Emergence and Communication: Overcoming some epistemological drawbacks in computational sociology

The system emerges *etsi non daretur Deus*.
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Abstract. Computational sociology models social phenomena using the concepts of emergence and downward causation. But the theoretical status of these concepts is ambiguous; they suppose too much ontology and are invoked by two opposed sociological stands, namely, individualistic and holistic interpretations of social phenomena. In this paper, we propose a theoretical alternative that not only might clarify those concepts, but also keep their heuristic and interpretative value for computational sociology. We do so by advancing two proposals. Firstly, we suggest a non-ontological framework that allows modellers to identify emergent processes. This framework asserts the macro level and micro level as the emergent by-products of an instrumental prompting (the very modellers' act of distinguishing). Secondly, in order to support analytically the modellers' simulations, we link this non-ontological framework with the theory of self-referential social systems. This theory gives an account of the emergence of the social realm from the bottom-up as communication and describes the process by which society limits the possible selections of individuals. These two proposals are well-positioned to overcome some epistemological drawbacks, although they also generate new challenges to computational sociology.

Keywords: Communication - Computational sociology - Downward causation - Emergence - Niklas Luhmann

I. Introduction

Over the past forty years, a new kind of method has increasingly been used in the social sciences: that of the computer simulation of social processes. Social simulation (or computational social science) is an outstanding method for modelling and building explanations of social processes, based on ideas about the emergence of complex behaviour from relatively simple activities. With this technique we can study properties of emergent orders that arise from local interactions among a multitude of independent components. And we can understand the ways in which such emergent orders can influence or constrain

the individual actions of those components. This process is known as 'self-organization' and is characterised by the concepts of 'bottom-up' and 'downward causation'. These concepts are closely related to the scientific and philosophical idea of 'emergence', a core idea in sociology and computational social science. For this reason, it is not surprising that computer simulation can make a difference between 'good' and 'bad' social science for some thinkers (Moss & Edmonds, 2005).

However, despite its possibilities (such as an empirical and normative understanding of dynamic systems, heuristic research and methodological advancement (Axelrod, 1997)), which exceed the limits of traditional methods in sociology, computer simulation in the social sciences also has some epistemological and methodological drawbacks. First, there is no agreement in the social simulation community about the idea of 'emergence' and its value for theory and explanation. Second, as a consequence, the community of simulationists is divided between 'individualist' and 'collectivist' emergentists. Finally, most research using computer simulation ignores the importance of symbolic communication in the social realm, even though only this process can be called social in its own right. Because social communication is not an important issue within the mainstream of computational sociology, it is not hard to understand the reason why the most important advances in computational models about the emergence and the evolution of language are made outside sociology (e.g., Perfors, 2002).

In order to analyse how these drawbacks can be overcome, in section II we begin by examining the notion of emergence in a selected group of theories in order to show the ambiguity of the concept and draw some relations between that notion and the different positions in computational sociology (section III). Then, we describe the over-ontological sense of emergence (section IV) and show a possible epistemological alternative in order to identify the logical conditions by which we can distinguish a simulation as describing 'emergent' features (section V). We relate this epistemological alternative to the distinction between individual and communication as advanced by the Niklas Luhmann's theory of self-referential social systems, because, we hold, this theoretical framework is well-positioned to be a sociological support for developing social simulations (section VI). We present that theory and conclude with some analytical consequences for computational sociology (section VII).

II. The two souls inhabiting emergence

In all the discussions about emergent phenomena there are two constraints (Schröder, 1998). First, emergent properties are always the properties of complex systems. So, elementary particles do not have emergent properties. Second, a property of a complex thing, in order to be emergent, must not be a property of a proper part of that thing. Thus, properties like mass, velocity and charge are not emergent properties. These two restrictions are uncontroversial, because they say nothing about the possible relations between the parts of a thing and its emergent properties except, obviously, that they must be at different levels. The quarrels arise when we try to define that relationship by answering two questions: (a) if we accept there are elementary properties, can there be authentic emergent properties endowed with causal power? (b), if we can recognise the

micro and macro levels as independent, can the properties of the parts explain the emergent properties? As we will see, these related ontological and epistemological topics are the focus of several debates.

In its strong sense, the concept of *emergence* means that nature (and society) articulates itself on different levels of organisation, and that each of these levels yields its own novel causal powers. These kinds of global organisations are called emergent because they cannot be reduced to the sum of the properties of their elements (Hulswit, 2005). In this way, for instance, consciousness is not deducible (therefore, it might be said, is not explainable) from neuronal properties alone and, similarly, society is not reducible to individual properties alone. In a more general way, no higher level is explainable from its constituent units. Here, the motto is: 'the whole is more than the sum of its components'. In order to explain that '*more than'*, the ontological statement about the existence of emergent properties is frequently followed by a kind of epistemological statement that asserts the non-reducibility of emergent (or macro) properties from properties of the parts in isolation.

This strong concept of emergence is often formulated in heavily metaphysical terms. As Bitbol (2007) suggests, those who defend the concept of emergence want to know whether there truly exists such emergent large-scale properties and whether these large scale properties are more than just epiphenomena; accordingly, they want to know whether they have or do not have the causal power of altering other (large-scale or micro-scale) properties. For this reason, in many works both *emergent properties* and *causal power* are used more or less interchangeably (in the critical realist literature, the two terms may be used more or less interchangeably, e.g., Elder-Vass, 2005).

This metaphysical formulation of emergence is not surprising considering its historical origins. Alexander, Morgan and Broad, the classical emergentists[1], invented and developed the concept during the early twentieth century in order to find a satisfactory compromise between two extreme ontologies; identity theories (or reductionist materialism) and dualism. The first of these two ontologies is monist and materialist: it says that there exists, in the world, nothing else other than material elements and their properties. The second ontology is dualist: it says that there are two substances or two realms of being: mind and matter, or life and inanimate matter. Classical emergentists tried to develop a middle position between these two ontologies. Since then "[e]mergence has been perceived as a third path between dualism and identity theory, and this third path is generally known as nonreductive materialism." (Sawyer, 2002, p. 554). But being a middle path does not preclude showing a little bend towards one or the other of the two extremes.

> Emergentism comes very close to monist materialism if it takes the high level behavior as a superficial symptom, with no relevance whatsoever to the real physical processes taking place at the low level (this is the "supervenience" view). Conversely, emergentism comes closer to dualism when it tries to endow the emergent properties with some sort ontological consistence, and with causal powers of their own. (Bitbol, 2007, p. 294)

[1] Classical emergentism, also known as "British Emergentism", is the school of thought represented by these thinkers of the early 20th century, who argued that emergent properties are not *deducible* and *explainable* in terms of properties of the lower elements.

These differences, related to the ontological and epistemological status of emergence, have been reinterpreted in sociology to link them with the longstanding debate over methodological individualism and methodological collectivism. The debate is based on the answer that social theorists make to the question: Where must social theory aim its attention in order to construct explanations about the social realm? There are two possible answers, namely, 'individual entities' (actors, individual action, desires, beliefs, etc.) or 'collectives entities' (institutions, norms, structures). This debate has been at the heart of social theory from its origins. For example, Emile Durkheim argued that social properties have causal force on the individual. His defining criterion of the social fact was its external constraint on the individual and, consequently, his methodological recommendation was that sociologists must consider the nature of society, not the nature of individuals (Durkheim, 1982, p. 63). However, some classical thinkers put forward the opposing claim. Max Weber proposed that social phenomena must be explained by showing how they result from individual actions, which in turn must be explained by reference to the intentional states that motivate the individual actors (Weber, 1978).

The concept of emergence was reinterpreted and handled according to this long-lasting division inside sociological theory, concerned with the relationship between agency and structure, individual and society, and micro and macro. Consequently, existing sociological uses of emergence are contradictory and unstable. On the one hand, many accounts of the micro-to-macro link use the philosophical concept of emergence to argue that social phenomena are brought about by individuals in action (Coleman, 1990; Elster, 1989). On the other hand, emergence has been invoked by methodological collectivists to indicate that, although only individuals exist, collectives possess emergent properties that cannot be reduced to individual ones (Archer, 1995; Bhaskar, 1982; Luhmann, 1996a). Sawyer talks about a 'slippery concept of emergence' in sociology and argues that "two opposed sociological paradigms both invoke the concept of emergence and draw opposed conclusions. The problem arises in part because sociologists have not developed an adequate account of emergence" (Sawyer, 2002, p. 552).

III. Emergence within computational sociology

In this context, what happens with computational sociology? As we will explain, the uses of emergence in computational sociology are ambiguous and unstable as well. Although the concept has become widely used within the social simulation community, it continues "to be vaguely defined and to stand in for different propositions about social generative mechanisms." (Goldspink & Kay, 2007, p. 1).

For Gilbert and Troitzsch (2005), computer simulation is an excellent technique for modelling and understanding social processes, based on ideas about the emergence of complex behaviour from relatively simple activities. Gilbert argues that "[w]e can say that a phenomenon is emergent when it can only be described and characterised using terms and measurements that are inappropriate or impossible to apply to the component units" (Gilbert, 2004, p. 3). Quoting Maturana and Varela's (1992) *autopoietic* theory, Gilbert and Troitzsch indicate that "the emphasis on processes and on relations between

components, both of which can be examined by means of simulation, accounts for the developing link between this theoretical perspective and simulation research" (Gilbert & Troitzsch, 2005, p. 12). In that sense, computational sociology provides the possibility of using experimental methods in order to model emergent social phenomena, or at least their computer representations; the possibility of directly studying the emergence of social institutions from individual interaction; and of using computer coding as a way of formalising dynamic social theories (Gilbert, 2004). Hence for these thinkers, there is a strong link between the theoretical concept of emergence and computer modelling.

The use of autopoietic theory in both computational sociology and social theory is hardly surprising. After all, Maturana and Varela always related autopoiesis with 'emergent properties' (Maturana & Varela, 1979, 1992; Varela, 1988) and developed a computational representation about their model of life by using cellular automata modelling (Varela, Maturana, & Uribe, 1974). In computational sociology, some theorists argue in favour of autopoiesis as a valid, useful and complete framework to understand social systems. Thus for instance Goldspink and Kay:

> Complex systems, artificial life and artificial societies currently model bottom up emergence and systems where top down influence operates only indirectly by downward propagation of constraint, not by more direct feedback. We have argued that this is not adequate for an understanding of human social systems. We have set out two mechanisms present in human social systems – non-reflexive and reflexive; suggested a suitable theoretical frame from which they may be considered – that of autopoiesis. (Goldspink & Kay, 2007, p. 7)

Nevertheless, not everyone in computational sociology shares this opinion about the concept of emergence and its value as a theoretical support for computer modelling. Epstein, another leader in the field of simulation, seems to look at it with suspicion. He doubts its practical usefulness: "I have always been uncomfortable with the vagueness and occasional mysticism surrounding this word" (Epstein, 2007, p. 31). For him, the problem with emergentism resides in emergent phenomena being unexplainable in principle, because (emergentists argue) the parts cannot explain the whole. But Epstein indicates that

> Obviously, "wholes" may have attributes or capabilities that their constituent parts cannot have (e.g., "whole" conscious people can have happy memories of childhood while, presumably, individual neurons cannot). Equally obvious, the parts have to be hooked up right –or interact in specific, and perhaps complicated, ways– for the whole to exhibit those attributes. We *at present* may be able to explain why these specific relationships among parts eventuate in the stated attributes of wholes, and we may not. But, unlike classical emergentists, we do not *preclude* such explanation in principle. (Epstein, 2007, p. 36; italics in original)

Epstein puts forward the idea that it "is precisely the generative sufficiency of the parts (the microspecifaction) that constitutes the whole's explanation!" (Epstein, 2007, p. 36)[2]. This claim goes against emergentism (or, at least, it goes against *classical*

[2] "Typical of classical emergentism would be the claim: *No description of the individual bee can ever explain the emergent phenomenon of the hive.* How would one know that? Is it a falsifiable empirical claim, or something that seems true because of a lax definition of terms? Perhaps the latter. The mischievous piece of the formulation is the phrase "description of the individual bee". What is that? Does "the bee's" description

emergentism). For Epstein agent-based modelling is reductionist *par excellence*. By attempting to generate social phenomena on computers or in mathematical models, "we are *denying* that they are unexplainable or undeducible in principle – we're trying to explain them precisely by figuring out microrules that will generate them." (Epstein, 2007, p. 36). In a similar 'individualistic' way, Hedström talks about the importance of constructing mechanism-based explanations, which implies describing how the social and the individual influence each other over time. Such explanations pay close attention to how actors in interaction with one another bring about social phenomena. For this sociologist, "[s]ocial phenomena, as here defined, refer to properties of groups of individuals (…) These social phenomena are the result of individuals' actions, but they also causally influence individuals' actions" (Hedström, 2005, p. 70). Consequently, computational sociology (specifically, agent-based analysis) is a "formalism designed for analyzing the relationship between individual-level and social-level phenomena, whatever these phenomena may be" (p. 76). Agent-based modelling is defined here in reductionist terms: because only agents and their local interactions are modelled, higher level patterns must just be epiphenomenal.

IV. The ontological sense of emergence

Individualist emergentism leads to understanding emergent properties as epiphenomenal (without causal power) because only individuals' actions create those properties; this is the main difference from those who assert that social properties are not deducible from the isolated individual. Although both perspectives affirm that only individuals exist, there are important differences in the epistemological and ontological status that each gives to the concept of emergence. On the one hand, for some sociologists, the most reasonable hypothesis is that patterns and characteristics of individual action generate the social regularities that we observe. This position is identified with reductionism. On the other hand, many accounts in sociology use the notion of emergence to argue that collective phenomena are realities in their own right; although brought about by individuals, they are not reducible to individual actions. This position is close to dualism.

This classical debate has affected modern trends in social research. As Gilbert argues

> A rather sterile debate between these two camps continued for much of the 1970s and 1980s. With the benefit of hindsight, it is now possible to argue that while there was some truth in both, neither was a particularly helpful or revealing way of conceiving the relationship between macro and micro behaviour. It is the case, however, the most, if not all, current simulation of human societies essentially adopt one or other of these positions, often without making this explicit. (Gilbert, 1996, p. 3)

Individualists argues that "the most reasonable ontological hypothesis we can formulate in order to make sense of the social world as we know it is that it is individuals in interaction with others that generate the social regularities we observe" (Hedström, 2005, p.

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not include its rules for interacting with others bees? (…) [T]he bee's interaction rules are what make it a bee –and not a lump. When (as a designer of agent object) you get these rules right –when you get "the individual bee" right– you get the hive, too." (Epstein, 2007, p. 37).

19). But this 'ontological individualism' does not imply the inevitability of 'methodological individualism'. The logical error of making ontological arguments when supporting methodological claims is quite common in the philosophy of the social sciences. As Sawyer (2002) notes, the fact that social properties are nothing more than their individual supervening base does not entail that an explanation must be provided in the language used to describe individuals. Moreover, consistent with epistemological empiricism, micro-sociology asserts that valid sociological explanations cannot be structural, but must always refer to situational micro-dynamics such as actors' desires, beliefs or opportunities, because only individuals, not structures, are endowed with causal power. However, we could just as plausibly say that because the notion of 'individuality' is a theoretical – and by no means well clarified – abstraction, individuals do not 'act' in any more realistic or empirical sense than do structures. As Fuchs (1989, p. 178) wonders, "[c]ausal explanations are attempts at making sense, making sense requires languages appropriate for particular analytical purposes, but why should there be only one language (that of microsociology) into which all our accounts must be translated to make them 'more empirical' and 'causally stronger'?".

Those who believe in the causal power of emergent properties fail in a similar way. Most affirm the ontological status of emergent properties by referring to the non-linearity of the equations ruling elementary processes. The key point is that the complex behaviour of non-linear systems cannot be predicted from the initial state of the components, experimentally measured with limited accuracy. This is taken by some to mean that there is *really* more in the global behaviour than in the individual processes. But, if we want to prove the real existence of emergent properties, endowed with causal power, we cannot be satisfied with showing that complex systems are unpredictable in practice because of restricted knowledge of the initial conditions and the underlying deterministic laws. This only yields epistemological emergence, not ontological emergence (Bitbol, 2007; Schröder, 1998). Moreover, the very concept of 'downward causation' seems to take for granted the definition of 'causation' and what thing is 'caused' (where to cause could be to restrain, to structure, to determine, to govern, or to delimit future events). The underlying problem is that nobody really knows what is meant by 'causation' or 'cause' or 'causing' (Hulswit, 2005). For this reason Kim argues that "[e]mergentism cannot live without downward causation but it cannot live with it either. Downward causation is the raison d'être of emergence, but it may well turn out to be what in the end undermines it" (Kim, 2006, p. 548).

V. Non-ontological emergence

Therefore, we have one concept and at the same time, one dilemma. The main question is whether we can both construct a non-ontological sense of emergent properties and establish its epistemological status for sociological research. The concept of *medium downward causation*, as proposed by Emmeche et al. (2000), although still heavily ontological, might be a good first step in order to answer that question. They define medium downward causation as follows: "an entity on a higher level comes into being through a realization of one amongst several possible states on the lower level – with the previous states of the higher level as the factor of selection." (Emmeche et al., 2000, p. 24). Here, the emergent

properties are understood in terms of constraining conditions and micro-macro relationships. They maintain that "*higher level entities are constraining conditions for the emergent activity of lower levels"* (Emmeche et al., 2000, p. 25; italics in original). Higher properties restrict the multiple possibilities that lower properties can describe, and by doing so, also constrain which higher level phenomena will result from that given lower level. In their scheme, downward (and upward) causation is the co-limitation of possibilities (or possible states) over time.

The problem is whether, with this 'medium' framework, we can maintain that emergent properties can constitute their own substance. The ontological claim that a higher entity "is a real substantial phenomenon in its own right" (Emmeche et al., 2000, p. 23) becomes ambiguous because medium downward causation entails a shift from a description in terms of *substances* to a descriptions in terms of *interactions*. Is it possible to keep the scheme of Emmeche et al. without their ontological claim about emergent properties?

Some philosophers of science have addressed this issue. For instance, Bitbol's re-construction of emergent properties presupposes a thorough criticism of ontological claims *at every single level of knowledge* (that is, both micro and macro levels) as we have seen above. His position is based upon the logic inherent to quantum mechanics, claiming that quantum laws do not express the nature of physical reality, but only the limits of experimental information. Bitbol (2007) argues that in an experimental situation with some entangled physical system, the empirical information that we obtain is only specific determinations of our understanding under those experimental conditions. Hence, both micro and macro levels are the *byproduct* of an *instrumental intervention*; both properties at the micro level and the macro properties are the result of our acts of observation. As Bitbol (2007, p. 302) concludes, "[t]he 'never ending tower' of autonomous domains in Quantum Field Theory indeed concerns domains of study, domains of concepts, but not domains of being". For this reason neither the concept of *ontological* emergence nor the idea of micro level properties can be sustained. The objection against non-reductive emergence and downward causation is defused by such a symmetrical construal of micro and macro properties, because what appears, and also what is acted upon, is relative to the instrument one uses.

This epistemological claim is not only restricted to research in quantum field theory and experimental physics. Spencer-Brown's calculus does not talk about experimental instruments or devices but begins with the basic operation of drawing a distinction (Spencer-Brown, 1994). The Maturana and Varela's biology of knowledge uses this operation and maintains that "[t]he act of indicating any being, object, thing, or unity involves making an *act of distinction* which distinguishes what has been indicated as separate from its background. Each time we refer to anything explicitly or implicitly, we are specifying a *criterion of distinction,* which indicates what we are talking about and specifies its properties as being, unity, or object" (Maturana & Varela, 1992, p. 40). This is an unavoidable situation for all observation, including the scientific one. A unity (entity, object) is therefore brought forth by an act of distinction.

However, have we got any analytical criteria to distinguish emergent properties in a non-ontological way? Again, it is Bitbol who provides a framework to distinguish upward

and downward dynamics *without* any causal power. Instead of giving analytical support to the causal nature of emergence by referring to some Aristotelian notion of cause, and the consequent strong claim that there exists causal power in property A to produce property B, Bitbol develops a co-emergent understanding of micro and macro properties in probabilistic terms. According to this framework, configuration A is the cause of the distinct configuration B if (i) whenever A has been actively set up, B occurs with a probability *p*; and (ii) whenever A has been actively removed, B does not occur[3]. Bitbol argues, with this definition we can speak of 'downward causation' in the following circumstances: if (i) whenever a high-level antecedent has been actively set up by means of a high-level coarse-grained device, a certain group of low-level phenomena, relative to a certain type of fine-grained experimental device, occurs with probability *p*; (ii) whenever the former high-level antecedent has been actively prevented, the former group of low-level phenomena is not observed. Because this procedure can easily been turned upside down, downward causation is the symmetric mirror image of upward causation (Bitbol, 2007, p. 305).

In this non-ontological framework, the issue of downward causation is not one of inherent powers, but one of *actions* and *relations*: actions which bring about the world (with its levels and properties), because the world comes into being as a direct result of our distinctions; and relations between micro and macro levels, in terms of limitation of possibilities, because when the higher level is set up, some low-level phenomena are likely to occur.

The notion of emergence is not all there is to 'mysticism', although, as Epstein states, it is sometimes treated as it were. Emergence might not be the central concept in computational modelling. But it is an interesting and important concept to comprehend social processes; it has a significant heuristic and interpretative value within social research in general and computational sociology in particular. However, as we showed in Section III, it is still not as well understood as it should be, considering the amount of serious scholarship devoted to it during the last decade or two[4]. For this reason, the non-ontological framework presented above can help to computational modellers to distinguish, identify and define emergent processes, either in social realm or in their computational simulations. In both cases, we are witnessing an emergent process if and only if we can analytically apply the 'medium concept of emergence' (as increasing co-limitation of possibilities) and the two conditions of causality as stated by Bitbol. The computational modeller can, strictly speaking, only identify her or his simulation as describing some emergent feature when these conditions are satisfied.

[3] Both conditions are necessary, because each of them serves to exclude, as Bitbol argues, a certain type of parasitic effect: "Condition (ii) is obviously indispensible, because if after having prevented A, B does not occur, this excludes that the frequent association of A and B was purely fortuitous. But condition (i) is also necessary, because if actively producing A by any means is enough to trigger the appearance of B (with probability *p*), this excludes that the observed association of A and B was due to some common cause. Condition (ii) is usually not sufficient for this latter purpose since there are situations where preventing A can only be done at the cost of preventing the common cause of A and B to occur". (Bitbol, 2007, pp. 15-16)

[4] A quick survey by *Google Scholar* shows that there are 5,430 hits for 'social simulation'. If we add to this searching the keyword 'emergence' there are 2,170 hits (40%). Searching for the word "emergence" in the *Journal of Artificial Societies and Social Simulation*, we find 495 occurrences.

There are many examples of social simulation where this logical framework can be used. One classic example is Schelling's (1971) model of residential segregation. In this model, made to demonstrate the unintended consequences of household migration, individual decisions about whether to move from a current location, given a certain threshold of tolerance, depend on the local levels of segregation, which, in turn, individual decisions tend to reinforce. The process finishes when a state of static equilibrium is reached, in which all individuals 'decide' to stay in their locations, grouped in clusters of similar individuals. Then a high level of segregation is apparent. However, it is not so obvious that the original Schelling model describes a limitation of possibilities (because the possibilities of individual's elections are just two, and always one of those two decisions must be taken). But an extension of this model presented by Gilbert (2002) with explicit 'downward causation' also showed segregation. In this case, some individual configurations (a simple set of rules and a level of tolerance within certain range of values) brought about clusters of similar individuals resulting in a limitation of possibilities of movement for some individuals. This process reinforces the segregation pattern. It is the individuals' configuration (not the individuals) that *causes* the macro behaviour, because with a different configuration (e.g., a threshold of tolerance lower than 30%) the segregation is not observed. The inverse relationship is true as well, because without the macro behaviour of segregation the possibilities of movement throughout the space would be higher for each individual.

Models about the evolution of lexicons are another example of simulations describing emergent features (Steels & Kaplan, 2002; Steels, 2003). In these simulations, agents are capable of bootstrapping their own ontology and shared lexicon without prior design or other forms of human intervention. An interesting phenomenon studied by these simulations is the process of 'damping synonymy and ambiguity' that arises as an emergent property in the lexicon. This damping is expected because the agents get explicit feedback about the co-occurrence of a referent-category and there is lateral inhibition as well as a positive feedback loop between previous uses and success. Thus, different agents engaged in a 'game' (which involves repeated dialogues in which a score measuring the associations between referents and categories are constantly updated) are more likely to select some categories (from a broader set of available categories) for expressing a specific referent, which, in turn, damp general synonymy, reinforcing the limitation of possibilities that agents have. This emergent process yields one category that comes to dominate the expression of one specific referent. Again, the micro-specifications (that the modeller implements) result in macro-behaviours that are supposed to reveal, in this case, the emergence of language.

The above examples show that modellers, facing up to some 'real world' phenomenon, do not need to make any supposition about the essence or the intrinsic nature of the two levels (Schelling was not interested in *why* people decide to move out; linguists do not have fossils to help them understand *how* language could have emerged). It is enough to know how to act selectively at one of the two levels in order to modify what is observed at the other level. As Bitbol says, "[i]t is no longer a question of own-being, but only of endless processes of which we partake by our actions" (Bitbol, 2007, p. 305).

Therefore, by overcoming the epistemological drawbacks inherent in the ontological sense of emergence we are able to distinguish emergent social order from individuals and the dynamic interaction of upward and downward causation as Emmeche et al. do[5]. The social researcher's observation is, simultaneously, the distinction between individual and society and the consequent mutual dependence (co-dependency or perhaps co-production?) that emerges in the *very* observation. The distinction between individual and society (or micro and macro properties) is then linked to the domain that is distinguished by one observer. As Gilbert argues,

> Emergent phenomena are ones where there is an observation mechanism for the emergent phenomenon that does not apply to structures at the lower level. (…) It is important to note that the definition of emergence involves an external "observation mechanism" (…) Different mechanism can yield different observations and so different conclusions about emergence. This implies that emergence and indeed the separation of structures into levels is a matter of scientific convention: there is a sense in which it is true to say that emergence is in the eye of the beholder. (Gilbert, 2006, p. 429)

The main issue is whether we as sociological observers are able to distinguish the social unity as different from the individual. In the following section, we introduce a sociological alternative to the individualistic and holistic interpretations of social phenomena. This alternative is based on the structural coupling of individual consciousness and social communication as advanced by the theory of self-referential social systems. In that perspective, communication is understood as an emergent order that exerts structural limitations on the possibilities of individual selections and where different kinds of emergent properties bring about different properties at the lower level.

VI. Social communication and social emergence

As Luhmann (1990, p. 6) says, "[c]onfronted with the question of elementary units, most sociologists would come up with the answer: action. Sometimes 'roles' or even human individuals are preferred". These traditional options overlook both the importance of communication in social research and its relation with the concept of emergence and perhaps for this reason symbolic communication has been studied mainly by linguistics, not by sociologists (Gostoli, 2008; Perfors, 2002; Steels, 2003; Werner & Dyer, 1992). Sawyer has described the issue in the following terms:

> A theory of social emergence requires an explicit theorization of symbolic communication and dynamic processes. Yet for the most part, sociological theorists who focus on the micro-macro link have not theorized communication, nor the role that communication plays in micro-macro relations. (Sawyer, 2005, p. 187)

The basic assertion is that the emergence of language is the emergence of society. But Sawyer goes one step further and relates symbolic interaction with computational

[5] Another important consequence of this framework for social theory in general and computational sociology in particular is related to the following question: if reality is brought about by observation, then what is the truth of the simulation? (Schmid, 2005). A related problem is the most effective procedure for verification and validation of computational models. However, these problems are beyond the scope of this paper.

sociology. By analyzing three broad classes of artificial societies, namely reactive, cognitive and collaborative agent societies, Sawyer suggests that differences in communication result in different emergent processes and outcomes. Emergence occurs only when there is an interaction among agents, but, what is more important, "different collective properties emerge and the processes of their emergence are different when the agent communication language is changed" (Sawyer, 2005, p. 188). Thus, Sawyer concludes that (i) the model of communication that is used in an artificial society has causal consequences for the type of emergent regularities under study and (ii) a theory of symbolic communication (that is, language) must be a core component in any explanation of social phenomena.

Nevertheless, Sawyer's theory of social emergence, which is based both on collaborative activities among agents and the distinction between ephemeral and stable emergence, is insufficient to explain the evolutionary stabilisation of social structures and the emergence of generalised symbolic media such as money and power. In some current trends in both social theory in general and computational sociology in particular, language is taken to be the basic element of society. However, language is not enough to stabilise complex social orders over time because language gives no motivation for co-ordinated selection among individuals. As Mascareño (2008, p. 4) argues, language "can limit selection possibilities but motivation itself derives from the structured expectations of meaningful constellations allowed by the evolution of symbolically generalized communication media". The mistake is to deposit into language more than language can actually hold. We need to use another theory about the emergence and evolution of social communication.

In the Parsonian tradition, ego and alter are each objects of orientation for the other. Every social interaction constitutes a situation of double contingency, that is, both *ego* and *alter* know that both know that one could also act differently (Vanderstraeten, 2002). The concept of double contingency implies that ego's gratifications are contingent on alter's selection of action and, in turn, alter's reaction will be contingent on ego's selection that will result from a complementary selection on alter's part and so on (Parsons, Shils, & Smelser, 2001). And for both alter and ego there are unlimited possible selections. Luhmann follows this conceptualisation and agrees with Parsons that social order is impossible unless the problem of double contingency is solved. In Luhmann's words: "We would emphasize that the problem of double contingency belongs to the conditions of possibility for action and that therefore the elements of action systems, namely, actions, can be constituted only in these systems and only by solving the problem of double contingency." (Luhmann, 1996a, p. 104). Luhmann explains the connection with the emergence of social order in the following terms:

> The basic situation of double contingency is then simple: two black boxes, whatever accident, come to have dealings with one another. (…) For the few aspects through which they deal with one another, their capacity for processing information can suffice. They remain separate; they do not merge (…) They concentrate on what they can observe as input and output in the other as a system in an environment (…) They can try to influence what they observe by their own action and can learn further from the feedback. In this way, an emergent order can arise that *is conditioned* by the complexity of the systems that make *possible but that does not depend on this complexity's being calculated or*

> *controlled*. We call this emergent order a social system. (Luhmann, 1996a, p. 110; italics in original)

However, Luhmann rejects the idea that this problem can be taken care of by reference to the concept of culture, as Parsons and many other sociologists believe. Culture appeals to norms and values to explain motivation and selection, but nobody elucidates how norms and values become stabilised and how they change (Luhmann, 1999a). Moreover, explaining social order using the concepts of culture, norms or values forces us to think (tautologically) that society was already grown before it grew itself. For this reason, culture is an insufficient concept to explain social phenomena.

To summarize, to overcome the problem of double contingency is to produce an emergent order, independent of both alter and ego; that is, independent of individuals. But, if social theory cannot explain the stability of social order on the basis of norms, values or consensus, what is to take their place? Because double contingency is a pre-eminent social problem, the solution requires the use of a pre-eminent social operation; namely communication. Social order can only be produced by means of communication, although it is this order that also enables communication (Vanderstraeten, 2002). This is a really counterintuitive proposition. A common-sense perspective would maintain not only that communication must necessarily be between individuals, but also that only individuals are able to communicate. Contrary to this view, Luhmann argues that, fundamentally speaking, individuals cannot communicate at all, not even in their capacity as psychic systems. In Luhmann's theory, individuals (or psychic systems) operate in terms of meaning in the form of a closed connection of consciousness. Similarly, social systems operate in terms of meaning in the form of a closed connection of communication. Therefore, the strong axiom of the theory is: communication alone is able to communicate (Andersen, 2003; Luhmann, 2007). Society is self-referential or *autopoietic* from this perspective, because it is understood as an independent and emergent phenomenon (that is, communication) that cannot be reduced to something other than itself, for instance, neither to consciousness nor to a sum of actions or individuals. Here we see the phenomenological insistence on observing society as it appears without reference to conditions external to society. And individuals, as psychic systems, are external to society.

But, what is communication? As Mascareño argues (2008), communication is a shared actualisation of meaning achieved through the evolution of social systems. This allows reciprocal co-ordination of expectations among participants. Only an evolutionary system-building process can select meaning variations and stabilise them into structures of expectations (or social systems).

Communication is an emergent order, a state *sui generis*. It emerges through a synthesis of three selections, namely: alter selects information from a horizon of meaningful possibilities; she or he instantiates it through language or actions (utterances); ego observes alter's conduct and understands or misunderstands this utterance and its information (Luhmann, 1990). Of course, ego can accept or reject the offer, but anyway it might be said that ego understands alter's proposal. "[T]he acceptance or rejection of an expected and understood selection are not part of the communicative event; they are connected acts (…) Viewed dynamically, the unity of an individual communication is

merely its connectivity" (Luhmann, 1996a, p. 148). Both acceptance and rejection are equally probable. "[U]nderstanding always includes misunderstanding, and if one does not add on presuppositions, the component of misunderstanding becomes so great that the continuation of communication becomes improbable" (Luhmann, 1996a, p. 158). Thus, the theory Luhmann is trying to formulate starts from the premise that it is implausible. And because the basic element of society is communication (and not individuals), social order also appears as a highly improbable event.

> This improbability of which we have become unaware must first be understood, and to do so requires what might be described as a contra-phenomenological effort, viewing communication not as a phenomenon but as a problem; thus, instead of looking for the most appropriate concept to cover the facts, we must first ask how communication is possible at all. (Luhmann, 1990, p. 87)

Luhmann (1990) argues that communication – if it comes about – must overcome three obstacles or improbabilities: (a) the individuality of human consciousness, (b) the extension of communication beyond direct participants and (c) the improbability of success. The first improbability is related with understanding; given that their bodies and minds are separate and individual, it is unlikely that one person can understand what another person means. Meaning can be understood only in context, and for each individual consists primarily of what his own memory supplies. Furthermore, as we said above, understanding always includes misunderstanding. The second improbability is related with the spatial and temporary limitations of communication in reaching recipients. That is, it is improbable that a communication can get to more people than are present in a given situation. Even if the communication finds a means of conveyance that is constant over time, it is still unlikely that it might attract attention: in other situations people have other things to do. The third improbability is that the communication, even if it is understood, is accepted and followed. By *success* Luhmann means "that the recipient of the communication accepts the selective content of the communication (the information) as a premise of his own behaviour, thus joining further selections to the primary selection and reinforcing its selectivity in the processes" (Luhmann, 1990, p. 88). Communicative success is the successful coupling of selections between alter and ego. Regarding all these three improbabilities, Luhmann argues:

> (…) no social system can be formed without communication. One must expect entropy, even if the opposite is the case. This does not contradict the theorem of improbability; it indicates more precisely where the problems lie whose solutions enable communication in the course of evolution, get system formation going, and transform improbabilities into probabilities. The immanent improbabilities of the communicative process and the way in which they are overcome and transformed into probabilities regulate the construction of social systems. (Luhmann, 1996a, p. 159)

However, despite these improbabilities, social order exists and we communicate daily. This is because social evolution has solved these improbabilities with three consequent agencies (or mechanisms), which Luhmann identifies with the concept of *media*. The first evolutionary achievement, to overcome the first improbability mentioned above, is *language*. Language is a medium which, via acoustical and optical signs, makes it more probable that ego understands alter. It can, through the use of equivalent signs, reinforce the impression that ego and alter hold equivalent opinions (Luhmann, 1990).

Linguistic statements produce so specific sounds, articulated in so improbable and recognizable ways that it is very difficult for ego to deny that the statement has a communicative intention. Thus, ego can observe that this 'sound' or 'action' uttered by alter has an underlying informative value, which ego will reconstruct and attribute. But language per se is still strongly coupled with interactional contexts. *Dissemination media*, such as writing, printing and electronic broadcasting, contribute to expanding communication themes beyond the restrictive boundaries of interaction systems. These media immensely increase the scope of communication and result in a social order decoupled from local contexts and from idiosyncratic interpretations. But both language and dissemination media make it even more doubtful which communications will succeed.

Language and dissemination media are preconditions to other media that make success probable, namely, *symbolically generalised communication media*. Only the later media achieve the ultimate aim of communication: to motivate heterogeneous individuals to act and experience in a relatively coordinated way (Mascareño, 2008). They make possible, at the individual level, what Luhmann calls "the nexus between selection and motivation" (Luhmann, 1996a, p. 161). And at the macro level, they make possible the emergence of meaningful constellations of co-ordinated selectivity which provide common significance, identifiable themes and complementary expectations. Motivation is implied in the selection of symbolic media as they generate their own conditions of acceptability and diffusion. Thus, the multiple possibilities of selection that individuals have can be restricted, making social order more likely. The complexity of the social realm emerges through the reduction of these multiple possibilities and through the selective conditioning of this reduction. Symbolically generalised communication media achieve this by defining the limits of what is structurally possible in each case, that is, in each social constellation of meaning (or social system). Luhmann analysed multiple examples of such media: *scientific truth* within the scientific system (Luhmann, 1994a), *power* within politics (Luhmann, 1990, 1994b), *validity* within the law (Luhmann, 1990, 1995, 2004), *love* within intimacy (Luhmann, 1999b) and *beauty* within art (Luhmann, 1990, 1996b, 2000).

The social dynamic or micro-macro link thus produced can be explained in the following terms (Mascareño 2008): In an upward direction, the process of mutual references from one individual (alter) to another (ego) continuously recreates the social order as stabilised constellations of meaning. Conversely, in a downward direction, these relatively stabilised structures of communication exert a conditioning effect on the progression of communicative events, which can be seen as a downward causation process expanding from the social, down to the psychic system. Alter's and ego's experiences and actions are modulated and coupled with stabilised expectations in social evolution. The structural couple between individual (psychic systems) and society (communication systems) does not mean that individual selections are determined because this would break the operational closure of both individual and society. Rather, symbolic media only "motivates to follow the orientation given by stabilised systemic structures. Otherwise individuals would lose their acceptance capability for selections, even though their counterfactual behaviour can trigger variations in the constellations of meaning that move society in unpredictable and contingent directions." (Mascareño, 2008, p. 6).

VII. Conclusion

In this paper we have considered some epistemological drawbacks to the concept of emergence (and the related dynamics of upward and downward causation) and some consequences of these drawbacks for computational sociology. Many of them are based upon the heavily ontological definition of emergent properties, which tend to split the social simulation community between those holding to an individualistic approach and those affirming a holistic one. In order to overcome these drawbacks, we have discussed some current trends in the philosophy of science, in which the concept of emergence is reconstructed, from a non-ontological position, with an understanding of causation in terms of constraining conditions and individual-society relationships. We have argued that Luhmann's theory of self-referential social system is consistent with such a non-ontological position on emergence and can deliver new insights and give analytical support to the computer simulation of social phenomena. His theory understands social communication as an emergent phenomenon that makes possible the restriction of the unlimited possibilities of selection that individuals have (double contingency).

We have paid attention to symbolically generalised communication media. These media are meaningful constellations of common significance, identifiable themes and complementary expectations. We described those constellations as structures of expectations that alter and ego use to reduce the uncertainty of their own double contingency; with only those media can individuals accept the selective content of the communication as a premise of their own behaviour. Symbolic media promote some selections and exclude others depending on the context of their instantiation: they motivate awareness of the other in intimate relations (love); payment operations in economic transactions (money); evaluation of the electoral consequences of political decisions (power); and the validity of arguments in science (scientific truth). Conversely, consumers generally do not buy in the supermarket using love; politicians who make decisions because they have been paid are considered to be corrupt; and even the Prime Minister must prove the validity of his arguments if he wants to submit a paper to the *British Journal of Sociology*. Therefore, different meaningful constellations bring about different expected selections.

The logic inherent in each constellation (or social system) has been developed by Luhmann in several works. His theoretical framework can be very useful to computational sociology, in order to make models theoretically informed. The interest in this analytical framework has been growing among the social simulation community. A good example is Fleischmann's computational model of a simple Luhmann economy (Fleischmann, 2005). Using an agent-based model, the author reproduces the evolutionary dynamic of the economy. For Luhmann, the circulation of the economy is made possible at the historical moment when economic institutions circumvent successfully the paradox of scarcity, according to which the richer supply of one is the greater need of the other (more abstractly, every access to scarce goods which serves the lessening of scarcity increases scarcity). Fleischmann's agent-based model showed conformity to Luhmann's hypothesis: giving specific initial conditions, the economy produces unevenness from unevenness. Others authors have worked on the relation between expectations and meaning (e.g. Leydesdorff, 2005; Duong & Grefenstette, 2005). However, Luhmann's premises still pose

some challenges to computational social science. For example, the theory of media can be considered, in Lakatos's terms, as a 'research programme' in its own right (Chernilo, 2002), because it explains the historical processes by which the constellations of co-ordinated selectivity become differentiated (therefore, this theory has empirical content and some of this content has been verified). However, there are no computational models of these evolutionary processes. This is a major topic for computational sociology, because it is accustomed to deal with the dynamic stabilization of social structures. At this stage we just can ask: Is computational sociology capable of undertaking the challenges that Luhmann's social theory generates?

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