ABSTRACT

In this thesis, an intelligent temporal database management system which is capable of performing temporal reasoning and temporal mining in order to provide effective security in temporal databases has been designed and implemented. This system uses interval stamping of tuples for valid time and instant stamping of tuples for transaction time and provides a query language called Extended Temporal Mining Structured Query Language (ETMSQL) that has been developed by integrating and extending the query languages Extended Temporal Structured Query Language (ETSQL) and Temporal Query Mining Language (TQML). The main advantage of this query language is that it follows both temporal relational algebra and temporal logic and hence it is capable of performing security checks through rules, agents and classification techniques.

There are many contributions that are provided in this research work. First, an architectural framework has been proposed and implemented that enables effective temporal reasoning and provides enhanced security mechanisms. Second, a rule system which consists four types of rules namely active IF..THEN rules, passive IF..THEN rules, active cascading rules and passive cascading rules has been proposed and implemented. The salient features of rule system are the ability to handle incomplete temporal data, deductive temporal reasoning, flexible addition and deletion of rules, specification and triggering of rules on multiple tables.
The third contribution of this work is the proposal and development of a temporal reasoning subsystem which is used for performing effective temporal reasoning tasks such as prediction, analysis of the past, planning and learning with the coordination of rule system. Prediction is carried out using statistical time series techniques and production rules. The analysis is performed on the historical data using explanation based reasoning by applying rules. Planning is derived from historical data, current data and forecasting on different values. The rule manager in coordination with the temporal database manager takes care of learning new rules during each phase of the non-monotonic temporal reasoning.

Finally, the temporal security subsystem which is a component of the proposed architecture provides a secure way to access the data present in the temporal database and also helps to detect intruders in the entire system. This subsystem consists of two sub components namely Access Control Module and Intrusion Detection Module. The Access Control Module provides security using temporal roles and agents. In order to provide security through temporal roles, this system uses temporal constraints and suitable agents for performing the role based access control. The Intrusion Detection Module uses effective classification techniques in order to achieve higher degree of accuracy in intrusion detection and provides only low false alarm rates.

Comparing with the existing temporal database management system having the query languages ETSQL and TQML, the proposed system provides a novel architecture with an extended query language called
Extended Temporal Mining Structured Query Language (ETMSQL) that provides additional constructs not only for temporal reasoning but also for security features. Moreover, the Access Control and Intrusion Detection Modules proposed in this work are capable of performing better than the existing security systems in terms of accuracy of authorization and detection rate.