Targeted social network advertising: An intuitive study to determine user centrality in dynamic contact network

Dr. Payal Gohel, Research Scholar,

Department of Computer Science, Saurashtra University, Rajkot-361001, Gujarat, India

email: Payalgohel.ce@gmail.com

Abstract - Rapid pace advancement in mobile technologies and huge penetration of smartphone devices have changed dynamics for the way we approach research and collect data. The use of social media defines an era where billions of users exposes themselves to online social settings and built their network. Social network has the capacity to impact our lives and has opened up new opportunities and possibilities that were not feasible earlier. This research targets the emergent area of group purchasing, social marketing and target advertising. Social marketing will enhance the market understanding by learning what people want rather than trying to persuade them to buy what they happen to be offering. This aim of this research is to investigate how the social marketing paradigm works, involve students in the research experiments to educate and train them regarding latest technologies involved, and identifying the approach to do it the right way. The proposed research presents a conceptual framework to design and develop the smart solutions to capture group purchase behavior. It will implement android app dubbed as SONET (Social contact network) to conduct research experiments and interacts with targeted users to ascertain target advertising. This app focuses on i) user's privacy, ii) periodical data capturing and iii) user's localization. In addition, questionnaire was be used in research experiments to gather qualitative and quantitative data including i) SONET app captures consistent data over time for 4 weeks and helps to build the dynamic datasets of physical contact network ii) Conducted online Survey to gather quantitative data using Social Network Services. Based on the collected qualitative and quantitative data, analysis will measure and identify the degree of point, control independence and user centrality.

Keywords: Social Network, Group behaviour, Target advertising, Mobile computing, Social marketing, Social network service.

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1. INTRODUCTION

This research targets the emerging area of group purchasing, social awareness and target advertising. It focuses on social marketing[1] which is the next big paradigm that is affecting and will affect our everyday lives. With the boom of social media and social network engine, users were expose to knowingly or unknowingly attack. Targeted social marketing will increase the market understanding by learning what people want and need rather than trying to persuade them to buy what they happen to be offering. Other researchers have cited new marketing models with the rise of social networking such as Tuangou refers to the phenomenon that a group of web users are organised using the internet and physically approach the retailers together to negotiate for a discount for a particular product or service by using their collective bargaining power [3]. Another social network service[2] (SNS) "Kakao-talk", a smartphone application in South Korea which recommends friends to the user by

[1] Social marketing is an integrated approach where consumer will receive offers, product promotions based on their social interaction with other people.

[2] SNS (social network service) is a web-based individual centered service, platform, or site that focuses on building

their contact information in their social network [4], even the UK government has issued guidelines for involvement[5]. It is pertinent to investigate the SNS structure characteristics and how these characteristics can affect the consumers' network involvement which may lead to increase purchase intention to the recommended deals by trusted source. In this case, friends would receive deals through SNS. So, Integration of SNS with marketing can increase the consumers' purchase intention and have positive effects to the online sellers.

This aim of this research is to investigate how the social marketing paradigm works, involve BU students in the research experiments to educate and train them regarding latest technologies involved, and identifying the approach to do it right. This research also gives high priority and investigates how to do all this while maintaining some user privacy. This is a very cutting edge and relevant research which will employ smartphone application to conduct research experiments and interacts with the targeted participants. The android app will be distributed to collect qualitative data and send offers to participants during experiments.

In order to achieve the research aim, important research objectives have been defined as following:

i) To develop smartphone application in order to build contact network datasets and investigates social marketing approach to infer social network structure, users centrality etc.
ii) To design research experiments to collect data from participants using developed mobile application and also use popular social networking application (whatsapp).
iii) To gather quantitative data through questionnaires with research participants, in order to analyse their using patterns and concern with social networking sites and enhance their understanding about social marketing.

In nutshell, the proposed research will produce social contact network[3] data sets (others in existence the Cambridge, infoComm, MIT and nokia [2]) via experiment which will contributes towards the originality of the research.

2. RELATED WORKS

Scellato et al. [9] investigated the different aspects of contact networks that grow over time. However, it is based on creating static graphs by combining all relationships seen in an interval of time. It could introduce connections which are not organized. A tensor is multi-dimensional matrix (for example a set of adjacency matrices) which are essentially reduced using PCA to a core tensor. Sun et al. [10] for example, use tensor analysis to examine time bound contact networks. They identify core multi-dimensional matrices which allow changes in the network to be able to track in time. Lin et. al. 11] examine context driven networks such as Flikr and Digg with the focus being on community detection. The spanning tree analysis carried out here is similar to that in Riolo et al. [12]. Joint diagonalization has been used in many applications where the evolution of a system can be tracked smoothly via its eigenspace. For example, Macagnano et al. [13] present an algorithm for localization of multiple objects given partial location information. As time evolves the location of the objects changes smoothly which may be seen through the evolution of the eigenvectors of a distance matrix. Other examples include blind beam forming [14] and blind source separation [14]. By applying joint diagonalization to social networks we are not tracking position but rather centrality (as centrality is related to the entries of the largest eigenvectors) [1].

3. DESIGN AND DEVELOPMENT OF – SONET

The important objective for this research is to mimic a real-world scenario and experiment using smartphone application to develop participant's data-sets while maintaining their privacy. This research developed **SO** Contact-**NET**work (SONET), an ANDROID based application to experiment the proposed approach. This section gives overview of the SONET app and explains three important aspects of it including i) user's privacy, ii) periodical data capturing and iii) Bluetooth localization and use of GCM (Google cloud messaging) to issue voucher etc;

2.1 USER'S PRIVACY

The author believes user's privacy is of highest importance and social media should focusses on keep it anonymous, safe and secure as per user's preferences. In today's era where nothing is private, user's digital security needs to be respected despite exposure to many unknown elements. In this research, the android app used RSA algorithm to encrypts the user's information. For example: in this app, users were kept anonymous throughout the process and their privacy were maintained. Application users RSA security fingerprint

and reflecting of social networks or social relations among people.

[3] A social contact network is the graph of relationships and active interactions within a group of individuals and plays a fundamental role as a medium for the spread of information, ideas, and influence among its members [1].

to encrypt the user information. This information can only be decrypt by person with private key.

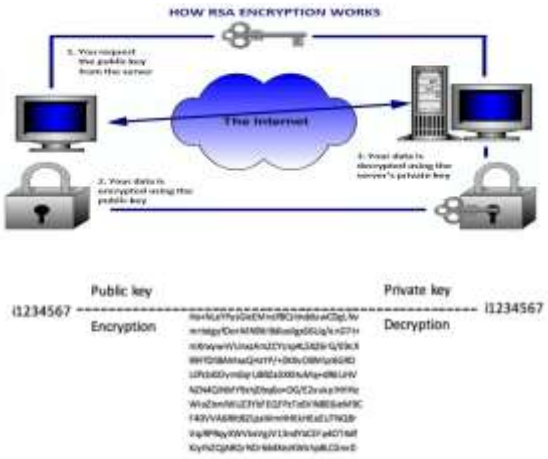

Figure 1 : RSA algorithm

Author believed with such kind of approach, there will be very less intrusion to user's privacy compare to current approach used by Google, Facebook who uses their user information without realizing that how much danger they are expose to and how their information is being manipulated on daily basis. The figure 1 explains how RSA encryption works. This research employs the asymmetric cryptographic RSA(Ron Rivest, Adi Shamir and Leonard, Adleman) algorithm to encrypt and decrypt user data. Asymmetric means that there are two different keys i) public key to encrypt the data and ii) private key to decrypt the data. In this project, all the user's information including their identity were encrypted with highly secured 128 bits encryption key.

Figure 2 : Encrypt user info;

The figure 2 demonstrates, once user enters their details, it will be encrypted in a form which will be impossible to reverse it. It uses 128 bits RSA algorithm, which is a very reliable cryptography algorithm to conduct experiment without compromising user's privacy. This encrypted code can only be decrypted by person with private key. It means, only the user's device can decrypt their information while loading from the server.

2.2 PERIODIC DATA COLLECTION PROCESS

This research study focuses on collecting and developing datasets by keeping traces of all access WIFI points passed by the participants and other network related information. Data is stored on a secure server. The metadata gives some insight on subset of information which will be stored in data server.

a) User and device ID - To create a unique id using random number generator and Bluetooth device id which is unique to each device.
b) Network ID connected to WiFi Network.,
c) Application scans all the available WiFi networks in near-by area.
d) WiFi access point.
e) Same WiFi network can have many router access points with unique id.
f) Other connection Info,
g) Connection time and user's centrality.

In brief, the data capturing process presents few pertinent points including i) assign a unique id to users in order to keep them anonymous ii) start/stop the data recording service from app UI iii) scan the available network points (on some occasions user may see many network with same name but different access points) and iv) Application should be able to send regular periodic updates to secure data server.

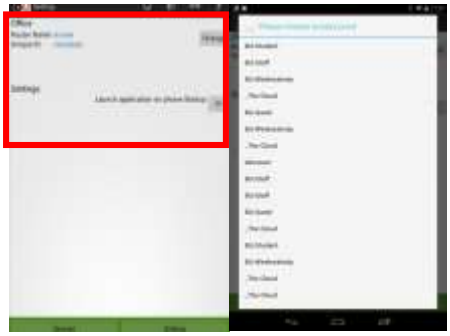

Figure 3: Scanning and collecting WiFI points details

The figure 3 demonstrates the flow of the data collection functionality which will scan all the Wi-Fi points and its network related information every 10 minutes throughout the day till the end of an experiment. Each day, it logs all the traces of Wi-Fi access points and compresses the file and sends back to SOAP data server. In order to collect reliable and continuous data, users have to keep on the service. The

developed app created the mechanism to balance the load but still battery would drain at higher speed than normal level.

The collected data will be quantified and analysed to infer the social network structure and understand its dynamic nature of the user's influence on the network.

Figure 4 : Periodic data collection service

2.3 USER LOCALISATION

The proposed research focussed on group purchase behaviour to create socially targeted advertising. Hence, the developed SONET app also logs whenever more than one participant is in the same location. It does not log the location itself. It maps the user's close proximity with other users and automatically reports back to server based on Bluetooth 2.0 communication. The research requires this information to infer the social network of the group as a whole. To develop the effectiveness of the approach, user localisation module was implemented.

Figure 5 : Users localisation

In this research, authors have used two ways to infer the user localisation by mapping the Wi-Fi access points and Bluetooth communication.

1. Establish communication between two users by analysing collected data (comparing their WIFI access point id, device id and timestamp).
2. Scan Bluetooth adapters in close proximity connection to match with wanted Ids and report back to secure server.

In nutshell, the SONET app assisted to capture the consistent data over time for 4 weeks and helped to build the dynamic datasets of social contact network (as explained in above sections) without compromising user's privacy and data integrity.

3. Design an experiment using SNS

Social networks are fundamentally social tools in which people are constantly monitoring and growing their social network, most social network media depict growth.

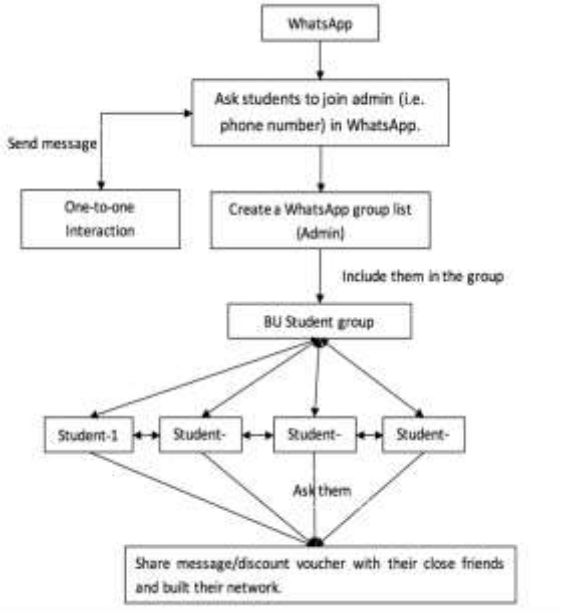

Figure 6 : design research experiment using SNS

Smartphone based SNS (WhatsApp) is proposed to infer the student social network structure based on their communication and then discounts was offered. This experiment involves sending a unique code via WhatsApp to participants offering them a discount based on their active participation for a particular period of time during the experiment. They may pass on information about this discount to a friend or colleague. Their friend may then message the WhatsApp service and request a discount for the same period. No other user intervention is required for this experiment. The more actively users participates in this experiment the more likely they will seed offers. Figure 8 shows the simple procedure to take part in this research experiment as following:

1. Join the "SONET" group by sending message to admin using WhatsApp application.

2. Then, admin will add participant into the "BU-Contact Network" group and send a unique code.
3. Participant can share this unique code with their friends. Then, participant will send this code to admin for asking an offer.
4. Admin will send an offer code to whoever asks for it.
5. Participant will go to i.e. Costa coffee and show them the code to claim their discounts.

Once data was collected, an understanding of social networks needs also to include accounts of centrality and of one user's relationship to other users in a network. [4] explored how "graph centralization" was based on differences in point centralities. The author also explained three competing theories regarding the definition of centrality based on degree of a point, control and independence.

- **Degree of a point**: It refers to the number of nodes connected to a given node. For example: The bigger social network, participants have, the more important they are.

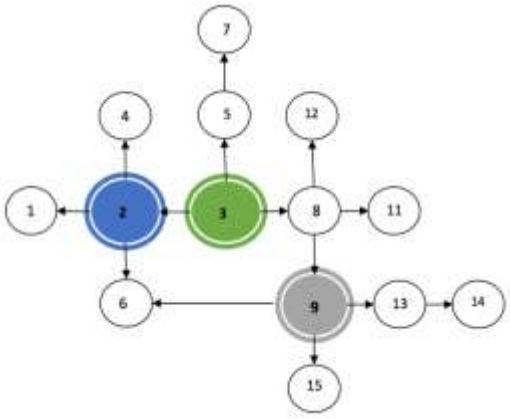

Figure 7 : User's social network based on experiments

- **Degree of Control:** It refers to the extent to which nodes depend on one specific node to communicate with other nodes. For example: if hundreds of friends are connected to each other only when i.e. UID100 serve as the bridge connecting them, then UID100 centrality is high and it means UID100 controls the communication flows.

- **Independence:** It means that a node is closely related to all the nodes considered. Hence, it is minimally dependent on any single node and is not subject to control. It means participant can reach the maximum number of people through the shortest number of links, without being dependent on a particular few nodes. Figure 6 presents user's centrality graph based on collected data where:

Author took a sample dataset of 15 students to understand the user influence on the social connections. AS per the data analysis, following results were deduced:
Degree of point: UID-2 and UID-9 have the most nodes connected to them.
Degree of Control: UID-3 serves as the bridge between the most nodes and controls the flow of information.
Independence: UID-9 is most closely connected to the other nodes by multiple nodes (UID-6 and UID-8).

4. DATA COLLECTION THROUGH SURVEY

Data was collected through survey from 15 research participants by online survey system. In order to get more appropriate data, author just focus on the people who had the SNS experience [7]. The author decided to user WhatsApp which was a very popular mobile messenger among University students. The aim of the survey is to understand the current state of social media concerns regarding user's privacy and protecting their data from unauthorised use. It asksed user what kind of data they are comfortable sharing with networks and what do they think they are sharing with popular network. The results will provide directions in research, development, training, and strategies that will form the basis to develop new direction in targeted marketing in the most efficient and intelligent way.

The survey was sent by e-mail, posted on social network and group messaging through WhatsApp to a statistical sample of 25 participant, out of which 15 responded. The sample was selected at random order to ascertain reliability about the population. The prior consent was taken, and the answers provided were kept confidential and used for statistical purposes and released in aggregate form only. Figure 6 presented the simple steps to conduct the survey [8].

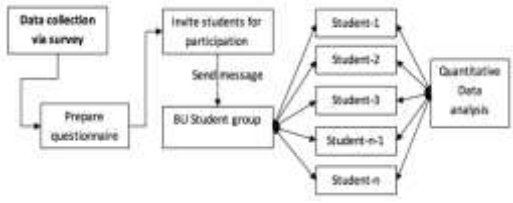

Figure 6: Data collection using survey

1. Prepare a questionnaire guide.
2. Design the questionnaire.
3. Run a pilot.
4. Revise the Questionnaire.

5. Send email to students and also announce a message to WhatsApp group for participation in the questionnaire/survey.
6. On survey completion, analyse the collected data.

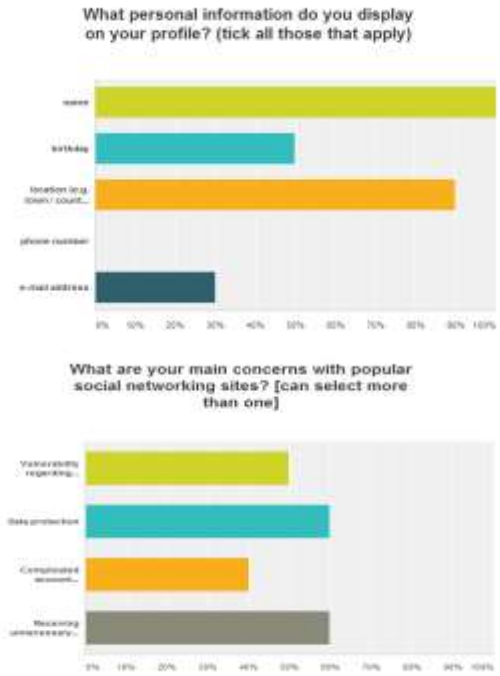

Figure 7: User's information sharing concerns on SNS i) what kind of information users display on their profile ii) user's main concerns regarding such information.

Among the respondents 75% were postgraduate and 25% were undergraduate students. Also there were 60% male and 40% female respondents who ranged in between 24-60 years age group. There are 90% respondents who were using Facebook and 100% who were using WhatsApp which were the most popular SNS and almost 70% of them had more than 100 contacts in their social network.

Figure 7 quantified the received data about user's sensitivity regarding sharing their private information. It was shares that all the participants were okay with sharing their name, 90% were okay sharing their location in their trusted social network, 50% shared their birthdays with their friends and about 30% shared their email id on social networking site. However, nobody suggested sharing their phone number on SNS as it considers being highly intrusive.

Without understanding the exposure on social network and privacy settings available on most network site, users are prone to get preyed. Sharing personal information on SNS makes users very vulnerable to cyber-attack. In another charts data presents, 60% participants felt exposed to cyber-attack and 50% of them thinks their privacy is not being protected. About 60% participants also felt that they are many advertising intrusions and 40% complained about very complicated preference settings regarding sharing information on social network. Such information assisted to identify underlying concerns for most laymen users. It also announces the need of design more secured, anonymous and less intrusive application.

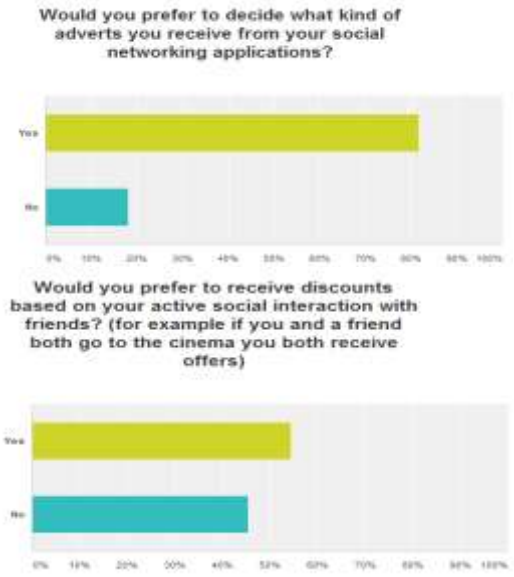

Figure 8: User's preferences regarding social marketing

Figure 8 shows almost 80% respondents preferred to decide what kind of product /offers they would like to receive. Another chart illustrates almost 55% participants preferred to receive group discount based on their active social interaction with their friends, family or work colleague (refer to figure 8).

The developed applicated will customise the user's preferences with their permission and develop an application where users have the right to receive or reject. In order to understand the social marketing concept where users would have more control regarding what kind of advert, when and how they prefer it etc.

5. CONCLUSION

Social networks are fundamentally social tools in which people are constantly monitoring and growing their social network, most social network depict growth using the degree of point definition, control and independence. Targeted Social network marketing will enhance the market understanding by learning what people want and

need rather than trying to persuade them to buy what they happen to be offering. This aim of this research is to investigate how the social marketing paradigm works, involve students in the research experiments to educate and train them regarding latest technologies involved, and identifying the approach to do it right. The proposed research successfully implemented android app dubbed as SONET to conduct research experiments and interacted with targeted. This app focuses on i) user's privacy related issues, ii) periodical data capturing and iii) user's localization. Various research methods are used in research experiments to conduct qualitative and quantitative data including i) SONET app captures consistent data over time for 4 weeks and helps to build the dynamic datasets of social contact network and ii) Conducted online Survey to gather quantitative data from SNS users. One of the critical challenges encountered during research was difficulty in finding suitable participants (user's with android OS mobile, interacting in a cluster etc) for this research. The research was conducted with limited number of participants, it collected consistent and continuous data periodically using aforementioned methods to investigate the social marketing approach and infer dynamic social contact network. However, the authors recommend collecting data from users in order to develop social network datasets and analyse it rigorously to infer dynamic contact network for future research.

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