Chapter 72
Neural Network Modeling for Organizational Psychology

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ABSTRACT

The nature itself of organizational psychology makes the study and modeling of emergence processes the key topic of this science. In this regard we can distinguish between two kinds of emergence: the one related to individual constructs and the other to collective constructs. In the former case the presence of suitable individual and contextual features gives rise to the emergence of suitable individual attitudes of holistic nature. In the latter case the features of single individuals belonging to a group, and reciprocally interacting, give rise to the occurrence of collective features and phenomena. In the last years both kinds of emergence have been studied through computational models. In this chapter we focus on the contribution of Artificial Neural Network (ANN) models to this modeling activity. As regards the emergence of individual constructs there is a consistent number of ANN-based models, most of which formulated in terms of recurrent networks. A review of their successes and failures constitutes a first part of the chapter. Instead, the emergence of collective constructs has been so far modelled by resorting to agent-based models. However, in recent times the ANN models have begun to be used with increasing frequency in this field. Namely, each agent can be modelled in an easier way by representing its structure through a suitable neural network. The final part of the chapter is, therefore, devoted to the problems underlying the use of ANNs as constituents of agent models.

INTRODUCTION

Within a previous chapter of this book we discussed the usefulness of ANN models in order to describe the processes of emergence which characterize most aspects of Organization Science. The conclusions reached in this chapter can be thus summarized:

1. The emergence processes are of the foremost importance in all domains of Economics and Organization Science, so as to make their study and modeling an unavoidable necessity;

2.   In principle some kinds of ANN models can be used to describe and model emergence processes; however, the most suitable models appear to be the ones based on recurrent networks;

3.   A correct and efficient use of recurrent networks in modeling emergence processes requires a specific and high mathematical as well statistical expertise, a circumstance which, up to recent times, hindered their application to the above quoted domains.

In the present chapter we will shortly review some concrete examples of applications of ANN models to Organizational Psychology. Our aim will be, firstly, to assess the successes and failures of these models, and, in the second place, to understand how they could be related to other models, like agent models, best known within Social Sciences and, in particular, Organization Psychology. This understanding could open the way to an easier and friendly use of recurrent ANN models. Our arguments will be based on a distinction between two kinds of emergence processes: the ones related to the emergence of *individual constructs* and the others to the emergence of *collective constructs*. In the former case the presence of suitable individual and contextual features gives rise to the emergence of suitable individual attitudes of wholistic nature. In the latter case the features of single individuals belonging to a group, and reciprocally interacting, give rise to the occurrence of collective features and phenomena. It is to be underlined that both kinds of emergence are of equal importance (and often concomitant) within Organizational Psychology.

In recent times there has been within Organizational Psychology an increase of the interest in the use of computational models (see, for instance, Weinhardt and Vancouver, 2012). This interest concerned also ANN models (even if agent-based models still seem to be more popular among organizational psychologists). However, despite this circumstance, so far we didn't observe an explosive increase of the number of papers dealing with applications of ANNs to Organizational Psychology. A possible explanation of this lack of papers could be based on the fact that the use of ANN models requires a lot of mathematical and software expertise, often scarce among organizational psychologists. While this chapter does not pretend to help in filling this cultural gap, notwithstanding we will preliminarily introduce some rudimentary notions about the ANN models so far used in Organizational Psychology. Therefore the aim of the following section is to allow the readers to understand at least the general concepts underlying these models.

THE ANN MODELS USED IN ORGANIZATIONAL PSYCHOLOGY

The world of ANN models is very wide and many textbooks have been written to describe at least its fundamental aspects (here we are forced to limit our quotations to few titles such as Bishop, 1996; Graupe, 2013; Haykin, 2009; Rojas, 1996; Rumelhart and McClelland, 1986). Within the present context we will be content with saying that, generally speaking, an ANN model is nothing but a network including two main components: the *nodes*, or *units* (often called *neurons*), and the links between units, often called *connections* (some people use the expression *synapses*, or *synaptic connections*). It is important to remark that each connection is associated with a numerical value, called *synaptic weight*, or, more simply, *weight*. The name 'neurons', given to the units, is related to the fact that, in order to have an admissible ANN, the units must have a time behaviour of a neuron-like kind. This requirement can be fulfilled in many ways, the most simple consisting in associating with each unit a numerical quantity, known as *activation*, which can vary with time according to evolutionary laws mimicking the ones ob-

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