WAKEFUL SOFTWARE AND WAKEFUL MUSICAL INSTRUMENTS: A THEORETICAL APPROACH TO THE IMPLEMENTATION

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A new category of content-related software is here proposed. 'Wakeful' software is one that senses and responds to an environment with which it may consistently interact meaningfully. The term 'wakeful' is here meant as 'sign-bearing,' in relation to the potential of computers and human beings to interact in terms of sign exchange.

The present proposal is based on concepts that interest any human-computer interaction that involves the generation or manipulation of content of any type. Specifically, the study was carried out in relation to music and computer-based interactive musical systems. Accordingly, the research offers definitions of both 'wakeful software' and of 'wakeful musical instruments,' which are particular types of computer programs and of interactive musical systems. In interactive music, the reasons why users and audiences can only occasionally interpret the sonic constructs as music, which an interactive system generates, are often obscure. The present study is part of a larger project that aims at defining a protocol for living being-machine interaction, in order to guarantee consistency of communication between these types of agents. Currently, the solution to such crucial problems as the above is being urgently sought in diverse fields of study, from computer science to philosophy of mind. Wakeful software is one, which respects such a protocol.

First of all, we shall give a definition of an 'interactive music system'. Robert Rowe described such systems as "those whose behaviour changes in response to musical input." (Rowe, 2001) On the other hand, a definition of 'wakefulness' implies a comprehension of what consciousness is; an umbrella term that has many different meanings and about whose fundamental characteristics there is no consensus. According to the Stanford Encyclopedia of Philosophy, while it is possible to understand consciousness as a mental state, an animal, person or other cognitive system may be conscious in the sense that they constitute forms of consciousness; they are conscious cognitive systems. In this specific regard, consciousness may be firstly identified as sentience or wakefulness. While sentience is the capability of any organism to sense and respond to its world (i.e. any living being), an organism is wakeful only when actually using such a capacity (i.e. a comatose living being might not be 'wakeful'). In both forms, the concept of 'response,' recalled by the definition, implicitly points at an act of communication, which may eventually or actually take place, between the cognitive system and the environment. The English term communication derives from Latin verb 'communicare' (to share). As pointed out by Dan J. Rothwell, a necessary condition, for a communication to be established, is that the communicating parties share a common environment of communication; they need to be capable of a similar interpretation of the messages being exchanged.

In relation to the focus of the study, the first question arises: do computers and human beings share such a communicative commonality? The present research will show that although they do not, specific techniques can be adopted for machines to simulate logics of communication, which are proper to living

beings. Such techniques may allow any human agent to consider the responses of content-related software, as either an act of real communication or a convincing simulation, to which attribute meaning. While sentience and wakefulness constitute relatively simple forms of consciousness, human beings and possibly other cognitive systems are more sophisticated; they are forms of self-consciousness. Creatures or cognitive systems, to be considered as such, need to be more than sentient and wakeful; according to the Stanford Encyclopedia of Philosophy, they are those which "are not only aware, but also aware that they are aware." A question, which has been formulated already many times, arises here again: can a computer be conscious?

In interactive software of any kind, the concept of agency is central. A peculiar relation exists between agency and consciousness. What is the nature of this relation and how is it possible to mean consciousness in relation to agency? Is any agent conscious? Interaction between human agent and machine occurs within what is called a multimodal ambient, where agents interact with each other by different modes (i.e. as in the planet Earth). In very general terms, agency can be defined as the capacity of an agent to act in a world. However, agency differs for intelligent and non-intelligent agents. For instance, there is general agreement that human beings are intelligent agents, who are able to make choices and to enact those choices on the world. Instead, natural forces are considered to be causes that involve only unthinking deterministic processes. In this simpler form of natural phenomena, agency seems to imply only the capacity to act in an environment. However, even excluding the Gaia theory, agency often exceeds the mere capacity of action; it implies a relationship which is connoted by a decisional nature that may help to clarify the distinction between intelligent and non-intelligent agents. The English word agency derives from the Latin 'agere' (to do): an agreement to act on one's behalf. Such 'action on behalf of' implies the authority to decide which action is appropriate. According to the Encyclopædia Britannica, "in computer science, an agent is a computer program that performs various actions continuously and autonomously on behalf of an individual or an organization." The authority of taking appropriate decisions is a capacity that cannot be simply described as deterministic, and leads us to discuss the subject of how human beings come to make decisions.

According to Thomas Nagel, a being is conscious just if there is a subjective way, a mode of consciousness that constitutes the creature's mental or experiential point of view. For Nagel, bats are conscious because there is 'something that it is like' for a bat to experience its world through its echo-locator senses. While a software agent is not a living creature, indeed certain software agents may be actually capable of sensing and responding to the environment. In which case, it makes sense to pose the question: 'what is it like to be a software agent?' May such agents be considered as conscious? Taking into account the above mentioned diverse forms of consciousness, software agents should be considered as capable both of sentience and wakefulness. However, can they be considered as forms of self-consciousness? Can they be aware of being aware? In order to progress toward the formulation of an answer to such a question, we will introduce few concepts from biosemiotics.

The Oxford Dictionary of Biochemistry and Molecular Biology defines biosemiotics as "the study of signs, of communication, and of information in living organisms." This term derives from the Greek 'bios' (life) and 'semeion' (sign). In biosemiotics, "signification (and sign) is understood in a very general sense, that is, not simply the transfer of information from one place to another, but the generation of the very content and meaning of that information in human as well as non-human sign producers and sign receivers." (Emmeche and Kull, 2011) This principle was described in different terms by the Nobel prizes Ernst Mayr and Manfred Eigen as the peculiarity of living forms and possibly, of man-made computers. However, computers are designed by humans to achieve specific goals; their teleology is derived. Instead, the informational characteristics of organisms evolved through adaptation and the same living

forms are the result of an evolution. While software agent can adapt to the world that they sense, as living beings do, for a computer such a process operates within a scenario that is to some extent predetermined by its designer. Nevertheless, two further observations can be made: in humans, the informational processes resulting from adaptation and self-adaptation are similar to each other; the informational processes by which humans and computers interact and adapt to the environment denote similar traits.

The necessary condition for self-adaptation to occur is that the mind – or whatever entity or organ may constitute the 'mind,' as we are considering the eventuality of self-conscious cognitive systems that do not have 'minds,' – needs to be attributing meanings to the perceived signs; a process of interpretation may have to take place. Interpretation is the process of attribution of meaning by which signs take shape in the mind. Any interpretation is always a bi-directional and recursive loop, since whereas the mind assigns a meaning to the sign, the sign itself is connoting the mind. This process, fundamental to forms of self-consciousness, is virtually open-ended, being the result of a recursive process of interpretation. Finally, we can now refine our question: are computers capable of interpretation?

Lending to the present investigation a few of the conceptual fundaments of biosemiotics, it is possible to describe interactions in a multimodal ambient as recursive sign exchanges occurring between agents, whereas such an ambient includes agents capable of interpretation. We shall clarify such a statement. There is a strict relation between an interaction and an interpretation process, interpretation being a form of mental interaction between thoughts and information retrieved from the external phenomenological reality. Therefore, interpretation maintains an interesting relation to the concept of agency. While internally representing reality, the mind does not operate 'on behalf' of reality; signs cannot be considered as agents, as they do not intentionally act, but instead are being acted on by the mind. Still, the character of intentionality, denoting the interpreting mind, is not only recursively self-fuelled but self-aimed. Hans-George Gadamer rethought "the traditional concept of hermeneutics as necessarily involving, not merely explication, but also application. In this respect, all interpretation, even of the past, is necessarily 'prejudgmental' in the sense that it is always oriented to present concerns and interests." (Malpas, 2009) We previously defined computers as inscribed within a derived teleology. Having now highlighted self-aimed intentionality as the peculiarity of interpretation, we have evidence that computers are not capable of interpretation. However, it still makes sense to further investigate the analogies between human and machine cognition, as they appear to root into a similar dynamic of interaction.

In biosemiotics terms, "a sign is not the same thing as a piece of information. It is related to information but only becomes 'information' through an act of interpretation." (Hoffmeyer, 2008) In the mind, each of the perceived signs evokes an entire net of concepts. When trying to explain and apply present concerns and interests to current experience, all the concepts thus educed interact. Not only do the concepts recalled by a certain sign interact with concepts afferent to a different one, but signs and concepts actually affect each other, and as concepts change, so do the related signs. Forms of self-consciousness operate an open-ended process of redefining both themselves and their world of signs; their interaction is populated by signs that affect concepts, which in turn affect other signs and concepts. Finally, we can state that interpretation exceeds the self-contained teleology of what computers are today, as from their 'what it is like' perspectives signs do not exist, only information about their own current state does it. Unsurprisingly, current computers are not forms of self-consciousness. Nevertheless, these implications will help us in defining what both wakeful software and wakeful musical instruments are.

In Rowe's definition of an interactive musical system, the term 'musical' exceeds the mere sonic phenomenon, as music is the result of an interpretation. In such a system, the presence of an interpreting

agent is implicit. For convenience, we shall use the following definition: 'an interactive musical system is one whose behaviour changes in response to inputs, which at least one interpreting agent recognizes as musical.' Will such an agent also consistently consider the system responses as being musical? Within art projects, in the present research, both users and audiences experiencing interactive music were frequently unable to interpret the sonic constructs, generated by such a system, as music. While computers treat the received stimuli as information, biological agents interpret such information as a network of signs. Such a discrepancy actually constitutes a structural obstruction, for living beings, in attributing meaning to actions or constructs that are generated by computers.

A step forward in finding a solution to this problem can be taken by considering biocommunication theory, which frames the interactions between subjects of the same species or between subjects of different species in terms of sign-exchanges occurring within a shared communicative commonality. "Intersubjective interactions are characterised by reciprocal validity claims. To speak, make propositions and understand utterances does not function through private encoding process and subsequently a private decoding process, but a shared rule-governed sign-mediated reciprocal interaction. The shared competence of semiotic rules and the socialised linguistic competence to build correct sentences enable the interaction partners to understand identical meaning of utterances." (Witzany, 2010) In order to circumvent the gap that we described above, the present study identifies specific structures of interrelation for living biological organism-machine interaction. These structures are defined as 'bio-logics'; logics that mimic the informational mechanisms of living beings. These bio-logics are implemented as computer algorithms to improve such interactions. Without being recalled in such a way, these structures were nevertheless frequently adopted in computer science. Similarly, interactive software often incorporated these types of algorithms. The present research recognizes that such structures and instruments belong to the categories that we are here defining. However, their cataloguing exceeds our scope, which is instead to highlight the consistent significance of such theories and to offer classification of their nature, as a protocol for designing such interactivity; a set of procedures to be followed in designing living being-machine interaction.

Among the bio-logics, the present paper proposes salience to enable human beings to consistently attribute meaning to actions operated by a computer or to constructs that it generates, which they might not otherwise consider to be coherent signs within the context. Usage and improvement of salience-based mechanisms has recently been the focus of consistent research (i.e. as in the EPSRC project, aka Salience project), which offered the chance to successfully adopt such techniques for better modelling of cognition in computing. The Oxford English Dictionary defines the adjective 'salient' as 'most noticeable or important' and similarly, the psychologist William Crano identified salience, as a factor that informs the awareness of the perceiving subject about the effects of an attitude upon himself/herself. An interpreting agent selects salient information, in virtue of the self-aimed, explanatory and applicative character of interpretation itself and attributes a meaning to such information, identifying it as a sign. In the constructs or actions produced by computer programs, whereas the morphologies reflect salience, interpreting agents may notice such a salience and therefore, recognize the information as a sign.

Therefore, software can be descried as wakeful, when sensing and responding in its multimodal ambient by defining salient morphologies to which living beings can attribute meaning, within the specific context. Such an attribution of meaning is actually consistent and not only occasional, as a communicative commonality is granted to these computers and living beings by the implementation of bio-logics. In such a framework, bio-logical algorithms format the information, as signs recognizable by living beings. Obviously, such a translation is only a simulation of an authentic process of interpretation. Still, regardless of whether the interpreting agents consider the machine to be a form of sentience, wakefulness,

self-consciousness, or just a convincing simulation, an act of communication can be actually established to a certain extent.

In communication, the resemblance of authenticity may be a valid surrogate for the real thing, as sets the necessary conditions for an eventual communication to actually occur; living beings recognize in salient interactions a logic that is proper to any life form. Alongside the approach offered by biocommunication theory, it is similarly possible to recall and extend Nagel's perspective in a direction offered by simulation theory, by which "human competence in predicting and explaining behaviour depends chiefly on a capacity for mental simulation." (Gordon, 1992) This theory deeply roots into the human capacity for empathy between subjects and "involves the imaginative method of projecting first personal experience, to achieve imaginative acquaintance with what it's like for the other." (Holton & Langton, 1998) In one of its latest formulations, simulation theory necessarily involves introspection, following the generation of a mental upshot for "detecting or determining the nature or character of that upshot." (Goldman, 2011) In humans, both a default tendency to empathy and a state of self-awareness are usually present. From one hand, an empathic feeling such as identification and eventually, even compassion, may arise after having recognized, in the interacting party, a characteristic that could denote life to a lower or higher degree: from unpredictability to reactivity, vulnerability, intentionality, or eventually, even humour. From the other hand, human beings may expose such characteristics when they do not imply intentionality, because of their sophisticated capacity of interpreting. Nevertheless, for humans, and possibly to a similar extent, for other living beings capable of self-consciousness, a simulation of intentionality may be more convincing, when it allows those to identify the trace of a sign within it. Forms of self-consciousness share an understanding of their world based on their subjective, experiential and only way to comprehend, and being aware of such an act. In direct proportion to the communicative commonality that they are sharing, these sophisticated living beings can consistently 'biocommunicate' its interpretation to each other, distinguishing between intentionality and a deterministic process. Sign exchanges constitute their mode of interacting (and communicating) within the multimodal ambient that they live in. Nevertheless, identifying within the responses of a computer a certain degree of intentionality, for however simulated and predetermined that can be, still may engage the interpreting agents into a convincing conversation with such a computer.

Any wakeful software is more than interactive, as it is more than sentient. It does not only have the capacity to eventually sense and respond; it can actually apply such a capacity in the mode in which the interpreting agents, populating its environment, interact. Such an instrument is wakeful, in the sense that those agents may repeatedly recognize its responses, as such. As content-related interactions involve the interpreting agents to interact in terms of sign exchange, wakeful software interacts with such an environment, in such terms. It is 'one that senses and responds to an environment with which it consistently interacts meaningfully.' Specifically for music, in play with a wakeful musical instrument, both user and audience may identify the generated sonic responses as salient information, which they may therefore interpret as a musical signs; for them, the interaction of the system is consistently musically meaningful. A wakeful musical instrument may be similarly defined as 'one that senses and responds to a musical environment with which it consistently interacts in a musical meaningful manner.'

References and Notes:

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