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Network structure and resilience of Mafia syndicates

Santa Agreste[a], Salvatore Catanese[a,b], Pasquale De Meo[c], Emilio Ferrara[d,*], Giacomo Fiumara[a]

[a] Department of Mathematics and Informatics, University of Messina, Italy
[b] Department of Mathematics and Informatics, University of Catania, Italy
[c] Department of Ancient and Modern Civilizations, University of Messina, Italy
[d] Information Sciences Institute, University of Southern California, Marina del Rey, CA, USA

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ABSTRACT

In this paper we present the results of our study of Sicilian Mafia organizations using *social network analysis*. The study investigates the network structure of a Mafia syndicate, describing its evolution and highlighting its plasticity to membership-targeting interventions and its resilience to disruption caused by police operations. We analyze two different datasets dealing with Mafia gangs that were built by examining different digital trails and judicial documents that span a period of ten years. The first dataset includes the phone contacts among suspected individuals, and the second captures the relationships among individuals actively involved in various criminal offenses. Our report illustrates the limits of traditional investigative methods like wiretapping. Criminals high up in the organization hierarchy do not occupy the most central positions in the criminal network, and oftentimes do not appear in the reconstructed criminal network at all. However, we also suggest possible strategies of intervention. We show that, although criminal networks (i.e., the network encoding mobsters and crime relationships) are extremely resilient to different kinds of attacks, contact networks (i.e., the network reporting suspects and reciprocated phone calls) are much more vulnerable, and their analysis can yield extremely valuable insights.

1. Introduction

The Sicilian Mafia (also known as *Cosa Nostra*) is a criminal organization which originated in Sicily, and, after decades of immigration waves, has now spread worldwide [26,28,35].

Police investigations revealed that the Mafia is a loose confederation of smaller syndicates (called "cosche," "clans," or "families") such that each syndicate takes control of a specific territory (usually a town or a part of it) by organizing and overseeing illegal activities. Members of a Mafia syndicate can be both mobsters and associates (i.e., people like drug-dealers, hitmen, or even corrupted politicians who are not part of the syndicate but act as collaborators or bystanders of its illicit activities). Mafia syndicates show a strong hierarchical organization [28]: on top of the organization there is a "boss," who is aided by an "underboss" and by various "lieutenants" who head branches of the Mafia syndicate. The boss also commands a crew of "soldiers" (often known as *picciotti*) who commit acts of violence that include intimidation, threats and murders.

* Corresponding author. Tel.: +1(310)448-8661.
E-mail address: ferrara@gmail.com, emilio.ferrara@gmail.com, ferrarae@isi.edu (E. Ferrara).

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Due to its normative structure, as well as strong ties with finance, entrepreneurs and politicians, the Mafia has risen to prominence as a worldwide criminal organization controlling illegal activities, including the trade of drugs, money laundering, and military weapon trafficking [10].

Understanding the structure of Mafia syndicates, unveiling the functional role of each of the members, and quantifying the ability of a syndicate to react to the detention of its members, are all crucial steps to effectively fight and dismantle these syndicates. In recent years, various researchers [20,27,28] illustrated the benefits of using *social network analysis* [32] to study the structure of criminal organizations.

The adoption of methods from social network analysis in the study of criminal organizations has strong theoretical and practical motivations. Studies from sociological literature (known as *social facilitation models* [28]) point out that the membership of an individual in a crime gang enormously amplifies her/his tendency to criminal behavior [36]. Destroying the network structure associated with a criminal organization is central to preventing individuals from committing crimes and also results in lower delinquency rates.

The first step in analyzing Mafia syndicates by means of social network analysis tools is to collect a sufficiently large data sample describing the various units composing the syndicate and their operations. Interactions among mobsters materialize under various forms. For instance, two mobsters can be tied if they committed the same crime together or if they have been seen together in the same setting. A powerful and well-known investigative method is *wiretapping*, i.e., the procedure of recording information flow among suspected criminals which has been sent using any type of electronic media, like phone calls (from both land lines and mobiles), emails, SMS messages and private communications over social media platforms. Wiretapping has proven effective for preventing and solving many crimes, such as terrorism, drug trafficking, kidnapping and political corruption.

Wiretapping has been extensively employed in Mafia-related investigations, but, if used alone, it may fail to reliably capture the structure of a Mafia syndicate. Newspapers, for instance, report that Mafia bosses often reveal their whereabouts to just few gang members and, in many cases, they issue orders and communications through handwritten notes known as *pizzini*.[1]

A promising investigation strategy requires supplementing information collected by wiretapping with data generated by other methods of investigation – like video surveillance, use of informants and under-cover agents, interviews of subjects, analysis of bank transactions, and so on. By gluing together these pieces of information, investigators can capture a more detailed picture of the structure of a Mafia syndicate. Unfortunately, the type of information cited above is the outcome of a long, expensive and often dangerous investigation process which likely spans years, or, in certain cases, even decades.

After examining several types of judicial documents spanning a ten-year period (including judicial documents, verdicts, depositions, interrogations, etc.) we built two datasets of information about Mafia gangs operating in the north of Sicily (Italy).

Law enforcement collected data about phone calls among suspected individuals; this dataset allowed us to build a network called *contact network* N_{con} in which each individual was associated with a vertex, and an edge between two vertices denoted the existence of at least one reciprocated phone call between the two individuals. The network N_{con} contains 1716 vertices and 8481 edges.

Further investigation allowed us to identify *crime relationships*. We say that a crime relationship exists between two individuals if they took part in the same criminal offense or if they have been seen together in the same setting. Criminal relationships were then mapped on a second network called *criminal network* N_{cri}. The network N_{cri} contained only 104 vertices and 2596 edges; all but *six* individuals in the criminal network were also present in the contact network. This means that the original dataset contained almost all mobsters, but there were mobsters who were part of the Mafia syndicate but never used mobile or land lines to communicate.

The availability of these datasets occurred under a collaboration framework with law enforcement. This offered us the unprecedented opportunity to understand the actual structure of a Mafia syndicate, and to quantify how syndicates are able to react to police operations leading to the detention of some of their members. In the first stage of our research, we studied the structural properties of N_{cri} and N_{con}. Our primary goal was to understand whether meaningful differences arise between the structural features of the two networks.

Subsequently, we investigated and compared the robustness of N_{con} and N_{cri}. We simulated a police operation leading to the arrest of a fraction f of individuals from the two networks, and we studied how these perturbations impacted the structure of both N_{con} and N_{cri}. Individuals were selected either randomly or on the basis of their centrality in the network. To this end, we used three different centrality metrics, namely *degree centrality*(*DC*), *betweenness centrality* (*BC*), and *closeness centrality* (*CC*). We considered two types of operations, namely: *(i) parallel attack*, i.e., we assumed that a fraction f of individuals were *simultaneously* deleted from the network along with their connections, and *(ii) sequential attack*. i.e., we were supposed to iteratively neutralize individuals along with their connections from the network until a fraction f of individuals had been neutralized. To measure the effectiveness of each operation, we computed two parameters – the size of the strongly connected component (`SCC`) of each network and the average path length (`APL`), defined as the mean of shortest path lengths in the network.

The main findings of our analysis can be summarized as follows:

[1] See http://news.bbc.co.uk/2/hi/europe/4899512.stm.