Mining Stock Market Time Series and Modeling Stock Price Crash Using a Pretopological Framework

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Abstract. We introduce a computational framework, namely a pretopological construct, for mining time series of stock prices in a financial market in order to expand a set of stocks by adding outside stocks whose average correlations with the inside are above a threshold. The threshold is considered as a function of the set's size to verify the effect of group impact in a financial crisis. The efficiency of this approach is tested by a consecutive expansion process started from a single stock of Merrill Lynch & Co., which had a large influence in the United State market during the studying time. We found that the ability to imitate the real diffusion process can be classified into three cases according to the value of θ - a scaling constant of the threshold function. Finally, the process using pretopological framework is compared to a classical one, the minimum spanning tree of the corresponding stock network, showing its pertinence.

Keywords: Pretopology theory · Modeling of a stock market crash · Computational intelligence

1 Introduction

Complex systems is a well-established science. A system can be defined as complex if it is composed of many components interacting with each other and has chaotic behavior and/or collective behavior, among other properties [1–4]. As this point of view, a stock market can be considered as a complex system with the interactions among stock prices and their collective behavior observed many times, especially in crises. A complex system can be modeled as a graph whose nodes represent its components and edges represent the interactions between each pair of nodes, which is called a complex network. Many networks, both modeled and real-world networks, are demonstrated to be fragile under an intentional attack [5–8]. However, the system can be damaged if there is a failure in one or several components that may imply its cascading failures and prevent it from properly working [9, 10]. Unlike intentional attacks where nodes are removed sequentially (rely on their structural characters such as degrees, betweenness...) by external intervention, the failures happen by itself due to the strong relationships between the system's components. In order to study the failures, we need a method that examines the evolution of a complex system in each

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