Chapter 40
Telemetry Data Mining Techniques, Applications, and Challenges

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ABSTRACT

The most recent rise of telemetry is around the use of Radio-telemetry technology for tracking the traces of moving objects. Initially, the radio telemetry was first used in the 1960s for studying the behavior and ecology of wild animals. Nowadays, there's a wide spectrum application of can benefits from radio telemetry technology with tracking methods, such as path discovery, location prediction, movement behavior analysis, and so on. Accordingly, rapid advance of telemetry tracking system boosts the generation of large-scale trajectory data of tracking traces of moving objects. In this study, we survey various applications of trajectory data mining and review an extensive collection of existing trajectory data mining techniques to be used as a guideline for designing future trajectory data mining solutions.

INTRODUCTION

Telemetry is the automatic measurement and wireless transmission of data from remote sources and then transmitting it to a central or host location (Mcdermott, 2006). There, it can be monitored and used to control a process at the remote site. Telemetry is the process by which an object's characteristics are measured, and the results transmitted to a distant station where they are displayed, and processed according to user specifications (Al-Serafi, 2015). Today, telemetry applications include measuring and

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transmitting data from sensors located in automobiles, smart meters, power sources, robots and even wildlife in what is commonly called the Internet of Things (IoT).

Thanks to the wide adoption of GPS and other telemetry tracking system, massive amounts of trajectory data of tracking traces of moving objects have been collected. Moving object data could be related to human, objects (e.g., airplanes, vehicles, spacecraft and ships), animals, and/or natural forces (e.g., hurricanes and tornadoes). Since trajectories are sequences of real-valued locations with errors and missing values, mining of this trajectory is not a straightforward task. Hence, research of trajectory mining has attracted a great deal of attention for recent years (Xiaoliang, 2012). In this survey we present brief review of the trajectory data mining techniques, applications and some research challenges and future works are reported. The rest of the paper is structured as follows: in the following section, Trajectory data model is defined then applications of trajectory data mining are discussed in the second section. In the third section, the important techniques of trajectory data mining tasks are presented. Finally, conclusion is presented.

TRAJECTORY DATA MODEL

A spatial trajectory is a trace generated by a moving object in geographical spaces, which is consisting of an ordered set of spatiotemporal points (Frentzos, 2007). This can be defined for any trajectory "T" which can be seen as an ordered set of spatiotemporal points consisting of 3 dimensions: location in terms of x-coordinate "x", y-coordinate "y" and temporal dimension in terms of time "t" This is formally defined as, and can be seen in Figure 1, (Al-Serafi, 2015)

$$T = \left\{\left(x_1, y_1, t_1\right), \left(x_2, y_2, t_2\right), \ldots, \left(x_n, y_n, t_n\right)\right\} \tag{1}$$

APPLICATION OF TRAJECTORY DATA MINING

There exists a wide spectrum of applications driven and improved by trajectory data mining, such as; knowing moving objects locations in advance can be substantial. Discovery of behavioral patterns and prediction of future movement can greatly influence different fields, such as analysis of the wild animals' movement in order to predict their migrations, monitoring and analysis of vehicle movement in order to predict traffic congestions, mobile user movement and access point availability prediction in order to assure the requested level of quality of service or analysis and location prediction of the movement of

Figure 1. Trajectory consisting of "n" points