

Chapter 1

Simulating the Past for Understanding the Present. A Critical Review

Juan A. Barceló and Florencia Del Castillo

1.1 Introduction to an Introduction

This book has been edited with the explicit idea of allowing the reader to imagine that virtual histories can be generated in a computer in the same way as in her/his mind. This is not a literary exercise, however, but an example of a radical revolution in the way of doing History as a social science. While computational models can be used to simulate real-world processes in great detail (e.g., some manufacturing processes), their greatest potential for historical explanation lies in using them as environments of systematic, controlled, virtual experiments in human social and socio-ecological dynamics (Bankes et al. 2002; Diamond and Robinson 2010; Barton et al. 2012; Barton 2013, 2014; Hmeljak and Goldstone 2016; Nakoinz and Knitter 2016; Cegielski and Rogers 2016). Importantly, such models are constructed from the bottom up, requiring the integration of knowledge about human social processes and theory about the relationships among individual actors and groups at multiple scales to create the algorithms which drive agent perception, decision-making, and action. Used in this way, building computational models can help refine our concepts about the operation of societies, and the models can serve as complex hypotheses that can be tested against the empirical record of archaeological, ethnological or historical research (Barton 2014).

The essays present in this book are the result of a special session organized during the annual conference of the European Social Simulation Association (ESSA) held at the Autonomous University of Barcelona (Spain) on September 2014. “Simulating the Past to Understand Human History”—SPUHH—for the first time in an ESSA con-

J.A. Barceló (✉)

Department of Prehistory, Universitat Autònoma de Barcelona, Bellaterra, Spain

e-mail: juanantonio.barcelo@uab.cat

F. Del Castillo

National Scientific and Technical Research Council (CONICET), Puerto Madryn, Argentina

e-mail: delcastillo@cenpat-conicet.gob.ar

© Springer International Publishing Switzerland 2016

J.A. Barceló and F. Del Castillo (eds.), *Simulating Prehistoric and Ancient Worlds*, Computational Social Sciences, DOI 10.1007/978-3-319-31481-5_1

ference gathered a multidisciplinary group of researchers interested in different developments of computer simulation in the archaeological and historical sciences. The most interesting part of this session was the increasing interest of a multidisciplinary community to implement computer simulations to solve historical problems. Not only archaeologists and historians are now interested on long term simulations, the presence of physicists, economists, computer scientists, historians, sociologists, geographers and anthropologists reflects the transdisciplinarity of this way of research. The papers selected to be published in this book express some of this excitement.

Most contributions are studies of the most remote past: prehistory and archaeology. But it does not mean that other historical periods cannot be made understandable recreating what people did and believed within a computer. In practice, then, the virtual pasts we can recreate within a computer are accessible in the sense that they tend to realign this paradigmatic new way of understanding the past with both the commonsense trivial idea that history is about what people did in the past (Düring 2014; Lake 2015; Lercari 2016; Cegielski and Rogers 2016; Marwick 2016).

1.1.1 A “New” Way of Understanding Human History?

History is a science that should look for causal affirmations about the formation processes of society. Therefore, the startpoint of historical research should be explaining past social events by showing how human behavior fit into a causal structure, that is to say, a vast network of interacting actions and entities, where a change in a property of an entity dialectically produces a change in a property of another entity (transformation).

This focus on the causal understanding of historical processes fits well with the notion that archaeology and history should offer something to contemporary society as an integrated science of long-term societal change and human-environment interaction (Rashevsky 1968; Abbott 1983; Turchin 2008, 2011; Hurley 2012; Gavin 2014; Lake 2015; Cegielski and Rogers 2016). History is not the identification of who did what in the past, but the quest for what produced a social action whose effects and consequences may be discerned in the present. Moreover, what generated those consequences was the interaction of a number of actions and entities, characterized by direct, invariant and change-relating generalizations. History as an explicitly scientific discipline should evolve from a subjective description of what we believe happened in the past, to an investigation of the causes of the present.

Descriptive chains of events, even if true, are not explanations but they are something to be explained. Clearly, nothing is gained if we introduce as an explanation of why some x occurred, an indicator that some y occurred before or after (where x and y refer to different acts, events or processes). In some sense, causal interactions are the factors explaining why a social action was performed at a specific time and place, which is, its motivation or reason.

We can understand social action in the past only in terms of how humans did it. It is easy to see then that the concept of mechanism becomes the heart of this kind

of causal explanation. Obviously, the word “mechanism” is here a parable of how social intentions, goals and behaviors are causally connected. A “social mechanism” should then explain how social activity worked, rather than why the traits contributing to these activities or workings are there (Bechtel and Richardson 1993; Machamer 2002; Craver 2001; Darden 2002; Glennan 2002; Gerring 2008; Ylikoski 2011; Maurer 2016). “Mechanisms are entities and activities organized such that they are productive of regular changes from start or set-up to finish or termination conditions” (Machamer et al. 2000, p. 3). No matter how long or complicated the causal process is, it can be called a mechanism if its description answers the question how did the cause bring about the effect.

We are adopting an analytical approach in which “social facts” are seen as generated, triggered, produced, brought about or “caused” by actions which themselves are in some sense “caused,” or at least partly determined by the constraints presented by the social environments and situations in which such actions take place (Elster 1989). To explain a social event therefore means to describe the various causal chains linking all the elements involved (once those elements have been appropriately described and separated) in constituting a social fact.

These prospective for a new way of understanding human history are strongly related with current developments in Analytical Sociology. Such a term officially entered the sociological vocabulary with Hedström’s *Dissecting the Social* (Hedström 2005) to denote the sociological perspective that seeks systematically to formulate and empirically test micro-founded, mechanism-based explanations of complex macro-level patterns and dynamics (see also: Bortolini 2007; Hedström and Bearman 2009a, b; Racko 2011; Raub et al. 2011; Bearman 2012; Edling 2012; Wan 2012; Opp 2013; Manzo 2010; 2014; Lombardo 2015). According to such definition, we can envisage a kind of “Analytical history” when trying to understand complex chains of change in terms of the discovery of patterns in transitions. To build such a discipline, and paraphrasing Manzo (2014), we should modify the actual way of describing the past and:

1. using concepts that are as clear and precise as possible to describe both the facts to be explained and the explanatory hypotheses/facts mobilized to explain them, while avoiding all linguistic obscurity and convolutedness (Pomeranz 2011),
2. mobilizing the best quantitative and qualitative empirical information available and use the technical tools best suited to describing the facts to be explained,
3. making emphasis on the social outcome(s) evidenced somewhere and some-when to understand what happened and why. This can be done by first formulating a “generative model” that is, a model of a set of mechanisms, where a mechanism is a set of entities and activities likely to trigger a sequence of events (i.e., a process) likely to bring about the outcome(s),
4. providing a realistic description of the relevant micro-level entities and activities assumed to be at work, as well as the structural interdependencies in which these entities are embedded and their activities unfold,
5. translating our hypothesis of the social mechanism implied in the causal connections between events into a “generative model” in order to rigorously assess

the internal consistency of the hypothesis and to determine its high-level consequences,

6. comparing the predictions made by the generative model with the empirical description of the historical facts to be explained in order to assess the generative sufficiency of the mechanisms postulated,
7. injecting as much empirical data as possible into the generative model in order to prove that the hypothesized assumptions are not only generative sufficient but also empirically grounded, and reanalyze its behavior and high-level consequences.

A common objection to employing mathematical and formal models in the study of historical dynamics is that social systems are so complex that any mathematical model would be a hopeless oversimplification without any chance of telling us interesting things about these systems. As Turchin (2008, 2011) has argued, this argument is wrong: when any model appears to be “complex” then, the only way to analyze its behavior is through objective measuring and using mathematical language. “Naked” human brain is not a bad tool for extrapolating linear trends, but it fails abysmally when confronted with systems of multiple parts interconnected with nonlinear feedback loops. We need mathematical formalism to express our ideas unambiguously, and both analytical methods and fast computers to determine the implications of the assumptions we made (West 2011).

The advantage of formal modeling is that, by making explicit and unambiguous the relationships between events and also the intended scope, it is easier to determine whether the model is supposed to be applicable to some observed phenomenon and, if so, whether it adequately fits it (Lake 2015; Nakoinz and Knitter 2016).

1.1.2 The Past as a Virtual Model

The past is only accessible through the filter of a “model” built indirectly from personal narratives, written in the past and preserved in our present. It is then an artificial world, more or less imaginary, more or less reliable: a replica of what really happened. There is no doubt that historians have been creating virtual surrogates of the past since the early days of Herodotus and Thucydides. Such virtual worlds are expressed narratively, using verbal language. In them, the historian places herself in the context in which the action took place, but she is situated in a virtual world extracted from a narration—supposed to be true—by an individual having seen someone doing something in the past, or explaining her intentions when acting (Bouissac 2015; Lercari 2016).

In any case, virtual worlds that can be narrated using verbal language can also be expressed using computer languages (Mayfield 2007; Millington et al. 2012). In that sense, an Artificial Society can be seen as a set of autonomous software entities (the agents) having autonomy to “act”, thus taking their own decisions based on

computer instructions that “simulate” the goals of the humans they “imitate” and the state of the world in which they are supposed to be. Computationally speaking, virtual agents will consist of a body that contains a set of state variables and behavioral instructions.

As the real world constrains the structure and behavior of the real agents, the simulated historical context plays that role for the simulated agent system. The perceptions of the simulated agents need to have some origin in all factors external to that agent, and it has to be represented in a specific environmental model. Thus, complex agent models require rich contextual information that should be transferred to a virtual model of the “landscape”. This global entity may carry some global state variables like its own dynamics. These dynamics also can be so complex, e.g., containing production of new entities, that one may assign some form of behavior with the simulated environment.

The successful completion of virtual agents’ tasks should be subject to the decision and actions of others, and on the specific way the environment constrains or determines the performance of social action. These models as well as real phenomena, for example, the societies, are dynamic because they change in time; therefore, a model will consist not only of structure but also of behavior. To observe a model’s behavior the passage of time on it is necessary and it is here where computer simulation functionality is required (Sansores 2007).

In this way, we can move the unit of analysis to the social system of situated agents, whose center of gravity lies in the functioning of the relationships between social activities, social action, operations, and social actors. The unit of analysis is thus not the individual, nor the context, but a relation between the two. Questions of scale are relevant to understand the advantages of computer simulation of historical events and processes. In a computer model of a remote past, the historian can disaggregate in reverse order to the way social organization has evolved: the highest level groups become independent systems, disassociated from other groups, and which can subsequently disaggregate into their respective subgroups. Because in a virtual past, agents, processes and environment interact with other components in multiple dynamic ways, in variable frequency and intensity across the nested hierarchical organization, the scale and direction of change at the system level is not necessarily proportional to the scale and direction of the phenomena that trigger it. Additionally, it is more the character of the interactions among components rather than their inherent characteristics that determines the behavior of a simulation at the system level.

This way of building “artificial societies” from individual building blocks representing the lowest units of analysis may be contrasted to macro simulation approaches that are typically based on generalized models where the characteristics of a population are averaged together and the model attempts to simulate changes in these averaged characteristics for the whole population. Thus, in macro simulations, the set of individuals is viewed as a single entity that can be characterized by a number of variables, whereas in micro simulations the structure is viewed as emergent from the interactions between low-level entities—the individuals.

In this framework, time is defined in terms of steps, and steps are defined by a transition system that has a recursive structure. History is then computable to the extent that it can be represented algorithmically as the successive states of some determined input \rightarrow output function (Abbott 1983; Ponse 1996; Moschovakis 2001; Moschovakis and Paschalis 2008; Mahoney 2015). Such a computable system should consist of a set of states, a set of labels representing the agents and the actions, and a transition relation, prescribing for each state the possible ‘next steps’, i.e., what actions can be performed, and (per action) what state results. Selecting one state as the root (the initial state) then yields a formal representation of a process. In this framework, time is defined in terms of steps, and steps are defined by the computational process (Mayfield 2007). However, it is not useful to call “computation” just any non-trivial yet somewhat disciplined coupling between state variables. We also want this coupling to be intentionally set up for the purpose of predicting or manipulating, in other words, from knowing or doing something (Toffoli 2005).

This way of considering the particular—causal—relationship between successive steps in an evolving social system of agents, activities and products (both people, things or other actions) brings about the vocabulary of complex systems and chaos theory into the domain of social science and history. Complexity social science is not a radically new domain, but in the recent years, it has changed its emphasis dealing with the unpredictability and non-linearity of many real world social mechanisms (Ball 2003; Dendrinos and Sonis 2012; Guastello 2013; Schieve and Allen 2014; Youngman and Hadzikadic 2014; Wright-Maley 2015). Complex adaptive systems (CAS) represent systems which are dynamic in space, time, organization, and membership and which are characterized by information transmission and processing that allow them to adjust to changing external and internal conditions (Barton 2014). Complex systems approaches offer the potential for new insights into processes of social change, linkages between the actions of individual human agents and societal-level characteristics, interactions between societies and their environment, and allometric relationships between size and organizational complexity.

1.1.3 Testing the Virtual Model

This emphasis on computability and algorithms implies a correlated emphasis in formalization, on objectivity, but not necessary on “truth”. Simulating the past is just a way of increasing the explanatory power of historical explanatory models and not necessarily their “truth likeness”.

We never know for sure whether the generated computer model of historical transitions and changes actually describes what happened really in the past. It is important to take into account, however, that the mechanical generation of “hypotheses” is no end in itself. A simulation can be “suggestive”, “imaginative”, “relevant”, “probable”, “plausible”, “credible” (Bankes et al. 2002; Garson 2009;

Simulating Prehistoric and Ancient Worlds

Barceló, J.A.; Del Castillo, F. (Eds.)

2016, VI, 404 p. 112 illus., 62 illus. in color., Hardcover

ISBN: 978-3-319-31479-2