# *Context as a Spurious Concept*

**Graeme Hirst**

Department of Computer Science
University of Toronto
Toronto, Ontario
Canada M5S 3G4

Presented at the AAAI Fall Symposium on
Context in Knowledge Representation and Natural Language,
Cambridge, Massachusetts, 8 November 1997

## Abstract

I take issue in this talk with AI formalizations of context, primarily the formalization by McCarthy and Buvač, that regard context as an undefined primitive whose formalization can be the same in many different kinds of AI tasks. In particular, any theory of context in natural language must take the special nature of natural language into account and cannot regard context simply as an undefined primitive. I show that there is no such thing as a coherent theory of context *simpliciter*—context pure and simple—and that context in natural language is not the same kind of thing as context in KR. In natural language, context is *constructed* by the speaker and the interpreter, and both have considerable discretion in so doing. Therefore, a formalization based on pre-defined contexts and pre-defined 'lifting axioms' cannot account for how context is used in real-world language.

# 1 Introduction

I'd like to start with a generalization that I've made over the last few years:

> "The solution to any problem in AI may be found in the writings of Wittgenstein, though the details of the implementation are sometimes rather sketchy."

Now, I'm not a scholar of Wittgenstein—in fact, the more I learn about him, the less I feel I understand him—and I'm hardly going to mention him in this talk. Nonetheless, he's going to be there in the background throughout the talk. He'd have been a great choice as an opening speaker for a symposium on context in KR and NL.

My purpose in this talk will be to show that there is no such thing as a coherent theory of context *simpliciter*—context pure and simple; that context in natural language is not the same kind of thing as context in KR; and that any theory of context in natural language must take the special nature of natural language into account and cannot regard context simply as an undefined primitive.

Before I proceed, I'd like to draw attention to the cogent paper by Varol Akman, "Context as a social construct", which he'll be presenting later today. Akman says many things in his paper that I wish *I'd* thought to say. (I don't mean to imply, however, that I agree with *everything* that Akman says, let alone that he agrees with everything that I'm going to say in this talk).

# 2 Context is as context does

I want to begin with what might seem to be a completely different topic—stressors. Its relevance will become clear in due course.

Hans Selye (1950) coined the word *stressor* to refer to anything that causes stress—a deviation or distortion of a system from its normal state.[1] Selye was mostly concerned with physiological responses to biogenic stressors, but much of the subsequent research concentrated on psychological stressors. Whether some thing or some event *is* a psychological stressor depends entirely on how it is interpreted by the person experiencing it. From one book on the topic:

[1] Selye's intent was to disambiguate the word *stress*, which, in casual usage, can refer both to a cause and to its effect; Selye reserved it for the latter and introduced the new word for the former (Selye 1950: 9).

> A stimulus becomes a stressor by virtue of the fact that it has, indeed, engendered a stress response. … Psychosocial stressors become stressors by virtue of the cognitive interpretation, or meaning, assigned to the stressor. … For example, a traffic jam is a neutral event; it only becomes a stressor by virtue of the fact that the driver interprets the traffic jam as a threatening or otherwise undesirable situation. If the driver would interpret the traffic jam as having some positive or desirable aspect to it, no stress response is likely to evolve. (Everly 1989: 6–7)

Consequently, psychological stressors can be almost anything from significant life events such as marriage and bereavement to a headache, a bad day at the office, a loud noise, sex or lack of sex, the number 4, the number 666 (*cf* Noshpitz and Coddington 1990). And the concept of 'stressor' now has even wider currency; ecologists, for example, will speak of the stressors of an ecosystem:

> This study identifies … ecological stressors to boreal lakes … The primary stressors are alterations in lake levels due to dam construction and removal; nutrient loading from the town site and marina; the sports fisheries; and contaminant loading from local … and long-range … atmospheric sources. (Evans 1997)

Thus, stressors are defined solely in terms of their effects—in fact, in terms of their effects on any particular person or system. What acts as a stressor for one person or system might have no effect at all on someone or something else. Just about anything can, in principle, be a stressor of something else.

What this means is that we cannot have any theory of the concept of 'stressor' *simpliciter*. There is no procedure by which we can determine whether or not a particular entity is a stressor just by looking at its properties or attributes. All we can do is actually apply the putative stressor to possible victims, and see if at least one of them experiences stress. Certainly, we can talk of 'frequent stressors' or 'likely stressors' of various kinds of stressees, and we can have theories of what kinds of objects these are and recognition procedures for them. But it's only when we particularize in just this way that we can have such theories and procedures.

In other words, 'stressor' is not a natural kind. And neither is 'context'. Like 'stressor', 'context' is a concept that is defined solely in terms of effects in a given situation.

Just about anything can, in principle, be a context. Whether something actually *is* a context can be determined only by its effect (which I'll describe a little while later). And what is a context in one particular case might not be a context in another case. What this means is that we can't have any theory of the nature of a context. There is no procedure by which we can determine whether or not a particular entity is a context just from looking at its properties or attributes. All we can do is apply the putative context to possible victims, and see if at least one of them experiences a contextual effect.

Consequently, any approach to 'context' *simpliciter* that tries to or purports to reify it, formalize it, or just speak of different views of it is inherently misguided.

McCarthy and Buvač (1997), for example, explicitly decline to give any definition of 'context'—it's as undefined as an element of a group, says McCarthy in another paper

(1996). But then they proceed to stipulate—despite the lack of definition—that contexts can be formalized as first-class objects, all of the same formal type, that they're things that propositions can be true in, and that they're things that can be entered and exited and nested. McCarthy and Buvač seem to see contexts as *containers* of some kind, at least metaphorically speaking. But that's just an assumption that they make, and it's an assumption that they make so deeply that they never even refer to it explicitly. My point in this talk is that 'context' simply doesn't permit this kind of approach.

Now, understand here that I am *not* opposing the general enterprise of formalizing abstracta. On the contrary, it's an enterprise that I engage in myself—for example in Hirst 1995, I wrote of "differences as first-class objects". Rather, I *am* suggesting that formalization, when appropriate, should be just about the final step, rather than the first step, in the understanding of a putative concept. And in the case of 'context', it's clear that we are still in a *very* early stage of understanding.

McCarthy (1996) suggests that a mathematical logic of contexts would be analogous to the mathematical theory of groups. But he himself points out that group theory arose from observations that the algebraic properties of integers under addition were the same as those of the rationals under multiplication, and the appropriate abstractions could then be made. In the case of context, however, we don't even have the observations yet. Sure, we can devise a nice new formal logic, and even call it a logic of context rather than, say, a logic of snibs or snecks or some gensymed word. But if the logic is to have something to say about what the English word *context* is about, then a little more work is in order. In his section entitled "Desiderata for a mathematical logic of context", even though he explicitly mentions applications in natural language, McCarthy lists nothing more than a few matters of formalization, and despite the heading, no desiderata deriving from the rather obvious need that a logic of context account for what context does in natural language, nor even the desideratum of finding out what such desiderata might be.

Even while side-stepping any definition of 'context', McCarthy and Buvač (1997), do say that contexts are "rich" objects. Yet they never open them up and look at their internal structure, preferring instead to follow a path analogous to the development of group theory, though they do seem to want their work to be genuinely useful in AI applications. This is all a bit like saying that a course on the algebra of groups, rings, and fields is the only qualification that anyone needs in order to become a professional accountant or bookkeeper.

So what we need to do is think a little bit about what a context is and what it does. (That's why I like Varol Akman's paper. Akman wants to formalize context too, and he does so in conjunction with careful thinking about what context is.)

## 3 Informal notions of context

One of the purposes of a symposium such as this one is to explore pre-theoretical notions of context. While many researchers in AI talk about "context", or use representations that implicitly or explicitly act as "context" in some sense, the notion of context is still pre-theoretical. And this symposium (and, even more so, its predecessor at IJCAI-95) was

conceived by Łucja Iwańska and others in recognition of that.

As academic researchers, our natural response to the announcement of a meeting like this is to give a paper with a short preamble on "Here's what context means to me, and hence should mean to everyone", and then, as if this were all beyond dispute, immediately proceed with a formalization, representation, or algorithm. Or even to dispense with the preamble, as if one's own view were just presumed to be accepted universally.

But here, I'd like to take things a little more slowly, and cover what is often just the preamble. For one thing, even to speak of "pre-theoretical notions of context" implies that a theory of context *simpliciter* will eventuate in due course, and, as I've just said, I don't think that there can be any such thing. So I'd like to speak of "informal", rather than "pre-theoretical", notions of context, and then restrict the discussion in such a way as to make theorizing and formalization possible.

To do this, I'll start by pointing to the name of the symposium itself: It's not *Context in AI*, nor *Context in Computer Vision*, nor *Context in Swedish Politics, 1894–1902*, nor is it just plain *Context*. Rather, it's *Context in Knowledge Representation and Natural Language*.

Now, this is a very ambiguous name. First, both the terms *knowledge representation* and *natural language* can denote objects of study, the enterprise of studying those objects, and, metonymously, both of these at once. I think Łucja probably intended the metonymous reading. Second, *and* in English can mean both intersection and union, and union additionally admits a distributive reading. So, loosely characterizing KR and NL as sets of topics or concerns, there are three main interpretations possible:

1. Context in (KR $\cap$ NL)
2. Context in (KR $\cup$ NL)
3. (Context in KR) $\cup$ (Context in NL)

Notice that the third interpretation isn't necessarily the same as the second. It doesn't go without saying that it's meaningful to speak at all of a unified notion of context in KR and NL, as in the second interpretation. Maybe only the third reading is meaningful—that is, context in KR and context in NL are two qualitatively different things, and the title of this symposium is a kind of zeugma or pun. It's like having a symposium named *Stressors of People and Boreal Lakes*, and talking about what a bad day at the office has in common with alterations in lake levels due to dam construction and removal.

And, indeed, the word *context* really covers quite a board territory. In their excellent survey article on the formalization of context, Akman and Surav (1996) show that there are many different kinds and uses of context even just within AI. Sure, there are similarities among these different kinds of context—that's why we use the same name for each—but it doesn't follow that everything we say about one kind will automatically be true of another kind. One of our jobs at this symposium is to try to sort out the different meanings, and not just to presuppose that no such work is needed.

So what I'll talk about next is why I think that context in KR and formal reasoning is not the same as context in natural language. It will follow from this that there can't be any useful theory or formalization of context *simpliciter*, because the behaviour of each kind of context is different. As I said before, all we have is the contextual effect.

But first, I need to make a distinction that I would have liked to have fitted in a little earlier. I want to distinguish between 'context' and 'element of context'. When I spoke earlier of "the effects of a context", what I really wanted to say was "the effects of one or more *elements* of context". But I couldn't actually say that earlier, because at that point I was still granting the idea of 'context' as a primitive. But now that we realize that we need to look at the internal structure of a context, we can talk about its individual elements and about their effects, either singly or in concert.

## 4 Context in KR

Now, my research is primarily in natural language and computational linguistics, and I don't feel qualified to comment on or criticize proposals for the formalization and use of context in formal knowledge representation and reasoning. Rather, I'll accept this research at face value, and then contrast it with what is required with regard to context in natural language, a topic that I *do* feel qualified to talk about.

So I see no problem with the basic idea, from McCarthy (1987), of making axioms context-dependent in order to be able to state them at the most convenient or useful level of generality, nor with the suggestions as to the advantages that might be gained from doing this that are set out by Shoham (1991) and Akman and Surav (1996). McCarthy and Buvač's well-known example in which different databases make different assumptions regarding the price of airplane components shows the benefits of this approach.

But at the same time it shows the limitations. The example involves formal, propositional reasoning, and the notion of a proposition being true or false in a context. It assumes that the assumptions made by the databases are static; and indeed, the exercise of writing *any* context-dependent axiom assumes that the "home" context for the axiom is, in effect, pre-defined; that contexts can be usefully related by generalization and specialization; and that lifting axioms can be pre-defined to relate truth in one context to truth in another. That's fine in a formal system, but it doesn't get us very far with language, to which I'll now turn.

## 5 Context in natural language

When it comes to talking about context in natural language, there is overwhelming consensus, I believe, on at least one point: context is a source of information that can be used (is used, should be used, may be used, must be used) by a language processor to reduce (or completely eliminate) ambiguity, vagueness, or underspecification in its interpretations of the utterances that it processes. That's one of the effects of context. It constrains interpretation.

And, in addition, context also affects both what the speaker intends to say in the first place and how he or she goes about doing that. But there are really two kinds of context in this—zeugma again. One is the situation in which the speaker, as an agent, forms the intent to do something, which in this case is to communicate some message. This context constrains the agent's intent. The other is the context that the speaker uses as a source of information

in creating that message, deciding exactly how it is to be expressed to the particular hearer. This context constrains the form of the communication and its exact content.

A point that immediately arises from this is that the use of context in natural language communication is a psychological construct that is not directly concerned with truth, but rather with interpretation and belief, with the *generation of meaning*. Propositional truth is involved only insofar as the interpreter may use their beliefs about what is and isn't true when they form an interpretation of some utterance. In natural language, a context is not something that propositions are "true in". It's something that interpretations are formed in, or, more precisely, formed *with*. An interpretation can be more or less vague or ambiguous, and more or less in accord with the speaker's intent, and if the interpretation is a proposition—which it needn't be, of course—then it might indeed have a truth value—though it needn't, of course.

A second point that arises is that the speaker has considerable discretion in the selection or construction of the context that is used in forming the utterance. That is, the speaker can (under constraints that I'll get to shortly) choose which potential elements of context to attend to and use and which ones to ignore. Likewise, the interpreter has considerable discretion in the construction of the interpretation—and, notwithstanding anything the speaker does, has discretion even in the selection or construction of the context that is used to create the interpretation. That is, the interpreter can also choose which potential elements of context to attend to and interpret with and which ones to ignore. In an ideal, cooperative conversation, the speaker and hearer will *harmonize* their contexts (*cf* Regoczei and Hirst 1990), *negotiating* what they deem to be relevant; but they're under no special obligation to do so.

What I'd really like to do at this point is read you about twenty pages on this topic from Donald N. Levine's fascinating book *The flight from ambiguity* (1985). I don't have time for that, so we'll have to make do with a couple of quotations and my attempts to summarize Levine's discussion.

Levine's main point is that an aversion to ambiguity in communication, and hence to the kind of discretionary interpretation that I've just described, is a modern Western phenomenon, "unique" in world history (p. 21). "Most if not all of the literate civilizations have considered the cultivation of ambiguous locution to be a wonderful art", Levine says (p. 21–22), and goes on to give many examples. For instance:

> 'The Somali language is sinuous' [says David Laitin]. … Political arguments and diplomatic messages take the form of alliterative poems, mastery of which is a key to prestige or power. These poems typically begin with long, vague, circumlocutory preludes, introducing the theme at hand, which is then couched in allegory. … 'A poetic message can be deliberately misinterpreted by the receiver, without his appearing to be stupid. [The receiver may] go into further allegory, circling round the issue in other ways, to prevent direct confrontation.' [Laitin 1977, p. 39] (Levine 1985, p. 23–24)

This approach to communication reaches its zenith in Amharic. Levine again:

> One is considered a master of spoken Amharic only when one's speech is leavened with ambiguous nuances as a matter of course. Even among the other people of

> Ethiopia, the Amhara have been noted for extremes of symbolism and subtlety in their everyday talk. … Amharic conversation abounds with general, evasive remarks, like … *Seṭagn!* ('Give me!') [in which] the speaker fails to specify what it is he wants. When the speaker [is asked] about the object he desires, his response still may not reveal what is really on his mind; and if it does, his interlocutor will likely as not interpret that response as a disguise. (pp. 25–26)

Levine goes on to describe the various so-called "wax and gold" formulas of Amharic poetry which have two levels of interpretation, a veneer and a deeper meaning. The deeper meaning might depend upon symbolism or allusion in the surface meaning. In the most difficult form, called "inside the olive", finding the esoteric meaning requires the interpreter to find a completely different context. But this isn't just a matter of poetry. Levine writes:

> The ambiguity symbolized by the formula 'wax and gold' colors the entire fabric of Amhara life. It patterns the speech and outlook of every Amhara. When he talks, his words carry *double entendre* as a matter of course; when he listens, he is ever on the lookout for latent meanings and hidden motives. As an Ethiopian anthropologist once told me, wax and gold is far more than a poetic formula; it is the Amhara 'way of life'. (pp. 27–28)

In other words, both the speaker and the interpreter have some discretion in *choosing* and *constructing* the context in which the interpretation is to be built. And while this discretion might be greater, and more explicitly licensed, in Amharic or Somali than in English, it's true in English too, even if our politicians don't routinely speak in alliterative allegorical poetry. We see it every day in our ordinary conversations (Devlin and Rosenberg 1996, p. 18), in advertising, political discourse, poetry, humor, allusion, persuasion and deception, negotiation of meaning, and misunderstanding and its repair (Hirst, McRoy, Heeman, Edmonds, and Horton 1994).

Here's a very simple example: In his first presidential campaign, Ross Perot said

> If the United States approves NAFTA, the giant sucking sound that we hear will be the sound of thousands of jobs and factories disappearing to Mexico.

Perot's remark was widely reported, and was frequently alluded to by other speakers. Three years later, the Reverend Jesse Jackson could write, in an article on Martin Luther King's "I have a dream" speech,

> The 'giant sucking sound' is not merely American jobs going to NAFTA and GATT cheap labor zones. The giant sucking sound is that as jobs and education diminish, our youth are being sucked into the jail industrial complex.[2]

Neither Perot nor NAFTA had been previously mentioned in the article, but Jackson could allude to them anyway by this phrase, and *make* them part of the context. A quick Web search

[2] "32 years later: The dream unfulfilled." *JaxFax*, **3**(34), 8 August 1995.
http://www.cais.com/pcedge/test/rb/fx50824.html

easily finds hundreds of such allusions to this one phrase. To fully understand the speaker's intent, the interpreter has to recognize the allusion and adjust the context of interpretation accordingly.

But of course, having discretion in constructing context does not mean having complete freedom. Obviously, considerable constraints arise from the message that is to be communicated, the circumstances under which the communication occurs, and the mechanisms of language itself. Even in Somali, the interpreter has to take the utterance itself as a given. And any language imposes rules as to how anaphora, for example, are to be interpreted with respect to the preceding text, and so any preceding text is necessarily an element of the context. Some aspects of the situation are also obligatorily included. For example, Deborah Tannen (1990) has shown that in American English, there are classes of sentences for which the gender of the speaker determines pragmatic aspects of the intended univocal interpretation, and it's therefore an element of the context that the interpreter ignores at his or her peril.

So what can actually be used as an element of context in natural language? Many other people have already offered inventories or taxonomies of the kinds of things that a speaker or interpreter must or may include in a context, and so I don't want to spend a lot of time here going into details. I need only point out that it includes just about anything in the circumstances of the utterance, and just about anything in the participants' knowledge or prior or current experience (*cf* Empson 1953). So, Sperber and Wilson (1986) have argued in detail that a speaker or listener can use any fact or belief about the world that they have as an element of context. Ferrari (1997), emphasizes the multimodal aspects of communication; he divides elements of context into those of linguistic context, perceptual context, intentional context, and encyclopedic knowledge, and he includes the message itself, along with all the circumstances of its utterance, in what he calls the "communicative situation". Zarri (1995) distinguishes between the *a priori* "internal / static" context and the "external / dynamic" context. The former includes knowledge of the language itself, such as the lexicon. Akman (1997) reiterates seven dimensions of context from the work of Wendell Harris, and I'll leave it to him to tell you about that later today. Manfred Pinkal (1985) summarizes it all rather well:

> Aside from the surrounding deictic coordinates, aside from the immediate linguistic cotext and accompanying gestural expressions at closer view, the following determinants can influence the attribution of sense: the entire frame of interaction, the individual biographies of the participants, the physical environment, the social embedding, the cultural and historical background, and—in addition to all of these—facts and dates no matter how far removed in time and space. Roughly speaking, 'context' can be
>
> *—I'd rather say "draw on"—*
>
> the whole world in relation to an utterance act. (Pinkal 1985, p. 36)

So the discretion exercised by a speaker or an interpreter in constructing a context is, in effect, a determination of what, among all this, is and isn't *relevant* to the utterance that is to

be interpreted (Sperber and Wilson 1986). But this leads us to a terminological difficulty. For something to even be considered for possible relevance seems to imply that, regardless of the actual decision, that thing *is* an element of the context—otherwise, how could it come to be considered? There are *two* intuitive notions of 'context' here. The first, which I've tacitly been using up to this point, is the set of things that are used to build the interpretation with (Sperber and Wilson 1986, p. 15); and the other is that, *plus* the things that *aren't* used but nonetheless had a potential to have been used. For example, you might say that because the gender of the speaker is *sometimes* a factor in interpretation, it is therefore *always* an element of context, even if the interpreter doesn't always choose to use it. But then, by the same argument, you'd have to say that Ross Perot's giant sucking sound is always in the context because a speaker can always make an utterance that alludes to it. And by a similar argument, *everything* is in *all* contexts. But that's not a very helpful view. A middle ground, and one that I lean toward, is to say that context involves a notion of *attention* to account for things that are at least considered for use in constructing the utterance or interpretation; to decide that something is *not* to be used in forming an interpretation is, in a sense, to use it in forming that interpretation!

We see then that context is both a psychological construct and, as Akman says, a social construct, and it's a social construct both in the sense that it is a construct *of* society and in the sense that it is constructed socially—in all our communication and social interactions—and constructed dynamically. It's not just a matter of moving axioms between pre-defined contexts with pre-defined lifting axioms.

Given all this, research on context in natural language starts to look quite familiar. In fact, much (or maybe most) research in natural language in AI for the last 25 years and more can be seen simply as attempts to characterize context (*cf* Sowa 1995). Roger Schank's scripts (Schank and Abelson 1977, Schank and Riesbeck 1981) and Gary Hendrix's partitioned semantic nets (1975) in the 1970s; my own marker passing in knowledge bases in the 1980s (Hirst 1987); present-day statistical approaches based on lexical co-occurrence; my own group's recent use of *lexical chains* as "cheap" context for tasks such as segmenting discourse, finding real-word spelling errors, and automatically creating hypertext (Morris and Hirst 1991, Hirst and St-Onge 1998, Green 1997)—these are all really just attempts to provide or construct contexts with which utterances can be interpreted.

These approaches have had varying degrees of success. Some were simply wrong—that is, they made observably false assumptions about the nature of language. For example, Schank's scripts assumed that situations always uniquely pre-determine the word meanings and inferences that are applicable in the situation. McCarthy and Buvač's approach seems to be, in effect, Schankian. Buvač (1996), for example, chooses between two homonymous meanings of the word *bank* in a logical form based on the sentence *Vanja is getting money at a bank* by assuming that all other words in the sentence are unambiguous and can be used to find the exact right axiom in the commonsense context. As far as I can tell, the example relies crucially on the assumption of univocality of the words *get*, *money* and *at*, and if *at* were changed to *from*, the method would fail on the resulting polysemy or metonymy.

Other AI approaches to interpretation in context were perhaps a little more correct in

principle, but still made unrealistic assumptions about language or impractical assumptions about the knowledge sources upon which they were supposed to draw; my own work on using semantic associations in a knowledge base as a context for disambiguation should probably go in this category. Nonetheless, this approach at least had the merit that interpretation was incremental, including the construction of context. It did not assume that parsing, let alone the building of a logical form, can occur prior to any consideration of context or to processes of disambiguation and interpretation.

So there's a sense in which just about all research in AI on natural language *is* research on context. And as we now see, it's somewhat different from context in KR.

There's one obvious objection to making this distinction between context in NL and context in knowledge representation and reasoning. Proper interpretation of natural language, we've been told for many years, *requires* knowledge representation and reasoning. So we'd better have a single theory of context that covers them both.

I have two responses to this. First, despite Sperber and Wilson (1986), it's becoming clear that while the knowledge used in interpreting natural language is broad, the reasoning is shallow. Although we can't yet characterize it precisely, it seems to be pretty much limited to reasoning about quite simple commonsense knowledge, knowledge of kinds, of associations, of typical situations, and even typical utterances. We don't do arbitrary reasoning in interpretation. So we don't need a very general theory.

Second, we probably *do* do arbitrary reasoning on arbitrary knowledge when we *assimilate* interpretations—when we build and refine our mental models. But there's no reason to think that that necessarily requires the same representations or mechanisms as are used in creating the interpretation. On the contrary, it's now clear that the mind uses many *different* kinds of representations and mechanisms. And, of course, to the extent that using natural language and representing and reasoning about knowledge are both cognitive activities, there's no reason to think that they are characterized by *any* AI-style formalizations—and plenty of reasons to think that they aren't, as Lakoff and Núñez (1997, p. 22–23) have argued.

## 6 Context as a spurious concept

So far, I've argued that the notion of 'context' can be defined only in terms of its effects in a particular situation. Just as a stressor is anything that stresses, one way or another, in at least one situation, context is something that constrains, one way or another, in at least one situation. In the case of natural language, many different kinds of things can be elements of context. Context in natural language is *constructed*, in part, by the speaker and the interpreter—it's not the same as context in KR.

In this light, 'context' *simpliciter* can be seen to come dangerously close to being a spurious or incoherent concept in much the same way that 'absolute motion' is a spurious concept (Peacocke 1992). In fact, there are quite a number of parallels between the two. In both cases, we have an intuition about the putative concept, and a very robust intuition at that. In our daily lives, we use what seems to be the notion of absolute motion in our navigation and moving around, and, as high-school science teachers know, it's not an easy notion to

break away from. For obvious cognitive reasons, it's a psychologically compelling idea. We only need to look at the history of science to see how reluctantly it was given up, even by highly educated people. Yet now, a hundred years after the Michaelson–Morley experiment, it seems so obvious that 'absolute motion' is an incoherent or spurious concept that it's hard to imagine how people ever thought otherwise.

Likewise, we use what seems to be a general notion of context when we build our interpretations of everything in our daily lives; but this is nothing more than an illusion that arises from our inability to examine our own mental processes of reasoning and language interpretation. Matthew Dryer (1997) has recently shown that the idea of sentence topic in linguistics, which has long been thought to be an intuitively well-founded concept, is in fact a chimera—what Dryer calls a "metalinguistic illusion". Dryer has shown that just because a sentence is about something, it doesn't follow that there's any constituent in the sentence that's what the sentence is about. All there is is discourse topic, even if the discourse is just a single sentence. 'Context' *simpliciter* might turn out to be like this—seemingly intuitively well-founded, but revealed as a chimera upon deeper analysis.

And both absolute motion and context *simpliciter* are easy to formalize. Cartesian coordinates work quite nicely for the former in simple everyday applications. For the latter, McCarthy and Buvač's (1997) formalization of context *simpliciter* can, under certain assumptions, find the price of airplane parts and disambiguate two homonymous senses of the word *bank* (Buvač 1996). But however useful they are in local human day-to-day navigation, Cartesian coordinates are not a very useful formalization for what is now known about the nature of space and time in theoretical physics. And simple formalizations of context *simpliciter* might work on toy examples, but there's no reason to expect them to apply to real-world natural language. On the contrary, a little analysis of what 'context' actually is suggests that they won't.

# 7 Conclusion

I think that AI in general is sometimes just a bit too impetuous in its desire to formalize things, and it tries to turn things into systems or logics without fully understanding them, as if simply by doing so they would thereby come to be understood. Sometimes this works; and sometimes it just leads to meaningless, ungrounded formal systems—Lakoff and Núñez (1997) again. To someone with a hammer, every screw looks like a nail. And topics that deal with language, cognition, and acting in and interpreting the world get more than their share of this bad treatment.

This seems to arise from a combination of overenthusiasm for Western scientific method and a misunderstanding of the nature of language that borders on fear. In this view, language is a messy and highly imperfect medium that is not to be trusted, but rather must either be sidestepped entirely or be beaten into submission by means of logic and formalism. This is pretty explicit in the work of Frege and Bertrand Russell (1918, p. 205), for example. Maybe that's why Russell looked up to Wittgenstein. Wittgenstein had the guts (and the brains) to engage the difficult questions of language that Russell avoided, and to find some frightening

answers—that some concepts can't be defined by necessary and sufficient conditions, for example. That leads to my second observation about AI and Wittgenstein:

> "All AI knows how to do is carry on as if Wittgenstein had never existed."

Nor Heidegger and Gadamer; nor Donald Levine; nor Sperber and Wilson; nor George Lakoff; nor Herb Clark; nor Harvey Sacks and Emanuel Schegloff and Harold Garfinkel and Erving Goffman. And I carry on that way too, at times—but at least *I* feel guilty about it.

So in this talk, I've been rather negative and pessimistic in places, and I don't want to close on that kind of a note. After all, one thing that the field of artificial intelligence has certainly succeeded in over the years is expressions of unbounded optimism. So I want to close by emphasizing that we *do* have a good chance of getting a handle on 'context'—but we need to avoid premature, uninformed formalization. Situation theory (Devlin 1991) seems to me to be one especially good candidate. There is a strong intuitive relationship between the ideas of 'context' and 'situation'; situation theory has been under development for many years; and computational and linguistic concerns have been there from the start (Barwise and Perry 1983). It is heartening to see books such as that of Devlin and Rosenberg (1996), who apply situation theory to real language in use and who say in their preface that their greatest intellectual debt is to Harvey Sacks. So I think that work on formalizing context that uses situation theory, such as that by Akman and Surav (1996, 1997) and Ferrari (1997), is pointing us in the right general direction. There are also many other promising approaches to context—I can't possibly mention all the names—and I'm looking forward to hearing about some of them in this symposium.

## Acknowledgements

I am indebted to Łucja Ivańska for asking me to write this paper; and to Stephen Regoczei, for enabling me to write it, by means of many discussions over the years on a number of the issues herein. I was also helped by discussions with, and provocations from, Nadia Talent and Chrysanne DiMarco. I am grateful to my fellow Canadian taxpayers for a research grant from the Natural Sciences and Engineering Research Council.

## References

Akman, Varol (1997). "Context as a social construct." *Working notes, AAAI Fall Symposium on Context in Knowledge Representation and Natural Language*, Cambridge, MA, 1–6.

Akman, Varol and Surav, Mehmet (1996). "Steps toward formalizing context." *AI Magazine*, **17**(3), Fall 1996, 55–72.

Akman, Varol and Surav, Mehmet (1997). "The use of situation theory in context modeling." *Computational Intelligence*, **13**(3), August 1997, 427–438.

Barwise, Jon and Perry, John (1983). *Situations and attitudes*. Cambridge, MA: The MIT Press.

Buvač, Saša (1996). "Resolving lexical ambiguity using a formal theory of context." In: van Deemter, Kees and Peters, Stanley (1996). *Semantic ambiguity and underspecification*, Stanford, CA: CSLI Publications. 101–124.

Devlin, Keith (1991). *Logic and information*. Cambridge University Press.

Devlin, Keith and Rosenberg, Duska (1996). *Language at work: Analyzing communication breakdown in the workplace to inform systems design*. Stanford: CSLI Publications.

Dryer, Matthew (1997). "The myth of sentence topic." Unpublished.

Empson, William (1953). *Seven types of ambiguity*, third edition. London: Chatto and Windus.

Evans, Marlene S. (1997). "Preserving and protecting boreal park lakes", National Hydrology Research Institute, University of Saskatchewan, 26 June 1997.
http://ecsask65.innovplace.saskatoon.sk.ca/pages/current/conserv/preser.html

Everly, George S. Jr (1989). *A clinical guide to the treatment of the human stress response*. New York: Plenum Press.

Ferrari, Giacomo (1997). "Types of context and their role in multimodal communication." *Computational Intelligence*, **13**(3), August 1997, 414–426.

Green, Stephen (1997). "Building hypertext links in newspaper articles using semantic similarity." *Third Workshop on Applications of Natural Language to Information Systems (NLDB '97)*, Vancouver, June 1997, 178–190.

Hendrix, Gary G. (1975). "Expanding the utility of semantic nets through partitioning." *Advance papers of the 4th International Joint Conference on Artificial Intelligence*, 115–121.

Hirst, Graeme (1987). *Semantic interpretation and the resolution of ambiguity*. Cambridge University Press.

Hirst, Graeme (1995). "Near-synonymy and the structure of lexical knowledge." *Working notes, AAAI Spring Symposium on Representation and Acquisition of Lexical Knowledge: Polysemy, Ambiguity, and Generativity*, Stanford University, March 1995, 51–56.

Hirst, Graeme and St-Onge, David (1998). "Lexical chains as representations of context for the detection and correction of malapropisms". In: Fellbaum, Christiane (editor), *WordNet: An electronic lexical database and some of its applications*, Cambridge, MA: The MIT Press, 1998.

Hirst, Graeme; McRoy, Susan; Heeman, Peter; Edmonds, Philip; and Horton, Diane (1994). "Repairing conversational misunderstandings and non-understandings." *Speech communication*, **15**(3–4), December 1994, 213–229.

Laitin, David D. (1977). *Politics, language, and thought*. The University of Chicago Press.

Lakoff, George and Núñez, Rafael E. (1997). "The metaphorical structure of mathematics: Sketch-

ing out cognitive foundations for a mind-based mathematics." In: English, Lyn D. (editor), *Mathematical reasoning: Analogies, metaphors, and images*. Mahwah, NJ: Lawrence Erlbaum Associates. 21–89.

Levine, Donald N. (1985). *The flight from ambiguity: Essays in social and cultural theory*. The University of Chicago Press.

McCarthy, John (1987). "Generality in artificial intelligence." *Communications of the ACM*, **30**(12), 1030–1035.

McCarthy, John (1996). "A logical AI approach to context." Unpublished note, 6 February 1996. http://www-formal.stanford.edu/jmc/logical.html

McCarthy, John and Buvač, Saša (1997). "Formalizing context (expanded notes)." In: Aliseda, Atocha; van Glabbeek Rob; and Westerståhl, Dag (editors), *Computing Natural Language*. Center for the Study of Language and Information, Stanford University. Reprinted in *Working notes, AAAI Fall Symposium on Context in Knowledge Representation and Natural Language*, Cambridge, MA, 99–136.

Morris, Jane and Hirst, Graeme (1991). "Lexical cohesion, the thesaurus, and the structure of text." *Computational linguistics*, **17**(1), March 1991, 21–48.

Noshpitz, Joseph D. and Coddington, R. Dean (1990). *Stressors and the adjustment disorders*. New York: John Wiley & Sons.

Peacocke, Christopher (1992). *A study of concepts*. The MIT Press.

Pinkal, Manfred (1985). "Kontextabhängigkeit, Vagheit, Mehrdeutigkeit." In: Schwarze, Christoph and Wunderlich, Dieter (editors), *Handbuch der Lexicologie*, Königstein: Athenäum Verlag. The quotation used is translated and cited in: Quasthoff, Uta M. "Context." In: Asher, R.E. (editor) *Encyclopedia of Language and Linguistics*, Pergamon Press, 1994, 730–737.

Regoczei, Stephen and Hirst, Graeme. "The meaning triangle as a tool for the acquisition of abstract, conceptual knowledge." *International journal of man–machine studies*, **33**(5), November 1990, 505–520.

Russell, Bertrand Arthur William (1918). "The philosophy of logical atomism." In *The philosophy of logical atomism and other essays 1914–19*, edited by John G. Slater (The collected papers of Bertrand Russell, volume 8), London: George Allen & Unwin, 1986. 157–244.

Schank, Roger C. and Abelson, Robert P. (1977) *Scripts, plans, goals, and understanding*. Hillsdale, NJ: Lawrence Erlbaum Associates.

Schank, Roger C. and Riesbeck, Christopher K. (1981) "The theory behind the programs: A theory of context." In: Schank, Roger C. and Riesbeck, Christopher K. (editors), *Inside computer understanding: Five programs plus miniatures*, Hillsdale, NJ: Lawrence Erlbaum Associates.

Selye, Hans (1950). *The physiology and pathology of exposure to stress*. Montreal: Acta.

Shoham, Yoav (1991). "Varieties of context." In: Lifschitz, Vladimir (editor), *Artificial intelligence and the mathematical theory of computation: Papers in honor of John McCarthy*, Academic Press. 393–407.

Sowa, John F. (1995). "Syntax, semantics, and pragmatics of contexts." *Working notes, Workshop on Context in Natural Language Processing*, International Joint Conference on Artificial Intelligence, Montreal, August 1995, 145–154.

Sperber, Dan and Wilson, Deirdre (1986). *Relevance: Communication and cognition*. Harvard University Press.

Tannen, Deborah (1990). *You just don't understand: Women and men in conversation*. New York: William Morrow and Company.

Zarri, Gian Piero (1995). " 'Internal' and 'external' knowledge context, and their use for the interpretation of natural language." *Working notes, Workshop on Context in Natural Language Processing*, International Joint Conference on Artificial Intelligence, Montreal, August 1995, 180–188.