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PhD Dissertation Announcement

A NONPARAMETRIC BAYESIAN FRAMEWORK FOR MOBILE DEVICE SECURITY AND LOCATION BASED SERVICES

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In June 2013, it was reported that, for the first time, more than half of American adults have smartphones. Smartphones are carried with the users most of the time and used to access all types of personal sensitive information, from email, Facebook to banking, files server, etc. With the excessive usage of the smartphones, there emerges two major problems, namely, how to protect the devices from cyber-attacks, and how to improve mobile users' experiences based on their locations.

To address the first problem, in this thesis, we propose a security framework to detect two kinds of attack, the Masquerade attack and the Sybil attack. Most existing literature employs supervised learning and assumes the number of devices is known. We, on the other hand, propose a non-parametric Bayesian method to detect the number of devices as well as determine which observations belong to which devices in an unsupervised passive manner. An attack can be detected by comparing the number of registered users with the number of devices found, and the malicious nodes are found based on the labels of their observations.

For the second problem, we propose a location based service (LBS) framework, to improve users' experience. LBS are applications in which, locations of users are utilized to activate a set of services which significantly improve users' experiences. Examples include a micro-climate control application, which can automatically adjust room temperature given the appearance of users. Or a network scheduling users' access application, where users' future whereabouts can be predicted and used for arranging files transfer to better enhance users' experiences.

In this thesis, we mainly focus our research on the above two fields. The nonparametric Bayesian framework was used as the generative model for both the observations extracted from the wireless signal in the wireless security problem, as well the observations extracted from the features that represent a location in the LBS. Beside the framework, the major contributions of the thesis include a missing data handling algorithm, a light-weight indoor place identification algorithm, a stopping rule to terminate the algorithm in a quickest way while maintaining a reasonable false alarm rate, and an unsupervised approach in defending against Masquerade and Sybil attacks in wireless network. Moreover, several mechanisms to predict users' future whereabouts such as a Dynamic Hidden Markov Model that can involve itself over time, or a prediction model based on Deep Learning were proposed. Most of the algorithms are examined with experimental data and achieves considerably high performances compared with other state-of-the-art approaches.

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