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QUANTIFY MUTUALLY DEPENDENT PRIVACY RISKS WITH LOCALITY DATA

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Abstract - *Co-location information about users is more and more available online. For example mobile users more and more normally details their co-locations with other users in the message and in the pictures they post on social networking websites by tagging the names of the friends they are with. The users' IP addresses also compose a source of co-location information. Combine with location information, such co-locations can be used to develop the suggestion of the users' locations, thus more intimidating their location privacy: As co-location information is taken into account, not only a user's report locations and mobility pattern can be used to limit her, but also those of her friends. In this paper, we study this problem by quantify the effect of co-location information on location privacy consider a challenger such as a social network operator that has access to such information. We formalize the problem and receive optimal suggestion algorithms that incorporate such co-location information, yet at the cost of high complexity. We propose some estimated suggestion algorithms, including a solution that relies on the idea broadcast algorithm executed on a general Bayesian network model, and we extensively evaluate their presentation. Our new results show that, even in the case where the supporter considers co-locations of the targeted user with a single friend, the median location privacy of the user is decrease by up to 62 percent in a typical setting. We also study the effect of the different parameters in different scenario.*

Keywords - Location Based Service (LBS), Location Privacy Protecting Mechanism (LPPM) Co-location, Social Networks, Bayesian network algorithm.

1. INTRODUCTION

Social networks, and in particular location-based social networks, have become very popular. Every day, millions of users post information, include their locations, about themselves, but also about their friends. A rising development which is the focus of this paper is to report co-locations with other users on social networks, the tagging friends on pictures they upload or in the messages they post. For example our initial survey involving 132 foursquare users, recruit through Amazon Mechanical Turk, reveals that 55.3% of the participant report co-locations in their check-ins and that for the users who do so, on average, 2.8 of their check-ins contain co-location information. In fact, co-location information can be obtained in many different ways, such as automatic face identification on pictures (which contains the time and location at which the picture was taken in their EXIF data. Face book's Photo Magic Bluetooth-enabled device sniff and coverage next devices. Also, users who connect from the same IP address are likely to be friendly to the same Internet access point, thus providing proof of their co-location. Attack exploits both location and co-location information can be quite powerful, as we show in this paper. Depicts and describe two instance in which co-location can develop the performance of a localization attack, thus debasing the location privacy of the users involved. It is clear that the proper use of such information by an attacker can be complex because he has to consider jointly the co-location information collected about a potentially large number of users. This is due to the fact that, in the incidence of co-location information, a user's location is connected with that of her friends, which is in turn connected to that of their own friends and so on.

2. SYSTEM MODEL AND FORMALIZATION

We think a set of mobile users who move in a given physical area. While on the go, users make use of some online services to which they communicate potentially obfuscated location and co-location information. Note that such information could be communicated by coincidence by the users (e.g., leaked from the IP addresses) without their even knowing it. We consider that a curious service provider wants to infer the location of the users from this information, so track them over time. In order to carry out the thought attack, based on which the location privacy of the users is evaluate the supporter would model the users as describe below. Our model is built upon and uses similar notations.

3. OPTIMAL LOCALIZATION ATTACK

With co-location information and under the assumption describe in the before section, the localization problem translate to solving an HMM deduction problem, for which

the forward-backward algorithm is a known solution. Basically, the forward-backward algorithm defines forward and backward variables that take into account the clarification by and after time in that order. The forward variable is the joint chance of location of user at time and all the explanation up to, and including, time. The backward variable is the qualified chance of all notes after time given the actual location of user at that time on the spot. Then, the posterior chance distribution of the possible locations for the targeted user is obtain by combining the forward and backward variables. With co-location information, the locations of the users are not commonly free: as soon as two users are co-located at some point in time their locations, before and after time become reliant.

4. APPROXIMATE LOCALIZATION ATTACK

We propose two low-complexity alternatives for the stage approximate localization attacks. Basically, the first charily selects a small set of users to consider when attacking an object user and perform an optimal joint localization attack on this small set of users consider only the co-locations between these users. The idea behind this heuristic is that the locations of a user are much connected with those of only a limited number of users a few co-workers during work hours, and her family and close friends the relax of the time. The second alternative makes use of all presented location and co-location information but only performs an approximate localization attacks.

5 .DIFFERENTIAL-PRIVACY PERSPECTIVES

We complement our inferential approach to privacy quantification, existing in the before sections, with a short analysis of the effect of co-locations on users' location privacy from a gap-privacy perspective. In the geo-in make out ability framework each study has a privacy cost that depends on the level of noise added by the device used (typically haggard from a planar Laplace distribution). For example, in order to promise differential privacy, one must begin noise with amplitude such that the expected distance between the actual location and the reported location is proportional. Consider the case of a single time on the spot. If two co-located users each report one obfuscated version of their actual locations, the adversary has access to two notes of the same variable, common location. Following the compos ability property of differential privacy, this means that, to guarantee differential privacy for the users' location, each person reported obfuscated location should please differential privacy data.

6. EXPERIMENTAL EVALUATIONS

Using a dataset of mobility traces, we assess the result of co-locations on users' privacy, with value to the various localization attacks existing in the before section.

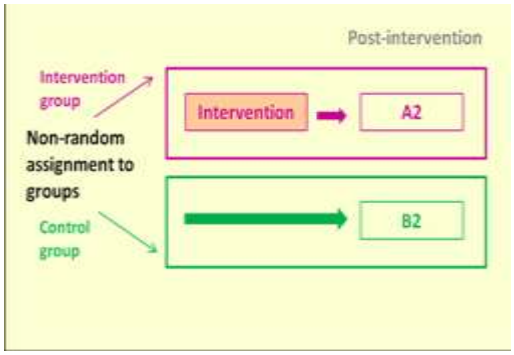

Fig.6.1 Experimental Evaluations

7. CONCLUSION

We have study the effect on users' location privacy when co-location information is presented, in addition to personality location information. To the best of our knowledge, this is the first paper to calculate the effects of co-location information that stems from social relations between users on location privacy; as such it constitute a first step towards bridge the gap between study on location privacy and social networks. In fact, most study on geo-location and social networks look at how social tie can be conditional from co-locations between those and how social ties can be used to de-a minimize mobility traces. We have shown that, by consider the users' locations jointly, a challenger can exploit co-location information to better localize users, hence lessening their person privacy.

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