Chapter VI

Early Works in Spatio-Temporal Mining

Spatio-temporal data mining is an emerging area with increasing importance in a variety of applications, such as homeland security, mobile services, surveillance systems, and health monitoring applications. However, mining in spatio-temporal databases is still in its infancy. Existing work on spatio-temporal data mining has mainly focused on three types of patterns: evolution patterns of natural phenomena, frequent movements of objects over time, and space-time clusters. While there has been much research on association rule mining on transactional, spatial, and temporal data, there is little literature on finding interesting associations in spatio-temporal data. In this chapter, we introduce the early attempts at spatio-temporal data mining and review the techniques to discover various interesting spatio-temporal patterns. This is followed by a review of the traditional association rules mining algorithms and their variants on transactional data, temporal data, and spatial data.
Spatio-Temporal Patterns

Evolution Patterns

A system called CONQUEST (Mesrobian, Muntz, & Shek, 1995; Stolorz, Nakamura, & Mesrobian, 1995) has been developed to find the evolution patterns of natural phenomena. This system allows some means of accessing and interpreting spatio-temporal data. It provides an environment that enables geophysical scientists to easily formulate queries of spatio-temporal patterns on massive data, such as cyclones, hurricanes, and fronts.

Following that, many researchers (Steinbach, Tan & Kumar, 2001; Tan, Steinbach, & Kumar, 2001) have attempted to mine interesting spatio-temporal patterns in earth science data. They apply existing data mining techniques to find clusters, predictive models, and trends, and they state that existing data mining algorithms cannot discover all the interesting patterns in spatio-temporal data (Tan, Steinbach, & Kumar, 2001).

Recently, Tsoukatos and Gunopulos (2001) presented an algorithm to discover frequent sequences in a depth-first manner over all locations in spatio-temporal databases. This is essentially a sequence mining algorithm whereby each location is treated as a transaction. The algorithm is able to find the common temporal relationships of events in some locations, but not the relationships of events among these locations.

The work in Basak, Sudarshan, and Trivedi (2004) studies mining patterns from spatial-temporal weather data. It views weather variables as spatio-temporal signals. Under this mapping, a widely-used technique in signal and image processing called independent component analysis (ICA) is applied to mine patterns in weather data. The mining result is validated by matching the independent component activities with the domain knowledge (North Atlantic Oscillation Index; see Bell & Visneck).

Mei, Liu, and Su (2006) study the problem of mining spatio-temporal theme patterns from Web logs. They put forward a novel probabilistic approach to model the sub-topic themes and spatio-temporal theme patterns simultaneously. The proposed model could extract common themes from Web logs; generate theme life cycles for each given location; and compute theme snapshots for each given time period. Spatio-temporal patterns are then discovered from theme life cycles and theme snapshots.
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