Abstract

Role-Based Access Control (RBAC) is one of the most popular models of access control. In RBAC, roles are assigned to users through which the access privileges are granted to them. *Role mining* is considered to be one of the essential steps in the successful deployment of RBAC. It is the process of creating a set of roles from the existing user-permission assignments. Though RBAC has gained widespread popularity over the past two decades, its applicability becomes limited in scenarios where additional constraints need to be associated with the availability of roles. Hence, several extensions of RBAC have been proposed. Temporal Role-Based Access Control (TRBAC) is one such extension. TRBAC allows roles to be enabled for certain time intervals and for the remaining time, they are disabled. A set of roles having such temporal constraints is, therefore, necessary for deploying TRBAC. Although a number of role mining approaches for RBAC implementation are present in the existing literature, not much attention has been given to creation of roles in the context of TRBAC. This dissertation focuses on designing role mining methods for TRBAC adoption.

Generation of roles having enabling durations requires input user-permission assignments containing temporal information. We call such assignments as *temporal user-permission assignments* and the process of creating roles from them as *temporal role mining*. We have named the problem of mining a minimal set of roles from the temporal user-permission assignments as the *Temporal Role Mining Problem* (TRMP). This problem has been proved to be NP-complete. For solving TRMP, two approaches have been proposed, which make use of traditional non-temporal role mining algorithms. Each method uses a time element consideration procedure in conjunction with non-temporal role mining.

Next, we present a matrix decomposition based formulation of TRMP. For this, we propose a new multiplication operator, named as *Boolean-Set Multiplication* which multiplies a set by a boolean variable. A strategy for solving TRMP based on many-valued concepts has also been proposed. Role minimization does not fully help to reduce the overall effort required to manage a TRBAC system. Therefore, we introduce a new metric for temporal role mining, named as the *Cumulative Overhead of Temporal Roles And Permissions* (CO-TRAP). This metric incorporates the temporal as well as permission overhead of the roles of TRBAC. The problem variant that minimizes CO-TRAP has been termed as *CO-TRAP Minimization Problem* (CO-TRAPMP). Moreover, we have proposed an algorithm using many-valued concepts for solving CO-TRAPMP.

Finally, we generalize the definition of TRMP by allowing a user-specified amount of mismatch between the input temporal user-permission assignments and

the ones determined from the output. This TRMP variant has been named as the *Generalized Temporal Role Mining Problem* (GTRMP). We have proved GTRMP to be NP-complete. An algorithm for solving GTRMP has also been proposed. This approach first creates a set of candidate roles and then greedily selects a minimum cardinality subset of the candidate role set. For role selection, we have proposed four greedy heuristics.

Performance of the proposed temporal role mining methods has been evaluated using benchmark data sets both in terms of the value of the minimization criterion under consideration and the overall execution time.

Keywords: *TRBAC, Temporal user-permission assignments, NP-complete, Matrix decomposition, Many-valued concepts, Generalized formulation*