexts – the external context is being perceived and this changes the mental state of the subject, i.e. his/her internal context. However, what part of the external context will be perceived and reflected is purely subjective and depends on subject's current state (incl. goals, currently used social and common sense schemas, currently active concepts, etc.), i.e. on subject's internal context.

Psychological experiments are typically manipulating external context and very rarely the internal context (exceptions are mood-dependence studies and priming effects), however, what we are really interested in are the mechanisms of context influence, i.e. how the internal context is being formed and how it is used.

The dynamic theory of context (Kokinov, 1995) accepts that the internal context is being formed by the interaction between at least three processes: *perception* of the environment or building new representations; accessing *memory* traces or reactivating and possibly modifying old representations; and *reasoning* or constructing new representations. It also assumes that it is the internal context which on its turn influences perception, memory, and reasoning processes.

## INTRINSIC CONTEXT VS. MODEL-BASED CONTEXT

The currently dominating view on context is model-based, i.e. it assumes the existence of a model of the cognitive process according to which some factors (e.g. the instructions, the stimuli, the goals of the subject) are variable and important for the process and are called inputs to the model while others are supposed to be either constant or irrelevant to the process and therefore they are not included in the model's inputs (they are "hardwired" in the model and can be considered as constants or parameters that rarely change). Thus if such a supposedly irrelevant factor turns out to influence subject's behaviour then this is called context effect and model's failure to predict the outcome of the experiment is explained by "interaction effect". This view has been expressed very clearly by Bernard Amy (1989): "Context effects are interactive effects, in the physical sense of the term. The course of an ongoing central process is modified by interaction with other ongoing processes. Contexts act not on the inputs of the central process but on the function itself". Similar views have been expressed by Davies & Thomson (1988b): "All distinctions of context assume a distinction between stimulus and setting, figure and ground"; and Lockhart (1988): "The vary phrase context effects assumes that it is both possible and useful to distinguish a core stimulus from other aspects of the total stimulus configuration and that core and context can be varied independently".

This view implies that the observer (external or internal) *focuses* on a specific part of the system's behaviour considering it as central and modelling it, and allows other contextual factors to influence or modify this central process, to redirect its focusing on different input data. This view has been expressed also by Cristiano Castelfranchi in the electronic discussion prior to the workshop, he has insisted on the relational nature of the notion of context ("context of" a process). Then, of course, the problem arises which factors to include in the model and which to leave out for the context. In my opinion such notion of context has not a high theoretical value, as it becomes equivalent to explanatory "trash" – everything which we cannot explain so far is context.

The dynamic theory of context assumes that the cognitive system is continuously changing and there is no clear difference between changing the input and changing the system itself. It assumes also that there is one global cognitive process described as the evolution of the system over time and that all more specific or partial processes that we are considering and modelling are only abstractions which allow us to simplify our scientific endeavour. Having this in mind then there is only one single global context for all these "abstract" processes – *the state of the dynamic system*. This is called *intrinsic context* of the cognitive system and is the focus of research of the dynamic theory of context. The intrinsic context includes what others characterise as "figure", i.e. subject's current goals and focus of attention are part of the context and might be considered as its core or central part. The problem is how to describe this global state of the system. Before we try to answer this question we shall make another useful distinction.

## IMPLICIT CONTEXT, EXPLICIT CONTEXT, AND META-CONTEXT

There are at least two different meanings of explicit/implicit used in the literature and both are relevant. The first one concerns the content of the memory traces – whether they include a representation of contextual features. For example, whether subjects encode information about some specific feature of the room setting, of the experimenter, etc. when asked to remember a list of words.<sup>2</sup> The traces may even include a meta-representation –

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<sup>1</sup> In the situated approach context is considered to be the interaction between the environment and subject's mind/body, thus there is no such separation between internal and external context (Shanon, 1990).

<sup>2</sup> This reading of explicit/implicit assumes model-based notion of context: the model assumes that room setting and experimenter's face are irrelevant to the task of list memorising and therefore are contextual factors. However, it might well be the case that for some subjects the vary experience of participating in the experiment

a representation of the context itself (i.e. to represent the context as an object) – e.g. “This law is true only in the domain of micro-particles, but not in the macro world”. This type of meta-representation is needed when subjects use several contexts within a short period of time and have to control the process of switching from one context to another. AI models tend to use the notion of context in this meta-representation meaning (McCarthy, 1991, Giunchiglia, 1993). Contextual features might also be implicitly represented, i.e. they could be inferred (reconstructed) from the content of other traces, e.g. the fact that there were a lot of broken glasses during the car crash last week might be inferred from our schema for a car crash (and might even be false in that particular case).

The second reading of implicit/explicit distinction (which is more relevant to the dynamic theory of context) concerns the subject’s level of awareness of the very fact of existence of some memory trace. According to the dynamic theory of context the level of awareness is a graded (continuous) and dynamic characteristic of every memory element, i.e. there are various degrees of awareness measured by the amount of processing capacity currently associated with this particular element. In other words accessibility is a key measure of explicitness. At the lowest end a memory trace could be completely inaccessible (neither consciously, nor unconsciously) at a particular moment, then it could be only unconsciously (implicitly) available (demonstrated by priming effects, but failing to be recognised in an explicit memory task, for example), then it could be consciously available (demonstrated by a standard recall or recognition task), and finally the very fact of existence of the memory trace might be consciously available (demonstrated in a meta-cognitive “feeling of knowing” experiment). Both isolated contextual features and the context as a whole might be implicitly or explicitly available. While explicit availability allows for controlled use of contextual information, implicit availability serves a very important role in human cognition – it is a fast and cheap way of automatic control of resource allocation. If resource allocation control was performed by conscious information processing strategies only, then human cognition would be very slow and inflexible.

## **DYNAMIC THEORY OF IMPLICIT CONTEXT**

According to the dynamic theory (Kokinov, 1995) *the implicit intrinsic internal context is considered as the dynamic fuzzy set of all memory elements (mental representations or operations) accessible for mental processing at a particular instant of time.* Accessibility of a memory element is modelled by the degree of its activation which is supposed to reflect its estimated relevance (the better the element is connected to the other currently active elements the more relevant it is supposed to be). Thus context is implicitly represented by the distribution of activation over the set of all memory elements. Each pattern of activation represents a specific context. As activation is graded the membership of a memory element to this context is also graded and therefore its relevance is graded as well. This results in different amount of processing resources being made available to different memory elements (in DUAL cognitive architecture (Kokinov, 1994b this is modelled by varying the speed of working of the mental operations and by varying the degree of accessibility of mental representations).

This does not exclude to have explicit meta-context representations in addition. The implicit intrinsic internal context (i.e. the mental state of the cognitive system) can be self-observed and part of it (which is consciously accessible) can be explicitly represented in a local structure and afterwards referred to. However, this is always a partial representation of the actual mental state.

The dynamic theory of context is being tested in two ways: (a) by psychological experiments on context effects on problem solving which have demonstrated that subjects are influenced in their problem solving activity even by seemingly irrelevant casual stimuli from the environment without always being aware of this influence (Kokinov, Yoveva, 1996, Kokinov, Hadjiilieva, Yoveva, to appear); and (b) by computer simulations of analogical problem solving (Kokinov, 1994a) replicating the priming effects shown earlier and predicting some of the data in the later conducted psychological experiments.

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(characterised by the experimenter, the room, the instructions, etc.) to be subjectively more important than the artificial list of words and therefore to encode this “contextual” information even in more details than the “target”. And because this subjective importance varies from person to person and from experiment to experiment, psychologists obtain controversial data on context effects (Davies & Thomson, 1988a).

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