Paper

A framework for event based modeling and analysis

Janusz Granat

Abstract— In this paper we will present a framework for modeling and management of complex systems. There are various approaches for modeling of these systems. One of the approaches is events driven modeling and management of complex system. Such approach is needed in information systems that provide information in real-time. Most of the existing modeling approaches use only information about type of event and the time when an event occurs. However, in the databases we can store and then we can use much richer information about events. This information might be structured as well as unstructured. There are new challenges in algorithms development in case of description of event by various attributes.

Keywords— event mining, temporal data mining, telecommunications.

1. Introduction

Recently, the focus is on real-time decision support [1] what requires a new class of the data processing, the analytical algorithms as well as modeling approaches. The actions have to be taken immediately after the event occurred. The delay may cause the fault of the system or significant loses. It should be stressed that we can distinguish a broad spectrum of various types of events. It will often require dedicated algorithms and approaches. However, the framework will help in generalization of the specified methods and algorithms. Moreover, this framework may help in integration of achievements in event based modeling in different scientific disciplines. At this time there are separate developments in temporal data mining, stochastic systems, event based control, etc. The combination of these approaches might significantly improve the results of new algorithms.

2. The modeling framework

Figure 1 shows the basic components of the event driven modeling framework: the system that is influenced by external as well as internal events, data and textual information about the system as well as about the events, models, algorithms, event detection algorithms, knowledge representation, description of decision maker behavior and actions.

In order to build models or algorithms we have to store the data about the system and the events. The existence and the proper quality of data are crucial to any further steps. We can distinguish primary data that are stored in relational databases and data that are prepared for specific modeling tasks. The data can be stored in one central database or can be stored in distributed databases. Moreover, the designers apply event based system design approach which leads to well structured databases that contain information about events. There is also increased importance of using textual information about events. Recently, the video sequences are becoming important source of data for event discovery.

The models use mathematical formulas to describe behavior of the system. In case of the presented framework the models describe dependencies between events and observable variables. Various models can be considered like stochastic models, temporal relationships, temporal sequence associations, etc. The algorithms on Fig. 1 are understood as algorithms that work with analytical models as well as algorithms for event mining or event processing. A key to understanding events is knowledge of what might have caused them and having that knowledge at the time the events happen. Event mining is one of key approaches. Event mining can be defined as a process of finding: the frequent events, the rare events, unknown event (it occurrence can be deduced from observation of the system), the correlation between events, the consequences of event and what caused the event. There is a special class of algorithms for event detection. We distinguish two classes of algorithms. Events detection based on numerical and categorical data analysis and event detection by analysis the textual information. The results of algorithms, data and textual information and results of algorithms go to the block called knowledge representation. In this block there is unifying representation of the results. However, the results are very simple form of the knowledge. Here, there is a place for introducing contextual knowledge and more advanced algorithms that support knowledge creation and management. There will be also represented the knowledge about the consequences of events. The ability to track event causality and consequences is an essential step toward online decision support and important challenge for new algorithms for event mining. The models and algorithms as well as data provides the decision maker important knowledge about the system. Then decision maker can specify various actions that will be applied in the system and reduce the influence of events on the system. The information about actions should be stored in computerized form. That will help later the evaluation of consequences of the chosen actions. In some cases the results of the algorithms can be directly applied to the system (for example the event based control algorithms).

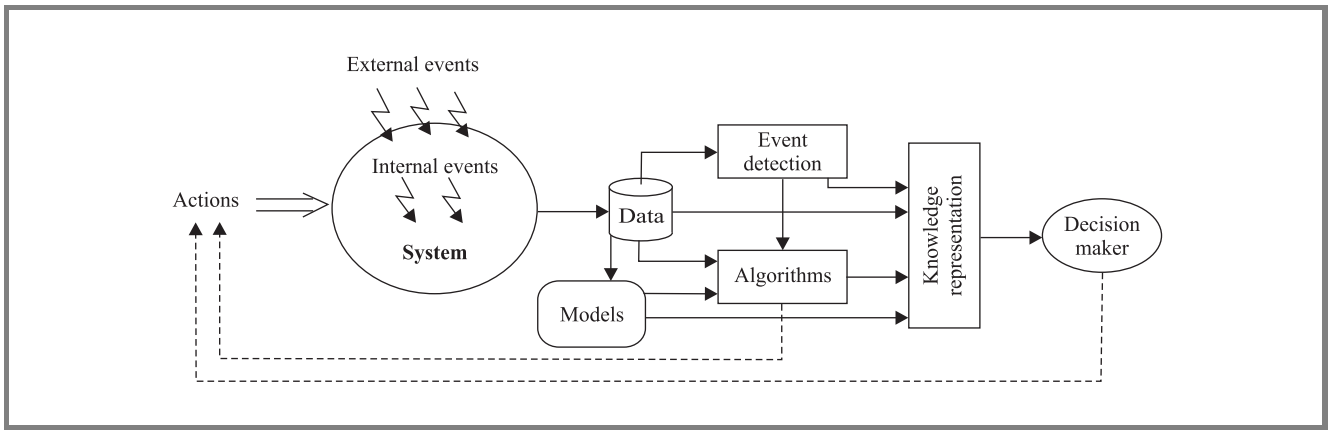

Fig. 1. Basic components of the modeling framework.

3. The applications

The presented approach has various applications in business monitoring, network management, intrusion detection, fault detection, etc. In this section we will present selected examples of event driven modeling: events monitoring, event processing networks, events in environmental scanning, event based control, temporal sequence associations for rare events, event mining and events in alerting systems. There is research on events monitoring in given environment. The sensor networks are applied for events monitoring. Sensor networks are systems of many sensing elements endowed with computation, communication and motion that can work together to provide information about events in an environment. In this case we have information about the type of event, the time and location of events. The control algorithms are used for positioning mobile sensors in response to a series of events. Many monitoring problems can be also stated as the problem of detecting a change in the parameters of a system called event detection. Another important concept are event processing networks (EPN) such networks consist of event processing agents called event sources, event processors and event viewers. EPN have been applied for computer network monitoring. The events sources were middleware sniffers. The aggregated information about events has been displayed by viewers and additionally has been used for event mining. This concept has been also applied for solving business problems. The organizations are working on improvement of the analysis of the external environment and influence of this environment on the performance of the organization. Environmental scanning is a new term and it means the acquisition and use of the information about events, trends, and relationships in an external environment. In this case the methods of dealing with unstructured information about events are especially important. In event based control the sampling is event-triggered instead time-triggered. The event-based PID controller can be build. Such approach reduces CPU utilization. The event-triggered PID controller is nonlinear system of hybrid nature. In many cases we have to monitor and analyze rare events like credit card frauds, network faults, etc. However, if we store the data about the system in the database it is very difficult to identify rare events. In this case the events are characterized by type of event and the time of occurrence of the event. Temporal sequence associations for rare events can be applied to solve this problem. Sometimes, it is impossible to observe the events directly. In such cases the data are stored in databases in form of time series. This data represents observations of the system in selected points. The observations are analyzed by the system and alarms are generated in case of abrupt changes in the values of observations. In the next step another algorithms finds the events that caused changes in the system.

The following algorithms can be considered: for significant change of observation find events that are the reasons of this change, prediction of future events by analyzing the changes of observations, prediction of changes of observations after the event occurs.

4. Conclusion

Presented modeling framework might help in developing future event driven approach for management and modeling of complex. This type of environment might help in real-time decision support. There is a new and challenging area for algorithms development.

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