Chapter II
Agent Cognitive Capabilities and Orders of Social Emergence

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ABSTRACT

This chapter critically examines our theoretical understanding of the dialectical relationship between emergent social structures and agent behaviors. While much has been written about emergence individually as a concept, and the use of simulation methods are being increasingly applied to the exploration of social behavior, the concept of "social emergence" remains ill defined. Furthermore, there has been little theoretical treatment or practical explorations of how both the range and type of emergent structures observed may change as agents are endowed with increasingly sophisticated cognitive abilities. While we are still a very long way from being able to build artificial agents with human-like cognitive capabilities, it would be timely to revisit the extent of the challenge and to see where recent advances in our understanding of higher order cognition leave us. This chapter provides a brief recount of the theory of emergence, considers recent contributions to thinking about orders of emergence, and unpacks these in terms of implied agent characteristics. Observations are made about the implications of alternative cognitive paradigms and the position is proposed that an enactivist view provides the most logical pathway to advancing our understanding. The chapter concludes by presenting an account of reflexive and non-reflexive modes of emergence, which incorporates this view.

INTRODUCTION

Building and working with artificial societies using the methods of multi-agent social simulation serves us in several ways: 1) It allows us to operationalize social theories and to compare simulated behaviors with those observed in the real world; and 2) it allows us to build new theory by exploring the minimal mechanisms that might explain observed social behavior. Most importantly 3) it provides a unique ability to explore the interplay between levels of phenomena and to understand dynamic properties of systems. A great deal can and has been achieved in both these areas with even the simple methods we currently have available. However, Keith Sawyer (2003) has recently reminded us that, to date, we

have worked with agents with very limited cognitive capability and that this necessarily limits the range and type of behavior which can be explored. This echoes a sentiment made a decade ago by Christiano Castelfranchi (1998a) that social simulation is not really *social* until it can provide an adequate account of the implication of feedback between macro and micro which becomes possible with higher cognitive functioning of social agents.

In many respects, developments in our capacity to simulate artificial societies have led us to confront anew a long-standing issue within social theory. This is a problem that social science conducted within traditional disciplinary boundaries has become quite adept at avoiding. Indeed it can be argued that the particular form disciplinary fragmentation takes in social science is a primary strategy for avoiding it. The problem is referred to in a number of ways depending on the disciplinary tradition. This chapter begins by revisiting this most important of problems. In terms of the challenge it poses to artificial societies it can be expressed in the following three questions:

1.   What are the fundamental cognitive characteristics which distinguish human agents from animal or automaton?
2.   How do these characteristics influence the range and type of behaviors agents may generate and the emergent structures which they may give rise to?
3.   How can we theorize about the relationship between cognitive capability and categories of emergent form?

These questions form the focus for this chapter. We begin to address them by revisiting the contribution of alternative schools of thought to our understanding of the nature and origins of emergent structure and alternative concepts of orders of emergence. We then discuss the implications of the two competing cognitive paradigms within AI—that of cognitivism and the enactive view. Finally we turn to current research on the development of human cognition and examine its implications for anticipating different orders of emergent structure—proposing what we call reflexive and non-reflexive classes of emergence.

Finally a research program for the advancement of understanding in this area is proposed.

This work has its origins in two strands of research with which the authors are currently involved. The first addresses the relationship between micro and macro levels of social behavior and organization directly. Over the past decade we have explored the characteristics of the micro-macro problem (see Chris Goldspink & Kay, 2003, 2004) in pursuit of a coherent and consistent account of the interpenetration (circular causality) between micro and macro phenomena. Our aim is to develop a theory which can provide a substantive account of fundamental social generative mechanisms. To date no such social theory exists that satisfactorily explains this dynamic.

The other strand is one author's involvement with the Centre for Research in Social Simulation and though it the European Union funded project titled Emergence in the Loop (EMIL). The aim of EMIL is to : a) provide a theoretical account of the mechanisms of normative self-regulation in a number of computer mediated communities b) specify the minimum cognitive processes agents require to behave in normative ways c) develop a simulator which can replicate the range and type of normative behavior identified by the empirical research so as to further deepen our understanding of how and under what conditions normative self-regulation is possible and the range and type of environmental factors which influence it.

A BRIEF RECOUNT OF THE THEORY OF EMERGENCE

The notion of emergence has a long history, having been invoked in a number of disciplines with varying degrees of centrality to the theoretical and methodological development of associated fields. Unfortunately the concept has largely remained opaque and ambiguous in its conceptualization, leading to the criticism that it stands as little more than a covering concept – used when no adequate account or explanation exists for some unexpected phenomena. Clayton has argued that the concept covers:

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