# Chapter 66
# An Approach of Role Updating in Context-Aware Role Mining

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## ABSTRACT

*With the rapid development of Internet of Things (IoT) and mobile technologies, the service offerings available in the IoT and mobile environments are increasing dramatically. How to provide intelligent and personalized services for users becomes a challenging issue. Several context aware service recommendation approaches have been reported to leverage roles to represent common knowledge within user communities, based on which services can be recommended for users. Prior studies on context aware role mining mainly focus on mining roles from a fixed data set of user behavior patterns, while most of them neglect the dynamic change of the input data. The frequent change of the user data will result in the change of extracted roles, and how to efficiently update extracted roles according to change of the input user data remains a challenging issue. In this paper, towards this issue, the authors introduce a novel role updating approach in context aware role mining. In the apporach, several algorithms are presented towards various scenarios such as new users and new contexts are removed from and added into the input data. Experiments show that compared with existing solutions, the proposed algorithms can guarantee the completeness of updating results while keeping good updating efficiency.*

## INTRODUCTION

Recent years have witnessed a rapid development in Internet of Things (IoT) and mobile technologies. IoT refers to the internetworking of physical devices, vehicles, buildings and other items embedded with electronics, software, sensors, actuators, and network connectivity that enable these objects to collect and exchange data (ITU, 2016). With the objective of allowing people and things to be connected any-time, anyplace, with anything and anyone, ideally using any path/network and any service (Sundmaeker, 2010), IoT will have a tremendous impact on the way people work and live. With the prevalence of IoT, an increasing number of real-world things will be connected to the IoT environment by exposing their features and capabilities as services, which will lead to a proliferation in services (Huang, 2016; Zhang, 2012). Similarly, as an essential enabling technology of IoT, the popularity of mobile technologies also stimulates the bloom of available services in the app stores such as Apple AppStore and Google Play.

Context-aware communication and computing is a key technology that enables intelligent interactions what the IoT paradigm envisions (Perera, 2014). Services provided by the pervasive and mobile environments of IoT are context-aware in essence. The increasing capability of collecting context information of users, e.g., location, time, and even users' current status, offers plenty of opportunities for service providers to provide personalized services for their customers, e.g., to make these devices more intelligent and adaptive to user behaviors by automatically recommending suitable services (Adomavicius, 2011; Woerndl, 2009; Tian, 2015). This is especially important due to the increasing number of services available in the IoT and mobile environments.

Service recommendation has been a hot topic in recent years. Most existing service recommendation approaches are based on individual intelligence or the local knowledge (e.g., similar neighbors) of users (Su, 2009), while neglect the common knowledge among the user community. In (Wang, 2012), the notion of "roles" is adopted to represent user groups, which represent the abstract characterization of user behaviors within a certain context. Users can play different roles in their daily life, and their roles change dynamically as the context changes. Users who play the same role are likely to share the same preferences and behavior patterns. Once a user's role in a given context is identified, the services closely related to the role can be recommended to the user. The services recommended by those who play the same roles as the user are usually more reliable or acceptable than those recommended by those who seldom play the same roles. However, users' roles are usually not explicitly specified; therefore, how to extract users' roles from users' behavior patterns becomes a key issue.

Many works have been conducted to find effective ways of context aware role mining (Wang, 2012; Wong, 2012; Wong, 2014; Hong, 2015). Given a three-dimension matrix <user, context, behavior>, these approaches can be used to generate a user-role assignment matrix as well as a role-behavior assignment matrix. In this way, the latent roles in the dataset can be identified. In these approaches, the input data set is usually fixed. However, in the pervasive IoT environment, the new coming user behavior patterns and the behaviors of existing users under various contexts might change frequently, which will result in the update of mined roles. Most existing works on role mining neglect the dynamic change of the input data set and how to update the extracted roles when user behavior patterns change have not been sufficiently discussed. Towards this issue, in this paper, the authors propose a novel approach to update roles by adapting the existing results of role mining rather than re-mining the whole dataset when the user behavior patterns change. More specifically, several algorithms are proposed towards various scenarios such as new users and new contexts are removed from and added into the input data. Experiments on a simulated data set show that compared with the algorithm that takes all the updated

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