Chapter 2
Mining Sociotechnical Patterns of Enterprise Systems With Complex Networks: A Guiding Framework

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ABSTRACT

Organizations worldwide are supporting their processes and decisions with enterprise systems (ES). Large amounts of data are produced and reproduced in these increasingly complex sociotechnical systems, opening new opportunities for the adoption of self-supervised learning techniques. Complex networks are viable solutions to create models that learn from data. This chapter presents (1) a review on the possibilities of networks for self-supervised learning, (2) three cases illustrating the potential of complex networks to address the autopoietic nature of ES (adoption of enterprise resource planning, web portal development, and healthcare data analytics), and (3) a framework to mine sociotechnical patters uncovering the entanglement of human practice and information technologies. For theory, this chapter explains the potential of complex networks to assess enterprise systems dynamics. For practice, the proposed framework can assist managers in establishing a strategy to continuously learn from their data to support decision-making in self-adapting scenarios.

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INTRODUCTION

Complexity and autopoiesis are inseparable concepts to understand organizational enterprise systems. According to Gershenson (2015) "[a]*utopoiesis can be defined as the ratio between the complexity of a system and the complexity of its environment*" but its measurement and visualization are challenging.

Big data has provided a fundamental ingredient for automatic learning: context data. This new strategic resource for organizations (Yin & Kaynak, 2015) is produced by a diversity of information technologies (IT). For example, enterprise systems (Markus, Petrie, & Axline, 2000; Pollock, Williams, & Procter, 2003), have evolved at an accelerated pace from simple local applications to complex platforms offering proactive support to interplay networks (Panetto et al., 2016). Artificial intelligence (AI) is also developing very fast to create new systems that autonomously learn from large volumes of data and extract behavioural patterns. This semantic knowledge mimics human learning processes and is useful for IT developers, for example, to identify the different dimensions of information systems (Barata & Cunha, 2013) that are more relevant to the organization but also for companies with a need to develop the full potential of their sociotechnical resources (Baxter & Sommerville, 2011).

Sociotechnical complex adaptive system (Vespignani, 2009) describes systems acquiring their form and attributes only from the evolving interdependence. These systems are able to develop adaptability in emergent and self-organizing behaviour within a self-supervised learning process (Sermanet, Lynch, Hsu, & Levine, 2017). Modelling such a complex system comprises the capability to learn from system own data (self-data) and visualize its significance interdependences. However, even with the capability of exploring "all the data" it is virtually impossible to remove uncertainty on learning. Managing uncertainty and the capacity of self-organizing are crucial on any decision-making process.

Complex networks are one of the predominant approaches to learn from data and deal with uncertainty (Mitchell, 2006), providing insights about the self-organization characteristics of a system (Prokopenko & Gershenson, 2014). The two fundamental properties of emergent behaviour and self-organization has demonstrated to be important on complexity modelling and structure understanding. Having its foundations in the field of physics, a complex network is a system of connected (linked) elements (nodes) that allows "*true predictive power of the behaviour of techno-social systems*" (Vespignani, 2009). The nodes that are significant to a complex network and its interrelations can be measured using different techniques such as information entropy (Guo et al., 2020), opening new opportunities to (1) learn from the complex system data, (2) measure its autopoiesis, and (3) graphically visualize its characteristics.

Drawing on the fundamental concepts of sociotechnical complex adaptive system (Vespignani, 2009), this chapter aims to uncover the potential of complex networks to understand and visualize an enterprise system autopoiesis.

The remainder of this chapter is presented as follows. The next section explains the research approach. Afterwards, background concepts to our research are introduced, namely (1) enterprise systems, (2) complex adaptive systems, and (3) complex networks supported in statistical based learning techniques. Subsequently, three cases of complex networks modelling are presented and discussed. Based on the literature review and the design process, a framework to measure autopoiesis in enterprise systems is proposed. The chapter closes stating the main conclusions, the limitations, and future work opportunities.