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Network visualization for financial crime detection ☆, ☆☆

Walter Didimo, Giuseppe Liotta, Fabrizio Montecchiani *

Dipartimento di Ingegneria, Università degli Studi di Perugia, Italy

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ABSTRACT

Objective: We present a new software system, VisFAN, for the visual analysis of financial activity networks.
Methods: We combine enhanced graph drawing techniques to devise novel algorithms and interaction functionalities for the visual exploration of networked data sets, together with tools for SNA and for the automatic generation of reports.
Results: An application example constructed on real data is presented. We also report the results of a study aimed at qualitatively understanding the satisfaction level of the analysts when using VisFAN.
Conclusion: VisFAN makes a strong use of visual interactive tools, combined with ad-hoc clustering techniques and customizable layout constraints management.
Implications: As this system confirms, information visualization can play a crucial role to face the discovery of financial crimes.

1. Introduction

Financial crimes represent a major problem of many governments and are often related to organized crimes like terrorism and narcotics trafficking. Money laundering and frauds are among the most common types of financial crimes. They are based on relevant volumes of financial transactions to conceal the identity, the source, or the destination of illegally gained money. The estimated amount of money laundered globally in 1 year is 2 trillion in current US dollars.[1] To face this problem, most governments have created special investigation agencies, called *financial intelligence units* (FIUs). Financial institutions, like banks, money service businesses, insurance agencies, casinos, must store all transactions executed by their customers in some kind of electronic archive and must report to FIUs about suspicious transactions. The main goal of FIUs is to collect and analyze suspicious transaction data to discover illegal activities, so to defend the integrity of worldwide financial markets and to prevent from organized crimes that can mine the homeland security.

The major challenge of financial subjects and of FIUs is to deal with the volume and the complexity of the collected data, which can be modeled as financial activity networks (FANs) whose nodes represent persons, companies, bank accounts, or other types of entities, and whose edges represent their connections according to a set of possible criteria. It is widely accepted that the exploration of such networks in order to discover criminal patterns strongly benefits from a strict integration of social network analysis (SNA) and visualization tools [17,40,42,43]. Due to the heterogeneity of the data and to the different methodologies followed by financial investigation analysts, any system for the visual analysis of FANs should offer a variety of flexible tools that guarantee strong interaction with the user. As it will be discussed in Section 5, there is a general

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* Corresponding author.
E-mail addresses: walter.didimo@unipg.it (W. Didimo), giuseppe.liotta@unipg.it (G. Liotta), fabrizio.montecchiani@unipg.it (F. Montecchiani).
[1] http://www.unodc.org/unodc/en/money-laundering/globalization.html.

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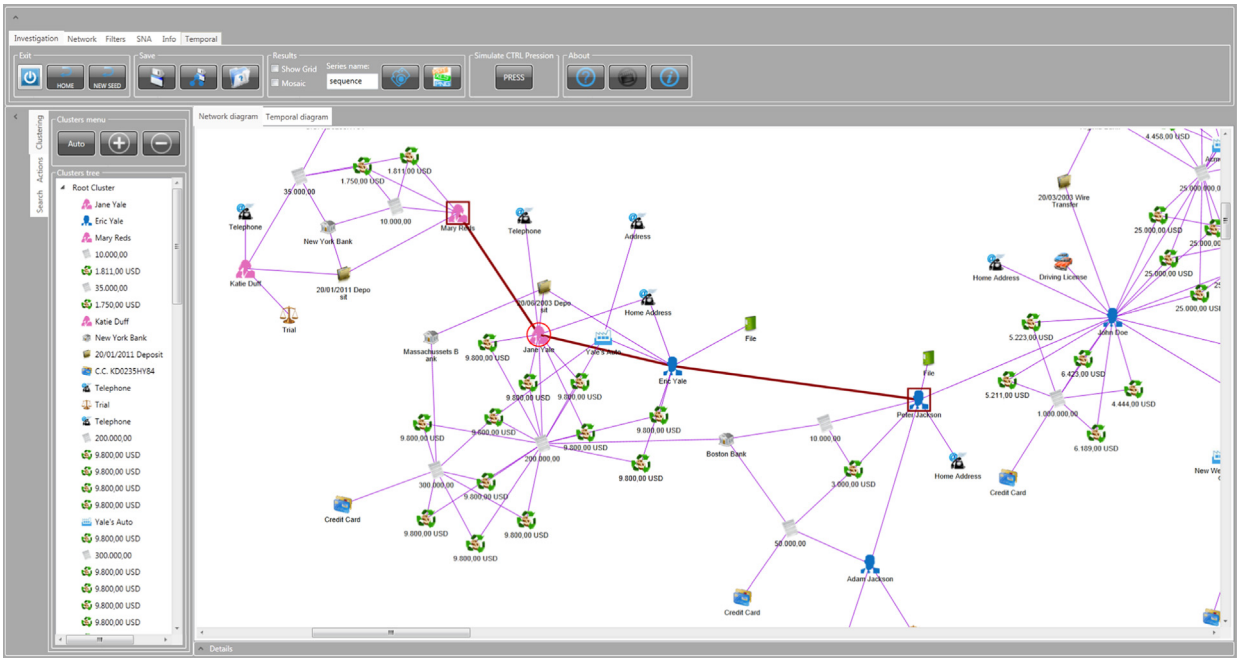

Fig. 1. Snapshot of the interface of VisFAN.

lack of these tools in the existing systems for the analysis of criminal networks.

In this paper we present a new system, called VisFAN. A snapshot of the system interface is shown in Fig. 1. A demonstrative video is also available.[2] If compared with previous software and methodologies for criminal network analysis and discovery, VisFAN presents the following main ingredients and novelties:

Multiple application scenarios: It allows either the analysis of data within the same financial institution (bank, money service businesses, insurance agency, etc.) or the analysis of suspicious transaction data collected by FIUs from different financial subjects. The system adopts different models to deal with the different types and sizes of the networked data sets managed in these two scenarios. On the other hand, unified algorithms and interaction paradigms are provided for fundamental analysis functionalities, such as clustering and automatic graph drawing.

Interaction paradigms: From the data exploration point of view, VisFAN fully combines *bottom-up* and *top-down* paradigms to visually navigate complex networks. Using the bottom-up interaction paradigm the analyst can start from a seminal node and iteratively enhance the network with new elements by adding neighbors of the displayed nodes. With the top-down interaction paradigm the analyst can use hierarchical clustering to recursively aggregate elements on the network currently displayed. Each cluster can be collapsed or expanded independently at any time, so that the analyst can simplify the network at her convenience. These two kinds of interaction paradigms can be arbitrarily alternated while maintaining consistency. A collapsed cluster is represented by a small blue square, whose label can indicate different types of related information.

Network clustering: The system makes it possible to mix automatic and manual clustering. It automatically computes a hierarchical clustering by exploiting *k-cores*, which have been proven to be effective for discovering relevant groups in social networks (see, e.g., [2,6,7,22,31,37]). In particular, we propose a general clustering approach and then specialize it to the different kinds of financial activity networks. The analyst can manually edit the current clustering structure at any time by creating new clusters or by modifying the existing ones.

Geometric constraints: VisFAN allows the analyst to modify the drawings in several ways. She can easily customize the dimensions of each cluster region; the readability of the drawing inside a cluster region and the number of attributes shown for this drawing are proportional to the dimensions of the region. This kind of interaction can be regarded as a new focus+context

[2] http://youtu.be/OApQMIIryeA.