Dialogues concerning a (possibly) new science

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Abstract

The paper relates virtual dialogues about social simulation, with the implicit reference to Galieo's 'dialogues concerning two new sciences'.

Keywords:
Social Simulations, Epistemology, Validation, Simulation Methods

The three characters, Dreamer, Experimentalist and Realistic, meet in an ideal place of Toscana. They come from different places of the old, decadent and altogether fundamentally renewing Europe of the early 21st century. They were invited in this place to discuss matters of high importance: Do agent based computer simulations offer a venue for a new social science? On what basis such a new science would stand? What role would play experimental approaches developed in social psychology? How to use case studies from the real world? Is there a need to develop a specific methodology of simulation?

A tiny breeze of spring brings perfumes from the high cypress along the pools and gardens. Dreamer opens the discussion.

Three different views on social simulations

1.1

Dreamer: In this very place, almost exactly 400 years ago, our far ancestors Simplicio, Salviati and Sagredo discussed the foundations of a new science[1]. Their dialogues can be seen as the birth of modern physics, which completely modified our perception and relation with Nature. We are here to examine if the same type of foundation is possible concerning another part of our surrounding reality: social phenomena. Are we about to discover the "language in which the great book of social reality is written"? I believe so. Other distinguished colleagues already announced this fundamental change in a more or less straightforward way (Gilbert and Conte 1995, Nowak and Vallacher 1998). I would like to be more precise. I believe that the fundamental feature that the language of social phenomena must be able to express is the "strange loop" between individual interactions and collective dynamics. Agent based simulations allow us to express such a strange loop. The Galileo Galilei of social phenomena might very well be among the young PhD students attending the last ESSA conference in Koblenz!

1.2

Realistic: Dear Dreamer, how can you be so naïve? How many great thinkers claimed to have

found this famous language of social phenomena? Take the Scottish philosophers Locke, Hume, Smith for instance. Each of them believed to have found the equivalent in social dynamics of the universal gravity principle. Illusions! 250 years later, all these magnificent theories interest only a dozen of decadent European specialists. K. Marx and his followers acted the same play of scientifically discovering the very mechanisms of social dynamics. What is left from these dramatic theoretical deliria? Ruins and death. The more recent research in social sciences, although its claims are generally more modest, is no less in a wrong direction in my view. Its theoretical principia are totally baroque: have you ever seen a utility function in reality? or a global equilibrium? Its experimental approaches, ridiculously mimicking physics, studies artificial, ideal situations which have nothing to do with social reality, and will never tell us anything about it! Nevertheless, I agree with you that agent based simulations could bring something new. But the reason is that they can be "reality driven", and ignore all these theoretical fantasies. A new science, yes, but a "tabula rasa", sticking to real case studies!

1.3

Experimentalist: Dear Realistic, you criticise theoretical concepts, but your proposal is also full of illusions. How did modern sciences develop? Through observations on well defined, well controlled experiments. It is impossible to drive any robust conclusion from a case study in the real world. Even if you take several case studies, which is better, you will never be able to ensure that your interpretation of the phenomenon is the right one. As Kant pointed out, the revolution of modern science consists of submitting Nature to questions as a Judge in a court, instead of letting it tell us what it wants. Dear Dreamer, I can address the same reproach to you. Computer simulations give us examples of complex links between individual interactions and collective dynamics. So what? The game of life is a perfect example of such dynamics. Does it tell us anything about social phenomena? Not at all. Nevertheless, I agree with both of you that something new might come out from social simulations. But only if we incorporate into them well established experimental facts, both about individual interactions and about global dynamics!

What epistemological basis ?

3.1

Dreamer: Well, I think that we at least agree on the potentiality of a new science opened by the use of agent based simulations. However, strong divergences appear among us about how this science should develop. Let us try to better identify the nature of our apparent disagreements, by considering in more details the epistemological basis we would favour for this science. Experimentalist, my dear friend, you are bringing us back to a very old debate in epistemology. It is well established that modern science is not only based on the experimental approach (although I agree that this plays a fundamental role), but on simple ideal abstractions, which can be expressed in mathematics and drive the experimentations. For instance, A. Koyré, in his study on the birth of modern physics, strongly stresses the fundamental role of the inertia principle: an object, in a void space, has a linear movement of constant velocity. This principle is totally abstract, and cannot be observed experimentally. Yet, it gives its meaning to the whole construction. We need an equivalent to this principle (or to the universal gravity) in social studies, and social simulations can help us to test candidate principles in full extent. Dear Realistic, Hume, Smith and Marx did not have this means to test their ideas! This is why we can do better now.

3.2

Realistic: Physics is based on abstract principles, I agree on that, my dear Dreamer, but not with the conclusions you make. Cartwright (1983) has argued (with examples) that relationships that hold in experimental conditions do not hold in real world applications. This is because these experiments are generally driven by simplistic principles. In social dynamics the situation is even more complex. In the real world various social processes may affect one another at different times. For example, attitudes may shift due to information provided by other people, norms may change and as a result people may start interacting with other people that in turn further affect their attitudes. Due to the inherently complex nature of many dynamical processes, the same behavioural mechanism may result in very different behavioural outcomes in different conditions. Hence the dynamics resulting from the interactions among large numbers of people are not accessible for laboratory research. You are both sticking to old

fashioned rusty scientific principles. Alas! Where ever one looks in the works of our contemporaries, one sees a compulsion to gain respectability by developing formal statements and using formal statistical methods. And, yet, what does formalisation give us? It gives us precision but not accuracy. In computer science, verification by formal proof does not necessarily (or even usually) imply validation - that a program will actually do what it was intended to do. In social science and social simulation, formalisation yields precision of expression but not accuracy of description. Accuracy requires using a language that does not require us to distort what we observe. To use numbers to represent qualitative social phenomena is just such a distortion. Both formalisms and experimental results should as far as possible retain the language used by those whose behaviour we seek to describe and to understand.

2.3

Experimentalist: Let me illustrate the crucial role of experimentations on an example. Consider the "shift to the extreme" phenomenon. This phenomenon was observed by G. Le Bon in the 19th century on real phenomena: when there are group discussions in which people must agree on a common position, extreme positions tend to be adopted by the group. Le Bon cites the example of the 4th of August 1789 night in the French revolution, in which extreme decisions were made. The problem is that you can find many counter examples of careful, balanced group decisions! This is only with Moscovici and Doise (1992) and other experimentalists that we managed to better understand this social phenomenon. They showed that there are conditions of communication favouring a shift to the extreme, and others, which on the contrary inhibit it. These facts could only be obtained by strictly controlling the conditions of experiments, and by replicating them many times, at different places. You see, dear Realistic, such experiments tell us much more about real group decision-making processes, than observation of case studies. Moreover, Agent Based simulations offer the possibility to test different social theories explaining these facts, as attempted in (Deffuant et al 2004). To improve the representation of behavioural dynamics in social simulation, I emphasise the importance of developing agent rules using existing major behaviour theories, which are based on well established empirical facts.

A common theoretical core for agents ?

3.1

Dreamer: Well, I think that our divergences about the epistemological grounding of the developing science are now very clear. Let us see if a deeper discussion about more concrete modelling methods would help to reconcile our views. The major question that pops up from the last point of our friend Experimentalist is: what level of theoretical detail is required in agent architectures? Obviously it is too complex to include all details of the abundance of social scientific theories in a single agent architecture. This would yield (if possible at all) an extremely complex architecture lacking transparency. I believe that we must on the contrary imagine new simple theoretical principles from which we could derive important experimental results, and possibly reinterpret them. Social simulations must take the results of social psychology into account, but to point out their common root to include in the agent dynamics ! There are already some attempts to design such architectures (for instance the BDI architecture). We must continue in this direction !

3.2

Realistic: Poor Dreamer! Your case is even worse than the one of my friend Experimentalist! Computer scientists also engage in faux formalism. They use logical structures such as BDI logics to design and sometimes to program their agent based software without ever proving the theorems implied by the formulations. They claim the virtues of formalism without the discipline of formalism. And how successful have they been? I quote Raphael Bordini et al. (2005):

> After almost a decade during which research on agent-oriented programming struggled to deliver any concrete results, the last couple of years has seen an impressive improvement in the quality of research in the area, as well as a considerable increase in the number or researchers involved in it. This lead to the creation of two international workshop series on the subject.

The citations given by Bordini *et al.* for nearly useful agent oriented programming have such titles as "Proving the asymmetry thesis principles for a BDI agent-oriented programming language" and "Efficient intention selection in BDI agents via decision-theoretic task scheduling". As a result, I think the quotation given above means that, having laboured mightily for ten years, the concrete results of formal BDI agent-oriented programming is a couple of international workshop series. There has certainly been useful programming using BDI-like constructs in agent oriented languages, but these have had nothing to do with BDI logics as formalisms for proving anything. The BDI programming paradigm may be useful. Claims to use BDI logic are a prime example of *faux formalism*. If the theories have not themselves been validated and their conditions of application identified, then I argue that there is no justification to constrain models or, more generally, social analysis by such theories. Case studies, *per contra*, can provide detailed accounts of dynamic social processes over quite extended intervals of time. Social simulation models designed and validated with the participation of stakeholders and other domain experts are then validated by comparing model numerical output with social statistics and also by allowing the stakeholders to assess the plausibility of the behaviour and interactions among the agents as models of the stakeholders themselves. Validation against case studies can also take the form of having independent experts or observers assess the qualitative behaviour of agents. By their nature, of course, agent based social simulation models of case studies support validation against history.

3.3

Experimentalist: Like Realistic, I am very reluctant to consider a priori simple rules or theories, and I disagree with your idea of finding the simplest explanations for social phenomena, dear Dreamer. The risk of using such 'simple rules' is that the actual (experimentally tested and empirically observed) behavioural dynamics generating the macro-level effects are misrepresented. For example, Reynolds (1987) developed an approach to simulate flocks as a distributed behavioural model, and many people who view these animated flocks immediately recognize them as a representation of a natural flock, and find them similarly delightful to watch. However, research on schooling of fish illustrate that we lack a good understanding of the micro-behaviour of fish in relation to schooling. Indeed, information about the behaviour of nearby neighbours is found to be a crucial factor in empirical studies, but which behavioural rules are in use is a puzzle and so far computational models fail to reproduce observed behaviour in detail (e.g., Camazine et al. 2001, see also Jager & Janssen 2003). Most human behaviour (simple) agent architectures being used, such as the one Dreamer mentioned, have a limited foundation in micro-level behavioural theories. As a consequence, they suffer from a lack of experimental grounding. This causes that strategies aimed at changing system behaviour as derived from the simulation model may not target the actual behavioural dynamics, and hence provide less realistic and applicable results. Yet I propose that the main constituents of social scientific theory should be integrated in agent architectures, e.g. human needs as drivers of behaviour, social and individual decision strategies involving different degrees of information processing, and cognition to represent agents knowledge base and learning capabilities. One example of such an integrated approach is the consumat approach (Jager, Janssen & Vlek 1999, see also Jager 2000).

3.4

Dreamer: Well, maybe our opinions, although different, are compatible, finally. My point is that we need a theoretical basis behind the micro-behaviour plethora of experimentally grounded theories. But I think that, this theoretical principle should be selected by strong tests against existing experimental evidences (and hopefully new experiments), to check its validity. It should also be tested against case studies and observations in the real world. Both of you will need to make modelling choices, you Experimentalist, to organise the integrated architecture, and you Realistic, to build your model representing the historical evolution in your case studies. Maybe our divergence is on the extent of this modelling principle: I dream of a general modelling principle that could have a very wide application, both explaining and enlightening current experimental results as well as case study observations. You believe that the discovery of such a grand principle is very unlikely. I agree that we certainly should not wait for it to go on working. We must go on testing concrete modelling methods against experimental and case studies evidence, because this is in my view how we will progressively design the fundamental principles we need. The point we have in common now is how to test and validate the models or

modelling principles. I propose to engage the discussion more specifically on this point.

Dealing with complexity

4.1

Realistic: Let me illustrate my view of social simulation practice on the example of the recent referenda in France and the Netherlands. Social simulations could provide major improvements in our understanding of these social events. Field researchers should collect data on people's attitudes and opinions, how various sources (friends, colleagues, religious organisations - in general, social networks as well as media) affected these attitudes, and how the global voting intentions vary over time. Social simulation researchers should formalize agents from these data and come back to panels of people to check that they agree with the individual models. Our friend Experimentalist's laboratory methods could and should also be used. In this way, we validate our models at micro level using the same qualitative terminology as our informants use. Of course, the simulations should also be validated against the global data on the voting intentions and the final vote by identifying and simulating social processes that are consistent with the actual outcome. The comparison to the real data should not take into account the particular values, which are beyond the precision of the models, but rather consider some general patterns and shapes, to define "stylised facts". The purpose of such a model would not be to predict if people in France and the Netherlands would reject the European constitution, but rather to understand the process in which they came (perhaps) to fear immigration and/ or to dislike the president Chirac or prime-minister Balkenende and to articulate the fear and the dislike by voting "non/nej/no".

4.2

Experimentalist: Dear Realistic, you are forgetting one of the main questions we are confronted with in social simulation: "Can we validate against cases if we know that in complex systems the outcomes could have been radically different". The point I want to address here is that calibrating a model to real case data is the most dangerous thing to do when modelling a complex system. Rather, we have to find the proper level for validation. In complex systems the same underlying (behavioural) processes may give rise to different development. For this reason, I agree that validation should focus on the processes in the system but not, I would argue, on the global outcomes of these processes. And again, I argue that these individual processes must be grounded on well validated observations in social psychology. Dear Realistic, simply asking some participants about how they proceed as you suggested, is very delicate. There can be a lot of biases in their answers. This is why the help of professional scientists in social psychology is absolutely necessary. In your example, I think that lab-social scientists should try to further reveal how source effects are related to the complexity of the message, and check on well controlled experiments the micro theories that they would produce. The social simulation researchers would then collaborate with them to formalise agents, and then to simulate them. The fact that some simulations do not produce the global result which actually took place would certainly not be an argument against such a model. The only requirement is that the real outcome is a possible outcome of the model (but its probability can be very low). To summarise, we should behave more as sailors, my friends! Sailors master the complexities of navigating their ships through various weather and sea conditions, which are often unpredictable by nature. Yet, their profound understanding of these dynamics allows them to respond efficiently in keeping their course and arriving at their port of destination. In contrast, many social scientists, even those interested in dynamics, endeavour to predict the destination of a voyage given a ship's initial position. Sailors would burst out laughing understanding these attempts. Rather, as good sailors we should focus on understanding the principles of the underlying dynamics instead of on the outcomes of these processes. This is not to say that the outcomes are of no importance! But in order to get a better scientific understanding of getting these outcomes, we should focus our research at the discovery of 'laws of social dynamics'.

4.3

Dreamer: I agree with you, my dear Experimentalist. And this is why we need to develop new practises and new methods of simulation. The result of one simulation means nothing. There is a need to systematically repeat the simulations with the same parameters to evaluate the randomness of the dynamics. We should also explore the space of parameters in order to identify their influence on the distribution of the results (because we generally have large

uncertainties on these parameters). This enables to observe regularities and identify the patterns or "stylised facts" mentioned by Realistic. We probably need tools to improve this practise, in particular to define the simulation protocols, and to automatically detect patterns. But, I think that the point is even deeper than this. Stochastic or nonlinear dynamics can give a variety of outcomes from similar initial conditions as well, without being complex. Complexity is related to the existence of (at least) two levels of description. The higher level, global dynamics, is generally almost impossible to directly infer from the lower level, individual dynamics. True complexity is often even more restrictive: the higher level must have an effect on the lower level (downward causation). The complexity of social phenomena may lie even deeper. Some researchers (Gilbert 2002 for instance) consider that downward causation is of a different nature in social phenomena, because individuals can recognise and react to the global emergent structures, justifying the definition of a "second-order" emergence. Other researchers (Dupuy 1992) explain the "second order emergence" by the particular plasticity of human mind, which can be radically modified by the global social context. The same child, if grown up in an Amazonian tribe or in the centre of Paris, becomes a totally different person. The downward causation observed in physics or biology does not have such a strong impact. Agent based social simulations can bring new and well grounded evidences to clarify these concepts and problems, because they allow the researchers to observe, as precisely as they want, the interactions between the lower and the higher levels. The challenge is now to elaborate theories of these interactions, which would provide, in my view, a major advance in our understanding of social dynamics, and therefore, of ourselves.

4.4

Realistic: Dreamer! Foolish abstract theories again! By all means, let us formalise the behaviour and social interactions we observe - that is, after all, what we are doing in writing and running our simulation models. Formalisation gives precision and it is more likely to make us precisely wrong than precisely right. Do we impose theories on our observation in the hope that they will be precisely right? Do we impose number on our descriptions of emotions, opinions, trust, reputation and norm? Or are we more likely to be both more precise and less wrong by using the words of natural language in describing these phenomena? Maybe abstract, formal descriptions - indeed, theories - will emerge from these formalised descriptions. But then again, maybe not.

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The night has come, and millions of stars are now witnessing the dispute. It will probably not end before the sun rises and sets many times. Around, some people are still active whereas most others are asleep. None imagine the struggle taking place in this villa, about the secrets of this so strange creation in which they all participate, and are at the same time the products: a human society.

Notes

[1] See “Dialogues concerning two new sciences” - Galileo Galilei.

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