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THE EMERGENCE OF COMPUTATIONAL SOCIOLOGY

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The world of science has undergone a major transformation by virtue of technological innovations in computing and information processing. Sociology is one site in which this change is being played out. Our basic aim is to set out a revised image of any modern science, within which we can conceptualize and discuss the role of a newly emergent subfield we term computational sociology. Specifically, we expand the familiar two-component model of a science, featuring a theoretical and an empirical side, to include a computational component. We show how the three components interrelate in a triangular system in which empirical data analysis, theoretical explanation and computer simulation link the three components. We close our paper with a brief discussion of how one new development in computation relates to concepts of sociology, an instance of the hybrid character of computational sociology.

THE THREE COMPONENTS OF SCIENCE

Recent developments in the natural sciences are beginning to transform our image of the basic components of any science. The familiar two-component model of science as an interplay of theory and empirical research is being expanded to include a third component, computation. Physics, for instance, has theoretical physics and experimental physics, and now computational physics also is a social reality. Chemistry and biology have evolved and expanded in similar ways. With the new three-component model of any science (say, X), three types of expertise arise: theoretical X, empirical X, and computational X and roles develop for those who specialize in such activity.

Relations between the three components of a science exist and correspond to three modern scientific activities: explanation is the interplay of theoretical X and empirical X; data analysis is the interplay of empirical X and computational X; and simulation analysis is the interplay of theoretical X and computational X. Computational sociology, then has at least two roles, according to this model of science (Figure 1).

First, computational sociology uses the ideas and technologies of modern computer science to help advance theoretical sociology through the construction and study of simulation models. The simulation models are related to the world indirectly through the linkages with theoretical sociology and empirical sociology. Insofar as the fundamental ideas of the theories have gained acceptance in a scientific

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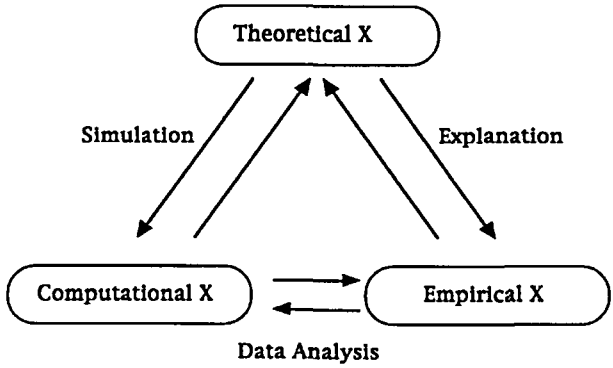


FIGURE 1. The three components of science.

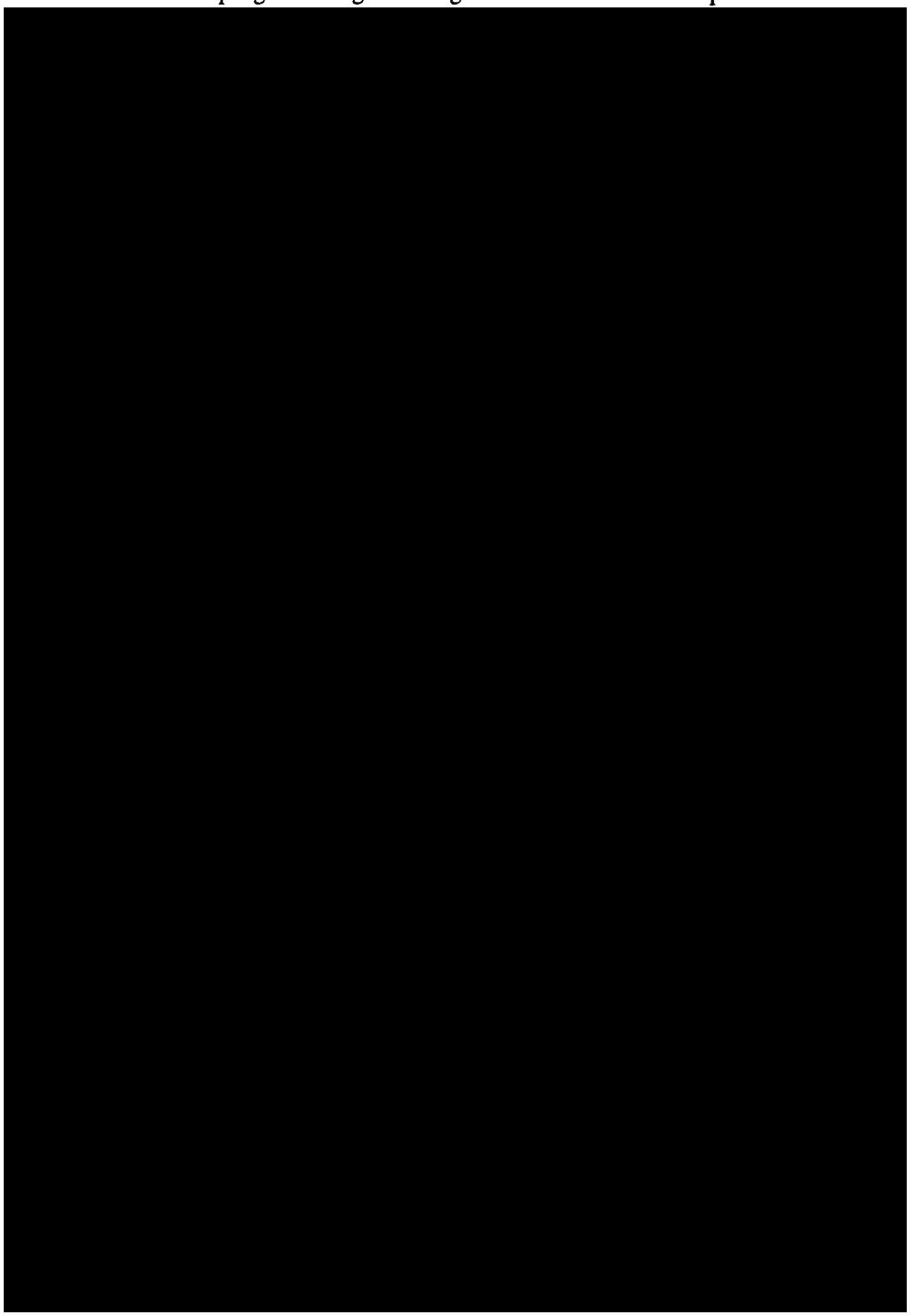
community, to that extent the results of the simulation help to explain a body of empirical phenomena. Otherwise, what we learn from the simulation studies are essentially logical implications of our theoretical assumptions. These help further empirical research to test ideas and to advance our explanatory capabilities as a science.

The spread of personal computing and the acceleration of advances in both hardware and software have created a revival of interest in simulation. For basic research, it is the linkage to theory that makes simulation studies using the new technology so important. Among the growing number of contributions in this direction, an important example is the role of simulation studies in theory-driven research on power in social networks (Cook, et al., 1983; Marsden, 1983; Markovsky, 1987; Yamagishi, Gillmore and Cook, 1988; Skvoretz and Willer, 1991). Recognition of the general significance of simulation methodology for theoretical sociology is growing (see, for instance, Collins, 1988: Appendix).

Simulation is above all concerned with process. As Evans (1988: 19) defines the term, "a simulation is a dynamic model implemented on a computer." If the dynamic model is simple enough, then no simulation may be needed to study its properties. But the more usual scientific experience today is that simple rules have complex consequences when they involve concatenation over time. Thus, to implement a dynamic model on a computer is to create a computational model that mirrors the analytical model such that computational processes will produce the model outcomes for a variety of conditions. As we vary the conditions, the model outcomes vary in ways that we learn about through use of the simulation program. There are various types of simulation, such as those implementing continuous-change (Hanneman, 1988) and those implementing event-driven dynamics (Fararo and Hummon, 1994). Yet, in our terms, these are only variants on a common theme in which the emergent computational sociology functions as a handmaiden of theoretical sociology.

Procedures developed in the context of simulation have a further relevance through their indirect connection to empirical sociology. Once a simulation program is constructed, it constitutes software that enables computational processes in the

other key role of data analysis. Empirical researchers with certain forms of data can use the simulation programs to generate grounded measures and processes.



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