Chapter 3
Spotted:
Connecting People, Locations, and Real-World Events in a Cellular Network

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ABSTRACT

Being able to react fast to exceptional events such as riots protests or disaster preventions is of paramount importance, especially when trying to ensure peoples' safety and security, or even save lives. This chapter presents a study on the use of fully anonymized and highly aggregated cellular network data, like Call Detail Records (CDRs) in order to connect people, locations and events. The goal of the study is to see if the CDR data can be used to detect exceptional spatio-temporal patterns of the collective human mobile data usage and correlate these 'anomalies' with real-world events (e.g., parades, public concerts, soccer match, traffic congestion, riots protests etc.). These observations could be further used to develop an intelligent system that detects exceptional events in real-time from CDRs data monitoring. Such system could be used in intelligent transportation management, urban planning, emergency situations, network resource allocation and performance optimization, etc.

INTRODUCTION

In the ever-evolving telecommunication industry, smart mobile computing devices have become increasingly affordable and powerful, leading to a significant growth in the number of advanced mobile users and their bandwidth demands. This, together with the improved next generation telecommunications infrastructure, motivates the continuing uptake of the mobility around the world. People can now connect to the Internet from anywhere at any time, while on the move (e.g. on foot, in the car, on the bus,

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stuck in traffic etc.) or stationary (e.g., at home/office/airport/coffee bars, etc.). The number of mobile users increases continuously as the penetration of both fixed and mobile broadband solutions becomes more affordable for the masses and more accessible around the globe. The connection to the Internet is possible and can be done via wireline or wireless solutions. Depending on the user location, wireless connectivity is enabled by different Radio Access Technologies (RATs) such as: Global System for Mobile Communications (GSM), Enhanced Data Rates for GSM Evolution (EDGE), Universal Mobile Telecommunications System (UMTS), High Speed Packet Access (HSPA), Long Term Evolution (LTE), Worldwide Interoperability for Microwave Access (WiMAX), Wireless Local Area Networks (WLAN), Wireless Personal Area Network (WPAN), etc. The use of all these RATs is rapidly spreading, covering various geographical locations in an overlapping manner.

Additionally, this increasing expansion of the telecommunication infrastructure could bring economic, social and technological benefits especially to the far reaching regions. For example, it can bring education to the remote regions; it can contribute to enabling innovations in healthcare (e.g., remote monitoring and diagnostics), smart grid solutions, social networking sites, economy, etc.

One of the key characteristics of these mobile networks and the mobile computing devices is that every time they are used a digital signature is recorded. Voluntarily or not, whenever people interact with the telecommunications networks or any type of social media platform, they leave behind digital traces. All these traces have become a powerful tool to analyze human behavior patterns. For example, the data collected by the cellular telecommunications systems referred to as Call Details Records (CDRs) is done in regular basis for billing and troubleshooting purposes. Moreover these CDRs contain the information details about every call carried within the cellular network, including information about the location, call duration, call time, and both parties involved in the conversation. Thus, there is an increase interest on making use of the information provided by the CDRs in order to analyze human mobility cheaply, frequently and especially at a very large scale. To this end, three main reasons could be identified in using the CDR data, such as: their usage incur insignificant additional costs as they are already being collected by the network operators to help manage their networks; they can be used for large-scale analysis as they are collected for all the active cellular phones within a network reaching billions of users worldwide; and they can be used for timely analysis as they are collected continuously for each incoming or outgoing calls and text message. Even though the importance of the CDRs is obvious, they have two important limitations that need to be mentioned as well: (1) they are sparse in time, as they are collected only when the mobile device is initiating or receiving calls or exchanges text messages; and (2) they are coarse in space as they record only the location of the communication tower the mobile device is connected to.

In general, understanding the human mobility patterns could have broad applicability on a wide range of areas, such as: network resource optimization, mobile computing, transportation systems, urban environment planning, events management, epidemiology, etc.

This chapter will explore the use of anonymized CDRs containing both voice-calls and SMS activities, from a cellular network in Ivory Coast in order to connect people, locations and events. The goal of this study is to identify the exceptional spatio-temporal patterns of the collective human activity from fully anonymized and highly aggregate cellular network data, like CDRs, and correlate these 'anomalies' with real-world events (e.g., parades, public concerts, soccer match, traffic congestion, etc.). These observations could be further used to develop an intelligent system that detects exceptional events in real-time from CDRs monitoring. The benefits of such systems could be threefold: