Chapter 1

Behavioral Implicit Communication (BIC): Communicating with Smart Environments via our Practical Behavior and Its Traces

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ABSTRACT

A crucial part of the intelligence that smart environments should display is a specific form of social intelligence: the ability to read human behavior and its traces in terms of underlying intentions and assumptions. Such ability is crucial to enable human users to tacitly coordinate and negotiate with smart and proactive digital environments. In this paper, the authors argue that the necessary tool for this ability is behavioral and stigmergic implicit (i.e. non-conventional) communication. The authors present a basic theory of such a fundamental interactive means—the theory of Behavioral Implicit Communication (BIC).

INTRODUCTION

It is widely acknowledged that a crucial part of the intelligence that we need in our smart environments is a specific form of social intelligence: the ability to “read” our behavior and its traces in terms of our intentions and assumptions (Augusto & McCullagh, 2007; Storf & Becker, 2008). This is a necessary condition for an active environment to coordinate its activities and changes with our behavior in an effective way. This is true, not only to avoid the creation of interferences and obstacles to our situated activity, but possibly to be cooperative and even pro-active, and for favoring our activity by removing obstacles, and by creating the needed conditions for our goals to
be achieved. Anticipating our steps in this way will enable new forms of cooperation and collaboration between users and smart environments. Ideally, this advanced capacity requires some capability of mindreading as part of its intelligence. The idea of mindreading, which has been developed in the philosophical and cognitive science communities, is used here to refer to the estimation of an agent’s (human’s) hidden cognitive variables, such as her (1) beliefs, (2) proximal and distal intentions, and (3) action goals (Csibra & Gergely, 2006; Iacoboni, 2008).

Indeed, it is almost a platitude that future smart environments should be able to observe our behavior, and to understand and anticipate it. It has been less emphasized, however, that once this form of ambient intelligence will be achieved, humans will be able to exploit it in new ways: i.e. by performing practical actions while knowing and expecting that the environment will notice and understand what we are doing. Our behavior—and its physical traces—will thus become a “message”, a “signal” often intentionally sent to the environment itself in order to obtain collaboration, although remaining a concrete practical action, not symbolic gestures or mimics. The theory of this form of communication is crucial for the future human-environment interaction (as for human-robot interaction).

In what follows we clarify this form of Behavioral Implicit Communication (BIC) (not to be confused with “non verbal behavior or communication”) both in its direct and indirect forms. We contend that such theory can be used to support an “explicit design” of more natural and effective forms of interaction between users and smart environments.

**BIC COMMUNICATION: FROM OBSERVATIONS TO SIGNALS**

Given the emphasis on the non-obstructive nature of the AmI applications in relation to the natural activities of humans, much of contemporary research is focused on approaches that minimize or do not rely at all on “explicit” interaction (Augusto & McCullagh, 2007). From our perspective, a paramount example of “explicit” interaction is the use of linguistic or gestural communication to support interaction between users and smart environments. However, beyond these two kinds of communication, there is a third one that we call Behavioral Implicit Communication, where there isn’t any specialized signal (i.e. neither arbitrary acoustic symbols nor codified gestures), but the practical behavior itself is the message. BIC is very useful in a coordination context (see below), where by simply performing an action we send a message to our partner(s) in the interaction. This message may for example be intentional, i.e. the sender wants that the receiver knows that she is performing that action.

However, this message exchange presupposes a more primitive and basic substrate which is due to “observation”: the unilateral capability of the agent to observe the other’s behavior and to “read” it; to understand what she is doing, what she intends and plans to do (her goals), or at least to predict and expect her next position or action using this information, for instance (some sort of primitive “inference”) for “anticipatory coordination” (Castelfranchi, 2006).

In other words, communication is based on and exploits “signification” (the semiotic ability of cognitive agents; for example the ability to take ‘smoke’ as a sign of ‘fire’, or to ascribe ‘thirst’ to a drinking agent) that goes beyond simple perception but it not necessarily used only for communication.

**A COMPUTATIONAL FRAMEWORK FOR OBSERVATION AND MIND-READING**

Below we sketch a computational framework to formalize the basic cognitive abilities that the
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